Sleep

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Sleep

Sleep is a naturally recurring state of mind and body, characterized by altered consciousness, relatively inhibited sensory activity, reduced muscle activity and inhibition of nearly all voluntary muscles during rapid eye movement sleep, and reduced interactions with surroundings.

We are spending ⅓ of our life time for sleep

Sleep is as essential to survival as food and water

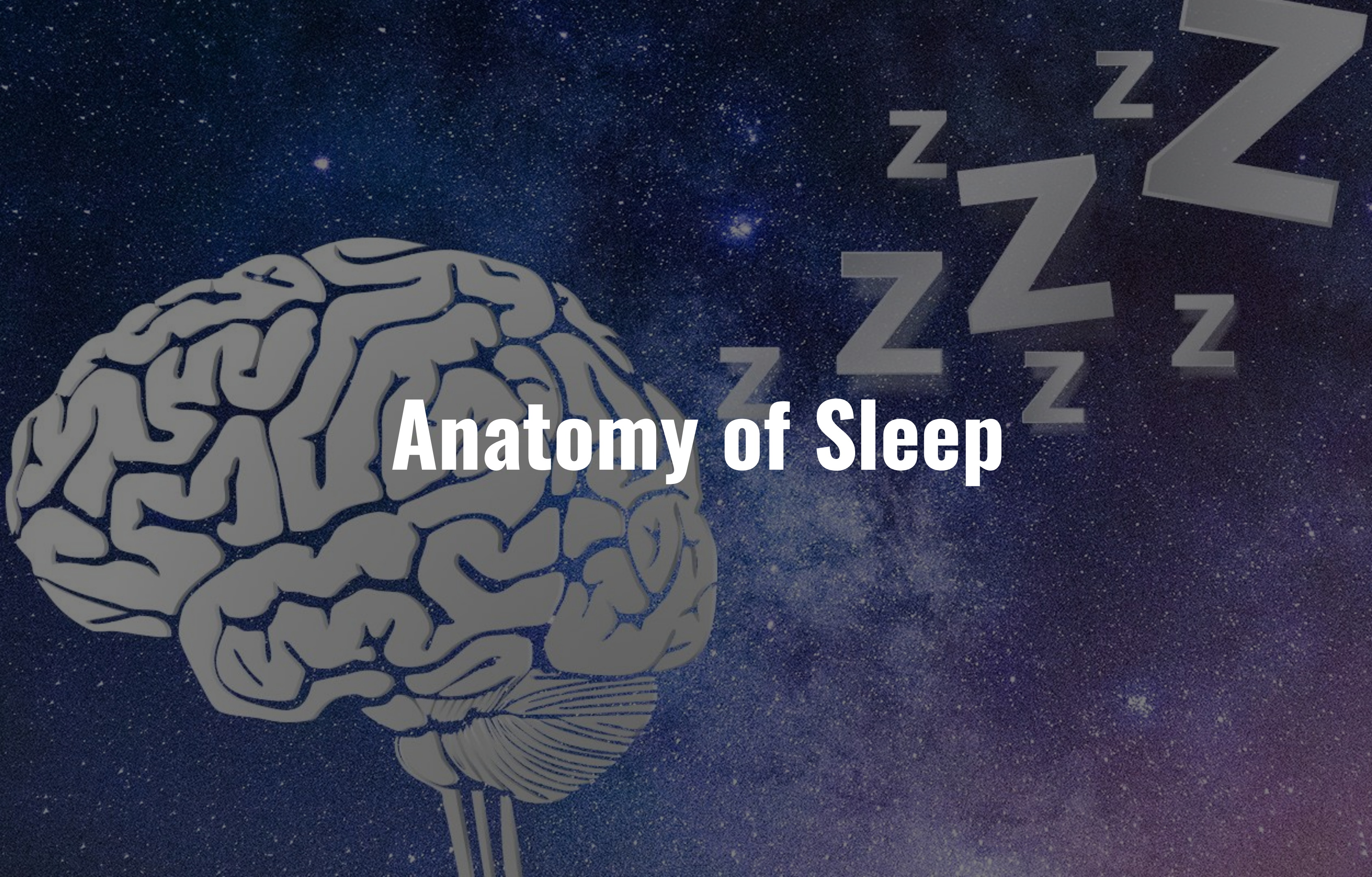
Sleep is important to a number of brain functions

Recent findings suggest that sleep plays a housekeeping role that removes toxins in our brain that build up while we are awake

Research shows that a chronic lack of sleep, or getting poor quality sleep, increases the risk of disorders including

1. high blood pressure,
2. cardiovascular disease,
3. diabetes,
4. depression, and
5. obesity

