DESCRIPTION

ANTI-HUMAN TROP-2 ANTIBODY HAVING ANTI-TUMOR ACTIVITY *IN VIVO*

Technical Field

The present invention relates to an anti-human TROP-2 antibody having anti-tumor activity, and particularly, to an anti-human TROP-2 antibody having anti-tumor activity *in vivo*. In addition, the present invention relates to a hybridoma, which produces the aforementioned antibody, and a use of the aforementioned antibody.

Background Art

Human TROP-2 (Tacstd2, GA733-1 and EGP-1) (hereinafter also referred to as "hTROP-2") is a single transmembrane, type 1 cell membrane protein consisting of 323 amino acid residues (see SEQ ID NO: 2), and this protein has been known to be overexpressed in various types of epidermal cell carcinomas. The presence of a cell membrane protein associated with immunological resistance, which is commonly expressed in both human trophoblasts and cancer cells, had been long suggested (Non-Patent Document 1). An antigen molecule recognized by mouse monoclonal antibodies (162-25.3, 162-46.2) reacting with the cell membrane protein of a human choriocarcinoma cell line BeWo was identified. This antigen molecule was considered as one of the molecules expressed in human trophoblasts, and was named as Trop-2 (Non-Patent Document 2). Thereafter, the same molecule was discovered by other researchers. That is to say, a tumor antigen recognized by a mouse monoclonal antibody GA733 which is obtained by immunization with stomach cancer cells SW948 was named as GA733-1 (Non-Patent Document 3), and an epithelial glycoprotein recognized by a mouse monoclonal antibody RS7-3G11 which is obtained by immunization with non-small cell lung cancer cells was named as an epithelial/carcinoma antigen, EGP-1 (Non-Patent Document 4). In 1995, the Trop-2 gene was cloned, and as a result, it was confirmed that these are the same molecules (Non-Patent Document 5). Moreover, it was clarified that the molecule has a function to amplify intracellular calcium signals in cancer cells (Non-Patent Document 6), and

therefore, it is also referred to as a tumor-associated calcium signal transducer 2 (TACSTD2).

The hTROP-2 gene is mapped on chromosome 1p32, and it constitutes a TACSTD gene family together with GA733-2 having a homology of approximately 50% therewith (which has been known as "TACSTD1," "epithelial glycoprotein EGP-2," "EpCAM" or "Trop-1") (Non-Patent Document 7). The hTROP-2 protein (323 amino acid residues; SEQ ID NO: 2) has a molecular weight of approximately 36K Dalton, and this protein consists of a hydrophilic signal peptide (1^{st} to 26^{th} amino acids), an extracellular domain (27^{th} to 274^{th} amino acids), a transmembrane domain (275^{th} to 297^{th} amino acids) and an intracellular domain (298^{th} to 323^{rd} amino acids). The extracellular domain has four heterogeneous N-linked glycosylation sites, and its apparent molecular weight is increased by 11 to 13K Dalton due to addition of sugar chains (Non-Patent Document 5). It is considered that TACSTD gene family has a characteristic thyroglobulin (TY) repeat sequence in the extracellular domain and is associated with the proliferation, invasion and metastasis of cancer cells.

To date, a physiological ligand of hTROP-2 has not been identified, and the molecular function thereof has not been clarified. However, it has been described that hTROP-2 transmits a calcium signal in tumor cells (Non-Patent Document 6). In addition, from the facts that intracellular serine 303 is phosphorylated by Ca^{2+}-dependent protein kinase C (Non-Patent Document 4) and that hTROP-2 has a PIP2-binding sequence in its intracellular domain, it has been suggested that hTROP-2 has a signaling function in tumor cells (Non-Patent Document 8).

As a result of *in vitro* diagnostic studies such as immunohistochemistry (IHC) and flow cytometry analysis, overexpression of hTROP-2 in many types of epithelium-derived carcinomas such as stomach cancer, lung cancer, colon cancer, ovary cancer, breast cancer, prostate cancer, pancreatic cancer, liver cancer and esophagus cancer has been reported. In contrast, the expression of hTROP-2 in normal tissues is limited to cells in the epithelial region, and the expression level of hTROP-2 in normal cells is lower than that in cancer cells. Thus, the association of TROP-2 with tumor formation is suggested (Patent Documents 1-3 and 9).

Moreover, in the analysis of an hTROP-2 expression level used as a biomarker in clinical samples, it has been demonstrated that, when hTROP-2 is highly expressed,

correlating with the malignancy of colon cancer (Non-Patent Documents 10 and 11), pancreatic cancer (Non-Patent Document 12) or oral cancer (Non-Patent Document 13), the possibility of metastasis or recurrence of such cancer is significantly high. Furthermore, in a large-scale gene expression analysis using a cDNA microarray technique, hTROP-2 has been identified as a gene cluster, which is overexpressed at the highest level in severe papillary carcinoma of the ovary, in comparison with in normal ovary epithelium (Non-Patent Document 14).

Still further, in recent years, an important role of hTROP-2 in tumor formation has been demonstrated in the models by using colon cancer cells (Non-Patent Document 15). Since the expression of hTROP-2 promotes the anchorage-independent cell proliferation of tumor cells and is required for the tumor formation and proliferation of cancer cells subcutaneously transplanted in immunodeficient mice, it raised the possibility that hTROP-2 would act as a functional tumor antigen and would be used as a new therapeutic target.

To date, studies regarding the anti-tumor effects of several anti-hTROP-2 antibodies have been reported. An RS7 antibody (Patent Document 1) has been examined by employing *in vivo* models, in which radiolabeled antibodies were used, and anti-tumor activity was demonstrated in nude mouse xenograft models. However, the anti-tumor effects by antibody alone (a naked antibody) have not been reported.

In addition, the cytotoxicity of a cytotoxin-attached anti-hTROP-2 monoclonal antibody BR110 (Patent Document 2) on human cancer cell lines H3619, H2987, MCF-7, H3396 and H2981 in *in vitro* experiments has been reported. However, the cytotoxicity of a naked antibody or an immune conjugate of BR110 *in vivo* has not been disclosed..

In recent years, it has been reported that an isolated monoclonal antibody, which was produced from a hybridoma cell line AR47A6.4.2 or AR52A301.5 obtained by immunizing mice with human ovary cancer tissues, bound to hTROP-2, and that, for the first time, it exhibited, as a naked antibody, anti-tumor activity on nude mouse xenograft models, as well as cytotoxicity *in vitro* (Patent Documents 3 and 4). In these patent documents, the aforementioned antibody exhibited anti-tumor effects by treatment with antibody alone in mouse xenograft models, into which pancreatic cancer cell lines BxPC-3 and PL45, a prostate cancer cell line PC-3, a breast cancer cell line MCF-7 and

a colon cancer cell line Colo205 had been transplanted. The therapeutic effects of the antibody have appeared in the models, into which BxPC-3 cells had been transplanted. Other than this, tumor formation and proliferation were only partially (approximately 40% to 60%) suppressed by the preventive administration of the antibody, and an extremely large amount (approximately 20 mg/kg) of the antibody was necessary for such suppression of tumor formation and proliferation.

Based on the above-mentioned previous findings, the potential use of the anti-hTROP-2 antibody as an anti-tumor antibody has been suggested. However, not all of the anti-hTROP-2 antibodies exhibit anti-tumor effects by treatment with antibody alone as naked antibodies *in vivo*. The antibodies exhibit different functions to hTROP-2, depending on a binding site, affinity and the profile of a monoclonal antibody.

Patent Document 1: U.S. Patent No. 6653104

Patent Document 2: U.S. Patent No. 5840854

Patent Document 3: U.S. Patent No. 7420040

Patent Document 4: U.S. Patent No. 7420041

Non-Patent Document 1: Faulk WP, et al., Proc. Natl. Acad. Sci. U.S.A., 75(4), pp. 1947-1951 (1978)

Non-Patent Document 2: Lipinski M, et al., Proc. Natl. Acad. Sci. U.S.A., 78(8), pp. 5147-5150 (1981)

Non-Patent Document 3: Linnenbach AJ, et al., Proc. Natl. Acad. Sci. U.S.A., 86(1), pp. 27-31 (1989)

Non-Patent Document 4: Basu A, et al., Int. J. Cancer, 62(4), pp. 472-479 (1995)

Non-Patent Document 5: Fornaro M, et al., Int. J. Cancer, 62(5), pp. 610-618 (1995)

Non-Patent Document 6: Ripani E, et al., Int. J. Cancer, 76(5), pp. 671-676 (1998)

Non-Patent Document 7: Calabrese G, et al., Cell Genet., 92(1-2), pp. 164-165 (2001)

Non-Patent Document 8: El Sewedy T et al., Int. J. Cancer, 75(2), pp. 324-330 (1998)

Non-Patent Document 9: Cubas R, et al., Biochim. Biophys. Acta., 1796(2), pp. 309-314 (2009)

Non-Patent Document 10: Ohmachi T et al., Clin. Cancer Res., 12(10), pp. 3057-3063 (2006)

Non-Patent Document 11: Fang YJ, et al., Int. J. Colorectal Dis., 24(8), pp. 875-884

(2009)
Non-Patent Document 12: Fong D, et al., Br. J. Cancer, 99(8), pp. 1290-1295 (2008)
Non-Patent Document 13: Fong D, et al., Mod. Pathol., 21(2), pp. 186-191 (2008)
Non-Patent Document 14: Santin AD, et al., Int. J. Cancer, 112(1), pp. 14-25 (2004)
Non-Patent Document 15: Wang J, et al., Mol. Cancer Ther., 7(2), pp. 280-285 (2008)

Summary of the Invention

Under the aforementioned circumstances, it has been desired to develop an anti-hTROP-2 antibody (an anti-hTROP-2 monoclonal antibody) having high anti-tumor activity *in vivo*, and particularly, an anti-hTROP-2 antibody or the like, which has an anti-tumor effect as a naked antibody alone *in vivo* and further, which has the anti-tumor effect at a low dose.

The present invention has been completed, while taking into consideration the aforementioned circumstances. The present invention provides an anti-hTROP-2 antibody (an anti-hTROP-2 monoclonal antibody), a hybridoma, which produces the antibody, a fragment of the antibody, a complex (an immunoconjugate) of the antibody or the like and a drug, a pharmaceutical composition for diagnosing or treating a tumor, a method for detecting a tumor, a kit for detecting or diagnosing a tumor, and the like, which will be described below.

(1) An antibody against human TROP-2, which has anti-tumor activity *in vivo*.

Examples of the antibody according to (1) above include: an antibody exhibiting tumor growth inhibitory activity of 50% or more at a dosage of 5 to 20 mg/kg body weight; an antibody whose frequency of administration for exhibiting the tumor growth inhibitory activity is at most once a week; an antibody exhibiting tumor growth inhibitory activity of 50% or more by a single administration of 10 mg/kg body weight; an antibody having anti-tumor activity on two or more types of human tumor cell lines; and an antibody having a dissociation constant (Kd value) of 1.0×10^{-10} M or less. Herein, the tumor is, for example, at least one type selected from the group consisting of human pancreatic cancer, human prostate cancer, human colon cancer and human breast cancer, and particularly, human pancreatic cancer. In addition, the tumor also includes a recurrent cancer and a metastatic cancer. Moreover, the tumor cell line is, for example, at least two types selected from the group consisting of a human pancreatic

cancer cell line PK-59, a human pancreatic cancer cell line BxPC-3, a human pancreatic cancer cell line KP-3L, a human pancreatic cancer cell line KP-2, a human pancreatic cancer cell line PK-1, a human pancreatic cancer cell line PK-45H, a human pancreatic cancer cell line PK-45P, a human pancreatic cancer cell line TCC-PAN2, a human pancreatic cancer cell line SUIT-2, a human colon cancer cell line CACO-2, a human colon cancer cell line SW480, a human colon cancer cell line DLD-1, a human colon cancer cell line HCT 116, a human breast cancer cell line JIMT-1, a human breast cancer cell line HCC1143, a human breast cancer cell line MCF-7, a human prostate cancer cell line DU145 and a human prostate cancer cell line PC-3; and particularly, a human pancreatic cancer cell line PK-59 and a human pancreatic cancer cell line BxPC-3.

Examples of the antibody according to (1) above include:

an antibody in which the amino acid sequences of CDR 1 to 3 of the H chain V region of the antibody are shown in SEQ ID NOS: 36 to 38, respectively, and/or the amino acid sequences of CDR 1 to 3 of the L chain V region of the antibody are shown in SEQ ID NOS: 41 to 43, respectively;

an antibody in which the amino acid sequences of CDR 1 to 3 of the H chain V region of the antibody are shown in SEQ ID NOS: 46 to 48, respectively, and/or the amino acid sequences of CDR 1 to 3 of the L chain V region of the antibody are shown in SEQ ID NOS: 51 to 53, respectively;

an antibody in which the amino acid sequences of CDR 1 to 3 of the H chain V region of the antibody are shown in SEQ ID NOS: 56 to 58, respectively, and/or the amino acid sequences of CDR 1 to 3 of the L chain V region of the antibody are shown in SEQ ID NOS: 61 to 63, respectively; and

an antibody in which the amino acid sequences of CDR 1 to 3 of the H chain V region of the antibody are shown in SEQ ID NOS: 66 to 68, respectively, and/or the amino acid sequences of CDR 1 to 3 of the L chain V region of the antibody are shown in SEQ ID NOS: 71 to 73, respectively.

An example of the antibody according to (1) above is a monoclonal antibody.

An example of the antibody according to (1) above is a genetically recombinant antibody, and more specific examples include a chimeric antibody, a humanized antibody and a human antibody.

Herein, examples of the above-described chimeric antibody include:

an antibody in which the H chain V region of the chimeric antibody consists of the amino acid sequence shown in SEQ ID NO: 35, and/or the L chain V region thereof consists of the amino acid sequence shown in SEQ ID NO: 40;

an antibody in which the H chain V region of the chimeric antibody consists of the amino acid sequence shown in SEQ ID NO: 45, and/or the L chain V region thereof consists of the amino acid sequence shown in SEQ ID NO: 50;

an antibody in which the H chain V region of the chimeric antibody consists of the amino acid sequence shown in SEQ ID NO: 55, and/or the L chain V region thereof consists of the amino acid sequence shown in SEQ ID NO: 60; and

an antibody in which the H chain V region of the chimeric antibody consists of the amino acid sequence shown in SEQ ID NO: 65, and/or the L chain V region thereof consists of the amino acid sequence shown in SEQ ID NO: 70.

(2) A monoclonal antibody against human TROP-2, which is produced by a hybridoma having accession No. FERM BP-11251, FERM BP-11252, FERM BP-11253, FERM BP-11346 or FERM BP-11254.

Examples of the antibody according to (1) and (2) above include: an antibody, which binds to a site, to which a monoclonal antibody produced by a hybridoma having accession No. FERM BP-11251, FERM BP-11252, FERM BP-11253, FERM BP-11346 or FERM BP-11254; and an antibody, which binds to a portion comprising at least one region (for example, any one region) selected from the group consisting of a region consisting of amino acids at positions 43 to 65, a region consisting of amino acids at positions 152 to 165, a region consisting of amino acids at positions 171 to 183, a region consisting of amino acids at positions 109 to 120, a region consisting of amino acids at positions 43 to 56, and a region consisting of amino acids at positions 193 to 206, in the amino acid sequence of human TROP-2 shown in SEQ ID NO: 2.

(3) An antibody fragment derived from the antibody according to (1) or (2) above.

Examples of the antibody fragment according to (3) above include:

an antibody fragment comprising the amino acid sequences shown in SEQ ID NOS: 36 to 38 and/or the amino acid sequences shown in SEQ ID NOS: 41 to 43, for example, an antibody fragment comprising the amino acid sequence shown in SEQ ID NO: 35 and/or the amino acid sequence shown in SEQ ID NO: 40;

an antibody fragment comprising the amino acid sequences shown in SEQ ID NOS: 46 to 48 and/or the amino acid sequences shown in SEQ ID NOS: 51 to 53, for example, an antibody fragment comprising the amino acid sequence shown in SEQ ID NO: 45 and/or the amino acid sequence shown in SEQ ID NO: 50;

an antibody fragment comprising the amino acid sequences shown in SEQ ID NOS: 56 to 58 and/or the amino acid sequences shown in SEQ ID NOS: 61 to 63, for example, an antibody fragment comprising the amino acid sequence shown in SEQ ID NO: 55 and/or the amino acid sequence shown in SEQ ID NO: 60; and

an antibody fragment comprising the amino acid sequences shown in SEQ ID NOS: 66 to 68 and/or the amino acid sequences shown in SEQ ID NOS: 71 to 73, for example, an antibody fragment comprising the amino acid sequence shown in SEQ ID NO: 65 and/or the amino acid sequence shown in SEQ ID NO: 70.

(4) A hybridoma, which produces the antibody according to (1) or (2) above.

(5) A hybridoma producing a monoclonal antibody against human TROP-2, which has accession No. FERM BP-11251, FERM BP-11252, FERM BP-11253, FERM BP-11346 or FERM ABP-11254.

(6) An antibody-drug conjugate, which comprises the antibody according to (1) or (2) above and a substance having anti-tumor activity and/or cell-killing activity.

(7) An antibody-drug conjugate, which comprises the antibody according to (3) above and a substance having anti-tumor activity and/or cell-killing activity.

With regard to the conjugate according to (6) and (7) above, the tumor is, for example, at least one type selected from the group consisting of human pancreatic cancer, human prostate cancer, human colon cancer and human breast cancer, and particularly, human pancreatic cancer. In addition, the tumor also includes a recurrent cancer and a metastatic cancer.

(8) A pharmaceutical composition, which comprises at least one type selected from the group consisting of the antibody according to (1) and (2) above, the antibody fragment according to (3) above and the conjugate according to (6) and (7) above.

An example of the composition according to (8) above is a composition used in the treatment of tumor, and particularly, a composition, which does not cause weight reduction as a side effect. Another example of the composition is a composition used in the diagnosis of tumor. Herein, the tumor is, for example, at least one type selected

from the group consisting of human pancreatic cancer, human prostate cancer, human colon cancer and human breast cancer, and particularly, human pancreatic cancer. In addition, the tumor also includes a recurrent cancer and a metastatic cancer.

(9) A tumor therapeutic agent, which comprises at least one type selected from the group consisting of the antibody according to (1) and (2) above, the antibody fragment according to (3) above and the conjugate according to (6) and (7) above.

An example of the therapeutic agent according to (9) above is a therapeutic agent, which does not cause weight reduction as a side effect.

(10) A tumor diagnostic agent, which comprises at least one type selected from the group consisting of the antibody according to (1) and (2) above, the antibody fragment according to (3) above and the conjugate according to (6) and (7) above.

With regard to the therapeutic agent according to (9) above and the diagnostic agent according to (10) above, the tumor is, for example, at least one type selected from the group consisting of human pancreatic cancer, human prostate cancer, human colon cancer and human breast cancer, and particularly, human pancreatic cancer. In addition, the tumor also includes a recurrent cancer and a metastatic cancer.

(11) A method for detecting a tumor, which comprises: allowing at least one type selected from the group consisting of the antibody according to (1) and (2) above, the antibody fragment according to (3) above and the conjugate according to (6) and (7) above, to react with a sample collected from a living body; and then detecting a signal(s) of the reacted antibody and/or antibody fragment.

With regard to the method according to (11) above, the tumor is, for example, at least one type selected from the group consisting of human pancreatic cancer, human prostate cancer, human colon cancer and human breast cancer, and particularly, human pancreatic cancer. In addition, the tumor also includes a recurrent cancer and a metastatic cancer.

(12) A kit for treating, diagnosing or detecting a tumor, which comprises at least one type selected from the group consisting of the antibody according to (1) and (2) above, the antibody fragment according to (3) above and the conjugate according to (6) and (7) above.

With regard to the kit according to (12) above, the tumor is, for example, at least one type selected from the group consisting of human pancreatic cancer, human

prostate cancer, human colon cancer and human breast cancer, and particularly, human pancreatic cancer. In addition, the tumor also includes a recurrent cancer and a metastatic cancer.

Brief Description of the Drawings

Figure 1 shows the measurement of the antigen binding affinity (Kd: dissociation constant) of an anti-hTROP-2 monoclonal antibody (K5-70). Abt: Antibody (total); Agf: Antigen (free).

Figure 2 shows the reactivity of a culture supernatant of hybridoma producing an anti-hTROP-2 monoclonal antibody, with HuH-7 cells (TROP-2-negative) and HuH-7-hTROP-2 cells. The filled histogram indicates HuH-7 cells, and the open histogram indicates HuH-7-hTROP-2 cells.

Figure 3 shows the reactivity of an anti-hTROP-2 monoclonal antibody with a human pancreatic cancer cell line (PK-59 cells), which endogenously expresses hTROP-2 on the cell surface. The filled histogram indicates the reaction of the cell line only with a secondary antibody (PE-labeled anti-mouse IgG), and the open histogram indicates the reaction of the cell line with each anti-hTROP-2 monoclonal antibody.

Figure 4 shows the reactivity of an anti-hTROP-2 monoclonal antibody with a human pancreatic cancer cell line (BxPC-3 cells), which endogenously expresses hTROP-2 on the cell surface. The filled histogram indicates the reaction of the cell line only with a secondary antibody (PE-labeled anti-mouse IgG), and the open histogram indicates the reaction of the cell line with each anti-hTROP-2 monoclonal antibody.

Figure 5 shows the reactivity of an anti-hTROP-2 monoclonal antibody (K5-70) with human pancreatic cancer cell lines. The filled histogram indicates the reaction of the cell line only with a secondary antibody (PE-labeled anti-mouse IgG), and the open histogram indicates the reaction of the cell line with each anti-hTROP-2 monoclonal antibody.

Figure 6 shows the reactivity of an anti-hTROP-2 monoclonal antibody (K5-70) with human colon cancer cell lines (Colo320, CACO2, SW480, DLD1, CW2 and HCT 116), human breast cancer cell lines (JIMT-1 and HCC1143), and human prostate cancer cell lines (PC-3 and DU145). The filled histogram indicates the reaction of the cell

line only with a secondary antibody (PE-labeled anti-mouse IgG), and the open histogram indicates the reaction of the cell line with the anti-hTROP-2 monoclonal antibody.

Figure 7 shows the cross-reactivity of anti-hTROP-2 monoclonal antibodies with mouse TROP-2. Cells prepared by allowing a mouse TROP-2 gene to be transiently expressed in CHO-K1 cells were used, and a T2-102 antibody (mouse IgG1) exhibiting cross-reactivity with mouse TROP-2 was used as a positive control antibody. The filled histogram indicates the reaction of the cells only with a secondary antibody (PE-labeled anti-mouse IgG), and the open histogram indicates the reaction of the cells with each anti-hTROP-2 monoclonal antibody.

Figure 8 shows the cross-reactivity of anti-hTROP-2 monoclonal antibodies with human EpCAM/TROP-1. Cells prepared by allowing a human EpCAM/TROP-1 gene to be transiently expressed in CHO-K1 cells were used, and a PE-labeled anti-human EpCAM monoclonal antibody (Becton, Dickinson and Company) was used as a positive control antibody. The filled histogram indicates the reaction of the cells only with a secondary antibody (PE-labeled anti-mouse IgG), and the open histogram indicates the reaction of the cells with each anti-hTROP-2 monoclonal antibody.

Figure 9 shows the cell growth inhibitory activity of anti-hTROP-2 antibodies (T6-16, T5-86, K5-70 and K5-107) on a human pancreatic cancer cell line (PK-59 cells). mIgG indicates a control antibody (mouse IgG), and YY01 indicates a commercially available anti-hTROP-2 antibody (Santa Cruz). White column: 0 μg/mL; gray column: 0.1 μg/mL; black column: 1 μg/mL. The activity level was expressed as a ratio to the value in the case of not adding antibody (0 μg/mL). The error bar indicates a standard deviation. $*P < 0.05$, $**P < 0.01$ (by Student's t-test).

Figure 10 shows a scratch assay of a human pancreatic cancer cell line (PK-59 cells) in the presence of anti-hTROP-2 antibodies (T6-16 and K5-70).

Figure 10A shows representative examples of photographs of the scratch regions of PK-59 cells. Day 0 shows a representative example immediately after scratching. mIgG (Day 1) shows a photograph taken 1 day (24 hours) after scratching and then adding a control antibody (mouse IgG, 1 μg/mL) to the medium. K5-70 (Day 1) shows a photograph taken 1 day (24 hours) after scratching and then adding a K5-70 antibody (1 μg/mL) to the medium. T6-16 (Day 1) shows a photograph taken 1 day (24 hours)

after scratching and then adding a T6-16 antibody (1 μg/mL) to the medium. Each arrow in each photograph indicates the width of a scratch region.

Figure 10B. The area of a scratch region was analyzed using image analysis software (Scion Image), and based on the obtained value, the values of various types of other samples were calculated using Day 0 of the control mIgG addition group as a standard value of 1.

*P <0.05, **P < 0.01 (by Student's t-test).

Figure 11 shows FACS analysis using a stem cell marker, which has been performed on a human pancreatic cancer cell line PK-59. Figure 11A is a view illustrating FACS showing the expression of EpCAM in the PK-59 cells. The filled histogram indicates the reaction of the cells only with a secondary antibody (PE-labeled anti-mouse IgG), and the open histogram indicates the reaction of the cells with an anti-human EpCAM antibody (Becton, Dickinson and Company). Figures 11B and C are views illustrating FACS showing the expression of P-glycoprotein/MCR1 of the PK-59 cells (Figure 11B), or the expression of ABCG2 in the PK-59 cells (Figure 11C). The blue histogram indicates the reaction of the cells only with a secondary antibody, and the red histogram indicates the reaction of the cells with an anti-human P-glycoprotein/MDR1 antibody (BD Biosciences Pharmingen) (Figure 11B), or with an anti-human ABCG2 antibody (BD Biosciences Pharmingen) (Figure 11C). Figure 11D shows FACS analysis, in which the PK-59 cells were double stained with pancreatic cancer stem cell markers, an FITC-labeled anti-human CD24 antibody (BD Biosciences Pharmingen) and a PE-labeled anti-human CD44 antibody (BD Biosciences Pharmingen). Each number in Figure 11D indicates the existing ratio of the cells in each fraction.

Figure 12 shows the evaluation of the anti-tumor activity of a novel anti-hTROP-2 monoclonal antibody clone K5-70 (mouse IgG2a) on xenograft treatment models using PK-59 cells.

Figure 12A shows the time course of tumor growth of a control group (mouse IgG) and a K5-70 administration group (a mean value ± standard deviation). The arrow indicates an antibody administration period. * P < 0.05, ** P < 0.01 (by Student's t-test).

Figure 12B shows the plotted tumor weight of each mouse at the time of the 21st

day (Day 21) (the final day of experiment) in the test of Figure 12A. The numerical value on each plot indicates a mean value ± standard deviation. ** $P < 0.01$ (by Student's t-test).

Figure 13 shows the evaluation of the anti-tumor activity of a clone K5-107 (A), a clone T6-16 (B) and a clone K5-116-2-1 (C) on xenograft treatment models using PK-59 cells. The symbol "●" indicates a control group (mouse IgG), and the symbol "○" indicates an anti-hTROP-2 antibody administration group. The arrow in the graph indicates an antibody administration period, and the numerical value on each plot indicates a mean value ± standard deviation. * $P < 0.05$ (by Student's t-test).

Figure 14 shows the evaluation of the anti-tumor activity of a clone K5-70 (A), a clone T6-16 (B) and a clone K5-116-2-1 (C) in xenograft prevention models using PK-59 cells. The symbol "●" indicates a control group (mouse IgG), and the symbol "○" indicates an anti-hTROP-2 antibody administration group. The arrow in the graph indicates an antibody administration period, and the numerical value on each plot indicates a mean value ± standard deviation. ** $P < 0.01$ (by Student's t-test).

Figure 15 shows the evaluation of the anti-tumor activity of a clone K5-70 on xenograft prevention and treatment models using BxPC-3 cells. Figure 15A shows the time course of tumor growth of a control group (mouse IgG) and a K5-70 administration group in prevention models (a mean value ± standard deviation). The arrow indicates an antibody administration period. ** $P < 0.01$ (by Student's t-test). Figure 15B shows the time course of tumor growth of a control group (mouse IgG) and a K5-70 administration group in treatment models (a mean value ± standard deviation). The arrow indicates an antibody administration period. * $P < 0.05$ (by Student's t-test).

Figure 16 shows the dose-dependent anti-tumor activity of a clone K5-70 on xenograft prevention models using PK-59 cells. The volume of a tumor is expressed as a mean value ± standard deviation.

Figure 16A shows the time course of tumor growth of a control group and K5-70 administration groups at different doses (a mean value ± standard deviation). The arrow indicates an antibody administration period. * $P < 0.05$ (by Student's t-test), ** $P < 0.01$ (by Student's t-test).

Figure 16B shows the plotted tumor weight of each mouse at the time of the 17^{th} day (Day 17) (the final day of experiment) in the test of Figure 16A. The numerical

number on each plot indicates a mean value ± standard deviation. ** $P < 0.01$ (by Student's t-test).

Figure 17 is a schematic view of a human/mouse chimeric TROP-2 protein used in the experiment. SP: signal sequence; TY domain: thyroglobulin type 1 region; TM: transmembrane region; C: intracellular region, wherein the filled region is a polypeptide derived from hTROP-2, whereas the open region is a polypeptide derived from mouse TROP-2. The number in the upper position of the schematic view of the chimeric protein indicates the amino acid number of a mouse TROP-2 protein, and the number in the lower position thereof indicates the amino acid number of an hTROP-2 protein.

Figure 18 shows the results obtained by identifying an anti-hTROP-2 monoclonal antibody-binding region, using human/mouse chimeric TROP-2. Using HEK293 cells, which constantly express either human/mouse chimeric TROP-2-C (hmTROP-2-C) or mouse/human chimeric TROP-2-D (mhTROP-2-D) proteins, the reactivity with the anti-hTROP-2 monoclonal antibodies shown in the figure was studied. As a negative control, mouse IgG2b was used.

