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(54) Titre : COMPOSITIONS DE GEL DE TESTOSTERONE ET PROCEDES CONNEXES

(54) Title: TESTOSTERONE GEL COMPOSITIONS AND RELATED METHODS

(57) **Abrégé/Abstract:**

Described are gel compositions containing active pharmaceutical ingredient such as testosterone, solvent, and thickener, the gel compositions being useful for transdermal administration of the active ingredient to a patient, and related methods. Certain embodiments of the gel composition specifically exclude Hsieh enhancer.



ABSTRACT

Described are gel compositions containing active pharmaceutical ingredient such as testosterone, solvent, and thickener, the gel compositions being useful for transdermal administration of the active ingredient to a patient, and related methods.

- 5 Certain embodiments of the gel composition specifically exclude Hsieh enhancer.

TESTOSTERONE GEL COMPOSITIONS AND RELATED METHODS**FIELD OF THE INVENTION**

The invention relates to gel compositions containing active pharmaceutical
5 ingredient such as testosterone, solvent, and gel-forming polymer (a.k.a. thickener),
useful for transdermal administration of the active ingredient to a patient, and related
methods.

BACKGROUND

Male hypogonadism is a common hormone deficiency in men that involves
10 decreased functional activity of the gonads. Male hypogonadism results from a
variety of conditions in which testosterone concentration is diminished below the
normal range. The hypogonadic condition is sometimes linked with a number of
physiological changes, such as diminished interest in sex, impotence, reduced lean
body mass, decreased bone density, affected mood, and reduced energy levels.

15 In the United States, men of all ages are treated for hypogonadism using
testosterone replacement therapy. Various methods of delivering testosterone have
been considered and developed to provide suitable replacement therapies. Examples
include intramuscular injections, pellet implants, transdermal patches, and
hydroalcoholic testosterone gels. Commercial testosterone gels include AndroGel®
20 testosterone gel from AbbVie, Inc., and Testim® testosterone gel from Auxilium,
each of which is a one-percent testosterone gel that is administered by application of
the gel to external skin surfaces whereafter testosterone in the gel passes through the
skin. AndroGel® is also commercially available in a 1.62 percent product.

A testosterone gel is a medicinal formulation that can be applied externally
25 to a patient's skin and deliver testosterone transdermally. These gels are designed to
provide a combination of useful rheological, tactile, and functional (testosterone
delivery) properties, preferably including desired pharmaceutical stability, and
without undesirable odor, texture, or appearance. Rheological properties such as gel
viscosity should allow a gel to be applied externally to skin and thereafter remain at
30 that location of application for a period of uptake of the testosterone through the
skin. Tactile properties relate to the feel and texture of the gel when touched and
applied by a user, with preferred gels exhibiting a smooth feel. Good delivery

properties (e.g., uptake) allow an effective amount of testosterone from the applied gel to be absorbed through skin during the time that the gel remains located at the skin surface.

Certain specific ingredients are included in commercial testosterone gel products to achieve desired properties of viscosity and uptake. For example, 5 **Testim® testosterone gel includes the chemically complex, cyclic, absorption enhancer oxacyclohexadecane-2-one.**

Doctors and patients continue to need improved testosterone gel products having good stability, cosmetic properties, and efficacy, especially such products 10 that also benefit from cost advantages or improved performance relative to current available product options.

SUMMARY

The following description relates to pharmaceutical compositions, such as compositions in the form of a gel (“gel compositions”), that include an active 15 pharmaceutical ingredient (“active ingredient”) that can be applied to the skin to transdermally administer the active ingredient to a patient. The active ingredient can be any that is desired for transdermal administration, though gel compositions of the invention that include testosterone as the active ingredient have been found to exhibit particularly useful or advantageous properties compared to other testosterone 20 gel compositions currently marketed.

Examples of gel compositions as described can include a combination of ingredients that includes a solvent, cosolvent, polyol, gel-forming polymer (i.e., “thickener”), and optional pH adjusting ingredient (pH-modifier), to provide bioavailability of the active ingredient that is as good as, equivalent to, or better than 25 certain currently-available commercial products such as Testim® testosterone gel and Androgel® testosterone gel. Advantageously, the gel compositions described herein can achieve useful, desirable, or improved functional and cosmetic properties without the need for certain complicated (also potentially expensive) or cosmetically undesirable (e.g., due to odor) ingredients present in one or more of those 30 commercial products. The ingredients used in the presently described gel compositions (solvent, cosolvent, polyol, gel-forming polymer, and pH-modifier) are relatively simple and inexpensive, well known, and widely available.

Advantageously, the pharmaceutical compositions as described do not require and can preferably exclude a “Hsieh enhancer” such as oxacyclohexadecane-2-one as used in the Testim® testosterone gel product and described in United States Patent Number 7,320,968. These “Hsieh enhancers” are also described in United States Patent Number 5,023,252. (The entirety of these two patent documents, and other patent documents legally related thereto based on a common priority, are incorporated herein by reference.) Pharmaceutical compositions of the present description can exclude the presence of any one or more of these “Hsieh enhancers” described in U.S. Patent Number 7,320,968 (and its family members) or 5,023,252. Such enhancers are said to be lipophilic, and certain specific Hsieh enhancers are said to be “macrocyclic” meaning a cyclic compound having at least 12 carbon atoms in the cyclic ring. Examples of macrocyclic enhancers include: (A) macrocyclic ketones, for example, 3-methylcyclopentadecanone (muscone), 9-cycloheptadecen-1-one (civetone), cyclohexadecanone, and cyclopentadecanone (normuscone); and (B) macrocyclic esters, for example, pentadecalactones such as oxacyclohexadecan-2-one (cyclopentadecanolide; omega-pentadecalactone).

As another example, the commercially available AndroGel® testosterone gel composition includes isopropyl myristate as a penetration enhancer. The presently-described pharmaceutical compositions do not require and can optionally exclude isopropyl myristate as an ingredient, e.g., as a penetration enhancer.

A testosterone gel composition as described herein, having useful or advantageous performance, does not require and specifically excludes any significant amount of a “Hsieh enhancer” or isopropyl myristate. A testosterone gel composition as described herein may be prepared with ingredients that are generally available commercially, and by relatively simple manufacturing steps and methods. Embodiments of the resultant gel composition do not exhibit an undesired odor that can arise from the presence of a “Hsieh enhancer.”

Data show that testosterone gel compositions described herein can exhibit transdermal absorption of testosterone that is as good as, e.g., equivalent to, or better than absorption of testosterone associated with commercial products such as the Testim® testosterone gel and AndroGel® testosterone gel products. The testosterone gel compositions can also be stable, and can have desirable cosmetic,

tactile properties (e.g., texture), rheological properties including diminished, and reduced or suppressed undesirable odor, preferably an absence of any noticeable undesirable odor.

In one aspect, the invention relates to a pharmaceutical composition that
5 contains: about 0.5 to about 10 weight percent testosterone; solvent comprising ethyl alcohol; cosolvent system comprising a cosolvent selected from diisopropyl adipate, methyl laurate, oleyl alcohol, and combinations thereof; polyol system comprising a polyol selected from glycerine, propylene glycol, polyethylene glycol, and combinations thereof; and gel-forming polymer, wherein the weight percent is based
10 on total weight of the pharmaceutical composition.

