Dérives de quinazolinone substituées en 5', compositions contenant ces dérives et procédés d'utilisation

5-substituted quinazolinone derivatives and compositions comprising the same

(57) Abrégé/Abstract:
Provided are 5-substituted quinazolinone compounds, and pharmaceutically acceptable salts, solvates, clathrates, stereoisomers, and prodrugs thereof. A representative compound of the invention is (see formula II), wherein R^4, R^5 and R^6 are as defined herein.
Abstract

Provided are 5-substituted quinazolinone compounds, and pharmaceutically acceptable salts, solvates, clathrates, stereoisomers, and prodrugs thereof. A representative compound of the invention is

\[ \text{(II),} \]

wherein \( R^4 \), \( R^5 \) and \( R^6 \) are as defined herein.
5-SUBSTITUTED QUINAZOLINONE DERIVATIVES
AND COMPOSITIONS COMPRISING THE SAME

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1. FIELD OF THE INVENTION
Provided herein are 5-substituted quinazolinone derivatives. Pharmaceutical compositions comprising the compounds are also disclosed.

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2. BACKGROUND OF THE INVENTION
2.1 PATHOBIOLOGY OF CANCER AND OTHER DISEASES
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., 1993).

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. However, options for the treatment of cancer are limited. For example, in the case of blood cancers (e.g., multiple myeloma), few treatment options are available, especially when conventional chemotherapy fails and bone-marrow transplantation is not an option. A tremendous demand therefore exists for new methods and compositions that can be used to treat patients with cancer.

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).

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; corneal graft rejection; neovascular glaucoma; retrolental fibroplasia; arthritis; and proliferative vitreoretinopathy.

Accordingly, compounds that can control angiogenesis or inhibit the production of certain cytokines, including TNFα, may be useful in the treatment and prevention of various diseases and conditions.

2.2 METHODS OF TREATING CANCER

Current cancer therapy may involve surgery, chemotherapy, hormonal therapy and/or radiation treatment to eradicate neoplastic cells in a patient (see, e.g., 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.

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).

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 mechanism 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 or become refractory to standard chemotherapeutic treatment protocols.

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.

3. **SUMMARY OF THE INVENTION**

Provided herein are 5- substituted quinazolinone compounds, and pharmaceutically acceptable salts, solvates (e.g., hydrates), prodrugs, clathrates, or stereoisomers thereof.

4. **DETAILED DESCRIPTION OF THE INVENTION**
4.1 **COMPOUNDS**

In one embodiment, provided herein are compounds of the formula (I):

![Chemical Structure](attachment:image)

(I),

and pharmaceutically acceptable salts, solvates, and stereoisomers thereof, wherein:

$R^1$ is: hydrogen; halo; -(CH$_2$)$_n$OH; (C$_1$-C$_6$)alkyl, optionally substituted with one or more halo; (C$_1$-C$_6$)alkoxy, optionally substituted with one or more halo; or

-(CH$_2$)$_n$NHR$^a$, wherein $R^a$ is:

hydrogen;

(C$_1$-C$_6$)alkyl, optionally substituted with one or more halo;

-(CH$_2$)$_n$-(6 to 10 membered aryl);

-C(O)-(CH$_2$)$_n$-(6 to 10 membered aryl) or -C(O)-(CH$_2$)$_n$-(6 to 10 membered heteroaryl), wherein the aryl or heteroaryl is optionally substituted with one or more of: halo; -SCF$_3$; (C$_1$-C$_6$)alkyl, itself optionally substituted with one or more halo; or (C$_1$-C$_6$)alkoxy, itself optionally substituted with one or more halo;

-C(O)-(C$_1$-C$_6$)alkyl, wherein the alkyl is optionally substituted with one or more halo;

-C(O)-(CH$_2$)$_n$-(C$_3$-C$_{10}$-cycloalkyl);

-C(O)-(CH$_2$)$_n$-NR$^a$R$^b$, wherein $R^a$ and $R^b$ are each independently:
hydrogen;
(C1-C4)alkyl, optionally substituted with one or more halo;
(C1-C4)alkoxy, optionally substituted with one or more halo; or
6 to 10 membered aryl, optionally substituted with one or more of: halo;
(C1-C4)alkyl, itself optionally substituted with one or more halo; or
(C1-C4)alkoxy, itself optionally substituted with one or more halo;
-C(O)-(CH2)n-O-(C1-C4)alkyl; or
-C(O)-(CH2)n-O-(CH2)m-(6 to 10 membered aryl);
R² is: hydrogen; -(CH2)nOH; phenyl; -O-(C1-C4)alkyl; or (C1-C4)alkyl, optionally substituted with
one or more halo;
R² is: hydrogen; or (C1-C4)alkyl, optionally substituted with one or more halo; and
n is 0, 1, or 2.

In one embodiment, provided herein are compounds of the formula (II):

\[ \text{(II)} \]

and pharmaceutically acceptable salts, solvates, and stereoisoemers thereof, wherein:
R⁴ is: hydrogen; halo; -(CH2)nOH; (C1-C4)alkyl, optionally substituted with one or more halo; or
(C1-C4)alkoxy, optionally substituted with one or more halo; and, more particularly,
R⁴ is: halo; -(CH2)nOH; (C1-C4)alkyl, optionally substituted with one or more halo; or (C1-C4)alkoxy,
optionally substituted with one or more halo;
R⁵ is: hydrogen; -(CH2)nOH; phenyl; -O-(C1-C4)alkyl; or (C1-C4)alkyl, optionally substituted with
one or more halo;
R⁵ is: hydrogen; or (C1-C4)alkyl, optionally substituted with one or more halo; and
n is 0, 1, or 2.

In one embodiment, R⁴ is hydrogen. In another embodiment, R⁴ is halo. In another
embodiment, R⁴ is (C1-C4)alkyl, optionally substituted with one or more halo. In another
embodiment, R⁴ is -(CH2)nOH or hydroxyl. In another embodiment, R⁴ is (C1-C4)alkoxy, optionally
substituted with one or more halo.

In one embodiment, R¹ is hydrogen. In another embodiment, R¹ is -(CH2)nOH or
hydroxyl. In another embodiment, R¹ is phenyl. In another embodiment, R¹ is -O-(C1-C4)alkyl,
optionally substituted with one or more halo. In another embodiment, R¹ is (C1-C4)alkyl, optionally
substituted with one or more halo.

In one embodiment, R⁵ is hydrogen. In another embodiment, R⁵ is (C1-C4)alkyl,
optionally substituted with one or more halo.

In one embodiment, n is 0. In another embodiment, n is 1. In another embodiment,
n is 2.

Compounds provided herein encompass any of the combinations of R⁴, R⁵, R⁶ and n
described above.
In one specific embodiment, \( R^4 \) is methyl. In another embodiment, \( R^4 \) is methoxy. In another embodiment, \( R^4 \) is \(-\text{CF}_3\). In another embodiment, \( R^5 \) is F or Cl.

In another specific embodiment, \( R^3 \) is methyl. In another embodiment, \( R^3 \) is \(-\text{CF}_3\). Specific examples include, but are not limited to:

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\text{[Chemical Structures]}
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In another embodiment, provided herein are compounds of the formula (III):

\[
\text{(III),}
\]

and pharmaceutically acceptable salts, solvates, and stereoisomers thereof, wherein:

\( R^6 \) is:

hydrogen;

\( (\text{C}_1-\text{C}_6)\text{alkyl} \), optionally substituted with one or more halo;
-C(O)-(C1-C6)alkyl, wherein the alkyl is optionally substituted with one or more halo;
-C(O)-(CH2)n-(C3-C10-cycloalkyl);
-C(O)-(CH2)n-NR'R, wherein R' and R'' are each independently:
hydrogen;
(C1-C6)alkyl, optionally substituted with one or more halo; or
(C1-C6)alkoxy, optionally substituted with one or more halo; or
-C(O)-(CH2)n-O-(C1-C6)alkyl.
R' is: hydrogen; -(CH2)nOH; phenyl; -O-(C1-C6)alkyl; or (C1-C6)alkyl, optionally substituted with one or more halo;
R'' is: hydrogen; or (C1-C6)alkyl, optionally substituted with one or more halo; and
n is 0, 1, or 2.
In one embodiment, R'' is hydrogen. In another embodiment, R'' is (C1-C6)alkyl, optionally substituted with one or more halo. In another embodiment, R'' is -C(O)-(C1-C6)alkyl. In another embodiment, R'' is -C(O)-(CH2)n-(C3-C10-cycloalkyl). In another embodiment, R'' is -C(O)-(CH2)n-NR'R, wherein R' and R'' are as described herein above. In another embodiment, R'' is -C(O)-(CH2)n-O-(C1-C6)alkyl.
In one embodiment, R' is hydrogen. In another embodiment, R' is -(CH2)nOH or hydroxyl. In another embodiment, R' is phenyl. In another embodiment, R' is -O-(C1-C6)alkyl, optionally substituted with one or more halo. In another embodiment, R' is (C1-C6)alkyl, optionally substituted with one or more halo.
In one embodiment, R' is hydrogen. In another embodiment, R' is (C1-C6)alkyl, optionally substituted with one or more halo.
In one embodiment, n is 0. In another embodiment, n is 1. In another embodiment, n is 2.
Compounds provided herein encompass any of the combinations of R'', R', R'' and n described above.
In one specific embodiment, R' is methyl. In another embodiment, R'' is -C(O)-(C1-C6)alkyl. In another embodiment, R'' is NH2. In another embodiment, R'' is -C(O)-CH2-O-(C1-C6)alkyl.
Specific examples include, but are not limited to:
In another embodiment, provided herein are compounds of the formula (IV):

![Chemical Structures]

and pharmaceutically acceptable salts, solvates, and stereoisomers thereof, wherein:

- \( R^8 \) is:
  - \((\text{CH}_2)_n-(6 \text{ to } 10 \text{ membered aryl});\)
  - \(-\text{C}(\text{O})-(\text{CH}_2)_n-(6 \text{ to } 10 \text{ membered heteroaryl}), \) wherein the aryl or heteroaryl is optionally substituted with one or more of: halo; \(-\text{SCF}_3; (\text{C}_1-\text{C}_6)\)alkyl, itself optionally substituted with one or more halo; or \((\text{C}_1-\text{C}_6)\)alkoxy, itself optionally substituted with one or more halo;
  - \(-\text{C}(\text{O})-(\text{CH}_2)_n-NHR^R\), wherein \( R^R \) is:
    - \(6 \text{ to } 10 \text{ membered aryl, optionally substituted with one or more of: halo;}\)
    - \((\text{C}_1-\text{C}_6)\)alkyl, itself optionally substituted with one or more halo; or
    - \((\text{C}_1-\text{C}_6)\)alkoxy, itself optionally substituted with one or more halo; or
-C(O)-(CH₂)ₙ-O-(CH₂)ₙ-(6 to 10 membered aryl);
R³ is: hydrogen; -(CH₂)ₙOH; phenyl; -O-(C₁-C₆)alkyl; or (C₁-C₆)alkyl, optionally substituted with one or more halo;
R¹⁰ is: hydrogen; or (C₁-C₆)alkyl, optionally substituted with one or more halo; and
n is 0, 1, or 2.

In one embodiment, R³ is -(CH₂)ₙ-(6 to 10 membered aryl). In another embodiment, R³ is -C(O)-(CH₂)ₙ-(6 to 10 membered aryl) or -C(O)-(CH₂)ₙ-(6 to 10 membered heteroaryl), wherein the aryl or heteroaryl is optionally substituted as described above. In another embodiment, R³ is -C(O)-(CH₂)ₙ-NHR⁰, wherein R⁰ is 6 to 10 membered aryl, optionally substituted as described above. In another embodiment, R³ is -C(O)-(CH₂)ₙ-O-(CH₂)ₙ-(6 to 10 membered aryl).

In one embodiment, R⁰ is hydrogen. In another embodiment, R⁰ is -(CH₂)ₙOH or hydroxyl. In another embodiment, R⁰ is phenyl. In another embodiment, R⁰ is -O-(C₁-C₆)alkyl, optionally substituted with one or more halo. In another embodiment, R⁰ is (C₁-C₆)alkyl, optionally substituted with one or more halo.

In one embodiment, R¹⁰ is hydrogen. In another embodiment, R¹⁰ is (C₁-C₆)alkyl, optionally substituted with one or more halo.

In one embodiment, n is 0. In another embodiment, n is 1. In another embodiment, n is 2.

Compounds provided herein encompass any of the combinations of R³, R⁰, R¹⁰ and n described above.

In one specific embodiment, R³ is methyl. In another embodiment, R³ is -C(O)-phenyl or -C(O)-CH₂-phenyl, wherein the phenyl is optionally substituted with methyl, -CF₃, and/or halo. In another embodiment, R³ is -C(O)-NH-phenyl, wherein the phenyl is optionally substituted with methyl, -CF₃, and/or halo.

Specific compounds include, but are not limited to:
As used herein, and unless otherwise specified, the term "pharmaceutically acceptable salt" refers to salts prepared from pharmaceutically acceptable non-toxic acids, including inorganic acids and organic acids. Suitable non-toxic acids include inorganic and organic acids such as, but not limited to, acetic, alginic, anthranilic, benzenesulfonic, benzoic, camphorsulfonic, citric, ethanesulfonic, formic, fumaric, furoic, gluconic, glutamic, gluconic, galacturonic, glycicidic, hydrobromic, hydrochloric, isethionic, lactic, maleic, malic, mandelic, methanesulfonic, muci, nitric, pamoic, pantothenic, phenylacetie, propionic, phosphoric, salicylic, stearic, succinic, sulfanilic, sulfuric, tartaric acid, p-toluenesulfonic and the like. In one embodiment, suitable are hydrochloric, hydrobromic, phosphoric, and sulfuric acids.

As used herein, and unless otherwise specified, the term "solvate" means a compound that further includes a stoichiometric or non-stoichiometric amount of solvent bound by non-covalent intermolecular forces. Where the solvent is water, the solvate is a hydrate.

As used herein, and unless otherwise specified, 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, compounds that comprise biohydrolyzable moieties such as biohydrolyzable amides, biohydrolyzable esters, biohydrolyzable carbamates, biohydrolyzable carbonates, biohydrolyzable...
ureides, and biohydrolyzable phosphate analogues. Other examples of prodrugs include compounds that comprise -NO, -NO₂, -ONO, or -ONO₂ moieties. Prodrugs can typically be prepared using well-known methods, such as those described in *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).

As used herein, and unless otherwise specified, the terms “biohydrolyzable carbamate,” “biohydrolyzable carbonate,” “biohydrolyzable ureide” and “biohydrolyzable phosphate” mean a carbamate, carbonate, ureide and 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 biohydrolyzable carbamates include, but are not limited to, carbamates that include lower alkylamine, substituted ethylenediamine, aminoacid, hydroxyalkylamine, heterocyclic and heteroaromatic amine, and polyether amine moieties.

As used herein, and unless otherwise specified, the term “stereoisomer” encompasses all enantiomerically/stereomerically pure and enantiomerically/stereomerically enriched compounds provided herein.

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, 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, 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, or 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 55% by weight of one stereoisomer of a compound, greater than about 60% by weight of one stereoisomer of a compound, greater than about 70% by weight, or 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.
As used herein, and unless otherwise indicated, the term "alkyl" refers to a saturated straight chain or branched hydrocarbon having a number of carbon atoms as specified herein. Representative saturated straight chain alkyIs include -methyl, -ethyl, -n-propyl, -n-butyl, -n-pentyl, and -n-hexyl; while saturated branched alkyIs include -isopropyl, -sec-butyl, -iso-butyl, -tert-butyl, -isopentyl, 2-methylbutyl, 3-methylbutyl, 2-methylpentyl, 3-methylpentyl, 4-methylpentyl, 2-methylhexyl, 3-methylhexyl, 4-methylhexyl, 5-methylhexyl, 2,3-dimethylbutyl, and the like. The term "alkyl" also encompasses cycloalkyl.

As used herein, and unless otherwise specified, the term "cycloalkyl" means a specie of alkyl containing from 3 to 15 carbon atoms, without alternating or resonating double bonds between carbon atoms. It may contain from 1 to 4 rings. Examples of unsubstituted cycloalkyls include, but are not limited to, cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, and adamantyl. A cycloalkyl may be substituted with one or more of the substituents.

As used herein, the term "aryl" means a carboxyclic aromatic ring containing from 5 to 14 ring atoms. The ring atoms of a carboxyclic aryl group are all carbon atoms. Aryl ring structures include compounds having one or more ring structures such as mono-, bi-, or tricyclic compounds as well as benzo-fused carboxyclic moieties such as 5,6,7,8-tetrahydroanaphthyl and the like. Specifically, the aryl group is a monocyclic ring or bicyclic ring. Representative aryl groups include phenyl, anthracenyl, fluorenyl, indenyl, azulenyl, phenanthrenyl and naphthyl.

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.

4.2 METHODS OF TREATMENT, PREVENTION AND MANAGEMENT

A compound provided herein, or a pharmaceutically acceptable salt, solvate (e.g., hydrate), prodrug, clathrate, or stereoisomer thereof may potentially be useful in methods of treating, preventing, and/or managing various diseases or disorders. Without being limited by a particular theory, compounds provided herein may potentially control angiogenesis or inhibit the production of certain cytokines including, but not limited to, TNF-α, IL-1β, IL-12, IL-18, GM-CSF, and/or IL-6. Without being limited by a particular theory, compounds provided herein may potentially stimulate the production of certain other cytokines including IL-10, and also act as a costimulatory signal for T cell activation, resulting in increased production of cytokines such as, but not limited to, IL-12 and/or IFN-γ. In addition, compounds provided herein may potentially enhance the effects of NK cells and antibody-mediated cellular cytotoxicity (ADCC). Further, compounds provided herein may be immunomodulatory and/or cytotoxic, and thus, may potentially be useful as chemotherapeutic agents. Consequently, without being limited by a particular theory, some or all of such characteristics
possessed by the compounds provided herein may render them potentially useful in treating, managing, and/or preventing various diseases or disorders.

Examples of diseases or disorders may include, but are not limited to, cancer, disorders associated with angiogenesis, pain including, but not limited to, Complex Regional Pain Syndrome ("CRPS"), Macular Degeneration ("MD") and related syndromes, skin diseases, pulmonary disorders, asbestos-related disorders, parasitic diseases, immunodeficiency disorders, CNS disorders, CNS injury, atherosclerosis and related disorders, dysfunctional sleep and related disorders, hemoglobinopathy and related disorders (e.g., anemia), TNFα-related disorders, and other various diseases and disorders.

As used herein, and unless otherwise specified, the terms "treat," "treating" and "treatment" refer to the eradication or amelioration of a disease or disorder, or of one or more symptoms associated with the disease or disorder. In certain embodiments, the terms refer to minimizing the spread or worsening of the disease or disorder resulting from the administration of one or more prophylactic or therapeutic agents to a subject with such a disease or disorder.

As used herein, and unless otherwise specified, the terms "prevent," "preventing" and "prevention" refer to the prevention of the onset, recurrence or spread of a disease or disorder, or of one or more symptoms thereof.

As used herein, and unless otherwise specified, the terms "manage," "managing" and "management" refer to preventing or slowing the progression, spread or worsening of a disease or disorder, or of one or more symptoms thereof. In certain cases, the beneficial effects that a subject derives from a prophylactic or therapeutic agent do not result in a cure of the disease or disorder.

As used herein, and unless otherwise specified, a "therapeutically effective amount" of a compound is an amount sufficient to provide a therapeutic benefit in the treatment or management of a disease or disorder, or to delay or minimize one or more symptoms associated with the disease or disorder. A therapeutically effective amount of a compound means an amount of therapeutic agent, alone or in combination with other therapies, which provides a therapeutic benefit in the treatment or management of the disease or disorder. The term "therapeutically effective amount" can encompass an amount that improves overall therapy, reduces or avoids symptoms or causes of disease or disorder, or enhances the therapeutic efficacy of another therapeutic agent.

As used herein, and unless otherwise specified, a "prophylactically effective amount" of a compound is an amount sufficient to prevent a disease or disorder, or prevent its recurrence. A prophylactically effective amount of a compound means an amount of therapeutic agent, alone or in combination with other agents, which provides a prophylactic benefit in the prevention of the disease. The term "prophylactically effective amount" can encompass an amount that improves overall prophylaxis or enhances the prophylactic efficacy of another prophylactic agent.
Examples of cancer and precancerous conditions may include, but are not limited to, those described in U.S. patent nos. 6,281,230 and 5,635,517 to Muller et al., in various U.S. patent publications to Zeldis, including publication nos. 2004/0220144A1, published November 4, 2004 (Treatment of Myelodysplastic Syndrome); 2004/0029832A1, published February 12, 2004 (Treatment of Various Types of Cancer); and 2004/0087546, published May 6, 2004 (Treatment of Myeloproliferative Diseases). Examples may also include those described in WO 2004/103274, published December 2, 2004.

Specific examples of cancer may include, but are not limited to, cancers of the skin, such as melanoma; lymph node; breast; cervix; uterus; gastrointestinal tract; lung; ovary; prostate; colon; rectum; mouth; brain; head and neck; throat; testes; kidney; pancreas; bone; spleen; liver; bladder; larynx; nasal passages; and AIDS-related cancers. The compounds may also be potentially useful for treating cancers of the blood and bone marrow, such as multiple myeloma and acute and chronic leukemias, for example, lymphoblastic, myelogenous, lymphocytic, and myelocytic leukemias. The compounds provided herein may potentially be used for treating, preventing or managing either primary or metastatic tumors.

Other specific cancers may include, but are not limited to, advanced malignancy, amyloidosis, neuroblastoma, meningioma, hemangiopericytoma, multiple brain metastases, glioblastoma multiformes, glioblastoma, brain stem glioma, poor prognosis malignant brain tumor, malignant glioma, recurrent malignant glioma, anaplastic astrocytoma, anaplastic oligodendroglioma, neuroendocrine tumor, rectal adenocarcinoma, Dukes C & D colorectal cancer, unresectable colorectal carcinoma, metastatic hepatocellular carcinoma, Kaposi's sarcoma, karotype acute myeloblastic leukemia, chronic lymphocytic leukemia (CLL), Hodgkin's lymphoma, non-Hodgkin's lymphoma, cutaneous T-Cell lymphoma, cutaneous B-Cell lymphoma, diffuse large B-Cell lymphoma, low grade follicular lymphoma, metastatic melanoma (localized melanoma, including, but not limited to, ocular melanoma), malignant mesothelioma, malignant pleural effusion mesothelioma syndrome, peritoneal carcinoma, papillary serous carcinoma, gynecologic sarcoma, soft tissue sarcoma, scleroderma, cutaneous vasculitis, Langerhans cell histiocytosis, leiomyosarcoma, fibrodyplasia ossificans progressive, hormone refractory prostate cancer, resected high-risk soft tissue sarcoma, unresectable hepatocellular carcinoma, Waldenstrom's macroglobulinemia, smoldering myeloma, indolent myeloma, fallopian tube cancer, androgen independent prostate cancer, androgen dependent stage IV non-metastatic prostate cancer, hormone-insensitive prostate cancer, chemotherapy-insensitive prostate cancer, papillary thyroid carcinoma, follicular thyroid carcinoma, medullary thyroid carcinoma, and leiomyoma. In a specific embodiment, the cancer may be metastatic. In another embodiment, the cancer may be refractory or resistance to chemotherapy or radiation.

In one embodiment, provided herein are methods that may potentially treat, prevent or manage various forms of leukemias such as chronic lymphocytic leukemia, chronic myelocytic
leukemia, acute lymphoblastic leukemia, acute myelogenous leukemia and acute myeloblastic leukemia, including leukemias that are relapsed, refractory or resistant, as disclosed in U.S. publication no. 2006/0030594, published February 9, 2006.

The term "leukemia" refers malignant neoplasms of the blood-forming tissues. The leukemia may include, but is not limited to, chronic lymphocytic leukemia, chronic myelocytic leukemia, acute lymphoblastic leukemia, acute myelogenous leukemia and acute myeloblastic leukemia. The leukemia may be relapsed, refractory or resistant to conventional therapy. The term "relapsed" refers to a situation where patients who have had a remission of leukemia after therapy have a return of leukemia cells in the marrow and a decrease in normal blood cells. The term "refractory or resistant" refers to a circumstance where patients, even after intensive treatment, have residual leukemia cells in their marrow.

In another embodiment, provided herein are methods that may potentially treat, prevent or manage various types of lymphomas, including Non-Hodgkin's lymphoma (NHL). The term "lymphoma" refers a heterogenous group of neoplasms arising in the reticuloendothelial and lymphatic systems. "NHL" refers to malignant monoclonal proliferation of lymphoid cells in sites of the immune system, including lymph nodes, bone marrow, spleen, liver and gastrointestinal tract. Examples of NHL may include, but are not limited to, mantle cell lymphoma (MCL), lymphocytic lymphoma of intermediate differentiation, intermediate lymphocytic lymphoma (ILL), diffuse poorly differentiated lymphocytic lymphoma (DPL), centrocytic lymphoma, diffuse small-cleaved cell lymphoma (DSCCL), follicular lymphoma, and any type of the mantle cell lymphomas that can be seen under the microscope (nodular, diffuse, blastic and mantle zone lymphoma).

Examples of diseases and disorders associated with, or characterized by, undesired angiogenesis may 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 rubecia (neovascularization of the angle). Specific examples of the diseases and disorders associated with, or characterized by, undesired angiogenesis may include, but are not limited to, arthritis, 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 Sjogren deletion syndrome.

Examples of pain may include, but are not limited to those described in U.S. patent publication no. 2005/0203142, published September 15, 2005. Specific types of pain may include, but are not limited to, nociceptive pain, neuropathic pain, mixed pain of nociceptive and neuropathic pain, visceral pain, migraine, headache and post-operative pain.
Examples of nociceptive pain may include, but are not limited to, pain associated with chemical or thermal burns, cuts of the skin, contusions of the skin, osteoarthritis, rheumatoid arthritis, tendonitis, and myofascial pain.

Examples of neuropathic pain may include, but are not limited to, CRPS type I, CRPS type II, reflex sympathetic dystrophy (RSD), reflex neurovascular dystrophy, reflex dystrophy, sympathetically maintained pain syndrome, causalgia, Sudeck atrophy of bone, algoneurodystrophy, shoulder hand syndrome, post-traumatic dystrophy, trigeminal neuralgia, post herpetic neuralgia, cancer related pain, phantom limb pain, fibromyalgia, chronic fatigue syndrome, spinal cord injury pain, central post-stroke pain, radiculopathy, diabetic neuropathy, post-stroke pain, luetic neuropathy, and other painful neuropathic conditions such as those induced by drugs such as vincristine and Velcade™.

As used herein, the terms "complex regional pain syndrome," "CRPS" and "CRPS and related syndromes" mean a chronic pain disorder characterized by one or more of the following: pain, whether spontaneous or evoked, including allodynia (painful response to a stimulus that is not usually painful) and hyperalgesia (exaggerated response to a stimulus that is usually only mildly painful); pain that is disproportionate to the inciting event (e.g., years of severe pain after an ankle sprain); regional pain that is not limited to a single peripheral nerve distribution; and autonomic dysregulation (e.g., edema, alteration in blood flow and hyperhidrosis) associated with trophic skin changes (hair and nail growth abnormalities and cutaneous ulceration).

Examples of MD and related syndromes may include, but are not limited to, those described in U.S. patent publication no. 2004/0091455, published May 13, 2004. Specific examples may include, but are not limited to, atrophic (dry) MD, exudative (wet) MD, age-related maculopathy (ARM), choroidal neovascularization (CNVM), retinal pigment epithelium detachment (PED), and atrophy of retinal pigment epithelium (RPE).

Examples of skin diseases may include, but are not limited to, those described in U.S. publication no. 2005/0214328A1, published September 29, 2005. Specific examples may include, but are not limited to, keratoses and related symptoms, skin diseases or disorders characterized with overgrowths of the epidermis, acne, and wrinkles.

As used herein, the term "keratosis" refers to any lesion on the epidermis marked by the presence of circumscribed overgrowths of the horny layer, including but not limited to actinic keratosis, seborrheic keratosis, keratoacanthoma, keratosis follicularis (Darier disease), inverted follicular keratosis, palmar plantar keratoderma (PPK, keratosis palmaris et plantaris), keratosis pilaris, and stucco keratosis. The term "actinic keratosis" also refers to senile keratosis, keratosis senilis, verruca senilis, plana senilis, solar keratosis, keratoderma or keratoma. The term "seborrheic keratosis" also refers to seborrheic wart, senile wart, or basal cell papilloma. Keratosis is characterized by one or more of the following symptoms: rough appearing, scaly, erythematous papules, plaques, spicules or nodules on exposed surfaces (e.g., face, hands, ears, neck, legs and thorax), excrescences of keratin referred to as cutaneous horns, hyperkeratosis, telangiectasias,
elastosis, pigmented lentigines, acanthosis, parakeratosis, dyskeratosis, papillomatosis, hyperpigmentation of the basal cells, cellular atypia, mitotic figures, abnormal cell-cell adhesion, dense inflammatory infiltrates and small prevalence of squamous cell carcinomas.

