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(54) Title: MONOCLONAL ANTIBODIES FOR TUMOR TREATMENT

(57) Abstract: The present invention relates to methods for inhibiting tumor growth, increasing survival of a subject having a tumor and inducing protection against tumor recurrence in a mammal. The methods comprise administering a humanized monoclonal antibody comprising CDR regions derived from the murine monoclonal antibody designated mBAT-1, in combination with at least one chemotherapeutic agent.



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MONOCLONAL ANTIBODIES FOR TUMOR TREATMENT

FIELD OF THE INVENTION

The present invention relates to methods for inhibiting tumor growth, increasing survival of a subject having a tumor and inducing protection against tumor recurrence in a mammal. The methods comprise administering a humanized monoclonal antibody comprising CDR regions derived from the murine monoclonal antibody designated mBAT-1, in combination with at least one chemotherapeutic agent.

5 BACKGROUND OF THE INVENTION

The rapid increase of knowledge in recent years about the molecular and cellular bases of immune regulation, particularly at the level of T cell responses, provides a new arsenal of immunotherapeutic approaches including the development of tumor vaccines. Certain monoclonal antibodies were shown to have immunomodulatory activity
10 including the ability to bind determinants on the surface of T cells and to induce proliferation, activation, maturation or differentiation of these cells.

BAT (also referred to as mBAT-1 or BAT-1) is a murine monoclonal antibody generated against a membrane preparation of a Burkitt lymphoma cell line (Daudi) that was shown to exhibit antitumor and immunostimulatory effects towards various types of
15 tumors (Hardy et al., 2001, Int. J. Oncol. 19:897). This monoclonal antibody was initially disclosed in U.S. Patent No. 5,897,862 to Hardy et al. BAT-1 is secreted by the hybridoma cell line having CNCM Accession No. I-1397.

The polynucleotide and amino-acid sequences of murine BAT are disclosed in WO 00/58363, to Hardy et al., and U.S. Patent Publication No. 2003/0026800. A
20 number of humanized monoclonal antibodies based on murine BAT are disclosed in U.S. Patent Application Publication No. 2008/0025980. According to the disclosure, the humanized monoclonal BAT antibody appears to induce a greater antitumor effect than those induced by the parent murine BAT antibody. Among various model systems tested, the BAT antitumor activity was studied in SCID (severe combined
25 immunodeficiency disease) mice, beige mice that are deficient in NK cells and nude mice that are deficient in T cells (Hardy, B., 1997, Proc. Natl. Acad. Sci. USA

94:5756). All mice were injected intravenously with murine B16 melanoma that subsequently develops tumors in the lungs. BAT exerted an antitumor effect only in SCID mice that were engrafted with either murine or human lymphocytes. In the athymic nude mice and the beige mice BAT exerted an antitumor activity, though this activity was less effective as compared to the antitumor activity of BAT in the wild-type mice.

The immunomodulatory effect of murine BAT was studied also in vitro. Murine BAT activates CD4⁺ T cells and induces the secretion of IFN- γ from these cells (Hardy et al., 2000, *Int. Immunol.* 12:1623 and Quaglino E. et al., 2005, *Vaccine* 9:23(25):3280-7, respectively). In addition, it was found that BAT triggers the proliferation of T cells and increases their cytolytic activity (Hardy, B. et al., 1997, *Hum. Antibodies*, 8:95).

Berger et al. (2008) discloses administration of the humanized monoclonal antibody CT-011, which is based on mBAT-1, to patients with advanced hematologic malignancies, and associated pharmacokinetics (Berger et al. *Clin. Cancer Res.* 2008;14(10) May 15, 2008).

It should be borne in mind that BAT antibodies are not expected to target the tumor cells themselves but rather the immune-functioning cells of the subject or patient, in order to modulate the immune response in a beneficial way.

One of the most widely used therapeutic treatments of cancer is chemotherapy. Chemotherapy drugs are divided into several groups based on their effect on specific chemical substances within cancer cells, the cellular activities or processes the drug interferes with, or the specific phases of the cell cycle the drug affects. Chemotherapy groups include: alkylating agents, nitrosoureas, antimetabolites, anthracyclines, topoisomerase I and II inhibitors, mitotic inhibitors and steroid inhibitors.

A chemotherapeutic drug may be provided as a sole therapy but is often used in combination with one or more other active agents. In some instances, specific combinations have been adapted to provide significantly better clinical results. For example, the antimetabolite fluorouracil (5FU) and the alkylating agent oxaliplatin, are used together in a combination regimen for the treatment of colorectal cancer. The combination therapy of fluorouracil, leucovorin (folinic acid) and oxaliplatin, also indicated for colorectal cancer, has been abbreviated as FOLFOX. The combination

therapy of cyclophosphamide, doxorubicin, vincristine and prednisone (abbreviated as CHOP) is used for the treatment of non-Hodgkin lymphoma, and the combination of CHOP and the chimeric monoclonal antibody rituximab (abbreviated as R-CHOP) is used for the treatment of diffuse large B cell lymphoma and other aggressive B-cell non-Hodgkin lymphomas.

A combination therapy of uracil, 5FU or uracil mustard with radiation and with a monoclonal antibody, which specifically binds to an extracellular domain of a VEGF receptor, is disclosed in U.S. Patent No. 6,811,779. This combined therapy is directed to inhibit angiogenesis. U.S. Patent No. 6,217,866 discloses a method for inhibiting the growth of human tumor cells that express human EGF receptors comprising administering an effective amount of an anti-neoplastic agent and an effective amount of a monoclonal antibody to a human cancer patient having said tumor cells; (i) wherein said antibody binds to the extra-cellular domain of the human EGF receptor of said tumor cell; (ii) wherein the antibody is not conjugated to the anti-neoplastic agent; and (iii) wherein the antibody inhibits the binding of EGF to the EGF receptor.

Nowhere in the background art is it taught or suggested that use of a humanized mBAT-1 monoclonal antibody in combination with chemotherapy will be advantageous. In fact, since BAT and antibodies based thereon are known to have immunostimulatory properties, it is highly surprising and unexpected that such antibodies in combination with cytotoxic or other chemotherapeutic drugs that act by killing proliferating cell populations can be used to achieve greater clinical efficacy than each type of agent on its own.

SUMMARY OF THE INVENTION

The present invention provides methods for inhibiting tumor growth, reducing tumor volume, increasing survival of a subject and inducing protection against tumor recurrence in subjects bearing solid and non-solid tumors. The methods comprise use of a humanized monoclonal antibody having at least one complementarity determining region (CDR) of murine monoclonal antibody BAT-1 (mBAT-1) and a framework region (FR) derived from an acceptor human immunoglobulin. An example of such an antibody is hBAT-1 (also referred to herein as CT-011). Some of the methods disclosed herein preferably comprise use of the humanized monoclonal antibody in a combination

regimen with at least one chemotherapeutic agent, whereas other methods disclosed herein relate to use of the humanized monoclonal antibody on its own, but which can optionally be employed in combination with one or more chemotherapeutic agents.

5 The principles of the invention are demonstrated herein using both mBAT-1 and CT-011 in lymphocyte cultures and in animal tumor models, and CT-011 in human patients having various types of hematologic tumors.

10 The invention is based, in part, on the unexpected discovery that the incorporation of CT-011 to a treatment regimen with various chemotherapeutic agents results in several beneficial antitumor and anticancer effects, including for example, reduction in the rate of tumor growth, inhibition of tumor growth, and increased survival time, as compared to monotherapies with either of the treatments alone. It has also been found that incorporation of a humanized antibody such as CT-011 into a chemotherapy regimen can provide the additional benefit of increased tolerability to dose-limiting toxicity (DLT) levels of a chemotherapeutic agent.

15 The invention is also based, in part, on the observation that treatment of induced tumors in animal models with the subject antibodies, either alone or in combination with a chemotherapeutic agent, results in both a "cure", as well as a memory effect for long-term protection against tumor recurrence upon subsequent challenge with the same tumor cells. Animals cured by treatment with the humanized antibody CT-011 were
20 thus rendered resistant to recurrence or re-exposure to the tumor. Furthermore, it is now disclosed that in certain instances human subjects undergoing early stage clinical trials with CT-011 also demonstrate long-term tumor control and protection effects after the administration of a single dose of this antibody and its elimination from the blood.

25 Without wishing to be bound by any theory or mechanism of action, the activity of humanized BAT monoclonal antibody in protecting against tumor recurrence or resurgence may be associated with the activity of such an antibody in protecting effector/memory T cells from apoptosis, as disclosed herein and exemplified with antibody CT-011.

30 Thus, in various aspects, the present invention provides combinations of antitumor agents that are not hitherto known to exert a cumulative or even an additive effect. According to certain principles of the invention, the combinations comprise one treatment which is administration of at least one chemotherapeutic agent, and another

different treatment which is administration of an immunostimulatory humanized monoclonal antibody based on mBAT-1. Unexpectedly, the two treatments achieve a greater beneficial antitumor effect when used in combination, than when used separately or each on its own. Combination therapy as used herein and in the claims may refer to
5 any of a number of different combination treatments, including for example, substantially overlapping periods of administration of two or more treatments; simultaneous, sequential or successive administration of two or more treatments, or scheduled administration of two or more treatments during alternating time periods.

According to a first aspect, the present invention provides a method of treating a
10 tumor, the method comprising (i) administering to a subject in need thereof an effective amount of a humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; and (ii) administering to the
15 subject an effective amount of at least one chemotherapeutic agent; thereby treating the tumor.

According to another aspect, the invention further provides a method of improving tolerability to at least one chemotherapeutic agent, the method comprising administering to a subject in need thereof an effective amount of a humanized monoclonal antibody or
20 a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; wherein the subject is undergoing chemotherapy with at least one chemotherapeutic agent; thereby improving tolerability to said chemotherapeutic agent.

According to yet another aspect of the invention, there is provided a method of enhancing survival or inhibiting disease progression in a subject having a tumor, wherein the subject is treated with at least one chemotherapeutic agent, the method comprising administering an effective amount of a humanized monoclonal antibody or a
25 fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; thereby enhancing survival of the subject.
30

According to yet another aspect, the invention provides a method of reducing or preventing tumor recurrence, the method comprising administering to a subject in need thereof an effective amount of a humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; thereby reducing or preventing tumor recurrence.

According to one embodiment, the method of reducing or preventing tumor recurrence further comprises administering to the subject at least one chemotherapeutic agent.

According to particular embodiments, the subject is undergoing or has completed a course of chemotherapy with at least one chemotherapeutic agent.

According to various embodiments, the light chain variable region of the humanized monoclonal antibody is characterized by the formula:

FR_{L1}-CDR_{L1}-FR_{L2}-CDR_{L2}-FR_{L3}-CDR_{L3}-FR_{L4}

wherein each FR is independently a framework region of a human antibody and each CDR is independently a complementarity determining region of the monoclonal mBAT-1 antibody.

According to various embodiments, the heavy chain variable region of the humanized monoclonal antibody is characterized by the formula:

FR_{H1}-CDR_{H1}-FR_{H2}-CDR_{H2}-FR_{H3}-CDR_{H3}-FR_{H4}

wherein each FR is independently a framework region of a human antibody and each CDR is independently a complementarity determining region of the monoclonal mBAT-1 antibody.

According to various embodiments, the FRs are derived from the light chain variable region of the human TEL9 antibody (SEQ ID NO: 130), or modified therefrom.

According to various embodiments, the FR amino acid sequences derived or modified from the light chain variable region of the human TEL9 antibody are selected from the group consisting of: FR_{L1}, [EIVLT QSPSS LSASV GDRVITC; SEQ ID NO: 1]; FR_{L2}, [W (F or Y) QQKPG KAPKL (W or L) IY; SEQ ID NO: 2]; FR_{L3}, [GVPSR FSGSG SGT (D or S) (Y or F) (C or T) LTINS LQPED FATYY C; SEQ ID

NO: 3]; and FR_{L4}, [FGGGT KLEIK; SEQ ID NO: 4].

According to various embodiments, the FRs are derived from the heavy chain variable region of the human hsighv1295 antibody (SEQ ID NO: 146), or modified therefrom.

5 According to various embodiments, the FR amino acid sequences derived or modified from the heavy chain variable region of the human hsighv1295 antibody are selected from the group consisting of: FR_{H1}, [Q (I or V) QLV QSGSE LKKPG ASVKI SCKAS GY (T or S) F (T or S); SEQ ID NO: 5]; FR_{H2}, [WV (R OR K) QAPGQ GL (Q or K) WMG; SEQ ID NO: 6]; FR_{H3}, [RF (V or A) FSLDT SV (N or S) TAYLQ ITS

10 (T or N) AEDTG MYFC (V or A) (R or K); SEQ ID NO: 7]; and FR_{H4}, [WGQGT LVTVS S; SEQ ID NO: 8].

According to various embodiments, the light chain variable region comprises at least one amino acid sequence selected from the group consisting of: CDR_{L1} [SARSS VSYM; SEQ ID NO: 9]; CDR_{L2} [RTSNL AS; SEQ ID NO: 10]; CDR_{L3} [QQRSS

15 FPLT; and SEQ ID NO: 11], wherein the CDRs are derived from the murine BAT-1 antibody and the subscripts "L" and "H" refer to light and heavy chain regions, respectively.

According to various embodiments, the heavy chain variable region comprises at least one amino acid sequence selected from the group consisting of: CDR_{H1} [NYGMN; SEQ ID NO: 12]; CDR_{H2} [WINTD SGEST YAEFF KG; SEQ ID NO: 13]; and CDR_{H3} [VGYDA LDY; SEQ ID NO: 14].

20

According to various embodiments, the humanized antibody comprises: a light chain variable region selected from the group consisting of: BATR_{κA} (SEQ ID NO: 15), BATR_{κB} (SEQ ID NO: 16), BATR_{κC} (SEQ ID NO: 17), and BATR_{κD} (SEQ ID NO: 18); and a heavy chain variable region selected from the group consisting of: A (SEQ ID NO: 20), BATRH_B (SEQ ID NO: 21), BATRH_C (SEQ ID NO: 22), BATRH_D (SEQ ID NO: 23) and BATRH_E (SEQ ID NO: 24).

25

According to yet other embodiments, the humanized antibody comprises variable regions selected from the group consisting of: BATRH_A/BATR_{κA} (SEQ ID NO: 20/SEQ ID NO: 15), BATRH_B/BATR_{κA} (SEQ ID NO: 21/SEQ ID NO: 15), BATRH_B/BATR_{κB} (SEQ ID NO: 21/SEQ ID NO: 16), BATRH_C/BATR_{κB} (SEQ ID NO: 22/SEQ ID NO: 16), BATRH_B/BATR_{κD} (SEQ ID NO: 21/SEQ ID NO: 18), and

30

BATRH_C/BATRK_D (SEQ ID NO: 22/SEQ ID NO: 18).

According to various preferred embodiments, the humanized monoclonal antibody has variable regions corresponding to BATRH_C/BATRK_D (SEQ ID NO: 22/SEQ ID NO: 18).

5 According to various embodiments, the antitumor activity of the humanized antibody or a fragment thereof is similar or greater than mBAT-1.

According to various embodiments, the fragment of the humanized antibody is selected from the group consisting of: Fv, F(ab'), F(ab')₂, and a single chain antibody.

10 The humanized monoclonal antibody of the invention is preferably generated by recombinant DNA technology, utilizing CDR grafting. Accordingly, the humanized antibody is produced by expression of polynucleotides, wherein the polynucleotides may encode the whole humanized antibody or the light chain variable region or the heavy chain variable region or the variable region of both chains of the humanized antibody. Further, the humanized antibody may be expressed in a host cell following co-
15 transfection of distinct vectors each comprising polynucleotides encoding the heavy or the light chain, or by transfection of a single vector comprising both light and heavy chain polynucleotide sequences.

According to various embodiments, the light chain of the humanized antibody is encoded by a polynucleotide sequence selected from the group consisting of: SEQ ID
20 NO: 87, SEQ ID NO: 88, and SEQ ID NO: 89.

According to various embodiments, the heavy chain of the humanized antibody is encoded by a polynucleotide sequence selected from the group consisting of: SEQ ID NO: 90, SEQ ID NO: 91, and SEQ ID NO: 92.

25 According to various embodiments, the at least one chemotherapeutic agent is selected from the group consisting of: antimetabolites, platinum-based drugs, mitotic inhibitors, anthracycline antibiotics, topoisomerase inhibitors, anti-angiogenic agents and combinations thereof.

According to a currently preferred embodiment, the at least one chemotherapeutic agent is selected so that hBAT-1 enhances survival of lymphocytes when used in
30 combination with the chemotherapeutic agent. Typically, the enhanced or increased survival may be conveniently assayed in vitro, as exemplified hereinbelow.

According to some embodiments, the at least one chemotherapeutic agent is an antimetabolite, including purine antagonists, pyrimidine antagonists and folate antagonists. According to some embodiments, the antimetabolite is a pyrimidine antagonist. According to some embodiments, the antimetabolite is selected from the group consisting of: 5-fluorouracil, uracil mustard, uracil, capecitabine, 6-mercaptapurine, methotrexate, gemcitabine, cytarabine, fludarabine, and pemetrexed.

According to some embodiments, the at least one chemotherapeutic agent is 5-fluorouracil.

According to some embodiments, the at least one chemotherapeutic agent is cytarabine.

According to some embodiments, the at least one chemotherapeutic agent is a platinum-based drug selected from the group consisting of: cisplatin, carboplatin and oxaliplatin.

According to yet other embodiments, the at least one chemotherapeutic agent is a mitotic inhibitor selected from the group consisting of: paclitaxel, docetaxel, etoposide, vinblastine, vincristine and vinorelbine.

According to yet other embodiments, the at least one chemotherapeutic agent is an anthracycline antibiotic selected from the group consisting of: daunorubicin, respinomycin D and idarubicin.

According to some embodiments, the at least one chemotherapeutic agent is an anti-angiogenic agent selected from the group consisting of: bevacizumab, dopamine, tetrathiomolybdate, and antiangiogenic variants of VEGF.

According to some embodiments, the at least one chemotherapeutic agent is other than a topoisomerase I inhibitor. According to some embodiments, the at least one chemotherapeutic agent is other than an alkylating agent.

According to various embodiments, the administering of the humanized antibody and of the at least one chemotherapeutic agent is carried out substantially simultaneously, concurrently, alternately, sequentially or successively. In some embodiments, the humanized antibody and the at least one chemotherapeutic agent are administered according to overlapping schedules.

According to particular embodiments, administering of the humanized antibody is

carried out prior to initial administration of the at least one chemotherapeutic agent.

According to other embodiments, administering of either or both of the humanized antibody and the at least one chemotherapeutic agent is carried out by a route selected from the group consisting of intravenous, oral, intraperitoneal, subcutaneous, isolated limb perfusion, infusion into an organ and combinations thereof.

According to various embodiments, the methods further comprise treating the subject with radiation. According to various embodiments, the methods comprise all of administering the humanized antibody, administering the at least one chemotherapeutic agent and treating the subject with radiation.

According to some embodiments, the humanized antibody, the at least one chemotherapeutic agent and radiation treatment are administered substantially simultaneously, concurrently, alternately, successively or according to overlapping schedules.

In particular embodiments, the methods of the invention further comprise assessing at least one parameter selected from the group consisting of: rate of tumor growth, tumor volume, number of metastases, tumor recurrence and combinations thereof.

In some embodiments, the tumor is a solid or a non-solid tumor. In some embodiments, the non-solid tumor is a hematologic malignancy. In particular embodiments, the tumor is selected from the group consisting of a colorectal carcinoma tumor; a non-small lung cancer (NSCLC) tumor; a small cell lung cancer (SCLC) tumor; a breast carcinoma tumor; a melanoma tumor; an ovarian carcinoma tumor; a cervical carcinoma tumor; a pancreatic cancer tumor; a head and neck carcinoma tumor; a gastrointestinal carcinoma tumor; an esophageal tumor; a hepatocellular carcinoma tumor; multiple myeloma; a renal cell carcinoma tumor; a prostate tumor; non-Hodgkin's lymphoma; Hodgkin's disease; mantle cell lymphoma; Kaposi's sarcoma; a squamous cell carcinoma tumor; a basal cell carcinoma tumor; acute myeloid leukemia (AML); chronic myelocytic leukemia (CML); acute lymphocytic leukemia (ALL), and chronic lymphocytic leukemia (CLL).

According to various embodiments, the subject is a human or non-human mammal. According to various preferred embodiments, the subject is a human.

In an additional aspect, the invention provides use of (i) a humanized monoclonal

antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; and (ii) at least one chemotherapeutic agent; for the preparation of a medicament for treating a tumor.

In another aspect, the invention provides a humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; for the treatment of a tumor in a subject undergoing chemotherapy with at least one chemotherapeutic agent.

In an additional aspect, the invention provides use of a humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom, for the preparation of a medicament for improving tolerability to at least one chemotherapeutic agent in a subject undergoing chemotherapy with said at least one chemotherapeutic agent.

