Welcome to PSY397H Biological Rhythms, Fall, 2023.
Tuesdays 10 am-1 pm.

Instructor: Dr. Martin Ralph Tel: (416) 978-7621 Room SS4017; Lab: (416) 978-3433
TA: Ann Zhang (416) 978-3433

<table>
<thead>
<tr>
<th>DATE</th>
<th>TOPIC</th>
<th>READINGS</th>
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<tbody>
<tr>
<td>Sept. 12</td>
<td>Biological and psychological representations of time; Temporal programs; Temporal biology and the organization of living things; Adaptive significance; “hierarchy” of circadian clocks.</td>
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<td>Sept. 19</td>
<td>Properties and synchronization of biological clocks. Resetting by light and nonphotic mechanisms including social zeitgebers and metabolism.</td>
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<td>Sept. 26</td>
<td>Molecular mechanisms of rhythm production and regulation – Molecular clocks throughout the living world. Discovery of clock genes.</td>
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<td>Oct. 3</td>
<td>The structure of circadian systems. Comparative anatomy and physiology across the 5 taxonomic groups.</td>
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<td>Oct. 10</td>
<td><strong>TEST 1</strong> (25%) covers everything including Oct 3. Followed by: Sleep, and circadian rhythms in human beings and other organisms. Chronotype, jet lag, temporal isolation.</td>
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<td>Oct. 17</td>
<td>The “other” circadian systems? Food entrainable oscillators; amphetamine sensitive oscillators; metabolic clocks, circadian disorganization in chronic mental disorders.</td>
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<td>Oct. 24</td>
<td>Non-circadian biological clocks: tidal, lunar, annual, ultradian rhythms. Time memory, time-place learning and the perception of time.</td>
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<td>Oct. 31</td>
<td>Seasonality. Photoperiodic time measurement</td>
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<td>Nov. 7</td>
<td><strong>Reading week (Nov. 6-10)</strong></td>
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<td>Nov. 14</td>
<td><strong>TEST 2</strong> (30%), Covers up to and including Oct. 31. Followed by lecture on Sleep, hibernation and memory consolidation.</td>
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<td>Nov. 21</td>
<td>Migration orientation and the sun compasses</td>
<td>J</td>
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<td>Nov. 28</td>
<td>Circadian disorganization, chronic disease, and longevity</td>
<td>K</td>
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<tr>
<td>Dec. 5</td>
<td>New models and conceptualizations of Time in biology; Daylight Saving Time and life on the Moon.</td>
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PSY397 Biological Rhythms

Tuesdays 10 am - 1 pm

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Course description
Biological rhythmicity is found throughout Nature, from bacteria to humans. While all living systems display various cycles, specific types of rhythms have evolved which provide temporal organization to the physiology and behavior of organisms and the ability to anticipate regular, cyclic changes in their environments. These are what we call “biological clocks”. Some mechanisms have become adapted for use in complex behaviors such as migration, seasonality, and coordinated reproduction. In addition, organisms gain an adaptive advantage from being able to predict the possible recurrence of conditioned that they have experienced. This is time memory, an aspect of circadian biology that is used in concert with the biological clock to predict the likelihood that significant events are going to recur at the same time as the initial experience. In this course, we will examine both mechanisms, the highly conserved systems that predict the regular changes in the environment, as well as the systems that underlie the memory of events that are not regular, nor linked to specific times of day. We will review current findings at all levels of organization from molecular genetic, to anatomical, to behavioral, always coming back to the question of how these rhythmic systems are able to function to predict demand, thereby operating as biological clocks, and we will examine the consequences of disordered timing systems.

Marking scheme

Term test 1: 25%; Term test 2: 30%; Final 2 hour exam: 45%

Tests will be a combination of multiple choice, short answer, matching, and fill-in-the-blanks. Some minor arithmetic calculations are required for some questions. No aids are allowed on tests.

Missed tests may be made up only with University of Toronto approved documentation.

