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(54) Titre : AGENTS CYTOTOXIQUES COMPRENANT DES TAXANES ET LEUR UTILISATION THERAPEUTIQUE
 (54) Title: CYTOTOXIC AGENTS COMPRISING TAXANES AND THEIR THERAPEUTIC USE

(57) **Abrégé/Abstract:**

A cytotoxic agent comprising one or more taxanes linked to a cell binding agent. A therapeutic composition for killing selected cell populations comprising: (A) a cytotoxic amount of one or more taxanes covalently bonded to a cell binding agent through a linking group, and (B) a pharmaceutically acceptable carrier, diluent or excipient. A method for killing selected cell populations comprising contacting target cells or tissue containing target cells with an effective amount of a cytotoxic agent comprising one or more taxanes linked to a cell binding agent. Novel sulfur-containing taxanes.

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(54) Title: CYTOTOXIC AGENTS COMPRISING TAXANES AND THEIR THERAPEUTIC USE

(57) Abstract: A cytotoxic agent comprising one or more taxanes linked to a cell binding agent. A therapeutic composition for killing selected cell populations comprising: (A) a cytotoxic amount of one or more taxanes covalently bonded to a cell binding agent through a linking group, and (B) a pharmaceutically acceptable carrier, diluent or excipient. A method for killing selected cell populations comprising contacting target cells or tissue containing target cells with an effective amount of a cytotoxic agent comprising one or more taxanes linked to a cell binding agent. Novel sulfur-containing taxanes.

CYTOTOXIC AGENTS COMPRISING TAXANES AND THEIR THERAPEUTIC USE

This is a continuation of U.S. provisional application number 60/167,228 filed November 24, 1999.

FIELD OF THE INVENTION

The present invention relates to novel cytotoxic agents and their therapeutic use. More specifically, the invention relates to novel cytotoxic agents comprising taxanes and their therapeutic use. These novel cytotoxic agents have therapeutic use as a result of delivering the taxanes to a specific cell population in a targeted fashion by chemically linking the taxane to a cell binding agent.

BACKGROUND OF THE INVENTION

Many reports have appeared on the attempted specific targeting of tumor cells with monoclonal antibody-drug conjugates (Sela et al, in *Immunoconjugates* 189-216 (C. Vogel, ed. 1987); Ghose et al, in *Targeted Drugs* 1-22 (E. Goldberg, ed. 1983); Diener et al, in *Antibody mediated delivery systems* 1-23 (J. Rodwell, ed. 1988); Pietersz et al, in *Antibody mediated delivery systems* 25-53 (J. Rodwell, ed. 1988); Bumol et al, in *Antibody mediated delivery systems* 55-79 (J. Rodwell, ed. 1988). All references and patents cited herein are incorporated by reference.

Cytotoxic drugs such as methotrexate, daunorubicin, doxorubicin, vincristine, vinblastine, melphalan, mitomycin C, and chlorambucil have been conjugated to a variety of murine monoclonal antibodies. In some cases, the drug molecules were linked to the antibody molecules through an intermediary carrier molecule such as serum albumin (Garnett et al, 46 *Cancer Res.* 2407-2412 (1986); Ohkawa et al 23

Cancer Immunol. Immunother. 81-86 (1986); Endo et al, 47 *Cancer Res.* 1076-1080 (1980)), dextran (Hurwitz et al, 2 *Appl. Biochem.* 25-35 (1980); Manabi et al, 34 *Biochem. Pharmacol.* 289-291 (1985); Dillman et al, 46 *Cancer Res.* 4886-4891 (1986); Shoval et al, 85 *Proc. Natl. Acad. Sci.* 8276-8280 (1988)), or polyglutamic acid (Tsukada et al, 73 *J. Natl. Canc. Inst.* 721-729 (1984); Kato et al 27 *J. Med. Chem.* 1602-1607 (1984); Tsukada et al, 52 *Br. J. Cancer* 111-116 (1985)).

A wide array of linker technologies has been employed for the preparation of such immunoconjugates and both cleavable and non-cleavable linkers have been investigated. In most cases, the full cytotoxic potential of the drugs could only be observed, however, if the drug molecules could be released from the conjugates in unmodified form at the target site.

One of the cleavable linkers that has been employed for the preparation of antibody-drug conjugates is an acid-labile linker based on *cis*-aconitic acid that takes advantage of the acidic environment of different intracellular compartments such as the endosomes encountered during receptor mediated endocytosis and the lysosomes. Shen and Ryser introduced this method for the preparation of conjugates of daunorubicin with macromolecular carriers (102 *Biochem. Biophys. Res. Commun.* 1048-1054 (1981)). Yang and Reisfeld used the same technique to conjugate daunorubicin to an anti-melanoma antibody (80 *J. Natl. Canc. Inst.* 1154-1159 (1988)). Dillman et al. also used an acid-labile linker in a similar fashion to prepare conjugates of daunorubicin with an anti-T cell antibody (48 *Cancer Res.* 6097-6102 (1988)).

An alternative approach, explored by Trouet et al, involved linking

daunorubicin to an antibody via a peptide spacer arm (79 *Proc. Natl. Acad. Sci.* 626-629 (1982)). This was done under the premise that free drug could be released from such a conjugate by the action of lysosomal peptidases.

In vitro cytotoxicity tests, however, have revealed that antibody-drug conjugates rarely achieved the same cytotoxic potency as the free unconjugated drugs. This suggested that mechanisms by which drug molecules are released from the antibodies are very inefficient. In the area of immunotoxins, conjugates formed via disulfide bridges between monoclonal antibodies and catalytically active protein toxins were shown to be more cytotoxic than conjugates containing other linkers. See, Lambert et al, 260 *J. Biol. Chem.* 12035-12041 (1985); Lambert et al, in *Immunotoxins* 175-209 (A. Frankel, ed. 1988); Ghetie et al 48 *Cancer Res.* 2610-2617 (1988). This was attributed to the high intracellular concentration of glutathione contributing to the efficient cleavage of the disulfide bond between an antibody molecule and a toxin. Despite this, there are only a few reported examples of the use of disulfide bridges for the preparation of conjugates between drugs and macromolecules. Shen et al (260 *J. Biol. Chem.* 10905-10908 (1985)) described the conversion of methotrexate into a mercaptoethylamide derivative followed by conjugation with poly-D-lysine via a disulfide bond. Another report described the preparation of a conjugate of the trisulfide containing toxic drug calicheamycin with an antibody (Hinman et al., 53 *Cancer Res.* 3336-3342 (1993)).

One reason for the lack of disulfide linked antibody-drug conjugates is the unavailability of cytotoxic drugs possessing a sulfur atom containing moiety that can be readily used to link the drug to an antibody via a disulfide bridge. Furthermore,

chemical modification of existing drugs is difficult without diminishing their cytotoxic potential.

Another major drawback with existing antibody-drug conjugates is their inability to deliver a sufficient concentration of drug to the target site because of the limited number of targeted antigens and the relatively moderate cytotoxicity of cancerostatic drugs like methotrexate, daunorubicin, and vincristine. In order to achieve significant cytotoxicity, linkage of a large number of drug molecules, either directly to the antibody or through a polymeric carrier molecule, becomes necessary. However, such heavily modified antibodies often display impaired binding to the target antigen and fast *in vivo* clearance from the blood stream.

In spite of the above described difficulties, useful cytotoxic agents comprising cell binding moieties and the group of cytotoxic drugs known as maytansinoids have been reported (USP 5,208,020, USP 5,416,064, and R. V. J. Chari, 31 *Advanced Drug Delivery Reviews* 89-104 (1998)). Similarly, useful cytotoxic agents comprising cell binding moieties and analogues and derivatives of the potent antitumor antibiotic CC-1065 have also been reported (USP 5,475,092 and USP 5,585,499).

Paclitaxel (Taxol), a cytotoxic natural product, and docetaxel (Taxotere), a semi-synthetic derivative (See Figure 1), are widely used in the treatment of cancer. These compounds belong to the family of compounds called taxanes. Taxanes are mitotic spindle poisons that inhibit the depolymerization of tubulin, resulting in an increase in the rate of microtubule assembly and cell death. While docetaxel and paclitaxel are useful agents in the treatment of cancer, their antitumor activity is limited because of their non-specific toxicity towards normal cells.

Further, compounds like paclitaxel and docetaxel themselves are not sufficiently potent to be used in conjugates of cell binding agents. Recently, a few new docetaxel analogs with greater potency than either docetaxel or paclitaxel have been described (Iwao Ojima et al., *J. Med. Chem.* 39, 3889-3896 (1996) and Figure 1). However, these compounds lack a suitable functionality that allows linkage via a cleavable bond to cell binding agents.

Accordingly, a method of treating diseases with taxanes wherein their side effects are reduced without compromising their cytotoxicity is greatly needed.

SUMMARY OF THE INVENTION

One object of the present invention is to provide taxanes that are highly toxic and that can still be effectively used in the treatment of many diseases.

Another object of the present invention is to provide novel taxanes.

These and other objects have been achieved by providing a cytotoxic agent comprising one or more taxanes linked to a cell binding agent.

In a second embodiment, the present invention provides a therapeutic composition comprising:

(A) an effective amount of one or more taxanes linked to a cell binding agent,

and

(B) a pharmaceutically acceptable carrier, diluent, or excipient.

In a third embodiment, the present invention provides a method of killing selected cell populations comprising contacting target cells or tissue containing target

cells, with a cytotoxic amount of a cytotoxic agent comprising one or more taxanes linked to a cell binding agent.

In a fourth embodiment, the present invention provides taxanes comprising a linking group capable of linking said taxanes to a cell binding agent or other chemical
5 moieties.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a chemical formula that represents structures of various taxanes, including some of the more potent taxanes described by Ojima et al., *supra*.

Figure 2 is a chemical formula that represents structures of some of the
10 disulfide-containing taxanes according to the present invention.

Figure 3 shows the structure of 10-deacetylbaccatin III, which is the starting material for preparing taxanes.

Figure 4 shows the anti-tumor effect of anti-EGF Receptor Antibody-Taxane Conjugate on human squamous cancer (A431) xenografts in SCID mice.

Figure 5 shows the body weight change of the SCID mice used in the
15 experiment described in Example 10.

Figure 6 shows the results of a cytotoxicity determination for the anti-EGF receptor-taxane conjugate on the target antigen-positive cell line A431 and for the N901-taxane conjugate for which the A431 cell line does not express the target
20 antigen.

Figure 7 shows the cytotoxic potency and selectivity of the TA.1-taxane

conjugate in the target antigen-positive cell line SK-BR-3 and the target antigen-negative cell line A431.

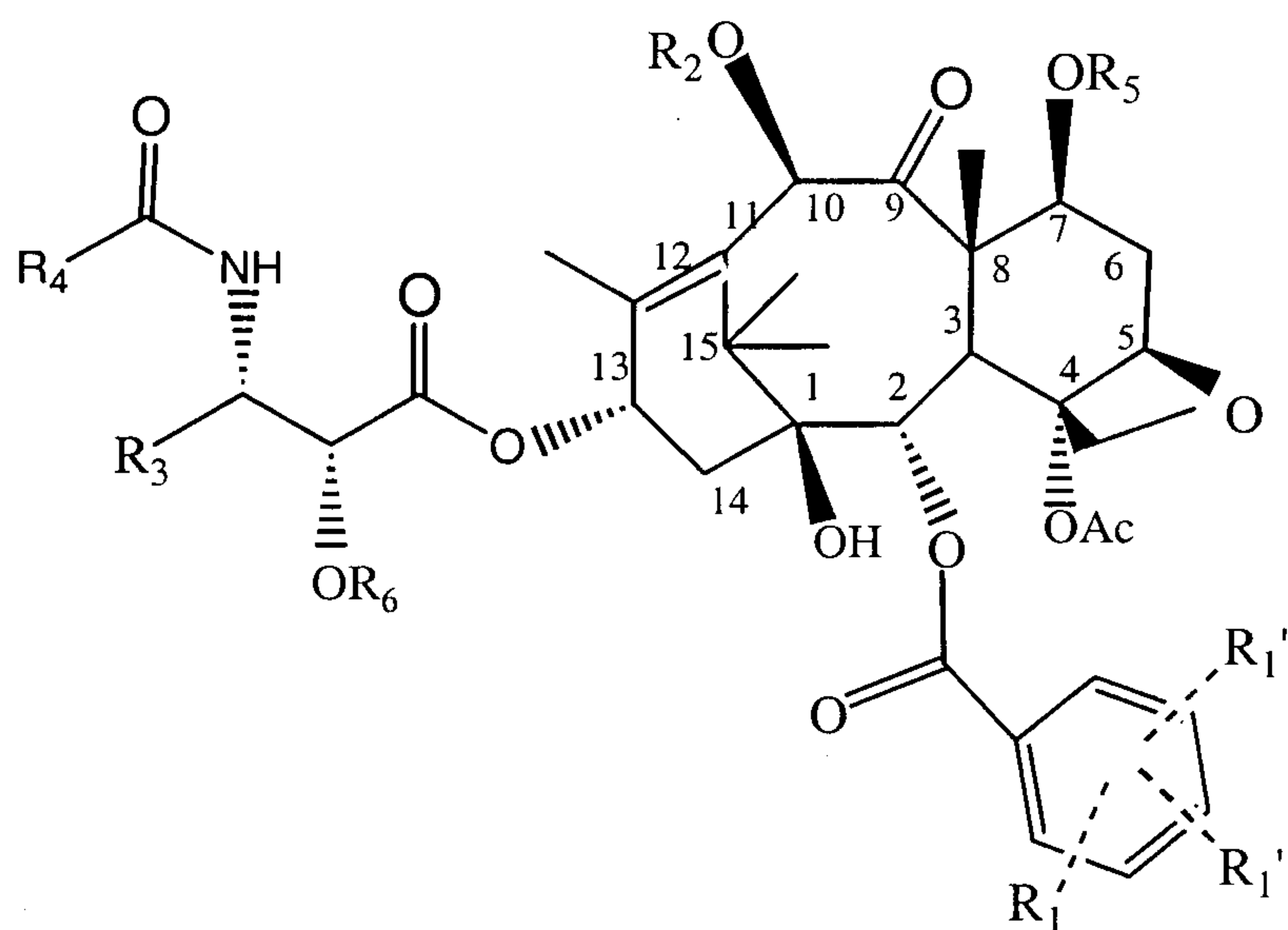
DETAILED DESCRIPTION OF THE INVENTION

This invention is based on the synthesis of novel taxanes that retain high
5 cytotoxicity and that can be effectively linked to cell binding agents. It has previously
been shown that the linkage of highly cytotoxic drugs to antibodies using a cleavable
link, such as a disulfide bond, ensures the release of fully active drug inside the cell, and
such conjugates are cytotoxic in an antigen specific manner (R.V.J. Chari et al, 52
Cancer Res. 127-131 (1992); USP 5,475,092; and USP 5,416,064). However, the art
10 reveals that it is extremely difficult to modify existing drugs without diminishing their
cytotoxic potential. The disclosed invention overcomes this problem by modifying the
disclosed taxanes with chemical moieties, and especially ones containing thiol or
disulfide groups, to which appropriate cell binding agents can be linked. As a result, the
disclosed novel taxanes preserve, and in some cases could even enhance, the cytotoxic
15 potency of known taxanes. The cell binding agent-taxane complexes permit the full
measure of the cytotoxic action of the taxanes to be applied in a targeted fashion against
unwanted cells only, therefore, avoiding side effects due to damage to non-targeted
healthy cells. This invention permits the taxanes to be target site-directed which had
previously been impossible. Thus, the invention provides useful agents for the
20 elimination of diseased or abnormal cells that are to be killed or lysed such as tumor cells
(particularly solid tumor cells), virus infected cells, microorganism infected cells,
parasite infected cells, autoimmune cells (cells that produce autoantibodies), activated
cells (those involved in graft rejection or graft vs. host disease), or any other type of

diseased or abnormal cells, while exhibiting a minimum of side effects.

The cytotoxic agent according to the present invention comprises one or more taxanes linked to a cell binding agent via a linking group. The linking group is part of a chemical moiety that is covalently bound to a taxane through conventional methods. In a preferred embodiment, the chemical moiety can be covalently bound to the taxane via an ether linkage.

The taxanes useful in the present invention have the formula (I) shown below:



(I)

These novel taxanes can be divided into four embodiments, (1), (2), (3) and (4), respectively. Examples of the four embodiments are shown in Figure 2.

In embodiments (1) to (4), R_1 is an electron withdrawing group, such as F, NO_2 , CN, Cl, CHF_2 , or CF_3 or an electron donating group such as $-\text{OCH}_3$, $-\text{OCH}_2\text{CH}_3$, $-\text{NR}_7\text{R}_8$, $-\text{OR}_9$, and R_1' and R_1'' are the same or different and are H, an electron withdrawing group, or an electron donating group. R_1 can also be H.