In an additional aspect, the invention provides a humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom, for improving tolerability to at least one chemotherapeutic agent in a subject undergoing chemotherapy with said at least one chemotherapeutic agent.

According to another aspect, the invention provides use of a humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; for the preparation of a medicament for enhancing survival or inhibiting disease progression in a subject having a tumor, wherein the subject is treated with at least one chemotherapeutic agent.

According to another aspect, the invention provides a humanized monoclonal

antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; for enhancing survival or inhibiting disease progression in a subject having a tumor, wherein the subject is treated with at least one chemotherapeutic agent.

According to yet another aspect, the invention provides use of a humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; for the preparation of a medicament of reducing or preventing recurrence of a tumor.

According to yet another aspect, the invention provides a humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; for reducing or preventing recurrence of a tumor.

In particular embodiments, the subject has undergone, is undergoing, or is scheduled to undergo chemotherapy with at least one chemotherapeutic agent.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 shows the effect of hBAT-1 in an assay based on viability of lymphocytes, when added to cultures concomitantly with vehicle control (gray bars) or in combination with 5FU (0.5mg/ml, white bars) and incubated for 72 hours. **Fig. 1A.** hBAT-1 (0.5 or 0.75 ug/ml as indicated) activity in the absence and presence of 5FU, presented as % difference in cell survival. **Fig. 1B.** hBAT-1 (0.75ug/ml) activity in the absence and presence of 5FU, expressed by Area Under dose response Curve (AUC presented as % difference x ug/ml). The incubation time with hBAT-1 (72 hours) is indicated on the x-axis. **Fig. 1C.** The effect of 5FU or vehicle control in the functional assay presented as viable cells/ml. The incubation time with 5FU or vehicle control (72 hours) is indicated on the x-axis.

Figure 2 shows the effect of hBAT-1 in an assay based on viability of lymphocytes when added to cultures 24 prior to addition of vehicle control (gray bars)

or 5FU (0.5mg/ml, white bars), followed by incubation for 72 hours. **Fig. 2A.-** hBAT-1 (0.5 or 0.75 ug/ml as indicated) activity in the absence and presence of 5FU, presented as % difference in cell survival. **Fig. 2B.** hBAT-1 (0.75 ug/ml) activity in the absence and presence of 5FU, presented as Area Under a dose response Curve (AUC presented as % difference x ug/ml). The incubation time with hBAT-1 (72 hours) is indicated on the x-axis.

Figure 3 shows the effect of hBAT-1 in an assay based on viability of lymphocytes when concomitantly added to cultures with vehicle control (gray bars) or in combination with SN-38 (active form of irinotecan at 0.1mg/ml, white bars) and incubated for 72 hours. **Fig. 3A.** hBAT-1 (0.5 or 0.75 ug/ml as indicated) activity in the absence and presence of SN-38, presented as % difference in cell survival. **Fig. 3B.** hBAT-1 (0.75 ug/ml) activity expressed by Area Under dose response Curve (AUC presented as % difference x ug/ml). The incubation time with hBAT-1 (72 hours) is indicated on the x-axis.

Figure 4 shows the effect of hBAT-1 in an assay based on viability of lymphocytes when added to cultures 24 prior to addition of vehicle control (gray bars) or SN-38 (active form of irinotecan at 0.1ug/ml, white bars), followed by incubation for 72 hours. **Fig. 4A.** hBAT-1 (0.5 or 0.75ug/ml as indicated) activity in the absence and presence of SN-38, presented as % difference in cell survival. **Fig. 4B.** hBAT-1 (0.75 ug/ml) activity expressed as Area Under a dose response Curve (AUC presented as % difference x ug/ml). The incubation time with hBAT-1 (72 hours) is indicated on the x-axis.

Figure 5 shows the effect of hBAT-1 in an assay based on viability of lymphocytes when added to cultures (at dose response concentrations of 0.25 to 1.25 ug/ml) concomitantly (**Fig. 5A**) or 24 prior to (**Fig. 5B**) addition of vehicle control (gray bars) or the indicated chemotherapeutic agent (white bars), followed by incubation for 72 hours. Cis, cisplatin (10ug/ml); Oxa, oxaliplatin (10ug/ml); Tax, paclitaxel (0.43ug/ml); Dac, dacarbazine (1ug/ml). hBAT-1 activity is presented as Area Under a dose response Curve (AUC presented as % difference x ug/ml). The incubation time with hBAT-1 (72 hours) is indicated on the x-axis.

Figure 6 shows the effect of hBAT-1 (0.75 or 1 ug/ml, as indicated) in an assay based on viability of lymphocytes when added concomitantly to cultures with vehicle

control) (black bars) or in combination with a chemotherapeutic agent (white bars) followed by incubation for 72 hours. Chemotherapeutic agents used were: cytarabine at 2mg/ml (**Fig. 6A**), cyclophosphamide at 1mg/ml (**Fig. 6B**) and doxorubicin at 0.03mg/ml (**Fig. 6C**). hBAT-1 activity is presented as % difference in cell survival.

Figure 7 shows the effect of hBAT-1 in an assay based on viability of isolated human CD4⁺ lymphocytes when added (at 0.75ug/ml) 24 prior to addition of vehicle control (black bars) or a chemotherapeutic agent (white bars), followed by incubation for 72 hours. Chemotherapeutic agents used were: 5FU at 1ug/ml (**Fig. 7A**) and cisplatin at 10ug/ml (**Fig. 7B**). hBAT-1 activity is presented as % difference in cell survival.

Figure 8 shows the antitumor effect in colorectal adenocarcinoma (CRC) bearing mice of vehicle (black circles); 5FU (20 mg/kg administered on days 6-9 and 15-16; white squares); hBAT-1 (10 µg/mouse administered on day 10; black squares); and a combination regimen (white circles) of hBAT-1 (10 µg/mouse administered on day 10) and 5FU (20 mg/kg administered on days 6-9 and 15-16).

Figure 9 shows the antitumor effect in CRC bearing mice of 5FU (20 mg/kg administered on days 6-9, 15-17, 22-24 and 29-31; white squares) and a combination regimen (white triangles) of hBAT-1 (10 µg/mouse administered on days 10, 18 and 25) and 5FU (20 mg/kg administered on days 6-9, 15-17, 22-24 and 29-31).

Figure 10 shows percentage of survival of CRC bearing mice treated with vehicle (white circles); 5FU (20 mg/kg administered on days 6-9, 15-17, 22-24, 29-31, 36-38 and 43-45; black triangles); hBAT-1 (10 µg/mouse administered on days 10, 18, 25, 32 and 39; black squares); and a combination regimen (black diamonds) of hBAT-1 (10 µg/mouse administered on days 10, 18, 25, 32 and 39) and 5FU (20 mg/kg administered on days 6-9, 15-17, 22-24, 29-31, 36-38 and 43-45).

Figure 11 shows percentage of survival of mice injected with B16 melanoma cells and treated with 5FU (50 mg/kg administered on days 1-4 and 7-8; black diamonds) or a combination regimen (white squares) of hBAT-1 (10 µg/mouse administered on day 10) and 5FU (50 mg/kg administered on days 1-4 and 7-8).

Figure 12 shows the antitumor effect, as evaluated by median tumor volume, upon treatment with vehicle (black circles); irinotecan (100 mg/kg administered on days

7 and 15; black squares); hBAT-1 (10 µg/mouse administered on day 10; white circles); and a combination regimen (white triangles) of hBAT-1 (10 µg/mouse administered on day 10) and irinotecan (100 mg/kg administered on days 7 and 15) in CRC bearing mice.

5 **Figure 13** shows percentage of survival of CRC bearing mice treated with vehicle (black circles); irinotecan (100 mg/kg administered on days 7 and 15, 22 and 29; black triangles); hBAT-1 (10 µg/mouse administered on days 10, 18, 25 and 32; white squares); and a combination regimen (black diamonds) of hBAT-1 (10 µg/mouse administered on days 10, 18, 25 and 32) and irinotecan (100 mg/kg administered on
10 days 7 and 15, 22 and 29).

Figure 14 shows the antitumor effect, as evaluated by the median tumor volume, upon treatment with vehicle (black circles); oxaliplatin (1mg/kg administered on days 4, 7-10, 14-17 and 22-23; white squares); and a combination regimen (black triangles) of hBAT-1 (10 µg/mouse administered on days 11 and 18) and oxaliplatin (1mg/kg
15 administered on days 4, 7-10, 14-17 and 22-23) in CRC bearing mice.

Figure 15 shows percentage of survival of CRC bearing mice treated with vehicle (black circles); oxaliplatin (1mg/kg administered on days 4, 7-10, 14-17, 22-24, 29-31; white squares); and a combination regimen (black triangles) of hBAT-1 (10 µg/mouse administered on days 11, 18, 25 and 32) and oxaliplatin (1 mg/kg administered on days
20 4, 7-10, 14-17, 22-24, 29-31).

Figure 16 shows the effect of a combination of hBAT-1 and a chemotherapeutic agent in protecting against tumor recurrence, as evaluated by median tumor volume (**Fig. 16A**) and percentage of survival (**Fig. 16B**). Mice (n=3) that had been cured of CRC for 2 or 5 months by a combination regimen of hBAT-1 and oxaliplatin, were then
25 re-challenged with the same CRC cell line (white squares). In addition, naïve mice (n=6) were newly introduced with CRC (black circles).

Figure 17 shows the effect of a combination of hBAT-1 and a chemotherapeutic agent in protecting against tumor recurrence, as evaluated by median tumor volume (**Fig. 17A**) and percentage of survival (**Fig. 17B**). Mice (n=2) that had been previously
30 cured of CRC by a combination regimen of hBAT-1 and oxaliplatin, as indicated by the lack of tumor recurrence upon challenge with the same CRC cell line, were then re-challenged with breast carcinoma (white squares). Challenge with breast carcinoma was

carried out 2 months after mice exhibited resistance against CRC tumor recurrence. In addition, naïve mice (n=6) were newly introduced with CRC (black circles).

Figure 18 shows the effect of CT-11 in an cell viability assay, using human CD4+CD45RO+ effector/memory T cells (black bars) and naïve CD4+CD45RO- T cells (white bars) treated with hBAT (1ug/ml), followed by incubation for 72 and 96 hours. Results are expressed as % difference in cell survival.

Figure 19 shows the amino acid sequences of various embodiments of the humanized BAT-1 VK region (SEQ ID NOS. 15-18). Where the BAT-1 Vκ region residues and the human TEL9 Vκ region (SEQ ID NO. 130) sequence match a dot [.] is shown. Where no amino acid is present at a specific residue position a dash [-] is shown. Where an amino acid in the TEL9 FRs is changed in the humanized BAT-1 Vκ region, it is highlighted in bold. The CDRs are described by the use of the nomenclature [=L1=]. The numbering used is as according to Kabat (Kabat et al., Sequences of proteins of immunological interest, Fifth Edition, U.S. Department of Health and Human Services, U.S. Government Printing Office, 1991).

Figure 20 presents the amino acid sequences of various embodiments of the humanized BAT-1 VH region (SEQ ID NOS. 20-24). Where the BAT-1 VH region residues and the human hsinhv1295 VH region (SEQ ID NO. 146) sequence match a dot [.] is shown. Where no amino acid is present at a specific residue position a dash [-] is shown. Where an amino acid in the hsinhv1295 FRs is changed in the humanized BAT-1 VH region, it is highlighted in bold. The CDRs are described by the use of the nomenclature [=H1=], while [-----] denotes part of the H1 structural loop. The numbering used is as according to Kabat (Kabat et al., *ibid*).

DETAILED DESCRIPTION OF THE INVENTION

Definitions

The term "antibody" (also referred to as an "immunoglobulin") is used in the broadest sense and specifically encompasses monoclonal antibodies (including full length monoclonal antibodies) and antibody fragments so long as they exhibit the desired biological activity. "Antibody fragments" comprise a portion of a full length antibody, generally the antigen binding or variable region thereof. Examples of antibody

fragments include Fab, Fab', F(ab')₂, and Fv fragments; diabodies; linear antibodies; single-chain antibody molecules; and multispecific antibodies formed from antibody fragments.

5 The basic unit of the naturally occurring antibody structure is a heterotetrameric glycoprotein complex of about 150,000 daltons, composed of two identical light (L) chains and two identical heavy (H) chains, linked together by both noncovalent associations and by disulfide bonds. Each heavy and light chain also has regularly spaced intrachain disulfide bridges. Five human antibody classes (IgG, IgA, IgM, IgD and IgE) exist, and within these classes, various subclasses, are recognized on the basis
10 of structural differences, such as the number of immunoglobulin units in a single antibody molecule, the disulfide bridge structure of the individual units, and differences in chain length and sequence. The class and subclass of an antibody is its isotype.

The amino terminal regions of the heavy and light chains are more diverse in sequence than the carboxy terminal regions, and hence are termed the variable domains.
15 This part of the antibody structure confers the antigen-binding specificity of the antibody. A heavy variable (VH) domain and a light variable (VL) domain together form a single antigen-binding site, thus, the basic immunoglobulin unit has two antigen-binding sites. Particular amino acid residues are believed to form an interface between the light and heavy chain variable domains (Chothia et al., J. Mol. Biol. 186, 651-63
20 (1985); Novotny and Haber, (1985) Proc. Natl. Acad. Sci. USA 82 4592-4596).

The carboxy terminal portion of the heavy and light chains form the constant domains i.e. CH₁, CH₂, CH₃, CL. While there is much less diversity in these domains, there are differences from one animal species to another, and further, within the same individual there are several different isotypes of antibody, each having a different
25 function.

The term "framework region" or "FR" refers to the amino acid residues in the variable domain of an antibody which are other than the hypervariable region amino acid residues as herein defined. The term "hypervariable region" as used herein refers to the amino acid residues in the variable domain of an antibody which are responsible for
30 antigen binding. The hypervariable region comprises amino acid residues from a "complementarity determining region" or "CDR". The CDRs are primarily responsible

for binding to an epitope of an antigen. The extent of FRs and CDRs has been precisely defined (see, Kabat et al., *ibid*).

The term "acceptor human immunoglobulin" refers to the human immunoglobulin providing the framework for a humanized antibody.

5 As used herein, the term "humanized antibody" refers to an antibody comprising a framework region from a human antibody and one or more CDRs from a non-human (usually a mouse or rat) immunoglobulin. Parts of a humanized immunoglobulin, except possibly the CDRs, are substantially identical to corresponding parts of natural human immunoglobulin sequences. In some cases however, specific amino acid residues, for
10 example in the framework regions, may be modified, so as to optimize performance of the humanized antibody. Importantly, the humanized antibody is expected to bind to the same antigen as the donor antibody that provides the CDRs. For further details, see e.g. U.S. Pat. No. 5,225,539 assigned to Medical Research Council, UK.

The terms "a framework region from an acceptor human immunoglobulin" and "a
15 framework region derived from an acceptor human immunoglobulin", and similar grammatical expressions are used interchangeably herein to refer to a framework region or portion thereof that has the same amino acid sequence of the acceptor human immunoglobulin.

The term "a framework region modified from an acceptor human
20 immunoglobulin" and similar grammatical expressions refers to a framework region that is altered in its amino acid sequence, for example by substitution or deletion or chemical modification of one or more amino acid residues, as compared to the sequence of the original acceptor human immunoglobulin. Modification in the FR region may be carried out so as to optimize performance of the humanized antibody being constructed, for
25 example to optimize antigen binding and avoid steric clashes. A detailed explanation of the basis and rationale for modifying specific residues in the FR regions of an acceptor immunoglobulin for construction of a humanized BAT antibody is provided in U.S. Patent Application Publication No. 2008/0025980.

Further, an FR may be chemically modified at one or more amino acid residues,
30 either by natural processes, such as processing or other post-translational modifications, or by chemical modification techniques. Chemical modifications include, without limitation, acetylation, acylation, amidation, ADP-ribosylation, glycosylation, GPI

anchor formation, covalent attachment of a liquid or lipid derivative, methylation, myristylation, pegylation, prenylation, phosphorylation, ubiquitination, or any similar process.

5 The term "human antibody" refers to an antibody encoded by a gene actually occurring in a human, or an allele, variant or mutant thereof.

10 The term "antitumor effect" as used herein, refers to a beneficial biological effect, which can be manifested by any one or more of: a decrease or stabilization of tumor volume, a decrease or stabilization of the number of tumor cells, a decrease or stabilization of the rate of tumor growth, a decrease or stabilization of the number of metastases, protection from tumor recurrence, an increase in life expectancy or survival of the subject with the tumor, an increase in life expectancy or survival without disease progression of the subject with the tumor or amelioration of various physiological symptoms associated with the cancerous condition. An "antitumor effect" can also be manifested by the ability of the combination of the invention to prevent the occurrence of tumor in the first place or the recurrence of the tumor. Given its properties, the methods of the invention can be used in the treatment of acute cancer, of dormant, controlled or stabilized cancer, as well as in cancer prophylaxis.

20 The term "mammal" means any mammal, including pet animals, such as dogs and cats; farm animals, such as pigs, cattle, sheep, and goats; laboratory animals, such as mice and rats; primates, such as monkeys, apes, and chimpanzees; and preferably, humans.

25 The term "effective amount" with respect to the humanized antibody and the chemotherapeutic agent(s) of the invention should be understood as meaning an amount of each of these active agents required to achieve a therapeutic effect, without causing excessive or uncontrollable adverse side effects. The effective amount required to achieve the therapeutic end result may depend on a number of factors including, for example, the specific type of the tumor and the severity of the patient's condition, and whether the combination is further co-administered with radiation. The effective amount (dose) of the active agents, in the context of the present invention should be sufficient to effect a beneficial therapeutic response in the subject over time, including inhibition of tumor growth, reduction in the rate of tumor growth, prevention of tumor and metastasis growth and enhanced survival.

The term “enhanced survival”, as used herein, refers to a prolonged length of time during which the subject or patient is alive following treatment with a method of the invention. Enhanced survival denotes the increased probability of staying free of disease progression for an individual suffering from cancer after a particular treatment. It is also used to describe the elevated percentage of individuals in a group whose disease is likely to remain stable (not showing signs of progression) after a specified duration of time, compared to a control group. It is also used to describe the elevated percentage of individuals in a group whose disease is likely to be cured (not showing signs of disease) after a specified duration of time, compared to a control group. This parameter may be measured by any one of the customary clinical endpoints denoted as "progression-free survival", "overall survival" and "disease free survival" used as an indication of the efficacy of a particular treatment.

The term “tolerability to chemotherapeutic agents” refers to the physiological, physicochemical and immunological capacity of a subject to tolerate the adverse side effects associated with treatment with one or more chemotherapeutic agents. Accordingly, the term “improving tolerability to chemotherapeutic agents” refers to increasing the physiological and physicochemical capacity to such adverse side effects, such that the severity of the adverse side effects is decreased and/or the number of side effects is decreased. Accordingly, “improving tolerability to chemotherapeutic agents” may refer to improving the quality of life of cancer patients treated with chemotherapeutic agents.

The term “tumor recurrence” refers to the re-emergence, reappearance, re-growth or proliferation of a tumor of the same type in either the same location or a different location, following a period during which the growth of the original tumor has been reversed, arrested or inhibited.

The term “enhances or increases lymphocyte survival” as used herein refers to the ability of a particular combination of treatments to prolong the viability of lymphocytes in vitro or in vivo, as compared to the viability of an identical cell population with only one of the treatments. For example, certain combinations of hBAT-1 and chemotherapeutic agents enhance lymphocyte survival, as assessed in an in vitro assay, as exemplified in Example 1 herein.

Methods of the Invention

Cancer immunotherapeutics are aimed by and large at modulating the response of the immune system to induce or enhance killing of tumor cells and control tumor growth. This approach utilizes using various immunomodulators including monoclonal
5 antibodies that selectively bind to specific determinants on T cells thereby either initiating an activation pathway or inducing an inhibitory effect.

According to certain aspects of the present invention, administration of the immunostimulatory humanized antibody in conjunction with at least one antitumor
10 chemotherapeutic agent acts to enhance the antitumor effect of chemotherapeutic agents, and vice versa. In preferred embodiments, the combinations of the immunostimulatory antibody together with the at least one chemotherapeutic agent improve the clinical outcome in a significant manner versus each of the treatments alone. In a preferred embodiment, there is synergy when tumors are treated with the humanized antibody of the invention in conjunction with at least one chemotherapeutic
15 agent, and, optionally further in conjunction with radiation.

