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University of Pennsylvania

PRELIMINARY SYLLABUS

BIBB240: Sleep and Chronobiology

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Teaching Assistant:

Sarah Reitz (sreitz@pennmedicine), _____John Morgan Building.

Class Time and Location:

Tuesdays (4:30pm - 7:30pm). Location to be determined.

Permission must be obtained from Prof. Raizen to record lectures.

Office Hours:

Professor Raizen _____To Be Determined_____

Sarah Reitz _____ To Be Determined _____

Course Performance Criteria:

- There will be two midterms, each worth 30% of your final grade, and a final exam, worth 40% of your grade. The first midterm exam will be on Feb 13, 2018. The second midterm exam will be on March 20. The midterm and final exams will consist of multiple choice and open-ended questions designed to assess basic knowledge of the concepts discussed in class as well as the ability to integrate information from different lectures and on-line lecture materials.

No make-up midterm exams will be given. If a student misses an exam, the relative weight of the cumulative final exam will go from 30% to 50% for that student. If you wish to submit an exam for a re-grade, you should do so in writing within *one week* of receiving the graded exam. If you submit an exam for a re-grade, the entire exam will be re-graded and your resulting score may higher or lower than the original grade. A fraction of exams are photocopied before being returned to the students. If an exam is determined to have been altered before submission for re-grading, the student will be reported to the Office for Student Conduct.

You must attend and participate in all classes.

Organization of 3-hr Class Period: Class begins promptly at 4:30 pm.

Lecture/discussion 75 minutes (4:30-5:45 pm)

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Break 15 minutes (5:45-6:00 pm)

Lecture/discussion 55 minutes (6:00-6:55 pm)

Course Materials:

1. Circadian Physiology [electronic resource]. 3rd Edition, by Roberto Refinetti, 2016, CRC Press
Available electronically via the Biomedical library
2. Why we Sleep: Unlocking the Power of Sleep and Dreams, by Matthew Walker, 2017, Simon & Schuster
3. San Diego BioClock Studio Videos https://ccb.ucsd.edu/the-bioclock-studio/about-bioclock-studio/projects/projects.html#Tutorials-on-Basic-Concepts
4. Your class notes on the lectures.
5. Optional reading: Time, Love, Memory, by Jonathan Weiner
6. Additional lecture materials from Professor Raizen that will be available to you electronically on Canvas.

Pre-requisites: BIBB109 is the only required course. However, much of the material we will cover requires a basic understanding of cell biology including transcription, translation, protein modifications, and excitable cell function. If these topics were not covered in BIBB109 or another biology course you have taken in high school or college, then please contact the course instructor.

Overview: This course will cover the science of chronobiology and sleep. The material will be presented with a strong historical perspective by discussing seminal scientific papers in the field. In addition to learning the state of the art of sleep and chronobiology, a goal for the course is to learn how to critically evaluate scientific evidence.

Topics to cover

1. What is a circadian rhythm? What is a Free Running Period, What is a phase response curve. Methods used for detection of a periodic rhythms.
2. Circadian rhythms in plants, algae, and fungus.
3. Circadian rhythms in Drosophila
4. Circadian rhythms in mammals.
5. Anatomical basis of circadian clocks in mammals. How do they entrain to light.
6. Molecular basis of circadian rhythms: TTFL and Redox rhythms.
7. What is sleep? How do define behaviorally. How to define electrophysiologically.
8. Sleep across phylogeny I: Vertebrates
9. Sleep across phylogeny II: Invertebrates
10. Mechanisms of sensory gating
11. Sleep-promoting circuitry: Pre-optic, parafacial zone.
12. Wake-promoting circuitry: midbrain VTA, hypocretin, Locus Coeruleus, TMN.
13. Molecular basis of sleep regulation
14. Sleep and anesthesia: Guest lecture _____
15. Sleep and rhythms in Drosophila: Guest lecture _____
16. Sleep disorders I: Disorders of excessive sleepiness
17. Sleep disorders II: Disorders of poor sleep ability.
18. Sleep disorders III: Disorders of motor control during sleep.
19. Functions of sleep I: information processing theories

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20. Functions of sleep II: metabolic theories.
21. Function of REM sleep and dreams.

Class and Date:

1 – Jan 16th The Scientific Method: Theory, hypothesis, prediction ; Thinking Parsimoniously – DR
CLASS LOCATION: STEMMLER BUILDING, DUNLAP AUD, PERELMAN SOM

Content

- Resolving issues of enrollment and attendance.
- Discussing course organization and student responsibilities.
- Distribution of Syllabus -- Q and A on syllabus.
- Discovery Channel video "If We Had No Moon" (1 hour) – What are 3 points made in the video relative to human circadian rhythms?
- NOVA video "Becoming Human" (1 hour) – What evidence was presented regarding the biological record that early hominids were circadian?

