

ROBERT T. TRANQUILLO

Personal

Address: 1267 Wyncrest Court
Arden Hills, MN 55112

Born: 17 August 1957
Philadelphia, PA

Marital Status: Married, three sons, one daughter

Education: Postdoctoral Fellow, Oxford University 1986-1987
PhD (ChE) University of Pennsylvania 1986
MS (ChE) Stanford University 1980
BS (ChE) Pennsylvania State University 1979

Professional Experience

Professor of Biomedical Engineering, University of Minnesota, July 2000 – present
Head of Biomedical Engineering, University of Minnesota, July 2000 – June 2019
Professor of Chemical Engineering, University of Minnesota, Sept 1998-present
Artificial Tissues Program Coordinator, University of Minnesota MRSEC, Sept 1998 - 2002
Associate Professor of Chemical Engineering, University of Minnesota, Sept 1993-1998
Assistant Professor of Chemical Engineering, University of Minnesota, Sept 1987- Sept 1993
Chemical Engineer (Chemical Engineering Laboratory, SRI International June 1980-June 1981
Chemical Engineer (Marshall Laboratory), E I du Pont de Nemours & Company, Summer 1979
Chemical Engineer (Plastics Division), Rohm and Haas Kentucky, Incorporated, Summer 1978

Academic Honors

Distinguished McKnight University Professor
TERMIS-Americas Senior Scientist Award
Fellow of the International Academy of Medical and Biological Engineering
Fellow of the Biomedical Engineering Society
Fellow of the American Institute for Medical and Biological Engineering
College Student Board Outstanding Professor in Biomedical Engineering
Shell Land Grant Chair in Chemical Engineering & Materials Science
NSF Presidential Young Investigator
McKnight-Land Grant Professor
NATO Postdoctoral Fellowship in Science and Engineering
EXXON Fellowship, University of Pennsylvania
University Fellowship, University of Pennsylvania
Graduate Engineering Fellowship, Stanford University
BS Highest Distinction, Pennsylvania State University

Research Interests

Mathematical models, *in vitro* and *in vivo* assays, and clinical applications of cell motility: cell migration (applied to wound healing and tissue engineering) - random migration, chemotaxis, contact guidance; soft tissue

engineering (bioartificial arteries and cardiovascular valves – including growth potential for pediatrics - and microvascularized myocardium, fabrication and functional characterization) – rheology, mechanics, fibril structure and cell compaction of cell/biopolymer constructs, bioreactor design and analysis; magnetic induced collagen and fibrin alignment (guided nerve regeneration; contact guidance studies); analytical and numerical analysis, stochastic processes; image processing and analysis.

Society Memberships

Biomedical Engineering Society (Board of Directors 1998-2001, Publications Board, 2003-2010 (Chair 2008-2010), Executive Committee (2008-2010)), BME Council of Chairs Long Range Planning Committee (2016-2018), Tissue Engineering and Regenerative Medicine Society (TERMIS-NA Member-at-Large, 2011-2014), North American Vascular Biology Society, International Society for Applied Vascular Biology, American Institute for Medical and Biological Engineering, International Academy of Medical and Biological Engineering

Editorial Boards

Tissue Engineering (2013-2016), Journal of Immunology and Regenerative Medicine (2016-2018)

Advisory/Review Boards

Departments of Biomedical Engineering: Georgia Tech (2022), University of Illinois-Urbana Champaign (2015-2023), University of Oklahoma (2015-2019), Penn State University (2019); Pediatric Heart Network DSMB (2020-2023), Heart Valve Collaboratory Pediatric Pre-Clinical Task Force (2024-2026)

Publications

1. S. H. Zigmond, R. Klausner, R. T. Tranquillo, D. A. Lauffenburger, "Analysis of the Requirements for Time-Averaging of the Receptor Occupancy for Gradient Detecting by Polymorphonuclear Leukocytes," in *Membrane Receptors and Cellular Regulation*, eds. M. Czech and C. R. Kahn, Alan R. Liss, 347 (1985).
2. R. T. Tranquillo and D. A. Lauffenburger, "Consequences of Chemosensory Phenomena for Leukocyte Chemotactic Orientation," *Cell Biophysics*, 8, 1 (1986).
3. R. T. Tranquillo and D. A. Lauffenburger, "Analysis of Leukocyte Chemosensory Movement," *Adv. Biosci.*, 66, 29 (1987).
4. R. T. Tranquillo and D. A. Lauffenburger, "Stochastic Model of Chemosensory Cell Movement," *J. Math. Biol.*, 25, 229 (1987).
5. D. A. Lauffenburger, B. Farrell, R. Tranquillo, A. Kistler, and S. Zigmond, "Commentary: Gradient Perception by Neutrophil Leukocytes, Continued," *J. Cell Sci.*, 88, 415 (1987).
6. R. T. Tranquillo, D. A. Lauffenburger, and S. H. Zigmond, "A Stochastic Model for Leukocyte Random Motility and Chemotaxis Based on Receptor Binding Fluctuations," *J. Cell Biol.*, 10, 303 (1988).
7. R. T. Tranquillo, B. E. Farrell, E. S. Fisher, and D. A. Lauffenburger, "A Stochastic Model for Chemosensory Cell Movement: Application to Neutrophil and Macrophage Persistence and Orientation," *Math. Biosci.*, 90, 287 (1988).
8. D. A. Lauffenburger, D. Hammer, R. Tranquillo, H. Buettner, and E. Fisher, "How Immune Cells Find Their Targets: Quantitative Studies of Cell Adhesion, Migration, and Chemotaxis," in *Theoretical*

Immunology, Part Two, SFI Studies in the Science of Complexity, ed., A. S. Perelson, Addison-Wesley, 1988.

9. D. A. Lauffenburger, R. T. Tranquillo, and S. H. Zigmond, "Concentration Gradients of Chemotactic Factors in Chemotaxis Assays," *Meth. Enzymol.*, *162*, 85 (1988).
10. R. T. Tranquillo, S. H. Zigmond, and D. A. Lauffenburger, "Measurement of the Chemotactic Coefficient for Human Neutrophils in the Under-Agarose Migration Assay," *Cell Motility Cytoskel.*, *11*, 1 (1988).
11. J. D. Murray, P. K. Maini and R. T. Tranquillo, "Mechanical Models of Biological Pattern Formation," *Phys. Rep.*, *171*, 59 (1988).
11. D. A. Lauffenburger, M. A. Rivero, R. T. Tranquillo and H. M. Buettner, "Transport Models for Chemotactic Cell Populations Based on Individual Cell Behavior," *Chem. Eng. Sci.*, *44*, 2881 (1989).
12. R. T. Tranquillo, "Theory and Models of Gradient Perception," in *Biology of the Chemotactic Response*, eds. J. Armitage and J. M. Lackie, pp. 35-75, Cambridge University Press, 1990.
13. R. T. Tranquillo and D. A. Lauffenburger, "Definition and Measurement of Cell Migration Coefficients," *Lect. Notes Biomath.*, *89*, 475 (1990).
14. R. T. Tranquillo, "Models of Chemical Gradient Sensing by Cells," *Lect. Notes Biomath.*, *89*, 415 (1990).
15. R. T. Tranquillo and W. Alt, "A Glossary of Terms Concerning Oriented Movement," *Lect. Notes Biomath.*, *89*, 510 (1990).
16. R. T. Tranquillo and J. D. Murray, "Continuum Model of Fibroblast-Driven Wound Contraction," *J. Theor. Biol.*, *158*, 135 (1992).
17. R. T. Tranquillo, M. Durrani and A. G. Moon, "Tissue Engineering Science: Consequences of Cell Traction Forces," *Cytotech.* *10*, 225 (1992).
18. A. G. Moon and R. T. Tranquillo, "The Fibroblast-populated Collagen Microsphere Assay of Cell Traction Force - Part 1: Continuum Model," *AIChE J.*, *39*, 13 (1993).
19. R. B. Dickinson and R. T. Tranquillo, "A Stochastic Model for Cell Random Motility and Haptotaxis Based on Adhesion Receptor Binding Fluctuations," *J. Math. Biol.*, *31*, 53 (1993).
20. S. Guido and R. T. Tranquillo, "A Methodology for the Systematic and Quantitative Study of Contact Guidance in Oriented Collagen Gels: Correlation of Fibroblast Orientation and Gel Birefringence," *J. Cell Sci.*, *105*, 317 (1993).
21. A. E. Faassen, D. L. Mooradian, R. T. Tranquillo, R. B. Dickinson, P. C. Letourneau, T. R. Oegema and J. B. McCarthy, "Cell Surface CD44-related Chondroitin Sulfate Proteoglycan is Required for Transforming Growth Factor- β -stimulated Mouse Melanoma Cell Motility and Invasive Behavior on Type I Collagen," *J. Cell Sci.*, *105*, 501 (1993).
22. R. B. Dickinson, J. B. McCarthy and R. T. Tranquillo, "Quantitative Characterization of Cell Invasion *In Vitro*: Formulation and Validation of a Mathematical Model of the Collagen Gel Invasion Assay," *Ann. Biomed. Eng.*, *21*, 679 (1993).
23. R. B. Dickinson and R. T. Tranquillo, "Optimal Estimation of Cell Movement Indices from the Statistical Analysis of Cell Tracking Data," *AIChE J.*, *39*, 1995 (1993).