Anatomy of Sleep



Brain and Sleep

Several structures within the brain are involved with sleep

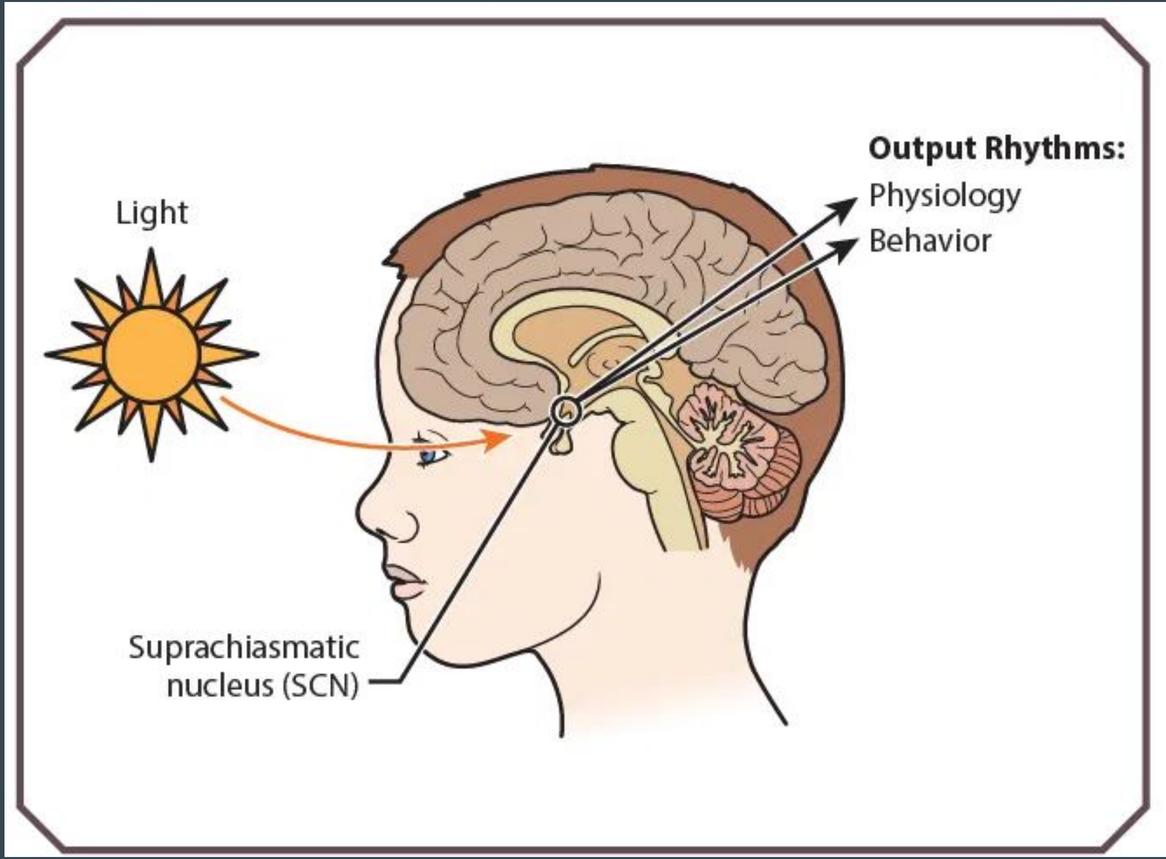
1. The **hypothalamus**
2. The **suprachiasmatic nucleus**
3. The **brain stem**
4. The **thalamus**
5. The **cerebral cortex**
6. The **pineal gland**
7. The **basal forebrain**
8. the **midbrain**
9. The **amygdala**

The hypothalamus

The **hypothalamus**, a peanut-sized structure deep inside the brain, contains groups of nerve cells that act as control centers affecting sleep and arousal.

SCN

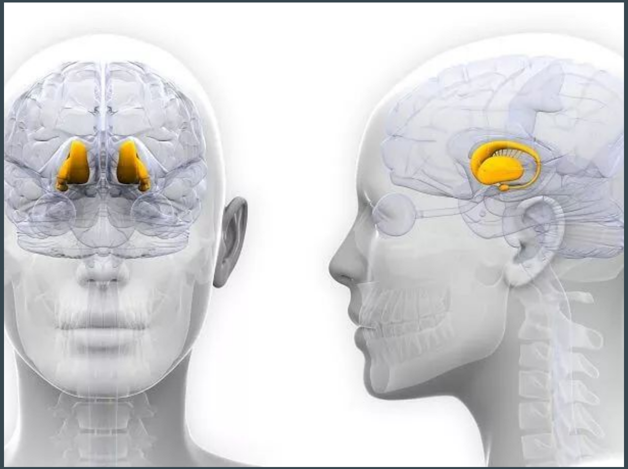
Within the hypothalamus is the **suprachiasmatic nucleus** (SCN) – clusters of thousands of cells that receive information about light exposure directly from the eyes and control our behavioral rhythm. Some people with damage to the SCN sleep erratically throughout the day because they are not able to match their circadian rhythms with the light-dark cycle. Most blind people maintain some ability to sense light and are able to modify their sleep/wake cycle.

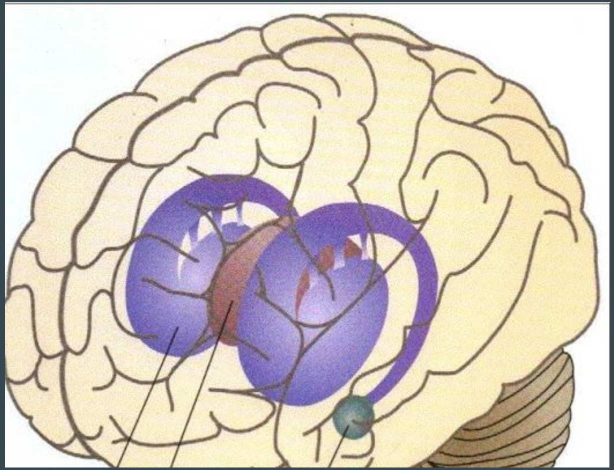


Brain Stem

1. The **brain stem**, at the base of the brain, communicates with the hypothalamus to control the transitions between wake and sleep.
2. The brainstem includes structures called the pons, medulla, and midbrain.
3. Sleep-promoting cells within the hypothalamus and the brain stem produce a brain chemical called *GABA*, which acts to reduce the activity of arousal centers in the hypothalamus and the brain stem.
4. The brain stem (especially the pons and medulla) also plays a special role in REM sleep;
5. it sends signals to relax muscles essential for body posture and limb movements, so that we don’t act out our dreams.

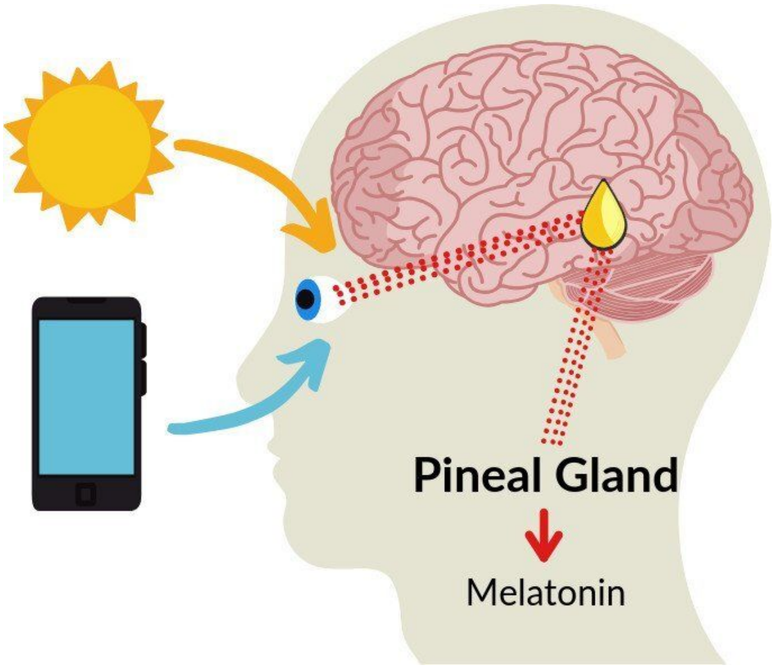
Thalamus





1. The **thalamus** acts as a relay for information from the senses to the **cerebral cortex**
2. the covering of the brain that interprets and processes information from short- to long-term memory
3. During most stages of sleep, the thalamus becomes quiet, letting you tune out the external world.
4. But during REM sleep, the thalamus is active, sending the cortex images, sounds, and other sensations that fill our dreams.

