Autonomic Nervous system

- Part of the peripheral nervous system. Controls visceral functions.
- Two parts of the autonomic nervous system:
  - Sympathetic nervous system (SNS): the "accelerator" (fight or flight)
  - Parasympathetic nervous system (PNS): the "break" (rest and digest; feed and breed)
- NREM sleep: the SNS inactive, PNS is active.
- Tonic REMS: SNS is even less active than during NREM, PNS is active.
- Phasic REMS: SNS and PNS activity levels vary "wildly."

Cardiovascular

- Heart rate and blood pressure:
  - Decrease during NREM sleep, remain steady, controlled.
  - During phasic REM sleep, both fluctuate dramatically.
- Blood flow rate in the brain:
  - During NREM sleep, slightly less compared to waking.
  - During phasic REM sleep, there are periodic increases in flow, even relative to the waking state.
Respiration

- During NREM sleep, respiration is regular and deeper than when awake.
  - Adjusts automatically to CO2 level
- During REM sleep, breathing rate varies substantially
  - Changes are only weakly correlated with CO2 level (if too low, will awaken)
- During all sleep, cough response is suppressed (circadian control)

Brain/body temperature

- Body temperature varies by about 2 degrees over nycthemeron, lowest during early morning
  - Circadian rhythms responsible for about half of temperature drop during sleep
    - The remainder reflects slowing of metabolic processes
  - NREM sleep: temperature is regulated automatically in response to environment
    - REM sleep: inefficient regulation of body temp.
      - If too hot or cold, will awaken
      - Brain temp often exceeds waking levels

Body hormones

- Growth hormone
  - Secretion triggered by sleep and exercise
  - Increase synchronized with sleep onset, not circadian time
  - Levels reduced by sleep deprivation, but rebounds with sleep recovery

Body hormones

- Cortisol
  - Important in response to stress (raises blood pressure and blood sugar levels) and in suppression of immune system
  - Is a circadian rhythm (highest level in morning)
  - Requires several days to reset after change in sleep timing (one important factor behind jet lag)
  - Levels too high or too low can disturb sleep and affect cognitive function
Body hormones

- Melatonin
  - Levels vary on circadian rhythm; much higher at night
  - A potent zeitgeber, but weak as sleep aid
  - Taken as supplement, appears to facilitate dreaming
    - People report more vivid dreams
    - 50 mg dose can dramatically increase REM sleep time

Effects of the body on sleep

- Infectious illness generally increases overall sleep time
  - Increase in SWS sleep, decrease in REM sleep
  - Infected rabbit survival correlated with amount of NREM sleep.
    Biochemical mechanism partially understood:
    - White blood cells digest bacteria, releasing chemicals that, through a cascade of events, increase cytokine levels
    - The cytokine increase promotes SWS sleep (independent evidence for this)
  - Thus, SWS is apparently recuperative: reduces metabolism and may free resources for fighting infection

- Food
  - Eating promotes sleep 1-2 hours later
    - Larger meals give larger sleep effects
    - High fat/protein meal increases REM
    - High carbohydrate meal increases SWS
  - When gaining weight, more and better sleep

- Caffeine
  - Peak blood concentration about 1.5 hours after intake
  - Half-life about 4 hours, still detectable up to 12-14 hours
  - Temporarily blocks adenosine binding in basal forebrain
  - Repeated dosage can fight effects of sleep deprivation for up to 48 hours
  - Afternoon/evening ingestion frequent cause of insomnia, though often without knowledge
Effects of the body on sleep

- Alcohol
  - Decreases sleep onset latency
  - Decreases REMS until metabolized
  - Increases second half awakening (sleep fragmentation)