

Pascale G. Charest

Assistant Professor

Department of Chemistry and Biochemistry

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EDUCATION

- 1998 *B.Sc. Biochemistry, Université de Sherbrooke, Sherbrooke, Canada*
- 2000 *M.Sc. Biochemistry, Université de Montréal, Montréal, Canada*
Advisor: Professor Michel Bouvier
Thesis title: *Study of the V2 vasopressin receptor palmitoylation*
Major field: Biochemistry
- 2005 *Ph.D. Biochemistry, Université de Montréal, Montréal, Canada*
Advisor: Professor Michel Bouvier
Thesis title: *Study of G protein-coupled receptor-mediated activation of ERK1/2 MAP kinases—
Role of the adaptor protein beta-arrestin*
Major field: Biochemistry and Molecular Pharmacology

EMPLOYMENT

- 2000–2005 *Teaching Assistant*
Department of Biochemistry, Université de Montréal, Montréal, Canada
- 2003–2005 *Lecturer*
Department of Biochemistry, Université de Montréal, Montréal, Canada
- 2005–2010 *Postdoctoral Research Associate*
Division of Biological Sciences, Section of Cell and Developmental Biology, University of
California-SanDiego, La Jolla, CA
Advisor: Richard A. Firtel
- 2010–2012 *Assistant Project Scientist (Research Faculty)*
Division of Biological Sciences, Section of Cell and Developmental Biology, University of
California-SanDiego, La Jolla, CA
- 2012–present *Assistant Professor*
Department of Chemistry and Biochemistry, University of Arizona, Tucson, AZ

HONORS AND AWARDS

Undergraduate research summer fellowship (1997)
Université de Sherbrooke, Sherbrooke, Canada

Graduate research fellowship, declined (1999)
Société Québécoise d'Hypertension Artérielle

Graduate research fellowship (1999-2000)
Canadian Hypertension Society

Poster presentation award (2000)
Société Québécoise d'Hypertension Artérielle, annual scientific meeting, Montréal, Canada

Graduate research fellowship (2000)
Université de Montréal, Montréal, Canada

Graduate research fellowship, declined (2001)
Canadian Hypertension Society

Graduate research fellowship (2001-2003)
Fonds de la Recherche en Santé du Québec

Graduate research fellowship (2001-2004)
Heart and Stroke Foundation of Canada

Postdoctoral research fellowship (2005-2008)
Fonds de la Recherche en Santé du Québec

American Cancer Society Research Scholar (2015)

University of Arizona nominee for the Camille Dreyfus Teacher-Scholar award (2017)

SERVICE/OUTREACH

Local/state

Community outreach

Summer 2013, Biochemistry Club/Middle School Summer Camp presenter
May 2016, American Cancer Society Climb to Conquer luncheon, presenter, Phoenix, AZ
Summer 2017, Mentor in Cienega High School senior exit program

Departmental service

May 2012, 2013, 2014, Poster fair judge
Feb 2013, 2014, 2015, 2016, Annual Peer Review reviewer
2013-2015, Biochemistry seminar coordinator
2013-2016, recruitment of sponsors for departmental seminars
2016, Working Group 3, evaluating and recommending plan for CBC's teaching enterprise
2016, CBC graduate student awards committee, ad hoc member

2016-2017, faculty advisor for the Program to Advance Women Scientists (PAWS) in Chemistry and Biochemistry

College service

Fall 2013, 2014, 2015 Medical School Multiple Mini Interview (MMI) evaluator

Service as grant reviewer

Spring 2015, Cancer Center Support Grants, Pilot Project for basic/clinical partnerships to promote translational research

Fall 2016, American Cancer Society Institutional Research Grant

Spring 2017, RDI Faculty Seed Grants

National/international

Memberships in professional societies

American Association for the Advancement of Science

American Society For Biochemistry and Molecular Biology

American Society For Cell Biology

Faculty of 1000

Service as manuscript reviewer (total number of manuscripts reviewed)

Molecular Biology of the Cell (4)

Journal of Biological Chemistry (1)

Scientific Reports (1)

Journal of Visualized Experiments (1)

Science Signaling (3)

Journal of Cell Science (2)

FEMS Microbiology Reviews (1)

FEBS Letters (2)

European Journal of Cell Biology (1)

Proceedings of the National Academy of Science (3)

