Anti-Met monoclonal antibody, fragments and derivatives thereof for use in tumor diagnosis, corresponding compositions and kits

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Field of the invention

The present invention concerns the use of a monoclonal antibody, fragments and/or derivatives thereof, as diagnostic tool for the detection of neoplastic cells. In particular, the present invention concerns the use of an anti-Met monoclonal antibody, fragments and/or derivatives thereof directed against the extracellular domain of hepatocyte growth factor receptor as a diagnostic tool for the detection of tumorigenic cells.

Background of invention

The *MET* oncogene, encoding the tyrosine kinase receptor for Hepatocyte Growth Factor (HGF), controls genetic programs leading to cell growth, invasion and protection from apoptosis. Deregulated activation of HGFR is critical not only for the acquisition of tumorigenic properties but also for the achievement of the invasive phenotype. The role of *MET* in human tumors emerged from several experimental approaches and was unequivocally proved by the discovery of *MET* activating mutations in inherited forms of carcinomas. Moreover, *MET* constitutive activation is frequent also in sporadic cancers and laboratories studies have shown that the *MET* oncogene is overexpressed in tumors of specific histotypes or is activated through autocrine mechanisms. Besides, the prevalence of abnormal MET expression is typically higher in metastases than in primary tumors, and is associated with poor clinical

prognosis. As an example, the *MET* gene is amplified in hematogenous metastases of colorectal carcinomas.

What is more, Engelman et al. (*Science* 2007; 316:1039-43) recently showed that lung tumours can develop resistance to epidermal growth factor receptor (EGFR) inhibitors as a result of amplification of the *MET* oncogene, while inhibition of Met signalling restored their sensitivity to EGFR inhibitors. This makes Met, on the analogy of e.g. EGFR, an interesting target for tumour detection, cancer prognostication, and anti-cancer therapy, even in the absence of genetic alterations.

Monoclonal antibodies (MAbs) are particularly attractive for this purpose. Especially intact MAbs (150 kDa) have shown value, because their long residence time allows neutralization/blockage of growth factors or growth factor receptors for a prolonged period of time. Neutralizing anti-HGF MAbs have been used, but their application is limited to tumours with HGF-dependent Met activation. Recently, it emerged that probably the best way to block the HGF/Met-induced invasive program is the competition with the Met receptor itself.

Recently, the group of Vande Woude pioneered gamma camera imaging for visualization of Met expressing tumours as disclosed in Hay RV, et al., *Clin Cancer Res* 2005; 11:7064s-9s and WO-A-2003/057155. For this purpose the anti-MET MAbs (MetSeek™) designated Met3 and Met5 were used. Antibodies were labelled with ^{125}I to enable gamma-camera imaging. Using relatively large tumours localized in the right thigh of the mice, i.e. far outside the abdominal region where ^{125}I uptake was high, Met5 gave better tumour visualization and retention than Met3. The authors, nevertheless, suggest to employ a mixture of MAbs recognizing different

epitopes of Met to improve the diagnostic results. Moreover, the antibodies disclosed in WO-A-2003/057155 do not allow a good detection of tumor cells expressing low levels of MET and tumours at early stage of development (i.e. having small masses) or new metastasis, especially if localized in the abdominal region.

Summary of the invention

The need is therefore felt for improved solutions enabling as early as possible reliable detection of tumorigenic cells expressing MET, the tyrosine kinase receptor for Hepatocyte Growth Factor.

The object of this disclosure is providing such improved solutions.

According to the invention, the above object is achieved thanks to the subject matter recalled specifically in the ensuing claims, which are understood as forming an integral part of this disclosure.

The invention provides the use of a monoclonal antibody, fragments and/or derivatives thereof directed against the extracellular domain of Hepatocyte Growth Factor Receptor (HGFR) as a diagnostic reagent to detect neoplastic cells, wherein the monoclonal antibody allows for the detection of such neoplastic cells even when MET is expressed at very low level on the cellular surface.

An embodiment of the invention provides an immuno-imaging agent for the detection of tumor cells by means of an *in vivo* immuno-imaging technique, the immuno-imaging agent including at least one of:

- an anti-Met monoclonal antibody,
- a fragment of an anti-Met monoclonal antibody containing the epitope binding region thereof,

- a genetically engineered antibody containing the epitope binding region or the complementary determining regions (CDRs) of an anti-Met monoclonal antibody,

- a humanized antibody containing the epitope binding region or the complementary determining regions (CDRs) of an anti-Met monoclonal antibody, or combinations thereof,

wherein the anti-Met monoclonal antibody - named DN30 - is produced by the hybridoma cell line deposited by Advanced Biotechnology Center (ABC), Interlab Cell Line Collection (ICLC), S.S. Banca Cellule e Colture in GMP, Largo Rosanna Benzi 10, Genova, Italy with accession number ICLC PD 05006.

An embodiment of the invention provides DN30 monoclonal antibody, its fragments or genetically engineered or humanized antibodies containing DN30 epitope binding region or CDRs coupled to a detectable signaling moiety, which is suitable for use in gamma camera imaging technique, MRI technique or PET technique.

A further embodiment of the instant invention concerns a diagnostic composition comprising DN30 monoclonal antibody, its fragments or genetically engineered or humanized antibodies containing DN30 epitope binding region or CDRs as the immuno-imaging agent, wherein the detection of said immuno-imaging agent occurs by means of *in vivo* immuno-imaging techniques, such as gamma camera imaging technique/SPECT, MRI technique or PET technique.

In a still further embodiment, the present invention provides a diagnostic kit including a first vial containing a diagnostic composition comprising DN30 monoclonal antibody, its fragments or genetically engineered or humanized antibodies containing DN30 epitope binding region or CDRs as an immuno-imaging

agent and optionally a second vial containing a detectable signaling moiety to be coupled to the immuno-imaging agent.

In an embodiment, the immuno-imaging agent is coupled either directly (e.g. via tyrosine residues of the antibody when ^{124}I is used) or indirectly (e.g. via a linker - as a metal chelating agent) to a detectable signaling moiety. In another embodiment, the immuno-imaging agent is coupled to a molecule able to be coupled (either *in vitro* or *in vivo*) to the detectable signaling moiety at the time and place of use.

The detectable signaling moiety may be already active or activatable, wherein in such a case the detectable signaling moiety is activatable i.a. by substitution with an active element, e.g. a metal, a radionuclide or a positron emitter suitable to be detected.

The detectable signaling moiety is selected as a function of the immuno-imaging technique employed for the diagnosis, i.e. gamma-emitting radionuclide (or gamma-emitter) in case of gamma camera-imaging technique/SPECT, metal or positron emitter in case of MRI or PET imaging techniques, respectively.