Examples of skin diseases or disorders characterized with overgrowths of the epidermis may include, but are not limited to, any conditions, diseases or disorders marked by the presence of overgrowths of the epidermis, including but not limited to, infections associated with papilloma virus, arsenical keratoses, sign of Leser-Trelat, warty dyskeratoma (WD), trichostasis spinulosa (TS), erythrokeratodermia variabilis (EKV), ichthyosis fetales (harlequin ichthyosis), knuckle pads, cutaneous melanocanthoma, porokeratosis, psoriasis, squamous cell carcinoma, confluent and reticulated papillomatosis (CRP),acrochordons, cutaneous horn, cowden disease (multiple hamartoma syndrome), dermatosis papulosa nigra (DPN), epidermal nevus syndrome (ENS), ichthyosis vulgaris, molluscum contagiosum, prurigo nodularis, and acanthosis nigricans (AN).

Examples of pulmonary disorders may include, but are not limited to, those described in U.S. publication no. 2005/0239842A1, published October 27, 2005. Specific examples may include pulmonary hypertension and related disorders. Examples of pulmonary hypertension and related disorders may include, but are not limited to: primary pulmonary hypertension (PPH); secondary pulmonary hypertension (SPH); familial PPH; sporadic PPH; precapillary pulmonary hypertension; pulmonary arterial hypertension (PAH); pulmonary artery hypertension; idiopathic pulmonary hypertension; thrombotic pulmonary arteriopathy (TPA);plexogenic pulmonary arteriopathy; functional classes I to IV pulmonary hypertension; and pulmonary hypertension associated with, related to, or secondary to, left ventricular dysfunction, mitral valvular disease, constrictive pericarditis, aortic stenosis, cardiomyopathy, mediastinal fibrosis, anomalous pulmonary venous drainage, pulmonary venoocclusive disease, collagen vascular disease, congenital heart disease, HIV virus infection, drugs and toxins such as fenfluramines, congenital heart disease, pulmonary venous hypertension, chronic obstructive pulmonary disease, interstitial lung disease, sleep-disordered breathing, alveolar hypoventilation disorder, chronic exposure to high altitude, neonatal lung disease, alveolar-capillary dysplasia, sickle cell disease, other coagulation disorder, chronic thromboemboli, connective tissue disease, lupus including systemic and cutaneous lupus, schistosomiasis, sarcoidosis or pulmonary capillary hemangiomatosis.

Examples of asbestosis-related disorders may include, but are not limited to, those described in U.S. publication no. 2005/0100529, published May 12, 2005. Specific examples may include, but are not limited to, mesothelioma, asbestosis, malignant pleural effusion, benign exudative effusion, pleural plaques, pleural calcification, diffuse pleural thickening, rounded atelectasis, fibrotic masses, and lung cancer.

Examples of parasitic diseases may include, but are not limited to, those described in U.S. publication no. 2006/0154880, published July 13, 2006.
Parasitic diseases may include diseases and disorders caused by human intracellular parasites such as, but not limited to, P. falciparum, P. ovale, P. vivax, P. malariae, L. donovani, L. infantum, L. aethiopica, L. major, L. tropica, L. mexicana, L. braziliensis, T. Gondii, B. microti, B. divergens, B. coli, C. parvum, C. cayetanensis, E. histolytica, I. belli, S. mansoni, S. haematobium, Trypanosoma ssp., Toxoplasma ssp., and O. volvulus. Other diseases and disorders caused by non-human intracellular parasites such as, but not limited to, Babesia bovis, Babesia canis, Banesia Gibsoni, Besnoitia darlingi, Cytospora felis, Eimeria ssp., Hammondia ssp., and Theileria ssp., may be also encompassed. Specific examples may include, but are not limited to, malaria, babesiosis, trypanosomiasis, leishmaniasis, toxoplasmosis, meningococcal meningitis, keratitis, amebiasis, giardiasis, cryptosporidiosis, isosporiasis, cyclosporiasis, microsporidiosis, ascariasis, trichuriasis, ancylostomiasis, strongyloidiasis, toxocariasis, trichinosis, lymphatic filariasis, onchocerciasis, filariasis, schistosomiasis, and dermatitis caused by animal schistosomes.

Examples of immunodeficiency disorders may include, but are not limited to, those described in U.S. application no. 11/289,723, filed November 30, 2005. Specific examples may include, but not limited to, adenosine deaminase deficiency, antibody deficiency with normal or elevated Igs, ataxia-telangiectasia, bare lymphocyte syndrome, common variable immunodeficiency, Ig deficiency with hyper-IgM, Ig heavy chain deletions, IgA deficiency, immunodeficiency with thymoma, reticular dysgenesis, Nezelof syndrome, selective IgG subclass deficiency, transient hypogammaglobulinemia of infancy, Wiscott-Aldrich syndrome, X-linked agammaglobulinemia, X-linked severe combined immunodeficiency.

Examples of CNS disorders may include, but are not limited to, those described in U.S. publication no. 2005/0143344, published June 30, 2005. Specific examples may include, but are not limited to, Amyotrophic Lateral Sclerosis, Alzheimer Disease, Parkinson Disease, Huntington's Disease, Multiple Sclerosis other neuroimunological disorders such as Tourette Syndrome, delirium, or disturbances in consciousness that occur over a short period of time, and amnestic disorder, or discreet memory impairments that occur in the absence of other central nervous system impairments.

Examples of CNS injuries and related syndromes may include, but are not limited to, those described in U.S. publication no. 2006/0122228, published June 8, 2006. Specific examples may include, but are not limited to, CNS injury/damage and related syndromes, including, but are not limited to, primary brain injury, secondary brain injury, traumatic brain injury, focal brain injury, diffuse axonal injury, head injury, concussion, post-concussion syndrome, cerebral contusion and laceration, subdural hemotoma, epidural hemotoma, post-traumatic epilepsy, chronic vegetative state, complete SCI, incomplete SCI, acute SCI, subacute SCI, chronic SCI, central cord syndrome, Brown-SEQUARD syndrome, anterior cord syndrome, conus medullaris syndrome, cauda equina syndrome, neurogenic shock, spinal shock, altered level of consciousness, headache, nausea, emesis, memory loss, dizziness,
diplopia, blurred vision, emotional lability, sleep disturbances, irritability, inability to concentrate, nervousness, behavioral impairment, cognitive deficit, and seizure.

Other disease or disorders may include, but are not limited to, viral, genetic, allergic, and autoimmune diseases. Specific examples may include, but are not limited to, HIV, hepatitis, adult respiratory distress syndrome, bone resorption diseases, chronic pulmonary inflammatory diseases, dermatitis, cystic fibrosis, septic shock, sepsis, endotoxic shock, hemodynamic shock, sepsis syndrome, post ischemic reperfusion injury, meningitis, psoriasis, fibrotic disease, cachexia, graft versus host disease, graft rejection, auto-immune disease, rheumatoid spondylitis, Crohn's disease, ulcerative colitis, inflammatory-bowel disease, multiple sclerosis, systemic lupus erythematosus, ENL in leprosy, radiation damage, cancer, asthma, or hyperoxic alveolar injury.

Examples of atherosclerosis and related conditions may include, but are not limited to, those disclosed in U.S. publication no. 2002/0054899, published May 9, 2002. Specific examples may include, but are not limited to, various forms of conditions involving atherosclerosis, including restenosis after vascular intervention such as angioplasty, stenting, atherectomy and grafting. Various forms of vascular intervention may be contemplated herein, including diseases of the cardiovascular and renal system, such as, but not limited to, renal angioplasty, percutaneous coronary intervention (PCI), percutaneous transluminal coronary angioplasty (PTCA), carotid percutaneous transluminal angioplasty (PTA), coronary by-pass grafting, angioplasty with stent implantation, peripheral percutaneous transluminal intervention of the iliac, femoral or popliteal arteries, and surgical intervention using impregnated artificial grafts.

The following chart provides a listing of the major systemic arteries that may be in need of treatment:
<table>
<thead>
<tr>
<th>Artery</th>
<th>Body Areas Supplied</th>
</tr>
</thead>
<tbody>
<tr>
<td>Axillary</td>
<td>Shoulder and axilla</td>
</tr>
<tr>
<td>Brachial</td>
<td>Upper arm</td>
</tr>
<tr>
<td>Brachiocephalic</td>
<td>Head, neck, and arm</td>
</tr>
<tr>
<td>Celiac</td>
<td>Divides into left gastric, splenic, and hepatic arteries</td>
</tr>
<tr>
<td>Common carotid</td>
<td>Neck</td>
</tr>
<tr>
<td>Common iliac</td>
<td>Divides into external and internal iliac arteries</td>
</tr>
<tr>
<td>Coronary</td>
<td>Heart</td>
</tr>
<tr>
<td>Deep femoral</td>
<td>Thigh</td>
</tr>
<tr>
<td>Digital</td>
<td>Fingers</td>
</tr>
<tr>
<td>Dorsalis pedis</td>
<td>Foot</td>
</tr>
<tr>
<td>External carotid</td>
<td>Neck and external head regions</td>
</tr>
<tr>
<td>External iliac</td>
<td>Femoral artery</td>
</tr>
<tr>
<td>Femoral</td>
<td>Thigh</td>
</tr>
<tr>
<td>Gastric</td>
<td>Stomach</td>
</tr>
<tr>
<td>Hepatic</td>
<td>Liver, gallbladder, pancreas, and duodenum</td>
</tr>
<tr>
<td>Inferior mesenteric</td>
<td>Descending colon, rectum, and pelvic wall</td>
</tr>
<tr>
<td>Internal carotid</td>
<td>Neck and internal head regions</td>
</tr>
<tr>
<td>Internal iliac</td>
<td>Rectum, urinary bladder, external genitalia, buttocks muscles, uterus and vagina</td>
</tr>
<tr>
<td>Left gastric</td>
<td>Esophagus and stomach</td>
</tr>
<tr>
<td>Middle sacral</td>
<td>Sacrum</td>
</tr>
<tr>
<td>Ovarian</td>
<td>Ovaries</td>
</tr>
<tr>
<td>Palmar arch</td>
<td>Hand</td>
</tr>
<tr>
<td>Peroneal</td>
<td>Calf</td>
</tr>
<tr>
<td>Popliteal</td>
<td>Knee</td>
</tr>
<tr>
<td>Posterior tibial</td>
<td>Calf</td>
</tr>
<tr>
<td>Pulmonary</td>
<td>Lungs</td>
</tr>
<tr>
<td>Radial</td>
<td>Forearm</td>
</tr>
<tr>
<td>Renal</td>
<td>Kidney</td>
</tr>
<tr>
<td>Splenic</td>
<td>Stomach, pancreas, and spleen</td>
</tr>
<tr>
<td>Subclavian</td>
<td>Shoulder</td>
</tr>
<tr>
<td>Superior mesenteric</td>
<td>Pancreas, small intestine, ascending and transverse colon</td>
</tr>
<tr>
<td>Testicular</td>
<td>Testes</td>
</tr>
<tr>
<td>Ulnar</td>
<td>Forearm</td>
</tr>
</tbody>
</table>

Examples of dysfunctional sleep and related syndromes may include, but are not limited to, those disclosed in U.S. publication no. 2005/0222209A1, published October 6, 2005.
Specific examples may include, but are not limited to, snoring, sleep
apnea, insomnia, narcolepsy, restless leg syndrome, sleep terrors, sleep walking, sleep eating, and dysfunctional sleep associated with chronic neurological or inflammatory conditions. Chronic neurological or inflammatory conditions, include, but are not limited to, Complex Regional Pain Syndrome, chronic low back pain, musculoskeletal pain, arthritis, radiculopathy, pain associated with cancer, fibromyalgia, chronic fatigue syndrome, visceral pain, bladder pain, chronic pancreatitis, neuropathies (diabetic, post-herpetic, traumatic or inflammatory), and neurodegenerative disorders such as Parkinson's Disease, Alzheimer's Disease, amyotrophic lateral sclerosis, multiple sclerosis, Huntington's Disease, bradykinesia, muscle rigidity, parkinsonian tremor; parkinsonian gait; motion freezing; depression; defective long-term memory, Rubinstein-Taybi syndrome (RTS); dementia; postural instability; hypokinetic disorders; synuclein disorders; multiple system atrophies; striatonigral degeneration; olivopontocerebellar atrophy; Shy-Drager syndrome; motor neuron disease with parkinsonian features; Lewy body dementia; Tau pathology disorders; progressive supranuclear palsy; corticobasal degeneration; frontotemporal dementia; amyloid pathology disorders; mild cognitive impairment; Alzheimer disease with parkinsonism; Wilson disease; Hallervorden-Spatz disease; Chediak-Hagashi disease; SCA-3 spinocerebellar ataxia; X-linked dystonia parkinsonism; prion disease; hyperkinetic disorders; chorea; ballismus; dystonia tremors; Amyotrophic Lateral Sclerosis (ALS); CNS trauma and myoclonus.

Examples of hemoglobinopathy and related disorders may include, but are not limited to, those described in U.S. publication no. 2005/0143420A1, published June 30, 2005.

Specific examples may include, but are not limited to, hemoglobinopathy, sickle cell anemia, and any other disorders related to the differentiation of CD34+ cells.

Examples of TNFa related disorders may include, but are not limited to, those described in WO 98/03502 and WO 98/54170.

Specific examples may include, but are not limited to: endotoxemia or toxic shock syndrome: cachexia; adult respiratory distress syndrome; bone resorption diseases such as arthritis; hypercalcemia; Graft versus Host Reaction; cerebral malaria; inflammation; tumor growth; chronic pulmonary inflammatory diseases; reperfusion injury; myocardial infarction; stroke; circulatory shock; rheumatoid arthritis; Crohn's disease; HIV infection and AIDS; other disorders such as rheumatoid arthritis, rheumatoid spondylitis, osteoarthritis, psoriatic arthritis and other arthritic conditions, septic shock, sepsis, endotoxic shock, graft versus host disease, wasting, Crohn's disease, ulcerative colitis, multiple sclerosis, systemic lupus erythematosus, ENL in leprosy, HIV, AIDS, and opportunistic infections in AIDS; disorders such as septic shock, sepsis, endotoxic shock,hemodynamic shock and sepsis syndrome, post ischemic reperfusion injury, malaria, mycobacterial infection, meningitis, psoriasis, congestive heart failure, fibrotic disease, cachexia, graft rejection, oncogenic or cancerous conditions, asthma, autoimmune disease, radiation damages, and hyperoxic alveolar injury; viral infections, such as those caused by the herpes viruses; viral conjunctivitis; or atopic dermatitis.
In other embodiments, the potential use of compounds provided herein in various immunological applications such as vaccine adjuvants, including anticancer vaccine adjuvants, as disclosed in U.S. Provisional Application No. 60/712,823, filed September 1, 2005, may be also encompassed. These embodiments may also relate to the potential uses of compounds provided herein in combination with vaccines to treat or prevent cancer or infectious diseases, and other various potential uses of immunomodulatory compounds such as reduction or desensitization of allergic reactions.

Doses of a compound provided herein, or a pharmaceutically acceptable salt, solvate, clathrate, stereoisomer or prodrug thereof, vary depending on factors such as: specific indication that may potentially be treated, prevented, or managed; age and condition of a patient; and amount of second active agent used, if any. Generally, a compound provided herein, or a pharmaceutically acceptable salt, solvate, clathrate, stereoisomer or prodrug thereof, may be used in an amount of from about 0.1 mg to about 500 mg per day, and may be adjusted in a conventional fashion (e.g., the same amount administered each day of the treatment, prevention or management period), in cycles (e.g., one week on, one week off), or in an amount that increases or decreases over the course of treatment, prevention, or management. In other embodiments, the dose may be from about 1 mg to about 300 mg, from about 0.1 mg to about 150 mg, from about 1 mg to about 200 mg, from about 10 mg to about 100 mg, from about 0.1 mg to about 50 mg, from about 1 mg to about 50 mg, from about 10 mg to about 50 mg, from about 20 mg to about 30 mg, or from about 1 mg to about 20 mg.

4.3 SECOND ACTIVE AGENTS

A compound provided herein, or a pharmaceutically acceptable salt, solvate, prodrug, clathrate, or stereoisomer thereof, may potentially be combined with other pharmacologically active compounds ("second active agents") in methods and compositions provided herein. Certain combinations may potentially work synergistically in the treatment of particular types of diseases or disorders, and conditions and symptoms associated with such diseases or disorders. A compound provided herein, or a pharmaceutically acceptable salt, solvate, clathrate, stereoisomer or prodrug thereof, may also potentially work to alleviate adverse effects associated with certain second active agents, and vice versa.

One or more second active ingredients or agents may potentially be used in the methods and compositions provided herein. Second active agents may be large molecules (e.g., proteins) or small molecules (e.g., synthetic inorganic, organometallic, or organic molecules).

Examples of large molecule active agents may 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, SGN-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; lyosphosphatidic acid acyltransferase inhibitors; IKB kinase
inhibitors; p38MAPK inhibitors; EGFR inhibitors (such as, for example, gefitinib and erlotinib HCL); HER-2 antibodies (such as, for example, trastuzumab (Herceptin®) and pertuzumab (Omnitarg™)); VEGFR antibodies (such as, for example, bevacizumab (Avastin™)); VEGFR inhibitors (such as, for example, flk-1 specific kinase inhibitors, SU5416 and ptk787/zk222584);
P13K inhibitors (such as, for example, wortmannin); C-Met inhibitors (such as, for example, PHA-665752); monoclonal antibodies (such as, for example, rituximab (Rituxan®), tositumomab (Bexxar®), edrecolomab (Panorex®) and G250); and anti-TNF-α antibodies. Examples of small molecule active agents may include, but are not limited to, anticancer agents and antibiotics (e.g., clarithromycin).

Specific second active compounds that may potentially be combined with compounds provided herein vary depending on the specific indication that may potentially be treated, prevented or managed.

For instance, for the potential treatment, prevention or management of cancer, second active agents may include, but are not limited to: semaxanib; cyclosporin; etanercept; doxycycline; bortezomib; aciclovir; aclarubicin; acodazole hydrochloride; acronine; adoselezin; aldesleukin; altretamine; ambomycin; ametantrone acetate; amsacrine; anastrozole; anthramycin; asparaginase; asperlin; azacitidine; azetepa; azotomycin; batimatstat; benzodepa; bicalutamide; bisantrene hydrochloride; bisnafide dimesylate; bizelesin; bleomycin sulfate; brequinar sodium; bropirimine; busulfan; caetinomycin; calusterone; caracemide; carbetimer; carboplatin; carmustine; carubcin hydrochloride; carzelesin; cedefingol; celecoxib; chlorambucil; cirolemycin; cisplatin; cladribine; crisnatonol mesylate; cyclophosphamide; ctyarabine; dacarbazine; daetinomycin; daunorubicin hydrochloride; decentbine; dexormaplatin; dezaguaniine; dezaguaniine mesylate; diaziquone; docetaxel; doxorubicin; doxorubicin hydrochloride; droloxifene; droloxifene citrate; dromostanolone propionate; duazomycin; edatrexate; eslornithine hydrochloride; esamitrectin; enloplatin; enpromate; epipropidine; epirubicin hydrochloride; erbulazole; esorubicin hydrochloride; estramustine; estramustine phosphate sodium; etanidazole; etoposide; etoposide phosphate; etoprine; fadrozole hydrochloride; fazarabine; fenretinide; floxuridine; fludarabine phosphate; fluorouracil; fluorocitabin; fosquidone; fostricin sodium; gemcitabine; gemcitabine hydrochloride; hydroxyurea; idarubicin hydrochloride; ifosfamide; ilmofosine; iproplatin; irinotecan; irinotecan hydrochloride; lanreotide acetate; letrazole; leuprolide acetate; liraizole hydrochloride; lometrexol sodium; lomustine; losoxantrone hydrochloride; masoproocol; maytansine; mechlorethamine hydrochloride; megestrol acetate; melengestrol acetate; melphalan; menogaril; mercaptopurine; methotrexate; methotrexate sodium; metoprine; meturedepa; mitindomide; mitocargin; mitocromin; mitogillin; mitomalcin; mitomycin; mitosper; mitotane; mitoxantrone hydrochloride; myoephenolic acid; nocodazole; nogalamycin; ormaplatin; oxisuran; paclitaxel; pegasparagse; pemiycin; pentamustine; peplomycin sulfate; perfosfamide; pipobroman; piposulfan; piroxantrone hydrochloride; plicamycin; plemestane; pofimer sodium; porfiromycin; prednimustine; procarbazine hydrochloride; puromycin; puromycin hydrochloride; pyrazofurin; ribothe; safingol; safingol hydrochloride; semustine; simtrazene; sparfsate sodium; sparsomycin; spirogermanium
hydrochloride; spiromustine; spirolatin; streptonigrin; streptozocin; sulofenur; talismycin;
tecogalan sodium; taxotere; tegafur; teloxantrone hydrochloride; temoporfin; teniposide; teroxirone;
testolactone; thiamiprine; thioguanine; thiopeta; tiazofurin; tirapazamine; toremifene citrate;
trestolone acetate; triciribine phosphate; trimetrexate; trimetrexate glucuronate; triptorelin;
tubulozole hydrochloride; uracil mustard; urdepa; vaperotide; verteporfin; vinblastine sulfate;
vincristine sulfate; vindesine; vindesine sulfate; vinepidine sulfate; vингlycinate sulfate; vinleurosine sulfate; vinorelbine tartrate; vinrosidine sulfate; vinzolidine sulfate; vorozole; zeniplatin; zinostatin;
and zorubicin hydrochloride.

Other second agents may include, but are not limited to: 20-еpi-1,25 dihydroxyvitamin
D3; 5-ethynyluracil; abiraterone; aclacubacin; acylfulvene; adecylenol; adozelusin; aldesleukin;
ALL-TK antagonists; altretamine; ambambustine; amidox; amifostine; aminolevulinic acid;
amrubicin; amscaricine; anagrelide; anastrozole; andrographolide; angiogenesis inhibitors; antagonist
D; antagonist G; antarelix; anti-dorsalizing morphogenetic protein-1; antiandrogen, prostatic
carcinoma; antiestrogen; antineoplaston; antisense oligonucleotides; aphidicolin glycinate; apoptosis
gene modulators; apotosis regulators; apurinic acid; ara-CDP-DL-PTBA; arginine deaminase;
asulacrine; atamestan; atrumistine; axinastatin 1; axinastatin 2; axinastatin 3; azasetron; azatoxin;
azatyrosine; baccatin III derivatives; balanol; batimatstat; BCR/ABL antagonists; benzochlorins;
benzoylstauroporine; beta lactam derivatives; beta-alethine; betaclamycin B; betulinic acid; bFGF
inhibitor; bicalutamide; bisantrene; bisaziridinylpermine; bisafide; bistratene A; bizelesin;
brefatate; bropirimine; budotitane; buthionine sulfoximine; calcipotriol; calphostin C; camptothecin
derivatives; capecitabine; carboxamide-amino-triazole; carboxamidotriazole; CaRest M3; CARN
700; cartilage derived inhibitor; carzelesin; casein kinase inhibitors (ICOS); castanospermine;
cecropin B; cetrorelix; chlorins; chloroquinoxaline sulfonamide; cicaprost; cis-porphyrin; cladrubine;
clomifene analogues; clotrimazole; collismycin A; collismycin B; combrestatin A4; combrestatin
analogue; conagenin; crambesicidin 816; crisatotol; cryptophycin B; cryptophycin A derivatives;
curacin A; cyclopentanthraquinones; cycloplatan; cypemycin; cytarabine ocfosfate; cytolytic factor;
cytostatin; dacliximab; decitabine; dehydrodideimin B; desolrelin; dexamethasone; dextosfamidade;
dexrazozone; dexverapamili; diaziquone; didemmin B; didox; diethylnorspermine; dihydro-5-azacytidine; dihydroxanol, 9-; dioxamycin; diphenyl spiromustine; docetaxel; documents;
dolasetron; doxifuridin; doxorubicin; droloxifene; dromobolin; duocarmycin SA; ebsele;
ecomustine; edelfosine; edrecolomab; eflornithine; elemene; emitefur; epirubicin; epipristide;
estramustine analogue; estrogen agonists; estrogen antagonists; etanidazole; etoposide phosphate;
exemestane; fadrozole; fazarabine; fenretinide; filgrastim; finasteride; flavopiridol; fleazolastine;
fluasterone; fludarabine; fluorouracunorucin hydrochloride; forfenimus; fornestrate; fornitsain;
fotemustine; gadolinium texaphyrin; gallium nitrate; galocitabine; ganirelix; gelatinase inhibitors;
gemcitabine; glutathione inhibitors; hepsulfam; heregulin; hexamethylene bisacetamide; hypercin;
ibandronic acid; idarubicin; idoxifene; idramantone; ilmosofine; ilomastat; imatinib (Gleevec®);
imiquimod; immunostimulant peptides; insulin-like growth factor-1 receptor inhibitor; interferon
agonists; interferons; interleukins; iobenguane; iododoxorubicin; ipomeanol, 4-; iroplact; irsogladine; isobengazole; isohomalicondrin B; itasetron; jasplakinolide; kahalalide F; lamellarin-N triacetate; lanreotide; leinamycin; lenogastatin; lentilian sulfate; leptolstatin; letrazole; leukemia inhibiting factor; leukocyte alpha interferon; leuprolide+estrogen+progesterone; leupreolin; levamisole; liaroze; linear polyamine analogue; lipophilic disaccharide peptide; lipophilic platinum compounds; lissoclinamide 7; lobaplatin; lombicine; lometrexol; lonidamine; losoxantrone; lroxirbine; lurtotecan; lutetium texaphyrin; lysofylline; lytic peptides; maitansine; mannostatin A; marimastat; masoprocol; maspin; matrilysin inhibitors; matrix metalloproteinase inhibitors; menogaril; merbarone; meterelin; methioninase; metoclopramide; MIF inhibitor; mifepristone; miltefosine; mirimostim; mitoguazone; mitolactol; mitomycin analogues; mitonafide; mitotoxin fibroblast growth factor-saporin; mitoxantrone; mofarotene; molgramostim; Erbitux; human choriionic gonadotrophin; monophosphoryl lipid A+mycobacterium cell wall sk; mopidamol; mustard anticancer agent; mycaperoxide B; mycobacterial cell wall extract; myriaporone; N-acetyldinaline; N-substituted benzamides; nafarelin; nagrestip; naloxone+pentazocine; napavin; naphtherpin; nartogastim; nedaplatin; nemorubicin; neridronic acid; nilutamide; nisamycin; nitric oxide modulators; nitroproxide antioxidant; nitrullyn; oblimersen (Genasense®); O6-benzylguanine; octreotide; okicenone; oligonucleotides; onapristone; ondansetron; ondansetron; oracin; oral cytokine inducer; ormaplatin; osaterone; oxaliplatin; oxauxvomycyn; paclitaxel; paclitaxel analogues; paclitaxel derivatives; palauamine; palmitoylrhizin; pamidronic acid; panaxytril; panomifene; parabactin; pazelliptine; pegaspargase; peldesine; pentosan polysulfate sodium; pentostatin; pentrozo; perflubron; perfosamide; perillyl alcohol; phenazinomycin; phenylacetate; phosphatase inhibitors; picibanil; pilocarpine hydrochloride; pirarubicin; piritrexim; placetin A; placetin B; plasminogen activator inhibitor; platinum complex; platinum compounds; platinum-triamine complex; porfimer sodium; porfiromycin; prednisone; propyl bis-acridone; prostaglandin J2; proteasome inhibitors; protein A-based immune modulator; protein kinase C inhibitor; protein kinase C inhibitors; microalgal; protein tyrosine phosphatase inhibitors; purine nucleoside phosphorylase inhibitors; purpurins; pyrazoloacridine; pyridoxylated hemoglobin polyoxyethylene conjugate; raf antagonists; raltitrexed; ramisetron; ras farnesyl protein transferase inhibitors; ras inhibitors; ras-GAP inhibitor; retelliptine demethylated; rhenium Re 186 etidronate; rhizoxin; ribozymes; RJ-1 retinamide; rohitukine; romurtide; roquinimex; rubiginone B1; ruboxyl; safingol; saintopin; SarCNu; sarco phytol A; sargramostim; Sdi 1 mimetics; semustine; senescence derived inhibitor 1; sense oligonucleotides; signal transduction inhibitors; sizofiran; sobuzoxane; sodium borocaptate; sodium phenylacetate; solventol; somatomedins binding protein; sonermin; sparfosic acid; spicamycin D; spiromustine; splenopentin; spongistatin 1; squalamine; stipiamide; stromelysin inhibitors; sulfinosine; superactive vasoactive intestinal peptide antagonist; suradista; suramin; swainsonine; tallimustine; tamoxifen methiodide; tauromustine; tazarotene; te cogalan sodium; tegafur; tellurapyrylim; telomerase inhibitors; temoporfin; teniposide; tetrachlorodecaoxide; tetrazomine; thaliblastin; thiocoraline; thrombopoietin; thrombopoietin mimetic; thymalfasin;
thymopoietin receptor agonist; thymotrinan; thyroid stimulating hormone; tin ethyl etiopurpurin; tirapazamine; titanocene dichloride; topsentin; toremifene; translation inhibitors; tretinoin; triacetyluridine; triciribine; trimetrexate; triptorelin; tropisetron; turosteride; tyrosine kinase inhibitors; tyrphostins; UBC inhibitors; ubenimex; urogenital sinus-derived growth inhibitory factor; urokinase receptor antagonists; vapreotide; variolin B; velaresol; veramine; verdins; verteoporfin; vinorelbine; vinxaltine; vitaxin; vorozole; zanoterone; zeniplatin; zilascorb; and zinostatin stimalamer.