Pineal Gland



1. The **pineal gland**, located within the brain's two hemispheres, receives signals from the SCN and increases production of the hormone *melatonin*, which helps put us to sleep once the lights go down.
2. People who have lost their sight and cannot coordinate their natural wake-sleep cycle using natural light can stabilize their sleep patterns by taking small amounts of melatonin at the same time each day.
3. Scientists believe that peaks and valleys of melatonin over time are important for matching the body's circadian rhythm to the external cycle of light and darkness.

Basal forebrain

1. The **basal forebrain**, near the front and bottom of the brain, also promotes sleep and wakefulness, while part of the **midbrain** acts as an arousal system.
2. Release of adenosine (a chemical by-product of cellular energy consumption) from cells in the basal forebrain and probably other regions supports your sleep drive.
3. Caffeine counteracts sleepiness by blocking the actions of adenosine.

Amygdala

The **amygdala**, an almond-shaped structure involved in processing emotions, becomes increasingly active during REM sleep.

Types of Sleep

There are two basic types of sleep:

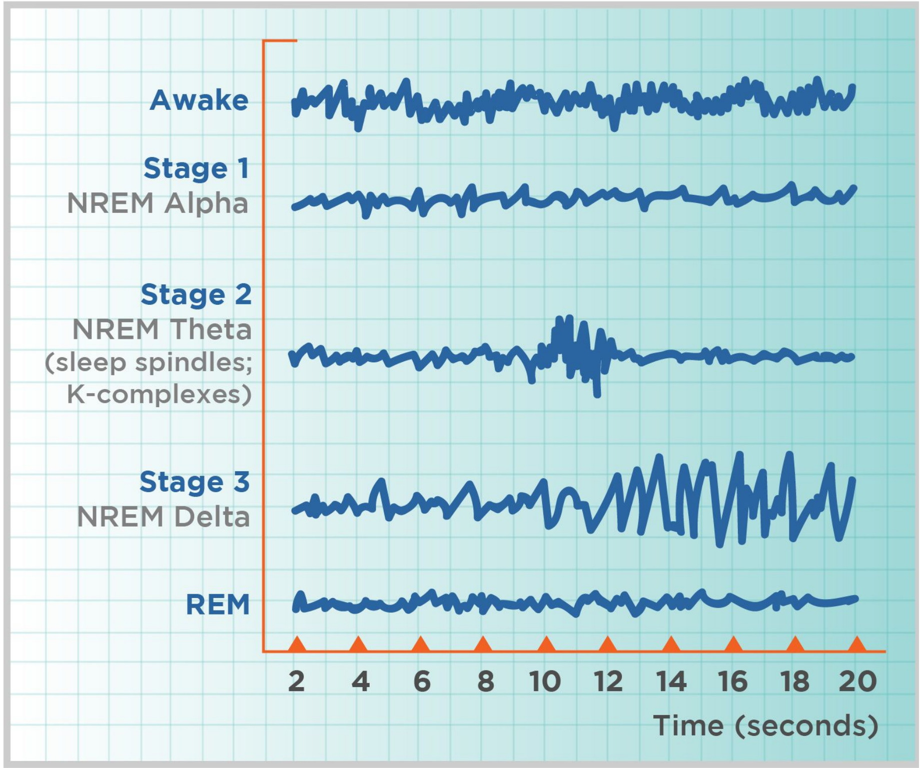
1. rapid eye movement (REM) sleep and
2. non-REM sleep (which has three different stages).

Each is linked to specific brain waves and neuronal activity.

We all cycle through all stages of non-REM and REM sleep several times during a typical night, with increasingly longer, deeper REM periods occurring toward morning.

Sleep Stages

EEG RECORDINGS DURING SLEEP



SLEEP STAGES

STAGE 1 Falling asleep/light sleep

STAGE 2 Heart rate slows and body temperature drops

STAGE 3&4 Deep sleep, muscles and tissues repair

R.E.M. Body is paralyzed and dreams begin

Stage One Sleep

Stage 1 non-REM sleep is the changeover from wakefulness to sleep.

During this short period (lasting several minutes) of relatively light sleep.

Our brain waves begin to slow from their daytime wakefulness patterns.

During stage one sleep

- Heartbeat slows down
- Breathing slows down
- Eye movements slow down
- Muscles relax and might occasionally twitch
- Brain waves begin to slow down

How Stage One Sleep Feels?

According to Harvard Health Publishing, it's **usually easy to wake someone from stage one sleep**, but not everyone will experience waking up from stage one in the same way:

"If awakened, one person might recall being drowsy, while another might describe having been asleep."

Stage 2

1. **Stage 2** non-REM sleep is a period of light sleep before we enter deeper sleep lasting **10 to 25 minutes**
2. Our heartbeat and breathing slow, and muscles relax even further.
3. Our body temperature drops and eye movements stop.
4. Brain wave activity slows but is marked by brief bursts of electrical activity.
5. We spend more of our repeated sleep cycles in stage 2 sleep than in other sleep stages.

During Stage Three Sleep

- Heartbeat and breathing slow down even more
- Muscles relax even more
- Body temperature drops
- Eye movements stop
- Brainwave activity slows. The National Institute of Neurological Disorders and Stroke says brainwave patterns are “marked by brief bursts of electrical activity

How Stage Two Sleep Feels?

It's **not as easy to wake someone from stage two sleep** as it is from stage one sleep.

However, stage two sleep is still a fairly light stage of sleep.

People won't feel disoriented if they wake up from stage two sleep.

Stage 3

1. **Stage 3** non-REM sleep is the period of deep sleep that we need to feel refreshed in the morning.
2. It lasts **20 to 40 minutes**
3. It occurs in longer periods during the first half of the night.
4. Our heartbeat and breathing slow to their lowest levels during sleep.
5. Our muscles are relaxed and it may be difficult to awaken you. Brain waves become even slower.