The present invention allows the detection of MET expression on the surface of the cells themselves, in a tissue, in an organ or in a biological sample, i.e. either *in vitro* or *in vivo*, for the purpose of diagnosis, prognosis and/or post-therapy monitoring.

The use of DN30 as immuno-imaging agent allows early detection of tumorigenic cells expressing Met on their surface even if MET expression on the surface of these cells is very low because of the high affinity (2.64 x 10e-9) of DN30 for Met. Further advantages in using DN30 as immuno-imaging agent lie in its unexpected property of being adherent to the

tumorigenic cell surface for a quite long period of time. Moreover, DN30 being able to be internalized within the tumorigenic cells allows to achieve an unexpectedly good tumour-to-nontumour ratio and consequently a surprising sensibility and specificity for the detection of tumorigenic cells.

Detailed description of the invention

The present invention will now be described in detail in relation to some preferred embodiments by way of non-limiting examples with reference to the annexed drawings, wherein:

- **Figure 1** shows immunohistochemical staining of Met expression with biotinylated DN30 on cytospins of GTL-16 (a) and FaDu (b) cells, and on frozen sections of GTL-16 (c) and FaDu (d) xenografts.

- **Figure 2** shows sequential HRRT PET images (coronal slices) of two different GTL-16 xenograft-bearing nude mice at 1, 2, 3, and 4 days after i.v. injection with ^{89}Zr-DN30 (2.6 MBq, 100 μg MAb). Image planes have been chosen where both the left and right tumours are visible. Xenografts are indicated by arrows.

- **Figure 3** shows sequential HRRT PET images (coronal slices) of two different FaDu xenograft-bearing nude mice at 1, 2, 3, and 4 days after injection with ^{89}Zr-DN30 (1.8 MBq, 100 μg MAb). Image planes have been chosen where both the left and right tumours are visible. Xenografts are indicated by arrows.

- **Figure 4** represents the nucleic acid (a) and aminoacid (b) sequence of DN30 heavy chain. The CDR regions are underlined both in the nucleotide and aminoacid sequence.

- **Figure 5** represents the nucleic acid (a) and aminoacid (b) sequence of DN30 light chain. The CDR regions are underlined both in the nucleotide and aminoacid sequence.

For optimal application of anti-Met MAbs in molecular imaging procedures the anti-Met MAbs should be capable of being internalized in tumor cells, as the case of DN30 MAb, after binding to the tumour cells and should have a high affinity for Met, i.e. able to bind Met even if the expression levels of Met on the cell surface are very low. Nevertheless, in case of non-internalizing MAbs, optimal molecular imaging can be obtained selecting suitable detectable signaling moieties as e.g. ^{124}I for PET imaging.

Traditionally for imaging of radioactivity, planar imaging with a gamma-camera or single photon emission computerized tomography (SPECT) have been used. More recently, positron emission tomography (PET) emerged as an attractive option for *in vivo* imaging of MAbs (immuno-PET). PET offers a high resolution and sensitivity combined with the unique ability to measure tissue concentrations of radioactivity in three dimensions.

The imaging procedures cited in the foregoing are per se conventional in the art and do not require to be further detailed herein.

To enable immuno-imaging of MAbs with the aforementioned immuno-imaging techniques appropriate detectable signaling moieties - with a half-life compatible with the time needed to achieve optimal tumor-to-nontumour ratios - has to be securely coupled (directly or through suitable chelating molecules) to the immuno-imaging agent. This strategy can be followed when the labelled immuno-imaging agent can be delivered

to the research/hospital site of use within 1-2 days. This is the advantage of long-lived positron emitters with a half life time of 3-4 days. If delivering takes about 30 hours, then it is necessary to deliver the labelled immuno-imaging agent with 30% more radioactivity, being the quality of the conjugate well preserved up to 2 days.

In case where the delivery of the immuno-imaging agent takes more than 30 hours other labeling procedures have to be followed. As an example, the immuno-imaging agent may be delivered in a first vial as a conjugate to a suitable bifunctional chelating molecule (first conjugate) and the detectable signaling moiety may be delivered separately in a second vial. The detectable signaling moiety is ready to be coupled to the immuno-imaging agent through the bifunctional chelating molecule. In such a case labeling can be easily performed at the research/hospital site of use. The first conjugate is labeled at room temperature with the detectable signaling moiety at the time needed.

In the following, attention will be paid to PET imaging technique, only as an exemplary embodiment of the invention.

In the present disclosure, the potential of MAb DN30 for quantitative PET imaging of Met expressing human tumour xenografts has been disclosed.

Visualization and quantification of MAb biodistribution using PET requires a suitable positron-emitting radionuclide. Two positron emitters seem well suited for imaging of intact MAbs, ^{89}Zr ($t_{1/2}$=78.4 h) and ^{124}I ($t_{1/2}$=100.3 h), since the physical half-life of these radionuclides matches the time needed for MAbs to achieve optimal tumour-to-nontumour ratios (2-4 days for intact MAbs). Copper-64 ($t_{1/2}$=12.7 h), yttrium-86 ($t_{1/2}$=14.7 h) and bromine-76 ($t_{1/2}$=16.2 h) are also used

for this purpose, but are less optimal for imaging at later time points.

In previous studies, the present inventors described procedures for production and purification of large amounts of these positron emitters and for their stable coupling to MAbs, with maintenance of the *in vivo* biodistribution characteristics of the latter (see Verel I, et al., *Eur J Nucl Med Mol Imaging* 2004; 31:1645-52 and Verel I, et al., *J Nucl Med* 2003; 44:1271-81). While ^{89}Zr is coupled via a chelate to the lysine residues of a MAb, ^{124}I can be coupled directly via tyrosine residues. Moreover, the present inventors demonstrated that ^{89}Zr is particularly suitable for PET imaging of internalizing MAbs, and ^{124}I for non-internalizing MAbs. In contrast to directly labelled ^{124}I, ^{89}Zr is trapped in the cell after internalization of the MAb (residualization). Residualization also occurs to some extent in organs of MAb catabolism like liver, kidney and spleen. The clinical potential of ^{89}Zr-immuno-PET and PET-CT for tumour detection was recently demonstrated also in head and neck cancer patients (Borjesson et al., *Clin Cancer Res* 2006;12: 3133-40).

The present inventors described also an alternative procedure for labelling an immuno-imaging agent with a detectable signaling moiety, which allows for storing the immuno-imaging agent suitably modified but not still radiolabelled for a quite long period of time. The labelling may be performed immediately before use. In such a case, the immuno-imaging agent is previously coupled to p-isothiocyanatibenzyl-desferrioxamine, which allows for subsequent coupling to the positron-emitter, e.g. ^{89}Zr or ^{68}Ga. The premodified immuno-imaging agent can be stored at -20°C until the day of planned use.

