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(54) Titre : MODULATION DE L'EXPRESSION DE FAS ET DE FASL
(54) Title: MODULATION OF FAS AND FASL EXPRESSION

(57) Abrégé/Abstract:
A method employing a compositon comprising a 2 to 10 base synthetic oligonucleotide sequence selected from the group consisting of $(GG)_n$, $(GT)_n$, at $(GT)_n$b, a $(GA)_n$b, and a $(GC)_n$b, wherein n is an integer between 1 and 3, and a and b are independently either none or one or more As, Cs, Gs, or Ts, or combinations thereof, for modulation of Fas and FasL expression or for modulation of the efficacy of therapeutic agents. The composition is administered to an animal or human with a pharmaceutically acceptable carrier, and optionally with a therapeutic agent, in an amount effective to modulate Fas and FasL expression, to treat the disease, or to modulate efficacy of the therapeutic agent.

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(54) Title: MODULATION OF FAS AND FASL EXPRESSION

(57) Abstract: A method employing a compositon comprising a 2 to 10 base synthetic oligonucleotide sequence selected from the group consisting of $(GG)_n$, $(GT)_n$, at $(GT)_nb$, a $(GA)_nb$, and a $(GC)_nb$, wherein n is an integer between 1 and 3, and a and b are independently either none or one or more As, Cs, Gs, or Ts, or combinations thereof, for modulation of Fas and FasL expression or for modulation of the efficacy of therapeutic agents. The composition is administered to an animal or human with a pharmaceutically acceptable carrier, and optionally with a therapeutic agent, in an amount effective to modulate Fas and FasL expression, to treat the disease, or to modulate efficacy of the therapeutic agent.

MODULATION OF FAS AND FASL EXPRESSION

FIELD OF THE INVENTION

The present invention relates compositions useful for modulating Fas and Fas ligand expression on cells and for modulating efficacy of therapeutic agents.

BACKGROUND OF THE INVENTION

The Fas (Apo-1, CD95) and Fas ligand (FasL, CD95L) system is one of the best-studied cell death systems. Fas is a type-I membrane protein abundantly expressed by cells in various tissues and particularly on activated T cells, heart cells, kidney cells and hepatocytes. FasL is a type-II transmembrane protein expressed particularly on activated T cells and natural killer cells (Nagata, S. Ann. Rev. Genet. 33:29, 1999), and is expressed constitutively in immune-privileged sites as, for example, the eye and testis (Griffith et al. Science 270:630, 1995).

Fas and FasL interactions (Fas/FasL) play an essential role in the regulation of immune cells and in the elimination of autoreactive cells (Sabelko-Downes et al. Curr. Opin. Immunol. 12:330, 2000). In addition, Fas/FasL mediates the killing of cancer cells and of virus-infected cells (Famularo et al. Med. Hypoth. 53:50, 1999; Owen-Schaub et al. Int. J. Oncol. 17:5, 2000). In contrast, FasL, expressed on cancer cells, may attack cells of the immune system (O'Connell, J. Exp. Med. 184:1075, 1996) or facilitate local tumor invasion by killing surrounding tissue (Yoong et al. Am. J. Pathol. 154:693, 1999). FasL, expressed on activated T cells, may also participate in tissue damage in fulminant

hepatitis and in graft-versus-host disease (Kondo et al. Nature Med. 3:409, 1997; Braun et al. J. Exp. Med. 183:657, 1996).

Binding of FasL to Fas, or cross-linking of Fas with agonistic antibodies, induces apoptosis (Nagata, S. Ann. Rev. Genet. 33:29, 1999) that results in cell death. Apoptosis is an active cellular death process characterized by distinctive morphological changes that include condensation of nuclear chromatin, cell shrinkage, nuclear disintegration, plasma membrane blebbing, and the formation of membrane-bound apoptotic bodies (Wyllie et al. Int. Rev. Cytol. 68:251, 1980). A molecular hallmark of apoptosis is degradation of cellular nuclear DNA into oligonucleosomal-length fragments as the result of activation of endogenous endonucleases (Wyllie A. Nature 284:555, 1980). Caspases (cysteine-aspartyl-specific proteases) have been implicated as key enzymes in the execution of the late stage of apoptosis. The binding of FasL to Fas activates a cascade of caspases via a FADD adaptor (Fas-associated protein with death domain), which leads to the cleavage of various cellular substrates and to DNA fragmentation (Nagata, S. Ann. Rev. Genet. 33:29, 1999).

Synthetic oligonucleotides are polyanionic sequences that can be internalized by cells (Vlassov et al. Biochim. Biophys. Acta 1197:95, 1994) and bind selectively to nucleic acids (Wagner, R. Nature: 372:333, 1994), to specific cellular proteins (Bates et al. J. Biol. Chem. 274:26369, 1999) and to specific nuclear proteins (Scaggiante et al. Eur. J. Biochem. 252:207, 1998), and inhibit cell proliferation. Proliferation is the culmination of the progression of a cell through the cell cycle, resulting in the division of one cell into two cells. Alterations in cell cycle progression occur in all cancers and may result from over-expression of genes, mutation of regulatory genes, or abrogation of DNA damage checkpoints (Hochhauser D. Anti-Cancer Chemotherapeutic Agents 8:903, 1997).

Synthetic phosphorothioate oligonucleotides containing unmethylated CpG dinucleotides flanked by two 5' purine and two 3' pyrimidine (CpG motifs) are reported to induce the synthesis of cytokines by macrophages and B cells, to increase the activity of NK cells and cytotoxic T lymphocytes, and to enhance T-

Natl. Acad. Sci. USA93:2879, 1996; Lipford et al. Eur. J. Immunol. 27:2340, 1997). A 20 base synthetic CpG motif is reported to block Fas expression on activated B cells and to block apoptosis induced by anti-Fas monoclonal antibodies (Wang et al. Cell. Immunol. 180:162, 1997). Irradiation is reported to upregulate the expression of Fas on cancer cells (Sheard et al. Int. J. Cancer 73:757, 1997; Nishioka et al. Int. J. Mol. Med. 3:275, 1999).

The ability to modulate the Fas/FasL system has many clinical applications for use in diseases including, but not limited to, neoplastic autoimmune, degenerative and cardiovascular diseases. However, most prior Fas/FasL modulating agents have proven to be less than adequate in clinical applications. Moreover, many of these agents are inefficient, toxic or have significant adverse effects.

