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The Power of Sleep—and Deprivation . . .



Sleep is independently linked with longevity; without sufficient sleep, you die—the loss of one hour of sleep per night can shorten your life span

Your brain is actually busier during sleep than it is when awake because it has many housekeeping chores to do

If your sleep is cut short some of those chores will not get done, which will impact you the following day, depending on which ones are neglected

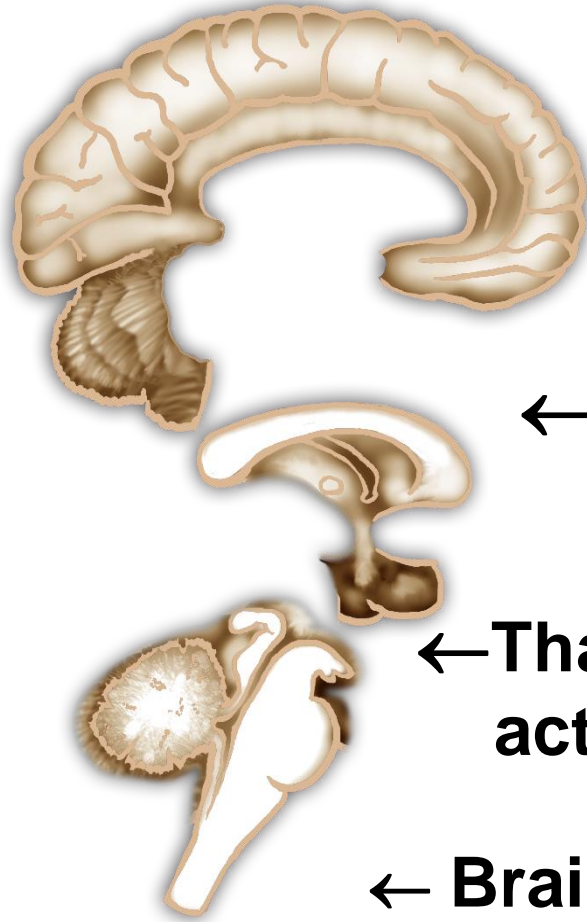
Mental exercise and fatigue takes more recovery time than physical exercise and fatigue



Unlike a coma, sleep is a quiet, partially-conscious, and reversible state from which you can be aroused by stimulation—sometimes with difficulty, because sensitivity to environmental stimuli (sounds, smells, and physical sensations) is lowered but not completely blocked

Sleep is very complicated any way you cut it—you will spend about 1/3 of your life sleeping, which helps you be productive during the remaining 2/3





← **Neocortex: RAS stimulation triggers awareness and alertness**

← **Hypothalamus: Suprachiasmatic Nuclei (SCN) is the master circadian rhythm clock**

← **Thalamus: “Sleep on” cells can block RAS activation of the cortex and induce sleep**

← **Brain Stem RAS: stimulates the brain into wakefulness; must be blocked to cause sleep**

Your brain does not *rest* during sleep, per se—hundreds of biological processes continue and some brain areas are even more active during sleep than when you are awake

Breathing, heart rate, blood pressure, continue as usual—other non-critical functions are suppressed (unless you eat just before going to bed)

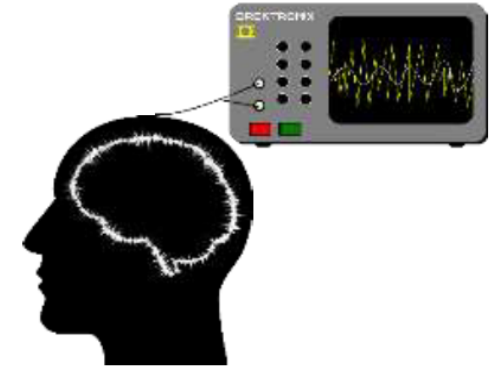
Thanks in large part to the invention of the EEG or electroencephalography and polysomnography more has been learned about sleep in the past 60 years than during the preceding 6,000 years



—J. Allan Hobson, *Sleep*

The brain generates two distinct types of brain waves that combine to form a sleep cycle:

- ✓ **Most human sleeping is slow-wave (SWS) or non-rapid eye movement (NREM) sleep, characterized by large, slow brain waves, relaxed muscles, and slow deep breathing**



- **Rapid eye movement (REM) sleep or dreaming sleep**

If there is sleep deprivation, the intensity of NREM sleep increases although the time spent in it does not markedly increase

Children age 7 to puberty need at least 8 hours per night

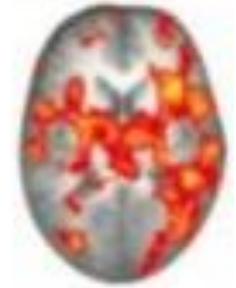
Teenagers need at least 9 hours per night but they often sleep only 7-8 hours or less

Some teenagers develop Delayed Sleep Phase Disorder in which circadian sleep rhythm is pushed back and they are not sleepy until long after their usual bedtime and then cannot awaken early for school—much less “learn”



Adults need 7-8 hours per night (a few more or less)

