

The Importance of Sleep to Health and Performance

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Our Case: Barry

- Barry is a 30-something former Marine who is an aspiring actor. He presents with a superficial flesh wound he says he got after “fooling around” at the gym the day after pulling an all nighter at his “second” job. He explains he is actually here to see how he can better manage his stressful life and lessen the chance of another injury.

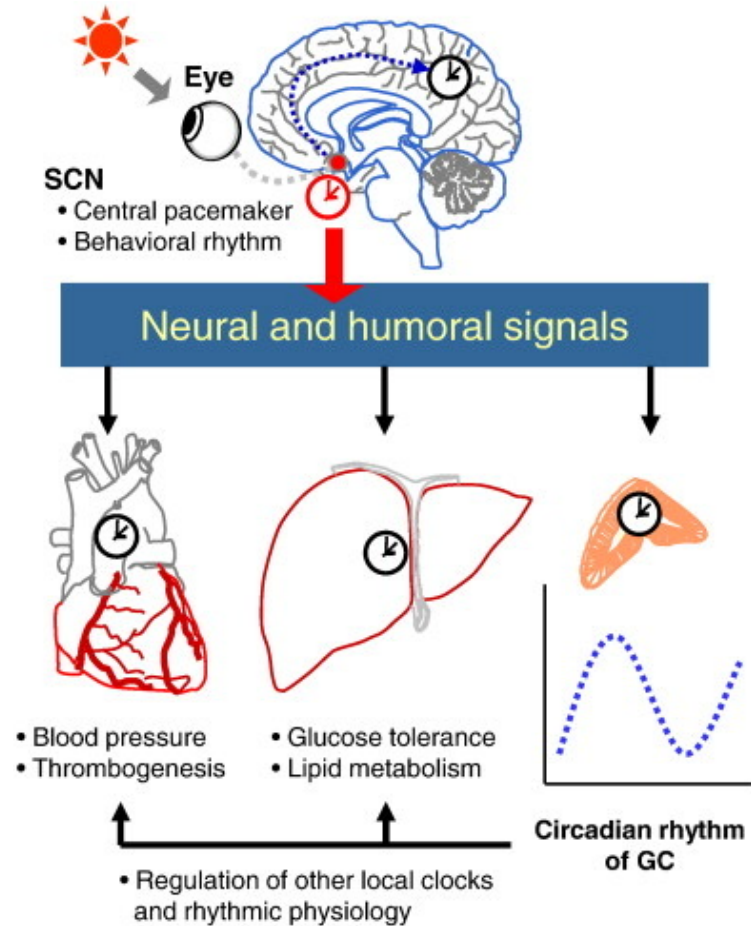


Learning Objectives:

- Review the basic physiology of sleep so we can teach our patients
- Review how sleep deprivation/restriction can impact everyday ADLs, growth and immune resilience
- Review how sleep deprivation/restriction can specifically impact athletic performance, injury risk
- Review basic sleep hygiene tenets so we can teach our patients

