

Sleep and Brain Health

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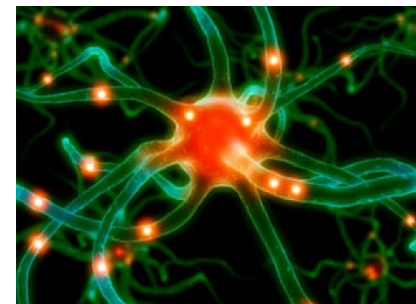
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What happens when we sleep?

- Going to sleep is NOT like switching off a light!!
- Sleep is an *active* process in which important processing, restoration and strengthening occurs
- Sleep helps us solidify and consolidate memories
 - after sleep you retain information and perform better on memory tasks
- Sleep assists in restoration, rejuvenation; muscle, nerve and tissue growth and repair and hormone synthesis



Why We Sleep When We Do

There are 2 processes that determine how much and when we sleep:

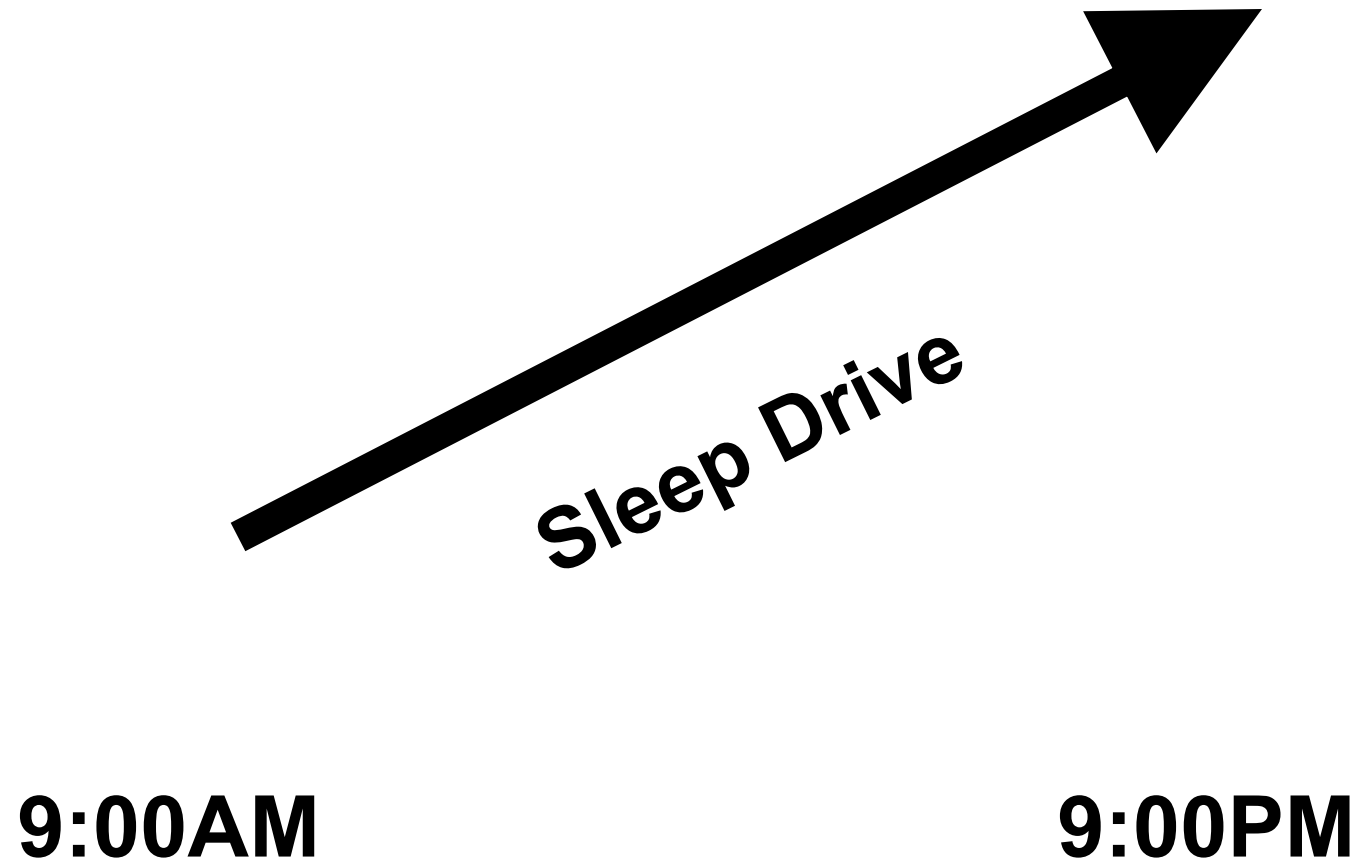
Homeostatic Drive (Process S)

- Represents the amount of sleep and wake throughout the 24-hour day
- The *homeostatic drive* in humans has a ratio of approximately 1/3 sleep (~ 8 hours) and 2/3 wake
- This drive increases the longer you go without sleeping – the longer you are awake, the sleepier you will get
- This sleep drive can be satisfied by sleep at any hour of the day or night
- Think of it as your **SLEEP NEED**

