Curriculum Vitae of Ioannis V. Yannas

1. DATE OF CV: May 2015

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2. FULL NAME: Ioannis Vassilios Yannas

3. DATE AND PLACE OF BIRTH: April 14, 1935; Athens, Greece

4. CITIZENSHIP: U.S.

5. EMPLOYMENT ADDRESS: MIT, 77 Massachusetts Avenue, Room 3-332, Cambridge, MA, USA. **PHONE:** 617-253-4469.

6. EDUCATION

1953-57 B.A. Harvard College (Chemistry)
1957-59 S.M. M.I.T. (Chem. Engineering)
1965 M.A. Princeton University (Phys. Chemistry)
1966 Ph.D. Princeton University (Phys. Chemistry)

7. CURRENT EMPLOYMENT

Professor, Departments of Mechanical and Biological Engineering, Massachusetts Institute of Technology (MIT), Cambridge, MA

8. PRINCIPAL PREVIOUS EMPLOYMENT OUTSIDE MIT

1980-81	Visiting Fellow, Shriners Hospital for Crippled Children, Boston, MA
1980-81	Visiting Fellow in Surgery, Massachusetts General Hospital, Boston, MA
1979-80	Professor of Polymer Science, National Technical University, Athens, Greece
1974	Visiting Professor, Royal Institute of Technology, Stockholm, Sweden
1959-63	W.R. Grace Co., Research Physical Chemist, Cambridge, MA

9. HISTORY OF MIT APPOINTMENTS

Rank	Dates
Teaching Assistant - Industrial Chemistry	1957
Teaching Assistant - Chemical Engineering	1958
Assistant Professor, Department of Mechanical Engineering	1966-68
DuPont Assistant Professor, Department of	

Mechanical Engineering	1968-69
Associate Professor without tenure, Department of Mechanical Engineering	1969-72
Tenured Associate Professor, Department of Mechanical Engineering	1973-1978
Professor, Department of Mechanical Engineering	1978-present
Professor, Materials Science and Engineering	1983-2000
Professor, Department of Biological Engineering	2006-present
Professor, Harvard-MIT Program in Health Sciences and Technology, MIT	1978-2000

10. **Industrial Consulting Record:**

Firm	Starting Dates
Foster-Miller Associates	1966
McNeill Engineering Co.	1968
Long Lok Corporation	1971
American Optical Company	1973
Parke-Davis	1975
Devro Inc.	1975
Belding Hemenway	1978
Meadox	1978
Becton Dickinson Division	1978
Hoague-Sprague Leasing Company	1979
AMF, Inc.	1979
American Can Company	1979
AVCO	1979
Hellenic Industrial Development Bank	1980
Marion Laboratories	1981
Thermedics	1983
Integra Life Sciences Corp.	1992
Geistlick Biomaterials	1993
Shriners Hospital for Crippled Children	1994
Various law firms	1990
Integra Life Sciences Corp.	1993-2001
Promethia Bioscience	2007-present
Orthomimetics (UK)	2007-2010
L'Oréal (France)	2009-2010

11. Department and Institute Committees at MIT, Other Assigned Duties (Available upon request)

12. Professional Service/Committees outside MIT

Committee	Starting Dates
National Science Foundation, reviewer	1969
National Institutes of Health, grants reviewer	1972-present
Several Journals, reviewer	1966-present
National Institute of Health	
Study section, Member	1977, 2008
Study section, Chairman	1980
National Institute of Health, Member, Consensus Panel, Conference on Biomaterials	1982
National Research Council, Committee of Advanced Structural Materials	1985-87
Editorial Board: *Journal of Biomedical Materials Research*	1986-
Editorial Board: *Journal of Materials Science: Materials in Medicine*	1990-2007
Editorial Board: *Tissue Engineering* (USA)	1995-2008
Editorial Board: *J Royal Soc Interface*	2005-2007
Editorial Board: *Biomedical Materials* (China)	2005-
Editorial Board: J Tissue Engineering (UK)	2009
Editorial Board: Materials Science and Engineering C: Materials for Biological Applications	2010-

13. Awards and Honors Received:

Award or Honor	Date
National Inventors Hall of Fame (U.S. Pat. 4,418,691, 1983, describing organ regeneration)	2015
American Burn Association establishes Burke/Yannas annual bioengineering award	2011
Matrix Biology Group Lecturer, London	2007
Ray A. and Robert L. Kroc Lecturer, MIT	2002
Sophia Award, Greek Institute, Cambridge, MA	2002
Fellow in Biomaterials Science and Engineering (FBSE), Society for Biomaterials	1996
Founding Fellow, American Institute of Medical and Biological Engineering	1993
Clemson Award for Applied Science and Engineering, Society for Biomaterials	1992
Doolittle Award of the American Chemical Society	1988
Member, National Academy of Medicine	1987
Fellow, American Institute of Chemists	1986

Society of Plastics Engineers, Medical Plastics Division, "Best Technical Paper Award"	1985
Society for Biomaterials, Founders Award	1982
Society of Plastics Engineers, Fred O. Conley Award	1982
Cutty Sark/Science Digest Award	1982
Zinon Papanastassiou Memorial Lecturer, Hellenic College	1982
Technology Magazine, selected for inclusion among "The Technology 100"	1981
American Society for Artificial Internal Organs selected among "Four Best Abstracts", Annual Meeting	1981
Hellenic Medical Society of New York, Annual Award	1978
Greek World Magazine, Annual Award	1977
DuPont Young Faculty Award, MIT	1968
Public Health Service Fellow, Princeton University	1963
Esso Standard Oil Fellow, MIT	1958
Harvard College Scholar, Harvard University	1954

Reports of research in mass media

Dr. Yannas' research on artificial skin, nerve regeneration and other areas of organ regeneration were reported in the following TV and printed media:

- 1996- TV: BBC, CNN, ABC, Discovery, and other channels.
- 1975-2000 Press: New York Times, Boston Globe, Der Spiegel, Newsweek, Time, Wall Street Journal and several others.
- 2007 A book, *The Sun Farmer* (Ivan R. Dee, Chicago, 2007), by Michael McCarthy, former reporter of the Wall Street Journal, describes the development of the product Integra© ("artificial skin") in Yannas' MIT lab and its use to treat a severely burned farmer.

