- Course Information -

University:	University of Nebraska at Omaha
College:	Arts and Sciences
Curriculum:	Biology
Number:	4890
Type:	Lecture
Title:	Genes, Brain, and Behavior
Short title:	Genes, Brain, and Behavior
Effective term:	Spring 2016
Graduate non-degree students:	Not allowed
Can course be taken for credit multiple times?	No

- Credit Hours Information -

Type:	Fixed
Hours:	3

- Cross-listing and/or Dual-listing (UG/G) Information -

Courses:	AS Neuroscience 4890, GR AS Biology 8896, GR AS Psychology 8896

- Duplication Information (not to be used for cross/dual-listings) - Use in ALL instances where there is potential that a course overlaps in content with another discipline. This feature allows the relevant chair(s)/directors(s) to review and approve early in the review process. Please use if there is potential for perceived duplication.

Curriculum:	Not applicable

- 1.0 Course Description Information -

1.1 Catalog description:

This course will evaluate the complex interaction between an organism's genome and neural activity pattern in the nervous system as related to behavior. In this course students will explore how changes in gene expression (allelic variants, epigenetics, differential regulation) and gene networks within neural tissue can reciprocally influence behaviors such as communication, foraging, reproduction, and cognition.

1.2 Prerequisites of the course:

Undergraduate: NEUR 1500 (Introduction to Neuroscience) and BIOL2140 (Genetics) or by permission of instructor Graduate: None

1.3 Overview of content and purpose of the course:

Many of the behaviors we observe are a result of the complex interaction between neural activity in the brain and the organism's genome. While neural activity patterns more directly influence immediate behavioral displays, between-individual variation or long-term changes within individuals are mediated in large part by differences in gene expression and/or their respective molecular networks. Thus to understand behavior (both natural and pathological) it is critical to account for the genome's effect on the nervous system. Neuro-genomics/genetics bridges molecular activity patterns in the brain with how they can influence or be influenced by behavior. In this course we explore the interactive nature between genes and the nervous system that will lead to a more complete understanding of behavioral variation.

1.4 Unusual circumstances of the course:

None

- 2.0 Course Justification Information -

2.1 Anticipated audience / demand:

This course serves to diversify the options for an advanced lecture course in the undergraduate Neuroscience curriculum. The course will meet the requirements for a Block I elective course for the Neuroscience major where students must take a minimum of 3-9 hours in this block. Many current Block I courses for the Neuroscience major are only tangentially related to neuroscience and this course will focus on advanced principles and topics directly related to neuroscience.

At the graduate level, this cross-listed course will serve students from the Neuroscience & Behavior graduate program in psychology. Additionally, this course could attract students from other gradaute programs in Biology.

2.2 Indicate how often this course will be offered and the anticipated enrollment:

The course will be offered once per year, and the anticipated enrollment is 25 undergraduates and 5 graduate students per offering.

2.3 If it is a significant change to an existing course please explain why it is needed:

No existing similar course

- *3.0 Objective Information* -

Is this course part of or being proposed for the General Education curriculum?

No

3.1 List of performance objectives stated as student learning outcomes:

Students will explain:

- how gene expression in the nervous system indirectly influences behavior

- how social and ecological enivronments can alter behavior via gene expression in the brain

- how allelic variation (isoforms, presence/absence) leads to differences in brain-based behaviors

- how genes can be differentially regulated in a variety of different ways by intracellular and extracellular signals in neurons

- how behavioral variation can be attributed to localized differences in gene expression in the brain

- how biological networks reveal important emergent properties depending on the scale of biological organization

- how within and between species behavioral variation may be attributed to different biological network properties in the brain.

- the capabilities and limitations of genomic analyses (Genome Wide Assocation Studies, Next-Generation Sequencing, Microarrays) and candidate gene analyses (qPCR, neurohistochemistry), in uncovering novel neuromolecular mechanisms of behavior and hypothesis generation.

- the capabilities and limitations of naturalistic and model systems in modeling neurogenetics of behavior

3.2 General Education Student Learning Outcomes

After completing the course, successful students shall be able to do the following:

- *4.0 Content and Organization Information* -

4.1 List the major topics central to this course:

1. Levels of analyses of animal behaviors to put the neurogenetic mechanisms into a larger evolutionary and ecological context

2. Mechanisms of gene regulation (allelic, inheritance, transcriptional, translational) in neurons leading to variation in behavior.

3. Gene x Environment interaction (epigenetics and transgenerational effects) that alter neural activity patterns leading to changes in behavior

4. Molecular and cellular neuroscience from the perspective of how genes can change electrical properties and wiring of neurons that lead to altered behaviors.

