Novel use of Antisecretory Factor.

Field of the invention

The present invention relates to the use of peptides, polypeptides and proteins, comprising certain elements of the group of proteins called Antisecretory Factor (AF) in the manufacture of a medicament for treating and/or preventing a condition that is characterised by or associated with the pathological loss and/or gain of cells or hyperproduction or abnormal degradation rate of proteins, expressed in the cell, such as at pathological degeneration, or loss of control of repair, recovery and/or regeneration of differentiated cells and/or tissues, including stem cells or progenitor cells, or medical conditions characterised by or associated with such conditions including damage to the brain and other parts of the nervous system by trauma, asphyxia, toxins, hypoxia, ischemia, infections or degenerative or metabolic insults, resulting in defect, hampered or otherwise abnormal structure and function. It especially relates to a new use of an antisecretory protein or homologues thereof having the same functional properties, or an oligo- or polypeptide or derivatives thereof, a new use of an antisecretory protein inducing food and a new use of an egg yolk with a high level of antisecretory protein.

Further the present invention relates to a method of propagating, inducing, reducing and/or maintaining the genesis of an isolated stem cell, and a method of treatment.

Background of the invention

Traumatic, asphyxial, hypoxic, ischemic, toxic, infectious, degenerative or metabolic insults to the central nervous system (CNS), peripheral nervous system (PNS) or autonomic nervous system (ANS) often result in damage to several different cell types. Examples on a degenerative condition in the CNS are Parkinson and Alzheimer di-

sease, either of which often causes loss of specific populations of cells. The former is in particular associated with the specific loss of dopaminergic neurons in the *substantia nigra*. Similarly, multiple sclerosis is associated with structural and functional affection of axons as well as loss of myelin and oligodendrocytes. Another illustration of a degenerative disorder caused by a loss of neurons is Alzheimer's disease. Additionally, there are many instances in which CNS, PNS and ANS injuries or diseases are associated with damage to oligodendroglia, astroglia, satellite cells, Schwann cells, microglia, vascular cells and neurons.

In general, replacement of neurons and differentiated glial cells following the degeneration or damage is not a characteristic of the adult mammalian brain. Neuronal loss is therefore usually considered permanent. However, it must be stressed that the recovery at diseases, brain tumours and neurotrauma mostly is due to repair and rebuilding of the surviving cells. Nonetheless, postnatal neurogenesis persists well into adulthood in all mammalian species, including man, in the subventricular zone (SVZ) at the lateral ventricles in the brain as well as in the subgranular zone (SGZ) in the dentate gyrus in the hippocampus (Ref. 2, 3, 4). Additionally, there is to a minor extent formation of neural progenitor cells in the spinal cord and in the ANS. It has to be stressed that vascular cells, microglial cells and macrophages as well as connective tissue cells may be rebuilt and formed at injuries to and diseases in nervous tissues.

There exists an omnipotent cell population in the brain, named the progenitor cells, as in other tissues in the body of adult mammals, including humans. Neuronal progenitor cells are stem cells and reside in the subventricular zone (SVZ) at the lateral ventricles of the brain and in the subgranular zone (SGZ) of the dentate gyrus in the hippocampus, where such cells continuously proliferate, and migrate into the adjacent brain struc-

tures, and eventually either degenerate or survive and differentiate. The new-born neurons preferentially in e.g. the SGZ migrate into the granule cell layer of the hippocampus and eventually express markers of differentiated neurons and have morphological characteristics corresponding to differentiated granular cells, establish axonal processes into the mossy fibre pathway and form synaptic connections with their targets in the hippocampus. (Ref. 5) It ought to be stressed that a considerable proportion of such newly formed cells may degenerate if not adequately stimulated, while others gain glial cell characteristics (Ref. 3, 4, 5).

The neurogenesis in the dentate gyrus is in itself especially intriguing as the hippocampus is intimately associated with spatial learning and memory (Ref. 6). The neurogenesis in the SVZ is via the rostral migratory stream supplying the olfactory lobe with new nerve cells, but at e.g. stroke and neurotrauma may the migrating primitive neuronal progenitor cells deviate to the injured or diseased site, if situated in reasonable vicinity to the migrating precursor cells.

The proliferation of progenitor cells in the SVZ and in the SGZ are influenced by e.g. the administration of growth factors, interleukines, N-methyl-d-aspartate (NMDA) receptor antagonist or by the removal of the adrenal glands, which latter results in reduced levels of or absence of corticosteroid hormones (Ref. 7, 8). Additionally, the exposure to an enriched environment is accompanied by an increased number of surviving, newly formed granule cells as well as by increased total number of surviving neurons in e.g. the dentate gyrus (Ref.9). The formation of new nerve cells turns reduced with age (Ref. 3).

Diminishing the inflammatory reaction in a nervous tissue after an injury or a disease is beneficiary and results in an increased number of surviving neurons, improved and extended formation of synapses and reduced

astrocytosis, concomitant with less hampering effects on the blood vessels and associated structures and thereby the circulation. A weak to moderate inflammation is beneficial with regard to the repair and to restorative events as well as to the neurogenesis, while a strong inflammation is detrimental and may result in an accentuated loss of cells and tissue, that otherwise might have recovered.

The antisecretory factor (AF) is a class of proteins occurring naturally in the body. The common knowledge of the Antisecretory Factor is summarised by Lange & Lönnroth (Ref. 1.). Its structure and some effects exerted by AF in the body of animals, including in man, is described in patent No WO97/08202 (Ref. 10). The human AF protein is a 41 kD protein, when isolated from the pituitary gland, comprising 382 amino acids.

The active site with regard to anti-inflammatory and antisecretory effects in AF:s is seemingly localized to the protein in a region close to the N-terminal parts of the AF, localized to no 1-163, or more preferably 36-52 or 36-44, or modifications thereof.

Recent studies, performed by the present inventors, have disclosed that AF are to some extent homologous with the protein S5a, also named Rpn 10, which constitute a subunit of a constituent prevailing in all cells, the 26 S proteasome, more specifically in the 19 S/PA 700 cap. In the present invention AF proteins are defined as a class of homologous proteins having the same functional properties. The proteasomes have a multitude of functions related to the degradation of surplus proteins as well as short-lived, unwanted, denatured, misfolded and otherwise abnormal proteins. Further, the AF/S5a/Rpn10 is involved in the distribution and transportation of cell constituents, most evidently proteins.

Davidson and Hickey (Ref. 11, 12) report in two articles published in 2004 in international, scientific journals, that they had generated an antibody against AF,

which modulated inflammatory reactions, confirming the statements in the previous patent application and patent (Ref 10, 14).

Summary of the invention

The present inventors have now surprisingly found that AF's and fragments thereof are capable of improving the repair of nervous tissues, as well as mediating and/or reducing the effects of trauma, inflammations and at progressive degenerations, as determined by reduced loss of nervous tissue, and by inhibiting the formation of, or improving the break-down of, β-amyloid and other tissue constituents otherwise accumulating, thereby rescuing the tissue. Beneficial effects have been documented for e.g. vascular constituents as well. AF and fragments thereof are further capable of rescuing nervous tissue constituents and support proliferation of progenitor cells prevailing in the adult CNS. This suggests a new and exiting mode of action in that AF and its fragments could mediate the rescuing and survival of affected cells, as well as facilitating proliferation and migration of stem and progenitor cells in the SVZ and SGZ.

In particular, the inventors have recognized that AF and certain fragments thereof can modulate the destruction, repair, regeneration of nervous tissue constituents, migration and differentiation of progenitor cells and the formation of synapses between existing cells and new cells, facilitating synapse formation and functional recovery as well as decreasing the rate and extent of degeneration and tissue destruction.

The present invention thus provides a new and improved means to treat injuries to, dysfunctions of, diseases in or disorders of the CNS, PNS and/or ANS, inter alia, and thereby provides possibilities for beneficial influence on the function of the tissue.

The brain and spinal cord in adult mammals, including humans, retain the ability to generate neurons

throughout life, although that is to a large extent restricted to certain regions only. New neurons, glial cells and tentatively also vascular cells are generated by the proliferation of stem or progenitor cells. During the research leading to the present invention, it became obvious that certain AF fragments rescue nervous tissue, and induced an increased formation of new cells, including processes and synapses between cells.

It has now surprisingly been found that it is possible to treat neural tissue loss after a CNS insult or during the progress of a neuronal disease or disorder by the administration of an effective amount of AF or certain AF fragments. It is thus possible to rescue nervous tissue, and to affect cell formation, migration and differentiation and synapse formation after either neuronal and glial cell loss in the CNS, PNS or ANS, or to prevent the age-related detoriation of said cells in the CNS, PNS and ANS.

In the subsequent text, amino acids are named according to the in biochemistry commonly used abbreviations based on the use of a single letter to identify each amino acid.