In other words, according to one aspect of the present invention the antitumor effect of the humanized antibody of the invention is augmented more than expected when combined with at least one chemotherapeutic agent. Synergy may be shown by greater antitumor effect with combined treatment than would be expected from the
20 additive effect of treatment with the humanized antibody and the chemotherapeutic agent(s), each on its own. For example, synergy is demonstrated in Examples 2, 3 and 6 herein, which disclose that combination therapy according to the invention exerts an increased antitumor effect, as measured by both tumor volume and survival of tumor bearing mice, as compared to the effect of either the antibody or chemotherapy alone.
25 More specifically, in assessing effect on tumor volume, Figure 8 shows that administration of the combination of hBAT-1 and 5FU is advantageous over each agent on its own, and Figure 9 shows that the combination of hBAT-1 and 5FU is synergistic over 5FU on its own. Similarly, in assessing effect on survival, it has been demonstrated that administration of the combination of hBAT-1 and 5FU is advantageous over each
30 agent on its own (Figure 10) or over 5FU on its own (Figure 11). A different combination, namely hBAT-1 and oxaliplatin, is not only advantageous over oxaliplatin in increasing survival, but also induces complete remission in some of the subjects (Figure 15). Synergy is also demonstrated by complete remission and generation of

tumor-specific memory protection in tumor bearing mice treated with the combination therapy of the invention as compared to the corresponding monotherapies (Figures 10, 15, 16, 17).

5 The *in vivo* effects exerted by the combinations of the invention are supported by *in vitro* functional assays of lymphocyte cell survival as disclosed in Example 1 herein. As exemplified, sequential treatment of murine lymphocytes with hBAT-1 followed by 5FU (administered after a period of 24 hours) unexpectedly enhanced lymphocyte survival by approximately 30% (Figure 2A). Concomitant treatment of lymphocytes with hBAT-1 and 5FU only slightly increased lymphocyte survival (Figure 1A) 10 compared to treatment with hBAT-1 alone, and 5FU on its own did not enhance cell survival (Fig. 1C), indicating mechanistic synergy of the sequential scheduled treatment. Synergistic activity was also observed in *in vitro* assays with the combination of the chemotherapeutic agent cisplatin and the humanized antibody (Figure 7B). Thus, combining certain chemotherapeutic agents, with the humanized antibody of the 15 invention results in synergistic effects *in vitro* and *in vivo*.

The synergistic effect disclosed and exemplified herein is utterly unexpected, given that BAT antibodies and chemotherapeutic agents are known to have completely different and even opposing mechanisms of action and types of targets. That is, BAT antibodies function by stimulating immune-functioning cells (as disclosed for example 20 in Hardy et al 1994; Hardy et al 1997), whereas chemotherapeutic agents such as 5FU and oxaliplatin act by killing rapidly dividing cells including immune-functioning cells.

As exemplified herein, the combinations according to the present invention are those where use of the chemotherapeutic agents in combination with the humanized antibody of the invention, demonstrate increased or enhanced lymphocyte cell survival. 25 As disclosed in Example 1 and Figures 1-7, lymphocyte cell survival may be conveniently assessed using *in vitro* assays.

Accordingly, in various embodiments, the chemotherapeutic agent may be selected from an antimetabolite, such as the pyrimidine analog 5-fluorouracil, or cytarabin, or a platinum-based drug, such as oxaliplatin or cisplatin. Further, in various 30 embodiments, the chemotherapeutic agent may be other than an agent selected from a topoisomerase I inhibitor (such as SN-38) and an alkylating agent (such as cyclophosphamide). Antitumor effect induced by the combinations of the invention

includes the prevention, inhibition of the progression of a tumor, reduction of tumor growth and protection against tumor recurrence, including cancerous and noncancerous tumors. The progression of a tumor includes the invasiveness, metastasis, recurrence and increase in size of the tumor. The reduction of tumor growth also includes the
5 destruction or elimination of a tumor leading to complete remission.

In addition, the invention has been further found to be effective for improving tolerability to chemotherapeutic agents. As is known in the art, a major setback for patients undergoing cancer chemotherapy is the appearance of severe and detrimental adverse side effects due to the potent toxicity of most chemotherapeutic agents. As
10 exemplified herein in Example 3, use of a humanized BAT antibody (CT-011) in combination with 5FU at dose-limiting toxicity (DLT) levels, using a sequential administration schedule, results in enhanced survival of mice. These observations support use of humanized BAT antibodies for improving tolerability to chemotherapeutic agents in patients undergoing chemotherapy.

The invention further provides a method of enhancing survival in a subject with a tumor, which comprises administration of the humanized antibody of the invention, either on its own, or optionally, combined with the further administration of one or more chemotherapeutic agents. For example, the "cure" effect induced by CT-011 in human cancer patients (Example 8) supports such an antibody monotherapy. This aspect
15 of the invention is particularly advantageous in cases where chemotherapy has failed or where the patient is unable to tolerate chemotherapeutic agents.

The invention further provides a method of reducing or preventing recurrence of a tumor, which comprises administration of the humanized antibody of the invention, either on its own, or optionally, combined with the further administration of one or
25 more chemotherapeutic agents. As demonstrated herein in Example 6, combination treatment of experimental animals using the humanized antibody of the invention and chemotherapeutic agents clearly induced a "memory" effect, such that tumor recurrence was inhibited upon re-challenge with the original tumor type.

All types of tumors may be treated by the methods of the present invention. The
30 tumors may be solid or non-solid.

Some examples of solid tumors that can be treated with the combination of the present invention include carcinomas, sarcomas, blastomas or gliomas. Some examples

of such tumors include epidermoid tumors, squamous tumors, such as head and neck tumors, colorectal tumors, prostate tumors, breast tumors, lung tumors, including small cell and non-small cell lung tumors, pancreatic tumors, thyroid tumors, ovarian tumors, liver tumors, esophageal tumors and gastric tumors. Other examples include Kaposi's sarcoma, CNS neoplasms, neuroblastomas, capillary hemangioblastomas, meningiomas and cerebral metastases, melanoma, gastrointestinal and renal carcinomas and sarcomas, rhabdomyosarcoma, glioblastoma, preferably glioblastoma multiforme, and leiomyosarcoma. Examples of vascularized skin cancers include squamous cell carcinoma, basal cell carcinoma and skin cancers that can be treated by suppressing the growth of malignant keratinocytes, such as human malignant keratinocytes.

Some examples of non-solid tumors include leukemias, multiple myelomas and lymphomas. Some examples of leukemias include acute myelocytic leukemia (AML), chronic myelocytic leukemia (CML), acute lymphocytic leukemia (ALL), chronic lymphocytic leukemia (CLL), erythrocytic leukemia or monocytic leukemia. Some examples of lymphomas include lymphomas associated with Hodgkin's disease, Non-Hodgkin's disease or mantle cell lymphoma.

Currently preferred types of tumors are selected from the following group: colorectal carcinoma; lung carcinoma including non small lung cancer (NSCLC) and small cell lung cancer (SCLC); breast carcinoma; melanoma; ovarian carcinoma; cervical carcinoma, pancreatic cancer; head and neck carcinoma; gastrointestinal carcinoma; esophageal tumors; hepatocellular carcinoma; multiple myeloma; renal cell carcinoma; prostate tumors; non-Hodgkin's lymphoma; Hodgkin's disease; mantle cell lymphoma; Kaposi's sarcoma; squamous cell carcinoma; basal cell carcinoma; acute myeloid leukemia (AML); chronic myelocytic leukemia (CML); acute lymphocytic leukemia (ALL); chronic lymphocytic leukemia (CLL).

It should be noted that according to the teaching of the present invention, the humanized antibody of the invention may be administered before, during, or after commencing chemotherapy and, optionally, radiation therapy, as well as any combination thereof, i.e. before and during, before and after, during and after, or before, during, and after commencing the chemotherapy and, optionally, the radiation therapy. For example, the antibody of the invention may be administered between 1 and 30 days prior to or after commencing chemotherapy. The antibody may further be administered between courses of chemotherapy.

In the combination therapy methods of the invention, the antibodies may be administered in parallel to the chemotherapy, for example substantially simultaneously or concurrently. Other administration schedules may also be used, for example, overlapping schedules or those which involve alternately, sequentially or successively administering the two types of treatment.

Humanized antibody of the invention

As used herein, the terms "BAT" and a BAT antibody" are used in a broad sense and specifically cover antibodies identical to or based on the murine monoclonal antibody known as mBAT-1, or an antigen binding fragment thereof. The monoclonal antibody mBAT-1 is secreted by the hybridoma cell line deposited at the Collection Nationale de Cultures de Microorganismes (CNCM), under Accession No. 1-1397, as disclosed in U.S. Patent No. 5,897,862. Further "BAT" and a BAT antibody" may refer to an antibody, which recognizes the same antigenic epitope as mBAT-1, for example a chimeric antibody as described in U.S. Patent Application Publication No. 2003/0026800. A BAT antibody also includes a humanized antibody, various examples of which are disclosed in WO03/099196 and U.S. Patent Application Publication No. 2008/0025980. The terms "CT-011", "hBAT" and "hBAT-1" are interchangeably used herein to refer to one humanized antibody according to the invention.

In general, the light chain variable region of the humanized monoclonal antibody is characterized by the formula:



wherein each FR is independently a framework region of a human antibody and each CDR is independently a complementarity determining region of the monoclonal mBAT-1 antibody.

In general, the heavy chain variable region of the humanized monoclonal antibody is characterized by the formula:



wherein each FR is independently a framework region of a human antibody and each CDR is independently a complementarity determining region of the monoclonal mBAT-1 antibody.

In particular embodiments, the FRs are derived from the light chain variable

region of the human TEL9 antibody (SEQ ID NO: 130), or are modified therefrom in certain amino acid residues.

Human TEL-9 antibody was identified in diverse libraries of immunoglobulin heavy (VH) and light (V kappa and V lambda) chain variable (V) genes prepared from peripheral blood lymphocytes of unimmunized donors (Marks et al. J Mol Biol. 1991, 222:581-97). This antibody was shown to bind specifically to the turkey egg-white lysozyme (TEL) antigen.

FR amino acid sequences derived or modified from the light chain variable region of the human TEL9 antibody may be selected from the group consisting of: FR_{L1}, [EIVLT QSPSS LSASV GDRVITC; SEQ ID NO: 1]; FR_{L2}, [W (F or Y) QQKPG KAPKL (W or L) IY; SEQ ID NO: 2]; FR_{L3}, [GVPSR FSGSG SGT (D or S) (Y or F) (C or T) LTINS LQPED FATYY C; SEQ ID NO: 3]; and FR_{L4}, [FGGGT KLEIK; SEQ ID NO: 4].

In particular embodiments, the FRs are derived from the heavy chain variable region of the human hshghv1295 antibody (SEQ ID NO: 146), or modified therefrom in certain amino acid residues.

Human hsiggv1295 antibody was isolated from stable hybridomas and Epstein-Barr virus-transformed B cell lines from the synovial fluid or peripheral blood of three patients with rheumatoid arthritis and one patient with systemic lupus erythematosus (Fang et al., J Exp Med. 1994, 179:1445-56).

FR amino acid sequences derived or modified from the heavy chain variable region of the human hshghv1295 antibody may be selected from the group consisting of: FR_{H1}, [Q (I or V) QLV QSGSE LKKPG ASVKI SCKAS GY (T or S) F (T or S); SEQ ID NO: 5]; FR_{H2}, [WV (R OR K) QAPGQ GL (Q or K) WMG; SEQ ID NO: 6]; FR_{H3}, [RF (V or A) FSLDT SV (N or S) TAYLQ ITSL (T or N) AEDTG MYFC (V or A) (R or K); SEQ ID NO: 7]; and FR_{H4}, [WGQGT LVTVS S; SEQ ID NO: 8].

According to various embodiments, the light chain variable region comprises at least one amino acid sequence selected from the group consisting of: CDR_{L1} [SARSS VSYM; SEQ ID NO: 9]; CDR_{L2} [RTSNL AS; SEQ ID NO: 10]; CDR_{L3} [QQRSS FPLT; SEQ ID NO: 11], wherein the CDRs are derived from the murine BAT-1 antibody and the subscripts "L" and "H" refer to light and heavy chain regions, respectively.

According to various embodiments, the heavy chain variable region comprises at least one amino acid sequence selected from the group consisting of: CDR_{H1} [NYGMN; SEQ ID NO: 12]; CDR_{H2} [WINTD SGEST YAEFF KG; SEQ ID NO: 13]; CDR_{H3} [VGYDA LDY; SEQ ID NO: 14].

5 According to various embodiments, the humanized antibody comprises: a light chain variable region selected from the group consisting of: BATR_{K_A} (SEQ ID NO: 15), BATR_{K_B} (SEQ ID NO: 16), BATR_{K_C} (SEQ ID NO: 17), and BATR_{K_D} (SEQ ID NO: 18); and

10 a heavy chain variable region selected from the group consisting of: A (SEQ ID NO: 20), BATR_{H_B} (SEQ ID NO: 21), BATR_{H_C} (SEQ ID NO: 22), BATR_{H_D} (SEQ ID NO: 23) and BATR_{H_E} (SEQ ID NO: 24).

According to yet other embodiments, the humanized antibody comprises variable regions selected from the group consisting of: BATR_{H_A}/BATR_{K_A} (SEQ ID NO: 20/SEQ ID NO: 15), BATR_{H_B}/BATR_{K_A} (SEQ ID NO: 21/SEQ ID NO: 15),
15 BATR_{H_B}/BATR_{K_B} (SEQ ID NO: 21/SEQ ID NO: 16), BATR_{H_C}/BATR_{K_B} (SEQ ID NO: 22/SEQ ID NO: 16), BATR_{H_B}/BATR_{K_D} (SEQ ID NO: 21/SEQ ID NO: 18), and BATR_{H_C}/BATR_{K_D} (SEQ ID NO: 22/SEQ ID NO: 18).

According to various preferred embodiments, the humanized monoclonal antibody has variable regions corresponding to BATR_{H_C}/BATR_{K_D} (SEQ ID NO: 22/SEQ ID
20 NO: 18).

In one embodiment, the humanized BAT antibody has a heavy chain variable region as set forth in SEQ ID NO: 22 which may be encoded by the polynucleotide sequence set forth in SEQ ID NO: 90.

25 In one embodiment, the humanized antibody has a light chain variable region as set forth in SEQ ID NO: 18 which may be encoded by the polynucleotide sequence set forth in SEQ ID NO: 89. Amino acid and nucleotide sequences of humanized antibodies suitable for use in the invention are disclosed in U.S. Patent Application Publication No. 2008/0025980. Human antibody framework regions of heavy chain variable regions and light chain variable regions suitable for use in the invention include for example SEQ
30 ID NOS: 111-128 and SEQ ID NOS: 130-144, respectively.

Chemotherapy

Chemotherapy drugs are divided into several groups based on their effect on cancer cells, the cellular activities or processes the drug interferes with, or the specific phases of the cell cycle the drug affects. Accordingly, chemotherapy drugs fall in one of the following categories: alkylating agents, nitrosoureas, antimetabolites, anthracyclines, topoisomerase I and II inhibitors, mitotic inhibitors, *inter alia* platinum based drugs, steroids and anti-angiogenic agents.

Antimetabolites, also termed “nucleoside analogs”, replace natural substances as building blocks in DNA molecules, thereby altering the function of enzymes required for cell metabolism and protein synthesis. In the event that they mimic nutrients required for cell growth, the cells eventually undergo lysis. If a nucleoside is replaced with a non-functional nucleoside analog, the latter is incorporated into DNA and RNA, finally inducing cell cycle arrest and apoptosis by inhibiting the cell's ability to synthesize DNA. Antimetabolites are cell-cycle specific and are most effective during the S-phase of cell division as they primarily act upon cells undergoing synthesis of new DNA for formation of new cells. The toxicities associated with these drugs are seen in cells that are growing and dividing quickly. Examples of antimetabolites include purine antagonists, pyrimidine antagonists, and folate antagonists. These agents damage cells during the S phase and are commonly used to treat leukemias, tumors of the breast, ovary, and the gastrointestinal tract, as well as other cancers. Specific examples of antimetabolites include 5-fluorouracil (also known as 5FU), capecitabine, 6-mercaptopurine, methotrexate, gemcitabine, cytarabine, fludarabine and pemetrexed.

Platinum-based chemotherapeutic drugs crosslink DNA in several different ways, interfering with cell division by mitosis. The damaged DNA elicits DNA repair mechanisms, which in turn activate apoptosis when repair proves impossible. Most notable among the DNA changes are the 1,2-intrastrand cross-links with purine bases. These include 1,2-intrastrand d(GpG) adducts which form nearly 90% of the adducts and the less common 1,2-intrastrand d(ApG) adducts. 1,3-intrastrand d(GpXpG) adducts occur but are readily excised by the nucleotide excision repair (NER). Other adducts include inter-strand crosslinks and nonfunctional adducts that have been postulated to contribute to the activity of platinum-based drugs. Interaction with cellular proteins, particularly HMG domain proteins, has also been advanced as a mechanism of interfering with mitosis, although this is probably not its primary method of action.

Platinum-based chemotherapeutic drugs include cisplatin (also known as cisplatinum or *cis*-diamminedichloridoplatinum II (CDDP), carboplatin and oxaliplatin. Cisplatin is frequently designated as an alkylating agent, though it has no alkyl group and cannot carry out alkylating reactions. It is correctly classified as alkylating-like. Platinum-based
5 chemotherapeutic drugs are used to treat various types of cancers, including sarcomas, some carcinomas (e.g. small cell lung cancer, and ovarian cancer), lymphomas and germ cell tumors.

Mitotic inhibitors interfere with cell division. The most known chemotherapeutic agent in this category is paclitaxel (also known as Taxol®, "plant alkaloid", "taxane" and an "antimicrotubule agent"). Together with docetaxel, it forms the drug category of
10 the taxanes. However, other mitotic inhibitors are known, including, but not limited to etoposide, vinblastine and vincristine. Paclitaxel acts by interfering with normal microtubule growth during cell division by arrests their function; it hyper-stabilizes their structure. This destroys the cell's ability to use its cytoskeleton in a flexible
15 manner. Specifically, paclitaxel binds to the β subunit of tubulin, the "building block" of microtubules, and the binding of paclitaxel locks these building blocks in place. The resulting microtubule/paclitaxel complex does not have the ability to disassemble. This adversely affects cell function because the shortening and lengthening of microtubules (termed dynamic instability) is necessary for their function as a mechanism to transport
20 other cellular components. For example, during mitosis, microtubules position the chromosomes all through their replication and subsequent separation into the two daughter-cell nuclei. Furthermore, paclitaxel induces programmed cell death (apoptosis) in cancer cells by binding to the apoptosis stopping protein Bcl-2 (B-cell leukemia 2) and thus arresting its function.

Another group of DNA-interacting drugs widely used in anti-cancer chemotherapy is the group of anthracycline antibiotics which includes, *inter alia*, daunorubicin, doxorubicin (also known as Adriamycin® and doxorubicin hydrochloride), respinomycin D and idarubicin. These drugs interact with DNA by intercalation and inhibition of macromolecular biosynthesis thereby inhibiting the progression of the
30 enzyme topoisomerase II, which unwinds DNA for transcription. They stabilize the topoisomerase II complex after it has broken the DNA chain for replication, preventing

the DNA double helix from being resealed and thereby stopping the process of replication. It is commonly used in the treatment of a wide range of cancers.

Alkylating antineoplastic agents directly attack DNA. They attach an alkyl group to DNA, cross-linking guanine nucleobases in DNA double-helix strands. This makes the strands unable to uncoil and separate. As this is necessary in DNA replication, the cells can no longer divide. These drugs act nonspecifically. Cyclophosphamide is an alkylating agent, however, it is a highly potent immunosuppressive substance.

Topoisomerase I and II inhibitors interfere with the enzymatic activity of topoisomerase I and 2, respectively, eventually leading to inhibition of both DNA replication and transcription. Examples of topoisomerase I inhibitors include topotecan and irinotecan. Irinotecan, is a prodrug converted to a biologically active metabolite 7-ethyl-10-hydroxy-camptothecin (SN-38) by a carboxylesterase-converting enzyme. One thousand-fold more potent than its parent compound irinotecan, SN-38 inhibits topoisomerase I activity by stabilizing the cleavable complex between topoisomerase I and DNA, resulting in DNA breaks that inhibit DNA replication and trigger apoptotic cell death. Because ongoing DNA synthesis is necessary for irinotecan to exert its cytotoxic effects, it is also classified as an S-phase-specific agent. Examples of topoisomerase II inhibitors include etoposide and teniposide.

Anti-angiogenic agents interfere with the generation of new blood vessels, eventually leading to the "starvation" of tumors. Non-limiting examples of anti-angiogenic agents include the monoclonal antibody bevacizumab, dopamine and tetrathiomolybdate.

Vascular endothelial growth factor (VEGF) is a 32-42 kDa dimeric glycoprotein which mediates vasodilatation, increased vascular permeability and endothelial cell mitogenesis. Differential exon splicing of the VEGF gene results in three main mRNA species which code for three secreted isoforms (subscripts denote numbers of amino acids): VEGF₁₈₉, VEGF₁₆₅, and VEGF₁₂₁. A number of minor splice variants have also been described (VEGF₂₀₆, VEGF₁₈₃, VEGF₁₄₅ and VEGF₁₄₈). Variants of VEGF polypeptides and their use in cancer therapy is disclosed for example, in WO/2003/012105.

