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(54) **MONOCLONAL ANTIBODIES AGAINST HUMAN PROTEIN Mcm3, PROCESS FOR THEIR PRODUCTION, AND THEIR USE**

GEGEN MENSCHLICHES MCM3-PROTEIN GERICHTETE MONOKLONALE ANTIKÖRPER,
VERFAHREN ZU DEREN HERSTELLUNG UND DEREN VERWENDUNG

ANTICORPS MONOCLONAUX CONTRE LA PROTEINE HUMAINE MCM3, TECHNIQUE DE
PRODUCTION ET D'UTILISATION DE CES ANTICORPS

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- **THOMMES P ET AL: "Properties of the nuclear P1 protein, a mammalian homologue of the yeast Mcm3 replication protein." NUCLEIC ACIDS RESEARCH, (1992 MAR 11) 20 (5) 1069-74., XP002150915 cited in the application**

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Description

Technical field

[0001] The present invention relates to monoclonal antibodies capable of specific binding to human protein Mcm3, processes for their production and their use.

Prior art

[0002] Mcm proteins were first described in the barm *S. cerevisiae*. It is known, that these proteins play an important role in the initiation of DNA replication, which was shown in the barm by its decisive role in the transmittance of extra chromosome DNA segments, minichromosomes (Maine et al., *Genetics*, 1984, 106: 365-385). This feature was the basis for the naming for these proteins, minichromosome maintenance, Mcm. The proteins of the Mcm family are highly conserved with respect to evolution.

[0003] At present six proteins (Mcm2, Mcm3, Mcm4, Mcm5, Mcm6, Mcm7) are described in the human system which with other cell cycle dependent structures form a protein complex that is necessary for DNA replication, and which were already postulated as DNA replication licence factors by J.J. Blow and R.A. Laskey in 1988 (*Nature*, 332:546-548). Mcm3 protein plays an important role by forming a biochemical strong bond with Mcm5 (A. Richter, R. Knippers, *Eur. J. Biochem.*, 1997, 247:136-141). Since Mcm3 and the other members of the Mcm family have such a basic function in the cell cycle, detection systems are desired, preferably immunobiochemical and immunohistological detections. Such detections are of need because new parameters for medical diagnosis, preferably in cancer diagnosis, can be achieved therewith.

[0004] It is known that human Mcm protein is immunogenic in the rabbit (Thommes et al., *Nucleic Acid Res.*, 1992, 20:1069-1074). But the known polyclonal antisera either do not react monospecifically in immunobiochemical analyses (Western Blot) and/or are not applicable quickly and without problems in routine immunohistology. (Hu, B., et al., *Nucleic Acid Res.*, 1993, 21: 5289-5293). Therefore, there is no tool at hand that can serve as a detection method for Mcm3 in medical diagnosis.

Summary of the invention

[0005] The object of the present invention is therefore to provide means that detect quickly and monospecifically Mcm3 protein in biochemical and also in histological systems conducted alone or together in combination. This detection can be conducted alone or in combination with other known markers.

[0006] According to the invention this is achieved by a monoclonal antibody capable of specific binding to human Mcm3, in which the monoclonal antibody reacts

with the same epitope of human Mcm3 as the monoclonal antibody obtainable from a hybridoma cell line with deposit number DSM ACC2388.

Further, hybridomas producing monoclonal antibodies according to the invention are disclosed.

[0007] Another aspect of the invention is the provision of diagnostic compositions and detection kits comprising the monoclonal antibody according to the present invention.

[0008] Yet another aspect is the use of the monoclonal antibody according to the present invention for the detection of Mcm3 in a sample.

[0009] Moreover, processes are disclosed relating to the production of a monoclonal antibody and hybridoma, respectively, according to the present invention.

[0010] Finally, the present invention relates to pharmaceutical preparations and medicines containing the monoclonal antibody and the use of the monoclonal antibody for the preparation of a medicament for the treatment of certain diseases.

[0011] These diseases or disorders are associated with an aberrant Mcm3 level or activity or can benefit from modulation of the activity or level of Mcm3. The medicament can be administered, e.g. either locally or systemically to a subject, in a pharmaceutically effective amount of a composition comprising an Mcm3 antibody according to the present invention.

Short description of the figures

[0012] Fig.1 shows a Western Blot using a monoclonal antibody according to the present invention (right side) and a polyclonal antibody known in the art (left side). It is clearly demonstrated that the antibody according to the present invention recognises only one band while the polyclonal antibody detects further bands in the range of 90 to 50 kDa. H denotes HeLa cells and C denotes CHO cells.

Detailed description of the invention

[0013] According to the invention a monoclonal antibody capable of specific binding to human Mcm3, in which the monoclonal antibody reacts with the same epitope of human Mcm3 as the monoclonal antibody obtainable from a hybridoma cell line with deposit number DSM ACC2388 is provided.

The monoclonal antibody according to the present invention can be obtained from any animal or the human being, whereby the monoclonal antibodies of the mouse are preferred.

[0014] Further, the monoclonal antibody may be altered biochemically, by genetic manipulation, or it may be synthetic, with the antibody possibly lacking portions completely or in parts, said portions being necessary for the recognition of Mcm3 and being substituted by others imparting further advantageous properties to the antibody.

[0015] A hybridoma cell line producing a preferred monoclonal antibody of the present invention, namely, a monoclonal mouse antibody with said above-mentioned detection, was deposited at the Deutschen Sammlung von Mikroorganismen und Zellkulturen GmbH (DSMZ) in Braunschweig under the number DSM ACC2388 on February 16, 1999.

[0016] The term "antibody" as used herein refers to immunoglobulin molecules and immunologically active portions of immunoglobulin molecules, i.e., molecules that contain an antigen binding site which specifically binds (immunoreacts with) Mcm3. Examples of immunologically active portions of immunoglobulin molecules include F(ab) and F(ab)₂ fragments which can be generated by treating the antibody with an enzyme such as pepsin. The invention provides monoclonal antibodies that bind Mcm3. The term "monoclonal antibody" or "monoclonal antibody composition", as used herein, refers to a population of antibody molecules that contain only one species of an antigen binding site capable of immunoreacting with a particular epitope of Mcm3. A monoclonal antibody composition thus typically displays a single binding affinity for Mcm3 with which it immunoreacts.

[0017] A disease, a disorder or condition "associated with" or "characterized by" an aberrant Mcm3 activity refers to a disease, disorder or condition in a subject which is caused by or contributed to by an aberrant Mcm3 activity.

[0018] The term "treating" as used herein is intended to encompass curing as well as ameliorating at least one symptom of the condition or disease.