Figure 19 shows the results obtained by identifying the antibody-binding region of an anti-hTROP-2 monoclonal antibody.

An hTROP-2 gene and each human/mouse chimeric TROP-2 gene were introduced into HEK293 cells, and FACS analysis was then carried out using the cells, in which the genes were transiently expressed. In Figure 19(A), the reactivity of K5-70, K5-107, T5-86 and K5-116-2-1 antibodies with hTROP-2 (upper case), with hmTROP-2-A (middle case) and with hmTROP-2-B (lower case) was studied. As a negative control, mouse IgG2b was used. In Figure 19(B), the reactivity of T6-4 and T6-16 antibodies with hTROP-2 (upper case), with mhTROP-2-E (middle case) and with mhTROP-2-F (lower case) was studied. As a negative control, mouse IgG2b was used.

Figure 20 shows the expression of hTROP-2 in human normal tissues. Human normal tissue arrays were immunostained with an anti-hTROP-2 monoclonal antibody clone K5-63-17. (A) skin, (B) esophagus, (C) kidney (cortex), (D) kidney (medulla), (E) pancreas, (F) prostate, (G) bladder, (H) tonsil, (I) heart, (J) liver (magnification: × 200)

Figure 21 shows the expression of hTROP-2 in cancer tissues. Human cancer tissue arrays were immunostained with an anti-hTROP-2 monoclonal antibody clone K5-

63-17. (A) breast cancer , (B) lung cancer, (C) esophagus cancer, (D) stomach cancer, (E) pancreatic cancer, (F) colon cancer , (G) bladder cancer, (H) prostate cancer, (I) ovary cancer (magnification: × 100)

Figure 22 shows the anti-tumor activity of a clone K5-70 by a single administration on xenograft prevention models using PK-59 cells.

Figure 22A shows time course of tumor formation in a control group (mouse IgG ●) and in a K5-70 administration group (○) (a mean value ± standard deviation). The arrow indicates antibody administration. * $P < 0.05$ (by Student's t-test), ** $P < 0.01$ (by Student's t-test).

Figure 22B shows the plotted tumor weight of each mouse at the time of the 28th day (Day 28) (the final day of experiment) in the test of Figure 22A. ** $P < 0.01$ (by Student's t-test).

Figure 22C shows time course of tumor formation in each mouse in a control group (mouse IgG ●) and in a K5-70 administration group (○). The arrow indicates antibody administration.

Figure 23 shows the anti-tumor activity of a clone K5-70 on xenograft treatment models using human colon cancer SW480 cells.

Figure 23A shows time course of tumor formation in a control group (mouse IgG ●) and in a K5-70 administration group (○) (a mean value ± standard deviation). The arrow indicates an antibody administration period. ** $P < 0.01$ (by Student's t-test).

Figure 23B shows the plotted tumor weight of each mouse at the time of the 44th day (Day 44) (the final day of experiment) in the test of Figure 23A. ** $P < 0.01$ (by Student's t-test).

Figure 24 shows the anti-tumor activity of a clone K5-116-2-1 on xenograft treatment models using SW480 cells.

Figure 24A shows time course of tumor formation in a control group (mouse IgG ●) and in a T6-16 administration group (○) (a mean value ± standard deviation). The arrow indicates an antibody administration period. ** $P < 0.01$ (by Student's t-test).

Figure 24B shows the plotted tumor weight of each mouse at the time of the 42nd day (Day 42) (the final day of experiment) in the test of Figure 24A. ** $P < 0.01$

(by Student's t-test).

Figure 25 shows the anti-tumor activity of a clone T6-16 on xenograft treatment models using SW480 cells.

Figure 25A shows time course of tumor formation in a control group (mouse IgG ●) and in a T6-16 administration group (○) (a mean value ± standard deviation). The arrow indicates an antibody administration period. * $P < 0.05$ (by Student's t-test).

Figure 25B shows the plotted tumor weight of each mouse at the time of the 42nd day (Day 42) (the final day of experiment) in the test of Figure 25A. * $P < 0.05$ (by Student's t-test).

Figure 26 shows the dose-dependent anti-tumor activity of a clone K5-70 on xenograft treatment models using SW480 cells.

Figure 26A shows time course of tumor formation in a control group (mouse IgG ●) and in a K5-70 administration group (○: 1 mg/kg, △: 5 mg/kg, □: 10 mg/kg) (a mean value ± standard deviation). The arrow indicates an antibody administration period. * $P < 0.05$ (by Student's t-test).

Figure 26B shows the plotted tumor weight of each mouse at the time of the 42nd day (Day 42) (the final day of experiment) in the test of Figure 26A. * $P < 0.05$ (by Student's t-test).

Figure 27 shows the anti-tumor activity of a clone K5-70 on xenograft treatment models using SW480 cells.

Figure 27A shows the anti-tumor activity of a K5-70 antibody at administration intervals of once a week. Time course of tumor formation in a control group (●: mouse IgG) and in a K5-70 administration group (○: 10 mg/kg) is shown (a mean value ± standard deviation). The arrow heads (Days 10, 17, 24, 31, and 38) indicate administration of a K5-70 antibody. * $P < 0.05$ by Student's t-test.

Figure 27B shows time course of tumor formation by administration of a K5-70 antibody at administration intervals of once every ten days (■: q10d) or once every two weeks (●: q14d). The closed circle (◇) indicates a control group (Mouse IgG, 10 mg/kg) (a mean value ± standard deviation). The filled arrowheads (▼: Days 9, 19, and 29) and the open arrowheads (▽: Days 9, 23, and 37) indicate administration of a K5-70 antibody. * $P < 0.05$, ** $P < 0.01$ by Student's t-test.

Figure 28 shows the dose-dependent anti-tumor activity of a clone T6-16 on

xenograft treatment models using SW480 cells.

Figure 28A shows time course of tumor formation in a control group (●: mouse IgG) and in a T6-16 administration group (○: 1 mg/kg, △: 5 mg/kg, □: 10 mg/kg) is shown (a mean value ± standard deviation). The arrow indicates an antibody administration period. ** $P < 0.01$ (by Student's t-test).

Figure 28B shows the plotted tumor weight of each mouse at the time of the 43rd day (Day 43) (the final day of experiment) in the test of Figure 28A. ** $P < 0.01$ (by Student's t-test).

Figure 29 shows the anti-tumor activity of a clone T6-16 on xenograft treatment models using SW480 cells. Time course of tumor formation in a control group (●: mouse IgG, 10 mg/kg) and in a T6-16 (10 mg/kg) administration group (○: q7d, △: q10d) is shown (a mean value ± standard deviation). The arrowheads (Days 10, 17, 24, 31, and 38) and the arrows (Days 10, 20, 30, and 40) indicate administration of a T6-16 antibody. Administration was carried out once every three days to the control group. * $P < 0.05$, ** $P < 0.01$ by Student's t-test.

Figure 30 shows the anti-tumor activity of a clone K5-70 on xenograft prevention models using human prostate DU-145 cells.

Figure 30A shows time course of tumor formation in a control group (●: mouse IgG) and in a K5-70 administration group (○) (a mean value ± standard deviation). The arrow indicates an antibody administration period. * $P < 0.05$ (by Student's t-test).

Figure 30B shows the plotted tumor weight of each mouse at the time of the 40th day (Day 40) (the final day of experiment) in the test of Figure 30A. * $P < 0.05$ (by Student's t-test).

Figure 31 shows the metastasis-inhibitory activity of a clone K5-70 on liver metastatic models using PK-59 cells.

Figures 31A and 31B show the excised liver image of a control group (mouse IgG) (A) and a K5-70 administration group (B), which were taken 6 weeks after the cell transplantation. The arrows indicate liver metastatic foci.

Figure 32 shows the anti-tumor activity of K5-70 on xenograft models using SW480 cells, which are recurrent cancer models after administration of irinotecan hydrochloride. This figure shows time course of tumor formation in a non-treat group (◆), in an irinotecan hydrochloride (40 mg/kg) + K5-70 (○: 10 mg/kg) administration

group, and in an irinotecan hydrochloride (40 mg/kg) + mouse IgG (●: 10 mg/kg) administration group (a mean value ± standard deviation). The arrowheads (Days 11, 14, and 17) indicate administration of irinotecan hydrochloride. The K-70 antibody or the mouse IgG was administered once every three days from Day 20. The arrow indicates an antibody administration period. *P < 0.05, **P < 0.01 by Student's t-test.

Figure 33 shows the cDNA nucleotide sequence of a clone K5-70 H chain variable region (VH) (SEQ ID NO: 34) and the deduced amino acid sequence (SEQ ID NO: 35). A signal peptide is shown in italics. The double-underlined glutamine (Q) indicates the N-terminal amino acid residue of a mature peptide. The CDR sequences (underlined; *IYWIN, NIYPSDSYTNYNQKFKD,* and *TSMADY*)were determined in accordance with the definitions of Kabat et al. (Sequences of Proteins of Immunological Interests, Fifth edition, NIH Publication No. 91-3242, U.S. Department of Health and Human Services, 1991). The amino acid sequences of CDR 1 to 3 of the clone K5-70 VH are shown in SEQ ID NOS: 36 to 38, respectively.

Figure 34 shows the cDNA nucleotide sequence of a clone K5-70 L chain variable region (VL) (SEQ ID NO: 39) and the deduced amino acid sequence (SEQ ID NO: 40). A signal peptide is shown in italics. The double-underlined aspartic acid (D) indicates the N-terminal amino acid residue of a mature peptide. The CDR sequences (underlined; *RASQSIGTSIH, YASESIS,* and *QQSNSWPFT*)were determined in accordance with the definitions of Kabat et al. (Sequences of Proteins of Immunological Interests, Fifth edition, NIH Publication No. 91-3242, U.S. Department of Health and Human Services, 1991). The amino acid sequences of CDR 1 to 3 of the clone K5-70 VL are shown in SEQ ID NOS: 41 to 43, respectively.

Figure 35 shows the cDNA nucleotide sequence of a clone K5-107 H chain variable region (VH) (SEQ ID NO: 44) and the deuced amino acid sequence (SEQ ID NO: 45). A signal peptide is shown in italics. The double-underlined glutamine (Q) indicates the N-terminal amino acid residue of a mature peptide. The CDR sequences (underlined; *SYWMH, NIYPGGGYTNYDEKFKS,* and *SSVFDY*)were determined in accordance with the definitions of Kabat et al. (Sequences of Proteins of Immunological Interests, Fifth edition, NIH Publication No. 91-3242, U.S. Department of Health and Human Services, 1991). The amino acid sequences of CDR 1 to 3 of the clone K5-107 VH are shown in SEQ ID NOS: 46 to 48, respectively.

Figure 36 shows the cDNA nucleotide sequence of a clone K5-107 L chain variable region (VL) (SEQ ID NO: 49) and the deduced amino acid sequence (SEQ ID NO: 50). A signal peptide is shown in italics. The double-underlined aspartic acid (D) indicates the N-terminal amino acid residue of a mature peptide. The CDR sequences (underlined; *RASQNIGTSIH, YASESIS*, and *QQSNSWPFT*)were determined in accordance with the definitions of Kabat et al. (Sequences of Proteins of Immunological Interests, Fifth edition, NIH Publication No. 91-3242, U.S. Department of Health and Human Services, 1991). The amino acid sequences of CDR 1 to 3 of the clone K5-107 VL are shown in SEQ ID NOS: 51 to 53, respectively.

Figure 37 shows the cDNA nucleotide sequence of a clone K5-116-2-1 H chain variable region (VH) (SEQ ID NO: 54) and the deduced amino acid sequence (SEQ ID NO: 55). A signal peptide is shown in italics. The double-underlined glutamine (Q) indicates the N-terminal amino acid residue of a mature peptide. The CDR sequences (underlined; *SYWIT*, *NIYPSDSYTNYNQKFRD*, and *LFDY*)were determined in accordance with the definitions of Kabat et al. (Sequences of Proteins of Immunological Interests, Fifth edition, NIH Publication No. 91-3242, U.S. Department of Health and Human Services, 1991). The amino acid sequences of CDR 1 to 3 of the clone K5-116-2-1 VH are shown in SEQ ID NOS: 56 to 58, respectively.

Figure 38 shows the cDNA nucleotide sequence of a clone K5-116-2-1 L chain variable region (VL) (SEQ ID NO: 59) and the deduced amino acid sequence (SEQ ID NO: 60). A signal peptide is shown in italics. The double-underlined aspartic acid (D) indicates the N-terminal amino acid residue of a mature peptide. The CDR sequences (underlined; *RASQSIGTSIH, YASESIS*, and *QQSNSWPFT*)were determined in accordance with the definitions of Kabat et al. (Sequences of Proteins of Immunological Interests, Fifth edition, NIH Publication No. 91-3242, U.S. Department of Health and Human Services, 1991). The amino acid sequences of CDR 1 to 3 of the clone K5-116-2-1 VL are shown in SEQ ID NOS: 61 to 63, respectively.

Figure 39 shows the cDNA nucleotide sequence of a clone T6-16 H chain variable region (VH) (SEQ ID NO: 64) and the deduced amino acid sequence (SEQ ID NO: 65). A signal peptide is shown in italics. The double-underlined glutamic acid (E) indicates the N-terminal amino acid residue of a mature peptide. The CDR sequences (underlined; *DYNMH*, *YIYPYNGGTGYNQRFKS*, and

EDYGSSPSYAMDY)were determined in accordance with the definitions of Kabat et al. (Sequences of Proteins of Immunological Interests, Fifth edition, NIH Publication No. 91-3242, U.S. Department of Health and Human Services, 1991). The amino acid sequences of CDR 1 to 3 of the clone T6-16 VH are shown in SEQ ID NOS: 66 to 68, respectively.

Figure 40 shows the cDNA nucleotide sequence of a clone T6-16 L chain variable region (VL) (SEQ ID NO: 69) and the deduced amino acid sequence (SEQ ID NO: 70). A signal peptide is shown in italics. The double-underlined aspartic acid (D) indicates the N-terminal amino acid residue of a mature peptide. The CDR sequences (underlined; *RSSQSLVHGNGNTYLH*, *KVSNRFS*, and *SQTTHVPT*)were determined in accordance with the definitions of Kabat et al. (Sequences of Proteins of Immunological Interests, Fifth edition, NIH Publication No. 91-3242, U.S. Department of Health and Human Services, 1991). The amino acid sequences of CDR 1 to 3 of the clone T6-16 VL are shown in SEQ ID NOS: 71 to 73, respectively.

Mode for Carrying Out the Invention

Hereinafter, the present invention will be described in detail. The following descriptions are not intended to limit the scope of the present invention. Other than the following examples, the present invention may be modified and may be carried out, as appropriate, within a range that does not impair the intention of the present invention

The present specification includes all of the contents as disclosed in the specification of Japanese Patent Application No. 2010-113302 (filed on May 17, 2010), which is a priority document of the present application.

In addition, all publications cited in the present specification, which include prior art documents and patent documents such as laid-open application publications and patent publications, are incorporated herein by reference in their entirety.

1. Summary of the present invention

As mentioned above, human TROP-2 (hTROP-2) is a single transmembrane, type 1 membrane protein having a full length of 323 amino acid residues. It has been known that an hTROP-2 gene and a gene product thereof are expressed in various types of cancer cells.

As mentioned above, it has been desired to develop an anti-human hTROP-2 antibody (an anti-human hTROP-2 monoclonal antibody) or the like having high anti-tumor activity *in vivo*. Under such circumstances, the present inventor performed a screening through an extremely large number of clones, and as a result, the inventor succeeded in obtaining a clone having high anti-tumor activity *in vivo*. Specifically, the present invention provides a monoclonal antibody, which specifically recognizes the extracellular region of hTROP-2 *in vivo*, and particularly, a monoclonal antibody exhibiting high affinity at a picomole (pM) order. The antibody of the present invention is extremely useful in that it is an anti-hTROP-2 monoclonal antibody, which exhibits significant tumor growth inhibitory activity at a lower dose than that of the existing anti-hTROP-2 antibody (for example, at a dosage of 1/20) when it is administered singly as a naked antibody, and which also exhibits significant tumor growth inhibitory activity on tumor-bearing mouse treatment models, in which multiple types of human cancer cells are used.

2. Production of anti-hTROP-2 antibody

(1) Preparation of antigen

Information regarding the amino acid sequence (SEQ ID NO: 2) of hTROP-2 is disclosed under "Accession number NP_002344" in the website of, for example, NCBI (GenBank) (http://www.ncbi.nlm.nih.gov/). Information regarding a nucleotide sequence (SEQ ID NO: 1) encoding the amino acid sequence of hTROP-2 is disclosed under "Accession number NM_002353" in the same website as described above.

As an antigen, a polypeptide or peptide (which is also simply referred to as a peptide) comprising at least a portion (the entire or a part) of the amino acid sequence of hTROP-2 can be used, and preferably, a peptide comprising at least a portion (the entire or a part) of the amino acid sequence of the extracellular region of hTROP-2 can be used. The extracellular region (including a signal peptide) of hTROP-2 indicates a region comprising the amino acids at positions 1 to 274 from the amino acid sequence shown in SEQ ID NO: 2 (the signal peptide: the amino acids at positions 1 to 26). Herein, with regard to a peptide used as an antigen, the above description "at least a portion of the amino acid sequence" is not particularly limited in terms of length. For example, a region comprising the amino acids at positions 1 to 145 from the amino acid sequence

shown in SEQ ID NO: 2, a region comprising the amino acids at positions 146 to 274 from the same amino acid sequence as described above, and the like are preferable.

A peptide used as an antigen may be produced either by chemical synthesis, or by synthesis according to a genetic engineering method using *Escherichia coli* or the like. A method well known to persons skilled in the art may be applied.

When a peptide is produced by chemical synthesis, it can be synthesized by a well known peptide synthesis method. In addition, either a solid-phase synthesis method or a liquid-phase synthesis method can be applied to the peptide synthesis. A commercially available peptide synthesizer (for example, PSSM-8 manufactured by Shimadzu Corporation, etc.) may also be used.

When a peptide is synthesized by a genetic engineering method, first, DNA encoding the peptide is designed and synthesized. The design and synthesis of such DNA can be carried out according to a PCR method, using a vector comprising an entire-length hTROP-2 gene or the like as a template, and also using primers designed to be able to synthesize a desired DNA region. Thereafter, the DNA is ligated to a suitable vector to obtain a recombinant vector used for protein expression, and this recombinant vector is then introduced into a host so that a gene of interest can be expressed therein, thereby obtaining a transformant (Sambrook J. et al., Molecular Cloning, A Laboratory Manual, 3rd edition, Cold Spring Harbor Laboratory Press, 2001).

As a vector, a phage or a plasmid capable of autonomously replicating in a host microorganism is used. Further, an animal virus or an insect virus vector can also be used. To produce a recombinant vector, a purified DNA may be cleaved with suitable restriction enzymes, and the thus cleaved DNA portion may be then inserted into the restriction enzyme site or the like of a suitable vector DNA, so as to ligate it to the vector. The type of a host used in transformation is not particularly limited, as long as it is able to express a gene of interest. Examples of such a host include bacteria (*Escherichia coli*, *Bacillus subtilis*, etc.), yeasts, animal cells (COS cells, CHO cells, etc.), insect cells, and insects. A mammal such as a goat may also be used as such a host. A method of introducing a recombinant vector into a host is publicly known.

The above-described transformant is cultured, and a peptide used as an antigen is then collected from the culture. The term "culture" is used herein to mean both (a) a culture supernatant, and (b) cultured cells, a cultured cell mass or a disintegrated

product thereof.

After completion of the culture, when a peptide of interest is produced in a cell mass or in cells, the peptide is extracted by disintegrating the cell mass or the cells. On the other hand, when a peptide of interest is produced outside a cell mass or outside cells, a culture solution is directly used, or the cell mass or the cells are removed from the culture solution by centrifugation or the like. Thereafter, the peptide of interest can be isolated and purified by a single use of biochemical methods commonly used in the isolation and purification of peptides, such as ammonium sulfate precipitation, gel filtration, ion exchange chromatography and affinity chromatography, or by appropriately combining the aforementioned biochemical methods.

In the present invention, a peptide used as an antigen can also be obtained by *in vitro* translation using a cell-free synthesis system. In this case, two methods, namely, a method using RNA as a template and a method using DNA as a template (transcription/translation) can be applied. As such a cell-free synthesis system, a commercially available system, such as Expressway™ system (Invitrogen), PURESYSTEM (registered trademark; Post Genome Institute) or TNT system (registered trademark; Promega) can be used.

The thus obtained peptide may bind to a suitable carrier protein such as bovine serum albumin (BSA), keyhole limpet hemocyanin (KLH), human thyroglobulin or chicken γ-globulin.

Moreover, the antigen may be a peptide consisting of an amino acid sequence comprising a deletion, substitution or addition of one or more amino acids with respect to the amino acid sequence of hTROP-2 (SEQ ID NO: 2) or a partial sequence thereof as described above. There can be used, for example, a peptide consisting of an amino acid sequence, in which one or more (preferably one or several (for example, 1 to 10, and more preferably 1 to 5)) amino acids are deleted, or one or more (preferably one or several (for example, 1 to 10, and more preferably 1 to 5)) amino acids are substituted with other amino acids, or one or more (preferably one or several (for example, 1 to 10, and more preferably 1 to 5)) other amino acids are added, with respect to the amino acid sequence of hTROP-2 or a partial sequence thereof.

In the present invention, a gene to be introduced into a cell or the like is a gene encoding an hTROP-2 protein or a partial fragment thereof, or a mutant protein thereof

or a fragment thereof. As such a gene, a gene having the nucleotide sequence shown in SEQ ID NO: 1 or a partial sequence thereof can be used, for example.

Furthermore, as a gene to be introduced into a cell or the like, there may also be used a nucleotide sequence hybridizing under stringent conditions with a sequence complementary to the nucleotide sequence shown in SEQ ID NO: 1 and encoding a protein having hTROP-2 activity, or a partial sequence thereof.

The description "stringent conditions" is used herein to mean washing conditions after completion of the hybridization. As such stringent conditions, a salt (sodium) concentration in buffer is 10 to 500 mM and a temperature is 42°C to 72°C, and preferably, the aforementioned salt condition is 50 to 300 mM and a temperature is 55°C to 68°C.

Mutation can be introduced into a gene according to a known method such as a Kunkel method or a Gapped duplex method, using, for example, a mutation introduction kit which utilizes site-directed mutagenesis, such as GeneTailor™ Site-Directed Mutagenesis System (manufactured by Invitrogen) or TaKaRa Site-Directed Mutagenesis System (Mutan-K, Mutan-Super Express Km, etc.; manufactured by Takara Bio Inc.).

(2) Production of polyclonal antibody

The prepared antigen is administered to a mammal for immunization. The type of such a mammal is not particularly limited. For example, a rat, a mouse and a rabbit can be used, and among them, a mouse is preferable.

The dosage of the antigen per animal can be determined, as appropriate, depending on the presence or absence of an adjuvant. Examples of such an adjuvant include a Freund's complete adjuvant (FCA), a Freund's incomplete adjuvant (FIA) and an aluminum hydroxide adjuvant. Immunization can be carried out mainly by injecting the antigen into the vein, footpad, subcutis or abdominal cavity of an animal. In addition, immunization interval is not particularly limited, and immunization is carried out at intervals of several days to several weeks, preferably at intervals of 1 week, 1 to 10 times, and preferably 2 or 3 times. Three to seven days after the final immunization day, an antibody titer is measured by enzyme immunoassay (ELISA or EIA), radioimmunoassay (RIA) or other methods. On the date at which a desired antibody titer is obtained, blood can be collected to obtain antiserum. In the above-described

method of collecting an antibody, if it is necessary to purify the antibody, the antibody can be purified by selecting a suitable method from known methods such as ammonium sulfate precipitation, ion exchange chromatography, gel filtration chromatography and affinity chromatography, or by combining the above-mentioned methods, as appropriate. Thereafter, the reactivity of a polyclonal antibody in the antiserum is measured by the ELISA method or the like.

(3) Production of monoclonal antibody

(3-1) Collection of antibody-producing cells

The anti-hTROP-2 antibody of the present invention is not limited, but it is preferably a monoclonal antibody.

The prepared antigen is administered to a mammal, such as a rat, a mouse or a rabbit, for immunization. The dosage of the antigen per animal can be determined, as appropriate, depending on the presence or absence of an adjuvant. The same adjuvants as described above can be used herein. Also, the same immunization methods as described above can be applied herein. One to sixty days, and preferably, one to fourteen days after the final immunization day, antibody-producing cells are collected. Examples of such antibody-producing cells include splenic cells, lymph node cells and peripheral blood cells. Of these, lymph node cells and splenic cells are preferable.

(3-2) Cell fusion

In order to obtain hybridomas (an antibody-producing cell line), the cell fusion of antibody-producing cells with myeloma cells is carried out. As myeloma cells to be fused with antibody-producing cells, commonly available established cells from animals such as mice can be used. The cell line used herein is preferably a cell line, which has drug selectivity, cannot survive in an unfused state in a HAT selective medium (containing hypoxanthine, aminopterin and thymidine), and can survive only in a state fused with antibody-producing cells.

Examples of myeloma cells include mouse myeloma cell lines such as P3-X63-Ag8.653, P3-X63-Ag8(X63), P3-X63-Ag8.U1(P3U1), P3/NS I/1-Ag4-1(NS1) and Sp2/0-Ag14(Sp2/0). Myeloma cells can be selected, while taking into consideration the compatibility with antibody-producing cells, as appropriate.

Subsequently, myeloma cells are fused with antibody-producing cells. For such cell fusion, antibody-producing cells (1×10^6 to 1×10^7 cells/mL) are mixed with

myeloma cells (2×10^5 to 2×10^6 cells/mL) in a medium for animal cells, such as DMEM or an RPMI-1640 medium containing no serum. The cell ratio between the antibody-producing cells and the myeloma cells (antibody-producing cells : myeloma cells) is not limited. In general, the cell ratio is preferably 1 : 1 to 10 : 1, and more preferably 3 : 1. Thereafter, a fusion reaction is carried out in the presence of a cell fusion promoter. As such a cell fusion promoter, polyethylene glycol having a mean molecular weight of 1,000 to 6,000 Dalton (D) or the like can be used. In addition, it is also possible to fuse antibody-producing cells with myeloma cells, employing a commercially available cell fusion apparatus which utilizes electrical stimulation (for example, electroporation).

(3-3) Selection and cloning of hybridomas

Hybridomas of interest are selected from the cells after the cell fusion treatment. As a method of selecting hybridomas, the cell suspension is appropriately diluted with, for example, a fetal bovine serum-containing RPMI-1640 medium, and the diluted solution is then dispersed on a microtiter plate. Thereafter, a selective medium is added to each well. While the selective medium is appropriately exchanged with a fresh one, culture is carried out. As a result, approximately 14 days after initiation of the culture on the selective medium, cells growing from the selective medium can be obtained as hybridomas.

Subsequently, screening is carried out to examine whether or not an antibody reacting with hTROP-2 is present in a culture supernatant of the growing hybridomas. The screening of hybridomas may be carried out according to an ordinary method, and thus, the screening method is not particularly limited. For example, an aliquot is collected from the culture supernatant of the growing hybridomas contained in the well, and screening is then carried out by ELISA, EIA, RIA or the like.

The cloning of the fused cells can be carried out by a limiting dilution method or the like. An antibody showing high reactivity with hTROP-2 is determined by flow cytometry or the like, and a hybridoma producing this antibody is then selected. The selected hybridoma is established as a clone.

(3-4) Collection of monoclonal antibody

As a method of culturing the established hybridoma and then collecting a monoclonal antibody from the obtained culture, a common cell culture method, an

ascites formation method or the like can be adopted. The term "culture" is used herein to mean allowing hybridomas to grow in a culture dish or a culture bottle, or allowing hybridomas to grow in the abdominal cavity of an animal, as described below.

In the case of the cell culture method, hybridomas are cultured in a medium for animal cells, such as a 10% fetal bovine serum-containing RPMI-1640 medium, an MEM medium or a serum-free medium, under common culture conditions (for example, 37°C, 5% CO_2 concentration) for 7 to 14 days, and thereafter, an antibody can be obtained from the culture supernatant.

In the case of the ascites formation method, approximately 1×10^7 hybridomas are administered into the abdominal cavity of an animal of the same species as the mammal from which myeloma cells are derived, so that large quantities of hybridomas are allowed to proliferate. Thereafter, 2 to 3 weeks later, ascites is preferably collected.

In the above-described antibody collection methods, if it is necessary to purify the antibody, the antibody can be purified by appropriately selecting a suitable method from known methods such as ammonium sulfate precipitation, ion exchange chromatography, gel filtration and affinity chromatography, or by combining the above-mentioned methods.

(3-5) Selection of clone having anti-tumor activity

The anti-hTROP-2 antibody of the present invention is an antibody having anti-tumor activity *in vivo*.

The term "anti-tumor activity" is used herein to mean activity of killing tumor cells (cancer cells) or activity of inhibiting tumor growth. Preferred examples of such anti-tumor activity include activity of inhibiting the growth of cancer cells and activity of inhibiting tumor angiogenesis. The type of human tumor (tumor cells), on which the antibody of the present invention is able to exhibit anti-tumor activity, includes various types of known human tumors, in which the expression of hTROP-2 has been confirmed. The type of such human tumor is not particularly limited. For example, one or two or more of human pancreatic cancer, human prostate cancer, human colon cancer and human breast cancer are preferable, and human pancreatic cancer is more preferable.

Moreover, the above-described tumor may be a recurrent cancer or a metastatic cancer. The antibody of the present invention is also able to exhibit excellent anti-tumor activity on these types of tumors.

