Sleep 2

• Sleep is a specialized state that a network of brain regions actively produces
  – moderate decrease in brain activity
  – decreased response to external stimuli

• Sleep fundamentally differs from:
  – Coma, vegetative state, minimally conscious state, and brain death
Stages of Sleep – EEG

• The electroencephalograph (EEG) allowed researchers to discover that there are various stages of sleep

• A polysomnograph is a combination of EEG and eye-movement records
Brain Activity Recorded via EEG During Sleep
Stage 1 Sleep

• Alpha waves are present when one begins a state of relaxation
• Stage 1 sleep: when sleep has just begun
  – EEG is dominated by irregular, jagged, and low voltage waves
  – Brain activity begins to decline
Stage 2 Sleep

• Stage 2 sleep:
  – Sleep spindles: 12 to 14 Hz waves during a burst that lasts at least half a second
  – K-complex: a sharp wave associated with temporary inhibition of neuronal firing
Slow Wave Sleep (SWS)  
Stages 3 and 4

- Stages 3 and 4 together constitute slow wave sleep (SWS):
  - Slow, large amplitude waves
  - Slowing of heart rate, breathing rate, brain activity
  - Synchronized neuronal activity
REM Sleep

- Rapid eye movement (REM)
  - “paradoxical sleep”
- EEG waves are irregular, low-voltage, and fast
- Postural muscles of body are more relaxed than other stages
- Pons projects to spinal cord and inhibits motor neurons
NREM and REM Cycle

• Stages other than REM: non-REM sleep (NREM)
• When people fall asleep, they progress through stages 1, 2, 3, and 4 in sequential order
  – After about an hour, the person cycles back through the stages from stage 4 to 3 and 2 and then REM
  – Sequence repeats, each cycle is ~90 min
NREM and REM Cycle

- Stages 3 and 4 predominate early in the night
- REM sleep is predominant later at night
- REM is strongly associated with dreaming, but people report dreaming in other stages of sleep
Brain Mechanisms of Wakefulness and Arousal

• Reticular formation is a part of the midbrain that extends from the medulla to the forebrain
  – promotes wakefulness
  – pontomesencephalon (PMC)
  – projects to:
    – hypothalamus
    – thalamus
    – cortex
    – basal forebrain
Brain Mechanisms of Wakefulness and Arousal

- **Locus coeruleus**
  - in the pons
  - releases norepinephrine to hypothalamic (e.g. SCN) and cortical areas in response to meaningful events

- **Hypothalamus**
  - histaminergic neurons
  - anti-histamines
Brain Mechanisms of Wakefulness and Arousal

• Hypothalamus: Orexin stimulates ACh-releasing cells in basal forebrain to promote arousal/wakefulness

• Basal forebrain (BFb)
  • releases ACh and also GABA
  • Alzheimer’s disease produces major damage in BFb
Ask your neighbor:

1. Quantity of your sleep?
2. Quality of your sleep?
3. Are you satisfied with your sleep quantity and quality?
4. If yes, what’s your secret?
5. If no, how to improve?

Write down and report on what your neighbor said.
http://healthysleep.med.harvard.edu/portal/

- maintain a consistent sleep-wake schedule
- use light to your advantage; expose yourself to sunlight during day and limit (blue) light exposure 1-2 hr before bedtime
- avoid caffeine, alcohol, nicotine, and other chemicals that interfere with sleep
- exercise regularly – but not right before bedtime
- use earplugs (or white noise) if necessary
- adjust the room temperature – cool; not too warm (open window?)
Possible Functions of Sleep

- Humans spend one-third of their life asleep!
- Why? Possible hypotheses:
  - Restoration - muscles, neurons
  - Cellular maintenance
  - Removing cellular waste
  - Energy conservation
  - Reorganizing synapses
  - Strengthening memories

https://www.ted.com/talks/russell_foster_why_do_we_sleep
Possible functions of REM sleep

- Humans spend one-fifth of life in REM
- Species differences in REM
  - Most common in birds and mammals
  - Percentage of REM sleep is positively correlated with the total amount of sleep
- Among humans (adults), those who get the most sleep have the highest percentage of REM
- Among humans, age differences
Age and REM Sleep in Humans

• Bottom line: we don’t know the function of REM!
• Same with dreaming…

FIGURE 9.19 Sleep patterns for people of various ages
REM sleep occupies about 8 hours a day in newborns but less than 2 hours in most adults. The sleep of infants is not quite like that of adults, however, and the criteria for identifying REM sleep are not the same. (From “Ontogenetic Development of Human Sleep-Dream Cycle,” by H. P. Roffwarg, J. N. Muzio, and W. C. Dement, Science, 152, 1966, 604–609. Copyright 1966)