SUMMARY

[0009a] In one aspect, there is provided a recombinant polypeptide comprising an amino acid sequence truncated relative to a full-length human type 21 alpha 1 collagen, and comprising an amino acid sequence according to SEQ ID NO: 76.

[0009b] In another aspect, there is provided a recombinant cell comprising at least one copy of a heterologous nucleic acid sequence encoding a recombinant polypeptide as described herein.

[0009c] In another aspect, there is provided a composition comprising between 0.005% w/w and 30% w/w of the recombinant polypeptide as described herein.

[0010] In one example, a non-naturally occurring collagen produced by a host cell is provided. The non-naturally occurring collagen is jellyfish (Hydrozoan) collagen, human collagen, Chondrosia reniformis (kidney sponge) collagen, or Rhincodon typus (whale shark) collagen. In an embodiment, the non-naturally occurring collagen is a full-length or a truncated collagen. In one embodiment, the collagen is truncated by an internal truncation of between 50 amino acids and 500 amino acids. In another embodiment, the truncation is at the C-terminal end or the N-terminal end of the collagen polypeptide. The non-naturally occurring collagens are SEQ ID NO: 10, SEQ ID NO: 12, SEQ ID NO: 14, SEQ ID NO: 16, SEQ ID NO: 18, SEQ ID NO: 20, SEQ ID NO: 74, SEQ ID NO: 76, SEQ ID NO: 78, SEQ ID NO: 80, SEQ ID NO: 82, SEQ TD NO: 84, SEQ ID NO: 86, SEQ ID NO: 89 SEQ ID NO: 91, SEQ ID NO: 92, SEQ ID NO: 94, SEQ ID NO: 96, SEQ ID NO: 102, SEQ ID NO: 104, SEQ ID NO: 106, SEQ ID NO: 108, SEQ ID NO: 110, or SEQ ID NO: 112.

[0011] In another example, the non-naturally occurring collagen further comprises amino acid sequences including a secretion tag, a histidine tag, a green fluorescent protein tag, a protease cleavage site, a Beta-lactamase and/or GEK amino acid trimer repeats and/or GDK amino acid trimer repeats. When the non-naturally occurring collagen comprises one or more amino acid trimer repeats of the sequence glycine-glutamic acid-lysine (GEK) and/or glycine-aspartic acid-lysine (GDK), the number of GEK and/or GDK trimer repeats can range from 2 to 50 trimer repeats. In one example, the secretion tag is DsbA, PelB, OmpA, TolB, MalE, lpp, TorA, or HylA, or a hybrid secretion tag that comprises a portion of one secretion tag fused to a portion of a second secretion tag. An exemplary secretion tag is DsbA.

[0012] In one example, provided are compositions that comprise between 0.005% and 30% w/w non-naturally occurring collagen. The compositions can further comprise at least one additional ingredient comprising a topical carrier or a preservative

[0013] Compositions comprising non-naturally occurring collagen are in one example topical compositions for applying to skin. The topical compositions are used for decreasing skin damage or promoting the repair of damaged skin.

[0014] One example provides methods for decreasing skin damage or promoting the repair of damaged skin. The method comprises applying the composition comprising elastin to the skin of a subject. The method increases the viability of the fibroblast cells or keratinocytes of the skin of the subject. In another example the application of

the composition increases the synthesis of procollagen by the fibroblast cells of the subject's skin. In another example the topical application of the composition protects skin or keratinocytes against UV damage. In yet another embodiment, thymine-thymine (TT) dimer formation is decreased by the collagens or elastins disclosed herein.

[0015] Another example provided herein are methods of increasing the viability of skin cells. The method comprises applying collagen or elastin molecules to the skin or skin cell. The collagen or elastin as provided increases the viability of keratinocytes and/or fibroblasts is increased upon exposure to UV radiation, urban dust or other damaging stimuli.

[0016] In another example provided herein are methods for decreasing the production of inflammatory cytokines in a skin cell. In one embodiment the skin cell is a keratinocyte. The method comprises applying a collagen or elastin molecule to a skin cell. The production of inflammatory cytokines including TNFα, IL-1α, IL-1β, IL-3, IL-6, IL-7, IL-8, IL-10, IL-18, and TL-1RA.

[0017] In another example, provided are methods of protecting skin cells against the effect of exposure to urban dust. The method comprises the step of applying the collagen or elastin disclosed herein to the skin cell. The exposure of skin cell to collagen or elastin increases the viability of the skin cell. In an embodiment, the skin cell is a keratinocyte or a fibroblast.

