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Compositions comprising a photosensitizer and a skin-penetration enhancer and their use in photodynamic treatment

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(54) **Title:** COMPOSITIONS COMPRISING A PHOTOSENSITIZER AND A SKIN-PENETRATION ENHANCER AND THEIR USE IN PHOTODYNAMIC TREATMENT

(57) **Abstract:** The present invention relates to a composition comprising a photosensitizing agent and a skin-penetration enhancer. The composition herein show improved delivery of the photosensitizer through the stratum corneum. In addition, the composition of the present invention show improved stability and a reduced incidence of skin photosensitivity.

COMPOSITIONS COMPRISING A PHOTOSENSITIZER AND A SKIN-PENETRATION ENHANCER AND THEIR USE IN PHOTODYNAMIC TREATMENT

Technical Field

5 The present invention relates to a composition comprising photosensitizing agents.

Background to the Invention

10 Photodynamic therapy is a diverse field of medical treatment. Generally, PDT involves the delivery of a photosensitizer to the target tissue and, subsequently, irradiating the target area with light of an appropriate wavelength to activate the PS. This activation results in an agent that modifies or destroys the target tissues. The PS is usually delivered systemically although it has been proposed to deliver it locally.

15 Local delivery has the advantage that the PS is delivered directly to the target tissue and, consequently, high concentrations of the drug in the target tissue can be achieved. However, local delivery also has some disadvantages. Photosensitizing agents do not easily penetrate the stratum corneum. In addition, 20 the PS agents are relatively reactive so it is difficult to formulate a stable composition.

At the time of writing, one product that is marketed for topical PDT is Levulan® Kerastick®. This product is used for the treatment of non-hyperkeratotic actinic 25 keratosis lesions on the face or scalp. The photosensitizer in this product is a pro-drug and is converted into the active *in situ*. The product is supplied in a plastic applicator tube containing two sealed glass ampules. One ampule contains the a solution to act as the vehicle and the other the photosensitizing agent as a dry solid. The applicator tube is enclosed in a protective cardboard sleeve and cap. 30 Immediately prior to application, the two ampules are crushed and the solution is mixed with the photosensitizer. The contents are then shaken for several minutes until the drug is dissolved. The solution containing dissolved drug must be discarded two hours after mixing due to the short stability of the product

Thus there remains a need for a stable photosensitizer composition suitable for topical application to the skin.

It has also been found that topical photosensitizer compositions can cause skin-photosensitivity reactions. In addition, it has been problematic to deliver the photosensitizer to the correct target tissue because often the stratum corneum is difficult to penetrate.

Summary of the Invention

In a first aspect, the invention provides use of:

- a) a BPD or green porphyrin photosensitizer; and
- b) at least one skin-penetration enhancer, in the manufacture of a composition for the photodynamic treatment of androgenetic alopecia, alopecia areata, or for promoting hair growth.

In one embodiment of the first aspect, the photosensitizer is present at a level of from 0.0001% to 50%.

In another embodiment of the first aspect, the skin-penetration enhancer is selected from glycol ethers, fatty acids, fatty acid esters, glycol esters, glycerides, azones, polysorbates, alcohols, dimethylsulfoxide, and mixtures thereof.

In an additional embodiment of the first aspect, the skin-penetration enhancer is selected from diethylene glycol monoethyl ether, polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

In one embodiment of the first aspect, the skin-penetration enhancer is present at a level of from about 0.1% to about 90%.

In one embodiment of the first aspect, the skin-penetration enhancer is also a solubilizer for the photosensitizer.

In an additional embodiment of the first aspect, the composition comprises a solubilizer selected from diethylene glycol monoethyl ether, polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

In another embodiment of the first aspect, the composition has a viscosity at 20°C of from about 50 cps to about 50000 cps.

In a second aspect, the invention provides use of a composition comprising a BPD or green-porphyrin photosensitizer, low molecular weight polyethylene glycol, diethylene glycol monoethyl ether, high molecular weight polyethylene glycol, and fatty alcohol in the manufacture of a medicament for photodynamic treatment.

In one embodiment of the second aspect, the composition is used in the manufacture of a medicament for photodynamic treatment of androgenetic alopecia, alopecia areata, skin cancers, acne, psoriasis atopic, dermatitis, endometrial ablation, or for promoting hair growth.

5 In another embodiment of the second aspect, the treatment comprises applying the composition or medicament to the target tissue and irradiating the target tissue with activation energy of an appropriate wavelength to activate the photosensitizer.

In a third aspect, the invention provides a method of photodynamic therapy comprising:

10 (i) applying to the skin a composition comprising benzoporphyrin derivative mono-acid (BPD-MA) known as EA6 as herein defined and a carrier wherein the carrier comprises more than one skin-penetration enhancer,

(ii) allowing time for at least some of the EA6 to penetrate through the stratum corneum,

15 (iii) washing the skin to which the composition has been applied, and

(iv) irradiating with activation energy at a wavelength appropriate to activate the EA6.

In a fourth aspect, the invention provides a process for the manufacture of a composition, said process comprising:

20 (a) preparing a lyophilized benzoporphyrin derivative mono-acid (BPD-MA) known as EA6,

(b) manufacturing a base composition comprising more than one skin penetration enhancer and, optionally, a solubilizer, and

(c) adding the lyophilized EA6 to the base with stirring.

25 In a fifth aspect, the invention provides use of:

(a) a BPD or green porphyrin photosensitizer; and

(b) diethylene glycol monoethyl ether, in the manufacture of a composition for the photodynamic treatment of androgenetic alopecia, alopecia areata, or for promoting hair growth.

30 In one embodiment of the fifth aspect, the photosensitizer is present at a level from 0.0001% to 50%.

In another embodiment of the fifth aspect, the composition further comprises an additional skin-penetration enhancer selected from glycol esters, fatty acids, fatty acid esters, glycol esters, glycerides, azones, polysorbates, alcohols, dimethylsulfoxide, and mixtures thereof.

35

In an additional embodiment of the fifth aspect, the composition further comprises an additional skin-penetration enhancer selected from polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

5 In another embodiment of the fifth aspect, the diethylene glycol monoethyl ether is present at a level of from 0.1% to about 90%.

In one embodiment of the fifth aspect, the composition comprises a solubilizer selected from polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

10 In another embodiment of the fifth aspect, the composition has a viscosity at 20°C of from about 50 cps to about 50000 cps.