The presence of anti-tumor activity *in vivo* can be confirmed, for example, by employing a tumor-bearing mouse (a mouse xenograft model), into the subcutis of which desired tumor cells have been transplanted, and then by administering the antibody as obtained above to the mouse. In this case, the antibody may be administered immediately after the transplantation of tumor cells (Prevention models). Alternatively, it may be administered after confirming that the transplanted tumor has reached a predetermined volume (Treatment models). The administration method is not limited. For example, the antibody may be administered once every three days, every one week, every ten days, or every two weeks, or by a single administration (only one time), at a dosage of 5 to 20 mg/kg body weight, via intraperitoneal administration or the like. In the case of prevention models, the presence or absence of anti-tumor activity and the level thereof can be evaluated based on tumor formation frequency and tumor volume. In the case of treatment models, the presence or absence of anti-tumor activity and the level thereof can be evaluated based on tumor volume.

In the present invention, a preferred example of the anti-hTROP-2 antibody having anti-tumor activity *in vivo* is an antibody in which the amino acid sequences of CDR 1 to 3 of the H chain V region thereof are shown in SEQ ID NOS: 36 to 38, respectively, and/or the amino acid sequences of CDR 1 to 3 of the L chain V region thereof are shown in SEQ ID NOS: 41 to 43, respectively. A preferred example of the H chain V region is an H chain V region consisting of the amino acid sequence shown in SEQ ID NO: 35. A preferred example of the L chain V region is an L chain V region consisting of the amino acid sequence shown in SEQ ID NO: 40.

As another embodiment of the anti-hTROP-2 antibody of the present invention, a preferred example is an antibody in which the amino acid sequences of CDR 1 to 3 of the H chain V region thereof are shown in SEQ ID NOS: 46 to 48, respectively, and/or the amino acid sequences of CDR 1 to 3 of the L chain V region thereof are shown in SEQ ID NOS: 51 to 53, respectively. A preferred example of the H chain V region is an H chain V region consisting of the amino acid sequence shown in SEQ ID NO: 45. A preferred example of the L chain V region is an L chain V region consisting of the amino acid sequence shown in SEQ ID NO: 50.

Likewise, as a further embodiment of the anti-hTROP-2 antibody of the present invention, a preferred example is an antibody in which the amino acid sequences of

CDR 1 to 3 of the H chain V region thereof are shown in SEQ ID NOS: 56 to 58, respectively, and/or the amino acid sequences of CDR 1 to 3 of the L chain V region thereof are shown in SEQ ID NOS: 61 to 63, respectively. A preferred example of the H chain V region is an H chain V region consisting of the amino acid sequence shown in SEQ ID NO: 55. A preferred example of the L chain V region is an L chain V region consisting of the amino acid sequence shown in SEQ ID NO: 60.

Likewise, as a further embodiment of the anti-hTROP-2 antibody of the present invention, a preferred example is an antibody in which the amino acid sequences of CDR 1 to 3 of the H chain V region thereof are shown in SEQ ID NOS: 66 to 68, respectively, and/or the amino acid sequences of CDR 1 to 3 of the L chain V region thereof are shown in SEQ ID NOS: 71 to 73, respectively. A preferred example of the H chain V region is an H chain V region consisting of the amino acid sequence shown in SEQ ID NO: 65. A preferred example of the L chain V region is an L chain V region consisting of the amino acid sequence shown in SEQ ID NO: 70.

In the present invention, more specifically, preferred examples of an anti-hTROP-2 antibody having anti-tumor activity *in vivo* include: an anti-hTROP-2 monoclonal antibody (clone name: K5-70) produced by a hybridoma with Accession number FERM BP-11251; an anti-hTROP-2 monoclonal antibody (clone name: K5-107) produced by a hybridoma with Accession number FERM BP-11252; an anti-hTROP-2 monoclonal antibody (clone name: K5-116-2-1) produced by a hybridoma with Accession number FERM BP-11253; an anti-hTROP-2 monoclonal antibody (clone name: T6-16) produced by a hybridoma with Accession number FERM BP-11346; and an anti-hTROP-2 monoclonal antibody (clone name: T5-86) produced by a hybridoma with Accession number FERM BP-11254.

Herein, the hybridoma with Accession number FERM BP-11251 was named as "Mouse-Mouse Hybridoma K5-70" and was deposited on May 12, 2010; the hybridoma with Accession number FERM BP-11252 was named as "Mouse-Mouse Hybridoma K5-107" and was deposited on May 12, 2010; the hybridoma with Accession number FERM BP-11253 was named as "Mouse-Mouse Hybridoma K5-116-2-1" and was deposited on May 12, 2010; the hybridoma with Accession number FERM BP-11346 was named as "Mouse-Mouse Hybridoma T6-16" and was deposited on March 1, 2011; and the hybridoma with Accession number FERM BP-11254 was named as "Mouse-Mouse

Hybridoma T5-86" and was deposited on May 12, 2010. All of these hybridomas were deposited with the International Patent Organism Depositary (IPOD), the National Institute of Advanced Industrial Science and Technology, an Independent Administrative Institution under the Ministry of Economy, Trade and Industry (the AIST, Tsukuba Central 6, Higashi 1-1-1, Tsukuba, Ibaraki, Japan, postal code: 305-8566).

Still further, another preferred example of the anti-hTROP-2 antibody of the present invention is an anti-hTROP-2 antibody that binds to a site (e.g. an epitope), to which a monoclonal antibody produced by the hybridoma having accession No. FERM BP-11251, FERM BP-11252, FERM BP-11253, FERM BP-11346 or FERM BP-11254 binds (recognizes).

Preferred examples of such an epitope will be given in (3-6) below.

(3-6) Epitope of anti-hTROP-2 antibody

The type of an epitope (an antigenic determinant) of the anti-hTROP-2 antibody of the present invention is not limited, as long as it is at least a portion of hTROP-2 as an antigen. For example, such an epitope is preferably at least a portion of a region formed by removing a region consisting of amino acids at positions 252 to 260from the amino acid sequence of hTROP-2 shown in SEQ ID NO: 2, more preferably at least a portion of a region consisting of amino acids at positions 1 to 69 or at least a portion of a region consisting of amino acids at positions 100 to 274 (except for a region consisting of amino acids at position 252 to 260), and further preferably at least a portion of a region consisting of amino acids at positions 27 to 69 or a region consisting of amino acids at positions 109 to 206. Particularly preferred examples of the above-described epitope include a region consisting of amino acids at positions 43 to 65, a region consisting of amino acids at positions 152 to 165, a region consisting of amino acids at positions 171 to 183, a region consisting of amino acids at positions 109 to 120, a region consisting of amino acids at positions 193 to 206, a region consisting of amino acids at positions 43 to 56, and a portion comprising such a region, in the amino acid sequence of hTROP-2 shown in SEQ ID NO: 2. Further particularly preferred examples include a region consisting of amino acids at positions 43 to 65, a region consisting of amino acids at positions 152 to 165, a region consisting of amino acids at positions 171 to 183, a region consisting of amino acids at positions 109 to 120, and a portion comprising such a region. An anti-hTROP-2 antibody, which recognizes the above-described

regions (binds to the above-described regions or portions comprising such regions), has high internalization activity into tumor cells, for example, and thus it is extremely useful as an immunoconjugate as described later.

(3-7) Characteristics of anti-hTROP-2 antibody

As described above, the anti-hTROP-2 antibody of the present invention is an antibody having high anti-tumor activity *in vivo* at a low dose. Specifically, it is preferable that the present anti-hTROP-2 antibody exhibits tumor growth inhibitory activity of 50% or more (preferably 80% or more, more preferably 90% or more, further preferably 95% or more, and particularly preferably almost 100% (for example, 98% or more, or 99% or more)) at a dose (as a naked antibody) of 20 mg/kg body weight or less (preferably 10 mg/kg body weight or less, more preferably 5 mg/kg body weight or less, and further preferably 1 mg/kg body weight or less) with respect to a tumor-bearing animal model.

Herein, the tumor growth inhibitory activity (%) can be calculated, for example, by the following formula:

Tumor growth inhibitory activity (%) = 100 – [(tumor volume or tumor weight of antibody administration group) / (tumor volume or tumor weight of control group)] × 100

In addition, the anti-hTROP-2 antibody of the present invention preferably has anti-tumor activity on two or more types of human tumor cell lines. The type of such a human tumor cell line is not limited. For example, such human tumor cell lines are at least two types selected from the group consisting of various types of human pancreatic cancer cell lines, human prostate cancer cell lines, human colon cancer cell lines and human breast cancer cell lines. Specifically, preferred examples of such human tumor cell lines include at least two types selected from the group consisting of a human pancreatic cancer cell line PK-59, a human pancreatic cancer cell line BxPC-3, a human pancreatic cancer cell line KP-3L, a human pancreatic cancer cell line KP-2, a human pancreatic cancer cell line PK-1, a human pancreatic cancer cell line PK-45H, a human pancreatic cancer cell line PK-45P, a human pancreatic cancer cell line TCC-PAN2, a human pancreatic cancer cell line SUIT-2, a human colon cancer cell line CACO-2, a human colon cancer cell line SW480, a human colon cancer cell line DLD-1, a human colon cancer cell line HCT 116, a human breast cancer cell line JIMT-1, a human breast

cancer cell line HCC1143, a human breast cancer cell line MCF-7, a human prostate cancer cell line DU145 and a human prostate cancer cell line PC-3. Of these, as the above-described two or more types of human tumor cell lines, the human pancreatic cancer cell line PK-59 and the human pancreatic cancer cell line BxPC-3 are more preferable.

Moreover, the anti-hTROP-2 antibody of the present invention has a dissociation constant (Kd value) of preferably 1.0×10^{-10} M or less, more preferably 1.0×10^{-11} M or less, and further preferably 1.0×10^{-12} M or less. Herein, the binding ability (affinity) of the antibody can be measured in the form of a dissociation constant (Kd value), a dissociation rate constant (Kdiss [1/Sec]) or an association rate constant (Kass [1/M.Sec]), for example, by Scatchard analysis or surface plasmon resonance sensor called Biacore. As such Biacore apparatuses, Biacore 3000, Biacore 2000, Biacore X, Biacore J and Biacore Q (all of which were manufactured by Biacore) may be used, for example. It is preferable that the antibody have a dissociation constant (Kd value) that is as small as possible because it could have high binding ability (affinity). The Kd value is determined based on the two parameters of Kdiss and Kass, and it can be expressed in the formula: Kd[M] = Kdiss/Kass. As a method of calculating the Kd value, the method described in the Examples as described later (specifically, Example 10) can be preferably adopted.

(4) Genetically recombinant antibody and antibody fragment

(4-1) Genetically recombinant antibody

In a preferred embodiment of the anti-hTROP-2 antibody of the present invention, there is provided a genetically recombinant antibody. The type of such a genetically recombinant antibody is not limited. Examples include a chimeric antibody, a humanized antibody, and a human antibody.

A chimeric antibody (that is, a humanized chimeric antibody) is an antibody formed by ligating (conjugating) the variable region of a mouse-derived antibody to the constant region of a human-derived antibody (please refer to Proc. Natl. Acad. Sci. U.S.A. 81, 6851-6855, (1984), etc.). When such a chimeric antibody is produced, the thus ligated antibody can be easily constructed by a genetic recombination technique.

When a humanized antibody is produced, a complementarity determining region (CDR) is transplanted from the variable region of a mouse antibody into the variable

region of a human antibody, so as to produce a reconstructed variable region, in which a framework region (FR) is derived from the human and CDR is derived from the mouse (what is called CDR grafting (CDR transplantation)). Subsequently, the thus humanized, reconstructed human variable region is ligated to a human constant region. Such a method for producing a humanized antibody is well known in the present technical field (please refer to see Nature, 321, 522-525 (1986); J. Mol. Biol., 196, 901-917 (1987); Queen C et al., Proc. Natl. Acad. Sci. USA, 86: 10029-10033 (1989); JP Patent Publication (Kohyo) No. 4-502408 A (1992) (Japanese Patent No. 2828340; Queen et al.), etc.).

In general, in the case of a human antibody (a complete human antibody), its structure comprising a Hyper Variable region that is the antigen-binding site of a V region, other parts of the V region, and a constant region is the same as the structure of the antibody of a human. However, such a Hyper Variable site may also be derived from other animals. A technique of producing a human antibody is publicly known, and a method for producing gene sequences that are common in humans by genetic engineering has been established. A human antibody can be obtained, for example, by a method using a human antibody-producing mouse that has human chromosomal fragments comprising the genes of the H chain and L chain of the human antibody (please refer to Tomizuka, K.et al., Nature Genetics, (1977) 16, 133-143; Kuroiwa, Y. et. al., Nuc. Acids Res., (1998) 26, 3447-3448; Yoshida, H. et. al., Animal Cell Technology: Basic and Applied Aspects, (1999) 10, 69-73 (Kitagawa, Y., Matsuda, T. and Iijima, S. eds.), Kluwer Academic Publishers; Tomizuka, K. et. al., Proc. Natl. Acad. Sci. USA, (2000) 97, 722-727, etc.), or by a method of obtaining a phage display-derived human antibody selected from a human antibody library (please refer to Wormstone, I. M. et. al, Investigative Ophthalmology & Visual Science., (2002) 43 (7), 2301-8; Carmen, S. et. al., Briefings in Functional Genomics and Proteomics,(2002) 1 (2), 189-203; Siriwardena, D. et. al., Opthalmology, (2002) 109 (3), 427-431, etc.).

In the case of the aforementioned chimeric antibody, humanized antibody and human antibody, the N-glycoside-linked sugar chain in the antibody Fc region is preferably a sugar chain, in which fucose does not bind to N-acetylglucosamine at the reducing terminal thereof. A specific example is an antibody consisting of genetically recombinant antibody molecules, which has, in the Fc region of the antibody molecules,

a sugar chain in which the position 1 of the fucose does not bind to the position 6 of the N-acetylglucosamine at the reducing terminal of the N-glycoside-linked sugar chain via an α bond. Such an antibody is able to significantly improve ADCC activity. This point (the characteristics of the N-glycoside-linked sugar chain in the antibody Fc region) is preferable also for the aforementioned polyclonal antibody and monoclonal antibody.

(4-2) Antibody fragment

The anti-hTROP-2 antibody fragment (partial fragment) of the present invention is included in the antibody of the present invention. Herein, the antibody fragment of the present invention has binding activity to hTROP-2 (namely, it is able to bind to hTROP-2) and also has anti-tumor activity *in vivo*, as in the case of the anti-hTROP-2 antibody of the present invention.

The fragment of the antibody means a region of a portion of an anti-hTROP-2 polyclonal antibody or anti-hTROP-2 monoclonal antibody (namely, an antibody fragment derived from the anti-hTROP-2 antibody of the present invention). Examples of such an antibody fragment include peptides comprising, as at least a portion thereof, Fab, Fab', $F(ab')_2$, Fv (variable fragment of antibody), a single-stranded antibody (an H chain, an L chain, an H chain V region, and an L chain V region, etc.), scFv, diabody (scFv dimer), dsFv (a disulfide-stabilized V region), and a complementarity determining region (CDR).

Fab is an antibody fragment with a molecular weight of approximately 50,000 having antigen-binding activity, which is formed by binding about a half on the N-terminal side of the H chain to the entire L chain via a disulfide bond, among fragments obtained by treating antibody molecules with a protease, papain. In addition, it is also possible to produce such Fab by inserting DNA encoding the Fab of an antibody into a prokaryote expression vector or a eukaryote expression vector, and then introducing the vector into a prokaryote or a eukaryote so as to allow the DNA to express therein.

$F(ab')_2$ is an antibody fragment with a molecular weight of approximately 100,000 having antigen-binding activity, whose size is slightly greater than Fab that binds to Fab via disulfide bond in the hinge region, among fragments obtained by treating antibody molecules with a protease, pepsin. In addition, it is also possible to produce such $F(ab')_2$ by the thioether bond or disulfide bond of Fab, as described later.

Fab' is an antibody fragment with a molecular weight of approximately 50,000 having antigen-binding activity, which is formed by cleaving the disulfide bond in the hinge region of the aforementioned $F(ab')_2$. In addition, it is also possible to produce such Fab' by inserting DNA encoding the Fab' fragment of an antibody into a prokaryote expression vector or a eukaryote expression vector, and then introducing the vector into a prokaryote or a eukaryote so as to allow the DNA to express therein.

scFv is an antibody fragment having antigen-binding activity, which is a VH-P-VL or VL-P-VH polypeptide formed by ligating a single H chain V region (VH) to a single L chain V region (VL) using a suitable peptide linker (P). Such scFv can be produced by obtaining cDNA encoding the VH and VL of an antibody, constructing DNA encoding scFv, inserting the DNA into a prokaryote expression vector or a eukaryote expression vector, and then introducing the vector into a prokaryote or a eukaryote so as to allow the DNA to express therein.

Diabody is an antibody fragment formed by dimerization of scFv, which has divalent antigen-binding activities. Such divalent antigen-binding activities may be identical to each other, or they may also be different from each other. Such diabody can be produced by obtaining cDNA encoding the VH and VL of an antibody, constructing DNA encoding scFv such that the length of the amino acid sequence of P is 8 residues or less, inserting the DNA into a prokaryote expression vector or a eukaryote expression vector, and then introducing the vector into a prokaryote or a eukaryote so as to allow the DNA to express therein.

dsFv is an antibody fragment formed by binding polypeptides, in which one amino acid residue in each of VH and VL has been substituted with a cysteine residue, to each other via a disulfide bond between the cysteine residues. The amino acid residue to be substituted with cysteine residues can be selected based on estimation of the three-dimensional structure of the antibody according to the method of Reiter et al. (Protein Engineering, 7, 697-704, 1994). Such dsFv can be produced by obtaining cDNA encoding the VH and VL of an antibody, constructing DNA encoding dsFv, inserting the DNA into a prokaryote expression vector or a eukaryote expression vector, and then introducing the vector into a prokaryote or a eukaryote so as to allow the DNA to express therein.

A peptide comprising a CDR comprises at least one region of CDRs of VH (CDR 1 to 3) and CDRs of VL (CDR 1 to 3). More preferred examples of such a peptide include a peptide comprising all of the CDRs of VH and a peptide comprising all of the CDRs of VL. A particularly preferred example of the peptide is a peptide comprising all of the CDRs of VH and VL (total 6 regions). Preferred examples of the amino acid sequence of such a CDR include the amino acid sequences shown in SEQ ID NOS: 36 to 38, 41 to 43, 46 to 48, 51 to 53, 56 to 58, 61 to 63, 66 to 68, and 71 to 73, as described above. A peptide comprising multiple CDRs can be bound to one another, directly or via a suitable peptide linker. Such a peptide comprising CDR can be produced by constructing DNA encoding the VH and VL of an antibody, inserting the DNA into a prokaryote expression vector or a eukaryote expression vector, and then introducing the expression vector into a prokaryote or a eukaryote so as to allow the DNA to express therein. Moreover, such a peptide comprising CDR can also be produced by chemical synthesis methods such as a Fmoc method (a fluorenylmethyloxycarbonyl method) and a tBoc method (a t-butyloxycarbonyl method).

The antibody fragment of the present invention, as is, may be an antibody fragment, which comprises a part of or the entire antibody Fc region in which fucose does not bind to N-acetylglucosamine at the reducing terminal of an N-glycoside-linked sugar chain. Otherwise, the antibody fragment of the present invention may also be a fusion protein, in which the aforementioned antibody fragment is fused with a part of or the entire antibody Fc region in which fucose does not bind to N-acetylglucosamine at the reducing terminal of an N-glycoside-linked sugar chain. Such an antibody fragment is able to significantly improve ADCC activity, and thus it is preferable.

Hereinafter, in the descriptions of the present specification, the aforementioned antibody fragments are also included in the anti-hTROP-2 antibody of the present invention.

3. Preparation of antibody-drug conjugate

As an immunoconjugate prepared using the aforementioned anti-hTROP-2 antibody of the present invention, there can be provided an antibody-drug conjugate, which comprises the aforementioned antibody and a substance (a compound, etc.) having anti-tumor activity and/or cell-killing activity. It is to be noted that a conjugate

formed by previously preparing each of the aforementioned antibody molecule and the aforementioned substance having anti-tumor activity and/or cell-killing activity, separately, and then combining them, is generally referred to as an immunoconjugate. On the other hand, a conjugate obtained by ligating a protein toxin used as such a substance having anti-tumor activity and/or cell-killing activity to an antibody gene on a gene according to a genetic recombination technique, so as to allow it to express as a single protein (a fusion protein), is generally referred to as an immunotoxin.

Examples of a substance having anti-tumor activity include doxorubicin, calicheamicin, mitomycin C, Auristatin E and radioactive isotope (RI). Examples of a substance having cell-killing activity include saporin, lysine, pseudomonas exotoxin, diphtheria toxin and radioactive isotope (RI). Of these, saporin and pseudomonas exotoxin are preferably used. The type of RI having anti-tumor activity and/or cell-killing activity is not particularly limited, and examples of such RI include ^{90}Y, ^{111}In, ^{125}I, ^{3}H, ^{35}S, ^{14}C, ^{186}Re, ^{188}Re, ^{189}Re, ^{177}Lu, ^{67}Cu, ^{212}Bi, ^{213}Bi, ^{211}At, ^{198}Au, ^{224}Ac, ^{126}I, ^{133}I, ^{77}Br, ^{113m}In, ^{95}Ru, ^{97}Ru, ^{103}Ru, ^{105}Ru, ^{107}Hg, ^{203}Hg, ^{94m}Tc, ^{121m}Te, ^{122m}Te, ^{125m}Te, ^{165}Tm, ^{167}Tm, ^{168}Tm, ^{111}Ag, ^{197}Pt, ^{109}Pd, ^{32}P, ^{33}P, ^{47}Sc, ^{153}Sm, ^{177}Lu, ^{105}Rh, ^{142}Pr, ^{143}Pr, ^{161}Tb, ^{166}Ho, ^{199}Au, ^{57}Co, ^{58}Co, ^{51}Cr, ^{59}Fe, ^{18}F, ^{75}Se, ^{201}Tl, ^{225}Ac, ^{76}Br, ^{86}Y, ^{169}Yb, ^{166}Dy, ^{212}Pb and ^{223}Ra.

A method for producing an antibody-drug conjugate is not limited. For example, a method of coupling an antibody with a drug via a disulfide bond or a hydrazone bond is applied.

The aforementioned anti-hTROP-2 antibody of the present invention is excellent in terms of internalization activity into target tumor cells that express hTROP-2. Thus, by previously combining a substance having anti-tumor activity and cell-killing activity with the anti-hTROP-2 antibody, it becomes possible to allow such a substance to directly and highly selectively act on the tumor cells. The antibody-drug conjugate of the present invention is extremely excellent in terms of ability to deliver the agent to the target tumor cells.

The internalization activity into cells can be evaluated by fluorescently labeling an antibody with rhodamine or the like and then observing the migratory behavior and localization of the antibody using a fluorescence microscope or the like.

Moreover, in the present invention, in addition to the aforementioned antibody-drug conjugate, there can also be provided an antibody fragment-drug conjugate, in which the aforementioned antibody fragment is used instead of an antibody. With regard to the details of such an antibody fragment-drug conjugate, the descriptions of the aforementioned antibody-drug conjugate can be applied, as appropriate.

Hereinafter, in the descriptions of the present specification, such an antibody fragment-drug conjugate is also included in the antibody-drug conjugate of the present invention.

4. Pharmaceutical composition

The anti-hTROP-2 antibody and antibody-drug conjugate of the present invention are useful as active ingredients contained in a pharmaceutical composition.

The pharmaceutical composition is useful as a pharmaceutical composition for treating and/or diagnosing a tumor. In particular, since the anti-hTROP-2 antibody of the present invention and an antibody-drug conjugate comprising the aforementioned antibody have excellent tumor growth inhibitory activity as such anti-tumor activity, they are preferably used in the treatment of tumor. That is to say, the anti-hTROP-2 antibody and antibody-drug conjugate of the present invention are useful as active ingredients contained in a tumor therapeutic agent and a tumor diagnostic agent. It is to be noted that the above-described treatment of tumor includes inhibition of tumor growth and suppression of tumor growth. Specifically, if it is a tumor therapeutic agent, examples of the tumor therapeutic agent include a tumor growth inhibitor and a tumor growth suppressor.

It is preferable to provide the pharmaceutical composition of the present invention in the form of a pharmaceutical composition comprising the anti-hTROP-2 antibody and/or antibody-drug conjugate of the present invention as active ingredient(s), and further comprising a pharmacologically acceptable carrier. In addition, the pharmaceutical composition of the present invention can be used in combination with known anti-tumor agents. By such a combined use, a higher anti-tumor effect can be obtained.

Target diseases (tumors), to which the pharmaceutical composition of the present invention is applied, include: the aforementioned various types of known human

tumors, in which the expression of hTROP-2 has previously been confirmed. Among others, one or two or more types selected from among human pancreatic cancer, human prostate cancer, human colon cancer and human breast cancer are particularly preferable. Such target disease may be a single disease, or two or more diseases may be developed in combination. Moreover, the target tumor may be a recurrent cancer or a metastatic cancer. The pharmaceutical composition of the present invention (further, the anti-hTROP-2 antibody and/or antibody-drug conjugate of the present invention) can be effectively used as a therapeutic agent and a diagnostic agent for a recurrent cancer or a metastatic cancer.

Examples of the "pharmacologically acceptable carrier" include an excipient, a diluent, an extender, a disintegrator, a stabilizer, a preservative, a buffer, an emulsifier, an aromatic, a coloring agent, a sweetener, a thickener, a corrigent, a solubilizer and other additives. Using one or more types of such carriers, a pharmaceutical composition can be prepared in the form of an injection, a liquid agent, a capsule, a suspension, an emulsion, a syrup, etc. These pharmaceutical compositions can be administered orally or parenterally. Another form for parenteral administration is, for example, an injection comprising one or more active ingredients, which is prepared by an ordinary method. Such an injection can be produced by dissolving or suspending the present antibody in a pharmacologically acceptable carrier such as a normal saline solution or a commercially available distilled water used for injection.

In particular, when an antibody fragment derived from the anti-hTROP-2 antibody of the present invention (particularly, an antibody fragment with a low molecular weight) is administered into a living body, a colloidal dispersion system can be used in addition to the aforementioned components. Such a colloidal dispersion system is anticipated to have an effect of enhancing the stability of a compound (an antibody fragment) in a living body or an effect of efficiently transporting such a compound to a specific organ, tissue, or cell. The type of such a colloidal dispersion system is not limited, as long as it is commonly used. Examples of such a colloidal dispersion system include dispersion systems comprising, as bases, polyethylene glycol, a macromolecular conjugate, a macromolecular aggregate, a nanocapsule, microsphere, beads, and lipids including an oil in water emulsifier, micelle, mixed micelle and liposome. Preferred examples of such a colloidal dispersion system include multiple

liposomes and the vesicles of artificial membrane, which have an effect of efficiently transporting such a compound to a specific organ, tissue, or cell (Mannino et al., Biotechniques, 1988, 6, 682; Blume and Cevc, Biochem. et Biophys. Acta, 1990, 1029, 91; Lappalainen et al., Antiviral Res., 1994, 23, 119; Chonn and Cullis, Current Op. Biotech., 1995, 6, 698).

The dosage of the pharmaceutical composition of the present invention differs depending on the age, sex, body weight and symptoms of a patient, therapeutic effects, an administration method, a treatment time, the types of the anti-hTROP-2 antibody and antibody-drug conjugate of the present invention contained in the pharmaceutical composition, etc. In general, the present pharmaceutical composition may be administered within the range between 600 μg and 6,000 mg per adult per administration. However, the dose is not limited to the aforementioned range.

In a case in which the pharmaceutical composition is administered in the form of an injection, for example, it may be administered at a dosage of 100 μg to 100 mg, per administration, per body weight of a human patient, once or divided over several administrations, as an average daily dose. Preferably, the pharmaceutical composition may be administered once every three days, once a week, once every ten days, or once every two weeks, or by a single administration (wherein the total number of administrations is 1). Examples of the dosage form include intravenous injection, subcutaneous injection, intradermal injection, intramuscular injection and intraperitoneal injection. Of these, intravenous injection is preferable. In addition, such an injection may be prepared in the form of a nonaqueous diluent (e.g. polyethylene glycol, vegetable oil such as olive oil, alcohols such as ethanol, etc.), a suspension, or an emulsion. Such an injection can be sterilized by mechanical sterilization using a filter, the mixing of a microbicide, etc. The injection can be produced in the form of an injection to be prepared before using. That is, a sterilized solid composition is prepared by a freeze-drying method or the like, and the composition is then dissolved in sterilized distilled water used for injection or other solvents before it is used, so that it can be then used.

The present invention provides a use of the aforementioned anti-hTROP-2 antibody and/or antibody-drug conjugate of the present invention in the production of a pharmaceutical agent (a drug) for treating and/or diagnosing a tumor. In addition, the

present invention provides the aforementioned anti-hTROP-2 antibody and/or antibody-drug conjugate of the present invention, which are used for treating and/or diagnosing a tumor.

Moreover, the present invention provides a method for treating and/or diagnosing a tumor, which is characterized in that it comprises using (namely, administering to patients) the aforementioned anti-hTROP-2 antibody and/or antibody-drug conjugate of the present invention. Furthermore, the present invention also provides the use of the aforementioned anti-hTROP-2 antibody and/or antibody-drug conjugate of the present invention in the treatment and/or diagnosis of tumor.

5. Method for detecting tumor

The method for detecting a tumor of the present invention is characterized in that it comprises allowing the aforementioned anti-hTROP-2 antibody of the present invention to react with a sample collected from a living body (hereinafter referred to as a biological sample), and detecting a signal(s) of the reacted antibody.

As described above, hTROP-2 has been confirmed to be specifically expressed in various types of tumor cells. Thus, hTROP-2, and particularly, free hTROP-2 (an extracellular region portion of hTROP-2) can be used as a marker for various types of tumors. In particular, such hTROP-2 can be preferably used as a marker for human pancreatic cancer, human prostate cancer, human colon cancer and human breast cancer.