Radiation

The source of radiation that may be used in combination with the humanized antibody of the invention and the chemotherapeutic agent(s) can be either external or internal to the patient being treated. When the source is external to the patient, the therapy is known as external beam radiation therapy (EBRT). When the source of radiation is internal to the patient, the treatment is called brachytherapy (BT).

Radiation is administered in accordance with well known standard techniques using standard equipment manufactured for this purpose, such as AECL Theratron and Varian Clinac.

The distance between the source of the external radiation and the point of entry into the patient may be any distance that represents an acceptable balance between killing target cells and minimizing side effects. Typically, the source of the external radiation is between 70 and 100 cm from the point of entry into the patient.

Brachytherapy is generally carried out by placing the source of radiation in the patient. Typically, the source of radiation is placed approximately 0-3 cm from the tissue being treated. Known techniques include interstitial, intercavitary, and surface brachytherapy. The radioactive seeds can be implanted permanently or temporarily. Some typical radioactive atoms that have been used in permanent implants include iodine-125 and radon. Some typical radioactive atoms that have been used in temporary implants include radium, cesium-137, and iridium-192. Some additional radioactive atoms that have been used in brachytherapy include americium-241 and gold-198.

The dose of radiation depends on numerous factors as is well known in the art. Such factors include the organ being treated, the healthy organs in the path of the radiation that might inadvertently be adversely affected, the tolerance of the patient for radiation therapy, and the area of the body in need of treatment. The dose will typically be between 1 and 100 Gy, and more particularly between 2 and 80 Gy. Some doses that have been reported include 35 Gy to the spinal cord, 15 Gy to the kidneys, 20 Gy to the liver, and 65-80 Gy to the prostate. It should be emphasized, however, that the invention is not limited to any particular dose. The dose will be determined by the treating physician in accordance with the particular factors in a given situation, including the factors mentioned above.

The dose of radiation for brachytherapy can be the same as that mentioned above for external beam radiation therapy. In addition to the factors mentioned above for

determining the dose of external beam radiation therapy, the nature of the radioactive atom used is also taken into account in determining the dose of brachytherapy.

Compositions, administration and dosages

For use in the methods of the invention, the humanized antibody may be formulated in a conventional manner using one or more pharmaceutically acceptable carriers, stabilizers or excipients (vehicles) to form a pharmaceutical composition as is known in the art, in particular with respect to protein active agents. Carrier(s) are “acceptable” in the sense of being compatible with the other ingredients of the composition and not deleterious to the recipient thereof. Suitable carriers typically include physiological saline or ethanol polyols such as glycerol or propylene glycol.

The antibody may be formulated as neutral or salt forms. Pharmaceutically acceptable salts include the acid addition salts (formed with free amino groups) and which are formed with inorganic acids such as hydrochloric or phosphoric acids, or such organic acids such as acetic, oxalic, tartaric and maleic. Salts formed with the free carboxyl groups may also be derived from inorganic bases such as sodium, potassium, ammonium, calcium, or ferric hydroxides, and organic bases as isopropylamine, trimethylamine, 2-ethylamino ethanol, histidine and procaine.

The compositions may be suitably formulated for intravenous intramuscular, subcutaneous, or intraperitoneal administration and conveniently comprise sterile aqueous solutions of the antibody, which are preferably isotonic with the blood of the recipient. Such formulations are typically prepared by dissolving solid active ingredient in water containing physiologically compatible substances such as sodium chloride, glycine, and the like, and having a buffered pH compatible with physiological conditions to produce an aqueous solution, and rendering said solution sterile. These may be prepared in unit or multi-dose containers, for example, sealed ampoules or vials.

The compositions may incorporate a stabilizer, such as for example polyethylene glycol, proteins, saccharides (for example trehalose), amino acids, inorganic acids and admixtures thereof. Stabilizers are used in aqueous solutions at the appropriate concentration and pH. The pH of the aqueous solution is adjusted to be within the range of 5.0-9.0, preferably within the range of 6-8. In formulating the antibody, anti-adsorption agent may be used. Other suitable excipients may typically include an antioxidant such as ascorbic acid.

The compositions may be formulated as controlled release preparations which may be achieved through the use of polymer to complex or absorb the proteins. Appropriate polymers for controlled release formulations include for example polyester, polyamino acids, polyvinyl, pyrrolidone, ethylenevinylacetate, and methylcellulose.

5 Another possible method for controlled release is to incorporate the antibody into particles of a polymeric material such as polyesters, polyamino acids, hydrogels, poly(lactic acid) or ethylene vinylacetate copolymers. Alternatively, instead of incorporating these agents into polymeric particles, it is possible to entrap these materials in microcapsules prepared, for example, by coacervation techniques or by
10 interfacial polymerization, for example, hydroxymethylcellulose or gelatin-microcapsules and poly(methylmethacrylate) microcapsules, respectively, or in colloidal drug delivery systems, for example, liposomes, albumin microspheres, microemulsions, nanoparticles, and nanocapsules or in macroemulsions.

When oral preparations are desired, the compositions may be combined with
15 carriers, such as lactose, sucrose, starch, talc magnesium stearate, crystalline cellulose, methyl cellulose, carboxymethyl cellulose, glycerin, sodium alginate or gum arabic.

The humanized antibody of the invention is preferably administered parenterally, generally by intravenous infusion. Administration may also be by intraperitoneal, oral, subcutaneous, or intramuscular routes. Antibodies are generally
20 administered in the range of about 0.1 to about 20 mg/kg of patient weight, commonly about 0.5 to about 10 mg/kg, and often about 1 to about 5 mg/kg. In this regard, it is preferred to use antibodies having a circulating half-life of at least 12 hours, preferably at least 4 days, more preferably up to 21 days. Chimeric and humanized antibodies are expected to have circulatory half-lives of up to four and up to 14-21 days, respectively.
25 In some cases it may be advantageous to administer a large loading dose followed by periodic (e.g., weekly) maintenance doses over the treatment period. Antibodies can also be delivered by slow-release delivery systems, pumps, and other known delivery systems for continuous infusion. Dosing regimens may be varied to provide the desired circulating levels of a particular antibody based on its pharmacokinetics. Thus, doses
30 will be calculated so that the desired circulating level of therapeutic agent is maintained.

Typically, the effective dose will be determined by the activity of the therapeutic combination and the condition of the subject, as well as the body weight or surface area of the subject to be treated. The size of the dose and the dosing regimen also will be

determined by the existence, nature, and extent of any adverse side effects that accompany the administration of each agent in the combination of the invention in a particular subject. In determining the effective amount of the therapeutic composition to be administered, the physician needs to evaluate *inter alia* circulating plasma levels, toxicity, and progression of the disease.

In various embodiments of the combination methods of the invention, the humanized antibody and the chemotherapeutic agent may be administered according to any of a number of treatment schedules, also referred to “dosing schedules” and “administration regimens”, referring to the frequency of administration and order of administration of each active agent. For example, the humanized antibody and the chemotherapeutic agent may be administered substantially simultaneously i.e. at the same time, using for example a combined dosage form or separate dosage forms. This form of administration may also be referred to as “concomitant” administration. Concurrent administration refers to administration of the active agents within the same general time period, for example on the same day(s) but not necessarily at the same time. For example, one active agent may require administration with food, while the other requires administration in the semi-fasting state. Alternate administration includes administration of one agent during a particular time period, for example over the course of a few days or a week, followed by administration of the other agent during a subsequent identical period of time, and then repeating the pattern for one or more cycles. Sequential or successive administration includes administration of one agent during a first time period, using one or more doses, followed by administration of the other agent during a second time period using one or more doses. An overlapping schedule may also be employed, which includes administration of the active agents on different days over the treatment period, not necessarily according to a regular sequence. Variations on these general guidelines may also be employed, according to the agents used and the condition of the subject.

In some particular combinations, it may be advantageous to use a specific sequence of administration e.g. one agent prior to the other. For example, as demonstrated herein (Figure 5) dacarbazine adversely affects the activity of the antibody when given concomitantly but not when added 24 hours after the humanized antibody.

Having now generally described the invention, the same will be more readily understood through reference to the following examples, which are provided by way of illustration and are not intended to be limiting of the present invention.

5 **EXAMPLES**

Example 1. In vitro functional assay

The functional assay is based on the ability of hBAT-1 to enhance the survival of murine and human lymphocytes in culture. In the present Example, the effect of hBAT-1 on enhanced survival of lymphocytes alone and in combination with
10 chemotherapeutic drugs was evaluated and expressed by % difference in cell survival or by the Area Under the dose response Curve (AUC, expressed in % difference X $\mu\text{g/ml}$). The chemotherapeutic agent was applied concomitantly or 24 hours after hBAT-1 treatment at the indicated concentrations. Chemotherapeutic agents tested in the functional assay included 5FU (Figs. 1,2 and 7), SN-38, an active derivative of
15 irinotecan (Figs. 3 and 4), cisplatin, oxaliplatin, Taxol (paclitaxel) and dacarbazine (Fig. 5 and 7), cytarabine, cyclophosphamide and doxorubicin (Fig. 6).

The results indicate that specific agents (e.g. 5FU, cisplatin, oxaliplatin, paclitaxel and cytarabine) do not adversely affect the activity of hBAT-1 in murine lymphocytes. Moreover, when given concomitantly with (cisplatin), or sequentially (5FU and
20 paclitaxel) with hBAT-1, a synergistic effect is observed, expressed by 20% to 30% enhancement in activity values (% difference in cell survival and AUC). Use of a chemotherapeutic agent alone has no activity in increasing lymphocyte cell survival in this functional assay (Fig. 1C). Synergistic results were obtained with isolated human CD4⁺ lymphocytes, demonstrating that sequential treatment of 5FU or cisplatin in
25 combination with hBAT resulted in activity (% difference in cell survival) that is 2 fold higher than the activity of the antibody alone (Fig. 7). The results also suggest that certain chemotherapeutic agents (e.g. SN-38; cyclophosphamide) may not be suitable for use in combination with humanized BAT antibodies, since they do not enhance cell survival when given in combination with hBAT-1 in murine lymphocyte culture. . In
30 addition, certain chemotherapeutic agents (e.g. dacarbazine) may be suitable only when used in a sequential administration schedule (Fig. 3-5).

Example 2. Combination therapy for colorectal cancer tumors

Colorectal carcinoma tumors (CT26 tumors) were induced by S.C. injection of CT26 cells, 10^6 cells/mouse (n=6). Day of injection is referred herein as day 0. 5-FU, 20 mg/kg, was administered I.P. on days 6-9, 15-17, 22-24 and 29-31, 36-38 and 43-45. 5 hBAT-1, 10 mg/mouse, was administered I.V. on days 10, 18, 25, 32 and 39 (Fig. 8-10). A case of relapse after complete remission (observed only in the combination therapy group) was further treated with 5FU at 20 mg/kg, on days 73-74, 77-80, 85-87, 92-93 and hBAT-1, 10 mg/mouse, administered I.V. on days 81 and 88.

10 In a follow up study on tumor size after a single cycle of treatment, tumor volume was measured every other day on days 4 to 16 post tumor inoculation. The results indicate that the combined therapy with 5FU is advantageous over therapy with either 5FU or hBAT-1 alone (Fig. 8).

15 In a follow up study on tumor size after 3 alternate cycles of treatment, tumor volume was measured every other day on days 4 to 28. The results indicate that the combination therapy of hBAT-1 antibody with 5FU is not only advantageous over 5FU monotherapy but the increase in activity is synergistic (Fig.9).

20 In a follow up study on overall survival, percentage survival was monitored and is presented in Fig.10 from day 28 and onwards. The results clearly show that in mice treated with the combination therapy, the percent of survival is significantly higher than in mice treated with either hBAT-1 or 5FU monotherapies, leading to durable complete remission in approximately 17% of the mice.

Example 3. Combination therapy for melanoma

25 Mice (n=7) were inoculated subcutaneously with B16 melanoma cells at 5×10^5 cells/mouse. Inoculation day is referred herein as day 0. 5-FU was administered intraperitoneally at 50 mg/kg on days 1-4 and 7-8. In the combination therapy group, a single dose of 10 mg/mouse of hBAT-1 was injected intravenously on day 10.

Percentage survival was monitored beginning at day 8. In mice treated with the combination therapy the percent of survival was significantly higher than in mice treated with high dosage of 5FU (Fig. 11).

30 Stated otherwise, combination treatment, using a sequential administration schedule in which the humanized antibody was administered after 9 daily cycles of 5FU

at dose-limiting toxicity (DLT) levels (50mg/kg/day), resulted in enhanced survival of mice in an experimental melanoma model. The results clearly suggest that the combination therapy improves tolerability to DLT levels of 5-FU.

Example 4. Combination therapy with irinotecan (1)

5 Colorectal carcinoma tumors (CT26 tumors) were induced by S.C. injection of CT26 cells, 10^6 cells/mouse (n=6). Day of injection is referred herein as day 0. Irinotecan, 100 mg/kg, was administered I.P. on days 7 and 15. hBAT-1, 10 mg/mouse, was administered I.V. on day 10 (Fig. 12).

10 In a follow up study on tumor size after a single cycle of treatment, tumor volume was measured daily on days 4 to 18. The results indicate that the combination therapy of hBAT-1 antibody with irinotecan is as effective as monotherapy with irinotecan, but less effective than hBAT-1 monotherapy (Fig. 12).

Example 5. Combination therapy with irinotecan (2)

15 Colorectal carcinoma tumors (CT26 tumors) were induced by S.C. injection of CT26 cells, 10^6 cells/mouse (n=6). Day of injection is referred herein as day 0. Irinotecan, 100 mg/kg, was administered I.P. on days 7 and 15. hBAT-1, 10 mg/mouse, was administered I.V. on day 10 (Fig. 13).

20 Percentage survival was monitored beginning at day 16. The results show that in mice treated with the combination therapy, the percent of survival is comparable to that of mice treated with irinotecan monotherapy, but lower than in mice treated with hBAT-1 monotherapy (Fig. 13).

Example 6. Combination therapy with oxaliplatin

25 Colorectal carcinoma tumors (CT26 tumors) were induced by S.C. injection of CT26 cells, 10^6 cells/mouse (n=6). Day of injection is referred herein as day 0. Oxaliplatin, 1 mg/kg, was administered I.P. on days 4, 7-10, 14-17, 22-24 and 29-31. hBAT-1, 10 mg/mouse, was administered I.V. on days 11, 18, 25 and 32 (Fig. 14-15).

In a follow up study on tumor size, tumor volume was measured every other day on days 4 to 23 post tumor inoculation. The results indicate that the combined therapy with oxaliplatin is advantageous over therapy with oxaliplatin alone (Fig. 14).

30 In a follow up on overall survival, percentage survival was monitored beginning at day 15. The results clearly show that in mice treated with the combination therapy, the

percent of survival is significantly higher than in mice treated with oxaliplatin monotherapy leading to durable complete remission in approximately 20% of the mice (Fig. 15).

Colorectal carcinoma tumors (CT26 tumors) were re-induced by S.C. injection of CT26 cells, 10^6 cells/mouse in mice that had been cured for 2 or 5 months by hBAT-1 and oxaliplatin combination therapy (n=3). Colorectal carcinoma tumors were newly induced in control naïve mice at a similar age (n=6). Day of injection is referred herein as day 0 (Fig. 16). Before the re-induction (re-challenge) of CRC, treatment-experienced mice were evaluated for complete clearance of serum levels of hBAT-1 by specific ELISA.

In a follow up study on tumor size, tumor volume was measured every other day and is presented as a follow up from days 4 to 23 post tumor inoculation. The results indicate that in mice previously cured by hBAT-1 and oxaliplatin combination therapy, no tumor was observed during the 2 months follow up, whilst in the control group, the tumor developed within days in all mice (Fig. 16A).

In a follow up study on overall survival, percentage survival was monitored beginning at day 21 post tumor re-inoculation. The results clearly show that the mice which were newly introduced with the tumor (CRC) died within 35 days, whilst mice previously cured by hBAT-1 and oxaliplatin combination therapy were protected from tumor growth, tumor recurrence and death for more than the 72 days of the study follow up (Fig. 16B).

Breast adenocarcinoma tumors (4T1 tumors) were re-induced by S.C. injection of 4T1 cells, 10^6 cells/mouse in mice previously cured by hBAT and oxaliplatin and protected against re-challenge of CRC for approximately 3 months (Mice described in Fig. 16, n=2). In these mice, the tumor was injected S.C. at a different site than that of the 1st CRC and 2nd CRC injection sites (re-challenged CRC tumors). Breast adenocarcinoma tumors were also introduced in naïve mice at a similar age (n=6). Day of injection is referred herein as day 0 (Fig. 17).

In a follow up study on tumor size, tumor volume was measured every other day and is presented from days 3 to 21 post tumor inoculation. The results indicate that the breast adenocarcinoma tumors progressed in both mice groups (Fig. 17A). These results clearly show that mice that have acquired full protection against colorectal carcinoma

following combination therapy of hBAT-1 and oxaliplatin (Fig. 16A), were not as protected against breast carcinoma (Fig. 17A).

In a follow up study on overall survival, percentage survival was monitored beginning at day 21 post tumor re-inoculation. The results clearly show that the mice in both groups died within 28 to 35 days from breast carcinoma, indicating that mice exhibiting long term protection against CRC recurrence (re-challenge) were not fully protected against a different type of tumor e.g. breast carcinoma. Since all previously treated mice were tested for the complete elimination of circulating serum levels of the antibody of the invention, it appears that the acquired tumor specific protection against colorectal carcinoma was not a result of an active therapy but rather of an immunological memory response induced following previous treatment with the antibody of the invention and oxaliplatin.

Overall, combination therapy of the antibody of the invention and specific chemotherapeutic agents, such as 5FU or oxaliplatin, when administered according to an alternating schedule, results in enhanced antitumor activity, as evaluated by the reduction in tumor growth and the enhancement in survival of tumor bearing mice. Unexpectedly, mice in the combination therapy groups have reached durable complete remission and in the case of oxaliplatin even acquired memory protection against tumor recurrence, as evaluated by re-challenge with the specific tumor (CRC).

Example 7. Effect of CT-011 on human effector/memory T cells

The activity of hBAT-1 (CT-011) was assessed in an assay based on viability of human lymphocytes. Effector/memory CD4+CD45RO+ and naïve CD4+CD45RO- lymphocytes were treated with hBAT at 1ug/ml, followed by incubation for 72 and 96 hours. The results are expressed as % difference in cell survival (Figure 18).

The results clearly indicate that CT-011 has a significant effect in enhancing the survival of human effector/memory CD4+CD45RO+ lymphocytes, but not that of naïve CD4+CD45RO- lymphocytes. The demonstrated activity of CT-011 in promoting the viability of memory precursor cells is consistent with the in vivo results demonstrating that CT-011 has activity in inducing immunological memory against tumor recurrence.

Example 8. Phase I clinical trial of humanized monoclonal antibody CT-011

Introduction

The objectives of this study were to assess the dose-limiting toxicities (DLTs), to determine the maximum tolerated dose (MTD) and to study the pharmacokinetics of CT-011 administered once to patients with advanced hematological malignancies. A full description of the study is provided in Berger et al. Clin. Cancer Res. 2008;14(10) May 15, 2008.

Patients And Methods

Entrance criteria for the study required that enrolled patients had to have one of the following hematological malignancies: acute myeloid leukemia (AML), chronic lymphocytic leukemia (CLL), non-Hodgkin's lymphoma (NHL), Hodgkin's lymphoma (HL), or multiple myeloma (MM) at an advanced stage of their disease and following chemotherapy and/or stem cell transplantation (SCT). Patients were eligible for this study provided that they met the criteria as set out in Berger et al.

Importantly, the criteria included: At least 4 weeks from stem cell transplantation (SCT) or 1 week from donor lymphocyte infusion (DLI); Life expectancy >3 months; Patients who were either receiving or did not recover from the effect of therapies having immune suppressive effects, or who were suffering from an autoimmune disorder were to be excluded. The exception to this was hydroxyurea treatment of AML patients, which was allowed to proceed. The use of concomitant anti-cancer treatment (chemotherapy and immunotherapy) was prohibited and accordingly was to be stopped at least 4 weeks prior to CT-011 administration.

The study enrolled a total of 17 patients. One patient who was enrolled at the lowest dose level (0.2 mg/kg) was re-enrolled 5 months after the first administration at a higher dose level (3.0 mg/kg) as a compassionate treatment for a total of 18 administered treatments. The total amount of CT-011 was determined based on the planned dosing (mg/kg base) and body weight. The infusion was carried out in a stepwise manner increasing the rate from 50 mL/hr to 100 mL/hr, and all patients received pre-medication prior to infusion consisting of a pain relief medication (paracetamol), corticosteroid (hydrocortison 100 mg) and an antihistamine (phenegan). The starting dose was 0.2 mg/kg, which was several ten-fold lower than the highest dose tested in toxicology studies conducted in non-human primates and mice on a human-equivalent-dose (HED) base. The further dose levels were 0.6 mg/kg, 1.5 mg/kg,

3 mg/kg, and 6 mg/kg. Escalation from one dose level to the next was allowed after all patients at the previous level were evaluated for at least 7 days following the dose administration.