In one aspect the present invention relates to the use of

an antisecretory protein or homologues thereof having the same functional properties;

or an oligo- or polypeptide or derivatives thereof comprising an amino acid sequence of Formula I:

X1-V-C-X2-X3-K-X4-R-X5 (Formula I)

wherein

X1 is I, amino acids nos. 1-35 of SEQ ID NO:1, or is absent

X2 is H, R or K

X3 is S or L

X4 is T or A

X5 is amino acids nos. 43-46, 43-51, 43-80 or 43-163 of SEQ ID NO:1, or is absent;

or a pharmaceutically acceptable salt thereof;

in the manufacture of a medicament for the treatment and/or prevention of a condition associated with or characterised by rescue or by a pathological loss and/or gain of cells and/or brain oedema.

In one embodiment of the invention the Formula I has the sequence chosen from one of:

a) amino acids numbers 35-42 of SEQ ID NO:1,

b) amino acids numbers 35-46 of SEQ ID NO:1,

c) amino acids numbers 36-51 of SEQ ID NO:1,

d) amino acids numbers 36-80 of SEQ ID NO:1,

e) amino acids numbers 1-80 of SEQ ID NO:1, or

f) amino acids numbers 1-163 of SEQ ID NO:1

or a pharmaceutically acceptable salt thereof.

SEQ ID NO: 1 is the amino acid sequence of the anti-secretory factor polypeptide or protein as given in Johansson, E. et al. (Ref. 13) or Lange, S et al. (Ref. 10, 14)

In a second aspect the present invention relates to the use of an antisecretory protein inducing food in the manufacture of a food or medical food for the treatment and/or prevention of a condition associated with or characterised by rescue or by a pathological loss and/or gain of cells and/or brain oedema.

In a third aspect the present invention relates to the use of an egg yolk with a high level, preferably at least 1000 FIL units/ml, of antisecretory protein or homologues thereof having the same functional properties, in the manufacture of a food or a medical food for the treatment and/or prevention of a condition associated with or characterised by rescue or by a pathological loss and/or gain of cells and/or brain oedema.

In one embodiment of the invention the condition is characterised by displaying a pathological degeneration of, loss of ability and/or loss of control of regenera-

tion of and/or loss of control of regeneration of a differentiated cell and/or tissue, an embryonic stem cell, an adult stem cell, a progenitor cell and/or a cell derived from a stem cell or progenitor cell. In still another embodiment the condition is associated with or characterised by a pathological loss and/or gain of cells in the peripheral nervous system, autonomic nervous system and/or central nervous system, and in yet another embodiment the condition is associated with or characterised by rescue or by a pathological loss and/or gain of neural stem cells or neural progenitor cells.

In one embodiment of the invention the condition is associated with or characterised by a pathological loss and/or gain of oligodendroglia, astroglia, Schwann cells, and/or neuronal cells and/or cell populations, and in another the condition is associated with or characterised by a pathological loss and/or gain of non-cholinergic neuronal cells, cholinergic neuronal cells and/or glial cells, and/or cell populations.

In still another embodiment of the invention the condition is caused by damage to the central nervous system or a defect in the central nervous system, and in yet another one the condition is caused by a traumatic, malignant, inflammatory, auto-immune or degenerative disorder.

In a further embodiment the condition is caused by axonal damage caused by concussion, contusion, axonal damage caused by head trauma, axonal damage caused by small vessel disease in the CNS and/or damage to the spinal cord after disease and/or trauma, in another embodiment said condition is characterised by memory loss, and finally in a last embodiment of the new uses the condition is brain oedema, multiple sclerosis, asphyxia, hypoxic injury, ischemic injury, traumatic injury, Parkinson's disease, Alzheimer's disease, stroke, Ménière´s disease or demyelinating disorder.

In a fourth aspect the present invention relates to the use of an egg yolk with a high level of antisecretory proteins or homologues thereof having the same functional properties according to any one of new uses as described above.

In a fifth aspect the present invention relates to the use of a food and/or drinking solution inducing the formation of antisecretory proteins or homologues thereof having the same functional properties according to any one of new uses as described above.

In one embodiment the medicament is formulated for intravenous infusion, intramuscular injection and/or subcutaneous injection, in another embodiment the medicament is formulated so that the active substance will pass into the ventricles and/or other cavities at or in a patient's brain when it is administered to said patient, and in yet another embodiment the medicament is formulated so that the active substance will pass into the cerebrospinal fluid of a patient when it is administered to said patient.

In a sixth aspect the present invention relates to a method of propagating, inducing, reducing and/or maintaining the genesis of an isolated stem cell and/or stem cell progeny from any germinal layer *in vitro*, characterised by treating the isolated cell with an antisecretory protein or homologues thereof having the same functional properties, or an oligo- or polypeptide or derivatives thereof comprising an amino acid sequence of Formula I:

X1-V-C-X2-X3-K-X4-R-X5 (Formula I)

wherein

X1 is I, amino acids nos. 1-35 of SEQ ID NO:1, or is absent

X2 is H, R or K

X3 is S or L

X4 is T or A

X5 is amino acids nos. 43-46, 43-51, 43-80 or 43-163 of SEQ ID NO:1, or is absent,

or a pharmaceutically acceptable salt thereof.

In one embodiment of the method described above the Formula I has a sequence chosen from one of:

a) amino acids numbers 35-42 of SEQ ID NO:1,

b) amino acids numbers 35-46 of SEQ ID NO:1,

c) amino acids numbers 36-51 of SEQ ID NO:1,

d) amino acids numbers 36-80 of SEQ ID NO:1,

e) amino acids numbers 1-80 of SEQ ID NO:1, or

f) amino acids numbers 1-163 of SEQ ID NO:1

or a pharmaceutically acceptable salt thereof.

In another embodiment of the method said isolated cell is chosen from the group comprising epithelial cells, fibroblasts, osteogenic cells, macrophages and microglial cells, vascular cells, bone cells, chondrocytes, myocardial cells, blood cells, neurons, oligodendrocytes, astroglial cells, progenitor cells, stem cells and/or cells derived from progenitor cells or stem cells.

In a seventh aspect the present invention relates to a method of treatment and/or prevention of a condition associated with or characterised by a pathological loss and/or gain of cells, comprising administering to a patient in need thereof an effective amount of an antisecretory protein, or an oligo- or polypeptide or derivatives thereof comprising an amino acid sequence of Formula I:

X1-V-C-X2-X3-K-X4-R-X5 (Formula I)

wherein

X1 is I, amino acids nos. 1-35 of SEQ ID NO:1, or is absent

X2 is H, R or K

X3 is S or L

X4 is T or A

X5 is amino acids nos. 43-46, 43-51, 43-80 or 43-163 of SEQ ID NO:1, or is absent,

or a pharmaceutically acceptable salt thereof.

In one embodiment of the method of treatment and/or prevention the Formula I has a sequence chosen from one of:

a) amino acids nos. 35-42 of SEQ ID NO:1,

b) amino acids nos. 35-46 of SEQ ID NO:1,

c) amino acids nos. 36-51 of SEQ ID NO:1,

d) amino acids nos. 36-80 of SEQ ID NO:1,

e) amino acids nos. 1-80 of SEQ ID NO:1, or

f) amino acids numbers 1-163 of SEQ ID NO:1

or a pharmaceutically acceptable salt thereof.

In another embodiment of the method the condition is characterised by displaying a pathological degeneration of, loss of ability and/or loss of control of regeneration of and/or loss of control of regeneration of a differentiated cell and/or tissue, an embryonic stem cell, an adult stem cell, a progenitor cell and/or a cell derived from a stem cell or progenitor cell, and in still another one the condition is associated with or characterised by a pathological loss and/or gain of cells in the peripheral, autonomic or central nervous system.

In yet another embodiment of the method the condition is associated with or characterised by a pathological loss and/or gain of neural stem cells or neural progenitor cells, and in still another one the condition is associated with or characterised by a pathological loss and/or gain of oligodendroglial, astroglial, Schwann cells, and/or neuronal cells and/or cell populations.

In a further embodiment the condition is associated with or characterised by a pathological loss and/or gain of non-cholinergic neuronal cells, cholinergic neuronal cells and/or glial cells, and/or cell populations, and in still another one the condition is caused by damage to the central nervous system or a defect in the central nervous system.

In one embodiment the condition is caused by a traumatic, malignant, inflammatory, auto-immune or degenerative disorder, in another one the condition is caused by axonal damage caused by concussion, contusion, axonal damage caused by head trauma, axonal damage caused by small vessel disease in the CNS and/or damage to the spinal cord after disease and/or trauma, and in still another one said condition is characterised by memory loss.

In one embodiment of the method of treatment and/or prevention the condition is brain oedema, multiple sclerosis, asphyxia, hypoxic injury, ischemic injury, traumatic injury, Parkinson's disease, Alzheimer's disease, stroke, Ménière´s disease or demyelinating disorder.

