Ramkumar T. Annamalai

Assistant Professor · Biomedical Engineering

760 Press Ave, 138 HKRB, Lexington, KY 40536

(859)257-2685 | ram.kumar@uky.edu | engr.uky.edu/ramlab | ramkumarta | @TheRamLab

Research focus: Immunomodulatory biomaterials, Musculoskeletal regeneration, and Immunotherapies

Education

PhD in Biomedical Engineering — GPA 3.9/4.0
Wayne State University, Detroit MI — Fall 2009 – 2014
- Advisor: Professor Howard W.T. Matthew

MS in Biomedical Engineering — GPA 3.9/4.0
Wayne State University, Detroit MI — Fall 2007 – 2009
- Advisor: Professor Howard W.T. Matthew

Bachelor of Technology in Biotechnology — 1st class (Distinction)
Bharathidasan University, Trichy, India — Fall 2003 – 2007
- Thesis Advisor: Dr. Ashok Chacko

Work Experience

Assistant Professor — Lexington, KY
Department of Biomedical Engineering at the University of Kentucky — Aug 2019 - Present
- College of Engineering

Assistant Research Scientist — Ann Arbor, MI
Department of Biomedical Engineering at the University of Michigan — Aug 2017 - July 2019
- Supervisor: Dr. Jan Stegemann, Mentor: Dr. David Kohn.

Postdoctoral Research Fellow — Ann Arbor, MI
Department of Biomedical Engineering at the University of Michigan — Jun 2014 - July 2017
- Supervisor: Dr. Jan Stegemann

Graduate Research Assistant — Detroit, MI
Department of Chemical Engineering at Wayne State University — Aug 2009 - May 2014
- Supervisor: Dr. Howard Matthew

Thomas C. Rumble University Graduate Fellow — Detroit, MI
Department of Biomedical Engineering at Wayne State University — 2011 - 2012
- Supervisor: Non-service award overseen by the department chair Dr. Albert King

Ongoing Research Grants

Ongoing Support

NIH NIAMS (1R21AR078447) — $350,322; Role: PI
Title: Magnetic nanocomplexes-induced immunomodulation for fracture healing — 2022-2024

NIH COBRE in Pharmaceutical Research and Innovation — $809,586; Role: PI
Title: Immunomodulatory therapy for bone defects — 2021-2024

OTA (Orthopedic Trauma Association — $50,000; Role: PI
Title: A bioinspired strategy to elicit transcriptional control of macrophages for bone regeneration — 2022-2023

2022 Igniting Research Collaborations (IRC) $29,700; Role: PI
Title: Immuno-liposomes for targeted delivery of senolytics for the treatment of osteoarthritis 2021-2022

Past Support

UK IRC $29,700; Role: MPI
Title: Effect of mechanical strain on myokine secretion and its role in diabetic bone disease 2020-2021

KBRIN P20GM103436 $10,000; Role: PI
Title: Magnetic Force-Induced Immunomodulation for Fracture Healing 2020-2021

AO Trauma $10,000; Role: co-I
Title: End Organ Effect of Coronavirus on the Musculoskeletal System: A Basic Science Study 2020-2021

Publications

Mechanical Stimulation of Muscles Influences Bone Phenotype by Modulating Myokine Secretion Under Review
Sureshkumar, Barnett, Kalaitzoglou, Fowlkes, and Annamalai RT 2022 (BioRxiv)

Injectable nanoporous microgels generate vascularized constructs and support bone regeneration in critical-sized defects Scientific Reports
Patrick MD, Keys JF, Sureshkumar H, and Annamalai RT 2022; 12: 15811

Licensing microgels prolong the immunomodulatory phenotype of mesenchymal stromal cells Front. Immunology
Matthew Patrick, and Annamalai RT 2022; 13:987032

Bioresponsive Microspheres for On-demand Delivery of Anti-inflammatory Cytokines for Articular Cartilage Repair J Biomed Mater Res A
Park E, Hart M, Rolauffs B, Stegemann J, Annamalai RT 2020; 108(3):722-733.