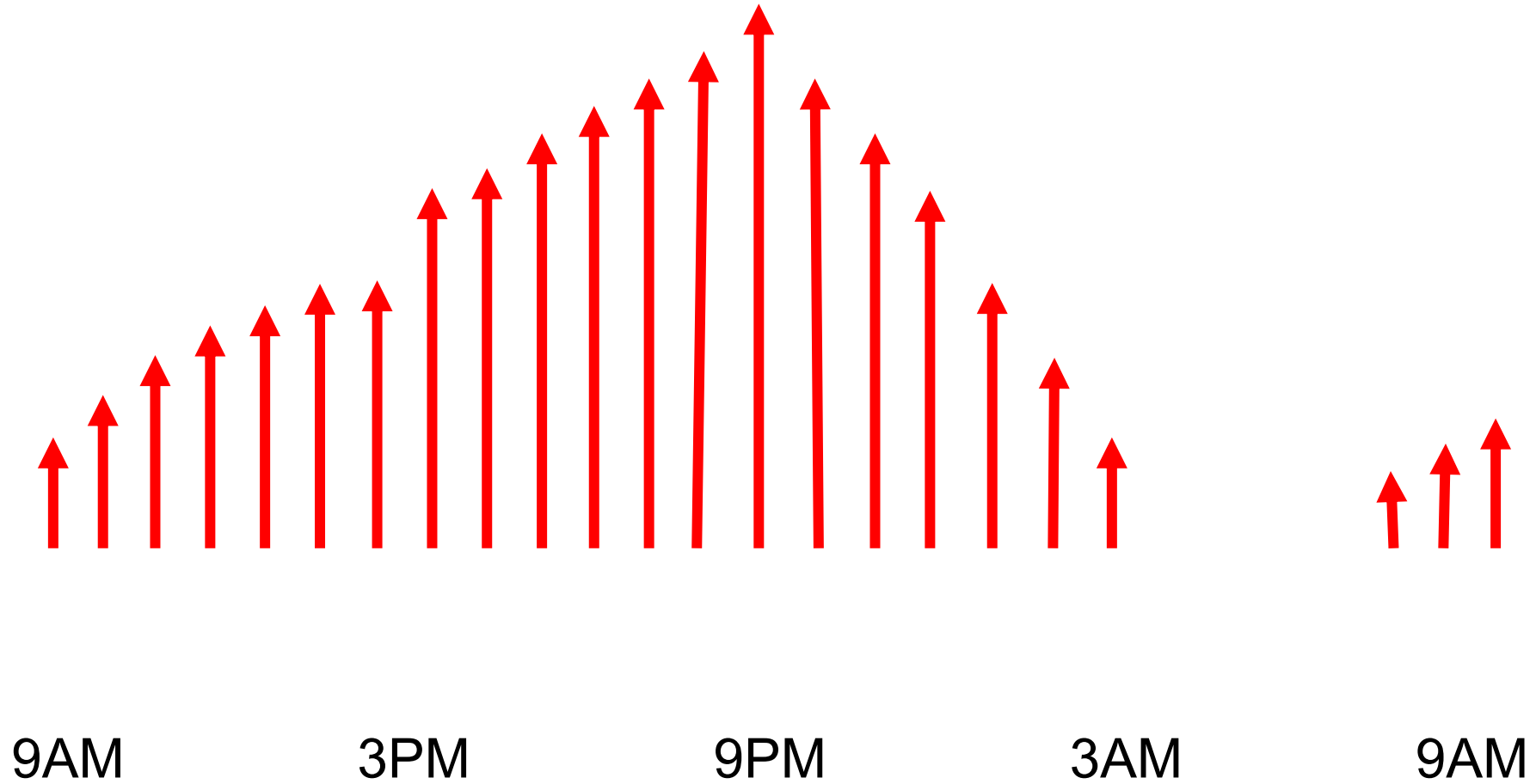
Circadian Rhythm (Process C)

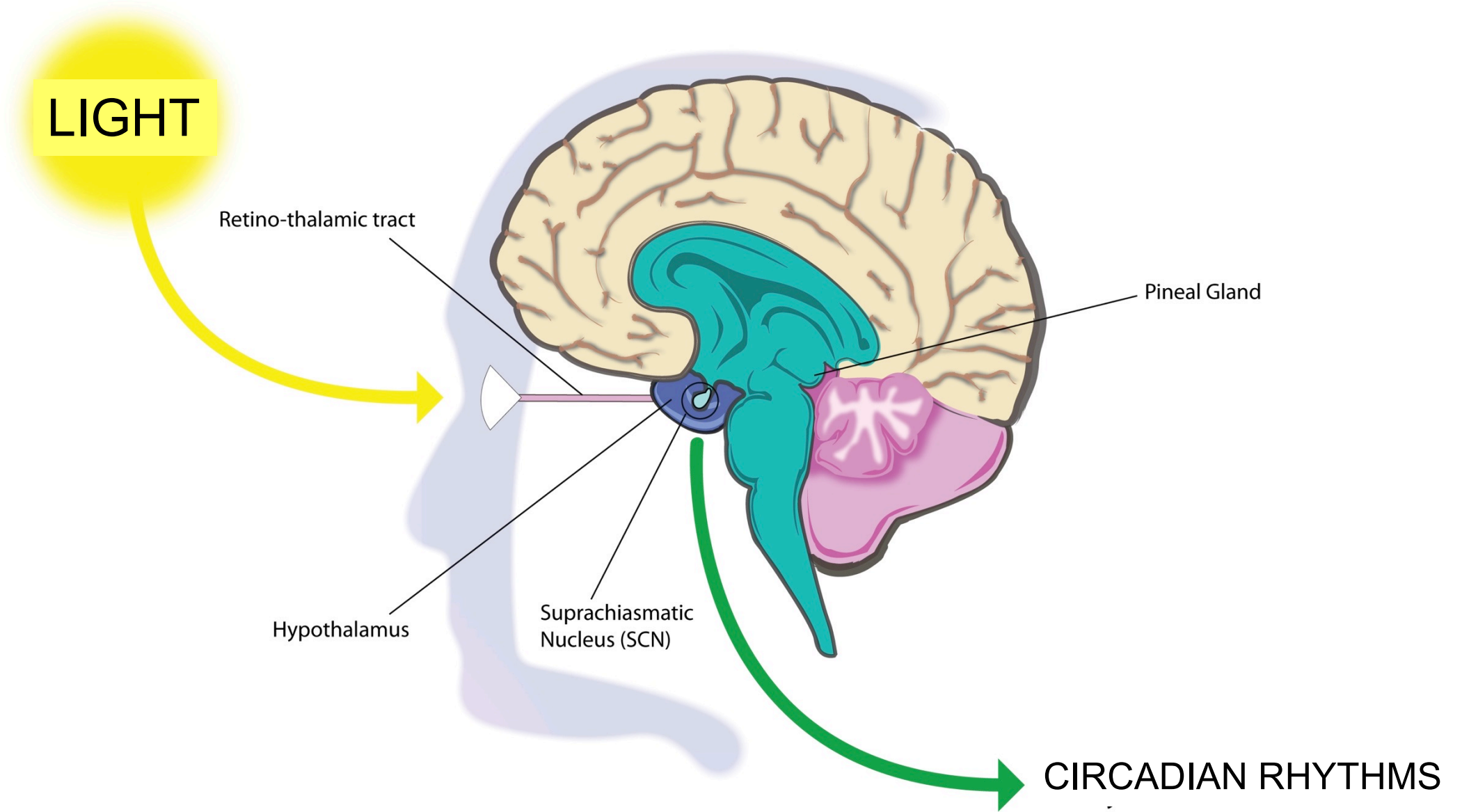
- A synchronized cycle of physiologic systems
- Present in every cell in your body – even one cell organisms have an internal rhythm
- Determines the ***timing*** of sleepiness (and other processes like hunger) promoted by the internal (body) clock
- This rhythm is why we sleep at night – lack of light promotes the release of chemicals to help us sleep; presence of light promotes chemicals to keep us alert/awake
- Think of it as your **SLEEP URGE**

