

## Benjamin S. Schuster, Ph.D.

Assistant Professor  
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### Professional Experience

Assistant Professor, Dept. of Chemical & Biochemical Engineering, Rutgers University 2019 – pres.  
Postdoctoral Associate, Dept. of Bioengineering, University of Pennsylvania 2014 – 2018

### Education

Ph.D., Biomedical Engineering, Johns Hopkins University 2014  
B.S., Biomedical Engineering, University of Minnesota, *with high distinction* 2008

### Research

*Current Research* 2019 – present  
Rutgers University Schuster Lab

- The Schuster Lab studies and engineers biomolecular materials with applications in biomanufacturing and pharmaceuticals.
- We are particularly interested in intrinsically disordered proteins that self-organize via liquid-liquid phase separation into meso-scale assemblies called biomolecular condensates.
- By understanding why and how these proteins assemble, we aim to gain new insights into their roles in health and disease.
- By engineering these proteins, we seek to invent new technologies for biocatalysis, bioseparations, and biopharmaceuticals.
- We employ approaches from biochemical engineering, protein chemistry, biophysics, and soft matter.

*Postdoctoral Research* 2014 – 2018  
University of Pennsylvania Advisor: Daniel A. Hammer, Ph.D.

- Awarded NIH Ruth Kirschstein National Research Service Award (F32).
- Engineered synthetic membrane-less organelles based on an intrinsically disordered protein that self-assembles into liquid droplets. Demonstrated methods to enzymatically trigger droplet assembly and disassembly. Devised modular strategies to control organelle composition by targeting exogenous cargo molecules into the organelles.

*Graduate Research* 2009 – 2014  
Johns Hopkins University Advisor: Justin Hanes, Ph.D.

- Thesis title: Probing and Overcoming Extracellular Barriers to Inhaled Nanomedicine.
- Discovered approaches to enhance pulmonary drug and gene delivery for cystic fibrosis, based on biophysical insights from quantitative microscopy. Collaborated with clinicians and researchers to design nanoparticles and viral vectors capable of penetrating the lung's mucus barrier for enhanced therapeutic efficacy.

### Honors and Awards

NSF CAREER award 2023 – present  
NIH MIRA award 2021 – present  
Research Council Award, Rutgers University 2020  
NIH Ruth L. Kirschstein National Research Service Award (NRSA) Fellowship 2016 – 2018  
Award for Research Excellence, Johns Hopkins Center for Nanomedicine 2014  
University of Minnesota Presidential Scholarship 2004 – 2008

## Publications

(Asterisks denote where BSS is a corresponding or co-corresponding author.)