Protein Science (1)

Small GTPases (2)

Open Biology (1)

Service as external grant reviewer

Fall 2015, Natural Science and Engineering Research Council of Canada

Spring 2017, Natural Science and Engineering Research Council of Canada

Service in international scientific meetings

Session chair, 2013 Annual International *Dictyostelium* Conference, Asheville NC

Organizer, 2016 Annual International *Dictyostelium* Conference, Tucson AZ

Departmental Committees

2012 Dissertation Committee

2013 Dissertation Committees (5)

2014 Dissertation Committees (6)

2013-2015 CBC/CMM /MCB Joint Seminar committee

2015 Dissertation Committees (6)

2015-2016 CBC faculty search committee

2016 Dissertation Committees (14)

2012-2016 Graduate Admissions Committee

2013-2016 CBC/CMM/IMB/MCB Joint Retreat committee
2016-present Graduate Program Committee
2016-present BMCB graduate program executive committee

College Committee

2013-present College of Science Awards Selection Committee

PUBLICATIONS

* Indicates publication based on work performed prior to initial faculty appointment (as graduate student, postdoctoral researcher, or Assistant Project Scientist)

For publications based on work done in current faculty position, authors are designated as follows: ^U, undergraduate student; ^G, graduate student; ^P, postdoctoral researcher; ^T, technician; ^C, collaborator; ^{SC}, student or staff of collaborator.

Refereed journal articles (published or accepted in final form)

1. * M. Azzi, P.G. Charest, S. Angers, M. Bouvier and G. Pineyro. "βArrestin-mediated activation of MAPK by inverse agonists reveals distinct active conformations for GPCRs". *Proc. Natl. Acad. Sci. U S A* 100(20):11406-11 (2003).
Recommended by Faculty of 1000, 27 Sep 2006
2. * P.G. Charest and M. Bouvier. "Palmitoylation of the V2 vasopressin receptor carboxyl tail facilitates βarrestin recruitment leading to efficient receptor endocytosis and ERK1/2 activation". *J. Biol. Chem.* 278(42):41541-51 (2003).
3. * J. Perroy, S. Pontier, P.G. Charest, M. Aubry and M. Bouvier. "Real-time monitoring of ubiquitination in living cells by BRET". *Nat. Meth.* 1(3):203-8 (2004).
Recommended by Faculty of 1000, 7 Jan 2005
4. * P.G. Charest, S. Terrillon and M. Bouvier. "Monitoring agonist-promoted conformational changes of β-arrestin in living cells by intramolecular BRET". *EMBO rep.* 6(4): 334-40 (2005).
5. * P.G. Charest and R.A. Firtel. "Feedback signaling controls leading edge formation during chemotaxis". *Curr. Opin. Genet. Dev.* 16(4):339-47 (2006).
6. * P.G. Charest, G. Oligny-Longpré, H. Bonin, M. Azzi and M. Bouvier. "The V2 vasopressin receptor stimulates ERK1/2 activity independently of heterotrimeric G protein signalling". *Cell. Signal.* 19(1):32-41 (2007).
7. * A.T. Sasaki, C. Janetopoulos, S. Lee, P.G. Charest, K. Takeda, L.W. Sundheimer, R. Meili, P.N. Devreotes and R.A. Firtel. "G Protein-Independent Ras/PI3K/F-Actin Circuit Regulates Basic Cell Motility". *J. Cell. Biol.* 178(2):185-91 (2007).
Recommended by Faculty of 1000, 27 Sep 2007
8. * F.F. Hamdan, M.D. Rochdi, B. Breton, D. Fessart, D.E. Michaud, P.G. Charest, S.A.

