

# Behavioural Neuro(epi)genetics and Genomics

Department of Psychology & Neuroscience

NESC 4670 & PSYO-NESC 6071 Winter 2024

*Dalhousie University acknowledges that we are in Mi'kma'ki, the ancestral and unceded territory of the Mi'kmaq People and pays respect to the Indigenous knowledges held by the Mi'kmaq People, and to the wisdom of their Elders past and present. The Mi'kmaq People signed Peace and Friendship Treaties with the Crown, and section 35 of the Constitution Act, 1982 recognizes and affirms Aboriginal and Treaty rights. We are all Treaty people.*

*Dalhousie University also acknowledges the histories, contributions, and legacies of African Nova Scotians, who have been here for over 400 years.*

## Course Instructor(s)

Name	Email	Office Hours
Ian Weaver (Instructor)	<a href="mailto:ian.weaver@dal.ca">ian.weaver@dal.ca</a>	Tuesdays, 13:30 - 15:30, LSC 3340 and online

## Course Description

CREDIT HOURS: 3

In this seminar course we discuss primary scientific literature on significant advances in (epi)genetic, cellular and behavioural approaches in molecular and systems neuroscience to examine social, emotional and cognitive abilities and further understand the roles of molecular and cellular pathways and environmental factors that underlie the neuropathology of neurodegenerative diseases (e.g., Parkinson's, Alzheimer's, and Huntington's), learning and attention disabilities (e.g., Autism, ADHD), addiction (e.g., alcoholism, drug abuse) and major psychosis (bipolar disorder, schizophrenia, major depression). The role of genetic and epigenetic mechanisms as well as methods used to study gene-environment interactions are examined, as well as ethical implications of epigenetics research. The course is also designed to provide students with the opportunity to think critically about research in this content area and to present about it. In the first module, key articles will be selected on several strategies that combine (epi)genetic, behavioural and contemporary pharmacological techniques to further increase our understanding of the neural circuitry supporting emotional regulation and

cognitive ability. In the second module, students will be able to select and present important articles that pique their own interest.

FORMAT: Seminar

LECTURE HOURS PER WEEK: 3

*Course Prerequisites*

NESC Honours student, Instructor permission required.

CROSS-LISTING: NESC 4670, NESC 6071, PSYO 6071

## Student Resources

**Office Hours: Tuesdays, 13:30– 15300;** Room 3340, Life Sciences Centre (Psychology Wing) and online (<https://outlook.office365.com/owa/calendar/OfficeHours4@dalu.onmicrosoft.com/bookings/>)

See end of document for additional resources available to students (resource centers, etc.).

## Course Structure

*Course Delivery*

**In-person**, seminars will also be recorded and posted on Brightspace.

*Lectures*

**Thursdays**, 09:35 - 11:55; Room C216-Psychology, Life Sciences Centre (Studley Campus)

## Course Materials

References to **required and additional** readings for the first half of the course are posted online on Brightspace. These readings have been selected instead of a course textbook. References for readings for the second half of the course will become available 2-3 weeks before they are discussed in seminars. Suggested popular textbooks and web links posted online on Brightspace are only to provide context and help fill in any gaps in background knowledge.

**Reading list:** Changes may be made at the instructor's discretion.

- Ng SF, Lin RC, Laybutt DR, Barres R, Owens JA, Morris MJ. Chronic high-fat diet in fathers programs  $\beta$ -cell dysfunction in female rat offspring. *Nature* 2010;467: 963–966.
- Dominguez-Salas P, et al. Maternal nutrition at conception modulates DNA methylation of human metastable epialleles. *Nat Commun.* 2014 Apr 29;5:3746.