Specific second active agents may include, but are not limited to, 2-methoxyestradiol, telomestatin, inducers of apoptosis in multiple myeloma cells (such as, for example, TRAIL), statins, semaxanib, cyclosporin, etanercept, doxycycline, bortezomib, oblimersen (Genasense®), remicade, docetaxel, celecoxib, melphalan, dexamethasone (Decadron®), steroids, gemcitabine, cisplatinum, temozolomide, etoposide, cyclophosphamide, temodar, carboplatin, procarbazine, gliadel, tamoxifen, topotecan, methotrexate, Arista®, taxol, taxotere, fluorouracil, leucovorin, irinotecan, Xeloda™, CPT-11, interferon alpha, pegylated interferon alpha (e.g., PEG INTRON-A), capecitabine, cisplatin, thiotepa, fludarabine, carboplatin, liposomal daunorubicin, cytarabine, doxetaxol, paclitaxel, vinblastine, IL-2, GM-CSF, dacarbazine, vinorelbine, zoledronic acid, palmitonate, biaxin, busulphan, prednisone, bisphosphonate, arsenic trioxide, vincristine, doxorubicin (Doxil®), paclitaxel, ganciclovir, adriamycin, estramustine sodium phosphate (Emcyt®), sulindac, and etoposide.

In another embodiment, examples of specific second agents according to the indications that may potentially be treated, prevented, or managed may be found in the following references: U.S. patent nos. 6,281,230 and 5,635,517; U.S. publication nos. 2004/0220144, 2004/0190609, 2004/0087546, 2005/0203142, 2004/0091455, 2005/0100529, 2005/0214328, 2005/0239842, 2006/0154880, 2006/0122228, and 2005/0143344; and U.S. provisional application no. 60/631,870.

Examples of second active agents that may be used for the potential treatment, prevention and/or management of pain may include, but are not limited to, conventional therapeutics used to treat or prevent pain such as antidepressants, anticonvulsants, antihypertensives, anxiolytics, calcium channel blockers, muscle relaxants, non-narcotic analgesics, opioid analgesics, anti-inflammatories, cox-2 inhibitors, immunomodulatory agents, alpha-adrenergic receptor agonists or antagonists, immunosuppressive agents, corticosteroids, hyperbaric oxygen, ketamine, other anesthetic agents, NMDA antagonists, and other therapeutics found, for example, in the Physician's Desk Reference 2003. Specific examples may include, but are not limited to, salicylic acid acetate (Aspirin®), celecoxib (Celebrex®), Enbrel®, ketamine, gabapentin (Neurontin®), phenytoin (Dilantin®), carbamazepine (Tegretol®), oxcarbazepine (Trileptal®), valproic acid (Depakene®), morphone sulfate, hydromorphone, prednisone, griseofulvin, penthonium, alendronate, dyphenhydramide, guanethidine, ketorolac (Acular®), thyrocaciton, dimethylsulfoxide (DMSO), clonidine (Catapress®), bretulium, ketanserin, reserpine, droperidol, atropine, phenolamine, bupivacaine,
lidocaine, acetaminophen, nortriptyline (Pamelor®), amitriptyline (Elavil®), imipramine (Tofranil®),
doxepin (Sinequan®), clomipramine (Anafranil®), fluoxetine (Prozac®), sertraline (Zoloft®),
naproxen, nefazodone (Serzone®), venlafaxine (Effexor®), trazodone (Desyrel®), bupropion
(Wellbutrin®), mexitelinite, nifedipine, propranolol, tramadol, lamotrigine, vioxx, ziconotide,
ketamine, dextromethorphan, benzodiazepines, bacofoil, tizanidine and phenoxybenzamine.

Examples of second active agents that may be used for the potential treatment, prevention
and/or management of macular degeneration and related syndromes may include, but are not limited to, a
steroid, a light sensitizer, an integrin, an antioxidant, an interferon, a xanthine derivative, a growth
hormone, a neurotrophic factor, a regulator of neovascularization, an anti-VEGF antibody, a
prostaglandin, an antibiotic, a phytoestrogen, an anti-inflammatory compound or an
antiangiogenesis compound, or a combination thereof. Specific examples may include, but are not
limited to, verteporfin, purlytin, an angiostatic steroid, rhuFab, interferon-2α, pentoxifylline, tin
etiopurpurin, motexafin, lutentin, lutetium, 9-fluoro-11,21-dihydroxy-16,
17-1-methylethylidinebis(oxy)pregna-1,4-diene-3,20-dione, latanoprost (see U.S. Patent No.
6,225,348), tetracycline and its derivatives, rifamycin and its derivatives, macrofides, metronidazole
(U.S. Patent Nos. 6,218,369 and 6,015,803), genistein, genistin, 6'-O-Mal genistin, 6'-O-Ac
genistin, daidzein, daidzin, 6'-O-Mal daidzin, 6'-O-Ac daidzin, glycitein, glycitin, 6'-O-Mal
glycitin, biochanin A, formononetin (U.S. Patent No. 6,001,368), triamcinolone acetonide,
dexamethasone (U.S. Patent No. 5,770,589), thalidomide, glutathione (U.S. Patent No. 5,632,984),
20 basic fibroblast growth factor (bFGF), transforming growth factor b (TGF-b), brain-derived
neurotrophic factor (BDNF), plasminogen activator factor type 2 (PAI-2), EYE101 (Eyetech
Pharmaceuticals), LY333531 (Eli Lilly), Miravant, and RETISERT implant (Bausch & Lomb).

Examples of second active agents that may be used for the potential treatment, prevention
and/or management of skin diseases may include, but are not limited to, keratolytics, retinoids, α-hydroxy
acids, antibiotics, collagen, botulinum toxin, interferon, steroids, and immunomodulatory agents. Specific
eXamples may include, but are not limited to, 5-fluorouracil, masoprocol, trichloroacetic acid,
salicylic acid, lactic acid, ammonium lactate, urea, retinoin, isotretinoin, antibiotics, collagen,
botulinum toxin, interferon, corticosteroid, transretinoic acid and collagens such as human placental
collagen, animal placental collagen, Dermalogen, AlloDerm, Fascia, Cynectra, Autologen, Zyderm,
Zyplast™, Resoplast, and Isolagen.

Examples of second active agents that may be used for the potential treatment, prevention
and/or management of pulmonary hypertension and related disorders may include, but are not limited to,
anticoagulants, diuretics, cardiac glycosides, calcium channel blockers, vasodilators, prostacyclin
analogues, endothelin antagonists, phosphodiesterase inhibitors (e.g., PDE V inhibitors),
endopeptidase inhibitors, lipid lowering agents, thromboxane inhibitors, and other therapeutics
known to reduce pulmonary artery pressure. Specific examples may include, but are not limited to,
warfarin (Coumadin®), a diuretic, a cardiac glycoside, digoxin-oxygen, diltiazem, nifedipine, a
vasodilator such as prostacyclin (e.g., prostaglandin I2 (PGI2), epoprostenol (EPO, Floran®), treprostinil (Remodulin®), nitric oxide (NO), bosentan (Tracleer®), amlopidine, epoprostenol (Flolan®), treprostinil (Remodulin®), prostacyclin, tadalafl (Cialis®), simvastatin (Zocor®), omapatrilat (Vanlev®), irbesartan (Avapro®), pravastatin (Pravachol®), digoxin, L-arginine, i洛prost, betaprost, and sildenafil (Viagra®).

Examples of second active agents that may be used for the potential treatment, prevention and/or management of asbestos-related disorders may include, but are not limited to, anthracycline, platinum, alkylating agent, oblimersen (Genasense®), cisplatinum, cyclophosphamide, temodar, carboplatin, procarbazine, gliadel, tamoxifen, topotecan, methotrexate, taxotere, irinotecan, capecitabine, cisplatin, thiota, fludarabine, carboplatin, liposomal daunorubicin, cytarabine, doxetaxel, pacilitaxel, vinblastine, IL-2, GM-CSF, dacarbazine, vinorelbine, zoledronic acid, palmitronate, biaxin, busulphan, prednisone, bisphosphonate, arsenic trioxide, vincristine, doxorubicin (Doxil®), paclitaxel, ganciclovir, adriamycin, bleomycin, hyaluronidase, mitomycin C, mepacrine, thiota, tetracycline and gemcitabine.

Examples of second active agents that may be used for the potential treatment, prevention and/or management of parasitic diseases may include, but are not limited to, chloroquine, quinine, quinidine, pyrimehtamine, sulfadiazine, doxycycline, clindamycin, mesloquine, halofantrine, primaquine, hydroxychloroquine, proguanil, atovaquone, azithromycin, suramin, pentamidine, melarsoprol, nifurtimox, benznidazole, amphotericin B, pentavalent antimony compounds (e.g., sodium stibogluconurate), interferon gamma, itraconazole, a combination of dead promastigotes and BCG, leucovorin, corticosteroids, sulfonamide, spiramycin, IgG (serology), trimethoprim, and sulfamethoxazole.

Examples of second active agents that may be used for the potential treatment, prevention and/or management of immunodeficiency disorders may include, but are not limited to: antibiotics (therapeutic or prophylactic) such as, but not limited to, ampicillin, tetracycline, penicillin, cephalosporins, streptomycin, kanamycin, and erythromycin; antivirals such as, but not limited to, amantadine, rimantadine, acyclovir, and ribavirin; immunoglobulin; plasma; immunologic enhancing drugs such as, but not limited to, levami sole and isoprinosine; biologics such as, but not limited to, gammaglobulin, transfer factor, interleukins, and interferons; hormones such as, but not limited to, thymic; and other immunologic agents such as, but not limited to, B cell stimulators (e.g., BAFF/BlyS), cytokines (e.g., IL-2, IL-4, and IL-5), growth factors (e.g., TGF-α), antibodies (e.g., anti-CD40 and IgM), oligonucleotides containing unmethylated CpG motifs, and vaccines (e.g., viral and tumor peptide vaccines).

Examples of second active agents that may be used for the potential treatment, prevention and/or management of CNS disorders may include, but are not limited to: opioids; a dopamine agonist or antagonist, such as, but not limited to, Levodopa, L-DOPA, cocaine, α-methyl-tyrosine, reserpine, tetrabenazine, benzotropine, pargylne, fenoldopam mesylate, cabergoline, pramipexole dihydrochloride, ropinorole, amantadine hydrochloride, selegiline hydrochloride, carbidopa,
pergolide mesylate, Sinemet CR, and Symmetrel; a MAO inhibitor, such as, but not limited to, 
irpniazid, clorgyline, phenelzine and isocarboxazid; a COMT inhibitor, such as, but not limited to, 
tolcapone and entacapone; a cholinesterase inhibitor, such as, but not limited to, physostigmine 
salicylate, physostigmine sulfate, physostigmine bromide, meostigmine bromide, neostigmine 
methylsulfate, ambenonim chloride, edrophonium chloride, tacrine, pralidoxime chloride, 
obidoxime chloride, trimeboxime bromide, diacetyl monoxim, endrophonium, pyridostigmine, and 
demecarium; an anti-inflammatory agent, such as, but not limited to, naproxen sodium, diclofenac 
sodium, diclofenac potassium, celecoxib, sulindac, oxaprozin, diflunisal, etodolac, meloxicam, 
ibuprofen, ketoprofen, nabumetone, refecoxib, methotrexate, lefluonimide, sulfasalazine, gold salts, 
Rho-D Immune Globulin, mycophenylate mofetil, cyclosporine, azathioprine, tacrolimus, 
basiliximab, daclizumab, salicylic acid, acetylsalicylic acid, methyl salicylate, diflunisal, salsalate, 
olsalazine, sulfasalazine, acetaminophen, indomethacin, sulindac, mefenamic acid, meclofenamate 
sodium, tolmetin, ketorolac, dichlofenac, flurbiprofen, oxaprozin, piroxicam, meloxicam, 
ampiroxicam, d Roxicam, pivoxicam, tenoxicam, phenylbutazone, oxyphenbutazone, antipyrine, 
aminopyrine, spazone, zileuton, aurothioglucose, gold sodium thiomalate, auranofin, methotrexate, 
colchicine, allopurinol, probenecid, sulfipyrazone and benz bromarone or betamethasone and other 
glucocorticoids; and an antiemetic agent, such as, but not limited to, metoclopramide, domperidone, 
prochlorperazine, promethazine, chlorgromazine, trimethobenzamidc, ondansetron, granisetron, 
hydroxyzine, acetylleucine monoethanolamine, alizapride, azasetron, benzquinamide, bietanautine, 
bromoprId, buclizine, clebopride, cyclozine, dimenhydrinate, diphenidol, dolasetron, meclizine, 
metallat, metopimazone, nabilone, oxyperndyl, pipamazine, scopolamine, sulpiride, 
tetrahydrocannabinol, thiethylperazine, thioproperazine, tropisetron, and a mixture thereof. 

Examples of second active agents that may be used for the potential treatment, 
prevention and/or management of CNS injuries and related syndromes may include, but are not limited to, 
immunomodulatory agents, immunosuppressive agents, antihypertensives, anticonvulsants, fibrinolytic 
agents, antiplatelet agents, antipsychotics, antidepressants, benzodiazepines, buspirone, amantadine, and 
other known or conventional agents used in patients with CNS injury/damage and related syndromes. 
Specific examples may include, but are not limited to: steroids (e.g., glucocorticoids, 
such as, but not limited to, methylprednisolone, dexamethasone and betamethasone); an anti-
inflammatory agent, including, but not limited to, naproxen sodium, diclofenac sodium, diclofenac 
potassium, celecoxib, sulindac, oxaprozin, diflunisal, etodolac, meloxicam, ibuprofen, ketoprofen, 
nabumetone, refecoxib, methotrexate, lefluonimide, sulfasalazine, gold salts, Rho-D Immune 
Globulin, mycophenylate mofetil, cyclosporine, azathioprine, tacrolimus, basiliximab, daclizumab, 
salicylic acid, acetylsalicylic acid, methyl salicylate, diflunisal, salsalate, olsalazine, sulfasalazine, 
acetonaphen, indomethacin, sulindac, mefenamic acid, meclofenamate sodium, tolmetin, 
ketoIolac, dichlofenac, flurbiprofen, oxaprozin, piroxicam, meloxicam, ampiroxicam, d Roxicam, 
pivoxicam, tenoxicam, phenylbutazone, oxyphenbutazone, antipyrine, aminopyrine, spazone, 
zileuton, aurothioglucose, gold sodium thiomalate, auranofin, methotrexate, colchicine, allopurinol,
probenecid, sulfinpyrazone and benz bromarone; a cAMP analog including, but not limited to, dBCAMP; an agent comprising a methylphenidate drug, which comprises L-threo-methylphenidate, d-threo-methylphenidate, dl-threo-methylphenidate, L-erythro-methylphenidate, d-erythro-methylphenidate, dl-erythro-methylphenidate, and a mixture thereof, and a diuretic agent such as, but not limited to, mannitol, furosemide, glycerol, and urea.

Examples of second active agent that may be used for the potential treatment, prevention and/or management of dysfunctional sleep and related syndromes may include, but are not limited to, a tricyclic antidepressant agent, a selective serotonin reuptake inhibitor, an antiepileptic agent (gabapentin, pregabaline, carbamazepine, oxcarbazepine, levetiracetam, topiramate), an antiarrhythmic agent, a sodium channel blocking agent, a selective inflammatory mediator inhibitor, an opioid agent, a second immunomodulatory compound, a combination agent, and other known or conventional agents used in sleep therapy. Specific examples may include, but are not limited to, Neurontin, oxycontin, morphine, topiramate, amitriptyline, nortriptyline, carbamazepine, Levodopa, L-DOPA, cocaine, a-methyl-tyrosine, reserpine, tetra benzamine, benzotropine, pargyline, fenoldopam mesylate, cabergoline, prami pexole dihydrochloride, ropinore, amantadine hydrochloride, selegiline hydrochloride, carbidopa, pergolide mesylate, Sinemet CR, Symmetrel, iproniazid, clorgyline, phennelzine, isocarboxazid, tolcapone, entacapone, physostigmine salisilate, physostigmine sulfate, physostigmine bromide, meostigmine bromide, neostigmine methylsulfate, ambenonin chloride, edrophonium chloride, tacrine, pralidoxime chloride, obidoxime chloride, trime doxime bromide, diacetyl monoxim, endrophonium, pyridostigmine, demecarium, napro xen sodium, diclofenac sodium, diclofenac potassium, celecoxib, sulindac, oxaprozin, diflunisal, etodolac, meloxicam, ibuprofen, ketoprofen, nabumetone, refexocib, methotrexate, leflunomide, sulfasalazine, gold salts, RHo-D Immune Gobulin, myophenolate mofetil, cyclosporine, azathioprine, tacrolimus, basiliximab, daclizumab, salicylic acid, acetylsalicylic acid, methyl salicylate, diflunisal, sal sale, olsalazine, sulfasalazine, acetaminophen, indomethacin, sulindac, m efenamic acid, meclofenamate sodium, tolmetin, ketorolac, diclofenac, fluribprofen, oxaprozin, piroxicam, meloxicam, ampi roxicam, dr oxicam, pivoxicam, tenoxicam, phenylbutazone, oxyphenbutazone, antipyrine, aminopyrine, apazone, zileuton, aurothioglucose, gold sodium thiomalate, aurano fin, methotrexate, colchicine, allopurinol, probenecid, sulfipyrazon e, benz bromarone, betamethasone and other glucocorticoids, metocolpromide, domperidone, prochlorperazine, promethazine, chlorpromazine, trimethobenzamide, ondansetron, granisetron, hydroxyzine, acetylleucine monoethanolamine, alizapride, azasetron, benzquinamide, bietaneutine, bromoprilde, buclizine, clebopride, cyclazine, dimenhydrinate, diphenidol, dolasetron, meclizine, methallatal, metopimazine, nabilone, oxyperdyl, pipamazine, scopalamine, sulpiride, tetrahydrocannabinol, thiethylperazine, thioproperazine, tropisetron, and a mixture thereof.

Examples of second active agents that may be used for the potential treatment, prevention and/or management of hemoglobinopathy and related disorders may include, but are not limited to: interleukins, such as IL-2 (including recombinant IL-II ("rIL2") and canarypox IL-2), IL-10, IL-12.
and IL-18; interferons, such as interferon alfa-2a, interferon alfa-2b, interferon alfa-n1, interferon alfa-n3, interferon beta-1a, and interferon gamma-1 b; and G-CSF; hydroxyurea; butyric acid or butyrate derivatives; nitrous oxide; hydroxy urea; HEMOXIN™ (NPRISAN™; see United States Patent No. 5,800,819); Gardos channel antagonists such as clotrimazole and triaryl methane derivatives; Deferoxamine; protein C; and transfusions of blood, or of a blood substitute such as Hemospantm or Hemospan™ PS (Sangart).

Administration of a compound provided herein, or a pharmaceutically acceptable salt, solvate, clathrate, stereoisomer or prodrug thereof, and the second active agents to a patient may 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 decomposing prior to entering the blood stream) and the disease that may potentially be treated. One of administration for compounds provided herein is oral. Routes of administration for the second active agents or ingredients are known to those of ordinary skill in the art. See, e.g., Physicians' Desk Reference (60th ed., 2006).

In one embodiment, the second active agent may be 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 that may potentially be treated or managed, the severity and stage of disease, and the amount(s) of compounds provided herein and any optional additional active agents concurrently administered to the patient.

As discussed elsewhere herein, also encompassed is a method that may potentially reduce, treat and/or prevent adverse or undesired effects associated with conventional therapy including, but not limited to, surgery, chemotherapy, radiation therapy, hormonal therapy, biological therapy and immunotherapy. Compounds provided herein and other active ingredients may potentially be administered to a patient prior to, during, or after the occurrence of the adverse effect associated with conventional therapy.

4.4 Cycling Therapy

In certain embodiments, the prophylactic or therapeutic agents provided herein may potentially be cyclically administered to a patient. Cycling therapy involves the administration of an active agent for a period of time, followed by a rest (i.e., discontinuation of the administration) for a period of time, and repeating this sequential administration. Cycling therapy may potentially 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 improve the efficacy of the treatment.

Consequently, in one embodiment, a compound provided herein may be 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. Cycling therapy may further allow the frequency, number, and length of dosing cycles to be increased. Thus, in another embodiment, a compound provided
herein may be administered for more cycles than are typical when it is administered alone. In yet another embodiment, a compound provided herein may be administered for a greater number of cycles than would typically cause dose-limiting toxicity in a patient to whom a second active ingredient is not also being administered.

In one embodiment, a compound provided herein may be administered daily and continuously for three or four weeks at a dose of from about 0.1 mg to about 500 mg per day, followed by a rest of one or two weeks. In other embodiments, the dose may be from about 1 mg to about 300 mg, from about 0.1 mg to about 150 mg, from about 1 mg to about 200 mg, from about 10 mg to about 100 mg, from about 0.1 mg to about 50 mg, from about 1 mg to about 50 mg, from about 10 mg to about 50 mg, from about 20 mg to about 30 mg, or from about 1 mg to about 20 mg, followed by a rest.

In one embodiment, a compound provided herein and a second active ingredient may be administered orally, with administration of the compound provided herein occurring 30 to 60 minutes prior to the second active ingredient, during a cycle of four to six weeks. In another embodiment, the combination of a compound provided herein and a second active ingredient may be administered by intravenous infusion over about 90 minutes every cycle.

Typically, the number of cycles during which the potential combination treatment is administered to a patient will be from about one to about 24 cycles, from about two to about 16 cycles, or from about four to about three cycles.

4.5 PHARMACEUTICAL COMPOSITIONS AND DOSAGE FORMS

Pharmaceutical compositions can be used in the preparation of individual, single unit dosage forms. Pharmaceutical compositions and dosage forms provided herein comprise a compound provided herein, or a pharmaceutically acceptable salt, solvate, stereoisomer, clathrate, or prodrug thereof. Pharmaceutical compositions and dosage forms can further comprise one or more excipients.

Pharmaceutical compositions and dosage forms provided herein can also comprise one or more additional active ingredients. Examples of optional second, or additional, active ingredients are disclosed in Section 4.3, above.

Single unit dosage forms provided herein 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 transcervicinal 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; suppositories; powders; aerosols (e.g., 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.

The composition, shape, and type of dosage forms 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 are used 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).

In one embodiment, 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, provided are pharmaceutical compositions and dosage forms that contain little, if any, lactose or 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.

Lactose-free compositions 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. In one embodiment, lactose-free dosage forms comprise active ingredients, microcrystalline cellulose, pregelatinized starch, and magnesium stearate.

Also provided are 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, NY, 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.

Anhydrous pharmaceutical compositions and dosage forms 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.

An anhydrous pharmaceutical composition should be prepared and stored such that its anhydrous nature is maintained. Accordingly, anhydrous compositions are, in one embodiment, 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.

Also provided are 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.

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. In one embodiment, dosage forms comprise a compound provided herein in an amount of from about 0.10 to about 500 mg. In other embodiments, dosage forms comprise a compound provided herein in an amount of about 0.1, 1, 2, 5, 7.5, 10, 12.5, 15, 17.5, 20, 25, 50, 100, 150, 200, 250, 300, 350, 400, 450, or 500 mg.

In other embodiments, 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 second active agent will depend on the specific agent used, the diseases or disorders that may potentially be treated or managed, and the amount(s) of a compound provided herein, and any optional additional active agents concurrently administered to the patient.

4.5.1 ORAL DOSAGE FORMS

Pharmaceutical compositions that are suitable for oral administration can be provided as discrete dosage forms, such as, but 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).

Oral dosage forms provided herein 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, diluents, granulating agents, lubricants, binders, and disintegrating agents.

In one embodiment, oral dosage forms are tablets or capsules, in which case solid excipients are employed. In another embodiment, tablets can be coated by standard aqueous or nonaqueous 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.

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.

Examples of excipients that can be used in oral dosage forms provided herein 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. 2208, 2906, 2910), microcrystalline cellulose, and mixtures thereof.

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 LM.

Examples of fillers suitable for use in the pharmaceutical compositions and dosage forms provided herein include, but are not limited to, talc, calcium carbonate (e.g., granules or powder), microcrystalline cellulose, powdered cellulose, dextrates, kaolin, mannitol, silicic acid, sorbitol, starch, pre-gelatinized starch, and mixtures thereof. The binder or filler in pharmaceutical compositions is, in one embodiment, present in from about 50 to about 99 weight percent of the pharmaceutical composition or dosage form.
Disintegrants may be used in the compositions 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 may be used to form solid oral dosage forms. The amount of disintegrant used varies based upon the type of formulation, and is readily discernible to those of ordinary skill in the art. In one embodiment, pharmaceutical compositions comprise from about 0.5 to about 15 weight percent of disintegrant, or from about 1 to about 5 weight percent of disintegrant.

Disintegrants that can be used in pharmaceutical compositions and dosage forms include, but are not limited to, agar-agar, alginic acid, calcium carbonate, microcrystalline cellulose, croscarmellose sodium, crospovidone, polacrilitin potassium, sodium starch glycolate, potato or tapioca starch, other starches, pre-gelatinized starch, other starches, clays, other algins, other celuloses, gums, and mixtures thereof.

Lubricants that can be used in pharmaceutical compositions and dosage forms 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, talc, hydrogenated vegetable oil (e.g., peanut oil, cottonseed 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 silica gel (AEROSIL200, manufactured by W.R. Grace Co. of Baltimore, MD), a coagulated aerosol of synthetic silica (marketed by Degussa Co. of Plano, TX), CAB-O-SIL (a pyrogenic silicon dioxide product sold by Cabot Co. of Boston, MA), and mixtures thereof. If used at all, lubricants may be used in an amount of less than about 1 weight percent of the pharmaceutical compositions or dosage forms into which they are incorporated.

In one embodiment, a solid oral dosage form comprises a compound provided herein, anhydrous lactose, microcrystalline cellulose, polyvinylpyrrolidone, stearic acid, colloidal anhydrous silica, and gelatin.

4.5.2 CONTROLLED RELEASE DOSAGE FORMS

Active ingredients provided herein 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. Patent Nos.: 3,843,770; 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. Such dosage forms can be used to provide slow or controlled-release of one or more active ingredients using, for example, hydropropylmethyl cellulose, other polymer matrices, gels, permeable membranes, osmotic systems, multilayer coatings, microparticles, liposomes, 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 agents provided herein. In one embodiment, provided are single unit dosage forms suitable for oral administration such as, but not limited to, tablets, capsules, gelcaps, and caplets that are adapted for controlled-release.

In one embodiment, controlled-release pharmaceutical products may potentially improve drug therapy over that achieved by their non-controlled counterparts. In another embodiment, the use of a 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 may include extended activity of the drug, reduced dosage frequency, and increased patient compliance. In addition, controlled-release formulations may 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.

In another embodiment, the controlled-release formulations are designed to initially release an amount of drug (active ingredient) that promptly produces the desired therapeutic or prophylactic effect, and gradually and continually release of other amounts of drug to maintain this level of therapeutic or prophylactic effect over an extended period of time. In one embodiment, in order to maintain a constant level of drug in the body, the drug can 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 compounds.

4.5.3 **PARENTERAL DOSAGE FORMS**

Parenteral dosage forms can be administered to patients by various routes including, but not limited to, subcutaneous, intravenous (including bolus injection), intramuscular, and intraarterial. In some embodiments, administration of a parenteral dosage form bypasses patients’ natural defenses against contaminants, and thus, in these embodiments, parenteral dosage forms are 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 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. For example, cyclodextrin and its derivatives may be used to potentially increase the solubility of a compound provided herein. See, e.g., U.S. Patent No. 5,134,127.

4.5.4 TOPICAL AND MUCOSAL DOSAGE FORMS

Topical and mucosal dosage forms provided herein include, but are not limited to, sprays, aerosols, solutions, emulsions, suspensions, eye drops or other ophthalmic preparations, 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 herein are well known to those skilled in the pharmaceutical arts, and depend on the particular tissue to which a given pharmaceutical composition or dosage form will be applied. In one embodiment, 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 non-toxic and pharmaceutically acceptable. Moisturizers or humectants can also be added to pharmaceutical compositions and dosage forms. Examples of additional ingredients are well known in the art. See, e.g., Remington's Pharmaceutical Sciences, 16th and 18th eds., Mack Publishing, Easton PA (1980 & 1990).

The pH of a pharmaceutical composition or dosage form may also be adjusted to improve delivery of one or more active ingredients. Also, the polarity of a solvent carrier, its ionic strength, or tonicity can be adjusted to improve delivery. Compounds such as stearates can also be added to pharmaceutical compositions or dosage forms to alter the hydrophilicity or lipophilicity of one or more active ingredients so as to improve delivery. In other embodiments, stearates can serve as a lipid vehicle for the formulation, as an emulsifying agent or surfactant, or as a delivery-enhancing or penetration-enhancing agent. In other embodiments, salts, solvates, prodrugs, clathrates, or stereoisomers of the active ingredients can be used to further adjust the properties of the resulting composition.

4.6 KITS

In one embodiment, active ingredients provided herein are not administered to a patient at the same time or by the same route of administration. In another embodiment, provided are kits which can simplify the administration of appropriate amounts of active ingredients.

In one embodiment, a kit comprises a dosage form of a compound provided herein. Kits can further comprise additional active ingredients 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, vinorelbine, 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 4.3).

In other embodiments, kits 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.

Kits 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, 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.