[0019] Monoclonal anti-Mcm3 antibodies can be prepared by immunizing a suitable subject with an Mcm3 immunogen. An appropriate immunogenic preparation can contain, for example, recombinantly expressed Mcm3 protein or a chemically synthesized Mcm3 polypeptide. The preparation can further include an adjuvant, such as Freund's complete or incomplete adjuvant, or similar immunostimulatory agents. Immunization of a suitable subject with an immunogenic Mcm3 preparation induces an anti-Mcm3 antibody response.

[0020] The anti-Mcm3 antibody titer in the immunized subject can be monitored over time by standard techniques, such as with an enzyme linked immunosorbent assay (ELISA) using immobilized Mcm3. If desired, the antibody molecules directed against Mcm3 can be isolated from the mammal (e.g., from the blood) and further purified by well known techniques, such as protein A chromatography to obtain the IgG fraction. At an appropriate time after immunization, e.g., when the antibody titers are highest, antibody-producing cells can be obtained from the subject and used to prepare monoclonal antibodies by standard techniques, such as the hybridoma technique originally described by Koehler and Milstein (1975) *Nature* 256:495-497 (see also, Brown et al. (1981) *J. Immunol.* 127:539-46; Brown et al. (1980) *J. Biol. Chem.* 255:4980-83; Yeh et al. (1976) *Proc. Natl.*

Acad. Sci. US. 4 76:2997-3 1; and Yeh et al. (1982) *Int. J. Cancer* 29:269-75), the more recent human B cell hybridoma technique (Kozbor et al. (1983) *Immunol Today* 4:72), the EBV-hybridoma technique (Cole et al. (1985), *Monoclonal Antibodies and Cancer Therapy*, Alan R. Liss, Inc., pp. 77-96) or trioma techniques. The technology for producing monoclonal antibody hybridomas is well known (see generally R. H. Kenneth, in *Monoclonal Antibodies: A new Dimension in Biological Analyses*, Plenum Publishing Corp., New York, New York (1980); E. A. Lerner (1981) *Yale J. Biol. Med.*, 54:387402; M. L. Gefter et al. (1977) *Somatic Cell Genet.* 3:23136). Briefly, an immortal cell line (typically a myeloma) is fused to lymphocytes (typically splenocytes) from a mammal immunized with Mcm3 immunogen as described above, and the culture supernatants of the resulting hybridoma cells are screened to identify a hybridoma producing a monoclonal antibody that binds Mcm3.

[0021] Any of the many well known protocols used for fusing lymphocytes and immortalized cell lines can be applied for the purpose of generating anti-Mcm3 monoclonal antibodies (see, e.g., G. Galfre et al. (1977) *Nature* 266:55052; Gefter et al. *Somatic Cell Genet.*, cited supra; Lerner, *Yale J. Biol. Med.*, cited supra; Kenneth, *Monoclonal Antibodies*, cited supra). Moreover, the ordinarily skilled worker will appreciate that there are many variations of such methods which also would be useful. Typically, the immortal cell line (e.g., a myeloma cell line) is derived from the same mammalian species as the lymphocytes. For example, murine hybridomas can be made by fusing lymphocytes from a mouse immunized with an immunogenic preparation of the present invention with an immortalized mouse cell line. Immortal cell lines are mouse myeloma cell lines that are sensitive to culture medium containing hypoxanthine, aminopterin and thymidine ("HAT medium"). Any of a number of myeloma cell lines can be used as a fusion partner according to standard techniques, e.g., the P3-NS 1/1-Ag4- 1; P3x63-Ag8.653 or Sp2/O-Ag14 myeloma lines. Typically, HAT-sensitive mouse myeloma cells are fused to mouse splenocytes using polyethylene glycol ("PEG"). Hybridoma cells resulting from the fusion are then selected using HAT medium, which kills unfused myeloma cells (unfused splenocytes die after several days because they are not transformed). Hybridoma cells producing a monoclonal antibody of the invention are detected by screening the hybridoma culture supernatants for antibodies that bind Mcm3, e.g., using a standard ELISA assay.

[0022] Alternative to preparing monoclonal antibody-secreting hybridomas, a monoclonal anti-Mcm3 antibody can be identified and isolated by screening a recombinant combinatorial immunoglobulin library (e.g., an antibody phage display library) with Mcm3 to thereby isolate immunoglobulin library members that bind Mcm3. Kits for generating and screening phage display libraries are commercially available (e.g., the Pharmacia Recombinant Phage Antibody System, Catalog No.

27-9400-01; and the Stratagene SurfZAP® Phage Display Kit, Catalog No. 240612). Additionally, examples of methods and reagents particularly amenable for use in generating and screening antibody display library can be found in, for example, Ladner et al. U.S. Patent No. 5,223,409; Kang et al. PCT International Publication No. WO 92/18619; Dower et al. PCT International Publication No. WO 91/17271; Winter et al. PCT International Publication WO 92/20791; Markland et al. PCT International Publication No. WO 92/15679; Breitling et al. PCT International Publication WO 93/01288; McCafferty et al. PCT International Publication No. WO 92/01047; Garrard et al. PCT International Publication No. WO 92/09690; Ladner et al. PCT International Publication No. WO 90/02809; Fuchs et al. (1991) *Bio/Technology* 9:1370-1372; Hay et al. (1992) *Hum. Antibod. Hybridomas* 3:81-85; Huse et al. (1989) *Science* 246:1275-1281; Griffiths et al. (1993) *EMBO J* 12:725-734; Hawkins et al. (1992) *J. Mol. Biol.* 226:889-896; Clarkson et al. (1991) *Nature* 352:624-628; Gram et al. (1992) *Proc. Natl. Acad. Sci. USA* 89:3576-3580; Garrard et al. (1991) *Bio/Technology* 9:1373-1377; Hoogenboom et al. (1991) *JtUC. Acid Res.* 19:4133-4137; Barbas et al. (1991) *Proc. Natl. Acad. Sci. USA* 88:7978-7982; and McCafferty et al. *Nature* (1990) 348:552-554.