24. R. T. Tranquillo and J. D. Murray, "Mechanistic Model of Wound Contraction," *J. Surg. Res.*, 55, 233 (1993).
25. P. V. Moghe and R. T. Tranquillo, "Stochastic Model of Chemoattractant-Receptor Dynamics in Leukocyte Chemosensory Movement," *Bull. Math. Biol.*, 5, 1041 (1994).
26. S. Guido, R. B. Dickinson and R. T. Tranquillo, "Correlation of Biased Cell Migration and Cell Orientation for Fibroblasts Exhibiting Contact Guidance in Oriented Collagen Gels," *Ann. Biomed. Eng.*, 22, 342 (1994).
27. V. H. Barocas and R. T. Tranquillo, "Biphasic Theory and *In Vitro* assays of Cell-Fibril Mechanical Interactions in Tissue-Equivalent Collagen Gels," in *Cell Mechanics and Cellular Engineering*, eds. V. C. Mow, F. Guilak, R. Tran-Son-Tay, R. M. Hochmuth, Springer-Verlag, p. 185 (1994).
28. R. T. Tranquillo and W. Alt, "Dynamic Morphology of Leukocytes: Statistical Analysis and a Stochastic Model for Receptor-Mediated Cell Motion and Orientation," in *Biomechanics of Active Motion and Division of Cells*, ed. N. Akkas, Springer-Verlag, p. 437 (1994).
29. P. V. Moghe and R. T. Tranquillo, "Stochasticity in Membrane-Localized Ligand-Receptor-G Protein Binding: Consequences for Leukocyte Movement Behavior," *Ann. Biomed. Eng.*, 23, 257 (1995).
30. V. H. Barocas, A. G. Moon and R. T. Tranquillo, "The Fibroblast-populated Collagen Microsphere Assay of Cell Traction Force - Part 2: Measurement of the Cell Traction Parameter," *J. Biomech. Eng.*, 117, 1 (1995).
31. P. V. Moghe, R. D. Nelson and R. T. Tranquillo, "Cytokine-Stimulated Chemotaxis of Human Neutrophils in a 3-D Conjoined Fibrin Gel Assay," *J. Immun. Methods*, 180, 193 (1995).
32. R. B. Dickinson and R. T. Tranquillo, "Transport Equations and Indices for Random and Biased Cell Migration Based on Single Cell Properties," *SIAM J. Appl. Math.*, 55, 1419 (1995).
33. R. T. Tranquillo and W. Alt, "Stochastic Model for Receptor-Mediated Cytomechanics and Cell Motion and Dynamic Morphology of Leukocyte," *J. Math. Biol.*, 34, 31 (1996).
34. R. T. Tranquillo, T. S. Girton, B. A. Bromberek, T. G. Triebes and D. L. Mooradian, "Magnetically-Oriented Tissue-Equivalent Tubes: Application to a Circumferentially-Oriented Media-Equivalent," *Biomaterials*, 17, 349 (1996).
35. V. H. Barocas and R. T. Tranquillo, "An Anisotropic Biphasic Theory of Tissue-Equivalent Mechanics: The Interplay Among Cell Traction, Fibrillar Network Deformation, Fibril Orientation and Cell Contact Guidance," *J. Biomech. Eng.*, 119, 137-145 (1997a).
36. V. H. Barocas and R. T. Tranquillo, "A Finite Element Solution for the Anisotropic Biphasic Theory of Tissue Mechanics: The Effect of Cell Contact Guidance on Isometric Cell Traction Force Measurement," *J. Biomech. Eng.* 119(3), 261-269 (1997b).
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38. V. H. Barocas, T. S. Girton and R. T. Tranquillo, "Engineered Alignment in Media-Equivalents: Magnetic Prealignment and Mandrel Compaction," *J. Biomech. Eng.* 120(5): 660-666 (1998).

39. Girton, T.S., Oegema, T.R. and Tranquillo, R. T., "Exploiting glycation to stiffen and strengthen tissue-equivalents for tissue engineering," *J. Biomed. Mat. Res.* 46(1): 87-92 (1999).
40. Knapp, D.M., Helou, E.F. and Tranquillo, R.T. "A Fibrin and Collagen Gel Assay for Fibroblast Chemotaxis: Assessment of Chemotaxis to GRGDSP," *Exp. Cell. Res.* 247:543-553 (1999).
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42. Ceballos, D., X. Navarro, N. Dubey, G. Wendelschafer-Crabb, W.R. Kennedy, and R.T. Tranquillo "Magnetically aligned collagen gel filling a collagen nerve guide improves peripheral nerve regeneration," *Exp. Neurol.* 158: 290-300 (1999).
43. Knapp, D.M., Barocas, V. H., Tower, T.T. and R.T. Tranquillo, "Estimation of Cell Traction and Migration in an Isometric Cell Traction Assay," *AIChE J* 45(12): 2628-2640 (1999).
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45. Wagle, M and Tranquillo, R.T. "A self-consistent cell flux expression for simultaneous chemotaxis and contact guidance in tissues" *J. Math. Biol.* 41(4): 315-330 (2000).
46. Dubey, N., Letourneau, P. C. and R. T. Tranquillo. "Neuronal contact guidance in magnetically-aligned fibrin gel: Effect of variation in gel mechano-structural properties." *Biomaterials* 22(10): 1065-1075 (2001).
47. Shreiber, D.I., P.A.J. Enever, and R.T. Tranquillo "Effects of PDGF-BB on Rat Dermal Fibroblast Behavior in Mechanically Stressed and Unstressed Collagen and Fibrin Gels" *Exp. Cell Res.* 266(1): 155-166 (2001)
48. Tower, T. T. and R. T. Tranquillo. "Alignment maps in tissues and fibrillar materials: I. Microscopic elliptical polarimetry," *Biophysical J* 81(5): 2954-2963 (2001).
49. Tower, T. T. and R. T. Tranquillo. "Alignment maps in tissues and fibrillar materials: II. Fast and simple map generation for tissues," *Biophysical J* 81(5): 2964-2971 (2001).
50. Bromberek, B.A., P.A.J. Enever, M.D. Caldwell, and R.T. Tranquillo "Macrophages influence a competition of contact guidance and chemotaxis for fibroblast alignment in a fibrin gel co-culture assay," *Exp Cell Res* 275:230-242 (2002).
51. P.A.J. Enever and R.T. Tranquillo "A novel implantable collagen gel assay for fibroblast traction and proliferation during wound healing," *J Surg Res* 105(2):160-72 (2002).
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54. Tower, T. T. Neidert, M. R. and R. T. Tranquillo. "Fiber alignment imaging during mechanical testing of soft tissues," *Ann Biomed Eng* (30):1221-1233 (2002).
55. Girton, T.S. and Tranquillo, R. T. "Confined compression of a tissue-equivalent: Collagen fibril and cell alignment in response to anisotropic strain," *J Biomech Eng* 124(5):568-575 (2002).