What Makes Us Sleep – Process S



Alerting Signal Keeps Us Awake – Process C





LIGHT

Retino-thalamic tract

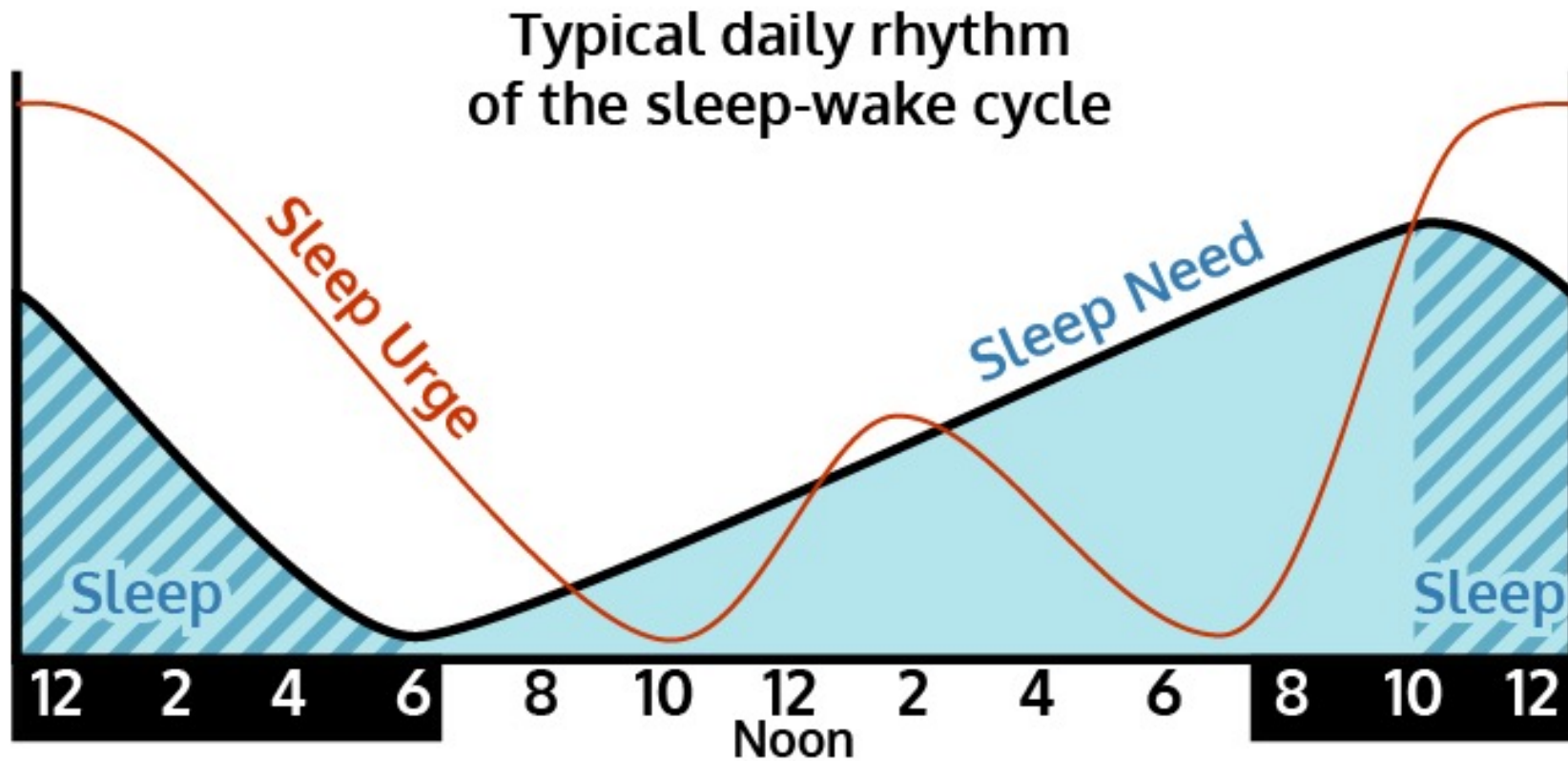
Pineal Gland

Hypothalamus

Suprachiasmatic Nucleus (SCN)

