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(54) **Title:** PEPTIDES AND THEIR USE IN THE TREATMENT OF SKIN

(57) **Abstract:** Embodiments of the invention are related generally to the methods of diminishing the signs of aging in and/or improving health of human integuments, such as skin, and compositions comprising peptides useful therefor. The compositions according to the invention may comprise one or more peptides or fragments or derivatives thereof derived from a growth factor, *e.g.*, Growth Differentiation Factor 11 (GDF11), in a topically acceptable vehicle.



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PEPTIDES AND THEIR USE IN THE TREATMENT OF SKIN

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to U.S. Provisional Patent Application Serial No. 62/095,873, filed December 23, 2014, the entirety of which is incorporated herein for all purposes.

SEQUENCE LISTING

[0002] The instant application contains a Sequence Listing which has been submitted electronically in ASCII format and is hereby incorporated by reference in its entirety. Said ASCII copy, created on December 19, 2014, is named SC179P-US_SL.txt and is 28,919 bytes in size.

FIELD OF INVENTION

[0003] The present invention relates generally to peptides comprising sequences homologous to fragments of certain human growth factors and their use in formulations and associated methods for improving the health and/or diminishing the dermatological signs of aging in human skin. In particular, the invention relates to peptides derived from human growth factors. These active peptides may promote the production of collagen and/or hyaluronic acid in human skin.

BACKGROUND

[0004] Growth factors are naturally occurring substances, usually proteins, that act as signaling molecules between cells. Their primary function is promoting cell differentiation and maturation. They play an important role in stimulating cell growth, proliferation, and wound healing. Many large classes, or superfamilies, of related growth factors are known.

[0005] Growth Differentiation Factor 11 (GDF11) is a protein belonging to the transforming growth factor (TGF) superfamily. Blood-derived GDF11 was recently shown to be involved in reverting aging phenotype in mice, including cardiac hypertrophy (see Loffredo et al., *Cell*, 2013, 153, 828–839), age-related sarcopenia (see Sinha et al., *Science*, 2014, 344:649-52), and decreased cognitive functions (see Villeda et al., *Nat. Med.* 2014;20:659-63). Transforming growth factor beta (TGFβ) is another member of the TGF family. It controls

proliferation, cellular differentiation, and other functions in most cells. Connective tissue growth factor (CTGF) is a protein of the CCN family of extracellular matrix-associated heparin-binding proteins. CTGF has important roles in many biological processes, including cell adhesion, migration, proliferation, angiogenesis, skeletal development, and tissue wound repair. It is thought that CTGF can cooperate with TGF β , although the pathways remain largely unknown. Finally, platelet-derived growth factor (PDGF) is known to play a significant role in angiogenesis, the growth of blood vessels from already-existing blood vessel tissue.

[0006] Due to the many important roles growth factors play in maintaining healthy tissues, there has been some interest in using them in dermatological formulations. There are, however, drawbacks associated with the use of growth factors in topical formulations.

[0007] It is therefore an object of the invention to provide new peptides, derived from growth factors, and topical compositions containing them. It is also an object of the invention to provide methods for improving the health and/or appearance of skin, combatting signs of intrinsic and photoaging, and/or treating skin disorders. It is a further object of the invention to provide compositions and methods for treating, reversing, forestalling and/or ameliorating skin wrinkles and fine lines with cosmetic compositions comprising effective amounts of a peptide of the invention.

[0008] The foregoing discussion is presented solely to provide a better understanding of the nature of the problems confronting the art and should not be construed in any way as an admission as to prior art.

SUMMARY OF THE INVENTION

[0009] In accordance with the foregoing objectives and others, the present invention provides active peptides and topical formulations thereof that are useful for improving one or more signs of dermatological aging when topically applied to human integuments (skin, lips, nails, hair, etc.), particularly skin. The peptides of the invention are derived from human growth factors. In some embodiments, the peptides are capable of increasing collagen and/or HA production within skin cells and therefore will have a beneficial effect on reducing the appearance of aging on skin (*e.g.*, diminishing the appearance of wrinkles and/or fine lines, tightening sagging skin, thickening thinning skin, evening skin tone, etc.).

[0010] Since using a full length growth factor (*e.g.*, GDF11, or TGF β , or CTGF, or PDFT) protein may present challenges, peptide sequences (*e.g.*, 3-15 or 3-12 or 3-10 or 3-8 or

3-6 or 3-4 amino acids) derived from the sequence of full-length proteins have been designed. These peptides, especially peptides similar to putative functional regions of the protein, are contemplated to have antiaging benefits in skin.

[0011] One aspect of the invention provides compositions for topical use comprising one or more GDF11-derived peptides or fragments or derivatives thereof (*e.g.*, having from about 3 to about 12 amino acids) of the invention in a physiologically acceptable carrier. Methods for ameliorating and/or preventing signs of human skin photo- and intrinsic aging comprising topically applying the compositions comprising one or more GDF11-derived peptides of the invention to the skin are also provided.

[0012] Another aspect of the invention provides compositions for topical use comprising one or more TGF β -derived peptides or fragments or derivatives thereof (*e.g.*, having from about 3 to about 12 amino acids) of the invention in a physiologically acceptable carrier. Methods for ameliorating and/or preventing signs of human skin photo- and intrinsic aging comprising topically applying the compositions comprising one or more TGF β -derived peptides of the invention to the skin are also provided.

[0013] Yet another aspect of the invention provides compositions for topical use comprising one or more CTGF-derived peptides or fragments or derivatives thereof (*e.g.*, having from about 3 to about 15 amino acids) of the invention in a physiologically acceptable carrier. Methods for ameliorating and/or preventing signs of human skin photo- and intrinsic aging comprising topically applying the compositions comprising one or more CTGF-derived peptides of the invention to the skin are also provided.

[0014] Yet another aspect of the invention provides compositions for topical use comprising one or more PDGF-derived peptides or fragments or derivatives thereof (*e.g.*, having from about 3 to about 12 amino acids) of the invention in a physiologically acceptable carrier. Methods for ameliorating and/or preventing signs of human skin photo- and intrinsic aging comprising topically applying the compositions comprising one or more PDGF-derived peptides of the invention to the skin are also provided.

[0015] These and other aspects of the present invention will become apparent to those skilled in the art after a reading of the following detailed description of the invention, including the illustrative embodiments and examples.

DETAILED DESCRIPTION

[0016] Detailed embodiments of the present invention are disclosed herein; however, it is to be understood that the disclosed embodiments are merely illustrative of the invention that may be embodied in various forms. In addition, each of the examples given in connection with the various embodiments of the invention is intended to be illustrative, and not restrictive. Therefore, specific structural and functional details disclosed herein are not to be interpreted as limiting, but merely as a representative basis for teaching one skilled in the art to variously employ the present invention.

[0017] All percentages given herein refer to the weight percentages of a particular component relative to the entire composition, including the vehicle, unless otherwise indicated. It will be understood that the sum of all weight % of individual components within a composition will not exceed 100%.

[0018] All terms used herein are intended to have their ordinary meaning unless otherwise provided. The phrases “physiologically acceptable,” “topically acceptable” and “dermatologically acceptable” are used interchangeably and are intended to mean that a particular component is generally regarded as safe and non-toxic for application to a human integument (*e.g.*, skin) at the levels employed. The term “prevent,” as used herein, includes delaying, slowing or forestalling the onset of or progression of a particular sign of skin aging. The phrase “individual in need thereof” refers to a human that could benefit from improved dermal appearance or health, including males or females. In some embodiments, the individual in need thereof is a female. The term “skin” includes, without limitation, the lips, skin of the face, hands, arms, neck, scalp, and chest. The term “thin” skin includes skin that is prematurely thinned, and may be diagnosed as such by a dermatologist. In some embodiments, the thin skin is skin of a female under the age of 40 or skin of a pre-menopausal female. As used herein, the term “consisting essentially of” is intended to limit the invention to the specified materials or steps and those that do not materially affect the basic and novel characteristics of the claimed invention, as understood from a reading of this specification.

[0019] As used herein, all terms are intended to have their ordinary meaning in the art unless specifically defined. The term “amino acid” is intended to include naturally occurring amino acids as well as non-naturally occurring amino acids and includes any small molecule (MW < 1,000 Daltons) having at least one carboxyl group and at least one primary or secondary amine group capable of forming peptide bonds. The term “peptide” is intended to include any molecule comprising at least two amino acids joined by a peptide bond and therefore includes

di-peptides, tri-peptides, oligopeptides, and polypeptides having up to about 20 amino acid residues. The term “peptide” also embraces structures having one or more linkers, spacers, or terminal groups which are not amino acids.

[0020] Peptides

[0021] The peptides of the invention comprise, consist essentially of, or consist of sequences derived from the Growth Differentiation Factor 11 (GDF11) protein or related proteins, such as TGF β , CTGF, and/or PDGF, or of regions of homology of two or more proteins (*e.g.*, regions of homology of GDF11 and TGF β). Consisting essentially of, as used herein, is intended to mean that additional amino acids may be present at either terminus provided they do not substantially impair the activity of the peptide.