Therefore, there is a continuing need for novel compositions and methods that modulate the expression of Fas and FasL on cells. There is also a need for novel compositions and methods that modulate the efficacy of Fas and FasL modulatory agents on disease. There is also a need for novel compositions and methods that modulate the expression of Fas and FasL on cells in order to treat diseases in animals or humans associated with altered expression of Fas or FasL on cells.

SUMMARY OF THE INVENTION

The present invention fulfills these needs by providing a novel method, employing new compositions comprising a synthetic phosphodiester oligodeoxynucleotide (hereinafter, "sequence") selected from the group consisting of $(GG)_n$, $(GT)_n$, $a(GT)_nb$, $a(GA)_nb$, and $a(GC)_nb$, wherein n is an integer between 1 and 3, and a and b are independently either none or one or more As, Cs, Gs, or Ts, or combinations thereof, wherein the total number of bases in the composition is between 2 and 10, preferably 4 to 8, more preferably 5 to 7, and most preferably 6.

The present invention provides new uses for these compositions. This composition is combined with a pharmaceutically acceptable carrier, and is

FasL expression in the animal or the human. This composition is also combined with a pharmaceutically acceptable carrier, and is administered to an animal or a human having a disease in an amount effective to modulate Fas and FasL expression in order to treat the disease in the animal or the human. This composition is also administered to an animal or human to modulate the efficacy of Fas and FasL modulatory agents, comprising administration of the composition in an amount effective to modulate efficacy of Fas and FasL modulatory agents to modulate Fas and FasL, or to treat an animal or a human having a disease. Another new use for this composition of the present invention is to modulate, and preferentially potentiate, the efficacy of a therapeutic agent to treat a disease, comprising administration of the composition in a pharmaceutically acceptable carrier, optionally in combination with a therapeutic agent, in an amount effective to modulate efficacy of the therapeutic agent administered to an animal or a human. The compositions of the present invention may be administered at any time before, during, or after administration of the therapeutic agent, in order to modulate the efficacy of the therapeutic agent. The compositions of the present invention may also be administered *in vitro*, for example to animal or human cells or tissues.

In a preferred embodiment, the composition of the present invention comprises a sequence selected from the group consisting of $(GG)_n$, $(GT)_n$, $a(GT)_nb$, $a(GA)_nb$, and $a(GC)_nb$, wherein n is an integer between 1 and 3, and a and b are independently either none or one or more As, Cs, Gs, or Ts, or combinations thereof provided the total number of bases in the composition is 6. In another preferred embodiment, the composition of the present invention comprises this sequence of 6 bases in combination with a pharmaceutically acceptable carrier. In yet another preferred embodiment, the composition of the present invention comprises this sequence of 6 bases in combination with a therapeutic agent and a pharmaceutically acceptable carrier. These compositions may be used in any of the methods described in the preceding paragraphs and throughout the specification.

The unexpected and surprising ability of the sequences of the present

unfulfilled need in the medical arts and provides an important benefit for animals, including humans.

Accordingly, an object of the present invention is to provide a new composition comprising a synthetic phosphodiester oligodeoxynucleotide (hereinafter, "sequence") selected from the group consisting of $(GG)_n$, $(GT)_n$, $a(GT)_nb$, $a(GA)_nb$, and $a(GC)_nb$, wherein n is an integer between 1 and 3, and a and b are independently either none or one or more As, Cs, Gs, or Ts, or combinations thereof, wherein the total number of bases in the composition is 2 to 10.

Another object of the present invention is to provide a new composition comprising a synthetic phosphodiester oligodeoxynucleotide (hereinafter, "sequence") selected from the group consisting of $(GG)_n$, $(GT)_n$, $a(GT)_nb$, $a(GA)_nb$, and $a(GC)_nb$, wherein n is an integer between 1 and 3, and a and b are independently either none or one or more As, Cs, Gs, or Ts, or combinations thereof, wherein the total number of bases in the composition is 4 to 8.

Yet another object of the present invention is to provide a new composition comprising a synthetic phosphodiester oligodeoxynucleotide (hereinafter, "sequence") selected from the group consisting of $(GG)_n$, $(GT)_n$, $a(GT)_nb$, $a(GA)_nb$, and $a(GC)_nb$, wherein n is an integer between 1 and 3, and a and b are independently either none or one or more As, Cs, Gs, or Ts, or combinations thereof, wherein the total number of bases in the composition is 5 to 7.

Another object of the present invention is to provide a new composition comprising a synthetic phosphodiester oligodeoxynucleotide (hereinafter, "sequence") selected from the group consisting of $(GG)_n$, $(GT)_n$, $a(GT)_nb$, $a(GA)_nb$, and $a(GC)_nb$, wherein n is an integer between 1 and 3, and a and b are independently either none or one or more As, Cs, Gs, or Ts, or combinations thereof, wherein the total number of bases in the composition is 6.

Yet another object of the present invention is to provide novel compositions comprising any of the sequences described herein, in combination with a pharmaceutically acceptable carrier.

Another object of the present invention is to provide novel compositions comprising any of the sequences described herein, in combination with a therapeutic agent and a pharmaceutically acceptable carrier.

Yet another object of the present invention is to provide for the use of any of the novel compositions described herein for the manufacture of a medicament.

Still another object of the present invention is to provide new uses for the compositions of the present invention.

Yet another object of the present invention is to provide a method to modulate the Fas expression on cells.

Another object of the present invention is to provide a method to modulate FasL expression on cells.

Still another object of the present invention is to provide a method to modulate the Fas expression on immune cells.

Another object of the present invention is to provide a method to modulate FasL expression on immune cells.

Yet another object of the present invention is to provide a method to modulate Fas expression on cancer cells.

Another object of the present invention is to provide a method to modulate FasL expression on cancer cells.

Another object of the present invention is to provide a method to treat a disease in an animal, including a human.

Yet another object of the present invention is to provide a method to treat a neoplastic disease.

Still another object of the present invention is to provide a method to treat an autoimmune disease.

Another object of the present invention is to provide a method to treat an inflammatory disease.

Yet another object of the present invention is to provide a method to treat a proliferative disease

Another object of the present invention is to provide a method to treat a lymphoproliferative disease.

Yet another object of the present invention is to provide a method to treat a degenerative disease.

Still another object of the present invention is to provide a method to treat a neurodegenerative disease.