5. **EXAMPLES**

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

5.1 **3-(5-METHYL-4-OXO-4H-QUINAZOLIN-3-YL)-PIPERIDINE-2,6-DIONE**

![Chemical Structure](image)

**Step 1:** A mixture of 2-amino-6-methylbenzoic acid (10.75 g, 71.1 mmol) and CDI (10.75 g, 66.3 mmol) in acetonitrile (150 mL) was stirred at room temperature for 1 hour. To the suspension, was added 3-amino-piperidine-2,6-dione hydrogen chloride (10.75 g, 65.3 mmol) and sodium hydrogen carbonate (8.0 g, 95 mmol), and the mixture was heated at 50 °C for 18 hours. The suspension was cooled to room temperature, filtered, and washed with acetonitrile (50 mL), water (2 x 50 mL), methanol (50 mL), and ethyl acetate (50 mL) to give 2-amino-N-(2,6-dioxo-piperidin-3-yl)-6-methyl-benzamide as a white solid (9.89 g, 58% yield): $^1$H NMR (DMSO-d$_6$) $\delta$ 1.98-2.17 (m, 5H, CH$_2$, CH$_3$) 2.51-2.56 (m, 1H, CH$H$), 2.74-2.86 (m, 1H, CH$H$), 4.68-4.77 (m, 1H, CH$H$), 4.80 (s, 1H, CO), 7.42-7.47 (m, 3H, ArH)
NCH₃), 5.18 (s, 2H, NH₂), 6.38 (d, J = 7 Hz, 1H, Ar), 6.50 (d, J = 7 Hz, 1H, Ar), 6.94 (t; J = 7 Hz; 1H, Ar), 8.59 (d, J = 8 Hz, 1H, NH), 10.90 (s, 1H, NH); ¹³C NMR (DMSO-d₆) δ 19.14, 23.75, 30.99, 49.10, 112.37, 17.21, 122.28, 128.96, 134.61, 145.22, 168.36, 172.84, 173.00; LCMS: MH = 262.

**Step 2:** A solution of 2-amino-N-(2,6-dioxo-piperidin-3-yl)-6-methyl-benzamide (0.60 g, 2.2 mmol), trimethyl orthoformate (3 mL, 26.8 mmol), and p-toluene sulfonic acid (0.060 g) in acetonitrile (20 mL) was heated to reflux for 30 hours. The mixture was cooled to room temperature. To the mixture, water (75 mL) and ether (20 mL) were added, and the resulting mixture was stirred for 2 hours. The suspension was filtered and washed with water and ether (50 mL each) to give 3-(5-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione as a white solid (0.28 g, 47% yield): HPLC: Waters Symmetry C₁₈, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 30/70 CH₃CN/0.1% H₃PO₄, 3.08 min (99%); mp: 262-264 °C; ¹H NMR (DMSO-d₆) δ 2.09-2.16 (m, 1H, CHH), 2.62-2.84 (m, 6H, CH₂, CH₃, CHH, CHH), 5.42 (brs, 1H, NCH₂), 7.32 (d, J = 7 Hz, 1H, Ar), 7.52 (d, J = 8 Hz, 1H, Ar), 7.69 (t, J = 8 Hz, 1H, Ar), 8.30 (s, 1H, CH₂), 11.12 (s, 1H, NH); ¹³C NMR (DMSO-d₆) δ 22.35, 22.62, 30.88, 58.00, 119.81, 125.36, 129.57, 133.72, 140.15, 147.08, 149.07, 160.21, 169.91, 172.33, 172.44; LCMS: MH = 272; Anal. Calcd. for C₁₄H₁₃N₃O₂: C, 61.99; H, 4.83; N, 15.49. Found: C, 61.67; H, 4.40; N, 15.41.

**5.2 3-(2,5-DIMETHYL-4-OKXO-4H-QUINAZOLIN-3-YL)-PPIPERIDINE-2,6-DIONE**

![Chemical Structure](image)

A solution of 2-amino-N-(2,6-dioxo-piperidin-3-yl)-6-methyl-benzamide (1.00 g, 3.8 mmol) and triethyl orthoacetate (0.9 mL, 4.9 mmol) in DMF (10 mL) was heated to reflux for 1 hour. The mixture was cooled to room temperature. To the solution, Celite (40 mL) was added, and the solvent was removed in vacuo. The solid was loaded on a SIM and purified with ISCO flash gel chromatography (silica gel, CH₃OH/CH₂Cl₂) to give 3-(2,5-dimethyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione as an off-white solid (0.46 g, 43% yield): HPLC: Waters Symmetry C₁₈, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 25/75 CH₃CN/0.1% H₃PO₄, 2.95 min (96%); mp: 292-294 °C; ¹H NMR (DMSO-d₆) δ 2.11-2.18 (m, 1H, CHH₂), 2.55-2.65 (m, 2H, CH₂), 2.60 (s, 3H, CH₃), 2.69 (s, 3H, CH₃), 2.78-2.85 (m, 1H, CHH₂), 5.19 (dd, J = 6, 11 Hz, 1H, NCH₂), 7.25 (d, J = 8 Hz, 1H, Ar), 7.43 (d, J = 8 Hz, 1H, Ar), 7.64 (t, J = 8 Hz, 1H, Ar), 10.99 (s, 1H, NH); ¹³C NMR (DMSO-d₆) δ 20.82, 22.43, 23.32, 30.55, 56.33, 118.69, 124.73, 128.82, 133.72, 139.82, 148.34, 154.58, 161.03, 169.61, 172.60; LCMS: MH = 286; Anal. Calcd. for C₁₄H₁₃N₃O₂ + 1 H₂O: C, 59.26; H, 5.68; N, 13.66. Found: C, 59.26; H, 5.68; N, 13.66.
5.3 \( \text{3S-3-(2,5-DIMETHYL-4-OXO-4H-QUINAZOLIN-3-YL)-PIPERIDINE-2,6-DIONE} \)

![Chemical Structure]

**Step 1:** A stirred suspension of 2,5-dimethyl-benzo[d][1,3]oxazin-4-one (7.4 g, 42 mmol), 4S-4-amino-4-carbamoyl-butyric acid tert-butyl ester (H-Glu(\text{OtBu})-NH2) (10.0 g, 42 mmol), imidazole (6.3 g, 92 mmol) and triphenyl phosphite (13.2 mL, 50 mmol) in acetonitrile (100 mL) was heated to reflux for 21 hours. The mixture was allowed to cool to 30 °C. To the mixture, was added water (100 mL) and hexane (100 mL) to give three layers. The lower two layers were separated and extracted with methylene chloride (2 × 100 mL). All three organic layers were combined. To the solution, was added Celite (2 teaspoons). The solvent was removed \textit{in vacuo}. The solid was placed in a SIM and purified by ISCO column chromatography (Silica gel, CH\textsubscript{3}CN/CH\textsubscript{2}Cl\textsubscript{2}, 0% gradient to 50% in 20 min) to give 4S-4-carbamoyl-4-(2,5-dimethyl-4-oxo-4H-quinazolin-3-yl)-butyric acid tert-butyl ester as a white solid (12.9 g, 86% yield). The product was used in the next step without further purification.

**Step 2:** A suspension of 4S-4-carbamoyl-4-(2,5-dimethyl-4-oxo-4H-quinazolin-3-yl)-butyric acid tert-butyl ester (8.7 g, 24 mmol) and HCl in ether (60 mL, 2N, 120 mmol) was stirred at room temperature for 2 days. The solvent was removed \textit{in vacuo}. The solid was stirred with ether (50 mL) for 1 hour. The suspension was filtered and washed with ether (20 mL) to give a yellow solid. The solid was stirred in methanol (50 mL) overnight. The suspension was filtered and washed with methanol to give 4S-4-carbamoyl-4-(2,5-dimethyl-4-oxo-4H-quinazolin-3-yl)-butyric acid as a white solid (7.0 g, 96% yield). The product was used in the next step without further purification.

**Step 3:** To a stirred suspension of 4S-4-carbamoyl-4-(2,5-dimethyl-4-oxo-4H-quinazolin-3-yl)-butyric acid (7.2 g, 24 mmol) in methylene chloride (250 mL), was added thionyl chloride (7 mL, 96 mmol) using a syringe pump (2 mL/min) at -40 °C. After 10 minutes, pyridine (7.7 mL, 96 mmol) was added to the mixture using a syringe pump (2 mL/min). The mixture was stirred at -40 °C for 5 hours. To the mixture, was added water (20 mL). After 5 minutes, sodium hydrogen carbonate (sat 100 mL) was added to the mixture. After 10 minutes, the mixture was transferred to a 0 °C bath and kept for 30 minutes. The organic layer was separated and concentrated \textit{in vacuo} to give a white solid. The solid was mixed with the first aqueous layer, and the suspension was stirred for 10 minutes. The suspension was filtered and washed with water (50 mL), sodium hydrogen carbonate (sat 50 mL), and water (2 × 50 mL) to give an off-white solid. The solid was dissolved in acetonitrile (150 mL), and Celite (3 teaspoons) was added. The solvent was removed \textit{in vacuo}. The solid was distributed in three SIMs, and each SIM was purified by ISCO column chromatography (Silica gel, CH\textsubscript{3}CN/CH\textsubscript{2}Cl\textsubscript{2}, 0% gradient to 50% in 15 min) to give 3S-3(2,5-dimethyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione as a white solid (2.92 g, 43% yield).
yield): HPLC: Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 20/80 CH3CN/0.1% H3PO4, 4.50 min (99.8 %); Chiral HPLC: ChiralPak AD 1 mL/min, 240 nm, 50/50 iPrOH/hexane, 12.62 (99.93%) (S-isomer), 18.58 (0.07%) (R-isomer) 99.86%ee; mp: 241-243 °C; 1H NMR (DMSO-d6) δ 2.11-2.18 (m, 1H, CHH), 2.55-2.65 (m, 2H, CH2), 2.60 (s, 3H, CH3), 2.69 (s, 3H, CH3), 2.76-2.85 (m, 1H, CHH), 5.19 (dd, J = 6, 11 Hz, 1H, NCH), 7.25 (d, J = 8 Hz, 1H, Ar), 7.43 (d, J = 8 Hz, 1H, Ar), 7.64 (t, J = 8 Hz, 1H, Ar), 10.99 (s, 1H, NH); 13C NMR (DMSO-d6) δ 20.82, 22.43, 23.32, 30.55, 56.33, 118.69, 124.73, 128.82, 133.72, 139.82, 148.34, 154.58, 161.03, 169.61, 172.60; LCMS: MH = 286; Anal Calcd for C18H13N3O3 + 0.5 H2O: C, 61.22; H, 5.48; N, 14.28; H2O, 3.06. Found: C, 60.98; H, 5.54; N, 14.21; H2O, 2.89.

5.4 3R-3-(2,5-DIMETHYL-4-OXO-4H-QUINAZOLIN-3-YL)-PIPERIDINE-2,6-DIONE

![Chemical Structure](image)

**Step 1:** A stirred suspension of 2,5-dimethyl-benzo[d][1,3]oxazin-4-one (7.8 g, 45 mmol), 2R-2-amino-4-carbamoyl-butyric acid tert-butyl ester (9 g, 45 mmol), imidazole (3.6 g, 53 mmol) and triphenyl phosphite (17 mL, 65 mmol) in acetonitrile (100 mL) was heated to reflux for 21 hours. The mixture was allowed to cool to 30 °C. To the mixture, was added water (100 mL) and methylene chloride (200 mL). The aqueous layer was extracted with methylene chloride (200 mL). The combined organic layers was washed with sodium hydrogen carbonate (sat 100 mL). To the organic layer, was added Celite (2 teaspoons). The solvent was removed in vacuo. The solid was distributed in three SIMs, and each SIM was purified by ISCO column chromatography (Silica gel, CH3CN/CH2Cl2, 0% gradient to 50% in 20 min) to give 4R-4-carbamoyl-2-(2,5-dimethyl-4-oxo-4H-quinazolin-3-yl)-butyric acid tert-butyl ester as a white solid (3.4 g, 21% yield). The product was used in the next step without further purification.

**Step 2:** A suspension of 4R-4-carbamoyl-4-(2,5-dimethyl-4-oxo-4H-quinazolin-3-yl)-butyric acid tert-butyl ester (3.4 g, 9.4 mmol) and HCl in ether (50 mL, 2N, 100 mmol) was stirred at room temperature for 4 days. The solvent was removed in vacuo. To the solid, was added methanol (30 mL). The solvent was removed in vacuo again. The solid was stirred in methylene chloride (30 mL) overnight. The suspension was filtered and washed with methylene chloride (20 mL) to give 4R-4-carbamoyl-2-(2,5-dimethyl-4-oxo-4H-quinazolin-3-yl)-butyric acid as a yellow solid (2.6 g, 91% yield). The product was used in the next step without further purification.

**Step 3:** To a stirred suspension of 4R-4-carbamoyl-2-(2,5-dimethyl-4-oxo-4H-quinazolin-3-yl)-butyric acid (3.2 g, 11 mmol) in methylene chloride (130 mL), was added thionyl chloride (3.1 mL, 43 mmol) using a syringe pump (2 mL/min) at -40 °C. After 10 minutes, pyridine (3.5 mL, 43 mmol) was added using a syringe pump (2 mL/min). The mixture was stirred at -40 °C for 4 hours. To the mixture, was added water (20 mL). After 5 minutes, sodium hydrogen...
carbonate (sat 140 mL) was added to the mixture. After 10 minutes, the mixture was transferred to a 0 °C bath and kept for 30 minutes. The organic solvent was removed in vacuo. The suspension was filtered and washed with water (50 mL) to give an off-white solid. The solid was dissolved in methanol (150 mL), and Celite (2 teaspoons) was added. The solvent was removed in vacuo. The solid was distributed in two SIMs, and each SIM was purified by ISCO column chromatography (Silica gel, CH₃CN/CH₂Cl₂, 0% gradient to 50% in 15 min) to give 3R-3-(2,5-dimethyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione as a white solid (1.4 g, 46% yield): HPLC: Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 25/75 CH₃CN/0.1% H₃PO₄, 2.75 min (99.3%); Chiral HPLC: ChiralPak AD 1 mL/min, 240 nm, 50/50 iPrOH/hexane, 6.23 (4.22%) (S-isomer), 8.23 (95.38%) (R-isomer), 91.53% ee; mp: 280 °C (decomp); ¹H NMR (DMSO-d₆) δ 2.11-2.18 (m, 1H, CH₂), 2.55-2.65 (m, 2H, CH₂), 2.60 (s, 3H, CH₃), 2.69 (s, 3H, CH₃), 2.78-2.85 (m, 1H, CH₂), 5.19 (dd, J = 6, 11 Hz, 1H, NCH), 7.25 (d, J = 8 Hz, 1H, Ar), 7.43 (d, J = 8 Hz, 1H, Ar), 7.64 (t, J = 8 Hz, 1H, Ar), 10.99 (s, 1H, NH); ¹³C NMR (DMSO-d₆) δ 20.82, 22.43, 23.32, 30.55, 56.33, 118.69, 124.73, 128.82, 133.72, 139.82, 148.34, 154.58, 161.03, 169.61, 172.60; LCMS: MH = 286; Anal. Calcd for C₁₅H₁₆N₃O₃: 0.35 H₂O: C, 61.78; H, 5.48; N, 14.41; H₂O, 2.16. Found: C, 61.42; H, 5.08; N, 14.32; H₂O, 2.17.

5.5 **3-(2-HYDROXY-5-METHYL-4-OXO-4H-QUINAZOLIN-3-YL)-PIPERIDINE-2,6-DIONE**

![Structure](image)

A solution of 2-amino-N-(2,6-dioxo-piperdin-3-yl)-6-methyl-benzamide (1.00 g, 3.8 mmol), CDI (0.62 g, 3.8 mmol) and DMAP (0.10 g, 0.82 mmol) in acetonitrile (12 mL) was heated at 150 °C in a microwave oven for 10 minutes. The suspension was filtered and washed with acetonitrile (2 x 20 mL), water (2 x 20 mL), HCl (1N, 25 mL), water (25 mL), methanol (2 x 20 mL), and ethyl acetate (2 x 20 mL) to give 3-(2-hydroxy-5-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione as an off-white solid (0.89 g, 81% yield): HPLC: Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 25/75 CH₃CN/0.1% H₃PO₄, 5.72 min (99%); mp: 373-375 °C; ¹H NMR (DMSO-d₆) δ 1.90-1.97 (m, 1H, CH₂), 2.49-2.58 (m, 2H, CH₂), 2.61 (s, 1.5H, CH₃), 2.69 (s, 1.5H, CH₃), 2.81-2.92 (m, 1H, CH₂), 5.55 (dd, J = 5, 11 Hz, 0.5H, NCH), 5.72 (dd, J = 5, 11 Hz, 0.5H, NCH), 6.99-7.08 (m, 2H, Ar), 7.50-7.55 (m, 1H, Ar), 10.92 (s, 0.5H, OH), 11.42 (s, 0.5H, NH), 11.56 (s, 0.5H, NH) (observed at 350K); ¹³C NMR (DMSO-d₆) δ 20.90, 21.38, 22.11, 22.41, 30.72, 30.77, 49.74, 50.99, 111.52, 112.15, 113.38, 125.67, 134.26, 143.34, 140.29, 140.63, 141.09, 141.45, 148.77, 149.99, 161.60, 162.39, 170.00, 170.38, 172.74; LCMS: MH = 288; Anal. Calcd. for C₁₅H₁₆N₃O₄: C, 58.53; H, 4.56; N, 14.63. Found: C, 58.40; H, 4.32; N, 14.59.
5.6 **3S-3-(2,5-DIMETHYL-4-OXO-4H-QUINAZOLIN-3-YL)-3-METHYL-PIPERIDINE-2,6-DIONE**

![Chemical Structure]

A stirred suspension of 2,5-dimethyl-benzo[d][1,3]oxazin-4-one (1.4 g, 8.1 mmol), 3S-3-amino-3-methyl-piperidine-2,6-dione hydrogen bromide (1.8 g, 8.1 mmol), imidazole (1.2 g, 18 mmol) and triphenyl phosphite (2.6 mL, 9.7 mmol) in acetonitrile (50 mL) was heated in a 65 °C oil bath overnight. The mixture was allowed to cool to room temperature. To the mixture, was added Celite. The solvent was removed in vacuo. The solid was placed in a SIM and purified by ISCO column chromatography (Silica gel, CH₃CN/CH₂Cl₂ 0% gradient to 100% in 15 min) to give 3S-3-(2,5-Dimethyl-4-oxo-4H-quinazolin-3-yl)-3-methyl-piperidine-2,6-dione as a white solid (220 mg, 9% yield). HPLC: Waters Symmetry C₁₈, 5 μm, 3.9 x 150 mm, 1 mL/min, 20/80 CH₃CN/0.1% H₃PO₄, 3.43 min (99.4 %); mp: 187-189 °C (decomp); ¹H NMR (DMSO-d₆) δ 1.90 (s, 3H, CH₃), 2.36-2.42 (m, 1H, CHH), 2.49-2.85 (m, 9H, 2CH₃, 3CHH), 7.22 (d, J = 7 Hz, 1H, Ar), 7.37 (d, J = 8 Hz, 1H, Ar), 7.62 (t, J = 8 Hz, 1H, Ar), 10.79 (s, 1H, NH); ¹³C NMR (DMSO-d₆) δ 22.17, 24.42, 26.21, 28.13, 28.95, 62.59, 118.82, 123.96, 128.59, 133.64, 139.48, 147.44, 153.73, 163.77, 171.45, 173.10; LCMS: MH+ = 300; Anal Calcd for C₁₆H₁₅N₃O₂: C, 64.20; H, 5.72; N, 14.04. Found: C, 64.08; H, 5.58; N, 13.86.

5.7 **3R-3-(2,5-DIMETHYL-4-OXO-4H-QUINAZOLIN-3-YL)-3-METHYL-PIPERIDINE-2,6-DIONE**

![Chemical Structure]

A stirred suspension of 2,5-dimethyl-benzo[d][1,3]oxazin-4-one (1.6 g, 9.0 mmol), 3R-3-amino-3-methyl-piperidine-2,6-dione hydrogen bromide (2.0 g, 9.0 mmol), imidazole (1.3 g, 20 mmol) and triphenyl phosphite (2.4 mL, 9.0 mmol) in acetonitrile (50 mL) was heated in a 65 °C oil bath overnight. The mixture was allowed to cool to room temperature. To the mixture, was added Celite. The solvent was removed in vacuo. The solid was placed in a SIM and purified by ISCO column chromatography (Silica gel, CH₃CN/CH₂Cl₂ 0% gradient to 100% in 15 min) to give 3R-3-(2,5-Dimethyl-4-oxo-4H-quinazolin-3-yl)-3-methyl-piperidine-2,6-dione as a white solid (90 mg, 3.4% yield). HPLC: Waters Symmetry C₁₈, 5 μm, 3.9 x 150 mm, 1 mL/min, 20/80 CH₃CN/0.1% H₃PO₄, 6.46 min (99.4 %); mp: 298-301 °C; ¹H NMR (DMSO-d₆) δ 1.90 (s, 3H, CH₃), 2.36-2.42 (m, 1H, CHH), 2.49-2.85 (m, 9H, 2CH₃, 3CHH), 7.22 (d, J = 7 Hz, 1H, Ar), 7.37 (d, J = 8 Hz, 1H, Ar), 7.62 (t, J = 8 Hz, 1H, Ar), 10.79 (s, 1H, NH); ¹³C NMR (DMSO-d₆) δ 22.17, 24.42, 26.21, 28.13, 28.95, 62.59, 118.82, 123.96, 128.59, 133.64, 139.48, 147.44, 153.73, 163.77,
171.45, 173.10; LCMS: MH = 300; Anal Calcd for C16H17N2O3: C, 64.20; H, 5.72; N, 14.04. Found: C, 63.81; H, 5.69; N, 13.92.

5.8 3-(5-METHOXY-2-METHYL-4-OXO-4H-QUINAZOLIN-3-YL)- Piperidine-2,6-dione

To a stirred mixture of 2-amino-6-methoxybenzoic acid (2.0 g, 12 mmol) and imidazole (1.0 g, 14 mmol) in acetonitrile (20 mL), was added acetyl chloride (1.0 mL, 14 mmol) at room temperature. The mixture was stirred at room temperature overnight. To the mixture, was added 3-amino-piperidine-2,6-dione hydrogen chloride (2.0 g, 12 mmol), imidazole (1.8 g, 26 mmol) and triphenyl phosphite (3.8 mL, 14 mmol) and heated to reflux for 22 hours. To the mixture, was added water (60 mL). The suspension was filtered and washed with water (2 X 50 mL), ethyl acetate (2 X 50 mL), sodium hydrogen carbonate (sat, 50 mL) and water (50 mL) to give 3-(5-methoxy-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione as a white solid (1.3 g, 35% yield). HPLC: Waters Symmetry C18, 5µm, 3.9 x 150 mm, 1 mL/min, 240 nm, 15/85 CH3CN/0.1% H3PO4, 3.37 min (99.4 %); mp: 274-276 °C; 1H NMR (DMSO-d6) δ 2.09-2.16 (m, 1H, CHF), 2.51-2.63 (m, 5H, CH2, 2CHH), 2.72-2.89 (m, 1H, CHF), 3.83 (s, 3H, CH3), 5.14 (dd, J = 6, 11 Hz, 1H, NCH), 6.98 (d, J = 8 Hz, 1H, Ar), 7.12 (d, J = 8 Hz, 1H, Ar), 7.69 (t, J = 8 Hz, 1H, Ar), 10.96 (s, 1H, NH); 13C NMR (DMSO-d6) δ 20.84, 23.36, 30.55, 55.85, 56.16, 107.96, 109.91, 118.26, 134.98, 149.24, 155.30, 158.13, 159.42, 169.63, 172.63; LCMS: MH = 302; Anal Calcd for C16H17N2O4 + 1.6 H2O: C, 54.57; H, 5.56; N, 12.73. Found: C, 54.19; H, 5.42; N, 12.55.

5.9 3-(5-FLUORO-2-METHYL-4-OXO-4H-QUINAZOLIN-3-YL)-PIPERIDINE- 2,6-DIONE

To a stirred mixture of 2-amino-6-fluorobenzoic acid (5.3 g, 34 mmol) and imidazole (2.8 g, 41 mmol) in acetonitrile (60 mL), was added acetyl chloride (2.9 mL, 41 mmol) at room temperature. The mixture was stirred at room temperature overnight. To the mixture, was added 3-amino-piperidine-2,6-dione hydrogen chloride (6.1 g, 37 mmol), imidazole (5.1 g, 75 mmol) and triphenyl phosphite (10.6 mL, 41 mmol) and heated to reflux for 22 hours. To the mixture, was added water (60 mL). The suspension was filtered and washed with water (2 X 50 mL), ethyl acetate (2 X 50 mL), and water (50 mL) to give a white solid, which was stirred in methanol (50 mL) overnight. The suspension was washed with methanol (30 mL) and water (30 mL) to give 3-(5-fluoro-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione as a white solid.
(7.6 g, 78% yield): HPLC: Waters Symmetry C$_{18}$, 5µm, 3.9 x 150 mm, 1 mL/min, 240 nm, 20/80 CH$_3$CN/0.1% H$_3$PO$_4$, 3.8 min (99.6 %); mp: 275-277 °C; $^1$H NMR (DMSO-$d_6$) δ 2.13-2.20 (m, 1H, CH$H$), 2.57-2.69 (m, 5H, CH$_3$, 2CH$H$), 2.77-2.90 (m, 1H, CH$H$), 5.25 (dd, J = 6, 11 Hz, 1H, NCH$_3$), 7.26 (ddd, J = 0.6, 8, 11 Hz, 1H, Ar), 7.44 (d, J = 8 Hz, 1H, Ar), 7.80 (dt, J = 5, 8 Hz 1H, Ar), 11.04 (s, 1H, NH$_2$); $^{13}$C NMR (DMSO-$d_6$) δ 20.73, 23.45, 30.57, 56.45, 109.79 (d, J$_{CF}$ = 6 Hz), 112.89 (d, J$_{CF}$ = 21 Hz), 122.64 (d, J$_{CF}$ = 4 Hz), 135.39 (d, J$_{CF}$ = 11 Hz), 148.86, 156.22, 157.46, 160.15 (d, J$_{CF}$ = 264 Hz), 169.38, 172.57; LCMS: MH = 290; Anal Calcd for C$_{14}$H$_{12}$N$_3$O$_3$F: C, 58.13; H, 4.18; N, 14.53; F, 6.57. Found: C, 57.98; H, 4.00; N, 14.45; F, 6.73.

5.10 3-(5-CHLORO-2-METHYL-4-OXO-4H-QUINAZOLIN-3-YL)-PIPERIDINE-2,6-DIONE

To a stirred mixture of 2-amino-6-chlorobenzoic acid (2.3 g, 13 mmol) and imidazole (1.1 g, 16 mmol) in acetonitrile (25 mL), was added acetyl chloride (1.1 mL, 16 mmol) at room temperature. The mixture was stirred at room temperature overnight. To the mixture, was added 3-amino-piperidine-2,6-dione hydrogen chloride (2.2 g, 13 mmol), imidazole (2.0 g, 30 mmol) and triphenyl phosphite (4.2 mL, 16 mmol) and heated to reflux for 22 hours. To the mixture, was added water (60 mL). The suspension was filtered and washed with water (2 X 50 mL), ethyl acetate (2 X 50 mL), and water (50 mL) to give a white solid, which was purified with preparative HPLC (C18 20/80 CH$_3$CN/H$_2$O) to give 3-(5-chloro-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione as a white solid (1.3 g, 31% yield): HPLC: Waters Symmetry C$_{18}$, 5µm, 3.9 x 150 mm, 1 mL/min, 240 nm, 25/75 CH$_3$CN/0.1% H$_3$PO$_4$, 4.16 min (99.9 %); mp: 315 °C (decomp); $^1$H NMR (DMSO-$d_6$) δ 2.13-2.19 (m, 1H, CH$H$), 2.57-2.68 (m, 5H, CH$_3$, 2CH$H$), 2.78-2.85 (m, 1H, CH$H$), 5.23 (dd, J = 5, 11 Hz, 1H, NCH$_3$), 7.51-7.58 (m, 2H, Ar), 7.74 (t, J = 8 Hz, 1H, Ar), 11.03 (s, 1H, NH$_2$); $^{13}$C NMR (DMSO-$d_6$) δ 20.63, 23.48, 30.53, 56.61, 117.14, 126.18, 128.98, 132.24, 134.52, 149.27, 155.99, 158.39, 169.38, 172.56; LCMS: MH = 306, 308; Anal Calcd for C$_{14}$H$_{12}$N$_3$O$_3$Cl + 1 H$_2$O: C, 51.94; H, 4.36; N, 12.98; Cl, 10.95. Found: C, 51.91; H, 4.24; N, 12.93; Cl, 10.20.

