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(54) **FACTOR IX MOIETY-POLYMER CONJUGATES HAVING A RELEASABLE LINKAGE**

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USPC **530/381**; 424/78.17; 585/27

(58) **Field of Classification Search**
USPC 530/381; 424/78.17; 585/27
See application file for complete search history.

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(57) **ABSTRACT**

The present invention provides Factor IX moiety-polymer conjugates having a releasable linkage. Methods of making conjugates, methods for administering conjugates, are also provided.

15 Claims, 2 Drawing Sheets

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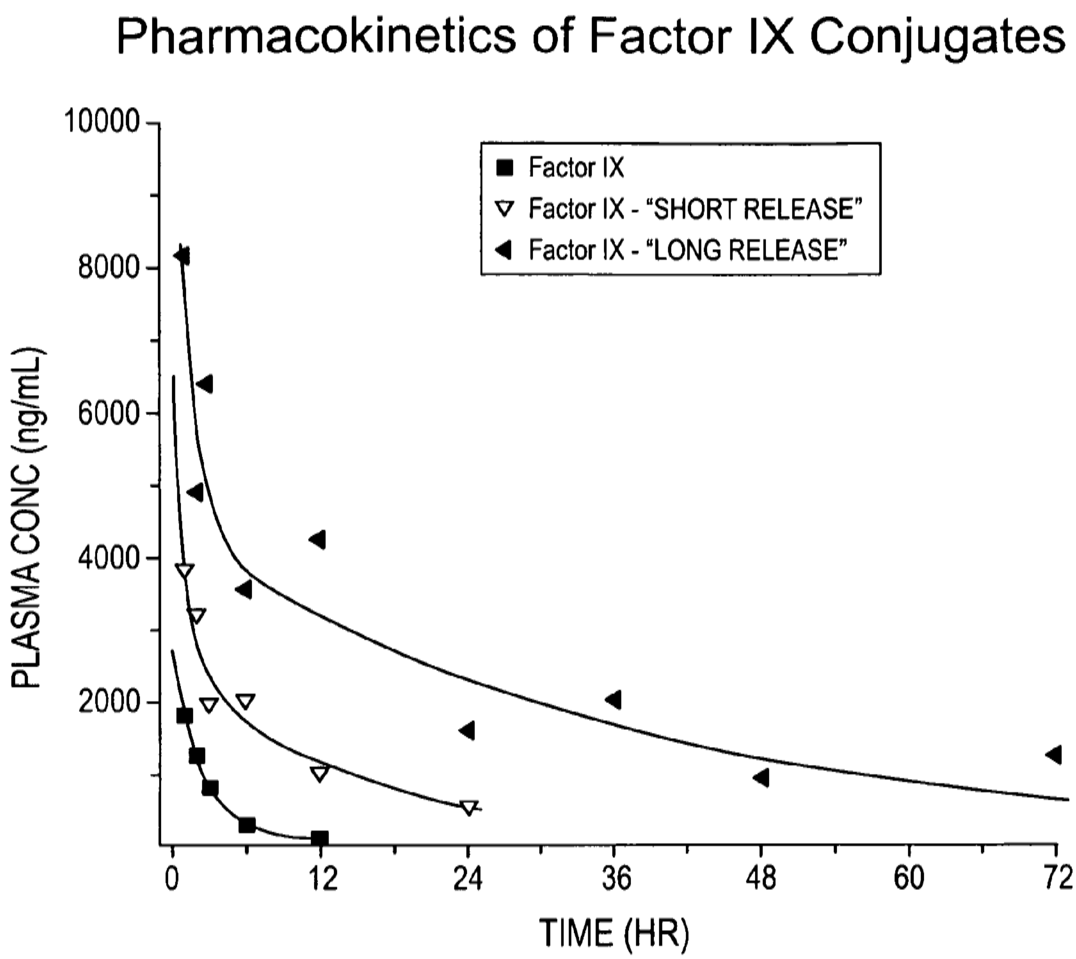

Pharmacokinetics of Factor IX Conjugates
Factor IX
Factor IX - "SHORT RELEASE"
Factor IX - "LONG RELEASE"
PLASMA CONC (ng/mL)
10000
8000
6000
4000
2000
0
12
24
36
48
60
72
TIME (HR)

Figure 1

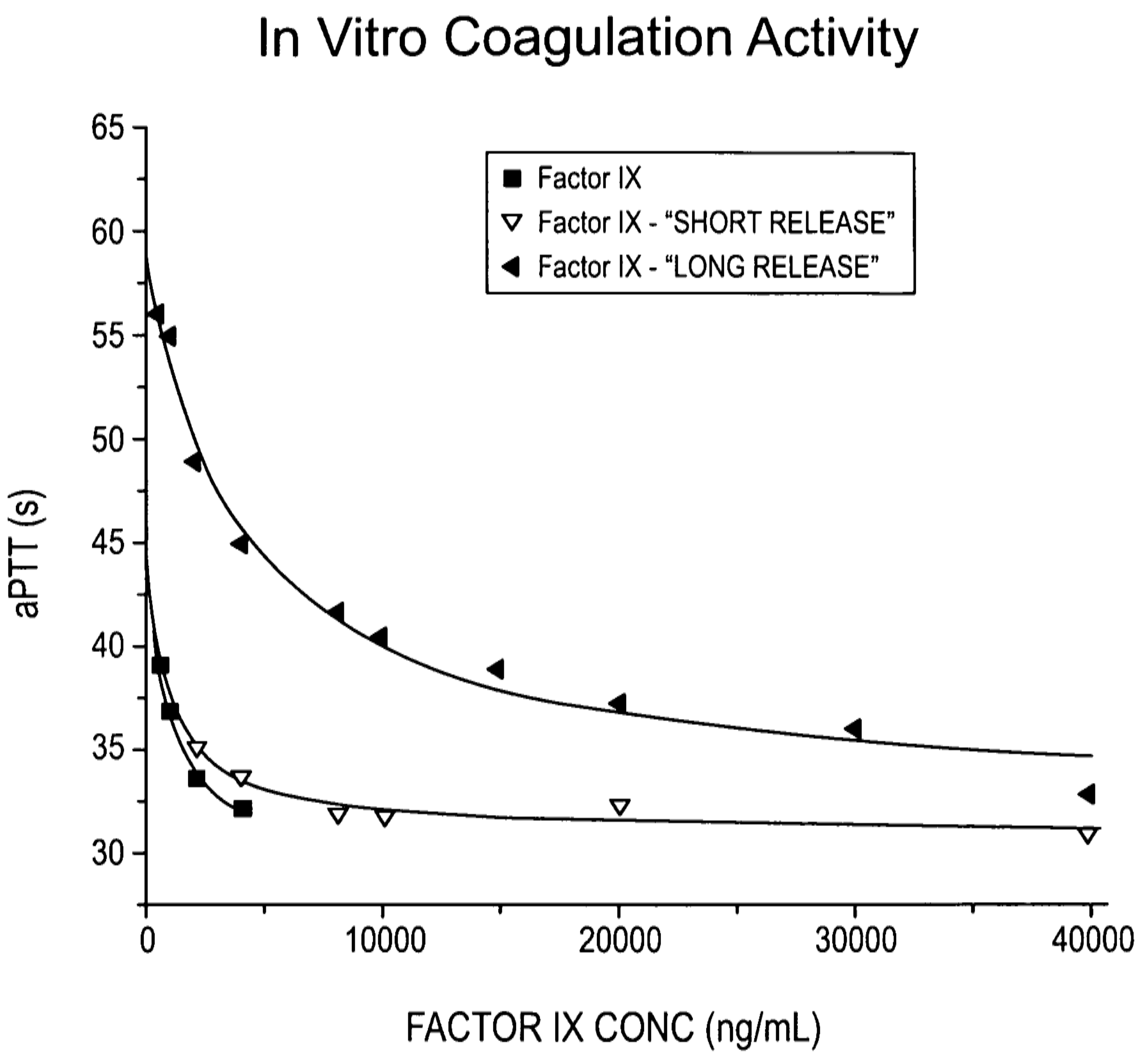

In Vitro Coagulation Activity
Factor IX
Factor IX - "SHORT RELEASE"
Factor IX - "LONG RELEASE"
aPTT (s)
65
60
55
50
45
40
35
30
0
10000
20000
30000
40000
FACTOR IX CONC (ng/mL)

Figure 2

FACTOR IX MOIETY-POLYMER CONJUGATES HAVING A RELEASABLE LINKAGE

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims the benefit of priority to U.S. provisional patent application Ser. No. 60/877,589, filed Dec. 27, 2006, which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

The present invention relates generally to polymer-active agent conjugates having a releasable linkage to thereby release the active agent in vivo. In addition, the invention relates to, among other things, methods for synthesizing the conjugates, methods for purifying the conjugates, and so on.

BACKGROUND OF THE INVENTION

Scientists and clinicians face a number of challenges in their attempts to develop active agents into forms suited for delivery to a patient. Active agents that are polypeptides, for example, are often delivered via injection rather than orally. In this way, the polypeptide is introduced into the systemic circulation without exposure to the proteolytic environment of the stomach. Injection of polypeptides, however, has several drawbacks. For example, many polypeptides have a relatively short half-life, thereby necessitating repeated injections, which are often inconvenient and painful. Moreover, some polypeptides can elicit one or more immune responses with the consequence that the patient's immune system attempts to destroy or otherwise neutralize the immunogenic polypeptide. Of course, once the polypeptide has been destroyed or otherwise neutralized, the polypeptide cannot exert its intended pharmacodynamic activity. Thus, delivery of active agents such as polypeptides is often problematic even when these agents are administered by injection.

Some success has been achieved in addressing the problems of delivering active agents via injection. For example, conjugating the active agent to a water-soluble polymer has resulted in a polymer-active agent conjugate having reduced immunogenicity and antigenicity. In addition, these polymer-active agent conjugates often have greatly increased half-lives compared to their unconjugated counterparts as a result of decreased clearance through the kidney and/or decreased enzymatic degradation in the systemic circulation. As a result of having a greater half-life, the polymer-active agent conjugate requires less frequent dosing, which in turn reduces the overall number of painful injections and inconvenient visits with a health care professional. Moreover, active agents that were only marginally soluble demonstrate a significant increase in water solubility when conjugated to a water-soluble polymer.

Due to its documented safety as well as its approval by the FDA for both topical and internal use, polyethylene glycol has been conjugated to active agents. When an active agent is conjugated to a polymer of polyethylene glycol or "PEG," the conjugated active agent is conventionally referred to as "PEGylated." The commercial success of PEGylated active agents such as PEGASYS® PEGylated interferon alpha-2a (Hoffmann-La Roche, Nutley, N.J.), PEG-INTRON® PEGylated interferon alpha-2b (Schering Corp., Kennilworth, N.J.), and NEULASTA™ PEG-filgrastim (Amgen Inc., Thousand Oaks, Calif.) demonstrates that administration of a conjugated form of an active agent can have significant advantages over the unconjugated counterpart. Small molecules such as distearoylphosphatidylethanolamine (Zalipsky (1994) *Bioconjug. Chem.* 4(4):296-299) and fluorouracil (Ouchi et al. (1992) *Drug Des. Discov.* 9(1):93-105) have also been PEGylated. Harris et al. have provided a review of the effects of PEGylation on pharmaceuticals. Harris et al. (2003) *Nat. Rev. Drug Discov.* 2(3):214-221.

Despite these successes, conjugation of a polymer to an active agent to result in a commercially relevant drug is often challenging. For example, conjugation can result in the polymer being attached at or near a site on the active agent that is necessary for pharmacologic activity (e.g., at or near a binding site). Such conjugates may therefore have unacceptably low activity due to, for example, the steric effects introduced by the polymer. Attempts to remedy conjugates having unacceptably low activity can be frustrated when the active agent has few or no other sites suited for attachment to a polymer. Thus, additional PEGylation alternatives have been desired.

One suggested approach for solving this and other problems is "reversible PEGylation" wherein the native active agent (or a moiety having increased activity compared to the PEGylated active agent) is released. For example, reversible PEGylation has been disclosed in the field of cancer chemotherapies. See Greenwald (1997) *Exp. Opin. Ther. Patents* 7(6):601-609. U.S. Patent Application Publication No. 2005/0079155 describes conjugates using reversible linkages. As described in this publication, reversible linkages can be effected through the use of an enzyme substrate moiety. It has been pointed out, however, that approaches relying on enzymatic activity are dependent on the availability of enzymes. See Peleg-Schulman (2004) *J. Med. Chem.* 47:4897-4904. Patient variability around the amount and activity of these enzymes can introduce inconsistent performance of the conjugate among different populations. Thus, additional approaches that do not rely on enzymatic processes for degradation have been described as being desirable.

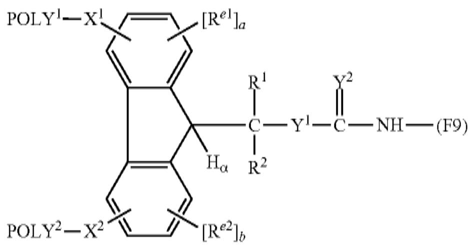
Another approach for reversible PEGylation is described in U.S. Pat. No. 7,060,259, which described (among other things) water-soluble prodrugs in which a biologically active agent is linked to a water-soluble non-immunogenic polymer by a hydrolyzable carbamate bond. As described therein, the biologically active agent can be readily released by the hydrolysis of the carbmate bond in vivo without the need for adding enzymes or catalytic materials.

Another approach for reversible PEGylation is described in Peleg-Schulman (2004) *J. Med. Chem.* 47:4897-4904, WO 2004/089280 and U.S. Patent Application Publication No. 2006/0171920. Although this approach has been applied to a limited number of active agents, these references ignore other active agents for which reversible PEGylation would be particularly suited. Yet another releasable approach is described in U.S. Patent Application Publication No. 2006/0293499

In the area of bleeding disorders, proteins (such as, for example, Factor IX) can sometimes be administered to a patient to address or otherwise ameliorate the bleeding disorder. Due to the relatively short half-life of Factor IX and related proteins, it would be advantageous to increase the in vivo half-life of these proteins by, for example, reversible PEGylation. Thus, the present invention seeks to solve this and other needs in the art.

SUMMARY OF THE INVENTION

In one or more embodiments of the invention, a conjugate of the following formula is provided:



wherein:

POLY^1 is a first water-soluble polymer;

POLY^2 is a second water-soluble polymer;

X^1 is a first spacer moiety;

X^2 is a second spacer moiety;

H_α is an ionizable hydrogen atom;

R^1 is H or an organic radical;

R^2 is H or an organic radical;

(a) is either zero or one;

(b) is either zero or one;

R^{e1}, when present, is a first electron altering group;

Re^2, when present, is a second electron altering group; and

Y^1 is O or S;

Y^2 is O or S; and

F9 is a residue of an amine-containing Factor IX moiety.

In one or more embodiments of the invention, methods for preparing conjugates are provided.

In one or more embodiments of the invention, pharmaceutical preparations comprising the conjugates are provided.

In one or more embodiments of the invention, methods for administering the conjugates are provided.

BRIEF DESCRIPTION OF THE FIGURES

FIG. **1** is a time-concentration curve of conjugates of the inventions. Additional information concerning this figure is provided in Example 3.

FIG. **2** is provides coagulation activity of conjugates of the invention. Additional information concerning this figure is provided in Example 4.

DETAILED DESCRIPTION OF THE INVENTION

Before describing the present invention in detail, it is to be understood that this invention is not limited to particular polymers, synthetic techniques, active agents, and the like, as such may vary.

