METHODS FOR TREATING CANCERS USING POLYMORPHIC FORMS OF 3-(4-AMINO-1-OXO-1,3 DIHYDRO-ISINDOL-2-YL)-PIPERIDINE-2,6-DIONE

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Methods of treating, preventing and/or managing cancer as well as and diseases and disorders associated with, or characterized by, undesired angiogenesis are disclosed. Specific methods encompass the administration of an immunomodulatory compound alone or in combination with a second active ingredient. The invention further relates to methods of reducing or avoiding adverse side effects associated with chemotherapy, radiation therapy, hormonal therapy, biological therapy or immunotherapy which comprise the administration of an immunomodulatory compound. Pharmaceutical compositions, single unit dosage forms, and kits suitable for use in methods of the invention are also disclosed.
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1. FIELD OF THE INVENTION

[0002] This invention relates to methods of treating, preventing or managing specific cancers, and other diseases including, but not limited to, those associated with, or characterized by, undesired angiogenesis, by the administration of one or more immunomodulatory compounds alone or in combination with other therapeutics. In particular, the invention encompasses the use of specific combinations, or “cocktails,” of drugs and other therapy, e.g., radiation to treat these specific cancers, including those refractory to conventional therapy. The invention also relates to pharmaceutical compositions and dosing regimens.

2. BACKGROUND OF THE INVENTION

[0003] 2.1 Pathobiology of Cancer and Other Diseases

[0004] Cancer is characterized primarily by an increase in the number of abnormal cells derived from a given normal tissue, invasion of adjacent tissues by these abnormal cells, or lymphatic or blood-borne spread of malignant cells to regional lymph nodes and to distant sites (metastasis). Clinical data and molecular biologic studies indicate that cancer is a multistep process that begins with minor preneoplastic changes, which may under certain conditions progress to neoplasia. The neoplastic lesion may evolve clonally and develop an increasing capacity for invasion, growth, metastasis, and heterogeneity, especially under conditions in which the neoplastic cells escape the host’s immune surveillance. Roitt, I., Brostoff, J and Kale, D., Immunology, 17.1-17.12 (3rd ed., Mosby, St. Louis, Mo., 1995).

[0005] There is an enormous variety of cancers which are described in detail in the medical literature. Examples includes cancer of the lung, colon, rectum, prostate, breast, brain, and intestine. The incidence of cancer continues to climb as the general population ages, as new cancers develop, and as susceptible populations (e.g., people infected with AIDS or excessively exposed to sunlight) grow. A tremendous demand therefore exists for new methods and compositions that can be used to treat patients with cancer.

[0006] Many types of cancers are associated with new blood vessel formation, a process known as angiogenesis. Several of the mechanisms involved in tumor-induced angiogenesis have been elucidated. The most direct of these mechanisms is the secretion by the tumor cells of cytokines with angiogenic properties. Examples of these cytokines include acidic and basic fibroblastic growth factor (a,b-FGF), angiogenin, vascular endothelial growth factor (VEGF), and TNF-α. Alternatively, tumor cells can release angiogenic peptides through the production of proteases and the subsequent breakdown of the extracellular matrix where some cytokines are stored (e.g., b-FGF). Angiogenesis can also be induced indirectly through the recruitment of inflammatory cells (particularly macrophages) and their subsequent release of angiogenic cytokines (e.g., TNF-α, b-FGF).

[0007] A variety of other diseases and disorders are also associated with, or characterized by, undesired angiogenesis. For example, enhanced or unregulated angiogenesis has been implicated in a number of diseases and medical conditions including, but not limited to, ocular neovascular diseases, choroidal neovascular diseases, retina neovascular diseases, ruberosis (neovascularization of the angle), viral diseases, genetic diseases, inflammatory diseases, allergic diseases, and autoimmune diseases. Examples of such diseases and conditions include, but are not limited to: diabetic retinopathy; retinopathy of prematurity;

[0008] corneal graft rejection; neovascular glaucoma; retrolental fibroplasia; and proliferative vitreoretinopathy.

[0009] Accordingly, compounds that can control angiogenesis or inhibit the production of certain cytokines, including TNF-α, may be useful in the treatment and prevention of various diseases and conditions.

[0010] 2.2 Methods of Treating Cancer

[0011] Current cancer therapy may involve surgery, chemotherapy, hormonal therapy and/or radiation treatment to eradicate neoplastic cells in a patient (see, for example, Stockdale, 1998, Medicine, vol. 3, Rubenstein and Federman, eds., Chapter 12, Section IV). Recently, cancer therapy could also involve biological therapy or immunotherapy. All of these approaches pose significant drawbacks for the patient. Surgery, for example, may be contraindicated due to the health of a patient or may be unacceptable to the patient. Additionally, surgery may not completely remove neoplastic tissue. Radiation therapy is only effective when the neoplastic tissue exhibits a higher sensitivity to radiation than normal tissue. Radiation therapy can also often elicit serious side effects. Hormonal therapy is rarely given as a single agent. Although hormonal therapy can be effective, it is often used to prevent or delay recurrence of cancer after other treatments have removed the majority of cancer cells. Biological therapies and immunotherapies are limited in number and may produce side effects such as rashes or swellings, flu-like symptoms, including fever, chills and fatigue, digestive tract problems or allergic reactions.

[0012] With respect to chemotherapy, there are a variety of chemotherapeutic agents available for treatment of cancer. A majority of cancer chemotherapeutics act by inhibiting DNA synthesis, either directly, or indirectly by inhibiting the biosynthesis of deoxyribonucleotide triphosphate precursors, to prevent DNA replication and concomitant cell division. Gilman et al., Goodman and Gilman’s: The Pharmacological Basis of Therapeutics, Tenth Ed. (McGraw Hill, New York).

[0013] Despite availability of a variety of chemotherapeutic agents, chemotherapy has many drawbacks. Stockdale, Medicine, vol. 3, Rubenstein and Federman, eds., Ch. 12, sect. 10, 1998. Almost all chemotherapeutic agents are toxic, and chemotherapy causes significant, and often dangerous side effects including severe nausea, bone marrow depression, and immunosuppression. Additionally, even with administration of combinations of chemotherapeutic agents, many tumor cells are resistant or develop resistance to the chemotherapeutic agents. In fact, those cells resistant to the particular chemotherapeutic agents used in the treatment protocol often
prove to be resistant to other drugs, even if those agents act by different mechanisms from those of the drugs used in the specific treatment. This phenomenon is referred to as pleiotropic drug or multidrug resistance. Because of the drug resistance, many cancers prove refractory to standard chemotherapeutic treatment protocols.

[0014] Other diseases or conditions associated with, or characterized by, undesired angiogenesis are also difficult to treat. However, some compounds such as protamine, heparin and steroids have been proposed to be useful in the treatment of certain specific diseases. Taylor et al., *Nature* 297:307 (1982); Folkman et al., *Science* 221:719 (1983); and U.S. Pat. Nos. 5,001,116 and 4,994,443. Thalidomide and certain derivatives of it have also been proposed for the treatment of such diseases and conditions. U.S. Pat. Nos. 5,593,990, 5,629,327, 5,712,291, 6,071,948 and 6,114,355 to D’Amato.

[0015] Still, there is a significant need for safe and effective methods of treating, preventing and managing cancer and other diseases and conditions, particularly for diseases that are refractory to standard treatments, such as surgery, radiation therapy, chemotherapy and hormonal therapy, while reducing or avoiding the toxicities and/or side effects associated with the conventional therapies.

[0016] 2.3 IMIDs™

A number of studies have been conducted with the aim of providing compounds that can safely and effectively be used to treat diseases associated with abnormal production of TNF-α. See, e.g., Marriott, J. B., et al., *Expert Opin. Biol. Ther.* 1(4):1-8 (2001); G. W. Muller, et al., *Journal of Medicinal Chemistry* 39(17): 3238-3240 (1996); and G. W. Muller, et al., *Bioorganic & Medicinal Chemistry Letters* 8: 2669-2674 (1998). Some studies have focused on a group of compounds selected for their capacity to potently inhibit TNF-α production by LPS stimulated PBMC. L. G. Corral, et al., *Ann. Rheum. Dis.* 58:(Suppl I) 1107-1113 (1999). These compounds, which are referred to as IMIDs™ (Celgene Corporation) or Immunomodulatory Drugs, show not only potent inhibition of TNF-α but also marked inhibition of LPS induced monocyte IL-1β and IL12 production. LPS induced IL6 is also inhibited by immunomodulatory compounds, albeit partially. These compounds are potent stimulators of LPS induced IL10. Id. Particular examples of IMID™s include, but are not limited to, the substituted 2-(2,6-dioxopyrrolidin-3-yl)phthalimides and substituted 2-(2,6-dioxopyrrolidin-3-yl)-1-oxoisoindoles described in U.S. Pat. Nos. 6,281,230 and 6,316,471, both to G. W. Muller, et al.

3. SUMMARY OF THE INVENTION

[0018] This invention encompasses methods of treating and preventing certain types of cancer, including primary and metastatic cancer, as well as cancers that are refractory or resistant to conventional chemotherapy. The methods comprise administering to a patient in need of such treatment or preventing a therapeutically or prophylactically effective amount of an immunomodulatory compound, or a pharmaceutically acceptable salt, solvate, hydrate, stereoisomer, clathrate, or prodrug thereof. The invention also encompasses methods of managing certain cancers (e.g., preventing or prolonging their recurrence, or lengthening the time of remission) which comprise administering to a patient in need of such management a prophylactically effective amount of an immunomodulatory compound of the invention, or a pharmaceutically acceptable salt, solvate, hydrate, stereoisomer, clathrate, or prodrug thereof.

[0019] In particular methods of the invention, an immunomodulatory compound is administered in combination with a therapy conventionally used to treat, prevent or manage cancer. Examples of such conventional therapies include, but are not limited to, surgery, chemotherapy, radiation therapy, hormonal therapy, biological therapy and immunotherapy.

[0020] This invention also encompasses methods of treating, managing or preventing diseases and disorders other than cancer that are associated with, or characterized by, undesired angiogenesis, which comprise administering to a patient in need of such treatment, management or prevention a therapeutically or prophylactically effective amount of an immunomodulatory compound, or a pharmaceutically acceptable salt, solvate, hydrate, stereoisomer, clathrate, or prodrug thereof.

[0021] In other methods of the invention, an immunomodulatory compound is administered in combination with a therapy conventionally used to treat, prevent or manage diseases or disorders associated with, or characterized by, undesired angiogenesis. Examples of such conventional therapies include, but are not limited to, surgery, chemotherapy, radiation therapy, hormonal therapy, biological therapy and immunotherapy.

[0022] This invention encompasses pharmaceutical compositions, single unit dosage forms, dosage regimens and kits which comprise an immunomodulatory compound, or a pharmaceutically acceptable salt, solvate, hydrate, stereoisomer, clathrate, or prodrug thereof, and a second, or additional, active agent. Second active agents include specific combinations, or “cocktails,” of drugs.

4. BRIEF DESCRIPTION OF FIGURE

[0023] FIG. 1 shows a comparison of the effects of 3-(4-amino-1-oxo-1,3-dihydro-isoxindol-2-yl)piperidine-2,6-dione (REVLIMID™) and thalidomide in inhibiting the proliferation of multiple myeloma (MM) cell lines in an in vitro study. The uptake of [3H]-thymidine by different MM cell lines (MM.1S, His Sultan, U266 and RPMI-8226) was measured as an indicator of the cell proliferation.

5. DETAILED DESCRIPTION OF THE INVENTION

[0024] A first embodiment of the invention encompasses methods of treating, managing, or preventing cancer which comprises administering to a patient in need of such treatment or preventing a therapeutically or prophylactically effective amount of an immunomodulatory compound of the invention, or a pharmaceutically acceptable salt, solvate, hydrate, stereoisomer, clathrate, or prodrug thereof.

[0025] In particular methods encompassed by this embodiment, the immunomodulatory compound is administered in combination with another drug ("second active agent") or method of treating, managing, or preventing cancer. Second active agents include small molecules and large molecules (e.g., proteins and antibodies), examples of which are provided herein, as well as stem cells. Methods, or therapies, that can be used in combination with the administration of the immunomodulatory compound include, but are not limited to, surgery, blood transfusions, immunotherapy, biological therapy, radiation therapy, and other non-drug based therapies presently used to treat, prevent or manage cancer.

[0026] Another embodiment of the invention encompasses methods of treating, managing or preventing diseases and
disorders other than cancer that are characterized by undesired angiogenesis. These methods comprise the administration of a therapeutically or prophylactically effective amount of an immunomodulatory compound, or a pharmaceutically acceptable salt, solvate, hydrate, stereoisomer, clathrate, or prodrug thereof.

[0027] Examples of diseases and disorders associated with, or characterized by, undesired angiogenesis include, but are not limited to, inflammatory diseases, autoimmune diseases, viral diseases, genetic diseases, allergic diseases, bacterial diseases, ocular neovascular diseases, choroidal neovascular diseases, retina neovascular diseases, and ruberosis (neovascularization of the angle). Specific examples of the diseases and disorders associated with, or characterized by, undesired angiogenesis include, but are not limited to, endometriosis, Crohn's disease, heart failure, advanced heart failure, renal impairment, endotoxemia, toxic shock syndrome, osteoarthritis, retrovirus replication, wasting, meningitis, silica-induced fibrosis, asbestos-induced fibrosis, veterinary disorder, malignancy-associated hypercalcemia, stroke, circulatory shock, periodontitis, gingivitis, macrocytic anemia, refractory anemia, and 5q-syndrome.

[0028] In particular methods encompassed by this embodiment, the immunomodulatory compound is administered in combination with a second active agent or method of treating, managing, or preventing the disease or condition. Second active agents include small molecules and large molecules (e.g., proteins and antibodies), examples of which are provided herein, as well as stem cells. Methods, or therapies, that can be used in combination with the administration of the immunomodulatory compound include, but are not limited to, surgery, blood transfusions, immunotherapy, biological therapy, radiation therapy, and other non-drug based therapies presently used to treat, prevent or manage disease and conditions associated with, or characterized by, undesired angiogenesis.

[0029] The invention also encompasses pharmaceutical compositions (e.g., single unit dosage forms) that can be used in methods disclosed herein. Particular pharmaceutical compositions comprise an immunomodulatory compound of the invention, or a pharmaceutically acceptable salt, solvate, hydrate, stereoisomer, clathrate, or prodrug thereof, and a second active agent.

[0030] 5.1 Immunomodulatory Compounds

[0031] Compounds of the invention can either be commercially purchased or prepared according to the methods described in the patents or patent publications disclosed herein. Further, optically pure compositions can be asymmetrically synthesized or resolved using known resolving agents or chiral columns as well as other standard synthetic organic chemistry techniques. Compounds used in the invention may include immunomodulatory compounds that are racemic, stereomerically enriched or stereomerically pure, and pharmaceutically acceptable salts, solvates, stereoisomers, clathrates, and prodrugs thereof.

[0032] As used herein, unless otherwise indicated, the term “solvates” includes hydrates of the compounds of the invention.

[0033] Preferred compounds used in the invention are small organic molecules having a molecular weight less than about 1,000 g/mol, and are not proteins, peptides, oligonucleotides, oligosaccharides or other macromolecules.

[0034] As used herein and unless otherwise indicated, the terms “immunomodulatory compounds” and “IMiDs™” (Celgene Corporation) encompasses small organic molecules that markedly inhibit TNF-α, LPS induced monocyte IL1β and IL12, and partially inhibit IL6 production. Specific immunomodulatory compounds are discussed below.

[0035] TNF-α is an inflammatory cytokine produced by macrophages and monocytes during acute inflammation. TNF-α is responsible for a diverse range of signaling events within cells. TNF-α may play a pathological role in cancer. Without being limited by theory, one of the biological effects exerted by the immunomodulatory compounds of the invention is the reduction of synthesis of TNF-α. Immunomodulatory compounds of the invention enhance the degradation of TNF-α mRNA.

[0036] Further, without being limited by theory, immunomodulatory compounds used in the invention may also be potent co-stimulators of T cells and increase cell proliferation dramatically in a dose dependent manner. Immunomodulatory compounds of the invention may also have a greater co-stimulatory effect on the CD8+ T cell subset than on the CD4+ T cell subset. In addition, the compounds preferably have anti-inflammatory properties, and efficiently co-stimulate T cells.

[0037] Specific examples of immunomodulatory compounds, include, but are not limited to, cyano and carboxy derivatives of substituted styrenes such as those disclosed in U.S. Pat. No. 5,929,117; 1-oxo-2-(2,6-dioxo-3-fluorophenyl)-dioxindolines and 1,3-dioxo-2-(2,6-dioxo-3-fluorophenyl)-dioxindolines such as those described in U.S. Pat. Nos. 5,874,448 and 5,955,476; the tetra substituted 2-(2,6-dioxopiperidin-3-yl)-1-oxoisindolines described in U.S. Pat. No. 5,798,368; 1-oxo and 1,3-dioxo-2-(2,6-dioxopiperidin-3-yl) isoinindolines (e.g., 4-methyl derivatives of thalidomide), including, but not limited to, those disclosed in U.S. Pat. Nos. 5,635,517, 6,476,052, 6,555,554, and 6,403,613; 1-oxo and 1,3-dioxoisindolines substituted in the 4- or 5-position of the indole ring (e.g., 4-(4-amino-1,3-dioxoisindoline-2-yl)-4-carbamoylbutanoic acid) described in U.S. Pat. No. 6,380,239; isoinindole-1-one and isoinindole-1,3-dione substituted in the 2-position with 2,6-dioxo-3-hydroxy-1-piperidin-5-yl (e.g., 2-(2,6-dioxo-3-hydroxy-5-fluoropiperidin-5-yl)-4-aminoindolin-1-one) described in U.S. Pat. No. 6,458,810; a class of non-polypeptide cyclic amidines disclosed in U.S. Pat. Nos. 5,698,579 and 5,877,200; aminothalidomide, as well as analogs, hydrolysis products, metabolites, derivatives and precursors of aminothalidomide, and substituted 2-(2,6-dioxopiperidin-3-yl)phthalimidines and substituted 2-(2,6-dioxopiperidin-3-yl)-1-oxoisindoles such as those described in U.S. Pat. Nos. 6,281,230 and 6,316,471; and isoinindle-imide compounds such as those described in U.S. patent application Ser. No. 09/972,487 filed on Oct. 5, 2001, U.S. patent application Ser. No. 10/032,286 filed on Dec. 21, 2001, and International Application No. PCT/US01/05041 (International Publication No. WO 02/059106). The entireties of each of the patents and patent applications identified herein are incorporated herein by reference. Immunomodulatory compounds do not include thalidomide.

[0038] Other specific immunomodulatory compounds of the invention include, but are not limited to, 1-oxo-1 and 1,3 dioxo-2-(2,6-dioxopiperidin-3-yl) isoinindolines substituted with amino in the benzo ring as described in U.S. Pat. No. 5,635,517 which is incorporated herein by reference. These compounds have the structure I:
in which one of X and Y is C—O, the other of X and Y is C—O or CH₂, and R² is hydrogen or lower alkyl, in particular methyl. Specific immunomodulatory compounds include, but are not limited to:

- **[0040]** 1-oxo-2-(2,6-dioxopiperidin-3-yl)-4-aminoisoindolone;
- **[0041]** 1-oxo-2-(2,6-dioxopiperidin-3-yl)-5-aminoisoindolone;
- **[0042]** 1-oxo-2-(2,6-dioxopiperidin-3-yl)-6-aminoisoindolone;
- **[0043]** 1-oxo-2-(2,6-dioxopiperidin-3-yl)-7-aminoisoindolone;
- **[0044]** 1,3-dioxo-2-(2,6-dioxopiperidin-3-yl)-4-aminoisoindolone; and
- **[0045]** 1,3-dioxo-2-(2,6-dioxopiperidin-3-yl)-5-aminoisoindolone.

