

New use of cell-permeable peptide inhibitors of the JNK signal transduction pathway for the treatment of various diseases

The present invention refers to the use of protein kinase inhibitors and more specifically to the use of inhibitors of the protein kinase c-Jun amino terminal kinase, JNK inhibitor sequences, chimeric peptides, or of nucleic acids encoding same as well as pharmaceutical compositions containing same, for the treatment of various novel diseases or disorders strongly related to JNK signaling.

The c-Jun amino terminal kinase (JNK) is a member of the stress-activated group of mitogen-activated protein (MAP) kinases. These kinases have been implicated in the control of cell growth and differentiation, and, more generally, in the response of cells to environmental stimuli. The JNK signal transduction pathway is activated in response to environmental stress and by the engagement of several classes of cell surface receptors. These receptors can include cytokine receptors, serpentine receptors and receptor tyrosine kinases. In mammalian cells, JNK has been implicated in biological processes such as oncogenic transformation and mediating adaptive responses to environmental stress. JNK has also been associated with modulating immune responses, including maturation and differentiation of immune cells, as well as effecting programmed cell death in cells identified for destruction by the immune system. This unique property makes JNK signaling a promising target for developing pharmacological intervention. Among several neurological disorders, JNK signaling is particularly implicated in ischemic stroke and Parkinson's disease, but also in other diseases as mentioned further below. Furthermore, the mitogen-activated protein kinase (MAPK) p38alpha was shown to negatively regulate the cell proliferation by antagonizing the JNK-cJun-pathway. The mitogen-activated protein kinase (MAPK) p38alpha therefore appears to be active in suppression of normal and cancer cell proliferation and, as a further, demonstrates the involvement of JNK in cancer diseases (see e.g. Hui *et al.*, Nature Genetics, Vol 39, No. 6, June 2007). It was also shown, that c-Jun N-terminal Kinase (JNK) is involved in neuropathic pain produced by spinal nerve ligation (SNL), wherein SNL induced a slow and persistent activation of JNK, in particular JNK1, whereas p38 mitogen-activated protein

kinase activation was found in spinal microglia after SNL, which had fallen to near basal level by 21 days (Zhuang et al., The Journal of Neuroscience, March 29, 2006, 26(13):3551-3560)).

Inhibition or interruption of JNK signaling pathway, particularly the provision of inhibitors of the JNK signaling pathway, thus appears to be a promising approach in combating disorders strongly related to JNK signaling. However, there are only a few inhibitors of the JNK signaling pathway known so far.

Inhibitors of the JNK signaling pathway as already known in the prior art, particularly include e.g. upstream kinase inhibitors (for example, CEP-1347), small chemical inhibitors of JNK (SP600125 and AS601245), which directly affect kinase activity e.g. by competing with the ATP-binding site of the protein kinase, and peptide inhibitors of the interaction between JNK and its substrates (D-JNK1 and I-JIP) (see e.g. Kuan et al., Current Drug Targets – CNS & Neurological Disorders, February 2005, vol. 4, no. 1, pp. 63-67(5)).

The upstream kinase inhibitor CEP-1347 (KT7515) is a semisynthetic inhibitor of the mixed lineage kinase family. CEP-1347 (KT7515) promotes neuronal survival at dosages that inhibit activation of the c-Jun amino-terminal kinases (JNKs) in primary embryonic cultures and differentiated PC12 cells after trophic withdrawal and in mice treated with 1-methyl-4-phenyl tetrahydropyridine. Further, CEP-1347 (KT7515) can promote long term-survival of cultured chick embryonic dorsal root ganglion, sympathetic, ciliary and motor neurons (see e.g. Borasio et al., Neuroreport. 9(7): 1435-1439, May 11th 1998.).

The small chemical JNK inhibitor SP600125 was found to reduce the levels of c-Jun phosphorylation, to protect dopaminergic neurons from apoptosis, and to partly restore the level of dopamine in MPTP-induced PD in C57BL/6N mice (Wang et al., Neurosci Res. 2004 Feb; 48(2); 195-202). These results furthermore indicate that JNK pathway is the major mediator of the neurotoxic effects of MPTP *in vivo* and inhibiting JNK activity may represent a new and effective strategy to treat PD.

A further example of small chemical inhibitors is the aforementioned JNK-Inhibitor AS601245. AS601245 inhibits the JNK signalling pathway and promotes cell survival after cerebral ischemia. *In vivo*, AS601245 provided significant protection against the delayed loss of hippocampal CA1 neurons in a gerbil model of transient global ischemia. This effect is

mediated by JNK inhibition and therefore by c-Jun expression and phosphorylation (see e.g. Carboni et al., J Pharmacol Exp Ther. 2004 Jul; 310(1):25-32. Epub 2004 Feb 26th).

A third class of inhibitors of the JNK signaling pathway represent peptide inhibitors of the interaction between JNK and its substrates, as mentioned above. As a starting point for construction of such JNK inhibitor peptides a sequence alignment of naturally occurring JNK proteins may be used. Typically, these proteins comprise JNK binding domains (JBDs) and occur in various insulin binding (IB) proteins, such as IB1 or IB2. The results of such an exemplary sequence alignment is e.g. a sequence alignment between the JNK binding domains of IB1 [SEQ ID NO: 13], IB2 [SEQ ID NO: 14], c-Jun [SEQ ID NO: 15] and ATF2 [SEQ ID NO: 16] (see e.g. FIGS. 1A-1C). Such an alignment reveals a partially conserved 8 amino acid sequence (see e.g. Figure 1A). A comparison of the JBDs of IB1 and IB2 further reveals two blocks of seven and three amino acids that are highly conserved between the two sequences.

Sequences constructed on basis of such an alignment are e.g. disclosed in WO 01/27268 or in WO 2007/031280. WO 2007/031280 and WO 01/27268 disclose small cell permeable fusion peptides, comprising a so-called TAT cell permeation sequence derived from the basic trafficking sequence of the HIV-TAT protein and a minimum 20 amino acid inhibitory sequence of IB1. Both components are covalently linked to each other. Exemplary (and at present the only) inhibitors of the MAPK-JNK signaling pathway disclosed in both WO 2007/031280 and WO 01/27268, are e.g. L-JNKI1 (JNK-inhibitor peptide composed of L amino acids) or the protease resistant D-JNKI1 peptides (JNK-inhibitor peptide composed of non-native D amino acids). These JNK-inhibitor (JNKI) peptides are specific for JNK (JNK1, JNK2 and JNK3). In contrast to those small compound inhibitors as discussed above, the inhibitor sequences in WO 2007/031280 or WO 01/27268, e.g. JNKI1, rather inhibit the interaction between JNK and its substrate. By its trafficking sequence derived from TAT, the fusion peptide is efficiently transported into cells. Due to the novel properties obtained by the trafficking component the fusion peptides are actively transported into cells, where they remain effective until proteolytic degradation.

However, peptides according to WO 2007/031280 or WO 01/27268 have only shown to be active in a particularly limited number of diseases, particularly non-malignant or immunological-related cell proliferative diseases.

One object of the present invention is thus, to identify further diseases, which can be combated with JNK inhibitor peptides. Another object of the present invention is to provide (the use of) new JNK inhibitor peptides and derivatives thereof for the treatment and/or prevention of those diseases and of diseases not yet or already known to be strongly related to JNK signaling.

This object is solved by the use of a JNK inhibitor sequence, preferably as defined herein, typically comprising less than 150 amino acids in length for the preparation of a pharmaceutical composition for treating and/or preventing various inflammatory or non-inflammatory diseases strongly related to JNK signaling in a subject, wherein the diseases or disorders are selected from the following groups:

- (a) encephalomyelitis, in particular acute disseminated encephalomyelitis, spondylitis, in particular ankylosing spondylitis, antisynthetase syndrome, dermatitis, in particular atopic dermatitis or contact dermatitis, hepatitis, in particular autoimmune hepatitis, autoimmune peripheral neuropathy, pancreatitis, in particular autoimmune pancreatitis, Behçet's disease, Bickerstaff's, encephalitis, Blau syndrome, Coeliac disease, Chagas disease, polyneuropathy, in particular chronic inflammatory demyelinating polyneuropathy, osteomyelitis, in particular chronic recurrent multifocal osteomyelitis, Churg-Strauss syndrome, Cogan syndrome, giant-cell arteritis, CREST syndrome, vasculitis, in particular cutaneous small-vessel vasculitis and urticarial vasculitis, dermatitis herpetiformis, dermatomyositis, systemic scleroderma, Dressler's syndrome, drug-induced lupus erythematosus, discoid lupus erythematosus, enthesitis, eosinophilic fasciitis, eosinophilic gastroenteritis, erythema nodosum, Idiopathic pulmonary fibrosis, gastritis, Grave's disease, Guillain-barré syndrome, Hashimoto's thyroiditis, Henoch-Schonlein purpura, Hidradenitis suppurativa, Idiopathic inflammatory demyelinating diseases, myositis, in particular inclusion body myositis, cystitis, in particular interstitial cystitis, Kawasaki disease, Lichen planus, lupoid hepatitis, Majeed syndrome, Ménière's disease, microscopic polyangiitis, mixed connective tissue disease, myelitis, in particular neuromyelitis optica, thyroiditis, in particular Ord's thyroiditis, rheumatism, in particular palindromic rheumatism, Parsonage-Turner syndrome, pemphigus vulgaris, perivenous encephalomyelitis, polyarteritis nodosa, polymyalgia, in particular

polymyalgia rheumatica, polymyositis, cirrhosis, in particular primary biliary cirrhosis, cholangitis, in particular primary sclerosing cholangitis, progressive inflammatory neuropathy, Rasmussen's encephalitis, relapsing polychondritis, arthritis, in particular reactive arthritis (Reiter disease) and rheumatoid arthritis, 5 rheumatic fever, sarcoidosis, Schnitzler syndrome, serum sickness, spondyloarthropathy, Takayasu's arteritis, Tolosa-Hunt syndrome, transverse myelitis, and Wegener's granulomatosis,

(b) inflammatory and non-inflammatory diseases of the eye, in particular selected from 10 uveitis, in particular anterior, intermediate and/or posterior uveitis, sympathetic uveitis and/or panuveitis; scleritis in general, in particular anterior scleritis, brawny scleritis, posterior scleritis, and scleritis with corneal involvement; episcleritis in general, in particular episcleritis periodica fugax and nodular episcleritis; retinitis; 15 corneal surgery; conjunctivitis in general, in particular acute conjunctivitis, mucopurulent conjunctivitis, atopic conjunctivitis, toxic conjunctivitis, pseudomembraneous conjunctivitis, serous conjunctivitis, chronic conjunctivitis, giant pupillary conjunctivitis, follicular conjunctivitis vernal conjunctivitis, blepharoconjunctivitis, and/or pingueculitis; non-infectious keratitis in general, in particular corneal ulcer, superficial keratitis, macular keratitis, filamentary keratitis, 20 photokeratitis, punctate keratitis, keratoconjunctivitis, for example exposure keratoconjunctivitis, dry eye syndrom (keratoconjunctivitis sicca), neurotrophic keratoconjunctivitis, ophthalmia nodosa, phlyctenular keratoconjunctivitis, vernal keratoconjunctivitis and other keratoconjunctivitis, interstitial and deep keratitis, sclerosing keratitis, corneal neovascularization and other keratitis; iridocyclitis in 25 general, in particular acute iridocyclitis, subacute iridocyclitis and chronic iridocyclitis, primary iridocyclitis, recurrent iridocyclitis and secondary iridocyclitis, lens-induced iridocyclitis, Fuchs' heterochromic cyclitis, Vogt-Koyanagi syndrome; iritis; chorioretinal inflammation in general, in particular focal and disseminated chorioretinal inflammation, chorioretinitis, chorioiditis, retinitis, retinochoroiditis, 30 posterior cyclitis, Harada's disease, chorioretinal inflammation in infectious and parasitic diseases; post-surgery inflammation of the eye, preferably intraocular inflammation following anterior and/or posterior segment surgery, for example after cataract surgery, laser eye surgery (e.g. Laser-in-situ-Keratomileusis (LASIK)), glaucoma surgery, refractive surgery, corneal surgery, vitreo-retinal surgery, eye

muscle surgery, oculoplastic surgery, ocular oncology surgery, conjunctival surgery including pterygium, and surgery involving the lacrimal apparatus, in particular post-surgery intraocular inflammation, preferably post-surgery intraocular inflammation after complex eye surgery and/or after uncomplicated eye surgery, for example inflammation of postprocedural bleb; inflammatory diseases damaging the retina of the eye; retinal vasculitis, in particular Eales disease and retinal perivasculitis; retinopathy in general, in particular diabetic retinopathy, (arterial hypertension induced) hypertensive retinopathy, exudative retinopathy, radiation induced retinopathy, sun-induced solar retinopathy, trauma-induced retinopathy, e.g. Purtscher's retinopathy, retinopathy of prematurity (ROP) and/or hyperviscosity-related retinopathy, non-diabetic proliferative retinopathy, and/or proliferative vitreo-retinopathy; blebitis; endophthalmitis; sympathetic ophthalmia; hordeolum; chalazion; blepharitis; dermatitis and other inflammations of the eyelid; dacryoadenitis; canaliculitis, in particular acute and chronic lacrimal canaliculitis; dacryocystitis; inflammation of the orbit, in particular cellulitis of orbit, periostitis of orbit, tenonitis of orbit, granuloma of orbit and orbital myositis; purulent and parasitic endophthalmitis;

(c) Addison's disease, Agammaglobulinemia, Alopecia areata, Amyotrophic lateral sclerosis, Antiphospholipid syndrome, Atopic allergy, Autoimmune aplastic anemia, Autoimmune cardiomyopathy, Autoimmune enteropathy, Autoimmune hemolytic anemia, Autoimmune inner ear, disease, Autoimmune lymphoproliferative syndrome, Autoimmune polyendocrine syndrome, Autoimmune progesterone dermatitis, Idiopathic thrombocytopenic purpura, Autoimmune urticaria, Balo concentric sclerosis, Bullous pemphigoid, Castleman's disease, Cicatricial pemphigoid, Cold agglutinin disease, Complement component 2 deficiency associated disease, Cushing's syndrome, Dagos disease, Adiposis dolorosa, Eosinophilic pneumonia, Epidermolysis bullosa acquisita, Hemolytic disease of the newborn, Cryoglobulinemia, Evans syndrome, Fibrodysplasia ossificans progressive, Gastrointestinal pemphigoid, Goodpasture's syndrome, Hashimoto's encephalopathy, Gestational pemphigoid, Hughes-stovin syndrome, Hypogammaglobulinemia, Lambert-eaton myasthenic syndrome, Lichen sclerosus, Morphea, Pityriasis lichenoides et varioliformis acuta, Myasthenia gravis, Narcolepsy, Neuromyotonia, Opsoclonus myoclonus syndrome, Paraneoplastic cerebellar

degeneration, Paroxysmal nocturnal hemoglobinuria, Parry-romberg syndrome, Pernicious anemia, POEMS syndrome, Pyoderma gangrenosum, Pure red cell aplasia, Raynaud's phenomenon, Restless legs syndrome, Retroperitoneal fibrosis, Autoimmune polyendocrine syndrome type 2, Stiff person syndrome, Susac's syndrome, Febrile neutrophilic dermatosis, Sydenham's chorea, Thrombocytopenia, and vitiligo,

(d) arthritis, in particular juvenile idiopathic arthritis, psoriastic arthritis and rheumatoid arthritis, and arthrosis, and osteoarthritis,

(e) skin diseases and diseases of the subcutaneous tissue, in particular selected from papulosquamous disorders in general, in particular psoriasis in general, for example psoriasis vulgaris, nummular psoriasis, plaque psoriasis, generalized pustular psoriasis, impetigo herpetiformis, Von Zumbusch's disease, acrodermatitis continua, guttate psoriasis, arthropathis psoriasis, distal interphalangeal psoriatic arthropathy, psoriatic arthritis mutilans, psoriatic spondylitis, psoriatic juvenile arthropathy, psoriatic arthropathy in general, and/or flexural psoriasis, parapsoriasis in general, for example large-plaque parapsoriasis, small-plaque parapsoriasis, retiform parapsoriasis, pityriasis lichenoides and lymphomatoid papulosis; pityriasis rosea; lichen planus and other papulosquamous disorders for example pityriasis rubra pilaris, lichen nitidus, lichen striatus, lichen ruber moniliformis, and infantile popular acrodermatitis; eczema; dermatitis in general, in particular atopic dermatitis for example Besnier's prurigo, atopic or diffuse neurodermatitis, flexural eczema, infantile eczema, intrinsic eczema, allergic eczema, other atopic dermatitis, seborrheic dermatitis for example seborrhea capitis, seborrheic infantile dermatitis, other seborrheic dermatitis, diaper dermatitis for example diaper erythema, diaper rash and psoriasiform diaper rash, allergic contact dermatitis, in particular due to metals, due to adhesives, due to cosmetics, due to drugs in contact with skin, due to dyes, due to other chemical products, due to food in contact with skin, due to plants except food, due to animal dander, and/or due to other agents, irritant contact dermatitis, in particular due to detergents, due to oils and greases, due to solvents, due to cosmetics, due to drugs in contact with skin, due to other chemical products, due to food in contact with skin, due to plants except food, due to metal, and/or due to other agents, unspecified contact dermatitis, exfoliative dermatitis, dermatitis for

example general and localized skin eruption due to substances taken internally, in particular due to drugs and medicaments, due to ingested food, due to other substances, nummular dermatitis, dermatitis gangrenosa, dermatitis herpetiformis, dry skin dermatitis, factitial dermatitis, perioral dermatitis, radiation-related disorders of the skin and subcutaneous tissue, stasis dermatitis, Lichen simplex chronicus and prurigo, pruritus, dyshidrosis, cutaneous autosensitization, infective dermatitis, erythema intertrigo and/or pityriasis alba; cellulitis (bacterial infection involving the skin); lymphangitis, in particular acute or chronic lymphangitis; panniculitis in general, in particular lobular panniculitis without vasculitis, for example acute panniculitis, previously termed Weber-Christian disease and systemic nodular panniculitis, lobular panniculitis with vasculitis, septal panniculitis without vasculitis and/or septal panniculitis with vasculitis; lymphadenitis, in particular acute lymphadenitis; pilonidal cyst and sinus; pyoderma in general, in particular pyoderma gangrenosum, pyoderma vegetans, dermatitis gangrenosa, purulent dermatitis, septic dermatitis and suppurative dermatitis; erythrasma; omphalitis; pemphigus, in particular pemphigus vulgaris, pemphigus vegetans, pemphigus foliaceus, Brazilian pemphigus, pemphigus erythematosus, drug-induced pemphigus, IgA pemphigus, for example subcorneal pustular dermatosis and intraepidermal neutrophilic IgA dermatosis, and/or paraneoplastic pemphigus; acne in general, in particular acne vulgaris, acne conglobata, acne varioliformis, acne necrotica miliaris, acne tropica, infantile acne acné excoriée des jeunes filles, Picker's acne, and/or acne keloid; mouth and other skin ulcers; urticaria in general, in particular allergic urticaria, idiopathic urticarial, urticarial due to cold and heat, dermatographic urticarial, vibratory urticarial, cholinergic urticarial, and/or contact urticarial; erythema in general, in particular erythema multiforme for example nonbullous erythema multiforme, Stevens-Johnson syndrome, toxic epidermal necrolysis (Lyell), and Stevens-Johnson syndrome-toxic epidermal necrolysis overlap syndrome, erythema nodosum, toxic erythema, erythema annulare centrifugum, erythema marginatum and/or other chronic figurate erythema; sunburn and other acute skin changes due to ultraviolet radiation; skin changes due to chronic exposure to nonionizing radiation; radiodermatitis; folliculitis; perifolliculitis; pseudofolliculitis barbae; hidradenitis suppurativa; sarcoidose; vascularitis; adult linear IgA disease; rosacea, in particular perioral dermatitis, rhinophyma, and other rosacea; and/or follicular cysts of skin and

subcutaneous tissue, in particular epidermal cyst, pilar cyst, trichodermal cyst, steatocystoma multiplex, sebaceous cyst and/or other follicular cysts;

(f) tauopathies, amyloidoses and prion diseases,

(g) polypes,

(h) inflammatory diseases of the mouth or the jaw bone, in particular selected from pulpitis in general, in particular acute pulpitis, chronic pulpitis, hyperplastic pulpitis, ulcerative pulpitis, irreversible pulpitis and/or reversible pulpitis; periimplantitis; periodontitis in general, in particular chronic periodontitis, complex periodontitis, simplex periodontitis, aggressive periodontitis, and/or apical periodontitis, e.g. of pulpal origin; periodontosis, in particular juvenile periodontosis; gingivitis in general, in particular acute gingivitis, chronic gingivitis, plaque-induced gingivitis, and/or non-plaque-induced gingivitis; pericoronitis, in particular acute and chronic pericoronitis; sialadenitis (sialoadenitis); parotitis, in particular infectious parotitis and autoimmune parotitis; stomatitis in general, in particular aphthous stomatitis (e.g., minor or major), Bednar's aphthae, periadenitis mucosa necrotica recurrens, recurrent aphthous ulcer, stomatitis herpetiformis, gangrenous stomatitis, denture stomatitis, ulcerative stomatitis, vesicular stomatitis and/or gingivostomatitis; mucositis, in particular mucositis due to antineoplastic therapy, due to (other) drugs, or due to radiation, ulcerative mucositis and/or oral mucositis; cheilitis in general, in particular chapped lips, actinic cheilitis, angular cheilitis, eczematous cheilitis, infectious cheilitis, granulomatous cheilitis, drug-related cheilitis, exfoliative cheilitis, cheilitis glandularis, and/or plasma cell cheilitis; cellulitis (bacterial infection), in particular of mouth and/or lips; desquamative disorders, in particular desquamative gingivitis; and/or temporomandibular joint disorder;

(i) osteonecrosis,

(j) diseases and/or disorders relating to degeneration of macula and/or posterior pole in general, in particular age-related macular degeneration (AMD), in particular the wet or the dry form of age-related macular degeneration, exudative and/or non-exudative age-related macular degeneration, and cataract,

(k) fibrotic diseases and/or disorders particularly selected from lung, heart, liver, bone marrow, mediastinum, retroperitoneum, skin, intestine, joint, and shoulder fibrosis,

5 (l) kidney diseases and/or disorders in particular selected from glomerulonephritis in general, for example nonproliferative glomerulonephritis, in particular minimal change disease, focal segmental glomerulosclerosis, focal segmental glomerular hyalinosis and/or sclerosis, focal glomerulonephritis, membranous glomerulonephritis, and/or thin basement membrane disease, and proliferative
10 glomerulonephritis, in particular membrano-proliferative glomerulonephritis, mesangio-proliferative glomerulonephritis, endocapillary proliferative glomerulonephritis, mesangiocapillary proliferative glomerulonephritis, dense deposit disease (membranoproliferative glomerulonephritis type II), extracapillary glomerulonephritis (crescentic glomerulonephritis), rapidly progressive
15 glomerulonephritis (RPGN), in particular Type I RPGN, Type II RPGN, Type III RPGN, and Type IV RPGN, acute proliferate glomerulonephritis, post-infectious glomerulonephritis, and/or IgA nephropathy (Berger's disease); acute nephritic syndrome; rapidly progressive nephritic syndrome; recurrent and persistent hematuria; chronic nephritic syndrome; nephrotic syndrome; proteinuria with
20 specified morphological lesion; glomerulitis; glomerulopathy; glomerulosclerosis; acute kidney injury ("AKI", also called "acute renal failure" or "acute kidney failure") in general, in particular prerenal AKI, intrinsic AKI, postrenal AKI, AKI with tubular necrosis for example acute tubular necrosis, renal tubular necrosis, AKI with cortical necrosis for example acute cortical necrosis and renal cortical necrosis, AKI with
25 medullary necrosis, for example medullary (papillary) necrosis, acute medullary (papillary) necrosis and chronic medullary (papillary) necrosis, or other AKI; chronic kidney disease; nephropathies in general, in particular membranous nephropathy, diabetic nephropathy, IgA nephropathy, hereditary nephropathy, analgesic nephropathy, CFHR5 nephropathy, contrast-induced nephropathy, amyloid nephropathy, reflux nephropathy and/or Mesoamerican nephropathy; nephritis in
30 general, in particular lupus nephritis, pyelonephritis, interstitial nephritis, tubulointerstitial nephritis, chronic nephritis or acute nephritis, diffuse proliferative nephritis, and/or focal proloferative nephritis, tubulo-interstitial nephritis, infectious interstitial nephritis, pyelitis, pyelonephritits, interstitial nephritis; tubulopathy,

tubulitis, in particular RTA (RTA1 and RTA2), Fanconi syndrome, Bartter syndrome, Gitelman syndrome, Liddle's syndrome, nephrogenic diabetes insipidus, renal papillary necrosis, hydronephrosis, pyonephrosis and/or acute tubular necrosis chronic kidney disease (CKD); Goodpasture syndrome (anti-glomerular basement antibody disease); granulomatosis with polyangiitis; microscopic polyangiitis; and/or Churg–Strauss syndrome;

(m) diseases and/or disorders of the urinary system in particular selected from ureteritis; urinary tract infection (bladder infection, acute cystitis); cystitis in general, in particular interstitial cystitis, Hunner's ulcer, trigonitis and/or hemorrhagic cystitis; urethritis, in particular nongonococcal urethritis or gonococcal urethritis; urethral syndrome; and/or retroperitoneal fibrosis;

(n) transplant rejection reactions in particular selected from kidney, heart, lung, pancreas, liver, blood cell, bone marrow, cornea, accidental severed limb, in particular fingers, hand, foot, face, nose, bone, cardiac valve, blood vessel or intestine transplant rejection reaction,

(o) Corticobasal degeneration, progressive supranuclear palsy, schizophrenia, inherited Kreutzfeld Jacob, motor neurone disease, spinocerebellar ataxia/atrophie, dementia, in particular frontotemporal dementia, dementia with lewy bodies, multiple system atrophy, hereditary spastic paraparesis, Friedreich's ataxia, Charcot Marie toot,

(p) hereditary or non-hereditary metabolic diseases, in particular selected from the group of metabolic disorders of the carbohydrate metabolism, e.g., glycogen storage disease, disorders of amino acid metabolism, e.g., phenylketonuria, maple syrup urine disease, glutaric acidemia type 1, urea Cycle Disorder or urea Cycle Defects, e.g., carbamoyl phosphate synthetase I deficiency, disorders of organic acid metabolism (organic acidurias), e.g., alcaptonuria, disorders of fatty acid oxidation and mitochondrial metabolism, e.g., medium-chain acyl-coenzyme A dehydrogenase deficiency (often shortened to MCADD.), disorders of porphyrin metabolism, e.g. acute intermittent porphyria, disorders of purine or pyrimidine metabolism, e.g., Lesch-Nyhan syndrome, Disorders of steroid metabolism, e.g., lipoid congenital adrenal hyperplasia, or congenital adrenal hyperplasia, disorders of mitochondrial function,

e.g., Kearns-Sayre syndrome, disorders of peroxisomal function. e.g., Zellweger syndrome, or lysosomal storage disorders, e.g., Gaucher's disease or Niemann Pick disease,

5 (q) cancer and/or tumor diseases, in particular selected from solid tumors in general; hematologic tumors in general, in particular leukemia, for example acute lymphocytic leukemia (L1, L2, L3), acute lymphoid leukaemia (ALL), acute myelogenous leukemia (AML), chronic lymphocytic leukaemia (CLL), chronic myeloid leukaemia (CML), promyelocytic leukemia (M3), monocytic leukemia (M5), myeloblastic leukemia (M1), myeloblastic leukemia (M2), megakaryoblastic leukemia (M7) and
10 myelomonocytic leukemia (M4); myeloma, for example multiple myeloma; lymphomas, for example non-Hodgkin's lymphomas, mycosis fungoides, Burkitt's lymphoma, and Hodgkin's syndrome; pancreatic cancer, in particular pancreatic carcinoma; ovarian cancer, in particular ovarian carcinoma; liver cancer and liver carcinoma in general, in particular liver metastases, liver cell carcinoma, hepatocellular carcinoma, hepatoma, intrahepatic bile duct carcinoma, cholangiocarcinoma, hepatoblastoma, angiosarcoma (of liver), and other specified or
15 unspecified sarcomas and carcinomas of the liver; skin cancer; melanoma, in particular malignant melanoma; squamous cell carcinoma; glioblastoma; colon cancer and colon carcinoma in general, in particular cecum carcinoma, appendix carcinoma, ascending colon carcinoma, hepatic flexure carcinoma, transverse colon carcinoma, splenic flexure carcinoma, descending colon carcinoma, sigmoid colon carcinoma, carcinoma of overlapping sites of colon and/or malignant carcinoid tumors of the colon; prostate cancer and prostate tumours, in particular prostate
20 carcinoma;

(r) further cancer and/or tumor diseases, in particular selected from acoustic neuroma lung carcinomas; adenocarcinomas; anal carcinoma; bronchial carcinoma; cervix carcinoma; cervical cancer; astrocytoma; basalioma; cancer with Bcr-Abl
30 transformation; bladder cancer; blastomas; bone cancer; brain metastases; brain tumours; breast cancer; carcinoids; cervical cancer; corpus carcinoma; craniopharyngeomas; CUP syndrome; virus-induced tumours; EBV-induced B cell lymphoma; endometrium carcinoma; erythroleukemia (M6); esophagus cancer; gallbladder cancer; gastrointestinal cancer; gastrointestinal stromal tumors;

- gastrointestinal tumours; genitourinary cancer; glaucoma; gliomas; head/neck tumours; hepatitis B-induced tumours; hepatocell or hepatocellular carcinomas; hepatocarcinomas; hepatomas; herpes virus-induced tumours; HTLV-1-induced lymphomas; HTLV-2-induced lymphomas; insulinomas; intestinal cancer; Kaposi's sarcoma; kidney cancer; kidney carcinomas; laryngeal cancer; leukemia; lid tumour; lung cancer; lymphoid cancer; mammary carcinomas; mantle cell lymphoma; neurinoma; medulloblastoma; meningioma; mesothelioma; non-small cell carcinoma; non-small cell carcinoma of the lung; oesophageal cancer; oesophageal carcinoma; oligodendroglioma; papilloma virus-induced carcinomas; penis cancer; pituitary tumour; plasmocytoma; rectal tumours; rectum carcinoma; renal-cell carcinoma; retinoblastoma; sarcomas; Schneeberger's disease; small cell lung carcinomas; small intestine cancer; small intestine tumours; soft tissue tumours; spinalioma; squamous cell carcinoma; stomach cancer; testicular cancer; throat cancer; thymoma; thyroid cancer; thyroid carcinoma; tongue cancer; undifferentiated AML (MO); urethral cancer; uterine cancer; vaginal cancer; Von Hippel Lindau disease; vulval cancer; Wilms' Tumor; Xeroderma pigmentosum;
- (s) neural, neuronal and/or neurodegenerative diseases, respectively, in particular selected from Alexander disease; tauopathies, in particular Alzheimer's disease in general, for example Alzheimer's disease with early onset, Alzheimer's disease with late onset, Alzheimer's dementia senile and presenile forms; Mild Cognitive Impairment, in particular Mild Cognitive Impairment due to Alzheimer's Disease; amyotrophic lateral sclerosis (ALS), apoplexy, Ataxia Telangiectasia, cut or otherwise disrupted axons, axotomy, brain lesions, CMT (Charcot-Marie-Tooth), corticobasal degeneration, dementia, diseases or disorders of the nervous system, dystonia, epilepsy, Farber's disease, Friedreich ataxia (SCA), gangliosidoses, Guillain-Barré syndrome, hereditary spastic paraplegia, Hirschsprung's disease, human immunodeficiency virus dementia, Huntington's disease, infarct of the brain, ischemic stroke, Krabbe disease, Lennox Gastaut Syndrome, lissencephaly, multiple sclerosis, myelodysplastic syndromes, myelopathy, AIDS-related neurodegenerative diseases, neurofibromatosis type 2 (NF-2), neurolyticism, neuronal apoptosis, neuronal death, neuropathic pain, neuropathy, chemotherapy induced neuropathy, diabetes induced neuropathy, NMDA-induced neurotoxicity, pain, Parkinson's disease, parkinsonism, Pick's Disease, polyneuropathy, progressive supranuclear

palsy, Sandhoff disease, spina bifida, stroke, Tay Sachs, TBI (diffuse axonal injury), treatment of dark neurone induced for example by an inflammatory pain, West Syndrome, spinal muscular atrophy,

- 5 (t) diseases resulting from bacterial or viral infection, in particular selected from inflammatory reactions caused by said infections, for example viral encephalitis, viral induced cancers (e.g. as mentioned above), human immunodeficiency virus dementia, meningitis, meningoencephalitis, encephalomyelitis, tonsillitis, varicella zoster virus infections,
- 10 (u) diseases of the respiratory system and in particular lung diseases, in particular selected from acute respiratory distress syndrome (ARDS); asthma; chronic illnesses involving the respiratory system; chronic obstructive pulmonary disease (COPD); cystic fibrosis; inflammatory lung diseases; pneumonia; pulmonary fibrosis, and
- 15 (v) metabolic disorders in particular selected from diabetes mellitus in general, in particular type 1 diabetes mellitus, type 2 diabetes mellitus, diabetes mellitus due to underlying condition, for example due to congenital rubella, Cushing's syndrome, cystic fibrosis, malignant neoplasm, malnutrition, or pancreatitis and other diseases
- 20 of the pancreas, drug or chemical induced diabetes mellitus, and/or other diabetes mellitus, Fabry disease, Gaucher disease, hypothermia, hyperthermia hypoxia, lipid histiocytosis, lipidoses, metachromatic leukodystrophy, mucopolysaccharidosis, Niemann Pick disease, obesity, and Wolman's disease.
- 25 According to one preferred embodiment, the disorder/disease to be prevented and/or treated is a disease and/or disorder relating to the degeneration of the macula, in particular selected from age-related macular degeneration (AMD), in particular the wet or the dry form of age-related macular degeneration, exudative and/or non-exudative age-related macular degeneration, and cataract.
- 30 The "dry" form of advanced AMD, results from atrophy of the retinal pigment epithelial layer below the retina, which causes vision loss through loss of photoreceptors (rods and cones) in the central part of the eye. Neovascular, the "wet" form of advanced AMD, causes vision loss due to abnormal blood vessel growth (choroidal neovascularization) in the choriocapillaris,
- 35 through Bruch's membrane, ultimately leading to blood and protein leakage below the

macula. Bleeding, leaking, and scarring from these blood vessels eventually cause irreversible damage to the photoreceptors and rapid vision loss, if left untreated. The inventive molecules are suitable for treating both forms of AMD.

- 5 According to another preferred embodiment, the disorder/disease to be prevented and/or treated is retinopathy, in particular selected from diabetic retinopathy, (arterial hypertension induced) hypertensive retinopathy, exudative retinopathy, radiation induced retinopathy, sun-induced solar retinopathy, trauma-induced retinopathy, e.g. Purtscher's retinopathy, retinopathy of prematurity (ROP) and/or hyperviscosity-related retinopathy, non-diabetic
10 proliferative retinopathy, and/or proliferative vitreo-retinopathy, whereby diabetic retinopathy and retinopathy of prematurity (ROP) are preferred and diabetic retinopathy is particularly preferred.

- Retinopathy of prematurity (ROP), previously known as retrolental fibroplasia (RLF), is a
15 disease of the eye affecting prematurely-born babies generally having received intensive neonatal care. It is thought to be caused by disorganized growth of retinal blood vessels which may result in scarring and retinal detachment. ROP can be mild and may resolve spontaneously, but it may lead to blindness in serious cases. As such, all preterm babies are at risk for ROP, and very low birth weight is an additional risk factor. Both oxygen toxicity
20 and relative hypoxia can contribute to the development of ROP. The inventive molecules are suitable for treating ROP.

- Furthermore, the inventive molecules are particularly suitable to treat all forms of retinopathy, in particular diabetes mellitus induced retinopathy, arterial hypertension induced
25 hypertensive retinopathy, radiation induced retinopathy (due to exposure to ionizing radiation), sun-induced solar retinopathy (exposure to sunlight), trauma-induced retinopathy (e.g. Purtscher's retinopathy) and hyperviscosity-related retinopathy as seen in disorders which cause paraproteinemia).

- 30 According to another preferred embodiment, the disorder/disease to be prevented and/or treated is post-surgery or post-trauma inflammation of the eye, in particular post-surgery intraocular inflammation, preferably intraocular inflammation following anterior and/or posterior segment surgery. While the inner of the eye is usually not very prone to infection and (e.g. subsequent) inflammation due to its self-contained and isolated structure,

inflammation is increasingly likely after surgical treatment of eye tissue and/or after other (e.g. mechanical) injuries (trauma). Despite technical advances in ocular surgery, the physical trauma of this procedure continues to induce post-operative (i.e. post-surgery) ocular inflammation warranting treatment. In ocular tissue, arachidonic acid is metabolized by cyclooxygenase (COX) to prostaglandins (PG) which are the most important lipid-derived mediators of inflammation. Surgical trauma causes a trigger of the arachidonic acid cascade which in turn generates PGs by activation of COX-1 and COX-2. Phospholipids in the cell membrane are the substrate for phospholipase A to generate arachidonic acid from which a family of chemically distinct PGs and leukotriens are produced. The conventional 'golden standard' for the treatment of ocular inflammation are topical corticosteroids and/or Non-Steroidal Anti-inflammatory Drugs (NSAIDs). Side effects reported with (short-term) corticosteroid use include cataract formation, increased Intra Ocular Pressure (IOP), increased susceptibility to viral infections and retardation of the corneal epithelial and stromal wound healing. In addition, prolonged treatment with corticosteroids is known to induce systemic side effects such as glucose impairment, hypertension, development of glaucoma, visual acuity defects, loss of visual field, and posterior subcapsular cataract formation. Therefore, the compounds for use in the present invention may in particular be used for the treatment of intraocular inflammation after eye surgery or trauma and in particular of inflamed wounds and wound edges.

Thereby, the ocular surgery may preferably concern the anterior and/or the posterior segment (of the eyeball). In general, the "anterior segment" refers to the front third of the eye. It includes structures in front of the vitreous humour, e.g. the cornea, iris, ciliary body, and lens, whereby within the anterior segment there are two fluid-filled spaces: (i) the anterior chamber between the posterior surface of the cornea (i.e. the corneal endothelium) and the iris, and (ii) the posterior chamber between the iris and the front face of the vitreous. The "posterior segment" in general refers to the back two thirds of the eye. It includes the anterior hyaloid membrane and all of the structures, in particular optical structures, behind it: the vitreous humor, retina, choroid, and optic nerve.

Examples of ocular surgery regarding post-surgery intraocular inflammation include (i) anterior and posterior combined surgery, which may include surgery for: cataract and retinal detachment, cataract and epimacular membrane and/or cataract and macular hole; (ii) glaucoma surgery; (iii) posterior segment surgery, in particular complex posterior segment

surgery; (iv) complicated intraocular surgery which may include cataract surgery associated with diabetic retinopathy and/or complicated retinal detachment ocular surgery. Moreover, the JNK inhibitors of the present invention can be used to treat and/or prevent post-surgery intraocular inflammation, whereby the ocular surgery is for example performed due to an indication selected from the following group including cataract, epimacular membrane, epiretinal membrane, foveoschisis, intravitreal haemorrhage, macular hole, neovascular glaucoma, relief of intraocular, subluxation of lens, in particular of intraocular lens, and vitreomacular traction. Further examples of eye surgeries include cataract surgery, laser eye surgery (e.g. Laser-in-situ-Keratomileusis (LASIK)), glaucoma surgery, refractive surgery, corneal surgery, vitreo-retinal surgery, eye muscle surgery, oculoplastic surgery, ocular oncology surgery, conjunctival surgery including pterygium, and/or surgery involving the lacrimal apparatus. Preferably the disorder/disease to be prevented and/or treated by the JNK inhibitor according to the present invention is intraocular inflammation following anterior and/or posterior segment surgery, preferably post-surgery intraocular inflammation after complex eye surgery and/or after uncomplicated eye surgery, e.g. inflammation of postprocedural bleb, or post-traumatic intraocular inflammation (preferably by subconjunctival injection).

According to another preferred embodiment, the disorder/disease to be prevented and/or treated is uveitis, in particular anterior, intermediate and/or posterior uveitis, sympathetic uveitis and/or panuveitis, preferably anterior and/or posterior uveitis.

According to another preferred embodiment, the disorder/disease to be prevented and/or treated is Dry Eye Syndrome. Dry eye syndrome (DES), also called keratitis sicca, xerophthalmia, keratoconjunctivitis sicca (KCS) or cornea sicca, is an eye disease caused by eye dryness, which, in turn, is caused by either decreased tear production or increased tear film evaporation. Typical symptoms of dry eye syndrome are dryness, burning and a sandy-gritty eye irritation. Dry eye syndrome is often associated with ocular surface inflammation. If dry eye syndrome is left untreated or becomes severe, it can produce complications that can cause eye damage, resulting in impaired vision or even in the loss of vision. Untreated dry eye syndrome can in particular lead to pathological cases in the eye epithelium, squamous metaplasia, loss of goblet cells, thickening of the corneal surface, corneal erosion, punctate keratopathy, epithelial defects, corneal ulceration, corneal neovascularization, corneal scarring, corneal thinning, and even corneal perforation. The JNK inhibitors

according to the present invention may be utilized in treatment and/or prevention of dry eye syndrome, e.g. due to aging, diabetes, contact lenses or other causes and/or after eye surgery or trauma, in particular after Lasik (laser-assisted in situ keratomileusis), commonly referred to simply as laser eye surgery, in particular of Sjögren or non-Sjögren syndrome dry eye.

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The standard treatment of dry eye may involve the administration of artificial tears, cyclosporine (in particular cyclosporine A; e.g. Restasis®); autologous serum eye drops; lubricating tear ointments and/or the administration of (cortico-)steroids, for example in the form of drops or eye ointments. Therefore, the present invention also relates to the use of the JNK inhibitor as described herein in a method of treatment of dry eye syndrome, wherein the method comprises the combined administration of the JNK inhibitor as defined herein together with a standard treatment for dry eye, in particular with any one of the above mentioned treatments. Particularly preferred is the combination with cyclosporine A and most preferably with artificial tears. Combined administration comprises the parallel administration and/or subsequent administration (either first the JNK inhibitor described herein and then the (cortico)steroids or vice versa). Certainly, subsequent and parallel administration may also be combined, e.g. the treatment is started with JNK inhibitors described herein and at a later point in time in the course of the treatment (cortico)steroids are given in parallel, or vice versa.

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According to another preferred embodiment, the disorder/disease to be prevented and/or treated is a skin disease, in particular papulosquamous disorders, in particular selected from psoriasis in general, for example psoriasis vulgaris, nummular psoriasis, plaque psoriasis, generalized pustular psoriasis, impetigo herpetiformis, Von Zumbusch's disease, acrodermatitis continua, guttate psoriasis, arthropathic psoriasis, distal interphalangeal psoriatic arthropathy, psoriatic arthritis mutilans, psoriatic spondylitis, psoriatic juvenile arthropathy, psoriatic arthropathy in general, and/or flexural psoriasis; parapsoriasis in general, for example large-plaque parapsoriasis, small-plaque parapsoriasis, retiform parapsoriasis, pityriasis lichenoides and lymphomatoid papulosis; pityriasis rosea; lichen planus and other papulosquamous disorders for example pityriasis rubra pilaris, lichen nitidus, lichen striatus, lichen ruber moniliformis, and infantile papular acrodermatitis. Preferably, the disorder/disease to be prevented and/or treated is psoriasis, for example psoriasis vulgaris, nummular psoriasis, plaque psoriasis, generalized pustular psoriasis, impetigo herpetiformis, Von Zumbusch's disease, acrodermatitis continua, guttate psoriasis, arthropathic psoriasis, distal interphalangeal psoriatic arthropathy, psoriatic arthritis mutilans,

psoriatic spondylitis, psoriatic juvenile arthropathy, psoriatic arthropathy in general, and/or flexural psoriasis.

According to another preferred embodiment, the disorder/disease to be prevented and/or treated is a neurodegenerative disease, in particular tauopathies, preferably Alzheimer's disease, for example Alzheimer's disease with early onset, Alzheimer's disease with late onset, Alzheimer's dementia senile and presenile forms.

Alzheimer's disease (AD) is a devastating neurodegenerative disorder that leads to progressive cognitive decline with memory loss and dementia. Neuropathological lesions are characterized by extracellular deposition of senile plaques, formed by β -amyloid ($A\beta$) peptide, and intracellular neurofibrillary tangles (NFTs), composed of hyperphosphorylated tau proteins (Duyckaerts et al., 2009, Acta Neuropathol 118: 5-36). According to the amyloid cascade hypothesis, neurodegeneration in AD could be linked to an abnormal amyloid precursor protein (APP) processing through the activity of the beta-site APP cleaving enzyme 1 (BACE1) and presenilin 1, leading to the production of toxic $A\beta$ oligomers that accumulate in fibrillar $A\beta$ peptides before forming $A\beta$ plaques. $A\beta$ accumulations can lead to synaptic dysfunction, altered kinase activities resulting in NFTs formation, neuronal loss and dementia (Hardy and Higgins, 1992, Science 256: 184-5). AD pathogenesis is thus believed to be triggered by the accumulation of $A\beta$, whereby $A\beta$ self-aggregates into oligomers, which can be of various sizes, and forms diffuse and neuritic plaques in the parenchyma and blood vessels. $A\beta$ oligomers and plaques are potent synaptotoxins, block proteasome function, inhibit mitochondrial activity, alter intracellular Ca^{2+} levels and stimulate inflammatory processes. Loss of the normal physiological functions of $A\beta$ is also thought to contribute to neuronal dysfunction. $A\beta$ interacts with the signalling pathways that regulate the phosphorylation of the microtubule-associated protein tau. Hyperphosphorylation of tau disrupts its normal function in regulating axonal transport and leads to the accumulation of neurofibrillary tangles (NFTs) and toxic species of soluble tau. Furthermore, degradation of hyperphosphorylated tau by the proteasome is inhibited by the actions of $A\beta$. These two proteins and their associated signalling pathways therefore represent important therapeutic targets for AD.

C-Jun N-terminal kinases (JNKs) are serine-threonine protein kinases, coded by three genes JNK1, JNK2, and JNK3, expressed as ten different isoforms by mRNA alternative splicing, each

isoforms being expressed as a short form (46 kDa) and a long form (54 kDa) (Davis, 2000, Cell 103: 239-52). While JNK1 and JNK2 are ubiquitous, JNK3 is mainly expressed in the brain (Kyriakis and Avruch, 2001, Physiol Rev 81: 807-69). JNKs are activated by phosphorylation (pJNK) through MAPKinase activation by extracellular stimuli, such as
5 ultraviolet stress, cytokines and A β peptides and they have multiple functions including gene expression regulation, cell proliferation and apoptosis (Dhanasekaran and Reddy, 2008, Oncogene 27: 6245-51).

According to the present invention, it is assumed that the JNK inhibitors according to the
10 present invention reduce tau hyperphosphorylation and, thus, neuronal loss. Therefore, the JNK inhibitors according to the present invention can be useful for treating and/or preventing tauopathies. Tauopathies are a class of neurodegenerative diseases associated with the pathological aggregation of tau protein in the human brain. The best-known tauopathy is Alzheimer's disease (AD), wherein tau protein is deposited within neurons in the form of
15 neurofibrillary tangles (NFTs), which are formed by hyperphosphorylation of tau protein. The degree of NFT involvement in AD is defined by Braak stages. Braak stages I and II are used when NFT involvement is confined mainly to the transentorhinal region of the brain, stages III and IV when there is also involvement of limbic regions such as the hippocampus, and V and VI when there is extensive neocortical involvement. This should not be confused with
20 the degree of senile plaque involvement, which progresses differently. Thus, the JNK inhibitors can be used according to the present invention for treating and/or preventing tauopathies, in particular Alzheimer's disease with NFT involvement, for example AD with Braak stage I, AD with Braak stage II, AD with Braak stage III, AD with Braak stage IV and/or AD with Braak stage V.

25 Further tauopathies, i.e. conditions in which neurofibrillary tangles (NFTs) are commonly observed, and which can thus be treated and/or prevented by the JNK inhibitors according to the present invention, include progressive supranuclear palsy although with straight filament rather than PHF (paired helical filaments) tau; dementia pugilistica (chronic traumatic encephalopathy); frontotemporal dementia and parkinsonism linked to chromosome 17,
30 however without detectable β -amyloid plaques; Lytico-Bodig disease (Parkinson-dementia complex of Guam); tangle-predominant dementia, with NFTs similar to AD, but without plaques; ganglioglioma and gangliocytoma; meningioangiomatosis; subacute sclerosing panencephalitis; and/or lead encephalopathy, tuberous sclerosis, Hallervorden-Spatz disease,

and lipofuscinosis. Further tauopathies, which can be treated and/or prevented by the JNK inhibitors according to the present invention, include Pick's disease; corticobasal degeneration; Argyrophilic grain disease (AGD); frontotemporal dementia and frontotemporal lobar degeneration. In Pick's disease and corticobasal degeneration tau proteins are deposited
5 in the form of inclusion bodies within swollen or "ballooned" neurons. Argyrophilic grain disease (AGD), another type of dementia, which is sometimes considered as a type of Alzheimer disease and which may co-exist with other tauopathies such as progressive supranuclear palsy, corticobasal degeneration, and also Pick's disease, is marked by the presence of abundant argyrophilic grains and coiled bodies on microscopic examination of
10 brain tissue. The non-Alzheimer's tauopathies are sometimes grouped together as "Pick's complex".

It is also preferred according to the present invention, that the disorder/disease to be prevented and/or treated by the JNK inhibitor according to the present invention is Mild Cognitive
15 Impairment (MCI), in particular MCI due to Alzheimer's Disease. Typically, Mild Cognitive Impairment (MCI) is different from Alzheimer's Disease, i.e. Mild Cognitive Impairment (MCI) is typically not Alzheimer's Disease, but is a disease on its own classified by ICD-10 in F06.7. In ICD-10 (F06.7), MCI is described as a disorder characterized by impairment of memory, learning difficulties, and reduced ability to concentrate on a task for more than brief periods.
20 There is often a marked feeling of mental fatigue when mental tasks are attempted, and new learning is found to be subjectively difficult even when objectively successful. None of these symptoms is so severe that a diagnosis of either dementia (F00-F03) or delirium (F05.-) can be made. The disorder may precede, accompany, or follow a wide variety of infections and physical disorders, both cerebral and systemic, but direct evidence of cerebral involvement
25 is not necessarily present. It can be differentiated from postencephalitic syndrome (F07.1) and postconcussional syndrome (F07.2) by its different etiology, more restricted range of generally milder symptoms, and usually shorter duration. Mild cognitive impairment (MCI), in particular MCI due to Alzheimer's Disease, causes a slight but noticeable and measurable decline in cognitive abilities, including memory and thinking skills. MCI involves the onset
30 and evolution of cognitive impairments whatever type beyond those expected based on the age and education of the individual, but which are not significant enough to interfere with their daily activities. The diagnosis of MCI is described for example by Albert MS, DeKosky ST, Dickson D, Dubois B, Feldman HH, Fox NC, Gamst A, Holtzman DM, Jagust WJ, Petersen

RC, Snyder PJ, Carrillo MC, Thies B, Phelps CH (2011) The diagnosis of mild cognitive impairment due to Alzheimer's disease: recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease; *Alzheimers Dement.*;7(3):270-9. MCI may be at the onset of whatever type of dementia or
5 represents an ephemeric form of cognitive impairment which may disappear over time without resulting in a clinical manifestation of dementia. A person with MCI is at an increased risk of developing Alzheimer's or another dementia, in particular at an increased risk of developing Alzheimer's Disease, without however necessarily developing dementia, in particular Alzheimer's Disease. No medications are currently approved by the U.S. Food and
10 Drug Administration (FDA) to treat Mild Cognitive Impairment. Drugs approved to treat symptoms of Alzheimer's Disease have not shown any lasting benefit in delaying or preventing progression of MCI to dementia.

According to another preferred embodiment, the disorder/disease to be prevented and/or
15 treated is an inflammatory disease of the mouth or the jaw bone, in particular pulpitis, periimplantitis, periodontitis, gingivitis, stomatitis, mucositis, desquamative disorders, and/or temporomandibular joint disorder, preferably periodontitis.

According to another preferred embodiment, the disorder/disease to be prevented and/or
20 treated is a graft rejection or transplant rejection reaction, in particular a liver, lung, kidney, pancreas, skin or heart transplant graft rejection, e.g. graft versus host or host versus graft.

According to still another preferred embodiment, the disorder/disease to be prevented and/or
25 treated is a nephrological disease (kidney disease), in particular selected from glomerulonephritis, for example nonproliferative glomerulonephritis, in particular minimal change disease, focal segmental glomerulosclerosis, focal segmental glomerular hyalinosis and/or sclerosis, focal glomerulonephritis, membranous glomerulonephritis, and/or thin basement membrane disease, and proliferative glomerulonephritis, in particular membrano-
30 proliferative glomerulonephritis, mesangio-proliferative glomerulonephritis, endocapillary proliferative glomerulonephritis, mesangiocapillary proliferative glomerulonephritis, dense deposit disease (membranoproliferative glomerulonephritis type II), extracapillary glomerulonephritis (crescentic glomerulonephritis), rapidly progressive glomerulonephritis (RPGN), in particular Type I RPGN, Type II RPGN, Type III RPGN, and Type IV RPGN, acute

proliferate glomerulonephritis, post-infectious glomerulonephritis, and/or IgA nephropathy (Berger's disease); acute nephritic syndrome; rapidly progressive nephritic syndrome; recurrent and persistent hematuria; chronic nephritic syndrome; nephrotic syndrome; proteinuria with specified morphological lesion; glomerulitis; glomerulopathy; glomerulosclerosis; acute kidney injury ("AKI", also called "acute renal failure" or "acute kidney failure") in general, in particular prerenal AKI, intrinsic AKI, postrenal AKI, AKI with tubular necrosis for example acute tubular necrosis, renal tubular necrosis, AKI with cortical necrosis for example acute cortical necrosis and renal cortical necrosis, AKI with medullary necrosis, for example medullary (papillary) necrosis, acute medullary (papillary) necrosis and chronic medullary (papillary) necrosis, or other AKI; chronic kidney disease; preferably the disorder/disease to be prevented and/or treated is glomerulonephritis. It is also preferred that the kidney disorder/disease to be prevented and/or treated is a nephropathy, in particular selected from membranous nephropathy, diabetic nephropathy, IgA nephropathy, hereditary nephropathy, analgesic nephropathy, CFHR5 nephropathy, contrast-induced nephropathy, amyloid nephropathy, reflux nephropathy and/or Mesoamerican nephropathy, diabetic nephropathy, preferably the disorder/disease to be prevented and/or treated is diabetic nephropathy.

According to still another preferred embodiment, the disorder/disease to be prevented and/or treated is a disease and/or disorder of the urinary system, in particular selected from ureteritis; urinary tract infection (bladder infection, acute cystitis); cystitis in general, in particular interstitial cystitis, Hunner's ulcer, trigonitis and/or hemorrhagic cystitis; urethritis, in particular nongonococcal urethritis or gonococcal urethritis; painful bladder syndrome; IC/PBS; urethral syndrome; and/or retroperitoneal fibrosis, preferably cystitis in general, in particular interstitial cystitis. In this context it is noted that interstitial cystitis (IC) varies very much in symptoms and severity and, thus, most researchers believe it is not one, but several diseases. In recent years, scientists have started to use the terms "bladder pain syndrome" (BPS) or "painful bladder syndrome" (PBS) to describe cases with painful urinary symptoms that may not meet the strictest definition of IC. The term "IC/PBS" includes all cases of urinary pain that can't be attributed to other causes, such as infection or urinary stones. The term interstitial cystitis, or IC, is typically used alone when describing cases that meet all of the IC criteria, for example as established by the National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK).

According to still another preferred embodiment, the disorder/disease to be prevented and/or treated is a cancer and/or tumor disease, in particular selected from solid tumors in general; hematologic tumors in general, in particular leukemia, for example acute lymphocytic leukemia (L1, L2, L3), acute lymphoid leukaemia (ALL), acute myelogenous leukemia (AML),
5 chronic lymphocytic leukaemia (CLL), chronic myeloid leukaemia (CML), promyelocytic leukemia (M3), monocytic leukemia (MS), myeloblastic leukemia (M1), myeloblastic leukemia (M2), megakaryoblastic leukemia (M7) and myelomonocytic leukemia (M4); myeloma, for example multiple myeloma; lymphomas, for example non-Hodgkin's lymphomas, mycosis fungoides, Burkitt's lymphoma, and Hodgkin's syndrome; pancreatic
10 cancer, in particular pancreatic carcinoma; ovarian cancer, in particular ovarian carcinoma; liver cancer and liver carcinoma in general, in particular liver metastases, liver cell carcinoma, hepatocellular carcinoma, hepatoma, intrahepatic bile duct carcinoma, cholangiocarcinoma, hepatoblastoma, angiosarcoma (of liver), and other specified or unspecified sarcomas and carcinomas of the liver; skin cancer; melanoma, in particular
15 malignant melanoma; squamous cell carcinoma; glioblastoma; colon cancer and colon carcinoma in general, in particular cecum carcinoma, appendix carcinoma, ascending colon carcinoma, hepatic flexure carcinoma, transverse colon carcinoma, splenic flexure carcinoma, descending colon carcinoma, sigmoid colon carcinoma, carcinoma of overlapping sites of colon and/or malignant carcinoid tumors of the colon; prostate cancer
20 and prostate tumours, in particular prostate carcinoma.

Moreover, in the following further diseases to be treated are disclosed:

The JNK inhibitors of the present invention may be used for example for the treatment of
25 inflammatory diseases including for example acute inflammation as well as chronic inflammation. The JNK inhibitors of the present invention may be used to treat any type of tissue inflammation, e.g. inflammation in the eye, inflammation in the mouth, inflammation of the respiratory system including in particular the lung, inflammation of the skin, inflammation within the cardiovascular system, inflammation of the brain, inflammation in
30 the ear, etc. Some non-limiting examples for such inflammatory disease states are mucositis, stomatitis, peri-implantitis, retinitis, chorioiditis, keratoconjunctivitis sicca, inflammatory bowel diseases (IBD), uveitis (e.g. anterior uveitis, intermediate uveitis, posterior uveitis), periodontitis, COPD, asthma, pulpitis, rheumatoid arthritis, osteoarthritis, Crohn's disease, psoriatic arthritis, vasculitis, interstitial cystitis; acute inflammation at a site of infection or

wound, meningitis, encephalitis, pneumonia, pharyngitis, tonsillitis, otitis (including otitis media), vasculitis, synovitis, enteritis, Crohn's disease, ulcerative colitis, graft rejection; post-surgery or post-trauma inflammation, in particular intraocular inflammation following ocular anterior and/or posterior segment surgery, etc.

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The JNK inhibitors as disclosed herein may for example be used in methods of treatment of ear diseases (in particular diseases of the inner ear), hearing loss (in particular acute hearing loss), damaged hair cell stereocilia, hair cell apoptosis, noise trauma, otitis, otitis media etc. Hearing loss and associated hair cell apoptosis are non-limiting examples for disorders
10 resulting from stress situations for cells in which JNK inhibition can modulate the stress response and for example block apoptosis.

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The JNK inhibitors of the present invention may also be used for the treatment of metabolic disorders, for example for the treatment of diabetes in general, in particular type 1 diabetes mellitus, type 2 diabetes mellitus, diabetes mellitus due to underlying condition, for example
due to congenital rubella, Cushing's syndrome, cystic fibrosis, malignant neoplasm, malnutrition, or pancreatitis and other diseases of the pancreas, drug or chemical induced diabetes mellitus, and/or other diabetes mellitus, Fabry disease, Gaucher disease, hypothermia, hyperthermia hypoxia, lipid histiocytosis, lipidoses, metachromatic
20 leukodystrophy, mucopolysaccharidosis, Niemann Pick disease, obesity, and Wolman's disease. Hypothermia, hyperthermia and hypoxia are again non-limiting examples for stress situations for cells in which JNK inhibition can modulate the stress response and for example block apoptosis.

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Likewise, the JNK inhibitors of the present invention may be used for the treatment of neural, neuronal and/or neurodegenerative diseases, respectively. Examples for such diseases are for example Alexander disease; tauopathies, in particular Alzheimer's disease, for example Alzheimer's disease with early onset, Alzheimer's disease with late onset, Alzheimer's dementia senile and presenile forms; Mild Cognitive Impairment, in particular Mild Cognitive
30 Impairment due to Alzheimer's Disease; amyotrophic lateral sclerosis (ALS), apoplexy, Ataxia Telangiectasia, cut or otherwise disrupted axons, axotomy, brain lesions, CMT (Charcot-Marie-Tooth), corticobasal degeneration, dementia, diseases or disorders of the nervous system, dystonia, epilepsy, Farber's disease, Friedreich ataxia (SCA), gangliosidoses, Guillain-Barré syndrome, hereditary spastic paraplegia, Hirschsprung's disease, human

immunodeficiency virus dementia, Huntington's disease, infarct of the brain, ischemic stroke, Krabbe disease, Lennox Gastaut Syndrome, lissencephaly, multiple sclerosis, myelodysplastic syndromes, myelopathy, AIDS-related neurodegenerative diseases, neurofibromatosis type 2 (NF-2), neurotactyria, neuronal apoptosis, neuronal death, neuropathic pain, neuropathy, chemotherapy induced neuropathy, diabetes induced neuropathy, NMDA-induced neurotoxicity, pain, Parkinson's disease, parkinsonism, Pick's Disease, polyneuropathy, progressive supranuclear palsy, Sandhoff disease, spina bifida, stroke, Tay Sachs, TBI (diffuse axonal injury), treatment of dark neurone induced for example by an inflammatory pain, West Syndrome, spinal muscular atrophy etc.

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With respect to autoimmune disorders, the JNK inhibitor peptides of the present invention may for example be used in a method of treatment of autoimmune diseases of the CNS, auto-inflammatory diseases, Celiac disease; Sjogren's syndrome, systemic lupus erythematosus etc.

15 Examples for bone diseases which may be treated with the JNK inhibitors of the present invention are for example arthritis, disc herniation, fibrodysplasia ossificans progressiva (FOP), osteoarthritis, osteopetrosis, osteoporosis, in particular diabetes induced osteoporosis, Paget's Disease, rheumatoid arthritis, etc.

20 Examples for preferred skin diseases which can be treated with the JNK inhibitors of the present invention are psoriasis and lupus erythematosus. In more general terms, skin diseases and diseases of the subcutaneous tissue, which can preferably be treated and/or prevented with the JNK inhibitors as disclosed herein are papulosquamous disorders. These include psoriasis, parapsoriasis, pityriasis rosea, lichen planus and other papulosquamous disorders
25 for example pityriasis rubra pilaris, lichen nitidus, lichen striatus, lichen ruber moniliformis, and infantile popular acrodermatitis. Preferably the disease to be treated and/or prevented by the JNK inhibitor according to the invention is selected from the group of psoriasis and parapsoriasis, whereby psoriasis is particularly preferred. Examples for psoriasis include psoriasis vulgaris, nummular psoriasis, plaque psoriasis, generalized pustular psoriasis,
30 impetigo herpetiformis, Von Zumbusch's disease, acrodermatitis continua, guttate psoriasis, arthropathis psoriasis, distal interphalangeal psoriatic arthropathy, psoriatic arthritis mutilans, psoriatic spondylitis, psoriatic juvenile arthropathy, psoriatic arthropathy in general, and/or flexural psoriasis. Examples for parapsoriasis include large-plaque parapsoriasis, small-plaque parapsoriasis, retiform parapsoriasis, pityriasis lichenoides and lymphomatoid papulosis.

Further examples for preferred skin diseases which can be treated with the JNK inhibitors of the present invention are eczema; dermatitis in general, in particular atopic dermatitis for example Besnier's prurigo, atopic or diffuse neurodermatitis, flexural eczema, infantile eczema, intrinsic eczema, allergic eczema, other atopic dermatitis, seborrheic dermatitis for example seborrhea capitis, seborrheic infantile dermatitis, other seborrheic dermatitis, diaper dermatitis for example diaper erythema, diaper rash and psoriasiform diaper rash, allergic contact dermatitis, in particular due to metals, due to adhesives, due to cosmetics, due to drugs in contact with skin, due to dyes, due to other chemical products, due to food in contact with skin, due to plants except food, due to animal dander, and/or due to other agents, irritant contact dermatitis, in particular due to detergents, due to oils and greases, due to solvents, due to cosmetics, due to drugs in contact with skin, due to other chemical products, due to food in contact with skin, due to plants except food, due to metal, and/or due to other agents, unspecified contact dermatitis, exfoliative dermatitis, dermatitis for example general and localized skin eruption due to substances taken internally, in particular due to drugs and medicaments, due to ingested food, due to other substances, nummular dermatitis, dermatitis gangrenosa, dermatitis herpetiformis, dry skin dermatitis, factitial dermatitis, perioral dermatitis, radiation-related disorders of the skin and subcutaneous tissue, stasis dermatitis, Lichen simplex chronicus and prurigo, pruritus, dyshidrosis, cutaneous autosensitization, infective dermatitis, erythema intertrigo and/or pityriasis alba; cellulitis (bacterial infection involving the skin); lymphangitis, in particular acute or chronic lymphangitis; panniculitis in general, in particular lobular panniculitis without vasculitis, for example acute panniculitis, previously termed Weber-Christian disease and systemic nodular panniculitis, lobular panniculitis with vasculitis, septal panniculitis without vasculitis and/or septal panniculitis with vasculitis; lymphadenitis, in particular acute lymphadenitis; pilonidal cyst and sinus; pyoderma in general, in particular pyoderma gangrenosum, pyoderma vegetans, dermatitis gangrenosa, purulent dermatitis, septic dermatitis and suppurative dermatitis; erythrasma; omphalitis; pemphigus, in particular pemphigus vulgaris, pemphigus vegetans, pemphigus foliaceus, Brazilian pemphigus, pemphigus erythematosis, drug-induced pemphigus, IgA pemphigus, for example subcorneal pustular dermatosis and intraepidermal neutrophilic IgA dermatosis, and/or paraneoplastic pemphigus; acne in general, in particular acne vulgaris, acne conglobata, acne varioliformis, acne necrotica miliaris, acne tropica, infantile acne acné excoriée des jeunes filles, Picker's acne, and/or acne keloid; mouth and other skin ulcers; urticaria in general, in particular allergic urticaria, idiopathic urticarial, urticarial due to cold

and heat, dermatographic urticarial, vibratory urticarial, cholinergic urticarial, and/or contact urticarial; erythema in general, in particular erythema multiforme for example nonbullous erythema multiforme, Stevens-Johnson syndrome, toxic epidermal necrolysis (Lyell), and Stevens-Johnson syndrome-toxic epidermal necrolysis overlap syndrome, erythema nodosum, toxic erythema, erythema annulare centrifugum, erythema marginatum and/or other chronic figurate erythema; sunburn and other acute skin changes due to ultraviolet radiation; skin changes due to chronic exposure to nonionizing radiation; radiodermatitis; folliculitis; perifolliculitis; pseudofolliculitis barbae; hidradenitis suppurativa; sarcoidose; vascularitis; adult linear IgA disease; rosacea, in particular perioral dermatitis, rhinophyma, and other rosacea; and/or follicular cysts of skin and subcutaneous tissue, in particular epidermal cyst, pilar cyst, trichodermal cyst, steatocystoma multiplex, sebaceous cyst and/or other follicular cysts.

Diseases of the eye, which may be treated with the JNK inhibitors of the present invention involve for example age-related macular degeneration (AMD), in particular in the wet and dry form; angioid streaks; anterior ischemic optic neuropathy; anterior uveitis; cataract, in particular age related cataract; central exudative chorioretinopathy; central serous chorioretinopathy; chalazion; chorioderemia; chorioiditis; choroidal sclerosis; conjunctivitis; cyclitis; diabetic retinopathy; dry eye syndrome; endophthalmitis; episcleritis; eye infection; fundus albipunctatus; gyrate atrophy of choroid and retina; hordeolum; inflammatory diseases of the blephara; inflammatory diseases of the choroid; inflammatory diseases of the ciliary body; inflammatory diseases of the conjunctiva; inflammatory diseases of the cornea; inflammatory diseases of the iris; inflammatory diseases of the lacrimal gland; inflammatory diseases of the orbital bone; inflammatory diseases of the sclera; inflammatory diseases of the vitreous body; inflammatory diseases of the uvea; inflammatory diseases of the retina; intermediate uveitis; iritis; keratitis; Leber's disease; multifocal choroiditis; myositis of the eye muscle; neovascular maculopathy (e.g. caused by high myopia, tilted disc syndrome, choroidal osteoma or the like); NMDA induced retinotoxicity; non-chronic or chronic inflammatory eye diseases; Oguchi's disease; optic nerve disease; orbital phlegmon; panophtalmitis; panuveitis; post capsule opacification; posterior capsule opacification (PCO) (a cataract after-surgery complication); posterior uveitis; proliferative vitreoretinopathy; retinal artery occlusion; retinal detachment, retinal diseases; retinal injuries; retinal macroaneurysm; retinal pigment epithelium detachment; retinal vein occlusion; retinitis; retinitis pigmentosa; retinitis punctata albescens; retinopathy, in particular retinopathy of

prematurity and diabetic retinopathy; scleritis; Stargardt's disease; treatment of inflamed ocular wounds and/or ocular wound edges; treatment of intraocular inflammation after eye surgery or trauma, preferably intraocular inflammation following anterior and/or posterior segment surgery; uveitis; vitelliform macular dystrophy; etc.

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In particular the JNK inhibitors of the present invention can be used to treat and/or prevent inflammatory diseases of the eye, whereby such diseases can relate to the eye as a whole or to different parts of the eye. For example, the JNK inhibitors of the present invention can be used to treat and/or prevent panophthalmitis, which is the inflammation of all coats of the eye including intraocular structures. Further inflammatory diseases of the eye, which can be treated and/or prevented with the JNK inhibitors of the present invention include for example endophthalmitis, for example purulent and parasitic endophthalmitis; blebitis; hordeolum; chalazion; blepharitis; dermatitis and other inflammations of the eyelid; dacryoadenitis; canaliculitis, in particular acute and chronic lacrimal canaliculitis; dacryocystitis; inflammation of the orbit, in particular cellulitis of orbit, periostitis of orbit, tenonitis of orbit, orbital granuloma (granulomatous inflammation) and orbital myositis.

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Furthermore, the JNK inhibitors of the present invention can be used to treat and/or prevent inflammatory diseases of the conjunctiva, in particular conjunctivitis, for example acute conjunctivitis, mucopurulent conjunctivitis, atopic conjunctivitis, toxic conjunctivitis, pseudomembranous conjunctivitis, serous conjunctivitis, chronic conjunctivitis, giant pupillary conjunctivitis, follicular conjunctivitis vernal conjunctivitis, blepharoconjunctivitis, and/or pingueculitis. Conjunctivitis is an inflammation of the conjunctiva, which is commonly due to an infection or an allergic reaction.

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In particular, the JNK inhibitors of the present invention can be used to treat and/or prevent inflammatory diseases of the sclera, the cornea, the iris, the ciliary body, the retina and/or the choroid of the eye. Preferably, the JNK inhibitors of the present invention can be used to treat and/or prevent uveitis, i.e. an inflammation of the uvea. The uvea consists of the middle, pigmented vascular structures of the eye and includes the iris, the ciliary body, and the choroid. Typically, uveitis is classified as anterior uveitis, intermediate uveitis, posterior uveitis, and/or panuveitis, whereby the latter is the inflammation of all the layers of the uvea. Furthermore, uveitis includes sympathetic ophthalmia (sympathetic uveitis), which is a bilateral diffuse granulomatous uveitis of both eyes following trauma to one eye. Anterior

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uveitis, which is particularly preferred to be treated with the JNK inhibitors of the present invention, includes iridocyclitis and iritis. Iritis is the inflammation of the anterior chamber and iris. Iridocyclitis presents the same symptoms as iritis, but also includes inflammation in the vitreous cavity. Examples of iridocyclitis to be prevented and/or treated with the JNK inhibitors of the present invention include – but are not limited to – acute iridocyclitis, subacute iridocyclitis and chronic iridocyclitis, primary iridocyclitis, recurrent iridocyclitis and secondary iridocyclitis, lens-induced iridocyclitis, Fuchs' heterochromic cyclitis, and Vogt-Koyanagi syndrome. Intermediate uveitis, also known as pars planitis, in particular includes vitritis, which is inflammation of cells in the vitreous cavity, sometimes with "snowbanking" or deposition of inflammatory material on the pars plana. Posterior uveitis includes in particular chorioretinitis, which is the inflammation of the retina and choroid, and chorioiditis (choroid only). In more general terms, the JNK inhibitors as disclosed herein can be used to treat and/or prevent chorioretinal inflammation in general, for example focal and/or disseminated chorioretinal inflammation, chorioretinitis, chorioiditis, retinochoroiditis, posterior cyclitis, Harada's disease, chorioretinal inflammation in infectious and parasitic diseases and/or retinitis, i.e. an inflammation of the retina. Inflammatory diseases damaging the retina of the eye in general are included, in addition to retinitis in particular retinal vasculitis, for example Eales disease and retinal perivasculitis. Further inflammatory diseases of the sclera, the cornea, the iris, the ciliary body, the retina and/or the choroid of the eye to be treated and/or prevented with the JNK inhibitors as disclosed herein include scleritis, i.e. an inflammation of the sclera, for example anterior scleritis, brawny scleritis, posterior scleritis, scleritis with corneal involvement and scleromalacia perforans; episcleritis, in particular episcleritis periodica fugax and nodular episcleritis; and keratitis, which is an inflammation of the cornea, in particular corneal ulcer, superficial keratitis, macular keratitis, filamentary keratitis, photokeratitis, punctate keratitis, keratoconjunctivitis, for example exposure keratoconjunctivitis, keratoconjunctivitis sicca (dry eyes), neurotrophic keratoconjunctivitis, ophthalmia nodosa, phlyctenular keratoconjunctivitis, vernal keratoconjunctivitis and other keratoconjunctivitis, interstitial and deep keratitis, sclerosing keratitis, corneal neovascularization and other keratitis.

In addition, the JNK inhibitors as disclosed herein are particularly useful to treat and/or prevent post-surgery (or "post-procedural") or post-trauma (intraocular) inflammation of the eye. "Post-surgery" refers in particular to a surgery performed on and/or in the eye, preferably anterior and/or posterior segment surgery, for example cataract surgery, laser eye surgery,

glaucoma surgery, refractive surgery, corneal surgery, vitreo-retinal surgery, eye muscle surgery, oculoplastic surgery, ocular oncology surgery, conjunctival surgery including pterygium, and/or surgery involving the lacrimal apparatus. Preferably, the surgery referred to in "post-surgery" is a complex eye surgery and/or an uncomplicated eye surgery. Particularly preferred is the use of JNK inhibitors as disclosed herein to treat and/or prevent post-surgery or post-trauma intraocular inflammation, in particular intraocular inflammation following anterior and/or posterior segment surgery.

Another particularly preferred eye disease to be treated and/or prevented with the JNK inhibitors according to the invention is retinopathy. Non-limiting examples of retinopathy include diabetic retinopathy, hypertensive retinopathy (e.g., arterial hypertension induced), exudative retinopathy, radiation induced retinopathy, sun-induced solar retinopathy, trauma-induced retinopathy, e.g. Purtscher's retinopathy, retinopathy of prematurity (ROP) and/or hyperviscosity-related retinopathy, non-diabetic proliferative retinopathy, and/or proliferative vitreo-retinopathy. The JNK inhibitors as disclosed herein are particularly preferred for the treatment and/or prevention of diabetic retinopathy and retinopathy of prematurity, respectively.

Furthermore, the JNK inhibitors as disclosed herein are preferably used in the treatment of diseases and/or disorders relating to degeneration of the macula and/or posterior pole in general. In particular, the treatment and/or prevention of age-related macular degeneration (AMD) is preferred, in particular the wet and/or the dry form of age-related macular degeneration, exudative and/or non-exudative age-related macular degeneration.

Exemplary diseases of the mouth which may be treated with the JNK inhibitors as disclosed herein are periodontitis, in particular chronic periodontitis; mucositis, oral desquamative disorders, oral liquen planus, pemphigus vulgaris, pulpitis; stomatitis; temporomandibular joint disorder, peri-implantitis etc. Preferred diseases of the mouth or the jaw bone to be prevented and/or treated with the JNK inhibitors according to the present invention can be selected from the group consisting of pulpitis in general, in particular acute pulpitis, chronic pulpitis, hyperplastic pulpitis, ulcerative pulpitis, irreversible pulpitis and/or reversible pulpitis; periimplantitis; periodontitis in general, in particular chronic periodontitis, complex periodontitis, simplex periodontitis, aggressive periodontitis, and/or apical periodontitis, e.g. of pulpal origin; periodontosis, in particular juvenile periodontosis; gingivitis in general, in

particular acute gingivitis, chronic gingivitis, plaque-induced gingivitis, and/or non-plaque-induced gingivitis; pericoronitis, in particular acute and chronic pericoronitis; sialadenitis (sialoadenitis); parotitis, in particular infectious parotitis and autoimmune parotitis; stomatitis in general, in particular aphthous stomatitis (e.g., minor or major), Bednar's aphthae, 5 periadenitis mucosa necrotica recurrens, recurrent aphthous ulcer, stomatitis herpetiformis, gangrenous stomatitis, denture stomatitis, ulcerative stomatitis, vesicular stomatitis and/or gingivostomatitis; mucositis, in particular mucositis due to antineoplastic therapy, due to (other) drugs, or due to radiation, ulcerative mucositis and/or oral mucositis; cheilitis in general, in particular chapped lips, actinic cheilitis, angular cheilitis, eczematous cheilitis, 10 infectious cheilitis, granulomatous cheilitis, drug-related cheilitis, exfoliative cheilitis, cheilitis glandularis, and/or plasma cell cheilitis; cellulitis (bacterial infection), in particular of mouth and/or lips; desquamative disorders, in particular desquamative gingivitis; and/or temporomandibular joint disorder.

15 The present invention is also suitable for use in the treatment of diseases resulting in loss of bladder function (e.g., urinary incontinence, overactive bladder, interstitial cystitis, or bladder cancer). In particular, diseases and/or disorders of the urinary system can be treated and/or prevented with the JNK inhibitors as disclosed herein. Such diseases are in particular selected from ureteritis; urinary tract infection (bladder infection, acute cystitis); cystitis in general, in 20 particular interstitial cystitis, Hunner's ulcer, trigonitis and/or hemorrhagic cystitis; urethritis, in particular nongonococcal urethritis or gonococcal urethritis; urethral syndrome; and/or retroperitoneal fibrosis.

In addition, kidney diseases and/or disorders can be treated and/or prevented with the JNK 25 inhibitor according to the present invention. Particularly preferred kidney diseases to be treated and/or prevented with the JNK inhibitor according to the present invention include glomerulopathies, in particular glomerulonephritis, acute kidney injury and nephropathies. Glomerulonephritis refers to several renal diseases, whereby many of the diseases are characterised by inflammation either of the glomeruli or small blood vessels in the kidneys, 30 but not all diseases necessarily have an inflammatory component. Non-limiting examples of glomerulonephritis diseases to be treated and/or prevented with the JNK inhibitor according to the present invention include nonproliferative glomerulonephritis, in particular minimal change disease, focal segmental glomerulosclerosis, focal segmental glomerular hyalinosis and/or sclerosis, focal glomerulonephritis, membranous glomerulonephritis, and/or thin

basement membrane disease, and proliferative glomerulonephritis, in particular membrano-proliferative glomerulonephritis, mesangio-proliferative glomerulonephritis, endocapillary proliferative glomerulonephritis, mesangiocapillary proliferative glomerulonephritis, dense deposit disease (membranoproliferative glomerulonephritis type II), extracapillary
5 glomerulonephritis (crescentic glomerulonephritis), rapidly progressive glomerulonephritis (RPGN), in particular Type I RPGN, Type II RPGN, Type III RPGN, and Type IV RPGN, acute proliferate glomerulonephritis, post-infectious glomerulonephritis, and/or IgA nephropathy (Berger's disease). Furthermore, diseases to be treated and/or prevented with the JNK inhibitor according to the present invention include acute nephritic syndrome; rapidly progressive
10 nephritic syndrome; recurrent and persistent hematuria; chronic nephritic syndrome; nephrotic syndrome; proteinuria with specified morphological lesion; glomerulitis; glomerulopathy; and glomerulosclerosis. Acute kidney injury ("AKI", also called "acute renal failure" or "acute kidney failure") is an abrupt loss of kidney function, which is often investigated in a renal ischemia/ reperfusion injury model, and which includes for example
15 prerenal AKI, intrinsic AKI, postrenal AKI, AKI with tubular necrosis for example acute tubular necrosis, renal tubular necrosis, AKI with cortical necrosis for example acute cortical necrosis and renal cortical necrosis, AKI with medullary necrosis, for example medullary (papillary) necrosis, acute medullary (papillary) necrosis and chronic medullary (papillary) necrosis, or other AKI. Nephropathies, i.e. damage to or disease of a kidney, includes also nephrosis, which is non-inflammatory nephropathy, and nephritis, which is inflammatory kidney
20 disease. The JNK inhibitor according to the present invention are preferably used to treat and/or prevent nephropathies, in particular membranous nephropathy, diabetic nephropathy, IgA nephropathy, hereditary nephropathy, analgesic nephropathy, CFHR5 nephropathy, contrast-induced nephropathy, amyloid nephropathy, reflux nephropathy and/or
25 Mesoamerican nephropathy; nephritis in general, in particular lupus nephritis, pyelonephritis, interstitial nephritis, tubulointerstitial nephritis, chronic nephritis or acute nephritis, diffuse proliferative nephritis, and/or focal proliferative nephritis, tubulo-interstitial nephritis, infectious interstitial nephritis, pyelitis, pyelonephritis, interstitial nephritis; tubulopathy, tubulitis, in particular RTA (RTA1 and RTA2), Fanconi syndrome, Bartter syndrome, Gitelman
30 syndrome, Liddle's syndrome, nephrogenic diabetes insipidus, renal papillary necrosis, hydronephrosis, pyonephrosis and/or acute tubular necrosis chronic kidney disease (CKD); Goodpasture syndrome (anti-glomerular basement antibody disease); granulomatosis with polyangiitis; microscopic polyangiitis; and/or Churg–Strauss syndrome. A particularly preferred nephropathy to be treated and/or prevented is diabetic nephropathy.

Another field of use is the treatment of pain, in particular neuropathic, incident, breakthrough, psychogenic, or phantom pain, all of these types of pain either in the acute or chronic form.

- 5 Likewise the JNK inhibitors of the present invention may - as already previously proposed for other JNK inhibitors - be used for the treatment of proliferative diseases like cancer and tumor diseases, such as acoustic neuroma; lung carcinomas; acute lymphocytic leukemia (L1, L2, L3); acute lymphoid leukaemia (ALL); acute myelogenous leukemia (AML); adenocarcinomas; anal carcinoma; bronchial carcinoma; cervix carcinoma; cervical cancer;
- 10 astrocytoma; basalioma; cancer with Bcr-Abl transformation; bladder cancer; blastomas; bone cancer; brain metastases; brain tumours; breast cancer; Burkitt's lymphoma; carcinoids; cervical cancer; chronic lymphocytic leukaemia (CLL); chronic myeloid leukaemia (CML); colon cancer and colon carcinoma in general, in particular cecum carcinoma, appendix carcinoma, ascending colon carcinoma, hepatic flexure carcinoma, transverse colon carcinoma, splenic flexure carcinoma, descending colon carcinoma, sigmoid colon carcinoma, carcinoma of overlapping sites of colon and/or malignant carcinoid tumors of the colon; corpus carcinoma; craniopharyngeomas; CUP syndrome; virus-induced tumours; EBV-induced B cell lymphoma; endometrium carcinoma; erythroleukemia (M6); esophagus cancer; gallbladder cancer; gastrointestinal cancer; gastrointestinal stromal tumors; gastrointestinal
- 15 tumours; genitourinary cancer; glaucoma; glioblastoma; gliomas; head/neck tumours; hepatitis B-induced tumours; hepatocellular carcinomas; hepatomas; herpes virus-induced tumours; Hodgkin's syndrome; HTLV-1-induced lymphomas; HTLV-2-induced lymphomas; insulinomas; intestinal cancer; Kaposi's sarcoma; kidney cancer; kidney carcinomas; laryngeal cancer; leukemia; lid tumour; liver cancer and liver carcinoma in general, in particular liver metastases, liver cell carcinoma, hepatocellular carcinoma, hepatoma; lung cancer; lymphoid cancer; lymphomas; malignant melanomas; mammary carcinomas; mantle cell lymphoma; medulloblastoma; megakaryoblastic leukemia (M7); melanoma, in particular malignant melanoma; meningioma; mesothelioma; monocytic leukemia (M5); multiple myeloma; mycosis fungoides; myeloblastic leukemia (M1);
- 20 myeloblastic leukemia (M2); myelomonocytic leukemia (M4); neurinoma; non-Hodgkin's lymphomas; non-small cell carcinoma; non-small cell carcinoma of the lung; oesophageal cancer; oesophageal carcinoma; oligodendroglioma; ovarian cancer; ovarian carcinoma; pancreatic cancer; pancreatic carcinoma; papilloma virus-induced carcinomas; penis cancer; pituitary tumour; plasmocytoma; promyelocytic leukemia (M3); prostate cancer; prostate
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tumours; rectal tumours; rectum carcinoma; renal-cell carcinoma; retinoblastoma; sarcomas; Schneeberger's disease; small cell lung carcinomas; small intestine cancer; small intestine tumours; soft tissue tumours; spinalioma; squamous cell carcinoma; stomach cancer; testicular cancer; throat cancer; thymoma; thyroid cancer; thyroid carcinoma; tongue cancer; undifferentiated AML (MO); urethral cancer; uterine cancer; vaginal cancer; Von Hippel Lindau disease; vulval cancer; Wilms' Tumor; Xeroderma pigmentosum; etc.

