

Patrick R. Secor, Ph.D.

Assistant Professor
Division of Biological Sciences
University of Montana
32 Campus Dr., Health Sciences Building 104, Missoula, MT 59812
Patrick.secor@mso.umt.edu - <https://patsecor.wixsite.com/mysite-1>

Education

Ph.D., Biological Sciences Department of Cell Biology & Neuroscience Center for Biofilm Engineering Montana State University	2011
B.S., Biochemistry Montana State University, cum laude	2006

Research Experience

Assistant Professor University of Montana Division of Biological Sciences Center for Biomolecular Structure and Design Center for Translational Medicine	2017 - present
Postdoctoral Fellow University of Washington Department of Microbiology Mentor: Pradeep K. Singh, MD	2013 - 2017
Postdoctoral Fellow University of Washington Department of Medicine Division of Pulmonary and Critical Care Medicine Mentor: William C. Parks, PhD	2011 - 2013
Technician Montana State University Department of Chemistry and Biochemistry Mass Spectrometry Facility Principal Investigator: Brian Bothner, PhD	2010 - 2011
Doctoral Research Montana State University Center for Biofilm Engineering Mentor: Garth A. James, PhD	2006 - 2010
Undergraduate Research Assistant Montana State University Center for Biofilm Engineering Principal Investigator: Garth A. James, PhD	2004 - 2006

Undergraduate Research Assistant Montana State University Department of Microbiology Principal Investigator: Barry H. Pyle, PhD	2003 - 2004
--	-------------

Awards and Honors

Searle Scholar Nominee University of Montana	2018
Young Investigator Award Center for Biofilm Engineering, Montana State University	2018
Young Investigator Award Center for Biomolecular Structure and Design, University of Montana	2017
NIH/NIAID Career Transition Award (K22)	2016
The Charlie Moore Endowed Fellowship for Cystic Fibrosis Research	2016
Cystic Fibrosis Foundation (National) Postdoctoral Fellowship	2015 - 2017
Cystic Fibrosis Foundation Fellowship, Seattle Chapter	2013 - 2014
W.G. Characklis Scholarship for Outstanding Ph.D. Student	2009
Best Poster Award Montana Biofilm Meeting, Montana State University	2009
INBRE Undergraduate Research Fellowship Montana State University	2006 - 2008
Undergraduate Scholar Program Scholarship Montana State University	2005 - 2006
Dean's Honor Roll, Montana State University	2003 - 2006

Funding

Active

NIH/NIAID R01AI138981 (PI) Immunization against filamentous bacteriophages to prevent bacterial infection	2018 - 2023
NIH/NIGMS CBSD COBRE P20GM103546 (PI on subaward) Young Investigator Award	2017 - 2020
NIH/NIAID Career Transition Award K22AI125282 (PI) Understanding polymer-induced bacterial aggregation and antimicrobial tolerance	2017 - 2019

Completed

Dr. Ralph and Marian Falk Medical Research Trust – Catalyst Award (Co-I)	2017 - 2019
University of Montana Genomics Core–Illumina Mini-Grant (PI) Genome reduction in filamentous bacteriophage	2018
The Charlie Moore Endowed Fellowship for Cystic Fibrosis Research	2016
Cystic Fibrosis Foundation (National) Postdoctoral Fellowship	2015 - 2017

Cystic Fibrosis Foundation Fellowship, Seattle Chapter	2013 - 2014
Stanford University Immunology Training Grant 5T32AI007290-29 (NIH/NIAID)	2013, awarded, but declined
University of Washington Pulmonary Training Grant 5T32HL007287-33 (NIH/NHLBI)	2011 - 2013

Peer Reviewed Publications

*Indicates corresponding author

Secor et al., Pf Bacteriophage and Their Impact on *Pseudomonas* Virulence, Mammalian Immunity, and Chronic infections. **Front. Immunol.**, 21 February 2020 doi.org/10.3389/fimmu.2020.00244

Johanna M. Sweere, Heather Ishak, Vivekananda Sunkari, Michelle S. Bach, Robert Manasherob, Koshika Yadava, Shannon M. Ruppert, Chandan K. Sen, Swathi Balaji, Sundeep G. Keswani, **Patrick R. Secor**, and Paul L. Bollyky. (2019) The Immune Response to Chronic *Pseudomonas aeruginosa* Wound Infection in Immunocompetent Mice. **Advances in Wound Care**, Vol. 8.