[0023] Additionally, recombinant anti-Mcm3 antibodies, such as chimeric and humanized monoclonal antibodies, comprising both human and non-human portions, which can be made using standard recombinant DNA techniques, are within the scope of the invention. Such chimeric and humanized monoclonal antibodies can be produced by recombinant DNA techniques known in the art, for example using methods described in Robinson et al. WO 87/02671 (International Application No. PCT/US86/02269); Akira, et al. European Patent Application 184,187; Taniguchi, M., European Patent Application 171,496; Morrison et al. European Patent Application 173,494; Neuberger et al. PCT International Publication No. WO 86/01533; Cabilly et al. U.S. Patent No. 4,816,567; Cabilly et al. European Patent Application 12 S,023; Better et al. (1988) *Science* 240:1041-1043; Liu et al. (1987) *Proc. Natl. Acad. Sci. USA* 84:3439-3443; Liu et al. (1987) *J. Immunol.* 139:3521-3526; Sun et al. (1987) *Proc. Natl. Acad. Sci. USA* 84:214-218; Nishimura et al. (1987) *Canc. Res.* 47:999-1005; Wood et al. (1985) *Nature* 314:446-449; and Shaw et al. (1988) *J. Natl. Cancer Inst.* 80:1553-1559; Morrison, S. L. (1985) *Science* 229:1202-1207; Oi et al. (1986) *Bio Techniques* 4:214; Winter U.S. Patent 5,225,539; Jones et al. (1986) *Nature* 321:552-525; Verhoeyan et al. (1988) *Science* 239:1534; and Seidler et al. (1988) *J. Immunol.* 141:4053-4060. An anti-Mcm3 monoclonal antibody can be used to isolate Mcm3 by standard techniques, such as affinity chromatography or immunoprecipitation. An anti-Mcm3 antibody can be used to detect Mcm3 protein (e.g., in a cellular lysate or cell supernatant) in order to evaluate the abundance and pattern of expression of Mcm3. Anti-Mcm3 antibodies

can be used diagnostically to monitor protein levels in tissue as part of a clinical testing procedure, e.g., to, for example, determine the efficacy of a given treatment regimen. Detection can be facilitated by coupling (i.e., physically linking) the antibody to a detectable substance. Examples of detectable substances include various enzymes, prosthetic groups, fluorescent materials, luminescent materials, bioluminescent materials, and radioactive materials. Examples of suitable enzymes include horseradish peroxidase, alkaline phosphatase, (-galactosidase, or acetylcholinesterase); examples of suitable prosthetic group complexes include streptavidin/biotin and avidin/biotin; examples of suitable fluorescent materials include umbelliferone, fluorescein, fluorescein isothiocyanate, rhodamine, dichlorotriazinylamine fluorescein, dansyl chloride, Cy-dyes, Alexa-dyes or phycoerythrin; an example of a luminescent material includes luminol; examples of bioluminescent materials include luciferase, luciferin, and aequorin, and examples of suitable radioactive material include ¹²⁵I, ¹³¹I, ³⁵S or ³H.

[0024] Preferably, monoclonal antibodies according to the invention can be produced with the initial screening strategy described further below. Since a plurality of prepared hybridoma are either not monospecifically against Mcm3 protein or are applicable only in immunobiochemical detection systems but not in immunohistological systems and vice versa, initial examination of generated hybridoma cells requires this strategy to produce monoclonal antibodies according to the invention which have both properties.

[0025] For the production of genetically altered and/or synthetic antibodies having the properties according to the invention one can start e.g. from monoclonal antibodies obtained as described above. For this it is suitable to analyse the Mcm3 binding regions of the monoclonal antibodies and to identify the parts that are necessary and unnecessary for the detection described above. Then the necessary portions can be modified and the unnecessary portions can be eliminated completely or in part and can be substituted, respectively, by portions imparting further advantageous properties to the antibodies. Also, portions not within the binding regions of the antibodies can be modified, eliminated, or substituted. It is known by the skilled person that particularly the DNA recombination technology is suitable for the above measures.

[0026] Monoclonal antibodies according to the invention are distinguished by detecting Mcm3 monospecifically both in biochemical and histological detecting systems. The antibodies are therefore suitable for the fast detection of a Mcm3 expression in very different samples.

[0027] Within the present context, the term "sample" is intended to cover all types of samples suitable for the purpose of the invention. Examples of such samples are serum, sputum, urine, liquor, tissue, and biopsies. In particular the sample may be a blood sample or a gy-

naecological sample.

[0028] Because of these features the antibodies according to the invention are excellently suitable in the application of diagnostic problems, in which comparatively the tissue topological distribution analysis, e.g. determined by immunohistochemistry with quantitative expression parameters, e.g. obtained by Western Blot or immunoprecipitation, shall be analysed.

[0029] With the antibodies according to the invention the monospecific detection of the Mcm3 expression can be performed reliably in one-by-one conducted immunobiochemical detection methods such as ELISA, Western Blot, and immunoprecipitation, the Western Blot hereby being preferred, or immunohistochemical tissues, preferably on routine fixed and paraffin embedded tissue. For this the antibodies according to the invention may be labelled, if it is appropriate, as described above, or employed in combination with labelled antibodies directed against them or other reagents.

[0030] Monoclonal antibodies according to the invention can inhibit in vivo the assembly of DNA precursors and therefore inhibit cell proliferation. Thus, these antibodies or the above mentioned derivatives of the same are suitable for the therapy of states of a disease which are accompanied by raised cell proliferation. Examples of such diseases are tumours, allergies, autoimmune diseases, scar formation, inflammations and rheumatic diseases as well as the suppression of defence reactions of transplantations.

[0031] For the production of pharmaceutical composition or a medicine the monoclonal antibodies according to the invention can be used alone or combined with common carriers, adjuvants and/or additives. The antibodies are suitable for the systemic, local, subcutaneous, intrathecal and topical application and for application by enema. For this they can be applied solved in suitable solvents, preferably as aqueous solution, in the form of liposomes, as emulsion or in solid state, e.g. as powder or in the form of microcapsules.

[0032] Alternatively, a monoclonal antibody of the present invention can be administered in a combined method of treatment with a different pharmaceutically active agent. Pharmaceutically active agents, that can be formulated with the monoclonal antibodies of the present invention, or alternatively can be administered in a combined method of treatment, can be for instance antibodies, in particular monoclonal antibodies, against other antigens, thus providing a "cocktail" containing a monoclonal antibody of the present invention and one or more (monoclonal) antibodies against other antigens involved in the pathogenesis of the relevant disease state.

[0033] Further active agents, that can be formulated with the monoclonal antibodies of the present invention, or alternatively can be administered in a combined method of treatment, especially in order to produce a therapeutically useful effect, depend on the disease state to be cured and are, for instance, commercially

available gamma globulin and immune globulin products, antibiotics, antimicrobial products, antibacterial and antitumor agents or a mixture of two or more of them.

[0034] Monoclonal antibodies according to the invention can be employed in a particularly advantageous way in the therapy of tumours, namely as such or in combination with other therapeutics and forms of therapy respectively, such as radiatio, that is resistant against conventional tumour therapeutics. Such resistances occur in unspecific cytostatica such as vinblastin or cisplatin either secondarily, i.e. after repeated application, or exist primarily at certain tumours, such as carcinoma of the kidneys.

