

## CURRICULUM VITAE

### **ARNOLD I. CAPLAN**

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## EDUCATION

### **Illinois Institute of Technology, Chicago, Illinois 60616, 1959 to 1963.**

B.S., Chemistry, 1963; spent 1½ years working for Dr. A. E. Martell, Chairman, Chemistry Department, on the chelative structure of reduced glutathione.

### **The Johns Hopkins University Medical School, Baltimore, Maryland 21205, 1963 to 1967.**

**1963-1966**, Ph.D., Physiological Chemistry; during the first year of graduate school, participated in a research project, "The Effects of Sr<sup>++</sup> on Swelling and ATP-Linked Contraction of Mitochondria," under the supervision of Dr. Albert L. Lehninger. Thesis work, under the supervision of Dr. J. W. Greenawalt, was concerned with the separation, identification and characterization of the inner and outer mitochondrial membranes. This entailed a combined electron microscopic and biochemical approach.

**1966-1967**, Postdoctoral Fellow with Dr. C. R. Hackenbrock, Department of Anatomy; research was concerned with an investigation of the ultrastructure of isolated, intact mitochondria during various metabolic states. The observations obtained were used to elaborate the general thesis of the ultrastructural basis for energy transfer.

### **Brandeis University, Waltham, Massachusetts 02154, 1967 to 1969.**

**1967-1968**, Postdoctoral Fellow with Dr. N. O. Kaplan, Graduate Department of Biochemistry; in collaboration with Dr. E. Zwilling of the Biology Department, investigation of the effects of nicotinamide-antagonized teratogens on cartilage and muscle development in both *in vitro* and *in vivo* systems.

**1968-1969**, Postdoctoral Fellow with Dr. E. Zwilling, Department of Biology; continuation of work initiated during the previous year.

## WORK HISTORY

### **Case Western Reserve University, Cleveland, Ohio 44106, 1969 to Present.**

**1981-Present**     **Professor, Department of Biology.**

Director, Cellular and Molecular Basis of Aging Training Program (ended 2007).

**1986-Present**     **Director, Skeletal Research Center.**

Professor of General Medical Sciences (Oncology).

**2005- Present**     Professor of Biomedical Engineering.

**2004-2011**        Professor of Pathology.

**1989-2000**        Professor of Physiology and Biophysics.

**1984-1985**        Erna and Jakob Michael Visiting Professor, Department of Biophysics, **Weizmann Institute of Science, Rehovot, Israel.**

**1981-1988**        Professor, Developmental Genetics and Anatomy.

**1976-1977**        (Josiah Macy, Jr. Faculty Scholar Award), Sabbatical Leave, **Faculte de Medecine de Strasbourg, Institute de Chimie Biologique, 67085 Strasbourg CEDEX, France.** In the laboratory of Prof. Pierre Chambon, research involved investigation of chromatin structure and function, especially as related to molecular details of the relationship between poly (ADP-ribose) and other chromatin constituents.

## Case Western Reserve University - Continued

- 1975-1981** Associate Professor, Departments of Biology and Anatomy; Co-Director, Developmental Biology Center; Research involved elucidation of the factors controlling muscle, bone and cartilage development in chick limb mesodermal cells. A working hypothesis was suggested that the local metabolic environment had a profound effect on the choice mechanism(s) governing mesodermal cell differentiation into particular phenotypic pathways.
- 1975-1991** Co-Director, Cellular and Molecular Biology Training Program.
- 1973** (Research Career Development Award) Leave of Absence as Visiting Professor, Department of Biochemistry and Biophysics, **University of California Medical School, San Francisco, California 94122**. In collaboration with Dr. Brian J. McCarthy, investigation into the basis of gene selectivity.
- 1969-1975** Assistant Professor, Departments of Biology and Anatomy (Medical School).

## HONORS/AWARDS

1. Lifetime Achievement Award, International Joint Preservation Congress, Warsaw, September 2017
2. Lifetime Achievement Award, National Center for Regenerative Medicine, August 2015
3. Inaugural Member of the "Pioneers of Innovation" chosen by the Advocacy Committee of the Orthopaedic Research Society, March 2014
4. Honorary Alumni of the Year Award, School of Med., Case Western Reserve University, September 2013
5. TERMIS-NA 2010 Inaugural Lifetime Achievement Award, December 2010
6. Elected Fellow: College of Fellows of the American Institute for Medical and Biological Engineering, Instillation, February 2010.
7. Honorary Member: Stem Cell Research Italy, 2010
8. The Genzyme Life-Time Achievement Award given by the International Cartilage Repair Society, October, 2007
9. The Marshall Urist Award for Excellence in Tissue Regeneration Research presented by the Orthopaedic Research Society, February 1999.
10. The Elizabeth Winston Lanier Award given by the American Academy of Orthopaedic Surgeons as part of their 1990 Kappa Delta Awards conferred on February 8, 1990.
11. The Erna and Jakob Michael Visiting Professorship; The Weizmann Institute of Science, Israel, 1984-85.
12. Josiah Macy Faculty Scholar Award, 1976-1977.
13. National Institutes of Health Career Development Award, 1971-1976.
14. American Cancer Society Postdoctoral Fellowship, 1967-1969.

## COMMERCIAL INTERESTS

1. President and Founder, Skeletech, Inc.; 1989-1992.
2. Founder, Chief Scientific Officer, Member of Board of Directors, Osiris Therapeutics, Inc. 1992-1997.
3. Founder, Arnold Caplan and associates, **aCa**, consulting group; 1996-Present
4. Founder, Cell Targeting, Inc., 2004-2011
5. Consultant, Chief Scientific Officer, Orthocyte a subsidiary of BioTime, Inc.
6. Founder, CellBank Technologies, LLP, 2011-Present

## **PUBLICATIONS**

<https://www.ncbi.nlm.nih.gov/myncbi/arnold.caplan.1/bibliography/public/>

### **1965**

1. AI Caplan and E Carafoli. The Effects of  $Sr^{++}$  on Swelling and ATP-Linked Contraction of Mitochondria. *Biochem Biophys Acta* 104:317-329 (1965).

### **1966**

2. AI Caplan and JW Greenawalt. Biochemical and Ultrastructural Properties of Osmotically Lysed Rat Liver Mitochondria. *J Cell Biol* 31:455-472 (1966).

### **1968**

3. AI Caplan and JW Greenawalt. The Effects of Osmotic Lysis on the Oxidative Phosphorylation and Compartmentation of Rat Liver Mitochondria. *J Cell Biol* 36:15-31 (1968).
4. AI Caplan, E Zwilling and NO Kaplan. 3-Acetylpyridine: Effects In Vitro Related to Teratogenic Activity in Chick Embryos. *Science* 160:1009-1010 (1968).

### **1969**

5. CR Hackenbrock and AI Caplan. Ion-Induced Ultrastructural Transformations in Isolated Mitochondria. *J Cell Biol* 42:221-234 (1969).

### **1970**

6. AI Caplan. Effects of the Nicotinamide-Sensitive Teratogen 3-Acetylpyridine on Chick Limb Cells in Culture. *Exp Cell Res* 62:341-355 (1970).

### **1971**

7. AI Caplan. The Teratogenic Action of the Nicotinamide Analogs 3-Acetylpyridine and 6-Aminonicotinamide on Developing Chick Embryos. *J Exp Biol* 178:351-358 (1971).

### **1972**

8. AI Caplan. Effects of a Nicotinamide-Sensitive Teratogen 6-Aminonicotinamide on Chick Limb Cells in Culture. *Exp Cell Res* 70:185-195 (1972).
9. AI Caplan. The Effects of the Nicotinamide-Sensitive Teratogen 3-Acetylpyridine on Chick Limb Mesodermal Cells in Culture: Biochemical Parameters. *J Exp Zool* 180:351-362 (1972).
10. AI Caplan. Comparison of the Capacity of Nicotinamide and Nicotinic Acid to Relieve the Effects of Muscle and Cartilage Teratogens in Developing Chick Embryos. *Dev Biol* 28:344-351 (1972).
11. AI Caplan. The Site and Sequence of Action of 6-Aminonicotinamide in Causing Bone Malformations of Embryonic Chick Limb and Its Relationship to Normal Development. *Dev Biol* 28:71-83 (1972).

### **1973**

12. AI Caplan and S Koutroupas. The Control of Muscle and Cartilage Development in the Chick Limb: The Role of Differential Vascularization. *J Embryol Exp Morph.* 29:571-583 (1973).
13. AI Caplan and AC Stoolmiller. Control of Chondrogenic Expression in Mesodermal Cells of Embryonic Chick Limb. *Proc Natl Acad Sci* 70:1712-1717 (1973).

### **1974**

14. MJ Rosenberg and AI Caplan. Nicotinamide Adenine Dinucleotide Levels in Cells of Developing Chick Limbs: Possible Control of Muscle and Cartilage Development. *Dev Biol* 38:157-164 (1974).

## 1975

15. MJ Rosenberg and AI Caplan. Nicotinamide Adenine Dinucleotide Levels in Chick Limb Mesodermal Cells In Vitro: Effects of 3-Acetylpyridine and Nicotinamide. *J Embryol Exp Morph* 33:947-956 (1975).
16. AI Caplan and MJ Rosenberg. Interrelationship Between Poly(Adenosine Diphosphoribose) Synthesis, Intracellular NAD Levels, and Muscle or Cartilage Differentiation from Embryonic Chick Limb Mesodermal Cells. *Proc Natl Acad Sci* 72:1852-1857 (1975).
17. AI Caplan and MJ Rosenberg. The Control of Chondrogenic and Myogenic Expression in Chick Limb Mesodermal Cells. In: *Extracellular Matrix Influences on Gene Expression*, Ed. H.C. Slavkin and R. Greulich, Academic Press, New York, pp. 47-55 (1975).
18. AI Caplan. Biochemical Influences on Organ and Tissue Differentiation. In: *7th Mead Johnson Symposium in Perinatal and Developmental Medicine: Clinical and Biological Aspects of Malformation*, Ed. R.S. Bloom, J.C. Sinclair and J.B. Warshaw, pp. 38-53 (1975).

## 1976

19. VC Hascall, TR Oegema, M Brown and AI Caplan. Isolation and Characterization of Proteoglycans from Avian Embryonic Limb Bud Chondrocytes Grown In Vitro. *J Biol Chem* 251:3511-3519 (1976).
20. P Osdoby and AI Caplan. The Possible Differentiation of Osteogenic Elements In Vitro from Chick Limb Mesodermal Cells: I. Morphological Evidence. *Dev Biol* 52:283-299 (1976).
21. CP Ordahl and AI Caplan. Transcriptional Diversity in Myogenesis. *Dev Biol* 54:61-72 (1976).
22. CP Ordahl, TR Johnson and AI Caplan. Sheared DNA Fragment Sizing: Comparison of Techniques. *Nucl Acids Res* 3:2985-2999 (1976).
23. AI Caplan. Simplified Procedure for Preparing Myogenic Cells for Culture. *J Embryol Exp Morph* 36:175-181 (1976).

## 1977

24. S DeLuca, D Heinegard, VC Hascall, JH Kimura and AI Caplan. Chemical and Physical Changes in Proteoglycans During Development of Chick Limb Bud Chondrocytes Grown In Vitro. *J Biol Chem* 252:6600-6608 (1977).
25. AI Caplan. Muscle, Cartilage and Bone Development and Differentiation from Chick Limb Mesenchymal Cells. In: *Vertebrate Limb and Somite Morphogenesis*. Ed. DA Ede, JR Hinchliffe and M Balls, Cambridge University Press, Cambridge, England, pp. 199-213 (1977).

## 1978

26. AI Caplan. Molecular Basis for Limb Morphogenesis. In: *5th International Conference on Birth Defects*, Ed. J Littlefield and J DeGrouchy, Excerpta Medica, pp. 208-220 (1978).
27. JH Kimura, P Osdoby, AI Caplan and VC Hascall. Electron Microscopic and Biochemical Studies of Proteoglycan Polydispersity in Chick Limb Bud Chondrocyte Cultures. *J Biol Chem* 253:4721-4729 (1978).
28. JE Zull, S Krug, D Abel and AI Caplan. Development of Parathyroid Hormone and Calcitonin-Activated Adenylate Cyclases in the Embryonic Limb and in Cultured Cells from Embryonic Chick Limb. *Proc Natl Acad Sci* 75:3871-3875 (1978).
29. S DeLuca, AI Caplan and VC Hascall. Biosynthesis of Proteoglycans by Chick Limb Bud Chondrocytes. *J Biol Chem* 253:4713-4720 (1978).
30. AI Caplan and CP Ordahl. Irreversible Gene Repression Model for Control of Development. *Science* 201:120-130 (1978).
31. JE Saffitz and AI Caplan. Separation of Transcriptionally Active and Inactive Chromatin: Agarose Gel Chromatography. *Biochem Biophys Acta* 520:368-375 (1978).
32. AI Caplan, MG Ord and LA Stocken. Chromatin Structure Through the Cell Cycle: Studies With Regenerating Rat Liver. *Biochem J* 174:475-483 (1978).

## **PUBLICATIONS**- Continued

33. JE Saffitz and AI Caplan. Hydroxylapatite Thermal Fractionation of Chromatin and DNA. *Biochem* 17:3480-3486 (1978).
34. JE Saffitz and AI Caplan. Attempted Separation of Transcriptionally Active and Inactive Chromatin by Hydroxylapatite Thermal Chromatography. *Biochem* 17:3487-3495 (1978).
35. CP Ordahl and AI Caplan. High Diversity in the Polyadenylated RNA Populations of Embryonic Myoblasts. *J Biol Chem* 253:7683-7691 (1978).
36. JH Kimura and AI Caplan. Identification of Glycogen as the Major Xylose Acceptor in Polysomal Preparations from Chick Embryo Cartilage Cultures. *Arch Biochem Biophys* 191:687-697 (1978).

### **1979**

37. AI Caplan, C Neidergang, H Okazaki and P Mandel. Poly(ADP-ribose) Levels as a Function of Chick Limb Mesenchymal Cell Development as Studied In Vitro and In Vivo. *Dev Biol* 72:102-109 (1979).
38. P Osdoby and AI Caplan. Osteogenesis in Cultures of Limb Mesenchymal Cells. *Dev Biol* 73:84-102 (1979).
39. LS Lohmander, VC Hascall and AI Caplan. Effects of 4-Methyl Umbelliferyl- $\beta$ -D-Xylopyranoside on Chondrogenesis and Proteoglycan Synthesis in Chick Limb Bud Mesenchymal Cell Cultures. *J Biol Chem* 254:10551-10561 (1979).
40. JH Kimura, P Osdoby, AI Caplan and VC Hascall. Electron Microscopic Examination of Isolated Proteoglycan Aggregates. In: *Glycoconjugate Research*, Vol. I, Ed. JO Gregory, RW Jeanloz, Academic Press, New York, pp. 189-192 (1979).
41. AI Caplan, C Neidergang, H Okazaki and P Mandel. Poly(ADP-ribose) Polymerase: Self-ADP-ribosylation, the Stimulation by DNA and the Effects on Nucleosome Formation and Stability. *Arch Biochem Biophys* 198:60-69 (1979).
42. LS Lohmander, VC Hascall and AI Caplan. Effects of  $\beta$ -D-Xyloside on Chondrogenesis and Proteoglycan Synthesis in Chick Limb Bud Cell Cultures. In: *Proc. of 2nd Munich Symposium on Biology of Connective Tissue: Biology of the Articular Cartilage in Health and Disease*, (1979).

### **1980**

43. AI Caplan and VC Hascall. Structure and Development Changes in Proteoglycans. In: *Dilatation of the Uterine Cervix*, Ed. F Naftolin and PG Stubblefield, Raven Press, New York, pp. 79-98 (1980).
44. P Osdoby and AI Caplan. Scanning Electron Microscopy of In Vitro Osteogenesis. *Calcif Tiss Intl* 30:43-50 (1980).
45. S DeLuca, LS Lohmander, B Nilsson, VC Hascall and AI Caplan. Proteoglycans from Chick Limb Bud Chondrocyte Cultures: Keratan Sulfate and Oligosaccharides which Contain Mannose and Sialic Acid. *J Biol Chem* 255:6077-6083 (1980).

### **1981**

46. AI Caplan. Embryological Development: Evolutionary History, Genetic Bias and Cellular Environment Control the Flow of Developmental Events. *J Col Sci Teach* 10:226-230; 289-293 (1981).
47. AI Caplan. Studies on the Role of NAD and Poly(ADP-ribose) in the Control of the Differentiation and Development of Embryonic Chick Limb Cells. In: *Novel ADP-Ribosylation of Regulatory Enzymes and Proteins*, Ed. T Sigamura and M Smulson, Elsevier, North Holland, pp. 315-324 (1981).
48. RL Stevens, SP Nissley, JH Kimura, M Rechler, AI Caplan and VC Hascall. Effects of Insulin and Multiplication-Stimulating Activity on Proteoglycan Biosynthesis in Chondrocytes from the Swarm Rat Chondrosarcoma. *J Biol Chem* 256:2045-2052 (1981).
49. AI Caplan. The Molecular Control of Muscle and Cartilage Development. In: *39th Annual Symposium of the Society for Developmental Biology*, Ed. S Subtelney and U Abbott, Alan R. Liss, Inc., New York, pp. 37-68 (1981).
50. P Osdoby and AI Caplan. First Bone Formation in Embryonic Chick Limbs. *Dev Biol* 86:147-156 (1981).

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51. P Osdoby and AI Caplan. Characterization of a Bone-Specific Alkaline Phosphatase in Cultures of Chick Limb Mesenchymal Cells. *Dev Biol* 86:136-146 (1981).
52. JE Zull, K Youngman and AI Caplan. The Development of Hormonal Responses of Cultured Embryonic Chick Limb Mesenchymal Cells. *Dev Biol* 86:61-68 (1981).

## 1982

53. K von der Mark, P Osdoby and AI Caplan. Effect of 4-Methyl Umbelliferyl- $\beta$ -D-Xyloside on Collagen Synthesis in Chick Limb Bud Mesenchymal Cell Cultures. *Dev Biol* 90:24-30 (1982).
54. MJ Katz, RJ Lasek, P Osdoby, JR Whittaker and AI Caplan. Bolton-Hunter Reagent as a Vital Stain for Developing Systems. *Dev Biol* 90:419-429 (1982).
55. DA Carrino and AI Caplan. Isolation and Preliminary Characterization of Proteoglycans Synthesized by Skeletal Muscle. *J Biol Chem* 257:14145-14154 (1982).
56. BW Cherney, RJ Midura and AI Caplan. Poly(ADP-ribose) and the Differentiation of Embryonic Tissue. In: *ADP-Ribosylation Reactions: Biology and Medicine*, Ed. O Hayaishi and K Ueda, Academic Press, New York, pp. 389-406 (1982).
57. CP Ordahl, T Cooper, C Ovitt, J Fornwald, AI Caplan and A Calman. Structure and Developmental Regulation of Muscle-Regulated Gene Sets. In: *Cold Spring Harbor Symposium, Muscle Development: Molecular and Cellular Control*. Ed. ML Pearson and HF Epstein (1982).
58. R Shogren, AM Jamieson, J Blackwell, DA Carrino and AI Caplan. Light Scattering Studies of Chick Limb Bud Proteoglycans. *J Biol Chem* 257:8627-8629 (1982).
59. P Osdoby, MC Martini and AI Caplan. Isolated Osteoclasts and Their Presumed Progenitor Cells, the Monocyte, in Culture. *J Exp Biol* 224:331-344 (1982).
60. MC Martini, P Osdoby and AI Caplan. Adhesion of Osteoclasts and Monocytes to Developing Bone. *J Exp Biol* 224:345-354 (1982).