[0018] In one example, a non-naturally occurring elastin produced by a host cell is provided. The non-naturally occurring elastin is jellyfish elastin, human elastin, Chondrosia reniformis (kidney sponge) elastin, or Rhincodon typus elastin. In an embodiment, the non-naturally occurring elastin is a full-length or truncated elastin. In one embodiment, the elastin is truncated by an internal truncation of between 50 amino acids and 500 amino acids. In another embodiment, the truncation is at the C-terminal end or the N-terminal end of the elastin polypeptide. The non-naturally occurring elastins are SEQ ID NO: 31, SEQ ID NO: 33, SEQ ID NO: 35, SEQ ID NO: 37, SEQ ID NO: 39, SEQ ID NO: 41, SEQ ID NO: 43, SEQ ID NO: 45, SEQ ID NO: 47, SEQ ID NO: 49, SEQ ID NO: 51, SEQ ID NO: 53, SEQ TD NO: 55 SEQ ID NO: 57, SEQ ID NO: 59, SEQ ID NO: 61, SEQ ID NO: 63, SEQ ID NO: 65, SEQ ID NO: 67, SEQ ID NO: 69, SEQ ID NO: 71, SEQ ID NO: 98, or SEQ ID NO: 110.

[0019] In another example, the non-naturally occurring elastin further comprises amino acid sequences including a secretion tag, a histidine tag, a green fluorescent

protein tag, a protease cleavage site, a Beta-lactamase and/or GEK amino acid trimer repeats and/or GDK amino acid trimer repeats. When the non-naturally occurring collagen comprises one or more amino acid trimer repeats of the sequence glycine-glutamic acid-lysine (GEK) and/or glycine-aspartic acid-lysine (GDK), the number of GEK and/or GDK trimer repeats can range from 2 to 50 trimer repeats. In one example, the secretion tag is DsbA, PelB, OmpA, TolB, MalE, lpp, TorA, or HylA, or a hybrid secretion tag that comprises a portion of one secretion tag fused to a portion of a second secretion tag. An exemplary secretion tag is DsbA.

[0020] In another embodiment, compositions that comprise between 0.005% and 30% w/w non-naturally occurring elastin are provided. The compositions can further comprise at least one additional ingredient comprising a topical carrier or a preservative.

[0021] Compositions comprising non-naturally occurring elastin are in one example topical compositions for applying to skin. The topical compositions are used for decreasing skin damage or promoting the repair of damaged skin.

[0022] One embodiment provides methods for decreasing skin damage or promoting the repair of damaged skin. The method comprises applying the composition comprising elastin to the skin of a subject. The method increases the viability of the fibroblast cells of the skin of the subject. In another example the application of the composition increases the synthesis of procollagen by the fibroblast cells of the subject's skin. In another example the topical application of the compositions protects skin or keratinocytes against UV damage. In yet another embodiment, thymine-thymine (TT) dimer formation is decreased by the collagens or elastins disclosed herein.

[0023] Another embodiment provides polynucleotides that encode a non-naturally occurring collagen or a non-naturally occurring elastin. The polynucleotides encode collagen or elastin from jellyfish, human, Chondrosia reniformis (kidney sponge), or Rhincodon typus . The encoded collagen or elastin may be full length or truncated. In one embodiment, the collagen or elastin is truncated by an internal truncation of between 50 amino acids and 500 amino acids.

[0024] In one embodiment polynucleotides that encode fusion proteins comprising a secretion tag, a histidine tag, a green fluorescent protein tag, a protease cleavage site, a Beta-lactamase along and/or GEK amino acid trimer repeat and/or GDK amino acid trimer repeats together with collagen or elastin are provided. The non-naturally

occurring collagen or elastin may comprise one or more amino acid trim er repeats of the sequence glycine-glutamic acid-lysine (GEK) and/or glycine-aspartic acid-lysine (GDK), the number of GEK and/or GDK trimer repeats can range from 2 to 50 trimer repeats. In one example, the secretion tag is DsbA, PelB, OmpA, TolB, MalE, lpp, TorA, or HylA, or a hybrid secretion tag that comprises a portion of one secretion tag fused to a portion of a second secretion tag. An exemplary embodiment secretion tag is DsbA.

[0025] The polynucleotides and vectors can be used to transform host cells and express the polynucleotides. Polynucleotides encoding a non-naturally occurring collagen, wherein the polynucleotide is SEQ ID NO: 9, SEQ ID NO: 11, SEQ ID NO: 13, SEQ ID NO: 15, SEQ ID NO: 17, SEQ ID NO: 19 SEQ ID NO: 73, SEQ ID NO: 75, SEQ ID NO: 77, SEQ ID NO: 79, SEQ ID NO: 81, SEQ ID NO: 83, SEQ ID NO: 85, SEQ ID NO: 90, SEQ ID NO: 93, SEQ ID NO: 95, SEQ ID NO: 97, SEQ ID NO: 103, SEQ ID NO: 105, SEQ ID NO: 107, SEQ ID NO: 109, SEQ ID NO:111, SEQ ID NO: 113, or SEQ ID NO: 105 are provided. Polynucleotides encoding a non-naturally occurring elastin, wherein the polynucleotide is SEQ ID NO: 34, SEQ ID NO: 36, SEQ ID NO: 38, SEQ ID NO: 40, SEQ ID NO: 42, SEQ ID NO: 44, SEQ ID NO: 46, SEQ ID NO: 48, SEQ ID NO: 50, SEQ ID NO: 52, SEQ ID NO: 54, SEQ ID NO: 56, SEQ ID NO: 58, SEQ ID NO: 60, SEQ ID NO: 62, SEQ ID NO: 64, SEQ ID NO: 66, SEQ ID NO: 68, SEQ ID NO: 70, and SEQ ID NO: 72, SEQ ID NO: 99, or SEQ ID NO:101provided.