During stage Three sleep

- Heartbeat and breathing slow to the lowest levels they will reach during sleep
- Muscles stay relaxed
- It might be difficult to wake up
- Brain waves slow down even more

How Stage Three Sleep Feels?

Stage three sleep is **very deep and hard to wake someone up from** — people may not notice loud noises, bright lights, or other things that might easily wake them from a lighter sleep.

“As NREM sleep progresses, the brain becomes less responsive to external stimuli, and it becomes increasingly difficult to awaken an individual from sleep,”

Harvard Health Publishing explains. If someone is woken from stage three sleep, they will probably feel **groggy and disoriented**.

Stage 4 REM

1. REM sleep, or Rapid Eye Movement sleep, is **a very "active" stage**.
2. **REM sleep** first occurs about 90 minutes after falling asleep.
3. Our eyes move rapidly from side to side behind closed eyelids.
4. Mixed frequency brain wave activity becomes closer to that seen in wakefulness.
5. Our breathing becomes faster and irregular, and our heart rate and blood pressure increase to near waking levels.
6. Most of our dreaming occurs during REM sleep, although some can also occur in non-REM sleep.
7. Our arm and leg muscles become temporarily paralyzed, which prevents us from acting out our dreams.
8. As we age, we sleep less of our time in REM sleep.
9. Memory consolidation most likely requires both non-REM and REM sleep.

During REM sleep

- Behind the eyelids, the eyes move rapidly from side to side
- Breathing speeds up and can become irregular
- Heart rate increases
- Blood pressure increases
- The majority of vivid dreaming occurs in this state
- Arms and leg muscles become temporarily paralyzed. The National Institute of Neurological Disorders and Stroke **explains that** this “prevents you from acting out your dreams”

How REM Sleep Feels?

According to Medical News Today, people experience **REM sleep** several times every night, and REM sleep accounts for "approximately 20 to 25 percent of an adult's sleep cycle."

REM stages will probably get longer as the night goes on. And the NIH **explains** that "REM is thought to be **involved in the process of storing memories, learning, and balancing your mood**, although the exact mechanisms are not well understood."

Sleep Mechanism

Sleep mechanism

Two internal biological mechanisms–circadian rhythm and homeostasis–work together to regulate when you are awake and sleep.

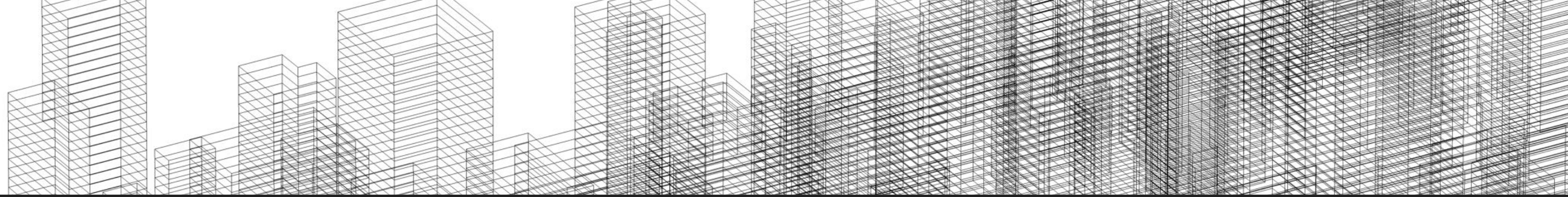
Circadian rhythms

- **Circadian rhythms** direct a wide variety of functions from daily fluctuations in wakefulness to body temperature, metabolism, and the release of hormones.
- They control your timing of sleep and cause us to be sleepy at night and our tendency to wake in the morning without an alarm.
- Our body's biological clock, which is based on a roughly 24-hour day, controls most circadian rhythms.
- Circadian rhythms synchronize with environmental cues (light, temperature) about the actual time of day, but they continue even in the absence of cues.

Sleep-wake homeostasis

1. **Sleep-wake homeostasis** keeps track of our need for sleep.
2. The homeostatic sleep drive reminds the body to sleep after a certain time and regulates sleep intensity.
3. This sleep drive gets stronger every hour we are awake and causes us to sleep longer and more deeply after a period of sleep deprivation.
4. Factors that influence our sleep-wake needs include medical conditions, medications, stress, sleep environment, and what we eat and drink.
5. Perhaps the greatest influence is the exposure to light.
6. Specialized cells in the retinas of our eyes process light and tell the brain whether it is day or night and can advance or delay our sleep-wake cycle.
7. Exposure to light can make it difficult to fall asleep and return to sleep when awakened.
8. Night shift workers often have trouble falling asleep when they go to bed, and also have trouble staying awake at work because their natural circadian rhythm and sleep-wake cycle is disrupted.
9. In the case of jet lag, circadian rhythms become out of sync with the time of day when people fly to a different time zone, creating a mismatch between their internal clock and the actual clock.

Brain Waves



Brain Waves

At the root of all our thoughts, emotions and behaviours is the communication between neurons within our brains. Brainwaves are produced by synchronised electrical pulses from masses of neurons communicating with each other.

Brain Waves

Brainwaves are detected using sensors placed on the scalp. They are divided into bandwidths to describe their functions (below), but are best thought of as a continuous spectrum of consciousness; from slow, loud and functional - to fast, subtle, and complex.

Brain Waves

It is a handy analogy to think of brainwaves as musical notes - the low frequency waves are like a deeply penetrating drum beat, while the higher frequency brainwaves are more like a subtle high pitched flute. Like a symphony, the higher and lower frequencies link and cohere with each other through harmonics.

Brain Waves

Our brainwaves change according to what we're doing and feeling. When slower brainwaves are dominant we can feel tired, slow, sluggish, or dreamy. The higher frequencies are dominant when we feel wired, or hyper-alert.

Brain Waves

The descriptions that follow are only broad descriptions - in practice things are far more complex, and brainwaves reflect different aspects when they occur in different locations in the brain.

Brainwave speed is measured in Hertz (cycles per second) and they are divided into bands delineating slow, moderate, and fast waves.

How are brain waves measured?

A test called an electroencephalogram (EEG) can evaluate the electrical activity in your brain and record the waves, which are measured in cycles per second, or Hertz (Hz).

Different waves occur at different times, based on what you're doing and how you're feeling.