R_7 and R_8 are the same or different and are linear, branched, or cyclic alkyl groups having 1 to 10 carbon atoms or simple or substituted aryl having 1 to 10 carbon atoms. Preferably the number of carbon atoms for R_7 and R_8 is 1 to 4. Also, preferably R_7 and R_8 are the same. Examples of preferred $-NR_7R_8$ groups include dimethyl amino, diethyl amino, dipropyl amino, and dibutyl amino, where the butyl moiety is any of primary, secondary, tertiary or isobutyl. R_9 is linear, branched or cyclic alkyl having 1 to 10 carbon atoms. R_1 is preferably F, NO_2 , or CF_3 .

Preferably, R_1 is in the meta position and R_1' and R_1'' are H.

In embodiments (1), (2) and (4), R_2 is heterocyclic, a linear, branched, or cyclic ester or ether having from 1 to 10 carbon atoms or a carbamate of the formula $-CNR_{10}R_{11}$, wherein R_{10} and R_{11} are the same or different and are H, linear, branched, or cyclic alkyl having 1 to 10 atoms or simple or substituted aryl having 1 to 10 carbon atoms. For esters, preferred examples include $-COCH_2CH_3$ and $-COCH_2CH_2CH_3$. For carbamates, preferred examples include $-CONHCH_2CH_3$, $-CONHCH_2CH_2CH_3$, $-CO$ -morpholino, $-CO$ -piperazino, $-CO$ -piperidino, or $-CO$ -*N*-methylpiperazino.

In embodiment (3), R_2 is the linking group.

In embodiments (1), (3) and (4), R_3 is aryl, or is linear, branched or cyclic alkyl having 1 to 10 carbon atoms, preferably $-CH_2CH(CH_3)_2$.

In embodiment (2), R_3 is $-CH=C(CH_3)_2$.

In all embodiments, R_4 is $-OC(CH_3)_3$ or $-C_6H_5$.

In embodiments (1) and (2), R_5 is the linking group and R_6 is H or has the same definition as above for R_2 for embodiments (1), (2) and (4).

In embodiment (3), R_5 is H or has the same definition as above for R_2 for embodiments (1), (2) and (4).

In embodiment (3), R_6 is H or has the same definition as above for R_2 for embodiments (1), (2) and (4).

5 In embodiment (4), R_5 is H or has the same definition as above for R_2 for embodiments (1), (2) and (4) and R_6 is a linking group.

The preferred positions for introduction of the linking group are R_2 and R_5 , with R_2 being the most preferred. Suitable linking groups are well known in the art and include disulfide groups, thioether groups, acid labile groups, photolabile groups, 10 peptidase labile groups and esterase labile groups. Preferred are disulfide groups and thioether groups.

When the linking group is a thiol- or disulfide-containing group, the side chain carrying the thiol or disulfide group can be linear or branched, aromatic or heterocyclic. One of ordinary skill in the art can readily identify suitable side chains. Specific 15 examples of the thiol- or disulfide- containing substituents include $-(CH_2)_nSZ$, $-CO(CH_2)_nSZ$, $-(CH_2)_nCH(CH_3)SZ$, $-CO(CH_2)_nCH(CH_3)SZ$, $-(CH_2)_nC(CH_3)_2SZ$, $-CO(CH_2)_nC(CH_3)_2SZ$, $-CONR_{12}(CH_2)_nSZ$, $-CONR_{12}(CH_2)_nCH(CH_3)SZ$, or $-CONR_{12}(CH_2)_nC(CH_3)_2SZ$, $-CO$ -morpholino- XSZ , $-CO$ -piperazino- XSZ , $-CO$ -piperidino- XSZ , and $-CO$ -*N*-methylpiperazino- XSZ wherein

20 Z is H or SR,

X is a linear alkyl or branched alkyl having 1-10 carbon atoms.

R and R_{12} are the same or different and are linear alkyl, branched alkyl or cyclic

alkyl having 1 to 10 carbon atoms, or simple or substituted aryl having from 1 to 10 carbon atoms or heterocyclic, and R₁₂ can in addition be H, and

n is an integer of 1 to 10.

Examples of linear alkyls include methyl, ethyl, propyl, butyl, pentyl and hexyl.

5 Examples of branched alkyls include isopropyl, isobutyl, sec.-butyl, tert.-butyl, isopentyl and 1-ethyl-propyl.

Examples of cyclic alkyls include cyclopropyl, cyclobutyl, cyclopentyl and cyclohexyl.

Examples of simple aryls include phenyl and naphthyl.

10 Examples of substituted aryls include aryls such as those described above substituted with alkyl groups, with halogens, such as Cl, Br, F, nitro groups, amino groups, sulfonic acid groups, carboxylic acid groups, hydroxy groups or alkoxy groups.

15 Examples of heterocyclics are compounds wherein the heteroatoms are selected from O, N, and S, and include morpholino, piperidino, piperazino, N-methylpiperazino, pyrrollyl, pyridyl, furyl and thiophene.

The taxanes of the present invention that have a thiol- or disulfide-containing substituent are in themselves novel.

20 The taxanes that have a thiol or disulfide-containing substituent can be synthesized according to known methods. The starting material for the synthesis is the commercially available 10-deacetylbaccatin III, shown in Figure 3. The chemistry to introduce various substituents is described in several publications (Ojima et al, *J.Med.*

*Chem.*39, 3889-3896, (1996), Ojima et al., 40 *J. Med. Chem.* 267-278 (1997); I. Ojima et al., 96 *Proc. Natl. Acad. Sci.*, 4256-4261 (1999); I. Ojima et al., USP 5,475,011 and USP 5,811,452.).

The substituent R₁ on the phenyl ring and the position of the substituent R₁ can
5 be varied until a compound of the desired toxicity is obtained. Furthermore, the degree
of substitution on the phenyl ring can be varied to achieve a desired toxicity. That is, the
phenyl ring can have one or more substituents (e.g., mono-, di-, or tri-substitution of the
phenyl ring) which provide another means for achieving a desired toxicity. High
cytotoxicity is defined as exhibiting a toxicity having an IC₅₀ in the range of 1 x 10⁻¹² to
10 3 x 10⁻⁹M, when measured *in vitro* with cultured cancer cells upon a 72 hour exposure
time to the drug. One of ordinary skill in the art can determine the appropriate chemical
moiety for R₁ and the appropriate position for R₁ using only routine experimentation.

For example electron withdrawing groups at the meta position are expected to
increase the cytotoxic potency, while substitution at the para position is not expected to
15 increase the potency as compared to the parent taxane. Typically a few representative
taxanes with substituents at the different positions (ortho, meta and para) will be initially
prepared and evaluated for *in vitro* cytotoxicity.

The disulfide or thiol-containing substituent can be introduced at one of the
positions where a hydroxyl group already exists. The chemistry to protect the various
20 hydroxyl groups, while reacting the desired one, has been described previously (see, for
example, the references cited *supra*). The substituent is introduced by simply converting
the free hydroxyl group to a disulfide-containing ether, a disulfide-containing ester, or a
disulfide-containing carbamate. This transformation is achieved as follows. The desired

hydroxyl group is deprotonated by treatment with the commercially available reagent lithium hexamethyldisilazane (1.2 equivalents) in tetrahydrofuran at -40°C as described in I. Ojima et al, *supra*. The resulting alkoxide anion is then reacted with an excess of a dihalo compound, such as dibromoethane, to give a halo ether. Displacement of the halogen with a thiol (by reaction with potassium thioacetate and treatment with mild base or hydroxylamine) will provide the desired thiol-containing taxane. The thiol group can be converted into a methyl or pyridyl disulfide by reaction with methyl methane thioisulfonate or dithiodipyridine respectively. This method is described in USP 5,416,064.

Alternatively, the desired hydroxyl group can be esterified directly by reaction with an acyl halide, such as 3-bromopropionyl chloride to give a bromo ester. Displacement of the bromo group by treatment with potassium thioacetate and further processing as described above will provide the thiol or disulfide-containing taxane ester. In order to prepare disulfide-containing carbamates, the hydroxyl group can be reacted with a commercially available chloroformate, such as para-nitrophenyl chloroformate followed by reaction with an amino alkyl disulfide (e. g., methyldithio cysteamine).

Disulfide-containing and thiol-containing taxane drugs of the invention can be evaluated for their ability to suppress proliferation of various unwanted cell lines *in vitro*. For example, cell lines such as the human epidermoid carcinoma line A431, the human breast tumor line SKBR3, and the Burkitt's lymphoma line Namalwa can easily be used for the assessment of cytotoxicity of these compounds. Cells to be evaluated can be exposed to the compounds for 72 hours and the surviving fractions of cells measured in direct assays by known methods. IC₅₀ values can then be calculated from the results of

the assays.

The effectiveness of the compounds of the invention as therapeutic agents depends on the careful selection of an appropriate cell binding agent. Cell binding agents may be of any kind presently known, or that become known and include peptides and non-peptides. Generally, these can be antibodies, or fragments thereof, (especially
5 monoclonal antibodies), lymphokines, hormones, growth factors, vitamins, nutrient-transport molecules (such as transferrin), or any other cell binding molecule or substance.

More specific examples of cell binding agents that can be used include:

10 -fragments of antibodies such as sFv, Fab, Fab', and F(ab')₂ (Parham, 131 *J. Immunol.* 2895-2902 (1983); Spring et al, 113 *J. Immunol.* 470-478 (1974); Nisonoff et al, 89 *Arch. Biochem. Biophys.* 230-244 (1960));

-interferons (e.g. α , β , γ);

-lymphokines such as IL-2, IL-3, IL-4, IL-6;

15 -hormones such as insulin, TRH (thyrotropin releasing hormones), MSH (melanocyte-stimulating hormone), steroid hormones, such as androgens and estrogens;

-vitamins such as folic acid;

-growth factors and colony-stimulating factors such as EGF, TGF- α , G-CSF, M-CSF and GM-CSF (Burgess, 5 *Immunology Today* 155-158 (1984)); and

20 -transferrin (O'Keefe et al, 260 *J. Biol. Chem.* 932-937 (1985)).

Monoclonal antibody techniques allow for the production of extremely specific

cell binding agents in the form of specific monoclonal antibodies or fragments thereof. Particularly well known in the art are techniques for creating monoclonal antibodies, or fragments thereof, by immunizing mice, rats, hamsters, or any other mammal with the antigen of interest such as the intact target cell, antigens isolated from the target cell, whole virus, attenuated whole virus, and viral proteins such as viral coat proteins. Sensitized human cells can also be used. Another method of creating monoclonal antibodies, or fragments thereof, is the use of phage libraries of sFv (single chain variable region), specifically human sFv. (See e.g., Griffiths et al., USP 5,885,793; McCafferty et al., WO 92/01047; Liming et al., WO 99/06587.)

Selection of the appropriate cell binding agent is a matter of choice that depends upon the particular cell population to be targeted, but in general monoclonal antibodies are preferred if an appropriate one is available.

For example, the monoclonal antibody J5 is a murine IgG_{2a} antibody that is specific for Common Acute Lymphoblastic Leukemia Antigen (CALLA) (Ritz et al, 283 *Nature* 583-585 (1980)) and can be used if the target cells express CALLA such as in the disease of acute lymphoblastic leukemia. Similarly, the monoclonal antibody anti-B4 is a murine IgG₁, that binds to the CD19 antigen on B cells (Nadler et al, 131 *J. Immunol.* 244-250 (1983)) and can be used if the target cells are B cells or diseased cells that express this antigen such as in non-Hodgkin's lymphoma or chronic lymphoblastic leukemia.

Additionally, GM-CSF which binds to myeloid cells can be used as a cell binding agent to diseased cells from acute myelogenous leukemia. IL-2 which binds to activated T-cells can be used for prevention of transplant graft rejection, for therapy and

prevention of graft-versus-host disease, and for treatment of acute T-cell leukemia.

MSH which binds to melanocytes can be used for the treatment of melanoma. Folic acid, which targets the folate receptor expressed on ovarian and other cancers, is also a suitable cell binding agent.

5 Cancers of the breast and testes can be successfully targeted with estrogen (or estrogen analogues) or androgen (or androgen analogues) respectively as cell binding agents.

 Conjugates of the taxanes of the invention and a cell binding agent can be formed using any techniques presently known or later developed. Numerous methods of
10 conjugation are taught in USP 5,416,064 and USP 5,475,092. The taxane ester can be modified to yield a free amino group and then linked to an antibody or other cell binding agent *via* an acid labile linker or a photolabile linker. The taxane ester can be condensed with a peptide and subsequently linked to a cell binding agent to produce a peptidase
15 labile linker. The hydroxyl group on the taxane ester can be succinylated and linked to a cell binding agent to produce a conjugate that can be cleaved by intracellular esterases to liberate free drug. Most preferably, the taxane ethers, esters, or carbamates are treated to create a free or protected thiol group, and then the disulfide- or thiol-containing taxanes are linked to the cell binding agent via disulfide bonds.

 Representative conjugates of the invention are antibody-taxane, antibody
20 fragment-taxane epidermal growth factor (EGF)-taxane, melanocyte stimulating hormone (MSH)-taxane, thyroid stimulating hormone (TSH)-taxane, estrogen-taxane, estrogen analogue-taxane, androgen-taxane, androgen analogue-taxane, and folate-taxane.

Taxane conjugates of antibodies, antibody fragments, protein or peptide hormones, protein or peptide growth factors and other proteins are made in the same way by known methods. For example, peptides and antibodies can be modified with cross linking reagents such as *N*-succinimidyl 3-(2-pyridyldithio)propionate, *N*-succinimidyl 4-(2-pyridyldithio)pentanoate (SPP),
5 4-succinimidyl-oxycarbonyl- α -methyl- α -(2-pyridyl dithio)-toluene (SMPT),
N-succinimidyl-3-(2-pyridyldithio) butyrate (SDPB), 2-iminothiolane, or
S-acetylsuccinic anhydride by known methods. See, Carlsson et al, 173 *Biochem. J.*
723-737 (1978); Blattler et al, 24 *Biochem.* 1517-1524 (1985); Lambert et al, 22
10 *Biochem.* 3913-3920 (1983); Klotz et al, 96 *Arch. Biochem. Biophys.* 605 (1962); and
Liu et al, 18 *Biochem.* 690 (1979), Blakey and Thorpe, 1 *Antibody, Immunoconjugates &*
Radiopharmaceuticals, 1-16 (1988), Worrell et al 1 *Anti-Cancer Drug Design* 179-184
(1986). The free or protected thiol-containing cell binding agent thus derived is then
reacted with a disulfide- or thiol-containing taxane to produce conjugates. The
15 conjugates can be purified by HPLC or by gel filtration.

Similarly, for example, estrogen and androgen cell binding agents such as estradiol and androstenediol can be esterified at the C-17 hydroxy group with an appropriate disulfide containing carboxylic acid using e.g., dicyclohexylcarbodiimide as a condensing agent. Examples of such carboxylic acids that can be employed are
20 3-(2-pyridyldithio) propanoic acid, 3-methyldithiopropoic acid, 4-(2-pyridyldithio)
pentanoic acid, and 3-phenyldithiopropoic acid. Esterification of the C-17 hydroxy
group can also be achieved by reaction with an appropriately protected thiol group
containing carboxylic acid chloride such as 3-*S*-acetylpropanoyl chloride. Other

methods of esterification can also be employed as described in the literature (Haslam, 36
Tetrahedron 2409-2433 (1980)). The protected or free thiol containing androgen or
estrogen can then be reacted with a disulfide- or thiol-containing taxane to produce
conjugates. The conjugates can be purified by column chromatography on silica gel or
5 by HPLC. Folic acid can be condensed with a suitable hydrazide such as
4-(2-pyridyldithio) pentanoic acid hydrazide in the presence of a condensing agent such
as dicyclohexyl carbodiimide to give a hydrazone containing an active disulfide. The
disulfide-containing folate can then be reacted with a thiol-containing taxane to produce
a conjugate that can be purified by column chromatography over silica gel or by HPLC

10 Preferably monoclonal antibody- or cell binding agent-taxane conjugates are
those that are joined via a disulfide bond, as discussed above, that are capable of
delivering taxane molecules. Such cell binding conjugates are prepared by known
methods such as by modifying monoclonal antibodies with succinimidyl pyridyl-
dithiopropionate (SPDP) (Carlsson et al, 173 *Biochem. J.* 723-737 (1978)). The
15 resulting thiopyridyl group is then displaced by treatment with thiol-containing taxanes
to produce disulfide linked conjugates. Alternatively, in the case of the
aryldithio-taxanes, the formation of the cell binding conjugate is effected by direct
displacement of the aryl-thiol of the taxane by sulfhydryl groups previously introduced
into antibody molecules. Conjugates containing 1 to 10 taxane drugs linked via a
20 disulfide bridge are readily prepared by either method.