CIRCADIAN RHYTHMS

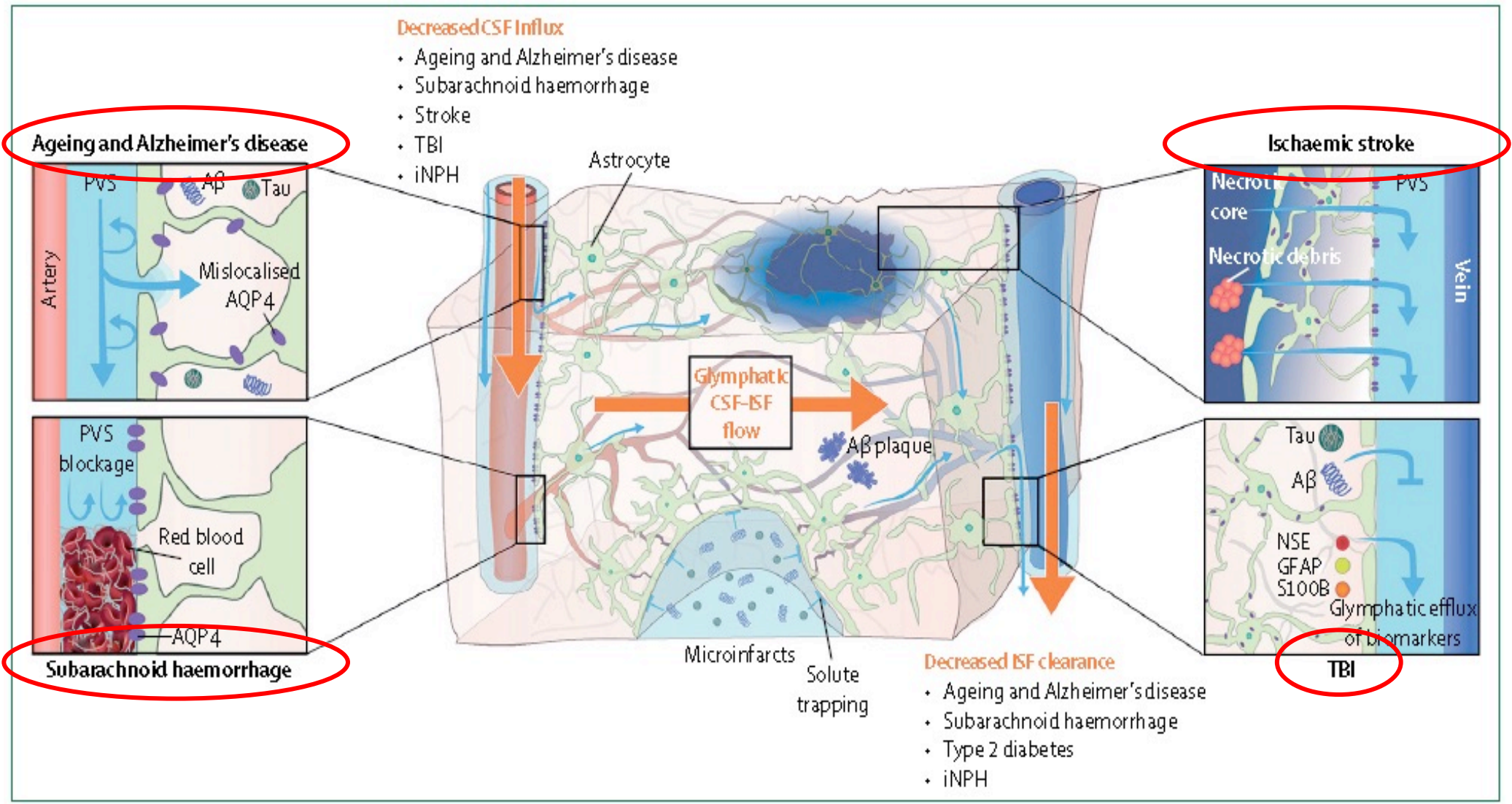
The 2 Processes In Action!!



Glymphatic Pathway Effect on Sleep

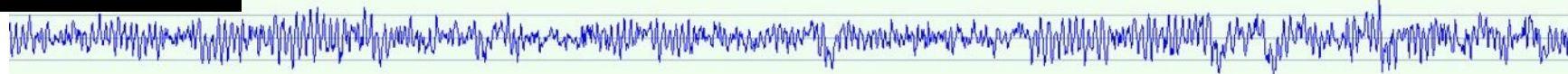
- The glymphatic (glial-lymphatic) pathway is a fluid-clearance pathway identified in the rodent brain in 2012
- This pathway involves the flow of cerebrospinal fluid in the brain along spaces next to incoming blood vessels and subsequently into the brain matter then directs flow towards the outflowing blood and lymph vessels, ultimately clearing fluid with cellular waste
- The glymphatic pathway is predominantly active during sleep, when the clearance of harmful metabolites such as amyloid β ($A\beta$) increases two-fold relative to the waking state.
- Glymphatic dysfunction has been shown in animal models of traumatic brain injury, Alzheimer's disease, and stroke

Electrical activity in the brain changes (particularly the slow waves) → blood flow decreases → CSF increases → wastes washed out