Since JNK signalling is also involved in many cardiovascular diseases and disorders, the use of JNK inhibitors in the treatment of such diseases has already been suggested in the past. The inhibitors of the present invention may be used accordingly, e.g. for the treatment of cardiovascular diseases such as arterial hypertension; arteriosclerosis; arteriosclerotic lesions; Behcet's syndrome; bifurcations of blood vessels; cardiac hypertrophy; cardiavascular hypertrophy; cardiomyopathies, in particular chemotherapy induced cardiomyopathies; cerebral ischemia; coronary heart diseases; dilatation of the abdominal aorta; focal cerebral ischemia; global cerebral ischemia; heart hypertrophy; infrarenal aneurism hypertension; ischemia; myocardial infarct, in particular acute myocardial infarction; myocarditis; reperfusion; restenosis; vasculitis; Wegener's granulomatosis; etc.

The JNK inhibitors of the present invention may in the context of cardiovascular diseases also be used complementary to coronary artery bypass graft surgery (CABG surgery); percutaneous transluminal coronary angioplasty (PTCA); and/or stent treatment, for example to prevent or treat intimal hyperplasia resulting from said (surgical) treatment.

Diseases of the respiratory system and in particular lung diseases which may be treated effectively with the JNK inhibitors of the present invention are for example acute respiratory distress syndrome (ARDS); asthma; chronic illnesses involving the respiratory system; chronic obstructive pulmonary disease (COPD); cystic fibrosis; inflammatory lung diseases; pneumonia; pulmonary fibrosis; etc.

Like the inhibitors in the prior art the inhibitors of the present invention may also be used to treat disease of the intestinal tract, e.g. colitis (e.g. atypical colitis, chemical colitis; collagenous colitis, distal colitis, diversion colitis; fulminant colitis, indeterminate colitis, infectious colitis, ischemic colitis, lymphocytic colitis, or microscopic colitis), Crohn's disease, gastroenteritis, Hirschsprung's disease, inflammatory digestive diseases;

inflammatory bowel disease (IBD), Morbus Crohn, non-chronic or chronic digestive diseases, non-chronic or chronic inflammatory digestive diseases; regional enteritis; ulcerative colitis etc.

- 5 The JNK inhibitors of the present invention may also serve as therapeutic agent for the treatment of infectious diseases resulting from e.g. bacterial or viral infection. The JNK inhibitors as disclosed herein may for example prevent or ameliorate inflammatory reactions caused by said infections. Examples for such diseases states, which are not considered to be limiting, are viral encephalitis; viral induced cancers (e.g. as mentioned above), human
10 immunodeficiency virus dementia, meningitis, meningoencephalitis, encephalomyelitis, tonsillitis, varicella zoster virus infections, etc.

There are many other diseases, disease states and disorders for which the JNK inhibitors of the present invention can be used as treatment, for example Aarskog syndrome, acetaminophen hepatotoxicity; Alder-Reilly anomaly; alopecia areata; alpha-1-antitrypsin
15 deficiency; anaphylaxis; apoptosis; apoptotic cell death; atypical hemolytic uremic syndrome; basopenia; basophilia; bipolar disorders; burns; cellular shear stress; Chedial-Higashi syndrome; DNA damage due to chemotherapeutic drugs; cholestasis; chromosome 11, Partial Monosomy 11q; chromosome 22, Trisomy Mosaic; chronic granulomatous
20 disease; hepatitis, such as chronic or fulminant hepatitis; clinical depression; common variable hypogammaglobulinemia; congenital C3 deficiency; CTL protection from activation-induced cell death (AICD); deafness; depression and depressive disorders (in particular prevention of depressive disorders develop on a background of cytokine-induced sickness behaviour), DiGeorge's syndrome; diseases caused by defective apoptosis; diseases of the
25 liver; diseases of the spine; diseases of the uterus; diseases states and symptoms due to exposure to DNA damaging agents and/or ionizing radiation and resulting cellular stress; Down Syndrome; Duchenne muscular dystrophy; ectodermal dysplasias; endometriosis; eosinopenia; eosinophilia; exocitoxic cell death; fetal alcohol syndrome; fibrosis; fibrotic disease; formation of fibrous tissue; free radicals (leading to cellular stress); graft rejection;
30 Graft versus host Disease, in particular skin graft versus host; hair loss; hemolytic uremic syndrome; hepatotoxicity; hyperalgesia, such as diabetes induced hyperalgesia; hyperthermia; hypoglycemia; hypothyroidism; idiopathic hypereosinophilic syndrome; IgA nephropathy; infantile sex-linked agammaglobulinemia; inflammatory pain; infrarenal aneurism; islet regeneration; islet transplantation; Job's syndrome (hyper-IgE); lazy leukocyte

syndrome; leukocyte glucose-6-phosphate dehydrogenase deficiency; leukodystrophy; leukopenia; lymphocytic leukocytosis; lymphocytopenia; lymphocytosis; major depression; mania; maniac depression; Marfan syndrome; mastocytosis; May Hegglin Anomaly; membranoproliferative glomerulonephritis Type II; monocytopenia; monocytosis; 5 myeloperoxidase deficiency-benign; myopathies; neutropenia; neutrophilia; Nezelof's syndrome; organ transplantation; oxidative stress injuries; Pelger-Huet anomaly; polycystic kidney diseases; post-dialysis syndrome; radiation syndromes; radiotherapy; renal diseases; renal failure; rescuing CTL from activation induced cell death; severe combined immunodeficiency disease; transplant rejection; transplantation; trisomy; unipolar 10 depression; UV-induced injuries; Wiskott Aldrich syndrome; wound healing; etc.

The inventors of the present invention consider temporomandibular joint disorder, mucositis, stomatitis, oral liquen planus (desquamative disorder), Pemphigus vulgaris (desquamative 15 disorder), periodontitis, chronic periodontitis, pulpitis, peri-implantitis, uveitis (anterior uveitis, intermediate uveitis, posterior uveitis), keratoconjunctivitis sicca (dry eye syndrome), age-related macular degeneration (AMD), in particular in the wet and dry form, retinopathy, in particular diabetic retinopathy, post-surgery or post-trauma intraocular inflammation, preferably intraocular inflammation following anterior and/or posterior segment surgery, glomerulonephritis, nephropathy, in particular diabetic nephropathy, interstitial cystitis, 20 coronary artery bypass graft surgery (CABG surgery), acute myocardial infarction, prevention of intimal hyperplasia following percutaneous transluminal coronary angioplasty (PTCA), prevention of intimal hyperplasia following stent placement, atherosclerosis, COPD, asthma, rheumatoid arthritis, osteoarthritis, Crohn's disease, inflammatory bowel disease (IBD), psoriasis, diabetes, stroke, Parkinson's disease, Alzheimer's disease, systemic lupus 25 erythematosus, and vasculitis, in particular Wegener's granulomatosis, to be particularly useful for treatment with the JNK inhibitors of the present invention.

According to another aspect the present invention provides a JNK inhibitor sequence comprising less than 150 amino acids in length for the (in vitro) treatment of a tissue or organ transplant prior to or after its transplantation. The term "prior to its transplantation" comprises 30 the time of isolation and the time of perfusion/transport. Thus, the treatment of a tissue or organ transplant "prior to its transplantation" refers for example to treatment during the isolation and/or during perfusion and/or during transport. In particular, a solution used for isolation of of a tissue or organ transplant as well as a solution used for perfusion, transport

and/or otherwise treatment of a tissue or organ transplant can preferably contain the JNK inhibitor according to the invention.

In transplantation the tolerable cold ischemia time (CIT) and the tolerable warm ischemia time (WIT) play critical roles. CIT is the length of time that elapses between an organ being removed from the donor, in particular the time of perfusion/treatment of an organ by cold solutions, to its transplantation into the recipient. WIT is in general a term used to describe ischemia of cells and tissues under normothermic conditions. In particular WIT refers to the length of time that elapses between a donor's death, in particular from the time of cross-clamping or of asystole in non-heart-beating donors, until cold perfusion is commenced. Additionally, WIT may also refer to ischemia during implantation, from removal of the organ from ice until reperfusion. In allotransplantation usually, a transplant originating from a brain-dead donor is typically not subjected to WIT, but has 8-12 hrs of CIT (time needed for transportation from the procurement hospital to the isolation lab), whereas a transplant from a non-heart beating donor is typically exposed to a longer WIT and also 8-12 hrs of CIT. However, such transplantation is currently not used routinely because of concerns about damage due to the WIT. In autotransplantation, WIT may occur, however, CIT is usually limited (typically 1 – 2 hrs, for example in islet autotransplantation in patients with chronic pancreatitis).

Depending on the donor, the organ and/or tissue is not perfused with blood for a variable amount of time prior to its transplantation, leading to ischemia. Ischemia is an inevitable event accompanying transplantation, for example kidney transplantation. Ischemic changes start with brain death, which is associated with severe hemodynamic disturbances: increasing intracranial pressure results in bradycardia and decreased cardiac output; the Cushing reflex causes tachycardia and increased blood pressure; and after a short period of stabilization, systemic vascular resistance declines with hypotension leading to cardiac arrest. Free radical-mediated injury releases proinflammatory cytokines and activates innate immunity. It has been suggested that all of these changes-the early innate response and the ischemic tissue damage play roles in the development of adaptive responses, which in turn may lead to transplant rejection. Hypothermic storage of the organ and/or tissue of various durations before transplantation add to ischemic tissue damage. The final stage of ischemic injury occurs during reperfusion. Reperfusion injury, the effector phase of ischemic injury, develops hours or days after the initial insult. Repair and regeneration processes occur together with

cellular apoptosis, autophagy, and necrosis; the fate of the organ depends on whether cell death or regeneration prevails. The whole process has been described as the ischemia-reperfusion (I-R) injury. It has a profound influence on not only the early but also the late function of a transplanted organ or tissue. Prevention of I-R injury can thus already be started
5 before organ recovery by donor pretreatment.

It was found that such transplants may be (pre-)treated by the JNK inhibitors according to the present invention in order to improve their viability and functionality until transplanted to the host. For that aspect of the invention, the transplant is a kidney, heart, lung, pancreas, in particular pancreatic islets (also called islets of Langerhans), liver, blood cell, bone marrow,
10 cornea, accidental severed limb, in particular fingers, hand, foot, face, nose, bone, cardiac valve, blood vessel or intestine transplant, preferably a kidney, heart, pancreas, in particular pancreatic islets (also called islets of Langerhans), or skin transplant.

Moreover, in a further aspect, the present invention provides a JNK inhibitor as defined herein for the treatment of a tissue or organ transplant, or an animal or human who received a tissue
15 or organ transplant during or after transplantation. The term "after transplantation" refers in particular to reperfusion of the organ or tissue, for example a kidney, whereby reperfusion begins for example by unclamping the respective blood flow. The treatment with a JNK inhibitor according to the present invention after transplantation refers in particular to the time interval of up to four hours after reperfusion, preferably up to two hours after reperfusion,
20 more preferably up to one hour after reperfusion and/or at the day(s) subsequent to transplantation. For the treatment after transplantation, for example after kidney transplantation, the JNK inhibitor according to the present invention may be administered for example to an animal or human who received a tissue or organ transplant as pharmaceutical composition as described herein, for example systemically, in particular intravenously, in a
25 dose in the range of 0.01 – 10 mg/kg, preferably in the range of 0.1 – 5 mg/kg, more preferably in the range of 0.5 – 2 mg/kg at a single dose or repeated doses.

For that aspect of the invention, the transplant is in particular a kidney, heart, lung, pancreas, in particular pancreatic islets (also called islets of Langerhans), liver, blood cell, bone marrow, cornea, accidental severed limb, in particular fingers, hand, foot, face, nose, bone, cardiac
30 valve, blood vessel or intestine transplant, preferably a kidney, heart, pancreas, in particular pancreatic islets (also called islets of Langerhans), or skin transplant.

Since JNK inhibitor sequences as known in the art only proved usability for a limited number of diseases, it was a surprising finding that JNK inhibitor sequences as defined herein may be used and are suitable for the treatment of diseases or disorders strongly related to JNK signaling as mentioned above. This was neither obvious nor suggested by the prior art, even though JNK inhibitor sequences in general have been known from the art.

Typically, a JNK inhibitor sequence as defined above may be derived from a human or rat IB1 sequence, preferably from an amino acid sequence as defined or encoded by any of sequences according to SEQ ID NO: 102 (depicts the IB1 cDNA sequence from rat and its predicted amino acid sequence), SEQ ID NO: 103 (depicts the IB1 protein sequence from rat encoded by the exon-intron boundary of the rIB1 gene – splice donor), SEQ ID NO: 104 (depicts the IB1 protein sequence from *Homo sapiens*), or SEQ ID NO: 105 (depicts the IB1 cDNA sequence from *Homo sapiens*), more preferably from an amino acid sequence as defined or encoded by any of sequences according to SEQ ID NO: 104 (depicts the IB1 protein sequence from *Homo sapiens*), or SEQ ID NO: 105 (depicts the IB1 cDNA sequence from *Homo sapiens*), or from any fragments or variants thereof. In other words, the JNK inhibitor sequence comprises a fragment, variant, or variant of such fragment of a human or rat IB1 sequence. Human or rat IB sequences are defined or encoded, respectively, by the sequences according to SEQ ID NO: 102, SEQ ID NO: 103, SEQ ID NO: 104 or SEQ ID NO: 105.

Preferably, such a JNK inhibitor sequence as used herein comprises a total length of less than 150 amino acid residues, preferably a range of 5 to 150 amino acid residues, more preferably 10 to 100 amino acid residues, even more preferably 10 to 75 amino acid residues and most preferably a range of 10 to 50 amino acid residues, e.g. 10 to 30, 10 to 20, or 10 to 15 amino acid residues.

More preferably, such a JNK inhibitor sequence and the above ranges may be selected from any of the above mentioned sequences, even more preferably from an amino acid sequence as defined according to SEQ ID NO: 104 or as encoded by SEQ ID NO: 105, even more preferably in the region between nucleotides 420 and 980 of SEQ ID NO: 105 or amino acids 105 and 291 of SEQ ID NO: 104, and most preferably in the region between nucleotides 561 and 647 of SEQ ID NO: 105 or amino acids 152 and 180 of SEQ ID NO: 104.

According to a particular embodiment, a JNK inhibitor sequence as used herein typically binds JNK and/or inhibits the activation of at least one JNK activated transcription factor, e.g. c-Jun or ATF2 (see e.g. SEQ ID NOs: 15 and 16, respectively) or Elk1.

5 Likewise, the JNK inhibitor sequence as used herein preferably comprises or consists of at least one amino acid sequence according to any one of SEQ ID NOs: 1 to 4, 13 to 20 and 33 to 100, or a fragment, derivative or variant thereof. More preferably, the JNK inhibitor sequence as used herein may contain 1, 2, 3, 4 or even more copies of an amino acid sequence according to SEQ ID NOs: 1 to 4, 13 to 20 and 33 to 100, or a variant, fragment or
 10 derivative thereof. If present in more than one copy, these amino acid sequences according to SEQ ID NOs: 1 to 4, 13 to 20 and 33 to 100, or variants, fragments, or derivatives thereof as used herein may be directly linked with each other without any linker sequence or via a linker sequence comprising 1 to 10, preferably 1 to 5 amino acids. Amino acids forming the linker sequence are preferably selected from glycine or proline as amino acid residues. More
 15 preferably, these amino acid sequences according to SEQ ID NOs: 1 to 4, 13 to 20 and 33 to 100, or fragments, variants or derivatives thereof, as used herein, may be separated by each other by a hinge of two, three or more proline residues.

The JNK inhibitor sequences as used herein may be composed of L-amino acids, D-amino
 20 acids, or a combination of both. Preferably, the JNK inhibitor sequences as used herein comprise at least 1 or even 2, preferably at least 3, 4 or 5, more preferably at least 6, 7, 8 or 9 and even more preferably at least 10 or more D- and/or L-amino acids, wherein the D- and/or L-amino acids may be arranged in the JNK inhibitor sequences as used herein in a blockwise, a non-blockwise or in an alternate manner.

25 According to one preferred embodiment the JNK inhibitor sequences as used herein may be exclusively composed of L-amino acids. The JNK inhibitor sequences as used herein may then comprise or consist of at least one „native JNK inhibitor sequence“ according to SEQ ID NO: 1 or 3. In this context, the term “native” or “native JNK inhibitor sequence(s)” is referred
 30 to non-altered JNK inhibitor sequences according to any of SEQ ID NOs: 1 or 3, as used herein, entirely composed of L-amino acids.

Accordingly, the JNK inhibitor sequence as used herein may comprise or consist of at least one (native) amino acid sequence $\text{NH}_2\text{-X}_n^b\text{-X}_n^a\text{-RPTTLXLXXXXXXQD-X}_n^b\text{-COOH}$ (L-IB

generic (s)) [SEQ ID NO: 3] and/or the JNK binding domain (JBDs) of IB1 XRPTTLXLXXXXXXQDS/TX (L-IB (generic)) [SEQ ID NO: 19]. In this context, each X typically represents an amino acid residue, preferably selected from any (native) amino acid residue. X_n^a typically represents one amino acid residue, preferably selected from any amino acid residue except serine or threonine, wherein n (the number of repetitions of X) is 0 or 1. Furthermore, each X_n^b may be selected from any amino acid residue, wherein n (the number of repetitions of X) is 0-5, 5-10, 10-15, 15-20, 20-30 or more, provided that if n (the number of repetitions of X) is 0 for X_n^a , X_n^b does preferably not comprise a serine or threonine at its C-terminus, in order to avoid a serine or threonine at this position. Preferably, X_n^b represents a contiguous stretch of peptide residues derived from SEQ ID NO: 1 or 3. X_n^a and X_n^b may represent either D or L amino acids. Additionally, the JNK inhibitor sequence as used herein may comprise or consist of at least one (native) amino acid sequence selected from the group comprising the JNK binding domain of IB1 DTYRPKRPTTLNLFQVPRSQDT (L-IB1) [SEQ ID NO: 17]. More preferably, the JNK inhibitor sequence as used herein further may comprise or consist of at least one (native) amino acid sequence NH_2 -RPKRPTTLNLFQVPRSQD-COOH (L-IB1(s)) [SEQ ID NO: 1]. Furthermore, the JNK inhibitor sequence as used herein may comprise or consist of at least one (native) amino acid sequence selected from the group comprising the JNK binding domain of IB1 L-IB1(s1) (NH_2 -TLNLFQVPRSQD-COOH, SEQ ID NO: 33); L-IB1(s2) (NH_2 -TTLNLFQVPRSQ-COOH, SEQ ID NO: 34); L-IB1(s3) (NH_2 -PTTLNLFQVPRS-COOH, SEQ ID NO: 35); L-IB1(s4) (NH_2 -RPTTLNLFQVPR-COOH, SEQ ID NO: 36); L-IB1(s5) (NH_2 -KRPTTLNLFQVP-COOH, SEQ ID NO: 37); L-IB1(s6) (NH_2 -PKRPTTLNLFQV-COOH, SEQ ID NO: 38); L-IB1(s7) (NH_2 -RPKRPTTLNLFQ-COOH, SEQ ID NO: 39); L-IB1(s8) (NH_2 -LNLFPQVPRSQD-COOH, SEQ ID NO: 40); L-IB1(s9) (NH_2 -TLNLFQVPRSQ-COOH, SEQ ID NO: 41); L-IB1(s10) (NH_2 -TTLNLFQVPRS-COOH, SEQ ID NO: 42); L-IB1(s11) (NH_2 -PTTLNLFQVPR-COOH, SEQ ID NO: 43); L-IB1(s12) (NH_2 -RPTTLNLFQVP-COOH, SEQ ID NO: 44); L-IB1(s13) (NH_2 -KRPTTLNLFQV-COOH, SEQ ID NO: 45); L-IB1(s14) (NH_2 -PKRPTTLNLFQ-COOH, SEQ ID NO: 46); L-IB1(s15) (NH_2 -RPKRPTTLNLF-COOH, SEQ ID NO: 47); L-IB1(s16) (NH_2 -NLFQVPRSQD-COOH, SEQ ID NO: 48); L-IB1(s17) (NH_2 -LNLFPQVPRSQ-COOH, SEQ ID NO: 49); L-IB1(s18) (NH_2 -TLNLFQVPRS-COOH, SEQ ID NO: 50); L-IB1(s19) (NH_2 -TTLNLFQVPR-COOH, SEQ ID NO: 51); L-IB1(s20) (NH_2 -PTTLNLFQVP-COOH, SEQ ID NO: 52); L-IB1(s21) (NH_2 -RPTTLNLFQV-COOH, SEQ ID NO: 53); L-IB1(s22) (NH_2 -KRPTTLNLFQ-COOH, SEQ ID NO: 54); L-IB1(s23) (NH_2 -PKRPTTLNLF-COOH, SEQ ID NO: 55); L-IB1(s24) (NH_2 -RPKRPTTLNLF-COOH, SEQ ID NO: 56); L-IB1(s25) (NH_2 -

LFPQVPRSQD-COOH, SEQ ID NO: 57); L-IB1(s26) (NH₂-NLFPQVPRSQ-COOH, SEQ ID NO: 58); L-IB1(s27) (NH₂-LNLFPQVPRS-COOH, SEQ ID NO: 59); L-IB1(s28) (NH₂-TLNLFPQVPR-COOH, SEQ ID NO: 60); L-IB1(s29) (NH₂-TTLNLFPQVP-COOH, SEQ ID NO: 61); L-IB1(s30) (NH₂-PTTLNLFPQV-COOH, SEQ ID NO: 62); L-IB1(s31) (NH₂-RPTTLNLFPQ-COOH, SEQ ID NO: 63); L-IB1(s32) (NH₂-KRPTTLNLFP-COOH, SEQ ID NO: 64); L-IB1(s33) (NH₂-PKRPTTLNLF-COOH, SEQ ID NO: 65); and L-IB1(s34) (NH₂-RPKRPTTLNL-COOH, SEQ ID NO: 66).

Additionally, the JNK inhibitor sequence as used herein may comprise or consist of at least one (native) amino acid sequence selected from the group comprising the (long) JNK binding domain (JBDs) of IB1 PGTGCGDTYRPKRPTTLNLFPQVPRSQDT (IB1-long) [SEQ ID NO: 13], the (long) JNK binding domain of IB2 IPSPSVEEPHKHRPTTLRLTTLGAQDS (IB2-long) [SEQ ID NO: 14], the JNK binding domain of c-Jun GAYGYSNPKILKQSMTLNLADPVGNLKPH (c-Jun) [SEQ ID NO: 15], the JNK binding domain of ATF2 TNEDHLAVHKHKHEMTLKFGPARNDVIV (ATF2) [SEQ ID NO: 16] (see e.g. Figure 1A-1C). In this context, an alignment revealed a partially conserved 8 amino acid sequence (see e.g. Figure 1A) and a further comparison of the JBDs of IB1 and IB2 revealed two blocks of seven and three amino acids that are highly conserved between the two sequences.

According to another preferred embodiment the JNK inhibitor sequences as used herein may be composed in part or exclusively of D-amino acids as defined above. More preferably, these JNK inhibitor sequences composed of D-amino acids are non-native D retro-inverso sequences of the above (native) JNK inhibitor sequences. The term "retro-inverso sequences" refers to an isomer of a linear peptide sequence in which the direction of the sequence is reversed and the chirality of each amino acid residue is inverted (see e.g. Jameson *et al.*, Nature, 368,744-746 (1994); Brady *et al.*, Nature, 368, 692-693 (1994)). The advantage of combining D-enantiomers and reverse synthesis is that the positions of carbonyl and amino groups in each amide bond are exchanged, while the position of the side-chain groups at each alpha carbon is preserved. Unless specifically stated otherwise, it is presumed that any given L-amino acid sequence or peptide as used according to the present invention may be converted into an D retro-inverso sequence or peptide by synthesizing a reverse of the sequence or peptide for the corresponding native L-amino acid sequence or peptide.

The D retro-inverso sequences as used herein and as defined above have a variety of useful properties. For example, D retro-inverso sequences as used herein enter cells as efficiently as L-amino acid sequences as used herein, whereas the D retro-inverso sequences as used herein are more stable than the corresponding L-amino acid sequences.

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Accordingly, the JNK inhibitor sequences as used herein may comprise or consist of at least one D retro-inverso sequence according to the amino acid sequence $\text{NH}_2\text{-X}_n^b\text{-DQXXXXXXXXLXLTPR-X}_n^a\text{-X}_n^b\text{-COOH}$ (D-IB1 generic (s)) [SEQ ID NO: 4] and/or $\text{XS/TDQXXXXXXXXLXLTPRX}$ (D-IB (generic)) [SEQ ID NO: 20]. As used in this context, X,

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X_n^a and X_n^b are as defined above (preferably, representing D amino acids), wherein X_n^b preferably represents a contiguous stretch of residues derived from SEQ ID NO: 2 or 4.

Additionally, the JNK inhibitor sequences as used herein may comprise or consist of at least one D retro-inverso sequence according to the amino acid sequence comprising the JNK binding domain (JBDs) of IB1 $\text{TDQSRPVQPFLNLTPRKPRYTD}$ (D-IB1) [SEQ ID NO: 18].

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More preferably, the JNK inhibitor sequences as used herein may comprise or consist of at least one D retro-inverso sequence according to the amino acid sequence $\text{NH}_2\text{-DQSRPVQPFLNLTPRKPR-COOH}$ (D-IB1(s)) [SEQ ID NO: 2]. Furthermore, the JNK inhibitor sequences as used herein may comprise or consist of at least one D retro-inverso sequence according to the amino acid sequence comprising the JNK binding domain (JBDs) of IB1 D-

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IB1(s1) ($\text{NH}_2\text{-QPFLNLTPRKPR-COOH}$, SEQ ID NO: 67); D-IB1(s2) ($\text{NH}_2\text{-VQPFLNLTPRKPR-COOH}$, SEQ ID NO: 68); D-IB1(s3) ($\text{NH}_2\text{-PVQPFLNLTPRK-COOH}$, SEQ ID NO: 69); D-IB1(s4) ($\text{NH}_2\text{-RPVQPFLNLTPR-COOH}$, SEQ ID NO: 70); D-IB1(s5) ($\text{NH}_2\text{-SRPVQPFLNLTPR-COOH}$, SEQ ID NO: 71); D-IB1(s6) ($\text{NH}_2\text{-QSRPVQPFLNLTT-COOH}$, SEQ ID NO: 72); D-IB1(s7) ($\text{NH}_2\text{-DQSRPVQPFLNLTT-COOH}$, SEQ ID NO: 73); D-IB1(s8) ($\text{NH}_2\text{-PFLNLTPRKPR-}$

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COOH , SEQ ID NO: 74); D-IB1(s9) ($\text{NH}_2\text{-QPFLNLTPRKPR-COOH}$, SEQ ID NO: 75); D-IB1(s10) ($\text{NH}_2\text{-VQPFLNLTPRK-COOH}$, SEQ ID NO: 76); D-IB1(s11) ($\text{NH}_2\text{-PVQPFLNLTPR-COOH}$, SEQ ID NO: 77); D-IB1(s12) ($\text{NH}_2\text{-RPVQPFLNLTPR-COOH}$, SEQ ID NO: 78); D-IB1(s13) ($\text{NH}_2\text{-SRPVQPFLNLTT-COOH}$, SEQ ID NO: 79); D-IB1(s14) ($\text{NH}_2\text{-QSRPVQPFLNLTT-COOH}$, SEQ ID NO: 80); D-IB1(s15) ($\text{NH}_2\text{-DQSRPVQPFLNL-COOH}$, SEQ ID NO: 81); D-

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IB1(s16) ($\text{NH}_2\text{-FLNLTPRKPR-COOH}$, SEQ ID NO: 82); D-IB1(s17) ($\text{NH}_2\text{-PFLNLTPRKPR-COOH}$, SEQ ID NO: 83); D-IB1(s18) ($\text{NH}_2\text{-QPFLNLTPRK-COOH}$, SEQ ID NO: 84); D-IB1(s19) ($\text{NH}_2\text{-VQPFLNLTPR-COOH}$, SEQ ID NO: 85); D-IB1(s20) ($\text{NH}_2\text{-PVQPFLNLTPR-COOH}$, SEQ ID NO: 86); D-IB1(s21) ($\text{NH}_2\text{-RPVQPFLNLTT-COOH}$, SEQ ID NO: 87); D-IB1(s22) ($\text{NH}_2\text{-SRPVQPFLNLTT-COOH}$, SEQ ID NO: 88); D-IB1(s23) ($\text{NH}_2\text{-QSRPVQPFLNL-}$

COOH, SEQ ID NO: 89); D-IB1(s24) (NH₂-DQSRPVQPFLN-COOH, SEQ ID NO: 90); D-IB1(s25) (NH₂-DQSRPVQPFL-COOH, SEQ ID NO: 91); D-IB1(s26) (NH₂-QSRPVQPFLN-COOH, SEQ ID NO: 92); D-IB1(s27) (NH₂-SRPVQPFLNL-COOH, SEQ ID NO: 93); D-IB1(s28) (NH₂-RPVQPFLNLT-COOH, SEQ ID NO: 94); D-IB1(s29) (NH₂-PVQPFLNLTT-COOH, SEQ ID NO: 95); D-IB1(s30) (NH₂-VQPFLNLTTTP-COOH, SEQ ID NO: 96); D-IB1(s31) (NH₂-QPFLNLTTTPR-COOH, SEQ ID NO: 97); D-IB1(s32) (NH₂-PFLNLTTTPRK-COOH, SEQ ID NO: 98); D-IB1(s33) (NH₂-FLNLTTTPRK-COOH, SEQ ID NO: 99); and D-IB1(s34) (NH₂-LNLTTTPRKPR-COOH, SEQ ID NO: 100).

The JNK inhibitor sequences as used herein and as disclosed above are presented in Table 1 (SEQ ID NO:s 1-4, 13-20 and 33-100). The table presents the name of the JNK inhibitor sequences as used herein, as well as their sequence identifier number, their length, and amino acid sequence. Furthermore, Table 1 shows sequences as well as their generic formulas, e.g. for SEQ ID NO's: 1, 2, 5, 6, 9 and 11 and SEQ ID NO's: 3, 4, 7, 8, 10 and 12, respectively.

Table 1 furthermore discloses the chimeric sequences SEQ ID NOs: 9-12 and 23-32 (see below), L-IB1 sequences SEQ ID NOs: 33 to 66 and D-IB1 sequences SEQ ID NOs: 67 to 100.

TABLE 1

SEQUENCE/PEPTIDE NAME	SEQ ID NO	AA	SEQUENCE
L-IB1(s)	1	19	RPKRPTTLNLFQVPRSQD (NH ₂ -RPKRPTTLNLFQVPRSQD-COOH)
D-IB1(s)	2	19	DQSRPVQPFLNLTTTPRKPR (NH ₂ -DQSRPVQPFLNLTTTPRKPR-COOH)
L-IB (generic) (s)	3	19	NH ₂ -X _n ^b -X _n ^a -RPTTLXLLLLXXXXQD-X _n ^b -COOH
D-IB (generic) (s)	4	19	NH ₂ -X _n ^b -DQXXXXXXXXLXLTTPR-X _n ^a -X _n ^b -COOH
L-TAT	5	10	GRKKRRQRRR (NH ₂ -GRKKRRQRRR-COOH)
D-TAT	6	10	RRRQRRKKRG (NH ₂ -RRRQRRKKRG-COOH)
L-generic-TAT (s)	7	11	NH ₂ -X _n ^b -RKKRRQRRR-X _n ^b -COOH
D-generic-TAT (s)	8	11	NH ₂ -X _n ^b -RRRQRRKKR-X _n ^b -COOH
L-TAT-IB1(s)	9	31	GRKKRRQRRRPPRPKRPTTLNLFQVPRSQD (NH ₂ -GRKKRRQRRRPPRPKRPTTLNLFQVPRSQD-COOH)
L-TAT-IB (generic) (s)	10	29	NH ₂ -X _n ^b -RKKRRQRRR-X _n ^b -X _n ^a -RPTTLXLLLLXXXXQD-X _n ^b -COOH
D-TAT-IB1(s)	11	31	DQSRPVQPFLNLTTTPRKPRPPRRRQRRKKRG (NH ₂ -DQSRPVQPFLNLTTTPRKPRPPRRRQRRKKRG-COOH)
D-TAT-IB (generic) (s)	12	29	NH ₂ -X _n ^b -DQXXXXXXXXLXLTTPR-X _n ^a -X _n ^b -RRRQRRKKR-X _n ^b -COOH
IB1-long	13	29	PGTGCGDTYRPKRPTTLNLFQVPRSQDT (NH ₂ - PGTGCGDTYRPKRPTTLNLFQVPRSQDT -COOH)
IB2-long	14	27	IPSPSVEEPHKHRPTTLRLTTLGAQDS (NH ₂ - IPSPSVEEPHKHRPTTLRLTTLGAQDS -COOH)
c-Jun	15	29	GAYGYSNPKILKQSMTLNLADPVGNLKPH (NH ₂ - GAYGYSNPKILKQSMTLNLADPVGNLKPH -COOH)

ATF2	16	29	TNEDHLAVHKHKHEMTLKFGPARNDSVIV (NH ₂ - TNEDHLAVHKHKHEMTLKFGPARNDSVIV -COOH)
L-IB1	17	23	DTYRPKRPTTLNLFQVPRSQDT (NH ₂ - DTYRPKRPTTLNLFQVPRSQDT -COOH)
D-IB1	18	23	TDQSRPVQPFLNLTPRKPRYTD (NH ₂ - TDQSRPVQPFLNLTPRKPRYTD -COOH)
L-IB (generic)	19	19	XRPTTLXLXXXXXXXXQDS/TX (NH ₂ - XRPTTLXLXXXXXXXXQDS/TX -COOH)
D-IB (generic)	20	19	XS/TDQXXXXXXXXXLTPRX (NH ₂ - XS/TDQXXXXXXXXXLTPRX -COOH)
L-generic-TAT	21	17	XXXXRKRRQRRRXXXX (NH ₂ - XXXXRKRRQRRRXXXX -COOH)
D-generic-TAT	22	17	XXXXRRRQRRKKRXXXX (NH ₂ - XXXXRRRQRRKKRXXXX -COOH)
L-TAT-IB1	23	35	GRKKRRQRRRPPDTYRPKRPTTLNLFQVPRSQDT (NH ₂ - GRKKRRQRRRPPDTYRPKRPTTLNLFQVPRSQDT -COOH)
L-TAT-IB (generic)	24	42	XXXXXXXXRKRRQRRRXXXXXXXXXRPTTLXLXXXXXXXXQDS/TX (NH ₂ - XXXXXXXXRKRRQRRRXXXXXXXXXRPTTLXLXXXXXXXXQDS/TX - COOH)
D-TAT-IB1	25	35	TDQSRPVQPFLNLTPRKPRYTDPPRRRQRRKKRG (NH ₂ - TDQSRPVQPFLNLTPRKPRYTDPPRRRQRRKKRG -COOH)
D-TAT-IB (generic)	26	42	XT/SDQXXXXXXXXXLTPRXXXXXXXXRRRQRRKKRXXXXXXXX (NH ₂ - XT/SDQXXXXXXXXXLTPRXXXXXXXXRRRQRRKKRXXXXXXXX - COOH)
L-TAT-IB1(s1)	27	30	RKKRRQRRRPPRPKRPTTLNLFQVPRSQD (NH ₂ -RKKRRQRRRPPRPKRPTTLNLFQVPRSQD-COOH)
L-TAT-IB1(s2)	28	30	GRKKRRQRRR _n °RPKRPTTLNLFQVPRSQD (NH ₂ -GRKKRRQRRR _n °RPKRPTTLNLFQVPRSQD-COOH)
L-TAT-IB1(s3)	29	29	RKKRRQRRR _n °RPKRPTTLNLFQVPRSQD (NH ₂ -RKKRRQRRR _n °RPKRPTTLNLFQVPRSQD-COOH)
D-TAT-IB1(s1)	30	30	DQSRPVQPFLNLTPRKPRPPRRRQRRKKR (NH ₂ -DQSRPVQPFLNLTPRKPRPPRRRQRRKKR-COOH)
D-TAT-IB1(s2)	31	30	DQSRPVQPFLNLTPRKPR _n °RRRQRRKKRG (NH ₂ -DQSRPVQPFLNLTPRKPR _n °RRRQRRKKRG-COOH)
D-TAT-IB1(s3)	32	29	DQSRPVQPFLNLTPRKPR _n °RRRQRRKKR (NH ₂ -DQSRPVQPFLNLTPRKPR _n °RRRQRRKKR-COOH)
L-IB1(s1)	33	13	TLNLFQVPRSQD (NH ₂ -TLNLFQVPRSQD-COOH)
L-IB1(s2)	34	13	TTLNLFQVPRSQ (NH ₂ -TTLNLFQVPRSQ-COOH)
L-IB1(s3)	35	13	PTTLNLFQVPRS (NH ₂ -PTTLNLFQVPRS-COOH)
L-IB1(s4)	36	13	RPTTLNLFQVPR (NH ₂ -RPTTLNLFQVPR-COOH)
L-IB1(s5)	37	13	KRPTTLNLFQVP (NH ₂ -KRPTTLNLFQVP-COOH)
L-IB1(s6)	38	13	PKRPTTLNLFQV (NH ₂ -PKRPTTLNLFQV-COOH)
L-IB1(s7)	39	13	RPKRPTTLNLFQ (NH ₂ -RPKRPTTLNLFQ-COOH)
L-IB1(s8)	40	12	LNLFQVPRSQD (NH ₂ -LNLFQVPRSQD-COOH)
L-IB1(s9)	41	12	TLNLFQVPRSQ

			(NH ₂ -TLNLFQVPRSQ-COOH)
L-IB1(s10)	42	12	TTLNLFQVPRS (NH ₂ -TTLNLFQVPRS-COOH)
L-IB1(s11)	43	12	PTTLNLFQVPR (NH ₂ -PTTLNLFQVPR-COOH)
L-IB1(s12)	44	12	RPTTLNLFQVP (NH ₂ -RPTTLNLFQVP-COOH)
L-IB1(s13)	45	12	KRPTTLNLFQV (NH ₂ -KRPTTLNLFQV-COOH)
L-IB1(s14)	46	12	PKRPTTLNLFQ (NH ₂ -PKRPTTLNLFQ-COOH)
L-IB1(s15)	47	12	RPKRPTTLNLF (NH ₂ -RPKRPTTLNLF-COOH)
L-IB1(s16)	48	11	NLFQVPRSQD (NH ₂ -NLFQVPRSQD-COOH)
L-IB1(s17)	49	11	LNLFQVPRSQ (NH ₂ -LNLFQVPRSQ-COOH)
L-IB1(s18)	50	11	TLNLFQVPRS (NH ₂ -TLNLFQVPRS-COOH)
L-IB1(s19)	51	11	TTLNLFQVPR (NH ₂ -TTLNLFQVPR-COOH)
L-IB1(s20)	52	11	PTTLNLFQVP (NH ₂ -PTTLNLFQVP-COOH)
L-IB1(s21)	53	11	RPTTLNLFQV (NH ₂ -RPTTLNLFQV-COOH)
L-IB1(s22)	54	11	KRPTTLNLFQ (NH ₂ -KRPTTLNLFQ-COOH)
L-IB1(s23)	55	11	PKRPTTLNLF (NH ₂ -PKRPTTLNLF-COOH)
L-IB1(s24)	56	11	RPKRPTTLNLF (NH ₂ -RPKRPTTLNLF-COOH)
L-IB1(s25)	57	10	LFPQVPRSQD (NH ₂ -LFPQVPRSQD-COOH)
L-IB1(s26)	58	10	NLFQVPRSQ (NH ₂ -NLFQVPRSQ-COOH)
L-IB1(s27)	59	10	LNLFQVPRS (NH ₂ -LNLFQVPRS-COOH)
L-IB1(s28)	60	10	TLNLFQVPR (NH ₂ -TLNLFQVPR-COOH)
L-IB1(s29)	61	10	TTLNLFQVP (NH ₂ -TTLNLFQVP-COOH)
L-IB1(s30)	62	10	PTTLNLFQV (NH ₂ -PTTLNLFQV-COOH)
L-IB1(s31)	63	10	RPTTLNLFQ (NH ₂ -RPTTLNLFQ-COOH)
L-IB1(s32)	64	10	KRPTTLNLF (NH ₂ -KRPTTLNLF-COOH)
L-IB1(s33)	65	10	PKRPTTLNLF (NH ₂ -PKRPTTLNLF-COOH)
L-IB1(s34)	66	10	RPKRPTTLNL (NH ₂ -RPKRPTTLNL-COOH)
D-IB1(s1)	67	13	QPFLNLTTPRKPR (NH ₂ -QPFLNLTTPRKPR-COOH)
D-IB1(s2)	68	13	VQPFLNLTTPRKPR

			(NH ₂ -VQPFLNLTPRK-PRK-COOH)
D-IB1(s3)	69	13	PVQPFLNLTPRK (NH ₂ -PVQPFLNLTPRK-COOH)
D-IB1(s4)	70	13	RPVQPFLNLTPR (NH ₂ -RPVQPFLNLTPR-COOH)
D-IB1(s5)	71	13	SRPVQPFLNLTP (NH ₂ -SRPVQPFLNLTP-COOH)
D-IB1(s6)	72	13	QSRPVQPFLNLTT (NH ₂ -QSRPVQPFLNLTT-COOH)
D-IB1(s7)	73	13	DQSRPVQPFLNL (NH ₂ -DQSRPVQPFLNL-COOH)
D-IB1(s8)	74	12	PFLNLTPRKPR (NH ₂ -PFLNLTPRKPR-COOH)
D-IB1(s9)	75	12	QPFLNLTPRK (NH ₂ -QPFLNLTPRK-COOH)
D-IB1(s10)	76	12	VQPFLNLTPRK (NH ₂ -VQPFLNLTPRK-COOH)
D-IB1(s11)	77	12	PVQPFLNLTPR (NH ₂ -PVQPFLNLTPR-COOH)
D-IB1(s12)	78	12	RPVQPFLNLTP (NH ₂ -RPVQPFLNLTP-COOH)
D-IB1(s13)	79	12	SRPVQPFLNLTT (NH ₂ -SRPVQPFLNLTT-COOH)
D-IB1(s14)	80	12	QSRPVQPFLNL (NH ₂ -QSRPVQPFLNL-COOH)
D-IB1(s15)	81	12	DQSRPVQPFLNL (NH ₂ -DQSRPVQPFLNL-COOH)
D-IB1(s16)	82	11	FLNLTPRKPR (NH ₂ -FLNLTPRKPR-COOH)
D-IB1(s17)	83	11	PFLNLTPRK (NH ₂ -PFLNLTPRK-COOH)
D-IB1(s18)	84	11	QPFLNLTPRK (NH ₂ -QPFLNLTPRK-COOH)
D-IB1(s19)	85	11	VQPFLNLTPR (NH ₂ -VQPFLNLTPR-COOH)
D-IB1(s20)	86	11	PVQPFLNLTP (NH ₂ -PVQPFLNLTP-COOH)
D-IB1(s21)	87	11	RPVQPFLNLTT (NH ₂ -RPVQPFLNLTT-COOH)
D-IB1(s22)	88	11	SRPVQPFLNL (NH ₂ -SRPVQPFLNL-COOH)
D-IB1(s23)	89	11	QSRPVQPFLNL (NH ₂ -QSRPVQPFLNL-COOH)
D-IB1(s24)	90	11	DQSRPVQPFLN (NH ₂ -DQSRPVQPFLN-COOH)
D-IB1(s25)	91	10	DQSRPVQPFL (NH ₂ -DQSRPVQPFL-COOH)
D-IB1(s26)	92	10	QSRPVQPFLN (NH ₂ -QSRPVQPFLN-COOH)
D-IB1(s27)	93	10	SRPVQPFLNL (NH ₂ -SRPVQPFLNL-COOH)
D-IB1(s28)	94	10	RPVQPFLNL (NH ₂ -RPVQPFLNL-COOH)
D-IB1(s29)	95	10	PVQPFLNLTT

			(NH ₂ -PVQPFLNLTT-COOH)
D-IB1(s30)	96	10	VQPFLNLTTTP (NH ₂ -VQPFLNLTTTP-COOH)
D-IB1(s31)	97	10	QPFLNLTTTPR (NH ₂ -QPFLNLTTTPR-COOH)
D-IB1(s32)	98	10	PFLNLTTTPRK (NH ₂ -PFLNLTTTPRK-COOH)
D-IB1(s33)	99	10	FLNLTTTPRK (NH ₂ -FLNLTTTPRK-COOH)
D-IB1(s34)	100	10	LNLTTTPRKPR (NH ₂ -LNLTTTPRKPR-COOH)

According to another preferred embodiment, the JNK inhibitor sequence as used herein comprises or consists of at least one variant, fragment and/or derivative of the above defined native or non-native amino acid sequences according to SEQ ID NOs: 1-4, 13-20 and 33-100. Preferably, these variants, fragments and/or derivatives retain biological activity of the above disclosed native or non-native JNK inhibitor sequences as used herein, particularly of native or non-native amino acid sequences according to SEQ ID NOs: 1-4, 13-20 and 33-100, i.e. binding JNK and/or inhibiting the activation of at least one JNK activated transcription factor, e.g. c-Jun, ATF2 or Elk1. Functionality may be tested by various tests, e.g. binding tests of the peptide to its target molecule or by biophysical methods, e.g. spectroscopy, computer modeling, structural analysis, etc.. Particularly, an JNK inhibitor sequence or variants, fragments and/or derivatives thereof as defined above may be analyzed by hydrophilicity analysis (see e.g. Hopp and Woods, 1981. Proc Natl Acad Sci USA 78: 3824-3828) that can be utilized to identify the hydrophobic and hydrophilic regions of the peptides, thus aiding in the design of substrates for experimental manipulation, such as in binding experiments, or for antibody synthesis. Secondary structural analysis may also be performed to identify regions of an JNK inhibitor sequence or of variants, fragments and/or derivatives thereof as used herein that assume specific structural motifs (see e.g. Chou and Fasman, 1974, Biochem 13: 222-223). Manipulation, translation, secondary structure prediction, hydrophilicity and hydrophobicity profiles, open reading frame prediction and plotting, and determination of sequence homologies can be accomplished using computer software programs available in the art. Other methods of structural analysis include, e.g. X-ray crystallography (see e.g. Engstrom, 1974. Biochem Exp Biol 11: 7-13), mass spectroscopy and gas chromatography (see e.g. METHODS IN PROTEIN SCIENCE, 1997, J. Wiley and Sons, New York, NY) and computer modeling (see e.g. Fletterick and Zoller, eds., 1986. Computer Graphics and Molecular Modeling, In: CURRENT COMMUNICATIONS IN MOLECULAR

BIOLOGY, Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY) may also be employed.

Accordingly, the JNK inhibitor sequence as used herein may comprise or consist of at least one variant of (native or non-native) amino acid sequences according to SEQ ID NOs: 1-4, 13-20 and 33-100. In the context of the present invention, a "variant of a (native or non-native) amino acid sequence according to SEQ ID NOs: 1-4, 13-20 and 33-100" is preferably a sequence derived from any of the sequences according to SEQ ID NOs: 1-4, 13-20 and 33-100, wherein the variant comprises amino acid alterations of the amino acid sequences according to SEQ ID NOs: 1-4, 13-20 and 33-100. Such alterations typically comprise 1 to 20, preferably 1 to 10 and more preferably 1 to 5 substitutions, additions and/or deletions of amino acids according to SEQ ID NOs: 1-4, 13-20 and 33-100, wherein the variant exhibits a sequence identity with any of the sequences according to SEQ ID NOs: 1-4, 13-20 and 33-100 of at least about 30%, 50%, 70%, 80%, 90%, 95%, 98% or even 99%.

If variants of (native or non-native) amino acid sequences according to SEQ ID NOs: 1-4, 13-20 and 33-100 as defined above and used herein are obtained by substitution of specific amino acids, such substitutions preferably comprise conservative amino acid substitutions. Conservative amino acid substitutions may include synonymous amino acid residues within a group which have sufficiently similar physicochemical properties, so that a substitution between members of the group will preserve the biological activity of the molecule (see e.g. Grantham, R. (1974), *Science* 185, 862-864). It is evident to the skilled person that amino acids may also be inserted and/or deleted in the above-defined sequences without altering their function, particularly if the insertions and/or deletions only involve a few amino acids, e.g. less than twenty, and preferably less than ten, and do not remove or displace amino acids which are critical to functional activity. Moreover, substitutions shall be avoided in variants as used herein, which lead to additional threonines at amino acid positions which are accessible for a phosphorylase, preferably a kinase, in order to avoid inactivation of the JNK-inhibitor sequence as used herein or of the chimeric peptide as used herein *in vivo* or *in vitro*.

Preferably, synonymous amino acid residues, which are classified into the same groups and are typically exchangeable by conservative amino acid substitutions, are defined in Table 2.

TABLE 2

Preferred Groups of Synonymous Amino Acid Residues		
	<u>Amino Acid</u>	<u>Synonymous Residue</u>
5	Ser	Ser, Thr, Gly, Asn
	Arg	Arg, Gln, Lys, Glu, His
	Leu	Ile, Phe, Tyr, Met, Val, Leu
	Pro	Gly, Ala, (Thr), Pro
	Thr	Pro, Ser, Ala, Gly, His, Gln, Thr
10	Ala	Gly, Thr, Pro, Ala
	Val	Met, Tyr, Phe, Ile, Leu, Val
	Gly	Ala, (Thr), Pro, Ser, Gly
	Ile	Met, Tyr, Phe, Val, Leu, Ile
	Phe	Trp, Met, Tyr, Ile, Val, Leu, Phe
15	Tyr	Trp, Met, Phe, Ile, Val, Leu, Tyr
	Cys	Ser, Thr, Cys
	His	Glu, Lys, Gln, Thr, Arg, His
	Gln	Glu, Lys, Asn, His, (Thr), Arg, Gln
	Asn	Gln, Asp, Ser, Asn
20	Lys	Glu, Gln, His, Arg, Lys
	Asp	Glu, Asn, Asp
	Glu	Asp, Lys, Asn, Gln, His, Arg, Glu
	Met	Phe, Ile, Val, Leu, Met
25	Trp	Trp

A specific form of a variant of SEQ ID NOs: 1-4, 13-20 and 33-100 as used herein is a fragment of the (native or non-native) amino acid sequences according to SEQ ID NOs: 1, 1-4, 13-20 and 33-100" as used herein, which is typically altered by at least one deletion as compared to SEQ ID NOs 1-4, 13-20 and 33-100. Preferably, a fragment comprises at least 4 contiguous amino acids of any of SEQ ID NOs: 1-4, 13-20 and 33-100, a length typically sufficient to allow for specific recognition of an epitope from any of these sequences. Even more preferably, the fragment comprises 4 to 18, 4 to 15, or most preferably 4 to 10 contiguous amino acids of any of SEQ ID NOs: 1-4, 13-20 and 33-100, wherein the lower limit of the range may be 4, or 5, 6, 7, 8, 9, or 10. Deleted amino acids may occur at any position of SEQ ID NOs: 1-4, 13-20 and 33-100, preferably N- or C-terminally.

Furthermore, a fragment of the (native or non-native) amino acid sequences according to SEQ ID NOs: 1-4, 13-20 and 33-100, as described above, may be defined as a sequence sharing a sequence identity with any of the sequences according to SEQ ID NOs: 1-4, 13-20 and 33-100 as used herein of at least about 30%, 50%, 70%, 80%, 90%, 95%, 98%, or even 99%.

The JNK inhibitor sequences as used herein may further comprise or consist of at least one derivative of (native or non-native) amino acid sequences according to SEQ ID NOs: 1-4, 13-20 and 33-100 as defined above. In this context, a "derivative of an (native or non-native) amino acid sequence according to SEQ ID NOs: 1-4, 13-20 and 33-100" is preferably an amino acid sequence derived from any of the sequences according to SEQ ID NOs: 1-4, 13-20 and 33-100, wherein the derivative comprises at least one modified L- or D-amino acid (forming non-natural amino acid(s)), preferably 1 to 20, more preferably 1 to 10, and even more preferably 1 to 5 modified L- or D-amino acids. Derivatives of variants or fragments also fall under the scope of the present invention.

"A modified amino acid" in this respect may be any amino acid which is altered e.g. by different glycosylation in various organisms, by phosphorylation or by labeling specific amino acids. Such a label is then typically selected from the group of labels comprising:

- (i) radioactive labels, i.e. radioactive phosphorylation or a radioactive label with sulphur, hydrogen, carbon, nitrogen, etc.;
- (ii) colored dyes (e.g. digoxigenin, etc.);
- (iii) fluorescent groups (e.g. fluorescein, etc.);
- (iv) chemoluminescent groups;
- (v) groups for immobilization on a solid phase (e.g. His-tag, biotin, strep-tag, flag-tag, antibodies, antigen, etc.); and
- (vi) a combination of labels of two or more of the labels mentioned under (i) to (v).

In the above context, an amino acid sequence having a sequence "sharing a sequence identity" of at least, for example, 95% to a query amino acid sequence of the present invention, is intended to mean that the sequence of the subject amino acid sequence is identical to the query sequence except that the subject amino acid sequence may include up to five amino acid alterations per each 100 amino acids of the query amino acid sequence. In other words, to obtain an amino acid sequence having a sequence of at least 95% identity to a query amino acid sequence, up to 5% (5 of 100) of the amino acid residues in the subject sequence may be inserted or substituted with another amino acid or deleted.

For sequences without exact correspondence, a "% identity" of a first sequence may be determined with respect to a second sequence. In general, these two sequences to be compared are aligned to give a maximum correlation between the sequences. This may

include inserting "gaps" in either one or both sequences, to enhance the degree of alignment. A % identity may then be determined over the whole length of each of the sequences being compared (so-called global alignment), that is particularly suitable for sequences of the same or similar length, or over shorter, defined lengths (so-called local alignment), that is more
5 suitable for sequences of unequal length.

Methods for comparing the identity and homology of two or more sequences, particularly as used herein, are well known in the art. Thus for instance, programs available in the Wisconsin Sequence Analysis Package, version 9.1 (Devereux *et al.*, 1984, Nucleic Acids Res. 12, 387-395.), for example the programs BESTFIT and GAP, may be used to determine the % identity
10 between two polynucleotides and the % identity and the % homology between two polypeptide sequences. BESTFIT uses the "local homology" algorithm of (Smith and Waterman (1981), J. Mol. Biol. 147, 195-197.) and finds the best single region of similarity between two sequences. Other programs for determining identity and/or similarity between
15 sequences are also known in the art, for instance the BLAST family of programs (Altschul *et al.*, 1990, J. Mol. Biol. 215, 403-410), accessible through the home page of the NCBI at world wide web site ncbi.nlm.nih.gov) and FASTA (Pearson (1990), Methods Enzymol. 183, 63-98; Pearson and Lipman (1988), Proc. Natl. Acad. Sci. U. S. A 85, 2444-2448.).

JNK-inhibitor sequences as used according to the present invention and as defined above may be obtained or produced by methods well-known in the art, e.g. by chemical synthesis or by genetic engineering methods as discussed below. For example, a peptide corresponding to a portion of an JNK inhibitor sequence as used herein including a desired region of said JNK inhibitor sequence, or that mediates the desired activity *in vitro* or *in vivo*, may be synthesized
20 by use of a peptide synthesizer.

JNK inhibitor sequence as used herein and as defined above, may be furthermore be modified by a trafficking sequence, allowing the JNK inhibitor sequence as used herein and as defined above to be transported effectively into the cells. Such modified JNK inhibitor sequence are
30 preferably provided and used as chimeric sequences.

According to a second aspect the present invention therefore provides the use of a chimeric peptide including at least one first domain and at least one second domain, for the preparation of a pharmaceutical composition for treating diseases or disorders strongly related to JNK

signaling as defined above in a subject, wherein the first domain of the chimeric peptide comprises a trafficking sequence, while the second domain of the chimeric peptide comprises an JNK inhibitor sequence as defined above, preferably of any of sequences according to SEQ ID NO: 1-4, 13-20 and 33-100 or a derivative or a fragment thereof.

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Typically, chimeric peptides as used according to the present invention have a length of at least 25 amino acid residues, e.g. 25 to 250 amino acid residues, more preferably 25 to 200 amino acid residues, even more preferably 25 to 150 amino acid residues, 25 to 100 and most preferably amino acid 25 to 50 amino acid residues.

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As a first domain the chimeric peptide as used herein preferably comprises a trafficking sequence, which is typically selected from any sequence of amino acids that directs a peptide (in which it is present) to a desired cellular destination. Thus, the trafficking sequence, as used herein, typically directs the peptide across the plasma membrane, e.g. from outside the cell, through the plasma membrane, and into the cytoplasm. Alternatively, or in addition, the trafficking sequence may direct the peptide to a desired location within the cell, e.g. the nucleus, the ribosome, the endoplasmic reticulum (ER), a lysosome, or peroxisome, by e.g. combining two components (e.g. a component for cell permeability and a component for nuclear location) or by one single component having e.g. properties of cell membrane transport and targeted e.g. intranuclear transport. The trafficking sequence may additionally comprise another component, which is capable of binding a cytoplasmic component or any other component or compartment of the cell (e.g. endoplasmic reticulum, mitochondria, Golgi apparatus, lysosomal vesicles). Accordingly, e.g. the trafficking sequence of the first domain and the JNK inhibitor sequence of the second domain may be localized in the cytoplasm or any other compartment of the cell. This allows to determine localization of the chimeric peptide in the cell upon uptake.

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Preferably, the trafficking sequence (being included in the first domain of the chimeric peptide as used herein) has a length of 5 to 150 amino acid sequences, more preferably a length of 5 to 100 and most preferably a length of from 5 to 50, 5 to 30 or even 5 to 15 amino acids.

More preferably, the trafficking sequence (contained in the first domain of the chimeric peptide as used herein) may occur as a continuous amino acid sequence stretch in the first domain. Alternatively, the trafficking sequence in the first domain may be splitted into two or

more fragments, wherein all of these fragments resemble the entire trafficking sequence and may be separated from each other by 1 to 10, preferably 1 to 5 amino acids, provided that the trafficking sequence as such retains its carrier properties as disclosed above. These amino acids separating the fragments of the trafficking sequence may e.g. be selected from amino acid sequences differing from the trafficking sequence. Alternatively, the first domain may contain a trafficking sequence composed of more than one component, each component with its own function for the transport of the cargo JNK inhibitor sequence of the second domain to e.g. a specific cell compartment.

10 The trafficking sequence as defined above may be composed of L-amino acids, D-amino acids, or a combination of both. Preferably, the trafficking sequence (being included in the first domain of the chimeric peptide as used herein) may comprise at least 1 or even 2, preferably at least 3, 4 or 5, more preferably at least 6, 7, 8 or 9 and even more preferably at least 10 or more D- and/or L-amino acids, wherein the D- and/or L-amino acids may be
15 arranged in the JNK trafficking sequences in a blockwise, a non-blockwise or in an alternate manner.

According to one alternative embodiment, the trafficking sequence of the chimeric peptide as used herein may be exclusively composed of L-amino acids. More preferably, the
20 trafficking sequence of the chimeric peptide as used herein comprises or consists of at least one „native“ trafficking sequence as defined above. In this context, the term “native” is referred to non-altered trafficking sequences, entirely composed of L-amino acids.

According to another alternative embodiment the trafficking sequence of the chimeric peptide as used herein may be exclusively composed of D-amino acids. More preferably, the
25 trafficking sequence of the chimeric peptide as used herein may comprise a D retro-inverso peptide of the sequences as presented above.

The trafficking sequence of the first domain of the chimeric peptide as used herein may be
30 obtained from naturally occurring sources or can be produced by using genetic engineering techniques or chemical synthesis (see e.g. Sambrook, J., Fritsch, E. F., Maniatis, T. (1989) Molecular cloning: A laboratory manual. 2nd edition. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, N.Y.).

Sources for the trafficking sequence of the first domain may be employed including, e.g. native proteins such as e.g. the TAT protein (e.g. as described in U.S. Patent Nos. 5,804,604 and 5,674,980, each of these references being incorporated herein by reference), VP22 (described in e.g. WO 97/05265; Elliott and O'Hare, Cell 88 : 223-233 (1997)), non-viral proteins (Jackson et al, Proc. Natl. Acad. Sci. USA 89 : 10691-10695 (1992)), trafficking sequences derived from Antennapedia (e.g. the antennapedia carrier sequence) or from basic peptides, e.g. peptides having a length of 5 to 15 amino acids, preferably 10 to 12 amino acids and comprising at least 80 %, more preferably 85 % or even 90 % basic amino acids, such as e.g. arginine, lysine and/or histidine. Furthermore, variants, fragments and derivatives of one of the native proteins used as trafficking sequences are disclosed herewith. With regard to variants, fragments and derivatives it is referred to the definition given above for JNK inhibitor sequences as used herein. Variants, fragments as well as derivatives are correspondingly defined as set forth above for JNK inhibitor sequences as used herein. Particularly, in the context of the trafficking sequence, a variant or fragment or derivative may be defined as a sequence sharing a sequence identity with one of the native proteins used as trafficking sequences as defined above of at least about 30%, 50%, 70%, 80%, 90%, 95%, 98%, or even 99%.

In a preferred embodiment of the chimeric peptide as used herein, the trafficking sequence of the first domain comprises or consists of a sequence derived from the human immunodeficiency virus (HIV)1 TAT protein, particularly some or all of the 86 amino acids that make up the TAT protein.

For a trafficking sequence (being included in the first domain of the chimeric peptide as used herein), partial sequences of the full-length TAT protein may be used forming a functionally effective fragment of a TAT protein, i.e. a TAT peptide that includes the region that mediates entry and uptake into cells. As to whether such a sequence is a functionally effective fragment of the TAT protein can be determined using known techniques (see e.g. Franked *et al.*, Proc. Natl. Acad. Sci, USA 86 : 7397-7401 (1989)). Thus, the trafficking sequence in the first domain of the chimeric peptide as used herein may be derived from a functionally effective fragment or portion of a TAT protein sequence that comprises less than 86 amino acids, and which exhibits uptake into cells, and optionally the uptake into the cell nucleus. More preferably, partial sequences (fragments) of TAT to be used as carrier to mediate permeation

of the chimeric peptide across the cell membrane, are intended to comprise the basic region (amino acids 48 to 57 or 49 to 57) of full-length TAT.

According to a more preferred embodiment, the trafficking sequence (being included in the first domain of the chimeric peptide as used herein) may comprise or consist of an amino acid sequence containing TAT residues 48-57 or 49 to 57, and most preferably a generic TAT sequence $\text{NH}_2\text{-X}_n^b\text{-RKKRRQRRR-X}_n^b\text{-COOH}$ (L-generic-TAT (s)) [SEQ ID NO: 7] and/or XXXXRKKRRQ RRRXXXX (L-generic-TAT) [SEQ ID NO: 21], wherein X or X_n^b is as defined above. Furthermore, the number of " X_n^b " residues in SEQ ID NOs :8 is not limited to the one depicted, and may vary as described above. Alternatively, the trafficking sequence being included in the first domain of the chimeric peptide as used herein may comprise or consist of a peptide containing e.g. the amino acid sequence $\text{NH}_2\text{-GRKKRRQRRR-COOH}$ (L-TAT) [SEQ ID NO: 5].

According to another more preferred embodiment the trafficking sequence (being included in the first domain of the chimeric peptide as used herein) may comprise a D retro-inverso peptide of the sequences as presented above, i.e. the D retro-inverso sequence of the generic TAT sequence having the sequence $\text{NH}_2\text{-X}_n^b\text{-RRRQRRKKR-X}_n^b\text{-COOH}$ (D-generic-TAT (s)) [SEQ ID NO : 8] and/or XXXXRRRQRRKKRXXXX (D-generic-TAT) [SEQ ID NO: 22]. Also here, X_n^b is as defined above (preferably representing D amino acids). Furthermore, the number of " X_n^b " residues in SEQ ID NOs :8 is not limited to the one depicted, and may vary as described above. Most preferably, the trafficking sequence as used herein may comprise the D retro-inverso sequence $\text{NH}_2\text{-RRRQRRKKRG-COOH}$ (D-TAT) [SEQ ID NO: 6].

According to another embodiment the trafficking sequence being included in the first domain of the chimeric peptide as used herein may comprise or consist of variants of the trafficking sequences as defined above. A "variant of a trafficking sequence" is preferably a sequence derived from a trafficking sequence as defined above, wherein the variant comprises a modification, for example, addition, (internal) deletion (leading to fragments) and/or substitution of at least one amino acid present in the trafficking sequence as defined above. Such (a) modification(s) typically comprise(s) 1 to 20, preferably 1 to 10 and more preferably 1 to 5 substitutions, additions and/or deletions of amino acids. Furthermore, the variant preferably exhibits a sequence identity with the trafficking sequence as defined above, more

preferably with any of SEQ ID NOs: 5 to 8 or 21-22, of at least about 30%, 50%, 70%, 80%, 90%, 95%, 98% or even 99%.

Preferably, such a modification of the trafficking sequence being included in the first domain of the chimeric peptide as used herein leads to a trafficking sequence with increased or decreased stability. Alternatively, variants of the trafficking sequence can be designed to modulate intracellular localization of the chimeric peptide as used herein. When added exogenously, such variants as defined above are typically designed such that the ability of the trafficking sequence to enter cells is retained (i.e. the uptake of the variant of the trafficking sequence into the cell is substantially similar to that of the native protein used a trafficking sequence). For example, alteration of the basic region thought to be important for nuclear localization (see e.g. Dang and Lee, J. Biol. Chem. 264 : 18019-18023 (1989); Hauber *et al.*, J. Virol. 63 : 1181-1187 (1989) ; *et al.*, J. Virol. 63 : 1-8 (1989)) can result in a cytoplasmic location or partially cytoplasmic location of the trafficking sequence, and therefore, of the JNK inhibitor sequence as component of the chimeric peptide as used herein. Additional to the above, further modifications may be introduced into the variant, e.g. by linking e.g. cholesterol or other lipid moieties to the trafficking sequence to produce a trafficking sequence having increased membrane solubility. Any of the above disclosed variants of the trafficking sequences being included in the first domain of the chimeric peptide as used herein can be produced using techniques typically known to a skilled person (see e.g. Sambrook, J., Fritsch, E. F., Maniatis, T. (1989) Molecular cloning: A laboratory manual. 2nd edition. Cold Spring Harbor Laboratory, Cold Spring Harbor, N.Y.)

As a second domain the chimeric peptide as used herein typically comprises an JNK inhibitor sequence, selected from any of the JNK inhibitor sequences as defined above, including variants, fragments and/or derivatives of these JNK inhibitor sequences.

Both domains, i.e. the first and the second domain(s), of the chimeric peptide as used herein, may be linked such as to form a functional unit. Any method for linking the first and second domain(s) as generally known in the art may be applied.

According to one embodiment, the first and the second domain(s) of the chimeric peptide as used herein are preferably linked by a covalent bond. A covalent bond, as defined herein, may be e.g. a peptide bond, which may be obtained by expressing the chimeric peptide as

defined above as a fusion protein. Fusion proteins, as described herein, can be formed and used in ways analogous to or readily adaptable from standard recombinant DNA techniques, as described below. However, both domains may also be linked via side chains or may be linked by a chemical linker moiety.

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The first and/or second domains of the chimeric peptide as used herein may occur in one or more copies in said chimeric peptide. If both domains are present in a single copy, the first domain may be linked either to the N-terminal or the C-terminal end of the second domain. If present in multiple copies, the first and second domain(s) may be arranged in any possible order. E.g. the first domain can be present in the chimeric peptide as used herein in a multiple copy number, e.g. in two, three or more copies, which are preferably arranged in consecutive order. Then, the second domain may be present in a single copy occurring at the N- or C-terminus of the sequence comprising the first domain. Alternatively, the second domain may be present in a multiple copy number, e.g. in two, three or more copies, and the first domain may be present in a single copy. According to both alternatives, first and second domain(s) can take any place in a consecutive arrangement. Exemplary arrangements are shown in the following: e.g. first domain – first domain – first domain – second domain; first domain – first domain – second domain – first domain; first domain – second domain – first domain – first domain; or e.g. second domain – first domain – first domain – first domain. It is well understood for a skilled person that these examples are for illustration purposes only and shall not limit the scope of the invention thereto. Thus, the number of copies and the arrangement may be varied as defined initially.

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Preferably, the first and second domain(s) may be directly linked with each other without any linker. Alternatively, they may be linked with each other via a linker sequence comprising 1 to 10, preferably 1 to 5 amino acids. Amino acids forming the linker sequence are preferably selected from glycine or proline as amino acid residues. More preferably, the first and second domain(s) may be separated by each other by a hinge of two, three or more proline residues between the first and second domain(s).

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The chimeric peptide as defined above and as used herein, comprising at least one first and at least one second domain, may be composed of L-amino acids, D-amino acids, or a combination of both. Therein, each domain (as well as the linkers used) may be composed of L-amino acids, D-amino acids, or a combination of both (e.g. D-TAT and L-IB1(s) or L-TAT

and D-IB1(s), etc.). Preferably, the chimeric peptide as used herein may comprise at least 1 or even 2, preferably at least 3, 4 or 5, more preferably at least 6, 7, 8 or 9 and even more preferably at least 10 or more D- and/or L-amino acids, wherein the D- and/or L-amino acids may be arranged in the chimeric peptide as used herein in a blockwise, a non-blockwise or in an alternate manner.

According to a specific embodiment the chimeric peptide as used herein comprises or consists of the L-amino acid chimeric peptides according to the generic L-TAT-IB peptide $\text{NH}_2\text{-X}_n^b\text{-RKKRRQRRR-X}_n^b\text{-X}_n^a\text{-RPTTLXLXXXXXXQD-X}_n^b\text{-COOH}$ (L-TAT-IB (generic) (s)) [SEQ ID NO: 10], wherein X, X_n^a and X_n^b are preferably as defined above. More preferably, the chimeric peptide as used herein comprises or consists of the L-amino acid chimeric peptide $\text{NH}_2\text{-GRKKRRQRRRPPRPKRPTTLNLFQVPRSQD-COOH}$ (L-TAT-IB1 (s)) [SEQ ID NO: 9]. Alternatively or additionally, the chimeric peptide as used herein comprises or consists of the L-amino acid chimeric peptide sequence GRKKRRQRRR PPDTYRPKRP TTLNLFQVP RSQDT (L-TAT-IB1) [SEQ ID NO: 23], or XXXXXXRKK RRQRRRXXXX XXXRPTTLX LXXXXXXQD S/TX (L-TAT-IB generic) [SEQ ID NO: 24], wherein X is preferably also as defined above, or the chimeric peptide as used herein comprises or consists of the L-amino acid chimeric peptide sequence RKKRRQRRRPPRPKRPTTLNLFQVPRSQD (L-TAT-IB1(s1)) [SEQ ID NO: 27], GRKKRRQRRRX $_n^c$ RPKRPTTLNLFQVPRSQD (L-TAT-IB1(s2)) [SEQ ID NO: 28], or RKKRRQRRRX $_n^c$ RPKRPTTLNLFQVPRSQD (L-TAT-IB1(s3)) [SEQ ID NO: 29]. In this context, each X typically represents an amino acid residue as defined above, more preferably X_n^c represents a contiguous stretch of peptide residues, each X independently selected from each other from glycine or proline, e.g. a monotonic glycine stretch or a monotonic proline stretch, wherein n (the number of repetitions of X_n^c) is typically 0-5, 5-10, 10-15, 15-20, 20-30 or even more, preferably 0-5 or 5-10. X_n^c may represent either D or L amino acids.

According to an alternative specific embodiment the chimeric peptide as used herein comprises or consists of D-amino acid chimeric peptides of the above disclosed L-amino acid chimeric peptides. Exemplary D retro-inverso chimeric peptides according to the present invention are e.g. the generic D-TAT-IB peptide $\text{NH}_2\text{-X}_n^b\text{-DQXXXXXXXXLXLTPR-X}_n^a\text{-X}_n^b\text{-RRRQRRKKR-X}_n^b\text{-COOH}$ (D-TAT-IB (generic) (s)) [SEQ ID NO: 12]. Herein, X, X_n^a and X_n^b are preferably as defined above (preferably representing D amino acids). More preferably, the chimeric peptide as used herein comprises or consists of D-amino acid chimeric peptides

according to the TAT-IB1 peptide NH₂-DQSRPVQPFLNLTPRKPRPPRRRQRRKKRG-COOH (D-TAT-IB1(s)) [SEQ ID NO: 11]. Alternatively or additionally, the chimeric peptide as used herein comprises or consists of the D-amino acid chimeric peptide sequence TDQSRPVQPFLNLTPRKPRYTDPPIRRRQRRKKRG (D-TAT-IB1) [SEQ ID NO: 25], or
 5 XT/SDQXXXXXXXXLXLTPRXXXXXXXXRRRQRRKKRXXXXXXXX (D-TAT-IB generic) [SEQ ID NO: 26], wherein X is preferably also as defined above, or the chimeric peptide as used herein comprises or consists of the D-amino acid chimeric peptide sequence DQSRPVQPFLNLTPRKPRPPRRRQRRKKR (D-TAT-IB1(s1)) [SEQ ID NO: 30], DQSRPVQPFLNLTPRKPRX_n^cRRRQRRKKRG (D-TAT-IB1(s2)) [SEQ ID NO: 31], or
 10 DQSRPVQPFLNLTPRKPRX_n^cRRRQRRKKR (D-TAT-IB1(s3)) [SEQ ID NO: 32]. X_n^c may be as defined above.

The first and second domain(s) of the chimeric peptide as defined above may be linked to each other by chemical or biochemical coupling carried out in any suitable manner known
 15 in the art, e.g. by establishing a peptide bond between the first and the second domain(s) e.g. by expressing the first and second domain(s) as a fusion protein, or e.g. by crosslinking the first and second domain(s) of the chimeric peptide as defined above.

Many known methods suitable for chemical crosslinking of the first and second domain(s) of
 20 the chimeric peptide as defined above are non-specific, i.e. they do not direct the point of coupling to any particular site on the transport polypeptide or cargo macromolecule. As a result, use of non-specific crosslinking agents may attack functional sites or sterically block active sites, rendering the conjugated proteins biologically inactive. Thus, preferably such crosslinking methods are used, which allow a more specific coupling of the first and second
 25 domain(s).

In this context, one way to increasing coupling specificity is a direct chemical coupling to a functional group present only once or a few times in one or both of the first and second domain(s) to be crosslinked. For example, cysteine, which is the only protein amino acid
 30 containing a thiol group, occurs in many proteins only a few times. Also, for example, if a polypeptide contains no lysine residues, a crosslinking reagent specific for primary amines will be selective for the amino terminus of that polypeptide. Successful utilization of this approach to increase coupling specificity requires that the polypeptide have the suitably rare and reactive residues in areas of the molecule that may be altered without loss of the

molecule's biological activity. Cysteine residues may be replaced when they occur in parts of a polypeptide sequence where their participation in a crosslinking reaction would otherwise likely interfere with biological activity. When a cysteine residue is replaced, it is typically desirable to minimize resulting changes in polypeptide folding. Changes in polypeptide folding are minimized when the replacement is chemically and sterically similar to cysteine. For these reasons, serine is preferred as a replacement for cysteine. As demonstrated in the examples below, a cysteine residue may be introduced into a polypeptide's amino acid sequence for crosslinking purposes. When a cysteine residue is introduced, introduction at or near the amino or carboxy terminus is preferred. Conventional methods are available for such amino acid sequence modifications, wherein the polypeptide of interest is produced by chemical synthesis or via expression of recombinant DNA.

Coupling of the first and second domain(s) of the chimeric peptide as defined above and used herein can also be accomplished via a coupling or conjugating agent. There are several intermolecular crosslinking reagents which can be utilized (see for example, Means and Feeney, CHEMICAL MODIFICATION OF PROTEINS, Holden-Day, 1974, pp. 39-43). Among these reagents are, for example, N-succinimidyl 3-(2-pyridyldithio) propionate (SPDP) or N,N'-(1,3-phenylene) bismaleimide (both of which are highly specific for sulfhydryl groups and form irreversible linkages); N, N'-ethylene-bis-(iodoacetamide) or other such reagent having 6 to 11 carbon methylene bridges (which are relatively specific for sulfhydryl groups); and 1,5-difluoro-2,4-dinitrobenzene (which forms irreversible linkages with amino and tyrosine groups). Other crosslinking reagents useful for this purpose include: p,p'-difluoro-m, m'-dinitrodiphenylsulfone which forms irreversible crosslinkages with amino and phenolic groups); dimethyl adipimidate (which is specific for amino groups); phenol-1,4 disulfonylchloride (which reacts principally with amino groups); hexamethylenediisocyanate or diisothiocyanate, or azophenyl-p-diisocyanate (which reacts principally with amino groups); glutaraldehyde (which reacts with several different side chains) and disdiazobenzidine (which reacts primarily with tyrosine and histidine).

Crosslinking reagents used for crosslinking the first and second domain(s) of the chimeric peptide as defined above may be homobifunctional, i.e. having two functional groups that undergo the same reaction. A preferred homobifunctional crosslinking reagent is bismaleimido-hexane ("BMH"). BMH contains two maleimide functional groups, which react specifically with sulfhydryl-containing compounds under mild conditions (pH 6.5-7.7). The

two maleimide groups are connected by a hydrocarbon chain. Therefore, BMH is useful for irreversible crosslinking of polypeptides that contain cysteine residues.

Crosslinking reagents used for crosslinking the first and second domain(s) of the chimeric peptide as defined above may also be heterobifunctional. Heterobifunctional crosslinking agents have two different functional groups, for example an amine-reactive group and a thiol-reactive group, that will crosslink two proteins having free amines and thiols, respectively. Examples of heterobifunctional crosslinking agents are succinimidyl 4-(N-maleimidomethyl)cyclohexane-1-carboxylate ("SMCC"), m-maleimidobenzoyl-N-hydroxysuccinimide ester ("MBS"), and succinimide 4-(p-maleimidophenyl)butyrate ("SMPB"), an extended chain analog of MBS. The succinimidyl group of these crosslinkers reacts with a primary amine, and the thiol-reactive maleimide forms a covalent bond with the thiol of a cysteine residue.

Crosslinking reagents suitable for crosslinking the first and second domain(s) of the chimeric peptide as defined above often have low solubility in water. A hydrophilic moiety, such as a sulfonate group, may thus be added to the crosslinking reagent to improve its water solubility. In this respect, Sulfo-MBS and Sulfo-SMCC are examples of crosslinking reagents modified for water solubility, which may be used according to the present invention.

Likewise, many crosslinking reagents yield a conjugate that is essentially non-cleavable under cellular conditions. However, some crosslinking reagents particularly suitable for crosslinking the first and second domain(s) of the chimeric peptide as defined above contain a covalent bond, such as a disulfide, that is cleavable under cellular conditions. For example, Traut's reagent, dithiobis(succinimidylpropionate) ("DSP"), and N-succinimidyl 3-(2-pyridyldithio)propionate ("SPDP") are well-known cleavable crosslinkers. The use of a cleavable crosslinking reagent permits the cargo moiety to separate from the transport polypeptide after delivery into the target cell. Direct disulfide linkage may also be useful.

Numerous crosslinking reagents, including the ones discussed above, are commercially available. Detailed instructions for their use are readily available from the commercial suppliers. A general reference on protein crosslinking and conjugate preparation is: Wong, CHEMISTRY OF PROTEIN CONJUGATION AND CROSSLINKING, CRC Press (1991).

Chemical crosslinking of the first and second domain(s) of the chimeric peptide as defined above may include the use of spacer arms. Spacer arms provide intramolecular flexibility or adjust intramolecular distances between conjugated moieties and thereby may help preserve biological activity. A spacer arm may be in the form of a polypeptide moiety that includes
5 spacer amino acids, e.g. proline. Alternatively, a spacer arm may be part of the crosslinking reagent, such as in "long-chain SPDP" (Pierce Chem. Co., Rockford, IL., cat. No. 21651 H).

Preferably, any of the peptides disclosed herein, in particular the JNK inhibitor, the trafficking sequence and the chimeric peptide as disclosed herein, preferably the JNK inhibitor according
10 to SEQ ID NO: 11, may have a modification at one or both of their termini, i.e. either at the C- or at the N-terminus or at both. The C-Terminus may preferably be modified by an amide modification, whereas the N-terminus may be modified by any suitable NH₂-protection group, such as e.g. acylation. More preferably, the JNK inhibitor and the chimeric peptide as disclosed herein, preferably the JNK inhibitor according to SEQ ID NO: 11, is modified by an
15 amide modification at the C-terminus.

It is also preferred that any of the peptides disclosed herein, in particular the JNK inhibitor, the trafficking sequence (e.g. of the chimeric peptide) and the chimeric peptide as disclosed herein, preferably the JNK inhibitor according to SEQ ID NO: 11, may be deleted at their N-
20 and/or C-terminus by 1, 2 or 3 amino acids. For example, in a chimeric peptide according to the present invention each domain, i.e. the JNK-inhibitor and the trafficking sequence domain, may be deleted at their N- and/or C-terminus by 1, 2 or 3 amino acids and/or the chimeric peptide according to the present invention may be deleted at its N- and/or C-terminus by 1, 2 or 3 amino acids. More preferably, the inventive chimeric peptide comprises
25 or consists of a D-amino acid chimeric peptide according to the TAT-IB1 peptide [NH₂-DQSRPVQPFLNLTPRKPRPPRRRQRRKKRG-COOH, SEQ ID NO: 11] and the linking portion of the first and second domain (instead of PP) may be composed of -X_n^a-X_n^b-, which are as defined above. In particular, the second domain(s) of SEQ ID NO: 11, eventually with
-X_n^a-X_n^b- instead of (PP), may be deleted at their N- and/or C-terminus by 1, 2 or 3 amino
30 acids. In another preferred embodiment, the first domain of SEQ ID NO: 11 may be deleted at its N- and or C-terminus by 1, 2 or 3 amino acids. This/these deletion/s may be combined with the deletion/s disclosed for the amino acid residues of the termini of the second domain. Again, the shorter the peptides are, the less their (unspecific) cell toxicity. However, the

peptides must retain their biological function, i.e. their cell membrane permeability (first domain) and their JNK inhibitory function (second domain).

Furthermore, variants, fragments or derivatives of one of the above disclosed chimeric peptides may be used herein. With regard to fragments and variants it is generally referred to the definition given above for JNK inhibitor sequences.

Particularly, in the context of the present invention, a "variant of a chimeric peptide" is preferably a sequence derived from any of the sequences according to SEQ ID NOs: 9 to 12 and 23 to 32, wherein the chimeric variant comprises amino acid alterations of the chimeric peptides according to SEQ ID NOs: 9 to 12 and 23 to 32 as used herein. Such alterations typically comprise 1 to 20, preferably 1 to 10 and more preferably 1 to 5 substitutions, additions and/or deletions (leading to fragments) of amino acids according to SEQ ID NOs: 9 to 12 and 23 to 32, wherein the altered chimeric peptide as used herein exhibits a sequence identity with any of the sequences according to SEQ ID NOs: 9-12 and 23 to 32 of at least about 30%, 50%, 70%, 80%, or 95%, 98%, or even 99%. Preferably, these variants retain the biological activity of the first and the second domain as contained in the chimeric peptide as used herein, i.e. the trafficking activity of the first domain as disclosed above and the activity of the second domain for binding JNK and/or inhibiting the activation of at least one JNK activated transcription factor.

Accordingly, the chimeric peptide as used herein also comprises fragments of the afore disclosed chimeric peptides, particularly of the chimeric peptide sequences according to any of SEQ ID NOs: 9 to 12 and 23 to 32. Thus, in the context of the present invention, a "fragment of the chimeric peptide" is preferably a sequence derived any of the sequences according to SEQ ID NOs: 9 to 12 and 23 to 32, wherein the fragment comprises at least 4 contiguous amino acids of any of SEQ ID NOs: 9 to 12 and 23 to 32. This fragment preferably comprises a length which is sufficient to allow specific recognition of an epitope from any of these sequences and to transport the sequence into the cells, the nucleus or a further preferred location. Even more preferably, the fragment comprises 4 to 18, 4 to 15, or most preferably 4 to 10 contiguous amino acids of any of SEQ ID NOs: 9 to 12 and 23 to 32. Fragments of the chimeric peptide as used herein further may be defined as a sequence sharing a sequence identity with any of the sequences according to any of SEQ ID NOs: 9 to 12 and 23 to 32 of at least about 30%, 50%, 70%, 80%, or 95%, 98%, or even 99%.

Finally, the chimeric peptide as used herein also comprises derivatives of the afore disclosed chimeric peptides, particularly of the chimeric peptide sequences according to any of SEQ ID NOs: 9 to 12 and 23 to 32.

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The present invention additionally refers to the use of nucleic acid sequences encoding JNK inhibitor sequences as defined above, chimeric peptides or their fragments, variants or derivatives, all as defined above, for the preparation of a pharmaceutical composition for treating diseases or disorders strongly related to JNK signaling as defined above in a subject.

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A preferable suitable nucleic acid encoding an JNK inhibitor sequence as used herein is typically chosen from human IB1 nucleic acid (GenBank Accession No. (AF074091), rat IB1 nucleic acid (GenBank Accession No. AF 108959), or human IB2 (GenBank Accession No AF218778) or from any nucleic acid sequence encoding any of the sequences as defined above, i.e. any sequence according to SEQ ID NO: 1-26.

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Nucleic acids encoding the JNK inhibitor sequences as used herein or chimeric peptides as used herein may be obtained by any method known in the art (e.g. by PCR amplification using synthetic primers hybridizable to the 3'- and 5'-termini of the sequence and/or by cloning from a cDNA or genomic library using an oligonucleotide sequence specific for the given gene sequence).

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Additionally, nucleic acid sequences are disclosed herein as well, which hybridize under stringent conditions with the appropriate strand coding for a (native) JNK inhibitor sequence or chimeric peptide as defined above. Preferably, such nucleic acid sequences comprise at least 6 (contiguous) nucleic acids, which have a length sufficient to allow for specific hybridization. More preferably, such nucleic acid sequences comprise 6 to 38, even more preferably 6 to 30, and most preferably 6 to 20 or 6 to 10 (contiguous) nucleic acids.

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"Stringent conditions" are sequence dependent and will be different under different circumstances. Generally, stringent conditions can be selected to be about 5°C lower than the thermal melting point (TM) for the specific sequence at a defined ionic strength and pH. The TM is the temperature (under defined ionic strength and pH) at which 50% of the target sequence hybridizes to a perfectly matched probe. Typically, stringent conditions will be those in which the salt concentration is at least about 0.02 molar at pH 7 and the temperature

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is at least about 60°C. As other factors may affect the stringency of hybridization (including, among others, base composition and size of the complementary strands), the presence of organic solvents and the extent of base mismatching, the combination of parameters is more important than the absolute measure of any one.