14. Organization Membership:

National Academy of Medicine
American Institute of Medical and Biological Engineering (Founding Fellow)
American Society for Cell Biology
Biomedical Engineering Society (Charter Member)
American Chemical Society
Society for Biomaterials (Fellow)
American Society for Cell Biology

15. Patents and Patent Applications Pending:

1. Yannas, J.F. Burke, P.L. Gordon, and C. Huang, "Multilayer Membrane Useful as Synthetic Skin", U.S. Pat. 4,060,081 (November 29, 1977).
2. Yannas, P.L. Gordon, C. Huang, F.H. Silver, and J.F. Burke, "Crosslinked Collagen-Mucopolysaccharide Composite Materials", U.S. Pat. 4,280,954 (July 28, 1981).
3. Yannas and D.L. Sieverding, "Cross Flow Filtration Molding Method", U.S. Pat. 4,252,759 (February 24, 1981).
4. Yannas and M.J. Forbes, "Procedures for Preparing Composite Materials from Collagen and Glycosaminoglycan", U.S. Pat. 4,350,629 (September 21, 1982).
5. Yannas, J.F. Burke, D.P. Orgill, and E.M. Skrabut, "Method of Promoting the Regeneration of Tissue at a Wound", U.S. Pat. 4,418,691 (December 6, 1983).
6. Yannas and J.F. Kirk, "Method for the Preparation of Collagen-Glycosaminoglycan Composite Materials", U.S. Pat. 4,448,718 (May 15, 1984).
7. Yannas and J.F. Burke, "Cell-Seeding Procedures Involving Fibrous Lattices", U.S. Pat. 4,458,678 (July 10, 1984).
8. Yannas and J.F. Burke, "Method of Using a Fibrous Lattice", U.S. Pat. 4,505,266 (March 19, 1985).
9. Yannas, J.F. Burke, and P.S. Stasikelis, "Method for Preserving Porosity in Porous Materials", U.S. Pat. 4,522,753 (June 11, 1985).
10. Yannas, "Process for Forming Multilayer Bioreplaceable Blood Vessel Prosthesis", U.S. Pat. 4,787,900 (November 29, 1988).
11. Yannas, "Multilayer Bioreplaceable Blood Vessel Prosthesis", U.S. Pat. 4,902,289 (February 20, 1990).
12. Yannas, Elaine Lee, and Ariel Ferdman, "Biodegradable Templates for the Regeneration of Tissues", U.S. Pat. 4,947,840 (August 14, 1990).
13. Yannas, D.P. Orgill, H.M. Loree II, J.F. Kirk, A. S.-P. Chang, B.B. Mikic, C. Krarup, T.V. Norregaard, and N.T. Zervas, "Prosthesis for Promotion of Nerve Regeneration", U.S. Pat. 4,955,893 (September 11, 1990).
14. Orgill, D. P., C. E. Butler, M. Barlow, S. Ritterbush, I. V. Yannas and C. C. Compton. “Method of skin regeneration using a collagen-glycosaminoglycan matrix and cultured epithelial autograft.”, U.S. Patent 5,489,3041 (1996).
15. Orgill D.P., C. E. Butler, M. Barlow, S. Ritterbush, I. V. Yannas, Carolyn C. Compton, “Method of skin regeneration using a collagen-glycosaminoglycan matrix and cultured epithelial autograft”. U.S.Patent 5,716,411 (Feb.10, 1998). .
16. Spector, M., Yannas, I. V. (and others). "Modification of collagen matrices for prolonged delivery of genes." MIT Case No. 9411. July 25, 2001.
17. Gibson, L. J., Yannas, I. V. and others. "Scaffolds with uniform pore channels" (disclosure submitted to MIT). 2003.
18. Sannino, A., Yannas I. V. and others. "Novel Technique to Fabricate Porous Tubes with Tube Walls Having Patterned Porosity". U.S. Serial No. 60/622,441. Filed 27 Oct. 2004.
19. Yannas I. V., L. J. Gibson, F. J. O’Brien, B. Harley, R. R. Brau, S. Samouhos, M. Spector . “Gradient scaffolding and Methods for Producing the Same". Pub. No. US 2006/0121609 A1 (Patent Application published Jun. 8, 2006)

20. Lynn AJ, Yannas IV, B. Harley, L. J. Gibson. "Method for Producing Scaffolds Comprising Porous Layers of Collagen, Calcium Phosphate and GAG". UK Patent Application No. 0504673.5. (Filed 7 March 2005.)
21. Harley BJ, Reddy HK, Yannas IV, Zagorski C. "Processing of angiogenic scaffolds for Large Organ Regeneration". US Serial no. 60/730,880. Filed 28 Oct. 2005.
22. I.V Yannas, H.K. Reddy, C.J. Zagorski, and B.A. Harley, "Gradient Template for Angiogenesis during Large Organ Regeneration". Intl. application No. PCT/US2006/043424. Intl. Filing Date: Nov. 6, 2006.
23. C.J. Zagorski, B.A. Harley, H.K. Reddy, I.V Yannas,. "Tissue Scaffolding Comprising Surface folds for Tissue Engineering". Intl. Application No. PCT/US2006/14484. Intl. filing Date: April 17, 2006.
24. Sannino A, Harley BA, Hastings AZ, Yannas IV; A novel technique to fabricate cylindrical and tubular structures with a patterned porosity. International (PCT) Patent Application patent PCT/US2005/039024. 2005 October 27, 2005.
25. Lynn AK, Harley BA, Gibson LJ, Yannas IV, Bonfield W, inventors; Biomaterial. U.K. Patent Application patent GB05/04673.5. 2005 March 7, 2005.
26. M.I.T. Case No. 13111, "Scaffolds for Control of the Fibrotic Healing Response of Liver Tissue", by Karen J. Ho, Seth J. Karp, Eric C. Soller and Ioannis V. Yannas.
27. MIT Case No. 13391 Masking of Scaffold Surfaces. Tzeranis D, So P. and Yannas IV.