5. Neuroanatomy and neural circuits/pathways implicated in behaviors

6. Biological networks in the context of functional and structural brain connectivity as related to behavior

7. Neurogenetic and neurogeonomics of

   a. Communication

b. Foraging

c. Sexual Behavior

d. Aggression

e. Parental Care

f. Stress and anxiety

g. Psychopathology

- *5.0 Teaching Methodology Information* -

5.1 Methods:

The pedagogical strategy utilized in this course will be mixed including,

- traditional lecture for fundamental concepts and overall scientific approaches to behavioral neurogenomics/neurogenetics

- interactive student led discussions and presentation of primary literature

- individual research projects and paper

- poster symposium open to the campus and community

- graduate student lecture

5.2 Student role:

- Each student will be expected to come to class prepared to discuss the focal topic of the lecture, including summarzing the major concepts, having critical questions on experimental methods, data interpretation, and conclusions of empirical studies.

- Students will provide timely summaries of their progress on their research project

- Students will be expected to attend all lectures, and be active participants in any in-class discussions/presentations

- *6.0 Evaluation Information* -

Students should be provided the actual list of projects, basis for determining the final grade, and grading scale at the beginning of each course.

6.1.1 Describe the typical types of student projects that will be the basis for evaluating student performance:

- two standard exams (identification, short-answer essay, long essay) on the material covered in lecture and readings

- research projects (e.g. term paper and poster presentation)

- graduate student performance will also be evaluated based upon quality, breadth, and depth of their classroom lectures on selected topics in behavioral neurogenetics/neurogenomics. Specifically, graduate students should submit the presentation with extensive literature citations utilized in preparing for the presentation.

6.2 Describe the typical basis for determining the final grade (e.g., weighting of various student projects):

Exams: 50%

Research Project (Undergraduate: 50%; Graduate: 30%)

Classroom Lecture (Graduate: 20%)

6.3 Grading type:

Letter grades

- *7.0 Resource Material Information* -

7.1 Textbook(s) or other required readings used in course:

The OMICs: Applications in Neuroscience. Coppola, G. New York: Oxford University Press, 2014

7.2 Other student suggested reading materials:

Behavioral Genetics. Plomin, R, DeFries, JC, Knopik, VS, Neiderhiser, JM. Worth Publishers, 2012

Principles of Behavioral Genetics. Anholt RH, Mackay, TFC. Academic Press, 2009

7.3 Current bibliography and other resources:

Aponte, Y., Atasoy, D., & Sternson, S. M. (2011). AGRP neurons are sufficient to orchestrate feeding behavior rapidly and without training. *Nature Neuroscience, 14*(3), 351-355. doi: DOI 10.1038/nn.2739

Ben-Shahar, Y. (2005). The foraging gene, behavioral plasticity, and honeybee division of labor. *J Comp Physiol A Neuroethol Sens Neural Behav Physiol, 191*(11), 987-994.

Bolhuis, J. J., & Gahr, M. (2006). Neural mechanisms of birdsong memory. *Nat Rev Neurosci, 7*(5), 347-357. doi: nrn1904 [pii]10.1038/nrn1904

Bolhuis, J. J., Okanoya, K., & Scharff, C. (2010). Twitter evolution: converging mechanisms in birdsong and human speech. *Nat Rev Neurosci, 11*(11), 747-759. doi: 10.1038/nrn2931

Bullmore, E., & Sporns, O. (2009). Complex brain networks: graph theoretical analysis of structural and functional systems. *Nat Rev Neurosci, 10*(3), 186-198. doi: 10.1038/nrn2575

Bush, W. S., & Moore, J. H. (2012). Chapter 11: Genome-wide association studies. *PLoS Comput Biol, 8*(12), e1002822. doi: 10.1371/journal.pcbi.1002822

Champagne, D. L., Hoefnagels, C. C., de Kloet, R. E., & Richardson, M. K. (2010). Translating rodent behavioral repertoire to zebrafish (Danio rerio): relevance for stress research. *Behav Brain Res, 214*(2), 332-342. doi: S0166-4328(10)00429-8 [pii]10.1016/j.bbr.2010.06.001

Champagne, F. A. (2008). Epigenetic mechanisms and the transgenerational effects of maternal care. *Front Neuroendocrinol, 29*(3), 386-397. doi: 10.1016/j.yfrne.2008.03.003

Champagne, F. A. (2011). Maternal imprints and the origins of variation. *Horm Behav, 60*(1), 4-11. doi: 10.1016/j.yhbeh.2011.02.016

