Power of 1 Wellness News

Newsletter 11 Δ November 01, 2020

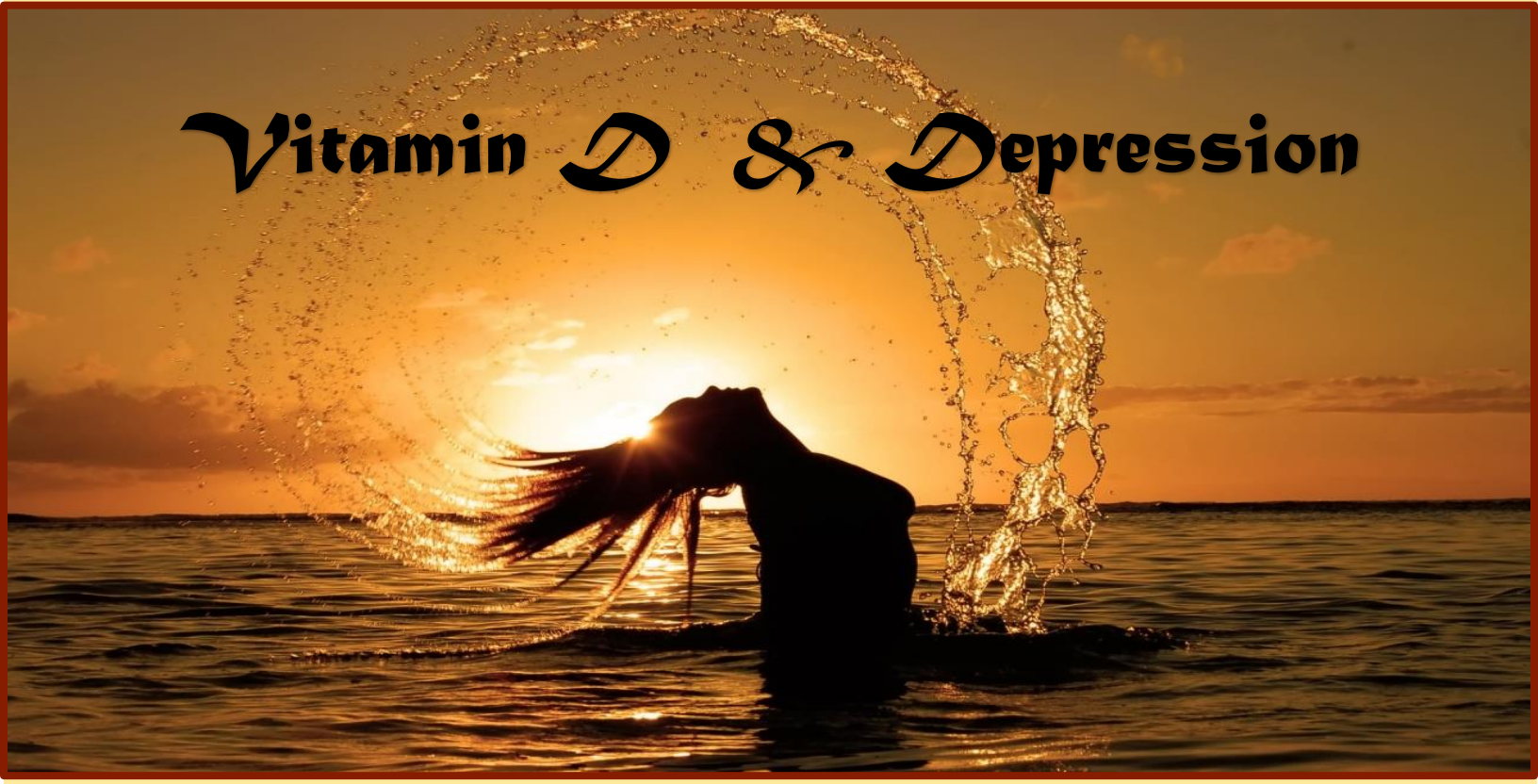
Wellness Word —

Let The Sunshine In

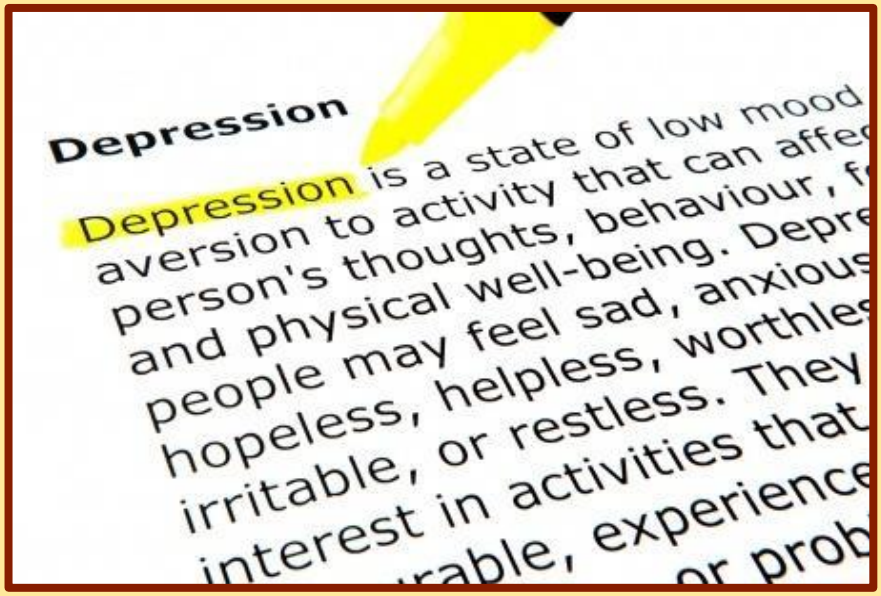
Timing is a crucial ingredient

in any given Outcome, often the deciding factor tipping events towards either a positive or negative trajectory. In the November issue we will be investigating the importance of timing or "when" we are exposed to light of various wavelengths, integrating its catalytic role with subsequent cascades of vitamin D, hormones, neurotransmitters, circadian rhythms, & discovering the ultimate influences it wields on our mental and physical well-being.

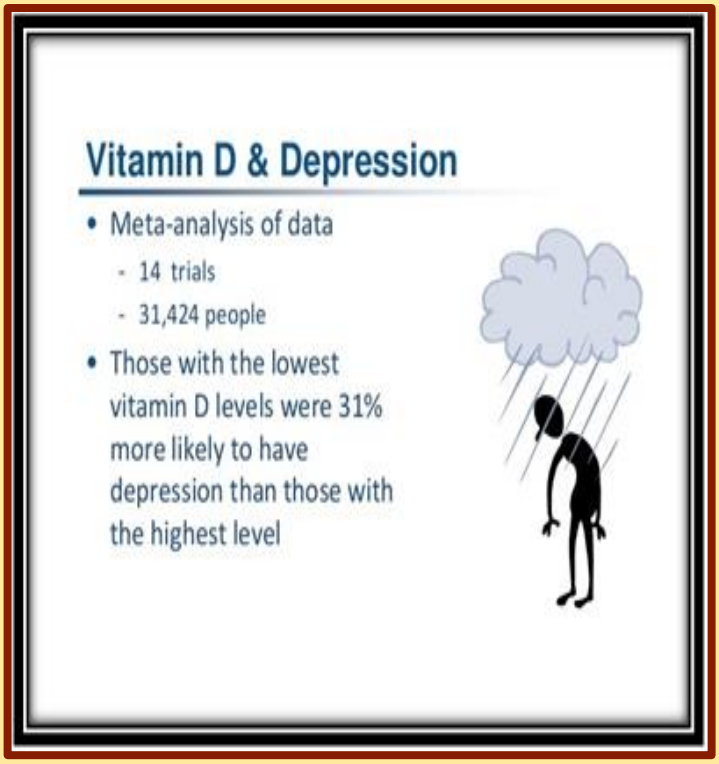
Vitamin D & Depression



"Depression in its own right is a disabling condition, impairing all aspects of human function. In persons with a chronic medical disease, depression often makes the management of chronic illness more difficult. Recently, vitamin D has been reported in the scientific and lay press as an important factor that may have significant health benefits in the prevention and the treatment of many chronic illnesses, including depression and other mental disorders." [Penckofer et al. Issues Mental Health Nursing. 2010 Jun; 31(6): 358-393.]



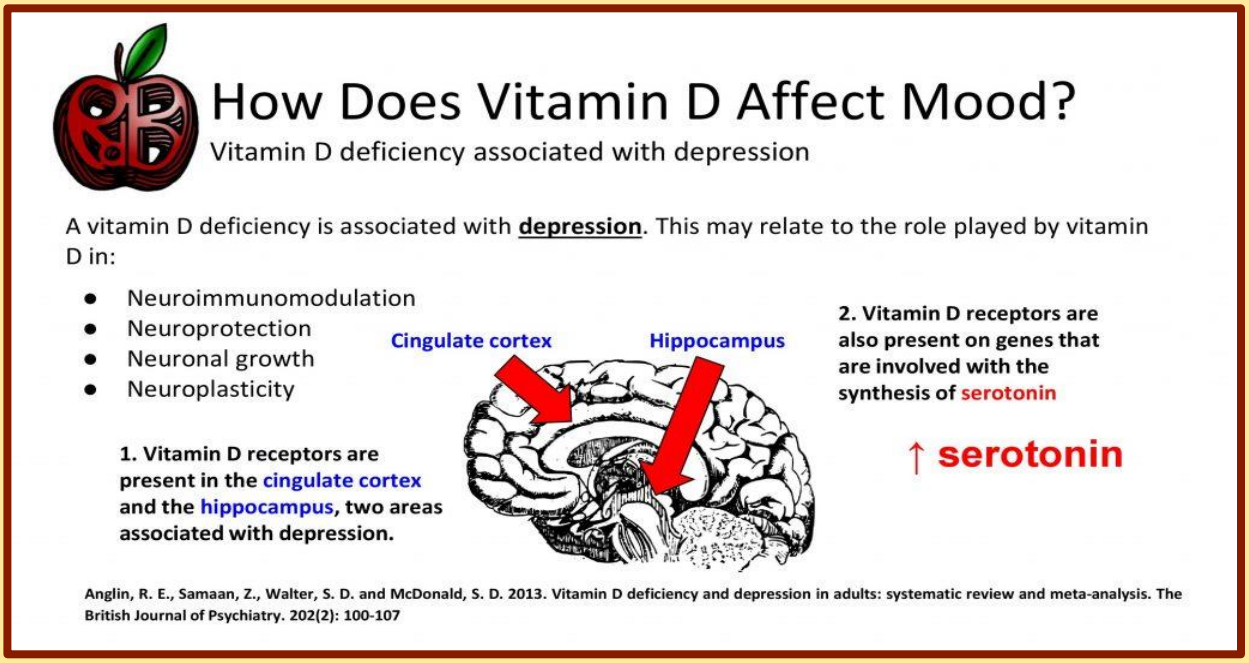
Depression is the leading cause of disability worldwide, affecting more than 300 million people of all ages. Before Covid-19, the World Health Organization (WHO) determined that depression ranked 4th on the global burden of disease list; with the advent of social distancing, isolation and quarantine precautions necessitated throughout 2020, rates of depression across the board have ballooned throughout all age groups. With viral spread and social isolation trending as a hallmark of the winter 2020-2021 season, a solid base of preventative measures has never been more timely.



As we have reviewed, most individuals in this country have insufficient levels of vitamin D. This holds especially true for persons diagnosed with depression as well as other mental disorders. Whether stemming from insufficient dietary intake or lifestyle choices (e.g., little outdoor exposure to sunshine), effective detection and treatment of inadequate vitamin D levels in persons with depression and other mental disorders may be an easy and cost-effective therapy which could improve patients' long-term health outcomes as well as their quality of life.

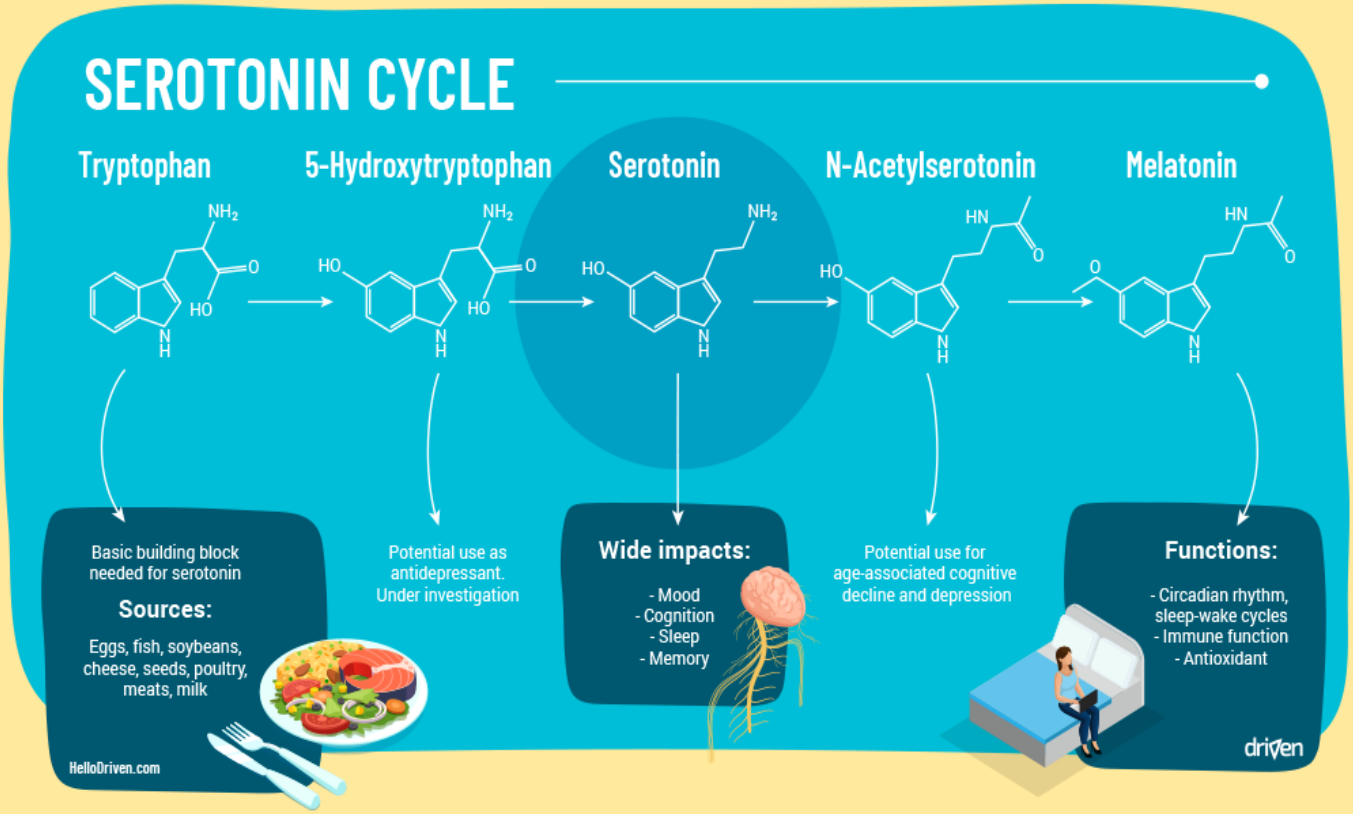
What is the link between Vitamin D and Depression?

Vitamin D is crucial to upholding proper functioning of the brain in general, and its receptors have been found in areas of the brain specifically associated with development of depression. Even more unequivocally, additional vitamin D receptors have been identified on genes involved with serotonin synthesis, a neurotransmitter commonly characterized by its control over mood and emotion. Therefore, lack of sufficient vitamin D has been directly tied to depression and other mental health problems.

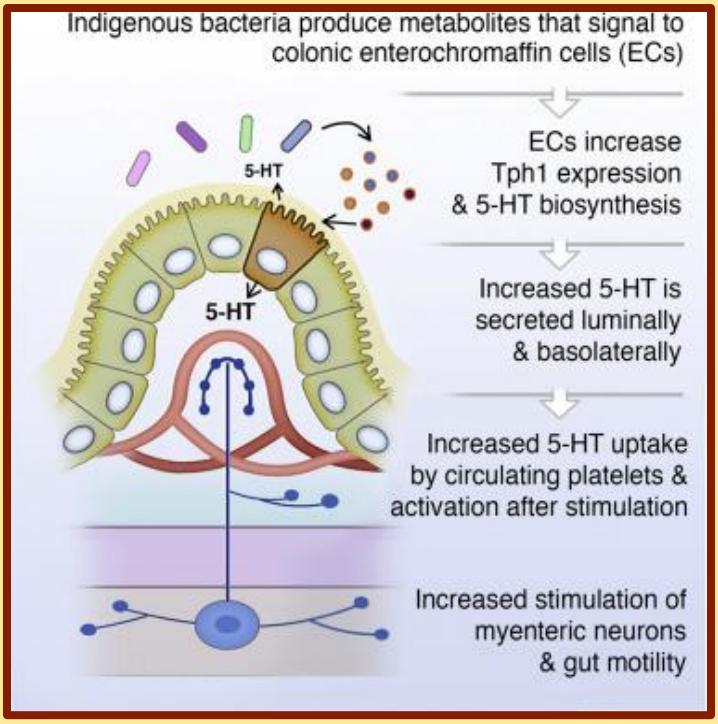


The Expansive Range and Roles of Serotonin

Serotonin is a monoamine neurotransmitter that helps to regulate mood, social behavior, learning, cognition, memory, cardiovascular function, sensorimotor function, pain sensation, appetite, bowel motility, bladder control, sexual desire in addition to its contribution to the sleep-wake cycle. As it is a prime facilitator in modulation of systemic and cellular functions, alterations in serotonin concentration in the body are associated with many different diseases, such as irritable bowel syndrome, restless legs syndrome, sudden infant death syndrome, autism, headache, insomnia, anxiety, depression, anorexia, schizophrenia, Parkinson's and Alzheimer's disease, pulmonary hypertension and myocardial infarction (heart attacks). Most of these should look somewhat familiar by now as they coincide and overlap with vitamin D deficiency, inflammatory incidence & metabolic dysfunction as well.

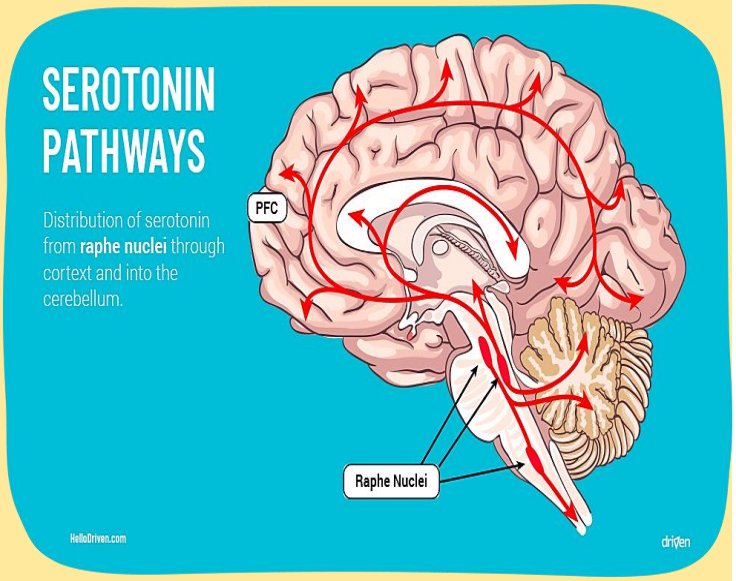


Serotonin is derived from the essential amino acid tryptophan. "Essential" in this case means that our bodies cannot make tryptophan on its own; instead, we are reliant upon dietary sources. In turn, serotonin (& its bioactive intermediary substrate 5-HT) is itself a precursor for the hormone melatonin and the variety of roles it plays, which we will expand upon later.



Serotonin is primarily synthesized, stored and secreted by gastrointestinal enterochromaffin cells (ECs): cells that line our gut and regulate peristaltic waves/motility and enzyme secretion. In other words, our gut produces the serotonin that it needs locally to control the movements of muscles responsible for moving food through the GI tract.

In the gut, about 90% of serotonin is synthesized and stored for modulation of gastrointestinal neurons while 9% is stored and transported in travelling blood platelets. The remaining 1% of serotonin is produced in the brain stem (see Raphe Nuclei in illustration below) and stored in vesicles to await release.



The brain also produces the serotonin it needs locally. There are at least 14 different types of serotonin receptors in the brain, all of which serve different purposes. From the brain stem, there are over 20 known serotonergic pathways throughout the brain where serotonin travels to and through neural structures, including the limbic system. The limbic system contains the hypothalamus and amygdala where serotonin's effects play a large role in anxiety, depression and mood regulation.

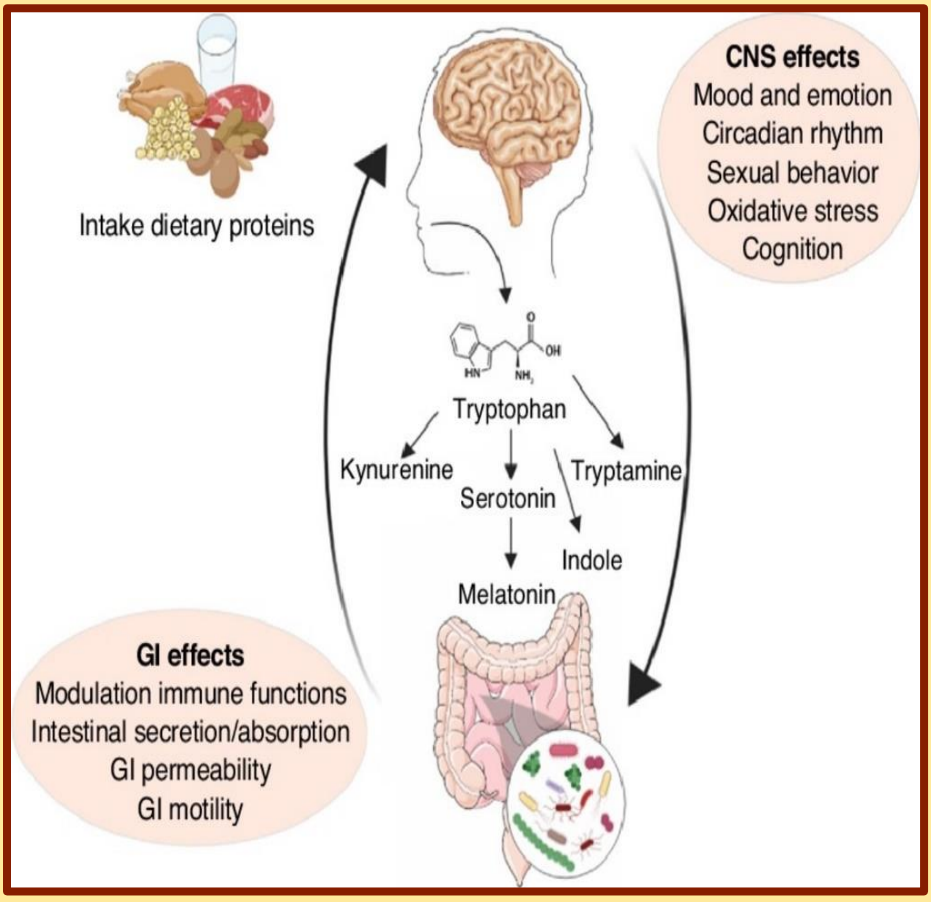
Evidence shows that the amygdala, the area of the brain which controls emotion, can be affected by varying levels of serotonin. Specifically, diminished levels of serotonin have long been linked to depression, and researchers have observed that increased levels of serotonin cause the brain to process emotionally charged information in a more positive way, thus decreasing negative thought processes.

With so many neural pathways, it should come as no surprise that there is a wide array of physical and mental effects produced throughout the body and with deficiencies, coinciding widespread dysfunction.

With serotonin deficiencies we see profound systemic dysregulation:

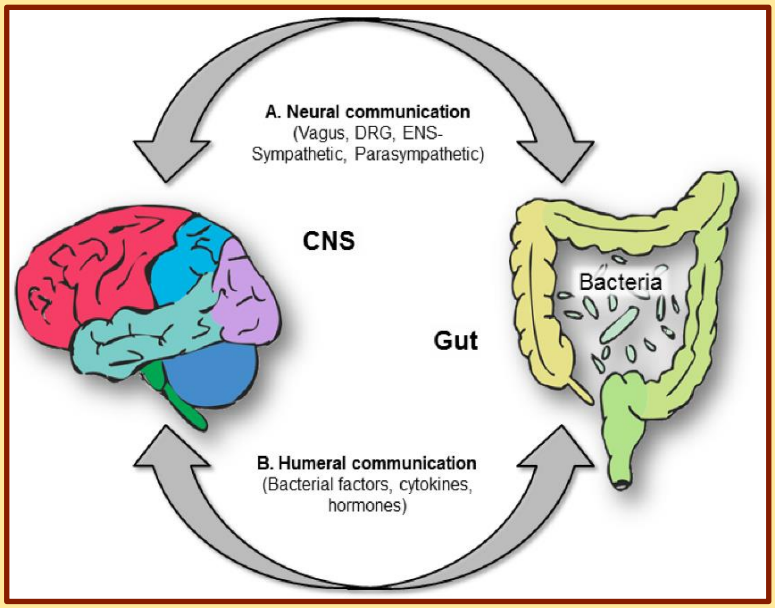
Physical Effects:

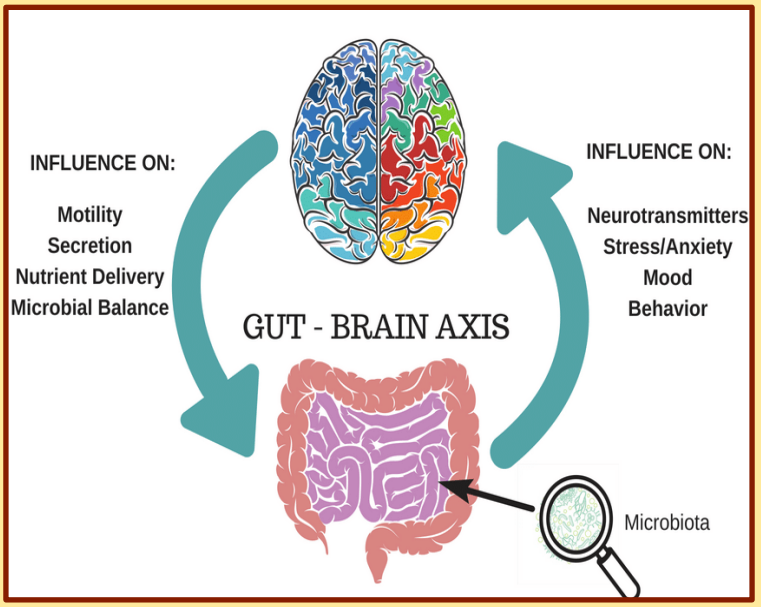
- Disrupted sleeping pattern
- Low appetite, craving of high sugar and fatty foods
- Low bone density
- Fatigue
- Nausea
- Chronic pain (joint, limb, back)



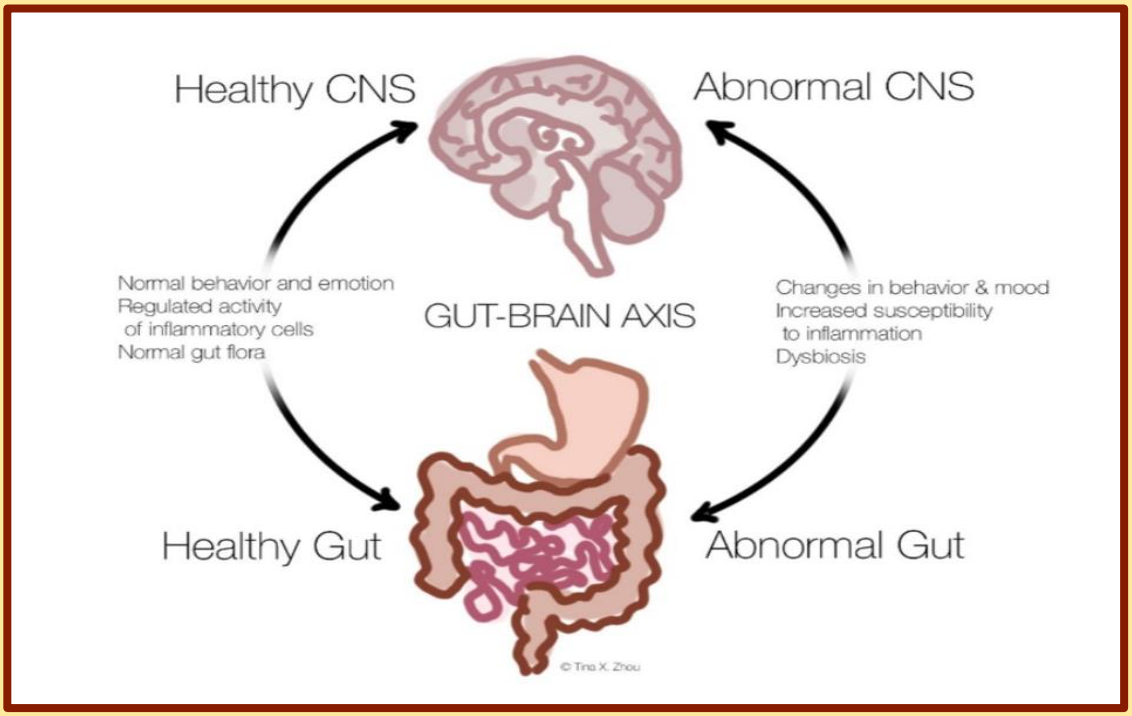
A common clinical association among individuals suffering from depression is that many also suffer from GI distress, such as low gut motility and constipation.

As we read in the October issue, recent studies continue to provide interconnections between the gut and brain and suggest that a shared glitch in neuronal chemistry—low serotonin—may be responsible for both sets of symptoms.





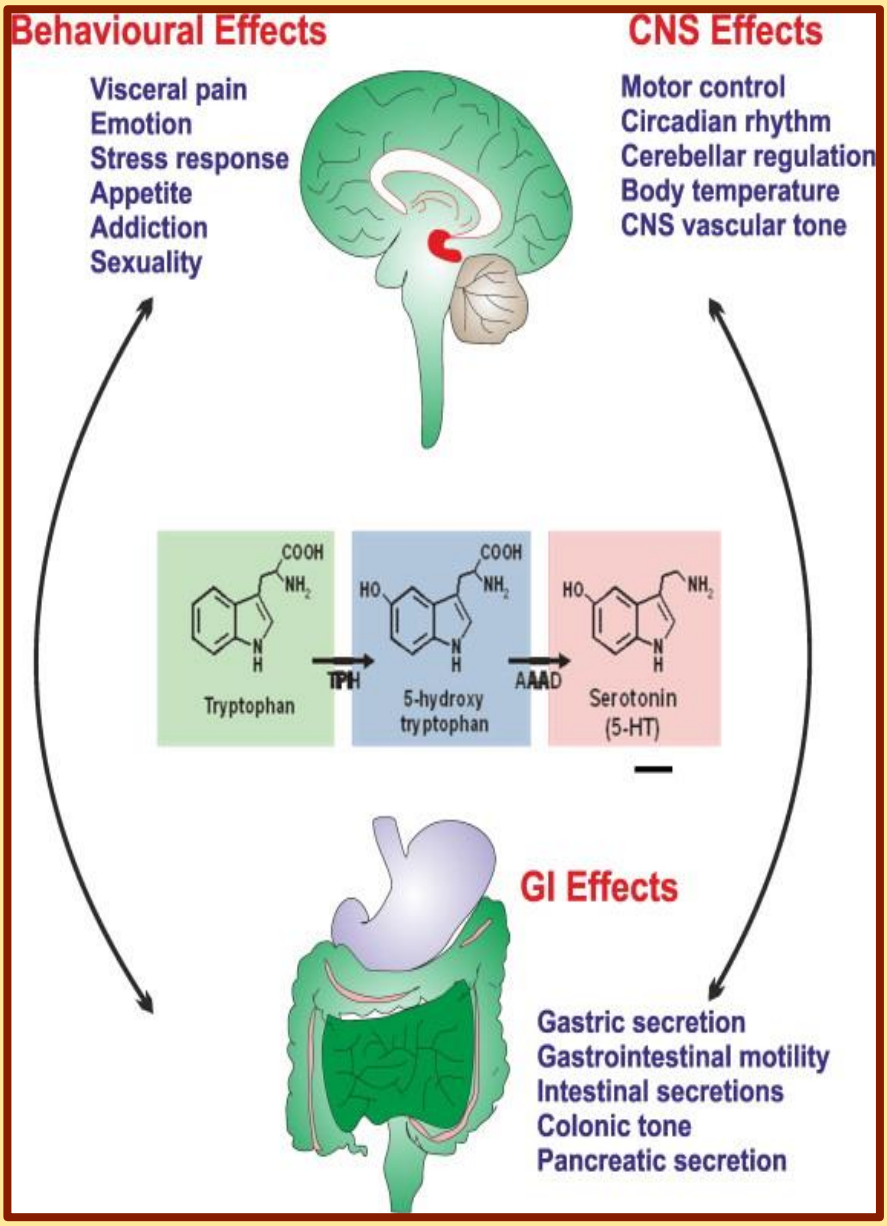
The gut is often referred to as the body's 'second brain.' It contains more neurons than the spinal cord and uses many of the same neurotransmitters as the brain. A serotonin shortage in the gut reduces the number of neurons in the gut, leading to deterioration of the gut's lining and slower motility throughout the GI tract. This dysfunction is translated throughout both body and brain chemistries, influencing ever-widening interactive and overlapping spheres of rhythmic, cognitive, behavioral, emotional, metabolic, inflammatory, immunologic, social and physical dysfunction.



Social Effects:

Because of its 'reward' processing and how it lifts mood (and because of the close link to dopamine) low serotonin can cause us to feel:

- High anxiety towards group exclusion (this in turn can develop a social ladder—a competitiveness regarding friendship and reward)
- Impaired learning and imitation learning ability (stress and anxiety shown to impair frontal and parietal mirror neuron system)
- Impaired social bonding (serotonin genes are also linked to autism and Asperger's)
- Slow assessment of social interaction



Emotional Effects:

Serotonin is closely involved with generation of anxiety, fear & depression:

- Decreased serotonin can cause an increase in impulsive behavior (alcoholism, over-eating, drug abuse) due to 'craving' for serotonin release.

- Decreased serotonin combined with decreased dopamine can result in depression and suicidal behavior, as well as increased aggression and large shift in mood.

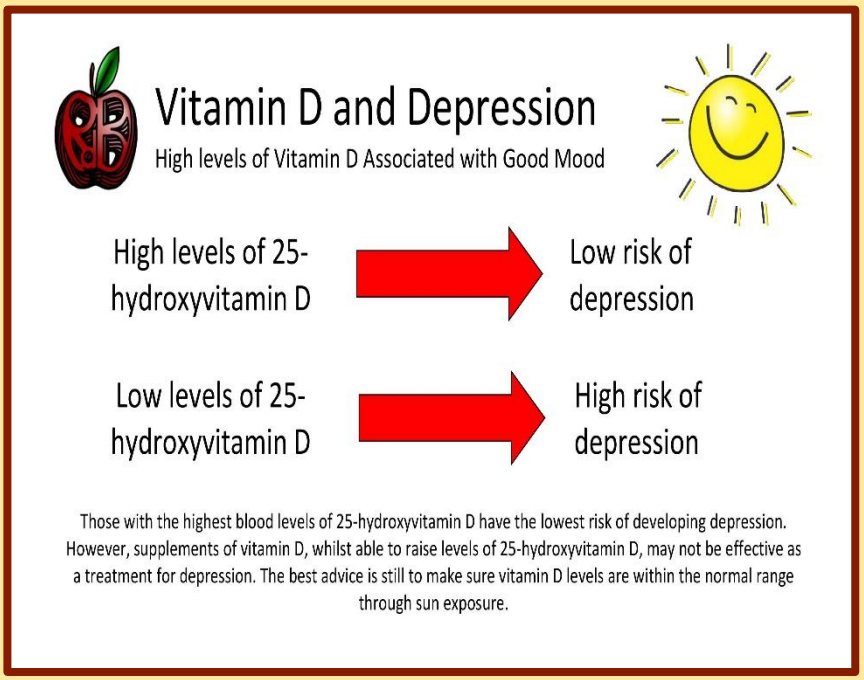
- Increased serotonin alongside decreased dopamine leads to high levels of stress & anxiety

- Decreased serotonin causes increased fear &decreased cognitive function (i.e., situation evaluation)

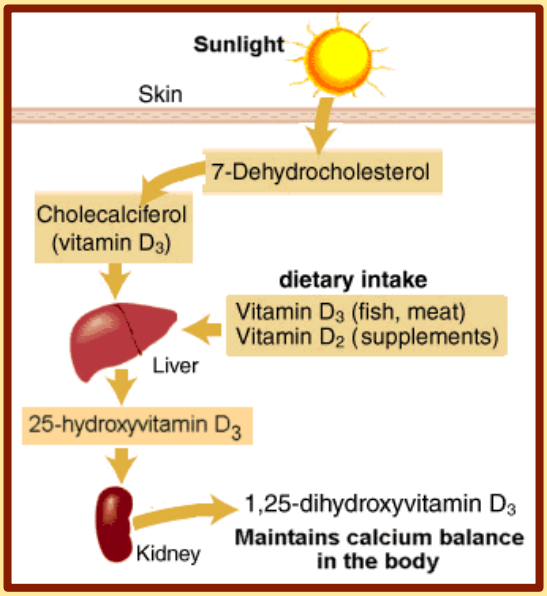
Vitamin D & Serotonin

Vitamin D may be an effective treatment for depression because it can alter serotonin neurotransmitter synthesis rates.

Studies have concluded that 1,25-hydroxyvitamin D acts to 1) jump start the conversion of tryptophan into serotonin and 2) govern serotonin concentrations in the brain by its guidance of genetic expression in serotonin neurons.



Taking the results together, vitamin D appears to fine-tune serotonin concentrations at the genetic level, amplifying serotonin in the central nervous system and making vitamin D a candidate for the treatment of neuropsychiatric disorders in which vitamin D and/or serotonin are implicated. This deduction has been supported through research reporting that vitamin D supplementation improved inattention, hyperactivity and impulsivity in children and adults with ADHD. Additional studies are currently ongoing to investigate how optimal vitamin D status may contribute to improving atypical social behaviors associated with psychological conditions, including autism spectrum disorders (impaired communication and social interaction) and depression through its role in regulation of serotonin neurotransmission.



→ **SOURCE FILE:** Vitamin D precursors are generated as sunlight activates cholesterol from skin cells & through intestinal absorption of dietary intake. Precursors are then converted to active metabolites in the liver & kidneys, 25-hydroxyvitamin D and 1,25-hydroxyvitamind D, respectively.

Additionally, vitamin D supplementation has been found to boost metabolic and inflammatory benefits:

- Reduces serum insulin
- Improves insulin sensitivity
- Improves pancreas B-cell function (cells that secrete insulin)
- Improves plasma antioxidant status
- Increases cellular glutathione (antioxidant/cell protection)

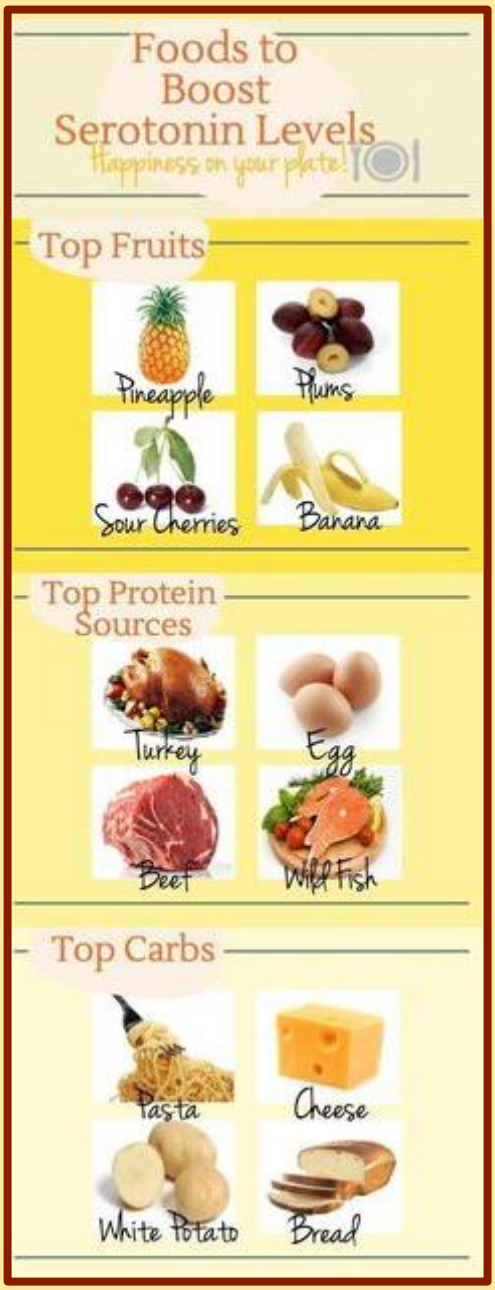
How to Increase Serotonin Naturally

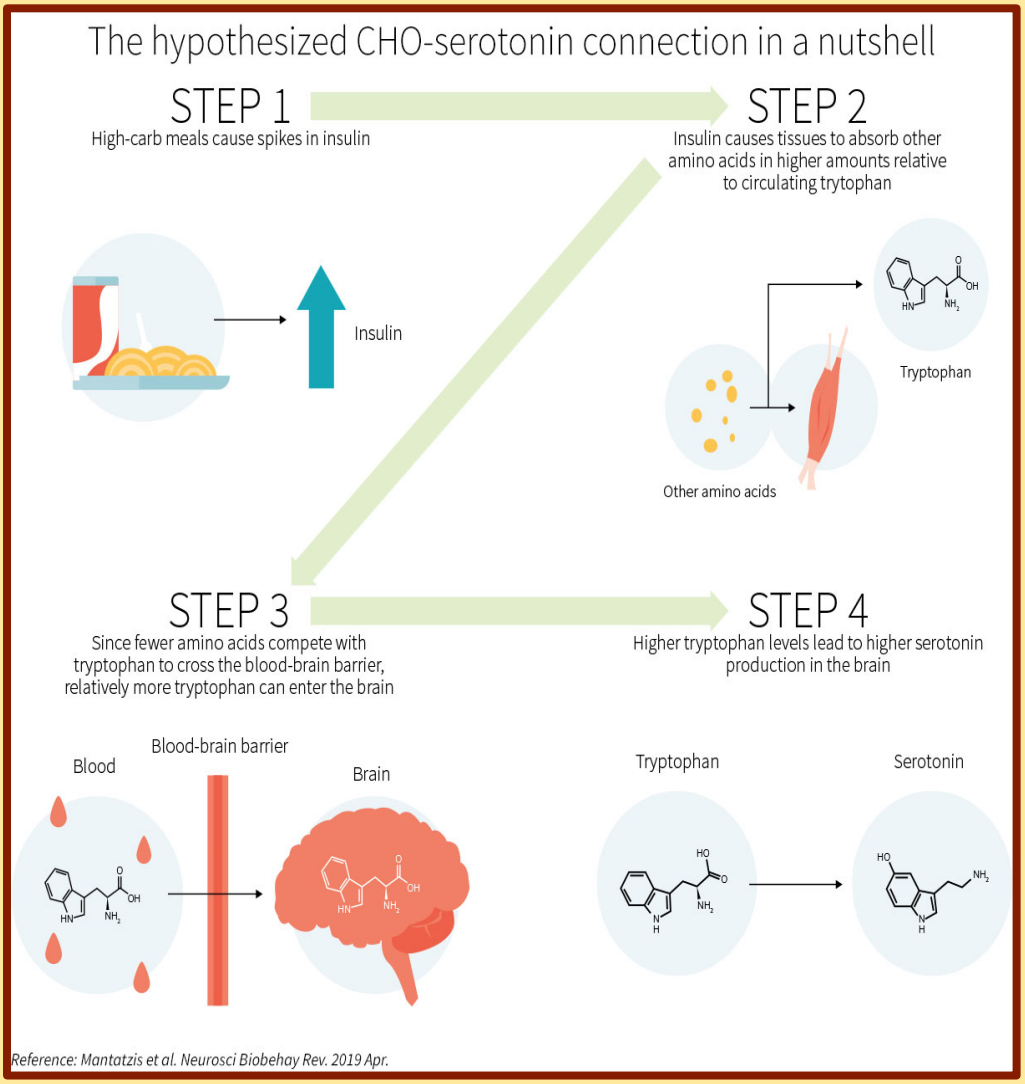
In the end, it all comes down to prioritizing and providing Balance in your life—time spent outdoors, time spent sleeping, time spent eating well, time spent engaged in physical activity. Here are 4 simple ways to help increase and regulate serotonin:

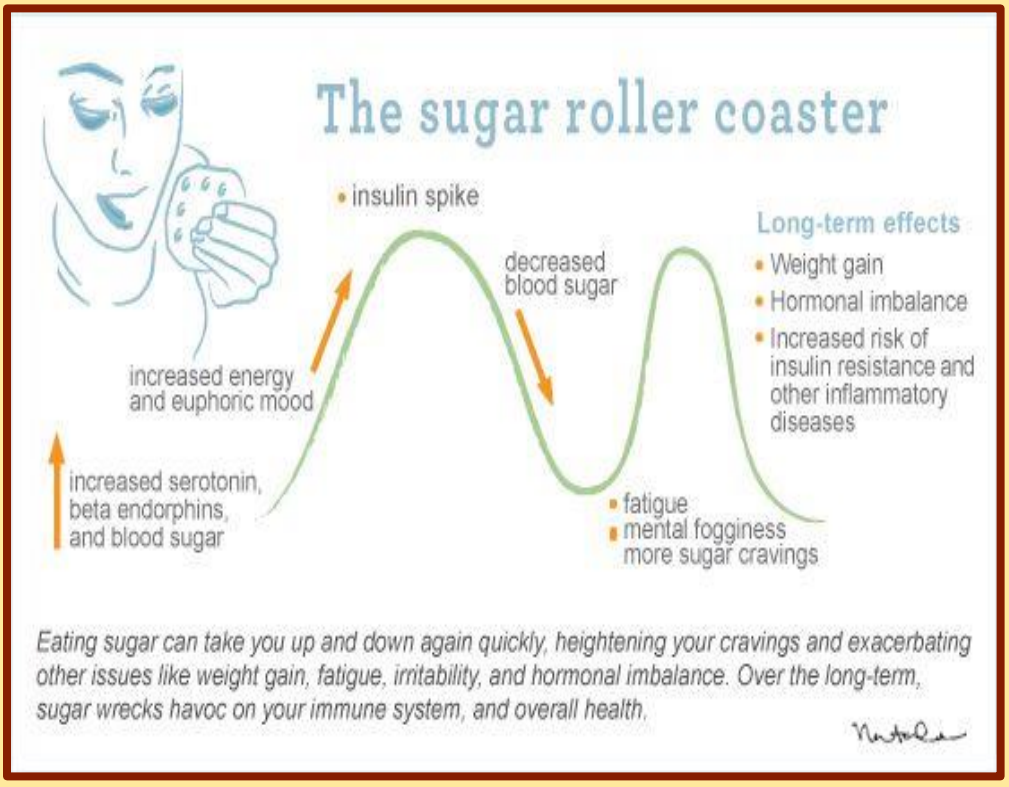
[Following title text & illustrations courtesy of Jurie Rossouw. Driven/on-line article. #Neurohack your brain for resilience Clip Art. 'Serotonin and Its Unusual Role in the Brain.' https://home.hellodriven.com/serotonin-role-in-brain.html]

Research has shown that when you consume a low-tryptophan diet, brain serotonin levels drop and tryptophan depletion is seen in those with mood disorders, such as depression and anxiety. Alternatively, Foods rich in protein that contain essential amino acids have been shown to boost levels of L-tryptophan in plasma, promoting serotonin synthesis in the CNS which may elevate mood, particularly if there was a lack in L-tryptophan affecting serotonin production.