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“High stringency conditions” may comprise the following, e.g. Step 1: Filters containing DNA are pretreated for 8 hours to overnight at 65°C in buffer composed of 6*SSC, 50 mM Tris-HCl (pH 7.5), 1 mM EDTA, 0.02% PVP, 0.02% Ficoll, 0.02% BSA, and 500 µg/ml denatured salmon sperm DNA. Step 2: Filters are hybridized for 48 hours at 65°C. in the above prehybridization mixture to which is added 100 mg/ml denatured salmon sperm DNA and 5-20*10⁶ cpm of ³²P-labeled probe. Step 3: Filters are washed for 1 hour at 37°C in a solution containing 2*SSC, 0.01% PVP, 0.01% Ficoll, and 0.01% BSA. This is followed by a wash in 0.1*SSC at 50°C for 45 minutes. Step 4: Filters are autoradiographed. Other conditions of high stringency that may be used are well known in the art (see e.g. Ausubel *et al.*, (eds.), 1993, Current Protocols in Molecular Biology, John Wiley and Sons, NY; and Kriegler, 1990, Gene Transfer and Expression, a Laboratory Manual, Stockton Press, NY).

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“Moderate stringency conditions” can include the following: Step 1: Filters containing DNA are pretreated for 6 hours at 55°C. in a solution containing 6*SSC, 5*Denhardt's solution, 0.5% SDS and 100 mg/ml denatured salmon sperm DNA. Step 2: Filters are hybridized for 18-20 hours at 55°C in the same solution with 5-20*10⁶ cpm ³²P-labeled probe added. Step 3: Filters are washed at 37°C for 1 hour in a solution containing 2*SSC, 0.1% SDS, then washed twice for 30 minutes at 60°C in a solution containing 1*SSC and 0.1% SDS. Step 4: Filters are blotted dry and exposed for autoradiography. Other conditions of moderate stringency that may be used are well-known in the art (see e.g. Ausubel *et al.*, (eds.), 1993, Current Protocols in Molecular Biology, John Wiley and Sons, NY; and Kriegler, 1990, Gene Transfer and Expression, a Laboratory Manual, Stockton Press, NY).

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Finally, “low stringency conditions” can include: Step 1: Filters containing DNA are pretreated for 6 hours at 40°C in a solution containing 35% formamide, 5X SSC, 50 mM Tris-HCl (pH 7.5), 5 mM EDTA, 0.1% PVP, 0.1% Ficoll, 1% BSA, and 500 µg/ml denatured salmon sperm DNA. Step 2: Filters are hybridized for 18-20 hours at 40°C in the same solution with the addition of 0.02% PVP, 0.02% Ficoll, 0.2% BSA, 100 µg/ml salmon sperm DNA, 10% (wt/vol) dextran sulfate, and 5-20 x 10⁶ cpm ³²P-labeled probe. Step 3: Filters are washed for

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1.5 hours at 55 C in a solution containing 2X SSC, 25 mM Tris-HCl (pH 7.4), 5 mM EDTA, and 0.1% SDS. The wash solution is replaced with fresh solution and incubated an additional 1.5 hours at 60°C. Step 4: Filters are blotted dry and exposed for autoradiography. If necessary, filters are washed for a third time at 65-68°C and reexposed to film. Other
5 conditions of low stringency that may be used are well known in the art (e.g. as employed for cross-species hybridizations). See e.g. Ausubel *et al.*, (eds.), 1993, CURRENT PROTOCOLS IN MOLECULAR BIOLOGY, John Wiley and Sons, NY; and Kriegler, 1990, GENE TRANSFER AND EXPRESSION, A LABORATORY MANUAL, Stockton Press, NY.

10 The nucleic acid sequences as defined above according to the present invention can be used to express peptides, i.e. an JNK inhibitor sequence as used herein or an chimeric peptide as used herein for analysis, characterization or therapeutic use; as markers for tissues in which the corresponding peptides (as used herein) are preferentially expressed (either constitutively or at a particular stage of tissue differentiation or development or in disease states). Other uses
15 for these nucleic acids include, e.g. molecular weight markers in gel electrophoresis-based analysis of nucleic acids.

According to a further embodiment of the present invention, expression vectors may be used for the above purposes for recombinant expression of one or more JNK inhibitor sequences
20 and/or chimeric peptides as defined above. The term "expression vector" is used herein to designate either circular or linear DNA or RNA, which is either double-stranded or single-stranded. It further comprises at least one nucleic acid as defined above to be transferred into a host cell or into a unicellular or multicellular host organism. The expression vector as used herein preferably comprises a nucleic acid as defined above encoding the JNK inhibitor
25 sequence as used herein or a fragment or a variant thereof, or the chimeric peptide as used herein, or a fragment or a variant thereof. Additionally, an expression vector according to the present invention preferably comprises appropriate elements for supporting expression including various regulatory elements, such as enhancers/promoters from viral, bacterial, plant, mammalian, and other eukaryotic sources that drive expression of the inserted
30 polynucleotide in host cells, such as insulators, boundary elements, LCRs (e.g. described by Blackwood and Kadonaga (1998), *Science* 281, 61-63) or matrix/scaffold attachment regions (e.g. described by Li, Harju and Peterson, (1999), *Trends Genet.* 15, 403-408). In some embodiments, the regulatory elements are heterologous (i.e. not the native gene promoter).

Alternately, the necessary transcriptional and translational signals may also be supplied by the native promoter for the genes and/or their flanking regions.

The term "promoter" as used herein refers to a region of DNA that functions to control the transcription of one or more nucleic acid sequences as defined above, and that is structurally identified by the presence of a binding site for DNA-dependent RNA-polymerase and of other DNA sequences, which interact to regulate promoter function. A functional expression promoting fragment of a promoter is a shortened or truncated promoter sequence retaining the activity as a promoter. Promoter activity may be measured by any assay known in the art (see e.g. Wood, de Wet, Dewji, and DeLuca, (1984), *Biochem Biophys. Res. Commun.* 124, 592-596; Seliger and McElroy, (1960), *Arch. Biochem. Biophys.* 88, 136-141) or commercially available from Promega®).

An "enhancer region" to be used in the expression vector as defined herein, typically refers to a region of DNA that functions to increase the transcription of one or more genes. More specifically, the term "enhancer", as used herein, is a DNA regulatory element that enhances, augments, improves, or ameliorates expression of a gene irrespective of its location and orientation vis-à-vis the gene to be expressed, and may be enhancing, augmenting, improving, or ameliorating expression of more than one promoter.

The promoter/enhancer sequences to be used in the expression vector as defined herein, may utilize plant, animal, insect, or fungus regulatory sequences. For example, promoter/enhancer elements can be used from yeast and other fungi (e.g. the GAL4 promoter, the alcohol dehydrogenase promoter, the phosphoglycerol kinase promoter, the alkaline phosphatase promoter). Alternatively, or in addition, they may include animal transcriptional control regions, e.g. (i) the insulin gene control region active within pancreatic beta-cells (see e.g. Hanahan, *et al.*, 1985. *Nature* 315: 115-122); (ii) the immunoglobulin gene control region active within lymphoid cells (see e.g. Grosschedl, *et al.*, 1984, *Cell* 38 : 647-658); (iii) the albumin gene control region active within liver (see e.g. Pinckert, *et al.*, 1987. *Genes and Dev* 1: 268-276; (iv) the myelin basic protein gene control region active within brain oligodendrocyte cells (see e.g. Readhead, *et al.*, 1987, *Cell* 48: 703-712); and (v) the gonadotropin-releasing hormone gene control region active within the hypothalamus (see e.g. Mason, *et al.*, 1986, *Science* 234: 1372-1378), and the like.

Additionally, the expression vector as defined herein may comprise an amplification marker. This amplification marker may be selected from the group consisting of, e.g. adenosine deaminase (ADA), dihydrofolate reductase (DHFR), multiple drug resistance gene (MDR), ornithine decarboxylase (ODC) and N-(phosphonacetyl)-L-aspartate resistance (CAD).

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Exemplary expression vectors or their derivatives suitable for the present invention particularly include, e.g. human or animal viruses (e.g. vaccinia virus or adenovirus); insect viruses (e.g. baculovirus); yeast vectors; bacteriophage vectors (e.g. lambda phage); plasmid vectors and cosmid vectors.

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The present invention additionally may utilize a variety of host-vector systems, which are capable of expressing the peptide coding sequence(s) of nucleic acids as defined above. These include, but are not limited to: (i) mammalian cell systems that are infected with vaccinia virus, adenovirus, and the like; (ii) insect cell systems infected with baculovirus and the like; (iii) yeast containing yeast vectors or (iv) bacteria transformed with bacteriophage, DNA, plasmid DNA, or cosmid DNA. Depending upon the host-vector system utilized, any one of a number of suitable transcription and translation elements may be used.

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Preferably, a host cell strain, suitable for such a host-vector system, may be selected that modulates the expression of inserted sequences of interest, or modifies or processes expressed peptides encoded by the sequences in the specific manner desired. In addition, expression from certain promoters may be enhanced in the presence of certain inducers in a selected host strain; thus facilitating control of the expression of a genetically-engineered peptide. Moreover, different host cells possess characteristic and specific mechanisms for the translational and post-translational processing and modification (e.g. glycosylation, phosphorylation, and the like) of expressed peptides. Appropriate cell lines or host systems may thus be chosen to ensure the desired modification and processing of the foreign peptide is achieved. For example, peptide expression within a bacterial system can be used to produce an non-glycosylated core peptide; whereas expression within mammalian cells ensures "native" glycosylation of a heterologous peptide.

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The present invention further provides the use of antibodies directed against the JNK inhibitor sequences and/or chimeric peptides as described above, for preparing a pharmaceutical

composition for the treatment of diseases or disorders strongly related to JNK signaling as defined herein. Furthermore, efficient means for production of antibodies specific for JNK inhibitor sequences according to the present invention, or for chimeric peptides containing such an inhibitor sequence, are described and may be utilized for this purpose.

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According to the invention, JNK inhibitor sequences and/or chimeric peptides as defined herein, as well as, fragments, variants or derivatives thereof, may be utilized as immunogens to generate antibodies that immunospecifically bind these peptide components. Such antibodies include, e.g. polyclonal, monoclonal, chimeric, single chain, Fab fragments and a Fab expression library. In a specific embodiment the present invention provides antibodies to chimeric peptides or to JNK inhibitor sequences as defined above. Various procedures known within the art may be used for the production of these antibodies.

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By way of example, various host animals may be immunized for production of polyclonal antibodies by injection with any chimeric peptide or JNK inhibitor sequence as defined above. Various adjuvants may be used thereby to increase the immunological response which include, but are not limited to, Freund's (complete and incomplete) adjuvant, mineral gels (e.g. aluminum hydroxide), surface active substances (e.g. lysolecithin, pluronic polyols, polyanions, peptides, oil emulsions, dinitrophenol, etc.), CpG, polymers, Pluronics, and human adjuvants such as Bacille Calmette-Guerin and *Corynebacterium parvum*.

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For preparation of monoclonal antibodies directed towards an chimeric peptide or a JNK inhibitor sequence as defined above, any technique may be utilized that provides for the production of antibody molecules by continuous cell line culture. Such techniques include, but are not limited to, the hybridoma technique (see Kohler and Milstein, 1975. *Nature* 256: 495-497); the trioma technique; the human B-cell hybridoma technique (see Kozbor, *et al.*, 1983, *Immunol Today* 4: 72) and the EBV hybridoma technique to produce human monoclonal antibodies (see Cole, *et al.*, 1985. In: *Monoclonal Antibodies and Cancer Therapy*, Alan R. Liss, Inc., pp. 77-96). Human monoclonal antibodies may be utilized in the practice of the present invention and may be produced by the use of human hybridomas (see Cote, *et al.*, 1983. *Proc Natl Acad Sci USA* 80: 2026-2030) or by transforming human B-cells with Epstein Barr Virus *in vitro* (see Cole, *et al.*, 1985. In: *Monoclonal Antibodies and Cancer Therapy* (Alan R. Liss, Inc., pp. 77-96).

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According to the invention, techniques can be adapted for the production of single-chain antibodies specific to the JNK inhibitor sequences and/or chimeric peptides (see e.g. U. S. Patent No. 4,946,778) as defined herein. In addition, methods can be adapted for the construction of Fab expression libraries (see e.g. Huse *et al.*, 1989. Science 246: 1275-1281) to allow rapid and effective identification of monoclonal Fab fragments with the desired specificity for these JNK inhibitor sequences and/or chimeric peptides. Non-human antibodies can be "humanized" by techniques well known in the art (see e.g. U. S. Patent No. 5,225,539). Antibody fragments that contain the idiotypes to a JNK inhibitor sequences and/or chimeric peptide as defined herein may be produced by techniques known in the art including, e.g. (i) a F(ab')₂ fragment produced by pepsin digestion of an antibody molecule; (ii) a Fab fragment generated by reducing the disulfide bridges of an F(ab')₂ fragment ; (iii) a Fab fragment generated by the treatment of the antibody molecule with papain and a reducing agent and (iv) Fv fragments.

In one embodiment of this invention, methods, that may be utilized for the screening of antibodies and which possess the desired specificity include, but are not limited to, enzyme-linked immunosorbent assay (ELISA) and other immunologically-mediated techniques known within the art. In a specific embodiment, selection of antibodies that are specific to a particular epitope of an JNK inhibitor sequence and/or an chimeric peptide as defined herein (e.g. a fragment thereof typically comprising a length of from 5 to 20, preferably 8 to 18 and most preferably 8 to 11 amino acids) is facilitated by generation of hybridomas that bind to the fragment of an JNK inhibitor sequence and/or an chimeric peptide, as defined herein, possessing such an epitope. These antibodies that are specific for an epitope as defined above are also provided herein.

The antibodies as defined herein may be used in methods known within the art referring to the localization and/or quantification of an JNK inhibitor sequence (and/or correspondingly to a chimeric peptide as defined above), e.g. for use in measuring levels of the peptide within appropriate physiological samples, for use in diagnostic methods, or for use in imaging the peptide, and the like.

The JNK inhibitor sequences, chimeric peptides, nucleic acids, vectors, host cells and/or antibodies as defined according to the invention can be formulated in a pharmaceutical composition, which may be applied in the prevention or treatment of any of the diseases as

defined herein, particularly in the prevention or treatment of diseases or disorders strongly related to JNK signaling as defined herein. Typically, such a pharmaceutical composition used according to the present invention includes as an active component, e.g.: (i) any one or more of the JNK inhibitor sequences and/or chimeric peptides as defined above, and/or variants, fragments or derivatives thereof, particularly JNK inhibitor sequences according to any of sequences of SEQ ID NOs: 1 to 4 and 13 to 20 and 33-100 and/or chimeric peptides according to any of sequences of SEQ ID NOs: 9 to 12 and 23 to 32, and/or JNK inhibitor sequences according to any of sequences of SEQ ID NOs: 1 to 4 and 13 to 20 and 33-100 comprising a trafficking sequence according to any of SEQ ID NOs: 5 to 8 and 21 to 22, or variants or fragments thereof within the above definitions; and/or (ii) nucleic acids encoding an JNK inhibitor sequence and/or an chimeric peptide as defined above and/or variants or fragments thereof, and/or (iii) cells comprising any one or more of the JNK inhibitor sequences and/or chimeric peptides, and/or variants, fragments or derivatives thereof, as defined above and/or (iv) cells transfected with a vector and/or nucleic acids encoding an JNK inhibitor sequence and/or an chimeric peptide as defined above and/or variants or fragments thereof.

According to a preferred embodiment, such a pharmaceutical composition as used according to the present invention typically comprises a safe and effective amount of a component as defined above, preferably of at least one JNK inhibitor sequence according to any of sequences of SEQ ID NOs: 1 to 4 and 13 to 20 and 33-100 and/or at least one chimeric peptide according to any of sequences of SEQ ID NOs: 9 to 12 and 23 to 32, and/or at least one JNK inhibitor sequence according to any of sequences of SEQ ID NOs: 1 to 4 and 13 to 20 and 33-100 comprising a trafficking sequence according to any of SEQ ID NOs: 5-8 and 21 to 22, or variants or fragments thereof within the above definitions, or at least one nucleic acids encoding same, or at least one vector, host cell or antibody as defined above. It is particularly preferred that a pharmaceutical composition as used according to the present invention comprises as an active component a chimeric peptide comprising or consisting of the sequence according to SEQ ID NO: 11.

In addition, the pharmaceutical composition as used according to the present invention may additionally – i.e. in addition to any one or more of the JNK inhibitor sequences and/or chimeric peptides as defined above, and/or variants, fragments or derivatives thereof – also comprise optionally a further “active component”, which is also useful in the respective disease. In this context, the pharmaceutical composition according to the present invention

may also combined in the therapy of the diseases according to the present invention with a further pharmaceutical composition comprising a further "active component". For example, a pharmaceutical composition comprising a JNK inhibitor and/or chimeric peptide according to the present invention may be used in post-surgery intraocular inflammation as stand-alone therapy or in combination with corticosteroids, preferably glucocorticoids, e.g. dexamethasone. Moreover, e.g. a pharmaceutical composition comprising a JNK inhibitor and/or chimeric peptide according to the present invention may preferably be used in the prevention and/or treatment of Alzheimer's Disease and/or Mild Cognitive Impairment, in particular MCI due to Alzheimer's disease, as stand-alone therapy or in combination with PKR inhibitors and, optionally, in addition to the JNK inhibitor according to the present invention and the PKR inhibitor with a amyloid lowering agent. PKR inhibitors are in particular peptides, e.g. "SC1481" by Polypeptide Group. Amyloid lowering agents include β -secretase (BACE1) inhibitors, γ -secretase inhibitors (GSI) and modulators (GSM). Examples of such amyloid lowering agents, which are currently in clinical trials may be retrieved from Vassar R. (2014) BACE1 inhibitor drugs in clinical trials for Alzheimer's disease. *Alzheimers Res Ther.*;6(9):89 or from Jia Q, Deng Y, Qing H (2014) Potential therapeutic strategies for Alzheimer's disease targeting or beyond β -amyloid: insights from clinical trials. *Biomed Res Int.* 2014;2014:837157; for example Pioglitazone, CTS-21166, MK8931, LY2886721, AZD3293, E2609, NIC5-15, Begacestat, CHF 5074, EVP-0962, Atorvastatin, Simvastatin, Etazolate, Epigallocatechin-3-gallate (EGCg), Scyllo-inositol (ELND005/AZD103), Tramiprosate (3 APS), PBT2, Affitope AD02, and Affitope AD03. In the case of a combination therapy, separate pharmaceutical compositions for the active components to be combined are preferred for better individual dosing, however for convenience also a single pharmaceutical composition comprising the active components to be combined is conceivable. In the case of separate pharmaceutical compositions for the active components to be combined the administration of the JNK inhibitor according to the present invention may be before, during (concomitant or overlapping administration) or after the administration of the other active component comprised in a separate pharmaceutical composition, for example the PKR inhibitor, the amyloid lowering agent or the glucocorticoid. Administration "before" the administration of the JNK inhibitor preferably means within 24 h, more preferably within 12 h, even more preferably within 3 h, particularly preferably within 1 h and most preferably within 30 min before the administration of the JNK inhibitor starts. Administration "after" the administration of the JNK inhibitor preferably means within 24 h, more preferably

within 12 h, even more preferably within 3 h, particularly preferably within 1 h and most preferably within 30 min after the administration of the JNK inhibitor is finished.

5 The inventors of the present invention additionally found, that the JNK-inhibitor sequence and the chimeric peptide, respectively, as defined herein, exhibit a particular well uptake rate into cells involved in the diseases of the present invention. Therefore, the amount of a JNK-inhibitor sequence and chimeric peptide, respectively, in the pharmaceutical composition to be administered to a subject, may –without being limited thereto - have a very low dose. Thus, the dose may be much lower than for peptide drugs known in the art, such as DTS-108
10 (Florence Meyer-Losic et al., Clin Cancer Res., 2008, 2145-53). This has several positive aspects, for example a reduction of potential side reactions and a reduction in costs.

Preferably, the dose (per kg bodyweight) is in the range of up to 10 mmol/kg, preferably up to 1 mmol/kg, more preferably up to 100 μ mol/kg, even more preferably up to 10 μ mol/kg,
15 even more preferably up to 1 μ mol/kg, even more preferably up to 100 nmol/kg, most preferably up to 50 nmol/kg.

Thus, the dose range may preferably be from about 0,01 pmol/kg to about 1 mmol/kg, from about 0,1 pmol/kg to about 0,1 mmol/kg, from about 1,0 pmol/kg to about 0,01 mmol/kg,
20 from about 10 pmol/kg to about 1 μ mol/kg, from about 50 pmol/kg to about 500 nmol/kg, from about 100 pmol/kg to about 300 nmol/kg, from about 200 pmol/kg to about 100 nmol/kg, from about 300 pmol/kg to about 50 nmol/kg, from about 500 pmol/kg to about 30 nmol/kg, from about 250 pmol/kg to about 5 nmol/kg, from about 750 pmol/kg to about 10 nmol/kg, from about 1 nmol/kg to about 50 nmol/kg, or a combination of any two of said
25 values.

In this context, prescription of treatment, e.g. decisions on dosage etc. when using the above pharmaceutical composition is typically within the responsibility of general practitioners and other medical doctors, and typically takes account of the disorder to be treated, the condition
30 of the individual patient, the site of delivery, the method of administration and other factors known to practitioners. Examples of the techniques and protocols mentioned above can be found in REMINGTON'S PHARMACEUTICAL SCIENCES, 16th edition, Osol, A. (ed), 1980. Accordingly, a "safe and effective amount" as defined above for components of the pharmaceutical compositions as used according to the present invention means an amount

of each or all of these components, that is sufficient to significantly induce a positive modification of diseases or disorders strongly related to JNK signaling as defined herein. At the same time, however, a "safe and effective amount" is small enough to avoid serious side-effects, that is to say to permit a sensible relationship between advantage and risk. The determination of these limits typically lies within the scope of sensible medical judgment. A "safe and effective amount" of such a component will vary in connection with the particular condition to be treated and also with the age and physical condition of the patient to be treated, the severity of the condition, the duration of the treatment, the nature of the accompanying therapy, of the particular pharmaceutically acceptable carrier used, and similar factors, within the knowledge and experience of the accompanying doctor. The pharmaceutical compositions according to the invention can be used according to the invention for human and also for veterinary medical purposes.

The pharmaceutical composition as used according to the present invention may furthermore comprise, in addition to one of these substances, a (compatible) pharmaceutically acceptable carrier, excipient, buffer, stabilizer or other materials well known to those skilled in the art.

In this context, the expression "(compatible) pharmaceutically acceptable carrier" preferably includes the liquid or non-liquid basis of the composition. The term "compatible" means that the constituents of the pharmaceutical composition as used herein are capable of being mixed with the pharmaceutically active component as defined above and with one another component in such a manner that no interaction occurs which would substantially reduce the pharmaceutical effectiveness of the composition under usual use conditions. Pharmaceutically acceptable carriers must, of course, have sufficiently high purity and sufficiently low toxicity to make them suitable for administration to a person to be treated.

If the pharmaceutical composition as used herein is provided in liquid form, the pharmaceutically acceptable carrier will typically comprise one or more (compatible) pharmaceutically acceptable liquid carriers. The composition may comprise as (compatible) pharmaceutically acceptable liquid carriers e.g. pyrogen-free water; isotonic saline, i.e. a solution of 0.9 % NaCl, or buffered (aqueous) solutions, e.g. phosphate, citrate etc. buffered solutions, vegetable oils, such as, for example, groundnut oil, cottonseed oil, sesame oil, olive oil, corn oil and oil from theobroma; polyols, such as, for example, polypropylene glycol, glycerol, sorbitol, mannitol and polyethylene glycol; alginic acid, etc.. Particularly for

injection and/or infusion of the pharmaceutical composition as used herein, a buffer, preferably an aqueous buffer, and/or 0.9 % NaCl may be used.

If the pharmaceutical composition as used herein is provided in solid form, the pharmaceutically acceptable carrier will typically comprise one or more (compatible) pharmaceutically acceptable solid carriers. The composition may comprise as (compatible) pharmaceutically acceptable solid carriers e.g. one or more compatible solid or liquid fillers or diluents or encapsulating compounds may be used as well, which are suitable for administration to a person. Some examples of such (compatible) pharmaceutically acceptable solid carriers are e.g. sugars, such as, for example, lactose, glucose and sucrose; starches, such as, for example, corn starch or potato starch; cellulose and its derivatives, such as, for example, sodium carboxymethylcellulose, ethylcellulose, cellulose acetate; powdered tragacanth; malt; gelatin; tallow; solid glidants, such as, for example, stearic acid, magnesium stearate; calcium sulphate, etc..

The precise nature of the (compatible) pharmaceutically acceptable carrier or other material may depend on the route of administration. The choice of a (compatible) pharmaceutically acceptable carrier may thus be determined in principle by the manner in which the pharmaceutical composition as used according to the invention is administered. Various possible routes of administration are listed in the list "Route of Administration" of the FDA (cf. FDA: Data Standards Manual – Drug Nomenclature Monographs – Monograph Number: C-DRG-00301; Version Number 004), which is incorporated by reference herein. Further guidance for selecting an appropriate route of administration, in particular for non-human animals, can be found in Turner PV et al. (2011) Journal of the American Association for Laboratory Animal Science, Vol. 50, No 5, p. 600 – 613, which is also incorporated by reference herein. Preferred examples for routes for administration include parenteral routes (e.g. via injection), such as intravenous, intramuscular, subcutaneous, intradermal, or transdermal routes, etc., enteral routes, such as oral, or rectal routes, etc., topical routes, such as nasal, or intranasal routes, etc., or other routes, such as epidermal routes or patch delivery. Also contemplated (in particular for eye related diseases) are instillation, intravitreal, and subconjunctival administration. Likewise, administration may occur intratympanical, for example, whenever ear related diseases are treated.

The pharmaceutical composition as used according to the invention can be administered, for example, systemically. In general, routes for systemic administration include, for example, parenteral routes (e.g. via injection and/or infusion), such as intravenous, intra-arterial, intraosseous, intramuscular, subcutaneous, intradermal, –transdermal, or transmucosal routes, etc., and enteral routes (e.g. as tablets, capsules, suppositories, via feeding tubes, gastrostomy), such as oral, gastrointestinal or rectal routes, etc.. By systemic administration a system-wide action can be achieved and systemic administration is often very convenient, however, depending on the circumstances it may also trigger unwanted “side-effects” and/or higher concentrations of the JNK inhibitor according to the invention may be necessary as compared to local administration. Systemic administration is in general applicable for the prevention and/or treatment of the diseases/disorders mentioned above due to its system-wide action. Preferred routes of systemic administration are intravenous, intramuscular, subcutaneous, oral and rectal administration, whereby intravenous and oral administration are particularly preferred.

The pharmaceutical composition as used according to the invention can also be administered, for example, locally, for example topically. Topical administration typically refers to application to body surfaces such as the skin or mucous membranes, whereas the more general term „local administration” additionally comprises application in and/or into specific parts of the body. Topical application is particularly preferred for the treatment and/or prevention of diseases and/or disorders of the skin and/or subcutaneous tissue as defined herein as well as for certain diseases of the mouth and/or diseases relating to or are accessible by mucous membranes.

Routes for local administration include, for example, inhalational routes, such as nasal, or intranasal routes, ophtalmic and otic drugs, e.g. eye drops and ear drops, administration through the mucous membranes in the body, etc., or other routes, such as epidermal routes, epicutaneous routes (application to the skin) or patch delivery and other local application, e.g. injection and/or infusion, into the organ or tissue to be treated etc.. In local administration side effects are typically largely avoided. It is of note, that certain routes of administration may provide both, a local and a systemic effect, for example inhalation.

Routes for administration for the pharmaceutical composition as used according to the invention can be chosen according to the desired location of the application depending on the disorder/disease to be prevented or treated.

- 5 For example, an enteral administration refers to the gastrointestinal tract as application location and includes oral (p.o.), gastrointestinal and rectal administration, whereby these are typically systemic administration routes, which are applicable to the prevention/treatment of the diseases mentioned above in general. In addition, enteral administration is preferred to prevent and/or treat diseases/disorders of the gastrointestinal tract as mentioned above, for
10 example inflammatory diseases of the gastrointestinal tract, metabolic diseases, cancer and tumor diseases, in particular of the gastrointestinal tract etc.. For example, the oral route is usually the most convenient for a patient and carries the lowest cost. Therefore, oral administration is preferred for convenient systemic administration, if applicable. Pharmaceutical compositions for oral administration may be in tablet, capsule, powder or
15 liquid form. A tablet may include a solid carrier as defined above, such as gelatin, and optionally an adjuvant. Liquid pharmaceutical compositions for oral administration generally may include a liquid carrier as defined above, such as water, petroleum, animal or vegetable oils, mineral oil or synthetic oil. Physiological saline solution, dextrose or other saccharide solution or glycols such as ethylene glycol, propylene glycol or polyethylene glycol may be
20 included.

- Furthermore, enteral administration also includes application locations in the proximal gastrointestinal tract without reaching the intestines, for example sublingual, sublabial, buccal or intragingival application. Such routes of administration are preferred for applications in
25 stomatology, i.e. disease/disorders of the mouth which may be treated and/or prevented with the JNK inhibitors as disclosed herein, for example pulpitis in general, in particular acute pulpitis, chronic pulpitis, hyperplastic pulpitis, ulcerative pulpitis, irreversible pulpitis and/or reversible pulpitis; periimplantitis; periodontitis in general, in particular chronic periodontitis, complex periodontitis, simplex periodontitis, aggressive periodontitis, and/or apical
30 periodontitis, e.g. of pulpal origin; periodontosis, in particular juvenile periodontosis; gingivitis in general, in particular acute gingivitis, chronic gingivitis, plaque-induced gingivitis, and/or non-plaque-induced gingivitis; pericoronitis, in particular acute and chronic pericoronitis; sialadenitis (sialoadenitis); parotitis, in particular infectious parotitis and autoimmune parotitis; stomatitis in general, in particular aphthous stomatitis (e.g., minor or

major), Bednar's aphthae, periadenitis mucosa necrotica recurrens, recurrent aphthous ulcer, stomatitis herpetiformis, gangrenous stomatitis, denture stomatitis, ulcerative stomatitis, vesicular stomatitis and/or gingivostomatitis; mucositis, in particular mucositis due to antineoplastic therapy, due to (other) drugs, or due to radiation, ulcerative mucositis and/or oral mucositis; cheilitis in general, in particular chapped lips, actinic cheilitis, angular cheilitis, eczematous cheilitis, infectious cheilitis, granulomatous cheilitis, drug-related cheilitis, exfoliative cheilitis, cheilitis glandularis, and/or plasma cell cheilitis; cellulitis (bacterial infection), in particular of mouth and/or lips; desquamative disorders, in particular desquamative gingivitis; and/or temporomandibular joint disorder. Particularly preferred diseases to be treated and/or prevented according to the invention by these routes of administration are selected from periodontitis, in particular chronic periodontitis, mucositis, oral desquamative disorders, oral lichen planus, pemphigus vulgaris, pulpitis, stomatitis, temporomandibular joint disorder, and peri-implantitis.

For example, intragingival administration, e.g. by injection into the gums (gingiva), is preferred in stomatology applications, for example for preventing and/or treating periodontitis. For example, disorders/diseases of the mouth, in particular periodontitis, may be prevented or treated by sublingual, sublabial, buccal or intragingival application, in particular intragingival application, of the pharmaceutical composition as defined above comprising a dose (per kg body weight) of 100 ng/kg to 100 mg/kg, preferably 10 µg/kg to 10 mg/kg of the JNK inhibitor according to the present invention, whereby the chimeric peptide according to a sequence of SEQ ID NO. 11 is particularly preferred.

Alternatively, the diseases of the mouth mentioned above may also be treated and/or prevented by systemic and, preferably, topical administration of the JNK inhibitor as disclosed herein or the respective pharmaceutical composition.

In addition, enteral administration also includes strictly enteral administration, i.e. directly into the intestines, which can be used for systemic as well as for local administration.

Moreover, the JNK inhibitor according to the present invention, used in the prevention and/or treatment of diseases and/or disorders according to the present invention may be administered to the central nervous system (CNS). Such routes of administration include in particular epidural (peridural), intra-CSF (intra-cerebrospinal fluid), intracerebroventricular

(intraventricular), intrathecal and intracerebral administration, for example administration into specific brain regions, whereby problems relating to the blood-brain-barrier can be avoided. Such CNS routes of administration are preferred if the disease/disorder to be treated is a neural, a neurological and/or a neurodegenerative disease as specified above.

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In addition, the JNK inhibitor according to the present invention, used in the prevention and/or treatment of diseases and/or disorders according to the present invention may be administered at, in or onto the eye. Such routes of administration include instillation, e.g. eye drops applied topically, for example onto the conjunctiva, and, in particular, intravitreal (IVT), subconjunctival, and posterior juxtасcleral administration, e.g. by injection, infusion and/or instillation and/or localized, sustained-release drug delivery (for example in case of the subconjunctival route), whereby eyedrops (for topical application), intravitreal (IVT) and subconjunctival routes of administration are particularly preferred. The subconjunctival route is safer and less invasive than the intravitreal route, however, the intravitreal route involves less systemic exposure than the subconjunctival route due to the presence of conjunctival and orbital blood vessels and tissue.

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Local administration onto/in the eye is particularly preferred for eye-related diseases/disorders to be treated and/or prevented as disclosed herein, for example age-related macular degeneration (AMD), in particular in the wet and dry form; angioid streaks; anterior ischemic optic neuropathy; anterior uveitis; cataract, in particular age related cataract; central exudative chorioretinopathy; central serous chorioretinopathy; chalazion; chorioideremia; chorioiditis; choroidal sclerosis; conjunctivitis; cyclitis; diabetic retinopathy; dry eye syndrome; endophthalmitis; episcleritis; eye infection; fundus albipunctatus; gyrate atrophy of choroid and retina; hordeolum; inflammatory diseases of the blephara; inflammatory diseases of the choroid; inflammatory diseases of the ciliary body; inflammatory diseases of the conjunctiva; inflammatory diseases of the cornea; inflammatory diseases of the iris; inflammatory diseases of the lacrimal gland; inflammatory diseases of the orbital bone; inflammatory diseases of the sclera; inflammatory diseases of the vitreous body; inflammatory diseases of the uvea; inflammatory diseases of the retina; intermediate uveitis; iritis; keratitis; Leber's disease; multifocal choroiditis; myositis of the eye muscle; neovascular maculopathy (e.g. caused by high myopia, tilted disc syndrome, choroidal osteoma or the like); NMDA induced retinotoxicity; non-chronic or chronic inflammatory eye diseases; Oguchi's disease; optic nerve disease; orbital phlegmon; panophthalmitis; panuveitis; post capsule opacification;

posterior capsule opacification (PCO) (a cataract after-surgery complication); posterior uveitis; intraocular inflammation, in particular post-surgery or post-trauma intraocular inflammation, preferably intraocular inflammation following anterior and/or posterior segment surgery; proliferative vitreoretinopathy; retinal artery occlusion; retinal detachment, 5 retinal diseases; retinal injuries; retinal macroaneurysm; retinal pigment epithelium detachment; retinal vein occlusion; retinitis; retinitis pigmentosa; retinitis punctata albescens; retinopathy, in particular retinopathy of prematurity and diabetic retinopathy; scleritis; Stargardt's disease; treatment of inflamed ocular wounds and/or ocular wound edges; treatment of intraocular inflammation after eye surgery or trauma; uveitis; vitelliform macular 10 dystrophy; etc.

In particular, age-related macular degeneration (AMD), in particular the wet and the dry form of AMD, uveitis, in particular anterior and/or posterior uveitis, retinopathy, in particular retinopathy of prematurity and diabetic retinopathy, and post-surgery or post-trauma eye 15 inflammation, in particular post-surgery or intraocular inflammation preferably intraocular inflammation following anterior and/or posterior segment surgery, are prevented and/or treated by the JNK inhibitor used according to the present invention by local administration in and/or onto the eye, preferably by instillation, e.g. eye drops, and/or intravitreal and/or subconjunctival administration, e.g. by injection or instillation. Instillation, e.g. eyedrops, 20 and/or subconjunctival administration, e.g. by injection, are thereby preferred routes of administration and subconjunctival administration, e.g. by subconjunctival injection, is particularly preferred. For these routes of administration, in particular intravitreal and/or subconjunctival administration, the respective pharmaceutical composition according to the present invention, preferably comprises a dose per eye in the range of 100 ng to 10 mg, more 25 preferably in the range of 1 µg to 5 mg, even more preferably in the range of 50 µg to 1 mg of the JNK inhibitor according to the present invention, preferably of the chimeric peptide according to a sequence of SEQ ID NO. 11 (i.e. a dose in the range of 100 ng to 10 mg, more preferably in the range of 1 µg to 5 mg, even more preferably in the range of 50 µg to 1 mg of the JNK inhibitor administered per eye). One single administration or more administrations, 30 in particular two, three, four or five, administrations of such dose(s) may be performed, whereby a single administration is preferred, however, also subsequent dose(s) may be administered, for example on different days of the treatment schedule. For example for intravitreal and/or subconjunctival administration in humans a single dose (per eye) of the JNK inhibitor is preferably in the range of 1 µg to 5 mg, preferably 50 µg to 1,5 mg, more

preferably 500 µg to 1 mg, most preferably 800 µg to 1 mg. The injection volume, in particular for subconjunctival injection, may be for example 100 µl to 500 µl, e.g. 250 µl. A single subconjunctival injection of such a dose is for example particularly useful to treat and/or prevent post-surgery intraocular inflammation in humans, preferably intraocular inflammation following anterior and/or posterior segment surgery.

For topical ocular administration, in particular as instillation, preferably eyedrops, which may be applied to both eyes or to one eye only, depending on the need, the pharmaceutical composition comprising the JNK inhibitor according to the invention is typically a solution, preferably an ophthalmic solution, e.g. comprising (sterile) 0.9 % NaCl. Such a pharmaceutical composition comprises in particular 0.001 % - 10 % of the JNK inhibitor as described herein, preferably 0.01 % - 5 % of the JNK inhibitor as described herein, more preferably 0.05 % - 2 % of the JNK inhibitor as described herein, even more preferably 0.1 % - 1 % of the JNK inhibitor as described herein. The eyedrops may be administered once or repeatedly, whereby repeated administration is preferred. In general, the administration depends on the need and may for example be on demand. In repeated administration, subsequent dose(s) may be administered on the same and/or different days of the treatment schedule, whereby on the same day a single dose or more than one single doses, in particular two, three, four or five, preferably two to four doses may be administered, whereby such repeated administration is preferably spaced by intervals of one or more hour(s), e.g. two, three, four, five, six, seven or eight hours. For example eye drops may be administered three or four times per day for several, e.g. two, three, four, five or six weeks.

In addition, eye diseases as described herein may of course also be treated and/or prevented by systemic application of the JNK inhibitor according to the invention (which also applies to the other diseases/disorders as described herein). The dose for systemic administration in eye diseases, in particular for intravenous administration, ranges preferably from 0.001 mg/kg to 10 mg/kg, more preferably from 0.01 mg/kg to 5 mg/kg, even more preferably from 0.1 mg/kg to 2 mg/kg. Such doses are for example particularly useful to treat and/or prevent uveitis, whereby the treatment schedule may comprises a single dose or repeated doses, whereby subsequent dose(s) may be administered on different days of the treatment schedule.

Preferably, for the prevention and/or treatment of uveitis, preferably anterior uveitis, more preferably acute anterior uveitis, a single dose or repeated doses of the JNK inhibitor

according to the invention, preferably the JNK inhibitor according to SEQ ID NO: 11, are administered subconjunctivally. Preferably, a single dose is administered. However, it is also preferred that repeated doses are administered, preferably weekly or every second week. Preferably, the JNK inhibitor according to the invention, preferably the JNK inhibitor according to SEQ ID NO: 11, is applied in doses, e.g. for (sub-conjunctival) injection, in the range of 0.01 µg/eye to 10 mg/eye, more preferably 0.1 µg/eye to 5 mg/eye, even more preferably 1 µg/eye to 2 mg/eye, particularly preferably 100 µg/eye to 1.5 mg/eye, most preferably 500 µg/eye to 1 mg/eye, e.g. 900 µg/eye.

For example, if more than a single dose is applied, in particular intravenously, in the treatment and/or prevention of uveitis, the doses are typically spaced by intervals of at least one day, preferably by intervals of at least two days, more preferably by intervals of at least three days, even more preferably by intervals of at least four days, at least five days, or at least six days, particularly preferably by intervals of at least a week, most preferably by intervals of at least ten days.

Other routes of administration for the use of the JNK inhibitor according to the present invention, which are typically chosen according to the disease to be prevented and/or treated and the respective pharmacokinetics, include – but are not limited to – epicutaneous application (onto the skin) and/or intralesional application (into a skin lesion), for example for skin diseases as defined herein (mentioned above), in particular selected from psoriasis, eczema, dermatitis, acne, mouth ulcers, erythema, lichen plan, sarcoidose, vascularitis, and adult linear IgA disease; nasal administration, for example for diseases of the respiratory system and in particular lung diseases, for example acute respiratory distress syndrome (ARDS), asthma, chronic illnesses involving the respiratory system, chronic obstructive pulmonary disease (COPD), cystic fibrosis, inflammatory lung diseases, pneumonia, and pulmonary fibrosis; intraarticular administration (into a joint space), for example in arthritis, in particular juvenile idiopathic arthritis, psoriatic arthritis and rheumatoid arthritis, and arthrosis, and osteoarthritis; intravesical administration (i.e. into the urinary bladder), for example for diseases of the urinary system, in particular the urinary bladder; intracardiac administration, intracavernous administration, intravaginal administration, and intradermal administration.

In general, the method of administration depends on various factors as mentioned above, for example the selected pharmaceutical carrier and the nature of the pharmaceutical

preparation (e.g. as a liquid, tablet etc.) as well as the route of administration. For example, the pharmaceutical composition comprising the JNK inhibitor according to the invention may be prepared as a liquid, for example as a solution of the JNK inhibitor according to the invention, preferably of the chimeric peptide according to a sequence of SEQ ID NO. 11, in 0.9 % NaCl. A liquid pharmaceutical composition can be administered by various methods, for example as a spray (e.g., for inhalational, intranasal etc. routes), as a fluid for topical application, by injection, including bolus injection, by infusion, for example by using a pump, by instillation, but also p.o., e.g. as drops or drinking solution, in a patch delivery system etc.. Accordingly, for the administration different devices may be used, in particular for injection and/or infusion, e.g. a syringe (including a pre-filled syringe); an injection device (e.g. the INJECT-EASET™ and GENJECTT™ device); an infusion pump (such as e.g. Accu-Chek™); an injector pen (such as the GENPENT™); a needleless device (e.g. MEDDECTOR™ and BIOJECTOR™); or an autoinjector.

The suitable amount of the pharmaceutical composition to be used can be determined by routine experiments with animal models. Such models include, without implying any limitation, for example rabbit, sheep, mouse, rat, gerbil, dog, pig and non-human primate models. Preferred unit dose forms for administration, in particular for injection and/or infusion, include sterile solutions of water, physiological saline or mixtures thereof. The pH of such solutions should be adjusted to about 7.4. Suitable carriers for administration, in particular for injection and/or infusion, include hydrogels, devices for controlled or delayed release, polylactic acid and collagen matrices. Suitable pharmaceutically acceptable carriers for topical application include those, which are suitable for use in lotions, creams, gels and the like. If the compound is to be administered perorally, tablets, capsules and the like are the preferred unit dose form. The pharmaceutically acceptable carriers for the preparation of unit dose forms, which can be used for oral administration are well known in the prior art. The choice thereof will depend on secondary considerations such as taste, costs and storability, which are not critical for the purposes of the present invention, and can be made without difficulty by a person skilled in the art.

For intravenous, intramuscular, intraperitoneal, cutaneous or subcutaneous injection and/or infusion, or injection and/or infusion at the site of affliction, i.e. local injection/infusion, the

active ingredient will be in the form of a parenterally acceptable aqueous solution which is pyrogen-free and has suitable pH, isotonicity and stability. Those of relevant skill in the art are well able to prepare suitable solutions using, for example, isotonic vehicles such as Sodium Chloride Injection, in particular 0.9 % NaCl, Ringer's Injection, Lactated Ringer's Injection. Preservatives, stabilizers, buffers, antioxidants and/or other additives may be included, as required. Whether it is a polypeptide, peptide, or nucleic acid molecule, other pharmaceutically useful compound according to the present invention that is to be given to an individual, administration is preferably in a "prophylactically effective amount or a "therapeutically effective amount" (as the case may be), this being sufficient to show benefit to the individual. The actual amount administered, and rate and time-course of administration, will depend on the nature and severity of what is being treated. For example, for i.v. administration in humans, single doses of up to 1 mg per kg body weight are preferred, more preferably up to 500 µg per kg body weight, even more preferably up to 100 µg per kg body weight, for example in the range of 100 ng to 1 mg per kg body weight, more specifically in the range of 1 µg to 500 µg per kg body weight, even more specifically in the range of 5 µg to 100 µg per kg body weight. Such doses may be administered for example as injection and/or infusion, in particular as infusion, whereby the duration of the infusion varies for example between 1 to 90 min, preferably 10 to 70 min, more preferably 30 to 60 min.

Particularly preferred embodiments of the use of the JNK inhibitor according to the present invention, for example the chimeric peptide having a sequence according to SEQ ID NO. 11, in particular in a pharmaceutical composition as defined herein, include – but are not limited to – the prevention and/or treatment of the following diseases/disorders:

(i) respiratory diseases, in particular lung inflammation and fibrosis, specifically COPD, wherein the JNK inhibitor is preferably applied in doses (per kg body weight) in the range of 1 ng/kg to 10 mg/kg, more preferably 10 ng/kg to 1 mg/kg, even more preferably 1 µg/kg to 0.1 mg/kg, whereby such a single dose may be repeated one, two, three or four times, and which is preferably applied systemically, e.g. i.v. or s.c., or intranasally;

(ii) metabolic diseases and disorders, for example diabetes in general, in particular type 1 diabetes mellitus, type 2 diabetes mellitus, diabetes mellitus due to underlying condition, for example due to congenital rubella, Cushing's syndrome,

cystic fibrosis, malignant neoplasm, malnutrition, or pancreatitis and other diseases of the pancreas, drug or chemical induced diabetes mellitus, and/or other diabetes mellitus, wherein for the treatment and/or prevention of the metabolic diseases the JNK inhibitor is preferably applied in doses (per kg body weight) in the range of 100 µg/kg to 100 mg/kg, more preferably 1 mg/kg to 50 mg/kg, even more preferably 5 mg/kg to 15 mg/kg, whereby such a single dose may be repeated daily for one to several, e.g. four, weeks, and which is preferably applied systemically, e.g. i.v. or s.c.;

- (iii) diseases of the mouth and/or the jaw bone, in particular inflammatory diseases of the mouth and/or the jaw bone selected from (i) pulpitis in general, in particular acute pulpitis, chronic pulpitis, hyperplastic pulpitis, ulcerative pulpitis, irreversible pulpitis and/or reversible pulpitis; (ii) periimplantitis; (iii) periodontitis in general, in particular chronic periodontitis, complex periodontitis, simplex periodontitis, aggressive periodontitis, and/or apical periodontitis, e.g. of pulpal origin; periodontosis, in particular juvenile periodontosis; (iv) gingivitis in general, in particular acute gingivitis, chronic gingivitis, plaque-induced gingivitis, and/or non-plaque-induced gingivitis; (v) pericoronitis, in particular acute and chronic pericoronitis; sialadenitis (sialoadenitis); parotitis, in particular infectious parotitis and autoimmune parotitis; (vi) stomatitis in general, in particular aphthous stomatitis (e.g., minor or major), Bednar's aphthae, periadenitis mucosa necrotica recurrens, recurrent aphthous ulcer, stomatitis herpetiformis, gangrenous stomatitis, denture stomatitis, ulcerative stomatitis, vesicular stomatitis and/or gingivostomatitis; (vii) mucositis, in particular mucositis due to antineoplastic therapy, due to (other) drugs, or due to radiation, ulcerative mucositis and/or oral mucositis; (viii) cheilitis in general, in particular chapped lips, actinic cheilitis, angular cheilitis, eczematous cheilitis, infectious cheilitis, granulomatous cheilitis, drug-related cheilitis, exfoliative cheilitis, cheilitis glandularis, and/or plasma cell cheilitis; and (ix) cellulitis (bacterial infection), in particular of mouth and/or lips; desquamative disorders, in particular desquamative gingivitis; and/or temporomandibular joint disorder, whereby periodontitis, periimplantitis, gingivitis, stomatitis and mucositis are preferred and periodontitis is particularly preferred; wherein for the treatment and/or prevention of the diseases of the mouth and/or the jaw bone the JNK inhibitor is preferably applied in doses (per kg body

weight) in the range of 100 µg/kg to 100 mg/kg, more preferably 1 mg/kg to 10 mg/kg, even more preferably 2 mg/kg to 5 mg/kg, and which is preferably applied intragingivally or topically, particularly preferably intragingivally;

- 5 (iv) nephrological diseases (kidney diseases), in particular selected from (i) glomerulonephritis, for example nonproliferative glomerulonephritis, in particular minimal change disease, focal segmental glomerulosclerosis, focal segmental glomerular hyalinosis and/or sclerosis, focal glomerulonephritis, membranous glomerulonephritis, and/or thin basement membrane disease, and proliferative
- 10 glomerulonephritis, in particular membrano-proliferative glomerulonephritis, mesangio-proliferative glomerulonephritis, endocapillary proliferative glomerulonephritis, mesangiocapillary proliferative glomerulonephritis, dense deposit disease (membranoproliferative glomerulonephritis type II), extracapillary glomerulonephritis (crescentic glomerulonephritis), rapidly progressive
- 15 glomerulonephritis (RPGN), in particular Type I RPGN, Type II RPGN, Type III RPGN, and Type IV RPGN, acute proliferate glomerulonephritis, post-infectious glomerulonephritis, and/or IgA nephropathy (Berger's disease); acute nephritic syndrome; rapidly progressive nephritic syndrome; recurrent and persistent hematuria; chronic nephritic syndrome; nephrotic syndrome; proteinuria with
- 20 specified morphological lesion; glomerulitis; glomerulopathy; glomerulosclerosis; (ii) acute kidney injury ("AKI", also called "acute renal failure" or "acute kidney failure") in general, in particular prerenal AKI, intrinsic AKI, postrenal AKI, AKI with tubular necrosis for example acute tubular necrosis, renal tubular necrosis, AKI with cortical necrosis for example acute cortical necrosis and renal cortical
- 25 necrosis, AKI with medullary necrosis, for example medullary (papillary) necrosis, acute medullary (papillary) necrosis and chronic medullary (papillary) necrosis, or other AKI; chronic kidney disease; or (iii) nephropathy, in particular selected from membranous nephropathy, diabetic nephropathy, IgA nephropathy, hereditary nephropathy, analgesic nephropathy, CFHR5 nephropathy, contrast-
- 30 induced nephropathy, amyloid nephropathy, reflux nephropathy and/or Mesoamerican nephropathy, diabetic nephropathy, diabetic nephropathy, whereby preferably the disorder/disease to be prevented and/or treated is glomerulonephritis or diabetic nephropathy, more preferably the disorder/disease to be prevented and/or treated is glomerulonephritis; wherein for the treatment

and/or prevention of the nephrological diseases (kidney diseases), preferably of glomerulonephritis, more preferably of glomerulonephritis with focal segmental glomerulosclerosis and/or fibrosis, the JNK inhibitor is preferably applied in doses (per kg body weight) in the range of 10 $\mu\text{g/kg}$ to 100 mg/kg, more preferably 100 $\mu\text{g/kg}$ to 10 mg/kg, even more preferably 1 mg/kg to 5 mg/kg, and the JNK inhibitor, preferably the chimeric peptide having a sequence according to SEQ ID NO. 11, is preferably administered, if applicable, once or repeatedly, preferably weekly (once per week) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more weeks, every second week (once per two weeks) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more weeks, monthly (once per month) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more months, every sixth week (once per every six weeks) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more months, every second month (once per two months) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more months or every third month (once per three months) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more weeks, more preferably weekly (once per week) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more weeks, every second week (once per two weeks) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more weeks, monthly (once per month) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more months, even more preferably monthly (once per month) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more months, and which is preferably applied systemically, e.g. i.v. or s.c.;

- (v) cancer and tumor diseases, in particular selected from (i) liver cancer and liver carcinoma in general, in particular liver metastases, liver cell carcinoma, hepatocellular carcinoma, hepatoma, intrahepatic bile duct carcinoma, cholangiocarcinoma, hepatoblastoma, angiosarcoma (of liver), and other specified or unspecified sarcomas and carcinomas of the liver; (ii) prostate cancer and/or prostate carcinoma; and/or (iii) colon cancer and colon carcinoma in general, in particular cecum carcinoma, appendix carcinoma, ascending colon carcinoma, hepatic flexure carcinoma, transverse colon carcinoma, splenic flexure carcinoma, descending colon carcinoma, sigmoid colon carcinoma, carcinoma of overlapping sites of colon and/or malignant carcinoid tumors of the colon, wherein for the treatment and/or prevention of the cancer and tumor diseases the JNK inhibitor is preferably applied in doses (per kg body weight) in the range of 1 $\mu\text{g/kg}$ to 100 mg/kg, more preferably 10 $\mu\text{g/kg}$ to 50 mg/kg, even

more preferably 0.1 mg/kg to 20 mg/kg, particularly preferably 0.1 mg/kg to 5 mg/kg, if applicable repeatedly, for example daily, every 2 or 3 days or weekly, for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, weeks, and which is preferably applied systemically, e.g. p.o., i.v. or s.c.;

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- (vi) diseases of the eye, in particular (i) age-related macular degeneration (AMD), including exudative and/or non-exudative age-related macular degeneration, preferably the wet or the dry form of age-related macular degeneration; (ii) retinopathy, in particular selected from diabetic retinopathy, (arterial hypertension induced) hypertensive retinopathy, exudative retinopathy, radiation induced retinopathy, sun-induced solar retinopathy, trauma-induced retinopathy, e.g. Purtscher's retinopathy, retinopathy of prematurity (ROP) and/or hyperviscosity-related retinopathy, non-diabetic proliferative retinopathy, and/or proliferative vitreo-retinopathy, whereby diabetic retinopathy and retinopathy of prematurity (ROP) are preferred and diabetic retinopathy is particularly preferred; (iii) post-surgery and/or post-trauma inflammation of the eye, in particular after a surgery performed on and/or in the eye, preferably intraocular inflammation following anterior and/or posterior segment surgery, for example after cataract surgery, laser eye surgery (e.g. Laser-in-situ-Keratomileusis (LASIK)), glaucoma surgery, refractive surgery, corneal surgery, vitreo-retinal surgery, eye muscle surgery, oculoplastic surgery, ocular oncology surgery, conjunctival surgery including pterygium, and/or surgery involving the lacrimal apparatus, in particular after complex eye surgery and/or after uncomplicated eye surgery; and/or (iv) uveitis, in particular anterior, intermediate and/or posterior uveitis, sympathetic uveitis and/or panuveitis, preferably anterior and/or posterior uveitis; wherein for the treatment and/or prevention of the diseases of the eye, preferably for the treatment and/or prevention of diabetic retinopathy, anterior and/or posterior uveitis or post-surgery and/or post-trauma inflammation of the eye, the JNK inhibitor is preferably applied in doses, e.g. for injection, in the range of 0.01 µg/eye to 10 mg/eye, more preferably 0.1 µg/eye to 5 mg/eye, even more preferably 1 µg/eye to 2 mg/eye, particularly preferably 100 µg/eye to 1.5 mg/eye, most preferably 500 µg/eye to 1 mg/eye, e.g. 900 µg/eye, preferably by a single injection, however, if necessary repeatedly, for example daily, every 2 or 3 days or weekly, for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, weeks, or once every 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, or more

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weeks, preferably once every 2, 3, 4, 6, 8, 10, or 12 weeks, and which is preferably applied i.v. or in or onto the eye, more preferably intravitreally or subconjunctivally, even more preferably subconjunctivally. For example, for treating and/or preventing post-surgery intraocular inflammation, in particular intraocular inflammation following anterior and/or posterior segment surgery, for example after cataract surgery, laser eye surgery (e.g. Laser-in-situ-Keratomileusis (LASIK)), glaucoma surgery, refractive surgery, corneal surgery, vitreo-retinal surgery, eye muscle surgery, oculoplastic surgery, ocular oncology surgery, conjunctival surgery including pterygium, and/or surgery involving the lacrimal apparatus, in particular after complex eye surgery and/or after uncomplicated eye surgery, subconjunctival administration and/or instillation, e.g. eye drops, are particularly preferred. Thereby, for subconjunctival administration a single injection after the surgery, preferably within three hours after surgery, for example just after the end of the surgical procedure when the patient is still in the operating room, is particularly preferred. For instillation for example application of two to four doses, preferably three doses per day for two to four weeks, preferably three weeks, is preferred, whereby the first dose may be applied for example just after surgery. Moreover, for treating and/or preventing post-surgery intraocular inflammation, in particular intraocular inflammation following anterior and/or posterior segment surgery, the JNK inhibitors of the present invention may be administered as stand-alone therapy, however, the JNK inhibitors of the present invention may also be administered in combination with other medications, e.g. with corticosteroids, preferably glucocorticoids, for example dexamethasone, in particular if the inflammation persists over a predetermined period. For example, the JNK inhibitors of the present invention may first be used alone and, if the inflammation persists may be combined with corticosteroids or, if corticosteroids were used alone first, they may be combined with the JNK inhibitors of the present invention if the inflammation persists;

- (vii) diseases and/or disorders of the urinary system, in particular ureteritis; urinary tract infection (bladder infection, acute cystitis); cystitis in general, in particular interstitial cystitis, Hunner's ulcer, trigonitis and/or hemorrhagic cystitis; urethritis, in particular nongonococcal urethritis or gonococcal urethritis; painful bladder syndrome; IC/PBS; urethral syndrome; and/or retroperitoneal fibrosis; preferably

- IC/PBS; wherein for the treatment and/or prevention of the diseases and/or disorders of the urinary system, preferably for the treatment and/or prevention of IC/PBS, the JNK inhibitor is preferably applied (i) systemically, more preferably intravenously, e.g. by intravenous injection, in doses of (per kg body weight) in the range of 100 ng/kg to 10 mg/kg, more preferably 1 µg/kg to 5 mg/kg, even more preferably 10 µg/kg to 2 mg/kg, particularly preferably 0.1 mg/kg to 1 mg/kg, most preferably 0.2 mg/kg to 0.5 mg/kg, preferably administered in one single dose, however, if applicable also preferably administered repeatedly, for example daily, every 2 or 3 days or weekly, for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, weeks; or the JNK inhibitor is also preferably applied (ii) intravesically, more preferably by intravesical infusion, preferably at a concentration of 10 µg/ml – 1000 mg/ml, more preferably 50 µg/ml – 500 mg/ml, even more preferably 100 µg/ml – 100 mg/ml, and particularly preferably 0.5 mg/ml – 50 mg/ml, preferably in single doses of 0.1 – 1000 mg, more preferably 0.5 – 500 mg, even more preferably 1 – 100 mg, and particularly preferably 2 – 10 mg, preferably administered in one single dose, however, if applicable also preferably administered repeatedly, for example daily, every 2 or 3 days or weekly, for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, weeks; and
- (viii) neural, neuronal or neurodegenerative disorders, in particular neurodegenerative disease, preferably Alzheimer's disease, for example Alzheimer's disease with early onset, Alzheimer's disease with late onset, Alzheimer's dementia senile and presenile forms, and/or Mild Cognitive Impairment, in particular Mild Cognitive Impairment due to Alzheimer's Disease, wherein for the treatment and/or prevention of the neural, neuronal or neurodegenerative disorders the JNK inhibitor is preferably applied in doses (per kg body weight) in the range of 1 µg/kg to 100 mg/kg, more preferably 10 µg/kg to 50 mg/kg, even more preferably 100 µg/kg to 10 mg/kg, and particularly preferably 500 µg/kg to 1 mg/kg, whereby the JNK inhibitor is preferably administered, if applicable, once or repeatedly, preferably weekly (once per week) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more weeks, every second week (once per two weeks) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more weeks, monthly (once per month) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more months, every sixth week (once per every six weeks) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more months, every second month

(once per two months) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more months or every third month (once per three months) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more weeks, more preferably weekly (once per week) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more weeks, every second week (once per two weeks) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more weeks, monthly (once per month) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more months, even more preferably monthly (once per month) for several, e.g. 2, 3, 4, 5, 6, 7, 8, 9, or 10, or more months, and which is preferably applied systemically, e.g. i.v., p.o., i.m., s.c. or intra-CSF (intra-cerebrospinal fluid) moreover, for treating and/or preventing neural, neuronal or neurodegenerative disorders, in particular neurodegenerative disease, preferably Alzheimer's disease, for example Alzheimer's disease with early onset, Alzheimer's disease with late onset, Alzheimer's dementia senile and presenile forms, and/or Mild Cognitive Impairment, in particular Mild Cognitive Impairment due to Alzheimer's Disease, the JNK inhibitors of the present invention may be administered as stand-alone therapy, however, the JNK inhibitors of the present invention may also be administered in combination with other medications, e.g. with a PKR inhibitor, e.g. "SC1481" by Polypeptide Group, and, optionally, in addition to the JNK inhibitor according to the present invention and the PKR inhibitor with a amyloid lowering agent, whereby amyloid lowering agents include β -secretase (BACE1) inhibitors, γ -secretase inhibitors (GSI) and modulators (GSM) and examples of such inhibitors, which are currently in clinical trials may be retrieved from Vassar R. (2014) BACE1 inhibitor drugs in clinical trials for Alzheimer's disease. *Alzheimers Res Ther.*;6(9):89 or from Jia Q, Deng Y, Qing H (2014) Potential therapeutic strategies for Alzheimer's disease targeting or beyond β -amyloid: insights from clinical trials. *Biomed Res Int.* 2014;2014:837157.

Prevention and/or treatment of a disease as defined herein typically includes administration of a pharmaceutical composition as defined above. The term "modulate" includes the suppression of expression of JNK when it is over-expressed in any of the above diseases. It also includes suppression of phosphorylation of c-jun, ATF2 or NFAT4 in any of the above diseases, for example, by using at least one JNK inhibitor sequence according to any of sequences of SEQ ID NOs: 1 to 4 and 13 to 20 and 33-100 and/or at least one chimeric peptide according to any of sequences of SEQ ID NOs: 9 to 12 and 23 to 32, whereby SEQ

ID NO: 11 is particularly preferred, and/or at least one JNK inhibitor sequence according to any of sequences of SEQ ID NOs: 1 to 4 and 13 to 20 and 33-100 comprising a trafficking sequence according to any of SEQ ID NOs: 5 to 8 and 21 to 22, or variants or fragments thereof within the above definitions, as a competitive inhibitor of the natural c-jun, ATF2 and NFAT4 binding site in a cell. The term "modulate" also includes suppression of hetero- and homomeric complexes of transcription factors made up of, without being limited thereto, c-jun, ATF2, or NFAT4 and their related partners, such as for example the AP-1 complex that is made up of c-jun, AFT2 and c-fos. When a disease or disorder strongly related to JNK signaling as defined above is associated with JNK overexpression, such suppressive JNK inhibitor sequences can be introduced to a cell. In some instances, "modulate" may then include the increase of JNK expression, for example by use of an IB peptide-specific antibody that blocks the binding of an IB-peptide to JNK, thus preventing JNK inhibition by the IB-related peptide.

Prevention and/or treatment of a subject with the pharmaceutical composition as disclosed above may be typically accomplished by administering (*in vivo*) an ("therapeutically effective") amount of said pharmaceutical composition to a subject, wherein the subject may be e.g. any mammal, e.g. a human, a primate, mouse, rat, dog, cat, cow, horse or pig, whereby a human is particularly preferred. The term "therapeutically effective" means that the active component of the pharmaceutical composition is of sufficient quantity to ameliorate the disease or disorder strongly related to JNK signaling as defined above.

Accordingly, any peptide as defined above, e.g. at least one JNK inhibitor sequence according to any of sequences of SEQ ID NOs: 1 to 4 and 13 to 20 and 33-100 and/or at least one chimeric peptide according to any of sequences of SEQ ID NOs: 9 to 12 and 23 to 32, preferably SEQ ID NO: 11, and/or at least one JNK inhibitor sequence according to any of sequences of SEQ ID NOs: 1 to 4 and 13 to 20 and 33-100 comprising a trafficking sequence according to any of SEQ ID NOs: 5 to 8 and 21 to 22, or variants or fragments thereof within the above definitions, may be utilized in a specific embodiment of the present invention to treat diseases or disorders strongly related to JNK signaling as defined above, e.g. by modulating activated JNK signaling pathways.

However, the above defined peptides may be also encoded by nucleic acids, which then may form part of the inventive pharmaceutical compositions, e.g. for use in gene therapy. In this context, gene therapy refers to therapy that is performed by administration of a specific

nucleic acid as defined above to a subject, e.g. by way of a pharmaceutical composition as defined above, wherein the nucleic acid(s) exclusively comprise(s) L-amino acids. In this embodiment of the present invention, the nucleic acid produces its encoded peptide(s), which then serve(s) to exert a therapeutic effect by modulating function of the disease or disorder.

5 Any of the methods relating to gene therapy available within the art may be used in the practice of the present invention (see e.g. Goldspiel, *et al.*, 1993. Clin Pharm 12: 488-505).

In a preferred embodiment, the nucleic acid as defined above and as used for gene therapy is part of an expression vector encoding and expressing any one or more of the IB-related
10 peptides as defined above within a suitable host, i.e. an JNK inhibitor sequence according to any of sequences of SEQ ID NOs: 1 to 4 and 13 to 20 and 33-100 and/or a chimeric peptide according to any of sequences of SEQ ID NOs: 9 to 12 and 23 to 32, and/or an JNK inhibitor sequence according to any of sequences of SEQ ID NOs: 1 to 4 and 13 to 20 and 33-100 comprising a trafficking sequence according to any of SEQ ID NOs: 5 to 8 and 21 to 22, or
15 variants or fragments thereof within the above definitions. In a specific embodiment, such an expression vector possesses a promoter that is operably-linked to coding region(s) of a JNK inhibitor sequence. The promoter may be defined as above, e.g. inducible or constitutive, and, optionally, tissue-specific.

20 In another specific embodiment, a nucleic acid molecule as defined above is used for gene therapy, in which the coding sequences of the nucleic acid molecule (and any other desired sequences thereof) as defined above are flanked by regions that promote homologous recombination at a desired site within the genome, thus providing for intra-chromosomal expression of these nucleic acids (see e.g. Koller and Smithies, 1989. Proc Natl Acad Sci USA
25 86: 8932-8935).

Delivery of the nucleic acid as defined above according to the invention into a patient for the purpose of gene therapy, particular in the context of the above mentioned diseases or disorders strongly related to JNK signaling as defined above may be either direct (i.e. the
30 patient is directly exposed to the nucleic acid or nucleic acid-containing vector) or indirect (i.e. cells are first transformed with the nucleic acid *in vitro*, then transplanted into the patient), whereby in general the routes of administration as mentioned above for the pharmaceutical composition apply as well, however, a local administration for example by local injection into the tissue or organ to be treated is preferred. These two approaches are known,

respectively, as *in vivo* or *ex vivo* gene therapy. In a specific embodiment of the present invention, a nucleic acid is directly administered *in vivo*, where it is expressed to produce the encoded product. This may be accomplished by any of numerous methods known in the art including, e.g. constructing the nucleic acid as part of an appropriate nucleic acid expression
5 vector and administering the same in a manner such that it becomes intracellular (e.g. by infection using a defective or attenuated retroviral, adeno-associated viral or other viral vector; see U. S. Patent No. 4,980,286); directly injecting naked DNA; using microparticle bombardment (e.g. a "GeneGun"; Biolistic, DuPont); coating the nucleic acids with lipids; using associated cell-surface receptors/transfecting agents; encapsulating in liposomes,
10 microparticles, or microcapsules; administering it in linkage to a peptide that is known to enter the nucleus; or by administering it in linkage to a ligand predisposed to receptor-mediated endocytosis (see e.g. Wu and Wu, 1987.J Biol Chem 262: 4429-4432), which can be used to "target" cell types that specifically express the receptors of interest, etc.

15 An additional approach to gene therapy in the practice of the present invention involves transferring a gene (comprising a nucleic acid as defined above) into cells in *in vitro* tissue culture by such methods as electroporation, lipofection, calcium phosphate-mediated transfection, viral infection, or the like. Generally, the method of transfer includes the concomitant transfer of a selectable marker to the cells. The cells are then placed under
20 selection pressure (e.g. antibiotic resistance) so as to facilitate the isolation of those cells that have taken up, and are expressing, the transferred gene. Those cells are then delivered to a patient. In a specific embodiment, prior to the *in vivo* administration of the resulting recombinant cell, the nucleic acid is introduced into a cell by any method known within the art including e.g. transfection, electroporation, microinjection, infection with a viral or
25 bacteriophage vector containing the nucleic acid sequences of interest, cell fusion, chromosome-mediated gene transfer, microcell-mediated gene transfer, spheroplast fusion, and similar methods that ensure that the necessary developmental and physiological functions of the recipient cells are not disrupted by the transfer. See e.g. Loeffler and Behr, 1993. Meth Enzymol 217 : 599-618. The chosen technique should provide for the stable
30 transfer of the nucleic acid to the cell, such that the nucleic acid is expressible by the cell. Preferably, the transferred nucleic acid is heritable and expressible by the cell progeny.

In preferred embodiments of the present invention, the resulting recombinant cells may be delivered to a patient by various methods known within the art including, e.g. injection of

epithelial cells (e.g. subcutaneously), application of recombinant skin cells as a skin graft onto the patient, and intravenous injection of recombinant blood cells (e.g. hematopoietic stem or progenitor cells). The total amount of cells that are envisioned for use depend upon the desired effect, patient state, and the like, and may be determined by one skilled within the art. Cells into which a nucleic acid can be introduced for purposes of gene therapy encompass any desired, available cell type, and may be xenogeneic, heterogeneic, syngeneic, or autogeneic. Cell types include, but are not limited to, differentiated cells such as epithelial cells, endothelial cells, keratinocytes, fibroblasts, muscle cells, hepatocytes and blood cells, or various stem or progenitor cells, in particular embryonic heart muscle cells, liver stem cells (International Patent Publication WO 94/08598), neural stem cells (Stemple and Anderson, 1992, Cell 71 : 973-985), hematopoietic stem or progenitor cells, e.g. as obtained from bone marrow, umbilical cord blood, peripheral blood, fetal liver, and the like. In a preferred embodiment, the cells utilized for gene therapy are autologous to the patient.

Alternatively and/or additionally, for treating diseases as mentioned herein targeting therapies may be used to deliver the JNK inhibitor sequences, chimeric peptides, and/or nucleic acids as defined above more specifically to certain types of cell, by the use of targeting systems such as (a targeting) antibody or cell specific ligands. Antibodies used for targeting are typically specific for cell surface proteins of cells associated with any of the diseases as defined below. By way of example, these antibodies may be directed to cell surface antibodies such as e.g. B cell-associated surface proteins such as MHC class II DR protein, CD18 (LFA-1 beta chain), CD45RO, CD40 or Bgp95, or cell surface proteins selected from e.g. CD2, CD4, CD5, CD7, CD8, CD9, CD10, CD13, CD16, CD19, CD20, CD21, CD22, CD23, CD24, CD25, CD30, CD33, CD34, CD38, CD39, CD4, CD43, CD45, CD52, CD56, CD68, CD71, CD138, etc.. Targeting constructs may be typically prepared by covalently binding the JNK inhibitor sequences, chimeric peptides, and nucleic acids as defined herein according to the invention to an antibody specific for a cell surface protein or by binding to a cell specific ligand. Proteins may e.g. be bound to such an antibody or may be attached thereto by a peptide bond or by chemical coupling, crosslinking, etc.. The targeting therapy may then be carried out by administering the targeting construct in a pharmaceutically efficient amount to a patient by any of the administration routes as defined below, e.g. intraperitoneal, nasal, intravenous, oral and patch delivery routes. Preferably, the JNK inhibitor sequences, chimeric peptides, or nucleic acids as defined herein according to the invention, being attached to the targeting antibodies or cell specific ligands as defined above,

may be released *in vitro* or *in vivo*, e.g. by hydrolysis of the covalent bond, by peptidases or by any other suitable method. Alternatively, if the JNK inhibitor sequences, chimeric peptides, or nucleic acids as defined herein according to the invention are attached to a small cell specific ligand, release of the ligand may not be carried out. If present at the cell surface, the chimeric peptides may enter the cell upon the activity of its trafficking sequence. Targeting may be desirable for a variety of reasons; for example if the JNK inhibitor sequences, chimeric peptides, and nucleic acids as defined herein according to the invention are unacceptably toxic or if it would otherwise require a too high dosage.

Instead of administering the JNK inhibitor sequences and/or chimeric peptides as defined herein according to the invention directly, they could be produced in the target cells by expression from an encoding gene introduced into the cells, e.g. from a viral vector to be administered. The viral vector typically encodes the JNK inhibitor sequences and/or chimeric peptides as defined herein according to the invention. The vector could be targeted to the specific cells to be treated. Moreover, the vector could contain regulatory elements, which are switched on more or less selectively by the target cells upon defined regulation. This technique represents a variant of the VDEPT technique (virus-directed enzyme prodrug therapy), which utilizes mature proteins instead of their precursor forms.

Alternatively, the JNK inhibitor sequences and/or chimeric peptides as defined herein could be administered in a precursor form by use of an antibody or a virus. These JNK inhibitor sequences and/or chimeric peptides may then be converted into the active form by an activating agent produced in, or targeted to, the cells to be treated. This type of approach is sometimes known as ADEPT (antibody-directed enzyme prodrug therapy) or VDEPT (virus-directed enzyme prodrug therapy); the former involving targeting the activating agent to the cells by conjugation to a cell-specific antibody, while the latter involves producing the activating agent, e.g. a JNK inhibitor sequence or the chimeric peptide, in a vector by expression from encoding DNA in a viral vector (see for example, EP-A-415731 and WO 90/07936).

According to another preferred embodiment, the JNK inhibitor sequences, chimeric peptides, nucleic acid sequences or antibodies to JNK inhibitor sequences or to chimeric peptides as defined herein, e.g. an JNK inhibitor sequence according to any of sequences of SEQ ID NOs: 1 to 4 and 13 to 20 and 33-100 and/or a chimeric peptide according to any of sequences of

SEQ ID NOs: 9 to 12 and 23 to 32, preferably SEQ ID NO: 11, and/or an JNK inhibitor sequence according to any of sequences of SEQ ID NOs: 1 to 4 and 13 to 20 and 33-100 comprising a trafficking sequence according to any of SEQ ID NOs: 5 to 8 and 21 to 22, or variants or fragments thereof within the above definitions, may be utilized for the treatment of a tissue or organ prior to its transplantation. Preferably, a solution for the isolation, transport, perfusion, implantation or the like of an organ and/or tissue to be transplanted comprises the JNK inhibitor according to the present invention, preferably in a concentration in the range of 1 to 1000 μ M, more preferably in the range of 10 to 500 μ M, even more preferably in the range of 50 to 150 μ M. For this aspect of the invention, the transplant is a kidney, heart, lung, pancreas, in particular pancreatic islets (also called islets of Langerhans), liver, blood cell, bone marrow, cornea, accidental severed limb, in particular fingers, hand, foot, face, nose, bone, cardiac valve, blood vessel or intestine transplant, preferably a kidney, heart, pancreas, in particular pancreatic islets (also called islets of Langerhans), or skin transplant. For example, the JNK inhibitor according to the invention may be contained in the solution for the isolation of pancreatic islets. Such a solution may be for example injected into the pancreatic duct prior to isolation. Moreover, it is preferred if a solution containing the JNK inhibitor according to the invention is applied in isolation, transport, perfusion, transplantation or the like of an organ and/or tissue, in particular if the time of ischemia exceeds 15 min, more preferably, if the time of ischemia exceeds 20 min, even more preferably if the time of ischemia is at least 30 min. These ischemia times may apply to warm and/or cold ischemia time, however, it is particularly preferred if they apply exclusively to warm ischemia time (WIT), whereby WIT refers to the length of time that elapses between a donor's death, in particular from the time of cross-clamping or of asystole in non-heart-beating donors, until cold perfusion is commenced and to ischemia during implantation, from removal of the organ from ice until reperfusion.

According to a further embodiment, the JNK inhibitor sequences, chimeric peptides, nucleic acid sequences or antibodies to JNK inhibitor sequences or to chimeric peptides as defined herein, e.g. an JNK inhibitor sequence according to any of sequences of SEQ ID NOs: 1 to 4 and 13 to 20 and 33-100 and/or a chimeric peptide according to any of sequences of SEQ ID NOs: 9 to 12 and 23 to 32, and/or an JNK inhibitor sequence according to any of sequences of SEQ ID NOs: 1 to 4 and 13 to 20 and 33-100 comprising a trafficking sequence according to any of SEQ ID NOs: 5 to 8 and 21 to 22, or variants or fragments thereof within the above definitions, may be utilized in (*in vitro*) assays (e.g. immunoassays) to detect, prognose,

diagnose, or monitor various conditions and disease states selected from diseases or disorders strongly related to JNK signaling as defined above, or monitor the treatment thereof. The immunoassay may be performed by a method comprising contacting a sample derived from a patient with an antibody to an JNK inhibitor sequence, a chimeric peptide, or a nucleic acid sequence, as defined above, under conditions such that immunospecific-binding may occur, and subsequently detecting or measuring the amount of any immunospecific-binding by the antibody. In a specific embodiment, an antibody specific for an JNK inhibitor sequence, a chimeric peptide or a nucleic acid sequence may be used to analyze a tissue or serum sample from a patient for the presence of JNK or a JNK inhibitor sequence; wherein an aberrant level of JNK is indicative of a diseased condition. The immunoassays that may be utilized include, but are not limited to, competitive and non-competitive assay systems using techniques such as Western Blots, radioimmunoassays (RIA), enzyme linked immunosorbent assay (ELISA), "sandwich" immunoassays, immunoprecipitation assays, precipitin reactions, gel diffusion precipitin reactions, immunodiffusion assays, agglutination assays, fluorescent immunoassays, complement-fixation assays, immunoradiometric assays, and protein-A immunoassays, etc.. Alternatively, (*in vitro*) assays may be performed by delivering the JNK inhibitor sequences, chimeric peptides, nucleic acid sequences or antibodies to JNK inhibitor sequences or to chimeric peptides, as defined above, to target cells typically selected from e.g. cultured animal cells, human cells or micro-organisms, and to monitor the cell response by biophysical methods typically known to a skilled person. The target cells typically used therein may be cultured cells (*in vitro*) or *in vivo* cells, i.e. cells composing the organs or tissues of living animals or humans, or microorganisms found in living animals or humans.

The present invention additionally provides the use of kits for diagnostic or therapeutic purposes, particular for the treatment, prevention or monitoring of diseases or disorders strongly related to JNK signaling as defined above, wherein the kit includes one or more containers containing JNK inhibitor sequences, chimeric peptides, nucleic acid sequences and/or antibodies to these JNK inhibitor sequences or to chimeric peptides as defined above, e.g. an anti-JNK inhibitor sequence antibody to an JNK inhibitor sequence according to any of sequences of SEQ ID NOs: 1 to 4 and 13 to 20 and 33-100, to a chimeric peptide according to any of sequences of SEQ ID NOs: 9 to 12 and 23 to 32, to an JNK inhibitor sequence according to any of sequences of SEQ ID NOs: 1 to 4 and 13 to 20 and 33-100 comprising a trafficking sequence according to any of SEQ ID NOs: 5 to 8 and 21 to 22, or to or variants or fragments thereof within the above definitions, or such an anti-JNK inhibitor sequence

antibody and, optionally, a labeled binding partner to the antibody. The label incorporated thereby into the antibody may include, but is not limited to, a chemiluminescent, enzymatic, fluorescent, colorimetric or radioactive moiety. In another specific embodiment, kits for diagnostic use in the treatment, prevention or monitoring of diseases or disorders strongly related to JNK signaling as defined above are provided which comprise one or more containers containing nucleic acids that encode, or alternatively, that are the complement to, an JNK inhibitor sequence and/or a chimeric peptide as defined above, optionally, a labeled binding partner to these nucleic acids, are also provided. In an alternative specific embodiment, the kit may be used for the above purposes as a kit, comprising one or more containers, a pair of oligonucleotide primers (e.g. each 6-30 nucleotides in length) that are capable of acting as amplification primers for polymerase chain reaction (PCR; see e.g. Innis, *et al.*, 1990. PCR PROTOCOLS, Academic Press, Inc., San Diego, CA), ligase chain reaction, cyclic probe reaction, and the like, or other methods known within the art used in context with the nucleic acids as defined above. The kit may, optionally, further comprise a predetermined amount of a purified JNK inhibitor sequence as defined above, a chimeric peptide as defined above, or nucleic acids encoding these, for use as a diagnostic, standard, or control in the assays for the above purposes.

The present invention is not to be limited in scope by the specific embodiments described herein. Indeed, various modifications of the invention in addition to those described herein will become apparent to those skilled in the art from the foregoing description and accompanying figures. Such modifications fall within the scope of the appended claims.

Various publications are cited herein, the disclosures of which are incorporated by reference in their entirety.

Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, suitable methods and materials are described below. All publications, patent applications, patents, and other references mentioned herein are incorporated by reference in their entirety. In the case of conflict, the present specification, including definitions, will control. In addition, the materials, methods,

and examples are illustrative only and not intended to be limiting. Other features and advantages of the invention will be apparent from the following detailed description and claims.

DESCRIPTION OF FIGURES

- Figure 1 are diagrams showing alignments of conserved JBD domain regions in the indicated transcription factors. JNK inhibitor sequences used herein were identified by carrying out sequence alignments. The results of this alignment are exemplarily shown in Figures 1A-1C. Figure 1A depicts the region of highest homology between the JBDs of IB1, IB2, c-Jun and ATF2. Panel B depicts the amino acid sequence of the JBDs of L-IB1(s) and L-IB1 for comparative reasons. Fully conserved residues are indicated by asterisks, while residues changed to Ala in the GFP-JBD_{23Mut} vector are indicated by open circles. Figure 1C shows the amino acid sequences of chimeric proteins that include a JNK inhibitor sequence and a trafficking sequence. In the example shown, the trafficking sequence is derived from the human immunodeficiency virus (HIV) TAT polypeptide, and the JNK inhibitor sequence is derived from an IB1(s) polypeptide. Human, mouse, and rat sequences are identical in Panels B and C.
- Figure 2 is a diagram showing sequences of generic TAT-IB fusion peptides from human, mouse and rat.
- Figure 3 depicts the results of the inhibition of endogenous JNK-activity in HepG2 cells using fusion peptides according to SEQ ID NOs: 9 and 11 in an one-well approach. As can be seen from Figure 3, particularly panel d in Figure 3, D-TAT-IB1(s) according to SEQ ID NO: 11 (here abbreviated as D-JNKI) effectively inhibits JNK activity, even better than L-TAT-IB1(s) according to SEQ ID NO: 9 (here abbreviated as L-JNKI).
- Figure 4 shows the result of the cytotoxicity assay with a chimeric JNK inhibitor sequence according to SEQ ID NO: 11, also termed XG-102 (see Example 12). As can be seen, XG-102 (SEQ ID NO: 11) is not cytotoxic for HFFs. HFFs were seeded in 96-well tissue culture plates. Medium containing DMSO (same level as the 5 μ M drug), or XG-102 at 1, 2, and 5 μ M was added for 24 h. Neutral Red was briefly added, the cells were fixed, then the dye was extracted.

Absorbance was measured at 540nm. No difference was observed between DMSO and 1 μ M XG-102.

Figure 5 depicts the results of the plaque reduction assay carried out for testing activity of a chimeric JNK inhibitor sequence according to SEQ ID NO: 11, also termed XG-102 against Varizella Zoster Virus (VZV) (see Example 12). As can be seen, XG-102 (SEQ ID NO: 11) is a potent inhibitor of Varizella Zoster Virus (VZV), particularly at concentrations of 0.5 μ M and 1 μ M

Figure 6 shows the results of the inhibition of Varizella Zoster Virus (VZV) in cultured human fibroblasts using a chimeric JNK inhibitor sequence according to SEQ ID NO: 11, also termed XG-102 (see Example 12). As can be seen, VZV shows a significant sensitivity to XG-102 (SEQ ID NO: 11). VZV replication was normal in the presence of the negative control (XG-100, the Tat peptide alone). XG-102 (SEQ ID NO: 11) thus prevented VZV replication already at the lowest concentration tested of 0.25 μ M.

Figure 7 depicts the activity of XG-102 (SEQ ID NO: 11) on cell recruitment in lung using MPO in lung homogenization in the treatment of Chronic Obstructive Pulmonary Disease (COPD) using an animal model of Bleomycin induced acute lung inflammation. As can be seen, MPO was not significantly induced after bleomycin administration. XG-102 (SEQ ID NO: 11) had thus only little effect on the MPO levels in the lung.

Figure 8 depicts the activity of XG-102 (SEQ ID NO: 11) on TNF levels in the treatment of Chronic Obstructive Pulmonary Disease (COPD) using an animal model of Bleomycin induced acute lung fibrosis. When measuring TNF levels, a trend to reduction of the TNF level in BALF after administration of XG-102 (SEQ ID NO: 11) was observed in the BLM model. TNF levels are very low after BLM.

Figure 9 depicts the activity of XG-102 (SEQ ID NO: 11) on cell recruitment in bronchoalveolar lavage space in the treatment of Chronic Obstructive Pulmonary Disease (COPD) using an animal model of Bleomycin induced acute lung fibrosis. At 0.1 mg/kg, XG-102 (SEQ ID NO: 11) reduces

significantly the lymphocyte recruitment and the number of total cells recruited during the inflammatory stage characterised at this point by the lymphocytes recruitment. At 0.1 mg/kg, XG-102 (SEQ ID NO: 11) enhances the lymphocytes recruitment or the number of total cell into the bronchoalveolar space (n= 5 mice per group; *, p < 0.05; **, p < 0.001).