In this disclosure, biodistribution and PET imaging studies were described in nude mice using two different xenograft lines with divergent levels of Met expression, the human gastric carcinoma cell line GTL-16 with high expression and the HNSCC cell line FaDu with low expression. The FaDu cell line was also chosen as a challenging model to examine imaging quality of radiolabelled DN30.

Both long-lived positron emitters, the residualizing radionuclide ^{89}Zr and the nonresidualizing radionuclide ^{124}I, were considered as candidates for PET imaging with DN30. If a MAb is internalized after binding to the tumour cell, the use of residualizing radionuclide for imaging might be advantageous because of higher tumour-to-nontumour ratios. The biodistribution of coinjected ^{89}Zr-DN30 and ^{131}I-DN30 (^{131}I as a substitute for ^{124}I to facilitate simultaneous counting) in GTL-16 xenograft bearing mice indeed revealed major differences in tumour uptake. Tumour uptake was substantially higher for ^{89}Zr compared to ^{131}I at all time points, and almost four times higher at the latest time point (5 days p.i.). As a result, tumour-to-nontumour ratios were significantly better for ^{89}Zr-DN30. In contrast to ^{89}Zr, levels of ^{131}I in tumours never exceeded levels of ^{131}I in blood.

On the basis of these results, the inventors consider that the residualizing radionuclide ^{89}Zr is better suited for PET imaging with DN30 than nonresidualizing iodine (^{124}I). Although, indirect radio-iodination methodologies can be applied that will result in higher retention of radioactivity in tumour cells after the internalization of labelled MAbs.

Using PET with ^{89}Zr-DN30, GTL-16 tumours as small as 11 mg could be clearly visualized from day 1 p.i. onwards. Also tumours with low Met expression, like the

FaDu xenografts, could be clearly delineated with ^{89}Zr-DN30 immuno-PET. Moreover, the potential of ^{89}Zr-immuno-PET for non-invasive quantification of DN30 biodistribution was illustrated by the excellent correlation between PET-assessed tumour uptake data and ex vivo tumour uptake data (R^2=0.98). In clinical trials, quantitative PET imaging would be preferable over repeated tumour biopsies, especially because tumours are often heterogeneous (resulting in non-representative biopsies) and difficult accessible.

Despite clear visualization of small tumours, ^{89}Zr-DN30 showed relatively high uptake in liver and spleen, especially when administered at relatively low protein dose (Table 2). Part of the liver and spleen uptake is due to residualization of ^{89}Zr after catabolism of the conjugate in these organs, as was also observed in inventors' previous studies with ^{89}Zr-cetuximab (Erbitux) and ^{89}Zr-ibritumomab tiuxetan (Zevalin) in the same animal model. Nevertheless, we hypothesize that the enhanced uptake of radioactivity in liver and spleen might be partly an artefact related to the nude mouse model, which will not occur in humans. At this point, even better images can be expected in clinical studies.

DN30 is a murine MAb of the IgG_{2a} isotype. Sharkey et al. (*Cancer Res* 1991; 51:3102-7) and Van Gog et al. (*Cancer Immunol Immunother* 1997; 44:103-11) described the phenomenon of fast blood clearance of murine MAbs with concomitant high accumulation in liver and spleen, in various strains of outbred *nu/nu* mice. Fast blood clearance and enhanced liver and spleen uptake did especially occur when murine IgG_{2a} or IgG_{2b} isotype MAbs, young animals, or a low MAb dose were used. The phenomenon was most prominent in animals with low endogenous IgG titers. The authors postulated that

rapid removal of MAb from the blood might be mediated by Fc-binding receptors in e.g. liver and spleen as long as endogenous MAb titres are low. A very similar phenomenon was observed in this disclosure when the MAb dose of DN30 was varied: lower MAb dose was associated with enhanced and variable blood clearance and a concomitant increased uptake in liver and particularly spleen (Table 2).

As far as the radiochemistry concerns, taking the step to clinical evaluation of immuno-PET with ^{89}Zr-labeled humanized or fully human anti-Met MAbs is relatively straightforward. Using the same radiochemical approach, the inventors recently reported on an immuno-PET study with ^{89}Zr-labeled anti-CD44v6 MAb U36 (75 MBq) for detection of lymph node metastases in 20 head and neck cancer patients and with ^{89}Zr-ibritumomab tiuxetan for prediction of ^{90}Y-ibritumomab tiuxetan biodistribution with PET in non-Hodgkin's lymphoma patients. With both ^{89}Zr-conjugates, excellent PET images were obtained.

DN30 pursuant to the present invention can be produced by conventional methods in animals or, preferably, by genetic engineering techniques.

The use of the monoclonal antibody DN30 according to the present invention is intended to include also the use of genetically engineered and humanized antibodies. Genetically engineered and humanized antibodies and methods for their production are known in the art. See, for a review Clark M. *Imm. Today*, 2000; 21:397-402.

The use of DN30 also include the use of fragments containing the epitope binding region or Complementary Determining Regions (CDRs) thereof as Fv, scFv, Fab, Fab', $F(ab')_2$ fragments. Conventional fragments are typically produced by proteolitic cleavage, but can

also be produced by chemical synthesis, such as liquid or solid phase synthesis, as well as by recombinant DNA techniques. With the expression "epitope binding region" is meant the portion of the antibody recognizing the antigen, i.e. the antigen-binding site. With the expression "Complementary Determining Region" is meant the short aminoacid sequence found in the variable domains of the antibody that complements the antigen and therefore provides the antibody with its specificity for that particular antigen.

MATERIAL AND METHODS

DN30 nucleotide and aminoacid sequences

The translation of the DN30 heavy chain nucleotide sequence corresponding to the SEQ ID No.: 1 and figure 4a is reported in figure 4b and SEQ ID No:6.

The nucleotidic and aminoacid sequences corresponding to the CDR regions are underlined in Figures 4a and 4b; their aminoacid sequences are: CDR-H1: GYTFTSYW (SEQ ID NO.:8); CDR-H2: INPSSGRT(SEQ ID NO.:9); CDR-H3: ASRGY(SEQ ID NO.:10).

The translation of the DN30 light chain nucleotide sequence corresponding to the SEQ ID No.: 2 and figure 5a is reported in figure 5b and in SEQ ID NO.:7.

The nucleotidic and aminoacid sequences corresponding to the CDR regions are underlined in Figures 5a and 5b; their aminoacid sequences are: CDR-L1: QSVDYDGGSY (SEQ ID NO.:11); CDR-L2: AAS (SEQ ID NO.:12); CDR-L3: QQSYEDPLT (SEQ ID NO.:13).

