FOUNDATION BLOCK
200 - NEUROSCIENCES
(LIBERAL ARTS & SCIENCE SECTION)
SYLLABUS

Course Description (from Calendar)
This course examines the brain, from molecules to whole networks, in order to understand a network that has more possible connections than there are particles in the universe. We look at brain function mapping, the mechanisms of learning and memory, language acquisition, and how the brain perceives the world. We use our own bodies in fun (and harmless) experiments to demonstrate how the nervous system works.

Section Description
The course satisfied the requirements for a Neurosciences Foundation block. This section will introduce students to neuropsychology, or in other words, the relationship between brain and behaviour. Students will explore the latest findings in the field, and explore the ethical and societal ramifications of these findings.

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Credits: 1 block
Pre-requisite: None

Course Goals
At the end of this course, students should have a good understanding of how the brain controls their behaviour, and be familiar with the techniques used to investigate the relationship between the brain and behaviour. Students will also gain an appreciation for the ways in which neurosciences in changing our perception of ourselves, is leading to clinical breakthroughs, and is posing new dilemmas for our society.

The following Quest outcomes will be developed:

- Critical thinking
  - Students will apply the knowledge gained through readings to real-life situations in solving daily case studies
- Communication
  - Students will be encouraged to develop their verbal communication skills through group RATs, team work on the daily case studies, and whole class discussions
  - Students will practice their written communication skills through the completion of their research paper (essay)

    - Students will develop visual communication skills through the creation of a television advertisement, as well as other daily assignments such as the creation of drawings and cartoons
    - Students will develop the skill of addressing a variety of audience, such as laymen (creation of a TV ad) and scientific (essay on a research question, using primary scientific literature)
    - Students will practice the skill of providing and receiving effective feedback on performance
- Research
    - Students will become familiar with the primary research tools of biopsychology and design a few experiments
    - Students will research databases and research primary scientific literature in attempting to answer their question for the research paper
- Ethics
    - Students will be asked to consider the ethical implications of recent developments in the field of neurosciences, such as neurogenetics
- Integration/breadth
    - Through case studies, students will evaluate the context in which brain research and neurological disorders occur

A particular emphasis will be placed on the following quantitative reasoning outcomes:

III. Graphical representations
- Time series
- Bar charts/histograms

V. Basic statistics
- Descriptions of center and spread
- Using the normal distribution
- Correlation vs causation

Method of Instruction

This course will be conducted in Team-Based Learning format. Students are responsible for reading the reading assignments and must come to class prepared to take an individual quiz on the reading (a Readiness Assessment Test, or RAT). Students will be grouped into permanent teams of four students for the duration of the course. Following the individual RAT, students will take the RAT again, but with their teammates. Students are encouraged to discuss their answers and come to a consensus about the correct answer. Following the group RAT, students will work together on a case study that requires students to use the knowledge they have acquired through their readings and apply it to real-life situations. Whole class discussions follow the team discussions. Some additional activities and experiments might also be conducted in the classroom. At the end of every class, students will be asked to produce, either in teams or individually, a report of the discussion. The format of this assignment will vary. Instructions will be given in class. The reports are due at the start of class on the following day.

Textbooks & Reading Materials

Pinel, J.P.J. (2005). **Biopsychology**, Sixth edition. Boston: Allyn & Bacon. (ISBN: 978-0205426515)

Articles or Book Chapters:

Mann, J.J. (2003). Neurobiology of suicidal behaviour. **Nature Review in Neurosciences 4**(10): 819-28.

Zupanc, G.K.H. (2004). **Large-Scale Navigation: Migration and Homing**. *In* Behavioral Neurobiology: An Integrative Approach. Oxford: Oxford University Press. pp. 201-249.

Branicky, R., and S. Hekimi (2006). What Keeps *C. elegans* regular: The genetics of defecation. **Trends in Genetics 22**(10): 571-9.

Vargha-Khadem, F., Gadian, D.G., Copp, A., and M. Mishkin (2005). FOXP2 and the neuroanatomy of speech and language. **Nature Review in Neurosciences 6**(2): 131-8.

