

Novella M Keeling

Contact: 1111 Engineering Dr. Boulder, CO 80309-0427

Work e-mail: novella.bates@colorado.edu

Education

- Ph.D., Biomedical Engineering, **Oregon Health & Science University** April 2022
Portland, OR
Dissertation Title: Engineering Novel Biomaterials and Evaluating the use of Novel Therapeutics in Current Clinical Devices to Mitigate Medical Device-induced Thrombosis
Advisor: Dr. Monica T. Hinds
- B.S., Chemistry (Biochemistry with honors), **Portland State University**, Portland, OR June 2017
Thesis: Transport and Reactivity of Prebiotic Molecules is affected by Aerosolization
Advisors: Drs. Dean Atkinson and Niles Lehman

Teaching Experience

1. Teaching Assistant Professor, Biomedical Engineering Program, The University of Colorado Boulder, Fall 2023 Biomedical Engineering Senior Design (BMEN 4010)

- Improved and taught the capstone projects course for senior students
- Obtained 13 industry-sponsored projects ranging from software development to medical device redesign for student team participation
- Topics covered in didactic portion of the course include project management, conflict management, budget planning and management, engineering design process, and professionalism
- There were 63 students (all Biomedical Engineering undergraduate seniors)

Introduction to Biomedical Engineering (BMEN 2000)

- Redesigned and taught the introductory course for the Biomedical Engineering major or minor degree
- Topics covered include review of general chemistry concepts, review of biological concepts ranging from small molecules to organ systems, and discussion of a variety of pharmacological and device therapeutics for a range of diseases
- There were 84 students in the class (all undergraduates either majoring or minoring in Biomedical Engineering)

2. Teaching Assistant Professor, Biomedical Engineering Program, The University of Colorado Boulder, Spring 2023 Biomedical Engineering Senior Design (BMEN 4020)

- Developed and taught the capstone projects course for senior students
- Obtained several industry-sponsored medical device projects for student team participation
- Topics covered in didactic portion of the course include project management, conflict management, budget planning and management, engineering design process, and professionalism
- Acted as director for one student team, responsibilities included advising the team on design decisions, coaching the team's Project Manager on navigating team dynamics, and coaching team on interactions with industry client
- There were 15 students (all Biomedical Engineering undergraduate seniors)

Introduction to Biomedical Engineering (BMEN 2000)

- Completely redesigned and taught the introductory course for the Biomedical Engineering major or minor degree
- Topics covered include an introduction to conservation of mass, energy, and charge in biomedical systems
- There were 35 students in the class (all undergraduates either majoring or minoring in Biomedical Engineering)

Independent Study (BMEN 4840)

- Developed a project and mentored an undergraduate student in the area of Engineering Education
- Taught pedagogical approaches to teaching a broad introductory course in engineering
- Taught strategies for development of course content based on desired learning outcomes

- Taught data collection and analysis techniques for qualitative and quantitative data

**3. Teaching Assistant Professor, Biomedical Engineering Program, The University of Colorado Boulder, Fall 2022
Biomedical Engineering Senior Design (BMEN 4010)**

- Developed and taught the capstone projects course for senior students
- Obtained several industry-sponsored medical device projects for student team participation
- Topics covered in didactic portion of the course include project management, conflict management, budget planning and management, engineering design process, and professionalism
- Acted as director for one student team, responsibilities included advising the team on design decisions, coaching the team's Project Manager on navigating team dynamics, and coaching team on interactions with industry client
- There were 17 students (all Biomedical Engineering undergraduate seniors)

Introduction to Biomedical Engineering (BMEN 2000)

- Taught the introductory course for the Biomedical Engineering major or minor degree
- Topics covered include review of general chemistry concepts, review of biological concepts ranging from small molecules to organ systems, and discussion of a variety of pharmacological and device therapeutics for a range of diseases
- There were 73 students in the class (all undergraduates either majoring or minoring in Biomedical Engineering)

4. Adjunct Faculty, Department of Chemistry, Clark College, Spring 2021

General Chemistry Preparation (CHEM& 139)

- Developed and taught a preparatory course for first year students preparing for the majors-level general chemistry sequence
- Developed this course for an online active learning environment and content was delivered in a flipped classroom style
- Topics covered include measurements, density, nomenclature, writing/balancing chemical equations, understanding the properties of elements and compounds, and stoichiometry
- The course had 19 students (all undergraduate science majors)

General Chemistry II & III Lab (CHEM& 152/153)

- Taught the second and third term of General Chemistry Lab
- Assisted in the development of this online lab course in collaboration with three other instructors
- There were a total of 68 students in the course (all undergraduate science majors)