1. Park A, **Schuster BS\***. Cross-linked biomolecular condensates as a novel method of enzyme immobilization for biocatalytic processes. *In preparation*.
2. Favetta B, Barai M, Wang H, Shi Z, **Schuster BS\***. Phosphorylation Regulates the Function of the SARS-CoV-2 Nucleocapsid Protein. *In preparation*.
3. Rizvi A, Favetta B, Jaber N, Lee Y-K, Idris N, **Schuster BS**, Dai W, Patterson JP. Revealing nanoscale structure and interfaces of polymer and protein condensates via cryo-electron microscopy. *In preparation*.
4. Li X, Kuchinski L, Park A, Murphy G, Camacho Soto K, **Schuster BS\***. Enzyme purification and sustained enzyme activity for pharmaceutical biocatalysis by fusion with phase-separating intrinsically disordered protein. *Under Review*.
5. Recki S, Garcia C, Barai M, Rizuan A, **Schuster BS\***, Kiick KL, Mittal J. Molecular language of protein liquid-liquid phase separation. *Accepted, Nature Chemistry*.
6. Kelley FM, Favetta B, Regy RM, Mittal J, **Schuster BS\***. Amphiphilic proteins coassemble into multiphasic condensates and act as biomolecular surfactants. *Proc Natl Acad Sci USA* 2021; 118:e2109967118.
7. Guan M, Garabedian MV, Leutenegger M, **Schuster BS**, Good MC, Hammer DA. Incorporation and Assembly of a Light-Emitting Enzymatic Reaction into Model Protein Condensates. *Biochemistry*. 2021; 60:3137-3151.
8. Wang H, Kelley FM, Milovanovic D, **Schuster BS**, Shi Z. Surface tension and viscosity of protein condensates quantified by micropipette aspiration. *Biophysical Reports* 2021; 1:100011.
9. Garabedian MV, Wang W, Dabdoub JB, Tong M, Caldwell RM, Benman W, **Schuster BS**, Deiters A, Good MC. Designer membraneless organelles sequester native factors for control of cell behavior. *Nature Chemical Biology*. 2021; 17:998-1007.
10. **Schuster BS\***, Dolan EM, Regy RM, Ranganath AK, Jovic N, Khare S, Shi Z, Mittal J. Biomolecular condensates: sequence determinants of phase separation, microstructural organization, enzymatic activity, and material properties. *Journal of Physical Chemistry B*. 2021; 125:3441-3451.
11. **Schuster BS**, Dignon GL, Tang WS, Kelley FM, Ranganath AK, Jahnke CN, Simpkins AG, Regy RM, Hammer DA, Good MC, Mittal J. Identifying sequence perturbations to an intrinsically disordered protein that determine its phase-separation behavior. *Proc Natl Acad Sci USA* 2020; 117:11421-11431.
12. Reed EH, **Schuster BS**, Good MC, Hammer DA. SPLIT: Stable Protein Coacervation using a Light Induced Transition. *ACS Synth Biol*. 2020; 9:500-507.
13. **Schuster BS**, Reed EH, Parthasarathy R, Janke CN, Caldwell RM, Bermudez JG, Ramage H, Good MC, Hammer DA. Controllable protein phase separation and modular recruitment to form responsive membraneless organelles. *Nature Communications* 2018; 9:2985.
14. Glantz ST, Berlew EE, Jaber Z, **Schuster BS**, Gardner KH, Chow BY. Directly light-regulated binding of RGS-LOV photoreceptors to anionic membrane phospholipids. *Proc Natl Acad Sci USA* 2018; 115:E7720-E7727.
15. Caldwell RM, Bermudez JG, Thai D, Aonbangkhen C, **Schuster BS**, Courtney T, Deiters A, Hammer DA, Chenoweth DM, Good MC. Optochemical control of protein localization and activity within cell-like compartments. *Biochemistry* 2018; 57:2590-2596.
16. **Schuster BS**, Allan DB, Kays JC, Hanes J, Leheny R. Photoactivatable fluorescent probes reveal heterogeneous nanoparticle permeation through biological gels at multiple scales. *Journal of Controlled Release* 2017; 260:124-133.
17. Schneider CS, Xu Q, Boylan NJ, Chisholm J, Tang B, **Schuster BS**, Henning A, Ensign LM, Lee E, Adstamongkonkul P, Simons BW, Wang SS, Gong X, Yu T, Boyle MP, Suk JS, and Hanes J.

Nanoparticles that do not adhere to mucus provide uniform and long-lasting drug delivery to airways following inhalation. *Science Advances* 2017; 3(4):e1601556.