- Laporte and M. Bouvier. "Unraveling g protein-coupled receptor endocytosis pathways using real-time monitoring of agonist-promoted interaction between beta-arrestins and AP-2". *J. Biol. Chem.* 282(40):29089-100 (2007).
9. * P.G. Charest and R.A. Firtel. "Big roles for small GTPases in the control of directed cell movement". *Biochem. J.* 401(2):377-90 (2007).
 10. * S. Zhang[#], P.G. Charest[#], and R.A. Firtel. "Spatio-temporal Regulation of Ras Activity Provides Directional Sensing". *Curr. Biol.* 18(20):1587-93 (2008). [#] Equal authorship.
Recommended by Faculty of 1000, 23 Sep 2009
 11. * V. Kölsch, P.G. Charest and R.A. Firtel. "The regulation of cell motility and chemotaxis by phospholipid signaling". *J. Cell Sci.* 121(Pt 5):551-9 (2008).
 12. * P.G. Charest, Z. Shen, A. Lakoduk, A.T. Sasaki, S.P. Briggs and R.A. Firtel. "A Ras signaling complex controls the RasC-TORC2 pathway and directed cell migration". *Dev. Cell.* 18:737-49 (2010).
Cover article
Highlighted in Nature Structural and Molecular Biology, 17: 678 (2010)
Recommended by Faculty of 1000, 5 Aug 2010
 13. * P.G. Charest and R.A. Firtel. "TORCing" neutrophil chemotaxis". *Dev. Cell* 19(6):795-6 (2010).
 14. * Hecht, M.L. Skoge, P.G. Charest, E. Ben-Jacob, R.A. Firtel, W.F. Loomis, H. Levine, and W.J. Rappel. "Activated membrane patches guide chemotactic cell motility". *PLoS Comput. Biol.* 7(6):e1002044 (2011).
 15. * K. Takeda, D. Shao, M. Adler, P.G. Charest, W.F. Loomis, H. Levine, A. Groisman, W.J. Rappel, and R.A. Firtel. "Incoherent feedforward control governs adaptation of activated Ras in eukaryotic chemotaxis pathway". *Sci. Signal.* 5, ra2 (2012).
 16. * V. Kölsch, Z. Shen, S. Lee, K. Plak, P. Lotfi, J. Chang, P.G. Charest, J.L. Romero, T.J. Jeon, A. Kortholt, S.P. Briggs, and R.A. Firtel. "Daydreamer, a Ras effector and GSK-3 substrate, is important for directional sensing and cell motility". *Mol. Biol. Cell.* 24(2):100-14 (2013).
 17. * K. Sumita, H. Yoshino, M. Sasaki, N. Majd, E.R. Kahoud, H. Takahashi, K. Takeuchi, T. Kuroda, S. Lee, P.G. Charest, K. Takeda, J.M. Asara, R.A. Firtel, D. Anastasiou, and A.T. Sasaki. "Degradation of activated K-Ras orthologue via K-Ras specific lysine residues is required for cytokinesis". *J. Biol. Chem.* 289:3950-9 (2014).
 18. A. Khanna^{SC*}, P. Lotfi^{T*}, A.J. Chavan^P, N.M. Montañó^G, P. Bolourani^{SC}, G. Weeks^C, Z. Shen^{SC}, S.P. Briggs^C, H. Pots^{SC}, P.J.M Van Haastert^C, A. Kortholt^{SC}, and P.G. Charest. "The small GTPases Ras and Rap1 bind to and control TORC2 activity". *Sci. Rep.* 6:25823 (2016). *equal contribution.
Recommended by Faculty of 1000, 2 Jun 2016
 19. AFM T. Islam^P, B.M. Stepanski^U, and P.G. Charest. "Studying chemoattractant signal transduction dynamics in *Dictyostelium* by BRET". *Methods Mol. Biol.* 1407:63-77 (2016).
 20. M. Scavello^G, A.R. Petlick^G, R. Ramesh^U, V.F. Thompson^T, P. Lotfi^T, and P.G. Charest. "Protein kinase A spatiotemporally controls chemoattractant signaling pathways and is critical for gradient sensing in *Dictyostelium*". *J. Cell Sci.*, 130:1545-1558 (2017).
Selected to be featured in the "In This Issue" section of the journal.

Patents

1. * M. Bouvier and P. Charest. Double brilliance beta-arrestin: A biosensor for monitoring the activity of receptors and signaling molecules, and methods of using same. Publication number CA 2,607,015 (2005). Patent number US 7,932,080 (2011).
2. * M. Bouvier, P. Charest, C. LeGouill, A. Beautrait. Arrestin Biosensor. Publication number US 2011/0275134 (2011) and CA 2,775,278 (2012).