Monoclonal antibodies, cell lines, and radioactivity

The murine IgG_{2a} MAb DN30 (7.0 mg/mL), directed against the extracellular domain of Met (K_d of 2.64 x 10^{-9} M), was obtained from the Institute for Cancer

Research and Treatment (IRCC), University of Turin Medical School, Italy. The hybridoma cell line was deposited by Advanced Biotechnology Center (ABC), Interlab Cell Line Collection (ICLC) Italy, with accession number ICLC PD 05006. Selection, construction, and production of DN30 have been described in Prat M, et al., *J Cell Sci* 1998; 111:237-47.

The human gastric carcinoma cell line GTL-16, in which the *MET* proto-oncogene is amplified and overexpressed (Ponzetto C, et al., *Oncogene* 1991; 6:553-9), was obtained from IRCC and deposited on April 16, 2008 by Advanced Biotechnology Center (ABC), Interlab Cell Line Collection (ICLC) Italy, with accession number ICLC PD 08003. The head and neck squamous cell carcinoma (HNSCC) cell line FaDu was obtained from Karl-Heinz Heider (Boehringer Ingelheim, Vienna, Austria) (Rangan SRS, *Cancer* 1972; 29:117-21).

^{89}Zr (2.7 GBq/mL in 1 M oxalic acid) was produced by BV Cyclotron (Amsterdam, The Netherlands) by a (p,n) reaction on natural yttrium-89 (^{89}Y) and isolated with a hydroxamate column (Verel I, et al., *J Nucl Med* 2003; 44:1271-81). ^{131}I (7.4 GBq/mL in 0.01 M sodium hydroxide) was purchased from GE Healthcare Life Sciences (Uppsala, Sweden).

Immunohistochemical staining of cell lines and xenografts

The cell lines GTL-16 and FaDu were characterized for Met expression by performing immunocytochemistry with biotinylated DN30. In short, cells were trypsinized, spun onto glass slides at a density of 5 x 10^4 cells/spin, and the glass slides were air dried overnight. After fixing the cells with freshly prepared 2% paraformaldehyde for 10 min, the slides were

incubated in Tris buffer (50 mM, pH 7.2) containing 2% bovine serum albumin (BSA) for 30 min, followed by incubation with biotinylated DN30 for 1 h at room temperature. After extensive washing with the Tris buffer, the cells were incubated with streptavidin-alkaline phosphatase (ChemMate Detection Kit; Dako, Glostrup, Denmark) for 1 h at room temperature. Colour developing was performed using freshly prepared substrate from the kit, followed by washing with demineralized water.

In addition, immunohistochemistry was performed on frozen sections of GTL-16 and FaDu xenografts. Cryostat sections (5 μm) were air dried and fixed in 2% paraformaldehyde for 10 min. Met staining was performed as described above.

Radiolabelling

a) For radiolabelling of DN30 with ^{89}Zr, a bifunctional metal-chelating moiety had to be conjugated to the MAb as described previously by Verel *et al. J Nucl Med* 2003; 44:1271-81. Briefly, the chelate desferal (Df; Novartis, Basel, Switserland) was succinylated (*N*-sucDf), temporarily filled with stable iron [Fe(III)], and coupled to the lysine residues of DN30 by means of a tetrafluorophenol-*N*-sucDf ester. After removal of Fe(III) by transchelation to EDTA, the premodified MAb was purified on a PD10 column (GE Healthcare Life Sciences). Approximately 1 *N*-sucDf moiety was coupled per DN30 molecule assessed by using ^{59}Fe (Perk LR, et al., *Eur J Nucl Med Mol Imaging* 2006; 33:1337-45). Subsequently, *N*-sucDf-DN30 (0.5 mg) was labelled with ^{89}Zr (max. 37 MBq) in 0.5 M HEPES buffer at pH 7.0. Finally, ^{89}Zr-*N*-sucDf-DN30 was purified on a PD10 column (eluent: 0.9% sodium chloride/gentisic acid

5 mg/mL, pH 5.0). ^{89}Zr-*N*-sucDf-DN30 will be abbreviated to ^{89}Zr-DN30 in the rest of this article.

Radioiodination of DN30 with ^{131}I was performed essentially as described in Visser GW et al., *J Nucl Med* 2001; 42:509-19. ^{131}I was used as substitute of ^{124}I to facilitate dual isotope counting together with ^{89}Zr in the biodistribution studies (see later). In short, to a 20 mL ß-scintillation glass vial coated with 75 µg IODO-GEN (Pierce Biotechnology, Rockford, IL), 0.05 mL of 0.5 M sodium phosphate (pH 7.4), 50-200 µg DN30 in 0.45 mL of 0.1 M sodium phosphate (pH 6.8), and 9-18.5 MBq of ^{131}I were added, successively. After gentle shaking for 4 min at room temperature, the reaction was quenched by the addition of 0.1 mL of 25 mg/mL ascorbic acid (pH 5.0). Finally, ^{131}I-DN30 was separated from non-reacted ^{131}I by purification on a PD10 column (eluent: 0.9% sodium chloride/ascorbic acid 5 mg/mL, pH 5.0).

b) Radiolabelling of DN30 with ^{89}Zr can also be performed according to a second protocol which allows storing of DN30 suitably modified but not still radiolabelled until the day of planned use.

In a solution of DN30 at a concentration equal or higher than 2 mg ml^{-1} having pH=8.9-9.1, p-isothiocyanatibenzyl-desferrioxamine in DMSO was dissolved at a concentration of between 2 and 5 mM (1.5-3.8 mg ml^{-1}) and mixed immediately, keeping the DMSO concentration below 5% in the conjugation reaction mixture. p-isothiocyanatibenzyl-desferrioxamine had to be in a 3-fold molar excess over the molar amount of DN30. The reaction mixture was incubated for 30 min at 37°C. The Df-DN30 conjugate was then purified using a PD-10 column according to the following protocol: i) the PD10 column was rinsed with 20 ml 0.9% NaCl/gentisic acid 5 mg ml^{-1} (pH = 4.9-5.3); ii) the

conjugation reaction mixture was pipetted onto the column and the flow-through discarded; iii) 1.5 ml 0.9% NaCl/gentisic acid 5 mg ml^{-1} (pH = 4.9-5.3) was pipetted onto the column and the flow-through discarded and iv) 2 ml 0.9% NaCl/gentisic acid 5 mg ml^{-1} (pH = 4.9-5.3) was pipetted onto the PD-10 column and the Df-DN30 conjugate collected.

After that, the Df-DN30 conjugate can be stored at -20°C until the day of planned use. The Df-DN30 conjugate is stable in storage for at least several weeks.