Hence, the anti-hTROP-2 antibody of the present invention is allowed to react with a biological sample, and a signal of the reacted antibody is then detected, so as to detect a tumor. The obtained antibody signal can be used as an indicator of the amount of an antigen in the biological sample (that is, an hTROP-2 amount or a free hTROP-2 amount). In detection of a tumor using the antibody of the present invention, first, a biological sample collected as an analyte from a subject, such as a tissue section or blood used as a test target, is allowed to bind to the antibody of the present invention by an antigen-antibody reaction. Subsequently, based on the measurement results of the amount of the bound antibody, the amount of an antigen of interest contained in the biological sample is measured. This measurement may be carried out in accordance with known immunoassay methods. For example, an immunoprecipitation method, an immunoagglutination method, radioimmunoassay, immunonephelometry, a Western blot

method, flow cytometry and the like can be used. In radioimmunoassay, a labeled antibody is used, and thus an antibody signal is expressed as the amount of the labeled antibody that is directly detected. Otherwise, an antibody whose concentration or antibody titer has been known may be used as a standard solution, and thus a signal of the target antibody may be expressed as a relative value. That is, both the standard solution and the analyte may be measured using a measurement device, and an antibody signal in a biological sample may be expressed as a value relative to the value of the standard solution used as a criterion. Examples of such radioimmunoassay include the ELISA method, the EI method, the RIA method, fluorescence immunoassay (FIA), and luminescence immunoassay. Of these, the ELISA method is particularly preferable in that it is simple and highly sensitive.

In the present invention, the state of a tumor can be evaluated or diagnosed, using the detection result obtained by the aforementioned detection method as an indicator. For example, when the detection result exceeds a predetermined standard value, the state of a tumor is defined as tumor positive, and when the detection result is less than the predetermined standard value, it is defined as tumor negative. In the case of tumor positive, it is determined that a certain type of tumor could have been developed, and thus the tumor state can be evaluated. The term "the state of a tumor" is used herein to mean the presence or absence of the development of a tumor, or the progression degree thereof. Thus, specific examples of the state of a tumor include the presence or absence of the development of a tumor, the progression degree thereof, the degree of malignancy, the presence or absence of metastasis, and the presence or absence of recurrence.

In the aforementioned evaluation, as a state of a tumor to be evaluated, only one state may be selected from the aforementioned examples, or multiple examples may be combined and selected. The presence or absence of a tumor can be evaluated by determining whether or not the tumor has been developed, with reference to the predetermined standard value used as a boundary, based on the obtained detection result. The degree of malignancy is used as an indicator that indicates the progression degree of a cancer. Based on the detection result, the target tumor can be classified into a certain disease stage and it can be evaluated. Otherwise, an early cancer and an advanced cancer can be distinguished from each other, and then they can be evaluated. For

example, it is also possible to determine the target tumor as an early cancer or an advanced cancer, using the detection result as an indicator. The metastasis of tumor can be evaluated by determining whether or not neoplasm has appeared at a site apart from the position of the initial lesion, using the detection result as an indicator. The recurrence can be evaluated by determining whether or not the detection result has exceeded the predetermined standard value again after interval stage or remission.

6. Kit for detecting or diagnosing tumor

The anti-hTROP-2 antibody of the present invention can be provided in the form of a kit for detecting or diagnosing a tumor. The kit of the present invention comprises a labeling substance, a solid-phase reagent on which the antibody or the labeled antibody has been immobilized, etc., as well as the aforementioned antibody. A labeling substance that labels the antibody means a substance labeled with an enzyme, a radioisotope, a fluorescent compound, a chemiluminescent compound, etc. The kit of the present invention may also comprise other reagents used for carrying out the detection of the present invention, in addition to the aforementioned constitutional elements. For example, when such a labeling substance is an enzyme labeling substance, the kit of the present invention may comprise an enzyme substrate (a chromogenic substrate, etc.), an enzyme substrate-solving solution, an enzyme reaction stop solution, a diluent used for analytes, etc. Moreover, the present kit may further comprise various types of buffers, sterilized water, various types of cell culture vessels, various types of reactors (an Eppendorf tube, etc.), a blocking agent (a serum component such as bovine serum albumin (BSA), skim milk, or goat serum), a washing agent, a surfactant, various types of plates, an antiseptic such as sodium azide, an experimental operation manual (instruction), etc.

The kit of the present invention can be effectively used to carry out the aforementioned detection method of the present invention, and thus it is extremely useful.

Hereinafter, the present invention will be more specifically described in the following examples. However, these examples are not intended to limit the scope of the present invention.

[Example 1]

[Cloning of hTROP-2 gene]

A full-length hTROP-2 gene was isolated from human fetal liver (10-week-old embryo) according to an RT-PCR method. First, the following PCR primers were designed based on the sequence of an hTROP-2 gene (Genbank accession No. NM_ 002353).

Forward primer: 5'-ttcctccgccccaccatggc-3' (SEQ ID NO: 3)

Reverse primer: 5'-ctcgagcaagctcggttcctttctc-3' (SEQ ID NO: 4)

When these primers were designed, a *Xho*I restriction enzyme-digested sequence except for a stop codon was added to the reverse primer. cDNA was synthesized from total RNA (TAKARA) prepared from human fetal liver (10-week-old embryo). Using this cDNA as a template, a PCR reaction was carried out with the aforementioned primers. Thereafter, development by agarose gel electrophoresis and extraction of a band of interest were carried out, and it was then cloned into a pCRII vector (Invitrogen) (pCRII-hTROP-2). The cloned hTROP-2 cDNA was confirmed by sequencing.

An expression vector was constructed by cleaving a *Eco*RI/*Xho*I fragment comprising an hTROP-2 gene from pCRII-hTROP-2, and then inserting the fragment into the *Eco*RI/*Xho*I site of a pcDNA4/*myc*-His© A vector (Invitrogen) (pcDNA4-hTROP-2-*myc*/His). Moreover, a *Hind*III/*Pme*I fragment comprising an hTROP-2 gene was cut out of pcDNA4-hTROP-2-*myc*/His (wherein the *Hind*III cleavage portion was blunt-ended), and the fragment was then inserted into a *Pme*I site of a pcDNA3.1(+) vector (Invitrogen), so as to construct an expression vector comprising a neomycin resistance gene (pcDNA3.1-hTROP-2-*myc*/His).

[Example 2]

[Construction of cell line capable of stably expressing hTROP-2 gene]

The expression vector (pcDNA3.1-hTROP-2-*myc*/His) encoding the full-length cDNA of hTROP-2, which had been produced by the above-described method, was introduced into HEK293 cells (RIKEN), HuH-7 cells (HSRRB), 7E2-C cells (described

in WO 2005/052156) and CHO-K1 cells (HSRRB), using a lipofectamine 2000 reagent (Invitrogen), and selection was then carried out using an antibiotic G418 (geneticin; GIBCO BRL). Thereafter, a cell line, which stably expressed hTROP-2, was established and obtained.

[Example 3]

[Production of recombinant protein of hTROP-2 extracellular region]

A gene fragment encoding a portion of the extracellular region of hTROP-2 (specifically, a region consisting of amino acids at positions 1 to 263 from the amino acid sequence shown in SEQ ID NO: 2) was amplified by a PCR method. The following primers were used in the amplification.

Forward primer: 5'-ttcctccgccccaccatggc-3' (SEQ ID NO: 3)
Reverse primer: 5'-ctcgagctcgtccaggtaatagatgagcg-3' (SEQ ID NO: 5)

In this operation, a *Xho*I restriction enzyme-digested sequence was added to the reverse primer. The DNA fragment amplified by the PCR method was developed by agarose gel electrophoresis, and it was then purified using QIAquick (registered trademark) Gel Extraction Kit (QIAGEN). The purified DNA fragment was subcloned into a pCR Blunt vector (Invitrogen) (pCRB-hTROP-2 EC), and the gene sequence was confirmed. Subsequently, a *Eco*RI/*Xho*I fragment comprising the gene fragment encoding the extracellular region of hTROP-2 was cut out of the pCRB-hTROP-2 EC, and it was then inserted into the *Eco*RI/*Xho*I site of a pcDNA4/*myc*-His© A vector (Invitrogen) (pcDNA4mH-hTROP-2 EC). Further, in order to produce a *Nru*I restriction enzyme cleavage site, the following oligonucleotides were associated and inserted into the *Bam*HI/*Eco*RI site of the pcDNA4mH-hTROP-2 EC.

Oligonucleotide 1: 5'-gatccactagtcgcgagtggtgg-3' (SEQ ID NO: 6)
Oligonucleotide 2: 5'-aattccaccactcgcgactagtg-3' (SEQ ID NO: 7)

Likewise, a pBgl II linker (TAKARA) was inserted into the *Pme*I site of the pcDNA4mH-hTROP-2 EC (pcDNA4mH-NB-hTROP-2 EC). In order to produce a

recombinant protein using baculovirus, a *Nru*I/*Bgl*II fragment comprising the gene fragment encoding the extracellular region of hTROP-2 was cut out of the pcDNA4mH-NB-hTROP-2 EC, and it was then inserted into the *Nru*I/*Bgl*II site of a pPSC8 vector (Nosan Corporation) (pPSC8-hTROP-2 EC). The production of the recombinant protein of the extracellular region of hTROP-2 using baculovirus was delegated to Nosan Corporation.

The recombinant protein of the extracellular region of hTROP-2 was purified as follows. Ni Sepharose 6 Fast Flow (GE Healthcare Biosciences) was added to a culture supernatant comprising the recombinant protein, so that they were allowed to bind to each other at 4°C for 2 hours. Thereafter, the resultant was washed with a phosphate buffer containing 20 mM imidazole, employing EconoColumn (BIO RAD), and it was then eluted with a phosphate buffer containing 300 mM imidazole, so that it was purified.

[Example 4]

[Isolation of human EpCAM cDNA and construction of expression vector]

A full-length human EpCAM gene was isolated from human fetal liver (10-week-old embryo) according to an RT-PCR method. First, the following PCR primers were designed based on the sequence of a human EpCAM gene (Genbank accession No. NM_002354).

Forward primer: 5'-tcctcgtgtcccactcccgg-3' (SEQ ID NO: 8)
Reverse primer: 5'-ctcgagtgcattgagttccctatgc-3' (SEQ ID NO: 9)

When these primers were designed, a *Xho*I restriction enzyme-digested sequence except for a stop codon was added to the reverse primer. cDNA was synthesized from total RNA (TAKARA) from human fetal liver (10-week-old embryo). Using this cDNA as a template, a PCR reaction was carried out with the aforementioned primers. Thereafter, development by agarose gel electrophoresis and extraction of a band of interest were carried out, and it was then cloned into a pCRII vector (Invitrogen) (pCRII-hEpCAM). The cloned human EpCAM cDNA was confirmed by sequencing.

An expression vector was constructed by cleaving a *Eco*RI/*Xho*I fragment

comprising a human EpCAM gene from pCRII-hEpCAM, and then inserting the fragment into the *Eco*RI/*Xho*I site of a pcDNA4/*myc*-His© A vector (Invitrogen) (pcDNA4-hEpCAM-*myc*/His). Moreover, a *Hind*III/*Pme*I fragment comprising a human EpCAM gene was cut out of pcDNA4-hEpCAM-*myc*/His (wherein the *Hind*III cleavage portion was blunt-ended), and the fragment was then inserted into the *Pme*I site of a pcDNA3.1(+) vector (Invitrogen), so as to construct an expression vector comprising a neomycin resistance gene (pcDNA3.1-hEpCAM-*myc*/His).

[Example 5]

[Production of anti-hTROP-2 monoclonal antibody]

As immunogens, there were used cell lines capable of stably expressing hTROP-2 (HEK293-hTROP-2 cells, CHO-K1-hTROP-2 cells and 7E2-C-hTROP-2 cells); human pancreatic cancer cell line endogenously expressing an hTROP-2 protein on the cell surface (PK-59, RCB1901; purchased from RIKEN cell bank); and the recombinant protein of the extracellular region of hTROP-2 produced by the above-described method.

In the case of the cell lines capable of stably expressing hTROP-2, 1×10^7 cells were used, and in the case of the recombinant hTROP-2 protein, 20 μg of the protein was used. The cell lines or the recombinant protein was mixed with an adjuvant TiterMax Gold (Funakoshi Corporation) at a mixing ratio of 1 : 1, so as to prepare an emulsion. The emulsion was then injected into the two footpads or abdominal cavity of a mouse (C57/BL6, Balb/c) (initial immunization). When immunization was carried out by injection into the two footpads for a short period of time, booster was carried out three to ten days after the initial immunization. On the day following the final immunization, lymph nodes were collected from both knees, and lymphocytes were then prepared. When immunization was carried out by injection into the abdominal cavity for a long period of time, boosters were carried out at intervals of once a week after the initial immunization (wherein boosters were carried out for 1 to 2 months). Thereafter, B cells were isolated from the spleen according to an ordinary method. In the case of immunization using cells as immunogens, a cell suspension which was PBS containing 5×10^6 cells was used for boosters. In the case of using a protein as an immunogen, 5 μg of a PBS solution was used.

The prepared lymphocytes were mixed with a mouse myeloma cell line (P3-

X63-Ag8.653) at a mixing ratio of 3 : 1, and cell fusion was then carried out according to a polyethylene glycol method. Thereafter, the fused cells were cultured for 7 to 28 days in a methyl cellulose medium (trade name: ClonaCell-HY Cloning Medium D; Stem Cell), which contained HAT (hypoxanthine, aminopterin and thymidine). Single colonies of growing hybridomas were each picked up and placed on a 96-well flat-bottom plate, and using a liquid selective medium containing HAT, the hybridomas were cultured in a 5% CO_2 incubator. A culture supernatant of growing hybridomas from single colonies was subjected to a primary screening via Cell ELISA (described later) and then to a secondary screening via FACS analysis using HuH-7-hTROP-2 cells, PK-59, thereby establishing 300 types of hybridomas, which produce anti-hTROP-2 monoclonal antibodies recognizing hTROP-2 proteins expressed on the cell surface of living cells.

[Example 6]

[Primary screening using Cell ELISA]

CHO-K1 cells (hTROP-2 negative control; purchased from Japan Health Sciences Foundation) and CHO-K1-hTROP-2 cells (or HUH-7 cells (hTROP-2 negative control; purchased from Japan Health Sciences Foundation) and HuH-7-hTROP-2 cells) were alternately inoculated on a 96-well culture plate (BD Falcon) at a cell density of 3 $\times 10^4$ cells/well, and the cells were then cultured in a 5% CO^2 atmosphere at 37°C for 1 to 2 days. The cell culture medium was removed by decantation. Thereafter, the cells were washed with ice-cold PBS, and were then treated with 4% paraformaldehyde-PBS for 5 minutes, so that the cells were immobilized. The cells were washed with PBS which had been cooled on ice, and an ELISA plate was then prepared. Thereafter, ELISA was carried out according to an ordinary method. Specific procedures will be described below.

First, blocking with a 2% skim milk-PBS solution was carried out at room temperature for 30 minutes to 1 hour. Subsequently, the hybridoma culture supernatant was added thereto, and they were then reacted at room temperature for 1 hour. Thereafter, the resultant was washed with a 0.1% Tween20-PBS solution three times. As a secondary antibody, Horseradish peroxidase (HRP)-labeled anti-mouse IgG (GE Healthcare Biosciences), which had been 1000 times diluted with a blocking solution,

was added to the resultant, and they were then reacted at room temperature for 1 hour. Thereafter, the resultant was washed with a 0.1% Tween20-PBS solution three times. A TMB (3,3',5,5'-tetramethylbenzidine: SIGMA) substrate solution was added to the reaction solution to carry out a color reaction, and the reaction was then terminated by adding 1 M sulfuric acid. Thereafter, absorbance (405 nm) was measured using Microplate reader Model 550 (BIO RAD). Hybridomas corresponding to a hybridoma culture supernatant exhibiting a high absorbance value to the negative control were subjected to a large-scale culture on a 24-well flat-bottom plate, and were then subjected to a secondary screening using FACS analysis.

[Example 7]

[Secondary screening using FACS analysis]

Hybridomas, which were found positive in the above-described primary screening using Cell ELISA, were subjected to a secondary screening using FACS analysis. In the evaluation of Hybridoma cells, HuH-7 cells, which were human liver cancer cells which did not express hTROP-2, were used as negative control cells and the reactivity with HuH-7-hTROP-2 cells, which were stably expressing hTROP-2, was used as an indicator. Then, the evaluation was carried out based on the reactivity with PK-59 cells (RCB1901; purchased from RIKEN cell bank), which were human pancreatic cancer cells endogenously expressing an hTROP-2 protein on the cell surface.

The cells were removed from the culture dish by a trypsin treatment, and a cell suspension was then prepared (cell density: 2×10^6 cells/mL). The hybridoma culture supernatant, which exhibited positive in the primary screening using Cell ELISA, was reacted with 100 μL of the cell suspension at 4°C for 20 minutes. The reaction mixture was washed with PBS, and it was then reacted with PE-labeled mouse IgG (BD Pharmingen) (0.1 μg) (4°C, 30 minutes). Thereafter, the reaction mixture was analyzed using FACSCalibur (Becton, Dickinson and Company).

Eventually, approximately 300 types of hybridomas, which produce an anti-hTROP-2 monoclonal antibody recognizing an hTROP-2 protein expressed on the cell surface of living cells, were established.

[Example 8]

[Identification of isotype]

The isotype of the produced anti-hTROP-2 monoclonal antibody was identified using MOUSE MONOCLONAL ANTIBODY ISOTYPING TEST KIT (Serotec) in accordance with a method included with the above-mentioned kit.

[Example 9]

[Ascites formation and purification of TROP-2 antibody]

The hybridoma clones produced by the above-described method were administered at a density of 3×10^6 clones into the abdominal cavity of a BALB/c nude mouse, to which 2,6,10,14-tetramethylpentadecane (pristane) had previously (seven days before) been administered. Two weeks later, ascites was collected. Moreover, this ascites was subjected to caprylic acid precipitation, and then to affinity purification using a protein G column (HiTrap protein G; GE Healthcare Biosciences) or a protein A column (HiTrap protein A; GE Healthcare Biosciences), so as to obtain anti-hTROP-2 monoclonal antibodies from individual hybridoma clones.

[Example 10]

[Measurement of antigen binding affinity (measurement of Kd value)]

The antigen binding affinity (Kd value) of the generated anti-hTROP-2 monoclonal antibody was calculated by a method using ELISA (Djavadi-Ohaniance L. et al (1996), In Antibody Engineering, Chapter 4, pp. 77-97. IRL Press, Oxford).

Specifically, the purified recombinant hTROP-2 protein (0.1 μg/mL) was added to a 96-well culture plate (Corning) so that the antigen was solid-phased (at room temperature for 1 hour, or at 4°C overnight). Subsequently, the resultant was washed with PBS three times, and 2% skim milk (PBS solution) was then added thereto to block it (at room temperature for 1 hour). The resultant was washed with PBS twice. Thereafter, an antigen-antibody complex which had previously been formed by mixing an antigen solution (a purified hTROP-2 protein; 50, 25, 12.5, 6.25, or 3.125 nM) with each clone (0.5 nM) of the anti-hTROP-2 monoclonal antibody and then equilibrating the mixture, was added to the above-described ELISA plate, and they were reacted (at room temperature for 1 hour). The reaction product was washed with PBS three times, and it was then reacted with HRP-labeled anti-mouse IgG (final concentration: 1 μg/mL)

(GE Healthcare Biosciences) diluted with a blocking solution (at room temperature for 1 hour). Subsequently, the reaction product was washed with a 0.1% Tween20-PBS solution three times, and a TMB (3,3',5,5'-tetramethylbenzidine: SIGMA) substrate solution was then added to the resultant to carry out a color reaction. Then, 1 M sulfuric acid was added to the reaction product to terminate the reaction. Using Microplate reader Model 550 (BIO RAD), absorbance was measured.

The following calculation expressions were used to measure dissociation constant (Kd).

In accordance with the law of mass action, an antigen-antibody reaction is represented by the following expressions.

$$\text{Ag (Antigen)} + \text{Ab (Antibody)} \underset{k2}{\overset{k1}{\Leftrightarrow}} \text{Ag-Ab (Antigen-Antibody complex)} \quad \cdots\cdot(1)$$

$$Kd = k2/k1 = Agf \times Abf / Ag\text{-}Ab = Agf \times Abf / x \quad \cdots\cdots(2)$$

In the expression (2), Agf represents the concentration of a free antigen, Abf represents the concentration of a free antibody, and Ag-Ab represents the concentration of an antigen-antibody complex. If Ag-Ab = x, the free antibody concentration is represented by the following expression.

$$Abf = Abt - x \quad \cdots\cdots(3)$$

The above expression (2) therefore can be

$$Kd = Agf \times (Abt - x) / x \quad \cdots\cdots(4)$$

If both terms of the expression (4) are multiplied by x / Kd×Abt,

$$x / Abt = Agf \times (1 - x/Abt) \times 1/Kd$$
$$x/Abt \times 1/Agf = (1 - x/Abt) \times 1/Kd \quad \cdots\cdots(5)$$

If X = x/Abt and Y = x/Abt×Agf in the expression (5),

$$Y = (1-X)\times 1/Kd \quad \cdots\cdots\cdots (6)$$

Based on the expression (6), the Kd value was calculated.

The Kd values of the generated 300 anti-hTROP-2 monoclonal antibody clones were measured by the above-described method. As a result, there were 133 clones exhibiting a Kd value of 1×10^{-10} (M) or less, 59 clones exhibiting a Kd value of 1×10^{-11} (M) or less, and 2 clones exhibiting a Kd value of 1×10^{-12} (M) or less.

Among the anti-hTROP-2 monoclonal antibodies, which exhibited tumor growth inhibitory activity *in vivo*, the Kd values of 5-70 (mouse IgG2a), T6-16 (mouse IgG2a), K5-107 (mouse IgG1), K5-116-2-1 (mouse IgG1) and T5-86 (mouse IgG1) were found to be 6.8×10^{-12} (M), 4.3×10^{-12} (M), 4.7×10^{-12} (M), 2.69×10^{-11} (M) and 8.49×10^{-11} (M), respectively (Figure 1 and Table 1).

Table 1

Kd values of anti-hTROP-2 monoclonal antibodies

Clone No.	K5-70	T6-16	K5-107	K5-116-2-1	T5-86
Kd ($\times 10^{-12}$ M)	6.8	4.3	4.7	26.9	84.9

[Example 11]

[Reactivity of anti-hTROP-2 monoclonal antibodies with human cancer cell lines]

The human cancer cell lines (human tumor cell lines) used in this studies were acquired from Health Science Research Resources Bank (HSRRB), RIKEN cell bank (RIKEN), ATCC (American Type Culture Collection), ECACC (European Collection of Cell Cultures) and DSMZ (German Collection of Microorganisms and Cell Cultures). Specifically, the following cancer cell lines were used.

huH-1 (HSRRB), HUH-6 (HSRRB), HuH-7 (HSRRB), JHH-5 (HSRRB), JHH-6 (HSRRB), JHH-7(HSRRB), HLE (HSRRB), HLF (HSRRB), HepG2 (HSRRB),

Alexander (HSRRB), KP-1N (HSRRB), KP-1NL (HSRRB), KP-2 (HSRRB), KP-3 (HSRRB), KP-3L (HSRRB), PK-1 (RIKEN), PANC-1 (RIKEN), MIA PaCa-2 (HSRRB), PK-59 (RIKEN), PK-45H (RIKEN), PK-45P (RIKEN), BxPC-3 (ATCC), SUIT-2 (HSRRB), TCC-PAN2 (HSRRB), SW480 (ATCC), DLD-1 (HSRRB), LoVo (HSRRB), COLO-320 (RIKEN), CACO-2 (RIKEN), CW-2 (RIKEN), HCT 116 (ATCC), HCC-56 (HSRRB), MCF-7 (HSRRB), JIMT-1 (DSMZ), HCC1143 (ATCC), A549 (HSRRB), DU145 (RIKEN) and PC-3 (HSRRB).

Cancer cells were removed from a culture dish by a trypsin treatment, and a cell suspension was then prepared (cell density: 2×10^6 cells/mL). An anti-hTROP-2 monoclonal antibody (0.1 μg) was added to 100 μL of the cell suspension, and they were then reacted at 4°C for 20 minutes. The reaction solution was washed with PBS, and it was then reacted with PE-labeled anti-mouse IgG (BD Biosciences Pharmingen) (0.1 μg) (at 4 °C for 30 minutes). Thereafter, the resultant was analyzed by FACSCalibur (Becton, Dickinson and Company).

All of the generated anti-hTROP-2 antibodies did not bind to a human liver cancer cell line HuH-7, which did not endogenously express hTROP-2. On the other hand, the anti-hTROP-2 antibodies bound to HuH-7-hTROP-2 cells, in which an hTROP-2 gene was stably expressed (Figure 2). Subsequently, the reactivity of the generated anti-hTROP-2 monoclonal antibodies with human cancer cell lines (in which an hTROP-2 protein was endogenously expressed on the cell surface) was examined by FACS analysis. As a result, the generated 300 types of anti-hTROP-2 monoclonal antibodies all bound to human pancreatic cancer cell lines (PK-59 and BxPC-3). In particular, K5-70, T6-16, K5-107, K5-116-2-1 and T5-86 antibodies, which exhibited tumor growth inhibitory activity *in vivo*, all bound to human cancer cell lines at high levels. For example, when compared with a case in which cancer cell lines were reacted with only PE-labeled anti-mouse IgG (BD Biosciences Pharmingen), the aforementioned antibodies exhibited the following binding ability to PK-59 cells and to BxPC-3 cells at mean fluorescence intensity: K5-70 (44 times), T6-16 (59 times), K5-107 (89 times), K5-116-2-1 (122 times) and T5-86 (15 times) (to PK-59 cells; Figure 3); and K5-70 (45 times), T6-16 (25 times), K5-107 (90 times), K5-116-2-1 (121 times) and T5-86 (10 times) (to BxPC-3 cells; Figure 4).

With regard to human cancer cell lines other than PK-59 and BxPC-3, among 12

types of pancreatic cancer cell lines, the anti-hTROP-2 monoclonal antibodies bound to KP-2, KP-3L, PK-1, PK-45H, SUIT-2 and TCC-PAN2, and did not bind to KP-1N, KP-1NL, KP-3, PANC-1 and MIA-PaCa2 (Figure 5). Among human colon cancer cell lines, the anti-hTROP-2 monoclonal antibodies bound to CACO-2, SW480, DLD-1 and HCT 116, and did not bind to COLO-320 and CW-2 (Figure 6). Furthermore, the anti-hTROP-2 monoclonal antibodies bound to JIMT-1 and HCC1143 (which were both human breast cancer cell lines) and to PC-3 and DU145 (which were both human prostate cancer cell lines). Thus, they recognized hTROP-2 proteins endogenously expressing on the cell surface of many types of human cancer cell lines (Figure 6).

[Example 12]

[Cross-reactivity with mouse TROP-2 protein and human TROP-1/EpCAM protein]

For the purpose of examining the specificity of the generated anti-hTROP-2 monoclonal antibodies, the reactivity of the antibodies with a mouse TROP-2 protein showing homology of 80% at the amino acid sequence level with the hTROP-2 protein, and with a human TROP-1/EpCAM protein showing homology of 50% at the amino acid sequence level with the hTROP-2 protein, was examined by FACS analysis.

Specifically, each of an expression vector (mouse TROP-2-pcDNA3.1(+), furnished by the Institute of Molecular and Cellular Biosciences, the University of Tokyo) comprising the full-length cDNA of a mouse TROP-2 gene (GenBank accession No. NM_020047, Y08830), and an expression vector (pcDNA3.1-hEpCAM-*myc*/His) comprising the full-length cDNA of a human TROP-1/EpCAM gene (GenBank accession No. NM_002354), was transiently introduced into CHO-K1 cells, using Lipofectamine2000 reagent (Invitrogen). Thereafter, 24 to 48 hours later, the cells were removed from a culture dish by treating them with trypsin, and a cell suspension was then prepared. The thus prepared cell suspension was successively reacted with the produced anti-hTROP-2 monoclonal antibody (0.1 μg) and with PE-labeled anti-mouse IgG, and it was then analyzed by FACSCalibur.

A T2-102 antibody (mouse IgG1) used as a positive control, which showed cross-reactivity with mouse TROP-2, exhibited high binding ability to the CHO-K1 cells in which the mouse TROP-2 gene was transiently expressed. On the other hand, K5-70, T6-16, K5-107, K5-116-2-1 and T5-86 antibodies did not show such cross-reactivity

with mouse TROP-2 (Figure 7).

Similarly, an anti-human EpCAM monoclonal antibody (BD Biosciences Pharmingen) used as a positive control exhibited high binding ability to the CHO-K1 cells in which the human EpCAM/TROP-1 was transiently expressed. On the other hand, K5-70, T6-16, K5-107, K5-116-2-1 and T5-86 antibodies did not show such cross-reactivity with human EpCAM/TROP-1 (Figure 8).

The aforementioned results demonstrated that the generated anti-hTROP-2 monoclonal antibodies, and in particular, K5-70, T6-16, K5-107, K5-116-2-1 and T5-86 antibodies, which exhibited anti-tumor activity *in vivo*, specifically bound to hTROP-2.