In a sixth aspect, the invention provides use of:

(a) benzoporphyrin derivative mono-acid (BPD-MA) known as EA6; and

(b) more than one skin penetration enhancer, in the manufacture of a composition for the photodynamic treatment of acne.

15 In one embodiment of the sixth aspect, the photosensitizer is present at a level from 0.0001% to 50%.

In another embodiment of the sixth aspect, at least one of the skin-penetration enhancers is selected from glycol esters, fatty acids, fatty acid esters, glycol esters, glycerides, azones, polysorbates, alcohols, dimethylsulfoxide, and mixtures thereof.

20 In an additional embodiment of the sixth aspect, at least one of the skin-penetration enhancers is selected from diethylene glycol monoethyl ether, polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

In one embodiment of the sixth aspect, the skin-penetration enhancers are present at a level of from about 0.1% to about 90%.

25 In one embodiment of the sixth aspect, the skin-penetration enhancers are also a solubilizer for the photosensitizer.

In an additional embodiment of the sixth aspect, the composition comprises a solubilizer selected from diethylene glycol monoethyl ether, polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

30 In another embodiment of the sixth aspect, the composition has a viscosity at 20°C of from about 50 cps to about 50000 cps.

In a seventh aspect, the invention provides use of:

(a) benzoporphyrin derivative mono-acid (BPD-MA) known as EA6; and

(b) diethylene glycol monoethyl ether, in the manufacture of a composition for the photodynamic treatment of acne.

In one embodiment of the seventh aspect, the photosensitizer is present at a level from 0.0001% to 50%.

5 In another embodiment of the seventh aspect, the composition further comprises an additional skin-penetration enhancer selected from glycol esters, fatty acids, fatty acid esters, glycol esters, glycerides, azones, polysorbates, alcohols, dimethylsulfoxide, and mixtures thereof.

10 In another embodiment of the seventh aspect, the composition further comprises an additional skin-penetration enhancer selected from polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

In an additional embodiment of the seventh aspect, the skin-penetration enhancer is present at a level of from about 0.1% to about 90%.

15 In another embodiment of the seventh aspect, the skin-penetration enhancer is also a solubilizer for the photosensitizer.

In one embodiment of the seventh aspect, the composition comprises a solubilizer selected from polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

20 In one embodiment of the seventh aspect, the composition has a viscosity at 20°C of from about 50 cps to about 50000 cps.

In an eighth aspect, the invention provides a method of photodynamic therapy comprising administering:

- (a) a BPD or green porphyrin photosensitizer; and
- (b) at least one skin-penetration enhancer

25 for photodynamic treatment of androgenetic alopecia, alopecia areata, or for promoting hair growth.

In one embodiment of the eighth aspect, the photosensitizer is present at a level from 0.0001% to 50%.

30 In one embodiment of the eighth aspect, the skin-penetration enhancer is selected from glycol ethers, fatty acids, fatty acid esters, glycol esters, glycerides, azones, polysorbates, alcohols, dimethylsulfoxide, and mixtures thereof.

In another embodiment of the eighth aspect, the skin-penetration enhancer is selected from diethylene glycol monoethyl ether, polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

In another embodiment of the eighth aspect, the skin-penetration enhancer is present at a level of from about 0.1% to about 90%.

In one embodiment of the eighth aspect, the skin-penetration enhancer is also a solubilizer for the photosensitizer.

5 In an additional embodiment of the eighth aspect, the BPD or green porphyrin photosensitizer and at least one skin-penetration enhancer are in a composition comprising a solubilizer selected from diethylene glycol monoethyl ether, polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

10 In another embodiment of the eighth aspect, the BPD or green porphyrin photosensitizer and at least one skin-penetration enhancer are in a composition with a viscosity at 20°C of from about 50 cps to about 50000 cps.

15 In a ninth aspect, the invention provides a method of photodynamic therapy comprising administering a BPD or green-porphyrin photosensitizer, low molecular weight polyethylene glycol, diethylene glycol monoethyl ether, high molecular weight polyethylene glycol, and fatty alcohol for photodynamic treatment.

In one embodiment of the ninth aspect, the photodynamic treatment is treatment of androgenetic alopecia, alopecia areata, skin cancers, psoriasis atopic, dermatitis, endometrial ablation, or for promoting hair growth.

20 In another embodiment of the ninth aspect, the photodynamic treatment is treatment of acne.

In one embodiment of the ninth aspect, the method further comprises applying the composition or medicament to the target tissue and irradiating the target tissue with activation energy of an appropriate wavelength to activate the photosensitizer.

25 In a tenth aspect, the invention provides method of photodynamic therapy comprising administering

- (a) a BPD or green porphyrin photosensitizer; and
- (b) diethylene glycol monoethyl ether

for photodynamic treatment of androgenetic alopecia, alopecia areata, or for promoting hair growth.

30 In one embodiment of the tenth aspect, the photosensitizer is present at a level from 0.0001% to 50%.

In another embodiment of the tenth aspect, the BPD or green porphyrin photosensitizer and diethylene glycol monoethyl ether are in a composition comprising an additional skin-penetration enhancer selected from glycol esters, fatty acids, fatty acid

esters, glycol esters, glycerides, azones, polysorbates, alcohols, dimethylsulfoxide, and mixtures thereof.

In one embodiment of the tenth aspect, the BPD or green porphyrin photosensitizer and diethylene glycol monoethyl ether are in a composition comprising an additional skin-penetration enhancer selected from polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

In an additional embodiment of the tenth aspect, the diethylene glycol monoethyl ether is present at a level of from 0.1% to about 90%.

In another embodiment of the tenth aspect, the BPD or green porphyrin photosensitizer and diethylene glycol monoethyl ether are in a composition comprising a solubilizer selected from polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

In another embodiment of the tenth aspect, the BPD or green porphyrin photosensitizer and diethylene glycol monoethyl ether are in a composition with a viscosity at 20°C of from about 50 cps to about 50000 cps.

In an eleventh aspect, the invention provides a method of photodynamic therapy comprising administering

- (a) benzoporphyrin derivative mono-acid (BPD-MA) known as EA6; and
- (b) more than one skin penetration enhancer,

for the photodynamic treatment of acne.

In one embodiment of the eleventh aspect, the photosensitizer is present at a level from 0.0001% to 50%.

In one embodiment of the eleventh aspect, at least one of the skin-penetration enhancers is selected from glycol esters, fatty acids, fatty acid esters, glycol esters, glycerides, azones, polysorbates, alcohols, dimethylsulfoxide, and mixtures thereof.