Manoli, D.s., Meissner, G.W. and B.S. Baker (2006). Blueprints for behavior: genetic specification of neural circuitry for innate behaviors. **Trends in Neurosciences 29**(8): 444-451.

Eastman N., and C. Campbell (2006). Neuroscience and legal determination of criminal responsibility. **Nature Reviews Neurosciences 7**(4): 311-8.

Rothstein, M.A. (2005). Science and society: Applications of behavioral genetics: Outpacing the science? **Nature Review Genetics 6**(10): 793-8.

Goldman D., Oroszi G., and F. Ducci (2005). The genetics of addiction: Uncovering the genes. **Nature Review Genetics 6**(7): 521-32.

Bourke, A.F. (2002). Genetics of social behaviour in fire ants. **Trends in Genetics 18**(5): 221-3.

Cox, T.M. (2002). The genetic consequences of our sweet tooth. **Nature Review in Genetics 3**(6): 481-7.

Levenson, J.M. and J.D. Sweatt (2005). Epigenetic mechanisms in memory formation. **Nature Review in Neurosciences 6**(2): 108-18.

Phelan, J.C. (2002). Genetic bases of mental illness – A cure for stigma? **Trends in Neurosciences 25**(8): 430-1.

Bucan, M., and T. Abel (2002). The mouse: Genetics meets behaviour. **Nature Review in Genetics 3**(2): 114-23.

Lockhart, D.J., and C. Barlow (2001). Expressing what's on your mind: DNA arrays and the brain. **Nature Review in Neurosciences 2**(1): 63-8.

Bell-Pedersen, D., Cassone, V.M., Earnest, D.J., Golden, S.S., Hardin, P.E., Thomas, T.L., and M.J. Zoran (2005). Circadian rhythms from multiple oscillators: Lessons from diverse organisms. **Nature Review Genetics 6**(7): 544-56.

Baldessarini, R.J. and J. Hennen (2004). Genetics of suicide: An overview. **Harvard Review in Psychiatry 12**(1): 1-13.

Lebedev, M.A. and M.A. Nicolelis (2006). Brain-Machine interfaces: Past, present, and future. **Trends in Neurosciences 29**(9): 536-46.

Donoghue, J.P. (2002). Connecting cortex to machines: Recent advances in brain interfaces. **Nature Neurosciences 5Suppl**: 1085-8.

Andersen, R.A., Musallam, S., and B. Pesaran (2004). Selecting the signals for a brain-machine interface. **Current Opinion in Neurobiology 14**(6): 720-6.

Karim, A.A., Hinterberger, T. Richter, J., Mellinger, J., Neumann, N., Flor, H., Kubler, A., and N. Birbaumer (2006). Neural internet: Web surfing with brain potentials for the completely paralyzed. Neurorehabil Neural Repair 20(4): 508-15.

Danilov, Y. and M. Tyler (2005). Brainport: An alternative input to the brain**. J. Integr Neurosci 4**(4): 537-50.

Butnik, S.M. (2005). Neurofeedback in adolescent and adults with attention deficit hyperactivity disorder**. J. Clin. Psychol 61**(5): 621-5.

Vernon, D.J. (2005). Can neurofeedback training enhance performance? An evaluation of the evidence with implications for future research. **Appl Psychophysiol Biofeedback 30**(4): 347-64.

Sherry, D.F. (2006). Neuroecology. **Annu Rev Psychol 57**: 167-97.

Rhodes, G. (2006). The evolutionary psychology of facial beauty. **Annu Rev Psychol 57**: 199-226.

Goldsmith, T.H., and W.F. Zimmerman (2001). Viewing Human Cultures in an Evolutionary Context. *In* **Biology, Evolution and Human Nature**. New York: John Wiley and Sons. pp.313-348

Popova, N.K. (2006). From genes to aggressive behavior: the role of serotonergic system. **Bioessays 28**(5):495-503.