Toxicity was evaluated according to the National Cancer Institute (NCI) Common Toxicity Criteria (CTCAE V2) and by its intensity (i.e., mild, moderate, severe). DLT was defined as that dose which induces any Grade 3 or 4 toxicity in one or more patients, or any Grade 2 toxicity in at least 2/3 or 3/6 patients. Adverse events not judged to be related to CT-011 were not considered as toxicity in terms of these dose escalation and MTD rules.

Subsequent to drug administration, patients were monitored for safety, including adverse events and clinical and laboratory responses at 24 hours, 48 hours, and on days 7, 14, and 21.

Sample collection, parameters used to assess clinical responses, pharmacokinetic analysis, immune system activation and statistical analysis are as described in Berger et al, 2008.

Results

The main characteristics of the enrolled patients (n=17) are listed in Table 1. Patient 003, initially treated at 0.2 mg/kg, requested a repeat compassionate treatment and was treated again at 3 mg/kg. Due to the 5 month interval between the first and second treatment, the different treatments were analyzed as separate individuals. Therefore, the number of CT-011 administrations used for the analyses was 18.

Table 1. Patient Characteristics

ID	Dose (mg/kg)	Age	Gender	Disease	Classification/ Type	Stage	ECOG	Last Treatment prior to CT- 011 therapy
001	0.2	64	F	AML	M4- Myelomonocytic	NR	2	Allogeneic SCT
002	0.2	62	F	NHL	ALCL	III	3	Irradiation
003	0.2	73	F	AML	M4- Myelomonocytic	NR	0	G-CSF, Erythropoietin, Blood transfusion
004	0.6	60	F	NHL	DLBCL	IV	1	Irradiation
005	0.6	52	M	CLL		C	2	Irradiation
006	0.6	26	F	HD		IVB	0	Irradiation
007	1.5	58	F	CLL		C	2	Mitoxantrone
008	1.5	68	F	CLL		A	1	Chlorambucil
009	1.5	53	M	AML	M2- Myelocytic	NR	1	Allogeneic SCT
010	3.0	33	F	AML	M4- Myelomonocytic	NR	1	Allogeneic SCT
011	3.0	20	M	AML	M1- Myelocytic	NR	0	Mitoxantrone+c ytosar
012	3.0	78	M	MDS	CMML	NR	2	Hydroxyurea, Thalidomide
013	6.0	65	M	AML	M4- Myelomonocytic	NR	2	Allogeneic SCT
014	3.0	40	F	NHL	DLBCL	II	4	Autologous SCT
015	3.0	56	F	NHL	Follicular Lymphoma	III	1	No therapy

ID	Dose (mg/kg)	Age	Gender	Disease	Classification/ Type	Stage	ECOG	Last Treatment prior to CT- 011 therapy
016	3.0	73	F	AML	M4- Myelomonocytic	NR	1	CT-011
017	6.0	78	M	MM	IgG; Kappa	IA	1	No therapy
018	6.0	72	F	AML	M4- Myelomonocytic	NR	1	Hydroxyurea

Abbreviations: ALCL, Acute lymphocytic cell lymphoma, CMML, Chronic myelomonocytic leukemia, DLBCL, Diffuse large B cell lymphoma, FAB classification-French, American and British, M1, M2, M4 according to the FAB classification, NR, Non 5 relevant, SCT, Stem cell transplantation.

No DLT was reached in the study. CT-011 was found to be safe and well tolerated with no treatment-related toxicities. No single dose MTD was found in this study.

During the study, 61% (11 of 18) of patients reported adverse events (AE), the 10 most frequent AE observed was diarrhea, but it was concluded that it was not associated with CT-011 treatment.

Four serious adverse events occurred, all of which resulted in death and occurred in AML patients. Clinical analysis concluded that all of these patients died from fulminate resistant leukemia and none of these deaths was considered to be related to 15 study drug.

Over the 21 days of the study no change in the average percentage of blasts in the peripheral blood of AML patients were observed with the exclusion of one AML patient (reduction in peripheral blasts from 50% to 5%). Additionally, there were no changes in disease parameters during the 21 days of the study in 2 CLL patients, 4 NHL patients 20 and in one Multiple Myeloma patient.

The cumulative survival of all patients (n=18) at 21 days was 76%, with a 95% confidence interval of 48%–90%. No difference in mean survival time across the dose groups was noted.

Patients were followed for survival beyond the 21 days of the study. The mean survival time in the study was 25 ± 27 weeks, ranging from 1.7 to over 77 weeks. This follow-up suggested that 6 patients exhibited apparent response to treatment with extended survival averaging at least 60 weeks. The 6 “responder” patients are represented in Table 2. There was one complete remission in patient #015 that received the fourth dose level of 3.0mg/kg. This patient was diagnosed with stage III follicular lymphoma involving nodes below and above the diaphragm. The patient did not receive any prior treatment for her disease. In a CT scan performed during a periodic check 10 month post CT-011 treatment complete elimination of tumor masses was observed. Interestingly, the patient did not receive any further treatment during the period lapsed between CT-011 treatment and the 10 month check. The patient has demonstrated a sustained remission 68 weeks following CT-011 treatment. One minimal response was observed in an AML patient receiving CT-011 at 0.2 and 3 mg/kg). The patient progressed 61 weeks after receiving CT-011. Four patients have shown stable disease: one with HD receiving CT-011 at 0.6 mg/kg had a stable disease for 35 weeks. Two patients with CLL receiving the antibody at 0.6 mg/kg and at 1.5 mg/kg were stable for 36 weeks and over 78 weeks, respectively. A MM patient receiving CT-011 at 6.0 mg/kg showed stable disease for over 60 weeks.

Table 2. Clinical responses during the study follow-up period.

Disease (Pt. No.)	Dose (mg/kg)	Observations	Overall Survival (Weeks)	Comments
NHL (015)	3.0	CR	>68	Follicular B cell lymphoma with large tumor masses at nodes above and below the diaphragm and at the mediastinum No previous treatment Elimination of tumor masses by CT scan noted 10 months post CT-011 treatment
CLL (008)	1.5	SD	>78	Binet stage A with bone marrow involvement and at ECOG 3 Received Leukeran about 2 years prior to CT-011 Stable for >17 months
CLL (005)	0.6	SD	36	Binet stage C with large tumor masses not responding to chemo- or radiotherapy and allogeneic SCT Stable for 8 months prior to deterioration

Disease (Pt. No.)	Dose (mg/kg)	Observations	Overall Survival (Weeks)	Comments
HD (006)	0.6	SD	35	Classification IV B; Resistant disease, failed autologous SCT and radiotherapy Stable for 8 months prior to deterioration
MM (017)	6.0	SD	>60	Common type, IgG kappa at Stage IA and ECOG 1 who did not receive any previous treatment for his disease Stable for >13 months
AML (003/016)	0.2/3.0	MR	61	Second dose 5 months post first dose. Platelet transfusion-independent for 9 months. Reduction in peripheral blasts (50% to 5%) on first dose

CR = complete response; SD = stable disease; MR = minimal response.

Discussion and Conclusion

The cumulative survival of all patients at 21 days was 76%, and follow up beyond the 21 days of the study revealed mean survival of 25 weeks. Given that most of the patients were at an advanced stage of their disease, it was surprisingly and unexpectedly found that 6 patients exhibited clinical benefit with extended survival averaging 60 weeks.

The median $t_{1/2}$ of CT-011 ranged from 217 hr to 410 hr (9 to 17 days), consistent with observations with other monoclonal antibodies in humans. Interestingly, the median $t_{1/2}$ for the 6 patients with apparent clinical response (Table 2) was somewhat higher than that of the rest of the patients. Taking into account the duration of the response with an average of 60 weeks in these 6 patients and the pharmacokinetics of the antibody with a highest half life of 410 hours, it appears that in some patients, tumor-specific immunological memory is induced, leading to durable anti-tumor immune response long after the antibody has been eliminated from the blood.

The foregoing description of the specific embodiments will so fully reveal the general nature of the invention that others can, by applying current knowledge, readily modify and/or adapt for various applications such specific embodiments without undue experimentation and without departing from the generic concept, and, therefore, such adaptations and modifications should and are intended to be comprehended within the

meaning and range of equivalents of the disclosed embodiments. It is to be understood that the phraseology or terminology employed herein is for the purpose of description and not of limitation. The means, materials, and steps for carrying out various disclosed functions may take a variety of alternative forms without departing from the invention.

CLAIMS

1. A method of treating a tumor, the method comprising (i) administering to a subject in need thereof an effective amount of a humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; and (ii) administering to the subject an effective amount of at least one chemotherapeutic agent; thereby treating the tumor.
2. The method according to claim 1, wherein the humanized antibody comprises: a light chain variable region selected from the group consisting of: BATR_{K_A} (SEQ ID NO: 15), BATR_{K_B} (SEQ ID NO: 16), BATR_{K_C} (SEQ ID NO: 17), and BATR_{K_D} (SEQ ID NO: 18), and a heavy chain variable region selected from the group consisting of: A (SEQ ID NO: 20), BATR_{H_B} (SEQ ID NO: 21), BATR_{H_C} (SEQ ID NO: 22), BATR_{H_D} (SEQ ID NO: 23) and BATR_{H_E} (SEQ ID NO: 24).
3. The method according to claim 1, wherein the humanized antibody comprises variable regions selected from the group consisting of: BATR_{H_A}/BATR_{K_A} (SEQ ID NO: 20/SEQ ID NO: 15), BATR_{H_B}/BATR_{K_A} (SEQ ID NO: 21/SEQ ID NO: 15), BATR_{H_B}/BATR_{K_B} (SEQ ID NO: 21/SEQ ID NO: 16), BATR_{H_C}/BATR_{K_B} (SEQ ID NO: 22/SEQ ID NO: 16), BATR_{H_B}/BATR_{K_D} (SEQ ID NO: 21/SEQ ID NO: 18), and BATR_{H_C}/BATR_{K_D} (SEQ ID NO: 22/SEQ ID NO: 18).
4. The method according to claim 3, wherein the humanized monoclonal has variable regions corresponding to BATR_{H_C}/BATR_{K_D} (SEQ ID NO: 22/SEQ ID NO: 18).
5. The method according to any one of claims 1-3, wherein the fragment of the humanized antibody is selected from the group consisting of: Fv, F(ab'), F(ab')₂, and a single chain antibody.
6. The method according to any one of claims 1-3, wherein the humanized antibody or the fragment thereof retains the antitumor activity of mBAT-1.

7. The method according to claim 1, wherein the at least one chemotherapeutic agent is selected from the group consisting of: antimetabolites, platinum-based agents, mitotic inhibitors, anthracycline antibiotics, topoisomerase inhibitors, anti-angiogenic agents and combinations thereof.
8. The method according to claim 7, wherein the at least one chemotherapeutic agent is selected from the group consisting of: an antimetabolite selected from the group consisting of: 5-fluorouracil, uracil mustard, uracil, capecitabine, 6-mercaptopurine, methotrexate, gemcitabine, cytarabine, fludarabine, and pemetrexed; a platinum-based agent selected from the group consisting of: cisplatin, carboplatin and oxaliplatin; a mitotic inhibitor selected from the group consisting of: paclitaxel, docetaxel, etoposide, vinblastine, vincristine and vinorelbine; an anti-angiogenic agent selected from the group consisting of: bevacizumab, dopamine, tetrathiomolybdate, anti-angiogenic variants of VEGF; and combinations thereof.
9. The method according to claim 8, wherein the at least one chemotherapeutic agent is selected from the group consisting of 5-fluorouracil, cytarabine, oxaliplatin, paclitaxel and combinations thereof.
10. The method according to claim 1, wherein the at least one chemotherapeutic agent is other than an agent selected from the group consisting of: a topoisomerase I inhibitor and an alkylating agent.
11. The method according to claim 1, wherein the administering of the humanized antibody and of the at least one chemotherapeutic agent is carried out substantially simultaneously, concurrently, alternately, sequentially or successively.
12. The method according to claim 1, wherein the humanized antibody and the at least one chemotherapeutic agent are administered according to an overlapping schedule.
13. The method according to claim 1, wherein the administering of the humanized antibody is carried out prior to initial administration of the at least one chemotherapeutic agent.

14. The method according to claim 1, wherein the administering of either or both of the humanized antibody and the at least one chemotherapeutic agent is carried out by a route selected from the group consisting of intravenous, oral, intraperitoneal, subcutaneous, isolated limb perfusion, infusion into an organ and combinations thereof.
15. The method according to claim 1, further comprising treating the subject with radiation.
16. The method according to claim 1, further comprising assessing at least one parameter selected from the group consisting of: rate of tumor growth, tumor volume, number of metastases, tumor recurrence and combinations thereof.
17. The method according to claim 1, wherein the tumor is selected from the group consisting of colorectal carcinoma; lung carcinoma; breast carcinoma; melanoma; ovarian carcinoma; cervical carcinoma, pancreatic cancer; multiple myeloma; renal cell carcinoma; non-Hodgkin's lymphoma; Hodgkin's disease; mantle acute myeloid leukemia (AML); chronic myelocytic leukemia (CML); acute lymphocytic leukemia (ALL), and chronic lymphocytic leukemia (CLL).
18. A method of improving tolerability to at least one chemotherapeutic agent, the method comprising administering to a subject in need thereof an effective amount of a humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; wherein the subject is undergoing chemotherapy with at least one chemotherapeutic agent; thereby improving tolerability to said at least one chemotherapeutic agent.
19. The method according to claim 18, wherein the humanized antibody comprises: a light chain variable region selected from the group consisting of: BATR_{K_A} (SEQ ID NO: 15), BATR_{K_B} (SEQ ID NO: 16), BATR_{K_C} (SEQ ID NO: 17), and BATR_{K_D} (SEQ ID NO: 18), and a heavy chain variable region selected from the group consisting of: A (SEQ ID NO: 20),

BATRH_B (SEQ ID NO: 21), BATRH_C (SEQ ID NO: 22), BATRH_D (SEQ ID NO: 23) and BATRH_E (SEQ ID NO: 24).

20. The method according to claim 18, wherein the humanized antibody comprises variable regions selected from the group consisting of:
5 BATRH_A/BATR_K_A (SEQ ID NO: 20/SEQ ID NO: 15), BATRH_B/BATR_K_A (SEQ ID NO: 21/SEQ ID NO: 15), BATRH_B/BATR_K_B (SEQ ID NO: 21/SEQ ID NO: 16), BATRH_C/BATR_K_B (SEQ ID NO: 22/SEQ ID NO: 16), BATRH_B/BATR_K_D (SEQ ID NO: 21/SEQ ID NO: 18), and BATRH_C/BATR_K_D (SEQ ID NO: 22/SEQ ID NO: 18).
- 10 21. The method according to claim 20, wherein the humanized monoclonal has variable regions corresponding to BATRH_C/BATR_K_D (SEQ ID NO: 22/SEQ ID NO: 18).
22. The method according to any one of claims 18-20, wherein the fragment of the humanized antibody is selected from the group consisting of: Fv, F
15 (ab'), F (ab')₂, and a single chain antibody.
23. The method according to any one of claims 18-20, wherein the humanized antibody or the fragment thereof retains the antitumor activity of mBAT-1
24. The method according to claim 18, wherein the at least one chemotherapeutic agent is selected from the group consisting of:
20 antimetabolites, platinum-based agents, mitotic inhibitors, anthracycline antibiotics, topoisomerase inhibitors, anti-angiogenic agents and combinations thereof.
25. The method according to claim 24, wherein the at least one chemotherapeutic agent is selected from the group consisting of: an
25 antimetabolite selected from the group consisting of: 5-fluorouracil, uracil mustard, uracil, capecitabine, 6-mercaptopurine, methotrexate, gemcitabine, cytarabine, fludarabine, and pemetrexed; a platinum-based agent selected from the group consisting of: cisplatin, carboplatin and oxaliplatin; a mitotic inhibitor selected from the group consisting of:
30 paclitaxel, docetaxel, etoposide, vinblastine, vincristine and vinorelbine; an anti-angiogenic agent selected from the group consisting of: bevacizumab, dopamine and tetrathiomolybdate, anti-angiogenic variants of VEGF; and

combinations thereof.

26. The method according to claim 25, wherein the at least one chemotherapeutic agent is selected from the group consisting of 5-fluorouracil, cytarabine, oxaliplatin, paclitaxel and combinations thereof.

5 27. The method according to claim 18, wherein the at least one chemotherapeutic agent is other than an agent selected from the group consisting of: a topoisomerase I inhibitor and an alkylating agent.

10 28. The method according to claim 18, wherein the administering of the humanized antibody and of the at least one chemotherapeutic agent is carried out substantially simultaneously, concurrently, alternately, sequentially or successively.

29. The method according to claim 18, wherein the administering of the humanized antibody is carried out prior to initial administration of the at least one chemotherapeutic agent.

15 30. The method according to claim 18, wherein the administering of either or both of the humanized antibody and the at least one chemotherapeutic agent is carried out by a route selected from the group consisting of intravenous, oral, intraperitoneal, subcutaneous, isolated limb perfusion, infusion into an organ and combinations thereof.

20 31. The method according to claim 18, wherein the chemotherapy is for treatment of a tumor selected from the group consisting of colorectal carcinoma; lung carcinoma; breast carcinoma; melanoma; ovarian carcinoma; cervical carcinoma, pancreatic cancer; multiple myeloma; renal cell carcinoma; non-Hodgkin's lymphoma; Hodgkin's disease; mantle acute myeloid leukemia (AML); chronic myelocytic leukemia (CML); acute
25 lymphocytic leukemia (ALL), and chronic lymphocytic leukemia (CLL)

30 32. A method of enhancing survival of a subject having a tumor, wherein the subject is treated with at least one chemotherapeutic agent, the method comprising administering an effective amount of a humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from

an acceptor human immunoglobulin, or modified therefrom; thereby enhancing survival of the subject.

33. The method according to claim 32, wherein the humanized antibody comprises: a light chain variable region selected from the group consisting of: BATR_{K_A} (SEQ ID NO: 15), BATR_{K_B} (SEQ ID NO: 16), BATR_{K_C} (SEQ ID NO: 17), and BATR_{K_D} (SEQ ID NO: 18), and a heavy chain variable region selected from the group consisting of: A (SEQ ID NO: 20), BATR_{H_B} (SEQ ID NO: 21), BATR_{H_C} (SEQ ID NO: 22), BATR_{H_D} (SEQ ID NO: 23) and BATR_{H_E} (SEQ ID NO: 24).
34. The method according to claim 32, wherein the humanized antibody comprises variable regions selected from the group consisting of: BATR_{H_A}/BATR_{K_A} (SEQ ID NO: 20/SEQ ID NO: 15), BATR_{H_B}/BATR_{K_A} (SEQ ID NO: 21/SEQ ID NO: 15), BATR_{H_B}/BATR_{K_B} (SEQ ID NO: 21/SEQ ID NO: 16), BATR_{H_C}/BATR_{K_B} (SEQ ID NO: 22/SEQ ID NO: 16), BATR_{H_B}/BATR_{K_D} (SEQ ID NO: 21/SEQ ID NO: 18), and BATR_{H_C}/BATR_{K_D} (SEQ ID NO: 22/SEQ ID NO: 18).
35. The method according to claim 32, wherein the humanized monoclonal has variable regions corresponding to BATR_{H_C}/BATR_{K_D} (SEQ ID NO: 22/SEQ ID NO: 18).
36. The method according to any one of claims 32-34, wherein the fragment of the humanized antibody is selected from the group consisting of: Fv, F (ab'), F (ab')₂, and a single chain antibody.
37. The method according to any one of claims 32-34, wherein the humanized antibody or the fragment thereof retains the antitumor activity of mBAT-1.
38. The method according to claim 32, wherein the at least one chemotherapeutic agent is selected from the group consisting of: antimetabolites, platinum-based agents, mitotic inhibitors, anthracycline antibiotics, topoisomerase inhibitors, anti-angiogenic agents and combinations thereof.
39. The method according to claim 38, wherein the at least one chemotherapeutic agent is selected from the group consisting of: an

antimetabolite selected from the group consisting of: 5-fluorouracil, uracil mustard, uracil, capecitabine, 6-mercaptopurine, methotrexate, gemcitabine, cytarabine, fludarabine, and pemetrexed; a platinum-based agent selected from the group consisting of: cisplatin, carboplatin and oxaliplatin; a mitotic inhibitor selected from the group consisting of: paclitaxel, docetaxel, etoposide, vinblastine, vincristine and vinorelbine; an anti-angiogenic agent selected from the group consisting of: bevacizumab, dopamine, tetrathiomolybdate, antiangiogenic variants of VEGF; and combinations thereof.