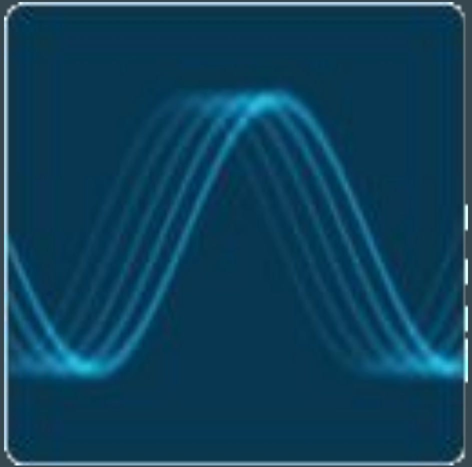
INFRA-LOW (<.5HZ)

Infra-Low brainwaves (also known as Slow Cortical Potentials), are thought to be the basic cortical rythms that underlie our higher brain functions. Very little is known about infra-low brainwaves. Their slow nature make them difficult to detect and accurately measure, so few studies have been done. They appear to take a major role in brain timing and network function.

DELTA WAVES (.5 TO 3 HZ)

Delta brainwaves are slow, loud brainwaves (low frequency and deeply penetrating, like a drum beat). They are generated in deepest meditation and dreamless sleep. Delta waves suspend external awareness and are the source of empathy. Healing and regeneration are stimulated in this state, and that is why deep restorative sleep is so essential to the healing process.

THETA WAVES (3 TO 8 HZ)

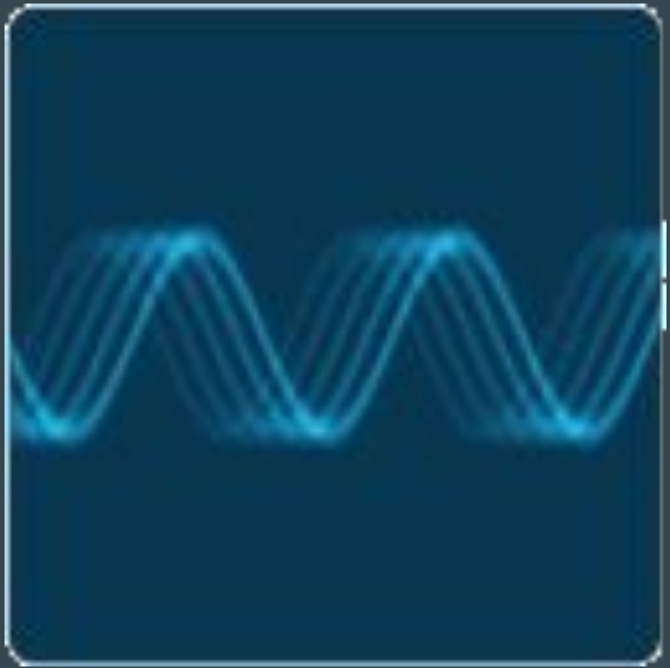


Theta brainwaves occur most often in sleep but are also dominant in deep meditation. Theta is our gateway to learning, memory, and intuition. In theta, our senses are withdrawn from the external world and focused on signals originating from within. It is that twilight state which we normally only experience fleetingly as we wake or drift off to sleep. In theta we are in a dream; vivid imagery, intuition and information beyond our normal conscious awareness. It’s where we hold our ‘stuff’, our fears, troubled history, and nightmares.

ALPHA WAVES (8 TO 12 HZ)

Alpha brainwaves are dominant during quietly flowing thoughts, and in some meditative states. Alpha is ‘the power of now’, being here, in the present. Alpha is the resting state for the brain. Alpha waves aid overall mental coordination, calmness, alertness, mind/body integration and learning.

BETA WAVES (12 TO 38 HZ)



Beta brainwaves dominate our normal waking state of consciousness when attention is directed towards cognitive tasks and the outside world. Beta is a ‘fast’ activity, present when we are alert, attentive, engaged in problem solving, judgment, decision making, or focused mental activity.

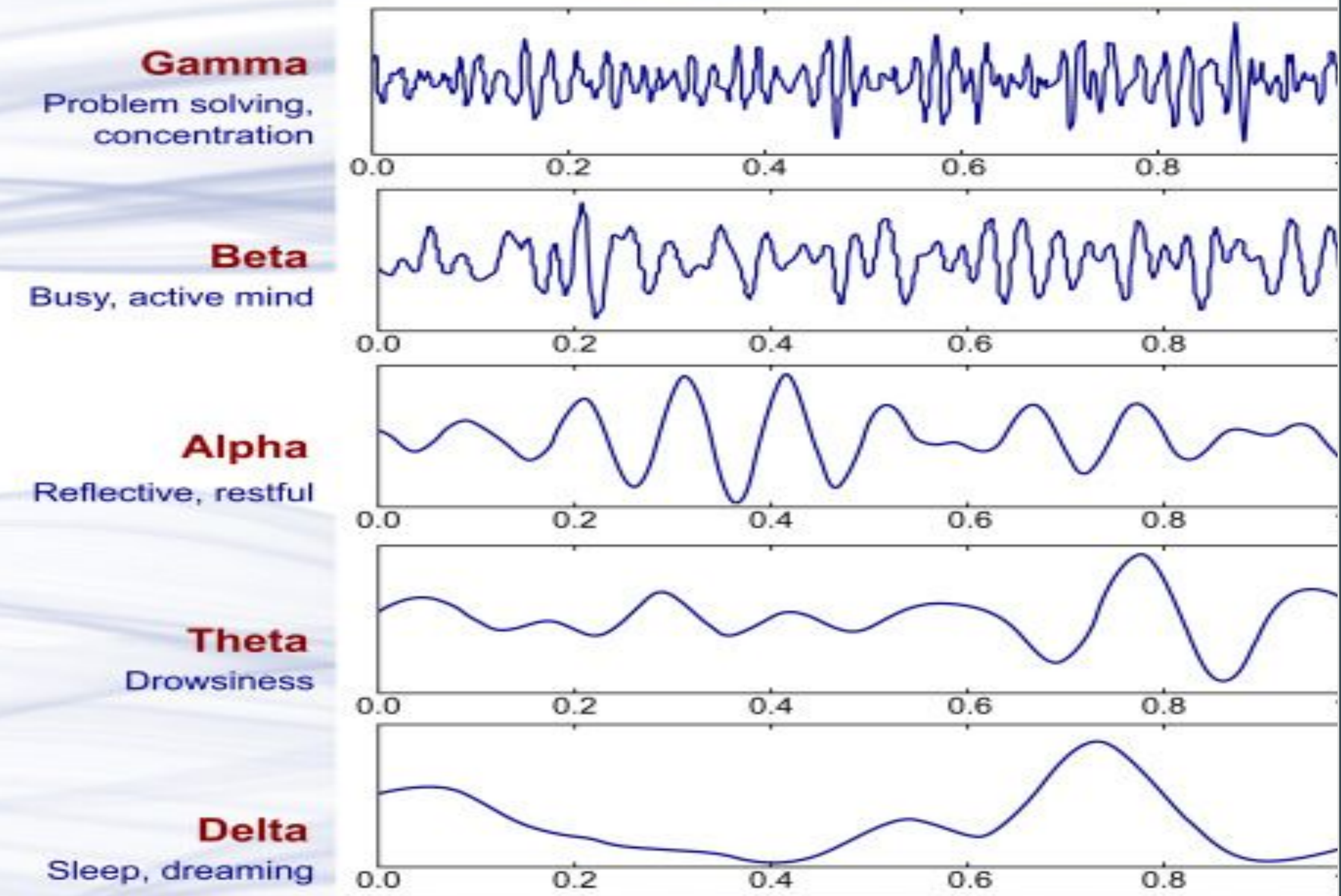
Beta brainwaves are further divided into three bands; Lo-Beta (Beta1, 12-15Hz) can be thought of as a 'fast idle', or musing. Beta (Beta2, 15-22Hz) is high engagement or actively figuring something out. Hi-Beta (Beta3, 22-38Hz) is highly complex thought, integrating new experiences, high anxiety, or excitement. Continual high frequency processing is not a very efficient way to run the brain, as it takes a tremendous amount of energy.