- **The greater the sleep needed, the faster you fall asleep**
- **Although it accounts for only 2% of total body weight, the brain uses 20% of all the energy resources, three times as much oxygen as body muscles cells, and twice as much energy as other body cells**
- **It has no stores of oxygen or glucose so needs a regular blood supply (glial cells store some glycogen)**
- **Body cells can use carbs, fats, and proteins for energy, brain neurons can only use carbs for glucose—and healthier carbs are, of course, preferred.**



The brain completes a variety of routine maintenance and housekeeping chores that can help you learn more quickly when awake and remember what you learned

- 1 - Restores brain energy reserves; helps maintain homeostasis including energy balance**
- 2 - Processes what happened during the previous 24 hours through dreaming during the REM stage**
- 3 - Provides the brain with special electrical stimulation to help with learning quickly, memory, decision-making, and cognitive performance when awake**



- 4 - Consolidates information processed during the day and moves it from short-term into long-term memory**
- 5 - Repairs cells in the hippocampus, your brain's search engine, so it can locate stored information and help you recall it**
- 6 - Helps regulate appetite, mood, and libido**
- 7 - Increases blood supply to muscle cells**
- 8 - Releases hormones for growth and development**

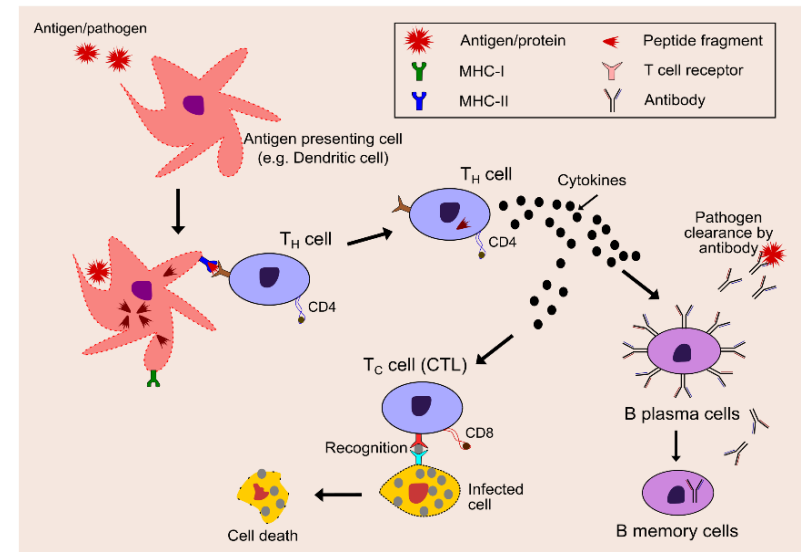


9 - During sleep the brain-body temperature and level of metabolic energy are reduced—the energy saved is used in growing and repairing cells

10 - Synthesizes new chemicals for the brain and immune system

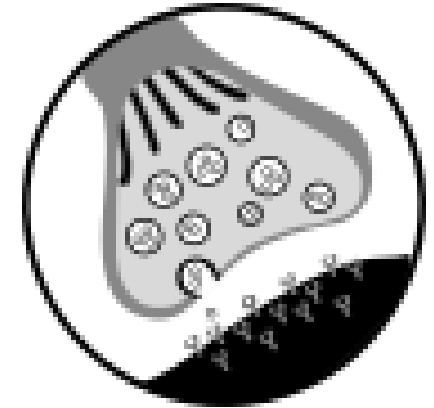
11 - Generates and repairs cells of the immune system

12- Repairs brain cells



13 - Opens up spaces between neurons so glial cells can help flush out toxic molecules including beta-amyloid proteins (the plaques of AD)

14 - Collects (reuptake) norepinephrine and serotonin from the synapse (synaptic gap) so they can be reused



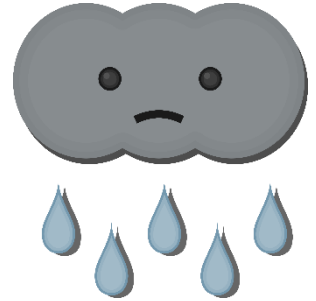
15 - Removes waste products from the brain

16 - Prepares food for the neurons (neurotrophins)

17 - Increases production of oligodendrocyte glial cells that form myelin sheath to wrap neuronal axons

Sleep deprivation is a major risk factor for many mental disorders including anxiety and depression

Interestingly, too little sleep or more than you need are both established risk factors for developing medical disorders such as heart disease, stroke, diabetes, kidney disease, and common infections like flu and pneumonia—the brain works best in homeostasis (balance)



Aging and longevity studies show that the longest lived and healthiest people typically get regular and restful sleep

The “free-running” circadian rhythm is approximately 24 hours and a few minutes

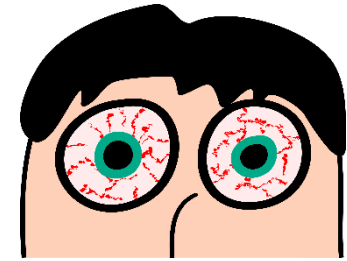


It uses solar light cues to keep synchronizing the SCN (circadian rhythm clock in the hypothalamus) back onto the 24-hr sleep cycle; known as *entraining*