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40. The method according to claim 39, wherein the at least one chemotherapeutic agent is selected from the group consisting of 5-fluorouracil, cytarabine, oxaliplatin, paclitaxel and combinations thereof.

15

41. The method according to claim 32, wherein the at least one chemotherapeutic agent is other than an agent selected from the group consisting of: a topoisomerase I inhibitor and an alkylating agent.

20

42. The method according to claim 32, wherein the administering of the humanized antibody and of the at least one chemotherapeutic agent is carried out substantially simultaneously, concurrently, alternately, sequentially or successively.

25

43. The method according to claim 32, wherein the humanized antibody and the at least one chemotherapeutic agent are administered according to an overlapping schedule.

30

44. The method according to claim 32, wherein the administering of the humanized antibody is carried out prior to initial administration of the at least one chemotherapeutic agent.

45. The method according to claim 32, further comprising treating the subject with radiation.

46. The method according to claim 32, wherein the subject has a tumor selected from the group consisting of colorectal carcinoma; lung carcinoma; breast carcinoma; melanoma; ovarian carcinoma; cervical carcinoma, pancreatic cancer; multiple myeloma; renal cell carcinoma; non-Hodgkin's lymphoma; Hodgkin's disease; mantle acute myeloid

leukemia (AML); chronic myelocytic leukemia (CML); acute lymphocytic leukemia (ALL), and chronic lymphocytic leukemia (CLL).

47. A method of reducing or preventing tumor recurrence, the method comprising administering to a subject in need thereof an effective amount of a humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; thereby reducing or preventing tumor recurrence.
48. The method according to claim 47, wherein the humanized antibody comprises: a light chain variable region selected from the group consisting of: BATR_{K_A} (SEQ ID NO: 15), BATR_{K_B} (SEQ ID NO: 16), BATR_{K_C} (SEQ ID NO: 17), and BATR_{K_D} (SEQ ID NO: 18), and a heavy chain variable region selected from the group consisting of: A (SEQ ID NO: 20), BATRH_B (SEQ ID NO: 21), BATRH_C (SEQ ID NO: 22), BATRH_D (SEQ ID NO: 23) and BATRH_E (SEQ ID NO: 24).
49. The method according to claim 47, wherein the humanized antibody comprises variable regions selected from the group consisting of: BATRH_A/BATR_{K_A} (SEQ ID NO: 20/SEQ ID NO: 15), BATRH_B/BATR_{K_A} (SEQ ID NO: 21/SEQ ID NO: 15), BATRH_B/BATR_{K_B} (SEQ ID NO: 21/SEQ ID NO: 16), BATRH_C/BATR_{K_B} (SEQ ID NO: 22/SEQ ID NO: 16), BATRH_B/BATR_{K_D} (SEQ ID NO: 21/SEQ ID NO: 18), and BATRH_C/BATR_{K_D} (SEQ ID NO: 22/SEQ ID NO: 18).
50. The method according to claim 49, wherein the humanized monoclonal antibody has variable regions corresponding to BATRH_C/BATR_{K_D} (SEQ ID NO: 22/SEQ ID NO: 18).
51. The method according to any one of claims 47-49, wherein the fragment of the humanized antibody is selected from the group consisting of: Fv, F(ab'), F(ab')₂, and a single chain antibody.
52. The method according to any one of claims 47-49, wherein the humanized antibody or the fragment thereof retains the antitumor activity of mBAT-1.

53. The method according to claim 47, wherein the method further comprises administering to the subject at least one chemotherapeutic agent.

54. The method according to claim 53, wherein the at least one chemotherapeutic agent is selected from the group consisting of:
5 antimetabolites, platinum-based agents, mitotic inhibitors, anthracycline antibiotics, topoisomerase inhibitors, anti-angiogenic agents and combinations thereof.

55. The method according to claim 54, wherein the at least one chemotherapeutic agent is selected from the group consisting of: an
10 antimetabolite selected from the group consisting of: 5-fluorouracil, uracil mustard, uracil, capecitabine, 6-mercaptopurine, methotrexate, gemcitabine, cytarabine, fludarabine, and pemetrexed; a platinum-based agent selected from the group consisting of: cisplatin, carboplatin and oxaliplatin; a mitotic inhibitor selected from the group consisting of:
15 paclitaxel, docetaxel, etoposide, vinblastine, vincristine and vinorelbine; an anti-angiogenic agent selected from the group consisting of: bevacizumab, dopamine and tetrathiomolybdate, antiangiogenic variants of VEGF; and combinations thereof.

56. The method according to claim 55, wherein the at least one
20 chemotherapeutic agent is selected from the group consisting of 5-fluorouracil, cytarabine, oxaliplatin, paclitaxel and combinations thereof.

57. The method according to claim 53, wherein the at least one chemotherapeutic agent is other than an agent selected from the group consisting of: a topoisomerase I inhibitor and an alkylating agent.

58. The method according to claim 53, wherein the administering of the
25 humanized antibody and of the at least one chemotherapeutic agent is carried out substantially simultaneously, concurrently, alternately, sequentially or successively.

59. The method according to claim 53, wherein the humanized antibody and
30 the at least one chemotherapeutic agent are administered according to a overlapping schedule.

60. The method according to claim 53, wherein the administering of the

humanized antibody is carried out prior to initial administration of the at least one chemotherapeutic agent.

61. The method according to claim 53, further comprising treating the subject with radiation.

62. The method according to claim 47, wherein the tumor is selected from the group consisting of colorectal carcinoma; lung carcinoma; breast carcinoma; melanoma; ovarian carcinoma; cervical carcinoma, pancreatic cancer; multiple myeloma; renal cell carcinoma; non-Hodgkin's lymphoma; Hodgkin's disease; mantle acute myeloid leukemia (AML); chronic myelocytic leukemia (CML); acute lymphocytic leukemia (ALL), and chronic lymphocytic leukemia (CLL).

63. Use of (i) a humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; and (ii) at least one chemotherapeutic agent; for the preparation of a medicament for treating a tumor.

64. A humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; for the treatment of a tumor in a subject undergoing chemotherapy with at least one chemotherapeutic agent.

65. Use of a humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom, for the preparation of a medicament for improving tolerability to at least one chemotherapeutic agent in a subject undergoing chemotherapy with said at least one chemotherapeutic agent.

66. A humanized monoclonal antibody or a fragment thereof, wherein the

antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom, for improving tolerability to at least one
5 chemotherapy agent in a subject undergoing chemotherapy with said at least one chemotherapy agent.

67. Use of a humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a
10 framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; for the preparation of a medicament for enhancing survival of a subject having a tumor, wherein the subject is being treated with at least one chemotherapy agent.

68. A humanized monoclonal antibody or a fragment thereof, wherein the
15 antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; for enhancing survival of a subject having a tumor, wherein the subject is being treated with at least one chemotherapy agent.
20

69. Use of a humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a
25 framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; for the preparation of a medicament of reducing or preventing tumor recurrence.

70. The use according to claim 69, wherein the tumor is in a subject who has undergone, is undergoing chemotherapy with at least one chemotherapy agent.

30 71. A humanized monoclonal antibody or a fragment thereof, wherein the antibody or the fragment thereof has at least one complementarity determining region of murine monoclonal antibody BAT (mBAT-1) and a

framework region (FR) from an acceptor human immunoglobulin, or modified therefrom; for reducing or preventing tumor recurrence.

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FIGURE 1A

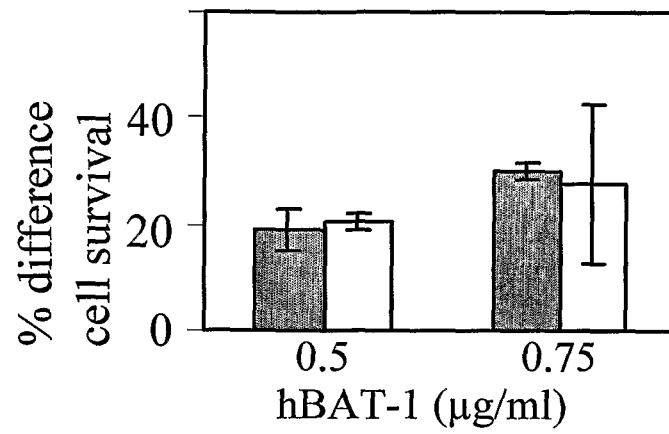


FIGURE 1B

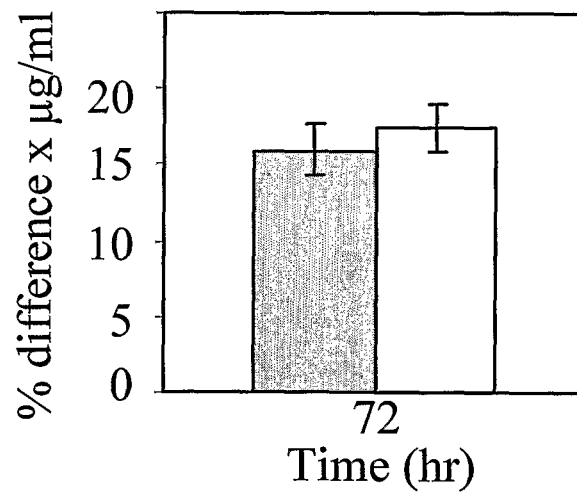
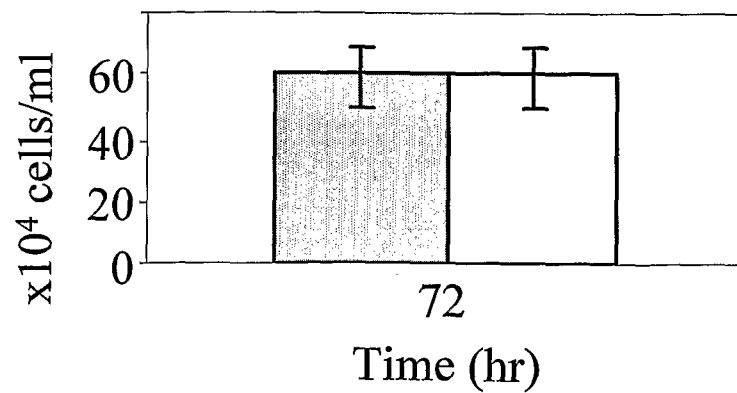


FIGURE 1C



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FIGURE 2A

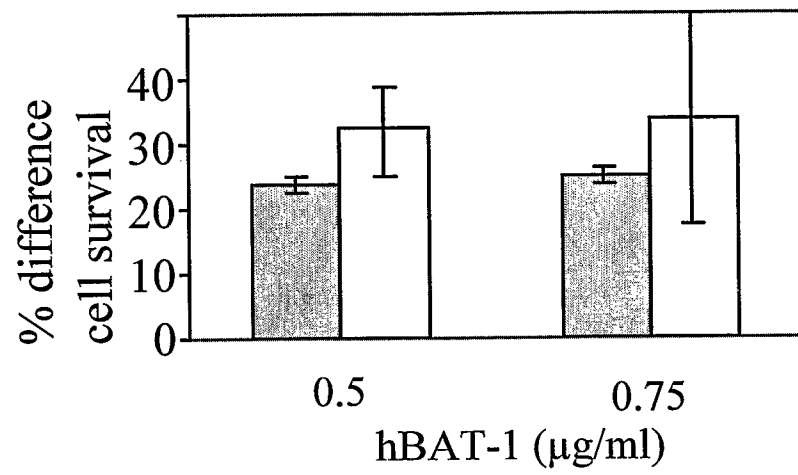
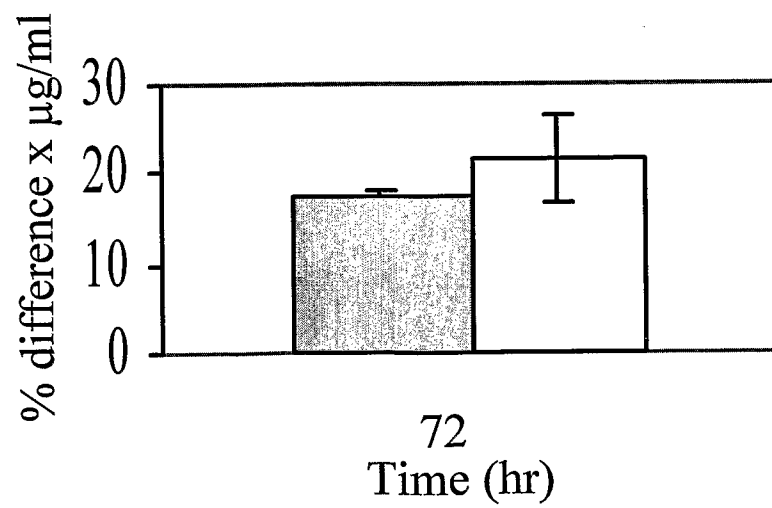


FIGURE 2B



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FIGURE 3A

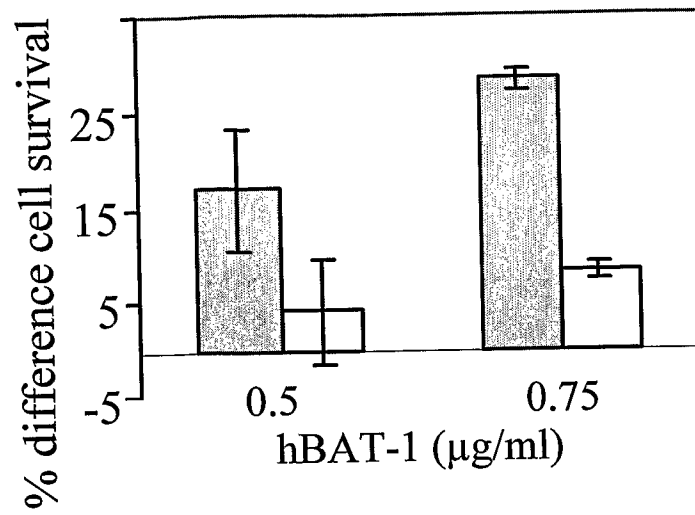
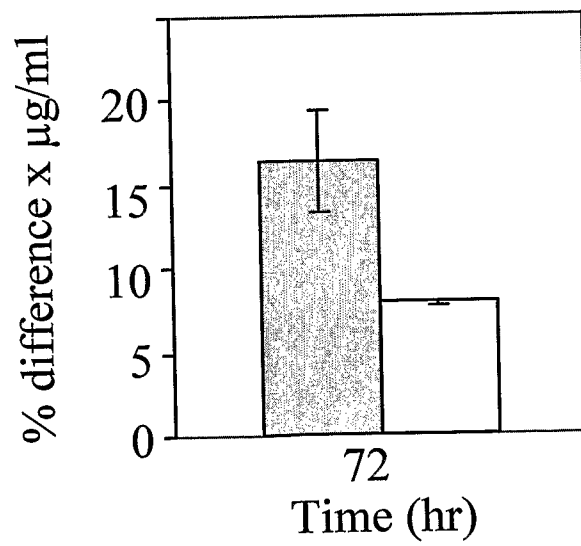


FIGURE 3B



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FIGURE 4A

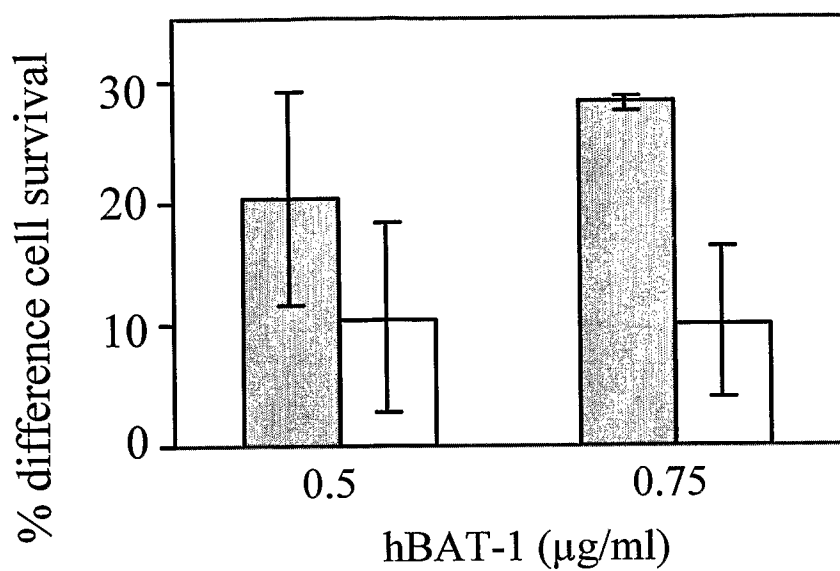
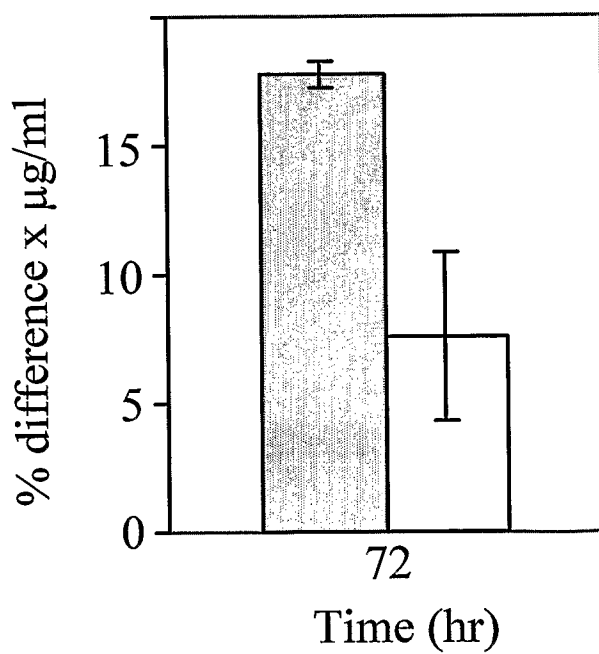


FIGURE 4B



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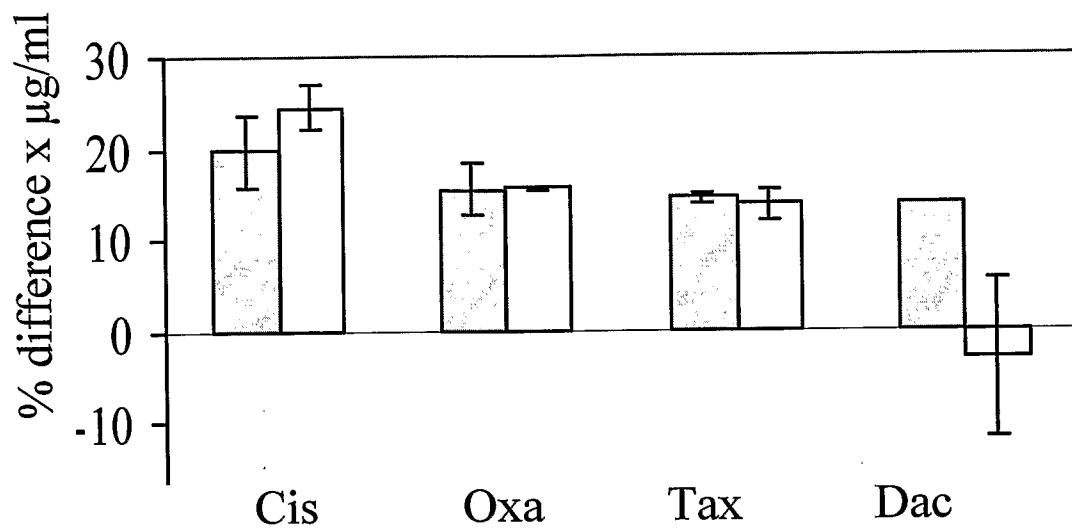