Tryptophan-rich foods include eggs, cheese, pineapple (fresh), ripened tomatoes, tofu (soy products are tryptophan-rich), salmon, nuts & seeds, turkey (poultry) and spinach. However, merely loading up on excessive protein isn't a sure-fire method as tryptophan is dependent upon carbohydrates (CHO) in order to cross the blood-brain barrier (BBB; the ultimate toxin-protective firewall for our brains), travel into the brain and then produce serotonin. The best way to provide this transport is by consuming a <u>Balanced Diet</u>. Eating a diet loaded with <u>Complex Carbohydrates, such as oatmeal, rice, whole wheat, fruits and vegetables</u>, provides tryptophan an "Easy-Pass" across the BBB and ultimately boosts serotonin stores and elevates mood.



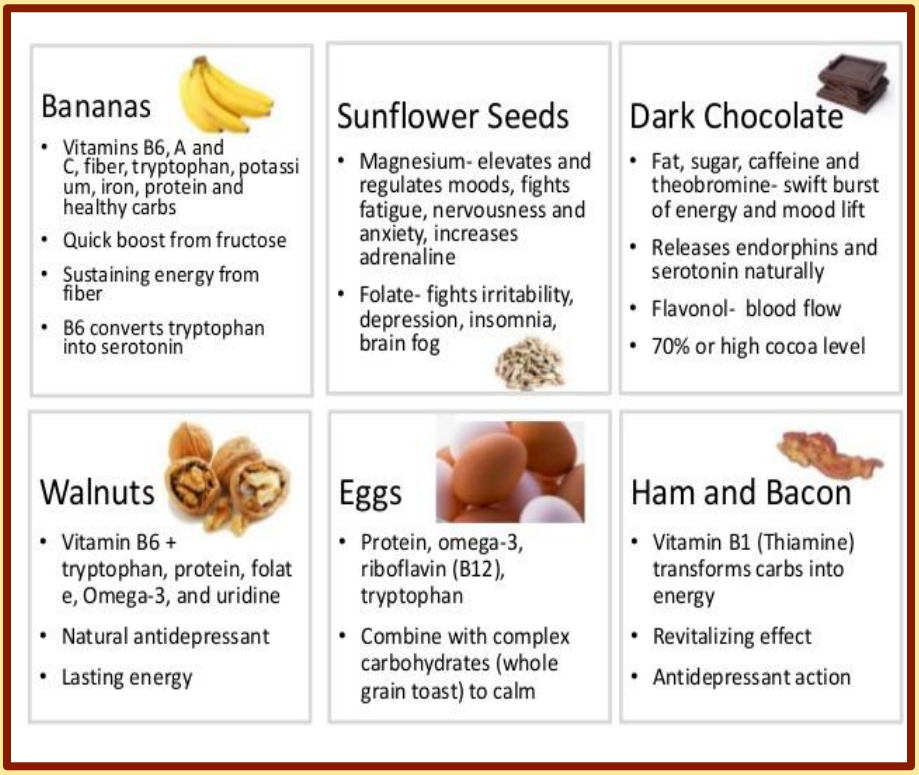




Warning!!!

Complex Carbs do NOT live in the same house as baked goods & desserts loaded with refined sugar, processed food (found in boxes or bags, tasty due to added sugars) or sodas & coffee drinks loaded with syrups, sauces and creams!!!

All Carbs are Not the Same so Avoid making False Equivalents!! Become familiar with the differences between Simple & Complex carbohydrates and comfortable recognizing the fructose gang which is driving global obesity with its Highly processed corn variants (corn syrup, fructose corn syrup and high-fructose corn syrup.)



Eating late at night can also affect serotonin levels before bed—a spike in serotonin before sleep can cause sleeplessness, which can also negatively affect your natural serotonin levels, which brings us to the next point:

Sleeping longer and deeper has been shown to boost serotonin concentration in platelets around the body during waking hours. Wrap up your day by dimming the lights in your house in the evening before bed. Try to disconnect yourself (avoid watching TV or looking at mobile devices) before sleep and wind down in other ways (reading a book, stretching, meditating). Keep in mind that blue light from electronic devices inhibits melatonin production and visual stimulation can trigger excitatory neurons, both of which may keep you awake for longer and impinge upon the quality of sleep you get.

Higher exposure to sunlight/white light and subsequent vitamin D production can increase levels of serotonin in the CNS, although evidence relating effects to serotonin are indirect thus far: Summer levels of serotonin have been found to be higher than winter levels and serotonin synthesis increases with increased hours of exposed sunlight.

Correlations between exercise's anti-depressant effect and raising of serotonin levels in the brain have been drawn in numerous articles but mechanisms are still not fully understood. However, exercise increases levels of tryptophan (the precursor to serotonin) in the brain, and these elevated levels persist after exercise. Exercise also increases the firing rate of serotonin neurons, resulting in an increase the release, synthesis and availability of serotonin, which in turn have an antidepressant effect on the CNS, ultimately elevating mood and dampening pain and physical symptoms.

Resources: *Excerpts within this article taken from the following texts:

Sue Penckofer, PhD, RN, Joanne Kouba, PhD, RD, Mary Byrn, BSN, RN and Carol Estwing Ferrans, PhD, RN, FAAN. 'Vitamin D and Depression: Where is all the sunshine?" Issues Mental Health Nursing. 2010 Jun; 31(6): 358-393. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2908269/

Jurie Rossouw. 'Serotonin and its Unusual Role in the Brain. (Internet Article). Driven. https://home.hellodriven.com/serotonin-role-in-brain.html

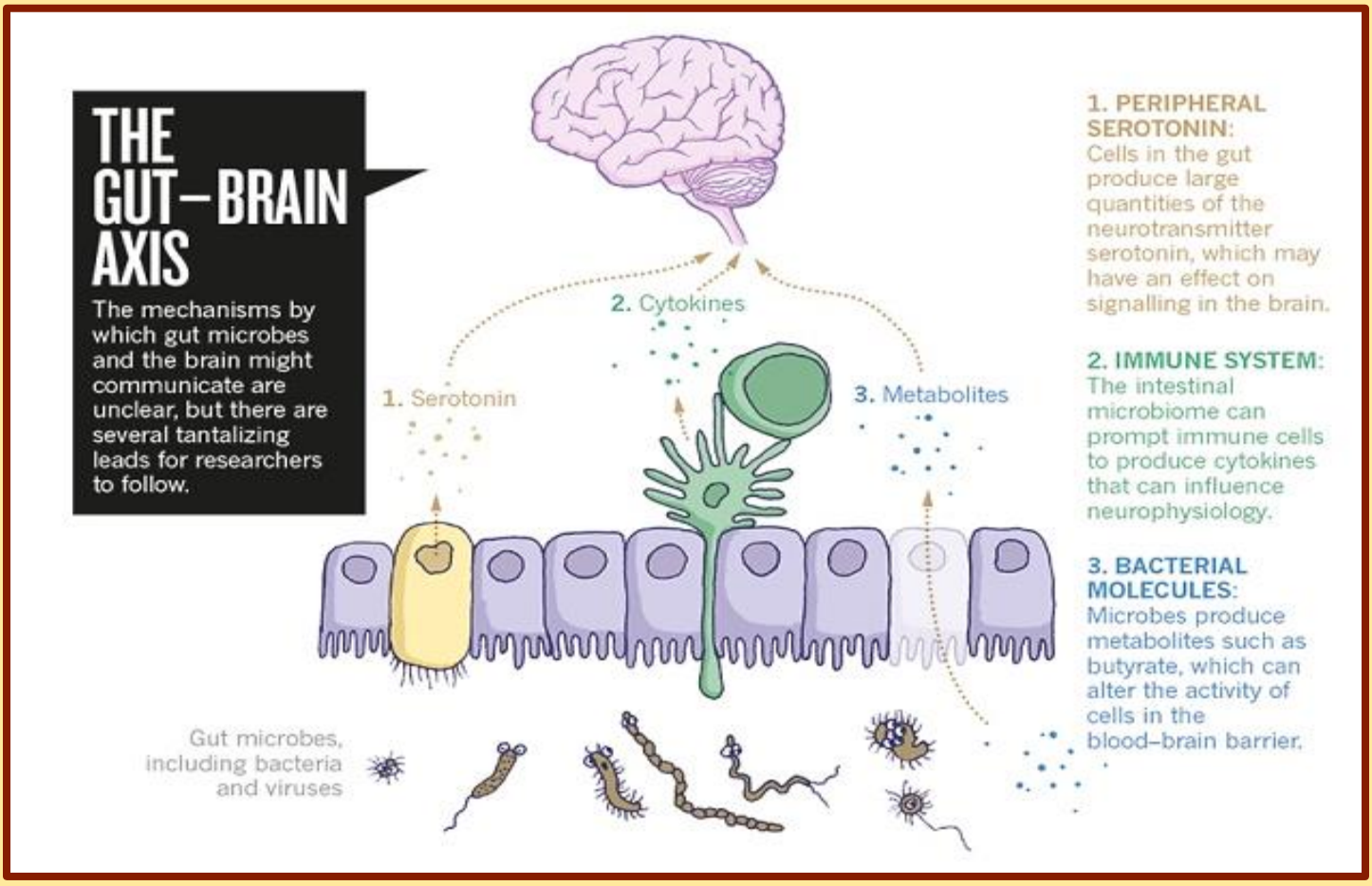
Marya S. Sabir, Mark R. Haussler, Sanchita Mallick, Ichiro Kaneko, Daniel A. Lucas, Carol A. Haussler, G. Kerr Whitfield, Peter W. Jurutka. 'Optimal vitamin D spurs serotonin: 1,25-dihydroxyvitamin D represses serotonin reuptake transport (SERT) and degradation (MAO-A) gene expression in cultured rate serotonergic neuronal cell lines.' Genes & Nutrition. 2018; 13: 19. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6042449/

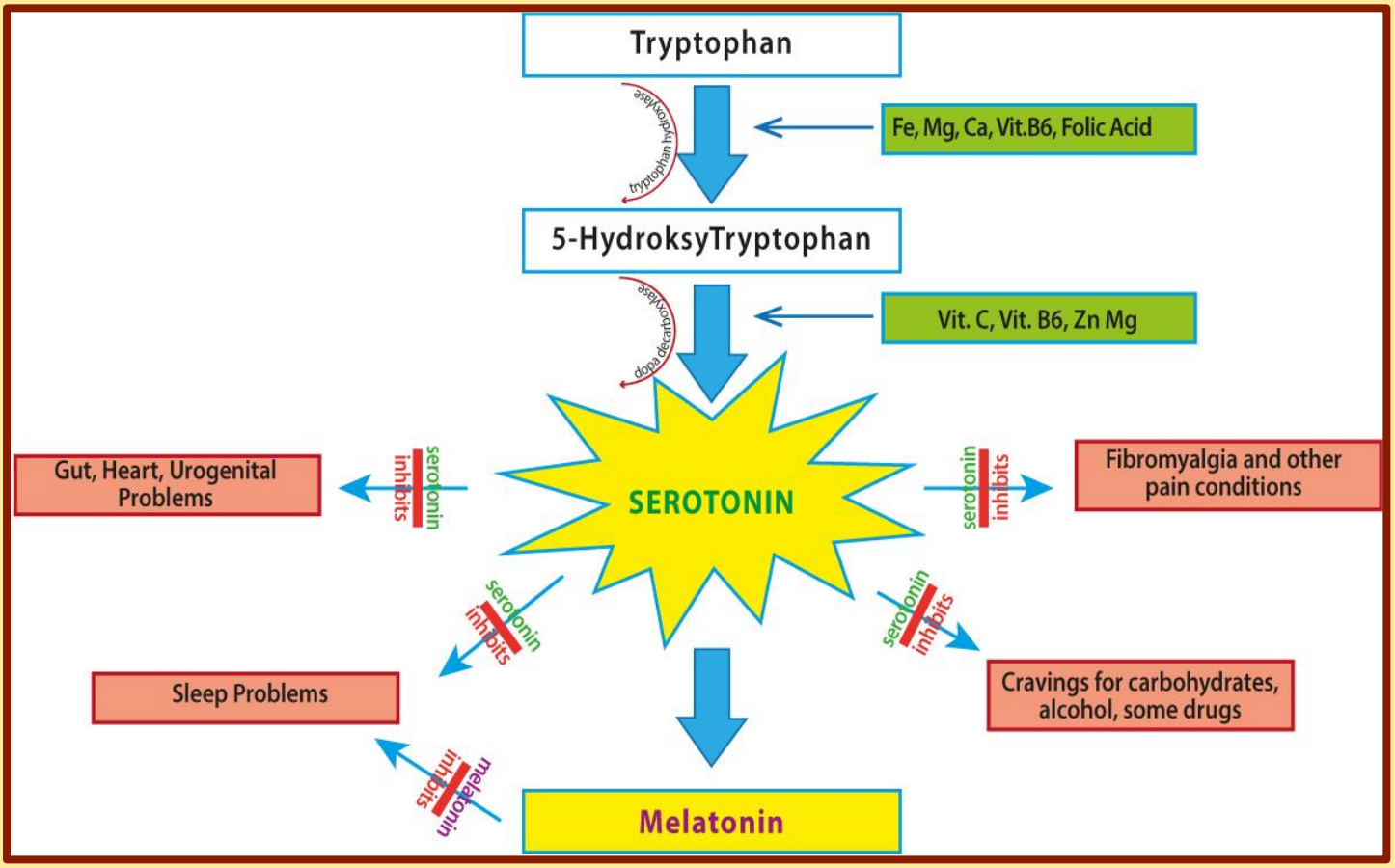
Melvin Sanicas. 'Depression & Vitamin D Deficiency: Is There a Connection? (Internet Article). Medium. May 27, 2017. https://medium.com/@melvin.sanicas/depression-vitamin-d-deficiency-is-there-a-connection-1d2fefb45da2

https://www.intechopen.com/books/serotonin-a-chemical-messenger-between-all-types-of-living-cells/immuno-thrombotic-effects-of-platelet-serotonin

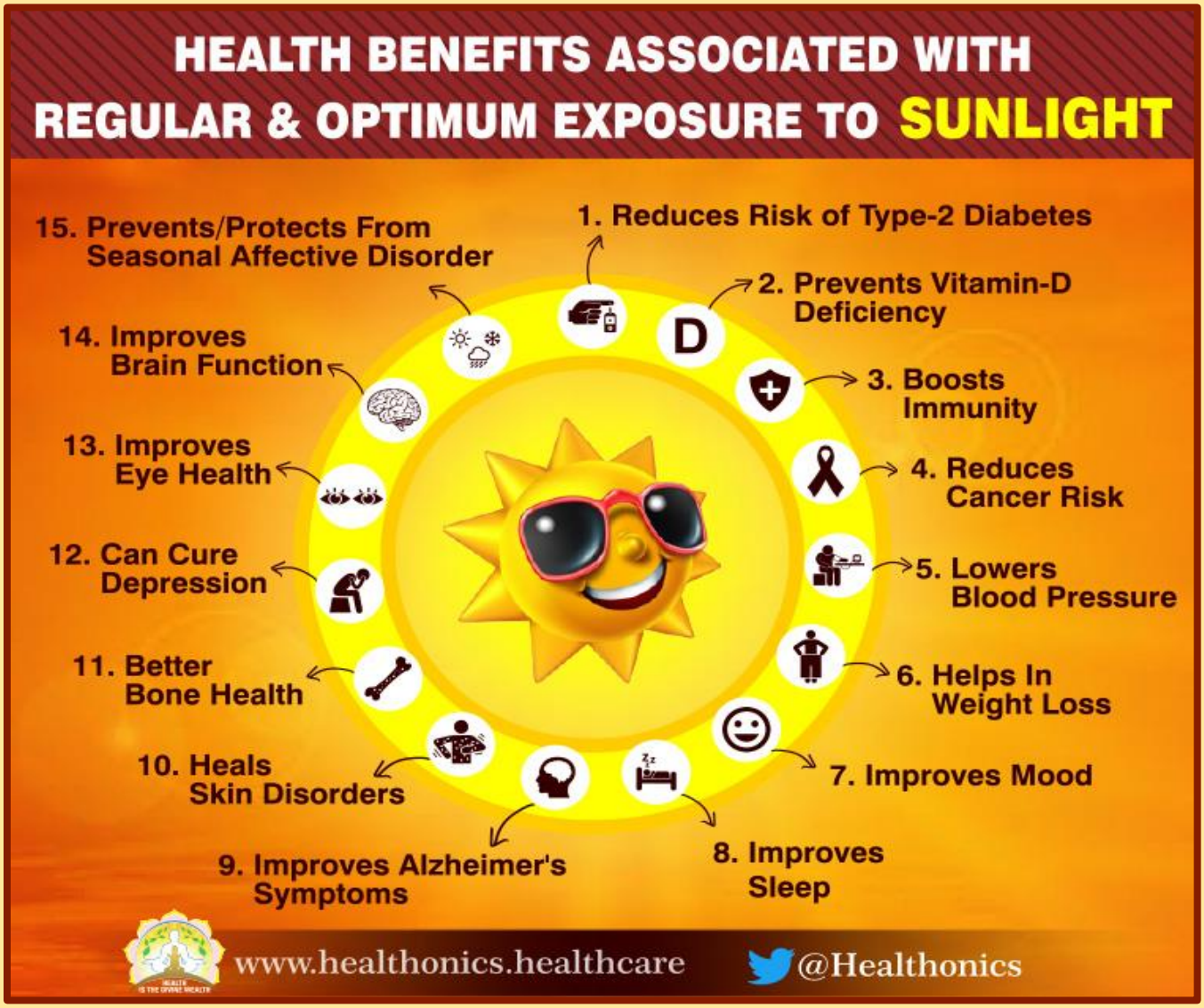
https://somaticmovementcenter.com/serotonin-melatonin/

Takeaway 1:


THE GUT–BRAIN AXIS
The mechanisms by which gut microbes and the brain might communicate are unclear, but there are several tantalizing leads for researchers to follow.
1. Serotonin
2. Cytokines
3. Metabolites
Gut microbes, including bacteria and viruses
1. PERIPHERAL SEROTONIN: Cells in the gut produce large quantities of the neurotransmitter serotonin, which may have an effect on signalling in the brain.
2. IMMUNE SYSTEM: The intestinal microbiome can prompt immune cells to produce cytokines that can influence neurophysiology.
3. BACTERIAL MOLECULES: Microbes produce metabolites such as butyrate, which can alter the activity of cells in the blood–brain barrier.


Tryptophan
tryptophan hydroxylase
Fe, Mg, Ca, Vit.B6, Folic Acid
5-HydroksyTryptophan
dopa decarboxylase
Vit. C, Vit. B6, Zn Mg
SEROTONIN
Gut, Heart, Urogenital Problems
serotonin inhibits
Fibromyalgia and other pain conditions
serotonin inhibits
serotonin inhibits
Sleep Problems
serotonin inhibits
Cravings for carbohydrates, alcohol, some drugs
melatonin inhibits
Melatonin

Takeaway 2:



Note: Sunlight exposure is often associated with an increase in cancer risk. While avoiding too much sunlight and sunburns, specifically, is wise to prevent skin cancer occurrence, adequate vitamin D exposure helps REDUCE cancer risk and is vital for every individual's cancer preventative measures.

Sunlight, in the correct doses, is essential for good health.

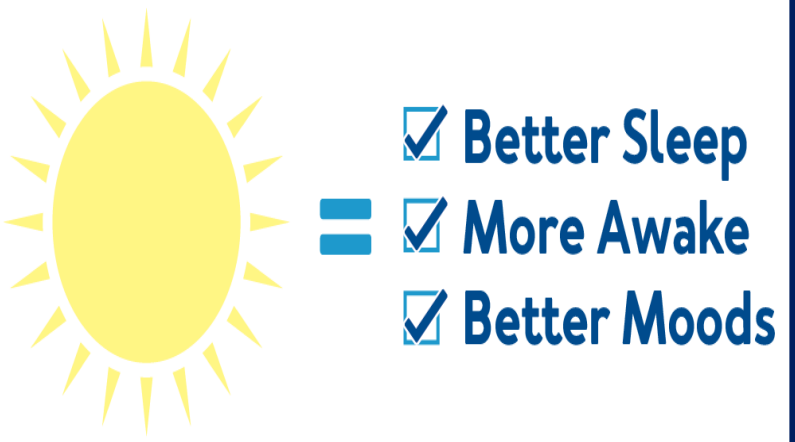
Light to Balance the Dark: Vitamin D for a Good Night's Sleep

Historically, human civilization evolved around patterns of exposure to bright natural light during the day and total darkness (or very dim light) at night. Work was agrarian, accomplished outdoors by the light of the sun/cycle of seasons and the advent of a darkened night sky preluded limited recreation by candlelight/dim light and sleep.

It was only in the recent past (circa 1880) with the inception of the Industrial Revolution and popularity of Edison's incandescent light bulb that we began to move more of our work indoors, artificially light up the night, & provide ample opportunities to extend the time we spent working/playing/not sleeping well past sun down.

Fast forward approximately another 150 years and our window to sleep and rest with the natural cycle of darkness has shrunk by multi-tiered assaults, compromised by light pollution, smart devices, shift work, travelling vehicles & titillating food/recreational choices.

What hasn't changed is the dependence of our body systems on natural light to keep us healthy. Our eyes and skin actually *require* exposure to daylight in order for our brains and bodies to function optimally. Likewise, we rely upon darkness so that our circadian clock can regulate our sleep cycle and other bodily rhythms and functions.



"Despite this, Americans spend a remarkable 87% of their days indoors and another 6% in their cars. Almost the entirety of our interaction with the modern world is taking place within walls of one sort or another—under artificial lighting and in controlled environments."

[Perlmutter & Perlmutter; p. 90]

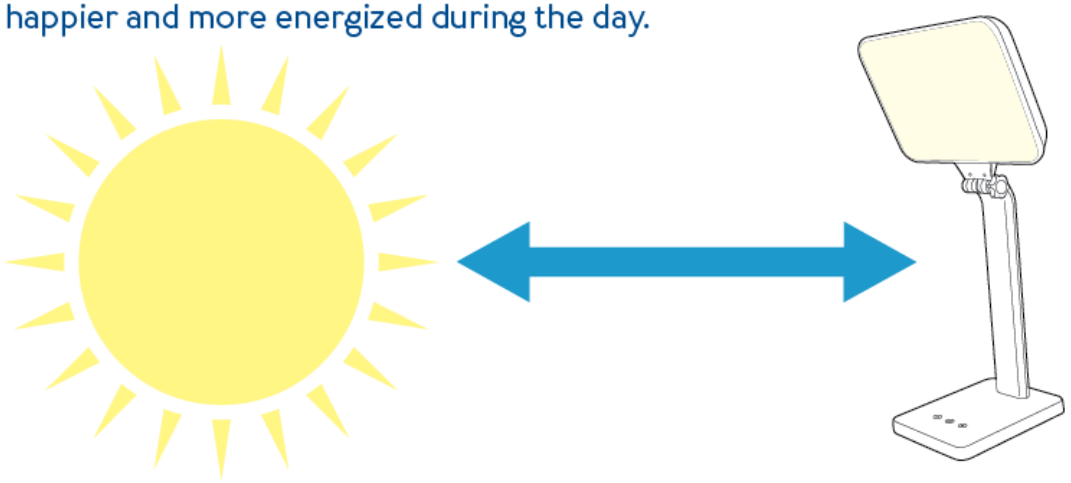
Spending our lives indoors has led to increasing rates of depression, poor cardiovascular health, nearsightedness, asthma and insomnia. Childhood rates of mental illness, nearsightedness, asthma and poor cardiovascular fitness have increased significantly in recent years as well, and children reportedly experience symptoms of seasonal affective disorder (SAD) during summer months simply because they spend most of their day indoors.

Part of the reason for the rising rates of these conditions is that we need exposure to daylight in order to produce adequate serotonin and its eventual derivative melatonin. If you're not spending time outside every day, it is 1)-likely your serotonin/melatonin synthesis has been compromised & 2)-your health is likely suffering because of it.

In fact, the brighter sunlight we're exposed to, the more serotonin we produce. Scientists have found that our SKIN produces serotonin when exposed to sunlight as well. Like our gut and brain, our skin produces serotonin for local use: regulation of the immune and vascular systems of the skin. Researchers in Germany found that just 15-20 minutes of UV-A exposure through photostimulation resulted in increased levels of serotonin in the blood.

Researchers have shown that bright light stimulates serotonin production and reduces depressive behavior. They have also shown the reverse—that light deprivation produces depressive behavior. Serotonin production is one of the reasons why bright light therapy (BLT) is now used to treat seasonal and non-seasonal depression.

Bright Light Therapy is eye exposure to an artificial light source that emits strong light, mimicking sunlight. This aids our bodies in the production of melatonin and serotonin when we have limited sunlight exposure, such as in the fall and winter. Supplementing low sunlight exposure with an artificial source can help us fall asleep more easily at night and feel happier and more energized during the day.



Balancing the Hazards & Benefits

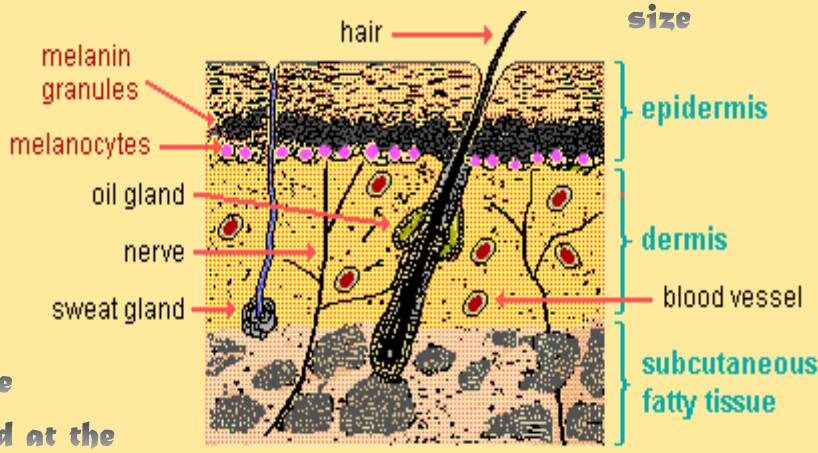
Sunlight is no exception to the old tried-&-true adage:

Everything in Moderation

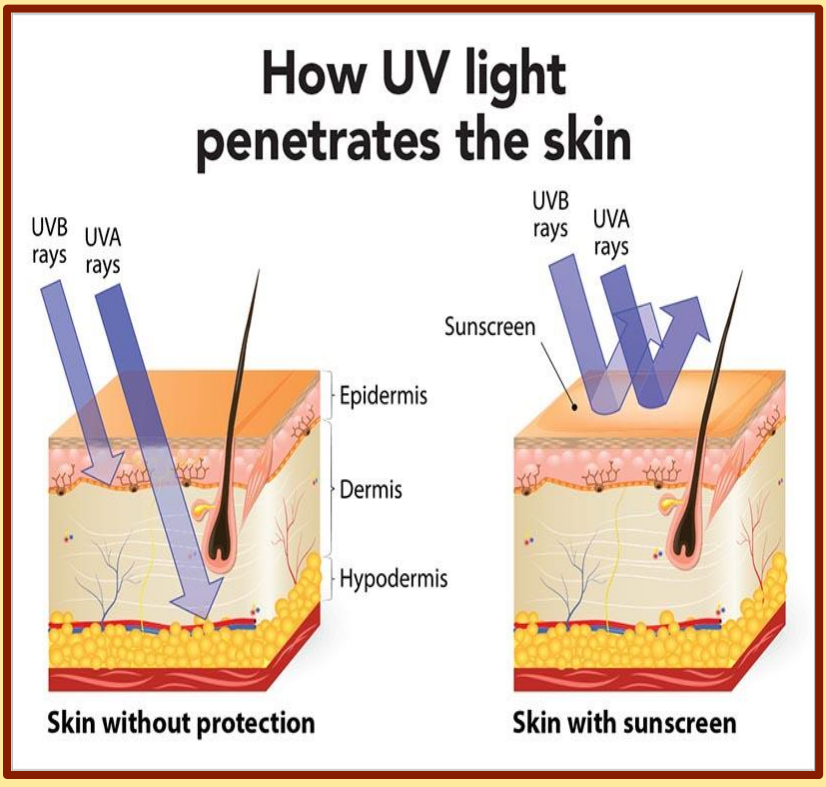
We all know of the hazards accompanying too much time in the sun and accumulation of too many ultraviolet (UV) rays...sunburn, wrinkles, eye damage, sun damage, melanomas and skin cancers, to name a few. However, in moderate amounts and during the right window of time, the immensity of scope and importance of scale that vitamin D provides for surprising facets of our health is irrefutable: the long-reaching and numerous benefits of these same rays cannot be understated! Let's venture into a quick exploration of the formula that manages to selectively strike the middle ground and walk the fine line, providing us maximum benefits while mitigating the risks of deleterious damage.

How it Works

In a nutshell, our skin contains an intrinsic shield against harmful rays of the sun called melanin. Skin (and hair) color is due primarily to the presence of melanin, a pigment controlled by at least 6 genes. There are 2 forms of melanin that occur in varying proportions and individuals differ in both concentration and size of melanin granules, all of which contributes to the composition of skin color unique to each individual.



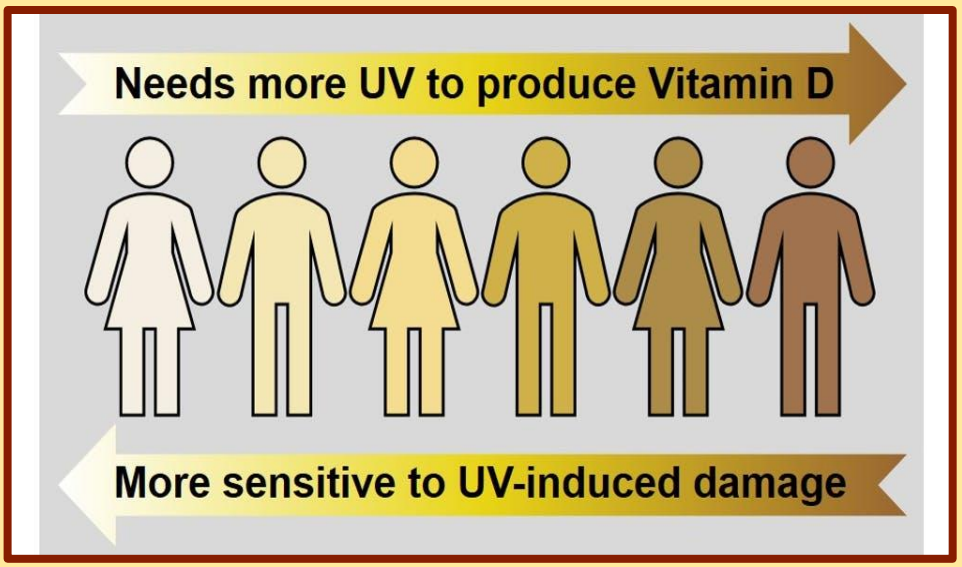
Melanin (not to be confused with the hormone melatonin!) is normally located in the epidermis or outer skin layer. It is produced at the base of the epidermis by specialized cells called melanocytes. These cells have photosensitive receptors similar to those in the eye that detect ultraviolet radiation from the sun and other sources. In response, they produce melanin within hours of exposure. Tanning is primarily an increase in the number and size of melanin granules due to the stimulation of ultraviolet radiation.



It would be harmful if melanin (or sunscreen/other preventative measures) acted as a complete block or impervious shield. A certain amount of shortwave ultraviolet radiation MUST penetrate the outer skin layer in order for the body to produce serotonin (UV-A) and vitamin D (UV-B), both of which are vital in bolstering our immune systems to prevent a wide range of cancers & defend our bodies against fungal, bacterial and viral infections, such as the common flu & Covid-19.

Shields Up!

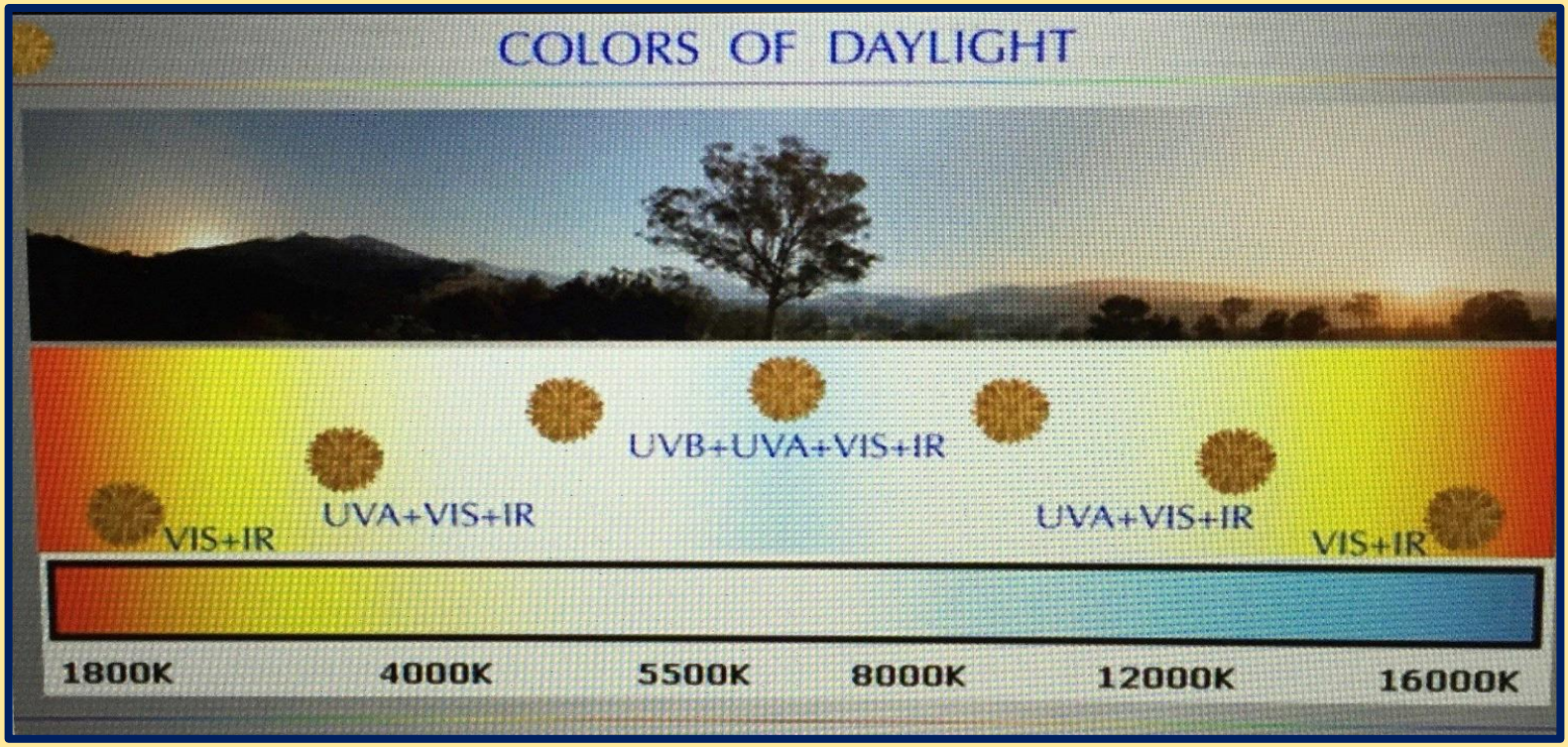
Instead of deflecting rays, the pigments in our skin (melanin) **absorb** UV rays from sunlight when bare skin is exposed to sunlight (<u>without</u> the chemical block of sunscreen). This UV absorption then **activates** specific genes which in turn produce bioactive products that are stored, processed into new hormone-like compounds, and then used for important bodily functions later, such as vitamin D & serotonin synthesis , regulation of circadian rhythms, reducing chances of cancer, reducing chances of major chronic diseases, improving mood/alleviating stress & anxiety. In other words, through its absorptive power melanin selectively turns solar radiation into a positive up-regulation of genes which we **absolutely require** for essential healthy bodily function.



Through its absorptive power, melanin directly shields and protects structures in and below the skin against free, UV-induced radicals (rogue elements that cause cellular/genetic damage) created by UV and visible light radiation. Those with darker skin (more melanin pigment, increased absorptive power) are more protected from sunburn/skin damage but also produce vitamin D more slowly. Those with lighter skin (less melanin pigment, decreased absorptive power) burn more easily in the sun but produce vitamin D more quickly.

The Healing Window

Science is starting to wake up to the fact that MORNING light__ the composition of light found between 8 and 10 AM__ is equipped to dexterously thread this needle for us: able to deliver in full measure BOTH benefits of AND safeguards from the sun.

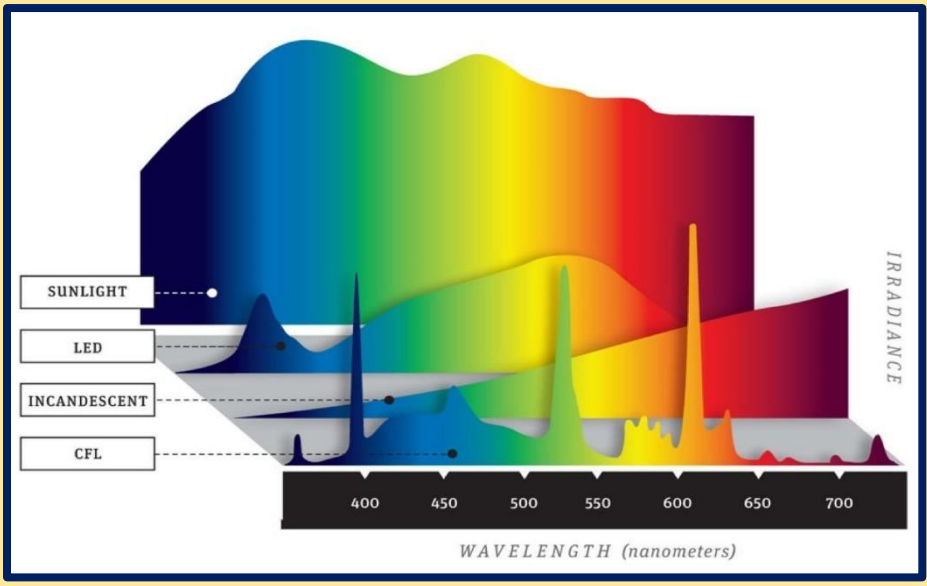


Concept of Note: *Not All Light is Created Equal!* Sunlight frequencies and wavelength combinations transition through different amalgamations at different times of day (above). The light at 8 AM is not the same light that we are exposed to at midday between the hours of 11 and 1!! As the composition of light is in constant flux throughout the day, so are the benefits and risks we accrue. *Timing Matters!*

Likewise, UV light within sunlight has other frequencies contained within it naturally that make it a different kind of stimulus for our cells for healing than that of:

1)- UV light frequencies that have been separated from other frequencies.

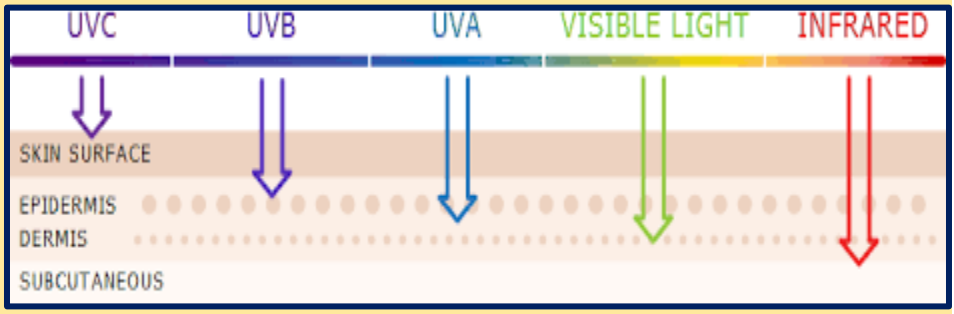
i.e.,



2)-artificial light sources which tend to predominate at one end of the spectrum, i.e., more damaging blue light (LED, fluorescent) or more soothing red light (incandescent, candlelight). *Type Matters!*

Focusing the Lens

AM Light = UV-A + VIS + IR



UV-A light increases a protein made in the brain called POMC that is processed into

1) melanocyte-stimulating hormone: stimulates melanin production & absorptive powers as well as appetite & energy homeostasis. Cue checks & balances for metabolism regulation.

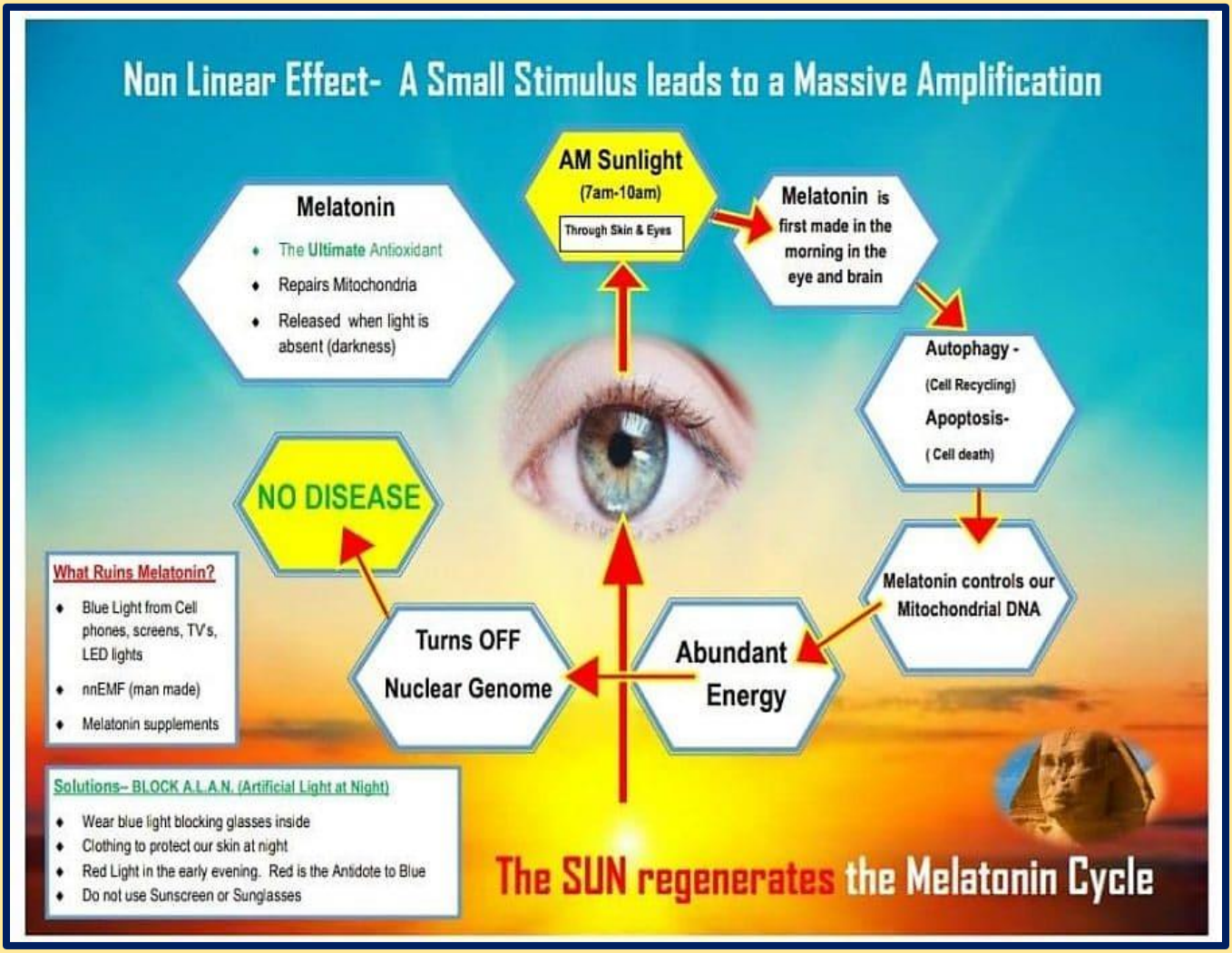
2) adrenocorticotropic hormone: regulates glucocorticoids from adrenal cortex (hello, cortisol balance). Cue calming & anti-inflammatory influences to relieve irritation/local inflammation by UV-exposed skin

3) Histidine: morning light increases amounts of this amino acid in the skin. Histidine's chemical structure allows it to absorb massive amounts of UV-A light which lowers erythema (reddening of skin due to inflammation) production in the skin. Cue improving our "solar callus" to offset risks of extended UV light exposure later in the day.