16. Professional Registration: Available upon request

17. Major New Products in Worldwide Clinical Use

Two products were either invented under Dr Yannas' supervision or were critically modified at the Fibers and Polymers Lab at MIT, which he has directed for many years.

The first, Dermis Regeneration Template™, marketed as Integra™, was invented during the period 1975-1982 at the Fibers and Polymers Lab, MIT, supervised by IV Yannas, was manufactured by Integra Life Sciences Inc, Plainsboro NJ, was approved by the Food and Drug Administration (FDA) in 1996 and currently appears to be the only medical device that can be used to regenerate the dermis in patients with skin loss. These patients are either burn patients, patients who undergo plastic and reconstructive surgery, or patients who suffer from chronic skin wounds. It has been used with over 200,000 patients (as of 2012).

The second device, Nerve Regeneration Template™, was synthesized as a porous collagen tube and studied with animals at the Yannas MIT lab (Yannas et al., Trans Soc Biomat 8:1946, 1985) to induce regeneration of peripheral nerves over unprecedented distance. The product Neuragen™, based on a porous collagen tube, was later modified and manufactured by Integra Life Sciences Inc., and was

approved by the FDA in 2002 for the treatment of paralysis of limbs and facial nerves.

18. Companies cofounded by IV Yannas

- Integra Life Sciences (Plainsboro, NJ, USA)
- Biofunction (Cambridge, MA)
- Orthomimetics (Cambridge, UK), subsequently owned by TiGenix Inc. (Belgium)

19. Teaching activities at MIT: Available upon request

20. Publications

a. Books:

Sole author:

Yannas IV, *Tissue and Organ Regeneration in Adults*. New York, Springer, 2001.

Yannas IV, *Tissue and Organ Regeneration in Adults. Extension of the Paradigm to Several Organs*. New York, Springer, 2015.

Editor, *Regenerative Medicine.* Two volumes. New York, Springer. 2005.

b. Papers in Refereed Journals (also invited chapters in books during period 2006-present):

1. Yannas, I.V. (J.B.) and Gonzales, R.N., "A clear instance of rheopectic flow", *Nature* 191:1384-1385 (1961).

2. Yannas, I.V. (J.B.) and Gonzales, F.N., "Phenomenological Characterization of a Rheopectic Suspension", *Rheological Bulletin* 30, No. 2 (1961).

3. Yannas, I.V. (J.B.) and Gonzalez, R.N., "Low Shear Viscometry in the Prediction of Coating Performance", *Technical Association of Pulp and Paper Industry Journal* 45:156-159A (1962).

4. Yannas, I.V., (J.B.) "Fractionation of Chemically Heterogeneous Latex Particles by Centrifugation", *Journal of Polymer Science* A2:1633-1640 (1964).

5. Yannas, I.V., (J.B.) "Highly Precise Density Determination for Polymers in Latex Form", *Polymer Letters* **2**:1005-1008 (1964).

6. Yannas, I.V. (J.B.) and Isgur, I.D., "Chemically Heterogeneous Populations of Copolymer Latex Particles. Preparation, Fractionation, and Characterization", *Journal of Polymer Science* **A2**:47194726 (1964).

7. Yannas, I.V. and Tobolsky, A.V., "Viscoelastic Properties of Plasticized Gelatin Films", *Journal of Physical Chemistry* **68**:3880-3882 (1964).

8. Yannas, I.V. and Tobolsky, A.V., "Approximate Master Curves for Amorphous Polymers from Modulus-Temperature Data", *Journal of Macromolecular Chemistry* 1**(2)**:399-402 (1966).

9. Yannas, I.V. and Tobolsky, A.V., "Transitions in Gelatin—Nonaqueous-diluent Systems", *Journal of Macromolecular Chemistry* 1**(4)**:723-737 (1966).

10. Yannas, I.V. and Tobolsky, A.V., "Crosslinking of Gelatin by Dehydration", *Nature* 215:509-510 (1967).

11. Yannas, I.V. and Tobolsky, A.V., "Stress Relaxation of Anhydrous Gelatin Rubbers", *Journal of Applied Polymer Science* 12:1-8 (1968).

12. Yannas, I.V. and Tobolsky, A.V., "High-Temperature Transformations of Gelatin", *European Polymer Journal* 4:257-264 (1968).

13. Yannas, I.V., "Isochronal Temperature-Concentration Diagram for a Polymer-Diluent System", *Journal of Polymer Science* A2**(6)**:687-694 (1968).

14. Yannas, I.V., "Vitrification Temperature of Water", *Science* 160:298-299 (1968).

15. Yannas, I.V., "Massive Internal Fracture of an Amorphous Polyester", *Science* 166:227-228 (1969).

16. Yannas, I.V., "Involvement of articular cartilage in a linear relaxation process during walking", *Nature* 227, 1358-1360 (1970).

17. Yannas, I.V. and Lunn, A.C., "The transition from linear to non-linear viscoelastic behavior, Part I, Creep of polycarbonate", *Journal of Macromolecular Science* B4:603-620 (1970).

18. Yannas, I.V. and Lunn A.C., "Infrared spectroscopic evidence for polycarbonate chain motion below Tg", *Polymer Letters* 9:611-615 (1971).

19. Yannas, I.V. and Haskell, V., "Utility of the Green-Rivlin theory in polymer mechanics", *Journal of Applied Physics* 42:610-613 (1971).

20. Yannas, I.V., Sung, N.-H., and Lunn, A.C., "The transition from linear to nonlinear viscoelastic behavior. Part II. Stress relaxation of polycarbonate", *Journal of Macromolecular Science* **B5**:487-503 (1971).

21. Yannas, I.V., "Collagen and gelatin in the solid state", *Reviews in Macromolecular Chemistry* **C7**:49-104B (1972).

22. Yannas, I.V., "The transition from linear to nonlinear viscoelastic behavior. Part III. Linearity below and above Tg", *Journal of Macromolecular Science* B6:91-100 (1972).

23. Yannas, I.V. and Doyle, M.J., "Comparison of optical and mechanical limits of linear relaxation behavior in glassy polycarbonate", *Journal of Polymer Science* A**-2(10)**:159-170 (1972).