In another embodiment of the method described above the antisecretory protein or homologues thereof having the same functional properties, or the oligo- or polypeptide or derivatives thereof is formulated into a medicament for intravenous infusion, intramuscular injection and/or subcutaneous injection, in yet another one the antisecretory protein or homologues thereof having the same functional properties, or the oligo- or polypeptide or derivatives thereof is formulated into a medicament so that the active substance will pass into the ventricles and /or other cavities in and/or at a patient's brain when it is administered to said patient, and in a final one the antisecretory protein or homologues thereof having the same functional properties, or the oligo- or polypeptide or derivatives thereof is formulated into a medicament so that the active substance will pass into the cerebrospinal fluid of a patient when it is administered to said patient.

In a eighth aspect the present invention relates to a method of propagating, inducing, reducing and/or maintaining the genesis of an isolated stem cell and/or stem cell progeny from any germinal layer from a patient, characterised by:

a) administering an effective amount of an antisecretory protein or homologues thereof having the same functional properties, or an oligo- or polypeptide or derivatives thereof comprising the amino acid sequence of Formula I as defined above to said patient prior to isolating said cell;

b) propagating said isolated cell *in vitro*;

followed by

c) transplanting said propagated cells into the same or another patient in need thereof.

In a ninth aspect the present invention relates to a method of propagating, inducing, reducing and/or maintaining the genesis of an isolated stem cell and/or stem cell progeny from any germinal layer from a patient, characterised by:

a) isolating said cell and/or stem cell progeny from the patient;

b) administering an effective amount of an antisecretory protein or homologues thereof having the same functional properties, or an oligo- or polypeptide or derivatives thereof comprising the amino acid sequence of Formula I as defined above to said isolated cell *in vitro* and propagating said cells;

followed by

c) transplanting said propagated cells back into the same or another patient in need thereof.

In one embodiment of the two methods just described said isolated cell is selected from the group consisting of fibroblasts, macrophages, vascular cells, bone cells, chondrocytes, myocardial cells, blood cells, neurons, oligodendrocytes, astroglial cells, Schwann cells, progenitor cells, stem cells and/or cells derived from progenitor cells or stem cells.

In some embodiments of the invention, the polypeptides of Formula I may additionally comprise protecting groups. Examples of N-terminal protecting groups include

acetyl. Examples of C-terminal protecting groups include amide.

Another embodiment of the invention is to treat conditions associated with insufficient formation of AF:s and related compounds or deficiency of AF receptor function by supplying the individual in an appropriate manner with the required AF, as described above.

It is obvious for any man, skilled in the art, that another embodiment of the invention consists of making use of endogenously produced AF:s. They can be achieved by utilizing the patent describing the method of induction of AF:s by the administration of AF inducing foods (Ref. 15).

Another embodiment of the invention utilizes the administration of egg yolks containing high levels of AF:s, also previously described in a patent (Ref. 16).

Detailed description of the invention

The term pathological loss and/or gain of cells are in the present context used to describe the common technical feature of a number of medical conditions and disorders. The conditions and disorders are characterised by displaying pathological degeneration of, loss of ability of regeneration of and/or loss of control of regeneration of a differentiated cell and/or tissue, an embryonic cell, an adult stem cell, a progenitor cell and/or a cell derived from a stem cell or a progenitor cell. Additionally, the term further does include improved survival and rescue of nervous tissue cells and reduced or abolished secondary degenerative effects.

The condition to be treated may be caused, inter alia, by one or more of traumatic asphyxia, neuropathic pain, hypoxic, ischemic, toxic, infectious, degenerative or metabolic insults to the nervous system. These often result in damage to several different cell types. Thus damage to brain due to any of the mentioned reasons, frequently causes neurological, cognitive defects and additional psychiatric symptoms. In other cases the con-

ditions may be caused by a traumatic, malignant, inflammatory, autoimmune or degenerative disorder or by treatment with drugs or x-ray. In yet other cases, the condition may be caused by genetic factors or the cause may be unknown. In yet further cases, the condition may be caused by axonal damage caused by concussion, axonal damage caused by head or body trauma, axonal damage caused by small vessel disease in the CNS and/or damage to the spinal cord after disease and/or trauma or by the effects of oedema at such an injury.

In one embodiment of the invention, the condition to be treated is a condition that is associated with or characterised by a pathological loss and/or gain of cells in the CNS as well as PNS and/or ANS.

Cells that may be affected by a polypeptide comprising a fragment of an amino acid sequence according to SEQ ID NO: 1 are, for example, stem cells, progenitor cells and or even differentiated cells gaining improved survival and regaining transiently lost function. They can belong to any of the three germ layers. Once stimulated the cells will differentiate, gain function and form synapses to replace malfunctioning, dying or lost cells or cell populations, such as in a in pathological CNS, PNS and/or ANS conditions, characterised by abnormal loss of cells, such as glia, and/or neuronal cell or cell populations, such as neuronal cells, and/ or glial cell and/or cell population as well as vascular and inflammatory cells.

The invention particularly relates to the treatment of conditions associated with or characterised by a loss of stem cells, preferably neural stem cells, or conditions characterised by or associated with a loss and/or gain of progenitor cells. Additionally, the invention relates to improved survival of stem or progenitor cells transplanted to nervous tissue.

The invention also relates particularly to the treatment of conditions associated with a loss and/or a

gain of differentiated cells. In one preferred embodiment the differentiated cells are bone cells, cartilage cells, cardiomyocytes, oligodendroglia, astroglia, neuronal cells, epithelial cells endothelium, skin, blood, liver, kidney, bone, connective tissue, lung tissue, exocrine gland tissue, and/or endocrine gland tissue or muscle cells. Preferably, the differentiated cells are neuronal cells, neurons, astrocytes, oligodendrocytes, Schwann cells, or other glial cells.

The invention also provides the use of a polypeptide comprising an amino acid sequence of formula 1, in the manufacture of a medicament for rescuing and normalising the cells in the nervous tissue as well as modulating the development of stem cells/ progenitor cells, and/ or synapses between cells in the CNS, PNS and/or ANS.

A further embodiment of the invention provides a method of modulating the development of stem cells and the synapses between cells in the CNS comprising contacting the stem cells ex vivo or in vivo with an amount of a polypeptide comprising an amino acid sequence of formula 1.

The uses and methods of the invention are preferably suited for the treatment for the treatment of abnormal and/or medical conditions affecting pathological loss or gain of progenitor cells and synapses between neural cells and/or cells derived from neuronal stem cells. The methods may thus be used to prevent, treat or ameliorate damages, diseases or deficits of the CNS, PNS and/or the ANS. The pharmaceutical active substance used according to the invention is especially suitable for the treatment of conditions affecting the Schwann cells, satellite cells, oligodendroglia, astroglia and/or neuronal cells. Such conditions may, e.g. be due to due to CNS damage or deficits, neuronal cell loss or memory loss. Such conditions may, e.g. be caused by a number of different factors or diseases such as traumatic, malignant, inflammatory, oedemic, autoimmune or degenerative disorders, such

as multiple sclerosis, hypoxic injury, ischemic injury, traumatic injury, Alzheimer's and Parkinson's disease, Ménière's disease and demyelisation disorder. The effect of the pharmaceutically active substance used to this preferred embodiment of the invention is due to their ability to improve cell survival, induce cell formation, synapses generation or the breakdown of neuronal plaque and/or β - APP, β-amyloid and other compounds accumulated in named cells.

Nonetheless, and as outlined above, the present invention is not restricted to the uses and methods for treating neuronal diseases and conditions, but said uses and methods may also be used for treating a large variety of mammalian conditions that are characterised by pathological cell loss and/or gain, such as Parkinson's disease, Alzheimer's disease, multiple sclerosis, stroke, asphyxia or hypoxia heart failure, heart infarction, diabetes, artrosis or arthritis, skin disease and burn injuries, chronic wounds, liver diseases or failure, muscle diseases or damages, cancer (tissues affected by cancer), pancreatic dysfunction and inflammatory bowel disease.

The pharmaceutical composition or medicament of the invention may additionally comprise one or more pharmacologically acceptable carriers, recipients or diluents, such as those known in the art.

The compositions or medicaments may be in form of, for example, fluid, semi-fluid, semi-solid or solid compositions such as, but not limited to, dissolved transfusion liquids, such as sterile saline, various salt solution, glucose solutions, phosphate buffer saline, blood, plasma or water, powders, microcapsules, micro spheres, nanoparticles, sprays, aerosols, inhalation devices, solutions, dispersions, suspensions, emulsions and mixtures thereof.

The compositions may be formulated according to conventional pharmaceutical practice, taking into considera-

tion the stability and reactivity of oligo- or polypeptides or of the protein.