In another embodiment of the eleventh aspect, at least one of the skin-penetration enhancers is selected from diethylene glycol monoethyl ether, polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

In another embodiment of the eleventh aspect, the more than one skin-penetration enhancers are present at a level of from about 0.1% to about 90%.

In an additional embodiment of the eleventh aspect, the more than one skin-penetration enhancers are also a solubilizer for the photosensitizer.

In one embodiment of the eleventh aspect, the EA6 and skin penetration enhancers are in a composition comprising

solubilizer selected from diethylene glycol monoethyl ether, polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

In an additional embodiment of the eleventh aspect, the EA6 and skin penetration enhancers are in a composition with a viscosity at 20°C of from about 50 cps to about
5 50000 cps.

In a twelfth aspect, the invention provides a method of photodynamic therapy comprising administering

(a) a BPD or green porphyrin photosensitizer; and

(b) diethylene glycol monoethyl ether,

10 for the photodynamic treatment of acne.

In one embodiment of the twelfth aspect, the photosensitizer is present at a level from 0.0001% to 50%.

In one embodiment of the twelfth aspect, the BPD or green porphyrin photosensitizer and diethylene glycol monoethyl ether are in a composition comprising an
15 additional skin-penetration enhancer selected from glycol esters, fatty acids, fatty acid esters, glycol esters, glycerides, azones, polysorbates, alcohols, dimethylsulfoxide, and mixtures thereof.

In another embodiment of the twelfth aspect, the BPD or green porphyrin photosensitizer and diethylene glycol monoethyl ether are in a composition comprising an
20 additional skin-penetration enhancer selected from polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

In another embodiment of the twelfth aspect, the diethylene glycol monoethyl ether is present at a level of from about 0.1% to about 90%.

In one embodiment of the twelfth aspect, the BPD or green porphyrin
25 photosensitizer and diethylene glycol monoethyl ether are in a composition comprising a solubiliser selected from polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

In another embodiment of the twelfth aspect, the BPD or green porphyrin photosensitizer and diethylene glycol monoethyl ether are in a composition with a
30 viscosity at 20°C of from about 50 cps to about 50000 cps.

In a thirteenth aspect, the invention provides a method of photodynamic therapy comprising administering

(a) benzoporphyrin derivative mono-acid (BPD-MA) known as EA6; and

(b) at least one skin-penetration enhancer,

2g

for the photodynamic treatment of acne.

In one embodiment of the thirteenth aspect, the EA6 is present at a level from 0.0001% to 50%.

5 In one embodiment of the thirteenth aspect, at least one skin-penetration enhancer is selected from glycol esters, fatty acids, fatty acid esters, glycol esters, glycerides, azones, polysorbates, alcohols, dimethylsulfoxide, and mixtures thereof.

In another embodiment of the thirteenth aspect, at least one skin-penetration enhancer is selected from diethylene glycol monoethyl ether, polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

10 In another embodiment of the thirteenth aspect, the skin-penetration enhancer is present at a level of from about 0.1% to about 90%.

In one embodiment of the thirteenth aspect, the skin-penetration enhancer is also a solubilizer for EA6.

15 In one embodiment of the thirteenth aspect, the EA6 and skin-penetration enhancer are in a composition comprising a solubilizer selected from diethylene glycol monoethyl ether, polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

In another embodiment of the thirteenth aspect, the composition has a viscosity at 20°C of from about 50 cps to about 50000 cps.

20 The present invention relates to a composition comprising a photosensitizing agent and at least one skin-penetration enhancer. The compositions herein show improved delivery of the photosensitizer through the stratum corneum. In addition, the compositions of the present invention show improved stability.

25 The photosensitizers of the present compositions are able to penetrate the stratum corneum. Consequently, when light energy is delivered, the photosensitizer is activated at the target tissue rather than at the surface. This means that the compositions are more efficacious. In addition, it has surprisingly been found that, when using the compositions of the present invention, administration of light does not cause substantial skin photosensitivity. While not wishing to be bound by theory, it is thought that this the fact
30 that the photosensitizer distributes to the epidermis, rather than in the dermis, means there is less skin photosensitivity.

Unless otherwise specified, all documents referred to are incorporated herein by reference.

35 Unless otherwise specified, all percentages herein are expressed as weight percentages.

Detailed Description

The present invention provides compositions comprising a photosensitizing agent and a skin penetration enhancer. These elements will be described in more detail below.

5

The compositions of the present invention are preferably substantially free of water. As used herein, the term "substantially free of water" means that the composition comprises less than about 5%, preferably less than about 3%, by weight, of free water. It is preferred that the compositions herein do not have a total water content (i.e. free water plus any water of hydration) of more than about 15%, preferably less than about 10%.

10

Photosensitizer

Any suitable photosensitizing agent may be used herein. Generally, these will absorb radiation in the range of from 400nm to 800nm, typically from 600nm to 750nm.

15

As used herein, "photosensitizer" or "photosensitizing agent" means a chemical compound which, when accumulated in selected target tissues and contacted by radiation, absorbs the light and induces changes to, or destruction of, the target. Virtually any chemical compound that can be taken up by target cells or tissues and absorbs light may be used in this invention. Preferably, the chemical compound is nontoxic to the animal to which it is administered or is capable of being formulated in a nontoxic composition. Preferably, the chemical compound in its photodegraded form is also nontoxic. A listing of photosensitive chemicals may be found in Kreimer-Birnbaum, Sem. Hematol. 26:157-73, 1989 (incorporated herein by reference) and in Redmond and Gamlin, Photochem. Photobiol. 70 (4): 391-475 (1999).

20

In preferred embodiments of the invention, the photosensitizer is selected from a particularly potent group of photosensitizers known as green porphyrins, which are described in detail in U.S. Patent No. 5,171,749 (incorporated herein by reference). The term "green porphyrins" refers to porphyrin derivatives obtained by reacting a

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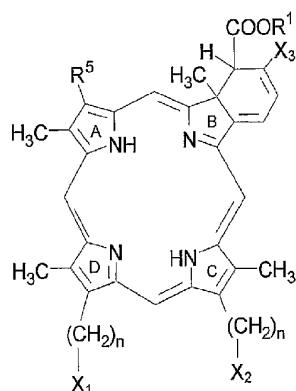
porphyrin nucleus with an alkyne in a Diels-Alder type reaction to obtain a mono-hydrobenzoporphyrin. Such resultant macropyrrolic compounds are called benzoporphyrin derivatives (BPDs), which is a synthetic chlorin-like porphyrin with various structural analogues, as shown in U.S. Patent 5,171,749. Typically, green

5 porphyrins are selected from a group of tetrapyrrolic porphyrin derivatives obtained by Diels-Alder reactions of acetylene derivatives with protoporphyrin under conditions that promote reaction at only one of the two available conjugated, nonaromatic diene structures present in the protoporphyrin-IX ring systems (rings A and B). Metallated forms of a Gp, in which a metal cation replaces one or two

10 hydrogens in the center of the ring system, may also be used in the practice of the invention. The preparation of the green porphyrin compounds useful in this invention is described in detail in U.S. Patent No. 5,095,030 (hereby incorporated by reference).