In another aspect the invention relates to a pharmaceutical composition in the form of a gel, consisting essentially of: about 0.5 to about 10 weight percent testosterone; ethyl alcohol; diisopropyl adipate; methyl laurate; oleyl alcohol; glycerine; propylene glycol; polyethylene glycol polyol; gel-forming polymer;
15 purified water; and optional pH- modifier, wherein the weight is based on total weight of the pharmaceutical composition.

In another aspect, the invention relates to a pharmaceutical composition in the form of a gel, consisting of: about 0.5 to about 10 weight percent testosterone; ethyl alcohol; cosolvent system consisting of diisopropyl adipate, methyl laurate,
20 and oleyl alcohol; polyol system consisting of glycerine, propylene glycol, polyethylene glycol; gel-forming polymer; purified water; and optional pH-adjuster, wherein the weight percent is based on total weight of the pharmaceutical composition.

In yet another aspect, the invention relates to a package containing from 3 to
25 6 grams pharmaceutical composition. The composition contains: about 0.5 to about 10 weight percent testosterone; solvent comprising ethyl alcohol; cosolvent system comprising cosolvent selected from diisopropyl adipate, methyl laurate, oleyl alcohol, and combinations thereof; polyol system comprising polyol selected from glycerine, propylene glycol, polyethylene glycol, and combinations thereof; and gel-
30 forming polymer, wherein the weight percent is based on total weight of the pharmaceutical composition.

In another aspect, the invention relates to a method for treating a condition associated with a deficiency of endogenous testosterone in a male patient. The method includes administering to the patient a pharmaceutical composition that contains: about 0.5 to about 10 weight percent testosterone; solvent comprising ethyl alcohol; cosolvent system comprising cosolvent selected from diisopropyl adipate, methyl laurate, oleyl alcohol, and combinations thereof; polyol system comprising polyol selected from glycerine, propylene glycol, polyethylene glycol, and combinations thereof; and gel-forming polymer, wherein the weight percent is based on total weight of the pharmaceutical composition.

In yet another aspect the invention relates to a method for transdermal delivery of testosterone to a patient. The method includes administering to the patient a pharmaceutical composition in the form of a gel, which contains: about 0.5 to about 10 weight percent testosterone; solvent comprising ethyl alcohol; cosolvent system comprising cosolvent selected from diisopropyl adipate, methyl laurate, oleyl alcohol, and combinations thereof; polyol system comprising polyol selected from glycerine, propylene glycol, polyethylene glycol, and combinations thereof; and gel-forming polymer, wherein the weight percent is based on total weight of the pharmaceutical composition.

In yet another aspect the invention relates to a method for treating hypogonadism in a patient. The method includes administering to the patient a pharmaceutical composition in the form of a gel, which contains: about 0.5 to about 10 weight percent testosterone; solvent comprising ethyl alcohol; cosolvent system comprising cosolvent selected from diisopropyl adipate, methyl laurate, oleyl alcohol, and combinations thereof; polyol system comprising polyol selected from glycerine, propylene glycol, polyethylene glycol, and combinations thereof; and gel-forming polymer, wherein the weight percent is based on total weight of the pharmaceutical composition.

In yet another aspect the invention relates to a method for maintaining an effective concentration of testosterone in the blood serum of a male for treating hypogonadism. The method includes transdermally delivering to the male by applying to the skin a pharmaceutical composition in the form of a gel. The gel contains: about 0.5 to about 10 weight percent testosterone based on total weight of

the pharmaceutical composition; solvent comprising ethyl alcohol; cosolvent system comprising a cosolvent selected from diisopropyl adipate, methyl laurate, oleyl alcohol, and combinations thereof; polyol system comprising a polyol selected from glycerine, propylene glycol, polyethylene glycol, and combinations thereof; and gel-forming polymer. The pharmaceutical composition is applied to skin of the male in the form of a unit dose that contains about 25 mg to about 200 mg of testosterone and is maintained on the skin for a period of time sufficient for delivery of the testosterone to the male's systemic circulation such that, following a single application of the unit dose to the skin, the amount of circulating testosterone (AUC₀₋₂₄) in blood serum of the male achieved in a 24-hour period following the application is about 1,000 to about 350,000 pg h/ml (picogram hour/milliliter) greater than the amount of circulating testosterone (AUC₀₋₂₄) in the blood serum of the male that would have been achieved in the same 24-hour period had the dose not been administered.

15 **BRIEF DESCRIPTION OF THE DRAWINGS**

Figure 1 is a graph showing flux of active ingredient of testosterone gel compositions, relative to time.

Figure 2 is a graph showing flux of active ingredient of testosterone gel compositions, relative to time.

20 **DETAILED DESCRIPTION**

While the present invention may be embodied in many different forms, the following description includes certain specific testosterone gel composition embodiments that particularly relate to treating hormone deficiency or hypogonadism in males. The present description is not to be limited to these exemplary embodiments.

The following description relates to pharmaceutical compositions that may take the form of a gel (or "hydroalcoholic gel") composition useful for transdermal administration of an active pharmaceutical ingredient, for example testosterone. This description explains that the pharmaceutical composition may preferably take the form of a pharmaceutical gel composition. But while a gel composition may be an exemplary or preferred form of a described pharmaceutical composition, other various forms of transdermal pharmaceutical compositions described herein can also

be useful, including creams, dispersions, emulsions, lotions, ointments, thickened solutions, etc.

The pharmaceutical composition contains the active ingredient such as testosterone in an amount and form effective to treat a condition of a patient. The pharmaceutical composition additionally contains various inactive (not pharmaceutically active) ingredients that in combination can produce a combination of desired properties including viscosity and other rheological properties, desired tactile (e.g., feel and texture) properties, desirable (e.g., non-offensive) odor properties, and useful or advantageous properties of effectively allowing transdermal passage of the active ingredient to the blood stream of a patient.

Exemplary pharmaceutical compositions as described herein can be in the form of a gel that includes: an active ingredient that can be an androgen suitable for transdermal administration, such as testosterone; solvent that includes a straight or branched lower alcohol (e.g., a C₂, C₃, or C₄ alcohol) such as ethyl alcohol (ethanol) or isopropyl alcohol (isopropanol) or a combination of two or more such lower alcohols; cosolvent or a combination of cosolvents (a single cosolvent or combination of two or more cosolvents being referred to as a “cosolvent system”) that can include one or more of diisopropyl adipate, methyl laurate, and a C₁₄ to C₂₂ alcohol (e.g., oleyl alcohol); polyol or a combination of polyols (a single polyol or combination of two or more polyols being referred to as a “polyol system”) that can include one or more of glycerine, propylene glycol, and polyethylene glycol; a gel-forming or “gelling” polymer (a.k.a., a “thickener”) that affects viscosity of the pharmaceutical composition; and an optional pH-modifier such as a base in an amount to desirably affect pH of the pharmaceutical composition.

The active ingredient can be an androgen such as testosterone, including any suitable form of testosterone such as 17- β -hydroxyandrost-4-en-3-one. The amount of active pharmaceutical ingredient (e.g., testosterone) in a gel composition can be an amount to produce a desired dosage upon application of the gel composition to a patient in need thereof and to be treated, for example an amount in the range from 0.25 to 10 percent by weight testosterone (e.g., 17- β -hydroxyandrost-4-en-3-one), e.g., from 0.5 to 5 or from 0.5 to 2 percent by weight testosterone (e.g., 17- β -hydroxyandrost-4-en-3-one), based on a total weight of the pharmaceutical

composition. A concentration of testosterone that has been used for commercial testosterone gel compositions is about 1 percent by weight based on total weight of the testosterone gel composition.