Another object of the present invention is to provide a method to treat a cardiovascular disease

Yet another object of the present invention is to provide a method to treat a graft rejection.

Another object of the present invention is to provide a method effective to treat an infection.

Yet another object of the present invention is to provide a method that modulates the effect of a therapeutic agent to treat disease.

Yet another object of the present invention is to provide a method that potentiates the effect of a therapeutic agent to treat disease.

Still another object of the present invention is to provide a method that potentiates the effect of a Fas modulating agent.

Another object of the present invention is to provide a method that potentiates the effect of a FasL modulating agent.

Yet another object of the present invention is to provide a method that potentiates the effect of an anti-neoplastic agent.

Another object of the present invention is to provide a method that potentiates the effect of an immunostimulatory agent.

Still another object of the present invention is to provide a method that potentiates the effect of an immunosuppressive agent.

Another object of the present invention is to provide a method that potentiates the effect of an anti-inflammatory agent.

It is another object of the present invention to provide a composition that is simple to prepare.

Another object of the present invention is to provide a composition that is minimally toxic to the recipient.

These and other objects, features and advantages of the present invention will become apparent after a review of the following detailed description of the disclosed embodiment and the appended claims.

DETAILED DESCRIPTION

The present invention fulfills these needs by providing new compositions and new methods of using these compositions. The present compositions comprise a synthetic phosphodiester oligodeoxynucleotide (hereinafter, "sequence") selected from the group consisting of $(GG)_n$, $(GT)_n$, $a(GT)_nb$, $a(GA)_nb$, and $a(GC)_nb$, wherein n is an integer between 1 and 3, and a and b are independently either none or one or more As, Cs, Gs, or Ts, or combinations thereof, wherein the total number of bases in the composition is between 2 and 10, preferably 4 to 8, more preferably 5 to 7, and most preferably 6. The compositions of the present invention further comprise any of the sequences described herein in combination with a pharmaceutically acceptable carrier. The compositions of the present invention further comprise any of the sequences described herein in combination with a therapeutic agent and a pharmaceutically acceptable carrier.

The present invention provides new uses for these novel compositions. This composition is combined with a pharmaceutically acceptable carrier, and is administered to an animal or a human an amount effective to modulate Fas and FasL expression in the animal or the human. This composition is also combined with a pharmaceutically acceptable carrier, and is administered to an animal or a human having a disease in an amount effective to modulate Fas and FasL expression in order to treat the disease in the animal or the human. This composition is also administered to an animal or human to modulate the efficacy of Fas and FasL modulatory agents, comprising administration of the composition in an amount effective to modulate efficacy of Fas and FasL modulatory agents to modulate Fas and FasL, or to treat an animal or a human having a disease. Another new use for this composition of the present invention is to modulate, and preferentially potentiate, the efficacy of a therapeutic agent to treat a disease,

carrier, optionally in combination with a therapeutic agent, in an amount effective to modulate efficacy of the therapeutic agent administered to an animal or a human. The composition of the present invention may be administered at any time before, during, or after administration of the therapeutic agent, in order to modulate the efficacy of the therapeutic agent.

In a preferred embodiment the composition of the present invention comprises a sequence selected from the group consisting of $(GG)_n$, $(GT)_n$, $a(GT)_nb$, $a(GA)_nb$, and $a(GC)_nb$, wherein n is an integer between 1 and 3, and a and b are independently either none or one or more As, Cs, Gs, or Ts, or combinations thereof provided the total number of bases in the composition is 6. In another preferred embodiment, the composition of the present invention comprises this sequence of 6 bases in combination with a pharmaceutically acceptable carrier. In yet another preferred embodiment, the composition of the present invention comprises this sequence of 6 bases in combination with a therapeutic agent and a pharmaceutically acceptable carrier. These compositions may be used in any of the methods described in this patent application.

As used herein the word "sequence" refers to a synthetic phosphodiester oligodeoxynucleotide comprised of adenine (A), cytosine (C), guanine (G) and thymine (T), with a total number of bases of 2 to 10, preferably 4 to 8, more preferably 5 to 7 and most preferably 6.

As used herein, the word "expression" refers to the cell surface concentration of Fas or of FasL.

As used herein, the words "response" refers to upregulation (increase) or downregulation (decrease) of Fas or of Fas L expression.

As used herein, the word "modulates" refers to changes in the expression of Fas or of FasL. Such changes include upregulation and downregulation of Fas or of FasL expression. The word modulate is also employed to describe the ability of the novel sequences of the present invention to modulate the efficacy of therapeutic agents, including Fas and FasL modulating agents, to treat disease or to modulate Fas or FasL expression.

As used herein, the phrases "therapeutically effective", "effective amount" and "amount effective to" refer to an amount of a sequence effective to modulate the expression of Fas or of FasL.

As used herein, the word "disease" refers to a condition wherein bodily health is impaired.

As used herein, the phrase "therapeutic agent" is any agent approved by a regulatory agency of a country or a state government or listed in the U.S. Pharmacopoeia or other generally recognized pharmacopoeia for use to treat a disease in an animal, including a human.

As used herein, the word "antineoplastic" refers to preventing the development, maturation, proliferation or spread of cancer cells

As used herein, the word "potentiates" refers to a degree of synergism that is greater than additive.

As used herein, the word "synergism" refers to the coordinated action of two or more agents.

Administration of an effective amount of a sequence of the present invention to an animal, including a human, is a therapeutic treatment that prevents, treats or eliminates a disease including, but not limited to, neoplastic, autoimmune, proliferative, lymphoproliferative, degenerative, and cardiovascular disease; infection; inflammation; and, graft, tissue and cell rejection.

Compositions comprising one or more sequences and a pharmaceutically acceptable carrier are prepared by uniformly and intimately bringing into association the sequence and the pharmaceutically acceptable carrier. Compositions comprising one or more sequences, a therapeutic agent and a pharmaceutically acceptable carrier are prepared by uniformly and intimately bringing into association the sequence, the therapeutic agent and the pharmaceutically acceptable carrier. Pharmaceutically acceptable carriers include liquid carriers, solid carriers or both. Liquid carriers are aqueous carriers, non-aqueous carriers or both and include, but are not limited to, solutions, suspensions and emulsions. Emulsions include, but are not limited to, oil emulsions, water in oil emulsions, water-in-oil-in-water emulsions, site-specific emulsions, long-

carriers are biological carriers, chemical carriers or both and include, but are not limited to, viral vector systems, plasmids, particles, microparticles, nanoparticles, microspheres, nanospheres, bacterial cell walls, minipumps, and biodegradable or non-biodegradable natural or synthetic polymers that allow for sustained release of the sequences.