CONFERENCES/SCHOLARLY PRESENTATIONS (LIMITED TO PERIOD IN CURRENT RANK)

Invited talks

CBC/CMM/MCB Joint Retreat, Biosphere 2, Sep 2011

Biotechnology and Biological Sciences Research Council Workshop, Vanderbilt U., Nashville, TN, Mar 2012

Drug Discovery and Developmental Therapeutics Seminar Series, College of Pharmacy, University of Arizona, Feb 2013

Arizona Imaging and Microanalysis Society annual conference, Tucson, Arizona, Mar 2013

Biological Chemistry Program Journal Club, University of Arizona, Sep 2013

Department of Immunobiology, University of Arizona, Oct 2013

Arizona Research Institute for Biomedical Imaging (ARIBI) spring workshop, Tucson, AZ, Apr 2014

Gordon Research Conference on Phosphorylation and G Protein-Mediated Signaling Networks, Biddeford, ME, Jun 2014 (Poster talk)

Gordon Research Conference on Directed Cell Migration, Galveston, TX, Jan 2015 (Poster talk)

Pennsylvania Muscle Institute, School of Medicine, University of Pennsylvania, Sept 2015

NIH/NIAID, Twinbrook campus, Rockville, MD, Sept 2015

Department of Basic Medical Sciences, College of Medicine, University of Arizona, Phoenix, AZ, Nov 2015

Microbiology and Immunobiology "Microlunch" seminar series, University of Arizona, Mar 2017

Contributed talks

Annual International *Dictyostelium* Conference, Asheville, NC, Aug 2013

Poster presentations at International Meetings (presenter underlined)

A. Khanna^{SC*}, P. Lotfi^{T*}, N.M. Montaño^G, P. Bolourani^{SC}, G. Weeks^C, Z. Shen^{SC}, S.P. Briggs^C, H. Pots^{SC}, P.J.M Van Haastert^C, A. Kortholt^{SC}, and P.G. Charest. “The small GTPases Ras and Rap1 bind to and control TORC2 activity”. Gordon Research Conference on Phosphorylation and G Protein-Mediated Signaling Networks, Biddeford, ME, Jun 2014 (selected for short talk).

M. Scavello^G, A.R.Petlick^G, V.F. Thompson^T, P. Lotfi^T, and P.G. Charest. “PKA spatiotemporally controls chemoattractant signaling pathways and is critical for gradient sensing in *Dictyostelium*”. Gordon Research Conference on Directed Cell Migration, Galveston, TX, Jan 2015 (selected for short talk).

A. Khanna^{SC*}, P. Lotfi^{T*}, N.M. Montaño^G, P. Bolourani^{SC}, G. Weeks^C, Z. Shen^{SC}, S.P. Briggs^C, H. Pots^{SC}, P.J.M Van Haastert^C, A. Kortholt^{SC}, and P.G. Charest. “The small GTPases Ras and Rap1 bind to and control TORC2 activity”. American Society for Cell Biology Annual Meeting, San Diego, CA, December 2015.

M. Scavello^G, A.R.Petlick^G, V.F. Thompson^T, P. Lotfi^T, and P.G. Charest. “PKA spatiotemporally controls chemoattractant signaling pathways and is critical for gradient sensing in *Dictyostelium*”. American Society for Cell Biology Annual Meeting, San Diego, CA, December 2015.

AFM T. Islam^P, B.M. Stepanski^U, and P.G. Charest. “Studying chemoattractant signal transduction dynamics in *Dictyostelium* by BRET”. American Society for Cell Biology Annual Meeting, San Diego, CA, December 2015 (selected for short talk).

A. Khanna^{SC*}, P. Lotfi^{T*}, A.J. Chavan^P, N.M. Montaño^G, P. Bolourani^{SC}, G. Weeks^C, Z. Shen^{SC}, S.P. Briggs^C, H. Pots^{SC}, P.J.M Van Haastert^C, A. Kortholt^{SC}, and P.G. Charest. “The small GTPases Ras and Rap1 bind to and control TORC2 activity”. Annual International *Dictyostelium* Conference, Tucson, AZ, Aug 2016.

AFM T. Islam^P, P. Haldeman^U, B.M. Stepanski^U, and P.G. Charest. “Heterotrimeric G protein activation and regulation monitored by Bioluminescence Resonance Energy Transfer (BRET)”. Annual International *Dictyostelium* Conference, Tucson, AZ, Aug 2016.

M. Scavello^G, A.R.Petlick^G, R.Ramesh^U, V.F. Thompson^T, P. Lotfi^T, and P.G. Charest. “The role of PKA in *Dictyostelium* chemotaxis”. Gordon Research Conference on Directed Cell Migration, Galveston, TX, Jan 2017.