15 Preferably, the BPD is a benzoporphyrin derivative diester di-acid (BPD-DA), mono-acid ring A (BPD-MA), mono-acid ring B (BPD-MB), or mixtures thereof. These compounds absorb light at about 692nm wavelength and have improved tissue penetration properties. The compounds of formulas BPD-MA and BPD-MB may be homogeneous, in which only the C ring carbalkoxyethyl or only the D ring

20 carbalkoxyethyl would be hydrolyzed, or may be mixtures of the C and D ring substituent hydrolyzates. A number of other BPD B-ring derivatives may also be used in the present methods. These derivatives have the following general formula:



wherein; R⁵ is vinyl, R¹ and R⁶ are methyl, and n is 2. X₁, X₂, and X₃ are listed in the tables below:

5

Table 1. Hydrophilic BPD B-ring analogs

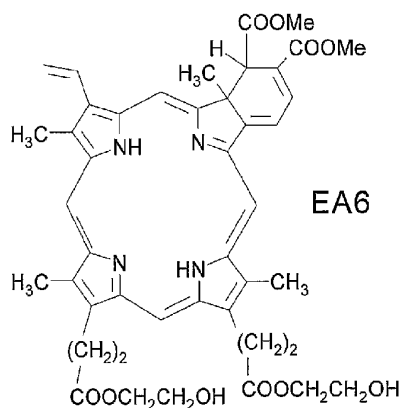
Drug	X ₁	X ₂	X ₃
QLT0061	COOH	COOH	COOH
QLT0077	CONH(CH ₂) ₂ N ⁺ (CH ₃) ₃ I ⁻	CONH(CH ₂) ₂ N ⁺ (CH ₃) ₃ I ⁻	COOCH ₃
QLT0079	CONH(CH ₂) ₂ N ⁺ (CH ₃) ₂ ((CH ₂) ₃ CH ₃)	CONH(CH ₂) ₂ N ⁺ (CH ₃) ₂ ((CH ₂) ₃ CH ₃)	COOCH ₃
QLT0086	CONHCH(COOH)CH ₂ COOH	CONHCH(COOH)CH ₂ COOH	COOCH ₃
QLT0092	CONH(CH ₂) ₂ NH(CH ₃) ₂ CF ₃ COO ⁻	CONH(CH ₂) ₂ NH(CH ₃) ₂ CF ₃ COO ⁻	COOCH ₃
QLT0094	CONHCH ₂ COOH	CONHCH ₂ COOH	CONHCH ₂ COOH

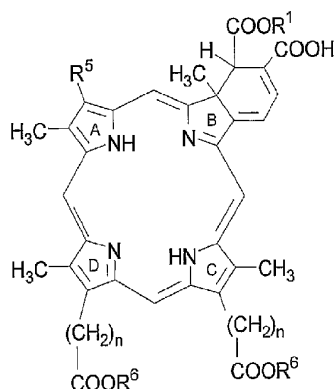
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Table 2. Lipophilic BPD B-ring analogs

Drug	X1	X2	X3
QLT0060	CO(O(CH ₂) ₂) ₀ OH	CO(O(CH ₂) ₂) ₀ OH	COOCH ₃
QLT0069	COOCH ₃	COOCH ₃	COOH
QLT0074	CO(OCH ₂ CH ₂) ₀ OH	CO(OCH ₂ CH ₂) ₀ OH	COOCH ₃
QLT0078	CO(O(CH ₂) ₂) ₂ OH	CO(O(CH ₂) ₂) ₀ OH	COOCH ₃
QLT0080	CO(O(CH ₂) ₂) ₃ OH	CO(O(CH ₂) ₂) ₁ OH	COOCH ₃
QLT0081	CO(O(CH ₂) ₂) ₂ OCH ₃	CO(O(CH ₂) ₂) ₂ OCH ₃	CO(O(CH ₂) ₂) ₂ OCH ₃
QLT0082	CO(O(CH ₂) ₂) ₂ OH	CO(O(CH ₂) ₂) ₂ OH	CO(O(CH ₂) ₂) ₂ OH
QLT0083	CO(O(CH ₂) ₂) ₃ OH	CO(O(CH ₂) ₂) ₃ OH	CO(O(CH ₂) ₂) ₃ OH
QLT0087	CO(O(CH ₂) ₂) ₄ OH	CO(O(CH ₂) ₂) ₄ OH	COOCH ₃
QLT0088	COOCH ₃	COOCH ₃	CONH(C ₆ H ₄)(C ₃ H ₇ N)
QLT0090	CO(O(CH ₂) ₂) ₅ OH	CO(O(CH ₂) ₂) ₅ OH	COOCH ₃
QLT0093	CO(O(CH ₂) ₂) ₅ OH	CO(O(CH ₂) ₂) ₅ OH	CO(O(CH ₂) ₂) ₅ OH

Preferred photosensitizers are the benzoporphyrin derivative mono-acid (BPD-MA),
 5 EA6, also known as QLT 0074, (as set forth in U.S. 5,929,105) and B3 (as set forth
 in U.S. Pat. No. 5,990,149). BPD-MA, for example, is lipophilic and a potent
 photosensitizer. EA6 and B3 have the following structures:





wherein; R⁵ is vinyl, R¹ and R⁶ are methyl, and n is 0, 1, 2, or 3. Preferably, n is 2.

5 Additionally, the photosensitizers used in the invention may be conjugated to various ligands to facilitate targeting. These ligands include receptor-specific ligands as well as immunoglobulins and fragments thereof. Preferred ligands include antibodies in general and monoclonal antibodies, as well as immunologically reactive fragments of both.

10 Dimeric forms of the green porphyrin and dimeric or multimeric forms of green porphyrin/porphyrin combinations can be used. The dimers and oligomeric compounds of the invention can be prepared using reactions analogous to those for dimerization and oligomerization of porphyrins *per se*. The green porphyrins or green porphyrin/porphyrin linkages can be made directly, or porphyrins may be
 15 coupled, followed by a Diels-Alder reaction of either or both terminal porphyrins to convert them to the corresponding green porphyrins. Of course combinations of two or more photosensitizers may be used in the practice of the invention.