**[0046]** Other specific immunomodulatory compounds of the invention belong to a class of substituted 2-(2,6-dioxopiperidin-3-yl)phthalimides and substituted 2-(2,6-dioxopiperidin-3-yl)-1-oxoisoindoles, such as those described in U.S. Pat. Nos. 6,281,230; 6,316,471; 6,335,349; and 6,476,052, and International Patent Application No. PCT/US97/13375 (International Publication No. WO 98/03502), each of which is incorporated herein by reference. Representative compounds are of formula:

![Chemical Structure](image1)

in which:

- **[0047]** one of X and Y is C—O and the other of X and Y is C—O or CH₂;
- **[0048]** (i) each of R¹, R², R³, and R⁴, independently of the others, is halo, alkyl of 1 to 4 carbon atoms, or alkoxy of 1 to 4 carbon atoms or (ii) one of R¹, R², R³, and R⁴ is —NH₂ and the remaining of R¹, R², R³, and R⁴ are hydrogen;
- **[0049]** R¹ is hydrogen or alkyl of 1 to 8 carbon atoms;
- **[0050]** R² is hydrogen, alkyl of 1 to 8 carbon atoms, benzylic, or halo;
- **[0051]** provided that R² is other than hydrogen if X and Y are C—O and (i) each of R¹, R², R³, and R⁴ is fluororo or (ii) one of R¹, R², R³, or R⁴ is amino.
- **[0052]** Compounds representative of this class are of the formulars:

![Chemical Structure](image2)

- **[0053]** wherein R¹ is hydrogen or methyl. In a separate embodiment, the invention encompasses the use of enantiomerically pure forms (e.g. optically pure (R) or (S) enantiomers) of these compounds.

- **[0054]** wherein R¹ is hydrogen or methyl. In a separate embodiment, the invention encompasses the use of enantiomerically pure forms (e.g. optically pure (R) or (S) enantiomers) of these compounds.

- **[0055]** and pharmaceutically acceptable salts, hydrates, solvates, clathrates, enantiomers, diastereomers, racemates, and mixtures of stereoisomers thereof, wherein:

- **[0056]** one of X and Y is C—O and the other is CH₂ or C—O.

- **[0057]** R¹ is H, (C₁₋₃)alkyl, (C₅₋₇)cycloalkyl, (C₂₋₃)alkeny, (C₂₋₃)alkynyl, benzylic, ary1, (C₂₋₃)alkyl-(C₂₋₃)heterocycloalkyl, (C₀₋₁)alkyl-(C₂₋₃)heteroaryl, C(O)R², C(S)R², C(O)OR², (C₂₋₃)alkyl-NH₂, (C₂₋₃)alkyl-OR², (C₂₋₃)alkyl-C(=O)OR², (C₂₋₃)alkyl-C(O)NH₂, C(S)NH₂, (C₂₋₃)alkyl-C(O)NR², C(S)NR², or (C₂₋₃)alkyl-O(C(O))R²;

- **[0059]** R² is H, benzyl, (C₁₋₃)alkyl, (C₂₋₃)ary1, or (C₂₋₃)alkynyl;

- **[0060]** R³ and R⁴ are independently (C₂₋₃)alkyl, (C₅₋₇)cycloalkyl, (C₂₋₃)alkeny, (C₂₋₃)alkynyl, benzylic, ary1, (C₀₋₁)alkyl-(C₂₋₃)heterocycloalkyl, (C₀₋₁)alkyl-(C₂₋₃)alkynyl, (C₀₋₁)alkyl-(C₂₋₃)heterocycloalkyl, (C₀₋₁)alkyl-(C₂₋₃)alkeny, (C₀₋₁)alkyl-(C₅₋₇)cycloalkyl, (C₀₋₁)alkyl-(C₂₋₃)cyanoalkyl, (C₀₋₁)alkyl-(C₂₋₃)oxyalkyl, (C₀₋₁)alkyl-(C₂₋₃)alkoxyalkyl, or (C₀₋₁)alkyl-(C₂₋₃)alkoxyalkyl.
In other specific compounds of formula II, heteroaryl is pyridyl, furyl, or thiophenyl.

In other specific compounds of formula II, R1 is C(O)OR2.

In other specific compounds of formula II, the H of C(O)NHCO(OC) can be replaced with (C1-C6)alkyl, aryl, or benzyl.

Further examples of the compounds in this class include, but are not limited to: (2-(2,6-dioxo-piperidin-3-yl)-1,3-dioxo-2,3-dihydro-1H-isooindol-4-yl)methyl-acetonitrile; (2-(2,6-dioxo-piperidin-3-yl)-1,3-dioxo-2,3-dihydro-1H-isooindol-4-ylmethyl)-carboxylic acid tert-butyl ester; 4-(aminomethyl)-2-(2,6-dioxo-(3-piperidyl))-isooindoline-1,3-dione; (2-(2,6-dioxo-piperidin-3-yl)l-1,3-dioxo-2,3-dihydro-1H-isooindol-4-ylmethyl)-acetamide; N-(2-(2,6-dioxo-(3-piperidyl))-1,3-dioxoisoindolin-4-yl) methyl-cyclopropylcarboxamide; 2-chloro-N{2-(2,6-dioxo-(3-piperidyl))-1,3-dioxoisoindolin-4-yl}methyl-acetamide; N-(2-(2,6-dioxo-(3-piperidyl))-1,3-dioxoisoindolin-4-yl)-3-pyridylcarboxamide; 3-{1-oxo-4-(benzylamino)-isoindolin-2-yl}piperidine-2,6-dione; 2-(2,6-dioxo-(3-piperidyl))-4-(benzylamino)-isoindoline-1,3-dione; N-[2-(2,6-dioxo-(3-piperidyl))-1,3-dioxoisoindolin-4-yl]methyl-propanamide; N-[2-(2,6-dioxo-(3-piperidyl))-1,3-dioxoisoindolin-4-yl]methyl-3-pyridylcarboxamide; N-{2-(2,6-dioxo-(3-piperidyl))-1,3-dioxoisoindolin-4-yl}methyl-4-pentanamide; N-[2-(2,6-dioxo-(3-piperidyl))-1,3-dioxoisoindolin-4-yl]methyl-2-furylcarboxamide; N-[2-(2,6-dioxo-(3-piperidyl))-1,3-dioxoisoindolin-4-yl] carboxymethyl)methyl acetate; N-[2-(2,6-dioxo-(3-piperidyl))-1,3-dioxoisoindolin-4-yl]pentanamide; N-[2-(2,6-dioxo-(3-piperidyl))-1,3-dioxoisoindolin-4-yl]methyl-2-thienylcarboxamide; N-[2-(2,6-dioxo-(3-piperidyl))-1,3-dioxoisoindolin-4-yl]methyl-(butylamino)carboxamide; N-[2-(2,6-dioxo-(3-piperidyl))-1,3-dioxoisoindolin-4-yl]methyl(octylamino)carboxamide; and N-[2-(2,6-dioxo-(3-piperidyl))-1,3-dioxoisoindolin-4-yl]methyl(benzylamino)carboxamide.

Still other specific immunomodulatory compounds of the invention belong to a class of isoindole-imides disclosed in U.S. Patent Application Publication Nos. US 2002/0045643, International Publication No. WO 98/54170, and U.S. Pat. No. 6,395,754, each of which is incorporated herein by reference. Representative compounds are of formula III:

and pharmaceutically acceptable salts, hydrates, solvates, clathrates, enantiomers, diastereomers, racemates, and mixtures of stereoisomers thereof, wherein:

one of X and Y is C==O and the other is CH2 or C==O;

R is H or CH2OCOR';

(i) each of R1, R2, R3, or R4, independently of the others, is halo, alkyl of 1 to 4 carbon atoms, or alkoxy of 1 to
4 carbon atoms or (ii) one of R¹, R², R³, or R⁴ is nitro or —NHR and the remaining of R¹, R², R³, or R⁴ are hydrogen;

[0085] R⁵ is hydrogen or alkyl of 1 to 8 carbons

[0086] R⁶ hydrogen, alkyl of 1 to 8 carbon atoms, benzo, chloro, or fluoro;

[0087] R¹ is R² = CHR¹⁰ — N(R⁸R⁹);

[0088] R⁷ is m-phenylene or p-phenylene or —(C₆H₄n)— in which n has a value of 0 to 4;

[0089] each of R⁸ and R⁹ taken independently of the other is hydrogen or alkyl of 1 to 8 carbon atoms, or R⁸ and R⁹ taken together are tetramethylenedi, pentamethylenedi, hexamethylenedi, or —CH₂CH₂XCH₂CH₂ — in which X = —O—, —S—, or —NH—;

[0090] R¹⁰ is hydrogen, alkyl of 8 carbon atoms, or phenyl; and

[0091] * represents a chiral carbon center.

[0092] Other representative compounds are of formula:

\[
\text{R¹ R² R³ R⁴}
\]

wherein:

[0093] one of X and Y is C—O and the other of X and Y is C=O or CH₂;

[0094] (i) each of R¹, R², R³, or R⁴, independently of the others, is halo, alkyl of 1 to 4 carbon atoms, or alkoxi of 1 to 4 carbon atoms or (ii) one of R¹, R², R³, and R⁴ is —NHR² and the remaining of R¹, R², R³, and R⁴ are hydrogen;

[0095] R¹ is hydrogen or alkyl of 1 to 8 carbon atoms;

[0096] R² is hydrogen, alkyl of 1 to 8 carbon atoms, benzo, chloro, or fluoro;

[0097] R³ is m-phenylene or p-phenylene or —(C₆H₄n)— in which n has a value of 0 to 4;

[0098] each of R⁸ and R⁹ taken independently of the other is hydrogen or alkyl of 1 to 8 carbon atoms, or R⁸ and R⁹ taken together are tetramethylenedi, pentamethylenedi, hexamethylenedi, or —CH₂CH₂XCH₂CH₂ — in which X = —O—, —S—, or —NH—;

[0099] R¹⁰ is hydrogen, alkyl of 8 carbon atoms, or phenyl.

[0100] Other representative compounds are of formula:

\[
\text{[Diagram of chemical structure]}
\]

[0101] in which:

[0102] one of X and Y is C—O and the other of X and Y is C=O or CH₂;

[0103] (i) each of R¹, R², R³, or R⁴, independently of the others, is halo, alkyl of 1 to 4 carbon atoms, or alkoxi of 1 to 4 carbon atoms or (ii) one of R¹, R², R³, and R⁴ is —NHR² and the remaining of R¹, R², R³, and R⁴ are hydrogen;

[0104] R² is hydrogen, alkyl of 1 to 8 carbon atoms, or phenyl.

[0105] R⁵ is hydrogen, alkyl of 1 to 8 carbon atoms, benzo, chloro, or fluoro;

[0106] Other representative compounds are of formula:

\[
\text{[Diagram of chemical structure]}
\]

[0107] in which:

[0108] one of X and Y is C—O and the other of X and Y is C=O or CH₂;

[0109] (i) each of R¹, R², R³, and R⁴, independently of the others, is halo, alkyl of 1 to 4 carbon atoms, or alkoxi of 1 to 4 carbon atoms or (ii) one of R¹, R², R³, and R⁴ is —NHR² and the remaining of R¹, R², R³, and R⁴ are hydrogen;

[0110] R⁶ is hydrogen, alkyl of 1 to 8 carbon atoms, or CO—R¹⁰ — CH(R¹⁰ NR¹⁰ R⁹)

[0111] R⁷ is alkyl of 1 to 8 carbon atoms, benzo, chloro, or fluoro.

[0112] Specific examples of the compounds are of formula:

\[
\text{[Diagram of chemical structure]}
\]

[0113] in which:

[0114] one of X and Y is C—O and the other of X and Y is C=O or CH₂;

[0115] R² is hydrogen, alkyl of 1 to 8 carbon atoms, benzo, chloro, or fluoro;

[0116] R³ is m-phenylene, p-phenylene or —(C₆H₄n)— in which n has a value of 0 to 4;

[0117] each of R⁸ and R⁹ taken independently of the other is hydrogen or alkyl of 1 to 8 carbon atoms, or R⁸ and R⁹ taken together are tetramethylenedi, pentamethylenedi, hexamethylenedi, or —CH₂CH₂XCH₂CH₂ — in which X = —O—, —S—, or —NH—;

[0118] R¹⁰ is hydrogen, alkyl of 1 to 8 carbon atoms, or phenyl.

[0119] The most preferred immunomodulatory compounds of the invention are 4-(amino)-2-(2,6-dioxo(3-piperidyl))-isoindoline-1,3-dione and 3-(4-amino-1-oxo-1,3-dihydroisoindol-2-yl)-piperidine-2,6-dione. The compounds can be obtained via standard, synthetic methods (see e.g., U.S. Pat. No. 5,635,517, incorporated herein by reference). The compounds are available from Celgene Corporation, Warren, N.J. 4-(Amino)-2-(2,6-dioxo(3-piperidyl))-isoindoline-1,3-dione has the following chemical structure:
The compound 3-(4-amino-1-oxo-1,3-dihydro-isooindol-2-yl)-piperidine-2,6-dione has the following chemical structure:

![Chemical structure of the compound](image)

In another embodiment, specific immunomodulatory compounds of the invention encompass polymorphic forms of 3-(4-amino-1-oxo-1,3 dihydro-isooindol-2-yl)-piperidine-2,6-dione such as Forms A, B, C, D, E, F, G and H, disclosed in U.S. provisional application No. 60/499,723 filed on Sep. 4, 2003, which is incorporated herein by reference. Also provided are polymorphic forms of 3-(4-amino-1-oxo-1,3 dihydro-isooindol-2-yl)-piperidine-2,6-dione, such as Forms A, B, C, D, E, F, G and H, which is substantially pure.

For example, Form A of 3-(4-amino-1-oxo-1,3 dihydro-isooindol-2-yl)-piperidine-2,6-dione is an unsolvated, crystalline material that can be obtained from non-aqueous solvent systems. Form A has an X-ray powder diffraction pattern comprising significant peaks at approximately 8, 14.5, 16, 17.5, 20.5, 24 and 26 degrees 20, and has a differential scanning calorimetry curve comprising an endotherm at about 270° C.

Form B of 3-(4-amino-1-oxo-1,3 dihydro-isooindol-2-yl)-piperidine-2,6-dione is a hemihydrated, crystalline material that can be obtained from various solvent systems, including, but not limited to, hexane, toluene, and water. Form B has an X-ray powder diffraction pattern comprising significant peaks at approximately 16, 18, 22 and 27 degrees 20, and has a differential scanning calorimetry curve comprising endotherms at about 146 and about 268° C. Form B typically loses about 3.1% volatiles up to about 175° C. (per approximately 0.46 moles of water).

Form C of 3-(4-amino-1-oxo-1,3 dihydro-isooindol-2-yl)-piperidine-2,6-dione is a hemisolvated crystalline material that can be obtained from solvents such as, but not limited to, acetone. Form C has an X-ray powder diffraction pattern comprising significant peaks at approximately 15.5 and 25 degrees 20, and has a differential scanning calorimetry curve comprising endotherms at about 150 and about 269° C.

Form D of 3-(4-amino-1-oxo-1,3 dihydro-isooindol-2-yl)-piperidine-2,6-dione is a crystalline, solvated polymorph prepared from a mixture of acetonitrile and water. Form D has an X-ray powder diffraction pattern comprising significant peaks at approximately 27 and 28 degrees 20, and has a differential scanning calorimetry curve comprising endotherms at about 122 and about 270° C.

Form E of 3-(4-amino-1-oxo-1,3 dihydro-isooindol-2-yl)-piperidine-2,6-dione is a dihydrated, crystalline material that can be obtained by slurring 3-(4-amino-1-oxo-1,3 dihydro-isooindol-2-yl)-piperidine-2,6-dione in water and by a slow evaporation of 3-(4-amino-1-oxo-1,3 dihydro-isooindol-2-yl)-piperidine-2,6-dione in a solvent system with a ratio of about 9:1 acetonewater. Form E has an X-ray powder diffraction pattern comprising significant peaks at approximately 20, 24.5 and 29 degrees 20, and has a differential scanning calorimetry curve comprising endotherms at about 99, 161 and 269° C.

Form F of 3-(4-amino-1-oxo-1,3 dihydro-isooindol-2-yl)-piperidine-2,6-dione is an unsolvated, crystalline material that can be obtained from the dehydration of Form E. Form F has an X-ray powder diffraction pattern comprising significant peaks at approximately 19, 19.5 and 25 degrees 20, and has a differential scanning calorimetry curve comprising an endotherm at about 269° C.

Form G of 3-(4-amino-1-oxo-1,3 dihydro-isooindol-2-yl)-piperidine-2,6-dione is an unsolvated, crystalline material that can be obtained from slurring forms B and E in a solvent such as, but not limited to, tetrahydrofuran (THF). Form G has an X-ray powder diffraction pattern comprising significant peaks at approximately 21, 23 and 24.5 degrees 20, and has a differential scanning calorimetry curve comprising an endotherm at about 248° C.

Form H of 3-(4-amino-1-oxo-1,3 dihydro-isooindol-2-yl)-piperidine-2,6-dione is a partially hydrated crystalline material that can be obtained by exposing Form E to 0% relative humidity. Form H has an X-ray powder diffraction pattern comprising significant peaks at approximately 15, 26 and 31 degrees 20, and has a differential scanning calorimetry curve comprising an endotherm between about 50 and about 125° C. and an endotherm at about 269° C.

As used herein and unless otherwise indicated, the term “substantially pure” when used to describe a polymorph of a compound means a solid form of the compound that comprises that polymorph and is substantially free of other polymorphs of the compound. A representative substantially pure polymorph comprises greater than about 80% by weight of one polymorphic form of the compound and less than 20% by weight of other polymorphic forms of the compound, more preferably greater than about 90% by weight of one polymorphic form of the compound and less than about 10% by weight of the other polymorphic forms of the compound, even more preferably greater than about 95% by weight of one polymorphic form of the compound and less than about 5% by weight of the other polymorphic forms of the compound, and most preferably greater than about 97% by weight of one polymorphic form of the compound and less than about 3% by weight of the other polymorphic forms of the compound.

Other specific immunomodulatory compounds of the invention include, but are not limited to, 1-oxo-2-(2,6-dioxo-3-thiapiperidin-3-yl) isoindolines and 1,3-dioxo-2-(2,6-dioxo-3-thiapiperidin-3-yl) isoindolines such as those described in U.S. Pat. Nos. 5,874,448 and 5,955,476, each of which is incorporated herein by reference. Representative compounds are of formula:
wherein \( Y \) is oxygen or \( H^2 \) and

[0133] each of \( R^1, R^2, R^3, \) and \( R^4, \) independently of the others, is hydrogen, halo, alkyl of 1 to 4 carbon atoms, alkoxy of 1 to 4 carbon atoms, or amino.