Figure 10 describes the results of the histology in the treatment of Chronic Obstructive Pulmonary Disease (COPD) using an animal model of Bleomycin induced acute lung fibrosis. 3 μ m sections of lungs were stained with haematoxylin and eosin. Inflammatory cells accumulation, fibrotic areas, loss of lung architecture were observed 10 days after BLM administration. As can be seen, a decrease of these parameters is observed after administration of XG-102 at the low dose (0.001 mg/kg) but not with the high dose (0.1 mg/kg).

Figure 11 shows the effects of a treatment with XG-102 (SEQ ID NO: 11) on brain A β ₁₋₄₀ and A β ₁₋₄₂ levels determined by ELISA. The Graphs represent the A β ₁₋₄₀ (left) and A β ₁₋₄₂ (right) levels determined by ELISA in different brain homogenate fractions with Triton 40 and Triton 42. Data are represented as scattered dot plot with individual values (black) and group mean $\pm$ SEM. Significant differences are marked with asterisks (* p<0.05; ** p<0.01). Significant group differences were observed only in Triton X-100 fraction for A β ₁₋₄₂.

Figure 12 depicts the effects of a treatment with XG-102 (SEQ ID NO: 11) on CSF A β ₁₋₄₀ and A β ₁₋₄₂ levels determined by ELISA. The Graphs represent the A β ₁₋₄₀ (left) and A β ₁₋₄₂ (right) levels determined by ELISA in CSF. Data are represented as scattered dot plot with individual values (black) and group mean $\pm$ SEM. Significant differences are marked with asterisks (* p<0.05; ** p<0.01). Treatment with XG-102 (SEQ ID NO: 11) in both dosages led to a significant decrease of A β ₁₋₄₀ and A β ₁₋₄₂ in CSF.

Figure 13 shows the treatment effects on the ThioflavinS staining visualized number of plaques in the hAPP Tg mice: The graphs represent the number of ThioflavinS stained plaques per mm² in the cortex and the hippocampus. XG-102 (SEQ ID

NO: 11) treatment reduced the number of plaques negatively dose-dependent in the hippocampus. Data are represented as means +SEM. N = 8 per group. *...p <0.05; **...p < 0.01.

- 5 Figure 14 depicts the treatment effects on the ThioflavinS visualized plaque area [%] in the hAPP Tg mice: The Graphs represent the plaque area [%] of ThioflavinS positive plaques in the cortex and the hippocampus. XG-102 (SEQ ID NO: 11) significantly reduced the area obtained by plaques in the hippocampus. Data are represented as means +SEM. N = 8 per group.
- 10 Figure 15 describes the results of the administration of XG-102 (SEQ ID NO: 11) on fasting blood glucose levels (absolute and relative) in the animal model for diabetes type 2. Fasting blood glucose was measured every third day until day 68 and on a regular basis until termination at day 111 in groups A and C. We observed a clear and significant (p<0.001) decrease in the level of fasting blood glucose of the diabetic db/db mice treated with XG-102 (SEQ ID NO: 11) (10 mg/kg) as compared to vehicle control. The fasting blood glucose levels of the mice treated with XG-102 (SEQ ID NO: 11) (10 mg/kg) reached a low plateau of approximately 5 mmol/L. This effect was evident after 14 days of dosing and persisted throughout the study, thus during the entire wash-out period from day 21 to day 111. In contrast, we observed no effect of low dose of XG-102 (SEQ ID NO: 11) (1 mg/kg) during 28 days of dosing.
- 15 Figure 16 describes the results of the administration of XG-102 (SEQ ID NO: 11), 10 mg/kg on body weight in the animal model for diabetes type 2. We observed a clear and significant (p<0.001) prevention of body weight increase in mice treated with XG-102 (SEQ ID NO: 11) (10 mg/kg) as compared to vehicle control. This effect was evident from day 28 of dosing and remained until the day of termination day 111. In contrast, we observed no effect of low dose of XG-102 (SEQ ID NO: 11) (1 mg/kg) on body weight during 28 days of dosing.
- 20 Figure 17, 18 describe the effect of vehicle or XG-102 (SEQ ID NO: 11) (10 mg/kg) in the animal model for diabetes type 2 on 24 hour food and water intake, and urine and faeces production as measured in metabolic cages on study day 68 in
- 25 Figure 16 describes the results of the administration of XG-102 (SEQ ID NO: 11), 10 mg/kg on body weight in the animal model for diabetes type 2. We observed a clear and significant (p<0.001) prevention of body weight increase in mice treated with XG-102 (SEQ ID NO: 11) (10 mg/kg) as compared to vehicle control. This effect was evident from day 28 of dosing and remained until the day of termination day 111. In contrast, we observed no effect of low dose of XG-102 (SEQ ID NO: 11) (1 mg/kg) on body weight during 28 days of dosing.
- 30 Figure 17, 18 describe the effect of vehicle or XG-102 (SEQ ID NO: 11) (10 mg/kg) in the animal model for diabetes type 2 on 24 hour food and water intake, and urine and faeces production as measured in metabolic cages on study day 68 in

Figures 17 (g) and 18 (normalized to g of body weight). We observed no significant effects of XG-102 (SEQ ID NO: 11) (10 mg/kg) on any of the measured parameters as compared to vehicle control though a trend towards a decrease in food intake and urine production was observed.

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Figure 19, 20 describe the the effect of vehicle or XG-102 (SEQ ID NO: 11) (10 mg/kg) in the animal model for diabetes type 2 as measured on day 57, 77 and 108 on plasma levels of insulin, MCP-1 and IL-6 in Figure 19; on plasma levels of tPAI-1, TNF and resistin in Figure 20; We observed no significant effects of XG-102 (SEQ ID NO: 11) (10 mg/kg) on any of the measured parameters as compared to vehicle control except the levels of plasma resistin, which was significantly higher in XG-102 (SEQ ID NO: 11) treated animals at day 77 and 108.

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Figure 21 shows the effect of vehicle or XG-102 (SEQ ID NO: 11) (10 mg/kg) in the animal model for diabetes type 2 on tissue weight of epididymal, inguinal subcutaneous, and retroperitoneal fat pads. We observed a significant decrease of epididymal ($p<0.05$) and retroperitoneal ($p<0.01$) fat mass in the mice treated with XG-102 as compared to vehicle control.

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Figure 22 depicts the effect of vehicle or XG-102 (SEQ ID NO: 11) (10 mg/kg) in the animal model for diabetes type 2 on tissue weight of brain, spleen and heart. We observed no significant effects of XG-102 (SEQ ID NO: 11) (10 mg/kg) on these parameters as compared to vehicle control.

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Figure 23 describes the effect of vehicle or XG-102 (SEQ ID NO: 11) (10 mg/kg) in the animal model for diabetes type 2 on tissue weight of kidney and liver. We observed a significant decrease of kidney ($p<0.05$) and liver ($p<0.01$) mass in the mice treated with XG-102 (SEQ ID NO: 11) as compared to vehicle control.

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Figure 24 Primary cultured macrophages were incubated with XG-102 (SEQ ID NO: 11) and extensively washed. Presence of XG-102 (SEQ ID NO: 11) was revealed

using a specific antibody against XG-102. XG-102 is strongly incorporated into primary macrophages.

- 5 Figure 25 Mice were treated via three different routes of administration (s.c., i.v., i.p.) with radiolabeled peptides with C¹⁴ (1mg/kg). Animals were sacrificed 72 hours after injection and processed for immunoradiography. Sagittal sections were exposed and revealed the accumulation XG-102 peptides in the liver, spleen, and bone marrow predominantly (XG-102: SEQ ID NO: 11).
- 10 Figure 26 shows an immunostaining against XG-102 (SEQ ID NO: 11) in the liver of rats injected with 1mg/kg of XG-102 i.v. Animals were sacrificed 24 hours after injection. Revelation was done using DAB substrate. This figure shows again the pronounced accumulation of XG-102 in the liver, and especially, in the Kupffer cells (macrophages).
- 15 Figure 27 shows the inhibition of Cytokine & Chemokine Release in two cell lines. XG-102 (SEQ ID NO:11) inhibits cytokine release in both myeloid and lymphoid cell lines, reducing LPS-induced TNF α , IL-6 and MCP-1 release in THP-1 cells (Panels A-C) and PMA & ionomycin-induced IFN γ , IL-6 and IL-2 production in Jurkat cells (Panels D- F). The control (XG-101) is less effective due to its lesser stability.
- 20 Figure 28 shows the inhibition of cytokine release in primary cells. XG-102 (SEQ ID NO:11) also inhibits cytokine release in primary lymphoid and myeloid cells, reducing LPS-induced TNF α , IL-6 and Rantes release in murine macrophages (Panels A-C) and PMA & ionomycin-induced TNF α and IFN γ production in murine T cells (Panels D-E). Effects occur at non-cytotoxic concentrations of XG-102 (Panel F)
- 25 Figure 29 shows the the IB1 cDNA sequence from rat and its predicted amino acid sequence (SEQ ID NO:102)
- 30 Figure 30 shows the IB1 protein sequence from rat encoded by the exon-intron boundary of the rIB1 gene – splice donor (SEQ ID NO:103)

- Figure 31 shows the IB1 protein sequence from *Homo sapiens* (SEQ ID NO:104)
- Figure 32 shows the IB1 cDNA sequence from *Homo sapiens* (SEQ ID NO:105)
- 5 Figure 33 Effect on islet Isolation on JNK/p38 activation. That experiment was designed to identify any effect evoked by the isolation process as such on JNK or p38. As control tubulin detection was used. Western blot staining as a function of the digestion time (min) is shown.
- 10 Figure 34 By that figure the effect of XG-102 on JNK activation during isolation is shown.
- Figure 35 Effect of XG-102 on JNK activation during isolation
- 15 Figure 36 Effect of XG-102 on OCR/DNA during isolation
- Figure 37 Effect of XG-102 (DJNK inhibitor) on ATP/ proteinJ by HPLC analysis
- Figure 38 shows that XG-103 increases significantly islet viability (OCR/DNA) as measured after 7 days of culturing
- 20 Figure 39 Figure 41 (A): Fluorescein angiography evaluation (mean score) ten minutes after fluorescein injection. The mean score is presented for day 14 and day 21 for five groups (XG-102 300 microgramm/ml, XG-102 3mg/ml, Kencort retard, 0,9 % NaCl solution, untreated)
- 25 Fig 41 (B) Proportion of fluorescein angiography evaluation (mean score) ten minutes after fluorescein injection, for five groups (XG-102 300 microgramm/ml, XG-102 3mg/ml, Kencort retard, 0,9 % NaCl solution, untreated) at day 14 and day 21.
- 30 Figure 41 (C) Incidence of ChNV formation ten minutes after fluorescein injection at day 14 and 21, for five groups (XG-102 300 microgramm/ml, XG-102 3mg/ml, Kencort retard, 0,9 % NaCl solution, untreated).

Figure 41 (D) Incidence of fluorescein leakage extend at day 14 and day 21; for five groups (XG-102 300 microgramm/ml, XG-102 3 mg/ml, Kencort retard, 0,9 % NaCl solution, untreated)

- 5 Figure 40 The design of the experiment for assessing XG-102's effect on kidney tissue upon adriamycin-induced induction of nephropathy is shown. The rat groups and the and their treatment regimen is shown.
- 10 Figure 41 It is shown that XG-102 does not evoke any adverse effect as to proteinuria. The ELISA assay was used to determine the albumin concentration for group 1, group 4 and group 5 as a function of the observation period (day 5, 8, 11, 14, 17, 20, 23, 26, 29, 32, 25, 38, 41)
- 15 Figure 42 Histological analysis 8 days after the onset of the experiment. Comparison of adriamycin treated rats of group 1 (left hand) and adriamycin and XG-102 treated rats of group 4 (right hand)
- 20 Figure 43 Histological analysis 14 days after the onset of the experiment. Comparison of adriamycin treated rats of group 1 (left hand) and adriamycin and XG-102 treated rats of group 4 (right hand)
- 25 Figure 44 Histological analysis 19 days after the onset of the experiment. Comparison of adriamycin treated rats of group 1 (left hand) and adriamycin and XG-102 treated rats of group 4 (right hand)
- 30 Figure 45 Histological analysis 41 days after the onset of the experiment. Comparison of adriamycin treated rats of group 1 (left hand) and adriamycin and XG-102 treated rats of group 4 (right hand)
- 30 Figure 46 Histological analysis (staining) of c-jun expression 8 days after onset of the experiment. Left hand Adriamycin treated histological preparation, in the middle: Adriamycin and XG-102 treated (resulting in a significant reduction of c-jun expression in the interstitium) and control on the right.

Figure 47 Histological analysis (staining) of c-jun expression 14 days after onset of the experiment. Left hand Adriamycin treated histological preparation, in the middle: Adriamycin and XG-102 treated (resulting in a significant reduction of c-jun expression in the interstitium) and control on the right.

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Figure 48 shows the renal function assessed by protidemia (A) and urea level (B) of rats in an Adriamycin (ADR)-induced nephropathy model on Days 8, 14, 29, 41 and 56 after ADR administration. Groups No. 1 ("ADR") and No. 2 ("ADR + XG-102") have been treated on Day 0 with ADR to induce necropathy, whereas groups No. 3 ("NaCl") and No. 4 ("XG-102") received 0.9% NaCl. Moreover, groups Nos. 2 and 4 have been treated on Day 0 with XG-102, whereas groups Nos. 1 and 3 received vehicle (0.9% NaCl).

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Figure 49 shows kidney sections of the rats in the Adriamycin (ADR)-induced nephropathy model stained with periodic acid-Schiff (PAS) (original magnification x40). For the sections shown in the left column, rats were sacrificed at Day 8 following ADR administration, whereas for the sections shown in the right column, rats were sacrificed at Day 56. ADR has been administered only to the groups "ADR" and "ADR + XG102", whereas the group "NaCl" received 0.9% NaCl only. The group "ADR + XG102" has been treated on Day 0 with XG-102, whereas the other groups ("ADR" and "NaCl") received vehicle (0.9% NaCl).

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Figure 50 shows the kidney fibrosis in ADR nephropathy evaluated with Masson's trichrome (blue) on Days 8 (left four panels) and 56 (right four panels) following ADR administration for the group "ADR" (upper panel), which has been treated with ADR and vehicle at Day 0 and for the group "ADR + XG102" (lower panel), which has been treated with ADR and XG-102 at Day 0. The original magnification x10 is depicted in the left panels for the respective day and the original magnification x40 is depicted in the right panels for the respective day.

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Figure 51 The study design of the experiment investigating the effects of XG-102 on puromycin aminonucleoside (PAN)-induced nephropathy. On day 0 and day

14 PAN or its vehicle have been injected for induction of nephropathy. At day 0 and at day 14, PAN has been administered first, followed by XG-102 administration. From day 0 to day 42 XG-102 or its vehicle have been administered once a week by *i.v.* route as described above. On day 56 animals have been sacrificed and samples (blood and kidneys) have been collected.

Figure 52 shows the effects of XG-102 on the glomerulosclerosis injury in puromycin aminonucleoside (PAN)-induced nephropathy. XG-102 has been administered to Groups 3 to 6 (labelled as "cpd" in the legend). The Group 2 and the Group 6 are different in term of number of iv injections as stated in the study plan of Example 20. Note that the score for Group 2 is very similar to the one reported by Najakima et al. (2010) using the same experimental protocol. *** $P < 0.001$ versus Group 1 using unpaired Student t-test; # $P < 0.05$; ### $P < 0.001$ versus Group 2 using one-way ANOVA followed by followed by Newman-Keuls test; §§§ $P < 0.001$ versus Group 2 using unpaired Student t-test.

Figure 53 shows the effects of XG-102 on the glomerular damage in puromycin aminonucleoside (PAN)-induced nephropathy. XG-102 has been administered to Groups 3 to 6 (labelled as "cpd" in the legend). The Group 2 and the Group 6 are different in term of number of iv injections as stated in the study plan of Example 20. *** $P < 0.001$ versus Group 1 using unpaired Student t-test; ### $P < 0.001$ versus Group 2 using one-way ANOVA followed by followed by Newman-Keuls test; §§§ $P < 0.001$ versus Group 2 using unpaired Student t-test.

Figure 54 shows the study schedule of Example 21 investigating the effects of chronic administration of XG-102 in a rat model of diabetic nephropathy. Animals were placed on high fat diet immediately after arrival. Animals in groups E and F are dosed daily each day from baseline phase onwards.

Figure 55 shows the effects of chronic administration of XG-102 in a rat model of diabetic nephropathy on the body weight of the rats. Only non-STZ treated rats showed an increase in body weight. Rats treated with XG-102 showed no differences in body weight compared to vehicle-treated rats in the STZ model.

The body weight of rats treated with the positive reference (Losartan), however, was significantly lower.

- 5 Figure 56 shows that XG-102 dose-dependently decreased JNK (A) and PAF2 (B) phosphorylation induced by 15-min ischemia in an experiment evaluating the dose-response to XG-102 in islet isolation/transplantation (Example 22). Isolation of rat islets has been carried out either immediately after animal sacrifice or after a 15-minute period of warm ischemia. JNK activation has been assessed by western blot at the end of the isolation process. As negative
10 controls, JNK activation has been assessed on unprocessed rat pancreases.
- 15 Figure 57 shows the effects of XG-102 on function and viability of rat pancreatic islets, whereby the islets have been isolated islets from 15 min ischemia rat and from no ischemia rat. A static insulin secretion test (basal or stimulated using glucose) has been performed directly after islet isolation and 18 h after culture at 37°C. Isolation affected islet function, whereby basal insulin secretion was higher in islets used directly after isolation compared to islets incubated during 18h whatever the conditions. However after culture, ischemia and inhibitor XG-102 had no impact on islet function in this experiment.
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- 25 Figure 58 shows another experiment wherein ischemia was pushed until 30 min and XG-102 was used at 100 microM. Still, a high basal secretion is observed when insulin secretion test was performed directly after isolation. Moreover, 30 min ischemia had a negative impact on islet function. These preliminary results suggested that 30 min ischemia seems to be a better model than 15 min to induce JNK activation. When islets from ischemic rats were isolated and incubated with XG-102, glucose-induced insulin secretion was higher as compared to ischemic rats.
- 30 Figure 59 The disposition of patients included in the study of Example 27, i.e. the randomized, double-blind, parallel group, controlled, multicentre trial to assess the efficacy and safety of a single sub-conjunctival injection of XG-102, compared to dexamethasone eye drops in post-surgery intraocular inflammation (Clinical Phase II).

- Figure 60 shows for the study of Example 27 the mean anterior chamber cell grade up to 28 days after the administration of the sub-conjunctival injection of study treatment for the PP analysis population for the three treatment groups XG-102 90 µg, XG-102 900 µg and the dexamethasone. The vertical lines represents the standard deviations (SD).
- Figure 61 shows for the study of Example 27 the results of the primary outcome in addition to the first secondary outcome for both the PP and FAS data sets regarding anterior chamber cell grade at day 28: Confidence Intervals and the Non-inferiority margin.
- Figure 62 shows for the study of Example 27 the anterior chamber flare grade (for the FAS) obtained up to day 28 after the administration of the sub-conjunctival injection of study treatment for the three treatment groups XG-102 90 µg, XG-102 900 µg and the dexamethasone. The vertical lines represents the standard deviations (SD).
- Figure 63 shows for the study of Example 27 the LFM (Laser Flare Meter) measurements which were obtained at the defined time points throughout the study up to day 28 for the FAS. The vertical lines represents the standard deviations (SD).
- Figure 64 shows for the study of Example 27 the overview of reported adverse events (serious and non-serious) by dose group.
- Figure 65 shows for the study of Example 27 the summary of the AEs (sorted by MedDRA SOC and PT term) which were reported for at least 2% of patients randomized to either of the three study groups.
- Figure 66 shows for the study of Example 27 the overview of the reported serious adverse events (SAEs).
- Figure 67 shows for Example 28 the proliferation of hepatocytes in XG-102 (in the figure referred to as "D-JNK11") or PBS treated Mapk14^{fl} and Mapk14^{Δli}* mice (left

panel) and in XG-102 (i.e. "D-JNK11") treated Mapk14^{ff} Jun^{ff} and Mapk14^{Δli*} Jun^{Δli*} mice (right panel). Mice were injected with either XG-102 (20 mg per kg body weight) or PBS, if applicable, before DEN treatment. The proliferation of hepatocytes was analyzed by Ki67 staining 48 h after DEN treatment. Quantification of Ki67-positive cells is shown.

Figure 68 3X10⁶ Huh7 human liver cancer cells were injected subcutaneously to both flank area of nude mice at 4 weeks of age (Example 29). Nude mice treated with XG-102 intraperitoneally twice a week at 5mg/kg after Huh7 injection. Tumor volumes were measured twice a week. Mice were killed 4 week after xenograft. Dotted cycles indicate the xenografted tumors.

Figure 69 shows for Example 30 the mean body weight and mean body weight change curves of mice bearing orthotopically injected HEP G2 tumor are shown. Mice were IV treated with XG-102 at 1mg/kg/inj following the Q4Dx4 treatment schedule repeated two times, at D10 and D41. Accordingly, in Figure 70 the respective statistical data are presented.

Figure 70 shows for Example 30 the tolerance of mice to XG-102. Mean body weights and MBWC ±SD are indicated. MBWC% corresponds to variation of mean body weight between the considered day and day of first treatment (D10). Statistical analysis was performed with the Bonferroni-Dunn test, taking vehicle treated group as reference.

Figure 71 shows for Example 30 the mice long survival curves, whereby proportion of surviving mice per group until sacrifice day (D185) is depicted. Mice were treated with XG-102 at the indicated doses following the Q4Dx4 treatment schedule repeated two times, at D10 and D41.

Figure 72 shows for Example 31 the tolerance of mice to XG-102 and XG-414 treatments, alone or in combination. Mean body weights and mean body weight changes ± SD are indicated. MBWC% corresponds to variation of mean body weight between the considered day and day of first treatment (D10).

Figure 73 shows for Example 31 the mice long survival curves, whereby proportion of surviving mice per group until sacrifice day (D171) is depicted. Mice sacrificed at D67 for autopsy were excluded from calculation. Mice were treated with XG-102 at the indicated doses following the Q4Dx4 treatment schedule repeated two times, at D10 and D41.

Figure 74 shows for Example 31 the tumor invasion observed by microscopic evaluation of mice sacrificed at D67 or between D67 and final sacrifice as histogram representations. The level of tumor take was classified in 4 different categories specified in the figure legend.

Figure 75 shows for Example 32 the mean tumor volume of PC-3 tumor bearing mice during the antitumor activity experiment. At D33, 3 groups of 5 animals were treated with vehicle and XG-102 (0.1 and 1mg/kg/inj, Q4Dx4).

Figure 76 shows for Example 33 a histogram representation of metastatic tumor invasion observed within liver or at its periphery (hilus) twenty-six days after HCT 116 tumor xenografting on mice caecum, in the different groups, PO or SC treated with vehicle or XG-102 at 0.1 and 1 mg/kg/adm. following the Q1Dx14 treatment schedule. The classification of microscopic observations was performed as described within the legend.

Figure 77 shows for Example 34 the electroretinography (ERG) measurements in right eyes of albino rats.

Figure 78 Renal ischemia was induced in rats of group G2 and group G3 by clamping both renal pedicles with atraumatic clamp for 40 min, whereas in group G1 rats no ischemia was induced. Rats of group G3 received a single dose of 2 mg/kg XG-102 (in 0.9% NaCl as vehicle) and rats of groups G1 and G2 received vehicle, respectively, by IV injection in the tail vein on Day 0, one hour after clamping period (after reperfusion) both renal pedicles with atraumatic clamp. Serum creatinine (Fig. 78A) and urea (Fig. 78B) were increased in vehicle-treated ischemic rats (G2) 24h following ischemia, as

compared to vehicle-treated controls rats without ischemia (G1). On the other hand, XG-102-treated-ischemic rats (G3) exhibited lower serum creatinine, relatively to untreated ischemic rats (G2).

Figure 79 shows for Example 40 the impact of 30 min ischemia and treatment with 100 μ M XG-102 on islet viability. Treatment with XG-102 decreases apoptosis and necrosis. These results show that XG-102 has a beneficial effect on islet viability

Figure 80 shows for Example 40 a western blot. In these experiments, 18h after isolation, islets were pre-treated or not with XG-102 100 μ M for 1h and then submitted to hypoxia for 4h, whereby XG-102 was still present (or not in control groups) during the 4 hour hypoxia ("H4"). As expected, hypoxia ("H4") induces JNK and JUN phosphorylation as compared to islets maintained in normoxia conditions ("N4"). However, the JNK inhibitor XG-102 did not inhibit phosphorylation of JNK and JUN induced by hypoxia (cf. Fig. 80 "H4 + XG102").

Figure 81 shows for Example 40 the islet viability in the hypoxia experiment. Hypoxia increased apoptosis and necrosis (H4 vs. N4). However, when islets were treated with XG-102, apoptosis and necrosis were decreased either in normoxia and hypoxia conditions. In conclusion XG102 had also a beneficial effect on islet viability in this hypoxia model.

Figure 82 shows the study design for Example 41.

Figure 83 shows for Example 41 the effects of vehicle and XG-102 (4 mg/kg, *i.v.*) on glomerular injury index at day 49 (Groups 1-5) and at day 77 (Groups 6-8) in a rat model of PAN-induced nephropathy. *** $P < 0.001$ group 2 and group 7 (PAN/vehicle) versus group 1 and group 6 (Saline/vehicle) using unpaired Student t-test ($n=12-15$ /group). ## $P < 0.01$; ### $P < 0.001$ groups from 3 to 5 (PAN/XG-102) versus group 2 (PAN/vehicle) using one-way ANOVA followed by Newman-Keuls test ($n=15$ /group). \$\$\$ $P < 0.001$ group 8 (PAN/XG-102) versus group 7 (PAN/vehicle) using unpaired Student t-test ($n=12-14$ /group).

Figure 84 shows for Example 41 the effects of vehicle and XG-102 (4 mg/kg, i.v.) on the percentage of injured glomeruli at day 49 (Groups 1-5) and at day 77 (Groups 6-8) in a rat model of PAN-induced nephropathy. *** $P < 0.001$ group 2 and group 7 (PAN/vehicle) versus group 1 and group 6 (Saline/vehicle) using unpaired Student *t*-test ($n=12-15/\text{group}$). ### $P < 0.001$ groups from 3 to 5 (PAN/XG-102) versus group 2 (PAN/vehicle) using one-way ANOVA followed by Newman-Keuls test ($n=15/\text{group}$). §§§ $P < 0.001$ group 8 (PAN/XG-102) versus group 7 (PAN/vehicle) using unpaired Student *t*-test ($n=12-14/\text{group}$).

Figure 85 shows for Example 41 representative images of glomerulosclerosis injury from kidney at day 49 (groups 1-5; PAS, 40x) for exemplary animals 3 (A-C), 8 (D-F), 13 (G-I), 57 (J-L), and 63 (M-O). Group 1 (A-C): Normal glomeruli in A and B (Grade 0) and focal segmental matrix deposition (Grade 1) (arrow) in C. Group 2 (D-F): Grade 1 glomerulus (D), Grade 2 glomerulus (E) and Grade 3 glomerulus (F). Matrix deposition and hypercellularity are noted (arrows). Group 3 (G-I): Grade 0 glomerulus (G), Grade 1 glomerulus (H) and Grade 1 glomerulus (I). Matrix deposition and hypercellularity are noted (arrows). Group 4 (J-L): Grade 1 glomerulus (J), Grade 1 glomerulus (K) and Grade 2 glomerulus (L). Matrix deposition and hypercellularity are noted (arrows). Group 5 (M-O): Grade 1 glomerulus (D), Grade 2 glomerulus (E) and Grade 3 glomerulus (F). Matrix deposition and hypercellularity are noted (arrows and circle).

Figure 86 shows for Example 41 representative images of glomerulosclerosis injury from kidney at day 77 (groups 6-8; PAS, 40x) for exemplary animals 28 (A-C), 34 (D-F), and 37 (G-I). Group 6 (A-C): Normal glomeruli in A and B (Grade 0) and focal segmental matrix deposition (Grade 1) (arrow) in C. Group 7 (D-F): Grade 1 glomerulus (D), Grade 2 glomerulus (E) and Grade 3 glomerulus (F). Matrix deposition and hypercellularity are noted (arrows and circle). Group 8 (G-I): Grade 0 glomerulus (G), Grade 1 glomerulus (H) and Grade 1 glomerulus (I). Matrix deposition and hypercellularity are noted (arrows).

Figure 87 shows for Example 42 the impact of hypoxia and XG-102 on viability of human islets. Fig. 87A shows that XG-102 decreased necrosis either in normoxic and

hypoxic conditions. Fig. 87B shows that XG-102 also decreases apoptosis induced by hypoxia. These results show that XG-102 has a beneficial effect on islet viability in the hypoxia model.

- 5 Figure 88 shows for Example 43 the results of ocular evaluation (A) and cellular infiltration in aqueous humor (B). Fig. 88A shows median values of ocular evaluation 24 h after induction. Fig. 88B shows leucocyte counts (cells/ μ l) in aqueous humor 24 h after induction.
- 10 Figure 89 shows for Example 39 SFT values (visual acuity) at Day 71 (A), Day 85 (B), Day 99 (C) and Day 113 (D). * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$; Student's t-test compared to vehicle group.
- 15 Figure 90 shows for Example 39 Contrast Threshold values at Day 71 (A), Day 85 (B), Day 99 (C) and Day 113 (D). * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$; Student's t-test compared to vehicle group.
- 20 Figure 91 shows for Example 39 the results of Multiplex cytokine analysis of 23 unique cytokines of the retinal tissue. STZ-induced diabetes raised retinal levels in vehicle treated animals for 13 of the 23 cytokines observed. Seven of the 13 elevated cytokines were reduced in STZ-diabetic animals treated with 2 μ g/eye XG-102. All cytokines were BLQ in the retinal tissue collected from the groups of rats receiving either 20 μ g/eye, or 200 μ g/eye XG-102.
- 25 Figure 92 shows for Example 24 the treatment effects on the clinical parameters GI (gingival inflammation) and PP (periodontal depth pocket). The first graph shows clinical parameters in the negative control group (unligated rats). Results are expressed as Mean $\pm$ SEM. n=10 rats per group. * $p < 0.05$ day 10 vs 0. \$ $p < 0.05$ day 17 vs 10.
- 30 Figure 93 shows for Example 24 the effects of placebo and XG-102 administration on total bacterial flora. Group 3 (XG-102) reduced significantly total bacterial flora at day 17 compared to day 10. Results are expressed as Mean $\pm$ SEM. n=10 rats per group. * $p < 0.05$ day 17 vs day 10.

- Figure 94 shows for Example 24 IL1- β quantification using ELISA assay. IL1- β was lower in group 3 than in placebo group. "SDD-1002" refers to XG-102. Experiments were done in duplicate. * $p < 0.05$ ligated groups vs unligated group. § $p < 0.05$ placebo group vs group 3.
- Figure 95 shows for Example 24 the effects of placebo and XG-102 administration on ABHL. "SDD-1002" refers to XG-102. Each measurement was done in duplicate. Results are expressed as Mean $\pm$ SEM. $n = 6$ rats per group. * $p < 0.05$ ligated groups vs unligated group.
- Figure 96 shows for Example 45 the study design.
- Figure 97 shows for Example 45 the effects of vehicle and XG-102 (2 mg/kg, *i.v.*) on tubular damages in a rat model of bilateral IR. *** $P < 0.001$ versus Group 1 (Sham/Vehicle) by a Student *t*-test ns; + $P < 0.05$ versus Group 2 (IR/Vehicle) by a one way ANOVA followed by a Bonferroni's post test.
- Figure 98 shows for Example 45 the effects of vehicle and XG-102 (2 mg/kg, *i.v.*) on total tubular histological scores in a rat model of bilateral IR. Total tubular score represents all tubular changes including degeneration and necrosis, tubular cast, tubular epithelial vacuolation and regeneration (basophil tubules). *** $P < 0.001$ versus Group 1 (Sham/Vehicle) by a Student *t*-test; + $P < 0.05$ versus Group 2 (IR/Vehicle) by a one way ANOVA followed by a Bonferroni's post test.
- Figure 99 shows for Example 45 representative images of hematoxylin/eosin stained kidney sections: comparison between Groups 2 (IR/Vehicle) and 3 (IR/XG-102). Animal 53 (Top Left), Animal 15 (Top Right), Animal 17 (Bottom left), and Animal 33 (Bottom right): 10x. Representative photomicrographs of tubular degeneration/necrosis and tubular casts in Group 2 and 3. Animals having scores from 1 to 4 are represented. The main difference between groups is that the severity of tubular necrosis and cast in Group 2 is generally higher than that observed in Group 3. In Group 2, lesions are extended partially or to

the majority of the cortex. Comparatively, in Group 3 lesions are limited to the cortico-medullary junction. Lesions consist of a mixture of active necrosis, cellular tubular casts, hyaline casts, and occasional basophilic tubules.

- 5 Figure 100 shows for Example 46 the study design (A) and the AUCs method to assess allodynia and hyperalgesia (B).
- 10 Figure 101 shows for Example 46 the effect of XG-102 (50 mg/mL, i.ves.) and ibuprofen (50 mg/mL, i.ves.) treatments on nociceptive parameters 24h post-CYP injection. Nociceptive threshold (A), nociceptive scores (B), AUC 1-8 g (C) or AUC 8-60 g (D) 24h after CYP injection. Results are expressed as mean $\pm$ s.e.m. (n=10). * $p<0.05$, ** $p<0.01$, *** $p<0.001$ vs Vehicle-treated group, Mann Whitney test (A and C), Two-way RM ANOVA (B), and Unpaired t test and Mann Whitney test (D).
- 15 Figure 102 shows for Example 46 the effect of XG-102 (50 mg/mL, i.ves.) and ibuprofen (50 mg/mL, i.ves.) treatments on urinary bladder wall thickness as well as haemorrhage scores 24h post-CYP injection. Urinary bladder wall thickness (A) or haemorrhage scores (B) 24h after CYP injection. Results are expressed as mean $\pm$ s.e.m. (n=10). ns= $p>0.05$, ** $p<0.01$, *** $p<0.001$ vs Vehicle-treated group, Mann Whitney test and Unpaired t test (A) or Mann Whitney test (B).
- 20 Figure 103 shows for Example 47 the effect of XG-102 (2 mg/kg, i.v.) and ibuprofen (10 mg/kg, i.v.) treatments on nociceptive parameters 24h post-CYP injection. Nociceptive threshold (A), nociceptive scores (B), AUC 1-8 g (C) or AUC 8-60 g (D) 24h after CYP injection. Results are expressed as mean $\pm$ s.e.m. (n=10). ** $p<0.01$, *** $p<0.001$ vs Vehicle-treated group, Mann Whitney test (A), Two-way RM ANOVA (B), Mann Whitney test and Unpaired t test (C) and Unpaired t test (D).
- 25 Figure 104 shows for Example 48 the study design (A) and the cystometric parameters analysed (B).
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Figure 105 shows for Example 48 the effects of vehicle (i.v.) on cystometric parameters in conscious female rats treated with CYP. Not significant *versus* basal values with a one way ANOVA with repeated measures, followed by a Dunnett's post-test.

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Figure 106 shows for Example 48 the effects of XG-102 (2 mg/kg, i.v.) on cystometric parameters in conscious female rats treated with CYP. ** $P < 0.01$ *versus* basal values with a one way ANOVA with repeated measures, followed by a Dunnett's post-test.

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Figure 107 shows for Example 37 the results of the determination of the cytotoxic activity of XG-102 against HepG2 (A) and PLC/PRF/5 (B) tumour cell lines using MTS assay.

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Figure 108 shows for Example 49 the effect of JNK inhibitor XG-102 on JNK activation. (A) Immunoblot analysis of primary mouse cortical neuron cultures exposed to 1 mM of hydrogen peroxide (H_2O_2) during 15 minutes. Neurons were pre-treated or not with 5 μ M or 10 μ M of the specific inhibitor of JNK, XG-102. (B) Corresponding histogram showing an increase of 34% of JNK activity, measured by the ratio of phosphorylated JNK on total JNK (pJNK/JNK), after induction of the oxidative stress. Pre-treatment of cortical neurons with the inhibitor XG-102 prevented JNK activity when used at 5 μ M and decreased by 45% JNK activity at a concentration of 10 μ M, in oxidative stress conditions. $n = 3$ per condition. Error bars = standard error of the mean (SEM).

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Figure 109 shows for Example 49 the effect of JNK inhibition on neuronal apoptosis. (A) Immunoblot analysis of primary mouse cortical neuron cultures exposed to 2 μ M of A β 1-42 (A β_{42}) during 5 hours. Neurons were pre-treated with or without 10 μ M of the specific inhibitor, XG-102. (B) Corresponding histograms showing no modification of JNK activity in condition of A β_{42} cell stress. Pre-treatment of cortical neurons with XG-102 did not modify JNK activity. (C) Neuronal apoptosis is measured by the level of cleaved PARP (poly(ADP-ribose) polymerase) protein, which is increased during apoptosis. A β_{42} stress

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induced apoptosis, with an increase of 40% of cleaved PARP, except if cultures were pre-treated with XG-102. In that case, apoptosis is decreased by 37%. $n = 3$ per condition. Error bars = standard error of the mean (SEM).

- 5 Figure 110 shows for Example 51 decrease of neuronal apoptosis after PKR down-regulation and/or JNK inhibition with XG-102. (A) Immunoblot results of the levels of JNK and c-Jun activation, caspase 3 and PARP cleaved activated fragments in primary neuronal cultures of WT and PKR^{-/-} mice, treated by 2 μ M of A β 42 after or not pre-inhibition of JNK with 10 μ M XG-102. (B-D)
- 10 Corresponding histograms of JNK activity (B), phospho c-Jun (C), and total c-Jun (D). (E-G) Apoptosis is measured by the level of cleaved caspase 3 (E), caspase 3 activity measured in the cell culture supernatant (F) and cleaved PARP (G). Data are means $\pm$ SEM ($n \geq 3$ per condition). * $P < 0.05$, ** $P < 0.01$, and *** $P < 0.001$.

EXAMPLES

Example 1: Identification of JNK Inhibitor sequences

5 Amino acid sequences important for efficient interaction with JNK were identified by sequence alignments between known JNK binding domain JBDs. A sequence comparison between the JBDs of IB1 [SEQ ID NO: 13], IB2 [SEQ ID NO: 14], c-Jun [SEQ ID NO: 15] and ATF2 [SEQ ID NO: 16] defined a weakly conserved 8 amino acid sequence (see Figure 1A). Since the JBDs of IB1 and IB2 are approximately 100 fold as efficient as c-Jun or ATF2 in
10 binding JNK (Dickens *et al.* Science 277: 693 (1997)), it was reasoned that conserved residues between IB1 and IB2 must be important to confer maximal binding. The comparison between the JBDs of IB1 and IB2 defined two blocks of seven and three amino acids that are highly conserved between the two sequences.

15 These two blocks are contained within a peptide sequence of 19 amino acids in L-IB1(s) [SEQ ID NO: 1] and are also shown for comparative reasons in a 23 aa peptide sequence derived from IB1 [SEQ ID NO: 17]. These sequences are shown in Figure 1B, dashes in the L-IB1 sequence indicate a gap in the sequence in order to align the conserved residues with L-
20 IB1(s).

Example 2: Preparation of JNK Inhibitor Fusion Proteins

JNK inhibitor fusion proteins according to SEQ ID NO: 9 were synthesized by covalently linking the C-terminal end of SEQ ID NO: 1 to a N-terminal 10 amino acid long carrier
25 peptide derived from the HIV-TAT4g 57 (Vives *et al.*, J Biol. Chem. 272: 16010 (1997)) according to SEQ ID NO: 5 via a linker consisting of two proline residues. This linker was used to allow for maximal flexibility and prevent unwanted secondary structural changes. The basic constructs were also prepared and designated L-IB1(s) (SEQ ID NO: 1) and L-TAT [SEQ
30 ID NO: 5], respectively.

All-D retro-inverso peptides according to SEQ ID NO: 11 were synthesized accordingly. The basic constructs were also prepared and designated D-IB1(s) [SEQ ID NO: 2] and D-TAT [SEQ
ID NO: 6], respectively.

All D and L fusion peptides according to SEQ ID NOs: 9, 10, 11 and 12 were produced by classical Fmoc synthesis and further analysed by Mass Spectrometry. They were finally purified by HPLC. To determine the effects of the proline linker, two types of TAT peptide were produced one with and one without two prolines. The addition of the two prolines did not appear to modify the entry or the localization of the TAT peptide inside cells. Generic peptides showing the conserved amino acid residues are given in Figure 2.

Example 3: Inhibition of Cell Death By JBD19

Effects of the 19 aa long JBD sequence of IB1(s) on JNK biological activities were studied. The 19 aa sequence was linked N-terminal to the Green Fluorescent Protein (GFP JBD19 construct), and the effect of this construct on pancreatic beta-cell apoptosis induced by IL1 was evaluated. This mode of apoptosis was previously shown to be blocked by transfection with JBD₁₋₂₈₀ whereas specific inhibitors of ERK1/2 or p38 as known in the art did not protect.

Oligonucleotides corresponding to JBD19 and comprising a conserved sequence of 19 amino acids as well as a sequence mutated at the fully conserved regions were synthesized and directionally inserted into the EcoRI and Sall sites of the pEGFP-N1 vector encoding the Green Fluorescent Protein (GFP) (from Clontech). Insulin producing TC-3 cells were cultured in RPMI 1640 medium supplemented with 10% Fetal Calf Serum, 100 µg/mL Streptomycin, 100 units/mL Penicillin and 2 mM Glutamine. Insulin producing TC-3 cells were transfected with the indicated vectors and IL-1 (10 ng/mL) was added to the cell culture medium. The number of apoptotic cells was counted at 48 hours after the addition of IL-1 using an inverted fluorescence microscope. Apoptotic cells were discriminated from normal cells by the characteristic "blebbing out" of the cytoplasm and were counted after two days.

GFP is Green Fluorescent protein expression vector used as a control; JBD19 is the vector expressing a chimeric GFP linked to the 19 aa sequence derived from the JBD of IB1; JBD19Mut is the same vector as GFP-JBD19, but with a JBD mutated at four conserved residues shown as Figure 1B ; and JBD₁₋₂₈₀ is the GFP vector linked to the entire JBD (aa 1-280). The GFP-JBD19 expressing construct prevented IL-1 induced pancreatic -cell apoptosis as efficiently as the entire JBD₁₋₂₈₀.

As additional controls, sequences mutated at fully conserved IB1(s) residues had greatly decreased ability to prevent apoptosis.

Example 4 : Cellular Import of TAT-IB1(s) Peptides

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The ability of the L-and D-enantiomeric forms of TAT and TAT-IB1(s) peptides ("TAT-IB peptides") to enter cells was evaluated. L-TAT, D-TAT, L-TAT-IB1(s), and D-TAT-IB1(s) peptides [SEQ ID NOs: 5, 6, 9 and 12, respectively] were labeled by N-terminal addition of a glycine residue conjugated to fluorescein. Labeled peptides (1 μ M) were added to TC-3
10 cell cultures, which were maintained as described in Example 3. At predetermined times cells were washed with PBS and fixed for five minutes in ice-cold methanol-acetone (1:1) before being examined under a fluorescence microscope. Fluorescein-labeled BSA (1 μ M, 12 moles/mole BSA) was used as a control. Results demonstrated that all the above fluorescein labeled peptides had efficiently and rapidly (less than five minutes) entered cells once added
15 to the culture medium. Conversely, fluorescein labeled bovine serum albumin (1 μ M BSA, 12 moles fluorescein/mole BSA) did not enter the cells.

A time course study indicated that the intensity of the fluorescent signal for the L-enantiomeric peptides decreased by 70% following a 24 hours period. Little to no signal was present at 48
20 hours. In contrast, D-TAT and D-TAT-IB1(s) were extremely stable inside the cells.

Fluorescent signals from these all-D retro-inverso peptides were still very strong 1 week later, and the signal was only slightly diminished at 2 weeks post treatment.

25 Example 5 : *In vitro* Inhibition of c-JUN, ATF2 and Elk1 Phosphorylation

The effects of the peptides on JNKs-mediated phosphorylation of their target transcription factors were investigated *in vitro*. Recombinant and non activated JNK1, JNK2 and JNK3 were produced using a TRANSCRIPTION AND TRANSLATION rabbit reticulocyte lysate kit
30 (Promega) and used in solid phase kinase assays with c-Jun, ATF2 and Elk1, either alone or fused to glutathione-S-transferase (GST), as substrates. Dose response studies were performed wherein L-TAT or L-TAT-IB1(s) peptides (0-25 μ M) were mixed with the recombinant JNK1, JNK2, or JNK3 kinases in reaction buffer (20 mM Tris-acetate, 1mM EGTA, 10 mM p-nitrophenyl-phosphate (pNPP), 5 mM sodium pyrophosphate, 10 mM p-glycerophosphate, 1

mM dithiothreitol) for 20 minutes. The kinase reactions were then initiated by the addition of 10 mM MgCl₂ and 5 pCi ³³P-gamma-dATP and 1 µg of either GST-Jun (aa 1-89), GST-AFT2 (aa 1-96) or GST-ELK1 (aa 307-428). GST-fusion proteins were purchased from Stratagene (La Jolla, CA).

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Ten µL of glutathione-agarose beads were also added to the mixture. Reaction products were then separated by SDS-PAGE on a denaturing 10 % polyacrylamide gel. Gels were dried and subsequently exposed to X-ray films (Kodak). Nearly complete inhibition of c-Jun, ATF2 and Elk1 phosphorylation by JNKs was observed at TAT-IB(s) peptide doses as low as 2.5 µM.

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However, a marked exception was the absence of TAT-IB(s) inhibition of JNK3 phosphorylation of Elk1. Overall, the TAT-IB1(s) peptide showed superior effects in inhibiting JNK family phosphorylation of their target transcription factors. The ability of D-TAT, D-TAT-IB1(s) and L-TAT-IB1(s) peptides (0-250 µM dosage study) to inhibit GST-Jun (aa 1-73) phosphorylation by recombinant JNK1, JNK2, and JNK3 by were analyzed as described above. Overall, D-TAT-IB1(s) peptide decreased JNK-mediated phosphorylation of c-Jun, but at levels approximately 10-20 fold less efficiently than L-TAT-IB1(s).

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Example 6: Inhibition of c-JUN Phosphorylation by activated JNKs

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The effects of the L-TAT or L-TAT-IB1(s) peptides as defined herein on JNKs activated by stressful stimuli were evaluated using GST-Jun to pull down JNKs from UV-light irradiated HeLa cells or IL-1 treated PTC cells. PTC cells were cultured as described above. HeLa cells were cultured in DMEM medium supplemented with 10 % Fetal Calf Serum, 100 µg/mL Streptomycin, 100 units/ml Penicillin and 2 mM Glutamine. One hour prior to being used for cell extract preparation, PTC cells were activated with IL-1 as described above, whereas HeLa cells were activated by UV-light (20 J/m²). Cell extracts were prepared from control, UV-light irradiated HeLa cells and IL-1 treated TC-3 cells by scraping the cell cultures in lysis buffer (20 mM Tris-acetate, 1 mM EGTA, 1% Triton X-100, 10 mM p-nitrophenyl-phosphate, 5 mM sodium pyrophosphate, 10 mMMP-glycerophosphate, 1 mM dithiothreitol).

25

30

Debris was removed by centrifugation for five minutes at 15,000 rpm in an SS-34 Beckman rotor. One-hundred µg extracts were incubated for one hour at room temperature with one µg GST-jun (amino acids 1-89) and 10 µL of glutathione-agarose beads (Sigma). Following four washes with the scraping buffer, the beads were resuspended in the same buffer supplemented with L-TAT or L-TAT-IB1(s) peptides (25 µM) for 20 minutes. Kinase reactions

were then initiated by addition of 10 mM MgCl₂ and 5 pCi ³³P-gamma-dATP and incubated for 30 minutes at 30°C.

Reaction products were then separated by SDS-PAGE on a denaturing 10 % polyacrylamide gel. Gels were dried and subsequently exposed to X-ray films (Kodak). The TAT-IB(s) peptides efficiently prevented phosphorylation of c-Jun by activated JNKs in these experiments.

Example 7: *In vivo* inhibition of c-JUN phosphorylation by TAT-IB(s) peptides as defined herein

To determine whether the cell-permeable peptides as defined herein could block JNK signaling *in vivo*, we used a heterologous GAL4 system. HeLa cells, cultured as described above, were co-transfected with the 5xGAL-LUC reporter vector together with the GAL-Jun expression construct (Stratagene) comprising the activation domain of c-Jun (amino acids 1-89) linked to the GAL4 DNA-binding domain. Activation of JNK was achieved by the co-transfection of vectors expressing the directly upstream kinases MKK4 and MKK7 (see Whitmarsh *et al.*, Science 285: 1573 (1999)). Briefly, 3x10⁵ cells were transfected with the plasmids in 3.5-cm dishes using DOTAP (Boehringer Mannheim) following instructions from the manufacturer. For experiments involving GAL-Jun, 20 ng of the plasmid was transfected with 1 µg of the reporter plasmid pFR-Luc (Stratagene) and 0.5 µg of either MKK4 or MKK7 expressing plasmids. Three hours following transfection, cell media were changed and TAT and TAT-IB1(s) peptides (1 µM) were added. The luciferase activities were measured 16 hours later using the "Dual Reporter System" from Promega after normalization to protein content. Addition of TAT-IB1(s) peptide blocked activation of c-Jun following MKK4 and MKK7 mediated activation of JNK. Because HeLa cells express JNK1 and JNK2 isoforms but not JNK3, we transfected cells with JNK3. Again, the TAT-IB(s) peptide inhibited JNK2 mediated activation of c-Jun.

Example 8: Synthesis of all-D retro-inverso IB(s) Peptides and variants thereof

Peptides of the invention may be all-D amino acid peptides synthesized in reverse to prevent natural proteolysis (i.e. all-D retro-inverso peptides). An all-D retro-inverso peptide of the invention would provide a peptide with functional properties similar to the native peptide,

wherein the side groups of the component amino acids would correspond to the native peptide alignment, but would retain a protease resistant backbone.

Retro-inverso peptides of the invention are analogs synthesized using D-amino acids by attaching the amino acids in a peptide chain such that the sequence of amino acids in the retro-inverso peptide analog is exactly opposite of that in the selected peptide which serves as the model. To illustrate, if the naturally occurring TAT protein (formed of L-amino acids) has the sequence GRKKRRQRRR [SEQ ID NO: 5], the retro-inverso peptide analog of this peptide (formed of D-amino acids) would have the sequence RRRQRRKKRG [SEQ ID NO: 6]. The procedures for synthesizing a chain of D-amino acids to form the retro-inverso peptides are known in the art (see e.g. Jameson *et al.*, Nature, 368,744-746 (1994); Brady *et al.*, Nature, 368,692-693 (1994); Guichard *et al.*, J. Med. Chem. 39,2030-2039 (1996)). Specifically, the retro-peptides according to SEQ ID NOs 2, 4, 6, 8, 11-12, 18, 20, 22 and 25-26, were produced by classical F-mock synthesis and further analyzed by Mass Spectrometry. They were finally purified by HPLC.

Since an inherent problem with native peptides is degradation by natural proteases and inherent immunogenicity, the heterobivalent or heteromultivalent compounds of this invention will be prepared to include the "retro-inverso isomer" of the desired peptide. Protecting the peptide from natural proteolysis should therefore increase the effectiveness of the specific heterobivalent or heteromultivalent compound, both by prolonging half-life and decreasing the extent of the immune response aimed at actively destroying the peptides.

Example 9: Long term biological activity of all-D retro-inverso IB(s) Peptides and variants thereof

Long term biological activity is predicted for the D-TAT-IB(s) retro-inverso containing peptide heteroconjugate (see chimeric sequences above) when compared to the native L-amino acid analog owing to protection of the D-TAT-IB(s) peptide from degradation by native proteases, as shown in Example 5.

Inhibition of IL-1 induced pancreatic beta-cell death by the D-TAT-IB1(s) peptide was analyzed. TC-3 cells were incubated as described above for 30 minutes with one single addition of the indicated peptides (1 μ M), then IL-1 (10 ng/ml) was added.

- 5 Apoptotic cells were then counted after two days of incubation with IL-1 by use of Propidium Iodide and Hoechst 33342 nuclear staining. A minimum of 1,000 cells were counted for each experiment. Standard Error of the Means (SEM) are indicated, n=5. The D-TAT-IB1 peptide decreased IL-1 induced apoptosis to a similar extent as L-TAT-IB peptides.
- 10 Long term inhibition of IL-1P induced cell-death by the D-TAT-IB1 peptide was also analyzed. TC-3 cells were incubated as above for 30 minutes with one single addition of the indicated peptides (1 μ M), then IL-1 (10 ng/ml) was added, followed by addition of the cytokine every two days. Apoptotic cells were then counted after 15 days of incubation with IL-1 by use of propidium iodide and Hoechst 33342 nuclear staining. Note that one single addition of the
- 15 TAT-IB1 peptide does not confer long-term protection. A minimum of 1.000 cells were counted for each experiment. As a result, D-TAT-IB1(s), but not L-TAT-IB1(s), was able to confer long term (15 day) protection.

Example 10: Suppression of JNK Transcription Factors by L-TAT-IB1(s) peptides as used
20 according to the present invention

- Gel retardation assays were carried out with an AP-1 doubled labeled probe (5'-CGC TTG ATG AGT CAG CCG GAA-3' (SEQ ID NO: 101). HeLa cell nuclear extracts that were treated or not for one hour with 5 ng/mlTNF- α , as indicated. TAT and L-TAT-IB1(s) peptides as used
- 25 according to the present invention were added 30 minutes before TNF-alpha. Only the part of the gel with the specific AP-1 DNA complex (as demonstrated by competition experiments with non-labeled specific and non-specific competitors) is shown.

- L-TAT-IB1(s) peptides as used according to the present invention decrease the formation of
- 30 the AP-1 DNA binding complex in the presence of TNF-alpha.

Example 11: Inhibition of endogenous JNK activity in HepG2 cells using an all-in one well approach (see Figure 3).

HepG2 cells were seeded at 3'000 cells/well the day prior the experiment. Then, increasing concentrations of either interleukin-1 [IL-1beta v)] or tumor necrosis factor [TNFalpha] (a) were added to activate JNK for 30 minutes. Cells were lysed in 20mM Hepes, 0.5% Tween pH 7.4 and processed for AlphaScreen JNK. (b) Z' for the JNK activity induced by 10 ng/ml IL-1 and measured in 384 wells/plate (n=96). (c) Inhibition of endogenous IL-1beta-induced JNK activity with chemical JNK inhibitors [staurosporin and SP600125]. (d) Effect of peptidic inhibitors L-TAT-IB1(s) according to SEQ ID NO: 9 [here abbreviated as L-JNKi (v)] and D-TAT-IB1(s) according to SEQ ID NO: 11 (here abbreviated as D-JNKi) and JBDs (corresponds to L-JNKI without the TAT sequence)] on IL-1 dependent JNK activity. All panels are representative of three independent experiments (n=3).

Methods: Alphascreen kinase assay

Principle: AlphaScreen is a non-radioactive bead-based technology used to study biomolecular interactions in a microplate format. The acronym ALPHA stands for Amplified Luminescence Proximity Homogenous Assay. It involves a biological interaction that brings a "donor" and an "acceptor" beads in close proximity, then a cascade of chemical reactions acts to produce an amplified signal. Upon laser excitation at 680 nm, a photosensitizer (phthalocyanine) in the "donor" bead converts ambient oxygen to an excited singlet state. Within its 4 µsec half-life, the singlet oxygen molecule can diffuse up to approximately 200 nm in solution and if an acceptor bead is within that proximity, the singlet oxygen reacts with a thioxene derivative in the "acceptor" bead, generating chemiluminescence at 370 nm that further activates fluorophores contained in the same "acceptor" bead. The excited fluorophores subsequently emit light at 520-620 nm. In the absence of an acceptor bead, singlet oxygen falls to ground state and no signal is produced.

Kinase reagents (B-GST-cJun, anti P-cJun antibody and active JNK3) were first diluted in kinase buffer (20 mM Tris-HCl pH 7.6, 10 mM MgCl₂, 1 mM DTT, 100 µM Na₃VO₄, 0.01% Tween-20) and added to wells (15 µl). Reactions were then incubated in presence of 10 µM of ATP for 1h at 23°C. Detection was performed by an addition of 10 µl of beads mix (Protein A acceptor 20 µg/ml and Streptavidin donor 20 µg/ml), diluted in detection buffer (20 mM Tris-HCl pH 7.4, 20 mM NaCl, 80 mM EDTA, 0.3% BSA), followed by an another one-hour

incubation at 23°C in the dark. For measurement of JNK endogenous activity, kinase assays were performed as described above except active JNK3 was replaced by cells lysates and reaction kinase components were added after the cells lysis. B-GST-cjun and P-cJun antibody were used at the same concentrations whereas ATP was used at 50 µM instead of 10 µM.

5 AlphaScreen signal was analyzed directly on the Fusion or En Vision apparatus.

Example 12: Determining the activity of all-D retro-inverso IB(s) Peptides and variants thereof in the treatment of viral infections – varicella-zoster virus (VZV)

10 Determination of the activity of IB(s) peptides and all-D retro-inverso IB(s) peptides as used according to the present invention was tested using the JNK inhibitor peptide XG-102 (SEQ ID NO: 11) as a test compound in cultured host cells (human foreskin fibroblasts (HFFs)). Viruses are obligate intracellular parasites that require a functional cell environment to complete their lifecycle; dying cells do not support virus replication. Additionally, inhibitors

15 of cell functions may be toxic to cells, which could non-specifically prevent virus growth. Thus, sick or dying host cells could exhibit nonspecifically reduced virus titers. Since this may falsify the results, a cytotoxicity assay was carried out first, determining the tolerance of the cultured cells to the test compound. Subsequently, a plaque reduction assay was carried out and then activity of the JNK inhibitor peptide XG-102 (SEQ ID NO: 11) was tested with

20 respect to Viral Zoster Virus (VZV) in infected cells.

A) Determination of the cytotoxicity of all-D retro-inverso IB(s) Peptides:

For determination of toxicity, cultured cells (human foreskin fibroblasts (HFFs)) were seeded in 96-well tissue culture plates. Medium containing DMSO (same level as 5 µM

25 XG-102 (SEQ ID NO: 11)), or XG-102 (SEQ ID NO: 11) was added at several concentrations of (1, 2, and 5 µM) for 24 h. Subsequently, a Neutral Red assay was carried out. Neutral Red colorimetric assays for cytotoxicity assays (in sets of 6 replicates) were used to set the maximum dose for subsequent efficacy assays (as performed in Taylor et al, 2004, J. Virology, 78:2853-2862). Live cells absorb Neutral

30 Red and, accordingly, the level of absorbance is a quantitative measure of cell viability and number. Neutral Red uptake is directly proportional to the number of cells and also reflects normal endocytosis. Therefore, a brief pulse of Neutral Red was added to the medium at 0 or 24 hours. After fixation and extraction, dye was added and the amount of dye in each sample was measured in an ELISA plate reader at 540nm (see

Figure 4). No cytotoxicity was observed with any amount of XG-102 (SEQ ID NO: 11), and cell growth was not restricted compared to the DMSO diluent alone (control). Thus the standard concentration of 1 μ M had no evident effects on HFF cells, and higher doses would also be well tolerated.

5
B) *Plaque reduction assay to evaluate the antiviral effects of XG-102 (SEQ ID NO: 11) against varicella-zoster virus (VZV)*

To determine whether XG-102 (SEQ ID NO: 11) had a dose-dependent antiviral effect, a range of concentrations surrounding the standard 1 μ M dose were tested. In this
10 plaque reduction assay, confluent human foreskin fibroblasts (HFFs) in 24-well plates were inoculated with VZV-infected HFFs at a ratio of 1:100 (multiplicity of infection MOI=0.01) and adsorbed to the cells for 2 hours. The excess virus was washed out, and medium containing 0 (DMSO only), 0.5, 1, or 2 μ M XG-102 (SEQ ID NO: 11) was added. One sample was taken at this time to measure the initial level of infection;
15 wherein each well contained ~150 pfu. After 24 hours, duplicate wells were trypsinized, and then the cell suspensions were titered on MeWo cell monolayers in triplicate to determine the number of VZV-infected cells in each sample. During unrestricted growth, VZV usually increases by 10-fold over 1 day because it propagates by cell-cell spread. This is what was observed for the cultures treated with DMSO
20 alone, which yielded 1200 ± 430 pfu (Figure 5). The results of the determination were as follows:

XG-102 (SEQ ID NO: 11)	Spread of VZV (pfu) $\pm$ SD
0 μ M (DMSO)	1233 ± 432
0.5 μ M	260 ± 53
1.0 μ M	212 ± 48
2.0 μ M	312 ± 79

25 XG-102 (SEQ ID NO: 11) had thus a strong antiviral effect at all the concentrations tested, with VZV yields near 200-300 pfu. Using the graph of these results to interpolate the EC₅₀, it was calculated that approximately 0.3 μ M XG-102 (SEQ ID NO: 11) caused VZV yield to decrease by 50%.

From the cytotoxicity and efficacy data, a preliminary Selective Index (Tox/EC₅₀) of 5.0 μ M / 0.3 μ M was calculated, which gives a value of ~17, wherein the true SI is considered even higher, since the concentration of XG-102 (SEQ ID NO: 11) was not yet approached that would kill 50% of the cells.

5
C) *Measurement of varicella-zoster virus (VZV) replication in human foreskin fibroblasts (HFFs) with XG-102 (SEQ ID NO: 11)*

To determine the minimum effective dose of XG-102 that prevents varicella-zoster virus (VZV) replication in human foreskin fibroblasts (HFFs) with XG-102 (SEQ ID NO: 11) confluent monolayers of HFFs were inoculated with VZV-BAC-Luc strain for 2h, then treated for 24h with XG-102 (SEQ ID NO: 11) in concentrations of 0.25, 0.5, or 1.0 μ M or with the negative control (XG-100, 1.0 μ M). Virus yield was measured by luciferase assay. Samples were in triplicate and the average luminescence is shown; error bars represent the standard deviation of the mean.

15
As a result, VZV replication was normal in the presence of the negative control (the Tat peptide alone). XG-102 (SEQ ID NO: 11) prevented VZV replication at the lowest concentration tested, 0.25 μ M. The minimum effective dose could not be determined in this experiment. While it is not yet known why VZV depends on JNK activity during infection, there appears to be a critical requirement for this enzyme. A low concentration (0.25 μ M) of XG-102 (SEQ ID NO: 11) is thus sufficient to completely block VZV spread in culture. One possible explanation for this effect is that this amount of XG-102 (SEQ ID NO: 11) binds to all the JNK molecules in the infected cells. Alternatively, 0.25 μ M XG-102 (SEQ ID NO: 11) may reduce JNK activity below a threshold level that is optimal for VZV replication. The results of this experiment are summarized in Figure 6.

30 Example 13: Determining the activity of all-D retro-inverso IB(s) Peptides and variants thereof in the treatment of Chronic Obstructive Pulmonary Disease (COPD)

In order to determine the activity of the exemplary all-D retro-inverso IB(s) peptide XG-102 (SEQ ID NO: 11) in the treatment of Chronic Obstructive Pulmonary Disease (COPD) XG-102 (SEQ ID NO: 11) is used in an animal model of Bleomycin induced acute lung

inflammation and fibrosis. The protocol of bleomycin induced inflammation and fibrosis has been described before in the literature. The aim of the Experiment was to investigate the effect of XG-102 (SEQ ID NO: 11) by subcutaneous (s.c.) route on neutrophil recruitment in broncho alveolar lavage (BAL) and lung in bleomycin induced inflammation and fibrosis:

- 5 - at 1 day after a single bleomycin administration (10 mg/kg)
- and at day 10 with the development of fibrosis

1) *Method and experimental approach*

10 The test compound XG-102 (SEQ ID NO: 11) at two doses and vehicle control were given s.c. with a single intranasal administration of bleomycin and mice were analyzed after 1 and 10 days. The animals used in the model were 10 C57BL/6 mice (8 weeks old) per group. The experimental groups included vehicle, 0.001 mg/kg XG-102 (SEQ ID NO: 11) and 0.1 mg/kg XG-102 (SEQ ID NO: 11), and the treatment consisted of repeated sub-cutaneous administration of XG-102 (SEQ ID NO: 11), prior to bleomycin administration then every 3 days. Acute lung inflammation at 24h was monitored by BAL lavage, cytology, cell counts, and lung myeloperoxidase activity. The effect of the compound was compared with vehicle controls. Lung fibrosis was assessed histologically using hematoxylin and eosin staining at day 10 after the single dose of bleomycin.

20 1.1) *Bleomycin administration*

 Bleomycin sulfate in saline (10 mg/kg body weight) from Bellon Laboratories (Montrouge, France) or saline were given through the airways by nasal instillation in a volume of 40 µL under light ketamine-xylazine anesthesia. The groups for Bleomycin administration for both bleomycin induced inflammation and fibrosis included: Vehicle, 0.001 mg/kg XG-102 (SEQ ID NO: 11) and 0.1 mg/kg XG-102 (SEQ ID NO: 11). The route for bleomycin induced inflammation was subcutaneous (s.c.) route, and administration occurred as a single dose. The route for bleomycin induced fibrosis was subcutaneous (s.c.) route, and administration occurred 3 times in 10 days.

30 1.2) *Bronchoalveolar lavage fluid (BALF)*

 After incision of the trachea, a plastic cannula was inserted and airspaces were washed using 0.3ml of PBS solution, heated to 37°C. The samples collected were dispatched in 2 fractions: the first one (1ml corresponding to the 2 first lavages) was

used for mediator measurement and the second one for the cell determination (4ml). The first fraction was centrifuged (600g for 10 min) and supernatant was fractionated and kept at -80°C until mediator determination. The cell pellet was then resuspended in 0.4ml sterile NaCl, 0,9%, and pooled with the second fraction and was used for cell counts.

1.3) *Lung homogenization*

After BAL the whole lung was removed and placed inside a microtube (Lysing matrix D, Q Bio Gene, Illkrich, France) with 1 ml of PBS, total lung tissue extract was prepared using a Fastprep® system (FP120, Q Bio Gene, Illkrich, France), the extract was then centrifuged and the supernatant stored at -80°C before mediator measurement and collagen assay with Sircol Collagen Assay (France Biochem Division, France).

1.4) *Cell count and determination*

Total cell count was determined in BAL fluid using a Malassez hemocytometer. Differential cell counts were performed on cytopsin preparations (Cytospin 3, Thermo Shandon) after staining with MGG Diff-quick (Dade Behring AG). Differential cell counts were made on 200 cells using standard morphological criteria.

1.5) *TNF measurement*

TNF level in BALF was determined using ELISA assay kits (Mouse DuoSet, R&D system, Minneapolis, USA) according to manufacturer's instructions. Results are reported as pg/ml.

1.6) *MPO-measurement*

MPO-levels were measured upon administration of XG-102. MPO was not significantly induced after bleomycin in this experiment. Furthermore, XG-102 had no effect on MPO levels in the lung.

1.7) *Histology*

After BAL and lung perfusion, the large lobe was fixed in 4% buffered formaldehyde for standard microscopic analysis. 3- m sections were stained with hematoxylin and eosin (H&E).

2.) Results

A) First Study: Bleomycin (BLM) induced acute lung inflammation

5 Groups: Vehicle, XG-102 (SEQ ID NO: 11) 0.001 mg/kg and XG-102 (SEQ ID NO: 11) 0.1 mg/kg

Route: s.c. route, single dose

a) Cell recruitment in bronchoalveolar lavage space

10 At 0.1 mg/kg, XG-102 (SEQ ID NO: 11) reduces significantly the neutrophil recruitment and the number of total cells recruited during the inflammatory stage. At 0.001 mg/kg, XG-102 (SEQ ID NO: 11) has no effect on neutrophil recruitment or other cell types into the bronchoalveolar space (one representative experiment with n= 5 mice per group; *, p < 0.05; **, p < 0.001).

15

b) Cell recruitment in lung using MPO in lung homogenization

Myeloperoxidase (MPO) plays an important role in host defense systems. This 140 kDa protein, composed of two heavy chains of 53kDa and two light chains of 15 kDa, was first discovered in the 1960s. The release of MPO from the granules of neutrophils and monocytes in response to the activation of leukocytes allows the conversion of hydrogen peroxide and chloride ions into hypochlorous acid (HOCl), a strong oxidizing agent. Although MPO serves an important purpose in the defense system, various studies show that MPO also plays a role in several inflammatory conditions, wherein an elevated MPO level e.g. has been linked to coronary artery diseases. Furthermore, tissue MPO levels reflect the state of activation of neutrophils and gives an indication on neutrophil tissue infiltration.

30 In the present experiment, MPO was not significantly induced after bleomycin administration. XG-102 (SEQ ID NO: 11) had thus no effect on the MPO levels in the lung (see Figure 7).

c) TNF measurement

When measuring TNF levels, a trend to reduction of the TNF level in BALF after administration of XG-102 (SEQ ID NO: 11) was observed, although TNF levels were very low after BLM administration (see Figure 8).

d) Conclusion

It could be observed that at 0.1 mg/kg, XG-102 (SEQ ID NO: 11) decreases the neutrophil and total cell recruitment into the bronchoalveolar space and induces a trend to decrease the TNF level. Moreover, the study of the histological slides showed a decrease of the inflammatory cell accumulation in the peribronchial space. It can thus be concluded that XG-102 (SEQ ID NO: 11) reduces the Bleomycin-induced inflammation.

According to the acquired results, the experiment was additionally performed in a fibrosis model.

B) Second Study: Bleomycin (BLM) induced lung fibrosis

Groups: Vehicle, XG-102 (SEQ ID NO: 11) 0.001 mg/kg and XG-102 (SEQ ID NO: 11) 0.1 mg/kg

Route: s.c. route, 3 times in 10 days

a) Cell recruitment in bronchoalveolar lavage space

At 0.001 mg/kg, XG-102 (SEQ ID NO: 11) reduced significantly the lymphocyte recruitment and the number of total cells recruited during the inflammatory stage characterised at this point by the lymphocytes recruitment. At 0.1 mg/kg, XG-102 (SEQ ID NO: 11) had no effect (n= 5 mice per group; *, $p < 0.05$; **, $p < 0.001$) (see Figure 9).

a) Histology

3 μ m sections of lungs were stained with haematoxylin and eosin. Inflammatory cells accumulation, fibrotic areas, loss of lung architecture were observed 10 days after BLM administration. A decrease of these parameters was observed after administration

of XG-102 at the low dose (0.001 mg/kg) but not with the high dose (0.1 mg/kg) (see Figure 10).

b) Conclusion:

It can be concluded that XG-102 (SEQ ID NO: 11) administered 3 times at the low dose of 0,001 mg/kg decreases the Bleomycin-induced later inflammation, in particular the lymphocytes recruitment observed at this time. Moreover, the test substance administered 3 times at this dose attenuates the Bleomycin-induced fibrosis. Less extended fibrotic areas with a more conserved lung structure could be observed.

Example 14: Determining the activity of all-D retro-inverso IB(s) Peptides and variants thereof in the treatment of Alzheimer's disease

In order to determine the activity of the exemplary all-D retro-inverso IB(s) peptide XG-102 (SEQ ID NO: 11) in Alzheimer's disease, XG-102 (SEQ ID NO: 11) was evaluated in the hAPP-transgenic mice model overexpressing APP751 with London and Swedish mutations using the behavioral Morris Water Maze test as well as immunohistological tests measuring plaque load and ELISA tests measuring β -amyloid₁₋₄₀ and β -amyloid₁₋₄₂ levels in the brain of mice.

a) METHODS

i) Introduction

The study was designed to evaluate the efficacy of the test substance (XG-102, SEQ ID NO: 11) on behavioral, biochemical and histological markers using 5 months ($\pm$ 2 weeks) old female hAPP Tg mice. Therefore, mice were treated every two or three weeks up to 4 months and in the end of the treatment period behavior was evaluated in the Morris Water Maze. At sacrifice brain, CSF and blood were collected. A β 40 and A β 42 levels were determined in four different brain homogenate fractions as well as in CSF of Tg mice. Plaque load was quantified in the cortex and the hippocampus of 8 Tg animals per treatment group.

ii) Animals

Female Tg mice with a C57BL/6xDBA background and an age of 5 months ($\pm$ 2 week) were randomly assigned to treatment groups 1 to 3 (n = 12). Animals were subjected to administration of vehicle or XG-102 (SEQ ID NO: 11) in two different concentrations beginning at 5 months of age and continued for up to 4 months with subcutaneous (s.c.) applications every second or third week. All animals which were used for the present study had dark eyes and were likely to perceive the landmarks outside the MWM pool. However, it had to be excluded that seeing abilities of an animal were poor, which was controlled in the visible platform training, the so called pretest, before treatment start for all animals including reserves enclosed to the study. In case a seeing handicap for a specific animal would have been affirmed, the mouse would have been excluded from the study.

iii) Animal Identification and Housing

Mice were individually identified by ear markings. They were housed in individual ventilated cages (IVCs) on standardized rodent bedding supplied by Rettenmaier®. Each cage contained a maximum of five mice. Mice were kept according to the JSW Standard Operating Procedures (*SOP GEN011*) written on the basis of international standards. Each cage was identified by a colored card indicating the study number, sex, the individual registration numbers (IRN) of the animals, date of birth, as well as the screening date and the treatment group allocation. The temperature during the study was maintained at approximately 24°C and the relative humidity was maintained at approximately 40 – 70 %. Animals were housed under a constant light-cycle (12 hours light/dark). Normal tap water was available to the animals *ad libitum*.

iv) Treatment

Forty female hAPP transgenic mice were treated with either 0.1 mg/kg b.w./every two weeks or 10 mg/kg b.w./every three weeks of the test substance XG-102 (SEQ ID NO: 11) in two different dosages (n=12/group) or treated with the vehicle (n=12) s.c. once every three weeks over four months.

v) Morris Water Maze (MWM)

The Morris Water Maze (MWM) task was conducted in a black circular pool of a diameter of 100 cm. Tap water was filled in with a temperature of $22\pm 1^{\circ}\text{C}$ and the pool was virtually divided into four sectors. A transparent platform (8 cm diameter) was placed about 0.5 cm beneath the water surface. During the whole test session, except the pretest, the platform was located in the southwest quadrant of the pool. One day before the 4 days lasting training session animals had to perform a so called "pre-test" (two 60 sec lasting trials) to ensure that the seeing abilities of each animal were normal. Only animals that fulfilled this task were enclosed to the MWM testing. In the MWM task each mouse had to perform three trials on four consecutive days. A single trial lasted for a maximum of maximum one minute. During this time, the mouse had the chance to find the hidden, diaphanous target. If the animal could not find a "way" out of the water, the investigator guided to or placed the mouse on the platform. After each trial mice were allowed to rest on the platform for 10-15 sec. During this time, the mice had the possibility to orientate in the surrounding. Investigations took place under dimmed light conditions, to prevent the tracking system from negative influences (Kaminski; PCS, Biomedical Research Systems). On the walls surrounding the pool, posters with black, bold geometric symbols (e.g. a circle and a square) were fixed which the mice could use the symbols as landmarks for their orientation. One swimming group per trial consisted of five to six mice, so that an intertrial time of about five to ten minutes was ensured. For the quantification of escape latency (the time [second] - the mouse needed to find the hidden platform and therefore to escape from the water), of pathway (the length of the trajectory [meter] to reach the target) and of the abidance in the goal quadrant a computerized tracking system was used. The computer was connected to a camera placed above the centre of the pool. The camera detected the signal of the light emitting diode (LED), which was fixed with a little hairgrip on the mouse's tail. One hour after the last trial on day 4 the mice had to fulfill a so-called probe trial. At this time, the platform was removed from the pool and during the one-minute probe trial; the experimenter counted the number of crossings over the former target position. Additionally the abidance in this

quadrant as well as the three other quadrants was calculated. Through out this trial a mouse could not get any, howsoever-natured, clue from the platform.

vi) Tissue Sampling

At the end of the treatment period, and following all behavioral testing, all remaining mice (n = 28) were sacrificed. Therefore, all mice were sedated by standard inhalation anesthesia (Isofluran, Baxter) as described in *SOP MET030*. Cerebrospinal fluid (CSF) was obtained by blunt dissection and exposure of the *foramen magnum*. Upon exposure, a Pasteur pipette was inserted to the approximate depth of 0.3 – 1 mm into the *foramen magnum*. CSF was collected by suctioning and capillary action until flow fully ceases. Two aliquots of each sample were immediately frozen and kept at -80°C until ready for further analysis with ELISA technique. After CSF sampling, each mouse was placed in dorsal recumbence, thorax was opened and a 26-gauge needle attached to a 1 cc syringe was inserted into the right cardiac ventricular chamber. Light suction was applied to the needle and blood was collected into EDTA and consequently used to obtain plasma. To get plasma, blood samples from each mouse were spun at 1,750 rpm (700g) for 10 minutes in a centrifuge (GS - 6R Beckman) using a rotor with swing buckets (GH - 3.8 Beckman). Plasma was frozen and stored at -20°C until further analysis. After blood sampling transgenic mice were intracardially perfused with 0.9% sodium chloride. Brains were rapidly removed the cerebellum was cut off. The right hemispheres of all mice were immersion fixed in freshly produced 4% Paraformaldehyde/PBS (pH 7.4) for one hour at room temperature. Thereafter brains were transferred to a 15% sucrose PBS solution for 24 hours to ensure cryoprotection. On the next day brains were frozen in isopentane and stored at -80°C until used for histological investigations (*SOP MET042*). The left hemispheres were weighed and frozen in liquid nitrogen and stored at -80°C for biochemical analysis.

vii) Determination of A β ₁₋₄₀ and A β ₁₋₄₂

In four different brain homogenate fractions of each Tg mouse as well as in CSF samples the A β ₁₋₄₀ and A β ₁₋₄₂ levels were evaluated with ELISA technique. Highly sensitive A β ₁₋₄₀ and A β ₁₋₄₂ ELISA test kits were purchased from *The*

*Genetics Company*TM, Switzerland (*SOP MET058*). CSF was prepared as described above. For the brain homogenates frozen hemispheres were homogenized in TRIS buffered saline (TBS) - buffer (5 ml) containing protease inhibitor cocktail. 1.25ml of this initial brain TBS homogenate was stored at -80°C, 1.25 ml have been further investigated. The remaining brain homogenate (2.5 ml) was centrifuged and the resulting supernatant (= TBS fraction) was aliquoted and kept at -20°C until ELISA determination. The pellet was suspended in Triton X-100 (2.5 ml), centrifuged and the supernatant (= Triton X-100 fraction) was aliquoted and kept at -20°C. These steps were repeated with SDS (2.5 ml). The pellet out of the SDS fraction was suspended in 70 % formic acid (0.5ml) prior to subsequent centrifugation. The obtained supernatant was neutralized with 1 M TRIS (9.5 ml) aliquoted and kept at -20°C (= FA fraction). Samples of the four brain homogenate fraction (TBS, Triton X-100, SDS, and FA) were used for A β ₁₋₄₀ and A β ₁₋₄₂ determination with ELISA technique. ELISA test kits were purchased from *The Genetics Company*TM, Switzerland (*SOP MET062*). It could be assumed that TBS and Triton X-100 solubilize monomeric to oligomeric structures. Polymers like protofibrils and water insoluble fibrils could be dissolved in SDS and FA. In this regard the investigation of all four fractions also provides insight in A polymerization status.

viii) Evaluation of Brain Morphology

Brain tissues of all Tg animals investigated were handled in exactly the same way to avoid bias due to variation of this procedure. From brain halves of 24 Tg mice (8 of each group) 20 cryo-sections per layer (altogether 5 layers), each 10 μ m thick (Leica CM 3050S) were sagittally cut and 5 (one from each layer) were processed and evaluated for quantification of plaque load. The five sagittal layers corresponded with the Figures 104 to 105, 107 to 108, 111 to 112, 115 to 116 and 118 to 119 according to the morphology atlas "The Mouse Brain" from Paxinos and Franklin (2nd edition). The first layer was specified by the requirement to include the whole hippocampus with its regions CA1, CA2, CA3, GDIb and GDmb. Immunoreactivity was quantitatively evaluated in the hippocampus and in the cortex using the monoclonal human A β -specific antibody 6E10 (Signet) as well as ThioflavinS

staining. Remaining brain hemispheres or tissue not used were saved and stored at JSW CNS until the end of the project.

b) EVALUATION

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i) Behavior

In the Morris Water Maze trials length of swimming path, escape latencies, swimming speed and in the probe trial crossings over the former platform position and the time spent in each quadrant of the pool were measured for each Tg animal with a special computer software.

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ii) Biochemical Evaluation

From all Tg mice CSF samples as well as samples from the brain preparations were analyzed with commercially available A β ₁₋₄₀ and A β ₁₋₄₂ ELISAs. Measurements of adequate standards were performed concurrently. Samples from brain preparations were analyzed in duplicates. Due to the small sample amount CSF samples were analyzed in a single measurement only.

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iii) Histology

Measurement of Amyloid Depositions and Plaque Load

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For 6E10 immunohistochemistry the following evaluation procedure was used:

aa) Contrasting the image for visualization of slice borders without applying the contrast on the image.

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bb) Interactive drawing of the cortical outlines and the following measurement of the cortical area (=region area).

cc) Interactive drawing of the area of interest (AOI), in which stained objects are detected over a certain intensity based threshold level (the same for each image) and above a size of 8 μm^2 .

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dd) Measurement of the area of each object, the sum of stained area in the AOI as well as the number of objects after a smooth contrasting to enhance signal/noise ratio (the same for each image).

ee) Repetition of aa)-dd) for the hippocampus.

- ff) Calculation of the mean plaque size (= "sum area of plaques / number of plaques"), the relative plaque number and area (= "number of plaques / region area" and "sum area of plaques / region area * 100").
- 5 gg) Automated data export into an Excel spread sheet, including the parameters "image title, region area, number of plaques, sum of plaque area, relative plaque number, relative plaque area and mean plaque size. A field for remarks was used to record image quality and exclusion criteria, respectively.
- 10 Exclusion criteria were missing parts of the slice, many wrinkles, dominant flaws or staining inconsistencies (e.g. due to bulges, which can impede the full reaction of the blocking reagent).
- hh) Closing the image without saving (to keep raw data raw).

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c) *RESULTS*

i) General Observations

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In total 40 female hAPP Tg mice were enclosed to study. From these mice 12 animals died due to unknown reason before the treatment period was finished.

ii) Behavioral Results

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Spatial learning in the MWM remained widely uninfluenced by XG-102 (SEQ ID NO: 11) treatment. 0.1mg/kg treated mice showed a tendency to have worse learning performance between day 1 and day 4. A two-way ANOVA of the mean performance on day 1 and 4 revealed highly significant learning for all groups ($p < 0.001$), but also a significant influence of factor treatment ($p = 0.045$). However, Bonferroni's post tests did not reach significance.

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iii) Biochemical Results

aa) A β Levels in the Brain Homogenate Fractions

A treatment with the test compound XG-102 (SEQ ID NO: 11) did not affect brain homogenate A β_{1-40} levels (see Figure 11). Group differences in A β_{1-42} levels appeared in Triton X-100 fraction, only.

There, animals treated with the low dose of the test compound XG-102 (SEQ ID NO: 11) (0.1 mg/kg) featured a significant reduction compared to the vehicle group ($p < 0.05$) as well as compared to the high dose group ($p < 0.01$).

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bb) CSF A β Levels

After treatment with the test substance XG-102 (SEQ ID NO: 2) A β_{1-40} and A β_{1-42} levels were significantly decreased in CSF compared to vehicle group. For both, A β_{1-40} and A β_{1-42} p-values were $p < 0.01$ for the high dosage (10 mg/kg) and < 0.05 for the lose dosage of XG-102 (SEQ ID NO: 2) (see Figure 12).

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iv) Results of Brain Histology and Immunohistochemistry

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aa) Amyloid Depositions and Plaque Load

Plaque load was quantified with two different methods. On the one hand an IHC staining with 6E10 primary directed against AA1-17 of the human amyloid peptide was performed, on the other hand a ThioflavinS staining marking beta-sheet structures and cores of mature, neuritic plaques was carried out. First of all, measured region areas, cortex and hippocampus, were highly constant throughout all groups, indicating that problems in the cutting and IHC procedures can be excluded and to a certain degree also a treatment induced atrophy (changes of $> 5\%$ would be detectable with this method). 6E10 and ThioflavinS quantifications revealed a selective reduction of beta-sheet structures in the center of the plaques after XG-102 (SEQ ID NO: 11) treatment, whereas human amyloid remained uninfluenced from treatment or slightly increased. In detail cortical 6E10 IR plaque load was increased versus vehicle in the 10 mg/kg XG-102 (SEQ ID NO: 11) treated mice, however, significance level was reached for the number of hippocampal plaques. Figures 13 and 14 show, in contrast to 6E10 IHC, that XG-102 (SEQ ID NO: 11) treatment led to a negatively dose dependent reduction of the number of hippocampal ThioflavinS positive plaques, as well as area percentage (number of plaques:

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p<0.05 for 10mg/kg, p<0.01 for 0.1 mg/kg XG-102 (SEQ ID NO: 11)). 0.1mg/kg XG-102 (SEQ ID NO: 11) treatment also reduced mean plaque size, however this effect did not reach significance level in the ANOVA (unpaired, two-tailed T-test: p = 0.074) These effects were not given for cortical plaques, a circumstance which is most probably due to the later onset of plaque pathology in the hippocampus than in the cortex. Treatment start at five months of age exactly hits the time point of plaque deposition in the hippocampus, whereas cortical plaques start to become visible at the used magnification for quantification at the age of three months. Qualitatively the proportion of 6E10 to ThioflavinS stained plaques increase and the beta-sheet plaque cores, as seen in doubly labeled slices, become smaller in size. Summarized, these data support that XG-102 (SEQ ID NO: 11) treatment acts against beta-sheet formation in the early phase of plaque deposition and beta sheet formation in plaque cores, respectively.

d) *SUMMARY OF EFFECTS AND CONCLUSIONS*

- Spatial navigation measured in the Morris water maze remained widely uninfluenced from treatment. 0.1 mg/kg XG-102 (SEQ ID NO: 11) treatment resulted in a slightly poorer learning performance between the first and the last training day.
- Except a decrease in the Triton X-100 fraction in the 0.1 mg/kg XG-102 (SEQ ID NO: 11) group A β ₁₋₄₀ and A β ₁₋₄₂ brain levels stayed stable.
- A decrease of A β levels was detectable in CSF for both dosages and fragments.
- XG-102 (SEQ ID NO: 11) treatment led to a tendentious increase of human amyloid beta in the higher dosed group in the 6E10 quantifications, which is in compliance with data obtained in A β ELISA.
- In contrast to that hippocampal beta-sheet load detected by ThioflavinS staining was dose dependently reduced after XG-102 (SEQ ID NO: 11) treatment, to a higher degree at lower dose 0.1 mg/kg XG-102 (SEQ ID NO: 11), whereas cortical plaque load remained unchanged. In accordance with the age-dependent onset of plaque deposition in the hippocampus at treatment start this hints at an early action on beta-sheet formation in the early phase of plaque deposition.