More specifically, a solution of the dithiopyridyl modified antibody at a
concentration of 1 mg/ml in 0.1 M potassium phosphate buffer, at pH 6.5 containing 1
mM EDTA is treated with the thiol-containing taxane (1.25 molar eq./

dithiopyridyl group). The release of thiopyridine from the modified antibody is monitored spectrophotometrically at 343 nm and is complete in about 20 hours. The antibody-taxane conjugate is purified and freed of unreacted drug and other low molecular weight material by gel filtration through a column of Sephadex G-25 or Sephacryl S300. The number of taxane moieties bound per antibody molecule can be determined by measuring the ratio of the absorbance at 230 nm and 275 nm. An average of 1-10 taxane molecules/antibody molecule can be linked via disulfide bonds by this method.

Antibody-taxane conjugates with non-cleavable links can also be prepared. The antibody can be modified with crosslinking reagents such as succinimidyl 4-(maleimidomethyl)cyclohexane-1-carboxylate (SMCC), sulfo-SMCC, *m*-maleimidobenzoyl-*N*-hydroxysuccinimide ester (MBS), sulfo-MBS or succinimidyl-iodoacetate, as described in the literature, to introduce 1-10 reactive groups. See, Yoshitake et al, 101 *Eur. J. Biochem.* 395-399 (1979); Hashida et al, *J. Applied Biochem.* 56-63 (1984); and Liu et al, 18 *Biochem.* 690-697 (1979). The modified antibody is then reacted with the thiol-containing taxane derivative to produce a conjugate. The conjugate can be purified by gel filtration through a Sephadex G-25 column.

The modified antibodies, or fragments thereof, are treated with the thiol-containing taxanes (1.25 molar equivalent/maleimido group). The mixtures are incubated overnight at about 4°C. The antibody-taxane conjugates are purified by gel filtration through a Sephadex G-25 column. Typically, an average of 1 to 10 taxanes per antibody are linked.

A preferred method is to modify antibodies, or fragments thereof, with succinimidyl-4-(maleimidomethyl)-cyclohexane-1-carboxylate (SMCC) to introduce maleimido groups followed by reaction of the modified antibody or fragment with the thiol-containing taxanes to give a thioether linked conjugate. Again, conjugates with 1 to 10 drug molecules per antibody molecule result.

Cytotoxicity of the taxanes and their antibody conjugates to non-adherent cell lines such as Namalwa and HL-60 can be measured by back-extrapolation of cell proliferation curves as described in Goldmacher et al, 135 *J. Immunol.* 3648-3651 (1985). Cytotoxicity of these compounds to adherent cell lines such as SKBR3 and A431 can be determined by clonogenic assays as described in Goldmacher et al, 102 *J. Cell Biol.* 1312-1319 (1986).

The present invention also provides a therapeutic composition comprising:

(A) an effective amount of one or more taxanes linked to a cell binding agent,

and

(B) a pharmaceutically acceptable carrier, diluent, or excipient.

Similarly, the present invention provides a method for killing selected cell populations comprising contacting target cells or tissue containing target cells with an effective amount of a cytotoxic agent comprising one or more taxanes linked to a cell binding agent.

The cytotoxic agent is prepared as described above.

Suitable pharmaceutically acceptable carriers, diluents, and excipients are well known and can be determined by those of ordinary skill in the art as the clinical situation

warrants.

Examples of suitable carriers, diluents and/or excipients include: (1) Dulbecco's phosphate buffered saline, pH about 7.4, containing or not containing about 1 mg/ml to 25 mg/ml human serum albumin, (2) 0.9% saline (0.9% w/v NaCl), and (3) 5% (w/v) dextrose; and may also contain an antioxidant such as tryptamine and a stabilizing agent such as Tween 20.

The method for killing selected cell populations can be practiced *in vitro*, *in vivo*, or *ex vivo*.

Examples of *in vitro* uses include treatments of autologous bone marrow prior to their transplant into the same patient in order to kill diseased or malignant cells: treatments of bone marrow prior to their transplantation in order to kill competent T cells and prevent graft-versus-host-disease (GVHD); treatments of cell cultures in order to kill all cells except for desired variants that do not express the target antigen; or to kill variants that express undesired antigen.

The conditions of non-clinical *in vitro* use are readily determined by one of ordinary skill in the art.

Examples of clinical *ex vivo* use are to remove tumor cells or lymphoid cells from bone marrow prior to autologous transplantation in cancer treatment or in treatment of autoimmune disease, or to remove T cells and other lymphoid cells from autologous or allogenic bone marrow or tissue prior to transplant in order to prevent GVHD. Treatment can be carried out as follows. Bone marrow is harvested from the patient or other individual and then incubated in medium containing serum to which is added the

cytotoxic agent of the invention, concentrations range from about 10 μ M to 1 pM, for about 30 minutes to about 48 hours at about 37°C. The exact conditions of concentration and time of incubation, i.e., the dose, are readily determined by one of ordinary skill in the art. After incubation the bone marrow cells are washed with medium containing serum and returned to the patient intravenously according to known methods. In circumstances where the patient receives other treatment such as a course of ablative chemotherapy or total-body irradiation between the time of harvest of the marrow and reinfusion of the treated cells, the treated marrow cells are stored frozen in liquid nitrogen using standard medical equipment.

For clinical *in vivo* use, the cytotoxic agent of the invention will be supplied as a solution or a lyophilized powder that are tested for sterility and for endotoxin levels. Examples of suitable protocols of conjugate administration are as follows. Conjugates are given weekly for 4 weeks as an intravenous bolus each week. Bolus doses are given in 50 to 100 ml of normal saline to which 5 to 10 ml of human serum albumin can be added. Dosages will be 10 μ g to 2000 mg per administration, intravenously (range of 100 ng to 20mg/kg per day). After four weeks of treatment, the patient can continue to receive treatment on a weekly basis. Specific clinical protocols with regard to route of administration, excipients, diluents, dosages, times, etc., can be determined by one of ordinary skill in the art as the clinical situation warrants.

Examples of medical conditions that can be treated according to the *in vivo* or *ex vivo* methods of killing selected cell populations include malignancy of any type including, for example, cancer of the lung, breast, colon, prostate, kidney, pancreas, ovary, and lymphatic organs; autoimmune diseases, such as systemic lupus, rheumatoid

arthritis, and multiple sclerosis; graft rejections, such as renal transplant rejection, liver
transplant rejection, lung transplant rejection, cardiac transplant rejection, and bone
marrow transplant rejection; graft versus host disease; viral infections, such as CMV
infection, HIV infection, AIDS, etc.; and parasite infections, such as giardiasis,
5 amoebiasis, schistosomiasis, and others as determined by one of ordinary skill in the art.

EXAMPLES

The invention will now be illustrated by reference to non-limiting examples.

Unless otherwise stated, all percents, ratios, parts, etc. are by weight.

EXAMPLE 1

10

***IN VITRO* CYTOTOXICITY ASSAYS**

The sulfide, disulfide, and sulfhydryl containing taxane drugs of the invention
can be evaluated for their ability to suppress proliferation of various human tumor cell
lines *in vitro*. Two adherent cell lines A431(human epidermoid carcinoma) and SKBR3
(human breast tumor) and the non-adherent cell line, Namalwa (Burkitt's lymphoma) are
15 used for the assessment of cytotoxicity of these compounds. Cells are exposed to the
compounds for 24 hours and the surviving fractions of cells are measured in direct
assays. (A431 and SKBR3 are assayed for plating efficiency (Goldmacher et al, 102 *J.*
Cell. Biol. 1312-1319 (1986) and Namalwa are assayed by growth back extrapolation
(Goldmacher et al, 135 *J. Immunol.* 3648-3651 (1985)). IC₅₀ values are then calculated
20 from this data.

EXAMPLE 2**CONJUGATION TO ANTIBODIES**

Conjugation of Thiol-containing Taxane to Antibodies via Disulfide Links: The conjugation of thiol-containing taxanes to antibodies, or fragments thereof, via disulfide links is performed in two steps. In the first step dithiopyridyl groups are introduced into antibodies or antibody fragments using succinimidyl pyridyldithiopentanoate (SPP) as described by Carlsson et al. The thiopyridyl groups are then displaced by reaction with the thiol-containing taxane to produce a conjugate.

Preparation of Antibody-SS-Taxane Conjugates. Antibodies anti-B4, anti-EGF receptor and N901, or fragments thereof, are modified with SPDP or SPP as described in the literature. Between 1 to 10 dithiopyridyl groups are introduced on the average per antibody molecule.

A solution of the dithiopyridyl modified antibody at a concentration of 1 mg/ml in 0.1 M potassium phosphate buffer pH 6.5 containing 1 mM EDTA at 25°C is treated with a thiol-containing taxane (1.25 molar equivalent/dithiopyridyl group). The release of thiopyridine from the modified antibody or fragment thereof is monitored spectrophotometrically at 343 nm and is found to be complete in about 20 hours. The antibody-taxane conjugate is purified and freed of unreacted drug and other low molecular weight material by gel filtration through a column of Sephadex G-25. The number of taxane molecules bound per antibody molecule is determined by measuring the ratio between the absorbances at 230 nm and 275 nm. An average of 1-10 taxane molecules per antibody molecule can be linked *via* disulfide bonds by this method.

Conjugation of Thiol-Containing Taxane to Antibodies via a Noncleavable

Thioether Link: The conjugation of a thiol-containing taxane is performed in two steps.

The antibody, or fragment thereof, is first reacted with succinimidyl

maleimidomethylcyclohexane carboxylate (SMCC) to introduce maleimido groups. The

5 modified antibody is then reacted with the thiol-containing taxane forming thioether links.

Preparation of Antibody-Taxane Conjugates (non-cleavable). Antibodies, anti-B4, anti-EGF receptor and N901, or fragments thereof, are modified with SMCC as described in the literature.

10 The modified antibodies or antibody fragments are treated with thiol-containing taxane (1.25 molar equivalent/maleimido group). The mixtures are incubated overnight at 4°C. The antibody-taxane conjugates are purified as described above. Typically, an average of 1-10 taxane molecules per antibody molecule are linked.

SPECIFIC PREPARATION OF ANTIBODY-TAXANE CONJUGATES.

15 Murine monoclonal antibodies directed against the human EGF receptor (EGFR) were developed. The EGF receptor is known to be over-expressed in several human squamous cell cancers, such as, head and neck, lung and breast. Four different antibodies, KS-61 (IgG2a), KS-77 (IgG1), KS-78 (Ig2a), and KS-62 (IgG2a) were linked to taxanes via disulfide bonds. The murine monoclonal antibody TA1, directed

20 against the *neu* oncogene over-expressed in human breast and ovarian cancers, was used for the preparation of TA1-taxane conjugates. The preparation of these particular conjugates is described in Examples 3 through 7.

EXAMPLE 3*Preparation Of Anti-EGFR Antibody KS-61-Taxane Conjugate*

The anti-EGFR antibody KS-61 was first modified with N-succinimidyl-4-[2-pyridyldithio] pentanoate (SPP) to introduce dithiopyridyl groups. The antibody (2.3 mg/mL) in 50 mM potassium phosphate buffer, pH 6.5, containing NaCl (50 mM) and EDTA (2 mM), was treated with SPP (11 molar equivalents in ethanol). The final ethanol concentration was 1.4% (v/v). After 90 minutes at ambient temperature, lysine (50 mM) was added to help in the removal of any non-covalently bound SPP. The reaction was allowed to proceed for two hours, and then purified by gel filtration through a Sephadex G25 column equilibrated in the above buffer. Antibody-containing fractions were pooled and the degree of modification was determined by treating a sample with dithiothreitol and measuring the change in absorbance at 343 nm (release of pyridine-2-thione with $\epsilon_{343} = 8,080 \text{ M}^{-1} \text{ cm}^{-1}$). Recovery of the antibody was about 90 %, with 5.0 pyridyldithio groups linked per antibody molecule.

The modified antibody was diluted with 50 mM potassium phosphate buffer, pH 6.5, containing NaCl (50 mM) and EDTA (2 mM) to a final concentration of 1.28 mg/mL. Taxane-SH (1.7 eq. per dithiopyridyl group) in ethanol (10 % v/v in final reaction mixture) was then added to the modified antibody solution. The reaction proceeded at ambient temperature under argon for 24 hours. The progress of the reaction was monitored spectrophotometrically at 343 nm for release of pyridine-2-thione, caused by disulfide exchange between the taxane-SH and the dithiopyridyl groups on the antibody. The increase in absorbance at 343 nm indicated

that the taxane had linked to the antibody. The reaction mixture was then loaded on to a Sephadex G25 SF gel filtration column equilibrated with phosphate-buffered saline (PBS, pH 6.5) containing 20% propylene glycol. The major peak comprised monomeric KS-61-Taxane. The concentration of the conjugate was determined by measuring the absorbance at 280 nm. The conjugate was formulated with Tween 80 (0.05%) and human serum albumin (HSA, 1 mg/mL).

EXAMPLE 4

Preparation Of Anti-EGFR Antibody KS-77-Taxane Conjugate

The anti-EGFR antibody KS-77 was modified with *N*-succinimidyl-4-[2-pyridyldithio] pentanoate (SPP) to introduce dithiopyridyl groups. The antibody (5.0 mg/mL) in 50 mM potassium phosphate buffer, pH 6.5, was treated with SPP (11 molar equivalents in ethanol). The final ethanol concentration was 2 % (v/v). After 90 minutes at ambient temperature, lysine (50 mM) was added to help in the removal of any non-covalently bound SPP. The reaction mixture was allowed to incubate for two hours, and then purified by gel filtration through a Sephadex G25 column equilibrated in the above buffer. Antibody containing fractions were pooled and the degree of modification was determined by treating a sample with dithiothreitol and measuring the change in absorbance at 343 nm (release of 2-mercaptopyridine with $\epsilon_{343} = 8,080 \text{ M}^{-1} \text{ cm}^{-1}$). Recovery of the antibody was about 90%, with 4.24 pyridyldithio groups linked per antibody molecule.

The modified antibody was diluted with 50 mM potassium phosphate buffer,

pH 6.5, containing NaCl (50 mM) and EDTA (2 mM) to a final concentration of 1.4 mg/mL. Taxane-SH (1.7 equivalents per dithiopyridyl group) in ethanol (10 % v/v in final reaction mixture) was then added to the modified antibody solution. The reaction proceeded at ambient temperature under argon for 24 hours. An increase in absorbance at 343 nm was noted, indicating that pyridine-2-thione was being released, and the taxane had linked to the antibody. The reaction mixture was then loaded on to a Sephacryl S300HR gel filtration column equilibrated with phosphate-buffered saline (PBS, pH 6.5). The major peak comprised monomeric KS-77-Taxane. The concentration of antibody KS-77 was determined by measuring the absorbance at 280 nm. The conjugate was formulated with Tween 80 (0.06%) and HSA (1 mg/mL).

EXAMPLE 5

Preparation Of Anti-EGFR Antibody KS-62-Taxane Conjugate

The anti-EGF antibody-taxane conjugate (KS-62-Taxane) was prepared in a manner similar to that described in Example 4. The modified antibody was diluted with 50 mM potassium phosphate buffer, pH 6.5, containing NaCl (50 mM) and EDTA (2 mM) to a final concentration of 2.5 mg/mL. The antibody was modified with SPP to introduce 5.25 pyridyldithio groups per antibody molecule. Taxane-SH (1.7 eq.) in ethanol (10 % v/v in final reaction mixture) was then added to the modified antibody solution. The reaction proceeded at ambient temperature under argon for 24 hours. The conjugate was purified by passage through a Sephacryl S300HR gel filtration column equilibrated with phosphate-buffered saline (PBS, pH 6.5). The major peak comprised monomeric KS-62-Taxane. The conjugate was formulated in PBS, containing Tween 80 (0.01%, w/v) and HSA (1 mg/mL).

EXAMPLE 6

Preparation Of Anti-EGFR Antibody KS-78-Taxane Conjugate

The anti-EGFR antibody-Taxane conjugate, KS-78-Taxane, was prepared in a manner similar to that described in Example 4. The modified antibody was diluted
5 with 50 mM potassium phosphate buffer, pH 6.5, containing NaCl (50 mM) and EDTA (2 mM) to a final concentration of 1.6 mg/mL. The antibody was modified with SPP to introduce 4.0 pyridyldithio groups per antibody molecule. Taxane-SH (1.7 eq.) in ethanol (15 % v/v in final reaction mixture) was then added to the modified antibody solution. The reaction proceeded at ambient temperature under
10 argon for 24 hours. The solution was then split into two batches, Batch A and Batch B, which were treated separately. Batch A was dialyzed against PBS, pH 6.5 containing 2 mM CHAPS (3-[(cholamidopropyl)dimethylammonio]-1-propanesulfonate) and 20 % (v/v) propylene glycol. The pH of the final solution was 6.0. Batch B was dialyzed into
15 PBS, pH 6.5 containing 20 % (v/v) propylene glycol. After dialyses, HSA (1 mg/mL) was added to both batches. Batch B was further treated with Tween 80 (0.05 %, w/v).