In addition to the active ingredient, the described pharmaceutical compositions (e.g., gels) include inactive ingredients to provide functional (e.g.,
5 rheological and absorption) properties, tactile properties, and cosmetic (e.g., odor, texture) properties. These inactive ingredients can include one or more solvent, cosolvent, gelling polymer, water, and optional base or other pH-adjusting or pH-modifying material. Additionally, the described pharmaceutical compositions may
10 optionally include other minor ingredients or excipients such as a stabilizer, emollient, antimicrobial, fragrance, and the like, in a low amount such as below 1 percent, below about 0.5 percent, or below about 0.2 percent by weight based on total weight pharmaceutical composition.

Examples of useful solvents include lower alcohols capable of containing the
15 active pharmaceutical ingredient in a dissolved form. Lower alcohols include saturated alkyl (straight or branched) alcohols having four or fewer (e.g., 2, 3, or 4) carbon atoms, with particular examples including ethanol and isopropanol. A lower alcohol such as ethyl alcohol can be used as the solvent for testosterone as an active pharmaceutical ingredient. Testosterone is relatively soluble in ethyl alcohol,
20 having a reported solubility of 0.17 grams per gram ethyl alcohol. A pharmaceutical gel composition can include any desired and useful amount of solvent (e.g., lower alcohol such as ethyl alcohol), with amounts in the range from 70 to 90 weight percent and from 75 to 85 weight percent (e.g., about 77 or about 78 weight percent, such as 78.35 weight percent) ethyl alcohol being preferred for certain
25 pharmaceutical gel compositions described herein that contain testosterone.

One or more additional solvent (e.g., "cosolvent") can also be included in the pharmaceutical gel composition in combination with the active ingredient and lower alcohol (primary) solvent described above. According to preferred pharmaceutical gel compositions, a certain specific combination of cosolvents has been identified to
30 provide desired or advantageous properties for a testosterone gel composition, the combination including diisopropyl adipate, methyl laurate, and an alkyl (branched, straight, unsaturated, or saturated) alcohol having from 14 to 22 carbon atoms such

as oleyl alcohol. Extensive experimentation led to the unexpected discovery that testosterone gel compositions containing this combination of cosolvents, in combination with ethyl alcohol as the primary solvent, exhibit desired, effective (e.g., bioequivalence with currently marketed products) and/or advantageous skin penetration properties. These same gel compositions did not exhibit an undue or undesirable odor and did exhibit useful or advantageous rheological and tactile properties. Extensive experimentation also identified useful and preferred amounts of total cosolvent (i.e., useful amounts of the three cosolvents taken in total), and useful amounts of each of the three cosolvents (individually, and relative to each other) for use as a cosolvent system in a gel composition.

A total amount of the combination of three cosolvents in a preferred cosolvent system (diisopropyl adipate, methyl laurate, and oleyl alcohol) in a testosterone gel composition, can be any useful amount, with an exemplary range being from 1 to 12 weight percent of these three ingredients, in total, based on the total weight of the composition, more preferably from about 2 to about 10 weight percent, or from about 2 to about 8 weight percent, based on a total weight of the composition.

Within these ranges, amounts of each of the three cosolvents of the preferred cosolvent system can be selected as desired, and preferably as follows. Preferred amounts of diisopropyl adipate can be in the range from 0.5 to 5 weight percent, e.g., from about 1 to about 3.5 weight percent or from 1 to 2 weight percent based on total weight pharmaceutical composition. Preferred amounts of methyl laurate can be in the range from 0.1 to 3 weight percent, e.g., from about 0.2 to about 2.5 weight percent, or from 0.2 to 0.4 weight percent based on total weight pharmaceutical composition. Preferred amounts of C₁₄ to C₂₂ (e.g., oleyl) alcohol can be in the range from 0.5 to 5 weight percent, e.g., from about 1 to about 3.5 weight percent, or from 1 to 2 weight percent based on total weight pharmaceutical composition.

Relative amounts (by weight) of diisopropyl adipate to C₁₄ to C₂₂ (e.g., oleyl) alcohol can be about 1 to 1, more generally within a range from 0.8 to 1.2 grams diisopropyl adipate per gram C₁₄ to C₂₂ (e.g., oleyl) alcohol. A preferred amount (by weight) of methyl laurate relative to diisopropyl adipate (or, alternately, relative to

the C₁₄ to C₂₂ (e.g., oleyl) alcohol) can be an amount of methyl laurate (by weight) that is less than the amount of diisopropyl adipate (alternately C₁₄ to C₂₂ (e.g., oleyl) alcohol), e.g., an amount that is in a range from about 10 percent (by weight) to about 70 percent (by weight) of the amount of diisopropyl adipate (alternately C₁₄ to
5 C₂₂ (e.g., oleyl) alcohol).

One particular cosolvent system of a pharmaceutical composition may contain about 1.5 weight percent diisopropyl adipate, about 0.25 weight percent methyl laurate, and about 1.5 weight percent oleyl alcohol, based on total weight pharmaceutical composition.

10 Preferred pharmaceutical gel compositions also include one or a combination of two or more polyols (a polyol system) to provide desired or advantageous tactile properties in combination with desired functional properties. Examples of useful polyols include one or a combination of propylene glycol, polyethylene glycol (e.g. polyethylene glycol 1000; the "1000" stands for an approximate or average
15 molecular weight of the ethylene glycol), and glycerine. These three polyols, in combination, have been found to impart positive tactile attributes to a pharmaceutical gel composition as described. The use of one or more of these polyols at a reasonable level can impart a smooth, slippery skin feel when the gel composition is applied, as opposed to a sticky or tacky feel.

20 Based on extensive experimentation, pharmaceutical gel compositions that include testosterone as an active pharmaceutical ingredient, ethanol solvent, and a polyol system that includes a combination of propylene glycol, polyethylene glycol (e.g. polyethylene glycol 1000), and glycerine, can exhibit desired, effective, or advantageous functionality. These gel compositions have been determined to not
25 exhibit undue or undesirable odor, while exhibiting useful or advantageous rheological, tactile, and cosmetic properties. Extensive experimentation also identified useful and preferred amounts of total amounts of polyol (i.e., useful amounts of the three polyols taken in total), and useful amounts of each polyol (individually, and relative to each other) in a gel composition.

30 Polyols, including the described combination of polyols in the described amounts and relative amounts, can also contribute to stability of a testosterone gel composition, by providing a reduced freezing point and resistance to freezing, and

resistance to testosterone degradation due to temperature cycling or freeze-thaw cycling.

A total amount of a polyol system containing the three identified polyols -- propylene glycol, polyethylene glycol (e.g. polyethylene glycol 1000), and glycerine -- in a testosterone gel composition, can be any useful amount, with an exemplary range being from 5 to 15 weight percent of these three polyols, in total, based on the total weight of the pharmaceutical gel composition, more preferably from 7 to 14 weight percent or from 8 to 12 weight percent.