Normal Sleep

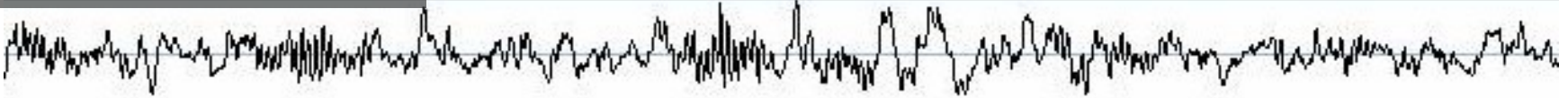
W - Awake



N1 – NREM Stage 1



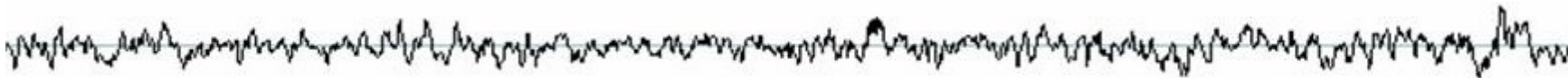
N2 – NREM Stage 2



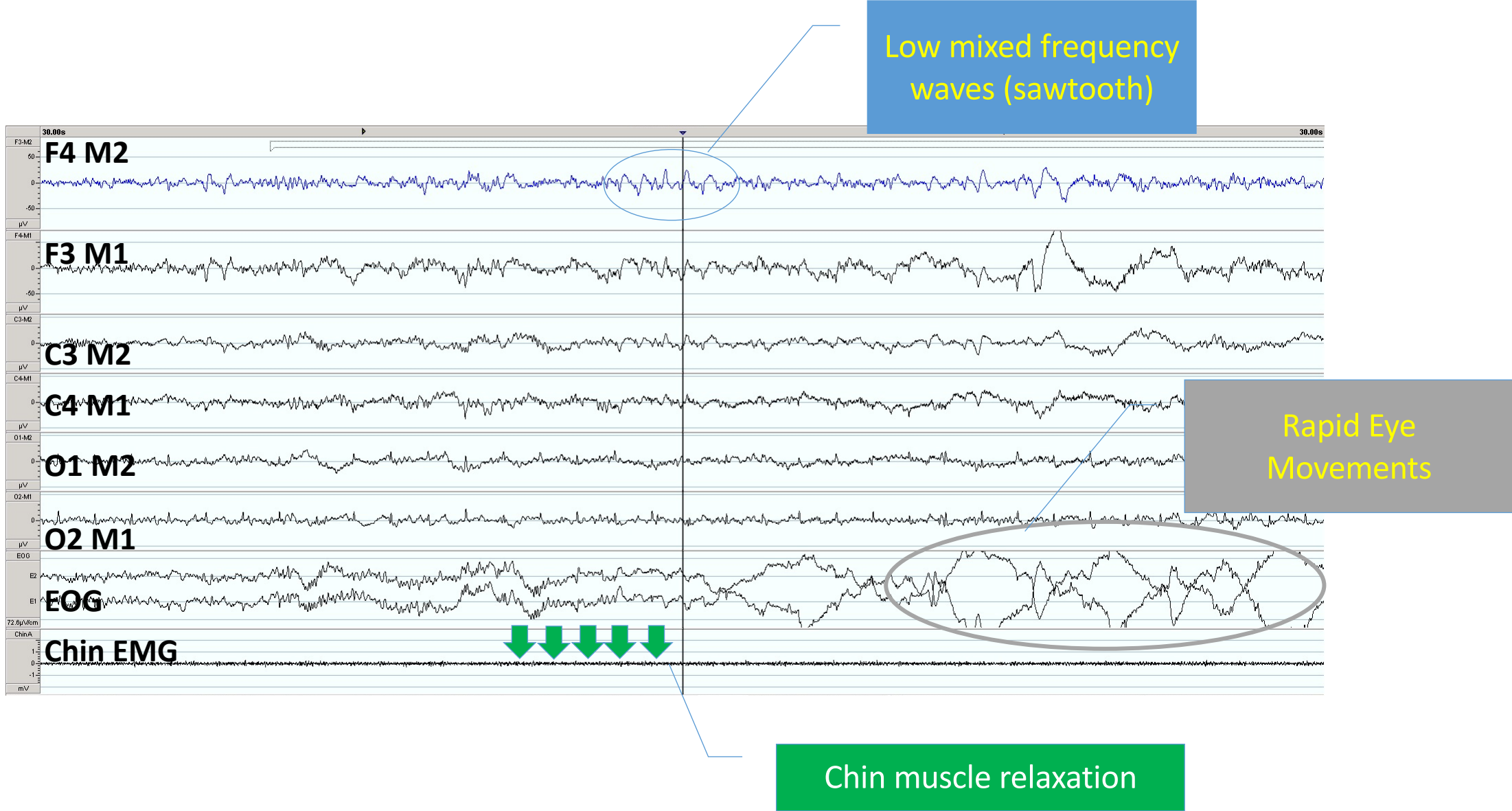
N3 - Delta or NREM Stage 3



R - REM



Stage R = REM

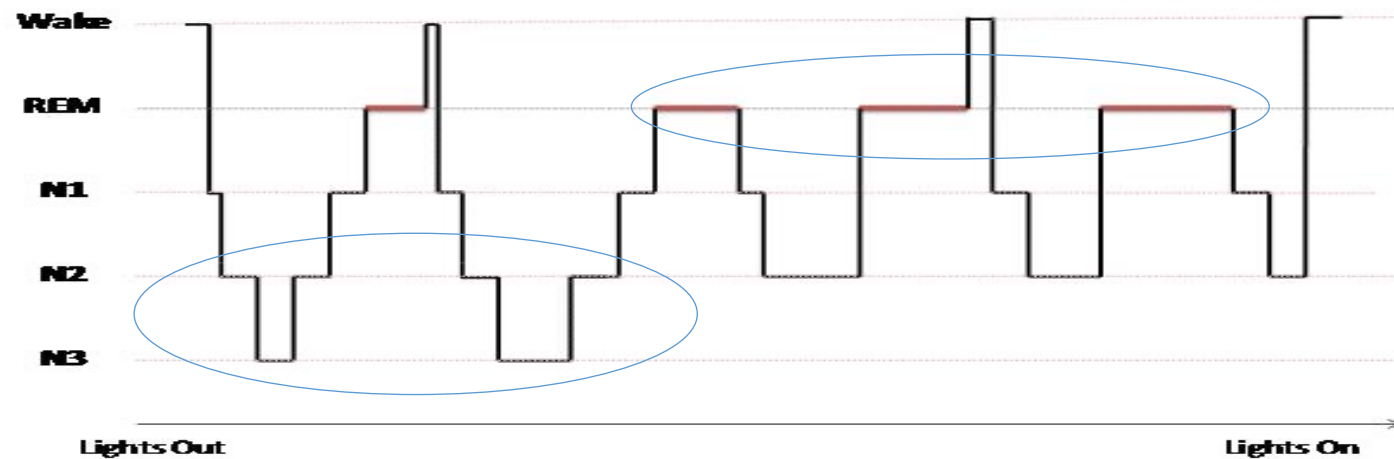


Characteristics of Sleep Stages

	<i>EEG frequency</i>	<i>Features</i>	<i>Key neural pathways</i>	<i>Hypothesized function</i>	<i>% of TST in healthy adults</i>
Wakefulness	Alert- beta Relaxed- alpha (8–13 Hz)				
N1	Theta (4–7 Hz)	Lightest sleep stage, slow eye movements	Cortex	Transitional state	2–5%
N2	Theta (4–7 Hz)	K-complex, spindles	Thalamo-cortical circuit		45–55%
N3	Delta (0.5–2 Hz)	Hypersynchronized slow wave activity	Thalamus	Physical repair (growth hormone)	15–20%
REM	Low-amplitude, mixed frequency	Sawtooth waves, atonia, sharply peaked eye movements	PPT/LDT	Memory consolidation	20–25%**

Normal Adult Sleep

- **Non-REM Stages 1 - 3**
 - Stages N1 - 3 (light through deep sleep)
 - 75% of total sleep time (TST)
- **REM (Rapid Eye Movement)**
 - 25% of total sleep time
 - Cycles every 90 - 120 minutes
 - Majority occurs in early morning (3 - 7 AM)