Preferred aqueous carriers include, but are not limited to, water, saline and pharmaceutically acceptable buffers. Preferred non-aqueous carriers include, but are not limited to, a mineral oil or a neutral oil including, but not limited to, a diglyceride, a triglyceride, a phospholipid, a lipid, an oil and mixtures thereof, wherein the oil contains an appropriate mix of polyunsaturated and saturated fatty acids. Optionally, stabilizing agents and excipients may be included regardless of the pharmaceutically acceptable carrier used to present the sequence to the cells.

The therapeutic effectiveness of a sequence may be increased by methods including, but not limited to, chemically modifying the base, sugar or phosphate backbone, chemically supplementing or biotechnologically amplifying the sequences using bacterial plasmids containing the appropriate sequences, complexing the sequences to biological or chemical carriers or coupling the sequences to tissue-type or cell-type directed ligands or antibodies.

The composition of the present invention further comprises a composition comprising a sequence and a therapeutic agent, wherein, when the sequence and the therapeutic agent are combined with a pharmaceutically acceptable carrier and administered to an animal or human having a disease. The sequence modulates and preferentially potentiates the effect of the therapeutic agent on the disease.

Therapeutic agents include, but not limited to, anti-neoplastic, anti-inflammatory, anti-autoimmune, anti-degenerative, Fas modulating and FasL modulating agents, or any combination thereof, and radiation therapy, or a combination of radiation therapy with therapeutic agents. These therapeutic agents include, but are not limited to, biologicals, drugs, chemotherapeutic drugs, immunostimulants, immunomodulators, immunotherapeutics, anti-virals, anti-infectives, antibiotics, cytokines, antigens, antibodies, nucleic acids, vaccines, aptabases, nucleic acids, antisense nucleic acids, telomerase inhibitors, caspase

biologically engineered and chemically synthesized agents, and agents that target cell death molecules for activation or inactivation.

Chemotherapeutic drugs include, but are not limited to, DNA damaging, DNA-alkylating, DNA-cross-linking, anti-tumor antibiotic, topoisomerase inhibiting, purine inhibiting, pyrimidine inhibiting, microtubule stabilizing, microtubule destabilizing, anti-metabolic, hormone antagonist, protein kinase inhibiting, HMG-CoA inhibiting, metaloproteinase inhibiting, CDK inhibiting, cyclin inhibiting, angiogenesis inhibiting, differentiation enhancing and molecular biologically modified viral, bacterial and extotoxic agents.

Routes of administration include, but are not limited to, oral, topical, subcutaneous, transdermal, subdermal, intra-muscular, intra-peritoneal, intra-vesical, intra-articular, intra-prostatic, intra-arterial, intra-venous, intra-dermal, intra-cranial, intra-lesional, intra-tumoral, intra-ocular, intra-pulmonary, intra-spinal, placement within cavities of the body, nasal inhalation and impression into skin. It is to be understood that administration of the compositions of the present invention may occur *in vivo*, *ex vivo* or *in vitro*. For example, the compositions of the present invention may be administered to animal or human cells or tissues *in vitro*. Appropriate doses for in vitro administration are about 1 nM to 1 mM, preferably about 10 nM to 100 μM, and more preferably about 100 nM to 10 μM.

Depending on the route of administration, the volume per dose is preferably about 0.001 to 100 ml per dose, more preferably about 0.01 to 50 ml per dose and most preferably about 0.1 to 30 ml per dose. A sequence in a pharmaceutically acceptable carrier, or sequence plus therapeutic agent in a pharmaceutically acceptable carrier, can be administered in a single dose treatment, in multiple dose treatments or continuously infused on a schedule and over a period of time appropriate to the disease being treated, the condition of the recipient and the route of administration. Moreover, the therapeutic agent can be administered before, concurrently with, or after administration of the sequence.

Preferably, the amount of sequence administered per dose is from about 0.001 to 100 mg/kg, more preferably from about 0.01 to 10 mg/ml and most preferably from about 0.1 to 5 mg/kg. A sequence plus a chemotherapeutic agent

and preferentially potentiate, the effect of the therapeutic agent. Preferably, the amount of therapeutic agent administered per dose is from about 0.001 to 1000 mg/m^2 or from about 0.01 to 1000 mg/kg, more preferably from about 0.01 to 500 mg/m^2 or about 0.01 to 500 mg/kg and most preferably from about 0.1 to 100 mg/m^2 or about 0.1 to 100 mg/kg. In one embodiment of a therapeutic agent, anti-Fas antibodies are employed and are administered in a dose of from about 0.003 to about 0.3 mg/kg, preferably 0.01 to about 0.1 mg/kg.

The particular sequence and the particular therapeutic agent administered, the amount per dose, the dose schedule and the route of administration should be decided by the practitioner using methods known to those skilled in the art and will depend on the type of disease, the severity of the disease, the location of the disease and other clinical factors such as the size, weight and physical condition of the recipient. In addition, *in vitro* assays may optionally be employed to help identify optimal ranges for sequence and for sequence plus therapeutic agent administration.

The following examples will serve to further illustrate the present invention without, at the same time, however, constituting any limitation thereof. On the contrary, it is to be clearly understood that resort may be had to various other embodiments, modifications, and equivalents thereof which, after reading the description herein, may suggest themselves to those skilled in the art without departing from the spirit of the invention.

Example 1

Preparation of sequences

Phosphodiester sequences were prepared by Sigma-Genosys (Woodlands, TX) using Abacus Segmented Synthesis Technology. Unless stated otherwise, the sequences were dispersed in autoclaved deionized water or in a pharmaceutically acceptable buffer such as, but not limited to, saline immediately prior to use.

Example 2

Cells

All cell lines were obtained from the American Type Culture Collection (ATCC, Rockville, MD) and were cultured in the medium recommended by the ATCC. Table 1 shows the cell lines, their origins and their properties.

