Human Chronobiology & Sleep

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Teaching Assistant:
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Class Time and Location:
Fridays (2:00pm - 5:00pm). Classes will be held in different classrooms in the John Morgan Building of the Perelman School of Medicine during the semester (the classroom for each lecture is listed below). Please note that neither food nor drinks are permitted in the rooms and you should not leave newspapers and trash after class.

Office Hours:
Anna Stern and Prof. Dinges will be available by appointment (send email request).

Course Performance Criteria:
- You must attend and participate in all classes (unless you have an excused absence submitted in writing through the Course Absence Report System, accessible through Penn InTouch). Participation includes taking notes, staying awake, and volunteering to respond to questions and engage in discussion. Each class is worth 1% of your final grade (14% in total).
- You must complete 2 exams (midterm & final), each worth 43% of your final grade. The midterm covers chronobiology and circadian rhythms, while the final is primarily on sleep, sleep deprivation, and sleep disorders.

Organization of 3-hr Class Period:
Class begins promptly at 2 pm.

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<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
<th>Time</th>
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<tbody>
<tr>
<td>Lecture/discussion</td>
<td>55 min</td>
<td>2:00-2:55 pm</td>
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<tr>
<td>Break</td>
<td>10 min</td>
<td>2:55-3:05 pm</td>
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<tr>
<td>Lecture/discussion</td>
<td>55 min</td>
<td>3:05-4:00 pm</td>
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<tr>
<td>Break</td>
<td>10 min</td>
<td>4:00-4:10 pm</td>
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<tr>
<td>Lecture/discussion</td>
<td>50 min</td>
<td>4:10-5:00 pm</td>
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Course Materials:
2. Your class notes on the lectures.
3. Additional lecture materials from Professor Dinges that will be available to you electronically on Blackboard.

Class and Date:
1 – Jan 16th Orientation to the course; the orbital mechanics instantiated in our genes – Prof. Dinges
LOCATION: John Morgan Building, Class of 62 Auditorium, Perelman School of Medicine
Lecture content: Prof. David Dinges
- Resolving issues of enrollment and attendance.
- Discussing course organization and student responsibilities.
- Distribution of Syllabus – Q and A on syllabus.
- Discussion of course structure, materials, and content.
- 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. 23rd  Origins, Measurements & Meanings of Biological Rhythmicity – Prof. Dinges

LOCATION: John Morgan Building, Class of 62 Auditorium, Perelman School of Medicine

Lecture content: Prof. David Dinges

• The astrophysical basis for endogenous biological rhythms.
• What is a photoperiod? What was Philadelphia’s photoperiod on Jan. 12, 2012?
• 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?
• How are biological rhythms measured?
• What are circadian, ultradian, and infradian rhythms?

3 -- Jan. 30th  Animal Circadian Rhythms. – Prof. Dinges

LOCATION: John Morgan Building, Class of 62 Auditorium, Perelman School of Medicine

Lecture content: Prof. David Dinges

• Characteristics, organization, and neural basis of endogenous rhythms.
• Suprachiasmatic nucleus: A cellular/molecular circadian clock.
• Measuring entraining inputs; endogenous rhythmicity, and oscillator outputs:
  -- zeitgebers -- phase response curves
  -- retinohypothalamic tract -- double raster plots
  -- endogenous rhythmicity and tau -- rest-activity cycles
  -- masking -- core body temperature
  -- phase relationships and external desynchrony -- endogenous melatonin secretion

4 – Feb. 6th  Organization of Circadian Pacemaker, Inputs and Outputs – Prof. Dinges

LOCATION: John Morgan Building, Class of 62 Auditorium, Perelman School of Medicine

Lecture content: Matt Wimmer, PhD

• More on biological rhythms
• Introduction to Drosophila Melanogaster circadian biology
• Mammalian circadian biology

Lecture content: Prof. David Dinges

• Experimental paradigms for establishing the presence and 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
• 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.
• Temporal profile of fatigue-related accidents.
• Shift work and night work.
• Jet lag.
• Circadian control of mood.
• Occupational, safety, and public policy implications of circadian influences on human performance and safety.