Elizabeth B. Burgener, Johanna M. Sweere, Michelle S. Bach, **Patrick R. Secor**, Naomi Haddock, Laura K. Jennings, Rasmus L. Marvig, Helle Krogh Johansen, Elio Rossi, Xiou Cao, Lu Tian, Laurence Nedelec, Søren Molin, Paul L. Bollyky, and Carlos E. Milla. (2019) Filamentous bacteriophages are associated with chronic *Pseudomonas* lung infections and antibiotic resistance in cystic fibrosis. **Science Translational Medicine**, Vol. 11, Issue 488, eaau9748

Johanna M. Sweere, Heather Ishak, Michelle S. Bach, Vivekananda Sunkari, Gemot Kaber, Robert Manasherob, Gina A. Suh, Medeea Popescu, Payton L. Marshall, Maria Birukova, Ethan Katznelson, Daniel V. Lazzareschi, Swathi Balaji, Sundeep Keswani, Thomas R. Hawn, **Patrick R. Secor**, and Paul L. Bollyky. (2019) Filamentous Bacteriophage Suppress Clearance of Bacterial Infection. **Science**, Vol. 363, Issue 6434, eaat9691.
Recommended in F1000Prime as being of special significance in its field

Secor P.R.*, Michaels, L.A., Ratjen, A., Jennings, L.K., Singh, P.K. Entropically-driven aggregation of bacteria by host polymers promotes antibiotic tolerance in *Pseudomonas aeruginosa*. **Proc Natl Acad Sci USA**, Oct 2018, 201806005; DOI:10.1073/pnas.1806005115
Recommended in F1000Prime as being of special significance in its field

Jorth, P.A., McLean, K., Ratjen, A., **Secor, P.R.**, Bautista, G.E., Ravishankar, S., Rezayat, A., Garudathri, J., Harrison, J.J., Harwood, R.A., Penewit, K., Waalkes, A., Singh, P.K., Salipante, S.J. (2017) Evolved aztreonam resistance is multifactorial and can produce hypervirulence in *Pseudomonas aeruginosa*. **mBio**, 8:e00517-17

Nazik, H., Joubert, L.M., **Secor, P.R.**, Sweere, J.M., Bollyky, P.L., Sass, G., Cegelski, L., Stevens, D.A. (2017) *Pseudomonas* Phage Inhibition of *Candida albicans*. **Microbiology**, 163 (11), 1568-1577

Secor P.R.*, Sass G, Nazik H, Stevens DA. (2017) Effect of acute predation with bacteriophage on intermicrobial aggression by *Pseudomonas aeruginosa*. **PLoS One**. 16;12(6):e0179659. doi: 10.1371/journal.pone.0179659. PubMed PMID: 28622385

Secor, P.R.*, Michaels, L.A., Smigiel, K.S., Rohani, M.G., Jennings, L.K., Hisert, K.B., Arrigoni, A., Braun, K.R., Birkland, T.P., Hallstrand, T.S., Lai, Y., Bollyky, P.L., Singh, P.K., Parks, W.C. (2017)

Filamentous bacteriophage produced by *Pseudomonas aeruginosa* alters the inflammatory response and promotes non-invasive infection *in vivo*. ***Infection and Immunity***, vol. 85, issue 1
Featured on journal cover

Penner, J.C., Ferreira, J.A.G., **Secor, P.R.**, Sweere, J.M., Birukova, M.K., Joubert, L.M., Haagensen, J.A.J., Garcia, O., Malkovskiy, A.V., Kaber, G., Nazik, H., Manasherob, R., Spormann, A.M., Clemons, K.V., Stevens, D.A., Bollyky, P.L. (2016) Pf4 Bacteriophage Produced by *Pseudomonas aeruginosa* Inhibits *Aspergillus fumigatus* Metabolism via Iron Sequestration. ***Microbiology***, 162, 1583-1594

Secor, P.R.*, Jennings, L.K., Michaels, L.A., Sweere, J.M., Singh, P.K., Parks, W.C., Bollyky, P.L. (2016) Biofilm assembly becomes crystal clear – filamentous bacteriophage organize the *Pseudomonas aeruginosa* biofilm matrix into a liquid crystal. ***Microbial Cell***, 3(1): 49-52
Featured on journal cover

Secor, P.R.*, Sweere, J.M., Michaels, L.A., Malkovskiy, A.V., Lazzareschi, D., Katznelson, E., Rajadas, J., Birnbaum, M.E., Arrigoni, A., Braun, K.R., Evanko, S.P., Stevens, D.A., Kaminsky, W., Singh, P.K., Parks, W.C., Bollyky, P.L. (2015) Filamentous Bacteriophage Promote Biofilm Assembly and Function. ***Cell Host & Microbe***, 18(5): 549-59