24. Yannas, I.V. and Huang, C., "Viscoelastic distinction between helical and coiled macromolecules", *Macromolecules* 5:99-100 (1972).

25. Yannas, I.V. and Huang, C., "Fracture of tendon collagen", *Journal of Polymer Science* **A2 (10)**:577-584 (1972).

26. Lunn, A.C. and Yannas, I.V., "Chain-backbone motion in glassy polycarbonate studied by polarized infrared spectroscopy", *Journal of Polymer Science* A2**(10)**:2189-2208 (1972).

27. Yannas, I.V. and Olson, D.A., "Linear relaxation analysis of the mechanochemical transformation of collagen fibers", *Biopolymers* 11:899-912 (1972).

28. Yannas, I.V., Sung, N-H. and Huang, C., "Resolution of components of the optical rotation tensor of collagen", *Journal of Physical Chemistry* **76**:2935 (1972).

29. Yannas, I.V. and Grodzinsky, A.J., "Electromechanical energy conversion with collagen fibers in an aqueous medium", *Journal of Mechanochemistry and Cell Motility* **2**:113-125 (1973).

30. Lunn, A.C., Lee, B-L. and Yannas, I.V., "Strain recovery of polyester and nylon 66 monofilaments under various temperature histories", *Polymer Engineering and Science* **14**:610-615 (1974).

31. Gordon, P.L., Huang, C., Lord, R.C. and Yannas, I.V., "The far infrared spectrum of collagen", *Macromolecules* 7:954-956 (1974).

32. Yannas, I.V., "Nonlinear viscoelasticity of solid polymers (in uniaxial tensile loading)", *Macromolecular Reviews* **9**:163-190 (1974).

33. Yannas, I.V., "A molecular mechanism for deformation in glassy and rubberlike polymers", *Bulletin of the American Physical Society* **20**, Series II, No. 3, p. 402 (March 1975).

34. Yannas, I.V., Burke, J.F., Huang, C. and Gordon P.L., "Correlation of in vivo collagen degradation rate with in vitro measurements", *Journal of Biomedical Materials Research* 9:623-628 (1975).

35. Comminou, M. and Yannas, I.V., "Dependence of stress-strain nonlinearity of connective tissue on the geometry of collagen fibers", *Journal of Biomechanics* 9:427-433 (1976).

36. Huang, C. and Yannas, I.V., "Mechanical studies of enzymatic degradation of insoluble collagen fibers", *Journal of Biomedical Materials Research*, Symposium No. 8, 137-154 (1977).

37. Jansson, J-F. and Yannas, I.V., "The infrared dichroism of glassy polycarbonate at small strains", *Journal of Polymer Science* 15:2103-2111 (1977).

38. Silver, F.H., Yannas, I.V. and Salzman, E.W., "Glycosaminoglycan inhibition of collagen induced platelet aggregation", *Thrombosis Research* 13:267-277 (1978).

39. Bansil, R., Yannas, I.V. and Stanley, H.E., "Raman spectroscopy: a structural probe of glycosaminoglycans", *Biochimica Biophysica Acta* 541:535-542 (1978).

40. Markenscoff, X. and Yannas, I.V., "On the Stress-Strain Relation for Skin", *Journal of Biomechanics* 12:127-129 (1979).

41. Silver, F.H., Yannas, I.V. and Salzman, E.W., "In vitro blood compatibility of glycosaminoglycan-precipitated collagens", *Journal of Biomedical Materials Research* 13:701-716 (1979).

42. Yannas, I.V. and Burke, J.F., "Design of an Artificial Skin. I, Design Principles", *Journal of Biomedical Materials Research* 14, 65-68 (1980).

43. Yannas, I.V., Burke, J.F., Gordon, P.L., Huang, C. and Rubenstein, R.H., "Design of an Artificial Skin. II. Control of Chemical Composition", *Journal of Biomedical Materials Research* **14**:107-131 (1980).

44. Dagalakis, N., Flink. J., Stasikelis, P., Burke, J.F. and Yannas, I.V., "Design of an Artificial Skin. Part III. Control of Pore Structure", *Journal of Biomedical Materials Research* 14:511-528 (1980).

45. Yannas, I.V., Burke, J.F., Warpehoski, M., Stasikelis, P., Skrabut, E.M., Orgill, D. and Giard, D.J., "Prompt, long-term functional replacement of skin", *Transactions of American Society for Artificial Internal Organs* 27:19-22 (1981).

46. Burke, J.F., Yannas, I.V., Quinby, W.C., Jr., Bondoc, C.C. and Jung, W.K., "Successful Use of a Physiologically Acceptable Artificial Skin in the Treatment of Extensive Burn Injury", *Annals of Surgery* 194:413-428 (1981).

47. Yannas, I.V., Burke, J.F., Orgill, D.P., Skrabut, E.M., "Wound Tissue Can Utilize a Polymeric Template to Synthesize a Functional Extension of Skin", *Science* 215:174-176 (1982).

48. Yannas, I.V. and Luise, R.R., "Distinction between Two Molecular Mechanisms of Deformation of Glassy Amorphous Polymers", *Journal of Macromolecular Science-Physics* B21:443-474 (1982).

49. Yannas, I.V., "What Criteria Should be Used for Designing Artificial Skin Replacements and How Well do the Current Grafting Materials Meet These Criteria?" *J. Trauma* 24:S29-S31 (1984).

50. Eman, W., Yannas, I.V. and Krueger, G.G., "Biology of Langerhans Cells: Further Insights into Origin and Migration", in *Clinical Research* 32:581A (1984).

51. Kardomateas, G. and Yannas, I.V., "A model for the Differing Crazing Behavior of Amorphous Polymer Glasses", *Philosophical Magazine* A52:39-50 (1985).

52. Murphy, G.F., Orgill, D.P., Hancock, W.W., Fonferko, E.B. and Yannas, I.V., "Morphological Reconstitution of Skin by Use of a Biodegradable Polymeric Graft", *Laboratory Investigations* **54**:45A (1986).