[0134] Other specific immunomodulatory compounds of the invention include, but are not limited to, the tetra substituted

\[
\text{2-(2,6-dioxopiperidin-3-yl)-1-oxoindolines}
\]
described in U.S. Pat. No. 5,798,368, which is incorporated herein by reference. Representative compounds are of formula:

[0135] wherein each of \( R^1, R^2, R^3, \) and \( R^4, \) independently of the others, is halo, alkyl of 1 to 4 carbon atoms, or alkoxy of 1 to 4 carbon atoms.

[0136] Other specific immunomodulatory compounds of the invention include, but are not limited to, 1-oxo and 1,3-dioxo-2-(2,6-dioxopiperidin-3-yl) isoindolines disclosed in U.S. Pat. No. 6,403,613, which is incorporated herein by reference. Representative compounds are of formula:

[0137] in which

[0138] \( Y \) is oxygen or \( H_2, \)

[0139] a first of \( R^2 \) and \( R^3 \) is halo, alkyl, alkoxy, alkylamino, dialkylamino, cyano, or carbamoyl, the second of \( R^1 \) and \( R^2, \) independently of the first, is hydrogen, halo, alkyl, alkoxy, alkylamino, dialkylamino, cyano, or carbamoyl, and

[0140] \( R^3 \) is hydrogen, alkyl, or benzyl.

[0141] Specific examples of the compounds are of formula:

[0142] wherein a first of \( R^1 \) and \( R^2 \) is halo, alkyl of from 1 to 4 carbon atoms, alkoxy of from 1 to 4 carbon atoms, dialkylamino in which each alkyl is of from 1 to 4 carbon atoms, cyano, or carbamoyl,

[0143] the second of \( R^1 \) and \( R^2, \) independently of the first, is hydrogen, halo, alkyl of from 1 to 4 carbon atoms, alkoxy of from 1 to 4 carbon atoms, alkylamino in which alkyl is of from 1 to 4 carbon atoms, dialkylamino in which each alkyl is of from 1 to 4 carbon atoms, cyano, or carbamoyl, and

[0144] \( R^3 \) is hydrogen, alkyl of from 1 to 4 carbon atoms, or benzyl. Other representative compounds are of formula:

[0145] wherein a first of \( R^1 \) and \( R^2 \) is halo, alkyl of from 1 to 4 carbon atoms, alkoxy of from 1 to 4 carbon atoms, dialkylamino in which each alkyl is of from 1 to 4 carbon atoms, cyano, or carbamoyl,

[0146] the second of \( R^1 \) and \( R^2, \) independently of the first, is hydrogen, halo, alkyl of from 1 to 4 carbon atoms, alkoxy of from 1 to 4 carbon atoms, alkylamino in which alkyl is of from 1 to 4 carbon atoms, dialkylamino in which each alkyl is of from 1 to 4 carbon atoms, cyano, or carbamoyl, and

[0147] \( R^3 \) is hydrogen, alkyl of from 1 to 4 carbon atoms, or benzyl.

[0148] Other specific immunomodulatory compounds of the invention include, but are not limited to, 1-oxo and 1,3-dioxoindolines substituted in the 4- or 5-position of the indoline ring described in U.S. Pat. No. 6,380,239, which is incorporated herein by reference. Representative compounds are of formula:

[0149] in which the carbon atom designated \( C^8 \) constitutes a center of chirality (when \( n \) is not zero and \( R^1 \) is not the same as \( R^3 \)); one of \( X^1 \) and \( X^2 \) is amino, nitro, alkyl of one to six carbons, or \( NH-Z, \) and the other of \( X^1 \) or \( X^2 \) is hydrogen; each of \( R^1 \) and \( R^2, \) independent of the other, is hydroxy or \( NH-Z; \) \( R^1 \) is hydrogen, alkyl of one to six carbons, halo, or haloalkyl; \( Z \) is hydrogen, aromatic, alkyl of one to six carbons, formyl, or acyl of one to six carbons; and \( n \) has a value of 0, 1, or 2; provided that if \( X^1 \) is amino, and \( n \) is 1 or 2, then \( R^1 \) and \( R^2 \) are not both hydroxy; and the salts thereof. Further representative compounds are of formula:
in which the carbon atom designated C constitutes a center of chirality when n is not zero and R is not R; one of X, X, and X is amino, nitro, alkyl of one to six carbons, or NH-Z, and the other of X or X is hydrogen; each of R and R independent of the other, is hydroxy or NH-Z; R is alkyl of one to six carbons, halo, or hydrogen; Z is hydrogen, aryl or an alkyl or acyl of one to six carbons; and n has a value of 0, 1, or 2.

Other representative compounds are of formula:

in which the carbon atom designated C constitutes a center of chirality when n is not zero and R' is not R; one of X' and X is amino, nitro, alkyl of one to six carbons, or NH-Z, and the other of X' or X is hydrogen; each of R' and R independent of the other, is hydroxy or NH-Z; R is alkyl of one to six carbons, halo, or hydrogen; Z is hydrogen, aryl, or an alkyl or acyl of one to six carbons; and n has a value of 0, 1, or 2; and the salts thereof. Specific examples of the compounds are of formula:

wherein one of X and X is alkyl of one to six carbons,

each of R' and R, independent of the other, is hydroxy or NH-Z;

R is alkyl of one to six carbons, halo, or hydrogen;

Z is hydrogen, phenyl, an acyl of one to six carbons, or an alkyl of one to six carbons; and

n has a value of 0, 1, or 2; and the salts thereof. Specific examples of the compounds are of formula:

wherein:

the carbon atoms designated * constitute centers of chirality;

X is —C(O) or —CH;

R is alkyl of 1 to 8 carbon atoms or —NH-R;

R is hydrogen, alkyl of 1 to 8 carbon atoms, or halogen;

R is hydrogen;

alkyl of 1 to 8 carbon atoms, unsubstituted or substituted with alkoxyl of 1 to 8 carbon atoms, halo, amino, or alkylamino of 1 to 4 carbon atoms,

cycloalkyl of 3 to 18 carbon atoms,

phenyl, unsubstituted or substituted with alkyl of 1 to 8 carbon atoms, alkoxyl of 1 to 8 carbon atoms, halo, amino, or alkylamino of 1 to 4 carbon atoms,

benzyl, unsubstituted or substituted with alkyl of 1 to 8 carbon atoms, alkoxyl of 1 to 8 carbon atoms, halo, amino, or alkylamino of 1 to 4 carbon atoms, or -COR in which

R is hydrogen,

alkyl of 1 to 8 carbon atoms, unsubstituted or substituted with alkoxyl of 1 to 8 carbon atoms, halo, amino, or alkylamino of 1 to 4 carbon atoms,

cycloalkyl of 3 to 18 carbon atoms,

phenyl, unsubstituted or substituted with alkyl of 1 to 8 carbon atoms, alkoxyl of 1 to 8 carbon atoms, halo, amino, or alkylamino of 1 to 4 carbon atoms, or
182] benzyl, unsubstituted or substituted with alkyl of 1 to 8 carbon atoms, alkoxy of 1 to 8 carbon atoms, halo, amino, or alkylamino of 1 to 4 carbon atoms.

183] Compounds of the invention can either be commercially purchased or prepared according to the methods described in the patents or patent publications disclosed herein. Further, optically pure compounds can be asymmetrically synthesized or resolved using known resolving agents or chiral columns as well as other standard synthetic organic chemistry techniques.

184] As used herein and unless otherwise indicated, the term “pharmaceutically acceptable salt” encompasses non-toxic acid and base addition salts of the compound to which the term refers. Acceptable non-toxic acid addition salts include those derived from organic and inorganic acids or bases known in the art, which include, for example, hydrochloric acid, hydrobromic acid, phosphoric acid, sulfuric acid, methanesulfonic acid, acetic acid, tartaric acid, lactic acid, succinic acid, citric acid, malic acid, maleic acid, sorbic acid, aconitic acid, salicylic acid, phthalic acid, embonic acid, and the like.

185] Compounds that are acidic in nature are capable of forming salts with various pharmaceutically acceptable bases. The bases that can be used to prepare pharmaceutically acceptable base addition salts of such acidic compounds are those that form non-toxic base addition salts, i.e., salts containing pharmaceutically acceptable cations such as, but not limited to, alkali metal or alkaline earth metal salts and the calcium, magnesium, sodium or potassium salts in particular. Suitable organic bases include, but are not limited to, N,N-dibenzylethanolamine, chloroprocaine, choline, diethanolamine, ethylenediamine, meglumine (N-methylglucamine), lysine, and procaine.

186] As used herein and unless otherwise indicated, the term “prodrug” means a derivative of a compound that can hydrolyze, oxidize, or otherwise react under biological conditions (in vitro or in vivo) to provide the compound. Examples of prodrugs include, but are not limited to, derivatives of immunomodulatory compounds of the invention that comprise biologically active moieties such as biologically active amides, biologically active esters, biologically active carbamates, biologically active carbonates, biologically active ureides, and biologically active phosphate analogues. Other examples of prodrugs include derivatives of immunomodulatory compounds of the invention that comprise NO$_2$ or NO$_3$, NO, NO$_2$-$\cdot$ ONO$_2$ or NO$_2$-$\cdot$ ONO$_2$ moieties. Prodrugs can typically be prepared using well-known methods, such as those described in 1 Burger’s Medicinal Chemistry and Drug Discovery, 172-178, 949-982 (Manfred E. Wolff ed., 5th ed. 1995), and Design of Prodrugs (H. Bundgaard ed., Elsevier, New York 1985).

187] As used herein and unless otherwise indicated, the terms “biologically active amide,” “biologically active ester,” “biologically active carbamate,” “biologically active carbonate,” “biologically active ureide,” “biologically active phosphate” mean an amide, ester, carbamate, carbonate, ureide, or phosphate, respectively, of a compound that either: 1) does not interfere with the biological activity of the compound but can confer upon that compound advantageous properties in vivo, such as uptake, duration of action, or onset of action; or 2) is biologically inactive but is converted in vivo to the biologically active compound. Examples of biologically active esters include, but are not limited to, lower alkyl esters, lower acetoxyalkyl esters (such as acetoxymethyl, acetoxyethyl, amino- nocarbonyloxyethyl, pivaloxygenoethyl, and pivaloxyox- one-ethyl esters), lactonyl esters (such as phthalyl and thiophthalyl esters), lower alkoxyacyloxyalkyl esters (such as methoxybenzyl-oxymethyl, ethoxybenzyl-oxymethyl and isoproxybenzyl-oxymethyl esters), alkoxyalkyl esters, choline esters, and acylamino alkyl esters (such as acetami- domethyl esters). Examples of biohydrolyzable amides include, but are not limited to, lower alkyl amides, amino amides, and alkylaminoalkyl carbonyl amides. Examples of biohydrolyzable carbamates include, but are not limited to, lower alkylamines, substituted ethylenediamines, amino acids, hydroxyalkylamines, heterocyclic and heteroaromatic amines, and polyether amines.

188] Various immunomodulatory compounds of the invention contain one or more chiral centers, and can exist as racemic mixtures of enantiomers or mixtures of diastereomers. This invention encompasses the use of stereomerically pure forms of such compounds, as well as the use of mixtures of those forms. For example, mixtures comprising equal or unequal amounts of the enantiomers of a particular immunomodulatory compound of the invention may be used in methods and compositions of the invention. These isomers may be asymmetry synthesized or resolved using standard techniques such as chiral columns or chiral resolving agents. See, e.g., Jacques, J., et al., Enantiomers, Racemates and Resolutions (Wiley-Interscience, New York, 1981); Wilen, S. H., et al., Tetrahedron 33:2725 (1977); Eliel, E. L., Stereochemistry of Carbon Compounds (McGraw-Hill, NY, 1962); and Wilen, S. H., Tables of Resolving Agents and Optical Resolutions p. 268 (E. L. Eliel, Ed., Univ. of Notre Dame Press, Notre Dame, Ind., 1972).

189] As used herein and unless otherwise indicated, the term “stereomerically pure” means a composition that comprises one stereoisomer of a compound and is substantially free of other stereoisomers of that compound. For example, a stereomerically pure composition of a compound having one chiral center will be substantially free of the opposite enantiomer of the compound. A stereomerically pure composition of a compound having two chiral centers will be substantially free of other diastereomers of the compound. A typical stereomerically pure compound comprises greater than about 80% by weight of one stereoisomer of the compound and less than about 20% by weight of other stereoisomers of the compound, more preferably greater than about 90% by weight of one stereoisomer of the compound and less than about 10% by weight of the other stereoisomers of the compound, even more preferably greater than about 95% by weight of one stereoisomer of the compound and less than about 5% by weight of the other stereoisomers of the compound, and most preferably greater than about 97% by weight of one stereoisomer of the compound and less than about 3% by weight of the other stereoisomers of the compound. As used herein and unless otherwise indicated, the term “stereomerically enriched” means a composition that comprises greater than about 60% by weight of one stereoisomer of a compound, preferably greater than about 70% by weight, more preferably greater than about 80% by weight of one stereoisomer of a compound. As used herein and unless otherwise indicated, the term “enantiomerically pure” means a stereomerically pure composition of a compound having one chiral center. Similarly, the term “enantiomerically enriched” means a stereomerically enriched composition of a compound having one chiral center.
[0190] It should be noted that if there is a discrepancy between a depicted structure and a name given that structure, the depicted structure is to be accorded more weight. In addition, if the stereochemistry of a structure or a portion of a structure is not indicated with, for example, bold or dashed lines, the structure or portion of the structure is to be interpreted as encompassing all stereoisomers of it.

[0191] 5.2 Second Active Agents

[0192] Immunomodulatory compounds can be combined with other pharmacologically active compounds ("second active agents") in methods and compositions of the invention. It is believed that certain combinations work synergistically in the treatment of particular types of cancer and certain diseases and conditions associated with, or characterized by, undesired angiogenesis. Immunomodulatory compounds can also work to alleviate adverse effects associated with certain second active agents, and some second active agents can be used to alleviate adverse effects associated with immunomodulatory compounds.

[0193] One or more second active ingredients or agents can be used in the methods and compositions of the invention together with an immunomodulatory compound. Second active agents can be large molecules (e.g., proteins) or small molecules (e.g., synthetic inorganic, organometallic, or organic molecules).

[0194] Examples of large molecule active agents include, but are not limited to, hematopoietic growth factors, cytokines, and monoclonal and polyclonal antibodies. Specific examples of the active agents are anti-CD40 monoclonal antibodies (such as, for example, SIGN-40); histone deacetylase inhibitors (such as, for example, SAHA and LAQ 824); heat-shock protein-90 inhibitors (such as, for example, 17-AAG); insulin-like growth factor-1 receptor kinase inhibitors; vascular endothelial growth factor receptor kinase inhibitors (such as, for example, PTK787; insulin growth factor receptor inhibitors; lysophosphatidic acid cytoskeleton inhibitors; IKK kinase inhibitors; p38MAPK inhibitors; EGF receptor inhibitors (such as, for example, gefitinib and erlotinib HCL); HER-2 antibodies (such as, for example, trastuzumab (Herceptin®) and pertuzumab (Omnitarg™)); VEGF receptor antibodies (such as, for example, bevacizumab (Avastin™)); VEGF inhibitors (such as, for example, flk-1 specific kinase inhibitors, SU5416 and ptrk878/rk2225841); PI3K inhibitors (such as, for example, wortmannin); C-Met inhibitors (such as, for example, PHA-665752); monoclonal antibodies (such as, for example, rituximab (Rituxan®), tocilizumab (Bexxar®), edrecolomab (Panorex®) and G250); and anti-TNF-α antibodies.

[0195] Typical large molecule active agents are biological molecules, such as naturally occurring or artificially made proteins. Proteins that are particularly useful in this invention include proteins that stimulate the survival and or proliferation of hematopoietic precursor cells and immunologically active poietic cells in vitro or in vivo. Particular proteins include, but are not limited to: interleukins, such as IL-2 (including recombinant IL-2 ("rIL-2") and canarypox IL-2), IL-10, IL-12, and IL-18; interferons, such as interferon α-2a, interferon α-2b, interferon α-α1, interferon α-α3, interferon β-1 a, and interferon gamma-I b; GM-CSF and GM-CSF; and EPO.

[0196] Particular proteins that can be used in the methods and compositions of the invention include, but are not limited to: filgrastim, which is sold in the United States under the trade name Neupogen® (Amgen, Thousand Oaks, Calif.); sargramostim, which is sold in the United States under the trade name Leukine® (Immunex, Seattle, Wash.); and recombinant EPO, which is sold in the United States under the trade name Epopgen® (Amgen, Thousand Oaks, Calif.).

[0197] Recombinant and mutated forms of GM-CSF can be prepared as described in U.S. Pat. Nos. 5,391,485; 5,393,870; and 5,229,496; all of which are incorporated herein by reference. Recombinant and mutated forms of G-CSF can be prepared as described in U.S. Pat. Nos. 4,810,643; 4,999,291; 5,528,823; and 5,580,755; all of which are incorporated herein by reference.

[0198] This invention encompasses the use of native, naturally occurring, and recombinant proteins. The invention further encompasses mutants and derivatives (e.g., modified forms) of naturally occurring proteins that exhibit, in vivo, at least some of the pharmacological activity of the proteins upon which they are based. Examples of mutants include, but are not limited to, proteins that have one or more amino acid residues that differ from the corresponding residues in the naturally occurring forms of the proteins. Also encompassed by the term "mutants" are proteins that lack carbohydrate moieties normally present in their naturally occurring forms (e.g., nonglycosylated forms). Examples of derivatives include, but are not limited to, pegylated derivatives and fusion proteins, such as proteins formed by fusing IgG1 or IgG3 to the protein or active portion of the protein of interest. See, e.g., Penichet, M. L. and Morrison, S. L., J. Immunol. Methods 248:91-101 (2001).

[0199] Large molecule active agents may be administered in the form of anti-cancer vaccines. For example, vaccines that secrete, or cause the secretion of, cytokines such as IL-2, G-CSF, and GM-CSF can be used in the methods, pharmaceutical compositions, and kits of the invention. See, e.g., Emens, L. A., et al., Curr. Opinion Mol. Ther. 3(1):77-84 (2001).

[0200] In one embodiment of the invention, the large molecule active agent reduces, eliminates, or prevents an adverse effect associated with the administration of an immunomodulatory compound. Depending on the particular immunomodulatory compound and the disease or disorder being treated, adverse effects can include, but are not limited to, drowsiness and somnolence, dizziness and orthostatic hypotension, neutropenia, infections that result from neutropenia, increased HIV-viral load, bradycardia, Stevens-Johnson Syndrome and toxic epidermal necrolysis, and seizures (e.g., grand mal convulsions). A specific adverse effect is neutropenia.

[0201] Second active agents that are small molecules can also be used to alleviate adverse effects associated with the administration of an immunomodulatory compound. However, like some large molecules, many are believed to be capable of providing a synergistic effect when administered with (e.g., before, after or simultaneously) an immunomodulatory compound. Examples of small molecule second active agents include, but are not limited to, anti-cancer agents, antibiotics, immunosuppressive agents, and steroids.