Example 15: Determining the activity of all-D retro-inverso IB(s) Peptides and variants thereof in the treatment of Diabetes Type 2

Example 15 is designed to determine the activity of IB(s) peptides and all-D retro-inverso IB(s) peptides and variants thereof in the treatment of Diabetes Type 2, particularly to determine the effect of chronic treatment with XG-102 (SEQ ID NO: 11) in the db/db mice model of type 2 diabetes by evaluating fasting blood glucose levels every third day (28 days)

10 a) Materials and methods

i) Animals

A total of twenty (20) male db/db mice (8 weeks old) were obtained from Charles River (Germany). Upon arrival, animals were group housed (n = 6-7/group) and offered regular rodent chow (Altromin standard #1324 chow; C. Petersen, Ringsted, Denmark) and water ad libitum unless otherwise stated. The mice were housed under a 12:12 L/D cycle (lights on at 4:00 and lights off at 16:00) and in temperature and humidity controlled rooms.

ii) Groups and randomization

On day -4, mice were randomized according to blood glucose level (fasted; blood glucose measured on Biosen S line analyzer (EKF diagnostic, Germany) to participate in one of the following drug treatment groups (n=6):

- 1) Vehicle control, S.C. (physiological saline)
- 2) XG-102 (SEQ ID NO: 11); 1 mg/kg; s.c.
- 3) XG-102 (SEQ ID NO: 11); 10 mg/kg; s.c

All doses listed were calculated for the free-base. Drug purity: 95.28%, peptide content: 78.0%. All compounds were administered sub-cutaneously (s.c.) in a volume of 3 ml/kg. The formulation instructions for vehicle control and XG-102 (SEQ ID NO: 11) were as follows:

First, XG-102 (SEQ ID NO: 11) was dissolved in the vehicle. The formulations (concentrations of 0.33 and 3.3 mg/ml, corresponding to the doses of 1 and 10 mg/kg, respectively) were prepared according to the procedure detailed

below. Concentrations were calculated and expressed taking into account test items purity and peptide content (multiplier coefficient was 1.346).

- Preparation of a stock solution: the freeze-dried test compound XG-102 (SEQ ID NO: 11) is thawed for one hour minimum and prepared as a stock solution in the vehicle at 1 mM (corresponding to 3.823 mg/mL). Aliquots are prepared for each treatment day and stored at approximately -80°C. Dilutions of this stock solution to the required concentrations are performed on each treatment day;
- Storage of the stock solution: at approximately -80°C;
- Storage of the diluted preparations: at room temperature for 24 hours maximum.

Prior to solubilisation, the powder was stored at -20°C. The stability of the stock solution is 3 months at approximately -80°C; the stability of the diluted formulations for animal dosing is 24 hours at room temperature. Unused diluted material could be stored for up to 7 days if kept at 4-8°C.

c) Experimental procedure

Following 8 days of acclimatization the mice were treated daily at 08.00 AM for 21 days by SC dosing 8 hours prior to lights out at 04.00 PM according to the outline groups. Then, on study day 21 dosing of the highest concentration of XG-102 (SEQ ID NO: 2) (10 mg/kg) was stopped, whereas daily dosing of vehicle control and XG-102 (SEQ ID NO: 2) (1 mg/kg) were continued until day study 28. From day 28 until termination at day 111 the vehicle and XG-102 (SEQ ID NO: 2) (10 mg/kg) treated mice were observed in a wash-out period (no dosing), whereas the mice treated with XG-102 (SEQ ID NO: 2) (1 mg/kg) was terminated after 28 days of treatment

i) Blood glucose

Blood glucose was measured from 7 hour fasted animals 6 hours post dosing by collection of 10 µl blood samples from the tail-vein in hematocrite tubes and subsequent analysis on a Biosen s-line analyzer (EKF-diagnostic; Germany).

ii) Metabolic cages

Groups 1+3: Mice were placed in metabolic cages for the recording of 24-hour food and water intake as well as 24-hour urine and faeces production. Mice were stratified into two sub-teams of $n = 6-7$ and subsequently the metabolic characterisation were performed on study days 71-72.

iii) Adipokine panel

Groups 1+3: On three occasions (study days 57, 66 and 108) blood was collected from the tail vein using EDTA coated hematocrite tubes (100µl). Following centrifugation of blood the plasma was collected and stored at -20°C until measurement. Then, the following panel of adipokines/cytokines was determined using Luminex based 7-plex: leptin, resistin, MCP-1, PAI-1, TNF, insulin and interleukin-6 (IL-6).

iv) Termination

Groups 1+3 (day 111): The following organs were excised and weighed: inguinal subcutaneous fat, epididymal fat, retroperitoneal fat, brain, liver, kidney, spleen and heart. All organs described above were samples in 4% PFA for possible future histo-pathological examination. Also, pancreas (*en bloc*) was sampled for possible stereological and immunohistochemical analysis, and eyes were sampled for possible later analysis of retinopathy. Group 2 (day 28): No tissues or plasma were collected.

c) Results

i) General observations

During the acute dosing period animals showed normal levels of alertness and activity and there were no signs of sedation in the drug treated animals. Food and water intake were within normal ranges among vehicle treated animals. However, after approximately two weeks dosing, nodular fibrosis was observed in the subcutaneous tissue as a reaction to the XG-102 (SEQ ID NO: 2) compound in the high dose, these progressed into open wounds all of the mice from group C. In group B mild nodular fibrosis was observed. As a consequence an alternation of injection sites were used. Following the end of dosing of the animals the animals healed and the nodular fibrosis was

gradually disappearing. We observed no clinical effects in the vehicle treated animals.

ii) Blood Glucose

5 Fasting blood glucose levels (absolute and relative) are shown in Figure 15. Fasting blood glucose was measured every third day until day 68 and on a regular basis until termination at day 111 in groups A and C. We observed a clear and significant ($p < 0.001$) decrease in the level of fasting blood glucose of the diabetic db/db mice treated with XG-102 (SEQ ID NO: 2) (10 mg/kg) as compared to vehicle control. The fasting blood glucose levels of the mice treated with XG-102 (SEQ ID NO: 2) (10 mg/kg) reached a low plateau of approximately 5 mmol/L. This effect was evident after 14 days of dosing and persisted throughout the study, thus during the entire wash-out period from day 21 to day 111. In contrast, we observed no effect of low dose of XG-102 (SEQ ID NO: 2) (1 mg/kg) during 28 days of dosing.

iii) Body Weight

20 Body weight determinations (absolute and relative) are shown in Figure 16. We observed a clear and significant ($p < 0.001$) prevention of body weight increase in mice treated with XG-102 (SEQ ID NO: 2) (10 mg/kg) as compared to vehicle control. This effect was evident from day 28 of dosing and remained until the day of termination day 111. In contrast, we observed no effect of low dose of XG-102 (SEQ ID NO: 2) (1 mg/kg) on body weight during 28 days of dosing.

iv) Metabolic cages

25 The effect of vehicle or XG-102 (SEQ ID NO: 2) (10 mg/kg) on 24 hour food and water intake, and urine and faeces production as measured in metabolic cages on study day 68 are shown in Figures 17 (g) and 18 (normalized to g of body weight). We observed no significant effects of XG-102 (SEQ ID NO: 2) (10 mg/kg) on any of the measured parameters as compared to vehicle control though a trend towards a decrease in food intake and urine production was observed.

v) Adipokines

The effect of vehicle or XG-102 (SEQ ID NO: 2) (10 mg/kg) as measured on day 57, 77 and 108 on plasma levels of insulin, MCP-1 and IL-6 are shown in Figure 19; on plasma levels of tPAI-1, TNF and resistin in Figure 20; We observed no significant effects of XG-102 (SEQ ID NO: 2) (10 mg/kg) on any of the measured parameters as compared to vehicle control except the levels of plasma resistin, which was significantly higher in XG-102 (SEQ ID NO: 2) treated animals at day 77 and 108.

vi) Tissue weight at termination

The effect of vehicle or XG-102 (SEQ ID NO: 2) (10 mg/kg) on tissue weight of epididymal, inguinal subcutaneous, and retroperitoneal fat pads are shown in Figure 21. We observed a significant decrease of epididymal ($p < 0.05$) and retroperitoneal ($p < 0.01$) fat mass in the mice treated with XG-102 as compared to vehicle control. The effect of vehicle or XG-102 (SEQ ID NO: 2) (10 mg/kg) on tissue weight of brain, spleen and heart is shown in Figure 22. We observed no significant effects of XG-102 (SEQ ID NO: 2) (10 mg/kg) on these parameters as compared to vehicle control. Finally, the effect of vehicle or XG-102 (SEQ ID NO: 2) (10 mg/kg) on tissue weight of kidney and liver is shown in Figure 23. We observed a significant decrease of kidney ($p < 0.05$) and liver ($p < 0.01$) mass in the mice treated with XG-102 (SEQ ID NO: 2) as compared to vehicle control.

Summarizing the results, administration of XG-102 (SEQ ID NO: 11), 10 mg/kg, appears to lead to a significant decrease in blood glucose levels and therefore, XG-102 (SEQ ID NO: 11) appears to be a promising new tool for treating diabetes and elevated blood glucose levels.

Example 16: Safety, tolerability and pharmacokinetics of a single intravenous infusion of 10, 40 and 80 µg/kg XG-102 (SEQ ID No.: 11) administered to healthy male volunteers in a randomized, double blind, placebo controlled, dose escalating Phase I study

5 The primary objective of the study was to assess the safety and tolerability of XG-102 following intravenous (iv) infusion of single escalating doses of XG-102 to healthy male volunteers. The secondary objective of the study was to assess the pharmacokinetics of XG-102 following iv infusion of single escalating doses of XG-102 to healthy male volunteers.
10 Doses were administered as a 60 minute iv infusion. For control purposes, placebo iv infusion was administered to control subjects.

This was a single-centre, randomized, double blind, placebo controlled, ascending single dose, sequential group study. Three dose levels of XG-102 (10, 40 and 80 µg/kg) were studied
15 in ascending order of dose, within each group subjects were randomized such that 6 subjects received XG-102, and 2 subjects received placebo. Screening was performed in the 3-week period prior to dosing. Dosing occurred on Day 0 for each subject. The Investigator checked on all subjects' well-being prior to their discharge from the CRU (at 24 hours after dosing). Subjects returned to the CRU 8 ± 2 days and 28 ± 5 days after dosing for post study
20 assessments.

A total of 24 subjects (healthy male subjects in the age of 18 to 45), in 3 groups of 8. 24 subjects entered and completed the study. Data for all subjects were included in the safety analyses; data for all subjects who received XG-102 were included in the pharmacokinetic
25 analyses.

*Summary:**Pharmacokinetic results:*

The pharmacokinetic parameters of XG-102 are presented in the following table:

Parameter	10 µg/kg (N=6)	40 µg/kg (N=6)	80 µg/kg (N=6)
AUC _{0-last} (ng.h/mL)	24.7 (26.1)	134 (15.2)	431 (41.0)
AUC _{0-∞} (ng.h/mL)	36.8 (23.4)	146 (17.5)	443 (41.0)
AUCextrap ^a (%)	34.1 (18.6 - 49.7)	6.7 (4.2 - 12.9)	2.9 (1.9 - 3.4)
C _{max} (ng/mL)	31.3 (24.4)	146 (16.7)	362 (34.9)
t _{max} ^a (h)	1.00 (1.00 - 1.05)	1.00 (1.00 - 1.00)	1.00 (1.00 - 1.00)
AUC _{0-last} (norm) (ng.h/mL)/(µg/kg)	3.10 (29.3)	3.64 (13.8)	5.91 (41.8)
AUC _{0-∞} (norm) (ng.h/mL)/(µg/kg)	4.61 (24.8)	3.96 (15.7)	6.07 (41.8)
C _{max} (norm) (ng/mL)/(µg/kg)	3.93 (28.0)	3.98 (15.9)	4.97 (35.6)
MRT (h)	1.00 (29.9)	0.76 (11.0)	1.02 (14.7)
t _{1/2} (h)	0.57 (44.6)	0.36 (22.3)	0.65 (38.8)
CL (mL/h)	17537 (23.9)	18399 (16.4)	13217 (43.5)
CL (mL/h/kg)	217 (24.8)	253 (15.7)	165 (41.8)
V _{ss} (mL)	17536 (36.8)	14040 (15.7)	13500 (30.5)
V _{ss} (mL/kg)	217 (27.5)	193 (13.7)	168 (29.8)

Geometric mean (CV%) data are presented

N = Number of subjects studied

(norm) = Normalized for dose and body weight

^a Median (min max)

The observed values of $t_{1/2}$ were short. Both peak exposure as measured by $C_{\max}$ and cumulative exposure as measured by $AUC_{0-\text{last}}$ increased with dose. The increase with dose of $C_{\max}$ appears to be more than linearly proportional on the basis of graphical examinations and of the geometric mean of its dose normalized values which after the highest 80 $\mu\text{g/kg}$ dose are above the 90% confidence intervals for the other doses. The increase with dose of $AUC_{0-\text{last}}$ is clearly more than linearly proportional from 40 to 80 $\mu\text{g/kg}$ as the 90% confidence intervals for its geometric mean dose normalized value does not overlap with those after the other tested doses; whereas when comparing values after 10 and 40 $\mu\text{g/kg}$ the 90% confidence intervals overlap, but its geometric mean dose normalized value after the 10 $\mu\text{g/kg}$ dose is lower than all values in the corresponding 90% confidence interval after the 40 $\mu\text{g/kg}$ dose.

XG-102 was safe and well tolerated when administered as single iv doses of 10, 40 or 80 $\mu\text{g/kg}$ to healthy male subjects. The incidence of adverse events in subjects who received XG-102 was similar to the incidence in subjects who received placebo. There were no clinically significant findings in clinical laboratory data, vital signs, ECGs, physical examinations or ocular examinations (fundus and IOP).

After the end of XG-102 intravenous infusion, its plasma concentrations quickly decreased, leading to values below the lower limit of quantification by at most 2 hours after the start of 10 $\mu\text{g/kg}$ XG-102 iv infusions, 3 hours after the start of 40 $\mu\text{g/kg}$ XG-102 iv infusions and by at most 7 hours after the start of 80 $\mu\text{g/kg}$ XG-102 intravenous infusions. The measured $t_{1/2}$ and MRT values are short, with geometric mean values per dose level ranging from 0.36 to 0.65 hours and from 0.76 to 1.02 hours, respectively.

The $AUC_{0-\text{last}}$ of XG-102 increases in a more than linear proportion with dose in the tested dose range, with non-overlapping 90% confidence intervals for its geometric mean dose normalized values between the 40 $\mu\text{g/kg}$ and the 80 $\mu\text{g/kg}$ dose and only limited overlap between the 90% confidence intervals for its geometric mean dose normalized values between the 10 $\mu\text{g/kg}$ and the 40 $\mu\text{g/kg}$.

The $C_{\max}$ of XG-102 appears to increase in a more than linear proportion with dose from 40 to 80 $\mu\text{g/kg}$. The geometric mean dose normalized $C_{\max}$ in the 80 $\mu\text{g/kg}$ dose group is higher than and outside the 90% confidence intervals for the geometric mean dose normalized $C_{\max}$ in the other dose groups, but the 90% confidence intervals for the geometric mean dose normalized $C_{\max}$ overlap among all dose levels.

The intersubject variability of XG-102 pharmacokinetic parameters was moderate in subjects treated with 10 and 40 $\mu\text{g/kg}$ doses (CV% of the geometric mean for most parameters approximately in the 15-30% range, exception was $t_{1/2}$ and total V_{ss} at the 10 $\mu\text{g/kg}$ dose group), but higher in the 80 $\mu\text{g/kg}$ dose group, in the approximately 29-44% range, other than for MRT (14.7%). This higher variability may be either an effect of the low sample size or a consequence of the observed non-linearities which are clearer at this dose.

Example 17: Use of XG-102 (SEQ ID No.: 11) to improve porcine islet isolation outcomes

The object was to evaluate the ability of XG-102 to (a) block the massive activation of JNK that occurs during islet isolation leading to cell stress and death; (b) reduce islet death, resulting to improvements in islet viability post-isolation, using the porcine model.

Porcine islet isolation results in a dramatic activation of JNK first observed in tissue samples ~ 20 min after the initiation of the islet isolation procedure (Figure 33). Analysis of existing data demonstrates that the addition of the XG-102 JNK inhibitor at the pancreas level during procurement and transfer to the isolation lab and in islet isolation solutions (10 micromolar concentration) during isolation blocks the activation of JNK (Figure 34), reduces the relative expression of the *c-fos* gene (Figure 35), and has a statistically significant and important effect on the viability of freshly isolated islets as measured by OCR/DNA (Figure 36) and ATP/ protein [total cell protein] (Figure 37). Comparisons were always made with paired untreated controls originating from the same pancreas donor. The data on islet viability presented in Figures 36 and 37 is consistent with a reduction in the activation of JNK typically observed during isolation (Figure 33) and a reduction in resulting *c-fos* gene expression (Figure 35). The differences in viability, JNK activation and *c-fos* expression became smaller after 7 days of culture.

6/6 (100%) of the isolations resulted in OCR/DNA values above the cut-off and were successfully transplanted in NHPs (Figure 38). This confirms that in this model even modest improvements in viability can have a profound impact on the transplantability of preparations. Based on the available data, XG-102 turned out to be an excellent agent to be used for clinical human or porcine islet isolations.

The porcine model is relevant for the following reasons: (1) The size of the porcine pancreas is closer to that of a human pancreas than a rat or canine pancreas; (2) Porcine islets are considered a viable option for future clinical islet xenotransplantation – therefore improvements in porcine islet isolation, which are critically needed can ultimately be clinically relevant.

Human pancreata for clinical islet allo-transplantation originating from brain-dead donors are typically not subjected to WIT but have 8-12 hrs of CIT (time needed for transportation from the procurement hospital to the isolation lab).

Human pancreata from non-heart beating donors are exposed to ~15 min of WIT and are not currently utilized routinely) because of concerns about damage due to the WIT and they would also experience 8-12 hrs of CIT.

Organs removed from chronic pancreatitis patients for islet auto-transplantation may experience WIT and limited (1-2 hrs CIT). It is anticipated that improvements reported with the porcine model below would be even bigger in the clinical auto-transplant case because the pancreata from chronic pancreatitis patients are typically inflamed and already stressed. This is also expected to be true in the clinical allo-cases with prolonged cold ischemia time and it has been reported by other groups using different JNK inhibitors. JNK activation increases with CIT from the time of pancreas procurement; Blocking JNK activation with a JNK inhibitor improves islet yield, viability and transplant outcomes and that is most pronounced at the longest cold ischemia time tested.

Example 18: Efficacy of XG-102 (SEQ ID No. 11) in Reducing the Choroidal Neovascularization using the Rat Argon Laser-Induced Choroidal Neovascularization Model.

The aim of this example was to determine whether two intravitreal administrations of XG-102 at two doses resulted in a decrease of choroidal neovascularization in a rat model of laser-induced choroidal neovascularization (ChNV). That model allows to make predictions on the potential use of a test compound for the treatment of age-related macular degeneration.

Forty (40) (+ 10 reserve) pigmented Brown Norway rats were divided into five (5) groups of eight (8) animals each. Choroidal neovascularization was induced using a 532 nm argon laser photocoagulator (six (6) 75 μ m-sized spots at 150 mW for 100 ms) in the right eyes. Test, reference and control items were administered by intravitreal injection on Days 0 (just after induction) and 7. Angiography was performed 10 min after fluorescein (tracer) subcutaneous injection, on Days 14 and 21 after induction on treated and untreated animals.

After sacrifice on Day 23, the right treated eye from all animals was sampled and the choroid was flat mounted. On sponsor's request, no quantification of the volume of the ChNV was performed.

Experimental set-up:

XG-102: 3 000 μ g/ml (equivalent to 15 μ g/eye) and 300 μ g/ml (equivalent to 1.5 μ g/eye). Kenacort® Retard (4% triamcinolone acetonide) as control reference. Control Vehicle: Saline (0.9% NaCl).

Animals

Species:	Rat. This is the species most commonly used in this experimental model
Strain:	Brown Norway (pigmented).
Age:	Approximately 8 weeks.
Weight:	175 – 200 g (on ordering).
Number/sex:	50 males (study 40; reserve 10).
Breeder:	“HARLAN FRANCE” - FR-03800 GANNAT.

Study Design

Forty (40) (+ ten (10) reserve) pigmented rats from the Brown Norway strain were divided into five (5) groups of eight (8) (+ 2 reserve) animals. Choroidal

neovascularization was induced using a 532 nm argon laser photocoagulator (six (6) 75 µm-sized spots at 150 mW for 100 ms) in the right eyes.

Test item (two doses, groups 1-2), vehicle and reference (5 µl) were administered by intravitreal injection in right eyes at Day 0 (after induction of neovascularization under the same anesthesia) and Day 7. Fundus neovessels were evaluated on Days 14 and 21 using Heidelberg's Retinal Angiography (HRA) in right eyes for treated and untreated animals.

The table below summarizes the allocation of animals in treatment groups:

<i>Group No.</i>	<i>Treatment</i>	<i>Dose</i>	<i>Route of Administration</i>	<i>Number of animals</i>
1	XG-102	3 000 µg/ml	IVT (5 µl in right eye at Day 0 and Day 7)	14, 17, 38, 26, 28, 31, 23, S8
2		300 µg/ml		24, 40, 19, 21, S5, 6, 39, 18
3	Saline	-		37, 12, 22, S3, 4, 3, 33, 35
4	Kenacort® Retard	4% triamcinolone acetonide		10, 3, 15, S1, 32, 8, 16, 9
5	Untreated	-	-	29, 7, 20, 36, S9, 27, 1, 11

10 Selection of the Animals

Forty (40) + ten (10) reserve animals were involved in this study. Only animals with no visible sign of ocular defect were selected. Then, the allocation in the treatment groups was done by a random function in Excel® software. Fifty (50) animals were induced and followed. The random allocation in the treatment groups determined the eight animals and the reserve animals per group. These latter animals were included in the calculations of results only if one or two animals normally involved died, had impact on lens during administration procedure or a corneal opacity (due to repetitive anesthesia).

Induction of Neovascularization

On Day 0, animals were anesthetized by an intramuscular injection of a mix xylazine/ketamine. Pupils from the right eyes were dilated by instillation of one drop of 0.5 % tropicamide. Then, six (6) choroidal burns (75 µm spot size) were done through a slit lamp, with a contact lens, around the optic disc, between the main vessel branches using an argon laser photocoagulator (532 nm; 150 mW; 100 ms). Production of a bubble at the time of laser treatment confirmed the rupture of Bruch's membrane.

Route and Method of Administration

Animals were anesthetized by intramuscular injection of a mix xylazine/ketamine. Test item, reference and vehicle (5 µl) were intravitreally injected in the right eyes dose regimen was on Day 0 and Day 7. The injection was performed under an operating microscope.

The intravitreal injections scheduled on Day 0 were done following the induction of neovascularization, under the same anesthesia.

The intravitreal injection was located in the supratemporal area at *pars plana* and performed using a 30G-needle mounted on a 10 µl Hamilton. The filled syringe was then mounted into the UltraMicroPump III to achieve accurate injection in microliter range.

Body Weights

The body weight of all animals was recorded before the start of study then once a week. The animal body weights, recorded before induction and treatment (baseline), then on Days 7, 14 and 21 were all within a normal range at the baseline: 180,6 ± 12,3 g (mean ± SD, n = 40). At Day 21, no relevant difference between test item, vehicle and untreated groups was observed. The animals gained: + 53 g (+ 29%) and + 62 g (+ 34%) for XG-102 at 300 µg/ml and 3000 µg/ml, respectively, versus + 56 g (+ 31%) and + 59 g (+ 34%) for the vehicle group and untreated group, respectively.

Animals treated with Kenacort® retard gained +21 g (+ 12%) between the baseline and Day 21 after induction.

Fluorescein Angiography

Fluorescein angiography was performed on Days 14 and 21 using an HRA. After anesthesia by an intramuscular injection of a mix xylazine/ketamine and pupillary dilation, 250 µl/100 g (body weight) of a 10% sodium fluorescein was injected subcutaneously using a 26G insulin

syringe, and fluorescein photos were recorded 10 minutes after dye injection.

This study was carried out on forty (40) Brown Norway rats. Argon laser was used to induce ChNV in the right eyes. The development of ChNV was evaluated by fluorescein angiography (FA). Treatments (test, reference and control items) were made by intravitreal administration on Days 0 and 7 after induction. Angiography was performed 10 min after fluorescein (tracer) injection, on Days 14 and 21 after induction. The grading was based on the highest intensity of fluorescein in each lesion and it was not determined by the size of the leakage area.

Results were expressed as the group mean score per time-point and by incidence of the number of spots at a given intensity score for each treatment and at each of both time-points. The Mann and Whitney test was used to determine if there was a statistically significant difference in the FA score between treated and control group. The statistical significance was attributed when $p < 0.05$ was obtained with Mann and Whitney-U test.

Figure 39 A shows the intensity of fluorescein leakage (mean score $\pm$ SD). and Figure 39 B illustrates the proportion of leaking spots in test item-treated eyes at both time-points. Figures 39 C and 39 D illustrate the percentage of leaking spots (score > 0) and of maximum leaking spot (score of 3) respectively

Evaluation by Fluorescein Angiography

The leakage of fluorescein on the angiograms was evaluated by two examiners in a masked fashion and graded as follows: Score 0, no leakage; Score 1, slightly stained; Score 2, moderate stained; Score 3, strongly stained. If the two scores assigned to a particular lesion did not coincide, the higher score was used for analysis.

Evaluation with Isolectin B₄ of ChNV by Labelling on Flat Mount Preparation (Quantification in Option)

On Day 23, after euthanasia by an i.p. injection of Dolethal®, the treated right eyes were harvested and fixed 4% paraformaldehyde solution 1 hour at room temperature. After washing, retina, choroid and sclera were dissected. The retina was carefully peeled. The sclera-choroid was flat mounted and incubated after blocking with FITC-isolectin B₄ antibody.

Statistical Analyses

Group mean values and standard deviation were calculated for all parameters. To assess the statistical significance of differences between the various concentration of the test item and the vehicle, a Mann and Whitney U test was used.

5 Results

(1) Reference compound Kenacort vs Vehicle and Untreated Groups

The following table summarizes the results of FA at 10 min on Days 14 and 21 (n = 8 animals per group, right eyes)

Treatment	Dose	Time-point	Mean score of fluorescein leakage		Incidence (% spots with score x)			
			Mean $\pm$ SD	% of reduction vs Vehicle	Score 0	Score 1	Score 2	Score 3
Untreated	-	Day 14	2.1 $\pm$ 1.0 (n = 48)	-	10	19	25	46
		Day 21	2.1 $\pm$ 0.9 (n = 48)	-	4	21	38	38
Vehicle (NaCl) IVT D0, D7	0.9%	Day 14	2.9 $\pm$ 0.5 (n = 48)	-	0	4	6	90
		Day 21	2.2 $\pm$ 1.0 (n = 48)	-	6	21	23	50
Kenacort® retard (triamcinolone acetonide) IVT D0, D7	4%	Day 14	0.1 $\pm$ 0.3 (n = 46)	97 % (p < 0.001)	87	13	0	0
		Day 21	0.3 $\pm$ 0.5 (n = 45)	86 % (p < 0.001)	69	31	0	0

Please note that numerical data may have been rounded for presentation, therefore, manual recalculation may result in slightly different values.

At Day 14, 90% of the spots were leaking in the untreated right eyes indicating the formation of ChNV. The mean score was 2.1 ± 1.0 (n = 48). At Day 21, the untreated animals showed 96% of leaking spots and mean score at 2.1 ± 0.9 (n = 48) indicating the persistence of the ChNV.

At Day 14, 100% of the spots were leaking in vehicle treated eyes with a mean score of 2.9 ± 0.5 (n = 48) indicating the formation and the severity of the ChNV. By Day 21, no relevant change in the incidence of leaking spots with 94% of the spots that were leaking and a mean score of 2.2 ± 1.0 (n = 48), indicating the persistence of the ChNV.

Scoring of FA revealed that Kenacort® retard following two intravitreal administrations at Days 0 and 7 significantly reduced the fluorescein leakage by 97% ($p < 0.001$, Mann & Whitney-U test) compared to the vehicle at Day 14 as shown by a mean score of 0.1 ± 0.3 ($n = 46$) vs 2.9 ± 0.5 for vehicle group.

5 The incidence of the leaking spots were reduced in Kenacort® retard group with 13% of the leaking spots compared to the vehicle-treated animals which showed 100% of the leaking spots at Day 14.

10 By Day 21, animals treated twice with Kenacort® retard showed a relevant reduction by 86% of the vascular leakage compared to vehicle-treated animals ($p < 0.001$, Mann & Whitney test) as shown by a mean score of 0.3 ± 0.5 ($n = 45$) vs 2.2 ± 1.0 , respectively.

The proportion of leaking spots compared to vehicle group at Day 21 was unchanged as shown by 31% of leaking spots for Kenacort® retard versus 94% for vehicle.

15

(2) XG-102-Treated Groups vs Vehicle Group

The following table summarizes the results of FA at 10 min on Days 14 and 21 (n = 8 animals per group, right eyes).

<i>Treatment</i>	<i>Dose</i>	<i>Time-point</i>	<i>Mean score of fluorescein leakage</i>		<i>Incidence (% spots with score x)</i>			
			<i>Mean ± SD</i>	<i>% of reduction vs Vehicle</i>	<i>Score 0</i>	<i>Score 1</i>	<i>Score 2</i>	<i>Score 3</i>
XG-102 IVT D0, D7	300 µg/ml	Day 14	2.4 ± 0.9 (n = 44)	17% (p < 0.05)	7	9	18	66
		Day 21	2.4 ± 0.8 (n = 44)	-9%	5	9	32	55
	3000 µg/ml	Day 14	1.7 ± 0.7 (n = 43)	41% (p < 0.001)	0	44	44	12
		Day 21	2.3 ± 0.7 (n = 43)	-5%	0	14	47	40
Vehicle NaCl IVT D0, D7	0.9%	Day 14	2.9 ± 0.5 (n = 48)	-	0	4	6	90
		Day 21	2.2 ± 1.0 (n = 48)	-	6	21	23	50

5

Please note that numerical data may have been rounded for presentation, therefore, manual recalculation may result in slightly different values.

A summary of the results is provided in Figure 39.

- 10 The general behaviour of animals was not altered following intravitreal administrations of XG-102 at both doses. No relevant complications were found during the clinical follow-up. The animal body weight increased during the study period: + 53 g (+ 29%) and + 62 g (+ 34%) for XG-102 at 300 µg/ml and 3000 µg/ml, respectively, versus + 56 g (+ 31%) and + 59 g (+ 34%) for the vehicle group and untreated group, respectively. Animals treated with
- 15 Kenacort® showed a weight gain of 21 g (+ 12%).

In the vehicle group, the induced eyes showed consistent fluorescein leakage 14 and 21 Days after laser injury. The mean fluorescein leakage was 2.9 ± 0.5 (n = 48 impacts) at Day 14 with 100% of leaking spot indicating the formation and the severity of the ChNV. At Day 21, formation of the ChNV remained consistent with 94% of the leaking spots and a mean fluorescein leakage of 2.2 ± 1.0 (n = 48 impacts).

20

Two intravitreal administrations at Days 0 and 7 of Kenacort® (200 µg/administration) inhibited the incidence of ChNV formation at Days 14 and 21 after induction with a mean score of 0.1 ± 0.3 ($p < 0.001$) and 0.3 ± 0.5 ($p < 0.001$) for Kenacort® retard versus 2.9 ± 0.5 and 2.2 ± 1.0 for vehicle, on Days 14 and 21, respectively. On day 14, 13% of the lesions showed leakage in the reference-treated group while 100% showed leakage in vehicle group. By Day 21, the incidence of the leaking spots remained reduced with Kenacort® retard (31%) in comparison to vehicle (94%).

Animals treated with XG-102 at 300 µg/mL and 3000 µg/mL showed a significant reduction of the vascular leakage at Day 14 by 17% ($p < 0.05$) with a mean score of 2.4 ± 0.9 for low dose, and by 41% ($p < 0.001$) with a mean score of 1.7 ± 0.7 for high dose of XG-102, compared to vehicle. At Day 21, XG-102 at both doses did not show a relevant reduction of the vascular leakage compared to vehicle.

A reduction of the proportion of spots with a score 3 was recorded for 300 µg/mL and 3000 µg/mL XG-102 groups on Day 14 as shown by 66% and 12% of score 3 for low and high XG-102 concentration respectively, compared to 90% of spots scored by 3 for vehicle group.

Using anatomic and functional metrics of measuring ChNV and under the given experimental conditions, XG-102 intravitreally administered at 300 and 3000 µg/mL inhibited the vascular leakage 7 days (Day 14 of the study) after the last administration.

Example 19: Effects of XG-102 on Adriamycin-induced nephropathy

The object of that example was to study the effects of XG-102 on inflammatory kidney disease, nephropathy. Adriamycin treatment induces glomerular disease in rat and mice mimicking human focal segmental and glomerular sclerosis (FSGS). In this model, tubular and interstitial inflammatory lesions occur during the disease course, partly due to heavy proteinuria. In the absence of therapy, kidney disease progresses to terminal renal failure within eight weeks. Podocyte injury is one of the initial steps in the sequences leading to glomerulosclerosis. The aim of the study was to investigate whether XG-102 could prevent the development of renal lesions and the renal failure.

XG-102 (control NaCl 0,9%) were administered to rats i.v.. In total 50 rats were treated, whereby 3 groups (of 10 rats) received XG-102 (low dose (20 µg/kg), medium dose (200 µg/kg) and high dose (2000 µg/kg). All of these three groups (and the placebo group) were treated with 10 mg/kg Adriamycin on day 0. A fifth group of 10 animals did not receive any adriamycin and was treated by the NaCl control. Histological preparations were provided at day 8, 14, 29 and 41.

These histological preparations clearly indicated that XG-102 has – over the entire observation period - a significantly positive effect on adriamycin-induced nephropathy. The nephrological tissue is significantly rescued from cell loss, see Figures 42 to 45). The effect on c-jun expression without treatment by XG-102 or with treatment by XG-102 is provided in Figures 46 and 47, respectively.

In a further study 40 male Sprague-Dawley rats (Charles River) were used (divided into 4 groups of ten rats). Nephropathy has been induced by a single intravenous injection of Adriamycin 10 mg/kg on Day 0. XG-102 (SEQ ID NO: 11; 2 mg/kg; in NaCl 0.9%) was administered intravenously in the tail vein on Day 0. The administration volume has been 0.2 ml.

The table below summarizes the random allocation:

Group N°	ADR (Day 0)	Treatment (Day 0)	Dose volume / Route of administration	Dose concentration	Number of animals
1	10 mg/kg	NaCl 0.9%	0.2 ml, IV	0	10
2	10 mg/kg	XG-102 2 mg/kg	0.2 ml, IV	1 mg/ml	10
3	NaCl 0.9%	NaCl 0.9%	0.2 ml, IV	0	10
4	NaCl 0.9%	XG-102 2 mg/kg	0.2 ml, IV	1 mg/ml	10

Each day, the general behavior and the appearance of all animals were observed. The health of the animals was monitored (moribund animals, abnormal important loss of weight, major intolerance of the substance, etc...). No rats were removed.

- 5 Blood was collected from the tail vein at Days 7, 14, 28, 42 and 56 from 4 rats per group. Serum creatinine concentrations, blood urea and protidemia were measured using appropriate kits from Advia Chemistry 1650 (Bayer Healthcare AG, Leverkusen, Germany). Two rats per group were sacrificed on Days 7, 14, 28, 42 and 56 after anesthesia. After animal
- 10 sacrifice, both kidneys were collected. For histopathological examination fixed tissue specimens were dehydrated in graded alcohol solutions, cleared in toluene, and embedded in paraffin. Sections (4 μ m) were stained with periodic acid-Schiff (PAS), and Masson's trichrome staining was performed to detect collagen deposition. Glomerular and tubulointerstitial sclerosis were quantified under microscope.
- 15 Results were expressed in the form of individual and summarized data tables using Microsoft Excel® Software. Numerical results were expressed as mean $\pm$ standard error of the mean (SEM). Due to the small number of animal tested, no statistical analyses was performed.

Effect of XG-102 on renal function during the progression of the disease:

- 20 Urea and creatinine serum levels were measured to study the renal function during the kidney disease course. Because creatinine interferes with the calorimetric dosage, only urea that is a fine indicator of renal function was analyzed. Whereas urea serum levels were remarkably stable in untreated rats (below 5 mmol/l), ADR induced progressive increase of urea levels, which sharply raised from Day 28 up to 25 mmol/l at Day 41, then 48 mmol/l at Day 56
- 25 reflecting terminal renal failure (Figure 38 B). On the other hand, XG-102-treated rats exhibited an urea serum level below 10 mmol/l throughout the course of the disease (Figure 48 B). On the other hand, XG-102-treated rats exhibited an urea serum level below 10 mmol/l throughout the course of the disease (Figure 48 B). The renal function of rats treated with XG-102 alone was similar to 0.9% NaCl-treated rats. These results suggest that XG-102 prevents
- 30 the progression to renal disease and renal failure.

Histopathological findings (PAS and Masson trichrome staining):

ADR-induced structural changes were evaluated under light microscope. Saline-treated control rats showed morphologically normal glomeruli and tubules. On Day 8, light

microscopic examination showed some areas with focal segmental glomerulosclerosis and proteinaceous casts in the ADR nephrosis group. In contrast, although some tubules were filled with proteins in XG-102-treated rats, glomeruli exhibited a normal architecture with absence or discrete mesangial hypercellularity, while the tubular structures and interstitium did not display pathological changes (Figure 49). By Day 14, ADR treated rats exhibited progressive glomerulosclerosis, hyaline deposits, tubular dilation and cast formation. The degree of glomerulosclerosis was dramatically worsened in this group and became diffuse with obvious adhesion between the glomerular tufts and the Bowman's space in most glomeruli by Day 29 and 41, associated with severe tubular atrophy and interstitial fibrosis. At Day 56, diffuse glomerular sclerosis was observed in all glomeruli (Figure 50). However, XG-102-treated rats had a relatively normal appearance at Day 8, and develop few focal and segmental glomerulosclerosis and tubulointerstitial fibrosis at Day 56 compared with ADR-treated rats. Altogether, these results strongly suggest that XG-102 prevents the development of glomerular and tubulointerstitial fibrosis and may explain the preservation of renal function in this group.

The study results provide evidence that XG-102 prevents the progression of glomerular and tubulointerstitial injuries induced by ADR. Moreover, this molecule preserves renal function.

Example 20: Effects of XG-102 on puromycin aminonucleoside (PAN)-induced nephropathy

The aim of this study was to evaluate the effects of XG-102 on chronic puromycin aminonucleoside-induced nephropathy in rats during 56 days. Puromycin aminonucleoside (PAN) is a podocyte toxin inducing a loss and fusion of podocytes foot processes. PAN-induced nephropathy is a well-described model of human idiopathic nephritic syndrome and focal segmental glomerulosclerosis (Pippin JW, 2008). The glomerular morphologic changes seen in rats with PAN nephrosis closely resemble those in human minimal change disease (MCD) and focal segmental glomerulosclerosis (FSGS). Intraperitoneal administration of PAN in rats results in a rapid development of nephritic syndrome, characterized by proteinuria, hypoalbuminemia and hypercholesterolemia (acute phase). This is a well-established animal model of human MCD. The pathological lesions of focal segmental glomerulosclerosis have

been observed in chronic PAN nephrosis induced by repeated intraperitoneal PAN injections (Nakajima, T., Kanozawa, K., & Mitarai, T. (2010). Effects of edaravone against glomerular injury in rats with chronic puromycin aminonucleoside nephrosis. J Saitama medical university, 37(1)). In accordance with the mechanism of injury, PAN causes direct DNA damage via the production of reactive oxygen species (ROS) and tissue damages, including glomerulosclerosis and interstitial fibrosis (Hewitson TD, 2012) in the chronic phase.

In this experiment 90 male Wistar rats (Charles River, France) were used (divided into 6 groups of 15 rats). To induce nephropathy puromycin aminonucleoside (PAN) was intraperitoneally administered at the dose of 130 mg/kg (5 ml/kg) at day 0 and at the dose of 60 mg/kg (5 ml/kg) at day 14 (Nakajima, T., Kanozawa, K., & Mitarai, T. (2010). Effects of edaravone against glomerular injury in rats with chronic puromycin aminonucleoside nephrosis. J Saitama medical university, 37(1)). Control rats (Group 1) received an equal amount of saline *i.p* at day 0 and at day 14. XG-102 or its vehicle (NaCl 0.9%) were administered into the tail vein (*i.v.*) once a week (Groups 1 to 5) starting from first PAN injection at day 0 for a total of 7 injections at day 0, 7, 14, 21, 28, 35 and 42. In a separate experimental group (Group 6), XG-102 was administered into the tail vein (*i.v.*) once a week starting from day 21 for a total of 4 injections at day 21, 28, 35 and 42 after PAN injection at day 0.

For XG-102 administration XG-102 powder has been dissolved in the vehicle NaCl 0.9% at the highest concentration to be tested. The highest concentration then represented the stock solution for the lower concentrations. Each stock solution has been filter (0.2 µm) sterilized. The lower concentration solutions to be administered were prepared by diluting the filtered stock solution in saline (0.9% NaCl) depending on the volume for *i.v.* injection.

The table below summarizes the experimental groups:

Group	PAN (<i>i.p.</i>)	Treatment (<i>i.v.</i>)	Number of <i>i.v.</i> administrations	Number of animals/group
1	no	vehicle	7	15
2	yes	vehicle	7	15
3	yes	XG-102 (1 mg/kg)	7	15

4	yes	XG-102 (2 mg/kg)	7	15
5	yes	XG-102 (4 mg/kg)	7	15
6	yes	XG-102 (4 mg/kg)	4	15

The study design is shown in Figure 51. Briefly, on day 0 and day 14 PAN or its vehicle (saline) have been injected for induction of nephropathy. At day 0 and at day 14, PAN has been administered first, followed by XG-102 administration. From day 0 to day 42 XG-102 or its vehicle (NaCl 0.9%) have been administered once a week by *i.v.* route as described above.

Animals were weighted once a week. All PAN-treated animals showed a decrease of body weight. However, all PAN-treated animals were homogeneous for body weight, i.e. no effects of XG-102 were observed compared to PAN/saline group (Group 2) on body weight. On day 56 animals have been sacrificed and samples (blood and kidneys) have been collected.

In particular, for blood and kidney sampling animals have been anesthetized by injection of pentobarbital (60 mg/kg; Ceva Sante Animale; Libourne, France). Blood samples have been collected from abdominal vein, transferred into tubes for coagulation (EDTA 3K; 30 minutes, 4°C) then centrifuged (10 minutes, 3000 rpm, 4°C) for plasma collection. Plasma has been stored at -20°C until use for biomarkers assay, e.g. creatinine and urea assays.

For quantification of biomarkers, Plasma LDL levels were quantified using an ABX Pentra 400 Clinical Chemistry analyzer (HORIBA) by the Phenotypage platform of Genotoul (Rangueil Hospital, Toulouse, France).

Kidneys have been removed, cleaned from all connective tissue and capsule and weighted on an electronic microbalance (Mettler, Toledo). Kidney samples have been fixed in formalin solution 10% (Sigma Aldrich, France) for 24-72 h, in particular 48 h, then embedded in paraffin. Three sections (3 to 5 µm) were made per block. The slides were stained by hematoxylin/eosin (HE), PAS-methenamine silver and Sirius Red for histological evaluation of morphological alterations, glomerulosclerosis and interstitial fibrosis quantification, respectively. All the slides were digitalized at X20 using Nanozoomer 2.0 HT from Hamamatsu (Japan). Histological preparation and imaging has been performed by Histalim

(Montpellier, France). Plasma creatinine and urea have been quantified using an ABX Pentra 400 Clinical Chemistry analyzer (HORIBA) by the Phenotypage platform of Genotoul (Rangueil Hospital, Toulouse, France).

5 Results are expressed by semi-quantitative scoring following to expert histopathologist evaluation. For the histological examination of glomerulosclerosis glomerular changes have been evaluated using a semi quantitative scoring system as described by Nakajima, T., Kanozawa, K., & Mitarai, T. (2010). Effects of edaravone against glomerular injury in rats with chronic puromycin aminonucleoside nephrosis. J Saitama medical university, 37(1), which is
10 hereby incorporated by reference. In brief, the degree of glomerular injury was assessed in 25 glomeruli per kidney section (2 sections per animal) for a total of 50 glomeruli per animal. Degree of injury in individual glomeruli was graded using a scale from 0 to 4, based on the percentage of glomerular involvement.

Score 0: normal,

15 Score 1: lesions in up to 25% of the glomerulus,

Score 2: lesions between 25-50% of the glomerulus,

Score 3: lesions between 50-75% of the glomerulus, and

Score 4: lesions between 75-100% of the glomerulus

20 All data have been calculated as mean values $\pm$ standard error of the mean (s.e.m.). Statistical analysis has been performed using GraphPad Prism, version 4 (GraphPad Software Inc., LaJolla, USA). The comparison of all the groups using two-way ANOVA followed by Bonferroni's post-test for body weight results. Comparison between group 1 (Saline/saline) and group 2 (PAN/saline) was performed using unpaired Student t-test. The effects of vehicle
25 and XG-102 were compared using one way ANOVA followed by Newman-Keuls test. A $P < 0.05$ value was accepted as statistical significance. Comparison between group 2 (PAN/vehicle) and group 6 (PAN/XG-102 4mg/kg, 4x iv) was performed using unpaired Student t-test.

30 The results of the glomerulosclerosis injury are shown in Figure 52. One of the main objectives of this study was to evaluate the glomerulosclerosis injury in a well-established model of focal segmental glomerulosceloris (FSGS) induced by repeated puromycin aminonucleoside injections in rats. The results showed that 7 iv injections of XG-102 significantly reduced PAN-induced glomerulosclerosis in a dose dependent manner.

However, the dose of 1 mg/kg had no effect on this pathological feature. 4 *iv* injections of XG-102 at the dose of 4 mg/kg, starting from day 21 resulted in a strong effect of XG-102 in reducing glomerulosclerosis induced by PAN (Figure 52).

5 The results of the glomerular damage are shown in Figure 53. One of the main objective of this study was to evaluate the effect of XG-102 on the glomerular damage induced by repeated PAN injections in rats. The results showed that XG-102 has (i) a preventive effect in that 7 *iv* injections at the dose of 2 and 4 mg/kg significantly reduced PAN-induced glomerulosclerosis in term of severity of lesions (glomerular injury score) but also significantly
10 decreased glomerular damage incidence (percentage of injured glomeruli) and that (ii) XG-102 has a curative effect in that 4 *iv* injections of XG-102 at the dose of 4 mg/kg, starting from day 21 post-PAN administration lead to a strong effect on glomerulosclerosis in term of both severity of lesions (glomerular injury score) and of glomerular damage incidence (percentage of injured glomeruli). Taken together, XG-102 showed a dose-response effect on
15 glomerulosclerosis injury, namely a preventive and a curative effect on the severity of lesions and glomerular damage incidence.

Regarding the analysis of biomarkers, serum LDL represents a good marker of the progression of FSGS and oxidative stress in this model. Serum levels of LDL increase and peak between
20 day 21 and day 28 after PAN injection, remaining still high in the chronic phases (cf. Nakajima et al., 2010). Accordingly, in the present study PAN-treated animals showed a significant increase of LDL plasma levels compared to Saline-treated animals (Group 1). In XG-102 treated animals a decrease in Plasma LDL was observed in particular for the 4 mg/kg groups (Group 5 and 6), although it was not significant. Thus, XG-102 tends to decrease
25 oxidative stress as shown by the decreases in serum LDL and by decreases in major lipid peroxidation product (4-HNE: 4-hydroxy-2-nonenal). Moreover, results obtained regarding the biomarkers ED-1 (rat CD-68) with Anti-CD68 showed that XG-102 also tends to decrease infiltrating macrophages.

Example 21: Effects of chronic administration of XG-102 in a rat model of diabetic nephropathy

The aim of this study has been to evaluate the effects of chronic administration of the JNK inhibitor peptide, XG-102 (1, 2, 4 mg/kg, weekly intravenous administration for 9 weeks), in a rat model of diabetic nephropathy. Losartan has been used as a positive control.

Seventy-four male Sprague-Dawley rats (200-250g; including 4 spare animals) from Charles River (Margate, Kent) were used. Rats were housed in pairs in polypropylene cages with free access to a high fat diet (D12492 60% of kcal derived from fat) and tap water at all times. The diet has been purchased from Research Diets, New Jersey, USA. All animals have been maintained at $21\pm4^{\circ}\text{C}$ and $55\pm20\%$ humidity on a normal light (lights on: 07:00 - 19:00).

The study schedule is shown in Figure 54. Animals have been housed in pairs throughout the study. For a 3-week period, during which time they have been weighed weekly (food and water will be weighed twice during the third week only (i.e. the week prior to STZ dosing on a Monday and a Thursday). During the third week of habituation, a blood sample has been taken from the lateral tail vein in the freely fed state using a hand-held glucose meter (One Touch Ultra 2). Blood sampling began at approximately 09:00.

Due to the size of the study, the animals have been run as two separate cohorts (each $n=4$ or 6 as far as possible due to paired housing) 72 hours out of phase (see Figure 54). About 40 animals have been assigned to Cohort A and the remaining 30 to Cohort B, balanced as far as possible for body weight, plasma glucose and food and water intake. For induction of diabetes streptozotocin (STZ) has been used. Since the diabetic phenotype of animals dosed with STZ is highly dependent on the batch of STZ, a pilot study has been undertaken in order to confirm the optimal STZ dose (35 or 45 mg/kg ip). STZ or vehicle has been given after the animals have been maintained on the diet for approximately 3 weeks as detailed in Figure 54. The spare animals will be dosed with STZ (one pair per cohort).

Group	Dose (ip)	Cohort A	Cohort B
A	vehicle 0.05M citric acid pH 4.5 ip	4	6
B-G	STZ (selected from pilot) ip	36	24

Each pair of animals has been administered the same treatment (i.e. both vehicle-treated or both will be STZ-treated). For the 7-day period post STZ dose, animals have been weighed daily and food and water intake determined twice weekly. For the remaining study duration, animals have been weighed and water and food intake assessed twice weekly (always on the day of intravenous dosing and typically on water refill day(s)). Subsequently, based on body weight and available food and water intake post STZ, animals have been allocated in groups B-F as detailed below in light of differences in dosing regimen.

Group	Dose	Cohort A	Cohort B
B-E	IV dosing	24	16
F-G	PO dosing	12	8

One week after STZ (or vehicle) treatment a blood sample has been taken from the lateral tail vein using a glucometer (One Touch Ultra2) in the freely fed state (blood samples taken beginning at approx. 09:00). Subsequently, animals in groups A-E have been dosed with vehicle by the intravenous route and animals in Groups F-G have been dosed with 1% methyl cellulose by the oral route. Animals in groups F-G continued to be dosed once daily beginning at approximately 09:00 each day. Animals have been weighed prior to dosing (this weight was recorded). Food and water have been recorded on the same days as the intravenous groups (A-E) only.

This baseline phase lasted for one week. Towards the end of the week animals have been allocated to drug treatments on the basis of blood glucose, and available body weight and food and water intake data. The allocation has been as detailed in the table below:

Group	Group	STZ	Cohort A	Cohort B	Total N
A	Vehicle (saline) – NON-STZ	NO	4	6	9-10
B	Vehicle (saline iv weekly)	STZ	6	4	9-10
C	XG-102 (1 mg/kg iv weekly)	STZ	6	4	9-10
D	XG-102 (2 mg/kg iv weekly)	STZ	6	4	9-10
E	XG-102 (4 mg/kg iv weekly)	STZ	6	4	9-10
F	Vehicle (methyl cellulose po daily)	STZ	6	4	9-10
G	Losartan (25 mg/kg po daily)	STZ	6	4	9-10

Dosing has been for 9 weeks in duration (9 administrations in total, see Figure 54). Animals in groups F and G have been weighed and dosed daily at approximately 09:00. Animals in groups A-E have been dosed once weekly by the intravenous route (as detailed on Figure 54). In all groups, food and water intake have been determined twice weekly (on the day of iv dosing and on water refill days. Blood glucose has been determined monthly. Samples were collected as detailed previously by glucometer (One Touch Ultra2). Blood samples have been taken in the freely fed state (beginning at approx. 09:00). Animals have been dosed immediately afterwards by the respective route to a timed schedule. Subsequent to dosing, each animal has been placed in a metabolism cage with free access to food and water for a 24h period. To reduce evaporation, the glass urine collectors have been placed in a polystyrene container (Sca-online, UK) which was filled with ice. Due to the anticipated increase in daily urine volume with STZ, urine has been collected (and stored refrigerated) at intervals (e.g. 8 hourly) to ensure that twenty four hours total urine volume for each metabolic cage can be recorded. The aliquots at each time point have been pooled so that a single 24h sample per animal is collected. Ten aliquots of 300 µl of pooled 24h urine have been taken and frozen at -80°C. Creatinine, glucose, urea, total protein and electrolytes (Na, K, Cl and Ca) have been determined on urine samples using a COBAS C111 and associated reagents (n=2 for all urine analyses). For urine collection sessions, the rats have been weighed at the time of placement in the cage and upon removal. Food consumed and water drunk has also been calculated. Blood glucose and urine parameters (creatinine, glucose, urea, total protein and electrolytes) have been determined again after a further month of dosing as previously described (see Figure 54).

During week 8 of treatment (see Figure 54) the glomerular filtration rate (GFR) of the animals has been assessed using the FITC-inulin method. This was performed based on the method of Stridh, S., Sallstrom, J. et al (2009): "C-Peptide Normalizes Glomerular Filtration Rate in Hyperfiltrating Conscious Diabetic Rats" Oxygen Transport to tissue XXX. Advances in experimental medical and biology. 645:219-25, which is hereby incorporated by reference. Specifically, FITC-inulin (1.5%) has been dissolved in saline and filtered through a 0.45 µm syringe filter. In order to remove residual free FITC, the solution has been dialysed in 2000 ml of saline at 4 °C overnight using a 1000 Da cut-off dialysis membrane (Spectra Por 6 from Fisher UK) and protected from light. The dialysed inulin has been filtered through a 0.22 µm syringe filter before use. Each animal has been dosed with 1 ml (15 mg) of FITC-inulin via the tail vein (i.e. intravenously). At 2, 5, 9, 15, 24, 35, 55, 80 minutes post dose a blood sample (80 µl) has been taken into a lithium-heparin collection tube (Sarstedt CB300LH). Each blood

sample underwent centrifugation in a cooled centrifuge and the plasma sample dispensed into a clean aliquot vial for subsequent determination of fluorescence at 496 nm excitation and 520 nm emission.

5 At termination, animals and food and water have been weighed. Animals have then been killed and a terminal blood sample (approx. 4.5 mL in an EDTA-coated tube) has been taken via cardiac puncture). The blood sample has been spun in a cooled centrifuge and aliquots (5 aliquots of 0.5 mL) stored frozen (-80°C). At necropsy, the left and right kidneys have been removed and weighed. Each kidney was cut sagittally into two halves and placed into a pot
10 of 10% neutral buffered formalin to fix for approximately 5 days. The kidneys have then been wax embedded and one half from each kidney placed into each cassette to produce one wax block for subsequent processing (i.e. one block with one half right kidney and one half left kidney) The remaining kidney halves have been disposed of. For the wax blocks, all tissues have been prepared using a Tissue Tek VIP processor (using graded alcohols to dehydrate
15 and xylene as a clearant). The blocks have then been impregnated with paraffin histo-wax prior to embedding in fresh histo-wax. Kidney tissues were sectioned at approximately 4-5µm and stained using methods for Haematoxylin and Eosin (H&E) and periodic acid Schiff (PAS). Subsequently, slides will be sent for assessment by a pathologist (e.g. to Harlan Laboratories Ltd. UK). The pathologist evaluated all slides stained by H&E and PAS for glomerular sclerosis,
20 tubule atrophy and interstitial expansion semi-quantitatively using a “+, ++, +++” system (or similar).

XG-102 has been dosed in the volume 1 ml/kg in commercially available sterile saline. To this end, XG-102 has been formulated prior to the first dosing by the addition of sterile saline,
25 whereby the highest dose has been formulated (4 mg/ml) and the lower doses were prepared by dilution of this 4 mg/ml stock. Aliquots were then prepared for each dosing session and stored frozen (-80 °C, stability 3 months at -80°C) until use. On the morning of dosing each aliquot has been removed from the freezer and allowed to thaw at room temperature prior to dosing (e.g. 30 minutes). The thawed solution has been mixed by inversion prior to dosing.
30 All dosing was completed as soon as possible after thawing but in all cases within 8 hours since the test item is stable in saline at room temperature at concentrations of 10 µg/ml – 50 mg/ml for 8 hours. Sterile polypropylene plastics (including pipette tips) have been used. The stock solution will be filter sterilised (0.2 µm) prior to use and prior to dilution to lower doses. Losartan potassium has been purchased from a Chemical supplier (e.g. Tocris UK) and

prepared for dosing each morning in a vehicle of 1% methyl cellulose at a volume of 5 ml/kg. Dosing factors have been applied where appropriate.

At the end of the study, body weights and weight of food and water bottles have been analysed. Results have been expressed as body weights, change in body weight per week for the first 4 weeks and per 4 weeks thereafter, and over the entire drug administration period, % reduction in body weight at the end of the study and drug treatment compared to the control group, food and water intakes, cumulative food intake and average food and water intakes per week for the first 4 weeks and per 4 weeks thereafter and over the duration of the feeding study. The effects of different treatments on body weight and food, cumulative food and water intake have been analysed by two-way analysis of covariance with treatment and cohort as factors and baseline (Day 1 body weight or the average food or water consumption from days -6 to 0) as the covariate, followed by appropriate multiple comparisons tests (two-tailed) to compare each group to the appropriate STZ vehicle group. Blood glucose has been analysed by general linear model with treatment and cohort as factors and baseline body weight, bleeding order and pre-study plasma level as covariates. Appropriate transformations and/or robust regression techniques may have been used to reduce the influence of outliers. Suitable multiple comparison tests (two-tailed) have been used to compare each group to the appropriate STZ vehicle group. Urine creatinine, glucose, urea, total protein and electrolytes have been expressed as treatment group means $\pm$ SEM. Analysis has been by general linear model with treatment and cohort as factors. Appropriate transformations and/or robust regression techniques may have been used to reduce the influence of outliers. Suitable multiple comparison tests (two-tailed) have been used to compare each group to the appropriate STZ vehicle group. Kidney weights have been analysed by general linear model with treatment and cohort as factors and Day 1 body weight as a covariate. To determine effects in addition to effects caused by changes in body weight, analysis has been by general linear model with treatment and cohort as factors and terminal body weight as a covariate. A log transformation and/or robust regression techniques has been used if appropriate. Appropriate multiple comparison techniques has been used to compare each group to the appropriate STZ vehicle group. For the pathology assessment, each treatment has been compared to the appropriate STZ vehicle group by exact Wilcoxon rank sum tests.

GFR has been calculated as Dose of FITC inulin / $AUC_{0-\infty}$. The AUC (of FITC inulin concentration) has been calculated by the log-linear trapezoidal rule (Stridh) with

extrapolation of the 2 to 5 min line to 0 min and linear regression of log-transformed data during a terminal phase from 24 to 80 min. Calculated GFR values were analysed by two-way analysis of variance with treatment and cohort as factors. A log transformation and/or robust regression techniques has been used if appropriate.

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In all analyses except GFR, animals dosed iv have been analysed separately from animals dosed po, as dosing by different routes during the baseline week may affect the baseline values used as covariates. The non-STZ group has been excluded from all analyses described above. Separate analyses have been performed for comparisons to the non-STZ group, including all groups in the analysis, but using baseline covariates before treatment with STZ, rather than those during the week before dosing. In all analyses, a p value of less than 0.05 will be considered to be statistically significant.

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The effects of chronic administration of XG-102 in this rat model of diabetic nephropathy on the body weight of the rats are shown in Figure 55. Only non-STZ treated rats showed an increase in body weight. Rats treated with XG-102 showed no differences in body weight compared to vehicle-treated rats in the STZ model. The body weight of rats treated with the positive reference Losartan, however, has been significantly lower. These results indicate that XG-102 is well-tolerated, whereas the positive reference Losartan resulted in a significant decrease of the body weight.

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Example 22: Evaluation of the dose-response to XG-102 in islet isolation/transplantation

This study is based on the previous study on islet isolation (cf. Example 17) and on the publication by Noguchi et al. (Noguchi, H., S. Matsumoto, et al. (2009). "Ductal injection of JNK inhibitors before pancreas preservation prevents islet apoptosis and improves islet graft function." Hum Gene Ther 20(1): 73-85.). These studies have shown, in a porcine islet isolation model that islets undergo a dramatic activation of JNK starting as early as 20 minutes after the initiation of the islet isolation procedure. This activation is the result of the method that combines warm ischemia, enzymatic digestion and mechanic stress on an already fragile tissue. The study of Example 17 it has shown that intravascular addition of XG-102 (10 μ M) to the preservation solution flushed into the porcine pancreas at the time of procurement has a significant impact on islet cell viability and functionality, assessed by oxygen consumption

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rate (OCR), and ATP concentration, and correlates with a decrease in JNK activation and c-fos gene expression. Noguchi et al have used a different inhibitor and added it at the same molar concentration into the pancreatic duct immediately after procurement. Porcine and human pancreases were used. They showed a similar effect on islet viability assessed by ATP concentration, but also an impact in vivo on diabetes reversal after transplantation under the kidney capsule of diabetic mice. The purpose of the present set of experiments has been to determine the dose-response curve of XG-102 and the optimal concentration at which to utilize it in islet isolation. In order to answer this question, a rodent model has been utilized. While differences between human and rodent pancreas and islets are acknowledged, this model was selected because of its straightforwardness and high cost-efficiency. The purpose of these experiments being solely the determination of the optimal dose of XG-102 required, the rat model appears as valid. Since the major purpose is JNK inhibition in human pancreases for the improvement of clinical allogeneic islet transplantation outcome, intraductal injection of the inhibitor has been done in these experiments. This is in effect the most likely way that the compound will be used in the clinical setting.

To assess the JNK activation in rat islets after isolation, islets of Langerhans have been isolated from Lewis rats by a classic enzymatic method using collagenase. Isolation has been carried out either immediately after animal sacrifice or after a 15-minute period of warm ischemia. JNK activation has been assessed by western blot at the end of the isolation process. JNK activation has been assessed on unprocessed rat pancreases as negative controls. Experiments have been done on 3 rats for each condition of ischemia plus 1 for the negative control, and repeated 3 times. This represents a total of 21 Lewis rats. The results shown in Figure 56 show that XG-102 dose-dependently decreased JNK (Figure 56 A) and PAF2 (Figure 56 B) phosphorylation induced by 15-min ischemia.

To study the effects of XG-102 on islet viability, the best model in terms of duration of ischemia (no warm ischemia vs 15-minute warm ischemia), i.e. the model most likely to show differences after JNK inhibition, has been selected based on the results of the previous experiments. Isolation has been carried out using XG-102 at a set concentration or vehicle, diluted in the collagenase solution and injected into the pancreatic duct prior to enzymatic digestion of the pancreas. XG-102 at the same molar concentration or vehicle has been used throughout the isolation procedure in the various washing or purification solutions utilized, and in the culture medium. Isolated islets have been cultured overnight in RPMI-based culture

medium. For each set of experiments, the following XG-102 concentrations have been utilized: 1 μ M, 3 μ M, 10 μ M, 50 μ M and 100 μ M. Three animals have been utilized in each group for each concentration, and experiments have been repeated 2-3 times depending on results. This represents a total of 60-90 Lewis rats. Islet yields have been determined. The following assessments of islet viability has been performed: JNK activation, OCR, ATP concentration, caspase release, etc..

To study the effect of XG-102 on islet function *in vivo* supplementary isolations have been done in order to assess the effect of JNK inhibition on *in vivo* islet function. *In vivo* experiments have been done only with islets isolated using the most effective XG-102 molar concentration in the *in vitro* experiments detailed above or with vehicle. Islet isolation has been performed as above. For each isolation, 1000 and 2000 IEQ have been transplanted under the kidney capsule of streptozotocin-induced diabetic immunodeficient mice. Proportion of animals reversing diabetes and time necessary for reversal of diabetes have been compared between animals transplanted with XG-102-treated or control islets. Transplants have been repeated 3 times. Number of animals required is approximately 30 Lewis rats and 24 NOD-*scid* mice.

As shown in Figure 57, to study the effects of XG-102 on function and viability of rat pancreatic islets have been isolated islets from 15 min ischemia rat and from no ischemia rat. A static insulin secretion test (basal or stimulated using glucose) has been performed directly after islet isolation and 18 h after culture at 37°C. It can be observed that isolation affects islet function. Indeed basal insulin secretion was higher in islets used directly after isolation compared to islets incubated during 18h whatever the conditions. These high basal levels reflect a distress of islet. However after culture, ischemia and inhibitor XG-102 had no impact on islet function in this experiment.

Because in the previous experiment it has been shown that islet from 15 min ischemia rats secreted same amount of insulin than islet from control rats in response to glucose, a new experiment has been performed, wherein ischemia was pushed until 30 min and JNK inhibitor XG-102 was used at 100 microM (Figure 58). In this experiment a high basal secretion when insulin secretion test was performed directly after isolation is still observed. Moreover, 30 min ischemia had a negative impact on islet function. These preliminary results suggested that 30 min ischemia seems to be a better model than 15 min to induce JNK activation. When islets

from ischemic rats were isolated and incubated with XG-102, glucose-induced insulin secretion was higher as compared to ischemic rats (Figure 58), suggesting a positive effect of XG-102 on the islet function.

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Example 23: Efficacy of XG-102 (SEQ ID No. 11) in a Rat Laser-Induced Choroidal Neovascularization (CNV) Model following subconjunctival Injections

The objectives of this study were to determine the efficacy of XG-102, a JNK-inhibitor, when administered by subconjunctival injections to rats in a model of laser-induced choroidal neovascularization (CNV). As outlined in the context of Example 18, this model allows predictions about a potential use of a compound for the treatment of age-related macular degeneration (AMD). In contrast to the study described in Example 18, the subconjunctival route of administration has been selected for the present study, because it is another preferred route for the administration in humans.

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The following experimental groups have been assigned:

Group No.	Test Material	Dose Level (µg/eye)	Dose Volume (µL/eye)	Dose Concentration	Number of Animals
					Males
1	Vehicle Control	0	5	0 mg/mL	8
2	XG-102	0.15	5	0.03 mg/mL	8
3	XG-102	1.5	5	0.3 mg/mL	8
4	XG-102	15	5	3 mg/mL	8
5	Reference Item 2	200	5	4%	8

The vehicle control, 0.9% NaCl, has been administered as received. Triamcinolone acetonide 4% serves as "Reference Item 2" and has also been administered as received. For XG-102 preparation, a stock solution equal to the highest dose level has been prepared in vehicle, 0.9% Sodium Chloride for Injection, and sterile filtered through a 0.22 µm polyvinylidene difluoride (PVDF) filter. The lower dose levels have been prepared by directly diluting the stock solution. Dose formulations have been prepared once at appropriate concentrations to meet dosage level requirements. All dilutions have been prepared by directly diluting the stock solution with vehicle. Two dosing aliquots (Days 1 and 8) have been prepared and

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stored in a freezer set to maintain -20°C. Aliquot(s) of each dose level have been thawed at ambient temperature on each day of dosing and the solution maintained at room temperature for no longer than 6 hours.

- 5 44 male Brown Norway rats (Charles River; age 10 weeks) have been used. A minimum acclimation period of 14 days has been allowed between animal receipt and the start of treatment in order to accustom the animals to the laboratory environment. Animals have been assigned to groups by a stratified randomization scheme designed to achieve similar group mean body weights. Animals in poor health or at extremes of body weight range were not
- 10 assigned to groups. Before the initiation of dosing, any assigned animals considered unsuitable for use in the study has been replaced by alternate animals obtained from the same shipment and maintained under the same environmental conditions. After initiation of dosing, study animals have been replaced during the replacement period with alternate animals in the event of accidental injury, non-test article-related health issues, or similar circumstances.
- 15 The alternate animals have been used as replacements on the study within 3 days. On arrival, animals have been individually housed until randomization. Following randomization, animals have been group housed (up to 3 animals of the same dosing group together) in stainless steel perforated floor cages equipped with an automatic watering valve. Animals have been separated during designated procedures/activities. PMI Nutrition International
- 20 Certified Rodent Chow No. 5CR4 (14% protein) has been provided ad libitum throughout the study, except during designated procedures. Municipal tap water after treatment by reverse osmosis and ultraviolet irradiation has been freely available to each animal via an automatic watering system (except during designated procedures). Animals have been socially housed for psychological/environmental enrichment and provided with items such as a hiding tube
- 25 and a chewing object, except during study procedures/activities.
- On day 1 of the study Laser-Induced Choroidal Neovascularization (CNV) Procedure has been performed. Prior to the CNV procedure, mydriatic drops (1% tropicamide) were applied to both eyes. Further applications have been performed as considered appropriate by the veterinary ophthalmologist. The animals have been anesthetized an isoflurane/oxygen mix
- 30 prior to and during the procedure. Under anesthesia, a 4-spot pattern have been made between the major retinal vessels around the optic disc of each eye using an 810 nm diode laser at an initial power setting of 300 mW (laser power may be increased for bubble formation), an initial spot size of 80 µm and a duration of 0.1 seconds. Laser parameters have been adjusted as required to ensure rupture of Bruch's membrane (correlated with bubble

formation). In the event that rupture of Bruch's membrane is not confirmed for a particular spot, this has been documented. In this case or in the case of hemorrhage, an additional spot may be added if considered appropriate by the veterinary ophthalmologist. Any notable events, such as retinal hemorrhage were documented for each laser spot. If hemorrhage is too severe, the animal has been excluded from the study and replaced. Hydration of the eyes has been maintained with a saline solution and/or carboxymethylcellulose sodium 1.0% during the procedure, as necessary.

Vehicle control, test item or reference item will be administered by subconjunctival injection to the left and right eyes of each animal on Days 1 and 8 as indicated in the Experimental Design above. The animals have been anesthetized (isoflurane) for the dose administration, which has been performed by a board-certified veterinary ophthalmologist. Topical antibiotics (gentamicin ophthalmic solution) have been applied to both eyes twice on the day before treatment, following the injection and at least once on the day following the injection. Prior to dosing, mydriatic drops (1% tropicamide and/or 2.5% phenylephrine) have been applied to each eye (further applications may be performed as considered appropriate by the veterinary ophthalmologist). During dosing, animals are maintained under anesthesia with isoflurane/oxygen gas. The conjunctivae has been flushed with 0.9% Sodium Chloride for Injection USP. A 29-gauge, 1/2-inch needle attached to a 0.5 cc Terumo insulin syringe has been used for each subconjunctival injection (one syringe/group/treatment). XG-102, vehicle control or reference item has been administered into the eyes of each animal at a dose volume of 50 µL/eye on Days 1 and 8. Both eyes have been examined immediately following each treatment to document any abnormalities caused by the administration procedure.

The in-life procedures, observations, and measurements listed below have been performed. More frequent observations may be undertaken if considered appropriate. Twice daily, once in the morning and once in the afternoon, throughout the study Mortality/Moribundity Checks have been performed, whereby the animals were observed for general health/mortality and moribundity. Animals have not been removed from cage during observation, unless necessary for identification or confirmation of possible findings. Once daily, beginning Week -1, Cageside Observations have been performed, whereby animals have not been removed from cage during observation, unless necessary for identification or confirmation of possible findings. Weekly, beginning Week -1, Detailed Clinical Observations have been performed,

whereby the animals were removed from the cage for examination. Weekly, starting Week - 2, Body Weights have been recorded for health monitoring purposes only whereby animals were individually weighed. Weekly, starting during the last week of the pre-treatment period, Food consumption has been quantitatively measured except on the day of scheduled euthanasia for health monitoring purposes only. Once prestudy for screening purposes, Ophthalmic Examinations have been performed, whereby all animals were subjected to funduscopy (indirect ophthalmoscopy) and biomicroscopic (slit lamp) examinations. The mydriatic used was 1% tropicamide. Once prestudy and at the end of Weeks 1, 2 and 3, Fluorescein Angiography has been performed, whereby mydriatic drops (1% tropicamide) have been applied to each eye at least 10 minutes prior to the test (further applications may be administered if considered necessary). Hydration of the eyes has been maintained by frequent irrigation with saline solution. The animals have been maintained under isoflurane/oxygen mix and/or with a sedative cocktail (ketamine 75 mg/kg; xylazine 7.5 g/kg), as necessary. Single and/or ART fundus images in infrared and/or red free modes have been obtained to serve as reference images for the angiographies. 0.2 ml of 10% Sodium Fluorescein Injection USP has been administered via rapid tail vein injection (via an abbocath), followed by a 0.5 ml saline flush. Still images have been recorded from both eyes at least 2 minutes following the fluorescein injection and no later than 5 minutes following the fluorescein injection. For evaluation the individual laser spots on the still images have been evaluated for leakage semiquantitatively on a scale of 0-4 by 2 independent readers, who will subsequently determine a consensus score.

In the fluorescein angiogram scoring procedure, firstly Angiography images (JPEG or BMP) have been exported from the HRA2 and copied on a CD or other appropriate medium and reviewed on a suitable computer. In the Grading Procedure the Images have been selected at an appropriate focus level for grading. (More than 1 image/eye may be needed in order to grade all laser spots.) The angiograms have been graded independently by 2 scientific personnel and the grade for each of the laser spots has been recorded. Following completion of the grading by each person, the grades have been compared and any discrepancy has been reviewed by both parties, and a grade agreed upon and documented. The grading scale will be from 0-4 as indicated below:

0 = no leakage (only laser scar or very diffuse small hyper-fluorescent area visible).

1 = minimal leakage (small areas of diffuse or solid hyper-fluorescence generally remaining within the laser-induced defect region).

2 = slight leakage (semisolid hyperfluorescence generally remaining within the boundary of the laser-induced defect region).

3 = moderate leakage (semisolid to solid hyper-fluorescence generally remaining within the boundary of the laser-induced defect region).

5 4 = Substantial leakage (solid hyper-fluorescent region extending beyond the boundary of the laser-induced defect region).

10 If an animal dies or is euthanized during the study, a necropsy has not been conducted and the carcass discarded. Animals surviving until scheduled euthanasia have a terminal body weight recorded. The animals will undergo exsanguination from the abdominal aorta after isoflurane anesthesia. When possible, the animals have been euthanized rotating across dose groups such that similar numbers of animals from each group, including controls, have been necropsied throughout the day(s). Representative samples of the tissues identified in the Tissue

15 Collection and Preservation table below have been collected from all animals and preserved in 10% neutral buffered formalin, unless otherwise indicated:

Tissue	Weight	Collect	Microscopic Evaluation	Comment
Animal identification	-	X	-	-
Eye	-	X	-	Bilateral; fixed 24 to 48 hrs in Davidson's fixative and transferred in ethanol 70% for at least 18 hrs, stored in 70% ethanol until processing. (euthanized animals only)
Nerve, optic	-	X	-	Bilateral; fixed 24 to 48 hrs in Davidson's fixative and transferred in ethanol 70% for at least 18 hrs, stored in 70% ethanol until processing (euthanized animals only)

X = procedure to be conducted; - = not applicable.

The following critical computerized systems have been used in the study:

System Name	Description of Data Collected and/or Analyzed
Provantis	Dose administration, bodyweight, food consumption, clinical observations, incidence of clinical observations, clinical biochemistry, hematology, coagulation, urinalysis, ophthalmology and gross pathology
Dispense	Test Item receipt and/or accountability of Test Item and/or vehicle and/or Reference Item(s)
SRS (PCS-MTL in-house application built with SAS) and SAS system for Windows	Statistical analyses of numerical in-life and terminal data
Heidelberg HRA 2 /Heidelberg Spectralis with EyeExplorer	Fluorescein angiography

Means and standard deviations have been calculated for body weight, food consumption and fluorescein angiography. Other data have been reported on an individual basis.

Example 24: Inhibitory effects of the JNK inhibitor XG-102 on the inflammatory response in a rat periodontitis model

The aim of this study is to investigate the influence of XG-102 (SEQ ID NO: 11) on inflammation induced in a periodontitis model in the rat.

30 Wistar rats (male, 6-8 weeks old) are used in this study (divided into 3 groups of ten rats).

Experimental periodontitis is induced by a ligature placed around the 1st molar (one molar per animal) on Day 0. One of the mandibular first molars of each animal was randomly assigned (left/right) to receive a 4/0 silk ligature in a cervical position. In order to immobilize the ligature, two knots were made at the mesial aspect of the first molars. The ligatures were kept in position in order to allow biofilm accumulation over 10 days. This procedure was

performed under general anesthesia by intraperitoneal injection of ketamine hydrochloride (80mg/kg) and xylazine hydrochloride (10 mg/kg).

One dose of 1 mg/kg XG-102 (dissolved in 0.9% NaCl as vehicle) is administered intragingivally (IGV) on day 10. In Group 2, vehicle was administered IGV on day 10. The administration volume is 10 µl. Administrations are performed IGV in the attached gingiva surrounding the first molar, whereby a fine hypodermic needle (Terumo, Myjector) was inserted in the buccal attached gingiva of the first molar. The total volume of injection was successfully introduced in gingival tissue.

The table below summarizes the random allocation:

Group N°	Ligature (Day 0)	Treatment	Route of administration	Number of animals
1	-	-	IGV	10
2	Yes	NaCl 0.9%	IGV	10
3	Yes	XG-102 1 mg/injection	IGV	10

Each day, the general behavior and the appearance of all animals is observed. If animal health is not compatible with the continuation of the study (moribund animals, abnormal important loss of weight, major intolerance of the substance, etc...), animals are ethically sacrificed under the responsibility of the Study Director. Periodontitis inflammation aspect are analyzed by macroscopic observation of gingival tissue on days 0, 10 and 17, whereby the gingival inflammation (GI), periodontal depth pocket (PP) and dental plaque index (IP) were noted blindly by an experimented dentist on days 0, 10 and 17 as periodontal clinical indices. Periodontitis inflammation was assessed by means of macroscopic observation of gingival index using a clinical scoring: 0) no gingival inflammation, 1) slight inflammation, 2) moderate inflammation, 3) severe inflammation. The depth pocket was estimated using a graduated probe (HU-Friedy, USA). Finally dental plaque index was estimated using a 0 to 3 score grade 0) no plaque formation, 1) thin biofilm dental plaque 2) visible dental plaque, 3) thick dental plaque.

For the identification of oral bacteria, bacterial population in dental pockets are identified by DNA probes (real time PCR) on 9 periodontopathogens (Aa : *Aggregatibacter actinomycetemcomitans*, Pg : *Porphyromonas gingivalis*, Tf : *Tannerella forsythensis*, Td :

Treponema denticola, Pi : *Prevotella intermedia*, Pm : *Peptostreptococcus micros*, Fn : *Fusobacterium nucleatum*, Cr : *Campylobacter rectus*, Ec : *Eikenella corrodens*) on days 0, 10 and 17 as well as total bacterial flora (Perio-analyses, Institut Clinident). For the collagen framework, measurements of total collagen amount are performed using Polarized-light microscopy. The collagen I/collagen III ratio is evaluated by histomorphometrical analysis.

On day 17 the animals are sacrificed and samples are collected. Gingival tissue will be excised for bio-molecular analysis on all animals. After euthanasia, mandibles will be excised for histological evaluation. Buccolingual serial sections were stained with a Modified Goldner's Masson Trichrome solution for measurement of bone loss and to evaluate inflammatory score.

For the evaluation of inflammatory cells, quantification of inflammatory cells is performed by histomorphometric measurements. To evaluate inflammatory score, slides were observed under an optical microscope (Zeiss, Axioskop, Germany). The areas between the first and second molars, where the ligature was placed, were analyzed under light microscopy using on a 0 to 3 score grade, considering the inflammatory cell influx, as described previously [Bitto A, Oteri G, Pisano M, Polito F, Irrera N, Minutoli L, Squadrito F, Altavilla D. Adenosine receptor stimulation by polynucleotides (PDRN) reduces inflammation in experimental periodontitis.] Clin Periodontol. 2013;40(1):26-32]: Score 0: absence of or only discrete cellular infiltration (inflammatory cell infiltration is sparse and restricted to the region of the marginal gingival). Score 1: minimal cellular infiltration (inflammatory cellular infiltration present all over the insert gingival). Score 2: moderate cellular infiltration (inflammatory cellular infiltration present in both gingival and periodontal ligament). Score 3: accentuated cellular infiltrate. A single examiner, who was not aware of the experimental data, carried out the histomorphometric measurements.

For the evaluation of tissue destruction, bone tissue destruction is evaluated on 3 animals per group by radiological analysis (micro-CT). Periodontal complex destruction is evaluated by histological analysis. The images were digitized at a magnification of x2.5 (Explora-Nova Morpho-Expert, software). The influence of treatments on periodontal bone loss was histometrically assessed by measuring the alveolar bone height loss (ABHL). Measurements were taken (in millimeters) from the cementenamel junction (CEJ) to the alveolar bone crest (ABC) along the buccal and lingual sides of the root of the first molars (Fig. 6), according to a

method previously reported [Bitto A, Oteri G, Pisano M, Polito F, Irrera N, Minutoli L, Squadrito F, Altavilla D. Adenosine receptor stimulation by polynucleotides (PDRN) reduces inflammation in experimental periodontitis. *J Clin Periodontol.* 2013;40(1):26-32]. Alveolar bone specimens from control group (unligated) were also measured to compare the results from both ligature groups. The mean amelo-cemental junction to alveolar bone height was calculated for each group of animals. To validate measurement conversions, a millimeter ruler was photographed and used as a calibrator. Evaluations was performed by a two examiners blind to the treatment assignment using an image analysis system (Image J, USA) and then mean values from the two observers were averaged.

For the evaluation of inflammatory markers, the level of inflammatory proteins (p-JNK, TNF- α , IL-1 β , IL-10, MMP-8, MMP-9) are measured from gingival tissue homogenates by by ELISA using commercially available kits (Biorad, Bioplex Pro Cytokine Assays, France for TNF- α , IL-1 β , IL-10; Uscn Life Science, USA for MMP-8, MMP-9, and Novateinbio, USA for JNK), according to the manufacturer's instructions.

For the evaluation of bone microarchitecture, bone trabecular measurements (thickness, separation) are evaluated by radiological analysis (micro-CT) on 3 animals per group on days 0, 10 and 17.

Results:

Only one dose of XG-102 treatment was given on day 10. The experimental periodontal disease induced by the placement of a silk thread around the cervix of first lower molars caused a significant increase ($p < 0.05$) in GI for the two ligated groups, and in both GI and PP only in group 3 (XG-102) as shown in figure 92. No significant effect of placebo on clinical parameters at day 17 was found. In group 3, one week after XG-102 injection (day 17), the treatment robustly decreased GI level (Fig. 92).

Regarding the microbiological quantification, the results showed an increase in total bacterial flora in all groups that did not reach significance value at day 10 ($p > 0.05$). Interestingly, only XG-102 had diminished significantly ($p < 0.05$) the total bacterial flora at day 17 compared to day 10 (Figure 93). This change coincided with the administration of the experimental

treatment. For group 3, XG-102 achieved to significantly decrease the total bacterial flora until the baseline level.

For the expression of IL1- β the XG-102 treated group (group 3) reduced significantly IL1- β expression compared to placebo group. This points out the beneficial effect of the XG-102 treatment for periodontitis obtained by decreasing pro-inflammatory cytokine expression (Figure 94).

In addition, periodontal bone loss / Alveolar bone height loss (ABHL) was assessed on day 17. The ABHL is an indicative not only of histological change/remodeling but also of bone resorption. The results showed that ligation significantly increased the ABHL of the molar in ligated group 2 compared with the control group ($p < 0.05$). Intergroup analysis revealed that bone destruction was less severe in the XG-102 treated animals (Figure 95). In fact, the group 3 had an ABHL level statistically comparable with negative control group. Thus, XG-102 administration prevents bone degradation and avoids bone loss. These data confirm the anti-inflammatory property (protective effect) of XG-102 against periodontitis. Intergroup analysis revealed that all ligatured groups had approximately the same levels of ABHL ($p > 0.05$) validating the rat periodontitis model.

Thus, the data of this study show a protective effect of XG-102 against experimental periodontitis.

Example 25: Effects of XG-102 (SEQ ID No. 11) in a Diabetic Retinopathy Prevention Study in the Streptozotocin Treated Rat (IVT)

The objective of this study was to determine the ability of XG-102 to prevent diabetic retinopathy when administered by intravitreal injections to streptozotocin (STZ)-treated (hyperglycemic) rats.

The study design was as follows:

Group No./ Identification	STZ (mg/kg) Day -7	XG-102 Dose Level (µg/eye) Days 1, 8, 15	Dose Volume (µL)	Dose Concentration (mg/mL)	Number of Animals
					Males
1/ Not induced, Vehicle	0	0	5	0	3
2/XG-102 – 0.2 µg/eye	55	0.2	5	0.04	8
3/ XG-102 – 2 µg/eye	55	2	5	0.4	8
4/Vehicle	55	0	5	0	5

All animals from Groups 2, 3, 4 received a 55 mg/kg intravenous (IV) dose of STZ on Day -7.