It is obvious that the compositions can include AF inducing food or egg yolks, which contain high levels of AF:s. AF inducing foods are preferably administered orally or perorally in compositions adapted for such a purpose. Egg yolks with levels of AF:s are preferably administered orally or perorally. AF and its derivates may as well be administrated by injections and with the aid of an aerosol or by superficial deposition.

The compositions or medicaments may be formulated according to conventional pharmaceutical practice, see, e.g., "Remington: The science and practice of pharmacy" 20th ed. Mack Publishing, Easton PA, 2000 ISBN 0-912734-04-3 and "Encyclopedia of Pharmaceutical Technology", edited by Swarbrick, J. & J. C. Boylan, Marcel Dekker, Inc., New York, 1988 ISBN 0-8247-2800-9.

The choice of pharmaceutically acceptable excipients in a composition or medicament for use according to the invention and the optimum concentration thereof may readily be determined by experimentation. Also whether a pharmaceutically acceptable excipient is suitable for use in a pharmaceutical composition is generally dependent on which kind of dosage form is chosen. However, a person skilled in the art of pharmaceutical formulation can find guidance in e.g., "Remington: The science and practice of pharmacy" 20th ed. Mack Publishing, Easton PA, 2000 ISBN 0-912734-04-3.

The choice of pharmaceutically acceptable excipients in a composition or medicament for use according to the invention and the optimum concentration thereof may readily be determined by experimentation. Also whether a pharmaceutically acceptable excipient is suitable for use in a pharmaceutical composition is generally dependent on which kind of dosage form is chosen. However, a person skilled in the art of pharmaceutical formulation can find guidance in e.g., "Remington: The science and practice of

pharmacy" 20th ed. Mack Publishing, Easton PA, 2000 ISBN 0-912734-04-3.

A pharmaceutically acceptable excipient is a substance, which is substantially harmless to the individual to which the composition will be administered. Such an excipient normally fulfils the requirements given by the national drug agencies. Official pharmacopoeias such as the United States of America Pharmacopoeia and the European Pharmacopoeia set standards for well-known pharmaceutically acceptable excipients.

The following is a review of relevant pharmaceutical compositions for use according to the invention. The review is based on the particular route of administration. However, it is appreciated that in those cases where a pharmaceutically acceptable excipient may be employed in different dosage forms or compositions, the application of a particular pharmaceutically acceptable excipient is not limited to a particular dosage form or of a particular function of the excipient.

Parenteral compositions:

For systemic application, the compositions according to the invention may contain conventional non-toxic pharmaceutically acceptable carriers and excipients, including microspheres and liposomes.

The compositions for use according to the invention may include all kinds of solid, semi-solid and fluid compositions. Compositions of particular relevance are e.g. solutions, suspensions and emulsions.

The pharmaceutically acceptable excipients may include solvents, buffering agents, preservatives, chelating agents, antioxidants, stabilisers, emulsifying agents, suspending agents and/or diluents. Examples of the different agents are given below.

Examples of various agents:

Examples of solvents include but are not limited to water, alcohols, blood, plasma, spinal fluid, ascites fluid and lymph fluid.

Examples of buffering agents include but are not limited to citric acid, acetic acid, tartaric acid, lactic acid, hydrogenphosphoric acid, bicarbonates, phosphates, diethylamine, etc.

Examples of chelating agents include but are not limited to sodium EDTA and citric acid.

Examples of antioxidants include but are not limited to butylated hydroxy anisole (BHA), ascorbic acid and derivatives thereof, tocopherol and derivatives thereof, cysteine, and mixtures thereof.

Examples of diluents and disintegrating agents include but are not limited to lactose, saccharose, emdex, calcium phosphates, calcium carbonate, calcium sulphate, mannitol, starches and microcrystaline cellulose.

Examples of binding agents include but are not limited to saccharose, sorbitol, gum acacia, sodium alginate, gelatine, starches, cellulose, sodium carboxymethylcellulose, methylcellulose, hydroxypropylcellulose, polyvinylpyrrolidone and polyetyleneglycol.

The pharmaceutical composition or the substance used according to the invention is preferably administered via intravenous peripheral infusion or via intramuscular or subcutaneous injection into the patient or via buccal, pulmonary, nasal or oral routes. Furthermore, it is also possible to administer the pharmaceutical composition or the pharmaceutically active substance through a surgically inserted shunt into a cerebral ventricle of the patient.

In one embodiment of the present invention, said pharmaceutical composition is formulated so that the active substance will pass into the ventricles of a patient's brain

In one embodiment of the present invention, said pharmaceutical composition is formulated so that the active substance will pass into the ventricles of a patient's brain or into the cerebrospinal fluid of said patient, when it is administered to said patient. This

may e.g. be achieved by mechanical devices, vectors, liposomes, lipospheres, or biological or synthetical carriers.

Preferably, the administered dosage range is about 0.001-100 mg of a polypeptide comprising the amino acid sequence of Formula I per 100 g body weight, comprising a range of 0.001-100 mg/1g, 0.001-100 mg/10g and 0.001-100 mg/50g body weight. Preferably, the administered dosage range is about 0.001-100 mg of a polypeptide comprising the amino acid sequence of Formula I per 1kg body weight.

When food inducing AF:s are used, the administered dosage correspond to 0,2-5 g of malted cereals per kg of bodyweight. When egg yolks with high levels, i e at least 1000 FIL units/ml, of AF:s are administered a dosage of 0,05-0,5 g per kg of bodyweight are used. The response of the individual should be controlled.

The invention may be used to treat humans or non-human mammals.

The terms "treatment" or "treating" as used herein relate to both therapeutic treatment in order to cure or alleviate a disease or a medical condition, characterised by abnormal loss and/or gain of cells, and to prophylactic treatment in order to prevent the development of a disease or a medical condition, characterised by pathological loss and/or gain of cells and cell constituents, e. g. synpapses. Thus both prophylactic and therapeutic treatments are included in the scope of the present invention. The terms "treatment" or "treating" also refer to the effecting of cell genesis from stem cells or progenitor cells by inducing the genesis of differentiated cells, such as e.g. neurons and/or glial cells after either neuronal, oligodendroglial or glial cell loss in the CNS, PNS or ANS, or to prevent the normal age-related deterioration in the CNS, PNS or ANS or other structures in the body. The treatment may either be performed in an acute or in a chronic way.

AF-expanded stem and/or progenitor cells may be propagated and either pre-differentiated prior to grafting or allowed to differentiate as a result of interactions between the transplanted cells and the host. AF-expanded stem cells and/or progenitor cells may be administered and/or grafted at a single time, or delivered repeatedly over a prolonged period. This will be especially useful if stem cells and/or progenitor cells are administered to enter the target organ via the bloodstream.

According to another preferred embodiment of the invention, it is possible to use a polypeptide comprising the amino acid sequence of Formula I to propagate progenitor cells or stem cells or other cells in a tissue culture or a cell culture. Such cells may thereafter be used for cell transplantation into a patient suffering from e.g. neuronal cell loss or a condition due to lack of endogenous cells of another type. The cells used to start the culture may either originate from the patient or from another human or animal donor, and may be used in the treatment of a broad variety of diseases and disorders comprising heart diseases such as infarct, diabetes, or in an assortment of neurological diseases and disorders, such as those referred to above.

Thus the invention also provides a method of propagating, inducing, reducing and/or maintaining the genesis of an isolated stem cell and/or stem cell progeny in vitro, characterised by treating the isolated cell with a polypeptide comprising the amino acid sequence of Formula I. Preferably, the isolated cell is selected from the group comprising epithelial cells, fibroblasts, osteogenic cells, macrophages and microglial cells, chondrocytes, myocardial cells, blood cells, neurons, oligodendrocytes, astroglial cells, progenitor cells, stem cells and/or cells derived from said cells. In general, the isolated cell will be treated under appropriate conditions and for a time, which is sufficient to achieve the

desired propagation, induction, reduction and/or maintenance.

When cells are to be removed from a patient for in vitro propagation, it may be advantageous first to increase the number of progenitor cells in the patient. This will better facilitate the subsequent isolation of said cells from patients. The number of progenitor cells is increased by use of the method or pharmaceutical composition according to the invention.

A polypeptide comprising the amino acid sequence of Formula I, may be used alone or conjunction with other medicaments, interleukins or e.g. growth factors such as epidermal growth factor (EGF), transforming growth factor (TGF), platelet derived growth factor (PDGF), fibroblast growth factor (FGF) or insulin-like growth factor (IGF), designed to induce cell genesis or proliferation e.g. in the CNS, PNS or ANS. A polypeptide comprising the amino acid sequence of Formula I, alone or in conjunction with other medicaments, peptides, growth-factors, steroids, lipids, glycosylated proteins or peptides, used either simultaneously or in sequence, may be used in order to facilitate cell genesis or the generation of specific cell types in vivo or in vitro. It may also be used to induce immature or multipotent cells to activate specific developmental programs as well as specific genes in the aforementioned cells.