The Df-DN30 conjugate could then be labelled (when necessary for use) with ^{89}Zr according to the following protocol: i) between 25-200 μl (A) of ^{89}Zr oxalic acid solution (between 37 and 185 MBq) was pipetted into a glass "reaction vial"; ii) while gently shaking, 200 - A μl 1M oxalic acid was added into the reaction vial. Subsequently, 90 μl 2 M Na_2CO_3 were pipetted into the reaction vial and incubated for 3 minutes at room temperature; iii) while gently shaking, successively 0.30 ml 0.5 M HEPES (pH=7.2), 0.71 ml of Df-DN30 (typically 1-3 mg), and 0.70 ml 0.5 M HEPES (pH=7.2) were pipetted into the reaction vial, keeping the pH of the labeling reaction in the range of 6.8-7.2. iv) The reaction mixture was then incubated for 1 h at room temperature while gently shaking. v) Meanwhile, a PD10 column was rinsed with 20 ml 0.9% NaCl/gentisic acid 5 mg ml^{-1} (pH=4.9-5.3); vi) after 1 h incubation, the reaction mixture was pipetted onto the column and the flow-through discarded. vii) 1.5 ml 0.9% NaCl/gentisic acid 5 mg ml^{-1} (pH = 4.9-5.3) was pipetted onto the column and the flow-through discarded; viii) 2 ml 0.9% NaCl/gentisic acid 5 mg ml^{-1} (pH=4.9-5.3) was pipetted to the PD-10 column and the purified radiolabeled DN30 collected. ix) The purified radiolabeled DN30 was

analyzed by ITLC and HPLC. When the radiochemical purity was greater than 95%, the solution was ready for storage at 4 °C or dilution in 0.9% NaCl/gentisic acid 5 mg ml^{-1} (pH=4.9-5.3) for *in vitro* or *in vivo* studies. The radiolabeled protein is stable in storage for at least several days.

Gentisic acid was introduced during labeling and storage to prevent deterioration of the protein integrity by radiation. Typically, 0.9-1.5 Df moieties were coupled per DN30 antibody. Radiolabeling of the Df-conjugated mAb with ^{89}Zr resulted in overall labeling yields of >85%. Resulting ^{89}Zr-mAb conjugates were optimal with respect to radiochemical purity (>95% according to ITLC and analytical HPLC), immunoreactivity, and in vivo stability.

Analyses

After each preparation of ^{89}Zr-DN30 or ^{131}I-DN30, the conjugates were analysed by instant thin-layer chromatography (ITLC) for radiolabelling efficiency and radiochemical purity, and by high performance liquid chromatography (HPLC) and sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) followed by phosphor imager analysis for integrity, and by a cell-binding assay for immunoreactivity. ITLC analyses of radiolabelled DN30 was performed on silica gel impregnated glass fibre sheets (Pall Corp., East Hills, NY). As the mobile phase, 0.02 M citrate buffer (pH 5.0) was used.

HPLC monitoring of the final products was performed on a Jasco HPLC system using a Superdex™ 200 10/300 GL size exclusion column (GE Healthcare Life Sciences). As eluent a mixture of 0.05 M sodium phosphate and 0.15 M sodium chloride (pH 6.8) was used at a flow rate of 0.5 mL/min. Electrophoresis was

performed on a Phastgel System (GE Healthcare Life Sciences) using preformed 7.5% SDS-PAGE gels under non-reducing conditions.

The immunoreactivity was determined by measuring binding of ^{89}Zr-DN30 and ^{131}I-DN30 (10000 cpm/mL) to a serial dilution of 2% paraformaldehyde-fixed GTL-16 cells essentially as described by Lindmo et al., *J Immunol Methods* 1984; 72:77-89. Data were graphically analysed in a modified Lineweaver-Burk (double-reciprocal) plot and the immunoreactivity was determined by extrapolating to conditions representing infinite antigen excess.

Biodistribution

Nude mice bearing subcutaneously implanted xenografts of the human gastric carcinoma cell line GTL-16 or the HNSCC cell line FaDu were used. Female mice (HSD:Athymic Nude-*Foxn1*^{nu}, 21-31 g, Harlan CPB) were 10-14 weeks old at the time of the experiment. All animal experiments were performed according to National Institutes of Health principles of laboratory animal care and Dutch national law ("Wet op de dierproeven", Stb 1985, 336).

Three sets of biodistribution studies were performed. In the first experiment, the biodistribution of intravenous (i.v.) coinjected ^{89}Zr-DN30 (0.28 ± 0.004 MBq) and ^{131}I-DN30 (0.37 ± 0.004 MBq) was assessed in GTL-16 bearing nude mice. Unlabeled DN30 was added to the injection mixture so that each of the animals received 100 μg of MAb in total. This initial antibody dose was chosen sufficiently high to prevent rapid IgG_{2a} isotype-related elimination of the MAb from the blood as has been described for the nude mouse model, and sufficiently low to prevent antigen saturation in the tumour. The mean tumor size at the start of the

experiment was 64 ± 33 mm^3. At 1, 2, 3 and 5 days post injection (p.i.), 4 mice per time point were anaesthetised, bled, killed, and dissected. After blood, tumour, and normal tissues had been weighed, the amount of radioactivity in each sample was measured in a gamma counter. Radioactivity uptake was calculated as the percentage of the injected dose per gram of tissue (%ID/g).

In the second experiment, the relation between protein dose of ^{89}Zr-DN30 and biodistribution was investigated in GTL-16 bearing nude mice. Four groups of 4 mice received 0.39 ± 0.02 MBq ^{89}Zr-DN30 by i.v. injection. Unlabelled DN30 was added to the injection mixture so that per group the animals received 25, 50, 100, or 200 μg DN30 in total, respectively. The mean tumor size at the start of the experiment was 50 ± 34 mm^3, and was similar for the different groups. At day 3 p.i., all animals were anaesthetised, bled, killed, and dissected, with further processing according to the above procedure.

In the third experiment, biodistribution of ^{89}Zr-DN30 (0.28 ± 0.01 MBq; 100 μg) was assessed in FaDu bearing nude mice (n = 16). The mean tumor size at the start of the experiment was 149 ± 47 mm^3. At 1, 2, 3, and 4 days p.i., the mice were anaesthetised, bled, killed, and dissected, with further processing according to the above procedure.

PET imaging procedures

Animal PET studies for imaging and quantification of tumor targeting of ^{89}Zr-DN30 were performed essentially as described by Verel et al., *J Nucl Med* 2003; 44:1663-70. Briefly, PET studies were performed using a double-crystal-layer HRRT PET scanner (Siemens/CTI Knoxville), a dedicated small animal and

human brain scanner (De Jong HWAM et al., *Phys Med Biol* 2007; 52:1505-26). Four GTL-16 xenograft-bearing nude mice were injected i.v. with 2.6 ± 0.04 MBq ^{89}Zr-DN30 (100 μg). The mean tumor size at the start of the experiment was 46 ± 19 mm^3. The animals were sedated using isoflurane and imaged at 10 min, and at 1, 2, 3, and 4 days p.i. 3D emission scans were acquired in 64-bit list mode during 60 min using a 400-650 keV window. The 64-bit list mode file was first converted into a single-frame histogram using a span of 9, and subsequently reconstructed using a 3D OP-OSEM reconstruction with 2 iterations and 16 subsets. After reconstruction, regions of interest (ROI) were drawn semiautomatic around the tumours using a 3D isocontour at 50% of maximum pixel value with background correction. Immediately after the last PET scan the animals were killed, dissected, and processed as described above.