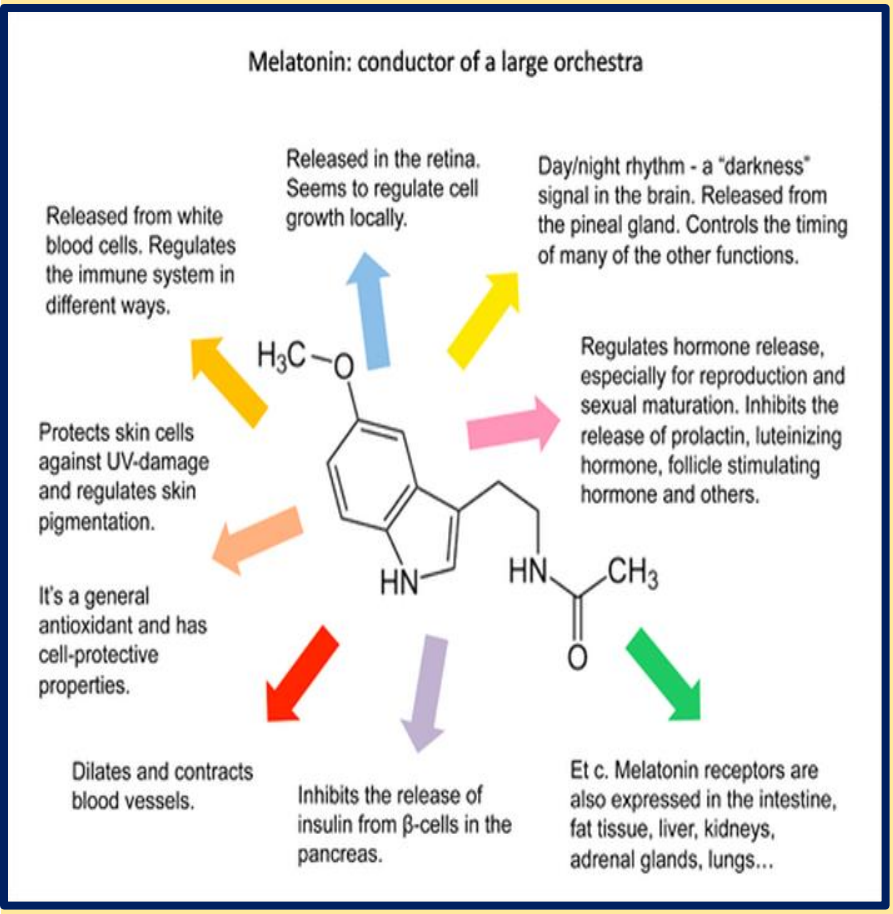
4) B-endorphins (naturally occurring form of opiate): stimulates opioid receptors. Cue pleasure, analgesic effects that dampen pain & affect mood/behavior.

According to Dr. Jack Kruse, neurosurgeon, "...It turns out that the combination of [ultraviolet (UV) and infrared (IR)] solar light humans are designed to get in the AM also pre-treats the skin to lower inflammation." The fact that UV light induces a small opiate (B-endorphin) response is nature's way of reinforcing the importance of this mechanism. Kruse also observes that both UV and infrared light are the most plentiful together in morning light received between 8 and 10 AM. Infrared light (composing 42% of sunlight, dominate in AM sunlight) helps enhance the absorption of UV rays in a healthy way as opposed to one being overloaded and sunburnt when out in the middle of the day. Furthermore, the fact that morning light (UV/IR combo) works in unison to create this circumstance portrays something deep about sunlight importance..."mood will be altered by a chronic lack of AM life."

Additionally, through morning light and the POMC protein many other proteins are cleaved (clipped or cut), thereby stimulating further pathways supporting dopamine synthesis (neurotransmitter; alertness, pleasure/reward center), metabolism (appetite, fat breakdown, steroid synthesis, sexual activity) and melatonin creation in the eye and skin (immune protection, circadian rhythm regulation).



We are already aware that healthy levels of serotonin (derived from morning light) increase our chances to improve mood, regulate pain perception as well as for maintaining healthy levels of melatonin necessary in regulating circadian rhythms and improving sleep quality. To review, after synthesis by the pineal gland, melatonin is then released into the bloodstream and distributed throughout the body. Research shows that melatonin reaches maximum levels between 2:00 AM and 4:00 AM in healthy individuals. As daylight approaches and our retinas detect increasing levels of light, melatonin levels fall. During the daytime, melatonin levels are low or undetectable.



In addition to the pineal gland, melatonin is produced throughout the body for local use. Photoreceptors of the retina (eye) produce melatonin to help protect the health and function of the eye. The gastrointestinal tract produces melatonin to regulate the health and function of the intestinal epithelium (gut lining), enhance the immune system of the gut and relax the GI muscles (anyone else experiencing serotonin déjà vu here?). And melatonin produced by the skin protects against oxidative stress and ultraviolet radiation-induced damage to the skin (not to be confused with the epidermal pigment melanin!)

Melatonin is both an antioxidant and free radical scavenger and plays an important role in our innate immune system. Melatonin deficiency weakens the immune system, making us more susceptible to viral and bacterial infections, autoimmune conditions, inflammation and even cancer. Melatonin can inhibit the growth of cancerous tumors and may help prevent breast, prostate, gastric and colorectal cancers. It also protects healthy cells from radiation-induced and chemotherapy-induced toxicity, so it can be used as an adjuvant of cancer therapies.

While we tend to be most aware of melatonin's function in the brain—its effect on our sleep patterns—about 500 times more melatonin is produced in our gut than in our brain! As such, local melatonin deficiency may lead to health problems in the GI tract. In the gut melatonin acts as a free radical scavenger, reduces secretion of hydrochloric acid, stimulates the immune system and increases microcirculation. It protects the mucosa (protective lining) against various irritant and heals lesions, including stomatitis, esophagitis, gastritis and peptic ulcers ('*itis*'=inflammation; mouth, esophagus, stomach and small intestine ulcers).

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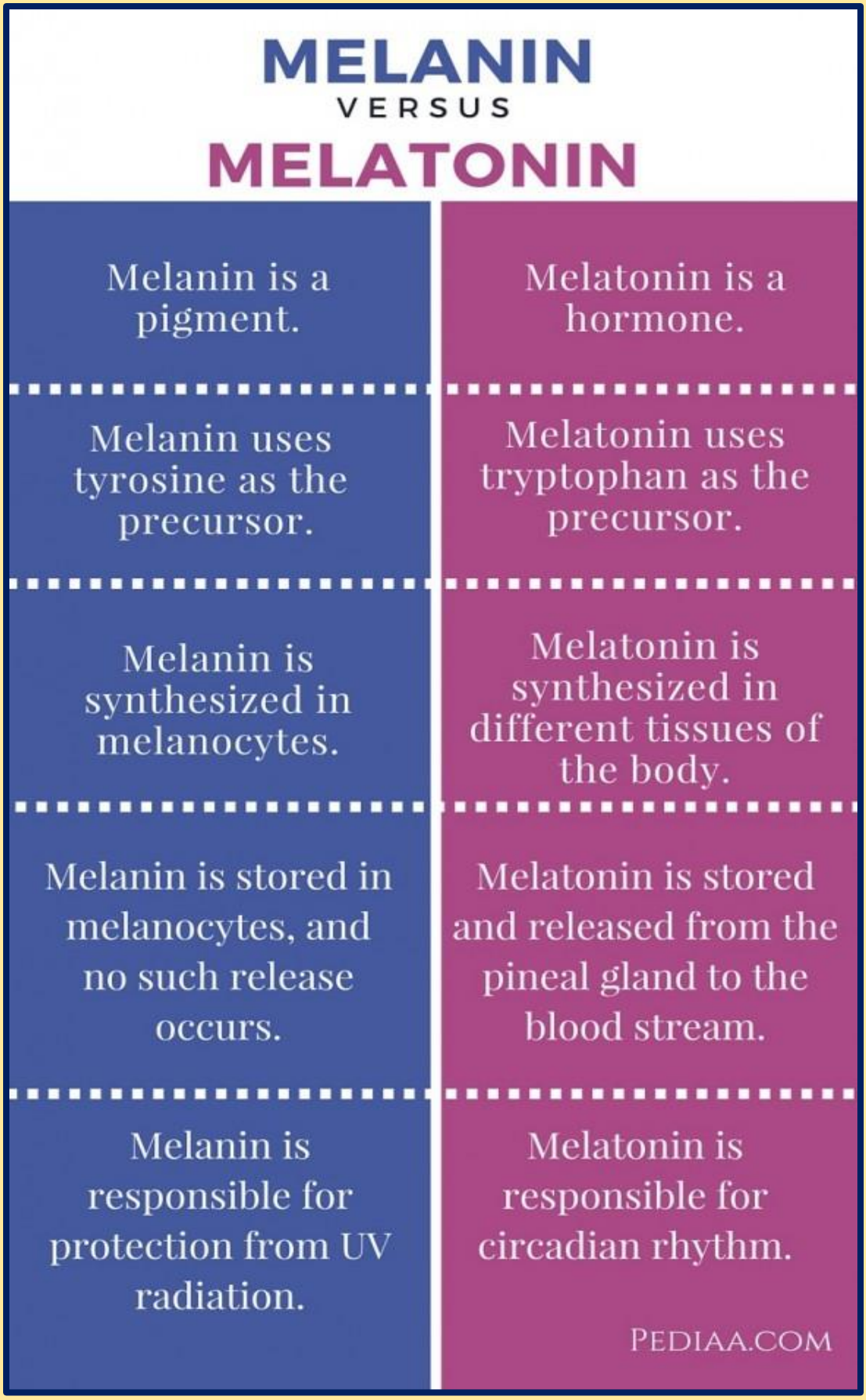
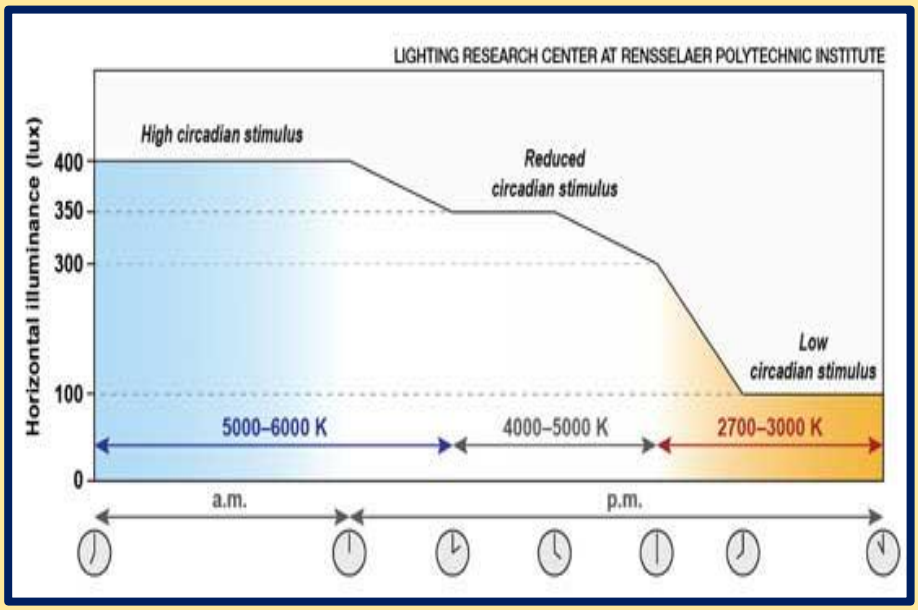

MELANIN
VERSUS
MELATONIN
Melanin is a pigment.
Melatonin is a hormone.
Melanin uses tyrosine as the precursor.
Melatonin uses tryptophan as the precursor.
Melanin is synthesized in melanocytes.
Melatonin is synthesized in different tissues of the body.
Melanin is stored in melanocytes, and no such release occurs.
Melatonin is stored and released from the pineal gland to the blood stream.
Melanin is responsible for protection from UV radiation.
Melatonin is responsible for circadian rhythm.
PEDIAA.COM



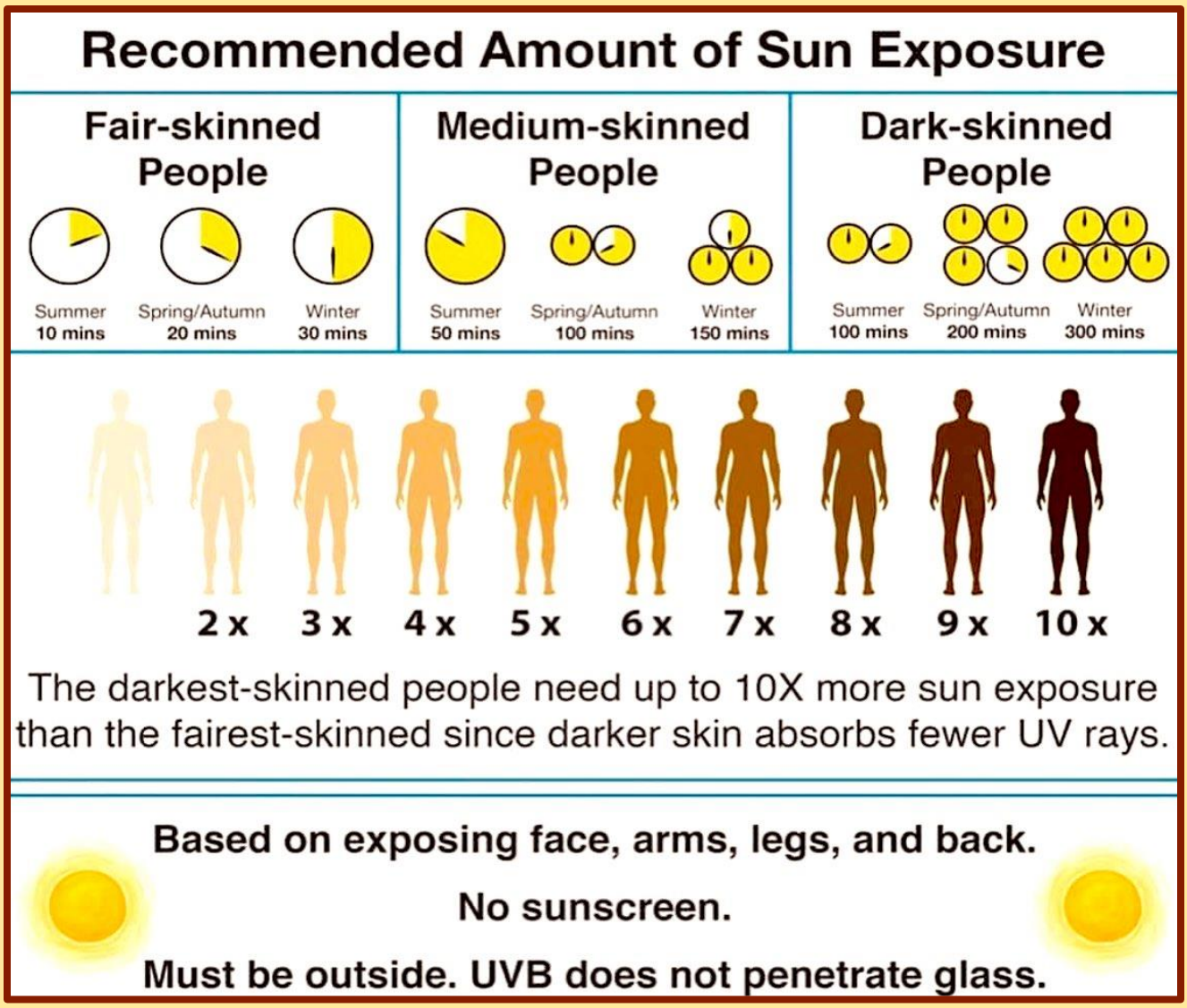
Timing is Crucial

Being exposed to natural light in the morning (without sunglasses or sunscreen) advances our circadian clock, stimulating melatonin production earlier in the evening, making it easier to fall asleep at night and improving its quality and duration. Daylight exposure later in the day has not been shown to have the same positive effects on circadian rhythms. In addition to regulating our sleep-wake cycle, circadian rhythms also regulate hormone production, appetite, core body temperature, brain wave activity, and cell regeneration. Keeping our circadian clock properly set and "on time" is vital to our overall health.

For all these reasons, the best time of day—morning (between 8 and 10 AM) —has been established scientifically as the optimal window that provides an array of health benefits without the increased risk for adverse effects found later in the day.

But how much is adequate? How much isn't enough? Too much? Where is that sweet spot of sun exposure that doesn't increase cancer risk??

According to the vitamin D council, there isn't an exact science or way to know how much each person will produce, though it can roughly be estimated according to skin color. Every person is different. The fairer a person is, the quicker they meet their vitamin D needs when exposed to the sun and will typically only need about 10-15 minutes of exposure. For someone of darker complexion, they'll need to spend a little more time to get the amounts they need, sometimes up to 2 hours.



What about the other benefits of sun exposure, such as increased endorphin exposure, circadian rhythm regularity, optimal melatonin levels and general chronic disease prevention?

Unfortunately, there aren't any studies that narrow down the numbers as of yet. But, generally speaking, if a person pursues their daily morning vitamin D exposure, they're likely to accrue these benefits in the exact same golden window. If we become early risers and maximize our sunny window of opportunity, our bodies will thank us.

Resources: *Excerpts within this article taken from the following texts:

https://primalherb.com/the-importance-of-early-morning-sunlight-you-need-to-know/

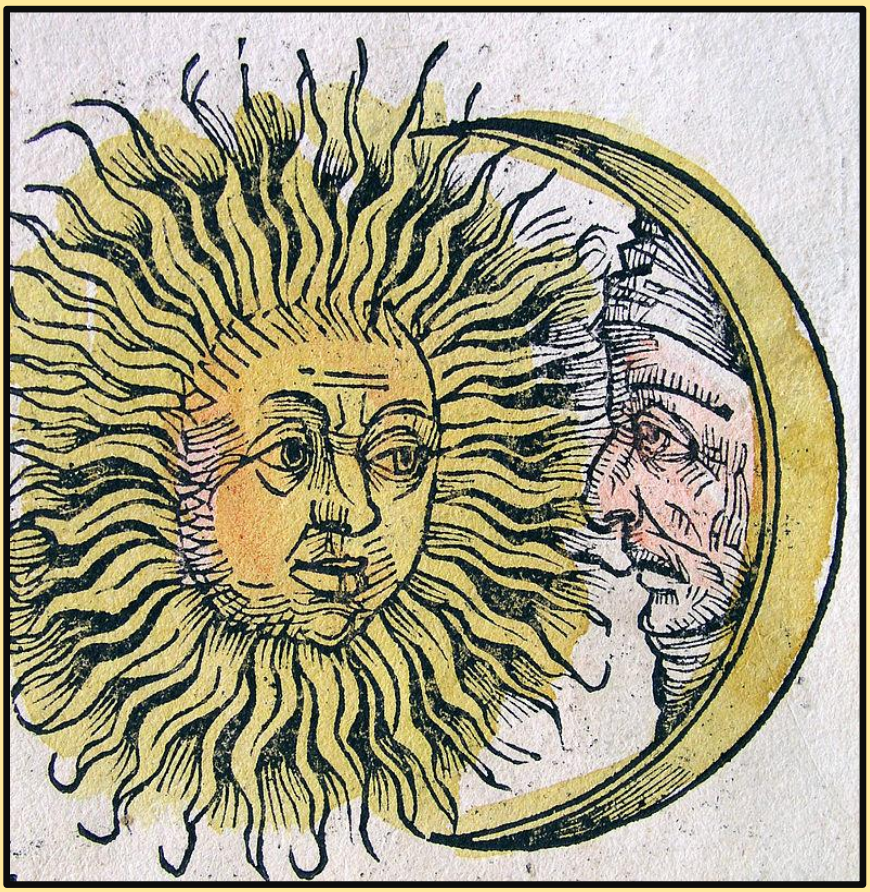
https://www.linkedin.com/pulse/time-rethink-your-truth-sun-jack-kruse/

https://somaticmovementcenter.com/serotonin-melatonin/

Takeaway:

Although the recent shift to indoor living is a big contributor to chronic disease as most of us live our lives deprived of the bright, natural light that is essential for health, this newsletter is neither denying or ignoring the very real threats posed by too much solar radiation, nor advocating against sun protective measures. Since we've depleted the ozone layer, we are, in fact, exposed to more injurious ultraviolet rays and these do increase our risk of developing sun damage, melanomas and carcinomas.

However, our biological processes, rhythms and defenses—our very well-being-- are all endangered when we do not factor in the necessity of daily solar exposure/absorption (albeit in small increments) into our survival equation and then undertake risk assessments, develop strategies to incorporate protective measures and make informed decisions about basking in the sun's light.



Not getting enough sun is just as harmful as getting too much sun. It's all about seeking the balance and prioritizing moderation.

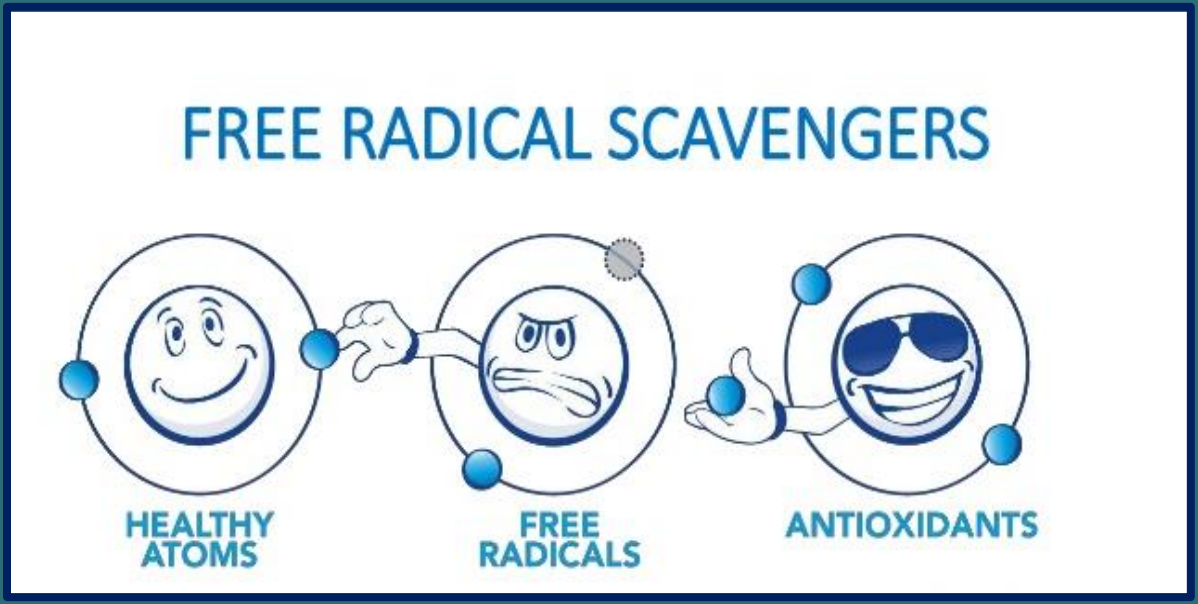
Instead of avoiding or blocking the sun completely, seek morning light between 8 and 10 AM. Choose to protect your skin and avoid long periods of time in direct sunlight during midday when sunlight is most intense, with UV-B added to the composition of morning light (UV-A + VIS + IR).

"If you spend much of the day indoors, find ways to make getting outside part of your regular routine. Get in touch with your primal need for daylight and darkness and their effects on your biological rhythms. Your brain and body will thank you for it!"

Wellness Word --- The Power of Antioxidants against Free Radicals

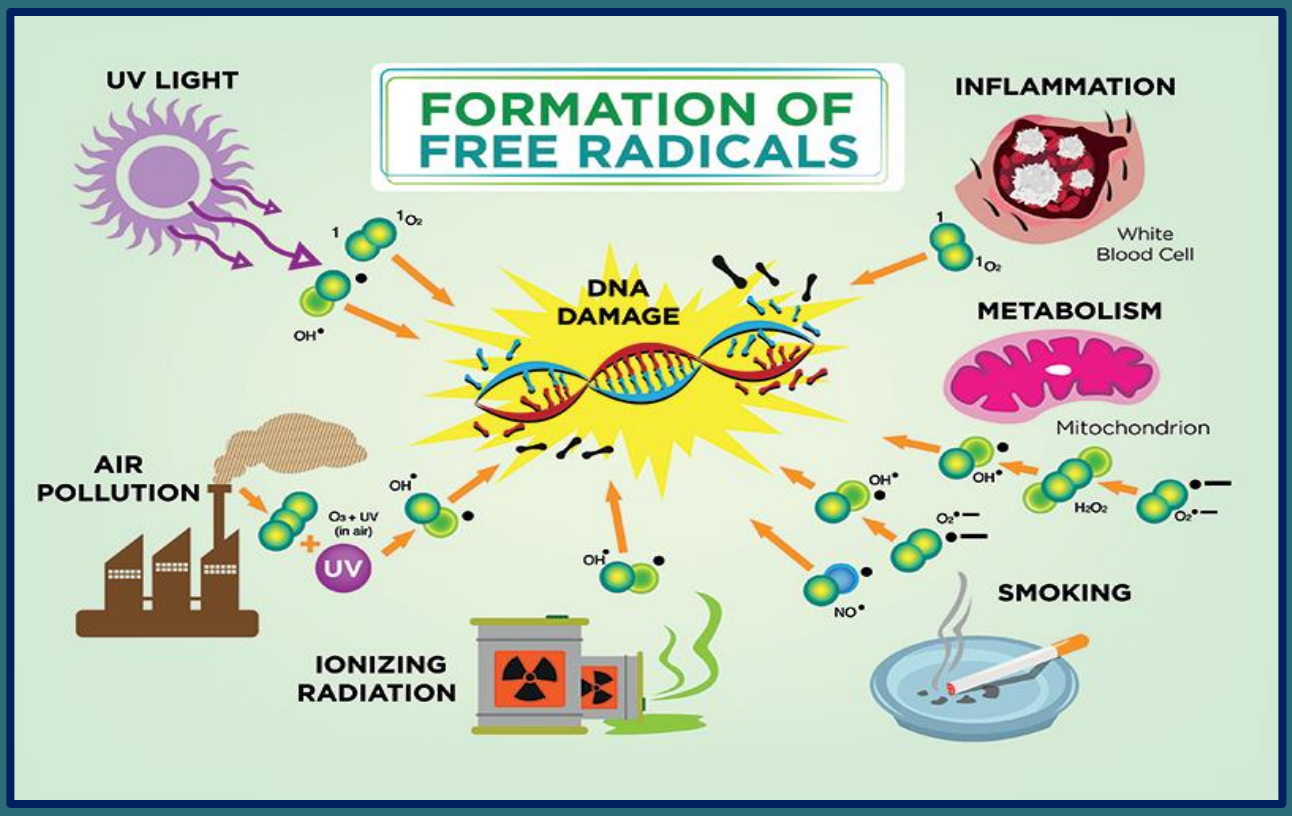
What are Free Radicals?

Free radicals are atoms, ions or molecules that contain an unpaired electron, which makes them unstable and highly reactive. In a process called oxidation, free radicals "steal electrons" from other molecules—fats, proteins, cell membranes, even DNA—altering the fundamental structure of the affected molecule. This sets off deleterious chain reactions by damaging a cell's genetic "blueprint," structure and ability to function. Over time, oxidative damage accumulates and contributes to aging and a variety of degenerative diseases.



Where are Free Radicals Most Likely to Attack?

- LDL Cholesterol: Increasing risk of cardiovascular disease via development of atherosclerotic plaques
- DNA: Increasing risk of cancer and aging
- Cell Membranes: Interrupting entry/exit composition to and from cell



Where do Free Radicals Come From?

Oxygen is an essential element for life and every cell in your body requires it for cellular metabolism. During cellular metabolism cells use oxygen to convert food into a form of energy the body can use, called ATP. Free radicals are produced as a natural byproduct of this process.

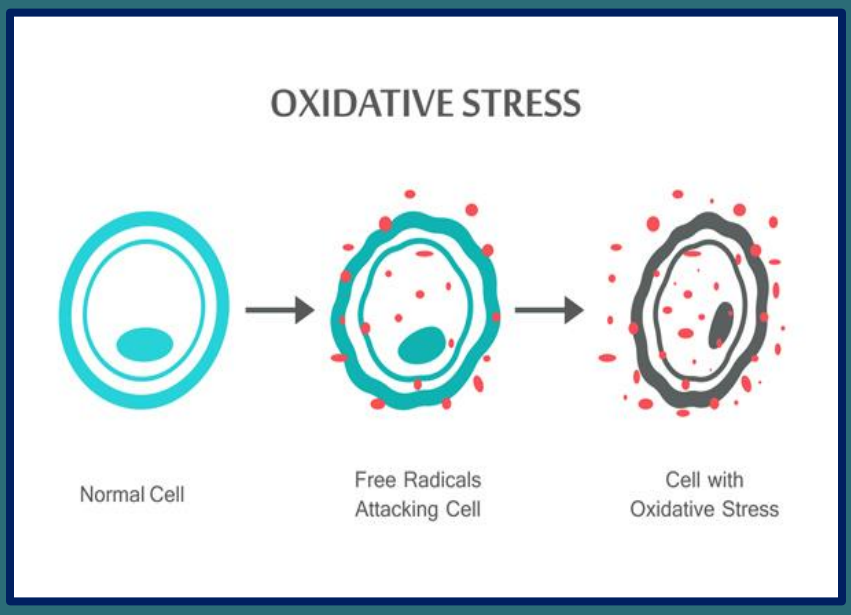
Intrinsically, other sources which generate free radicals and in turn to which free radicals contribute are:

- Inflammation
- Stress
- Illness
- Aging

Extrinsically, hazardous environmental sources, such as pollution, toxic metals, alcohol, cigarette smoke, radiation, industrial chemicals and medications, expose us to free radicals.

Food sources of free radicals are from cooked and processed meats. Because meat contains fats, those fats can also become oxidized when cooked at high temperatures. The iron found in meat, especially red meat, can also become oxidized. Preservatives used in processed meats, including sausages, bacon, ham, pepperoni, hotdogs, salami, corned beef and many deli meats, may also create free radicals. For these reasons, the American Institute for Cancer Research recommends avoiding processed meats and marinating meats you intend to grill.

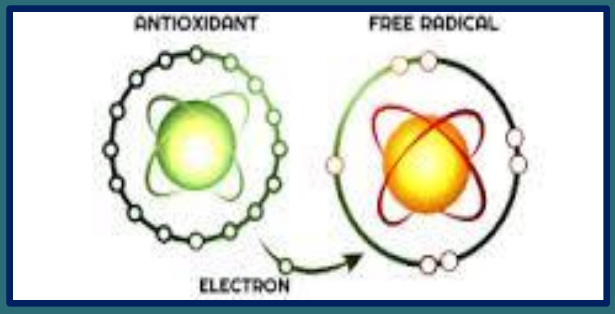
Completely avoiding free radicals is neither possible nor desirable. At low concentrations, free radicals are beneficial to the human body: Our immune systems use them to help defend themselves against pathogens. As in all things, however, proper balance is critical, and problems begin when free radicals are wildly out of balance. When free radicals overwhelm your body, it leads to oxidative stress.



What is oxidative stress?

Oxidative stress is the damage that results from an imbalance between free radicals and your body's store of antioxidants. According to the free radical theory of aging, organisms age because of accumulated free radical damage to cells and DNA. The theory states that cumulative damage to cell components and connective tissue leads to wrinkles, decreased physical capability, increased susceptibility to disease and death. Though the free radical theory of aging remains controversial, oxidative stress contributes to degenerative conditions such as arthritis, heart disease, hypertension, Alzheimer's disease, Parkinson's disease, muscular dystrophy, etc.

The Power of Antioxidants Against Free Radicals



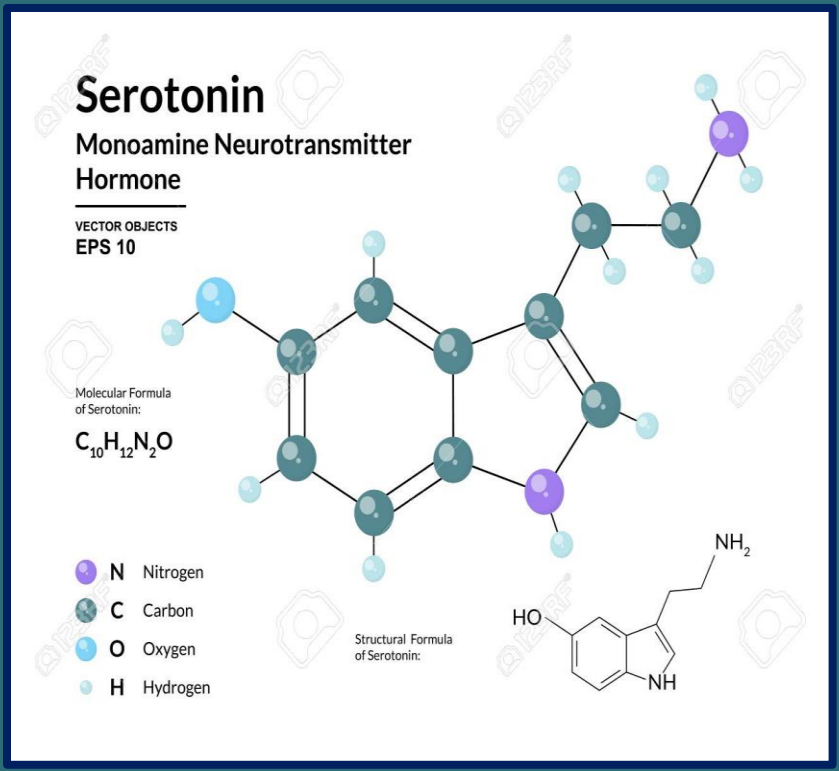
As we have determined, free radicals forage through your body looking for electrons to steal (or give away) and they are not picky. To achieve stability, they need a pair (i.e., a couplet) of electrons, and they frantically seek molecules to achieve this. Free radicals will take (or leave) an electron, whether it is available or not, including those in fragile DNA molecules, proteins, and fats. Antioxidants stop free radical damage to molecules by accepting or donating an electron to make it stable. Antioxidants are unique in that they remain stable when they donate an electron. Antioxidants sources are often discussed in terms of their free radical scavenging abilities. The "free radical scavenging activity" of antioxidants varies from one to the next (melatonin being a powerful one!).

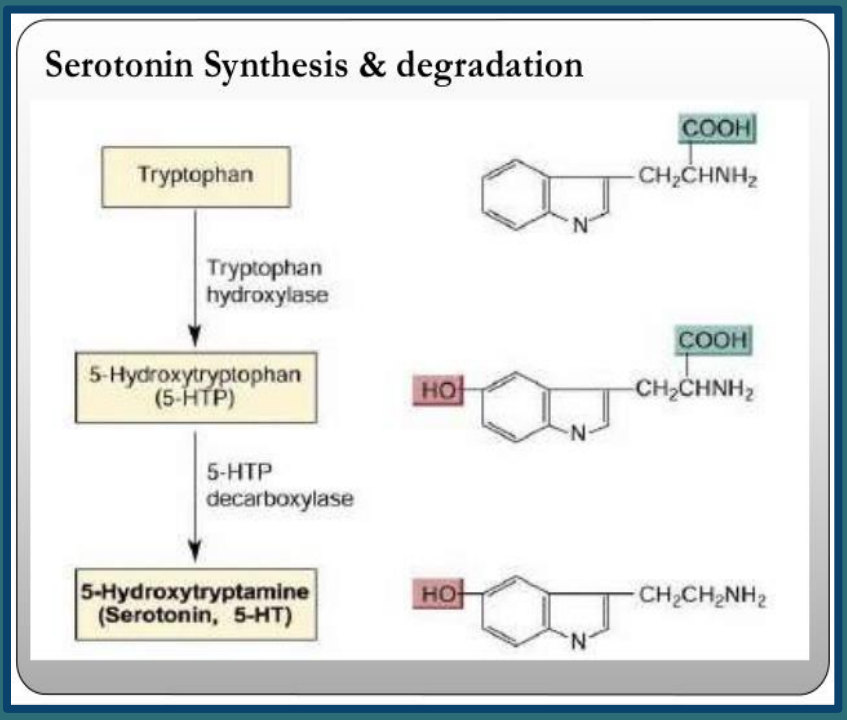
Important Antioxidants

The body naturally produces some antioxidants, like glutathione, ubiquinol and uric acid. You likely ingest many others through diet or supplements. Some of the strongest antioxidants come from fruits and vegetables through their unique plant-based compounds called phytochemicals. Ultimately, healthy living is the product of an intentional accumulation of healthy choices and a commitment to living a healthy lifestyle every day. By doing something as simple as planning fruits and vegetables into your snacks and meals, you provide a buffer to free radical exposure from those external and environmental factors that are outside of our ability to control, plan or decide.

Hormone Interplay: The Skinny on Serotonin

So far we have discussed serotonin's importance in our sleep-wake cycles serving as a precursor to melatonin and touched on its relevance in regulating our moods and gut health. Now, for the rest of the story....



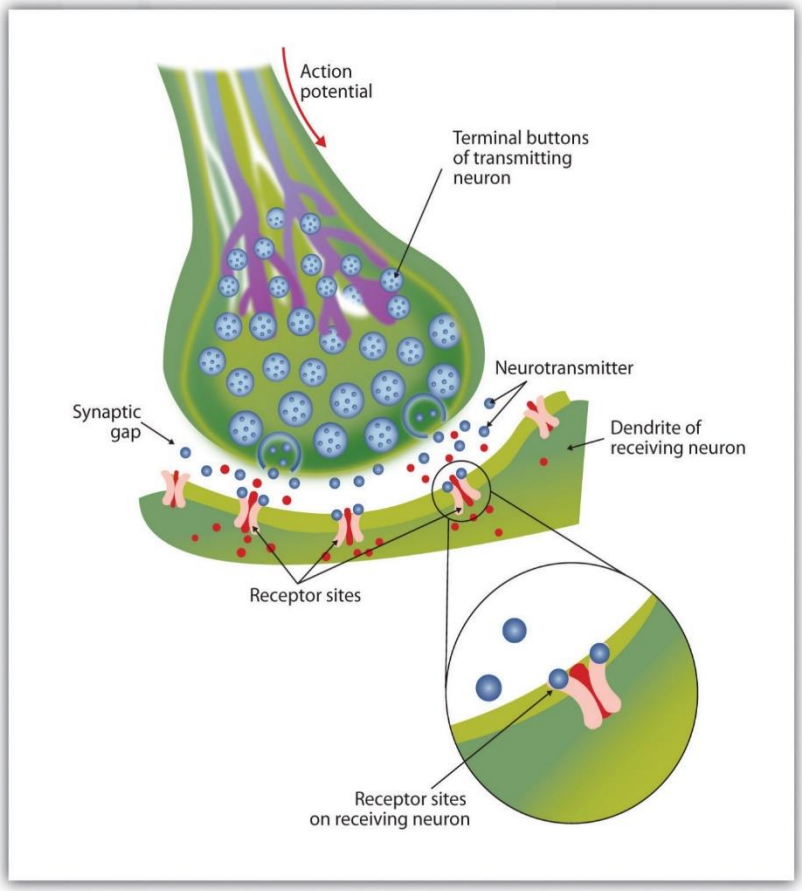


→SOURCE FILE: What the heck is a monoamine neurotransmitter, anyway?

A **monoamine** simply describes the chemical structure of a group of neurotransmitters (mono=1) with 1 amine (or NH) bound within the molecule. In the illustrations to the left, the "NH" or "N" within the cojoined ring-like components is the "monoamine" being referred to; the "OH" and "NH2" groups are the side chains, which typically are responsible for allocating specific properites to the molecule.

A **neurotransmitter** is a method of chemical transmission. Whereas hormones are chemicals released into the bloodstream that travel to target organs elsewhere in the body to modulate their effects, neurotransmitters are transported across exceedingly small distances spanning a cell membrane. They move by binding to receptors on the cell membrane. Ready? Time to cut loose and start dancing to this beat:

Cell membranes have a variety of ways they manage transport. In the case of serotonin, the molecules pass through via chemical synapses. A synapse is the site where information is transmitted or moves from 1 cell to another. Or, think of serotonin as a traveler wanting to cross the border between the US and Canada.



Whether it is stored in GI enterochromaffin cells, circulating platelets or vesicles in the brain, serotonin either needs to enter the cell for storage or be released from the cell in order to perform a function. Either way, it must provide an incentive (or passport) to be allowed across the cell border.

A synaptic gap or cleft acts as the conduit (or border checkpoint) that information is transmitted across. On 1 side of the membrane a substance (serotonin) within a granule/vesicle binds to and is released from the presynaptic terminal. After traveling across the synaptic gap, it binds to receptors on the postsynaptic terminal and through a sequence of events is allowed passage into another cell, concluding its journey across the membrane. The sequence of events or incentive—in effect, the "passport to cross the border"—involves a change in the electrical charge (called action potential) in the cell membrane to make channels (or border gates) "leaky" so serotonin/chemical messengers can slip through.

Yikes! Anyone verging on a case of toxic TMI from all the tech speak? No worries...Moving on from here!!!

Benefits of Serotonin

- Promotes heart health; assists in lowering complications surrounding heart attack and stroke
- Promotes brain development; support brain cells in proper maturation
- Boosts health of skin; minimizes factors contributing to stress, anxiety and depression & enhances relaxation
- Provides relief from headaches and migraines
- Enhances moods; assists in lowering anxiety and depression

Causes of Serotonin Deficiency

- **Stress:** Leading a stressful life can decrease serotonin levels in the body

- **Poor Diet:** Proteins, vitamins and minerals are utilized in the process of creating neurotransmitters; thus, consuming a diet without sufficient vitamins, minerals and proteins directly affects neurotransmitter production.

  For instance, vitamin B6 is used to manufacture serotonin from tryptophan. Low levels of vitamin B6 affect the synthesis of serotonin, leading to a drop in circulating levels. Similarly, tryptophan is an amino acid that acts as a building block for serotonin. Neglecting to eat foods rich in tryptophan (such as poultry, eggs, cheese, seeds, nuts) likewise creates deficits in serotonin production. Additionally, a diet rich in protein but low in complex carbohydrates is counterproductive since consumed tryptophan cannot cross the blood-brain barrier to reach the brain, again decreasing serotonin levels.

- **Toxic Substances:** Toxic substances such as mercury, lead and chemicals such as pesticide can destroy the nerve cells that produce serotonin in your body, leading to a drop in serotonin production.

- **Drugs:** Certain drugs inhibit production and lower serotonin levels, such as caffeine, nicotine, alcohol, antidepressants & certain cholesterol-lowering prescriptives.

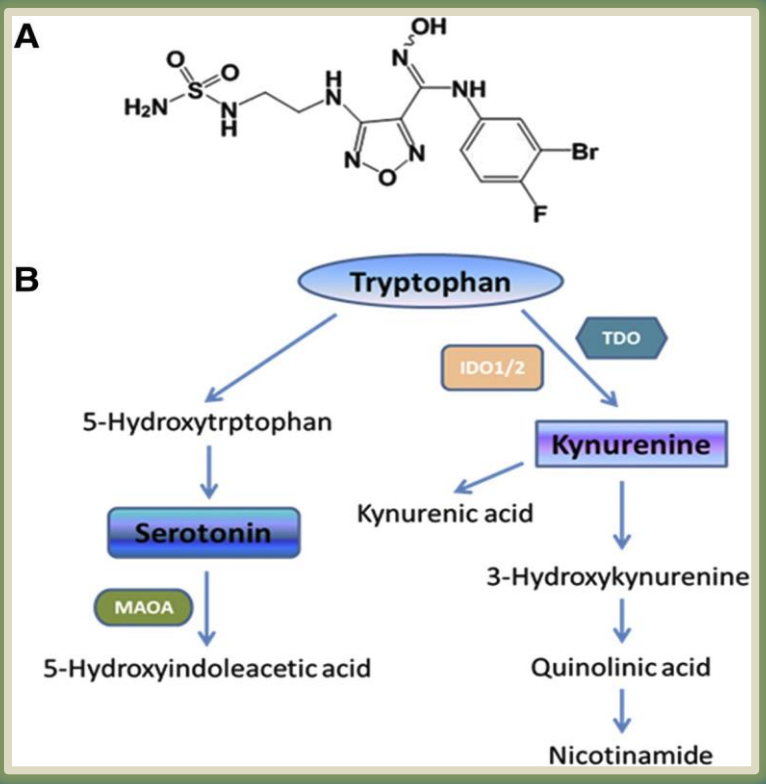
- **Hormonal Changes:** Fluctuations in hormone concentrations can have a negative impact on levels of serotonin/other neurotransmitters.

Effects of Serotonin Deficiency

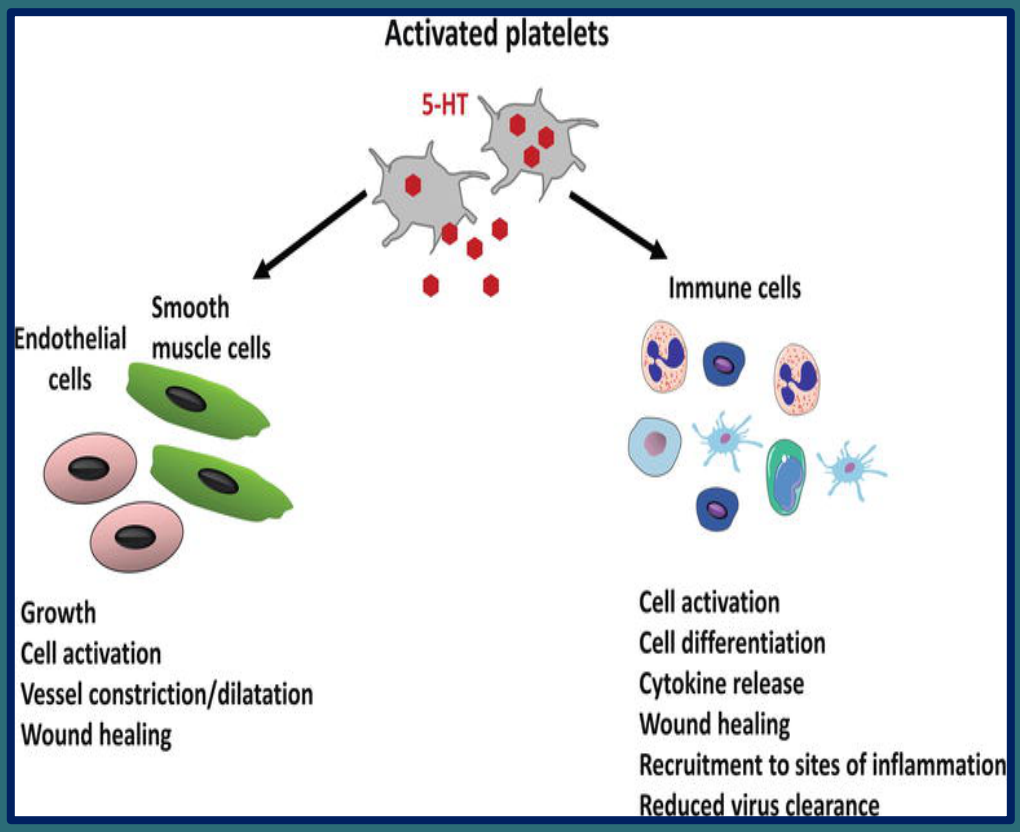
Low serotonin levels in your body can cause many undesirable effects that may make you lead an unproductive life. Deficiencies may lead to increases in:

- Irritability & Aggression
- Memory Loss
- Acute or chronic pain in muscles/joints
- Anxiety & Depression, Fears & Phobias
- Suicidal tendencies
- Addiction: Alcohol & Drug use
- Addiction: Overeating & Binging
- Addiction: Sexual activity
- Obsessive-Compulsive disorder
- Seizures & Migraines
- Hypoglycemia
- Disruption of circadian rhythms & Insomnia
- Communication & social dysfunction

Deficiencies in serotonin are notable when normal tryptophan conversion by the Serotonin Pathway is hijacked and instead tryptophan is diverted to the Kynurenine Pathway instead (right). Diversion from the serotonin-synthesis pathway and accumulation of kynurenine byproducts are notable with inflammation: poor diet/increased methylation that leads to inflammation, stress that leads to inflammation, increased cortisol that leads to inflammation, inadequate sleep that leads to inflammation.