## 1983

61. SJ Hunter and AI Caplan. The Control of Cartilage Differentiation. In: *Cartilage, Vol. II, Development and Differentiation*, Ed. BK Hall, Academic Press, New York, pp. 87-120 (1983).
62. P Osdoby, MC Martini and AI Caplan. The Development of Long Bones of the Limb: Cell and Matrix Interactions of Osteoclasts and Monocytes. In: *Limb Development and Regeneration, Part B*, Ed. RO Kelly, PF Goetinck and JA MacCabe, Alan R. Liss, Inc., New York, pp. 229-238 (1983).
63. DM Jargiello and AI Caplan. The Fluid Flow Dynamics in the Developing Chick Wing. In: *Limb Development and Regeneration, Part A*, Ed. JF Fallon and AI Caplan, Alan R. Liss, Inc., New York, pp. 143-154 (1983).
64. DA Carrino and AI Caplan. Proteoglycans Produced by Skeletal Muscle In Vitro and In Vivo. In: *Limb Development and Regeneration, Part B*, Ed. RO Kelly, PF Goetinck and JA MacCabe, Alan R. Liss, Inc., New York, pp. 379-390 (1983).
65. AI Caplan, GT Syftestad and P Osdoby. The Development of Bone and Cartilage in Tissue Culture. *J Clin Ortho Rel Res.* 174:243-263 (1983).
66. DM Jargiello and AI Caplan. The Establishment of Vascular-Derived Micro-Environments in the Developing Chick Wing. *Dev Biol* 97:364-374 (1983).
67. DP Lennon, P Osdoby, DA Carrino, BM Vertel and AI Caplan. Isolation and Characterization of Chondrocytes and Non-Chondrocytes from High-Density Chick Limb Bud Cell Cultures. *J Craniofac Genet Develop Biol* 3:235-251 (1983).
68. DA Carrino, DP Lennon and AI Caplan. Extracellular Matrix and the Maintenance of the Differentiated State: Proteoglycans Synthesized by Replated Chondrocytes and Non-Chondrocytes. *Dev Biol* 99:132-144 (1983).
69. AI Caplan, MY Fisman and HM Eppenberger. Molecular and Cell Isoforms During Development. *Science* 221:921-927 (1983).

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70. RL Shogren, J Blackwell, AM Jamieson, DA Carrino, DG Pechak and AI Caplan. Light-Scattering Studies of Chick Limb Bud Proteoglycan Aggregate. *J Biol Chem* 258:8627-8629 (1983).

### 1984

71. AI Caplan. Cartilage. *Scientific American* 251:84-94 (1984).
72. DA Carrino, DG Pechak and AI Caplan. Characterization of Proteoglycans which are Synthesized During Skeletal Muscle Development. In: *Developmental Processes in Normal and Diseased Muscle*, Ed. H Eppenberger and J-C Perriard: Vol. 9 of *Experimental Biology and Medicine*, Ed. A Wolsky, S Karger, Publishers, Basel, Switzerland, pp. 80-86 (1984).
73. GT Syftestad and AI Caplan. A Fraction from Extracts from Demineralized Bone Stimulates the Conversion of Mesenchymal Cells into Chondrocytes. *Dev Biol* 104:348-356 (1984).
74. GT Syftestad and AI Caplan. Effects of Osteoinductive Bone Matrix Extracts on the Transition of Mesenchymal Cells into Chondrocytes. *Calc Tiss Intl* 36:625-627 (1984).
75. DA Carrino and AI Caplan. Isolation and Partial Characterization of High-Buoyant-Density Proteoglycans Synthesized In Ovo by Embryonic Chick Skeletal Muscle and Heart. *J Biol Chem* 259:12419-12430 (1984).

### 1985

76. DA Carrino and AI Caplan. Isolation and Characterization of Proteoglycans Synthesized In Ovo by Embryonic Chick Cartilage and New Bone. *J Biol Chem* 260:122-127 (1985).
77. AI Caplan. The Vasculature and Limb Development. *Cell Diff* 16:1-11 (1985).
78. DG Pechak, DA Carrino and AI Caplan. Electron Microscopic Characterization of Chick Embryonic Skeletal Muscle Proteoglycans. *J Cell Biol* 100:1767-1776 (1985).
79. RF Drushel, DG Pechak and AI Caplan. The Anatomy, Ultrastructure and Fluid Dynamics of the Developing Vasculature of the Embryonic Chick Wing Bud. *Cell Diff* 16:13-28 (1985).
80. AI Caplan. Poly(ADP-ribose)Synthetase and Cell Differentiation. In: *ADP-Ribosylation of Proteins*, Ed. F Althaus, H Hilz and S Shall, Springer-Verlag, Berlin, pp. 388-396 (1985).
81. GT Syftestad, M Weitzhandler and AI Caplan. Isolation and Characterization of Osteogenic Cells Derived from First Bone of the Embryonic Tibia. *Dev Biol* 110:275-283 (1985).
82. DA Carrino, M Weitzhandler and AI Caplan. Proteoglycans Synthesized During the Cartilage to Bone Transition. In: *The Chemistry and Biology of Mineralized Tissues*, Ed. WT Butler, Ebsco Media, Inc., Birmingham, Alabama, pp. 197-208 (1985).
83. RJ Midura, BW Cherney and AI Caplan. The Relationship of Nicotinamide Adenine Dinucleotide to the Chondrogenic Differentiation of Limb Mesenchymal Cells. *Dev Biol* 111:232-242 (1985).
84. BW Cherney, RJ Midura and AI Caplan. Poly(ADP-ribose) Synthetase and Chick Limb Mesenchymal Cell Differentiation. *Dev Biol* 112:115-125 (1985).
85. GT Syftestad, PA Lucas and AI Caplan. The In Vitro Chondrogenic Response of Limb Bud Mesenchyme to a Water-Soluble Fraction Prepared from Demineralized Bone Matrix. *Differentiation* 29:230-237 (1985).

### 1986

86. DA Carrino and AI Caplan. Proteoglycan Synthesis During Skeletal Muscle Development. In: *Molecular Biology of Muscle Development, UCLA Symposia on Molecular and Cellular Development*, Vol. 29, Ed. C Emerson, DA Fischman, B Nadal-Ginard and MAQ Siddiqui, Alan R. Liss, Inc., New York, pp. 117-132 (1986).
87. MJ Kujawa, DG Pechak, MY Fizman and AI Caplan. Hyaluronic Acid Bonded to Cell Culture Surfaces Inhibits the Program of Myogenesis. *Dev Biol* 113:10-16 (1986).
88. H Ohno, J Blackwell, AM Jamieson, DG Pechak, DA Carrino and AI Caplan. Structure of Native Proteoglycan Aggregates from Chick Limb Bud Chondrocytes. *Biopolymers* 25:931-946 (1986).

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89. MJ Kujawa and AI Caplan. Hyaluronic Acid Bonded to Cell Culture Surfaces Stimulates Chondrogenesis in Stage 24 Limb Mesenchyme Cell Cultures. *Dev Biol* 114:504-518 (1986).
90. AI Caplan. Molecular and Cellular Differentiation of Muscle, Cartilage and Bone in the Developing Limb. In: *Progress in Developmental Biology Part B, Progress in Clinical and Biological Research*. Vol. 217B, Ed. HC Slavkin, Alan R. Liss, Inc., New York, pp. 307-318 (1986).
91. MJ Kujawa, DA Carrino and AI Caplan. Substrate-Bonded Hyaluronic Acid Exhibits a Size-Dependent Stimulation of Chondrogenic Differentiation of Stage 24 Limb Mesenchymal Cells in Culture. *Dev Biol* 114:519-528 (1986).
92. AI Caplan. The Extracellular Matrix is Instructive. *BioEssays* 5:129-132 (1986).
93. PA Lucas, GT Syftestad and AI Caplan. Partial Isolation and Characterization of a Chemotactic Factor from Adult Bone for Mesenchymal Cells. *Bone* 7:365-371 (1986).
94. H Ohno, J Blackwell, AM Jamieson, DA Carrino and AI Caplan. Calibration of the Relative Molecular Mass of Proteoglycan Subunit by Column Chromatography on Sepharose CL-2B. *Biochem J* 235:553-557 (1986).
95. DG Pechak, MJ Kujawa and AI Caplan. Morphological and Histological Events During First Bone Formation in Embryonic Chick Limbs. *Bone* 7:441-458 (1986).
96. DG Pechak, MJ Kujawa and AI Caplan. Morphology of Bone Development and Bone Remodeling in Embryonic Chick Limbs. *Bone* 7:459-472 (1986).

## 1987

97. AI Caplan. Bone Development and Repair. *BioEssays* 6:171-175 (1987).
98. AI Caplan and DG Pechak. The Cellular and Molecular Embryology of Bone Formation. In: *Bone and Mineral Research*, Vol. 5, Ed. WA Peck, Elsevier, New York, pp. 117-184 (1987).
99. AM Jamieson, J Blackwell, H Reihanian, H Ohno, R Gupta, DA Carrino, AI Caplan, LH Tang and LC Rosenberg. Thermal and Solvent Stability of Proteoglycan Aggregates by Quasielastic Laser Light-Scattering. *Carbohydr Res* 160:329-342 (1987).
100. SE Haynesworth, DA Carrino and AI Caplan. Characterization of the Core Protein of the Large Chondroitin Sulfate Proteoglycan Synthesized by Chondrocytes in Chick Limb Bud Cell Cultures. *J Biol Chem* 262:10574-10581 (1987).
101. AR Poole and AI Caplan. An Appreciation: Dame Honor B. Fell, R.F.S. (1900-1986). *Dev Biol* 122:297-299 (1987).
102. GT Syftestad, PA Lucas, H Ohgushi and AI Caplan. Chondrogenesis as an In Vitro Response to Bioactive Factors Extracted from Adult Bone and Non-Skeletal Tissues. In: *UCLA Symposium Volume, Development and Diseases of Cartilage and Bone Matrix*, Ed. T Thornhill and A Senn, Alan R. Liss, Inc., New York, pp. 187-199 (1987).

## 1988

103. HE Young, DA Carrino and AI Caplan. Initial Characterization of Small Proteoglycans Synthesized by Embryonic Chick Leg Muscle-Associated Connective Tissues. *Conn Tiss Res* 17:99-118 (1988).
104. H Ohgushi, GT Syftestad and AI Caplan. In Vitro Chondrogenesis Stimulated by Extracts of Gall Bladder Epithelium. *Bone* 8:375-379 (1988).
105. RF Drushel and AI Caplan. The Extravascular Fluid Dynamics of the Chick Wing Bud. *Dev Biol* 126:7-18 (1988).
106. PA Lucas, GT Syftestad and AI Caplan. A Water-Soluble Fraction from Adult Bone Stimulates the Differentiation of Cartilage in Explants of Embryonic Muscle. *Differentiation* 37:47-52 (1988).
107. PA Lucas and AI Caplan. Chemotactic Response of Embryonic Limb Bud Mesenchymal Cells and Muscle-Derived Fibroblasts to Transforming Growth Factor Beta. *Conn Tiss Res* 18:1-7 (1988).
108. AI Caplan. Biomaterials and Bone Repair. *BIOMAT* 87:15-24 (1988).



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109. DA Carrino and AI Caplan. Extracellular Matrix and Sequential Replacement Events During Tissue Formation, Remodeling and Repair. In: *The Biology of Tooth Movement*, Ed. LA Norton and CJ Burstone, CRC Press, Inc., Boca Raton, Florida, Chapter 11, pp. 183-194 (1988).
110. AI Caplan. Bone Development. In: *Cell and Molecular Biology of Vertebrate Hard Tissues*. CIBA Foundation Symposium 136, Wiley, Chichester, pp. 3-21 (1988).
111. M Weitzhandler, DA Carrino and AI Caplan. Proteoglycans Synthesized During the Cartilage-to-Bone Transition in Developing Chick Embryos. *Bone* 9:225-233 (1988).
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469. Y Dai, W Xu, RA Somoza, JF Welter, AI Caplan, CC Liu. An Integrated Multi-Function Heterogeneous Biochemical Circuit for High-Resolution Electrochemistry based Genetic Analysis. *Angewandte Chemie*. <https://doi.org/10.1002/anie.202010648>.
470. D Lennon, RA Somoza, MA Schluchter, AI Caplan. The habitat assay, a platform to study in vivo properties of human mesenchymal stem cells. *Tissue Eng Part A*. 26(23-24):1378-1387. Epub 2020 Nov 26. PMID: 33107389; PMCID: PMC7759284. <https://doi.org/10.1089/ten.tea.2020.0178>
471. Sadeghi Z, Kenyon JD, Richardson B, Khalifa AO, Cartwright M, Conroy B, Caplan A, Cameron MJ, Hijaz A. Transcriptomic Analysis of Human Mesenchymal Stem Cell Therapy in Incontinent Rat Injured Urethra. *Tissue Eng Part A*. 2020 Jul;26(13-14):792-810. doi: 10.1089/ten.tea.2020.0033. Epub 2020 Jul 2. PMID: 32614683; PMCID: PMC7398447.

## 2021

472. G Lanzoni, E Linetsky, D Correa, SM Cayetano, RA Alvarez, D Kouroupis, AA Gil, R Poggioli, P Ruiz, AC Marttos, K Hirani, CA Bell, H Kusack, LRafkin, D Baidal, A Pastewski, K Gawri, C Leñero, AMA Mantero, SW Metalonis, X Wang, L Roque, B Masters, NS Keny on, E Ginzburg, X Xu, J Tan, AI Caplan, MK Glassberg, R Alejandro, and C Ricordi. Umbilical Cord Mesenchymal Stem Cells for COVID-19 ARDS: A Double Blind, Phase 1/2a, Randomized Controlled Trial. *Stem Cells Trans Med*. 2021;1–14.
473. BA Kerr, L Shi, AH Jinnah, KS Harris, JS Willey, DP Lennon, AI Caplan, TV Byzova. Kindlin-3 mutation in mesenchymal stem cells results in enhanced chondrogenesis. *Exp Cell Res* 399(2): 15 February 2021, 112456. <https://doi.org/10.1016/j.yexcr.2020.112456>
474. AM van Heeckeren, MT Sutton, DR Fletcher, CA Hodges, AI Caplan, TL Bonfield. Enhancing cystic fibrosis immune regulation. *Front Pharmacol*. (12)269, May, 2021. DOI=10.3389/fphar.2021.573065 <https://www.frontiersin.org/article/10.3389/fphar.2021.573065>,
475. AI Caplan. Placebo Controls: Now??? *Arch Immunol Ther Exp (Warsz)*. Published online 29 March 2021. <https://doi.org/10.1007/s000005-021-00612-x>.
476. TL Bonfield, MT Sutton, DR Fletcher, MA Folz, V Ragavapuram, RA Somoza, AI Caplan. Donor-defined mesenchymal stem cell antimicrobial potency against nontuberculous mycobacterium. *Stem Cells Transl Med*. 2021;10:1202–1216. DOI: 10.1002/sctm.20-0521
477. Y Zhong, AI Caplan, JF Welter and H Baskaran. Glucose Availability Affects Extracellular Matrix Synthesis During Chondrogenesis In Vitro. *Tissue Eng Part A*. 2021 Jan 26. doi: 10.1089/ten.TEA.2020.0144. Epub ahead of print. PMID: 33499734.
478. DJ Vail, RA Somoza, AI Caplan. MicroRNA Regulation of Bone Marrow Mesenchymal Stem Cell Chondrogenesis: Toward Articular Cartilage. *Tissue Eng Part A*. 2021 Jul 30. <https://doi.org/10.1089/ten.TEA.2021.0112>. Epub ahead of print. PMID: 34328786.
479. JM Sorrell, MA Baber, R Somoza, J Kenyon and AI Caplan. Migration of Human Bone Marrow-Derived Mesenchymal Stem Cells during Wound Healing. *Cells*. Migration of Human Bone Marrow-Derived Mesenchymal Stem Cells during Wound Healing. Preprints 2021, 2021060374. <https://www.preprints.org/manuscript/202106.0374/v1> (doi: 10.20944/preprints202106.0374.v1).
480. K. Peltari, L. Acevedo Rúa, M. Mumme, C. Manferdini, S. Darwiche, A. Khalil, D. Buchner, G. Lisignoli, P. Occhetta, B. von Rechenberg, M. Haug, D. Schäfer, M. Jakob, A. Caplan, I. Martin, A. Barbero. Engineered nasal cartilage for the repair of osteoarthritic knee cartilage defects. *Sci Transl Med*. Accepted.
481. Y Nossin, E Farrell, WJLM Koevoet, F Datema, RA Somoza, AI Caplan, GJVM van Osch. The releasate of avascular cartilage demonstrates inherent pro-angiogenic properties in vitro and in vivo. *Cartilage*. Accepted.

## **PUBLICATIONS - Continued**

482. W Qu, Z Wang, E Engelberg-Cook, AB Siddik, G Bu, JG Allickson, E Kubrova, AI Caplan, JM Hare, C Ricordi, CJ Pepine, J Kurtzberg, JM Pascual, RL Rodriguez, T Nayfeh, S Saadi, EM Richards, K March, FP Sanfilippo. Effectiveness and Safety of MSC Cell Therapies for Hospitalized Patients with COVID-19: A Systematic Review and Meta-analysis. *Lancet*. Submitted.
483. Y Nossin, E Farrell, WJLM Koevoet, F Datema, RA Somoza, AI Caplan, GJVM van Osch. Is Cartilage Anti-Angiogenic? *Osteoarthritis and Cartilage*. Submitted.
484. M Breitman, T Bonfield, A Caplan, H Lazarus, M Haghiac, S LaSalvia, J Reese Koç, N Singer. Optimization of Human Mesenchymal Stem Cells for RA: Implications for Improved Therapeutic Outcomes. *RMD Open*. Submitted.
485. TL Bonfield, D Lennon, AI Caplan. Human mesenchymal stem cells resolve infection and inflammation in pseudomonas aeruginosa infected cystic fibrosis transmembrane receptor knockout mice. *Stem Cell Discovery*. Submitted.
486. Y Zhong, AI Caplan, JF Welter and H Baskaran. Biomolecular uptake/secretion to monitor and predict tissue quality in chondrogenesis, *Annals of Biomedical Engineering*, submitted
487. JM Sorrell, RA Somoza, AI Caplan. CD146/MCAM Is an Adipogenic Marker for Mesenchymal Stem Cells, Adipose-Derived Stem Cells, and Dermal Fibroblasts. In preparation.
488. DP Lennon, G Wera, M Kraay, AI Caplan. Bone normally discarded after joint-replacement surgery is a source of stem cells. In preparation.