Table 1

Cell lines

CELL LINE	ORIGIN	PROPERTIES
JURKAT	Human T cell leukemia	Suspension tumor model Atypical multi-drug resistance associated with p190-MRP protein
UMUC-3	Human bladder cancer	P-glycoprotein overexpression
T-24	Human bladder cancer	p53 mutated
LNCaP	Human prostate cancer	Solid tumor model; metastatic TGF-beta 1 receptor-negative; androgen-dependent
OVCAR-3	Human ovarian cancer	Solid tumor model; metastatic p53 mutated; p21/waf-1/Cip-1 deleted
SK-OV-3	Human ovarian cancer	Solid tumor model; metastatic TGF-beta 1 receptor-negative; androgen-dependent
MCF-7	Human breast cancer	Solid tumor model; non-metastatic Caspase 3-negative; estrogen-depend

Peripheral blood mononuclear cells (hereinafter, "PBMCs") were isolated from human blood by Ficoll-Hypaque (Amersham Pharmacia Biotech, Baie d'Urfée, Québec, Canada) density gradient centrifugation.

Cancer cells and PBMCs were seeded in 6 well flat-bottom microplates and were maintained at 37°C in a 5% CO_2 atmosphere. Unless stated otherwise, 2 X 10^5 cells/ml were incubated for 48 h with 0 µg/ml (control) or 100 µg/ml (5.5 µM) (treated) of the sequences.

Example 3

Measurement of Fas and of FasL at the cell surface

Fas and FasL expression were measured by flow cytometry using anti-Fas FITC-conjugated monoclonal antibodies and anti-FasL PE-conjugated monoclonal antibodies in a FACScalibur Flow Cytometer (Becton Dickinson, San Jose, CA, USA) using the CELLQuest program (Becton Dickinson).

Results are expressed as percentage (%) increase in the expression of Fas

Example 4

Modulation of Fas and FasL on Jurkat leukemia T cells

Jurkat human leukemia T cells are an atypical multi-drug resistant human suspension tumor cell model. Jurkat T cells were incubated with the 6 base sequences shown in Table 2.

Table 2

Percentage increase of Fas and of FasL on Jurkat human leukemia T cells

SEQUENCE	% INCREASE	
	Fas	FasL
TGTGTG SEQ ID NO:1 - (6 bases)	52	93
GTGTGT SEQ ID NO:2 - (6 bases)	52	43
TTTGTT SEQ ID NO:3 - (6 bases)	258	497
GGTGGG SEQ ID NO:4 - (6 bases)	61	22
GGGTGG SEQ ID NO:5 - (6 bases)	150	145
TTGTTT SEQ ID NO:6 - (6 bases)	126	140
AAGTAA SEQ ID NO:7 - (6 bases)	-4	-21
CCGTCC SEQ ID NO:8 - (6 bases)	107	151
TGGTTG SEQ ID NO:9 - (6 bases)	362	952
ATGTAT SEQ ID NO:10 - (6 bases)	246	393
CTGTCT SEQ ID NO:11 - (6 bases)	203	413
TCGTTC SEQ ID NO:12 - (6 bases)	121	75
GGTTGG SEQ ID NO:13 - (6 bases)	99	86
GGAAGG SEQ ID NO:14 - (6 bases)	67	88
GGCCGG SEQ ID NO:15 - (6 bases)	75	41
GGGGGG SEQ ID NO:16 - (6 bases)	118	49
GGGAGG SEQ ID NO:17 - (6 bases)	77	91
GGGCGG SEQ ID NO:18 - (6 bases)	208	356

Example 5

Modulation of Fas and of FasL on PBMCs

PBMCs were incubated with the 6 base sequences shown in Table 3.

Table 3

Percentage increase of Fas and of FasL on PBMCs

SEQUENCE	% INCREASE	
	Fas	FasL
TGTGTG SEQ ID NO:1 - (6 bases)	126	260
GTGTGT SEQ ID NO:2 - (6 bases)	94	99
TTTGTT SEQ ID NO:3 - (6 bases)	1165	1528
GGTGGG SEQ ID NO:4 - (6 bases)	57	59
GGGTGG SEQ ID NO:5 - (6 bases)	3	-20
TTGTTT SEQ ID NO:6 - (6 bases)	338	441
AAGTAA SEQ ID NO:7 - (6 bases)	13	-26
CCGTCC SEQ ID NO:28 - (6 bases)	1046	1147
TGGTTG SEQ ID NO:9 - (6 bases)	1043	1322
ATGTAT SEQ ID NO:10 - (6 bases)	377	457
CTGTCT SEQ ID NO:11 - (6 bases)	310	476
TCGTTC SEQ ID NO:12 - (6 bases)	597	847
GGTTGG SEQ ID NO:13 - (6 bases)	-3	-32
GGAAGG SEQ ID NO:14 - (6 bases)	112	162
GGCCGG SEQ ID NO:15 - (6 bases)	6	-29
GGGGGG SEQ ID NO:16 - (6 bases)	38	42
GGGAGG SEQ ID NO:17 - (6 bases)	266	356
GGGCGG SEQ ID NO:18 - (6 bases)	523	850

Example 6

Modulation of Fas and of FasL on T-24 bladder cancer cells

T-24 bladder cancer cells are a p53 mutated human cell line T-24 cells (1.0×10^5 cells/ml) were incubated with the 6 base sequences shown in Table 4.

Table 4

Percentage increase of Fas and of FasL on T-24 bladder cancer cells

SEQUENCE	% INCREASE	
	Fas	FasL
TGTGTG SEQ ID NO:1 - (6 bases)	84	213
GTGTGT SEQ ID NO:2 - (6 bases)	93	77
TTTGTT SEQ ID NO:3 - (6 bases)	279	549
GGTGGG SEQ ID NO:4 - (6 bases)	106	29
GGGTGG SEQ ID NO:5 - (6 bases)	80	13
TTGTTT SEQ ID NO:6 - (6 bases)	116	152
AAGTAA SEQ ID NO:7 - (6 bases)	16	-10
CCGTCC SEQ ID NO:8 - (6 bases)	282	459
TGGTTG SEQ ID NO:9 - (6 bases)	180	397
ATGTAT SEQ ID NO:10 - (6 bases)	90	150
CTGTCT SEQ ID NO:11 - (6 bases)	107	165
TCGTTC SEQ ID NO:12 - (6 bases)	105	74
GGTTGG SEQ ID NO:13 - (6 bases)	75	25
GGAAGG SEQ ID NO:14 - (6 bases)	46	14
GGCCGG SEQ ID NO:15 - (6 bases)	56	18
GGGGGG SEQ ID NO:16 - (6 bases)	35	-14
GGGAGG SEQ ID NO:17 - (6 bases)	124	75
GGGCGG SEQ ID NO:18 - (6 bases)	139	205

Example 7

Modulation of Fas and of FasL on UMUC-3 bladder cancer cells

UMUC-3 bladder cancer cells are a P-glycoprotein overexpressing human cell line. UMUC-3 cells (1.0×10^5 cells/ml) were incubated with the 6 base sequences shown in Table 5.