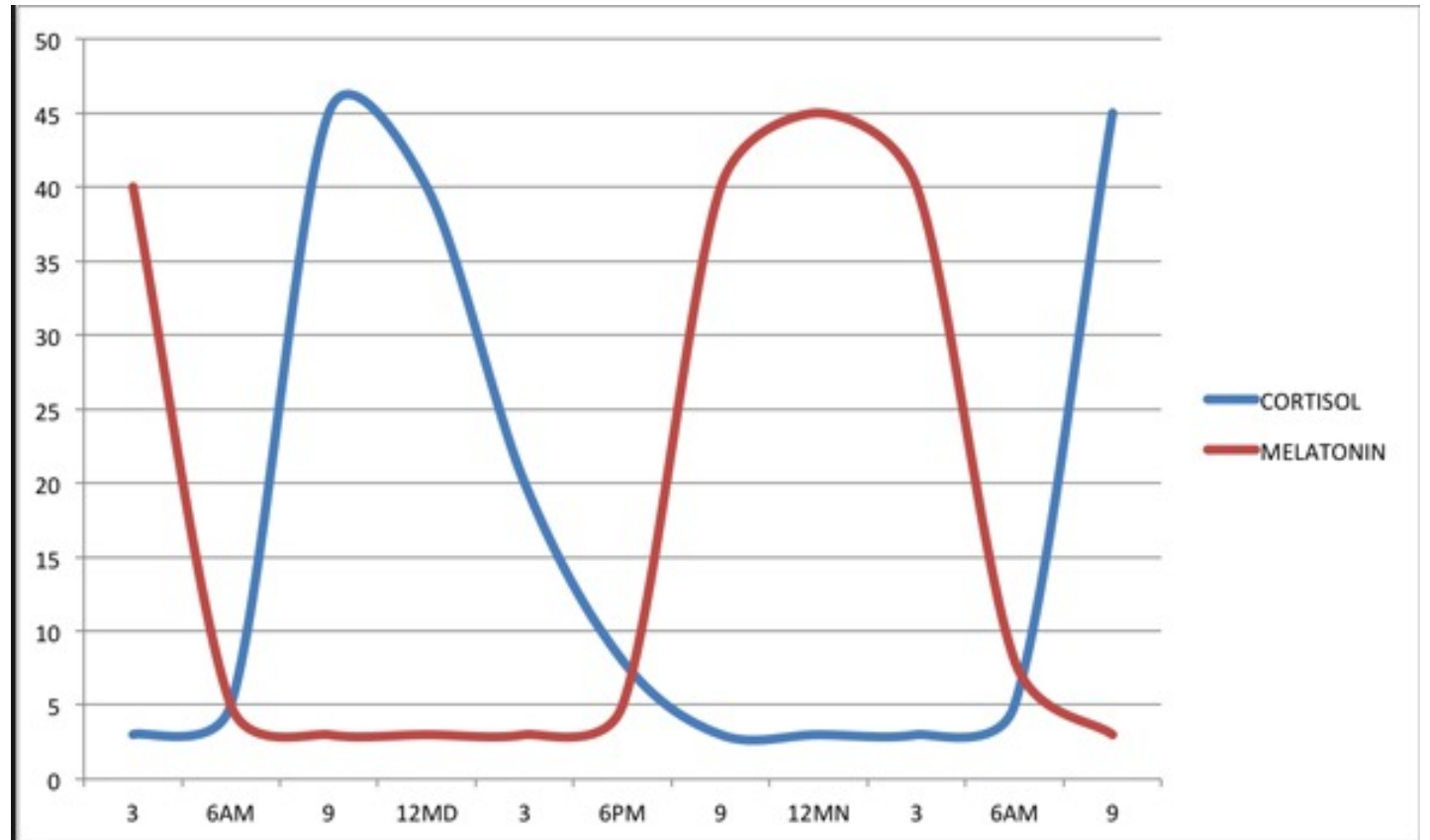
Sleep Physiology-a review

Circadian Rhythm



- In mammals, is regulated by the hypothalamic superchiasmatic nucleus (the master CLOCK)
- Circadian genes help regulate this clock and are expressed in central and peripheral tissues
- These genes are most impacted by the light/dark cycle of the 24h clock but are also impacted by meal timing, cortisol levels, seasons (in part due to types of food consumed!)