## **ABSTRACTS**

Over 150 abstracts have been published from 1965 through 1995. The exact number and citations are no longer recorded.

## **PATENTS**

1. Arnold I. Caplan and Glenn T. Syftestad (August 26, 1986). Bone Protein Purification Process. Patent No. 4,608,199.
2. Arnold I. Caplan and Glenn T. Syftestad (November 4, 1986). Process of Adapting Soluble Bone Protein for Use in Stimulating Osteoinduction. Patent No. 4,620,327.
3. Arnold I. Caplan and Stephen E. Haynesworth (March 30, 1993). Method for Enhancing the Implantation and Differentiation of Marrow-Derived Mesenchymal Cells. Patent No. 5,197,985.
4. Arnold I. Caplan and Stephen E. Haynesworth (July 13, 1993). Method for Treating Connective Tissue Disorders. Patent No. 5,226,914.
5. Arnold I. Caplan and Stephen E. Haynesworth (January 23, 1996). Human Mesenchymal Stem Cells. Patent No. 5,486,359.
6. Arnold I. Caplan, Stanton Gerson and Stephen E. Haynesworth (January 7, 1997). Transduced Mesenchymal Stem Cells. Patent No. 5,591,625.
7. Arnold I. Caplan and Stephen E. Haynesworth (July 1, 1997). Monoclonal Antibodies for Human Osteogenic Cell Surface Antigens. Patent No. 5,643,736
8. Arnold I. Caplan, Stanton Gerson and Stephen E. Haynesworth (March 31, 1998). Enhancing Bone Marrow Engraftment Using MSCs. Patent No. 5,733,542.
9. Arnold I. Caplan, Scott P. Bruder and Stephen E. Haynesworth (April 7, 1998). Lineage-Directed Induction of Human Mesenchymal Stem Cell Differentiation. Patent No. 5,736,396.
10. Arnold I. Caplan, David Fink, and Randell Young (January 5, 1999). Biomatrix for Soft Tissue Regeneration. Patent No. 5,855,619.
11. Arnold I. Caplan, Scott P. Bruder and Stephen E. Haynesworth (August 24, 1999). Lineage-Directed Induction of Human Mesenchymal Stem Cell Differentiation. Patent No. 5,942,225.
12. Arnold I. Caplan, Stephen E. Haynesworth, and Stanton L. Gerson. (January 4, 2000). Enhancing Hematopoietic Progenitor Cell Engraftment Using Mesenchymal Stem Cells. Patent No. 6,010,696.
13. Arnold I. Caplan and Stephen E. Haynesworth (July 11, 2000). Monoclonal Antibodies for Human Mesenchymal Stem Cells. Patent No. 6,087,113.

## **SELECTED ADDRESSES**

14. Arnold I. Caplan, Scott P. Bruder, James S. Burns, Daniel Markshak. (2000). Bone Regeneration in Osteoporosis Using Human Bone Marrow Mesenchymal Cells. Patent No. EP 1 007 063 A1.
15. Giovanni, A., Callegaro, L., Young, R.G., Murphy, J.M., Fink, D.J, Bruder, S.P., Barry, F.P., Kadiyala, S., Caplan, A.I., Moskowitz, R., Yoo, J.U., and Solchaga, L.S. (November 19, 2002). Biological material for the repair of connective tissue defects comprising mesenchymal stem cells and hyaluronic acid derivative. Patent No. 6,482,231.
16. Arnold I. Caplan and J. Michael Sorrell (December 24, 2002). Multilayer skin or dermal equivalent having a layer containing mesenchymal stem cells. Patent No. 6,497,875.
17. Arnold I. Caplan and Stephen E. Haynesworth (November 12, 2003). Mesenchymal stem cells and their use. Patent No. EP 1 361 267 A2.
18. Victor M. Goldberg, Arnold I. Caplan, Francis P. Barry, David J. Fink, Daniel R. Marshak, James S. Burns (December 28, 2004). Osteoarthritis cartilage regeneration. Patent No. 6,835,377.
19. D Asselineau and AI Caplan (March 20, 2007). Antibodies specific for papillary fibroblasts as markers for skin quality. Patent No. 7,192,719.
20. Arnold I. Caplan, Randell G. Young, James E. Dennis (March 9, 2008). Myogenic differentiation of human mesenchymal stem cells. Patent No. EP0852463.
21. Arnold I. Caplan, Tracey L. Bonfield (August 16, 2012). Mesenchymal Stem Cell Therapies. Provisional Patent Appln. No. 61/683,987.
22. James E. Dennis, Arnold I. Caplan, Nir Cohen (April 26, 2016). Cell Targeting Methods and Compositions. Patent No. US 9,321,992 B2.
23. Correa D, Caplan AI (August 24, 2017). Pericyte assay for transendothelial migration. United States Patent Application 20170241990. (<http://www.freepatentsonline.com/y2017/0241990.html>)

## **SELECTED ADDRESSES**

### **1968**

Invited Lecture: Gordon Conference on Vitamins and Cofactors; July 1968.

### **1971**

Invited Lecturer: Workshop Meeting on "Limb Development," Boulder, Colorado; June 1971. (See Dev. Biol. 27:285-288 (1972) for a summary of this meeting.)

Invited Speaker: Gordon Conference on "Mucopolysaccharides," July 1971.

### **1972**

Invited Lecturer: Conference of "Limb Development" sponsored by the International Society of Developmental Biologists, Grenoble, France; August 1972.

### **1974**

Invited Lecturer: Second International Santa Catalina Island Colloquium on "Extracellular Matrix Influences on Gene Expression," September 1974.

### **1975**

Invited Participant: Mead-Johnson Symposium on "Clinical and Biological Aspects of Malformations," Vail, Colorado; June 1975.

Invited Speaker: Gordon Conference on "Bones and Teeth," July 1975.

### **1976**

Invited Lecturer: Third Symposium of the British Society for Developmental Biology (Cosponsored by The International Society of Developmental Biologists) on "Vertebrate Limb and Somite Development," Glasgow, United Kingdom; September 1976.

### **1977**

Symposium Lecturer: Fifth International Conference on "Birth Defects," Montreal, Canada; August 1977.

### **1978**

Invited Participant: Dahlem Conference on "Fetal Growth," Berlin, Germany; February 1978.

Invited Participant: W. Alton Jones Cell Science Center, "Structure and Metabolism of Proteoglycans in Cultured Cells"; February 1978.

Invited Lecturer: Conference on the "Biology of Cervical Dilatation"; August 1978.

### **1979**

Invited Lecturer and Rapporteur: Fogarty International Conference on "Novel ADP-Ribosylations of Regulatory Enzymes and Proteins," Washington, D.C.; October 1979.

## SELECTED ADDRESSES

### 1980

Symposium Lecturer: AAAS Annual Meeting, San Francisco, California; January 1980.

Symposium Lecturer: Annual Meeting of the National Science Teachers Association, Anaheim, California; March 1980.

Invited Participant: EMBO Workshop on "Muscle Cell Culture in the Study of Gene Expression During Differentiation," Shoshon, Israel; March 1980.

Symposium Lecturer: Midwest Connective Tissue Workshop, Cleveland, Ohio; May 1980.

Symposium Lecturer: 39th Symposium of the Society for Developmental Biology, Storrs, Connecticut; June 1980.

### 1981

Invited Participant: VI<sup>th</sup> International Symposium on Glycoconjugates, Tokyo, Japan; September 1981. Satellite meeting on "Proteoglycans," Hakone, Japan.

### 1982

Invited Participant: XV<sup>th</sup> EMBO International Embryology Conference, Strasbourg, France; June 1982.

Organizer and Participant: "Third International Conference on Limb Development and Regeneration," Storrs, Connecticut; June 1982.

Workshop on Limb Development organized by NIHCD, Washington, D.C.; September 1982.

### 1983

Invited Lecturer: 3rd EMBO Workshop on "Molecular and Cellular Aspects of Myogenesis and Myofibrillogenesis in Cell Cultures of Normal and Diseased Muscle," Boldern, Switzerland; March 1983.

Invited Lecturer: "Workshop on Local Mechanisms Regulating Bone Formation," NIDR/NIH, Bethesda, Maryland; May 1983.

Invited Lecturer: Gordon Research Conference, "The Biochemistry and Physiology of Bones and Teeth"; July 1983.

Invited Lecturer: Midwest Connective Tissue Workshop, Northwestern University, Chicago, Illinois; October 1983.

Distinguished Lecturer Series: University of Texas Health Science Center, Dallas, Texas; November 1983.

Mini Symposium Lecturer: 23rd Annual Meeting, The American Society for Cell Biology, San Antonio, Texas; November/December 1983.

### 1984

Invited Lecturer: Third Annual Mid-Atlantic States Regional Meeting of the Society for Developmental Biology, Millersville University, Millersville, Pennsylvania; April 1984.

Invited Participant and Session Chairman: Gordon Conference on Proteoglycans, Plymouth State College, New Hampshire; June 1984. Invited Participant: "The Second International Conference on the Chemistry and Biology of Mineralized Tissues," Gulf Shores, Alabama; September 1984.

Invited Lecturer: Seventh International Symposium on ADP-Ribosylation Reactions, Vitznau, Switzerland; September 1984.

Invited Lecturer: 1984 Annual Meeting of the Society of Complex Carbohydrates," Chicago, Illinois; October 1984.

### 1985

Plenary Lecturer: UCLA Meetings on "Molecular Biology of Muscle Development," Park City, Utah; March 1985.

Session Chairman: 25th Annual Midwest Regional Developmental Biology Meetings, Cleveland, Ohio; May 1985.

Workshop on Arthritis organized by NIH, Warrenton, Virginia; July 1985.

Plenary Lecturer: Tenth International Congress of the International Society of Developmental Biologists, Los Angeles, California; August 1985.

Mini Symposium Lecturer: 25th Annual Meeting, The American Society for Cell Biology, Atlanta, Georgia; November 1985.

### 1986

Invited Participant: CIBA Foundation Symposium on "Functions of the Proteoglycans," London, England; January 1986.

Invited Participant: 7th International Workshop on Calcified Tissues, Ein Gedi, Israel; March 1986. Symposium Lecturer: 1986 American Association for Dental Research, Washington, D.C.; March 1986.

Platform Lecturer: UCLA Meeting on "Development and Diseases of Cartilage and Bone Matrix," Lake Tahoe, California; March 1986.

Symposium Lecturer: Annual Teratology Society Meeting, Boston, Massachusetts; July 1986.



## **SELECTED ADDRESSES**

Invited Participant and Lecturer: Gordon Research Conference on "Bioengineering and Orthopedic Sciences," Proctor Academy, Andover, New Hampshire; August 1986.

Invited Participant and Lecturer: EMBO Meeting on "Molecular Biology of Muscle Development," Bendor, France; August/September 1986.

Symposium Lecturer: "The Biology of Tooth Movement," University of Connecticut, Farmington, Connecticut; November 1986.

Distinguished Lecturer: Columbia University, College of Physicians and Surgeons, Department of Orthopaedics, New York, New York; December 1986.

### **1987**

Organized and conducted: "Workshop on Hard Tissue and Ceramics," Santa Barbara, California; January 1987.

Invited Participant: "8th International Symposium on ADP-Ribosylation," Fort Worth, Texas; May/June 1987.

Invited Participant and Group Leader: "NIH/AAOS Workshop on Injury and Repair of the Musculoskeletal Soft Tissues," Savannah, Georgia; June 1987.

Invited Participant: MDA "Colloquium on Growth Regulation in Normal and Dystrophic Muscle," MIT Endicott House, Dedham, Massachusetts; July/August 1987.

Symposium Lecturer at the Annual Meeting of the Chilean Society of Biology (Cell Biology Section), Santiago, Chile; September 1987.

Invited Participant: Battelle Pacific Northwest Laboratories/U.S. Department of Energy workshop on "Chemistry at Interfaces," Richland, Washington; October 1987.

Invited Lecturer and Proposer: CIBA Foundation Symposium No. 137, "Cell and Molecular Biology of Hard Tissue," London, England; October 1987.

Invited Lecturer, "Midwest Connective Tissue Workshop," Chicago, Illinois; November 1987. Keynote Speaker: "Conference on Mineralized Tissues and Biomaterials," Bordeaux, France; December 1987.

### **1988**

Invited Discussant: "Second International Workshop on Cells and Cytokines in Bone and Cartilage," Davos, Switzerland; April 1988.

Organizer and Participant: "Bioactive Factors from Bone: A Celebration for Marshall Urist," San Antonio, Texas; May 1988.

Invited Participant: Third Annual Bone Workshop, "The Role of Growth Factors in Bone Formation," sponsored by Merck Sharp & Dohme Research Laboratories, Branchburg Farms, New Jersey; July 1988.

Invited Participant: "Workshop on Myocardial Regeneration," Rockefeller University, New York, New York; June 1988. Invited Participant: "Workshop on Bone Healing," Genentech, Inc., San Francisco, California; August 1988.

Invited Speaker: "Third Annual Meeting of the Orthopaedic Research Society of Japan," Tokyo, Japan; September 1988.

Invited Lecturer and Chairperson: "The Third International Conference on the Chemistry and Biology of Mineralized Tissues," Chatham, Massachusetts; October 1988.

Invited Lecturer: "Midwest Connective Tissue Workshop," Chicago, Illinois; November 1988.

### **1989**

Invited Lecturer: "International Symposium on Recent Advances in Drug Delivery Systems," Salt Lake City, Utah; February 1989.

Invited Lecturer: "The XXI European Symposium on Calcified Tissues," Jerusalem, Israel; March 1989.

Organizer and Symposium Lecturer: "Cellular and Molecular Biology of Skeletal Repair," Cleveland, Ohio; April 1989.

Invited Participant: "Bone Biology Workshop," organized by Merck Sharp & Dohme Research Laboratories, Branchburg Farms, New Jersey; June 1989.

Invited Lecturer: Gordon Research Conference, "Biology of Aging," Plymouth, New Hampshire; July 1989.

Invited Lecturer: "National Conference on Biotechnology Ventures," Redwood Shores, California; November 1989.

Invited Lecturer: "Controversies of Total Knee Arthroplasty: Issues for the Nineties," sponsored by The Knee Society, Phoenix, Arizona; November 1989.

Invited Lecturer: "Materials Research Society, Fall Meeting," Boston, Massachusetts; November/December 1989.

Invited Lecturer: "Conference on Mineralized Tissue and Biomaterials," Bordeaux, France; December 1989.

### **1990**

Distinguished Professor Lecture: Hospital for Special Surgery, Cornell Medical School, New York, New York; February 1990.

## SELECTED ADDRESSES

Kappa Delta Award Lecture at the Annual Meeting of the American Academy of Orthopaedic Surgeons, New Orleans, Louisiana; February 1990.

Invited Lecturer: UCLA Symposium on "Tissue Engineering," Keystone, Colorado; April 1990.

Invited Lecturer: NATO Advanced Research Workshop, "Developmental Patterning of The Vertebrate Limb," Santander, Spain; September 1990.

Invited Lecturer: Ohio Symposium on "Advances in Biomaterials Science and Engineering," Cleveland, Ohio; October 1990.

Invited Lecturer: Midwest Connective Tissue Workshop, Chicago, Illinois; November 1990.

Invited Participant: Workshop on "The Bone Biomaterials Interface," Toronto, Canada; December 1990.

### 1991

Organizer/Participant: Workshop on "Materials Processing Strategies for Producing Useful Ceramic Materials Biomimetically," San Diego, California; January 1991.

Invited Lecturer: "International Update on Bone Allografts Symposium," Washington, D.C.; April 1991.

Organizer/Participant: Workshop on "Orthopaedic Applications of Growth Factors," Indianapolis, Indiana; April 1991.

Invited Lecturer: "Annual Meeting of the Scanning Microscopy Society," Bethesda, Maryland; May 1991.

Invited Lecturer: "International Conference on the Biological Mechanisms of Tooth Movement and Craniofacial Adaptation," Columbus, Ohio; May 1991.

Invited Lecturer: "European Developmental Biology Congress," Jerusalem, Israel; August 1991.

Invited Lecturer: Midwest Connective Tissue Workshop, Chicago, Illinois; November 1991.

Invited Lecturer: Workshop on "Biology of Biomechanics of Synovium: The Knee as a Model," Scottsdale, Arizona; November 1991.

### 1992

Invited Lecturer: Controlled Release Society Workshop: "Biomaterials, Fundamentals, Applications and Recent Developments," Jupiter Beach, Florida; January 1992.

Invited Lecturer: "4th International Conference on Calcified Tissues," Del Coronado (San Diego), California; February 1992.

Invited Lecturer: Keystone Symposia on Molecular and Cellular Biology: "Tissue Engineering," Keystone, Colorado; April 1992.

Invited Lecturer: "Biotech Ohio," Columbus, Ohio; May 1992.

Invited Participant: "4th International Conference on Limb Development and Regeneration," Asilomar (Pacific Grove), California; June 1992. Invited Participant: "Frontiers in Rehabilitation Medicine: Osteogenesis Imperfecta," NIH, Bethesda, Maryland; September 1992.

Invited Participant: Midwest Connective Tissue Workshop, Chicago, Illinois; October 1992.

Invited Lecturer: European Research Conference, "Biology of Cartilage and Bone: Molecular and Cellular Aspects," sponsored by European Science Foundation, Obernai, France; November 1992.

### 1993

Invited Lecturer: "The Biological Approach to Hard and Soft Tissue Reconstruction and Repair Processes" Centennial Celebration, Dental School/Northwestern University, Chicago, Illinois; January 1993.

Invited Lecturer: Ralph V. McKinney, Jr. Memorial Symposium, "Experimental Evaluations of the Bone-Dental Interface," IADR/AADR Annual Meeting, Chicago, Illinois; March 1993.

Invited Lecturer: "Bone Repair and Osteoporosis", IBC Conference, San Francisco, CA; June 1993.

Invited Lecturer: "Portland Bone Symposium," Portland, Oregon; July 1993.

Invited Lecturer: "Frontiers of Implant Science" Symposium, American Academy of Implant Dentistry Regional Foundation Annual Meeting, Dallas Texas; October 1993.

Invited Lecturer: "International Conference on the Biological Mechanisms of Tooth Eruption, Resorption and Replacement by Implants," Danvers, Massachusetts; October 1993.

Invited Participant: "Bone Repair" Symposium, National Institutes of Health/American Academy of Orthopaedic Surgeons Conference, Tampa, Florida; November 1993.