Injectable osteogenic microtissues containing mesenchymal stromal cells conformally fill and repair critical-size defects Biomaterials
Annamalai RT, Hong, Schott, Tiruchinapally, Levi and Stegemann 2019; 208:32-44

Harnessing macrophage mediated pathways for degradation of gelation microspheres for Spatiotemporal Control of BMP2 Release Biomaterials
Annamalai RT, Turner P, Carson W, Kunkel S, Levi B and Stegemann J 2018; 161:216-227

Vascular network formation by microvascular endothelial cells in modular fibrin microtissues ACS Biomaterials
Annamalai RT, Rioja, Putnam and Stegemann 2016; 2(11):1914-25

Transport Analysis of Engineered Liver Tissue Fabricated Using a Capsule-Based, Modular Approach Ann Biomed Eng
Annamalai RT and Matthew HW 2019; 47(5):1223-36

Biofabrication of injectable fibrin microtissues for minimally-invasive therapies-Application of surfactants Biomedical Materials
Annamalai RT, Naik, Prout, Putnam, and Stegemann 2018; 13:045005

Collagen Type II enhances chondrogenic differentiation in agarose-based nodular microtissues Cytotherapy
Annamalai RT, Mertz, Daley and Stegemann 2016; 18(2):263-77

A glycosaminoglycan based, modular tissue scaffold system for rapid assembly of perfusable, high cell density, engineered tissues
Annamalai RT, Armant and Matthew
PLoS One
2014; 9(1):e84287

Endothelial sprouting and network formation in collagen- and fibrin-based modular microbeads
Rioja AY, Annamalai RT, Spencer, Putnam and Stegemann J
Acta Biomaterialia
2016; 29:33-41

Multimode ultrasound viscoelastography for interrogation of mechanical properties in heterogeneous biomaterials
Hong X, Annamalai RT, Kemmerer T, Deng C, Stegemann, J
Biomaterials
2018; 178:11-22

Evaluation of salivary cytokines for diagnosis of both trauma-induced and genetic heterotopic ossification
Sung, Chung, Habbouche, Cholok, Allen, Annamalai RT, Priest, Loder, Li, Stegemann, Kunkel and Levi
Front Endocrinol
2017; 8:74

Longitudinal monitoring of osteogenesis and vasculogenesis in ECM matrices using multimode ultrasound viscoelastography
Annamalai RT, Hong X, Hobson E, Deng C, Stegemann, J
In-Preparation
2021

National Conference Presentations (Podium)

Substrate Curvature Modulate Macrophage Response via Actin Cytoskeletal Modifications
A Sovar, M Patrick, and Annamalai RT
BMES
Orlando, 2021

Intracellular Magnetic Force-Induced Phenotype Modulation of Macrophages for Fracture Healing
Sureshkumar H, Z Yi, S Tong, and Annamalai RT
BMES
Orlando, 2021

Influence of Mechanical Stimulation on Myokine Secretion and its Role in Diabetic Bone Disease
Sureshkumar H, Barnett, Patrick, Kalaitzoglou, Fowlkes, and Annamalai RT
BMES
Orlando, 2021

MSC-Licensing Nanoporous Microgels Sustain a Potent Immunomodulatory Phenotype for Cell Therapies
M Patrick, and Annamalai RT
BMES
Orlando, 2021

Intracellular Magnetic Force-Induced Phenotype Modulation of Macrophages for Fracture Healing
Sureshkumar H, Z Yi, S Tong, and Annamalai RT
MSHRS
Virtual, 2021

Effect of Mechanical Strain on Myokine Secretion and its Role in Diabetic Bone Disease
Barnett E, Kalaitzoglou, Fowlkes, and Annamalai RT
SFB
Virtual, 2021

Vascularized Bone Regeneration in a Critical-Sized Calvarial Defect is Potentiated by MP-Mediated Release of BMP2 from Bioresponsive Microspheres
Annamalai RT, Turner, Levi, Kunkel, and Stegemann
BMES
Philadelphia, 2019

Bone Regeneration in a Critical-Sized Calvarial Defect is Potentiated by Macrophage-Mediated Release of BMP2
Annamalai RT, Turner, Levi, Kunkel, and Stegemann
BMES
Atlanta, 2018

Harnessing the Regenerative Potential of Macrophages Using Instructive Extracellular Matrices — BMES
Annamalai RT, Carson, Levi, Kunkel, and Stegemann — Phoenix, 2017

Multiphase Osteogenic and Vasculogenic Microtissues Support Endothelial Cell Network Formation and Enhance the Mineralization Potential of MSCs — BMES
Annamalai RT, Schott, Hong, Tiruchinapally, Levi and Stegemann — Phoenix, 2017

Harnessing Macrophage-Mediated Secretion of BMP2 and VEGF for Bone Tissue Engineering — TERMIS
Annamalai RT, Carson, Agarwal, Kunkel, Levi and Stegemann — San Diego, 2016

Comparison of Bulk and Local Elastic and Viscoelastic Properties of Hydrogels using Non-destructive Ultrasound Imaging — TERMIS
Annamalai RT, Hong, Kuttig, Deng and Stegemann — San Diego, 2016