EXAMPLE 7

Preparation Of TA1-Taxane Conjugate

The murine monoclonal antibody TA1, which binds to the *neu* oncogene
20 expressed on breast and ovarian tumors, was used in the preparation of a taxane conjugate. TA1 (3.2 mg/mL) in 50 mM potassium phosphate buffer, pH 6.5, containing NaCl (50 mM) and EDTA (2 mM) was treated with SPP (8.0 molar

equivalents in ethanol). The final ethanol concentration was 5% (v/v). After 90 minutes at ambient temperature, lysine (50 mM) was added to help in the removal of any non-covalently bound SPP. The reaction mixture was incubated for 2 hours, and then gel filtered through a Sephadex G25 column equilibrated in the above buffer.

5 Antibody-containing fractions were pooled and the degree of modification was determined by treating a sample with dithiothreitol and measuring the change in absorbance at 343 nm (release of pyridine-2-thione with $\epsilon_{343} = 8,080 \text{ M}^{-1} \text{ cm}^{-1}$). Recovery of the antibody was about 90 %, with 4.9 pyridyldithio groups linked per antibody molecule.

10 The modified antibody was diluted with 50 mM potassium phosphate buffer, pH 6.5, containing NaCl (50 mM) and EDTA (2 mM) to a final concentration of 1.0 mg/mL. Taxane-SH (1.7 eq. per pyridyldithio group incorporated) in ethanol (10 % v/v in final reaction mixture) was then added to the modified antibody solution. The reaction proceeded at ambient temperature under argon for 24 hours. The release of
15 pyridine-2-thione (monitored at 343 nm), indicated that the disulfide exchange between the Taxane-SH and the pyridyldithio substituent on the antibody was complete. A portion of the reaction mixture (4.0 mg) was then loaded on a Sephacryl S300HR gel filtration column equilibrated with phosphate-buffered saline (PBS, pH 6.5). The major peak comprised monomeric TA1-Taxane. The remaining conjugate
20 was diluted to 0.5 mg/mL, and dialyzed into 50 mM potassium phosphate buffer, pH 6.5, containing NaCl (50 mM), EDTA (2 mM) and 20 % propylene glycol. The concentration of antibody TA1 was determined in both species by measuring the absorbance at 280 nm. The conjugates were formulated in PBS containing Tween 80

(0.01%) and HSA (1 mg/mL).

EXAMPLE 8

OTHER METHODS OF LINKING TAXANES

Acid Labile Linkers

5 Taxanes can be esterified with N-protected amino acids, such as
N-tboc-L-alanine in the presence of dicyclohexyl-carbodiimide and
dimethylaminopyridine (DMAP) by standard methods described in the chemical
literature. Cleavage of the t-boc protecting group with trifluoroacetic acid will give a
taxane ester containing a terminal amino group. This amino group containing taxane can
10 be linked to antibodies, or fragments thereof, and other cell binding agents via an acid
labile linker as previously described (Blättler et al, 24 *Biochemistry*, 1517-1524 (1985),
U.S. Patent Nos. 4,542,225, 4,569,789 and 4,764,368).

Photolabile Linker

The amino group-containing taxane derivative described above can be linked to
15 cell binding agents via a photolabile linker as previously described. (Senter et al, 42
Photochemistry and Photobiology, 231-237 (1985), U.S. Patent 4,625,014).

Peptidase Labile Linker

The amino group-containing taxane described above can also be linked to cell
binding agents via peptide spacer linkers. It has been previously shown that short
20 peptide spacers between drugs and macromolecular protein carriers are stable in serum
but are readily hydrolyzed by intracellular lysosomal peptidases (Trouet et al, 79 *Proc.*
Nat'l. Acad. Sci., 626-629 (1982)). The amino group containing taxane can be

condensed with peptides such as Ala-Leu, Leu-Ala-Leu or a dimer of Ala-Leu using condensing agents such as 1-[3-(dimethylamino)propyl]-3-ethyl carbodiimide-HCl to give a peptide derivative of the taxane which can then be linked to cell binding agents.

Esterase Labile Linker

5 Taxanes can be esterified by reaction of the hydroxyl group with succinic anhydride and then linked to a cell binding agent to produce a conjugate that can be cleaved by intracellular esterases to liberate free drug. (For examples see: Aboud-Pirak et al, 38 *Biochem. Pharmacol.*, 641-648 (1989), Laguzza et al, 32 *J. Med. Chem.*, 549-555 (1989)).

10

EXAMPLE 9

IN VIVO ANTI-TUMOR ACTIVITY

The anti-tumor effect of anti-EGF receptor antibody-taxane conjugate on human squamous cancer (A431) xenografts in SCID mice was established as follows. The anti-tumor effect of two different anti-human epidermal growth factor
15 receptor-taxane conjugates (anti-EGFR-taxane conjugates), KS-61-Taxane and KS-77-Taxane was evaluated in a human tumor xenograft model in SCID mice.

Five week old female SCID mice (25 animals) were inoculated subcutaneously in the right flank with A-431 human squamous cancer cells (1.5×10^6 cells/mouse) in 0.1 mL of serum-free medium. The tumors were grown for 11 days to
20 an average size of 100.0 mm^3 (range of $54 - 145 \text{ mm}^3$). The animals were then randomly divided into four groups (3 to 5 animals per group) according to their tumor size. The first group received KS-61-Taxane conjugate (10 mg/kg, qd x 5)

administered intravenously. The second group received the KS-77-Taxane conjugate (10 mg/kg, qd x 5) administered intravenously. The third group received free (non-conjugated) taxane (0.24 mg/kg, qd x 5, intravenously) at the same dose as that present in the conjugate. The fourth group, a control group, of animals received PBS
5 using the same treatment schedule as in groups 1-3.

The sizes of the tumors were measured twice weekly and the tumor volumes were calculated with the formula: $\frac{1}{2}(\text{length} \times \text{width} \times \text{height})$. The weight of the animals was also measured twice per week. The results are shown in Figures 4 and 5. The tumors in the control group of mice grew to a size of nearly 1000 mm³ in 31
10 days. Treatment with free taxane showed no therapeutic effect, and the tumors in this group grew at essentially the same rate as in the control group of animals that received PBS.

In contrast, both of the anti-EGFR-taxane conjugates showed remarkable anti-tumor activity resulting in complete inhibition of tumor growth in all the treated
15 animals for the duration of the experiment--34 days for the KS-61-Taxane conjugate and 27 days for the KS-77-Taxane conjugate. The data also show that targeted delivery of the taxane using a tumor-specific antibody is essential for the anti-tumor activity, since an equivalent dose of unconjugated taxane showed no anti-tumor effect in this model. Importantly, the doses of antibody-taxane conjugate used were non-
20 toxic to the animals as demonstrated by the absence of any weight loss (see Figure 5).

EXAMPLE 10**IN VITRO CYTOTOXICITY OF ANTIBODY-TAXANE
CONJUGATES**

The cytotoxicity of anti-EGFR-taxane conjugate, KS-78-Taxane, was
5 measured in a clonogenic assay using the EGF-receptor-positive human A431 cell
line (ATCC CRL 1555). N901-taxane conjugate, a similar conjugate made with the
mouse monoclonal N901 antibody against human CD56 was tested as a specificity
control, since A431 cells do not express its target antigen, CD56. The cytotoxicity of
TA.1-Taxane conjugate, a conjugate made with the mouse monoclonal antibody TA.1
10 against human Neu antigen, was measured on the antigen-positive human cell line
SK-BR-3 (ATCC HTB 30) and the antigen-negative A431 cell line. Cells were plated
at different densities in 6-well tissue-culture plates in DMEM medium supplemented
with 10 % fetal calf serum. Immunoconjugates at varying concentrations were added
and the cells were maintained in a humidified atmosphere at 37 °C and 6 % CO₂ until
15 colonies of approximately 20 cells or more were formed (6 to 10 days). Control
plates contained no immunoconjugate. The cells were then fixed with formaldehyde,
stained with crystal violet, and counted under a low-magnification microscope.
Plating efficiencies were then determined from the colony numbers and surviving
fractions of cells were calculated as the ratio of the plating efficiency of the treated
20 sample and the plating efficiency of the control.

Figure 6 shows the results of the cytotoxicity determination for the two
Batches of KS-78-Taxane conjugate on the target antigen-positive cell line A431.
Conjugates from both batches show similar toxicity to the target cells; treatment for 6

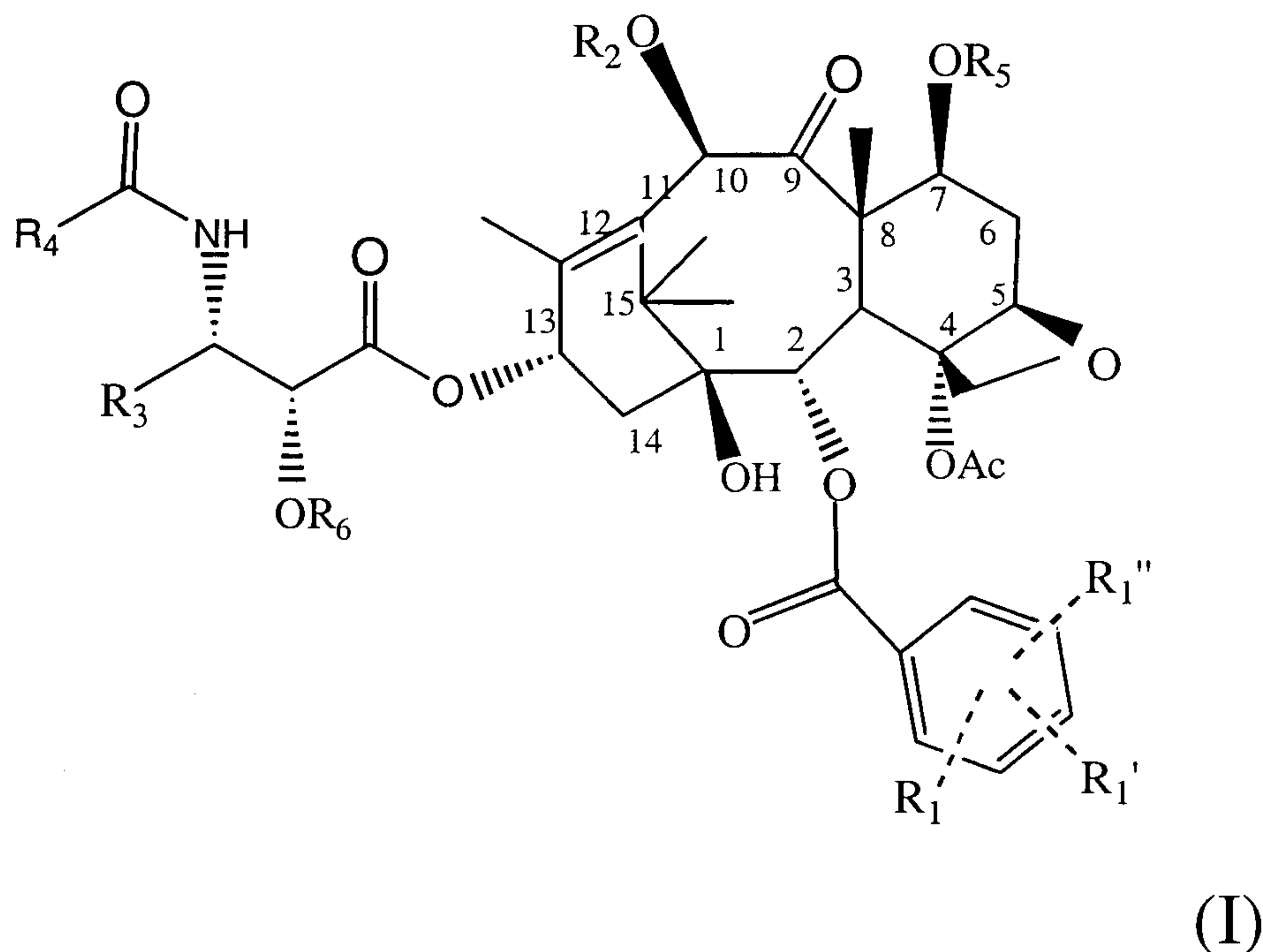
days at concentrations of 10^{-8} M achieved surviving fractions of less than 10^{-2} (less than 1 % of cells survive). A control conjugate, N901-Taxane, for which there are no antigens present on the surface of A431 cells, shows no toxicity to the cells at concentrations of up to 3×10^{-8} M. Unconjugated KS-78 antibody also shows very little cytotoxic effect. These results demonstrate the target antigen-specific cytotoxicity of the KS-78-taxane conjugate.

The cytotoxic potency and selectivity of the TA.1-taxane conjugate was assayed with the target antigen-positive cell line SK-BR-3 and the target antigen-negative cell line A431. The results are shown in Figure 7. At a conjugate concentration of 10^{-9} M, more than 90 % of the target SK-BR-3 cells were killed (surviving fraction of less than 0.1), while no toxicity towards the non-target A431 cells was observed. These results demonstrate the selective killing of antigen-positive cells and that the cytotoxic effect of the conjugate is dependent on the specific binding through its antibody component.

While the invention has been described in detail and with reference to specific embodiments thereof, it will be apparent to one of ordinary skill in the art that various changes and modifications can be made therein without departing from the spirit and scope of the invention.

WHAT IS CLAIMED IS:

1. A compound represented by formula (I):



(I)

wherein:

R₁ is H, an electron withdrawing group, or an electron donating group, and R₁' and R₁'' are the same or different, and are H, an electron withdrawing group, or an electron donating group;

R₂ is heterocyclic, a linear, branched, or cyclic ester or ether having from 1 to 10 carbon atoms or a carbamate of the formula -CNR₁₀R₁₁, wherein R₁₀ and R₁₁ are the same or different and are H, linear, branched or cyclic alkyl having 1 to 10 carbon atoms or aryl;

R_3 is aryl, or a linear, branched, or cyclic alkyl having from 1 to 10 carbon atoms;

R_4 is $-\text{OC}(\text{CH}_3)_3$ or phenyl;

R_5 is a linking group; and

R_6 is heterocyclic, H, a linear, branched, or cyclic ester or ether having from 1 to 10 carbon atoms or a carbamate of the formula $\text{CNR}_{10}\text{R}_{11}$, wherein R_{10} and R_{11} are the same or different and are H, linear, branched or cyclic alkyl having 1 to 10 carbon atoms or aryl.

2. The compound of claim 1, wherein R_1 is F, NO_2 , CN, Cl, CHF_2 , CF_3 , $-\text{OCH}_3$, $-\text{OCH}_2\text{CH}_3$, or $-\text{NR}_7\text{R}_8$, wherein:

R_7 and R_8 are the same or different and are linear, branched, or cyclic alkyl having 1 to 10 carbon atoms or simple or substituted aryl having 1 to 10 carbon atoms.

3. The compound of claim 2, wherein R_7 and R_8 each has 1 to 4 carbon atoms.

4. The compound of claim 2 or 3, wherein R_7 and R_8 are the same.

5. The compound of claim 1, wherein R_2 is $-\text{COC}_2\text{H}_5$, $-\text{CH}_2\text{CH}_3$, $-\text{CONHCH}_2\text{CH}_3$, $-\text{CO-morpholino}$, $-\text{CO-piperidino}$, $-\text{CO-piperazino}$, or $-\text{CO-N-methylpiperazino}$.

