Nathan R. Richbourg, Ph.D. *Curriculum Vitae*

Assistant Professor
Dept. of Chemical and Biomedical Engineering
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HydrogelDesign.org

INTERESTS

My research interests lie at the intersection of hydrogel-based materials design and the function of healthy and diseased bone marrow. My experience is built on a combination of chemical engineering and biomedical engineering with an emphasis of polymer physics and the unique cell-environment interactions found in bone marrow. My PhD work on modeling hydrogel structure-property relationships is published in leading journals in the field and summarized at HydrogelDesign.org. My undergraduate and postdoctoral research both focus on tissue engineering, cancer, and biomaterials for the bone marrow microenvironment, and I intend to combine these three experiences in the Richbourg lab's work to engineer solutions to bottlenecks in hematopoietic stem cell (HSC) transplants for blood cancers, sickle cell disease, and other genetic disorders. I will use cell-environment interaction models to provide insight into the mechanisms of cellular communication within the HSC niche.

EDUCATION

PhD — Biomedical Engineering
2018 – 2022 — **University of Texas at Austin**, Austin, TX.
Advisor: Nicholas A. Peppas
Dissertation: Fundamental, Model-Driven Investigations of Structure and Physical Properties of Poly(Vinyl Alcohol) Hydrogels and Multi-Arm Poly(Ethylene Glycol) Hydrogels: Decoupling Stiffness and Solute Transport

BS — Chemical Engineering
2014 – 18 — **University of Oklahoma,** Norman, OK.
Undergraduate Research Advisor: Vassilios I. Sikavitsas
Undergraduate Honors Thesis: Characterization of a Biomimetic Surface Modification for 2-D and 3-D PLLA Scaffolds

PROFESSIONAL EXPERIENCE

8/2025 – Date — Assistant Professor, Dept. of Chemical and Biomedical Engineering
FAMU-FSU College of Engineering, Tallahassee, FL 32310

7/2024 – 7/25 — Postdoctoral Researcher, Department of Biomedical Engineering, PI: **Shelly Peyton**
Tufts University, Medford, MA 02155

9/2022 – 6/24 — Postdoctoral Researcher, Department of Chemical Engineering, PI: **Shelly Peyton**
University of Massachusetts Amherst, Amherst, MA 01003

9/2018 – 8/22 — Graduate Research Fellow, Department of Biomedical Engineering, PI: **Nicholas Peppas**
University of Texas at Austin, Austin, TX 78712

9/2016 – 12/16 — Visiting Undergraduate Research Assistant, Dept. of Chemical and Biological Eng., PI: **Nathaniel Hwang**
Seoul National University, Seoul, South Korea

9/2014 – 6/18 — Undergraduate Research Assistant, School of Chem., Biol., and Mol. Eng., PI: **Vassilios Sikavitsas**
University of Oklahoma, Norman OK 73019

AWARDS AND HONORS

2024 — UMinn Soft Matter Future Faculty Workshop Fellow
2024 — Tufts University Postdoctoral Travel Award for STEEM GRC
2024 – 2025 — Tufts IRACDA Scholar
2024 – 2025 — Organ Design and Engineering Training T32 Postdoctoral Fellowship

2024	WiscProf Future Faculty in Engineering Workshop Fellow
2023	Leadership Travel Award for NCI Junior Investigator Meeting
2022	UT Professional Development Award for ACS Spring Meeting
2022	ACS Excellence in Graduate Polymer Research Award
2021 – 2022	UT University Graduate Continuing Fellowship
2018 – 2022	UT Thrust 2000 Graduate Fellowship in Engineering
2018 – 2021	NSF Graduate Research Fellowship
2017	OU School of Biomedical Engineering Summer Undergraduate Research Fellowship
2016	OU Biomedical Engineering Center Summer Undergraduate Research Fellowship
2016	OU School of CBME F. Mark Townsend Scholarship Award
2016	OU College of International Studies Philip Farish Study Abroad Travel Award
2015 – 2018	OK LSAMP Undergraduate Research Scholarship Program
2014 – 2018	OU National Scholars Program Scholarship
2014	National Merit Scholarship

RESEARCH ARTICLES

12. **Richbourg, N.**, Wechsler, M., Rodriguez Cruz, J., Peppas, N. (2024) Model-based modular hydrogel design. *Nat Rev Bioeng*. https://doi.org/10.1038/s44222-024-00167-4

11. **Richbourg, N.**, Irakoze, N., Kim, H., Peyton, S. (2024) Outlook and Opportunities for Engineered Environments of Breast Cancer Dormancy. *Sci Adv.* https://doi.org/10.1126/sciadv.adl0165