The Circadian Rhythm: melatonin and cortisol



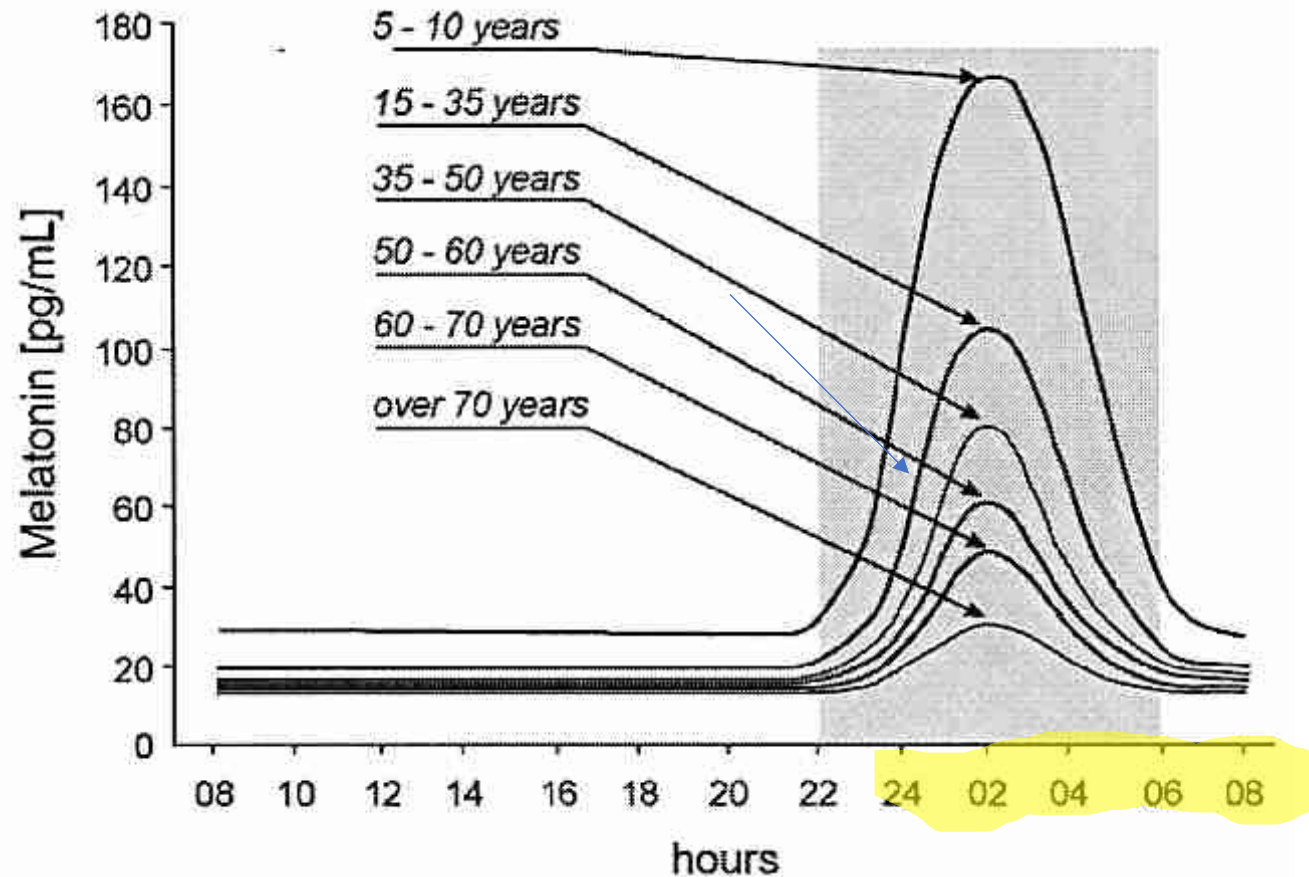
Melatonin

- Made mostly in pineal gland (due to signals from the SCN) and retina by the methylation of serotonin by SAM-e (and this reaction must occur in darkness)
- T_{1/2}: 1-2 hours
- Receptor: MT1 and MT2
- An antioxidant that can cross the blood brain barrier
- Interacts with the HPA axis and protects against effects of sustained glucocorticoid release, helps in memory consolidation
- Is being studied as an anti-cancer agent; it stimulates NK and T helper cells, multiple cytokines (caution in autoimmune dz)
- Metabolized by liver, cleared in urine (caution in liver/renal dz)
- May inhibit ovulation, libido (avoid if pregnancy present/suspected/desired)

Cortisol

- Made by the zona fasciculata layer of adrenal cortex due to ACTH from anterior pituitary (from CRH from the paraventricular nucleus of the hypothalamus), release peaks 45 mins after awakening (“cortisol awakening response”, governed by the SCN)
- T_{1/2}:
- Receptor: CGR
- A steroid hormone that affects every organ system in the body and is a potent immune suppressant (x NFκB) and transcription promoter or repressor
- May be peripherally repressed by the Clock transcription factor (not to be confused with the central CLOCK diurnal circadian system in the SCN)

Melatonin



This is why
we sleep at
NIGHT!!!!