56. Shreiber, D.I., Barocas, V.H. and Tranquillo, R. T. "Temporal variations in cell migration and traction during fibroblast-mediated gel compaction," *Biophys J* 84:4120-4114 (2003).
57. Grassl, E. D., T. R. Oegema and R. T. Tranquillo "A fibrin-based arterial media-equivalent," *J Biomed Mat Res* 60(4):607-12 (2002).
58. Isenberg, B., and Tranquillo, R. T. "Long-term cyclic distention enhances the mechanical properties of collagen-based media-equivalents," *Ann Biomech Eng* 84:4120-4114 (2003).
59. Long, J. L. and R. T. Tranquillo. "Elastic fiber production in cardiovascular tissue-equivalents," *Matrix Biol* 22:339-350 (2003).
60. Ross, J.J. and R. T. Tranquillo. "ECM gene expression correlates with in vitro tissue growth and development in fibrin gel remodeled by neonatal smooth muscle cells," *Matrix Biol* 22:477-490 (2003).
61. Rosner, B. I., Siegel, R., Grosberg, A., and R. T. Tranquillo, "Rational design of contact guiding, neurotrophic guidance chambers for peripheral nerve regeneration," *Ann Biomed Eng* 31:1383-1401 (2003).
62. Devireddy, R.V., M. R. Neidert, J. C. Bischof, and R. T. Tranquillo. "Cryopreservation of collagen-based tissue-equivalents - Part I: Effect of freezing on cell viability and mechanical properties in the absence of cryoprotective agents," *Tissue Eng* 9:1089-100 (2003).
63. Neidert, M.R., Devireddy R.V., Tranquillo R.T., and Bischof J.C. " Cryopreservation of collagen-based tissue-equivalents - Part II: Improved freezing in the presence of cryoprotective agents," *Tissue Eng* 10:23-32 (2004).
64. Rosner, B. I., Hang, T-C., and R. T. Tranquillo, "Schwann cell behavior in three-dimensional collagen gels: Evidence for differential mechano-transduction and the influence of TGF-beta1 in morphological polarization and differentiation," *Exp Neurol* 195:81-91 (2005).
65. Isenberg, B.C., Williams, C. and R.T. Tranquillo, "Small-Diameter Artificial Arteries Engineered In Vitro," *Circ Res*, 98:25 (2006). (invited)
66. Neidert, M.R. and R. T. Tranquillo, "Tissue engineered valves with commissural alignment," *Tissue Eng* 12:891-903 (2006).
67. Williams, C., Johnson, S. L., Robinson, P. S. and R. T. Tranquillo, "Cell Sourcing for Fibrin-Based Valve Constructs," *Tissue Eng* 12:1489-1502 (2006).
68. Isenberg, B.C., Williams, C. and R.T. Tranquillo, "Endothelialization and Flow Conditioning of Fibrin-based Media-equivalents," *Ann Biomed Eng* 34:971-985 (2006).
69. Ross J.J., Zhigang H., Willenbring B., Zeng L., Isenberg B., Lee E.H., Reyes M., Keirstead S.A., Weir E.K., Tranquillo R.T., Verfaillie C.M., "Cytokine Induction of Functional Smooth Muscle Cells from Multipotent Adult Progenitor Cells," *J Clin Invest* 116:3139-3149 (2006).
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73. Jhun, C-S, Evans, M.C., Barocas, V.H. and R. T. Tranquillo, "Fiber Re-Orientation in Planar Biaxial Loading of Bioartificial Tissues Possessing Prescribed Alignment" *J Biomech Eng*, 131:081006-1-0810068 (2009) (cover photo)
74. Robinson, P. S. and R. T. Tranquillo, "Planar Biaxial Behavior of Native and Tissue-Engineered Heart Valve Leaflets" *Tissue Eng Part A*. 15: 2763-72 (2009).
75. Black, L.D., Meyers, J.D., Weinbaum, J.S., Shvelidze, Y.A. and R. T. Tranquillo, "Cell-induced alignment augments twitch force of fibrin gel-based engineered myocardium" *Tissue Eng Part A*, 15:3099-108 (2009).
76. Syedain, Z. and R. T. Tranquillo, "A Bioreactor for Tissue Engineered Heart Valves Based on Controlled Cyclic Stretching," *Biomaterials* 30:4078-84 (2009).
77. Bjork J. W. and R. T. Tranquillo, "Transmural Flow Bioreactor for Vascular Tissue Engineering," *Biotech & Bioeng* 104:1197-206 (2009).
78. Sander, E.A., Stylianopoulos, T., Tranquillo, R. T., and V. H. Barocas, "Image-based multi-scale modeling predicts tissue-level and network-level fiber reorganization in stretched cell-compacted collagen gels" *PNAS* 106:17675-80 (2009).
79. Syedain, Z. H., Bjork, J.W., Sando, L. and R. T. Tranquillo, "Controlled compaction with ruthenium-catalyzed photochemical cross-linking of fibrin-based engineered connective tissue," *Biomaterials* 30:6695-701 (2009).
80. Weinbaum J. S. and R. T. Tranquillo, "Monitoring Collagen Transcription by Vascular Smooth Muscle Cells in Fibrin-Based Tissue Constructs," *Tissue Eng Part C* 16: 459-67 (2010).
81. Huynh, T.H. and R. T. Tranquillo, "Fusion of concentrically layered tubular tissue constructs increases burst strength," *Ann Biomed Eng* 38:2226 (2010). (cover photo)
82. Weinbaum J. S., Tranquillo, R. T. and R. P. Mecham, "The Matrix-Binding Domain of Microfibril-associated Glycoprotein-1 Targets Active Connective Tissue Growth Factor to a Fibroblast-Produced Extracellular Matrix," *Macromol Biosci* 16:459 (2010).
83. Ahmann, K. A., Weinbaum J. S., Johnson, S. L. and Tranquillo, R. T., "Fibrin Degradation Enhances Vascular Smooth Muscle Cell Proliferation and Matrix Deposition in Fibrin-Based Tissue Constructs Fabricated In Vitro," *Tissue Eng Part A* 16:3261 (2010).
84. Syedain, Z.H. Meier, L.A., Bjork, J.W, Lee, A. and R. T. Tranquillo, "Implantable arterial grafts from human fibroblasts and fibrin using a multi-graft pulsed flow-stretch bioreactor with noninvasive strength monitoring," *Biomaterials* 32:714 (2011).
85. Sander, E.A., Barocas, V.H. and R. T. Tranquillo, "Initial fiber alignment pattern alters extracellular matrix synthesis in fibroblast populated fibrin gel cruciforms and correlates with predicted tension," *Ann Biomed Eng* 39:714 (2011).

86. Bjork J. W., Johnson, S. L. and R. T. Tranquillo, "Ruthenium-catalyzed photo cross-linking of fibrin-based engineered tissue," *Biomaterials* 32: 2479 (2011).
87. Syedain, Z.H. and R. T. Tranquillo, "TGF- β diminishes collagen deposition during long-term cyclic stretching of engineered connective tissue: Role of decreased ERK signaling," *J Biomech* 44:848 (2011).
88. Syedain, Z.H., Lahti, M.T., Berry, J.M., Johnson, S. L. Robinson, P. S., Ruth G.R. and R. T. Tranquillo, "Implantation of a tissue-engineered heart valve from human fibroblasts exhibiting short term function in the sheep pulmonary artery," *Cardiovasc Eng Tech* 2:101 (2011).
89. Morin, K.T. and R. T. Tranquillo, "Guided sprouting from endothelial spheroids in fibrin gels aligned by magnetic fields and cell-induced gel compaction," *Biomaterials* 32:6111 (2011).
90. Ahmann, K. A., Johnson, S. L., Hebbel, R.P. and Tranquillo, R. T., "Shear stress responses of adult blood outgrowth endothelial cells seeded on bioartificial tissue," *Tissue Eng Part A* 17:2511 (2011). (cover photo)
91. Bjork J. W., Meier L.A. and R. T. Tranquillo, "Hypoxic culture and insulin yield improvements to fibrin-based engineered tissue" *Tissue Eng Part A* 18:785 (2012).
92. Lai, V. K., Lake, S. P., Frey, C.R., Tranquillo, R.T. and V.H. Barocas, "Mechanical behavior of collagen-fibrin co-gels reflect transition from series to parallel interactions with increasing collagen content," *J Biomech Eng* 134: 011004-1 (2012).
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94. Syedain, Z.H., Bradee, A.R., Kren S., Taylor, D.A. and R. T. Tranquillo, "Decellularized tissue-engineered heart valve leaflets with recellularization potential," *Tissue Eng Part A* 19:759 (2013).
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96. Weidenhamer, N.K and R. T. Tranquillo, "Influence of cyclic mechanical stretch and tissue constraints on cellular and collagen alignment in fibroblast-derived cell sheets," *Tissue Eng Part C* 19:386-95 (2013).
97. Weinbaum J. S., Schmidt, J.B. and R. T. Tranquillo, "Combating adaptation to cyclic stretching by prolonging activation of extracellular signal-regulated kinase," *Cell Molec Bioeng* 6:279-286 (2013).
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100. Morin, K.T., Dries-Devlin, J.L. and R. T. Tranquillo, "Engineered microvessels possessing alignment and high lumen density via cell-induced fibrin gel compaction and interstitial flow," *Tissue Eng Part A* 20: 553-65 (2014).
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103. Meier, L.A., Syedain, Z.H., Lahti, M.T., Johnson, S.L., Chen, M.H., Hebbel, R.P and R. T. Tranquillo, "Blood Outgrowth Endothelial Cells Alter Remodeling of Completely Biological Engineered Grafts Implanted into the Sheep Femoral Artery," *J Cardiovasc Trans Res* 7: 242-9 (2014).
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106. Morin, K.T., Carlson, P. C. and R. T. Tranquillo, "Automated image analysis programs for the quantification of microvascular network characteristics," *Methods* 84: 76-83 (2015).
107. Reimer J.M., Syedain, Z.H., Haynie, B and R.T. Tranquillo, "Pediatric tubular pulmonary heart valve from decellularized engineered tissue tubes," *Biomaterials* 62:88-94 (2015).
108. Schmidt, J.B. and R.T. Tranquillo, "The effects of intermittent versus incrementally increasing strain magnitude cyclic stretching on ERK signaling and collagen production in engineered tissue," *Cell Molec Bioeng* 9:55-64 (2015).
109. Wendel, J., Ye, L., Rao, T. Zhang, J., Zhang, J., Kamp, T.J. and R.T. Tranquillo, "Functional consequences of a tissue-engineered cardiac patch from human induced pluripotent stem cell-derived cardiomyocytes in a rat infarct model," *STEM CELLS Transl Med* 4:1324-32 (2015)
110. Syedain, Z.H., Reimer J.M., Schmidt, J.B., Lahti, M., Berry, J., Bianco, R. and R. T. Tranquillo, "6-month aortic valve implantation of an off-the-shelf tissue-engineered valve in sheep," *Biomaterials* 73:175-84 (2015).
111. Schaefer, J.A. and R.T. Tranquillo, "Tissue contraction force microscopy for optimization of engineered cardiac tissue," *Tissue Eng Part C* 22:76-83 (2016).
112. Schmidt, J.B. and R.T. Tranquillo, "Cyclic stretch and perfusion bioreactor for conditioning large diameter engineered tissue tubes," *Ann Biomed Eng* 44: 1785-97 (2016).
113. Lai, V.K., Nedrelow, D.S., Lake, S.P., Kim, B., Weiss, E.M., Tranquillo, R.T. and V.H. Barocas, "Swelling of collagen-hyaluronic acid co-gels: An in vitro residual stress model," *Ann Biomed Eng* 44:2984-93 (2016).
114. Riemenschneider, S.B., Mattia, D.J, Wendel, J.S., Schaefer, J.A., Ye, L., Guzman, P. and R.T. Tranquillo, "Inosculation and perfusion of tissue patches containing aligned human microvessels after myocardial infarction," *Biomaterials* 97: 51-61 (2016).
115. Syedain, Z.H., Reimer, J. M., Lahti, M., Berry, J., Johnson, S., Bianco, R. and R. T. Tranquillo, "Tissue engineering of acellular vascular grafts capable of somatic growth in young lambs," *Nature Comms* 7:12951 (2016).