[0022] In one embodiment, the invention comprises any 3 or 4 consecutive amino acids derived from the sequence of Growth Differentiation Factor 11 (GDF11) precursor [Homo sapiens], NCBI Reference Sequence Accession No.: NP_005802.1, shown in Table 1 (SEQ ID NO: 1).

Table 1. Sequence of GDF11 Precursor [Homo Sapiens]

1	mvlaapl11	fl11ale1r	rgeaaegpa	aaaaaaaaa	agvggerss	papsvapep
	g	p	a	a	r	d
61	gcpvcvwrq	srelrlesi	sqilsklrl	eapnisrev	kqllpkapp	qqildlhdf
	h	k	k	v	l	q
12	gdalqpedf	eedeyhatt	tvismaget	pavqtdgsp	cchfhfspk	mftkvlkaq
1	l	e	d	l	v	l
18	wvylrpvpr	atvylqilr	kpltggega	gggggrrhi	irslkielh	rsghwqsid
1	p	l	g	r	s	f
24	kqvlhswfr	pqsnggiei	afdpsgtdl	vtslgpgae	lhpfmelrv	entkrstrn
1	q	n	a	g	l	l
30	gldcdehss	srccryplt	dfeafgwdw	iapkrykan	csgqceymf	qkyphthlv
1	e	v	i	y	m	q
36	qanprgsag	cctptkmsp	nmlyfndkq	iiygkipgm	vdrccgs	
1	p	i	q	v		

[0023] In some embodiments, the peptides of the invention comprise, consist essentially of, or consist of three or four consecutive amino acids from the sequence of GDF11 provided in Table 1. For example, the peptides of the invention may comprise three or four consecutive amino acids from the amino acids 1-10 or 11-20 or 21-30 or 31-40 or 41-50 or 51-60 or 61-70 or 71-80 or 81-90 or 91-100 or 101-110 or 111-120 or 121-130 or 131-140 or 141-150 or 151-160 or 161-170 or 171-180 or 181-190 or 191-200 or 201-210 or 211-220 or 221-230 or 231-240 or 241-250 or 251-260 or 261-270 or 271-280 or 281-290 or 291-300 or 301-

310 or 311-320 or 321-330 or 331-340 or 341-350 or 351-360 or 361-370 or 371-380 or 381-390 or 391-400 or 401-407 of sequence of GDF11 provided in Table 1. In other embodiments, the peptides of the invention may comprise, consist essentially of, or consist of three or four consecutive amino acids from the amino acids 5-14 or 15-24 or 25-34 or 35-44 or 45-54 or 55-64 or 65-74 or 75-84 or 85-94 or 95-104 or 105-114 or 115-124 or 125-134 or 135-144 or 145-154 or 155-164 or 165-174 or 175-184 or 185-194 or 195-204 or 205-214 or 215-224 or 225-234 or 235-244 or 245-254 or 255-264 or 265-274 or 275-284 or 285-294 or 295-304 or 305-314 or 315-324 or 325-334 or 335-344 or 345-354 or 355-364 or 365-374 or 375-384 or 385-394 or 395-407 of sequence of GDF11 provided in Table 1.

[0024] In one embodiment, the invention comprises any 3 or 4 consecutive amino acids derived from the sequence of Connective Tissue Growth Factor (CTGF) [Homo sapiens], NCBI GenBank Accession No.: AAA91279.1, shown in Table 2 (SEQ ID NO: 2).

Table 2. Sequence of CTGF [Homo Sapiens]

1	mtaasmgpv	vafvllal	srpavgqnc	gpcrcpdep	prcpagvsl	ldgcgcerv
	r	c	s	a	v	c
61	akqlgelct	rdpcdphkg	fcdfgspan	kigvctakd	apcifggvtv	rsgesfqss
	e	l	r	g	y	c
12	kyqctcldg	vgcmplcsm	vrlpspdep	prrvklpgk	ceewvcdep	dqtvvgpal
1	a	d	f	c	k	a
18	ayrledtfg	dptmiranc	vqttewsac	ktcgmgist	vtndnascr	ekqsrlcmv
1	p	l	s	r	l	r
24	pceadleen	kkgkkcirt	kiskpikfe	sgctsmkty	akfcgvctd	rcctphrtt
1	i	p	l	r	g	t
30	lpvefkcpd	evmknmmf	ktcachync	gdndifesl	yrkmygdma	
1	g	i	p	y		

[0025] In some embodiments, the peptides of the invention comprise, consist essentially of, or consist of three or four consecutive amino acids from the sequence of CTGF provided in Table 2. For example, the peptides of the invention may comprise three or four consecutive amino acids from the amino acids 1-10 or 11-20 or 21-30 or 31-40 or 41-50 or 51-60 or 61-70 or 71-80 or 81-90 or 91-100 or 101-110 or 111-120 or 121-130 or 131-140 or 141-150 or 151-160 or 161-170 or 171-180 or 181-190 or 191-200 or 201-210 or 211-220 or 221-230 or 231-240 or 241-250 or 251-260 or 261-270 or 271-280 or 281-290 or 291-300 or 301-310 or 311-320 or 321-330 or 331-340 or 341-349 of sequence of CTGF provided in Table 2. In other embodiments, the peptides of the invention may comprise, consist essentially of, or consist of three or four consecutive amino acids from the amino acids 5-14 or 15-24 or 25-34 or 35-44 or 45-54 or 55-64 or 65-74 or 75-84 or 85-94 or 95-104 or 105-114 or 115-124 or

125-134 or 135-144 or 145-154 or 155-164 or 165-174 or 175-184 or 185-194 or 195-204 or 205-214 or 215-224 or 225-234 or 235-244 or 245-254 or 255-264 or 265-274 or 275-284 or 285-294 or 295-304 or 305-314 or 315-324 or 325-334 or 335-344 or 345-349 of sequence of CTGF provided in Table 2.

[0026] In one embodiment, the invention comprises any 3 or 4 consecutive amino acids derived from the sequence of Transforming Growth Factor-beta (TGFβ) [Homo sapiens] NCBI GenBank Accession No.: AAA36738.1, shown in Table 3 (SEQ ID NO: 3).

Table 3. Sequence of TGFβ [Homo Sapiens]

1	mhvrslraa	phsfvalwa	lflrlrsala	fsldnevhs	fihrrlrsq	rremgreil
	a	p	d	s	e	s
61	ilglphrpr	hlqgkhnsa	mfmlldlyna	aveegggpg	qgfsypyka	fstqgppla
	p	p	m	g	v	s
12	lqdsfhfltd	dmvmsfvnl	ehdkeffhp	yhhrefrfd	skipegeav	aaefriykd
1	a	v	r	l	t	y
18	irerfdnet	risvyqvlq	hlgresdlf	ldsrtlwas	egwlvfdit	tsnhwvvnv
1	f	e	l	e	a	r
24	hnlglqlsv	tldggsinp	lagligrhg	qnkqpfmva	fkatevhfr	irstgskqr
1	e	k	p	f	s	s
30	qnrsktpk	ealrmanva	nsssdqrqa	kkhelyvsf	dlgwqdwii	pegyaayyc
1	q	e	c	r	a	e
36	gecafplns	mnatnhaiv	tlvhfinpe	vpkpccapt	lnaisvlyf	dssnvilkk
1	y	q	t	q	d	y
42	rnmvvracg	h				
1	c					

[0027] In some embodiments, the peptides of the invention comprise, consist essentially of, or consist of three or four consecutive amino acids from the sequence of TGFβ provided in Table 3. For example, the peptides of the invention may comprise three or four consecutive amino acids from the amino acids 1-10 or 11-20 or 21-30 or 31-40 or 41-50 or 51-60 or 61-70 or 71-80 or 81-90 or 91-100 or 101-110 or 111-120 or 121-130 or 131-140 or 141-150 or 151-160 or 161-170 or 171-180 or 181-190 or 191-200 or 201-210 or 211-220 or 221-230 or 231-240 or 241-250 or 251-260 or 261-270 or 271-280 or 281-290 or 291-300 or 301-310 or 311-320 or 321-330 or 331-340 or 341-350 or 351-360 or 361-370 or 371-380 or 381-390 or 391-400 or 401-410 or 411-420 or 421-431 of sequence of TGFβ provided in Table 3. In other embodiments, the peptides of the invention may comprise, consist essentially of, or consist of three or four consecutive amino acids from the amino acids 5-14 or 15-24 or 25-34 or 35-44 or 45-54 or 55-64 or 65-74 or 75-84 or 85-94 or 95-104 or 105-114 or 115-124 or 125-134 or 135-144 or 145-154 or 155-164 or 165-174 or 175-184 or 185-194 or 195-204 or 205-214 or 215-224 or 225-234 or 235-244 or 245-254 or 255-264 or 265-274 or 275-284 or

285-294 or 295-304 or 305-314 or 315-324 or 325-334 or 335-344 or 345-354 or 355-364 or 365-374 or 375-384 or 385-394 or 395-404 or 405-414 or 415-424 or 425-431 of sequence of TGF β provided in Table 3.

[0028] In one embodiment, the invention comprises any 3 or 4 consecutive amino acids derived from the sequence of Platelet-Derived Growth Factor (PDGF) [Homo sapiens] (NCBI GenBank Accession No.: AAA60552.1), shown in Table 4 (SEQ ID NO: 4).