MEDIA COVERAGE

Arizona Public Media-NPR story “UA Researcher Wins \$792K Grant for Cancer Study”, May 2015.
<https://www.azpm.org/s/31016-ua-researcher-wins-792k-grant-for-cancer-study/>

AWARDED GRANTS

Private Foundations

- Faculty Seed Grant, University of Arizona Foundation. Aug 2014-Jul 2015
"Ras proteins activate TORC2 to promote cancer cell metastasis."
 Total cost \$10,000
 Role: PI (100% of the project effort)
- Research Scholar Grant, American Cancer Society. Jul 2015-Jun 2019
Signaling mechanisms underlying the directed motility of eukaryotic cells.
 Total cost \$792,000
 Role: PI (90% of the project effort; Wouter Jan-Rappel, collaborator, 10% effort)

Governmental organizations

- TRIF Optics/Imaging grant, UA Technology Research Initiative Funds. Jan 2016-July 2016
An environmental control system for a spinning disk confocal microscope.
 Total cost \$37,000
 Role: PI

INFORMATION ON TEACHING AND ADVISING

Extent of teaching*Courses taught*

- Fall 2012 MED819, Medical Foundations, 4 lectures, 140 students
- Fall 2012 BIOC296B, Introduction to Experimental Biochemistry, 1 unit, 43 students
 Note: Only gave first 2 classes due to birth of a child.
- Spring 2013 BIOC568, Nucleic Acids, Signaling and Metabolism, 4 units, 16 students
 Note: In charge of 15 classes (one of three instructors that semester)
- Fall 2013 MED819, Medical Foundations, 4 lectures, 120 students
- Fall 2013 BIOC296B, Introduction to Experimental Biochemistry, 1 unit, 78 students
- Spring 2014 BIOC568, Nucleic Acids, Signaling and Metabolism, 4 units, 18 students
- Fall 2014 MED819, Medical Foundations, 4 lectures, 116 students
- Fall 2014 BIOC296B, Introduction to Experimental Biochemistry, 1 unit, 76 students
- Spring 2015 BIOC568, Nucleic Acids, Signaling and Metabolism, 4 units, 16 students
- Fall 2015 MED819, Medical Foundations, 4 lectures, 119 students
- Fall 2015 BIOC296B, Introduction to Experimental Biochemistry, 1 unit, 65 students
- Spring 2016 BIOC568, Nucleic Acids, Signaling and Metabolism, 4 units, 12 students
- Fall 2016 MED819, Medical Foundations, 4 lectures, 135 students
- Fall 2016 BIOC296B, Introduction to Experimental Biochemistry, 1 unit, 69 students
- Spring 2017 BIOC568, Nucleic Acids, Signaling and Metabolism, 4 units, 19 students

Other contributions to courses

- Jan 2013 MCB181, Introductory Biology, honors section, guest lecturer, 1 lecture
- Spring 2013 BIOC296B, Introduction to Experimental Biochemistry, replaced Roger Miesfeld in 2 classes
- Nov 2013 MCB572, Cell Systems, guest lecturer, 2 lectures

Individual Student Contact

Collaborations with undergraduate and graduate students on research projects

- 2014-2015 Keith Olson, Chemistry and Biochemistry graduate student in the Hruby group.

Graduate student rotations

- AY2013-14 Shannon Collins (BCP), Chandi DeSilva (BCP), Amanda Hansen (BCP), Maggie Scavello (BCP), Yang Zhou (BCP), and Nichole Eshleman (ABBS).
- AY2014-15 Julia Lewis (BCP), Jonathan Sawyer (BCP), and Branden Stepanski (BCP).
- AY2015-16 Taylor Gee (BCP), Niloufar Mollaselehi (BCP), Matthew Rollins (BCP), Alexander Humby (ABBS), and Julie McGrath (ABBS).
- AY2016-17 Zekun Liu (BCP), Stephen Smith (BCP), Kristiane Torgeson (BCP), Cody Schmidlin (ABBS).