Table 5

Percentage increase of Fas and of FasL on UMUC-3 bladder cancer cells

SEQUENCE	% INCREASE	
	Fas	FasL
TGTGTG SEQ ID NO:1 - (6 bases)	72	112
GTGTGT SEQ ID NO:2 - (6 bases)	72	154
TTTGTT SEQ ID NO:3 - (6 bases)	108	231
GGTGGG SEQ ID NO:4 - (6 bases)	62	113
GGGTGG SEQ ID NO:5 - (6 bases)	67	143
TTGTTT SEQ ID NO:6 - (6 bases)	57	132
AAGTAA SEQ ID NO:7 - (6 bases)	6	-1
CCGTCC SEQ ID NO:8 - (6 bases)	55	149
TGGTTG SEQ ID NO:9 - (6 bases)	143	300
ATGTAT SEQ ID NO:10 - (6 bases)	42	95
CTGTCT SEQ ID NO:11 - (6 bases)	45	156
TCGTTC SEQ ID NO:12 - (6 bases)	47	112
GGTTGG SEQ ID NO:13 - (6 bases)	47	98
GGAAGG SEQ ID NO:14 - (6 bases)	1	8
GGCCGG SEQ ID NO:15 - (6 bases)	23	58
GGGGGG SEQ ID NO:16 - (6 bases)	-5	10
GGGAGG SEQ ID NO:17 - (6 bases)	39	106
GGGCGG SEQ ID NO:18 - (6 bases)	72	250

Example 8

Modulation of Fas and of FasL on OVCAR-3 ovarian cancer cells

OVCAR-3 ovarian cancer cells are a p53 mutated, p21/waf-1/Cip deleted, metastatic human solid tumor model. OVCAR-3 cells were incubated with the 6 base sequences shown in Table 6.

Table 6

Percentage increase of Fas and of FasL on OVCAR-3 ovarian cancer cells

SEQUENCE	% INCREASE	
	Fas	FasL
TGTGTG SEQ ID NO:1 - (6 bases)	64	70
GTGTGT SEQ ID NO:2 - (6 bases)	77	69
TTTGTT SEQ ID NO:3 - (6 bases)	193	341
GGTGGG SEQ ID NO:4 - (6 bases)	41	14
GGGTGG SEQ ID NO:5 - (6 bases)	43	9
TTGTTT SEQ ID NO:6 - (6 bases)	65	98
AAGTAA SEQ ID NO:7 - (6 bases)	16	-2
CCGTCC SEQ ID NO:8 - (6 bases)	83	95
TGGTTG SEQ ID NO:9 - (6 bases)	221	270
ATGTAT SEQ ID NO:10 - (6 bases)	93	114
CTGTCT SEQ ID NO:11 - (6 bases)	52	93
TCGTTC SEQ ID NO:12 - (6 bases)	126	224
GGTTGG SEQ ID NO:13 - (6 bases)	22	10
GGAAGG SEQ ID NO:14 - (6 bases)	15	1
GGCCGG SEQ ID NO:15 - (6 bases)	19	-2
GGGGGG SEQ ID NO:16 - (6 bases)	-1	7
GGGAGG SEQ ID NO:17 - (6 bases)	49	59
GGGCGG SEQ ID NO:18 - (6 bases)	65	142

Example 9

Modulation of Fas and of FasL on SK-OV 3 ovarian cancer cells

SK-OV-3 ovarian cancer cells are a p53 mutated, p21/waf-1/Cip deleted, $p15^{ink4B}$,$p16^{ink4}$ deleted metastatic human solid tumor model. SK-OV 3 cells (1.0 X 10^5 cells/ml) were incubated with the 6 base sequences shown in Table 7.

Table 7

Percentage increase of Fas and FasL on SK-OV-3 ovarian cancer cells

SEQUENCE	% INCREASE	
	Fas	FasL
TGTGTG SEQ ID NO:1 - (6 bases)	49	37
GTGTGT SEQ ID NO:2 - (6 bases)	60	24
TTTGTT SEQ ID NO:3 - (6 bases)	108	103
GGTGGG SEQ ID NO:4 - (6 bases)	-1	-17
GGGTGG SEQ ID NO:5 - (6 bases)	3	-31
TTGTTT SEQ ID NO:6 - (6 bases)	41	24
AAGTAA SEQ ID NO:7 - (6 bases)	-12	-22
CCGTCC SEQ ID NO:8 - (6 bases)	58	32
TGGTTG SEQ ID NO:9 - (6 bases)	63	53
ATGTAT SEQ ID NO:10 - (6 bases)	34	33
CTGTCT SEQ ID NO:11 - (6 bases)	15	26
TCGTTC SEQ ID NO:12 - (6 bases)	9	-3
GGTTGG SEQ ID NO:13 - (6 bases)	16	-3
GGAAGG SEQ ID NO:14 - (6 bases)	-15	-31
GGCCGG SEQ ID NO:15 - (6 bases)	0	-27
GGGGGG SEQ ID NO:16 - (6 bases)	-14	-28
GGGAGG SEQ ID NO:17 - (6 bases)	-6	-16
GGGCGG SEQ ID NO:18 - (6 bases)	29	42

Example 10

Modulation of Fas and of FasL on LNCaP prostate cancer cells

LNCaP prostate cancer cells are a TGF-beta 1 receptor negative, androgen-independent, metastatic human solid tumor model. LNCaP cells were incubated with the 6 base sequences shown in Table 8.