5.11 3-(2-METHYL-4-OXO-5-TRIFLUOROMETHYL-4H-QUINAZOLIN-3-YL)-PIPERIDINE-2,6-DIONE

To a stirred mixture of 2-amino-6-(trifluoromethyl)benzoic acid (3.0 g, 15 mmol) and imidazole (1.2 g, 18 mmol) in acetonitrile (30 mL), was added acetyl chloride (1.3 mL, 18
mmol) at room temperature. The mixture was stirred at room temperature overnight. To the mixture, was added 3-amino-piperidine-2,6-dione hydrogen chloride (2.4 g, 15 mmol), imidazole (2.2 g, 32 mmol) and triphenyl phosphite (4.6 mL, 18 mmol) and heated to reflux for 22 hours. To the mixture, was added water (100 mL). The suspension was filtered and washed with water (2 X 50 mL), ethyl acetate (2 X 50 mL), sodium hydrogen carbonate (sat, 50 mL) and water (50 mL) to give 3-(2-methyl-4-oxo-5-trifluoromethyl-4H-quinazolin-3-yI)-piperidine-2,6-dione as a white solid (2.02 g, 51% yield): HPLC: Waters Symmetry C18, 5 μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 30/70 CH3CN/0.1% H3PO4, 4.84 min (99.9 %); mp: 268-270 °C; 1H NMR (DMSO-d6) δ 2.14-2.22 (m, 1H, CHF), 2.55-2.70 (m, 5H, CH3, 2CHF), 2.76-2.92 (m, 1H, CHF), 5.29 (dd, J = 6, 11 Hz, 1H, NCH3), 7.89-7.98 (m, 3H, Ar), 11.06 (s, 1H, NH); 13C NMR (DMSO-d6) δ 20.45, 23.27, 30.43, 56.74, 117.19, 123.19 (q, JCF = 273 Hz), 125.75 (q, JCF = 7 Hz), 126.42 (q, JCF = 32 Hz), 132.05, 133.97, 149.12, 156.58, 157.59, 169.19, 172.48; LCMS: MH = 340; Anal Caled for C13H12N3O3F3 + 1 H2O: C, 50.43; H, 3.95; N, 11.76; F, 15.95. Found: C, 50.26; H, 3.82; N, 11.66; F, 15.71.

5.12 3-(5-CHLORO-4-OXO-4H-QUINAZOLIN-3-YL)-PIPERIDINE-2,6-DIONE

Step 1: A mixture of 2-amino-6-chlorobenzoic acid (3.0 g, 17 mmol) and CDI (2.6 g, 16 mmol) in acetonitrile (40 mL) was stirred at room temperature for 1.5 hours. To the suspension, was added 3-amino-piperidine-2,6-dione hydrogen chloride (2.6 g, 16 mmol) and sodium hydrogen carbonate (1.8 g, 21 mmol), and the mixture was heated at 50 °C for 21 hours. The suspension was cooled to room temperature for 1 hour. The suspension was filtered and washed with water (50 mL) and ethyl acetate (20 mL). The solid was dried in a vacuum oven overnight to give 2-amino-N-(2,6-dioxo-piperidin-3-yl)-6-chloro-benzamide as a white solid (1.7 g, 35% yield): HPLC, Waters Symmetry C-18, 3.9 x 150 mm, 5 μm, 1 mL/min, 240 nm, 5/95 grad to 95/5 for 5 min CH3CN/0.1% H3PO4, 4.01; 1H NMR (DMSO-d6) δ 1.92-1.98 (m, 1H, CHF), 2.05-2.20 (m, 1H, CHF), 2.49-2.57 (m, 1H, CHF), 2.76-2.88 (m, 1H, CHF), 4.67-4.76 (m, 1H, NCH3), 5.61 (s, 2H, NH2), 6.57 (d, J = 8 Hz, 1H, Ar), 6.63 (d, J = 8 Hz, 1H, Ar), 7.04 (t; J = 8 Hz, 1H, Ar), 8.83 (d, J = 8 Hz, 1H, NH), 10.95 (s, 1H, NH); 13C NMR (DMSO-d6) δ 23.50, 30.96, 49.31, 113.29, 115.51, 120.97, 130.03, 130.19, 147.03, 165.60, 172.92, 172.97; LCMS: MH= 282, 284.

Step 2: A solution of 2-amino-N-(2,6-dioxo-piperidin-3-yl)-6-chloro-benzamide (0.8 g, 2.8 mmol) and trimethyl orthoformate (4 mL) and p-toluene sulfonic acid (280 mg) was heated to 150 °C via a microwave oven for 30 minutes. To the mixture, was added methanol (15 mL), and the mixture was stirred for 5 minutes. The suspension was filtered and washed with methanol to give 3-(5-chloro-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione as a white solid (400 mg, 48% yield): HPLC: Waters Symmetry C18, 5 μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 30/70 CH3CN/0.1% H3PO4, 2.35 min (99.2 %); mp: 308-310 °C; 1H NMR (DMSO-d6) δ 2.13-2.19 (m, 1H, - 47 -
\[ \text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3 \], 2.57-2.72 (m, 2H, 2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3), 2.83-2.89 (m, 1H, \text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3), 5.43 (\text{br, 1H, NCH}_3\text{H}), 7.60 (\text{dd, J = 1, 8 Hz, 1H, Ar}), 7.66 (\text{dd, J = 1, 8 Hz, 1H, Ar}), 7.79 (\text{t, J = 8 Hz, 1H, Ar}), 8.39 (\text{s, 1H, CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3), 11.16 (\text{s, 1H, NCH}_3\text{H}); ^{13}\text{C NMR (DMSO-d}_6\text{)} \delta 22.18, 30.84, 56.16, 118.35, 126.81, 129.74, 132.45, 134.54, 148.18, 149.98, 157.62, 169.68, 172.39; \text{LCMS: } \text{MH} = 292, 294; \text{Anal Calcd for C}_{13}\text{H}_{10}\text{N}_2\text{O}_3\text{Cl} + 0.15 \text{H}_2\text{O:}}

\[ \text{C}, 53.04; \text{H}, 3.53; \text{N}, 14.27. \text{Found: C}, 52.68; \text{H}, 3.14; \text{N}, 14.17. \]

5.13 3-(2-ETHYL-5-METHYL-4-OXO-4H-QUINAZOLIN-3-YL)-PIPERIDINE-2,6-DIONE

\[ \text{Step 1: A mixture of 2-amino-6-methylbenzoic acid (45 g, 297 mmol) and CDI (45 g, 278 mmol) in acetonitrile (500 mL) was stirred at room temperature for 1.5 hours. To the suspension, was added 3-amino-piperidine-2,6-dione hydrogen chloride (45 g, 273 mmol) and sodium hydrogen carbonate (34 g, 409 mmol), and the mixture was heated at 50 °C for 21 hours. The suspension was cooled to room temperature for 1 hour. The suspension was filtered. The solid was stirred with water (150 mL) and ethyl acetate (150 mL) for 3 hours. The suspension was filtered and washed with water (2 X 50 mL) and ethyl acetate (2 X 50 mL). The solid was dried in a vacuum oven overnight to give 2-amino-2-(6-dioxo-piperidin-3-yl)-6-methyl-benzoamide as a white solid (41.3 g, 58% yield): HPLC, Waters Symmetry C-18, 3.9 x 150 mm, 5 \mu m, 1 mL/min, 240 nm, 5/95 grad to 95/5 for 5 min CH\text{3CN/0.1% H}_2\text{PO}_4\text{, 4.44 (91%); } ^{1}\text{H NMR (DMSO-d}_6\text{)} \delta 1.98-2.17 (m, 5H, CH\text{3CH}, CH\text{3}), 2.51-2.56 (m, 1H, CH\text{CH}), 2.74-2.86 (m, 1H, CH\text{CH}), 4.68-4.77 (m, 1H, NCH\text{3H}), 5.18 (s, 2H, NH\text{3H}), 6.38 (d, J = 7 Hz, 1H, Ar), 6.50 (d, J = 7 Hz, 1H, Ar), 6.94 (t; J = 7 Hz, 1H, Ar), 8.59 (d, J = 8 Hz, 1H, NH\text{3H}), 10.90 (s, 1H, NH\text{3H}); ^{13}\text{C NMR (DMSO-d}_6\text{)} \delta 19.14, 23.75, 30.99, 49.10, 112.37, 17.21, 122.28, 128.96, 134.61, 145.22, 168.36, 172.84, 173.00; \text{LCMS: } \text{MH} = 262. \]

\[ \text{Step 2: A solution of 2-amino-N-(2,6-dioxo-piperidin-3-yl)-6-methyl-benzoamide (0.5 g, 1.9 mmol) and triethyl orthoformate (0.42 mL, 2.1 mmol) in DMF (5 mL) was heated at 150 °C in a microwave oven for 1.5 hours. To the mixture, was added water (30 mL). The mixture was cooled in an ice-water bath. The suspension was filtered to give a solid, which was stirred in methanol (15 mL) overnight. The suspension was filtered and washed with methanol (10 mL) and ethyl acetate (10 mL) to give 3-(2-ethyl-5-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione as a white solid (0.13 g, 22% yield): HPLC: Waters Symmetry C\text{18}, 5 \mu m, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 grad 90/10 in 5 min CH\text{3CN/0.1% H}_2\text{PO}_4\text{, 5.74 min (98.9%); mp: 228-230 °C; } ^{1}\text{H NMR (DMSO-d}_6\text{)} \delta 1.27 (t; J = 7 Hz, 3H, CH\text{3}), 2.07-2.13 (m, 1H, CH\text{CH}), 2.50 (s, 3H, CH\text{3}), 2.51-2.65 (m, 2H, 2CH\text{CH}), 2.82-2.92 (m, 3H, CH\text{3}, CH\text{CH}), 5.21 (dd, J = 6, 11 Hz, 1H, NCH\text{3H}), 7.25 (d, J = 8 Hz, 1H, Ar), 7.46 (d, J = 8 Hz, 1H, Ar), 7.64 (t, J = 8 Hz, 1H, Ar), 10.98 (s, 1H, NH\text{3H}); ^{13}\text{C NMR (DMSO-d}_6\text{)} \delta 11.18, 21.05, 22.48, 28.02, 35.51, 55.26, 118.64, 125.00, 128.86, 133.70, 139.82, - 48 -]
148.27, 157.69, 161.14, 169.75, 172.63; LCMS: MH = 300; Anal Calcd for C_{16}H_{17}N_{3}O_{2}: C, 64.20; H, 5.72; N, 14.04. Found: C, 61.30; H, 5.34; N, 13.28.

5.14 **3-(2-BUTYL-5-METHYL-4-OXO-4H-QUINAZOLIN-3-YL)-PIPERIDINE-2,6-DIONE**

![Structure](image)

A solution of 2-amino-N-(2,6-dioxo-piperidin-3-yl)-6-methyl-benzamide (0.65 g, 2.5 mmol) and trimethyl orthopentionate (0.66 mL, 3.8 mmol) and p-toluenesulfonic acid (140 mg) in DMF (7 mL) was heated at 150 °C in a microwave oven for 20 minutes. The mixture was extracted with ethyl acetate (50 mL) and water (50 mL). The aqueous layer was extracted with ethyl acetate (50 mL). The combined organic layers was washed with water (50 mL), HCl (1N, 50 mL) and brine (50 mL). The solvent was removed in vacuo to give an oil, which was purified with column chromatography (Silica Gel, methanol/methylene chloride 0% gradient to 5% 15 min), and followed by reversed layer column chromatography (C-18, acetonitrile/water 0% gradient to 100% 15 min) to give 3-(2-butyl-5-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione as a white solid (80 mg, 10% yield): HPLC: Waters Symmetry C_{18}, 5 μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 grad 90/10 in 5 min CH_{3}CN/0.1% H_{2}PO_{4}, 6.59 min (95.4%); mp: 190-192 °C; \(^{1}\text{H NMR}\) (DMSO-d_{6}) δ 0.95 (t, J = 8 Hz, 3H, CH_{3}), 1.40-1.49 (m, 2H, CH_{2}), 1.67-1.75 (m, 2H, CH_{2}), 2.05-2.09 (m, 1H, CH_{3}), 2.51-2.67 (m, 3H, CH_{2}, CH_{3}), 2.69 (s, 3H, CH_{3}), 2.81-2.90 (m, 3H, CH_{2}, CH_{3}), 5.20 (dd, J = 5, 11 Hz, 1H, NCH), 7.25 (d, J = 7 Hz, 1H, Ar), 7.44 (d, J = 8 Hz, 1H, Ar), 7.64 (t, J = 8 Hz, 1H, Ar), 10.98 (s, 1H, N=), \(^{13}\text{C NMR}\) (DMSO-d_{6}) δ 13.80, 21.11, 21.72, 22.48, 28.60, 30.50, 34.42, 55.41, 118.63, 124.98, 128.83, 133.70, 139.81, 148.25, 156.95, 161.17, 169.75, 172.65; LCMS: MH = 328; Anal Calcd for C_{16}H_{17}N_{3}O_{2}: C, 66.04; H, 6.47; N, 12.84. Found: C, 65.87; H, 6.61; N, 12.89.

5.15 **3-(5-METHYL-4-OXO-2-TRIFLUOROMETHYL-4H-QUINAZOLIN-3-YL)-PIPERIDINE-2,6-DIONE**

![Structure](image)

To a stirred suspension of 2-amino-N-(2,6-dioxo-piperidin-3-yl)-6-methyl-benzamide (1.0 g, 3.8 mmol) and triethylamine (1.6 mL, 11.5 mmol) in acetonitrile (20 mL) at 0 °C, was added trifluoroacetic anhydrous (0.9 mL, 6.4 mmol). The mixture was kept at 0 °C for 2 hours. The mixture was then heated at 50 °C for 12 hours. To the mixture, was added water (50 mL). The
suspension was filtered and washed with water (50 mL) to give a brown solid. The solid was stirred in reagent alcohol (10 mL) for 3 hours. The suspension was filtered and washed with reagent alcohol (10 mL) to give 3-(5-methyl-4-oxo-2-trifluoromethyl-4H-quinazolin-3-yl)-piperidine-2,6-dione as an off-white solid (200 mg, 15% yield): HPLC: Waters Symmetry C18, 5 μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 40/60 CH3CN/0.1% H3PO4, 6.39 min (98.1%); mp: 308-310 °C; 1H NMR (DMSO-d6) δ 2.06-2.12 (m, 1H, CHF), 2.51-2.75 (m, 2H, 2CHF), 2.75 (s, 3H, CH3), 2.89-2.99 (m, 1H, CHF), 5.12 (dd, J = 6, 11 Hz, 1H, NCHF), 7.53 (d, J = 8 Hz, 1H, Ar), 7.69 (d, J = 8 Hz, 1H, Ar), 7.83 (t, J = 8 Hz, 1H, Ar), 10.98 (s, 1H, NH); 13C NMR (DMSO-d6) δ 21.28, 22.37, 30.23, 56.37, 117.8 (q, J_C-F = 277 Hz), 120.05, 126.43, 132.22, 134.76, 140.67, 141.31 (q, J_C-F = 35 Hz), 145.57, 160.44, 168.84, 172.46; LCMS: MH = 340; Anal Caled for C15H12N2O2F2: C, 53.10; H, 3.57; N, 12.39. Found: C, 52.92; H, 3.49; N, 12.14.

5.16 3-(5-METHYL-4-OXO-2-PHENYL-4H-QUINAZOLIN-3-YL)-PIPERIDINE-2,6-DIONE

Step 1: A mixture of 2-amino-6-methylbenzoic acid (1.0 g, 6.6 mmol) and benzoic anhydride (3.3 g, 15 mmol) in acetonitrile (15 mL) was heated to reflux for 17 hours. The solution was allowed to cool to room temperature. The suspension was filtered to give a mixture of 5-methyl-2-phenyl-benzo[d][1,3]oxazin-4-one and benzoic acid (1:0.4, 1.0 g). The solid was used in the next step without further purification.

Step 2: A stirred suspension of solid (1.0 g) from step 1, 3-amino-piperidine-2,6-dione hydrogen chloride (0.71 g, 4.3 mmol) and triphenyl phosphite (1.3 mL, 5.1 mmol) in pyridine (10 mL) was heated to reflux for 20 hours. To the mixture, was added Celite (1 teaspoon), and the solvent was removed in vacuo. The resulted solid was placed in a SIM and purified by ISCO column chromatography (Silica gel, CH3CN/CH2Cl2 5% gradient to 100% in 15 min). Those tubes containing product were collected. The solvent was removed in vacuo to give a solid, which was stirred with reagent alcohol (30 mL) overnight. The suspension was filtered to give 3-(5-Methyl-4-oxo-2-phenyl-4H-quinazolin-3-yl)-piperidine-2,6-dione as a white solid (404 mg, 27% yield): HPLC: Waters Symmetry C18, 5 μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 35/65 CH3CN/0.1% H3PO4, 6.24 min (100%); mp: 298-300 °C; 1H NMR (DMSO-d6) δ 2.02-2.09 (m, 1H, CHF), 2.42-2.73 (m, 3H, CH2, CHF), 2.76 (s, 3H, CH3), 4.81 (dd, J = 6, 11 Hz, 1H, NCHF), 7.34 (d, J = 7 Hz, 1H, Ar), 7.51-7.64 (m, 6H, Ar), 7.71 (t, J = 7 Hz, 1H, Ar), 10.94 (s, 1H, NH); 13C NMR (DMSO-d6) δ 21.14, 22.53, 30.25, 57.76, 118.95, 125.47, 127.76, 128.83, 128.58, 130.05, 134.06, 134.84, 140.07, 148.11, 155.92, 151.17, 159.69, 172.40; LCMS: MH = 348; Anal Caled for C28H17N3O3: C, 69.15; H, 4.93; N, 12.10. Found: C, 68.76; H, 4.81; N, 12.14.
5.17 3-(5-AMINO-2-METHYL-4-OXO-4H-QUINAZOLIN-3-YL)-PIPERIDINE-2,6-DIONE

Step 1: To a solution of potassium hydroxide (16.1 g, 286 mmol) in water (500 mL), was added 3-nitrophthalimide (25.0 g, 130 mmol) in portion at 0 °C. The suspension was stirred at 0 °C for 3 hours, and then heated to 30 °C for 3 hours. To the solution, was added HCl (100 mL, 6N). The resulting suspension was cooled to 0 °C for 1 hour. The suspension was filtered and washed with cold water (2 x 10 mL) to give 3-nitro-phthalamic acid as a white solid (24.6 g, 90% yield): 1H NMR (DMSO-d6) δ 7.69 (s, 1H, NH), 7.74 (t, J = 8 Hz, 1H, Ar), 7.92 (dd, J = 1, 8 Hz, 1H, Ar), 8.13 (dd, J = 1, 8 Hz, 1H, Ar), 8.15 (brs, 1H, NHH), 13.59 (s, 1H, OH); 13C NMR (DMSO-d6) δ 125.33, 129.15, 130.25, 132.54, 136.72, 147.03, 165.90, 167.31.

Step 2: To a mixture of 3-nitro-phthalamic acid (24.6 g, 117 mmol) and potassium hydroxide (6.56 g, 117 mmol) in water (118 mL), was added a mixture of bromine (6 mL), potassium hydroxide (13.2 g, 234 mmol) in water (240 mL) at 0 °C, followed by addition of a solution of potassium hydroxide (19.8 g, 351 mmol) in water (350 mL). After 5 minutes at 0 °C, the mixture was heated in a 100 °C oil bath for 1 hour. The reaction solution was cooled to room temperature, and then, in an ice-water bath for 30 minutes. To the mixture, a solution of HCl (240 mL, 2N) was added dropwise at 0 °C, and the resulting mixture was kept for 1 hour. The suspension was filtered and washed with water (5 mL) to give 2-amino-6-nitro-benzoic acid as yellow solid (15.6 g, 73% yield): HPLC: Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, CH3CN/0.1% H3PO4, 5% grad to 95% over 5 min, 5.83 min (85%); 1H NMR (DMSO-d6) δ 6.90 (dd, J = 1, 8 Hz, 1H, Ar), 7.01 (dd, J = 1, 9 Hz, 1H, Ar), 7.31 (t, J = 8 Hz, 1H, Ar), 8.5-9.5 (brs, 3H, OH, NH3); 13C NMR (DMSO-d6) δ 105.58, 110.14, 120.07, 131.74, 149.80, 151.36, 166.30; LCMS: MH = 183.

Step 3: A mixture of 2-amino-6-nitro-benzoic acid (1.5 g, 8.2 mmol) in acetic anhydride (15 mL) was heated at 200 °C for 30 minutes in a microwave oven. The mixture was filtered and washed with ethyl acetate (20 mL). The filtrate was concentrated in vacuo. The solid was stirred in ether (20 mL) for 2 hours. The suspension was filtered and washed with ether (20 mL) to give 2-methyl-5-nitro-benzo[d][1,3]oxazin-4-one as a light brown solid (1.4 g, 85% yield): HPLC: Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, CH3CN/0.1% H3PO4, 5% grad 95% in 5 min, 5.36 min (92%); 1H NMR (DMSO-d6) δ 2.42 (s, 3H, CH3), 7.79 (dd, J = 1, 8 Hz, 1H, Ar), 7.93 (dd, J = 1, 8 Hz, 1H, Ar), 8.06 (t, J = 8 Hz, 1H, Ar); 13C NMR (DMSO-d6) δ 20.87, 107.79, 121.54, 128.87, 137.19, 147.12, 148.46, 155.18, 161.78; LCMS: MH = 207.
Step 4: Two vials each with a suspension of 5-nitro-2-methyl-benzo[d][1,3]oxazin-4-one (0.60 g, 2.91 mmol) and 3-amino-piperidine-2,6-dione hydrogen chloride (0.48 g, 2.91 mmol) in pyridine (15 mL) were heated at 170 °C for 10 minutes in a microwave oven. The suspension was filtered and washed with pyridine (5 mL). The filtrate was concentrated in vacuo. The resulting mixture was stirred in HCl (30 mL, 1N), ethyl acetate (15 mL) and ether (15 mL) for 2 hours. The suspension was filtered and washed with water (30 mL) and ethyl acetate (30 mL) to give a dark brown solid, which was stirred with methanol (50 mL) at room temperature overnight. The suspension was filtered and washed with methanol to give 3-(2-methyl-5-nitro-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione as a black solid (490 mg, 27% yield). The solid was used in the next step without further purification.

Step 5: A mixture of 3-(2-methyl-5-nitro-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione (250 mg) and Pd(OH)₂ on carbon (110 mg) in DMF (40 mL) was shaken under hydrogen (50 psi) for 12 hours. The suspension was filtered through a pad of Celite and washed with DMF (10 mL). The filtrate was concentrated in vacuo and the resulting oil was purified by flash column chromatography (silica gel, methanol/methylene chloride) to give 3-(5-amino-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione as a white solid (156 mg, 69% yield): HPLC: Waters Symmetry C₁₈, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH₃CN/0.1% H₃PO₄, 3.52 min (99.9%); mp: 293-295 °C; ¹H NMR (DMSO-d₆) δ 2.10-2.17 (m, 1H, CH₂), 2.53 (s, 3H, CH₃), 2.59-2.69 (m, 2H, CH₂), 2.76-2.89 (m, 1H, CHH), 5.14 (dd, J = 6, 11 Hz, 1H, NCH), 6.56 (d, J = 8 Hz, 1H, Ar), 6.59 (d, J = 8 Hz, 1H, Ar), 7.02 (s, 2H, NH₂), 7.36 (t, J = 8 Hz, 1H, Ar), 10.98 (s, 1H, NH); ¹³C NMR (DMSO-d₆) δ 20.98, 23.14, 30.52, 55.92, 104.15, 110.48, 111.37, 134.92, 148.17, 150.55, 153.62, 162.59, 169.65, 172.57; LCMS: MH = 287; Anal. Calcd. for C₁₄H₁₄N₄O₃ + 0.3 H₂O: C, 57.65; H, 5.05; N, 19.21. Found: C, 57.50; H, 4.73; N, 19.00.

5.18 (S)-3-(5-AMINO-2-METHYL-4-OXOQUINAZOLIN-3(4H)-YL)-3-METHYLPIPERIDINE-2,6-DIONE

Step 1: A mixture of 2-methyl-5-nitro-4H-benzo[d][1,3]oxazin-4-one (2.0 g, 9.7 mmol), (S)-3-amino-3-methylpiperidine-2,6-dione hydrobromide (2.2 g, 9.7 mmol), imidazole (1.5 g, 21 mmol), and triphenylphosphite (3.7 g, 12 mmol) in DMF (20 mL) was stirred under nitrogen at 45 °C for 40 hours. The mixture was evaporated, and the residue was chromatographed on silica gel using a dichloromethane-acetonitrile gradient. The product eluted at 15% acetonitrile, providing (S)-3-methyl-3-(2-methyl-5-nitro-4-oxoquinazolin-3(4H)-yl)piperidine-2,6-dione as a yellow solid (0.70 g, 22% yield); ¹H NMR (DMSO-d₆) δ 1.94 (s, 3H, CH₃), 2.35-2.40 (m, 1H, CHH), 2.45-2.59 (m, 2H, 2CHH), 2.71-2.83 (m, 4H, CH₃, CHH), 7.75-7.82 (m, 2H, Ar), 7.95 (dd, J = 8, 8 Hz, 1H, Ar), 10.86 (s, 1H, NH).
Step 2: A mixture of (S)-3-methyl-3-(2-methyl-5-nitro-4-oxoquinazolin-3(4H)-yl)piperidine-2,6-dione (0.30 g, 1.0 mmol) and 10% Pd-C (0.2 g, 50% wet), in 200 mL of 3:1 ethyl acetate-methanol was shaken under 50 psi H₂ for 45 minutes. The mixture was filtered through Celite, and the solvent was evaporated. The residue was redissolved in 200 mL of 4:1 dichloromethane-acetone, and manganese dioxide (0.20 g, 2.2 mmol) was added. This mixture was stirred for 16 hours. The mixture was filtered through Celite, and the filtrate was evaporated. The residue was chromatographed on silica gel using a dichloromethane-acetonitrile gradient, eluting (S)-3-(5-amino-2-methyl-4-oxoquinazolin-3(4H)-yl)-3-methylpiperidine-2,6-dione as a beige solid (0.10 g, 37% yield): HPLC, Waters Symmetry C-18, 3.9 x 150 mm, 5 µm, 1 ml/min, 240 nm, 20/80 CH₂CN/0.1 % H₃PO₄, 1.63 (99.20%); mp 297-299 °C; ¹H NMR (DMSO-d₆) δ 1.88 (s, 3H, CH₃), 2.31-2.36 (m, 1H, CH₂), 2.53-2.59 (m, 2H, 2CH₃), 2.62 (s, 3H, CH₃), 2.71-2.84 (m, 1H, CH₂), 6.53-6.56 (m, 2H, Ar), 6.95 (br, 2H, NH₂), 7.35 (t, J = 8 Hz, 1H, Ar), 10.72 (s, 1H, NH); ¹³C NMR (DMSO-d₆) δ 24.5, 26.3, 28.3, 29.0, 62.2, 104.2, 110.5, 110.8, 135.0, 147.4, 150.4, 152.9, 164.9, 171.5, 173.0; Anal. Calcd for C₁₅H₁₈N₄O₃: C, 59.99; H, 5.37; N, 18.66. Found: C, 59.61; H, 5.43; N, 18.59.

5.19 (R)-3-(5-AMINO-2-METHYL-4-OXOQUINAZOLIN-3(4H)-YL)-3-METHYLPIPERIDINE-2,6-DIONE

Step 1: A mixture of 2-methyl-5-nitro-4H-benzo[d][1,3]oxazin-4-one (2.0 g, 9.7 mmol), (R)-3-amino-3-methylpiperidine-2,6-dione hydrobromide (2.2 g, 9.7 mmol), imidazole (1.5 g, 21 mmol), and triphenylphosphite (3.7 g, 12 mmol) in DMF (20 mL) was stirred under nitrogen at 45 °C for 40 hours. The mixture was evaporated, and the residue was chromatographed on silica gel using a dichloromethane-acetonitrile gradient. The product eluted at 60% acetonitrile, providing (R)-3-methyl-3-(2-methyl-5-nitro-4-oxoquinazolin-3(4H)-yl)piperidine-2,6-dione as a yellow solid (0.60 g, 19% yield); ¹H NMR (DMSO-d₆) δ 1.94 (s, 3H, CH₃), 2.35-2.40 (m, 1H, CH₂), 2.45-2.59 (m, 2H, 2CH₃), 2.71-2.83 (m, 4H, CH₂, CH₂, CH₂), 7.75-7.82 (m, 2H, Ar), 7.95 (dd, J = 8, 8 Hz, 1H, Ar), 10.86 (s, 1H, NH).

Step 2: A mixture of (R)-3-methyl-3-(2-methyl-5-nitro-4-oxoquinazolin-3(4H)-yl)piperidine-2,6-dione (0.40 g, 1.2 mmol) and 10% Pd-C (0.2 g, 50% wet), in 200 mL of 3:1 ethyl acetate-methanol was shaken under 50 psi H₂ for 3 hours. The mixture was filtered through Celite, and the solvent was evaporated. The residue was chromatographed on silica gel using a dichloromethane-acetonitrile gradient, providing (R)-3-(5-amino-2-methyl-4-oxoquinazolin-3(4H)-yl)-3-methylpiperidine-2,6-dione as an off-white solid (0.16 g 44% yield): HPLC, Waters Symmetry C-18, 3.9 x 150 mm, 5 µm, 1 ml/min, 240 nm, 20/80 CH₂CN/0.1 % H₃PO₄, 1.62 (98.71%); mp 295-297 °C; ¹H NMR (DMSO-d₆) δ 1.88 (s, 3H, CH₃), 2.31-2.36 (m, 1H, CH₂), 2.53-
2.59 (m, 2H, 2CH3H), 2.62 (s, 3H, CH3), 2.71-2.84 (m, 1H, CH2H), 6.53-6.56 (m, 2H, Ar), 6.95 (br, 2H, NH2), 7.35 (t, J = 8 Hz, 1H, Ar), 10.72 (s, 1H, NH); 13C NMR (DMSO- d6) δ 24.5, 26.3, 28.3, 29.0, 62.2, 104.2, 110.5, 110.8, 135.0, 147.4, 150.4, 152.9, 164.9, 171.5, 173.0; Anal. Calcd for C18H16N4O5: C, 59.99; H, 5.37; N, 18.66. Found: C, 59.73; H, 5.26; N, 18.69.