Table 4. Sequence of PDGF [Homo Sapiens]

1	mnrcwalf1	lccylrlvs	egdpieel	emlsdhsir	fddlqrllh	dpgeedgae
	s	a	y	s	g	l
61	dlnmtrshs	geleslarg	rslgsltia	pamiaeckt	tevfeisrr	idrtanfl
	g	r	e	r	l	v
12	wppcvevqr	sgccnnrnv	crptqvqlr	vqvrkieiv	kkpifkkt	tledhlaek
1	c	q	p	r	v	c
18	etvaaarpv	rspggsqeq	aktpqtrvt	rtvrvrpp	gkhrkfkht	dktalketl
1	t	r	i	k	h	g
24	a					
1						

[0029] In some embodiments, the peptides of the invention comprise, consist essentially of, or consist of three or four consecutive amino acids from the sequence of PDGF provided in Table 4. For example, the peptides of the invention may comprise three or four consecutive amino acids from the amino acids 1-10 or 11-20 or 21-30 or 31-40 or 41-50 or 51-60 or 61-70 or 71-80 or 81-90 or 91-100 or 101-110 or 111-120 or 121-130 or 131-140 or 141-150 or 151-160 or 161-170 or 171-180 or 181-190 or 191-200 or 201-210 or 211-220 or 221-230 or 231-241 of sequence of PDGF provided in Table 4. In other embodiments, the peptides of the invention may comprise, consist essentially of, or consist of three or four consecutive amino acids from the amino acids 5-14 or 15-24 or 25-34 or 35-44 or 45-54 or 55-64 or 65-74 or 75-84 or 85-94 or 95-104 or 105-114 or 115-124 or 125-134 or 135-144 or 145-154 or 155-164 or 165-174 or 175-184 or 185-194 or 195-204 or 205-214 or 215-224 or 225-234 or 235-241 of sequence of PDGF provided in Table 4.

[0030] In some embodiments, the peptides of the invention are derived from regions of homology between any two of GDF11, TGF β , CTGF, and PDGF. In some embodiments, the regions of homology may span from 3-16 or 3-12 or 3-8 or 3-6 consecutive amino acids in the sequences. In some embodiments, the regions of homology may span from 4-16 or 4-12 or 4-8 or 4-6 consecutive amino acids in the sequences. These regions may be at least 50%, or at least 60%, or at least 70%, or at least 80%, or at least 90% homologous.

[0031] In some embodiments the peptides according to the invention exclude the peptides having Sequence ID NOs 5-86. In another embodiment exclude peptide having Sequence ID NOs 87-92.

[0032] One aspect of the invention provides peptides derived from GDF11 having the following sequence: QILSKLRL (Gln-Ile-Leu-Ser-Lys-Leu-Arg-Leu) (SEQ ID NO: 5), LRLK (Leu-Arg-Leu-Lys) (SEQ ID NO: 6), and MVV (Met-Val-Val) (SEQ ID NO: 7).

[0033] Another aspect of the invention provides peptides derived from TGF β having the following sequence: QILSKLRL (Gln-Ile-Leu-Ser-Lys-Leu-Arg-Leu) (SEQ ID NO: 5), LRLK (Leu-Arg-Leu-Lys) (SEQ ID NO: 6).

[0034] Another aspect of the invention provides peptides derived from CTGF having the following sequence: TAKDGAP (Thr-Ala-Lys-Asp-Gly-Ala-Pro) (SEQ ID NO: 8), IFGGTVYRS (Ile-Phe-Gly-Gly-Thr-Val-Tyr-Arg-Ser) (SEQ ID NO: 9), and RTPKISKPIKFELSG (Arg-Thr-Pro-Lys-Ile-Ser-Lys-Pro-Ile-Lys-Phe-Glu-Leu-Ser-Gly) (SEQ ID NO: 10).

[0035] Yet another aspect of the invention provides peptides derived from PDGF having the following sequence: AECK (Ala-Glu-Cys-Lys) (SEQ ID NO: 11).

[0036] Peptides of the invention may have one or more additional amino acids joined to the amino and/or carboxy terminus *via* peptide bonds. In some embodiments, the peptides will comprise a hydrocarbon chain on the amino and/or carboxyl terminus, including, without limitation, C₁₋₂₄ or C₆₋₁₈ or C₁₂₋₁₈ aliphatic hydrocarbons, which may be straight chained or branched or cyclic. In some embodiments, the peptides include the reaction product of a peptide with a fatty acid or fatty alcohol. For example, the N-terminus may be reacted with a C₆₋₂₄ fatty acid (*e.g.*, palmitic acid) to form an amide bond. The carboxyl terminus may be reacted with a C₆₋₂₄ fatty alcohol (*e.g.*, cetyl alcohol) to form an ester. These fatty derivatives may improve the lipophilicity of the peptide. The phrase “consisting essentially of,” as used herein, is intended to mean that additional amino acids or other residues may be present at either terminus of the peptide and/or on a side chain provided they do not substantially impair the activity of the peptide to stimulate collagen and/or HA production.

[0037] Topically acceptable salts, esters, and prodrugs (collectively “derivatives”) of the peptides of the invention are also suitable. The esters may include C₁₋₂₄ aliphatic hydrocarbon esters of the carboxyl terminus and/or the carboxyl side chain, including C₁₋₂₄ or

C₁₋₁₈ or C₁₋₁₆ or C₁₋₁₂ or C₁₋₆ alkyl esters. Salts will typically be acid addition salts formed by the reaction of the peptide with an inorganic or an organic acid. Inorganic acids include mineral acids such as HCl and H₂SO₄, and the like. Organic acids include citric, benzoic, tartaric, malic, maleic, succinic, acetic, and propionic acid. Prodrugs include any esters or amides that hydrolyze *in vivo* to yield the peptide of formula (I). Examples of suitable prodrugs can be found in the book entitled "Prodrugs and Targeted Delivery: Towards Better ADME Properties," Volume 47 (2011), published by WILEY-VCH Verlag & Co, which is herein incorporated by reference in its entirety. In one embodiment, the prodrug is formed by reacting the peptide with glyoxylic acid to produce peptidyl- α -hydroxyglycine derivatives having improved stability. In other embodiment the prodrugs may include terminal N-acetyl derivatives, side chain N-acetyl derivatives, N-hydroxy methylation or N-phthalidation of its N-terminus and/or side chain. In some embodiments either terminus may be functionalized with an amino acid of the form H₂N-(CH₂)_n-CO₂H where "n" is an integer from 1-10, including amino valeric acid. In some embodiments, a lysine-amino valeric acid group is added at either terminus through a peptide bond.

[0038] Fragments of the peptides of the invention are also contemplated. Fragments, as used herein, are defined as having at least 3 aminoacids of the peptide sequence from which they are derived.

[0039] In one aspect, the following tripeptide fragments of the peptide derived from GDF11 and having the sequence QILSKLRL (SEQ ID NO: 5) are contemplated: QIL (Gln-Ile-Leu) (SEQ ID NO: 12), ILS (Ile-Leu-Ser) (SEQ ID NO: 13), LSK (Leu-Ser-Lys) (SEQ ID NO: 14), SKL (Ser-Lys-Leu) (SEQ ID NO: 15), KLR (Lys-Leu-Arg) (SEQ ID NO: 16), and LRL (Leu-Arg-Leu) (SEQ ID NO: 17). Tetrapeptide fragments include the following sequences: QILS (Gln-Ile-Leu-Ser) (SEQ ID NO: 18), ILSK (Ile-Leu-Ser-Lys) (SEQ ID NO: 19), LSKL (Leu-Ser-Lys-Leu) (SEQ ID NO: 20), SKLR (Ser-Lys-Leu-Arg) (SEQ ID NO: 21), and KLRL (Lys-Leu-Arg-Leu) (SEQ ID NO: 22) or derivatives of such peptides.

[0040] In another aspect, the following tripeptide fragments of the peptide derived from GDF11 and having the sequence LRLK (SEQ ID NO: 6) are contemplated: LRL (Leu-Arg-Leu) (SEQ ID NO: 23) and RLK (Arg-Leu-Lys) (SEQ ID NO: 24), and derivatives of such peptides.

[0041] In yet another aspect, the following tripeptide fragments of the peptide derived from CTGF and having the sequence TAKDGAP (SEQ ID NO: 8) are contemplated: TAK (Thr-Ala-Lys) (SEQ ID NO: 25), AKD (Ala-Lys-Asp) (SEQ ID NO: 26), KDG (Lys-Asp-Gly) (SEQ ID NO: 27), DGA (Asp-Gly-Ala) (SEQ ID NO: 28), and GAP (Gly-Ala-Pro) (SEQ ID NO: 29) or derivatives thereof. Tetrapeptide fragments include the following sequences: TAKD (Thr-Ala-Lys-Asp) (SEQ ID NO: 30), AKDG (Ala-Lys-Asp-Gly) (SEQ ID NO: 31), KDGA (Lys-Asp-Gly-Ala) (SEQ ID NO: 32), and DGAP (Asp-Gly-Ala-Pro) (SEQ ID NO: 33) or derivatives thereof.