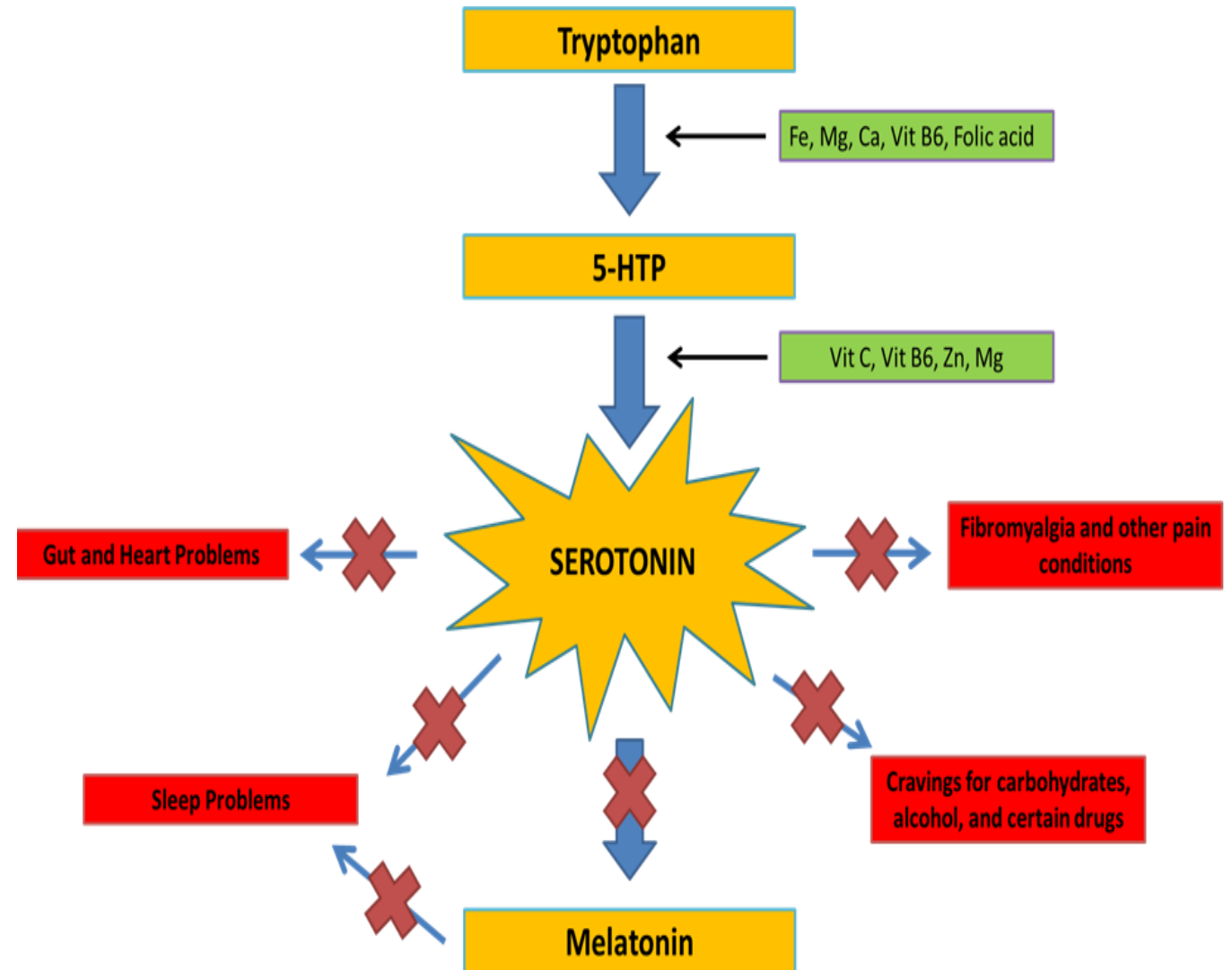
Hypnos, Greek God of Sleep

- Lived in a **cave** in the **underworld** where there was no sun or moon
- His next door neighbor was his brother, Thanos (God of Death)
- His mother was Nyx (Goddess of **Night**) and his father was Erebus (God of **Darkness**)
- Outside his cave grew **poppies** and other sleep-inducing plants
- A river flowed thru the cave called Lethe, the river or **forgetfulness**