On Reserve at the Library

Sacks, Oliver (1998). The Man who mistook his wife for a hat and other clinical tales. (ISBN: 978-0684853949)

Sacks, Oliver (1996). An Anthropologist on Mars: Seven paradoxical tales. (ISBN: 978-0679756972)

Other Required Materials

Tentative Course Schedule

DAY	TOPIC & OUTCOMES	EVALUATION	READING ASSIGNMENT (note: Pinel pages are from 5th ed.)
1	**Anatomy of the Nervous System** • Name the major anatomical structures of the central nervous system • Describe the different cellular components of the nervous system (eg. glial cells, grey vs white matter, etc.) • Describe the available neuroanatomical techniques available to researchers		Pinel, ch. 3 (p. 51-78)
2	**Cellular & Chemical Nature of the Brain** • Draw a neuron's structure • Draw a synapse • Describe the sequence of events involved in neurotransmission • Describe the different types of neurotransmitter and their characteristics • Compare and contrast excitation and inhibition in neural processing	-Individual RAT -Group RAT -Daily Assignment from Day 1	Pinel, ch. 4 (p. 79-103)
3	**Neuropsychology, Imaging and Brain Mapping** • Describe the methods used to record brain activity, to view static and dynamic brain images, for	-Individual RAT -Group RAT -Daily Assignment from Day 2	Pinel, ch. 5 (p. 104-131)

	invasive physiological research, for pharmacological research, for genetic engineering, and for neuropsychological testing • Select the appropriate research method to study a particular aspect of the nervous system (i.e. design a biopsychology experiment) • Identify the active region of a brain during a task from experimental data • Describe how brain functions were historically mapped to specific regions • Hypothesize why the brain appears to localize certain functions to specific areas • Discuss the apparent contradiction that brain functions are both localized and distributed, and that brain systems are organized hierarchically and in parallel		
4	**Asymmetric Brains** • Ascertain whether variations in the brain's anatomical asymmetry correlates with functional asymmetries • Predict the brain's functional lateralization architecture based on information on handedness • Develop a hypothesis explaining the evolution of cerebral lateralization • Predict the effects of commissurotomies on various behaviours	-Individual RAT -Group RAT -Daily Assignment from Day 3	Pinel, ch. 16 (p. 406-436)
5	**Brain Development and Plasticity** • Differentiate between the elements of development that are under genetic and environmental control • Compare the plasticity potentials of developing and adult brains • Describe the process by which neuronal networks are built	-Individual RAT -Group RAT -Daily Assignment from Day 4 -Formative Peer Evaluation	Pinel, ch. 9-10 (p. 221-267)
6	**Sensation and Perception** • Describe the neural pathway from a photon of light impinging upon the	-Individual RAT -Group RAT -Daily Assignment	Pinel, ch. 6-7 (p. 132-193)

	retina to conscious visual detection of light • Explain optical illusions using knowledge of how the brain perceives light • Compare and contrast the visual sensory system with the auditory, chemical detection and somatosensory systems • Propose where pain is felt	from Day 5	
7	**Motor Control** • Differentiate between a reflexive and a cortical neural signal that causes movement • Describe the neural processes involved in deliberately moving a certain portion of your body	-Individual RAT -Group RAT -Daily Assignment from Day 6	Pinel, ch. 8 (p. 194-220)
8	**Homeostasis** • Describe the physiological mechanisms for regulating hunger, thirst, body temperature and body weight • Explain everyday observations such as why we do not get hungry at night and why women crave salts during menstruation or pregnancy, etc…	-Individual RAT -Group RAT -Daily Assignment from Day 7	Pinel, ch. 12 (p. 297-323)
9	**Rhythms of the Brain** • Create a hypothesis of why we sleep and dream, supported by evidence • Design a sleep-reduction program that is tailored to the student's lifestyle and preferences and is consistent with research literature on circadian rhythms and sleep deprivation • Describe the evidence for a 24 hr biological clock in our body • Describe how a biological clock can be reset, making reference to the effects on the mechanism of the clock	-Individual RAT -Group RAT -Daily Assignment from Day 8	Pinel, ch. 14 (p. 350-379)
10	**Emotions** • Hypothesize why we show our emotions through facial expressions	-Individual RAT -Group RAT -Daily Assignment	Pinel, ch. 17 (p. 437-460)