[Example 13]

[Measurement of cell growth inhibitory activity]

As a method of examining the activity of the anti-hTROP-2 monoclonal antibody to inhibit the function of hTROP-2, the influence of the antibody on the cell growth of human cancer cells, which endogenously express hTROP-2 on the cell surface, was evaluated by measuring the number of living cells using TetraColor ONE (Seikagaku Corporation). Specifically, PK-59 cells were suspended in an RPMI1640 medium containing 0.5% fetal bovine serum (manufactured by BioWest) at a cell concentration of 2×10^5 cells/mL, and 100 μL of the prepared cell suspension was then added to each well of a 96-well culture plate. Subsequently, mouse IgG (negative control) and anti-hTROP-2 monoclonal antibodies (final concentrations: 0.1 and 1 μg/mL) were added to the wells, and the mixtures were then cultured at 37°C in a 5% CO_2 incubator for 72 hours. As a control, a commercially available anti-hTROP-2 monoclonal antibody (clone YY01, Santa Cruz) was used. TetraColor ONE (Seikagaku Corporation) was added to the wells, and they were then reacted in a 5% CO_2 incubator for 1 to 2 hours. After completion of the reaction, the 96-well culture plate was directly subjected to the measurement of absorbance at a wavelength of 490 nm (control wavelength: 655 nm), using Microplate Reader. The experiment was carried out using 3 wells for each group. A significant difference test was carried out according to Student's t-test, and $P < 0.05$ was determined to be statistically significant.

Among anti-hTROP-2 monoclonal antibodies, which had been generated by our own company so far, approximately 160 clones were examined by the above-described

method, in terms of their effect on the cell growth of PK-59 cells. As a result, T6-16, T5-86, K5-70 and K5-107, which had exhibited tumor growth inhibitory activity *in vivo*, were confirmed to have cell growth inhibitory activity of 20% to 40%, when compared with mouse IgG (negative control). It became clear that these anti-hTROP-2 antibodies have activity to bind to hTROP-2 proteins, which were expressed on the surface of human cancer cells, to neutralize the hTROP-2 proteins, and to inhibit the growth of the cancer cells (Figure 9).

[Example 14]

[Scratch assay]

The effect of an anti-hTROP-2 monoclonal antibody on the migratory ability of human cancer cells was evaluated by a scratch assay. PK-59 cells were suspended in an RPMI1640 medium containing 10% fetal bovine serum at a cell concentration of 3×10^5 cells/mL, and 100 μL of the prepared cell suspension was then added to each well of a 96-well culture plate. When the cells became confluent, a portion of the monolayer-cultured cells was peeled, such that the plate was scratched in a longitudinal direction with the end of a tip. An anti-hTROP-2 monoclonal antibody and mouse IgG used as a negative control were added to the medium to final concentrations of 0.1 and 1 μg/mL, respectively, and culture was then carried out for 24 hours. Before addition of the antibody (Day 0) and 24 hours after the culture (Day 1), the cell peeled region was photographed, and the distance between the cells was then measured. Moreover, the area of such a peeled region was quantified using Scion Image software. The experiment was carried out using 8 wells for each group. A significant difference test was carried out according to Student's t-test, and $P < 0.05$ was determined to be statistically significant.

The effect of an hTROP-2 antibody on the migratory ability of the cells invading the scratch region was examined. As with the cell growth inhibition assay, antibodies having beneficial effects were evaluated. As an evaluation method, the cells were photographed on Day 0 (when the antibody was added) and on Day 1 (24 hours after the addition of the antibody), and the migratory distance (μm) and the area of a scratch region were determined by image analysis. As a result, as shown in Figure 10, clear differences were observed in terms of the migratory ability of the cells. The

antibodies T6-16 and K5-70, which were used in the present test, had significant cell growth inhibitory activity, when compared with the control. Even in a reproducibility test, the same tendency was observed. Particularly, T6-16 had a result of $P < 0.01$ (by Student's t-test), and there was found correlation with the *in vivo* test.

[Example 15]

[Evaluation of beneficial effects of anti-hTROP-2 monoclonal antibody on tumor-bearing mice]

Prevention model

Pancreatic cancer cell lines (PK-59 and BxPC-3), which expressed hTROP-2, were removed by treating the cells with trypsin, and PBS was added to them to prepare a cell suspension having a concentration of 1×10^8 cells/mL. The thus prepared cell suspension was mixed with an equal amount of Matrigel (BD Biosciences Pharmingen) on ice. Using a 26 G syringe, 100 μL of the obtained mixture (5×10^6 cells) was injected into the subcutis of the right flank of each of 6-week-old female nude mouse (Balb/c, nu/nu). On the day of the transplantation of the cancer cells (Day 1), the mice were divided into groups, and administration of the antibody (1, 5 or 10 mg/kg body weight, intraperitoneal administration) was initiated. Thereafter, administration of the antibody was continued at intervals of once every three days. Anti-tumor activity was evaluated based on tumor formation frequency and tumor volume. The tumor volume was calculated by the following formula.

$$\text{Tumor volume } (mm^3) = (\text{minor axis})^2 \times (\text{major axis}) \times \pi/6$$

Treatment model

Pancreatic cancer cell lines (PK-59 and BxPC-3), which expressed hTROP-2, were removed by treating the cells with trypsin, and PBS was added to them to prepare a cell suspension having a concentration of 1×10^8 cells/mL. The thus prepared cell suspension was mixed with an equal amount of Matrigel (BD Biosciences Pharmingen) on ice. Using a 26 G syringe, 100 μL of the obtained mixture (5×10^6 cells) was injected into the subcutis of the right flank of each of 6-week-old female nude mouse (Balb/c, nu/nu). Five to six days after the transplantation of the cancer cells, mice whose tumor volume had increased to 50 to 150 mm^3 (mean value: approximately 100

mm^3) were divided into groups. The day on which the mice were divided into groups was defined as a first day (Day 1), and administration of the antibody was initiated. The antibody was intraperitoneally administered at intervals of once every three days (10 mg/kg body weight). Anti-tumor activity was evaluated by measuring tumor volume. A significant difference test was carried out according to Student's t-test, and $P < 0.05$ was determined to be statistically significant.

[Example 16]

[Analysis of *in vivo* anti-tumor activity of anti-hTROP-2 monoclonal antibody on human pancreatic cancer cell xenograft model]

It is essential for an antibody used for the treatment of cancer, which targets hTROP-2, to have the activity of specifically killing tumor tissues expressing hTROP-2 or inhibiting the growth of tumor.

Anti-hTROP-2 monoclonal antibodies (approximately 160 clones), which were newly produced in the present invention, were evaluated using the xenograft treatment models of a pancreatic cancer cell line PK-59. The PK-59 cells express, on the surface thereof, EpCAM (Figure 11A) acting as a pancreatic cancer stem cell marker (Chenwei Li, et al. Cancer Res 2007; 67: (3). 1030-1037), and also express P-glycoprotein/MDR1 (Figure 11B) and ABCG2/CDw338 (Figure 11C) (Chen, C. J. et al. Cell 47 (3), 381-389 (1986), Allikmets, R., et al. Hum. Mol. Genet. 5 (10), 1649-1655 (1996)), which are ABC transporters associated with drug resistance. In addition, the PK-59 cells contain a cell fraction (8.93%) (Figure 11D) positive for both CD24 and CD44, which is characteristic for pancreatic cancer stem cells, and they are assumed to be a highly malignant human pancreatic cancer cell line (Chenwei Li, et al. Cancer Res 2007; 67: (3). 1030-1037, Jane E. Visvader and Geoffrey J. Lindeman. Nat Rev Cancer. Vol. 8(10):755-68, 2008).

Most of the newly generated approximately 160 clones did not exhibit beneficial effects on the xenograft treatment models of PK-59 cells. Among such clones, clones exhibiting significant tumor growth inhibitory activity, namely clones K5-70, T6-16, K5-107, T5-86 and K5-116-2-1 could be obtained.

In a clone K5-70 (mouse IgG2a) administration group, tumor growth rate is statistically significantly inhibited. On the 21st day after initiation of the

administration (day 21), the tumor volume of a control group (N = 14) was 1200.8 ± 377.3 mm^3, whereas the tumor volume of the clone K5-70 administration group was 748.7 ± 162.9 mm^3 ($P < 0.01$ by Student's t-test) (Figure 12A). When the tumor volume at the time of initiation of the administration of the antibody was defined as 1.0, the tumor volume on the 21st day (Day 21) was 7.8 in the clone K5-70 administration group, whereas the tumor volume of the control group was 12.5 (Figure 12A). The weight of the tumor excised was 0.43 ± 0.14 g ($P < 0.01$ by Student's t-test) in the clone K5-70 administration group, whereas that of the control group was 0.73 ± 0.26 g. Thus, the clone K5-70 exhibited inhibitory activity of approximately 60% (Figure 12B).

Similarly, tumor growth rate was statistically significantly inhibited even in a clone K5-107 (mouse IgG1) administration group (N = 8), a clone T6-16 (mouse IgG2a) administration group (N = 8), a clone T5-86 (mouse IgG1) administration group and a clone K5-116-2-1 (mouse IgG2a) administration group (N = 8). On the 17th day after initiation of the administration (Day 17), the tumor volumes of the clone K5-107 administration group (N = 8) and the clone T6-16 administration group (N = 8) were 698.2 ± 175.9 mm^3 ($P < 0.05$ by Student's t-test) and 707.2 ± 254.5 mm^3 ($P < 0.05$ by Student's t-test), respectively, whereas the tumor volume of the control group was 1039.3 ± 271.6 mm^3. Likewise, on the 16th day after initiation of the administration (Day 16), the tumor volume of the clone K5-116-2-1 administration group (N = 8) was 508.5 ± 225.2 mm^3 ($P < 0.05$ by Student's t-test), whereas the tumor volume of the control group (N = 8) was 797.0 ± 172.9 mm^3 (Figure 13).

On the other hand, in the case of the clone T5-86, on the 15th day after initiation of the administration (Day 15), the tumor of the clone T5-86 administration group (N = 8) was 744.1 ± 289.1 mm^3, whereas the tumor volume of the control group (N = 8) was 1033.2 ± 319.4 mm^3. Thus, there was found no significant difference in terms of tumor volume. However, in the comparison of tumor weight, which was performed on the same day, the tumor weight of the clone T5-86 administration group was 0.44 ± 0.13 g ($P < 0.05$ by Student's t-test), whereas the tumor weight of the control group was 0.62 ± 0.14 g. Thus, the clone T5-86 exhibited significant inhibitory activity.

Moreover, in terms of both tumor volume and tumor weight, the ratio (T/C) of each clone antibody administration group to the control group on the final day of experiment is shown in Table 2 below. As shown in Table 2, each clone antibody

exhibited significant inhibitory activity (T/C = 62% to 72%) on each clone antibody administration group.

Table 2

Group	N (number of mice)	Tumor volume T/C (%)	Tumor weight T/C (%)
K5-70	14	62.3**	58.8**
K5-107	8	67.2*	65.0*
T6-16	8	68.0*	64.7*
T5-86	8	72.0	70.5*
K5-116-2-1	8	63.8*	60.5*

* $P < 0.05$, ** $P < 0.01$ (by Student's t-test)

Furthermore, the anti-tumor activity of each of the clones K5-70, T6-16 and K5-116-2-1 on the xenograft prevention models of the pancreatic cancer cell line PK-59 was analyzed. After completion of the administration of each antibody clone, tumor growth was inhibited in all individuals (N = 8). On the 18th day after initiation of the administration (Day 18), the tumor volume of the clone K5-70 administration group (10 mg/kg body weight) was 62.4 ± 80.4 mm^3 ($P < 0.01$ by Student's t-test), whereas the tumor volume of the control group (N = 8) was 880.8 ± 206.4 mm^3. Thus, the clone K5-70 exhibited tumor growth inhibitory activity of 92.9%. On the 28th day after initiation of the administration (Day 28), the tumor volume of the clone T6-16 administration group (10 mg/kg body weight) was 152.4 ± 122.3 mm^3 ($P < 0.01$ by Student's t-test), whereas the tumor volume of the control group (N = 8) was 992.3 ± 250.8 mm^3. Thus, the clone T6-16 exhibited tumor growth inhibitory activity of 84.6%. On the 20th day after initiation of the administration (Day 20), the tumor volume of the clone K5-116-2-1 administration group (10 mg/kg body weight) was 207.7 ± 319.2 mm^3 ($P < 0.01$ by Student's t-test), whereas the tumor volume of the control group (N = 8) was 1159.4 ± 413.3 mm^3. Thus, the clone K5-116-2-1 exhibited tumor growth inhibitory activity of 82.1% (Figure 14 and Table 3). Moreover, in all of the

experiments, there was no significant difference between the control group and each anti-hTROP-2 antibody administration group in terms of a change in mean body weight throughout the test period.

In terms of both tumor volume and tumor weight, the ratio (T/C) of each clone antibody administration group to the control group on the final day of experiment is shown in Table 3 below. As shown in Table 3, significant tumor growth inhibition was observed in each clone antibody administration group, and in particular, a significant effect such as T/C = 10% or less was confirmed in the clone K5-70 administration group.

Table 3

Group	N (number of mice)	Tumor volume T/C (%)	Tumor weight T/C (%)
K5-70	8	7.1**	5.8**
T6-16	8	15.3**	10.5**
K5-116-2-1	8	23.2**	21.5**

** P < 0.01 (by Student's t-test)

The known anti-TROP-2 antibody AR47A6.4.2 (U.S. Patent No. 7420041) has exhibited the effect of inhibiting tumor growth, at a dosage of 20 mg/kg, on xenograft prevention models using various human cancer cell lines. This anti-TROP-2 antibody AR47A6.4.2 has inhibited the tumor growth of a human pancreatic cancer cell line PL45 at a percentage of almost 100%. However, this antibody has had the effect of inhibiting tumor on a pancreatic cancer cell line BxPC-3 at a percentage of approximately 50%, on a prostate cancer cell line PC-3 at a percentage of approximately 40%, on a breast cancer cell line MCF-7 at a percentage of approximately 60%, and on a colon cancer cell line Colo205 at a percentage of approximately 40%. In contrast, the anti-hTROP-2 antibody of the invention of the present application has exhibited a higher tumor growth inhibitory effect at a dosage of half the aforementioned dose (10 mg/kg).

[Example 17]

[Analysis of anti-tumor activity on xenograft models (prevention models and treatment models) of human pancreatic cancer cell line BxPC-3]

As in the case of using the above-described xenograft treatment models of the human pancreatic cancer cell line PK-59, the anti-tumor activity of the clone K5-70 on xenograft prevention models and xenograft treatment models of a human pancreatic cancer cell line BxPC-3 was analyzed.

When compared with a control group (N = 8), the tumor growth of the clone K-70 administration group was significantly inhibited. On the 52nd day (Day 52), the tumor volume of the clone K5-70 administration group (N = 8) was 236.0 ± 136.4 mm^3, whereas the tumor volume of the control group (N = 8) was 616.3 ± 266.8 mm^3. Thus, the clone K-70 exhibited a tumor growth inhibitory effect of 61.7% ($P < 0.01$ by Student's t-test) (Figure 15).

From the aforementioned results, it became clear that the anti-hTROP-2 monoclonal antibody exhibits significant tumor growth inhibitory activity *in vivo* on at least two cancer cell species.

[Example 18]

[Dose-dependent anti-tumor activity of anti-hTROP-2 antibody (clone K5-70) on xenograft prevention models of hTROP-2-expressing pancreatic cancer cell line (PK-59 cells)]

For the purpose of analyzing more in detail the tumor growth inhibitory activity *in vivo* of the anti-hTROP-2 antibody, a dose-dependent test was carried out. As shown in Figure 16, the tumor growth of PK-59 cells was dose-dependently inhibited by administration of K5-70. On the 21st day after administration of the antibody (Day 21), the tumor volume of the control group (N = 7) was 937.8 ± 295.3 mm^3. On the other hand, the tumor volume of the K5-70 (1 mg/kg) administration group (N = 8) was 493.5 ± 305.1 mm^3, showing an inhibitory rate of 50%, and the tumor volume of the K5-70 (5 mg/kg) administration group (N = 8) was 124.7 ± 89.0 mm^3, showing an inhibitory rate of 90%. Thus, it became clear that, when compared with the known anti-TROP-2 antibody AR47A6.4.2 (U.S. Patent No. 7420041), the anti-hTROP-2 antibody of the present invention exhibits *in vivo* a tumor growth inhibitory effect equivalent to that of the anti-TROP-2 antibody AR47A6.4.2 at a dosage of one-twentieth the anti-TROP-2

antibody AR47A6.4.2, and that it exhibits a higher inhibitory effect of 90% at a dosage of one-fourth thereof.

[Example 19]

[Epitope assay]

Preparation of human/mouse chimeric TROP-2 protein

A human/mouse TROP-2 gene was prepared according to a PCR method. PCR primers as shown below were designed based on a human TROP-2 gene sequence and a mouse TROP-2 gene sequence (Genbank accession No. NM_020047).

Human/mouse TROP-2-C primers

Y606 (forward side): 5'-cctgagcctacgctgcgacgaagtggtgcg-3' (SEQ ID NO: 10)

Y607 (reverse side): 5'-cgcaccacttcgtcgcagcgtaggctcagg-3' (SEQ ID NO: 11)

Human/mouse TROP-2-A primers

Y612 (forward side): 5'-gactgctccacgctgacttccaagtgcctg-3' (SEQ ID NO: 12)

Y613 (reverse side): 5'-caggcacttggaagtcagcgtggagcagtc-3' SEQ ID NO: 13)

Human/mouse TROP-2-B primers

Y614 (forward side): 5'-ctcgtggacaacgatggcctctacgacccg-3' (SEQ ID NO: 14)

Y615 (reverse side): 5'-cgggtcgtagaggccatcgttgtccacgag-3' (SEQ ID NO: 15)

Mouse/human TROP-2-D primers

Y608 (forward side): 5'-ccaaagcctgcgctgcgatgagctggtgcgc-3' (SEQ ID NO: 16)

Y609 (reverse side): 5'-gcgcaccagctcatcgcagcgcaggctttgg-3' (SEQ ID NO: 17)

Mouse/human TROP-2-E primers

Y616 (forward side): 5'-agcttcctatccgcggtgcactacgagcag-3' (SEQ ID NO: 18)

Y617 (reverse side): 5'-ctgctcgtagtgcaccgcggataggaagct-3' (SEQ ID NO: 19)

Mouse/human TROP-2-F primers

Y618 (forward side): 5'-gacattaaaggcgagtctctattccagggc-3' (SEQ ID NO: 20)

Y619 (reverse side): 5'-gccctggaatagagactcgcctttaatgtc-3' (SEQ ID NO: 21)

Mouse TROP-2 primers

Forward primer: 5-ctactccaccccaccctggcg-3' (SEQ ID NO: 22)

Reverse primer: 5'-ctcgagcaagctaggttcgcttctc-3' (SEQ ID NO: 23)

To the mouse TROP-2 reverse primer, a *Xho*I restriction enzyme-digested sequence except for a stop codon was added. A schematic view of the prepared human/mouse chimeric TROP-2 proteins is shown in Figure 17.

The hmTROP-2-A chimeric protein is a chimeric protein, which consists of a polypeptide ranging from the N-terminus to the amino acid at position 69 of the hTROP-2 protein and a polypeptide ranging from the amino acid at position 64 to the C-terminus of the mouse TROP-2 protein. The hmTROP-2-B chimeric protein is a chimeric protein, which consists of a polypeptide ranging from the N-terminus to the amino acid at position 101 of the hTROP-2 protein and a polypeptide ranging from the amino acid at position 96 to the C-terminus of the mouse TROP-2 protein. The hmTROP-2-C chimeric protein is a chimeric protein, which consists of a polypeptide ranging from the N-terminus to the amino acid at position 145 of the hTROP-2 protein and a polypeptide ranging from the amino acid at position 140 to the C-terminus of the mouse TROP-2 protein. The mhTROP-2-D chimeric protein is a chimeric protein, which consists of a polypeptide ranging from the N-terminus to the amino acid at position 139 of the mouse TROP-2 protein and a polypeptide ranging from the amino acid at position 146 to the C-terminus of the hTROP-2 protein. The mhTROP-2-E chimeric protein is a chimeric protein, which consists of a polypeptide ranging from the N-terminus to the amino acid at position 187 of the mouse TROP-2 protein and a polypeptide ranging from the amino acid at position 194 to the C-terminus of the hTROP-2 protein. The mhTROP-2-F chimeric protein is a chimeric protein, which consists of a polypeptide ranging from the N-terminus to the amino acid at position 227 of the mouse TROP-2 protein and a polypeptide ranging from the amino acid at position 234 to the C-terminus of the hTROP-2 protein.

Expression vectors used in the preparation of the above-described chimeric proteins were specifically constructed by the following methods. In order to prepare an

hmTROP-2-A chimeric gene, the hTROP-2 gene was used as a template, and PCR was carried out using the hTROP-2 forward primer and the human/mouse TROP-2-A primer Y613. Likewise, the mouse TROP-2 gene was used as a template, and PCR was carried out using the human/mouse TROP-2-A primer Y612 and the mouse TROP-2 reverse primer. A DNA fragment amplified by the PCR was developed using acrylamide gel, and a band of interest was then recovered by extraction. Subsequently, the extracted two types of DNA fragments were mixed to prepare a template, and PCR was then carried out using the hTROP-2 forward primer and the mouse TROP-2 reverse primer. A PCR product was developed by agarose gel electrophoresis, and a DNA fragment of interest was then extracted. The extracted DNA fragment was cloned into a pCR (registered trademark)-Blunt vector (Invitrogen) (pCRB-hmTROP-2-A), and a gene sequence was then confirmed. An expression vector for animal cells was produced by removing the hTROP-2 gene from pcDNA3.1-hTROP-2-*myc*/His by *Eco*RI/*Xho*I digestion, and then inserting therein an *Eco*RI/*Xho*I fragment containing an hmTROP-2-A chimeric gene prepared from pCRB-hmTROP-2-A (pcDNA3.1-hmTROP-2-A-*myc*/His). Additionally, the following chimeric genes were prepared by the same method as described above, and expression vectors were constructed: hmTROP-2-B (using a human TROP-2 forward primer, a human/mouse TROP-2-B primer Y615, a human/mouse TROP-2-B primer Y614 and a mouse TROP-2 reverse primer), hmTROP-2-C (using a human TROP-2 forward primer, a human/mouse TROP-2-C primer Y607, a human/mouse TROP-2-C primer Y606 and a mouse TROP-2 reverse primer), mhTROP-2-D (using a mouse TROP-2 forward primer, a mouse/human TROP-2-D primer Y609, a mouse/human TROP-2-D primer Y608 and a human TROP-2 reverse primer), mhTROP-2-E (using a mouse TROP-2 forward primer, a mouse/human TROP-2-E primer Y617, a mouse/human TROP-2-E primer Y616 and a human TROP-2 reverse primer), mhTROP-2-F (using a mouse TROP-2 forward primer, a mouse/human TROP-2-F primer Y619, a mouse/human TROP-2-F primer Y618 and a human TROP-2 reverse primer) (pcDNA3.1-hmTROP-2-B-*myc*/His, pcDNA3.1-hmTROP-2-C-*myc*/His, pcDNA3.1-mhTROP-2-D-*myc*/His, pcDNA3.1-mhTROP-2-E-*myc*/His, and pcDNA3.1-mhTROP-2-F-*myc*/His).

Establishment of HEK293 cell lines, which constitutively express hTROP-2,

human/mouse TROP-2-C and mouse/human TROP-2-D chimeric proteins

The above-described expression vectors pcDNA3.1-hTROP-2-*myc*/His, pcDNA3.1-hmTROP-2-C-*myc*/His and pcDNA3.1-mhTROP-2-D-*myc*/His were each introduced into HEK293 cells. Selection was carried out using an antibiotic G418 (Calbiochem), and HEK293 cell lines constitutively expressing the hTROP-2 protein, the hmTROP-2-C chimeric protein and the mhTROP-2-D chimeric protein were established.

The binding regions of the anti-hTROP-2 monoclonal antibodies K5-70, T5-86, K5-107, T6-4, T6-16 and K5-116-2-1, which had exhibited beneficial effects on the xenograft treatment models of the pancreatic cancer cell line PK-59, were identified. First, the reactivity of the anti-hTROP-2 monoclonal antibodies exhibiting beneficial effects with HEK293 cells, which constantly express the chimeric proteins hmTROP-2-C and mhTROP-2-D, was examined by FACS analysis (Figure 18). As a result, it was found that K5-70, K5-107, T5-86 and K5-116-2-1 reacted with hmTROP-2-C, but that these antibodies did not react with mhTROP-2-D. On the other hand, T6-4 and T6-16 reacted with mhTROP-2-D, but they did not react with hmTROP-2-C. From these results, the binding region of each of K5-70, K5-107, T5-84 and K5-116-2-1 was limited to a region ranging from the N-terminus to the amino acid at position 145 of hTROP-2, and the binding region of each of T6-4 and T6-16 was limited to a region ranging from the amino acid at position 146 to the amino acid at position 274 of hTROP-2 (Figure 18).

In order to analyze the binding regions more in detail, vectors used in the expression of hmTROP-2-A, hmTROP-2-B, mhTROP-2-E and mhTROP-2-F chimeric proteins were prepared, and the reactivity of the chimeric proteins with the anti-hTROP-2 monoclonal antibodies exhibiting beneficial effects was analyzed (Figure 19). The newly prepared expression vectors, which were to be used in the expression of the chimeric proteins, were each introduced into HEK293 cells, and FACS analysis was then carried out, using the cells which transiently expressed the chimeric proteins. K5-70, K5-107, T5-86 and K5-116-2-1 reacted with hmTROP-2-A, but did not react with mhTROP-2-B. The examined 6 types of monoclonal antibodies all reacted with hTROP-2. These results clearly showed that the binding region of K5-70, K5-107, T5-86 and K5-116-2-1 is present in a region ranging from the N-terminus to the amino acid at position 69 of hTROP-2. Moreover, T6-4 and T6-16 reacted with neither mhTROP-

2-E nor mhTROP-2-F. This suggested that these antibodies recognize a region ranging from the amino acid at position 146 to the amino acid at position 193 of hTROP-2.

[Example 20]

[Immunohistochemistry]

<Materials/Method>

The following normal and cancer tissue arrays were used in immunohistostaining.

Human normal tissue arrays:

Human, normal organs in duplicates (Catalog No.: AB1, Super Bio Chips)

Normal tissues more than single spots (Catalog No.: A103(VI), ISU ABXIS)

Lung cancer tissue arrays:

Human lung cancer-metastasis-normal (Catalog No.: CCA3, Super Bio Chips)

Human lung carcinoma tissue with margin tissue, 2 location cores (Catalog No.: OD-CT-RsLug03-002, Shanghai Outdo Biotech)

Pancreatic cancer tissue array:

Human pancreas carcinoma tissue with mono-pathological type from 60 cases, 2 location cores (Catalog No.: OD-CT-DgPan03-001, Shanghai Outdo Biotech)

Liver cancer tissue arrays:

Hepatocellular carcinoma, grades I to III with normal tissue controls, 63 cases tissue arrays (Catalog No.: CS03-01-002U, Cybrdi)

Human liver carcinoma tissue with mono-pathological type from 30 cases, 2 location cores (Catalog No.: OD-CT-DgLiv02-002, Shanghai Outdo Biotech)

Colon cancer tissue arrays:

Human, colorectal cancer (Catalog No.: CD3, Super Bio Chips)

Human colon carcinoma with margin tissue, 2 location cores (Catalog No.: OD-CT-DgCol03-002, Shanghai Outdo Biotech)

Colon cancer lymph node metastasis and liver metastasis tissue arrays:

Colorectal (colon and rectum) cancer with matched lymph node metastasis tissue array, 44 cases/99 cores, trial slide (Catalog No.: CO991t, Biomax us)

Colorectal (colon and rectum) cancer with matched lymph node metastasis and

normal adjacent tissue array, 43 cases/99 cores (Catalog No.: CO992, Biomax us)

Colon cancer tissues_liver metastasis (Catalog No.: A203(IV), ISU ABXIS)

Breast cancer tissue arrays:

Human, breast cancer-metastasis-normal (Catalog No.: CBA3, Super Bio Chips)

Human breast carcinoma with margin tissue, 2 location cores (Catalog No.: OD-CT-RpBre03-002, Shanghai Outdo Biotech)

Stomach cancer tissue arrays:

Human, stomach cancer (Catalog No.: CQ1, Super Bio Chips)

Human gastric carcinoma with margin tissue, 2 location cores (Catalog No.: OD-CT-DgStm03-002, Shanghai Outdo Biotech)

Esophagus cancer tissue array:

Human, esophagus cancer (Catalog No.: CR1, Super Bio Chips)

Human esophagus carcinoma with margin tissue, 2 location cores (Catalog No.: OD-CT-DgEso03-002, Shanghai Outdo Biotech)

Ovary cancer tissue array:

Human, ovary cancer (Catalog No.: CJ1, Super Bio Chips)

Prostate cancer tissue array:

Human, prostate cancer-normal (Catalog No.: CA3, Super Bio Chips)

Bladder cancer tissue array:

Bladder carcinoma / transitional cell carcinoma, grades I to III with normal tissue arrays (Catalog No.: CC12-01-001U, Cybrdi)

Patient information and clinical information regarding the above-described tissue arrays were obtained from data sheets attached herewith and the homepages of individual companies.

Immunohistostaining method

After completion of a deparaffinization treatment, the tissue array slides of human normal tissues and cancer tissues were subjected to a protease treatment with pepsin at 37°C for 5 minutes. Thereafter, the sections were used in immunostaining using an anti-hTROP-2 monoclonal antibody. A color reaction was carried out using DAB(3,3'-diaminobenzidine) as a substrate, and as a counter staining, nuclear staining

was then carried out using hematoxylin.