6. The compound of claim 1, wherein R_5 is a thiol- or disulfide-containing linking group.

7. The compound of claim 6, wherein R_5 is $-(\text{CH}_2)_n\text{SZ}$, $-\text{CO}(\text{CH}_2)_n\text{SZ}$, $-(\text{CH}_2)_n\text{CH}(\text{CH}_3)\text{SZ}$, $-\text{CO}(\text{CH}_2)_n\text{CH}(\text{CH}_3)\text{SZ}$, $-(\text{CH}_2)_n\text{C}(\text{CH}_3)_2\text{SZ}$, $-\text{CO}(\text{CH}_2)_n\text{C}(\text{CH}_3)_2\text{SZ}$, $-\text{CONR}_{12}(\text{CH}_2)_n\text{SZ}$, $-\text{CONR}_{12}(\text{CH}_2)_n\text{CH}(\text{CH}_3)\text{SZ}$,

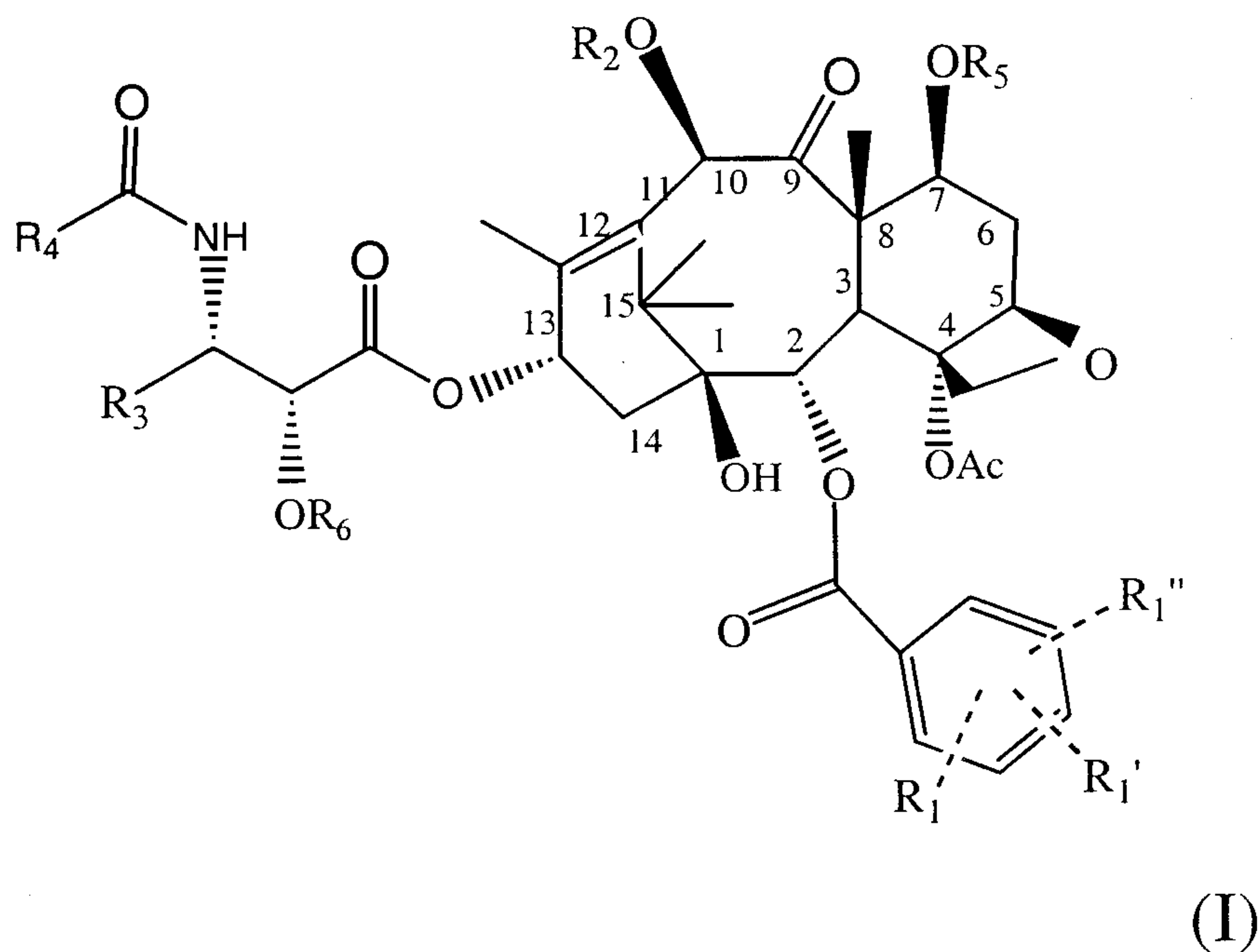
-CONR₁₂(CH₂)_nC(CH₃)₂SZ, -CO-morpholino-XSZ, -CO-piperidino-XSZ,
-CO-piperazino-XSZ, or -CO-N-methylpiperazino-XSZ, wherein

Z is H or SR, wherein R and R₁₂ are the same or different and are linear alkyl, branched alkyl or cyclic alkyl having from 1 to 10 carbon atoms, or simple or substituted aryl having from 1 to 10 carbon atoms or heterocyclic, and R₁₂ in addition can be H, X is a linear alkyl or branched alkyl having 1-10 carbon atoms, and

n is an integer of 1 to 10.

8. The compound of claim 1, wherein R₁ is in the meta position and R₁' and R₁" are H.

9. A compound represented by formula (I):



wherein:

R_1 is H, an electron withdrawing group, or an electron donating group, and R_1' and R_1'' are the same or different, and are H, an electron withdrawing group, or an electron donating group;

R_2 is heterocyclic, linear, branched, or cyclic ester or ether having from 1 to 10 carbon atoms or a carbamate of the formula $CNR_{10}R_{11}$, wherein R_{10} and R_{11} are the same or different and are H, linear, branched or cyclic alkyl having 1 to 10 carbon atoms or aryl;

R_3 is $-CH=C(CH_3)_2$;

R_4 is $-OC(CH_3)_3$ or phenyl;

R_5 is a linking group; and

R_6 is heterocyclic, H, a linear, branched, or cyclic ester or ether having from 1 to 10 carbon atoms or a carbamate of the formula $CNR_{10}R_{11}$, wherein R_{10} and R_{11} are the same or different and are H, linear, branched or cyclic alkyl having 1 to 10 carbon atoms or aryl.

10. The compound of claim 9, wherein R_1 is F, NO_2 , CN, Cl, CHF_2 , CF_3 , $-OCH_3$, $-OCH_2CH_3$, or $-NR_7R_8$, wherein:

R_7 and R_8 are the same or different and are linear, branched, or cyclic alkyl having 1 to 10 carbon atoms or simple or substituted aryl having 1 to 10 carbon atoms.

11. The compound of claim 10, wherein R_7 and R_8 each has 1 to 4 carbon atoms.

12. The compound of claim 10 or 11, wherein R_7 and R_8 are the same.

13. The compound of claim 9, wherein R_2 is $-COC_2H_5$, $-CH_2CH_3$, $-CONHCH_2CH_3$, $-CO$ -morpholino, $-CO$ piperidino, $-CO$ -piperazino, or $-CO$ -*N*-methylpiperazino.

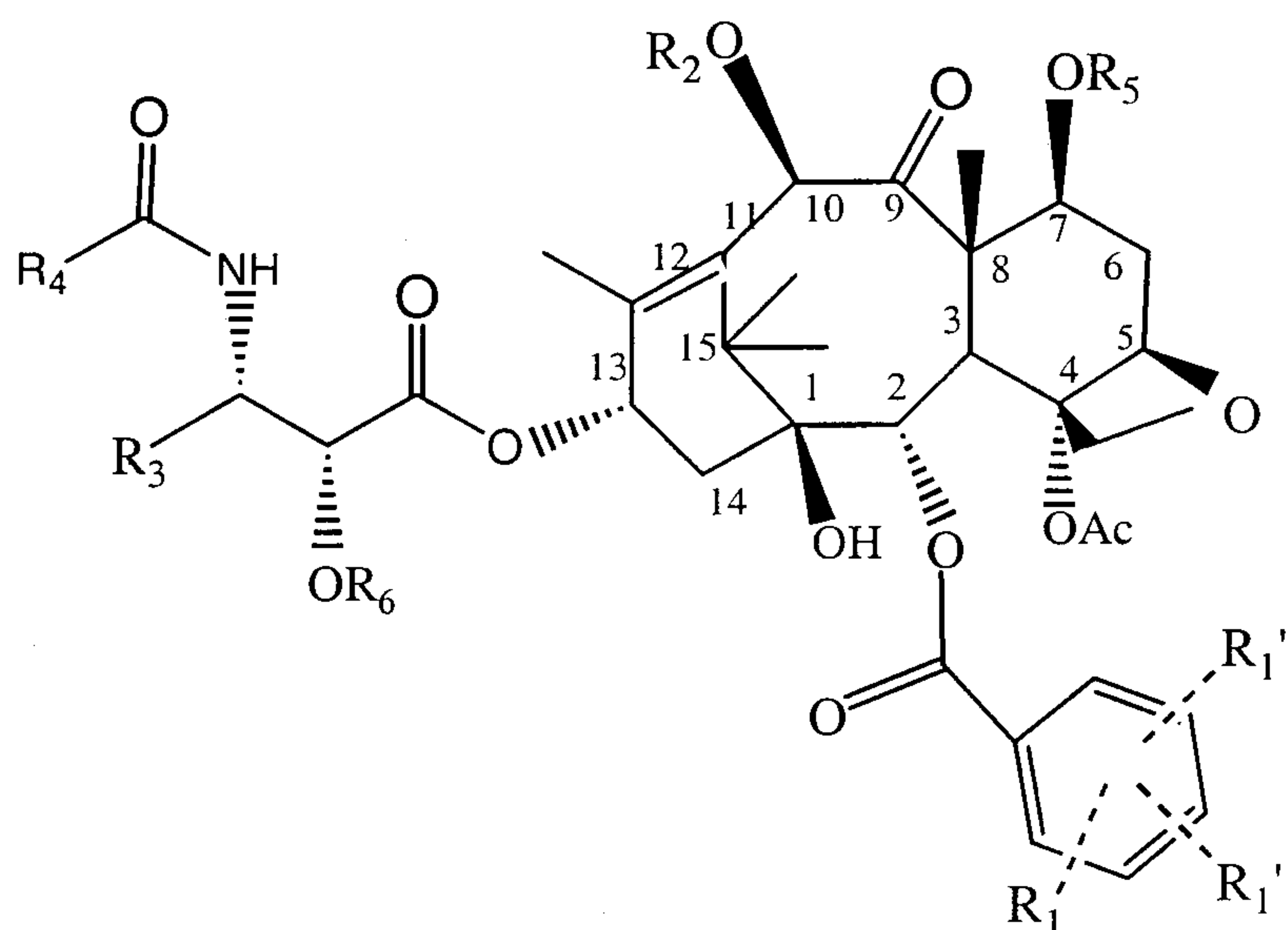
14. The compound of claim 9, wherein R_5 is a thiol- or disulfide-containing linking group.

15. The compound of claim 14, wherein R_5 is $-(CH_2)_nSZ$, $-CO(CH_2)_nSZ$, $-(CH_2)_nCH(CH_3)SZ$, $-CO(CH_2)_nCH(CH_3)SZ$, $-(CH_2)_nC(CH_3)_2SZ$, $-CO(CH_2)_nC(CH_3)_2SZ$, $-CONR_{12}(CH_2)_nSZ$, $-CONR_{12}(CH_2)_nCH(CH_3)SZ$, $-CONR_{12}(CH_2)_nC(CH_3)_2SZ$, $-CO$ -morpholino- XSZ , $-CO$ -piperidino- XSZ , $-CO$ -piperazino- XSZ , or $-CO$ -*N*-methylpiperazino- XSZ wherein

Z is H or SR, wherein R and R_{12} are the same or different and are linear alkyl, branched alkyl or cyclic alkyl having from 1 to 10 carbon atoms, or simple or substituted aryl having from 1 to 10 carbon atoms or heterocyclic, and R_{12} in addition can be H, X is a linear alkyl or branched alkyl having 1-10 carbon atoms, and n is an integer of 1 to 10.

16. The compound of claim 9, wherein R_1 is in the meta position and R_1' and R_1'' are H.

17. A compound represented by formula (I):



(I)

wherein:

R_1 is H, an electron withdrawing group, or an electron donating group, and R_1' and R_1'' are the same or different, and are H, an electron withdrawing group, or an electron donating group;

R_2 is a linking group;

R_3 is aryl, or is a linear, branched, or cyclic alkyl having from 1 to 10 carbon atoms;

R_4 is $-\text{OC}(\text{CH}_3)_3$ or phenyl;

R_5 is heterocyclic, H, a linear, branched, or cyclic ester or ether having from 1 to 10 carbon atoms or a carbamate of the formula $\text{CNR}_{10}\text{R}_{11}$, wherein R_{10} and R_{11} are the same or different and are H, linear, branched or cyclic alkyl having 1 to 10 carbon atoms or aryl; and

R_6 is heterocyclic, H, a linear, branched, or cyclic ester or ether having from 1 to 10 carbon atoms or a carbamate of the formula $\text{CNR}_{10}\text{R}_{11}$, wherein R_{10} and R_{11} are the same or different and are H, linear, branched or cyclic alkyl having 1 to 10 carbon atoms or aryl.

18. The compound of claim 17, wherein at least one of R_1 is F, NO_2 , CN, Cl, CHF_2 , CF_3 , $-\text{OCH}_3$, $-\text{OCH}_2\text{CH}_3$, or $-\text{NR}_7\text{R}_8$ wherein:

R_7 and R_8 are the same or different and are linear, branched, or cyclic alkyl having 1 to 10 carbon atoms or simple or substituted aryl having 1 to 10 carbon atoms.

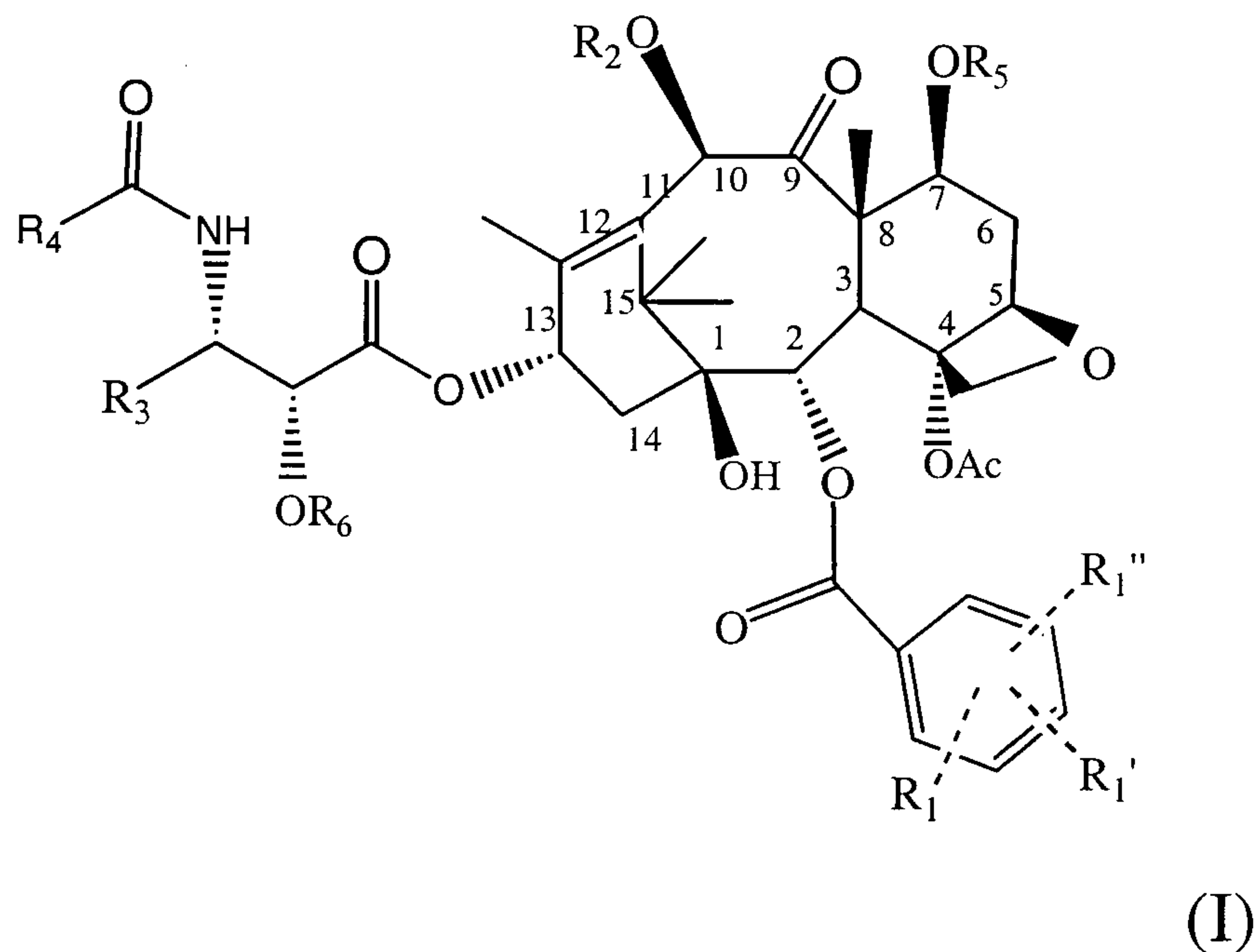
19. The compound of claim 18, wherein R_7 and R_8 each has 1 to 4 carbon atoms.

20. The compound of claim 18 and 19, wherein R_7 and R_8 are the same.
21. The compound of claim 17, wherein R_2 is a thiol- or disulfide-containing linking group.
22. The compound of claim 21 wherein R_2 is $-(CH_2)_nSZ$, $-CO(CH_2)_nSZ$, $-(CH_2)_nCH(CH_3)SZ$, $-CO(CH_2)_nCH(CH_3)SZ$, $-(CH_2)_nC(CH_3)_2SZ$, $-CO(CH_2)_nC(CH_3)_2SZ$, $-CONR_{12}(CH_2)_nSZ$, $-CONR_{12}(CH_2)_nCH(CH_3)SZ$, $-CONR_{12}(CH_2)_nC(CH_3)_2SZ$, $-CO$ -morpholino- XSZ , $-CO$ -piperidino- XSZ , $-CO$ -piperazino- XSZ , or $-CO$ -*N*-methylpiperazino- XSZ wherein

Z is H or SR, wherein R and R_{12} are the same or different and are linear alkyl, branched alkyl or cyclic alkyl having from 1 to 10 carbon atoms, or simple or substituted aryl having from 1 to 10 carbon atoms or heterocyclic, and R_{12} in addition can be H, X is a linear alkyl or branched alkyl having 1-10 carbon atoms, and n is an integer of 1 to 10.