It must be noted that, as used in this specification and the claims, the singular forms "a," "an," and "the" include plural referents unless the context clearly dictates otherwise. Thus, for example, reference to a "polymer" includes a single polymer as well as two or more of the same or different polymers, reference to a "conjugate" refers to a single conjugate as well as two or more of the same or different conjugates, reference to an "excipient" includes a single excipient as well as two or more of the same or different excipients, and the like.

In describing and claiming the present invention, the following terminology will be used in accordance with the definitions described below.

"PEG," "polyethylene glycol" and "poly(ethylene glycol)" as used herein, are meant to encompass any water-soluble poly(ethylene oxide). Typically, PEGs for use in accordance with the invention comprise the following structure "—O$(CH_2CH_2O)_m$—" where (m) is 2 to 4000. As used herein, PEG also includes "—CH_2CH_2—O$(CH_2CH_2O)_m$—CH_2CH_2—" and "—$(CH_2CH_2O)_m$—," depending upon whether or not the terminal oxygens have been displaced. When the PEG further comprises a spacer moiety (to be described in greater detail below), the atoms comprising the spacer moiety, when covalently attached to a water-soluble polymer segment, do not result in the formation of an oxygen-oxygen bond (i.e., an "—O—O—" or peroxide linkage). Throughout the specification and claims, it should be remembered that the term "PEG" includes structures having various terminal or "end capping" groups and so forth. The term "PEG" also means a polymer that contains a majority, that is to say, greater than 50%, of —CH_2CH_2O— monomeric subunits. With respect to specific forms, the PEG can take any number of a variety of molecular weights, as well as structures or geometries such as "branched," "linear," "forked," "multifunctional," and the like, to be described in greater detail below.

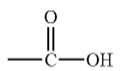
The terms "end-capped" or "terminally capped" are interchangeably used herein to refer to a terminal or endpoint of a polymer having an end-capping moiety. Typically, although not necessarily, the end-capping moiety comprises a hydroxy or C_{1-20} alkoxy group. Thus, examples of end-capping moieties include alkoxy (e.g., methoxy, ethoxy and benzyloxy), as well as aryl, heteroaryl, cyclo, heterocyclo, and the like. In addition, saturated, unsaturated, substituted and unsubstituted forms of each of the foregoing are envisioned. Moreover, the end-capping group can also be a silane. The end-capping group can also advantageously comprise a detectable label. When the polymer has an end-capping group comprising a detectable label, the amount or location of the polymer and/or the moiety (e.g., active agent) of interest to which the polymer is coupled can be determined by using a suitable detector. Such labels include, without limitation, fluorescers, chemiluminescers, moieties used in enzyme labeling, calorimetric (e.g., dyes), metal ions, radioactive moieties, and the like. Suitable detectors include photometers, films, spectrometers, and the like.

"Non-naturally occurring" with respect to a polymer or water-soluble polymer means a polymer that in its entirety is not found in nature. A non-naturally occurring polymer or water-soluble polymer may, however, contain one or more subunits or portions of a subunit that are naturally occurring, so long as the overall polymer structure is not found in nature.

The term "water-soluble polymer" is any polymer that is soluble in water at room temperature. Typically, a water-soluble polymer will transmit at least about 75%, more preferably at least about 95% of light, transmitted by the same solution after filtering. On a weight basis, a water-soluble polymer will preferably be at least about 35% (by weight) soluble in water, more preferably at least about 50% (by weight) soluble in water, still more preferably about 70% (by weight) soluble in water, and still more preferably about 85% (by weight) soluble in water. It is still more preferred, however, that the water-soluble polymer is about 95% (by weight) soluble in water and most preferred that the water-soluble polymer is completely soluble in water.

Molecular weight in the context of a water-soluble polymer of the invention, such as PEG, can be expressed as either a number average molecular weight or a weight average molecular weight. Unless otherwise indicated, all references to molecular weight herein refer to the weight average molecular weight. Both molecular weight determinations, number average and weight average, can be measured using gel permeation chromatography or other liquid chromatography techniques. Other methods for measuring molecular weight values can also be used, such as the use of end-group analysis or the measurement of colligative properties (e.g., freezing-point depression, boiling-point elevation, or osmotic pressure) to determine number average molecular weight or the use of light scattering techniques, ultracentrifugation or viscometry to determine weight average molecular weight. The polymers of the invention are typically polydisperse (i.e., number average molecular weight and weight average molecular weight of the polymers are not equal), possessing low polydispersity values of preferably less than about 1.2, more preferably less than about 1.15, still more preferably less than about 1.10, yet still more preferably less than about 1.05, and most preferably less than about 1.03.

As used herein, the term "carboxylic acid" is a moiety having a



functional group [also represented as a "—COOH" or —C(O)OH], as well as moieties that are derivatives of a carboxylic acid, such derivatives including, for example, protected carboxylic acids. Thus, unless the context clearly dictates otherwise, the term carboxylic acid includes not only the acid form, but corresponding esters and protected forms as well. With regard to protecting groups suited for a carboxylic acid and any other functional group described herein, reference is made to Greene et al., "Protective Groups in Organic Synthesis" 3rd Edition, John Wiley and Sons, Inc., New York, 1999.

The terms "reactive" and "activated" when used in conjunction with a particular functional group, refer to a reactive functional group that reacts readily with an electrophile or a nucleophile on another molecule. This is in contrast to those groups that require strong catalysts or highly impractical reaction conditions in order to react (i.e., a "nonreactive" or "inert" group).

The terms "protected," "protecting group," and "protective group" refer to the presence of a moiety (i.e., the protecting group) that prevents or blocks reaction of a particular chemically reactive functional group in a molecule under certain reaction conditions. The protecting group will vary depending upon the type of chemically reactive functional group being protected as well as the reaction conditions to be employed and the presence of additional reactive or protecting groups in the molecule, if any. Protecting groups known in the art can be found in Greene et al., supra.

As used herein, the term "functional group" or any synonym thereof is meant to encompass protected forms thereof.

The terms "spacer" or "spacer moiety" are used herein to refer to an atom or a collection of atoms optionally appearing between one moiety and another. The spacer moieties may be hydrolytically stable or may include one or more physiologically hydrolyzable or enzymatically releasable linkages.

An "organic radical" as used herein includes, for example, alkyl, substituted alkyl, alkenyl, substituted alkenyl, alkynyl, substituted alkynyl, aryl and substituted aryl.

"Alkyl" refers to a hydrocarbon chain, typically ranging from about 1 to 20 atoms in length. Such hydrocarbon chains are preferably but not necessarily saturated and may be branched or straight chain, although typically straight chain is preferred. Exemplary alkyl groups include methyl, ethyl, propyl, butyl, pentyl, 1-methylbutyl, 1-ethylpropyl, 3-methylpentyl, and the like. As used herein, "alkyl" includes cycloalkyl when three or more carbon atoms are referenced and lower alkyl.

"Lower alkyl" refers to an alkyl group containing from 1 to 6 carbon atoms, and may be straight chain or branched, as exemplified by methyl, ethyl, n-butyl, iso-butyl, and tert-butyl.

"Cycloalkyl" refers to a saturated or unsaturated cyclic hydrocarbon chain, including bridged, fused, or spiro cyclic compounds, preferably made up of 3 to about 12 carbon atoms, more preferably 3 to about 8 carbon atoms.

"Non-interfering substituents" are those groups that, when present in a molecule, are typically non-reactive with other functional groups contained within the molecule.

The term "substituted" as in, for example, "substituted alkyl," refers to a moiety (e.g., an alkyl group) substituted with one or more non-interfering substituents, such as, but not limited to: C_3-C_8 cycloalkyl, e.g., cyclopropyl, cyclobutyl, and the like; halo, e.g., fluoro, chloro, bromo, and iodo; cyano; alkoxy, lower phenyl; substituted phenyl; and the like, for one or more hydrogen atoms. "Substituted aryl" is aryl having one or more non-interfering groups as a substituent. For substitutions on a phenyl ring, the substituents may be in any orientation (i.e., ortho, meta, or para). "Substituted ammonium" is ammonium having one or more non-interfering groups (e.g., an organic radical) as a substituent.

"Alkoxy" refers to an —O—R group, wherein R is alkyl or substituted alkyl, preferably C_1-C_{20} alkyl (e.g., methoxy, ethoxy, propyloxy, benzyl, etc.), more preferably C_1-C_7 alkyl.

As used herein, "alkenyl" refers to a branched or unbranched hydrocarbon group of 2 to 15 atoms in length, containing at least one double bond. Exemplary alkenyl include (without limitation) ethenyl, n-propenyl, isopropenyl, n-butenyl, iso-butenyl, octenyl, decenyl, tetradecenyl, and the like.

The term "alkynyl" as used herein refers to a branched or unbranched hydrocarbon group of 2 to 15 atoms in length, containing at least one triple bond. Exemplary alkynyl include (without limitation) ethynyl, n-butynyl, iso-pentynyl, octynyl, decynyl, and so forth.

"Aryl" means one or more aromatic rings, each of 5 or 6 core carbon atoms. Aryl includes multiple aryl rings that may be fused, as in naphthyl, or unfused, as in biphenyl. Aryl rings may also be fused or unfused with one or more cyclic hydrocarbon, heteroaryl, or heterocyclic rings. As used herein, "aryl" includes heteroaryl. An aromatic-containing moiety (e.g., Ar^1, Ar^2, and so forth), means a structure containing aryl.

"Heteroaryl" is an aryl group containing from one to four heteroatoms, preferably N, O, or S, or a combination thereof. Heteroaryl rings may also be fused with one or more cyclic hydrocarbon, heterocyclic, aryl, or heteroaryl rings.

"Heterocycle" or "heterocyclic" means one or more rings of 5-12 atoms, preferably 5-7 atoms, with or without unsaturation or aromatic character and having at least one ring atom which is not a carbon. Preferred heteroatoms include sulfur, oxygen, and nitrogen.

"Substituted heteroaryl" is heteroaryl having one or more non-interfering groups as substituents.

"Substituted heterocycle" is a heterocycle having one or more side chains formed from non-interfering substituents.

"Electrophile" refers to an ion or atom or collection of atoms, that may be ionic, having an electrophilic center, i.e., a center that is electron seeking, capable of reacting with a nucleophile.

"Nucleophile" refers to an ion or atom or collection of atoms that may be ionic having a nucleophilic center, i.e., a center that is seeking an electrophilic center or with an electrophile.

A "physiologically cleavable" as well as a "hydrolyzable" bond is a relatively weak bond that reacts with water (i.e., is hydrolyzed) under physiological conditions. The tendency of a bond to hydrolyze in water will depend not only on the general type of linkage connecting two central atoms but also on the substituents attached to these central atoms. Exemplary hydrolyzable bonds include, but are not limited to, carboxylate ester, phosphate ester, anhydride, acetal, ketal, acyloxyalkyl ether, imine, and ortho esters.

A "releasable linkage" includes, but is not limited to, a physiologically cleavable bond, a hydrolyzable bond, and an enzymatically degradable linkage. Thus, a "releasable linkage" is a linkage that may undergo either hydrolysis or cleavage by some other mechanism (e.g., enzyme-catalyzed, acid-catalyzed, base-catalyzed, and so forth) under physiological conditions. For example, a "releasable linkage" can involve an elimination reaction that has a base abstraction of a proton, (e.g., an ionizable hydrogen atom; H_α), as the driving force. For purposes herein, a "releasable linkage" is synonymous with a "degradable linkage."

An "enzymatically releasable linkage" means a linkage that is subject to degradation by one or more enzymes.

A "hydrolytically stable" linkage or bond refers to a chemical bond, typically a covalent bond, that is substantially stable in water, that is to say, does not undergo hydrolysis under physiological conditions to any appreciable extent over an extended period of time. Examples of hydrolytically stable linkages include but are not limited to the following: carbon-carbon bonds (e.g., in aliphatic chains), ethers, amides, and the like. Generally, a hydrolytically stable linkage is one that exhibits a rate of hydrolysis of less than about 1-2% per day under physiological conditions. Hydrolysis rates of representative chemical bonds can be found in most standard chemistry textbooks. It must be pointed out that some linkages can be hydrolytically stable or hydrolyzable, depending upon (for example) adjacent and neighboring atoms and ambient conditions. One of ordinary skill in the art can determine whether a given linkage or bond is hydrolytically stable or hydrolyzable in a given context by, for example, placing a linkage-containing molecule of interest under conditions of interest and testing for evidence of hydrolysis (e.g., the presence and amount of two molecules resulting from the cleavage of a single molecule). Other approaches known to those of ordinary skill in the art for determining whether a given linkage or bond is hydrolytically stable or hydrolyzable can also be used.

The terms "active agent," "biologically active agent" and "pharmacologically active agent" are used interchangeably herein and are defined to include any agent, drug, compound, composition of matter or mixture that provides some pharmacologic, often beneficial, effect that can be demonstrated in vivo or in vitro. This includes food supplements, nutrients, nutriceuticals, drugs, proteins, vaccines, antibodies, vitamins, and other beneficial agents. As used herein, these terms further include any physiologically or pharmacologically active substance that produces a localized or systemic effect in a patient.

"Pharmaceutically acceptable excipient" or "pharmaceutically acceptable carrier" refers to an excipient that can be included in the compositions of the invention and that causes no significant adverse toxicological effects to the patient.

"Pharmacologically effective amount," "physiologically effective amount," and "therapeutically effective amount" are used interchangeably herein to mean the amount of a polymer-active agent conjugate—typically present in a pharmaceutical preparation—that is needed to provide a desired level of active agent and/or conjugate in the bloodstream or in a target tissue. The exact amount will depend upon numerous factors, e.g., the particular active agent, the components and physical characteristics of the pharmaceutical preparation, intended patient population, patient considerations, and the like, and can readily be determined by one of ordinary skill in the art, based upon the information provided herein and available in the relevant literature.

"Multifunctional" in the context of a polymer means a polymer having 3 or more functional groups contained therein, where the functional groups may be the same or different. Multifunctional polymers will typically contain from about 3-100 functional groups, or from 3-50 functional groups, or from 3-25 functional groups, or from 3-15 functional groups, or from 3 to 10 functional groups, or will contain 3, 4, 5, 6, 7, 8, 9 or 10 functional groups within the polymer. A "difunctional" polymer means a polymer having two functional groups contained therein, either the same (i.e., homodifunctional) or different (i.e., heterodifunctional).

"Branched," in reference to the geometry or overall structure of a polymer, refers to polymer having 2 or more polymer "arms." A branched polymer may possess 2 polymer arms, 3 polymer arms, 4 polymer arms, 6 polymer arms, 8 polymer arms or more. One particular type of highly branched polymer is a dendritic polymer or dendrimer, which, for the purposes of the invention, is considered to possess a structure distinct from that of a branched polymer.

A "dendrimer" or dendritic polymer is a globular, size monodisperse polymer in which all bonds emerge radially from a central focal point or core with a regular branching pattern and with repeat units that each contribute a branch point. Dendrimers exhibit certain dendritic state properties such as core encapsulation, making them unique from other types of polymers.

A basic or acidic reactant described herein includes neutral, charged, and any corresponding salt forms thereof.

The term "patient," refers to a living organism suffering from or prone to a condition that can be prevented or treated by administration of a conjugate as provided herein, and includes both humans and animals.

As used herein, "drug release rate" means a rate (stated as a half-life) in which half of the total amount of polymer-active agent conjugates in a system will cleave into the active agent and a polymeric residue.

"Optional" and "optionally" mean that the subsequently described circumstance may or may not occur, so that the description includes instances where the circumstance occurs and instances where it does not.