116. Reimer, J.M., Syedain, Z.H., Haynie, B., Lahti, M., Berry, J. and R. T. Tranquillo, "Implantation of a tissue-engineered tubular heart valve in growing lambs," *Ann Biomed Eng* 5: 439-451 (2017).
117. Syedain, Z.H., Graham, M.L., Dunn, T.B., O'Brien, T., Johnson, S.L., Schumacher, R.J. and R. T. Tranquillo, "A completely biological 'off-the-shelf' arteriovenous graft that recellularizes in baboons," *Science Transl Med* 9(414): 10.1126/scitranslmed.aan4209 (2017) (cover photo).
118. Schaefer, J.A., Guzman, P.A., Riemenschneider, S.B., Kamp, T.J. and R.T. Tranquillo, "A cardiac patch from aligned microvessel and cardiomyocyte patches," *J Tissue Eng Regen Med* 12:546-566 (2018).
119. La, A. and R. T. Tranquillo, "Shear conditioning of adipose stem cells for reduced platelet binding to engineered vascular grafts," *Tissue Eng Part A* 24:1242-1250 (2018).
120. Syedain, Z.H., Jenson, A., Patel, P., Feagler, C., Bahmer, L., Faizer, R. and R. T. Tranquillo, "Tissue-engineered transcatheter vein valve," *Biomaterials* 216: 119229 (2019).
121. Thrivikraman, G., Johnson, S.L., Syedain, Z.H., Lee, H-S and R. T. Tranquillo, "Biologically-engineered mechanical model of a calcified artery," *Acta Biomaterialia* 110: 164-174 (2020).
122. Syedain, Z.H., et al. and R. T. Tranquillo, "Pediatric tri-tube valved conduits made from fibroblast-produced extracellular matrix evaluated over 52 weeks in growing lambs," *Sci Transl Med* 13: 585 (2021).
123. Syedain, Z., Prunty, A., Li, J. and R. T. Tranquillo, "Evaluation of probe burst test as a measure of strength for a biologically-engineered vascular graft," *J Mech Behav Biomed Mater* 119:104527 (2021).
124. Thrivikraman, G., et al. and R. T. Tranquillo, "Cell contact guidance via sensing anisotropy of network mechanical resistance," *PNAS* 118: (2021)
125. Bersie-Larson, L.M., Lai, V.K., Dhume, R.Y., Provenzano, P.P., Barocas, V.H. and R. T. Tranquillo, "Elucidating the signal for contact guidance contained in aligned fibrils with a microstructural-mechanical model," *J R Soc Interface* 19(190): 20210951 (2022).
126. Syedain, Z. H., M. Lahti, G. Hiremath, J. Berry, J. P. Carney, J. Schappa Faustich, T. Shannon, A. Rivera, H. Wiputra, R. Shi, R. Bianco, R. MacIver, J. E. Mayer and R. T. Tranquillo, "Evaluation of an engineered vascular graft exhibiting somatic growth in lambs to model repair of absent pulmonary artery branch," *Commun Med (Lond)* 4: 201 (2024).
127. Syedain ZH, Lahti M, Berry J, Carney JP, Schappa Faustich J, Haynie B, Maher J, Hiremath G, R. Bianco, J. E. Mayer, R. MacIver and R. T. Tranquillo, "Biologically-engineered valved conduits for RVOT repair evaluated for 52 weeks in growing lambs," *Cardiovasc Res*. 00:1-10 (2025).
128. Li, J., Yu, Y., and R. T. Tranquillo, "Computational construction and design optimization of a novel tri-tube heart valve," *Biomech Modeling Mechanobiol* 24(3): 1103-1121 (2025).
129. Thrivikraman, G., et al. and R. T. Tranquillo, "Melanoma/CSPG4-enhanced collagen-mediated contact guidance requires mutant active BRAF and the CSPG4 core protein cytoplasmic domain," *Cell Molec Bioeng* 19(1): 61-72 (2026).

Invited Presentations

1. "Analysis of Leukocyte Chemosensory Movement," International Congress on the Biological and Clinical Aspects of Phagocyte Function, Pavia, Italy, September 1986.

2. "Stochastic Model of Leukocyte Chemosensory Movement," International Conference on Mathematical Models in Biology, Oberwalfach, FRG, March 1987.
3. "On Why Cells Don't Crawl in Straight Lines: Consequences of Stochastic Receptor Sensing of Chemical Concentrations," Gordon Conference on Oscillations and Dynamic Instabilities in Chemical Systems, Plymouth, New Hampshire, July 1988.
4. "Mechanisms of Leukocyte Chemosensory Movement," American Society for Gravitational and Space Biology Annual Meeting, Washington, D.C., October 1988.
5. "Models for Chemical Sensing," Workshop on Modeling, Analysis, and Simulation of Biological Motion Konigswinter, FRG, March 1989.
6. "Receptor-Regulated Motility of Leukocytes," International Conference on Mathematical Models in Biology, Oberwalfach, FRG, February 1990.
7. "Theory and Models of Gradient Perception," Symposium on Motility and Taxis, Society for General Microbiology Annual Meeting, York, England, December 1990.
8. "Stochastic Model of Chemotactic Receptor-Mediated Dynamic Morphology of Leukocytes," Symposium on Some Mathematical Questions in Biology, American Society of Cell Biology Annual Meeting, Denver, Colorado, November 1992.
9. "Quantitative Tissue Engineering," NIGMS Meeting on Research Opportunities in Biomolecular Engineering: The Interface Between Chemical Engineering and Biology, Washington, D.C., December 1992.
10. "Biphasic Theory and *In Vitro* Assays of Cell-Fibril Mechanical Interactions in Tissue-Equivalent Collagen Gels," Second World Congress of Biomechanics, Amsterdam, The Netherlands, July 1994.
11. "Anisotropic Biphasic Model of Cell-Fiber Mechanical Interactions," Workshop on Cell and Tissue Motion_Models, Analysis and Simulation, Bonn-Rottgen, Germany, March 1995.
12. "Magnetically-Oriented Tissue-Equivalent Tubes: Application to a Circumferentially-Oriented Media Equivalent," Second International Conference on Cellular Engineering, La Jolla, CA, August 1995.
13. "An Anisotropic Biphasic Theory of Tissue-Equivalent Mechanics: The Interplay Among Cell Traction, Fibrillar Network Deformation, Fibril Orientation and Cell Contact Guidance," Gordon Research Conference on Bioengineering and Orthopedic Science, Andover, New Hampshire, August 1996.
14. "Manifestations of Cell Motility in Tissue-Like Gels," Workshop on Cell Mechanics, Atlanta, GA, November 1996.
15. "Circumferential Alignment and Mechanical Stiffening of Media-Equivalents," Workshop on Biomaterials and Tissue Engineering, Hilton Head Island, S. Carolina, February 1997.
16. "Self-Organization of Tissue-Equivalents: The Nature and Role of Contact Guidance," 4th Abercrombie Symposium on Cell Behaviour: Control and Mechanism of Motility, Oxford, England, September 1997.