10. **Richbourg, N.,** Peppas, N. (2023) Structurally decoupled stiffness and solute transport in multi-arm poly(ethylene glycol) hydrogels. *Biomaterials.* **301**, 122272, https://doi.org/10.1016/j.biomaterials.2023.122272

9. Kundu, A., Dougan, C., Mahmoud, S., Kilic, A., Panagiotou, A., Irakoze, N., **Richbourg, N.,** Peyton, S. (2023) Tenascin-C activation of lung fibroblasts in a 3D synthetic lung extracellular matrix mimic. *Adv Mater***.** 2301493, https://doi.org/10.1002/adma.202301493

8. **Richbourg, N.,** Peppas, N. (2023) Solute diffusion and partitioning in multi-arm poly(ethylene glycol) hydrogels. *J Mater Chem B.* **11**, 377-388, https://doi.org/10.1039/D2TB02004A

7. **Richbourg, N.,** Rausch, M., Peppas, N. (2022) Cross-evaluation of stiffness measurement methods for hydrogels. *Polymer*. 258, 125316, https://doi.org/10.1016/j.polymer.2022.125316

6. **Richbourg, N.,** Peppas, N. (2021) High Throughput FRAP Analysis of Solute Diffusion in Hydrogels. *Macromolecules.* 54 (22), 10477-10486, https://doi.org/10.1021/acs.macromol.1c01752

5. **Richbourg, N.,** Ravikumar, A., Peppas, N. (2021) Solute Transport Dependence on 3D Geometry of Hydrogel Networks. *Macromol Chem Phys.* 2100138, https://doi.org/10.1002/macp.202100138

4. **Richbourg, N.,** Wancura, M., Gilchrist, A., Toubbeh, S., Harley, B., Cosgriff-Hernandez, E., Peppas, N. (2021) Precise control of synthetic hydrogel network structure via linear, independent synthesis-swelling relationships. *Sci Adv.* 7 (7), https://doi.org/10.1126/sciadv.abe3245

3. **Richbourg, N.,** & Peppas, N. (2020). The Swollen Polymer Network Hypothesis: Quantitative Models of Hydrogel Swelling, Stiffness, and Solute Transport. *Prog Polym Sci.* 105, 101243. https://doi.org/10.1016/j.progpolymsci.2020.101243

2. **Richbourg, N.,** Peppas, N., & Sikavitsas, V. (2019). Tuning the Biomimetic Behavior of Scaffolds for Regenerative Medicine Through Surface Modifications. *J Tissue Eng Regen Med.* 13 (8), 1275-1293. https://doi.org/10.1002/term.2859

1. Karami, D., **Richbourg, N.,** & Sikavitsas, V. (2019). Dynamic In Vitro Models for Tumor Tissue Engineering. *Cancer Letters.* 449, 178-185. https://doi.org/10.1016/j.canlet.2019.01.043

SERVICE POSITIONS

Fa 2024	BMES Annual Meeting Abstract Reviewer and Session Co-Chair (Endometriosis and Uterine Fibroids, Biomaterials)
Su 2023 – Sp 2024	Postdoctoral Researchers Organizing (PRO) UAW 2322 Union for Postdocs at UMass Chair

Sp 2023 – Su 2023	2023 National Cancer Institute (NCI) Junior Investigator Annual Meeting Planning Committee Member
Sp 2023 – Sp 2024	UMass Chemical Engineering DEI Committee Postdoctoral Researcher Representative, Member
Fa 2020 – Sp 2022	UT BME Graduate-Undergraduate Research Union (GURU) Chair
Sp 2020 – Fa 2020	UT BME Graduate Recruitment Student Committee (GRSC) Chair
Sp 2019 – Sp 2020	UT BME Graduate-Undergraduate Research Union (GURU) Event Coordination Officer
Sp 2019 – Fa 2019	UT BME Graduate Recruitment Student Committee (GRSC) Lab Tour Coordinator
2018 – Date	**Ad Hoc Reviewer:** Science Advances, Regenerative Biomaterials, Expert Opinion on Drug Discovery, Journal of Biomedical Materials Research: Parts A & B, Journal of Materials Chemistry B, ACS Omega, ACS Biomaterials Science & Engineering, Clinical & Experimental Metastasis, Advanced Healthcare Materials, Regenerative Engineering and Translational Medicine