2 -- Jan. 30th Origins, Measurements & Meanings of Biological Rhythmicity–DR

Content:

- Discussion of course structure, materials, and content.
- Discussion of videos shown in first class.
- The astrophysical basis for endogenous biological rhythms.
- What is a photoperiod? What was Philadelphia's photoperiod on Jan. 24, 2007?
- Humans on Mars--Earth-based endogenous rhythms in Martian orbital mechanics.
- Discussion of biological rhythms & sleep -- Are humans unique among animals?
- What do plants and people have in common?
- Some historical firsts in establishing endogenous biological rhythmicity.
- Two processes (endogenous circadian pacemaker & homeostatic drive for sleep).
- Chronobiological paradigm compared to the homeostatic paradigm.
- What are the functions of biological rhythms?
- What kinds of rhythmic processes are found in humans?
- What are biorhythms versus biological rhythms?
- How are biological rhythms measured?
- What are circadian, ultradian, and infradian rhythms?

3 – Feb 6th Animal Circadian Rhythms. – Guest lecturer?

Content:

- Introduction to Drosophila Melanogaster circadian biology
- Mammalian circadian biology

4 – Feb. 13rd MIDTERM 1

5 -- Feb. 20th Human Circadian Rhythms: Physiological systems, hormones, sleep – DR

Content:

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- Experimental paradigms for establishing the presence and relative influence of endogenous circadian rhythmicity:

  -- free-run and spontaneous internal desynchrony -- ultradian days

  -- disentrainment -- forced desynchrony

  -- constant routine and sleep deprivation

- Circadian control of neuroendocrine rhythms:
  -- melatonin -- thyroid hormones

  -- cortisol -- growth hormone

- Circadian control of sleep physiology:
  -- sleep onset, sleep duration, REM sleep, non-REM sleep

6 -- Feb. 27th Human Circadian Rhythms: Alertness and Accidents – DR

Content:

- Circadian control of sleepiness and alertness -- methodological issues.
- Circadian control of neurobehavioral performance: What aspects of cognitive performance are affected?
- Two-process model and biomathematical models of fatigue.
- A biphasic sleep propensity rhythm -- the case for siesta.
- Temporal profile of fatigue-related accidents.
- Shift work and night work.
- Jet lag.
- Delayed sleep phase syndrome.
- Circadian control of mood.
- Seasonal affective disorder.
- Occupational, safety, and public policy implications of circadian influences on human performance and safety.
- Review for midterm exam

March 6th: No class (SPRING BREAK)

8 – March 13rd Sleep Phenomenology -- From Phylogeny to Ontogeny – DR

Content:

- Sleep: Behavioral and electrophysiological definitions.
- How do you know whether/when an organism is sleeping?
- Sleep and evolution.
- The increasing hypersynchrony of nonREM sleep.
- Waking versus REM sleep, versus nonREM sleep: Physiology and behavior.
- Developmental changes in sleep across the lifespan.

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March 20h MIDTERM 2

9 – March 27th Animal Models of Sleep-Wake Neurobiology — Sarah Reitz

Content:

- Do flies sleep?
- Sleep in Rats and Mice

Neurobiology of Sleep and Waking -- What keeps us awake? What puts us to sleep? – DR

- Ascending reticular activation.
- Basal forebrain -- nucleus of the solitary tract.
- Ventrolateral preoptic area (VLPO).
- Aminergic brainstem nuclei (TMN, LC, DR, PT)
- Wakefulness: Dopamine, CRF, TRF, VIP, histamine, serotonin, noradrenaline.
- REM sleep: Acetylcholine.
- NREM sleep: GABA.
- Adenosine.
- Growth factors and immune neuropeptides.
- Benzodiazepines and newer hypnotics.
- Caffeine, amphetamine and modafinil.

11 – April 3rd Functions of Waking … of Sleep … of REM … of Dreams? (Part 1) – DR

Content:

- Sleep propensity as measured by sleep latency tests.
- Sleepiness and its neurobehavioral consequences.
- Sleep deprivation and sleep debt.
- Wake state instability.
- Drowsy driving.
- Sleepiness countermeasures.
- Physiological correlates of severe sleep deprivation (disk-over-water paradigm).
- Sleep and mentation: From hypnogogic reverie to dreams to sleep inertia to dreaming awake.

12 – April 10th Functions of Waking … of Sleep … of REM … of Dreams? (Part 2) – DR

Content:

- Sleep propensity as measured by sleep latency tests.
- Sleepiness and its neurobehavioral consequences.
- Sleep deprivation and sleep debt.
- Wake state instability.
- Drowsy driving.
- Sleepiness countermeasures.
- Physiological correlates of severe sleep deprivation (disk-over-water paradigm).
- Sleep and mentation: From hypnogogic reverie to dreams to sleep inertia to dreaming awake.

13 -- April 17th Sleep Disorders -- Diagnosis and Treatment. (Part 1) – DR

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Content:

- Narcolepsy.
- Obstructive sleep apnea syndrome (and central apnea).
- Restless Legs Syndrome.
- Periodic Limb Movements.
- Disorders of arousal (parasomnias)
- Sleep disorders. Nature Neuroscience Supplement, 5: 1071-1075, November 2002.

14 -- April 24h Sleep Disorders -- Diagnosis and Treatment. (Part 2) and Review for Final Exam
Content:

- Disorders of Sleep-Wake Schedule.
- Insomnia and sleep in psychiatric disorders and medical conditions.
- **Sleep disturbances due to environmental noise – Dr. Mathias Basner**
- Review for final exam

FINAL EXAM
Date: TBA

Location: TO BE ANNOUNCED