- Gao Y, et al. Vitamin C-induced pluripotent state in mouse embryonic stem cells by modulating microRNA expression. *FEBS J.* 2015 Feb;282(4):685-99
- Domingos AI, Leptin regulates the reward value of nutrient. *Nature Neuroscience* 14, 1562–1568 (2011)
- Dunn GA, Bale TL. Maternal high-fat diet effects on third-generation female body size via the paternal lineage. *Endocrinology.* 2011 Jun;152(6):2228-36.
- Wu J, et al. Alzheimer's disease (AD)-like pathology in aged monkeys after infantile exposure to environmental metal lead (Pb): evidence for a developmental origin and environmental link for AD. *J Neurosci.* 2008 Jan 2;28(1):3-9.
- Franklin TB, et al. Epigenetic transmission of the impact of early stress across generations. *Biol Psychiatry* 2010; 68:408-15.
- Mueller BR, Bale TL. Sex-specific programming of offspring emotionality after stress early in pregnancy. *J Neurosci* 2008;28:9055–9065.
- Murgatroyd C, et al (2009) Dynamic DNA methylation programs persistent adverse effects of early-life stress. *Nat Neurosci* 12:1559–1566.
- Guan JS, et al. HDAC2 negatively regulates memory formation and synaptic plasticity. *Nature* 2009;459:55–60.
- Vassoler FM, et al. Epigenetic inheritance of a cocaine- resistance phenotype. *Nat Neurosci.* 2013 Jan;16(1):42-7.
- Wang H, et al. Histone deacetylase inhibitors facilitate partner preference formation in female prairie voles. *Nat Neurosci* 2013; 16: 919-24.
- Zovkic IB, Paulukaitis BS, Day JJ, Etikala DM, Sweatt JD. Histone H2A.Z subunit exchange controls consolidation of recent and remote memory. *Nature.* 2014 Nov 27;515(7528):582-6.
- Sohal, I. Neocortical excitation/inhibition balance in information processing and social dysfunction. *Nature*, 477 (2011), pp. 171–178
- Mehta D, et al. Childhood maltreatment is associated with distinct genomic and epigenetic profiles in posttraumatic stress disorder. *Proc Natl Acad Sci U S A.* 2013 May 14;110(20):8302-7.
- Hunter RG, et al. Acute stress and hippocampal histone H3 lysine 9 trimethylation, a retrotransposon silencing response. *Proc Natl Acad Sci USA.* 2012;109(43):17657–17662.
- Anacker C. Neuroanatomic Differences Associated with Stress Susceptibility and Resilience. *Biol Psychiatry.* 2015 Aug 18.

- Paz, T.J. et al. Closed-loop optogenetic control of thalamus as a tool for interrupting seizures after cortical injury. *Nat. Neurosci.*, 16 (2013), pp. 64–70
- Borghol, N, et al. Associations with early-life socio-economic position in adult DNA methylation. *Int J Epidemiol.* 2012 Feb;41(1):62-74.
- Yehuda, R. et al. Holocaust Exposure Induced Intergenerational Effects on FKBP5 Methylation. *Biol Psychiatry.* 2015 Aug 12. pii: S0006-3223(15)00652-6.
- Lei Cao-Lei et al. DNA Methylation Signatures Triggered by Prenatal Maternal Stress Exposure to a Natural Disaster: Project Ice Storm. *PLoS ONE*, vol. 9, no. 9, Article ID e107653, 2014.
- Rajasethupathy, P. et al (2015). Projections from neocortex mediate top-down control of memory retrieval. *Nature* 526, 653–659
- Morath J. et al Effects of Psychotherapy on DNA Strand Break Accumulation Originating from Traumatic Stress. *Psychother Psychosom* 2014;83:289-297
- McGowan, P.O. et. al.Epigenetic regulation of the glucocorticoid receptor in human brain associates with childhood abuse. *Nat Neurosci.* 2009 Mar; 12(3): 342–348.
- Magown, P. et al. Direct optical activation of skeletal muscle fibres efficiently controls muscle contraction and attenuates denervation atrophy.*Nat Commun.* 2015 Oct 13;6:8506.
- Glaros, S., et al. (2007). The reversible epigenetic silencing of BRM: implications for clinical targeted therapy. *Oncogene*, 26(49), 7058–7066.
- Escobar, R., et al. (2014). Better quality of mother–child interaction at 4 years of age decreases emotional overeating in IUGR girls. *Appetite*, 81, 337-342.
- Nagata, T. et al. Association between DNA Methylation of the BDNF Promoter Region and Clinical Presentation in Alzheimer's Disease. *Dement Geriatr Cogn Dis Extra.* 2015 Jan-Apr; 5(1): 64–73.