By the above mentioned term "cell genesis" is meant the generation of new cells such as neurons, oligodendrocytes, Schwann cells, satellite cells and astroglial cells from multipotent cells, progenitor cells or stem cells within the adult CNS or PNS or other organs of the body, in situ or in isolation.

Furthermore, the invention also relates to the therapeutic use of substances that decrease the amount of active AF or naturally occurring analogous of AF in the patient and thus decrease the genesis of new cells, e.g. of oligodendrocytes in patients with axonal or spinal

cord injury, such as axonal damage caused by concussion, axonal damage caused by head trauma, axonal damage caused by small vessel disease in the CNS, and/or damage to the spinal cord after disease and/or trauma. Examples of such substances are drugs, antibodies, compounds, peptides and/or inhibitor of endogenous AF release.

Since AF supports the genesis of new cells and especially neurons in the hippocampus, a structure intimately coupled to learning and memory, a polypeptide comprising the amino acid sequence of Formula I may be used in order to facilitate learning and memory by the genesis of said cells.

Whilst the present invention relates primarily to a method for treating abnormal conditions in the CNS or PNS that are characterised by pathological loss and/or gain of cells, by affecting neural stem cells or progenitor cells, the uses and methods of the invention may be equally useful for treating and/or preventing medical conditions in other organs of the body, provided that said medical conditions characterised by pathological loss and/or gain of cells.

Whilst reference has primarily been made herein to the use of polypeptides comprising an amino acid sequence of Formula I, the invention relates, mutatis mutandis, also to polypeptides consisting essentially of an amino acid sequence of Formula I, and to polypeptides consisting of an amino acid sequence of Formula I.

The polypeptides comprising an amino acid sequence of Formula I may be produced by standard means, including recombinant and synthetic routes.

The invention will be more fully understood when reading the following Examples, which are intended merely to illustrate, but not to limit, the scope of the invention.

Description of the drawings

Figure 1. Confocal immunofluorescence micrographs of dentate gyrus from a sham treated control brain (A) and

after seizures induced by intraabdominal injection of kainic acid (10 mg/ml) in buffered saline (B - 7 d; C - 28 d), disclosing the distribution of proliferating cell clusters. The newly formed cells are stained dark. The number of ribonucleotide reductase (RNR) positive cells, i.e. mitotic, in the SGZ is significantly increased at 7 d (B), and at 28 d (C) after seizures. The insert in B is from one another section of the same brain stained with the same approach method, illustrating two positive = mitotic cell clusters. GCL = granular cell layer, Hil = hilus. Scale bar = 200 μm (A, B, C), 20 μm (insert in B).

Figure 2. Photo of brains from rats 2 days after that a freezing probe had been positioned for 40 seconds on the outside of their skull bone. The two brains in the upper row had had free access to standard pellets and tap water prior to and after the brain injury. Note the bleedings and the discoloured brain tissue. The two brains in the lower row had had unlimited access to SPC food and drinking solution for 12 days prior to the exposure of the outside of the skull bone to a freezing probe and then for the next two days, prior to sacrifice. Note the absence of macroscopic bleeding and the less extensive brain damage. The high AF levels in the rats fed on SPC reduced the brain damage, as further confirmed by light microscopy of stained sections.

Figure 3. Photo of brains from rats 6 days after that a freezing probe had been positioned for 40 seconds on the outside of their skull bone. The three brains in the upper row are from adult rats that had had free access to standard pellets and tap water prior to and after the brain injury. Note the minor bleedings and the shallow defect in the brain tissue. The three brains in the lower row had had unlimited access to SPC food and drinking solution for 5 days prior to the exposure of the outside of the skull bone to a freezing probe and then for the next six days, prior to sacrifice. Note the less

extensive brain damage, as compared to the rat brains in the upper panel. The AF levels in the rats fed on SPC for 5 days prior to the freezing injury reduced the brain damage, as further confirmed by light microscopy of stained sections.

Examples

Example 1: Induction of elevated AF formation increased the neurogenesis

The following experiment was performed to assess whether administration of AF influenced the neurogenesis in the brain of a normal adult mammal, the rat.

Rats (body weight 180 - 350 g at the start of the experiments), male and female, were purchased from B & K AB, Stockholm , Sweden. The animals were kept in cages of approved type and size, and the light was on from 06 to 18. The regional animal experiments ethical committee granted permission for the experiments. Measures were taken to reduce discomfort and pain.

The test rats were fed on SPC pelleted food and drinking an extract of SPC for at least 10 days prior to sacrifice. The animals were not exposed to any surgery or otherwise manipulated. The rats were anaesthetized by either an intraabdominal injection of an overdose of pentobarbital sodium in saline or by the inhalation of isofluorane. The thoracic cavity was opened, the left ventricle of the heart canulated and a tempered balanced buffered salt solution, with heparin added, infused to rinse the vascular system from blood. Thereafter, a buffered formaldehyde solution in saline was infused to fix the tissue. Eventually, the brain, spinal cord, retina and additional parts of nervous tissues were dissected and further fixed over night in buffered formalin in the cold. The next day, the forebrain and the hippocampus were dissected, rinsed and immersed in buffered saline with 20 % sucrose added prior to sectioning in a cryostate microtome. The thin sections, 5 - 25 µm thick, were then processed for immunohistochemical demonstration

of the distribution and prevalence of the R1 subunit of ribonucleotide reductase (RNR) (Fig. 1 a), an enzyme of key importance for any DNA synthesis, disclosing cell formation by mitosis (Zhu, H., et al., Ref. 14). In parallel, additional tissue specimens from the forebrain and the hippocampus were embedded in paraffin and processed as described above.

Light microscopy of sections processed for RNR immunohistochemistry disclosed that treatment of normal adult rats for at least 10 days with SPC food increased the occurrence of proliferating stem cells and progenitor cells in the SGZ in the hippocampus, as compared to animals having been supplied with standard rodent pellets. Elevated frequency of dividing cells could be revealed as well in the SVZ in the forebrain. The identity of the newly formed cells was disclosed immunohistochemically with the aid of antibodies against doublecortin (expressed by migrating, immature nerve cells), NeuN (expressed by mature nerve cells), and GFAP (expressed by astrocytes).

It is concluded that supplying adult mammals with SPC food for at least 10 days seemed to markedly promote the proliferation of stem and progenitor cells in the adult brain.

Example 2: Model for brain injury by application of a freezing probe

The following experiment was performed to assess the damage caused on the rodent brain by the application of a very cold probe on the outside of the skull bone

Rats (body weight 180 - 350 g at the start of the experiments), male and female, were purchased from B & K AB, Stockholm, Sweden. The animals were kept in cages of approved type and size, and the light was on from 06 to 18. The regional animal experiments ethical committee granted permission for the experiments. Measures were taken to reduce discomfort and pain.

The rats were anaesthetized by the inhalation of isofluorane, and had their heads shaved. The skin was cut open in the mid sagittal plane on the skull. The calvarium was exposed on the left side between the bregma and the lambda. The periostium was detached from the bone, which then was rinsed. Thereafter, great care was taken to remove blood and any fluid from the calvarium as that may impair the subsequent procedure. A probe made of brass, having a cylindric 4 mm long end piece with a diameter of 3 mm, was cooled by immersion in a standardized manner in liquid nitrogen. The cooled probe was thereafter applied for 40 s on the calvarium in between the lambda and bregma, 4 mm lateral to the sagittal mid line. The probe was then removed and the skin wound sutured. The application of the freezing probe resulted transiently in that the brain tissue underlying the exposure site turn frozen. It ought to be stressed that the skull was not opened and no fractures or other signs of gross damage induced. The animals moved afterwards without any obvious problems, behaved normally and ingested food and drinking fluid close to as those untreated, after having recovered from the anaesthesia.

At 2 days after the freezing injury the left cerebral cortex showed discoloration and bleeding in an area with a diameter of 3-5 mm, immediately underneath the part of the skull bone exposed to the cooling (Fig. 2). A shallow depression indicated that there was a loss of nervous tissue. There is an oedema in the penumbra, i.e. the brain substance bordering the central zone of severely injured nervous tissue. The oedema could at closer inspection be revealed to be spread to the white matter, most evidently on the same side as injured. Light microscopic examination of stained, thin sections disclosed necrotic tissue in the centre of the injured cerebral cortex, with oedema which is likely to add to the secondary tissue and cell damage in the penumbra. The primary damage is the one taking place during the first few se-

conds after the application of the freezing probe. The secondary brain damage comprises changes taking place after a minute or more, the exact time being defined depending on the type of injury. The secondary changes may turn out to become more severe with time, especially if there is a brain oedema, which tend to be deleterious. There was an inflammatory reaction starting within minutes, most evidently in the penumbra, and characterised by the appearance of an increasing number of activated astrocytes and microglia cells. The blood vessels were also damaged but rapidly rebuilt. However, the necrotic, central part of the injured tissue was not revascularised until after days or even weeks.