Sterile vials containing 0.0412 g of inducing agent (STZ) were pre-weighed, sealed and transferred to the dosing room for administration to Groups 2 to 4 animals and Spares on Day -7. A duplicate set of empty, appropriately labeled sterile vials were provided. The reconstituted STZ solution was filtered into these vials for dosing. The Reference Item, 0.9% NaCl, was administered as received. XG-102 was prepared using the correction factor 1.383. A stock solution equal to the highest dose level was prepared in vehicle, 0.9% Sodium Chloride for Injection, and sterile filtered through a 0.22 µm polyvinylidene difluoride (PVDF) filter. The lower dose levels were prepared by directly diluting the stock solution. Dose formulations were prepared once at appropriate concentrations to meet dosage level requirements. All dilutions were prepared by directly diluting the stock solution with vehicle. Three dosing aliquots (Days 1, 8 and 15) were prepared and stored in a freezer set to maintain -20°C. Aliquot(s) of each dose level were thawed at ambient temperature on each day of dosing and the solution maintained at room temperature for no longer than 6 hours.

60 male Brown Norway rats were received from Charles River Labs, Inc., Portage, IL. The animals were approximately 8 weeks old and weighed between 166 and 228 g. The Brown Norway rat was chosen as the animal model for this study as it is an accepted species for use in the STZ-induced diabetic retinopathy model. The total number of animals used in this study was considered to be the minimum required to properly characterize the effects of the Test Items. This study has been designed such that it didnot require an unnecessary number of animals to accomplish its objectives. A minimum acclimation period of 20 days was allowed between animal receipt and the start of treatment in order to accustom the animals to the laboratory environment. Animals were assigned to groups by a stratified randomization

scheme designed to achieve similar group mean body weights. Animals in poor health or at extremes of body weight range were not assigned to groups. Before the initiation of dosing, any assigned animals considered unsuitable for use in the study were replaced by alternate animals obtained from the same shipment and maintained under the same environmental conditions. The alternate animals were used as replacements on the study within 3 days of initiation. On arrival, animals were individually housed until randomization. Following randomization, animals were group housed (up to 3 animals of the same dosing group together) in stainless steel perforated floor cages equipped with an automatic watering valve. The room in which the animals were kept was documented in the study records. Animals were separated during designated procedures/activities. Temperatures of 19°C to 25°C with a relative humidity of 30% to 70% were maintained. A 12-hour light/12-hour dark cycle was maintained, except when interrupted for designated procedures. PMI Nutrition International Certified Rodent Chow No. 5CR4 (14% protein) was provided ad libitum throughout the study, except during designated procedures. Municipal tap water after treatment by reverse osmosis and ultraviolet irradiation was freely available to each animal via an automatic watering system (except during designated procedures). Animals were socially housed for psychological/environmental enrichment and were provided with items such as a hiding device and a chewing object, except when interrupted by study procedures/activities.

For administration of Inducing Agent (Groups 2 to 4, Day -7), one vial of STZ per animal (including spares) was reconstituted within 3 minutes of injection with 1.5 mL of Sterile Water for Injection, USP, to provide a concentration of 27.5 mg/mL. The vial was inverted or swirled to dissolve STZ. The resultant solution was filtered via a 0.22 µm Millex-GV filter into a empty sterile appropriately labeled vial. The STZ (55 mg/kg) was administered by intravenous injection on Day -7, within 3 minutes of formulation via a syringe. The dose volume was 2 mL/kg and the actual dose administration was based on the most recent practical body weight of each animal. The animals were restrained during the injection.

Test items or reference item were administered by intravitreal injection to the left and right eyes of each animal on Days 1, 8 and 15 as indicated in the Experimental Design table. The animals were anesthetized (isoflurane) for the dose administration, which was performed by a board-certified veterinary ophthalmologist. Topical antibiotics (gentamicin ophthalmic solution) were applied to both eyes twice on the day before treatment, following the injection and at least once on the day following the injection. Prior to dosing, mydriatic drops (1%

tropicamide and/or 2.5% phenylephrine) were applied to each eye (further applications were performed when considered appropriate by the veterinary ophthalmologist). During dosing, animals were maintained under anesthesia with isoflurane/oxygen gas. The conjunctivae were flushed with 0.9% Sodium Chloride for Injection USP. A 10 µL Hamilton syringe with 32-gauge, 1/2-inch needle was used for each intravitreal injection (one syringe/group/treatment). The dose volume was 5 µL/eye. Both eyes were examined by slit-lamp biomicroscopy and/or indirect ophthalmoscopy immediately following each treatment to document any abnormalities (especially to the lens, vitreous and retina) caused by the administration procedure. Corneal opacities were considered secondary to experimental procedures involving anesthesia. Some of these opacities were associated also with corneal vascularization. Other ocular findings were noted, but were generally of low incidence or sporadic across groups, and/or did not persist. These findings included, but were not limited to: multifocal/diffuse corneal opacities, vitreous air bubbles, focal/diffuse/multifocal vitreous opacities, and focal retina opacities.

Streptozotocin was administered by intravenous injection to induce diabetic retinopathy in the rat. The intravitreal injection route was selected for the Test Items because this is the intended route of administration in humans. The dose levels were selected based on information obtained with previous proof of concept studies as well as MTD and toxicity studies using the IVT route of administration.

The in-life procedures, observations, and measurements listed below were performed for study animals. Throughout the study, animals were observed for general health/mortality and moribundity twice daily, once in the morning and once in the afternoon. Animals were not removed from cage during observation, unless necessary for identification or confirmation of possible findings. The animals were removed from the cage, and a detailed clinical observation was performed weekly, beginning during Week -1. Animals were weighed individually twice weekly, starting during Week -1. Food consumption was quantitatively measured weekly starting during the last week of the pretreatment period. All animals were subjected to funduscopy (indirect ophthalmoscopy) and biomicroscopic (slit lamp) examinations once pre-treatment and again on Day 22. The mydriatic used was 1% tropicamide. Intraocular pressure was measured following each ophthalmology examination, once prestudy and on Day 22, using a TonoVet™ rebound tonometer. The pre-treatment

tonometry readings were performed at the same times as anticipated for the final measurements to reduce diurnal variability.

Electroretinogram evaluations were performed once pretreatment and on Days 6, 13, and 20, prior to fluorescein angiography. Animals were dark-adapted overnight prior to ERG recording and then anesthetized with an intramuscular injection of 75 mg/kg ketamine and 7.5 mg/kg xylazine. Tropicamide (1%) was applied to each eye prior to the test (further applications were administered if considered necessary). The eyelids were retracted by means of a lid speculum, and a contact lens or gold loop electrode was placed on the surface of each eye.

A needle electrode was placed cutaneously under each eye (reference) and on the head, posterior to the brow or at the base of the tail (ground). Carboxymethylcellulose (1%) drops were applied to the interior surface of the contact lens electrodes prior to placing them on the eyes. Each ERG occasion consisted of the following series of scotopic single flash stimuli:

1) -30 dB single flash, a-wave amplitude and latency, average of 5 single flashes, 10 seconds between flashes.

2) -10 dB single flash, a- and b-wave amplitudes and latency, average of 5 single flashes, 15 seconds between flashes.

3) 0 dB, average of 2 single flashes, a- and b-wave amplitude and latency, approximately 120 seconds between flashes (a longer time period is acceptable).

Following evaluation of the scotopic response, the animals were adapted to background light at approximately 25 to 30 cd/m² for a period of approximately 5 minutes (a longer time period was acceptable), followed by an average of 20 sweeps of photopic white flicker at 1 Hz (a- and b-wave amplitudes and latency), then 20 sweeps of photopic flicker at 29 Hz (b-wave amplitude and latency). Waveforms were analyzed for a- and b-wave amplitudes and latency, and oscillatory potentials (OP) 1 through 4 from the 0 dB scotopic stimulus were filtered and analyzed for amplitude and latency.

Fluorescein angiography evaluations were performed once pretreatment and on Days 7, 14, and 21, following electroretinography. An isoflurane/oxygen mix was used prior to and during the procedure as the anesthesia. The mydriatic agent, 1% tropicamide, was used as necessary. Hydration of the eyes was maintained by irrigation with saline solution, as needed. 0.2 mL of 10% Sodium Fluorescein Injection U.S.P. was administered via rapid tail vein injection, followed by a 0.5 mL saline flush. Still images of the fundus were recorded from both eyes between 10-15 minutes following the fluorescein injection. Images were taken from the right

eye first, followed by the left. A topical bland ophthalmic ointment was administered to the eyes following the angiographies. Images were evaluated qualitatively for vascular integrity/diffuse leakage.

- 5 Blood Glucose Level Determination were once pre-STZ treatment, Day -6 (the day following STZ administration) and three times per week thereafter (all animals). Additional blood glucose measurements may have been performed as required to monitor animal health status. Levels were determined by glucometer using blood drops taken from the tail vein. Values were measured in mmol/L and converted into mg/dL by multiplying by 18 for reporting
10 purposes. Urine Glucose Level Determination was weekly, beginning Week -1, following overnight collection. Animals had access to food and water during the collection period. Urine glucose was measured by the Clinical Laboratory department using the P800 analyzer. from the abdominal aorta after isoflurane anesthesia. When possible, the animals were euthanized rotating across dose groups such that similar numbers of animals from each group,
15 including controls were necropsied at similar times throughout the day.

- Main study animals were subjected to a complete necropsy examination, which included evaluation of the carcass and musculoskeletal system; all external surfaces and orifices; cranial cavity and external surfaces of the brain; and thoracic, abdominal, and pelvic cavities
20 with their associated organs and tissues. Necropsy procedures were performed by qualified personnel with appropriate training and experience in animal anatomy and gross pathology. A veterinary pathologist, or other suitably qualified person, was available.

- Representative samples of the tissues identified below were collected from all animals and
25 preserved in 10% neutral buffered formalin, unless otherwise indicated.

Tissue Collection and Preservation

Tissue	Weight	Collect	Microscopic Evaluation	Comment
Animal identification	-	X	-	-
Eye	-	X	-	Bilateral; fixed in Davidson's fixative (euthanized animals only).
Gross lesions/masses	-	X	-	-
Nerve, optic	-	X	-	Bilateral; fixed in Davidson's fixative (euthanized animals only)

X = procedure to be conducted; - = not applicable.

The following parameters and end points were evaluated in this study: mortality, clinical signs, body weights, body weight changes, food consumption, ophthalmology, intra-ocular pressure, electroretinography (ERG), fluorescein angiography, blood and urine glucose determination, gross necropsy examinations.

5

Consistent with the diabetic retinopathy rat model, there were hyperglycemia-related deaths, clinical signs of deteriorating condition, and decreases in body weights, body weight gains, increased food consumption, and severe increases blood and urine glucose levels. Multiple ocular changes noted in the STZ-induced groups were secondary to the nature of the hyperglycemic state, notably the anterior cortical cataracts. There were no XG-102-related deaths during the study. There were no XG-102-related clinical signs or effects on body weights, body weight gains or food consumption. Fluorescein angiography imagery did not reveal any vascular leakage and there were no apparent XG-102-related macroscopic findings at necropsy.

15

On Days 6, 13 and 20, some amplitudes of scotopic and photopic ERG assessments for animals given ≤ 2 $\mu\text{g}/\text{eye}$ XG-102 were mildly increased or comparable to the STZ-treated control animals, but these responses generally remained within the control variability. Latencies for XG-102 groups were comparable and remained within the control and/or pretreatment variation. There were some sporadic differences in oscillatory potential amplitudes when comparing animals given ≤ 2 $\mu\text{g}/\text{eye}$ XG-102 with STZ-treated controls.

20

The following Table includes a summary of amplitudes for all ERG stimuli by occasion (pretreatment, and Days 6, 13 and 20, respectively). The values represent the group mean and standard deviation (below):

25

<i>Oscillatory Potential #1 Scotopic Single Flash 0dB - B-Wave</i>				
<i>Group</i>	<i>Amplitude (μV)</i>			
	<i>Pre</i>	<i>6</i>	<i>13</i>	<i>20</i>
Non-induced	54	50	34	41
Vehicle	9	11	12	7
XG-102	46	49	37	36
0.2 $\mu\text{g}/\text{eye}$	10	12	17	18
XG-102	58	40	33	26
2 $\mu\text{g}/\text{eye}$	14	11	15	7
Vehicle	53	40	14	35
	21	4	11	12
<i>Oscillatory Potential #2 Scotopic Single Flash 0dB - B-Wave</i>				

<i>Group</i>	<i>Amplitude (μV)</i>			
	<i>Pre</i>	<i>6</i>	<i>13</i>	<i>20</i>
Non-induced	180	129	107	84
Vehicle	14	32	40	8
XG-102	167	98	63	70
0.2 μg/eye	34	28	25	33
XG-102	226	93	92	49
2 μg/eye	49	17	31	14
Vehicle	180	98	124	58
	88	27	39	12
<i>Oscillatory Potential #3 Scotopic Single Flash 0dB - B-Wave</i>				
<i>Group</i>	<i>Amplitude (μV)</i>			
	<i>Pre</i>	<i>6</i>	<i>13</i>	<i>20</i>
Non-induced	376	273	214	195
Vehicle	26	68	80	18
XG-102	326	219	165	164
0.2 μg/eye	64	82	58	63
XG-102	428	239	219	137
2 μg/eye	77	33	55	35
Vehicle	348	251	239	164
	149	58	54	37
<i>Oscillatory Potential #4 Scotopic Single Flash 0dB - B-Wave</i>				
<i>Group</i>	<i>Amplitude (μV)</i>			
	<i>Pre</i>	<i>6</i>	<i>13</i>	<i>20</i>
Non-induced	219	162	136	142
Vehicle	26	39	24	14
XG-102	172	147	129	116
0.2 μg/eye	33	64	45	38
XG-102	219	182	160	130
2 μg/eye	32	27	49	50
Vehicle	162	178	143	136
	52	31	45	35

<i>Scotopic Single Flash -30dB - B-Wave</i>				
<i>Group</i>	<i>Amplitude (μV)</i>			
	<i>Pre</i>	<i>6</i>	<i>13</i>	<i>20</i>
Non-induced	434	311	308	170
Vehicle	35	113	47	60
XG-102	360	269	270	240
0.2 μg/eye	90	120	143	136
XG-102	417	270	292	166
2 μg/eye	68	140	142	108
Vehicle	369	224	197	136
	85	77	71	47
<i>Scotopic Single Flash -10dB - A-Wave</i>				

Group	Amplitude (μV)			
	Pre	6	13	20
Non-induced	-217	-152	-124	-109
Vehicle	23	39	31	30
XG-102	-191	-151	-128	-129
0.2 $\mu g/eye$	39	64	59	56
XG-102	-254	-124	-152	-84
2 $\mu g/eye$	48	46	75	40
Vehicle	-206	-104	-111	-96
	57	26	38	30
Scotopic Single Flash 0dB - A-Wave				
Group	Amplitude (μV)			
	Pre	6	13	20
Non-induced	-355	-244	-188	-188
Vehicle	37	57	96	77
XG-102	-303	-209	-203	-198
0.2 $\mu g/eye$	70	73	78	74
XG-102	-394	-205	-261	-147
2 $\mu g/eye$	75	74	142	61
Vehicle	-323	-177	-208	-142
	110	38	67	43
Scotopic Single Flash 0dB - B-Wave				
Group	Amplitude (μV)			
	Pre	6	13	20
Non-induced	899	415	640	180
Vehicle	99	161	201	80
XG-102	739	421	442	433
0.2 $\mu g/eye$	169	176	209	224
XG-102	944	383	524	278
2 $\mu g/eye$	176	177	132	202
Vehicle	755	283	468	255
	250	103	194	83
Photopic 1Hz Flicker A-Wave				
Group	Amplitude (μV)			
	Pre	6	13	20
Non-induced	-3	-2	-7	-5
Vehicle	1	2	4	4
XG-102	-2	-3	-4	-2
0.2 $\mu g/eye$	2	2	4	3
XG-102	-3	-3	-6	-2
2 $\mu g/eye$	2	3	6	3
Vehicle	-4	-2	-2	-6
	2	2	2	5
Photopic 1Hz Flicker B-Wave				
Group	Amplitude (μV)			
	Pre	6	13	20
Non-induced	133	72	95	40

Vehicle	15	21	36	8
XG-102	112	63	71	70
0.2 µg/eye	29	25	34	32
XG-102	146	69	91	45
2 µg/eye	31	28	27	28
Vehicle	100	61	100	32
	14	20	39	16
<i>Photopic 29Hz Flicker - B-Wave</i>				
<i>Group</i>	<i>Amplitude (µV)</i>			
	<i>Pre</i>	<i>6</i>	<i>13</i>	<i>20</i>
Non-induced	22	13	16	12
Vehicle	4	3	4	5
XG-102	18	9	14	10
0.2 µg/eye	6	4	6	4
XG-102	27	11	17	9
2 µg/eye	6	4	7	4
Vehicle	19	11	19	13
	9	3	7	7

As can be retrieved from these data, there is a tendency for XG-102 to reverse the decrease of the wave amplitude.

5

Example 26: Effects of XG-102 (SEQ ID No. 11) in a Diabetic Retinopathy Prevention Study in the Streptozotocin Treated Albino Rat (subconjunctival)

The objective of this study was determine the ability of XG-102 to prevent diabetic retinopathy when administered by weekly subconjunctival injection to streptozotocin (STZ)-treated (hyperglycemic) rats for 3 weeks.

The experimental design is shown in the following:

<i>Group No./ Identification</i>	<i>STZ (mg/kg) Day -7</i>	<i>Test Item Dose Level (µg/eye/week)</i>	<i>Dose Volume (µL)</i>	<i>Dose Concentration (mg/mL)</i>	<i>No. of Animals</i>
					<i>Males</i>
1/Not induced, Vehicle	0	-	50	0	8
2/Induced, Vehicle	55	-	50	0	10
3/ XG-102 - low dose	55	2	50	0.04	8
4/ XG-102 - mid dose	55	20	50	0.4	8
5/ XG-102 - high dose	55	200	50	4	8

All animals from Groups 2 to 5 will receive a 55 mg/kg intravenous (IV) dose of STZ on Day -7.

Naïve Long Evans rats were used (42 male animals; 10 weeks of age, at time of dosing; Charles River, St. Constant, QC). The Long Evans rat was chosen as the animal model for this study as it is an accepted species for use in the STZ-induced diabetic retinopathy model. The total number of animals to be used in this study is considered to be the minimum required to properly characterize the effects of the test item and has been designed such that it does not require an unnecessary number of animals to accomplish its objectives. At this time, studies in laboratory animals provide the best available basis for extrapolation to humans. Acceptable models which do not use live animals currently do not exist. Projected release of alternates will be Day 4. Animals will be housed in stainless-steel cages. PMI Nutrition International Certified Rodent Chow No. 5CR4 (14% protein) was provided daily in amounts appropriate for the size and age of the animals. Municipal tap water, processed through a reverse osmosis filter and passed through UV light treatment, was freely available to each animal. Animals were socially housed (up to 3 animals/cage) for psychological/environmental enrichment and were provided with items such as a hiding tube and a chewing object, except during study procedures/activities. Only animals that are determined to be suitable for use on study were assigned. On arrival, animals were individually housed until randomization. Following randomization, animals will be socialized.

Sterile vials containing 0.0412 g of inducing agent (STZ) will be pre-weighed, sealed and transferred to the dosing room for administration to Groups 2 to 5 animals and selected spares on Day -7. A duplicate set of empty, appropriately labeled sterile vials will be provided. The reconstituted STZ solution will be filtered into these vials for dosing. The Test Item, XG-102, was prepared using the provided correction factor. A stock solution equal to the highest dose level was prepared in vehicle, 0.9% Sodium Chloride for Injection, and sterile filtered through a 0.22 μ m polyvinylidene difluoride (PVDF) filter. The lower dose levels were prepared by directly diluting this stock solution with saline. Dosing aliquots were prepared and stored in a freezer set to maintain -20°C. Aliquot(s) of each dose level were thawed at ambient temperature on each day of dosing and the solutions maintained at room temperature for no longer than 6 hours. The vehicle, 0.9% Sodium Chloride for Injection, was administered as received. One vial of STZ per animal (including spares) was reconstituted within 3 minutes of injection with 1.5 mL of Sterile Water for Injection, USP, to provide a concentration of 27.5 mg/mL. The vial was inverted or swirled to dissolve the STZ. The reconstituted STZ solution was filtered via a 0.22 μ m Millex-GV filter into empty sterile vials for dosing. STZ was administered by intravenous injection on Day -7, within 3 minutes of formulation via a syringe. The dose volume was 2 mL/kg and the actual dose administration was based on the most recent practical body weight of each animal. The animals will be restrained during the injection. STZ-treated animals were considered diabetic if the blood glucose level is $\geq$ 250 mg/dL. Test item or vehicle were administered by subconjunctival injection to the left and right eyes of each animal on Days 1, 8 and 15 and again on Day 24 (Rep 1), Day 23 (Rep 2 and 3), Day 22 (Rep 4) and Day 34 (Rep 1) Day 33 (Rep 2 and 3) and Day 32 (Rep 4). The animals were anesthetized (isoflurane) for the dose administration, which was performed by a board-certified veterinary ophthalmologist. Topical antibiotics (0.3% tobramycin ointment) was applied to both eyes twice on the day before treatment, following the injection and at least once on the day following the injection. Prior to dosing, mydriatic drops (1% tropicamide and/or 2.5% phenylephrine) were applied to each eye (further applications may be performed as considered appropriate by the veterinary ophthalmologist). During dosing, animals were maintained under anesthesia with isoflurane/oxygen gas. The conjunctivae were flushed with 0.9% Sodium Chloride for Injection USP. A 29-gauge, 1/2-inch needle attached to a 0.5 cc Terumo insulin syringe was used for each subconjunctival injection (one syringe/group/treatment). Test items or reference item were administered into the eyes of each animal at a dose volume of 50 μ L/eye. Both eyes were examined immediately following each treatment to document any abnormalities caused by the administration procedure.

Streptozotocin is being administered IV to induce diabetic retinopathy in the rat. The subconjunctival route has been selected for the Test Item because this is the intended route of administration in humans. The dose levels were selected based on information obtained with previous proof of concept studies as well as MTD and toxicity studies using the subconjunctival route of administration. Morbidity/mortality checks were performed at least twice daily (AM and PM). Cage side observations were performed once daily. Detailed clinical examinations were performed weekly. Quantitative food consumption were performed weekly. Body weights were recorded twice weekly. Ophthalmic examinations were performed once prestudy and again on Day 37 (Rep 1), Day 36 (Rep 2 and 3) and Day 35 (Rep 4). All animals were subjected to funduscopy (indirect ophthalmoscopy) and biomicroscopic (slit lamp) examinations. The mydriatic used will be 1% tropicamide. Intraocular pressure was measured once prestudy and on Day 37 (Rep 1), Day 36 (Rep 2 and 3) and Day 35 (Rep 4). The pre-treatment tonometry readings were performed at the same times as anticipated for the final measurements to reduce diurnal variability. Intraocular pressure was measured following the ophthalmology examinations, using a TonoVet™ rebound tonometer.

Electroretinogram evaluations were performed once pretreatment and on Days 7, 14, 21, and Day 36 (Rep 1), Day 35 (Rep 2 and 3) and Day 34 (Rep 4). Animals were dark-adapted overnight prior to ERG recording and then anesthetized with an intramuscular injection of 75 mg/kg ketamine and 7.5 mg/kg xylazine. Tropicamide (1%) was applied to each eye prior to the test (further applications may be administered if considered necessary). The eyelids were retracted by means of a lid speculum, and a contact lens or gold loop electrode was placed on the surface of each eye. A needle electrode was placed cutaneously under each eye (reference) and on the head posterior to the brow or at the base of the tail (ground). Carboxymethylcellulose (1%) drops were applied to the interior surface of the contact lens electrodes prior to placing them on the eyes.

1) -30 dB single flash, average of 5 single flashes, 10 second between flashes

2) -10 dB single flash, average of 5 single flashes, 15 seconds between flashes.

3) 0 dB, average of 2 single flashes, approximately 120 seconds between flashes (a longer time period is acceptable).

Following evaluation of the scotopic response, the animals were adapted to background light at approximately 25 to 30 cd/m² for a period of approximately 5 minutes (a longer time period is acceptable), followed by an average of 20 sweeps of photopic white flicker at 1 Hz, then

20 sweeps of photopic flicker at 29 Hz. Waveforms were analyzed for a- and b-wave amplitudes and latency and oscillatory potentials 1 through 4 from the 0 dB scotopic stimulus will be filtered and analyzed for amplitude and latency.

5 Indocyanin Green angiography evaluations were performed once pretreatment (Day -2 or -1) and on Days 8, 15, 22, and Day 35 (Rep 1), Day 34 (Rep 2 and 3) and Day 33 (Rep 4). An isoflurane/oxygen mix was used prior to and during the procedure as the anesthesia. The mydriatic agent used was 1% tropicamide as necessary. Hydration of the eyes was maintained by irrigation with saline solution, as needed. 0.2 mL of 0.5% Indocyanin Green
10 was administered via rapid tail vein injection, followed by a 0.5 mL saline flush. Still images of the fundus were recorded from both eyes between 10-15 minutes following the ICG injection. Images were taken from the right eye first, followed by the left. A topical bland ophthalmic ointment was administered to the eyes following the angiographies. Images were evaluated qualitatively for vascular integrity/diffuse leakage.

15 Blood glucose level were measured once pre-STZ treatment, on Day -6 (the day following STZ administration) and again on Day -1. Additional blood glucose measurements may be performed as required to monitor animal health status. Levels were determined by glucometer using blood drops taken in the tail vein. Values were measured in mmol/L and converted
20 into mg/dL by multiplying by 18 for reporting purposes.

Main study animals surviving until scheduled euthanasia were euthanized by exsanguination from the abdominal aorta after isoflurane anesthesia. When possible, the animals were euthanized rotating across dose groups such that similar numbers of animals from each group,
25 including controls were necropsied at similar times throughout the day. Representative samples of the tissues (eye, nerve optic) were collected from all animals and preserved in 10% neutral buffered formalin, unless otherwise indicated. Eyes and optic nerves collected bilaterally and fixed in Davidson's fixative 24 to 48 hours and then stored in 70% ethanol (euthanized animals only).

30
Example 27: A randomized, double-blind, parallel group, controlled, multicentre trial to assess the efficacy and safety of a single sub-conjunctival injection of XG-102,

compared to dexamethasone eye drops in post-surgery intraocular inflammation (Clinical Phase II)

Despite technical advances in ocular surgery, the physical trauma of this procedure continues to induce post-operative ocular inflammation warranting treatment. In ocular tissue, arachidonic acid is metabolized by cyclooxygenase (COX) to prostaglandins (PG) which are the most important lipid-derived mediators of inflammation. Surgical trauma causes a trigger of the arachidonic acid cascade which in turn generates PGs by activation of COX-1 and COX-2. Phospholipids in the cell membrane are the substrate for phospholipase A to generate arachidonic acid from which a family of chemically distinct PGs and leukotriens are produced. The 'golden standard' for the treatment of ocular inflammation are topical corticosteroids and/or Non-Steroidal Anti-inflammatory Drugs (NSAIDs). Side effects reported with (short-term) corticosteroid use include cataract formation, increased Intra Ocular Pressure (IOP), increased susceptibility to viral infections and retardation of the corneal epithelial and stromal wound healing. In addition, prolonged treatment with corticosteroids have been known to induce systemic side effects such as glucose impairment, hypertension, development of glaucoma, visual acuity defects, loss of visual field, and posterior subcapsular cataract formation. The Investigational Medicinal Product (IMP) under investigation - XG-102 - is a protease-resistant peptide that selectively inhibits c-Jun N-terminal Kinase (JNK) activity in a non-Adenosine Triphosphate (ATP) competitive manner. XG-102 is a 31 D-amino acids JNK inhibitor peptide with all amino acids except glycine (which is achiral) in the D-configuration. This choice was made to increase the resistance of the compound to proteases, which usually degrade peptides soon after their administration. Since JNK activation leads to the phosphorylation and activation of the activator protein-1 (AP-1) transcription factor family and other cellular factors implicated in autoimmune and inflammatory diseases, compounds that inhibit the JNK pathway may have an indicated therapeutic value. Ocular MTD (Maximum Tolerated Dose) studies in rats and rabbits as well as ocular local tolerance in rabbits showed that XG-102 was well-tolerated after sub-conjunctival, intravitreal (IVT) and intravenous (iv) administrations. Ocular MTD studies in rats and rabbits after sub-conjunctival administration showed that the No Observed Adverse Effect Level (NOAEL) was around 20 µg in rats and 600 µg in rabbits. Ocular pharmacokinetics after single and repeated (daily for 7 days) sub-conjunctival administration have been studied in rabbits and showed that XG-102 was still present in choroid, bulbar conjunctiva and iris-ciliary body 7 days after administration with a t_{max} between 1 and 4 hours depending on the ocular structure, whereas

no XG-102 was detectable at any time in plasma. Given the deleterious side effects of the current 'golden standard' to treat (post-operative) intraocular inflammation, it is clinically justified to find other treatment alternatives which on the one hand are efficacious in reducing the inflammation while on the other hand, do not have the (deleterious) side effects associated with corticosteroid use. XG-102 has shown promising results both in the pre-clinical studies and phase I/Ib studies performed to date.

The previous trial was an open label, single-center, dose escalation / dose finding study which was designed to assess the safety and tolerability of a single sub-conjunctival injection of XG-102, administered in addition to the 'usual' post-op anti-inflammatory therapy in patients with post-surgery or post-traumatic intraocular inflammation. The XG-102 doses which were investigated were 45, 90, 450 and 900 µg. In total, 20 patients (5 patients in each dose group) were enrolled in this study. The conclusion of the previous study was that XG-102, administered as a sub-conjunctival injection in patients with recent post-surgery or trauma intraocular inflammation was safe and well tolerated. Following the successful completion of the previous study, it was decided to continue with the development of XG-102 in intraocular inflammation and to perform the present study where the objective was to evaluate the efficacy and safety, compared to dexamethasone eye drops, of a single sub-conjunctival dose of XG-102 administered immediately post-op in the evolution of post-op intraocular inflammation, as assessed by chamber cell grade. This is the first study investigating the efficacy of XG-102 when administered as a stand-alone therapy in the evolution of post-operative intraocular inflammation.

The objectives of the present study were to evaluate the efficacy and safety of a single sub-conjunctival injection of XG-102 90 or 900 µg administered within maximally 3 hours after the end of the surgical procedure compared to dexamethasone eye drops administered 4 times/day for 21 days in post-operative intraocular inflammation.

The primary objective of the present study was to evaluate if a single sub-conjunctival injection of 900 µg XG-102 is non-inferior to treatment with dexamethasone eye drops administered 4 times/day for 21 days in the evolution of post-operative intraocular inflammation. In accordance with this trial's primary objective, the primary outcome was evaluated by the mean anterior chamber cells grade at day 28 post-administration of the sub-

conjunctival injection of study treatment comparing XG-102 900 µg with dexamethasone eye drops.

The secondary objectives were to evaluate the effect of a single sub-conjunctival injection of either 90 µg or 900 µg XG-102 compared to dexamethasone eye drops (4 times/day, administered for 21 days) on:

Efficacy outcome parameters

- a) Anterior chamber cells grade at day 28 (XG-102 90 µg vs dexamethasone)
- b) Anterior chamber cells grade at day 7 and day 14 (XG-102 900 µg vs dexamethasone)
- c) Anterior chamber cells grade at day 7 and day 14 (XG-102 90 µg vs dexamethasone)
- d) Anterior chamber flare grade at day 7, 14 and day 28 (XG-102 900 µg vs dexamethasone)
- e) Anterior chamber flare grade at day 7, 14 and day 28 (XG-102 90 µg vs dexamethasone)
- f) Rescue medication use
- g) Evolution of the intraocular inflammation over time

Safety and tolerability outcome parameters:

- a) Visual acuity by ETDRS method
- b) Slit Lamp examination findings
- c) The results of the ophthalmic fundus examination
- d) Intra Ocular Pressure (IOP) measurements
- e) Vital signs (blood pressure (BP), pulse rate (PR) and rhythm)
- f) The results of the hematology and chemistry laboratory tests
- g) The occurrence of Adverse Events
- h) Presence (or not) of XG-102 in plasma 1 hour after the administration of study treatment in a subset of patients (approximately 30)

The present trial was a randomized (1:1:1), controlled, double-blind, multicenter non-inferiority clinical trial with three parallel groups of equal size. Randomization, which was blocked by center, was performed using a web-based, secure, randomization system. Eligible patients were male or female (post-menopausal, or sterile by tubal ligation or hysterectomy), who were > 18 years of age and who had undergone one of the following ocular surgeries: (a) anterior and posterior segment combined surgery which may include surgery for: cataract and retinal detachment, cataract and epimacular membrane and/or cataract and macular hole or (b) glaucoma surgery or (c) complex posterior segment surgery or (d) complicated intraocular surgery which may include cataract surgery associated with diabetic retinopathy

and/or complicated retinal detachment ocular surgery. Patients were not eligible to participate if any of the following exclusion criteria was present at the moment of randomization:

1. Administration of any investigational drug within 12 weeks prior to the administration of study treatment.
2. Presence of a contraindication to prescribe dexamethasone eye drops.
3. Existence of a persistent fungal or bacterial eye infection, refractory to anti-infective treatment.
4. History of intraocular hypertension known to be provoked by corticosteroid use.
5. Presence of a corneal ulcer, corneal perforation or lesion associated with an incomplete re-epithelialization.
6. Existence of any surgical or medical condition which, in the judgment of the Investigator, might interfere with this study.
7. A history of any serious adverse reaction or hypersensitivity to protein-type drugs or to vaccines.
8. Currently treated for seasonal allergic reactions (example: hay fever, asthma).
9. Females of childbearing potential.
10. Males not willing to use an effective method of contraception (e.g. combined contraceptive pill or barrier methods) with non-menopausal female partners up to day 28 (i.e. the date when the last visit is performed) in the study.
11. Patients not willing to comply with the provisions of this protocol.

The study protocol planned that 138 patients would be randomized and administered the sub-conjunctival injection of study treatment. It was also stated in the study protocol that randomized patients for whom the sub-conjunctival injection of study treatment was not administered would be replaced. Patients were randomly allocated to either XG-102 90 or 900 µg which was administered as a single, sub-conjunctival injection of 250 µl within maximally 3 hours after the end of the eye surgery or to dexamethasone eye drops, which were instilled 4 times per day for 21 days. The first study treatment eye drop was instilled within maximally 15 minutes after the sub-conjunctival injection of study treatment. In order to maintain the blinding, patients randomized to the XG-102 group received eye drops containing a NaCl 0.9% solution and patients randomized to the dexamethasone group were administered a sub-conjunctival injection containing NaCl 0.9%. Patients were followed for, in total, 28 (± 5) days after administration of the sub-conjunctival injection of study treatment.

They returned to the out-patient clinic to perform the visits/investigations as required by the study protocol. The below table shows planned visit schedule in addition to the procedures/investigations carried out at each visit. The study protocol planned that the data safety and monitoring board (DSMB) would be responsible to oversee patient safety. This was to be achieved by reviewing Serious Adverse Events (SAE) as they occurred in addition to reviewing the cumulative patient data during the study. Details concerning the timing of the data reviews were detailed in the DSMB charter.

Assessment	Screening visit: prior to eye surgery	Visit 1 21 hrs (± 3 hrs) after sub-conj. inj	Visit 2 7 days (± 1 day) after sub-conj. inj	Visit 3 14 days (± 2) after sub-conj. inj	Visit 4 28 days (± 5) after sub-conj. inj
Written informed consent	x ^a				
Demographic data, ophthalmolog, MH	x ^b				
Body height, body weight	x ^b				
Concomitant treatments	x ^b	x	x	x	x
Seated vital signs	x ^b	x			x
Ophthalmic fundus	x ^b	x	x	x	x
Intra Ocular Pressure	x ^b	x	x	x	x
Slit Lamp examination ± Laser Flare Meter	x ^b	x	x	x	x
Visual acuity examination (by ETDRS method)	x ^b	x	x	x	x
Blood sampling	x ^{b,c}	x			x
Final Inclusion/exclusion criteria review	x ^b				
Randomization	x ^d				
Preparation of study treatment syringe	x ^c				
Admin. study treatment	x ^f				
Blood sampling for XG-I02 quantification	x ^g				
Adverse Event reporting	x ^h	x	x	x	x

- a. Informed consent was obtained prior to the surgical procedure being performed and prior to any study related procedure being performed.
- b. Was done prior to ocular eye surgery being performed.
- c. The following blood samples were performed prior to the surgical procedure being performed. Chemistry blood samples to be performed were: Aspartate Transaminase (AST), Alanine Transaminase (ALT), C-Reactive Protein (CRP),

creatinine kinase (CK), glucose, creatinine and gamma-glutamyl transferase. Hematology: hemoglobin (Hb), hematocrit (HCT) and full white cell count.

- d. Prior to performing the surgical procedure, the patient eligibility was determined. Eligible patients were randomized using the web-based system before the surgical procedure was started.
- e. The study treatment vial was removed from the freezer at least one hour prior to the sub-conjunctival injection. The vial was placed in a secure location at ambient temperature to defrost before preparation of the study treatment syringe. The study treatment eye drops were retrieved from the pharmacy at the same time as the study treatment vials.
- f. The administration of study treatment (sub-conjunctival injection and eye drops) was done within maximally 3 hours after the end of the surgical procedure. The sub-conjunctival injection was administered first, followed by the eye drops 5 to 15 minutes later.
- g. Was done 1 hour after administration of study treatment in approximately 30 patients recruited from the Hôtel-Dieu Hospital.
- h. Observation for the occurrence of Adverse Events started as soon as the administration of study treatment was started.

15 Patients were randomized to one of the three study groups:

1. A single sub-conjunctival injection of XG-102 90 µg + placebo eye drops 4 times/day for 21 days or
2. A single sub-conjunctival injection of XG-102 900 µg + placebo eye drops 4 times/day for 21 days or
3. A single sub-conjunctival injection of NaCl 0.9% + dexamethasone eye drops 4 times/day for 21 days.

Randomization, which was blocked by center, was done centrally using a web-based (i.e. e-SOCDATM) randomization system.

25 XG-102 was used at doses 90 and 900 µg (single administration of 250 µl). Mode of administration was a single sub-conjunctival injection. Duration of treatment was one single administration (sub-conjunctival injection).

The Reference product Dexamethasone (Dexafree ®) was used at a dose of 1 mg/ml. Mode of administration was eye drop (4 times / day, 21 days). Duration of treatment was 21 days - 4 times / day.

The Placebo NaCl was used at a dose of 0.9%. Mode of administration was a single sub-conjunctival injection (250 µL) or eye drop (4 times / day, 21 days). Duration of treatment was one single administration (sub-conjunctival injection) and for the eye drops, 21 days - 4 times / day.

Based on preclinical pharmacology and toxicology studies in addition to the safety and preliminary efficacy data obtained from the previous study, two doses - 90 and 900 µg XG-102 - were selected for this trial. In the previous study, the safety profile of the 90 and 900 µg doses were similar. In addition, the reduction of the intraocular inflammation, in combination

with corticosteroid eye drops, behaved in the same manner in both dose groups. Taking into account the precautionary measures taken for this study (role of the DSMB, and possibility to introduce open label anti-inflammatory treatment in the case of persistent inflammation), the XG-102 doses selected for this study were on the one hand, considered not to compromise patient safety while on the other hand, were sufficiently high to provide meaningful data for the objectives of the study. The sub-conjunctival route of administration is one of the intended routes of administration for patients with the diagnosis under investigation as both safety and efficacy has been shown in animals and in humans using this route of administration. The dexamethasone dose (i.e. 1 mg/ml / 0.4 ml eye drops) in addition to the frequency (i.e. 4 drops per day) and duration (i.e. 21 days) for use chosen for this study is the standard dose/duration of use for dexamethasone eye drops as used in clinical practice for post-operative ocular inflammation.

The study protocol stipulated that the sub-conjunctival injection of study treatment was to be administered within maximally 3 hours at the end of the eye surgery and that this was to be followed within maximally 15 minutes by the instillation of the first study treatment eye drop. The administration of the study treatments at the end of the ocular surgery followed the standard routine for the administration of anti-inflammatory treatments following the eye surgery procedures which were part of the study inclusion.

Neither the Investigator, the patient, the operational team at the CC (Coordinating Center) nor the Sponsor personnel (other than pharmacovigilance staff) had access to the randomization plan. The study treatment vials containing the XG-102 solution or placebo (i.e. NaCl 0.9% solution) were identical in appearance and consistency. The eye drop solutions in single dose containers containing either dexamethasone solution or NaCl 0.9% were identical in appearance and consistency. The packaging and labeling of study treatment was performed according to GMP (Good Manufacturing Practice) and GCP (Good Clinical Practice). In addition, the content of the labels affixed on the study treatment packs was in accordance with local regulations for clinical trials. For each patient two identically numbered study treatment packs were supplied. One study treatment 'pack' contained 1 vial of XG-102 solution (90 or 900 µg) or 1 vial of placebo (NaCl 0.9%) - depending on the treatment group to which the patient was randomized - and the second 'pack' contained the eye drop solution in single dose containers containing either dexamethasone or placebo (NaCl 0.9%) with sufficient supplies to enable treatment for 4 times/day for 21 days. Once allocated to a patient,

a study treatment pack number was not allocated to another patient. The patient's study identification number (i.e. patient identification number) was written on the label by hand by the person who handed out the study treatment. The size and shape of the outer study treatment boxes were identical for the XG-102 and placebo solutions. In an emergency situation where knowledge of a patient's study treatment allocation would have been necessary to determine the further medical management of the patient concerned, or if knowledge of a patient's treatment allocation was required for regulatory reporting purposes, the blinded Investigator or the Sponsor delegated pharmacovigilance officer, respectively had the user access rights to the study treatment code for the patient concerned via the secure, web-based trial-specific treatment allocation system within e-SOCDATTM. If the treatment code was accessed for any one patient, all information (i.e. the name of the person who accessed the treatment code, the reason, date and time and patient for whom the code was accessed) concerning study treatment code access, would be tracked and stored in the web-based system if the study treatment code was accessed.

The primary objective was evaluated by the mean anterior chamber cells grade at day 28 post-administration of the sub-conjunctival administration of study treatment. The criteria for evaluation of the primary objective was

a. Anterior chamber cells grade at day 28 (XG-102 900 µg vs dexamethasone).

The criteria for evaluation of the secondary objectives were

a. Anterior chamber cells grade at day 28 (XG-102 90 µg vs dexamethasone)

b. Anterior chamber cells grade at day 7 and day 14 (XG-102 900 µg vs dexamethasone)

c. Anterior chamber cells grade at day 7 and day 14 (XG-102 90 µg vs dexamethasone)

d. Anterior chamber flare grade at day 7, 14 and day 28 (XG-102 900 µg vs dexamethasone)

e. Anterior chamber flare grade at day 7, 14 and day 28 (XG-102 90 µg vs dexamethasone)

f. Rescue medication use

g. Evolution of the intraocular inflammation over time as assessed by Cleared ocular inflammation.

The ophthalmology examinations were performed at baseline (i.e. either on the day of surgery, but before the surgery was performed). Thereafter, patients were seen at 21 (± 3) hours after the sub-conjunctival injection was administered, and then at 7 (± 1), 14 (± 2) and 28 (± 5) days. In order to reduce operator variability, the sites were instructed that, where

possible, the same operator should perform all ophthalmology examinations for the same patient throughout the trial. The ophthalmology measurements were performed in accordance with the study-specific instructions. The latter were reviewed and discussed with the site teams during the initiation visit and during each monitoring visit. For the

5 determination of the cell / flare count and cell / flare grade, the SUN Working Group's consensus was used by the sites using the SUN Working group definitions ("Standardization of Uveitis Nomenclature for Reporting Clinical Data. Results of the First International Workshop,," American Journal of Ophthalmology, vol 140, no. 3, pp. 509-516, 2005).

10 The criteria for evaluation of safety were:

- a. Visual acuity by ETDRS method
- b. Slit Lamp examination findings
- c. The results of the ophthalmic fundus examination
- d. Intra Ocular Pressure (IOP) measurements
- 15 e. Vital signs (blood pressure (BP), pulse rate (PR) and rhythm)
- f. The results of the hematology and chemistry laboratory tests
- g. The occurrence of Adverse Events
- h. Presence (or not) of XG-102 in plasma 1 hour after the administration of study treatment in a subset of patients (approximately 30).

20

The definitions for an adverse event were:

An Adverse Event (AE) is defined as 'any untoward medical occurrence in a patient administered a medicinal product and which does not necessarily have a causal relationship with this treatment'. An AE is therefore any unfavorable and unintended sign, symptom or

25 disease temporally associated with the use of a medicinal product, whether or not considered related to the medicinal product.

An AE was considered to be serious if the event:

- resulted in death
- was life-threatening
- 30 • required in-subject hospitalization or prolongation of existing hospitalization
- resulted in persistent or significant disability/incapacity
- resulted in a congenital anomaly/birth defect in an offspring conceived during the treatment period

- was medically significant and jeopardizes the patient or requires intervention to prevent one of the above outcomes

The term "life-threatening" in the definition of "serious" referred to an event in which the subject was at risk of death at the time of the event; it did not refer to an event which hypothetically might have caused death, were it more severe. A Suspected Unexpected Serious Adverse Reaction (SUSAR) was defined as a suspected adverse reaction related to the treatment that is both unexpected (i.e. not consistent with the expected outcomes of the study treatment being administered) and serious.

The quantification (plasma) of XG-102 in plasma was evaluated in a subset of 32 patients located in one site. A venous blood sample (2 ml) was obtained using a Li-Heparin tube 60 minutes after sub-conjunctival administration of study treatment. The exact time when the sample was performed was entered in the space provided on the e-CRF. The blood sample was centrifuged for 10 minutes at 2,500 RPM at room temperature. After centrifugation, using a pipette, the plasma was transferred to two 1.5 ml cryotubes. The cryotubes were then placed in a freezer at -80°C and were then subsequently sent in dry ice with a temperature data logger to the central laboratory responsible for the analysis. Upon receipt at the central laboratory, the samples were stored at -80°C until analyzed.

Statistical methods: The primary objective was a non in-inferiority comparison between XG-102 900 µg and dexamethasone eye drops on anterior chamber cell grade at day 28 following the sub-conjunctival injection of study treatment. The primary outcome was analyzed for the Per-Protocol (PP) population and repeated for sensitivity reasons on the Full Analysis Set (FAS). Non-inferiority of XG-102 900 µg to dexamethasone could be declared if the upper bound of the 95% CI around the estimated difference lay below 0.5 anterior chamber cell grade. The first secondary end-point - anterior chamber cell grade at day 28 comparing XG-102 90 µg and dexamethasone was analyzed in the same manner as for the primary outcome. All other secondary outcomes were evaluated by superiority testing on the FAS using a two-sided alpha value of 0.005. The safety analyses were performed on the FAS group by treatment received.

The disposition of patients included in the present study is shown in Figure 59. In total, 157 patients provided informed consent and 151 of these were randomized. Of the 151

randomized patients, 6 were not administered the sub-conjunctival injection of study treatment. As per the requirements in the study protocol, these randomized patients were replaced. In total, 145 patients were administered the sub-conjunctival injection of study treatment (i.e. XG-102 or placebo) and 144 patients completed the study as planned by the study protocol. In total, 1 patient withdrew from follow-up. The following Table displays the completeness of follow-up for the three study groups:

	90 µg XG-102 (N=47)	900 µg XG-102 (N=48)	Dexamethasone (N=50)
	# patients (%)	# patients (%)	# patients (%)
Randomized	50	50	51
Randomized but not administered study tx	3	2	1
Randomized and administered study tx	47 (100.0%)	48 (100.0%)	50 (100.0%)
Premature withdrawal of study tx eye drops	10 (21.3%)	8 (16.7%)	3 (6.0%)
Premature withdrawal from follow-up	0 (0.0%)	1 (2.1%)	0 (0.0%)
Visit 4 performed as planned by the protocol	47 (100.0%)	47 (97.9%)	50 (100.0%)
Lost to follow-up	0 (0.0%)	1 (2.1%)	0 (0.0%)

Data are number of patients (%). N=Number of patients in each group, #=number, µg=microgram, %=percentage, tx=treatment.

The Full Analysis Set (FAS) comprised all randomized patients for whom the sub-conjunctival injection of study treatment was started/administered. The FAS set was analyzed according to the intention-to-treat principle, i.e. patients were evaluated in the treatment group to which they were randomized irrespective of the treatment received. In addition, data was removed from the FAS analysis sets for visits which were performed outside the allowed time windows.

The PP analysis set was a subset of the FAS. Patients were excluded from the PP analysis data set in case because of either major violations after randomization and/or introduction of open label anti-inflammatory treatment during follow-up. In addition, data was removed from the PP analysis sets for visits which were performed outside the allowed time windows.

The safety set included all randomized patients for whom the sub-conjunctival injection of study treatment was started/administered. Patients were analyzed as treated, i.e. according to

the treatment which they received. The safety set was the primary analysis set for the safety analysis.

The baseline characteristics and comorbidities were balanced between the three treatment groups both for FAS and PP populations. The table below shows some of the main baseline co-morbidities by treatment group for the PP analysis population. The percentage of patients with retinal detachment was higher in patients allocated to the XG-102 90 µg (52%) compared to the XG-102 900 µg (41%) and the dexamethasone groups (40%) while the percentage of patients with diabetes was higher in patients randomized to XG-102 900 µg group (33%) compared to XG-102 90 µg group (22%) and dexamethasone group (26%).

	90 µg XG-102 (N=46)	900 µg XG-102 (N=46)	Dexamethasone (N=50)
	# patients (%)	# patients (%)	# patients (%)
Retinal detachment	24 (52.2%)	19 (41.3%)	20 (40.0%)
Glaucoma	6 (13.0%)	6 (13.0%)	6 (12.0%)
Diabetic retinopathy	5 (10.9%)	6 (13.0%)	4 (8.0%)
Hypertension	16 (34.8%)	25 (54.3%)	24 (48.0%)
Diabetes	10 (21.7%)	15 (32.6%)	13 (26.0%)
Hypercholesterolemia	17 (37.0%)	20 (43.5%)	21 (42.0%)

Data are number of patients (%). N=Number of patients in each group, #=number, µg=microgram, %=percentage.

The following table shows, by treatment group, the indication for ocular surgery at baseline in addition to the type of surgery performed for the PP analysis population. The percentage of patients who underwent complex posterior segment surgery was higher in patients allocated to the XG-102 90 µg (50%) compared to those allocated to the XG-102 900 µg (46%) and the dexamethasone groups (42%). The percentage of patients in each treatment group for whom gas (SF6 or C2F6) was instilled during the surgery performed at baseline was 43% (XG-102 90 µg), 37% (XG-102 900 µg) and 38% (dexamethasone) respectively.

	90 µg XG-102 (N=46)	900 µg XG-102 (N=46)	Dexamethasone (N=50)
	# patients (%)	# patients (%)	# patients (%)
Type of ocular surgery			
Anterior and posterior segment combined surgery	18 (39.1%)	22 (47.8%)	26 (52.0%)
Glaucoma surgery	5 (10.9%)	3 (6.5%)	3 (6.0%)
Complex posterior segment surgery	23 (50.0%)	21 (45.7%)	21 (42.0%)

Eye concerned			
Left	17 (37.0%)	23 (50.0%)	25 (50.0%)
Right	29 (63.0%)	23 (50.0%)	25 (50.0%)
Indication of ocular surgery			
Cataract	19 (28.8%)	22 (31.4%)	25 (31.6%)
Epimacular membrane	8 (12.1%)	8 (11.4%)	10 (12.7%)
Epiretinal membrane	4 (6.1%)	6 (8.6%)	10 (12.7%)
Foveoschisis	0 (0.0%)	0 (0.0%)	1 (1.3%)
Intravitreal hemorrhage	5 (7.6%)	4 (5.7%)	3 (3.8%)
Macular hole	2 (3.0%)	6 (8.6%)	2 (2.5%)
Neovascular glaucoma	1 (1.5%)	0 (0.0%)	0 (0.0%)
Relief of intraocular pressure	5 (7.6%)	3 (4.3%)	3 (3.8%)
Retinal detachment	22 (33.3%)	19 (27.1%)	20 (25.3%)
Subluxation of intraocular lens	0 (0.0%)	1 (1.4%)	0 (0.0%)
Subluxation of lens	0 (0.0%)	0 (0.0%)	1 (1.3%)
Vitreomacular traction	0 (0.0%)	1 (1.4%)	4 (5.1%)
Type of gas	20 (43.5%)	17 (37.0%)	19 (38.0%)
SF6	11 (55.0%)	11 (64.7%)	12 (63.2%)
C2F6	9 (45.0%)	6 (35.3%)	7 (36.8%)

Data are number of patients (%). N=Number of patients in each group, #=number, µg=microgram, %=percentage, SD=Standard deviation. Nr. available = Number of patients for whom data are available

Anterior chamber cell grade at day 28 - XG-102 900 µg vs dexamethasone:

- 5 The primary endpoint was analyzed as the mean difference in the anterior chamber cells grade at day 28, comparing the XG-102 900 µg dose with the dexamethasone group, using an adjusted repeated measures model. Only data collected for the day 7, 14 and 28 visits were used in the repeated model. The primary analysis was performed on the PP analysis data set and a sensitivity analysis was performed on the FAS data set. For the first secondary
- 10 outcome, - i.e. Anterior chamber cells grade at day 28 (XG-102 90 µg vs dexamethasone) - non-inferiority was determined in the same manner as for the primary endpoint, using the same non-inferiority margin of 0.5 anterior chamber cell grade. The mean anterior chamber cell grade up to 28 days after the administration of the sub-conjunctival injection of study treatment for the PP analysis population is shown in Figure 60 for the three treatment groups
- 15 - i.e. XG-102 90 µg, XG-102 900 µg and the dexamethasone - while the statistical model results are shown in the following table:

Dose group	Model adjusted mean [95%CI]	Dose group comparison	Estimated difference [95%CI]	Pvalue (non-inferiority)	Pvalue (superiority)
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Visit 2 (7 days +/- 2 days after administration of study tx)

XG-102 90 µg	1.05 [0.84 - 1.26]	XG-102 90 µg versus Dexamethasone	0.142 [-0.142 - 0.425]		0.327
XG-102 900 µg	0.96 [0.76 - 1.16]	XG-102 900 µg versus Dexamethasone	0.056 [-0.222 - 0.333]		0.694
Dexamethasone	0.91 [0.72 - 1.10]	XG-102 900 µg versus XG-102 90 µg	-0.086 [-0.377 - 0.205]		0.561

Visit 3 (14 days +/- 3 days after administration of study tx)

XG-102 90 µg	0.80 [0.58 - 1.01]	XG-102 90 µg versus Dexamethasone	0.009 [-0.278 - 0.296]		0.948
XG-102 900 µg	0.77 [0.56 - 0.98]	XG-102 900 µg versus Dexamethasone	-0.017 [-0.300 - 0.266]		0.906
Dexamethasone	0.79 [0.60 - 0.98]	XG-102 900 µg versus XG-102 90 µg	-0.026 [-0.323 - 0.271]		0.862

5

Visit 4 (28 days +/- 8 days after administration of study tx)

XG-102 90 µg	0.58 [0.36 - 0.81]	XG-102 90 µg versus Dexamethasone	0.086 [-0.214 - 0.385]	0.003	0.573
XG-102 900 µg	0.44 [0.23 - 0.66]	XG-102 900 µg versus Dexamethasone*	-0.054 [-0.350 - 0.242]	<0.001*	0.720
Dexamethasone	0.50 [0.30 - 0.70]	XG-102 900 µg versus XG-102 90 µg	-0.140 [-0.453 - 0.174]		0.381

CI=Confidence Interval, µg=microgram, %=percentage, tx=treatment.

* Primary comparison'

- 10 The results of the primary outcome in addition to the first secondary outcome are shown in Figure 61 for both the PP and FAS data sets. XG-102 900 µg was non-inferior to dexamethasone eye drops in the evolution of post-operative intraocular inflammation as assessed by anterior chamber cell grade at day 28 (difference of -0.054 anterior cell grade, 95% Confidence Interval (CI) -0.350 - 0.242, p<0.001). The same analysis was repeated on
- 15 the FAS and XG-102 900 µg was found to be non-inferior to dexamethasone eye drops (difference -0.032 cell grade, 95% CI -0.301 - 0.238, p<0.001). Given that the upper boundary crossed zero for the FAS and PP analysis sets, XG-102 900 µg was not superior to dexamethasone eye drops (p=0.818 for the FAS and p=0.720 for the PP analysis set) for anterior chamber cell grade at day 28.

20

Anterior chamber cell grade at day 28 - XG-102 90 µg vs dexamethasone:

Concerning the secondary endpoint comparing XG-102 90 µg with dexamethasone eye drops, XG-102 90 µg was non-inferior to dexamethasone in the evolution of post-operative intraocular inflammation (difference 0.086 anterior cell grade, 95% CI -0.214 - 0.385, p=0.003). The same analysis was repeated on the FAS and XG-102 90 µg was found to be non-inferior to dexamethasone eye drops (difference of 0.053 anterior cell grade 95% CI -0.215 - 0.321 p<0.001).

Anterior chamber cell grade at day 7 and 14 for XG-102 90 µg vs dexamethasone and XG-102 900 µg vs dexamethasone:

The statistical analyses for the anterior chamber cell grade at day 7 and 14 for XG-102 90 µg vs dexamethasone and XG-102 900 µg vs dexamethasone were performed on the FAS data set. There were no statistically significant differences in anterior chamber cell grade between XG-102 90 µg and dexamethasone and between XG-102 900 µg and dexamethasone at either day 7 or day 14.

Anterior chamber flare grade at day 7, 14 and day 28 for XG-102 90 µg vs dexamethasone and XG-102 900 µg vs dexamethasone:

The anterior chamber flare grade (for the FAS) obtained up to day 28 is shown in Figure 62 and the model results is shown in the table below. There was no statistically significant difference in the anterior chamber flare grade between XG-102 90 µg and dexamethasone and between XG-102 900 µg and dexamethasone at either day 7 or day 14 or at day 28.

Dose group	Model adjusted mean [95%CI]	Dose group comparison	Estimated difference [95%CI]	Pvalue
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Visit 2 (7 days +/- 2 days after administration of study tx)

XG-102 90 ug	0.93 [0.73 - 1.14]	XG-102 90 ug versus Dexamethasone	0.133 [-0.154 - 0.420]	0.363
XG-102 900 ug	0.80 [0.60 - 1.00]	XG-102 900 ug versus Dexamethasone	-0.003 [-0.284 - 0.278]	0.983
Dexamethasone	0.80 [0.60 - 1.00]	XG-102 900 ug versus XG-102 90 ug	-0.136 [-0.424 - 0.152]	0.353

Visit 3 (14 days +/- 3 days after administration of study tx)

XG-102 90 ug	0.72 [0.52 - 0.92]	XG-102 90 ug versus Dexamethasone	0.142 [-0.140 - 0.424]	0.322
XG-102 900 ug	0.80 [0.59 - 1.00]	XG-102 900 ug versus Dexamethasone	0.220 [-0.061 - 0.502]	0.125
Dexamethasone	0.58 [0.38 - 0.77]	XG-102 900 ug versus XG-102 90 ug	0.078 [-0.210 - 0.366]	0.595

Visit 4 (28 days +/- 8 days after administration of study tx)

XG-102 90 ug	0.48 [0.28 - 0.69]	XG-102 90 ug versus Dexamethasone	0.027 [-0.255 - 0.309]	0.851
XG-102 900 ug	0.44 [0.23 - 0.64]	XG-102 900 ug versus Dexamethasone	-0.017 [-0.301 - 0.267]	0.906
Dexamethasone	0.46 [0.26 - 0.65]	XG-102 900 ug versus XG-102 90 ug	-0.044 [-0.333 - 0.245]	0.764

CI=Confidence Interval, µg=microgram, %=percentage, tx=treatment.

Cleared ocular inflammation:

The evaluation of ocular inflammation over time was assessed by cleared ocular inflammation. The latter was defined as the proportion of subjects that had a summed ocular inflammation score of grade 0 defined as anterior cell grade = 0 and anterior chamber flare grade = 0. This outcome was evaluated at day 7, 14 and day 28 comparing XG-102 900 µg with dexamethasone and XG-102 90 µg with dexamethasone. The summary statistic results for the FAS and PP populations is shown in the table below. Concerning the analysis performed on the FAS, compared to the usual care group, for patients allocated to the XG-102 900 µg group the odds of having cleared inflammation at day 7 post-surgery was 0.76 (95% CI 0.25 - 2.28), at day 14 post-surgery, 1.25 (95% CI 0.47 - 3.32) and at day 28 post-surgery, 1.13 (95% CI 0.49 - 2.60). Concerning patients allocated to the XG-102 90 µg group, compared to the usual care group, the odds of having cleared inflammation at day 7 post-surgery was 0.52 (95% CI 0.15 - 1.83), at day 14 post-surgery, 0.85 (95% CI 0.30 - 2.40) and at day 28 post-surgery, 1.24 (95% CI 0.54 - 2.87). Concerning the analysis performed on the PP analysis set, compared to the usual care group, for patients allocated to the XG-102 900 µg group the odds of having cleared inflammation at day 7 post-surgery was 0.84 (95% CI 0.28 - 2.46), at day 14 post-surgery, 1.12 (95% CI 0.41- 3.05) and at day 28 post-surgery, 1.26 (95% CI 0.52 - 3.04). Concerning patients allocated to the XG-102 90 µg group, compared to the usual care group, the odds of having cleared inflammation at day 7 post-surgery was 0.56 (95% CI 0.16 - 1.97), at day 14 post-surgery, 0.97 (95% CI 0.34 - 2.77) and at day 28 post-surgery, 1.45 (95% CI 0.58 - 3.61).

Full analysis population			Per-protocol analysis population		
90 µg XG-102 (N=47)	900 µg XG-102 (N=48)	Dexamethasone (N=50)	90 µg XG-102 (N=46)	900 µg XG-102 (N=46)	Dexamethasone (N=50)
# patients (%)	# patients (%)	# patients (%)	# patients (%)	# patients (%)	# patients (%)
Visit 1 (21 hours after administration of study tx)					
Nr. available (%)	47 (100.0%)	48 (100.0%)	49 (98.0%)	46 (100.0%)	46 (100.0%)
Yes	2 (4.3%)	2 (4.2%)	4 (8.2%)	2 (4.3%)	2 (4.3%)
Visit 2 (7 days +/- 2 days after administration of study tx)					
Nr. available (%)	42 (89.4%)	47 (97.9%)	48 (96.0%)	39 (84.8%)	44 (95.7%)
Yes	5 (11.9%)	7 (14.9%)	9 (18.8%)	5 (12.8%)	7 (15.9%)
Visit 3 (14 days +/- 3 days after administration of study tx)					
Nr. available (%)	45 (95.7%)	43 (89.6%)	49 (98.0%)	37 (80.4%)	40 (87.0%)
Yes	8 (17.8%)	10 (23.3%)	10 (20.4%)	8 (21.6%)	9 (22.5%)

Visit 4 (28 days +/- 8 days after administration of study tx)						
Nr. available (%)	45 (95.7%)	43 (89.6%)	48 (96.0%)	33 (71.7%)	34 (73.9%)	43 (86.0%)
Yes	18 (40.0%)	17 (39.5%)	17 (35.4%)	14 (42.4%)	15 (44.1%)	15 (34.9%)

Data are number of patients (%). N=Number of patients in each group, #=number, µg=microgram, %=percentage. Tx=treatment.

**Cleared ocular inflammation is defined as 0 cell (i.e. cell grade as 0) and no flare (i.e. flare grade as 0)

Laser Flare meter (LFM):

- 5 The LFM measurements which were obtained at the defined time points throughout the study are depicted as the LFM measurements over time and up to day 28 for the FAS in Figure 63.

10 Rescue medication was defined in the study protocol as any open-label anti-inflammatory ocular treatment which was prescribed for patients during follow-up because of persistent eye inflammation as judged by the Investigator. The study protocol stipulated that the study treatment eye drops were to be stopped at the introduction of open-label anti-inflammatory ocular treatment. The percentage of patients for whom rescue medication was introduced in the XG-102 90 µg group was statistically different when compared to the dexamethasone group (21.3% vs 4.0% for the XG-102 90 µg and dexamethasone groups respectively (p=0.013)) while the difference between XG-102 900 µg and dexamethasone (14.6% and 4.0% respectively for the two groups) was not statistically significant (p=0.88)

Pharmacokinetics in plasma:

20 Blood sampling for quantification of XG-102 was taken 60 minutes after the sub-conjunctival administration of XG-102 in a subset of 32 patients. The analytical report of quantification of XG-102 in plasma shows that XG-102 was not detected in the plasma samples for any patient – see the following table:

	90 µg XG-102 (N=11)	900 µg XG-102 (N=9)	Dexamethasone (N=12)
	# patients (%)	# patients (%)	# patients (%)
# patients with sample	11 (100.0%)	9 (100.0%)	12 (100.0%)
<LLOQ*	11 (100.0%)	9 (100.0%)	12 (100.0%)

25 Data are number of patients (%). N=Number of patients for whom an XG-102 quantification sample was obtained, #=number, µg=microgram, %=percentage. LLOQ=Less than the Limit of Quantification *Values which were below the LLOQ (i.e. < 10ng/mL) were considered as 'not detectable'

30 In summary, XG-102 900 µg was non-inferior to dexamethasone eye drops in the evolution of post-operative intraocular inflammation (difference of -0.054 anterior cell grade, 95% CI -

0.350 - 0.242, $p < 0.001$). The same analysis was repeated on the FAS and XG-102 900 μg was found to be non-inferior to dexamethasone eye drops (difference -0.032 cell grade, 95% CI -0.301 - 0.238, $p < 0.001$). Given that the upper boundary crossed zero for the FAS and PP analysis sets, XG-102 900 μg was not superior to dexamethasone eye drops ($p = 0.818$ for the FAS and $p = 0.720$ for the PP analysis set) for the anterior chamber cell grade at day 28.

Concerning the secondary endpoint comparing XG-102 90 μg with dexamethasone eye drops, XG-102 90 μg was non-inferior to dexamethasone eye in the evolution of post-operative intraocular inflammation (difference 0.086 anterior cell grade, 95% CI -0.214 - 0.385, $p = 0.003$). The same analysis was repeated on the FAS and XG-102 90 μg was found to be non-inferior to dexamethasone eye drops (difference of 0.053 anterior cell grade 95% CI -0.215 - 0.321 $p < 0.001$).

There were no statistically significant differences in anterior chamber cell grade between XG-102 90 μg and dexamethasone and between XG-102 900 μg and dexamethasone at either day 7 or day 14. There was no statistically significant difference in the anterior chamber flare grade between XG-102 90 μg and dexamethasone and between XG-102 900 μg and dexamethasone at either day 7 or day 14 or at day 28.

The evaluation of ocular inflammation over time was assessed by cleared ocular inflammation. The latter was defined as the proportion of subjects that had a summed ocular inflammation score of grade 0 defined as anterior cell grade = 0 and anterior chamber flare grade = 0. This outcome was evaluated at day 7, 14 and day 28 comparing XG-102 900 μg with dexamethasone and XG-102 90 μg with dexamethasone. Concerning the analysis performed on the FAS, compared to the usual care group, for patients allocated to the XG-102 900 μg group the odds of having cleared inflammation at day 7 post-surgery was 0.76 (95% CI 0.25 - 2.28), at day 14 post-surgery, 1.25 (95% CI 0.47 - 3.32) and at day 28 post-surgery, 1.13 (95% CI 0.49 - 2.60). Concerning patients allocated to the XG-102 90 μg group, compared to the usual care group, the odds of having cleared inflammation at day 7 post-surgery was 0.52 (95% CI 0.15 - 1.83), at day 14 post-surgery, 0.85 (95% CI 0.30 - 2.40) and at day 28 post-surgery, 1.24 (95% CI 0.54 - 2.87).

SAFETY EVALUATION

Extent of exposure:

The present study was a double-blind study. All patients who were randomized and for whom the sub-conjunctival injection was started are included in the safety analysis by dose group. Only treatment emergent AEs have been analyzed, i.e. AEs that occurred after the start of the sub-conjunctival injection of study treatment. If the study treatment eye drops were stopped prematurely (i.e. before day 21), the patients concerned continued follow-up until day 28, in accordance with the study protocol. The sub-conjunctival injection of study treatment was administered for 145 patients in total of which 47 patients were administered XG-102 90µg, 48 patients were administered XG-102 900 µg and 50 patients allocated to the dexamethasone group were administered to NaCL 0.9%. For all patients in whom the sub-conjunctival injection of study treatment was started, the total amount (i.e. 250 µL) of study treatment was administered.

The exposure by patient for the study treatment eye drops is shown in the table below. Concerning the study treatment eye drops, the overall compliance with the instillation of the study treatment eye drops as required by the study protocol was > 90% in the three study groups. Patients allocated to the XG-102 treatment groups had a slightly higher compliance with the instillation of the study treatment eye drops (95% and 94% for the XG-102 90µg and XG-102 900 µg groups respectively) compared to patients allocated to the dexamethasone group where the compliance was 91%. Fifty patients received dexamethasone eye drops for an average of 20 days (6-21 days, min-max) with a maximal cumulated dose of 81 drops (81 x 0.05mg=4.05mg).

	90 µg XG-102 (N=47)	900 µg XG-102 (N=48)	Dexamethasone (N=50)
	mean (min – max)	mean (min – max)	mean (min – max)
Days under treatment eye drops	18 (1 - 21)	19 (1 - 21)	20 (6 - 21)
Compliance with study treatment eye drops*	95.3% (75.3% - 100%)	93.8% (33.3% - 100%)	90.6% (33.3% - 100%)

footnote: For patients who stopped the study treatment eye drops prematurely, compliance was calculated as used/planned

100 where planned = 4(days from start and up to withdrawal). For patients who used the study treatment eye drops as planned by the protocol, compliance was calculated as ((81 – unused eye drops bottles)/81)*100

Adverse events

Summary of adverse events by dose group:

The overview of reported adverse events (serious and non-serious) is displayed in Figure 64 by dose group. There was not a statistically significant difference between the XG-102 90 µg and dexamethasone groups and between the XG-102 900 µg and dexamethasone groups with

respect to the number of patients for whom an AE was reported. For patients allocated to XG-102 90 µg, a total of 78 AEs were reported for 31 / 47 (66%) patients allocated to this group and for patients allocated to XG-102 900 µg, a total of 69 AEs were reported for 32 / 48 (67%) patients. For patients allocated to the dexamethasone group, a total of 55 AEs were reported for 29 / 50 (58%) patients. The percentage of patients who experienced an AE within 24 hours after administration of study treatment was similar between the three study treatment groups (i.e. 34%, 27% and 30% for the XG-102 90 µg, the XG-102 900 µg and dexamethasone groups' respectively).

The distribution of the reported AEs by severity and dose group is shown in table below. The majority (approximately 70%) of reported AEs were considered by the Investigator as being 'mild' for the three dose groups.

Dose group	Severity		
	Mild	Moderate	Severe
XG-102 90 µg	55 (70.5%)	6 (7.7%)	17 (21.7%)
XG-102 900 µg	49 (71.0%)	12 (17.4%)	8 (11.6%)
Dexamethasone	42 (76.4%)	9 (16.4%)	4 (7.3%)

Data are number of events (% or reported events)

The summary overview of AEs which led to an interruption of the study treatment eye drops is shown by dose group in the following table:

Dose group	Adverse events which led to an interruption of study treatment
XG-102 90 µg	11 (14.1%)
XG-102 900 µg	8 (11.6%)
Dexamethasone	3 (5.5%)

Data are number of events (% of reported events)

For patients allocated to the XG-102 90 µg dose group, 11 events (14% of all reported AEs in this dose group) resulted in the premature withdrawal of study treatment while in the XG-102 900 µg and dexamethasone dose groups, the study treatment eye drops were interrupted for 8 events (12 % of all reported AEs in this dose group) and 3 events (6% of all reported AEs in this dose group) respectively.

Investigators assessed (in a blinded manner) the relationship of each reported AE to any of the study treatments. An event was considered to be related to study treatment if the Investigator

ticked either 'possible' or 'probable' as the reply to this question. In addition, the Investigator had to specify to which of the study treatments (i.e. XG-102 or dexamethasone) the event was considered related to - see the table below. AEs were considered by the Investigators (blinded assessment) to be possibly or probably related to study medication for 18 events reported for patients in the XG-102 90 µg, for 13 events reported for patients in the XG-102 900 µg, and for 15 events reported for patients in dexamethasone group (see table below). None of the reported SAEs were considered by the Investigator to be either possibly or probably related to either of the study treatments.

	90 µg XG-102 (N=47)	900 µg XG-102 (N=48)	Dexamethasone (N=50)
Relationship to study treatment as assessed by the Investigator	Total # events	Total # events	Total # events
Possibly or Probably related	18	13	15
AEs considered by the Investigator to be related to:			
XG-102	16 (20.5%)	12 (17.4%)	13 (23.64%)
Dexamethasone	2 (2.6%)	1 (1.5%)	2 (3.6%)

Data are number of events. N=Number of patients in each group, #=number, µg=microgram, %=percentage.

Display of adverse events:

A reported event was considered to be related to study treatment if the Investigator had ticked either 'Possible' or 'Probable' as the reply to the question 'Related to study treatment' on the e-CRF. The summary of the AEs (sorted by MedDRA SOC and PT term) which were reported for at least 2% of patients randomized to either of the three study groups may be found in Figure 65.

Analysis of adverse events

Overall, there was not a statistically significant difference between either of the XG-102 dose groups and the dexamethasone dose group with respect to the number of patients for whom an AE was reported. For patients allocated to XG-102 90 µg, a total of 78 AEs were reported for 31 / 47 (66%) patients allocated to this group and for patients allocated to XG-102 900 µg, a total of 69 AEs were reported for 32 / 48 (67%). For patients allocated to the dexamethasone group, a total of 55 AEs were reported for 29 / 50 (58%). The percentage of patients who experienced an AE within 24 hours after administration of study treatment was similar between the three study treatment groups (i.e. 34%, 27% and 30% for the XG-102 90 µg, the XG-102 900 µg and dexamethasone groups' respectively).

The most frequently reported AEs were in the SOC 'EYE DISORDERS'. Within this SOC, 49 events were reported for 26 (55%) patients allocated to XG-102 90 µg, 43 events were reported for 24 (50%) patients allocated to XG-102 900 µg and 30 events were reported for 16 (32%) of patients allocated to dexamethasone. There was a statistically significant difference between the XG-102 90 µg and dexamethasone group with respect to the number of patients for whom an event was reported in this SOC ($p=0.025$). Events suggestive of inflammation (such as 'eye inflammation', 'Corneal oedema', 'Eyelid oedema') were more frequently reported for patients allocated to XG-102 90 µg compared to patients allocated to either the XG-102 900 µg or dexamethasone dose groups. Eye pain was more frequently reported for patients allocated to the XG-102 900 µg group and when compared to the dexamethasone group, the difference in the number of patients for whom this event was reported was statistically significant ($p=0.029$). Within the SOC 'investigations', 'Intraocular pressure increased' was reported more frequently for patients allocated to XG-102 90 µg (23%) when compared to 10% and 14% for the XG-102 900 µg and dexamethasone groups respectively. The difference in number of patients for whom this event was reported (between XG-102 90 µg and dexamethasone) was not statistically significant. The study treatment eye drops were interrupted because of an AE for 11 patients allocated to XG-102 90 µg, for 8 patients allocated to XG-102 900 µg and for 3 patients allocated to dexamethasone. Figure 65 displays a summary of the AEs (sorted by MedDRA SOC and Preferred Term (PT)) which occurred for at least 2% of patients, irrespective of the randomized group.

Serious adverse events

The serious adverse events concerned are listed in Figure 66. In total, 9 SAEs were reported for 9 patients - i.e. for 4 patients randomized to the XG-102 90 µg dose group, for 3 patients randomized to the XG-102 900 µg dose group and for 2 patients randomized to the dexamethasone dose group. In total, one SAE (for a patient randomized to the XG-102 90 µg dose group) was reported within the first 24 hours after administration of the sub-conjunctival injection of study treatment. None of the reported SAEs were considered by the Investigator as being related to study treatment. The 'reason for seriousness' for all reported SAEs was 'hospitalization'. The overview of the reported SAEs is shown in Figure 66.

Clinical Laboratory evaluation

The hematology and chemistry assays which were performed for the study are shown in the following table. All laboratory tests were performed locally.

Hematology:	Hemoglobin, hematocrit, White blood cell count (WBC), neutrophils, basophils, eosinophils, monocytes and lymphocytes
Chemistry:	Creatinine, Aspartate Transaminase (AST), Alanine Transaminase (ALT), gamma-glutamyltransferase (gamma-GT), glucose, CK, CRP

Safety conclusions

Overall, XG-102 90 µg and XG-102 900 µg was well tolerated in patients who underwent complex ocular surgery. The study treatment eye drops were stopped prematurely for 11 patients randomized to XG-102 90 µg, for 8 patients randomized to XG-102 900 µg and for 3 patients randomized to dexamethasone. The reason for the premature withdrawal of study treatment was primarily because of persistent eye inflammation which in the opinion of the Investigator necessitated intensification of anti-inflammatory treatment. For the patients concerned, treatment with open-label anti-inflammatory ocular treatment was initiated.

No fatal events were reported in this study. In total, 9 SAEs were reported for 9 patients and none of these events were considered as being related to the study treatment.

Concerning the overall number of reported AEs, there are not a statistically significant difference between either of the XG-102 dose groups and the dexamethasone group with respect to the number of patients for whom an AE was reported. For patients allocated to XG-102 90 µg, a total of 78 AEs were reported for 31 / 47 (66%) patients allocated to this group and for patients allocated to XG-102 900 µg, a total of 69 AEs were reported for 32 / 48 (67%) patients. For patients allocated to the dexamethasone group, a total of 55 AEs were reported for 29 / 50 (58%) patients. The percentage of patients who experienced an AE within 24 hours after administration of study treatment was similar between the three study treatment groups (i.e. 34%, 27% and 30% for the XG-102 90 µg, the XG-102 900 µg and dexamethasone groups, respectively). The number of patients who experienced an AE suggestive of eye inflammation was higher in patients allocated to the XG-102 90 µg group compared to the XG-102 900 µg and dexamethasone groups which suggests that XG-102 90 µg may be less efficacious in the treatment of eye inflammation secondary to complex ocular surgery. The number of patients who experienced an AE suggestive of eye pain was higher in patients allocated to the XG-102 900 µg group compared to the XG-102 90 µg and dexamethasone groups. For two patients in the XG-102 90 µg group, eye pain was reported less than 24 hours after the injection of the sub-conjunctival injection of study treatment - for one of these

patients, analgesic treatment had not been prescribed post-operatively. For one of these patients, eye pain was again reported as an AE 35 days later which was at the same time when the patient was reported as having an elevated IOP.

For three patients in the XG-102 900 µg group, eye pain was reported less than 24 hours after the injection of the sub-conjunctival injection of study treatment and for one of these patients, eye pain was again reported as an AE five days later. For four patients in the same dose group, eye pain was reported > 24 hours after the sub-conjunctival injection of study treatment concomitantly. For three of these patients, eye pain was reported concomitantly with other AEs. Eye pain was reported for one patient in the dexamethasone group > 24 hours after the sub-conjunctival injection of study treatment concomitantly. This event was reported concomitantly with another AE. Given that complex surgery was performed, eye pain could also be related to the presence of stitches following the surgery.

Summary

Compliance: For all patients in whom the sub-conjunctival injection of study treatment was started, the total amount (i.e. 250 µL) was administered. In the three study treatment groups, the overall compliance with the study treatment eye drops was > 90%.

Safety: There was not a statistically significant difference between either of the XG-102 dose groups and the dexamethasone group with respect to the number of patients for whom an adverse event was reported. For patients allocated to XG-102 90 µg, a total of 78 adverse events were reported for 31 / 47 (66%) patients allocated to this group and for patients allocated to XG-102 900 µg, a total of 69 adverse events were reported for 32 / 48 (67%) patients. For patients allocated to the dexamethasone group, a total of 55 adverse events were reported for 29 / 50 (58%) patients. The percentage of patients who experienced an adverse event within 24 hours after administration of study treatment was similar between the three study treatment groups (i.e. 34%, 27% and 30% for the XG-102 90 µg, the XG-102 900 µg and dexamethasone groups' respectively). More patients allocated to the XG-102 90 µg group, compared to the XG-102 900 µg and dexamethasone groups, experienced an adverse event suggestive of eye inflammation which may suggest that XG-102 90 µg may be less efficacious (compared to the 900 µg and dexamethasone dose groups) in the treatment of eye inflammation secondary to complex ocular surgery. The number of patients who experienced an adverse event suggestive of eye pain was higher in patients allocated to the XG-102 900 µg group compared to the XG-102 90 µg and dexamethasone groups. The eye pain may be

related to the presence of stitches following the surgery. 'Intraocular pressure increased' was reported more frequently for patients allocated to XG-102 90 µg (23%) when compared to 10% and 14% for the XG-102 900 µg and dexamethasone groups respectively. The difference in number of patients for whom this event was reported (between XG-102 90 µg and dexamethasone was not statistically significant).

The majority (approximately 70%) of all reported adverse events (AE) were considered by the Investigator as being mild. In total, AEs were considered by the Investigators (blinded assessment) to be possibly or probably related to study medication for 18 events reported for patients in the XG-102 90 µg, for 13 events reported for patients in the XG-102 900 µg, and for 15 events reported for patients in dexamethasone group. No fatal events were reported in this study. In total, 9 SAEs were reported for 9 patients and none of these events were considered as being related to the study treatment.

The quantification of XG-102 was performed in a sub-set of 32 patients. A blood sample was obtained 1 hour after the sub-conjunctival injection of study treatment. For all samples obtained (and irrespective of the assigned dose group) the XG-102 concentration was analyzed as being below the Lower Limit of Quantification (LLOQ) of < 10 ng/ml.

According to our definitions of non-inferiority, both XG-102 900 µg and XG-102 90 µg administered as a single sub-conjunctival injection was non-inferior to treatment with dexamethasone eye drops instilled 4 times / day for 21 days in the treatment of post-operative intraocular inflammation as assessed by anterior chamber cell grade, in patients who underwent complex ocular surgery.

Overall, XG-102 90 µg and XG-102 900 µg was well tolerated. None of the reported adverse events were suggestive of an intolerable or irreversible side effect of XG-102. The increased number of events suggestive of eye inflammation reported in the XG-102 90 µg suggests that this dose is less effective in the treatment of post-operative intraocular inflammation in patients following complex intraocular surgery. This is also probably enforced by the percentage of patients for whom rescue medication was introduced due to persistent eye inflammation in the XG-102 90 µg group. The plasma quantification of XG-102 which was assessed 1 hour after administration of the sub conjunctival injection of study treatment demonstrated that there was no systemic passage of XG-102.

Example 28: Effects of XG-102 on in vivo hepatocarcinoma in p-38 (Mapk14) deficient mice

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Mapk14, which is also known as p-38, is a well-known negative regulator of cell proliferation and tumorigenesis. In this study, Mapk14^{fl/fl} and Mapk14^{Δli*} mice as well as Mapk14^{fl/fl} Jun^{fl/fl} and Mapk14^{Δli*} Jun^{Δli*} mice have been used. “Mapk14^{Δli*}”, and “Mapk14^{Δli*} Jun^{Δli*}” respectively, means herein polyIC-treated Mx-cre/Mapk14^{fl/fl} mice, and Mx-cre deleted Mapk14^{fl/fl} Jun^{fl/fl} mice respectively, thus resulting in Mapk14 “deletion”, and Jun deletion respectively, by the Mx-cre process, i.e. “Mapk14^{-/-}” mice, and “Mapk14^{-/-}Jun^{-/-}” mice respectively.

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XG-102 has been administered intraperitoneal twice weekly at a dose of 20 mg/kg to study its effects on the diethylnitrosamine (DEN)-induced hyperproliferation of hepatocytes and liver tumor cells (cf. Hui L. *et al.*, p38a suppresses normal and cancer cell proliferation by antagonizing the JNK-c-Jun pathway. Nature Genetics, 2007; 39: 741–749). PBS has been used as control. Specifically, the Mapk14^{fl/fl} and Mapk14^{Δli*} mice were injected with either PBS or XG-102 (20 mg per kg body weight) before DEN treatment. The proliferation of hepatocytes in the mice was then analyzed by Ki67 staining 48 h after DEN treatment and quantified.

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Figure 67 shows in the left panel the proliferation of hepatocytes (quantification of Ki67-positive cells) in XG-102 (in the figure referred to as “D-JNKI1”) or PBS treated Mapk14^{fl/fl} and Mapk14^{Δli*} mice. In PBS conditions (control), Mapk14^{-/-} cells (Mapk14^{Δli*}) are proliferating more intensively than Mapk14^{+/+} cells (Mapk14^{fl/fl}), since the negative regulation of Mapk14 (p38) on cell proliferation and tumorigenesis is not present. Administration of XG-102 reverts this “non-activity” of Mapk14 (in Mapk14^{-/-} cells) by the activity of of XG-102 (DJNKI1).

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In the right panel of Figure 67 the proliferation of hepatocytes (quantification of Ki67-positive cells) in XG-102 (in the figure referred to as “D-JNKI1”) treated Mapk14^{fl/fl} Jun^{fl/fl} (meaning Mapk14^{+/+} Jun^{+/+}) and Mapk14^{Δli*} Jun^{Δli*} mice (meaning Mapk14^{-/-} Jun^{-/-}) is shown. The results are equivalent and mimic those of Mapk14^{fl/fl} in PBS condition and Mapk14^{Δli*} in XG-102 (DJNKI1) condition. Thus, XG-102 activity is “equivalent” to deleting the Jun gene in the cell line.

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Taken together, these results are confirming that XG-102 has an activity on the growth of cancer cell lines (reverting the overgrowth induced by Mapk14 deletion) and this is probably mediated by Jun.

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Example 29: Effects of XG-102 on in vivo human liver cancer cells (implanted)

To study the effect of XG-102 on in vivo human liver cancer cells, 3×10^6 Huh7 human liver cancer cells were injected subcutaneously to both flank area of nude mice at 4 weeks of age.

10 Nude mice treated with XG-102 intraperitoneally twice a week at 5mg/kg after Huh7 injection. Tumor volumes were measured twice a week. Mice were killed 4 week after xenograft.

15 As shown in Figure 68, XG-102 administered intraperitoneally twice weekly after subcutaneous injection of human hepatocellular carcinoma in nude mice markedly reduced tumor growth at a dose of 5 mg/kg.