	• Describe the regions of the brain involved in generating emotions, and why they evolved • Deduce how the effects of stress can alter the CNS permanently • Defend or refute that emotions are a right hemisphere phenomenon	from Day 9	
11	**Cognition: Learning, Memory, Attention, Language, Thinking and Consciousness** • Decipher the roles of various anatomical regions of the brain in learning and memory from case studies • Describe cellular and molecular models of learning and memory • Evaluate whether there is a neuronal basis for consciousness • Design a fMRI study to identify the areas of the brain involved in comprehending speech • Compare and contrast the areas of the brain activated in the production of a first or second language, or a sign language • Defend the idea that spatial neglect is a problem of attention, not sensation • Explain how the brain's response can be different to conscious and unconscious stimuli • Design an experiment to you're your hypothesis of why ADHD is for more prevalent today than in the past • Defend the claim that brain size is not proportional to intelligence • Explain the causes and effects of laughter and humour	-Individual RAT -Group RAT -Daily Assignment from Day 10	Pinel, ch. 11 (p. 268-296)
12	**Abnormal Psychology** • Explain the uses of the DSM • Outline the evidence for a biological basis for schizophrenia • Hypothesize about possible treatments for major depressive disorders • Differentiate between feeling	-Individual RAT -Group RAT -Daily Assignment from Day 11	Pinel, ch. 18 (p. 461-551) Mann (2003)

	stressed and anxiety disorders • Discuss why the mechanism by which a disorder is alleviated is not necessarily opposite to the mechanism by which it was caused		
13	**Drugs and Addiction** • Explain how various drugs affect the CNS • Describe the mechanisms that cause cravings and addictions • Compare and contrast the biological effects of socially acceptable drugs (eg., caffeine, nicotine and alcohol) and illicit drugs (heroin, cocaine, marijuana, etc.) • Modify current legislations related to drug abuse in light of knowledge about the biology of abuse • Create an anti-drug television campaign, using your knowledge of drug addiction and its effects on the addict, family and friends, & society • Reflect upon your stance towards drugs taken for pharmacological or recreational use, as well as those taken for preventative health reasons or for improving yourself	-Individual RAT -Group RAT -Daily Assignment from Day 12	Pinel, ch. 15 (p. 380-405)
14	**Hormones and Sex** • Compare and contrast the neurological and endocrine systems • Describe how hormones affect behaviour and anatomy • Explain how the neurological and endocrine systems interact to produce sexual behaviour • Discuss whether endocrinology or neuroscience can explain sexual orientation	-Individual RAT -Group RAT -Daily Assignment from Day 13 -Research Paper	Pinel, ch. 13 (p. 324-349)
15	**Neuroscience of Animal Behaviour** • Describe a well-studied example of how a seemingly complex animal behaviour can be explained by simple neurological pathways • Evaluate whether all seemingly-complex animal (including human) behaviour can be explained by	-Individual RAT -Group RAT -Daily Assignment from Day 14	Zupanc pp 201-249