5.20 N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YL]-2-METHOXY-ACETAMIDE

To a stirred mixture of 3-(5-amino-2-methyl-4-oxo-4H-quinoxalin-3-yl)-piperidine-2,6-dione (0.11 g, 0.35 mmol) in tetrahydrofuran (4 mL), was added methoxyacetyl chloride (0.06 mL, 0.70 mmol) and heated at 80 °C for one hour. The mixture was quenched with a few drops of methanol. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-yl]-2-methoxy-acetamide (44 mg, 35% yield) as a white solid; HPLC, Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, gradient to 95/5 in 5 min, kept for 5 min, 6.77 min (96.3%); mp, 282-284 °C; 1H NMR (DMSO-d6) δ 2.20-2.22 (m, 1H, CH2H), 2.60-2.85 (m, 6H, CHCH2, CH3), 3.40 (s, 3H, CH3), 4.04 (s, 2H, CH2H), 5.30 (dd, J = 6, 11 Hz, 1H, CH), 7.30-8.64 (m, 3H, Ar), 11.09 (s, 1H, NH), 12.31 (s, 1H, NH); 13C NMR (DMSO-d6) δ 20.77, 23.31, 30.62, 56.71, 59.04, 71.88, 107.95, 115.39, 120.94, 135.51, 138.89, 147.90, 154.84, 162.69, 169.12, 169.34, 172.64. LCMS MH = 359; Anal Calcd For C18H16N4O5 + 0.7 H2O: C, 55.04; H, 5.27; N, 15.10. Found: C, 54.75; H, 5.32; N, 14.91.

5.21 N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YL]-ACETAMIDE

To a stirred mixture of 3-(5-amino-2-methyl-4-oxo-4H-quinoxalin-3-yl)-piperidine-2,6-dione (0.45 g, 1.5 mmol) in tetrahydrofuran (10 mL), was added acetyl chloride (0.63 mL, 8.8 mmol) and heated at 80 °C for one hour. The mixture was quenched with a few drops of methanol. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-yl]-acetamide (80 mg, 16% yield); HPLC, Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, gradient to 95/5 in 5 min, kept for 5
min, 5.15 min (98.6%); mp, 320-322 °C; 1HNMR (DMSO-d6) δ 2.16 (s, 3H, CH3), 2.18-2.24 (m, 1H, CH), 2.59-2.90 (m, 6H, CHCH2, CH2), 5.32 (dd, J = 6, 11 Hz, 1H, CH), 7.28-8.54 (m, 3H, Ar), 11.08 (s, 1H, NH), 11.70 (s, 1H, NH); 13C NMR (DMSO-d6) δ 20.65, 23.35, 25.29, 30.57, 56.71, 107.39, 115.09, 120.38, 135.63, 139.84, 147.84, 154.71, 163.01, 168.67, 169.29, 172.60. LCMS MH = 329; Anal Calc'd For C16H16N4O4 + 2.2 H2O: C, 52.23; H, 5.59; N, 15.23. Found: C, 52.20; H, 5.57; N, 15.21.

5.22 2-CYCLOPROPYL-N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-oxo-3,4-DIHYDRO-QUINAZOLIN-5-YL]-ACETAMIDE

To a stirred mixture of 3-(5-amino-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione (0.41 g, 1.3 mmol) in tetrahydrofuran (8 mL), was added cyclopropane carbonyl chloride (0.24 mL, 2.7 mmol) and heated at 80 °C for one hour. The mixture was quenched with a few drops of methanol. The solvent was evaporated and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%96%) to give 2-cyclopropyl-N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-yl]-acetamide as a white solid (110 mg, 23% yield); HPLC, Waters Symmetry C18, 5µm, 3.9 x 150 mm, 1 mL/min, 240 nm, 35/65 CH3CN/0.1% H3PO4, 2.78 min (98.2%); mp, 239-241 °C; 1HNMR (DMSO-d6) δ 0.87 (d, J = 5 Hz, 4H, CH3CH2), 1.70-1.75 (q, J = 6 Hz, 1H, CHF), 2.20-2.25 (m, 1H, CHF), 2.59-2.88 (m, 5H, CH2, CH3), 5.33 (dd, J = 6, 12 Hz, 1H, CHF), 7.26-8.52 (m, 3H, Ar), 11.10 (s, 1H, NH), 12.03 (s, 1H, NH); 13C NMR (DMSO-d6) δ 7.88, 7.99, 16.26, 20.68, 23.34, 30.56, 56.73, 115.24, 120.29, 135.64, 139.80, 147.85, 154.72, 163.14, 169.34, 171.92, 172.60. LCMS MH = 355; Anal Calc'd For C16H16N4O4 + 1.7 H2O: C, 56.16; H, 5.60; N, 14.55. Found: C, 55.90; H, 5.50; N, 14.31.

5.23 HEPTANOIC ACID [3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YL]-AMIDE

To a stirred mixture of 3-(5-amino-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione (0.49 g, 1.6 mmol) in tetrahydrofuran (10 mL), was added heptanoyl chloride (0.88 mL, 5.7 mmol) and heated at 80 °C for two hours. The mixture was quenched with a few drops of methanol. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%96%) to give heptanoic acid [3-(2,6-
dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-yl]-amide as a white solid (120 mg, 18% yield); HPLC, Waters Symmetry C18, 5 μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, gradient to 95/5 in 5 min, kept for 5 min, 7.12 min (95.5%); mp, 230-232°C; 1HNMR (DMSO-d6) δ 0.86 (t, J = 7 Hz, 3H, CH3), 1.24-1.36 (m, 6H, 3CH2), 1.56-1.65 (m, 2H, CH2), 2.18-2.23 (m, 1H, CHF), 2.40 (t, J = 7 Hz, 2H, CH2), 2.59-2.88 (m, 6H, CHCH2, CH2), 5.32 (dd, J = 6, 11 Hz, 1H, CHF), 7.26-8.55 (m, 3H, Ar), 11.09 (s, 1H, NH), 11.74 (s, 1H, NH); 13C NMR (DMSO-d6) δ 13.86, 20.65, 21.89, 24.35, 24.66, 28.05, 30.60, 30.95, 37.64, 56.73, 107.43, 115.12, 120.32, 135.63, 139.85, 147.86, 154.71, 163.07, 169.28, 171.51, 172.57. LCMS MH = 399; Anal Calcd For C21H26N4O4 + 0.3 H2O: C, 62.45; H, 6.64; N, 13.87. Found: C, 62.28; H, 6.66; N, 13.61.

5.24 N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-yl]-2-ethoxy-acetamide

To a stirred solution of ethoxyacetic acid (0.39 mL, 4.2 mmol), oxalyl chloride (0.34 mL, 3.9 mmol) in diethylether (3 mL) was added DMF (0.02 mL). The mixture was stirred at room temp for two hours, followed by addition of 3-(5-amino-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione (0.60 g, 2.0 mmol) and tetrahydrofuran (20 mL). The mixture was refluxed overnight and then cooled and quenched by methanol (~5 mL). The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-yl]-2-ethoxy-acetamide as a white solid (90 mg, 12% yield); HPLC, Waters Symmetry C18, 5 μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, gradient to 95/5 in 5 min, kept for 5 min, 5.75 min (99.6%); mp, 291-293°C; 1HNMR (DMSO-d6) δ 1.23 (t, J = 6 Hz, 3H, CH2CH3), 2.18-2.25 (m, 1H, CHF), 2.58-2.92 (m, 6H, CHCH2, CH3), 3.57 (q, J = 7 Hz, 2H, CH2CH3), 4.01-4.12 (dd, J = 16 Hz, 2H, CH2O), 5.30 (dd, J = 6, 11 Hz, 1H, CHF), 7.30-8.64 (m, 3H, Ar), 11.07 (s, 1H, NH), 12.52 (s, 1H, NH); 13C NMR (DMSO-d6) δ 14.61, 20.81, 23.25, 30.52, 56.64, 67.05, 70.09, 107.95, 115.13, 120.83, 135.55, 138.97, 147.90, 154.80, 162.61, 169.38, 169.54, 172.51. LCMS MH = 373; Anal Calcd For C18H20N4O5: C, 58.06; H, 5.41; N, 15.05. Found: C, 57.83; H, 5.37; N, 14.92.
5.25 2-DIMETHYLAMINO-N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YL]-ACETAMIDE HYDROGEN CHLORIDE

To a stirred suspension of 2-chloro-N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-yl]-acetamide (0.75 g, 2.1 mmol) in DMF (3 mL), was added dimethylamine in THF (3.6 mL, 2N, 7.2 mmol) at room temperature. After 2 days, sodium hydrogen carbonate (sat, 10 mL) and water (10 mL) were added to the mixture. After 1 hour, the suspension was filtered and washed with water (5 mL) to give a white solid. To the stirred suspension of above solid in methylene chloride (20 mL), was added HCl in ether (2 mL, 2N, 4 mmol) at room temperature. After 18 hours, the suspension was filtered and washed with methylene chloride (2 x 20 mL) to give 2-dimethylamino-N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-yl]-acetamide hydrogen chloride as a white solid (0.72 g, 85% yield): HPLC: Waters Symmetry C18, 5µm, 3.9 x 150 mm, 1 mL/min, 200 nm, 10/90 CH3CN/0.1% H3PO4, 2.50 min (62.2%) and 2.71 (37.7%); mp: 256-258 °C; 1H NMR (DMSO-d6) δ 2.21-2.28 (m, 1H, CHH2), 2.61-2.70 (m, 2H, 2CHH2), 2.73 (s, 3H, CH3), 2.88 (s, 6H, 2CH3), 2.93-3.00 (m, 1H, CHH), 4.40 (d, J = 4 Hz, 2H, CH2), 5.44 (dd, J = 6, 11 Hz, 1H, NCH2), 7.45 (ddd, J = 1, 8 Hz, 1H, Ar), 7.88 (t, J = 8 Hz, 1H, Ar), 8.46 (dd, J = 1, 8 Hz, 1H, Ar), 10.48 (brs, 1H, HCl), 11.11 (s, 1H, NH), 11.50 (brs, 1H, HCl), 11.85 (s, 1H, NH); 13C NMR (DMSO-d6) δ 20.57, 23.04, 30.52, 43.16, 56.83, 58.16, 107.98, 107.98, 116.49, 120.95, 135.94, 138.34, 146.82, 155.92, 162.45 163.75, 169.02, 172.63; LCMS: MH = 372; Anal Calcd for C18H13N3O4 + 1.8 HCl + 0.5 H2O: C, 48.47; H, 5.38; N, 15.70; Cl, 14.31. Found: C, 48.34; H, 5.03; N, 15.39; Cl, 14.03.

5.26 2-CHLORO-N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YL]-ACETAMIDE

The stirred mixture of 3-(5-amino-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione (4.0 g, 14 mmol) and chloroacetyl chloride (7.7 mL, 98 mmol) was heated in a 100 °C oil bath for 15 minutes. The mixture was allowed to cool to room temperature. Acetonitrile (5 mL) was added to the mixture. The suspension was filtered and washed with ethyl acetate (2 x 10 mL) to give a white solid. The solid was stirred in methanol (50 mL) overnight. The suspension was filtered and washed with methanol (20 mL) to give 2-chloro-N-[3-(2,6-dioxo-piperidin-3-yl)-2-
methyl-4-oxo-3,4-dihydro-quinazolin-5-yl]-acetamide as a white solid (4.5 g, 90% yield): HPLC: Waters Symmetry C₁₈, 5 µm, 3.9 x 150 mm, 1 mL/min, 240 nm, 20/80 CH₂CN/0.1% H₃PO₄, 12.79 min (97.6 %); mp: 275-277 °C; ¹H NMR (DMSO-d₆) δ 2.18-2.25 (m, 1H, CHH₂), 2.61-2.80 (m, 5H, CH₃, 2CHH₂), 2.86-2.91 (m, 1H, CHH₂), 4.48-4.53 (m, 2H, CH₂), 5.36 (dd, J = 6, 11 Hz, 1H, NCH), 7.39 (dd, J = 1, 8 Hz, 1H, Ar), 8.73 (t, J = 8 Hz, 1H, Ar), 8.57 (dd, J = 1, 8 Hz, 1H, Ar), 10.7 (brs, 1H, HCl), 11.11 (s, 1H, NH), 12.26 (s, 1H, NH); ¹³C NMR (DMSO-d₆) δ 20.66, 23.10, 30.60, 43.56, 56.84, 107.89, 115.65, 120.87, 135.77, 138.87, 147.17, 155.49, 162.67, 165.55, 169.14, 172.60; LCMS: MH = 363, 365; Anal Calc'd for C₁₆H₂₂N₂O₄Cl + 1.05 HCl: C, 47.92; H, 4.03; N, 13.97; Cl, 18.12. Found: C, 48.24; H, 3.79; N, 13.84; Cl, 18.27.

5.27 [3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YL]-CARBAMIC ACID ETHYL ESTER

To a stirred mixture of 3-(5-amino-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione (0.41 g, 1.3 mmol) in tetrahydrofuran (10 mL), was added ethyl chloroformate (0.45 mL, 4.7 mmol) and heated at 80 °C for three hours. The mixture was quenched with a few drops of methanol. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give [3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-yl]-carbamic acid ethyl ester as a white solid (130 mg, 27% yield); HPLC, Waters Symmetry C₁₈, 5 µm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH₂CN/0.1% H₃PO₄, gradient to 95/5 in 5 min, kept for 5 min, 6.26 min (99.2 %); mp, 284-286 °C (decomposed); ¹H NMR (DMSO-d₆) δ 1.26 (t, J = 7 Hz, 3H, CH₂CH₃), 2.15-2.19 (m, 1H, CHH), 2.58-2.90 (m, 6H, CHCH₂, CH₃), 4.16 (q, J = 7 Hz, 2H, CH₂CH₃), 5.31 (dd, J = 6, 11 Hz, 1H, CH), 7.23-8.24 (m, 3H, Ar), 11.08 (s, 1H, NH), 11.30 (s, 1H, NH); ¹³C NMR (DMSO-d₆) δ 14.28, 20.72, 23.28, 30.53, 56.70, 60.99, 107.14, 113.36, 119.59, 135.73, 140.00, 147.95, 152.66, 154.73, 169.31, 172.54. LCMS MH = 359; Anal Calc'd For C₁₇H₁₈N₂O₅ + 0.8 H₂O: C, 54.78; H, 5.30; N, 15.03. Found: C, 54.67; H, 4.99; N, 14.80.

5.28 [3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL]-CARBAMIC ACID TERT-BUTYL ESTER
Step 1: A mixture of 2-methyl-6-nitro-benzoic acid methyl ester (99 g, 508 mmol), 1,3-dibromo-5,5-dimethylhydantoin (DBH) (80 g, 279 mmol), in methyl acetate (600 mL) was heated at 78 °C for 40 minutes, while stirred with a mechanical stirrer. Then a solution of 2,2'-azobisisobutyro-nitrile (AIBN) (4.2 g, 25 mmol) in methyl acetate (80 mL) was added and heated at 75 °C for 11 hours. The mixture was allowed to cool to 15 °C and stirred for 2 hours to age the precipitate. The suspension was filtered, washed with 10 °C methyl acetate (2 x 50 mL) to give a brown filtrate. To the filtrate, was added heptane (500 mL). The solution was washed with 2% brine (2 x 500 mL) and water (2 x 500 mL). The organic layer was concentrated to about 2 volumes, added t-butyl methyl ether (300 mL), heated at 70 °C for 15 minutes, cooled the solution to 53 °C over one hour, seeded with the product (about 250 mg) at 45 °C, then at 20–25 °C, while blowing nitrogen with a glass pipette overnight. The resulting suspension was filtered via a medium pore-sized funnel, washed with a pre-cooled 10 °C mixed solvent of heptane/MTBE (1/2 vol/vol) and suction dried in hood overnight to give 2-bromomethyl-6-nitro-benzoic acid methyl ester as an off-white solid (49 g, 35% yield). The solid was used in the next step without further purification.

Step 2: A stirred mixture of 2-bromomethyl-6-nitro-benzoic acid methyl ester (36.6 g, 134 mmol), di-tert-butyl iminodiacarbonylate (29.1 g, 134 mmol), cesium carbonate (89.3 g, 274 mmol), and lithium iodide (0.89 g, 6.7 mmol) in 2-butane (400 mL) was heated to reflux in a 100 °C oil bath for 12 hours while stirred with a mechanical stirrer. The mixture was allowed to cool to room temperature. To the mixture, was add brine (300 mL), water (300 mL), ethyl acetate (750 mL) and stirred for 10 minutes, then the suspension was filtered through a pad of Celite. The two layers were separated, and the organic layer was evaporated to a less volume and the aqueous layer was extracted with ethyl acetate (2 x 150 mL). The combined organic layers were washed with brine (500 mL), dried over magnesium sulfate while de-colored at the same time with charcoal at room temp for 30 minutes. The black mixture was filtered through a pad of Celite. The filtrate was evaporated to give 2-(di-tert-butoxycarbonylamino-methyl)-6-nitro-benzoic acid methyl ester as a brown oil (51.53 g, 94% yield). The product was used in the next step without further purification.

Step 3: To a stirred brown solution of 2-(di-tert-butoxycarbonylamino-methyl)-6-nitro-benzoic acid methyl ester (51.53 g, 126 mmol) in methylene chloride (600 mL), was added trifluoroacetic acid (18.2 mL, 245 mmol), and the mixture was stirred at room temp overnight. Sat. sodium bicarbonate (400 mL) was added to the solution, and the mixture was stirred for 10 minutes. The organic layer was separated, dried over magnesium sulfate and evaporated to give 2-(tert-butoxycarbonylamino-methyl)-6-nitro-benzoic acid methyl ester as a brown oil (41.4 g, 106% crude yield). The product was used in the next step without further purification.

Step 4: A mixture of 2-(tert-butoxycarbonylamino-methyl)-6-nitro-benzoic acid methyl ester (38.96 g, 126 mmol) lithium hydroxide (3.61 g, 151 mmol) in methanol (450 mL) and water (225 mL) was stirred with a mechanical stirrer at room temp overnight. The methanol was evaporated and to the aqueous solution, was added 1 N HCl (200 mL) to form the precipitate. Ether (300 mL) was added, and the mixture was stirred at 0 °C for 2 hours. The suspension was filtered,
washed with water (100 mL) and ether (100 mL), and suction dried in hood overnight to give 2-(tert-butoxycarbonylamino-methyl)-6-nitro-benzoic acid as a yellow solid (22.4 g, 60% yield). The product was used in the next step without further purification.

Step 5: A mixture of 2-(tert-butoxycarbonylamino-methyl)-6-nitro-benzoic acid (2.19 g, 75 mmol) in methanol (530 mL) and palladium/carbon (0.2 g) was hydrogenated with a Parr-shaker overnight at 51 psi. The black mixture was filtered through a pad of Celite, and the filtrate was evaporated to give a foamy brown oil, which was stirred in ether (300 mL) overnight. The suspension was filtered to give 2-amino-6-(tert-butoxycarbonylamino-methyl)-benzoic acid as a yellow solid (13.0 g, 65% yield). The product was used in the next step without further purification.

Step 6: To a stirred solution of 2-amino-6-(tert-butoxycarbonylamino-methyl)-benzoic acid (13.0 g, 48.8 mmol), imidazole (3.99 g, 58.6 mmol) in acetonitrile (160 mL), was added acetyl chloride (4.18 mL, 58.6 mmol), and the mixture was stirred at room temp overnight. To the mixture, was added 3-amino-piperidine-2,6-dione hydrogen chloride (8.03 g, 48.8 mmol), imidazole (6.65 g, 97.6 mmol) and triphenyl phosphite (15.4 mL, 58.6 mmol), and the mixture was heated to reflux for 6 hours. The mixture was cooled to room temperature, and water (500 mL) was added. The suspension was filtered, washed with water (50 mL), ethyl acetate (20 mL), ether (50 mL), and suction dried to give [3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-carbamic acid tert-butyl ester as a brown solid (10.5 g, 54% yield): HPLC: Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 30/70 CH3CN/0.1% H3PO4, 5.50 min (98.5 %); mp: 206-208 °C; 1H NMR (DMSO-d6) δ 1.40 (s, 9H, 3CH3), 2.15-2.20 (m, 1H, CH4), 2.55-2.68 (m, 5H, CH2s, 2CH2), 2.79-2.86 (m, 1H, CH4), 4.63-4367 (m, 2H, CH2s), 5.22 (dd, J = 6, 11 Hz, 1H, NCH), 7.20 (t, J = 6 Hz, 1H, NHH), 7.32 (d, J = 8 Hz, 1H, Ar), 7.48 (d, J = 8 Hz, 1H, Ar), 7.76 (t, J = 8 Hz, 1H, Ar), 11.02 (s, 1H, NH); 13C NMR (DMSO-d6) δ 20.79, 23.27, 28.19, 30.57, 42.82, 56.47, 77.91, 117.53, 123.86, 125.33, 133.92, 141.76, 148.44, 154.76, 155.67, 161.01, 169.51, 172.59, LCMS: MH = 401; Anal Caled for C29H28N4O5 + 0.5 H2O: C, 58.67; H, 6.15; N, 13.68. Found: C, 58.45; H, 5.88; N, 13.34.

5.29 3-(5-AMINOMETHYL-2-METHYL-4-OXO-4H-QUINAZOLIN-3-YL)-PIPERIDINE-2,6-DIONE

Step 1: To a stirred brown solution of [3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-carbamic acid tert-butyl ester (10.4 g, 25.9 mmol) in methanol (108 mL) and methylene chloride (108 mL), was added 2 M HCl in ether (304 mL), and the mixture was stirred overnight. Solvent was evaporated, and the residue was stirred in ether (200 mL) for 2 hours. The suspension was filtered to give 3-(5-aminomethyl-2-methyl-4-oxo-4H-
quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride as a light yellow solid (8.9 g, 102% crude yield). The product was used in the next step without further purification.

**Step 2:** 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (1.0 g) was stirred in iso-propanol (10 mL) overnight, and the suspension was filtered. The resulting solid was further stirred in methanol (10 mL) overnight, and the suspension was filtered. The solid was dissolved in pure water (60 mL), and the solution was washed with ethyl acetate (2 x 100 mL). The aqueous was evaporated to give 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride as an off-white solid (0.35 g, 35% yield). HPLC, Waters Xterra RP 18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, Waters LC Module 1, 05/95 CH3CN/0.1% (HCO2)NH4, 8.04 min (99.9%); mp, 256 °C (decomposed).

1H NMR (DMSO-d6) δ 2.14-2.20 (m, 1H, CH/H), 2.58-2.92 (m, 6H, CHCH₂, CH₃), 4.25-4.32 (m, 1H, NHCH/H), 4.58-4.64 (m, 1H, NHCH/H), 5.33 (dd, J = 6, 11 Hz, 1H, CH), 7.53-7.89 (m, 3H, Ar), 8.31 (brs, 3H, ClNH₂), 11.06 (s, 1H, NH₂); 13C NMR (DMSO-d6) δ 20.58, 23.15, 30.508, 41.38, 56.64, 118.38, 127.51, 129.25, 134.20, 134.33, 147.86, 155.63, 160.86, 169.26, 172.59. LCMS MH = 301; Anal Calcd For C₁₇H₁₄N₂O₄Cl + 0.5 H₂O and + 0.55 HCl: C, 49.25; H, 5.11; N, 15.31; Cl, 15.02. Found: C, 49.23; H, 5.00; N, 15.24; Cl, 14.97.

N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL]-ACETAMIDE

To a stirred mixture of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.65 g, 1.9 mmol) in acetonitrile (10 mL), was added acetyl chloride (0.13 mL, 1.8 mmol) and N,N-diisopropyl ethylamine (0.70 mL, 4.3 mmol). The mixture was stirred at room temp for 15 minutes. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-acetamide as a light yellow solid (104 mg, 16% yield); HPLC, Waters Symmetry C₁₈, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH₃CN/0.1% H₃PO₄, gradient to 95/5 in 5 min, kept for 5 min, 3.93 min (99.0%); mp, 293-291 °C; 1H NMR (DMSO-d6) δ 1.92 (s, 3H, CH₃), 2.14-2.20 (m, 1H, CH/H), 2.57-2.86 (m, 6H, CHCH₂, CH₃), 4.73-4.77 (m, 2H, CH₂NH), 5.23 (dd, J = 6, 11 Hz, 1H, CH), 7.31-7.76 (m, 3H, Ar), 8.22 (t, J = 6 Hz, 1H, CH₂N/H); 13C NMR (DMSO-d6) δ 20.78, 22.60, 23.26, 30.58, 41.49, 56.48, 117.65, 124.48, 125.42, 133.83, 141.06, 148.44, 154.75, 160.95, 169.32, 169.51, 172.58. LCMS MH = 343; Anal Calcd For C₁₇H₁₄N₂O₄: C, 59.64; H, 5.30; N, 16.37. Found: C, 59.46; H, 5.05; N, 16.24.
5.31 N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL]-BUTYRAMIDE

![Chemical Structure](image)

To a stirred mixture of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.53 g, 1.6 mmol) in acetonitrile (10 mL), was added butyryl chloride (0.25 mL, 2.4 mmol) and N, N-diisopropyl ethylamine (0.65 mL, 3.9 mmol). The mixture was stirred at room temp for 15 minutes. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-butyramide as a light yellow solid (270 mg, 46% yield); HPLC, Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, gradient to 95/5 in 5 min, kept for 5 min, 5.18 min (98.6%); mp, 250-252 °C; 1HNMR (DMSO-d6) δ 0.88 (t, J = 7 Hz, 3H, CH3), 1.56 (m, J = 7 Hz, 2H, CH2CH3CH3), 2.15-2.20 (m, 3H, CH3, CHH), 2.57-2.89 (m, 6H, CHCH2, CH3), 4.77-4.85 (m, 2H, CH2NH), 5.23 (dd, J = 6, 11 Hz, 1H, CH), 7.30-7.76 (m, 3H, Ar), 8.18 (t, J = 5 Hz, 1H, CH3NH), 11.02 (s, 1H, NH); 13C NMR (DMSO-d6) δ 13.65, 18.67, 20.77, 23.27, 30.58, 37.32, 41.39, 56.47, 117.63, 124.28, 125.38, 133.83, 141.23, 148.44, 154.76, 160.95, 169.51, 172.14, 172.60. LCMS MH = 371; Anal Calcd For C19H22N4O4: C, 61.61; H, 5.99; N, 15.13. Found: C, 61.49; H, 5.76; N, 15.00.

5.32 HEPTANOIC ACID [3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL]-AMIDE

![Chemical Structure](image)

To a stirred mixture of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.49 g, 1.5 mmol) in acetonitrile (10 mL), was added heptanoyl chloride (0.34 mL, 2.2 mmol) and N, N-diisopropyl ethylamine (0.60 mL, 3.7 mmol). The mixture was stirred at room temp for 15 minutes. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give heptanoic acid [3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-amide as a light yellow solid (280 mg, 47% yield); HPLC, Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, gradient to 95/5 in 5 min, kept for 5 min, 6.10 min (97.8%); mp, 208-210 °C; 1HNMR (DMSO-d6) δ 0.86 (t, J = 6 Hz, 3H, CH3), 1.25-2.21 (m, 11H, CH2CH3CH2CH2CH2CH2, CHH), 2.57-2.89 (m, 6H, CHCH2, CH3), 4.68-4.84 (m, 2H,
5.23 (dd, J = 6, 12 Hz, 1H, CH₂), 7.29-7.75 (m, 3H, Ar), 8.18 (t, J = 6 Hz, 1H, CH₂NH), 11.02 (s, 1H, NH); ¹³C NMR (DMSO-d₆) δ 13.87, 20.77, 21.98, 23.27, 25.22, 28.31, 30.59, 31.96, 35.37, 38.68, 38.96, 39.23, 39.51, 39.79, 40.07, 40.35, 41.39, 56.47, 117.63, 124.30, 125.39, 133.78, 141.23, 148.44, 154.75, 160.95, 169.51, 172.29, 172.59. LCMS MH = 413; Anal Calcd For C₂₃H₂₈N₄O₆: C, 64.06; H, 6.84; N, 13.58. Found: C, 64.05; H, 6.80; N, 13.58.

5.33 N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL]-3,3-DIMETHYL-BUTYRAMIDE

![Structure of N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL]-3,3-DIMETHYL-BUTYRAMIDE](image)

To a stirred mixture of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quiazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.49 g, 1.5 mmol) in acetonitrile (10 mL), was added t-butylacetyl chloride (0.31 mL, 2.2 mmol) and N, N-diisopropyl ethylamine (0.60 mL, 3.7 mmol). The mixture was stirred at room temp for 15 minutes. The solvent was evaporated, and the residue was purified by flash column chromatography (Siica gel, methanol/methylene chloride 4%/96%) to give N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-3,3-dimethyl-butyramide as a light yellow solid (120 mg, 22% yield); HPLC, Waters Symmetry C₁₈, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH₃CN/0.1% H₃PO₄, gradient to 95/5 in 5 min, kept for 5 min, 5.74 min (98.4%); mp, 212-214 °C; ¹H NMR (DMSO-d₆) δ 0.96 (s, 9H, 3CH₃), 2.08 (s, 2H, CH₃Me), 2.12-2.19 (m, 1H, CHH₂), 2.57-2.86 (m, 6H, CHCH₃, CH₂), 4.68-4.85 (m, 2H, CH₂NH), 5.24 (dd, J = 6, 11 Hz, 1H, CH), 7.34-7.76 (m, 3H, Ar), 8.11 (t, J = 6 Hz, 1H, CH₂NH), 11.02 (s, 1H, NH); ¹³C NMR (DMSO-d₆) δ 20.76, 23.28, 29.69, 30.47, 30.58, 41.43, 48.76, 56.47, 117.65, 124.64, 125.42, 133.77, 141.19, 148.42, 154.75, 160.93, 169.51, 170.97, 172.60. LCMS MH = 399; Anal Calcd For C₂₇H₂₆N₄O₂ + 0.1 H₂O: C, 63.02; H, 6.60; N, 14.00. Found: C, 62.86; H, 6.70; N, 13.92.