PRESENTATIONS

Oral Presentations

2/2025	12. *Modular Hydrogel Design to Investigate How the Extracellular Matrix Supports Dormant Cancer Cells in Bone Marrow* ODET T32 Seminar Series, Brigham and Women's Hospital, Boston, MA
2/2025	11. *Modular Hydrogel Design to Model Health and Disease* Virginia Tech Chemical Engineering Seminar, Roanoke, VI
11/2024	10. *Modeling Environmental Triggers of Breast Cancer Dormancy and Reawakening* Converging on Cancer @ Tufts Research Symposium, Tufts University, Medford, MA
10/2024	9. *Modeling Breast Cancer Dormancy in a 3D Bone Marrow-Mimicking Microenvironment* Tufts BME Retreat, Tufts University, Medford, MA
10/2023	8. *Engineered Microenvironments for Studying Breast Cancer Dormancy* Molecular & Cellular Biology Program Postdoc Showcase, UMass Amherst, Amherst, MA
8/2023	7. *Physical Environmental Influences on Breast Cancer Dormancy* NCI Junior Investigator Meeting, Philadelphia, PA
7/2023	6. *Modular Hydrogel Design to Mimic Healthy and Diseased Microenvironments* Biomaterials and Tissue Engineering Gordon Research Seminar, Holderness, NH
3/2023	5. *Designing Modular, Biomimetic Hydrogels for 3D Cell Culture* Biomedical Engineering Graduate Society (BEGS) Seminar, UMass Amherst, Amherst, MA
5/2021	4. *Predicting Hydrogel Mechanics from Network Structure: Possibilities and Pitfalls* IUTAM Symposium on Mechanics of Smart and Tough Gels, Virtual
4/2021	3. *Decoupling the Biophysical Influences of Stiffness and Diffusivity in 3D Encapsulation Hydrogel Scaffolds* Society for Biomaterials 2021 Annual Meeting, Virtual

3/2021 2. *Coordinated Experimental Analysis of Swollen Polymer Networks Shows Linear Synthesis-Swelling Correlations and Reveals Fundamental Inconsistencies in Theoretical Equations*
APS 2021 March Meeting, Virtual

4/2016 1. *RGD Surface Modification of Cell Culture Scaffolds*
OU Undergraduate Research Day, Norman, OK

Poster Presentations

10/2024 14. *Modular hydrogel design regulates signal protein transport between encapsulated cells*
Richbourg, N., Rampal, A., Huber, R., Lorenzana, A., Irakoze, N., Haag, C., Peyton, S.
BMES 2024 Annual Meeting, Baltimore, MD

9/2024 13. *Protein transport restriction in modular poly(ethylene glycol) hydrogels inhibits cell growth*
Richbourg, N., Rampal, A., Huber, R., Lorenzana, A., Irakoze, N., Haag, C., Peyton, S.
Society for Biomaterials Regional Symposia Northeastern, Boston, MA

7/2024 12. *Protein transport restriction in modular poly(ethylene glycol) hydrogels inhibits cell growth*
Richbourg, N., Rampal, A., Huber, R., Lorenzana, A., Irakoze, N., Haag, C., Peyton, S.
Signal Transduction by Engineered Extracellular Matrix (STEEM) Gordon Research Conference & Seminar, Manchester, NH

8/2023 11. *Physical Environmental Influences on Breast Cancer Dormancy*
Richbourg, N., Kim, H., Irakoze, N., Peyton, S.
NCI Junior Investigator Meeting, Philadelphia, PA

7/2023 10. *Modular, Biomimetic Hydrogel Design: Models, Materials, and Methods*
Richbourg, N., Peyton, S.
Biomaterials and Tissue Engineering Gordon Research Conference & Seminar, Holderness, NH

2/2023 9. *Biochemical and Physical Approaches to Modeling Cancer Cell Interactions with Extracellular Matrix*
Richbourg, N., Kundu, A.N., Peppas, N., Peyton, S.
Physical Science of Cancer Gordon Research Conference & Seminar, Galveston, TX

4/2022 8. *Junction Functionality-Dependent Stiffness and Solute Transport in Biocompatible Hydrogels*
Richbourg, N., Peppas, N.
Society for Biomaterials 2022 Annual Meeting, Baltimore, MD

3/2022 7. *Structural Control and High-Throughput FRAP Analysis of Solute Diffusion in Hydrogels*
Richbourg, N. (Excellence in Graduate Polymer Research Award), Peppas, N.
ACS 2022 Spring Meeting, San Diego, CA

10/2021 6. *High-Throughput FRAP Analysis of Solute Diffusion in Biomedical Hydrogels*
Richbourg, N., Peppas, N.
BMES 2021 Annual Meeting, Virtual

10/2020 5. *Structural Control of Stiffness and Solute Diffusivity in Hydrogel Scaffolds*
Richbourg, N., Peppas, N.
BMES 2020 Annual Meeting, Virtual