Any injury to the brain inducing an inflammation causes a transient elevation of the stem and progenitor cell proliferation in the SGZ and in the SVZ, if those areas are not badly impaired. Further, the new neural stem and progenitor cells must be stimulated in order to survive, migrate, and differentiate; otherwise the cell proliferation may result in a net loss of neuronal cells.

Concomitantly, there is an accumulation of beta amyloid precursor proteins (β-APP) and beta-amyloid (Aβ), formed as a result of the brain injury and accumulating in nerve cells bodies and processes. β-APP and Aβ are both toxic to nerve cells and start to accumulate within a few hours after a neurotrauma. However, if these two proteins dissolve and thus disappear, the possibility for the affected nerve cells to survive, recover, and reintegrate structurally and functionally must be considered as highly beneficial. Further, cytoskeletal constituents, such as neurofilaments and microtubules, are suffering at a neurotrauma and accumulate, forming aggregates and tangles, which make the primary injury worse and even deleterious. Axons and dendrites appear as being irregularly beaded, swollen and distorted due to the focal accumulation of cytoskeletal constituents, cell organelles and amyloid. Due to the disorganisation of nerve cells after

a trauma, such as that due to freezing, the normal very precise and regular organisation of the cell machinery is lost in parts and normal cell constituents may accumulate or appear in abnormal concentrations, such as ubiquitin. Nerve cells do normally not divide, with the exception of those in the SGZ and SVZ, but may after a neurotrauma start to form proteins and other compounds in abnormally high amounts, such as i.e. cyclins and related constituents, normally only prevalent in dividing cells.

The glial cells, the astrocytes and the microglial cells, proliferated and turned hypertrofic. There was further a rebuilding of the residuing blood vessels and angiogenesis in the injured tissue.

The oedema that is appearing after any neurotrauma aggravates the injury to the tissue (secondary damage).

At six days after the freezing injury (Fig. 2) there is a shallow cavity in the centre of the injured cortex due to loss of brain tissue. Minute residues of the bleeding may be recognized, but most of the extravasated blood was removed. The necrosis in the centre of the injury was in parts cleaned from debris and therefore looked as a fairly distinctly delimited depression. The penumbra, enclosing the central necrosis, is rich in microglial cells and hypertrophic, proliferating astrocytes. Injured and dying nerve cells are seen in the penumbra as well as surviving ones. Most nerve cells show accumulation of neurofilaments, β-APP and Aβ. It is concluded that the freezing of the brain through the intact skull bone results in a reproducible manner in damage to the brain.

Example 3: AF:s rescue freeze-injured brain tissue, as investigated after 2 days

The following experiment was performed to assess if increased occurrence of AF in a body affected the extent and severity of a brain injury caused on the rodent brain by the application of a freezing probe on the outside of the skull bone, exerted neuroprotection.

Rats (body weight 180 - 350 g at the start of the experiments), male and female, were supplied with SPC food and drinking fluid for at least 10 days prior to the brain injury. At the day of injury, the rat were anaesthetized and prepared as described in experiment 2. The freezing probe was applied once for 40 seconds. After suturing the skin wound in the skull and recovered from the anaesthesia, the rats were allowed to move freely and had access to SPC food and drinking fluid.

Two days after the freezing injury, the rats were sacrificed and fixed by perfusion as described. When opening the skull bone, it became obvious that there was less extensive brain injury as compared to that in the animals having had commercial standard pellets and tap water (Fig. 2). There were minute bleedings only to be recognized. Further the shallow depression of the central parts of the injured area was not obvious. The penumbra appeared to be affected by less oedema, than that observed in animals fed on standard pelleted food and tap water. Light microscopic investigation of thin, stained sections through the injured brain tissue disclosed less extensive occurrence of damaged cells and only minor extravasation of blood elements. Irregularly distributed swellings and beadings were sparse. The otherwise prominent accumulation of e.g. amyloid and neurofilaments was less marked. The gliosis was less prominent that in the reference animals, supplied with standard food and tap water. However, there was a certain variation in the extent of the neuroprotection exerted by the SPC food and drinking fluid after two days.

It is concluded that the experimental induction of increased formation of AF in a body results in neuroprotection as disclosed by reduced brain tissue damage after a focal injury, investigated after 2 days.

Example 4: AF:s rescue freeze-injured brain tissue, as investigated after 6 days

The following experiment was performed to assess if increased occurrence of AF in a body affected the extent and severity of a brain injury caused on the rodent brain by the application of a freezing probe on the outside of the skull bone, exerting neuroprotection.

Rats (body weight 180 - 350 g at the start of the experiments), male and female, were supplied with SPC food and drinking fluid for at least 10 days prior to the brain injury. At the day of injury, the rat were anaesthetized and prepared as described in experiment 2. The freezing probe was applied once for 40 seconds. After suturing the skin wound in the skull and recovered from the anaesthesia, the rats were allowed to move freely and had access to SPC food and drinking fluid.

Six days after the freezing injury, the rats were sacrificed and fixed by perfusion as described. When opening the skull bone, it became obvious that there was less extensive brain injury as compared to that in the animals having had commercial standard pellets and tap water (Fig. 3). There were no bleedings to be recognized. Further the shallow depression of the central parts of the injured area was not marked and in some cases difficult to identify for certain. The penumbra appeared to be affected by less oedema, than that observed in animals fed on standard pelleted food and tap water. Light microscopic investigation of thin, stained sections through the injured brain tissue disclosed less extensive occurrence of damaged cells and rarely any residing extravasation of blood. Irregularly distributed swellings and beadings of axons and dendrites were sparse. There was a distinct astrogliosis in the penumbra region, but not as extensive and widespread as in the corresponding brains from rats having had standard pellets and tap water. There was, however, a variation in the extent of the neuroprotection exerted by the SPC food and drinking fluid.

When investigating the hippocampus, there was a marked increase in the proliferation of neural stem and progenitor cells in the SGZ. The same was true for the SVZ, but less obvious.

It is concluded that the experimental induction of increased formation of AF in a body results neuroprotection as disclosed by reduced brain tissue damage after a focal injury, less prominent gliosis and increased formation of new nerve cells from stem cells and progenitor cells in, most evidently, the SGZ, as investigated after 6 days.

Example 5: Daily intravenous injections of a derivate of AF (a 16 amino acid peptide) rescue freeze-injured brain tissue, as investigated after 6 days

The following experiment was performed to assess if increased occurrence of AF in a body affected the extent and severity of a brain injury caused on the rodent brain by the application of a freezing probe on the outside of the skull bone, exerted neuroprotection.

Rats (body weight 180 - 350 g at the start of the experiments), male and female, were supplied with standard pelleted food and tap water prior to and after the brain injury. At the day of injury, the rat were anaesthetized and prepared as described in experiment 2. The freezing probe was applied once for 40 seconds. After suturing the skin wound in the skull and recovered from the anaesthesia, the rats were allowed to move freely.

All rats received twice daily for 5 days, starting on the day of surgery, an intravenous injection of 1-10 µg per kg body weight of a synthetic peptide, being a fragment of AF, comprising amino acids 36 - 51, i.e. composed of 16 amino acids. It was dissolved in saline and prepared freshly prior to each injection. There was no intravenous injection of the peptide on the day of sacrifice, day 6. No side effects with regard to motor activity, explorative behaviour, food intake or drinking habits could be observed for any of the animals.

Six days after the freezing injury, the rats were sacrificed and fixed by perfusion as described. When opening the skull bone, it became obvious that there was less extensive brain injury as compared to that in the animals having had commercial standard pellets and tap water. There were no bleedings in or on the brain. Further the shallow depression of the central parts of the injured area was not marked and in some cases difficult to identify for certain. The penumbra appeared to be affected by minor oedema. Light microscopic investigation of thin, stained sections through the injured brain tissue disclosed less extensive occurrence of damaged cells and rarely any residing extravasation of blood than observed in the brains from rats treated and investigated as in experiment 2. Irregularly distributed swellings and beadings of axons and dendrites were sparse. There was a distinct astrogliosis in the penumbra region, but not as extensive and wide-spread as in the corresponding brains from rats having had standard pellets and tap water. There was, however, a variation in the extent of the neuroprotection exerted by the injected peptide.

When investigating the hippocampus, there was an increased proliferation of neural stem and progenitor cells in the SGZ. The same was true for the SVZ.

It is concluded that the intravenous daily injections of a fragment of AF during the first 5 days after a freezing injury results in neuroprotection as disclosed by reduced brain tissue damage after a focal injury, less prominent gliosis and elevated formation of new nerve cells from stem cells and progenitor cells in most evidently the SGZ, as investigated after 6 days.

Example 6: AF rescue brain tissue, injured by the excitotoxic drug kainic acid, as investigated after 6 days

The following experiment was performed to assess if increased occurrence of AF in a body affected the extent and severity of a brain injury, caused on the rodent

brain by the intraperitoneal injection of the excitotoxic compound kainic acid, exerted neuroprotection.