The increased activation of the kynurenine pathway has recently been implicated as a key link between inflammation and depression. This may explain the strong correlation between inflammatory conditions, such as metabolic syndrome, diabetes and obesity, and the increased risk of depression as well as between stress and mental health conditions. Investigation of the Kynurenine pathway is currently underway to explore the direct (physical and mental effects resulting from its metabolites) and indirect (decreased serotonin production) connections to depression, cognitive impairment, and better mental health.



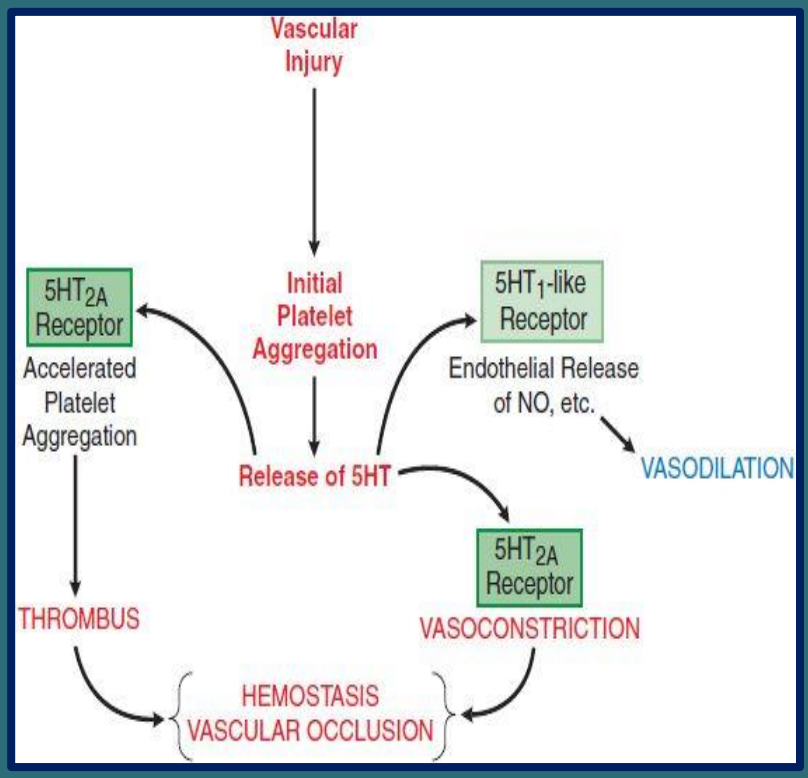
It blocks the digestive system.

Normally, gastrointestinal smooth muscles contract (peristalsis) to move food and liquid through the tract. Sufficient serotonin enhances this gut muscle performance. In cases where the level of serotonin drops, it lowers the quantity of calcium released from the cells. Repressed calcium in turn impairs contraction of gut muscles which causes slow motility and blockages, constipation, and difficulty in passing stool.

It affects blood flow

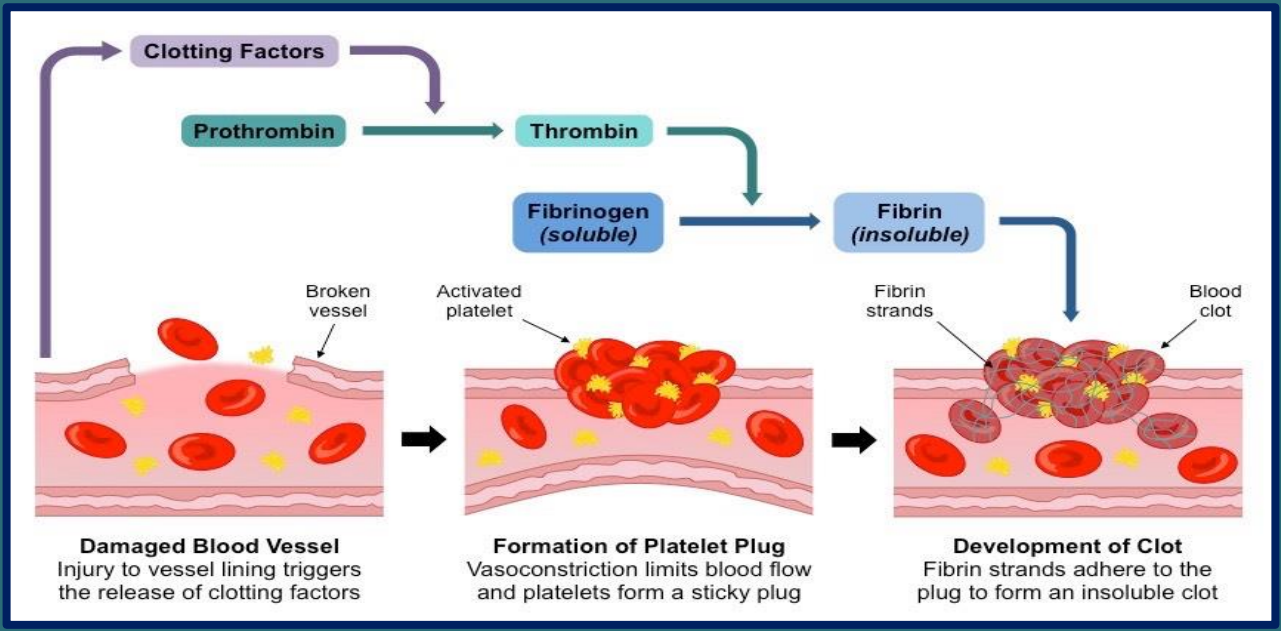
Flow of blood around your body needs muscles to contract properly, especially in returning venous blood from the periphery of the body back to the heart to be reoxygenated. When serotonin dips too low and muscle contraction is impaired, blood flow is disrupted which can lead to many serious health complications, such as cardiovascular problems, peripheral vascular disease and stroke.

Additionally, platelet serotonin functions in the vasculature by modulation of endothelial (inner lining of blood vessels), smooth muscle and immune cells: it has growth-promoting effects on endothelial cells which may facilitate tissue healing after vascular damages and exerts dual effects of constriction and dilation on the vasculature.

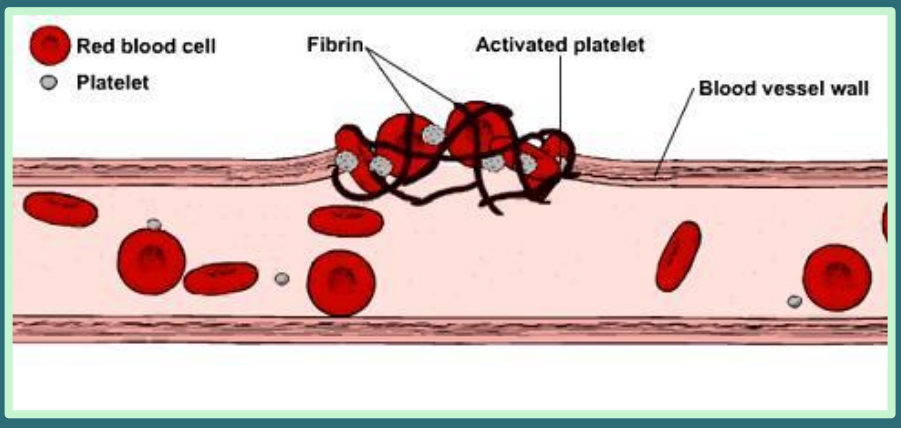


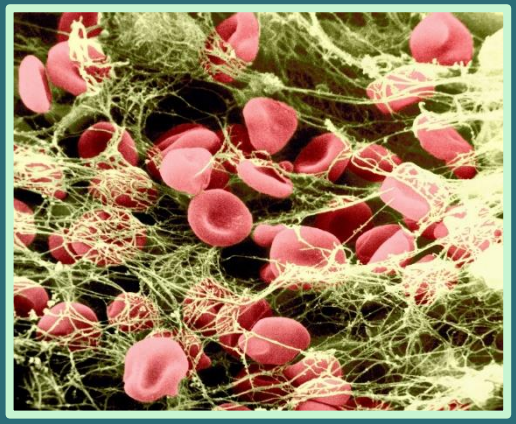
It lowers the ability of blood to clot

Platelets transport and store serotonin (5-HT) at a high concentration in dense vesicles and granules. When injury occurs, the inflammatory cascade begins, clotting factors are released, and platelets are among the cells that are activated and move to the area to assist with repair.



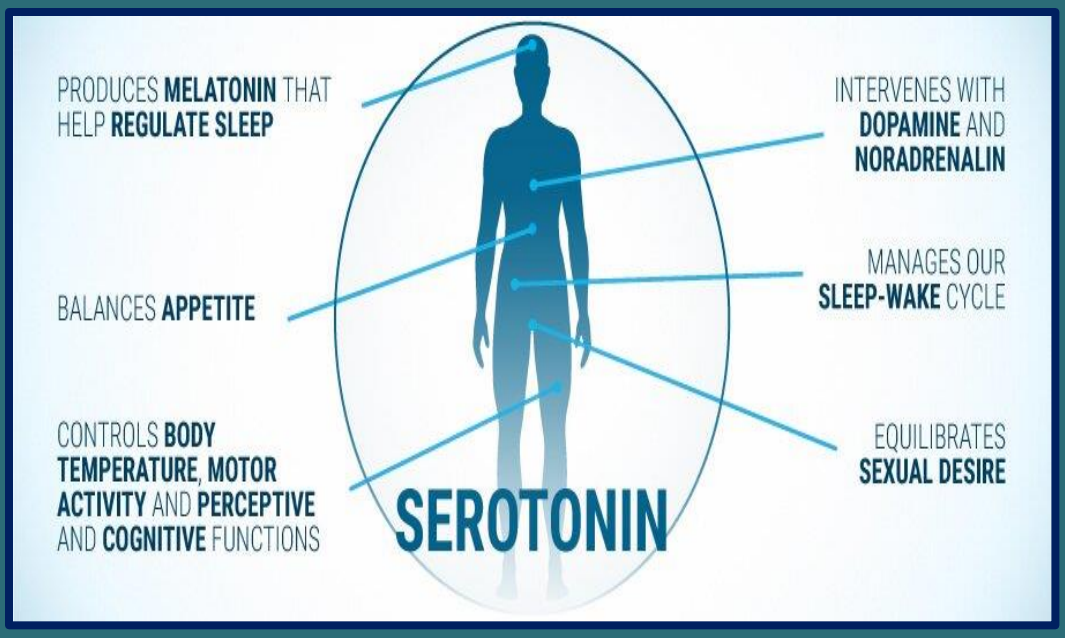
Upon platelet activation, serotonin is released where it acts as an amplifier, broadening platelet activation throughout surrounding cells and recruiting additional circulating platelets to aggregate at the site of damage and form a vascular "plug." Serotonin also promotes vasoconstriction, narrowing the vessels to lessen bleeding loss. Activation of platelets begins another cascade dedicated to production of a thrombus or clot (i.e., scab), to "seal the deal." Sticky platelets that have joined together to fashion the initial plug are further adhered by production of a "net" of fibrous strands, aptly called fibrin.

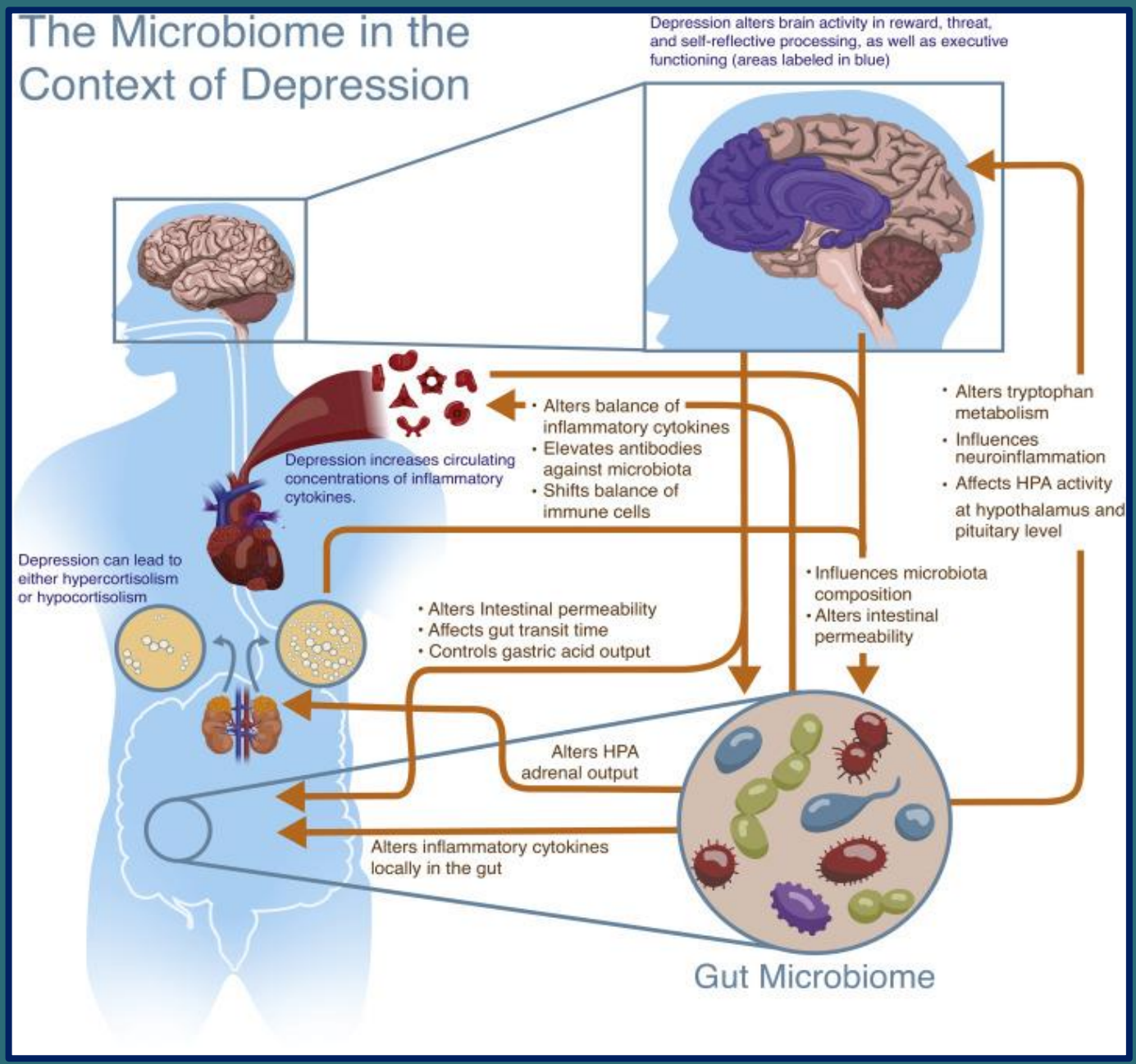




Abnormal serotonin concentrations in the blood plasma or increased platelet serotonin release promotes the development of thrombosis (condition of clotting), sepsis, allergic asthma, myocardial infarction (heart attack) and stroke. On the other hand, a drop in platelet serotonin levels impairs the clotting process, leading to excessive bleeding.

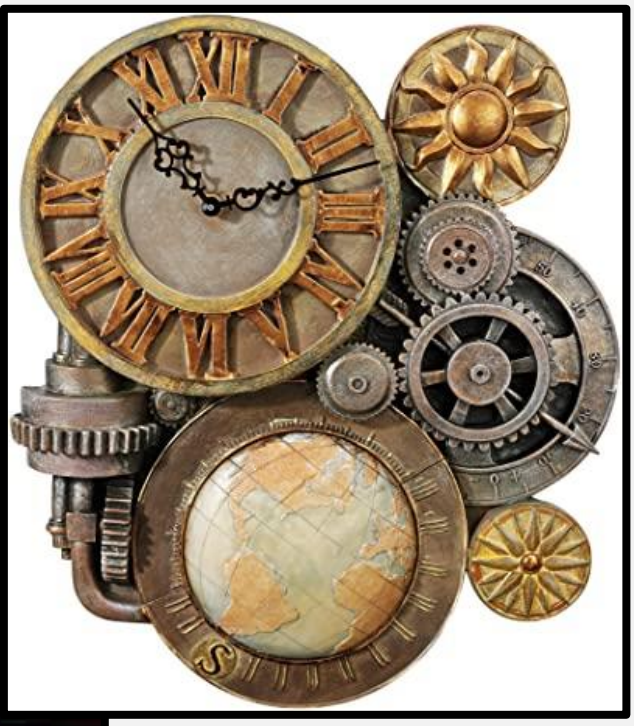
Takeaway:


PRODUCES MELATONIN THAT HELP REGULATE SLEEP
BALANCES APPETITE
CONTROLS BODY TEMPERATURE, MOTOR ACTIVITY AND PERCEPTIVE AND COGNITIVE FUNCTIONS
INTERVENES WITH DOPAMINE AND NORADRENALIN
MANAGES OUR SLEEP-WAKE CYCLE
EQUILIBRATES SEXUAL DESIRE
SEROTONIN


The Microbiome in the Context of Depression
Depression alters brain activity in reward, threat, and self-reflective processing, as well as executive functioning (areas labeled in blue)
Depression increases circulating concentrations of inflammatory cytokines.
• Alters balance of inflammatory cytokines
• Elevates antibodies against microbiota
• Shifts balance of immune cells
• Alters tryptophan metabolism
• Influences neuroinflammation
• Affects HPA activity at hypothalamus and pituitary level
Depression can lead to either hypercortisolism or hypocortisolism
• Alters Intestinal permeability
• Affects gut transit time
• Controls gastric acid output
• Influences microbiota composition
• Alters intestinal permeability
Alters HPA adrenal output
Alters inflammatory cytokines locally in the gut
Gut Microbiome

Wellness Wizard — Let there be Light

~Rhythms & Blues~

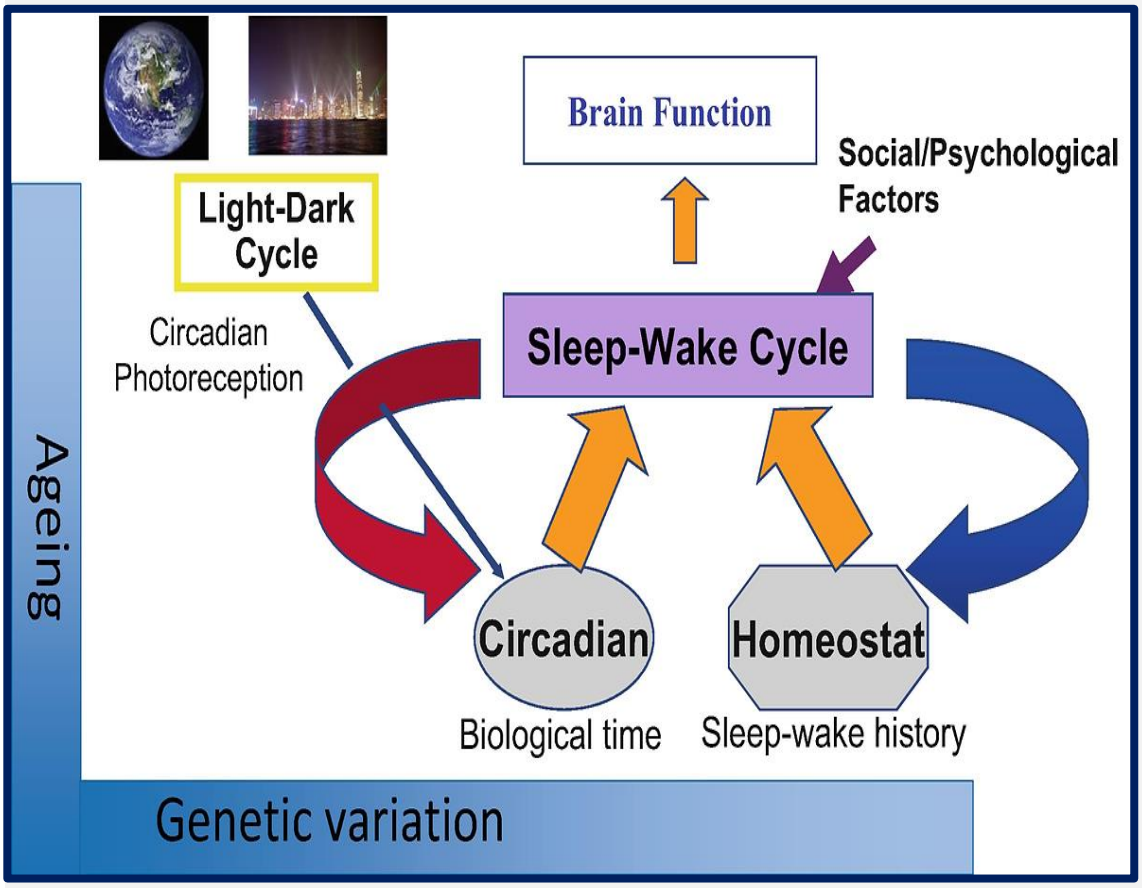


~(Part 2)~

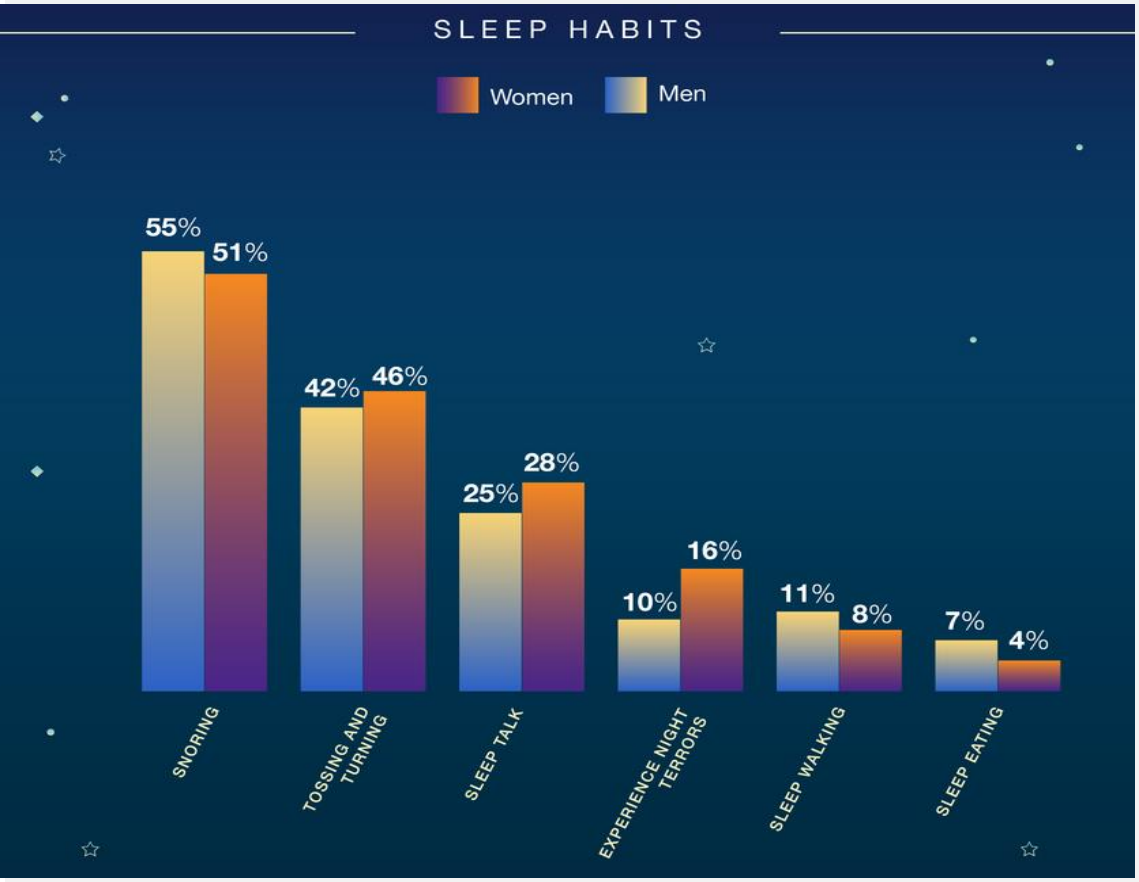
Circadian Rhythm Sabotage & The Blue-Light Blues

The 2017 Nobel Prize in Medicine was awarded to 3 scientists who identified the molecular clock inside our cells that aims to keep us in sync with the sun. Sustained and optimal functioning of our physiological systems is dependent upon circadian control of interrelated sleep-wake behavior, hormone secretion, neurotransmission, neuroplasticity, cellular function and gene expression. Likewise, circadian disruption by nighttime light introduces aberrancies to these mechanisms and is associated with increasing incidence of certain cancers, metabolic dysfunction (diabetes, heart disease), cognitive neurodegeneration (dementia) and mood disorders.

The adoption of all-pervasive artificial illumination has ushered in a striking imbalance between lifestyle and sun cycle that has thrown off our clocks, blurred the lines between night and day, increased the difficulties in synchronizing biological processes and sabotaged our health. For many, the notion of enjoying a full night's sleep and waking refreshed invokes a yearning wistfulness yoked to the grimmer reality of hard-won, poor quality and broken intervals of nightly UNrest. Given the expensive price tag engendered through circadian rhythm dissonance, how is it that we are not stacking our biological clocks to improve our health care, incentivizing sleep as a priority to gain advantages in productivity and rallying behind a culture that capitalizes on the natural resources we find just outside the windows and doors that we live locked behind????

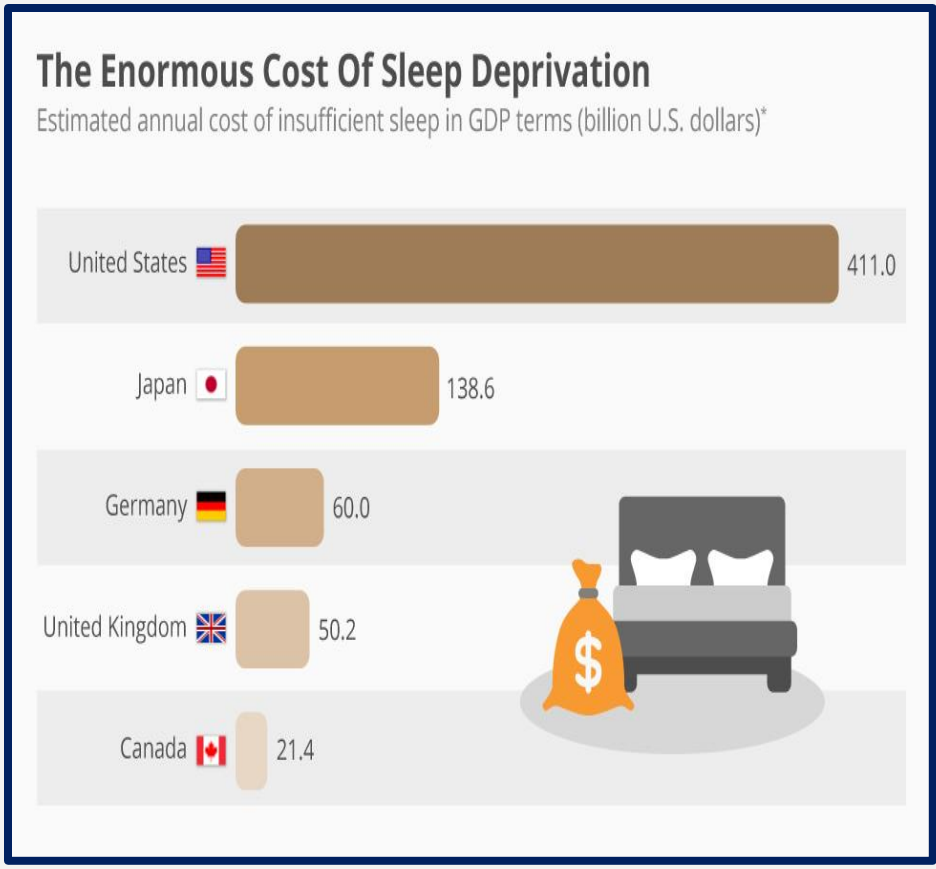


"Insomnia is by far the most common problem, the main reason 4% of US adults take sleeping pills in any given month. Insomniacs generally take longer to fall asleep, wake up for prolonged periods during the night, or both. If sleep is such a ubiquitous natural phenomenon, refined across the eons, why do so many of us have such trouble with it? Blame evolution; blame the modern world. Or blame the mismatch between the two."

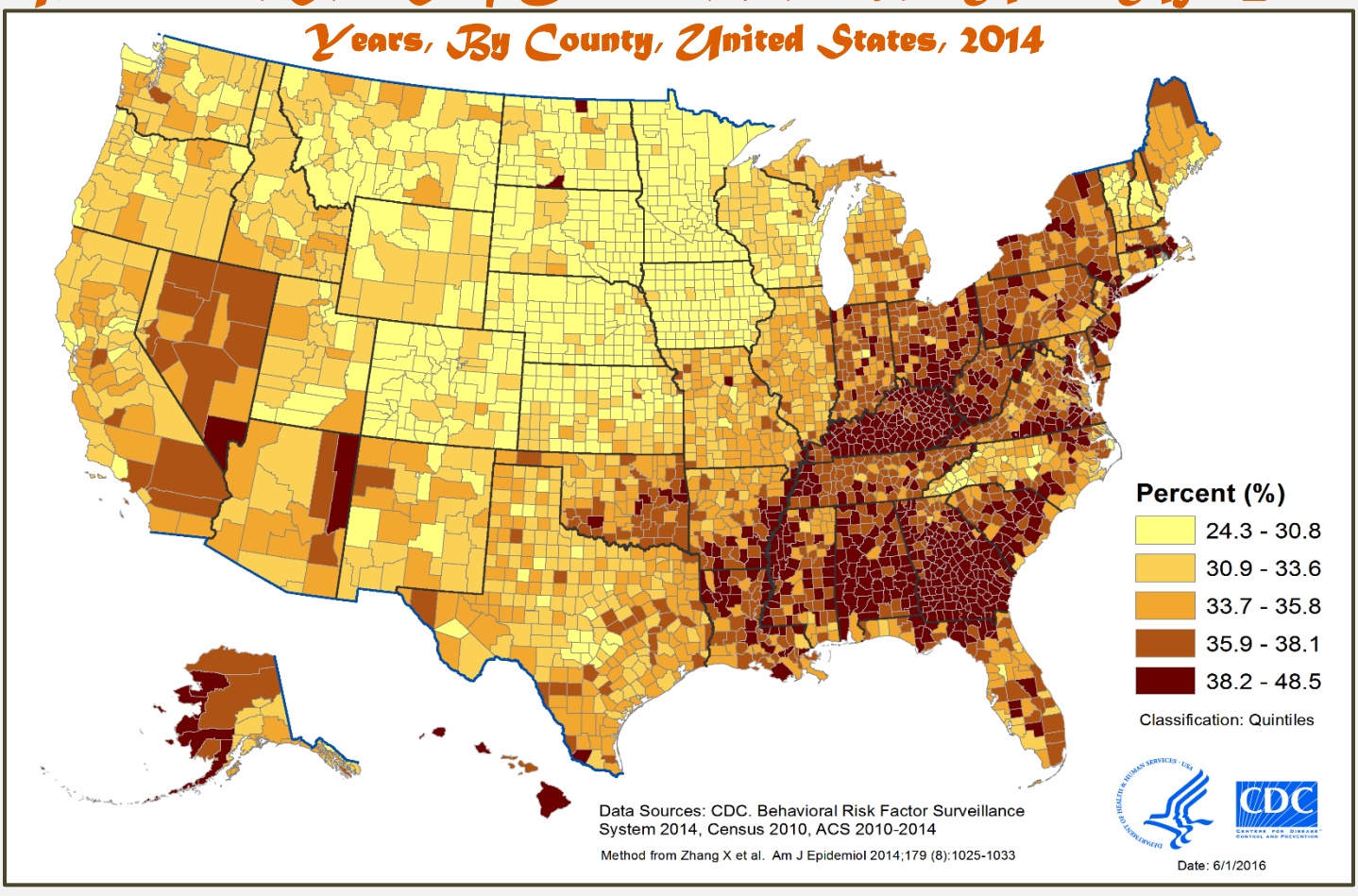


"Evolution endowed us, like other creatures, with sleep that is malleable in its timing and readily interruptible, so it can be subordinated to higher priorities. The brain has an override system, operating in all stages of sleep, that can rouse us when it perceives an emergency—the cry of a child or the footfall of an approaching danger."

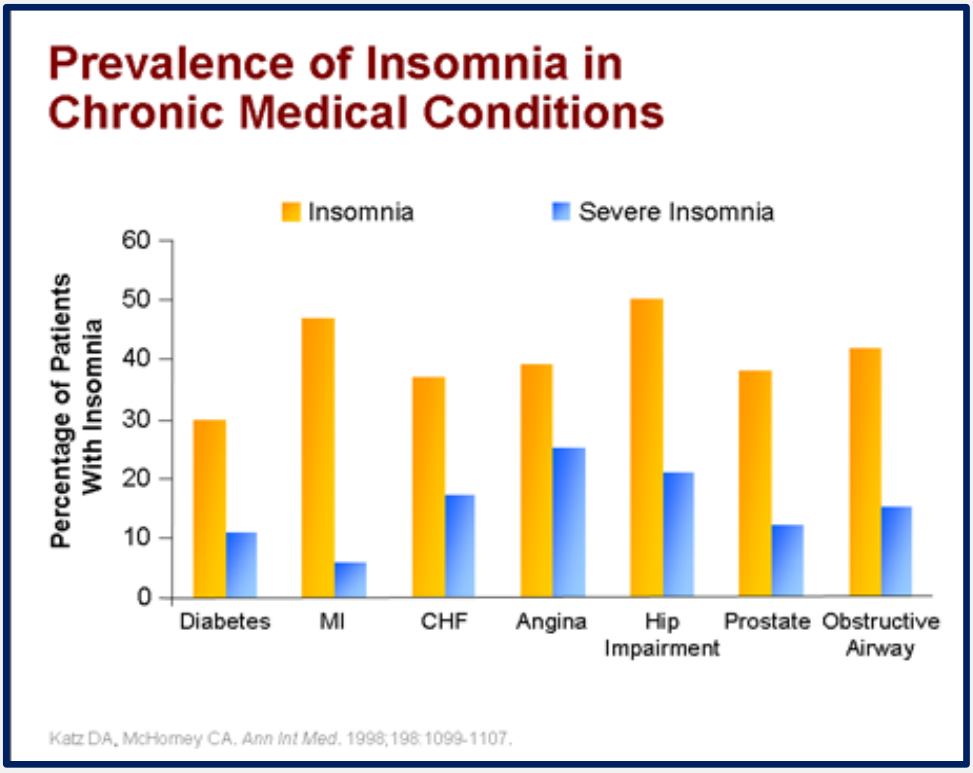
"The problem is that in the modern world, our ancient, wake-up call is constantly triggered by non-life-threatening situations, like anxiety before an exam, worries about finances or every car alarm in the neighborhood."

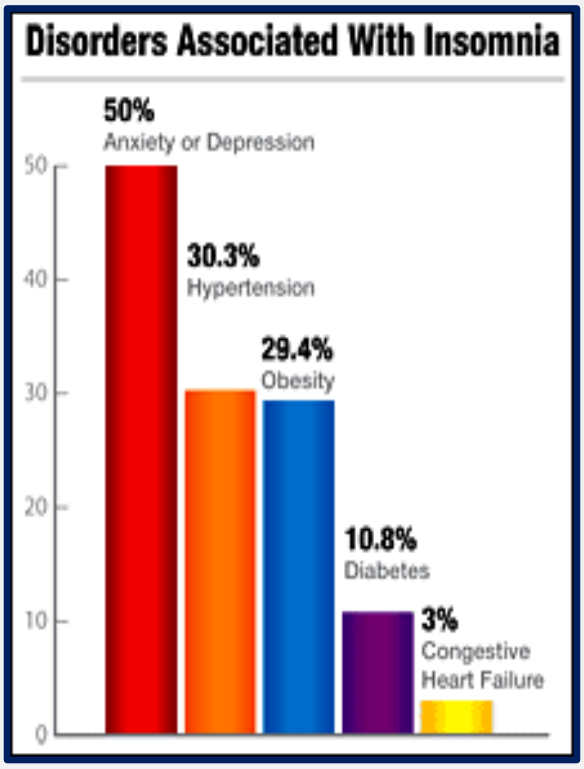


Prevalence of Short Sleep Duration (<7 hours) for Adults Aged ≥ 18 Years, By County, United States, 2014

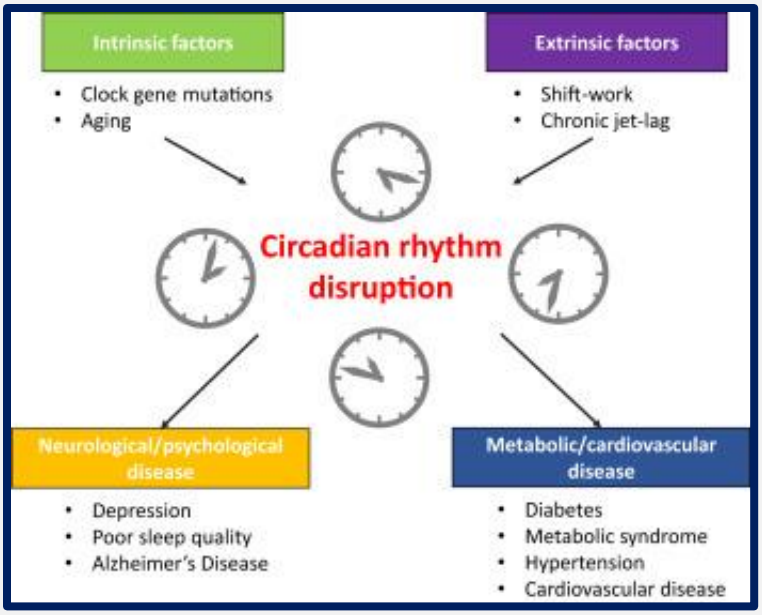


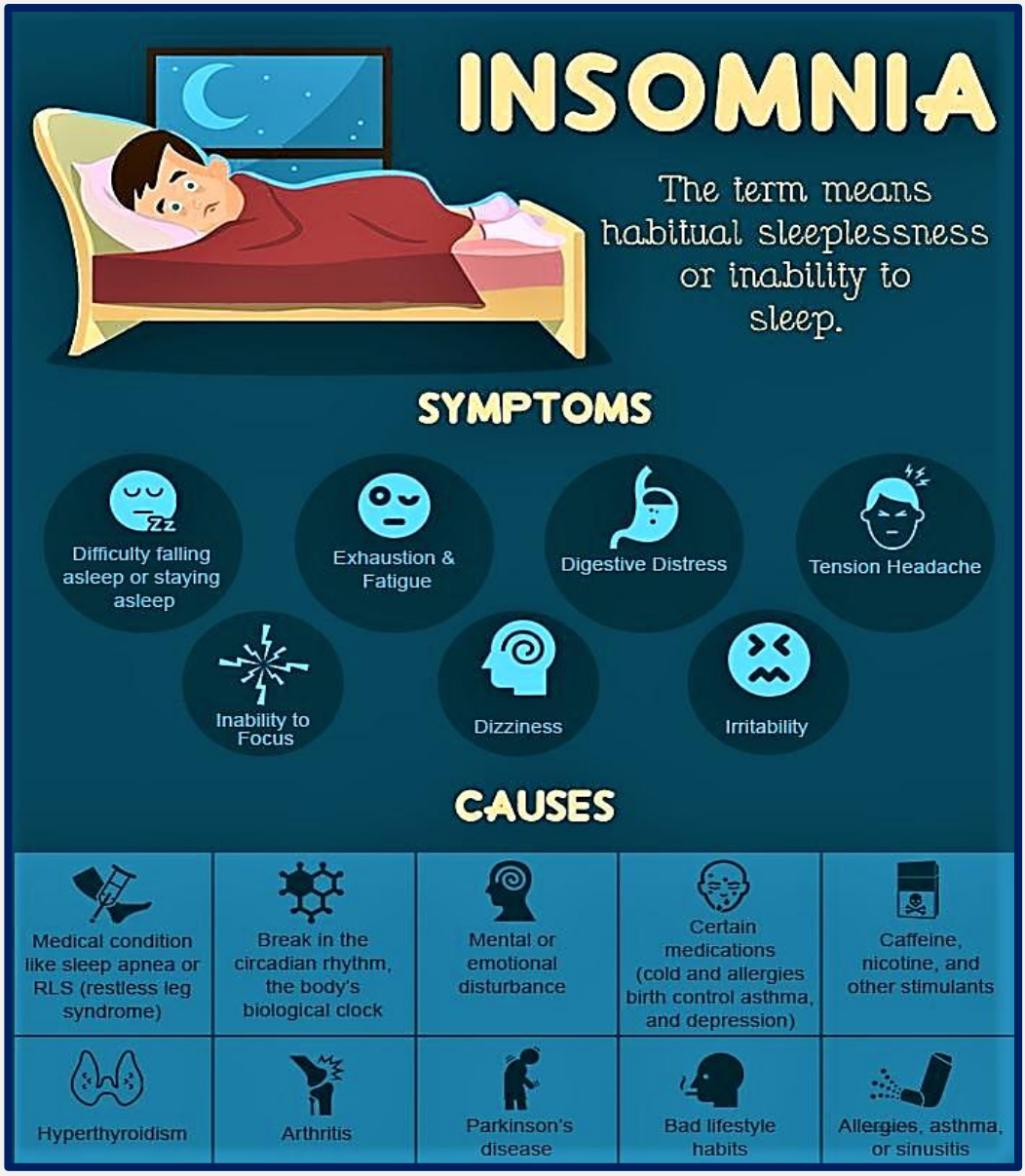
"Before the industrial revolution, which brought us alarm clocks and fixed work schedules, we could often counteract insomnia simply by sleeping in. No longer. And if you're one of those people who are proud of being able to fall asleep quickly just about anywhere, you can stop gloating—it's a distinct sign, especially if you're less than 40 years old, that you're acutely sleep-deprived." [Finkel; pp. 67-72]



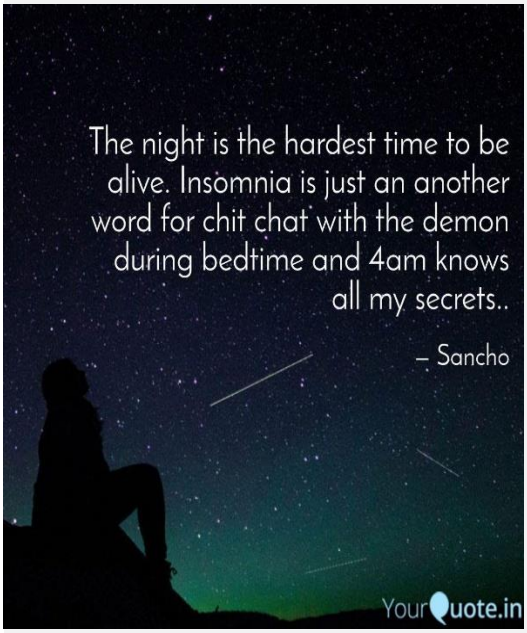


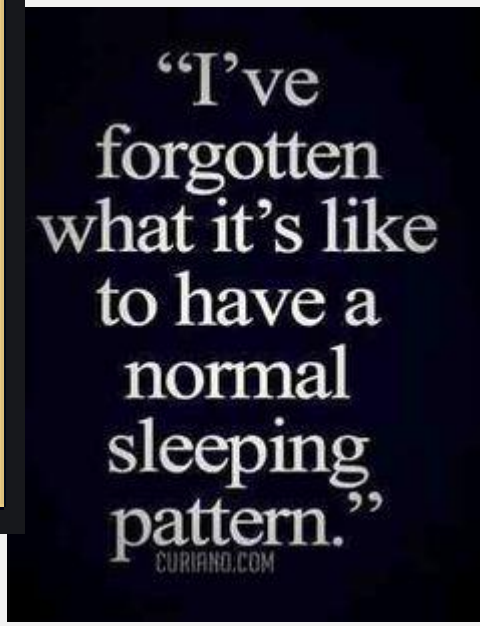
A disturbed sleep-wake circadian rhythm can give rise to serious sleeping problems. Without the proper signaling from the body's internal clock, a person can struggle to fall asleep, wake up during the night, or be unable to sleep as long as they want into the morning. Their total sleep can be reduced, and a disrupted circadian rhythm can also mean shallower, fragmented and lower-quality sleep. As a whole, a misaligned circadian rhythm can negatively affect sleep in many ways, increasing a person's risk of insomnia and excessive daytime sleepiness, not to mention significantly contributing to addictive behaviors, chronic diseases, negative emotions, poor memory and bad decision making.





Insomnia is a sleep disorder that is characterized by difficulty falling and/or staying asleep, waking up often during the night and having trouble going back to sleep and/or feeling tired upon waking. Insomnia also varies in how long it lasts and how often it occurs. It can be short-term (acute insomnia), lasting from 1 night to a few weeks. Insomnia is determined chronic when a person has insomnia at least 3 nights/week for 3 months or longer. It is often associated with 1 or more chronic diseases, with mutually destructive exacerbation.