5. Adjunct Faculty, Department of Chemistry, Clark College, Winter 2021

General Chemistry Preparation (CHEM& 139, two sections)

- Developed and taught two sections of a preparatory course for first year students preparing for the majors-level general chemistry sequence
- Developed this course for an online active learning environment and content was delivered in a flipped classroom style
- Topics covered include measurements, density, nomenclature, writing/balancing chemical equations, understanding the properties of elements and compounds, and stoichiometry
- One section of the course had 17 students and the other section had 19 students (all undergraduate science majors)

6. Adjunct Faculty, Department of Chemistry, Clark College, Fall 2020

Chemical Concepts with Lab (CHEM& 110)

- Taught an introductory chemistry course for students looking to satisfy their General Education Science degree requirement
- Taught this course online in a traditional lecture style with some class time focused on group discussion and problem solving
- Topics covered included the structure of the atom, chemical and physical properties of matter, chemical reactions, unit conversions, and stoichiometric problem solving
- This course had 36 students (all undergraduate non science majors)

General Chemistry I Lab (CHEM& 151)

- Taught the first term of General Chemistry Lab
- Assisted in the development of this online lab course in collaboration with three other instructors
- There were a total of 70 students in the course (all undergraduate science majors)

7. Adjunct Faculty, Department of Chemistry, Clark College, Spring 2020

Organic Chemistry III Lab (CHEM& 253)

- Developed and taught an online organic chemistry lab for undergraduate science majors
- Developed this course in collaboration with the organic chemistry lecture instructor
- Recorded myself performing 6 different experiments and edited the videos, such that students had a first-person experience of the lab work. Students required to read measurements, take lab notes/observations as if they were performing the experiences themselves, and write full lab reports based on the results.
- The course covered two spectroscopy labs, four synthesis labs, and a “Determine the Unknown Compound” project
- There were three sections of this lab, each with 18 students (all undergraduate science majors)

8. Adjunct Faculty, Department of Chemistry, Clark College, Winter 2020

Introductory to Chemistry and Introduction to Organic/Biochemistry (CHEM& 121 and CHEM& 131)

- Taught two courses intended for students on a “pre-health” track, seeking two-year degrees, such as nursing and dental hygiene
- The two courses covered topics such as measurement, unit conversions, atomic structure, chemical reactions, properties of organic compounds, macromolecules and metabolism, and nutrition
- Each of these courses had 18 students

General Chemistry II Lab (CHEM& 152)

- This course was taught in an “open lab” format, where students arrived at the lab at any time to perform their experiments
- There were 10 instructors teaching this course and each would take a few shifts in the open lab
- There were 170 students enrolled in the lab but the capacity at any given time for in lab work was 20 students (all undergraduate science majors)

9. Supplemental Instructor, (CH 221, 222, and 223), Portland State University, Fall 2015 – Spring 2017

- Taught a problem solving workshop for general chemistry that was intended to supplement the lecture and lab content of the majors-level sequence
- Prepared several problems week-to-week based on the lecture content present by Dr. Eric Sheagley
- This course had 12 students (all undergraduate science majors)

10. Chemistry and Biochemistry Learning Assistant, Portland State University, Fall 2015 – Spring 2017

- Assisted Dr. Eric Sheagley in the large general chemistry lecture hall
- Dr. Sheagley used peer oriented guided inquiry learning techniques in a flipped classroom
- I was tasked with monitoring group activities, prompting discussion amongst students by asking guiding questions, and answering any questions that students had about the material
- This course had an average of 160 students each quarter over two years (all undergraduate science majors)

Mentoring Experience

1. Teaching and Course Assistant Mentor, University of Colorado Boulder, Fall 2023

Mentored Qiming Fan, Ushmi Akruwala, and Violeta Salazar in grading and leading group work within a large lecture hall for an introductory course.

2. Teaching and Course Assistant Mentor, University of Colorado Boulder, Spring 2023

Mentored Corrin Bowman, Catalina Bastias, and Kathleen Stewart in grading and leading subgroups within a large lecture hall for an introductory course.

3. Teaching and Course Assistant Mentor, University of Colorado Boulder, Fall 2022

Mentored Jane Song, Liana Kerr-Layton, Mia Fox, Catalina Bastias, Nick Vaver, and Kathleen Stewart in grading and leading subgroups within a large lecture hall for an introductory course.