As used herein, the "halo" designator (e.g., fluoro, chloro, iodo, bromo, and so forth) is generally used when the halogen is attached to a molecule, while the suffix "ide" (e.g., fluoride, chloride, iodide, bromide, and so forth) is used when the halogen exists in its independent ionic form (e.g., such as when a leaving group leaves a molecule).

The term "Factor IX moiety," as used herein, refers to a moiety having Factor IX activity. The Factor IX moiety will also have at least amine group suited for reaction with a polymeric reagent. Typically, although not necessarily, the Factor IX moiety is a protein. In addition, the term "Factor IX moiety" encompasses both the Factor IX moiety prior to conjugation as well as the Factor IX moiety residue following conjugation. As will be explained in further detail below, one of ordinary skill in the art can determine whether any given moiety has Factor IX activity. As used herein, the term "Factor IX moiety" includes proteins modified deliberately, as for example, by site directed mutagenesis or accidentally through mutations. The term "Factor IX moiety" also includes derivatives having from 1 to 6 additional glycosylation sites, derivatives having at least one additional amino acid at the carboxy terminal end of the protein wherein the additional amino acid(s) includes at least one glycosylation site, and derivatives having an amino acid sequence which includes at least one glycosylation site.

In the context of the present discussion, it should be recognized that the definition of a variable provided with respect to one structure or formula is applicable to the same variable repeated in a different structure, unless the context dictates otherwise.

As previously stated, the present invention comprises (among other things) conjugates having a releasable linkage.

Before describing exemplary conjugates of the invention, embodiments of a water-soluble polymer and a functional group capable of reacting with an amino group of an active agent to form a releasable linkage, such as a carbamate linkage will be discussed.

With respect to a given water-soluble polymer, each water-soluble polymer (e.g., POLY, $POLY^1$ and $POLY^2$) can comprise any polymer so long as the polymer is water-soluble and non-peptidic. Although preferably a poly(ethylene glycol), a water-soluble polymer for use herein can be, for example, other water-soluble polymers such as other poly(alkylene glycols) [also referred to as "poly(alkyleneoxides)"], such as poly(propylene glycol) ("PPG"), copolymers of ethylene glycol and propylene glycol and the like, poly(olefinic alcohol), poly(vinylpyrrolidone), poly(hydroxyalkylmethacrylamide), poly(hydroxyalkylmethacrylate), poly(saccharides), poly(α-hydroxy acid), poly(vinyl alcohol), polyphosphazene, polyoxazoline, poly(N-acryloylmorpholine), such as described in U.S. Pat. No. 5,629,384. The water soluble polymer can be a homopolymer, copolymer, terpolymer, nonrandom block polymer, and random block polymer of any of the foregoing. In addition, a water-soluble polymer can be linear, but can also be in other forms (e.g., branched, forked, and the like) as will be described in further detail below. In the context of being present within an overall structure, a water-soluble polymer has from 1 to about 300 termini.

In instances where the polymeric reagent comprises two or more water-soluble polymers, each water-soluble polymer in the overall structure can be the same or different. It is preferred, however, that all water-soluble polymers in the overall structure are of the same type. For example, it is preferred that all water-soluble polymers within a given structure are poly (ethylene glycol) polymers.

Although the weight-average molecular weight of any individual water-soluble polymer can vary, the weight average molecular weight of any given water-soluble polymer will typically be in the following range: 100 Daltons to about 150,000 Daltons. Exemplary ranges, however, include weight-average molecular weights in the following ranges: in the range of from about 880 Daltons to about 5,000 Daltons; in the range of greater than 5,000 Daltons to about 100,000 Daltons; in the range of from about 6,000 Daltons to about 90,000 Daltons; in the range of from about 10,000 Daltons to about 85,000 Daltons; in the range of greater than 10,000 Daltons to about 85,000 Daltons; in the range of from about 20,000 Daltons to about 85,000 Daltons; in the range of from about 53,000 Daltons to about 85,000 Daltons; in the range of from about 25,000 Daltons to about 120,000 Daltons; in the range of from about 29,000 Daltons to about 120,000 Daltons; in the range of from about 35,000 Daltons to about 120,000 Daltons; in the range of about 880 Daltons to about 60,000 Daltons; in the range of about 440 Daltons to about 40,000 Daltons; in the range of about 440 Daltons to about 30,000 Daltons; and in the range of from about 40,000 Daltons to about 120,000 Daltons. For any given water-soluble polymer, PEGs having a molecular weight in one or more of these ranges are preferred.

Exemplary weight-average molecular weights for the water-soluble polymer include about 100 Daltons, about 200 Daltons, about 300 Daltons, about 400 Daltons, about 440 Daltons, about 500 Daltons, about 600 Daltons, about 700 Daltons, about 750 Daltons, about 800 Daltons, about 900 Daltons, about 1,000 Daltons, about 1,500 Daltons, about 2,000 Daltons, about 2,200 Daltons, about 2,500 Daltons, about 3,000 Daltons, about 4,000 Daltons, about 4,400 Daltons, about 4,500 Daltons, about 5,000 Daltons, about 5,500 Daltons, about 6,000 Daltons, about 7,000 Daltons, about 7,500 Daltons, about 8,000 Daltons, about 9,000 Daltons, about 10,000 Daltons, about 11,000 Daltons, about 12,000 Daltons, about 13,000 Daltons, about 14,000 Daltons, about 15,000 Daltons, about 16,000 Daltons, about 17,000 Daltons, about 18,000 Daltons, about 19,000 Daltons, about 20,000 Daltons, about 22,500 Daltons, about 25,000 Daltons, about 30,000 Daltons, about 35,000 Daltons, about 40,000 Daltons, about 45,000 Daltons, about 50,000 Daltons, about 55,000 Daltons, about 60,000 Daltons, about 65,000 Daltons, about 70,000 Daltons, and about 75,000 Daltons. Branched versions of the water-soluble polymer (e.g., a branched 40,000 Dalton water-soluble polymer comprised of two 20,000 Dalton polymers) having a total weight average molecular weight of any of the foregoing can also be used.

The polymeric reagent used to prepare the conjugate will comprise at least one water-soluble polymer having a total size in the range suited for the desired rate of release of the conjugate formed therefrom. For example, a conjugate having a relatively long release rate can be prepared from a polymeric reagent having a size suited for (a) extended circulation prior to release of the active agent from the conjugate, and (b) moderately rapid in vivo clearance of the species liberated from the conjugate upon release from the conjugate. Likewise, when the conjugate has a relatively fast release rate, then the polymeric reagent would typically have a lower molecular weight.

When a PEG is used as the water-soluble polymer(s) in the polymeric reagent, the PEG typically comprises a number of (OCH_2CH_2) monomers [or (CH_2CH_2O) monomers, depending on how the PEG is defined]. As used throughout the description, the number of repeating units is identified by the subscript "n" in "$(OCH_2CH_2)n$." Thus, the value of (n) typically falls within one or more of the following ranges: from 2 to about 3400, from about 4 to about 1500, from about 100 to about 2300, from about 100 to about 2270, from about 136 to about 2050, from about 225 to about 1930, from about 450 to about 1930, from about 1200 to about 1930, from about 568 to about 2727, from about 660 to about 2730, from about 795 to about 2730, from about 795 to about 2730, from about 909 to about 2730, and from about 1,200 to about 1,900. For any given polymer in which the molecular weight is known, it is possible to determine the number of repeating units (i.e., "n") by dividing the total weight-average molecular weight of the polymer by the molecular weight of the repeating monomer.

Each water-soluble polymer is typically biocompatible and non-immunogenic. With respect to biocompatibility, a substance is considered biocompatible if the beneficial effects associated with use of the substance alone or with another substance (e.g., an active agent) in connection with living tissues (e.g., administration to a patient) outweighs any deleterious effects as evaluated by a clinician, e.g., a physician. With respect to non-immunogenicity, a substance is considered non-immunogenic if use of the substance alone or with another substance in connection with living tissues does not produce an immune response (e.g., the formation of antibodies) or, if an immune response is produced, that such a response is not deemed clinically significant or important as evaluated by a clinician. It is particularly preferred that the water-soluble polymers described herein as well as conjugates of active agents and the polymers are biocompatible and non-immunogenic.

In one form useful, free or nonbound PEG is a linear polymer terminated at each end with hydroxyl groups:

$$HO—CH_2CH_2O—(CH_2CH_2O)_{m'}—CH_2CH_2—OH$$

wherein (M') typically ranges from zero to about 4,000, preferably from about 20 to about 1,000.

The above polymer, alpha-,omega-dihydroxylpoly(ethylene glycol), can be represented in brief form as HO-PEG-OH where it is understood that the -PEG-symbol can represent the following structural unit:

$$—CH_2CH_2O—(CH_2CH_2O)_{m'}—CH_2CH_2—$$

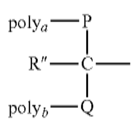
where (M') is as defined as above.

Another type of free or nonbound PEG useful in the present invention is methoxy-PEG-OH, or mPEG in brief, in which one terminus is the relatively inert methoxy group, while the other terminus is a hydroxyl group. The structure of mPEG is given below.

$$CH_3O—CH_2CH_2O—(CH_2CH_2O)_{m'}—CH_2CH_2—$$

where (M') is as described above.

Multi-armed or branched PEG molecules, such as those described in U.S. Pat. No. 5,932,462, can also be used as the PEG polymer. For example, PEG can have the structure:



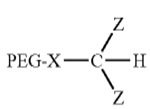
wherein:

poly$_a$ and poly$_b$ are PEG backbones (either the same or different), such as methoxy poly(ethylene glycol);

R" is a nonreactive moiety, such as H, methyl or a PEG backbone; and

P and Q are nonreactive linkages. In a preferred embodiment, the branched PEG polymer is methoxy poly(ethylene glycol) disubstituted lysine.

In addition, the PEG can comprise a forked PEG. An example of a free or nonbound forked PEG is represented by the following formula:



wherein: X is a spacer moiety and each Z is an activated terminal group linked to CH by a chain of atoms of defined length. The chain of atoms linking the Z functional groups to the branching carbon atom serve as a tethering group and may comprise, for example, alkyl chains, ether chains, ester chains, amide chains and combinations thereof. U.S. Pat. No. 6,362,254, discloses various forked PEG structures capable of use in the present invention.

The PEG polymer may comprise a pendant PEG molecule having reactive groups, such as carboxyl, covalently attached along the length of the PEG rather than at the end of the PEG chain. The pendant reactive groups can be attached to the PEG directly or through a spacer moiety, such as an alkylene group.

In addition to the above-described forms of PEG, each water-soluble polymer in the polymeric reagent can also be prepared with one or more weak or releasable linkages in the polymer, including any of the above described polymers. For example, PEG can be prepared with ester linkages in the polymer that are subject to hydrolysis. As shown below, this hydrolysis results in cleavage of the polymer into fragments of lower molecular weight:

$$\text{-PEG-}CO_2\text{-PEG-}+H_2O \longrightarrow \text{-PEG-}CO_2H+HO\text{-PEG-}$$

Other hydrolytically degradable linkages, useful as a degradable linkage within a polymer backbone, include carbonate linkages; imine linkages resulting, for example, from reaction of an amine and an aldehyde (see, e.g., Ouchi et al. (1997) *Polymer Preprints* 38(1):582-3); phosphate ester linkages formed, for example, by reacting an alcohol with a phosphate group; hydrazone linkages which are typically formed by reaction of a hydrazide and an aldehyde; acetal linkages that are typically formed by reaction between an aldehyde and an alcohol; ortho ester linkages that are, for example, formed by reaction between a formate and an alcohol; amide linkages formed by an amine group, e.g., at an end of a polymer such as PEG, and a carboxyl group of another PEG chain; urethane linkages formed from reaction of, e.g., a PEG with a terminal isocyanate group and a PEG alcohol; peptide linkages formed by an amine group, e.g., at an end of a polymer such as PEG, and a carboxyl group of a peptide; and oligonucleotide linkages formed by, for example, a phosphoramidite group, e.g., at the end of a polymer, and a 5' hydroxyl group of an oligonucleotide.

It is understood by those of ordinary skill in the art that the term poly(ethylene glycol) or PEG represents or includes all the above forms of PEG.

Those of ordinary skill in the art will recognize that the foregoing discussion concerning substantially water-soluble polymers is by no means exhaustive and is merely illustrative, and that all polymeric materials having the qualities described above are contemplated. As used herein, the term "water-soluble polymer" refers both to a molecule as well as the residue of water-soluble polymer that has been attached to another moiety. The following description of a water-soluble polymer are applicable not only to the polymeric reagent, but to the corresponding conjugates formed using the described polymeric reagents.

The functional group of the polymeric reagents used to form the conjugates described herein is a functional group capable of reacting with an amino group of an active agent to form a releasable linkage, such as a carbamate linkage. The invention is not limited with respect to the specific functional group so long as the functional group is capable of reacting with an amino group of an active agent to form a releasable linkage, such as a carbamate linkage. Exemplary functional groups capable of reacting with an amino group of an active agent include those functional groups selected from the group consisting of active carbonates such as N-succinimidyl, 1-benzotriazolyl, imidazole, carbonate halides (such as carbonate chloride and carbonate bromide), phenolates (such as p-nitrophenolate) and so forth. Also, as a special case, if the active agent is available with the active amine group converted into an isocyanate or isothiocyanate group, then the functional group of the polymeric reagent can be hydroxyl as the reaction of these components provide a releasable carbamate linkage.

R^1 is H or an organic radical;

R^2 is H or an organic radical;

(a) is either zero or one;

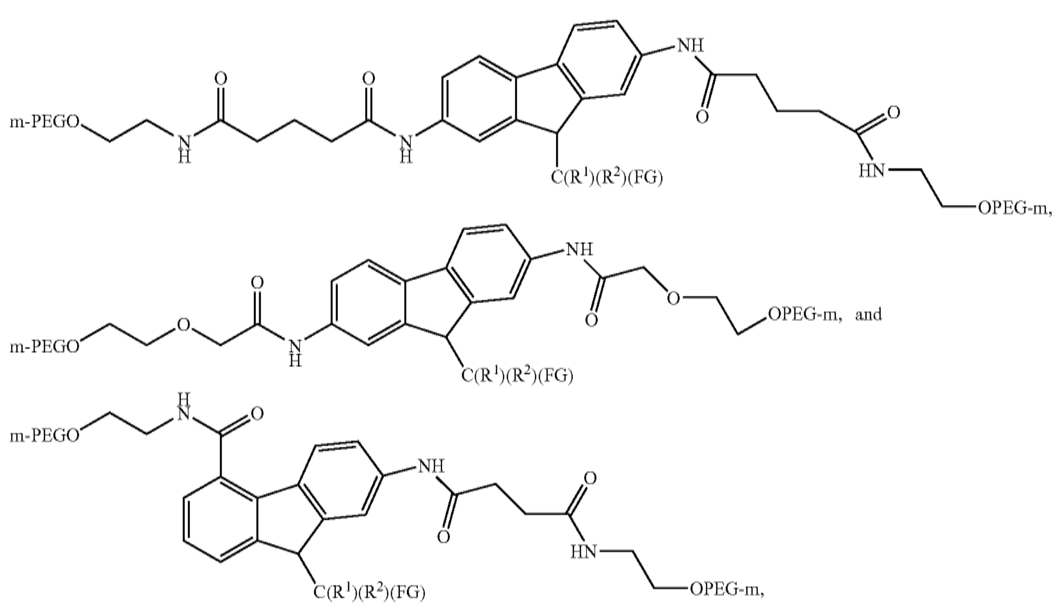
(b) is either zero or one;

R^{e1}, when present, is a first electron altering group;

R^{e2}, when present, is a second electron altering group; and

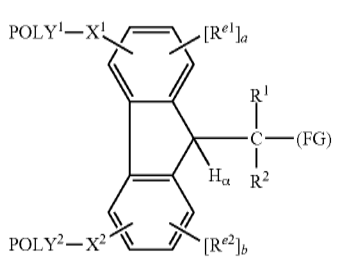
(FG) is a functional group capable of reacting with an amino group of an active agent to form a releasable linkage, such as a carbamate linkage.