[0202] Examples of anti-cancer agents include, but are not limited to: semaxanib; cyclosporin; etanercept; doxycycline; bortezomib; aciclovir; aclacinomycin; acodazole hydrochloride; acronine; adenosine; aldosekinin; alretamine; ambomycin; ametantrone acetate; amsacrine; anastrozole; anthracyclin; asparaginase; asperlin; azactidine; azetepa; azotomycin;
batimastat; benzopae; bicalutamide; bisantrene hydrochloride; bisafide dimeylsate; bizelesin; blecaminic sulfate; brequinar sodium; broprinidine; busulfan; capecitabine; calsertan; caracemide; carbetim; carbofuran; cemustine; carbusine hydrochloride; cezaruline; cefadoline; cefoerobin; chlorambucil; clocyromycin; cisplatin; clodribine; crinosat mesylate; cyclophosphamide; cytarabine; dacarbazine; dactinomycin; daunorubicin hydrochloride; deactibine; dexoraplatin; dezogranumazine; dezoguanine mesylate; dziazaquine; docetaxel; doxorubicin; doxorubicin hydrochloride; drofloicistine; drofloixone irontrate; dromostanolone propionate; dua- zomycin; edaratase; efornithine hydrochloride; elasmuricin; enoplont; enpromate; epipropidine; epirubicin hydrochloride; erubolzone; esorubicin hydrochloride; estramustine; estramustine phosphate sodium; etansodazole; etoposide; etoposide phosphate; etoprine; fadrozole hydrochloride; fazarabin; fenretinide; fludarabine phosphate; fluorouracil; flucitocinine; fosgildone; fostrieicin sodium; gemicitabine; gemcitabine hydrochloride; hydroxyurea; ibudrinic hydrochloride; ifosofamine; iproplatin; irinotecan; irinotecan hydrochloride; lanreotide acetate; letrozole; leuprolide acetate; lariozole hydrochloride; lometrexol sodium; lomustine; losoxantone hydrochloride; masoprostol; maytansine; mechlorethamine hydrochloride; megestrol acetate; melengestrol acetate; melphalan; menogaril; mercaptopurine; methotrexate; methotrexate sodium; metoprine; miretaspase; mitomodine; mitocurcin; mitogillin; mitomalcin; mitomycin; mitosper; mitotane; mitoxantrone hydrochloride; mycophenolic acid; noeadrozole; nogalamycin; onaraplargin; oxisuran; paclitaxel; pemalganose; pellomycin; portamustine; peplomycin sulfate; perfamustin; pipobroman; piposulfon; pixoratone hydrochloride; plicamycin; plomestane; poriferid sodium; porinomycin; prednimustine; procabazine hydrochloride; puromycin; puromycin hydrochloride; pyrazofurin; riboprine; safingol; safingol hydrochloride; semustine; simtrazene; sparofolate sodium; sparsomycin; spironemom hydrochloride; spiromustine; spiroplatin; streptomycin; streptozocin; sulfoxene; talosmycin; tegocalan sodium; taxotere; tegafur; tefoxarzone hydrochloride; temoporfin; teniposide; teroxorone; testoxacrine; thiamiprine; thioquane; thiotepa; tiaxorafin; tirapazamine; toremifene citrate; tretinone acetate; triciribine phosphate; trimetrexate; trioxarzone; tubulozole hydrochloride; urcsetin mustard; uroeprine; vaptoreorfin; vanilbuein sulfate; vincristine sulfate; vindesine; vindesine sulfate; vine- pidine sulfate; vinulysine sulfate; vinuleurocine sulfate; vinorelbine tartrate; vinrosidine sulfate; vinzoldine sulfate; vorozole; xenaplatin; xenostatin; and zorubicin hydrochloride.

[0203] Other anti-cancer drugs include, but are not limited to:
[0204] 20-epi-1,25 dihydroxyvitamin D3; 5-ethylureidacyl; abi- raterone; aclacinbucic; acylfurone; adecypropenol; adzeolesin; adzoeshulin; ALL-TK antagonists; altretamine; ambavamtine; amidox; amifostine; aminolevulinic acid; amrubcinic; anacserine; angareide; anastrozole; androgapholide; angio- genesis inhibitors; antagonist D; antagonist G; antarelix; an- dorsalizing morphogenetic protein-1; antiandrogen, prostatic carcinoma; antiandrogen; antineoplaston; antisense oligo- nucleotides; aphidicolin glycine; apomorphine gene modula- tors; apoposis regulator; apurinic acid; ara-CDP-DL- PTBA; arginine deaminase; asulcrine; atamestrate; atrimustine; axinastatin 1; axinastatin 2; axinastatin 3; azas- etron; azatocin; azatyrrosine; baccatin III derivatives; bol- anal; batimastat; BCR/ABL antagonists; benzochlorzid; benzoyltaurosporine; beta lactam derivatives; beta-alethine; betamethromin B; betulinic acid; bFGF inhibitor; bicaluta- mine; bisantrene; bisazidirindylperimine; bisafide; bistatene A; bizelesin; breflate; broprinidine; budotatine; buthionine sulfoximine; calcipotriol; calphostin C; camptothecin deriv- atives; canpiceatine; carboxamide-aminotriazole; carboxy- midotiazole; CaRest M3: CARN 700: cartilage derived inhibitor; carzaline; casein kinase inhibitors (ICOS); castanospermine; cereopin B; cetrorelin; chlorins; chloroqui- noxalinesulfonamide; cispampro; cis-pporphyrin; cladribine; clomifene analogues; clorimazole; collumycin A; collumycin B; comberstatin A4; comberstatin analogues; conag- nin; crambescidin 816; crisnatol; cryprrphycin B; cryprrphy- cin A derivatives; curacin A; cyclopentanfzranquiones; cycloplam; cypermcytin; cytarabine; cyclofate; cytoxic factor; cytostatin; dacliximab; decitabine; dehydrodizmincin B; deslorelin; dexamethasone; dextrisomal; dextrizone; dexamethasone; didoxin B; didox; diethylnor- spermim; dihydro-5-azacytidine; dihydroxytoxol, 9-; doisynaxim; diphenyl spiromustine; doctaxel; docosanol; dolare- ton; doxifluridone; doxorubicin; droxorifine; duxanobulin; duocarmycin SA; ebselen; ecomustine; edelfosine; edrecol- mab; effornithine; elemene; emetefur; epirubicin; episteride; estramustine analogs; estrogen agonists; estrogen antagonists; etanidazole; etoposide phosphate; exemestane; fadro- zole; fazarabine; fenretinide; filgrastim; finasteride; flavo- pricipol; flezelastine; flustarone; fludarabine; fluorodanorurinc hydrochloride; forfenimex; forcenose; fostricain; fotemustine; gadolinium tetracyphrin; gallium nitrate; galocitobine; ganirel; gelatinase inhibitors; gemcit- abine; glutathione inhibitors; hepsulfam; hergulin; hexam- ethylene bisacetamid; hypercin; ibandronic acid; idarubicin; iodofurin; idoxifene; idramontone; ilomosine; ilomastat; imatinib (e.g., Glivec®); imiquimod; immunomodulation peptides; insulin-like growth factor-1 receptor inhibitor; interferon agonists; interferons; interleetukin; iobeguanne; iododoxorubin- icip; ipomeanol, 4-; iropact; isrogladine; isobengazole; iso- homoualicondrin B; itaseton; jaspilkinolide; kaluralide F; lamelarins-N triacetate; lanreotide; leunaminic; lenogrestin; leninan sulfate; leptomast sitol; letrozole; leukemia inhibiting factor; leukocyte alpha interferon; leuprolide+estrogen+ progesterone; levopreolin; levarusilose; liarozole; linear polyamine analogue; lipopholic disruptor peptide; lipo- philic platinum compounds; lissociaminde 7; lobaplamin; lombricine; lometrexol; lomdamine; losoxantrone; lotox- ribine; luroetocen; lutetiam tetracyphrin; lysylofeline; lytic pep- tides; maitainse; mannastatin A; marimastat; masoprolol; maspin; matrixins inhibitors; matrix metalloproteinase inhibitors; menogaril; saponasin; methioninase; metcolsparadime; MIF inhibitor; mifepristone; miltefosine; mimrostin; mitougaonize; mitolactol; mitomycin analogues; mitofanide; mitotixin fibroblast growth factor-saporin; mitoxantrone; mofaroten; mofologastin; mufibrin; mycophoroxide B; mycobacterial cell wall extract; myriapor- one; N-acetyldialline; N-substituted benzamides; naefrinlein; nagrestip; naloxone+pentazocine; napavin; naphterpin; nar- togrumst; nepadlin; nemorubicin; nerardinic acid; nhuta- mine; nismacyn; nitric oxide modulators; nitrogen oxide anti- oxidant; nitrylul; oblimersen (Genessense®); O'-benzylnucleotide; octreotide; oclikerson; oligonucleotides; onapristone; ondasoteron; ondasoteron; oracil; oral cytokine inducer; ormaplatin; osaterone; oxaplatin; oxasomycin;
paclitaxel; paclitaxel analogues; paclitaxel derivatives; paalamine; palmitoylhydroxizine; pamidronic acid; panax\nytriol; panonifene; parabactin; paazzilirine; peganparase; peldesine; pentosan polysulfate sodium; pentostatin; pentro\nzole; perfluorobut; perfløsamine; perillyl alcohol; phenazino\nymycin; phenylacacetate; phosphatase inhibitors; picibanil; pilo\ncarpine hydrochloride; pirarubicin; pirirxem; placein A; placein B; plasmomagen activator inhibitor; platinum complex; pl
atium compounds; platinum-triamine complex; por\nfirmer sodium; porflomycin; prednisone; propyl bis-acri\ndone; prostaglandin J2; proteasome inhibitors; protein A-
based immune modulator; protein kinase C inhibitor; protein kinase C inhibitors, microalg; protein tyrosine phos\nphatase inhibitors; purine nucleoside phosphorylase inhibi\tors; purpurins; pyrazoloacridine; pyridoxylated hemoglobin polyoxygenylene conjugate; raft antagonists; ratlirexed; ramosetron; ras farnesyl protein transferase inhibitors; ras inhibi\tors; ras-GAP inhibitor; retelliptine demethylated; rhe\nnium Re 186 etidronate; rhoxizin; ribozymes; RII retinanide; rohitukine; romuridite; roquimexin; rubigione B1; ruboxyl; sa
lingol; santopin; SarCNU; sarcothyl B; sarcosamostim; Sfl I mimetics; semustine; senescence derived inhibitor 1; sense oligonucleotides; signal transduction inhibitors; sizofur
ran; sobuzoxane; sodium borocapatate; sodium phenylacetate; solvent; somatomedin binding protein; sonoerin; sparfosic acid; spicamyclin D; spromustine; sploenoxin; spogensitregn; squamous; squilamidine; stromelysin inhibitors; sulfi
nosine; superactive vasovucine intestinal peptide antagonistsudris; suramin; swainsosine; tallnustine; tamoxifen methiodide; tauromustine; tazaronete; tegocalcan sodium; te
qafur; tellurapyrium; telomerase inhibitors; termoporin; teniposide; tetrachlorodecaoxide; tetrazemone; thalidustione; thicoradin; thiocholochrome; thropobromine; thropoboromin mimetic; thy
malaflisan; thymopoietin receptor agonist; thymotrinan; thyroid stimulating hormone; tin ethyl etopurpurin; tira-
pazamine; titancene bichloride; topsentin; toremifene; trans\literation inhibitors; tretinoin; triacetyluridine; tricirbinbine; trimetrexate; tripelorein; tropisetron; turosteride; tyrosine kinase inhibitors; typhostins; UBC inhibitors; ubiquinenu
rogenital sinus-derived growth inhibitory factor; urikinase recep\ntor antagonists; vaprocide; variobin B; velalox; veramine; verdins; verteporfin; vinorelbine; vinvalazine; vitaxin; vorozole; zanotrone; zenplatin; zilesceorb; and zinostatin stimulamer.[0204] Specific second active agents include, but are not limited to, 2-methoxyestradiol, telomestatin, inducers of apo\nplos in multiple myeloma cells (such as, for example, TRAIL), statins, semaxanib, cyclosporin, etanercept, doxy\ncycline, eortozinm, oblomeron) (Genasense®) remicade, docetaxel, celecoxib, melphanal, dexamethasone(Decadex\nron®), steroids, genmucicibra, cisplatin, temozolomide, etoposide, cyclophosphamide, temoda, carboplatin, procar\nbazine, gliadel, tamoxifen, topotecan, methotrexate, Arista®, taxol, taxotere, fluorouracil, leucovorin, irinotecan, xeloda, CPT-11, interferon alpha, pegylated interferon alpha (e.g., PEG INTRON-A), capacitabin, cisplatin, thiopeta, fludara\nbin, carboplatin, liposomal daunorubicin, cytarbina, dox\uetaxol, paclitaxel, vinblastine, IL-2, GM-CSF, dacarbazine, vinorelbine, zoleodonic acid, palmitronate, baxion, busul\nplan, prednisonine, bisphosphonate, arseic trioxide, vinceri\ntine, doxorubicin) (Dexil®), paclitaxel, ganciclovir, adriamy\ncin, estramustine sodium phosphate) (Emcyt®), sulindac, and etoposide.[0205] 5.3 Methods of Treatments and Prevention
[0206] Methods of this invention encompass methods of treating, preventing and/or managing various types of cancer and diseases and disorders associated with, or characterized by, undesired angiogenesis. As used herein, unless otherwise specified, the term “treating” refers to the administration of a compound of the invention or any additional active agent after the onset of symptoms of the particular disease or disorder. As used herein, unless otherwise specified, the term “preventing” refers to the administration prior to the onset of symptoms, particularly to patients at risk of cancer, and other diseases and disorders associated with, or characterized by, undesired angiogenesis. The term “prevention” includes the inhibition of a symptom of the particular disease or disorder. Patients with familiar history of cancer and diseases and disorders associated with, or characterized by, undesired angiogenesis are preferred candidates for preventive regimens. As used herein and unless otherwise indicated, the term “managing” encompasses preventing the recurrence of the particular disease or disorder in a patient who had suffered from it, and/or lengthening the time a patient who had suffered from the disease or disorder remains in remission.[0207] As used herein, the term “cancer” includes, but is not limited to, solid tumors and blood-borne tumors. The term “cancer” refers to disease of skin tissues, organs, blood, and vessels, including, but not limited to, cancers of the bladder, bone or blood, brain, breast, cervix, colon, endometrium, esophagus, eye, head, kidney, liver, lymph nodes, lung, mouth, neck, ovaries, pancreas, prostate, rectum, stomach, testis, thyroid, and uterus. Specific cancers include, but are not limited to, advanced malignancy, amyloidosis, nephroblastoma, meningioma, atypical meningioma, hemangioendo
cytoma, multiple brain metastases, glioblastoma multiformes, glioblastoma, brain stem glioma, poor prognosis malignant brain tumor, malignant glioma, recurrent malignant glioma, anaplastic astrocytoma, anaplastic oligodendro
glioma, neuroendocrine tumor, rectal adenocarcinoma, Dukes C & D colorectal cancer, unrespectable colorectal can
cinoma, metastatic hepatocellular carcinoma, Kaposi’s sar
static melanoma (localized melanoma, including, but not limi\ted to, ocular melanoma), malignant mesothelioma, malign\nant pheural effusion mesothelioma syndrome, peritoneal carcinoma, papillary serous carcinoma, gynoecologic car
cinoma, soft tissue sarcoma, scedroema, cutaneous vascu\lisits, Langerhans cell histiocytosis, leiomyosarcoma, fibrody\nsplasia ossificans progressiva, hormone refractory prostate cance
r, recoted high-risk soft tissue sarcoma, unrectectable hepato\cellular carcinoma, Waldenstrom’s macroglobulinemia, smoldering myeloma, indolent myeloma, falltopian tube cancer, androgen independent prostate cancer, androgen dependent stage IV non-metastatic prostate cancer, hormone
insensitive prostate cancer, chemotherapy-insensitive proste\tcancer, papillary thyroid cancer, follicular thyroid carcino\ma, medullary thyroid carcinoma, and leiomyoma. In a spec\ifice embodiment, the cancer is metastatic. In another embodiment, the cancer is refractory or resistant to che
motherapy or radiation; in particular, refractory to thalidomide.[0208] As used herein to refer to diseases and conditions other than cancer, the terms “diseases or disorders associated with, or characterized by, undesired angiogenesis,” “diseases
or disorders associated with undesired angiogenesis,” and “diseases or disorders characterized by undesired angiogenesis” refer to diseases, disorders and conditions that are caused, mediated or attenuated by undesired, unwanted or uncontrolled angiogenesis, including, but not limited to, inflammatory diseases, autoimmune diseases, genetic diseases, allergic diseases, bacterial diseases, ocular neovascular diseases, choroidal neovascular diseases, and retina neovascular diseases.

**[0209]** Examples of such diseases or disorders associated with undesired angiogenesis include, but are not limited to, endometriosis, Crohn’s disease, heart failure, advanced hereditary, renal impairment, diabetic retinopathy, retinopathy of prematurity, corneal graft rejection, neovascular glaucoma, retrolental fibroplasia, proliferative vitreoretinopathy, trachoma, myopia, optic pits, epidemic keratoconjunctivitis, atopic keratitis, superior limbic keratitis, pterygium keratitis, sicca, sjogren, acne rosacea, phlyctenulosis, syphilis, lipid degeneration, bacterial ulcer, fungal ulcer, Herpes simplex infection, Herpes zoster infection, protozoan infection, Kaposis sarcoma, Moorfan ulcer, Terrien’s marginal degeneration, marginal keratolysis, rheumatoid arthritis, systemic lupus, polyarteritis, trauma, Wegener’s sarcoidosis, scleritis, Steven’s Johnson disease, periplagial radial keratotomy, sickle cell anemia, sarcoid, pseudoxanthoma elasticum, Paget’s disease, vein occlusion, artery occlusion, carotid obstructive disease, chronic uveitis, chronic vitritis, Lyme’s disease, Eales disease, Bochet’s disease, retinitis, choroiditis, presumed ocular histoplasmosis, Bests disease, Stargardt disease, pars planitis, chronic retinal detachment, hyperviscosity syndromes, toxoplasmosis, rubella, sarcoidosis, sclerosis, soriasis, psoriasis, primary sclerosing cholangitis, proctitis, primary biliary srosis, idiopathic pulmonary fibrosis, alcoholic hepatitis, endotoxemia, toxic shock syndrome, osteoarthritis, retrovirus replication, wasting, meningitis, silica-induced fibrosis, asbestos-induced fibrosis, malignancy-associated hypercalcaemia, stroke, circulatory shock, periodontitis, gingivitis, macrocytic anemia, refractory anemia, 5q-syndrome, and veterinary disorder caused by feline immunodeficiency virus, equine infectious anemia virus, caprine arthritis virus, visna virus, maedi virus or lenti virus.

**[0210]** In specific embodiments of the invention, diseases or disorders associated with undesired angiogenesis do not include congestive heart failure, cardiomyopathy, pulmonary edema, endotoxin-mediated septic shock, acute viral myocarditis, cardiac allograft rejection, myocardial infarction, HIV, hepatitis, adult respiratory distress syndrome, bone resorption disease, chronic obstructive pulmonary diseases, chronic pulmonary inflammatory disease, dermatitis, cystic fibrosis, septic shock, sepsis, endotoxic shock, hemodynamic shock, sepsis syndrome, post ischemic repertusion injury, fibrotic disease, cachexia, graft rejection, rheumatoid spondylitis, osteoporosis, ulcerative colitis, inflammatory bowel disease, multiple sclerosis, systemic lupus erythematosus, erythema nodosum leprosum in leprosy, radiation damage, asthma, hyperoxic alveolar injury, malaria, mycobacterial infection, and opportunistic infections resulting from HIV.

