

Attention!

This is a *representative* syllabus.

The syllabus for the course when you enroll may be **different.**

Use the syllabus provided **by your instructor** for the most up-to-date information. Please refer to your instructor for more information for the specific requirements for a given semester.

SYLLABUS

SPRING 2016

Neuroscience 4623: Behavioral and Molecular Biological Clocks (3 credits)

Class meets @ 9:35-10:55 on Mondays and Wednesdays in 170 DHLRI

Instructors:

Professor Randy Nelson

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Course Assistant:

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Course Summary: A consideration of the broad variety of biological rhythms of animals and humans, including ultradian, daily, lunar, tidal and annual cycles. After considering the field in historical perspective, we will spend several weeks on the formal properties of biological clocks and then go to the ways in which rhythms are generated on a molecular basis and how they are synchronized to the external environment. Emphasis is on the role of the molecular and cellular mechanisms of circadian clocks, and how these clocks affect the nervous and endocrine systems of mammals and birds in relation to behavioral rhythms of eating, drinking, sleeping, sex activity, hibernation, migration, seasonal affective disorders, menstrual and estrous cycles. Lecture notes and additional readings will be posted in Carmen.

Prerequisite: Psychology 4313 or a course in physiology.

Grading: Grades will be based on two midterm (60% of the final grade), and a final (cumulative) examination (40% of the final grade). The exam material will consist of both lecture material and material from your readings. The tests are multiple-choice, short answer, and essay examinations. Students will be responsible for attending class, reading the assigned materials in the reader, and studying the materials. Final grades will be calculated as follows: $\geq 90\%$ of the highest score = A; $\geq 80\%$ of the top score = B; $\geq 70\%$ of the top score = C; $\geq 60\%$ of the top score = D. $< 59\%$ of the top score = F.

Academic Ethics: All students enrolled in courses at the Ohio State University should be familiar with the University's policy on academic integrity (http://www.asc.ohiostate.edu/honors/conduct_document.htm). The instructor and course assistants are committed to maintaining a fair assessment of student performance in this course. There is one major ethical consideration in this course. The three exams are closed book. No notes may be used during the examinations and you may not confer with your fellow students or look at other examinations for answers during the exam period. Prior to the examinations, all students are encouraged to study in small groups to facilitate your preparation for the tests. However, once you enter the examination room, you are expected to work alone.

Absence from Exams: Make-up exams and quizzes may be taken only in cases in which absence from the scheduled exam is unavoidable, such as in cases of illness or family emergency. Any such absence must be approved by the instructor in advance of the exam. Any excuse for an absence must be documented and reported to the instructor or CA as soon as possible. Undocumented absences from the scheduled exams will result in 0 points for that exam. Students are also expected to abide by the Code of Student Conduct as outlined in the University Student Handbook (http://www.asc.ohio-state.edu/honors/conduct_document.htm).

Accommodations for Disabled Students: The policy of The Ohio State University is to provide every reasonable, appropriate, and necessary accommodation to qualified disabled students. The University's colleges and academic centers evaluate and judge applications on an individual basis and no categories of disabled individuals are automatically barred from admission. The privacy rights of each disabled person are honored to the fullest extent possible. The University's interest in a student's disabilities are only for the purpose of accommodating his/her specific disability, thereby providing an academically qualified disabled student access to programs and activities accorded all other qualified students. Whenever generally accessible facilities do not adequately accommodate a specific disability, the University makes every reasonable accommodation and program or facility adjustment to assure individual access. These policies are fully supported and practiced in this class. **If you have a disability documented with The Ohio State University Office of Disability Services (<http://www.ods.ohio-state.edu>; 614.292.3307, or visit 150 Pomerene Hall), then please contact the instructor privately by the end of the second week of the semester so that**

any accommodations (e.g., large font exams, separate examination facilities) can be made (contact information is listed above).

Textbook: *Chronobiology: Biological Timekeeping*, 2004. Dunlap et al., Sinauer and Associates. Instructor-provided readings will also be used (see below).

Important! If you are having difficulty with any of the material, either in lecture or in the readings, then please see the instructor for help. The instructor is here to facilitate your learning, and that means not only giving lectures, but also consulting with you individually. The quarter is very short, so it is critical to seek assistance as soon as you detect a problem.