Jennings L.K., Storek K.M., Ledvina H.E., Coulon C., Marmont L.S., Sadovskaya I., **Secor, P.R.**, Tseng B.S., Scian M., Filloux A., Wozniak D.J., Howell P.L., Parsek M.R. (2015) Pel is a cationic exopolysaccharide that cross-links extracellular DNA in the *Pseudomonas aeruginosa* biofilm matrix. ***Proc Natl Acad Sci USA***, 112(36): 11353-8

Secor, P. R.*, Jennings, L. K., James, G. A., Kirker, K. R., Pulcini, E. D., McInerney, K., Gerlach, R., Livinghouse, T., Hilmer, J. K., Bothner, B., Fleckman, P., Olerud, J. E., Stewart, P. S. (2012) Phevalin (aureusimine B) production by *Staphylococcus aureus* biofilm and impacts on human keratinocyte gene expression, ***PLoS One*** 7(7) e40973

Secor, P. R.*, James, G. A., Fleckman, P., Olerud, J. E., McInerney, K., and Stewart, P.S. (2011) *Staphylococcus aureus* Biofilm and Planktonic cultures differentially impact gene expression, MAPK phosphorylation, and cytokine production in human keratinocytes. ***BMC Microbiol***, 11:143

Kirker, K.R., **Secor, P.R.**, James, G.A, Fleckman, P., Olerud, J.E., Stewart, P.S., (2009) Loss of viability and induction of apoptosis in human keratinocytes exposed to *Staphylococcus aureus* biofilms in vitro. ***Wound Repair Regen***, 17(5): 690-9

Dowd, S.E., Sun, Y., **Secor, P.R.**, Rhoads, D.D., Wolcott, B.M., James, G.A., Wolcott, R.D. (2008) Survey of bacterial diversity in chronic wounds using pyrosequencing, DGGE, and full ribosome shotgun sequencing. ***BMC Microbiol***, 8: 43

James, G.A., Swogger, E., Wolcott, R., Pulcini, E., **Secor, P.R.**, Sestrich, J., Costerton, J.W., Stewart, P.S. (2008) Biofilms in chronic wounds. ***Wound Repair Regen***, 16(1): 37-44
Cited over 1,000 times

Other Publications

Bollyky, P.L. and **Secor, P.R.** (2019) The Innate Sense of Bacteriophages. ***Cell Host & Microbe***, 25(2).

Service and Outreach

University service:

Neuroscience Faculty Search Committee University of Montana	Sept. 2019
Examination chair, Shaun Wachter Comp Exam University of Montana	Sept. 2019
Undergraduate Award and Scholarship Committee University of Montana	March 2019–present
Center for Translational Medicine Faculty Advisory Council University of Montana	Jan. 2018–present
Graduate Admissions Committee University of Montana	Sept. 2017–present
Microbiology Curriculum Advisory Committee University of Montana	Aug. 2017

Professional service:

Ad hoc reviewer, <i>Virus Evolution</i>	2020 - present
Ad hoc reviewer, <i>Journal of Bacteriology</i>	2019 - present
Ad hoc reviewer, <i>Soft Matter</i>	2019 - present
Ad hoc reviewer, <i>eLife</i>	2018 - present
Ad hoc reviewer, <i>Cell Host & Microbe</i>	2017 - present

Outreach:

From Bench to Bedside, <i>Vision Magazine</i> , https://medium.com/vision-2019	2019
Promoting Enrichment Activities for Kids (PEAK) Outreach Program University of Montana	2018
Harkins High School Science Fusion Lecturer University of Montana	Oct. 2017
Laser Scanning Confocal Microscopy Workshop Montana Biofilm Meeting, Montana State University	bi-annual, 2007 - 2010
American Indian Research Opportunities (AIRO) Program Montana State University	2007 - 2009
Promoting Enrichment Activities for Kids (PEAK) Outreach Program Helena, MT public schools	2007

Teaching

BIOM 450/451, Microbial Physiology and Lab	Fall 2018 - present
--	---------------------

University of Montana	
HIMI Summer Institute on Scientific Teaching	Summer 2018
Guest lecturer	Spring 2018
University of Montana	
BIOM 410 Microbial Genetics	
Co-Instructor	Spring, 2010
Montana State University	
Microbes in the Environment	
Teaching Assistant	2007 - 2008
Montana State University	
Molecules to Cells	

Patents

Monoclonal antibody and vaccine targeting filamentous bacteriophage
U.S. Patent applications 62/027,698 and 62/027,713