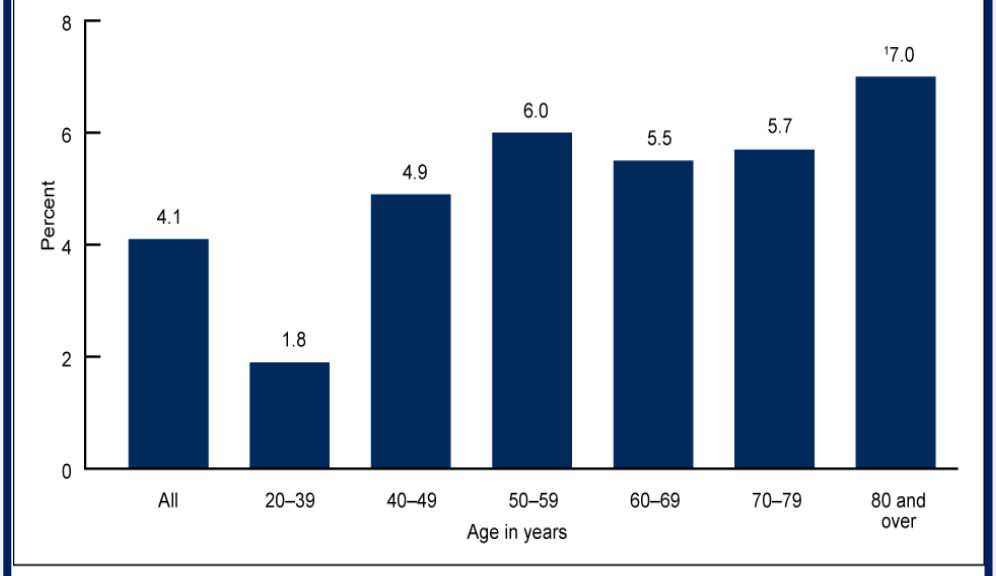


As increases in sleep difficulty have become more profound, the global pharmaceutical industry has concomitantly stepped into the breach and provided a chemically-assisted version of the original "good night's sleep." All pharmaceutical sleep aids work by essentially the same mechanism, boosting the neurotransmitter GABA, which calms neural activity. One of the latest reports shows that the global market for insomnia therapeutics was valued at $2.18 billion in 2016 and was predicted to grow annually at least until 2025. The vast majority of this value—99% of it—is drug sales, with 1% attributed to medical devices. Every month, almost 10 million Americans will seek relief by use of sleep aids of some sort.

Taking a sleeping pill may make it *seem* as though you've gotten more sleep or at least a better night's rest but no type of sleep aid, whether over the counter or prescription, induces natural sleep. **Sedation is not the same as sleep.**

Popular sleep medications can cause significant health consequences that last much longer than a single night. All hypnotics have the ability to cause amnestic (memory loss) effects as they reduce sleep latency (amount of time it takes to fall asleep), restrict the deeper brain waves produced during REM sleep and block memory consolidation.

Figure 1. Percentage of adults aged 20 and over who used prescription sleep aids in the past 30 days, by age: United States, 2005–2010

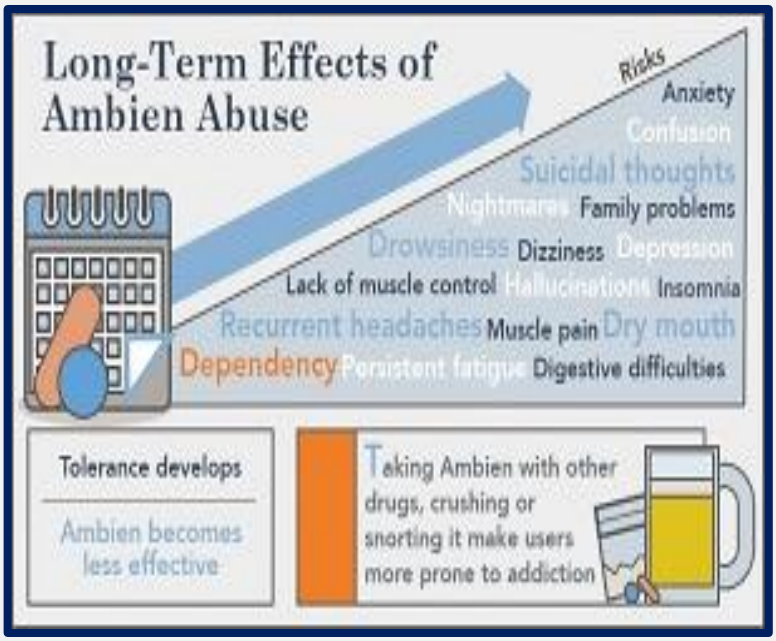


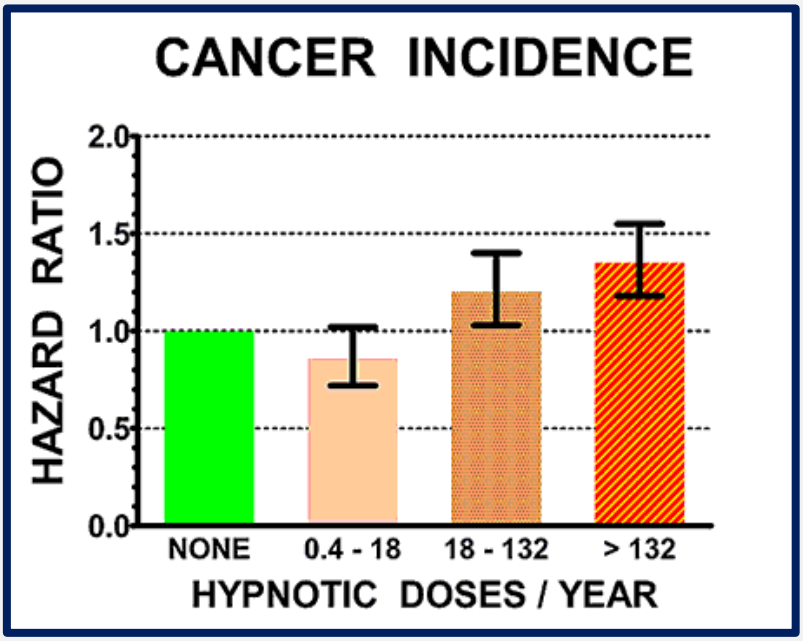
†Significant increasing linear trend by age ($p < 0.05$).
NOTE: Sleep aids include all hypnotic drugs and four antidepressant or sedative medications commonly prescribed for insomnia or depression.
SOURCE: CDC/NCHS, National Health and Nutrition Examination Survey.

This leads to grogginess and forgetfulness the following morning, making productivity challenging. Feelings of sluggishness might lead to greater caffeine consumption, increased difficulty sleeping, perpetuating the cycle. As neuroscientist Matthew Walker explains, **"Sleeping pills do not provide natural sleep, can damage health and increase the risk of life-threatening diseases."**

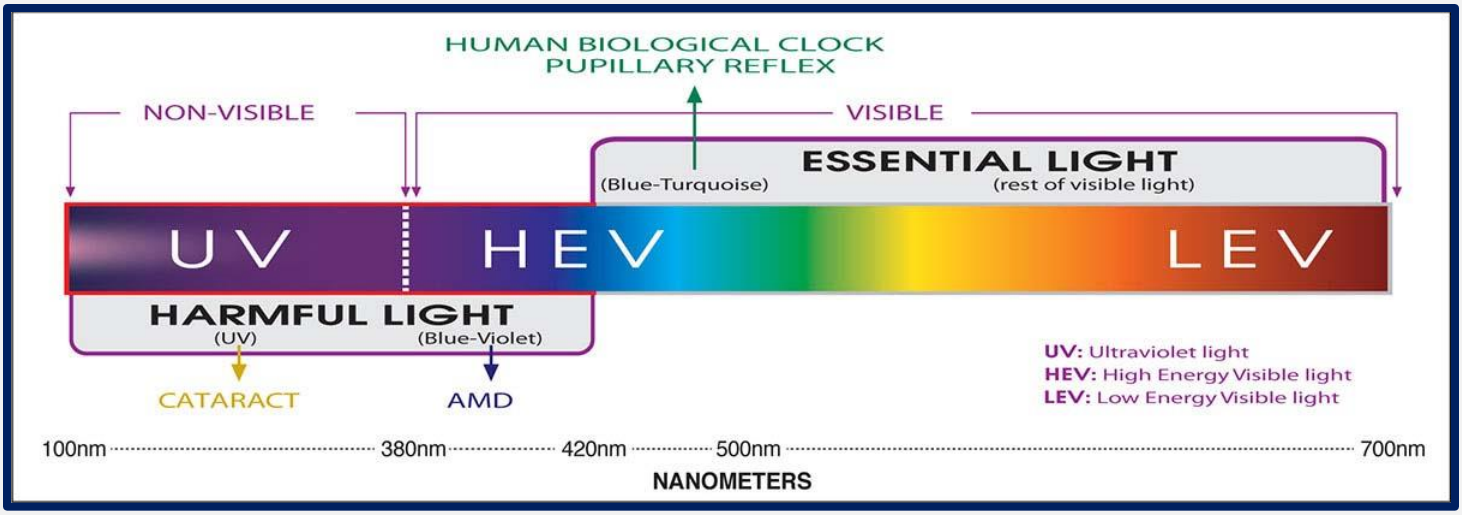
Expanding on that thought, consistently relying upon sleep medications increases your risk of cancer, depression, infections, dementia, and, more importantly, these drugs appear to increase your risk of dying early. Sleep medications have been linked to around 400,00 US deaths per year. Studies with hypnotics (prescription sleep medications) have shown increased risks of death of over 500% compared to those who did not take drugs, and "the number of hypnotic-associated deaths may be almost comparable to the number of deaths attributed to cigarette smoking, cancer or heart disease."

Luckily, there is a plentiful listing of supportive behaviors that assist in upholding sleep hygiene, i.e., create environments and daily routines that promote consistent, uninterrupted sleep. As with so many other conditions we have discussed this year, our choices define our sleep quality: our habitual daily, evening and bedroom patterns can either reinforce our circadian sleep-wake cycle or offset it. Let's delve into causes, containment and countermeasures!



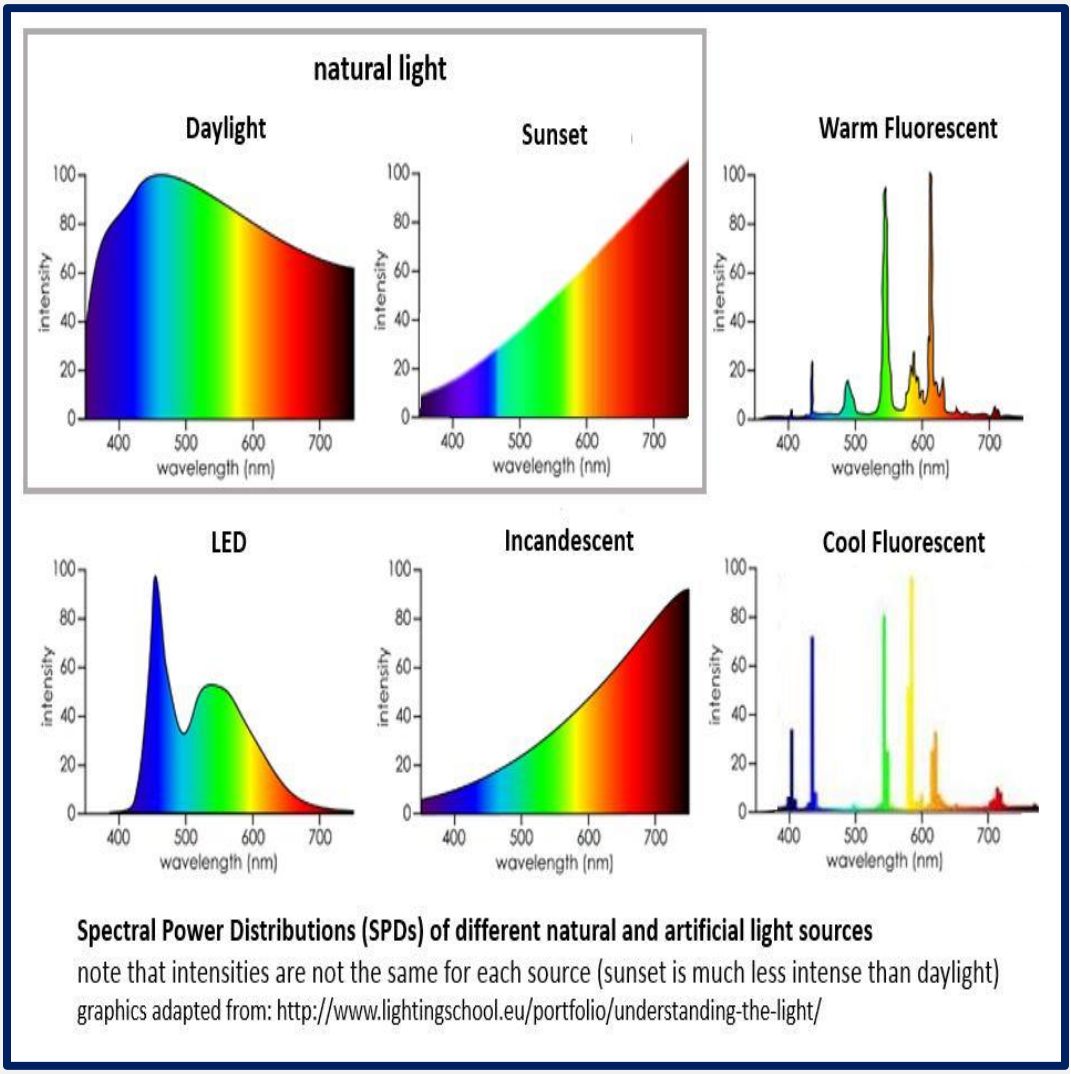


Considering the deleterious side effects, early morbidity, addictive nature and lack of true efficacy, natural, pill-free strategies to improve your sleep hygiene will likely outperform everything else in the long term.

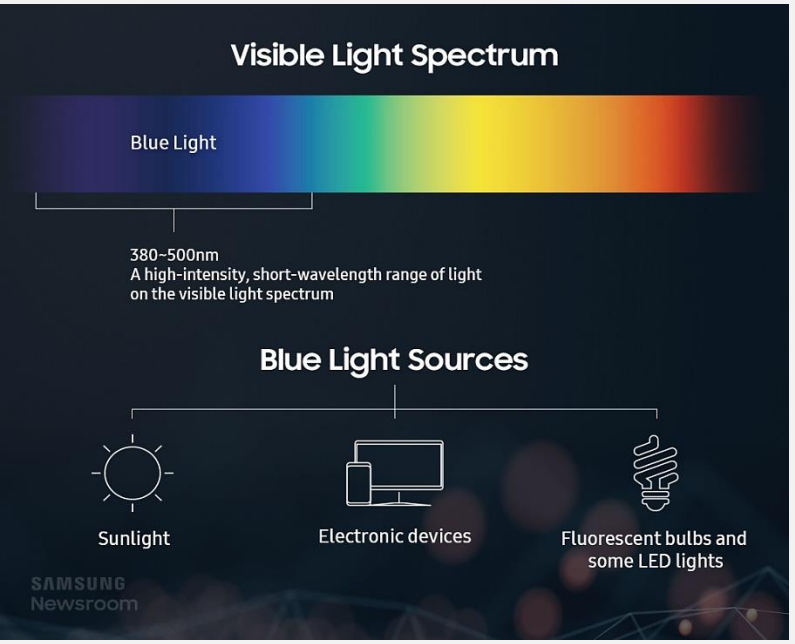


Hopefully it has become evident by now that one of the primary determinants of our health that we can directly reinforce for ourselves is that of light exposure; also, that specificity in timing and type contribute to pivotal determinants weighted either toward systemic sabotage or systemic support.

As we have determined, visible light synchronizes the human biological clock in the suprachiasmatic nuclei (SCN) to the solar 24-hour cycle. Visible light is the segment of the electromagnetic spectrum that the human eye can view; typically, detection encompasses the wavelength between 380 to 780 nanometers (nm). However, the beneficial effect on circadian synchronization, sleep quality, mood and cognitive performance depends on light spectral composition, the timing of light exposure as well as its intensity.



Spectral Power Distributions (SPDs) of different natural and artificial light sources
note that intensities are not the same for each source (sunset is much less intense than daylight)
graphics adapted from: http://www.lightingschool.eu/portfolio/understanding-the-light/

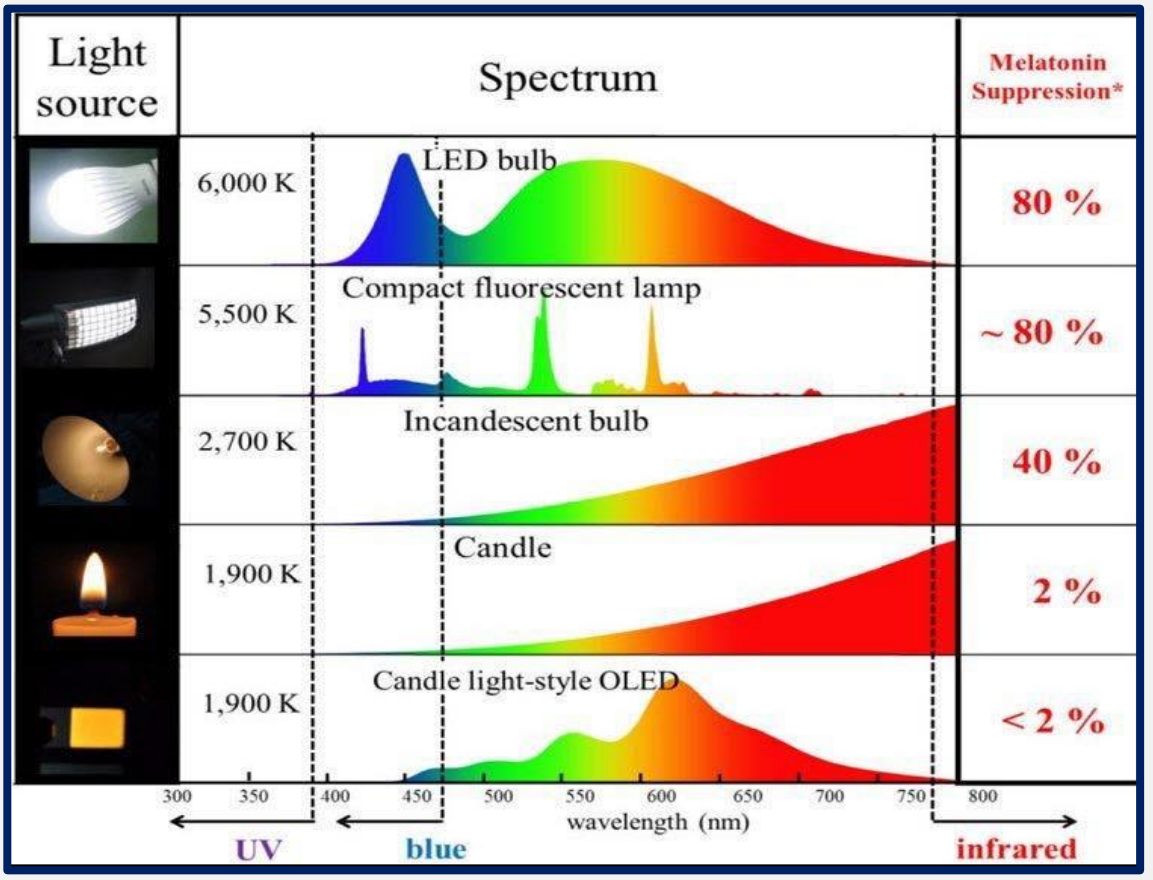


Different sources of light encompass different wavelengths and intensities along the spectrum. During eras predominated by candlelight and incandescent lighting, there was more orange-red light harnessed to provide illumination.

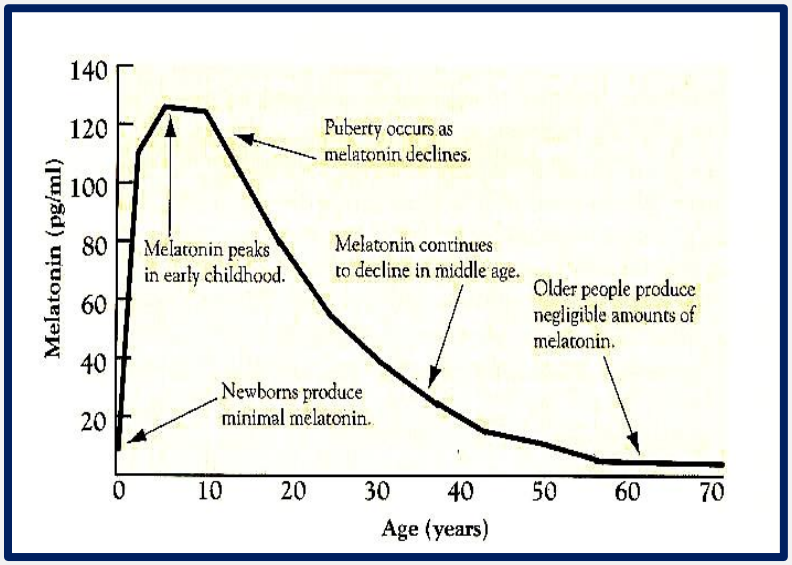
On the other hand, if modern life had a theme color, it would be painted in shades of BLUE. Exposure to blue light during the day (sunlight & artificial light) is important to suppress melatonin secretion and for keeping organisms' wellbeing, alertness and cognitive performance during the day. However, chronic exposure to low-intensity blue light directly before bedtime (blue light-enriched LED digital screens) have serious implications on sleep quality, circadian phase and sleep cycle durations.

Blue light is not blue, per se—it merely refers to a certain wavelength of light on the spectrum of visible light that stimulates us, boosting attention and reaction times. Although beneficial during the day, when we want to be awake and alert, blue light can sabotage us at night. Additionally, not all blue light is created equal: Blue-Violet light (shorter wavelength/higher intensity = harmful blue light) is believed to be the most harmful to the retina, while Blue-Turquoise light produces positive effects on regulating the sleep-wake cycle.

Cell phones, tablets, TVs and computer screens are all sources of blue light as well as LED lighting that has all but replaced incandescent bulbs and the fluorescent lighting most of us work under in industrial settings.

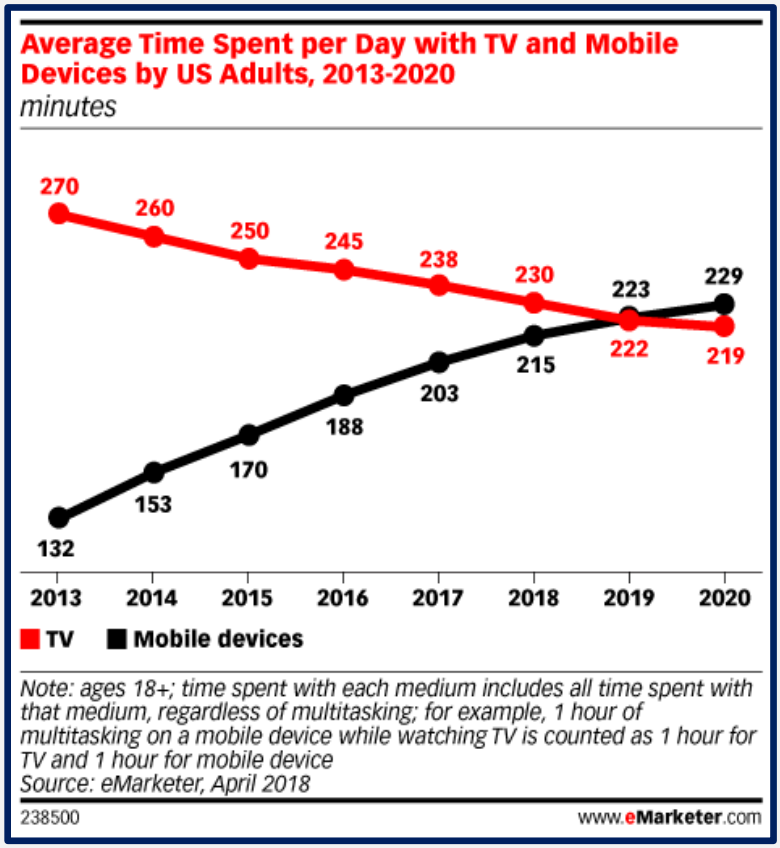


Blue light wavelength has been shown to suppress melatonin production for about twice as long as green and is more effective in causing a phase delay of the circadian rhythm. This particular wavelength (~460 nm) has proved more powerful in elevating body temperature, heart rate and reducing sleepiness, while provoking responses in alertness-related subcortical structures and limbic areas. Further studies indicate blue wavelengths suppress sleep-associated delta brainwaves better than green wavelengths and boosted the alpha wavelength associated with alertness. Thus, today it is understood that blue light seems to be the strongest synchronizing agent for the circadian system, and although it has many physiologic functions, one of the most important is entraining the circadian rhythm. Factors that contribute to blue light/circadian asynchrony include the process of aging, usage of blue light-emitting devices at night and shift work.

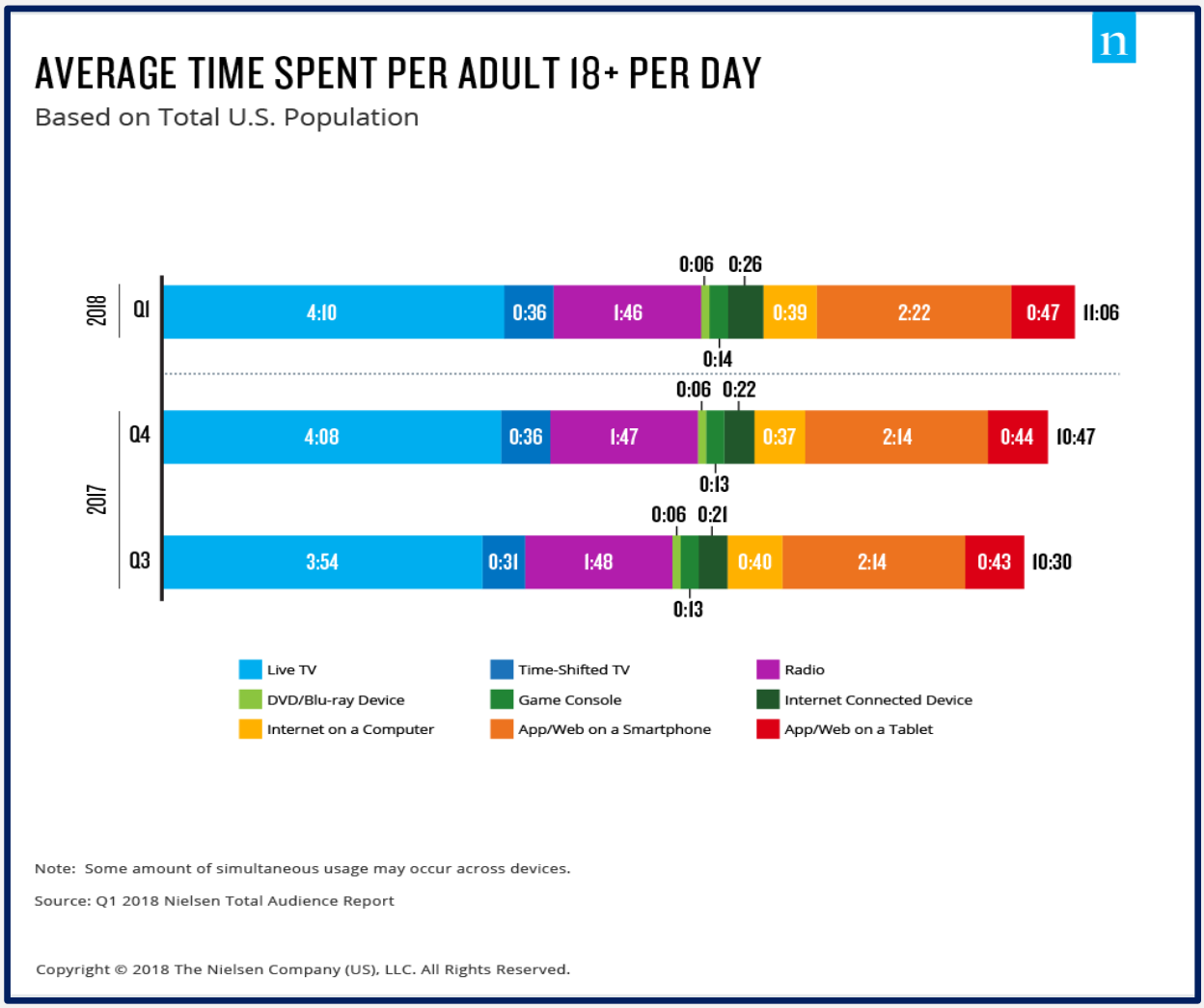


Aging is a natural process but one frequently linked to decreased overall sleep and decreased sleep quality. Age-related changes occur in our eyes over time; specifically, alterations in lens density and reduction in pupil size (miosis), both of which are known to reduce the transmission of blue light and subsequent melatonin production. Studies document that alterations in amounts of blue light that pass through the eye are cause for significant reductions in (morning) melatonin suppression, subjective alertness, sleepiness and mood. Diminished daytime blue light input to the circadian clock contributes to disturbed circadian rhythms, inefficient sleep and disease in the elderly.

While people exposed to more blue light (closer to UV rays) in the morning had an easier time getting to sleep (and having more restful sleep) compared to those who were exposed to periods of UV rays later in the day, light rich in red wavelengths (closer to infrared) are best at night because they have the least power to promote alertness or reset our 24-hour biological clock. The bluer and brighter the light, the more likely it is to suppress melatonin release and shift our sleep cycle—especially when we're exposed to it at night and up close on electronic screens.



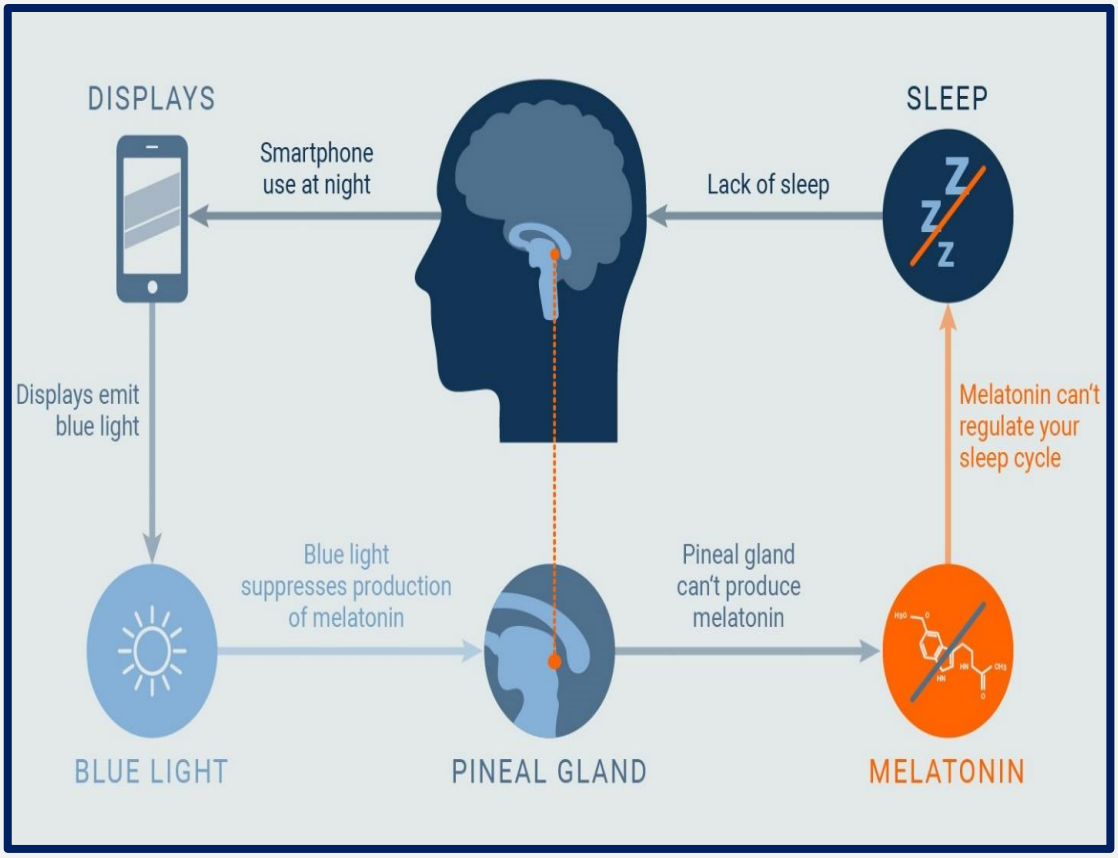
Consider that Americans spend upwards of 11 hours daily with screens from our electronic devices, well over half of our day. In today's modern society, our exposure to blue-light emitting devices has crossed the boundaries of work and communication and now encompasses household and business accounting/banking, side-line businesses/vending, traditional/non-traditional shopping and recreation of all kinds. In fact, time that we used to spend on our feet, out and about running errands, socializing, researching, conducting business is now spent on-line and blue-lighted, spanning all hours that we are awake. Where this range of flexibility can be convenient, it also infringes upon time we need away from blue light and contributes to the dark-deprived society that we've become.

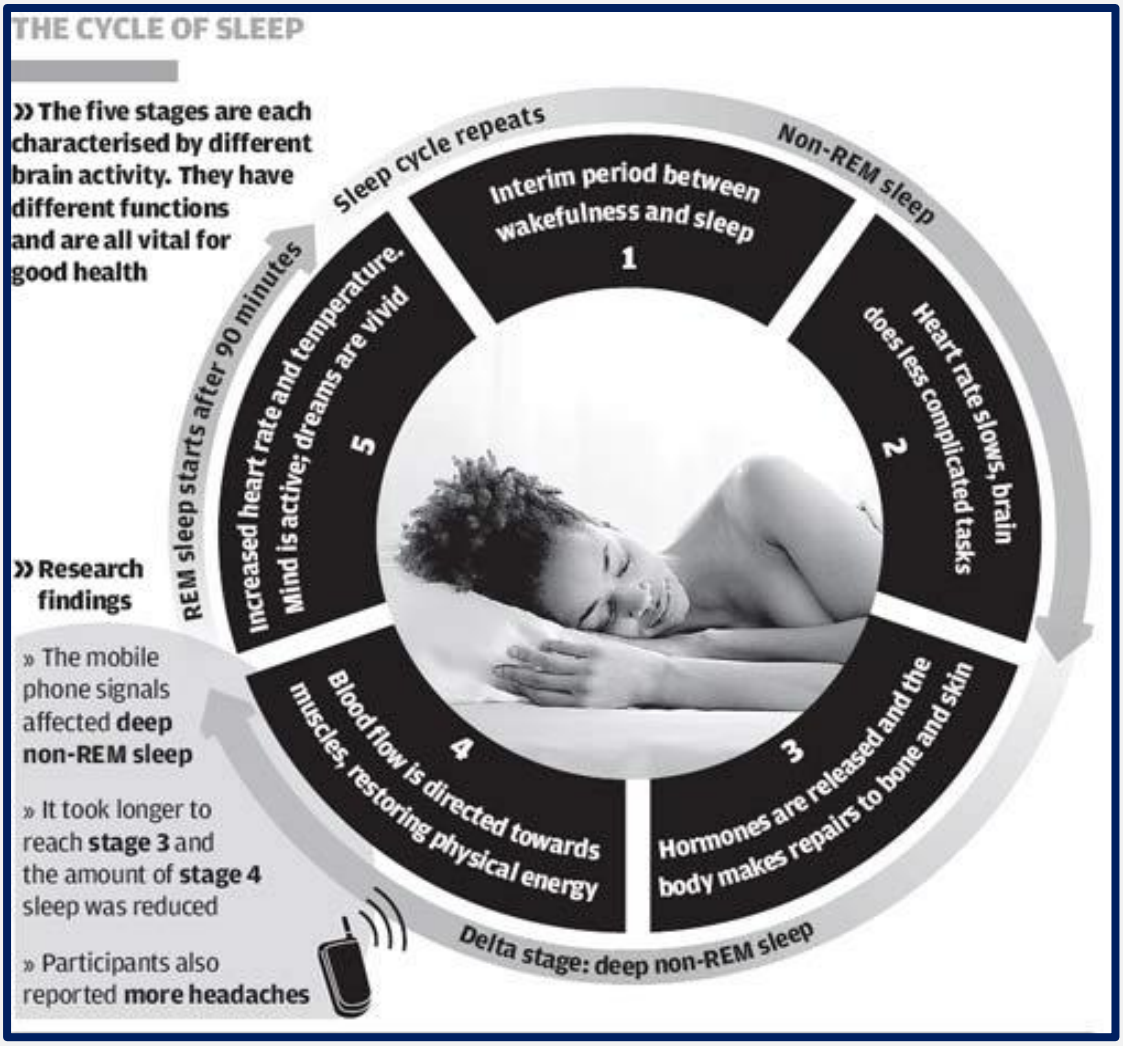


Findings from numerous studies have concluded that our longer average screen times result in shorter sleep duration and worse sleep efficiency.

For example, reading light-emitting e-books before sleep, as compared with printed media, produced a delay in the circadian clock, suppressed melatonin blood concentration levels, increased the time necessary to fall asleep, delayed/reduced phase of rapid eye movement sleep and reduced alertness the following morning.

In addition to extended usage, the presence of electronic devices overnight in the bedroom have also been found to contribute to ambient noise & light that interferes with high-quality sleep.

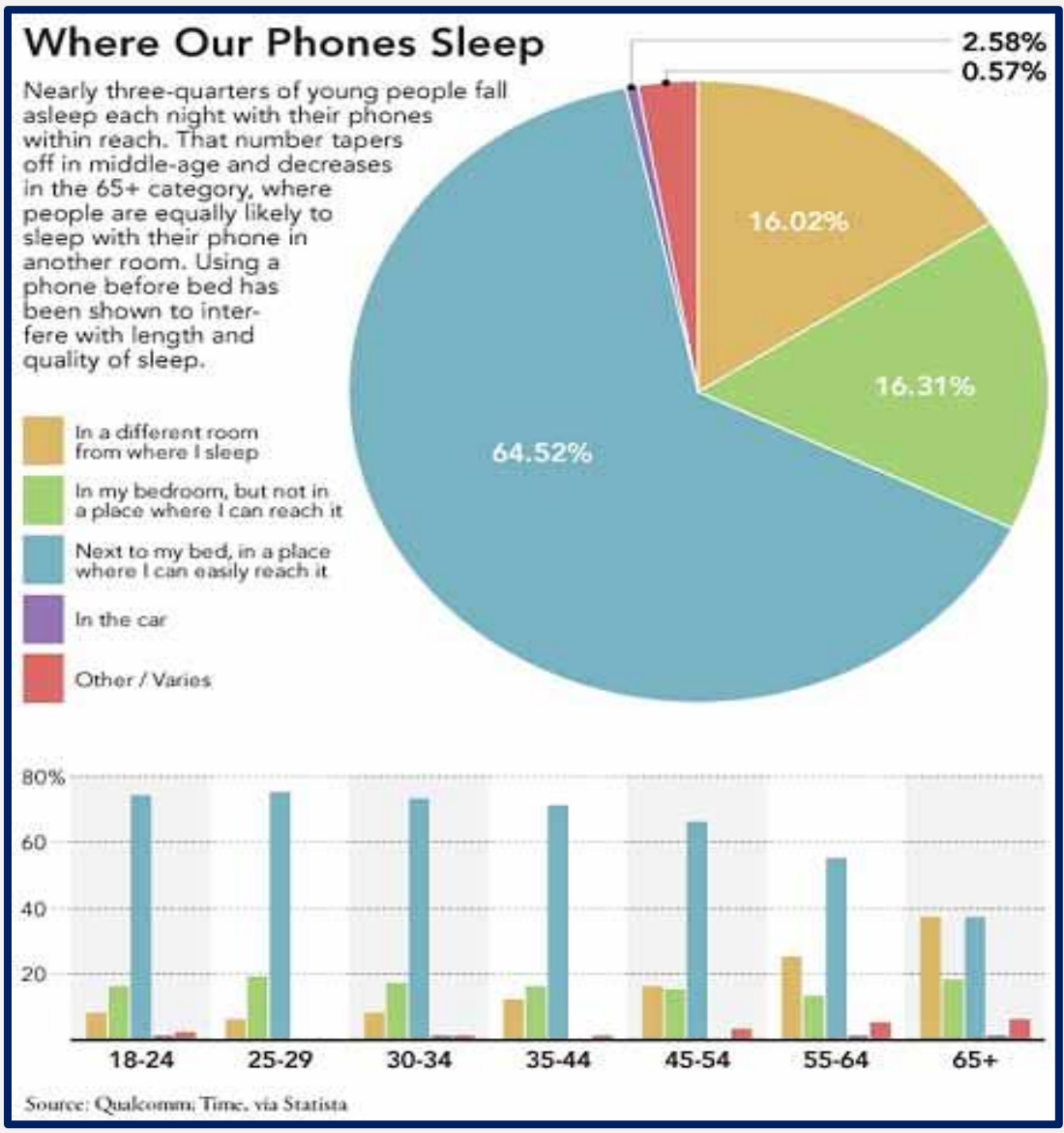


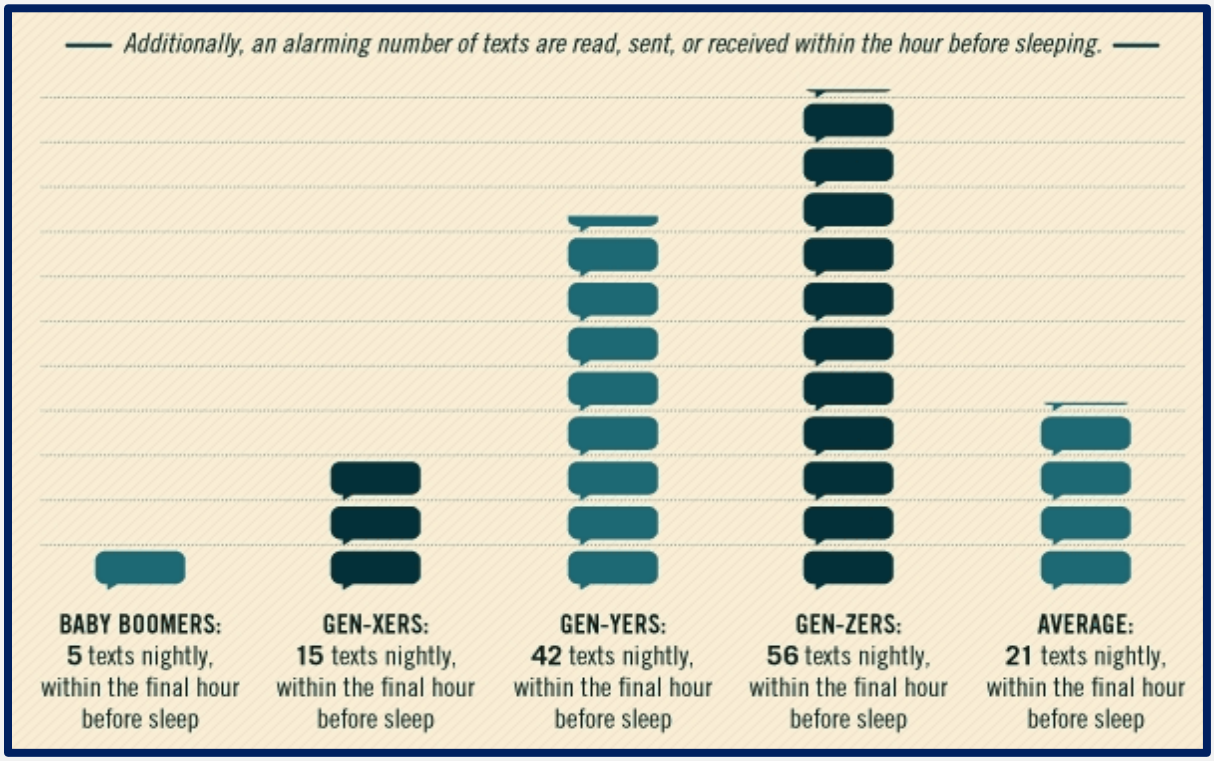


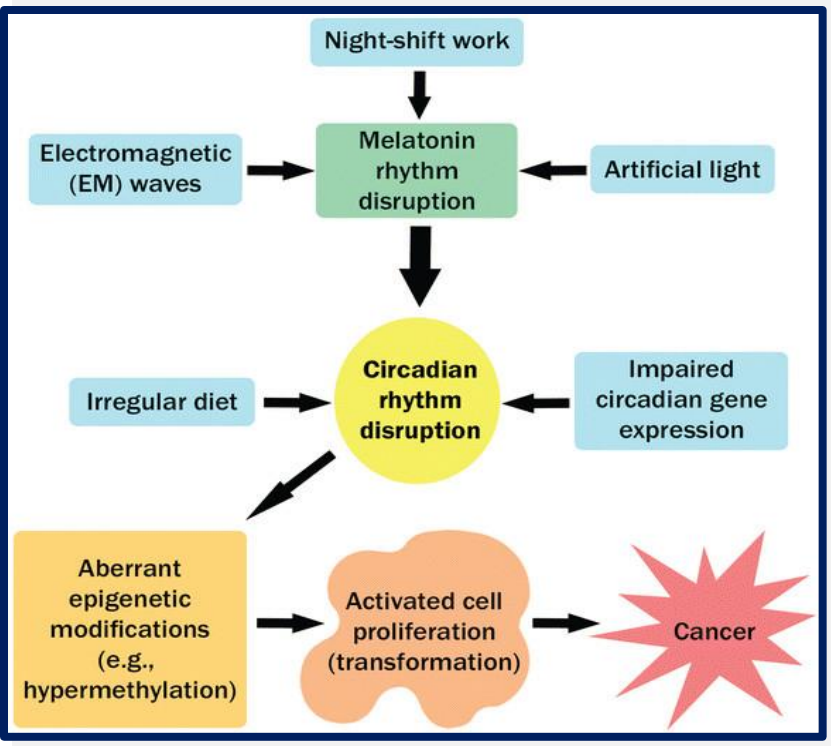
Nearly half of American children use screens in the hour before they sleep.

A 2006 poll of American adolescents showed that 97% of those surveyed have at least 1 electronic item (TV, phone, music-playing device) in their bedrooms.

Twelfth graders have around 4 of these devices.







Chronic disruptions of circadian rhythm may have the potential to seriously affect human health, mediated through decreases in melatonin levels and their role in development of chronic diseases and conditions, such as cancer, cardiovascular diseases, reproduction, endometriosis, gastrointestinal and digestive problems, diabetes, obesity, depression, sleep deprivation, bipolar spectrum disorders and cognitive impairment. In general, it is suggested that circadian disruptions are increasing health risks in night-shift workers and flight attendants potentially suffering from both jet-lag and night-shift work.