If you become ill and it affects your ability to do your academic work, consult me right away. Normally, I will ask you for documentation in support of your specific medical circumstances. This documentation can be an Absence Declaration (via ACORN) or the University’s Verification of Student Illness or Injury (VOI) form. The VOI indicates the impact and severity of the illness, while protecting your privacy about the details of the nature of the illness. If you cannot submit a VOI due to limits on terms of use, you can submit a different form (like a letter from a doctor), as long as it is an original document, and it contains the same information as the VOI (including dates, academic impact, practitioner’s signature, phone and registration number). For more information on the VOI, please see http://www.illnessverification.utoronto.ca. For information on Absence Declaration Tool for A&S students, please see https://www.artsci.utoronto.ca/absence. If you get a concussion, break your hand, or suffer some other acute injury, you should register with Accessibility Services as soon as possible. Please note that students can only use the Absence Declaration on ACORN once per
semester. Documentation must be given to me within one week of missing a term test, in any of the forms mentioned above.

**Asking questions, office hours and reviews**

Within reason, you are encouraged to ask questions during the lectures. Bear in mind that although the instructor may be responsive in this way, your fellow students may not appreciate too many interruptions. The instructor will reserve some lecture time at the end of each class to answer questions. Official office hours: 11-12 am Fridays. Additional hours will be scheduled prior to term tests (times to determined from class discussions). Other hours by appointment.
Recommended resources


Seasons of Life: The Biological Rhythms That Enable Living Things to Thrive and Survive by Russell G. Foster and Leon Kreitzman | Jun 30 2009

TEXTBOOK (recommended)

The BioClock Studio, UCSD: https://ccb.ucsd.edu/the-bioclock-studio/index.html

Reading list (articles) and concepts to learn

A. Week 1; September 12 (Function of clocks and other rhythmic organization in living organisms; discovery of circadian clocks; ubiquity of clocks across species and levels of biological organization)


B. Week 2; September 19 (Basic mechanism of biological clocks; synchronization of clocks and other oscillators; environmental synchronizers and mechanisms of entrainment)


C. Week 3; September 26 (Comparing and contrasting the physiology and anatomy of circadian clocks across species; methods for identifying pacemakers; applying principles of entrainment)


D. Week 4; October 3 (Discovery of the molecular circadian systems in representative species across the phylogenetic tree; conservation of circadian mechanisms within taxonomic kingdoms, evidence for separate derivation of clock mechanisms between kingdoms; adaptive significance of circadian mechanisms)


E. Week 5; October 10; Term Test 1

Plus lecture: (Human chronobiology; ontogeny of circadian rhythms in human beings; clock dysfunction and physical and mental disorder; effects of chronic circadian misalignment or poor entrainment; significance of “chronotype” in health and performance; effects of daylight staving time)


23. Hahn C1, Cowell JM, Wiprzycka UJ, Goldstein D, Ralph M, Hasher L, Zelazo PD. (2012) Circadian rhythms in executive function during the transition to adolescence: the effect of


G. Week 7; October 24 (time memory; anticipation of significant events)


I. Week 10; November 14 TBA Term test 2. (*Theoretical roles for sleep; role of sleep in memory; remembering over long periods of torpor; circadian rhythms in the old and in the cold*)

J. Week 11; November 21 TBA (*Using the Sun and other celestial objects to determine direction*)

K. Week 12; November 28 TBA (*Circadian dysfunction and chronic, non-communicable disease; circadian disruption and aging; heart disease, diabetes, metabolic syndrome; relationship between circadian rhythms and metabolism*)

L. Week 13; December 5 TBA (*Conceptual and mathematical modelling of circadian patterns over time; potential for diagnostic tools for prevalent disorders; using models to predict disorder over the lifespan, inform diagnosis, and validated successful treatment; efforts to design sleep and rhythm friendly environments; recognizing temporal restrictions on life in space and other planets*)