20 In addition to the above mentioned preferred photosensitizing agents, additional examples of photosensitizers useful in the invention include, but are not limited to, green porphyrins disclosed in US Pat. Nos. 5,283,255, 4,920,143, 4,883,790, 5,095,030, and 5,171,749; and green porphyrin derivatives, discussed in US Pat.

Nos. 5,880,145 and 5,990,149. Several structures of typical green porphyrins are shown in the above cited patents, which also provide details for the production of the compounds.

5 The amount of photosensitizer used herein will depend on a variety of factors such as the specific type of PS and the type of activation energy source. However, it is preferred that the compositions herein comprise from about 0.0001% to about 50%, more preferably from about 0.001% to about 5%, even more preferably from about 0.01% to about 2%, still more preferably from about 0.1% to about 1%, by weight,
10 of photosensitizer.

Skin-Penetration Enhancer

The compositions herein must comprise a skin-penetration enhancer. As used herein, the term "skin-penetration enhancer" means a substance or mixture of
15 substances that aids in the delivery of the photosensitizing agent through the Stratum Corneum of the skin.

Any skin-penetration enhancer suitable for aiding the delivery of the photosensitizing agent can be used herein. A list of skin-penetration enhancers
20 can be found in "Pharmaceutical Skin Penetration Enhancement" (1993) Walters, K.A., ed.; Hadgraft, J., ed - New York, N.Y. Marcel Dekker and in "Skin Penetration Enhancers cited in the Technical Literature" Osbourne, D.W. Pharmaceutical Technology, November 1997, pp 59-65, both of which are incorporated herein by reference. Highly preferred for use in the compositions herein are hydrophobic skin-
25 penetration enhancers.

Preferred skin-penetration enhancers are selected from glycol ethers, fatty acids, fatty acid esters, glycol esters, glycerides, azones, polysorbates, alcohols, dimethylsulfoxide, and mixtures thereof.

30 Preferred skin-penetration enhancers for use herein include, but are not limited to, diethylene glycol monoethyl ether (Transcutol®), Oleyl alcohol, Oleic acid, Azone (Laurocapram or 1-n-Dodecyl azacycloheptan-2-one), Propylene glycol mono- and

diesters of fats and fatty acids (e.g. propylene glycol monocaprylate, propylene glycol monolaurate), Triglycerides and lipids (e.g. linoleic acid), Macroglycerides or Polyethylene glycol glycerides and fatty esters (e.g. stearyl macroglycerides, oleoyl macroglycerides, lauroyl macroglycerides, Oleyl macrogol-6-glycerides, Lauroyl macrogol-6 glycerides), Glycerides and fatty acid esters of polyethylene glycol (e.g. caprylocaproyl macroglycerides, capryl-caproyl macroglycerides, oleoyl macroglycerides), Polyoxyl 40 Hydrogenated Castor Oil (Cremophor RH 40), Polysorbate 80 (Tween 80), Dodecylazacycloheptanone, SEPA® such as described in US Patent 4,861,764 (e.g. 2-n-nonyl-1,3-dioxolane), and mixtures thereof.

Most preferred is diethylene glycol monoethyl ether (available from Gattefosse under the tradename Transcutol).

It is preferred that the compositions herein comprise from about 0.1% to about 99%, preferably from about 0.1% to about 90%, more preferably from about 5% to about 90%, even more preferably from about 15% to about 75%, by weight of skin penetration enhancer.

It is preferred that the ratio of photosensitizer to skin-penetration enhancer is from about 1:20 to about 1:10000, more preferably from about 1:60 to 1:300, on the basis of percentages by weight of total composition.

It is highly preferred that the compositions of the present invention have a viscosity at 20°C of from about 50 cps to about 50000 cps, more preferably from about 500 cps to about 40000 cps, even more preferably from about 5000 cps to about 30000 cps.

Solubilizer

It is highly preferred that the compositions herein comprise a solubilizer. This is especially true when the photosensitizer is hydrophobic. Some solubilizers are also penetration enhancers and it is preferred that the compositions herein comprise a penetration enhancer that is also a solubilizer for the photosensitizer.

Preferably the solubilizer is selected from glycol ethers, polyethylene glycol, polyethylene glycol derivatives, propylene glycol, propylene glycol derivatives, fatty alcohols, aromatic alcohols, propylene glycol, glycerols, oils, surfactants, glucosides, and mixtures thereof.

More preferably the solubilizer is selected from diethylene glycol monoethyl ether (Transcutol®), polyethylene glycol of average molecular weight from 100 to 5000, triethylene glycol, tetraethylene glycol, pentaethylene glycol, hexaethylene glycol, septaethylene glycol, octaethylene glycol, propylene glycol, propylene glycol mono- and diesters of fats and fatty acids (e.g. propylene glycol monocaprylate, propylene glycol monolaurate), benzyl alcohol, glycerol, oleyl alcohol, mineral oil, lanolin/lanolin derivatives, petrolatum or other petroleum products suitable for application to the skin, propylene glycol mono- and diesters of fats and fatty acids, macrogols, macrogolglycerides or polyethylene glycol glycerides and fatty esters (e.g. stearyl macrogolglycerides, oleyl macrogolglycerides, lauroyl macrogolglycerides, linoleoyl macrogolglycerides), ethoxylated castor oil (e.g. Cremophor – a polyoxyl hydrogenated castor oil), C6-C30 triglycerides, natural oils, glucosides (e.g. cetearyl glucoside), surfactants, and mixtures thereof.

More preferable the solubilizer is selected from diethylene glycol monoethyl ether (Transcutol®), PEG-200, oleyl alcohol, and mixtures thereof.

It is preferred that the compositions herein comprise from about 0.1% to about 99%, more preferably from about 1% to about 75%, by weight of solubilizer.

Viscosity Modifying Agents

The compositions herein preferably comprise a viscosity modifying agent. Preferred viscosity modifiers are selected from polyethylene glycols, acrylic acid-based polymers (carbopol polymers or carbomers), polymers of acrylic acid crosslinked with allyl sucrose or allylpentaerythritol (carbopol homopolymers), polymers of acrylic acid modified by long chain (C10-C30) alkyl acrylates and crosslinked with allylpentaerythritol (carbopol copolymers), poloxamers also known

as pluronics (block polymers; e.g. Poloxamer 124, 188, 237, 338, 407), waxes (paraffin, glyceryl monostearate, diethylene glycol monostearate, propylene glycol monostearate, ethylene glycol monostearate, glycol stearate), hard fats (e.g. Saturated C8-C18 fatty acid glycerides), xanthan gum, polyvinyl alcohol, solid alcohols, and mixtures thereof. More preferably the viscosity modifiers are selected from high molecular weight polyethylene glycols, especially PEG-3350.