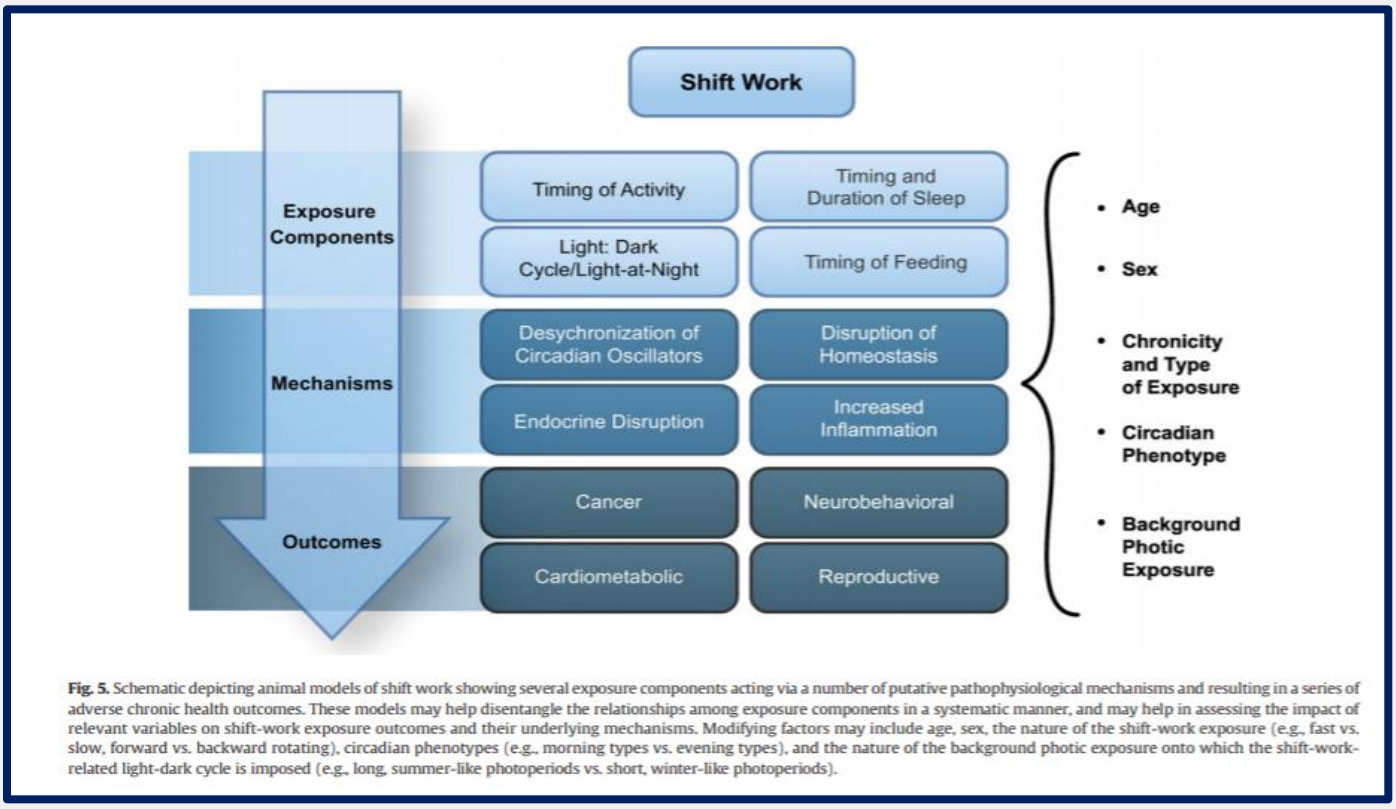
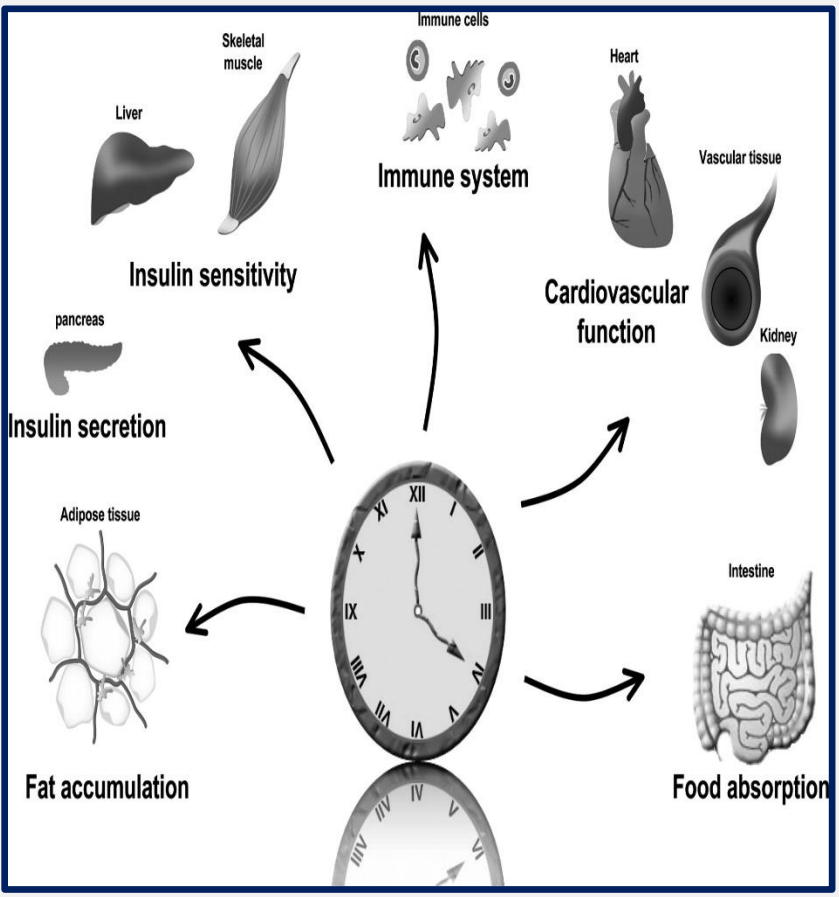


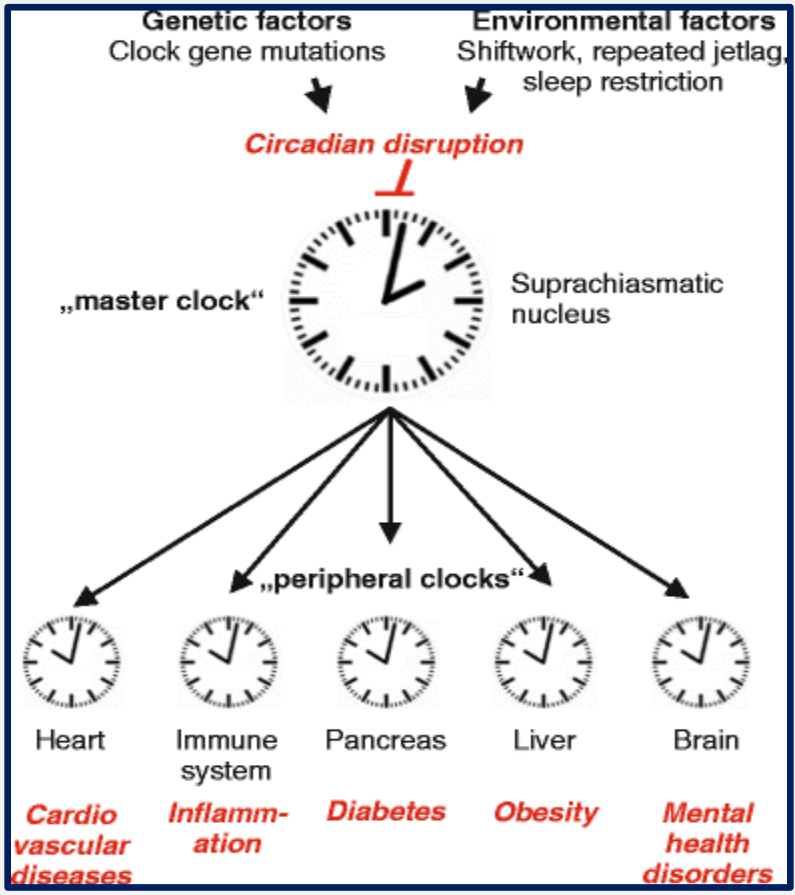
Fig. 5. Schematic depicting animal models of shift work showing several exposure components acting via a number of putative pathophysiological mechanisms and resulting in a series of adverse chronic health outcomes. These models may help disentangle the relationships among exposure components in a systematic manner, and may help in assessing the impact of relevant variables on shift-work exposure outcomes and their underlying mechanisms. Modifying factors may include age, sex, the nature of the shift-work exposure (e.g., fast vs. slow, forward vs. backward rotating), circadian phenotypes (e.g., morning types vs. evening types), and the nature of the background photic exposure onto which the shift-work-related light-dark cycle is imposed (e.g., long, summer-like photoperiods vs. short, winter-like photoperiods).

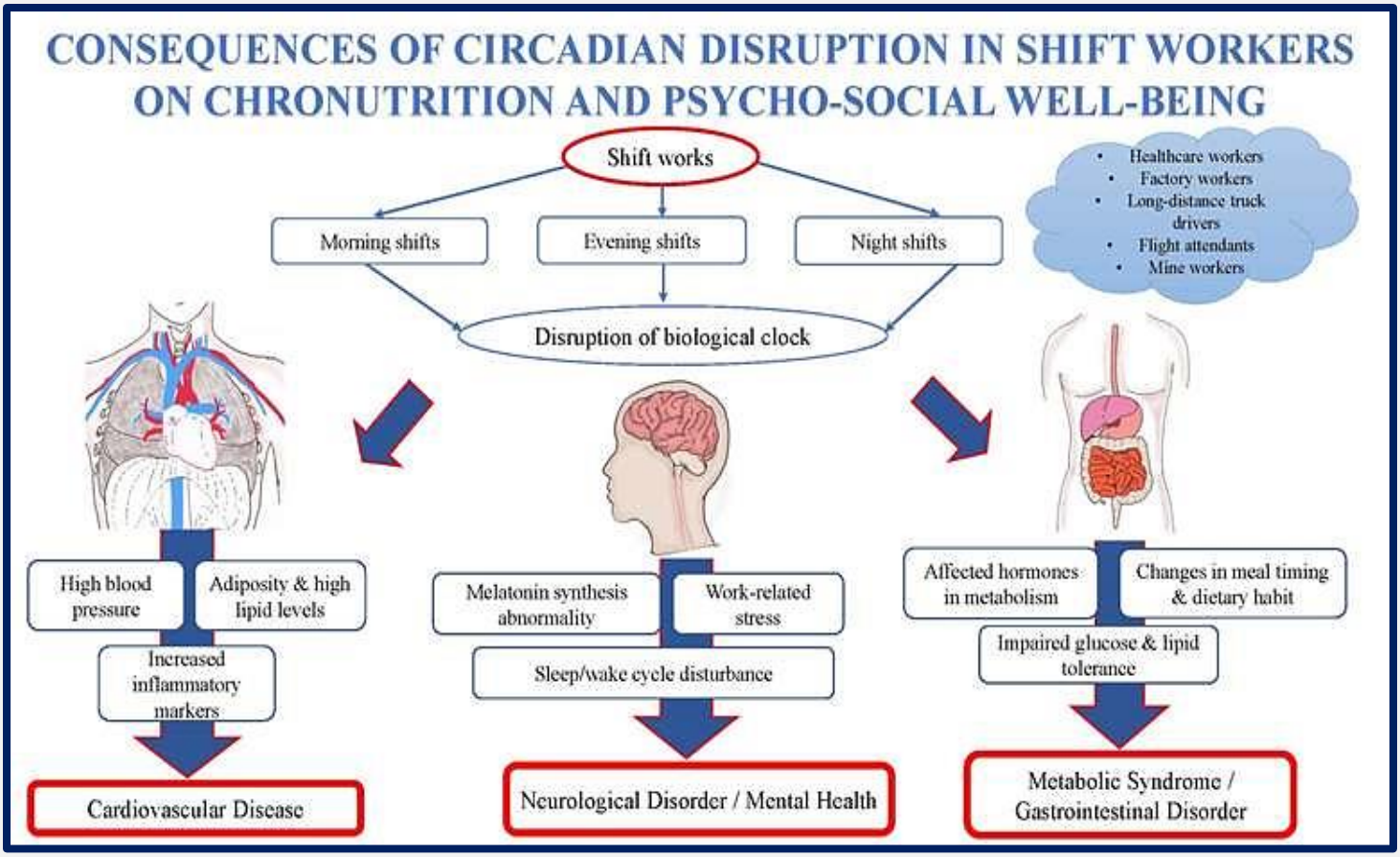
The most convincing evidence of an association between circadian disruption and health risk is found in incidence of reproductive cancers. A recent meta-analysis of studies investigating the relationship between shift work and female breast cancer risk demonstrated a significantly increased risk of 40%! A significant association between breast cancer risk and exposure to nonoccupational light during the night at home was also found for women who did not sleep during the period of melatonin level peaks or who frequently turned on the light during the night. Similarly, increased breast cancer risk was also correlated with increased bedroom illumination, and men had an almost 3-fold increase in risk of prostate cancer.

"It is further hypothesized that the SCN needs repeated input by external, as well as metabolic factors to sustain synchronization between endogenous physiological rhythms and external demands. Modern, hectic lifestyles with omnipresent and energy efficient lighting pollution often lead to a desensitization of the biological clock which results in abnormal endocrine responses, a basic component of type 2 diabetes."

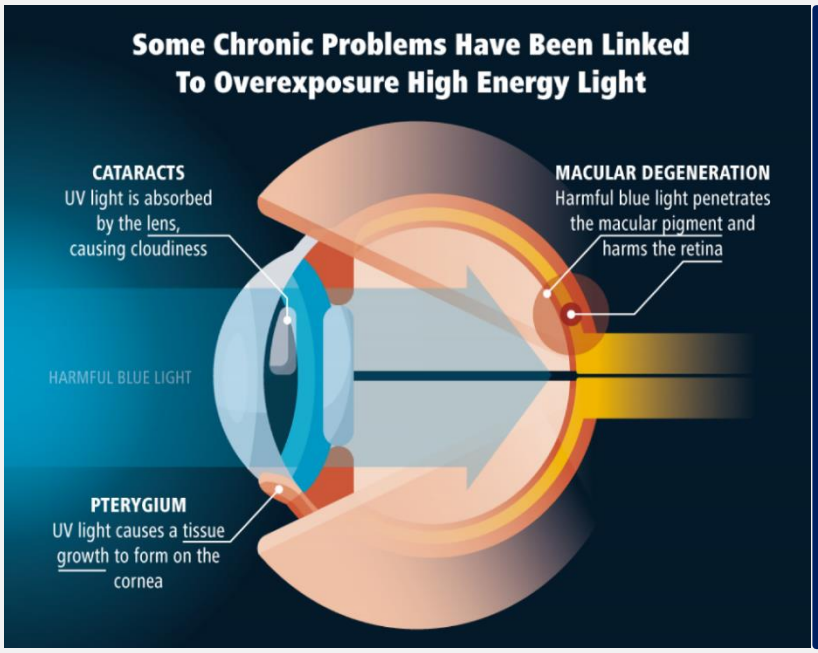
Investigations into the cardiovascular system have revealed variations in daytime gene expression, protein expression and organ function with potential influence of circadian clock disruptions on development of cardiometabolic syndrome. A desynchronization of peripheral clocks in cardiac tissue affects the metabolic activity of cardiac muscle cells. This leads to the accumulation of fatty acids inside the heart cells and subsequent contractile dysfunction of the heart.

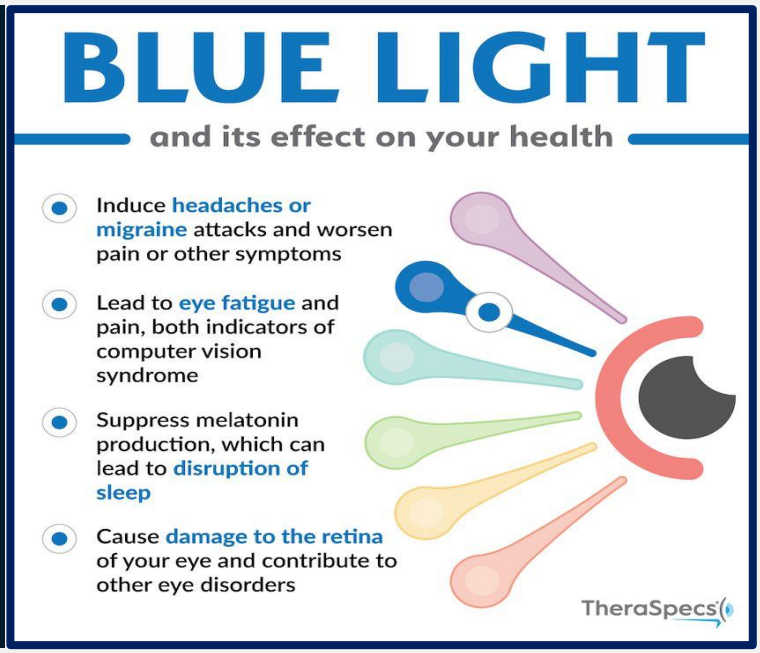






In addition to a host of metabolic, immunologic and neurologic disorders, evidence is also rising that circadian rhythm, along with the spectrum composition and intensity of light, impacts eye growth and onset/progression of eye conditions. Too much blue light exposure can cause tired eyes, headaches, stress on your vision. Children, especially, run an increased risk of damage as their natural eye defenses are not fully developed. Blue light (especially that shifted to blue-violet wavelength) is suspected to be a factor in retinal diseases, which can lead to blindness.

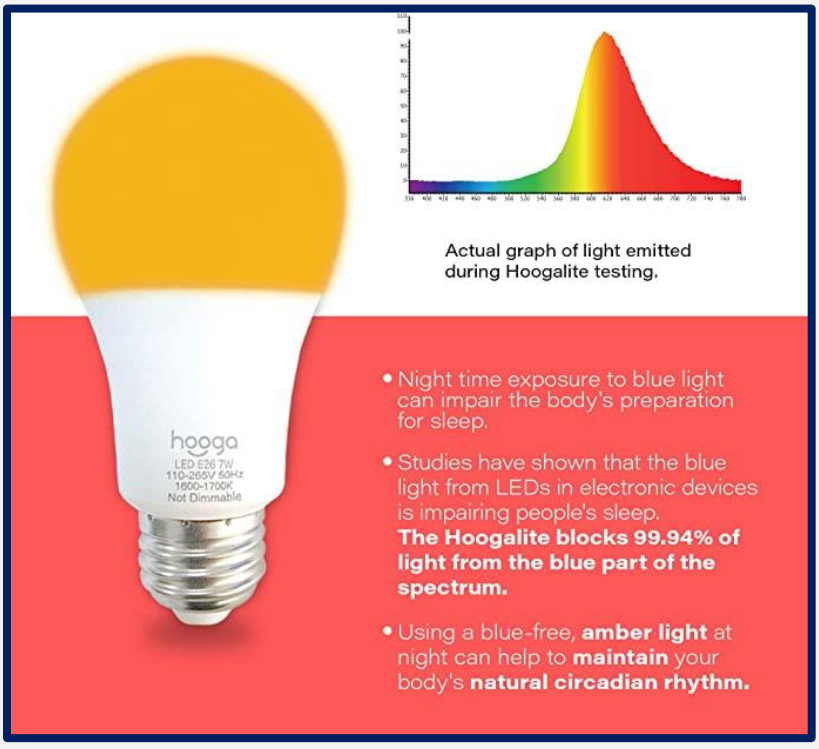




In summary, although electric light was pivotal in advancing the wealth, safety, productivity, and flexibility of our societies, it has also become so prolific, circadian disruption so extensive and sleep so fragmented, that we are globally feeling the detrimental strains to our collective physical, mental, psychological and emotional health. Unprecedented exposure to light at night through indoor and outdoor light pollution is now prevalent throughout life, beginning early in childhood and extending into old age: children sleeping with night lights; dense, urbanized populations with high levels of outdoor illumination; adolescents and adults with more evening use of electronic media; shift workers engaged in careers that expose them to light at night on a chronic or rotating basis; elderly institutionalized in hospitals or nursing homes exposed to artificial light at night because of 24-hour nursing activities and safety concerns require constant lighting.

Currently, blue light is considered to have the strongest effect in synchronizing human circadian rhythm. It is also apparent that there are 2 key components to keep a healthy circadian system: while exposure to low levels of blue light as well as bright light during the night or before bedtime may disrupt the circadian rhythm with severe health implications, blue light exposure during the daytime is crucial for vitality and regulation of both master and peripheral clocks.

Accumulation of this knowledge opens a number of doors whereby we can draw on our creativity, inventiveness and marketing of solutions to customize our blue-light exposure. Electronic manufacturers and software providers already offer a variation of blue light blocking features for displays and devices that support a “night mode” with brightness reduction features that allow us to differentiate our daytime and nighttime settings. Other base technologies which could advance in the near future include eyewear glasses with filtered lenses and amber-coated lightbulbs to block blue light, and the imposition of proper, bright artificial light with a more blue-weighted spectrum during morning hours to enhance performance and learning indoors.



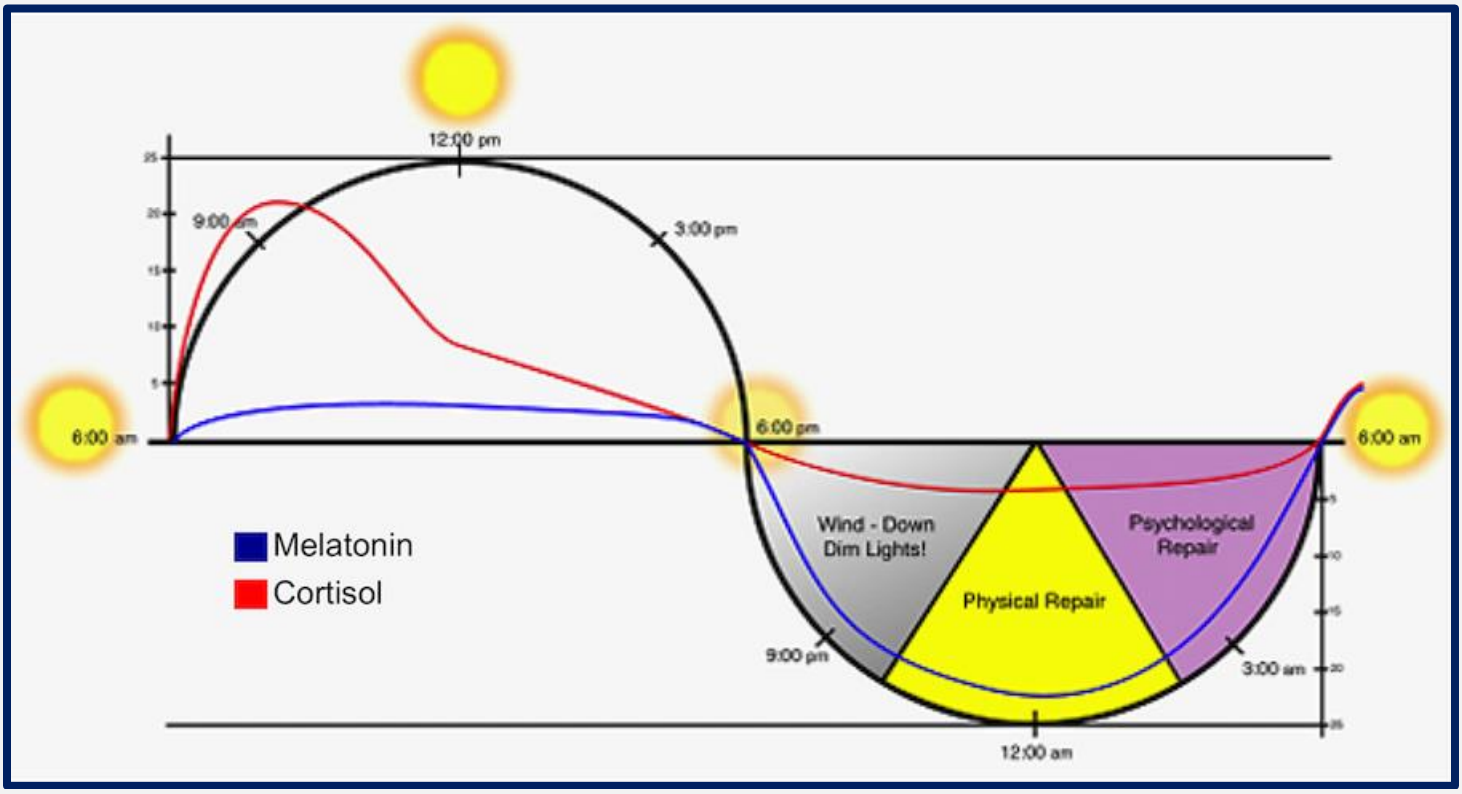
Just like our exposure to natural sunlight, it is time to respect our natural biological processes and accommodate our circadian needs by selectively choosing our windows of blue light and expanding our practices of sleep hygiene to protect, shield, support, maintain the rhythms that are responsible for sustaining us.

Maintaining a Healthy Circadian Rhythm through Investment in Sleep Hygiene Practices

While we don't have full control over our circadian rhythm, there are plenty of supportive guidelines that can be practiced to improve our sleep hygiene and better entrain our 24-hour sleep cycles. Prioritizing sleep and combating insomnia are dependent upon our choices!!

- **Seek out the sun.** Exposure to natural light, especially early in the day, helps reinforce the strongest circadian cue, set your biological clock and prime you for a good night's sleep. Seek out morning light (between 8-10 AM) for ~15 minutes, outdoors and without sunglasses or sunscreen.
- **Follow a consistent sleep schedule.** Varying your bedtime or morning wake-up time can hinder your body's ability to adjust to a stable circadian rhythm. Get up and go to bed at the same times every day, even on weekends.
- **Get daily exercise but refrain from scheduling at least 4 hours before bedtime.** Activity during the day can support your internal clock and help make it easier to fall asleep at night. However, timing of the workout is important. Exercise in the morning or early afternoon will not interfere with sleep.
- **Keep naps short and early in the afternoon.** Late and long naps can push back your bedtime and throw your sleep schedule off-kilter. If possible, refrain from napping to ensure you are tired at bedtime. If you can't make it through the day without lying down, limit sleep to less than 1 hour, before 3 p.m.

- **Avoid caffeine, nicotine & alcohol at least 4-6 hours before bed.** Caffeine and nicotine are stimulants that can keep you awake and interfere with the natural balance between sleep and wakefulness. Coffee, tea, cola, cocoa, chocolate, and some prescription & non-prescription drugs contain caffeine. Everyone is different, but if you're having trouble sleeping, you should avoid caffeine after noon. Cigarettes and some drugs contain nicotine. Alcohol may seem to help you sleep in the beginning as it slows brain activity but it ultimately produces a fragmented night's sleep.
- **Have a light snack before bed.** If your stomach is too empty, that can interfere with sleep. However, if you eat a heavy meal before bedtime, that can interfere as well. Dairy products contain tryptophan (precursor to serotonin & melatonin, acts as a natural sleep inducer), which is probably why drinking warm milk 30 minutes before bed is sometimes recommended.
- **Take a hot bath 90 minutes before bedtime.** A hot bath will soothe sore muscles, promote relaxation and raise your body temperature, but it is the subsequent *drop* in body temperature that may leave you feeling sleepy.
- **Limit light before bed.** Artificial light exposure at night can interfere with circadian rhythm. Experts advise dimming the lights and putting down electronic devices in the lead-up to bedtime to stimulate melatonin production.



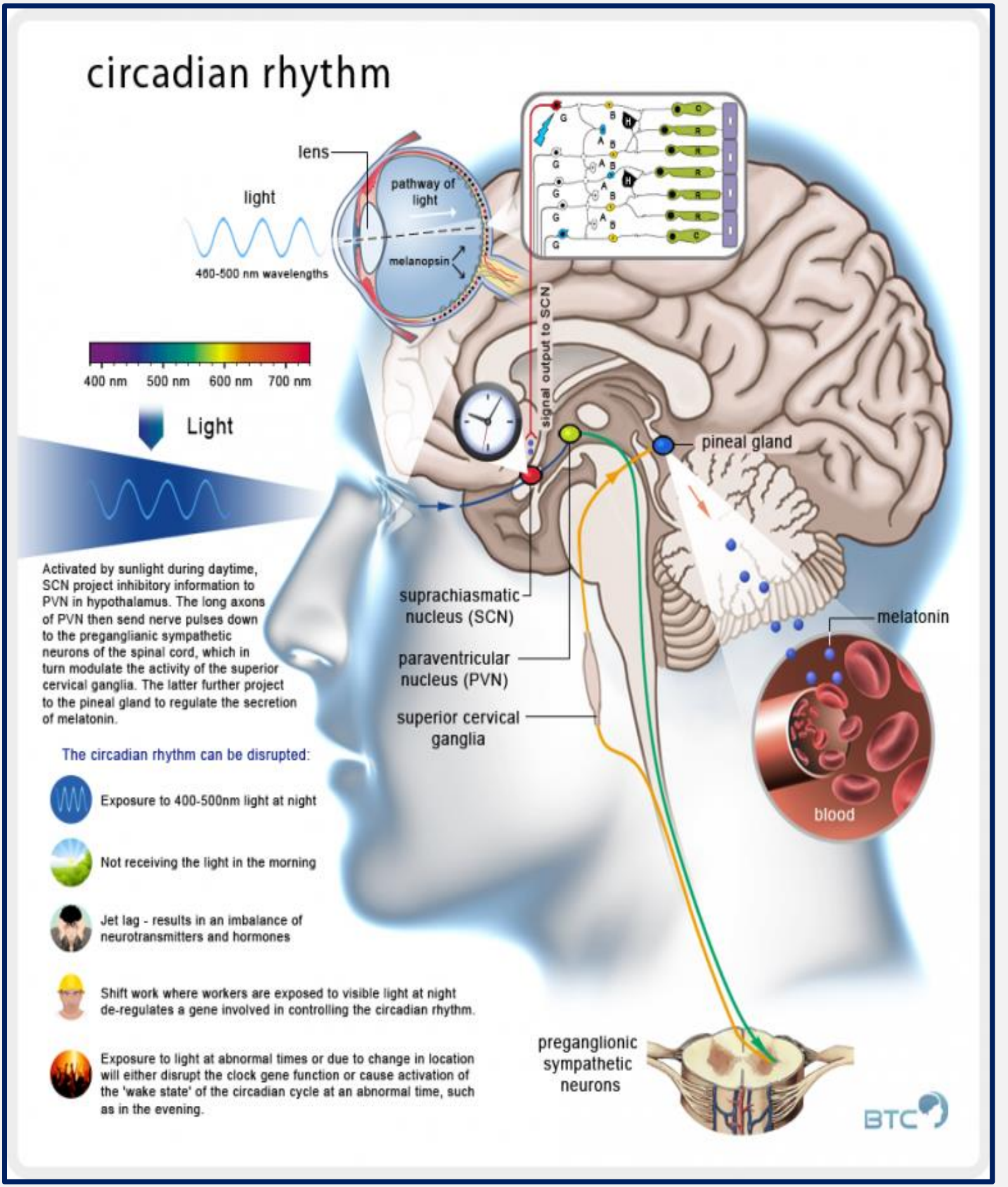
- **Develop sleep rituals.** It is important to establish routine cues that lets your brain and body know it's time to slow down and sleep. Sleep is a physiological process of gradual descent rather than instant gratification triggered by flipping a switch. Establish habitual end-of-evening activities in the 20-60 minutes prior to bed that work best for you and stick to them: listen to relaxing music, read something soothing for 15 minutes, have a cup of caffeine-free tea or do relaxation exercises.
- **If you can't fall asleep or have been trying to get back to sleep for 20-25 minutes, get up & do something boring until you feel sleepy.** Our brains are incredibly associative and the recommendation is to create an association between brain and bed of sound and consistent sleep. It is recommended to get up and out of bed if efforts to sleep have been fruitless. Sit quietly in the dark, journal or list out anything that preoccupies your mind or read an appliance manual by lamplight. Whatever your choice, keep things quiet and dim; avoid exposing yourself to bright light while you are up as this will cue your brain that it is time to wake up.
- **Only use your bed for sleeping (and sex).** Refrain from using your bed to watch TV, pay bills, do work or reading. Again, our brains are associative and by only using our bed for a primary activity, we entrain the behavior that when we go to bed our brain and body know it is the time and place for sleep.
- **Keep it quiet, cool and comfortable.** Both our brain and bodies need to drop their core temperature by about 1 degree Celsius (2-3 degrees Fahrenheit) in order to initiate sleep and then stay asleep. It's always easier to fall asleep in a room that's too cold than too hot and you can always add enough blankets to stay comfortably warm. Aim for a bedroom temperature of approximately 68 degrees. If there is ambient light from outdoors flooding the room or early morning sun bothers you, invest in blackout shades/curtains or eye mask to block the light. If noises are bothersome, consider ear plugs, a noise machine or even leave a box fan running on a low setting.

Sleep is influenced by our surrounding environment: light, food, medications/drugs, exercise, stress, emotions, hormonal shifts and our reactivity to extrinsic factors.

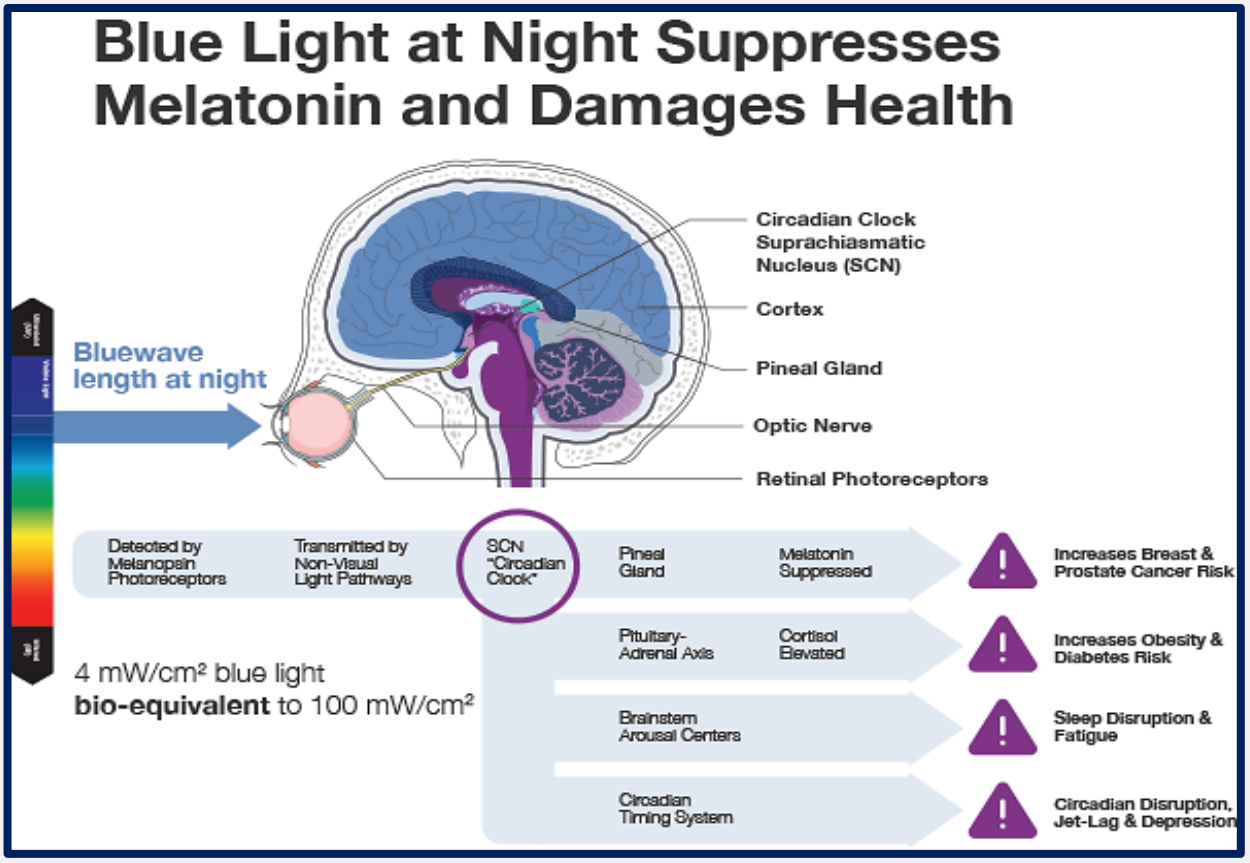
Sleep disturbances are generally not smoothed out with an instant fix. It may require some time (weeks to months) to try out, replace and fully entrench new habits, reset the clock and equilibrate your system.

Sleep is Life-Support. It's always a good idea to seek help from a sleep specialist sooner rather than later! Especially if you have a genuine sleep disorder, tips are not going to fix the root of the problem. Working cooperatively with a specialist to re-establish quality sleep is always recommended over and above complicating and exacerbating the problem with sleeping pills!!

Takeaway 1:

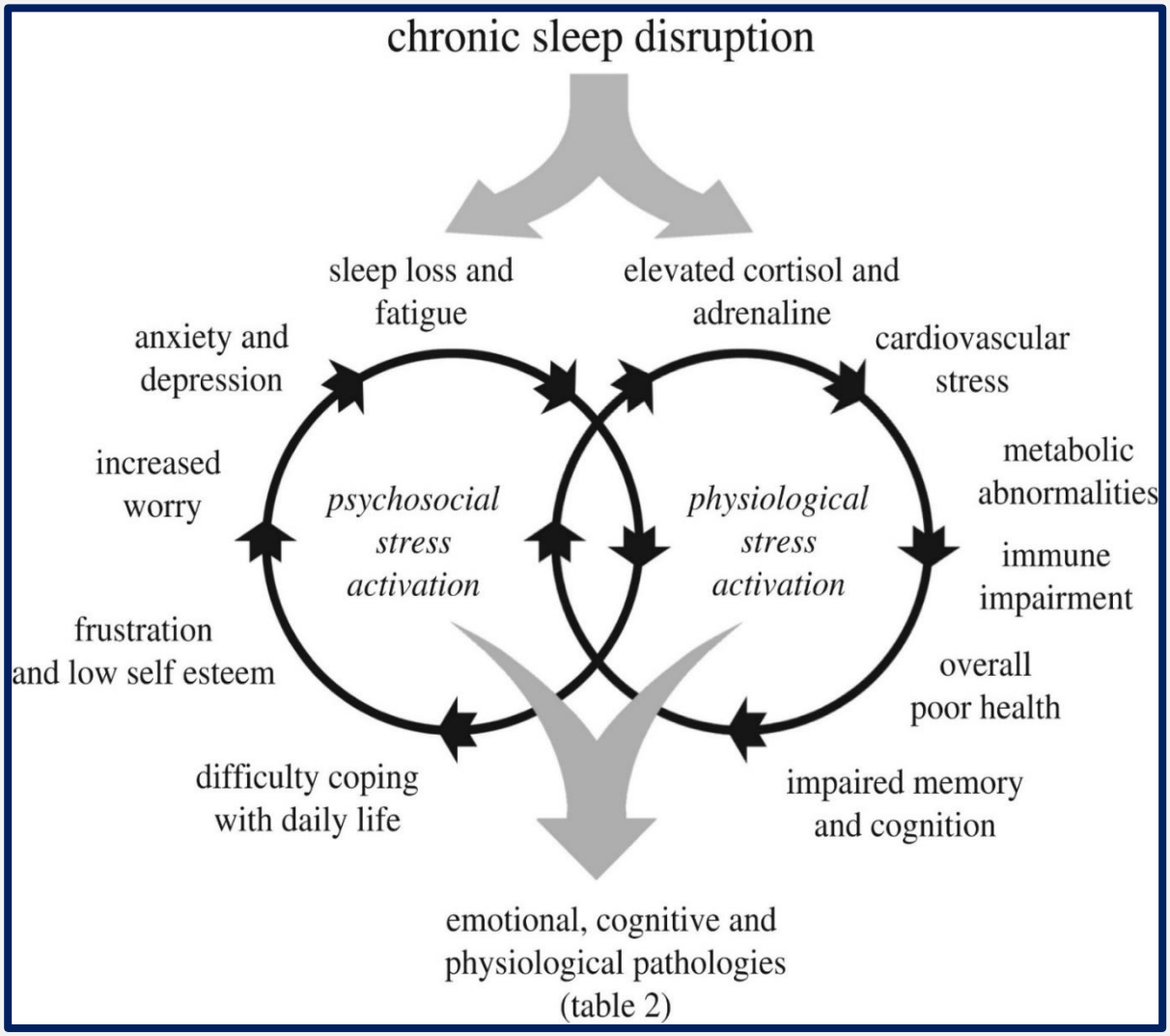

circadian rhythm
lens
light
pathway of light
melanopsin
460-500 nm wavelengths
400 nm
500 nm
600 nm
700 nm
Light
signal output to SCN
pineal gland
melatonin
suprachiasmatic nucleus (SCN)
paraventricular nucleus (PVN)
superior cervical ganglia
blood
preganglionic sympathetic neurons
Activated by sunlight during daytime, SCN project inhibitory information to PVN in hypothalamus. The long axons of PVN then send nerve pulses down to the preganglianic sympathetic neurons of the spinal cord, which in turn modulate the activity of the superior cervical ganglia. The latter further project to the pineal gland to regulate the secretion of melatonin.
The circadian rhythm can be disrupted:
Exposure to 400-500nm light at night
Not receiving the light in the morning
Jet lag - results in an imbalance of neurotransmitters and hormones
Shift work where workers are exposed to visible light at night de-regulates a gene involved in controlling the circadian rhythm.
Exposure to light at abnormal times or due to change in location will either disrupt the clock gene function or cause activation of the 'wake state' of the circadian cycle at an abnormal time, such as in the evening.
BTC

Takeaway 2:


Blue Light at Night Suppresses Melatonin and Damages Health
Bluewave length at night
Circadian Clock Suprachiasmatic Nucleus (SCN)
Cortex
Pineal Gland
Optic Nerve
Retinal Photoreceptors
Detected by Melanopsin Photoreceptors
Transmitted by Non-Visual Light Pathways
SCN "Circadian Clock"
Pineal Gland
Melatonin Suppressed
Increases Breast & Prostate Cancer Risk
Pituitary-Adrenal Axis
Cortisol Elevated
Increases Obesity & Diabetes Risk
Brainstem Arousal Centers
Sleep Disruption & Fatigue
Circadian Timing System
Circadian Disruption, Jet-Lag & Depression
4 mW/cm² blue light
bio-equivalent to 100 mW/cm²


Circadian Rhythm Sleep Disorders
Some people's sleep-wake cycles don't fit a daytime schedule and cannot be changed simply by discipline.
CRSDs are PHYSIOLOGICAL. Faulty rhythms of melatonin, cortisol and core body temperature can be measured.
Forcing people with CRSDs to live according to society's schedule often results in sleep deprivation and may lead to chronic illnesses such as fibromyalgia, diabetes, heart disease and cancer.
DIAGNOSIS
Misdiagnosis is common! CRSDs can look like depression, ADHD, primary insomnia and other disorders.
Delayed Sleep-Wake Phase Disorder
People who sleep and wake very late
DSWPD is the most common circadian rhythm disorder. It affects 1 in 600 ADULTS (over half a million in America and 100,000 in the UK).
About 10% of teenagers develop temporary DSWPD.
GOOD MORNING CLASS!
Non-24-Hour Sleep-Wake Disorder
People who have more than than 24 hours in their sleep-wake cycle, which moves right around the clock over several weeks
Both blind and sighted people can have Non-24.
Advanced Sleep-Wake Phase Disorder
People who sleep and wake very early
Treatments?
Good sleep hygiene is not sufficient.
Sleeping pills are not an effective long-term treatment.
DRUG
Treatments include:
· Morning bright light exposure
· Evening light restriction
· Melatonin
When treatments don't work, home life suffers and formal accommodations are needed at work and/or school.
There are currently no cures for Circadian Rhythm Sleep Disorders
For more information please visit: csd-n.org
Art & design by Lily Style
© Circadian Sleep Disorders Network

Takeaway 3:



Resources: *Excerpts within this article taken from the following texts:

Michael Breus, Ph.D. Psychology Today. ;The Effects of Cortisol on Your Sleep.; April 10, 2020. https://www.psychologytoday.com/us/blog/sleep-newzzz/202004/the-effects-cortisol-your-sleep#:~:text=In%20this%20way%2C%20cortisol%20plays,and%20help%20bring%20about%20sleep.

Michael Finkel. The Science of Sleep. National Geographic. August 2018, pp. 40-77.

Camila Hirotsu; Sergio Tufik; Monica Levy Andersen. Sleep Science. Review: 'Interactions between sleep, stress, and metabolism: From physiological to pathological conditions.' Vol. 8 Issue 3. 2015. http://sleepscience.org.br/details/236/en-US/interactions-between-sleep--stress--and-metabolism--from-physiological-to-pathological-conditions

David Perlmutter, MD and Austin Perlmutter, MD. Brain Wash. pp.139-143

Siegfried Wahl, Patrick Schaupp, Christian Lappe, Iliya V. Ivanov. 'The inner clock—Blue light sets the human rhythm.' (Review Article). Journal of Biophotonics. August 21, 2019. https://onlinelibrary.wiley.com/doi/full/10.1002/jbio.201900102

Wellness Bites: Getting Grounded with SWEETPOTATOES

Sweetpotatoes are not actually potatoes (or yams); instead, they belong to the bindweed or morning glory family, are broadly adaptable and grown worldwide. The earliest cultivation records date to 750 BC in Peru, although archeological evidence shows cultivation may have begun around 2500-1850 BC. Its large, starchy, sweet-tasting tuberous roots are served as a cooked vegetable and the young leaves and shoots are sometimes eaten as greens. They come in a variety of sizes and colors, including orange, red, pink, violet, yellow white and purple. In Japan the crop has long been cultivated for manufacture of starch and alcohol.