- 4. Junior Graduate Student Mentor, Oregon Health & Science University, ongoing since Fall 2021**
Hillary Le: graduate student in the Hinds laboratory interested in the impact of THC on developmental biology.
- 5. Junior Graduate Student Mentor, Oregon Health & Science University, ongoing since Fall 2020**
Rick Mathews: current MD/PhD graduate student in the Hinds laboratory interested in studying mechanisms of hypertension.
- 6. Junior Graduate Student Mentor, Oregon Health & Science University, ongoing since Fall 2019**
Meghan Fallon: graduate student in the Hinds laboratory studying the effects of anisotropic micropatterning on the function of endothelial cells and underlying mechanisms driving cell alignment on surfaces. I have trained Meghan in benchtop biochemical assays and microplate reader assays.
- 7. Undergraduate Student Mentor, Equity Program, Oregon Health & Science University, Summer 2021**
Laura Martinez: senior undergraduate student from Washington State University interested in careers in medicine and research.
- 8. Undergraduate Student Mentor, Oregon Health & Science University, Summer 2019**
Claire Johnston: freshman bioengineering undergraduate student from Oregon State University interested in a career in research. I trained Claire in endothelial cell culture, biochemical benchtop assays, material manufacturing, and understanding how to interpret primary literature in the area of cardiovascular engineering.
- 9. Undergraduate Student Mentor, American Heart Association Undergraduate Fellow, Oregon Health & Science University, Summer 2019**
Heather Heidenreich: senior bioengineering undergraduate student from Washington State University interested in a career in biotech or research. I trained Heather in benchtop biochemical assays to assess in vitro thrombogenicity, microplate reader assays, and material manufacturing. I led the project that Heather was working on in the lab, which led to her first publication in a peer reviewed journal.
- 10. High School Student Mentor, Oregon Health & Science University, Summer 2018**
Alex Adamek: high school student from St. Mary's Academy interested in majoring in bioengineering or biomedical engineering in college.

Service and Leadership

- Associate Faculty Director of External Relations, University of Colorado Boulder, Biomedical Engineering Program, Fall 2023 – Spring 2024
- Panelist, Career Panel, Oregon Health & Science University, Fall 2023
- Panelist for Colorado Advantage “Preparation for Graduate School” Panel.
 - 15 Students - 11 Non-CU and 4 CU Students, 12 Undergraduate and 3 Graduate
- Meet Your Major, University of Colorado Boulder, Biomedical Engineering Program, Fall 2023
- Engagement Survey Task Force, College of Engineering and Applied Science, University of Colorado Boulder, 2023-2024
- Panelist, Society of Women Engineers professional development event, University of Colorado Boulder, Fall 2023
- Speaker, Engineering World Health student chapter team building event, University of Colorado Boulder, Fall 2023
- BFA Academic Affairs Committee Member, University of Colorado Boulder, ongoing since Fall 2023
- Inclusive Culture Committee Member, University of Colorado Boulder, ongoing since Fall 2023
- Biomedical Engineering Society Student Chapter Faculty Advisor, University of Colorado Boulder, ongoing since Fall 2023
- Engineering World Health Faculty Mentor, University of Colorado Boulder, ongoing since Spring 2023
- Biomedical Engineering Undergraduate Committee Member, University of Colorado Boulder, ongoing since Fall 2022
- Chair of the Faculty Governance Teaching Affairs Committee, College of Engineering and Applied Science, University of Colorado Boulder, on going since Spring 2022
- Faculty Governance Committee Member, College of Engineering and Applied Science, University of Colorado Boulder, on going since Spring 2022
- Faculty Transfer Advocate, University of Colorado Boulder, Spring 2023

- receive updates, training, and access to Dean's Office funds for events. these students will highly value the connections and interactions they will receive from department faculty.
- *On Track!* OHSU Science Outreach Volunteer, Program Director: Kathryn Lenahan, Portland, OR, Ongoing since Fall 2017
 - Worked with students in middle school and high school to share information about careers in biomedical engineers
 - For middle school students, we executed a project where they had to build a stethoscope with craft materials for a low cost
 - For high school students, we provided our professional experience, gave tours around our university/hospital, and held a career fair
 - I have also worked with *On Track!* to give senior high school students an opportunity to shadow in the lab for a full day
- Women in Science PDX STEMpowerment Coordinator, Outreach Chair: Ruth Barrett, Portland, OR, Fall 2018 – Winter 2020
 - I initiated classroom visits to local elementary schools to provide scientific demonstrations.
- Student representative for OHSU Biomedical Engineering Diversity, Equity, and Inclusion Committee, ongoing since Spring 2020
 - As a student representative on the DEI committee, I ensure that committee initiatives are inclusive of students and take our needs into consideration when making department level decisions.
- Oregon Health & Science Research Leadership Scholars award, Fall 2019 – Fall 2020
 - This program gave me the opportunity to participate in institution-wide monthly Research Roundtable meetings with deans, chairs of departments, and research leaders. I was able to give a student perspective during research planning discussions.
- Biomedical Engineering Society (BMES) Student Chapter President, Fall 2018 – Winter 2020
 - I was president of the first BMES student chapter at OHSU. We initiated this group to give biomedical engineering graduate students access to a community of scientists which they could learn from professionally and academically. We wrote bylaws and established the student group at OHSU as an approved student group. We also established our group within the national BMES organization. At OHSU, our group organized talks by industry speakers, research scientists, and senior graduate students to discuss a variety of topics.