Champagne, F. A. (2013). Early environments, glucocorticoid receptors, and behavioral epigenetics. *Behav Neurosci, 127*(5), 628-636. doi: 10.1037/a0034186

Chandrasekaran, S., Ament, S. A., Eddy, J. A., Rodriguez-Zas, S. L., Schatz, B. R., Price, N. D., & Robinson, G. E. (2011). Behavior-specific changes in transcriptional modules lead to distinct and predictable neurogenomic states. *Proc Natl Acad Sci U S A, 108*(44), 18020-18025. doi: 10.1073/pnas.1114093108

Clayton, D. F. (2013). The genomics of memory and learning in songbirds. *Annu Rev Genomics Hum Genet, 14*, 45-65. doi: 10.1146/annurev-genom-090711-163809

Crews, D. (2011). Epigenetic modifications of brain and behavior: theory and practice. *Horm Behav, 59*(3), 393-398. doi: 10.1016/j.yhbeh.2010.07.001

Cummings, M. E. (2012). Looking for sexual selection in the female brain. *Philosophical Transactions of the Royal Society B-Biological Sciences, 367*(1600), 2348-2356. doi: DOI 10.1098/rstb.2012.0105

Douglas, S. J., Dawson-Scully, K., & Sokolowski, M. B. (2005). The neurogenetics and evolution of food-related behaviour. *Trends Neurosci, 28*(12), 644-652. doi: DOI 10.1016/j.tins.2005.09.006

Dulac, C., O'Connell, L. A., & Wu, Z. (2014). Neural control of maternal and paternal behaviors. *Science, 345*(6198), 765-770. doi: 10.1126/science.1253291

Fisher, S. E., & Scharff, C. (2009). FOXP2 as a molecular window into speech and language. *Trends in Genetics, 25*(4), 166-177. doi: DOI 10.1016/j.tig.2009.03.002

Fitzpatrick, M. J., Ben-Shahar, Y., Smid, H. M., Vet, L. E., Robinson, G. E., & Sokolowski, M. B. (2005). Candidate genes for behavioural ecology. *Trends Ecol Evol, 20*(2), 96-104. doi: 10.1016/j.tree.2004.11.017

Harris, R. M., & Hofmann, H. A. (2014). Neurogenomics of behavioral plasticity. *Adv Exp Med Biol, 781*, 149-168. doi: 10.1007/978-94-007-7347-9_8

Insel, T. R. (2010). Rethinking schizophrenia. *Nature, 468*(7321), 187-193. doi: 10.1038/nature09552

Jones, A. G., & Ratterman, N. L. (2009). Mate choice and sexual selection: what have we learned since Darwin? *Proc Natl Acad Sci U S A, 106 Suppl 1*, 10001-10008. doi: 0901129106 [pii]10.1073/pnas.0901129106

Kolb, B., & Gibb, R. (2014). Searching for the principles of brain plasticity and behavior. *Cortex, 58*, 251-260. doi: 10.1016/j.cortex.2013.11.012

Lin, L. C., Vanier, D. R., & London, S. E. (2014). Social information embedded in vocalizations induces neurogenomic and behavioral responses. *PLoS ONE, 9*(11), e112905. doi: 10.1371/journal.pone.0112905

Maney, D. L., & Goodson, J. L. (2011). Neurogenomic mechanisms of aggression in songbirds. *Adv Genet, 75*, 83-119. doi: 10.1016/B978-0-12-380858-5.00002-2

McCarthy, M. I., Abecasis, G. R., Cardon, L. R., Goldstein, D. B., Little, J., Ioannidis, J. P., & Hirschhorn, J. N. (2008). Genome-wide association studies for complex traits: consensus, uncertainty and challenges. *Nat Rev Genet, 9*(5), 356-369. doi: 10.1038/nrg2344

Metzker, M. L. (2010). Sequencing technologies - the next generation. *Nat Rev Genet, 11*(1), 31-46. doi: nrg2626 [pii]10.1038/nrg2626

Nelson, R. J., & Trainor, B. C. (2007). Neural mechanisms of aggression. *Nat Rev Neurosci, 8*(7), 536-546. doi: 10.1038/nrn2174

Newbury, D. F., & Monaco, A. P. (2010). Genetic advances in the study of speech and language disorders. *Neuron, 68*(2), 309-320. doi: 10.1016/j.neuron.2010.10.001

O'Connell, L. A., & Hofmann, H. A. (2010). Genes, hormones, and circuits: An integrative approach to study the evolution of social behavior. *Front Neuroendocrinol*. doi: S0091-3022(10)00079-8 [pii]10.1016/j.yfrne.2010.12.004