6/2020 4. *Reexamining Hydrogel Swelling and Mesh Size as Predictors of Solute Diffusivity*
Richbourg, N., Peppas, N.
Controlled Release Society Annual Meeting, Virtual

10/2019 3. *Quantitative Models Relating the Synthesis, Swelling, and Network Structure of Hydrogel Scaffolds for Regenerative Medicine*
Richbourg, N., Peppas, N.
BMES 2019 Annual Meeting, Philadelphia, PA

5/2019 2. *Reevaluating Hydrogel Network Structure with an Expanded Thermodynamic Model*
Richbourg, N., Peppas, N.
Texas Biomaterials Day, Houston, TX

5/2017 1. *Surface Modifications of Aliphatic Polyester Scaffolds for Tissue Engineering*
Richbourg, N. (3rd Prize), Sikavitsas, V.
OK-LSAMP Symposium, Stillwater, OK

TEACHING EXPERIENCE

Fa 2025 Course Instructor for CBE 3631 Biotransport Phenomena, FAMU-FSU
Sp 2025 Guest Lecture on Cancer Tissue Engineering for Tissue Engineering CHE 5332_001 at Villanova U
Sp 2024 Guest Lecture for Chemical Engineering Separations CHEM-ENG 338 at UMass Amherst
12/22, 5/23 Outreach Presentations to Northampton, MA High School Students
Fa 2021 Attended Grad. Level Eng. Ed. Course: Assessment and Curriculum Design in Engineering at UT Austin
Sp 2016 Undergraduate Teaching Assistant for Moment, Heat, and Mass Transfer 1 CH E 3113,
School of Chemical, Biological, and Molecular Engineering at the University of Oklahoma

FORMAL MENTORING EXPERIENCE

2018 – 2019 Sebastian Salvador, Undergraduate Student, UT Austin (Current: Engineer, Fluor Corporation)
2019 – 2020 Jessie Sun, Undergraduate Student, UT Austin (Current: Ph.D. Student, University of Delaware)
2019 – 2021 Akhila Ravikumar, Undergraduate Student, UT Austin (Current: Engineer, Plexus Corp)
2020 – 2021 Mauricio Gonzalez, Undergraduate Student, UT Austin
2021 – 2022 Zain Moin, Undergraduate Student, UT Austin
2023 – 2023 Shreya Manikandan, Undergraduate Student, UMass Amherst
2023 – 2024 Cole Haag, Undergraduate Student, UMass Amherst
2023 – 2023 Ezekiel Eliamani, Undergraduate MURALS REU Student, Summer 2023, UMass Amherst
2023 – 2023 Asher Passano, High School Student, Engineering the Cell Summer 2023 Program, UMass Amherst
2023 – 2023 Izabella Martinez, High School Student, Engineering the Cell Summer 2023 Program, UMass Amherst
2023 – 2023 Jamesna Sainvil, High School Student, Engineering the Cell Summer 2023 Program, UMass Amherst
2023 – 2023 Kassi Perry, High School Student, Engineering the Cell Summer 2023 Program, UMass Amherst
2023 – 2023 Laura Brown, High School Student, Engineering the Cell Summer 2023 Program, UMass Amherst
2023 – 2023 Vaishali Konowitz, High School Student, Engineering the Cell Summer 2023 Program, UMass Amherst
2023 – 2024 Kristie Cheng, Graduate Student, Peppas Lab, UT Austin (Guidance on project related to my PhD)
2023 – 2023 Aliyah Daliyer, Graduate Student, UMass Amherst (Peyton lab rotation student, Fall 2023)
2023 – 2025 Auggie Wirasaputra, PhD Student, Peyton Lab, UMass Amherst & Tufts University
2024 – 2024 Asher Baynes, Undergraduate Student, Peyton Lab, Tufts University
2024 – 2024 Emily Gong, Undergraduate Student, Peyton Lab, Tufts University
2024 – 2025 Tianna Edwards, PhD Student, Peyton Lab, Tufts University
2024 – Date Ishaan Duggal, PhD Student, Peppas Lab, UT Austin
2024 – 2025 Juan Flechas-Beltran, PhD Student, Peyton Lab, Tufts University

PROFESSIONAL MEMBERSHIP

2021 – Date American Physical Society (APS) Division of Polymer Physics (DPOLY)
2019 – Date American Chemical Society (ACS) POLY & PMSE
2019 – Date Biomedical Engineering Society (BMES)
2019 – Date Society for Biomaterials (SFB)
2025 – Date American Institute of Chemical Engineers (AIChE)