GAMMA WAVES (38 TO 42 HZ)

Gamma brainwaves are the fastest of brain waves (high frequency, like a flute), and relate to simultaneous processing of information from different brain areas. Gamma brainwaves pass information rapidly and quietly. The most subtle of the brainwave frequencies, the mind has to be quiet to access gamma.

Gamma was dismissed as 'spare brain noise' until researchers discovered it was highly active when in states of universal love, altruism, and the ‘higher virtues’. Gamma is also above the frequency of neuronal firing, so how it is generated remains a mystery. It is speculated that gamma rhythms modulate perception and consciousness, and that a greater presence of gamma relates to expanded consciousness and spiritual emergence.

Frequency band	Frequency	Brain states
Gamma (γ)	>35 Hz	Concentration
Beta (β)	12–35 Hz	Anxiety dominant, active, external attention, relaxed
Alpha (α)	8–12 Hz	Very relaxed, passive attention
Theta (θ)	4–8 Hz	Deeply relaxed, inward focused
Delta (δ)	0.5–4 Hz	Sleep


Gamma
Problem solving, concentration
Beta
Busy, active mind
Alpha
Reflective, restful
Theta
Drowsiness
Delta
Sleep, dreaming
0.0
0.2
0.4
0.6
0.8

WHAT BRAINWAVES MEAN TO US

Our brainwave profile and our daily experience of the world are inseparable. When our brainwaves are out of balance, there will be corresponding problems in our emotional or neuro-physical health. Research has identified brainwave patterns associated with all sorts of emotional and neurological conditions.

Over-arousal in certain brain areas is linked with anxiety disorders, sleep problems, nightmares, hyper-vigilance, impulsive behaviour, anger/aggression, agitated depression, chronic nerve pain and spasticity. Under-arousal in certain brain areas leads to some types of depression, attention deficit, chronic pain and insomnia. A combination of under-arousal and over-arousal is seen in cases of anxiety, depression and ADHD.

Instabilities in brain rhythms correlate with tics, obsessive-compulsive disorder, aggressive behaviour, rage, bruxism, panic attacks, bipolar disorder, migraines, narcolepsy, epilepsy, sleep apnea, vertigo, tinnitus, anorexia/bulimia, PMT, diabetes, hypoglycaemia and explosive behaviour.