20 **Example 30: Antitumor Activity of 1mg/kg XG-102 in Swiss nude mice bearing orthotopic HEP G2 Human Liver Carcinoma**

The objective of this study was to determine the antitumor activity of 1 mg/kg XG-102 in the model of SWISS *Nude* mice bearing the orthotopic Hep G2 human hepatocarcinoma tumor.

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20 healthy female SWISS Nude mice were obtained from Charles River (L'Arbresles, France). Animal experiments were performed according to the European ethical guidelines of animal experimentation and the English guidelines for welfare of animals in experimental neoplasia. The animals were maintained in rooms under controlled conditions of temperature ($23 \pm 2^\circ\text{C}$), humidity ($45 \pm 5\%$), photoperiod (12h light/12h dark) and air exchange. Animals were
30 maintained in SPF conditions and room temperature and humidity was continuously monitored. The air handling system was programmed for 14 air changes per hour, with no recirculation. Fresh outside air pass through a series of filters, before being diffused evenly into each room. A high pressure (20 ± 4 Pa) was maintained in the experimentation room to

prevent contamination or the spread of pathogens within a mouse colony. All personnel working under SPF conditions followed specific guidelines regarding hygiene and clothing when they entered the animal husbandry area. Animals were housed in polycarbonate cages (UAR, Epinay sur Orge, France) that are equipped to provide food and water. The standard area cages used were 800 cm² with a maximum of 10 mice per cage according to internal standard operating procedures. Bedding for animals was sterile wood shavings (SERLAB, Cergy-Pontoise, France), replaced once a week. Animal food was purchased from SERLAB (Cergy-Pontoise, France). The type of sterile controlled granules was DIETEX. The food was provided ad libitum, being placed in the metal lid on top of the cage. Water was also provided ad libitum from water bottles equipped with rubber stoppers and sipper tubes. Water bottles were cleaned, filled with water, sterilized by filtration and replaced twice a week.

For XG-102 administration a stock solution was prepared at 10 mM (corresponding to 38.22 mg/ml) in sterile water (WFI, Aguettant). Aliquots were prepared for each treatment day and stored at approximately –80°C. Dilutions with WFI of this stock solution to 0.2 mg/ml was performed on each treatment day and stored at 2-4°C for maximum 24 hours. The stability of the stock solution is more than 100 days at approximately –80°C; the stability of the diluted formulations for animal dosing is 24 hours at 2-4°C. Diluted formulations were maintained on ice until use and unused diluted material was discarded. The treatment dose of XG-102 was injected at 1 mg/kg/inj. Injections were performed at days D10, D14, D18, D22, D41, D45, D49 and D53 ([Q4Dx4]x2). XG-102 substances were injected intravenously (IV) at 5 ml/kg via the caudal vein of mice. The injection volumes were adapted according to the most recent individual body weight of mice.

The tumor cell line and culture media were purchased and provided by Oncodesign:

Cell line	Type	Specie	Origin	Reference
Hep G2	Human hepatocarcinoma	human	ATCC*	4

* American Type Culture Collection, Manassas, Virginia, USA.

The Hep G2 cell line was established from the tumor tissue of a 15-year old Argentine boy with a hepatocellular carcinoma in 1975 (ADEN D.P. et al., Nature, 282: 615-616, 1979). Tumor cells grew as adherent monolayers at 37°C in a humidified atmosphere (5% CO₂, 95% air). The culture medium was RPMI 1640 containing 2 mM L-glutamine (Ref BE12-702F, Lonza, Verviers, Belgium) and supplemented with 10% FBS (Ref DE14-801E, Lonza). For

experimental use, the cells were detached from the culture flask by a 5-minute treatment with trypsin-versene (Ref 02-007E, Cambrex), diluted in Hanks' medium without calcium or magnesium (Ref BE10-543F, Cambrex) and neutralized by addition of complete culture medium. Cells were counted in a hemocytometer and their viability was assessed by 0.25% trypan blue exclusion. Mycoplasma detection was performed using the MycoAlert® Mycoplasma Detection Kit (Ref LT07- 318, Lonza) in accordance with the manufacturer instructions. The MycoAlert® Assay is a selective biochemical test that exploits the activity of mycoplasmal enzymes. The viable mycoplasma are lysed and the enzymes react with the MycoAlert® substrate catalyzing the conversion of ADP to ATP. By measuring the level of ATP in a sample both before and after the addition of the MycoAlert® substrate a ratio can be obtained which is indicative of the presence or absence of mycoplasma. The mycoplasma test was assayed in duplicate from the culture supernatants of the cell lines and compared to negative and positive controls (MycoAlert® Assay Control Set Ref LT07-518, Lonza) (Internal Standard Operating Procedure No TEC-007/002, data not shown but archived).

Experimental Design:

Twenty four hours before tumor induction, 20 female SWISS Nude mice were irradiated with a γ -source (2.5 Gy, Co60, INRA, Dijon, France). At D0, Hep G2 tumors were induced orthotopically on 20 female SWISS Nude. Under anesthesia, the animal abdomen was opened through a median incision under aseptic conditions. Ten millions (10^7) Hep G2 tumor cells suspended in 50 μ l of RPMI 1640 culture medium were injected in the subcapsular area of the liver. The abdominal cavity was subsequently closed in 2 layers with 5-0 sutures.

At D10, mice were randomized before treatment start according to their body weight to form 2 groups of 10 mice. The body weight of each group was not statistically different from the others (analysis of variance). Mice from group 1 received one IV injection of vehicle at 5 ml/kg/inj. at D10, D14, D18, D22, D41, D45, D49 and D53 ([Q4Dx4]x2) and mice from group 2 received one IV injection of XG-102 at 1 mg/kg/inj. at D10, D14, D18, D22, D41, D45, D49 and D53 ([Q4Dx4]x2):

<i>Group</i>	<i>No.</i>	<i>Treatment</i>	<i>Dose</i>	<i>Route</i>	<i>Treatment</i>
1	8	vehicle	-	IV	[Q4Dx4]x2
2	7	XG-102	1	IV	[Q4Dx4]x2

Surviving mice were sacrificed at D185.

Mice were monitored every day throughout the study for behaviour and survival. The body weight was monitored twice a week for all mice throughout the study. Isoflurane® Forene (Centravet, Bondoufle, France) was used to anaesthetize the animals before cell injection, IV treatments and sacrifice. During the course of the experiment, animals were killed under anaesthesia with Isoflurane® by cervical dislocation if any of the following occurred:

- Signs of suffering (cachexia, weakening, difficulty to move or to eat),
- Compound toxicity (hunching, convulsions),
- 20% weight loss for 3 consecutive days or 25% body weight loss on any day.

An autopsy was performed in each case. When mice looked moribund, they were sacrificed and necropsied. Livers were collected and weighed.

For the body weight analysis body weight curves of mice were drawn. Mean body weight change (MBWC): Average weight change of treated animals in grams (weight at day X minus weight at D10) was calculated.

Efficacy parameters were expressed as a percent (T/C%). T will be the median survival times of animals treated with drugs and C is the median survival times of control animals treated with vehicle. Survival systems indicated a degree of success when T/C percents exceed 125. T/C% was expressed as follows: $T/C\% = [T/C] \times 100$. Survival curves of mice were drawn. Mean survival time was calculated for each group of treatment as the mean of the days of death. Median survival time was calculated for each group of treatment as the median of the days of death. The log-Rank (Kaplan-Meier) test was used to compare the survival curves. Statistical analysis of the body weight and MBWC was performed using the Bonferroni/Dunn test (ANOVA comparison) using StatView® software (Abacus Concept, Berkeley, USA). A p value <0.05 is considered significant. All groups were compared with themselves.

In Figure 69 the mean body weight and mean body weight change curves of mice bearing orthotopically injected HEP G2 tumor are shown. Mice were IV treated with XG-102 at 1mg/kg/inj following the Q4Dx4 treatment schedule repeated two times, at D10 and D41. As shown in Figure 69, no apparent differences occurred for the body weight, indicating that XG-102 was well-tolerated. Accordingly, in Figure 70 the respective statistical data are presented.

Figure 71 shows the mice long survival curves, whereby proportion of surviving mice per group until sacrifice day (D185) is depicted. Mice were treated with XG-102 at the indicated doses following the Q4Dx4 treatment schedule repeated two times, at D10 and D41. These data clearly show a prolonged survival for mice treated with XG-102. Accordingly, the statistical data are presented below (survival analysis of mice xenografted with HepG2 tumor and treated with XG-102):

Treatment (D10 & D41, Q4Dx4)	Median survival time $\pm$ SD (day)	Mean survival time (day)	T/C (%)
Vehicle	102 $\pm$ 8	102	-
XG-102 1mg/kg	111 $\pm$ 14	123	120

Group	Chi	df	p	significance
XG-102 1mg/kg	5.1550	1	0.0232	S

Mice survival time was expressed as median survival time as T/C (%) values (the ratio between the median of the days of death of treated group and the tumor bearing untreated control group). Statistical analysis was performed with the Log-Rank test, taking vehicle treated group as reference.

Taken together, these data indicate that administration of XG-102 prolongs the survival time of mice xenografted with HepG2 tumor.

Example 31: Antitumor Activity of XG-102 (dose/response) in Swiss nude mice bearing orthotopic HEP G2 Human Liver Carcinoma

The objective of this study was to determine the antitumor activity of XG-102 (dose/response) in the model of SWISS *Nude* mice bearing the orthotopic Hep G2 human hepatocarcinoma tumor.

32 healthy female SWISS Nude mice were obtained from Charles River (L'Arbresles, France). Animal experiments were performed according to the European ethical guidelines of animal experimentation and the English guidelines for welfare of animals in experimental neoplasia. The animals were maintained in rooms under controlled conditions of temperature ($23 \pm 2^\circ\text{C}$), humidity ($45 \pm 5\%$), photoperiod (12h light/12h dark) and air exchange. Animals were maintained in SPF conditions and room temperature and humidity was continuously

monitored. The air handling system was programmed for 14 air changes per hour, with no recirculation. Fresh outside air pass through a series of filters, before being diffused evenly into each room. A high pressure (20 ± 4 Pa) was maintained in the experimentation room to prevent contamination or the spread of pathogens within a mouse colony. All personnel working under SPF conditions followed specific guidelines regarding hygiene and clothing when they entered the animal husbandry area. Animals were housed in polycarbonate cages (UAR, Epinay sur Orge, France) that are equipped to provide food and water. The standard area cages used were 800 cm² with a maximum of 10 mice per cage according to internal standard operating procedures. Bedding for animals was sterile wood shavings (SERLAB, Cergy-Pontoise, France), replaced once a week. Animal food was purchased from SERLAB (Cergy-Pontoise, France). The type of sterile controlled granules was DIETEX. The food was provided ad libitum, being placed in the metal lid on top of the cage. Water was also provided ad libitum from water bottles equipped with rubber stoppers and sipper tubes. Water bottles was cleaned, filled with water, sterilized by filtration and replaced twice a week.

For XG-102 administration XG-102 was prepared at the concentration of 1 mg/ml with sterile water (WFI, Aguetant, France). It was then diluted at the concentrations of 0.2 and 0.02 mg/ml with sterile water. All these steps were performed within one hour prior to injection to mice. XG-102 was injected at 0.1, 1 and 5 mg/kg/inj. Four injections were performed, each separated by four days (Q4Dx4). XG-102 substances were injected intravenously (IV) at 5 ml/kg via the caudal vein of mice. The injection volumes were adapted according to the most recent individual body weight of mice.

The tumor cell line and culture media were purchased and provided by Oncodesign:

Cell line	Type	Specie	Origin	Reference
Hep G2	Human hepatocarcinoma	human	ATCC*	4

* American Type Culture Collection, Manassas, Virginia, USA.

The Hep G2 cell line was established from the tumor tissue of a 15-year old Argentine boy with a hepatocellular carcinoma in 1975 (ADEN D.P. et al., Nature, 282: 615-616, 1979).

Tumor cells grew as adherent monolayers at 37°C in a humidified atmosphere (5% CO₂, 95% air). The culture medium was RPMI 1640 containing 2 mM L-glutamine (Ref BE12-702F, Lonza, Verviers, Belgium) and supplemented with 10% FBS (Ref DE14-801E, Lonza). For experimental use, the cells were detached from the culture flask by a 5-minute treatment with

trypsin-versene (Ref 02-007E, Cambrex), diluted in Hanks' medium without calcium or magnesium (Ref BE10-543F, Cambrex) and neutralized by addition of complete culture medium. Cells were counted in a hemocytometer and their viability was assessed by 0.25% trypan blue exclusion. Mycoplasma detection was performed using the MycoAlert® Mycoplasma Detection Kit (Ref LT07- 318, Lonza) in accordance with the manufacturer instructions. The MycoAlert® Assay is a selective biochemical test that exploits the activity of mycoplasmal enzymes. The viable mycoplasma are lysed and the enzymes react with the MycoAlert® substrate catalyzing the conversion of ADP to ATP. By measuring the level of ATP in a sample both before and after the addition of the MycoAlert® substrate a ratio can be obtained which is indicative of the presence or absence of mycoplasma. The mycoplasma test was assayed in duplicate from the culture supernatants of the cell lines and compared to negative and positive controls (MycoAlert® Assay Control Set Ref LT07-518, Lonza) (Internal Standard Operating Procedure No TEC-007/002).

Experimental Design:

Twenty four hours before tumor induction, 32 female SWISS Nude mice were irradiated with a γ -source (2.5 Gy, Co⁶⁰, INRA, Dijon, France). At D0, Hep G2 tumors were induced orthotopically on 32 female SWISS Nude. Under anesthesia, the animal abdomen was opened through a median incision under aseptic conditions. Ten millions (10⁷) Hep G2 tumor cells suspended in 50 μ l of RPMI 1640 culture medium were injected in the subcapsular area of the liver. The abdominal cavity was subsequently closed in 2 layers with 5-0 sutures.

At D10, mice were randomized before treatment start according to their body weight to form 4 groups of 8 mice. The body weight of each group was not statistically different from the others (analysis of variance). Mice from group 1 received one IV injection of vehicle at 5 ml/kg/inj. once every four days repeated four times (Q4Dx4), mice from group 2 received one IV injection of XG-102 at 0.1 mg/kg/inj. once every four days repeated four times (Q4Dx4), mice from group 3 received one IV injection of XG-102 at 1 mg/kg/inj. once every four days repeated four times (Q4Dx4), and mice from group 4 received one IV injection of XG-102 at 5 mg/kg/inj. once every four days repeated four times (Q4Dx4):

<i>Group</i>	<i>No.</i>	<i>Treatment</i>	<i>Dose</i>	<i>Route</i>	<i>Treatment</i>
1	8	vehicle	-	IV	Q4Dx4
2	8	XG-102	0.1	IV	Q4Dx4
3	8	XG-102	1	IV	Q4Dx4

4	8	XG-102	5	IV	Q4Dx4
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Surviving mice were sacrificed at D171.

Mice were monitored every day throughout the study for behaviour and survival. The body weight was monitored twice a week for all mice throughout the study. Isoflurane® Forene (Centravet, Bondoufle, France) was used to anaesthetize the animals before cell injection, IV treatments and sacrifice. During the course of the experiment, animals were killed under anaesthesia with Isoflurane® by cervical dislocation if any of the following occurred:

- Signs of suffering (cachexia, weakening, difficulty to move or to eat),
- Compound toxicity (hunching, convulsions),
- 20% weight loss for 3 consecutive days or 25% body weight loss on any day.

An autopsy was performed in each case.

At D67, 3 mice randomly selected per group during randomization were sacrificed for observation of macroscopic development. The remaining mice in each group were kept for survival monitoring. Final sacrifice was performed at D171. Primary tumors and livers were collected and weighed from sacrificed animals. Each liver was fixed in 10% neutral buffered formalin. Forty eight (48) hours after collection, they were embedded in paraffin (Histosec®) and used for anapathological analysis. For the estimation of metastatic invasion in mouse liver by histological analysis, paraffin-embedded sections (5µm) were deparaffinized in xylene and rehydrated by serial incubations in 100%, 95%, and 70% ethanol. All sections were stained with haematoxylin and eosin (HE) (Ref. S3309, Dakocytomation, Trappes, France) for histological analyses. The coverslip was mounted with aqueous mountant (Aquatex, Ref 1.08562, Merck) and sections were viewed under a light microscope (DMRB Leica). Histological sections were analyzed by a pathologist expert to determine the metastatic invasion in liver.

For the body weight analysis body weight curves of mice were drawn. Mean body weight change (MBWC): Average weight change of treated animals in grams (weight at day X minus weight at D10) was calculated.

Efficacy parameters were expressed as a percent (T/C%). T will be the median survival times of animals treated with drugs and C is the median survival times of control animals treated

with vehicle. Survival systems indicated a degree of success when T/C percents exceed 125. T/C% was expressed as follows: $T/C\% = [T/C] \times 100$. Survival curves of mice were drawn. Mean survival time was calculated for each group of treatment as the mean of the days of death. Median survival time was calculated for each group of treatment as the median of the days of death. The log-Rank (Kaplan-Meier) test was used to compare the survival curves. Statistical analysis of the body weight and MBWC was performed using the Bonferroni/Dunn test (ANOVA comparison) using StatView® software (Abacus Concept, Berkeley, USA). A p value <0.05 is considered significant. All groups were compared with themselves.

Figure 72 shows the statistical data regarding the mean body weight and mean body weight change curves of mice bearing orthotopically injected HEP G2 tumor. Mice were IV treated with XG-102 following the Q4Dx4 treatment schedule repeated two times, at D10 and D41. As shown in Figure 72, no apparent differences occurred for the body weight, indicating that XG-102 was well-tolerated.

Figure 73 shows the mice long survival curves, whereby proportion of surviving mice per group until sacrifice day (D171) is depicted. Mice sacrificed at D67 for autopsy were excluded from calculation. Mice were treated with XG-102 at the indicated doses following the Q4Dx4 treatment schedule repeated two times, at D10 and D41. These data clearly show a prolonged survival for mice treated with XG-102 in a dose-dependent manner. Accordingly, the statistical data are presented below (survival analysis of mice xenografted with HepG2 tumor and treated with XG-102):

Treatment (D10 & D41, Q4Dx4)	Median survival time (day)	T/C (%)	Statistical analysis
Vehicle	86	-	-
XG-102 0.1mg/kg	105	123	NS
XG-102 1mg/kg	138	161	NS
XG-102 5mg/kg	118	137	NS

Mice sacrificed as D67 for autopsy were excluded from calculation. Mice survival time was expressed as median survival time as T/C (%) values (the ratio between the median of the days of death of treated group and the tumor bearing untreated control group). A T/C% value >125% is indicative of anti-tumor effectiveness.

The following table shows the tumor development of HepG2 cancer cells into liver. Detection of tumor masses on liver was performed by microscopic observation after HE staining on mice sacrificed at D171:

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Group	Animal ID	Observation
Vehicle	933	Tumor on liver
XG-102 0.1mg/kg	8665	Tumor (1.3cm) on liver
	2925	No tumor detected
XG-102 1mg/kg	8631	No tumor detected
	8641	No tumor detected
	2929	Tumor (1.9cm) on liver
XG-102 5mg/kg	2931	No tumor detected
	2765	No tumor detected
	2767	No tumor detected

In Figure 74 the tumor invasion observed by microscopic evaluation of mice sacrificed at D67 or between D67 and final sacrifice are shown as histogram representations. The level of tumor take was classified in 4 different categories specified in the figure legend.

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Example 32: Antitumor Activity of XG-102 in Balb/c nude mice bearing subcutaneous PC-3 human prostate tumors

The objective of this study was to determine the antitumor activity of XG-102 (dose/response) in the model of Balb/c *Nude* mice bearing the subcutaneous PC-3 human prostate tumors.

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15 healthy male Balb/c Nude mice were obtained from Charles River (L'Arbresles, France). Animal experiments were performed according to the European ethical guidelines of animal experimentation and the English guidelines for welfare of animals in experimental neoplasia. The animals were maintained in rooms under controlled conditions of temperature ($23 \pm 2^\circ\text{C}$), humidity ($45 \pm 5\%$), photoperiod (12h light/12h dark) and air exchange. Animals were maintained in SPF conditions and room temperature and humidity was continuously monitored. The air handling system was programmed for 14 air changes per hour, with no recirculation. Fresh outside air pass through a series of filters, before being diffused evenly into each room. A high pressure ($20 \pm 4 \text{ Pa}$) was maintained in the experimentation room to

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prevent contamination or the spread of pathogens within a mouse colony. All personnel working under SPF conditions followed specific guidelines regarding hygiene and clothing when they entered the animal husbandry area. Animals were housed in polycarbonate cages (UAR, Epinay sur Orge, France) that are equipped to provide food and water. The standard area cages used were 800 cm² with a maximum of 10 mice per cage according to internal standard operating procedures. Bedding for animals was sterile wood shavings (SERLAB, Cergy-Pontoise, France), replaced once a week. Animal food was purchased from SERLAB (Cergy-Pontoise, France). The type of sterile controlled granules was DIETEX. The food was provided ad libitum, being placed in the metal lid on top of the cage. Water was also provided ad libitum from water bottles equipped with rubber stoppers and sipper tubes. Water bottles were cleaned, filled with water, sterilized by filtration and replaced twice a week.

For XG-102 administration XG-102 was prepared at the concentration of 0.2 mg/ml with sterile water (WFI, Aguetant, France). It was then diluted to the concentration of 0.02 mg/ml with sterile water. All these steps were performed within one hour prior to injection to mice. XG-102 was injected at 0.1 and 1 mg/kg/inj. Four injections were performed, each separated by four days (Q4Dx4). XG-102 substances were injected intravenously (IV) at 5 ml/kg via the caudal vein of mice. In case of necrosis of the tail during the injection period, the intraperitoneal (IP) route was used. The injection volumes were adapted according to the most recent individual body weight of mice.

The tumor cell line and culture media were purchased and provided by Oncodesign:

Cell line	Origin	Source	Reference
PC-3	Human prostatic adenocarcinoma	ATCC*	BISSERY M.C. <i>et al.</i> , Bull. Cancer 1991, 78: 587-602.

* American Type Culture Collection, Manassas, Virginia, USA.

The PC-3 was initiated from a bone metastasis of a grade IV prostatic adenocarcinoma from a 62-year old male Caucasian (VOLENEC F.J. *et al.*, J Surg Oncol 1980;13(1):39-44). Tumor cells grew as adherent monolayers at 37°C in a humidified atmosphere (5% CO₂, 95% air). The culture medium was RPMI 1640 containing 2 mM L-glutamine (Ref BE12-702F, Lonza, Verviers, Belgium) and supplemented with 10% FBS (Ref DE14-801E, Lonza). For experimental use, the cells were detached from the culture flask by a 5-minute treatment with trypsin-versene (Ref 02-007E, Cambrex), diluted in Hanks' medium without calcium or magnesium (Ref BE10-543F, Cambrex) and neutralized by addition of complete culture

medium. Cells were counted in a hemocytometer and their viability was assessed by 0.25% trypan blue exclusion. Mycoplasma detection was performed using the MycoAlert® Mycoplasma Detection Kit (Ref LT07- 318, Lonza) in accordance with the manufacturer instructions. The MycoAlert® Assay is a selective biochemical test that exploits the activity of mycoplasmal enzymes. The viable mycoplasma are lysed and the enzymes react with the MycoAlert® substrate catalyzing the conversion of ADP to ATP. By measuring the level of ATP in a sample both before and after the addition of the MycoAlert® substrate a ratio can be obtained which is indicative of the presence or absence of mycoplasma. The mycoplasma test was assayed in duplicate from the culture supernatants of the cell lines and compared to negative and positive controls (MycoAlert® Assay Control Set Ref LT07-518, Lonza) (Internal Standard Operating Procedure No TEC-007/002).

Experimental Design:

Forty-eight hours before tumor induction, 15 male Balb/c Nude mice were irradiated with a γ -source (2.5 Gy, Co⁶⁰, INRA, Dijon, France). At D0, twenty millions (2×10^7) PC-3 cells suspended in 200 μ l of RPMI medium were subcutaneously injected in the right flank of the 60 male Balb/c *Nude* mice.

When the mean tumor volume reached $80 \pm 38 \text{ mm}^3$, mice were randomized before treatment start according to their tumor volume to form 3 groups of 5 mice. The tumor volume of each group was not statistically different from the others (analysis of variance).

The treatment schedule of the test substance was as follows: Mice from group 1 received one IV injection of vehicle at 5 ml/kg/inj. once every four days repeated four times (Q4Dx4), Mice from group 2 received one IV injection of XG-102 at 0.1 mg/kg/inj. once every four days repeated four times (Q4Dx4), and Mice from group 3 received one IV injection of XG-102 at 1 mg/kg/inj. once every four days repeated four times (Q4Dx4):

Group	No.	Treatment	Dose	Route	Treatment
1	5	vehicle	-	IV	Q4Dx4
2	5	XG-102	0.1	IV	Q4Dx4
3	5	XG-102	1	IV	Q4Dx4

Mice were sacrificed when tumors reached a maximum volume of 2000 mm^3 .

Mice were monitored every day throughout the study for behaviour and survival. The body weight and tumor volume was monitored twice a week for all mice throughout the study. Isoflurane® Forene (Centravet, Bondoufle, France) was used to anaesthetize the animals before cell injection, IV treatments and sacrifice. During the course of the experiment, animals were killed under anaesthesia with Isoflurane® by cervical dislocation if any of the following occurred:

- Signs of suffering (cachexia, weakening, difficulty to move or to eat),
- Compound toxicity (hunching, convulsions),
- 20% weight loss for 3 consecutive days or 25% body weight loss on any day,
- Tumor volume of more than 2000 mm³.

An autopsy was performed in each case.

For the body weight analysis body weight curves of mice were drawn. Curves were stopped when more than 40% of dead mice were recorded in at least one group. Mean body weight change (MBWC): Average weight change of treated animals in grams (weight at day X minus weight at D33) was calculated.

The tumor volume was calculated with the following formula where length corresponds to the largest tumor diameter and width to the smallest tumor diameter: $TV = (\text{length} \times \text{width}^2)/2$. Tumor growth curves were drawn using the mean tumor volumes (MTV) +/- SD. Curves were stopped when more than 40% of mice were dead. Individual tumor volume curves were also drawn. Relative tumor volume curve using the relative tumor volumes (RTV) at different time points calculated as shown below were drawn. Curves were stopped when more than 40% of mice were dead. The RTV was calculated following the formula:

$$RTV = (\text{Tumor volume at DX}) / (\text{Tumor volume at D33}) \times 100$$

Tumor doubling time (DT) defined as the period required to reach a MTV of 200% during the exponential tumor growth phase was calculated using Vivo Manager® software. Time to reach V was calculated. Volume V was defined as a target volume deduced from experimental data and chosen in the exponential phase of tumor growth. Volume V was chosen as close as possible for all mice of each group, the time to reach this Volume V was deduced from experimental data. Tumor growth inhibition (T/C %) defined as the ratio of the median tumor volumes of treated groups *versus* vehicle treated group was calculated. The effective criteria for the T/C% ratio according to NCI standards, is ~ 42% (BISSERY M.C. *et al.*, Bull. Cancer 1991, 78: 587-602). All statistical analyses were performed using Vivo Manager® software.

Statistical analysis of the toxicity and the efficiency of the treatment (BWC, MBWC, TV, RTV, TTRV and DT) was performed using the Bonferroni/Dunn test (ANOVA comparison). All groups were compared with each other.

5 In Figure 75 shows the mean tumor volume of PC-3 tumor bearing mice during the antitumor activity experiment. At D33, 3 groups of 5 animals were treated with vehicle and XG-102 (0.1 and 1mg/kg/inj, Q4Dx4). These data indicate a reduction of tumor volume over time for XG-102 treatment in a dose-dependent manner, whereby the effects were more prominent for 1 mg/kg XG-102.

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Example 33: Effects of XG-102 on tumor growth in SCID mice bearing orthotopic HCT 116 human colon tumors

15 The objective of this study was to determine the effect of XG-102 on the growth of HCT 116 human colon tumor orthotopically xenografted in SCID mice.

80 healthy female SCID mice were obtained from Charles River (L'Arbresles, France). Animal experiments were performed according to the European ethical guidelines of animal experimentation and the English guidelines for welfare of animals in experimental neoplasia. The animals were maintained in rooms under controlled conditions of temperature ($23 \pm 2^\circ\text{C}$), humidity ($45 \pm 5\%$), photoperiod (12h light/12h dark) and air exchange. Animals were maintained in SPF conditions and room temperature and humidity was continuously monitored. The air handling system was programmed for 14 air changes per hour, with no recirculation. Fresh outside air pass through a series of filters, before being diffused evenly into each room. A high pressure ($20 \pm 4 \text{ Pa}$) was maintained in the experimentation room to prevent contamination or the spread of pathogens within a mouse colony. All personnel working under SPF conditions followed specific guidelines regarding hygiene and clothing when they entered the animal husbandry area. Animals were housed in polycarbonate cages (UAR, Epinay sur Orge, France) that are equipped to provide food and water. The standard area cages used were 800 cm² with a maximum of 10 mice per cage according to internal standard operating procedures. Bedding for animals was sterile corn cob bedding (LAB COB 12, SERLAB, CergyMPontoise, France), replaced once a week. Animal food was purchased from DIETEX. The type of sterile controlled granules was DIETEX. The food was provided ad

libitum, being placed in the metal lid on top of the cage. Water was also provided ad libitum from water bottles equipped with rubber stoppers and sipper tubes. Water bottles was cleaned, filled with water, sterilized by filtration and replaced twice a week.

- 5 For XG-102 administration the required amount of XG-102 was dissolved in the vehicle. The formulation was prepared according to the procedure detailed below. Concentrations were calculated and expressed taking into account test item purity and peptide content (multiplier coefficient was 74.6%). After thawing of XG-102, a stock solution was prepared at 10 mM (corresponding to 38.22 mg/ml) in sterile water (WFI, Batch 500 111 00 J, Aguetant, France)
- 10 and allowed to equilibrate to room temperature for 20 minutes minimum. Aliquots were prepared for each treatment day and stored at approximately -80°C. Dilutions of this stock solution to the required concentrations were performed on each treatment day and stored at 2-4°C for maximum 24 hours. The period of stability of the stock solution is more than 100 days at approximately - 80°C. The period of stability of the diluted formulations for animal
- 15 dosing is 24 hours at 2-4°C. Diluted solutions were maintained on ice until use. Unused material was discarded. XG-102 was injected once daily at 0.1 and 1 mg/kg/inj. for a total of fourteen consecutive administrations (Q1Dx14). The routes of substance administrations were: injected subcutaneously (SC) at 5 ml/kg/inj., administered *per os* (PO) to mice by oral gavage *via* a canula at 5 ml/kg/adm. The injection and administration volumes were adapted,
- 20 according to the daily individual body weight of mice.

The tumor cell line and culture media were purchased and provided by Oncodesign:

Cell line	Origin	Source	Reference
HTC116	Human colon adenocarcinoma	ATCC*	BRATTAIN M.G. <i>et al.</i> , Cancer Res. 1981, 41: 1751M1756.

* American Type Culture Collection, Manassas, Virginia, USA.

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The HCT 116 variant cell line was isolated from a primary cell culture of a single colonic carcinoma of a male patient (BRATTAIN M.G. *et al.*, Cancer Res. 1981, 41: 1751M1756).

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Tumor cells grew as adherent monolayers at 37°C in a humidified atmosphere (5% CO₂, 95% air). The culture medium was RPMI 1640 containing 2 mM L-glutamine (Ref BE12-702F, Lonza, Verviers, Belgium) and supplemented with 10% FBS (Ref DE14-801E, Lonza). For experimental use, the cells were detached from the culture flask by a 5-minute treatment with

trypsin-versene (Ref 02-007E, Cambrex), diluted in Hanks' medium without calcium or magnesium (Ref BE10-543F, Cambrex) and neutralized by addition of complete culture medium. Cells were counted in a hemocytometer and their viability was assessed by 0.25% trypan blue exclusion. Mycoplasma detection was performed using the MycoAlert® Mycoplasma Detection Kit (Ref LT07- 318, Lonza) in accordance with the manufacturer instructions. The MycoAlert® Assay is a selective biochemical test that exploits the activity of mycoplasmal enzymes. The viable mycoplasma are lysed and the enzymes react with the MycoAlert® substrate catalyzing the conversion of ADP to ATP. By measuring the level of ATP in a sample both before and after the addition of the MycoAlert® substrate a ratio can be obtained which is indicative of the presence or absence of mycoplasma. The mycoplasma test was assayed in duplicate from the culture supernatants of the cell lines and compared to negative and positive controls (MycoAlert® Assay Control Set Ref LT07-518, Lonza) (Internal Standard Operating Procedure No TEC-007/002).

Experimental Design:

Twenty four to Forty-eight hours before tumor induction, 5 SCID mice were irradiated with a γ -source (1.8 Gy, Co⁶⁰, INRA, Dijon, France). Ten millions (10^7) HCT 116 cells suspended in 200 μ l of RPMI medium were subcutaneously injected in the right flank of the 5 female SCID mice. When tumors reached 1000-2000 mm³, mice were sacrificed. Tumors were surgically excised from the animal to obtain fresh tumor fragments (20~30 mg) to be orthotopically implanted on the caecum of 75 mice at D0.

Twenty four to forty-eight hours before tumor implantation, 75 SCID mice were irradiated with a γ -source (1.8 Gy, Co⁶⁰, INRA, Dijon, France). The surgery was performed in the afternoon, with a minimum delay of two hours after the 7th XG-102 treatment. The abdomen from anaesthetized animal was opened through a median incision under aseptic conditions. The caecum was exteriorized and a small lesion was performed on caecum wall. The tumor fragment was placed on lesion and fixed with 6/0 sutures. The abdominal cavity was subsequently closed in 2 layers with 4/0 sutures.

At D-7, mice were randomized according to their body weight before treatment start to form 5 groups of 15 mice. The body weight of each group was not statistically different from the others (analysis of variance). The treatment began at D-7 according to following treatment schedule:

- Mice from group 1 received one PO administration of XG-102 vehicle at 5 ml/kg/inj. once daily for a total of fourteen consecutive administrations (Q 1Dx14),
- Mice from group 2 received one PO administration of XG-102 at 0.1 mg/kg/inj. once daily for a total of fourteen consecutive administrations (Q1 Dx 14),
- 5 • Mice from group 3 received one PO administration of XG-102 at 1 mg/kg/inj. Once daily for a total of fourteen consecutive administrations (Q1Dx14),
- Mice from group 4 received one SC injection of XG-102 at 0.1 mg/kg/inj. once daily for a total of fourteen successive administrations (Q1Dx14),
- 10 • Mice from group 5 received one SC injection of XG-102 at 1 mg/kg/inj. once daily for a total of fourteen consecutive administrations (Q1Dx14):

<i>Group</i>	<i>No.</i>	<i>Treatment</i>	<i>Route</i>	<i>Dose (mg/kg/inj.)</i>	<i>Treatment Schedule</i>
1	15	vehicle	po	-	Q1Dx14
2	15	XG-102	po	0.1	Q1Dx14
3	15	XG-102	po	1	Q1Dx14
4	15	XG-102	sc	0.1	Q1Dx14
5	15	XG-102	sc	1	Q1Dx14

Mice were monitored every day throughout the study for behaviour and survival. The body weight and tumor volume was monitored twice a week for all mice throughout the study.

15 Isoflurane® Forene (Centravet, Bondoufle, France) was used to anaesthetize the animals before cell injection, surgery (orthotopic tumor implantation) and sacrifice.

During SC tumor amplification, the tumor volume was monitored twice a week for all mice throughout the study.

20 Mice were sacrificed at D26. The liver and tumors were collected and weighed for all animals. Invasion of liver by tumor nodules was evaluated macroscopically. Livers and tumors were fixed in 10% neutral buffered formalin. Forty eight (48) hours after collection, they were embedded in paraffin (Histosec®) and used for histology analysis. Two slides were issued from two different parts into the core of each tumor. Each slide was identified by the mouse identification number. One slide was issued per liver, localized at its center. It was identified by the mouse identification number. For determination of proliferating index by Ki67 marker, paraffin-embedded sections (5 µm) were deparaffinized in xylene (Ref. 11699027, Labonord,

Templemars, France) and rehydrated by serial incubations in 100%, 95%, and 70% ethanol (Ref. 13099500, Labonord). Endogenous peroxidase was inhibited by incubating tissues in hydrogen peroxide containing solution for 10 min at room temperature before addition of the first antibody. A biotin blocking system was used to reduce background. Sections were treated for 20 min with 3 % bovine serum albumin (BSA) in PBS (1X) completed with 3% goat serum at room temperature to inhibit crossreactivity before addition of the first antibody. Tissue sections were incubated for 1 hour at room temperature with the mouse anti-human Ki-67 clone MIB-1 monoclonal antibody (Ref M7240, Dako cytometry; 1: 100 dilution, 80 µg/ml). A non-relevant biotinylated mouse IgG1 antibody (Ref X0931, Dako cytometry, 1: 120 dilution, 100 µg/ml) was used as a negative control slide ensuring the specificity of reaction. The sections were further incubated with the secondary goat anti-mouse antibody (Ref. 89904, Sigma) coupled to biotin. Then, tissue sections were incubated for 30 min at room temperature with the avidin-biotin-peroxidase conjugate (Ref PK-6100, Vector Laboratories, 1 :50 dilution). DAB peroxidase substrate (Ref SK-4100, Vector Laboratories) was used as a chromogen to visualize the reaction. Sections were counterstained with Mayer's haematoxylin for histological study. After each incubation, sections were washed two times with 1X PBS. The coverslip was mounted with aqueous mountant and sections were visualized under a light microscope (DMRB Leica).

For detection of metastasis in mouse liver by histological analysis, paraffin-embedded sections (5µm) were deparaffinized in xylene and rehydrated by serial incubations in 100%, 95%, and 70% ethanol. All sections were stained with haematoxylin and eosin (HE) (Ref. 83309, Dakocytometry, Trappes, France) for histological analyses. The coverslip was mounted with aqueous mountant (Aquatex, Ref 1.08562, Merck) and sections were viewed under a light microscope (DMRB Leica). Histological sections were analyzed by an experienced pathologist to determine the metastatic invasion in liver.

For the body weight analysis body weight curves of mice were drawn. Curves were stopped when more than 40% of dead mice were recorded in at least one group. Mean body weight change (MBWC): Average weight change of treated animals in grams (weight at day X minus weight at D-7) was calculated.

Tumor weights were calculated. Tumor growth inhibition (T/C %) was defined as the ratio of the median tumor weight of treated groups versus vehicle treated group. The effective criteria

for the T/C% ratio according to NCI standards is $\leq 42\%$. For semi-quantification of proliferating index (Ki-67 staining), the numeric images of stained tumor sections were blindly analyzed and classified as no staining (level 0 corresponding to none stained area), low staining (level 1 corresponding to less than 10% of stained area), moderate staining (level 2 corresponding to 10 to 30% of stained area) and strong staining (level 3 corresponding to more than 30% of stained area). Representative pictures were taken. For detection of metastasis in the liver mean liver weights were measured, and the number of metastasis per liver was estimated on entire liver macroscopically and on section by histological analysis. Results were reported in a table. Representative pictures were taken. All statistical analyses were performed using Vivo manager® software, Statistical analysis of the toxicity and the efficiency of the treatment (MBWC, TV, Volume V and time to reach V, DT) were performed using the Bonferroni/Dunn test (ANOVA comparison). All groups were compared with each other.

Ten millions (10^7) HCT 116 cells were SC injected in 5 irradiated female SCID mice. No mycoplasma was detected in cells and their viability was 99 % before injection. Thirty-nine days after, when mean tumor volume was $864 \pm 426 \text{ mm}^3$, mice were sacrificed. Their tumor was isolated and cut into pieces of approximately 20~30 mg. These pieces were implanted at D0 onto the cecum of 75 treated animals. From D0 to 09, surgery complications due to tumor implantation induced death of 33% of mice in vehicle treated group. In the treated groups, percentages of death were 40%, 34%, 47% and 40%, with no dose related effect. The fact that treatments with XG-102 did not significantly modify lethality compared to vehicle treated group suggest that treatments were tolerated by animals. Moreover, between the day of treatment start (D-7) and two days before surgery (D-2), the six daily treatments did not induce any significant body weight loss, indicating again that XG-102 was well tolerated. At D-2, MBWC was distributed between $+5.2 \pm 4.6\%$ for vehicle treated group to $+7.1 \pm 4.6\%$ in the group PO treated at 0.1 mg/kg/adm. In addition, after surgery, no MBWC difference was observed between the group treated with vehicle and those treated with XG-102 at different doses, even if a significant decrease caused by surgery was observed for all groups, when comparing MBWC before and after surgery.

The mean liver weights in mice sacrificed at D26 were distributed between $0.82 \pm 0.17 \text{ g}$ in vehicle treated group and $0.91 \pm 0.17 \text{ g}$ in the group PO treated at 0.1 mg/kg. They were not significantly different. In the vehicle treated group, 20% did not develop any metastasis in

liver. As shown in Figure 76, this control group was the one where the number of mice developing more than 1 metastasis in liver was the highest (40%). In the treated groups, this score was distributed between 12.5% for the group PO treated at 1 mg/kg to 25% for the groups PO treated at 0.1 mg/kg or SC treated at 1 mg/kg. Remarkably, the group PO treated at 1 mg/kg had the highest number of mice with no liver metastasis, suggesting that XG-102 might decrease metastatic power of HCT 116 orthotopic tumor.

Example 34: Evaluation of efficacy of XG-102 in reducing the photoreceptors light damage in rat (AMD model)

The aim of this study was to investigate the dose effect of XG-102 on light-induced photoreceptor cell death.

50 male Rat (Sprague-Dawley (albinos rat); approximately 8 weeks; 200 – 250 g (on ordering)) have been used. Rats are most commonly used in this experimental model. Animals were examined before study, and particular attention was paid to the eyes. Animals were held in observation for 2 weeks following their arrival. Animals were observed daily for signs of illness. Only healthy animals with no ocular abnormalities were accepted for use in experiments. Animals were housed individually in standard cages (420 x 270 x 190 mm)ⁱⁱ. All animals were housed under identical environmental conditions. The temperature was held at $22 \pm 2^{\circ}\text{C}$ and the relative humidity at $55 \pm 10\%$. Rooms were continuously ventilated (15 times per hour). A cycle of 12 hours light (200-300 lx) and 12 hours darkness was automatically controlled. These parameters were continuously controlled and recorded. Throughout the study, animals had free access to food and water. They were fed a standard dry pellet diet. Tap water was available ad libitum from plastic bottles.

Study Design:

Forty-eight (48) rats were randomly divided into six (6) groups of eight (8) animals each.

Test item (XG-102: 30 mg/ml, 3 mg/ml, and 0.3 mg/ml) and vehicle (0.9% NaCl) were administered by intravitreal injection in right eyes the day before induction. The reference (Phenyl-N-test-Butylnitron (PBN) (50 mg/kg)) and vehicle were intraperitoneally injected 30 min before induction then, 3 times during 12 hours of light exposition, then once after induction. Animals were placed in constant light (7000 lux) for 24 h. Electroretinograms (ERG) were recorded before light treatment and on days 9, 16 and 23 after induction. Eyes were

then taken for histology and outer nuclear layer (ONL) thickness assessment. The table below summarizes the allocation of animals in treatment groups:

Group No.	Treatment	Dose	Route of administration (volume)	Time of administration	Animals Identification
1	XG-102	30 000 µg/mL 150 µg/eye	i.v.t. (5 µl)	Day before induction (D0)	13, 38, 9, 35, 2, 23, 25, 36
2		3 000 µg/mL 15 µg/eye			18, 28, 5, 27, 16, 12, 30, 1
3		300 µg/mL 1.5 µg/eye			3, 11, 8, 17, 31, 7, 22, 15
4	Vehicle	-			6, 29, 24, 21, 40, 32, 14, 37
5	PBN	50 mg/kg	i.p. (2.5 ml/kg) (5 times)	30 min before induction, then 2 h, 4 h, 6 h (during light exposure – D1) and 24 h (at the cessation of exposure – D2) after induction	4, 39, 19, 33, 10, 26, 34, 20
6	Vehicle	-			41, 42, 43, 44, 45, 46, 47, 48

Forty-eight (48) animals out of fifty (50) were used in this study. Only animals with no visible sign of ocular defect were selected. Then, the randomization in the treatment groups was done by a random function in Excel® software.

Route and Method of Administration

For the intravitreal injection animals were anesthetized by intramuscular injection of a mixture of xylazine / ketamine. Test item (5 µl) and vehicle (5 µl) were injected in the right eye. The injection was performed under an operating microscope in the supratemporal area at pars plana using a 33G-needle mounted on a 50 µl Hamilton. The filled syringe was mounted into the UltraMicroPump III to achieve accurate injection in microliter range. Reference and vehicle were injected intraperitoneally at a dose volume of 2.5 ml/kg using a 30G-needle mounted on a 1 ml-syringe.

Light Exposure: The rats that had been dark-adapted overnight were exposed for 24 hours to a continuous white fluorescent light (7000 lx) in clear plastic cages. Each cage contained one rat. After exposure, the rats returned to rearing cyclic light conditions.

The body weight of all animals was recorded before the start of the study then at the end of the study. Each day, the general behavior and the aspect of all animals were observed.

ERG was recorded before induction and 7, 14 and 21 days after cessation of exposure (Days 9, 16 and 23) on right eyes of dark-adapted and anesthetized animals. The latency times (for a- and b-wave) and the a-wave and b-wave amplitudes were measured for each ERG; the latency times were expressed as millisecond and the a-wave and b-wave as a percentage of the baseline value obtained before light exposure. 15 min before measurement 10 μ l Mydriaticum® (0.5% tropicamide) were instilled for pupillary dilatation.

ERG parameters:

- Color: white maximum.
- Maximum intensity: 2.6 cd.s/m² (0dB); Duration 0.24 ms; number of flash: 1.
- Filter: 50 Hz.
- Impedance Threshold: 90 k Ω .

Measurement of the ONL Thickness: After ERG testing, animal was euthanized by an overdose of pentobarbital and the right eyes were enucleated, fixed and embedded in paraffin. Sections (5 μ m thick) were performed along the vertical meridian and stained with Trichrome-Masson. The vertical meridian included the optic nerve. ONL Thickness was done every 500 μ m (seven points) between 500 and 3500 μ m from the optic nerve in the inferior retina using a standard microscope (Leica).

Results were expressed in the form of individual and summarized data tables using Microsoft Excel® Software. Group mean values and standard deviation were calculated. A statistical Mann and Whitney test was used to evaluate the differences between pair-wise groups. For comparison between time-point into each vehicle groups, a Friedman test was used.

Results

General behavior and appearance were normal in all animals.

The animal body weights all were within a normal range at baseline: 379 ± 13 g (mean $\pm$ SD; n = 48). On sacrifice day (Day 23) no visible differences between test articles, and vehicle were observed. The mean body weights, recorded for each group just before the start of the study (baseline) and on the day of euthanasia were within a normal range with a body weight gain about $31 \pm 5\%$ (mean $\pm$ SD; n = 48).

Electroretinograms

To investigate the protective effect on photoreceptors, test, vehicle and reference items were evaluated in light-induced photodegeneration model. The functional status of retina was evaluated by electroretinography. Electroretinography waves' amplitudes were normalized to baseline values and expressed as a percent of the baseline. Figure 77 illustrates the time course of recovery for the different groups.

Phenyl-N-tert-Butylnitron, a synthetic anti-oxidant that has been shown to protect albino rat from light-induced photoreceptor death was used as reference in the assay. Three doses of XG-102 were tested: 1.5 µg/eye (0.3 mg/ml, Low dose), 15 µg/eye (3 mg/ml, Mid dose) and 150 µg/eye (30 mg/ml, High dose). The mean values of the a and b-waves for amplitude (in %; mean ± SD) are summarized in the following tables:

A-wave	Time after the beginning of exposure								
	Day 9			Day 16			Day 23		
	Mean	±	SD	Mean	±	SD	Mean	±	SD
Vehicle (IVT)	5.7	±	4.9	13.2	±	9.7	22.5	±	9.6
XG-102 (ivt, 1.5 µg/eye)	39.5§	±	19.0	47.5§	±	16.5	48.3§	±	15.2
XG-102 (ivt, 15 µg/eye)	35.7§	±	22.0	51.1§	±	18.9	41.8	±	23.6
XG-102 (ivt, 150 µg/eye)	23.6	±	25.3	24.1	±	28.1	23.7	±	27.2
Vehicle (ip)	9.0	±	19.2	13.6	±	24.0	18.6	±	22.0
PBN (ip, 50 mg/kg)	70.4§	±	16.2	79.6§	±	9.4	76.2§	±	13.1

§ $p < 0.05$ by Mann and Whitney test, x vs. vehicle.

B-wave	Time after the beginning of exposure								
	Day 9			Day 16			Day 23		
	Mean	±	SD	Mean	±	SD	Mean	±	SD
Vehicle (IVT)	15.3	±	11.4	24.8	±	15.9	30.6	±	13.8
XG-102 (ivt, 1.5 µg/eye)	55.3§	±	23.8	61.7§	±	19.7	73.5§	±	22.0
XG-102 (ivt, 15 µg/eye)	60.6§	±	32.8	62.3§	±	18.5	56.5	±	29.8
XG-102 (ivt, 150 µg/eye)	31.9	±	42.6	38.9	±	51.5	37.1	±	54.4
Vehicle (ip)	15.6	±	29.3	17.3	±	30.6	24.9	±	33.9

PBN (ip, 50 mg/kg)	100 $\pm$ 18.6	103.6 $\pm$ 12.1	102.4 $\pm$ 11.0
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$\$ p < 0.05$ by Mann and Whitney test, x vs. vehicle.

As also shown in Figure 77, the mean a-wave amplitude in the induced groups that was injected with vehicle by intraperitoneal or intravitreal injection showed reduction at Days 9, 16 and 23 compared with control values on baseline. The a-wave was reduced to less than 50% of control values on Day 9 ($p < 0.01$), Days 16 ($p < 0.01$) and 23 ($p < 0.05$). The b-wave was significantly reduced to less than 50% of control values on Day 9 ($p < 0.01$) and Day 16 ($p < 0.01$). On Day 23, the reduction was not statistically significant. In the group treated with PBN and exposed to the damaging light, the retinal function was preserved to a large extent. The recovery of the a-wave was significantly improved compared with vehicle at Day 9 ($p < 0.01$), at Day 16 ($p < 0.01$) and Day 23 ($p < 0.01$) and was 70.4%, 79.6% and 76.2%, respectively. Similarly, the recovery of the b-wave was significantly greater ($p < 0.01$) than the vehicle, 100%, 103.6% and 102.4% at days 9, 16 and 23, respectively.

Rats treated with different doses of intravitreal XG-102 up to 15 μ g/eye and exposed to the damaging light, showed a preservation of the retinal function to a large extent compared with vehicle at Days 9, 16 and 23. The recovery of the a-wave was 47.5% ($p < 0.01$) and 51.1% ($p < 0.01$) at Day 16 and 48.3% ($p < 0.01$) and 41.8% ($p < 0.05$) at Day 23 for the low and mid dose, respectively. Similarly, the recovery of the b-wave was greater than the vehicle and was 55.3% and 60.6% at Day 9, 61.7% and 62.3% at Day 16, 73.5% and 56.5% at Day 23, for the low and mid dose respectively. On the other hand, high-dose (150 μ g/eye group) XG-102 showed no effect in preventing light damage. The recovery of the a-wave was 23.6%, 24.1% and 23.7% versus 5.7%, 13.2% and 22.5% for the vehicle group at Days 9, 16 and 23, respectively. Similarly, the recovery of the b-wave was 31.9%, 38.9% and 37.1% versus 15%, 24.8% and 30.6% for the vehicle group at Days 9, 16 and 23, respectively.

ONL Thickness

To assess the ability of treatment to preserve photoreceptor structure, the thickness of the ONL was evaluated 21 days after cessation of exposure (Day 23). The mean values are summarized in the following table:

<i>Treatment</i>	<i>ONL thickness (μm)</i>	<i>ONL thickness Loss (% comparison with control non-induced eye)</i>
Non-induced eyes (internal data)	40.6 ± 4.6	-
Vehicle (IVT)	13.94 ± 3.35	66%
XG-102 (ivt, 1.5 $\mu\text{g}/\text{eye}$)	24.89 ± 4.01 §	39%
XG-102 (ivt, 15 $\mu\text{g}/\text{eye}$)	24.42 ± 5.99 §	40%
XG-102 (ivt, 150 $\mu\text{g}/\text{eye}$)	18.95 ± 9.17	53%
Vehicle (ip)	12.56 ± 8.15	69%
PBN (ip, 50 mg/kg)	34.05 ± 4.00 §	16%

§ $p < 0.05$ by Mann and Whitney test, x vs. vehicle (ivt, ip).

A decrease in ONL thickness was observed in the eyes of vehicle-treated rats. A 66% to 69% loss of mean ONL thickness was observed in vehicle-treated eyes after exposure compared with untreated eyes. Administration of PBN showed a significant protection compared with vehicle groups (ivt and ip, $p < 0.001$). When the rats were treated with PBN, the ONL was preserved. Only a small decrease (16%) was observed compared with untreated eyes in normal condition ($40.6 \pm 4.6 \mu\text{m}$, internal data). The decrease in ONL thickness was inhibited in the XG-102-treated rats with the low and mid doses ($p < 0.01$ compared with vehicle). No protection was observed with high dose XG-102. A 40% loss of the mean ONL thickness was observed in low and mid doses XG-102-treated eyes.

Thus, under these experimental conditions, it can be stated that:

- In vehicle treated groups (2 routes of administration: ivt, ip) a bright light exposure induced a decrease of retinal function and a loss of photoreceptor. 23 days after exposure, the recovery of the a-wave was 18.6% (ip) and 22.5% (ivt); 69% (ip) and 66% (ivt) loss of mean ONL thickness was observed.
- Systemic administration (i.p.) of PBN protects significantly the retina from light damage. The PBN-treated group maintained 76.2% of a-wave and only a small loss (16%) of mean ONL thickness was observed.
- Intravitreal injection of 1.5 and 15 $\mu\text{g}/\text{eye}$ XG-102 protects significantly the retina from light damage. The XG-102 treated group maintained 48.3% and 41.8% of a-wave and a 40% loss of mean ONL thickness was observed.

Taken together, according to the statistical analyses, intravitreal injection of XG-102 (1.5 and 15 µg/eye) was efficient to protect retinal function. Under these experimental conditions, the results indicate that XG-102 by IVT at doses 1.5 µg and 15 µg/eye protects the structure and function of the retina from acute light-induced damage.

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Example 35: Efficacy and safety of XG-102 in reduction of post-cataract surgery intraocular inflammation (Clinical Phase III)

10 A multicenter, randomized, double-masked, vehicle-controlled, parallel group phase III study served to assess the efficacy and safety of a single sub-conjunctival injection of XG-102 for the reduction of post-cataract surgery intraocular inflammation. The purpose of this study is to evaluate the clinical efficacy and safety of XG-102 (900µg) compared to vehicle (NaCl 0.9%) in the treatment of subjects with inflammation and pain following uncomplicated cataract surgery.

15 The study focuses on inflammation and pain following eye surgery, in particular unilateral cataract extraction via phacoemulsification and posterior chamber intraocular lens (PCIOL) implantation in the study eye. Treatment by a single sub-conjunctival injection of 900µg of XG-102 is compared versus placebo (vehicle: NaCl 0.9%) sub-conjunctival injection. Visits # 3, 4, 5, 6 and 7 are planned at days 2, 8, 15, 22 and 85 respectively.

20

In particular the absence of anterior chamber cells for the 900µg XG-102 sub-conjunctival injection compared to vehicle, preferably at visit 5 at day 15, and the absence of pain for the 900µg XG-102 compared to vehicle, preferably at visit 3 at day 2, serve as primary outcome measures. Secondary outcome measures are in particular absence of anterior chamber cells, preferably at visits 3, 4 and 6 (Days 2, 8 and 22 respectively), absence of pain, preferably at visits 4, 5 and 6 (Days 8, 15 and 22 respectively), absence of flare, preferably at visits 3, 4, 5 and 6 (Days 2, 8, 15 and 22 respectively), absence of anterior chamber cells and flare, preferably at visits 3, 4, 5 and 6 (Days 2, 8, 15 and 22 respectively), and use of rescue medication on or prior each visit and overall. Other pre-specified outcome measures include

25 in particular pin-hole visual acuity, preferably at visits 3, 4, 5, 6 and 7 (Days 2, 8, 15, 22 and 85 respectively), slit-lamp biomicroscopy, preferably at visits 3, 4, 5, 6 and 7 (Days 2, 8, 15, 22 and 85 respectively), dilated indirect ophthalmoscopy, preferably at visit 6 (Day 22), intraocular pressure (IOP), preferably at visits 3, 4, 5 and 6 (Days 2, 8, 15 and 22 respectively),

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specular microscopy, preferably at visit 7 (Day 85), and adverse event (AE) monitoring, preferably at visits 3, 4, 5, 6 and 7 (Days 2, 8, 15, 22 and 85 respectively).

5 Example 36: Effects of XG-102 (SEQ ID No. 11) on Renal Ischemia/Reperfusion Lesions

Renal Ischemia/Reperfusion (Renal I/R) injury is a commonly employed model of acute kidney injury (AKI), also known as acute renal failure. In addition to the clinical relevance of studies that examine renal I/R injury to acute kidney injury, experimental renal I/R injury is also an
10 important model that is used to assess the conditions that occur in patients receiving a kidney transplant. Depending upon the donor, transplanted kidneys are not perfused with blood for a variable amount of time prior to transplantation. Because AKI has such serious effects in patients, and all transplanted kidneys experience renal I/R injury to some extent, the clinical relevance and translational importance of this type of research to human health is extremely
15 high. The aim of this study is thus to investigate the influence of the JNK inhibitor XG-102 (SEQ ID NO: 11) on experimental renal ischemia/reperfusion in rats.

Twenty-six (26) male Wistar rats (age 5 – 6 weeks) were used in this study (divided into 2 groups of 10 rats and 1 group of 6 rats). Rats were housed in standard cages and had free
20 access to food and tap water. Each day, the general behavior and the appearance of all animals were observed. The health of the animals was monitored (moribund animals, abnormal important loss of weight, major intolerance of the substance, etc...). No rats were removed.

25 Renal ischemia was induced by clamping both renal pedicles with atraumatic clamp. A single dose of 2 mg/kg XG-102 (in 0.9% NaCl as vehicle) or vehicle, respectively, was administered by IV injection in the tail vein on Day 0, one hour after clamping period (after reperfusion) both renal pedicles with atraumatic clamp. The administration volume was 2 ml/kg. Heparin (5000 UI/kg) was administered intraperitoneally 1 hour before clamping (in all groups).

30

The table below summarizes the random allocation:

Group N°	Treatment (1 hour after clamping)	Dose volume / Route of administration	Concentration	Renal Ischemia time (min)	Number of animals
1	NaCl 0.9%	2 mL/kg, IV	0		6
2	NaCl 0.9%	2 mL/kg, IV	0	40	10
3	XG-102 (2 mg/kg)	2 mL/kg, IV	1 mg/mL	40	10

For sample collection, rats were housed individually in metabolic cages (Techniplast, France). Urine was collected at 72 hours. Blood samples were obtained from tail vein before and at 24 hours after reperfusion. After animal sacrifice, both kidneys were collected.

For evaluation of proteinuria and albuminuria appropriate kits from Advia Chemistry 1650 (Bayer Healthcare AG, Leverkusen, Germany) were used.

For evaluation of renal function, blood was collected from the tail vein at 24 hours after reperfusion. Serum creatinine ($\mu\text{mol/mL}$) and urea concentrations (mmol/mL) were measured using appropriate kits (Bayer Healthcare AG, Leverkusen, Germany).

Evaluation of histological lesions was performed at 24 and 72 hours after reperfusion.

For light microscopy, kidneys were be incubated for 16 hours in Dubosq-Brazil, dehydrated, embedded in paraffin, cut into sections and stained with hematoxylin and eosin (H&E) or with periodic acid-Schiff (PAS).

For immunohistochemistry, kidney samples were fixed for 16 hours in Dubosq Brazil, and subsequently dehydrated and embedded in paraffin. Antigen retrieval was performed by immersing the slides in boiling 0.01 M citrate buffer in a 500 W microwave oven for 15 min. The endogenous peroxidase activity was blocked with 0,3% H_2O_2 in methanol for 30 min. Slides were incubated with the blocking reagents consisting of the Avidin- biotin solution for 30 min and the normal blocking serum for 20 min. For immunodetection, the slides were incubated overnight with an antibody, then with a biotinylated secondary antibody. An avidinbiotinylated horseradish peroxidase complex (Vectastain ABC Reagent, Vector Laboratories; Burlingame, CA) and 3,3'-diaminobenzidine (Sigma Biochemicals; St Louis, MO) as a chromogen were applied for visualization of the immunoreaction. Slides were

counterstained with hematoxylin. Omission of the primary antibody was considered as a negative control.

Immunofluorescence labeling was carried out on 4 mm thick cryostat sections of kidney tissue fixed in acetone for 10 min, air-dried for 30 min at room temperature, then incubated in PBS for 3 min and blocked in 1 % BSA in PBS. The sections were incubated with the indicated antibodies for 1 hour at room temperature, washed in PBS and incubated with Red Texas-conjugated secondary antibodies. Sections will be examined by fluorescence microscopy (Zeiss).

Moreover, expression of several markers specific of podocyte damage, inflammation and renal fibrosis (RelA, TGF β , TNF α , Masson trichrome) were evaluated by immunohistochemistry and immunofluorescence. Quantitative transcription profile of TNF α , IL6, CXCL 1 (KC), CXCL2 (MIP-2) and MCP1 in kidneys were determined.

Results:

Results are shown in Fig. 78. Serum creatinine (Fig. 78A) and urea (Fig. 78B) were increased in vehicle-treated ischemic rats (G2) 24h following ischemia, as compared to vehicle-treated controls rats without ischemia (G1). On the other hand, XG-102-treated-ischemic rats (G3) exhibited lower serum creatinine, relatively to untreated ischemic rats (G2). These results suggest that XG102 may prevent the ischemia-induced renal failure.

Example 37: Antitumour activity of XG-102 (SEQ ID No. 11) against human liver tumour cell lines

The aim of this study is to determine the cytotoxic activity of XG-102 (SEQ ID No. 11) against human hepatocarcinoma and human hepatoma cell lines using MTS assay.

The human hepatocarcinoma cell line HepG2 (origin: American Type Culture Collection, Manassas, Virginia, USA; the HepG2 cell line was established from the tumor tissue of a 15-year old Argentine boy with a hepatocellular carcinoma in 1975, there is no evidence of a Hepatitis B virus genome in this cell line) and the human hepatoma cell line PLC/PRF/5 (origin: American Type Culture Collection, Manassas, Virginia, USA; the PLC/PRF/5 cell line

secrete hepatitis virus B surface antigen (HBsAg)) are used. Tumor cells are grown as monolayer at 37°C in a humidified atmosphere (5% CO₂, 95% air). The culture medium is EMEM (ref: BE12-611F, Lonza) supplemented with 10% fetal bovine serum (ref: 3302, Pan), 0.1 mM NEAA (ref: BE13-114E, Lonza) and 1 mM NaPyr (ref: BE13-115E, Lonza). The cells are adherent to plastic flasks. For experimental use, tumor cells are detached from the culture flask by a 5-minute treatment with trypsin-versene (ref: BE02-007E, Lonza), in Hanks' medium without calcium or magnesium (ref: BE10-543F, Lonza) and neutralized by addition of complete culture medium. The cells are counted in a hemocytometer and their viability is assessed by 0.25% trypan blue exclusion assay.

Tumor cells are plated at the optimal seeding density in flat-bottom microtitration 96-well plates (ref 167008, Nunc, Dutscher, Brumath, France) and incubated in 190 µL drug-free culture medium at +37°C in a humidified atmosphere containing 5% CO₂ for 24 hours before treatment.

Dilutions of XG-102 (SEQ ID No. 11) as well as distribution to plates containing cells are performed manually. At treatment start 10 µL of XG-102 (SEQ ID No. 11) dilutions are added to wells at the following final concentrations (for both cell lines): 0, 3.8×10^{-3} , 1.5×10^{-2} , 6.1×10^{-2} , 0.24, 0.98, 3.9, 15.6, 63, 250 and 1000 µM. Then cells are incubated for 72 hours in 200 µL final volume of culture medium containing XG-102 at + 37°C in a humidified atmosphere containing 5% CO₂. At the end of treatments, the cytotoxic activity is evaluated by a MTS assay.

The *in vitro* cytotoxic activity of the XG-102 is revealed by a MTS assay using tetrazolium compound (MTS, 3-(4,5-dimethylthiazol-2-yl)-5-(3-carboxymethoxy phenyl)-2-(4-sulfophenyl)-2H-tetrazolium) and an electron coupling reagent named PMS (phenazine methosulfate). Like MTT, MTS is bio-reduced by cells into a formazan product that is directly soluble in culture medium without processing, unlike MTT. At the end of cell treatment, 40 µL of a 0.22 µM freshly filtered combined solution of MTS (20 mL at 2 mg/mL, ref: G11 11, Promega, Charbonnieres, France) and PMS (1 mL at 0.92 mg/mL, ref: P9625, Sigma) in Dulbecco's Phosphate Buffered Saline (DPBS, ref: 17-513F, Cambrex), are added in each well. Absorbance (Optical Density, OD) is measured at 490 nm in each well using a VICTOR3™ 1420 multilabeled counter (Wallac, PerkinElmer, Courtaboeuf, France).

Individual OD values of MTS assays are provided. Dose response for index of cytotoxicity (IC) is expressed as follows:

$$IC = (OD_{\text{drug-exposed wells}} / OD_{\text{vehicle-exposed wells}}) \times 100$$

5

whereby IC₅₀ refers to the drug concentration to obtain a 50% inhibition of cell proliferation. IC₅₀ represent drug concentration required to obtain 50% of cellular cytotoxicity. Dose-response curves are plotted using XLFit5 (IDBS, United Kingdom) and provided. The IC₅₀ determination values are calculated using the XLFit5 software from semi-log curves. Each individual IC₅₀ determination values are provided as well as mean $\pm$ SD IC₅₀ values.

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Figure 107 shows the results of the determination of the cytotoxic activity of XG-102 against HepG2 and PLC/PRF/5 tumour cell lines using MTS assay.

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Example 38: Effects of XG-102 (SEQ ID No. 11) in a Rat model of Experimental Autoimmune Uveitis (posterior uveitis)

In the United States, there are approximately 70,000 cases of uveitis per year, and autoimmune uveitis is responsible for approximately 10% of severe vision loss (Caspi et al., 2012). Experimental autoimmune uveitis (EAU) is an organ specific autoimmune disease that targets the neural retina, i.e. it is a model of posterior uveitis. This autoimmune response is induced when animals are immunized with retinal antigens, e.g. Interphotoreceptor retinoid-binding protein (IRBP). In this study, animals are immunized with IRBP. After a period of 9-14 days, animals develop uveitis in the eye. At the end of the study, animals are sacrificed and eyes submitted for histology.

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Sixty-four (64) male Lewis rats (8 weeks, Charles River) are randomly assigned to test groups. Groups 1 to 6 are immunized with an emulsion of interphotoreceptor binding protein (IRBP) in Complete Freund's Adjuvant (CFA).

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Group Assignment:

Group	Number of animals	Route	Dose	Dose Concentration ($\mu\text{g}/\mu\text{L}$ or mg/mL)	Dose Volume
1/Vehicle	10	Sub-conj.	0 $\mu\text{g}/\text{eye}$	0	5 $\mu\text{L}/\text{Eye}$
2/XG-102	10	Sub-conj.	20 $\mu\text{g}/\text{eye}$	4	5 $\mu\text{L}/\text{Eye}$
3/Vehicle	10	Intravitreal	0 $\mu\text{g}/\text{eye}$	0	5 $\mu\text{L}/\text{Eye}$
4/XG-102	10	Intravitreal	2 $\mu\text{g}/\text{eye}$	0.4	5 $\mu\text{L}/\text{Eye}$
5/FTY-720	10	Oral	0.3 mg/kg	0.03	10 mL/kg
6/No Treatment	10	n/a	n/a	n/a	n/a
7/Naive	4	n/a	n/a	n/a	n/a

5

FTY 720 is used as positive control (group 5). Animals (group 5) are given 0.3 $\text{mg}/\text{kg}/\text{day}$ FTY 720 in 10% PEG and sterile water (once daily from day -3 to day 13; route: oral gavage). The total volume per day is no more than 10 $\text{mL}/\text{kg}/\text{day}$. Rats are weighed every Monday, Wednesday, and Friday, and the volume to be administered is determined by the group's average weight.

10

XG-102 is given at a single dose at day -1 either at 20 $\mu\text{g}/\text{eye}$ subconjunctivally (group 2) or at 2 $\mu\text{g}/\text{eye}$ intravitreally (group 4). To this end, animals are sedated with an intraperitoneal (IP) injection of a mixture of ketamine and xylazine (k/x) at a concentration of 33.3 mg/kg ketamine and 6.7 mg/kg xylazine. Once fully sedated (as confirmed by lack of toe pinch reflex), each eye is given a drop of Proparacaine. Under a dissection microscope, 5 μL of XG-102 (as described above) are carefully administered into the vitreous or sub-conjunctiva of each eye. Lubrication (such as Puralube®) is added to the eye to prevent corneal ulcer formation. The animal is then placed on a warm heating pad and monitored until fully awake.

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On day 0, groups 1 to 6 are immunized by a single subcutaneous administration of IRBP/CFA. To this end, an emulsion of IRBP in CFA is made at the day of injection. Animals are lightly anesthetized with isoflurane and receive 50 μg IRBP in 200 μL of CFA.

- All animals are daily checked for general health/mortality and morbidity. Prior to any dose (or Day -3 for the untreated but immunized and naïve groups) and prior to euthanasia on Day 14, fundus exams are performed. To this end, animals are sedated with k/x (the same amount as specified above). Once sedated, a drop of GONAK is placed on each eye and is gently placed on a platform. The eye is positioned to make gentle contact with a special lens for fundus imaging. Images are taken with the Micron III. Animals receiving IVT injections have baseline fundus exams just prior to injection when they are already sedated. All other animals not receiving IVT injections are sedated on Day -3. For clinical evaluation, on day 13 animals are observed under a dissection microscope and scored on a scale of 0-4 based on their clinical disease. After sacrifice on day 14 and upon verification of death, both eyes of each animal are carefully removed via forceps, being sure to keep as much of the optic nerve intact as possible. Eyes are placed in Davidson's fixative for 24 hours. Eyes are transferred to 70% ethanol for histology. Each eye is stained with hematoxylin and eosin for histological analysis.
- The experimental design is summarized below:

Procedure	Day-3	Day-2	Day-1	Day 0	Days 1-12	Day 13	Day 14
Baseline Fundus- Groups 5-7	X						
Baseline Fundus- Groups 1-4			X				
Oral dose FTY720 - Group 5	X	X	X	X	X	X	
Sub-conj or IVT of XG-102 or vehicle groups 1-4			X				
Immunization group 1-6				X			
Clinical Evaluations/ Photographs						X	
Final Fundus- All groups							X
Euthanasia and Tissue Collection							X

Example 39: Effects of XG-102 (SEQ ID No. 11) in a rat model of Diabetic Retinopathy

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The objective of this study is to determine the dose-dependent effect of XG-102 on loss of visual acuity, ocular clinical signs and cytokine profiling after repeated sub-conjunctival administration in a rat model of streptozotocin (STZ)-induced diabetes.

To this end, 30 rats (female, Brown Norway, 6-8 weeks at time of STZ-treatment are assigned to the following 5 groups (6 animals per group):

Group	STZ	Treatment	Assessment
1	-	Vehicle NaCl 0.9%	Weekly recording of body weight and blood glucose levels (Weeks 1-16); Weekly Draize scoring of chemosis, hyperemia, and discharge (Weeks 1-16); Quantification of contrast threshold at Days 43, 57, 71, 85, 99, and 113; Quantification of spatial frequency threshold at Days 43, 57, 71, 85, 99, and 113; Quantification of scotopic a-wave, scotopic b-wave, and photopic b-wave at Day 114; Multiplex cytokine quantification of retinas using Bio-Rad rat 23-plex kit
2	+	Vehicle NaCl 0.9%	
3	+	XG-102 (2 µg/eye/2-week)	
4	+	XG-102 (20 µg/eye/2-week)	
5	+	XG-102 (200 µg/eye/2-week)	

- 5 The "treatment" (vehicle or XG-102) is for each group bilateral sub-conjunctival administration (vehicle or XG-102, respectively) on Days 22, 36, 50, 64, 78, 92, and 106.

The experimental design is the following:

Day 1: IP injection of streptozotocin (Groups 2-5)

- 10 Day 4: Blood glucose quantification

Day 22: Bilateral sub-conjunctival injection of vehicle or XG-102 (Groups 2-5)

Day 36: Bilateral sub-conjunctival injection of vehicle or XG-102 (Groups 2-5)

Day 43: OKT* assessment of contrast sensitivity and spatial frequency threshold

Day 50: Bilateral sub-conjunctival injection of vehicle or XG-102 (Groups 2-5)

- 15 Day 57: OKT assessment of contrast sensitivity and spatial frequency threshold

Day 64: Bilateral sub-conjunctival injection of vehicle or XG-102 (Groups 2-5)

Day 71: OKT assessment of contrast sensitivity and spatial frequency threshold

Day 78: Bilateral sub-conjunctival injection of vehicle or XG-102 (Groups 2-5)

Day 85: OKT assessment of contrast sensitivity and spatial frequency threshold

- 20 Day 92: Bilateral sub-conjunctival injection of vehicle or XG-102 (Groups 2-5)

Day 99: OKT assessment of contrast sensitivity and spatial frequency threshold

Day 106: Bilateral sub-conjunctival injection of vehicle or XG-102 (Groups 2-5)

Day 113: OKT assessment of contrast sensitivity and spatial frequency threshold

Day 114: Scotopic and Photopic ERG analyses

Day 114: Enucleation of retinas for multiplex cytokine analyses

*OKT: optokinetic tracking

For streptomycin administration, rats of the same age are weighed the day prior to injections
5 and are fasted overnight, and cages are marked with yellow cards in animal facility. The
weights are averaged, and a single dose is calculated for all rats based upon the average
weight. No more than ten animals are injected with a single preparation of STZ due to quick
decrease of STZ activity in solution, and the procedure is repeated for each batch of 10
10 animals. STZ powder is dissolved in 10 mM sodium citrate, pH 4.5, immediately before
injection and rats receive 50 mg/kg STZ intraperitoneally in a volume of 1 mL using a 22
gauge syringe with care to avoid stomach and any vital organs.

For subconjunctival administration, animals are anesthetized with ketamine/xylazine
(Ketamine and xylazine are mixed using a U-100 syringe utilizing 20 units of ketamine (100
15 mg/mL) and 100 units of xylazine (20 mg/mL) and the anesthesia mixture is applied via IP
injection at 1 mL/kg (body weight)) and pupils are dilated with topical administration of
Cyclogel and/or Tropicamide. Following sedation and dilation, a total volume of 50 µL per
eye is injected into conjunctiva using a 31-gauge needle attached to an insulin syringe.

20 For Draize scoring of hyperemia, chemosis, and discharge, animals are restrained by hand
and scores for chemosis, hyperemia, and discharge are recorded by a masked observer using
the "EyeCRO ocular scoring system".

All optokinetic tracking experiments are performed using an Optomotry designed for rodent
25 use (Cerebra) Mechanics Inc.). In this non-invasive assessment, rats are placed onto a platform
surrounded by 4 LCD screens which resides within a light-protected box. Visual stimuli are
then presented to the rats via the LCD screens and a masked observer visualizes and scores
optokinetic tracking reflexes from a digital camcorder which is mounted on the top of the
box. For measurements of spatial frequency threshold, the rats are tested at a range of spatial
30 frequencies from 0.034 to 0.664 cycles/degree. The Optomotry device employs a proprietary
algorithm to accept the input from the masked observer and automatically adjust the testing
stimuli based upon whether the animal exhibited the correct or incorrect tracking reflex. All
measurements of contrast threshold are performed at a spatial frequency threshold of 0.064
cycles/degree.

For electroretinography (ERG), after a minimum of 12 h dark adaptation, animals are anesthetized by intraperitoneal injection of 85 mg/kg ketamine and 14 mg/kg xylazine. Animal preparation is performed under a dim red light (< 50 lux). ERG analyses are performed using an Espion system from Diagnosys. For the assessment of scotopic response, a stimulus intensity of 40 (S) cd.s/m² is presented to the dark-adapted dilated eyes. The amplitude of the scotopic a-wave is then measured from the prestimulus baseline to the a-wave trough. The amplitude of the b-wave is then measured from the trough of the a-wave to the crest of the b-wave. To evaluate photopic response, animals are light adapted for 10 min then presented a strobe flash to the dilated eyes with an intensity of 10 (S) cd.s/m². A total of 25 repeated flashes and measurements are averaged to produce the final waveform. The amplitude of the photopic b-wave is then measured from the trough of the a-wave to the crest of the b-wave.

For multiplex cytokine analysis, at study termination, the retinas will be individually isolated and immediately snap-frozen in liquid N₂. The Bio-Rad "Bio-plex Pro Rat Cytokine 23-plex assay (Cat# L80-01V11 S5) is used according to manufacturer's specifications to quantify the protein expression of EPO, G-CSF, GM-CSF, GRO/KC, IFN- γ , IL-1 α , IL-1 β , IL-2, IL-4, IL-5, IL-6, IL-7, IL-10, IL-12, p70, IL-13, IL-17A, IL-18, M-CSF, MCP-1, MIP-3 α , RANTES, TNF- α , and VEGF in each retina isolated in the study.

Results:

To determine the ocular tolerability of bilateral sub-conjunctival administration of XG-102, a comprehensive ophthalmic examination of signs of ocular irritation indicated by chemosis, hyperemia, or discharge was performed once a week for the duration of the study. The rats were scored on a scale of 0 (normal) to 4 (severe) for each indicator. There was no observed ocular irritation at any time point in any of the animals administered either vehicle or XG-102.

Optokinetic tracking was used to measure the maximum spatial frequency distinguished by STZ-diabetic Brown Norway rats at 2-week intervals beginning on Day 43 (6 weeks post-STZ). There is no loss in visual acuity in the non-diabetic group administered vehicle. At Day 43, there was no difference in visual acuity across groups. Visual acuity decreases in STZ-diabetic rats treated with vehicle at Day 57. All STZ-diabetic rats show a decline in visual

acuity between Day 57 and Day 99 (Fig. 89 A – C). However, treatment with either 20 µg/eye, or 200 µg/eye XG-102, significantly delays the progressive decline in visual acuity at each of these time points (Fig. 89 A – C). At Day 113, all groups administered XG-102 display higher visual acuity scores relative to the vehicle treated STZ-diabetic group, with the groups receiving either 2 µg/eye or 200 µg/eye having significantly higher spatial frequency thresholds (Fig. 89D).

Optokinetic tracking was used to measure the threshold at which STZ-diabetic rats were able to distinguish contrast in visually presented stimuli at 2-week intervals beginning on Day 43.

There is no loss in contrast sensitivity in the non-diabetic group administered vehicle. At Day 43 and Day 57, the STZ-diabetic groups administered either vehicle, or 2 µg/eye XG-102 had decreased contrast threshold values relative to all other groups. All STZ-diabetic groups show a decline in contrast threshold values over the course of the study, but the decline is significantly delayed in the group treated with 200 µg/eye (Figure 90 A, B). At Day 99, all XG-102 treated groups have significantly higher contrast threshold values relative to the vehicle group (Figure 90 C), and the values remain higher through Day 113 (Figure 90 D).

At Day 114, eyes were enucleated, and retinal tissue was collected and processed for Multiplex cytokine analysis of 23 unique cytokines. STZ-induced diabetes raised retinal levels in vehicle treated animals for 13 of the 23 cytokines observed (Figure 91). Seven of the 13 elevated cytokines were reduced in STZ-diabetic animals treated with 2 µg/eye XG-102 (Figure 91). All cytokines were BLQ in the retinal tissue collected from the groups of rats receiving either 20 µg/eye, or 200 µg/eye XG-102 (Figure 91). The total protein concentration was equal for all samples used to detect cytokines, and the standard curves for each individual cytokine had high r-squared values. Therefore, there is no evidence for protein degradation or deficiencies in the assay itself. The cytokines that were upregulated in vehicle treated diabetic animals, and downregulated by treatment with 2 µg/eye XG-102 were: IL-β, IL-13, IL-17, RANTES, GM-CSF, MCSF, and IL-7. Each of these cytokines is linked to inflammation-associated diabetic retinopathy disease progression.

Taken together, bilateral sub-conjunctival delivery of XG-102 was well tolerated by Brown Norway rats as there was no indication of chemosis, hyperemia, or discharge at any point throughout the study. Visual acuity and contrast sensitivity display a progressive decline in STZ-diabetic rats in all treatment groups. The vision loss is greatest in rats treated with vehicle

alone. All treatment doses of XG-102 conferred improvements in vision relative to vehicle alone. Treatment with either 2 µg/eye or 200 µg/eye XG-102 significantly rescues visual acuity at Day 113 post-STZ administration; and treatment with 2 µg/eye SDD-1002 significantly rescues contrast sensitivity at Day 113 post-STZ administration relative to vehicle treated STZ-diabetic rats. STZ-induced diabetes resulted in higher retinal cytokine levels in 18 of the 23 cytokines analyzed in this study. 10 of the 18 elevated cytokine levels were decreased by treatment with 2 µg/eye XG-102. All cytokine levels were below the limit of quantification (BLQ) in the retinal tissue of STZ-diabetic rats receiving the two highest doses of XG-102 (20 and 200 µg/eye).

The results of this study indicate that sub-conjunctival delivery of XG-102 is well tolerated by rats and does not cause adverse effects. XG-102 is effective in improving loss of both visual acuity and contrast sensitivity over 16 weeks in STZ-induced diabetic retinopathy in rats.

Example 40: Evaluation of XG-102 (SEQ ID NO: 11) in Langerhans islet isolation and transplantation

This study is based on the previous studies on islet isolation and transplantation (cf. Examples 17 and 22) and aims at determining the effects of XG-102 on islet viability.

In the first part of this study, the model described in Example 22 was used, i.e. ischemia for a period of 30 min and XG-102 was applied at 100 µM.

As shown in Fig. 79 concerning the impact of ischemia and XG-102 on islet viability, it was again observed that XG-102 decreases apoptosis and necrosis. These results show that XG-102 has a beneficial effect on islet viability.

Because islet isolation is a long process, in which different pathways could be activated to impact islet function and viability, in the second part of this study another model than ischemia was used to investigate the effects of the JNK inhibitor XG-102 on islet viability. Therefore, hypoxia was used as a model for islet isolation/transplantation, since it is known to induce JNK phosphorylation. In these experiments, 18h after isolation, islets were pre-

treated or not with XG-102 100 μ M for 1h and then submitted to hypoxia for 4h, whereby XG-102 was still present (or not in control groups) during the 4 hour hypoxia ("H4").

As shown in the western blot shown in Fig. 80, hypoxia ("H4") induces JNK and JUN phosphorylation as compared to islets maintained in normoxia conditions ("N4"), as expected. Surprisingly, however, the JNK inhibitor XG-102 did not inhibit phosphorylation of JNK and JUN induced by hypoxia (cf. Fig. 80 "H4 + XG102").

Regarding the viability, hypoxia increased apoptosis and necrosis, as shown in Fig. 81 (H4 vs. N4). However when islets were treated with XG-102, apoptosis and necrosis were decreased either in normoxia and hypoxia conditions. In conclusion XG102 had also a beneficial effect on islet viability in this hypoxia model.

Example 41: Effects of XG-102 on puromycine aminonucleoside (PAN)-induced nephropathy – frequency of administration

The aim of this study was to determine the frequency of administration of XG-102 in a model of glomerulonephritis, namely in chronic puromycine aminonucleoside-induced nephropathy in rats. This study is thus based on the study described in Example 20 and the dose of 4 mg/kg XG-102 was chosen based on the results of the study described in Example 20.

This study thus includes the following 8 groups of 15 rats each, whereby "SDD-1002" refers to XG-102:

Group	PAN (<i>i.p.</i>)	Treatment (<i>i.v.</i>)	Number of <i>i.v.</i> administrations	Number of animals/group	Day(s) of administration	Day of sacrifice
1	no	vehicle	2	12	21 and 35	49
2	yes	vehicle	2	12	21 and 35	49
3	yes	SDD-1002	4	12	21, 28, 35 and 42	49
4	yes	SDD-1002	2	12	21 and 35	49
5	yes	SDD-1002	1	12	21	49
6	no	vehicle	1	12	21	77
7	yes	vehicle	1	12	21	77
8	yes	SDD-1002	1	12	21	77

The dose of XG-102 is 4 mg/kg for a single administration in all groups (group 3, 4, 5, and 8). The groups thus vary in the number of *i.v.* administrations as specified above.

5

Male Wistar rats are treated with two repeated intraperitoneal injections (*i.p.*) of PAN (Sigma Aldrich, France) at day 0 (130 mg/kg of body weight) and at day 14 (60 mg/kg of body weight) in saline (0.9 % NaCl). Control rats (groups 1 and 6) receive an equal amount of saline *i.p.* at day 0 and at day 14.

10

XG-102 or its vehicle (0.9% NaCl) are administered into the tail vein (*i.v.*) at different time points as listed above. XG-102 or vehicle administration will start at day 21 after the first PAN injection at day 0. XG-102 will be administered at the dose of 4 mg/kg.

15 The temporal schedule is summarized as follows:

Day 0 and day 14: PAN or its vehicle (saline) injection for induction of nephropathy.

From day 21 to day 42: XG-102 or its vehicle administration by *i.v.* route as described above.

Day 21: Blood sample collection in conscious animals for creatinine and urea quantification (n=12 chosen by randomization in vehicle, n=6, and PAN-treated, n=6, animals).

20 *Day 49 or day 77:* Blood sample collection, sacrifice of animals and sample collections (kidneys).

The study design is shown schematically in Figure 82.

Blood samples are collected in conscious animals at day 21 after the first PAN injection at day 0. For blood and kidney sampling at days 49 and 77 animals are anesthetized by injection of pentobarbital (60 mg/kg; Ceva Sante Animale; Libourne, France). Blood samples are collected and transferred into tubes coated with EDTA 3K (4 °C) , then centrifuged (10 minutes, 3000 rpm, 4°C) for plasma collection. Plasma is stored at -20°C until use for creatinine and urea assays.