REM vs. NREM Sleep

- Non-REM (Slow Wave, N3, delta)
 - Physical restoration
 - Driven by homeostatic pressure
 - Quiet brain, “active” body
- REM
 - Mental restoration/memory
 - Driven by circadian pressure
 - Active brain, quiet body

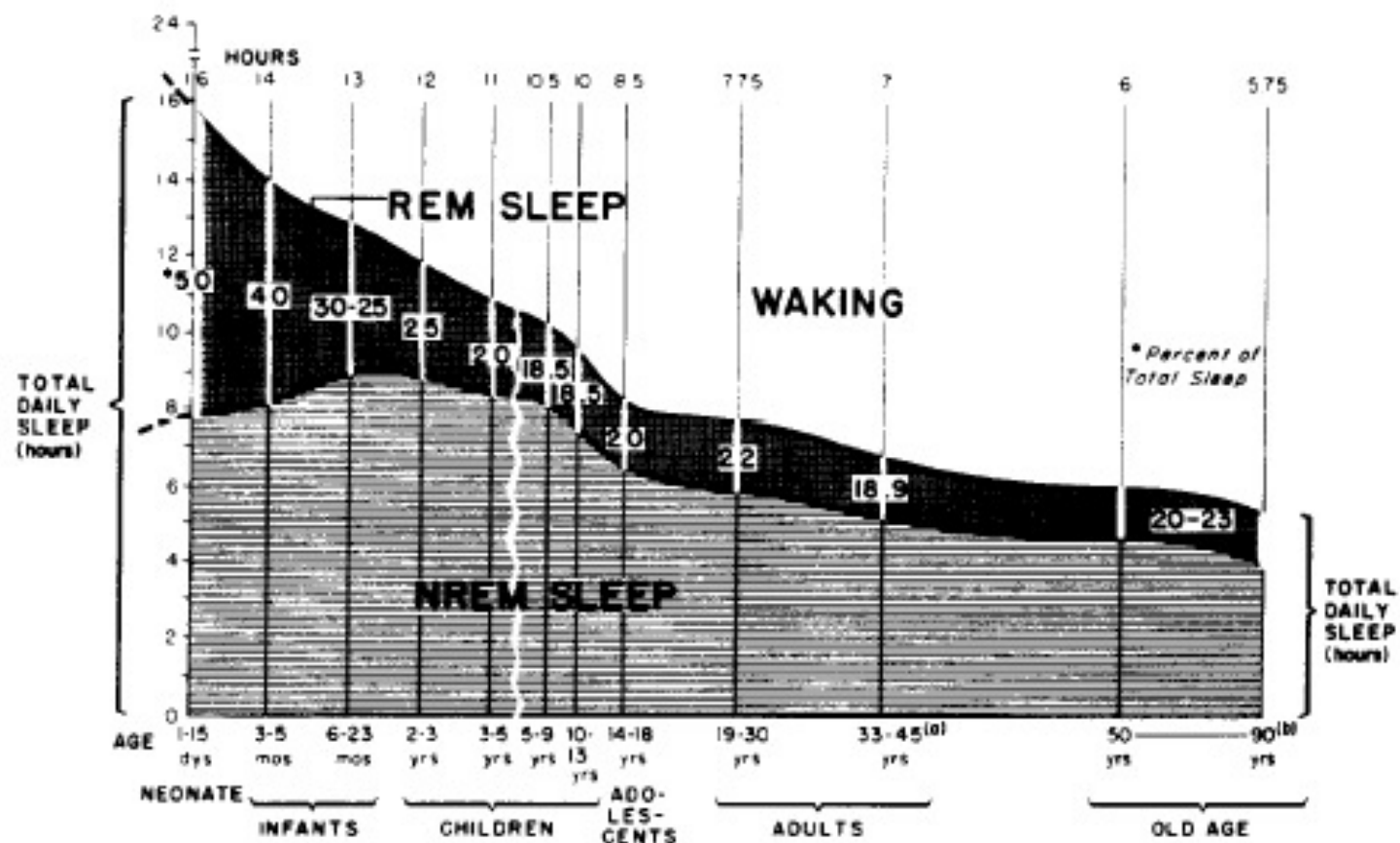


How much sleep do you need?

Most sleep organizations agree that:

- Adults should sleep ≥ 6 hours/night on a regular basis to promote optimal health
- Sleeping < 6 hrs/nt is associated with:
 - Weight gain, obesity, diabetes, high blood pressure, stroke, depression
 - Impaired immune function, increased pain
 - Subpar performance, increased errors, more accidents

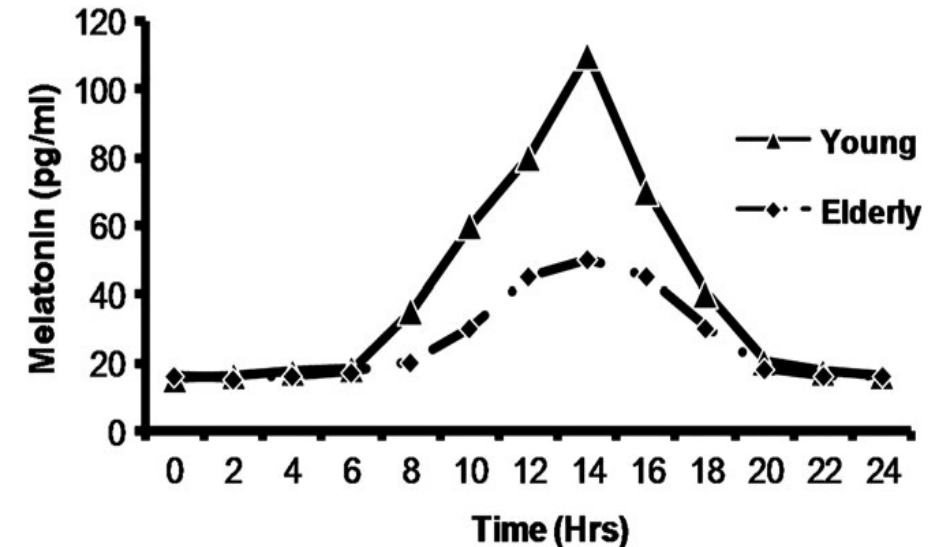
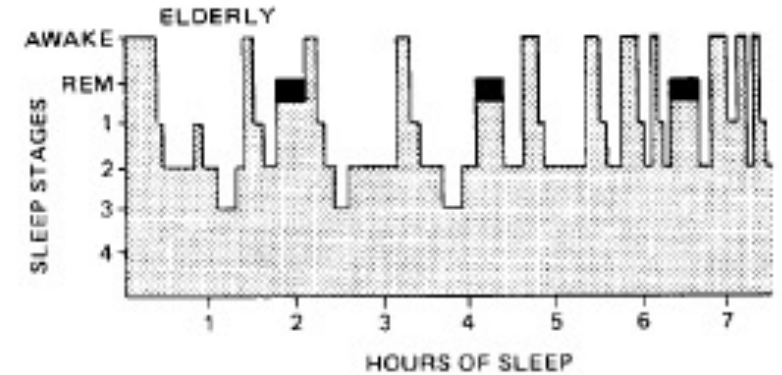
Sleep Stages: Across the Life Span