	Date	Lecture Topic	Readings
1	11 January	Course Organization and Overview; Strong Inference	Platt (#1)
2	13 January	Circadian rhythms: Terminology; basic concepts and properties	Chapter 1
3	18 January	No Class-Martin Luther King Day	
4	20 January	Circadian Rhythms: Phase response curves, entrainment, formal models	Chapter 3
5	25 January	Mammalian circadian pacemakers: Early history and histology	Chapter 5 Moore, Pickard and Turek, Reppert and Weaver
6	27 January	Hormones and circadian rhythms	Zucker
7	1 February	Midterm Exam I (25% of final grade)	
8	3 February	Molecular basis of circadian rhythms I	Chapter 7 Reppert and Weaver: Vitaterna et al.
9	8 February	Cell autonomous clocks and clock cell communication	Welsh and Kay Antle and Silver
10	10 February	Molecular basis of circadian rhythms II	Chapter 8
11	15 February	Molecular basis of circadian rhythms III	Chapter 8 de la Iglesia et al.
12	17 February	Input pathways to light entrainment	Reppert and Weaver: Dziema et al.
13	22 February	Entrainment of circadian rhythms by nonphotic cues	Mrosovsky Maywood et al.
14	24 February	Ontogeny of circadian rhythms	Reppert et al
15	29 February	Ultradian and infradian rhythms	Daan; Klein
16	2 March	Tidal and lunar rhythms	
17	7 March	Estrous, menstrual cycles	Fitzgerald and Zucker; Swann and Turek;

			Sanduleak
18	9 March	Midterm Exam II (25% of final grade)	Wikelski and Hau
	14 March	Spring Break (no class)	
	16 March	Spring Break (no class)	
19	21 March	Annual Rhythms: Hibernation, torpor and migration	Ruby
20	23 March	Photoperiodism I	Chapter 4
21	28 March	Photoperiodism II	Chapter 4
22	30 March	Seasonal Affective Disorder	Wehr
23	4 April	Circadian clocks and metabolism	Bass and Takahashi
24	6 April	Circadian clocks and sleep	Saper
25	11 April	Circadian clocks in clinical medicine (anesthesia and surgery)	Chalet
26	13 April	Circadian disruption: Jet lag	Sack
27	18 April	Circadian disruption and light at night I	Navara and Nelson
28	25 April	Circadian disruption and light at night II	Bedrosian
	29 April	Final Exam (50% of final grade)	

Reading List

Lecture 1:

Platt, JR., 1964. Strong inference. *Science*, 146:347-353.

Lecture 4:

Moore, R.Y. 1999. Organization and function of a central nervous system circadian oscillator: The suprachiasmatic hypothalamic nucleus. *Federation Proceedings*, 42: 2783-2789.

Inouye, ST & Kawamura, H. 1979. Persistence of circadian rhythmicity in a mammalian hypothalamic "island" containing the suprachiasmatic nucleus. *PNAS*, 76:5962- 5966.

Pickard, G.E. & Turek, F.W. 1992. Splitting of the circadian rhythm of activity is abolished by unilateral lesions of the suprachiasmatic nuclei. *Science*, 215:1119-1121.

Reppert, S.M. & Weaver, D. 2002. Coordination of circadian timing in mammals, *Nature*, 418:935-941.

Lecture 5:

Zucker, I. 1999. Hormones and hamster circadian organization. In: M. Suda (ed) *Biological Rhythms and Their Central Mechanisms*. Elsevier/North-Holland Biomedical Press.

Lecture 6:

Reppert, S.M. & Weaver, D. 2002. Coordination of circadian timing in mammals, *Nature*, 418:935-941.

Vitaterna, Takahashi J, Turek, F.W. 2001. Overview of circadian rhythms. *Alcohol Res Health*, 25:85-93.

Lecture 7:

Welsh, D.K. & Kay, S.A. 2005. Bioluminescence imaging in living organisms. *Curr Opin Biotechnol.*, 16:73-8.

Antle, M.C. & Silver, R. 2005. Orchestrating time: arrangements of the brain circadian clock. *Trends Neurosci.*, 28:145-51.