More specifically, these operations were carried out as follows. A paraffin-embedded section was subjected to a deparaffinization treatment, and was then subjected to a protease treatment with pepsin (DAKO) at 37°C for 5 minutes. After activation of the antigen, the section was treated at room temperature for 20 minutes using a solution prepared by adding a hydrogen peroxide solution to methanol to a final concentration of 0.3%, so that endogenous peroxidase activity was eliminated. The resultant was washed with PBS at room temperature for 5 minutes twice, and it was then blocked at room temperature for 30 minutes using a PBS solution containing 1.5% normal horse serum (DAKO), so as to carry out an operation to block non-specific binding in the tissues. Subsequently, the resultant was reacted with anti-hTROP-2 monoclonal antibody clone K5-63-17 (final concentration: 10 μg/ml), which had been diluted with a PBS solution containing 1.5% normal horse serum, at room temperature for 1 hour, and was then washed with PBS at room temperature for 5 minutes three times. Thereafter, a biotinylated anti-mouse IgG antibody (Vector), which had been 200 times diluted with a PBS solution containing 1.5% normal horse serum, was reacted at room temperature for 30 minutes. The reaction product was washed with PBS at room temperature for 5 minutes three times, and a reagent of Vectastain ABC kit (Vector) was mixed in accordance with the instruction manual included therewith, so as to prepare an ABC complex. This ABC complex was reacted at room temperature for 30 minutes. The reaction product was washed with PBS at room temperature for 5 minutes three times, and color development was then carried out using Histofine Peroxidase Substrate Simple Stain DAB solution (Nichirei Biosciences). After completion of the color development, the reaction product was washed with deionized water for 5 minutes, and the nucleus was stained with Mayer's hematoxylin solution (Wako Pure Chemical Industries, Ltd.). Thereafter, dehydration was carried out with alcohol, followed by penetration with xylene and mounting in Entellan New (Merck Japan).

<Results>

Expression of hTROP-2 in human normal tissues

The expression pattern of hTROP-2 in human normal tissues was analyzed using the anti-hTROP-2 monoclonal antibody clone K5-63-17. A human normal tissue array

(Catalog No.: AB1, Super Bio Chips) was deparaffinized, and was then subjected to a hydrophilic treatment. Thereafter, the antigen was activated with a protease, pepsin, and immunostaining was then carried out using the anti-hTROP-2 monoclonal antibody clone K5-63-17 (Figure 20). As a result, staining was observed in the skin, esophagus, kidney (cortex and medulla), pancreas, prostate, bladder and tonsil. A majority of stained images localized in the cell membrane (Figure 20A, B, C, D, F, G and H), but hTROP-2 expression was partially observed even in the cytoplasm (Figure 20E and H). On the other hand, such staining was not observed in the heart, liver, stomach, small intestine, large intestine, skeletal muscle, lung, spleen, thymus gland and the like (Figure 20I and J).

Expression of hTROP-2 in human cancer tissues

In order to examine the expression of hTROP-2 (hTROP-2-positive rate) in human cancer tissues, the cancer tissue arrays of various human cancer species were immunostained using the anti-hTROP-2 monoclonal antibody clone K5-63-17. A tissue section, in which 10% or more of cancer cells were stained, was defined as hTROP-2-positive. The staining results are shown in Table 4.

Table 4

Cancer tissues	number of TROP-2-positive cases / total number of cases	TROP-2-positive rate (%)
Breast cancer	32/80	40
Lung cancer	53/81	65.4
Esophagus cancer	69/90	76.7
Stomach cancer	25/90	27.8
Colon cancer	29/178	16.3
Pancreatic cancer	26/62	41.9
Liver cancer	7/92	7.61
Bladder cancer	42/59	71.2
Prostate cancer	35/38	92.1
Ovary cancer	14/58	24.1

Representative stained images are shown in Figure 21. Among cancer species, regarding which the expression of hTROP-2 had been analyzed, prostate cancer had the

highest positive rate (92.1%), and also, lung cancer (65.4%), esophagus cancer (76.7%), bladder cancer (71.2%) and the like had high positive rates. Liver cancer had the lowest positive rate (7.61%). It was observed from stained images that, as with in normal cells, hTROP-2 was highly localized in the cell membrane even in the case of cancer cells (Figure 21 A to F, H and I). In addition, hTROP-2 was also localized in the cytoplasm in some cases (Figure 21A, B, E and G).

The hTROP-2-positive rate in pancreatic cancer was 41.9%. The relationship between this hTROP-2-positive rate and the grade (degree of differentiation) of pancreatic cancer was analyzed. As a result, hTROP-2 was expressed at high frequency in pancreatic cancer with a high grade, namely, with a low degree of differentiation (Table 5).

Table 5

Pancreatic cancer hTROP-2-positive spots 26/62 (41.94%)

Grade	-	+	Positive rate	
I	8	0	0%	
I - II	5	0	0%	
II	19	21	52.5%	
II - III	4	5	55.6%	p<0.01
total	36	26		

[Example 21]

[Anti-tumor activity of K5-70 antibody by single administration on xenograft prevention models of human pancreatic cancer cell line PK-59]

Strong anti-tumor activity *in vivo* of a clone K5-70 (mouse IgG2a) was exhibited even by a single administration of K5-70 at a dosage of 10 mg/kg body weight to xenograft prevention models using a human pancreatic cancer cell line PK-59. In a control group (mouse IgG, 10 mg/kg body weight, N = 3), tumor formation was observed in all of the individuals, and the tumor volume on the 28th day after cell transplantation (Day 28) was 781.7 ± 74.5 mm^3. On the other hand, in a group in which K5-70 was administered only once on the day of transplantation of the cancer cells (Day 1) (10 mg/kg body weight, N = 3), the tumor volume on Day 28 was 144.4 ± 176.9 mm^3 ($P < 0.05$ by Student's t-test), showing tumor growth inhibitory activity of

81.5% (Figure 22A). With regard to tumor weight, the tumor weight of the control group on Day 28 was 0.59 ± 0.06 g. In contrast, the tumor weight of the clone K5-70 administration group was 0.07 ± 0.10 g ($P < 0.01$ by Student's t-test), showing an inhibitory activity of 88% (Figure 22B). With regard to both tumor volume and tumor weight, tumor formation was completely inhibited in 2 out of 3 individuals in the K5-70 administration group at a dosage of 10 mg/kg body weight per administration (Figure 22C).

[Example 22]

[Anti-tumor activity of anti-human TROP-2 monoclonal antibody on xenograft treatment models of human colon cancer cell line SW480]

The anti-tumor activity of each of anti-human TROP-2 monoclonal antibodies (clones K5-70, K5-116-2-1, and T6-16) was examined with xenograft treatment models using a human colon cancer cell line SW480. SW480 cells (5×10^6 cells) were subcutaneously transplanted into the right flank of each of 6-week-old female NOD-scid mouse (Day 1). When the mean tumor volume reached 100 mm^3, grouping was carried out (Day 7 or Day 10). From Day 7 or Day 10, intraperitoneal administration of the antibody was carried out at administration intervals of once every three days. The anti-tumor activity of clone K5-70 and the anti-tumor activities of clones K5-116-2-1 and T6-16 were evaluated by independent studies, separately. In the study of evaluating the anti-tumor activity of K5-70, the tumor volume of a control group (mouse IgG (10 mg/kg body weight), N = 8) on the 44^{th} day after cancer cell transplantation (Day 44) was 365.4 ± 214.6 mm^3. On the other hand, the tumor volume of a K5-70 (10 mg/kg body weight) administration group was 27.4 ± 29.4 mm^3 ($P < 0.01$ by Student's t-test), and thus, tumor formation was significantly inhibited in the K5-70 administration group (inhibitory rate: 92.5%) (Figure 23A). With regard to tumor weight, the tumor weight of the control group was 0.11 ± 0.07 g, whereas the tumor weight of the K5-70 administration group was 0.005 ± 0.007 (g) ($P < 0.01$ by Student's t-test), showing an inhibitory rate of 95.5% (Figure 23B). In particular, in two out of the eight individual mice in the K5-70 administration group, tumor formation was completely inhibited, and the presence of tumor could not be confirmed.

In the study of evaluating the anti-tumor activities of K5-116-2-1 and T6-16,

which was carried out separately, the tumor volume of the control group on Day 42 was 713.8 ± 354.5 mm^3 (N = 8). In contrast, the tumor volume of the K5-116-2-1 administration group (10 mg/kg body weight) was 188.9 ± 97.4 mm^3 (N = 8, P < 0.01 by Student's t-test) (Figure 24A), and the tumor volume of the T6-16 administration group (10 mg/kg body weight) was 292.8 ± 199.7 mm^3 (N = 8, P < 0.01 by Student's t-test) (Figure 25A). Thus, the two above administration groups showed inhibitory rates of 73.5% and 59.0%, respectively. With regard to tumor weight as well, the tumor weight of the control group was 0.39 ± 0.19 g. In contrast, the tumor weight of the K5-116-2-1 administration group was 0.10 ± 0.07 g (P < 0.01 by Student's t-test), and the tumor weight of the T6-16 administration group was 0.17 ± 0.14 g (P < 0.05 by Student's t-test). Thus, the two above administration groups showed inhibitory rates of 72.2% and 56.4%, respectively (Figure 24B and Figure 25B).

[Example 23]

[Dose-dependent anti-tumor activity of clone K5-70 on xenograft treatment models using human colon cancer cell line SW480]

Subsequently, the dose-dependent anti-tumor activity of clone K5-70 (mouse IgG2a) was examined with xenograft treatment models using a human colon cancer cell line SW480. SW480 cells (5×10^6 cells) were subcutaneously transplanted into the right flank of each of 6-week-old female NOD-scid mouse. Ten days after the transplantation (Day 10) at which the mean tumor volume reached 100 mm^3, the mice were divided into a control group (mouse IgG, 10 mg/kg body weight administration group, N = 8, 104.4 ± 17.6 mm^3), a K5-70 (1 mg/kg body weight) administration group (N = 8, 104.3 ± 16.1 mm^3), a K5-70 (5 mg/kg body weight) administration group (N = 8, 104.6 ± 15.9 mm^3), and a K5-70 (10 mg/kg body weight) administration group (N = 8, 104.8 ± 14.9 mm^3). Then, intraperitoneal administration was carried out at administration intervals of once every three days. On Day 42, the tumor volume of the control group was 713.8 ± 354.5 mm^3. On the other hand, in the K5-70 administration groups, dose-dependent tumor formation inhibitory activity was observed. That is, the tumor volume of the 1 mg/kg body weight administration group was 485.0 ± 207.3 mm^3 (inhibitory rate: 32.1%), the tumor volume of the 5 mg/kg body weight administration group was 339.5 ± 253.2 mm^3 (inhibitory rate: 52.4%), and the tumor volume of the 10

mg/kg body weight administration group was 355.4 ± 202.8 mm^3 (inhibitory rate: 50.2 %, $P < 0.05$ by Student's t-test) (Figure 26A). Likewise, with regard to tumor weight on Day 42, the tumor weight of the control group was 0.39 ± 0.19 g. On the other hand, the tumor weight of the K5-70 (1 mg/kg body weight) administration group was 0.24 ± 0.11 g (inhibitory rate: 37.8%), the tumor weight of the 5 mg/kg body weight administration group was 0.17 ± 0.14 g (inhibitory rate: 55.8%, $P < 0.05$ by Student's t-test), and the tumor weight of the 10 mg/kg body weight administration group was 0.20 ± 0.13 g (inhibitory rate: 47.1 %). Thus, dose-dependent anti-tumor activity was confirmed (Figure 26B).

[Example 24]

[Analysis of administration intervals of clone K5-70 to xenograft treatment models using human colon cancer cell line SW480]

Subsequently, in order to analyze optimal administration intervals of clone K5-70 (mouse IgG2a), the anti-tumor activity of the clone K5-70 when it was administered once a week (once every 7 days) was examined with xenograft treatment models using a human colon cancer cell line SW480. SW480 cells (5×10^6 cells) were subcutaneously transplanted into the right flank of each of 6-week-old female NOD-scid mouse. Ten days after the transplantation (Day 10) at which the mean tumor volume reached 100 mm^3, the mice were divided into a control group (mouse IgG, 10 mg/kg body weight administration group, N = 8, 104.4 ± 17.6 mm^3) and a K5-70 (10 mg/kg body weight, once a week) administration group (N = 8, 104.3 ± 16.1 mm^3). Then, intraperitoneal administration was carried out once every 7 days. On Day 42, the tumor volume of the control group was 713.8 ± 354.5 mm^3, whereas the tumor volume of the K5-70 administration group (once a week) was 323.3 ± 239.9 mm^3 (inhibitory rate: 55%, $P < 0.05$ by Student's t-test) (Figure 27A). Moreover, when the administration interval was increased to once every 10 days and to once every two weeks, the tumor volume of the control group on Day 39 was 956.9 ± 367.8 mm^3. On the other hand, the tumor volume of the K5-70 administration group (administered once every 10 days) on Day 39 was 525.4 ± 180.6 mm^3 (inhibitory rate: 45.1%, $P < 0.01$ by Student's t-test), and the tumor volume of the K5-70 administration group (administered once every 14 days) was 459.4 ± 217.6 mm^3 (inhibitory rate: 52.0%, $P < 0.01$ by Student's t-test) (Figure 27B). In the

prior arts (US 7420040 and US 7420041), when antibodies were administered to xenograft treatment models using a pancreatic cancer cell line (BxPC-3) at a dosage of 20 mg/kg body weight, three times a week (at administration intervals of 2 days), the antibodies exhibited anti-tumor activity at an inhibitory rate of 50% to 60%. In contrast, the K-70 antibody exhibited anti-tumor activity equivalent to those of the prior arts, at a dosage of half of the prior arts (10 mg/kg body weight), once every 2 weeks (at administration intervals of 12 days). If taking into consideration a single dosage and administration intervals, it became clear that the K5-70 antibody exhibited significant anti-tumor activity at a total dosage of at least one twelfth of those of the prior-arts.

[Example 25]

[Dose-dependent anti-tumor activity of clone T6-16 on xenograft treatment models using human colon cancer cell line SW480]

Subsequently, the dose-dependent anti-tumor activity of clone T6-16 (mouse IgG2a) was examined with xenograft treatment models using a human colon cancer cell line SW480. SW480 cells (5×10^6 cells) were subcutaneously transplanted into the right flank of each of 6-week-old female NOD-scid mice. Ten days after the transplantation (Day 10) at which the mean tumor volume reached 100 mm^3, the mice were divided into a control group (mouse IgG, 10 mg/kg body weight administration group, N = 8, 105.8 ± 9.9mm^3), a T6-16 (1 mg/kg body weight) administration group (N = 8, 104.4 ± 13.3 mm^3), a T6-16 (5 mg/kg body weight) administration group (N = 8, 104.7 ± 13.0 mm^3), and a T6-16 (10 mg/kg body weight) administration group (N = 8, 104.8 ± 12.4 mm^3). Then, intraperitoneal administration was carried out at administration intervals of once every three days. On Day 43, the tumor volume of the control group was 473.5 ± 137.0 mm^3. On the other hand, in the T6-16 administration groups, dose-dependent tumor formation inhibitory activity was observed. That is, the tumor volume of the 1 mg/kg body weight administration group was 397.9 ± 97.5 mm^3 (inhibitory rate: 16.0%), the tumor volume of the 5 mg/kg body weight administration group was 195.9 ± 89.7 mm^3 (inhibitory rate: 58.7 %, $P < 0.01$ by Student's t-test), and the tumor volume of the 10 mg/kg body weight administration group was 190.2 ± 56.5 mm^3 (inhibitory rate: 59.8 %, $P < 0.01$ by Student's t-test) (Figure 28A). Likewise, with regard to tumor weight on Day 43, the tumor weight of the control group was 0.19

± 0.07 g. On the other hand, the tumor weight of the T6-16 (1 mg/kg body weight) administration group was 0.20 ± 0.08 g, the tumor weight of the 5 mg/kg body weight administration group was 0.08 ± 0.04 g (inhibitory rate: 57.9%, $P < 0.01$ by Student's t-test), and the tumor weight of the 10 mg/kg body weight administration group was 0.09 ± 0.04 g (inhibitory rate: 52.6 %, $P < 0.01$ by Student's t-test). Thus, dose-dependent anti-tumor activity was confirmed (Figure 28B).

[Example 26]

[Analysis of administration intervals of clone T6-16 to xenograft treatment models using human colon cancer cell line SW480]

Subsequently, in order to analyze optimal administration intervals of clone T6-16 (mouse IgG2a), the anti-tumor activity of the clone T6-16 when it was administered at administration intervals of once a week (once every 7 days) and once every 10 days was examined with xenograft treatment models using a human colon cancer cell line SW480. SW480 cells (5×10^6 cells) were subcutenously transplanted into the right flank of each of 6-week-old female NOD-scid mouse. Ten days after the transplantation (Day 10) at which the mean tumor volume reached 100 mm^3, the mice were divided into a control group (mouse IgG, 10 mg/kg body weight administration group, N = 8, 105.8 ± 9.9 mm^3), a T6-16 (10 mg/kg body weight, once a week) administration group (N = 8, 105.0 ± 11.6 mm^3), a T6-16 (10 mg/kg body weight, once every 10 days) administration group (N = 5, 130.8 ± 2.4 mm^3). Then, administration was initiated. On Day 43, the tumor volume of the control group was 473.5 ± 137.0 mm^3. On the other hand, the tumor volume of the T6-16 (once a week) administration group was 243.7 ± 65.3 mm^3 (inhibitory rate: 48.5%, $P < 0.01$ by Student's t-test), and the tumor volume of the T6-16 (once every 10 days) administration group was 297.8 ± 54.4 mm^3 (inhibitory rate: 37.1%, $P < 0.05$ by Student's t-test) (Figure 29). In the prior arts (US 7420040 and US 7420041), when antibodies were administered to xenograft treatment models using a pancreatic cancer cell line (BxPC-3) at a dosage of 20 mg/kg body weight, three times a week (at administration intervals of 2 days), the antibodies exhibited anti-tumor activity at an inhibitory rate of 50% to 60%. In contrast, the T6-16 antibody was found to exhibit significant anti-tumor activity, when it was administered at a dosage of half of the prior arts once every 10 day (at administration

intervals of 8 days). If taking into consideration a single dosage and administration intervals, it became clear that the T6-16 antibody exhibited significant anti-tumor activity at a total dosage of at least one eighth of those of the prior-arts.

[Example 27]

[Analysis of anti-tumor activity of clone K5-70 on xenograft prevention models using human prostate cancer cell line DU-145]

The anti-tumor activity of clone K5-70 on human prostate cancer was evaluated with xenograft prevention models using DU-145 cells (RIKEN Cell Bank, RCB2143). DU-145 cells (5×10^6 cells) were subcutaneously transplanted into each of 6-week-old female nude mouse (Balb/c, nu/nu). The day on which the transplantation was carried out was defined as Day 1. The mice were divided into a control group (N = 8) and a K5-70 administration group (N = 8). From Day 1, K-70 was intraperitoneally administered to the mice at a frequency of once every 3 days at a dosage of 10 mg/kg body weight. On Day 40, the tumor volume of the control group was 368.2 ± 307.8 mm^3. On the other hand, the tumor volume of the K5-70 administration group was 30.6 ± 29.6 mm^3 ($P < 0.05$ by Student's t-test), showing a tumor formation inhibitory activity of approximately 90% (Figure 30A). With regard to tumor weight, further significant anti-tumor activity was observed. The tumor weight of the control group on Day 40 was 0.18 ± 0.18 g. In contrast, in the K5-70 administration group, tumors disappeared from all of the 8 individual mice, and thus, tumor formation was completely inhibited (Figure 30B). From the above-mentioned results, it became clear that the anti-human TROP-2 monoclonal antibody clone K5-70 shows strong anti-tumor activity even on human prostate cancer.

[Example 28]

[Metastasis-inhibitory activity of clone K5-70 on liver metastasis models using human pancreatic cancer cell line PK-59]

Cancer metastasis is an important factor that influences clinical prognosis in the treatment of gastrointestinal cancer. The control of metastasis is therapeutically significantly important. If not only tumor formation but also the metastasis of cancer to other organs could be suppressed by administering an antibody for use in cancer

therapy that targets to TROP-2, high clinical usefulness would be anticipated. Thus, this is a desired property as a cancer therapeutic antibody.

The expression of TROP-2 was confirmed in many types of carcinomas. It was reported that TROP-2 was expressed at a high level particularly in metastatic foci (Br. J. Cancer (2008); 99: 1290-1295, Clin. Cancer Res. (2006); 12: 3057-3063, Mod. Pathol. (2008); 21: 186-191). Moreover, it was also reported that, when Trop-2-gene-introduced cancer cells were transplanted into nude mice via transsplenic or transpancreastic administration, the incidence of liver metastasis increased (WO 2010/089782, Molecular Cancer (2010); 9: 253), and thus, the report suggested the importance of TROP-2 in the cancer metastasis process. However, to date, there have been no reports specifically describing that an antibody that targets TROP-2 has metastasis-inhibitory action *in vivo*.

The anti-hTROP-2 mouse monoclonal antibody K5-70, which was discovered by the present invention, exhibits high therapeutic effects on xenograft models, into the subcutis of which pancreatic cancer cells had been transplanted. It was demonstrated by a scratch assay performed *in vitro* that the antibody K5-70 is able to suppress the migration ability of pancreatic cancer cells PK-59, in addition to the effect of suppressing the growth of cancer cells. Thus, it was considered that the antibody K5-70 could inhibit cancer metastasis *in vivo*. Hence, the metastasis-inhibitory effect of an anti-hTROP-2 mouse monoclonal antibody was examined, using models in which pancreatic cancer cells PK-59 were injected into the spleen of nude mice so that liver metastasis was developed.

A pancreatic cancer cell line (PK-59) endogenously expressing hTROP-2 was harvest by treatment with trypsin, and a 2×10^7 cells/mL cell suspension was then prepared with PBS. The cell suspension was preserved on ice until transplantation. Each of 6- or 7-week-old female nude mouse (Balb/c, nu/nu) was anesthetized by intraperitoneal administration of pentobarbital, and 10 to 15 mm of the left flank thereof was excised under anesthesia. The spleen was taken out of the abdominal cavity, and 50 μL of the cell suspension (1×10^6 cells) was then injected into the spleen using a 26G syringe. Four minutes after injection of the cells, the hilum of spleen was ligated with 5-0 silk sutures, and the spleen was then excised. The cut peritoneum was closed with 5-0 silk sutures, and the surgical site was then closed with Wound Clips (AUTOCLIP

9mm, Becton Dickinson). On the day before cancer cell transplantation, the mice were divided into groups. An anti-hTROP-2 monoclonal antibody (K5-70) or a control antibody (purified mouse IgG) was intraperitoneally administered to mice at a dosage of 10 mg/kg body weight. In addition, seven days after cancer cell transplantation, such an antibody was administered in the same manner as described above. Four to six weeks after the cancer cell transplantation, the mice were subjected to euthanasia by cervical dislocation. Then, the liver was excised from each mouse, and the presence or absence of metastatic foci was confirmed.

In the control group in which the mouse IgG was administered to the mice, in 4 out of the 6 mice into which PK-59 cells had been transplanted, apparent metastatic foci (2 to 7 foci) were observed around the liver lobe four to six weeks after the transplantation (Figure 31A, incidence of metastasis: 67%, Table 6). In contrast, in four mice in the K5-70 administration group, into which the PK-59 cells had also been transplanted, such metastatic foci were not observed in the liver of all of the mice, and thus, an incidence of metastasis was 0% (Figure 31B, Table 6).

Table 6

Metastasis-suppressing effect of clone K5-70 on liver metastasis models produced by transsplenic transplantation of PK-59 cells into nude mice

Administration group	Weeks after transplantation	Individual No.	Number of metastatic foci		Determination of metastasis	
Control group	4W	C-1	0		-	
	4W	C-2	5		++	
	6W	C-3	7		++	
	6W	C-4	7		++	
	6W	C-5	2		+	
	6W	C-6	0		-	
		Average number of metastatic foci	3.5	Incidence of metastasis		67%
K5-70 administration group	4W	K-1	0		-	
	6W	K-2	0		-	
	6W	K-3	0		-	
	6W	K-4	0		-	
		Average number of metastatic foci	0	Incidence of metastasis		0%

From these results, it became clear that the anti-hTROP-2 antibody K5-70 has extremely strong inhibitory action on the liver metastasis of the pancreatic cancer cells PK-59.

[Example 29]

[Anti-tumor activity of K5-70 antibody on xenograft models using colon cancer cell line SW480, which are recurrent cancer models after administration of irinotecan hydrochloride]

In recent years, many chemotherapeutical drugs for suppressing the growth of cancer cells have been developed as cancer therapeutic drugs. These drugs have achieved certain treatment results. However, these chemotherapeutical drugs have been problematic in terms of side effects associated with the growth suppressive action thereof on normal cells other than cancer cells and the recurrence of cancer after suspension of the treatment. Accordingly, if tumor recurrence after completion of the treatment with chemotherapeutical drugs could be suppressed by administration of a cancer therapeutic antibody targeting to TROP-2, high clinical usefulness would be anticipated. Thus, this is a desired property as a cancer therapeutic antibody.

As therapeutic agents for colon cancer, in addition to 5-FU and platinum-containing drugs, irinotecan hydrochloride (Topotecin, Daiichi Sankyo Co., Ltd.) having a topoisomerase inhibitory effect has been recently applied to clinical sites. With regard to animal models as well, the anti-tumor effect of irinotecan hydrochloride on mouse models, into which various types of human tumor cells including colon cancer as a typical example had been transplanted, has been reported (Cancer Chemother Pharmacol. (1991); 28(3):192-8). Thus, the recurrence-preventing effect of the anti-hTROP-2 antibody clone K5-70 (mouse IgG2a) on recurrent tumor after administration of irinotecan hydrochloride has been examined with xenograft models using a human colon cancer cell line SW480. SW480 cells (5×10^6 cells) were subcutaneously transplanted into the right flank of 8-week-old female NOD-scid mice. Eleven days after the transplantation (Day 11) at which the mean tumor volume reached 100 mm^3, the mice were divided into a non-treat group (normal saline administration group, N = 8, 130.7 ± 16.2 mm^3) and an irinotecan hydrochloride (CPT-11, Topotecin, Daiichi Sankyo Co., Ltd.) administration group (N = 16, 123.0 ± 21.4 mm^3). Thereafter, irinotecan hydrochloride was intraperitoneally administered to the mice at a dosage of 40 mg/kg body weight, once every 3 days, total 3 times (Days 11, 14, and 17). On the third day after the final administration of irinotecan hydrochloride (Day 20), the tumor volume of

the non-treat group reached 232.1 ± 21.1 mm^3. On the other hand, the tumor volume of the irinotecan hydrochloride administration group was 126.6 ± 26.6 mm^3 ($P < 0.01$ by Student's t-test), and thus, an apparent tumor-suppressing effect was observed. At this stage, the irinotecan hydrochloride administration group was divided into two groups based on tumor size. One group was defined as a K5-70 (10 mg/kg body weight) administration group (N = 8, tumor volume on Day 20: 126.0 ± 28.0 mm^3), and the other group was defined as a mouse IgG (10mg/kg body weight) administration group (N = 8, tumor size on Day 20: 127.2 ± 27.0 mm^3). Intraperitoneal administration and the measurement of tumor volume were carried out on each group once every 3 days, so that the recurrence of tumor was evaluated (Figure 32). In the mouse IgG administration group, from the 18^{th} day after the final administration of irinotecan hydrochloride (Day 35), several mice having an apparent recurrent tumor with a tumor volume of greater than 300 mm^3 were observed. On the 30^{th} day after the final administration of irinotecan hydrochloride (Day 47), a tumor with a tumor volume of greater than 300 mm^3 was observed in 5 out of the 8 mice (mean tumor volume: 401.7 ± 172.7 mm^3). In contrast, in the K5-70 administration group, tumor recurrence was significantly suppressed, and the mean tumor volume was 180.5 ± 142.1 mm^3 ($P < 0.05$ by Student's t-test) (Figure 32). In particular, in the K5-70 administration group, the tumor volume on Day 47 became smaller than the tumor volume when the mice were divided into groups (126.0 ± 28.0 mm^3). The tumor volume became less than 100 mm^3 in 4 out of the 8 mice. From these results, it became clear that the anti-hTROP-2 antibody K5-70 has extremely strong suppressive action even on recurrent tumor after administration of irinotecan hydrochloride.

[Example 30]

[Epitope mapping using CLIPS technology]

<Materials and methods>

Peptide synthesis

15-mer and 30-mer of linear peptides derived from TROP-2 extracellular domains, which were used in the present experiment, were obtained by solid-phase synthesis according to a Fmoc (9-Fluorenylmethoxycarbonyl) method. In addition, for discontinuous epitope analysis, a 17-mer peptides derived from a TROP-2 extracellular

domain, to both ends of which cysteine residues had been added, was synthesized, and a conformation having one or two loop structures was reconstructed by CLIPS technology (Chemically Linked Peptides on Scaffolds technology). When another cysteine residue was present close to the added cysteine residue, it was substituted with alanine.

Epitope screening ELISA

5034 types of the synthesized peptides were covalently bound to PEPSCAN cards (455 peptides/card), and the binding of the synthesized peptides to antibodies was then analyzed by the ELISA method. The PEPSCAN cards were allowed to react with anti-human TROP-2 monoclonal antibodies (K5-70, K5-107, K5-116-2-1, T5-86, and T6-16) that had been diluted to a concentration of 1 μg/mL with a blocking buffer (a phosphate buffer containing 4% horse serum, 5% ovalbumin, and 1% Tween). After washing, the resultant was allowed to react with a 1000-fold diluted peroxidase-secondary antibody complex at 25°C for 1 hour. After washing, a substrate solution (a solution containing 2,2'-azino-di-3-ethylbenzthiazoline sulfonate (ABTS) and 2 μL of 3% hydrogen peroxide solution) was added to the reaction solution, followed by a chromogenic reaction for 1 hour. The binding activity of the antibodies was quantified by photographing with a CCD camera and then performing an image analysis.