O'Connell, L. A., & Hofmann, H. A. (2011). The vertebrate mesolimbic reward system and social behavior network: a comparative synthesis. *J Comp Neurol, 519*(18), 3599-3639. doi: 10.1002/cne.22735

O'Connell, L. A., & Hofmann, H. A. (2012). Evolution of a vertebrate social decision-making network. *Science, 336*(6085), 1154-1157. doi: 336/6085/1154 [pii]10.1126/science.1218889

Pfenning, A. R., Hara, E., Whitney, O., Rivas, M. V., Wang, R., Roulhac, P. L., . . . Jarvis, E. D. (2014). Convergent transcriptional specializations in the brains of humans and song-learning birds. *Science, 346*(6215), 1256846. doi: 10.1126/science.1256846

Preuss, T. M. (2012). Human brain evolution: from gene discovery to phenotype discovery. *Proc Natl Acad Sci U S A, 109 Suppl 1*, 10709-10716. doi: 10.1073/pnas.1201894109

Reaume, C. J., & Sokolowski, M. B. (2011). Conservation of gene function in behaviour. *Philosophical Transactions of the Royal Society B-Biological Sciences, 366*(1574), 2100-2110. doi: DOI 10.1098/rstb.2011.0028

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Robinson, G. E., Fernald, R. D., & Clayton, D. F. (2008). Genes and social behavior. *Science, 322*(5903), 896-900. doi: 10.1126/science.1159277

Robinson, G. E., Grozinger, C. M., & Whitfield, C. W. (2005). Sociogenomics: social life in molecular terms. *Nat Rev Genet, 6*(4), 257-270. doi: 10.1038/nrg1575

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Sporns, O. (2013c). Making sense of brain network data. *Nat Methods, 10*(6), 491-493. doi: 10.1038/nmeth.2485

Sweatt, J. D. (2013). The emerging field of neuroepigenetics. *Neuron, 80*(3), 624-632. doi: 10.1016/j.neuron.2013.10.023

Tinbergen, N. (1963). On aims and methods of ethology. *Zeitschrift fur Tierpsychologie, 20*, 410-433.

van den Heuvel, M. P., & Fornito, A. (2014). Brain networks in schizophrenia. *Neuropsychol Rev, 24*(1), 32-48. doi: 10.1007/s11065-014-9248-7

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Whitfield, C. W., Ben-Shahar, Y., Brillet, C., Leoncini, I., Crauser, D., Leconte, Y., . . . Robinson, G. E. (2006). Genomic dissection of behavioral maturation in the honey bee. *Proc Natl Acad Sci U S A, 103*(44), 16068-16075. doi: 10.1073/pnas.0606909103

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Whitney, O., Pfenning, A. R., Howard, J. T., Blatti, C. A., Liu, F., Ward, J. M., . . . Jarvis, E. D. (2014). Core and region-enriched networks of behaviorally regulated genes and the singing genome. *Science, 346*(6215), 1256780. doi: 10.1126/science.1256780

Young, K. A., Gobrogge, K. L., Liu, Y., & Wang, Z. (2011). The neurobiology of pair bonding: insights from a socially monogamous rodent. *Front Neuroendocrinol, 32*(1), 53-69. doi: S0091-3022(10)00055-5 [pii]10.1016/j.yfrne.2010.07.006

Young, L. J., Nilsen, R., Waymire, K. G., MacGregor, G. R., & Insel, T. R. (1999). Increased affiliative response to vasopressin in mice expressing the V1a receptor from a monogamous vole. *Nature (London), 400*(6746), 766-768.

Young, L. J., & Wang, Z. (2004). The neurobiology of pair bonding. *Nat Neurosci, 7*(10), 1048-1054. doi: 10.1038/nn1327nn1327 [pii]

Zayed, A., & Robinson, G. E. (2012). Understanding the Relationship Between Brain Gene Expression and Social Behavior: Lessons from the Honey Bee. *Annual Review of Genetics, Vol 46, 46*, 591-615. doi: DOI 10.1146/annurev-genet-110711-155517

- *8.0 Other Information* -

8.1 Accommodations statement:

Appropriate accommodations are provided for students who are registered with the Accessibility Services Center and make their requests sufficiently in advance. For more information, contact Accessibility Services Center (MBSC 126, Phone: 402-554-2872, unodisability@unomaha.edu) or visit unomaha.edu/disability.

8.2 Other:

No other comments.

* 8.3 Author(s):

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