Non-24 Hour sleep-wake disorder: visually impaired individuals often develop greater than 24 hour sleep cycles; if the SCN is not cued by light to synchronize the circadian rhythm to the 24-hour light-dark day, it does not *entrain*

The SCN does NOT react well to rapid changes in light and dark (outside of the sun's regular rise and setting)

This produces circadian disruption problems that cause sleep dysfunction, which is often seen in shift work and jet lag



The number of time zones crossed is the factor in jet lag; estimates are that it can take one day for every time zone crossed to have the SCN catch up; E-W or W-E flights are more problematic than N-S or S-N flights

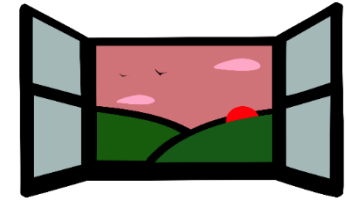
20-40% of Americans do shift work; rotating shifts keep them continually in jet lag

60-70% of shift workers have a sleep disorder; they fall asleep at work 2-5 times as much as daytime workers, and make more errors on the job, often resulting in disastrous consequences

Have higher risk of heart disease, GI disorders, menstrual irregularities, weakened immune systems, certain cancers, emotional problems, divorce, substance abuse, depression, and social relationship problems



Season Affective Disorder (SAD): a type of depression related to circadian rhythms—the incidence is higher in countries with shorter days and less light during winter months (e.g., Alaska, Iceland, Finland, Norway, Denmark, Canada’s Northern Territories)



SAD is often linked to high rates of substance abuse and suicide attempts; as days have more sunlight, symptoms often go into remission—symptoms may improve by use of “natural light bulbs” indoors and/or daily exposure to bright light for 30-60- minutes, usually in the morning

Sleep deprivation is pandemic; an estimated 80 percent of the world's population needs an alarm clock to wake up; common symptoms include:

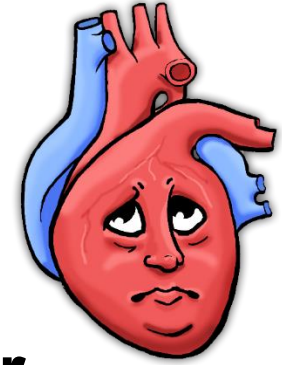
- **↑ Daytime sleepiness**
- **↑ Irritability, nervousness**
- **↑ Impaired ability to manage stress**
- **↑ Arguing, fighting, and relationship conflict**
- **↑ Problems with concentration and memory**
- **↑ Behavioral learning and/or social problems**



- **↑ Risk of blurred vision**
- **↑ Distractibility**
- **↑ Prostate cancer**
- **↑ Appetite (with only 4 hours of sleep people ate 300 additional calories next day)**
- **↑ Weight gain / obesity linked with 50 chronic diseases**
- **↑ Risk of clumsiness with accidents and injuries**
- **↑ Likelihood for smoking and using alcohol**
- **↑ Chronic inflammation and frequent infections**
- **↑ Rate of aging and potentially shorter lifespan**



- **↑ High blood pressure, heart disease, and stroke**
- **↑ Anxiety, depression, and suicide risk**
- **↑ Risk of Alzheimer's and other dementia**
- **↑ Insulin resistance and diabetes**
- **↑ S/S of Attention Deficit-Hyperactivity Disorder**
- **↑ Increased risk of infertility**
- **↓ Libido and sex drive**
- **↓ Vaccine effectiveness**
- **↓ Memory and problem-solving ability**



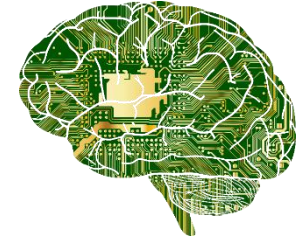
By 20 hours without sleep, your reaction time is similar to that of a person with a blood alcohol level of 0.08



PET Scans show that sleep deprivation for 24 hours results in significant brain changes in areas responsible for judgment, impulse control, attention, and visual association, yet you believe you are functioning just fine

The temperature of your brain rises when you are sleep deprived. Yawning causes you to take in deeper breaths of air. Inhaling cool air ventilates your sinuses and helps to dissipate brain heat.

Your biological clock can become programmed to stay up late on Friday and Saturday nights, then sleep in on Saturday and Sunday mornings, which can make it difficult to wake up on Monday ...



Sleep Tips:

- **Go to bed at same time every night as close to 10 pm as possible (sleep before midnight may be more restorative)**
- **Go to bed and get up at the same time on weekends**

- **Sleep in a dark, cool room**
- **Avoid rotating shifts if at all possible**
- **Cell phones, iPads, computers, and TV in the bedroom impair quality of sleep for everyone**
- **Avoid eating after 7 pm so sleep is less interrupted by digestion**
- **Drink a glass of water before going to sleep to help keep the brain hydrated and decrease risk of brain blood clots**
- **“Hum” yourself to sleep . . .**