<Results>

The anti-human TROP-2 monoclonal antibodies K5-70, K5-107, K5-116-2-1, T5-86 and T6-16, which exhibited beneficial effects, were subjected to epitope analysis using CLIPS (Chemically Linked Peptides on Scaffolds) technology. It is to be noted that the term "amino acid number" is used in the present examples to mean the amino acid number in the amino acid sequence shown in SEQ ID NO: 2 (hTROP-2 protein (323 amino acid residues)).

The result of analysis for the K5-70 antibody is shown in Table 7 below. As a result, it was found that 33 peptides exhibit strong binding activity to the K5-70 antibody. In these 33 peptides, a sequence comprising VCSPDGPGGRCQCRALGSGMAVD (amino acid numbers 43-65) (peptide Nos. 1-7 and 9 in Table 7), a sequence comprising HHILIDLRHRPTAG (amino acid numbers 152-165) (peptide Nos. 14, 22-25, 28, 29, 31 and 33 in Table 7), a sequence comprising VHYEQPTIQIELRQ (amino acid numbers 193-206) (peptide Nos. 8, 10, 12, 13, 15, 18,

20, 21, 23, 26, 28, 30 and 32 in Table 7), and a sequence comprising DAELRRLFRER (amino acid numbers 171-183) (peptide Nos. 11, 12, 14, 16, 18, 19, 21, 22, 25, 29 and 31 in Table 7) appeared repeatedly. The K5-70 antibody particularly strongly bound to the sequence comprising VCSPDGPGGRCQCRALGSGMAVD. From these results, it was suggested that, in the hTROP-2 protein, the aforementioned 4 types of peptide sequence regions are likely to be epitopes of the K5-70 antibody.

Table 7

Binding of K5-70 antibody to CLIPS peptides derived from human TROP-2 extracellular domains

number	peptide	binding of K5-70
1	NKMTVCSPDGPGGRCQCRALGSGMAVDCST	2742
2	TVCSPDGPGGRCQCRALGSGMAVDCSTLTS	2604
3	TNKMTVCSPDGPGGRCQCRALGSGMAVDCS	2562
4	MTVCSPDGPGGRCQCRALGSGMAVDCSTLT	2402
5	KMTVCSPDGPGGRCQCRALGSGMAVDCSTL	1770
6	PTNNKMTVCSPDGPGGRCQCRALGSGMAVDC	1391
7	VCSPDGPGGRCQCRALGSGMAVDCSTLTSK	932
8	CAAVHYEQPTIQIELRCAAVHYEQPTIQIELRC	876
9	CPTNKMTVCSPDGPGGRCQCRALGSGMAVD	839
10	CVHYEQPTIQIELRQNCVHYEQPTIQIELRQNC	825
11	HSDLDAELRRLFRERCHSDLDAELRRLFRERC	725
12	RLFRERYRLHPKFVAAVHYEQPTIQIELRQ	687
13	AVHYEQPTIQIELRQ	642
14	CAGAFNHSDLDAELRRCHHILIDLRHRPTAGAC	624
15	CPKFVAAVHYEQPTIQCGLDLRVRGEPLQVERC	579
16	CHSDLDAELRRLFRERCGLDLRV	538
17	FQGRGGLDLRVRGEP	538
18	CVHYEQPTIQIELRQNCDLDAELRRLFRERYRC	524
19	CHSDLDAELRRLFRERCRGEPLQ	519
20	CTIQIELRQNTSQKAACVHYEQPTIQIELRQNC	513
21	CVHYEQPTIQIELRQNCHSDLDAELRRLFRERC	511
22	CHHILIDLRHRPTAGACHSDLDAELRRLFRERC	489
23	CHHILIDLRHRPTAGACVHYEQPTIQIELRQNC	489
24	CHHILIDLRHRPTAGACGLDLRVRGEPLQVERC	488
25	CDAELRRLFRERYRLHCDELVRTHHILIDLRHC	483
26	CVHYEQPTIQIELRQNC	483
27	CAFNHSDLDAELRRLFCVHYEQPTIQIELRQNC	478
28	CVHYEQPTIQIELRQNCHHILIDLRHRPTAGAC	473
29	CDAELRRLFRERYRLHCDELVRTHHILIDLRHC	472
30	VHYEQPTIQIELRQNCGLDLRVRGEPLQVERC	470
31	CDELVRTHHILIDLRHCDLDAELRRLFRERC	469
32	AVHYEQPTIQIELRQCAVHYEQPTIQIELRQC	468
33	CHSDLDAELRRLFRERCDELVRTHHILIDLRHC	466

The result of analysis for the K5-107 antibody is shown in Table 8 below. As a result, it was found that a sequence comprising VCSPDGPGGRCQCRALGSGMAVD (amino acid numbers 43-65) was comprised in 10 out of the 20 peptides (peptide Nos. 1-

6, 8, 13,14 and 17 in Table 8) (Table 8).

Accordingly, it was suggested that, in the hTROP-2 protein, the aforementioned peptide sequence region consisting of VCSPDGPGGRCQCRALGSGMAVD may be an epitope of the K5-107 antibody.

Table 8

Binding of K5-107 antibody to CLIPS peptides derived from human TROP-2 extracellular domains

number	peptide	binding of K5-107
1	TNKMTVCSPDGPGGRCQCRALGSGMAVDCS	2763
2	NKMTVCSPDGPGGRCQCRALGSGMAVDCST	2761
3	KMTVCSPDGPGGRCQCRALGSGMAVDCSTL	2752
4	MTVCSPDGPGGRCQCRALGSGMAVDCSTLT	2726
5	CPTNKMTVCSPDGPGGRCQCRALGSGMAVD	2723
6	TVCSPDGPGGRCQCRALGSGMAVDCSTLTS	2720
7	TCPTNKMTVCSPDGPGGRCQCRALGSGMAV	2716
8	VCSPDGPGGRCQCRALGSGMAVDCSTLTSK	2689
9	CSPDGPGGRCQCRALGSGMAVDCSTLTSKC	2655
10	CTCPTNKMTVCSPDGPGGRCQCRALGSGMA	2655
11	NCTCPTNKMTVCSPDGPGGRCQCRALGSGM	2207
12	DNCTCPTNKMTVCSPDGPGGRCQCRALGSG	1816
13	TNKMTVCSPDGPGGRCQCRALGSGMAVDCS	1525
14	CTVCSPDGPGGRCQCRALGSGMAVDASTLTSKC	1118
15	QDNCTCPTNKMTVCSPDGPGGRCQCRALGS	874
16	SPDGPGGRCQCRALGSGMAVDCSTLTSKCL	561
17	CTNKMTVCSPDGPGGRCQCRALGSGMAVDASTC	380
18	TVCSPDGPGGRCQCR	312
19	CAPKNARTLVRPSEHACARTLVRPSEHALVDNC	284
20	HSDLDAELRRLFRERCHSDLDAELRRLFRERC	272

The result of analysis for the K5-116-2-1 antibody is shown in Table 9 below. In this analysis, three types of peptide sequences, namely, a sequence comprising VCSPDGPGGRCQCRALGSGMAVD (amino acid numbers 43-65) (peptide Nos. 1-7, 15 and 25 in Table 9), a sequence comprising HHILIDLRHRPTAG (amino acid numbers 152-165) (peptide Nos. 8-11, 16, 17, 19, 20, 22-24, and 27-29 in Table 9), and a sequence comprising DLDAELRRLFRER (amino acid numbers 171-183) (peptide Nos. 11-14, 17, 19, 21, 23 and 29 in Table 9) appeared several times (Table 9). Accordingly, it was suggested that, in the hTROP-2 protein, these three types of peptide sequence regions may be epitopes of the K5-116-2-1 antibody.

Table 9

Binding of K5-116-2-1 antibody to CLIPS peptides derived from human TROP-2 extracellular domains

number	peptide	binding of K5-116-2-1
1	TVCSPDGPGGRCQCRALGSGMAVDCSTLTS	2672
2	NKMTVCSPDGPGGRCQCRALGSGMAVDCST	2613
3	TNKMTVCSPDGPGGRCQCRALGSGMAVDCS	2482
4	MTVCSPDGPGGRCQCRALGSGMAVDCSTLT	2440
5	KMTVCSPDGPGGRCQCRALGSGMAVDCSTL	2423
6	CPTNKMTVCSPDGPGGRCQCRALGSGMAVD	2136
7	PTNKMTVCSPDGPGGRCQCRALGSGMAVDC	1723
8	CAGAFNHSDLDAELRRCHHILIDLRHRPTAGAC	1643
9	CTHHILIDLRHRPTAGC	1586
10	CVHYEQPTIQIELRQNCHHILIDLRHRPTAGAC	1504
11	CHHILIDLRHRPTAGCHSDLDAELRRLFRERC	1475
12	HSDLDAELRRLFRERCHSDLDAELRRLFRERC	1467
13	CDAELRRLFRERYRLHCHSDLDAELRRLFRERC	1462
14	CDAELRRLFRERYRLHCPK	1442
15	VCSPDGPGGRCQCRALGSGMAVDCSTLTSK	1432
16	DLSLRCDELVRTHHILIDLRHRPTAGAFNH	1421
17	CDELVRTHHILIDLRHCDLDAELRRLFRERYRC	1392
18	CFQGRGGLDLRVRGEPC	1376
19	CDAELRRLFRERYRLHCDELVRTHHILIDLRHC	1366
20	CGLDLRVRGEPLQVERCHHILIDLRHRPTAGAC	1342
21	CHSDLDAELRRLFRERCHSDLDAELRRLFRERC	1331
22	CDELVRTHHILIDLRHCHHILIDLRHRPTAGAC	1323
23	CDAELRRLFRERYRLHCDELVRTHHILIDLRHC	1266
24	CHHILIDLRHRPTAGACRGEPLQVERTLIYYLC	1229
25	CSPDGPGGRCQCRAL	1227
26	CTVASPDGPGGRAQARACVHYEQPTIQIELRQNC	1223
27	CHHILIDLRHRPTAGACVHYEQPTIQIELRQNC	1222
28	LSLRCDELVRTHHILIDLRHRPTAGAFNHS	1220
29	CDELVRTHHILIDLRHCHSDLDAELRRLFRERC	1205

The results of analysis for the T5-86 and T6-16 antibodies are shown in Table 10 and Table 11 below, respectively. In these analyses, the antibodies strongly bound to a peptide comprising a sequence consisting of DPEGRFKARQCN (amino acid numbers 109-120). The above-mentioned peptide sequence was comprised in 22 out of the 26 peptides binding to the T5-86 antibody (peptide Nos. 1-3, 5-8, 10-13, 15-19, and 21-26 in Table 10), and it was comprised in 4 out of the 26 peptides binding to the T6-16 antibody (peptde Nos. 1, 2, 9 and 13 in Table 11) (Table 10 and Table 11). Moreover, in the analysis regarding the T5-86 antibody, other than the sequence comprising DPEGRFKARQCN (amino acid numbers 109-120), a sequence comprising VCSPDGPGGRCQCR (amino acid numbers 43-56) (peptide Nos. 4, 14 and 20 in Table

10) appeared several times . Furthermore, in the analysis regarding the T6-16 antibody as well, another sequence comprising HHILIDLRHRPTAG (amino acid numbers 152-165) (peptide Nos. No. 4-8, 10-12, 19, 21, 23, 25 and 26 in Table 11) was found several times. Accordingly, it was suggested that, in the hTROP-2 protein, two types of peptide sequence regions, namely, DPEGRFKARQCN (amino acid numbers 109-120) and VCSPDGPGGRCQCR (amino acid numbers 43-56), may be epitopes of the K5-86 antibody. It was also suggested that, in the hTROP-2 protein, two types of peptide sequence regions, namely, DPEGRFKARQCN (amino acid numbers 109-120) and HHILIDLRHRPTAG (amino acid numbers 152-165), may be epitopes of the T6-16 antibody.

Table 10

Binding of T5-86 antibody to CLIPS peptides derived from human TROP-2 extracellular domains

number	peptide	binding of T5-86
1	CYDPDADPEGRFKARQCADPEGRFKARQANQTC	2306
2	PDCDPEGRFKARQCN	2292
3	CADPEGRFKARQANCPDADPEGRFKARQANC	2287
4	VCSPDGPGGRCQCRA	2263
5	CYDPDADPEGRFKARQCPDADPEGRFKARQANC	2260
6	CADPEGRFKARQANQTCTDPDADPEGRFKARQC	2240
7	CADPEGRFKARQANQTCYDPDADPEGRFKARQC	2208
8	DCDPEGRFKARQCNQ	2150
9	CTVASPDGPGGRAQARCHSDLDAELRRLFRERC	2086
10	CDADPEGRFKARQANQCDADPEGRFKARQANQC	2035
11	DGRFKARQANQTSVAWCARTLVRPSEHALVDNC	2019
12	DADPEGRFKARQANQTCPDADPEGRFKARQANC	1980
13	CPDADPEGRFKARQANCPDADPEGRFKARQANC	1950
14	CSPDGPGGRCQCRAL	1946
15	CEGRFKARQANQTSVACEGRFKARQANQTSVAC	1895
16	CTVASPDGPGGRAQARCPDADPEGRFKARQANC	1890
17	CGLYDPDADPEGRFKACPDADPEGRFKARQANC	1857
18	DPDCDPEGRFKARQCNCQTSVCWCVNSVGVR	1850
19	CPEGRFKARQANQTSVCDELVRHHILIDLRHC	1841
20	CPDGPGGRAQARALGSCHSDLDAELRRLFRERC	1830
21	CTLVRPSEHALVDNDGCGRFKARQANQTSVAWC	1820
22	CPDADPEGRFKARQANCYDPDADPEGRFKARQC	1795
23	CGLYDPDADPEGRFKACPEGRFKARQANQTSVC	1793
24	YDPDCDPEGRFKARQ	1775
25	CPDADPEGRFKARQANCADPEGRFKARQANQTC	1773
26	CDPEGRFKARQCNQT	1772

Table 11

Binding of T6-16 antibody to CLIPS peptides derived from human TROP-2 extracellular domains

number	peptide	binding of T6-16
1	CVNSVGVRRTDKGDLSCPDCYDPDADPEGRFKARQC	1072
2	CSVGVRRTDKGDLSLRCYDPDADPEGRFKARQC	786
3	HSDLDAELRRLFRERCHSDLDAELRRLFRERC	714
4	CDELVRTHHILIDLRHCDLDAELRRLFRERYRC	713
5	CVNSVGVRRTDKGDLSLRCDELVRTHHILI	688
6	VRRTDKGDLSLRCDELVRTHHILIDLRHRP	670
7	CVERTLIYYLDEIPPKCHHILIDLRHRPTAGAC	626
8	CHHILIDLRHRPTAGACHSDLDAELRRLFRERC	620
9	CVNSVGVRRTDKGDLSCPDADPEGRFKARQANC	611
10	CVHYEQPTIQIELRQNCHHILIDLRHRPTAGAC	602
11	VGVRRTDKGDLSLRCDELVRTHHILIDLRH	601
12	CAGAFNHSDLDAELRRCHHILIDLRHRPTAGAC	592
13	CSVGVRRTDKGDLSLRCPDADPEGRFKARQANC	585
14	CVRPSEHALVDNDGLYCSVGVRRTDKGDLSLRC	573
15	CDAELRRLFRERYRLHCHSDLDAELRRLFRERC	566
16	CSVGVRRTDKGDLSLRCNDGLYDPDADPEGRFC	559
17	CVNSVGVRRTDKGDLSCGLYDPDADPEGRFKAC	553
18	CDLDAELRRLFRERYRCHSDLDAELRRLFRERC	534
19	CDELVRTHHILIDLRHCHHILIDLRHRPTAGAC	534
20	CAGAFNHSDLDAELRRCDLDAELRRLFRERYRC	529
21	CDAELRRLFRERYRLHCDELVRTHHILIDLRHC	527
22	CVHYEQPTIQIELRQNCDLDAELRRLFRERYRC	526
23	CHHILIDLRHRPTAGACVHYEQPTIQIELRQNC	524
24	CGVRRTDKGDLSLRADCGVRRTDKGDLSLRADC	524
25	CGLDLRVRGEPLQVERCHHILIDLRHRPTAGAC	521
26	CDLDAELRRLFRERYRCDELVRTHHILIDLRHC	516

[Example 31]

[Sequencing of variable regions of antibody genes of mouse anti-human TROP-2 antibodies (clones K5-70, K5-107, K5-116-2-1, and T6-16)]

Total RNA was extracted from 3 × 10^6 mouse anti-TROP-2 monoclonal antibody-producing hybridomas, using TRIzol reagent (Invitrogen). With regard to the clone K5-70, clone K5-107, and clone K5-116-2-1, cDNA was synthesized employing SMARTer^{TM} RACE cDNA Amplification kit (Clontech) according to the method included with the kit, using a mouse IgG H chain-specific primer (5'-TCCAKAGTT-3' (SEQ ID NO: 24)) and a mouse IgG L chain-specific primer (5'-GCTGTCCTGATC-3'

(SEQ ID NO: 25)). With regard to the clone T6-16, cDNA was synthesized employing GeneRacer kit (Invitrogen) according to the method included with the kit, using an oligo dT primer. Genes encoding the variable regions (VH, VL) of the H and L chains of clone K5-70 (mouse IgG2a), clone K5-107 (mouse IgG1) and clone K5-116-2-1 (mouse IgG2a) were each cloned by a PCR method using the above-synthesized cDNA as a template. In this operation, 10 × Universal Primer A Mix (UPM) included with SMARTer™ RACE cDNA Amplification kit was used as a 5'-primer. On the other hand, as a 3'-primer for VH amplification, a primer having a sequence specific to the mouse IgG H chain was used, and as a 3'-primer for VL amplification, a primer having a sequence specific to the mouse IgG L chain was used.

5'-Primer (10 × Universal Primer A Mix (UPM)):

Long (0.4 μM)

5'-CTAATACGACTCACTATAGGGCAAGCAGTGGTATCAACGCAGAGT-3' (SEQ ID NO: 26)

Short (2 μM)

5'-CTAATACGACTCACTATAGGGC-3' (SEQ ID NO: 27)

3'-Primer (R primer):

VH: 5'-GGGAARTARCCCTTGACCAGGCA-3' (SEQ ID NO: 28)

5'-GGGAARTAGCCTTTGACAAGGCA-3' (SEQ ID NO: 29)

VL: 5'-CACTGCCATCAATVTTCCACTTGACA-3' (SEQ ID NO: 30)

Using each of the above-described primers, PCR was carried out under the following composition of reaction solution and reaction conditions. In addition, a R primer for amplification of VH cDNA was prepared by mixing the two above sequences with each other at an equimolar ratio and was then used.

<Composition of reaction solution>

Template cDNA:	2.5 μL
5 × PrimeSTAR buffer (Mg^{2+} plus):	10 μL
2.5 mM dNTP:	4 μL
PrimeSTAR HS DNA polymerase (2.5 U/μL):	0.5 μL
10 × Universal Primer A Mix (UPM):	5 μL
R primer (10 μM):	1 μL
Sterilized water:	27 μL
Total:	50 μL

<Reaction conditions>

A reaction was carried out at 94°C (10 sec), and thereafter, a cycle consisting of "heat denaturation/dissociation at 98°C (10 sec) → annealing at 60°C (5 sec) → synthesis/elongation at 72°C (60 sec)" was carried out 30 times in total. Finally, a reaction was carried out at 72°C (3 min).

The synthesized VH and VL cDNAs were subcloned into a pMD20-T vector (Takara Bio Inc.), and the nucleotide sequences thereof were determined. The nucleotide sequences of a plurality of VH clones and VL clones were decoded, and nucleotide sequences specific to the variable regions of mouse H chain and L chain were identified. Figure 33 and Figure 34 show the consensus cDNA nucleotide sequences of the VH and VL of K5-70, and putative amino acid sequences. Figure 35 and Figure 36 show the consensus cDNA nucleotide sequences of the VH and VL of K5-107, and putative amino acid sequences. Figure 37 and Figure 38 show the consensus cDNA nucleotide sequences of the VH and VL of K5-116-2-1, and putative amino acid sequences.

Genes encoding the variable regions (VH, VL) of the H and L chains of clone T6-16 were cloned by a PCR method using the above-synthesized cDNA as a template. In this operation, a primer included with GeneRacer kit was used as a 5'-primer. On the other hand, as a 3'-primer for VH amplification, a primer having a sequence specific to the mouse IgG H chain was used, and as a 3'-primer for VL amplification, a primer

having a sequence specific to the mouse IgG L chain was used.

5'-Primer (F primer):

5'-CGACTGGAGCACGAGGACACTGA-3' (SEQ ID NO: 31)

3'-Primer (R primer):

VH: 5'- GCCAGTGGATAGACAGATGG-3' (SEQ ID NO: 32)

VL: 5'- GATGGATACAGTTGGTGCAGC-3' (SEQ ID NO: 33)

Using each of the above-described primers, PCR was carried out under the following composition of reaction solution and reaction conditions.

<Composition of reaction solution>

Template cDNA:	1.0 μL
5 × PrimeSTAR buffer (Mg^{2+} plus):	10 μL
2.5 mM dNTP:	4 μL
PrimeSTAR HS DNA polymerase (2.5 U/μL):	0.5 μL
F primer (10 μM):	3 μL
R primer (10 μM):	1.0 μL
Sterilized water:	30.5 μL
Total:	50 μL

<Reaction conditions>

A cycle consisting of "heat denaturation/dissociation at 98°C (10 sec) → annealing at 57°C (10 sec) → synthesis/elongation at 72°C (60 sec)" was carried out 35 times in total.

The synthesized VH and VL cDNAs were subcloned into a pCR4Blunt-TOPO vector (Invitrogen), and the nucleotide sequences thereof were determined. The nucleotide sequences of a plurality of VH clones and VL clones were decoded, and nucleotide sequences specific to the variable regions of mouse H chain and L chain were identified. Figure 39 and Figure 40 show the consensus cDNA nucleotide sequences of the VH and VL of T6-16, and putative amino acid sequences.

Industrial Applicability

The present invention is able to provide an antibody, which specifically reacts with hTROP-2 and has high anti-tumor activity *in vivo*, and particularly, a monoclonal antibody having high anti-tumor activity *in vivo* at a low dose. In addition, the present invention is able to provide a hybridoma, which produces the antibody, a fragment of the antibody, a complex of the antibody or the like and various types of drugs, a pharmaceutical composition for diagnosing or treating a tumor, a method for detecting a tumor, and a kit for detecting or diagnosing a tumor.

[Sequence Listing Free Text]

SEQ ID NO: 3	Synthetic DNA
SEQ ID NO: 4	Synthetic DNA
SEQ ID NO: 5	Synthetic DNA
SEQ ID NO: 6	Synthetic DNA
SEQ ID NO: 7	Synthetic DNA
SEQ ID NO: 8	Synthetic DNA
SEQ ID NO: 9	Synthetic DNA
SEQ ID NO: 10	Synthetic DNA
SEQ ID NO: 11	Synthetic DNA
SEQ ID NO: 12	Synthetic DNA
SEQ ID NO: 13	Synthetic DNA
SEQ ID NO: 14	Synthetic DNA
SEQ ID NO: 15	Synthetic DNA
SEQ ID NO: 16	Synthetic DNA
SEQ ID NO: 17	Synthetic DNA
SEQ ID NO: 18	Synthetic DNA
SEQ ID NO: 19	Synthetic DNA
SEQ ID NO: 20	Synthetic DNA
SEQ ID NO: 21	Synthetic DNA
SEQ ID NO: 22	Synthetic DNA
SEQ ID NO: 23	Synthetic DNA

SEQ ID NO: 24	Synthetic DNA
SEQ ID NO: 25	Synthetic DNA
SEQ ID NO: 26	Synthetic DNA
SEQ ID NO: 27	Synthetic DNA
SEQ ID NO: 28	Synthetic DNA
SEQ ID NO: 29	Synthetic DNA
SEQ ID NO: 30	Synthetic DNA
SEQ ID NO: 31	Synthetic DNA
SEQ ID NO: 32	Synthetic DNA
SEQ ID NO: 33	Synthetic DNA

CLAIMS

1. An antibody against human TROP-2, which has anti-tumor activity *in vivo*.

2. The antibody according to claim 1, which exhibits 50% or more of tumor growth inhibitory activity at a dosage of 5 to 20 mg/kg body weight.

3. The antibody according to claim 2, wherein the frequency of administration for exhibiting the tumor growth inhibitory activity is at most once a week.

4. The antibody according to claim 1, which exhibits 50% or more of the tumor growth inhibitory activity by a single administration of the antibody at a dosage of 10 mg/kg body weight.

5. The antibody according to any one of claims 1 to 4, which has anti-tumor activity on two or more types of human tumor cell lines.

6. The antibody according to any one of claims 1 to 5, wherein the dissociation constant (Kd value) is 1.0×10^{-10} M or less.

7. The antibody according to any one of claims 1 to 6, which is a monoclonal antibody.

8. The antibody according to any one of claims 1 to 7, wherein the tumor is at least one type selected from the group consisting of human pancreatic cancer, human prostate cancer, human colon cancer and human breast cancer.

9. The antibody according to any one of claims 1 to 7, wherein the tumor is human pancreatic cancer.

10. The antibody according to any one of claims 1 to 9, wherein the tumor is a recurrent cancer or a metastatic cancer.

11. The antibody according to any one of claims 5 to 10, wherein the tumor cell lines are at least two types selected from the group consisting of a human pancreatic cancer cell line PK-59, a human pancreatic cancer cell line BxPC-3, a human pancreatic cancer cell line KP-3L, a human pancreatic cancer cell line KP-2, a human pancreatic cancer cell line PK-1, a human pancreatic cancer cell line PK-45H, a human pancreatic cancer cell line PK-45P, a human pancreatic cancer cell line TCC-PAN2, a human pancreatic cancer cell line SUIT-2, a human colon cancer cell line CACO-2, a human colon cancer cell line SW480, a human colon cancer cell line DLD-1, a human colon cancer cell line HCT 116, a human breast cancer cell line JIMT-1, a human breast cancer

cell line HCC1143, a human breast cancer cell line MCF-7, a human prostate cancer cell line DU145 and a human prostate cancer cell line PC-3.

12. The antibody according to any one of claims 5 to 10, wherein the tumor cell lines are the human pancreatic cancer cell line PK-59 and the human pancreatic cancer cell line BxPC-3.

13. The antibody according to any one of claims 1 to 12, wherein the amino acid sequences of CDR 1 to 3 of the H chain V region of the antibody are shown in SEQ ID NOS: 36 to 38, respectively, and/or the amino acid sequences of CDR 1 to 3 of the L chain V region of the antibody are shown in SEQ ID NOS: 41 to 43, respectively.

14. The antibody according to any one of claims 1 to 12, wherein the amino acid sequences of CDR 1 to 3 of the H chain V region of the antibody are shown in SEQ ID NOS: 46 to 48, respectively, and/or the amino acid sequences of CDR 1 to 3 of the L chain V region of the antibody are shown in SEQ ID NOS: 51 to 53, respectively.

15. The antibody according to any one of claims 1 to 12, wherein the amino acid sequences of CDR 1 to 3 of the H chain V region of the antibody are shown in SEQ ID NOS: 56 to 58, respectively, and/or the amino acid sequences of CDR 1 to 3 of the L chain V region of the antibody are shown in SEQ ID NOS: 61 to 63, respectively.

16. The antibody according to any one of claims 1 to 12, wherein the amino acid sequences of CDR 1 to 3 of the H chain V region of the antibody are shown in SEQ ID NOS: 66 to 68, respectively, and/or the amino acid sequences of CDR 1 to 3 of the L chain V region of the antibody are shown in SEQ ID NOS: 71 to 73, respectively.

17. The antibody according to any one of claims 1 to 16, wherein the antibody is a genetically recombinant antibody.

18. The antibody according to claim 17, wherein the genetically recombinant antibody is a chimeric antibody, a humanized antibody, or a human antibody.

19. The antibody according to claim 18, wherein the H chain V region of the chimeric antibody consists of the amino acid sequence shown in SEQ ID NO: 35, and/or the L chain V region thereof consists of the amino acid sequence shown in SEQ ID NO: 40.

20. The antibody according to claim 18, wherein the H chain V region of the chimeric antibody consists of the amino acid sequence shown in SEQ ID NO: 45, and/or the L chain V region thereof consists of the amino acid sequence shown in SEQ ID NO:

50.

21. The antibody according to claim 18, wherein the H chain V region of the chimeric antibody consists of the amino acid sequence shown in SEQ ID NO: 55, and/or the L chain V region thereof consists of the amino acid sequence shown in SEQ ID NO: 60.

22. The antibody according to claim 18, wherein the H chain V region of the chimeric antibody consists of the amino acid sequence shown in SEQ ID NO: 65, and/or the L chain V region thereof consists of the amino acid sequence shown in SEQ ID NO: 70.

23. A monoclonal antibody against human TROP-2, which is produced by a hybridoma having accession No. FERM BP-11251.

24. A monoclonal antibody against human TROP-2, which is produced by a hybridoma having accession No. FERM BP-11252.

25. A monoclonal antibody against human TROP-2, which is produced by a hybridoma having accession No. FERM BP-11253.

26. A monoclonal antibody against human TROP-2, which is produced by a hybridoma having accession No. FERM BP-11346.

27. A monoclonal antibody against human TROP-2, which is produced by a hybridoma having accession No. FERM BP-11254.

28. The antibody according to any one of claims 1 to 22, which binds to a site, to which the monoclonal antibody produced by the hybridoma having accession No. FERM BP-11251, FERM BP-11252, FERM BP-11253, FERM BP-11346 or FERM BP-11254 binds.

29. The antibody according to any one of claims 1 to 22, which binds to a portion comprising at least one region selected from the group consisting of a region consisting of amino acids at positions 43 to 65, a region consisting of amino acids at positions 152 to 165, a region consisting of amino acids at positions 171 to 183, a region consisting of amino acids at positions 109 to 120, a region consisting of amino acids at positions 43 to 56, and a region consisting of amino acids at positions 193 to 206, in the amino acid sequence of human TROP-2 shown in SEQ ID NO: 2.