	simple neurological pathways		
16	**Genetics of Behaviour** • Describe a behaviour under a simple genetic control in a model organism • Deduce how much a behavioral trait is under the control of genetics and environment using data from twins studies • Evaluate the implications of the new knowledge of neurogenetics on society and self	-Individual RAT -Group RAT -Daily Assignment from Day 15	Branicky & Hekimi (2006); Vargha-Khadem *et al*. (2005); Bourke (2002); Manoli *et al*. (2006); Eastman & Campbell (2006) Rothstein (2005) Goldman *et al*. (2005); Levenson & Sweatt (2005); Phelan (2002); Cox (2002); Bucan & Abel (2002); Lockhardt & Barlow (2001); Bell-Pedersen *et al.* (2005); Baldessarini & Hennen (2004); Popova (2006)
17	**Neural implants and Biofeedback** • Describe the current limitations on the use of neural implants and assess potential uses in the near future • Evaluate whether biofeedback is an effective form of training and therapy for behavioral diseases, and compare its effectiveness to other forms of treatment	-Individual RAT -Group RAT -Daily Assignment from Day 16	Lebedev & Nicolelis (2006); Donoghue (2002); Andersen *et al.* (2004); Karim *et al*., (2006); Danilov & Tyler (2005); Butnik (2005); Vernon (2005)
18	**Evolutionary Psychology** • Explain elements of our culture (fashion, mate preference, etc) using evolutionary reasoning • Evaluate whether evolutionary psychology is a science	-Individual RAT -Group RAT -Daily Assignment from Day 17 -Daily Assignment from Day 18	Sherry (2006); Rhodes (2006); Goldsmith & Zimmerman (2001)

		-Summative Peer Assessment -Blog	

Method of Assessment

25% Individual RAT (X17)
20% Group RAT - weighted (X17)
30% Daily Assignments - weighted (X18)
10% Research Paper (X1)
10% Peer Assessment (X2)
5% Blog (minimum 10 entries)
100%

Individual RAT. Students are responsible for reading the assigned material. Given the importance of the knowledge gained from readings in helping the group solve cases, the students' comprehension of the reading will be assessed through a multiple choice exam at the beginning of every class. Students who are late or absent from class without prior arrangement with the instructor will be given the mark of "0".

Group RAT - Weighted. Immediately following the daily RAT, students will retake the exam with their team. This group exam is an opportunity for students to evaluate their own knowledge and to teach their teammate. Students are encouraged to discuss the answers and come to a consensus before answering each question. At the end of the block, the mark obtained for the group RAT may differ between each teammate depending on each team member's contribution, as assessed by their peer. The calculations are described in the Peer Assessment section. Students who are late or absent from class without prior arrangement with the instructor will be given the mark of "0" (note: the other team members' mark will not be affected).

Daily Assignment – Weighted. At the end of every class, students will be asked to prepare an assignment designed to synthesize the knowledge gained that day through readings, team discussions and class activities. The format of these assignments will vary, and will sometimes consist of individual work, and sometimes of team work. The mark obtained on assignments on which the entire team is expected to contribute may vary between members of the group, depending on peer evaluation of each team member's contribution. See Peer Assessment for more detail. Unless agreed upon with the instructor, daily assignments are due at the beginning of the next class. Late assignments will be penalized at a cost of 10% less than the grade of the assignment for each day late.

Peer Assessment. Given the importance of effective team functioning in this course, students will be asked to evaluate their teammates' contribution to the team effort twice during the course. The first time, on day 5, students will anonymously evaluate their teammate, with the goal of giving them constructive feedback on their performance. The results of this evaluation will not affect the evaluated students' mark. However, the

quality of the feedback will constitute 5% of the mark of the evaluator. On the final day of class, students will be asked to repeat the evaluation of the team members' contribution. The quality of this evaluation will once again account for 5% of the evaluator's final mark. The results of the assessment will be used to calculate each member's contribution and weight the team mark. Part of the evaluation will consist in assigning a total of 30 points to each of the members of your team, proportional to their contribution to the team effort. The total amount of points received by each team member, divided by 30, will constitute the weighing ratio. This ration will be multiplied to the group mark, giving each person in the team a potentially different score. Group conflicts are bound to occur and students are encouraged to try to resolve these conflicts internally. However, if resolution seems unlikely, please contact the instructor.

Research Paper. Students will be asked to select one of several possible research questions at the beginning of the block, based upon their interest in the topic (note: students may be allowed to formulate their own research question, based upon early instructor approval). Students will need to research the primary scientific literature to seek answers to these questions and form a thesis in answer to the question. The format of delivery of the research paper is a written essay. The essay should be between 2-4 pages long (600-1200 words), and contain, at a minimum, reference to 10 research articles. Each student must work individually on their paper. This essay is due on Day 14. The appendix contains a list of possible questions.