Lecture 9:

de la Iglesia, H.O., Meyer, J., Carpino, A. Jr. & Schwartz, W.J. 2000. Antiphase oscillation of the left and right suprachiasmatic nuclei. *Science*, 290:799-801.

Lecture 10:

Reppert, S.M. & Weaver, D. 2002. Coordination of circadian timing in mammals, *Nature*, 418:935-941.

Dziema, H., Oatis, B., Butcher, G.Q., Yates, R., Hoyt, K.R. & Obrietan K. 2003. The ERK/MAP kinase pathway couples light to immediate-early gene expression in the suprachiasmatic nucleus. *Eur J Neurosci.*, 17:1617-27.

Lecture 11:

Mrosovsky, N. 1998. Phase response curves for social entrainment. *J.Comp. Physiol.*, 162:35-46.

Maywood, E.S., Mrosovsky, N., Field, M.D. & Hastings, M.H. 1999. Rapid down-regulation of mammalian period genes during behavioral resetting of the circadian clock. *Proc. Natl. Acad. Sci.*, 96:15211-6.

Lecture 12:

Reppert, S.M., Weaver, D.R. & Rivkees, S.A. 1988. Maternal communication of circadian phase to the developing mammal. *Psychoneuroendocrinology*, 13: 63-78.

Lecture 13:

Daan, S. & Slopeema, S. 1978. Short-term rhythms in foraging behavior of the common vole. *J. Comp. Physiol.*, 127: 215-227.

Klein, R. & Armitage, R. 1979. Rhythms in human performance: 1 ½ -hour oscillations in cognitive style. *Science*, 204:1326-1328.

Lecture 14:

Wikelski, M.; Hau, M. "Is there an endogenous tidal foraging rhythm in marine iguanas?." *Journal of Biological Rhythms*, v. 10 issue 4, 1995, p. 335-50.

Lecture 15:

Fitzgerald, K.E. & Zucker, I. 1996. Circadian organization of the estrous cycle of the golden hamster. *PNAS*, 73: 2923-2927.

Swann, JM & Turek, F.W. 1985. Multiple circadian oscillators regulate the timing of behavioral and endocrine rhythms in female golden hamsters. *Science*, 225:898- 900.
Sanduleak, N. 1995. The moon is acquitted of murder in Cleveland. *Skeptical Inquirer*, 3:236-242.

Lecture 16:

Ruby, NF. "Hibernation: when good clocks go cold." *Journal of Biological Rhythms*, v. 18 issue 4, 2003, p. 275-86.

Lecture 19:

Wehr, TA., et al. "A circadian signal of change of season in patients with seasonal affective disorder." *Archives of General Psychiatry*, v. 58 issue 12, 2001, p. 1108-14.

Lecture 20:

Bass, J.; Takahashi, JS. "Circadian integration of metabolism and energetics." *American Association for the Advancement of Science. Science*, v. 330 issue 6009, 2010, p. 1349-54.

Lecture 21:

Saper, CB.; Scammell, TE.; Lu, J. "Hypothalamic regulation of sleep and circadian rhythms." *Nature (London)*, v. 437 issue 7063, 2005, p. 1257-63.

Lecture 22:

Sephton, S.; Spiegel, D. "Circadian disruption in cancer: a neuroendocrine-immune pathway from stress to disease?." *Brain, Behavior, and Immunity*, v. 17 issue 5, 2003, p. 321-8.

Lecture 23:

Challet, E., et al. "Reciprocal relationships between general (Propofol) anesthesia and circadian time in rats." *Neuropsychopharmacology : official publication of the American College of Neuropsychopharmacology*, v. 32 issue 3, 2007, p. 728-35.

Lecture 24:

Sack, RL. "The pathophysiology of jet lag." *Travel Medicine & Infectious Disease*, v. 7 issue 2, 2009, p. 102-10.

Lecture 25:

Navara, KJ.; Nelson, RJ. "The dark side of light at night: physiological, epidemiological, and ecological consequences." *Journal of Pineal Research*, v. 43 issue 3, 2007, p. 215-24.

Lecture 26:

Bedrosian, TA.; Nelson, RJ. "Influence of the modern light environment on mood." *Molecular Psychiatry*, v. 18 issue 7, 2013, p. 751-7.