### 1994

Invited Lecturer: "Symposium on BMP and Bone Repair," Johns Hopkins University, Baltimore, Maryland; June 1994.

Invited Lecturer: "FASEB Summer Research Conference on Repair and Regeneration: At the Interface," Saxtons River, Vermont; July 1994.

Invited Lecturer: "Gordon Research Conf on Bioengineering and Orthopaedics Sciences,"; August 1994.

Invited Lecturer: "European Tissue Culture Soc Symp on Applied Cell Culture," Verona, Italy; Oct 1994.

Invited Lecturer: "Annual Meeting of the National Capital Area Tissue Culture Society," College Park, Maryland; October 1994.

## SELECTED ADDRESSES

### 1995

Invited Lecturer: "Developmental Biology" Graduate Course, University of Puerto Rico, San Juan, Puerto Rico; February 1995.

Invited Lecturer: "International Symposium on Bone and Soft Tissue Allografts," Musculoskeletal Transplantation Foundation, Washington, D.C.; April 1995.

Invited Lecturer: "Portland Bone Meeting," Portland, Oregon; August 1995.

Invited Lecturer: "Tissue Engineering and Bone/Cartilage Stimulation," IBC Conference, Washington, D.C.; August 1995.

Session Chair and Presenter: "5th International Conference on the Chemistry and Biology of Mineralized Tissue," Kohler, Wisconsin; October 1995.

Invited Lecturer: "Second International Symposium on Fibrodysplasia Ossificans Progressiva," Philadelphia, Pennsylvania; October 1995.

Invited Lecturer: "Second Combined Meeting of the USA, Japanese, Canadian and European Orthopaedic Research Societies," Del Coronado, California; November 1995.

### 1996

Invited Lecturer: "Tissue Engineering/Wound Repair," Keystone Symposia on Molecular and Cellular Biology, Taos, New Mexico; January 1996.

Invited Lecturer: "Stem Cells," Branbury Conference, Cold Spring Harbor, NY; February 1996

Invited Lecturer: "Fifth Internl Workshop on Calcified Tissues," Jerusalem, Israel; March 1996.

Invited Lecturer: National Disease Research Interchange. "Frontiers in Human Tissue Research". Philadelphia, PA; April 1996.

Invited Lecturer: "Scientific Frontiers in Clinical Density," NIH, Bethesda, Maryland; June 1996.

Invited Lecturer: "6th International Conference on the Molecular Biology and Pathology of Matrix," Philadelphia, Pennsylvania; June 1996.

Invited Lecture: Washington, DC section of AADR, Dental & Medical Materials Group of N.I.S.T., NIH, Bethesda, MD, June, 1996

Symposium Lecture: "The Intl Cong on Human Cell and Cell Culture", Tokyo, Japan, August, 1996.

Invited Plenary Lecture: "Third International Congress of the Cell Transplant Society," Miami Beach, Florida, September 1996.

### 1997

Invited Lecture: Keystone Symposia on Molecular and Cellular Biology, "Biology of Sarcomas II: Molecular, Pathologic, and Oncologic Aspects of Mesenchymal Growth and Differentiation," Copper Mountain, Colorado. February 1997.

Invited Lecture: Gordon Conf on "Wound Repair". Colby-Sawyer College, New Hampshire. June, 1997.

Invited Lecture: Workshop on "Osteobiology", Salsomaggiore, Italy. June, 1997.

Invited Lecture: "International Symposium on Gene Therapy for Single Gene Disorders," Helsinki, Finland, June, 1997.

Invited Lecture: Fifth Annual Course on "Advances in Tissue Engineering" Rice University, Houston, Texas, August, 1997.

Invited Lecture: 7th Ann. Mtg. of the "European Tissue Repair Society", Cologne, Germany, August, 1997.

Invited Lecture and Session Chair: IBC Conference on "Skin Substitutes", Boston, MA, September, 1997.

Invited Lecture: European Tissue Culture Society Annual Meeting. Mainz, Germany. October, 1997.

Invited Lecture/Participant: Workshop on "Fracture Repair Agumentation" Organized by the Association of Bone and Joint Surgeons and the Intl Society for Fracture Repair. Tampa, Florida, October, 1997.

### 1998

Invited Lecture: Harvard University "Biology, Biochemistry and Physiology of the Skeletal Systems of Vertebrate," Boston, MA, February, 1998.

Invited Lecture: Tissue Engineering Course: Food and Drug Administration, Rockville, MD, March,

Invited Lecture: 1998 MSGSA Symposium the University of Calgary, Alberta, Canada, April, 1998.

Invited Lecture: The Cleveland Clinic Foundation, Division of Rheumatology and Immunologic Diseases, Cleveland, Ohio, May, 1998.

Invited Lecture: The 50<sup>th</sup> Anniversary of the Dental School Research Symposium. University of Alabama, Birmingham, Alabama, May, 1998.

Invited Lecture: Tissue Engineering Course, Rice University, Houston, Texas, August, 1998.

Plenary Lecture: "North Sea Biomaterials Conference" and "The 14<sup>th</sup> European Society for Biomaterials Conference." The Hague, The Netherlands, September, 1998.

Invited Lecture: Annual Meeting of the Biomedical Engineering Society, Cleveland, Ohio, October, 1998.

Organizer and Lecturer: Orthopaedic Tissue Engineering Workshop, Tampa, Florida, November, 1998.

## SELECTED ADDRESSES

Plenary Lecture: "Second Tissue Engineering Society Meeting" Orlando, Florida, December, 1998.

Invited lecture: "2<sup>nd</sup> SIS Symposium," Orlando, Florida, December, 1998.

### 1999

Invited Lecture: IBC 2<sup>nd</sup> Annual Conference on "Orthopaedic Biomaterials," Cambridge, MA, March, 1999.

Presidential Guest Lecture: 72<sup>nd</sup> Annual Mtg of the Japanese Orthop. Assn, Yokohama, Japan, April, 1999.

Invited Lecture and Session Chair: Workshop on "Cartilage Repair," Lake Tahoe, California, June, 1999.

Invited Participant: New Frontiers in Medical Science "Redefining Hyaluronan," Padua, Italy, June, 1999.

Symposium Lecture: The 5th Annual Orthop. Symposium, School of Medicine, Stony Brook, NY, June, 1999.

Session Chair: "Portland Bone Symposium," Portland, Oregon, August, 1999.

Invited Lecture: "Advances in Tissue Engineering," Rice University, August, 1999.

Symposium Lecture: "4<sup>th</sup> Intl. Symposium of Tissue Eng. for Therapeutic Use." Kyoto, Japan, September, 1999.

Symposium Lecture: 14<sup>th</sup> Annual Orthopaedic Research Meeting, Nara, Japan, October, 1999.

Symposium Lecture: Fondation Rene Touraine Pour La Recherche Dermatologie, "Extracellular Matrix." Paris, France, October, 1999.

Participant/Group Leader: Technology Forum Workshop: NIH/FDA, Bethesda, MD, November, 1999.

Invited Lecture: ABJS Workshop "Orthopaedics and Gene Therapy" Tampa, FL, November, 1999.

Invited Participant: Bone Engineering International Workshop, Institute for Biomaterials and Biomedical Engineering, University of Toronto, November, 1999.

### 2000

Invited Lecture: Tissue Engineering Symposium, Pittsburg, PA, April, 2000.

Invited Lecture: Cartilage Repair Society Annual Meeting, Tossburg, Sweden, April, 2000.

Invited Lecture: NYAS "Tissue Repair and Remodeling in Arthritis," New York City, NY, May, 2000.

Invited Lecture: Symposium on "Stem Cells in the Embryo and in the Adult Prospects for Therapy." Collège de France, Paris, May, 2000.

Invited Lecture: Gordon Research Conference, "Signal Transduction by Engineered Extracellular Matrices," June, 2000.

Invited Lecture: "HA 2000" Conference, Wales, Great Britain, September, 2000.

Invited Lecture: "Functional Tissue Engineering Workshop" Sponsored by the U.S. Nat'l Committee on Biomechanics, Tampa, FL, September, 2000.

Invited Lecture: ABJS "Articular Cartilage Repair 2000" Tampa, FL, November, 2000.

Invited Lecture/Organizer: L'Oreal Symposium on "The Science and Technology of Skin" Lyon, France, October, 2000.

Invited Lecture: Italian Orthopaedics Society Annual Meeting. Torino, Italy, October, 2000.

Invited Lecture: Annual ASTM Meeting. "Cell-Based Therapies," Orlando, FL, November, 2000.

Invited Lecture and Teaching Seminar: "The Art of Tissue Engineering 2000" Utrecht, The Netherlands, November 2000.

Invited Lecture: Engineering Orthopaedics, University of Michigan, Ann Arbor, MI, December 2000.

### 2001

Invited Lecture: Annual Research Meeting of Otolaryngology Society. "Tissue Engineering Symposium" St. Petersburg, FL, February 2001.

Organizer/Lecture: Workshop on "STEM CELLS" at the Annual Meeting of the Orthopaedic Research Society, Dallas, Texas, February 2002.

Invited Lecture: Ernst Klenk Symposium. "Stem Cells" Cologne, Germany, February, 2001.

Invited Lecture: Arthritis Foundation Research Conference. San Diego, CA, March 2001.

Invited Lecture/Organizer: Engineering Tissue Growth, International Conference, Pittsburgh, PA, March.

Invited Lecture: Experimental Biology/Am. Soc. Of Investigative Pathology, Orlando, FL, April 2001.

Organizer: Midwest Tissue Engineering Consortium Annual Meeting, Cleveland, Ohio, April 2001.

Invited Lecture: European Congress of Rheumatology. Symposium on Stem Cells, Prague, Czech Republic, June 2001.

Invited Lecture: World Congress of Biomedical Engineering. "Tissue Engineering Symposium" and "Toxicology of Skin Symposium." St. Louis, MO., June 2001.

Invited Participant: BECON 2001. "Reparative Medicine: Growing Tissues and Organs" NIH, Bethesda, MD, June 2001.

Invited Participant: Stem Cell Workshop, NIH, Bethesda, MD, August 2001.

Invited Lecturer: Annual Midwest Seminars of Dental Medicine, Green Bay, WI, September, 2001.

Invited Lecturer: Topics in Geriatric Medicine. Veterans Administration Hospital, Cleveland, OH, September, 2001.

Invited Participant: Osteogenesis Imperfecta. NIH Workshop, Chicago, IL, December, 2001.

## **SELECTED ADDRESSES**

Invited Lecturer: Symposium on Stem Cells, Eli Lilly Corporation, Indianapolis, IN, October, 2001.  
Invited Lecture: World Congress of the OsteoArthritis Research Society International. Washington, DC, October 2001.

Invited Lecturer: "Tecvest 2001" New York, NY, October 2001.

Invited Keynote Lecturer: Binnial Meeting of the European Tissue Engineering Society, Freiburg, Germany, November, 2001.

### **2002**

Invited Lecture: New Frontiers in Science and Technology Lecture Series. University of Buffalo Medical School, Buffalo, NY, January 2002.

Invited Lecture: "AO Conference on Cell Therapies in Orthopaedics", Zurich, Switzerland. March, 2002.

Invited Lecture: "MSCs and their use in Skeletal Tissue Regeneration", London, Ont. Canada, March, 2002.

Invited Lecture: Engineering Tissue Growth, Pittsburgh, PA, March 2002.

Invited Lecture: North American Vascular Biology Organization, Workshop on Tissue Engineering, Salt Lake City, Utah. April, 2002.

Invited Lecture and Meeting Moderator: Novartis Foundation Symposium #249 on Tissue Engineering, London, England, April, 2002.

Organizer/Founder: Midwest Tissue Engineering Consortium, 2<sup>nd</sup> Meeting, Ann Arbor, MI. April, 2002

Invited Lecture: McGowan Institute Distinguished Lecture Series, Pittsburgh, PA. April, 2002.

Invited Lecture: Society for Biomaterials Annual Meeting, Tampa, FL. April, 2002.

Invited Lecture: Senior Day Symposium, Park Synagogue, Cleveland Heights, OH. May 2002.

Invited Lecture: Symposium on TMJ, NIH, Bethesda, MD 2002.

Invited Lecture/Session Chair: Aegean Conference on Tissue Engineering, Myconos, Greece. May, 2002.

Organizer/Lecture: Short Course on "Cell-Based Therapies and Tissue Engineering", Case Western Reserve University, Cleveland, OH. May, 2002.

Invited Lecture: Cartilage Repair Society Annual Meeting. Toronto, Canada, June, 2002.

Invited Lecture: Gordon Res. Conferences on Signal Transduction and Tissue Engineering. June, 2002.

Invited Lecture: Baltic Stem Cell Conference, University of Rostock, Rostock, Germany. June, 2002.

Invited Lecture: 10<sup>th</sup> Annual Tissue Engineering Course, Rice University, Houston, TX. August, 2002.

Organizer/Lecture: International Symposium on Aging of Skin. Cleveland, OH, September, 2002.

Invited Lecture/Course Director: Annual Meeting of the Society for Otolaryngology, San Diego, CA. September, 2002.

Invited Lecture: Italian Orthopaedic Society, Bologna, Italy. October, 2002.

Invited Lecture: ICCC and JSGST Symposium. Kyoto, Japan, October, 2002.

Invited Lecture: Cold Spring Harbor Laboratory Meeting on Stem Cells, Long Island, NY. Nov., 2002.

Invited Lecture: 1<sup>st</sup> Intl. Mtg. of the Stem Cell Network. North Rhine Westphalia, Düsseldorf Germany, November 2002.

Invited Lecture: University of Texas, San Antonio. Distinguished Professor Lecture. December, 2002.

### **2003**

Invited Chair/Participant: AAOS Workshop, "Tissue Engineering in Musculoskeletal Clinical Practice" Santa Fe, NM. January, 2003.

Invited Lecturer: 2003 Alpha Group Educational Workshop. Antigua. February, 2003.

Invited Lecturer/Organizer: 3<sup>rd</sup> Engineering Tissue Growth Intl. Conf. and Exposition. Pitts., PA, March 2003.

Invited Lecturer: 29<sup>th</sup> Mtg. of the Society for Biomaterials. Reno, NV, April 2003.

Invited Lecturer: Keystone Conference "Stem Cells", Steamboat Springs, CO, April 2003.

Invited Lecturer: Research Frontiers Symposium. University of Alabama, Birmingham, AL, April 2003.

Organizer: Midwest Tissue Engineering Meeting. Cincinnati, OH, April 2003.

Invited Lecturer: Gerontology Inst. Workshop on Stem Cells. Univ. of Michigan, Ann Arbor, MI, May 2003.

Organizer: 2<sup>nd</sup> Annual Cell-Based Therapies and Tissue Engineering Short course (CTTE-2003), Case Western Reserve University, Cleveland, May 2003.

Webcast: Invited by Tissue Engineering Society, June 2003.

Invited Lecturer: 2<sup>nd</sup> Mtg. of the Institute of Arthritis and Pain. Vienna, July 2003

Invited Lecturer: Alegen Healthcare Institute, Omaha, NB, August 2003.

Invited Lecturer: Distinguished Scientist Lecture Series "Health Sciences and Engineering" Dept. of Biomedical Engineering, University of Michigan, Ann Arbor, MI, October 2003.

Invited Lecturer: Workshop on Osteogenesis Imperfecta, New York, NY, October 2003.

Invited Lecturer: Glaxo/Smith/Kline Stem Cell Symposium, Philadelphia, PA, October 2003.

Invited Lecturer: Workshop on Osteoarthritis (ABJS). Tampa, FL, November 2003.

Invited Lecturer: International Biomaterials Conference, Japan, December 2003.

## RESEARCH SUPPORT

### 2004

Invited Lecturer: The Bone Summit (International Meeting), Cleveland, OH, May 2004.

Invited Lecturer: International Cartilage Repair Society, Ghent, Belgium, May 2004.

Organizer: 3<sup>rd</sup> Annual Cell-Based Therapies and Tissue Engineering Short course (CTTE-2004), Case Western Reserve University, Cleveland, May 2004.

Invited Lecturer: Distinguished Scientist Lecture Series, Mayorca, Spain, June 2004.

Invited Lecturer: Tissue Engineering Symposium LEMI, Bordeaux, France, June 2004.

Instructor: Medical Uses of Hyaluronan, Sanofi Course, New York, NY, June 2004.

Invited Lecturer: Tissue Engineering Course, Rice University, Houston, TX, August 2004.

Invited Lecturer: BioCity Symposium on Regenerative Medicine, Turku, Finland, August 2004.

Invited Lecturer: NCI: CTER Symposium Sacroma and MSCs, Washington, DC, September 2004.

Invited Lecturer: Musculoskeletal Ventures Symposium, Memphis, TN, October 2004.

Invited Lecturer: BioCity Symposium on Stem Cells, Stuttgart, Germany, November 2004.

### 2005

Invited Lecturer: MSCs and Tissue Engineering and New Insights into Aging, Departments of Cell Biology and Pathology, UCSF, San Francisco, CA, January 2005.

Invited Lecturer: Regenerate 2005, Hilton Head SC, March 2005.

Invited Lecturer: Knowles Lecture, Arthritis Foundation, San Francisco, CA, April 2005.

Invited Lecturer: The Cartilage Summit, Cleveland OH, May 2005.

Invited Lecturer: Tissue Engineering Symposium, Warsaw, Poland, May 2005.

Invited Lecturer: 2<sup>nd</sup> International Conference on Tissue Engineering, Crete, Greece, May 2005.

Organizer: 4<sup>th</sup> Annual Cell-Based Therapies and Tissue Engineering Short course (CTTE-2005), Case Western Reserve University, Cleveland, May 2005.

Invited Lecturer: IX International Conference on Osteogenesis Imperfecta, Annapolis, MD, June 2005.

Distinguished Lecturer: Division of Orthopaedics, University of California at Sacramento, CA, June 2005.

Invited Lecturer: Tissue Engineering Course, Rice University, Houston, TX, August 2005.

Invited Lecturer: LOEX Symposium 2005, Sainte Foy, Quebec Canada, September 2005.

Invited Lecturer: Current Progress in Tissue Engineering and Regenerative Medicine, Harvard University Review Course, Boston, MA, September 2005.

Invited Advisor/Participant: Annual Australian Stem Cell Centre International Scientific Advisory Board Meeting, Melbourne, Australia, November 2005.

Invited Lecturer: Regenerative Medicine Institute, National Centre for Biomedical Engineering and Science, National University of Ireland, Galway Ireland, October 2005.

Invited Lecturer: The 13<sup>th</sup> Annual Congress of the European Society of Gene Therapy, Prague, Czechoslovakia, October 2005.

### 2006

Invited Participant: American Orthopaedic Society for Sports Medicine, La Jolla, CA, January 2006.

Invited Keynote Speaker: International Cartilage Repair Society Meeting, San Diego, CA, January 2006.