Optional Ingredients

The compositions herein may comprise a variety of optional components. Any suitable ingredient may be used herein but typically these optional component will render the compositions more cosmetically acceptable or provide additional usage benefits. Some examples of preferred optional ingredients include, but are not limited to, emulsifiers, humectants, emollients, surfactants, oils, waxes, fatty alcohols, dispersants, skin-benefit agents, pH adjusters, dyes/coulourants, analgesics, perfumes, preservatives, and mixtures thereof.

Examples of suitable preservatives include but are not limited to parabens, benzyl alcohol, quaternium 15, imidazolidyl urea, disodium EDTA, methylisothiazoline, alcohols, and mixtures thereof. Examples of suitable emulsifiers include but are not limited to waxes, sorbitan esters, polysorbates, ethoxylated castor oil, ethoxylated fatty alcohols, macroglycerides or polyethylene glycol glycerides and fatty esters (e.g. stearyl macroglycerides, oleoyl macroglycerides, lauroyl macroglycerides), esters of saturated fatty acids (e.g. diethylene glycol parmitostearate), macrogols of cetostearyl ether (e.g. macrogol-6-cetostearyl ether), polymers of high molecular weight, crosslinked acrylic acid-based polymers (carbopols or carbomers) , and mixtures thereof. Examples of suitable emollients include but are not limited to propylene glycol dipelargonate, 2-octyldodecyl myristate, non-polar esters, triglycerides and esters (animal and vegetable oils), lanolin, lanolin derivatives, cholesterol, glucosides (e.g. cetearyl glucoside), pegylated lanolin, ethoxylated glycerides, and mixtures thereof. Examples of suitable surfactants include but are not limited to sorbitan esters, polysorbates, sarcosinates, taurate, ethoxylated castor oil, ethoxylated fatty alcohols, ethoxylated glycerides, caprylocaproyl macrogol-8 glycerides, polyglyceryl-6 dioleate, and

mixtures thereof. Examples of suitable oils include but are not limited to propylene glycol monocaprylate, medium chain triglycerides (MCT), 2-octyl-dodecyl myristate, cetearyl ethylhexanoate, and mixtures thereof. Examples of suitable fatty alcohols include but are not limited to cetostearyl alcohol, cetyl alcohol, stearyl alcohol, and mixtures thereof.

Also useful in the compositions herein are lipids and triglycerides (e.g. concentrates of Seed Oil Lipids, Concentrates of Marine Oil Lipids, high purity triglycerides and esters), alkyl ether sulfates, alkyl polyglycosides, alkylsulfates, amphoteric cream bases, and mixtures thereof.

A preferred embodiment of the present invention comprises green-porphyrin photosensitizer, low molecular weight PEG such as PEG200, diethylene glycol monoethyl ether (Transcutol®), high molecular weight PEG such as PEG3350 and fatty alcohol such as oleyl alcohol. While not wishing to be bound by theory it is believed that the PEG3350 acts as a viscosity modifier while the Transcutol, PEG 200, and oleyl alcohol act to deliver the photosensitizer through the stratum corneum.

20 Method of Use

The present invention also relates to a method of using a composition as described hereinabove. Said method comprises:

- 25 (i) applying to the skin a composition comprising a photosensitizing agent and a carrier wherein the carrier comprises a skin-penetration enhancer,
- (ii) allowing time for at least some of the photosensitizer to penetrate through the stratum corneum,
- (iii) washing the skin to which the composition has been applied, and
- 30 (iv) irradiating with activation energy at a wavelength appropriate to activate the photosensitizer.

The washing step can be performed with any suitable substance.

The washing step can be performed using a composition comprising at least one of the ingredients of the carrier. Preferably, the wash composition comprises two or more, more preferably all, of the ingredients of the carrier. It is preferred that the levels of ingredient(s) in the wash composition are at the same or similar levels as
5 in the carrier.

While not wishing to be bound by theory, it is believed that the washing step removes excess photosensitizer which might otherwise mask the target preventing the activation energy from reaching the target. The utilization of a composition
10 similar to the carrier is believed to aid with the penetration of the photosensitizer composition through the creation of a concentration gradient.

Process

The present compositions can be made by any suitable process. Preferably, the
15 photosensitizer is lyophilized. A preferred process for production of the present compositions comprises:

- a) Preparation of lyophilized photosensitizer,
- b) Manufacture of base composition comprising a skin penetration enhancer and,
20 optionally, a solubilizer,
- c) Addition of the photosensitizer to the base with stirring.

In an alternative process the photosensitizer is first dissolved in a solubilizer with
25 heating. As mentioned above it is preferred that the solubilizer is also a skin-penetration enhancer. After cooling any remaining ingredients are added.

Method of Treatment

The compositions of the present invention may be used for promoting hair growth. The present method comprises applying a composition of the present invention to a
30 suitable target and activating the photosensitizing agent. Typically, from about 0.1g to about 50g, preferably from about 1g to about 10g, of the composition is applied to the target. The activation energy can be from an suitable energy source.

The compositions of the present invention can be used for the treatment of androgenetic alopecia. The present method comprises applying a composition of the present invention to a suitable target and activating the photosensitizing agent. Typically, from about 0.1g to about 50g, preferably from about 1g to about 10g, of the composition is applied to the target. The activation energy can be from an
5 suitable energy source.

The compositions of the present invention can be used for the treatment of alopecia areata. The present method comprises applying a composition of the present
10 invention to a suitable target and activating the photosensitizing agent. Typically, from about 0.1g to about 50g, preferably from about 1g to about 10g, of the composition is applied to the target. The activation energy can be from an suitable energy source.

15 The compositions of the present invention can be used for the treatment of skin cancers. The present method comprises applying a composition of the present invention to a suitable target and activating the photosensitizing agent. Typically, from about 0.1g to about 50g, preferably from about 1g to about 10g, of the composition is applied to the target. The activation energy can be from an suitable
20 energy source.

The compositions of the present invention can be used for the treatment of acne. The present method comprises applying a composition of the present invention to a suitable target and activating the photosensitizing agent. Typically, from about 0.1g
25 to about 50g, preferably from about 1g to about 10g, of the composition is applied to the target. The activation energy can be from an suitable energy source.