Advising (73)

- 2013-2015 Julie Cheung, Kyle Arrington, Tam Minh Le, Vitality Florin, Victoria Monteleone, David Wasiak, Mallory Feagan, Rebecca Luiten, Haley Kent, Sarah Smith, Kate Li, Thien Ba duc Tran, Iris Mora, Andy Vo Phan, Lauren Dominick, Matthew Shallenberger, Nadia Collaco, Katrina Lichauca, Jacob McGuffin.
- 2014-2016 Christelle Feliciano, Peter Hanson, Adrianna Pulver, Nicole Schwalbe, Tyler Smith, Jason Bolton, Stefan Hinote, Bryan Thvedt, Ali Icenogle, Christine McDevitt, Christen Nguyen, Nicholas Everetts, Daria Timonina, Clayton Lanham, Estefania Lopez.
- 2015-present Sierra Baker, Johnna Hartenstine, Jordon Barrows, Mason Kaapke, Ali Muller, Christopher Schicker, Dagoberto Robles, Elise Munoz, Victor Hugo Ruiz, Rishab Srivastava, Gabrielle Grinslade, Fabian Matty, Kyungjae Au, Samantha Dunlap.
- 2016-present Leah VanProoyen, Branson Grieser, Josephine Uong, Thy Tran, Carline Neumann, Benjamin Rabichow, Robyn Finley, Catherine Waters, Leah Homad, Andrea Paralta, Bradford Hill, Cody Stepanski, Keith Lei, Laritza Salinas, Lauren Koch, Lawrence Sun, Matthew Ramsey, Taylor Ha, Juan Carlos Bautista, Jorge Gonzalez, Ismael Hernandez, Alfredo Lara, Miguel Pacheco, Benjamin Rounseville.
- 2017-present Maria Serafini

Undergraduate research studies directed and in progress (including senior thesis work)

- 2012-2014 Branden Stepanski (Graduate school, University of Utah)
- 2014 Harrison Platt
- 2013-2015 Joseph Cada (ASU College of Law, class of 2019)
- 2014-2017 Matthew O'Mara (applying to graduate schools)
- 2015-2017 Pearce Haldeman (Lab technician CalTech, Applying to MD/PhD programs)
- 2014-present Ramya Ramesh
- 2017-present McKenna Schultz
- 2017-present Bailey Antonowicz

Undergraduate lab shadowing supervised

Spring 2016 Cheyne White (Arizona Science Engineering and Math Scholars program)
Fall 2016 Destiny Mankel (Arizona Science Engineering and Math Scholars program)

High school student research studies supervised

Summer 2016 Ethan Weiss (KEYS High School Summer Internship Program)
Summer 2017 Jordan Pilch (KEYS High School Summer Internship Program)

Theses directed and in progress

2012-2014 Alexandra Petlick (MS), Nieves Montano (MS)
2014-2016 Amanda Hansen (MS)
2015-2016 Dustin Daniel (Professional Sciences Master's Program, Applied Biosciences GIDP)

Dissertations directed and in progress

2014-present Maggie Scavello (Biochemistry/Biological Chemistry Program), Shannon Collins
[MD/PhD program (Biochemistry/Biological Chemistry Program)]
2017-present Stephen Smith (Biochemistry/Biological Chemistry program), Agata Orlinski
(Biochemistry/Biological Chemistry program)

Postdoctoral advising

2013-2016 AFM Tariqul Islam (stayed on as senior research staff)
2015-2017 Anita Chavan

Service on other dissertation and graduate committees

2013-2014 Alayna George Thompson
2012-2014 Nikola Kenjic
2014-2016 Brandon Cornali
2013-2016 Flora Kimani
2015-2016 Mahsa Ghaffarri
2013-present Chandi DeSilva, Jessica Whales
2014-present Yang Zhou, Neng Ke
2015-present Matthew Bienick, Jonathan Sawyer
2016-present Garrett Davis, Sarah Young, Chathuri Kombala
2017-present Kristiane Torgeson
2017-present Claudia Barahona

Contributions to Instructional Innovations

Teaching workshops attended

Fall 2013 AAU-STEM Education Project: Teaching Talks (3)
AAU-STEM Faculty Learning Community, participant
Spring 2014 AAU-STEM Education Project: Teaching Talks (4)
AAU-STEM Faculty Learning Community, participant

Development of course materials

2013-2014 Development of new curriculum for BIOC568, with inclusion of active learning exercises
2014 Developed in-class active learning and assessment exercises for MED819
2014-present Continued development of new course material for BIOC568