18. Chu KK, Mojahed D, Fernandez CM, Li Y, Liu L, Wilsterman EJ, Diephuis B, Birket SE, Bowers H, Martin Solomon G, **Schuster BS**, Hanes J, Rowe SM, Tearney GJ. Particle-tracking microrheology using micro-optical coherence tomography. *Biophysical Journal* 2016; 111:1053-63.
19. **Schuster BS**, Ensign LM, Allan DB, Suk JS, Hanes J. Particle tracking in drug and gene delivery research: state-of-the-art applications and methods. *Advanced Drug Delivery Reviews* 2015; 91:70-91.
20. Yu T, Chan KW, Anonuevo A, Song X, **Schuster BS**, Chattopadhyay S, Xu Q, Oskolkov N, Patel H, Ensign LM, van Zijl PC, McMahon MT, Hanes J. Liposome-based mucus-penetrating particles (MPP) for mucosal theranostics: demonstration of diamagnetic chemical exchange saturation transfer (diaCEST) magnetic resonance imaging (MRI). *Nanomedicine* 2015; 11:401-5.
21. Nance E, Zhang C, Shih TY, Xu Q, **Schuster BS**, Hanes J. Brain-penetrating nanoparticles improve paclitaxel efficacy in malignant glioma following local administration. *ACS Nano* 2014; 8:10655-64.
22. Birket SE, Chu KK, Liu L, Houser GH, Diephuis BJ, Wilsterman EJ, Dierksen G, Mazur M, Shastry S, Li Y, Watson JD, Smith AT, **Schuster BS**, Hanes J, Grizzle WE, Sorscher EJ, Tearney GJ, Rowe SM. A functional anatomic defect of the cystic fibrosis airway. *Am J Respir Crit Care Med* 2014; 190:421-32.
23. **Schuster BS**, Kim AJ, Kays JC, Kanzawa MM, Guggino WB, Boyle MP, Rowe SM, Muzyczka N, Suk JS, Hanes J. Overcoming the cystic fibrosis sputum barrier to leading adeno-associated virus gene therapy vectors. *Molecular Therapy* 2014; 22:1484-1493.
24. Kim AJ, Boylan NJ, Suk JS, Hwangbo M, Yu T, **Schuster BS**, Cebotaru L, Lesniak WG, Oh JS, Adstamongkonkul P, Choi AY, Kannan RM, Hanes J. Use of single-site-functionalized PEG dendrons to prepare gene vectors that penetrate human mucus barriers. *Angew Chem Int Ed* 2013; 52:3985-8.
25. **Schuster BS**, Suk JS, Woodworth GF, Hanes J. Nanoparticle diffusion in respiratory mucus from humans without lung disease. *Biomaterials* 2013; 34:3439-46.
26. Langham AA, Khandelia H, **Schuster B**, Waring AJ, Lehrer RI, Kaznessis YN. Correlation between simulated physicochemical properties and hemolysis of protegrin-like antimicrobial peptides: predicting experimental toxicity. *Peptides* 2008; 29:1085-93.

### Invited Presentations (Since Joining Rutgers)

1. Rutgers University, Department of Chemical and Biochemical Engineering, September 22, 2023
2. Princeton University, February 16, 2023
3. Rutgers University, Institute for Quantitative Biomedicine, January 24, 2023
4. Johns Hopkins University Center for Nanomedicine, December 15, 2022.
5. New Jersey Institute of Technology, May 3, 2022.
6. University of Maryland, College Park, March 7, 2022.
7. IDP Seminars (Online seminar series about intrinsically disordered proteins, with worldwide audience), October 7, 2021.
8. Rutgers University, Biomedical Engineering, September 9, 2019
9. Rutgers University, Chemistry and Chemical Biology, September 3, 2019

### Selected Conference Posters and Presentations

(Presenting author is underlined.)

1. Kelley FM, Linders B, Ani A, Favetta B, Barai M, Ma Y, Gu Y, **Schuster BS**. “Controlled recruitment of particles into biomolecular condensates.” Biophysical Society 68th Annual Meeting, February 13, 2024 (Presentation).
2. Barai M, Pinlac E, Recki S, Garcia C, Kiick KL, Mittal J, **Schuster BS**. “Sequence-Specific Insights into the Time-Dependent Material Properties of Biomolecular Condensates.” Biophysical Society 68th Annual Meeting, February 12, 2024 (Poster).
3. Favetta B, Barai M, Wang H, Shi Z, **Schuster BS**. “Phosphorylation Regulates the Function of the