The compositions of the present invention can be used for the treatment of psoriasis. The present method comprises applying a composition of the present
30 invention to a suitable target and activating the photosensitizing agent. Typically, from about 0.1g to about 50g, preferably from about 1g to about 10g, of the composition is applied to the target. The activation energy can be from an suitable energy source.

The compositions of the present invention can be used for the treatment of atopic dermatitis. The present method comprises applying a composition of the present invention to a suitable target and activating the photosensitizing agent. Typically, from about 0.1g to about 50g, preferably from about 1g to about 10g, of the composition is applied to the target. The activation energy can be from an suitable energy source.

The compositions of the present invention can be used for the treatment of endometrial ablation. The present method comprises applying a composition of the present invention to a suitable target and activating the photosensitizing agent. Typically, from about 0.1g to about 50g, preferably from about 1g to about 10g, of the composition is applied to the target. The activation energy can be from an suitable energy source.

Examples

It will be understood that the following embodiments of the present invention are intended to be illustrative of some of the possible applications or principles. Various modifications may be made by the skilled person without departing from the true spirit and scope of the invention.

	<u>Example 1</u> <u>(wt%)</u>	<u>Example 2</u> <u>(wt%)</u>	<u>Example 3</u> <u>(wt%)</u>	<u>Comparative</u> <u>Example (wt%)</u>
QLT0074	0.5	0.25	0.75	0.5
PEG-200	54	50	58	54
Transcutol® ¹	20	24	16	0
PEG-3350	15.5	10	15.5	15.5
Oleyl Alcohol	10	15.75	10	30

¹ Diethylene glycol monethyl ether available from Gattefosse Canada Inc., Baie D'Urfé, Québec, H9X 2T3, Canada

The above compositions were prepared in the following way:

- a) Preparation of cryodesiccated photosensitizer – the QLT0074 is dissolved in Glacial Acetic Acid. The solution is then frozen in a dry ice/isopropanol bath and the acetic acid is removed by lyophilization. The resultant material is a fine fluffy powder which goes into topical solution easily.
- 5 b) Manufacture of base – the PEG 200 is warmed to 80-90 °C with stirring. PEG 3.35K is added with stirring followed by oleyl alcohol, then where present the transcuto[®]. Stirring is continued until solution is clear.
- c) Addition of photosensitizer - base composition is cooled to approx. 50 °C and the photosensitizer is added with stirring. Stirring is continued with cooling until
- 10 homogeneous paste is achieved. The resulting formulation is checked for the absence of undissolved photosensitizer crystals by phase contrast microscopy.

It was found that Examples 1-3 gave good penetration of the QLT0074 through the stratum corneum while the comparative example did not.

15

The claims defining the invention are as follows:

1. Use of:
 - a) a BPD or green porphyrin photosensitizer; and
 - b) at least one skin-penetration enhancer, in the manufacture of a
5 composition for the photodynamic treatment of androgenetic alopecia, alopecia areata, or for promoting hair growth.
2. Use of a composition comprising a BPD or green-porphyrin photosensitizer, low molecular weight polyethylene glycol, diethylene glycol monoethyl ether, high molecular weight polyethylene glycol, and fatty alcohol in the manufacture of a
10 medicament for photodynamic treatment.
3. A method of photodynamic therapy comprising:
 - (i) applying to the skin a composition comprising benzoporphyrin derivative mono-acid (BPD-MA) known as EA6 as herein defined and a carrier wherein the carrier comprises more than one skin-penetration enhancer,
15 (ii) allowing time for at least some of the EA6 to penetrate through the stratum corneum,
 - (iii) washing the skin to which the composition has been applied, and
 - (iv) irradiating with activation energy at a wavelength appropriate to activate the EA6.
- 20 4. A process for the manufacture of a composition, said process comprising:
 - (a) preparing a lyophilized benzoporphyrin derivative mono-acid (BPD-MA) known as EA6,
 - (b) manufacturing a base composition comprising more than one skin penetration enhancer and, optionally, a solubilizer, and
 - (c) adding the lyophilized EA6 to the base with stirring.
25
5. Use of:
 - a) a BPD or green porphyrin photosensitizer; and
 - b) diethylene glycol monoethyl ether, in the manufacture of a composition
for the photodynamic treatment of androgenetic alopecia, alopecia areata, or for
30 promoting hair growth.
6. Use of:
 - a) benzoporphyrin derivative mono-acid (BPD-MA) known as EA6; and

b) more than one skin penetration enhancer, in the manufacture of a composition for the photodynamic treatment of acne.

7. Use of:

- (a) benzoporphyrin derivative mono-acid (BPD-MA) known as EA6; and
- (b) diethylene glycol monoethyl ether, in the manufacture of a composition for the photodynamic treatment of acne.

8. A method of photodynamic therapy comprising administering:

- (a) a BPD or green porphyrin photosensitizer; and
 - (b) at least one skin-penetration enhancer
- for photodynamic treatment of androgenetic alopecia, alopecia areata, or for promoting hair growth.

9. The method of claim 8, wherein the photosensitizer is present at a level from 0.0001% to 50%.

10. The method of claim 8 or 9, wherein the skin-penetration enhancer is selected from glycol ethers, fatty acids, fatty acid esters, glycol esters, glycerides, azones, polysorbates, alcohols, dimethylsulfoxide, and mixtures thereof.

11. The method of claim 8 or 10, wherein the skin-penetration enhancer is selected from diethylene glycol monoethyl ether, polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

12. The method of any one of claims 8 to 11, wherein the skin-penetration enhancer is present at a level of from about 0.1% to about 90%.

13. The method of any one of claims 8 to 12, wherein the skin-penetration enhancer is also a solubilizer for the photosensitizer.

14. The method of any one of claims 8 to 13, wherein the BPD or green porphyrin photosensitizer and at least one skin-penetration enhancer are in a composition comprising a solubilizer selected from diethylene glycol monoethyl ether, polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

15. The method of any one of claims 8 to 14, wherein the BPD or green porphyrin photosensitizer and at least one skin-penetration enhancer are in a composition with a viscosity at 20°C of from about 50 cps to about 50000 cps.

16. A method of photodynamic therapy comprising administering a BPD or green-porphyrin photosensitizer, low molecular weight polyethylene glycol, diethylene glycol monoethyl ether, high molecular weight polyethylene glycol, and fatty alcohol for photodynamic treatment.