**[0211]** This invention encompasses methods of treating patients who have been previously treated for cancer or diseases or disorders associated with, or characterized by, undesired angiogenesis, but are non-responsive to standard therapies, as well as those who have not previously been treated. The invention also encompasses methods of treating patients regardless of patient’s age, although some diseases or disorders are more common in certain age groups. The invention further encompasses methods of treating patients who have undergone surgery in an attempt to treat the disease or condition at issue, as well as those who have not. Because patients with cancer and diseases and disorders characterized by undesired angiogenesis have heterogeneous clinical manifestations and varying clinical outcomes, the treatment given to a patient may vary, depending on his/her/prospective. The skilled clinician will be able to readily determine without undue experimentation specific secondary agents, types of surgery, and types of non-drug based standard therapy that can be effectively used to treat an individual patient with cancer and other diseases or disorders.

**[0212]** Methods encompassed by this invention comprise administering one or more immunomodulatory compound of the invention, or a pharmaceutically acceptable salt, solvate, hydrate, stereoisomer, clathrate, or prodrug thereof, to a patient, or alternatively from about 10 to about 50 mg every other day.

**[0213]** In one embodiment of the invention, an immunomodulatory compound of the invention can be administered orally and in single or divided daily doses in an amount of from about 0.10 to about 150 mg/day. In a particular embodiment, 4-(amino-2-(2,6-dioxo(3-piperidyl))-isindole-1,3-dione may be administered in an amount of from about 0.1 to about 1 mg per day, or alternatively from about 0.1 to about 5 mg every other day. In a preferred embodiment, 3-(4-amino-1-oxo,1,3-dihydro-isindol-2-yl)piperidine-2,6-dione may be administered in an amount of from about 1 to about 25 mg per day, or alternatively from about 10 to about 50 mg every other day.

**[0214]** In a specific embodiment, 4-(amino)-2-(2,6-dioxo(3-piperidyl))-isindole-1,3-dione may be administered in an amount of about 1, 2, or 5 mg per day to patients with relapsed multiple myeloma. In a particular embodiment, 4-(4-amino-1-oxo,1,3-dihydro-isindol-2-yl)piperidine-2,6-dione may be administered initially in an amount of 1 mg/day and the dose can be escalated every week to 10, 20, 20, 30, 35 and 50 mg/day. In a specific embodiment, 4-(4-amino-1-oxo,1,3-dihydro-isindol-2-yl)piperidine-2,6-dione can be administered in an amount of up to about 30 mg/day to patients with solid tumor. In a particular embodiment, 3-(4-amino-1-oxo,1,3-dihydro-isindol-2-yl)piperidine-2,6-dione can be administered in an amount of up to about 40 mg/day to patients with glioma.

**[0215]** In a specific embodiment, 4-(amino)-2-(2,6-dioxo(3-piperidyl))-isindole-1,3-dione may be administered in an amount of from about 0.1 to about 1 mg per day, or alternatively from about 0.1 to about 5 mg every other day, to patients with diseases or disorders associated with, or characterized by, undesired angiogenesis including, but not limited to, endotoxemia, toxic shock syndrome, osteoarthritis, retrovirus replication, wasting, meningitis, silica-induced fibrosis, asbestos-induced fibrosis, veterinary disorder, malignancy-associated hypercalcaemia, stroke, circulatory shock, periodontitis, gingivitis, macrocytic anemia, refractory anemia, and 5q-syndrome.

**[0216]** In another specific embodiment, 3-(4-amino-1-oxo,1,3-dihydro-isindol-2-yl)piperidine-2,6-dione may be administered in an amount of from about 1 to about 25 mg per day, or alternatively from about 10 to about 50 mg every other day, to patients with diseases or disorders associated with, or
characterized by, undesired angiogenesis including, but not limited to, endotoxia, toxic shock syndrome, osteoarthritis, retrovirus replication, wasting, meningitis, silica-induced fibrosis, asbestos-induced fibrosis, veterinary disorder, malignancy-associated hypercalcemia, stroke, circulatory shock, periodontitis, gingivitis, macrocytic anemia, refractory anemia, and 5q-syndrome.

[0217] 5.3.1 Combination Therapy with a Second Active Agent

[0218] Specific methods of the invention comprise administering an immunomodulatory compound of the invention, or a pharmaceutically acceptable salt, solvate, hydrate, stereoisomer, clathrate, or prodrug thereof, in combination with one or more second active agents, and/or in combination with radiation therapy, blood transfusions, or surgery. Examples of immunomodulatory compounds of the invention are disclosed herein (see, e.g., section 5.1). Examples of second active agents are also disclosed herein (see, e.g., section 5.2).

[0219] Administration of the immunomodulatory compounds and the second active agents to a patient can occur simultaneously or sequentially by the same or different routes of administration. The suitability of a particular route of administration employed for a particular active agent will depend on the active agent itself (e.g., whether it can be administered orally without decompounding prior to entering the blood stream) and the disease being treated. A preferred route of administration for an immunomodulatory compound of the invention is orally. Preferred routes of administration for the second active agents or ingredients of the invention are known to those of ordinary skill in the art. See, e.g., Physicians’ Desk Reference, 1755-1760 (56th ed., 2002).

[0220] In one embodiment of the invention, the second active agent is administered intravenously or subcutaneously and once or twice daily in an amount of from about 1 to about 1000 mg, from about 5 to about 500 mg, from about 10 to about 350 mg, or from about 50 to about 200 mg. The specific amount of the second active agent will depend on the specific agent used, the type of disease being treated or managed, the severity and stage of disease, and the amount(s) of immunomodulatory compounds of the invention and any optional additional active agents concurrently administered to the patient. In a particular embodiment, the second active agent is oblimersen (Genasense®), GM-CSF, G-CSF, EPO, taxotere, irinotecan, dacarbazine, transretinoid acid, topotecan, pentoxifylline, ciprofloxacin, dexamethasone, vincristine, doxorubicin, COX-2 inhibitor, IL2, IL8, IL18, IFN, Ara-C, vinorelbine, or a combination thereof.

[0221] In a particular embodiment, GM-CSF, G-CSF or EPO is administered subcutaneously during about five days in a four or six week cycle in an amount of from about 1 to about 750 mg/m²/day, preferably an amount of from about 25 to about 500 mg/m²/day, more preferably in an amount of from about 50 to about 250 mg/m²/day, and most preferably in an amount of from about 50 to about 200 mg/m²/day. In a certain embodiment, GM-CSF may be administered in an amount of from about 20 to about 500 mcg/m² intravenously over 2 hours, or from about 5 to about 12 mcg/m²/day subcutaneously. In a specific embodiment, G-CSF may be administered subcutaneously in an amount of about 1 mcg/kg/day initially and can be adjusted depending on rise of total granulocyte counts. The maintenance dose of G-CSF may be administered in an amount of about 300 (in smaller patients) or 480 mcg subcutaneously. In a certain embodiment, EPO may be administered subcutaneously in an amount of 10,000 Unit 3 times per week.

[0222] In another embodiment, an immunomodulatory compound is administered in an amount of from about 0.1 mg to about 150 mg/d alone or in combination with a second active agent to patients with metastatic melanoma (localized melanoma, including, but not limited to, ocular melanoma). In one embodiment, 3-(4-amino-1-oxo-1,3-dihydro-isindol-2-yl)-piperidine-2,6-dione in an amount of from about 1 to about 25 mg/d and dacarbazine in an amount of about from 200 to 1,000 mg/m²/d are administered to patients with metastatic or localized melanoma. In another embodiment, 3-(4-amino-1-oxo-1,3-dihydro-isindol-2-yl)-piperidine-2,6-dione is administered in an amount of from about 1 to about 25 mg/d and temozolomide are administered to patients with metastatic or localized melanoma. In another embodiment, 3-(4-amino-1-oxo-1,3-dihydro-isindol-2-yl)-piperidine-2,6-dione is administered in an amount of from about 1 to about 25 mg/d and temozolomide are administered to patients with metastatic or localized melanoma whose disease has progressed on treatment with dacarbazine, IL-2 and/or IFN. In a specific embodiment, 3-(4-amino-1-oxo-1,3-dihydro-isindol-2-yl)-piperidine-2,6-dione is administered to patients with relapsed or refractory multiple myeloma in an amount of about 15 mg/d twice a day or about 30 mg/d four times a day in a combination with dexamethasone.

[0223] In another embodiment, an immunomodulatory compound is administered with melphalan and dexamethasone to patients with amyloidosis. In a specific embodiment, an immunomodulatory compound of the invention and steroids can be administered to patients with amyloidosis.

[0224] In another embodiment, an immunomodulatory compound is administered with gemcitabine and cisplatin to patients with locally advanced or metastatic transitional cell bladder cancer.

[0225] In another embodiment, an immunomodulatory compound is administered in combination with a second active ingredient as follows: temozolomide to pediatric patients with relapsed or progressive brain tumors or recurrent neuroblastoma; celecoxib, etoposide and cyclophosphamide for relapsed or progressive CNS cancer; temodar to patients with recurrent or progressive meningioma, malignant meningioma, hemangioendothelioma, multiple brain metastases, relapsed brain tumors, or newly diagnosed glioblastoma multiformes; irinotecan to patients with recurrent glioblastoma; carboplatin to pediatric patients with brain stem glioma; procarbazine to pediatric patients with progressive malignant gliomas; cyclophosphamide to patients with poor prognosis malignant brain tumors, newly diagnosed or recurrent glioblastoma multiformes; Gliadel® for high grade recurrent malignant gliomas; temozolomide and tamoxifen for anaplastic astrocytoma; or topotecan for gliomas, glioblastoma, anaplastic astrocytoma or anaplastic oligodendroglioma.

[0226] In another embodiment, an immunomodulatory compound is administered with methotrexate and cyclophosphamide to patients with metastatic breast cancer.

[0227] In another embodiment, an immunomodulatory compound is administered with temozolomide to patients with neuroendocrine tumors.

[0228] In another embodiment, an immunomodulatory compound is administered with gemcitabine to patients with recurrent or metastatic head or neck cancer. In another
[0229] In another embodiment, an immunomodulatory compound is administered with gemcitabine to patients with pancreatic cancer.

[0230] In another embodiment, an immunomodulatory compound is administered to patients with colon cancer in combination with Arisal®, taxol and/or taxotere.

[0231] In another embodiment, an immunomodulatory compound is administered with capecitabine to patients with refractory colorectal cancer or patients who fail first line therapy or have poor performance in colon or rectal adenocarcinoma.

[0232] In another embodiment, an immunomodulatory compound is administered in combination with fluorouracil, leucovorin, and irinotecan to patients with Dukes C & D colorectal cancer or to patients who have been previously treated for metastatic colorectal cancer.

[0233] In another embodiment, an immunomodulatory compound is administered to patients with refractory colorectal cancer in combination with capecitabine, xeloda, and/or CPT-11.

[0234] In another embodiment, an immunomodulatory compound is administered alone or in combination with interferon alpha or capecitabine to patients with unresectable or metastatic hepatocellular carcinoma; or with cisplatin and thiotepa to patients with primary or metastatic liver cancer.

[0235] In another embodiment, an immunomodulatory compound is administered in combination with pegylated interferon alpha to patients with Kaposi’s sarcoma.

[0236] In another embodiment, an immunomodulatory compound is administered in combination with fludarabine, carbolplatin, and/or topotecan to patients with refractory or relapsed or high-risk acute myelogenous leukemia.

[0237] In another embodiment, an immunomodulatory compound is administered in combination with liposomal daunorubicin, topotecan and/or cytarabine to patients with unfavorable karyotype acute myeloblastic leukemia.

[0238] In another embodiment, an immunomodulatory compound is administered in combination with gemcitabine and irinotecan to patients with non-small cell lung cancer. In one embodiment, an immunomodulatory compound is administered in combination with carboplatin and irinotecan to patients with non-small cell lung cancer. In one embodiment, an immunomodulatory compound is administered with doxetuxol to patients with non-small cell lung cancer who have been previously treated with carbop/VP 16 and radiotherapy.

[0239] In another embodiment, an immunomodulatory compound is administered in combination with carboplatin and/or taxotere, or in combination with carboplatin, pacilitaxel and/or thoracic radiotherapy to patients with non-small cell lung cancer. In a specific embodiment, an immunomodulatory compound is administered in combination with taxotere to patients with stage IIIIB or IV non-small cell lung cancer.

[0240] In another embodiment, an immunomodulatory compound of the invention is administered in combination with oblimersen(Gensense®) to patients with small cell lung cancer.

[0241] In another embodiment, an immunomodulatory compound is administered alone or in combination with a second active ingredient such as vinblastine or fludarabine to patients with various types of lymphoma, including, but not limited to, Hodgkin’s lymphoma, non-Hodgkin’s lymphoma, cutaneous T-Cell lymphoma, cutaneous B-Cell lymphoma, diffuse large B-Cell lymphoma or relapsed or refractory low grade follicular lymphoma.

[0242] In another embodiment, an immunomodulatory compound is administered in combination with taxotere, IL-2, IFN, GM-CSF, and/or dacarbazine to patients with various types or stages of melanoma.

[0243] In another embodiment, an immunomodulatory compound is administered alone or in combination with vinorelbine to patients with malignant mesothelioma, or stage IIB non-small cell lung cancer with pleural implants or malignant pleural effusion mesothelioma syndrome.

[0244] In another embodiment, an immunomodulatory compound is administered to patients with various types or stages of multiple myeloma in combination with dexamethasone, zolederonic acid, palmitonate, GM-CSF, biaxin, vinblatine, melphalan, busulphan, cyclophosphamide, IFN, palmitonate, prednisone, biphosphonate, celecoxib, arsenic trioxide, PEG INTRON-A, vincristine, or a combination thereof.

[0245] In another embodiment, an immunomodulatory compound is administered to patients with relapsed or refractory multiple myeloma in combination with doxorubicin (Doxil®, vincristine and/or dexamethasone)(Decadron®).

[0246] In another embodiment, an immunomodulatory compound is administered to patients with various types or stages of ovarian cancer such as peritoneal carcinoma, papillary serous carcinoma, refractory ovarian cancer or recurrent ovarian cancer, in combination with taxol, carboplatin, doxorubicin, gemcitabine, cisplatin, xeloda, pacitaxel, dexamethasone, or a combination thereof.

[0247] In another embodiment, an immunomodulatory compound is administered to patients with various types or stages of prostate cancer, in combination with xeloda, 5 FU/LV, gemcitabine, irinotecan plus gemcitabine, cyclophosphamide, vincristine, dexamethasone, GM-CSF, celecoxib, taxotere, ganciclovir, pacitaxel, adriamycin, docetaxel, estramustine, Emcyt, or a combination thereof.

[0248] In another embodiment, 3-(4-amino-1-oxo-1,3-dihydro-isoindeo-2-yl)-piperidine-2,6-dione is administered with taxotere to patients with prostate cancer.

[0249] In another embodiment, 4-(amino)-2-(2,6-dioxo(3-piperidyl))-isindolone-1,3-dione is administered with GM-CSF to patients with prostate cancer.

[0250] In another embodiment, an immunomodulatory compound is administered to patients with various types or stages of renal cell cancer, in combination with capecitabine, IFN, tamoxifen, IL-2, GM-CSF, Celebrex®, or a combination thereof.

[0251] In another embodiment, an immunomodulatory compound is administered to patients with various types or stages of gynecologic, uterus or soft tissue sarcoma cancer in combination with IFN, a COX-2 inhibitor such as Celebrex®, and/or sulindac.

[0252] In another embodiment, an immunomodulatory compound is administered to patients with various types or stages of solid tumors in combination with celebrex, etoposide, cyclophosphamide, docetaxel, apecitabine, IFN, tamoxifen, IL-2, GM-CSF, or a combination thereof.

[0253] In another embodiment, an immunomodulatory compound is administered to patients with scleroderma or
cutaneous vasculitis in combination with celebrex, etoposide, cyclophosphamide, docetaxel, apecitabine, IFN, tamoxifen, IL-2, GM-CSF, or a combination thereof.

[0254] This invention also encompasses a method of increasing the dosage of an anti-cancer drug or agent that can be safely and effectively administered to a patient, which comprises administering to a patient (e.g., a human) an immunomodulatory compound of the invention, or a pharmaceutically acceptable derivative, salt, solvate, clathrate, hydrate, or prodrug thereof. Patents that can benefit by this method are those likely to suffer from an adverse effect associated with anti-cancer drugs for treating a specific cancer of the skin, subcutaneous tissue, lymph nodes, brain, lung, liver, bone, intestine, colon, heart, pancreas, adrenal, kidney, prostate, breast, colorectal, or combinations thereof. The administration of an immunomodulatory compound of the invention alleviates or reduces adverse effects which are of such severity that it would otherwise limit the amount of anti-cancer drug.

[0255] In one embodiment, an immunomodulatory compound of the invention can be administered orally and daily in an amount of from about 0.1 to about 150 mg, and preferably from about 1 to about 50 mg, more preferably from about 2 to about 25 mg prior to, during, or after the occurrence of the adverse effect associated with the administration of an anti-cancer drug to a patient. In a particular embodiment, an immunomodulatory compound of the invention is administered in combination with specific agents such as heparin, aspirin, coumadin, or G-CSF to avoid adverse effects that are associated with anti-cancer drugs such as but not limited to neutropenia or thrombocytopenia.

[0256] In one embodiment, an immunomodulatory compound of the invention can be administered to patients with diseases and disorders associated with, or characterized by, undesired angiogenesis in combination with additional active ingredients including but not limited to anti-cancer drugs, anti-inflammatories, antihistamines, antibiotics, and steroids.

[0257] In another embodiment, this invention encompasses a method of treating, preventing and/or managing cancer, which comprises administering an immunomodulatory compound of the invention, or a pharmaceutically acceptable salt, solvate, hydrate, stereoisomer, clathrate, or prodrug thereof, in conjunction with (e.g. before, during, or after) conventional therapy including, but not limited to, surgery, immunotherapy, biological therapy, radiation therapy, or other non-drug based therapy presently used to treat, prevent or manage cancer. The combined use of the immunomodulatory compounds of the invention and conventional therapy may provide a unique treatment regimen that is unexpectedly effective in certain patients. Without being limited by theory, it is believed that immunomodulatory compounds of the invention may provide additive or synergistic effects when given concurrently with conventional therapy.

[0258] In another embodiment, this invention encompasses a method of treating, preventing and/or managing diseases and disorders associated with, or characterized by, undesired angiogenesis, which comprises administering an immunomodulatory compound of the invention, or a pharmaceutically acceptable salt, solvate, hydrate, stereoisomer, clathrate, or prodrug thereof, in conjunction with (e.g. before, during, or after) conventional therapy including, but not limited to, surgery, immunotherapy, biological therapy, radiation therapy, or other non-drug based therapy presently used to treat, prevent or manage diseases and disorders associated with, or characterized by, undesired angiogenesis. The combined use of the immunomodulatory compounds of the invention and conventional therapy may provide a unique treatment regimen that is unexpectedly effective in certain patients. Without being limited by theory, it is believed that immunomodulatory compounds of the invention may provide additive or synergistic effects when given concurrently with conventional therapy.