Injectable, Cell-Seeded, Modular Microtissues for Bone Regeneration in Critical Size Defects — BMES
Annamalai RT, Agarwal, Levi and Stegemann — Minneapolis, 2016

Macrophage-mediated Degradation of Gelatin Microspheres for Release of BMP2 — BMES
Annamalai RT, Turner, Carson and Stegemann — Minneapolis, 2016

Network Formation by Microvascular Endothelial Cells within Modular Fibrin microtissues — TERMIS - World Congress
Annamalai RT, Rioja AY, Putnam and Stegemann — Boston, 2016

Rapid Assembly of Perfusable and Vascularizable Modular Constructs for Hepatic Tissue Engineering — SFB
Annamalai RT and Matthew — Denver, 2014

Tissue Density Culture in GAG-Based Microcapsules as a Foundation for Modular Tissue Engineering — SFB
Annamalai RT, Armant and Matthew — Seattle, 2010

Engineering Differentiated Cells and Stem Cells Using GAG-Chitosan Capsules as Tissue Modules — BMES
Annamalai RT, Armant, and Matthew — Austin, 2010

National Conference Presentations (Poster)

Effect of Mechanical Strain on Myokine Secretion and its Role in Diabetic Bone Disease — SFB
Barnett, Kalaitzoglou, Fowlkes, and Annamalai RT — Chicago, 2021

Bioresponsive Microspheres for on-demand Delivery of Anti-inflammatory Cytokines for Inflammatory Arthritis — SFB
Park, Hart, Rolauffs, Stegemann, and Annamalai RT — Seattle, 2019

Modular microtissues for the regeneration of functional bone in large defects — WCB
Annamalai RT, Hong, Schott, Levi, and Stegemann — Dublin, 2018

Bone Regeneration using Minimally-Invasive Delivery of Modular Microtissues — TERMIS
Annamalai RT, Hong, Agarwal, Levi and Stegemann — San Diego, 2016

Injectable Modular Microtissues for Orthopaedic Reconstruction and Regeneration — MSHRS
Annamalai RT, Agarwal, Breuler, Levi and Stegemann — Orlando, 2016

Material properties and differentiation potential of collagen-II based 3D microbeads for cartilage tissue engineering — SFB
Annamalai RT, Mertz, Daley, and Stegemann — Charlotte, 2015

Modular Biomaterial Systems for Rapid and Functional Vascularization — SFB
Annamalai RT, Armant, and Matthew — Boston, 2013

Modular Biomaterial Scaffolds for Scalable Tissue Assembly and Rapid Vascularization — AIChE
Annamalai RT, Armant, and Matthew — San Francisco, 2013

Engineering ECM-Based Modular Scaffolds for Perfusion and Functional Vascularization — BMES
Annamalai RT, Armant, and Matthew — Atlanta, 2012

Modular Tissue Engineering with GAG-Based Microcapsules: Assembling 3D Tissue Structures — TERMIS
Annamalai RT, Armant, and Matthew — Orlando, 2010

Tissue Density Culture in Gag-Based Microcapsules as a Foundation for Modular Tissue Engineering — BMES
Annamalai RT, Armant, and Matthew — Austin, 2010

Other National Conference Presentations

The Effect of MSC Phenotype on Osteogenesis and Vasculogenesis in Engineered Multiphase Microenvironments — SFB
Schott, Annamalai RT, Juliar, and Stegemann — Seattle, 2019

Injectable Gelatin Microcarriers for Osteogenic Induction of MSCs for Bone Regeneration — SFB
Nweke, Annamalai RT, and Stegemann — Seattle, 2019

Multimode Ultrasound Viscoelastography (MUVE) for the Interrogation Of Microscale Mechanical Properties in Heterogeneous Biomaterials — WCB
Hong, Annamalai RT, Hobson, Deng, and Stegemann — Dublin, 2018

Macrophage-specific TGF-B is a Targetable Cytokine to Prevent Heterotopic Ossification — PSRC
Cholok, Agarwal, Loder, Chung, Annamalai RT, Habbouche, Priest, Carson, Breuler, Ranganathan, Li, Butts, Kaura, Hsung, Li, Mishina, and Levi — Durham, 2017

Influence of Endothelial Cells on Mesenchymal Stem Cell Osteogenesis in Co-Culture Systems — BMES
Schott, Annamalai RT, and Stegemann — Phoenix, 2017

Cell-Mediated Degradation of Genipin-Crosslinked Gelatin Microspheres for Growth Factor Delivery — BMES
Turner, Annamalai RT, Rioja, and Stegemann — Tampa, 2015

AIChE	**National**, American Institute of Chemical Engineer
BMES	**National**, Biomedical Engineering Society
MHSRS	**National**, Military Health System Research Symposium
PSRC	**National**, Plastic Surgery Research Council
SFB	**National**, Society For Biomaterials
TERMIS	**National**, Tissue Engineering and Regenerative Medicine International
TERMIS	**International**, Tissue Engineering and Regenerative Medicine International-World Congress
WCB	**International**, World Congress of Biomechanics

Teaching Experience

Instructor: University of Kentucky, Lexington

Introduction to Biomaterials (BME 488) Since Fall 2020
Course Description: Study of biological and man-made materials that perform, improve or restore natural functions. Structure, properties of materials used in orthopedic, soft tissue, and cardiovascular applications.