[0042] In yet another aspect, the following tripeptide fragments of the peptide derived from CTGF and having the sequence IFGGTVYRS (SEQ ID NO: 9) are contemplated: IFG (SEQ ID NO: 34), FGG (SEQ ID NO: 35), GGT (SEQ ID NO: 36), GTV (SEQ ID NO: 37), TVY (SEQ ID NO: 38), VYR (SEQ ID NO: 39), and YRS (SEQ ID NO: 40) or derivatives thereof. Tetrapeptide fragments include the following sequences: IFGG (SEQ ID NO: 41), FGGT (SEQ ID NO: 42), GGTV (SEQ ID NO: 43), GTVY (SEQ ID NO: 44), TVYR (SEQ ID NO: 45), and VYRS (SEQ ID NO: 46) or derivatives thereof.

[0043] In yet another aspect, the following tripeptide fragments of the peptide derived from CTGF and having the sequence RTPKISKPIKFELSG (SEQ ID NO: 10) are contemplated: RTP (SEQ ID NO: 47), TPK (SEQ ID NO: 48), PKI (SEQ ID NO: 49), KIS (SEQ ID NO: 50), ISK (SEQ ID NO: 51), SKP (SEQ ID NO: 52), KPI (SEQ ID NO: 53), PIK (SEQ ID NO: 54), IKF (SEQ ID NO: 55), KFE (SEQ ID NO: 56), FEL (SEQ ID NO: 57), ELS (SEQ ID NO: 58), and LSG (SEQ ID NO: 59) or derivatives thereof. Tetrapeptide fragments include the following sequences: RTPK (SEQ ID NO: 60), TPKI (SEQ ID NO: 61), PKIS (SEQ ID NO: 62), KISK (SEQ ID NO: 63), ISKP (SEQ ID NO: 64), SKPI (SEQ ID NO: 65), KPIK (SEQ ID NO: 66), PIKF (SEQ ID NO: 67), IKFE (SEQ ID NO: 68), KFEL (SEQ ID NO: 69), FELS (SEQ ID NO: 70), and ELSG (SEQ ID NO: 71) or derivatives thereof.

[0044] In yet another aspect, the following tripeptide fragments of the peptide derived from CTGF and having the sequence IFGGTVYRS (SEQ ID NO: 9) are contemplated: IFG (SEQ ID NO: 72), FGG (SEQ ID NO: 73), GGT (SEQ ID NO: 74), GTV (SEQ ID NO: 75), TVY (SEQ ID NO: 76), VYR (SEQ ID NO: 77), and YRS (SEQ ID NO: 78) or derivatives thereof. Tetrapeptide fragments include the following sequences: IFGG (SEQ ID NO: 79), FGGT (SEQ ID NO: 80), GGTV (SEQ ID NO: 81), GTVY (SEQ ID NO: 82), TVYR (SEQ ID NO: 83), and VYRS (SEQ ID NO: 84) or derivatives thereof.

[0045] In another aspect, the following tripeptide fragments of the peptide derived from PDGF and having the sequence AECK (SEQ ID NO: 11) are contemplated: AEC (SEQ ID NO: 85) and ECK (SEQ ID NO: 86) or derivatives thereof.

[0046] A peptide comprising peptides of the invention (*e.g.*, SEQ ID NOs: 5-86) or fragments or derivatives thereof, may have one or more additional amino acids joined to the amino and/or carboxy terminus *via* peptide bonds. In some embodiments, the peptides or fragments thereof (SEQ ID NOs: 5-86) will have from 3 to 20 or from 3 to 16 or from 3 to 12 or from 3 to 10 or from 3-9 or from 3-8 or from 3-7 or from 3-6 amino acids. In some embodiments, the peptides will comprise a hydrocarbon chain on the amino and/or carboxyl terminus, including, without limitation, C₁₋₂₄ or C₆₋₁₈ or C₁₂₋₁₈ aliphatic hydrocarbons, which may be straight chained or branched or cyclic. In some embodiments, the peptides include the reaction product of a peptide with a fatty acid or fatty alcohol. For example, the N-terminus may be reacted with a C₆₋₂₄ fatty acid (*e.g.*, palmitic acid) to form an amide bond. The carboxyl terminus may be reacted with a C₆₋₂₄ fatty alcohol (*e.g.*, cetyl alcohol) to form an ester. These fatty derivatives may improve the lipophilicity of the peptide. The phrase “consisting essentially of,” as used herein, is intended to mean that additional amino acids or other residues may be present at either terminus of the peptide and/or on a side chain provided they do not substantially impair the activity of the peptide to stimulate collagen production.

[0047] It is well within the skill in the art to prepare peptides using, for example, conventional protection and activation chemistry. Typically, the amino functionality of a first amino acid is protected with a removable amino protecting group and the carboxyl functionality of a second amino acid is protected with a removable carboxyl protecting group. Suitable amine protecting groups include, without limitation, benzoyloxycarbonyl (Cbz), tert-butoxycarbonyl (t-Boc), and 9-fluorenylmethoxycarbonyl (Fmoc). The carboxyl group may be protected by forming an acid or base labile ester such as a methyl, ethyl, benzyl, or trimethylsilyl esters. After protection, the first and second amino acids are reacted in a suitable solvent such as water or DMF in the presence of an *in situ* activating agent such as N,N'-dicyclohexylcarbodiimide (DCCI), diisopropylcarbodiimide (DIPCDI), or 1-ethyl-3-(3'-dimethylaminopropyl)carbodiimide (EDCI) to effect peptide bond formation. Reactive moieties on the side chains of either amino acid are protected with protecting groups such as *tert*-butyl or benzyl for OH and SH; methyl, ethyl, *tert*-butyl or benzyl for carboxyl groups, and 2,2,5,7,8-pentamethylchroman-6-sulphonyl for the —NHC(NH₂)=NH functionality of

Arg. Following the coupling reaction, selective deprotection of the amino group of the first amino acid is accomplished by acid hydrolysis under conditions that do not remove the carboxyl protecting group of the second amino acid. The procedure is repeated with additional amino protected amino acids. Solid phase synthesis, such as the well-known Merrifield method, is especially useful for synthesizing the peptides of the invention. Lysine-amino valeric acid (K-ava) derivatives are described in U.S. Patent No. 8,551,956, the disclosure of which is hereby incorporated by reference.

[0048] Topical Compositions

[0049] The compositions according to the invention may be formulated in a variety of forms for topical application and will typically comprise from about 0.000001% by weight to about 20% by weight of the peptide. More typically, the peptide will comprise from about 0.00001% by weight to about 10% by weight, and more preferably from about 0.00001% by weight to about 5% by weight of the composition. In one embodiment, the active peptide or a fragment or derivative thereof will comprise from about 0.00001% by weight to about 0.0001% by weight or to about 0.001% by weight or to about 0.1% by weight of the composition. The compositions may comprise an effective amount of the peptide, by which is meant an amount sufficient to stimulate production of collagen in the skin. In other embodiments, the amount of peptide or a fragment or derivative thereof will be sufficient to diminish the appearance of dermatological signs of aging in a given area of skin when topically applied thereto daily for a period of at least eight weeks.

[0050] The peptides of the invention (*e.g.*, SEQ ID NOs: 5-86) are provided in physiologically acceptable vehicles or carriers. The vehicle may be either hydrophobic or hydrophilic. Suitable, hydrophobic carriers include, for example, waxy non-ionic substances commonly used in cosmetics, such as esters and ethers of fatty alcohols and of fatty acids, with carbon chain length from C₄ to C₂₂, preferably from C₈ to C₁₈, or from C₁₂ to C₁₈.

[0051] Examples of a fatty hydrophobic carriers include isopropyl myristate, isopropyl palmitate, octyl palmitate, isopropyl lanolate, acetylated lanolin alcohol, the benzoate of C₁₂-C₁₅ alcohols, cetearyl octanoate, cetyl palmitate, myristyl myristate, myristyl lactate, cetyl acetate, propylene glycol dicaprylate/caprate, decyl oleate, acetylated lanolin, stearyl heptanoate, diisostearyl malate, octyl hydroxystearate, octyl hydroxystearate, isopropyl isostearate, and the like.

[0052] Suitable hydrophilic carriers may comprise, for example, water, lower alcohols (C₁₋₆), glycols and alkoxyated glycols commonly used in cosmetics, including ethylene glycol, diethylene glycol, triethylene glycol, propylene glycol, dipropylene glycol, and the like.

[0053] The topically acceptable vehicle may be in the form of an emulsion. Non-limiting examples of suitable emulsions include water-in-oil emulsions, oil-in-water emulsions, silicone-in-water emulsions, water-in-silicone emulsions, wax-in-water emulsions, water-oil-water triple emulsions or the like having the appearance of a cream, gel or microemulsions. As used herein, the term "oil" includes silicone oils unless otherwise indicated. The emulsion may include an emulsifier, such as a nonionic, anionic or amphoteric surfactant, or a gellant, typically in an amount from about 0.001% to about 5% by weight.