Conference Activity

Center for Biomolecular Structure and Dynamics Research Symposium University of Montana	2019
Center for Biomolecular Structure and Dynamics Research Symposium Seeley Lake, MT, speaker	2018
Montana Biofilm Meeting Center for Biofilm Engineering, Bozeman, MT, speaker	2018
Pacific Northwest Epithelial Biology Meeting Seattle, WA, speaker	2016
Cystic Fibrosis Foundation Retreat Seattle, WA, speaker	2016
Gordon Research Conference: Microbial Stress Responses South Hadley, MA, poster	2016
North American Cystic Fibrosis Conference Phoenix, AZ, speaker	2015
North American Cystic Fibrosis Conference Atlanta, GA, speaker	2014
Cystic Fibrosis Foundation Retreat Seattle, WA, speaker	2012
5 th American Society for Microbiology Conference on Biofilms Cancun, Mexico, poster	2009
4 th American Society for Microbiology Conference on Biofilms Quebec City, Quebec, Canada, poster	2007

Montana Biofilm Meeting 2006 - 2010
 Bozeman, MT, speaker

Invited Oral Presentations

Center for Biomolecular Structure and Dynamics Research Symposium University of Montana "Bacteriophage Pathobiology: Leveraging phage/host/microbe interactions for therapeutic gain"	2019
Integrative Microbiology Seminar Series, UCSF San Francisco, CA "Targeting Bacteriophage to Treat Bacterial Infection"	2019
Rocky Mountain Laboratories, NIAID Hamilton, MT "Targeting Bacteriophage to Treat Bacterial Infection"	2019
Department of Pathology, University of Utah Salt Lake City, UT "Targeting Bacteriophage to Treat Bacterial Infection"	2019
Division of Biological Sciences, University of California, San Diego La Jolla, CA "Targeting Bacteriophage to Treat Bacterial Infection"	2019
Department of Microbiology and Immunology Seminar Series Bozeman, MT Montana State University "Targeting Bacteriophage to Treat Bacterial Infection"	2019
Vanderbilt Institute for Infection, Immunology, and Inflammation Nashville, TN Vanderbilt University "Targeting Bacteriophage to Treat Bacterial Infection"	2019
Center for Biomolecular Structure and Dynamics Research Symposium Seeley Lake, MT, speaker University of Montana "A bacteriophage regulates virulence factor production by <i>P. aeruginosa</i> "	2018
Montana Biofilm Meeting Bozeman, MT Center for Biofilm Engineering, Montana State University "A bacteriophage integrase regulates virulence factor production by <i>P. aeruginosa</i> "	2018
Organismal Biology, Ecology, and Evolution Brewery Chalk Talk Series Missoula, MT University of Montana "Genome reduction in a bacteriophage"	2018

Harkins High School Science Fusion Lecture Missoula, MT University of Montana “When bacteria get sick—How virus–bacteria interactions affect infection”	2017
CBSD COBRE Symposium Missoula, MT University of Montana “Tolerating a crowd: Defining how macromolecular crowding promotes antibiotic tolerance”	2017
Pacific Northwest Epithelial Biology Meeting Seattle, WA University of Washington “Filamentous bacteriophage promote a non-invasive infection phenotype <i>in vivo</i> ”	2016
Cystic Fibrosis Foundation Retreat Seattle, WA University of Washington “Entropically-driven bacterial aggregation promotes antibiotic tolerance in <i>Pseudomonas aeruginosa</i> ”	2016
North American Cystic Fibrosis Conference Phoenix, AZ “Host and microbial polymers passively aggregate CF pathogens producing resistance to killing and promoting interspecies interactions”	2015
North American Cystic Fibrosis Conference Atlanta, GA “Host conditions can produce the non-invasive and resistant phenotype of CF infections”	2014
Cystic Fibrosis Foundation Retreat Seattle, WA University of Washington “Filamentous bacteriophage as structural components of <i>Pseudomonas aeruginosa</i> biofilms”	2012
Montana Biofilm Meeting Bozeman, MT Montana State University “Keratinocytes produce pro-inflammatory markers during <i>S. aureus</i> biofilm infection”	2010
Montana Biofilm Meeting Bozeman, MT Montana State University “Host-pathogen interactions in an <i>in vitro</i> chronic wound model”	2009
Montana Biofilm Meeting Bozeman, MT Montana State University “Molecular characterization of wound biofilm communities”	2008

Montana Biofilm Meeting Bozeman, MT Montana State University "The impacts of <i>S. aureus</i> biofilm on keratinocyte morphology"	2008
Molecular Probes, Invitrogen Eugene, OR "Host-pathogen interactions in an <i>in vitro</i> chronic wound model"	2008
Montana Biofilm Meeting Bozeman, MT Montana State University "Molecular biology of chronic wound biofilms"	2007
Montana Biofilm Meeting Bozeman, MT Montana State University "Community analysis of chronic wounds using molecular techniques"	2006