Blog. As one of the goals of this course is for students to reflect upon the importance of neuroscience to themselves and to our changing society, students will be asked to keep a blog in which they comment upon the material they are learning and reflect upon how this material is affecting their lives, helping them understand themselves or others better, changing their views of the world, changing our society, or is simply irking them or igniting their interest. A rubric will be used to evaluate the blogs, and will assist students in determining what constitutes a good entry (hint: a reflective, personally meaningful entry is desirable). A minimum of 10 entries are required (reflections on at least 10 different subjects/days). The length of these entries is up to the student but should be at least 5 sentences long. The rubric is available on the Course Management System. This is an individual assignment. It is due at the end of the last day of class. Unless arranged with the instructor, no late assignment will be accepted.

Students will be given a final mark on 100% which will be converted to a letter grade in their transcript using the following conversion:

Mark (%)	Grade	Grade Point
95-100	A	4.0
90-95	A-	3.7
85-90	B+	3.3
80-85	B	3.0
75-80	B-	2.7
70-75	C+	2.3
65-70	C	2.0

60-65	C-	1.7
55-60	D	1.0
< 55	F	0.0

Course and University Policy
Students are referred to the Quest University Canada Calendar for information on academic policies, including plagiarism, grading, the honour principle, attendance and participation.

Appendix

Possible questions for research paper:

1. **Case Histories in Popular Science**. Pick a chapter/case history from either the book "The Man Who Mistook His Wife for a Hat" or "An Anthropologist on Mars" by Oliver Sacks. Find articles in the primary research literature that talk about the disorder featured in the short story. What are the symptoms? Causes? Are there elements reported in Sack's case history that is typical of a person with this disorder? That is not expected? Why might there be a discrepancy?
2. **Prions and Memory**. Prions, the proteins that are thought to cause Mad Cow Disease, have been implicated in learning and memory. What evidence points to their involvement in learning, and how might they work? What's the difference between the prions involved in learning and those that cause Mad Cow Disease?
3. **Puberty Onset**. The onset of puberty appears to be happening at an earlier age than in previous generations. What are the possible causes and the evidence supporting these? What possible effect might this earlier onset have on society and self?
4. **Seasonal Affective Disorder and Light**. Why is light treatment a treatment for Seasonal Affective Disorder, and by what mechanism might it work to help people suffering from this disease? Would you expect that someone moving to Squamish who had never before showed any symptoms of SAD suddenly develop the disease?
5. **Antipsychotic drugs and Sex**. Why do certain antipsychotic drugs affect the sexual behaviour of the people taking the drugs?
6. **Facial Recognition**. Explore facial recognition. Why is it important in our species? Where in the brain does it happen? Does it occur consciously or unconsciously? By what age is this system developed? People who were exposed mainly to one type of race in early childhood often have difficulty differentiating among people of other races in later life? Why might this be? What consequences would this have on society?
7. **Celebrities and Neurological Diseases**. Pick a condition that has afflicted a personality (eg. Parkinson for Michael J. Fox, broken spinal column for Christopher Reeves, Stephen Hawkins and ALS) and discuss what is known about the molecular and cellular basis for the disease, current treatments and why they are insufficient, and the outlook for alleviating symptoms of finding a cure. Also discuss how the affliction has influence the ability of the celebrity to function, as well as how the personality has brought change to our society's way of thinking about this disease through public disclosure of their ailment.
8. **Learning and Memory**. Use knowledge about endocrinology and neurology to describe the best possible study techniques for an 18-22 years old (at what times of the day should a student be studying, under what conditions, etc…). Support your assertions with references to the primary literature.
9. **Consciousness.** Review current theories about the biological basis of consciousness. What evidence can you bring forward that you are conscious of

your own existence? How would you test the consciousness of an animal? How would you assess whether an artificial intelligence system is conscious?