The Power of Sleep—and its Deprivation . . .

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Brain References
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Sleep is the interest we have to pay on the capital which is called in at death; and the higher the rate of interest and the more regularly it is paid, the further the date of redemption is postponed

—Arthur Schopenhauer

Sleep is the golden chain that ties health and your body together

—Thomas Dekker

Those who say they ‘sleep like a baby’ do not have one

—Old Proverb

Studies have shown that sleep is independently linked with longevity
SLEEP can be defined as a quiet, partially-conscious, and reversible state from which you can be aroused by stimulation—sometimes with difficulty, as sensitivity to environmental stimuli (sounds, smells, and physical sensations) is lowered but not completely blocked.

It is not the same as a coma!

Sleep is very complicated any way you look at 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: The Reticular Activating System or RAS stimulates the brain into wakefulness and must be blocked in order for sleep to occur
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 but other non-critical functions are suppressed (unless you eat just before going to bed and food is digested).

Electroencephalography and polysomnography have revealed more about sleep in the past 60 years than was known 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 sleep deprivation, the intensity of NREM sleep increases although the time spent in it does not markedly increase
Typically, all humans have a sleep onset of NREM sleep; during a typical 8-hour sleep period, the average adult goes through five or six 90-110 minute sleep cycles.

Newborns often sleep 16-18 hours a day with half NREM and half REM sleep.

Throughout childhood REM sleep gradually declines until by puberty REM is about $\frac{1}{4}$th of the total sleep time.

In adulthood REM sleep is about $\frac{1}{5}$th of the total sleep time.
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; they are not sleepy until long after their usual bedtime and then cannot awaken early for school—much less “learn”

Average adult needs 7-8 hours per night (some more or less)
Sleep caveats:

• 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.

• Stores no 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 use carbs—and need healthier carbs.
It is pretty simple: 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 require more recovery time than do physical exercise and fatigue.
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

2 - Processes what happened during the past 24 hours through dreaming

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 - Assists in maintaining homeostasis including your energy balance

7 - Collects (reuptake) norepinephrine and serotonin so these substances can be reused
8 - Reduces brain-body temperature and level of metabolic energy—saved energy is used in growing cells
9 - Generates and repairs immune system cells
10 - Synthesizes new chemicals for brain and immune system
11 - Releases hormones for growth and development
12 - Repairs cells in the brain and nervous system
10 - Opens up spaces between neurons (synapse) so glial cells can help flush out toxic molecules including beta-amyloid proteins (the plaques of Alzheimer’s Disease)

11 - Increases blood supply to muscle cells

12 - Removes waste products from the brain

13 - Helps regulate appetite, mood, and libido

14 - Prepares neurotrophins, food for the neurons

15 - 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.

Either too little sleep and 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 individuals typically get regular and restful sleep.
The “free-running” circadian rhythm cycle is approximately 24 hours and a few minutes. Need 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: a sleep-wake disorder that visually impaired individuals often develop; 24-hour sleep cycles lengthen; the SCN is not cued by light to synchronize the circadian rhythm to the 24-hour light-dark day and does not entrain.
The SCN does NOT react well to rapid changes in light and dark.

This produces circadian disruption problems that cause sleep dysfunctions, 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.
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 result in making it difficult to go to sleep Sunday night and to wake up early on Monday morning.

Solution: go to bed and get up at the same time on weekends as during the week—do something pleasant Sunday night until you fall asleep, then Monday morning get up as soon as the alarm goes off.
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, some cancers, emotional problems, divorce, depression, social relationship problems, and substance abuse
Seasonal Affective Disorder or SAD is a type of depression related to circadian rhythms; incidence is higher in countries with shorter days and less light during winter months.

SAD is often linked to high rates of substance abuse and suicide attempts; as the days become longer with more sunlight, symptoms often go into remission.

Symptoms may improve by the use of “natural light bulbs” and/or daily exposure to bright light for 30-60- minutes, usually in the morning.
Sleep deprivation is pandemic; an estimated 80% of the world’s population requires an alarm clock to wake up—common sleep-deprivation symptoms include:

- Daytime sleepiness
- Irritability and / or nervousness
- Distractibility, Blurred vision
- Impaired ability to manage stress
- Problems with concentration and memory
- Behavioral learning and / or social problems
• Diminished sex drive and increased risk of infertility
• Increased illnesses and infections
• Increased appetite (with only 4 hours sleep, study participants ate 300 more calories the next day)
• Weight gain and obesity, which is now linked with more than 50 chronic diseases
• Reduced problem-solving ability
• Increased arguing, fighting, and conflict
• Clumsiness with increased accidents and injuries
• Increased likelihood for smoking and using alcohol
Insulin resistance and diabetes
High blood pressure, heart disease, and stroke
Anxiety, depression, and suicide risk
Risk of Alzheimer’s and other dementias
Chronic inflammation, Prostate cancer
Attention Deficit-Hyperactivity Disorder
Rate of aging and potentially shorter lifespan
Vaccine effectiveness
Memory and problem solving abilities
After 20 hours without sleep, your reaction time is similar to that of a person with a blood alcohol level of 0.08

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

The temperature of your brain increases 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.

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Sleep tips that are key to health and longevity:

• Go to bed at same time every night as close to 10 pm as possible (sleep before midnight may be more restorative)
• Avoid eating after 7 pm so digestion doesn’t disrupt sleep
• Drink a glass of water before going to sleep to keep the brain hydrated and decrease risk of blood clots
• Sleep in a dark, cool room
• Avoid rotating shifts if at all possible
• No Cell phones, iPads, computers, TV, or clocks with LED-light in the bedroom as they impair quality of sleep

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