17. "Fabrication of a Tissue-Equivalent Cardiovascular Valve," Minisymposium on Tissue Engineering, 1999 BMES/EMBS Annual Meeting, Atlanta, GA, October 1999.
18. "Engineered Alignment of Self-Assembled Biopolymers for Artificial Tissues," CFMR Symposium on Polymers and Biopolymers, Michigan State University, February, 2000.
19. "Biomechanical Issues in Artificial (Soft) Tissue Fabrication from Cell-Contracted Biopolymers," Functional Tissue Engineering Workshop, Tampa, September, 2000.
20. "The Tissue Engineered Small Diameter Artery," BECON Symposium on Reparative Medicine: Growing Tissues and Organs, Vascular Assembly Panel, Washington, D.C. June, 2001.
21. "Cell-remodeled biopolymers with engineered alignment." GRC on Biomaterials and Tissue Engineering, Plymouth, NH, July 2003.
22. "In Vitro Tissue Growth and Development In Fibrin Gel Remodeled By Neonatal and MAPC-derived Smooth Muscle Cells." Regenerate, Seattle, WA, June 2004.
23. "Cardiovascular Tissue Engineering Based on Controlled Cell Remodeling of Biopolymers." Clemson/MUSC/USC Bioengineering Colloquium, October 2004.
24. "Cardiovascular Tissue Engineering Based on Controlled Cell Remodeling of Biopolymers." Area 15 d/e Plenary Lecture, AIChE Annual Meeting, Austin, TX November 2004.
25. "Paradigm for Self-Organized Tissue Growth: Cell-Mediated Fibrin Gel Contraction, Alignment, and Remodeling." Regenerate, Atlanta, GA, June 2005.
26. "In Vitro Tissue Growth & Development in Fibrin Gel Remodeled by Smooth Muscle Cells." Experimental Biology, San Francisco, CA, April 2006.
27. "Exploiting contact guidance for guided nerve regeneration and growth of aligned cardiovascular tissues." EMBO/IGB Meeting - Workshop on Cell Migration, Tissue Invasion And Disease, Capri, Italy, October 2006.
28. "Cardiovascular Tissue Engineering Based on Controlled Cell Remodeling of Biopolymers." 5th Annual Gene Therapy Symposium for Heart, Lung, and Blood Diseases: Tissue Engineering and Regenerative Medicine, Sonoma, CA, November 2006.
29. "Towards tissue-engineered grafts via controlled cellular remodeling of fibrin gel tubes." NAVBO Vascular Matrix Biology and Bioengineering Workshop, Whistler Village, BC, Canada, March 2007.
30. "Cardiovascular Tissue Engineering Based on Controlled Cell Remodeling of Biopolymers." Center for Vascular Remodeling and Regeneration, University of Pittsburgh, Pittsburgh, PA, May 2007.
31. "Effects of Cyclic Distension on Fibrin-Based Tubular Tissue Constructs." TERMIS-NA, Toronto, CA, April 2007
32. "Cardiovascular Tissue Engineering Based on Controlled Cell Remodeling of Biopolymers." TERMIS-EU, London, UK, September 2007
33. "Cardiovascular Tissue Engineering Based on Cell-Remodeled Fibrin." 2008 Annual BMES Meeting, St. Louis, MO, September 2008

34. "Vascular Tissue Engineering Based on Cell-Remodeled Fibrin." 2008 Annual BMES Meeting, St. Louis, MO, September 2008
35. "Flow Responses of Blood Outgrowth Endothelial Cells in Vascular Tissue Engineering." Experimental Biology Annual Meeting, New Orleans, LA, April 2009
36. "Fibrin-based Tissue Engineering." Wound Healing Society Annual Meeting, Dallas, TX, April 2009
37. "Towards A Completely Biological Living Heart Valve Replacement." IEEE-EMBS Annual Meeting, Minneapolis, MN, September 2009
38. "The Ups and Downs of Cyclic Stretching to Promote Tissue Growth." 2011 BMES-SPRBM Meeting, Miami, FL, January 2011.
39. "Monitoring Collagen Transcription Noninvasively During Bioreactor Culture of Engineered Tissues." NIH/NIST Functional Imaging for Regenerative Medicine Workshop, Gaithersburg, MD, May 2012.
40. "A Bioengineering Approach to Biologic Valves." 1st International Biological Valve Symposium, Mayo Clinic, Rochester, MN, September 2012.
41. "The Ups and Downs of Cyclic Stretching to Promote Tissue Growth." 2011 BMES-SPRBM Meeting, Miami, FL, January 2011.
42. "Aligned Engineered Microvessels with High Lumen Density via Cell-Induced Fibrin Gel Compaction and Interstitial Flow." 3rd Cellular and Molecular Bioengineering Conference, Kona, HI, January 2013.
43. OSU Mathematical Biosciences Institute workshop on Mathematics Guiding Bioartificial Heart Valve Design, Columbus, OH, October 2013.
44. "Tissue-Engineered Arteries and Heart Valves Based on Fibroblast Remodeling of Fibrin Gel Tubes." 2nd Annual UAB Comprehensive Cardiovascular Center Symposium on Cardiovascular Repair and Regeneration, Birmingham, AL, October 2013.
45. UVA Cardiovascular Research Training Grant, Charlottesville, VA, October 2013.
46. "Cardiovascular Tissue Engineering Based on Controlled Cell Remodeling of Biopolymers." 12th Annual Gene Therapy Symposium for Heart, Lung, and Blood Diseases: Tolerance and Immune Modulation, Sonoma, CA, November 2013.
47. "Fibrin Properties and Applications in Medicine and Tissue Engineering." NAS Biomedical Engineering Materials and Applications Roundtable on Naturally Derived Biomaterials, Washington, D.C., April 2014.
48. "Off-the-Shelf Heart Valves and Vascular Grafts Grown In Vitro." BioInterface 2016, Minneapolis, MN, October 2016.
49. "Decellularized Tissue-Engineered Tubes as Vascular Grafts and Heart Valves." Plenary Lecture for Society for Biomaterials Annual Meeting, Minneapolis, MN, April 2017.
50. "Completely Biological "Off-the-Shelf" Vascular Grafts." International Society of Vascular Tissue Engineering, Columbus, OH, June 2017.

51. “Biologically-engineered Vascular Grafts and Heart Valves that Reanimate.” ASAIO 64th Annual Conference, Washington DC, June 2018.
52. “Biologically-engineered Tubes of Cell-Produced Extracellular Matrix for Vascular Grafts and Tubular Heart Valves.” World Congress of Biomechanics, Dublin, Ireland, July 2018.
53. “Tissue-engineered Pediatric Pulmonary Valve Conduit in a Growing Lamb Model.” The International Society for Applied Cardiovascular Biology- 16th Biennial Meeting, Bordeaux, France, September 2018.
54. “Biologically-engineered Tubes for Pediatric Conduits That Grow.” Society for Biomaterials Annual Meeting, Seattle, WA, April 2019.
55. “Imagine Heart Valves that Grow and Don't Wear Out.” University of Kentucky College of Engineering Biomedical Research Day, Lexington, KY, April 2019
56. “Small Diameter Tissue-engineered Vessels: The Gel Approach.” European Symposium on Vascular Biomaterials, Strasbourg, France October 2019.
57. “Regenerative Medicine and Medtronic.” Medtronic Board of Directors, Boulder, CO March 2020.
58. “Designing a pulmonary valve that grows with the child - a story of discovery” NHLBI Developmental Origins of Health and Disease (DOHAD) Research Interest Group, June 2021. (virtual)
59. “Creating a pulmonary valve that grows with the child - a story of discovery” Additional Ventures Back to Basics Speaker Series: Pioneers in Cardiovascular Science - Tissue Engineering and Stem Cell Biology, September 2021. (virtual)
60. “Acellular Vascular Grafts from Fibroblast-remodeled Fibrin that Grow and Self-repair” NAVBO, October 2021. (virtual)
61. “Pediatric tri-tube valved conduits of biologically-engineered matrix evaluated 52 weeks in growing lambs” European Symposium on Vascular Biomaterials, Strasbourg, France November 2021. (virtual)
62. “My Viewpoint - Potential Game-Changers: 10 Thoughts on Tissue-Engineered Heart Valves” Napa Cardiology, Napa, CA, TBD. (postponed)
63. “Growing Conduits for Repair of Congenital Heart Defects” 18th Biennial ISACB Meeting, Memphis October 2022
64. Heart Valve Collaboratory Pediatric Heart Valve Workshop, October 2022. (virtual)
65. “ECM-Based Tissue-Engineered Heart Valves” HVS/ICHVTE Meeting, Malaga, Spain, March 2023.
66. “Growth of an off-the-shelf conduit in lambs, a GLP study” European Symposium on Vascular Biomaterials, Strasbourg, France, April 2023.
67. “Engineered vascular grafts exhibiting somatic growth in lambs” The International Society for Applied Cardiovascular Biology- 16th Biennial Meeting, Vienna, Austria, November 2024.
68. “Biologically-engineered pediatric conduits that grow” UC Davis Department of Surgery Research Day, Davis, CA, April 2025.

69. “Biologically-engineered pediatric conduits that grow” 8th Aegean Conference on Tissue Engineering, Crete, Greece, June 2025.
70. “Biologically-engineered pediatric conduits that grow” 10th Heart Valve Biology and Tissue Engineering Meeting, London, September 2025.