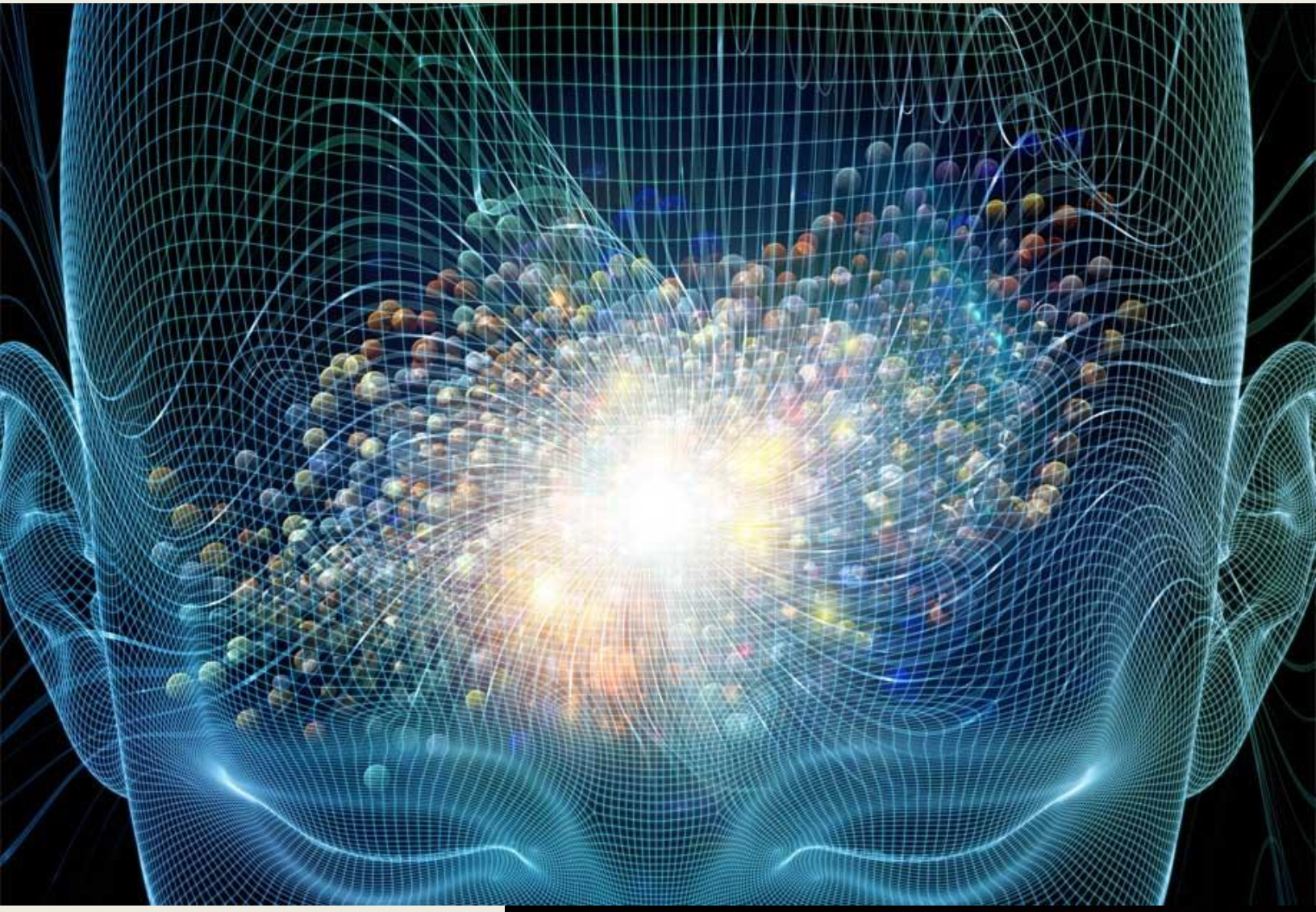
Fiber, beta-carotene/vitamin A, B vitamins, vitamin C, vitamin D, calcium, iron, magnesium, potassium, phosphorus, zinc, antioxidants.

Sweetpotatoes pack a powerful nutritional punch. One medium potato provides 400% of your daily vitamin A requirement, supporting the health of your eyes, immune system, reproductive system and organs like your heart and kidneys; improving blood sugar regulation; reducing oxidative damage and cancer risk.

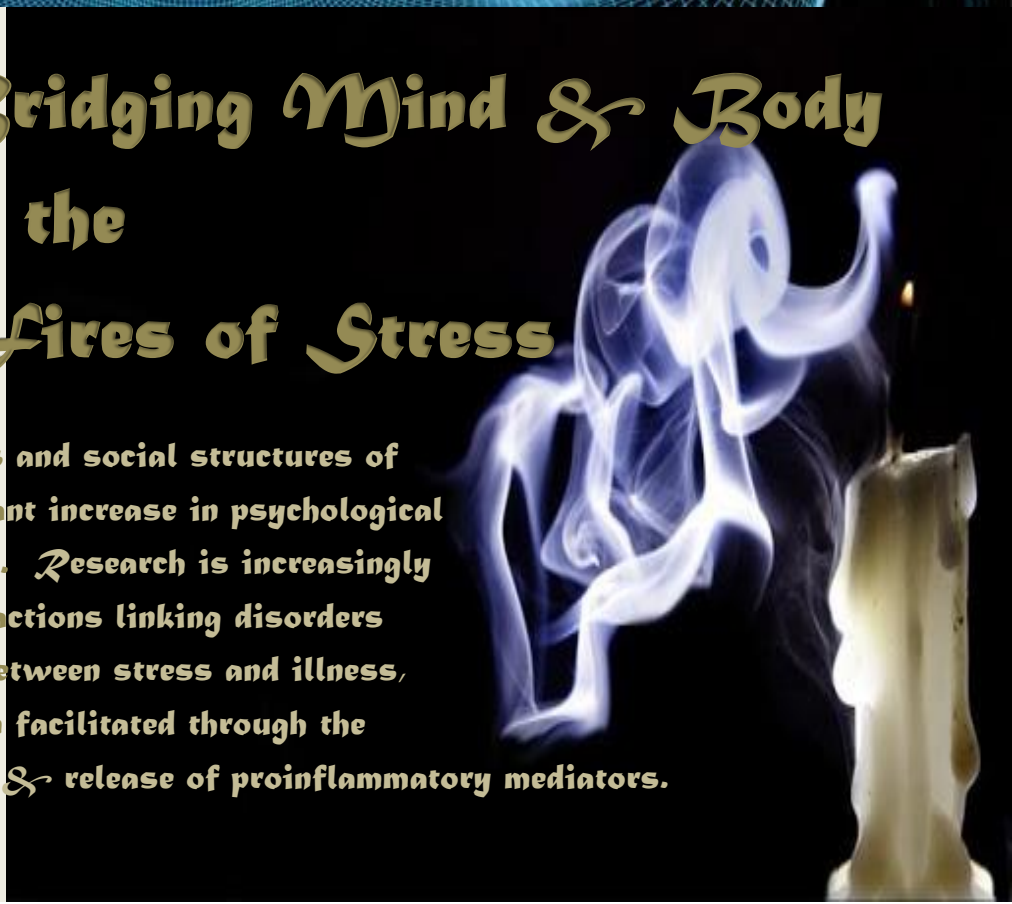
Sweetpotatoes are considered fairly high in substances called oxalates, which may increase your risk of kidney stones if your are prone to the condition. Although cooking sweet potatoes slightly reduces their beta-carotene content, they still retain at least 70% of this nutrient & are considered an excellent source. Preparing sweet potatoes with a liitle fat, such as advocado or olive oil, can help boost absorption of beta-carotene since it's a fat-soluable nutrient.

Sweetpotatoes can be enjoyed with or without skin and can be baked, boiled, roasted, fried, steamed or pan-cooked. Their natural sweetness pairs well with many different seasonings, making for versatile utility in both savory and sweet dishes: sweet potato chips/fries—peeled, thinly sliced or cut into wedges/matchsticks & baked or fried; sweet potato toast—cut into thin slices, toasted & topped with ingredients like nut butter or advocado; mashed sweet potatoes—peeled, boiled and mashed with milk, syrup &/or seasoning; baked sweet potatoes—baked whole in the oven until fork-tender; sweet potato hash—peeled, diced and cooked with onion in a pan; spiralized sweet potatoes—cut into spirals, sauteed, and sauced; in baked goods—sweeet potatoes add moisture without fat.

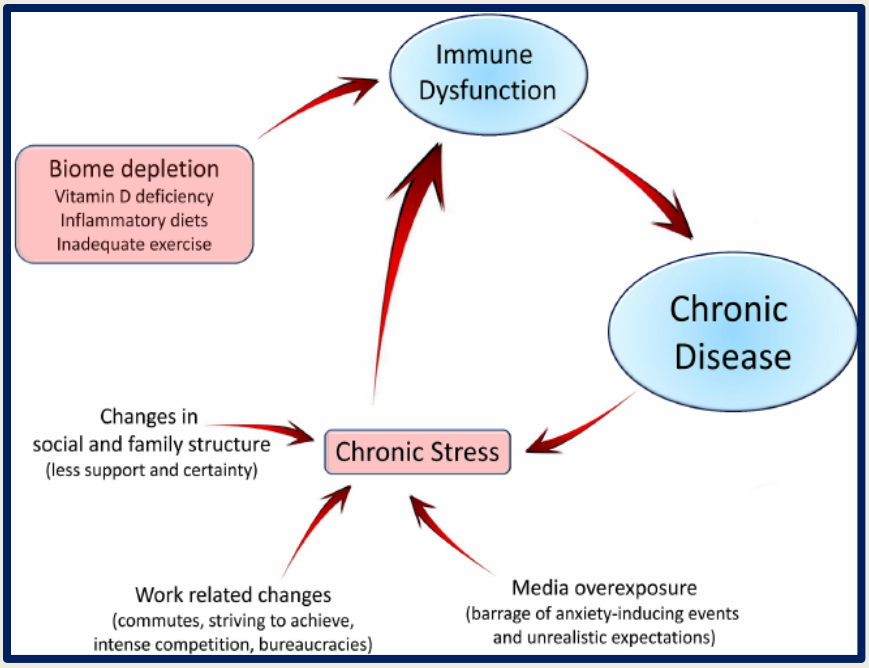
INEXPENSIVE! NUTRIENT-DENSE! Packed with nutrients that promote a healthy gut.



Wellness Focus: Bridging Mind & Body to Cool the Fires of Stress

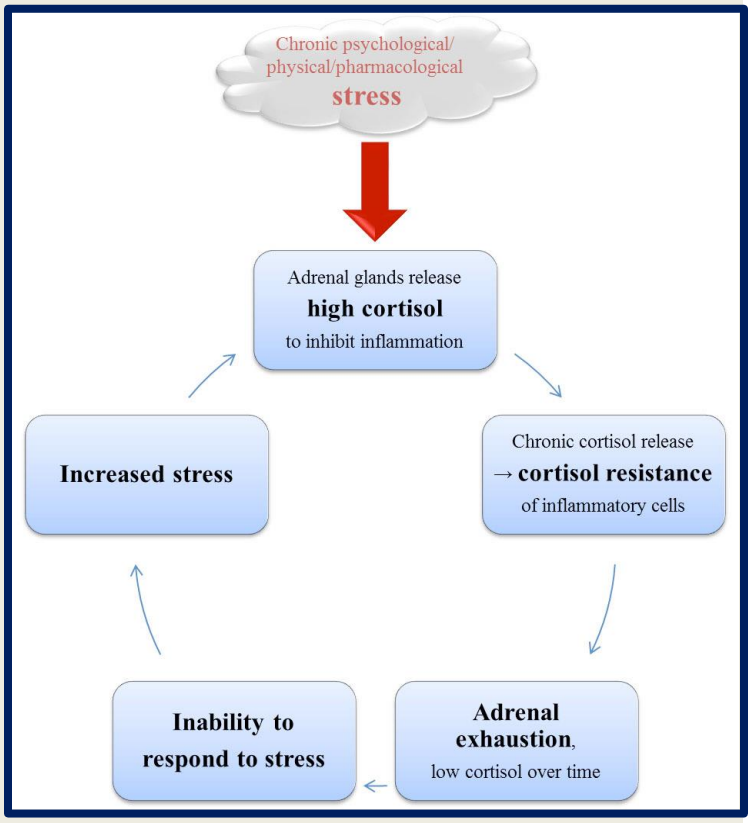


Modern lifestyles, environments and social structures of communities have led to significant increase in psychological and systemic oxidative stressors. Research is increasingly demonstrating bidirectional interactions linking disorders between the mind and body and between stress and illness, with the key response mechanism facilitated through the activation of the immune system & release of proinflammatory mediators.

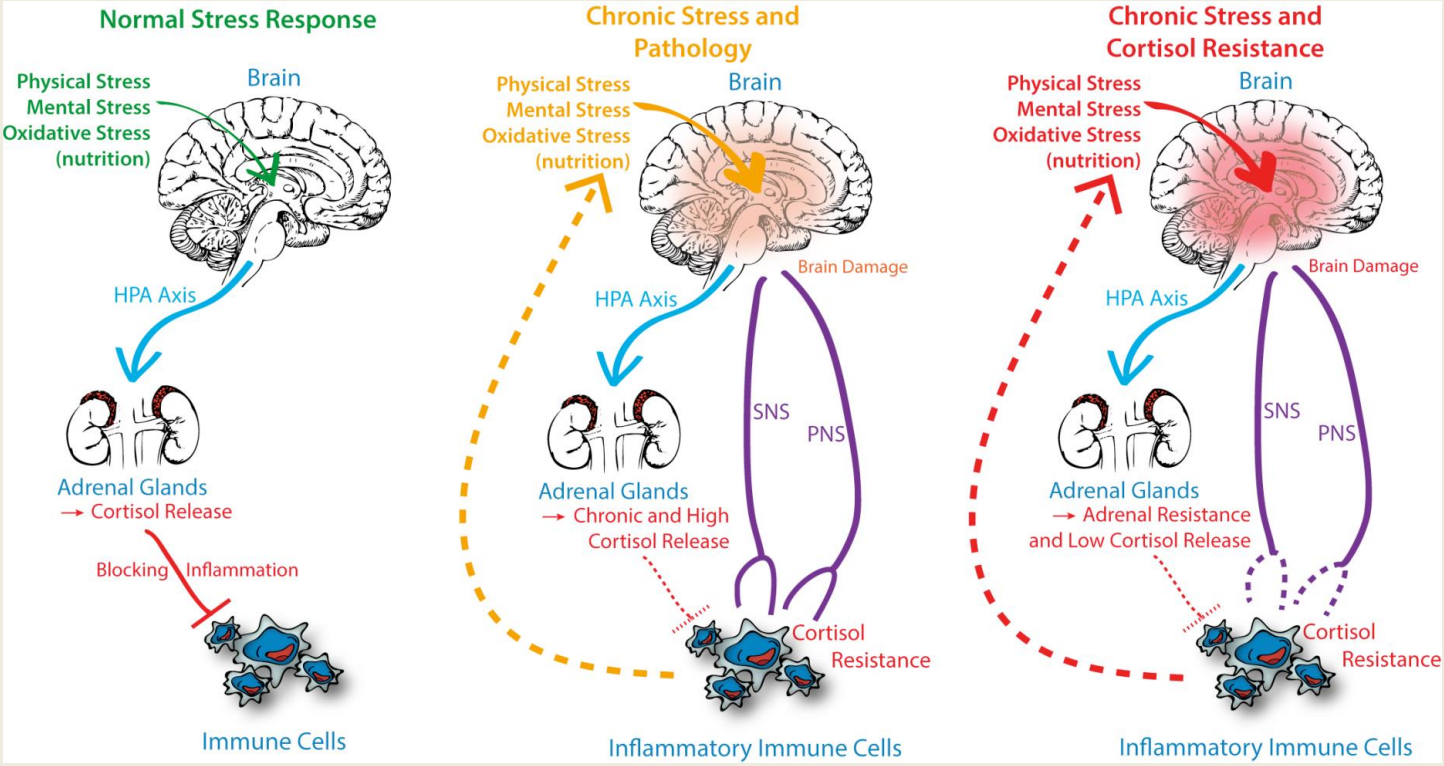


Stress has been defined as the presence of acute or persistent psychological threats to the organism that result in significant strain on the body's compensatory systems. In medicine, "stress" is defined by the body's nonspecific response to any extra demand by physical, psychological or pharmacological events.

Systemically, stress induces (via sympathetic "fight or flight" pathway, September newsletter) activation of the hypothalamic-pituitary-adrenal (HPA) axis that acts on the adrenal glands to release cortisol. This process typically creates a negative feedback loop, where the excess cortisol activates the brain's glucocorticoid receptors to suppress further production by the mechanism. However, high cortisol levels that are associated with repeated or chronic stress can lead to hyperactivation (or overdrive) of the HPA axis, especially within the limbic brain areas that regulate mood and emotional responses.



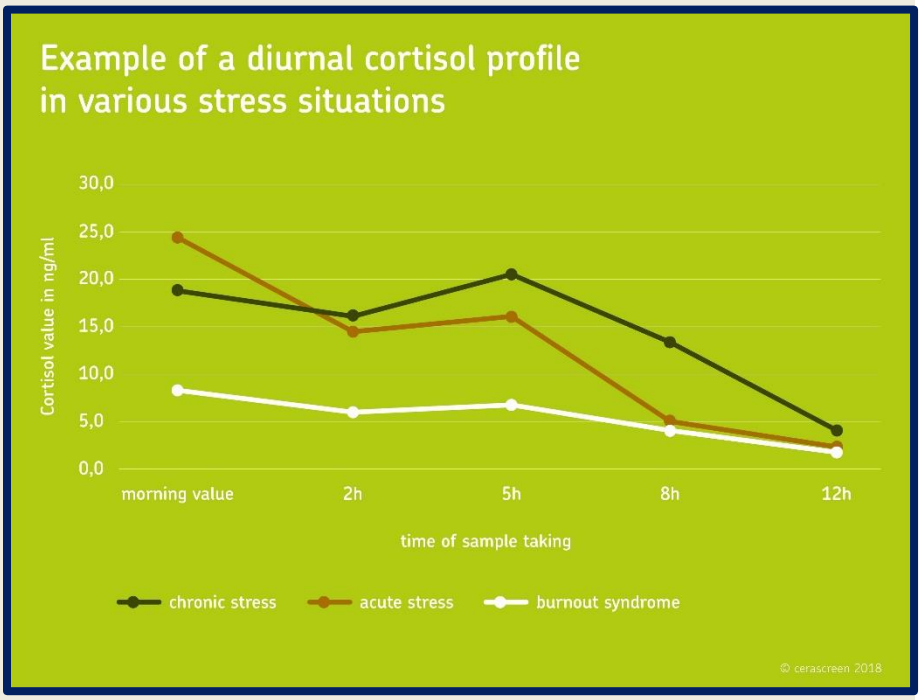
Like a car driven too far, too fast, under persistent stressors, brain and body structure/function begins to "overheat," sputter, breakdown and cease working properly.



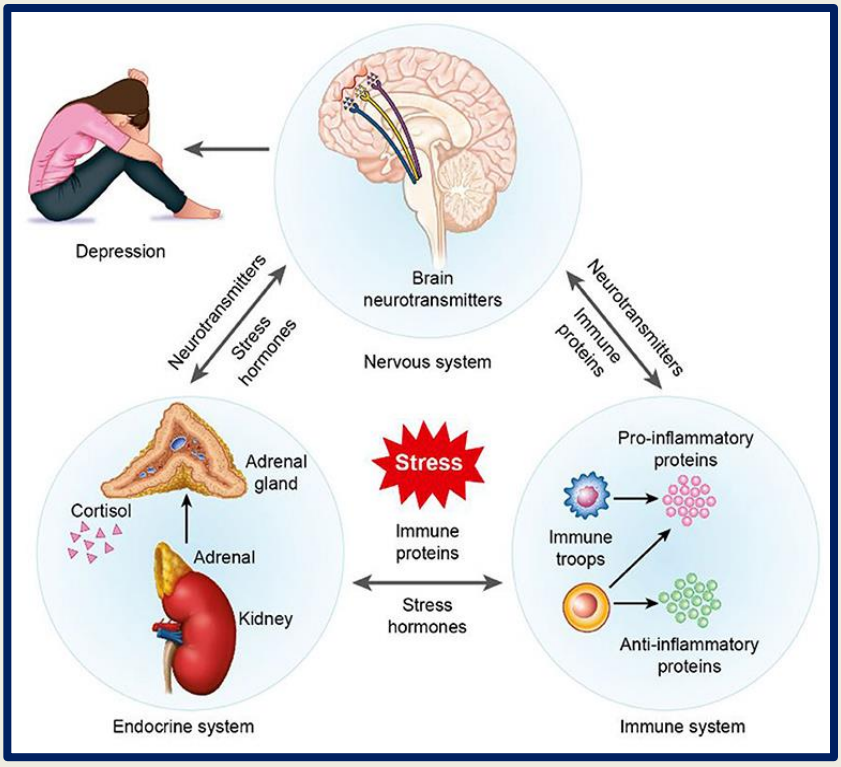
Role of stress induced activation of HPA axis, cortisol, and sympathetic nervous system (SNS) and parasympathetic nervous system (PNS) neurotransmitter release to combat immune cell activation. Stress (green arrow acting on the brain) affects brain function dierctly *via* the Locus coeruleus in the brain stem, hypothalamus and other brain regions. In an healthy individual, this stress is compensated by cortisol (released *via* the HPA axis), which also blocks activation of inflammatory immune cells (left); Under chronic stress, cortisol is continuously activated but inflammatory immune cells downregulate their receptors and contribute to stressing brain regions by inflammatory cytokines (green dashed line). Inflammatory cells of hematopoietic system also affect human licocalin-2 (LCN2) production in the liver and □-amylase in saliva. When cortisol fails to downmodulate inflammatory cells, the state of stress is described as cortisol resistance (middle panel). In the most detrimental advanced stage of depression, adrenal resistance is the most important characteristic. In case of adrenal resistance, the adrenals attempt to help the body to resist prolonged stress by producing persistently increased cortisol. Subsequently, the ability of adrenal glands to make even normal amounts of cortisol is lost, which is known as adrenal exhaustion or adrenal fatigue. In this situation, the communication and regulatory function of the SNS and PNS is also affected, which may account for various aspects of immune dysfunction, such as increased and chronic infections or autoimmune diseases. [Vashist & Schneider]

When the feedback loop becomes sidelined and non-functional, cortisol runs unchecked. Excess cortisol production leads to increases in blood sugar, blood pressure and protein catabolism apart from the suppression of immune cells, insomnia and suppression of gastrointestinal function and digestion. When the adrenals have been maxed out ("burnout") and can no longer respond to stress, the body starts deteriorating. Moreover, chronic stress is also accompanied by increased secretion of proinflammatory cytokines that can further impair nerve cell transmission (neurotransmitters) and plasticity (ability to change through growth and reorganization) within brain circuits, especially those structures within the limbic brain (hippocampus, amygala).

Specific to the central nervous system, it is believed that the brain communicates with the immune system through cytokines ("moving cells"), neuropeptides (proteins) and neurotransmitters, and stress results from inflammation that stimulates endogenous immune cells (macrophages, microglia) to secrete inflammatory cytokines. The brain tries to combat this inflammation via increased cortisol secretion.



Therefore, the initial phase of stress is characterized by high levels of inflammatory cytokines, which act to increase tryoptophan degradation (thereby decreasing serotonin and subsequently melatonin as well). The secondary phase is characterized by a high cortisol level and a unique loss of cortisol peaks in the morning and low cortisol concentrations in the evening hours.



The activation of the immune response and release of proinflammatory mediators is the link that connects chronic stress, systemic illness and mental disorders. In contrast to coordinated physiological processes that underlie maintenance of steady state or homeostasis, prolonged psychological or traumatic stress can lead to disruption of cellular and systemic equilibriums, resulting in dysfunction of both the nervous system and peripheral organ systems. Thus, chronic stress can ultimately lead to alterations and dysfunction of internal systems that control stress responses and consequent development of both metnal and physical illnesses.

This concept is further supported by clinical reports indicating that psychological stress and systemic disorders are both commonly associated with adverse impact on mental health and development of comorbid psychiatric illnesses. Indeed, clinical depression is present in up to 50% of patients with chronic systemic conditions (e.g., pain, stroke, Alzheimer's, cardiovascular disease, obesity, diabetes and cancer), much higher than the rate of 5% to 8% in the general population, resulting in impaired physical recovery, more intricate treatment regimens, increased morbidity/mortality and elevated healthcare costs. [Duric et. al]

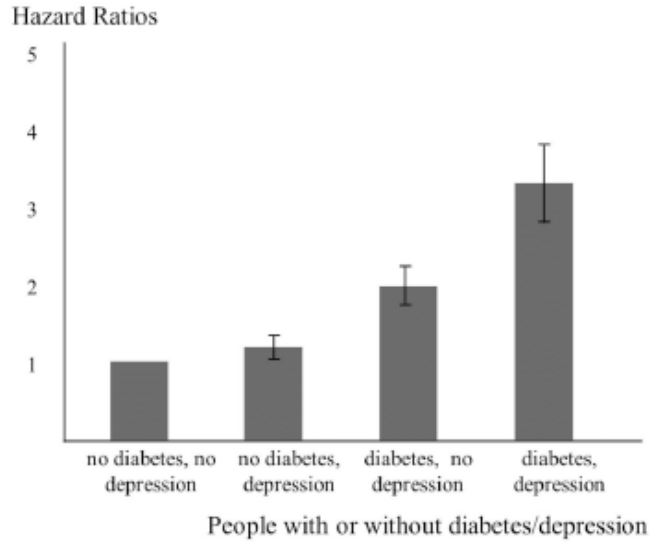
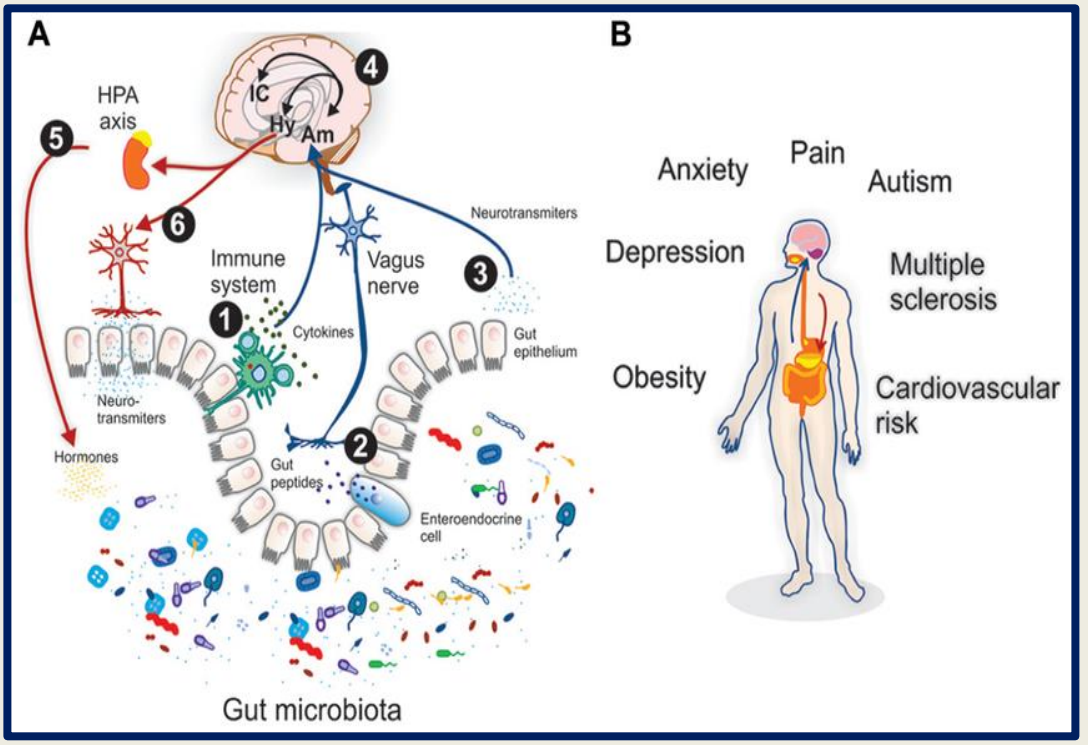
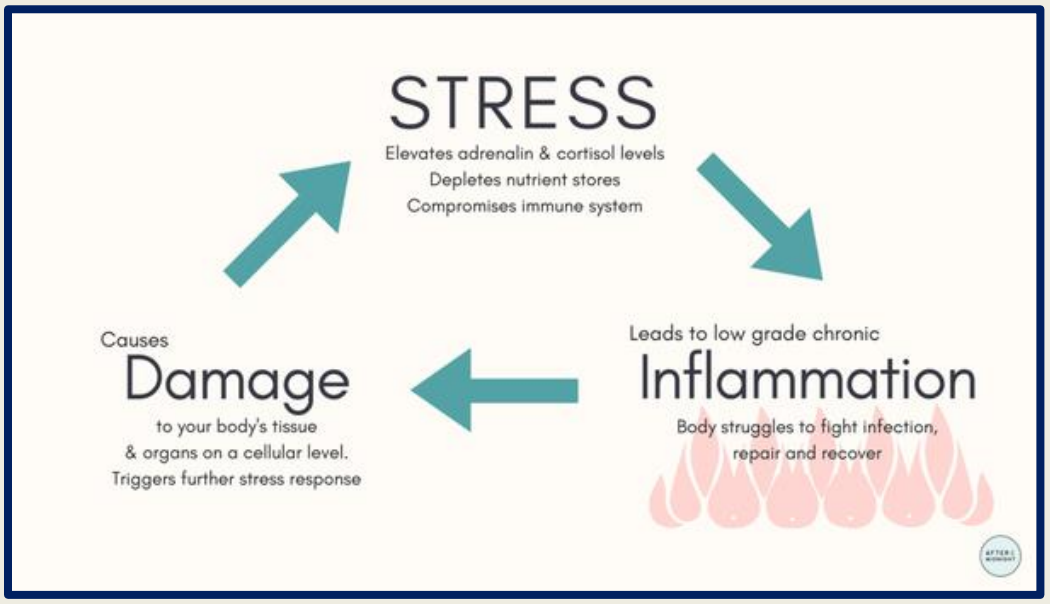


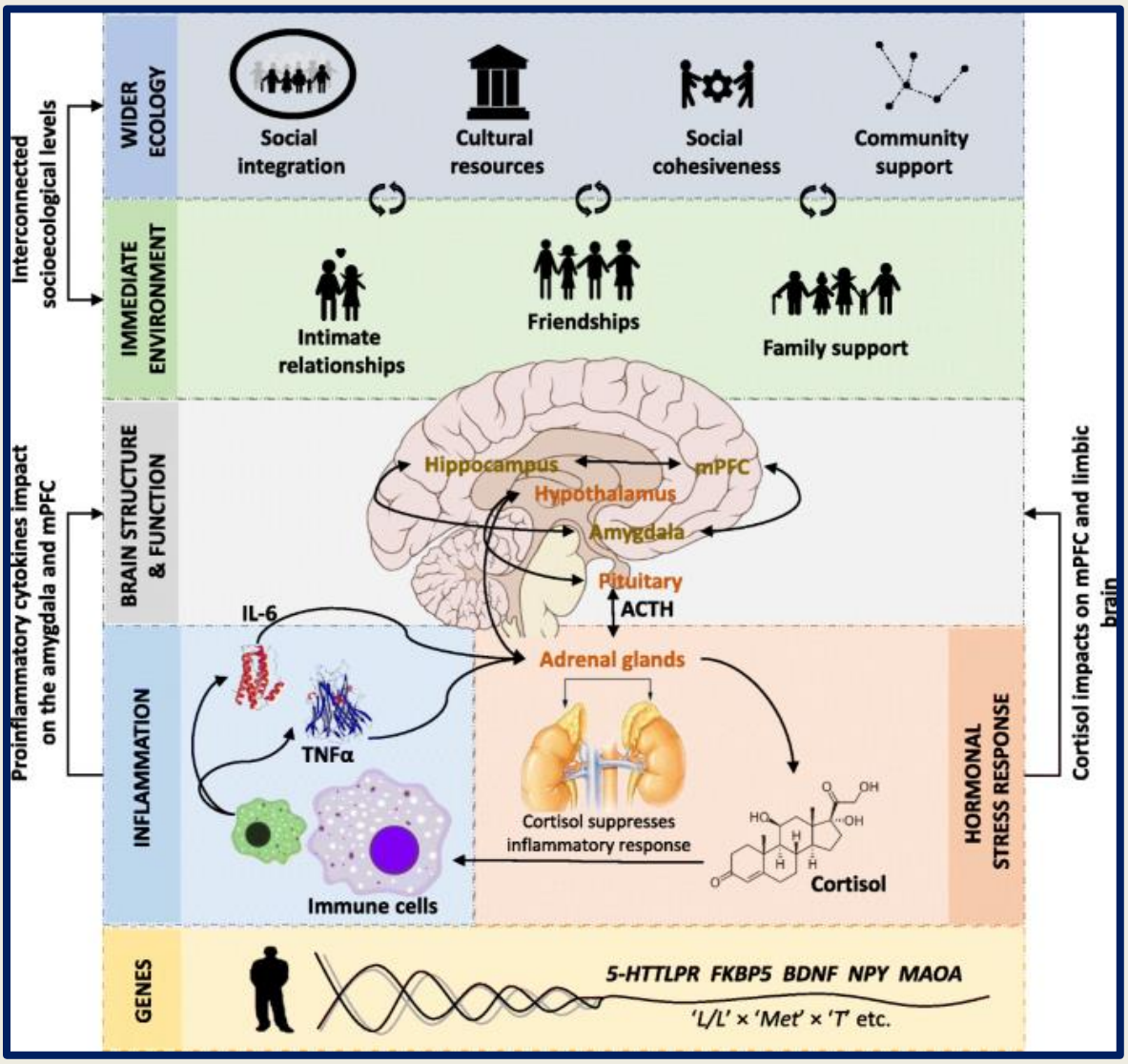
Figure 1: Effect of depression on all-cause mortality in patients with diabetes [8]. Reproduced with permission from Elsevier Ireland Ltd.

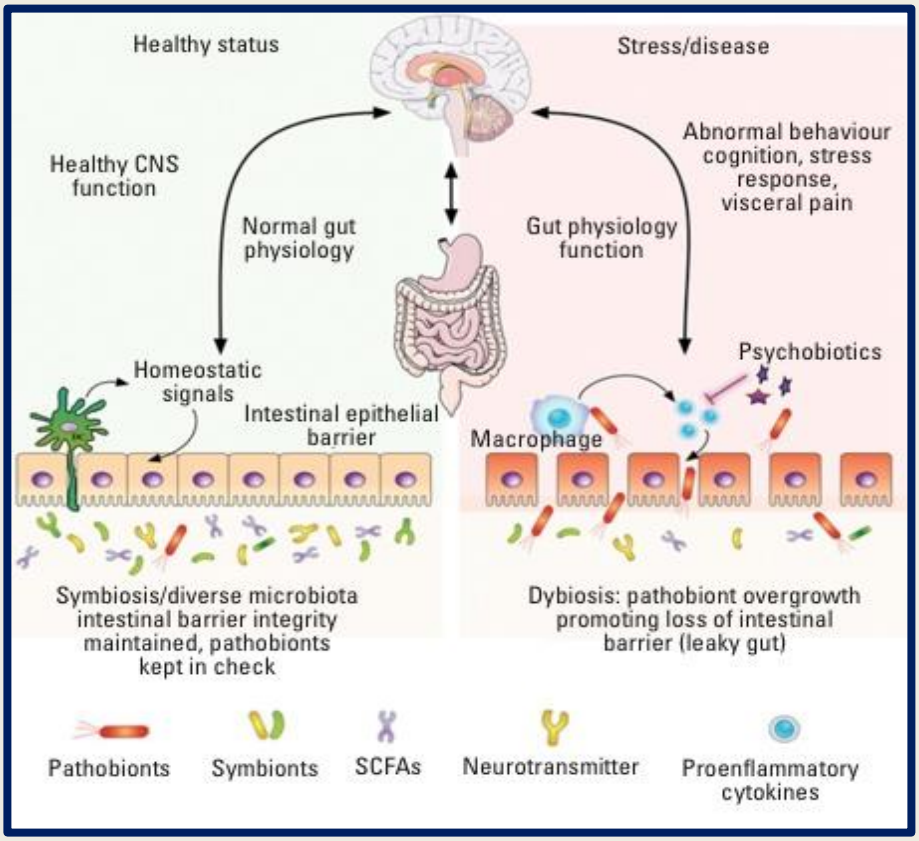
Stressors affect the nervous system and brain as a whole; however, mood-regulating structures within the limbic area (i.e., hippocampus, amygdala) and the prefrontal cortex are especially vulnerable to chronic stress. Their sensitivity sparks the HPA axis (via neurotransmitters, hormones) to drive the bidirectional microbiota-gut-brain axis. Consequent feedback and interaction between the endocrine system (hormones) and immune system (cytokines) further alter metabolism supporting our brain, mood, gut, heart, liver, skeletal muscles, reproductive organs and vascular system. We see the cumulative effects play out in our lives by the development and burden of chronic diseases.



Utilizing all we have discovered within our metabolic, inflammatory and stress series this year, let's take a few steps back to observe the big picture & provide a few working examples.

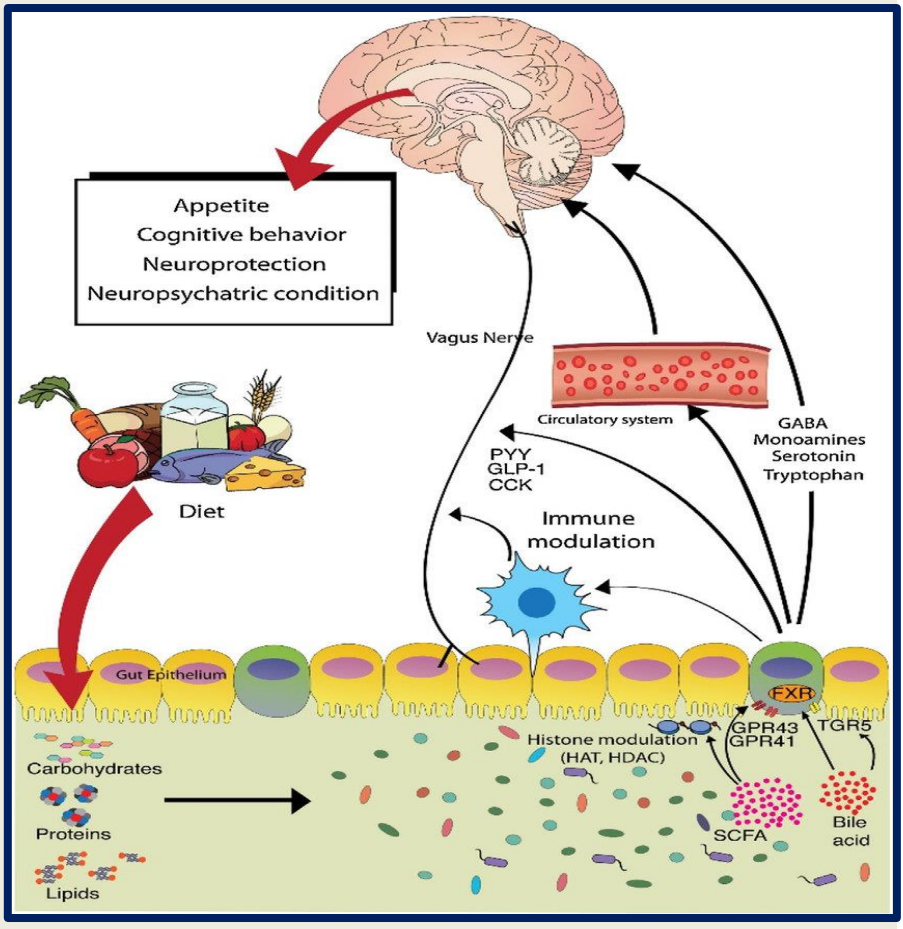




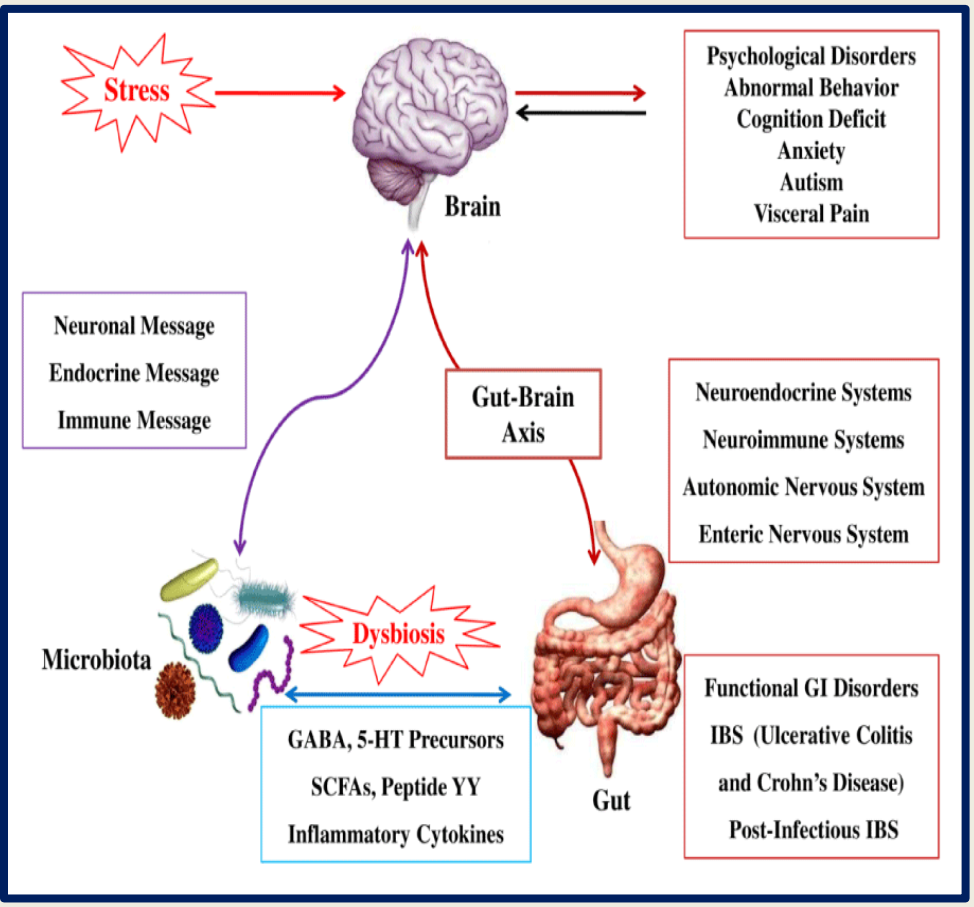


As we have repeatedly conveyed, the choices that define our lifestyle...the nutrients we consume, the activity we engage in, the hours of sleep we prioritize, the effiecacy of our stress management techniques and the connections we forge/support we receive through our social networks.... all of these choices are persistently weighing in the balance of our health-disease scales.

Everything is connected: Our hormones, neurotransmitters, and inflammatory cytokines mediate the pathways between our different organ systems. They are constantly delivering factors that update microenvironments, which then cause repercussions for our mind-body outcomes. Our minds and bodies are interdependent: we do not alter one without spurring alterations in the other. The state of our physical bodies alters the physical state of our brains. Changes in the physical create reciprocal dysfunctions in the way we interpret, think, feel, behave and ultimately experience. And vice versa.



The bottom line boils down to us: our choices and actions drive our disease load, our health and our wellness. Everyone has a genetic blueprint that ultimately directs predispositions and tendencies, but our input provides the means of either supporting or sabotaging our bodies efforts to function. Although we may see symtoms crop up in one local spot or another, it is important to realize that the origination is systemically a shared load, through contributions of our whole body, and that the duration (acute/chronic) and intensity of our stressors will diminish, maintain or grow our trajectory. Let's look at a few examples.



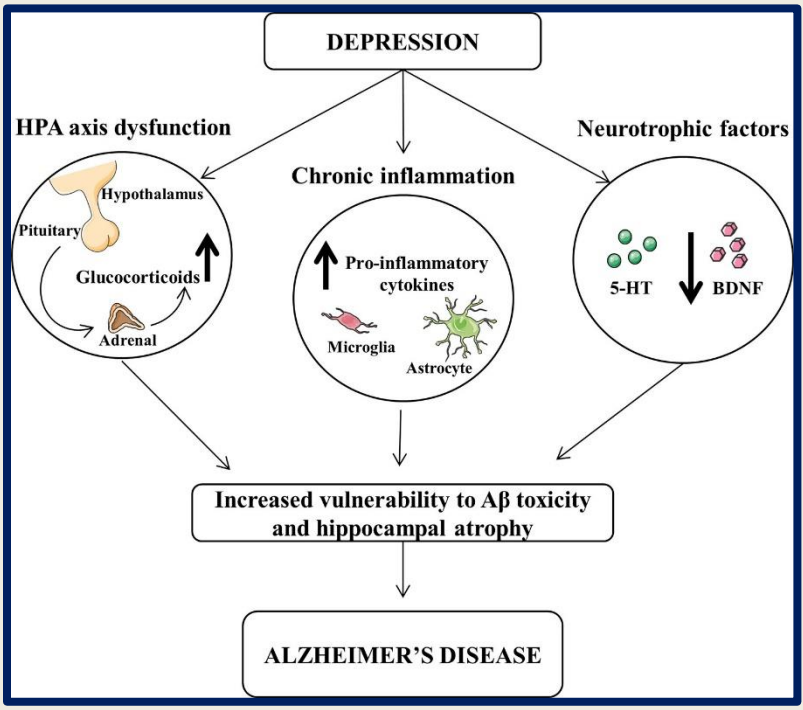
Chronic psychological stress leads to depression, which is apparent in the form of persistent sadness, lowered mood, low energy level, loss of interest or pleasure, feelings of guilt, disturbed sleep, anhedonia (lack of pleasure), low self-esteem and self-confidence, loss of appetite, low libdo, poor concentration and difficulty in functioning normally.

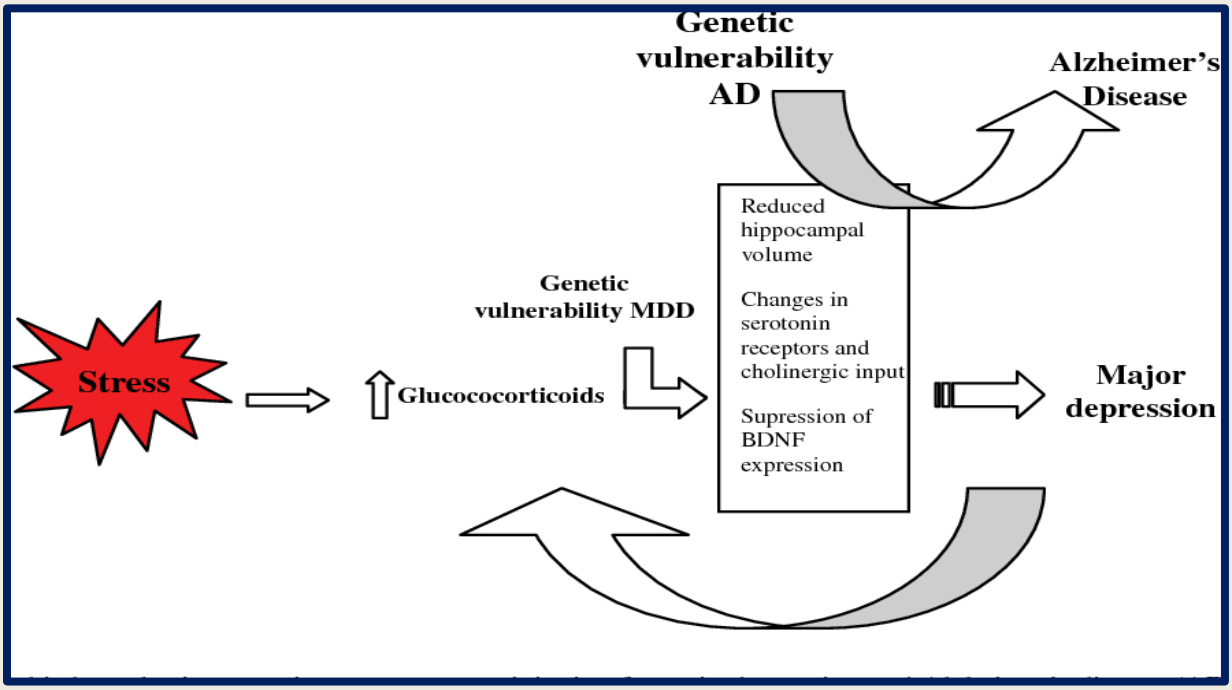
Depression has been recognized as a hidden burden by the World Health Organization (WHO) in 2013, which is an exponentially growing global epidemic and the leading cause of disability worldwide. There are at least 350 million people living with depression, while more than 450 million suffer from the mental disorders mainly due to prolonged psychological stress. It has been firmly established that depression affects women more commonly than men, by a burden of 50% higher for females, and that depression is linked to the development of chronic disease.