In a second imaging study, a group of four FaDu xenograft-bearing nude mice were injected i.v. with 1.8 ± 0.01 MBq ^{89}Zr-DN30 (100 μg). The mean tumor size at the start of the experiment was 231 ± 64 mm^3. Imaging was performed as described above.

Statistical analyses

Differences in tissue uptake between coinjected conjugates were statistically analyzed for each time point with SPSS 11.0 software using Student *t*-test for paired data. Two-sided significance levels were calculated and $P < 0.01$ was considered statistically significant. Statistical analysis of differences in tissue uptake between different groups was performed using Student *t*-test for unpaired data. Regression analysis of PET-defined ^{89}Zr tumour uptake versus ex

vivo assessed ^{89}Zr tumour uptake was also performed with SPSS 11.0 software.

RESULTS

Immunohistochemistry

The cell lines GTL-16 and FaDu both expressed Met (Fig. 1a and 1b), but Met expression was highest in GTL-16 (~100000 copies at outer cell surface). Met copy number could not accurately be determined for FaDu. Higher Met expression was also found for GLT-16 xenografts in comparison with FaDu xenografts (Fig. 1c and 1d).

Radiolabelling

Radiolabelling of DN30 with ^{131}I or *N*-sucDf-DN30 with ^{89}Zr resulted in overall labelling yields of >85% and >70%, respectively. The radiochemical purity, as determined by ITLC, was always higher than 95% for both products. The specific radioactivities of the final products ranged from 30 to 80 MBq/mg for ^{131}I-DN30 and from 54 to 70 MBq/mg for ^{89}Zr-DN30. HPLC and SDS-PAGE analysis revealed optimal integrity of DN30, irrespective of whether the MAb was labelled with ^{131}I or ^{89}Zr. The immunoreactivity of both radioimmunoconjugates was always >70% at the highest cell concentration and >95% at infinite antigen excess.

Biodistribution

In the first study, the inventors compared the biodistribution of co-injected ^{89}Zr-DN30 and ^{131}I-DN30 (100 µg DN30 total) in GTL-16-tumour-bearing nude mice up to 5 days after injection. ^{89}Zr-DN30 showed a significantly higher tumour accumulation, as well as a significantly higher liver and spleen uptake compared to the ^{131}I-labeled counterpart (Table 1). The ^{89}Zr-DN30

tumour accumulation ranged from 12.2 ± 4.3 %ID/g to 19.6 ± 3.3 %ID/g, and the ^{131}I-DN30 accumulation from 7.8 ± 3.1 %ID/g to 5.3 ± 1.0 %ID/g, in the time period between 1 and 5 days p.i.. Small differences in uptake of both conjugates were found for blood and all other normal tissues. Nevertheless, tumour-to-normal tissue ratios were always higher for ^{89}Zr-DN30, except for liver and spleen at the earliest time points. In contrast to ^{89}Zr, levels of ^{131}I in tumours never exceeded levels of ^{131}I in blood. On the basis of these results, the inventors selected ^{89}Zr-DN30 for the remaining biodistribution and PET imaging studies.

Table 1

Biodistribution time	**1 d**	**2 d**	**3 d**	**5 d**
Uptake of ^{89}Zr-DN30 [%ID/g][a]				
Blood	17.1 (2.1)	13.3 (1.0)*	10.6 (3.2)*	8.8 (2.3)*
Tumour (GTL-16)	12.2 (4.3)*	17.3 (4.5)*	18.1 (4.5)*	19.6 (3.3)*
Sternum	2.89 (0.3)	3.1 (0.5)*	3.1 (0.3)*	2.2 (0.2)*
Heart	4.2 (0.6)	3.5 (0.6)	2.8 (0.6)	3.7 (1.0)
Lung	6.2 (0.4)	5.7 (0.2)	4.5 (0.7)	3.7 (0.6)
Liver	6.1 (0.3)*	6.3 (0.2)*	8.4 (2.4)*	7.2 (0.7)*
Spleen	6.6 (1.1)*	8.6 (0.9)*	7.9 (1.6)*	7.4 (1.8)*
Kidney	4.0 (0.6)	3.9 (0.2)*	3.5 (0.2)	3.1 (0.2)*
Bladder	3.3 (0.6)	3.3 (0.4)	3.2 (0.3)	2.9 (0.3)
Muscle	1.2 (0.2)	1.2 (0.1)	1.2 (0.2)	0.6 (0.2)
Colon	1.5 (0.2)*	1.9 (0.2)	1.8 (0.7)	1.3 (0.4)
Ileum	1.8 (0.3)	2.5 (0.7)	2.4 (1.2)	2.2 (0.8)
Stomach	1.5 (0.1)	1.7 (0.2)	1.5 (0.3)	1.6 (0.5)
Uptake of ^{131}I-DN30 [%ID/g][a]				
Blood	17.6 (2.1)	15.0 (0.9)	12.4 (3.2)	9.9 (2.0)
Tumour (GTL-16)	7.8 (3.1)	7.8 (1.1)	6.7 (1.5)	5.3 (1.0)
Sternum	2.8 (0.3)	2.3 (0.5)	2.1 (0.4)	1.2 (0.3)
Heart	4.5 (0.7)	3.9 (0.7)	3.0 (0.8)	3.9 (0.9)

Biodistribution time	1 d	2 d	3 d	5 d
Lung	6.7 (0.3)	6.3 (0.3)	4.8 (0.7)	3.5 (0.6)
Liver	2.9 (0.5)	2.8 (0.3)	3.1 (0.8)	1.8 (0.1)
Spleen	3.8 (0.3)	4.2 (0.6)	4.0 (0.9)	2.2 (0.2)
Kidney	4.0 (0.8)	3.8 (0.2)	3.0 (0.4)	2.1 (0.3)
Bladder	4.2 (0.7)	4.7 (1.1)	3.5 (0.5)	2.7 (0.3)
Muscle	1.3 (0.2)	1.4 (0.3)	1.2 (0.2)	0.6 (0.1)
Colon	1.6 (0.2)	1.8 (0.1)	1.6 (0.4)	0.9 (0.2)
Ileum	1.8 (0.3)	2.1 (0.4)	1.7 (0.5)	1.2 (0.2)
Stomach	2.6 (0.7)	2.1 (0.2)	1.9 (0.3)	1.2 (0.2)

* Significant differences ($P<0.01$) between ^{89}Zr-DN30 and ^{131}I-DN30 uptake are marked with an asterisk.
[a]All data are presented as mean ± S.D. (n=4).