23. The compound of claim 17, wherein R_5 is $-COC_2H_5$, $-CH_2CH_3$, $-CONHCH_2CH_3$, $-CO$ -morpholino, $-CO$ -piperidino, $-CO$ -piperazino, or CO -*N*-methylpiperazino.
24. The compound of claim 17, wherein R_1 is in the meta position and R_1' and R_1'' are H.

25. A compound represented by formula (I):



wherein:

R_1 is H, an electron withdrawing group, or an electron donating group, and R_1' and R_1'' are the same or different and are H, an electron withdrawing group, or an electron donating group;

R_2 is heterocyclic, H a linear, branched, or cyclic ester or ether having from 1 to 10 carbon atoms or a carbamate of the formula $CNR_{10}R_{11}$, wherein R_{10} and R_{11} are the same or different and are H, linear, branched or cyclic alkyl having 1 to 10 carbon atoms or aryl;

R_3 is aryl, or is a linear, branched or cyclic alkyl having from 1 to 10 carbon atoms;

R_4 is $-OC(CH_3)_3$ or phenyl;

R_5 is heterocyclic, H, a linear, branched, or cyclic ester or ether having from 1 to 10 carbon atoms or a carbamate of the formula $CNR_{10}R_{11}$, wherein R_{10} and R_{11} are the same or different and are H, linear, branched or cyclic alkyl having 1 to 10 carbon atoms or aryl;

R_6 is a linking group.

26. The compound of claim 25, wherein R_1 is F, NO_2 , CN, Cl, CHF_2 , CF_3 , $-OCH_3$, $-OCH_2CH_3$, or $-NR_7R_8$ wherein:

R_7 and R_8 are the same or different and are linear, branched, or cyclic alkyl having 1 to 10 carbon atoms or simple or substituted aryl having 1 to 10 carbon atoms.

27. The compound of claim 26, wherein R_7 and R_8 each has 1 to 4 carbon atoms.

28. The compound of claim 26 or 27, wherein R_7 and R_8 are the same.

29. The compound of claim 25, wherein R_2 is $-COC_2H_5$, $-CH_2CH_3$, $-CONHCH_2CH_3$, $-CO$ -morpholino, $-CO$ -piperidino, $-CO$ -piperazino, or $-CO$ -*N*-methylpiperazino.

30. The compound of claim 25, wherein R_6 is a thiol- or disulfide-containing linking group.

31. The compound of claim 30, wherein R_6 is $-(CH_2)_nSZ$, $-CO(CH_2)_nSZ$, $-(CH_2)_nCH(CH_3)SZ$, $-CO(CH_2)_nCH(CH_3)SZ$, $-(CH_2)_nC(CH_3)_2SZ$, $-CO(CH_2)_nC(CH_3)_2SZ$, $-CONR_{12}(CH_2)_nSZ$, $-CONR_{12}(CH_2)_nCH(CH_3)SZ$, $-CONR_{12}(CH_2)_nC(CH_3)_2SZ$, $-CO$ -morpholino- XSZ , $-CO$ -piperidino- XSZ , $-CO$ -piperazino- XSZ , or $-CO$ -*N*-methylpiperazino- XSZ wherein:

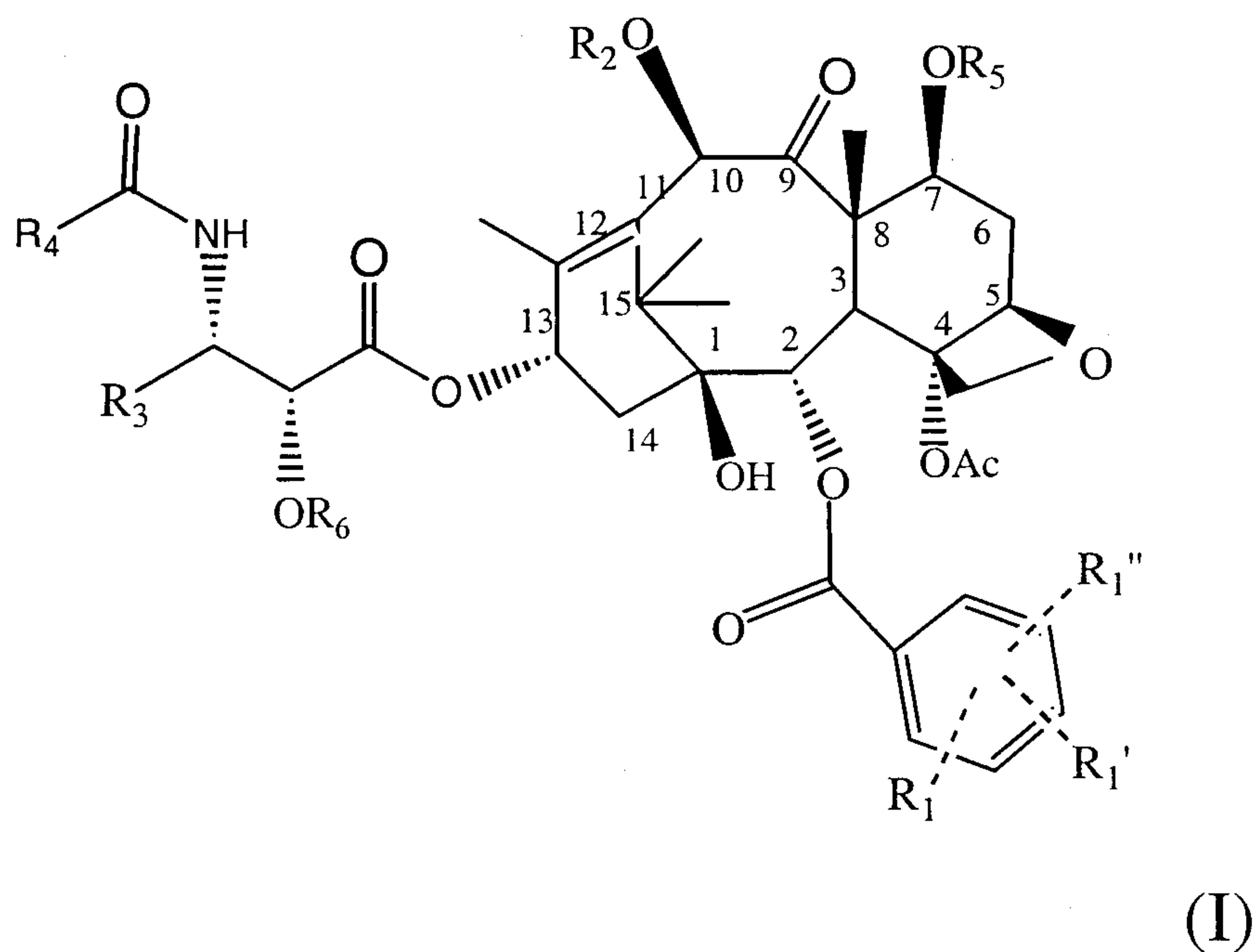
Z is H or SR, wherein R and R_{12} are the same or different and are linear alkyl, branched alkyl or cyclic alkyl having from 1 to 10 carbon atoms, or simple or substituted

aryl having from 1 to 10 carbon atoms or heterocyclic, and R_{12} in addition can be H, X is a linear alkyl or branched alkyl having 1-10 carbon atoms, and

n is an integer of 1 to 10.

32. The compound of claim 25, wherein R_1 is in the meta position and R_1' and R_1'' are H.

33. A cytotoxic agent comprising one or more taxanes covalently bonded to a cell binding agent through a linking group, wherein at least one of said taxanes is a compound represented by formula (I):



wherein:

R_1 is H, an electron withdrawing group, or an electron donating group, and R_1' and R_1'' are the same or different and are H, an electron withdrawing group, or an electron donating group;

R_2 is a heterocyclic, linear, branched, or cyclic ester or ether having from 1 to 10 carbon atoms or a carbamate of the formula $CNR_{10}R_{11}$; wherein R_{10} and R_{11} are the same or different and are H, linear, branched or cyclic alkyl having 1 to 10 carbon atoms or aryl;

R_3 is aryl, or is a linear, branched, or cyclic alkyl having from 1 to 10 carbon atoms;

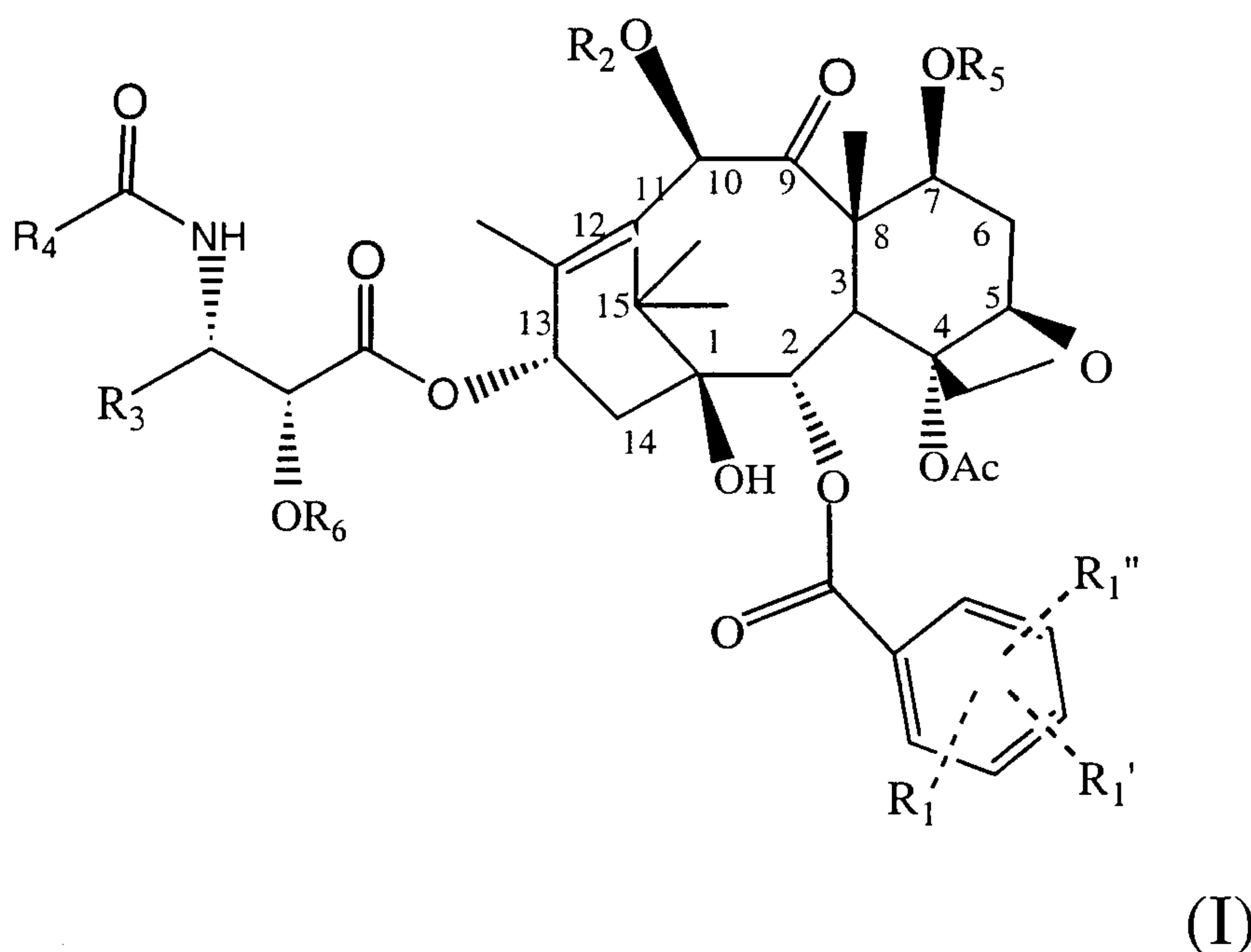
R_4 is $-OC(CH_3)_3$ or phenyl;

R_5 is a linking group; and

R_6 is a heterocyclic, H, linear, branched, or cyclic ester or ether having from 1 to 10 carbon atoms or a carbamate of the formula $CNR_{10}R_{11}$, wherein R_{10} and R_{11} are the same or different and are H, linear, branched or cyclic alkyl having 1 to 10 carbon atoms or aryl.

34. A cytotoxic agent comprising one or more taxanes covalently bonded to a cell binding agent through a linking group, wherein at least one of said taxanes is a compound represented by formula (I):

wherein:



R_1 is H, an electron withdrawing group, or an electron donating group, and R_1' and R_1'' are the same or different and are H, an electron withdrawing group, or an electron donating group;

R_2 is a heterocyclic, linear, branched, or cyclic ester or ether having from 1 to 10 carbon atoms or a carbamate of the formula $CNR_{10}R_{11}$, wherein R_{10} and R_{11} are the same or different and are H, linear, branched or cyclic alkyl having 1 to 10 carbon atoms or aryl;

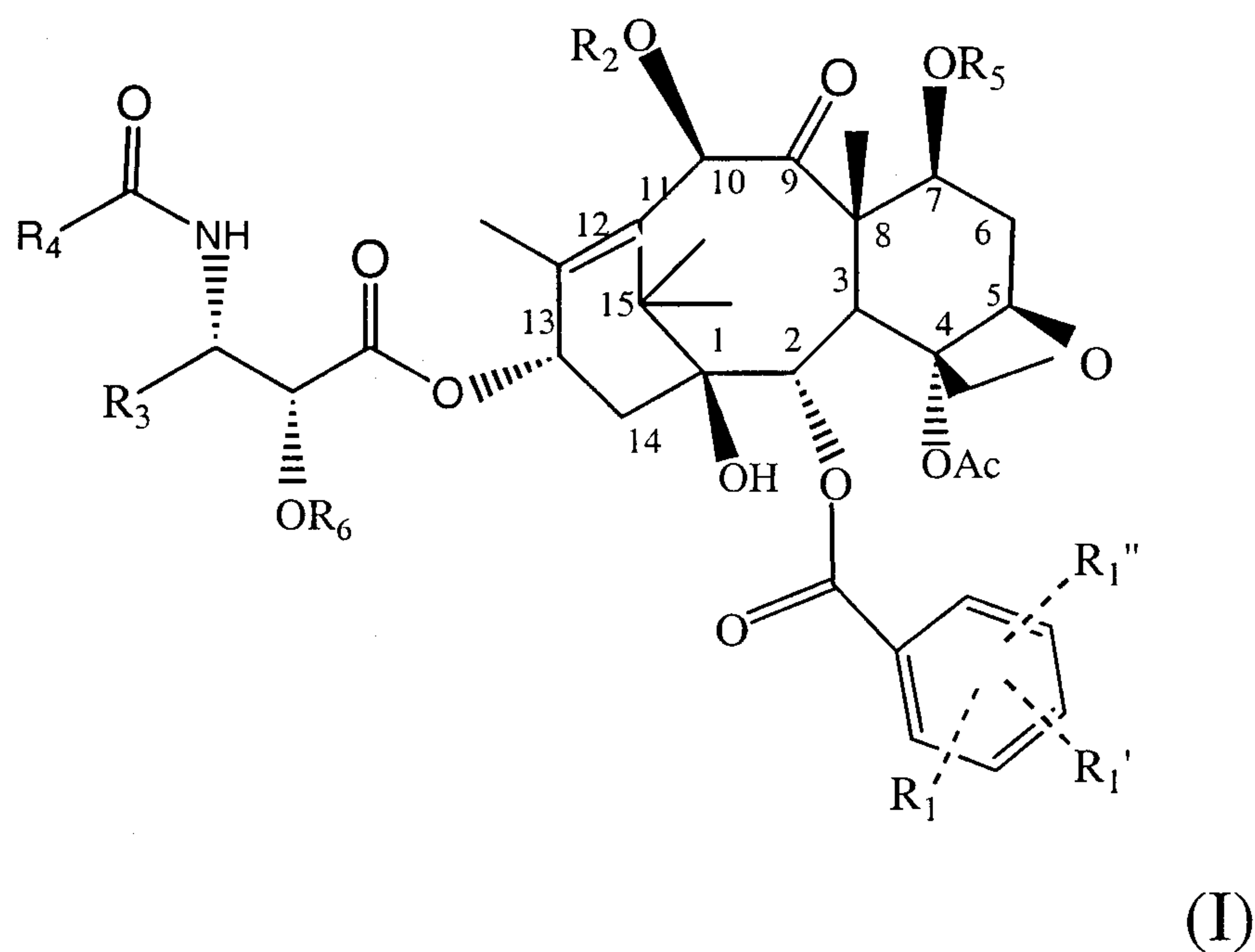
R_3 is $-CH=C(CH_3)_2$;

R_4 is $-\text{OC}(\text{CH}_3)_3$ or phenyl;

R_5 is a linking group; and

R_6 is heterocyclic, H, a linear, branched, or cyclic ester or ether having from 1 to 10 carbon atoms or a carbamate of the formula $\text{CNR}_{10}\text{R}_{11}$, wherein R_{10} and R_{11} are the same or different and are H, linear, branched or cyclic alkyl having 1 to 10 carbon atoms or aryl.