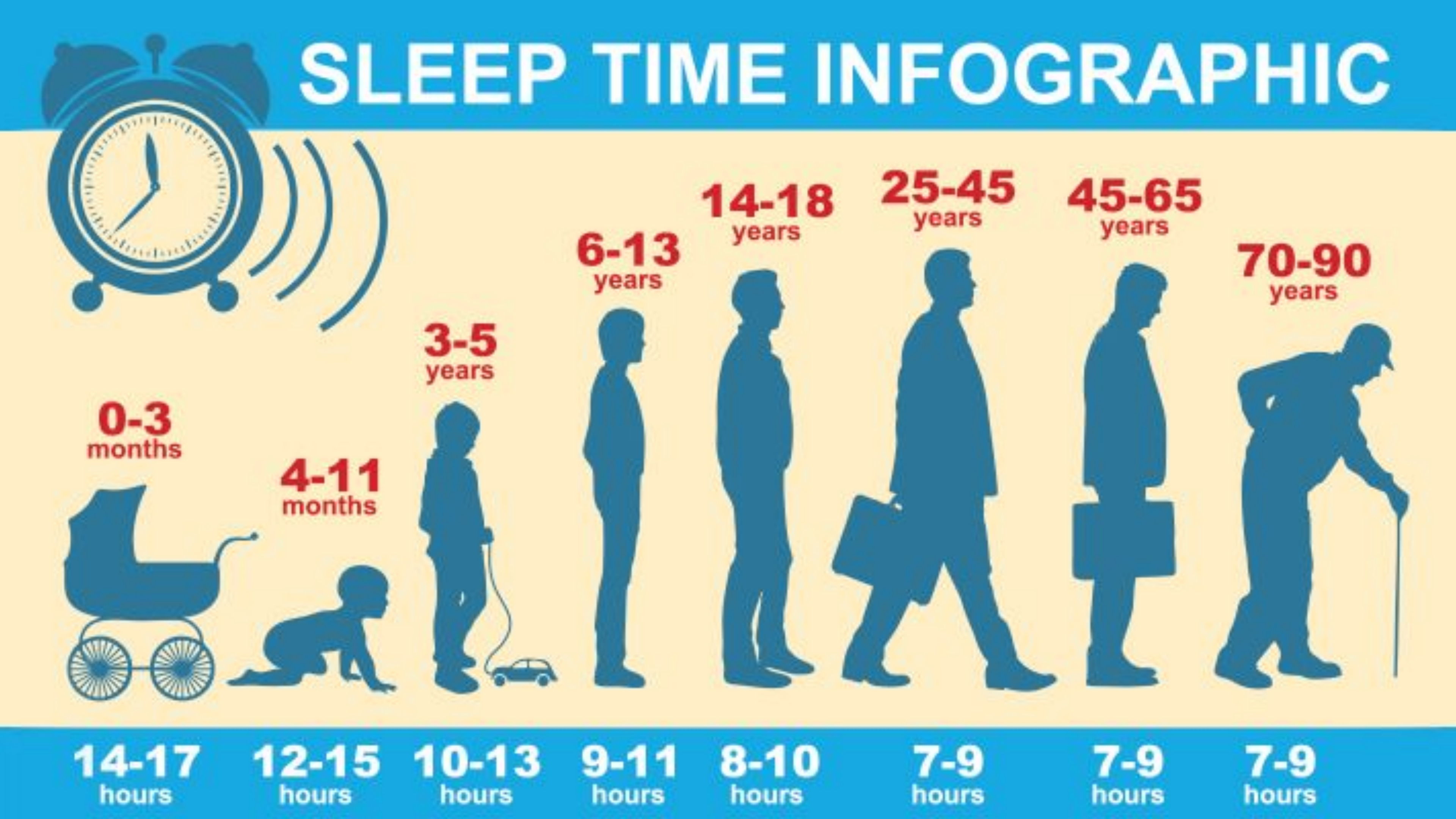
ALTERING YOUR BRAINWAVES

By rule of thumb, any process that changes your perception changes your brainwaves.

Chemical interventions such as medications or recreational drugs are the most common methods to alter brain function; however brainwave training is our method of choice.

Over the long term, traditional eastern methods (such as meditation and yoga) train your brainwaves into balance. Of the newer methods, brainwave entrainment is an easy, low-cost method to temporarily alter your brainwave state. If you are trying to solve a particular difficulty or fine-tune your brainwave function, state-of-the-art brain training methods like neurofeedback and pEMF deliver targeted, quick, and lasting results.


Sleep Time

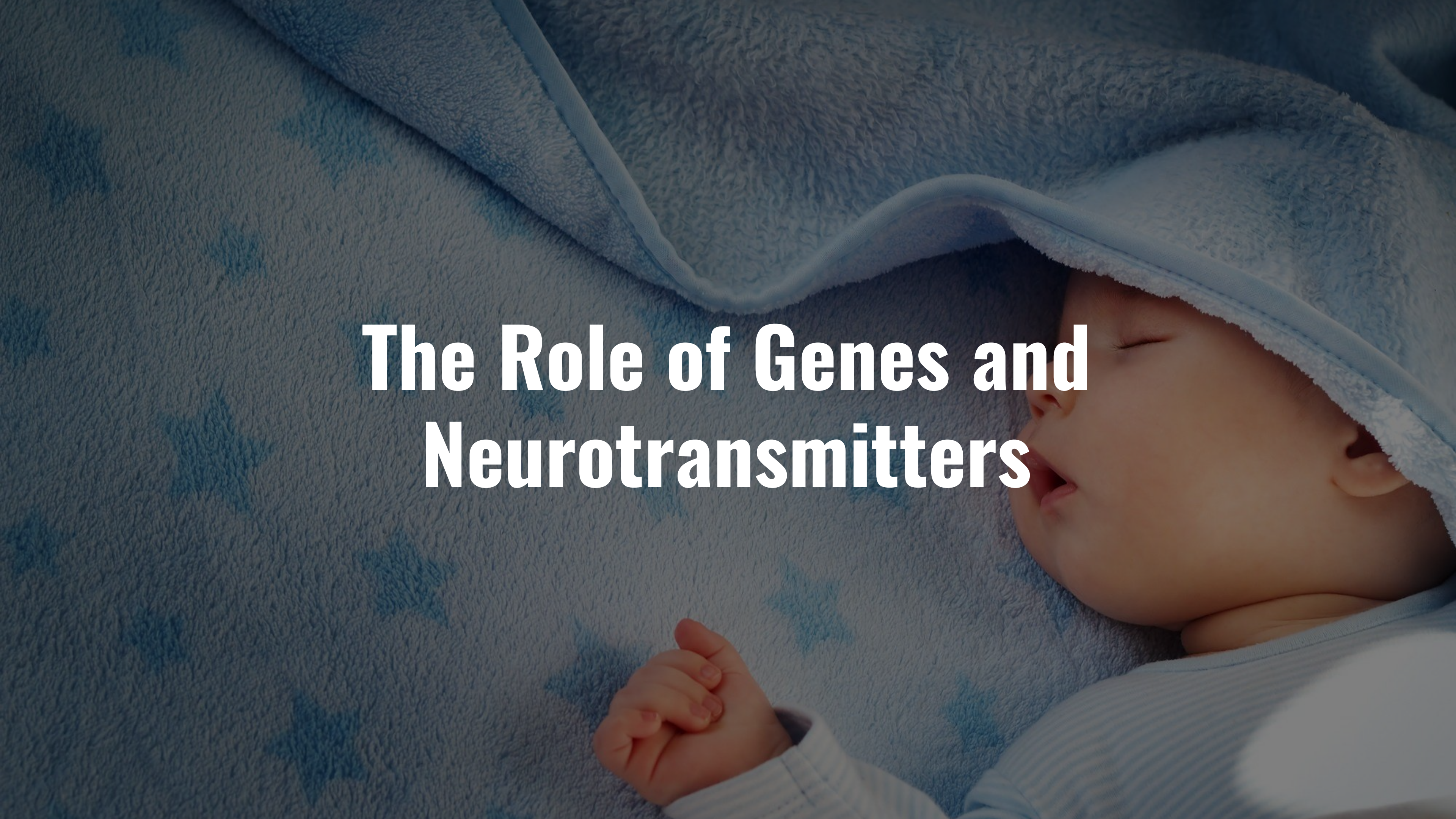

SLEEP TIME INFOGRAPHIC
0-3 months
4-11 months
3-5 years
6-13 years
14-18 years
25-45 years
45-65 years
70-90 years
14-17 hours
12-15 hours
10-13 hours
9-11 hours
8-10 hours
7-9 hours
7-9 hours
7-9 hours

How Much Sleep Do we Need?