Invited Keynote Speaker: 24<sup>th</sup> Scientific Conference Society Physical Regulation in Biology and Medicine, Cancun, Mexico, January 2006.

Invited Lecturer: Buck Institute and CHORI (Oakland), San Francisco, CA, January 2006.

Invited Participant: Workshop on Pain and Osteoarthritis, Phoenix, AZ, January 2006.

Keynote Speaker: Adult Stem Cell Summit, Chicago, IL, March 2006.

Organizer/Participant: InterWest Workshop on Cell-Based Therapy, Napa Valley, CA, April 2006.

Invited Lecturer: 6<sup>th</sup> Regenerate International Conference and Exposition, Pittsburgh, PA, April 2006.

Organizer: 5<sup>th</sup> Annual Cell-Based Therapies and Tissue Engineering Short course (CTTE-2006), Case Western Reserve University, Cleveland, May 2006.

Invited Speaker: BioMed 2006, Jerusalem, Israel, June 2006.

Invited Seminar: Cell Biology Department, Tel Aviv University, Israel, June 2006.

Invited Speaker: AO Trustees Meeting (Stem Cells). Berne, Switzerland, June 2006.

Invited Participant: ISSCR Meeting, Toronto, Canada, July 2006.

Invited Speaker: CHI CELLutions Summit, Boston, MA, August 2006.

Invited Speaker: 14<sup>th</sup> Annual Tissue Engineering Course, Rice University, Houston, TX, August 2006.

Invited Lecturer: International Meeting "Embryonic and Somatic Stem Cells-Regenerative Systems for Cell and Tissue Repair", Dresden, Germany, September 2006.

Organizer: After Meeting Think Tank Shoulder Society, Chicago, IL, September, 2006.

Invited Speaker: AAOS Development in Orthopaedics. Toronto, Canada, October, 2006.

## RESEARCH SUPPORT

Invited Speaker: Marshall S. Levy, MD, Memorial Lecture, Pittsburgh, PA, November, 2006.

### 2007

Invited Lecturer: Center for Cranial Facial Biology, USC, Los Angeles, CA, January 2007.

Organizer/Lecturer: NSF/NIH Workshop on Tissue Engineering, Regenerative Medicine and Stem Cells, Arlington, VA, February 2007.

Invited Lecturer: Stem Cell Summit, San Diego, CA, February 2007.

Invited Lecturer: Genzyme Corporation, Boston, MA, February 2007.

Invited Lecturer: Grand Rounds, Department of Rheumatology, UH, CWRU, March 2007.

Invited Lecturer: Annual Meeting Veterinary Orthopaedic Surgeons, Sun Valley, ID, March 2007.

Invited Lecturer: Graduate Student Research Day, University of Toledo, Toledo, OH, March 2007.

Invited Lecturer: Keystone Conference "Development and Tissue Engineering", Snowbird, UT, April 2007.

Invited Lecturer: International Workshop on Hyaluronan, Charleston, SC, April 2007.

Invited Lecturer: Workshop on Functional Tissue Engineering, Hilton Head, SC, April 2007.

Invited Lecturer: Melvin Glimcher Symposium, Harvard University, Boston, MA, May 2007.

Invited Lecturer: Regenerative Medicine Conference, University of Toronto, Toronto, Canada, June 2007.

Invited Lecturer/Session Chair: TERMIS North America, Toronto, Canada, June 2007.

Invited Lecturer: 15<sup>th</sup> Annual Tissue Engineering Course, Rice University, Houston, TX, August 2007.

Invited Lecturer: Internal Symposium on Regenerative Medicine, Mulhouse, France, September 2007.

Invited Lecturer: International Cartilage Repair Society, Warsaw, Poland, September 2007.

Invited Lecturer: Department of Cell and Molecular Biology Seminar and also the Graduate Stem Cell Course, University of North Carolina at Chapel Hill, October 2007.

Invited Lecturer: Department of Experimental Medicine and Pathology, Medical School, Universita La Sapienza, Rome, Italy, November 2007.

Invited Lecturer: Italian Society of Orthopaedics and Trauma Annual Meeting, Bologna, Italy, November 2007.

Invited Lecturer: Harvard Stem Cell Institute, Boston, MA, November 2007

Invited Lecturer: The McKnight Brain Institute's Program in Stem Cell and Regenerative Medicine. Amelia Island, FL, December 2007.

### 2008

Invited Lecturer: Department of Cell Biology and Anatomy Seminar Program, Medical University of South Carolina; Charleston, SC, January 2008.

Invited Lecturer: The Stem Cell Summit; New York, NY, February, 2008.

Invited Lecturer: International Chinese Hard Tissue Society Symposium; San Francisco, CA, March 2008.

Invited Lecturer: ORS/AAOS, Combined Symposium; San Francisco, CA, March 2008.

Invited Lecturer: Biomedical Engineering Department; Distinguished Lecturer, Johns Hopkins University, Baltimore, MD, April 2008.

Keynote Speaker: Midwest Tissue Engineering Consortium, Cincinnati, OH, April, 2008.

Invited Lecturer: Academy of Medical Sciences, Moscow, Russia, April 2008.

Invited Lecture: Moscow Orthopaedic Institute, Moscow, Russia, April 2008.

Invited Lecturer: The Cartilage Summit, Cleveland Clinic Foundation; Cleveland, OH, May 2008.

Invited Lecturer: Distinguished Professor Lecture, Hospital for Special Surgery, New York, NY, May 2008.

Invited Member: Biomaterials National Program: Meeting of International Scientific Advisory Panel, Utrecht, The Netherlands, June, 2008.

Invited Lecturer: Stem Cell Symposium, Catholic University, Seoul, S. Korea, June, 2008.

Invited Lecturer: Department of Medical Biology. Daegu University, Daegu, S. Korea, June, 2008.

Invited Lecturer: Cell Signaling and Regenerative Medicine, Gordon Research Conference, Lewiston, Maine, July, 2008.

Organization and Lectured: Second Annual Executive Education Course in "Regenerative Medicine and Entrepreneurism", Cleveland, OH, July 2008.

Organizer and Lecturer: MSC 2008, Regenerative Medicine & Adult Stem Cell Therapy International Meeting, Cleveland, Ohio, August, 2008.

Invited Lecturer: 15<sup>th</sup> Annual Tissue Engineering Course, Rice University, Houston, TX, August, 2008.

Invited Lecturer: Science of Autism Meeting, Thoughtful House, Austin, TX, September, 2008.

Invited Lecturer: Department of Biology, Graduate Department Seminar Series, Cleveland State University, Cleveland, Ohio, October, 2008.

Invited Lecturer: The McGowan Distinguished Professor Lecture, McGowan Institute, University of Pittsburgh, Pittsburgh, PA, October, 2008.

## RESEARCH SUPPORT

- Invited Lecturer: The International Cartilage Repair Society “Strategic Issues in Cartilage” Meeting, Miami, Florida, October, 2008.
- Invited Lecturer: The 9th New Jersey Symposium on Biomaterials Science and Regenerative Medicine. University of New Jersey Medical College, Rutgers, NJ October, 2008.
- Invited Lecturer: HEMO2009, 2 plenary lectures, San Paulo, Brazil, November, 2008.
- Invited Lecturer: Department of Genetics, Universidade Federal do Rio Grande do Sul, Porto Alegre RS, Brazil, November, 2008.
- 2009**
- Invited Lecturer: University of Twente, Faculty Science & Technology, Institute for Biomedical Technology. The Netherlands, January, 2009.
- Invited Lecturer: Cardiology Grand Rounds; Jefferson Medical School. Philadelphia, PA, January, 2009.
- Invited Lecturer: 4th Annual Stem Cell Summit. New York, New York, February, 2009.
- Invited Lecturer: Annual American Academy of Orthopaedic Surgeons, Pediatric Orthopaedic Surgeons of North America (Specialty Day: Basic Science Lecture). Las Vegas, NV, February, 2009.
- Invited Lecturer: Stamcelinstituut Leuven (SCIL). Brussels, Belgium, April, 2009.
- Invited Lecturer: Second Annual Translational Medicine Alliance Forum. Philadelphia, PA, May, 2009.
- Organizer: 8th Annual Cell-Based Therapies and Tissue Engineering Short Course (CTTE-2009). Case Western Reserve University, Cleveland, May, 2009.
- Invited Lecturer: 3rd International Stem Cell Meeting. Tel Aviv, Israel, June, 2009.
- Invited Lecturer: Rambam Medical Center, Haifa, Israel, June, 2009.
- Organizer and Lecturer: Second Annual Business Course in Regenerative Medicine and Entrepreneurism, Case Western Reserve University. Cleveland, Ohio, July, 2009.
- Organizer and Lecturer: MSC09, Regenerative Medicine & Adult Stem Cell Therapy International Meeting, Cleveland, Ohio, August, 2009.
- Invited Lecturer: 17th Annual “Advances in Tissue Engineering”. Rice University, Houston, TX, August, 2009.
- Invited Lecturer: Children's Hospital Medical Center of Akron. Akron, Ohio, August, 2009
- Invited Lecturer: McGill University, Engineering School, Montreal, Canada, September, 2009
- Invited Lecturer: University of Pretoria, Forestry and Agricultural Biotechnology Institute (FABI). Pretoria, South Africa, September, 2009.
- Invited Lecturer: Symposium: The Science of Cartilage Repair. Chicago, Illinois, October 2009.
- Invited Lecturer: IFATS 2009 Conference. Daegu, South Korea, October, 2009.
- Invited Lecturer: Carnegie Mellon University, Dept. of Biological Sciences. Pittsburgh, PA, November, 2009.
- 2010**
- Invited Lecturer: Stem Cell World Congress. San Francisco, CA, January 2010.
- Invited Lecturer: 5<sup>th</sup> Annual Stem Cell Summit, New York, NY, February 2010.
- Invited Lecturer: Department of Rheumatology, Metrohealth, Cleveland, Ohio, March, 2010.
- Invited Lecturer: Veterinary and Regenerative Medicine, Santa Ynez, Ca, March 2010.
- Invited Lecturer: OrthoIndy Journal Club: Indianapolis, IN, March 2010.
- Organizer: 9th Annual Cell-Based Therapies and Tissue Engineering Short Course (CTTE-2009). Case Western Reserve University, Cleveland, May, 2010.
- Organizer and Lecturer: Third Annual Business Education Course: The Business of Regenerative Medicine: From Stem Cells to the Market Place, Case Western Reserve University. Cleveland, Ohio, July, 2010.
- Organizer and Lecturer: MSC09, Regenerative Medicine & Adult Stem Cell Therapy International Meeting, Cleveland, Ohio, August, 2010.
- Invited Lecturer: 18<sup>th</sup> Annual Tissue Engineering Course, Rice University, August, 2010.
- Invited Lecturer: V Brazilian Congress on Stem Cells and Cell Therapy, Gramado, RS, Brazil, September 2010
- Invited Lecturer: National Institute of Science and Technology for Stem Cells and Cell Therapy, Ribeirão Preto, Brazil, September 2010.
- Invited Lecturer: Butantan Institute, São Paulo-SP, Brazil, September, 2010.
- Invited Lecturer: 2010 World Stem Cell Summit, Detroit, MI, October 2010.
- Invited Lecturer: GE Global Research Cell Manufacturing 2010 Symposium, Niskayuna, NY , October 2010.
- Invited Lecturer: 10<sup>th</sup> New Jersey Symposium on Biomaterials Science, New Brunswick, NJ, October 2010.
- Invited Lecturer: TERMIS NA 2010, Orlando, FL, December 2010
- 2011**
- Invited Lecturer: Center for Law, Technology & the Arts-JOLTI, Case Western Reserve University School of Law, Cleveland, OH, January 2011.
- Invited Lecturer: 6<sup>th</sup> Annual Stem Cell Summit. NY, New York, March 2011.



## **RESEARCH SUPPORT**

- Invited Lecturer: Rainbow Babies & Childrens Hospital, Pediatric Pulmonary Department, Case Western Reserve University, April 2011.
- Invited Lecturer: 2011 Translational Regenerative Medicine Forum. Washington, DC, April 2011.
- Invited Lecturer: Science, Engineering & Technology Gateway Ohio (SETGO), Bowling Green State University, Bowling Green, OH. April 2011
- Invited Lecturer: 1<sup>st</sup> International Dental and Craniofacial Stem Cell Conference, Columbia University, New York, NY, April 2011.
- Invited Lecturer: Geriatric Medicine, Case Western Reserve University. Cleveland, Ohio, April, 2011
- Invited Lecturer: Biotime, Inc. Oakland CA, May 2011.
- Organizer: 10<sup>th</sup> Annual Cell-Based Therapies and Tissue Engineering Short Course (CTTE-2011). Case Western Reserve University, Cleveland, OH, May, 2011
- Invited Lecturer: International Society for Stem Cell Research (ISSCR), Toronto, Canada, ON, June, 2011.
- Invited Lecturer: American College of Rheumatology 2011 Pediatric Rheumatology Symposium, Miami, FL, June 2011.
- Organizer and Lecturer: 4<sup>th</sup> Annual Business Education Course: The Business of Regenerative Medicine: From Stem Cells to the Market Place, Case Western Reserve University. Cleveland, OH, July, 2011.
- Invited Lecturer: 19<sup>th</sup> Annual Tissue Engineering Course, Rice University. Houston, TX, August, 2011.
- Organizer and Lecturer: MSC11, Regenerative Medicine & Adult Stem Cell Therapy International Meeting. Cleveland, Ohio, August, 2011.
- Invited Lecturer: 1<sup>st</sup> Annual Cell Therapy Commercialization Summit (CTSC). Boston, MA, September, 2011.
- Invited Lecturer: World Stem Cell Summit. Pasadena, CA, October, 2011.
- Invited Lecturer: 8<sup>th</sup> Latin American Congress on Clinical Research. Buenos Aires, Argentina, October, 2011.
- Invited Lecturer: University of Wisconsin, Stem Cell & Regenerative Medicine Center. Madison, WI, November, 2011
- Invited Lecturer: 2011 ACR/ARHP Annual Scientific Meeting, Chicago, IL, November 2011.
- Invited Lecturer: Life Sciences Summit 2011. New York, NY, November, 2011.
- Invited Lecturer: NY Academy of Sciences Symposium: "Advances in Adult Stem Cell Therapy in Tissue Repair for Cardiovascular Diseases". New York, NY, November, 2011.
- Invited Lecturer: Center for Advanced Research and Technology Summit. Bridgewater, NJ, November, 2011.
- 2012**
- Invited Lecturer: 7<sup>th</sup> Annual New York Stem Cell Summit. New York, NY, February 2012.
- Invited Lecturer: Cell Society Meeting, San Diego, CA, February 2012.
- Invited Lecturer: Department of Orthopaedics, UCLA, Los Angeles, CA February 2012.
- Invited Lecturer: Society of Urodynamics, Female Pelvic Medicine and Urogenital Reconstruction Winter Meeting, New Orleans, LA, March 2012
- Invited Lecturer: Medical University of South Carolina Spine Care Conference, Kiawah Island, SC, May 2012.
- Invited Lecturer: Till & McCulloch Meeting, Montreal, Canada, May 2012.
- Invited Lecturer: Stem Cell Institute Catholic University of Leuven, Belgium, May 2012
- Organizer: 11<sup>th</sup> Annual Cell-Based Therapies and Tissue Engineering Short Course (CTTE-2012). Case Western Reserve University, Cleveland, OH, May, 2012.
- Invited Lecturer: Chicago Orthobiologics & Cell Regeneration Summit (CORS), Burr Ridge, IL, June 2012.
- Invited Lecturer: Faculty of Medicine University of Monterrey, Monterrey, Mexico, June 2012.
- Invited Lecturer: National Academy of Medicine of Mexico, Mexico, June 2012.
- Organizer and Lecturer: 5<sup>th</sup> Annual Business Education Course: The Business of Regenerative Medicine: From Stem Cells to the Market Place, Case Western Reserve University. Cleveland, OH, July, 2012.
- Invited Lecturer: International Conference on Mesenchymal Stem Cells, Galway, Ireland, July 2012.
- Invited Lecturer: 20<sup>th</sup> Annual Tissue Engineering Course, Rice University. Houston, TX, August, 2012.
- Organizer and Lecturer: MSC12, Regenerative Medicine & Adult Stem Cell Therapy International Meeting. Cleveland, Ohio, August, 2012.
- Invited Lecturer: Life Sciences Baltics 2012 Conference, Vilnius, Lithuania, September 2012.
- Invited Lecturer: Houston Stem Cell Summit, Houston, Texas, October 2012.
- Invited Lecturer: Wake Forest Institute for Regenerative Medicine, Winston-Salem, NC, November 2012
- Invited Lecturer: World Stem Cell Summit, West Palm Beach, Florida, December 2012
- 2013**
- Invited Lecturer: SpineSmith/Celling BioSciences; Austin, Texas January 2013
- Invited Lecturer: Rainbow Babies & Children's Hospital, Pediatric Pulmonary; Cleveland, Ohio, January 2013
- Invited Lecturer: 7th Annual Stem Cell Summit; NY, New York, February 2013.