Exemplary polymeric reagents fall within the following formulae:



Exemplary polymeric reagents will now be discussed in further detail. It must be remembered that while stereochemistry is not specifically shown in any formulae or structures (whether for a polymeric reagent, conjugate, or any other formula or structure), the provided formulae and structures contemplate both enantiomers, as well as compositions comprising mixtures of each enantiomer in equal amounts (i.e., a racemic mixture) and unequal amounts.

An exemplary polymeric reagent has the following structure:



wherein:

$POLY^1$ is a first water-soluble polymer;

$POLY^2$ is a second water-soluble polymer;

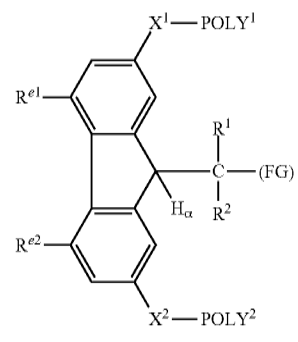
X^1 is a first spacer moiety;

X^2 is a second spacer moiety;

H_α is an ionizable hydrogen atom;

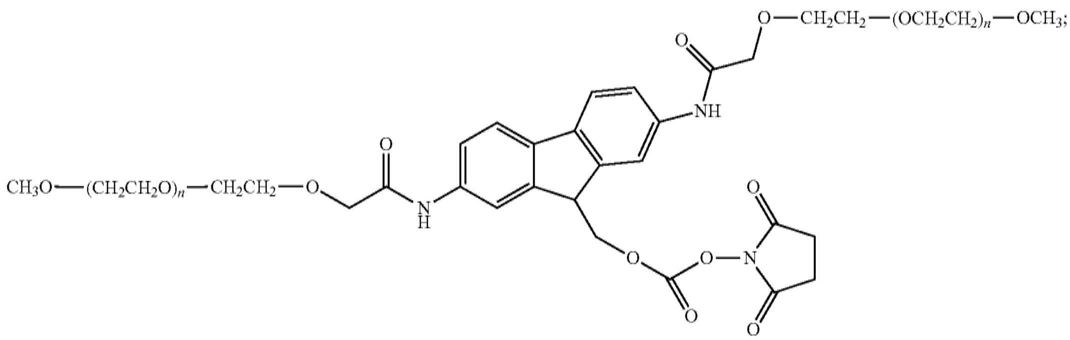
wherein, in each instance: (FG) is a functional group capable of reacting with an amino group of an active agent to form a releasable linkage, such as a carbamate linkage; R^1 is H or an organic radical; and R^2 is H or an organic radical;

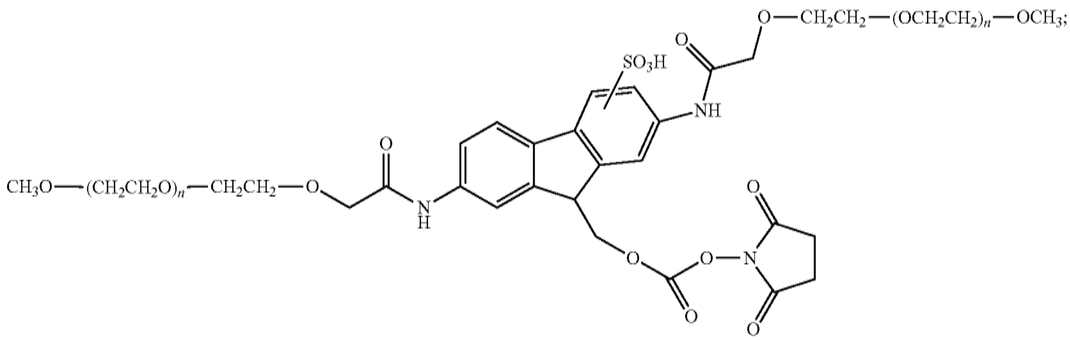
Still other exemplary polymeric reagents have the structure:

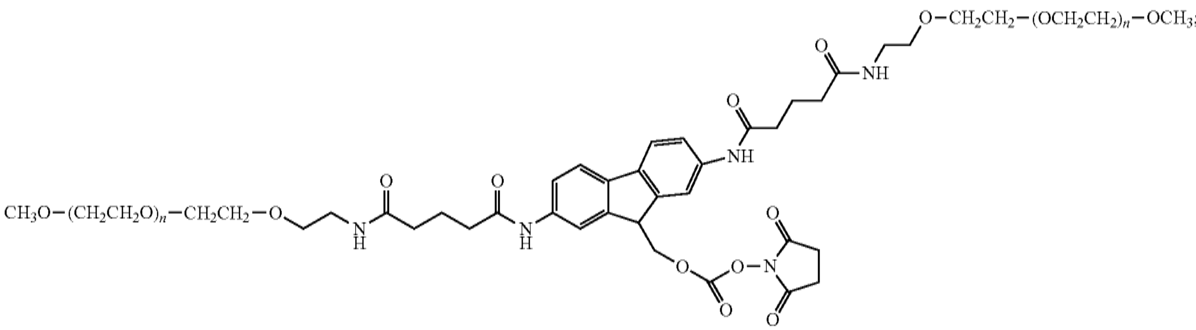


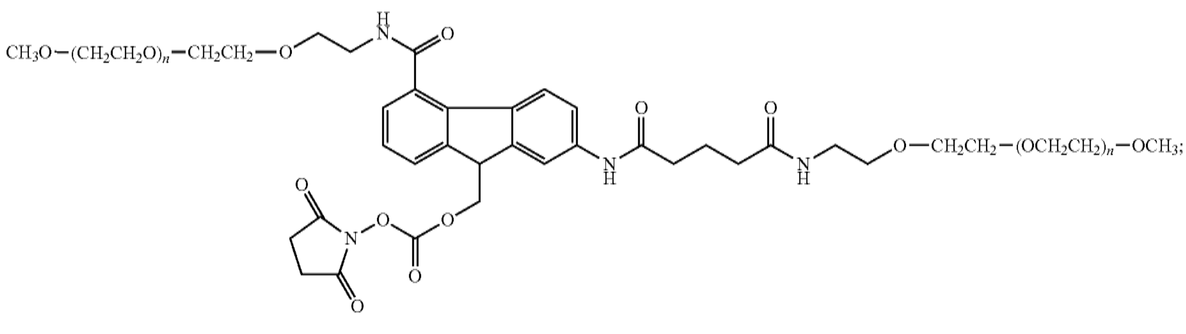
wherein each of $POLY^1$, $POLY^2$, X^1, X^2, R^1, R^2, H_α and (FG) is as previously defined, and R^{e1} is a first electron altering group; and R^{e2} is a second electron altering group.

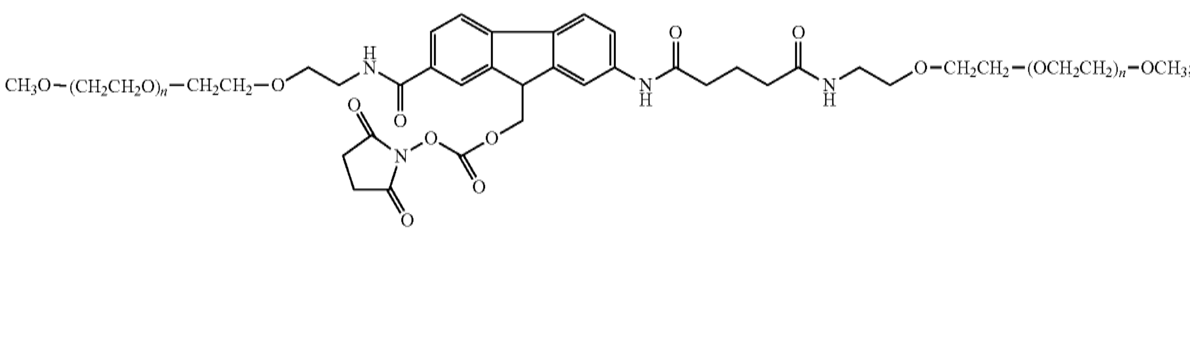
Still other exemplary polymeric reagents fall within the following structures











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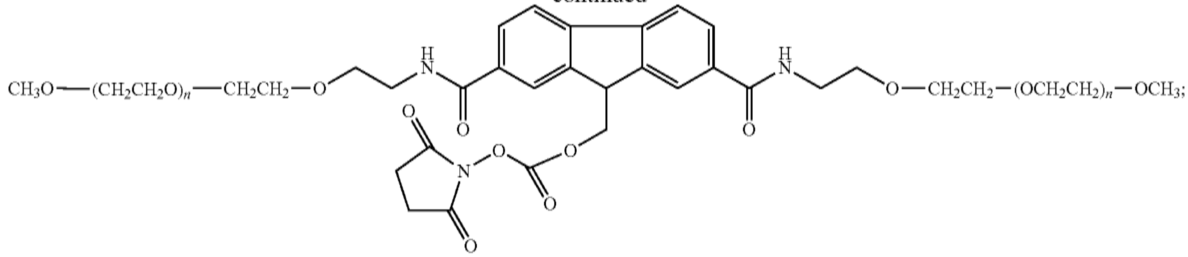
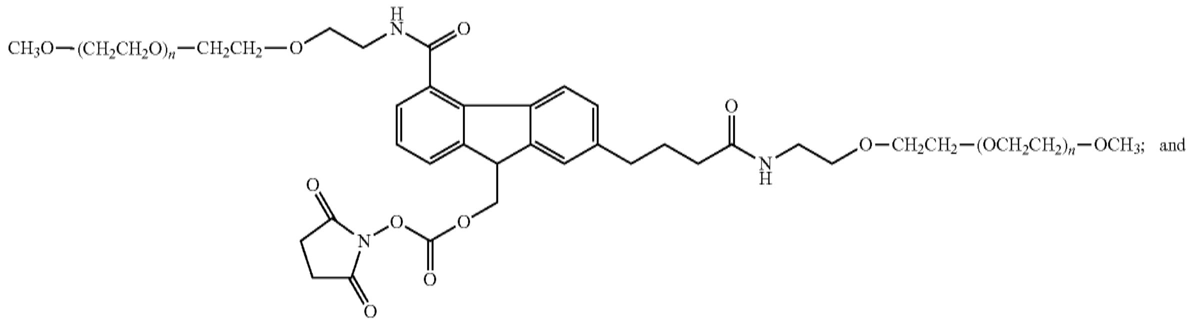
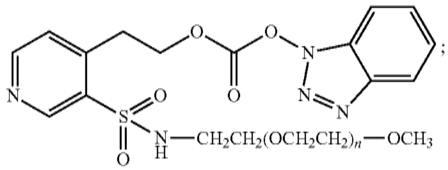




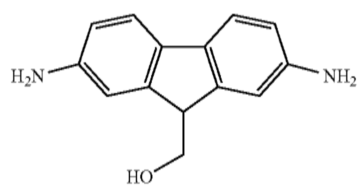


wherein, for each structure and in each instance, (n) is independently an integer from 4 to 1500.

The polymeric reagents can be prepared in any number of ways. Consequently, synthesis of the polymeric reagents is not limited to the specific technique or approach used in their preparation.

In one method for preparing a polymeric reagent useful in preparing the conjugates described herein, the method comprises: (a) providing an aromatic-containing moiety bearing a first attachment site, a second attachment site and an optional third attachment site; (b) reacting a functional group reagent with the first attachment site to result in the first attachment site bearing a functional group capable of reacting with an amino group of an active agent and result in a releasable linkage, such as a carbamate; and (c) reacting a water-soluble polymer bearing a reactive group with the second attachment site and, when present, the optional third attachment site to result in (i) the second attachment site bearing a water-soluble polymer through a spacer moiety and (ii) the optional third attachment site, when present, bearing a second water-soluble polymer through a spacer moiety. In some instances, (b) is performed before step (c) while in other instances, (c) is performed before step (b).

Thus, in this method for preparing a polymeric reagent, a required step is (a) providing an aromatic-containing moiety bearing a first attachment site, a second attachment site and an optional third attachment site. In the context of a synthetic preparation, it is understood that "providing" a material means to obtain the material (by, for example, synthesizing it or obtaining it commercially). An exemplary aromatic-containing moiety, for illustrative purposes, is 9-hydroxymethyl-2,7-diaminofluorene, as shown below.



This aromatic-containing moiety, 9-hydroxymethyl-2,7-diaminofluorene, is an example of an aromatic-containing moiety having three attachment sites: a hydroxyl group at the 9 position and amino groups at each of the 2 and 7 positions. The aromatic-containing moiety can be provided in a base or salt form. With respect to 9-hydroxymethyl-2,7-diaminofluorene, it is possible to use the dihydrochloride form. Other aromatic-containing moieties can be provided via synthetic preparation and/or purchase from a commercial supplier.

Having provided the aromatic-containing moiety, another step in the method broadly includes the step of reacting a water-soluble polymer bearing a reactive group with the attachment site(s) on the aromatic-containing moiety. Here, any art-known approach for attaching a water-soluble polymer to one or more attachment sites on the aromatic-containing moiety can be used and the method is not limited to the specific approach. For example, an amine-reactive PEG (such as an N-succinimidyl ester-terminated mPEG, formed, for example, from the reaction of N-hydroxysuccinimide and $CH_3O—CH_2CH_2—(OCH_2CH_2)—OCH_2CH_2—OCH_2COOH$ with dicyclohexyl carbodiimide (DCC) or diisopropyl carbodiimide (DIC) as a condensing agent and optionally in the presence of a base) can be reacted with an amine bearing aromatic-containing moiety such as 9-hydroxymethyl-2,7-diaminofluorene.

In some instances, reaction of the water-soluble polymer bearing a reactive group with the aromatic-containing moiety will result in all possible attachment sites having water-soluble polymer attached thereto. In such circumstances it is necessary to remove at least one water-soluble polymer so that an attachment site is made available for reaction with a functional group reagent. Thus, for example, reaction of the N-succinimidyl ester-terminated mPEG discussed in the previous paragraph with 9-hydroxymethyl-2,7-diaminofluorene results in a mixture comprising (a) a species bearing two water-soluble polymers, one at each of the two amine sites, and (b) a species bearing three water-soluble polymers, one at each of the two amine sites, and one at the hydroxyl site. Here, it is possible to remove and collect higher molecular weight species by using size-exclusion chromatography. In addition it is possible to treat the mixture to high pH [treating, for example, the mixture to lithium hydroxide (LiOH), sodium hydroxide (NaOH), potassium hydroxide (KOH)], followed by ion-exchange chromatography (IEC). In either case, the result is a composition containing mostly 9-hydroxymethyl-2,7-diaminofluorene bearing two water-soluble polymers, one at each of the two amine sites. A third hydroxyl site is thereby available for reaction with a functional group reagent.

The final step is reacting a reactive site of the aromatic-containing moiety with a functional group reagent. A preferred approach is to react the hydroxyl-containing 9-hydroxymethyl-2,7-diaminofluorene bearing two water-soluble polymers, one at each of the two amine sites with triphosgene followed by treatment with N-hydroxysuccinimide. In this way, a functional group capable of reacting with an amino group of an active agent to form a relasable linkage, such as a carbamate linkage (in this case, an "activated carbonate") is formed on the hydroxyl-containing reactive site.