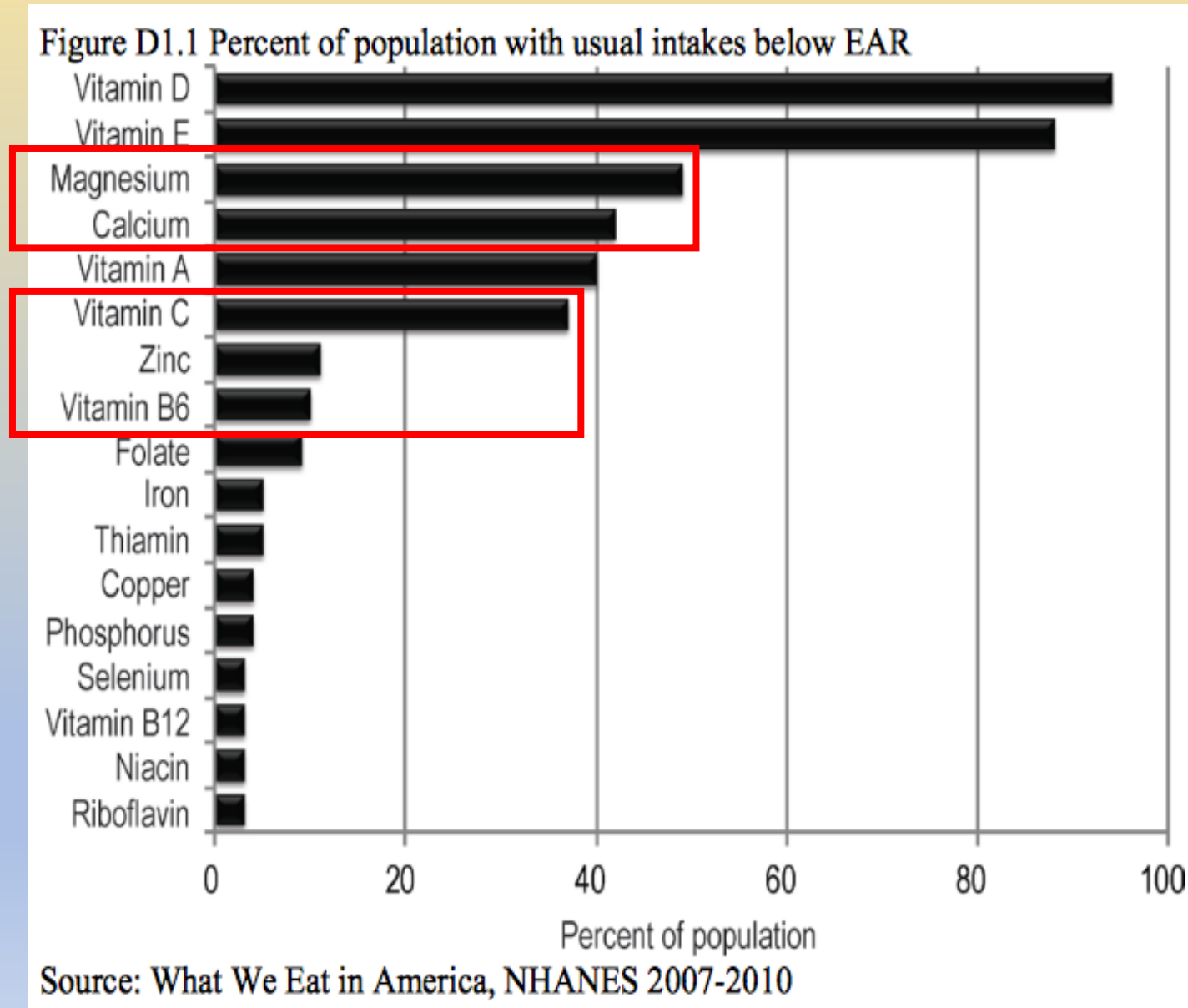


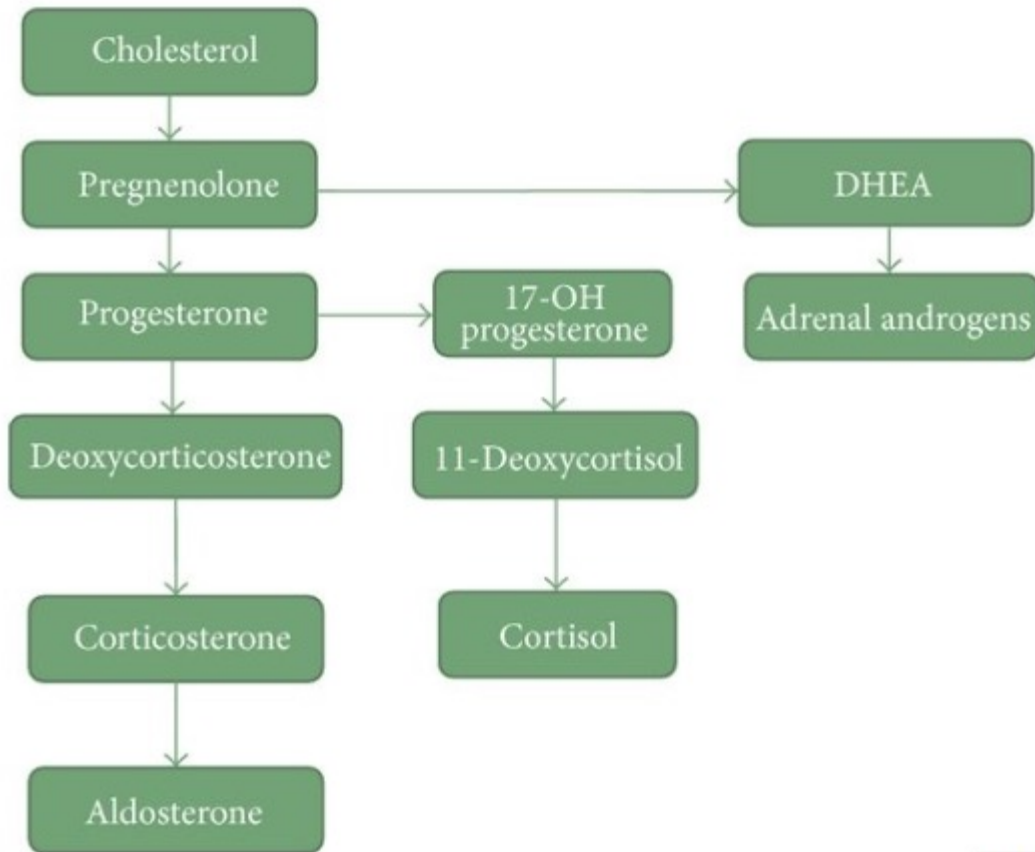
How We Make Melatonin:

- Requires the essential amino acid tryptophan
- Requires multiple essential vitamins and minerals
- Requires darkness
- Made in mitochondria



NHANES data on vitamin and mineral intake





600 x 50

How We Make Cortisol:

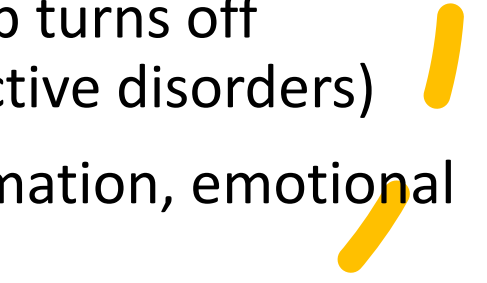
- Requires fewer nutrient cofactors
- Occurs in both cytoplasm and mitochondria
- Remember cholesterol is not an essential nutrient; our livers can make plenty!

Impact of Sleep Deprivation/Restriction on Growth and Resilience

Circadian Rhythm Disruption- Impacts on General Health

- May impact cell proliferation and tumor growth via the Clock gene expression (PMID: [29731875](#))
- Is associated with depression (PMID: [36376857](#)) and bipolar disorder (PMID: [32090195](#))
- May impact bone remodeling and be a factor in osteoporosis (MT being studied as on OP treatment) (PMID: [36238690](#))
- Decreases pain tolerance and predisposes to chronic pain (PMID: [26237772](#))
- Is associated with obesity and creates a hypothalamic change in the amygdala reward center after just one night of restricted sleep (PMID: [30559151](#))
- Increase in sympathetic and decrease in parasympathetic tone (PMID: [35992930](#))
- Increase in proinflammatory cytokines (PMID: [31288293](#))

Role of the circadian flow

- Healing/repair: including muscle building after exertion, and bone formation (day: formation, night: resorption)
 - Cellular/DNA repair and autophagy→aging, mitochondrial reserve
 - Blood sugar and lipid metabolism→poor sleep accelerates metabolic syndrome diseases (DM2, NAFLD)
 - Disruption of endothelial function (CVD)
 - Intestinal mucosal integrity*** (implications for autoimmune disease, leaky gut)
 - Limbic system balance (adequate sleep turns off hypervigilience, decreases risk of affective disorders)
 - Brain “defrag” –learning, memory formation, emotional regulation occur during deep sleep
- 

The Circadian Rhythm: cortisol





Barry

- You explain all this to Barry who now seems very anxious. You explain better sleep may improve his anxiety, but he quickly denies anxiety. Instead you decide to educate him on how poor sleep increases our risk of injury.

Impact of Sleep Deprivation/Restriction on Athletic Performance and Injury Risk

How much Sleep Do We Need

- **8 hours a night. Period.**
- Elite athletes tend to get about 6.5h/night—not far off from what many Americans get
- A rare genetic mutation does allow less than 5% of us to only need 6 hours, but there is a 95% chance that you are not one of them!
- Both the IOC and the NCAA released statements making sleep a central aspect of athletic physical and mental health in 2019, with both bodies recommending at least 7 hrs of sleep nightly PMID: [32005349](#)
- While diet and exercise are revered pillars of health and closely managed by athletes, sleep impacts both of these and should be a part of all medical discussions with athletes
- Empiric sleep hygiene education should be a part of sports medicine consults due to the multiple benefits of sleep for overall health and performance and the multiple poor outcomes associated with reduced sleep

Impact of Too Little Sleep on the Central Nervous System

PMID: [31288293](#)

Even a few nights of sleep restriction (less than 6 hrs) worsens objective cognitive function while the subjects do not endorse this change

It also stimulates the sympathetic nervous system

Longer periods of sleep restriction worsen mood states and increase impulsivity

There is a dose-dependent effect on reaction times and on go/no go response (the ability to withhold incorrect responses)

Response times are slower

Memory formation (and therefore learning) is impacted, which can impact play and skill recall and anticipation/pattern recognition

Caffeine may mitigate most of these effects, with strongest benefit being 1-2 hours after ingestion, lasting 6-8h

Impact of Alterations of Sleep Time on Athletic Performance is Well Demonstrated PMID: [31288293](#)