- SARS-CoV-2 Nucleocapsid Protein”. Biophysical Society 68th Annual Meeting, February 12, 2024 (Poster).
4. Kelley FM, Linders B, Ani A, Favetta B, Barai M, Ma Y, Gu Y, **Schuster BS**. “Nanoparticle Toolbox for Probing Biomolecular Condensates.” Rutgers-Princeton Biomolecular Condensates Day, Princeton, NJ. September 14, 2023. (Presentation)
  5. Barai M, Recki S, Garcia C, Kiick KL, Mittal J, **Schuster BS**. “Sequence Determinants of Biomolecular Condensate Viscosity of Model Repeat Intrinsically Disordered Proteins.” Rutgers-Princeton Biomolecular Condensates Day, Princeton, NJ. September 14, 2023. (Poster)
  6. Favetta B, Barai M, Wang H, Shi Z, **Schuster BS**. “RNA type determines SARS-CoV-2 Nucleocapsid condensate structure and function.” Rutgers-Princeton Biomolecular Condensates Day, Princeton, NJ. September 14, 2023. (Presentation)
  7. Park A, Zhang H, **Schuster BS**. “Crosslinking RGG biomolecular condensates to form novel protein-based biomaterials.” Rutgers-Princeton Biomolecular Condensates Day, Princeton, NJ. September 14, 2023. (Presentation)
  8. Li X, Park A, Murphy G, Kamacho Soto K, **Schuster BS**. “Enzyme purification and sustained enzyme activity by fusion with phase-separating intrinsically disordered protein.” Rutgers-Princeton Biomolecular Condensates Day, Princeton, NJ. September 14, 2023. (Poster)
  9. Favetta B, Kelley FM, Regy RM, Mittal J, **Schuster BS**. “Amphiphilic Proteins Coassemble into Multiphasic Condensates and Act As Biomolecular Surfactants.” ASCB-EMBO 2022 Meeting, Washington, DC. December 4, 2022. (Poster)
  10. Kelley FM, Favetta B, Regy RM, Mittal J, **Schuster BS**. “Amphiphilic Proteins Coassemble into Multiphasic Condensates and Act As Biomolecular Surfactants.” AIChE Annual Meeting, Phoenix, AZ. November 16, 2022. (Presentation)
  11. Li X, Park A, Murphy G, Kamacho Soto K, **Schuster BS**. “Enzyme Purification and Sustained Enzyme Activity By Fusion with Phase-Separating Intrinsically Disordered Protein.” AIChE Annual Meeting, Phoenix, AZ. November 15, 2022. (Presentation)
  12. Li X, Park A, Murphy G, Kamacho Soto K, **Schuster BS**. “Engineering Novel Enzyme Encapsulation Strategies for Biocatalysis using Protein Phase Separation.” Mid-Atlantic ACS Regional Meeting (MARM), Trenton, NJ. June 3, 2022. (Presentation)
  13. Kelley FM, **Schuster BS**. “Amphiphilic proteins coat membraneless organelles and act as biological surfactants.” Biophysical Society 65th Annual Meeting, February 23, 2021. (Presentation)
  14. **Schuster BS**, Dignon G, Jahnke C, Good MC, Hammer DA, Mittal J. “Sequence perturbations that modulate coacervation of an intrinsically disordered protein.” ACS Spring 2020 National Meeting, Philadelphia, PA. March 25, 2020. (Presentation; Conference cancelled due to COVID-19 pandemic)
  15. **Schuster BS**, Dignon G, Jahnke C, Good MC, Hammer DA, Mittal J. “Sequence Determinants of Protein Phase Separation of the Intrinsically Disordered RGG Domain from LAF-1.” Biophysical Society 63rd Annual Meeting, Baltimore, MD. March 6, 2019. (Presentation)
  16. **Schuster BS**, Reed EH, Jahnke C, Ramage H, Good MC, Hammer DA. “Synthetic Organelles Engineered from Phase-Separating Proteins.” 2018 AIChE Annual Meeting, Pittsburgh, PA. October 31, 2018. (Presentation)
  17. **Schuster BS**, Reed EH, Jahnke C, Good MC, Hammer DA. “Controllable phase separation and modular recruitment to investigate biochemical compartmentalization in membraneless organelles.” Biophysical Society 62nd Annual Meeting, San Francisco, CA. February 18, 2018. (Poster)
  18. **Schuster BS**, Reed EH, Jahnke C, Good MC, Hammer DA. “Controllable phase separation and modular recruitment to form synthetic membraneless organelles.” ASCB-EMBO 2017 Meeting, Philadelphia, PA. December 3, 2017. (Poster)
  19. **Schuster BS**, Reed EH, Good MC, Hammer DA. “Protease-responsive droplets engineered from self-assembled disordered proteins.” 2017 AIChE Annual Meeting, Minneapolis, MN. November 2, 2017. (Presentation)
  20. **Schuster BS**, Hammer DA. “Protease-responsive microspheres engineered from self-assembled dis-