Within these ranges, amounts of each polyol can be selected as desired, for example as follows. Preferred amounts of propylene glycol can be in the range from 2 to 8 weight percent, e.g., from about 3 to about 7 weight percent. Preferred amounts of polyethylene glycol can be in the range from 0.2 to 0.8 weight percent, e.g., from about 0.3 to about 0.7 weight percent. Preferred amounts of glycerine can be in the range from 2 to 8 weight percent, e.g., from about 3 to about 7 weight percent. Relative amounts (by weight) of propylene glycol to glycerine can be about 1 to 1, more generally within a range from 0.8 to 1.2 grams propylene glycol to glycerine. A preferred amount (by weight) of polyethylene glycol relative to propylene glycol (or, alternately, relative to the glycerine) can be an amount of polyethylene glycol (by weight) that is less than fifty percent of the amount (by weight) of propylene glycol (alternately glycerine), e.g., an amount that is in the range from about 5 percent (by weight) to about 25 percent (by weight) polyethylene glycol to propylene glycol (alternately glycerine).

One particular polyol system of a pharmaceutical composition may contain about 0.5 weight percent polyethylene glycol (e.g., PEG 1000), about 5.0 weight percent propylene glycol, and about 5.0 weight percent glycerine, based on total weight pharmaceutical composition.

The described pharmaceutical compositions also include a gel-forming polymer or "thickener" for use in increasing the viscosity of the composition. Increased viscosity retards the flow of the composition, thus allowing for improved surface cling. Increased viscosity retards also the movement of particles dispersed in the composition, allowing for compounds dispersed therein to remain suspended therein for relatively long periods of time. A pharmaceutical gel composition as

described herein may have any desired or useful viscosity. A preferred viscosity may be comparable to a viscosity of a comparable or equivalent (e.g., bioequivalent) commercially available testosterone gel product such as the Testim® or the AndroGel® testosterone gel product.

5 Examples of gel-forming polymers include various natural and synthetic **polymeric materials known in the pharmaceutical composition and dosage form arts** for increasing viscosity of a pharmaceutical composition or dosage form, including: cellulosic polymers, for example, cellulose, hydroxyethylcellulose, carboxymethylcellulose, and hydroxypropylmethylcellulose; polyalkylene oxide
10 polymers (e.g., polyethylene oxide), polyvinyl alcohol, and acrylic polymers (e.g., acrylic acid co-polymers and homopolymers).

In certain pharmaceutical composition embodiments, preferred gel-forming polymers can be carbomer polymers, for example non-linear polymers of acrylic acid cross-linked with a polyalkenyl polyether. Examples of carbomers useful in
15 pharmaceutical compositions as described include carboxypolymethylene, carboxyvinyl polymer, and alkyl acrylates, for example, acrylic acid-alkyl methacrylate copolymers. Examples also include polymers of acrylic acid cross-linked with polyalkenyl ethers or divinyl glycol such as those that make up the Carbopol® line of polymeric thickeners (e.g., Carbopol® 980, Carbopol® 980 NF,
20 Pemulen™ TR-1 (acrylic acid-alkyl methacrylate copolymer) polymers) and similar polymeric thickeners.

These and other useful gel-forming polymers can be a homopolymer or copolymer having a polymeric backbone made up of polymerized acrylic acid monomers, which may become crosslinked. Exemplary such polyacrylate gel-
25 forming polymers contain long polymer chains having pendant carboxylic acid functionalities, crosslinked, e.g., with polyalkenyl polyethers.

Certain presently preferred testosterone gel compositions of the present description include a gel-forming polymer as described, in an amount to produce a gel composition that exhibits viscosity and consistency comparable to the Testim®
30 testosterone gel and AndroGel® testosterone gel products. Examples of preferred amounts of carbomer gel-forming polymer (e.g., polyacrylate) in a gel composition can be useful to achieve desired viscosity and other functional and cosmetic

properties, with amounts in the range from 0.1 to 10 percent by weight (based on the total weight of the pharmaceutical gel composition) being useful, and preferred amounts being in the range from 0.2 to 6 or from 0.3 to 3 weight percent based on total weight pharmaceutical composition.

5 In pharmaceutical compositions that contain acidic materials, e.g., an acidic gel-forming polymer such as a carbomer, a pH-modifier may be included. A pH-modifier can be a basic ingredient that affects pH such as by neutralizing an acidic component of the gel composition. In particular, certain of the preferred gel composition described herein can include gel-forming polymer that includes pendant
10 acidic (carboxylic acid) groups, and a pH-modifier (base) to neutralize such pendant acid groups and impart a desired pH (or “apparent pH”) to the gel.

 The type of base useful in a gel composition can be any base useful to affect pH as desired, such as to neutralize acid functionalities of a polyacrylate gel-forming polymer, and that also is not incompatible with the gel composition generally.
15 Examples of useful bases include sodium hydroxide (e.g., 0.1 normal (N) sodium hydroxide), tromethamine, and others. A preferred base for certain pharmaceutical gel compositions may be tromethamine. The amount of base included in pharmaceutical gel composition can be any desired amount, such as an amount sufficient to affect pH as desired, such as to neutralize acid functionalities of a
20 polyacrylate gel-forming polymer.

 In selecting a combination of base chemistry and concentration, these may preferably be selected to result in a gel composition that is physically stable and clear (not cloudy). For example, when 4.75% of 0.1N sodium hydroxide was used in a system with ethanol as solvent, a resulting sodium salt precipitated in the
25 ethanol system, evident as cloudiness. Gel compositions using tromethamine remained clear and colorless while maintaining a consistent viscosity and stability.

 A base may be added to a pharmaceutical composition to provide a desired pH reading using a standard pH meter. As used herein, the term “apparent pH” refers a result of a measurement made using a standard pH meter by placing the
30 electrode into a pharmaceutical gel composition as described, as if to measure pH of the pharmaceutical gel composition. The pH meter can be any standard pH meter, and the measurement can be performed at standard conditions of testing for pH of an

aqueous liquid. A pharmaceutical composition as described herein may include some amount of water, but may sometimes include a relatively low amount of water and a high amount of non-water solvent and cosolvent, along with other non-water ingredients such as polyol, gelling polymer, and solids. As a consequence, a value
5 obtained by taking a measurement of a pharmaceutical gel composition as described using a pH meter, may not necessarily be a measure of a concentration of hydrogen ions in the composition. Still, a standard pH meter is capable of taking a measured reading from the composition when the electrode is placed in the pharmaceutical composition as if taking a pH measurement. If the reading of the pH meter is not
10 considered a true pH of the pharmaceutical composition, due to its relatively low water content, the measurement is still considered to be an “apparent pH” of the pharmaceutical composition for purposes of the present description and claims.

According to certain examples of pharmaceutical gel composition as described, an apparent pH of these compositions may be in a range from 4.5 to 6.5,
15 e.g., from 5.5 to 6.5. Still, compositions having an apparent pH outside of these identified ranges may still be useful pharmaceutical compositions.

According to certain particularly preferred testosterone gel compositions, combinations of certain preferred ingredients can be included in amounts also described, to provide preferred properties such as preferred skin penetration
20 properties, preferred viscosity, and preferred tactile properties. The ingredients of the particularly preferred pharmaceutical gel compositions include the lower alcohol solvent ethanol; a cosolvent system (including diisopropyl adipate, methyl laurate, and oleyl alcohol); and a polyol system (including propylene glycol, polyethylene glycol, and glycerine) each in amounts as described herein. Exemplary gel
25 compositions can also contain these ingredients along with an active pharmaceutical ingredient, gel-forming polymer, optional pH-modifier, and water, in the absence or substantial absence of other ingredients. Such compositions are considered to consist of or consist essentially of these ingredients. A substantial absence of other ingredients can allow for a small amount of such other ingredients, e.g., less than 1,
30 0.5, or 0.2 weight percent of other added ingredients based on a total weight of the pharmaceutical composition.