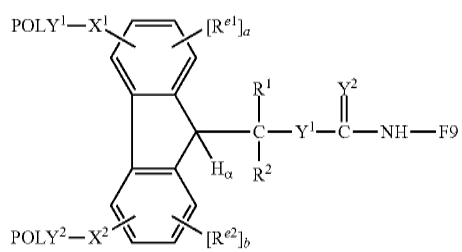
No matter which approach is used, the steps of synthetic method take place in an appropriate solvent. One of ordinary skill in the art can determine whether any specific solvent is appropriate for any given reaction. Typically, however, the solvent is preferably a nonpolar solvent or a polar aprotic solvent. Nonlimiting examples of nonpolar solvents include benzene, xylene, dioxane, tetrahydrofuran (THF), t-butyl alcohol and toluene. Particularly preferred nonpolar solvents include toluene, xylene, dioxane, tetrahydrofuran, and t-butyl alcohol. Exemplary polar aprotic solvents include, but are not limited to, DMSO (dimethyl sulfoxide), HMPA (hexamethylphosphoramide), DMF (dimethylformamide), DMA (dimethylacetamide), NMP (N-methylpyrrolidinone).

Once prepared, the polymeric reagents can be isolated. Known methods can be used to isolate the polymeric reagent, but it is particularly preferred to use chromatography, e.g., size exclusion chromatography. Alternately or in addition, the method includes the step of purifying the polymeric reagent once it is formed. Again, standard art-known purification methods can be used to purify the polymeric reagent.

The polymeric reagents are sensitive to moisture and oxygen and are ideally stored under an inert atmosphere, such as under argon or under nitrogen, and at low temperature. In this way, potentially degradative processes associated with, for example, atmospheric oxygen, are reduced or avoided entirely. In some cases, to avoid oxidative degradation, antioxidants, such as butylated hydroxyl toluene (BHT), can be added to the polymeric reagent prior to storage. In addition, it is preferred to minimize the amount of moisture associated with the storage conditions to reduce potentially damaging reactions associated with water, e.g., hydrolysis of the active ester. Moreover, it is preferred to keep the storage conditions dark in order to prevent certain degradative processes that involve light. Thus, preferred storage conditions include one or more of the following: storage under dry argon or another dry inert gas; storage at temperatures below about −15° C.; storage in the absence of light; and storage with a suitable amount (e.g., about 50 to about 500 parts per million) of an antioxidant such as BHT.

The above-described polymeric reagents are useful for conjugation to biologically active agents. For example, an amino group (e.g., primary amine) on an active agent will react with the functional group capable of reacting with an amino group of an active agent to form a releasable, such as a carbamate linkage.

Exemplary conjugates have the following structure:



wherein:

POLY^1 is a first water-soluble polymer;

POLY^2 is a second water-soluble polymer;

X^1 is a first spacer moiety;

X^2 is a second spacer moiety;

H$_\alpha$ is an ionizable hydrogen atom;

R^1 is H or an organic radical;

R^2 is H or an organic radical;

(a) is either zero or one;

(b) is either zero or one;

R^{e1}, when present, is a first electron altering group;

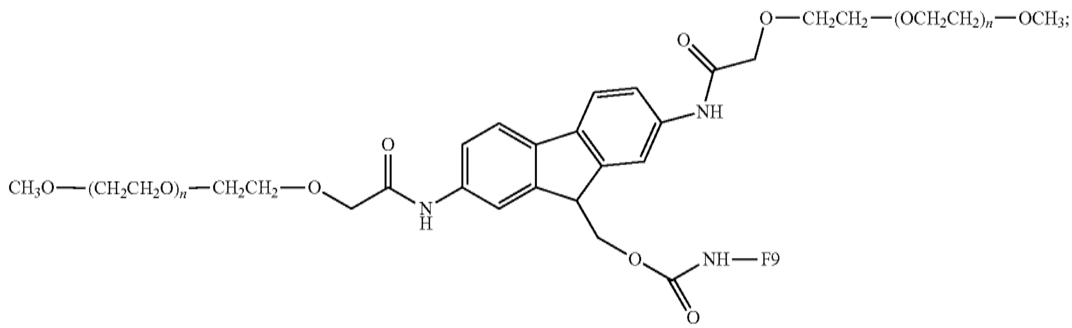
R^{e2}, when present, is a second electron altering group;

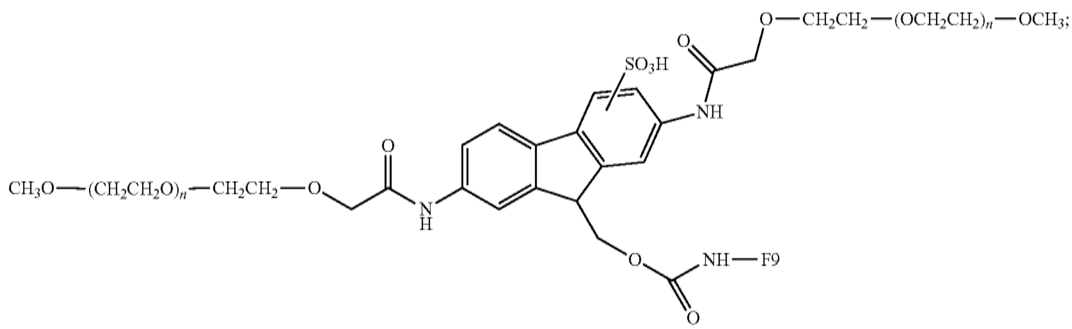
Y^1 is O or S;

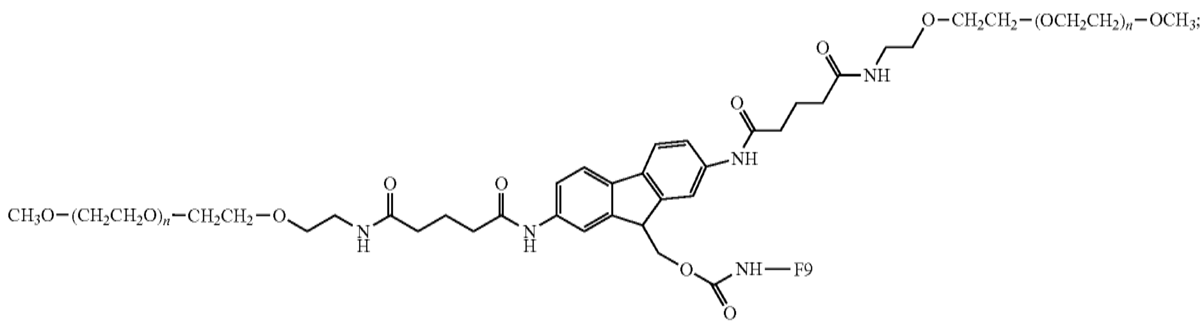
Y^2 is O or S; and

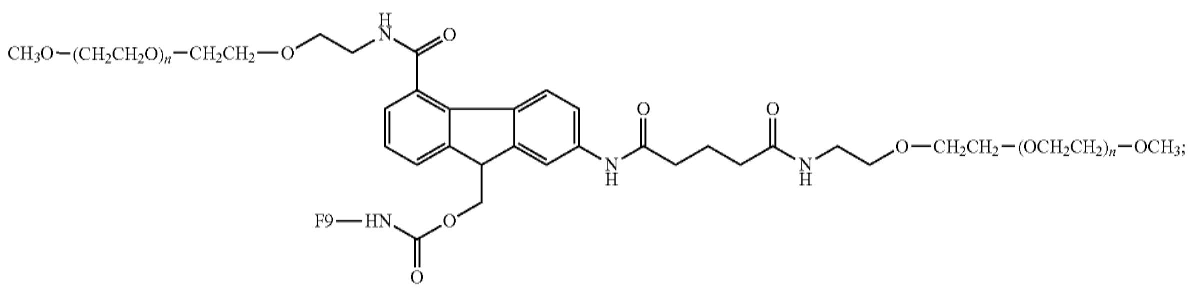
F9 is a residue of an amine-containing Factor IX moiety.

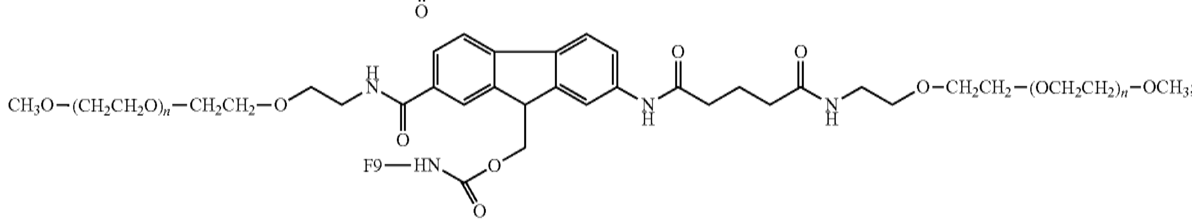
Exemplary conjugates include those of the following formulae:

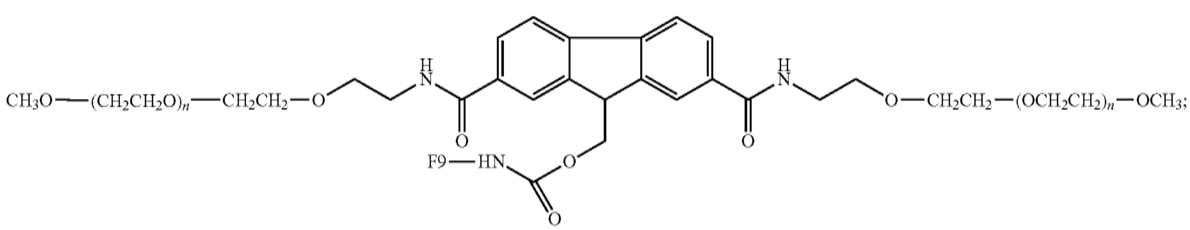












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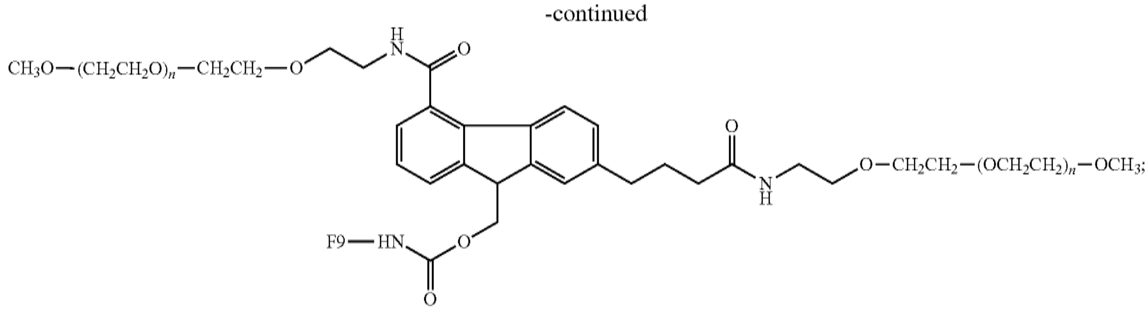
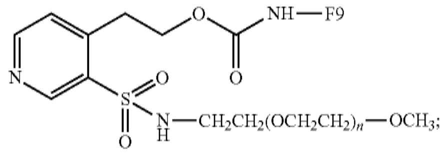


and



wherein, for each structure and in each instance, (n) is independently an integer from 4 to 1500, and F9 is a residue of an amine-containing Factor IX moiety.

The biologically active agent to which a polymeric reagent as described herein can be conjugated, is an amine-containing biologically active agent. Typically, the biologically active agent will be a macromolecule, such as a polypeptide, having a molecular weight greater than about 3,500 Daltons. Pharmacologically active polypeptides represent a preferred type of biologically active agent. It should be understood that for purposes of the present discussion, the term "polypeptide" will be generic for oligopeptides and proteins. With regard to polypeptides, the amine to which the polymeric reagent couples to can be on the N-terminus or an amine-containing side chain of an amino acid (such as lysine) within the polypeptide.

The invention also provides for a method of preparing a conjugate comprising the step of contacting a polymeric reagent with a biologically active agent under conditions suitable to form a covalent attachment between the polymer and the biologically active agent. Typically, the polymer is added to the active agent or surface at an equimolar amount (with respect to the desired number of groups suitable for reaction with the reactive group) or at a molar excess. For example, the polymeric reagent can be added to the target active agent at a molar ratio of about 1:1 (polymeric reagent: active agent), 1.5:1, 2:1, 3:1, 4:1, 5:1, 6:1, 8:1, or 10:1. The conjugation reaction is allowed to proceed until substantially no further conjugation occurs, which can generally be determined by monitoring the progress of the reaction over time. Progress of the reaction can be monitored by withdrawing aliquots from the reaction mixture at various time points and analyzing the reaction mixture by SDS-PAGE or MALDI-TOF mass spectrometry or any other suitable analytical method. Once a plateau is reached with respect to the amount of conjugate formed or the amount of unconjugated polymer remaining, the reaction is assumed to be complete. Typically, the conjugation reaction takes anywhere from minutes to several hours (e.g., from 5 minutes to 24 hours or more). The resulting product mixture is preferably, but not necessarily, purified to separate out excess reagents, unconjugated reactants (e.g., active agent) undesired multi-conjugated species, and free or unreacted polymer. The resulting conjugates can then be further characterized using analytical methods such as MALDI, capillary electrophoresis, gel electrophoresis, and/or chromatography.

With respect to polymer-active agent conjugates, the conjugates can be purified to obtain/isolate different conjugated species. Alternatively, and more preferably for lower molecular weight (e.g., less than about 20 kiloDaltons, more preferably less than about 10 kiloDaltons) polymers, the product mixture can be purified to obtain the distribution of water-soluble polymer segments per active agent. For example, the product mixture can be purified to obtain an average of anywhere from one to five PEGs per active agent (e.g., polypeptide). The strategy for purification of the final conjugate reaction mixture will depend upon a number of factors, including, for example, the molecular weight of the polymer employed, the particular active agent, the desired dosing regimen, and the residual activity and in vivo properties of the individual conjugate(s).

If desired, conjugates having different molecular weights can be isolated using gel filtration chromatography. That is to say, gel filtration chromatography is used to fractionate differently numbered polymer-to-active agent ratios (e.g., 1-mer, 2-mer, 3-mer, and so forth, wherein "1-mer" indicates 1 polymer to active agent, "2-mer" indicates two polymers to active agent, and so on) on the basis of their differing molecular weights (where the difference corresponds essentially to the average molecular weight of the water-soluble polymer segments). For example, in an exemplary reaction where a 100 kDa protein is randomly conjugated to a polymeric reagent having a molecular weight of about 20 kDa, the resulting reaction mixture will likely contain unmodified protein (MW 100 kDa), mono-PEGylated protein (MW 120 kDa), di-PEGylated protein (MW 140 kDa), and so forth. While this approach can be used to separate PEG and other polymer conjugates having different molecular weights, this approach is generally ineffective for separating positional isomers having different polymer attachment sites within the protein. For example, gel filtration chromatography can be used to separate from each other mixtures of PEG 1-mers, 2-mers, 3-mers, and so forth, although each of the recovered PEG-mer compositions may contain PEGs attached to different reactive amino groups (e.g., lysine residues) within the active agent.