- Sleep restriction leads to lower:
 - Decreased strength, Torque, time to exhaustion
 - minute ventilation
 - sprint times
 - running performance
 - tennis serve accuracy
 - minute ventilation
 - Increase in cortisol levels and therefore catabolism
- One study looked at the outcomes of **40 yrs of NFL** games and saw that East Coast teams performed worse in night games played on the west coast and failed to cover the point spread
- Sleep extension after sleep restriction (catch up sleep) leads to improved:
 - cognitive function
 - Sprint times
 - Tennis serve accuracy
 - Basketball shooting accuracy
 - Swim turn and kick stroke efficiency
 - reaction times
 - Restoration of anabolism
- Multiple studies recommend sleep times of **9 hours per night for elite athletes**

Sleep Disruption and Injury Risk, Recovery PMID: [32005349](#)

Subjective insomnia and low sleep scores are associated with a higher risk of concussion

Concussions worsen sleep and prolonged sleep symptoms after concussion may be an indicator of prolonged concussion recovery time

Multiple studies in adolescent athletes have shown increased overall injury risk if sleep times were less than 8 hours per night

Sleep restriction is associated with lower fruit and vegetable intake

Later sleep onset times are associated with increased carbohydrate intake

Poor sleep increases the release of pro-inflammatory IL-6 and CRP, slowing healing and worsening pain, and cortisol—a catabolic agent, impacting muscle growth

Sleep Hygiene

Insomnia is a Symptom, not a Disease

- A fever is not a disease in itself, but a symptom of a disease; if you simply treat a fever with Tylenol then do nothing else, that is bad medicine
- Insomnia is not a disease in itself, but a symptom of disease; if you simply treat with a sedative/hypnotic and do nothing else, that is bad medicine
- Do the appropriate medical workup, leverage Sleep Medicine, and if the underlying cause is truly anxiety or insomnia fixation, the most powerful tool is CBT (evidence based!)

Sleep Hygiene is the sum of all habits that impact sleep



The prerequisite for sleep are:

Elimination of light “noise” (sleep occurs in total darkness!)

Elimination of body “noise” (avoid sleep disruptors: ETOH, caffeine, large meals—especially high fat meals—later in the day, intrusive thoughts—qHS meditative practices like reading, bathing, journaling)

Elimination of room “noise” (no electronics, light, sound, heat, reminders of the daytime/outside world)

Other things that help:

A cool space (ideally less than 65 degrees)

A warm shower before bed (quiets body noise and helps jettison heat from the body due to dilated skin capillaries, lowering core temperature)

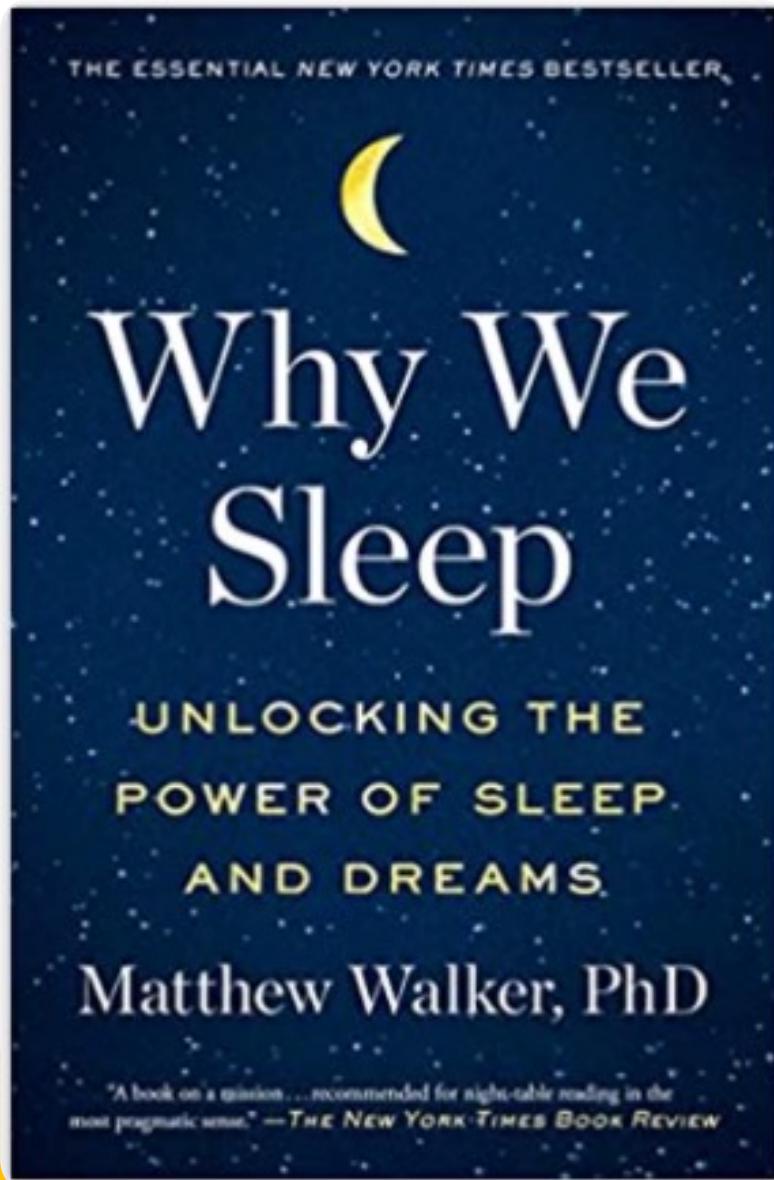
Some Foods that Support Sleep:

Food, Magnesium	Mg / serving	Food, Melatonin	Ng/g
Almonds, dry roasted, 1 ounce	80	Tomato	3–114 ng/g
Spinach, boiled, ½ cup	78	Walnuts	3–4 ng/g
Cashews, dry roasted, 1 ounce	74	Cereals (rice, barley)	300–1,000 <u>pg/g</u>
Peanuts, oil roasted, ¼ cup	63	Strawberry	1–11 ng/g
Black beans, cooked, ½ cup	60	Olive oil	53–119 <u>pg/ml</u>
Edamame, shelled, cooked, ½ cup	50	Cow's milk (unprocessed)	3–25 <u>pg/ml</u>
Peanut butter, 2 tablespoons	49	<u>Nighttime</u> milk	10–40 ng/ml
Avocado, cubed, 1 cup	44		
Rice, brown, cooked, ½ cup	42		
Yogurt, plain, low fat, 8 ounces	42		

Some Supplements that Support Sleep:

- **Melatonin**: long acting is best (remember the short t_{1/2} of MT), can be combined with short-acting
- **Valerian root extract** (essentially treats anxiety)- GABAnergic, will need 6+ weeks to take effect, look for an extract that is standardized to 0.8% valerenic acid, 300-900mg
- **Hops** (great in combo with Valerian): great for minds that stay awake, looks for a 5:1 ethanolic extract of the flower, 1 dropper qhs
- **Passionflower**: this actually induces sleepiness/GABAnergic—does not need to be standardized, 350-700mg qhs
- Always avoid supplements in pregnancy, those on blood thinners, those under 12, and remind athletes that supplements are not regulated and are ASSUMED safe, not PROVEN safe
- Excipients may be present that will cause a positive UDS screen on antidoping testing; USP certification is a way to lessen this risk as these products are independently tested for accuracy in labeling and contaminants
- Some to avoid especially in drug-tested athletes: California poppy, CBD products





Barry:

- After all this great advice Barry seems less anxious and promises to implement the sleep tips you provided; he explains he has some friends with similar issues and asks if he can refer them to you. You happily encourage him to send them your way and recommend this great book on the science of sleep.

Resources to Share with Patients

- CALM app
- Sleep Hygiene handout (not technically KP branded—for your use only): https://www.fammed.wisc.edu/files/webfm-uploads/documents/outreach/im/handout_sleep.pdf
- <https://www.sleepfoundation.org/>
- www.drnaiman.com

Sources

https://www.greekmythology.com/Other_Gods/Hypnos/hypnos.html

<http://www.cdc.gov/nchs/nhanes/>

www.iom.nationalacademies.org

www.ods.od.nih.gov

<https://www.naturemade.com/pages/nature-made-quality>

<http://fnic.nal.usda.gov/fnic/interactiveDRI/>

<https://pubmed.ncbi.nlm.nih.gov/31132574/>

[MELATONIN \(benbest.com\)](http://benbest.com)

<https://www.ncbi.nlm.nih.gov/books/NBK534823/>

<https://www.ncbi.nlm.nih.gov/books/NBK538239/>

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5920822/>

SOURCES

Dr. Tierona Low Dog, Fortify Your Life. National Geographic, 2016

Rakel, D et al. The Integrative Medicine Textbook. 3Ed, 2012.

Predicting and mitigating fatigue effects due to sleep deprivation: A review, Kayser et al.

PMID: [35992930](#)

Possible contribution of chronobiology to cardiovascular health. Sato et al. PMID: 24478711

Sleep and athletic performance: the effects of sleep loss on exercise performance, and physiological and cognitive responses to exercise. Fullagar et al. PMID: 25315456

Smith RS, Efron B, Mah CD, Malhotra A. The impact of circadian misalignment on athletic performance in professional football players. *Sleep* 2013; 36: 1999–2001

Chung et al: Circadian rhythm of adrenal glucocorticoid: Its regulation and clinical implications.

<https://doi.org/10.1016/j.bbadis.2011.02.003>

QUESTIONS?