- ordered proteins.” 254th ACS National Meeting, Washington, DC. August, 22, 2017. (Presentation)
21. **Schuster BS**, Parthasarathy P, Reed E, Hammer DA. “Engineering protease-triggered disassembly of intrinsically disordered protein droplets.” Biophysical Society 61st Annual Meeting, New Orleans, LA. February 13, 2017. (Poster)
  22. **Schuster BS**, Parthasarathy P, Reed E, Hammer DA. “Engineering protease-responsive protein microspheres from self-assembled disordered proteins.” Biomedical Engineering Society Annual Meeting, Minneapolis, MN. October 6, 2016. (Presentation)
  23. Kays JC, **Schuster BS**, Allan DB, Hanes J, Leheny R. “Multiscale diffusion measurements in biological gels using photoactivatable fluorescent nanoparticles.” Biophysical Society 59th Annual Meeting, Baltimore, MD. February 8, 2015. (Poster)
  24. **Schuster BS**, Kim AJ, Kays JC, Kanzawa MM, Suk JS, Hanes J. “The cystic fibrosis sputum barrier to adeno-associated virus gene therapy.” 12th Annual US-Japan Symposium on Drug Delivery Systems, Lahaina, Maui, Hawaii. December 18, 2013. (Poster and Invited Presentation)
  25. **Schuster BS**, Suk JS, Woodworth GW, Hanes J. “Nanoparticle diffusion in human respiratory mucus.” Biomedical Engineering Society Annual Conference, Atlanta, GA. October 26, 2012. (Presentation)

## Teaching and Mentoring

### *Course Instructor, Rutgers University*

Biochemical Engineering (38 students)	Fall 2023
Biological Foundations of Chemical Engineering (co-taught with G. Dignon; 53 students)	Spring 2022
Biochemical Engineering (75 students)	Fall 2022
Biological Foundations of Chemical Engineering (71 students)	Spring 2022
Biochemical Engineering (co-taught with Haoran Zhang; 107 students)	Fall 2021
Biological Foundations of Chemical Engineering (85 students)	Spring 2021
Biological Foundations of Chemical Engineering (110 students)	Spring 2020
Biochemical Engineering (co-taught with Haoran Zhang; 76 students)	Fall 2019
Biological Foundations of Chemical Engineering (89 students)	Spring 2019

### *Ph.D. Students, Rutgers University*

Mayur Barai, 2021– present  
 Augene Park, 2020 – present  
 Bruna Favetta, 2020 – present  
 Xinyi Li, 2019 – present  
 Fleurie Kelley, 2018 – present

### *Masters Students, Rutgers University*

John Knight, 2023 - present  
 Liam Kuchinski, 2023-present  
 Aishwarya Kanchi Ranganath, 2019-2021 (to PhD at U Buffalo)  
 Rashmi Vasthare, 2019 (to Regeneron Pharmaceuticals)

### *Undergraduate Students, Rutgers University*

Present: Emily Pinlac, Anas Ani  
 Graduated: Liam Kuchinski, Ashley Huang, Amelia Rucki, Maxwell Shapiro, Kaleb Friedman

### *REU Students*

Bridget Linders (CU-Boulder), Summer 2023

## Thesis Committees

Augene Park - CBE (Schuster) PhD thesis proposal 10/23/23  
Yadiel Varela-Soler - CBE (Roth) PhD thesis proposal 5/30/23  
Mayur Barai - CBE (Schuster) PhD thesis proposal 4/24/23  
Bruna Favetta - BME (Schuster) PhD thesis proposal 2/27/23  
Xinyi Li - CBE (Schuster) PhD thesis proposal, 3/28/22  
Yuxin Liu - CBE (Zhang), PhD thesis proposal 11/12/21 and defense 9/12/22  
Prin Chaksmithanont - CBE (Glasser) PhD thesis proposal 10/29/21  
Zachary Power - CBE (Chundawat) MS thesis defense 7/30/21  
Lei Zhuang - CBE (Zhang) PhD thesis proposal 5/26/21  
Fleurie Kelley - CBE (Schuster) PhD thesis proposal 5/25/21  
Dharanidaran Jayachandran - CBE (Chundawat) PhD thesis proposal 5/20/21 and defense 9/8/23  
Bhargava Nemmaru - CBE (Chundawat) PhD thesis proposal 8/12/20 and defense 11/22/21  
Sweta Gargatte - CBE (Zhang) MS thesis defense 3/15/20  
Mike Magaracci - UPenn BE (Chow), PhD thesis proposal 12/19/19 and defense 11/19/21  
Yiyao Zhou - CBE (Zhang) MS thesis defense 3/19/19  
Parva Patel - CBE (Neimark) MS thesis defense 4/12/19  
Xiaonan Wang - CBE (Zhang) PhD thesis proposal 4/17/19 and defense 12/8/20  
Zhenghong Li - CBE (Zhang) PhD thesis proposal 5/6/19 and defense 4/17/20  
Madhura Kasture - CBE (Chundawat) MS thesis defense 9/18/19  
Antonio Goncalves - CBE (Chundawat) MS thesis defense 9/23/19  
Jessica McDonald - CBE (Roth) MS thesis defense 9/26/19