[0035] The dosages of such antibodies will vary with the condition being treated and the recipient of the treatment, but will be in the range of 1 to about 100 mg for an adult patient preferably 1 to 10 mg usually administered daily for a certain period. A two part dosing regime may be preferable wherein 1 to 5 mg are administered.

[0036] In another preferred embodiment, the detection of Mcm3 is conducted in combination with the detection of the proteins Ki-67 and p27.

[0037] One of the most cited cell cycle associated proteins, used for histopathologic diagnostics within the past 16 years, is the Ki-67 protein (Scholzen T and Gerdes J (2000) *J Cell Physiol* 182: 311-322; Gerdes J, Schwab U, Lemke H and Stein H (1983). *Int.J.Cancer* 31, 13-20). The Ki-67 protein is expressed in proliferating cells, but rapidly disappears when cells enter a resting state (Baisch, H, and Gerdes, J (1987). *Cell Tissue Kinet.* 20(4), 387-391). Clinical studies have shown that the Ki-67 antigen is an independent prognostic marker in many different human neoplasms, e.g. breast cancer (Jansen RL, Hupperets PS, Arends JW, Joosten-Achjanie SR, Volovics A, Schouten HC, and Hillen HF (1998). *Br. J. Cancer*, 78: 460-465), soft tissue sarcoma, meningiomas (Perry A, Stafford SL, Scheithauer BW, Suman VJ, and Lohse CM (1998). *Cancer* 82: 2262-2269), prostate cancer (Mashal RD, Lester S, Corless C, Richie JP, Chandra R, Probert KJ, and Dutta A (1996) *Cancer Res* 56(18):4159-63) and non-Hodgkin lymphoma (Gerdes et al. (1984), *J. Immunol.* 133: 1710-1715).

[0038] The protein p27 belongs to the family of cyclin dependent kinase inhibitors (CDKI), which regulate cell cycle progression by binding and inactivating cyclin-dependent-kinases complexes at defined checkpoints within the cell cycle (Toyoshima H, and Hunter T (1994) *Cell* 78(1):67-74). The expression of p27 serves as a robust marker for differentiation in normal developing tissue and also in tumors displaying deregulated growth (Lloyd RV, Jin L, Qian X, and Kulig E (1997) *Am J Path* 150: 401-407., Zhang P, Wong C, DePinho RA, Harper JW, and Elledge SJ (1998) *Genes Dev* 12(20): 3162-3167).

[0039] Performing combined staining of tissues detecting the three proteins simultaneously, allow a more

detailed assessment of cell proliferation and differentiation processes that determine individual tumor growth. MCM3 protein is expressed in cells that have ceased to proliferate, but are not terminally differentiated according to the absence of p27 protein expression, whereas Ki-67 is expressed in proliferating cells only. P27 can be found in quiescent cells but not in proliferating cells. Ki-67, MCM3 and p27 provide one set of parameters which define complementary biological properties that are suitable for a detailed characterization of disordered cell growth and tumorigenesis. Tumor diagnostics may also benefit from a combined assessment of these markers which may be of help to choose the most appropriate therapy concept for an individual patient.

[0040] The present invention will be illustrated by the following examples:

EXAMPLES

Example 1

[0041] Production of monoclonal antibodies according to the invention.

[0042] Mice were used for immunisation. Recombinant human MCM3 protein was used as antigen.

Record of immunisation and fusion

[0043] Day 1: 100 µg MCM3 protein in 100 µl PBS (phosphate buffered saline) were mixed completely and thoroughly with 100 µl Freund's adjuvant and were injected subsequently into a mouse.

[0044] Day 14: 50 µg MCM3 protein in 100 µl PBS were mixed completely and thoroughly with 100 µl Freund's adjuvant and were injected subsequently into a mouse.

[0045] Day 21: 50 µg MCM3 protein in 100 µl PBS were mixed completely and thoroughly with 100 µl Freund's adjuvant and were injected subsequently into a mouse.

[0046] Day 37: 50 µg MCM3 protein in 100 µl PBS were mixed completely and thoroughly with 100 µl Freund's adjuvant and were injected subsequently into a mouse.

[0047] On day 39 the mouse was killed painlessly. Spleen cells were removed and fused with myeloma cells. Hybridoma that reached full growth were obtained

Screening of hybridoma supernatant and cloning.

[0048] At first supernatants of the hybridoma which reached full growth were tested in a spot-blot-assay. For this 1 ml recombinant human MCM3 in PBS (2 ng/ml) was placed on 1 cm x 0.5 cm sized pieces of nitrocellulose membrane. These pieces are placed in a 48 well-plate and dried for 15 minutes at room temperature. Subsequently incubation was made with blocking puffer (PBS, 0.005 Tween 20, 4% gelatine) for 45 minutes at

room temperature. After several washing steps with PBS (0.05% Tween 20, 0.5% gelatine) incubation was made with the hybridoma supernatant for 60 minutes at room temperature. After several washing steps with PBS (0.05% Tween 20, 0.5% gelatine) a commercially available phosphatase-coupled goat-anti-mouse antibody, Dianova, Hamburg (dilution according to the instruction of the producer 1:10000) was added. After incubation for 1 hour at room temperature with PBS (0.05% Tween 20, 0.5% gelatine) the alkaline phosphatase detection reaction was conducted with the developer solution (36 mM 5' bromo-4-chloro-3-indolyl-phosphate; 400 mM nitro blue tetrazolium, 100 mM Tris-HCl, pH 9.5, 100 mM NaCl, 5 mM MgCl₂) for 10 minutes at room temperature.

[0049] The hybridoma supernatant which were tested positive in the spot-blot were tested subsequently immunohistologically. For this paraffin sections, e.g. tonsil, were dehydrated according to standard procedures (2 x 100% xylene, 2 x 100% EtOH, 2 x 70% EtOH, 2 x 40% EtOH), followed by washing briefly in water. The sections were then cooked in citrate buffer pH 6 (2.1g citric acid monohydrate for 1l, adjust with 2N NaOH to pH 6) in a pressure cooker for 1-5 minutes. After opening the cooker the sections were washed immediately in cold (RT) TBS, followed by incubation with hybridoma supernatant in a humid chamber for 30 minutes. After washing in TBS for several times antibodies bound to the sections were detected by means of the indirect immunoperoxidase method, stained with hemalum, embedded and evaluated microscopically.