Kidneys are removed, cleaned from all connective tissue and capsule and weighted on an electronic microbalance (Mettler, Toledo). Kidneys are transferred in Formalin solution 10% (Sigma Aldrich, France) for 48 h and then transferred in ethanol 70% for further histological preparation and imaging by Histalim (Montpellier, France). At the end of the protocol, animals are sacrificed by cervical dislocation.

For biomarker quantification, e.g. plasma creatinine and urea, will be quantified using an ABX Pentra 400 Clinical Chemistry analyzer (HORIBA) by the Phenotypage platform of Genotoul (Rangueil Hospital, Toulouse, France).

Histological preparation and imaging are performed by Histalim (Montpellier, France). Kidney sections of paraffin embedded tissue are stained by Hematoxylin/eosin, PAS-methenamine silver and Sirius Red for histological evaluation of morphological alterations, glomerular damage evaluation and interstitial fibrosis quantification, respectively. Results are expressed by semi-quantitative scoring following to expert histopathologist evaluation. Fibrosis is expressed as percentage of Red Sirius stained area on total kidney section surface.

All the slides are digitalized at X20 with the Nanozoomer 2.0HT from Hamamatsu (Japan).

Histological examination of glomerulosclerosis

Glomerular changes were evaluated on H&E, PAS and PAS-M stained sections using a semi quantitative scoring system as adapted from Nakajima et al. (2010). Briefly, the degree of glomerular injury was assessed in 25 glomeruli per kidney section (2 sections per animal) for a total of 50 glomeruli per animal. Degree of injury in individual glomeruli was graded using a scale from 0 to 4, based on the percentage of glomerular involvement.

Score 0: normal,

Score 1: lesions in up to 25% of the glomerulus,

Score 2: lesions between 26-50% of the glomerulus,

Score 3: lesions between 51-75% of the glomerulus, and

Score 4: lesions between 76-100% of the glomerulus

The incidence of glomerular damage was expressed as percentage (%) of injured glomeruli (from score 1 to 4) of the total number of evaluated glomeruli (50/animal).

Scores were determined blinded by a histopathologist at Histalim.

Expression and analysis of results

For each group results were expressed as mean values $\pm$ s.e.m.

10 Statistical test used:

- Comparison of all groups using two-way ANOVA for body weight results.
- Comparisons between Group 1 or 6 (Saline/vehicle) and Group 2 or 7 (PAN/vehicle) were performed using unpaired Student *t*-test.
- Comparison between Group 2 (PAN/vehicle) and Groups from 3 to 5 (PAN/XG-102) were performed using a one-way ANOVA followed by Bonferroni's or Newman-Keuls post-test.
- Comparisons between Group 7 (PAN/vehicle) and Group 8 (PAN/XG-102) were performed using unpaired Student *t*-test.
- For statistical analysis of histological scores, when all data were identical or equal to zero one value was modified (for example: 0 to 0.0001) to allow the statistical test to be performed.

A $P < 0.05$ value was accepted as statistical significance.

Results: Glomerular injury score and incidence

25 Glomerular injury was evaluated after collection at day 49 (Groups 1-5) and at day 77 (Groups 6-8).

Glomerular injury score (Figure 83) represents an evaluation of severity of glomerular damage and sclerosis. Quantification of glomerular damage incidence expressed as percentage of injured glomeruli (Figure 84) is an index of the frequency of the lesions and indirectly of the remaining functional nephrons.

Day 49 (groups 1-5):

In naïve control rats (Group 1: Saline/vehicle; Figure 85 A-C), more than 90% of glomeruli were of normal appearance histologically while a small percentage of the glomeruli showed slight segmental evidence of glomerulosclerosis which was mainly characterized by a minimal increase in mesangial matrix and focal hypercellularity. There was low inter-individual variability in the extent of glomerular changes. The glomerular injury score (GIS) in Group 1 (saline/vehicle) was 0.09 ± 0.01 (Figure 83).

In comparison, animals receiving puromycin alone (Group 2) showed histological changes in more than 90% of glomeruli (Figure 84) with a GIS of 1.50 ± 0.06 (Figure 83). Changes (Figure 85 D-F) included a mild to moderate increase in mesangial matrix accompanied by a variable hypercellularity of the glomerular tuft. The number of mesangial cells appeared often slightly increased. The presence of large and pale cells was also noted. These pale cells are likely enlarged podocytes with the presence of occasional macrophages. A small percentage of glomeruli showed a greater degree of glomerular injury with a thickening of the Bowman's capsule and hypertrophy/hyperplasia of parietal epithelial cells in addition to changes in the glomerular tuft. In some cases, glomerular changes were mainly associated with increased PAS positive material in the glomerular tuft and with a slight increase in cellularity. More than 80% of glomeruli were graded with a score of 2 or 3, and some Grade 4 glomeruli were observed. These Grade 4 glomeruli were characterized by an almost global sclerosis and a significant decrease in cellularity. They were representative of terminal glomerulosclerosis.

Glomeruli in Group 3 (PAN/XG-102, 4 *i.v.*) were less affected in percentage (76.9%, Figure 84) and severity in comparison to Group 2 (PAN/vehicle) animals. The Group 3 (PAN/XG-102) GIS was 0.94 ± 0.05 (Figure 83) and significantly different compared to Group 2 ($P < 0.0001$). The glomerular changes were associated with segmental hypercellularity of the mesangial cells often accompanied by a slight increase in mesangial matrix deposition (Figure 85 G-I) as described for Group 2 (PAN/vehicle) animals. There were also certain glomeruli showing a slight increase number of large and pale podocytes, as observed mainly in group 4 and 5, but not as much in Group 2 (PAN/vehicle). The percentage of affected glomeruli was significantly lower than that observed in Group 2 (Figure 7, $P < 0.001$). A clear difference in the percentage of Grade 1 and Grade 2 glomeruli was noted between the groups: Group 3 animals showed an average of 61% of glomeruli with a Grade 1 in comparison to 37% for Group 2, and an average of 15% of glomeruli with Grade 2, whereas the average was 46% in Group 2.

In Group 4 (PAN/XG-102, 2 *i.v.*; Figure 85 J-L), the glomerular changes were a mixture of segmental membranoproliferative to more diffuse proliferative glomerulosclerosis. The GIS was 1.26 ± 0.06 (Figure 83) and significantly different in comparison to 1.50 ± 0.06 for Group 2 ($P < 0.01$). This difference was mostly attributable to higher percentage of Grade 1 glomeruli combined to a lower percentage of Grade 2 glomeruli when compared to Group 2.

In Group 5 (PAN/XG-102, 1 *i.v.*; Figure 85 M-O), the GIS was comparable to Group 2 (1.53 ± 0.05 , Figure 83). At the histology level, glomerular changes were often due to both hypercellularity (mesangial cells) and an increase in mesangial matrix, as observed in Group 2. The respective percentages of affected glomeruli in each Grade (Figure 84) were very comparable between the 2 groups.

Day 77 (groups 6-8).

As observed at Day 49, all naïve control animals (Group 6: saline/vehicle; Figure 86 A-C) presented a high percentage of normal glomeruli (>60-90% Grade 0, Figure 84). Histologically, the glomerular changes were identical to that observed in Group 1 (saline/vehicle, day 49) and consisted, when present, in a minimal and segmental increase in both mesangial matrix and cellularity.

Group 7 (PAN/vehicle; Figure 86 D-F) showed a GIS of 1.39 ± 0.10 (Figure 83) and significantly different compared to Group 6 (saline/vehicle, $P < 0.001$). Three animals of this group (rats n° 74, 111, and 115) were excluded due to a large difference with the Group average (> 2 SD from the mean). Histologically, glomerular lesions ranged from a minimal to mild segmental membranoproliferative glomerulosclerosis (Grade 1 and 2) to a moderate to severe terminal glomerulosclerosis (Grade 3 and 4). The percentage of affected glomeruli (91%) was comparable to that observed in Group 2 (90%) at day 49 (Figure 84).

In comparison to Group 7 (PAN/vehicle), animals in Group 8 (PAN/XG-102, 1 *i.v.*) presented a significant decrease of GIS (0.82 ± 0.04 vs 1.39 ± 0.10 , Figure 83; $P < 0.001$). Group 8 (PAN/XG-102, 1 *i.v.*) presented also a lower percentage of affected glomeruli (69%) in comparison to 91 % of Group 7 (PAN/vehicle, Figure 85; $P < 0.001$). Histologically, glomerular changes when present in Group 8 were characteristic of a segmental membrano-proliferative

glomerulosclerosis (Figure 86 G-I), as described in Group 3 (PAN/XG-102, 4 *i.v.*) animals at day 49.

In summary, the glomerular changes observed in rats receiving puromycin were histologically consistent to what has been described in the literature (Hill, 1986) and in Example 21. The lesions consisted of a membranoproliferative and progressive glomerulopathy with evidence of increased mesangial cell number, presence of large and pale cells, and increased mesangial matrix. XG-102 significantly reduced the extent and severity of glomerular changes when administered (i) by 4 *i.v.* (weekly, Group 3) and 2 *i.v.* (every 2-weeks, Group 4) compared to Group 2 (PAN/vehicle) at day 49; and (ii) by 1 *i.v.* (Group 8) compared to Group 7 (PAN/vehicle) at day 77 (2 months after administration).

These results show that XG-102 has a curative effect: (i) four (weekly administration) and two (every 2 weeks administration) *i.v.* injections of XG-102 at the dose of 4 mg/kg significantly reduced PAN-induced glomerulosclerosis in term of severity of lesions (glomerular injury score) but also significantly decreased glomerular damage incidence (percentage of injured glomeruli) at day 49; (ii) single *i.v.* injection of XG-102 at the dose of 4 mg/kg also lead to a strong effect on glomerulosclerosis in term of both severity of lesions (glomerular injury score) and of glomerular damage incidence (percentage of injured glomeruli) at day 77 (2 months after administration); and (iii) the duration of action of XG-102 is considered to be up to 2 months. Taken together, even a single injection of XG-102 caused a strong long-term effect observed on day 77.

Example 42: Evaluation of XG-102 (SEQ ID NO: 11) in Langerhans islet isolation and transplantation

This study is based on the previous studies on porcine and rat islet isolation and transplantation (cf. Examples 17, 22 and 40) and aims at determining the effects of XG-102 on human islet function. To this end, the same hypoxia model was used as described in Example 40 for rat islets.

Briefly, human islets were pre-treated or not with 100 microM XG-102 for 1h and then submitted to hypoxia during 24h still in presence or not of the inhibitor XG-102.

As shown in Fig. 87 relating to the impact of ischemia and XG-102 on islet viability, it was again observed that XG-102 decreases apoptosis and necrosis under hypoxia conditions. In particular, Fig. 87A shows that XG-102 decreased necrosis either in normoxic and hypoxic conditions. Fig. 87B shows that XG-102 also decreases apoptosis induced by hypoxia. These results show that XG-102 has a beneficial effect on islet viability in the hypoxia model.

Example 43: Evaluation of the action duration of XG-102 (SEQ ID NO: 11) in a rat model of endotoxin-induced uveitis following subconjunctival administration

Acute anterior uveitis is a recurrent inflammatory disease of the eye that occurs commonly and may have potentially blinding sequelae. The pathogenesis of this disease is poorly understood. Patients suffering from acute anterior uveitis complain of photophobia (light sensitivity), which is frequently severe. Other symptoms may include redness of the eye, tearing and reduced vision. Findings on examination are characteristic and include congestion of vessels, cells and protein flare in aqueous humor, and miosis. In severe cases a hypopyon and or fibrin may form. Clinically, chronic progressive or relapsing forms of non-infectious uveitis are treated with topical and/or systemic corticosteroids. However, long-term use of these drugs can result in deleterious ocular and systemic side effects such as glaucoma, cataract, osteoporosis, hypertension and diabetes. Use of alternative steroid-sparing, immunosuppressive agents has also shown clinical benefit, but in themselves carry adverse risks. Given these restrictions, there is an obvious demand for development of new therapeutic strategies. Recent advances in knowledge of the mechanisms of inflammatory resolution and the discovery of several inflammatory mediators has led to a whole new range of potential therapeutic possibilities.

The Endotoxin-Induced Uveitis (EIU) in the rat is a useful animal model for human anterior uveitis. The systemic administration of LPS results in an acute inflammatory response in the anterior and posterior segment of the eye with a breakdown of blood-ocular barrier and inflammatory cell infiltration. Clinical signs of EIU reflect the changes seen in human disease. The characteristic protein flare and cells in the aqueous humor, miosis and posterior synechiae occur, as do fibrin clots and hypopyon.

The aim of this study was to evaluate the duration of action of SDD-1002 following sub-conjunctival administration in a rat model of EIU.

90 male Lewis rats were used, age approximately 6-8 weeks (at the induction), 4 weeks (at the injection for the Day-28), 5 weeks (at the injection for the Day-21), 6 weeks (at the injection for the Day-14, Day-7 and for the Day 0), 7 weeks (at the injection for Day-2 and Day-1), and housed by five in standard cages. Animals were allocated to the following groups:

Group No.	Treatment	Dose	Time-point
1	XG-102	20 microgram/eye	Day-28
2			Day-21
3			Day-14
4			Day-7
5			Day-2
6			Day-1
7			Day 0
8	Saline (0.9% NaCl)	-	
9	Solumedrol®	20 microgram/eye	

Thus, each animal received a single subconjunctival injection of either XG-102 (20 µg/eye), saline (0.9% NaCl) vehicle control or Solumedrol® (20 µg/eye) into each eye. Methylprednisolone (Solumedrol®) is most commonly used in uveitis as sub-conjunctival treatment.

The schedule of the study is shown in the following:

<i>Study date</i>	<i>Procedure</i>	<i>Ocular</i>	<i>Sampling</i>
Baseline	General clinical examination - Weighing	Slit-lamp	-
D-28	General clinical examination – Weighing sub-conjunctival administration of test item (group 1) (20 µg/eye, both eyes)	-	-
D-21	General clinical examination – Weighing sub-conjunctival administration of test item (group 2) (20 µg/eye, both eyes)	-	-

D-14	General clinical examination – Weighing sub-conjunctival administration of test item (group 3) (20 µg/eye, both eyes)	-	-
D-7	General clinical examination – Weighing sub-conjunctival administration of test item (group 4) (20 µg/eye, both eyes)	-	-
D-2	General clinical examination – Weighing sub-conjunctival administration of test item (group 5) (20 µg/eye, both eyes)	-	-
D-1	General clinical examination – Weighing sub-conjunctival administration of test item (group 6) (20 µg/eye, both eyes)	-	-
D0	General clinical examination – Weighing sub-conjunctival administration of test item (group 7), control item (group 8), reference item (group 9) (20 µg/eye, both eyes) Induction of ocular inflammation for all groups	Slit-lamp before induction	-
D1	Ocular clinical examination – Weighing Euthanasia	Slit-lamp	Aqueous humor for leucocyte count and protein level

On Day 0, ocular inflammation was induced by a single footpad injection of liposaccharide (LPS, 1 mg/kg, 0.5 mL/kg Sigma # L6511) on anesthetized animals. LPS powder was reconstituted the day of induction. XG-102 was administered by a single injection (20 microgram/5 microL) in each eye on Day -28 or Day -21 or Day -14 or Day -7 or Day -2 or Day -1 or Day 0 (immediately before induction). Saline control and reference item (Solumedrol®; 20 µg/eye) were administered by a single injection in each eye on Day 0 (immediately before induction).

Animals were examined with a slit-lamp before XG-102 administration (baseline) before induction (Day 0) then 24h after induction (Day 1). The inflammation was graded using a scoring system as described by Devos A., Van Haren M., Verhagen C., Hoek Zema R., Kijlstra A: Systemic anti-tumor necrosis factor antibody treatment exacerbates Endotoxin Induced Uveitis in the rat. Exp. Eye. Res. 1995; 61: 667-675. Briefly, flare, miosis and hypopion were scored for absence (0), or presence (1), iris hyperemia and cells in the anterior chamber were scored for absence (0), or mild (1) or severe presence (2). The maximum score (sum of the five parameter scores) was 7.

At the end of the evaluation (24h after induction), animals were euthanized by intravenous injection of overdosed pentobarbital. The aqueous humor was collected immediately for each eye. For quantification of Cellular Infiltration in Aqueous Humor (AH), the sample was diluted 10-fold with PBS before detection. The number of infiltrated cells was manually counted after Giemsa staining under microscope.

Results:

1. Ocular Evaluation

The pathologic symptoms of EIU in Lewis rat eyes injected with LPS and treated with vehicle, test item or reference were graded in blinded fashion with a slit-lamp microscope to evaluate its efficacy. The results are illustrated in Figure 88A and summarized below:

Treatment	Mean $\pm$ SEM (n=20)	Median	Reduction of clinical scores
Vehicle (5 μ L/eye, both eyes treated on the day of induction)	4.0 $\pm$ 0.2	4.0	-
Methylprednisolone (20 μ g/eye, both eyes treated on the day of induction)	2.0 $\pm$ 0.2	2.0	50%
SDD-1002 (20 μ g/eye, both eyes treated on the day of induction)	2.8 $\pm$ 0.2	3.0	30%
SDD-1002 (20 μ g/eye, both eyes treated 1 day before the induction)	1.6 $\pm$ 0.1	1.5	60%
SDD-1002 (20 μ g/eye, both eyes treated 2 days before the induction)	1.8 $\pm$ 0.2	2.0	55%
SDD-1002 (20 μ g/eye, both eyes treated 7 days before the induction)	3.3 $\pm$ 0.2	3.0	18%
SDD-1002 (20 μ g/eye, both eyes treated 14 days before the induction)	2.9 $\pm$ 0.2	3.0	28%
SDD-1002 (20 μ g/eye, both eyes treated 21 days before the induction)	3.1 $\pm$ 0.3	3.0	23%
SDD-1002 (20 μ g/eye, both eyes treated 28 days before the induction)	3.3 $\pm$ 0.2	4.0	18%

Reduction: (mean grade in vehicle-treated eye – mean grade in test item-treated eye) / (mean grade in vehicle- treated eye)

Twenty-four hours after LPS induction, clinical scores for the vehicle-treated rats were 4.0 $\pm$ 0.2 (mean $\pm$ SEM, n=20) with median of 4 (range, 2-5).

A reduction in the severity of the ocular inflammation was detected 24 hours after induction and treatment with XG-102. The reduction was higher particularly as the delay between the induction and the treatment is short. The maximal reduction was observed when XG-102 was administered 1 day before induction. The mean score was 1.6 ± 0.1 with median of 1.5 (-60%, $p < 0.001$ compared with vehicle). The reduction was less marked (18 to 23%) when XG-102 was administered 7, 21 or 28 days before, but was significant when XG-102 was administered 14 days before induction (28%, $p < 0.05$). Sub-conjunctival treatment with methylprednisolone (20 $\mu\text{g}/\text{eye}$, both eyes treated), used as positive control drugs also significantly reduced the clinical scores by 50% (mean score: 2.0 ± 0.2 , median: 2).

2. Cellular infiltration in aqueous humor

Twenty-four hours after LPS Induction, the number of inflammatory cells that had infiltrated into the aqueous humor was counted for each group. The results are illustrated in Figure 88B and summarized below:

Treatment	Mean $\pm$ SEM (n=20)	Median	Reduction of leucocytes
Vehicle (5 $\mu\text{L}/\text{eye}$, both eyes treated on the day of induction)	3236 ± 346	3215	-
Methylprednisolone (20 $\mu\text{g}/\text{eye}$, both eyes treated on the day of induction)	3170 ± 276	3385	2%
SDD-1002 (20 $\mu\text{g}/\text{eye}$, both eyes treated on the day of induction)	2226 ± 192	2005	31%
SDD-1002 (20 $\mu\text{g}/\text{eye}$, both eyes treated 1 day before the induction)	1668 ± 149	1540	48%
SDD-1002 (20 $\mu\text{g}/\text{eye}$, both eyes treated 2 days before the induction)	1844 ± 232	1500	43%
SDD-1002 (20 $\mu\text{g}/\text{eye}$, both eyes treated 7 days before the induction)	2878 ± 331	2473	11%
SDD-1002 (20 $\mu\text{g}/\text{eye}$, both eyes treated 14 days before the induction)	976 ± 143	648	70%
SDD-1002 (20 $\mu\text{g}/\text{eye}$, both eyes treated 21 days before the induction)	1029 ± 164	1023	68%
SDD-1002 (20 $\mu\text{g}/\text{eye}$, both eyes treated 28 days before the induction)	1260 ± 263	915	61%

The median value number of inflammatory cells in the aqueous humor of vehicle-treated eyes was 3236 cells/ μL (range 270 – 6140 cells/ μL). The withdrawal of aqueous humor could not be performed in 2 out of 20 injured eyes in vehicle group; the formation of fibrin clot blocked

the needle during the withdrawal process. Rats treated with XG-102 showed a significantly reduced number of infiltrating cells compared with that of vehicle whatever the delay between treatment and the day of induction. Rats treated with methylprednisolone did not have significant difference in the number of infiltrating cells with that of vehicle. A dose similar to dexamethasone (20 µg) and to the test item was used. Regarding to the leucocyte infiltration, methylprednisolone was less potent than dexamethasone at the same dose (data from previous studies). In clinic, methylprednisolone is used regionally with typical doses ranging from 40-125 mg whereas dexamethasone acetate is used with doses ranging from 4-8 mg.

Conclusion:

The result herein demonstrates that single sub-conjunctival injection of XG-102 in both eyes partially prevented the endotoxin-induced inflammation observed in the anterior chamber, since a significant reduction of clinical scores and cellular infiltration were observed. The XG-102 is active up to 28 days on the inflammatory EIU model in the rat. The efficacy on clinical scores was observed up to 4 weeks, with a marked effect the first two days and on cellular infiltration in aqueous humor up to 4 weeks with a marked effect at 2, 3 and 4 weeks. The methylprednisolone (20 µg/eye, both eyes treated) could not show any significant efficacy on cellular infiltration even if a reduction of clinical scores was observed. This lack of efficacy (compared to previous data with dexamethasone) may be related to low administered dose.

Example 44: Effects of XG-102 (SEQ ID No. 11) in a rat model of Diabetic Retinopathy

This study is based on the previous studies of XG-102 in diabetic retinopathy as described in Examples 25, 26 and 39. The objective of this study is to determine the action duration of XG-102 on loss of visual acuity, ocular clinical signs, retinal layer thickness, and cytokine profiling after repeated sub-conjunctival administration on varying frequencies in a rat model of streptozotocin (STZ)-induced diabetic retinopathy.

To this end, 36 rats (female, Brown Norway, 6-8 weeks at time of STZ-treatment are assigned to the following 6 groups (6 animals per group):

Group	STZ	Treatment	Assessment
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1	-	Vehicle NaCl 0.9%	Weekly recording of body weight and blood glucose levels (Weeks 1-16); Weekly Draize scoring of chemosis, hyperemia, and discharge (Weeks 1-16); Quantification of contrast threshold at Days 43, 57, 71, 85, 99, and 106; Quantification of spatial frequency threshold at Days 43, 57, 71, 85, 99, and 106; Multiplex cytokine quantification of retinas using Bio-Rad rat 23-plex kit (n=8 retinas/arm) Enucleation of eyes for quantitative retinal histology (n=4 eyes/arm – each eye from a separate animal)
2	+	Vehicle NaCl 0.9%	
3	+	XG-102 (200 µg/eye at 3-week intervals)	
4	+	XG-102 (200 µg/eye at 4-week intervals)	
5	+	XG-102 (200 µg/eye at 6-week intervals)	
6	+	XG-102 (200 µg/eye at 12-week intervals)	

Groups 1, 2, and 5 were treated by bilateral sub-conjunctival administration of vehicle or XG-102, respectively, (cf. above) on Days 22 and 64. Group 3 was treated by bilateral sub-conjunctival administration of XG-102 on Days 22, 43, 64 and 85. Group 4 was treated by bilateral sub-conjunctival administration of XG-102 on Days 22, 50 and 78. Group 6 was treated by bilateral sub-conjunctival administration of XG-102 on Day 22.

The experimental design is the following:

Day 1: IP injection of streptozotocin (groups 2-6)

10 Day 4: Blood glucose quantification

Day 22: Bilateral subconjunctival injection of vehicle or test agent (Groups 1-6)

Day 43: OKT assessment of contrast sensitivity and spatial frequency threshold

Day 43: Bilateral subconjunctival injection of vehicle or test agent (Group 3)

Day 50: Bilateral subconjunctival injection of vehicle or test agent (Group 4)

15 Day 57: OKT assessment of contrast sensitivity and spatial frequency threshold

Day 64: Bilateral subconjunctival injection of vehicle or test agent (Groups 1-3, and 5)

Day 71: OKT assessment of contrast sensitivity and spatial frequency threshold

Day 78: Bilateral subconjunctival injection of vehicle or test agent (Group 4)

Day 85: OKT assessment of contrast sensitivity and spatial frequency threshold

20 Day 85: Bilateral subconjunctival injection of vehicle or test agent (Group 3)

Day 99: OKT assessment of contrast sensitivity and spatial frequency threshold

Day 106: OKT assessment of contrast sensitivity and spatial frequency threshold

Day 107: Collection of tissue

n=4 eyes/group collected for quantitative retinal histology

n=8 retinas/group collected multiplex cytokine analyses

*OKT: optokinetic tracking

- 5 For streptomycin administration, rats of the same age are weighed the day prior to injections and are fasted overnight, and cages are marked with yellow cards in animal facility. The weights are averaged, and a single dose is calculated for all rats based upon the average weight. No more than ten animals are injected with a single preparation of STZ due to quick decrease of STZ activity in solution, and the procedure is repeated for each batch of 10
- 10 animals. STZ powder is dissolved in 10 mM sodium citrate, pH 4.5, immediately before injection and rats receive 50 mg/kg STZ intraperitoneally in a volume of 1 mL using a 22 gauge syringe with care to avoid stomach and any vital organs.

- For subconjunctival administration, animals are anesthetized with ketamine/xylazine
- 15 (Ketamine and xylazine are mixed using a U-100 syringe utilizing 20 units of ketamine (100 mg/mL) and 100 units of xylazine (20 mg/mL) and the anesthesia mixture is applied via IP injection at 1 mL/kg (body weight)) and pupils are dilated with topical administration of Cyclogel and/or Tropicamide. Following sedation and dilation, a total volume of 30 μ L per eye is injected into conjunctiva using a 31-gauge needle attached to an insulin syringe.

20

For Draize scoring of hyperemia, chemosis, and discharge, animals are restrained by hand and scores for chemosis, hyperemia, and discharge are recorded by a masked observer using the "EyeCRO ocular scoring system".

- 25 All optokinetic tracking experiments are performed using an Optomotry designed for rodent use (Cerebra) Mechanics Inc.). In this non-invasive assessment, rats are placed onto a platform surrounded by 4 LCD screens which resides within a light-protected box. Visual stimuli are then presented to the rats via the LCD screens and a masked observer visualizes and scores optokinetic tracking reflexes from a digital camcorder which is mounted on the top of the
- 30 box. For measurements of spatial frequency threshold, the rats are tested at a range of spatial frequencies from 0.034 to 0.664 cycles/degree. The Optomotry device employs a proprietary algorithm to accept the input from the masked observer and automatically adjust the testing stimuli based upon whether the animal exhibited the correct or incorrect tracking reflex. All

measurements of contrast threshold are performed at a spatial frequency threshold of 0.064 cycles/degree.

For multiplex cytokine analysis, at study termination, the retinas will be individually isolated and immediately snap-frozen in liquid N₂. The Bio-Rad "Bio-plex Pro Rat Cytokine 23-plex assay (Cat# L80-01V11 S5) is used according to manufacturer's specifications to quantify the protein expression of EPO, G-CSF, GM-CSF, GRO/KC, IFN- γ , IL-1 α , IL-1 β , IL-2, IL-4, IL-5, IL-6, IL-7, IL-10, IL-12, p70, IL-13, IL-17A, IL-18, M-CSF, MCP-1, MIP-3 α , RANTES, TNF- α , and VEGF in each retina isolated in the study.

Example 45: Effects of XG-102 (SEQ ID No. 11) in a rat model of kidney bilateral ischemia reperfusion

This study is based on the previous study of XG-102 in renal ischemia/reperfusion (Example 36). The aim of the study was to evaluate the effect of XG-102 on histological damages in a rat model of kidney bilateral ischemia reperfusion.

Ischemia reperfusion (IR) injury is a complex phenomenon, which is often encountered in vascular surgery, organ procurement and transplantation in humans. The experimental model of kidney bilateral ischemia reperfusion (IR) in rodents leads to an acute tubular injury characterized by impaired kidney function and tubular degeneration. The present model is frequently used for providing a rapid proof of concept for the use of drug candidates in preventing renal IR damages.

Male Sprague-Dawley rats weighing 200-250 g at delivery were used (Charles River Laboratories, L'Arbresle, France). Animals were delivered to the laboratory at least 5 days before the experiments during which time they were acclimatized to laboratory conditions. This study included 3 groups of 11-12 rats each, as follow:

Group	IR surgery	Treatment (<i>i.v.</i>)	Number of animals/group
-------	------------	---------------------------	-------------------------

1	Sham-operated	vehicle	12
2	yes	vehicle	11
3	yes	XG-102 (2 mg/kg)	12

The study design is shown in Figure 96.

The protocol of warm renal ischemia was similar to that previously described (Pechman KR *et al.*, 2009). Briefly, under general anesthesia (pentobarbital; 60 mg/kg, *i.p.* and atropine; 1 mg/kg, *i.p.*), both renal pedicles were isolated and clamped for 40 minutes using atraumatic clamps. After this time, clamps were released to start reperfusion. Animals were maintained at 37°C using a thermo-regulated system (TCAT-2LV Controller, Physitemp Instruments, Clifton, NJ, USA) during the surgery. All the animals were sacrificed 24 hours after the release of both vascular clamps (reperfusion). Sham-operated animals underwent the same surgical procedure without clamping of the kidney vessels.

XG-102 or vehicle (0.9% NaCl) were administered into the tail vein (*i.v.*) at the dose of 2 mg/kg twenty minutes after the release of the second vascular clamp. Intravenous administrations into the tail vein were performed using the volume of 1 mL/kg.

After sacrifice, kidneys were removed, cleaned from all connective tissue and capsule and weighted on an electronic balance (VWR, France). One kidney was transferred in formalin solution 10% (Sigma Aldrich, France) for at least 24 h and then transferred in ethanol 70% for further histological analysis performed by Histalim (Montpellier, France). Right and left kidneys were randomly chosen. Kidney samples were fixed in 10% formalin during 72 hours, transferred into 70 % ethanol, then embedded in paraffin blocks by Histalim (Montpellier, France). One longitudinal section (3 to 5 µm) was made per block. Kidney sections of paraffin embedded tissue were stained by hematoxylin and eosin (H&E). All the slides were digitalized at X20 magnitude using Nanozoomer 2.0 HT from Hamamatsu (Hamamatsu, Japan). Each tissue section was examined histologically in a blinded manner to determine if tubular changes were present. The severity of each finding was then graded as follows:

Tubular damage score consisted of either degeneration/necrosis, tubular epithelial vacuolation, regeneration (basophil tubules), and tubular cast:

0: <5% tubules affected (background)

1: 5-20% of tubules affected

2: 21-40% of tubules affected

3: 41-75% of tubules affected

5 4: >75% of tubules affected

As shown in Figure 97, Group 2 (IR/Vehicle) animals showed a significant increase of tubular damages including tubular degeneration and necrosis, tubular cast formation, and basophilic tubules compared to Sham/Vehicle animals. XG-102 showed significant beneficial effects on tubular damages, specifically on tubular degeneration, necrosis and tubular cast formation (Figure 97) and on the total tubular score (Figure 98). The main difference in term of tubular degeneration and necrosis between animals from XG-102 treated rats (Group 3) and vehicle (Group 2) animals is that the number of tubules affected was lower, and the lesions were mostly limited to the cortico-medullary junction and not extended to the superficial cortex. Kidneys from Group 3 (IR/XG-102) presented also a less severe score for tubular casts when compared to Group 2 (IR/Vehicle). Representative images of these histologicals changes are included in Figure 99.

In particular, tubular changes in Group 1 (Sham/Vehicle) were limited to the presence of single to a few basophilic tubules (Score 1) in 3/12 animals (Figure 97). This incidence is within expected normal limits in naïve young adult control rats and was considered as incidental in origin. Comparatively, all animals in Group 2 (IR/Vehicle) presented moderate to marked (Score 3 and 4) tubular epithelial degeneration and necrosis (3.45 ± 0.52). The most affected tubules were concentrated at the cortico-medullary junction and were histologically characterized by tubules containing large clumps of sloughed and necrotic epithelial cells. Tubular degenerative lesions were also present in most of the cortex in animals with the most severe lesions (Score 4). In addition to tubular degeneration, all animals showed a large number of tubular casts in lumen (Score 3). The presence of small to moderate number of basophilic tubules (Score 1 and 2, mean= 1.36 ± 0.67) was also observed throughout the cortex in 10/11 animals of Group 2 (IR/Vehicle). The basophilic tubules were indicative of early epithelial regeneration in tubules. For Group 3 (IR/XG-102), tubular lesions were essentially of the same nature and appearance to that observed in Group 2 (IR/Vehicle), but were generally less severe in distribution.

More specifically, the mean tubular epithelial degeneration / necrosis score was 2.67 ± 0.65 in Group 3 (IR/XG-102). The main difference between Group 2 (IR/Vehicle) and Group 3 (IR/XG-102) was that several animals in the latter group showed a score of 2 (5/12 in Group 3 and 0/11 in Group 2). Finally, only 1/12 animal in Group 3 had a score of 4 comparatively to 5/11 for Group 2. Histologically, the main difference in term of tubular degeneration and necrosis between animals from Group 3 (IR/XG-102) in comparison to Group 2 (IR/Vehicle) was that the number of tubules affected was lower, and the lesions were mostly limited to the cortico-medullary junction and were not extended to the superficial cortex. Group 3 (IR/XG-102) and kidneys presented also a less severe score for tubular casts when compared to Group 2 (IR/Vehicle). Actually, tubular cast scores were 2.50 ± 0.52 in Group 3 (IR/XG-102). In comparison, Group 2 (IR/vehicle) tubular cast score was 3.00 ± 0.00 . The number of basophilic tubules in Group 3 (IR/XG-102) were very comparable to that observed in Group 2. The mean basophilic tubule score for Group 3 (IR/XG-102) was 1.33 ± 0.65 ; the score for Group 2 was 1.36 ± 0.67 (Figure 97).

There was no tubular vacuolation observed in any of the four experimental groups. Accordingly, the total tubular score in Group 1 (Sham/Vehicle) was very low as expected (0.25 ± 0.45) since only few animals presented basophilic tubules without any other tubular changes. In Group 2, the total tubular score was the highest among the four experimental groups, and ranged from 6 to 9 (7.82 ± 0.98). Group 3 total tubular score was relatively lower to that observed in Group 2 (IR/vehicle) with scores ranging from 5 to 8 (6.50 ± 0.80). The differences observed between Group 2 (IR/vehicle) and Group 3 (IR/XG-102) were considered to be biologically significant.

Taken together, XG-102 showed significant beneficial effects on tubular damages and specifically on tubular degeneration, necrosis and tubular cast formation. The main difference in term of tubular degeneration and necrosis between animals from XG-102 treated rats (Group 3) and vehicle (Group 2) IR animals is that the number of tubules affected was lower, and the lesions were mostly limited to the cortico-medullary junction and not extended to the superficial cortex. Kidneys from Group 3 (IR/XG-102) presented also a less severe score for tubular casts when compared to Group 2 (IR/Vehicle).

Example 46: Effects of XG-102 (SEQ ID No. 11) administered intravesically on acute cystitis model induced by cyclophosphamide in conscious rats: Evaluation of visceral pain and urinary bladder inflammation

- 5 The aim of the present study was to evaluate the effects of intravesical treatment with XG-102 (50 mg/mL) on urinary bladder pain and inflammation in acute CYP-induced cystitis in female Sprague-Dawley rats. This preclinical model is well-used to test therapeutic approaches for the treatment of interstitial cystitis / painful bladder syndrome (IC/PBS).
- 10 Adult female Sprague-Dawley rats (Janvier Labs, Le Genest Saint Isle, France), weighing 215 ± 20 g at the beginning of the experiments, were used. Animals were acclimatized to the laboratory conditions for at least 3 days before the start of any experiments. The animals were allocated to the following four experimental groups (n=10 animals per group):

Group	Injection (i.p.)	Treatment (i.ves.)	n
1	Saline	Vehicle (500 μ L, i.ves.)	10
2	CYP	Vehicle (500 μ L, i.ves.)	10
3	CYP	XG-102 (50 mg/mL, i.ves.)	10
4	CYP	Ibuprofen (50 mg/mL, i.ves.)	10

15

To induce acute cystitis, a single i.p. injection of CYP at a dose of 150 mg/kg in a final volume of 5 mL/kg was performed. Control rats received physiological saline under the same experimental conditions as CYP (final volume of 5 mL/kg, i.p.).

- 20 On the day of each experiment, weight of rats was recorded. Then, in a randomized manner, 500 μ L of XG-102 (50 mg/mL), ibuprofen (50 mg/mL) or vehicle were intravesically infused during 30 min under isoflurane anesthesia (2% - 3%).

Assessment of referred visceral pain using von Frey filaments:

- 25 Standardized conditions including fixed time-of-day (a.m. to minimize the potential circadian variations in the behaviours responses) and single-experimenter testing of all animals were applied to minimize variability behavior-based pain testing. Visceral pain including allodynia

and hyperalgesia was evaluated by applying to the lower abdomen, close to the urinary bladder, a set of 8 calibrated von Frey filaments of increasing forces (1, 2, 4, 6, 8, 10, 26 and 60 g) with an interstimulus interval of 5 seconds. Prior testing, the abdominal area designed for mechanical stimulation of each animal was shaved. Animals were then placed on a raised wire mesh floor under individual transparent Plexiglas box and acclimatized for at least 30 minutes before starting the von Frey test. Filaments were then applied 1-2 seconds through the mesh floor with enough strength to cause the filament to slightly bend. Each filament was tested 3 times. Care was taken to stimulate different areas within the lower abdominal region in the vicinity of the urinary bladder to avoid desensitization.

Nociceptive behaviors were scored for each animal and each filament as follows:

Score	Behavior
0	no response
1	reaction of the animal (<i>e.g.</i> retraction of the abdomen)
2	reaction of the animal and change of position
3	reaction of the animal, change of position and licking of the site stimulated with von Frey filaments and / or

The study design is schematically shown in Fig. 100 A. Briefly, acute cystitis was induced by CYP injection (i.p.) at D0 (as described above). XG-102, ibuprofen or vehicle was intravesically administrated once just after CYP injection (as described above). Von Frey testing was performed in a non-blinded manner as follow:

- At D-1, rats were acclimatized to the individual Plexiglas box for a minimum of 30 min and to the von Frey filaments application, in order to decrease the level of stress due to the new environment.
- At D0, von Frey testing was performed 15 min before CYP or saline injection in order to obtain basal values (D0, T=-15min).
- At D1, von Frey testing was performed 24 hours after CYP or saline injection in order to analyze test compounds effect on CYP-induced visceral pain (D1, T=+24h).
- Just after von Frey testing (+24h), rats were anesthetized for blood samples collection, then sacrificed and urinary bladders were collected as described below.

At the end of the experiment, rats were sacrificed by injection of pentobarbital (54.7 mg/mL, 0.5 mL/rat, i.p.) followed by cervical dislocation. Urinary bladders were rapidly collected and cleaned from lipoid tissue. Urinary bladders were weighed, cut at the bladder neck and haemorrhage scoring was performed (see table below). Finally, wall thickness was measured using a digital caliper by placing the bladder wall between the two outside jaws. Urinary bladder haemorrhage scores were adapted from Gray's criteria (Gray *et al.*, 1986) as follows:

Scores	Haemorrhage
0	absent - normal aspect
1	telangiectasia - dilatation of the mucosal blood vessels
2	petechial haemorrhages - mucosal pinpoint red dots (glomerulation)
3	Hemorrhagic spots with blood clots

Nociceptive parameters are expressed as follows:

Parameters	Expression	Description
nociceptive threshold	g	von Frey filament for which a first score of at least 1 (for 3 applications) is obtained
nociceptive scores	%	% of the maximal response (maximum score = 9) for 3 pooled applications
area under the curve (AUC) 1-8 g (allodynia)	% scores x g	plot of individual percentage of nociceptive scores against von Frey forces from : 1 to 8 g or 8 to 60g
area under the curve (AUC) 8-60 g (hyperalgesia)		

AUCs were calculated using GraphPad Prism® (GraphPad Software Inc., La Jolla, CA, USA). The AUCs method to assess allodynia and hyperalgesia is schematically shown in Figure 100 B.

Macroscopic parameters are expressed as follows:

Parameters	Expression
whole urinary bladder weight	mg and % of body weight
haemorrhage	scores
urinary wall thickness	mm

Results:

- 5 Before CYP injection, no significant difference in the nociceptive parameters were observed between the 3 different CYP-injected groups. In order to analyse effect of XG-102 on CYP-induced visceral pain, nociceptive parameters were compared between the Vehicle- and the XG-102-treated groups. Twenty-four hours after CYP injection, nociceptive threshold was significantly increased by XG-102 treatment as compared to vehicle ($p < 0.01$, Figure 101 A).
- 10 XG-102 treatment also significantly decreased nociceptive scores in CYP-injected rats as compared to vehicle ($p < 0.001$, Figure 101 B). In addition, AUC 1-8 g was significantly decreased by XG-102 treatment as compared to vehicle ($p < 0.001$, Figure 101 C). Similarly, AUC 8-60 g was reduced by XG-102 treatment as compared to vehicle ($p < 0.01$, Figure 101 D). In order to analyse the effects of ibuprofen on CYP-induced visceral pain, nociceptive
- 15 parameters were compared between the Vehicle- and the Ibuprofen-treated groups. Nociceptive threshold was significantly increased by ibuprofen treatment as compared to vehicle in CYP injected rats ($p < 0.01$, Figure 101 A). Similarly in the Ibuprofen group significant decrease of nociceptive scores was observed as compared to vehicle ($p < 0.01$, Figure 101 B). In addition, AUC 1-8 g and AUC 8-60 g were significantly decreased by ibuprofen treatment
- 20 as compared to vehicle ($p < 0.001$ and $p < 0.05$, Figures 101 C and 101 D, respectively).

Moreover, urinary wall thickness was significantly decreased in XG-102-treated rats ($p < 0.01$, Figure 102 A). Although XG-102 treatment also showed a trend towards decreased haemorrhage scores, it did not reach statistical significance (Figure 102 B). For ibuprofen, also

25 a significant decrease was observed in urinary bladder wall thickness ($p < 0.001$, Figure 102 A). However, no significant change was observed regarding haemorrhage scores ($p > 0.05$, Figure 102 B) in the Ibuprofen-treated group. It is noteworthy that reddish urine was noticed for some animal in the Ibuprofen-treated group.

Taken together, intravesical treatment of XG-102 (50 mg/mL) significantly reversed visceral pain induced by CYP, 24h after its injection. XG-102 efficiently inhibited both allodynia and hyperalgesia. On analyzed inflammatory parameters, XG-102 decreased urinary bladder inflammation (wall thickness). In conclusion, administered intravesically, XG-102 displayed strong antinociceptive effects and significant anti-inflammatory properties in an experimental model of IC/PBS.

Example 47: Effects of XG-102 (SEQ ID No. 11) administered intravenously on acute cystitis model induced by cyclophosphamide in conscious rats: Evaluation of visceral pain

The aim of the present study was to evaluate the effects of intravenous treatment with XG-102 (2 mg/kg) on urinary bladder pain in acute CYP-induced cystitis in female Sprague-Dawley rats. This preclinical model is well-used to test therapeutic approaches for the treatment of interstitial cystitis / painful bladder syndrome (IC/PBS).

Adult female Sprague-Dawley rats (Janvier Labs, Le Genest Saint Isle, France), weighing 215 ± 20 g at the beginning of the experiments, were used. Animals were acclimatized to the laboratory conditions for at least 3 days before the start of any experiments. The animals were allocated to the following four experimental groups (n=10 animals per group):

Group	Injection (i.p.)	Treatment (i.ves.)	n
1	Saline	Vehicle (1 mL/kg, i.v.)	10
2	CYP	Vehicle (1 mL/kg, i.v.)	10
3	CYP	XG-102 (2 mg/kg, i.v.)	10
4	CYP	Ibuprofen (10 mg/kg, i.v.)	10

To induce acute cystitis, a single i.p. injection of CYP at a dose of 150 mg/kg in a final volume of 5 mL/kg was performed. Control rats received physiological saline under the same experimental conditions as CYP (final volume of 5 mL/kg, i.p.).

On the day of each experiment, weight of rats was recorded. Then, in a randomized manner, XG-102 (2 mg/kg), ibuprofen (10 mg/kg) or vehicle were intravenously administered at a volume of 1 mL/kg.

5 Assessment of referred visceral pain using von Frey filaments:

Standardized conditions including fixed time-of-day (a.m. to minimize the potential circadian variations in the behaviours responses) and single-experimenter testing of all animals were applied to minimize variability behavior-based pain testing. Visceral pain including allodynia and hyperalgesia was evaluated by applying to the lower abdomen, close to the urinary bladder, a set of 8 calibrated von Frey filaments of increasing forces (1, 2, 4, 6, 8, 10, 26 and 60 g) with an interstimulus interval of 5 seconds. Prior testing, the abdominal area designed for mechanical stimulation of each animal was shaved. Animals were then placed on a raised wire mesh floor under individual transparent Plexiglas box and acclimatized for at least 30 minutes before starting the von Frey test. Filaments were then applied 1-2 seconds through the mesh floor with enough strength to cause the filament to slightly bend. Each filament was tested 3 times. Care was taken to stimulate different areas within the lower abdominal region in the vicinity of the urinary bladder to avoid desensitization.

Nociceptive behaviors were scored for each animal and each filament as follows:

Score	Behavior
0	no response
1	reaction of the animal (<i>e.g.</i> retraction of the abdomen)
2	reaction of the animal and change of position
3	reaction of the animal, change of position and licking of the site stimulated with von Frey filaments and / or

The study design differs from that of Example 46 (cf. Figure 100 A) only in the route of administration (intravenously instead of intravesically) and the doses as specified above. Briefly, acute cystitis was induced by CYP injection (i.p.) at D0 (as described above). XG-102, ibuprofen or vehicle was intravenously administered once just after CYP injection (as described above). Von Frey testing was performed in a non-blinded manner as follow:

- At D-1, rats were acclimatized to the individual Plexiglas box for a minimum of 30 min and to the von Frey filaments application, in order to decrease the level of stress due to the new environment.
- At D0, von Frey testing was performed 15 min before CYP or saline injection in order to obtain basal values (D0, T=-15min).
- At D1, von Frey testing was performed 24 hours after CYP or saline injection in order to analyze test compounds effect on CYP-induced visceral pain (D1, T=+24h).
- Just after von Frey testing (+24h), rats were anesthetized for blood samples collection, then sacrificed and urinary bladders were collected as described below.

Nociceptive parameters are expressed as follows:

Parameters	Expression	Description
nociceptive threshold	g	von Frey filament for which a first score of at least 1 (for 3 applications) is obtained
nociceptive scores	%	% of the maximal response (maximum score = 9) for 3 pooled applications
area under the curve (AUC) 1-8 g (allodynia)	% scores x g	plot of individual percentage of nociceptive scores against von Frey forces from : 1 to 8 g or 8 to 60g
area under the curve (AUC) 8-60 g (hyperalgesia)		

AUCs were calculated using GraphPad Prism® (GraphPad Software Inc., La Jolla, CA, USA).

The AUCs method to assess allodynia and hyperalgesia is schematically shown in Figure 100 B.

Results:

Before CYP injection, no significant difference in the nociceptive parameters was observed between the 3 different CYP-injected groups. In order to analyse the effect of XG-102 on CYP-induced visceral pain, nociceptive parameters were compared between the Vehicle- and the XG-102-treated groups independently. Twenty-four hours after CYP injection, nociceptive threshold was significantly increased by XG-102 treatment as compared to vehicle ($p < 0.01$, Figure 103 A). XG-102 treatment significantly decreased nociceptive scores in CYP-injected

rats as compared to vehicle ($p < 0.001$, Figure 103 B). In addition, AUC 1-8 g was significantly decreased by XG-102 treatment as compared to vehicle ($p < 0.001$, Figure 103 C). Similarly, AUC 8-60 g was significantly reduced by XG-102 treatment as compared to vehicle ($p < 0.001$, Figure 103 D). In order to analyse effect of ibuprofen on CYP-induced visceral pain, nociceptive parameters were compared between Vehicle- and Ibuprofen-treated groups. Nociceptive threshold was significantly increased by ibuprofen treatment as compared to vehicle in CYPinjected rats ($p < 0.01$, Figure 103 A). Ibuprofen treatment significantly decrease nociceptive scores as compared to vehicle ($p < 0.001$, Figure 103 B). In addition, AUC 1-8 g and AUC 8-60 g were significantly reduced by ibuprofen treatment as compared to vehicle ($p < 0.001$, Figures 103 C and 103 D).

Taken together, intravenous treatment of XG-102 (2 mg/kg) thus significantly reversed visceral pain induced by CYP, 24h after its injection. XG-102 efficiently inhibited both allodynia and hyperalgesia. Similar effects were observed with intravenous administration of ibuprofen (10 mg/kg). In conclusion, in the experimental cystitis preclinical model, XG-102 displayed significant anti-nociceptive properties.

Example 48: Effects of XG-102 (SEQ ID No. 11) administered intravenously on cystometric parameters in conscious rats with acute cystitis induced by cyclophosphamide

The aim of the present study was to evaluate the effects of intravenous (i.v.) administration of XG-102 (2 mg/kg) on cystometric parameters in CYP-induced cystitis in conscious female Sprague-Dawley rats. This preclinical model is well-used to test therapeutic approaches for the treatment of interstitial cystitis / painful bladder syndrome (IC/PBS).

Female Sprague-Dawley rats (211 – 281 g) were used (Janvier Labs, Le Genest Saint Isle, France). They were delivered to the laboratory at least 5 days before the experiments in order to be acclimatized to laboratory conditions. The animals were allocated to the following three experimental groups:

Groups	i.p. administration	i.v. treatment	dose	n
1	Physiological saline	Vehicle	-	11

2	CYP 150 mg/kg	Vehicle	-	10
3	CYP 150 mg/kg	XG-102	2 mg/kg	11

Rats were anesthetized with isoflurane (1.5 - 3%). After a laparotomy, bladder was exteriorized and a polyethylene catheter (0.58 and 0.96 mm of internal and outer diameter, respectively) was implanted in the bladder through the dome and exteriorized at the scapular level. A jugular polyethylene catheter (0.58 and 0.96 mm of internal and outer diameter, respectively) was also implanted and exteriorized at the scapular level for i.v. administrations. At D-1 (24 hours after the surgery), a single dose of CYP at 150 mg/kg or its vehicle (physiological saline: 0.9% NaCl) was administered i.p. at 5 mL/kg.

The method evaluating the effects of test substances on lower urinary tract function has been described by Lluet P, Barras M, Palea S. Cholinergic and purinergic contribution to the micturition reflex in conscious rats with long-term bladder outlet obstruction. *Neurourol Urodyn.* 2002; 21: 142-153. Cystometric investigations were performed in conscious rats 24 hours postintraperitoneal injection of CYP or vehicle. On the day of experiment, animals were held under partial restraint in a restraining device. The bladder catheter was connected via a T-tube to a pressure transducer to measure the intravesical pressure and to an injection pump to fill the bladder at a rate of 2 mL/hr. Vesical pressure was recorded continuously for 120 min: a 60 min as a basal period before intravenous administration and a 60 min period post-administration.

XG-102 or vehicle (1 mL in 5 min) was administered intravenously after 1 hour of basal period.

The study design is schematically shown in Fig. 104 A.

The following cystometric parameters were analysed (see Fig. 104 B):

- Threshold Pressure (ThP, mmHg), pressure just before micturition,
- Amplitude of micturition (AM), *i.e.* pressure between threshold pressure (ThP) and maximal pressure of micturition (MP) (mmHg),
- Intercontraction interval (ICI), *i.e.* time between two subsequent micturitions (sec), and
- Bladder capacity (BC), *i.e.* ICI x infusion rate (mL).

Results:

No effects of vehicle (i.v.) was observed on the cystometric parameters ICI, BC, ThP and AM parameters in conscious rats treated with CYP, compared to basal values (Figure 105 A, B, C and D). In contrats, XG-102 (2 mg/kg, i.v.) significantly increased ICI and BC 30-60 min post-administration in CYP-treated rats, compared to basal values ($P < 0.01$, Figure 106 A and B). This increase was associated with a significant decrease in ThP at the same time point ($P < 0.01$, Figure 106 C).

Taken together, intravenous treatment of XG-102 (2 mg/kg) significantly increased ICI and BC and decreased ThP for the period of 30-60 min post administration.

Example 49: Effects of XG-102 (SEQ ID No. 11) on β -amyloid-induced neuronal apoptosis (Alzheimer's disease model)

The effect of the JNK inhibitor XG-102 on JNK activation and on neuronal apoptosis was investigated in two experiments. In a first experiment the effect of different doses of XG-102 on JNK activation after induction of oxidative stress was determined. In a second experiment the effect of XG-102 on JNK activation and neuronal apoptosis after $A\beta_{42}$ cell stress was determined.

In experiment 1, primary mouse cortical neuron cultures were exposed to 1mM of hydrogen peroxide (H_2O_2) for 15 minutes to induce oxidative stress. Neurons were pre-treated with or without 5 μ M or 10 μ M of the specific inhibitor of JNK, XG-102 (SEQ ID No. 11). Levels of phosphorylated JNK (pJNK), total JNK (JNK) and Tubulin (control) were determined. The ratio of pJNK/JNK served as a measure of JNK activity.

Results of the immunoblot analysis of the primary mouse cortical neuron cultures pre-treated with or without 5 μ M or 10 μ M of XG-102 and exposed to 1mM of hydrogen peroxide (H_2O_2) during 15 minutes are shown in Figure 108 (A). In Figure 108 (B), the corresponding histogram is depicted with the ratio of phosphorylated JNK on total JNK (pJNK/JNK) for the different experimental groups. As can be retrieved from this histogram, after induction of the oxidative stress JNK activity increased by 34% ("Controls" vs. " H_2O_2 "). Pre-treatment of cortical neurons

with the inhibitor XG-102 prevented JNK activity when used at 5 μ M. A decreased JNK activity (45% of controls) is noted with a concentration of 10 μ M, in oxidative stress conditions.

- 5 In experiment 2, primary mouse cortical neuron cultures were exposed to 2 μ M of β -amyloid 1-42 ($A\beta_{42}$) for 5 hours to induce $A\beta_{42}$ cell stress. Neurons were pre-treated with or without 10 μ M of the specific inhibitor of JNK, XG-102 (SEQ ID No. 11). Levels of phosphorylated JNK (pJNK), total JNK (JNK), c-Jun, cleaved PARP and Tubulin (control) were determined. The ratio of pJNK/JNK served as a measure of JNK activity. The level of cleaved protein PARP, which is known to increase during apoptosis, served as a measure of neuronal apoptosis.

Results of the immunoblot analysis of the primary mouse cortical neuron cultures pre-treated with or without 10 μ M of XG-102 and exposed to 2 μ M of β -amyloid 1-42 ($A\beta_{42}$) during 5 hours are shown in Figure 109 (A). In Figure 109 (B and C), the corresponding histograms are depicted showing the ratio of phosphorylated JNK on total JNK (pJNK/JNK) for the different experimental groups (B) and the level of cleaved protein PARP (C). Interestingly, in the condition of $A\beta_{42}$ cell stress, no modification of JNK activity was observed, neither with nor without XG-102 pre-treatment (Fig. 109 B). Neuronal apoptosis was measured by the level of cleaved protein PARP, which is increased during apoptosis (Fig. 109 C). Accordingly, β -amyloid 1-42 ($A\beta_{42}$) treatment resulted in a 40 % increase of cleaved PARP, indicating $A\beta_{42}$ stress induced apoptosis. However, if cultures were pre-treated with XG-102 (10 μ M), apoptosis was decreased by 37 %.

Taken together, XG-102 thus prevented JNK activity in oxidative stress conditions produced by H_2O_2 and decreased neuronal apoptosis induced by $A\beta_{42}$.

Example 50: Effects of XG-102 (SEQ ID No. 11) on brain lesions and apoptosis in 5XFAD mice (mouse model of Alzheimer's disease)

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The aim of this study is to analyze the modulation of brain lesions and apoptosis with the injection of JNK peptide inhibitor XG-102 in a mouse model of Alzheimer's disease (AD), the 5XFAD mice.

To this end, male 3 months-old C57Bl/65XFAD, C57Bl/6 wildtype littermates, and C57Bl/6 5XFAD/PKR knockout mice are used. The mice of each genotype are randomly divided into 10 groups of 5 animals each. 25 animals are treated with XG-102 and 25 animals are the saline controls. The effect of XG-102 is evaluated after 3 months or 6 months of repeated injections in the caudal vein of the tail (every 21 days) at 10 mg/kg. The table below summarizes the random allocation:

Group N°	Mice	Treatment	Duration	Route of administration	Number of animal
1	WT	Saline	3 months	i.v. injection every 3 weeks (caudal vein)	5
2	5XFAD	Saline	3 months		5
3	5XFAD/PKR KO	Saline	3 months		5
4	WT	XG-102 10 mg/kg	3 months		5
5	5XFAD	XG-102 10 mg/kg	3 months		5
6	5XFAD/PKR KO	XG-102 10 mg/kg	3 months		5
7	WT	Saline	6 months		5
8	5XFAD	Saline	6 months		5
9	WT	XG-102 10 mg/kg	6 months		5
10	5XFAD	XG-102 10 mg/kg	6 months		5

Administrations are performed by intravenous injections in the caudal vein (tail). Each aliquot is diluted 10 times in NaCl 0.9% to obtain a solution at 1.4 mg/mL. The volume injected does not exceed 200 μ L, and it is adjusted according to the mouse weight. The dose volume is 7.1 mL/kg.

At the end the experiments, after 3 or 6 months of injections, mice are anesthetized by intraperitoneal injection of sodium pentobarbital (50 mg/kg) and sacrificed. Brains are then removed and dissected on ice then placed in 4% (v/v) paraformaldehyde in PBS for immunohistochemistry or immediately frozen in liquid nitrogen for immunoblotting and ELISA studies. For immunoblot and ELISA analyses, brains samples are homogenized and sonicated in a radio immune precipitation assay buffer (RIPA).

JNK activity, A β pathway (A β , sAPP α , sAPP β , BACE1, NEP), tau pathway (tau phosphorylation, CDK5 activation, GSK3 activation, p35, p25) and apoptosis (cleaved PARP, cleaved caspase 3) is analyzed by immunoblot. A β production and caspase 3 activity is

analyzed by ELISA. The number and size of senile plaques, inflammation (GFAP, IBA1), and apoptosis (Tunnel, NeuN, caspase 3) are analyzed by immunohistochemistry.

5 Example 51: Effects of XG-102 (SEQ ID No. 11) alone or in combination with PKR down-regulation on β -amyloid-induced neuronal apoptosis (Alzheimer's disease model)

10 To obtain primary cortical neuronal cultures, E15.5 mice embryos were dissected in PBS (Phosphate Buffered Saline) 6% glucose, on ice. Embryos cortices were minced into small pieces and treated with PBS glucose trypsin (Sigma Aldrich, Saint-Louis, USA) for 20 min at 37°C. Dissociated cortical cells were cultured in Neurobasal media complemented with B27, Glutamax and penicillin-streptomycin (Gibco). Neurons were cultured at 37°C, 5% CO₂ on pre-coated with poly-L-lysine (Sigma Aldrich) petri dishes. Neurons were cultured to maturity
15 (7 days) before use.

20 To induce A β ₄₂ stress 2 μ M of A β 1-42 (Thermo Fisher Scientific, MA, USA) were used during 5h on cortical neurons. A β 42-1 inversed peptide (Thermo Fisher Scientific) was used as negative control. A β 1-42 and A β 42-1 were dissolved in pure water and incubated at 37°C
20 for 48h before use.

To inhibit JNK, cortical neurons were pre-treated with 10 μ M of XG-102 1h before cell-stress treatment.

25 For immunoblot analysis cells were lysed on ice in a lysis buffer containing 10nM NaPi pH 7.8, 59nM NaCl, 1% Triton, 0.5% DOC, 0,1% SDS, 10% glycerol, 0,1 μ M calyculin A, 1mM Na₃VO₄ and 1X of a protease inhibitor cocktail (Sigma Aldrich). Lysates were sonicated and centrifugated 10 min at 15000g at 4°C. The supernatant protein concentration was determined with the Micro BCA protein assay kit (Thermo Scientific). Thirty micrograms of
30 proteins were resolved on SDS-PAGE and transferred onto nitrocellulose membrane. After blocking with TBS 5% skim milk, the membranes were probed with primary antibodies to JNK full, c-Jun, PKR, eIF2 α (Santa Cruz, Danvers, USA), pJNK (Millipore, Billerica, USA), phosphor eIF2 α (Thermo Fisher Scientific), PARP and tubulin (Cell Signaling, Danvers, USA). IR Dyes 800 and 700 (Rockland Immunochemical Inc, Gilbertsville, USA) antibodies were

used as secondary antibodies. Blots were reveled with Odyssey imaging system (LI-COR Biosciences, Lincoln, USA).

For caspase 3 activity analysis culture cell supernatants containing degenerating and dead neurons, and cell medium were collected in parallel of adhesive neurons lysis. Culture cell supernatants were centrifugated 10 min at 15000g at 4°C. Pellets were then resuspended in lysis buffer and caspase 3 activity was measured by using the Caspase 3 Assay kit reagents and protocol (Abcam, Cambridge, UK).

10 Results:

Decrease of JNK and c-JNK activations with XG-102 in A β ₄₂-stressed WT and PKR^{-/-} neurons

In the neuronal cultures stressed by A β ₄₂ peptides, the efficacy of XG-102 was investigated. XG-102 was used at 10 μ M, and added to cell medium 1 hour before the induction of A β ₄₂ stress. In WT neurons, JNK activation is only reduced after JNKi exposure (-60%, Fig. 3A) in A β ₄₂ stressed cultures. Both peptides showed efficacy in order to decrease c-Jun phosphorylation: -74% with XG-102 (Fig. 2C) and -29% with JNKi (Fig. 3C), and c-Jun expression: -65% with XG-102 (Fig. 2D) and -62% (Fig. 3D), compared to stressed WT neurons without peptides. In PKR^{-/-} neurons, JNK activation is reduced by XG-102 (-35%, Fig. 2A) and JNKi (-60%, Fig. 3A) in A β ₄₂ stressed cultures. In PKR^{-/-} cultures, the use of both peptides does not modified c-Jun activation (Fig. 2C and 3C), but the use of JNKi showed a decrease by 62% of c-Jun protein expression after A β ₄₂ stress induction (Fig. 3D).

XG-102 showed – 74% efficacy in order to decrease c-Jun phosphorylation (Fig. 110 C) and -65% efficacy in order to decrease c-Jun expression (Fig. 110 D), compared to stressed WT neurons without peptides.

In PKR^{-/-} neurons, JNK activation is reduced by XG-102 (-35%, Fig. 110 A) in A β ₄₂ stressed cultures. In PKR^{-/-} cultures, the use of XG-102 does not modify c-Jun activation (Fig. 110 C).

Decrease of neuronal apoptosis after JNK inhibition in A β ₄₂-stressed WT neurons

In WT neuronal cultures treated by A β ₄₂ peptides, the use of XG-102 decreased apoptosis. With XG-102 it was noted a 93% reduction of cleaved caspase 3 expression level (Fig. 110 E), a 71% decrease of caspase 3 activity (Fig. 110 F), and a 55% decrease of cleaved PARP expression level (Fig. 110 G) compared to A β ₄₂ treated WT neurons.

Neuronal death due to A β ₄₂ drastically reduced after dual inhibition of PKR and JNK in neurons

10 In PKR^{-/-} neurons treated by A β ₄₂ and XG-102, the efficacy of the dual inhibition of PKR and JNK was assessed for neuronal apoptosis. In neurons dually inhibited for PKR and JNK, cleaved caspase 3, caspase 3 activity and PARP expression levels decreased respectively by 83%, 87% and 93% compared to treated WT neurons.

CLAIMS

1. Use of a JNK inhibitor sequence comprising less than 150 amino acids in length for the
5 preparation of a pharmaceutical composition for treating diseases or disorders strongly
related to JNK signaling in a subject, wherein the diseases or disorders strongly related to
JNK signaling in a subject are selected from inflammatory or non-inflammatory diseases of
the following groups:
- 10 (a) Mild Cognitive Impairment, in particular Mild Cognitive Impairment due to Alzheimer's
Disease;
- (b) intraocular inflammation following anterior and/or posterior segment surgery, for example
after cataract surgery, laser eye surgery, glaucoma surgery, refractive surgery, corneal
15 surgery, vitreo-retinal surgery, eye muscle surgery, oculoplastic surgery, ocular oncology
surgery, conjunctival surgery including pterygium, and/or surgery involving the lacrimal
apparatus, in particular after complex eye surgery, post-traumatic surgery and/or after
uncomplicated eye surgery;
- 20 (c) age-related macular degeneration (AMD), in particular the wet or the dry form of age-
related macular degeneration, and cataract,
- (d) eye inflammatory diseases, in particular selected from uveitis, scleritis, corneal surgery,
conjunctivitis, non-infectious keratitis, iritis, chorioretinal inflammation, inflammatory
25 diseases damaging the retina of the eye, retinopathy, in particular diabetic retinopathy,
arterial hypertension induced hypertensive retinopathy, radiation induced retinopathy,
sun-induced solar retinopathy, trauma-induced retinopathy, e.g. Purtscher's retinopathy,
retinopathy of prematurity (ROP) and hyperviscosity-related retinopathy,
- 30 (e) cancer and tumor diseases, in particular selected from (i) liver cancer and liver carcinoma
in general, in particular liver metastases, liver cell carcinoma, hepatocellular carcinoma,
hepatoma, intrahepatic bile duct carcinoma, cholangiocarcinoma, hepatoblastoma,
angiosarcoma (of liver), and other specified or unspecified sarcomas and carcinomas of
the liver; (ii) prostate cancer and/or prostate carcinoma; and/or (iii) colon cancer and

colon carcinoma in general, in particular cecum carcinoma, appendix carcinoma, ascending colon carcinoma, hepatic flexure carcinoma, transverse colon carcinoma, splenic flexure carcinoma, descending colon carcinoma, sigmoid colon carcinoma, carcinoma of overlapping sites of colon and/or malignant carcinoid tumors of the colon,

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- (f) diseases of the mouth and/or the jaw bone, in particular inflammatory diseases of the mouth and/or the jaw bone selected from pulpitis in general, in particular acute pulpitis, chronic pulpitis, hyperplastic pulpitis, ulcerative pulpitis, irreversible pulpitis and/or reversible pulpitis; periimplantitis; periodontitis in general, in particular chronic periodontitis, complex periodontitis, simplex periodontitis, aggressive periodontitis, and/or apical periodontitis, e.g. of pulpal origin; periodontosis, in particular juvenile periodontosis; gingivitis in general, in particular acute gingivitis, chronic gingivitis, plaque-induced gingivitis, and/or non-plaque-induced gingivitis; pericoronitis, in particular acute and chronic pericoronitis; sialadenitis (sialoadenitis); parotitis, in particular infectious parotitis and autoimmune parotitis; stomatitis in general, in particular aphthous stomatitis (e.g., minor or major), Bednar's aphthae, periadenitis mucosa necrotica recurrens, recurrent aphthous ulcer, stomatitis herpetiformis, gangrenous stomatitis, denture stomatitis, ulcerative stomatitis, vesicular stomatitis and/or gingivostomatitis; mucositis, in particular mucositis due to antineoplastic therapy, due to (other) drugs, or due to radiation, ulcerative mucositis and/or oral mucositis; cheilitis in general, in particular chapped lips, actinic cheilitis, angular cheilitis, eczematous cheilitis, infectious cheilitis, granulomatous cheilitis, drug-related cheilitis, exfoliative cheilitis, cheilitis glandularis, and/or plasma cell cheilitis; and cellulitis (bacterial infection), in particular of mouth and/or lips; desquamative disorders, in particular desquamative gingivitis; and/or temporomandibular joint disorder

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- (g) Addison's disease, Agammaglobulinemia, Alopecia areata, Amyotrophic lateral sclerosis, Antiphospholipid syndrome, Atopic allergy, Autoimmune aplastic anemia, Autoimmune cardiomyopathy, Autoimmune enteropathy, Autoimmune hemolytic anemia, Autoimmune inner ear, disease, Autoimmune lymphoproliferative syndrome, Autoimmune polyendocrine syndrome, Autoimmune progesterone dermatitis, Idiopathic thrombocytopenic purpura, Autoimmune urticaria, Balo concentric sclerosis, Bullous pemphigoid, Castleman's disease, Cicatricial pemphigoid, Cold agglutinin disease, Complement component 2 deficiency associated disease, Cushing's syndrome, Dagos

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- disease, Adiposis dolorosa, Eosinophilic pneumonia, Epidermolysis bullosa acquisita, Hemolytic disease of the newborn, Cryoglobulinemia, Evans syndrome, Fibrodysplasia ossificans progressive, Gastrointestinal pemphigoid, Goodpasture's syndrome, Hashimoto's encephalopathy, Gestational pemphigoid, Hughes-stovin syndrome,
- 5 Hypogammaglobulinemia, Lambert-eaton myasthenic syndrome, Lichen sclerosus, Morphea, Pityriasis lichenoides et varioliformis acuta, Myasthenia gravis, Narcolepsy, Neuromyotonia, Opsoclonus myoclonus syndrome, Paraneoplastic cerebellar degeneration, Paroxysmal nocturnal hemoglobinuria, Parry-romberg syndrome, Pernicious anemia, POEMS syndrome, Pyoderma gangrenosum, Pure red cell aplasia,
- 10 Raynaud's phenomenon, Restless legs syndrome, Retroperitoneal fibrosis, Autoimmune polyendocrine syndrome type 2, Stiff person syndrome, Susac's syndrome, Febrile neutrophilic dermatosis, Sydenham's chorea, Thrombocytopenia, and vitiligo,
- (h) arthritis, in particular juvenile idiopathic arthritis, psoriatic arthritis and rheumatoid
- 15 arthritis, and arthrosis, and osteoarthritis,
- (i) skin diseases in particular selected from psoriasis, eczema, dermatitis, acne, mouth ulcers, erythema, lichen plan, sarcoidose, vascularitis, adult linear IgA disease,
- 20 (j) tauopathies, amyloidoses and prion diseases, in particular Alzheimer's disease in general, for example Alzheimer's disease with early onset, Alzheimer's disease with late onset, Alzheimer's dementia senile and presenile forms;
- (k) polypes,
- 25 (l) inflammatory diseases of the mouth or the jaw bone, in particular pulpitis, periimplantitis, periodontitis, gingivitis, stomatitis, mucositis, desquamative disorders, temporomandibular joint disorder,
- 30 (m) osteonecrosis,
- (n) encephalomyelitis, in particular acute disseminated encephalomyelitis, spondylitis, in particular ankylosing spondylitis, antisynthetase syndrome, dermatitis, in particular atopic dermatitis or contact dermatitis, hepatitis, in particular autoimmune hepatitis,

- autoimmune peripheral neuropathy, pancreatitis, in particular autoimmune pancreatitis, Behçet's disease, Bickerstaff's, encephalitis, Blau syndrome, Coeliac disease, Chagas disease, polyneuropathy, in particular chronic inflammatory demyelinating polyneuropathy, osteomyelitis, in particular chronic recurrent multifocal osteomyelitis,
- 5 Churg-Strauss syndrome, Cogan syndrome, giant-cell arteritis, CREST syndrome, vasculitis, in particular cutaneous small-vessel vasculitis and urticarial vasculitis, dermatitis herpetiformis, dermatomyositis, systemic scleroderma, Dressler's syndrome, drug-induced lupus erythematosus, discoid lupus erythematosus, enthesitis, eosinophilic fasciitis, eosinophilic gastroenteritis, erythema nodosum, Idiopathic pulmonary fibrosis,
- 10 gastritis, Grave's disease, Guillain-barré syndrome, Hashimoto's thyroiditis, Henoch-Schonlein purpura, Hidradenitis suppurativa, Idiopathic inflammatory demyelinating diseases, myositis, in particular inclusion body myositis, cystitis, in particular interstitial cystitis, Kawasaki disease, Lichen planus, lupoid hepatitis, Majeed syndrome, Ménière's disease, microscopic polyangiitis, mixed connective tissue disease, myelitis, in particular
- 15 neuromyelitis optica, thyroiditis, in particular Ord's thyroiditis, rheumatism, in particular palindromic rheumatism, Parsonage-Turner syndrome, pemphigus vulgaris, perivenous encephalomyelitis, polyarteritis nodosa, polymyalgia, in particular polymyalgia rheumatica, polymyositis, cirrhosis, in particular primary biliary cirrhosis, cholangitis, in particular primary sclerosing cholangitis, progressive inflammatory neuropathy,
- 20 Rasmussen's encephalitis, relapsing polychondritis, arthritis, in particular reactive arthritis (Reiter disease) and rheumatoid arthritis, rheumatic fever, sarcoidosis, Schnitzler syndrome, serum sickness, spondyloarthropathy, Takayasu's arteritis, Tolosa-Hunt syndrome, transverse myelitis, and Wegener's granulomatosis,
- 25 (o) fibrotic diseases and/or disorders particularly selected from lung, heart, liver, bone marrow, mediastinum, retroperitoneum, skin, intestine, joint, and shoulder fibrosis,
- (p) kidney diseases and/or disorders in particular selected from glomerulonephritis in general, in particular membrano-proliferative glomerulonephritis, mesangio-proliferative
- 30 glomerulonephritis, rapidly progressive glomerulonephritis, nephropathies in general, in particular membranous nephropathy or diabetic nephropathy, nephritis in general, in particular lupus nephritis, pyelonephritis, interstitial nephritis, tubulointerstitial nephritis, chronic nephritis or acute nephritis, and minimal change disease and focal segmental glomerulosclerosis,

(q) sympathetic ophthalmia,

5 (r) skin, kidney, heart, lung, pancreas, liver, blood cell, bone marrow, cornea, accidental severed limb, in particular fingers, hand, foot, face, nose, bone, cardiac valve, blood vessel or intestine transplant rejection reaction,

10 (s) Corticobasal degeneration, progressive supranuclear palsy, schizophrenia, inherited Kreutzfeldt Jacob, motor neurone disease, spinocerebellar ataxia/atrophie, dementia, in particular frontotemporal dementia, dementia with lewy bodies, multiple system atrophy, hereditary spastic paraparesis, Friedreich's ataxia, Charcot Marie toot,

or

15 (t) the disease is a hereditary or non-hereditary metabolic disease, in particular selected from the group of metabolic disorders of the carbohydrate metabolism, e.g., glycogen storage disease, disorders of amino acid metabolism, e.g., phenylketonuria, maple syrup urine disease, glutaric acidemia type 1, urea Cycle Disorder or urea Cycle Defects, e.g., carbamoyl phosphate synthetase I deficiency, disorders of organic acid metabolism
20 (organic acidurias), e.g., alcaptonuria, disorders of fatty acid oxidation and mitochondrial metabolism, e.g., medium-chain acyl-coenzyme A dehydrogenase deficiency (often shortened to MCADD.), disorders of porphyrin metabolism, e.g. acute intermittent porphyria, disorders of purine or pyrimidine metabolism, e.g., Lesch-Nyhan syndrome, Disorders of steroid metabolism, e.g., lipoid congenital adrenal hyperplasia, or congenital
25 adrenal hyperplasia, disorders of mitochondrial function, e.g., Kearns-Sayre syndrome, disorders of peroxisomal function. e.g., Zellweger syndrome, or lysosomal storage disorders, e.g., Gaucher's disease or Niemann Pick disease.

2. The use according to claim 1, wherein the disorder/disease is intraocular inflammation
30 following anterior and/or posterior segment surgery, for example after cataract surgery, laser eye surgery, glaucoma surgery, refractive surgery, corneal surgery, vitreo-retinal surgery, eye muscle surgery, oculoplastic surgery, ocular oncology surgery, conjunctival surgery including pterygium, and/or surgery involving the lacrimal apparatus, in particular after complex eye surgery and/or after uncomplicated eye surgery.

3. The use according to claim 2, wherein the JNK inhibitor is applied in doses, e.g. for injection, in the range of 0.01 µg/eye to 10 mg/eye, more preferably 0.1 µg/eye to 5 mg/eye, even more preferably 1 µg/eye to 2 mg/eye, particularly preferably 100 µg/eye to 1.5 mg/eye, most preferably 500 µg/eye to 1 mg/eye, e.g. 900 µg/eye.
4. The use according to claim 2 or 3, wherein the JNK inhibitor is applied is by instillation, intravitreally or subconjunctivally, preferably subconjunctivally.
5. The use according to claim 4, wherein the JNK inhibitor is applied is by a single injection after the surgery, preferably within three hours after surgery, for example just after the end of the surgical procedure when the patient is still in the operating room.
6. The use according to claim 1, wherein the disorder/disease is retinopathy, in particular diabetic retinopathy.
7. The use according to claim 1, wherein the disease/disorder is psoriasis.
8. The use according to claim 1, wherein the disorder/disease is periodontitis.
9. The use according to claim 1, wherein the disorder/disease is a graft rejection or transplant rejection reaction, in particular a kidney, pancreas, skin or heart transplant graft rejection.
10. The use according to claim 1, wherein the disease/disorder is glomerulonephritis.
11. The use according to claim 1, wherein the disease/disorder is a cancer and/or tumor disease, in particular selected from (i) liver cancer and liver carcinoma in general, in particular liver metastases, liver cell carcinoma, hepatocellular carcinoma, hepatoma, intrahepatic bile duct carcinoma, cholangiocarcinoma, hepatoblastoma, angiosarcoma (of liver), and other specified or unspecified sarcomas and carcinomas of the liver; (ii) prostate cancer and/or prostate carcinoma; and/or (iii) colon cancer and colon carcinoma in general, in particular cecum carcinoma, appendix carcinoma, ascending

colon carcinoma, hepatic flexure carcinoma, transverse colon carcinoma, splenic flexure carcinoma, descending colon carcinoma, sigmoid colon carcinoma, carcinoma of overlapping sites of colon and/or malignant carcinoid tumors of the colon.

- 5 12. Use of a JNK inhibitor sequence comprising less than 150 amino acids in length for the treatment of a tissue or organ transplant prior its transplantation.
13. Use according to claim 7, wherein the transplant is a kidney, heart, lung, pancreas, liver, blood cell, bone marrow, cornea, accidental severed limb, in particular fingers, hand,
10 foot, face, nose, bone, cardiac valve, blood vessel or intestine transplant.
14. The use of a JNK inhibitor sequence according to any of claims 1 to 13, wherein the JNK inhibitor sequence comprises a range of 5 to 150 amino acid residues, more preferably 10 to 100 amino acid residues, even more preferably 10 to 75 amino acid residues and
15 most preferably a range of 10 to 50 amino acid residues.
15. The use of a JNK inhibitor sequence of any of claims 1 to 14, wherein the JNK inhibitor sequence binds c-jun amino terminal kinase (JNK).
- 20 16. The use of a JNK inhibitor sequence of any of claims 1 to 15, wherein the JNK inhibitor sequence inhibits the activation of at least one JNK targeted transcription factor when the JNK inhibitor sequence is present in a JNK expressing cell.
- 25 17. The use of a JNK inhibitor sequence of any of claims 1 to 16, wherein the JNK targeted transcription factor is selected from the group consisting of c-Jun, ATF2, and Elk1.
18. The use of a JNK inhibitor sequence of any of claims 1 to 17, wherein the JNK inhibitor sequence alters a JNK effect when the peptide is present in a JNK expressing cell.
- 30 19. The use according to any of claims 1 to 18, wherein the JNK inhibitor sequence is composed of L-amino acids, D-amino acids, or a combination of both, preferably comprises at least 1 or even 2, preferably at least 3, 4 or 5, more preferably at least 6, 7, 8 or 9 and even more preferably at least 10 or more D- and/or L-amino acids, wherein

the D- and/or L-amino acids may be arranged in the JNK inhibitor sequences in a blockwise, a non-blockwise or in an alternate manner.

20. The use according to any of the preceding claims, wherein the JNK inhibitor sequence
5 comprises a fragment, variant, or variant of such fragment of a human or rat IB1 sequence as defined or encoded by any of sequences according to SEQ ID NO: 102, SEQ ID NO: 103, SEQ ID NO: 104 or SEQ ID NO: 105.
21. The use according to any of claims 1 to 20, wherein the JNK inhibitor sequence
10 comprises or consists of at least one amino acid sequence according to SEQ ID NOs: 1 to 4, 13 to 20 and 33 to 100, or a fragment, derivative or variant thereof.
22. Use of a chimeric peptide comprising at least one first domain and at least one second
15 domain linked by a covalent bond, the first domain comprising a trafficking sequence, and the second domain comprising a JNK inhibitor sequence as defined in any of claims 1 to 21 for the preparation of a pharmaceutical composition for treating diseases or disorders strongly related to JNK signaling in a subject in a subject, wherein the diseases or disorders strongly related to JNK signaling in a subject are as defined in any of claims 1 to 13.
- 20
23. The use of the chimeric peptide of claim 22, wherein the chimeric peptide is composed of L-amino acids, D-amino acids, or a combination of both, preferably comprises at least 1 or even 2, preferably at least 3, 4 or 5, more preferably at least 6, 7, 8 or 9 and even more preferably at least 10 or more D- and/or L-amino acids, wherein the D- and/or L-
25 amino acids may be arranged in the chimeric peptide in a blockwise, a non-blockwise or in an alternate manner.
24. The use of the chimeric peptide of any of claims 22 or 23, wherein the trafficking
30 sequence comprises the amino acid sequence of a human immunodeficiency virus TAT polypeptide.
25. The use of the chimeric peptide of any of claims 22 to 24, wherein the trafficking sequence consists of or comprises the amino acid sequence of SEQ ID NO: 5, 6, 7, 8, 21 or 22.

26. The use of the chimeric peptide of any of claims 22 to 25, wherein the trafficking sequences augments cellular uptake of the peptide.
- 5 27. The use of the chimeric peptide of any of claims 22 to 26, wherein the trafficking sequence directs nuclear localization of the peptide.
28. The use of the chimeric peptide of any of claims 22 to 27, wherein the chimeric peptide consists of or comprises the amino acid sequence of any of SEQ ID NOs: 9 to 12 and 23
10 to 32, or a fragment, or variant thereof.
29. The use of the chimeric peptide of any of claims 22 to 28, wherein the chimeric peptide consists of or comprises the amino acid sequence of SEQ ID NO: 9 or 11.
- 15 30. The use of a JNK inhibitor sequence as defined in any of claims 1 to 21 or a chimeric peptide as defined in any of claims 22 to 29; wherein the disease/disorder to be prevented and/or treated is Mild Cognitive Impairment, in particular Mild Cognitive Impairment due to Alzheimer's Disease, and wherein the pharmaceutical composition further comprises a PKR inhibitor.
- 20 31. Use of an isolated nucleic acid encoding a JNK inhibitor sequence as defined in any of claims 1 to 21 and 30 or a chimeric peptide as defined in any of claims 22 to 30 for the preparation of a pharmaceutical composition for treating diseases or disorders strongly related to JNK signaling in a subject, wherein the diseases or disorders strongly related
25 to JNK signaling in a subject are as defined according to any of claims 1 to 13.
32. Use of a vector comprising the nucleic acid as defined in claim 31 for the preparation of a pharmaceutical composition for treating diseases or disorders strongly related to JNK signaling in a subject, wherein the diseases or disorders strongly related to JNK signaling
30 in a subject are as defined according to any of claims 1 to 13.
33. Use of a cell comprising the vector as defined in claim 32 for the preparation of a pharmaceutical composition for treating diseases or disorders strongly related to JNK

signaling in a subject, wherein the diseases or disorders strongly related to JNK signaling in a subject are as defined according to any of claims 1 to 13.

- 5 34. Use of an antibody which binds immunospecifically to a JNK inhibitor sequence according to any of claims 1 to 21 and 30 or to a chimeric peptide according to any of claims 22 to 30 for the preparation of a pharmaceutical composition for treating diseases or disorders strongly related to JNK signaling in a subject, wherein the diseases or disorders strongly related to JNK signaling in a subject are as defined according to any of claims 1 to 13.
- 10 35. The use according to any of the preceding claims, wherein the pharmaceutical composition is to be administered by an administration route selected from the group consisting of parenteral routes, including intravenous, intramuscular, subcutaneous, intradermal, transdermal, enteral routes, including orally, rectally, topical routes, including nasal, intranasal, and other routes, including epidermal or patch delivery.
- 15 36. The use according to anyone of the preceding claims, wherein a dose (per kg bodyweight) of the JNK inhibitor sequence and/or chimeric peptide is in the range of up to 10 mmol/kg, preferably up to 1 mmol/kg, more preferably up to 100 μ mol/kg, even more preferably up to 10 μ mol/kg, even more preferably up to 1 μ mol/kg, even more preferably up to 100 nmol/kg, most preferably up to 50 nmol/kg.
- 20 37. The use according to anyone of the preceding claims, wherein a dose of the JNK inhibitor sequence and/or chimeric peptide in the range of from about 1 pmol/kg to about 1 mmol/kg, from about 10 pmol/kg to about 0,1 mmol/kg, from about 10 pmol/kg to about 0,01 mmol/kg, from about 50 pmol/kg to about 1 μ mol/kg, from about 100 pmol/kg to about 500 nmol/kg, from about 200 pmol/kg to about 300 nmol/kg, from about 300 pmol/kg to about 100 nmol/kg, from about 500 pmol/kg to about 50 nmol/kg, from about 750 pmol/kg to about 30 nmol/kg, from about 250 pmol/kg to about 5 nmol/kg, from about 1 nmol/kg to about 10 nmol/kg, or a combination of any two of said values.
- 25 30