[0054] The topically acceptable vehicle may include water; vegetable oils; mineral oils; ester oils such as octal palmitate, isopropyl myristate and isopropyl palmitate; ethers such as dicapryl ether and dimethyl isosorbide; alcohols such as ethanol and isopropanol; fatty alcohols such as cetyl alcohol, cetearyl alcohol, stearyl alcohol and behenyl alcohol; isoparaffins such as isooctane, isododecane (IDD) and isohexadecane; silicone oils such as cyclomethicone, dimethicone, dimethicone cross-polymer, polysiloxanes and their derivatives, preferably organomodified derivatives including PDMS, dimethicone copolyol, dimethiconols, and amodimethiconols; hydrocarbon oils such as mineral oil, petrolatum, isoeicosane and polyolefins, *e.g.*, (hydrogenated) polyisobutene; polyols such as propylene glycol, glycerin, butylene glycol, pentylene glycol, hexylene glycol, caprylyl glycol; waxes such as beeswax, carnauba, ozokerite, microcrystalline wax, polyethylene wax, and botanical waxes; or any combinations or mixtures of the foregoing. Aqueous vehicles may include one or more solvents miscible with water, including lower alcohols, such as ethanol, isopropanol, and the like. The vehicle may comprise from about 50% to about 99% by weight of the composition.

[0055] In one embodiment of the invention, the compositions may include one or more additional skin actives, including but not limited to, retinoids, botanicals, keratolytic agents, desquamating agents, keratinocyte proliferation enhancers, collagenase inhibitors, elastase inhibitors, depigmenting agents, anti-inflammatory agents, steroids, anti-acne agents, antioxidants, and advanced glycation end-product (AGE) inhibitors, to name but a few. The amounts of these various ingredients are those conventionally used in the cosmetic field to achieve their intended purpose, and range individually or collectively typically from about 0.001 wt % to about 20 wt % by weight of the composition. The nature of these ingredients

and their amounts must be compatible with the production and function of the compositions of the disclosure.

[0056] Exemplary anti-aging components include, without limitation, botanicals (*e.g.*, *Butea frondosa* extract, *Tiliacora triandra* extract, *Portulaca oleracea*, *Melicope elleryana*, etc.); phytol; phytonic acid; retinoids; hydroxy acids (including alpha-hydroxy acids and beta-hydroxy acids), salicylic acid and alkyl salicylates; exfoliating agents (*e.g.*, glycolic acid, 3,6,9-trioxaundecanedioic acid, etc.), estrogen synthetase stimulating compounds (*e.g.*, caffeine and derivatives); compounds capable of inhibiting 5 alpha-reductase activity (*e.g.*, linolenic acid, linoleic acid, finasteride, and mixtures thereof); and barrier function enhancing agents (*e.g.*, ceramides, glycerides, cholesterol and its esters, alpha-hydroxy and omega-hydroxy fatty acids and esters thereof, etc.), to name a few.

[0057] Exemplary retinoids include, without limitation, retinoic acid (*e.g.*, all-trans, or 9-cis, or 13-cis), and derivatives thereof, retinaldehyde, retinol (Vitamin A) and esters thereof, such as retinyl palmitate, retinyl acetate and retinyl propionate, and salts thereof. Particular mention may be made of retinol. When present, the retinoids will typically be included in amounts from about 0.0001% to about 5% by weight, more typically from about 0.01% to about 2.5% by weight, or from about 0.1% to about 1.0% by weight. Compositions according to this embodiment will typically include an antioxidant such as ascorbic acid and/or BHT and/or a chelating agent such as EDTA or a salt thereof (*e.g.*, disodium EDTA) in amounts effective to stabilize the retinoid (*e.g.*, 0.0001% - 5%).

[0058] In another embodiment, the topical compositions of the present invention may also include one or more of the following: a skin penetration enhancer; an emollient, such as isopropyl myristate, petrolatum, volatile or non-volatile silicones oils (*e.g.*, methicone, dimethicone), ester oils, mineral oils, and fatty acid esters; a humectant, such as glycerin, hexylene glycol or caprylyl glycol; a skin plumper, such as palmitoyl oligopeptide, collagen, collagen and/or glycosaminoglycan (GAG) enhancing agents; a sunscreen, such as avobenzone or octyl methoxycinnamate; an exfoliating agent; and an antioxidant.

[0059] Suitable exfoliating agents include, for example, alpha-hydroxy acids, beta-hydroxy acids, oxa-acids, oxadiacids, and their derivatives such as esters, anhydrides and salts thereof. Suitable hydroxy acids include, for example, glycolic acid, lactic acid, malic acid, tartaric acid, citric acid, 2-hydroxyalkanoic acid, mandelic acid, salicylic acid and derivatives

thereof. One exemplary exfoliating agent is glycolic acid. When present, the exfoliating agent may comprise from about 0.001% to about 20% by weight of the composition.

[0060] Examples of antioxidants that may be used in the present compositions include compounds having phenolic hydroxy functions, such as ascorbic acid and its derivatives/esters; beta-carotene; catechins; curcumin; ferulic acid derivatives (*e.g.*, ethyl ferulate, sodium ferulate); gallic acid derivatives (*e.g.*, propyl gallate); lycopene; reductic acid; rosmarinic acid; tannic acid; tetrahydrocurcumin; tocopherol and its derivatives, including tocopheryl acetate; uric acid; or any mixtures thereof. Other suitable antioxidants are those that have one or more thiol functions (-SH), in either reduced or non-reduced form, such as glutathione, lipoic acid, thioglycolic acid, and other sulfhydryl compounds. The antioxidant may be inorganic, such as bisulfites, metabisulfites, sulfites, or other inorganic salts and acids containing sulfur. Antioxidants may comprise, individually or collectively, from about 0.001% to about 10 % (w/w), or from about 0.01% to about 5% (w/w) of the total weight of the composition.

[0061] Other additives include: vitamins, such as tocopherol and ascorbic acid; vitamin derivatives such as ascorbyl monopalmitate, tocopheryl acetate, and Vitamin E palmitate; thickeners such as hydroxyalkyl cellulose, carboxymethylcellulose, carbomers, and vegetable gums such as xanthan gum; gelling agents, such as ester-terminated polyester amides; structuring agents; metal chelating agents such as EDTA or salts thereof; pigments; colorants; and pH adjusters (citric acid, ethanolamine, sodium hydroxide, etc.). The composition may optionally comprise other components known to those skilled in the art including, but not limited to, film formers, moisturizers, minerals, viscosity and/or rheology modifiers, anti-acne agents, insect repellents, skin cooling compounds, skin protectants, lubricants, fragrances, preservatives, stabilizers, and mixtures thereof. The foregoing may individually or collectively comprise from about 0.0001% to about 20% by weight of the composition.

[0062] In addition, the compositions contemplated by this disclosure can include one or more compatible cosmetically acceptable adjuvants commonly used and known by the skilled practitioner, such as colorants, pearls, chromalites, micas, pigments, dyes, fragrances, emollients, humectants, preservatives, vitamins, chelators, thickeners, anesthetics, anti-allergens, antifungals, antimicrobials, other anti-inflammatory agents, antioxidants, antiseptics, depigmenting agents, film formers, insect repellents, pharmaceutical agents, photostabilizing agents, sunscreens, stabilizers, surfactants, thickeners, viscosity modifiers, and botanicals. The topical compositions of the present disclosure may also include a skin

penetration enhancer, a surface smoother, a skin plumper, an optical diffuser, an exfoliation promoter, and an antioxidant. Details with respect to these and other suitable cosmetic ingredients can be found in the "International Cosmetic Ingredient Dictionary and Handbook," 10th Edition (2004), published by the Cosmetic, Toiletry, and Fragrance Association (CTFA), at pp. 2177-2299, which is herein incorporated by reference in its entirety. The amounts of these various substances are those that are conventionally used in the cosmetic or pharmaceutical fields, for example, they can constitute from about 0.01% to about 20% of the total weight of the composition.

[0063] A sunscreen may be included to protect the skin from damaging ultraviolet rays. In an illustrative embodiment of the present disclosure, the sunscreen provides both UVA and UVB protection, by using either a single sunscreen or a combination of sunscreens. Among the sunscreens that can be employed in the present compositions are avobenzone, cinnamic acid derivatives (such as octylmethoxy cinnamate), octyl salicylate, oxybenzone, octocrylene, titanium dioxide, zinc oxide, or any mixtures thereof. The sunscreen may be present from about 1 wt % to about 30 wt % of the total weight of the composition.

[0064] In one embodiment, the topical composition will have a pH range from 1 to 13, with a pH in the range of from 2 to 12 being typical. In some embodiment, the composition will have a pH in the range of from 3.5 to 7 or from 7-10.5. In some embodiments, the pH will be in the range of 3-4, or 4-5, or 5-6, or 6-7, or 7-8, or 8-9, or 9-10, or 10-11, or 11-12. Suitable pH adjusters such as sodium hydroxide, citric acid and triethanolamine may be added to bring the pH within the desired range.

[0065] Another embodiment of the present disclosure is directed to the delivery of the described compositions by the use of targeted delivery systems, for example, liposomes, microspheres (see, *e.g.*, U.S. Pat. No. 5,770,222 to Unger et al.), and the like, so that the components and/or active constituents can more readily reach and affect the subcutaneous layer of the area of application, *e.g.*, face or neck, or the other area of the skin.

[0066] The compositions may be formulated in a variety of product forms, such as, for example, a lotion, cream, serum, spray, aerosol, cake, ointment, essence, gel, paste, patch, pencil, towelette, mask, stick, foam, elixir, concentrate, and the like, particularly for topical administration. Preferably the composition is formulated as a lotion, cream, ointment, or gel.