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Invited Lecturer: University of Miami; Miami, Florida, February 2013  
Invited Lecturer: Israstem 2013; Ramat Gan, Israel, April 2013  
Invited Lecturer: Stem Cell Institute; Panama City, Panama, May 2013  
Organizer: 12<sup>th</sup> Annual Cell-Based Therapies and Tissue Engineering Short Course (CTTE-2012). Case Western Reserve University; Cleveland, OH, May, 2013.  
Invited Lecturer: University of Maryland FDA-CERSI Workshop; Bethesda, Maryland, May 2013  
Invited Lecturer: OrthoTec Conference 2013; Warsaw, Indiana, June 2013  
Invited Lecturer: European Society for Animal Cell Technology (ESACT); Paris, France, June 2013  
Organizer and Lecturer: 6<sup>th</sup> Annual Business Education Course: The Business of Regenerative Medicine: From Stem Cells to the Market Place, Case Western Reserve University. Cleveland, Ohio, July, 2013.  
Invited Lecturer: 21<sup>th</sup> Annual Tissue Engineering Course; Rice University. Houston, Texas, August, 2013  
Organizer and Lecturer: MSC13, Regenerative Medicine & Adult Stem Cell Therapy International Meeting; Cleveland, Ohio, August, 2013.  
Invited Lecturer: Cell Society 3rd Annual Clinical Mtg., Coronado Is., San Diego, California, September 2013  
Invited Lecturer: University Hospitals of Cleveland; Division of Pain Medicine, Cleveland, Ohio, October 2013  
Invited Lecturer: World Summit on Regenerative Medicine; Xi'an, China October 2013  
Invited Lecturer: TERMIS-AP; Wuzhen Town, China, October 2013  
Invited Lecturer: Young Investigators Lecture, Waterside Resort, Wuzhen Town, China, October 2013  
Invited Lecturer: Wulf H. Utian LLC; Advances and Promises of Stem Cell Technology, Woodmere, Ohio, October 2013  
Invited Lecturer: Gaetano Pini Orthopaedic Hospital Milan, Italy, December 2013.  
Invited Lecturer: San Raffaele Hospital, Milan Italy, December 2013.  
Invited Lecturer: ICRS Focus Meeting; Bologna, Italy, December 2013

### **2014**

Invited Lecturer: 21st Annual Park Synagogue University Day, Cleveland Heights, Ohio, January 2014  
Invited Lecturer: JP Morgan Healthcare Conference, San Francisco, CA, January 2014  
Invited Lecturer: University of Virginia, Department of Biology, Charlottesville, VA, February 2014  
Invited Lecturer: NBA Physician's Association, New Orleans, LA February, 2014  
Invited Lecturer: American Academy of Orthopaedic Surgeons Annual Meeting, New Orleans, LA March 2014  
Invited Lecturer: Wake Forest Institute for Regenerative Medicine, Winston-Salem, NC March 2014  
Invited Lecturer: Ankara Cartilage Symposium 2014, Ankara, Turkey, April 2014  
Invited Lecturer: Platform for Advanced Cellular Therapies (PACT) Symposium, Vienna, Austria, April 2014  
Invited Lecturer: Stem Cells & Regenerative Medicine International Symposium, Seoul, S. Korea, April 2014  
Invited Lecturer: 9th World Stem Cells and Regenerative Medicine Conference, London, England, May 2014  
Invited Lecturer: University Hospitals Case Medical Center 23rd Annual Cleveland Review of Rheumatic Diseases, Cleveland, Ohio, May 2014  
Organizer: 13th Annual Cell-Based Therapies and Tissue Engineering Short Course (CTTE-2014). Case Western Reserve University; Cleveland, OH, May, 2014  
Invited Lecturer: 22nd Annual World Congress on Anti-Aging, Regenerative and Functional Medicine, Orlando, FL, May 2014  
Invited Lecturer: Stem Cells and Regenerative Medicine Congress, London, England, May 2014  
Invited Lecturer: The Orthobiologic Institute 5th Annual PRP & Regenerative Medicine Symposium, Las Vegas, Nevada, June 2014  
Invited Lecturer: USC Ostrow School of Dentistry Symposium 2014, Los Angeles, California, June 2014  
Invited Lecturer: IV World Congress of Minimally Invasive Spine Surgery and Techniques 2014, Paris, France, June 2014  
Invited Lecturer: 4th Annual International Vision Restoration: Regenerative Medicine in Ophthalmology, Pittsburgh, PA, June 2014  
Organizer and Lecturer: 7th Annual Business Education Course: The Business of Regenerative Medicine: New Therapies, New Models, Centre for Commercialization of Regenerative Medicine. Toronto, ON, July 2014  
Invited Lecturer: Human Longevity, Inc. San Diego, CA, July 2014.  
Invited Lecturer: 22nd Annual Tissue Engineering Course; Rice University. Houston, Texas, August 2014  
Organizer and Lecturer: NCRM Cancer Stem Cell Conference, Cleveland, Ohio August 2014  
Invited Lecturer: 25th Annual North American Menopause Society, Washington, DC, October 2014  
Invited Lecturer: American Society of Nephrology Kidney Week 2014, November 2014

### **2015**

Invited Lecturer: Neurology Department, Case Western Reserve University, Cleveland, OH, January 2015  
Invited Lecturer: NCRM Retreat, Case Western Reserve University, Cleveland, OH, March, 2015 (RENEW)

## **RESEARCH SUPPORT**

- Invited Lecturer: Symposium on Advanced Wound Care (SAWC), San Antonio, TX, May 2015  
Organizer: 14th Annual Cell-Based Therapies and Tissue Engineering Short Course (CTTE). Case Western Reserve University; Cleveland, OH, May, 2015  
Invited Lecturer: 2015 Mini Medical School, Case Western Reserve University, Cleveland, OH, May, 2015  
Invited Lecturer: 22nd Annual Park Synagogue University Day, Cleveland Heights, Ohio, May, 2015  
Invited Lecturer: ICRS International Meeting, Chicago, IL, May, 2015  
Invited Lecturer: The Orthobiologic Institute 6th Annual PRP & Regenerative Medicine Symposium, Las Vegas, Nevada, June 2015  
Invited Lecturer: XX Colegio Mexicano de Especialistas en Ginecología y Obstetricia (COMEGO), (3 lectures), Mexico City, Mexico, June 2015  
Organizer and Lecturer: 8th Annual Business Education Course: The Business of Regenerative Medicine: Cells at Work, Georgia Institute of Technology. Atlanta, GA, July 2015  
Organizer and Lecturer: MSC15, Regenerative Medicine & Adult Stem Cell Therapy International Meeting; Cleveland, Ohio, August, 2015.  
Invited Lecturer: 23rd Annual Tissue Engineering Course; Rice University. Houston, Texas, August 2015  
Invited Lecturer: II Joint Preservation Congress (2 lectures), Warsaw, Poland September 2015  
Invited Lecturer: 2015 4<sup>th</sup> TERMIS World Congress, Boston, MA, September 2015  
Invited Lecturer: Alliance for the Advancement of Cellular Therapies Chicago Conference, Chicago, IL, September 2015  
Invited Lecturer: ISCT South and Central America 2015 Regional Meeting (3 lectures), Santiago, Chile, October 2015  
Invited Lecturer: Eastside Conversations, CWRU Siegal Lifelong Learning Ctr. Cleveland, OH, November 2015  
Invited Lecturer: Department of Cell Biology, University of Virginia, Charlottesville, VA November 2015  
Invited Lecturer: American Society of Regional Anesthesia and Pain Medicine, Miami, FL, November 2015  
Invited Lecturer: Global Men's Health Summit, Panama City, Panama, December 2015  
Invited Lecturer: World Stem Cell Summit, Atlanta, Georgia, December 2015  
Invited Lecturer: Institute of Advanced Biomedical Engineering and Science, Tokyo Women's Medical University, Tokyo, Japan, December 2015
- 2016**
- Invited Lecturer: Department of Orthopedics, Virginia Commonwealth University, Richmond, VA, January 2016  
Invited Lecturer: Department of Pediatrics, Case Western Reserve University, Cleveland, OH, January 2016  
Invited Lecturer: Harvard Stem Cell Institute MSC Colloquium, Boston, MA, March 2016  
Invited Lecturer: Orthobiologics Consortium, Cedar Knolls, New Jersey, April 2016  
Invited Lecturer: American Association of Orthopaedic Medicine Annual Conference, Clearwater, Florida, April 2016  
Invited Lecturer: University of California, Davis Department of Orthopaedic (Grand Rounds), Davis, CA April 2016  
Invited Lecturer: 9th Symposium on Biologic Scaffolds for Regenerative Medicine, Napa, California, April 2016  
Organizer: 15th Annual Cell-Based Therapies and Tissue Engineering Short Course (CTTE). Case Western Reserve University; Cleveland, OH, May, 2016  
Invited Lecturer: 89th Annual Meeting of the Japanese Orthopaedic Association, Yokohoma, Japan, May 2016.  
Invited Lecturer: Stem Cells in Medicine Conference, Panama City, Panama, May 2016.  
Invited Lecturer: The Orthobiologic Institute 7th Annual PRP & Regenerative Medicine Symposium, Las Vegas, Nevada, June 2016  
Invited Lecturer: 1st International Autologous Micro Fractured and Purified Adipose Tissue Graft Summit, Hangzhou, China, June 2016.  
Organizer and Lecturer: 9th Annual Business Education Course: The Business of Regenerative Medicine: How To Build A Company, Harvard Stem Cell Institute, Boston, MA July 2016  
Invited Lecturer: IV SOLCEMA Latin American Stem Cell Congress Santiago, Chile, July 2016  
Invited Lecturer: National Youth Sports Health and Safety Institute and the American College of Sports Medicine "Innovation Think Tank" Vail, CO August 2016.  
Invited Lecturer: 2nd Vail Scientific Summit on Regenerative & Translational Medicine, Vail, CO, August 2016  
Invited Lecturer: 24th Annual Tissue Engineering Course; Rice University. Houston, TX, August 2016  
Invited Lecturer: Karolinska Institutet, Hematology/Oncology, Stockholm, Sweden, September 2016

## RESEARCH SUPPORT

Invited Lecturer: 3<sup>rd</sup> Cancer Stem Cell Conference, Cleveland, Ohio, September 2016  
Invited Lecturer: 13th ICRS World Congress, Sorrento-Naples, Italy, September 2016  
Invited Lecturer: SIGASCOT 2016 International Congress, Florence, Italy, September 2016  
Invited Lecturer: First Inter American Regenerative and Cellular Medicine Conf., Havana, Cuba, October 2016  
Invited Lecturer: Biochemistry Department, Case Western Reserve University, Cleveland, OH, November 2016  
Invited Lecturer: 7th North American Veterinary Regenerative Medicine Association (NAVRMA) Conference, Amelia Island, FL, November 2016  
Invited Lecturer: 2016 World Stem Cell Summit, West Palm Beach, FL, December 2016

### 2017

Invited Lecturer: Interventional Orthopedics Foundation Meeting, Denver Colorado, February 2017  
Invited Lecturer: Menorah Park, CWRU Siegal Lifelong Learning Ctr. Cleveland, OH, March 2017  
Invited Lecturer: Regenerative Medicine Workshop, Hilton Head, SC, March 2017  
Invited Lecturer: Kenyatta National Hospital, College of Health Sciences, Nairobi, Africa, March 2017  
Invited Lecturer: University Hospitals Cleveland Medical Center, Urology Institute, Cleveland, OH, April 2017  
Invited Lecturer: I International Congress on Regenerative Medicine, San Jose, Costa Rica, April 2017  
Invited Lecturer: Whitetulip Cleveland Medical Forum, Cleveland, OH, April 2017  
Invited Lecturer: Stanford University School of Medicine (TOPS), Stanford, CA April 2017  
Invited Lecturer: Isokinetic Conference Barcelona, Spain, May 1 2017  
Organizer and Lecturer: 16th Annual Cell-Based Therapies and Tissue Engineering Short Course (CTTE). Case Western Reserve University; Cleveland, OH, May, 2017  
Invited Lecturer: Departments of Periodontics and Biological Sciences, Case Western Reserve University, Cleveland, OH, June 2017  
Invited Lecturer: The King's Fund, London, England, June 2017  
Invited Lecturer: ICRS Heritage Summit, Gothenburg, Sweden, June 2017  
Organizer and Lecturer: 10th Annual Business Education Course: The Business of Regenerative Medicine: Leadership, Innovation & Entrepreneurship, Centre for Commercialization of Regenerative Medicine; Toronto, ON, July 2017

Invited Lecturer: Hospital Zambrano Hellion TecSalud; Monterrey, Mexico, August 2017  
Invited Lecturer: 22nd Annual Budapest Pain Conference; Budapest, Hungary, August 2017  
Invited Lecturer: 25th Annual Tissue Engineering Course; Rice University. Houston, TX, August 2017  
Invited Lecturer: 4th Joint Preservation Congress; Warsaw, Poland, September 2017  
Invited Lecturer: 2017 Organ Transplantation Academic Conference; Wuhan, China, October 2017

### 2018

Invited Lecturer: World Stem Cell Summit; Miami Florida, January 2018  
Invited Lecturer: Phacilitate Leaders Forum; Miami, Florida, January 2018  
Invited Lecturer: 4<sup>th</sup> Annual Perinatal Stem Cell Society Congress; Salt Lake City, Utah, February 2018  
Invited Lecturer: The Medical Association of the Bahamas 46th Annual Scientific Conference; Nassau, Bahamas, March 2018  
Invited Lecturer: American Society of Interventional Pain Physicians 20th Annual Meeting; Orlando, FL, March 2018  
Invited Lecturer: 2nd Annual INBRE Distinguished Lecture Series, Winthrop University; Rock Hill, SC April 2018  
Invited Lecturer: 2nd Regenerative Medicine Symposium, San Jose, Costa Rica, April 2018  
Invited Lecturer: International Society for Cellular Therapy (ISCT), Montreal, Canada, May 2018  
Invited Lecturer: 9th World Congress of the World Institute of Pain (WIP), Dublin, Ireland, May 2018  
Invited Lecturer: Trinity College, Department of Orthopedics, Dublin, Ireland, May 2018  
Organizer and Lecturer: 17th Annual Cell-Based Therapies and Tissue Engineering Short Course (CTTE). Case Western Reserve University; Cleveland, OH, May 2018  
Invited Lecturer: The Orthobiologic Institute (TOBI); Wynn, Las Vegas, June 2018  
Organizer and Lecturer: 11th Annual Business Education Course: The Business of Regenerative Medicine: Innovation, Clinical Translation & Entrepreneurship, Centre for Commercialization of Regenerative Medicine; Philadelphia, PA, July 2018  
Invited Lecturer: Jefferson Medical School, Orthopedics, Philadelphia, PA, July 2018  
Invited Lecturer: ESPCR Stem Cell Conference, Cairo University, Alexandria, Egypt, July 2018  
Invited Lecturer: 26th Annual Tissue Engineering Course; Rice University. Houston, TX, August 2018  
Invited Lecturer: 4th Cancer Stem Cell Conference; Cleveland, Ohio, August 2018  
Invited Lecturer: 23rd Annual Gabor Racz Advanced Interventional Budapest, Pain Conference and Workshop;

## RESEARCH SUPPORT

Budapest, Hungary, August 2018

Invited Lecturer: Washington University School of Medicine, St. Louis MO, October 2018

Invited Lecturer: Indiana University School of Medicine, Indianapolis, IN, October 2018

Invited Lecturer: American Orthopaedic Society for Sports Medicine (AOSSM), Rosemont, IL, October 2018

Invited Lecturer: American College of Rheumatology 2018 National Convention, Chicago, IL, October 2018

Invited Lecturer: 21<sup>st</sup> Annual Pain Symposium, Anesthesia Pain Care Consultants, Fort Lauderdale, FL, October 2018

Invited lecturer: Indiana University Purdue University of Indianapolis, Indianapolis, IN, October 2018

Invited Lecturer: Cedars-Sinai Kerlan-Jobe Institute, Santa Monica, CA, November 2018

Invited Lecturer: Royal Society of Medicine, Orthopedics Today, London, England, December 2018

Invited Lecturer: Humanitas University, Regenerative medicine in Orthopedics, Milan, Italy, December 2018

Invited lecturer: International Cartilage Regeneration & Joint Preservation Society (ICRS), Milan, Italy, December 2018

### 2019

Invited Lecturer: Int'l Cartilage Regeneration & Joint Preservation Society, San Diego, CA January 2019

Invited Lecturer: 32<sup>nd</sup> Annual Meeting of Japanese Cartilage Metabolism Society, Osaka, Japan February 2019

Invited Lecturer: American Academy of Pain Medicine 2019 Annual Meeting, Denver, Colorado, March 2019

Invited Lecturer: Terapie Cellulari E Malattie Neurodegenerative, Bologna, Italy, April 2019

Invited Lecturer: American Medical Society for Sports Medicine Inaugural Regenerative Medicine Summit, Houston, TX, April 2019

Organizer and Lecturer: 18th Annual Cell-Based Therapies and Tissue Engineering Short Course (CTTE). Case Western Reserve University; Cleveland, OH, May 2019

Invited Lecturer: The Orthobiologic Institute (TOBI) 10th Annual PRP & Regenerative Medicine Symposium; Chicago, IL, June 2019

Invited Lecturer: 11th Int'l Society for Applied Biological Sciences (ISABS), Split, Croatia, June 2019

Invited Lecturer: Congress of the International Association of Pediatric Dentistry, Cancun, MX July 2019

Organizer and Lecturer: 12th Annual Business Education Course: The Business of Regenerative Medicine: Defining and Creating Value, Boston, MA, July 2019

Invited Lecturer: 26th Annual Tissue Engineering Course; Rice University. Houston, TX, August 2019

Organizer and Lecturer: 50<sup>th</sup> Year Symposium, Case Western Reserve Univ., Cleveland, OH, September 2019

Invited Lecturer: The Medical Scientist Training Program Distinguished Lecture Services University of California; Irvine CA, September 2019

Invited Lecturer: SoCal Annual Cell & Gene Therapy Conference, Newport Beach, CA, October 2019

Invited Lecturer: ON Foundation/ONstage, Switzerland, October 2019

Invited Lecturer: Texas Pain Society 11th Annual Scientific Conference, San Antonio, TX, October 2019

Invited Lecturer: 2<sup>nd</sup> Annual Health Span Hawaii Summit, Honolulu, HI, November 2019

Invited lecturer: American Academy of Oral Medicine Fall Meeting, Cleveland Clinic, Cleveland, OH, November 2019

Invited Lecturer: 6<sup>th</sup> International Joint Preservation Congress, Warsaw, Poland, December 2019

Invited Lecturer: A4M Regenerative Medicine Workshop, Venetian, NV, December 2019

### 2020

Invited Lecturer: Phacilitate Leaders World and World Stem Cell Summit, Miami FL, January, 2020

Invited Lecturer and Participant: Biologic Association Annual Meeting (Think Tank & Lecture), Carlsbad, CA February 2020

Invited Lecturer: Interventional Orthopedics Foundation (IOF) 5th Annual Scientific Meeting, Bloomfield, CO February 2020

Invited Lecturer: American Academy of Pain Medicine (AAPM) 36<sup>th</sup> Annual Meeting, National Harbor, MD, February 2020

Invited Lecturer: ON Foundation, Monthly Webinar, Luzern, Switzerland, May 2020

Invited Lecture: Immunology & Immunotherapeutics Committee, Webinar, Case Western Reserve University, July, 2020

Invited Lecturer: International Asian Pacific Association of Surgical Tissue Banks (APASTB), Indonesia, Airlangga Webinar Conference Series. June 2020

Invited Lecturer: International Asian Pacific Association of Surgical Tissue Banks (APASTB), Indonesia, Airlangga Webinar Conference Series. July 2020

Organizer and Lecturer: 19th Annual Cell-Based Therapies and Tissue Engineering Short Course (CTTE Webinar). Case Western Reserve University; Cleveland, OH, August 2020

Invited Lecturer: Arthritis Foundation OACS Forum Series, Webinar, September 2020

## RESEARCH SUPPORT

Invited Lecturer: International Cartilage Regeneration & Joint Preservation Society (ICRS) Virtual Conference, October 2020

Invited Lecturer: Stem Wars II: International Symposium Webinar, Bologna, Italy, October, 2020

Invited Lecturer: Cedars-Sinai Symposium on Translation Medicine and Biomanufacturing, Webinar, Los Angeles, CA, November 2020

Invited Lecturer: American Academy of Orthopedic Medicine (AAOM) 2020 Virtual Conference Series, Denver, CO, December 2020

### 2021

Invited Lecturer: Student Society for Stem Cell Research (SSSCR), Opening Speaker, Virtual Conference, Toronto, CA, March 2021