## Assessment

This seminar emphasizes student presentations and group discussion. During most meetings, students will present and discuss primary scientific literature. Grades will be based on the instructor's assessment of elements listed below.

i.) Presentations of Scientific Papers: weighted at 45%

Depending on class size, each student will have 2 or 3 opportunities to lead the discussion of an assigned research article. Students will be assessed on their ability to present the main objectives of the study and the major results, the thoroughness of their evaluation of the paper, and discussion of how the findings extend previous work clearly and succinctly. Students are encouraged to seek out review and methodology papers to help them prepare for each presentation. PowerPoint is preferred for presentations.

ii.) Participation in Class Discussion: weighted at 15%

The open format of class presentations relies on an informed and interested audience. Although it is easier to passively listen to each presentation, one of the goals of the class is for students to develop their critical thinking skills and ability to debate issues arising from scientific research. Herein, non-presenting students will complete a presentation rating form on the: i) paper topic and selection relevancy; ii) delivery; iii) clarity and organisation; iii) visuals; iv) overall impression as well as provide general advice to presenter. Before the end of class the rating student submits their completed assessment to the instructor who awards them with a 'participation point'. The instructor will then give the presenter student the anonymous feedback in the context of their own comments before the next class. Therefore, class participation will be qualitatively monitored throughout the course.

iii.) Edited Notes on Presentations: weighted at 40%

Rather than have one large term paper due at the end of the course, student audience members will review and edit their in-class notes on each presentation so that they can be used as 'article summaries'. Rough notes should start with initial impressions from reading each paper before class and be updated with ideas arising from discussion of the article. These notes will then be edited to create a cohesive one-page article summary for each paper. Article summaries for the previous week's presentations should be emailed to [ian.weaver@dal.ca](mailto:ian.weaver@dal.ca) (in .pdf or .doc format) before the beginning of the following class (5 % penalty/day for late summaries). Please note, the final summaries (for Seminar 12) should be emailed to [ian.weaver@dal.ca](mailto:ian.weaver@dal.ca) by 11:59pm on Wednesday 10<sup>th</sup> April, 2024.

### *Other course requirements*

None

Conversion of numerical grades to final letter grades follows the

#### Dalhousie Grade Scale

A+ (90-100)	B+ (77-79)	C+ (65-69)	D (50-54)
A (85-89)	B (73-76)	C (60-64)	F (0-49)
A- (80-84)	B- (70-72)	C- (55-59)	

### **Course Policies on Missed or Late Academic Requirements**

All classes must be attended at the scheduled time. Grades are final at the end of term and cannot be 'bumped up' with extra work. **Missed presentations** due to illness or exceptional circumstances **must** be communicated to the instructor immediately. An alternative make-up will only be considered with a DECLARATION OF ABSENCE, completed, signed, and emailed to [ian.weaver@dal.ca](mailto:ian.weaver@dal.ca) within 24 hours of the class. There will be a 5% penalty/day for late 'article summaries'.

### **Course Policies related to Academic Integrity**

Students are allowed to discuss general concepts with each other, but each assignment submitted **must** be 'individual work'. Plagiarism detection tools will assist in detecting textual similarities between compared works as well as generative AI and large language models (ChatGPT etc).

### **Learning Objectives**

This seminar series consists of student presentations of recent original research articles that have had an impact on our understanding of neuroscience. The aim of the seminar series is to introduce primary scientific literature on the use of genetic techniques to study the molecular & cellular bases of behaviour. Reverse genetic approaches utilizing gene knockout and transgenic technology and forward genetic approaches using mutagenesis and quantitative genetic techniques will be discussed, as well as application of these studies to different model organisms. e.g., how to make transgenic mice and recent advances in next-generation biological techniques (e.g., optogenetics) and genome editing (e.g., CRISPR/Cas9) tools for investigation of neural circuits underlying brain function. Content area will cover psychology, neurology, neuroendocrinology, immunology, (epi)genetics, animal modelling, cognitive neuroscience, and the scope from genes, to brain, to behaviour to treatment. In the first module, key articles will be selected on several strategies that combine (epi)genetic, behavioural, and contemporary

pharmacological techniques to further increase our understanding of the neural circuitry supporting emotional regulation and cognitive ability. The main objectives are covered within four themes: 1) Nutrition and developmental origins of health and disease; 2) From xenobiotics to stress, linking early life experience with adult behaviour; 3) Learning/memory and addiction; 4) Normal aging, neurodegeneration, and neuropsychiatric disorders. In the second module, students will be able to select and present important articles that pique their own interest.