Table 8

Percentage increase of Fas and of FasL on LNCaP prostate cancer cells

SEQUENCE	% INCREASE	
	Fas	FasL
TGTGTG SEQ ID NO:1 - (6 bases)	29	40
GTGTGT SEQ ID NO:2 - (6 bases)	34	5
TTTGTT SEQ ID NO:3 - (6 bases)	199	344
GGTGGG SEQ ID NO:4 - (6 bases)	21	8
GGGTGG SEQ ID NO:5 - (6 bases)	15	-1
TTGTTT SEQ ID NO:6 - (6 bases)	40	73
AAGTAA SEQ ID NO:7 - (6 bases)	0	-16
CCGTCC SEQ ID NO:8 - (6 bases)	0	311
TGGTTG SEQ ID NO:9 - (6 bases)	184	241
ATGTAT SEQ ID NO:10 - (6 bases)	44	68
CTGTCT SEQ ID NO:11 - (6 bases)	17	55
TCGTTC SEQ ID NO:12 - (6 bases)	111	171
GGTTGG SEQ ID NO:13 - (6 bases)	23	-3
GGAAGG SEQ ID NO:14 - (6 bases)	26	-4
GGCCGG SEQ ID NO:15 - (6 bases)	12	-4
GGGGGG SEQ ID NO:16 - (6 bases)	6	13
GGGAGG SEQ ID NO:17 - (6 bases)	48	55
GGGCGG SEQ ID NO:18 - (6 bases)	55	126

Example 11

Modulation of Fas and of FasL on MCF-7 breast cancer cells

MCF-7 human breast cancer cells are a caspase-3 negative, estrogen-dependent human solid tumor model. MCF-7 cells (1 x 10^5 cells/ml) were incubated with the 6 base sequences shown in Table 9.

Table 9

Percentage increase of Fas and of FasL on MCF-7 breast cancer cells

SEQUENCE	% INCREASE	
	Fas	FasL
TGTGTG SEQ ID NO:1 - (6 bases)	122	121
GTGTGT SEQ ID NO:2 - (6 bases)	155	135
TTTGTT SEQ ID NO:3 - (6 bases)	361	528
GGTGGG SEQ ID NO:4 - (6 bases)	106	110
GGGTGG SEQ ID NO:5 - (6 bases)	93	81
TTGTTT SEQ ID NO:6 - (6 bases)	143	159
AAGTAA SEQ ID NO:7 - (6 bases)	12	21
CCGTCC SEQ ID NO:8 - (6 bases)	200	322
TGGTTG SEQ ID NO:9 - (6 bases)	255	481
ATGTAT SEQ ID NO:10 - (6 bases)	129	214
CTGTCT SEQ ID NO:11 - (6 bases)	73	128
TCGTTC SEQ ID NO:12 - (6 bases)	56	98
GGTTGG SEQ ID NO:13 - (6 bases)	99	83
GGAAGG SEQ ID NO:14 - (6 bases)	62	84
GGCCGG SEQ ID NO:15 - (6 bases)	63	78
GGGGGG SEQ ID NO:16 - (6 bases)	-7	18
GGGAGG SEQ ID NO:17 - (6 bases)	127	194
GGGCGG SEQ ID NO:18 - (6 bases)	165	322

Example 12

Inhibition of Fas expression on Jurkat human leukemia T cells by cycloheximide

Jurkat human leukemia T cells were pre-incubated with 0.0 µg/ml (- CHX) or with 0.1 µg/ml of cycloheximide (+ CHX) for 1 h. Ten µg/ml or 100 µg/ml of 6 base SEQ ID NO:5 (GGGTGG) was added to both the - CHX and + CHX cells and the incubation was continued for 24 hours and for 48 hours (Table 10).

Table 10

Percentage increase of Fas on Jurkat human leukemia T cells

SEQUENCE	% INCREASE			
	24 h		48 h	
	- CHX	+ CHX	- CHX	+ CHX
GGGTGG SEQ ID NO:5 - (6 bases) 10 µg/ml	63	5	91	51
GGGTGG SEQ ID NO:5 -(6 bases) 100 µg/ml	62	22	150	115

As shown in Table 10, SEQ ID NO:5 upregulated Fas expression on Jurkat T cells. With 10 µg/ml of SEQ ID NO:5, cycloheximide decreased Fas expression 92% after 24 h and 44% after 48 h. With 100 µg/ml of SEQ ID NO:5 cycloheximide decreased Fas expression 65% after 24 h and 23% after 48 h. These data suggest that 6 base SEQ ID NO:5 stimulates de novo synthesis of Fas.

Example 13

Synergistic effect of SEQ ID No:5 (GGGTGG) and agonistic anti-Fas antibodies on inhibition of UMUC-3 bladder cancer cell proliferation

UMUC-3 bladder cancer cells were incubated for 48 hours with 0.00, 0.02 and 0.20 µg/ml of agonistic anti-Fas monoclonal antibodies (clone CH-11: Coulter-Immunotech, Marseille, France) + 0 or 10 µg/ml of SEQ ID NO:5. Cell proliferation was measured using dimethylthiazol-diphenyltetrazolium (MTT) reduction (Mosman et al. J. Immunol. Methods 65:55, 1983). MTT was measured at a wavelength of 570 nm using a multiplate spectrophotometer reader (ELX800, Bio-TEK Instruments Inc., Winooski, VT).

Table 11

Inhibition of UMUC-3 bladder cancer cell proliferation

SEQUENCE	% INHIBITION		
	Anti-Fas antibodies		
	0.0 µg/ml	0.02 µg/ml	0.2 µg/ml
No sequence	0	7	17
GGGTGG SEQ ID NO:5 - (6 bases) 10 µg/ml	23	38	44

As shown in Table 11, 6 base SEQ ID NO:5 potentiated the inhibitory activity of 0.02 and 0.2 µg/ml of agonistic anti-Fas antibodies on UMUC-3 cell proliferation.

Example 14

Additive effect of SEQ ID NO:5 (GGGTGG) and agonistic anti-Fas antibodies on inhibition of Jurkat leukemia T cell proliferation.

Jurkat T leukemia cells were incubated for 48 hours with 0.00, 0.02 and 0.20 µg/ml of agonistic anti-Fas monoclonal antibodies (clone CH-11) + 0 and 10 µg/ml of SEQ ID NO:5. Cell proliferation was measured as in Example 13.

Table 12

Inhibition of Jurkat human leukemia T cell proliferation

SEQUENCE	% INHIBITION		
	Anti-Fas antibodies		
	0.0 µg/ml	0.02 µg/ml	0.2 µg/ml
No sequence	0	16	33
GGGTGG SEQ ID NO:5 - (6 bases) 10 µg/ml	16	28	48

As shown in Table 12, the effects of 6 base SEQ ID NO:5 and of 0.02 and 0.2 µg/ml of agonistic anti-Fas antibodies on Jurkat T cell proliferation were additive.