Biomaterial Science and Engineering (BME 661) Since Fall 2019
Course Description: Advanced study of biological and man-made materials that recreate, improve or restore natural functions along with case-studies on fabricating specific functional tissues and organs. An open-ended design project is also included in this course.

Tissue Engineering (BME 465) Since Spring 2022
Course Description: This course focuses on understanding the principles of tissue engineering and regenerative medicine. Emphasis is on the components and design criteria of tissue engineering constructs.

Oral Biology (OBI 651) - Guest lecturer Since Spring 2020
Course Description: Guest lecturer for the sessions on ”Biomaterials and Drug Delivery.” with emphasis on drug delivery methods/devices that can be used in the oral cavity. This course is offered in College of Dentistry.

Guest Lecturer: University of Michigan, Ann Arbor

Introduction to Tissue Engineering (BME 474) 2015-2019
Topics: Angiogenesis, vascular tissue engineering and mass transfer in biological systems
Instructor: Dr. Ariella Shikanov

Advances in Tissue Engineering (BIOMATLS 584) 2016-2019
Topics: Vascular tissue engineering and microscale technologies for tissue vascularization
Instructor: Dr. David Kohn

Bioreaction Engineering and Design (BME 321) 2018-2019
Topics: Physical and transport analysis of perfusion bioreactors for liver tissue engineering
Instructor: Dr. Ariella Shikanov

Invited Lecturer

Tissue Engineering, Lawrence Technological University, Southfield, MI 2013-2014
Topics: 3D cell cultures, modular tissue engineering, and perfusion bioreactors design and development. Instructor: Yawen Li.

Tissue Engineering and Hybrid Systems: Wayne State University, Detroit, MI 2009-2014
Topics: Mammalian cell culture techniques, cell growth kinetics, Stem cells for tissue engineering and regenerative medicine, extracellular matrix components, bioreactor design and development. Instructor: Howard Matthew.

Teaching Assistant

Experimental Methods in Biomaterials Lab (BME Level 5000) 2009-2012
Supervised grad/undergrad students to perform animal cell culture techniques, immunostaining, immunohistochemistry, fluorescence and phase contrast microscopy, scaffolding, live/dead assays, proliferation assays and biochemical assays.

Honors & Awards

2016	**Winner**, Logo design contest Michigan Postdoctoral Association of the College of Engineering
2012	**Travel Award**, Biomedical Engineering National Society (BMES), USA
2012	**Student Appointee** , BME Chair Search Committee (Appointed by Dean), Wayne State University
2011	**Thomas C. Rumble Fellowship**, Wayne State University, USA
2010	**Travel Award**, Biomedical Engineering National Society (BMES), USA
2007	**Best Oral Presentation**, Biotechnology National Symposium, Arunai Engineering College, India

Academic Service & Campus Affiliations

2022-	**Panelist**, NSF (BMMB) and NIH (BMBI) grant review panels and study sections
2022-	**Review Editor**, Frontiers in Immunology
2019-	**Faculty Advisor**, Society For Biomaterials Chapter at University of Kentucky
2012-	**Journal Reviewer**, Carbohydrate Polymer, International Journal of Materials Research, Scientific reports, Journal of Biological Engineering, Biomedical Materials, Royal Society for Chemistry, Cellular Physiology & Biochemistry, and Biomaterials.
2014-18	**Project Reviewer**, BME 420/430 Design course
2018	**Abstract Reviewer**, Biomedical Engineering National Society (BMES)
2017-19	**Chair**, Michigan Postdoctoral Association for College of Engineering
2015	**Session Co-chair (Podium presentations)**, TERMIS - World Congress, Boston.
2017	**Member, Organizing Committee**, Biomaterials Day, University of Michigan
2016	**Session Co-chair (Podium presentations)**, TERMIS-North America, San Diego
2011-12	**President**, Biomedical Engineering Society- Wayne State Chapter
2010-14	**Committee Member**, Due Process Committee, Wayne State University
2011	**Chair, Organizing Committee**, Biomedical Engineering Research Day, Wayne State University