To investigate if 100 µg is an appropriate protein dose of MAb DN30 for efficient tumour targeting in mice, the biodistribution of ^{89}Zr-DN30 was assessed for four protein doses ranging from 25 - 200 µg in GTL-16 xenograft-bearing nude mice at day 3 p.i.. The average uptake levels in blood, tumour, and normal tissues, and tumour-to-normal tissue ratios are shown in Table 2. Tumour uptake levels combined with tumour-to-normal tissue ratios were considered most favourable for the 50 and 100 µg group. At the lowest protein dose, blood levels of DN30 were relatively low and strongly variable between mice, while e.g. spleen uptake was high, which is indicative for rapid IgG_{2a} isotype-related elimination of MAbs in the nude mouse model. Therefore, the inventors used the 100 µg MAb dose in the subsequent biodistribution and imaging studies.

Table 2

Protein dose	25 µg	50 µg	100 µg	200 µg
Uptake of ^{89}Zr-DN30 [%ID/g][a]				
Blood*	2.8 (4.4)	5.6 (1.8)	8.9 (2.7)	10.2 (1.0)
Tumour	14.3 (3.9)	16.6 (2.7)	18.4 (5.0)	15.1 (3.7)

Protein dose	25 µg	50 µg	100 µg	200 µg
Sternum	2.9 (0.2)	2.4 (0.3)	2.7 (0.4)	2.5 (0.3)
Heart	1.6 (1.1)	1.8 (0.3)	2.4 (0.4)	2.7 (0.5)
Lung	2.0 (1.4)	3.1 (0.7)	4.4 (1.0)	4.4 (0.3)
Liver	9.9 (2.4)	7.4 (1.1)	8.0 (2.0)	9.0 (5.1)
Spleen	11.0 (5.3)	8.4 (2.6)	8.0 (3.4)	6.6 (0.3)
Kidney	2.2 (0.2)	2.6 (0.2)	3.2 (0.1)	3.3 (0.3)
Muscle	0.7 (0.2)	0.8 (0.1)	1.1 (0.1)	1.0 (0.1)
Tumour/Tissue ratios				
T/Blood	5.0	2.9	2.1	1.5
T/Sternum	5.0	6.8	6.9	6.0
T/Heart	9.1	9.4	7.5	5.5
T/Lung	7.3	5.4	4.2	3.4
T/Liver	1.4	2.2	2.3	1.7
T/Spleen	1.3	2.0	2.3	2.3
T/Kidney	6.5	6.5	5.7	4.5
T/Muscle	21.5	20.1	17.5	15.4

* Significant differences ($P<0.01$) in ^{89}Zr-DN30 uptake between the given protein doses are marked with an asterisk.
[a]All data are presented as mean ± S.D. (n=4).

In the third experiment, biodistribution of ^{89}Zr-DN30 was assessed in FaDu (low Met expression)-bearing nude mice up to 4 days p.i. (Table 3). Uptake of ^{89}Zr-DN30 in FaDu tumours was significantly lower than that in GTL-16 tumours, e.g. at 3 days p.i. the FaDu tumour uptake was 7.8 ± 1.2 %ID/g compared to 18.1 ± 4.5 %ID/g in the GTL-16 tumours (P <0.01). This lower uptake correlates with the different expression levels of Met in these tumours as determined by immunohistochemistry (Fig. 1).

Table 3

Biodistribution time	1 d	2 d	3 d	4 d
Uptake of ^{89}Zr-DN30 [%ID/g][a]				
Blood	14.4 (1.0)	11.9 (1.5)	10.3 (1.5)	9.3 (2.3)

Biodistribution time	1 d	2 d	3 d	4 d
Tumour (FaDu)	6.3 (0.9)	9.3 (1.0)	7.8 (1.2)	6.7 (0.3)
Sternum	2.5 (0.3)	2.7 (0.1)	2.5 (0.2)	3.0 (0.4)
Heart	3.3 (0.5)	3.3 (0.4)	2.9 (0.4)	2.7 (1.0)
Lung	5.7 (0.8)	5.3 (0.4)	4.5 (0.2)	4.8 (2.0)
Liver	4.1 (0.9)	4.8 (0.8)	4.7 (0.7)	4.9 (0.1)
Spleen	4.5 (0.7)	5.4 (1.4)	4.3 (0.8)	5.9 (0.9)
Kidney	3.3 (0.6)	3.6 (0.3)	3.1 (0.4)	3.0 (0.3)
Bladder	3.3 (0.8)	3.4 (0.3)	3.1 (0.3)	2.6 (0.6)
Muscle	1.3 (0.2)	1.3 (0.01)	1.1 (0.2)	0.9 (0.1)
Colon	1.6 (0.2)	2.0 (0.2)	1.3 (0.4)	1.0 (0.01)
Ileum	1.9 (0.5)	2.6 (0.7)	1.5 (0.5)	1.2 (0.1)
Stomach	1.6 (0.4)	1.6 (0.1)	1.3 (0.2)	1.0 (0.2)

[a] All data are presented as mean ± S.D. (n=4).

PET imaging

Representative PET images of mice bearing Met expressing human cancer xenografts, between 1 and 4 days after i.v. injection of ^{89}Zr-DN30, are shown in Fig. 2 (GTL-16) and Fig. 3 (FaDu). At the earliest imaging time point, 10 min p.i., only activity in the blood pool was observed (scans not shown). All tumours (arrows) could be clearly visualized in both xenograft hosts as early as 1 day p.i., and good delineation of the tumours persisted through the final imaging session. As expected from the biodistribution data, tumour uptake was more pronounced in the GTL-16 xenografts. Tumour localization was obvious along with some blood pool, which diminished over time, and liver and spleen uptake. Noteworthy, GTL-16 tumours as small as 11 mg were clearly visualized. A good correlation was found between PET-defined tumour uptake data and ex vivo tumour uptake measurements (R^2=0.98).

Naturally, while the principle of the invention remains the same, the details of construction and the embodiments may widely vary with respect to what has

been described and illustrated purely by way of example, without departing from the scope of the present invention as defined in the appended claims.

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CLAIMS

1. An immuno-imaging agent for the detection of tumor cells by means of an immuno-imaging technique including at least one of:

- an anti-Met monoclonal antibody,
- a fragment of an anti-Met monoclonal antibody containing the epitope binding region thereof,
- a genetically engineered antibody containing the epitope binding region or Complementary Determining Regions of an anti-Met monoclonal antibody,
- a humanized antibody containing the epitope binding region or Complementary Determining Regions of an anti-Met monoclonal antibody, or combinations thereof,

characterized in that said anti-Met monoclonal antibody is produced by the hybridoma cell line ICLC PD 05006.