5.34 CYCLOPROPANE CARBOXYLIC ACID [3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL]-AMIDE

![Structure of CYCLOPROPANE CARBOXYLIC ACID [3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL]-AMIDE](image)

To a stirred mixture of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quiazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.53 g, 1.6 mmol) in acetonitrile (10 mL), was added cyclopropane carboxylic acid chloride (0.16 mL, 1.7 mmol) and N, N-diisopropyl ethylamine (0.59 mL, 3.6 mmol). The mixture was stirred at room temp for 15 minutes. The solvent was evaporated,
and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give cyclopropanecarboxylic acid [3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-amide as an off-white solid (310 mg, 54% yield); HPLC, Waters Symmetry C18, 5 μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, gradient to 95/5 in 5 min, kept for 5 min, 5.50 min (98.6%); mp, decomposed at 298 °C; 1H NMR (DMSO-d6) δ 0.67-0.70 (m, 4H, cyclo-CH₂CH₂), 1.65-1.73 (m, 1H, cyclo-CH), 2.11-2.20 (m, 1H, CHH), 2.57-2.89 (m, 6H, CHCH₂, CH₃), 4.77-4.87 (m, 2H, CH₂NH), 5.23 (dd, J = 6, 12 Hz, 1H, CH), 7.31-7.78 (m, 3H, Ar), 8.44 (t, J = 6 Hz, 1H, CH₂NH), 11.02 (s, 1H, NH); 13C NMR (DMSO-d6) δ 6.28, 13.57, 20.76, 23.28, 30.58, 41.53, 56.47, 117.65, 124.50, 125.44, 133.89, 141.14, 148.44, 154.77, 160.94, 169.53, 172.60, 172.73. LCMS MH = 369; Anal Caled For C₁₉H₁₉N₂O₄ + 0.1 H₂O: C, 61.65; H, 5.50; N, 15.13. Found: C, 61.48; H, 5.47; N, 14.97.

5.35 2-DIMETHYLAMINO-N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL]-ACETAMIDE

To a stirred solution of dimethylamino-acetic acid (0.27 g, 1.9 mmol) in DMF in a 40 °C oil bath (8 mL), was added 1.1′ carbonyldiimidazole (0.35 g, 2.1 mmol) and stirred for one hour. Then 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.65 g, 1.9 mmol) was added and stirred for 15 minutes. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give 2-dimethylamino-N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-acetamide as a light yellow solid (340 mg, 46% yield); HPLC, Waters Symmetry C18, 5 μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 05/95 CH3CN/0.1% H3PO4, 7.29 min (99.8%); mp, 275 °C (decomposed); 1H NMR (DMSO-d6) δ 2.16-2.19 (m, 7H, CHH and NMe2), 2.63-2.91 (m, 8H, CHCH₂, CH₃ and NCH₂), 4.74-4.76 (m, 2H, CH₂NH), 5.25 (dd, J = 6, 12 Hz, 1H, CHH), 7.31-7.76 (m, 3H, Ar), 8.26 (t, J = 6 Hz, 1H, CH₂NH), 11.03 (s, 1H, NH); 13C NMR (DMSO-d6) δ 20.68, 23.31, 30.59, 41.62, 45.54, 56.51, 62.81, 117.69, 125.53, 125.74, 133.96, 140.54, 148.52, 154.82, 161.03, 169.42, 169.63, 172.63. LCMS MH = 386; Anal Caled For C₁₉H₁₉N₂O₄: C, 59.21; H, 6.01; N, 18.17. Found: C, 58.95; H, 6.05; N, 17.79.
5.36 3-CHLORO-N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-
 DIHYDRO-QUINAZOLIN-5-YL]-BENZAMIDE

To a stirred mixture of 3-(5-amino-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-
2,6-dione (0.46 g, 1.5 mmol) in tetrahydrofuran (10 mL), was added 3-chlorobenzoyl chloride (0.68
mL, 5.3 mmol) and heated at 80 °C for three hours. The mixture was quenched with a few drops of
methanol. The solvent was evaporated, and the residue was purified by flash column
chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give 3-chloro-N-[3-(2,6-
dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-yl]-benzamide as a white solid (300
mg, 46% yield); HPLC, Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90
CH3CN/0.1% H3PO4, gradient to 95/5 in 5 min, kept for 5 min, 7.04 min (98.2%); mp, 326-328 °C;
1H NMR (DMSO-d6) δ 2.18-2.28 (m, 1H, CHH), 2.61-2.92 (m, 6H, CHCH2, CH2), 5.36 (dd, J = 6,
11 Hz, 1H, CH), 7.37-8.70 (m, 7H, Ar), 11.12 (s, 1H, NH2), 12.72 (s, 1H, NH); 13C NMR (DMSO-
d6) δ 20.74, 23.39, 30.66, 40.41, 56.90, 115.69, 121.28, 125.21, 127.12, 131.13, 132.14, 135.78,
163.46, 169.30, 172.59, 172.62. LCMS MH = 425, 427; Anal Calcd For C21H15N2O4Cl + 0.3 H2O:
C, 58.62; H, 4.12; N, 13.02; Cl, 8.24. Found: C, 58.46; H, 3.74; N, 12.70; Cl, 7.98.

5.37 2-BENZYL-OXY-N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-
3,4-DIHYDRO-QUINAZOLIN-5-YL]-ACETAMIDE

To a stirred mixture of 3-(5-amino-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-
2,6-dione (0.42 g, 1.4 mmol) in tetrahydrofuran (10 mL), was added benzylxoyacetyl chloride (0.75
mL, 4.8 mmol) and heated at 80 °C for three hours. The mixture was quenched with a few drops of
methanol. The solvent was evaporated, and the residue was purified by flash column
chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give 2-benzylxoy-N-[3-(2,6-
dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-yl]-acetamide as a white solid (280
mg, 47% yield); HPLC, Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90
CH3CN/0.1% H3PO4, gradient to 95/5 in 5 min, kept for 5 min, 6.46 min (99.2%); mp, 272-274 °C;
1H NMR (DMSO-d6) δ 2.17-2.22 (m, 1H, CHH), 2.65-2.93 (m, 6H, CHCH2, CH2), 4.13-4.30 (dd, J =
15, 36 Hz, 2H, CH2), 4.64 (s, 2H, CH2), 5.33 (dd, J = 5, 11 Hz, 1H, CH), 7.25-8.68 (m, 8H, Ar),
11.10 (s, 1H, NH2), 12.48 (s, 1H, NH); 13C NMR (DMSO-d6) δ 20.62, 23.38, 30.83, 56.93, 70.17,
72.80, 107.95, 115.38, 120.97, 127.47, 127.53, 128.13, 135.52, 137.33, 138.95, 147.90, 154.90,
162.73, 168.94, 169.28, 172.51, 172.62. LCMS MH = 435; Anal Calcd For C_{23}H_{22}N_{4}O_{5} + 0.6 H_{2}O:
C, 62.04; H, 5.25; N, 12.58. Found: C, 61.82; H, 4.90; N, 12.49.

5.38 N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-
QUINAZOLIN-5-YLMETHYL]-2-PHENYL-ACETAMIDE

To a stirred mixture of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-
piperidine-2,6-dione hydrogen chloride (0.51 g, 1.5 mmol) in acetonitrile (10 mL), was added
phenyl acetyl chloride (0.22 mL, 1.7 mmol) and N, N-diisopropyl ethylamine (0.57 mL, 3.5 mmol).
The mixture was stirred at room temp for 15 minutes. The solvent was evaporated, and the residue
was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to
give N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-2-phenyl-
acetamide as a light yellow solid (254 mg, 40% yield); HPLC, Waters Symmetry C_{18}, 5μm, 3.9 x
150 mm, 1 mL/min, 240 nm, 10/90 CH_{3}CN/0.1% H_{3}PO_{4}, gradient to 95/5 in 5 min, kept for 5 min,
5.70 min (98.5%); mp, 275-277 °C; 1H NMR (DMSO-d_{6}) δ 2.11-2.18 (m, 1H, CH/H), 2.58-2.86 (m,
6H, CHCH_{2}, CH_{3}), 3.53 (s, 2H, CH_{2}NH), 4.74-4.78 (m, 2H, CH_{2}NH), 5.23 (dd, J = 6, 11 Hz, 1H, CH),
7.21-7.71 (m, 8H, Ar), 8.35 (t, J = 6 Hz, 1H, CH_{2}NH), 11.01 (s, 1H, NH); 13C NMR (DMSO-d_{6}) δ
20.74, 23.27, 30.58, 41.69, 42.41, 56.48, 117.69, 124.70, 125.56, 126.34, 128.20, 129.03, 133.80,
136.30, 140.74, 148.44, 154.79, 160.91, 169.48, 170.23, 172.58. LCMS MH = 419; Anal Calcd For
C_{23}H_{22}N_{4}O_{4} + 0.2 H_{2}O: C, 65.45; H, 5.35; N, 13.27. Found: C, 65.32; H, 5.04; N, 13.10.

5.39 PYRIDINE-2-CARBOXYLIC ACID[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-
METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL]-AMIDE

To a stirred mixture of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-
piperidine-2,6-dione hydrogen chloride (0.55 g, 1.6 mmol) in acetonitrile (10 mL), was added
picolinoyl chloride hydrogen chloride (0.32 g, 1.8 mmol) and N, N-diisopropyl ethylamine (0.62
mL, 3.8 mmol). The mixture was stirred at room temp for 15 minutes. The solvent was evaporated,
and the residue was purified by flash column chromatography (Silica gel, methanol/methylene
chloride 4%/96%) to give pyridine-2-carboxylic acid[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-
3,4-dihydro-quinazolin-5-ylmethyl]-amide as an off-white solid (67 mg, 10% yield); HPLC, Waters Symmetry C18, 5 μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, gradient to 95/5 in 5 min, kept for 5 min, 6.85 min (99.4%); mp, 261-263 °C; 1H NMR (DMSO-d6) δ 2.08-2.27 (m, 1H, CH), 2.64-2.93 (m, 6H, CH2CH2, CH3), 4.91-5.05 (m, 2H, CH2NH), 5.27 (dd, J = 6, 11 Hz, 1H, CH), 7.33-8.69 (m, 7H, Ar), 9.32 (s, J = 6 Hz, 1H, CH2NH), 11.06 (s, 1H, NH); 13C NMR (DMSO-d6) δ 20.73, 23.31, 30.62, 42.12, 56.57, 117.72, 121.86, 125.18, 125.76, 126.60, 134.05, 137.82, 140.30, 148.55, 149.77, 154.87, 161.17, 163.79, 169.47, 172.65. LCMS MH = 406; Anal Calcd For C23H19N3O4 + 0.5 H2O: C, 60.86; H, 4.86; N, 16.90. Found: C, 60.72; H, 4.62; N, 16.69.

5.40 2-(4-CHLORO-PHENYL)-N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL]-ACETAMIDE

To a stirred solution of (4-chloro-phenyl)-acetic acid (0.31 g, 1.8 mmol) in DMF in a 40 °C oil bath (8 mL), was added 1.1'-carbonyldiimidazole (0.33 g, 2.0 mmol) and stirred for one hour. To the mixture, 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.62 g, 1.8 mmol) was added, and the mixture was stirred for 15 minutes. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give 2-(4-chloro-phenyl)-N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-acetamide as an off-white solid (580 mg, 70% yield); HPLC, Waters Symmetry C18, 5 μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, grad. to 95/5 in 5 min, kept 5 min, 6.10 min (98.5%); mp, 285 °C (decomposed); 1H NMR (DMSO-d6) δ 2.14-2.19 (m, 1H, CHH), 2.57-2.86 (m, 6H, CH2CH2, CH3), 3.54 (s, 2H, ArCH2), 4.74-4.78 (m, 2H, CH2NH), 5.23 (dd, J = 6, 11 Hz, 1H, CH), 7.26-7.72 (m, 7H, Ar), 8.39 (s, J = 6 Hz, 1H, CH2NH), 11.02 (s, 1H, NH); 13C NMR (DMSO-d6) δ 20.74, 23.28, 30.59, 41.49, 41.72, 56.48, 117.68, 124.72, 125.59, 128.13, 130.92, 131.08, 133.82, 135.32, 140.64, 148.44, 154.80, 160.90, 169.50, 169.88, 172.59. LCMS MH = 453, 455; Anal Calcd For C23H21N3O4Cl + 0.15 H2O + 0.06 CH3Cl2: C, 59.78; H, 4.69; N, 12.16; Cl, 8.62. Found: C, 59.78; H, 4.60; N, 12.22; Cl, 9.00.
5.41 \textbf{N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL]-2-(4-TRIFLUOROMETHOXY-PHENYL)-ACETAMIDE}

To a stirred solution of (4-chloro-phenyl)-acetic acid (0.35 g, 1.6 mmol) in DMF in a 40 °C oil bath (8 mL), was added 1.1' carbonyldimidazole (0.29 g, 1.8 mmol) and stirred for one hour. To the mixture, 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.54 g, 1.6 mmol) was added, and the mixture was stirred for 15 minutes. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-2-(4-trifluoromethoxy-phenyl)-acetamides a white solid (600 mg, 74% yield); HPLC, Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, grad. to 95/5 in 5 min, kept 5 min, 6.46 min (99.1%); mp, 217-219 °C; 1H NMR (DMSO-d6) δ 2.14-2.19 (m, 1H, CHH), 2.57-2.89 (m, 6H, CHCH2, CH3), 3.58 (s, 2H, ArCH2), 4.69-4.85 (m, 2H, CH2NH), 5.24 (dd, J = 6, 11 Hz, 1H, CH), 7.26-7.71 (m, 7H, Ar), 8.44 (t, J = 6 Hz, 1H, CH3NHF), 11.02 (s, 1H, NH); 13C NMR (DMSO-d6) δ 20.74, 23.27, 30.58, 41.42, 41.70, 56.48, 117.69, 120.79, 124.67, 125.59, 130.89, 133.78, 135.86, 140.65, 147.00, 148.44, 154.81, 160.91, 169.50, 169.88, 172.59. LCMS MH = 503; Anal Calcd For C24H21N4O5F3: C, 57.37; H, 4.21; N, 11.15; F, 11.34. Found: C, 57.10; H, 3.97; N, 10.97; F, 11.14.

5.42 \textbf{2-(3,4-DICHLORO-PHENYL)-N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL]-ACETAMIDE}

To a stirred solution of (3,4-dichloro-phenyl)-acetic acid (0.30 g, 1.5 mmol) in DMF (8 mL) in a 40 °C oil bath, was added 1.1' carbonyldimidazole (0.26 g, 1.6 mmol) and stirred for one hour. To the mixture, 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.50 g, 1.5 mmol) was added, and the mixture was stirred for 15 minutes. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica...
gel, methanol/methylene chloride 4%/96%) to give 2-(3,4-dichloro-phenyl)-N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-acetamide as a yellow solid (540 mg, 74% yield); HPLC, Waters Symmetry C18, 5 μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH₃CN/0.1% H₃PO₄, grad. to 95/5 in 5 min, kept 5 min, 6.41 min (98.43%); mp, 262-264 °C;

5³¹H NMR (DMSO-d₆) δ 2.14-2.19 (m, 1H, CHH), 2.57-2.89 (m, 6H, CHCH₂, CH₃), 3.57 (s, 2H, ArCH₂), 4.64-4.85 (m, 2H, CH₂NH), 5.24 (dd, J = 6, 11 Hz, 1H, CH), 7.26-7.73 (m, 6H, Ar), 8.42 (t, J = 6 Hz, 1H, CH₂NH), 11.02 (s, 1H, NH).³¹C NMR (DMSO-d₆) δ 20.73, 23.28, 30.60, 40.98, 41.76, 56.49, 117.70, 124.84, 125.65, 129.06, 129.55, 130.27, 130.63, 131.11, 133.82, 137.43, 140.52, 148.46, 154.81, 160.90, 169.42, 169.49, 172.59. LCMS MH = 487, 489; Anal Calcd For C₂₃H₂₀N₄O₄Cl₂: C, 56.69; H, 4.14; N, 11.50; Cl, 14.55. Found: C, 56.50; H, 3.95; N, 11.25; Cl, 14.29.

5.43 N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YL METHYL]-2-(4-FLUORO-PHENYL)-ACETAMIDE

To a stirred solution of (4-fluoro-phenyl)-acetic acid (0.23 g, 1.5 mmol) in DMF (8 mL) in a 40 °C oil bath, was added 1.1’ carbonyldimidazole (0.26 g, 1.6 mmol) and stirred for one hour. To the mixture, 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.49 g, 1.5 mmol) was added, and the mixture was stirred for 15 minutes. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-2-(4-fluoro-phenyl)-acetamide as a white solid (480 mg, 76% yield); HPLC, Waters Symmetry C18, 5 μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH₃CN/0.1% H₃PO₄, grad. to 95/5 in 5 min, kept 5 min, 5.83 min (99.2%); mp, decomposed at 290 °C;¹H NMR (DMSO-d₆) δ 2.12-2.19 (m, 1H, CHH), 2.57-2.91 (m, 6H, CHCH₂, CH₃), 3.53 (s, 2H, ArCH₂), 4.68-4.83 (m, 2H, CH₂NH), 5.23 (dd, J = 6, 11 Hz, 1H, CHF), 7.09-7.72 (m, 7H, Ar), 8.36 (t, J = 6 Hz, 1H, CH₂NH), 11.02 (s, 1H, NH).³¹C NMR (DMSO-d₆) δ 20.74, 23.28, 30.58, 41.36, 41.70, 56.48, 114.89 (d, JCF = 21 Hz), 117.69, 124.72, 125.58, 130.86 (d, JCF = 7 Hz), 132.45 (d, JCF = 3 Hz), 133.82, 140.68, 148.44, 154.80, 160.91, 161.00 (d, JCF = 242 Hz), 169.50, 170.15, 172.59. LCMS MH = 437; Anal Calcd For C₂₃H₂₁N₄O₄F: C, 63.30; H, 4.85; N, 12.84; F, 4.35. Found: C, 63.25; H, 4.66; N, 12.73; F, 4.21.
5.44 N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-
QUINAZOLIN-5-YLMETHYL]-2-(3-FLUORO-4-METHYL-PHENYL)-
ACETAMIDE

To a stirred solution of (3-fluoro-4-methyl-phenyl)-acetic acid (0.25 g, 1.5 mmol) in
DMF (8 mL) in a 40 °C oil bath, was added 1.1' carbonyldiimidazole (0.27 g, 1.6 mmol) and stirred
for one hour. To the mixture, 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-
2,6-dione hydrogen chloride (0.50 g, 1.5 mmol) was added, and the mixture was stirred for 15
minutes. The solvent was evaporated, and the residue was purified by flash column chromatography
(Silica gel, methanol/methylene chloride 4%/96%) to give N-[3-(2,6-Dioxo-piperidin-3-yl)-2-
methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-2-(3-fluoro-4-methyl-phenyl)-acetic acid as a
yellow solid (500 mg, 74% yield); HPLC, Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min,
240 nm, 10/90 CH3CN/0.1% H3PO4, grad. to 95/5 in 5 min, kept 5 min, 6.10 min (99.3%); mp, 264-
266 °C; 1H NMR (DMSO-d6) δ 2.15-2.20 (m, 4H, CHH and CH3Ar), 2.57-2.91 (m, 6H, CHCH3,
CH2), 3.51 (s, 2H, ArCH2), 4.73-4.78 (m, 2H, CH3NH), 5.23 (dd, J = 6, 11 Hz, 1H, CH), 6.99-7.72
(m, 6H, Ar), 8.34 (t, J = 6 Hz, 1H, CH3NH), 11.01 (s, 1H, NH); 13C NMR (DMSO-d6) δ 13.76 (d, JCF =
3 Hz), 20.73, 23.27, 30.59, 41.60, 41.72, 56.48, 115.43 (d, JCF = 22 Hz), 117.69, 121.98 (d, JCF =
17 Hz), 124.82 (d, JCF = 7 Hz), 124.83, 125.59, 131.23 (d, JCF = 5 Hz), 133.80, 136.12 (d, JCF = 8
Hz), 140.64, 148.44, 154.80, 160.38 (d, JCF = 242 Hz), 160.91, 169.49, 169.90, 172.58. LCMS MH
= 451; Anal Calcd For C24H23N4O4F: C, 63.99; H, 5.15; N, 12.44; F, 4.22. Found: C, 63.61; H, 5.19;
N, 12.33; F, 4.20.

5.45 N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-
QUINAZOLIN-5-YLMETHYL]-2-(4-TRIFLUOROMETHYL-PHENYL)-
ACETAMIDE

To a stirred solution of (4-trifluoromethyl-phenyl)-acetic acid (0.26 g, 1.3 mmol) in
DMF (8 mL) in a 40 °C oil bath, was added 1.1' carbonyldiimidazole (0.22 g, 1.4 mmol) and stirred
for one hour. To the mixture, 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-
2,6-dione hydrogen chloride (0.42 g, 1.3 mmol) was added, and the mixture was stirred for 15
minutes. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-2-(4-trifluoromethyl-phenyl)-acetamide as an off-white solid (450 mg, 74% yield); HPLC, Waters Symmetry C_{18}, 5 μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH_{3}CN/0.1% H_{3}PO_{4}, grad. to 95/5 in 5 min, kept 5 min, 6.36 min (99.1%); mp, 199-201 °C; {^1}H NMR (DMSO-d_{6}) δ 2.14-2.19 (m, 1H, CHH), 2.57-2.87 (m, 6H, CHCH_{2}, CH_{3}), 3.66 (s, 2H, ArCH_{2}), 4.75-4.86 (m, 2H, CH_{2}NH), 5.24 (dd, J = 6, 11 Hz, 1H, CH), 7.27-7.72 (m, 7H, Ar), 8.48 (t, J = 6 Hz, 1H, CH_{2}NH), 11.02 (s, 1H, NH); {^{13}C} NMR (DMSO-d_{6}) δ 20.74, 23.28, 30.58, 41.75, 41.93, 56.48, 117.69, 124.72, 125.01 (d, J_{CF} = 4 Hz), 125.01 (d, J_{CF} = 10 Hz), 125.61, 129.91, 133.82, 140.58, 141.19, 148.45, 154.81, 160.90, 169.50, 169.54, 172.59. LCMS MH = 487; Anal Calcd For C_{24}H_{31}N_{4}O_{4}F_{3}: C, 57.76; H, 4.52; N, 11.23; F, 11.42. Found: C, 57.38; H, 4.49; N, 11.07; F, 11.64.

5.46 1-(4-CHLORO-PHENYL)-3-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL]-UREA

To a stirred suspension of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.44 g, 1.3 mmol) and triethylamine (0.25 mL, 1.8 mmol) in THF (8 mL) at 5-10 °C, was added 4-chlorophenyl isocyanate (0.21 mL, 1.7 mmol) and stirred for ten minutes. Then the mixture was stirred at room temperature overnight. The mixture was quenched with methanol (~1 mL), and the solvent was evaporated. The residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give 1-(4-chlorophenyl)-3-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-urea as a yellow solid (390 mg, 66% yield); HPLC, Waters Symmetry C_{18}, 5 μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH_{3}CN/0.1% H_{3}PO_{4}, grad. to 95/5 in 5 min, kept 5 min, 6.34 min (98.7%); mp, 255-257 °C; {^1}H NMR (DMSO-d_{6}) δ 2.17-2.23 (m, 1H, CHH), 2.59-2.94 (m, 6H, CHCH_{2}, CH_{3}), 4.72 (d, J = 6 Hz, 2H, CH_{2}NH), 5.27 (dd, J = 6, 11 Hz, 1H, CH), 6.65 (t, J = 5 Hz, 1H, CH_{2}NH), 7.21-7.78 (m, 7H, Ar), 8.92 (s, 1H, NH), 11.04 (s, 1H, NH); {^{13}C} NMR (DMSO-d_{6}) δ 20.70, 23.31, 30.62, 42.30, 56.51, 117.81, 119.02, 124.42, 125.77, 126.21, 128.42, 133.99, 139.47, 141.32, 148.50, 154.76, 154.88, 161.02, 169.49, 172.65. LCMS MH = 454, 456; Anal Calcd For C_{22}H_{22}N_{4}O_{4}Cl: C, 58.22; H, 4.44; N, 15.43; Cl, 7.81. Found: C, 58.11; H, 4.24; N, 15.16; Cl, 7.80.
5.47 1-(3-CHLORO-4-METHYL-PHENYL)-3-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL]-UREA

To a stirred suspension of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.51 g, 1.5 mmol) and triethylamine (0.30 mL, 2.1 mmol) in THF (15 mL) at 5–10 °C, was added 3-chloro-4-methyl phenyl isocyanate (0.27 mL, 1.9 mmol). Then the mixture was stirred at room temperature overnight. The mixture was quenched with methanol (~1 mL), and the solvent was evaporated. The residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give 1-(3-chloro-4-methyl-phenyl)-3-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-urea as an off-white solid (520 mg, 73% yield); HPLC, Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, grad. to 95/5 in 5 min, kept 5 min, 6.58 min (99.1%); mp, 250-252 °C; 1H NMR (DMSO-d6) δ 2.17-2.22 (m, 4H, CHH, ArCH3), 2.59-2.93 (m, 6H, CHCH3, CH2), 4.71 (d, J = 6 Hz, 2H, CH2NH), 5.27 (dd, J = 6, 11 Hz, 1H, CH), 6.64 (t, J = 6 Hz, 1H, CH2NH), 7.06-7.78 (m, 6H, Ar), 8.88 (s, 1H, N/), 11.04 (s, 1H, NH); 13C NMR (DMSO-d6) δ 18.69, 20.70, 23.31, 30.62, 42.31, 56.52, 116.24, 117.46, 117.81, 125.78, 126.28, 127.24, 130.98, 132.96, 133.99, 139.66, 141.30, 148.49, 154.76, 154.88, 161.02, 169.49, 172.65. LCMS MH = 468, 470; Anal Calcd For C23H22N3O2Cl + 0.2 H2O: C, 58.59; H, 4.79; N, 14.85; Cl, 7.52. Found: C, 58.42; H, 4.55; N, 14.57; Cl, 7.83.

5.48 1-(3,4-DIMETHYL-PHENYL)-3-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL]-UREA

To a stirred suspension of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.53 g, 1.6 mmol) and triethylamine (0.31 mL, 2.2 mmol) in THF (15 mL) at 5–10 °C, was added 3,4-dimethyl phenyl isocyanate (0.29 mL, 2.1 mmol). Then the mixture was stirred at room temperature overnight. The mixture was quenched with methanol (~1 mL), and the solvent was evaporated. The residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give 1-(3,4-dimethyl-phenyl)-3-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-urea as an off-white solid (520 mg, 73% yield); HPLC, Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, grad. to 95/5 in 5 min, kept 5 min, 6.14 min (96.6%); mp, 241-243 °C; 1H NMR (DMSO-d6) δ 2.11-2.21 (m, 7H, CHH, 2ArCH3), 2.59-2.94 (m, 6H, CHCH3, CH3),
4.71 (d, J = 5 Hz, 2H, CH₃NH), 5.27 (dd, J = 6, 11 Hz, 1H, CH), 6.56 (t, J = 5 Hz, 1H, CH₂NH), 6.92-7.78 (m, 6H, Ar), 8.58 (s, 1H, NH₂), 11.05 (s, 1H, NH); ¹³C NMR (DMSO-d₆) δ 18.58, 19.59, 20.70, 23.24, 30.62, 42.26, 56.52, 115.18, 117.76, 118.99, 125.54, 126.28, 128.50, 129.46, 134.01, 136.03, 138.15, 141.69, 148.27, 154.87, 155.11, 160.94, 169.47, 172.65. LCMS MH = 448; Anal Calcd For C₂₃H₂₃N₅O₄ + 2.0 H₂O: C, 59.62; H, 6.05; N, 14.48. Found: C, 59.36; H, 5.95; N, 14.24.

5.49 **N-[(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDROQUINAZOLIN-5-YLMETHYL]-4-METHYL-BENZAMIDE**

To a stirred mixture of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.47 g, 1.4 mmol) in tetrahydrofuran (10 mL), was added p-toluoyl chloride (0.37 mL, 2.8 mmol) and triethylamine (0.79 mL, 5.6 mmol). The mixture was stirred at room temp overnight. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione as a white solid (360 mg, 61% yield); HPLC, Waters Symmetry C₁₈, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH₃CN/0.1% H₃PO₄, gradient to 95/5 in 5 min, kept for 5 min, 5.97 min (97.3%); mp, 283-285°C; ¹H NMR (DMSO-d₆) δ 1.7-2.23 (m, 1H, CH₂H), 2.37 (s, 3H, CH₃), 2.58-2.92 (m, 6H, CHCH₂, CH₃), 4.90-5.07 (m, 2H, CH₂NH), 5.25 (dd, J = 6, 11 Hz, 1H, CH), 7.29-7.84 (m, 7H, Ar), 8.85 (t, 1H, J = 6 Hz, CH₂NH), 11.05 (s, 1H, NH); ¹³C NMR (DMSO-d₆) δ 20.82, 20.93, 23.29, 30.60, 42.07, 56.53, 117.65, 120.97, 124.02, 125.40, 127.21, 128.89, 131.43, 133.92, 141.11, 141.17, 148.50, 154.80, 161.11, 166.14, 169.54, 172.62. LCMS MH = 419; Anal Calcd For C₂₃H₂₂N₄O₄ + 0.4 H₂O: C, 64.90; H, 5.40; N, 13.16. Found: C, 64.96; H, 5.37; N, 13.15.