[0050] The antibody according to the present invention shows the following staining pattern. The antibody predominantly reacts with the nuclei of cells in proliferative regions, indicated by the fact that cells of the dark zone within the germinal centers of human tonsils stain positive for MCM3. Likewise cells near the basal layer of the normal mucosa react with the MCM3 specific antibody. It should be noted that MCM3 staining was also seen in the intermediate and upper layer which belong to the non-proliferating cell compartment of the oral mucosa.

[0051] Hybridoma which were positive both in the spot-blot and in immunohistology, were cloned and re-cloned until they were monoclonal. Independent monoclonal antibodies were obtained. A hybridoma cell line producing a monoclonal antibody according to the invention was deposited at the Deutschen Sammlung von Mikroorganismen und Zellkulturen (DSMZ) in Braunschweig under number DSM ACC2388 on February 16, 1999.

Example 2

[0052] Western Blot analysis of cell lysates with a polyclonal rabbit anti-MCM3 antibody and a monoclonal antibody according to the invention.

[0053] Cell lysates of the cell line HELA (H) and CHO

(C) were applied to sodium dodecyl sulphate polyacrylamide gel electrophoresis (SDS PAGE). The proteins separated in the gel were transferred to a nitrocellulose membrane in a wet-blotting chamber over night. This membrane was then incubated with a diluted rabbit anti Mcm3 antiserum (Hu, B., et al., Nucleic Acid Res., 1993, 21: 5289-5293) (0.15 µg / ml) for 1 hour at room temperature. After several washing steps with PBS (0.05% Tween 20, 0.5% gelatin) a commercially available phosphatase-coupled goat-rabbit antibody (dilution according to the instructions of the producer, Dianova, Hamburg 1:10000) was added. After incubation of 1 hour at room temperature and once more washing in TNT-buffer (150 mM NaCl, 10 mM Tris ph 7.5, 0.05% Tween 20) the detection was conducted with the chemiluminescence method with the ECL system (Amersham Life Science, Braunschweig) according to the instructions of the producer.

[0054] As can be ascertained in Fig. 1, it turned out that the polyclonal anti-Mcm3 rabbit antibody revealed, besides the expected prominent main protein band with an apparent molecular weight of 105 kDa, further proteins in the molecular weight range between 50 kDa and 90 kDa.

[0055] The monoclonal anti-Mcm3 antibody according to the invention revealed only the expected protein band with an apparent molecular weight of 105 kDa.

[0056] Further, in immunohistochemical studies, the monoclonal antibody according to the present invention demonstrates its usefulness for the detection of Mcm3

Example 3

[0057] Immunoprecipitation with anti Mcm3 antibodies according to the invention

[0058] 1 µg anti-Mcm3 primary antibody is added to 10 µl Dynabeads (Dyna M280 sheep-anti-mouse, Dynal, Hamburg) and incubated for 30 minutes at 4°C under rolling.

[0059] Cell preparations (1 x 10⁶ Cells) are taken up in immunoprecipitation buffer (18 mM Tris/HCl, 150 mM NaCl, 0.3% hexadecylmethyl-ammoniumbromide, 5 mM EDTA and 1 mM DTT) comprising protease inhibitors, cooked for 5 minutes, cooled on ice and centrifuged (5 minutes, 14000 rpm). The excess liquid is added to the complex of Dynalbeads / primary antibodies and incubated at 4°C for 30 minutes on a roller.

[0060] Then the tube is placed in a Dynal magnetic concentrator for 20 seconds and the excess liquid is removed. Magnetic beads are resuspended in 500 µl NET (Tris/HCl 18 mM, NaCl 150 mM, EDTA 5 mM, DTT 1 mM) placed again in the magnetic concentrator and the supernatant is removed after 20 seconds. In this way, the beads are washed several times.

[0061] The so purified Mcm3 can then be analysed by means of SDS-PAGE.

Example 4

[0062] Micro injection of anti- Mcm3 antibodies according to the invention in nuclei of permanent cell line cells.

[0063] HEp-2 were cultivated on CELLocate® cover slips for microinjection and used in the logarithmic growth period. Anti-Mcm3 antibodies according to the invention and an irrelevant control antibody, respectively, were microinjected with a transjector and micro manipulator into the nuclei under light microscopy control (pressure of injection 130 hPa; time of injection between 0,3 and 0,5 seconds). The injected cells were then cultivated with bromodesoxyuridin (BrdU) containing (0.1 mM) medium for 6 hours. After fixation (5 minutes 4% paraformaldehyde at room temperature) the cover slips were washed three times in Tris-buffered saline (TBS), incubated in 100 % EtOH for 10 minutes at -20°C followed by permeation of the adhering cells by transferring directly in 0.1% Triton X-100 TBS for 10 minutes by room temperature. The injected antibodies were then detected with a commercially available Cy3 coupled goat anti mouse antibody, Dianova, Hamburg (dilution according to the instructions of the producer in PBS/ 10% bovine serum albumin). The preparations were first incubated in 2M HCl for 60 minutes at 37°C for the detection of BrdU fixed into the cells. Subsequently, the preparations were washed first several times with distilled water, then two times with PBS. Then incubation with a commercially available FITC labelled anti BrdU antibody, Boehringer Mannheim, Mannheim (dilution according to the instructions of the producer) overnight at 4°C in a humid chamber was performed. Then the preparations were washed thoroughly five times in PBS for 10 minutes, covered with DABCO (1,4-diazabicyclo [2,2,2]octane) in 90% glycerol, and evaluated by fluorescence microscopy.

[0064] It turned out that almost all cells injected with control antibodies incorporated also BrdU, hence passing during the experiment the normal cell cycle. In contrast only between 20% to 50% of the cells that had been injected with anti-Mcm3 antibodies according to the invention incorporated BrdU. The proliferation of these cells was therefore inhibited by the antibodies according to the invention.

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Claims

1. A monoclonal antibody capable of specific binding to human Mcm3, in which the monoclonal antibody reacts with the same epitope of human Mcm3 as the monoclonal antibody obtainable from a hybridoma cell line with deposit number DSM ACC2388. 45
2. A monoclonal antibody according to Claim 1, which is capable of binding to human Mcm3 both immunohistologically and immunobiochemically. 50
3. A monoclonal antibody according to Claim 1 or Claim 2, which is a recombinant, chimeric, humanised, synthetic or genetically altered antibody. 55

4. A monoclonal antibody according to Claim 1,2 or 3, which is labelled with a detectable substance.

5. A monoclonal antibody according to Claim 4, in which the detectable substance comprises a fluorescent, radioactive, enzymatic or a luminescent label.

6. A monoclonal antibody according to any preceding claim, which is produced by a hybridoma cell line with the deposit number DSM ACC2388.