Gel filtration columns suitable for carrying out this type of separation include Superdex™ and Sephadex™ columns available from Amersham Biosciences (Piscataway, N.J.). Selection of a particular column will depend upon the desired fractionation range desired. Elution is generally carried out using a suitable buffer, such as phosphate, acetate, or the like. The collected fractions may be analyzed by a number of different methods, for example, (i) optical density (OD) at 280 nm for protein content, (ii) bovine serum albumin (BSA) protein analysis, (iii) iodine testing for PEG content [Sims et al. (1980) *Anal. Biochem,* 107:60-63], and (iv) sodium dodecyl sulfate polyacrylamide gel electrophoresis (SDS PAGE), followed by staining with barium iodide.

Separation of positional isomers is carried out by reverse phase chromatography using a reverse phase-high performance liquid chromatography (RP-HPLC) C18 column (Amersham Biosciences or Vydac) or by ion exchange chromatography using an ion exchange column, e.g., a Sepharose™ ion exchange column available from Amersham Biosciences. Either approach can be used to separate polymer-active agent isomers having the same molecular weight (positional isomers).

With respect to the Factor IX moiety, the Factor IX moiety useful for the present invention includes any protein that has the same activity (although not necessarily the same degree of activity) as native, human Factor IX.

As previously stated, the term "Factor IX moiety" shall include the Factor IX moiety prior to conjugation as well as to the Factor IX moiety following attachment to a water-soluble polymer. It is understood, however, that when the Factor IX moiety is attached to a nonpeptidic water-soluble polymer, the Factor IX moiety is slightly altered due to the presence of one or more covalent bonds associated with linkage to the polymer (or spacer moiety that is attached to the polymer). Often, this slightly altered form of the Factor IX moiety attached to another molecule is referred to a "residue" of the Factor IX moiety.

The Factor IX moiety can be derived from either non-recombinant methods or from recombinant methods and the invention is not limited in this regard. In addition, the Factor IX moiety can be derived from human sources or from animal sources.

The Factor IX moiety can be derived non-recombinantly. For example, the Factor IX moiety can be obtained from blood-derived sources. In particular, Factor IX can be fractionated from human plasma using precipitation and centrifugation techniques known to those of ordinary skill in the art. See, for example, Wickerhauser (1976) *Transfusion* 16(4): 345-350 and Slichter et al. (1976) *Transfusion* 16(6):616-626. Factor IX can also be isolated from human granulocytes. See Szmitkoski et al. (1977) *Haematologia* (*Budap.*) 11(1-2):177-187.

The Factor IX moiety can be derived from recombinant methods. For example, the cDNA coding for native Factor IX, which is a Factor IX moiety, has been isolated, characterized, and cloned into expression vectors. See, e.g., Choo et al. (1982) "Molecular Cloning of the Gene for Human Anti-hemophilic Factor IX," Nature, Vol. 299: 178-180, and Kurachi et al. (1982) "Isolation and Characterization of a cDNA Coding for Human Factor IX," Proc. Natl. Acad. Sci. U.S.A., Vol. 79: 6461-65.

Once expressed, native Factor IX is a single chain glycoprotein of about 55,000 Daltons. It can structurally be considered as having four domains: the Gla or gamma carboxyglutamate-rich domain; the EGF-like regions; the activation peptide; and the active site.

With respect to the Factor IX moieties moieties, biologically active fragments, deletion variants, substitution variants or addition variants of any of the foregoing that maintain at least some degree of the desired Factor IX activity can also be used.

The active agent can advantageously be modified to include one or more amino acid residues such as, for example, lysine, cysteine and/or arginine, in order to provide facile attachment of the polymer to an atom within the side chain of the amino acid. Techniques for adding amino acid residues are well known to those of ordinary skill in the art. Reference is made to J. March, Advanced Organic Chemistry: Reactions Mechanisms and Structure, 4th Ed. (New York: Wiley-Interscience, 1992).

The active agent can be obtained from blood-derived sources. For example, Factor VIII can be fractionated from human plasma using precipitation and centrifugation techniques known to those of ordinary skill in the art. See, for example, Wickerhauser (1976) *Transfusion* 16(4):345-350 and Slichter et al. (1976) *Transfusion* 16(6):616-626. Factor VIII can also be isolated from human granulocytes. See Szmitkoski et al. (1977) *Haematologia* (*Budap.*) 11(1-2): 177-187.

In addition, the active agent can also be obtained from recombinant methods. Briefly, recombinant methods involve constructing the nucleic acid encoding the desired polypeptide or fragment, cloning the nucleic acid into an expression vector, transforming a host cell (e.g., bacteria, yeast, or mammalian cell such as Chinese hamster ovary cell or baby hamster kidney cell), and expressing the nucleic acid to produce the desired polypeptide or fragment. Methods for producing and expressing recombinant polypeptides in vitro and in prokaryotic and eukaryotic host cells are known to those of ordinary skill in the art. See, for example, U.S. Pat. No. 4,868,122.

The above exemplary biologically active agents are meant to encompass, where applicable, analogues, agonists, antagonists, inhibitors, isomers, and pharmaceutically acceptable salt forms thereof. In reference to peptides and proteins, the invention is intended to encompass synthetic, recombinant, native, glycosylated, and non-glycosylated forms, as well as biologically active fragments thereof. In addition, the term "active agent" is intended to encompass the active agent prior to conjugation as well as the active agent "residue" following conjugation.

For any given moiety, it is possible to determine whether that moiety has Factor IX activity. For example, several animal lines have been intentionally bred with the genetic mutation for hemophilia such that an animal produced from such a line has very low and insufficient levels of Factor IX. Such lines are available from a variety of sources such as, without limitation, the Division of Laboratories and Research, New York Department of Public Health, Albany, N.Y. and the Department of Pathology, University of North Carolina, Chapel Hill, N.C. Both of these sources, for example, provide canines suffering from canine hemophilia B. In order to test the Factor IX activity of any given moiety in question, the moiety is injected into the diseased animal, a small cut made and bleeding time compared to an treated diseased animal as a control. Another method useful for determining Factor IX activity is to determine cofactor and procoagulant activity. See, for example, Mertens et al. (1994) *Brit. J. Haematol.* 85:133-42. Other methods known to those of ordinary skill in the art can also be used to determine whether a given moiety has Factor IX activity. Such methods are useful for determining the Factor IX activity of both a proposed Factor IX moiety as well as the corresponding polymer-Factor IX moiety conjugate.

The present invention also includes pharmaceutical preparations comprising a conjugate as provided herein in combination with a pharmaceutical excipient. Generally, the conjugate itself will be in a solid form (e.g., a precipitate), which can be combined with a suitable pharmaceutical excipient that can be in either solid or liquid form.

Exemplary excipients include, without limitation, those selected from the group consisting of carbohydrates, inorganic salts, antimicrobial agents, antioxidants, surfactants, buffers, acids, bases, and combinations thereof.

A carbohydrate such as a sugar, a derivatized sugar such as an alditol, aldonic acid, an esterified sugar, and/or a sugar polymer may be present as an excipient. Specific carbohydrate excipients include, for example: monosaccharides, such as fructose, maltose, galactose, glucose, D-mannose, sorbose, and the like; disaccharides, such as lactose, sucrose, trehalose, cellobiose, and the like; polysaccharides, such as raffinose, melezitose, maltodextrins, dextrans, starches, and the like; and alditols, such as mannitol, xylitol, maltitol, lactitol, xylitol, sorbitol (glucitol), pyranosyl sorbitol, myoinositol, and the like.

The excipient can also include an inorganic salt or buffer such as citric acid, sodium chloride, potassium chloride, sodium sulfate, potassium nitrate, sodium phosphate monobasic, sodium phosphate dibasic, and combinations thereof.

The preparation may also include an antimicrobial agent for preventing or deterring microbial growth. Nonlimiting examples of antimicrobial agents suitable for the present invention include benzalkonium chloride, benzethonium chloride, benzyl alcohol, cetylpyridinium chloride, chlorobutanol, phenol, phenylethyl alcohol, phenylmercuric nitrate, thimersol, and combinations thereof.

An antioxidant can be present in the preparation as well. Antioxidants are used to prevent oxidation, thereby preventing the deterioration of the conjugate or other components of the preparation. Suitable antioxidants for use in the present invention include, for example, ascorbyl palmitate, butylated hydroxyanisole, butylated hydroxytoluene, hypophosphorous acid, monothioglycerol, propyl gallate, sodium bisulfite, sodium formaldehyde sulfoxylate, sodium metabisulfite, and combinations thereof.

A surfactant may be present as an excipient. Exemplary surfactants include: polysorbates, such as "Tween 20" and "Tween 80," and pluronics such as F68 and F88 (both of which are available from BASF, Mount Olive, N.J.); sorbitan esters; lipids, such as phospholipids such as lecithin and other phosphatidylcholines, phosphatidylethanolamines (although preferably not in liposomal form), fatty acids and fatty esters; steroids, such as cholesterol; and chelating agents, such as EDTA, zinc and other such suitable cations.

Acids or bases may be present as an excipient in the preparation. Nonlimiting examples of acids that can be used include those acids selected from the group consisting of hydrochloric acid, acetic acid, phosphoric acid, citric acid, malic acid, lactic acid, formic acid, trichloroacetic acid, nitric acid, perchloric acid, phosphoric acid, sulfuric acid, fumaric acid, and combinations thereof. Examples of suitable bases include, without limitation, bases selected from the group consisting of sodium hydroxide, sodium acetate, ammonium hydroxide, potassium hydroxide, ammonium acetate, potassium acetate, sodium phosphate, potassium phosphate, sodium citrate, sodium formate, sodium sulfate, potassium sulfate, potassium fumerate, and combinations thereof.

The pharmaceutical preparations encompass all types of formulations and in particular those that are suited for injection, e.g., powders that can be reconstituted as well as suspensions and solutions. The amount of the conjugate (i.e., the conjugate formed between the active agent and the polymer described herein) in the composition will vary depending on a number of factors, but will optimally be a therapeutically effective dose when the composition is stored in a unit dose container (e.g., a vial). In addition, the pharmaceutical preparation can be housed in a syringe. A therapeutically effective dose can be determined experimentally by repeated administration of increasing amounts of the conjugate in order to determine which amount produces a clinically desired endpoint.

The amount of any individual excipient in the composition will vary depending on the activity of the excipient and particular needs of the composition. Typically, the optimal amount of any individual excipient is determined through routine experimentation, i.e., by preparing compositions containing varying amounts of the excipient (ranging from low to high), examining the stability and other parameters, and then determining the range at which optimal performance is attained with no significant adverse effects.

Generally, however, the excipient will be present in the composition in an amount of about 1% to about 99% by weight, preferably from about 5%-98% by weight, more preferably from about 15-95% by weight of the excipient, with concentrations less than 30% by weight most preferred.

These foregoing pharmaceutical excipients along with other excipients are described in "Remington: The Science & Practice of Pharmacy", 19^{th} ed., Williams & Williams, (1995), the "Physician's Desk Reference", 5^{nd} ed., Medical Economics, Montvale, N.J. (1998), and Kibbe, A. H., Handbook of Pharmaceutical Excipients, 3^{rd} Edition, American Pharmaceutical Association, Washington, D.C., 2000.

The pharmaceutical preparations of the present invention are typically, although not necessarily, administered via injection and are therefore generally liquid solutions or suspensions immediately prior to administration. The pharmaceutical preparation can also take other forms such as syrups, creams, ointments, tablets, powders, and the like. Other modes of administration are also included, such as pulmonary, rectal, transdermal, transmucosal, oral, intrathecal, subcutaneous, intra-arterial, and so forth.

As previously described, the conjugates can be administered parenterally by intravenous injection, or less preferably by intramuscular or by subcutaneous injection. Suitable formulation types for parenteral administration include ready-for-injection solutions, dry powders for combination with a solvent prior to use, suspensions ready for injection, dry insoluble compositions for combination with a vehicle prior to use, and emulsions and liquid concentrates for dilution prior to administration, among others.

The invention also provides a method for administering a conjugate as provided herein to a patient suffering from a condition that is responsive to treatment with conjugate. The method comprises administering, generally via injection, a therapeutically effective amount of the conjugate (preferably provided as part of a pharmaceutical preparation). The method of administering may be used to treat any condition that can be remedied or prevented by administration of the particular conjugate. Those of ordinary skill in the art appreciate which conditions a specific conjugate can effectively treat. The actual dose to be administered will vary depend upon the age, weight, and general condition of the subject as well as the severity of the condition being treated, the judgment of the health care professional, and conjugate being administered. Therapeutically effective amounts are known to those skilled in the art and/or are described in the pertinent reference texts and literature. Generally, a therapeutically effective amount will range from about 0.001 mg to 100 mg, preferably in doses from 0.01 mg/day to 75 mg/day, and more preferably in doses from 0.10 mg/day to 50 mg/day.

The unit dosage of any given conjugate (again, preferably provided as part of a pharmaceutical preparation) can be administered in a variety of dosing schedules depending on the judgment of the clinician, needs of the patient, and so forth. The specific dosing schedule will be known by those of ordinary skill in the art or can be determined experimentally using routine methods. Exemplary dosing schedules include, without limitation, administration five times a day, four times a day, three times a day, twice daily, once daily, three times weekly, twice weekly, once weekly, twice monthly, once monthly, and any combination thereof. Once the clinical endpoint has been achieved, dosing of the composition is halted.

It is to be understood that while the invention has been described in conjunction with the preferred specific embodiments thereof, that the foregoing description as well as the experimental that follow are intended to illustrate and not limit the scope of the invention. Other aspects, advantages and modifications within the scope of the invention will be apparent to those skilled in the art to which the invention pertains.

All articles, books, patents, patent publications and other publications referenced herein are hereby incorporated by reference in their entireties.

EXPERIMENTAL

The practice of the invention will employ, unless otherwise indicated, conventional techniques of organic synthesis and the like, which are understood by one of ordinary skill in the art and are explained in the literature. In the following examples, efforts have been made to ensure accuracy with respect to numbers used (e.g., amounts, temperatures, and so forth), but some experimental error and deviation should be accounted for. Unless otherwise indicated, temperature is in degrees Celsius and pressure is at or near atmospheric pressure at sea level. All reagents were obtained commercially unless otherwise indicated. All generated NMR was obtained from a 300 or 400 MHz NMR spectrometer manufactured by Bruker (Billerica, Mass.). All processing is carried out in glass or glass-lined vessels and contact with metal-containing vessels or equipment is avoided.

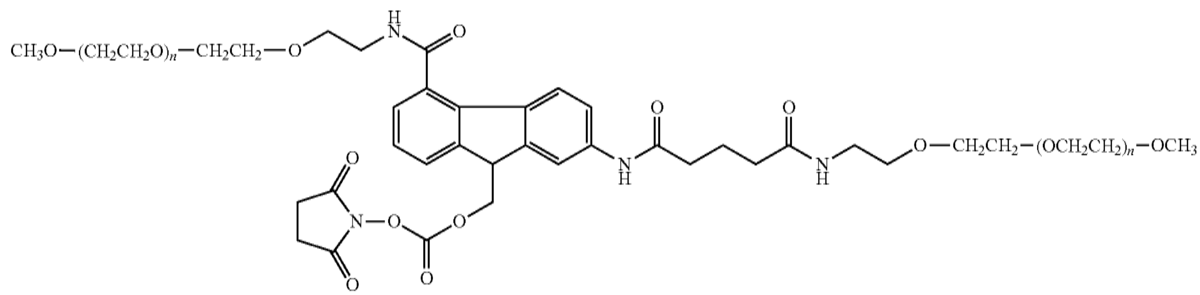
The following abbreviations will be used.