Research Experience

Graduate Research Fellow, Oregon Health & Science University, Portland, OR

Dissertation Topic: Mechanisms and characterization of medical device-induced thrombosis

Advisor: Dr. Monica T. Hinds

Fall 2017 – Spring 2022

Project: *Evaluation of the effect of crosslinking method of poly(vinyl alcohol) hydrogels on thrombogenicity*

- Optimized the manufacturing of chemically and physically crosslinked poly (vinyl alcohol), PVA
- Designed experiments to assess thrombogenicity of crosslinked PVA materials
- Measured platelet adhesion, time to generate fibrin, and activation of coagulation factor XII on materials
- Demonstrated that the crosslinking of PVA affected both the platelet adhesion and the time to generate fibrin, but did not alter initiation of FXII-dependent coagulation
- Enhanced the knowledge of how thrombogenicity of PVA is dependent on manufacturing and indicated how crosslinked PVA might perform in vivo
- Addressed a long held controversy on the hemocompatibility of PVA
- Published this work in Cardiovascular Engineering and Technology
- Presented this work at national and international conferences

Project: *Bioconjugation of a collagen-mimicking peptide onto poly(vinyl alcohol) encourages endothelialization while minimizing thrombosis*

- Manufactured a novel PVA biomaterial by covalently attaching a collagen-mimicking peptide, GFPGER, to the surface of planar and tubular PVA

- Characterized the surface properties of the modified material, using a captive bubble method to measure the contact angle on the surface of the PVA, x-ray photoelectron spectroscopy, and a fluorescent-labeled peptide for quantification purposes
- Examined endothelial cell (EC) attachment to the modified samples using immunohistochemistry by staining for VE-cadherin, actin, and nuclei and quantified ECs with a DNA quantification assay
- Quantified platelet attachment and time to fibrin clot formation in vitro
- Used a non-human primate ex vivo arteriovenous shunt model to measure platelet attachment and fibrin formation under physiologically relevant flow profiles
- Demonstrated that GFPGER-modified PVA increases EC attachment, while decreasing platelet attachment and fibrin formation in vitro and ex vivo
- Analyzed all data using R programming
- Overall, showed that covalently-modified GFPGER-PVA promoted EC attachment while maintaining the material's hemocompatibility
- Published this work in *Frontiers: Bioengineering and Biotechnology*
- Presented this work at national and international conferences
- Received two national fellowship grants

Undergraduate Graduate Research Fellow, Portland State University, Portland, OR
 Advisor: Drs. Dean Atkinson and Niles Lehman

Spring 2016 – Spring 2017

Project: *Exploring the Effects of Aerosolization on Prebiotic Transport and Reactivity*

- Designed and constructed an aerosol chamber to mimic the conditions of early Earth, where the transport and reactivity of a model, ribonucleic acid (RNA)-based, chemical system could be examined
 - A sintered glass filter was attached to a peristaltic pump, which was placed at one end of the aerosol chamber and used as the aerosol generator
 - RNA molecules in the aerosol phase were collected on filter paper at the opposite end of the chamber
- Determined an enzymatic detection method using avian myeloblastosis virus reverse transcriptase and the polymerase chain reaction provided the best yield of RNA at low concentrations
- Improved our knowledge of possible chemical reactions that may have led to life on early Earth

Honors, Scholarships, and Grants

Honors

- Invited panelist for the ARCS Scholar Awards Event, October 20, 2021, virtual
- Society for Biomaterials Student Travel Achievement Recognition Award, funded Winter 2021
- Western Washington University Chemistry Seminar invited talk, "Bioconjugation of a collagen-mimicking peptide to poly(vinyl alcohol) promotes endothelial cell attachment while maintaining hemocompatibility", Fall 2020
- OHSU Foundation invited talk, "From Classroom to Clinic: Meet the Biomedical Leaders of Tomorrow", March 2020 (delayed due COVID)
- Guest Lecturer: "Engineering Vascular Grafts to Treat Cardiovascular Disease", EGR 491/591 Biomicrofluidics, Instructor: Patrick Journey, PhD, University of Portland, OR
- Chemistry Honors Recipient, Spring 2017
- Portland State University Dean's list, Fall 2015 – Spring 2017