By the end of the course students should be able to:

- List and define major genetic and epigenetic processes in neurobiology.
- Name and discuss important neural and developmental pathways that are regulated by genetic and epigenetic factors.
- Gain an understanding of how misregulation of genetic and epigenetic mechanisms can lead to disease states. Recognize how epigenetic machinery can be targets for therapeutic agents.
- Read, comprehend, critically analyse and integrate knowledge from primary research articles.
- Explain commonly used molecular, cellular, and behavioural techniques and design experiments using these techniques to address a biological question.
- Contribute to academic discussion.

### Course Content

Seminar	Date	Lesson Topic(s)	Assessment/Deadline
1	Thursday 11 <sup>th</sup> Jan, 24	Introduction to the course	
2	Thursday 18 <sup>th</sup> Jan, 24	The Construction of transgenic and gene knockout-knockin mouse models of human disease	
3	Thursday 25 <sup>th</sup> Jan, 24	Optogenetic approaches and epigenetic mechanisms in neurobehavioural research	
4	Thursday 1 <sup>st</sup> Feb, 24	<b>Section 1 - Assigned articles,</b> <i>Theme 1 - Nutrition and developmental origins of health and disease</i>	
5	Thursday 8 <sup>th</sup> Feb, 24	<i>Theme 2 - From exnobiotics to stress, linking early life experience with adult behavior</i>	Seminar 4 summaries
6	Thursday 15 <sup>th</sup> Feb, 24	Continued from previous seminar	Seminar 5 summaries

Mon 19 <sup>th</sup> - Fri 23 <sup>rd</sup> Feb, 24		WINTER STUDY BREAK	
7	Thursday 29 <sup>th</sup> Feb, 24	<i>Theme 3 - Learning-memory and addiction</i>	Seminar 6 summaries
8	Thursday 07 <sup>th</sup> Mar, 24	<i>Theme 4 - Normal aging, neurodegeneration and neuropsychiatric disorders</i>	Seminar 7 summaries
9	Thursday 14 <sup>th</sup> Mar, 24	Continued from previous seminar	Seminar 8 summaries
10	Thursday 21 <sup>st</sup> Mar, 24	<b>Section 2 - Articles chosen by students</b>	Seminar 9 summaries
11	Thursday 28 <sup>th</sup> Mar, 24	Continued from previous seminar	Seminar 10 summaries
12	Thursday 04 <sup>th</sup> Apr, 24	Continued from previous seminar	Seminar 11 summaries
Wednesday 10 <sup>th</sup> Apr, 24		BREAK BEFORE EXAMS	Seminar 12 summaries



## University Policies and Statements

### Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit or e-mail the Indigenous Student Centre at 1321 Edward St or [elders@dal.ca](mailto:elders@dal.ca). Additional information regarding the Indigenous Student Centre can be found at: [https://www.dal.ca/campus\\_life/communities/indigenous.html](https://www.dal.ca/campus_life/communities/indigenous.html)

### Internationalization

At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: <https://www.dal.ca/about-dal/internationalization.html>

### Academic Integrity

At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Additional academic integrity information can be found at: [https://www.dal.ca/dept/university\\_secretariat/academic-integrity.html](https://www.dal.ca/dept/university_secretariat/academic-integrity.html)

### Accessibility

The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre ([https://www.dal.ca/campus\\_life/academic-support/accessibility.html](https://www.dal.ca/campus_life/academic-support/accessibility.html)) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (<https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html>)

## **Conduct in the Classroom – Culture of Respect**

Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

## **Diversity and Inclusion – Culture of Respect**

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: <http://www.dal.ca/cultureofrespect.html>

## **Student Code of Conduct**

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner - perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. The full Code of Student Conduct can be found at:

[https://www.dal.ca/dept/university\\_secretariat/policies/student-life/code-of-student-conduct.html](https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html)

## **Fair Dealing Policy**

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: [https://www.dal.ca/dept/university\\_secretariat/policies/academic/fair-dealing-policy-.html](https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html)

## **Originality Checking Software**

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at:

[https://www.dal.ca/dept/university\\_secretariat/policies/academic/student-submission-of-assignments-and-use-of-originality-checking-software-policy-.html](https://www.dal.ca/dept/university_secretariat/policies/academic/student-submission-of-assignments-and-use-of-originality-checking-software-policy-.html)

## **Student Use of Course Materials**

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.