Invited Lecturer: Joint Preservation Congress, Cartilage Repair Webinar, Keynote Speaker, Virtual Conference, Warsaw, Poland, March 2021

Invited Lecturer: Asian Pacific Association of Surgical Tissue Banks (APASTB), Virtual Conference, Univertias Airlangga, Indonesia, March 2021

Invited Lecturer: 5th Grade Middle School, Virtual Science Lecture. Orange School System, Pepper Pike, OH, April 2021

Invited Lecturer: April 10, 2021. Regenerative Medicine Webinar. "The New MSC". Warsaw, Poland, April 2021

Invited lecturer: CryoVida Webinar Use and Management of Mesenchymal Stem Cells, Virtual Conference, Mexico City, MX, April 2021

Organizer and Lecturer: 20th Annual Cell-Based Therapies and Tissue Engineering Short Course (CTTE). Case Western Reserve University; Virtual Conference, Cleveland, OH, May 2021

Invited Lecturer: World Stem Cell Summit and WFIRM/RMF Annual Regenerative Medicine Essentials Summer Course, Virtual Conference, June 2021

Invited Lecturer: AOSSM-AANA Combined 2021 Annual Meeting. Biologic Association 2nd Annual Summit, Nashville, Tennessee, July 2021

Invited Lecturer: 28th Annual Advances in Tissue Engineering Short Course, Rice University, Virtual Conference, August 2021

Invited Lecturer: 6th Annual Vail Scientific Summit, Vail, CO, August 2021

Invited Lecturer: Advanced Regenerative Medicine Institute (ARMI) EVOLVE 2021 Advanced Courses, Salt Lake City, UT, September 2021

Invited Lecturer: Robert M. Nerem Symposium, Georgia Tech, Atlanta, GA September 2021

Invited Lecturer: 12th Annual Orthobiologics Symposium (TOBI) Virtual Conference, October 2021

Invited Lecturer: 18th Annual International Federation for Adipose Therapeutics and Science (IFATS) Fort Lauderdale, FL, November 2021

Invited Lecturer: 6th International Cartilage Regeneration & Joint Preservation Society (ICRS), Joint Preservation Symposium, Miami, Florida, November 2021

## RESEARCH SUPPORT

### PAST SUPPORT (as Principal Investigator)

#### National Institutes of Health

<b>HD-07209</b> ; May 1974 through May 1977 .....	\$120,000
<b>AM-17110</b> ; Program Project; September 1973 through September 1979.....	\$ 13,000/annum
<b>DE-72403</b> ; July 1977 through July 1980.....	\$ 51,000
<b>HD-13016</b> ; October 1979 through 1982.....	\$ 38,000/annum
<b>GM-25743</b> ; EM Equipment Grant 1980-1983 .....	\$150,000
<b>AG-02921</b> ; Program Project; 1982 through July 1992.....	\$250,000/annum
<b>DE-04008</b> ; July 1978 through February 1995 .....	\$120,000/annum
<b>AR-40990</b> ; February 1992 through January 1998 .....	\$139,000/annum
<b>AG-11331</b> ; <b>June</b> 1992 through May 1998.....	\$210,000/annum
<b>AR37726</b> ; December 1989 through November 1999 .....	\$336,768
<b>AG08932</b> ; October 1989 through November 1999 .....	\$250,742
<b>DE07220</b> ; March 1993 to February 1998 (June 2001 to May 2003) .....	\$244,004
<b>T32-AG00105-20</b> Cellular and Molecular Aging Training Grant Originally funded in 1984, now through April 2006.....	\$215,000/annum

**RESEARCH SUPPORT**

**T32 GM-085056**; Training Grant in Cellular and Molecular Biology; Co-Principal Investigator; July 1975 through 1991.

**T32 AG-00105** (AI Caplan, P.I.); "Cellular and Molecular Aging Training Grant;" 5% effort; July 1995 to April 2000 (April 2002 to April 2005) .....\$214,850 (originally funded in 1984)

**R01-DE13740** (D Dean, P.I., AI Caplan, Co-P.I.) "Strength and Resorption of Biodegradable Skull Implants" 5% effort, February 2002 to January 2005).

**R01-AR48316-01** (AI Caplan, PI, JE Dennis, Co-PI) "Targeted Progenitor Cell Engraftment;" 20% effort September 2001 through July 2006.....\$237,500/annum

**R01-AR049785** (JE Dennis, PI, AI Caplan Co-PI) "Targeted Cellular Repair of Articular Cartilage" June 2004 through May 2009.....\$41,695

**R01-DE015322-01A1** (JE Dennis, PI, AI Caplan Co-PI) "Tissue Engineering of Cartilage Subtypes" August 2004 through July 2009 .....\$1,816,875

**R01-DE015322-01A1** (JE Dennis, PI, AI Caplan Co-PI) "Tissue Engineering of Cartilage Subtypes" August 2004 through July 2010 .....\$1,816,875

**R01-AG021542-01A2** (AI Caplan, PI, DA Carrino Co-PI) "A Window into the Aging Process: Skin Proteoglycans". July 2005 through June 2010 .....\$1,912,500

**R01-AR050208-01** (JF Welter, PI, AI Caplan Investigator) "Engineering cartilage; an approach to joint repair" April 2005 through March 2010. ....\$15,000/Yr.

**R01-DE016887** (J Elisseff, AI Caplan Investigator) "Tissue Engineering in Congenital Craniofacial Defects" July 2007 through May 2011. ....\$25,000/Yr.

**TECH09-006** (AI Caplan, PD) "Treatment of Acute and Chronic Wounds with Tissue Engineering Strategies" August 2008 through June 2011 .....\$107,190

**S1072764** (AI Caplan, PD) Armed Forces Institute for Regenerative Medicine (AFIRM) March 2008 through June 2010.....\$302,562

**R01-DE13740** (D Dean, PI, AI Caplan Investigator) "Strength and Resorption of Biodegradable Skull Implants" July 2007 through May 31, 2012. ....\$28,000/Yr.

**MTF0213MS** (M Siemionow, PI; AI Caplan, Co-PI) Novel Human Allograft Epineural Conduit for Restoration of Long Nerve Defects. February 01, 2013-February 31, 2014 .....\$26,226

**P01-AR053622** (AI Caplan, PI, D Correa, Co-PI) Program Project Grant Project II Tissue Engineered Cartilage Repair. August 15, 2008 through July 31, 2014.....\$135,246

**P01-AR053622** (AI Caplan, PI, V. Goldberg Co-PI) Program Project Grant Core A Tissue Engineered Cartilage Repair. August 15, 2008 through July 31, 2014.....\$83,844

**R01-EB020367-01** (AI Caplan, PI) CWRU Center for Multimodal Evaluation of Engineered Cartilage July 1, 2014 through June 30, 2016 .....\$815,117

**R01-CA163562** (AI Caplan, PI, D Correa, Co-PI) Bone Marrow MSCs/Pericytes: Gatekeepers Controlling Skeletal Metastasis. August 23, 2012 through July 31, 2017 .....\$315,367

**W81XWH-14-2-0004** (A Atala, PI) DoD, Armed Forces Institute for Regenerative Medicine II CF-03: Craniomaxillofacial Tissue Engineered Bone Grafts 07/30/2013-12/31/2019 (no cost extension) \$207,195

**CON211741** (T Bonfield, PI) Optimization of MSCs to Treat Microbacterium Avium Complex in Patients with Chronic Bronchiectasis or Interstitial Pulmonary Fibrosis July 1, 2016 through June 30, 2019 (no cost extension) ..... \$288,687

**Muscular Dystrophy Association**

January 1975 through July 1996:

Yearly grants of ..... \$16,000-\$65,000

**Osiris Therapeutics, Inc.:**

"Metabolic Bone/Joint Disease" January 1995 to July 1999 (yearly grants of \$100,000 to \$200,000).

**Veterans Administration** (University of Cincinnati); "Cell-Assisted Tendon

Repair with Aging;" (August, 1998 to July, 1999)..... \$15,500

**Electric Power Research Institute Inc.**

**EPRI/UBP900424** "Biomimetic Approaches to

New Designs for Brittle Laminates;" with Dr. Arthur Heuer (July, 1996 to Dec. 1999 .....\$724,019

**Department of Energy**

## **RESEARCH SUPPORT**

Through Battelle Pacific Northwest Laboratories, an RFP to the Skeletal Research Center; "Development of New Ceramic/Polymer Composites." Co-Principal Investigator with Dr. Arthur Heuer; July 1, 1988 to September 30, 1991 (with four CWRU laboratories).....\$595,000

### **National Science Foundation**

1970 through June 1973.....\$ 38,000  
DCM76-23672; July 1977 through December 1979 .....\$ 60,000

### **American Cancer Society**

1971 through June 1973.....\$ 62,500  
VC-162; July 1974 through July 1976.....\$ 80,000

### **National Foundation (March of Dimes)**

I-401; July 1975 through July 1981 .....\$210,000

### **The Kroc Foundation**

July 1, 1982 through June 30, 1984 .....\$ 80,000  
Endowment Gift for Arthritis Research (with Dr. Roland Moskowitz)  
Lectureship and travel support; April 1985 .....\$ 50,000

### **Anna Fuller Fund for Cancer Research**

1970 through September 1973.....\$ 17,000

### **BARD**

U.S.-Israel Binational Agricultural Research and Development Fund  
Project No. IS-2679-96; "Extracellular Matrix Molecules of the Eggshell as Related to Eggshell Quality;" (June, 1997 to June 2000).....\$155,000

### **STATE OF OHIO**

Clinical Tissue Engineering Center (CTEC) (AI Caplan, Co-PI) BRTT State of Ohio.  
August 2008 through June 2012. ....\$50,000

## **PAST INDUSTRIAL SUPPORT**

Genentech, Inc.; Syntex, Inc.; Robapharm, Inc.; Marion Merrill Dow, Inc.; DePuy, Inc.; Zimmer, Inc.; Kourion Therapeutics, Inc.; L'Oreal; Wright Medical Technology; Fidia Advanced Biopolymers; BioMimetic Therapeutics, Inc.

## **PRESENT SUPPORT (2020)**

### **NATIONAL INSTITUTES OF HEALTH**

1R01CA251612-01 (AI Caplan, PI) Role of Perivascular Mesenchymal Stem Cells (pMSCs) in the Bone Marrow Niche and the Extracellular Matrix in the Control of Skeletal Metastasis  
September 1, 2020 – May 31,2025 .....\$368,288

1P41EB021911-01 (AI Caplan, PI) CWRU Center for Multimodal Evaluation of Engineered Cartilage  
June 1, 2016 through March 31, 2021 .....\$1,284,459

1P41EB021911-03S1 (AI Caplan, PI) Administrative Supplement to CWRU Center for Multi-Modal evaluation of Engineered Cartilage September 1, 2018 through March 31, 2021 .....\$234,000

### **OTHER RESEARCH SUPPORT**

L. David and E. Virginia Baldwin Program for Cell Therapy  
October, 2007 to Present ....\$2,654,300

L. David and E. Virginia Baldwin COVID-19 Project  
June, 2020 to Present.....\$294,509



## COLLABORATIVE FACULTY- Continued

### GRADUATE STUDENTS, POSTDOCTORAL FELLOWS AND OTHER PROFESSIONALS

#### PAST

1. **James H. Kimura**, Ph.D.; Graduate Student, degree 1976; was Professor of Orthopedics, Joint and Bone Center, Henry Ford Hospital until 2002, now retired, Detroit, Michigan.
2. **Martin J. Rosenberg**, Ph.D.; Postdoctoral Fellow, 1972-1974; now Executive Officer, Department of Biology, Case Western Reserve University, Cleveland, Ohio.
3. **Jeffrey Saffitz**, M.S., Ph.D., M.D.; Graduate Student, degree 1978; now Professor, Pathology Department, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA.
4. **Anna Palka**, M.S.; Graduate Student, degree 1977; was a Research Technician, National Institutes of Health, Bethesda, Maryland.
5. **Philip Osdoby**, Ph.D.; Graduate Student, degree 1978/Arthritis Foundation Fellow 1979-1981; now Professor, Department of Biological Science, Washington University, St. Louis, Missouri.
6. **Charles P. Ordahl**; Postdoctoral Fellow, 1975-1978; now Professor, Department of Anatomy, University of California School of Medicine, San Francisco, California.
7. **Karen Glasier**; Postdoctoral Fellow, 1977-1979; now Pharmaceutical Company Representative, Cleveland, Ohio.
8. **David A. Carrino**, Ph.D.; Postdoctoral Fellow, 1979-1980; now Senior Research Associate, Department of Biology, Case Western Reserve University, Cleveland, Ohio.
9. **Gail Yander**, Ph.D.; Postdoctoral Fellow, 1979-1980; was Researcher, Eastman Kodak Company, Rochester, New York.
10. **Mary C. Martini**, M.S.; Graduate Student, 1980; now in private medical practice and affiliate of University Medical Center, Pittsburgh, Pennsylvania.
11. **Hue-Lee Kaung**, Ph.D.; sabbatical Visiting Professor, 1980-1981; now in Department of Pediatrics, Case Western Reserve University, Cleveland, Ohio.
12. **Larry W. Fisher**, Ph.D.; Postdoctoral Fellow, 1980-1981; now Staff Scientist at National Institutes of Health, Bethesda, Maryland.
13. **Susan J. Hunter**, Ph.D.; Postdoctoral Fellow, 1980-1981; now Professor, Department of Zoology, University of Maine, Orono, Maine.
14. **Jeffrey A. MacCabe**, Ph.D.; sabbatical Visiting Professor, June-September 1981; now Professor, Department of Zoology, University of Tennessee, Knoxville, Tennessee.
15. **Barry W. Cherney**, Ph.D.; Graduate Student, degree 1984; was Staff Scientist, FDA, Washington, D.C.
16. **Zvi Nevo**, Ph.D.; sabbatical Visiting Professor, July-October 1983; now Professor and Chair, Department of Chemical Pathology, Tel-Aviv University, Israel.
17. **Gerry Beaudoin**, Ph.D.; Research Associate, 1982-1984; was Staff Scientist, Avery Corporation.
18. **Ronald J. Midura**, Ph.D.; Graduate Student, degree 1984; now Staff Scientist, Section of Musculoskeletal Biology, Dept. of Biomedical Eng., The Cleveland Clinic Foundation, Cleveland, Ohio.
19. **Deborah E. Hall**, Ph.D.; Graduate Student, degree 1985; was Research Scientist, Department of Anatomy, University of California at San Francisco, San Francisco, California; now free-lance writer.
20. **Michael Weitzhandler**, Ph.D.; Graduate Student, degree 1985; was Research Scientist, Dionex Corporation, Sunnyvale, California.
21. **Carol Cooper**, Ph.D., M.D.; Graduate Student, degree 1985; was Ophthalmologist, Shokoohi Eye Center, Midland, Michigan .
22. **Ellen J. Matzkin**, M.D.; Postdoctoral Fellow, 1985-1986; now in private medical practice in New York.
23. **Uri Oron**, Ph.D.; sabbatical, 1985-1986; now Professor in Zoology at Tel-Aviv University, Tel-Aviv, Israel.
24. **Stephen E. Haynesworth**, Ph.D.; Graduate Student, degree 1987 (1988-1992 as Senior Research Associate); now Associate Professor and Associate Dean, College of Arts and Sciences, Department of Biology, Case Western Reserve University, Cleveland, Ohio.
25. **Hajime Ohgushi**, M.D.; Postdoctoral Fellow, 1985-1987; now Team Leader & Research Head, Tissue Engineering Research Center, Amagasaki City, Hyogo, Japan
26. **David G. Pechak**, Ph.D.; Postdoctoral Fellow/Senior Research Associate, 1981-1987; now Research Scientist, Kraft Foods, Chicago, Illinois.
27. **Mary J. Kujawa**, Ph.D., M.D.; Postdoctoral Fellow, 1983-1987; now Psychiatry, Atlanta, Georgia.
28. **Terry Rabinowitz**, D.D.S., M.D.; Visiting Assistant Professor, 1983-1986; now Associate Professor of Psychiatry, Fletcher Allen Healthcare, Burlington, VT.
29. **Glenn T. Syftestad**, Ph.D.; Postdoctoral Fellow, Research Associate/Research Scientist, 1981-1987; was Associate Professor, Department of Orthopaedics, University of California, Davis, California.

## COLLABORATIVE FACULTY- Continued

30. **Paul A. Lucas**, Ph.D.; Postdoctoral Fellow, 1984-1987; now Director of Orthopaedic Research, Department of Orthopaedics, New York Medical College, Val Halla, New York.
31. **Henry E. Young**, Ph.D.; Postdoctoral Fellow, 1983-1987; now Professor, Mercer Medical School, Macon, Georgia.
32. **Danny Gazit**, Ph.D., D.D.S.; CIBA Bursury, 1987; now Professor at Hebrew University/Hadassah Medical Center, Jerusalem, Israel.
33. **Samuel Itay**, M.D.; Visiting Scientist, 1986-1988; was Department of Orthopaedics, Beilinson Hospital, Petach Tikva, Israel.
34. **Jun Goshima**, M.D.; Visiting Scientist, 1987-1989; was Assistant Professor, Department of Orthopaedics, Nara Medical University, Nara, Japan.
35. **Haruhiko Nakahara**, M.D.; Visiting Scientist, 1987-1989; was Department of Orthopaedics, Osaka University Medical School, Osaka, Japan.
36. **James H. Reese**, Ph.D.; Senior Research Associate, 1986-1989; was Senior Research Associate, Medical College of Ohio, Toledo, Ohio.
37. **Kazuo Watanabe**, Ph.D.; sabbatical Visiting Scientist, 1989-1990; now Professor, Department of Zoology, Hiroshima University, Hiroshima, Japan.
38. **Scott P. Bruder**, Ph.D.; M.D./Ph.D. Graduate Student, 1987-1990; now Sr. Vice President and Chief Technology Officer BD, Franklin Lakes, NJ.
39. **Marlene Willen**, M.D.; Postdoctoral Fellow, 1989-1990; was Dermatology Metrohealth Medical Center, Cleveland, Ohio.
40. **Naoto Ozawa**, M.D.; Visiting Scientist, 1990-1991; was Orthopaedic Surgeon, Yokohama City University, Yokohama, Japan.
41. **Tatsuhiko Goto**, M.D.; Visiting Scientist, 1989-1991; now Orthopaedic Surgeon and Associate Professor, National Defense Medical School, Tokyo, Japan.
42. **Osamu Nakamura**, Ph.D.; Visiting Scientist, 1989-1991; now Div. of Function. Mat. Sc. Kyushu Nat'l Indus. Res. Inst., Tosu Saga, Japan.
43. **Mohamed Rahima**, D.D.S.; collaborative Researcher, 1988-91; now in private practice, Chicago, Illinois.
44. **Stephen J. Pineda**, M.D.; Research Fellow, 1990-91; now Orthopaedic Surgery, University of Maryland Hospital, Baltimore, Maryland.
45. **Jose Luis Arias**, D.V.M.; sabbatical Visiting Scientist, 1989-1991; now Professor, School of Veterinary Science, University of Chile, Santiago, Chile.
46. **Linan Dong**, D.D.S.; Visiting Scientist, 1990-1991; Beijing Medical University, Beijing, People's Republic of China.
47. **Maria Soledad Fernandez**; visiting master's-degree candidate, 1989-1991; now Associate Professor at University of Chile, Santiago, Chile.
48. **Anne E. Linton**, M.D.; Research Fellow/Orthopaedic Surgery Resident, 1991-1992; was Addiction Psychiatry, Oregon Health Sciences University, Portland, Oregon.
49. **Shigeyuki Wakitani**, M.D.; Visiting Scientist, 1990-1992; now Associate Professor/Orthopaedic Surgeon, Osaka University Medical School, Osaka, Japan.
50. **Iri Liebergall**, M.D., Visiting Scientist, 1991-1992; now Professor of Orthopaedic Surgery, Hebrew University, Jerusalem, Israel.
51. **Juan Pablo Rodriguez**, Ph.D.; Postdoctoral Fellow, 1991-1992; now Associate Professor, University of Chile, Santiago, Chile.
52. **Richard F. Drushel**, Ph.D.; Graduate Student, 1987-1992; now Instructor, Department of Biology, Case Western Reserve University, Cleveland, Ohio.
53. **Toshihiro Sugihara**, M.D., Ph.D.; Visiting Scientist, 1991-1993; now Assistant Professor, St. Marianna University, Kawasaki, Japan.
54. **Tomoyuki Saito**, M.D., Visiting Scientist, 1991-1993; now Professor and Director, Department of Orthopaedic Surgery, Yokohama City University, Yokohama City, Japan.
55. **Yu Mochizuki**, M.D., Ph.D.; Visiting Scientist, 1991-1993; Surgeon, Department of Orthopaedics, Hiroshima University Hiroshima, Japan.
56. **Sara Sarig**, Ph.D., Sabbatical/Visiting Professor, 1992-1993; Professor, The Hebrew University of Jerusalem, Jerusalem, Israel (deceased).
57. **Bruce Greene**, M.D., Research Fellow and Resident/Department of Orthopaedics, 1992-1993; now in private practice, Ithaca, New York.
58. **Randell G. Young**, D.V.M.; Postdoctoral Fellow/Research Fellow (surgical models), 1989-1993; now Manager, Preclinical Studies, Osiris Therapeutics, Inc., Baltimore, Maryland.