HPLC high pressure liquid chromatography

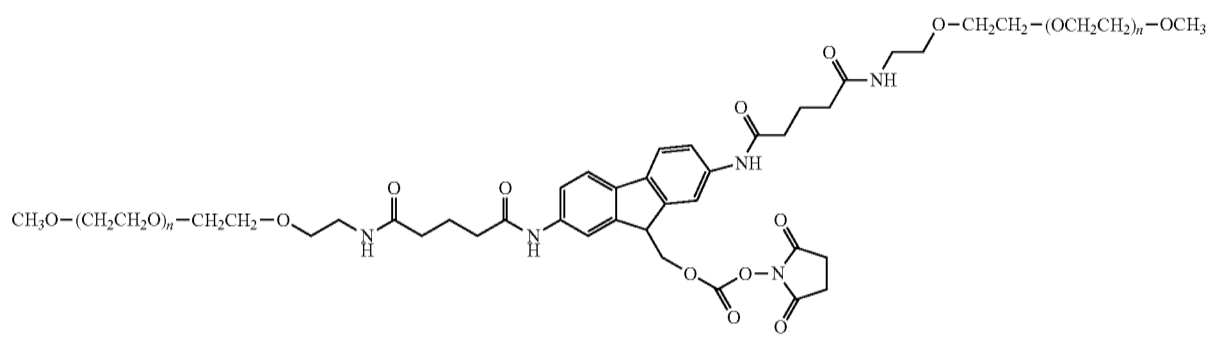
SDS-PAGE sodium dodecylsulfate polyacrylamide gel electrophoresis

The Factor IX used in the following examples is isolated from the commercially available preparation marketed under the BENEFIX® brand of recombinant Factor IX (Wyeth, Madison N.J.). The isolated protein solution is stored at reduced temperatures.

Polymeric reagents were made in accordance with the basic approaches described in U.S. Patent Application Publication No. 2006/0293499 and had the following structures:



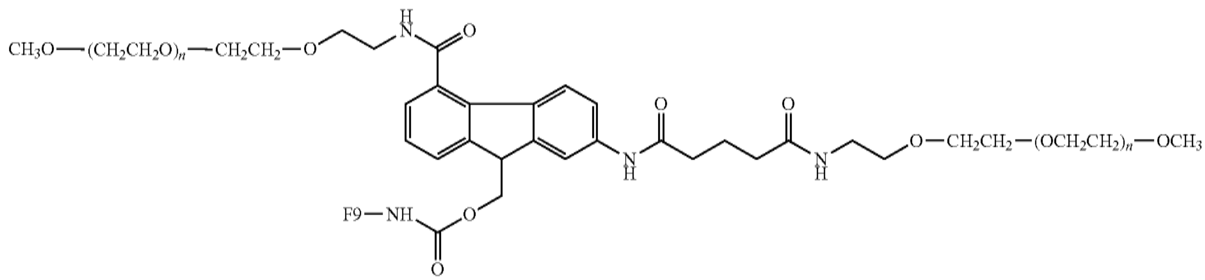
"polymeric reagent A"



"polymeric reagent B"

Example 1

Preparation of Factor IX Conjugate (20,000 Da Total Polymer Weight Average Molecular Weight) ("Short Release")



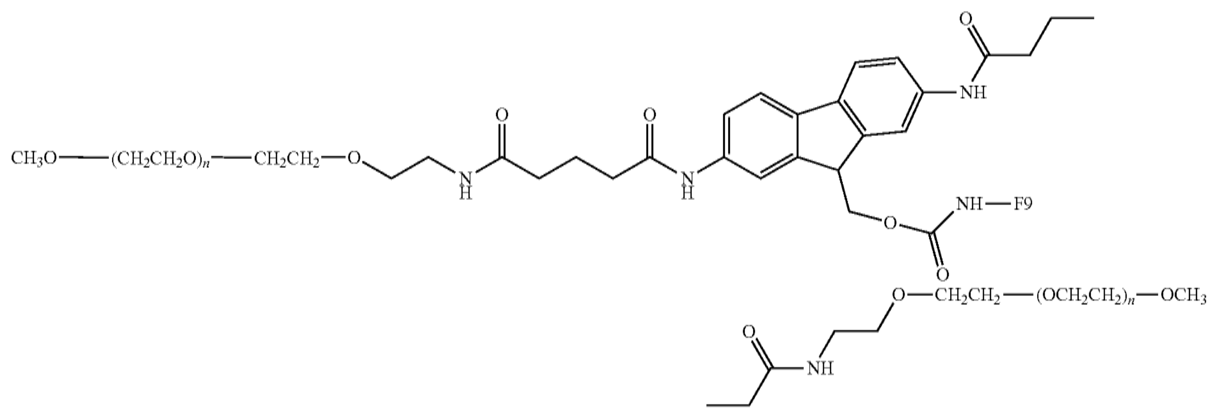
(wherein F9 is a residue of Factor IX)

A vial of Benefix® Factor IX (5.5 mg Factor IX, Wyeth) was removed from 4° C. storage and was allowed to warm to room temperature. The lyophilized powder was resuspended as described in the package insert (10 mL of sterile water per vial). While the Factor IX solution was resolublizing on a rocker plate, polymeric reagent A was removed from −20° C. storage and warmed to room temperature. The Benefix® resuspended liquid was buffer exchanged into 1×PBS+1% Sucrose+0.005% Tween 20 pH 7.3 using a 16/10 HiPrep DeSalt column from GE to remove the glycine in the formulation. The protein fractions were collected and pooled into 50 mL conical tubes for the polymer reagent conjugation reaction. A 9.34 excess molar ratio (relative to Factor IX) of polymeric reagent A having a total polymer weight average molecular weight (i.e., the sum of the weight average molecular weight of each polymer "arm") of about 40,000 Da, which was freshly dissolved in 2 mM HCl, was slowly pipetted into the Factor IX solution. A stir bar was added to the reaction and the solution was stirred on low speed for the three hour conjugation process. The reaction was then quenched by the 1:100 addition of 1 M glycine in water, which was allowed to shake gently on a shaker at room temperature for another 30 minutes. It is believed that addition of the glycine should occur within 24 hours. The solution was diluted by a 3:1 (volume) addition of 20 15 mM Bis-Tris pH 7.5+1% Sucrose+10 mM Histidine+0.005% Tween 20. The solution was mixed well by gentle swirling, and the unbound polymeric reagent A in the solution was then removed by ion exchange chromatography. The conjugated Factor IX was eluted by a NaCl gradient. A "short release" Factor IX conjugate was thereby prepared.

The basic procedure was repeated except that polymeric reagent A having a total polymer weight average molecular weight of about 40,000 Da and 640.64 mg of the polymeric reagent was used.

Example 2

Preparation of Factor IX Conjugate (20,000 Da Total Polymer Weight Average Molecular Weight) ("Long Release")



(wherein F9 is a residue of Factor IX)

A vial of Benefix® Factor IX (5.5 mg Factor IX, Wyeth) was removed from 4° C. storage and was allowed to warm to room temperature. The lyophilized powder was resuspended as described in the package insert (10 mL of sterile water per vial). While the Factor IX solution was resolublizing on a rocker plate, the polymeric reagent B was removed from −20° C. storage and warmed to room temperature. The Benefix® resuspended liquid was buffer exchanged into 1×PBS+1% Sucrose+0.005% Tween 20 pH 7.3 using a 16/10 HiPrep DeSalt column from GE to remove the glycine in the formulation. The protein fractions were collected and pooled into 50 mL conical tubes for the polymer reagent conjugation reaction. A 9.34 excess molar ratio (relative to Factor IX) of polymeric reagent B having a total polymer weight average molecular weight (i.e., the sum of the weight average molecular weight of each polymer "arm") of about 40,000 Da, which was freshly dissolved in 2 mM HCl, was slowly pipetted into the Factor IX solution. A stir bar was added to the reaction and the solution was stirred on low speed for the three hour conjugation process. The reaction was then quenched by the 1:100 addition of 1 M glycine in water, which was allowed to shake gently on a shaker at room temperature for another 30 minutes. It is believed that addition of the glycine should occur within 24 hours. The solution was diluted by a 3:1 (volume) addition of 20 15 mM Bis-Tris pH 7.5+1% Sucrose+10 mM Histidine+0.005% Tween 20. The solution was mixed well by gentle swirling, and the unbound polymeric reagent B in the solution was then removed by ion exchange chromatography. The conjugated Factor IX was eluted by a NaCl gradient. A "long release" Factor IX conjugate was thereby prepared.

The basic procedure was repeated except that polymeric reagent B having a total polymer weight average molecular weight of about 40,000 Da and 400.4 mg of the polymeric reagent were used.

Example 3

Pharmacokinetics

The pharmacokinetics of conjugates prepared in accordance with Examples 1 and 2, each have a total polymer weight average molecular weight of 20,000 Da (along with Factor IX as a control) were determined using conventional techniques. Briefly, male SD rats were used (180-220 grams; 6-7 weeks old) and given one 100 μL iv injection. Four animals per group were used and blood plasma collected at various time points (e.g., 0, 1, 2, 3, 6, 12, 24, 36, 48, 72 hours) following injection.

The results are provided in Table 1 below, wherein V is volume of distribution, CL is total plasma clearance, AUC is area under the plasma concentration-time curve, and $T_{1/2}$ beta is the half-life of the terminal elimination phase. A concentration-time curve was also prepared and is provided as FIG. **1**.

TABLE 1

Conjugate Pharmacokinetics Values

Dose (ug/kg)	Treatment	V (mL/kg)	CL (mL/hr/kg)	AUC (ng/mL*hr/kg)	$T_{1/2}$ beta (hr)
500	Factor IX	183.9	59.3	8431.5	2.4
500	Factor IX - "short release"	76.7	11.8	42489.8	8.9
500	Factor IX - "long release"	44.2	2.9	170391.3	21.2
	Ratios				
	Factor IX - "short release"/Factor IX	0.42	0.20	5.04	3.77
	Factor IX - "long release"/Factor IX	0.24	0.05	20.21	8.98

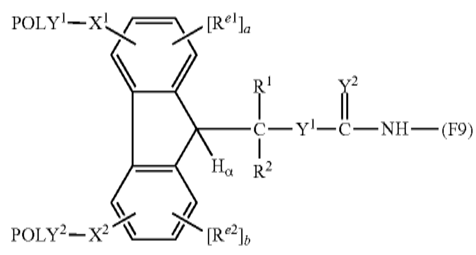
Example 4

Coagulation Activity

The in vitro coagulation activities of conjugates prepared in accordance with Examples 1 and 2, each have a total polymer weight average molecular weight of 20,000 Da (along with Factor IX as a control) were determined using conventional techniques. Results are provided in FIG. **2**.

What is claimed is:

1. A compound having the following structure:



wherein:

$POLY^1$ is a first water-soluble polymer;

$POLY^2$ is a second water-soluble polymer;

X^1 is a first spacer moiety;

X^2 is a second spacer moiety;

H_α is an ionizable hydrogen atom;

R^1 is H or an organic radical;

R^2 is H or an organic radical;

(a) is either zero or one;

(b) is either zero or one;

R^{e1}, when present, is a first electron altering group;

R^{e2}, when present, is a second electron altering group;

Y^1 is O or S;

Y^2 is O or S; and

(F9) is a residue of an amine-containing Factor IX moiety.

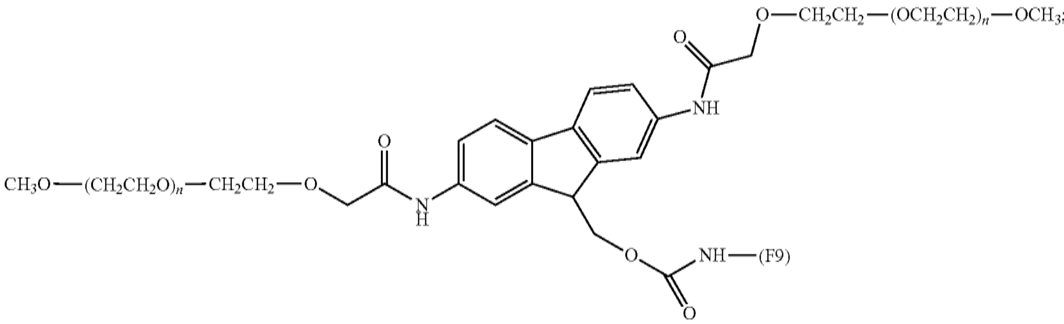
2. The compound of claim **1**, wherein the amine-containing Factor IX moiety is recombinant Factor IX.

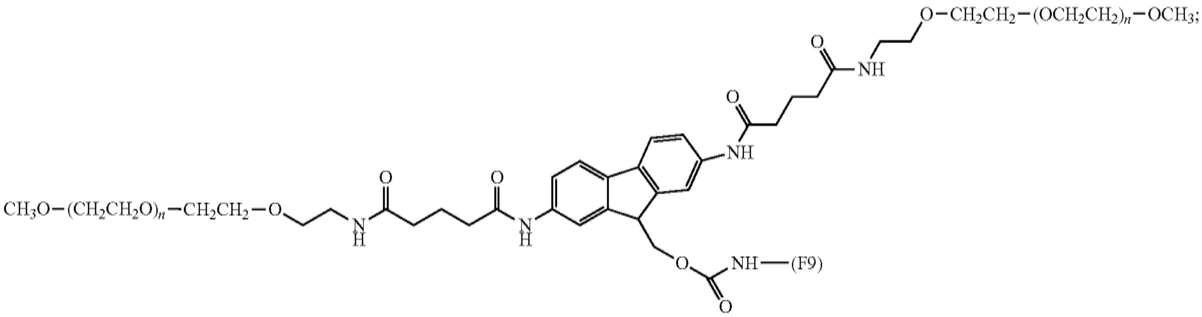
3. The compound of claim **2**, wherein the recombinant Factor IX is human recombinant Factor IX.

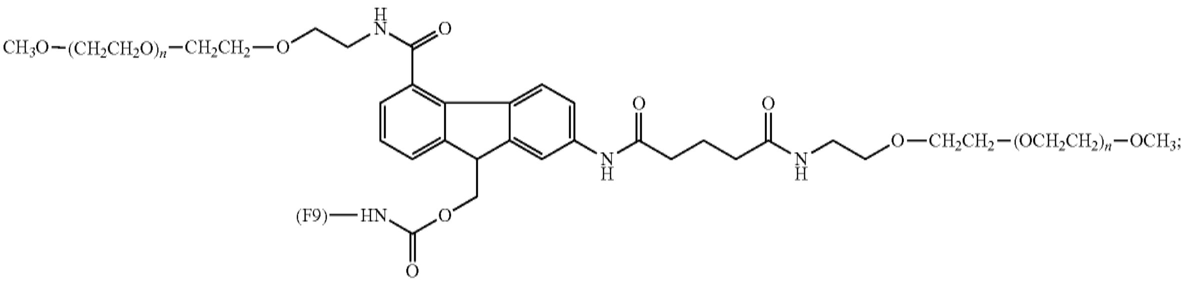
4. The compound of claim **1**, wherein the first water-soluble polymer is a poly(alkylene oxide) and the second water-soluble polymer is a poly(alkylene oxide).