A pharmaceutical composition described as “consisting of” a group of specific ingredients is a composition made by combining the specified ingredients and no other identifiable ingredient. The pharmaceutical composition may include other (non-ingredient) materials only to the extent that the other materials were
5 useful or appurtenant to preparation of one of the recited ingredients, such as the gel-forming polymer, solvent, cosolvent, polyol, active ingredient, or pH-modifier, and then only in a functionally insignificant amount.

A pharmaceutical composition described as “consisting essentially of” a group of specific ingredients is a gel composition made by combining the specified
10 ingredients and no other identifiable ingredient other than optional minor (e.g., “excipient”) ingredients such as a stabilizer, emollient, antimicrobial agent, coloring agent, fragrance, and the like, in a low amount such as below about 1, 0.5 percent, or below about 0.2 percent by weight total such additional ingredients based on a total weight of the pharmaceutical composition.

The pharmaceutical composition of the present description may be
15 formulated and prepared using conventional methods and equipment known in the pharmaceutical arts, such as by relatively simple combining, mixing, and stirring steps using known types of equipment. Standard glassware or stainless steel mixing vessels may be used. The composition can be formulated typically at room
20 temperature or slightly above and at atmospheric pressures.

For purposes of a single example, a preferred pharmaceutical composition as described can be prepared by a method that includes steps useful to prepare known versions of alcohol gels, including combining ingredients in a manner to result in a stable and effective transdermal gel. Useful methods can include steps that ensure
25 desired functionality of a gel-forming polymer, such as by an order of addition of ingredients that hydrates and optionally neutralizes a gel-forming carbomer polymer (if used). An example of a method useful to prepare a one-percent testosterone gel composition can include a step of hydrating gel-forming polymer or polymers (e.g., Carbopol® and Pemulen™ (acrylates) ingredients) in a portion of ethanol solvent.
30 Testosterone, USP, is dissolved in a separate portion of ethanol. The gel-forming polymer is then combined with the ethanolic solution of testosterone.

With the exception of aqueous tromethamine as a pH-modifier, the remaining ingredients of the pharmaceutical composition can be added to this combined ethanolic mixture either in a single subsequent step of adding a mixture of the remaining ingredients, or in multiple steps of adding multiple ingredients singly.

5 For example, a system of cosolvents may be added together in one step and one or more polyols of a polyol system may be added separately or together. A tromethamine solution can be added in a final step. All ingredients are miscible in ethanol. Thus, after each component addition the result remains a solution.

A pharmaceutical composition as described may be contained in a tube, a sachet, a metered pump, or another useful dispensing device. Such a tube or sachet
10 may contain one unit dose of the composition, *e.g.*, 5 grams of testosterone gel which can contain 50 mg of testosterone. A metered pump may be capable of dispensing one metered dose of the composition per actuation, which metered dose may or may not contain a unit dose.

15 As one example, a gel composition can be dispensed from a hand-held meter-dosed pump capable of delivering a metered dose of the gel, such as about 1.25 grams (g) of the testosterone gel with each actuation, *e.g.*, with four pump actuations, a total of 5 grams (a single unit dose) of the testosterone gel may be delivered. In another embodiment, the gel composition can be packaged in foil
20 packet. Each packet can hold a single unit dose of the gel, such as an amount of about 5 grams of testosterone gel. A patient can tear the packet along a perforated edge to remove the gel. As another alternative, a gel composition as described can be dispensed from a rigid multi-dose container (*e.g.*, with a hand pump) having a foil packet of the composition inside the container. Any useful dispensing option, as
25 described or otherwise, can allow a user to deliver an accurate amount of a desired dosage of the gel composition, by mass or volume, (*e.g.*, 5.0 g, 7.5 g, 10 g, etc.).

A condition in a patient related to below-normal androgen concentration in blood serum of the patient may be treated by administering to the patient a pharmaceutical composition as described, such as a topically-delivered, transdermal
30 gel composition as described. A pharmaceutical gel composition may be applied and rubbed onto skin of the patient, such as intact, clean, and dry skin of the

shoulder, upper arm, axilla, the upper torso, or thigh, and maintained thereon for a period of time sufficient for delivery of androgen to the blood serum of the patient.

The dosage amount will depend upon the condition to be treated, the frequency of administration of the dose, and the amount of androgen in the gel composition. Without limitation, a pharmaceutical gel composition as described can be applied to skin of a patient in the form of a unit dose that contains from about 25 milligrams (mg) to about 200 mg of testosterone. A single unit dose of the testosterone gel composition can be in a range from 2.5 grams (which at a 1% concentration contains 25 mg of testosterone) to 20 grams (which at a 1% concentration contains 200 mg of testosterone). As particular examples, a single unit dose of the testosterone gel composition can be 5 grams (containing 50 mg of testosterone) or 10 grams (containing and 100 mg of testosterone).

For the purpose of treating male hypogonadism, a preferred once daily dosage amount (e.g., unit dose) of a gel composition of the present invention (containing 1 percent testosterone) can be from about 1 to about 10 grams of the gel composition, and preferably about 5 to about 10 grams of the gel composition. The unit dose can be maintained on the skin for a period of time sufficient for delivery of the testosterone to the patient's systemic circulation such that, following a single application of the unit dose to the skin, the amount of circulating testosterone (AUC_{0-24}) in blood serum of the patient achieved in a 24-hour period following the application is a useful or desired amount, such as an amount that is about 1,000 to about 350,000 pg h/ml (picogram hour/milliliter) (e.g., about 10,000 to about 100,000 pg h/ml, such as about 66,250 pg h/ml) greater than the amount of circulating testosterone (AUC_{0-24}) in the blood serum of the patient that would have been achieved in the same 24-hour period had the dose not been administered.

In situations where a unit dose is applied, one or more of such unit doses may be administered to a patient, depending upon the condition to be treated, the amount of androgen to be delivered, and the frequency of administration. The number of such unit doses may be increased or decreased as needed, depending upon, as stated above, whether a desired clinical effect has been achieved and the concentration of androgen in the blood serum of the patient treated.

If, after a period of time has passed following the initial administration of a testosterone gel composition (for example, about 14 days), a desired clinical response has not been achieved or if the androgen concentration in the blood serum of the patient is determined and found to remain below the normal adult concentration thereof, *i.e.*, below about 250 to about 300 ng h/dL (nanogram hour per deciliter) (*i.e.*, 2,500 to about 3,000 picogram hour per milliliter), the amount of the dose, the frequency of the dose, and/or the number of applications of the dose may be increased. Similarly, if, after a period of time has passed following the initial administration of the gel composition (for example, about 14 days), the androgen concentration in the blood serum of the patient is determined and found to be above the normal adult concentration thereof, the amount of the dose, the frequency of the dose, and/or the number of applications of the dose may be decreased.

Example 1

Gel compositions that can be used as a topical gel for delivery of testosterone, including certain pharmaceutical compositions of the invention, were prepared according to the following Tables. The ingredients and amounts of ingredients used in each example are given in percent by weight relative to the total weight of the composition.