FIGURE 5A

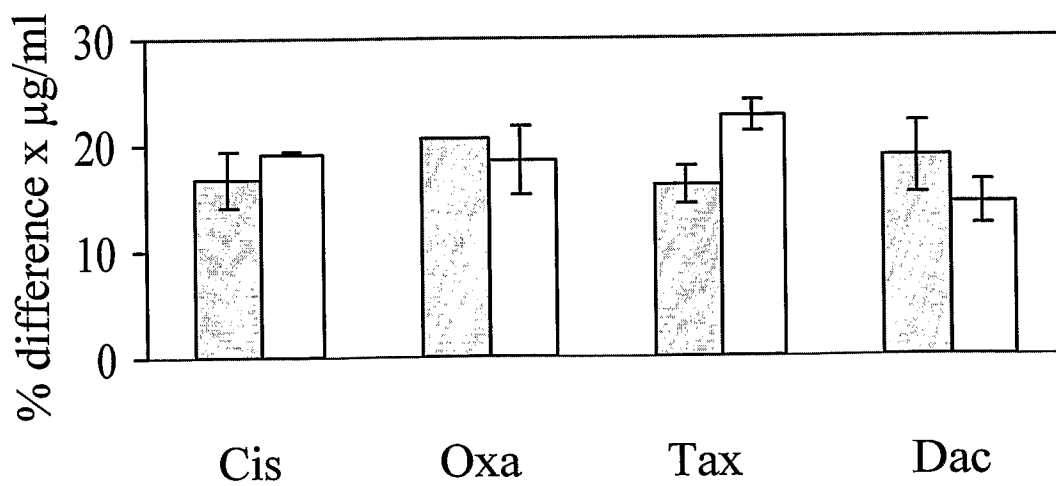


FIGURE 5B

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FIGURE 6A

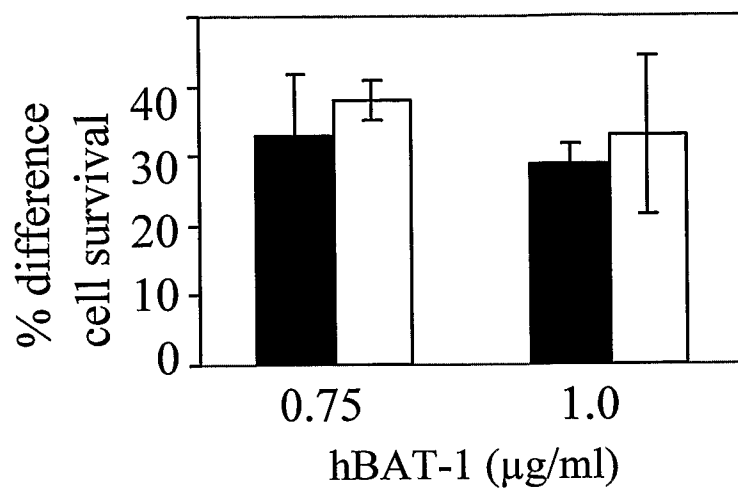


FIGURE 6B

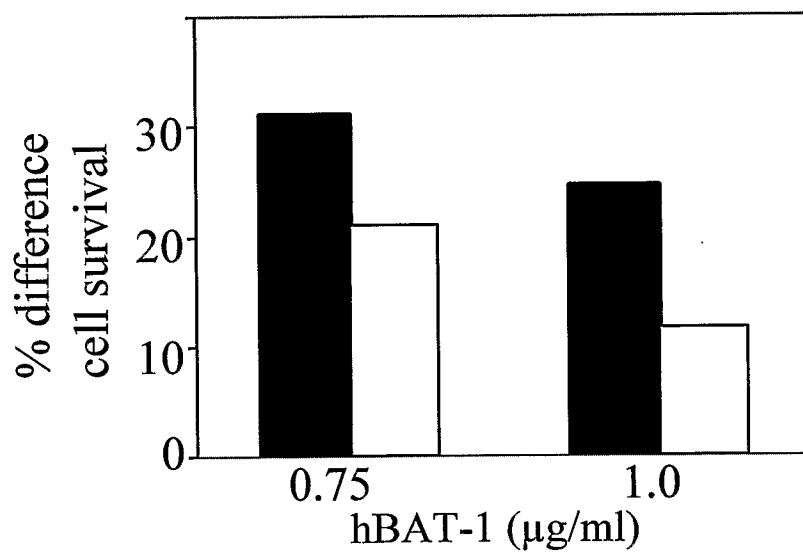
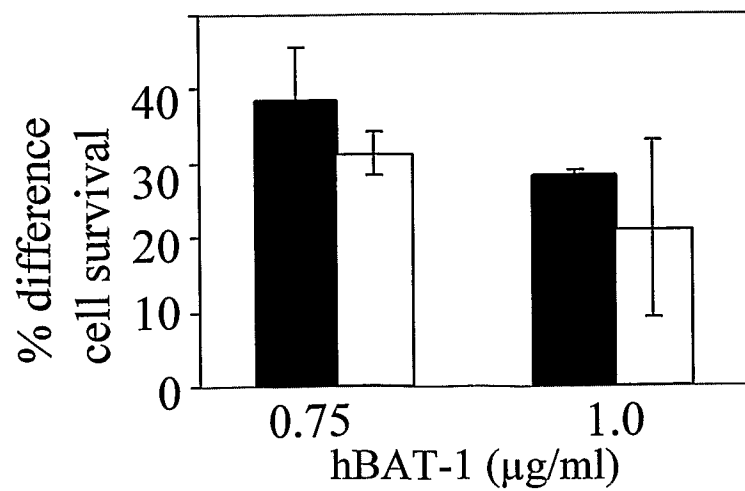


FIGURE 6C



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FIGURE 7A

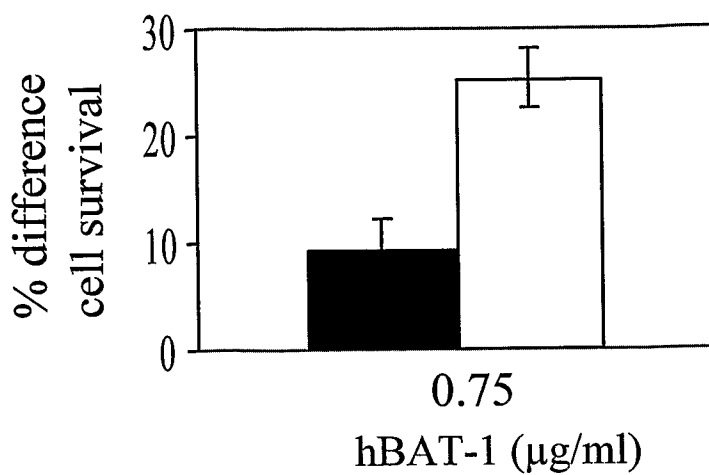
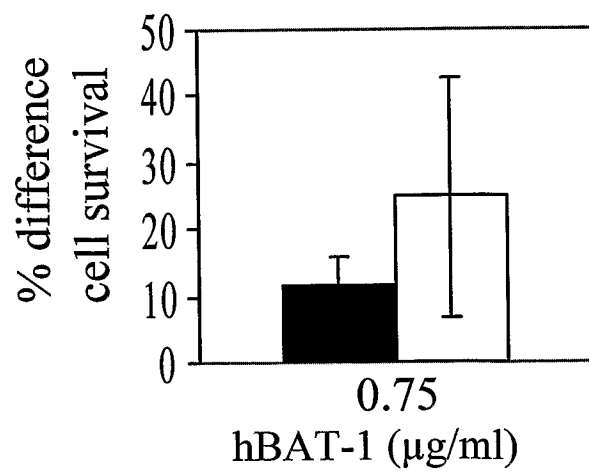


FIGURE 7B



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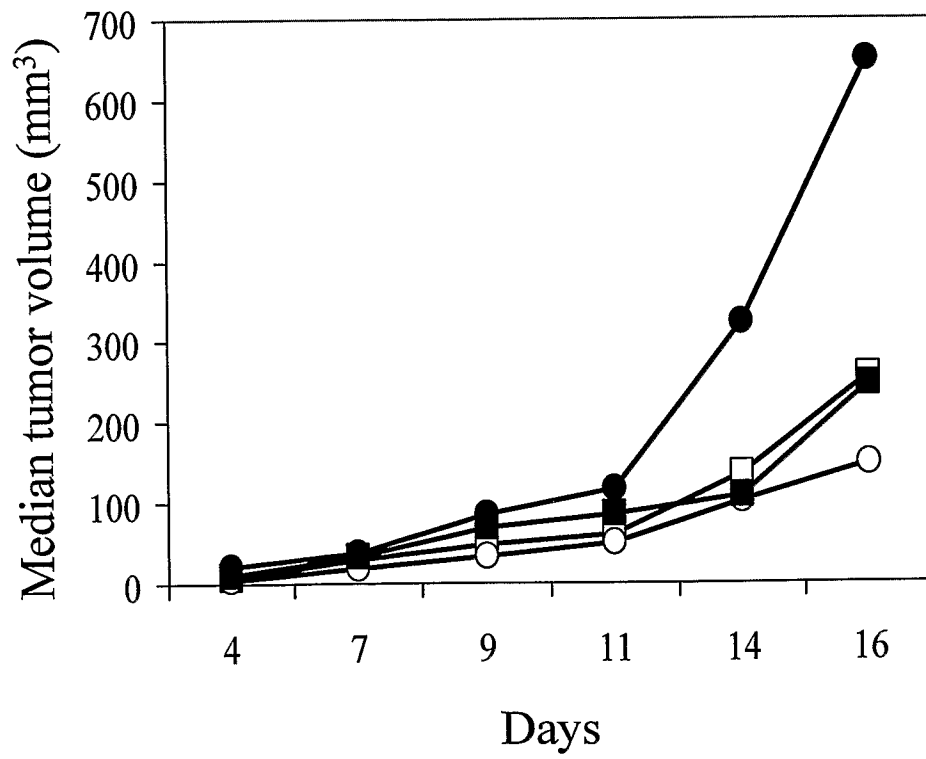


FIGURE 8

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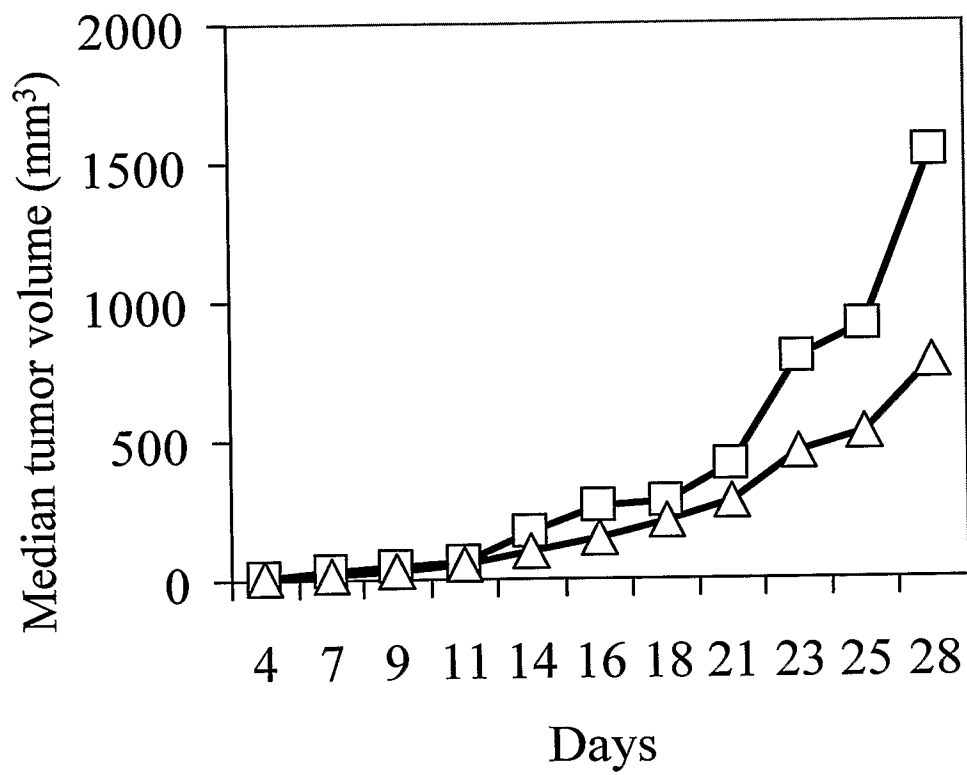


FIGURE 9

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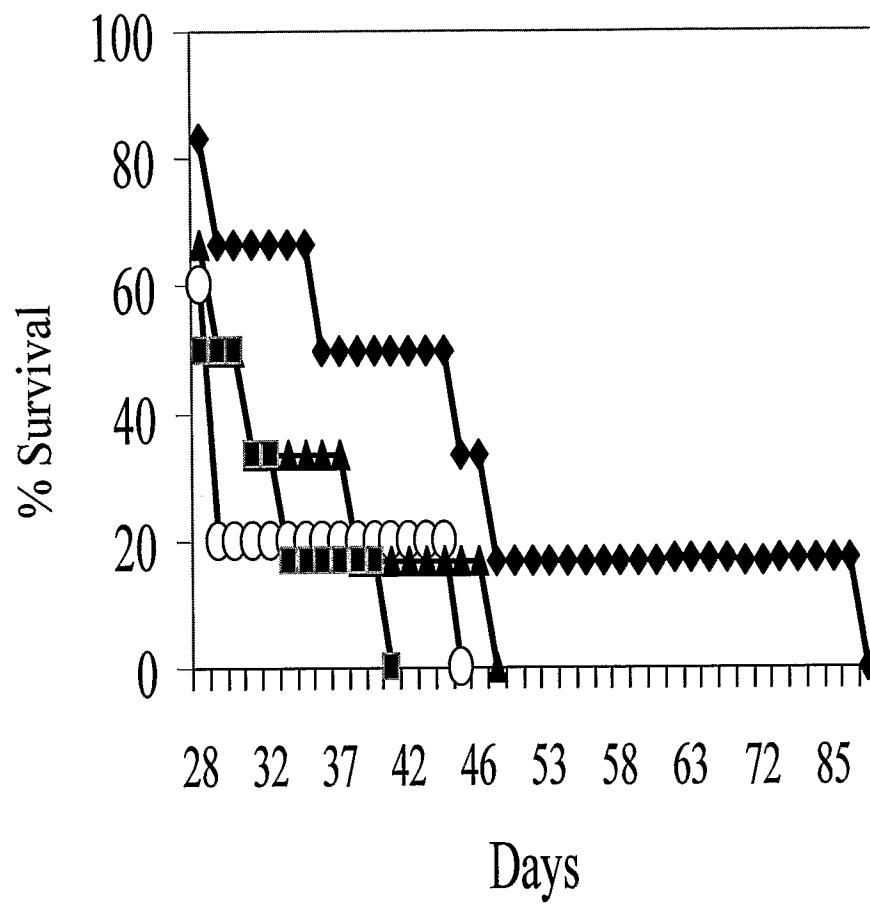


FIGURE 10

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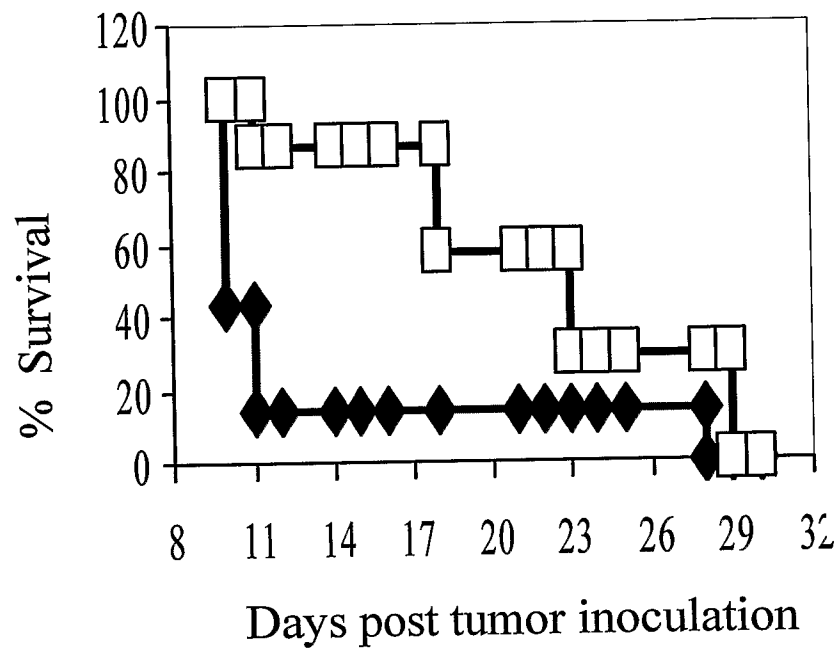


FIGURE 11

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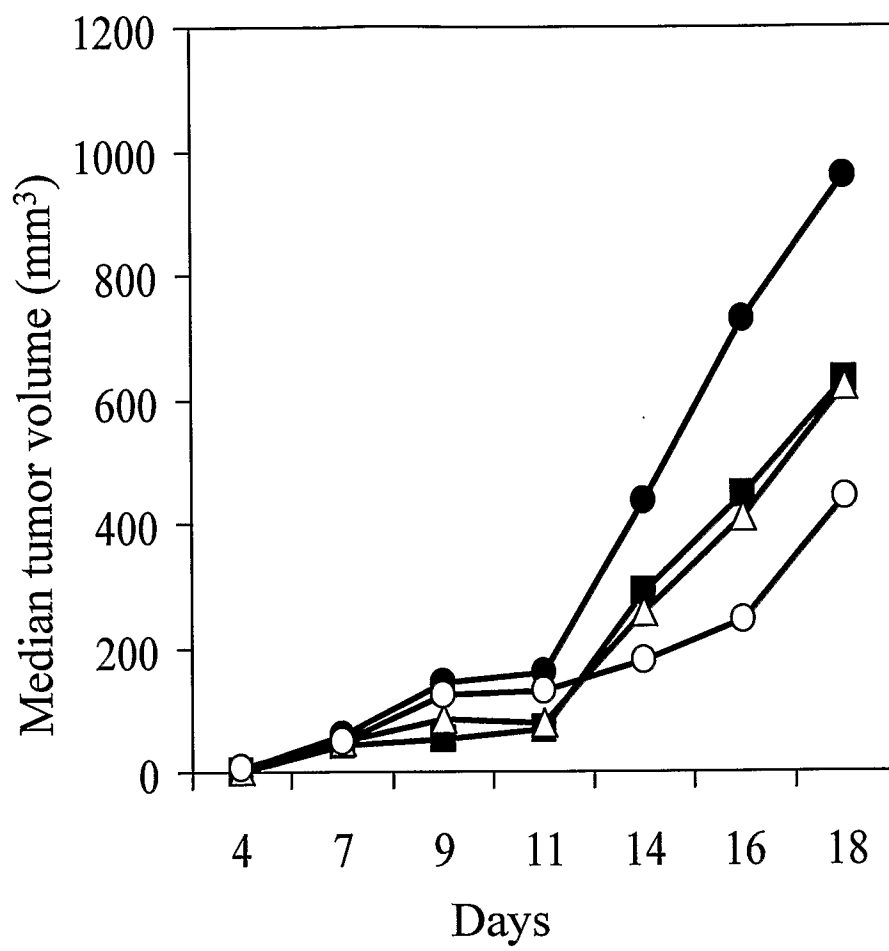


FIGURE 12

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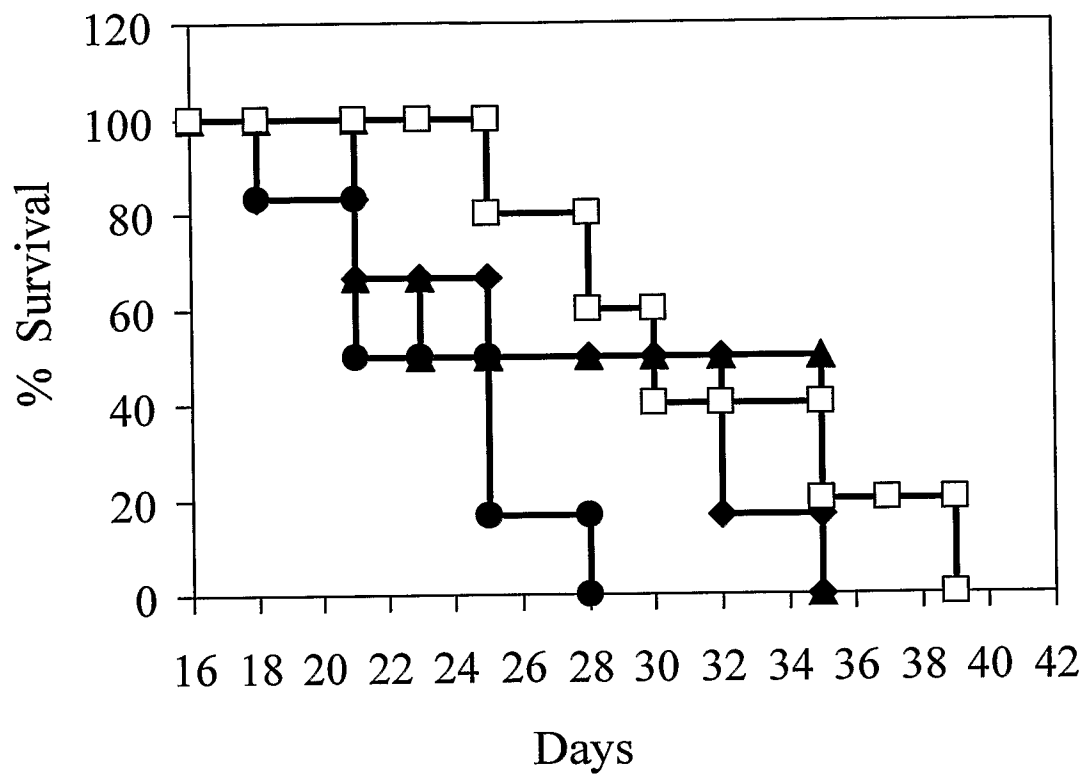