35. A cytotoxic agent comprising one or more taxanes covalently bonded to a cell binding agent through a linking group, wherein at least one of said taxanes is a compound represented by formula (I):



wherein:

R_1 is H, an electron withdrawing group, or an electron donating group, and R_1' and R_1'' are the same or different and are H, an electron withdrawing group, or an electron donating group;

R_2 is a linking group;

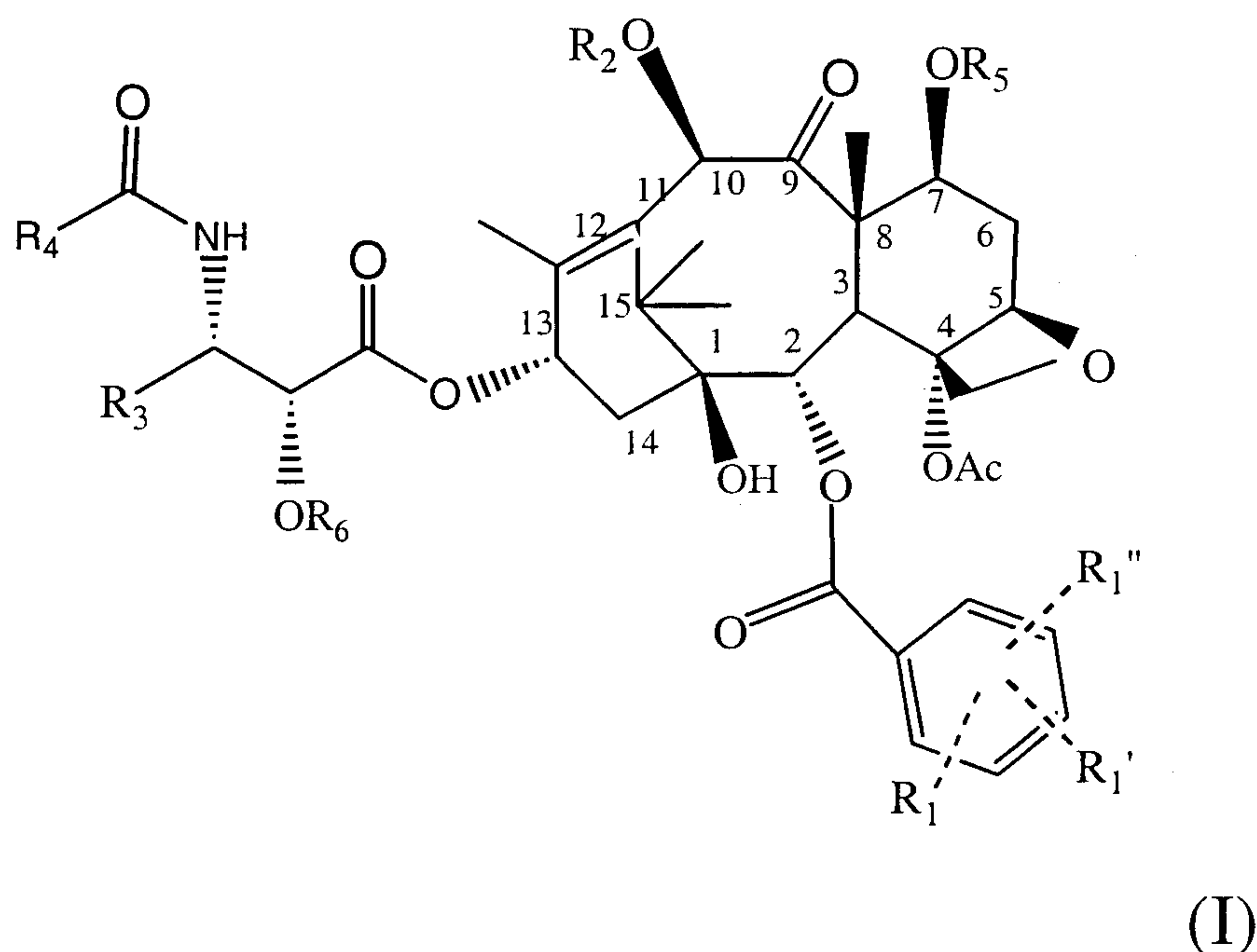
R_3 is aryl, or is a linear, branched, or cyclic alkyl having from 1 to 10 carbon atoms;

R_4 is $-\text{OC}(\text{CH}_3)_3$ or phenyl;

R_5 is a heterocyclic, H, linear, branched, or cyclic ester or ether having from 1 to 10 carbon atoms or a carbamate of the formula $\text{CNR}_{10}\text{R}_{11}$, wherein R_{10} and R_{11} are the same or different and are H, linear, branched or cyclic alkyl having 1 to 10 carbon atoms or aryl; and

R_6 is heterocyclic, H, a linear, branched, or cyclic ester or ether having from 1 to 10 carbon atoms or a carbamate of the formula $\text{CNR}_{10}\text{R}_{11}$, wherein R_{10} and R_{11} are the same or different and are H, linear, branched or cyclic alkyl having 1 to 10 carbon atoms or aryl.

36. A cytotoxic agent comprising one or more taxanes covalently bonded to a cell binding agent through a linking group, wherein at least one of said taxanes is a compound represented by formula (I):



wherein:

R_1 is H, an electron withdrawing group, or an electron donating group, and R_1' and R_1'' are the same or different and are H, an electron withdrawing group, or an electron donating group;

R_2 is heterocyclic, H, a linear, branched, or cyclic ester or ether having from 1 to 10 carbon atoms or a carbamate of the formula $CNR_{10}R_{11}$, wherein R_{10} and R_{11} are the same or different and are H, linear, branched or cyclic alkyl having 1 to 10 carbon atoms or aryl;

R_3 is aryl, or is a linear, branched or cyclic alkyl having from 1 to 10 carbon atoms;

R₄ is -OC(CH₃)₃ or phenyl;

R₅ is heterocyclic, H, a linear, branched, or cyclic ester or ether having from 1 to 10 carbon atoms or a carbamate of the formula CNR₁₀R₁₁, wherein R₁₀ and R₁₁ are the same or different and are H, linear, branched or cyclic alkyl having 1 to 10 carbon atoms or aryl;

R₆ is a linking group.

37. A therapeutic composition comprising:

(A) a therapeutically effective amount of the cytotoxic agent of any one of claims 33, 34, 35 or 36; and

(B) a pharmaceutically acceptable carrier.

38. The cytotoxic agent of any one of claims 33, 34, 35, or 36 wherein the cell binding agent is selected from the group consisting of antibodies, an antibody fragment, interferons, lymphokines, hormones, vitamins, growth factors, colony stimulating factors, and transferrin.

39. The cytotoxic agent of any one of claims 33, 34, 35, or 36 wherein the cell binding agent is an antibody.

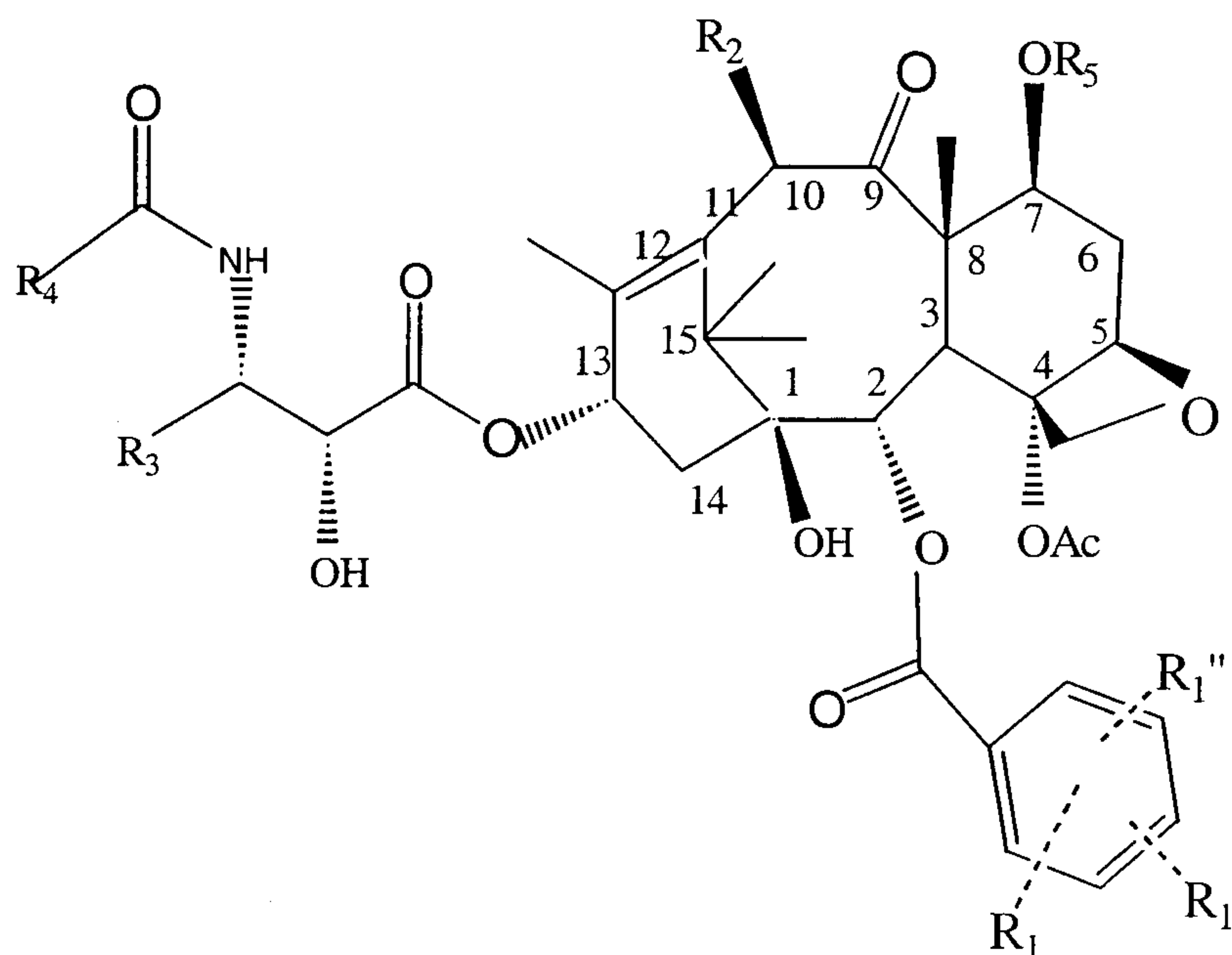
40. The cytotoxic agent of any one of claims 33, 34, 35, or 36 wherein the cell binding agent is a monoclonal antibody.

41. The cytotoxic agent of any one of claims 33, 34, 35, or 36 wherein the cell binding agent is an antigen specific antibody fragment.

42. The cytotoxic agent of any one of claims 33, 34, 35, or 36 wherein the antibody fragment is sFV, Fab, Fab', or F(ab')₂.

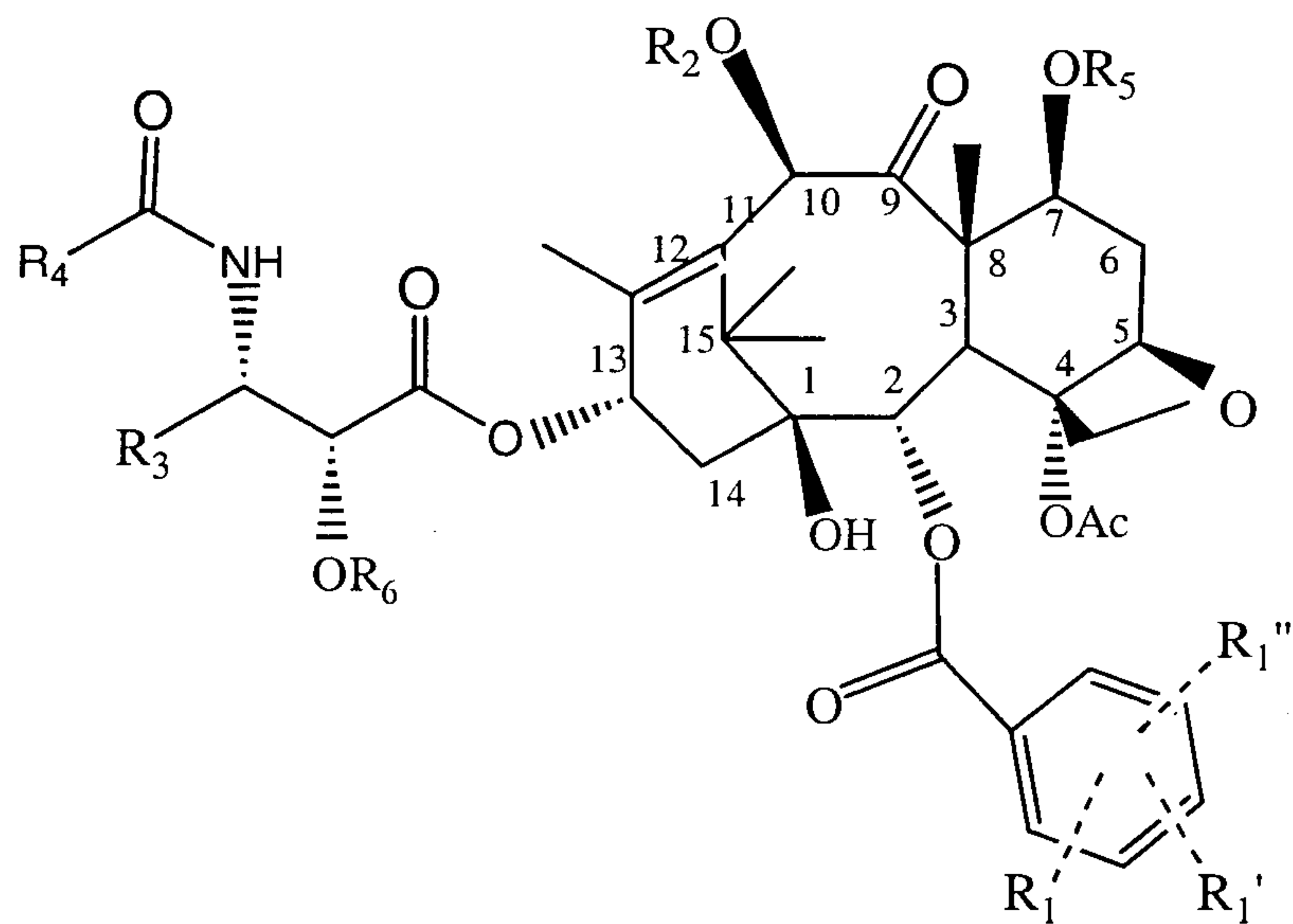
43. The cytotoxic agent of any one of claims 33, 34, 35, or 36 wherein the cell binding agent is a growth factor or colony stimulating factor.
44. A method of killing selected cell populations comprising contacting target cells or tissue containing target cells with an effective amount of the cytotoxic agent of any one of claims 33, 34, 35 or 36.

Figure 1.