Seminars

1. SRI International, Chemical Engineering Laboratory, November 1984.
2. University of California, Berkeley, Department of Chemical Engineering, February 1985.
3. University of Rochester, Department of Chemical Engineering, April 1985.
4. University of Minnesota, Department of Chemical Engineering, April 1985.
5. Penn State University, Department of Chemical Engineering, May 1985.
6. New Jersey Institute of Technology, Department of Chemical Engineering, April 1986.
7. King's College, MRC Cell Biophysics Unit, October 1986.
8. University of Oxford, Mathematical Institute, October 1986.
9. University of Glasgow, Department of Cell Biology, December 1986.
10. University of Oxford, Developmental Biology Group, February 1987.
11. University of Heidelberg, Institute of Applied Mathematics, February 1987.
12. University of Strathclyde, Department of Mathematics, May 1987.
13. The Slade Hospital, Dermatology Department, June 1987.
14. University of Minnesota, Department of Microbiology, January 1988.
15. University of Minnesota, Department of Oral Biology, January 1988.
16. The Procter & Gamble Company, December 1989.
17. University of Minnesota, Biophysics Program, December 1989.
18. University of Minnesota, Biomedical Engineering Program, December 1989.
19. University of Minnesota, Dept. of Genetics & Cell Biology, April 1990.
20. The Procter & Gamble Company, February 1991.
21. The Shriners Burns Institute, February 1991.
22. University of Bonn, Bonner Biomathematics Colloquium, May 1991.
23. University of Bonn, Institute for Applied Mathematics, May 1991.
24. Rice University, Department of Chemical Engineering, March 1992.
25. University of Illinois, Department of Chemical Engineering, April 1992.
26. The Procter & Gamble Company, June 1992.
27. University of Bonn, Bonner Biomathematics Colloquium, March 1994.
28. University of Bonn, Institute for Applied Mathematics, March 1994.
29. Johns Hopkins University, Department of Chemical Engineering, July 1994.
30. Duke University, Department of Biomedical Engineering, February 1995.
31. The University of Wisconsin--Madison, Department of Chemical Engineering, September 1995.
32. Massachusetts Institute of Technology, Department of Chemical Engineering, December 1995.
33. The University of Florida, Department of Chemical Engineering, March 1996.
34. Johns Hopkins University, Department of Chemical Engineering, April 1996.
35. University of Pennsylvania, Department of Chemical Engineering, December 1997.
36. Rutgers University, Department of Chemical Engineering, December 1997.
37. University of Colorado, Department of Chemical Engineering, October 1998.
38. Iowa State University, Department of Chemical Engineering, November 1998.
39. University of Virginia, Department of Biomedical Engineering, May 1999.
40. Penn State University, Department of Chemical Engineering, November 1999.
41. Washington University, Department of Biomedical Engineering, May 2000.
42. Harvard University, Division of Engineering and Applied Science, June 2001.
43. University of Pennsylvania, Department of Biomedical Engineering, November 2001.

44. Northwestern University, Department of Biomedical Engineering, January 2002.
45. Johns Hopkins University, Center for Computational Medicine and Biology, April 2002.
46. NC State University, Department of Chemical Engineering, November 2002.
47. University of Michigan, Department of Biomedical Engineering, November 2003.
48. University of Virginia, Department of Biomedical Engineering, November 2003.
49. University of Pittsburgh, McGowan Institute for Regenerative Medicine, January 2004.
50. 3M Tech Forum, Life Sciences Chapter, July 2004.
51. MIT, Division of Bioengineering (Inaugural Medtronic BME Distinguished Lecture), November 2004.
52. Boston University, Department of Biomedical Engineering (Distinguished Chairs and Scientists Series), November 2004.
53. Rice University, Department of Bioengineering, November 2004.
54. UC-Irvine, Department of Biomedical Engineering, January 2005.
55. University of Wisconsin-Madison, Department of Chemical Engineering, October 2005.
56. RPI, Department of Biomedical Engineering, November 2005.
57. Columbia University, Department of Biomedical Engineering, November 2005.
58. University of Texas-Austin, Department of Biomedical Engineering, November 2005.
59. Medical College of Wisconsin, Department of Physiology, November 2006.
60. University of Toronto, IBBME ("Distinguished Speakers in Bioengineering" lecture series), April 2007.
61. Purdue University, Department of Biomedical Engineering, November 2007.
62. Duke University, Department of Biomedical Engineering, December 2007.
63. Clemson University, Department of Biomedical Engineering, February 2008.
64. Wake Forest Institute of Regenerative Medicine, October 2008.
65. FIBR Team Winter Conference, February 2009.
66. University of Houston, Department of Chemical and Biomolecular Engineering, October 2009.
67. Rice University, Department of Bioengineering, November 2009.
68. CMU University, Department of Chemical and Biomolecular Engineering, November 2009.
69. UC-Davis, Department of Biomedical Engineering, January 2010.
70. GIT, Department of Chemical and Biomolecular Engineering, November 2010.
71. Texas A&M, Department of Biomedical Engineering, November 2011.
72. University of Florida, Department of Chemical Engineering, January 2012.
73. Johns Hopkins University, Department of Chemical Engineering, March 2012.
74. Cornell University, Department of Biomedical Engineering, November 2012.
75. UC-Irvine, Department of Biomedical Engineering, December 2012.
76. Rice University, Department of Bioengineering, January 2013.
77. Northwestern University, Department of Biomedical Engineering, April 2013.
78. Cardiovascular Research Seminar Series, Mayo Clinic, May 2013.
79. Institute of Complex Molecular Systems, Eindhoven University of Technology, May 2013.
80. University of Rochester, Department of Biomedical Engineering, November 2013.
81. UC-San Diego, Department of Bioengineering, January 2014.
82. UC-Berkeley, Department of Bioengineering, February 2014.
83. Colorado State University, Department of Biomedical Engineering, October 2015.
84. Rice University, Department of Bioengineering, November 2015.
85. Thee Ohio State University, Department of Biomedical Engineering, October 2016.
86. WPI, Department of Biomedical Engineering, November 2016.
87. University of Nebraska, Department of Surgery, March 2017.
88. Penn State University, Department of Biomedical Engineering, November 2017.
89. UCLA, Department of Bioengineering, April 2018.
90. Florida International University, Department of Bioengineering, February 2019.
91. Webinar, International Society of Applied Vascular Biology, February 2020.
92. Rowan University, Department of Bioengineering, December 2020.
93. University of Pennsylvania, Physical Sciences of Oncology Center, March 2021.
94. Basic Science and Engineering (BASE) Seminar Series, Stanford University, May 2022.
95. UNC/NCSU, Department of Bioengineering, November 2022.

96. University of Pittsburgh, Department of Bioengineering, November 2023.
97. University of Auckland, Bioengineering Institute, January 2024.
98. University of Galway, CURAM, April 2024.
99. Penn State University, Department of Chemical Engineering (Centennial seminar series), October 2024.
100. University of Nebraska, Department of Biomechanics, November 2024.

Research Support (PI unless indicated otherwise)

Active

DOD Peer Reviewed Medical Research Program – Technology/Therapeutic Development Award-Funding Level 2 “Valved Conduits That Grow for Congenital Heart Disease” \$3,991,560 (total costs) 6/1/25-5/31/29

Children’s Heart Foundation “Growing Transcatheter Pulmonary Stent Valve for Congenital Heart Disease” \$300,000 (total costs) 1/1/2025-12/31/26

UMN OVPR International Institute for Biosensing Program. International Institute for Biosensing Program. “Using light-sheet microscopy and FRET-based talin force sensors to investigate dynamic cell force generation” \$213,788 (total costs) 8/1/23 – 7/31/26

NIH/NHLBI R61/R33 Catalyze Program “Biologically-engineered Transcatheter Vein Valve: Design Optimization and Preclinical Testing” \$754, 633 (total costs) 2/15/23 – 6/30/27

DOD Peer Reviewed Medical Research Program – Technology/Therapeutic Development Award-Funding Level 2 “Biologically Engineered Growing Heart Conduits” \$3,700,000 (total costs) 6/15/22-6/14/26

Regenerative Medicine Minnesota “Rapidly Endothelialized Vascular Bypass Grafts From Autologous Adipose Microvessels” \$249,812 (total costs) 3/1/2022 – 3/1/2024

Frank J Maslowski and Eleanor a Maslowski Charitable Trust “Pediatric Conduits That Grow” \$472,027 (cumulative direct costs) 1/1/17 - 12/31/25

Completed

NIH 2R01 HL107572 “Completely biological tissue-engineered pulmonic valve grown in vitro from human cells for pediatric patients” \$3,723,799 (total costs) 6/15/2018-6/14/2022

NSF CBET “Elucidating the signal for contact guidance in aligned fibrils to improve tissue engineering” \$315,000 (total costs) 7/1/16-6/30/20

NIH NHLBI PACT HHSN26820160014I/HHSN26800004 “Human dermal fibroblast MCB and decellularized tissue tube” (PI: D.H. McKenna) \$757,154 (total costs) 4/16/18-7/15/19 (NCE)

Spectranetics Corp. “Development of tissue-engineered grafts as atherosclerotic lesion models” (Phillips) \$83,830 (total costs) 9/1/2018 – 8/31/2019

Regenerative Medicine Minnesota “Regenerative Vein Valve” \$250,000 (total costs) 3/01/2018 - 2/28/2020

Summer's Wish Pediatric Cardiology Innovators Fund, “Clinical Trial Approval for a Pediatric Conduit that Grows” 1/1/2017 – 12/31/2019 \$80,000 (total costs)

MN-REACH “Commercialization of a tissue-engineered AV graft” \$135,000 (direct costs) 10/1/16-12/31/18

Vascudyne, Inc. “CABG Study using UMN (Tranquillo Lab) Grafts” 9/1/16-1/1/17 \$30,000 (direct costs)

Regenerative Medicine Minnesota “Endothelialization of Engineered Coronary Artery Bypass Grafts Using Bone Marrow and Adipose-derived Mesenchymal Stem Cells” \$491,828 (total costs) 7/01/2015 - 6/30/2017

UMN/Mayo Partnership in Biotechnology and Medical Genomics “Transcatheter Aortic Valve From Engineered Tissue” \$900,000 (total costs) 2/01/2015 - 1/31/2017 (co-PI with A. Lerman, Mayo)