Table 1 Testosterone Gel 1% Formulations (Examples 1-1 through 1-12)

Example	1-1	1-2	1-3	1-4	1-5	1-6	1-7	1-8	1-9	1-10	1-11	1-12
Ingredient												
Testosterone, USP	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Ethyl alcohol, anhydrous, USP	q.s. to 100	q.s. to 100	q.s. to 100	q.s. to 100	q.s. to 100	q.s. to 100	67.0	67.5	67.0	67.0	q.s. to 100	67.0
Glycerin, 99.7%, USP	5.0	5.0	5.0	5.0	5.0	5.0	-	-	-	-	5.0	-
Carbomer 980	1.5	1.5	1.5	1.5	1.5	1.5	0.9	0.9	0.9	0.9	1.5	0.9
Pemulen™ TR-1	0.3	0.3	0.3	0.3	0.3	0.3	-	-	-	-	0.3	-
PEG 1000, NF	0.5	0.5	0.5	0.5	0.5	0.5	-	-	-	-	0.5	-
Tromethamine, USP	0.1	0.1	0.1	0.1	0.1	0.1	-	-	-	-	0.1	-
Sodium hydroxide (0.1 N)	-	-	-	-	-	-	4.72	4.72	4.72	4.72	-	4.72
Propylene Glycol, USP	5.0	5.0	5.0	13.0	5.0	6.0	-	-	8.0	-	8.0	-
Pentadecalactone	8.0	-	-	-	-	-	-	-	-	-	-	-
dl-limonene	-	-	-	-	-	2.0	-	-	-	-	-	-
Diisopropyl adipate	-	-	-	-	3.0	-	-	-	-	-	-	-
Lauryl alcohol	-	-	-	-	-	3.0	-	-	-	-	2.0	-
Methyl laurate	-	-	-	-	2.0	2.0	-	-	-	-	1.0	-
Isopropyl myristate	-	8.0	-	-	-	-	0.5	-	-	-	-	-
Oleyl alcohol	-	-	-	-	3.0	-	-	-	-	3.0	-	5.0
Propylene glycol dicaprylate / dicaprinate (Miglyol 840)	-	-	-	-	-	-	-	-	-	3.0	-	5.0
PG-dipelargonate	-	-	-	-	-	-	-	-	-	0.6	-	-
Purified Water, USP	5.0	5.0	13.0	5.0	5.0	5.0	q.s. to 100	q.s. to 100	q.s. to 100	q.s. to 100	5.0	q.s. to 100

Example	1-1	1-2	1-3	1-4	1-5	1-6	1-7	1-8	1-9	1-10	1-11	1-12
Ingredient												
Apparent pH	5.3	5.2	5.2	5.4	5.5	5.0	5.1	5.4	5.5	5.3	5.7	5.5
Viscosity, cP at 25°C	978	763	1,383	1,531	1,017	732	275	494	1,102	766	1,436	516
Visual appearance	Clear	Clear	Clear	Clear	NA	NA	Clear	Clear	Clear	NA	Clear	Cloudy

Based on the *in vitro* performance results of the Examples of Table 1, Example 1-5 had desired performance. Additional examples (1-5A, 1-5B, 1-5C, and 1-5D) were prepared having formulations similar to but different from the Example 5 formulation. The formulations of Examples 1-5A, 1-5B, 1-5C, and 1-5D varied in terms of the ratios and overall levels of cosolvents of the diisopropyl adipate, methyl laurate, oleyl alcohol cosolvent system. See Table 2 below.

Table 2 Testosterone Gel 1% Formulations (the “5-series”)

Example	1-5	1-5A	1-5B	1-5C	1-5D
Ingredient					
Testosterone, USP	1.0	1.0	1.0	1.0	1.0
Ethyl alcohol, anhydrous, USP	q.s. to 100	75.1	q.s. to 100	77.3	78.3
Glycerin, 99.7%, USP	5.0	5.0	5.0	5.0	5.0
Carbomer 980	1.5	1.5	1.5	1.5	1.5
Acrylates (Pemulen TR-1)	0.3	0.3	0.3	0.3	0.3
PEG 1000, NF	0.5	0.5	0.5	0.5	0.5
Tromethamine, USP	0.1	0.1	0.1	0.1	0.1
Propylene Glycol, USP	5.0	5.0	5.0	5.0	5.0
Diisopropyl adipate	3.0	2.5	2.0	2.0	1.5
Methyl laurate	2.0	1.5	1.0	0.25	0.25
Oleyl alcohol	3.0	2.5	2.0	2.0	1.5
Purified Water, USP	5.0	5.0	5.0	5.0	5.0

10 The performance of the “5-Series” Example formulations compared well to the commercial Testim® testosterone gel product. Figure 2 illustrates performance data of the “5-series” compared to Testim® testosterone gel product.

Example 2 – *In Vitro* Evaluation of Percutaneous Absorption of Testosterone

15 To characterize the percutaneous absorption pharmacokinetics of testosterone in the various Example formulations of Table 1 and Table 2, absorption was measured in human cadaver skin *in vitro*, using the finite dose technique and Franz diffusion cell (Franz, *J. Invest. Dermatol.*, 65:190-195 (1975)). Results are depicted at Figure 1 and Figure 2.

20 The example testosterone gel formulations described in Table 1 were initially screened in an *in-vitro* skin penetration study. The graph at Figure 1 illustrates the

results for *in-vitro* human skin penetration studies of Examples 1-through 1-11. The example testosterone gel formulations described in Table 2 were also tested in an *in vitro* skin penetration study. The graph at Figure 2 illustrates the results for *in vitro* human skin penetration studies of Examples 1-5A-through 1-5D.

5 Example 3

The testosterone gel formulation shown in Table 3 is bioequivalent to Testim® testosterone gel, possesses good long term stability, can be manufactured with consistency, and is cosmetically pleasing to a patient, including a lack of undesirable odor.

10 Table 3

1% Testosterone Gel Formulation	
Component	Percent by weight
Ethyl alcohol, anhydrous, USP	78.35
Testosterone, USP	1.00
Glycerin, 99.7%, USP	5.00
Diisopropyl adipate	1.50
Methyl laurate	0.25
Oleyl alcohol, NF	1.50
Carbomer Homopolymer Type C*, NF (Carbomer 980)	1.50
Carbomer Copolymer Type B*, NF (Pemulen TR-1, Acrylates)	0.30
Propylene glycol, USP	5.00
Polyethylene glycol 1000, USP	0.50
Purified Water, USP	5.00
Tromethamine, USP	0.10

*(allyl pentaerythritol crosslinked)

Claims:

1. A pharmaceutical composition consisting essentially of:
 - about 0.5 to about 2 weight percent testosterone;
 - about 75 to about 85 weight percent ethyl alcohol;
 - 5 about 2 to about 10 weight percent cosolvent system, wherein the cosolvent system consists of diisopropyl adipate, methyl laurate, and oleyl alcohol;
 - about 7 to about 14 weight percent polyol system, wherein the polyol system comprises a polyol selected from glycerine, propylene glycol, polyethylene glycol, and combinations thereof;
 - 10 about 0.5 to about 3 weight percent carbomer gel forming polymer; and
 - pH-modifier, wherein the weight percent is based upon the total weight of the pharmaceutical composition.
2. The pharmaceutical composition of claim 1 wherein the diisopropyl adipate, methyl
15 laurate, and oleyl alcohol are present in the cosolvent system in a ratio from (0.8-1.2) to (0.1-0.7) to 1.
3. The pharmaceutical composition of claim 1, wherein the diisopropyl adipate, methyl
20 laurate, and oleyl alcohol are present in the cosolvent system in a ratio from 6:1:6.
4. The pharmaceutical composition of claim 1, having
 - about 3 to about 7 weight percent glycerine;
 - about 3 to about 7 weight percent propylene glycol; and
 - about 0.3 to about 0.7 weight percent polyethylene glycol.
- 25 5. The pharmaceutical composition of claim 1 having:
purified water.
6. The pharmaceutical composition of claim 1, wherein the pH-modifier is tromethamine
30 that is present at about 0.1 weight percent.