Rats (body weight 180 - 350 g at the start of the experiments), male and female, were supplied with SPC food and drinking fluid for at least 10 days prior to the brain injury. The same number of rats got in parallel standard pelleted food and tap water, for comparison.

At the day of injury, kainic acid (Sigma Chemical Co, St. Louis, Mo, USA), dissolved in buffered saline, and at an amount of 10 mg/kg body weight, was injected once into the abdomen. Thereafter, the rats were allowed to move freely and had access to SPC food and drinking fluid. After 45 - 60 minutes, the rats started to behave stereotypically, performing repeatedly one or two movements. Thereafter, they got unilateral and generalized seizures. The rats were closely monitored and the extent of affection recorded. At 3 hours after the kainite treatment, diazepam was injected to stop the seizures. Only rats exerting a standardised type and extent of seizures were included in the present study.

Six days after the seizures, the rats were sacrificed and fixed by perfusion as described. When opening the skull bone, no signs of brain damage could be disclosed. There was no difference between those having had SPC food and those fed on standard pellets and tap water. There was no macroscopically demonstrable oedema in either case.

Light microscopic investigation of thin, stained sections through the hippocampus of the brains disclosed differences in the extent of damage between the two groups of animals. Those treated with SPC food showed less extensive degeneration of nerve cells in the CA1 and CA3/4 regions as compared to those more severely injured having had standard pellets and tap water. The same difference could be discerned for the sprouting of mossy fibres. Irregularly distributed swellings and beadings of axons and dendrites were recognized. There was as well a

less prominent astrogliosis in the hilus region and in the stratum lacunosum and the stratum moleculare as well as in the hilus in rats having been fed on SPC food, as compared to those having had standard pellets. There was, a considerable variation in the extent of the neuroprotection exerted by the SPC food and drinking fluid.

When investigating the hippocampus, it was obvious that there was an increased proliferation of neural stem and progenitor cells in the SGZ (Fig. 1). The same was true, although less prominent, for the SVZ. There was an increased rate of survival of the newly formed RNR-positive cells in the SGZ after feeding with SPC food and drinking solution.

It is concluded that the experimental induction of increased formation of AF in a body resulted in neuroprotection, as disclosed by reduced extent of the brain tissue damage in the hippocampus at 6 days after seizures, and concomitantly less prominent gliosis and increased formation of new nerve cells from stem cells and progenitor cells in most evidently the SGZ.

Example 7: Effects of AF and AF fragments on the rescue of brain tissue, after a diffuse brain injury, most evidently on the diffuse axonal injury.

The following experiment is to be performed to assess if increased occurrence of AF or AF fragments in a body affected the extent and severity of a diffuse brain injury, caused by a rotational acceleration trauma to a rabbits head.

The most common brain injury is that named brain concussion. It affects 80.000 - 90.000 Swedes annually and of those about every fourth had to stay in a hospital for at least a day for clinical examination and observation. The corresponding figures for the USA is that about 2 million individuals suffer from brain concussion and of those roughly half a million stay in a hospital for a day or more. A large number of those affected are investigated by x-ray, and/or MRI.

After a brain concussion there is at an increased risk for such individuals to suffer for long time periods of neuropsychiatric sequele and pain. Further, there is an increased risk for subsequent development of dementia, most evidently Alzheimer's disease.

Young and adult rabbits will be used. Anaesthetized rabbits will have their skull bone freed from soft tissue. A helmet, made of plastic and reinforced with glass fibres, will be glued to the skull bone. The helmet is connected to a exposure equipment, that transmit a rotational acceleration trauma to the head, either anterior-posterior or the reverse. The rabbits will be treated by administration of AF or synthetic peptides corresponding to selected sequences of AF. Additional rabbits will be fed SPC food and drinking solution or alternatively compositions based on egg yolk. The exposure parameters will be closely monitored by a computerised recording system.

At predefined time periods after the rotational acceleration trauma, the brains will be removed from sacrificed rabbits and carefully investigated for presumed neuroprotective effects by the AF and its derivates as well as egg yolk. The advantage of the planned experiments is that the brain injury is standardized and correspond to that most frequent for human beings, a brain concussion. The formation of brain oedema will be closely monitored by the intracerebral implantation of fibre optic sensors, connected to a computer. Thereby, the effects of AF and its derivates on the oedema formation and histopathological abnormalities can be closely followed and documented. Long-term studies will as well be performed.

It is concluded that the experimental induction of a diffuse brain injury, which is treated with AF or derivates thereof, is of key importance for the evaluation of neuroprotective long-term effects on the simulated condition, which in clinical medical practice is being the dominant cause of brain injury in humans.

References

1. Lange, S. & Lönnroth, I. Int. Review of Cytology 210 39-75 (2001)
2. Eriksson, P. S. et al.: Nature Med. 11: 1313-1317 (1998)
3. Kuhn, H. et al.: J Neurosci. 16: 2027-2033 (1996)
4. Zhu, H., Wang, Z.-Y. & Hansson, H.-A.: Brain Res. 977:180-189 (2003)
5. Gage, F. H.: Science 287: 1433-1438 (2000)
6. McNamara, R. K. et al.: Brain Res. Rev. 18: 33-49 (1993)
7. Cameron, H. A. et al.: Neuroscience 61: 203-209 (1994)
8. Cameron, H. A. et al.: Neuroscience 82: 349-354 (1998)
9. Kempermann, G. et al.: Nature 386: 493-495 (1997)
10. Lange, S et al: WO97/08202
11. Davidson, J., & Hickey, W. F.: Lab. Investigation 84: 307-319 (2004)
12. Davidson, J., & Hickey, W. F.: J. Leukocyt Biol 74: 907-919 (2004)
13. Johansson, E et al.: J Biol. Chem. 270: 20615-20620 (1995)
14. Lange, S et al.: US Pat 6,344,440
15. Lange, S et al: PCT/SE97/01918
16. Lange, S et al.: PCT/SE 99/02340

CLAIMS

1. Use of an antisecretory protein or homologues thereof having the same functional properties, or an oligo- or polypeptide or derivatives thereof comprising an amino acid sequence of Formula I:

X1-V-C-X2-X3-K-X4-R-X5 (Formula I)

wherein

X1 is I, amino acids nos. 1-35 of SEQ ID NO:1, or is absent

X2 is H, R or K

X3 is S or L

X4 is T or A

X5 is amino acids nos. 43-46, 43-51, 43-80 or 43-163 of SEQ ID NO:1, or is absent,

or a pharmaceutically acceptable salt thereof, in the manufacture of a medicament for the treatment and/or prevention of a condition associated with or characterised by rescue a pathological loss and/or gain of cells and/or brain oedema.

2. Use according to claim 1, wherein Formula I has the sequence chosen from one of:

a) amino acids numbers 35-42 of SEQ ID NO:1,

b) amino acids numbers 35-46 of SEQ ID NO:1,

c) amino acids numbers 36-51 of SEQ ID NO:1,

d) amino acids numbers 36-80 of SEQ ID NO:1,

e) amino acids numbers 1-80 of SEQ ID NO:1, or

f) amino acids numbers 1-163 of SEQ ID NO:1

or a pharmaceutically acceptable salt thereof.

3. Use of an antisecretory protein inducing food in the manufacture of a food or medical food for the treatment and/or prevention of a condition associated with or characterised by rescue or a pathological loss and/or gain of cells and/or brain oedema.

4. Use of an egg yolk with a high level, preferably at least 1000 FIL units/ml, of antisecretory protein or homologues thereof having the same functional properties, in the manufacture of a food or a medical food for the treatment and/or prevention of a condition associated with or characterised by rescue or by a pathological loss and/or gain of cells and/or brain oedema.

5. Use according to any one of claims 1-4, wherein the condition is characterised by displaying a pathological degeneration of, loss of ability and/or loss of control of regeneration of and/or loss of control of regeneration of a differentiated cell and/or tissue, an embryonic stem cell, an adult stem cell, a progenitor cell and/or a cell derived from a stem cell or progenitor cell.

6. Use according to any one of claims 1-5, wherein the condition is associated with or characterised by a pathological loss and/or gain of cells in the peripheral nervous system, autonomic nervous system and/or central nervous system.

7. Use according to any one of claims 1-6, wherein the condition is associated with or characterised by a pathological loss and/or gain of neural stem cells or neural progenitor cells.

8. Use according to any one of claims 1-5, wherein the condition is associated with or characterised by a pathological loss and/or gain of oligodendroglia, astroglia, Schwann cells, and/or neuronal cells and/or cell populations.

9. Use according to claims 8, wherein the condition is associated with or characterised by a pathological loss and/or gain of non-cholinergic neuronal cells, cholinergic neuronal cells and/or glial cells, and/or cell populations.