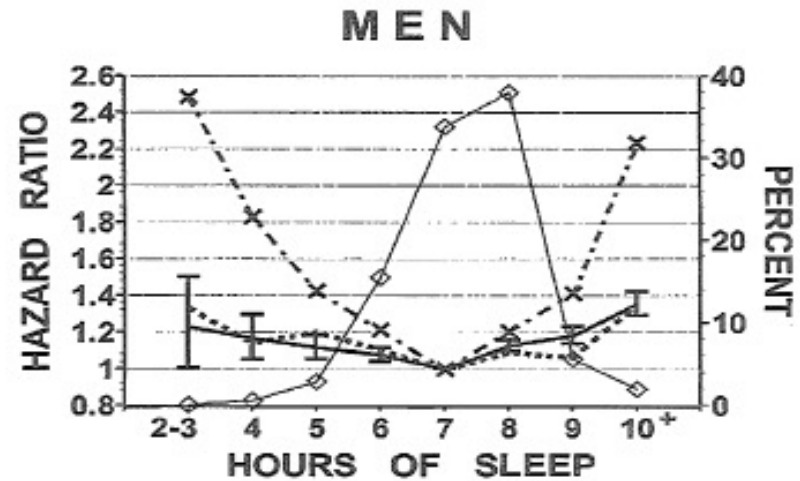
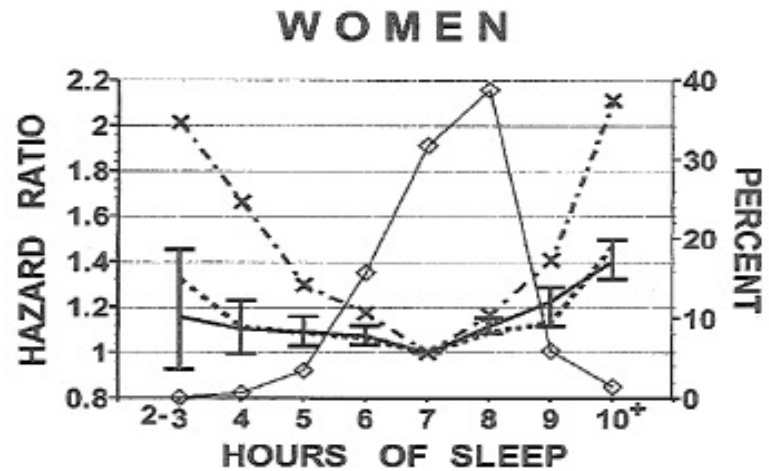
Mahowald M, Sleep Academic Award Program, NHLBI and AASM

Sleep Changes with Aging

- Increased awakenings and arousals
- Decreased deep sleep (worse in men)
- Increased stage shifts
- Fewer “cycles”
- Reduced sleep efficiency
- Phase advancement (earlier to bed, earlier to rise)
- Napping



What about Sleep and Death?



- 7 hours was standard
- Line with “x” excluded “sick” people
- People who slept shorter and longer hours had more than 1.5-2x’s the mortality

How Can I Tell If I am Getting Enough Sleep?

Symptoms:

- Yawning
- Moodiness, depressed mood
- Fatigue
- Irritability
- Difficulty learning new concepts and forgetfulness
- Inability to concentrate
- Lack of motivation
- Clumsiness
- Increased appetite and carbohydrate cravings
- Reduced sex drive

Markers of sleep deprivation

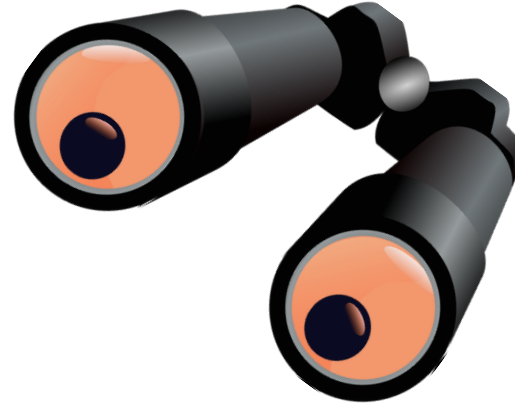
- Regular alarm clock use
- More than 1 hour difference in weekend vs weekday sleep time
- Excess caffeine use

Helpful Tips for Getting a GOOD SLEEP!

- Don't eat a large meal before bedtime. If you are hungry at night, eat a light, healthy snack.
- Exercise regularly and maintain a healthy diet.
- Avoid consuming **caffeine** in the late afternoon or evening.
- Avoid consuming **alcohol** before bedtime.
- Reduce your **fluid intake** before bedtime
- Try to keep a relatively consistent sleep schedule. Get up around the same time every day, even on weekends or during vacations (assuming you are getting enough sleep).
- Set a bedtime that is early enough for you to get at least 7 hours of sleep.
- Avoid long naps
- Pets out of the bedroom

Helpful Tips for Getting a GOOD SLEEP!