[0259] As discussed elsewhere herein, the invention encompasses a method of reducing, treating and/or preventing adverse or undesired effects associated with conventional therapy including, but not limited to, surgery, chemotherapy, radiation therapy, hormonal therapy, biological therapy and immunotherapy. One or more immunomodulatory compounds of the invention and other active ingredient can be administered to a patient prior to, during, or after the occurrence of the adverse effect associated with conventional therapy.

[0260] In one embodiment, an immunomodulatory compound of the invention can be administered in an amount of from about 0.1 to about 150 mg, and preferably from about 1 to about 25 mg, more preferably from about 2 to about 10 mg orally and daily alone, or in combination with a second active agent disclosed herein (see, e.g., section 5.2), prior to, during, or after the use of conventional therapy.

[0261] In a specific embodiment of this method, an immunomodulatory compound of the invention and docetaxel are administered to patients with non-small cell lung cancer who were previously treated with carboplatin and radiotherapy.

[0262] 5.3.2 Use with Transplantation Therapy

[0263] Compounds of the invention can be used to reduce the risk of Graft Versus Host Disease (GVHD). Therefore, the invention encompasses a method of treating, preventing and/or managing cancer, which comprises administering the immunomodulatory compound of the invention, or a pharmaceutically acceptable salt, solvate, hydrate, stereoisomer, clathrate, or prodrug thereof, in conjunction with transplantation therapy.

[0264] As those of ordinary skill in the art are aware, the treatment of cancer is often based on the stages and mechanism of the disease. For example, as inevitable leukemic transformation develops in certain stages of cancer, transplantation of peripheral blood stem cells, hematopoietic stem cell preparation or bone marrow may be necessary. The combined use of the immunomodulatory compound of the invention and transplantation therapy provides a unique and unexpected synergism. In particular, an immunomodulatory compound of the invention exhibits immunomodulatory activity that may provide additive or synergistic effects when given concurrently with transplantation therapy in patients with cancer.

[0265] An immunomodulatory compound of the invention can work in combination with transplantation therapy reducing complications associated with the invasive procedure of transplantation and risk of GVHD. This invention encompasses a method of treating, preventing and/or managing cancer which comprises administering to a patient (e.g., a human) an immunomodulatory compound of the invention, or a pharmaceutically acceptable salt, solvate, hydrate, stereoisomer, clathrate, or prodrug thereof, before, during, or after the transplantation of umbilical cord blood, placental blood, peripheral blood stem cell, hematopoietic stem cell preparation or bone marrow. Examples of stem cells suitable for use in the methods of the invention are disclosed in U.S. patent
application Ser. No. 10/411,655, filed Apr. 11, 2003 by R. Hariri et al., the entirety of which is incorporated herein by reference.

[0266] In another embodiment, this invention encompasses a method of treating, preventing and/or managing diseases and disorders associated with, or characterized by, undesired angiogenesis, which comprises administering to a patient (e.g., a human) an immunomodulatory compound of the invention, or a pharmaceutically acceptable salt, solvate, hydrate, stereoisomer, clathrate, or prodrug thereof, before, during, or after the transplantation of umbilical cord blood, placental blood, peripheral blood stem cell, hematopoietic stem cell preparation or bone marrow.

[0267] In one embodiment of this method, an immunomodulatory compound of the invention is administered to patients with multiple myeloma before, during, or after the transplantation of autologous peripheral blood progenitor cell.

[0268] In another embodiment, an immunomodulatory compound is administered to patients with relapsing multiple myeloma after the stem cell transplantation.

[0269] In another embodiment, an immunomodulatory compound and prednisone are administered as maintenance therapy to patients with multiple myeloma following the transplantation of autologous stem cell.

[0270] In another embodiment, an immunomodulatory compound and dexamethasone are administered as salvage therapy for low risk post transplantation to patients with multiple myeloma.

[0271] In another embodiment, an immunomodulatory compound and dexamethasone are administered as maintenance therapy to patients with multiple myeloma following the transplantation of autologous bone marrow.

[0272] In another embodiment, an immunomodulatory compound is administered following the administration of high dose of melphalan and the transplantation of autologous stem cell to patients with chemotherapy responsive multiple myeloma.

[0273] In another embodiment, an immunomodulatory compound and PEG INTRO-A are administered as maintenance therapy to patients with multiple myeloma following the transplantation of autologous CD34-selected peripheral stem cell.

[0274] In another embodiment, an immunomodulatory compound is administered with post transplant consolidation chemotherapy to patients with newly diagnosed multiple myeloma to evaluate anti-angiogenesis.

[0275] In another embodiment, an immunomodulatory compound and dexamethasone are administered as maintenance therapy after DCEP consolidation, following the treatment with high dose of melphalan and the transplantation of peripheral blood stem cell to 65 years of age or older patients with multiple myeloma.

[0276] 5.3.3 Cycling Therapy

[0277] In certain embodiments, the prophylactic or therapeutic agents of the invention are cyclically administered to a patient. Cycling therapy involves the administration of an active agent for a period of time, followed by a rest for a period of time, and repeating this sequential administration. Cycling therapy can reduce the development of resistance to one or more of the therapies, avoid or reduce the side effects of one of the therapies, and/or improves the efficacy of the treatment.

[0278] Consequently, in one specific embodiment of the invention, an immunomodulatory compound of the invention is administered daily in a single or divided doses in a four to six week cycle with a rest period of about a week or two weeks. The invention further allows the frequency, number, and length of dosing cycles to be increased. Thus, another specific embodiment of the invention encompasses the administration of an immunomodulatory compound of the invention for more cycles than are typical when it is administered alone. In yet another specific embodiment of the invention, an immunomodulatory compound of the invention is administered for a greater number of cycles that would typically cause dose-limiting toxicity in a patient to whom a second active ingredient is not also being administered.

[0279] In one embodiment, an immunomodulatory compound of the invention is administered daily and continuously for three or four weeks at a dose of from about 0.1 to about 150 mg/d followed by a break of one or two weeks. 4-(Amino)-2-(2,6-dioxo(3-piperidyl))-isindole-1,3-dione is preferably administered daily and continuously at an initial dose of 0.1 to 5 mg/d with dose escalation (every week) by 1 to 10 mg/d to a maximum dose of 50 mg/d for as long as therapy is tolerated. In a particular embodiment, 3-(4-amino-1-oxo-1,3-dihydropyrrolidinyl)-piperidine-2,6-dione is administered in an amount of about 1, 5, 10, or 25 mg/day, preferably in an amount of about 10 mg/day for three to four weeks, followed by one week or two weeks of rest in a four or six week cycle.

[0280] In one embodiment of the invention, an immunomodulatory compound of the invention and a second active ingredient are administered orally, with administration of an immunomodulatory compound of the invention occurring 30 to 60 minutes prior to a second active ingredient, during a cycle of four to six weeks. In another embodiment of the invention, the combination of an immunomodulatory compound of the invention and a second active ingredient is administered by intravenous infusion over about 90 minutes every cycle. In a specific embodiment, one cycle comprises the administration of from about 1 to about 25 mg/day of 3-(4-amino-1-oxo-1,3-dihydropyrrolidinyl)-piperidine-2,6-dione and from about 50 to about 200 mg/m²/day of a second active ingredient daily for three to four weeks and then one or two weeks of rest. In another specific embodiment, each cycle comprises the administration of from about 5 to about 10 mg/day of 4-(amino)-2-(2,6-dioxo(3-piperidyl))-isindole-1,3-dione and from about 50 to about 200 mg/m²/day of a second active ingredient for 3 to 4 weeks followed by one or two weeks of rest. Typically, the number of cycles during which the combinatorial treatment is administered to a patient will be from about one to about 24 cycles, more typically from about two to about 16 cycles, and even more typically from about four to about three cycles.

5.4 Pharmaceutical Compositions and Dosage Forms

[0282] Pharmaceutical compositions can be used in the preparation of individual, single unit dosage forms. Pharmaceutical compositions and dosage forms of the invention comprise an immunomodulatory compound of the invention, or a pharmaceutically acceptable salt, solvate, hydrate, stereoisomer, clathrate, or prodrug thereof. Pharmaceutical compositions and dosage forms of the invention can further comprise one or more excipients.

[0283] Pharmaceutical compositions and dosage forms of the invention can also comprise one or more additional active
ingredients. Consequently, pharmaceutical compositions and dosage forms of the invention comprise the active ingredients disclosed herein (e.g., an immunomodulatory compound and a second active agent). Examples of optional second, or additional, active ingredients are disclosed herein (see, e.g., section 5.2).

[0284] Single unit dosage forms of the invention are suitable for oral, mucosal (e.g., nasal, sublingual, vaginal, buccal, or rectal), parenteral (e.g., subcutaneous, intravenous, bolus injection, intramuscular, or intraarterial), topical (e.g., eye drops or other ophthalmic preparations), transdermal or transcutaneous administration to a patient. Examples of dosage forms include, but are not limited to: tablets; caplets; capsules, such as soft elastic gelatin capsules; cachets; troches; lozenges; dispersions; suspensions; powders; aerosols; nasal sprays or inhalers; gels; liquid dosage forms suitable for oral or mucosal administration to a patient, including suspensions (e.g., aqueous or non-aqueous liquid suspensions, oil-in-water emulsions, or a water-in-oil liquid emulsions), solutions, and elixirs; liquid dosage forms suitable for parenteral administration to a patient; eye drops or other ophthalmic preparations suitable for topical administration; and sterile solids (e.g., crystalline or amorphous solids) that can be reconstituted to provide liquid dosage forms suitable for parenteral administration to a patient.

[0285] The composition, shape, and type of dosage forms of the invention will typically vary depending on their use. For example, a dosage form used in the acute treatment of a disease may contain larger amounts of one or more of the active ingredients it comprises than a dosage form used in the chronic treatment of the same disease. Similarly, a parenteral dosage form may contain smaller amounts of one or more of the active ingredients it comprises than an oral dosage form used to treat the same disease. These and other ways in which specific dosage forms encompassed by this invention will vary from one another will be readily apparent to those skilled in the art. See, e.g., Remington’s Pharmaceutical Sciences, 18th ed., Mack Publishing, Easton Pa. (1990).

[0286] Typical pharmaceutical compositions and dosage forms comprise one or more excipients. Suitable excipients are well known to those skilled in the art of pharmacy, and non-limiting examples of suitable excipients are provided herein. Whether a particular excipient is suitable for incorporation into a pharmaceutical composition or dosage form depends on a variety of factors well known in the art including, but not limited to, the way in which the dosage form will be administered to a patient. For example, oral dosage forms such as tablets may contain excipients not suited for use in parenteral dosage forms. The suitability of a particular excipient may also depend on the specific active ingredients in the dosage form. For example, the decomposition of some active ingredients may be accelerated by some excipients such as lactose, or when exposed to water. Active ingredients that comprise primary or secondary amines are particularly susceptible to such accelerated decomposition. Consequently, this invention encompasses pharmaceutical compositions and dosage forms that contain little, if any, lactose other mono- or di-saccharides. As used herein, the term “lactose-free” means that the amount of lactose present, if any, is insufficient to substantially increase the degradation rate of an active ingredient.

[0287] Lactose-free compositions of the invention can comprise excipients that are well known in the art and are listed, for example, in the U.S. Pharmacopeia (USP) 25-NF20 (2002). In general, lactose-free compositions comprise active ingredients, a binder/filler, and a lubricant in pharmaceutically compatible and pharmaceutically acceptable amounts. Preferred lactose-free dosage forms comprise active ingredients, microcrystalline cellulose, pregelatinized starch, and magnesium stearate.

[0288] This invention further encompasses anhydrous pharmaceutical compositions and dosage forms comprising active ingredients, since water can facilitate the degradation of some compounds. For example, the addition of water (e.g., 5%) is widely accepted in the pharmaceutical arts as a means of simulating long-term storage in order to determine characteristics such as shelf-life or the stability of formulations over time. See, e.g., Jens T. Carstensen, Drug Stability: Principles & Practice, 2d Ed., Marcel Dekker, NY, N.Y., 1995, pp. 379-80. In effect, water and heat accelerate the decomposition of some compounds. Thus, the effect of water on a formulation can be of great significance since moisture and/or humidity are commonly encountered during manufacture, handling, packaging, storage, shipment, and use of formulations.

[0289] Anhydrous pharmaceutical compositions and dosage forms of the invention can be prepared using anhydrous or low moisture containing ingredients and low moisture or low humidity conditions. Pharmaceutical compositions and dosage forms that comprise lactose and at least one active ingredient that comprises a primary or secondary amine are preferably anhydrous if substantial contact with moisture and/or humidity during manufacturing, packaging, and/or storage is expected.

[0290] An anhydrous pharmaceutical composition should be prepared and stored such that its anhydrous nature is maintained. Accordingly, anhydrous compositions are preferably packaged using materials known to prevent exposure to water such that they can be included in suitable formulary kits. Examples of suitable packaging include, but are not limited to, hermetically sealed foils, plastics, unit dose containers (e.g., vials), blister packs, and strip packs.

[0291] The invention further encompasses pharmaceutical compositions and dosage forms that comprise one or more compounds that reduce the rate by which an active ingredient will decompose. Such compounds, which are referred to herein as “stabilizers,” include, but are not limited to, antioxidants such as ascorbic acid, pH buffers, or salt buffers.

[0292] Like the amounts and types of excipients, the amounts and specific types of active ingredients in a dosage form may differ depending on factors such as, but not limited to, the route by which it is to be administered to patients. However, typical dosage forms of the invention comprise an immunomodulatory compound of the invention or a pharmaceutically acceptable salt, solvate, hydrate, stereoisomer, clathrate, or prodrug thereof in an amount of from about 0.1 to about 150 mg. Typical dosage forms comprise an immunomodulatory compound of the invention or a pharmaceutically acceptable salt, solvate, hydrate, stereoisomer, clathrate, or prodrug thereof in an amount of about 0.1, 1, 2, 5, 7.5, 10, 12.5, 15, 17.5, 20, 25, 50, 100, 150 or 200 mg. In a particular embodiment, a preferred dosage form comprises 4-(amino)-2-(2,6-dioxo(3-piperidyl))-isoindoline-1,3-dione in an amount of about 1, 2, 5, 10, 25 or 50 mg. In a specific embodiment, a preferred dosage form comprises 3-(4-amino-1-oxo-1,3-dihydroisoindol-2-yl)-piperidine-2,6-dione in an amount of about 5, 10, 25 or 50 mg. Typical dosage forms comprise the second active ingredient in an amount of 1 to
about 1000 mg, from about 5 to about 500 mg, from about 10 to about 350 mg, or from about 50 to about 200 mg. Of course, the specific amount of the anti-cancer drug will depend on the specific agent used, the type of cancer being treated or managed, and the amount(s) of an immunomodulatory compound of the invention and any optional additional active agents concurrently administered to the patient.

[0293] 5.4.1 Oral Dosage Forms

[0294] Pharmaceutical compositions of the invention that are suitable for oral administration can be presented as discrete dosage forms, such as, but are not limited to, tablets (e.g., chewable tablets), caplets, capsules, and liquids (e.g., flavored syrups). Such dosage forms contain predetermined amounts of active ingredients, and may be prepared by methods of pharmacy well known to those skilled in the art. See generally, Remington’s Pharmaceutical Sciences, 18th ed., Mack Publishing, Easton Pa. (1990).

[0295] Typical oral dosage forms of the invention are prepared by combining the active ingredients in an intimate admixture with at least one excipient according to conventional pharmaceutical compounding techniques. Excipients can take a wide variety of forms depending on the form of preparation desired for administration. For example, excipients suitable for use in oral liquid or aerosol dosage forms include, but are not limited to, water, glycols, oils, alcohols, flavoring agents, preservatives, and coloring agents. Examples of excipients suitable for use in solid oral dosage forms (e.g., powders, tablets, capsules, and caplets) include, but are not limited to, starches, sugars, micro-crystalline cellulose, dextrose, granulating agents, lubricants, binders, and disintegrating agents.

[0296] Because of their ease of administration, tablets and capsules represent the most advantageous oral dosage unit forms, in which case solid excipients are employed. If desired, tablets can be coated by standard aqueous or non-aqueous techniques. Such dosage forms can be prepared by any of the methods of pharmacy. In general, pharmaceutical compositions and dosage forms are prepared by uniformly and intimately admixing the active ingredients with liquid carriers, finely divided solid carriers, or both, and then shaping the product into the desired presentation if necessary.

[0297] For example, a tablet can be prepared by compression or molding. Compressed tablets can be prepared by compressing in a suitable machine the active ingredients in a free-flowing form such as powder or granules, optionally mixed with an excipient. Molded tablets can be made by molding in a suitable machine a mixture of the powdered compound moistened with an inert liquid diluent.

[0298] Examples of excipients that can be used in oral dosage forms of the invention include, but are not limited to, binders, fillers, disintegrants, and lubricants. Binders suitable for use in pharmaceutical compositions and dosage forms include, but are not limited to, corn starch, potato starch, or other starches, gelatin, natural and synthetic gums such as acacia, sodium alginate, alginic acid, other alginates, powdered tragacanth, guar gum, cellulose and its derivatives (e.g., ethyl cellulose, cellulose acetate, carboxymethyl cellulose calcium, sodium carboxymethyl cellulose), polyvinyl pyrrolidone, methyl cellulose, pre-gelatinized starch, hydroxypropyl methyl cellulose, (e.g., Nos. 2206, 2906, 2910), microcrystalline cellulose, and mixtures thereof.

[0299] Suitable forms of microcrystalline cellulose include, but are not limited to, the materials sold as AVICEL-PH-101, AVICEL-PH-103 AVICEL RC-581, AVICEL-PH-105 (available from FMC Corporation, American Viscose Division, Avicel Sales, Marcus Hook, Pa.), and mixtures thereof. An specific binder is a mixture of microcrystalline cellulose and sodium carboxymethyl cellulose sold as AVICEL RC-581. Suitable anhydrous or low moisture excipients or additives include AVICEL-PH-103™ and Starch 1500 L.M.

[0300] Examples of fillers suitable for use in the pharmaceutical compositions and dosage forms disclosed herein include, but are not limited to, tate, calcium carbonate (e.g., granules or powder), microcrystalline cellulose, powdered cellulose, dextrose, kaolin, mannitol, silic acid, sorbitol, starch, pre-gelatinized starch, and mixtures thereof. The binder or filler in pharmaceutical compositions of the invention is typically present in from about 50 to about 99 weight percent of the pharmaceutical composition or dosage form.

[0301] Disintegrants are used in the compositions of the invention to provide tablets that disintegrate when exposed to an aqueous environment. Tablets that contain too much disintegrant may disintegrate in storage, while those that contain too little may not disintegrate at a desired rate or under the desired conditions. Thus, a sufficient amount of disintegrant that is neither too much nor too little to detrimentally alter the release of the active ingredients should be used to form solid oral dosage forms of the invention. The amount of disintegrant used varies based upon the type of formulation, and is readily discernible to those of ordinary skill in the art. Typical pharmaceutical compositions comprise from about 0.5 to about 15 weight percent of disintegrant, preferably from about 1 to about 5 weight percent of disintegrant.