Compound	R_1	R_2	R_3	R_4	R_5
Paclitaxel (Taxol)	-H	-COCH ₃	-C ₆ H ₅	-C ₆ H ₅	H
Docetaxel (Taxotere)	-H	-H	-C ₆ H ₅	-OC(CH ₃) ₃	H
More Potent Taxanes	-F	-CH ₂ CH ₃	-CH ₂ CH(CH ₃) ₂	-OC(CH ₃) ₃	H
	-F	-CH ₂ CH ₃	-CH=C(CH ₃) ₂	-OC(CH ₃) ₃	H
	-Cl	-CH ₂ CH ₃	-CH ₂ CH(CH ₃) ₂	-OC(CH ₃) ₃	H
	-OCH ₃	-CH ₃	-CH ₂ CH(CH ₃) ₂	-OC(CH ₃) ₃	H

Figure 2



	R ₁	R ₂	R ₃	R ₄	R ₅	R ₆
1	-F	-COCH ₂ CH ₃ , -CH ₂ CH ₃ , or -CONHCH ₂ CH ₃	-CH ₂ CH(CH ₃) ₂ or -C ₆ H ₅	-OC(CH ₃) ₃ or -C ₆ H ₅	-CH ₂ CH ₂ SH or -COCH ₂ CH ₂ SH	-COCH ₂ CH ₃ , -CH ₂ CH ₃ , or CONHCH ₂ CH ₃
2	-F	-COCH ₂ CH ₃ , -CH ₂ CH ₃ , or -CONHCH ₂ CH ₃	-CH=C(CH ₃) ₂ or -C ₆ H ₅	-OC(CH ₃) ₃ or -C ₆ H ₅	-CH ₂ CH ₂ SH or -COCH ₂ CH ₂ SH	-COCH ₂ CH ₃ , -CH ₂ CH ₃ , or CONHCH ₂ CH ₃
3	-F	-COCH ₂ CH ₂ SH -CH ₂ CH ₂ SH	-CH ₂ CH(CH ₃) ₂ or -C ₆ H ₅	-OC(CH ₃) ₃ or -C ₆ H ₅	-COCH ₂ CH ₃ , -CH ₂ CH ₃ , or -CONHCH ₂ CH ₃	-COCH ₂ CH ₃ , -CH ₂ CH ₃ , or CONHCH ₂ CH ₃
4	-F	-COCH ₂ CH ₃ , -CH ₂ CH ₃ , or -CONHCH ₂ CH ₃	-CH ₂ CH(CH ₃) ₂ or -C ₆ H ₅	-OC(CH ₃) ₃ or -C ₆ H ₅	-COCH ₂ CH ₃ , -CH ₂ CH ₃ , or -CONHCH ₂ CH ₃	-CH ₂ CH ₂ SH or COCH ₂ CH ₂ SH

Figure 3.

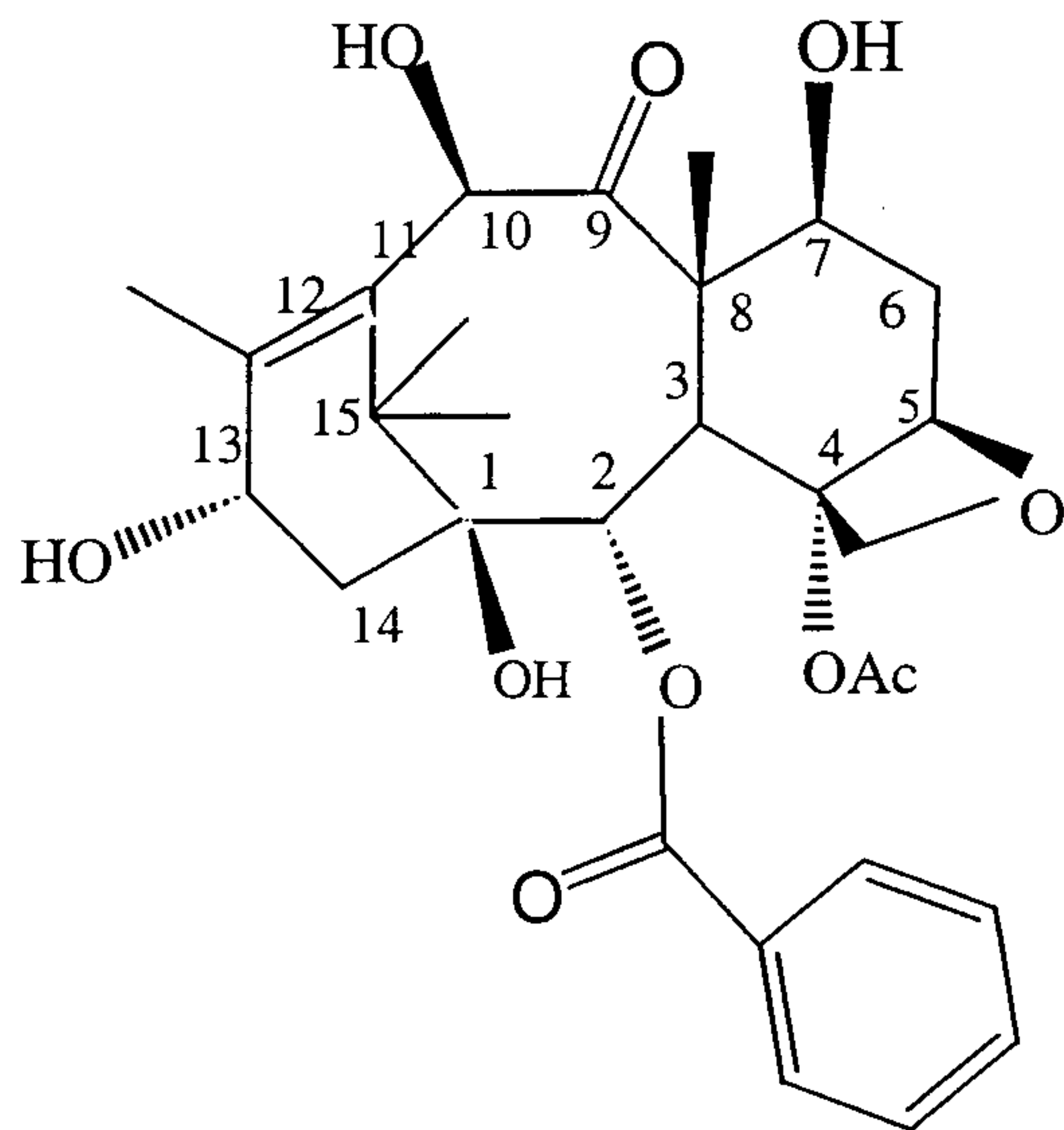


Figure 4.

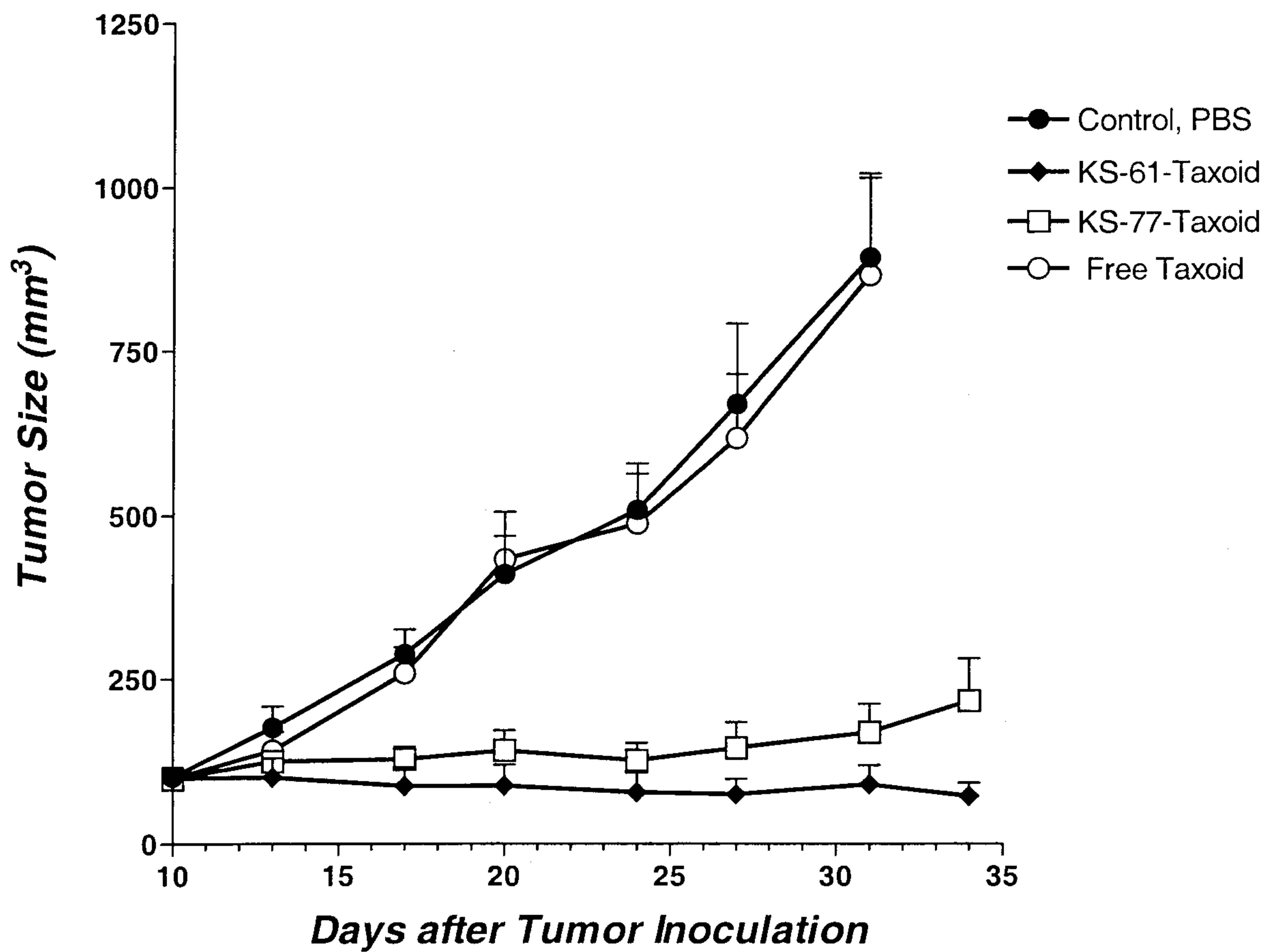


Figure 5.

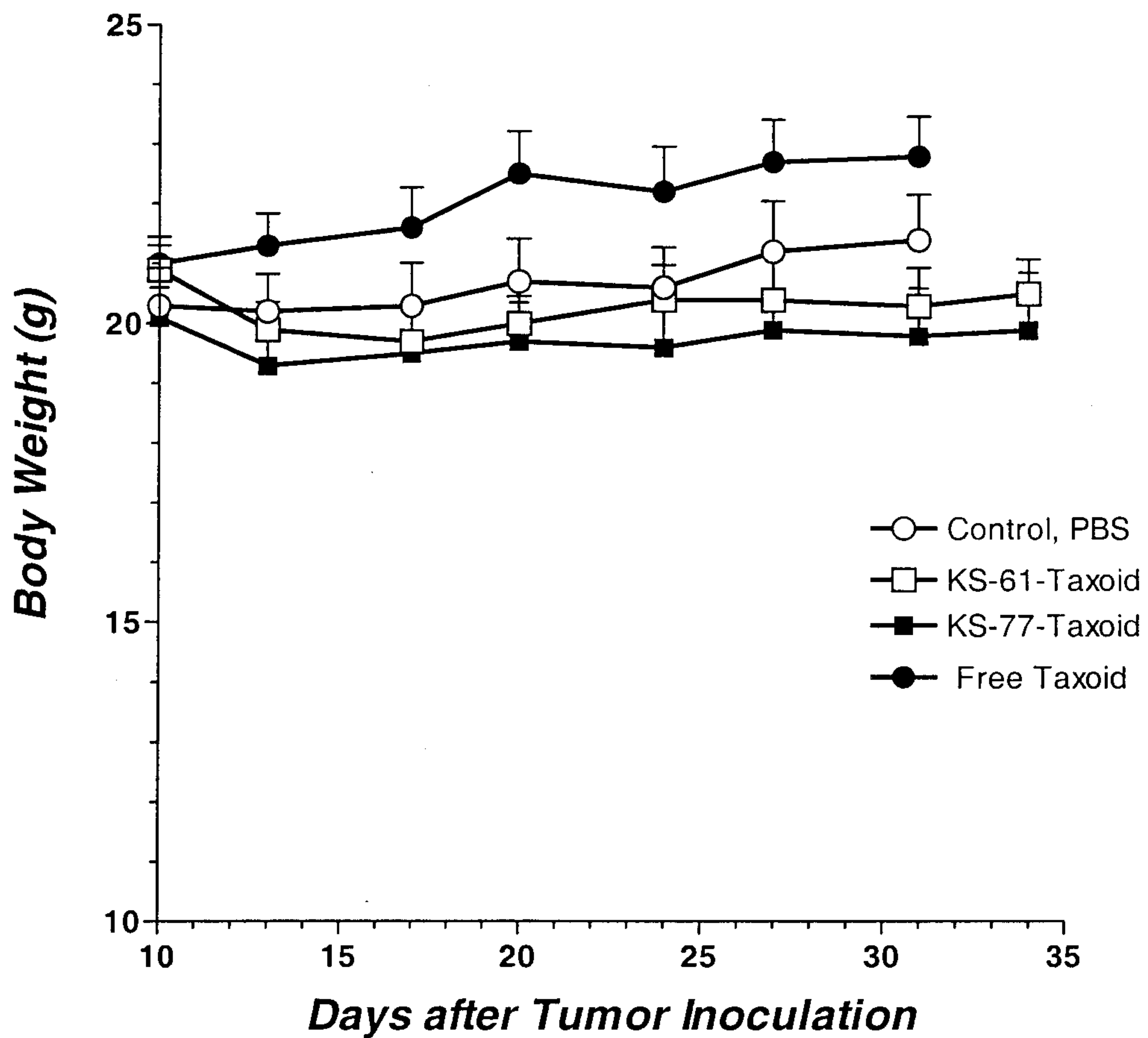


Figure 6.

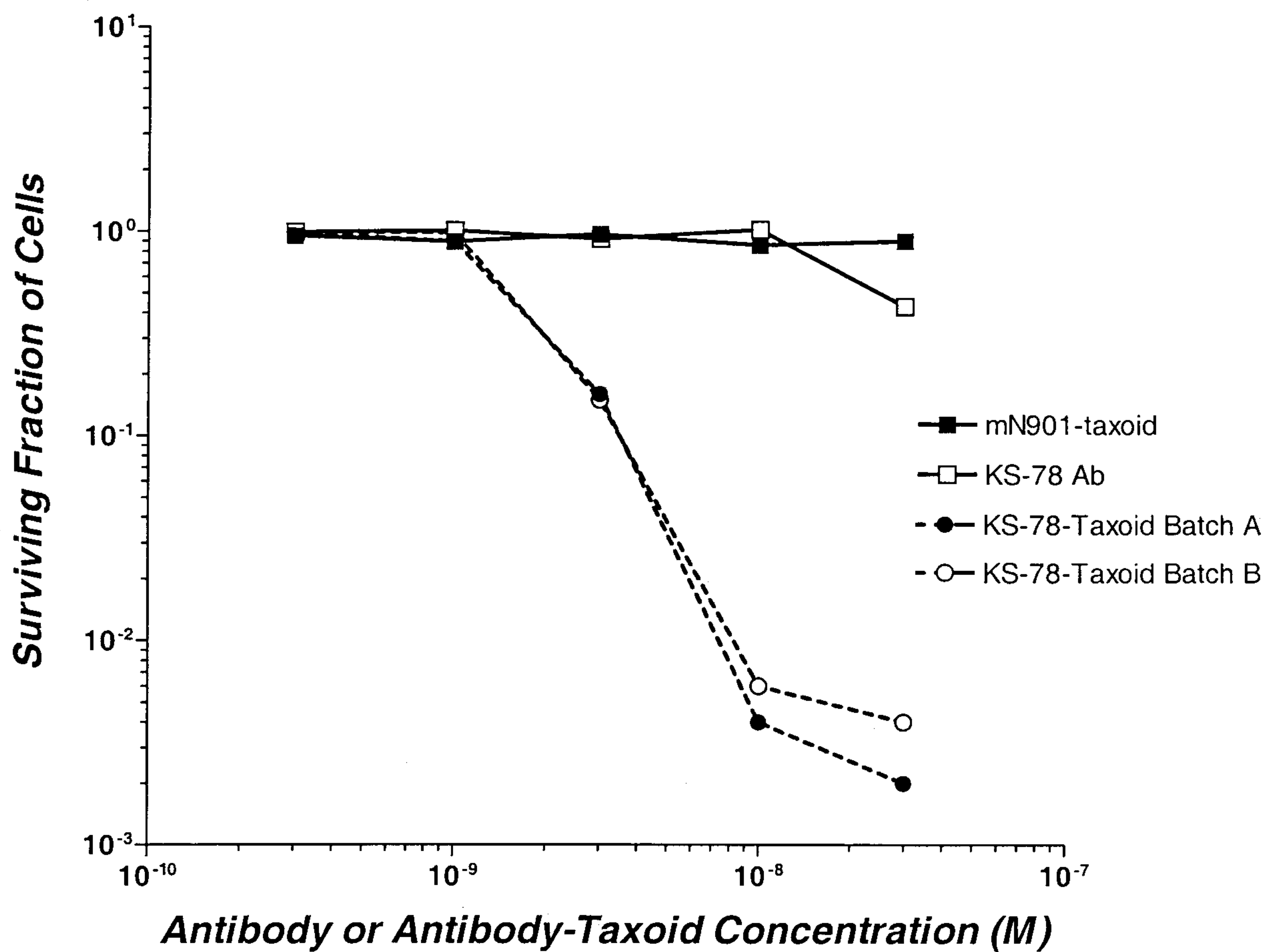


Figure 7.