Example 15

Effect of 6 base sequences and agonistic anti-Fas antibodies on EL-4 murine T

EL-4 murine T lymphoma cells are implanted into C57/BL6 lpr/lpr (Fas negative mice). The mice are divided into 30 groups of 10 mice. On day 0, group 1 mice receive saline, group 2 mice receive 1, 10 or 100 mg/kg of SEQ. ID NO:5, group 3 mice receive 1, 10 or 100 mg/kg of SEQ. ID NO:16, group 4 receive 1, 10 or 100 mg/kg of SEQ. ID NO:17, group 5 mice receive 1, 10 or 100 mg/kg of SEQ. ID NO:18, group 6 mice receive anti-Fas antibodies, group 7 mice receive 1, 10 or 100 mg/kg of SEQ. ID NO:5 + anti-Fas antibodies, group 8 mice receive 1, 10 or 100 mg/kg of SEQ. ID NO:16 + anti-Fas antibodies, group 9 receive 1, 10 or 100 mg/kg of SEQ. ID NO:17 + anti-Fas antibodies, group 10 mice receive 1, 10 or 100 mg/kg of SEQ. ID NO:18 + anti-Fas antibodies. In these different groups, anti-Fas antibodies are administered at any dose in the range of about 0.003 to about 0.3 mg/kg. Group 1 mice have the most tumor mass, groups 2, 3, 4, 5 and 6 mice have less tumor mass than group 1 mice, and group 7, 8, 9 and 10 mice have the least tumor mass. The efficacy of the SEQ. ID NO:5, the SEQ. ID NO:16 and the SEQ. ID NO:17 is dose-dependent.

Example 16

Female (SJL/J x PL/J) F1 mice are injected subcutaneously in both femoral regions with an emulsion containing 0.5 mg of myelin basic protein (MBP) mixed with complete Freund's adjuvant. After 24 h, 400 ng of *Bordetella pertussis* toxin is administered intraperitoneally. On the day of onset (day 0), group 1 mice receive saline, group 2 mice receive 1, 10 or 100 mg/kg of SEQ. ID NO:5, group 3 mice receive 1, 10 or 100 mg/kg of SEQ. ID NO:16, group 4 mice receive 1, 10 or 100 mg/kg of SEQ. ID NO:17, group 5 mice receive 1, 10 or 100 mg/kg of SEQ. ID NO:18, group 6 mice receive anti-Fas antibodies, group 7 mice receive 1, 10 or 100 mg/kg of SEQ. ID NO:5 + anti-Fas antibodies, group 8 mice receive 1, 10 or 100 mg/kg of SEQ. ID NO:16 + anti-Fas antibodies, group 9 receive 1, 10 or 100 mg/kg of SEQ. ID NO:17 + anti-Fas antibodies, group 10 mice receive 1, 10 or 100 mg/kg of SEQ. ID NO:18 + anti-Fas antibodies for 3 days by intracisternal administration (20 μg/day). In these different groups, anti-Fas antibodies are administered at any dose in the range of about 0.003 to about

group 1, 2, 3, 4 and 5 mice. Group 7, 8, 9 and 10 mice show the least progression of EAE. The efficacy of the SEQ. ID NO:5, the SEQ. ID NO:16 and the SEQ. ID NO:17 is dose-dependent.

CLAIMS

We claim:

1. A composition comprising a synthetic phosphodiester oligonucleotide sequence of 6 bases, selected from the group consisting of $(GG)_n$, $(GT)_n$, $a(GT)_nb$, $a(GA)_nb$, and $a(GC)_nb$, wherein n is an integer between 1 and 3, and a and b are independently either none or one or more As, Cs, Gs, or Ts, or combinations thereof, wherein the composition is useful for modulating Fas or FasL expression in an animal when administered in an effective amount to the animal.

2. A composition comprising a synthetic phosphodiester oligonucleotide sequence of 6 bases, selected from the group consisting of $(GG)_n$, $(GT)_n$, $a(GT)_nb$, $a(GA)_nb$, and $a(GC)_nb$, wherein n is an integer between 1 and 3, and a and b are independently either none or one or more As, Cs, Gs, or Ts, or combinations thereof, wherein the composition is useful for modulating efficacy of a therapeutic agent in an animal when administered in an effective amount to the animal.

3. The composition of Claim 1 or 2, wherein the sequence is any one of SEQ ID NO: 1 to SEQ ID NO:18.

4. The composition of any one of Claims 1 to 3, further comprising a pharmaceutically acceptable carrier.

5. The composition of any one of Claims 1 to 4, further comprising a therapeutic agent.

6. A composition comprising a synthetic phosphodiester oligonucleotide sequence of 6 bases, wherein the sequence is any one of SEQ ID NO:1 to SEQ ID NO:18.

7. A method of modulating Fas or FasL expression in an animal or a human comprising administration of any one of Claims 1, 3, 5, or 6 and a pharmaceutically acceptable carrier to the animal or the human in an amount effective to modulate Fas or FasL expression in the animal or the human.

8. A method of modulating efficacy of a therapeutic agent in an animal or human comprising administration of an effective amount of the composition of any one of Claims 2, 3, 5, or 6 before, concurrently with, or after administration of the

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therapeutic agent, wherein the amount is effective to modulate efficacy of the therapeutic agent.

9. The method of Claims 7 or 8, wherein the animal or human has a disease.

10. The method of Claim 9, wherein the disease is cancer.

11. The method of Claim 10, wherein the cancer is selected from the group consisting of ovarian, prostate, breast, bladder, and leukemia.

12. The method of Claim 11, wherein the disease is autoimmune encephalomyelitis.

13. The method of Claim 7 or 8, wherein the animal or human has inflammation, infection, graft rejection, tissue rejection or cell rejection.

14. Use of any one of the compositions of any of Claims 1-6 in the manufacture of a medicament.

15. Use of any one of the compositions of Claims 1, 3, 4, 5, or 6 for modulation of Fas or FasL expression in cells of an animal or a human, comprising administration to the animal or the human of any one of the compositions of Claims 1, 3, 4, 5, or 6 in an amount effective to modulate Fas or FasL expression in the cells of the animal or the human.

16. Use of any one of the compositions of Claims 2-6 for modulation of efficacy of a therapeutic agent comprising administration to the animal or the human of any one of the compositions of Claims 2-6 in an amount effective to modulate efficacy of the therapeutic agent.

Empfangs AMENDED SHEET