5 -- Feb. 13th  Human Circadian Rhythms: Physiological systems, hormones, sleep – Prof. Dinges

LOCATION: John Morgan Building, Class of 62 Auditorium, Perelman School of Medicine

Lecture content: Prof. David Dinges

• Phase response curves
• Circadian rhythm disorders

Read BASICS OF SLEEP GUIDE chapters 18A, 18B, 19
6 – Feb. 20th  Review for Midterm Exam – Prof. Dinges  
LOCATION: John Morgan Building, Class of 62 Auditorium, Perelman School of Medicine

7 – Feb. 27th  Midterm exam on chronobiology – Prof. Dinges / Anna Stern  
LOCATION: John Morgan Building, Class of 62 Auditorium, Perelman School of Medicine

8 – March 6th  Sleep Phenomenology: From Phylogeny to Ontogeny and the Functions of Sleep – Prof. Dinges  
LOCATION: John Morgan Building, Class of 62 Auditorium, Perelman School of Medicine  
Lecture content: Prof. David Dinges  
• 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.  
• The lethal effects of sleep deprivation?  
• What does epidemiology suggest are the functions of sleep?

9 – March 13th  SPRING BREAK

10 – March 20th  Neurobiology of Sleep and Waking -- What keeps us awake? What puts us to sleep? – Prof. Dinges  
LOCATION: John Morgan Building, Class of 62 Auditorium, Perelman School of Medicine  
Lecture content: Prof. David Dinges  
• 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.  
• Hypnotics: Benzodiazepines and newer hypnotics.  
• Stimulants: Caffeine, amphetamine and modafinil.

11 – March 27th  
LOCATION: John Morgan Building, Class of 62 Auditorium, Perelman School of Medicine  
Lecture content: Andrea Spaeth, PhD  
• Sleep, Eating and Weight  
Lecture content: Robin Yuan (Doctoral Student)  
• Sleep and Memory  
Lecture content: Prof. David Dinges  
• Consequences of Sleep Deprivation –Prof. David Dinges  
Read BASICS OF SLEEP GUIDE chapters 1-7 and 11-17B

12 – April 3rd  
LOCATION: John Morgan Building, REUNION HALL Auditorium (across the hall from Class of 62 Auditorium), Perelman School of Medicine  
Lecture content: Mathias Basner, MD, PhD, MSc  
• Sociodemographics of sleep  
Lecture content: Prof. David Dinges  
• Sleep propensity as measured by sleep latency tests.  
• Sleepiness and its neurobehavioral consequences.  
• Sleep deprivation and sleep debt.  
• Wake state instability.  
• Drowsy driving and other fatigue-related accidents and catastrophes.  
• Sleepiness countermeasures.  
• Sleep and mentation: From hypnogogic reverie to dreams to sleep inertia to dreaming awake.
13 – April 10th  Sleep Disorders Part I
LOCATION: John Morgan Building, Class of 62 Auditorium, Perelman School of Medicine
Lecture content:
- Sleep and environmental noise – Mathias Basner, MD, PhD, MSc
- Sleep and aging – Anna Stern (Doctoral student)
Lecture content: Prof. David Dinges
- Narcolepsy.
- Hypersomnolence syndromes
- Obstructive sleep apnea syndrome (and central apnea).

14 – April 17th  Sleep Disorders Part II – Prof. David Dinges
LOCATION: John Morgan Building, Class of 62 Auditorium, Perelman School of Medicine
Lecture content: Prof. David Dinges
- Restless Legs Syndrome.
- Periodic Limb Movements.
- Disorders of arousal (parasomnias)
- Insomnia and sleep in psychiatric disorders and medical conditions.

15 -- April 24th  Review for Final Exam – Prof. David Dinges
LOCATION: John Morgan Building, Class of 62 Auditorium, Perelman School of Medicine
- Read/review BASICS OF SLEEP GUIDE chapters 20-22
- Additional lecture time (as required)
- Review for final exam

FINAL EXAM
Date: Monday, May 4, 2015, 6-8pm
Location: Class of 62, John Morgan Building, Perelman School of Medicine