7. A hybridoma cell line which expresses a monoclonal antibody according to any preceding claim.

8. A hybridoma cell line having the deposit number DSM ACC2388.

9. Use of a monoclonal antibody according to any of Claims 1 to 6 to detect human Mcm 3 *in vitro*.

10. A use according to Claim 9 for the immunohistological, immunocytological or immunobiochemical detection of human Mcm3 in a sample.

11. A use according to Claim 9 or 10, **characterized in that** the sample is selected from the group consisting of: serum, a blood sample, sputum, urine, liquor, a tissue, a biopsy, a gynaecological sample and a fine needle aspiration.

12. A use according to Claim 9, 10 or 11, in which the human Mcm3 is detected by a method selected from the group consisting of: ELISA, RIA, Western Blot, Far Western blot, immunoprecipitation, affinity chromatography, FACS and binding to magnetic beads.

13. Use of a monoclonal antibody according to any of Claims 1 to 6 for the detection of a proliferating cell *in vitro*, further comprising detecting Ki-67 and p27.

14. Use of a monoclonal antibody according to any of Claims 1 to 6 for the detection of a cancer cell or a neoplastic cell *in vitro*.

15. A use according to Claim 13 or 14, comprising any of the features set out in Claims 11 or 12.

16. A method for the production of a hybridoma capable of expressing a monoclonal antibody according to any of Claims 1 to 6, comprising immortalizing a lymphocyte obtained from an animal immunised with human Mcm3, to produce a hybridoma, and selecting a hybridoma which expresses the antibody.

17. A method according to Claim 16, in which a hybridoma is selected which expresses a monoclonal

antibody capable of reacting both immunobiochemically and immunohistochemically with human Mcm3.

18. A method for the production of a monoclonal antibody according to any of Claims 1 to 6, comprising expressing the antibody from a hybridoma obtained by a process according to Claim 16 or 17. 5
19. Use of a monoclonal antibody according to any of Claims 1 to 6, for the purification of human Mcm3. 10
20. A use according to Claim 19, comprising affinity chromatography or immunoprecipitation with the monoclonal antibody. 15
21. A diagnostic composition comprising a monoclonal antibody according to any of Claims 1 to 6.
22. A pharmaceutical composition comprising a monoclonal antibody according to any of Claims 1 to 6, together with a pharmaceutically acceptable carrier, adjuvant or additive. 20
23. A monoclonal antibody according to any of Claims 1 to 6 for use in a method of diagnosis or therapy of a disease. 25
24. Use of a monoclonal antibody according to any of Claims 1 to 6 for the preparation of a pharmaceutical composition for the treatment of a disease. 30
25. A monoclonal antibody according to Claim 23 for a use as specified therein, or a use according to Claim 24, in which the disease is one caused by or contributed by the activity or level of Mcm3 expression. 35
26. A monoclonal antibody according to Claim 23 or 25 for a use as specified therein, or a use according to Claim 24 or 25, in which the disease is selected from the group consisting of: tumors, allergies, auto-immunopathies, scar formation, inflammation and rheumatic diseases as well as the suppression of defense reactions of transplantations. 40
27. A diagnostic kit comprising a monoclonal antibody according to any of Claims 1 to 6, together with an agent capable of detecting Ki-67 and an agent capable of detecting p27. 45
28. An *in vitro* method of exposing a cell to a monoclonal antibody according to any of Claims 1 to 6, for disrupting or preventing any one of the cell cycle, DNA replication and proliferation by the cell. 50

Patentansprüche

1. Monoklonaler Antikörper, der zu einer spezifischen Bindung an menschliches Mcm3 fähig ist, worin der monoklonale Antikörper mit demselben Epitop von menschlichem Mcm3 reagiert wie der monoklonale Antikörper, der von einer Hybridomzelllinie mit der Hinterlegungsnummer DSM ACC2388 erhältlich ist.
2. Monoklonaler Antikörper gemäß Anspruch 1, der sowohl immunhistologisch als auch immunbiochemisch zur Bindung an menschliches Mcm3 fähig ist.
3. Monoklonaler Antikörper gemäß Anspruch 1 oder 2, wobei es sich um einen rekombinanten, chimären, humanisierten, synthetisch oder genetisch veränderten Antikörper handelt. 15
4. Monoklonaler Antikörper gemäß Anspruch 1, 2 oder 3, der mit einer nachweisbaren Substanz markiert ist. 20
5. Monoklonaler Antikörper gemäß Anspruch 4, worin die nachweisbare Substanz eine fluoreszierende, radioaktive, enzymatische oder lumineszierende Markierung umfaßt. 25
6. Monoklonaler Antikörper gemäß einem der vorstehenden Ansprüche, der durch eine Hybridomzelllinie mit der Hinterlegungsnummer DSM ACC2388 erzeugt wird.
7. Hybridomzelllinie, die einen monoklonalen Antikörper gemäß einem der vorstehenden Ansprüche exprimiert. 35
8. Hybridomzelllinie mit der Hinterlegungsnummer DSM ACC2388.
9. Verwendung eines monoklonalen Antikörpers gemäß einem der Ansprüche 1 bis 6 zum Nachweis von menschlichem Mcm3 *in vitro*. 40
10. Verwendung gemäß Anspruch 9 für den immunhistologischen, immunzytologischen oder immunbiochemischen Nachweis von menschlichem Mcm3 in einer Probe. 45
11. Verwendung gemäß Anspruch 9 oder 10, **dadurch gekennzeichnet, daß** die Probe ausgewählt ist aus der Gruppe bestehend aus: Serum, einer Blutprobe, Sputum, Urin, Liquor, einem Gewebe, einer Biopsie, einer gynäkologischen Probe und einer feinen Nadelaspiration. 50
12. Verwendung gemäß Anspruch 9, 10 oder 11, worin das menschliche Mcm3 durch ein Verfahren nachgewiesen wird ausgewählt aus der Gruppe beste-

hend aus: ELISA, RIA, Western-Blot, Far Western-Blot, Immunpräzipitation, Affinitätschromatographie, FACS und Bindung an magnetische Kügelchen.