53. Yannas, I.V., Lee, E., Orgill, D.P., Skrabut, E.M., and Murphy, G.F., "Synthesis and characterization of a model extracellular matrix that induces partial regeneration of adult mammalian skin", *Proceedings of the National Academy of Sciences USA*, **86**:933-937 (l989).

54. Sylvester, M.F., Yannas, I.V., Salzman, E.W., and Forbes, M.J., "Collagen Banded Fibril Structure and the Collagen-Platelet Reaction", *Thromb. Res.* **55**:135-148 (1989).

55. Murphy, G.F., Orgill, D.P., and Yannas, I.V., "Dermal Regeneration is Induced by Biodegradable Collagen-Glycosaminoglycan Grafts", *Lab. Invest.* **63**:305-313 (1990).

56. Yannas, I.V., "Biologically Active Analogs of the Extracellular Matrix", *Angewandte Chemie* 29:20-35 (1990).

57. Ferdman, A.G. and Yannas, I.V., "The Scattering of Light from Histological Sections: A New Method for the Analysis of Connective Tissue." *J. Investigative Dermatology*, **100:**710-716 (1993).

58. Yannas, I.V. (1994). "Applications of ECM analogs in surgery." *J. Cell. Biochem*. **56**:188-191.

59. Louie, L.K., Yannas, I.V. and M. Spector (1994). "Development of a collagen-GAG copolymer implant for the study of tendon regeneration." *Mat. Res. Soc. Symp. Proc*. **331**:19-24.

60. Shafritz, T.A., Rosenberg, L.C. and Yannas, I.V. (1994). "Specific effects of glycosaminoglycans in an analog of extracellular matrix that delays wound contraction and induces regeneration." *Wound Rep. Reg*., **2**:270-276.

61. Yannas, I.V. (1995). "Tissue regeneration templates based on collagen-glycosaminoglycan copolymers." *Adv. Polymer Sci.* **122**:219-244.

62. Chen, C.S., Yannas, I.V. and Spector, M. (1995). "Pore strain behavior of collagen-glycosaminoglycan analogues of extracellular matrix." *Biomaterial*s, **16**:777-783.

63. Faryniarz, D.A., Chaponnier, C., Gabbiani, G., Yannas, I.V. and M. Spector (1995). "Myofibroblasts in the healing lapine collateral ligament: Possible mechanisms of contraction." *J. Ortho. Res.*, **14:**228-237.

64. Yannas, I.V., Colt, J. and Wai, Y.C. (1996)."Wound contraction and scar synthesis during development of the amphibian *Rana catesbeiana*."*Wound Rep. Reg*., **4**:31-41**.**

65. Ellis, D.L. and Yannas, I.V. (1996). Recent advances in tissue synthesis *in vivo* by use of collagen-glycosaminoglycan copolymers, *Biomaterials*, **17**, No. 3, 291-299.

66. Chamberlain, L. J., I. V. Yannas, H.-P. Hsu and M. Spector (1997). Histological response to a fully degradable collagen device implanted in a gap in the rat sciatic nerve. Tissue Eng. **3**:353-362.

67. Nehrer, S., Breinan, H.A., Ramappa, A., Shortkroff, S., Young, G., Minas, T., Sledge, C.B., Yannas, I.V. and Spector, M. (1997). Canine chondrocytes seeded in type I and type II collagen implants investigated In Vitro, J. Biomed Mater Res (Appl. Biomater.), **38**:95-104.

68. Nehrer, S., Breinan, H.A., Ramappa, A., Young, G., Shortkkroff, S., Louie, L.K., Sledge, C.B., Yannas, I.V. and Spector, M. (1997). Matrix collagen type and pore size influence behavior of seeded canine chondrocytes, Biomaterials **18**:769-776.

69. Spilker, M. H., I. V. Yannas, H.-P. Hsu, T. V. Norregaard, S. K. Kostyk and M. Spector (1997). The effects of collagen-based implants on early healing of the adult rat spinal cord. Tissue Eng. **3**:309-317.

70. Yannas, I. V. (1998). Studies on the biological activity of the dermal regeneration template. Wound Rep. Reg. **6**:518-524.

71. Brown, R. A., R. Prajapati, D. A. McGrouther, I. V. Yannas and M. Eastwood (1998). Tensional homeostasis in dermal fibroblasts: Mechanical responses to mechanical loading in three-dimensional substrates. J. Cell Physiol. **175**:323-332.

72. Orgill, D. P. and Yannas, I. V. (1998). Design of an artificial skin. IV Use of island graft to isolate organ regeneration from scar synthesis and other processes leading to skin wound closure. J. Biomed. Mater. Res. **36**:531-535.

73. Compton, C. C., C. E. Butler, I. V. Yannas, G. Warland and D. P. Orgill (1998). Organized skin structure is regenerated *in vivo* from collagen-GAG matrices seeded with autologous keratinocytes. J. Invest. Dermatol. **110**:908-916.

74. Butler, C. E., D. P. Orgill, I. V. Yannas and C. C. Compton (1998). Effect of keratinocyte seeding of collagen-glycosaminoglycan membranes on the regeneration of skin in a porcine model. Plast. Reconstr. Surg. **101**:1572-1579.

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68. Louie, L.K., Yannas, I.V., and Spector, M., “Development of a Collagen-GAG Copolymer Implant for the Study of Tendon Regeneration”, *Mat. Res. Soc. Symp. Proc.* 331:19-24 (1994).

69. Butler, C.E., Orgill, D.P., Compton, C. and Yannas, I.V. (1996). Effects of cell culturing on keratinocyte-seeded collagen-glycosaminoglycan matrix skin replacement in full-thickness porcine wounds, *Surg. For.* 47: 752-754.

Several abstracts presented to Society for Biomaterials and other societies during the period 1996-2016.

d. Other Major Publications (mostly chapters in books during 1971-2004; after 2004, chapters in books are listed under “Publications” above):

1. Tobolsky, A.V. and Yannas, I.V., "Thermodynamics of polymer solutions", Chapter 4 in *Polymer Science and Materials*, Vol. 1, 67-82 (1971).