[0067] The invention also provides a method for ameliorating and/or preventing signs of human skin photo- and intrinsic aging comprising topically applying the compositions of the invention. The compositions of the invention are preferably applied to affected skin areas once or twice daily for as long as is necessary to achieve desired anti-aging results.

[0068] Methods of Treatment

[0069] Methods are provided for enhancing the production of collagen and/or HA in human skin comprising topically applying to an area of the skin in need thereof (*e.g.*, sagging skin, thinning skin, skin suffering from wrinkles and fine lines, etc.) a topical composition comprising a topically acceptable vehicle, and an effective amount of a peptide of the invention (*e.g.*, SEQ ID NOs: 5-86), for a time sufficient to improve the appearance thereof. The treatment may be at least once or twice daily and may last for a period of at least four weeks, typically at least eight weeks or longer. The composition may optionally further comprise a retinoid and/or an alpha-hydroxy acid (*e.g.*, glycolic acid) and/or a beta-hydroxy acid (*e.g.*, salicylic acid or a derivative) in amounts effective to improve the appearance of skin.

[0070] In another aspect of the invention, the compositions are applied topically to improve the aesthetic appearance of human skin. The method comprises topically applying to an area of the skin in need thereof a composition comprising an effective amount of a peptide of the invention (*e.g.*, SEQ ID NOs: 5-86) for a time sufficient to improve the aesthetic appearance of said human skin. The compositions are topically applied to the skin in effective amounts, by which is meant an amount sufficient to achieve a measurable improvement in skin health or reduction in one or more dermatological signs of aging with daily (once, twice, etc.) administration, typically for a period of at least one week or more.

[0071] The aesthetic improvement of human skin may be an improvement of any attribute or characteristic of skin, including without limitation:

- (a) treatment, reduction, and/or prevention of fine lines or wrinkles;
- (b) reduction of skin pore size;
- (c) improvement in skin thickness, plumpness, and/or tautness;
- (d) improvement in skin smoothness, suppleness and/or softness;
- (e) improvement in skin tone, radiance, and/or clarity;
- (f) improvement in procollagen, and/or collagen production;

- (g) improvement in maintenance and remodeling of elastin;
- (h) improvement in skin texture and/or promotion of retexturization;
- (i) improvement in skin barrier repair and/or function;
- (j) improvement in appearance of skin contours;
- (k) restoration of skin luster and/or brightness;
- (l) replenishment of essential nutrients and/or constituents in the skin;
- (m) improvement of skin appearance decreased by aging and/or menopause;
- (n) improvement in skin moisturization;
- (o) increase in skin elasticity and/or resiliency;
- (p) treatment, reduction, and/or prevention of skin sagging;
- (q) improvement in skin firmness; and
- (r) reduction of pigment spots and/or mottled skin; and
- (s) improvement of optical properties of skin by light diffraction or reflection.

[0072] In a related implementation, a method is provided for the treatment of wrinkles and/or fine lines on the skin human skin (typically, skin of the face) comprising topically applying to an area of the skin in need thereof (*e.g.*, applying to a wrinkle or fine line) a composition comprising a peptide of the invention (*e.g.*, SEQ ID NOs: 5-86), for a time sufficient to improve the aesthetic appearance of said human skin. The treatment may be at least once or twice daily and may last for a period of at least four weeks, typically at least eight weeks or longer. The composition may optionally further comprise a retinoid (*e.g.*, retinol or retinyl palmitate) and/or an alpha-hydroxy acid (*e.g.*, glycolic acid) and/or a beta-hydroxy acid (*e.g.*, salicylic acid or derivative) in amounts effective to improve the appearance of skin.

[0073] In yet another aspect of the invention, methods are provided for reducing the severity of, reducing the number of, or preventing or forestalling the onset of, wrinkles or fine lines on human skin comprising topically applying to an area of the skin in need thereof (*e.g.*, wrinkled skin), an effective amount (*e.g.*, 0.001% – 1% by weight, w/w) of a peptide of the invention (*e.g.*, SEQ ID NOs: 5-86) in combination with an effective amount (*e.g.*, 0.01% – 5% by weight, w/w) of retinol and/or an effective amount (*e.g.*, 0.001% – 5% by weight, w/w) of an alpha-hydroxy acid (*e.g.*, glycolic acid) and/or a beta-hydroxy acid (*e.g.*, salicylic acid).

[0074] The invention provides a method for treating aging skin by topically applying a composition comprising a collagen-stimulating peptide (*e.g.*, SEQ ID NOs: 5-86), typically in a physiologically acceptable vehicle, over the affected area for a period of time sufficient to remediate, reverse, reduce, ameliorate, or prevent dermatological signs of aging. Generally, the improvement in the condition and/or aesthetic appearance is selected from the group consisting of: reducing dermatological signs of chronological aging, photo-aging, hormonal aging, and/or actinic aging; preventing and/or reducing the appearance of lines and/or wrinkles; reducing the noticeability of facial lines and wrinkles, facial wrinkles on the cheeks, forehead, perpendicular wrinkles between the eyes, horizontal wrinkles above the eyes, and around the mouth, marionette lines, and particularly deep wrinkles or creases; improving the appearance of suborbital lines and/or periorbital lines; reducing the appearance of crow's feet; rejuvenating and/or revitalizing skin, particularly aging skin; reducing skin fragility; preventing and/or reversing of loss of glycosaminoglycans and/or collagen; ameliorating the effects of estrogen imbalance; preventing skin atrophy; preventing, reducing, and/or treating hyperpigmentation or hypopigmentation; minimizing skin discoloration; improving skin tone, radiance, clarity and/or tautness; preventing, reducing, and/or ameliorating skin sagging; improving skin firmness, plumpness, suppleness and/or softness; improving procollagen and/or collagen production; improving skin texture and/or promoting retexturization; improving skin barrier repair and/or function; improving the appearance of skin contours; restoring skin luster and/or brightness; minimizing dermatological signs of fatigue and/or stress; resisting environmental stress; replenishing ingredients in the skin decreased by aging and/or menopause; improving communication among skin cells; increasing cell proliferation and/or multiplication; increasing skin cell metabolism decreased by aging and/or menopause; retarding cellular aging; improving skin moisturization; enhancing skin thickness; slowing or halting skin thinning; increasing skin elasticity and/or resiliency; enhancing exfoliation; improving microcirculation; decreasing and/or preventing cellulite formation; and any combinations thereof. In some embodiments, each of the forgoing is associated with female skin.

[0075] In some embodiments, the peptides of the invention (*e.g.*, SEQ ID NOs: 5-86) will be used to reduce the severity of fine lines or wrinkles, often in combination with retinol. The composition will typically be applied to the skin one, two, or three times daily for as long as is necessary to achieve desired results. The treatment regimen may comprise daily application for at least one week, at least two weeks, at least four weeks, at least eight weeks,

or at least twelve weeks or more. Chronic treatment regimens are also contemplated. The effect of a composition on the formation or appearance of fine lines and wrinkles can be evaluated qualitatively, *e.g.*, by visual inspection, or quantitatively, *e.g.*, by microscopic or computer assisted measurements of wrinkle morphology (*e.g.*, the number, depth, length, area, volume and/or width of wrinkles per unit area of skin). In one embodiment, the compositions of the invention will be applied to the skin in an amount from about 0.001 to about 100 mg/cm², more typically from about 0.01 to about 20 mg/cm², or from about 0.1 to about 10 mg/cm².

[0076] It is also contemplated that the compositions of the invention will be useful for treating thin skin by topically applying the composition comprising the active peptides (*e.g.*, SEQ ID NOs: 5-86) to thin skin of an individual in need thereof. "Thin skin" is intended to include skin that is thinned due to chronological aging, menopause, or photo-damage and skin that is thinning prematurely. In some embodiments, the treatment is for thin skin in men, whereas other embodiments treat thin skin in women, pre-menopausal or post-menopausal, as it is believed that skin thins differently with age in men and women, and in particular in women at different stages of life.

[0077] The method of the invention may be employed prophylactically to forestall aging including in individuals that have not manifested signs of skin aging, most commonly in individuals under 25 years of age. The method may also reverse or treat signs of aging once manifested as is common in individuals over 25 years of age, or to slow the progression of dermatological aging in such individuals.

[0078] In one embodiment, the compositions of the invention comprising active peptides (*e.g.*, SEQ ID NOs: 5-86) are applied to human skin to reduce sebum production or improve the appearance of skin affected by cellulite, and/or reduce unwanted lipogenesis or increase lipolysis. In this embodiment, the peptides of the invention can be formulated in topically acceptable vehicles (as described herein) and may include one or more additional agents such as anti-acne ingredients (*e.g.*, salicylic acid, benzoyl peroxide and other peroxides, sulfur, retinoids, etc.) in the case of a facial composition, or, in the case of a cellulite treatment, the formulation may comprise any ingredients suitable for treatment of cellulite, including without limitation, perilla oil and other unsaturated fatty oils and omega-3 fatty acids such as alpha-linolenic acid; caffeine; theophylline; xanthines; retinoids (*e.g.*, retinol); and the like. A cellulite treatment according to the invention will typically be applied topically to skin suffering from cellulite, including skin of the buttocks and thighs for a period of time sufficient

to improve the appearance thereof, including for example, daily treatment for at least four weeks, at least eight weeks, at least twelve weeks, or longer. In one embodiment, the compositions are topically applied to treat acne.