7. A pharmaceutical composition consisting essentially of:
about 0.5 to about 2 weight percent testosterone;
about 75 to about 85 weight percent ethyl alcohol;
about 1 to about 2 weight percent diisopropyl adipate;
5 about 0.2 to about 0.4 weight percent methyl laurate;
about 1 to about 2 weight percent oleyl alcohol;
about 3 to about 7 weight percent glycerine;
about 3 to about 7 weight percent propylene glycol;
about 0.3 to about 0.7 weight percent polyethylene glycol;
10 about 1 to about 3 weight percent gel-forming polymer;
purified water; and
about 0.1 weight percent tromethamine, wherein the weight percent is based
upon the total weight of the pharmaceutical composition.
- 15 8. The pharmaceutical composition according to claim 7 wherein the pharmaceutical
composition can be applied to skin of a patient in the form of a unit dose that contains about 25
mg to about 200 mg of testosterone, and maintained on the skin for a period of time sufficient
for delivery of the testosterone to the patient's systemic circulation such that, following a
single application of the unit dose to the skin, the amount of circulating testosterone (AUC_{0-24})
20 in blood serum of the patient achieved in a 24-hour period following the application is about
46,000 to about 95,000 $pg \cdot h/mL$ (picogram-hour/milliliter) greater than the amount of
circulating testosterone (AUC_{0-24}) in the blood serum of the patient that would have been
achieved in the same 24-hour period had the dose not been administered.
- 25 9. A use of a pharmaceutical composition in the form of a gel to deliver transdermally
testosterone to a patient, wherein the composition consists essentially of:
about 0.5 to about 2 weight percent testosterone;
about 75 to about 85 weight percent ethyl alcohol;
about 2 to about 10 weight percent cosolvent system, wherein the cosolvent
30 system consists of diisopropyl adipate, methyl laurate, and oleyl alcohol;

about 7 to about 14 weight percent polyol system, wherein the polyol system comprises a polyol selected from glycerine, propylene glycol, polyethylene glycol, and combinations thereof;

about 0.5 to about 3 weight percent carbomer gel forming polymer; and

5 pH-modifier, wherein the weight percent is based upon the total weight of the pharmaceutical composition.

10. The use of claim 9, wherein the diisopropyl adipate, methyl laurate, and oleyl alcohol are present in the cosolvent system in a ratio of (0.8-1.2) to (0.1-0.7) to 1.

10

11. The use of claim 9, wherein the diisopropyl adipate, methyl laurate, and oleyl alcohol are present in the cosolvent system in a ratio of 6:1:6.

12. The use of claim 9, wherein the patient is a male, and the pharmaceutical composition is applicable to the skin of the male patient in the form of a unit dose that contains about 15 25 mg to about 200 mg of testosterone

13. The use of claim 12, wherein the composition is adapted to be maintained on the skin of the male patient for a period of time sufficient for delivery of the testosterone to the 20 systemic circulation of the male patient such that, following a single application of the unit dose to the skin, the amount of circulating testosterone (AUC_{0-24}) in blood serum of the male achieved in a 24-hour period following the application is about 46,000 to about 95,000 $pg \cdot h/mL$ (picogram-hour/milliliter) greater than the amount of circulating testosterone (AUC_{0-24}) in the blood serum of the male that would have been achieved in the same 24-hour period 25 had the dose not been administered.

14. The use of claim 9, wherein the patient has a condition associated with a deficiency of endogenous testosterone.

30 15. The use of claim 9, wherein the patient is a male patient.

16. The use of claim 15, wherein the male patient has hypogonadism.

17. The use of claim 16, wherein the pharmaceutical composition is applicable to the male patient's skin in the form of a unit dose that contains about 25 mg to about 200 mg of

5 testosterone; and

the pharmaceutical composition is adapted to be maintained on the skin for a period of time sufficient for delivery of the testosterone to the male's systemic circulation such that, following a single application of the unit dose to the skin, the amount of circulating testosterone (AUC₀₋₂₄) in blood serum of the male achieved in a 24-hour period following the

10 application is about 46,000 to about 95,000 pg•h/mL (picogram-hour/milliliter) greater than the amount of circulating testosterone (AUC₀₋₂₄) in the blood serum of the male that would have been achieved in the same 24-hour period had the dose not been administered.

18. A pharmaceutical composition according to claim 1 having about 1 weight percent

15 testosterone.

19. A pharmaceutical composition according to claim 7 having about 1 weight percent testosterone.

20 20. A pharmaceutical composition according to claim 7 having about 78 weight percent ethyl alcohol.

21. A pharmaceutical composition according to claim 7 having about 1.5 weight percent diisopropyl adipate.

25

22. A pharmaceutical composition according to claim 7 having about .25 weight percent methyl laurate.

23. A pharmaceutical composition according to claim 7 having about 1.5 weight percent

30 oleyl alcohol.

24. A package containing a pharmaceutical composition consisting essentially of:
about 0.5 to about 2 weight percent testosterone;
about 75 to about 85 weight percent ethyl alcohol;
about 2 to about 10 weight percent cosolvent system, wherein the cosolvent
5 system consists of diisopropyl adipate, methyl laurate, and oleyl alcohol;
about 7 to about 14 weight percent polyol system, wherein the polyol system
comprises a polyol selected from glycerine, propylene glycol, polyethylene glycol, and
combinations thereof;
about 0.5 to about 3 weight percent carbomer gel forming polymer; and
10 pH-modifier, wherein the weight percent is based upon the total weight of the
pharmaceutical composition.
25. A package according to claim 24 containing from 3 to 6 grams of the pharmaceutical
composition.
- 15 26. A package according to claim 24, wherein the package is adapted for dispensing a
single dose of the pharmaceutical composition.
27. A package according to claim 24, wherein the package is adapted for dispensing a
20 metered volume of the pharmaceutical composition.
28. A package according to claim 27, wherein the metered volume comprises multiple
doses.
- 25 29. A package according to claim 28, wherein the package is a pump.
30. A package according to claim 24, wherein the package is a pump.