2. Yannas, I.V., "Physical chemistry of collagen in the solid state", Chapter 3 in *Biomedical Physics and Biomaterials Science*, pp. 41-63 (1972).

3. Yannas, I.V., "Use of Artificial Skin in Wound Management", Chapter 15 in *The Surgical Wound*, P. Dineen, ed., Lea and Febiger, Philadelphia, pp. 171-190 (1981).

4. Yannas, I.V., Burke, J.F., Trelstad, R.L., Stasikelis, P., Warpehoski, M., Skrabut, E. and Giard, D., "Single-Application Closure of Deep Skin Wounds with a Polymeric Membrane", in *1981 Advances in Bioengineering*, D.C. Viano, editor, pp. 207-209 (1981).

5. Yannas, I.V. and Burke, J.F., "Artificial Skin Design: Permanent Closure of Full Thickness Skin Wounds", in *Biomaterials 1980*, G.D. Winter, D.F. Gibbons and H. Plenck, Jr., John Wiley, New York, pp. 635-640 (1982).

6. Yannas, I.V. and Luise, R.R., "The Strophon Theory of Deformation of Glassy Amorphous Polymers. Application to Small Deformations", in *The Strength and Stiffness of Polymers*, A.E. Zachariades and R.S. Porter, editors, Dekker, New York, Chapter 6, pp. 255-292 (1982).

7. Yannas, I.V., Burke, J.F., Wapehoski, M., Stasikelis, P., Skrabut, E.M., Orgill, D.P., Giard, D., "Design Principles and Preliminary Clinical Performance of an Artificial Skin", in *Biomaterials: Interfacial Phenomena and Applications*, N. Peppas and S.L. Cooper, editor, Advances in Chemistry Series, ACS, Washington, No. 199, 475-481 (1982).

8. Yannas, I.V., Orgill, D.P., Skrabut, E.M. and Burke, J.F., "Skin Regeneration with a Bioreplaceable Polymeric Template", Chapter 13 in *Polymeric Materials and Artificial Organs*, C.G. Gebelein, editor, ACS, Washington, pp. 191-197 (1984).

9. Yannas, I.V. and Orgill, D.P., Artificial Skin: A Fifth Route to Organ Repair, in *Polymeric Biomaterials*, E. Piskin and A.S. Hoffmann, eds., Martinas, Nijhogg, Dordrecht, pp. 221-230 (1986).

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11. Yannas, I.V., Orgill, D.P., Silver, J., Norregaard, T.V., Zervas, N.T., and Schoene, W.C., "Regeneration of Sciatic Nerve Across 15-mm Gap by Use of a Polymeric Template", in *Advances in Biomedical Polymers*, Charles G. Gebelein, editor, Plenum Publishing Corp., NY, pp. 1-9 (l987).

12. Yannas, I.V., "Regeneration of Skin and Nerves by use of Collagen Templates", in Vol. III, *Collagen: Biotechnology*, M. Nimni, editor, CRC Press, Boca Raton, FL, Chapt. 4, pp. 87-115 (l988).

13. Yannas, I.V., "Control of Kinetics and Mechanism of Skin Wound Healing By Use of a Bilayer Polymeric Membrane", in *Engineering Applications of New Composites*, S.A. Paipetis and G.C. Papanicolaou, eds., Omega Scientific, Wallingford, pp. 14-16 (l988).

14. Yannas, I.V., Lee, E., and Dionne Bentz, M., "Control of Skin Wound Contraction Rate by Critically Insoluble Collagen Matrices", in *Applied Bioactive Polymeric Materials*, C.G. Gebelein, C.E. Carraher, and V.R. Foster, eds., Plenum Press, NY, pp. 313-318 (1988).

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17. Chang, A.S., Yannas, I.V., Perutz, S., Loree, H., Sethi, R.R., Krarup, C., Norregaard, T.V., Zervas, N.T., and Silver, J., "Electrophysiological Study of Recovery of Peripheral Nerves Regenerated by a Collagen-Glycosaminoglycan Copolymer Matrix", in *Progress in Biomedical Polymers*, C.G. Gebelein, ed., Plenum Press, NY, pp. 107-120, (1990).

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21. Luise, R. and Yannas, I.V., "Mechanics of Strophons in Glassy Amorphous Polymers. Unified view of Stiffness, Yielding and Crazing Behavior.", in *Computational Modeling of Polymers*, J. Bicerano, ed., Marcel Dekker, Inc., New York, NY pp. 191-218 (1992).

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23. Yannas, I. V. (1996). Natural Materials, Chapter 2.7 in *Biomaterials Science: An Introduction to Materials in Medicine*, B. Ratner, A. Hoffman, J. Lemons and F. Schoen, eds., Academic Press, NY, pp. 84-94.

24. Yannas, I.V. "Materials for Skin and Nerve Regeneration; Biologically Active Analogs of the Extracellular Matrix", Chapter 5 in *Materials Science and Technology. Medical and Dental Materials*, D.F. Williams, vol. ed., Vol 14. pp. 179-208 (1992).

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26. Yannas, I.V. (1995). "Regeneration templates." Chapter 109, pp. 1619-1635, in *The Biomedical Engineering Handbook*, J.D. Bronzino, editor, CRC Press.

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34. Chamberlain, L. J. and I. V. Yannas (1998). Preparation of collagen-glycosaminoglycan copolymers for tissue regeneration. In J. R. Morgan and M. L. Yarmush, eds. *Methods of Molecular Medicine*, vol. 18: Tissue Engineering, Humana Press, Tolowa, NJ, Chap. 1, pp. 3-17.

35. Landstrom, A. and I. V. Yannas (1999). Peripheral nerve regeneration. In G. Adelman and B. H. Smith, eds. Encyclopedia of Neuroscience, 2nd ed., Elsevier, New York, pp. 1611-1613.

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41. Yannas, I. V. (2000). Natural materials. In: B. Ratner, ed., Second Edition. Biomaterials Science. Academic Press, New York, Boca Raton.

42. Harley, B. and I. V. Yannas. 2003. Skin, Tissue Engineering. Chapter in Encyclopedia of Medical Devices, Second Edition, New York, John Wiley and Sons (In the press).