[0079] In certain embodiments, the compositions described herein comprising active peptides (*e.g.*, SEQ ID NOs: 5-86) can be used to treat and/or prevent hyper-pigmentation of skin and/or of the hair, for example, to lighten skin or hair. In some embodiments, the compositions are topically applied to the skin or hair, for example to an area of hyper-pigmented skin or hair. Hyper-pigmentation includes any coloration of an individual's skin or hair that is darker than desired by the individual and that is caused by melanocytes. Such unwanted pigmentation may also be called discoloration. Hyper-pigmented areas of the skin include areas of discrete or mottled hyper-pigmentation. Areas of discrete hyper-pigmentation can be distinct, uniform areas of darker color and may appear as brown spots or freckles on the skin, including marks commonly called pigment spots or "age spots." Areas of mottled hyper-pigmentation of the skin can be dark blotches that are larger and more irregular in size and shape than areas of discrete pigmentation. Areas of hyper-pigmentation also include areas of tanned skin, for example, skin tanned due to UV exposure. Hyper-pigmented hair includes any shade of hair that is darker than desired.

[0080] Treating hyper-pigmentation or hyper-pigmented skin/hair refers to eradicating, reducing, ameliorating, or reversing one or more of the unwanted features associated with hyper-pigmentation, such as producing a perceptible lightening of the skin or hair in the affected area. Lightening hyper-pigmented areas of the skin may be desirable, in one embodiment, in diminishing age spots; lightening a suntan; evening or optimizing skin tones, *e.g.*, in areas of mottled hyper-pigmentation; in treating melasmic and chloasmic patches, freckles, after-burn scars, and post-injury hyper-pigmentation. Preventing hyper-pigmentation or hyper-pigmented skin refers to affording skin, not yet affected by hyper-pigmentation, a benefit that serves to avoid, delay, forestall, or minimize one or more unwanted features associated with skin hyper-pigmentation, such as reducing the darkness or size of hyper-pigmented areas that eventually develop.

[0081] In another embodiment, the peptides of the invention (*e.g.*, SEQ ID NOs: 5-86) are intended for oral use, including for pharmaceutical use. Pharmaceutical formulations will include pharmaceutically acceptable carriers (*i.e.*, diluents and excipients). The pharmaceutical compositions may be included in solid dosage forms, including compressed

tablets and capsules, or in liquid or powder forms (including lyophilized powders of the peptide suitable for reconstitution with water). Pharmaceutical dosage forms will typically include from about 0.1 mg to about 200 mg, or from about 1 mg to about 100 mg of the peptides of the invention. The dosage forms may be immediate release, in which case they will typically comprise a water-soluble or dispersible carrier such as microcrystalline cellulose, mannitol, hydroxypropyl methyl cellulose, PVP or the like, or may be delayed, sustained, or modified release, in which case they may comprise water-insoluble polymers such as cellulose ethers (*e.g.*, ethylcellulose), alone or in combination with water soluble or dispersible polymers, to regulate the rate of dissolution of the dosage form in the stomach.

[0082] In one embodiment, the composition is intended for use as a non-therapeutic treatment. In another embodiment, the composition is an article intended to be rubbed, poured, sprinkled, or sprayed on, introduced into, or otherwise applied to the human body for cleansing, beautifying, promoting attractiveness, or altering the appearance, in accordance with the US FD&C Act, §201(i).

EXAMPLES

[0083] The following example illustrates a specific aspect of the instant description. The example should not be construed as limiting, as the example merely provides specific understanding and practice of the embodiments and its various aspects.

EXAMPLE 1

[0084] The peptides of the invention were synthesized by GenScript (Piscataway, NJ).

[0085] Human dermal fibroblast cells were grown in a 96 well plate in DMEM media (available from Corning, NY) supplemented with 10% Fetal Bovine Serum (FBS) and L-glutamine (0.07x10⁵ cells/plate). After reaching about 75% confluence, cells were transferred into DMEM media without FBS and incubated for 4-6 hours. Next, cells were treated with a peptide at 0.00001%, 0.0001%, 0.001% final concentration in DMEM media without FBS for 48h. After treatment the media were collected, and cell viability was measured using MTT. Amount of collagen secreted was tested in the media using HTRF human pro-collagen I kit (available from Cisbio Inc., Bedford, MA). Amount of secreted Hyaluronic Acid (HA) was tested in the media using HA Elisa kit (available from Corgenix, Broomfield, CO).

[0086] Results are summarized in Table 5 below as percent change of pro-collagen I and/or HA production relative to vehicle control using the following keys with the peptide concentration provided in parentheses:

Pro-Collagen I Increase Key: 0: <10%, +: 10-30%, ++:30-50%, +++:50-70%, ++++: >70%

HA Increase Key: 0: <20%, +: 20-50%, ++:50-90%, +++:90-150%, ++++: >150%

Table 5

Peptide Sequence	Origin	Increase in Pro-Collagen I Production	Increase in HA Production
GDALQPE (SEQ ID NO: 87)	GDF11	0	0
QPED (SEQ ID NO: 88)	GDF11	0	0
QILSKLRL (SEQ ID NO: 5)	GDF11 and TGF β	+ (0.001%)	0
LRLK (SEQ ID NO: 6)	GDF11 and TGF β	0	+ (0.001%)
MVV (SEQ ID NO: 7)	GDF11 and TGF β	0	+ (0.0001%)
EASAEPE (SEQ ID NO: 89)	TGF β	0	0
TAKDGAP (SEQ ID NO: 8)	CTGF	+ (0.00001%)	++ (0.001%)
IFGGTVYRS (SEQ ID NO: 9)	CTGF	+ (0.001%)	++ (0.001%)
RTPKISKPIKFELSG (SEQ ID NO: 10)	CTGF	0	+ (0.001%)
RKIE (SEQ ID NO: 90)	PDGF	0	0
AECK (SEQ ID NO: 11)	PDGF	0	+++ (0.001%)
NRNV (SEQ ID NO: 91)	PDGF	0	0
LENTKRS (SEQ ID NO: 92)	GDF11 and TGF β	0	0

[0087] As shown in Table 5, peptides of the invention effectively increase pro-collagen I and/or hyaluronic acid production in human dermal fibroblast cells.

[0088] As various changes can be made in the above-described subject matter without departing from the scope and spirit of the present invention, it is intended that all subject matter contained in the above description, or defined in the appended claims, be interpreted as descriptive and illustrative of the present invention. Many modifications and variations of the present invention are possible in light of the above teachings. Accordingly, the present description is intended to embrace all such alternatives, modifications, and variances which fall within the scope of the appended claims.

EMBODIMENTS

1. A method for diminishing the appearance of dermatological signs of aging comprising topically applying to the skin a composition comprising, in a topically acceptable vehicle, a peptide having from 3 to 12 aminoacids corresponding to a sequence of GDF11, or a salt, ester, or prodrug thereof.
2. The method according to claim 1, wherein said dermatological signs of aging include the appearance of fine lines and wrinkles.
3. The method according to claim 1, wherein said peptide increases collagen production in skin.
4. The method according to claim 1, wherein said peptide increases hyaluronic acid production in skin.
5. The method according to claim 1, wherein said composition is applied at least once daily for at least one week.
6. A cosmetic composition comprising a topically acceptable vehicle said a peptide comprising from 3 to 12 aminoacids corresponding to a sequence of GDF11, or a salt, ester, or prodrug thereof.
7. The cosmetic composition of claim 6, wherein said peptide is present in an amount from about 0.000001% to about 1% by weight.
8. The cosmetic composition of claim 6, wherein said topically acceptable vehicle comprises a water-in-oil, oil-in-water, silicone-in-water, or water-in-silicone emulsion.
9. The cosmetic composition of claim 8, wherein said topically acceptable vehicle further comprises an emulsifier.

10. The cosmetic composition of claim 6 further comprising an additional active ingredient selected from the group consisting of alpha-hydroxy acids, thiodipropionic acid or esters thereof, salicylic acid, niacinamide, hexyl resorcinol, phytol, and retinoids.
11. A method for diminishing the appearance of dermatological signs of aging comprising topically applying to the skin a composition comprising, in a topically acceptable vehicle, a peptide having from 3 to 12 aminoacids corresponding to a sequence of TGF β , or a salt, ester, or prodrug thereof.
12. The method according to claim 11, wherein said dermatological signs of aging include the appearance of fine lines and wrinkles.
13. The method according to claim 11, wherein said peptide increases collagen production in skin.
14. The method according to claim 11, wherein said peptide increases hyaluronic acid production in skin.
15. The method according to claim 11, wherein said composition is applied at least once daily for at least one week.
16. A cosmetic composition comprising a topically acceptable vehicle said a peptide comprising from 3 to 12 aminoacids corresponding to a sequence of TGF β , or a salt, ester, or prodrug thereof.
17. The cosmetic composition of claim 16, wherein said peptide is present in an amount from about 0.000001% to about 1% by weight.
18. The cosmetic composition of claim 16, wherein said topically acceptable vehicle comprises a water-in-oil, oil-in-water, silicone-in-water, or water-in-silicone emulsion.
19. The cosmetic composition of claim 18, wherein said topically acceptable vehicle further comprises an emulsifier.
20. The cosmetic composition of claim 16 further comprising an additional active ingredient selected from the group consisting of alpha-hydroxy acids, thiodipropionic acid or esters thereof, salicylic acid, niacinamide, hexyl resorcinol, phytol, and retinoids.
21. A method for diminishing the appearance of dermatological signs of aging comprising topically applying to the skin a composition comprising, in a topically acceptable vehicle, a

peptide having from 3 to 15 aminoacids corresponding to a sequence of CTGF, or a salt, ester, or prodrug thereof.