UMN CTSI/ODAT-PDIC “Preclinical demonstration of growth capacity of a tissue-engineered RVOT graft” \$50,000 (total costs) 8/1/2014 – 7/31/2015

John and Nancy Lindahl Children’s Heart Research Innovators Fund “Preclinical evaluation of completely biological engineered human vascular grafts” \$363,626 (total costs) 10/16/2013 – 12/31/2015

NIH R01 HL108670 “Biopolymer-guided human stem cell assembly for engineered myocardium” \$2,965,348 (total costs) 9/5/2011-5/31/2015

NIH R01 HL107572 “Completely biological tissue-engineered pulmonic valve grown in vitro from human cells for pediatric patients” (score 1.0 / 1%) \$4,508,048 (total costs) 4/1/2011 – 3/31/2016

UMN IEM “Creating an Endothelium from Autologous Mesenchymal Stem Cells” \$25,000 (total costs) 1/1/2014 – 12/31/2014

UMN CTSI/ODAT “Preclinical evaluation of a novel tissue-engineered heart valve, \$50,000 (total costs) 7/1/2013 – 6/30/2014

Mayo Clinic “A tubular tissue-engineered heart valve from human fibroblasts for aortic valve replacement” \$235,464 (total costs) 10/1/2013 – 9/30/2014

NIH/NIBIB R21 EB011561 “Systems biology approach to optimize tissue growth in vitro” \$390,813 (total costs) 9/30/2010 – 8/31/2013

NIH/NHLBI R01 HL083880 “Engineered Artery Growth in Vitro Based on Cell-Remodeled Fibrin” 4,308,044 (total costs) 6/01/2006 - 5/31/2011

UMN/Mayo Partnership in Biotechnology and Medical Genomics “Cell Therapy of Cardiac Arrhythmias” \$828,040 (total costs) 1/01/2009 - 12/31/2010 (co-PI with D. Packer, Mayo)

NIH/NHLBI R01 HL071538 Biomedical Engineering Research Partnership "Tissue-engineered Valve from Cell-Remodeled Biopolymer" \$4,151,853 (total costs) 6/01/2003 - 5/31/2008

NIH/NIBIB R21 EB00989 "Biopolymer-mimetic Worm-like Micelle Tissue Scaffolds" \$150,000 (annual direct costs) 10/1/02-9/30/05

NIH/NHLBI R01 HL60495-01A1 “Development of a Bioartificial Artery” \$205,000 (annual direct costs) 4/1/99-3/31/03

Supplement to Program Project NIH/GM-50150 (PI: Caldwell, M. D.), “Fibroblast Migration-Traction Correlation and Wound Strengthening” \$154,258 (total direct costs) 8/1/99-7/31/00

NSF/MDC/CCR-9527151 (PI: Petzold, L. R.), “A High-Performance Problem Solving Environment for Optimization and Control of Chemical and Biological Processes,” \$47,000 (direct costs to RTT annually), October 1995-September 2000.

Supplement to Program Project NIH/GM-50150 (PI: Caldwell, M. D.), "Characterizing the Mechanisms and Regulation of Wound Resolution *In Vitro*," \$244,028 (total direct costs), August 1996-July 1999.

NSF/BES-9522758, "Magnetically-Oriented Tissue-Equivalents: Mathematical Model and Application," \$344,988 (total direct costs), October 1995-September 1998.

NIH/STTR (PI: Garg, A. K., Integra Life Sciences), "Nerve Regeneration Using Magnetically Aligned Collagen," \$45,871 (direct costs to RTT), April 1997-March 1998.

NSF/BBS Research Training Group Program, (co-PI's: Tirrell, M. V. and Furcht, L. T.), "Characterization of Cell Behavior in Biological Matrices," \$66,000 (direct costs to RTT in 1998/1999), August 1994-September 1999.

NIH First Independent Research Support and Transition (FIRST) Award, "Predictive Model and *In Vitro* Assay of Wound Healing and Contraction", \$495,200, April 1991-May 1996.

NSF Presidential Young Investigator Award NSF/BCS-8957736, \$125,000 (to \$500,000 with matching funds provision), October 1989-September 1994.

University of Minnesota McKnight-Land Grant Professorship, \$102,000, June 1989-June 1992.

NSF Research Initiation Award NSF/EET-880969, "The Neutrophil Model for Growth Factor Signalling," \$70,000, June 1988-June 1990 (University matching funds of \$10,000).

NSF Engineering Research Equipment Grant NSF/EET-8807691, "Image Analysis for Automated Microscopy," \$58,000 (University matching funds of \$29,000).

ACS Institutional Research Grant IN-13-29-8, "Verification of a Mathematical Model of the Collagen Gel Invasion Assay," \$5,000, December 1988-December 1989.

Graduate School Grant-in-Aid, "Experimental Verification of a Model for Cell Mechanical Interactions with Materials," \$8,000, December 1988-June 1989.

Other Support

NIH T32 Training Grant "Multidisciplinary Training in Cardiovascular Engineering" (co-PI with V. Barocas) \$1,071,522 (total direct costs) 7/1/19-6/30/24

Whitaker Foundation Special Opportunity Award, "Lab-based Courses for BME Undergraduates and Practicing Engineers," \$999,432 (total costs), 11/1/01-10/31/04.

Patents

"Growing Transcatheter Pulmonary Stent Valve" USPTO provisional application (with L. Voce and G. Hiremath)

"Biologically-Engineered Pediatric Valved Conduit and Methods of Making and Using" U.S. Patent Pending (with Z. Syedain)

"Methods and Compositions for Endothelializing Grafts" PCT pending (with G. Thirvrikian, S. Johnson, T. Shannon, J. Maher)

"A Tissue-Engineered Valve and Method of Making" U.S. Patent Pending (with Z. Syedain)

“Prosthetic Valves and Methods of Making” U.S. Patent Pending (with Z. Syedain)

“Decellularized Biologically-Engineered Tubular Grafts” U.S. Patents # 10,111,740, #10,105,208 (with Z. Syedain and L. Meier)

“Engineered blood vessels” U.S. Patent # 8,192,348 (with J. Ross and M. Reyes)

"Tissue-Equivalent Approach to a Tissue-Engineered Cardiovascular Valve" U.S. Patent #6,666,886 (with T. Girton and M. Neidert)

“Tissue-Equivalent Rods Containing Aligned Collagen Fibrils and Schwann Cells” U.S. Patent #6,057,137 (with S. Guido)

“Magnetically Oriented Tissue-Equivalent and Biopolymer Tubes” U.S. Patent #5,948,654 (with D. Mooradian, S. Guido, and T. Girton)

University Service

- Program Advisory Committee for the Biomedical Engineering Graduate Program, 1989.
- Search Committee for the Earl Bakken Endowed Professorship in Biomedical Engineering, 1989-1991, 2002-2003.
- Senate Committee on Computing and Information Services, 1990-1992.
- Minnesota Supercomputer Institute Undergraduate Internship Committee, 1994-1995.
- University Senate, 1995-1996.
- Graduate School Fellowship Committee, 1996.
- Search Committee for the Director of Development for the Institute of Technology, 1995-1996.
- Graduate Recruiting Committee, Department of Chemical Engineering & Materials Science, 1987-2000.
- Acting Director of Undergraduate Studies, Department of Biomedical Engineering, 1998-1999, 2003-2004.
- Head, Department of Biomedical Engineering, 2000-2019
- Director of Graduate Studies, Department of Biomedical Engineering, 2000-2003, 2005-2006.
- Search Committee for Director of the Cancer Center, 2004-2005.
- Ad Hoc Committee on Biomedical Engineering and Medical Devices (Chair), 2005-2006.
- University Strategic Positioning Task Force on Undergraduate Reform: Honors, 2005.
- Search Committee for Director of the Medical Devices Center (Chair), 2007.
- College of Science & Engineering Strategic Planning Committee, 2010-2011.
- Medical Devices Center Advisory Board, 2012 – 2019
- OVPR Research Compliance Advisory Committee, 2014 – 2017.
- Search Committee for Chief of Cardiovascular Division, 2015-2016.
- Advanced Preclinical Imaging Center Advisory Board, 2016 – present
- College of Science & Engineering Research Advisory Committee, 2020 – 2023.
- OVPR National Security Institute Planning Committee, 2023

University Programs

- President's Distinguished Faculty Mentor Program, 1990-1991, 1999-2004, 2007-2009, 2011, 2016.
- Bush Foundation Program for Excellence in Teaching, 1991-1992.
- Steering Committee for the Christian Faculty-Staff Network, 1987-1995.
- Biomedical Engineering Institute, Associate Director for Research, 1996-1998.
- Biointerfacial Engineering Program, Principal Investigator, 1991-1998.
- Minnesota Supercomputer Institute, Associate Fellow, 1994-2002.
- MRSEC Artificial Tissues Program (IRG Leader), 1998-2002.