43. Brau RR and Yannas IV (2004). Tissue Engineering of Skin. In *Encyclopedia of Biomaterials and Biomedical Engineering.* pp. 1652-1660. Marcel Dekker.

44. Yannas, I. V. 2004. Biologically active scaffolds. In: *Scaffolds in Tissue Engineering*, ed. J. Elisseef. New York: Humana Press.

45. Yannas IV, Wu J and Spilker M. (2004). Peripheral Nerve Regeneration. In *Encyclopedia of Neuroscience. 3rd edition.* Eds.G. Adelman and B.H. Smith. Elsevier.

21. Invited Lectures: Available upon request

22. Theses Supervised by IV Yannas (record of training graduate students):

S.B. Theses:

S.A. Kornfeld, The Molecular Basis for Mechanical Deformation of Polyethylene Terephthalate, June 1968.

D.S. Rogut, A Collagen Engine: Its Design, Construction and Evaluation, June 1968.

D.S. Mark, Optimizing Collagen Fibers for Use in a Collagen Engine, September 1969.

B.M. Kinney, Thromboresistivity and Stability of Collagen-Mucopolysaccharide Analogs of Vascular Tissue, May 1976.

G.D. Speer, Centrifugal Sedimentation Casting of Prosthetic Blood Vessels, May 1976.

D. Sieverding, Process for Manufacturing Three Dimensional Articles from Collagen, Collagen Mucopolysaccharide Composite, and Other Fibrous Proteins, June 1976.

R.S. Frank, Manufacture of Collagen and Collagen-Mucopolysaccharide Composite Vessels by Cross Flow Filtration, August 1977.

R.B. Dobbin, Effects of pH on the Small Angle Diffraction Pattern of Collagen, May 1979.

R.G. Ackerley, The Effect of Decreasing pH on the Transmission Electron Microscope Image of Collagen, May 1980.

M.F. Sylvester, Electrical Semiconduction in Collagen, June 1980.

L.E. Achenie, Electrical Conduction of Halogen Doped Bovine Hide Collagen, May 1981.

F.T. Thwaites, Manufacture of Collagen-Mucopolysaccharide Vascular Prostheses by Cross Flow Filtration, May 1981.

C.S. Kang, Siliconizing of an Artificial Skin: Investigation of a Reverse Transfer (Drawdown) Method. June 1981.

A.M. Sircar, A Biodegradable Adhesive for Medical Applications, June 1982.

R.W. Wilson, The Effect of Strain and Glycosaminoglycan Content on the Degradation Rate of Collagen-Based Membranes by Bacterial Collagenase, February 1983.

S.D. Flynn, Effects of Glutaraldehyde Crosslinking and Chondroitin-6-Sulfate upon the Mechanical Properties and In Vivo Healing Response of an Artificial Skin, May 1983.

P. Kerlee, Mechanical Properties of Skin, May 1983.

J.F. Kirk, Study of Vapor Induced Crosslinking in Collagen/GAG Foams, May 1983.

M.L. Paget, A Preliminary Study Using Measurement of Shear Wave Propagation Velocity to Non-Invasively Measure Changes in the Shear Elasticity of Skin Grafts During Healing, January 1984.

M. Wong, Quantification of Pore Size in Collagen-GAG Artificial Skin, June 1985.

V.M. Ng, Replacement of Silastic Components of the Artificial Skin with Biodegradable Substitutes, June 1985.

H. Irving, Effects of Freeze Drying Temperature on the Average Pore Size in Collagen-GAG Artificial Skin, May 1986.

H.M. Richard III, Replacement of the Silicone Layer of the Artificial Skin with Biodegradable Substitutes, June 1986.

H. Pickford, Chromium Labeling of an Artificial Skin, June 1986.

D.A. Gebala, Separation of Epidermal Langerhans Cells, June 1989.

A. Duros, Development of an In Vitro Model to Study Regeneration of Nerve Cells, May 1991

C. Raman, C.K., Enzymatic Deletion of Chondroitin 6-Sulfate from Collagene-Glycosaminoglycan Matrices, June 1991.

N. Sharfman, Processing-Property Relations of Collagen-Glycosaminoglycan Copolymer Foams Freeze-Dried at Various Temperatures, January 1992.

A. Chong, Wound Healing in an Amphibian Model, 1993.

[List needs updating. Additional BS theses were completed since 1993.]

S.M. Theses:

N.K. Jain, Annealing of Internal Stresses in Amorphous Polycarbonate, October 1968.

S. Arghyros, The Dehydration of Soluble Collagen, January 1969

J.N. Shah, The Heat Setting of Nylon 6.6, January 1969.

C. Huang, Solid State Properties of Collagen and Gelatin, January 1971.

B.L. Lee, Deformation and Recovery of Certain Polymers. An Instrument for the Study of Compressive Creep and Recovery of Swollen Polymers, June 1973.

C.B. Brogna, Crosslinking Mucopolysaccharides with Divinyl Sulfone, September 1973.

F.H. Silver, Physicochemical Design and Characterization of Candidate Collagen-Mucopolysaccharide Nonthrombogenic Materials, January l975.

G.H. Wang, Collagen-Mucopolysaccharide Interaction, September 1975.

R.H. Rubenstein, Standardization of Collagen-Mucopolysaccharide Composite Materials, February 1977.

P.G.H. Fernandez, Mechanical Properties and Rate of Enzymatic Degradation of Collagen-Mucopolysaccharide Composite Materials, January 1979.

P.J. Stasikelis, Burn Dressings Based on Collagen: Structural Parameters Affecting Performance, May 1979.

M.J. Forbes, Cross-Flow Filtration, Transmission Electron Micrographic Analysis and Blood Compatibility Testing of Collagen Composite Materials for Use as Vascular Prostheses, May 1980.

D.P. Orgill, Biodegradable Adhesives for Orthopedic Surgery, May 1980.

M.F. Sylvester, Thrombogenicity of Collagen, February 1982.