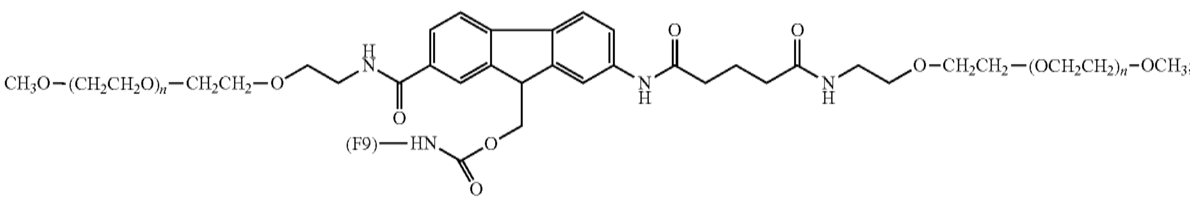
5. The compound of claim **1**, wherein the first water-soluble polymer has a weight-average molecular weight of between 10,000 Daltons to 85,000 Daltons and the second water-soluble polymer has a weight-average molecular weight of between 10,000 Daltons to 85,000 Daltons.

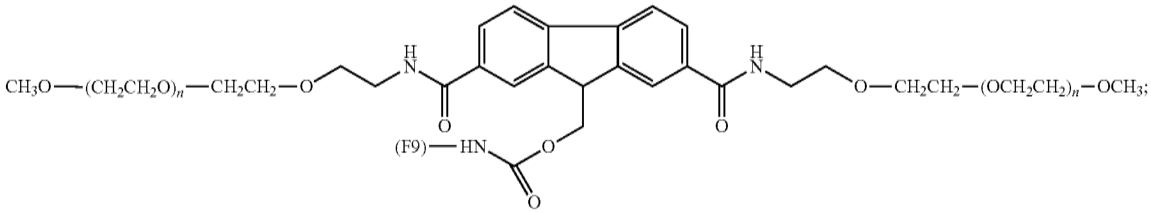
6. The compound of claim **1**, having a structure selected from the group consisting of:



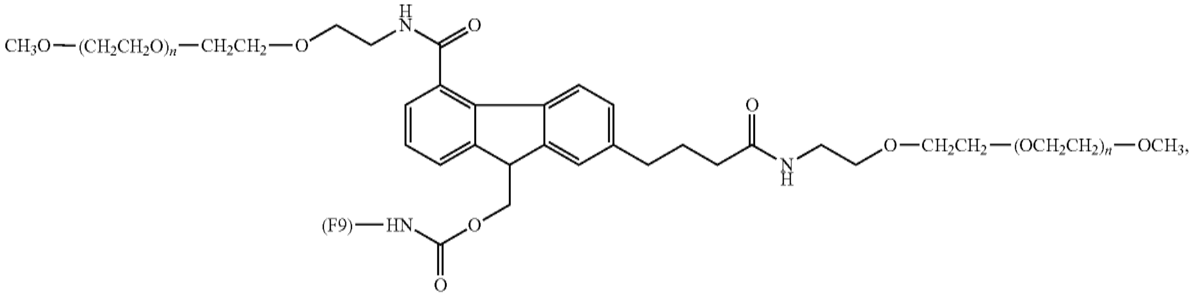






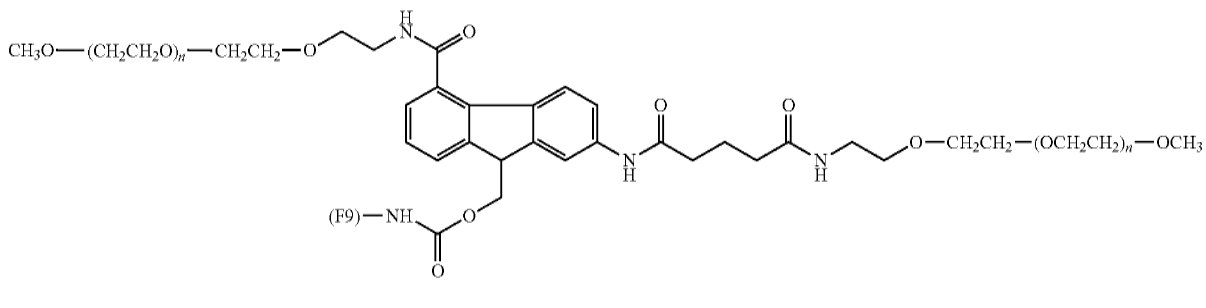


and



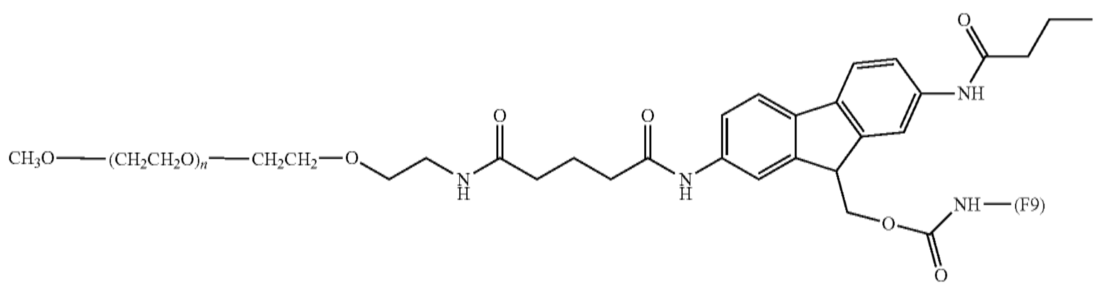
wherein, for each structure and in each instance, (n) is independently an integer from 4 to 1500, and (F9) is a residue of an amine-containing Factor IX moiety.

7. The compound of claim **1**, having the following structure:



wherein, (F9) is a residue of an amine-containing Factor IX moiety and (n), in each instance, is independently from 4 to 1500.

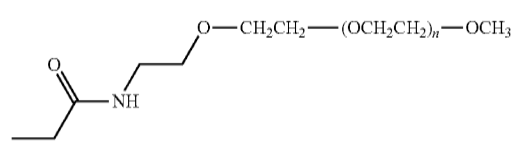
8. The compound of claim **1**, having the following structure:

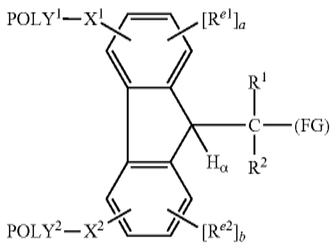


wherein, (F9) is a residue of an amine-containing Factor IX moiety and (n), in each instance, is independently from 4 to 1500.

9. The compound of claim **7**, wherein the Factor IX moiety is human recombinant Factor IX.

10. A method comprising contacting a polymeric reagent with a Factor IX moiety comprising an amino group under conditions suitable to form a covalent attachment between the polymeric reagent and the Factor IX moiety amino group, wherein the polymeric reagent has the following structure:





wherein:

$POLY^1$ is a first water-soluble polymer;

$POLY^2$ is a second water-soluble polymer;

X^1 is a first spacer moiety;

X^2 is a second spacer moiety;

H_α is an ionizable hydrogen atom;

R^1 is H or an organic radical;

R^2 is H or an organic radical;

(a) is either zero or one;

(b) is either zero or one;

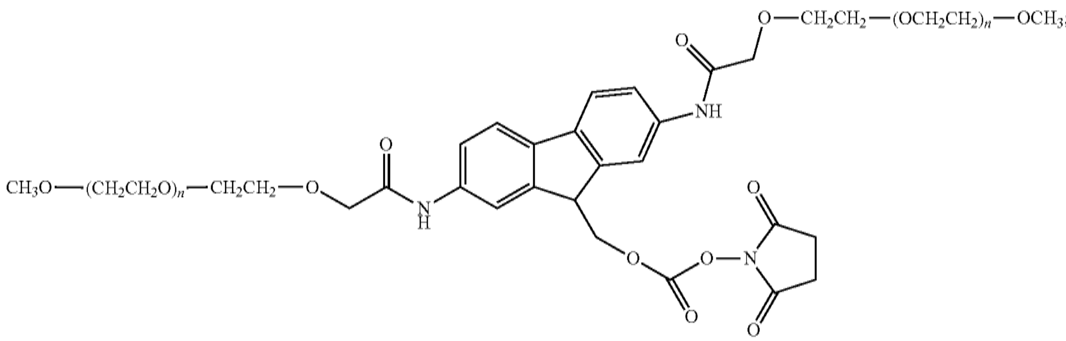
R^{e1}, when present, is a first electron altering group;

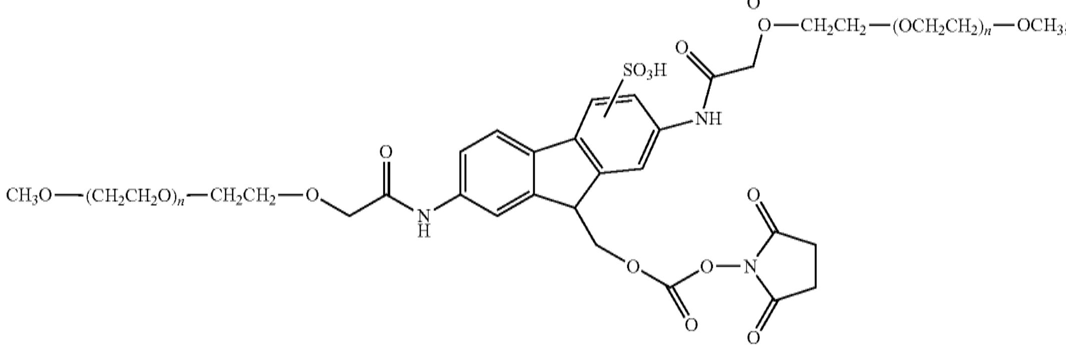
R^{e2}, when present, is a second electron altering group; and

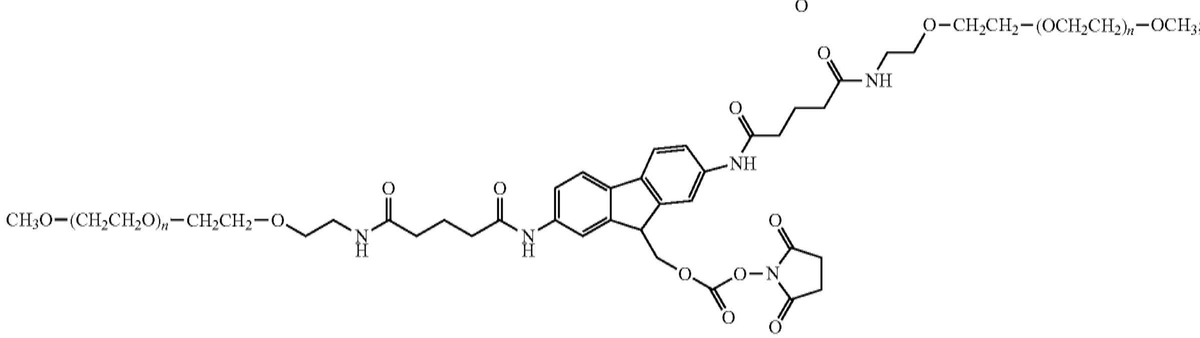
(FG) is a functional group capable of reacting with the amino group of the Factor IX moiety to form a releasable linkage.

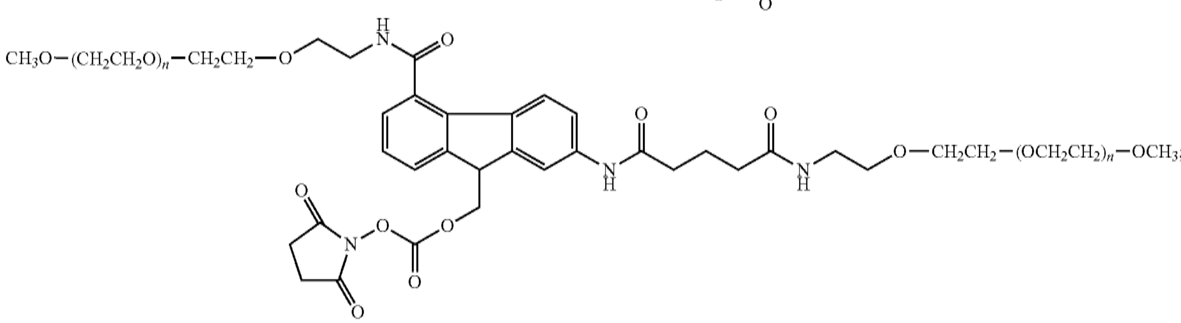
11. The method of claim **10**, wherein the releasable linkage is a carbamate linkage.

12. The method of claim **10**, wherein the polymeric reagent has a structure selected from the group consisting of:









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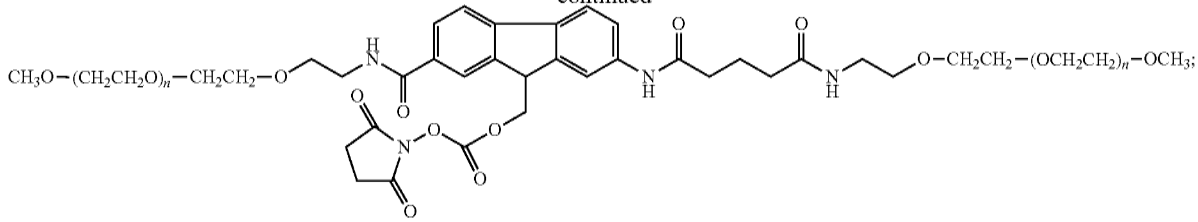
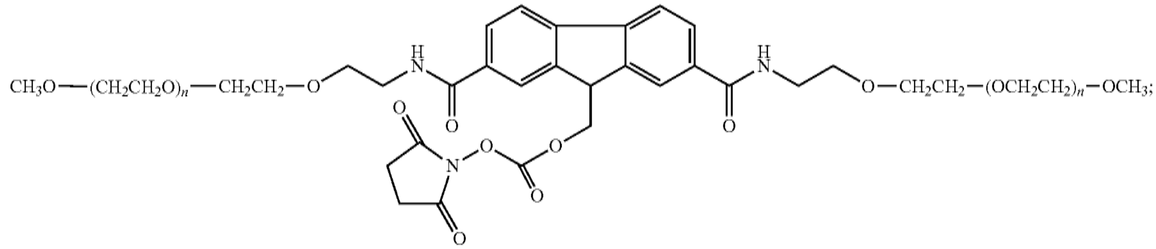
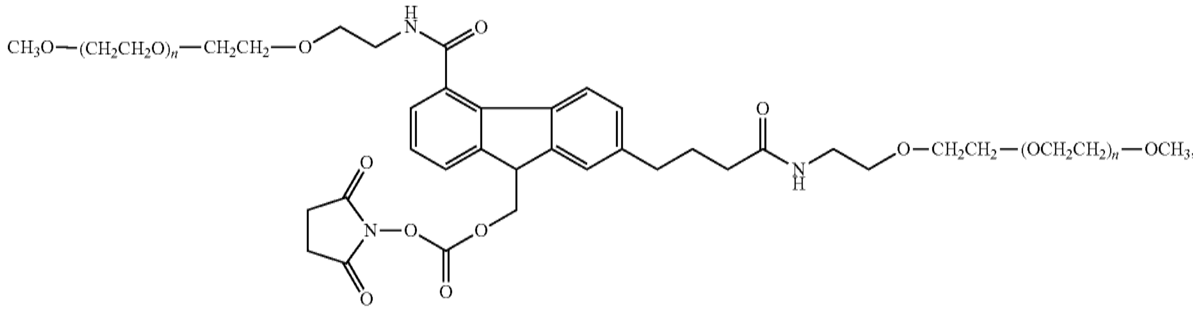




and



wherein, for each structure and in each instance, (n) is independently an integer from 4 to 1500.

13. The method of claim **12**, wherein Factor IX moiety is human recombinant Factor IX.

14. The compound of claim **8**, wherein the Factor IX moiety is human recombinant Factor IX.

15. A composition comprising a compound of any one of claims **1** though **9** or claim **14** and a pharmaceutically acceptable excipient.

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