### Service to the University

- Mentor in the Biotechnology Training Program, 2020-present
- Member of the BME graduate faculty, 2019-present
- Member of graduate admissions committee, CBE, 2021 - present
- Member of graduate admissions committee, BME, 2020 - present
- Mentor for the Advanced Materials REU, Summer 2023
- Co-organizer of CBE seminar series, Fall 2020 - Spring 2023
- Reviewer, Busch Biomedical Grants, 2022
- Member of faculty search committee, CBE, 2019-2020, 2021-2022
- CBE PhD Preliminary exam committee member, 6/2021, 7/2022
- BME PhD Qualifying exam committee member, 6/2020, 6/2021

### Service to the Profession

- NIH study section, February 2024
- Co-organizer, Rutgers-Princeton Biomolecular Condensates Day, September 14, 2023
- Conference Chair, 2022 AIChE conference, Protein Assemblies and Aggregates
- Ad hoc reviewer, Israel Science Foundation, 2021
- NSF review panel, 2020
- Journal reviewer (ad hoc): Science Advances; Intl. Journal of Pharmaceutics; Biophysical Journal, Nature Communications, Nature Chemistry, Protein Science

### Research Support

#### *Current Support*

1. NSF CAREER: Surfactant Proteins that Stabilize Biomolecular Condensates: From Biophysics to Biomaterials for Biomanufacturing  
6/1/23 – 5/31/28 (\$653,842 total)  
Role: PI
2. R35 GM142903, NIH (NIGMS)

Sequence determinants of membraneless organelle rheology  
8/15/21 – 06/30/26 (\$1,850,652 total)  
Role: PI

*Completed Support*

1. R35 GM142903-01S1, NIH (NIGMS)  
Sequence determinants of membraneless organelle rheology – Research supplement to promote diversity  
1/1/2022 – 12/31/2023 (\$166,852 total)  
Role: PI
2. R35 GM142903-02S2, NIH (NIGMS)  
Sequence determinants of membraneless organelle rheology (Undergraduate supplement)  
7/1/2022 – 6/30/2023 (\$14,306 total)  
Role: PI
3. Rutgers Biotechnology Training Program (NIH T32GM135141) – PhD fellowships awarded to Schuster lab students Fleurie Kelley (2020-2022) and Augene Park (2021-2023).
4. Core Facility Utilization Grants - Nanoscale structure of biomolecular condensates from high-resolution light and electron microscopy  
6/1/22 – 12/31/22 (\$5,000 total)  
Role: PI
5. Collaborative Research Agreement, Merck Sharp & Dohme Corp.  
Leveraging arginine/glycine-rich (RGG) domain phase separation to encapsulate biomolecules  
10/1/20 – 8/31/22 (\$120,000 total)  
Role: PI (Merck PI: Grant Murphy)
6. New Jersey Health Foundation Research Project Grant  
Self-assembling antimicrobial peptide particles for treatment of antibiotic-resistant infections  
2/15/21 – 2/14/22 + 1 year NCE (\$35,000 total)  
Role: PI (co-PI: Haoran Zhang)
7. Busch Biomedical Grant, Rutgers University  
Developing a new paradigm for antibiotic discovery using advanced synthetic biology tools  
9/1/19 – 8/31/21 + 1 yr NCE (\$40,000 total)  
Role: Co-PI (PI: Haoran Zhang)