**COLLABORATIVE FACULTY- Continued**

59. **Felix Ma**, Undergraduate Student, 1991-1994; now Resident, Hennepin County Medical Center, Minneapolis, Minnesota.
60. **Mehrun Elyaderani**, M.D., Research Fellow, 1993-1995; was Department of Orthopaedics, University Hospitals of Cleveland, Cleveland, Ohio.
61. **David J. Fink**, Ph.D., Adjunct Professor and Consultant, 1991-1995; was CEO/President of Biotech startup, Baltimore, Maryland.
62. **Pierre Cassiede**, Visiting Scholar, 1991-1995; now Laboratoire de recherche sur les matériaux d'intérêt biologique, Faculté de chirurgie dentaire. Nante, France.
63. **Leona M. Mann**, D.D.S., Graduate Student/Research Fellow, 1993-1995; now in private practice, Atlanta, GA.
64. **Christopher Walsh**, M.D., Postdoctoral Fellow, 1994-1995; was in Practice, Department of Orthopaedics, University Hospitals of Cleveland, Cleveland, Ohio.
65. **Kristina Siddall**, Undergraduate, CWRU, Summer 1994.
66. **Lukasz Curylo**, M.D., Postdoctoral Fellow, 1995-96, was Resident, Department of Orthopaedic, University Hospitals of Cleveland, Cleveland, Ohio.
67. **Glen Feltham**, M.D., Postdoctoral Fellow, 1995-96, was Resident, Department of Orthopaedic, University Hospitals of Cleveland, Cleveland, Ohio.
68. **Frederick Jacquot**, M.D., Visiting Scientist, 1995-96, now Chef de Clinique - Assistant, Department of Orthopaedic Surgery, Hospital Raymond Poincare, Garches France.
69. **Douglas Arm**, Ph.D., Postdoctoral Fellow 1995-96, now Researcher, Interpore Inc, San Diego, CA.
70. **Keigo Hanada**, Ph.D., Visiting Scientist, 1995-97, now Researcher at Kaken Industry, Tokyo, Japan.
71. **Keita Nishimura**, M.D., Visiting Scientist, 1996-97, now Researcher, University of Japan, Tokyo, Japan.
72. **James E. Fleming, Jr.**, M.D.; Graduate Student/Research Fellow, 1991-97, was Resident, Cleveland Clinic Foundation, Cleveland, Ohio.
73. **Traci G. Barthel**, M.D.; Research Fellow, 1996-97, was Resident, University Hospitals, Cleveland, Ohio.
74. **Barbara A. Huibregtse**, D.V.M., Postdoctoral Fellow/Research Associate, 1994-97, now Preclinical Manager, Boston Scientific Corp., Natick, Massachusetts.
75. **Emmanuel K. Konstantakos**, Undergraduate, 1995-1997, now Medical Student, CWRU.
76. **Randell Bateman**, 1997-1998, now resident, University of Minn., Minn, MN.
77. **Antonios Mikos**, Ph.D., Sabbatical/Visiting Professor, 1998, now Professor of Bioengineering and Chemical Engineering, Rice University.
78. **Magnus Lundberg**, M.D., Ph.D., Visiting Scientist, 1997-1998, now Attending Physician, University Hospital, Linkoping, Sweden.
79. **John Edminson**, Undergraduate Student, CWRU, 1996-1998, now Medical student, CWRU.
80. **Kukuji Yamashita**, D.D.S., Ph.D., Visiting Scientist, 1996-1998, now Associate Professor, First Department of Oral Anatomy, University of Tokushima, School of Dentistry, Tokushima, Japan.
81. **Neil Topham**, M.D., Research Fellow, 1997-1999, now Resident, Plastic Surgery, University Hospitals of Cleveland, Ohio.
82. **Maralyn B. Seavolt**, M.D., Postdoctoral Fellow, 1998-1999, was Resident, Dermatology, Cleveland Clinic Foundation, Cleveland, Ohio.
83. **Andreas Naumann**, M.D., Visiting Scientist, 1999-2000, now staff Doctor/Researcher, Munich, Germany.
84. **Laure Brinon**, Ph.D., Visiting Researcher, 2000-2001, now Project Manager, Dermal and Transdermal Systems. ETHYMED, Massy, France.
85. **Enrico Tognana**, Ph.D., Visiting Researcher, 2001, now Project Manager, Fidia Advanced Biopolymers Srl, Albano Terme, Italy.
86. **Hervé Pagon**, M.S., Visiting Researcher, 2000-2001, L'Oreal Recherche, France
87. **Tommi Tallheden**, Visiting Graduate Student, 2001-2002, now Göteborg University Faculty.
88. **Brian Drew**, M.D., Postdoctoral Fellow, 2001-2002, now Physician, Ear, Nose and Throat, Minneapolis, MN.
89. **Nir Cohen**, M.D., Visiting Researcher, 2001-2002, now Faculty, Department Orthopaedics, Tel Aviv University; Tel Aviv, Israel.
90. **Konrad Slynarski**, M.D., Visiting Researcher, 2001-2002, now Assistant Professor, Warsaw Poland.
91. **Wa'el Kafienah**, M.D., Visiting Researcher, 2002, now University of Bristol Academic Rheumatology, Bristol, United Kingdom.
92. **Mauro Fiorini**, Visiting Researcher, 2002-2003, now Researcher at Fidia Adv. Biopol., Srl, Albano Terme, Italy.

## COLLABORATIVE FACULTY- Continued

93. **Russell Wang**, D.D.S., Associate Professor, School of Dentistry, 2000-2003, now Case Western Reserve University, Cleveland, Ohio.
94. **Katsuhiro Nishioka**, M.D., Visiting Researcher, 2001-2004.
95. **Jizong Gao**, M.D., Ph.D., Research Associate 1998-2004, now with Zimmer Corporation, Austin, Texas.
96. **James Dennis**, Ph.D., Sr. Research Associate; 1988-2005, now Assistant Professor Orthopaedics at University Hospitals, Cleveland, Ohio.
97. **In-Hwan Song**, M.D., Ph.D., visiting researcher, South Korea, 2004-2005, now Associate Professor and Chairman Department of Anatomy, School of Medicine Yeungnam University, Daegu, South Korea.
98. **Daphne A. Bascom**, M.D., Ph.D., Assistant Professor Otolaryngology Surgery U.H./CWRU, 2002-2005, now Physician Director, Clinical Transformation, Cleveland Clinic Foundation.
99. **Yu-Han Chang**, Ph.D., visiting researcher, Taiwan, 2004-2006, now Attending Physician, Division of Adult Joint Reconstruction, Department of Orthopaedics, Chang Gung Memorial Hospital, Taipei, Taiwan.
100. **Karthik Karibandi**, BA non-designated graduate student, 2005-2006, now Medical Student.
101. **José A. Andrades**, Ph.D., Professor of Cell Biology University of Malaga, Malaga Spain visiting scientist, 2006.
102. **Andreas Winkel**, Ph.D., Postdoctoral fellow 2006-2007, now Postdoctoral fellow, Department of Prosthetic Dentistry, Hannover Medical School, Hannover, Germany.
103. **James (Jay) Henderson**, Ph.D., postdoctoral fellow, 2004-2008, now Assistance Professor Syracuse University.
104. **Sung-Eun Yang**, M.D., Ph.D., visiting researcher, South Korea, 2007-2008, now Assistant Professor Korean University, Seoul, S. Korea.
105. **Fozia Khan**, Ph.D., visiting researcher, 2008-2009, now Assistant Professor, King Saud University, Riyadh, Kingdom of Saudia Arabia.
106. **Durba Mukhopadhyay**, Ph.D.; cartilage repair/rheumatoid arthritis 2008-2009, now at Cuyahoga Community College.
107. **Jonathan Teets**, Medical Student 2009-2010.
108. **Robert M. Lowe**, M.D., Ph.D., rheumatoid arthritis 2009-2011.
109. **Luis A. Solchaga**, Ph.D., tissue engineering, 1994-2010, now Research Scientist at BioMeimetic, Nashville, Tennessee.
110. **Michael Haag**, M.S., 2003-2010. Director Licensing, Technology Transfer Office, Case Western Reserve University.
111. **Kitsie Penick**, BA, Research Assistant III, bioreactors, tissue engineering, 2010-2014. Department of Surgery, University of Arizona.
112. **David A. Carrino**, Ph.D.; 1979-2013. Chemistry Department, Case Western Reserve University.
113. **Paul Lin**, MD-Ph.D., 2005-2013. Medical Student, MD/PhD Program, Case Western Reserve University.
114. **Vance Holt, III**, Ph.D. 2008-2013. Department of Health and Human Science NIH/NIAMS, Bethesda, MD
115. **Steven Greenberg**, M.S., 2012- 2013. Clinical Researcher, Johns Hopkins University, Baltimore, MD.
116. **Lori Duesler**, Research Assistant III, bioreactors, tissue engineering, 2010-2014. Pathology Department, Case Western Reserve University.
117. **Asuman Bilgin**, B.S., 2011-2015. Research Assistant/Research Visitor. California Polytechnic State University-San Luis Obispo.
118. **Diego Correa**, M.D., Ph.D., rheumatoid arthritis 2009-2015.
119. **Obinna Ugwuegbu**, Undergraduate Student Case Western Reserve University, 2015-2016.
120. **Stephen Wang**, Undergraduate Student Case Western Reserve University, 2016-2017.
121. **Abdullah Osme**, M.D., Visiting scientist, gene expression studies 2016-17
122. **Donald P. Lennon**, D.D.S.; tissue culture, 1979-2017.
123. **Hulya Bukulmez**, M.D.; rheumatoid arthritis 2008-18. Metrohealth Medical Center, Cleveland, OH
124. **Maneesh Dave**, M.D.; stem cells and GI tract 2014-2019. Associate Professor, University of California at Davis, Davis, CA
125. **Zhihan Wang**, Undergraduate Student Case Western Reserve University, 2017-2020 now at McGill University, Montreal Quebec, Canada
126. **Yiyan Wang**, Undergraduate Student Case Western Reserve University, 2018-2020
127. **Pravallika Kesarla**, Undergraduate Student Case Western Reserve University 2019-2020
128. **Kevin Echelberry**, Undergraduate Student Case Western Reserve University 2019-2020
129. **Lori Duesler**, B.S., Research Assistant III (tissue engineering) 2016-2020
130. **Jaydah Robertson**, Undergraduate Case Western Reserve University 2019-2021

## **COLLABORATIVE FACULTY- Continued**

### **PRESENT SENIOR RESEARCH ASSOCIATES (as Laboratory Staff), Research Professors and Postdoctoral Fellows and Senior Staff**

1. **J. Michael Sorrell**, Ph.D.; monoclonal antibodies, 1990-
2. **Jean F. Welter**, M.D., Ph.D.; bioreactors, tissue engineering, 2004-
3. **Rodrigo Somoza**, Ph.D.; metastasis, cartilage tissue engineering, 2012-
4. **Jonathan Kenyon**, Ph.D.; stem cell, molecular biology 2015-
5. **Sayyed M. Motavalli**, Ph.D.; cartilage tissue engineering 2016-
6. **Miguel Fuentes Chandia**, PhD; 2021-

### **GRADUATE STUDENTS**

None

### **SUPPORT STAFF**

1. Amad Awadallah, Research Assistant III (histology), 2010-
2. Margie Harris, Research Assistant I (tissue culture), 1984-
3. Tammie Lee, Department Assistant III, 2007-

### **COLLABORATIVE FACULTY (Shared Resources)**

1. Stanton Gerson, M.D., Department of Medicine, Hematology/Oncology (Medical School)
2. Harihara Baskaran, Ph.D., Chemical Engineering (Engineering)
3. Tracey Bonfield, Ph.D., Pulmonary, Pediatrics (RBC)
4. Aaron Weinberg, Ph.D., Department of Biological Sciences (Dental School)
5. Adonis Hijaz, M.D., Urology Institute, (University Hospitals Case Medical Center)
6. Jianguo Cheng, M.D., Department of Pain Management and Neurosciences (CCF)

### **REVIEWER**

Developmental Biology, Science

Journal of Bone and Joint Surgery, Tissue and Cell

Journal of Cell Biology, Bone

Journal of Craniofacial Genetics, Connective Tissue Research Development

Clinical Orthopaedics and Related Research, Journal of Biomaterials Research

Cell Physiology, Experimental Cell Research

Differentiation, Journal of Biological Chemistry

Journal of Orthopaedic Research, Tissue Engineering

Cell Transplantation, Developmental Dynamics

Tissue Engineering and Regenerative Medicine

### **REVIEWER GRANTING AGENCIES**

National Science Foundation (ad hoc)

National Institutes of Health (ad hoc and site visits)

### **PAST ADVISORY BOARDS**

BioMedical Materials International Scientific Advisory Board. Mijdrecht, The Netherlands.

External Advisory Board of The Stem Cell Institute in Leuven. Leuven, Belgium.

### **UNIVERSITY COMMITTEES\***

1. University Restructuring and Strategic Planning Committee, 1986-1987.
2. Faculty Senate Research Committee, 1984-1986.

## **COLLABORATIVE FACULTY- Continued**

3. Case Institute Strategic Planning Committee, 1985-1986.
  4. President's Committee for the Biological Sciences, 1985-1986.
  5. Dean's Committee for Tenure and Promotion, 1984-1985.
  6. President's Committee for Tenure and Promotion, 1981-1988.
  7. University Hospitals Strategic Planning Task Force, 1988.
  8. Chairmen's Search Committee, Orthopaedics, University Hospitals, 1989.
  9. Provost's Committee on Continuing Education, 1989.
  10. Faculty Senate Research Committee, 1990-1993.
  11. University Hospitals Biotechnology Committee, 1991-1994.
- \*Committee assignments are no longer recorded (1995-present).**

## **TEACHING EXPERIENCE** (1968-1992; teaching activities are no longer recorded.)

### **Case Western Reserve University**

1. Biology Core Curriculum (4th semester), Spring. Course is referred to as "Organismal Biology." I taught about one-third of the lectures where I tried to expose students to the events involved in organ formation so that the rest of the course could cover organ and whole animal physiology.
2. "Theories in Aging": An option course for medical students. I am responsible for one week's material.
3. Seminar in Advanced Developmental Biology. A weekly meeting of undergraduate, graduate and medical students interested in selected research topics in Developmental Biology.
4. Correlated Curriculum in Cellular and Molecular Biology. A year-long multidiscipline graduate course, which was taken by all of the student in the Cellular and Molecular Biology Program plus other incoming graduate students. This course was: 7 contact hours/week and had 25 to 45 graduate students from all of the preclinical departments of the Medical School and several departments from the undergraduate school. I have given lectures on Chromatin and Connective Tissue Biochemistry and Molecular Development.
5. Initiated an introductory Biology course designed for engineering and science students called, "Biological Molecules." This course attempts to introduce basic concepts in Biology (evolution, genetics, etc.) by discussing the biological molecules involved. For example, all of the principles of evolution can be brought forth in discussing the primary structure of hemoglobin's or cytochrome c. Previously given every Fall; 3 credit hours with approximately 40 to 50 lectures and 50 to 100 students. No longer offered
6. "Developmental Biology." Basic events from gametogenesis to organogenesis are covered in this 3 credit hour, 40 to 50 lecture course attended by 40 to 100 students. No longer offered.
7. Developmental Biology Laboratory: Twelve separate weekly presentations covering development in sea urchins, chick and frog with emphasis on experimental embryology. The course, as now organized, stresses the molecular biology of development. Two credits, two sections, 24 students each. No longer offered.
8. "Cell Biology": Gave several lectures in the department's required sophomore level Cell Biology Course primarily in the areas of energy metabolism from a structural and biochemical standpoint and chromatin structure and chemistry.
9. "Cell Biology Laboratory": I have given one or two exercises per year (usually in the area of cell fractionation or mitochondrial function). Two credits, 3 sections, 20 students each.
10. "Freshman Special Studies": During the Spring of 1970 and 1971, I offered a course in this unique Freshman Special Studies program which involved a modification of Herman Epstein's "Biology for Non-Science Majors." Three credit hours, 40 to 50 one hour meetings, 20 students. No longer offered.
11. Various graduate and medical school lectures, including areas in Developmental Cell and Molecular Biology.

### **Brandeis University**

Taught section of "Biology for Non-Science Majors." An experimental course attempting to expose non-science majors to scientific exploration by using research publications as teaching tools.

## **REFERENCES FURNISHED UPON REQUEST**