- Get bright light exposure during the day and limit exposure to bright light in the evenings.
- Turn off electronic devices at least 30 minutes before bedtime.
- If you have trouble sleeping, a TV will not make it better (noise, light, content, etc)!!
- Establish a relaxing bedtime routine.
- Make your bedroom quiet and relaxing. Keep the room at a comfortable, cool temperature (fans might help).
- Showers or bath should not be taken right before bedtime; give your body a few minutes to cool down.
- Don't go to bed unless you are sleepy.
- If you don't fall asleep after 20 minutes, get out of bed.



Common Sleep Disorders

- Insomnia / Circadian Rhythm Disorders
- Obstructive sleep apnea

What is “Insomnia”?

- Everyone has the occasional night of poor sleep, usually due to staying up too late or waking up too early. This does not mean you have insomnia, it means you didn't get enough sleep
- Insomnia means you chronically don't get enough sleep and have daytime effects from that lack of sleep
- Types of sleep issues:
 - Difficulty falling asleep
 - Difficulty staying asleep throughout the night
 - Waking up too early in the morning
- Most insomniacs complain of fatigue, but are generally not “sleepy”

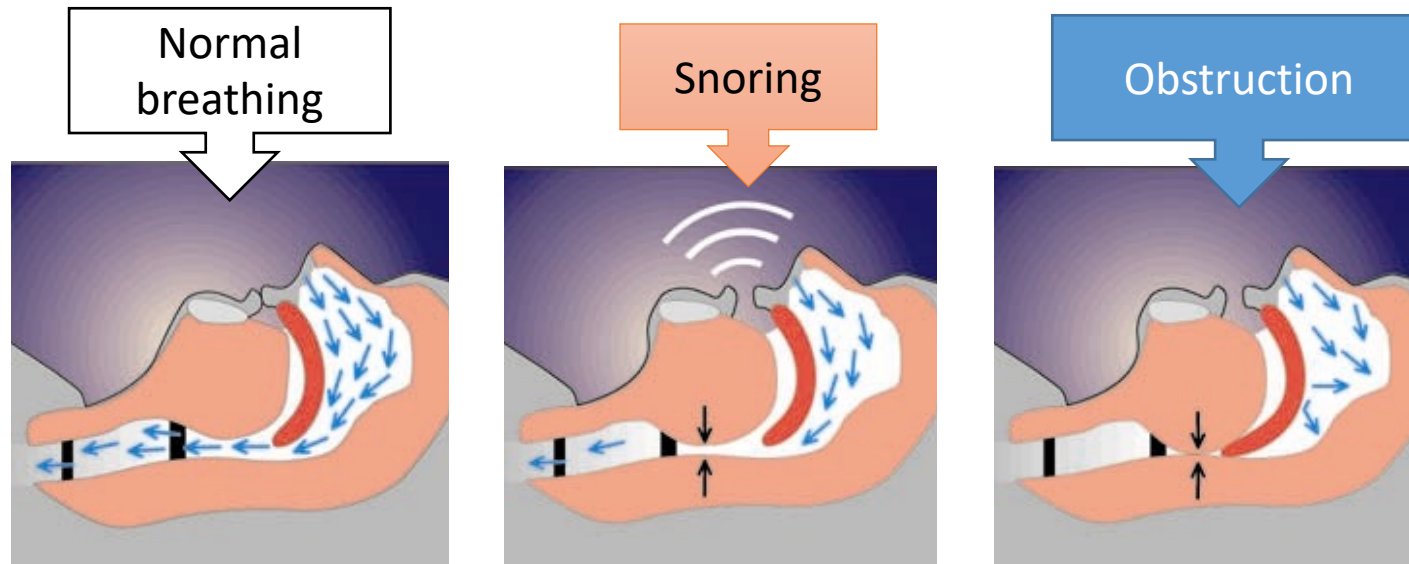
Insomnia Associations

- Stress
- Other sleep disorders
- Mental disorders such as depression and anxiety
- Medications
- Substance abuse
- Medical disorders
- Pain
- Circadian rhythm disorders (night owls)
- Poor sleeping environment
- Shift work
- Obsessing about sleep

Insomnia: Behavioral Management

- Preferred over medications
- Types:
 - Stimulus control: reinforce association bed and bedtime with *sleep*
 - Use bed for sleep (and intimate relations) only
 - Go to bed only when sleepy
 - If sleep onset does not come in 15-20 min, get out of bed until drowsy
 - When out of bed, do something relaxing and NOT using a bright light
 - Avoid napping
 - Sleep restriction/compression: reducing time in bed awake with a systematic approach
 - Mindfulness, relaxation techniques/meditation, diaphragmatic breathing
- Professional behavioral therapy (CBT-Insomnia)

Obstructive Sleep Apnea



OSA Signs and Symptoms

- Snoring – typically nightly, loud
- Gasping, choking, irregular breathing during sleep
- Daytime sleepiness
- Insomnia, chronic fatigue, poor sleep
- Awakenings with a headache
- Mood swings, depression
- Short term memory problems

Obstructive sleep apnea

- Can be diagnosed oftentimes with a home analysis kit
 - Not everyone has to come to the sleep laboratory
- *Not everyone will end up on a CPAP machine* – alternative treatments are out there for some
- Most patients who have sleep apnea are unaware – bedpartners and family members are usually the ones to observe the problem; have to convince them to be tested
- Very common in certain groups: diabetics, poorly controlled high blood pressure, atrial fibrillation, stroke, obesity, Downs syndrome

Obstructive sleep apnea has:

Many Serious Consequences...

- Cardiac Arrhythmias
- Congestive Heart Failure
- Depression
- Diabetes
- Frequent Urination
- Heart Attacks



- Hypersomnia
- Hypertension
- Memory Loss
- Sexual Dysfunction
- Stroke
- and more...



Death – Sleep Apnea is the DEADLIEST sleep disorder

Summary

- Sleep is vitally important to brain health as it is needed to consolidate our memories and recharge our alertness and cognition
- Ideal sleep will be long enough to cycle through all of the stages which are needed to complete its restorative properties
- Sleep is also important in clearing out waste products in our brains; the buildup of which may accelerate risk of dementia
- The right amount of sleep varies but should be a minimum of 6 hours in adults; this need is relatively stable across the adult lifespan
- Be cognizant of sleep disorders as potential causes for poor sleep