Faculty of Science

# Student Resources and Support

## University Policies and Programs

Important Dates in the Academic Year (including add/drop dates):

[http://www.dal.ca/academics/important\\_dates.html](http://www.dal.ca/academics/important_dates.html)

Classroom Recording Protocol:

[https://www.dal.ca/dept/university\\_secretariat/policies/academic/classroom-recording-protocol.html](https://www.dal.ca/dept/university_secretariat/policies/academic/classroom-recording-protocol.html)

Dalhousie Grading Practices Policies:

[https://www.dal.ca/dept/university\\_secretariat/policies/academic/grading-practices-policy.html](https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html)

Grade Appeal Process: [https://www.dal.ca/campus\\_life/academic-support/grades-and-student-records/appealing-a-grade.html](https://www.dal.ca/campus_life/academic-support/grades-and-student-records/appealing-a-grade.html)

Sexualized Violence Policy: [https://www.dal.ca/dept/university\\_secretariat/policies/health-and-safety/sexualized-violence-policy.html](https://www.dal.ca/dept/university_secretariat/policies/health-and-safety/sexualized-violence-policy.html)

Scent-Free Program: <https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>

## Learning and Support Resources

General Academic Support – Advising (Halifax): [https://www.dal.ca/campus\\_life/academic-support/advising.html](https://www.dal.ca/campus_life/academic-support/advising.html)

General Academic Support – Advising (Truro): <https://www.dal.ca/about-dal/agricultural-campus/ssc/academic-support/advising.html>

Student Health & Wellness Centre: [https://www.dal.ca/campus\\_life/health-and-wellness.html](https://www.dal.ca/campus_life/health-and-wellness.html)

On Track (helps you transition into university, and supports you through your first year at Dalhousie and beyond): [https://www.dal.ca/campus\\_life/academic-support/On-track.html](https://www.dal.ca/campus_life/academic-support/On-track.html)

Indigenous Student Centre: [https://www.dal.ca/campus\\_life/communities/indigenous.html](https://www.dal.ca/campus_life/communities/indigenous.html)

Indigenous Connection: <https://www.dal.ca/about-dal/indigenous-connection.html>

Elders-in-Residence (The Elders in Residence program provides students with access to First Nations elders for guidance, counsel, and support. Visit the office in the Indigenous Student Centre or contact the program at [elders@dal.ca](mailto:elders@dal.ca) or 902-494-6803:

<https://cdn.dal.ca/content/dam/dalhousie/pdf/academics/UG/indigenous-studies/Elder-Protocol-July2018.pdf>

Black Student Advising Centre: [https://www.dal.ca/campus\\_life/communities/black-student-advising.html](https://www.dal.ca/campus_life/communities/black-student-advising.html)

International Centre: [https://www.dal.ca/campus\\_life/international-centre.html](https://www.dal.ca/campus_life/international-centre.html)

South House Sexual and Gender Resource Centre: <https://southhousehalifax.ca/about/>

LGBTQ2SIA+ Collaborative: <https://www.dal.ca/dept/vpei/edia/education/community-specific-spaces/LGBTQ2SIA-collaborative.html>

Dalhousie Libraries: <http://libraries.dal.ca/>

Copyright Office: <https://libraries.dal.ca/services/copyright-office.html>

Dalhousie Student Advocacy Services: <https://www.dsu.ca/dsas?rq=student%20advocacy>

Dalhousie Ombudsperson: [https://www.dal.ca/campus\\_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html](https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html)

Human Rights and Equity Services: <https://www.dal.ca/dept/hres.html>

Writing Centre: [https://www.dal.ca/campus\\_life/academic-support/writing-and-study-skills.html](https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html)

Study Skills/Tutoring: [http://www.dal.ca/campus\\_life/academic-support/study-skills-and-tutoring.html](http://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html)

Faculty of Science Advising Support: <https://www.dal.ca/faculty/science/current-students/undergrad-students/degree-planning.html>

## **Safety**

Biosafety: <http://www.dal.ca/dept/safety/programs-services/biosafety.html>

Chemical Safety: <https://www.dal.ca/dept/safety/programs-services/chemical-safety.html>

Radiation Safety: <http://www.dal.ca/dept/safety/programs-services/radiation-safety.html>

Laser Safety: <https://www.dal.ca/dept/safety/programs-services/radiation-safety/laser-safety.html>