E. H-Y. Chen, The Effects of Porosity and Crosslinking of a Collagen Based Artificial Skin on Wound Healing, June 1982.

J.F. Kirk, Solid State Crosslinking Process for Collagen-Glycosaminoglycan Membranes, January 1986.

E. Lee, Effect of Crosslink Density of Collagen Grafts on Wound Contraction Kinetics, May 1986.

A. S-P. Chang, Electrophysiological Recovery of Peripheral Nerves Regenerated by Biodegradable Polymer Matrix, May 1988.

H.M. Loree II, A Freeze-Drying Process for Fabrication of Polymeric Bridges for Peripheral Nerve Regeneration, May 1988.

L.S. Ritterbush, Use of an Extracellular Matrix Analog to Assess Immunogenicity of Epidermal Cell Allografts, February 1992.

A. Landstrom, Nerve Regeneration Induced by Collagen-GAG Matrix in Collagen Tubes, September 1994.

L. J. Chamberlain, Long Term Functional and Morphological Evaluation of Peripheral Nerves Regenerated Through Degradable Collagen Implants, September 1996.

M. Spilker, Studies of Axonal Elongation Across a Gap in the Spinal Cord, January 1997.

B. Harley. Critical biodegradation rate of tubulation device used in peripheral nerve regeneration. January, 2002.

R. Brau. Contractile stresses during peripheral nerve regeneration. January, 2002.

K. Corin. Cancellation of contractile stresses during peripheral nerve regeneration. In progress, 2005.

E. Soller. Methodology for study of contractile stresses during peripheral nerve regeneration. 2005.

M. Wong, Genomics of scaffold-induced nerve regeneration. 2006

A. Sarkar. Effect of upregulation of stem cell presence in skin wound healing. 2007.

K. Miu. Proteomics of scaffold-induced nerve regeneration. 2009.

Melissa C. Buydash. Mechanical Modeling of Tissue Response During Early Stage Entubulated Peripheral Nerve Regeneration, 2013.

Doctoral Theses:

A.C. Lunn, The Molecular Basis of Homogeneous Deformation in Glassy Polycarbonate, June 1972.

N-H. Sung, Structure and Properties of Collagen and Gelatin in the Hydrated and Anhydrous Solid State, June 1972.

C. Huang, Physicochemical Studies of Collagen and Collagen-Mucopolysaccharide Composite Materials (Model Materials for Skin), February 1974.

K. Troxel, Mechanisms of Alteration of Skin Wound Contraction Kinetics by Porous Collagen-GAG Materials, December 1994.

L. Louie, Effect of a Porous Collagen-Glycosaminoglycan Copolymer on Early Tendon Healing in a Novel Animal Model, February 1997.

L. J. Chamberlain, Influence of Implant Parameters on the Mechanisms of Peripheral Nerve Regeneration, June 1998.

M.H. Spilker, Peripheral Nerve Regeneration through Tubular Devices. June 2000.

E. Soller, PhD. Cell-mediated Contraction and Induced Regeneration of the Injured Peripheral Nerve. June 2011.

D. Tzeranis, PhD. Imaging Studies of Peripheral Nerve Regeneration Induced by Porous Collagen Biomaterials, June 2013.

PROFESSIONAL DEVELOPMENT OF CERTAIN MIT DOCTORAL STUDENTS WHO WORKED WITH IV YANNAS

1. F.H. Silver, Thesis title: "GAG Inhibition of Collagen-Platelet Interaction", May 1977.

Currently: F.H.Silver, PhD, Professor, Department of Pathology and Laboratory Medicine, Robert Wood Johnson Medical School, Piscataway, NJ

2. D.P. Orgill, "The Effects of an Artificial Skin on Scarring and Contraction in Open Wounds", April 1983. (First investigator who seeded a scaffold with cells and showed that the implant induced simultaneous regeneration of the dermis and the epidermis in the guinea pig model of a full-thickness skin wound)

D.P. Orgill, "Partial Regeneration in Mammalian Tissues Using Polymeric Materials", Doctor of Medicine Degree, Harvard Medical School. March 1985.

(First investigator who showed that the same scaffold that induces skin regeneration also induces peripheral nerve regeneration)

Currently: Dennis P. Orgill, M.D., Ph.D. , Professor of Surgery Harvard Medical School, Vice Chairman for Quality Improvement Department of Surgery, Brigham and Women's Hospital Boston, MA 02115

3. A. Ferdman, "Small Angle Light Scattering Properties of Regenerated Dermis", September 1987. (First investigator who developed a quantitative assay for scar tissue, based on use of a laser light scattering approach using conventional histological slides)

Currently: Ariel Ferdman, PhD., President of Fe-ri Construction Inc., parent to three engineering companies in Puerto Rico.

4. M. H. Spilker. "Peripheral nerve regeneration through tubular devices: A comparison of assays of device effectiveness", June 2000.

2000-2009 Vice President, Research & Development and Program Management, Integra LifeSciences Holding Corporation. Plainsboro, NJ

Currently: 2009 Vice President of Research & Development, Musculoskeletal Transplant Foundation, Edison, NJ

5. T. Freyman (jointly with Prof. L. J. Gibson). "Development of an In Vitro Model of Contraction by Fibroblasts". June 2001.

Currently: Toby Freyman, PhD, Vice President for Research and Development, Arsenal Medical, Watertown, MA

6. B. Hill. *In Vivo* Tissue Engineering in the Rat Kidney Using Collagen – Glycosaminoglycan Matrices. Doctor of Medicine, Harvard Medical School.

7. D. Tzeranis, PhD thesis completed, 2013 (in collaboration with Prof. P. So). (First investigator to develop a method, based on two-photon microscopy, for quantitative assay of ligands for integrins α1β1 and α 2β1 on a scaffold surface.)

8. B. Harley (thesis jointly jointly with Prof. L. J. Gibson). "Micromechanics of Cell-Matrix Interactions". 2006. (First investigator to measure traction forces exerted by an individual cell on the individual struts of a three dimensional scaffold)

Currently: Brendan A. Harley, Sc.D., Assistant Professor, Dept. of Chemical and Biomolecular Engineering, Institute for Genomic Biology, University of Illinois at Urbana-Champaign, Urbana, IL.