[0026] Host cells that express the polynucleotides of the disclosure are disclosed. Host cells can be any host cell including bacterial cells, yeast cells, fungal cells, insect cells, mammalian cells, plant cells and any other cells used to express exogenous polynucleotides.

[0027] Bacterial host cells in which the cells have been modified to inhibit cell division and the periplasmic space is increased are provided. An exemplary host cell is E. coli.

[0028] One embodiment provides a method of producing a non-naturally occurring collagen or a non-naturally occurring elastin. The method comprises the steps of inoculating a culture medium with a recombinant host cell comprising polynucleotides that encode the collagen or elastin, cultivating the host cell, and isolating the non-naturally occurring collagen or the non-naturally occurring elastin from the host cell.

CLAIMS

What is claimed is:

1. A recombinant polypeptide comprising an amino acid sequence truncated relative to a full-length human type 21 alpha 1 collagen, and comprising an amino acid sequence according to SEQ ID NO: 76.

2. The recombinant polypeptide of claim 1, wherein the amino acid sequence truncated relative to a full-length human type 21 alpha 1 collagen has a truncation of between 50 amino acids and 800 amino acids relative to a full-length human type 21 alpha 1 collagen.

3. The recombinant polypeptide of claim 1 or 2, wherein the amino acid sequence truncated relative to a full-length human type 21 alpha 1 collagen comprises a truncation at an N-terminal end relative to a full-length human type 21 alpha 1 collagen, a truncation at a C-terminal end relative to a full-length human type 21 alpha 1 collagen, an internal truncation relative to a full-length human type 21 alpha 1 collagen, or any combination thereof.

4. The recombinant polypeptide of any one of claims 1-3, wherein the amino acid sequence truncated relative to a full-length human type 21 alpha 1 collagen comprises a truncation at an N-terminal end relative to a full-length human type 21 alpha 1 collagen, and a truncation at a C-terminal end relative to a full-length human type 21 alpha 1 collagen.

5. The recombinant polypeptide of any one of claims 1-4, wherein the amino acid sequence truncated relative to a full-length human type 21 alpha 1 collagen has a truncation at an N-terminal end of between 50 amino acids and 600 amino acids.

6. The recombinant polypeptide of any one of claims 1-5, wherein the amino acid sequence truncated relative to a full-length human type 21 alpha 1 collagen has a truncation at a C-terminal end of between 50 amino acids and 250 amino acids.

7. The recombinant polypeptide of any one of claims 1-6, wherein the amino acid sequence truncated relative to a full-length human type 21 alpha 1 collagen has a truncation of between 50 amino acids and 600 amino acids at an N-terminal end and a truncation of between 50 amino acids and 250 amino acids at a C-terminal end relative to a full-length human type 21 alpha collagen.

8. The recombinant polypeptide of claim 1, wherein the recombinant polypeptide consists of an amino acid sequence according to SEQ ID NO: 76.

9. The recombinant polypeptide of any one of claims 1-8, further comprising one or more selected from the group consisting of: a secretion tag; a fluorescent protein; a protease cleavage site; and a beta-lactamase protein.

10. The recombinant polypeptide of claim 9, wherein the secretion tag is DsbA.

11. A recombinant cell comprising at least one copy of a heterologous nucleic acid sequence encoding a recombinant polypeptide according to any one of claims 1-10.

12. The recombinant cell of claim 11, wherein the recombinant cell is a bacterial cell.

13. The recombinant cell of claim 12, wherein the bacterial cell is of the species *Escherichia coli*.

14. The recombinant cell of any one of claims 11-13, wherein the heterologous nucleic acid sequence comprises SEQ ID NO: 75.

15. The recombinant cell of any one of claims 11-14, wherein the heterologous nucleic acid sequence is codon-optimized for expression in a cell.

16. The recombinant cell of any one of claims 11-16, wherein the recombinant cell is capable of secreting the recombinant polypeptide extracellularly.

17. A composition comprising between 0.005% w/w and 30% w/w of the recombinant polypeptide of any one of claims 1-10.

18. The composition of claim 17, wherein the composition is formulated for topical application.

19. The composition of claim 17 or 18, wherein the composition comprises a topical carrier, a preservative, or both.

20. The composition of any one of claims 17-19, wherein the composition is a cosmetic.