17. The method of claim 16, wherein the photodynamic treatment is treatment of androgenetic alopecia, alopecia areata, skin cancers, psoriasis atopic, dermatitis, endometrial ablation, or for promoting hair growth.

18. The method of claim 16, wherein the photodynamic treatment is treatment of
5 acne.

19. The method of claim 8, 17 or 18, further comprising applying the composition or medicament to the target tissue and irradiating the target tissue with activation energy of an appropriate wavelength to activate the photosensitizer.

20. A method of photodynamic therapy comprising administering

(a) a BPD or green porphyrin photosensitizer; and

(b) diethylene glycol monoethyl ether

for photodynamic treatment of androgenetic alopecia, alopecia areata, or for promoting hair growth.

21. The method of claim 20, wherein the photosensitizer is present at a level
15 from 0.0001% to 50%.

22. The method of claim 20 or 21, wherein the BPD or green porphyrin photosensitizer and diethylene glycol monoethyl ether are in a composition comprising an additional skin-penetration enhancer selected from glycol esters, fatty acids, fatty acid esters, glycol esters, glycerides, azones, polysorbates, alcohols, dimethylsulfoxide, and
20 mixtures thereof.

23. The method of claim 20 or 21, wherein the BPD or green porphyrin photosensitizer and diethylene glycol monoethyl ether are in a composition comprising an additional skin-penetration enhancer selected from polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

24. The method of any one of claims 20 to 23, wherein the diethylene glycol monoethyl ether is present at a level of from 0.1% to about 90%.

25. The method of any one of claims 20 to 24, wherein the BPD or green porphyrin photosensitizer and diethylene glycol monoethyl ether are in a composition comprising a solubilizer selected from polyethylene glycol of average molecular weight
30 from 200 to 4000, oleyl alcohol, and mixtures thereof.

26. The method of any one of claims 20 to 25, wherein the BPD or green porphyrin photosensitizer and diethylene glycol monoethyl ether are in a composition with a viscosity at 20°C of from about 50 cps to about 50000 cps.

27. A method of photodynamic therapy comprising administering

- (a) benzoporphyrin derivative mono-acid (BPD-MA) known as EA6; and
- (b) more than one skin penetration enhancer,

for the photodynamic treatment of acne.

28. The method of claim 27, wherein the photosensitizer is present at a level
5 from 0.0001% to 50%.

29. The method of claim 27 or 28, wherein at least one of the skin-penetration
enhancers is selected from glycol esters, fatty acids, fatty acid esters, glycol esters,
glycerides, azones, polysorbates, alcohols, dimethylsulfoxide, and mixtures thereof.

30. The method of 27 or 28, wherein at least one of the skin-penetration
10 enhancers is selected from diethylene glycol monoethyl ether, polyethylene glycol of
average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

31. The method of any one of claims 27 to 30, wherein the more than one skin-
penetration enhancers are present at a level of from about 0.1% to about 90%.

32. The method of any one of claims 27 to 31, wherein the more than one skin-
15 penetration enhancers are also a solubilizer for the photosensitizer.

33. The method of any one of claims 27 to 32, wherein the EA6 and skin
penetration enhancers are in a composition comprising a solubilizer selected from
diethylene glycol monoethyl ether, polyethylene glycol of average molecular weight from
200 to 4000, oleyl alcohol, and mixtures thereof.

34. The method of any one of claims 27 to 33, wherein the EA6 and skin
20 penetration enhancers are in a composition with a viscosity at 20°C of from about 50 cps
to about 50000 cps.

35. A method of photodynamic therapy comprising administering

- (a) a BPD or green porphyrin photosensitizer; and
 - (b) diethylene glycol monoethyl ether,
- 25
-
- for the photodynamic treatment of acne.

36. The method of claim 35, wherein the photosensitizer is present at a level
from 0.0001% to 50%.

37. The method of claim 35 or 36, wherein the BPD or green porphyrin
30 photosensitizer and diethylene glycol monoethyl ether are in a composition comprising an
additional skin-penetration enhancer selected from glycol esters, fatty acids, fatty acid
esters, glycol esters, glycerides, azones, polysorbates, alcohols, dimethylsulfoxide, and
mixtures thereof.

38. The method of claim 35 or 36, wherein the BPD or green porphyrin photosensitizer and diethylene glycol monoethyl ether are in a composition comprising an additional skin-penetration enhancer selected from polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

5 39. The method of any one of claims 35 to 38, wherein the diethylene glycol monoethyl ether is present at a level of from about 0.1% to about 90%.

40. The method of any one of claims 35 to 39, wherein the BPD or green porphyrin photosensitizer and diethylene glycol monoethyl ether are in a composition comprising a solubiliser selected from polyethylene glycol of average molecular weight
10 from 200 to 4000, oleyl alcohol, and mixtures thereof.

41. The method of any one of claims 35 to 40, wherein the BPD or green porphyrin photosensitizer and diethylene glycol monoethyl ether are in a composition with a viscosity at 20°C of from about 50 cps to about 50000 cps.

42. The method of any one of claims 35 to 41, wherein the photosensitizer is
15 benzoporphyrin derivative mono-acid (BPD-MA) known as EA6.

43. A method of photodynamic therapy comprising administering

- (a) benzoporphyrin derivative mono-acid (BPD-MA) known as EA6; and
- (b) at least one skin-penetration enhancer,

for the photodynamic treatment of acne.

20 44. The method of claim 43, wherein the EA6 is present at a level from 0.0001% to 50%.

45. The method of claim 43 or 44, wherein at least one skin-penetration enhancer is selected from glycol esters, fatty acids, fatty acid esters, glycol esters, glycerides, azones, polysorbates, alcohols, dimethylsulfoxide, and mixtures thereof.

25 46. The method of claim 43 or 44, wherein at least one skin-penetration enhancer is selected from diethylene glycol monoethyl ether, polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

47. The method of any one of claims 43 to 46, wherein the skin-penetration enhancer is present at a level of from about 0.1% to about 90%.

30 48. The method of any one of claims 43 to 47, wherein the skin-penetration enhancer is also a solubilizer for EA6.

49. The method of any one of claims 43 to 48, wherein the EA6 and skin-penetration enhancer are in a composition comprising a solubilizer selected from

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diethylene glycol monoethyl ether, polyethylene glycol of average molecular weight from 200 to 4000, oleyl alcohol, and mixtures thereof.

50. The method of any one of claims 43 to 49, wherein the composition has a viscosity at 20°C of from about 50 cps to about 50000 cps.

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