22. The method according to claim 21, wherein said dermatological signs of aging include the appearance of fine lines and wrinkles.

23. The method according to claim 21, wherein said peptide increases collagen production in skin.

24. The method according to claim 21, wherein said peptide increases hyaluronic acid production in skin.

25. The method according to claim 21, wherein said composition is applied at least once daily for at least one week.

26. A cosmetic composition comprising a topically acceptable vehicle said a peptide comprising from 3 to 15 aminoacids corresponding to a sequence of CTGF, or a salt, ester, or prodrug thereof.

27. The cosmetic composition of claim 26, wherein said peptide is present in an amount from about 0.000001% to about 1% by weight.

28. The cosmetic composition of claim 26, wherein said topically acceptable vehicle comprises a water-in-oil, oil-in-water, silicone-in-water, or water-in-silicone emulsion.

29. The cosmetic composition of claim 28, wherein said topically acceptable vehicle further comprises an emulsifier.

30. The cosmetic composition of claim 26 further comprising an additional active ingredient selected from the group consisting of alpha-hydroxy acids, thiodipropionic acid or esters thereof, salicylic acid, niacinamide, hexyl resorcinol, phytol, and retinoids.

31. A method for diminishing the appearance of dermatological signs of aging comprising topically applying to the skin a composition comprising, in a topically acceptable vehicle, a peptide having from 3 to 12 aminoacids corresponding to a sequence of PDGF, or a salt, ester, or prodrug thereof.

32. The method according to claim 31, wherein said dermatological signs of aging include the appearance of fine lines and wrinkles.

33. The method according to claim 31, wherein said peptide increases collagen production in skin.

34. The method according to claim 31, wherein said peptide increases hyaluronic acid production in skin.

35. The method according to claim 31, wherein said composition is applied at least once daily for at least one week.

36. A cosmetic composition comprising a topically acceptable vehicle said a peptide comprising from 3 to 12 aminoacids corresponding to a sequence of PDGF, or a salt, ester, or prodrug thereof.

37. The cosmetic composition of claim 36, wherein said peptide is present in an amount from about 0.000001% to about 1% by weight.

38. The cosmetic composition of claim 36, wherein said topically acceptable vehicle comprises a water-in-oil, oil-in-water, silicone-in-water, or water-in-silicone emulsion.

39. The cosmetic composition of claim 38, wherein said topically acceptable vehicle further comprises an emulsifier.

40. The cosmetic composition of claim 36 further comprising an additional active ingredient selected from the group consisting of alpha-hydroxy acids, thiodipropionic acid or esters thereof, salicylic acid, niacinamide, hexyl resorcinol, phytol, and retinoids.

41. A method for diminishing the appearance of dermatological signs of aging comprising topically applying to the skin a composition comprising, in a topically acceptable vehicle, a peptide having from 3 to 12 aminoacids corresponding to a sequence homologous to a sequence of two or more of GDF11, TGF β , CTGF, or PDGF, or a salt, ester, or prodrug thereof.

42. A composition comprising, in a topically acceptable vehicle, a peptide having from 3 to 12 aminoacids corresponding to a sequence homologous to a sequence of two or more of GDF11, TGF β , CTGF, or PDGF, or a salt, ester, or prodrug thereof.

The composition of claim 42 further comprising an additional active ingredient selected from the group consisting of alpha-hydroxy acids, thiodipropionic acid or esters thereof, salicylic acid, niacinamide, hexyl resorcinol, phytol, and retinoids.

CLAIMS:

What is claimed is:

1. A method for diminishing the appearance of dermatological signs of aging comprising topically applying to the skin a composition comprising, in a topically acceptable vehicle, a peptide having from 3 to 12 aminoacids corresponding to a sequence of GDF11, or a salt, ester, or prodrug thereof.
2. The method according to claim 1, wherein said dermatological signs of aging include the appearance of fine lines and wrinkles.
3. The method according to claim 1, wherein said peptide increases collagen production in skin.
4. The method according to claim 1, wherein said peptide increases hyaluronic acid production in skin.
5. The method according to claim 1, wherein said composition is applied at least once daily for at least one week.
6. A method for diminishing the appearance of dermatological signs of aging comprising topically applying to the skin a composition comprising, in a topically acceptable vehicle, a peptide having from 3 to 12 aminoacids corresponding to a sequence of TGF β , or a salt, ester, or prodrug thereof.
7. The method according to claim 6, wherein said dermatological signs of aging include the appearance of fine lines and wrinkles.
8. The method according to claim 6, wherein said peptide increases collagen production in skin.
9. The method according to claim 6, wherein said peptide increases hyaluronic acid production in skin.
10. The method according to claim 6, wherein said composition is applied at least once daily for at least one week.
11. A method for diminishing the appearance of dermatological signs of aging comprising topically applying to the skin a composition comprising, in a topically acceptable

vehicle, a peptide having from 3 to 15 aminoacids corresponding to a sequence of CTGF, or a salt, ester, or prodrug thereof

12. The method according to claim 11, wherein said dermatological signs of aging include the appearance of fine lines and wrinkles.
13. The method according to claim 11, wherein said peptide increases collagen production in skin.
14. The method according to claim 11, wherein said peptide increases hyaluronic acid production in skin.
15. The method according to claim 11, wherein said composition is applied at least once daily for at least one week.
16. A method for diminishing the appearance of dermatological signs of aging comprising topically applying to the skin a composition comprising, in a topically acceptable vehicle, a peptide having from 3 to 12 aminoacids corresponding to a sequence of PDGF, or a salt, ester, or prodrug thereof.
17. The method according to claim 16, wherein said dermatological signs of aging include the appearance of fine lines and wrinkles.
18. The method according to claim 16, wherein said peptide increases collagen production in skin.
19. The method according to claim 16, wherein said peptide increases hyaluronic acid production in skin.
20. The method according to claim 16, wherein said composition is applied at least once daily for at least one week.
21. A method for diminishing the appearance of dermatological signs of aging comprising topically applying to the skin a composition comprising, in a topically acceptable vehicle, a peptide having from 3 to 12 aminoacids corresponding to a sequence homologous to a sequence of two or more of GDF11, TGF β , CTGF, or PDGF, or a salt, ester, or prodrug thereof.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 15/48240

A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - A61K 38/18, A61P 17/00 (2015.01) CPC - A61K 38/18, A61K 38/1841, A61K 38/1858, A61K 38/1875 According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC(8) - A61K 38/18, A61P 17/00 (2015.01) CPC - A61K 38/18, A61K 38/1841, A61K 38/1858, A61K 38/1875 Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched USPC - 514/1.1, 514/7.6, 514/8.2, 514/8.8, 514/8.9 (keyword limited; terms below) Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PatBase, Google Patents, Google Scholar Search terms: skin, dermatological, age, aging, lines, wrinkles, GDF11, GDF-11, growth differentiation factor 11, BMP11, BMP-11, bone morphogenetic protein 11, TGF-beta, transforming growth factor beta, CTGF, CCN2, connective tissue growth factor, HCS24, IGFBP88		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	WO 2014/160496 A1 (STEMETRIX INC) 02 October 2014 (02.10.2014) para [04], [05], [013], [014], [028], [047], [080], [082]	1-3, 5-8, 10, 21 ----- 4, 9
X --- Y	US 2012/0115938 A1 (TABOR et al.) 10 May 2012 (10.05.2012) para [0008], [0011], [0050], [0073], [0127], [0204], [0290], [0307]	11-20 ----- 4, 9
☐ Further documents are listed in the continuation of Box C. ☐		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 30 October 2015 (30.10.2015)		Date of mailing of the international search report 04 DEC 2015
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300		Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 15/48240

Box No. 1 Nucleotide and/or amino acid sequence(s) (Continuation of item 1.c of the first sheet)

1. With regard to any nucleotide and/or amino acid sequence disclosed in the international application, the international search was carried out on the basis of a sequence listing:
- a. ☒ forming part of the international application as filed:
☒ in the form of an Annex C/ST.25 text file.
☐ on paper or in the form of an image file.
- b. ☐ furnished together with the international application under PCT Rule 13ter.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
- c. ☐ furnished subsequent to the international filing date for the purposes of international search only:
☐ in the form of an Annex C/ST.25 text file (Rule 13ter.1(a)).
☐ on paper or in the form of an image file (Rule 13ter.1(b) and Administrative Instructions, Section 713).
2. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.
3. Additional comments: