

Annual Report of Activities and Outcomes

1. Name of the Unit

Centre for Applied Mathematics in Bioscience and Medicine (CAMBAM) The reporting period is May 1, 2018 – April 30, 2019

2. Name and contact information of co-directors

Erik Cook, Department of Physiology, erik.cook@mcgill.ca Fred Guichard, Department of Biology, fred.guichard@mcgill.ca

3. Status as an official research centre

CAMBAM received Senate approval as an official McGill Research Centre on November 16, 2011.

4. Number of Unit members

CAMBAM has 36 full members and 7 associate members (see Appendix 9 for a list of members).

5. Number of members affiliated with McGill's Faculty of Medicine

CAMBAM has 19 full members are in the Faculty of Medicine

<u>6. URL</u>

http://www.crm.umontreal.ca/labo/cambam/en/

At the request of last year's reviewers, we began updating our website in March 2019. Because CAMBAM is a member of the FRQNT-funded Center for Research in Mathematics (CRM) network, we decided to move our web site to their host-site. This is because the CRM offers CAMBAM administrative and technical in-kind support. The new website is almost complete but we need to transfer a few additional members to the new platform.

7. Summary of the past year's overall goals and objectives (half page)

PURPOSE: CAMBAM was established to create an interdisciplinary Faculty of Medicine led network of researchers and trainees focused on quantitative biosciences. Quantitative bioscience (also referred to as bioinformatics, mathematical or systems biology) is the application of physics, mathematics and computation to all spheres of biology and medicine. Examples range from mathematical descriptions of gene and cellular regulation to optimized models of clinical drug delivery.

GOALS: CAMBAM's first major goal is to maintain McGill's international leadership in the emerging field of quantitative biosciences. Because quantitative bioscience is highly interdisciplinary, our second goal is to connect researchers and students across faculties and institutions by creating a framework for scientific and social interaction (i.e., bring people together). CAMBAM's third goal is to support and prepare students and postdocs for the expanding career opportunities in quantitative biosciences.

ACHIEVEMENTS: To meet CAMBAM's goal of maintaining an international reputation as a leader in quantitative bioscience, we are part of an FQRNT-funded multi-centre grant headed by the CRM. CAMBAM's lead in organizing the International Society for Mathematical Biology conference and organizing various international summer schools maintains our international leadership. To meet our goal of connecting researchers, CAMBAM partnered with the new Quantitative Life Science program, McGill's Initiative in Computational Medicine, and the Ludmer Centre to run a lively seminar series, with 16 of 31 invited speakers from outside of Quebec. Finally, with the funds raised from various sources, we were able to achieve our goal of supporting fellowships for trainees working in CAMBAM affiliated labs. These and other CAMBAM activities are outlined below.

8. Major achievements (1 page)

- CAMBAM's financial support and partnership with the Centre de Recherches Mathematiques (CRM). CAMBAM is part of the CRM (www.crm.umontreal.ca), a network of 12 research centres across Quebec and Ontario. This collaboration brings quantitative bioscience to the CRM and connects CAMBAM to the larger community of mathematical and computational researchers. As a member of CRM, CAMBAM took an active part in preparing CRM's successful FRQNT application (\$2.4M over 6 years) and now receives \$35K in funding was well as additional in-kind support from being part of the larger CRM network.
- Joint CAMBAM/NSERC-Create summer school in complex dynamics (Appendix 1). Last June 18-29 we held a very successful 2-week Nonlinear Dynamics in the Life Sciences Summer School in the McIntyre building. A grant for \$26K from the William K. and Katherine W. Estes Fund and the Psychonomic Society was used to support the summer school. CAMBAM member Anmar Khadra and Caroline Palmer co-organized the school and 10 CAMBAM faculty members (out of 17) taught the 40 students attending (Grad: 30, UG: 7 and PDF: 3). The 2-week program included 8 days of lectures and computer labs, led by experts in nonlinear dynamics from math, physics, physiology, psychology, and neuroscience. Also included were 2 days of lab work and presentations by trainee teams of concepts covered in the lectures and labs.
- CAMBAM's weekly Seminars in Quantitative Life Sciences and Medicine (Appendix 2). We partnered with Quantitative Life Science, McGill's Initiative in Computational Medicine, and the Ludmer Centre to run a very active seminar series (31 talks) during 2018/19. Talks were held in McIntyre and the MNI and attendance ranged from 35 to over 100 (see Appendix 2 for a list of speakers). Because of the funds available to CAMBAM, and the contributions from out partners, we were able to invite 20 speakers from outside McGill. This seminar series is a critical part of CAMBAM's networking environment.
- CAMBAM's graduate and postdoctoral fellowships (Appendix 3). This year, CAMBAM awarded 7 fellowships to research groups for trainees (a total of \$49K). Students and PDFs in CAMBAM affiliated labs were asked to submit their research descriptions, interest in qualitative bioscience and discuss past participation in CAMBAM events.
- CAMBAM's Symposium in Nonlinear Mathematics in Medicine and Biology (Appendix 4). This was CAMBAM's major event of 2018 and was attended by over 100 faculty and students, with 17 invited speakers over two days. The symposium honored CAMBAM members Leon Glass and Michael Mackey's 30+ year contribution to the field that laid the foundation for the creation of CAMBAM.
- CAMBAM's support of the Physics and AI workshop (Appendix 5). CAMBAM member Paul Francois organized this symposium to highlight AI techniques is a wide range of physical science applications that also included a strong biophysics, biology and medicine component. There were 190 participants with over 140 trainees with a variety of backgrounds and departmental affiliations (UG, grad and PDF).

- CAMBAM's participation in the 2019 Society for Mathematical Biology (SMB) Annual Meeting (Appendix 6). CAMBAM members Jacques Belair, Fred Guichard and Anmar Khadra are the lead organizers for this international meeting to be held in July. This conference will highlight the international impact of CAMBAM and McGill in the field of quantitative bioscience.
- CAMBAM's upcoming Summer School on Nonlinear Dynamics in Life Sciences (Appendix 7). CAMBAM has joined the Fields Institute for Research in Mathematical Sciences to organize this international summer school to be held in July. CAMBAM member Anmar Khadra, along with 5 other CAMBAM members, represent the majority of the organization and teaching efforts that will highlight mathematical methods in the biosciences.
- CAMBAM's participation in the upcoming Fluid Dynamics of Disease Transmission (Appendix 8). CAMBAM teamed up with associate member Lydia Bourouiba (MIT) to help organize and support this conference and summer school. CAMBAM will be sending two students to attend this event.
- CAMBAM's support of McGill's new interfaculty Quantitative Life Science (QLS) Ph.D. program. Co-directors (Cook and Guichard) are members of the governing board for McGill's new interfaculty Ph.D. training program in Quantitative Life Sciences. This new program was officially approved by McGill's Senate in March 2017 and was recently approved by Quebec's Ministry of Education. The QLS program now has 30 students which compliments CAMBAM's training mission.
- **Public outreach.** CAMBAM has been a major organizer and supporter of the Cutting Edge Lectures in Science series (CAMBAM members Cook, Mackey and Guichard are part of the Cutting Edge organizing committee). These public lectures, held at the McGill's Redpath Museum, feature some of McGill's most prominent researchers.
- **Research.** CAMBAM members have active, externally funded, individual research programs. In the period covered by this report, they have published over 250 research papers.

9. New Members

Arjun Krishnaswamy (PI, full member, Physiology, McGill) and Lydia Bourouiba (PI, associate member, Civil and Environmental Engineering and Mechanical Engineering, MIT)

10. Members who have left

These members have left McGill and/or indicated that CAMBAM does not align with their interests: Michael Hallett (PI, full member), Mircea Alexandru Mateescu (PI, full member), Sam Musallam (PI, full member), Michael Rabbat (PI, full member), Vamsy Chodavarapu (PI, full member)

<u>11. Alignment with the mission of the Faculty of Medicine (half page)</u></u>

CAMBAM contributes to the Faculty's research mission by developing mathematical and computational tools for understanding how complex biological systems function - from molecular to organismal levels. CAMBAM's contribution was specifically mentioned in the 2017 McGill Faculties of Medicine and Dentistry Strategic Research Plan. In addition, CAMBAM has close ties with the newly created Initiative in Computational Medicine (MiCM).

Bioscience and health research is quickly expanding from being an exclusively data collection endeavor to one that embraces the development of new technologies and quantitative methods. For example, much of the field of genetics is now driven by statistical and computational algorithms. To meet these changing needs, our researchers actively prepare students for life in both academic research and industry with the goal of bridging the "training gap" that exists between students in bioscience and those from mathematics, physics and engineering. Importantly, CAMBAM's interdisciplinary mission directly supports McGill's Strategic Research Plan to create a "convergence of life sciences, natural sciences, and engineering".

During the next few years, CAMBAM will continue its leadership role in Quantitative Biology at McGill, within Quebec and internationally. CAMBAM and the Department of Physiology were recently awarded the recruitment of new faculty member to focus on links between artificial intelligence to bioscience research. We will continue to sponsor and promote interdisciplinary seminars, workshops, events and summer schools to bring together researchers from across faculties and institutions to solve critical problems in bioscience and medicine.

12. Why support from the Faculty of Medicine continues to be crucial (half page)

Faculty of Medicine support has allowed CAMBAM to achieve its many objectives. CAMBAM is one of the most multidisciplinary centers (members are from across faculties), with a long track record of successful Canadian (Fields, CAPnet) and international collaborations (MBI, NIMBios and MIT). With Faculty of Medicine funding, CAMBAM has accomplished all of its important objectives and maintains a level of activity (both local and international) that compares favorably with other McGill research centers. Continuing support from the Faculty of Medicine will promote our interdisciplinary support of quantitative bioscience at McGill as well as allow us to maintain our international presence. For example, CAMBAM members are the major organizer for the Society for International Mathematical Biology meeting to be held in Montreal July 22-26, 2019.

13. List action items that the Unit has taken or will consider taking in the next year towards growth and sustainability (half page)

- Over the next year, CAMBAM will begin working with the CRM to prepare for its renewal of its current FQRNT-funded network grant. Being part of the funded CRM network reduces CAMBAM's dependence on Faculty of Medicine support and has allowed us to be much more active.
- With the recruitment of the several new AI faculty recruits during the next year (including that in the Department of Physiology), CAMBAM will develop and promote this new aspect of quantitative bioscience.
- CAMBAM will continue to develop its new partnership with the Fields Institute for Research in Mathematical Sciences. This year, the Fields is contributing over \$20K in-kind support to help run our joint 2019 summer school on Nonlinear Dynamics in Life Science. Having partners that contribute to our activities frees up financial support for our trainees.
- Continue our partnerships with QLS, MiCM, and the Ludmer to run the very successful McGill-wide seminar series in Quantitative Life Sciences and Medicine. This partnership in organizing this seminar series is important for maintaining CAMBAM's larger presence in the McGill community.

14. Provide suggestions about how the Faculty could do better to support the Unit and research efforts (half page)

Clarify the rules for funding inter-faculty centers such as CAMBAM. Because of the interdisciplinary nature of quantitative bioscience, many of our members (approximately 47%) come from outside the Faculty of Medicine. We are uncertain as to whether this is an considered a strength or weakness compared to other Faculty of Medicine centers.

15. Year-end financial report

The financial report and budget for next year is attached at the end of the Appendix. Note that 100% of CAMBAM funds go to centre activities and trainee fellowships (no administrative salaries or director stipends).

In the past year, CAMBAM was funded by the Faculty of Medicine at \$15,000. CAMBAM has secured other funding by our membership with CRM, plus we have made the additional efforts to raise money through other activities such as our recent 2018 international summer schools (\$26,000 in outside funding from William K. and Katherine W. Estes Fund and the Psychonomic Society). This upcoming year we will receive a significant in-kind contribution from The Fields Institute for Research in Mathematical Sciences to help finance our 2019 summer school.

However, this year we ran a \$6,600 deficit due to our commitments and activities. Thus, we are requesting \$20,000 from the Faculty of Medicine for the upcoming year.

APPENDIX 1 - SUMMER SCHOOL IN COMPLEX DYNAMICS

June 18 - 29, 2018 Location: McGill University

The Joint CAMBAM/NSERC-CREATE in Complex Dynamics Summer School

Nonlinear Dynamics in Life Sciences with Applications to Neuroscience and Psychology

-- June 18 - 29 , 2018 --

Organizers

Anmar Khadra (McGill University)

Caroline Palmer (McGill University)

Lecturers

Leon Glass (McGill University)
Jacques Bélair (University of Montreal)
Michael Guevara (McGill University)
Michael Mackey (McGill University)
Frédéric Guichard (McGill University)
André Longtin (University of Ottawa)
Julie Carrier (University of Montreal)
Anmar Khadra (McGill University)
Erik Cook (McGill University)
Gil Bub (McGill University)

Frithjof Lutscher (University of Ottawa)
Caroline Palmer (McGill University)
Derek Bowie (McGill University)
Paul Francois (McGill University)
Paula Silva (University of Cincinnati)
Arjun Krishnaswamy (McGill University)
Jennifer Ryan (Rotman Research Institute - Baycrest)

Molly Henry (Western University)

Description

Living systems are typical examples of dynamical systems with many interrelated parts or subsystems, from small-scale cellular relationships to large-scale population relationships. Nonlinear dynamics arise when the behaviour of one subsystem, with its own dynamics, becomes the input for another subsystem, imposing certain constraints on its dynamics. Mathematics, physics, and biological sciences have contributed important theoretical developments to the understanding of how nonlinear dynamics explain behaviour in a wide range of disciplines in natural sciences, social sciences, and life sciences, based on common principles arising from differential equations. Nonlinear dynamics underlie the developmental trajectory of living organisms; the spread of information in neural networks and disease in populations; and the prediction of evolving ecosystems in changing environments. While different challenges arise in each research area, the required quantitative models are shared across areas. These models, accompanied by statistical and computational tools, provide young scientists with a platform to understand the dynamics of their systems and to guide new experiments. As a result, the fields of mathematical and computational modeling have had significant impact across the natural and life sciences, including neuroscience, physiology, psychology, computer science, ecology, and evolutionary biology.

In this summer school, we aim to provide a new generation of trainees with the opportunity to learn more about the basics of this field and give them an overview of the latest advancements made in quantitative biosciences, with particular emphasis on neuroscience and psychology.



McGill University McIntyre Medical Building 3655 Promenade Sir William Osler Montreal QC, Canada H3G 1Y6

For information on how to apply, please visit the following LINK.Financial support to attend the summer school is available.

CREATE-trainees in Complex Dynamics can register HERE.

For more information, contact :

summer.school@cnd.mcgill.ca





Psychonomic Society

Center for Applied Mathematics in Bioscience and Medicine (CAMBAM)

NSERC-CREATE: Complex Dynamics of Brain and Behaviour

The summer school recruited 40 student attendees from psychology, neuroscience, biology, physiology, math and physics; the applicants reflected primarily graduate students but also postdocs and undergraduates. The 40 trainees were recruited from 4 continents.

APPENDIX 2 - CAMBAM'S SEMINAR SERIES

Seminars were usually held in room 1027 of McIntyre or the de Grandpre Communications Centre at the MNI. Attendance was approximately 35 to 40, but ranged to over a 100 for a few of our outside speakers. This seminar series was jointly supported by McGill's Quantitative Life Science (QLS) program, MiCM, and the Ludmer Centre.

September 11, 2018 Hinke Osinga, University of Auckland When slow meets global: geometric insight from numerics

September 18, 2018

Frank Harrell, Vanderbilt University Musings on statistical models vs. machine learning in health research

September 25, 2018

Dominique Gravel, University of Sherbrooke Predicting the architecture of biodiversity

October 2, 2018

Jackie Vogel, McGill University Born that way: The role of initial state in the formation, stability and function of the mitotic spindle

October 9, 2018

Dannie Durand, Carnegie Mellon University Evolutionary rewiring of a bacterial signaling pathway

October 16, 2018

Eric Cytrynbaum, University of British Columbia Control of growth in plant cells through kinetic and mechanical microtubule organization

October 23, 2018

Josee Dupuis , Boston University Ancestry attracts, but love is blind: Evaluation of structured mating

October 30, 2018

Alan Evans, McGill University Modelling of connectivity in normal and disordered brains

November 6, 2018

Leslie Loew, University of Connecticut The interplay of structural and cellular biophysics controls clustering of multivalent molecules

November 13, 2018

Sylvain Baillet, McGill University The predictive machine: neural network architectures for brain perceptual inference

November 20, 2018

Hamed Najafabadi, McGill University RNA stability, the uncharted territory of gene regulation

November 27, 2018

Conor Liston, Weill Cornell Medicine Resting-state connectivity biomarkers define neurophysiological subtypes of depression

December 4, 2018

Anna Goldenberg, University of Toronto Developing machine learning models for phenotype prediction vs disease mechanism detection. A play in 3 acts.

December 11, 2018

Erica Moodie, McGill University SMART studies: An Evidence-Based approach to Precision Medicine.

January 8, 2019

Ed Bullmore, University of Cambridge Slow connectome dynamics during adolescence and genetic risks for schizophrenia

January 15, 2019

Sabrina Leslie, McGill University Deconstructing biology with simple singlemolecule imaging: Controlling conformation, confinement, and concentration

January 22, 2019

Pierre-Andre Menard, Computer Research Institute of Montreal Natural language processing in the medical field: CRIM'S projects and tools

January 29, 2019

Matt van der Meer, Dartmouth University Oscillations as an organizing principle for understanding information processing in the rodent ventral striatum

February 5, 2019

Mathieu Lavallee, University of Ottawa Getting more out of mass spectrometry-based proteomics using supervised learning approaches and on-the-fly data analysis

February 12, 2019

Gil McVean, Oxford University Mapping the structure of genetic risk for common disease in the UK Biobank

February 19, 2019

Nicolas Moitessier, McGill University Computational methods in drug discovery – can computers truly assist medicinal chemists?

February 26, 2019

Sidartha Goyal, University of Toronto How adaptive immunity constrains the composition and fate of large bacterial populations

March 5, 2019

Anita Layton, University of Waterloo Cardiovascular benefits and potential side effects of SGLT2 inhibitors, a new class of antihyperglyceamic drugs

March 12, 2019

Ma'n Zawati, McGill University Rise of the Planet of the Apps: Ethical and Legal Considerations of mhealth Apps in Medical Research

March 19, 2019

Shawn Brown, McGill University CBRAIN, a platform for accomplishing science on advanced research computing

March 26, 2019

Bratislav Misic, McGill University The Connected Brain

April 2, 2019

Jean-Francois Ethier, University of Sherbrooke PARS3, an infrastructure to support data access activities in context of learning health systems.

April 9, 2019

Bryan Grenfell, Princeton University

Spatio-temporal dynamics of childhood infectious disease: predictability and the impact of vaccination

April 16, 2019

Adrianne Jenner, University of Sydney A Hybrid Mathematical Approach to Improve Chemotherapy Implant Treatment of Pancreatic Cancer

April 23, 2019 Nigam Shah, Stanford University Good machine learning for better healthcare

April 30, 2019

Anmar Khadra, McGill University Understanding cellular polarity and adhesion dynamics involved in cell motility using spatiotemporal models

APPENDIX 3 - 2018 CAMBAM FELLOWSHIPS

A call for fellowship applications was sent out to all CAMBAM affiliated labs in May 2019, and applications were received by April 1, 2019 (see application form below). Seven CAMBAM groups applied for support, and we awarded \$7,000 to all seven groups (groups included joint mentorship and multiple trainees). The list of groups and trainees is below.



CAMBAM Winter 2019 Fellowship Application Due 1 April 2019

Please include this form plus trainee's CV in a single PDF document to erik.cook@mcgill.ca

Fellowships (and amounts) are awarded based on the quality of the applicant, past participation in CAMBAM, past CAMBAM support received by applicant, funds available, number of applications received by CAMBAM, and number of applicants from the same lab.

Name and level of trainee (MSc, PhD or PDF):

Name of supervisor(s) and department:

List previous CAMBAM fellowships received by applicant (if any):

Brief statement (short paragraph) about the interdisciplinary nature of the trainee's research across biology, mathematics and computation:

Brief description of the trainee's and/or supervisor's participation in CAMBAM sponsored events during the last year:

Recipients of CAMBAM's 2019 fellowships (\$7,000 to each group that applied).

CAMBAM group: Morgan Craig (Mathématiques et de statistique, Université de Montréal; Physiology, McGill) **Trainee:** Adrianne Jenner (PDF)

CAMBAM group: Jacques Bélair (Mathématiques, Université de Montréal) **Trainee:** Brian Treacy (PhD)

CAMBAM group: Frithjof Lutscher (Mathematics, Univ of Ottawa) & Frédéric Guichard (Biology, McGill) **Trainees:** Brendon McGuinness (PhD) and Ramesh Arumugam (PDF)

CAMBAM group: Erik Cook (Physiology, McGill) & Arjun Krishnaswamy (Physiology, McGill) **Trainee:** Daniel Borisov (MSc)

CAMBAM group: Anmar Khadra (Physiology, McGill) **Trainee:** Saeed Farjami (PDF)

CAMBAM group: Tony Humphries (Math & Stats and Physiology, McGill) & Mike Mackey (Physiology, Physics and Math & Stats, McGill) **Trainees:** Shaza Alsibaai (PhD) and Zhao Wendy Wang (MSc)

CAMBAM group: Lea Popovic (Dept of Mathematics and Statistics, Concordia) **Trainee:** Guillaume Ballif (PhD)

APPENDIX 4 - SYMPOSIUM IN NONLINEAR MATHEMATICS IN MEDICINE AND BIOLOGY

June 14-15, 2018 Location: McGill University



Leon Glass and Michael C. Mackey Diamond Symposium: Nonlinear Mathematics in Medicine and Biology

Thursday June 14 2018

8:45 Welcome – Alvin Shrier, McGill University, Canada

Session Chair (sessions 1 & 2): Dr. John White, McGill University, Canada

Session 1: Biophysics

- 9:00 Lennart Hilbert, Center for Systems Biology Dresden, Germany Physical principles of 3D DNA organization in the cell nucleus
- 9:15 Alejandro Rey, *McGill University, Canada* Mechanics of shape selection in anisotropic soft matter
- 9:30 Marc Roussel, University of Lethbridge, Canada Small binding-site occlusion delays in biopolymerizations: Do they matter?
- 9:45 Chiu Fan Lee, Imperial College London, United Kingdom Universal features in phase separation: implications for stress granule formation
- 10:00 Hiroyuki Ito, *Kyoto Sangyo University, Japan* From heart to brain - exploring causality in brain by brain-machine interface
- 10:15 Coffee Mix

Session 2: Neurosciences

- 10:45 Christian Hauptmann, Desyncra Operating GmbH, Germany Disrupting neuronal hyperactivity: concept and clinical experiences
- 11:00 John Lewis, University of Ottawa, Canada Dynamics of electric sensing
- 11:15 Katsumi Tateno, Kyushu Institute of Technology, Japan Electroreception in glass catfish

Keynote Lecture:

11:30 John Milton, *The Claremont Colleges, United States of America* Switching feedback and neural control 12:15 Lunch

Session Chair (sessions 3 & 4): Dr. Jacques Bélair, Université de Montréal, Canada

Session 3: Cardiac and Muscle Dynamics

- 1:45 Hortensia González Gómez, Universidad National Autonoma de Mexico, Mexico Some lessons from rhythmicity
- 2:00 Gil Bub, McGill University, Canada New methods for cardiac control
- 2:15 Madalena Costa, Harvard Medical School, United States of America Fragmentation of the heartbeat: dynamical dysfunction of the cardiac master clock in aging and disease
- 2:30 Moises Santillan, Cinvestav, Mexico Calcium dynamics in smooth muscle cells
- 2:45 **Trine Krogh-Madsen**, *Weill Cornell Medical College, United States of America* Global optimization of cardiac myocyte models
- 3:00 Coffee Mix

Session 4: Practical Applications

- 3:15 Morgan Craig, *Harvard University, United States of America* Designing and predicting the impact of oral long-acting antiretroviral therapy
- 3:30 Lydia Bourouiba, Massachusetts Institute of Technology, United States of America Fluids and health

Keynote Lecture:

- 3:45 James Collins, *Massachusetts Institute of Technology, United States of America Biological physicists living in Mackey-Glass houses should throw stones.*
- 4:30 Wrap up

Leon Glass and Michael C. Mackey Diamond Symposium: Nonlinear Mathematics in Medicine and Biology

Friday June 15 2018

Session Chair (sessions 5 & 6): Dr. Gil Bub, McGill University, Canada

Session 5: Time Delay

- 9:00 Eduardo S. Zeron, *Cinvestav, Mexico* Stability of the Delay Chemical Master Equation
- 9:15 Jianhong Wu, York University, Canada Physiologically structured models for tick population dynamics
- 9:30 **Tony Humphries**, *McGill University*, *Canada* Dynamics and bifurcations of blood cell population models with delays
- 9:45 Joseph Mahaffy, San Diego State University, United States of America Modeling thrombopoiesis: stability analysis of a reduced model
- 10:00 Coraci Malta, Universidade de Sao Paulo, Brasil Delay differential equations: transient oscillations and metastability
- 10:15 Coffee Mix

Session 6: Organs

- 10:45 Marcos Nahmad, Cinvestav, Mexico Mechanisms of organ size control during development
- 11:00 Jinzhi Lei, Tsinghua University, China Cancer development as a dynamical system
- 11:15 **Theodore Perkins**, University of Ottawa, Canada Quantitative understanding of the erythropoietic proteome

Keynote Lecture:

11:30 André Longtin, University of Ottawa, Canada Detecting biosignals in noise: the low and high hanging fruit

12:15 Lunch

Session Chair (sessions 7 & 8): Dr. Michael Guevara, McGill University, Canada

Session 7: Practical Applications

- 1:30 Eric Libby, Umeå University, Sweden Paradoxes in self-improvement
- 1:45 **Roy Wilds**, *Interset*, *Canada* Unsupervised machine learning for insider threat detection
- 2:00 Bart Borek, Vertex Pharmaceuticals Inc, United States of America Quantitative biology of cystic fibrosis
- 2:15 Claudia Lerma, Instituto Nacional de Cardiologia, Mexico Prediction of sudden cardiac death by quantitative analysis of ventricular ectopic beats in short-term RR interval recordings
- 2:30 Anna Sher, *Pfizer Inc, United States of America Quantitative systems pharmacology: cardiovascular and metabolic applications*
- 2:45 Colin Hill, GNS Healthcare, United States of America Commercializing systems biology: how AI and big data is driving precision medicine
- 3:00 Coffee Mix

Session 8: Genetic Networks

- 3:15 Roderick Edwards, University of Victoria, Canada Glass networks: from gene regulation to cybersecurity
- 3:30 **Tomas Gedeon**, *Montana State University*, *United States of America* Parameterized Glass networks and network dynamics

Keynote Lecture:

- 3:45 Stuart Kauffman, Institute for Systems Biology (Seattle) and Emeritus University of Pennsylvania, United States of America Ensembles, dynamics and cell types
- 4:30 Wrap up

APPENDIX 5 - PHYSICS AND AI WORKSHOP

May 6-7, 2019 Location: McGill University



APPENDIX 6 - CAMBAM'S PARTICIPATION IN THE UPCOMING SOCIETY FOR MATHEMATICAL BIOLOGY MEETING

July 22-26, 2019 Location: University of Montreal



APPENDIX 7 - CAMBAM'S UPCOMING SUMMER SCHOOL ON NONLINEAR DYNAMICS IN LIFE SCIENCES

July 15-19, 2019 Location: Fields Institute for Research in Mathematical Sciences, Toronto

Summer School on Nonlinear Dynamics in Life Sciences

July 15 - 19, 2019, The Fields Institute Location: Fields Institute, Stewart Library

Description

Living systems are typical examples of dynamical systems with many interrelated parts or subsystems, from small-scale cellular relationships to large-scale population relationships. Nonlinear dynamics arise when the behaviour of one subsystem, with its own dynamics, becomes the input for another subsystem, imposing certain constraints on its dynamics. Mathematics, physics, and biological sciences have contributed important theoretical developments to the understanding of how nonlinear dynamics explain behaviour in a wide range of disciplines in natural sciences, social sciences, and life sciences, based on common principles arising from differential equations. Nonlinear dynamics underlie the developmental trajectory of living organisms; the spread of information in neural networks and disease in populations; and the prediction of evolving ecosystems in changing environments. While different challenges arise in each research area, the required quantitative models are shared across areas. These models, accompanied by statistical and computational tools, provide young scientists with a platform to understand the dynamics of their systems and to guide new experiments. As a result, the fields of mathematical and computational modeling have had significant impact across the natural and life sciences, including neuroscience, physiology, immunology, computer science, ecology, and evolutionary biology.

Summer School Schedule, please click here.

Co-Sponsor



Summer School on Nonlinear Dynamics in Life Sciences

Topics and Lecturers			
Dates	Lecture topics	Lecturers	
Monday, July 15	Finite difference equations, phase resetting and phase locking, Poincaré maps and introduction to ordinary differential equations	Leon Glass and Gil Bub	
Tuesday, July 16	Coupled nonlinear oscillators, phase locking, phase transitions, population persistence and spread; Instructors	Sue Ann Campbell and Fred Guichard	
Wednesday, July 17	Bifurcation methods; electrophysiological systems: Hodgkin-Huxley and FitzHugh- Nagumo models	Michael Guevara and Anmar Khadra	
Thursday, July 18	Deterministic and stochastic models, reaction kinetics, gene and metabolic networks	Paul Francios and Brian Ingalls	
Friday, July 19	Computational and stochastic approaches to problems arising in the life sciences	Sivabal Sivaloganathan and Mohammad Kohandel	

Sponsored by Fields Institute and Centre for Applied Mathematics in Bioscience and Medicine

APPENDIX 8 - CAMBAM'S PARTICIPATION IN THE UPCOMING FLUID DYNAMICS OF DISEASE TRANSMISSION

July 23-Aug 2, 2019 Location: Cargese International School, France



APPENDIX 9 - CAMBAM Membership

2018/2019 Board of Directors

Faculty members

Erik Cook (Co-director), Department of Physiology, McGill University Frédéric Guichard (Co-director), Department of Biology, McGill University Michael Mackey (Past Director), Department of Physiology, McGill University Jacques Belair, Department of Mathematics and Statistics, Université de Montréal Fahima Nekka, Department of Pharmacology, Université de Montréal Anmar Khadra, Department of Physiology, McGill University **Student member** Laurent Mackay, Department of Physiology, McGill University **VP RIR Representative** Kristina Ohrvall **Faculty of Medicine Representative** Shari Baum, Associate Dean, Research **External member**

Jesse Vincent-Herscovici, Director, Strategic Accounts and Business Development, Mitacs Inc.

Full Members

Jacques Bélair	Department of Mathematics and Statistics, Université de Montréal
Mathieu Blanchette	School of Computer Science, McGill University
Gil Bub	Department of Physiology, McGill University
David Buckeridge	Department of Epidemiology, McGill University
Maurice Chacron	Department of Physiology, McGill University
Philippe Comtois	Department of Biomedical Engineering, Université de Montreal
Erik Cook	Department of Physiology, McGill University
Eusebius Doedel	Department of Statistics and Mathematics, Concordia University
Alan Evans	Department of Neurology, McGill University
Paul Francois	Department of Physics, McGill University
Gregor Fussmann	Department of Biology, McGill University
Leon Glass	Department of Physiology, McGill University
Mladen Glavinovic	Department of Physiology, McGill University
Michael Guevara	Department of Physiology, McGill University

Frédéric Guichard	Department of Biology, McGill University
Tony Humphries	Department of Mathematics and Statistics, McGill University
Vincent Jacquemet	Department of Physiology and Institut de Génie Biomédical, Université de Montréal
Anmar Khadra	Department of Physiology, McGill University
Arjun Krishnaswamy	Department of Physiology, McGill University
Svetlana Komarova	Faculty of Dentistry, McGill University
Claudia Kleinman	Department of Human Genetics, Faculty of Medicine
Sabrina R. Leslie	Department of Physics, McGill University
Brian Leung	Department of Biology and School of Environment, McGill University
Nicole Li	School of Communication Sciences and Disorders, McGill University
Michael Mackey	Department of Physiology, McGill University
Jacek Majewski	Department of Human Genetics, McGill University
Fahima Nekka	Department of Pharmacology, Université de Montréal
Christopher Pack	Department of Neurology and Neurosurgery, McGill University
Lea Popovic	Department and Statics and Mathematics, Concordia University
Alejandro Rey	Department of Chemical Engineering, McGill University
Alfredo Ribiero da-Silva	Department of Pharmacology and Therapeutics, McGill University
Amir Shmuel	Department of Neurology and Neurosurgery, McGill University
Alain Vinet	Department of Physiology and Institut de Génie Biomédical, Université de Montréal
Jackie Vogel	Department of Biology, McGill University
Brian Wilhelm	Department of Biomedical Engineering, Université de Montreal
Brandon Xia	Department of Bioengineering, McGill University

Juli AthertonDepartment of Mathematics, UQAMLydia BourouibaCivil and Environmental Engineering and Mechanical Engineering, MITKathleen CullenBiomedical Engineering, Johns HopkinsFrithjof LutscherDepartment of Mathematics and Statistics, University of OttawaAndré LongtinDepartment of Physics, University of OttawaGenevieve LefebvreDepartment of Mathematics, UQAMEdward VigmondDepartment of Electrical Engineering, Université de Bordeaux

Associate Members

1/6 6/1/19

Appendix 2



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leaicine	

Year-End Financial Statement for May 1st 2018 to April 30th 2019

Research Centre, Core Facility, Network name:		САМВАМ		
Director and Administrator (names and Erik Cook contact information):		k (erik.cook@mcgill.ca) Fred Guichard (fred.guichard@mcgill.ca)		
Sources of Income/Revenue:				
		Cash	In-kind	
From Faculty of Medicine		15,000		
FRQNT with Centre de reserches mathematiques (through McGill VP RIR)		35,000		
Faculty of Science		3,000		
The \$26,000 grant from the William K. and Katherine W. Estes Fund and the Psychonomic Society was used exclusively for the joint CAMBAM/NSERC- CREATE summer school and thus not listed as revenue.				
Carry over from previous year				
TOTAL Income/Revenue:		53,000		
Expenditures				

Where applicable, provide details of items of expenditure as indicated below, e.g. salary components should be listed by individual, the cost of each workshop, individual working group, or other meetings should be given, as well as any research project funds expended

		Contributing Organization contribution	
	Faculty of		
Description	Medicine funds	Cash	In-kind

Student and trainee salaries (2019 fellowships)				
awarded in May 2019.	49,000			
Seminar series external speakers (2018/19) Note				
that QLS, NiCM & Ludmer also supported this				
seminar series.				
	2,600			
CAMBAM's Symposium in Nonlinear Mathematics in				
Medicine and Biology (June 14 - 15, 2018).				
	3,000			
CAMBAM/NSERC-Create summer school in complex				
dynamics (June 18 - 19, 2018). Paid fees for				
international students and the \$26,000 grant from				
the William K. and Katherine W. Estes Fund and the				
	0			
Physics and AI workshop (May 6 - 7, 2019)	5,000			
TOTAL EXPENDITURES	59,600			
Carryover amount: Please note that a carryover balance is not permitted for some accounts (to clarify accounts affected, please consult Financial Affairs)				
Provide the reason for carryover * if permitted: <i>It is</i>				
essential that reasons be provided by carryover				
requests				

*It is the responsibility of the Centre, Core Facility, Network to ensure that the carryover amount requested in this document has been discussed with the Financial Affairs Office of the Faculty of Medicine

Director of Research Contre, Cope Facility or Network	or his/her Delega	te:	
Signature Gull Work			
Date 31 May 2019			



Faculty of **Medicine**

Budget plan for May 1st 2019 to April 30th 2020

Total request from Medicine for 2019-20:

20,000

Sources of Income/Revenue:

20

	Cash
From Faculty of Medicine	20,000
FRQNT with Centre de reserches mathematiques	
(through McGill VP RIR)	35,000
Faculty of Science	3,000
TOTAL Income/Revenue:	58,000
Expenditures	

Where applicable, provide details of items of expenditure as indicated below, e.g. salary co listed by individual, the cost of each workshop, individual working group, or other meetings well as any research project funds expended

	Faculty of	Contributing Organizati
Description	Medicine	Cash
Student and trainee salaries (2020 fellowships)		35,400

CAMBAM student travel to Fluid Dynamics of Disease	
Transmission (July 23 - Aug 2, 2019)	3,000
CAMBAM seminars	3,500
CAMBAM/Fields Summer School on Nonlinear	
Dynamics in Life Sciences (July 15 - 19, 2019)	
	8,000
CAMBAM's yearly symposium	
	1,500
Other expenditure:	6.600
Over-experial tare from previous year	0,000
TOTAL EXPENDITURES	58,000