[0302] Disintegrants that can be used in pharmaceutical compositions and dosage forms of the invention include, but are not limited to, agar-agar, alginic acid, calcium carbonate, microcrystalline cellulose, crossmethyl cellulose sodium, crospovidone, polacrilin potassium, sodium starch glycocate, potato or tapioca starch, other starches, pre-gelatinized starch, other starches, clays, other alginates, other celluloses, gums, and mixtures thereof.

[0303] Lubricants that can be used in pharmaceutical compositions and dosage forms of the invention include, but are not limited to, calcium stearate, magnesium stearate, mineral oil, light mineral oil, glycerin, sorbitol, mannitol, polyethylene glycol, other glycols, stearic acid, sodium lauryl sulfate, taurine, hydrogenated vegetable oil, vegetable oil, mineral oil, sunflower oil, sesame oil, olive oil, corn oil, and soybean oil), zinc stearate, ethyl oleate, ethyl laurate, agar, and mixtures thereof. Additional lubricants include, for example, a syloid silicica gel (AEROSIL 200, manufactured by W.R. Grace Co. of Baltimore, Md.), a coagulated aerosol of synthetic silica (marketed by Degussa Co. of Plano, Tex.), CAB-O-SIL (a pyrogenic silicon dioxide product sold by Cabot Co. of Boston, Mass.), and mixtures thereof. If used at all, lubricants are typically used in an amount of less than about 1 weight percent of the pharmaceutical compositions or dosage forms into which they are incorporated.

[0304] A preferred solid oral dosage form of the invention comprises an immunomodulatory compound of the invention, anhydrous lactose, microcrystalline cellulose, polyvinylpyrrolidone, stearic acid, colloidal anhydrous silica, and gelatin.

[0305] 5.4.2 Delayed Release Dosage Forms

[0306] Active ingredients of the invention can be administered by controlled release means or by delivery devices that are well known to those of ordinary skill in the art. Examples
include, but are not limited to, those described in U.S. Pat.
Nos. 3,845,770; 3,916,899; 3,536,809; 3,598,123; and 4,008,719, 5,674,533, 5,059,595, 5,591,767, 5,120,548, 5,073,543, 5,639,476, 5,354,556, and 5,733,566, each of which is incor-
porated herein by reference. Such dosage forms can be used
to provide slow or controlled-release of one or more active
ingredients using, for example, hydroxypropylmethyl cellulose,
other polymer matrices, gels, permeable membranes, osmotic
systems, multilayer coatings, microparticles, liposomes,
and microspheres, or a combination thereof to provide the desired
release profile in varying proportions. Suitable controlled-
release formulations known to those of ordinary skill in the
art, including those described herein, can be readily selected
for use with the active ingredients of the invention. The inven-
tion thus encompasses single unit dosage forms suitable for
oral administration such as, but not limited to, tablets, cap-
sules, gels, and caplets that are adapted for controlled-
release.

All controlled-release pharmaceutical products have a
common goal of improving drug therapy over that achieved by
their non-controlled counterparts. Ideally, the use of an
optimally designed controlled-release preparation in
medical treatment is characterized by a minimum of drug
substance being employed to cure or control the condition in
a minimum amount of time. Advantages of controlled-release
formulations include extended activity of the drug, reduced
dosage frequency, and increased patient compliance. In addi-
tion, controlled-release formulations can be used to affect the
time of onset of action or other characteristics, such as blood
levels of the drug, and can thus affect the occurrence of side
(e.g., adverse) effects.

Most controlled-release formulations are designed to
initially release an amount of drug (active ingredient) that
promptly produces the desired therapeutic effect, and gradu-
ally and continually release other amounts of drug to main-
tain this level of therapeutic or prophylactic effect over an
extended period of time. In order to maintain this constant
level of drug in the body, the drug must be released from the
dosage form at a rate that will replace the amount of drug
being metabolized and excreted from the body. Controlled-
release of an active ingredient can be stimulated by various
conditions including, but not limited to, pH, temperature,
enzymes, water, or other physiological conditions or com-
pounds.

Parenteral Dosage Forms

Parenteral dosage forms can be administered to
patients by various routes including, but not limited to,
subcutaneous, intravenous (including bolus injection), intramus-
cular, and intraarterial. Because their administration typically
bypasses patients’ natural defenses against contaminants,
parenteral dosage forms are preferably sterile or capable of
being sterilized prior to administration to a patient. Examples
of parenteral dosage forms include, but are not limited to,
solutions ready for injection, dry products ready to be
dissolved or suspended in a pharmaceutically acceptable
vehicle for injection, suspensions ready for injection, and emulsions.

Suitable vehicles that can be used to provide
parenteral dosage forms of the invention are well known
to those skilled in the art. Examples include, but are not limited
to: Water for Injection USP; aqueous vehicles such as, but not
limited to, Sodium Chloride Injection, Ringer’s Injection,
Dextrose Injection, Dextrose and Sodium Chloride Injection,
and Lactated Ringer’s Injection; water-miscible vehicles
such as, but not limited to, ethyl alcohol, polyethylene glycol,
and polypropylene glycol; and non-aqueous vehicles such as,
but not limited to, corn oil, cottonseed oil, peanut oil, sesame
oil, ethyl oleate, isopropyl myristate, and benzyl benzoate.

Compounds that increase the solubility of one or
more of the active ingredients disclosed herein can also be
incorporated into the parenteral dosage forms of the inven-
tion. For example, cyclodextrin and its derivatives can be used
to increase the solubility of an immunomodulatory com-
pound of the invention and its derivatives. See, e.g., U.S. Pat.
No. 5,134,127, which is incorporated herein by reference.

Topical and mucosal dosage forms of the invention
include, but are not limited to, sprays, aerosols, solutions,
emulsions, suspensions, eye drops or other opthalmic prep-
rations, or other forms known to one of skill in the art. See,
e.g., Remington’s

Pharmaceutical Sciences, 16th and 18th eds., Mack
Publishing, Easton Pa. (1980 & 1990); and Introduction to
Pharmaceutical Dosage Forms, 4th ed., Lea & Febiger,
Philadelphia (1985). Dosage forms suitable for treating
mucosal tissues within the oral cavity can be formulated as
mouthwashes or as oral gels.

Suitable excipients (e.g., carriers and diluents) and
other materials that can be used to provide topical and
mucosal dosage forms encompassed by this invention are
well known to those skilled in the pharmaceutical arts, and
depend on the particular tissue to which a given pharmaceu-
tical composition or dosage form will be applied. With that
in mind, typical excipients include, but are not limited to,
water, acetone, ethanol, ethylene glycol, propylene glycol,
butane-1,3-diol, isopropyl myristate, isopropyl palmitate,
mineral oil, and mixtures thereof to form solutions, emulsions
or gels, which are nontoxic and pharmaceutically accept-
able. Moisturizers or humectants can also be added to phar-
maceutical compositions and dosage forms if desired.
Examples of such additional ingredients are well known in
the art. See, e.g., Remington’s Pharmaceutical Sciences, 16th

The pH of a pharmaceutical composition or dosage
form may also be adjusted to improve delivery of one or more
active ingredients. Similarly, the polarity of a solvent carrier,
it’s ionic strength, or toxicity can be adjusted to improve
delivery. Compounds such as stearates can also be added to
pharmaceutical compositions or dosage forms to advan-
tageously alter the hydrophilicity or lipophilicity of one or
more active ingredients so as to improve delivery. In this
regard, stearates can serve as a lipid vehicle for the formul-
ation, as an emulsifying agent or surfactant, and as a delivery-
enhancing or penetration-enhancing agent. Different salts,
hydrates or solvates of the active ingredients can be used to
further adjust the properties of the resulting composition.

Typically, active ingredients of the invention are
preferably not administered to a patient at the same time or
by the same route of administration. This invention therefore
encompasses kits which, when used by the medical practi-
cioner, can simplify the administration of appropriate amounts
of active ingredients to a patient.

A typical kit of the invention comprises a dosage
form of an immunomodulatory compound of the invention, or
a pharmaceutically acceptable salt, solvate, hydrate, stereo-
isomer, prodrug, or clathrate thereof. Kits encompassed
by this invention can further comprise additional active ingre-
dients such as oblimersen (Genasense®), melphalan, G-CSF,
GM-CSF, EPO, topotecan, dacarbazine, irinotecan, taxotere, IFN, COX-2 inhibitor, pentoxifylline, ciprofloxacin, dexamethasone, IL2, IL8, IL18, Ara-C, vincristine, isotretinoin, 13 cis-retinoic acid, or a pharmacologically active mutant or derivative thereof, or a combination thereof. Examples of the additional active ingredients include, but are not limited to, those disclosed herein (see, e.g., section 5.2).

[0321] Kits of the invention can further comprise devices that are used to administer the active ingredients. Examples of such devices include, but are not limited to, syringes, drip bags, patches, and inhalers.

[0322] Kits of the invention can further comprise cells or blood for transplantation as well as pharmaceutically acceptable vehicles that can be used to administer one or more active ingredients. For example, if an active ingredient is provided in a solid form that must be reconstituted for parenteral administration, the kit can comprise a sealed container of a suitable vehicle in which the active ingredient can be dissolved to form a particulate-free sterile solution that is suitable for parenteral administration. Examples of pharmaceutically acceptable vehicles include, but are not limited to: Water for Injection USP, aqueous vehicles such as, but not limited to, Sodium Chloride Injection, Ringer’s Injection, Dextrose Injection, Dextror and Sodium Chloride Injection, and Lactated Ringer’s Injection; water-miscible vehicles such as, but not limited to, ethanol, polyethylene glycol, and polypropylene glycol; and non-aqueous vehicles such as, but not limited to, corn oil, cottonseed oil, peanut oil, sesame oil, ethyl oleate, isopropyl myristate, and benzyl benzate.

6. EXAMPLES

[0323] Certain embodiments of the invention are illustrated by the following non-limiting examples.

[0324] 6.1 Modulation of Cytokine Production

[0325] A series of non-clinical pharmacological and toxicological studies have been performed to support the clinical evaluation of an immunomodulatory compound of the invention in human subjects. These studies were performed in accordance with internationally recognized guidelines for study design and in compliance with the requirements of Good Laboratory Practice (GLP), unless otherwise noted.

[0326] Inhibition of TNF-α production following LPS-stimulation of human PBMC and human whole blood by 4-(aminoo)-2-(2,6-dioxo(3-piperidyl))-isooindoline-1,3-dione, 3-(4-aminoo-1-oxo-1,3-dihydroisooindol-2-yl)-piperidine-2,6-dione and thalidomide was investigated in vitro (Muller et al., Bioorg. Med. Chem. Lett. 9 (1625-1630, 1999)). The IC₅₀’s of 4-(aminoo)-2-(2,6-dioxo(3-piperidyl))-isooindoline-1,3-dione for inhibiting production of TNF-α following LPS-stimulation of PBMC and human whole blood were ~24 nM (6.55 ng/mL) and ~25 nM (6.83 ng/mL), respectively. In vitro studies suggest a pharmacological activity profile for 3-(4-aminoo-1-oxo-1,3-dihydroisooindol-2-yl)-piperidine-2,6-dione that is similar to, but at least 200 times more potent than, thalidomide. In vitro studies have also demonstrated that concentrations of 4-(aminoo)-2-(2,6-dioxo(3-piperidyl))-isooindoline-1,3-dione of 2.73 to 27.3 ng/mL (0.01 to 0.1 μM) achieved 50% inhibition of the proliferation of MM.1S and Hs Sultan cells.

[0327] The IC₅₀’s of 3-(4-aminoo-1-oxo-1,3-dihydroisooindol-2-yl)-piperidine-2,6-dione for inhibiting production of TNF-α following LPS-stimulation of PBMC and human whole blood were ~100 nM (25.9 ng/mL) and ~480 nM (103.6 ng/mL), respectively. Thalidomide, in contrast, had an IC₅₀ of ~194 μM (50.2 μg/mL) for inhibiting production of LPS-stimulation of PBMC. In vitro studies suggest a pharmacological activity profile for 3-(4-aminoo-1-oxo-1,3-dihydroisooindol-2-yl)-piperidine-2,6-dione that is similar to, but 50 to 2000 times more potent than, thalidomide. It has been shown that the compound is approximately 50-100 times more potent than thalidomide in stimulating the proliferation of T-cells following primary induction by T-cell receptor (TCR) activation. 3-(4-aminoo-1-oxo-1,3-dihydroisooindol-2-yl)-piperidine-2,6-dione is also approximately 50 to 100 times more potent than thalidomide in augmenting the production of IL-2 and IFN-γ following TCR activation of PBMC (IL-2) or T-cells (IFN-γ). In addition, 3-(4-aminoo-1-oxo-1,3-dihydroisooindol-2-yl)-piperidine-2,6-dione exhibited dose-dependent inhibition of IL-PS-stimulated production of the pro-inflammatory cytokines TNF-α, IL-113, and IL-6 by PBMC while it increased production of the anti-inflammatory cytokine IL-10.

[0328] 6.2 Inhibition of MM Cell Proliferation

[0329] The ability of 3-(4-aminoo-1-oxo-1,3-dihydroisooindol-2-yl)-piperidine-2,6-dione and thalidomide for comparison to effect the proliferation of MM cell lines has been investigated in an in vitro study. Uptake [³H]-thyminde by different MM cell lines (MM.1S, Hs Sultan, U266 and RPMI-8226) was measured as an indicator of cell proliferation. Cells were incubated in the presence of compounds for 48 hours; [³H]-thyminde was included for the last 8 hours of the incubation period. Addition of 3-(4-aminoo-1-oxo-1,3-dihydroisooindol-2-yl)-piperidine-2,6-dione to MM.1S and Hs Sultan cells resulted in 50% inhibition of cell proliferation at concentrations of 0.4 μM and 1 μM, respectively. In contrast, addition of thalidomide at concentrations up to 100 μM resulted in only 15% and 20% inhibition of cell proliferation in MM.1S and Hs Sultan cells, respectively. These data are summarized in FIG. 1.

[0330] 6.3 Toxicology Studies

[0331] The effects of 3-(4-aminoo-1-oxo-1,3-dihydroisooindol-2-yl)-piperidine-2,6-dione on cardiovascular and respiratory function are investigated in anesthetized dogs. Two groups of Beagle dogs (2/sex/group) are used. One group receives three doses of vehicle only and the other receives three ascending doses of 3-(4-aminoo-1-oxo-1,3-dihydroisooindol-2-yl)-piperidine-2,6-dione (2, 10, and 20 μg/kg). In all cases, doses of 3-(4-aminoo-1-oxo-1,3-dihydroisooindol-2-yl)-piperidine-2,6-dione or vehicle are successively administered via infusion through the jugular vein separated by intervals of at least 30 minutes.

[0332] The cardiovascular and respiratory changes induced by 3-(4-aminoo-1-oxo-1,3-dihydroisooindol-2-yl)-piperidine-2,6-dione are minimal at all doses when compared to the vehicle control group. The only statistically significant difference between the vehicle and treatment groups is a small increase in arterial blood pressure (from 94 mmHg to 101 mmHg) following administration of the low dose of 3-(4-aminoo-1-oxo-1,3-dihydroisooindol-2-yl)-piperidine-2,6-dione. This effect lasts approximately 15 minutes and is not seen at higher doses. Deviations in femoral blood flow, respiratory parameters, and Qtc interval are common to both the control and treated groups and are not considered treatment-related.

[0333] 6.4 Cycling Therapy in Patients

[0334] In a specific embodiment, an immunomodulatory compound of the invention are cyclically administered to patients with cancer. Cycling therapy involves the adminis-
tration of a first agent for a period of time, followed by a rest for a period of time and repeating this sequential administration. Cycling therapy can reduce the development of resistance to one or more of the therapies, avoid or reduce the side effects of one of the therapies, and/or improves the efficacy of the treatment.

[0335] In a specific embodiment, prophylactic or therapeutic agents are administered in a cycle of about 4 to 6 weeks, about once or twice every day. One cycle can comprise the administration of a therapeutic on prophylactic agent for three to four weeks and at least a week or two weeks of rest. The number of cycles administered is from about one to about 24 cycles, more typically from about two to about 16 cycles, and more specifically from about four to about eight cycles.

[0336] For example, in a cycle of four weeks, on day 1, the administration of 25 mg/d of 3-(4-amino-1-oxo-1,3-dihydroisoindol-2-yl)-piperidine-2,6-dione is started. On day 22, the administration of the compound is stopped for a week of rest. On day 29, the administration of 25 mg/d of 3-(4-amino-1-oxo-1,3-dihydroisoindol-2-yl)-piperdin-2,6-dione is begun.

[0337] 6.5 Clinical Studies in Patients

[0338] 6.5.1 Treatment of Relapsed Multiple Myeloma p 4-(Amino)-2-(2,6-dioxo(3-piperidyl))-isoindoline-1,3-dione (Actimid™) was administered to patients with relapsed/refractory multiple myeloma. The study was conducted in compliance with Good Clinical Practices. Patients were at least 18 years old, had been diagnosed with multiple myeloma (with paraprotein in serum and/or urine), and were considered refractory to treatment after at least two cycles of treatment, or have relapsed after two cycles of treatment.

[0339] Patients who have progressive disease, according to the Southwest Oncology Group (SWOG) criteria, on their prior regimen are considered treatment refractory. Relapse following remission is defined as >25% increase in M component from baseline levels; reappearance of the M paraprotein that had previously disappeared; or a definite increase in the size and number of lytic bone lesions recognized on radiographs. Patients may have had prior therapy with thalidomide, provided they were able to tolerate the treatment. A Zubrod performance status of 0 to 2 is required for all patients.

[0340] 4-(Amino)-2-(2,6-dioxo(3-piperidyl))-isoindoline-1,3-dione is administered to patients at doses of 1, 2, 5, or 10 mg/day for up to four weeks; at each dose level, three patients are initially enrolled. Dosing occurs at approximately the same time each morning; all doses are administered in the fasted state (no eating for at least two hours prior to dosing and two hours after dosing). 4-(Amino)-2-(2,6-dioxo(3-piperidyl))-isoindoline-1,3-dione doses are administered in an ascending fashion such that patients in the first cohort receive the lowest dose of 4-(amino)-2-(2,6-dioxo(3-piperidyl))- isoindoline-1,3-dione (1 mg/day) and escalation to the next higher dose level occurs only following the establishment of safety and tolerability at the current dose. If one out of three patients at any dose level experience dose limiting toxicity (DLT), three additional patients are enrolled at that dose. If none of the three additional patients experience DLT, escalation to the next dose level occurs; dose escalations continue in a similar fashion until the MTD is established or the maximum daily dose (10 mg/day) is attained. However, if one of the three additional patients enrolled experiences DLT, the MTD has been reached. If two or more of the three additional patients enrolled experience DLT, the MTD is judged to have been exceeded and three additional patients are enrolled at the preceding dose level to confirm the MTD. Once the MTD has been identified, four additional patients are enrolled at that dose level so that a total of 10 patients is treated at the MTD.