2. The immuno-imaging agent according to claim 1, wherein said immuno-imaging technique is selected among gamma camera imaging technique, PET-technique and MRI-technique.

3. The immuno-imaging agent according to claim 1, wherein said immuno-imaging agent is coupled directly or indirectly to a detectable signaling moiety, wherein said detectable signaling moiety is active or activatable.

4. The immuno-imaging agent according to claim 1, wherein said immuno-imaging agent is coupled to a molecule suitable to be subsequently coupled to a detectable signaling moiety, wherein said detectable signaling moiety is active or activatable.

5. The immuno-imaging agent according to claim 3 or claim 4, wherein said detectable signaling moiety is selected among a gamma camera-imageable agent, a PET-imageable agent, a MRI-imageable agent.

6. The immuno-imaging agent according to claim 5, wherein said gamma camera-imageable agent is selected from ^{3}H, ^{14}C, ^{35}S, ^{99m}Tc, ^{123}I, ^{125}I, ^{131}I, ^{111}In, ^{97}Ru, ^{67}Ga, and ^{201}Tl, ^{186}Re, ^{177}Lu.

7. The immuno-imaging agent according to claim 5, wherein said PET-imageable agent is selected from ^{89}Zr, ^{124}I, ^{64}Cu, ^{76}Br, ^{86}Y, ^{18}F, ^{68}Ga, ^{45}Ti.

8. The immuno-imaging agent according to claim 5, said MRI-imageable agent is selected from Ga, Mn, Cu, Fe, Au, and Eu.

9. The immuno-imaging agent according to any one of claims 1 to 8, wherein said anti-Met monoclonal antibody presents a nucleotide sequence comprising SEQ ID NO.:1 and SEQ ID NO.:2, or a nucleotide sequence comprising SEQ ID NO.:1 and SEQ ID NO.:2 wherein at least one conservative substitution is present.

10. The immuno-imaging agent according to any one of claims 1 to 8, wherein said fragment containing the epitope binding region of said anti-Met monoclonal antibody is selected from Fab, $F(ab')_2$, Fab', Fv, scFv.

11. The immuno-imaging agent according to any one of claims 1 to 8, wherein said genetically engineered antibody containing the epitope binding region or Complementary Determining Regions of said anti-Met monoclonal antibody presents a nucleotide sequence

comprising SEQ ID NO.:8 (CDR-H1), SEQ ID NO.:9 (CDR-H2), SEQ ID NO.:10 (CDR-H3), SEQ ID NO.:11 (CDR-L1), SEQ ID NO.:12 (CDR-L2) and SEQ ID NO.:13 (CDR-L3).

12. The immuno-imaging agent according to any one of claims 1 to 8, wherein said humanized antibody containing the epitope binding region or Complementary Determining Regions of said anti-Met monoclonal antibody is a mouse/human chimeric antibody.

13. A diagnostic composition suitable for use in an immuno-imaging technique comprising:

(i) an immuno-imaging agent including at least one of:

- an anti-Met monoclonal antibody,
- a fragment of an anti-Met monoclonal antibody containing the epitope binding region thereof,
- a genetically engineered antibody containing the epitope binding region or Complementary Determining Regions of an anti-Met monoclonal antibody,
- a humanized antibody containing the epitope binding region or Complementary Determining Regions of an anti-Met monoclonal antibody, or combinations thereof,

wherein said immuno-imaging agent a) is coupled directly or indirectly to a detectable signaling moiety, or b) is coupled to a molecule suitable to be subsequently coupled to a detectable signaling moiety, wherein said detectable signaling moiety is active or activatable, and

(ii) a diagnostically acceptable carrier and/or excipient,

characterized in that said anti-Met monoclonal antibody is produced by the hybridoma cell line ICLC PD 05006.

14. Composition according to claim 13, wherein said immuno-imaging technique is selected from gamma camera imaging technique, PET-technique and MRI-technique.

15. Composition according to claim 13, wherein said detectable signaling moiety is selected from a gamma camera-imageable agent, a PET-imageable agent, a MRI-imageable agent.

16. Composition according to claim 15, wherein said gamma camera-imageable agent is selected from ^{3}H, ^{14}C, ^{35}S, ^{99m}Tc, ^{123}I, ^{125}I, ^{131}I, ^{111}In, ^{97}Ru, ^{67}Ga, ^{201}Tl, ^{186}Re, and ^{177}Lu.

17. Composition according to claim 15, wherein said PET-imageable agent is selected from ^{89}Zr, ^{124}I, ^{64}Cu, ^{76}Br, ^{86}Y, ^{18}F, ^{68}Ga, and ^{45}Ti.

18. Composition according to claim 15, said MRI-imageable agent is selected from Ga, Mn, Cu, Fe, Au, and Eu.

19. Composition according to any one of claims 13 to 18, wherein said anti-Met monoclonal antibody presents a nucleotide sequence comprising SEQ ID NO.:1 and SEQ ID NO.:2, or a nucleotide sequence comprising SEQ ID NO.:1 and SEQ ID NO.:2 wherein at least one conservative substitution is present.

20. Composition according to any one of claims 13 to 18, wherein said fragment containing the epitope binding region of said anti-Met monoclonal antibody is selected from Fab, $F(ab')_2$, Fab', Fv, scFv.

21. Composition according to any one of claims 13 to 18, wherein said genetically engineered antibody containing the epitope binding region or Complementary Determining Regions of said anti-Met monoclonal antibody presents a nucleotide sequence comprising SEQ ID NO.:8 (CDR-H1), SEQ ID NO.:9 (CDR-H2), SEQ ID NO.:10 (CDR-H3), SEQ ID NO.:11 (CDR-L1), SEQ ID NO.:12 (CDR-L2) and SEQ ID NO.:13 (CDR-L3).

22. Composition according to any one of claims 12 13 to 18, wherein said humanized antibody containing the epitope binding region or Complementary Determining Regions of said anti-Met monoclonal antibody is a mouse/human chimeric antibody.

23. Diagnostic kit comprising a first vial containing an immuno-imaging agent according to any one of claims 1 to 12 or a diagnostic composition according to any one of claims 13 to 22, and instructions for using said immuno-imaging agent or said diagnostic composition for the diagnosis of a cancerous condition or a tumor in a subject, wherein said cancer or tumor cells express Met.

24. Diagnostic kit according to claim 23, wherein said first vial contains said immuno-imaging agent coupled to a molecule suitable to be coupled to a detectable signaling moiety, and said kit comprises a second vial comprising said detectable signaling moiety suitable to be coupled to said immuno-imaging agent.

SEQUENCE LISTING

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