10. Use according to any one of claims 1-9, wherein the condition is caused by damage to the central nervous system or a defect in the central nervous system.

11. Use according to any one of claims 1-9, wherein the condition is caused by a traumatic, malignant, inflammatory, auto-immune or degenerative disorder.

12. Use according to any one of claims 1-9, wherein the condition is caused by axonal damage caused by concussion, contusion, axonal damage caused by head trauma, axonal damage caused by small vessel disease in the CNS and/or damage to the spinal cord after disease and/or trauma.

13. Use according to any one of claims 1-12, wherein wherein said condition is characterised by memory loss.

14. Use according to any one of claims 1-13, wherein the condition is brain oedema, multiple sclerosis, asphyxia, hypoxic injury, ischemic injury, traumatic injury, Parkinson's disease, Alzheimer's disease, stroke, Ménière´s disease or demyelinating disorder.

15. Use of an egg yolk with a high level of antisecretory proteins or homologues thereof having the same functional properties according to any one of claims 1-14.

16. Use of a food and/or drinking solution inducing the formation of antisecretory proteins or homologues thereof having the same functional properties according to any one of claims 1-14.

17. Use according to any one of claims 1-2 and 5-14, wherein the medicament is formulated for intravenous infusion, intramuscular injection and/or subcutaneous injection.

18. Use according to any one of claims 1-2, 5-14, and 17, wherein the medicament is formulated so that the active substance will pass into the ventricles and/or other cavities at or in a patient's brain when it is administered to said patient.

19. Use according to any one of claims 1-2 and 5-14, wherein the medicament is formulated so that the active substance will pass into the cerebrospinal fluid of a patient when it is administered to said patient.

20. A method of propagating, inducing, reducing and/or maintaining the genesis of an isolated stem cell and/or stem cell progeny from any germinal layer *in vitro*, characterised by treating the isolated cell with an antisecretory protein or homologues thereof having the same functional properties, or an oligo- or polypeptide or derivatives thereof comprising an amino acid sequence of Formula I:

X1-V-C-X2-X3-K-X4-R-X5 (Formula I)

wherein

X1 is I, amino acids nos. 1-35 of SEQ ID NO:1, or is absent

X2 is H, R or K

X3 is S or L

X4 is T or A

X5 is amino acids nos. 43-46, 43-51, 43-80 or 43-163 of SEQ ID NO:1, or is absent,

or a pharmaceutically acceptable salt thereof.

21. A method according to claim 20, wherein Formula I has a sequence chosen from one of:

a) amino acids numbers 35-42 of SEQ ID NO:1,

b) amino acids numbers 35-46 of SEQ ID NO:1,

c) amino acids numbers 36-51 of SEQ ID NO:1,

d) amino acids numbers 36-80 of SEQ ID NO:1,

e) amino acids numbers 1-80 of SEQ ID NO:1, or

f) amino acids numbers 1-163 of SEQ ID NO:1

or a pharmaceutically acceptable salt thereof.

22. A method according to claim 20 or 21, wherein said isolated cell is chosen from the group comprising epithelial cells, fibroblasts, osteogenic cells, macrophages and microglial cells, vascular cells, bone cells, chondrocytes, myocardial cells, blood cells, neurons, oligodendrocytes, astroglial cells, progenitor cells, stem cells and/or cells derived from progenitor cells or stem cells.

23. A method of treatment and/or prevention of a condition associated with or characterised by a pathological loss and/or gain of cells, comprising administering to a patient in need thereof an effective amount of an antisecretory protein, or an oligo- or polypeptide or derivatives thereof comprising an amino acid sequence of Formula I:

X1-V-C-X2-X3-K-X4-R-X5 (Formula I)

wherein

X1 is I, amino acids nos. 1-35 of SEQ ID NO:1, or is absent

X2 is H, R or K

X3 is S or L

X4 is T or A

X5 is amino acids nos. 43-46, 43-51, 43-80 or 43-163 of SEQ ID NO:1, or is absent,

or a pharmaceutically acceptable salt thereof.

24. A method according to claim 23, wherein Formula I has a sequence chosen from one of:

a) amino acids nos. 35-42 of SEQ ID NO:1,

b) amino acids nos. 35-46 of SEQ ID NO:1,

c) amino acids nos. 36-51 of SEQ ID NO:1,

d) amino acids nos. 36-80 of SEQ ID NO:1,

e) amino acids nos. 1-80 of SEQ ID NO:1, or

f) amino acids numbers 1-163 of SEQ ID NO:1

or a pharmaceutically acceptable salt thereof.

25. A method according to claim 23 or 24, wherein the condition is characterised by displaying a pathological degeneration of, loss of ability and/or loss of control of regeneration of and/or loss of control of regeneration of a differentiated cell and/or tissue, an embryonic stem cell, an adult stem cell, a progenitor cell and/or a cell derived from a stem cell or progenitor cell.

26. A method according to any one of claims 23-25, wherein the condition is associated with or characterised by a pathological loss and/or gain of cells in the peripheral, autonomic or central nervous system.

27. A method according to any one of claims 23-26, wherein the condition is associated with or characterised by a pathological loss and/or gain of neural stem cells or neural progenitor cells.

28. A method according to any one of claims 23-26, wherein the condition is associated with or characterised by a pathological loss and/or gain of oligodendroglial, astroglial, Schwann cells, and/or neuronal cells and/or cell populations.

29. A method according to claim 28, wherein the condition is associated with or characterised by a pathological loss and/or gain of non-cholinergic neuronal cells, cholinergic neuronal cells and/or glial cells, and/or cell populations.

30. A method according to any one of claims 23-29, wherein the condition is caused by damage to the central nervous system or a defect in the central nervous system.

31. A method according to any one of claims 23-29, wherein the condition is caused by a traumatic, malignant, inflammatory, auto-immune or degenerative disorder.

32. A method according to any one of claims 23-29, wherein the condition is caused by axonal damage caused by concussion, contusion, axonal damage caused by head trauma, axonal damage caused by small vessel disease in the CNS and/or damage to the spinal cord after disease and/or trauma.

33. A method according to any one of claims 23-32, wherein said condition is characterised by memory loss.

34. A method according to any one of claims 23-33, wherein the condition is brain oedema, multiple sclerosis, asphyxia, hypoxic injury, ischemic injury, traumatic injury, Parkinson's disease, Alzheimer's disease, stroke, Ménière´s disease or demyelinating disorder.

35. A method according to any one of claims 23-34, wherein the antisecretory protein or homologues thereof having the same functional properties, or the oligo- or polypeptide or derivatives thereof is formulated into a medicament for intravenous infusion, intramuscular injection and/or subcutaneous injection.

36. A method according to any one of claims 21-33, wherein the antisecretory protein or homologues thereof having the same functional properties, or the oligo- or polypeptide or derivatives thereof is formulated into a medicament so that the active substance will pass into the ventricles and /or other cavities in and/or at a patient's brain when it is administered to said patient.

37. A method according to any one of claims 21-34, wherein the antisecretory protein or homologues thereof having the same functional properties, or the oligo- or polypeptide or derivatives thereof is formulated into a medicament so that the active substance will pass into the cerebrospinal fluid of a patient when it is administered to said patient.

38. A method of propagating, inducing, reducing and/or maintaining the genesis of an isolated stem cell and/or stem cell progeny from any germinal layer from a patient, characterised by:

a) administering an effective amount of an antisecretory protein or homologues thereof having the same functional properties, or an oligo- or polypeptide or derivatives thereof comprising the amino acid sequence of Formula I as defined in claim 1 or claim 2 to said patient prior to isolating said cell;

b) propagating said isolated cell *in vitro*;

followed by

c) transplanting said propagated cells into the same or another patient in need thereof.

39. A method of propagating, inducing, reducing and/or maintaining the genesis of an isolated stem cell

and/or stem cell progeny from any germinal layer from a patient, characterised by:

a) isolating said cell and/or stem cell progeny from the patient;

b) administering an effective amount of an antisecretory protein or homologues thereof having the same functional properties, or an oligo- or polypeptide or derivatives thereof comprising the amino acid sequence of Formula I as defined in claim 1 or claim 2 to said isolated cell *in vitro* and propagating said cells; followed by

c) transplanting said propagated cells back into the same or another patient in need thereof.

40. A method according to claim 38 or claim 39, wherein said isolated cell is selected from the group consisting of fibroblasts, macrophages, vascular cells, bone cells, chondrocytes, myocardial cells, blood cells, neurons, oligodendrocytes, astroglial cells, Schwann cells, progenitor cells, stem cells and/or cells derived from progenitor cells or stem cells.

41. Use according to any one of claims 1-19, for the treatment of conditions associated with insufficient formation of antisecretory factors.

42. Use according to any one of claims 1-19, for the treatment of conditions associated with insufficient function of the AF receptors and antisecretory factor binding tissue constituents