1. Our need for sleep and our sleep patterns change as we age, but this varies significantly across individuals of the same age.
2. There is no magic "number of sleep hours" that works for everybody of the same age.
3. Babies initially sleep as much as 16 to 18 hours per day, which may boost growth and development (especially of the brain).
4. School-age children and teens on average need about 9.5 hours of sleep per night.
5. Most adults need 7-9 hours of sleep a night, but after age 60, nighttime sleep tends to be shorter, lighter, and interrupted by multiple awakenings.
6. Elderly people are also more likely to take medications that interfere with sleep.
7. In general, people are getting less sleep than they need due to longer work hours and the availability of round-the-clock entertainment and other activities.
8. Many people feel they can "catch up" on missed sleep during the weekend but, depending on how sleep-deprived they are, sleeping longer on the weekends may not be adequate.

Dreaming

1. Everyone dreams.
2. We spend about 2 hours each night dreaming but may not remember most of our dreams.
3. Its exact purpose isn't known, but dreaming may help us process our emotions.
4. Events from the day often invade our thoughts during sleep, and people suffering from stress or anxiety are more likely to have frightening dreams.
5. Dreams can be experienced in all stages of sleep but usually are most vivid in REM sleep.
6. Some people dream in color, while others only recall dreams in black and white.



The Role of Genes and Neurotransmitters

Chemical signals to sleep

1

Clusters of sleep-promoting neurons in many parts of the brain become more active as we get ready for bed.

2

Nerve-signaling chemicals called neurotransmitters can “switch off” or dampen the activity of cells that signal arousal or relaxation.

3

GABA is associated with sleep, muscle relaxation, and sedation. Norepinephrine and orexin (also called hypocretin) keep some parts of the brain active while we are awake.

4

Other neurotransmitters that shape sleep and wakefulness include acetylcholine, histamine, adrenaline, cortisol, and serotonin.

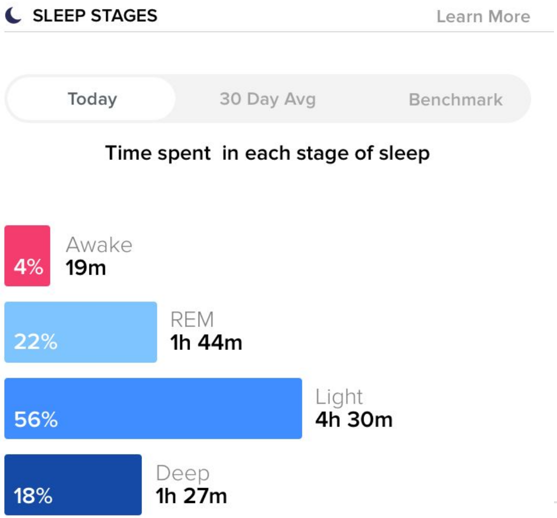
Genes and sleep

1. Genes may play a significant role in how much sleep we need.
2. Scientists have identified several genes involved with sleep and sleep disorders, including genes that control the excitability of neurons, and "clock" genes such as *Per*, *tim*, and *Cry* that influence our circadian rhythms and the timing of sleep.
3. Genome-wide association studies have identified sites on various chromosomes that increase our susceptibility to sleep disorders.
4. Also, different genes have been identified with such sleep disorders as familial advanced sleep-phase disorder, narcolepsy, and restless legs syndrome.
5. Some of the genes expressed in the cerebral cortex and other brain areas change their level of expression between sleep and wake.
6. Several genetic models–including the worm, fruit fly, and zebrafish–are helping scientists to identify molecular mechanisms and genetic variants involved in normal sleep and sleep disorders.
7. Additional research will provide better understand of inherited sleep patterns and risks of circadian and sleep disorders.

Sleep studies

1. Our health care provider may recommend a polysomnogram or other test to diagnose a sleep disorder.
2. A polysomnogram typically involves spending the night at a sleep lab or sleep center.
3. It records our breathing, oxygen levels, eye and limb movements, heart rate, and brain waves throughout the night.
4. Our sleep is also video and audio recorded.
5. The data can help a sleep specialist determine if we are reaching and proceeding properly through the various sleep stages.
6. Results may be used to develop a treatment plan or determine if further tests are needed.

Tracking Sleep Through Smart Technology



Millions of people are using smartphone apps, bedside monitors, and wearable items (including bracelets, smart watches, and headbands) to informally collect and analyze data about their sleep.

Smart technology can record sounds and movement during sleep, journal hours slept, and monitor heartbeat and respiration.

Using a companion app, data from some devices can be synced to a smartphone or tablet, or uploaded to a PC. Other apps and devices make white noise, produce light that stimulates melatonin production, and use gentle vibrations to help us sleep and wake.

Tips for Getting a Good Night's Sleep

1. **Set a schedule** – go to bed and wake up at the same time each day.
2. **Exercise 20 to 30 minutes** a day but no later than a few hours before going to bed.
3. **Avoid caffeine and nicotine** late in the day and alcoholic drinks before bed.
4. **Relax before bed** – try a warm bath, reading, or another relaxing routine.
5. **Create a room for sleep** – avoid bright lights and loud sounds, keep the room at a comfortable temperature, and don’t watch TV or have a computer in your bedroom.
6. **Don’t lie in bed awake**. If you can’t get to sleep, do something else, like reading or listening to music, until you feel tired.
7. **Consult Psychologist** if you have a problem sleeping or if you feel unusually tired during the day. Most sleep disorders can be treated effectively.

Hope Through Research

1. Scientists continue to learn about the function and regulation of sleep.
2. A key focus of research is to understand the risks involved with being chronically sleep deprived and the relationship between sleep and disease.
3. People who are chronically sleep deprived are more likely to be overweight, have strokes and cardiovascular disease, infections, and certain types of cancer than those who get enough sleep.
4. Sleep disturbances are common among people with age-related neurological disorders such as Alzheimer's disease and Parkinson's disease.
5. Many mysteries remain about the association between sleep and these health problems.
6. Does the lack of sleep lead to certain disorders, or do certain diseases cause a lack of sleep?
7. These, and many other questions about sleep, represent the frontier of sleep research.

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