30. The antibody according to any one of claims 1 to 22, which binds to a portion comprising a region consisting of the amino acids at positions 43 to 65 in the amino acid

sequence of human TROP-2 shown in SEQ ID NO: 2.

31. The antibody according to any one of claims 1 to 22, which binds to a portion comprising a region consisting of the amino acids at positions 152 to 165 in the amino acid sequence of human TROP-2 shown in SEQ ID NO: 2.

32. The antibody according to any one of claims 1 to 22, which binds to a portion comprising a region consisting of the amino acids at positions 171 to 183 in the amino acid sequence of human TROP-2 shown in SEQ ID NO: 2.

33. The antibody according to any one of claims 1 to 22, which binds to a portion comprising a region consisting of the amino acids at positions 109 to 120 in the amino acid sequence of human TROP-2 shown in SEQ ID NO: 2.

34. An antibody fragment derived from the antibody according to any one of claims 1 to 33.

35. The antibody fragment according to claim 34, which comprises the amino acid sequences shown in SEQ ID NOS: 36 to 38 and/or the amino acid sequences shown in SEQ ID NOS: 41 to 43.

36. The antibody fragment according to claim 35, which comprises the amino acid sequence shown in SEQ ID NO: 35 and/or the amino acid sequence shown in SEQ ID NO: 40.

37. The antibody fragment according to claim 34, which comprises the amino acid sequences shown in SEQ ID NOS: 46 to 48 and/or the amino acid sequences shown in SEQ ID NOS: 51 to 53.

38. The antibody fragment according to claim 37, which comprises the amino acid sequence shown in SEQ ID NO: 45 and/or the amino acid sequence shown in SEQ ID NO: 50.

39. The antibody fragment according to claim 34, which comprises the amino acid sequences shown in SEQ ID NOS: 56 to 58 and/or the amino acid sequences shown in SEQ ID NOS: 61 to 63.

40. The antibody fragment according to claim 38, which comprises the amino acid sequence shown in SEQ ID NO: 55 and/or the amino acid sequence shown in SEQ ID NO: 60.

41. The antibody fragment according to claim 34, which comprises the amino acid sequences shown in SEQ ID NOS: 66 to 68 and/or the amino acid sequences shown in

SEQ ID NOS: 71 to 73.

42. The antibody fragment according to claim 41, which comprises the amino acid sequence shown in SEQ ID NO: 65 and/or the amino acid sequence shown in SEQ ID NO: 70.

43. A hybridoma, which produces the antibody according to any one of claims 1 to 22 and 28 to 33.

44. A hybridoma producing a monoclonal antibody against human TROP-2, which has accession No. FERM BP-11251.

45. A hybridoma producing a monoclonal antibody against human TROP-2, which has accession No. FERM BP-11252.

46. A hybridoma producing a monoclonal antibody against human TROP-2, which has accession No. FERM BP-11253.

47. A hybridoma producing a monoclonal antibody against human TROP-2, which has accession No. FERM BP-11346.

48. A hybridoma producing a monoclonal antibody against human TROP-2, which has accession No. FERM BP-11254.

49. An antibody-drug conjugate, which comprises the antibody according to any one of claims 1 to 33 and a substance having anti-tumor activity and/or cell-killing activity.

50. An antibody fragment-drug conjugate, which comprises the antibody fragment according to any one of claims 34 to 42 and a substance having anti-tumor activity and/or cell-killing activity.

51. The conjugate according to claim 49 or 50, wherein the tumor is at least one type selected from the group consisting of human pancreatic cancer, human prostate cancer, human colon cancer and human breast cancer.

52. The conjugate according to claim 49 or 50, wherein the tumor is human pancreatic cancer.

53. The conjugate according to any one of claims 49 to 52, wherein the tumor is a recurrent cancer of a metastatic cancer.

54. A pharmaceutical composition, which comprises at least one type selected from the group consisting of the antibody according to any one of claims 1 to 33, the antibody fragment according to any one of claims 34 to 42 and the conjugate according to any one of claims 49 to 53.

55. The composition according to claim 54, which is used in the treatment of tumor.

56. The composition according to claim 55, which does not cause weight reduction as a side effect.

57. The composition according to claim 54, which is used in the diagnosis of tumor.

58. The composition according to any one of claims 54 to 57, wherein the tumor is at least one type selected from the group consisting of human pancreatic cancer, human prostate cancer, human colon cancer and human breast cancer.

59. The composition according to any one of claims 55 to 58, wherein the tumor is a recurrent cancer or a metastatic cancer.

60. A tumor therapeutic agent, which comprises at least one type selected from the group consisting of the antibody according to any one of claims 1 to 33, the antibody fragment according to any one of claims 34 to 42 and the conjugate according to any one of claims 49 to 53.

61. The therapeutic agent according to claim 60, which does not cause weight reduction as a side effect.

62. The therapeutic agent according to claim 60 or 61, wherein the tumor is at least one type selected from the group consisting of human pancreatic cancer, human prostate cancer, human colon cancer and human breast cancer.

63. A tumor diagnostic agent, which comprises at least one type selected from the group consisting of the antibody according to any one of claims 1 to 33, the antibody fragment according to any one of claims 34 to 42 and the conjugate according to any one of claims 49 to 53.

64. The diagnostic agent according to claim 63, wherein the tumor is at least one type selected from the group consisting of human pancreatic cancer, human prostate cancer, human colon cancer and human breast cancer.

65. A method for detecting a tumor, which comprises: allowing at least one type selected from the group consisting of the antibody according to any one of claims 1 to 33, the antibody fragment according to any one of claims 34 to 42 and the conjugate according to any one of claims 49 to 53, to react with a sample collected from a living body; and then detecting a signal(s) of the reacted antibody and/or antibody fragment.

66. The method according to claim 65, wherein the tumor is at least one type selected from the group consisting of human pancreatic cancer, human prostate cancer,

human colon cancer and human breast cancer.

67. A kit for treating, diagnosing or detecting a tumor, which comprises at least one type selected from the group consisting of the antibody according to any one of claims 1 to 33, the antibody fragment according to any one of claims 34 to 42 and the conjugate according to any one of claims 49 to 53.

68. The kit according to claim 67, wherein the tumor is at least one type selected from the group consisting of human pancreatic cancer, human prostate cancer, human colon cancer and human breast cancer.

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Val Ser Pro Gly Glu Arg Val Ser Phe Ser Cys Arg Ala Ser Gln Ser
        35                  40                  45

Ile Gly Thr Ser Ile His Trp Tyr Gln Gln Arg Thr Asn Gly Ser Pro
    50                  55                  60

Arg Leu Leu Ile Lys Tyr Ala Ser Glu Ser Ile Ser Gly Ile Pro Ser
65                  70                  75                  80

Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr Leu Ser Ile Asn
                85                  90                  95

Ser Val Glu Ser Glu Asp Ile Ala Asp Tyr Tyr Cys Gln Gln Ser Asn
            100                 105                 110
```

Ser Trp Pro Phe Thr Phe Gly Ser Gly Thr Lys Leu Glu Ile Lys
115 120 125

<210> 41
<211> 11
<212> PRT
<213> homo sapiens

<400> 41

Arg Ala Ser Gln Ser Ile Gly Thr Ser Ile His
1 5 10

<210> 42
<211> 7
<212> PRT
<213> homo sapiens

<400> 42

Tyr Ala Ser Glu Ser Ile Ser
1 5

<210> 43
<211> 9
<212> PRT
<213> homo sapiens

<400> 43

Gln Gln Ser Asn Ser Trp Pro Phe Thr
1 5

<210> 44
<211> 402
<212> DNA
<213> homo sapiens

<220>
<221> CDS
<222> (1).. (402)

<400> 44
atg gga tgg agc tgt atc atc ctc ttc ttg gta gca aca gct aca ggt 48
Met Gly Trp Ser Cys Ile Ile Leu Phe Leu Val Ala Thr Ala Thr Gly

```
1               5                   10                  15

gtc cac tcc cag gtc caa ctg cag caa cct ggg tct gag ctg gtg agg      96
Val His Ser Gln Val Gln Leu Gln Gln Pro Gly Ser Glu Leu Val Arg
            20                  25                  30

cct gga gct tca gtg aag ctg tcc tgc aag gct tct ggc tac aca ttc     144
Pro Gly Ala Ser Val Lys Leu Ser Cys Lys Ala Ser Gly Tyr Thr Phe
        35                  40                  45

acc agc tac tgg atg cac tgg gtg aag cag agg cat gga caa ggc ctt     192
Thr Ser Tyr Trp Met His Trp Val Lys Gln Arg His Gly Gln Gly Leu
    50                  55                  60

gag tgg att gga aat att tat cct ggt ggt ggt tat act aac tac gat     240
Glu Trp Ile Gly Asn Ile Tyr Pro Gly Gly Gly Tyr Thr Asn Tyr Asp
65                  70                  75                  80

gag aag ttc aag agc aag ggc aca ctg act gta gac aca tcc tcc agc     288
Glu Lys Phe Lys Ser Lys Gly Thr Leu Thr Val Asp Thr Ser Ser Ser
                85                  90                  95

aca gcc tac atg cac ctc agc agc ctg aca tct gag gac tct gcg gtc     336
Thr Ala Tyr Met His Leu Ser Ser Leu Thr Ser Glu Asp Ser Ala Val
            100                 105                 110

tat tac tgt aca aga tca tcc gtt ttt gac tac tgg ggc caa ggc acc     384
Tyr Tyr Cys Thr Arg Ser Ser Val Phe Asp Tyr Trp Gly Gln Gly Thr
        115                 120                 125

act ctc aca gtc tcc tca                                             402
Thr Leu Thr Val Ser Ser
    130
```

<210> 45
<211> 134
<212> PRT
<213> homo sapiens

<400> 45

```
Met Gly Trp Ser Cys Ile Ile Leu Phe Leu Val Ala Thr Ala Thr Gly
1               5                   10                  15

Val His Ser Gln Val Gln Leu Gln Gln Pro Gly Ser Glu Leu Val Arg
            20                  25                  30

Pro Gly Ala Ser Val Lys Leu Ser Cys Lys Ala Ser Gly Tyr Thr Phe
```

35 40 45

Thr Ser Tyr Trp Met His Trp Val Lys Gln Arg His Gly Gln Gly Leu
50 55 60

Glu Trp Ile Gly Asn Ile Tyr Pro Gly Gly Gly Tyr Thr Asn Tyr Asp
65 70 75 80

Glu Lys Phe Lys Ser Lys Gly Thr Leu Thr Val Asp Thr Ser Ser Ser
85 90 95

Thr Ala Tyr Met His Leu Ser Ser Leu Thr Ser Glu Asp Ser Ala Val
100 105 110

Tyr Tyr Cys Thr Arg Ser Ser Val Phe Asp Tyr Trp Gly Gln Gly Thr
115 120 125

Thr Leu Thr Val Ser Ser
130

<210> 46
<211> 5
<212> PRT
<213> homo sapiens

<400> 46

Ser Tyr Trp Met His
1 5

<210> 47
<211> 17
<212> PRT
<213> homo sapiens

<400> 47

Asn Ile Tyr Pro Gly Gly Gly Tyr Thr Asn Tyr Asp Glu Lys Phe Lys
1 5 10 15

Ser

<210> 48
<211> 6
<212> PRT
<213> homo sapiens

<400> 48

Ser Ser Val Phe Asp Tyr
1 5

<210> 49
<211> 381
<212> DNA
<213> homo sapiens

<220>
<221> CDS
<222> (1).. (381)

<400> 49

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atg gta tcc aca cct cag ttc ctt gta ttt ttg ctt ttc tgg att cca      48
Met Val Ser Thr Pro Gln Phe Leu Val Phe Leu Leu Phe Trp Ile Pro
1               5                  10                  15

gcc tcc aga ggt gac atc ttg ctg act cag tct cca gcc atc ctg tct      96
Ala Ser Arg Gly Asp Ile Leu Leu Thr Gln Ser Pro Ala Ile Leu Ser
            20                  25                  30

gtg agt cca gga gaa aga gtc agt ttc tcc tgc agg gcc agt cag aac     144
Val Ser Pro Gly Glu Arg Val Ser Phe Ser Cys Arg Ala Ser Gln Asn
        35                  40                  45

att ggc aca agc ata cac tgg ttt cag caa aga aca aat ggt tct cca     192
Ile Gly Thr Ser Ile His Trp Phe Gln Gln Arg Thr Asn Gly Ser Pro
    50                  55                  60

agg ctt ctc ata aag tat gct tct gag tct atc tct ggg atc cct tcc     240
Arg Leu Leu Ile Lys Tyr Ala Ser Glu Ser Ile Ser Gly Ile Pro Ser
65                  70                  75                  80

agg ttt agt ggc agt gga tca ggg aca gat ttt act ctt agc atc aac     288
Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr Leu Ser Ile Asn
                85                  90                  95

agt gtg gag tct gaa gat att gca gat tat tac tgt caa caa agt aat     336
Ser Val Glu Ser Glu Asp Ile Ala Asp Tyr Tyr Cys Gln Gln Ser Asn
            100                 105                 110
```

agc tgg cca ttc acg ttc ggc tcg ggg aca aag ttg gaa ata aaa 381
Ser Trp Pro Phe Thr Phe Gly Ser Gly Thr Lys Leu Glu Ile Lys
115 120 125

<210> 50
<211> 127
<212> PRT
<213> homo sapiens

<400> 50

Met Val Ser Thr Pro Gln Phe Leu Val Phe Leu Leu Phe Trp Ile Pro
1 5 10 15

Ala Ser Arg Gly Asp Ile Leu Leu Thr Gln Ser Pro Ala Ile Leu Ser
20 25 30

Val Ser Pro Gly Glu Arg Val Ser Phe Ser Cys Arg Ala Ser Gln Asn
35 40 45

Ile Gly Thr Ser Ile His Trp Phe Gln Gln Arg Thr Asn Gly Ser Pro
50 55 60

Arg Leu Leu Ile Lys Tyr Ala Ser Glu Ser Ile Ser Gly Ile Pro Ser
65 70 75 80

Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr Leu Ser Ile Asn
85 90 95

Ser Val Glu Ser Glu Asp Ile Ala Asp Tyr Tyr Cys Gln Gln Ser Asn
100 105 110

Ser Trp Pro Phe Thr Phe Gly Ser Gly Thr Lys Leu Glu Ile Lys
115 120 125

<210> 51
<211> 11
<212> PRT
<213> homo sapiens

<400> 51

Arg Ala Ser Gln Asn Ile Gly Thr Ser Ile His
1 5 10

<210> 52
<211> 7
<212> PRT
<213> homo sapiens

<400> 52

Tyr Ala Ser Glu Ser Ile Ser
1 5

<210> 53
<211> 9
<212> PRT
<213> homo sapiens

<400> 53

Gln Gln Ser Asn Ser Trp Pro Phe Thr
1 5

<210> 54
<211> 396
<212> DNA
<213> homo sapiens

<220>
<221> CDS
<222> (1).. (396)

<400> 54
atg gga tgg agc tgt atc atc ctc ttc ttg gta gca aca gct aca ggt 48
Met Gly Trp Ser Cys Ile Ile Leu Phe Leu Val Ala Thr Ala Thr Gly
1 5 10 15

gtc cac tcc cag gtc caa ctg cag cag cct ggg gct gag ctg gtg agg 96
Val His Ser Gln Val Gln Leu Gln Gln Pro Gly Ala Glu Leu Val Arg
20 25 30

cct ggg gct tca gtg aag ctg tcc tgc aag gct tct ggc tac acc ttc 144
Pro Gly Ala Ser Val Lys Leu Ser Cys Lys Ala Ser Gly Tyr Thr Phe
35 40 45

acc agc tac tgg ata acc tgg gtg aag cag agg cct gga caa ggc ctt 192

```
Thr Ser Tyr Trp Ile Thr Trp Val Lys Gln Arg Pro Gly Gln Gly Leu
    50                  55                  60

gag tgg atc gga aat att tat cct tct gat agt tat act aac tac aat      240
Glu Trp Ile Gly Asn Ile Tyr Pro Ser Asp Ser Tyr Thr Asn Tyr Asn
65                  70                  75                  80

caa aag ttc agg gac aag gcc aca ttg act gta gac aaa tcc tcc agt      288
Gln Lys Phe Arg Asp Lys Ala Thr Leu Thr Val Asp Lys Ser Ser Ser
                85                  90                  95

aca gcc tac atg cag ctc agc agc ccg aca tct gag gac tct gcg gtc      336
Thr Ala Tyr Met Gln Leu Ser Ser Pro Thr Ser Glu Asp Ser Ala Val
            100                 105                 110

tat tac tgt tca gcc ctc ttt gac tac tgg ggc caa ggc acc act ctc      384
Tyr Tyr Cys Ser Ala Leu Phe Asp Tyr Trp Gly Gln Gly Thr Thr Leu
        115                 120                 125

aca gtc tcc tca                                                     396
Thr Val Ser Ser
    130
```

<210> 55
<211> 132
<212> PRT
<213> homo sapiens

<400> 55

```
Met Gly Trp Ser Cys Ile Ile Leu Phe Leu Val Ala Thr Ala Thr Gly
1               5                   10                  15

Val His Ser Gln Val Gln Leu Gln Gln Pro Gly Ala Glu Leu Val Arg
            20                  25                  30

Pro Gly Ala Ser Val Lys Leu Ser Cys Lys Ala Ser Gly Tyr Thr Phe
        35                  40                  45

Thr Ser Tyr Trp Ile Thr Trp Val Lys Gln Arg Pro Gly Gln Gly Leu
    50                  55                  60

Glu Trp Ile Gly Asn Ile Tyr Pro Ser Asp Ser Tyr Thr Asn Tyr Asn
65                  70                  75                  80
```

```
Gln Lys Phe Arg Asp Lys Ala Thr Leu Thr Val Asp Lys Ser Ser Ser
                85                  90                  95

Thr Ala Tyr Met Gln Leu Ser Ser Pro Thr Ser Glu Asp Ser Ala Val
            100                 105                 110

Tyr Tyr Cys Ser Ala Leu Phe Asp Tyr Trp Gly Gln Gly Thr Thr Leu
        115                 120                 125

Thr Val Ser Ser
    130
```

<210> 56
<211> 5
<212> PRT
<213> homo sapiens

<400> 56

```
Ser Tyr Trp Ile Thr
1               5
```

<210> 57
<211> 17
<212> PRT
<213> homo sapiens

<400> 57

```
Asn Ile Tyr Pro Ser Asp Ser Tyr Thr Asn Tyr Asn Gln Lys Phe Arg
1               5                   10                  15

Asp
```

<210> 58
<211> 4
<212> PRT
<213> homo sapiens

<400> 58

```
Leu Phe Asp Tyr
1
```

<210> 59
<211> 381
<212> DNA
<213> homo sapiens

<220>
<221> CDS
<222> (1)..(381)

<400> 59
atg gta tcc aca cct cag ttc ctt gta ttt ttg ctt ttc tgg att cca 48
Met Val Ser Thr Pro Gln Phe Leu Val Phe Leu Leu Phe Trp Ile Pro
1 5 10 15

gcc tcc aga ggt gac atc ttg ctg act cag tct cca gcc atc ctg tct 96
Ala Ser Arg Gly Asp Ile Leu Leu Thr Gln Ser Pro Ala Ile Leu Ser
20 25 30

gtg agt cca gga gaa aga gtc agt ttc tcc tgc agg gcc agt cag agc 144
Val Ser Pro Gly Glu Arg Val Ser Phe Ser Cys Arg Ala Ser Gln Ser
35 40 45

att ggc aca agc ata cac tgg tat cag caa aga aca aat ggt tct cca 192
Ile Gly Thr Ser Ile His Trp Tyr Gln Gln Arg Thr Asn Gly Ser Pro
50 55 60

agg ctt ctc ata aag tat gct tct gag tct atc tct ggg atc cct tcc 240
Arg Leu Leu Ile Lys Tyr Ala Ser Glu Ser Ile Ser Gly Ile Pro Ser
65 70 75 80

agg ttt agt ggc agt gga tca ggg aca gat ttt att ctt agc atc aac 288
Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Ile Leu Ser Ile Asn
85 90 95

agt gtg gag tct gaa gat att gca gat tat tac tgt caa caa agt aat 336
Ser Val Glu Ser Glu Asp Ile Ala Asp Tyr Tyr Cys Gln Gln Ser Asn
100 105 110

agc tgg cca ttc acg ttc ggc tcg ggg aca aag ttg gaa ata aaa 381
Ser Trp Pro Phe Thr Phe Gly Ser Gly Thr Lys Leu Glu Ile Lys
115 120 125

<210> 60
<211> 127
<212> PRT
<213> homo sapiens

<400> 60

Met Val Ser Thr Pro Gln Phe Leu Val Phe Leu Leu Phe Trp Ile Pro
1 5 10 15

Ala Ser Arg Gly Asp Ile Leu Leu Thr Gln Ser Pro Ala Ile Leu Ser
20 25 30

Val Ser Pro Gly Glu Arg Val Ser Phe Ser Cys Arg Ala Ser Gln Ser
35 40 45

Ile Gly Thr Ser Ile His Trp Tyr Gln Gln Arg Thr Asn Gly Ser Pro
50 55 60

Arg Leu Leu Ile Lys Tyr Ala Ser Glu Ser Ile Ser Gly Ile Pro Ser
65 70 75 80

Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Ile Leu Ser Ile Asn
85 90 95

Ser Val Glu Ser Glu Asp Ile Ala Asp Tyr Tyr Cys Gln Gln Ser Asn
100 105 110

Ser Trp Pro Phe Thr Phe Gly Ser Gly Thr Lys Leu Glu Ile Lys
115 120 125

<210> 61
<211> 11
<212> PRT
<213> homo sapiens

<400> 61

Arg Ala Ser Gln Ser Ile Gly Thr Ser Ile His
1 5 10

<210> 62
<211> 7
<212> PRT
<213> homo sapiens

<400> 62

Tyr Ala Ser Glu Ser Ile Ser
1 5

<210> 63
<211> 9
<212> PRT
<213> homo sapiens

<400> 63

Gln Gln Ser Asn Ser Trp Pro Phe Thr
1 5

<210> 64
<211> 423
<212> DNA
<213> homo sapiens

<220>
<221> CDS
<222> (1).. (423)

<400> 64

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atg gga tgg agc tgg atc ttt ctc ttc ctc ctg tca gga act gca ggc      48
Met Gly Trp Ser Trp Ile Phe Leu Phe Leu Leu Ser Gly Thr Ala Gly
1               5                  10                  15

gtc cac tct gag gtc cag ctt cag cag tca gga cct gag ctg gtg aaa      96
Val His Ser Glu Val Gln Leu Gln Gln Ser Gly Pro Glu Leu Val Lys
            20                  25                  30

cct ggg gcc tca gtg aag att tcc tgc aag gct tct gga tac aca ttc     144
Pro Gly Ala Ser Val Lys Ile Ser Cys Lys Ala Ser Gly Tyr Thr Phe
        35                  40                  45

act gac tac aat atg cac tgg gtg aag cag agc cat gga aag aac ctt     192
Thr Asp Tyr Asn Met His Trp Val Lys Gln Ser His Gly Lys Asn Leu
    50                  55                  60

gaa tgg att gga tat att tat cct tac aat ggt ggt act ggc tac aac     240
Glu Trp Ile Gly Tyr Ile Tyr Pro Tyr Asn Gly Gly Thr Gly Tyr Asn
65                  70                  75                  80

cag agg ttc aag agc agg gcc aca atg act gta gac aaa tcc tcc agc     288
Gln Arg Phe Lys Ser Arg Ala Thr Met Thr Val Asp Lys Ser Ser Ser
                85                  90                  95
```

```
aca gcc tac atg gag ctc cgc agc ctg aca tct gat gac tct gca gtc      336
Thr Ala Tyr Met Glu Leu Arg Ser Leu Thr Ser Asp Asp Ser Ala Val
            100                 105                 110

tat tac tgt gca aga gaa gac tac ggt agt agc ccc tct tat gct atg      384
Tyr Tyr Cys Ala Arg Glu Asp Tyr Gly Ser Ser Pro Ser Tyr Ala Met
        115                 120                 125

gac tat tgg ggt caa gga acc tca gtc atc gtc tcc tca                  423
Asp Tyr Trp Gly Gln Gly Thr Ser Val Ile Val Ser Ser
    130                 135                 140
```

<210> 65
<211> 141
<212> PRT
<213> homo sapiens

<400> 65

```
Met Gly Trp Ser Trp Ile Phe Leu Phe Leu Leu Ser Gly Thr Ala Gly
1               5                   10                  15

Val His Ser Glu Val Gln Leu Gln Gln Ser Gly Pro Glu Leu Val Lys
            20                  25                  30

Pro Gly Ala Ser Val Lys Ile Ser Cys Lys Ala Ser Gly Tyr Thr Phe
        35                  40                  45

Thr Asp Tyr Asn Met His Trp Val Lys Gln Ser His Gly Lys Asn Leu
    50                  55                  60

Glu Trp Ile Gly Tyr Ile Tyr Pro Tyr Asn Gly Gly Thr Gly Tyr Asn
65                  70                  75                  80

Gln Arg Phe Lys Ser Arg Ala Thr Met Thr Val Asp Lys Ser Ser Ser
                85                  90                  95

Thr Ala Tyr Met Glu Leu Arg Ser Leu Thr Ser Asp Asp Ser Ala Val
            100                 105                 110

Tyr Tyr Cys Ala Arg Glu Asp Tyr Gly Ser Ser Pro Ser Tyr Ala Met
        115                 120                 125
```

Asp Tyr Trp Gly Gln Gly Thr Ser Val Ile Val Ser Ser
130 135 140

<210> 66
<211> 5
<212> PRT
<213> homo sapiens

<400> 66

Asp Tyr Asn Met His
1 5

<210> 67
<211> 17
<212> PRT
<213> homo sapiens

<400> 67

Tyr Ile Tyr Pro Tyr Asn Gly Gly Thr Gly Tyr Asn Gln Arg Phe Lys
1 5 10 15

Ser

<210> 68
<211> 13
<212> PRT
<213> homo sapiens

<400> 68

Glu Asp Tyr Gly Ser Ser Pro Ser Tyr Ala Met Asp Tyr
1 5 10

<210> 69
<211> 390
<212> DNA
<213> homo sapiens

<220>
<221> CDS
<222> (1).. (390)

<400> 69

```
atg aag ttg cct gtt agg ctg ttg gtg ctg atg ttc tgg att cct gct      48
Met Lys Leu Pro Val Arg Leu Leu Val Leu Met Phe Trp Ile Pro Ala
1               5                   10                  15

tcc agc agt gat gtt gtg atg acc caa act cca ctc tcc ctg cct gtc      96
Ser Ser Ser Asp Val Val Met Thr Gln Thr Pro Leu Ser Leu Pro Val
            20                  25                  30

agt ctt gga gat cag gcc tcc atc tct tgc aga tct agt cag agc ctt     144
Ser Leu Gly Asp Gln Ala Ser Ile Ser Cys Arg Ser Ser Gln Ser Leu
        35                  40                  45

gta cac ggt aat gga aac acc tat tta cat tgg tac ctg cag aag cca     192
Val His Gly Asn Gly Asn Thr Tyr Leu His Trp Tyr Leu Gln Lys Pro
    50                  55                  60

ggc cag tct cca aag ctc ctg atc tac aaa gtt tcc aac cga ttt tct     240
Gly Gln Ser Pro Lys Leu Leu Ile Tyr Lys Val Ser Asn Arg Phe Ser
65                  70                  75                  80

ggg gtc cca gac agg ttc agt ggc agt gga tca ggg acg gat ttc aca     288
Gly Val Pro Asp Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
                85                  90                  95

ctc aag atc agc aga gtg gag gct gag gat ctg gga gtt tat ttc tgc     336
Leu Lys Ile Ser Arg Val Glu Ala Glu Asp Leu Gly Val Tyr Phe Cys
            100                 105                 110

tct caa act aca cat gtt ccc acg ttc ggc tcg ggg aca aag ttg gaa     384
Ser Gln Thr Thr His Val Pro Thr Phe Gly Ser Gly Thr Lys Leu Glu
        115                 120                 125

ata aaa                                                            390
Ile Lys
    130
```

<210> 70
<211> 130
<212> PRT
<213> homo sapiens

<400> 70

```
Met Lys Leu Pro Val Arg Leu Leu Val Leu Met Phe Trp Ile Pro Ala
1               5                   10                  15

Ser Ser Ser Asp Val Val Met Thr Gln Thr Pro Leu Ser Leu Pro Val
```

20 25 30

Ser Leu Gly Asp Gln Ala Ser Ile Ser Cys Arg Ser Ser Gln Ser Leu
35 40 45

Val His Gly Asn Gly Asn Thr Tyr Leu His Trp Tyr Leu Gln Lys Pro
50 55 60

Gly Gln Ser Pro Lys Leu Leu Ile Tyr Lys Val Ser Asn Arg Phe Ser
65 70 75 80

Gly Val Pro Asp Arg Phe Ser Gly Ser Gly Ser Gly Thr Asp Phe Thr
85 90 95

Leu Lys Ile Ser Arg Val Glu Ala Glu Asp Leu Gly Val Tyr Phe Cys
100 105 110

Ser Gln Thr Thr His Val Pro Thr Phe Gly Ser Gly Thr Lys Leu Glu
115 120 125

Ile Lys
130

<210> 71
<211> 16
<212> PRT
<213> homo sapiens

<400> 71

Arg Ser Ser Gln Ser Leu Val His Gly Asn Gly Asn Thr Tyr Leu His
1 5 10 15

<210> 72
<211> 7
<212> PRT
<213> homo sapiens

<400> 72

Lys Val Ser Asn Arg Phe Ser
1 5

<210> 73
<211> 8
<212> PRT
<213> homo sapiens

<400> 73

Ser Gln Thr Thr His Val Pro Thr
1 5