- Institute for Engineering in Medicine, Member, 2000 – present
- Lillehei Heart Institute, Member, 2010 – present
- Stem Cell Institute, Member, 2013 – present

Courses Taught

- ChE 100 - Introduction to Chemical Engineering, University of Pennsylvania, Fall 1983 (as Exxon Fellow).
- BMEN 1601,1602 – Freshman Seminar in Biomedical Engineering, Spring/Fall 2000-2023.
- BMEN 2401 – Programming for Biomedical Engineers, Fall 2024, Spring 2026
- BMEn 3101 - Biomedical Transport Processes, Spring 2001, Fall 2001, Spring 2003-2006, Spring 2008-2013.
- BMEn 5910 - Biomedical Transport Processes, Spring 1997, Spring 1998, Spring 1999, Spring 2001
- BMEn 5311/ChEn 5753 - Biomedical Transport Processes, Spring 2000, Spring 2015, Spring 2016, Spring 2017, Spring 2018, Spring 2019, Spring 2020, Spring 2021, Spring 2022, Spring 2023, Spring 2025, Spring 2026.
- BMEn 5920 - Cell Engineering, Spring 1997.
- ChEn 3001 - Programming for Computational Methods, Winter 1992.
- ChEn 5001 - Computational Methods in Chemical Engineering and Materials Science, Spring 1988, Fall 1988, Spring 1989, Spring 1990, Fall 1990, Spring 1992, Spring 1993, Fall 1993, Spring 1994, Fall 1995.
- ChEn 5103 - Heat and Mass Transfer, Spring 1995.
- ChEn 5401 - Unit Operations Laboratory, Spring 1995.
- ChEn 5601 - Process Control, Winter 1995, Winter 1996, Winter 1997, Winter 1999.
- ChEn 4601 - Process Control, Spring 2000.
- ChEn 8901 - Engineered Soft Tissues, Spring 1996.
- ChEn 8903 - Cellular Bioengineering, Fall 1989, Fall 1992, Fall 1994.
- ChEn 8004 - Transport Phenomena, Winter 1988, Winter 1989, Winter 1990, Winter 1992.
- ChEn 8301 - Transport Phenomena, Fall 1999.

Graduate Student Theses Directed

- Mohammad Durrani (M.S.): Mathematical modeling of biomechanical phenomena in wound contraction (August 1991).
- James Pray (M.S.): Characterization of an *In Vitro* wound healing assay (January 1991) (Plan B project in Biomedical Engineering Graduate Program).
- Stefano Guido (M.S.): Quantitative characterization of contact guidance exhibited by fibroblasts in collagen gels using birefringence (February 1991).
- Richard Dickinson (Ph.D.): Quantitative analysis and mathematical models of receptor-mediated tumor cell invasion, migration and haptotaxis (October 1992).
- Alice Moon (Ph.D.): Cell traction forces exerted on the extracellular matrix: Modeling and measurement (December 1992).
- Prabhas Moghe (Ph.D.): Phenomenological and mechanistic analyses of leukocyte chemotaxis (September 1993).
- Victor Barocas (Ph.D.): Anisotropic, biphasic modeling of cell-collagen mechanical interactions in tissue equivalents (January 1996).

- James Schneider (Ph.D.): Direct Measurement of Forces Between Bilayer-bound Cell Adhesion Elements and Control of Cell Adhesion to Substrata by Surface Modification (December 1997) (jointly advised by M. Tirrell).
- Timothy Girton (Ph.D.): Tissue Engineering an Arterial Media-Equivalent (May 1999).
- David Knapp (Ph.D.): Cell Migration and Traction in Tissue-Equivalents and an *In Vitro* Assay for Wound Healing (August 1999).
- Narendra Dubey (Ph.D.): Contact Guidance of Neurites with Application to Nerve Regeneration (December 1999).
- Mihir Wagle (Ph.D.): Transport Models for Tissue Cells (June 2000).
- Theodore Tower (Ph.D.): Polarimetric Characterization of Tissues and Biopolymer Gels (June, 2000).
- Benjamin Rosner (M.D./Ph.D.): Contact Guiding Neurotrophic Collagen Gel Rods for Peripheral Nerve Regeneration (April, 2001).
- Evie Lee (M.S.): *In Vitro* Remodeling for Improved Tissue-Equivalents (June, 2001).
- Paul Enever (Ph.D.): Fibroblast Traction and Migration in Collagen and Fibrin: Biomechanical and Biochemical Influences on Wound Healing (July, 2001).
- Jennifer Long (M.D./Ph.D.): Elastogenesis in Cardiovascular Tissue-Equivalents (July, 2002).
- Jeff Ross (M.S.): Gene Expression in Cardiovascular Tissue-Equivalents (August, 2002).
- Erin Grassl (Ph.D.): Enhancing the Properties of the Medial Layer of a Bio-Artificial Artery (November, 2002).
- Michael Neidert (Ph.D.): Tissue Engineering a Cardiovascular Valve (April, 2003).
- Audrey Gandadjaja (M.S.): “Enhancement of Entubulation Repair with Schwann Cells” (September, 2004).
- Brett Isenberg (Ph.D.): The Roles of Mechanical Signaling in the Development of a Bio-Artificial Artery (May, 2005).
- Sumeet Jain (Ph.D.): Synthesis of Biopolymer-mimetic Worm-like Micelle Tissue Scaffolds (August, 2005).
- Bradley VanWinkle (M.S.): Characterization of Biopolymer-mimetic Worm-like Micelle Tissue Scaffolds (November, 2005).
- Jason Meyers (M.S.): “Development of a Tissue-Engineered Myocardial Patch” (August, 2006).
- Paul Robinson (Ph.D.): “Development of a Functional Tissue-Engineered Heart Valve Replacement” (December, 2007).
- Zeeshan Syedain (Ph.D.): “Controlled Stretching Bioreactor for Development of a Tissue-Engineered Heart Valve” (April, 2009).

- Katie Ahmann (Ph.D.): “Design of a Fibrin-Based Vascular Graft Seeded with Blood Outgrowth Endothelial Cells” (November, 2010).
- Jason Bjork (Ph.D.): “Transport and Mechanical Property Enhancements for Tissue Engineered Vascular Grafts” (December, 2010).
- Kristen Thatcher (Ph.D.): “The Development and Alignment of Engineered Microvasculature in Fibrin Gel” (November, 2012).
- Victor Lai (Ph.D., co-advised by V. Barocas): “Modeling of Bioengineered Tissue Mechanics” (April, 2013).
- Nathan Weidenhamer (Ph.D.): “Modulating Mesenchymal Stem Cell Invasion into Decellularized Engineered Tissues” (May, 2013).
- Richard Beck (Ph.D.): “A Systems Biology Rationale for In Vitro Tissue Growth Optimization” (May, 2013).
- Jill Schmidt (Ph.D.): “Bioreactor Conditioning for Accelerated Remodeling of Fibrin-Based Tissue Engineered Heart Valves” (July, 2015).
- Jackie Wendel (Ph.D.): “Cardiac Patches for the Delivery of Cells to the Injured Myocardium” (July, 2015).
- Jay Reimer (Ph.D.): “Development of a Tubular Biological Tissue-Engineered Heart Valve with Growth Potential” (May, 2016).
- Sonja Belgrade (Ph.D.): “Development of Pre-Vascularized Tissues Containing Aligned and Perfusable Microvessels” (May, 2016).
- Jeremy Schaefer (Ph.D.): “Development of a Bi-layer Engineered Cardiac Tissue” (July, 2016).
- Anh La (Ph.D.): “Creating an Endothelium from Autologous Mesenchymal Stem Cells” (July, 2018).
- Jirong Lee (Ph.D.): “Computational Construction and Simulation of Novel Heart Valve and Vein Valve Designs” (May 2023).
- Tate Shannon (Ph.D.): “Development of Regenerative, Tissue-Engineered Vascular Grafts for Use in Sites with High Risk of Blood Clotting” (expected completion May 2026).
- Luke Voce (Ph.D.): The Design and Development of a Tissue Engineered Vein Valve (expected completion December 2026).
- Adam Ley (Ph.D.): The Role of Mechanically Anisotropic Cues in Cell Organization in Vasculogenesis (expected completion December 2026).
- Jack Maher (Ph.D.): Regeneration of a Biologically-engineered Vascular Graft (expected completion August 2027).

Postdoctoral Students Supervised

- David Shreiber (Ph.D. BioE, University of Pennsylvania) 1998 - 2002

- Stacey Dixon (Ph.D. ME, Georgia Tech) 2000 – 2002
- Chrysanthi (Sandy) Williams (Ph.D. BME, Georgia Tech) 2004 – 2005
- Choon-Sik Jhun (Ph.D. BME, Texas A&M) 2005 – 2007.
- Lauren Black (Ph.D. BME, Boston University) 2006 – 2009.
- Justin Weinbaum (Ph.D. Molecular Biology, Washington University) 2007 – 2013.
- Jessica Dries-Devlin (Ph.D. Physiology, E. Carolina University) 2012 – 2013.
- Zeeshan Syedain (Ph.D. ChEn, University of Minnesota) 2009 – 2012.
- Greeshma Thrivikraman Nair (Ph.D. Nano Sci & Eng, India Inst. of Science) 2018 – 2021.
- Eric Yu (Ph.D. ChEn, UW-Madison) 2023 - 2025

Research Associates Supervised

- Zeeshan Syedain (Ph.D. ChEn, University of Minnesota) 2012 – present

Graduate Faculty Membership

- Biomedical Engineering
- Chemical Engineering
- Integrative Biology & Physiology
- Materials Science and Engineering