FIGURE 13

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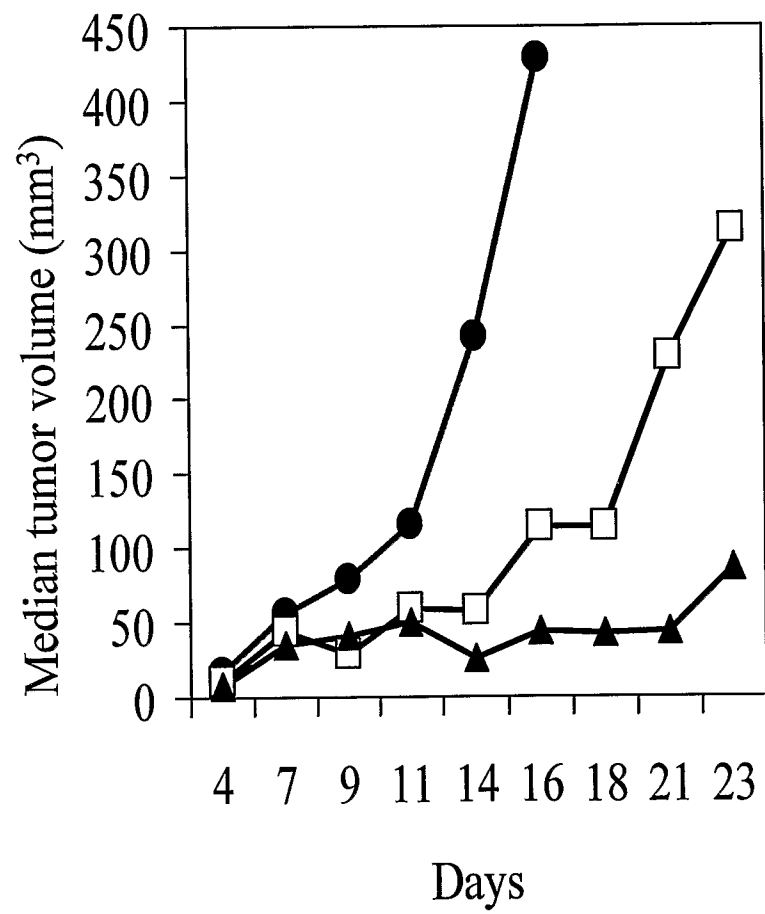


FIGURE 14

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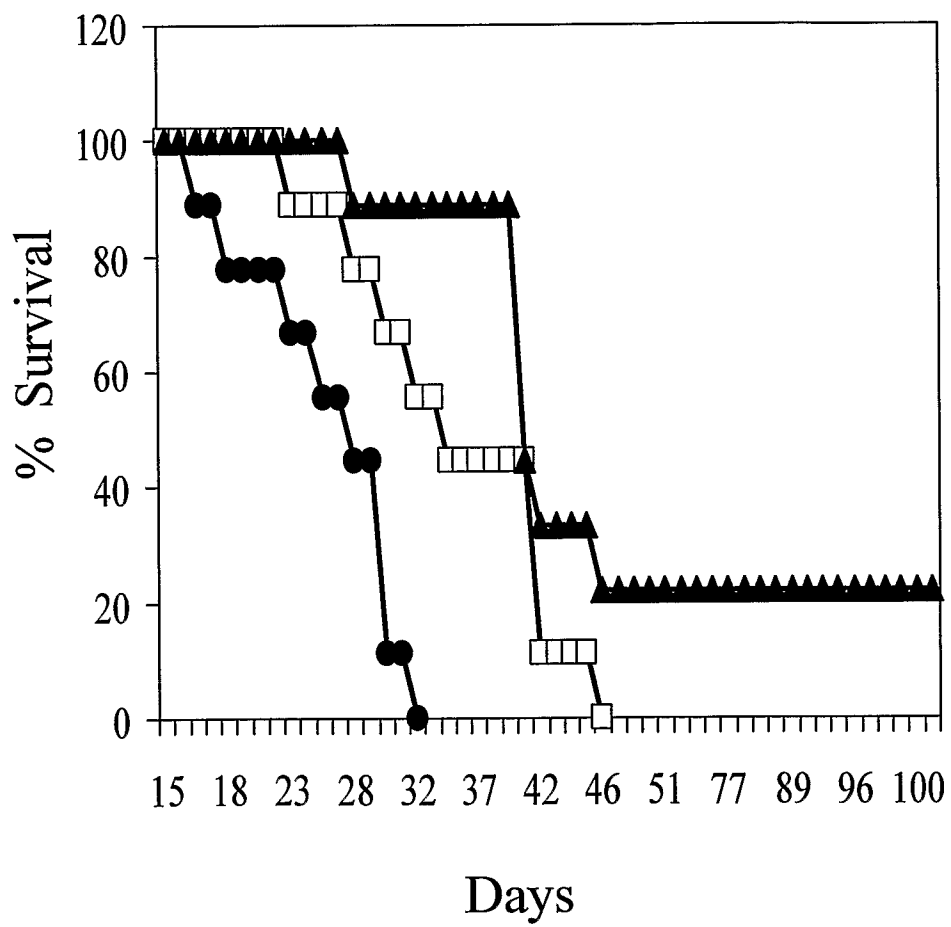


FIGURE 15

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FIGURE 16A

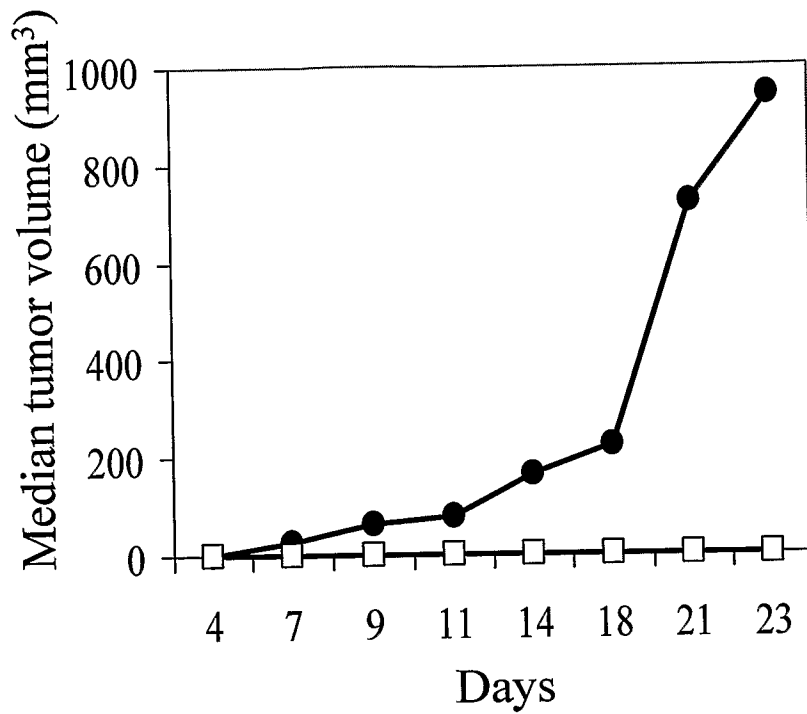
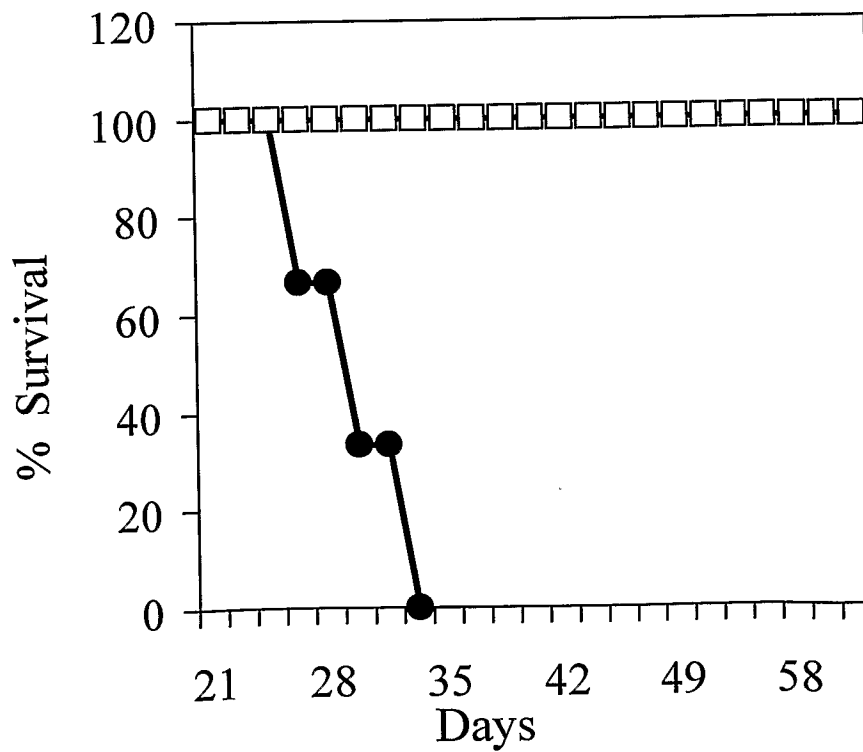


FIGURE 16B



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FIGURE 17A

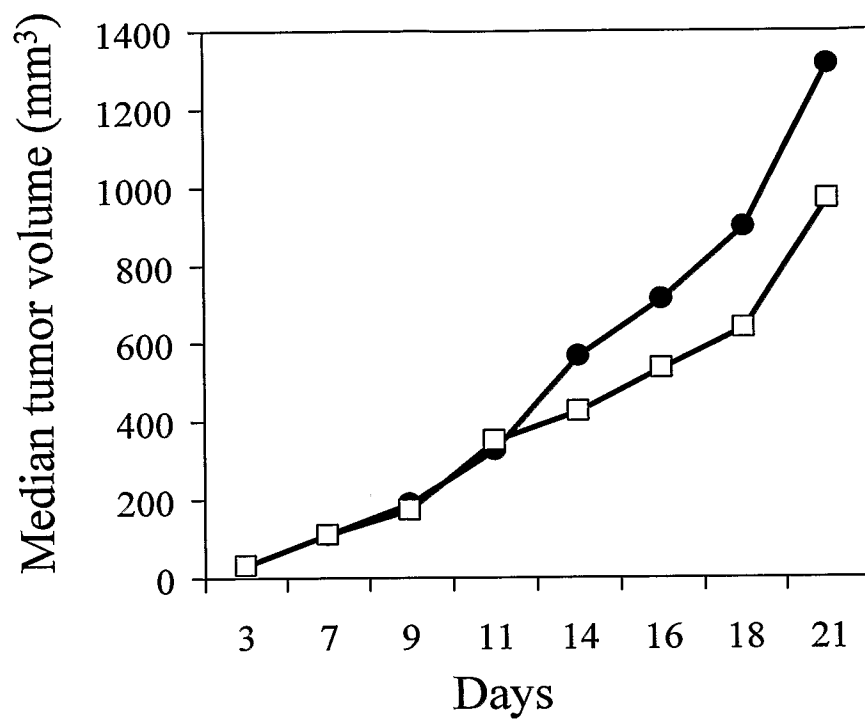
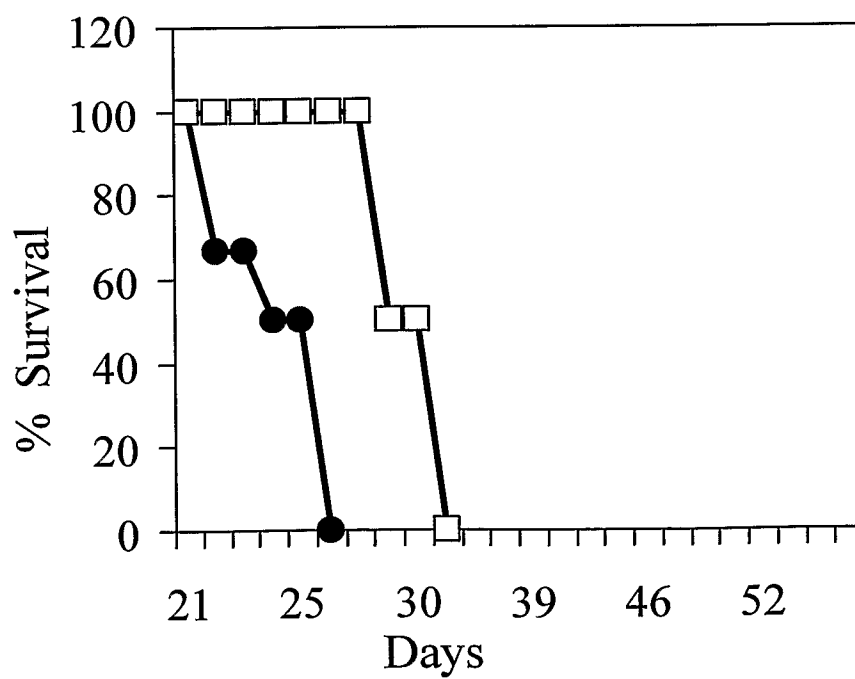


FIGURE 17B



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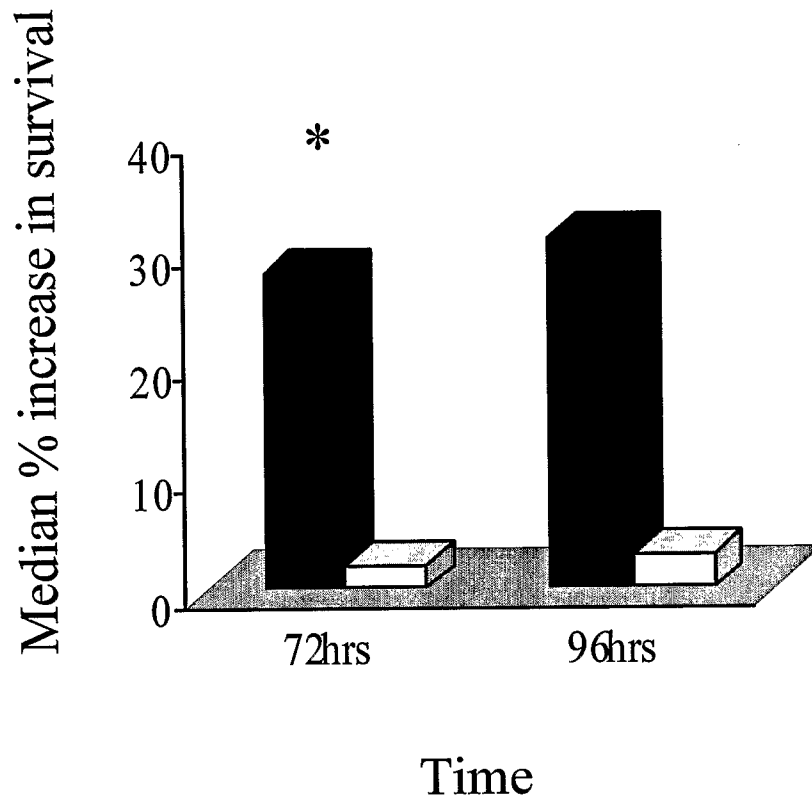


FIGURE 18

CDRs Kabat NO		==L2==						
SEQ ID NO.		1	2	3	4	5	6	7
Mouse BATV _k	129	12345678901234567890123456789012345678901234567890						
Human TEL9V _k	130	QIVLTQSPAIMASPGEKVTITCSARSSVSYMHWFQQKPGTSPKLWIYRTSNLASGVPARFSGSGSGTSY						
Variants		E.....SSL...V.DR.....R.SQISN.LN.Y.....KA...L..AA.T.Q.....S.....D						
BATRK _A	15	EIVLTQSPSSLSASVGDRVTITCSARS-SVSYMHWYQQKPGKAPKLLIYRTSNLASGVPSRFSGSGGTD						
BATRK _B	16	EIVLTQSPSSLSASVGDRVTITCSARS-SVSYMHW F QQKPGKAPKL W IYRTSNLASGVPSRFSGSGGTD						
BATRK _C	17	EIVLTQSPSSLSASVGDRVTITCSARS-SVSYMHW F QQKPGKAPKL W IYRTSNLASGVPSRFSGSGGTD						
BATRK _D	18	EIVLTQSPSSLSASVGDRVTITCSARS-SVSYMHW F QQKPGKAPKL W IYRTSNLASGVPSRFSGSGGTS						
<hr/>								
CDRs Kabat NO		===L3===						
SEQ ID NO		8	9	10				
Mouse BATV _k	129	1234567890123456789012345678901234567						
Human TEL9V	130	CLTISRMEAEADAATYYCQQRSSFPLTFGSGTKLEIK						
Variants		FT...NSLQP..F.....TN.....G.....						
BATRK _A	15	FTLTINSLQPEDFATYYCQQRSSFPLTFGGGTKLEIK						
BATRK _B	16	Y TLTINSLQPEDFATYYCQQRSSFPLTFGGGTKLEIK						
BATRK _C	17	Y CLTINSLQPEDFATYYCQQRSSFPLTFGGGTKLEIK						
BATRK _D	18	Y CLTINSLQPEDFATYYCQQRSSFPLTFGGGTKLEIK						

FIGURE 19

CDRs Kabat Numbers		-----H1=							=====H2=====							
		1	2	3	4	5	6	7								
Mouse BATV_H (SEQ ID NO: 145)		123456789012345678901234567890123456789012345678901234567890123456														
hsighv 1295 V_H (SEQ ID NO: 146)		QIQLVQSGPELKKPGEIVKISCKASGYTFTNYGMNVWKQAPGKGLKWMGWINTDSGESTYAEFFKGRFAFSLETSAN														
Variant SEQ ID NO.		V.....S.....AS.....S.SSHAI...R.....Q...Q.....NT.SP...QG.T...V...D...VS														
Variant SEQ ID NO.																
BATRH _A	20	QVQLVQSGSELKKPGASVKISCKASGYSFSNYGMNVWRQAPGQGLQWMGWINTDSGESTYAEFFKGRFVFSLDTSVS														
BATRH _B	21	QVQLVQSGSELKKPGASVKISCKASGYTFTNYGMNVWRQAPGQGLQWMGWINTDSGESTYAEFFKGRFVFSLDTSVS														
BATRH _C	22	QVQLVQSGSELKKPGASVKISCKASGYTFTNYGMNVWRQAPGQGLQWMGWINTDSGESTYAEFFKGRFVFSLDTSVN														
BATRH _D	23	QIQLVQSGSELKKPGASVKISCKASGYTFTNYGMNVWRQAPGQGLQWMGWINTDSGESTYAEFFKGRFVFSLDTSVN														
BATRH _E	24	QIQLVQSGSELKKPGASVKISCKASGYTFTNYGMNVWKQAPGQGLKWMGWINTDSGESTYAEFFKGRFAFSLDTSVN														
CDRs Kabat Numbers		=====H3=====														
		8	9	10	11											
Mouse BATV_H (SEQ ID NO: 145)		789012ABC345678901234567890ABC1234567890123														
hsighv 1295 V_H (SEQ ID NO: 146)		TAYLQINNINNEDTATYFCVRVGYDAL---DYWGQGTSVTVSS														
Variant SEQ ID NO.	TS.TA...GM...AKESHSSA LDL.....L.....														
Variant SEQ ID NO.																
BATRH _A	20	TAYLQITSLTAEDTGMVFCAKVGYDAL---DYWGQGTSLVTVSS														
BATRH _B	21	TAYLQITSLTAEDTGMVFCAKVGYDAL---DYWGQGTSLVTVSS														
BATRH _C	22	TAYLQITSLTAEDTGMVFCVRVGYDAL---DYWGQGTSLVTVSS														
BATRH _D	23	TAYLQITSLTAEDTGMVFCVRVGYDAL---DYWGQGTSLVTVSS														
BATRH _E	24	TAYLQITSLNAEDTGMVFCVRVGYDAL---DYWGQGTSLVTVSS														

FIGURE 20

INTERNATIONAL SEARCH REPORT

International application No
PCT/IL2009/000153

A. CLASSIFICATION OF SUBJECT MATTER
INV. C07K16/30 A61K39/395

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
C07K A61K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, BIOSIS, CHEM ABS Data

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Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	WO 03/099196 A (CURE TECH LTD [IL]; MOR RESEARCH APPLIC LTD [IL]; HARDY BRITTA [IL]; J) 4 December 2003 (2003-12-04) the whole document ----- -/--	1-71

☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Date of the actual completion of the international search

14 May 2009

Date of mailing of the international search report

08/06/2009

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Hix, Rebecca

INTERNATIONAL SEARCH REPORT

International application No

PCT/IL2009/000153

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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INTERNATIONAL SEARCH REPORT

International application No

PCT/IL2009/000153

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Information on patent family members

International application No

PCT/IL2009/000153

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