13. Verwendung eines monoklonalen Antikörpers gemäß irgendeinem der Ansprüche 1 bis 6 für den Nachweis einer proliferierenden Zelle in vitro, weiterhin umfassend den Nachweis von Ki-67 und p27. 5
14. Verwendung eines monoklonalen Antikörpers gemäß einem der Ansprüche 1 bis 6 für den Nachweis einer Krebszelle oder einer neoplastischen Zelle in vitro. 10
15. Verwendung gemäß Anspruch 13 oder 14, umfassend irgendeines der Merkmale wie ausgeführt in den Ansprüchen 11 oder 12. 15
16. Verfahren zur Erzeugung eines Hybridoms, das einen monoklonalen Antikörper gemäß einem der Ansprüche 1 bis 6 exprimieren kann, umfassend das Immortalisieren eines Lymphozyten, erhalten von einem Tier, immunisiert mit menschlichem Mcm3, zur Erzeugung eines Hybridoms und Selektieren eines Hybridoms, das den Antikörper exprimiert. 20
17. Verfahren gemäß Anspruch 16, worin ein Hybridom selektiert wird, das einen monoklonalen Antikörper exprimiert, der sowohl immunbiochemisch als auch immunhistochemisch mit menschlichem Mcm3 reagieren kann. 25
18. Verfahren zur Erzeugung eines monoklonalen Antikörpers gemäß einem der Ansprüche 1 bis 6, umfassend die Expression des Antikörpers von einem Hybridom, erhalten durch ein Verfahren gemäß Anspruch 16 oder 17. 30
19. Verwendung eines monoklonalen Antikörpers gemäß einem der Ansprüche 1 bis 6 für die Reinigung von menschlichem Mcm3. 35
20. Verwendung gemäß Anspruch 19, umfassend die Affinitätschromatographie oder Immunpräzipitation mit dem monoklonalen Antikörper. 40
21. Diagnostische Zusammensetzung, umfassend einen monoklonalen Antikörper gemäß einem der Ansprüche 1 bis 6. 45
22. Pharmazeutische Zusammensetzung, umfassend einen monoklonalen Antikörper gemäß einem der Ansprüche 1 bis 6, zusammen mit einem pharmazeutisch akzeptablen Träger, Adjuvans oder Additiv. 50
23. Monoklonaler Antikörper gemäß einem der Ansprü-

che 1 bis 6 zur Verwendung in einem Diagnose- oder einem Therapieverfahren einer Erkrankung.

24. Verwendung eines monoklonalen Antikörpers gemäß einem der Ansprüche 1 bis 6 für die Herstellung einer pharmazeutischen Zusammensetzung für die Behandlung einer Erkrankung. 5
25. Monoklonaler Antikörper gemäß Anspruch 23 für eine Verwendung wie darin angegeben oder eine Verwendung gemäß Anspruch 24, worin die Erkrankung eine solche ist die durch eine Aktivität oder ein Niveau einer Mcm3-Expression ausgelöst wird oder wobei dieselben dazu beitragen. 10
26. Monoklonaler Antikörper gemäß Anspruch 23 oder 25 für eine darin definierte Verwendung oder eine Verwendung gemäß Anspruch 24 oder 25, worin die Erkrankung ausgewählt ist aus der Gruppe bestehend aus: Tumoren, Allergien, Auto-Immunopathien, Narbenbildung, Entzündungen und rheumatischen Erkrankungen wie auch die Unterdrückung von Verteidigungsreaktionen bei Transplantationen. 15
27. Diagnosekit, umfassend einen monoklonalen Antikörper gemäß einem der Ansprüche 1 bis 6, zusammen mit einem Mittel, das zum Nachweis von Ki-67 fähig ist, und einem Mittel, das zum Nachweis von p27 fähig ist. 20
28. In vitro Verfahren, eine Zelle gegenüber einem monoklonalen Antikörper gemäß einem der Ansprüche 1 bis 6 auszusetzen, um den Zellzyklus, die DNA-Replikation und/oder die Proliferation durch die Zelle zu unterbrechen oder zu verhindern. 25

Revendications

1. Anticorps monoclonal capable de se lier spécifiquement avec le Mcm3 humain, où l'anticorps monoclonal réagit avec le même épitope du Mcm3 humain que l'anticorps monoclonal pouvant être obtenu d'une lignée de cellules hybridomes avec le numéro de dépôt DSM ACC2388. 30
2. Anticorps monoclonal selon la revendication 1, qui est capable de se lier avec le Mcm3 humain, de manières à la fois immunohistologique et immunobiochimique. 35
3. Anticorps monoclonal selon la revendication 1 ou 2, qui est un anticorps recombiné, chimère, humanisé, synthétique ou génétiquement altéré. 40
4. Anticorps monoclonal selon la revendication 1, 2 ou 3, qui est marqué avec une substance détectable. 45

5. Anticorps monoclonal selon la revendication 4, où la substance détectable comprend un marqueur fluorescent, radioactif, enzymatique ou luminescent.
6. Anticorps monoclonal selon l'une quelconque des revendications précédentes, qui est produit par une lignée de cellules hybridomes avec le numéro de dépôt DSM ACC2388.
7. Lignée de cellules hybridomes, qui exprime un anticorps monoclonal selon l'une quelconque des revendications précédentes.
8. Lignée de cellules hybridomes ayant le numéro de dépôt DSM ACC2388.
9. Utilisation d'un anticorps monoclonal selon l'une quelconque des revendications 1 à 6, pour détecter le Mcm3 humain *in vitro*.
10. Utilisation selon la revendication 9, pour la détection immunohistologique, immunocytologique ou immunobiochimique du Mcm3 humain dans un échantillon.
11. Utilisation selon la revendication 9 ou 10, **caractérisée en ce que** l'échantillon est sélectionné parmi le groupe consistant en le sérum, un échantillon sanguin, le crachat, l'urine, une liqueur, un tissu, une biopsie, un échantillon gynécologique et une aspiration par aiguille fine.
12. Utilisation selon la revendication 9, 10 ou 11, dans laquelle le Mcm3 humain est détecté par un procédé sélectionné parmi le groupe consistant en un ELISA, un RIA, un transfert de Western, un transfert de far-Western, une immunoprécipitation, une chromatographie d'affinité, un FACS et la liaison à des billes magnétiques.
13. Utilisation d'un anticorps monoclonal selon l'une quelconque des revendications 1 à 6, pour détecter une cellule proliférante *in vitro*, comprenant en outre la détection de Ki-67 et de p27.
14. Utilisation d'un anticorps monoclonal selon l'une quelconque des revendications 1 à 6, pour détecter une cellule cancéreuse ou une cellule néoplasique *in vitro*.
15. Utilisation selon la revendication 13 ou 14, comprenant l'une quelconque des caractéristiques données aux revendications 11 ou 12.
16. Procédé de production d'un hybridome capable d'exprimer un anticorps monoclonal selon l'une quelconque des revendications 1 à 6, comprenant l'immortalisation d'un lymphocyte obtenu d'un animal immunisé avec le Mcm3 humain, pour produire un hybridome, et la sélection d'un hybridome qui exprime l'anticorps.
17. Procédé selon la revendication 16, dans lequel un hybridome est choisi, lequel exprime un anticorps monoclonal capable de réagir de manières à la fois immunobiochimique et immunohistochimique, avec le Mcm3 humain.
18. Procédé de production d'un anticorps monoclonal selon l'une quelconque des revendications 1 à 6, comprenant l'expression de l'anticorps par un hybridome obtenu par un procédé selon la revendication 16 ou 17.
19. Utilisation d'un anticorps monoclonal selon l'une quelconque des revendications 1 à 6, pour purifier le Mcm3 humain.
20. Utilisation selon la revendication 19, comprenant une chromatographie d'affinité ou une immunoprécipitation avec l'anticorps monoclonal.
21. Composition diagnostique comprenant un anticorps monoclonal selon l'une quelconque des revendications 1 à 6.
22. Composition pharmaceutique comprenant un anticorps monoclonal selon l'une quelconque des revendications 1 à 6, avec un support, adjuvant ou additif pharmaceutiquement acceptable.
23. Anticorps monoclonal selon l'une quelconque des revendications 1 à 6, à utiliser dans un procédé de diagnostic ou de thérapie d'une maladie.
24. Utilisation d'un anticorps monoclonal selon l'une quelconque des revendications 1 à 6, pour préparer une composition pharmaceutique pour le traitement d'une maladie.
25. Anticorps monoclonal selon la revendication 23, à utiliser tel que spécifié dans celle-ci ou utilisation selon la revendication 24, où la maladie est une maladie causée par ou dont une contribution est donnée par l'activité ou le niveau d'expression du Mcm3.
26. Anticorps monoclonal selon la revendication 23 ou 25, à utiliser tel que spécifié dans celles-ci ou utilisation selon la revendication 24 ou 25, où la maladie est sélectionnée parmi le groupe consistant en les tumeurs, les allergies, les auto-immunopathies, la formation d'escarre, l'inflammation et les maladies rhumatismales, ainsi que la suppression des réactions de défense des transplantations.