5.50 **N-[(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDROQUINAZOLIN-5-YLMETHYL]-3-METHYL-BENZAMIDE**

To a stirred solution of m-toluic acid (0.24 g, 1.8 mmol) in DMF (8 mL) in a 40°C oil bath, was added 1.1' carbonyldimidazole (0.31 g, 1.9 mmol) and stirred for one hour. To the mixture, 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.59 g, 1.8 mmol) was added, and the mixture was stirred for 45 minutes. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel,
methanol/methylene chloride 4% / 96%) to give N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-
dihydro-quinoxalin-5-ylmethyl]-3-methyl-benzamide as a light green solid (560 mg, 76% yield); HPLC, Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, grad. to 95/5 in 5 min, kept 5 min, 6.00 min (99.2%); mp, 263-265 °C; 1H NMR (DMSO-d6) δ 2.18-
2.21 (m, 1H, CHH), 2.38 (s, 3H, CH3Ar), 2.59-2.88 (m, 6H, CHCH2, CH3), 4.95-5.12 (m, 2H, 
CH2NH), 5.26 (dd, J = 6, 11 Hz, 1H, CH), 7.33-7.76 (m, 7H, Ar), 8.89 (t, J = 5 Hz, 1H, CH2NH), 
11.05 (s, 1H, NH); 13C NMR (DMSO-d6) δ 20.83, 20.92, 23.29, 30.60, 42.12, 56.52, 117.65, 123.98, 
124.32, 125.40, 127.76, 128.26, 131.85, 133.93, 134.23, 137.65, 141.04, 148.50, 154.80, 161.11, 
166.39, 169.53, 172.61. LCMS MH = 419; Anal Caled For C23H23N4O6 + 0.6 H2O: C, 64.36; H, 
5.45; N, 13.05. Found: C, 64.36; H, 5.24; N, 13.22.

5.51 4-CHLORO-N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-
DIHYDRO-QUINOXALIN-5-YLMETHYL]-BENZAMIDE

To a stirred mixture of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinoxalin-3-yl)-
piperidine-2,6-dione hydrogen chloride (0.48 g, 1.4 mmol) in acetonitrile (10 mL), was added 4-
chloro-benzoyl chloride (0.27 mL, 2.2 mmol) and N, N-diisopropyl ethylamine (0.62 mL, 3.6 
mmol). The mixture was stirred at room temp overnight. The solvent was evaporated, and the 
residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride

4% / 96%) to give 4-chloro-N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinoxalin-
5-ylmethyl]-benzamide as a white solid (390 mg, 62% yield); HPLC, Waters Symmetry C18, 5μm, 
3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, gradient to 95/5 in 5 min, kept for 5 
min, 6.18 min (98.0%); mp, 276-278 °C; 1H NMR (DMSO-d6) δ 2.18-2.23 (m, 1H, CHH), 2.58-2.93 
(m, 6H, CHCH2, CH3), 4.97-5.08 (m, 2H, CH2NH), 5.26 (dd, J = 6, 11 Hz, 1H, CH), 7.33-7.96 (m, 
7H, Ar), 9.01 (t, 1H, J = 6 Hz, CH2NH), 11.05 (s, 1H, NH); 13C NMR (DMSO-d6) δ 20.82, 23.29, 
30.60, 42.21, 56.54, 117.66, 124.16, 125.52, 128.45, 129.17, 132.95, 133.95, 136.13, 140.69, 
148.52, 154.84, 161.10, 165.23, 169.54, 172.63. LCMS MH = 439, 441; Anal Caled For 
C23H19N4O6Cl + 0.1 H2O: C, 59.96; H, 4.39; N, 12.71; Cl, 8.05. Found: C, 59.80; H, 4.13; N, 12.61; 
Cl, 8.30.
5.52 N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDROQUINAZOLIN-5-YLMETHYL]-3-FLUORO-BENZAMIDE

To a stirred mixture of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinoxalin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.47 g, 1.4 mmol) in acetonitrile (10 mL), was added 3-fluoro-benzoyle chloride (0.25 mL, 2.1 mmol) and N, N-diisopropyl ethylamine (0.61 mL, 3.5 mmol). The mixture was stirred at room temp overnight. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinoxalin-5-ylmethyl]-3-fluoro-benzamide as a white solid (230 mg, 40% yield); HPLC, Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, gradient to 95/5 in 5 min, kept for 5 min, 5.80 min (98.8%); mp, 240-242 °C; 1H NMR (DMSO-d6) δ 2.18-2.24 (m, 1H, CHF), 2.59-2.93 (m, 6H, CHCH2, CH3), 4.93-5.10 (m, 2H, CH2NH), 5.28 (dd, J = 6, 11 Hz, 1H, CH), 7.36-7.80 (m, 7H, Ar), 9.08 (t, 1H, J = 6 Hz, CH2NH), 11.06 (s, 1H, NH); 13C NMR (DMSO-d6) δ 20.79, 23.07, 30.58, 42.16, 56.58, 113.94, 114.24, 117.52, 118.09, 118.36, 123.38, 123.41, 124.16, 124.99, 130.52, 130.62, 134.12, 136.52, 136.61, 140.79, 147.84, 155.29, 160.39, 160.90, 163.62, 164.99, 165.02, 169.45, 172.60. LCMS MH = 423; Anal Calcd For C23H29N3O4F + 0.4 H2O: C, 61.51; H, 4.65; N, 13.04; F, 4.42. Found: C, 61.32; H, 4.44; N, 12.97; F, 4.27.

5.53 N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDROQUINAZOLIN-5-YLMETHYL]-4-TRIFLUOROMETHYL-BENZAMIDE

To a stirred mixture of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinoxalin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.45 g, 1.3 mmol) in acetonitrile (10 mL), was added 4-trifluoromethyl-benzoyle chloride (0.30 mL, 2.0 mmol) and N, N-diisopropyl ethylamine (0.58 mL, 3.3 mmol). The mixture was stirred at room temp overnight. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinoxalin-5-ylmethyl]-4-trifluoromethyl-benzamide as a white solid (420 mg, 67% yield); HPLC, Waters Symmetry C18, 5μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, gradient to 95/5
in 5 min, kept for 5 min, 6.46 min (97.2%); mp, 253-255 °C; \(^1\)HNMR (DMSO-\(d_6\)) \(\delta\) 2.18-2.24 (m, 1H, CH\(_2\)), 2.59-2.94 (m, 6H, CH\(_2\)CH\(_2\), CH\(_3\)), 4.94-5.11 (m, 2H, CH\(_2\)NH), 5.27 (dd, J = 6, 11 Hz, 1H, CH\(_2\)), 7.36-8.13 (m, 7H, Ar), 9.16 (t, J = 5 Hz, 1H, CH\(_2\)NH); \(^1^\)C NMR (DMSO-
\(d_6\)) \(\delta\) 20.82, 23.28, 30.60, 42.31, 56.56, 117.68, 124.28, 125.39, 125.44, 125.57, 125.74, 128.16, 130.99, 131.41, 133.98, 137.96, 140.45, 148.50, 154.89, 161.10, 165.12, 169.54, 172.63. LCMS MH = 473; Anal Calc'd For C\(_{23}\)H\(_{19}\)N\(_4\)O\(_3\)F\(_3\) + 0.5 H\(_2\)O: C, 57.38; H, 4.19; N, 11.64; F, 11.84. Found: C, 57.01; H, 4.05; N, 11.53; F, 11.56.

5.54 N-[(3-(2,6-DI-OXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL)-4-TRIFLUOROMETHoxy-BENZAMIDE

To a stirred mixture of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinoxaline-3-yl)-piperidine-2,6-dione hydrogen chloride (0.49 g, 1.5 mmol) in acetonitrile (10 mL), was added 4-trifluoromethoxy-benzoyl chloride (0.34 mL, 2.2 mmol) and N, N-diisopropyl ethylamine (0.63 mL, 3.6 mmol). The mixture was stirred at room temp for 15 minutes. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give N-[(3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinoxaline-5-ylmethyl)-4-trifluoromethoxy-benzamide as a white solid (370 mg, 54% yield); HPLC, Waters Symmetry C\(_{18}\), 5\(\mu\)m, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH\(_3\)CN/0.1% H\(_3\)PO\(_4\), gradient to 95/5 in 5 min, kept for 5 min, 6.54 min (98.6%); mp, 258-260 °C; \(^1\)HNMR (DMSO-\(d_6\)) \(\delta\) 2.18-2.23 (m, 1H, CH\(_2\)), 2.59-2.92 (m, 6H, CH\(_2\)CH\(_2\), CH\(_3\)), 4.98-5.09 (m, 2H, CH\(_2\)NH), 5.26 (dd, J = 6, 11 Hz, 1H, CH\(_2\)), 7.34-8.07 (m, 7H, Ar), 9.05 (t, J = 5 Hz, 1H, CH\(_2\)NH); \(^1^\)C NMR (DMSO-
\(d_6\)) \(\delta\) 20.82, 23.29, 30.60, 42.22, 56.54, 117.66, 120.70, 124.15, 125.52, 129.59, 133.30, 133.96, 140.65, 148.51, 150.33, 154.84, 161.10, 165.05, 169.54, 172.63. LCMS MH = 489; Anal Calc'd For C\(_{23}\)H\(_{19}\)N\(_4\)O\(_3\)F\(_3\): C, 56.56; H, 3.92; N, 11.47; F, 11.67. Found: C, 56.32; H, 3.60; N, 11.23; F, 11.56.

5.55 N-[(3-(2,6-DI-OXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL)-BENZAMIDE

To a stirred mixture of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinoxaline-3-yl)-piperidine-2,6-dione hydrogen chloride (0.59 g, 1.8 mmol) in acetonitrile (10 mL), was added
benzoyl chloride (0.31 mL, 2.7 mmol) and N, N-diisopropyl ethyamine (0.77 mL, 4.4 mmol). The
mixture was stirred at room temp for 15 minutes. The solvent was evaporated, and the residue was
purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give
N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-benzamide as a
white solid (260 mg, 36% yield); HPLC, Waters Symmetry C\textsubscript{18}, 5µm, 3.9 x 150 mm, 1 mL/min,
240 nm, 10/90 CH\textsubscript{3}CN/0.1% H\textsubscript{3}PO\textsubscript{4}, gradient to 95/5 in 5 min, kept for 5 min, 5.70 min (99.6%);
melting point 247-249 °C; \textsuperscript{1}HNMR (DMSO-d\textsubscript{6}) 2.17-2.23 (m, 1H, CH\textsubscript{2}H), 2.59-2.90 (m, 6H, CH\textsubscript{2}CH\textsubscript{3}, CH\textsubscript{3}),
4.92-5.09 (m, 2H, CH\textsubscript{2}NH), 5.26 (dd, J = 6, 12 Hz, 1H, CH\textsubscript{2}CH\textsubscript{3}), 7.47-7.94 (m, 8H, Ar), 8.93 (t, J = 5
Hz, 1H, CH\textsubscript{2}NH), 11.05 (s, 1H, NH); \textsuperscript{13}C NMR (DMSO-d\textsubscript{6}) 20.82, 23.29, 30.60, 42.12, 56.53,
117.65, 124.01, 125.43, 127.20, 128.37, 131.30, 133.95, 134.21, 140.99, 148.50, 154.81, 161.11,
166.26, 169.54, 172.62. LCMS MH = 405; Anal Calcld For C\textsubscript{22}H\textsubscript{28}N\textsubscript{4}O\textsubscript{4} + 0.5 H\textsubscript{2}O: C, 63.91; H,
5.12; N, 13.55. Found: C, 63.78; H, 4.82; N, 13.45.

5.56 3,4-DICHLORO-N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDRO-QUINAZOLIN-5-YLMETHYL]-BENZAMIDE

To a stirred mixture of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.46 g, 1.4 mmol) in acetonitrile (10 mL), was added 3,4-
dichloro-benzoyl chloride (0.34 g, 1.6 mmol) and N, N-diisopropyl ethyamine (0.54 mL, 3.3
mmol). The mixture was stirred at room temp for 15 minutes. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride
4%/96%) to give 3,4-dichloro-N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-
quinazolin-5-ylmethyl]-benzamide as a white solid (450 mg, 70% yield); HPLC, Waters Symmetry C\textsubscript{18}, 5µm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH\textsubscript{3}CN/0.1% H\textsubscript{3}PO\textsubscript{4}, gradient to 95/5 in 5 min,
kept for 5 min, 6.60 min (99.6%); mp, 271-273 °C; \textsuperscript{1}HNMR (DMSO-d\textsubscript{6}) 2.17-2.22 (m, 1H, CH\textsubscript{2}H),
2.58-2.90 (m, 6H, CH\textsubscript{2}CH\textsubscript{3}, CH\textsubscript{3}), 4.97-5.09 (m, 2H, CH\textsubscript{2}NH), 5.26 (dd, J = 6, 11 Hz, 1H, CH\textsubscript{2}CH\textsubscript{3}), 7.34-8.17 (m, 6H, Ar), 9.14 (t, J = 5 Hz, 1H, CH\textsubscript{2}NH), 11.04 (s, 1H, NH); \textsuperscript{13}C NMR (DMSO-d\textsubscript{6}) 20.80,
23.29, 30.60, 42.30, 56.52, 117.66, 124.17, 125.56, 127.58, 129.28, 130.76, 131.31, 133.97, 134.11,
134.56, 140.39, 148.50, 154.86, 161.06, 164.10, 169.53, 172.62. LCMS MH = 473, 475; Anal Calcld
For C\textsubscript{22}H\textsubscript{19}N\textsubscript{4}O\textsubscript{4}Cl\textsubscript{2} + 0.1 CH\textsubscript{3}Cl: C, 55.09; H, 3.81; N, 11.63; Cl, 16.19. Found: C, 54.88; H, 3.60;
N, 11.46; Cl, 16.38.
5.57 N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDROQUINAZOLIN-5-YLMETHYL]-3-TRIFLUOROMETHYL-BENZAMIDE

To a stirred solution of 3-trifluoromethyl-benzoic acid (0.28 g, 1.5 mmol) in DMF (8 mL) in a 40 °C oil bath, was added 1.1' carbonyldimidazole (0.27 g, 1.6 mmol) and stirred for one hour. Then 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.50 g, 1.5 mmol) was added and stirred for 15 minutes. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-3-trifluoromethyl-benzamide as an off-white solid (440 mg, 62% yield); HPLC, Waters Symmetry C18, 5 μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, grad. to 95/5 in 5 min, kept 5 min, 6.37 min (98.3%); mp, 233-235 °C; 1H NMR (DMSO-d6) δ 2.17-2.23 (m, 1H, CHH), 2.58-2.91 (m, 6H, CHCH3, CH3), 4.95-5.12 (m, 2H, CH2NH), 5.27 (dd, J = 6, 11 Hz, 1H, CH), 7.36-8.27 (m, 7H, Ar), 9.23 (t, J = 5 Hz, 1H, CH2NH), 11.05 (s, 1H, NH); 13C NMR (DMSO-d6) δ 20.79, 23.29, 30.60, 42.29, 56.52, 117.68, 123.85 (q, JcF = 3 Hz), 123.98 (d, JcF = 273 Hz), 124.15, 125.53, 127.90 (d, JcF = 3 Hz), 129.19 (d, JcF = 32 Hz), 129.72, 131.37, 133.97, 135.05, 140.50, 148.50, 154.86, 161.07, 164.85, 169.54, 172.62. LCMS MH = 473; Anal Calcd For C23H19N5O4F3: C, 58.48; H, 4.05; N, 11.86; F, 12.06. Found: C, 58.19; H, 3.84; N, 11.86; F, 12.00.

5.58 N-[3-(2,6-DIOXO-PIPERIDIN-3-YL)-2-METHYL-4-OXO-3,4-DIHYDROQUINAZOLIN-5-YLMETHYL]-4-TRIFLUOROMETHYLSULFANYLBENZAMIDE

To a stirred suspension of 3-(5-aminomethyl-2-methyl-4-oxo-4H-quinazolin-3-yl)-piperidine-2,6-dione hydrogen chloride (0.49 g, 1.5 mmol) in acetonitrile (10 mL), was added 4-trifluoromethylthio-benzoyl chloride (0.37 mL, 2.2 mmol) and N, N-disopropyl ethylamine (0.60 mL, 3.7 mmol). The mixture was stirred at room temp for 30 minutes. The solvent was evaporated, and the residue was purified by flash column chromatography (Silica gel, methanol/methylene chloride 4%/96%) to give N-[3-(2,6-dioxo-piperidin-3-yl)-2-methyl-4-oxo-3,4-dihydro-quinazolin-5-ylmethyl]-4-trifluoromethyl-sulfanyl-benzamide as an off-white solid (520 mg, 70% yield); HPLC, Waters Symmetry C18, 5 μm, 3.9 x 150 mm, 1 mL/min, 240 nm, 10/90 CH3CN/0.1% H3PO4, gradient to 95/5 in 5 min, kept for 5 min, 6.70 min (98.3%); mp, 236-238 °C; 1HNMR (DMSO-d6) δ
5.59 ASSAYS

5.59.1 **TNFα Inhibition Assay in PMBC**

Peripheral blood mononuclear cells (PBMC) from normal donors are obtained by ficoll Hypaque (Pharmacia, Piscataway, NJ, USA) density centrifugation. Cells are cultured in RPMI 1640 (Life Technologies, Grand Island, NY, USA) supplemented with 10% AB+human serum (Gemini Bio-products, Woodland, CA, USA), 2 mM L-glutamine, 100 U/ml penicillin, and 100 μg/ml streptomycin (Life Technologies).

PBMC (2 x 10^8 cells) are plated in 96-well flat-bottom Costar tissue culture plates (Corning, NY, USA) in triplicate. Cells are stimulated with LPS (from Salmonella abortus equi, Sigma cat.no. L-1887, St.Louis, MO, USA) at 1 ng/ml final in the absence or presence of compounds. Compounds provided herein are dissolved in DMSO (Sigma) and further dilutions are done in culture medium immediately before use. The final DMSO concentration in all assays can be about 0.25%. Compounds are added to cells 1 hour before LPS stimulation. Cells are then incubated for 18-20 hours at 37°C in 5% CO₂, and supernatants are then collected, diluted with culture medium and assayed for TNFα levels by ELISA (Endogen, Boston, MA, USA). IC₅₀s are calculated using non-linear regression, sigmoidal dose-response, constraining the top to 100% and bottom to 0%, allowing variable slope (GraphPad Prism v3.02).

5.59.2 **IL-2 and MIP-3α Production by T Cells**

PBMC are depleted of adherent monocytes by placing 1 x 10⁶ PBMC in 10 ml complete medium (RPMI 1640 supplemented with 10% heat-inactivated fetal bovine serum, 2 mM L-glutamine, 100 U/ml penicillin, and 100 μg/ml streptomycin) per 10 cm tissue culture dish, in 37°C, 5% CO₂ incubator for 30-60 minutes. The dish is rinsed with medium to remove all non-adherent PBMC. T cells are purified by negative selection using the following antibody (Pharmeric) and Dynabead (Dynal) mixture for every 1 x 10⁶ non-adherent PBMC: 0.3 ml Sheep anti-mouse IgG beads, 15 μl anti-CD16, 15 μl anti-CD33, 15 μl anti-CD56, 0.23 ml anti-CD19 beads, 0.23 ml anti-HLA class II beads, and 56 μl anti-CD14 beads. The cells and bead/antibody mixture is rotated end-over-end for 30-60 minutes at 4°C. Purified T cells are removed from beads using a Dynal magnet. Typical yield is about 50% T cells, 87-95% CD3⁺ by flow cytometry.

Tissue culture 96-well flat-bottom plates are coated with anti-CD3 antibody OKT3 at 5 μg/ml in PBS, 100 μl per well, incubated at 37°C for 3-6 hours, then washed four times with
complete medium 100 µl/well just before T cells are added. Compounds are diluted to 20 times of
final in a round bottom tissue culture 96-well plate. Final concentrations are about 10 µM to about
0.00064 µM. A 10 mM stock of compounds provided herein is diluted 1:50 in complete for the first
20x dilution of 200 µM in 2 % DMSO and serially diluted 1:5 into 2 % DMSO. Compound is added
at 10 µl per 200 µl culture, to give a final DMSO concentration of 0.1 %. Cultures are incubated at
37°C, 5 % CO₂ for 2-3 days, and supernatants analyzed for IL-2 and MIP-3α by ELISA (R&D
Systems). IL-2 and MIP-3α levels are normalized to the amount produced in the presence of an
amount of a compound provided herein, and EC₅₀% calculated using non-linear regression, sigmoidal
dose-response, constraining the top to 100 % and bottom to 0 %, allowing variable slope (GraphPad
Prism v3.02).

5.59.3 Cell Proliferation Assay

Cell lines Namalwa, MUTZ-5, and UT-7 are obtained from the Deutsche Sammlung
von Mikroorganismen und Zellkulturen GmbH (Braunschweig, Germany). The cell line KG-1 is
obtained from the American Type Culture Collection (Manassas, VA, USA). Cell proliferation as
indicated by ³H-thymidine incorporation is measured in all cell lines as follows.

Cells are plated in 96-well plates at 6000 cells per well in media. The cells are pre-
treated with compounds at about 100, 10, 1, 0.1, 0.01, 0.001, 0.0001 and 0 µM in a final
concentration of about 0.25 % DMSO in triplicate at 37°C in a humidified incubator at 5 % CO₂ for
72 hours. One microcurie of ³H-thymidine (Amersham) is then added to each well, and cells are
incubated again at 37°C in a humidified incubator at 5 % CO₂ for 6 hours. The cells are harvested
onto UniFilter GF/C filter plates (Perkin Elmer) using a cell harvester (Tomtec), and the plates are
allowed to dry overnight. Microscint 20 (Packard) (25 µl/well) is added, and plates are analyzed in
TopCount NXT (Packard). Each well is counted for one minute. Percent inhibition of cell
proliferation is calculated by averaging all triplicates and normalizing to the DMSO control (0 %
inhibition). Each compound is tested in each cell line in three separate experiments. Final IC₅₀% are
calculated using non-linear regression, sigmoidal dose-response, constraining the top to 100 % and
bottom to 0 %, allowing variable slope. (GraphPad Prism v3.02).

5.59.4 Immunoprecipitation and Immunoblot

Namalwa cells are treated with DMSO or an amount of a compound provided
herein for 1 hour, then stimulated with 10 U/ml of Epo (R&D Systems) for 30 minutes. Cell lysates
are prepared and either immunoprecipitated with Epo receptor Ab or separated immediately by
SDS-PAGE. Immunoblots are probed with Akt, phospo-Akt (Ser473 or Thr308), phospho-Gab1
(Y627), Gab1, IRS2, actin and IRF-1 Abs and analyzed on a Storm 860 Imager using ImageQuant
software (Molecular Dynamics).
5.59.5 Cell Cycle Analysis
Cells are treated with DMSO or an amount of a compound provided herein overnight. Propidium iodide staining for cell cycle is performed using CycleTEST PLUS (Becton Dickinson) according to manufacturer's protocol. Following staining, cells are analyzed by a FACSCalibur flow cytometer using ModFit LT software (Becton Dickinson).

5.59.6 Apoptosis Analysis
Cells are treated with DMSO or an amount of a compound provided herein at various time points, then washed with annexin-V wash buffer (BD Biosciences). Cells are incubated with annexin-V binding protein and propidium iodide (BD Biosciences) for 10 minutes. Samples are analyzed using flow cytometry.

5.59.7 Luciferase Assay
Namalwa cells are transfected with 4 µg of AP1-luciferase (Stratagene) per 1 x 10⁶ cells and 3 µl Lipofectamine 2000 (Invitrogen) reagent according to manufacturer’s instructions. Six hours post-transfection, cells are treated with DMSO or an amount of a compound provided herein. Luciferase activity is assayed using luciferase lysis buffer and substrate (Promega) and measured using a luminometer (Turner Designs).

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 as defined by the appended claims.

Citation or identification of any reference in this application is not an admission that such reference is available as prior art to this invention.
53686-77

CLAIMS:

1. A compound having a structure of formula (II):

   ![Chemical Structure](image)

   (II),

   or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof, wherein:

   $R^4$ is: halo; $-(\text{CH}_2)_n\text{OH}$; $(\text{C}_1-\text{C}_6)$alkyl, optionally substituted with one or more halo; or
   $(\text{C}_1-\text{C}_6)$alkoxy, optionally substituted with one or more halo;

   $R^5$ is: hydrogen; $-(\text{CH}_2)_n\text{OH}$; phenyl; $-\text{O}-(\text{C}_1-\text{C}_6)$alkyl; or $(\text{C}_1-\text{C}_6)$alkyl, optionally substituted with one or more halo;

   $R^6$ is: hydrogen; or $(\text{C}_1-\text{C}_6)$alkyl, optionally substituted with one or more halo; and

   $n$ is 0, 1, or 2.

2. The compound of claim 1, or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof, wherein $R^4$ is methyl or methoxy.

3. The compound of claim 1, or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof, wherein $R^4$ is F or Cl.

4. The compound of claim 1, or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof, wherein $R^4$ is $-\text{CF}_3$.

5. The compound of claim 1, which is:

   ![Chemical Structures]

   - 82 -
or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof.

6. A compound having a structure of formula (III):

![Chemical Structure](image)

(III),

or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof, wherein:

5. $R^d$ is:

hydrogen;
(C₁-C₆)alkyl, optionally substituted with one or more halo;

-C(O)-(C₁-C₆)alkyl, wherein the alkyl is optionally substituted with one or more halo;

-C(O)-(CH₂)ₙ-(C₃-C₁₀-cycloalkyl);

-C(O)-(CH₂)ₙ-NR⁸R⁹, wherein R⁸ and R⁹ are each independently:

5 hydrogen;

(C₁-C₆)alkyl, optionally substituted with one or more halo; or

(C₁-C₆)alkoxy, optionally substituted with one or more halo; or

-C(O)-(CH₂)ₙ-O-(C₁-C₆)alkyl.

R⁷ is: hydrogen; -(CH₂)ₙOH; phenyl; -O-(C₁-C₆)alkyl; or (C₁-C₆)alkyl, optionally substituted with one or more halo;

R⁸ is: hydrogen; or (C₁-C₆)alkyl, optionally substituted with one or more halo; and

n is 0, 1, or 2.

7. The compound of claim 6, or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof, wherein R⁷ is methyl.

15 8. The compound of claim 6, or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof, wherein R⁴ is -C(O)-(C₁-C₆)alkyl.

9. The compound of claim 6, or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof, wherein R⁴ is -C(O)-CH₃-O-(C₁-C₆)alkyl.

10. The compound of claim 6, which is:
or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof.

11. A compound having a structure of formula (IV):
(IV),

or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof; wherein:

$R^8$ is:

-$(\text{CH}_2)_n$-(6 to 10 membered aryl);

-$(\text{O})(\text{CH}_2)_n$-(6 to 10 membered aryl) or $-$(\text{O})(\text{CH}_2)_n$-(6 to 10 membered heteroaryl),

wherein the aryl or heteroaryl is optionally substituted with one or more of: halo; $-\text{SCF}_3$;

$(\text{C}_1-\text{C}_6)$alkyl, itself optionally substituted with one or more halo; or $(\text{C}_1-\text{C}_6)$alkoxy, itself optionally substituted with one or more halo;

$-$(\text{O})(\text{CH}_2)_n-NHR^h$, wherein $R^h$ is:

$6$ to $10$ membered aryl, optionally substituted with one or more of: halo;

$(\text{C}_1-\text{C}_6)$alkyl, itself optionally substituted with one or more halo; or

$(\text{C}_1-\text{C}_6)$alkoxy, itself optionally substituted with one or more halo; or

$-$(\text{O})(\text{CH}_2)_n$O-(\text{CH}_2)_n$-(6 to 10 membered aryl);

$R^9$ is: hydrogen; $-(\text{CH}_2)_n$OH; phenyl; $-$(\text{C}_1-\text{C}_6)$alkyl; or $(\text{C}_1-\text{C}_6)$alkyl, optionally substituted with one or more halo;

$R^{10}$ is: hydrogen; or $(\text{C}_1-\text{C}_6)$alkyl, optionally substituted with one or more halo; and

$n$ is 0, 1, or 2.

12. The compound of claim 11, wherein $R^9$ is methyl.
13. The compound of claim 11, wherein R² is -C(O)-phenyl, -C(O)-CH₂-phenyl, or -C(O)-NH-phenyl.

14. The compound of claim 13, wherein the phenyl is substituted with one or more of methyl, -CF₃, or halogen.

15. The compound of claim 11, which is:
or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof.

16. A pharmaceutical composition comprising a compound of any one of claims 1 to 15, or a pharmaceutically acceptable salt, solvate, or stereoisomer thereof, and a pharmaceutically acceptable excipient.