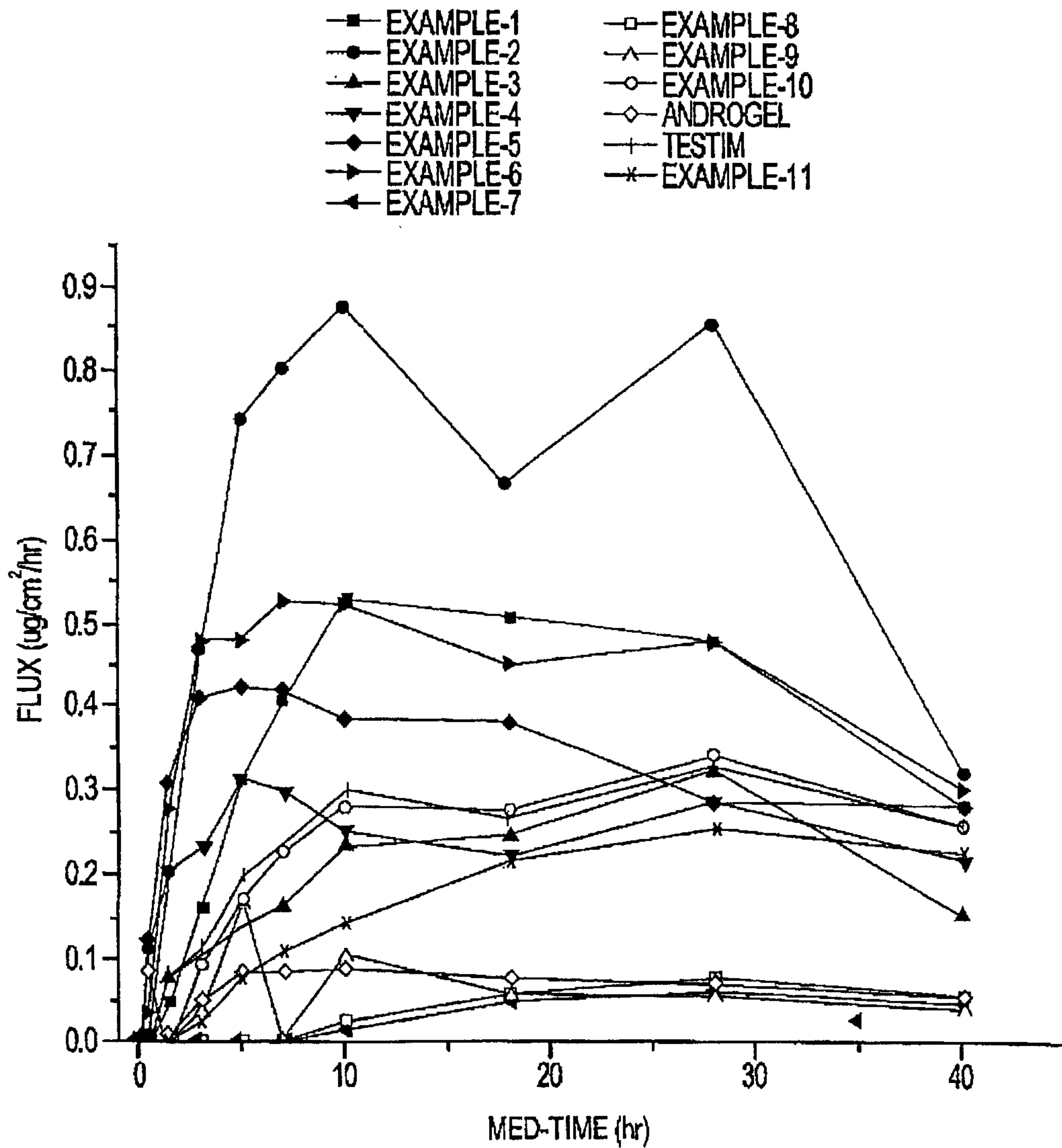


Figure 1

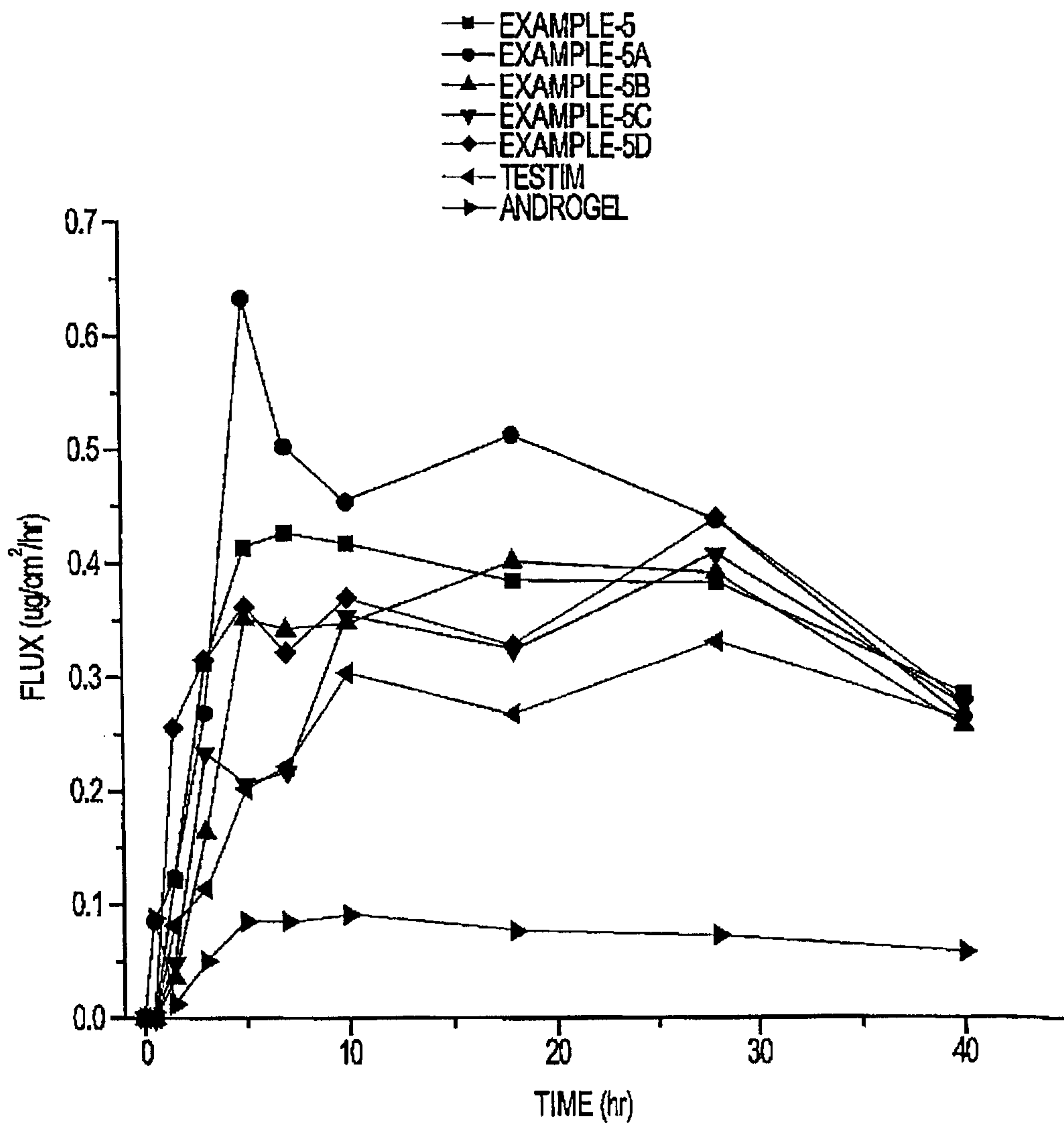


Figure 2