Grants

- American Heart Association Predoctoral Fellowship Award, funded Spring 2021
- NIH National Research Service Award (NRSA) Individual Predoctoral Fellowship to Promote Diversity in Health-Related Research, funded Aug 2021
- NIH Diversity Supplement - Surface Modification Compliant Vascular Grafts, Winter 2018 – Spring 2021

Scholarships

- Dean Atkinson's Summer Research Scholarship, Summer 2016
- Achievement Rewards for College Scientists (ARCS) Scholarship, Fall 2019 – Fall 2022

Publications

1. **Keeling NM**, Wallisch M, Jordan KR, Johnson J, Puy C, McCarty OJT, Nguyen KP, Aslan JE, Gruber A, Hinds MT, Anderson DEJ. Pharmacological targeting of coagulation factors XII and XI by monoclonal antibodies reduces thrombosis in nitinol stents under flow. *Journal of Thrombosis and Hemostasis*. Under review Dec 2023.
2. Faase R, **Keeling NM**, Plaut JS, Guerra A, Hinds MT, Baio J, Jurney PL. Temporal Changes in the Surface Chemistry and Topography of Reactive Ion Plasma-Treated Poly(vinyl alcohol) Alter Endothelialization Potential. *ACS Appl. Mater. Interfaces*. 2023 Dec 20.
3. **Bates NM**, Fallon ME, Hinds MT. In Vivo Imaging of Tissue-Engineered Grafts Within Pulmonary Artery of a Growing Large Animal Model. *JACC Basic Transl Sci*. 2022 Mar 28;7(3):220-222. PMC8993903.
4. Fallon ME, Le HH, **Bates NM**, Yao Y, Yim EKF, Hinds MT, Anderson DEJ. Hemocompatibility of micropatterned biomaterial surfaces is dependent on topographical feature size. *Frontiers Physiol. Sec. Biophysics*. 2022 Sept.
5. **Bates NM**, Puy C, Jurney PL, McCarty OJT, Hinds MT. Evaluation of the effect of crosslinking method of poly(vinyl alcohol) hydrogels on thrombogenicity. *Cardiovasc Eng Technol*. 2020 Aug; 11(4):448-455. PMC7390681.
6. **Bates NM**, Heidenreich HE, Fallon ME, Yao Y, Yim EKF, McCarty OJT, Hinds MT, Anderson DEJ. Bioconjugation of a collagen-mimicking peptide onto poly(vinyl alcohol) encourages endothelialization while minimizing thrombosis. *Frontiers in Bioeng and Biotech*. 2020 Dec 18; 8:621768. PMC7793657.

Presentations

1. **Bates, NM**, Heidenreich, HE, Fallon, ME, Yao, Y, Yim, EKF, Hinds, MT, and Anderson, DEJ. Modification of poly(vinyl alcohol) with a collagen-mimicking peptide encourages endothelialization while minimizing thrombosis, Poster presentation for AfroBioTech Conference, Virtual, October 2020.
2. **Bates, NM**, Puy, C, McCarty, OJT, and Hinds, MT. The Crosslinking Method of Poly(vinyl) Alcohol Hydrogels Alters Platelet Adhesion and Fibrin Formation, Poster presentation for Bio-medical Engineering Society (BMES), Philadelphia, Pennsylvania; October 2019
3. **Bates, NM**, Puy, C, McCarty, OJT, and Hinds, MT. Crosslinking of Poly(vinyl) Alcohol Hydrogels determines Material Thrombogenicity, Poster presentation for International Society on Thrombosis and Haemostasis (ISTH), Melbourne, Australia; July 2019
4. **Bates, NM**, Puy, C, McCarty, OJT, and Hinds, MT. Thrombogenicity of Poly(vinyl alcohol) Hydrogels is Dependent on the Crosslinking Agent, Poster presentation Society for Biomaterials (SFB), Seattle, Washington; April 2019
5. **Bates, NM**, Exploring the Effects of Aerosolization on Prebiotic Transport and Reactivity, Chemistry Honors Symposium, Portland, OR, Talk given at Chemistry Honors Symposium (2017)

References Available Upon Request