[0341] Blood sampling for analysis of pharmacokinetic parameters is performed on Days 1 and 28 according to the following sampling schedule: pre-dose, 0.25, 0.5, 0.75, 1, 1.5, 2, 2.5, 3, 4, 6, 8, 10, 12, 18, and 24 hours post-dose. An additional blood sample is collected at each weekly visit for the determination of 4-(amino)-2-(2,6-dioxo(3-piperidyl))- isoindoline-1,3-dione levels. Total urine collections are also made with urine pooled according to the following time intervals post-dose: 0 to 4, 4 to 8, 8 to 12, and 12 to 24 hours. Safety assessments are made by monitoring adverse events, vital signs, ECGs, clinical laboratory evaluations (blood chemistry, hematology, lymphocyte phenotyping, and urinalysis), and physical examination at specific times during the study.

[0342] Results of interim pharmacokinetic analyses obtained following single- and multiple-dose administration of 4-(amino)-2-(2,6-dioxo(3-piperidyl))-isoindoline-1,3-dione to multiple myeloma patients are presented below in Tables 1 and 2. These data show that 4-(amino)-2-(2,6-dioxo(3-piperidyl))-isoindoline-1,3-dione was steadily absorbed at all dose levels in relapsed multiple myeloma patients. Maximum plasma concentrations occurred at a median T_max of between 2.5 and 2.8 hours post-dose at Day 1 and between 3 and 4 hours post-dose at Week 4. At doses 1, plasma concentrations declined in a monophasic manner after reaching C_max. The start of the elimination phase occurred between 3 and 10 hours post-dose at Day 1 and Week 4, respectively.

[0343] These data also showed that after 4 weeks of dosing, 4-(amino)-2-(2,6-dioxo(3-piperidyl))-isoindoline-1,3-dione accumulated to a small extent (mean accumulation ratios ~1.02 to 1.52 and ~0.94 to 1.62 for C_max and AUC(0→τ), respectively). There was a little dose proportional increase in AUC(0→τ) and C_max values with increasing dose. A five-fold higher dose of 4-(amino)-2-(2,6-dioxo(3-piperidyl))-isoindoline-1,3-dione produced a 3.2- and 2.2-fold increase in C_max at Day 1 and Week 4, respectively. Similarly, a 5-fold increase in dose resulted in a 3.6- and 2.3-fold increase in AUC(0→τ), at Day 1 and Week 4, respectively.

**TABLE 1**

<table>
<thead>
<tr>
<th>Pharmacokinetic parameters of Actimid™ in relapsed multiple myeloma patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>---------------------------</td>
</tr>
<tr>
<td>C_max (ng/mL)</td>
</tr>
<tr>
<td>t_max (h)</td>
</tr>
<tr>
<td>AUC(0→τ) (ng · h/mL)</td>
</tr>
<tr>
<td>AUC(0→τ) (ng · h/mL)</td>
</tr>
<tr>
<td>t(1/2) (h)</td>
</tr>
</tbody>
</table>

* indicates significantly different from control.
TABLE 1-continued

<table>
<thead>
<tr>
<th>Parameter</th>
<th>1 mg (N = 6)</th>
<th>2 mg (N = 2)</th>
<th>5 mg (N = 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CL/F mL/min</td>
<td>114.75 (29.20)</td>
<td>121.43 (22.22)</td>
<td>182.31 (117.06)</td>
</tr>
<tr>
<td>Vzff L</td>
<td>69.55 (44.97)</td>
<td>65.31 (2.80)</td>
<td>87.24 (22.61)</td>
</tr>
</tbody>
</table>

1 = 24 hours, N/A = not available

TABLE 2

<table>
<thead>
<tr>
<th>Parameter</th>
<th>1 mg (N = 5)</th>
<th>2 mg (N = 2)</th>
<th>5 mg (N = 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cmax ng/mL</td>
<td>23.20 (7.48)</td>
<td>30.05* (15.64)</td>
<td>58.07 (38.08)</td>
</tr>
<tr>
<td>t1/2 h</td>
<td>3.6 (1.5)</td>
<td>2.8* (0.3)</td>
<td>5.0 (2.6)</td>
</tr>
<tr>
<td>AUC0-24 h/mL</td>
<td>239.31 (122.59)</td>
<td>269.36 (186.34)</td>
<td>597.24 (354.23)</td>
</tr>
<tr>
<td>CL/F mL/min</td>
<td>87.85 (48.48)</td>
<td>162.68 (113.54)</td>
<td>207.50 (175.41)</td>
</tr>
<tr>
<td>Vzff L</td>
<td>41.35* (8.84)</td>
<td>95.04 (35.39)</td>
<td>103.95 (27.25)</td>
</tr>
</tbody>
</table>

1 = 24 hours, N/A = not available, N* = 2 patients

[0344] 6.5.2 Treatment of Relapsed Multiple Myeloma

[0345] Two Phase 1 clinical studies of 3-(4-amino-1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione have been conducted to identify the maximum tolerated dose (MTD) in patients with refractory or relapsed multiple myeloma. These studies have also characterized the safety profile of 3-(4-amino-1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione when ascending doses of 3-(4-amino-1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione were given orally for up to 4 weeks. Patients started 3-(4-amino-1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione treatment at 5 mg/day with subsequent escalation to 10, 25, and 50 mg/day. Patients for 28 days at their assigned dose, with the option of extended treatment for those who did not exhibit disease progression or experience dose limiting toxicity (DLT). Patients were evaluated for adverse events at each visit and the severity of these events was graded according to the National Cancer Institute (NCI) Common Toxicity Criteria. Patients were discontinued if they experienced DLT (Grade 3 or greater non-hematological, or Grade 4 hematological toxicity).

[0346] In this study, 27 patients were enrolled. All patients had relapsed multiple myeloma and 18 (72%) were refractory to salvage therapy. Among these patients, 15 had undergone prior autologous stem cell transplantation and 16 patients had received prior thalidomide treatment. The median number of prior regimens was 3 (range 2 to 6).

[0347] Blood and urine samples were collected for analysis of pharmacokinetic parameters on Days 1 and 28. Blood samples were collected according to the following sampling schedule: pre-dose, 0.25, 0.5, 0.75, 1, 1.5, 2, 2.5, 3, 4, 6, 8, 10, 12, 18, and 24 hours post-dose. In addition, a blood sample was collected at each weekly clinic visit for 3-(4-amino-1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione determination. Total urine was collected and pooled according to the following time intervals post-dose: 0 to 4, 4 to 8, 8 to 12, and 12 to 24 hours. Response to treatment was assessed by M-protein quantification (by immunoelectrophoresis) from serum and a 24-hour urine collection, with creatinine clearance and 24-hour protein calculations undertaken at screening, baseline, Weeks 2 and 4, and monthly thereafter (or upon early termination). Bone marrow aspirates and/or tissue biopsy are also performed at Months 3, 6 and 12 if a patient's paraprotein serum concentration or 24-hour urine protein excretion declined to the next lower level, based on best response criteria. Preliminary results for the 28-day treatment period are summarized below.

[0348] Preliminary pharmacokinetic analyses based on these two studies indicated that AUC and Cmax values increase proportionally with dose following single and multiple doses in multiple myeloma patients (as seen in healthy volunteers). Further, there was no evidence of accumulation with multiple dosing as single dose AUC0-24 was comparable to multiple dose AUC0-24 following the same dose of 3-(4-amino-1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione. Similar to healthy volunteer studies, double peaks were observed. Exposure in multiple myeloma patients appeared to be slightly higher based on Cmax and AUC values as compared to healthy male volunteers while clearance in multiple myeloma patients was lower than it was in healthy volunteers, consistent with their poorer renal function (both as a consequence of their age and their disease). Finally, 3-(4-amino-1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione half-life in patients was shorter than in healthy volunteers (mean 8 hours, ranging up to 17 hours).

[0349] In this study, the first cohort of 3 patients was treated for 28 days at 5 mg/day without any dose limiting toxicity (DLT). The second cohort of 3 patients subsequently commenced therapy at 10 mg/day. Patients in the second 10 mg/day of 3-(4-amino-1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione cohort tolerated treatment well.

[0350] 6.5.3 Treatment of Solid Tumors

[0351] Study with 3-(4-amino-1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione was conducted in patients...
with varying types of solid tumors, including metastatic melanoma (13), carcinoma of the pancreas (2), carcinoid-
unknown primary (1), renal carcinoma (1), breast carcinoma (1) and NSCLC (2). Patients received 5 mg/day 3-(4-amino-
1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione for seven days and are subsequently escalated every seven days to
10 mg/day, 25 mg/day, and 50 mg/day for a total of 4 weeks of treatment. Patients who, experienced clinical benefit were
permitted to continue on treatment as Named Patients.

[0352] The study initially enrolled 20 patients and was subsequently amended to enroll 16 additional patients (adre-
nal carcinoma, NSCLC, malignant mesothelioma, breast cancer, metastatic melanoma (8), renal cell cancer (4)) at a higher
dose. The 16 additional patients were given weekly escalating doses of 25 mg/day, 50 mg/day, 75 mg/day, 100 mg/day, 125
mg/day, and 150 mg/day over a 6-week period with continuing treatment for an additional six weeks.

[0353] The study of Phase 1 study was designed to determine a maximum tolerated dose (MTD) of 3-(4-amino-1-
1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione in patients with refractory solid tumors and/or lymphoma, as well as to characterize the pharmacokinetic and side effect profiles of 3-(4-amino-1-oxo-1,3-dihydro-isoindol-2-yl)-pi-
peridine-2,6-dione in this patient population. The study design dictates that at least 3 patients must be enrolled at a
dose level and have completed 28 days of treatment prior to enrollment of patients at the next higher dose level. Patients in
the first cohort began dosing at 5 mg/day of 3-(4-amino-1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione.
Patients will be escalated to 10, 20, 25, and 30 mg/day provided there is no toxicity.

[0354] In this study, the MTD is defined as the highest dose level in which fewer than two of six patients treated did not
experience Grade 3 or greater non-hematological toxicity or Grade 4 or greater hematological toxicity. If, at any given
dose level in either study, one out of three patients experiences toxicity, three additional patients must be treated at that
particular dose. If, however, two out of six patients experience DLT, the MTD is judged to have been exceeded. No further
dose escalations are to occur and additional patients are to be enrolled at the previous dose level. The dose of 3-(4-amino-
1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione administered is escalated until the MTD is achieved or the maximum
daily dose is reached.

[0355] No DLTs were reported in the initial group of 20 patients enrolled in the study. Thirteen of the original 20 trial
patients, along with 2 non-trial patients, continued on treatment as named patients at doses up to 150 mg/day.

[0356] 6.5.4 Treatment of Gliomas

[0357] This study was performed to find toxicity in patients with recurrent, high-grade gliomas. The study is designed
such that patients are given increasingly higher doses of 3-(4-amino-1-oxo-1,3-dihydro-isoindol -2-yl)-piperidine-2,6-di-
once a maximum tolerated dose (MTD) is established. The study also seeks to obtain preliminary toxicity informa-
tion and pharmacokinetic data on 3-(4-amino-1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione, as well as to
develop exploratory data concerning surrogate end points of angiogenic activity in vivo using functional neuro-imaging
studies, and in vitro assays of serum angiogenic peptides.

[0358] Patients enrolled in the first cohort receive 2.5 mg/m²/day for a 4-week cycle. During each 4-week cycle of
therapy, 3-(4-amino-1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione administered once daily for 3 weeks fol-
lowed by a week of rest. Patients who complete a treatment cycle may receive another cycle of 3-(4-amino-1-oxo-1,3-
dihydro-isoindol-2-yl)-piperidine-2,6-dione treatment if two criteria are met. First, the patient must have stable disease or
have experienced a partial response or complete response, or the patient is benefiting from the therapy with 3-(4-amino-1-
1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione as evidenced by a decrease in tumor-related symptoms such as
neurological deficits. Second, the patient must have recovered from toxicity related to 3-(4-amino-1-oxo-1,3-dihydro-
isoindol-2-yl) -piperidine-2,6-dione which occurred in the prior cycle by Day 42 or sooner (28-day cycle plus limit of 2
weeks to recover) as evidenced by a return to Grade ≤1 toxicity level. Patients who experience DLT in the previous
cycle should have their dose modified. DLT is defined as an non-hematological event Grade ≥3 toxicity or hematological
event of Grade 4 toxicity thought to be related to the study medication. Patients who experience DLT in the first cycle
and have no response to therapy are removed from the study.

[0359] 3-(4-amino-1-oxo-1,3-dihydro-isoindol-2-yl) -piperidine-2,6-dione doses are subsequently escalated to 5, 8, 11,
15, and 20 mg/m²/day to a maximum total daily dose of 40 mg. Patients continue to receive 3-(4-amino-1-oxo-1,3-dihy-
dro-isoindol-2-yl)-piperidine-2,6-dione on a 4-week cycle per dose level until one of the off-study criteria are met.

[0360] Three patients are enrolled in each cohort. If at least one DLT occurs, three additional patients are added to the
cohort at that particular dose level. If two DLTs occur, the MTD, defined as the dose at which fewer than one-third of patients at each dose level experiences DLT has been exceeded and four more patients are treated at the previous
dose.

[0361] Patients who experience DLT during the first 4-week cycle are removed from the study, except if they have
a response to therapy. For patients who have completed their first 4-week cycle of without DLT, but who subsequently
experience Grade 3 or 4 hematological and/or nonhematological toxicity, treatment is suspended for a minimum of a
week. If the toxicity resolves to <Grade 2 within three weeks, the patient is treated at two dose levels lower than the dose
that caused the toxicity (or a 50% reduction if the patient was treated at the first or second dose level). Patients in whom
Grade 3 or 4 toxicity does not resolve to <Grade 1 within three weeks, or those who have another Grade 3 toxicity at the
reduced dose are removed from the study.

[0362] Pharmacokinetic sampling is performed prior the first dose of 3-(4-amino-1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione (Day 1) and 0.5, 1, 2, 4, 6, 8, 24, and 48 hours thereafter. Sampling is also conducted pre-dose on
Days 7 and 21 and 0.5, 1, 2, 4, 6, 8, and 24 post-dose on Day 21 to evaluate steady-state 3-(4-amino-1-oxo-1,3-dihydro-
isoindol-2-yl) -piperidine-2,6-dione levels.

[0363] 6.5.5 Treatment of Metastatic Melanoma

[0364] Patients with metastatic melanoma were started on 3-(4-amino-1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-
dione at 5 mg/day for seven days. The dose was then increased every seven days to 10 mg/day, 25 mg/day, and 50
mg/day, respectively, for a total of four weeks on therapy. Five of the 13 melanoma patients who were treated under this
regimen either showed disease stabilization or a partial response in the first four weeks of treatment. Tumor response
was seen in cutaneous and subcutaneous lesions (five patients), lymph nodes (two patients), and liver (one patient).
The duration of response was approximately six months. The
result suggests that the compound appears as a promising new anti-cancer agent and has both antiangiogenic and immuno modulatory properties.

[0365] 6.5.6 Treatment of Relapsed or Refractory Multiple Myeloma

[0366] Patients with relapsed and refractory Duke-Salmon stage III multiple myeloma, who have either failed at least three previous regimens or presented with poor performance status, neutropenia or thrombocytopenia, are treated with up to four cycles of combination of melphalan (50 mg intravenously), an immunomodulatory compound of the invention (about 1 to 150 mg orally daily), and dexamethasone (40 mg/day orally on days 1 to 4) every four to six weeks. Maintenance treatment consisting of daily an immunomodulatory compound of the invention and monthly dexamethasone are continued until the disease progression. The therapy using an immunomodulatory compound of the invention in combination with melphalan and dexamethasone is highly active and generally tolerated in heavily pretreated multiple myeloma patients whose prognosis is otherwise poor.

[0367] The embodiments of the invention described above are intended to be merely exemplary, and those skilled in the art will recognize, or will be able to ascertain using no more than routine experimentation, numerous equivalents of specific compounds, materials, and procedures. All such equivalents are considered to be within the scope of the invention and are encompassed by the appended claims.

1-32. (canceled)

33. A method of treating a blood-borne tumor, which comprises administering to a patient having the blood-borne tumor a therapeutically effective amount of a hydrated crystalline form of 3-(4-amino-1-oxo-1,3-dihydro-isoindol-2-yl)-piperidine-2,6-dione.

34. The method of claim 33, wherein the crystalline form is a hemihydrate.

35. The method of claim 34, wherein the crystalline form has an X-ray powder diffraction pattern comprising peaks at approximately 16, 22 and 27 degrees 20.

36. The method of claim 35, wherein the X-ray powder diffraction pattern further comprises a peak at approximately 18 degrees 20.

37. The method of claim 34, wherein the crystalline form has differential scanning calorimetry thermogram comprising endotherms with maxima at about 146°C and about 268°C.

38. The method of claim 34, wherein the crystalline form exhibits a mass loss of about 3.1% of its total mass when heated to about 175°C.

39. The method of claim 34, wherein the blood-borne tumor is myeloma, lymphoma, or leukemia.

40. The method of claim 39, wherein the myeloma is multiple myeloma, smoldering myeloma, or indolent myeloma.

41. The method of claim 40, wherein the multiple myeloma is relapsed multiple myeloma, refractory multiple myeloma, or newly diagnosed multiple myeloma.

42. The method of claim 39, wherein the lymphoma is non-Hodgkin's lymphoma, Hodgkin's lymphoma, cutaneous T-Cell lymphoma, cutaneous B-Cell lymphoma, diffuse large B-Cell lymphoma, or low grade follicular lymphoma.

43. The method of claim 39, wherein the lymphoma is non-Hodgkin's lymphoma.

44. The method of claim 39, wherein the leukemia is myeloblastic leukemia or myelogenous leukemia.

45. The method of claim 34, wherein the therapeutically effective amount is about 5 mg, 10 mg, 15 mg, or 25 mg.

46. The method of claim 34, wherein the crystalline form is administered orally.

47. The method of claim 34, wherein the crystalline form is administered in a capsule.

48. The method of claim 34, wherein the crystalline form is administered in a tablet.

49. The method of claim 34, wherein the crystalline form is substantially pure.

50. The method of claim 33, wherein the crystalline form has an X-ray powder diffraction pattern comprising peaks at approximately 27 and 28 degrees 20.

51. The method of claim 50, wherein the crystalline form has a differential scanning calorimetry curve comprising endotherms with maxima at about 122°C and about 270°C.

52. The method of claim 50, wherein the blood-borne tumor is myeloma, lymphoma, or leukemia.

53. The method of claim 52, wherein the myeloma is multiple myeloma, smoldering myeloma, or indolent myeloma.

54. The method of claim 53, wherein the multiple myeloma is relapsed multiple myeloma, refractory multiple myeloma, or newly diagnosed multiple myeloma.

55. The method of claim 52, wherein the lymphoma is non-Hodgkin's lymphoma, Hodgkin's lymphoma, cutaneous T-Cell lymphoma, cutaneous B-Cell lymphoma, diffuse large B-Cell lymphoma, or low grade follicular lymphoma.

56. The method of claim 52, wherein the lymphoma is non-Hodgkin's lymphoma.

57. The method of claim 52, wherein the leukemia is myeloblastic leukemia or myelogenous leukemia.

58. The method of claim 50, wherein the therapeutically effective amount is about 5 mg, 10 mg, 15 mg, or 25 mg.

59. The method of claim 50, wherein the crystalline form is administered orally.

60. The method of claim 50, wherein the crystalline form is administered in capsule.

61. The method of claim 50, wherein the crystalline form is administered in a tablet.

62. The method of claim 50, wherein the crystalline form is substantially pure.