27. Kit diagnostique comprenant un anticorps monoclonal selon l'une quelconque des revendications 1 à 6, avec un agent capable de détecter le Ki-67 et un agent capable de détecter le p27.

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28. Procédé in vitro d'exposition d'une cellule à un anticorps monoclonal selon l'une quelconque des revendications 1 à 6, pour l'interruption ou la prévention d'un l'un quelconque parmi le cycle cellulaire, la réplication de l'ADN et la prolifération de la cellule.

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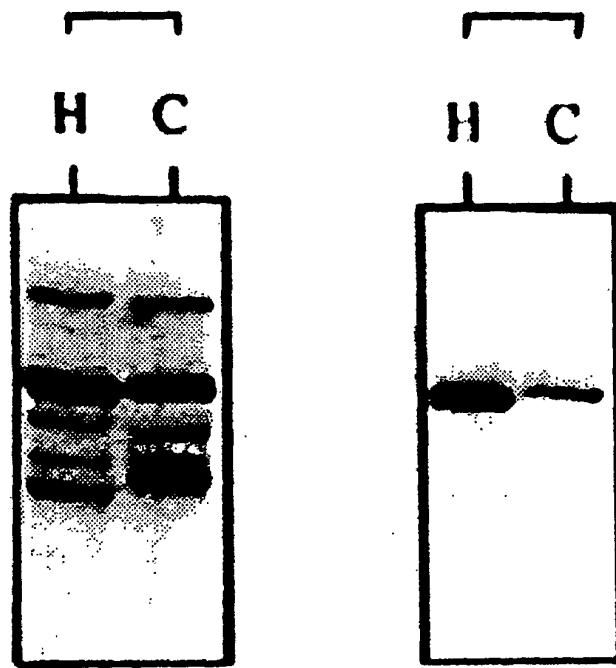


Fig.1

专利名称(译)	针对人类蛋白质的单克隆抗体Mcm3，其生产过程及其使用		
公开(公告)号	EP1165615B1	公开(公告)日	2005-05-25
申请号	EP2000920645	申请日	2000-03-31
[标]申请(专利权)人(译)	丹麦达科有限公司		
申请(专利权)人(译)	Dako公司的A / S		
当前申请(专利权)人(译)	DAKOCYTOMATION DENMARK A / S		
[标]发明人	GERDES JOHANNES SCHOLZEN THOMAS ENDL ELMAR WOHLENBERG CLAUDIA BARON LUHR BETTINA HAHN MARGRIT PRILLA PATRICIA SZUWINSKI JOHANNA KNIPPERS ROLF		
发明人	GERDES, JOHANNES SCHOLZEN, THOMAS ENDL, ELMAR WOHLENBERG, CLAUDIA BARON-LUHR, BETTINA HAHN, MARGRIT PRILLA, PATRICIA SZUWINSKI, JOHANNA KNIPPERS, ROLF		
IPC分类号	G01N33/53 A61K39/395 A61P17/02 A61P29/00 A61P35/00 A61P37/06 A61P37/08 A61P43/00 C07K1 /22 C07K16/14 C07K16/18 C12N5/10 C12N5/18 C12N5/20 C12P21/08 C12R1/91 G01N33/574 G01N33/577 C12N5/16		
CPC分类号	A61K2039/505 A61P17/02 A61P29/00 C07K16/14 Y10S435/975		
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其他公开文献	EP1165615A2		
外部链接	Espacenet		

摘要(译)

本发明涉及抗人Mcm3蛋白的单克隆抗体，产生这种抗体的杂交瘤细胞系，制备方法及其用途，含有本发明单克隆抗体的药物组合，它们用于预防和治疗的用途。某些疾病以及与预防和治疗与Mcm3表达有关的疾病有关的方法。根据本发明的单克隆抗体在免疫组织学和免疫生物化学检测系统中单一地特异性地检测和结合人Mcm3。制备这些单克隆抗体的方法包括用免疫生物化学方法初步筛选过量的杂交瘤上清液，然后通过免疫组织化学方法进行第二次阳性杂交瘤筛选。

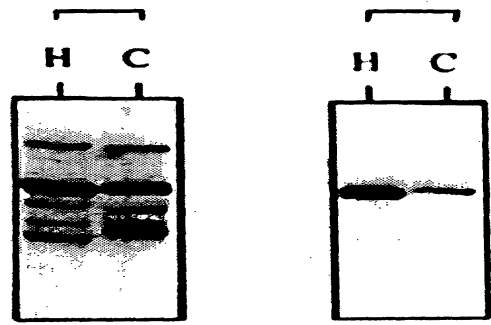


Fig.1