Links Through Structural Deficits:

While different types of psychiatric disorders are commonly observed (and well documented) following stroke, including depression, anxiety, emotional incontinence, delusions and hallucinations, the pathway of their development is highly complex and poorly understood. However, emerging evidence links post stroke depression to multifactorial alterations through anatomical structure (amygdala), disruptions of neural pathways and cerebrovascular impairments (high blood pressure/cholesterol, hardening of the arteries).

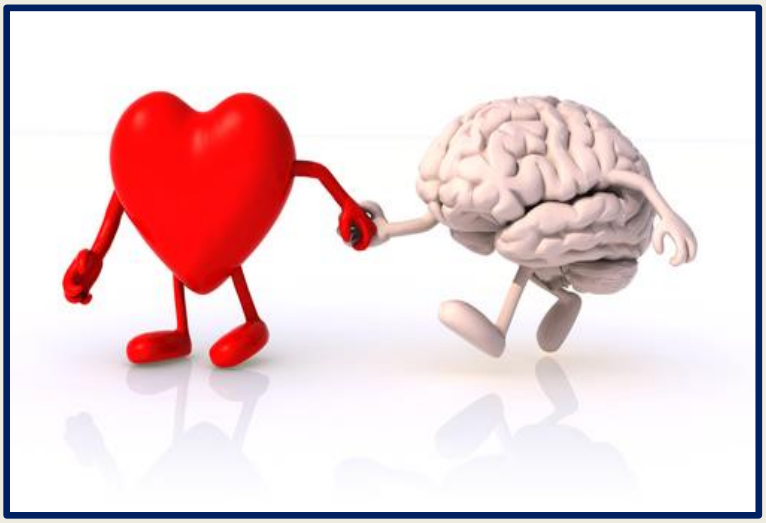
Likewise, evidence supports links between Alzheimer's disease and various mood disorders, including depression through common mechanisms: 1) depletions in growth factor activity (BDNF) within key areas of the brain (hippocampus, prefrontal cortex) leading to progressive cell death and neurodegeneration; and 2) activation of the peripheral immune system and release of proinflammatory cytokines.

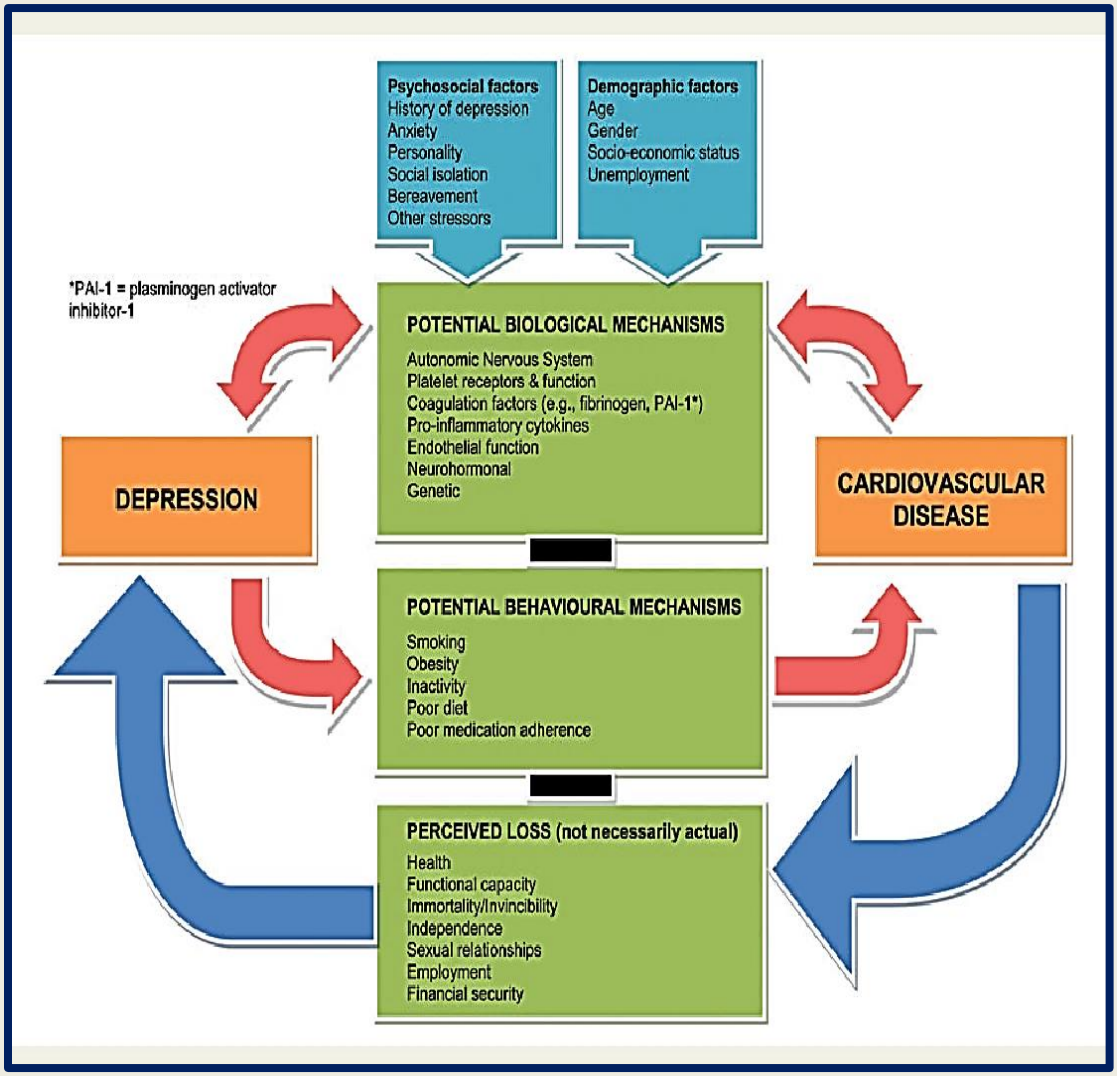




Links Through Inflammatory Mediators:

Cardiovascular health is also a multiplex, influenced by medical history (high blood pressure/cholesterol, diabetes), family history, lifestyle choices (e.g., exercise, nutrition) and behavioral risk factors (e.g., smoking, sedentary lifestyle). Risk can also be significantly increased by previous exposures to psychological stressors (e.g., PTSD) as well as chronic stress, which is closely associated with poor food choices, a driver of obesity and metabolic syndrome.

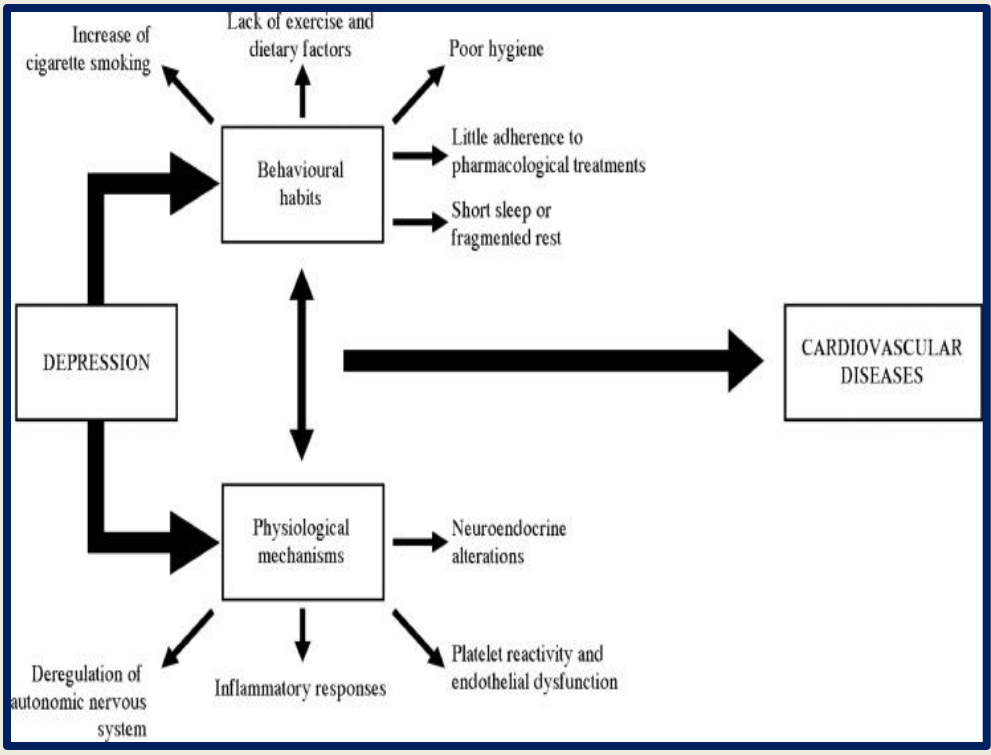




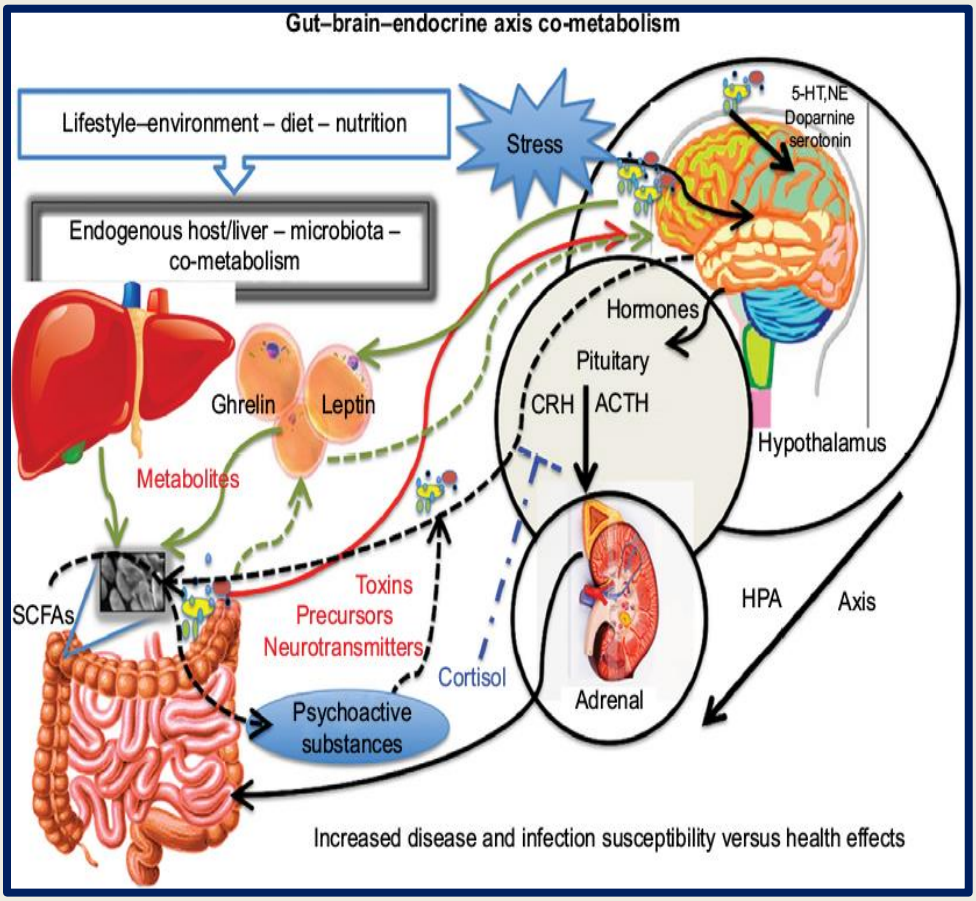
A number of recent studies have linked depression to peripheral artery disease, coronary artery disease, heart attack/stroke, heart failure and high blood pressure, suggesting that depression, perhaps as a result of chronic stress, can also have a major impact on cardiovascular health through vascular dysfunction and reduced vascular reactivity.

The mechanism? Multiple pathways of inflammation from our by-now-familiar actors.

Inception of persistent stress has been shown to increase proinflammatory cascades and reactive oxygen species (free radicals/oxidative stress). It activates both the HPA axis and sympathetic nervous system activity while dampening activity of vasodilators (agents that relax blood vessels, such as nitric oxide) and the parasympathetic nervous system (October newslestter).

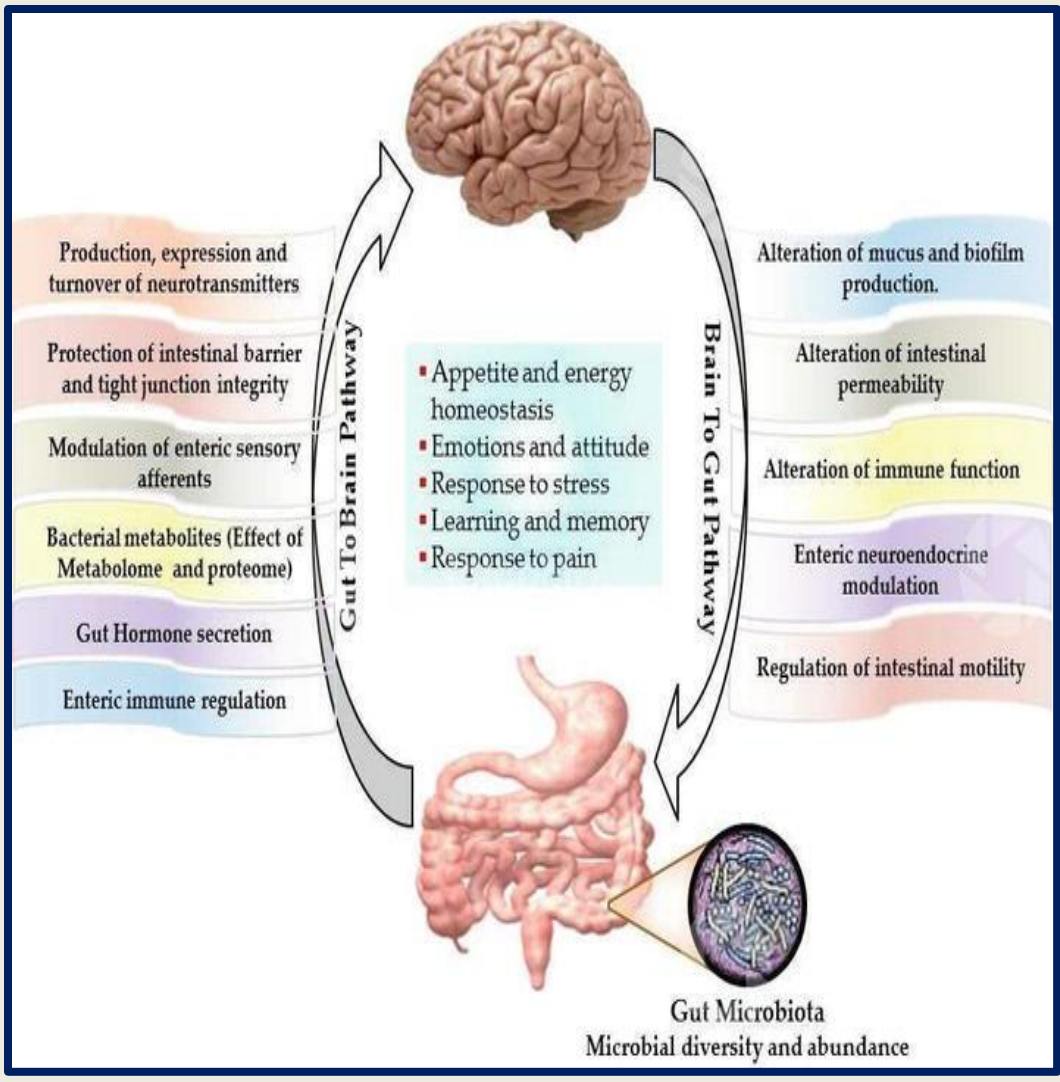


Links Through Functional Deficits:



In addition to the symptoms of physical illness, patients with GI disorders commonly exhibit mental health problems and often diagnosed with psychiatric illness. Similarly to other systemic illnesses, the relationship between mood and GI disorders appears to be bidirectional. For instance, patients with depression have been found to have a significantly higher frequency of IBS and at greater risk for subsequent development of GI symptoms.

Potential mechanisms linking GI and mood disorders include alterations in brain regions involved in emotion regulation, the gut-brain axis, the HPA axis and proinflammatory signaling. At the molecular level, alterations in growth factor (BDNF) and serotonin production may contribute to comorbid occurrence of GI and mood disorders. As we have previously seen, symptoms associated with GI disorders, such as chronic pain and inflammation, may also serve as risk factors for development of depression. Conversly, mood disorders in turn can adversely affect the course of GI disorders as well as treatment outcomes.



Links Through Pain:

Chronic pain is commonly associated with altered mood; in fact, it is estimated that comorbid depression can be present in 30%-50% of clinical chronic pain patients.

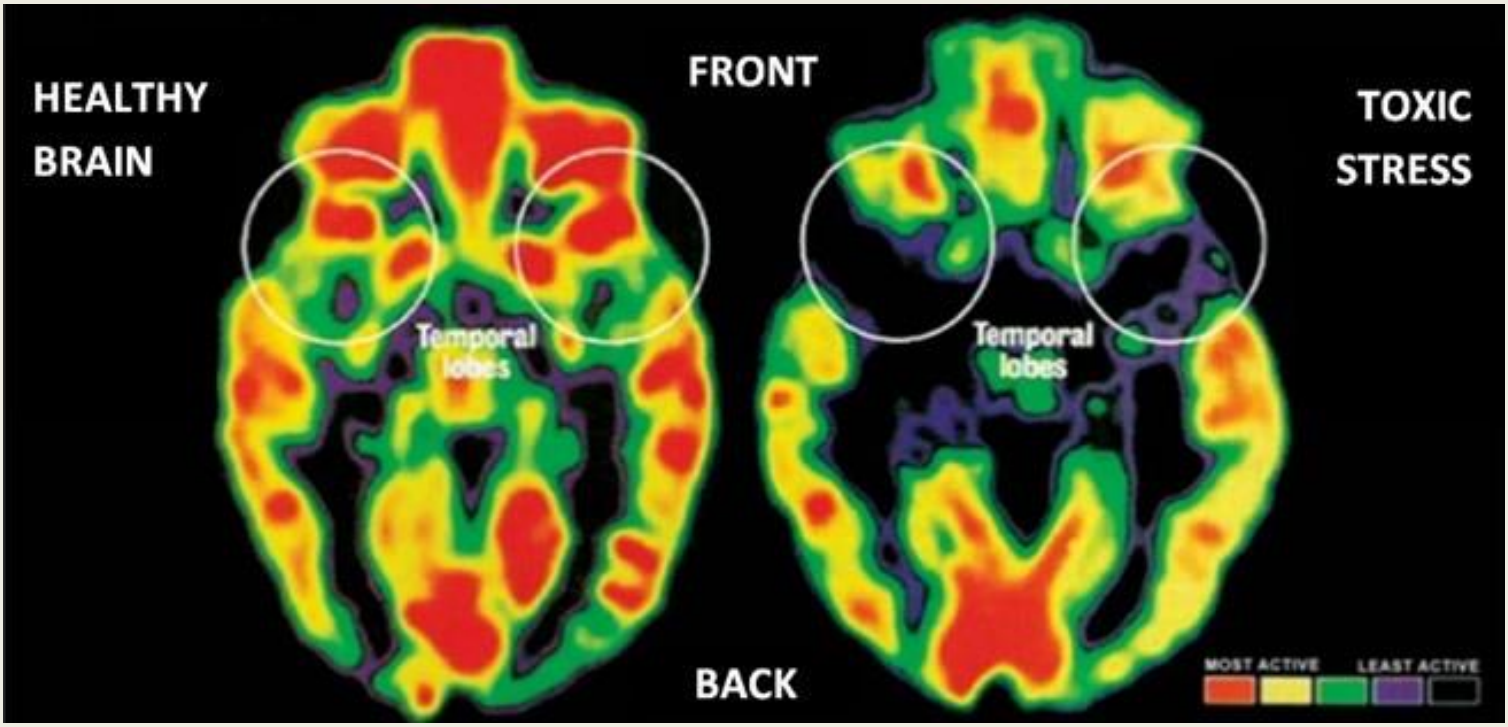
Neuroimaging studies have revealed a "pain matrix" within the brain involving primarily limbic neurocircuitry (including the amygdala and hippocampus) that is thought to incorporate aspects such as attention, anticipation, memory, empathy into formation and characterization of the overall pain experience and perception. Persistent pain and prolonged stress cause cellular and molecular adjustments within the limbic brain area as well as overactivation of the HPA axis.

These alterations have been observed to result in dysfunctions in pain processing, mood disorders and mental illness. Evidence also supports that relationships between pain and mood disorders are most likely reciprocal: studies have shown high correlations between the severity of depression and the duration and severity of pain, number of pain sites, number of pain days, frequency of breakthrough pain and general pain-related inhibition in daily functioning.

In summary, stress-related detrimental modifications in structure, organziation and function of the brain is a driving force behind coincidental psychiatric (mind) and systemic somatic (body) disorders. Recent findings have pointed the way towards the immunoinflammatory system as a key response mechanism involved in the bidirectional interaction between stress and illness, although further studies are needed to reveal exact mechanisms involved.

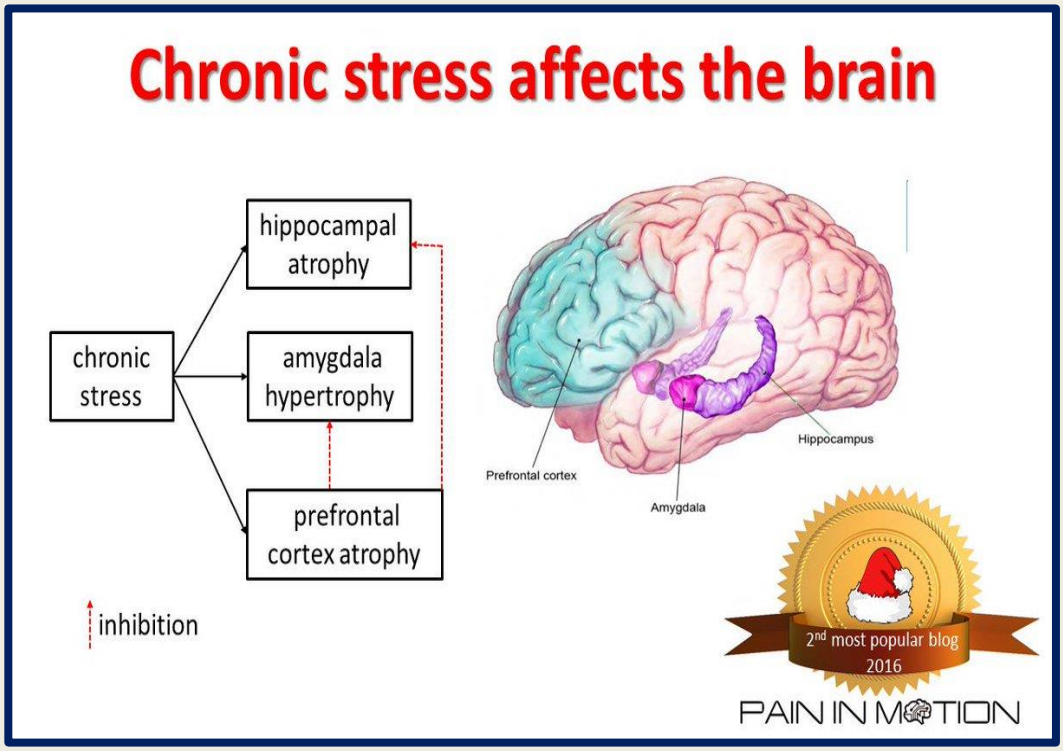
Adaptation & Alleviation

The structure and function of the brain is as much an identifying signature as that of the whorls of your fingertips. It is reflective of your genetic history, your childhood environment, your dietary intake, your sleeping habits, your typical inflammatory loads, your acute and chronic stressors, your triumphs and tragedies, your choices in smoking/alchol/therapeutic and recreational pharmaceuticals: all that has made you you also defines how you typically learn, think, change, interact, adapt, behave.



Stress changes how the brain is structured, how it functions, how it processes information and what type and intensity of mood/emotion dominates. Stress interferes with our higher centers of learning, cognition, reason and logic. It attenuates our concentration, information storage/retrieval and memory packaging. Stress can affect the brains of men and women differently and even create Jekyll-and-Hyde scenarios where we step out of character to become unrecognziable to ourself and others.

The brain is composed of different sections that perform different tasks. Researchers believe that when one part of the brain is busy or intensely focused, the other parts of the brain divert energy away from their tasks. For example, if you are in a dangerous or emotionally taxing situation, the amygdala (part of brain governing survival instincts) may take over, leaving the parts of the brain in charge of storing memory and performing higher-order tasks (prefrontal cortex) with less energy and ability to get their own jobs done (commonly known as the "amygdala hijack"). The thought being that the brain shunts resources in survival mode, just like the body does, so we may end up more forgetful of the events surrounding a traumatic event or even experience memory lapses.



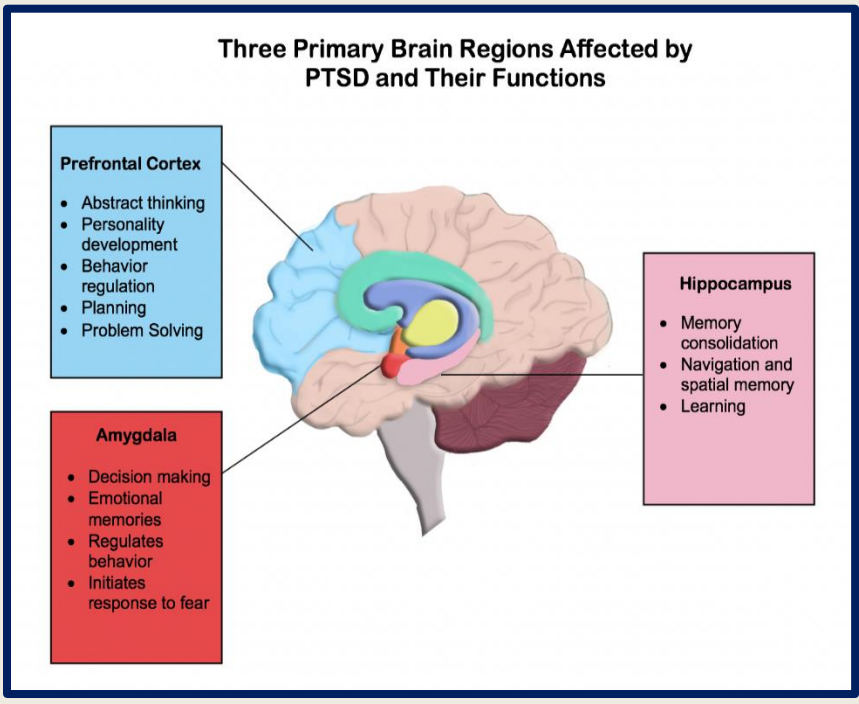
There is evidence that trauma and chronic (persistent) stress change the brain dramatically, literally rewiring your circuitry or pathways normally used, thereby shifting normal composition and functions. Much like a muscle displays hypertrophic (hyper=more/excess) growth after intensive workouts, when one part of the brain is activated to the exclusion of another, the part paid less attention becomes weaker. When faced with prolonged trauma/stress, our brains exhibit more activity and build up the primitive portions designed to handle threats, and the part of the brain tasked with more complex thought is sidelined and atrophies (shrinks).

These brain changes are sometimes reversible but difficult to reverse in other situations, depending on the type, intensity and duration of the stress; unpredictable at best. For instance, while stressful childhood experiences seem to take more of a toll on a developing brain, some research has found that people who demonstrate resilience in overcoming past trauma appear to have generated new brain mechanisms to compensate. These new pathways help to overcome stress-related brain changes accrued earlier in life.

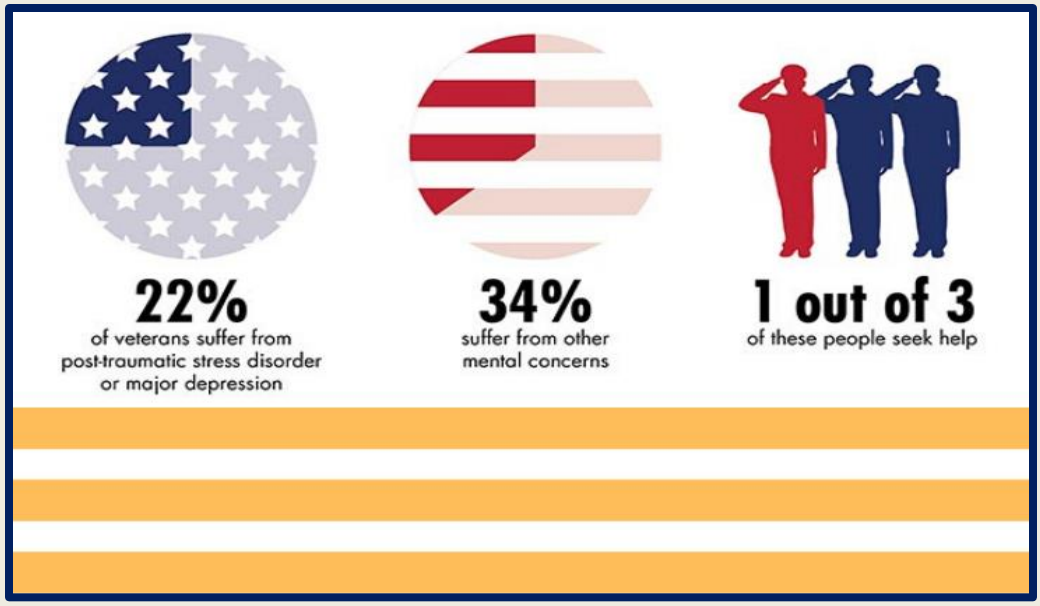
While the effects of stress on the brain are well documented, it's less clear which stress will prove damaging and raise the risk of memory problems later in life. "Certainly, more stress is likely worse, and long-term stress is generally worse than short-term stress." [Dr. Kerry Ressler, chief scientific officer at McLean Hospital, professor of psychiatry at Harvard Medical School].

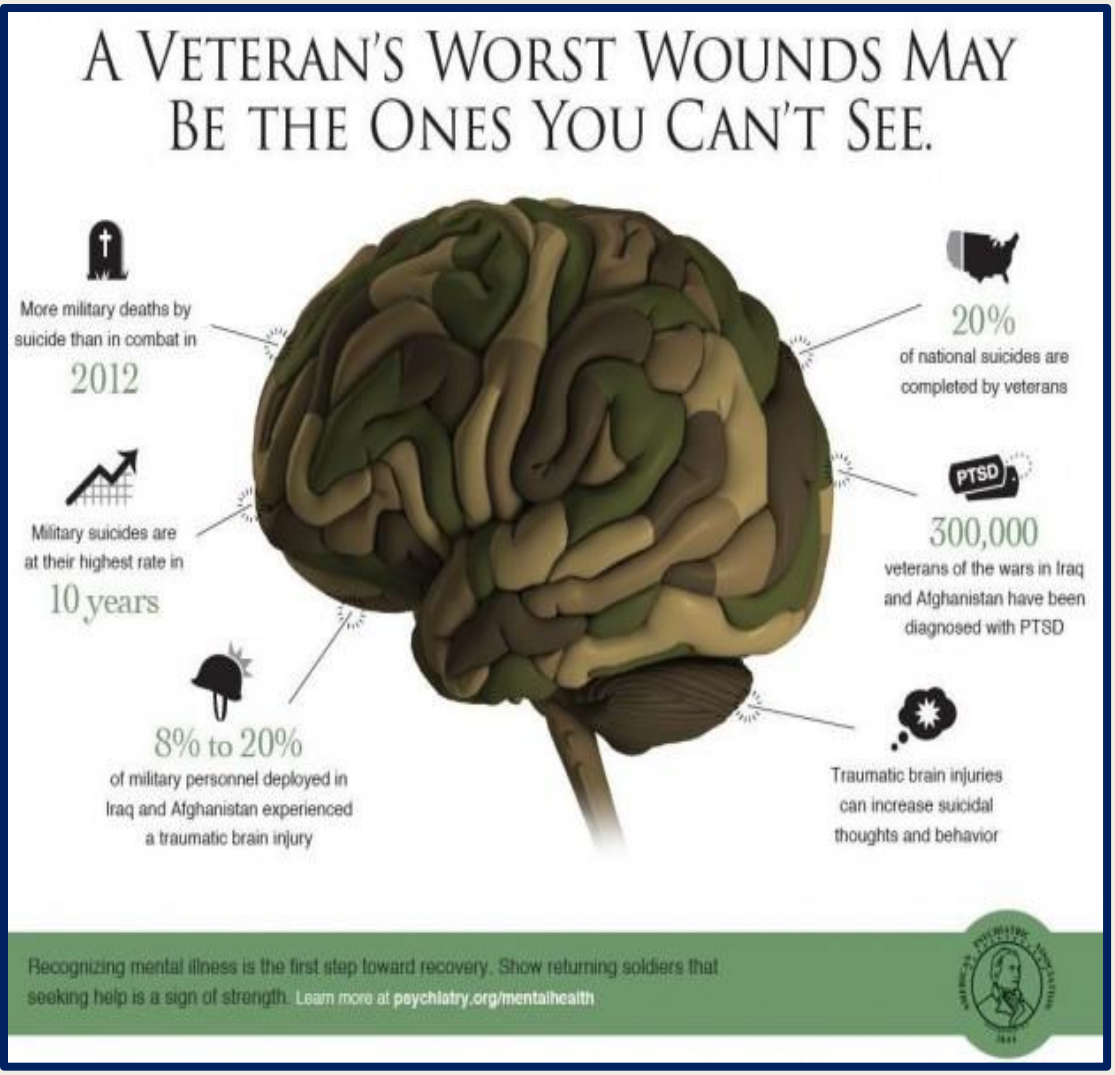
Additional factors that make stress more harmful:

- **The stress is unpredictable.** If a person can anticipate stress, it is less damaging than stress that appears to be more random.
- **There is no time limit on the stress.** If you are stress about an upcoming presentation, paper or exam, the stress you are experiencing has a finite end-point when you know you will get relief. If the stress has no end-point it may be more challenging to cope with.
- **You lack support.** If you feel supported during your stress, you are more likely to weather it successfully than if you don't.



One of the best examples of layered and accumulated stressors is illustrated by our returning military veterans returning home with PTSD. Their post-traumatic stress disorder is an amalgamation of physical, environmental, mental and social determinants, all of which are integrated into multisymptom conditions. In order to treat the veteran population, specialists must tease apart and address a multitude of domains, not just one.



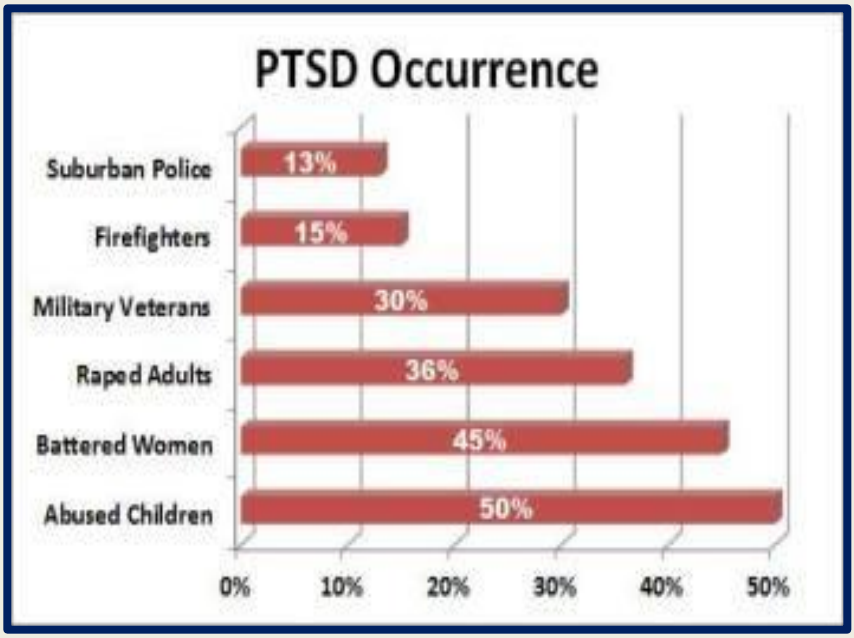


Social Determinants: substance use/misuse, homelessness, inadequate social support, issues related to financial well-being, aggressive behaviors.

Physical Determinants: traumatic brain injuries, hearing impairments, tinnitus (ringing of the ears), chronic pain and inflammation and multiple-system conditions underscored by exposure to/accumulation of environmental hazards and toxins.

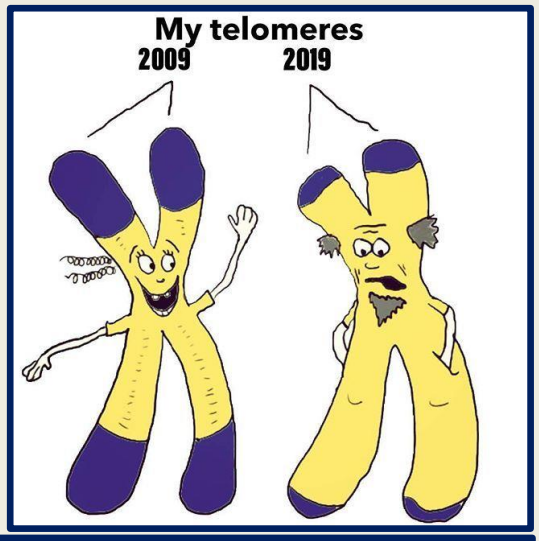
Mental Determinatnts: High rates of PTSD are interconnected with increased risks of physical health problems, substance use/misuse, suicide, homelessness, aggression/violence, anxiety/depression, other mental health problems.

Other victims of trauma and subsequent PTSD face similar challenges with integration of treatment and healing across multiple aspects of the body and brain; with realignment of emotions and behaviors; and with alleviation of complex exacerbations from proinflammatory mediators and chronic stress affecting and intertwined across all domains.



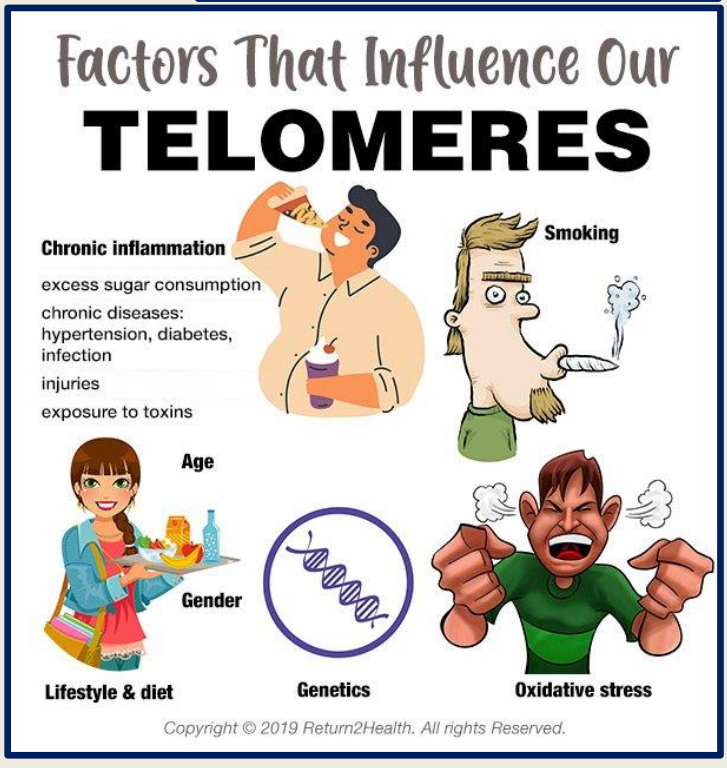
Increasing amounts of stress dominating modern life has attracted significant interest and concern as multiple studies have exhibited that stress and, in particular, high levels of cortisol generate cognitive decline. Research has shown higher morning cortisol levels are associated with worse brain structure and cognition; adults in their 40s and 50s with higher levels of cortisol performed worse on memory and other cognitive tasks than peers of the same age with average cortisol levels; and higher cortisol in the blood is also associated with smaller brain volumes. As we've thus far established significance through systemic interaction and brain structure/function, let's finish by narrowing the scope to see how this works down at the cellular range:

1. Your Brain Cells End Up Committing Suicide



It has to do with telomere length, the protective endcaps on your chromosomes (evoke plastic tips on the end of your shoelaces). Studies have shown that perceived stress causes shortening of telomeres. Longer telomere length facilitates neurogenesis or the production of new brain cells. Once your telomeres get too short, cells are signaled to die. So, one cause of brain atrophy (shrinkage) is shortening of telomeres. Many researchers believe that telomere length may be the best indicator of risk for chronic disease, including Alzheimer's.

2. Your Brain Makes Fewer New Neurons (brain cells)



Brain-derived neurotrophic factor (BDNF) has been referred to as fertilizer or "Miracle Grow" for the brain. It is a protein that stimulates your brain to form new neurons (brain cells) and to maintain the health of existing ones. Cortisol halts the production of BDNF. The more stress, the more cortisol. The more cortisol the less BDNF. The less BDNF, the fewer brain cells available for function and cognition. Studies have also found a correlation between Alzheimer's and lower levels of BDNF.

3. Your Brain Begins to Shrink

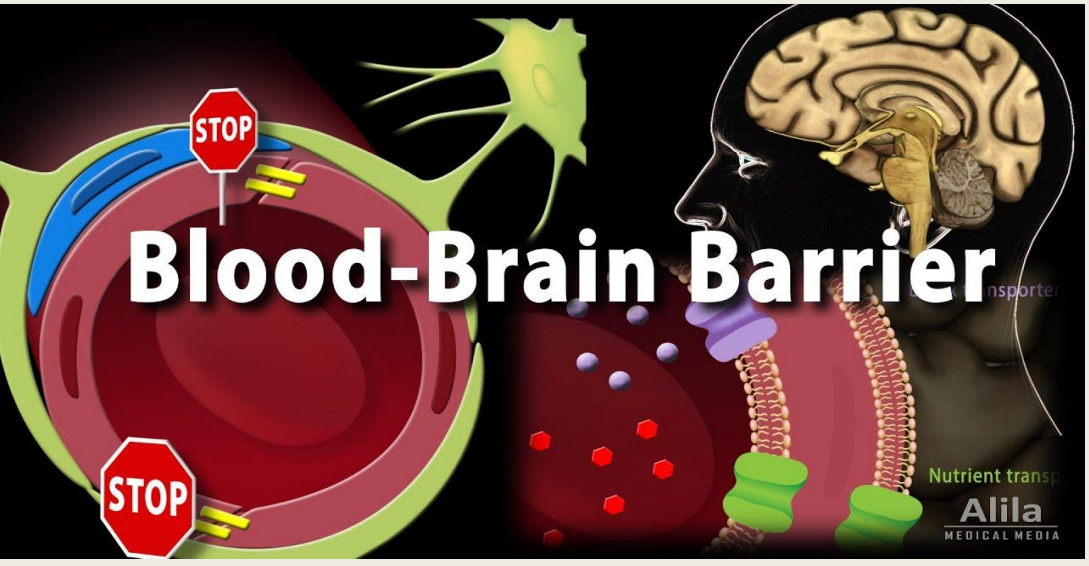
Under chronic prolonged stress circulating levels of cortisol remain too high. This elevation has the ability to halt the formation of neurons in the hippocampus, the part of your brain where memories are stored. This measurably shrinks (via quantiative diagnostic comparison) the physical structure (hippocampal region), functional capacity (memory storage) and cognitive ability (retrieval of past experience/people/place/event) of this region.

4. Your Brain Rusts

Inflammation is associated with many neurodegenerative diseases, including Alzheimer's disease and Parkinson's disease. The brain, with its high oxygen consumption, is particularly susceptible to oxidative stress. As oxygen is consumed or metabolized, free radicals are formed. Though free radicals do stimulate repair, when produced in high amounts they damage cells and also DNA. If your body lacks sufficient antioxidants, which neutralize free radicals, your body and brain operate in a state of oxidative stress.

5. Your Brain Becomes "Leaky" and Toxins Seep In

Because of its primal importance, the brain acts as a very elite club with extra security to keep out all but the most helpful molecules. It accomplishes this through the blood brain barrier (BBB) which is composed of highly specialized cells designed to act as the protective details or "gatekeepers." It operates as a filter, selectively allowing nutrients in and preventing harmful substances from crossing. Stress causes the BBB to become "leaky," the equivalent of poking large holes in a fine-gauge filter. Now toxins such as chemicals, heavy metals and other pathogens have access to your brain and can cause damage to your neurons. In the early stages of this process, you are largely unaware that you have a "leaky" brain," but over time symptoms such as brain fog, anxiety, memory issues and difficulty concentrating can appear.



Protecting Yourself from Damaging Stress

To better cope with stress, consider how you might minimize factors that make it worse. Here are some tips to help better manage stress and hopefully prevent some of the damaging effects it could have on your brain.

- **Establish some control over your situation.** If stress isn't predictable, focus on controlling the things that are. "Having a routine is good for development and health," says Dr. Kerry Ressler, professor of psychiatry at Harvard Medical School. Predictability combats stress.

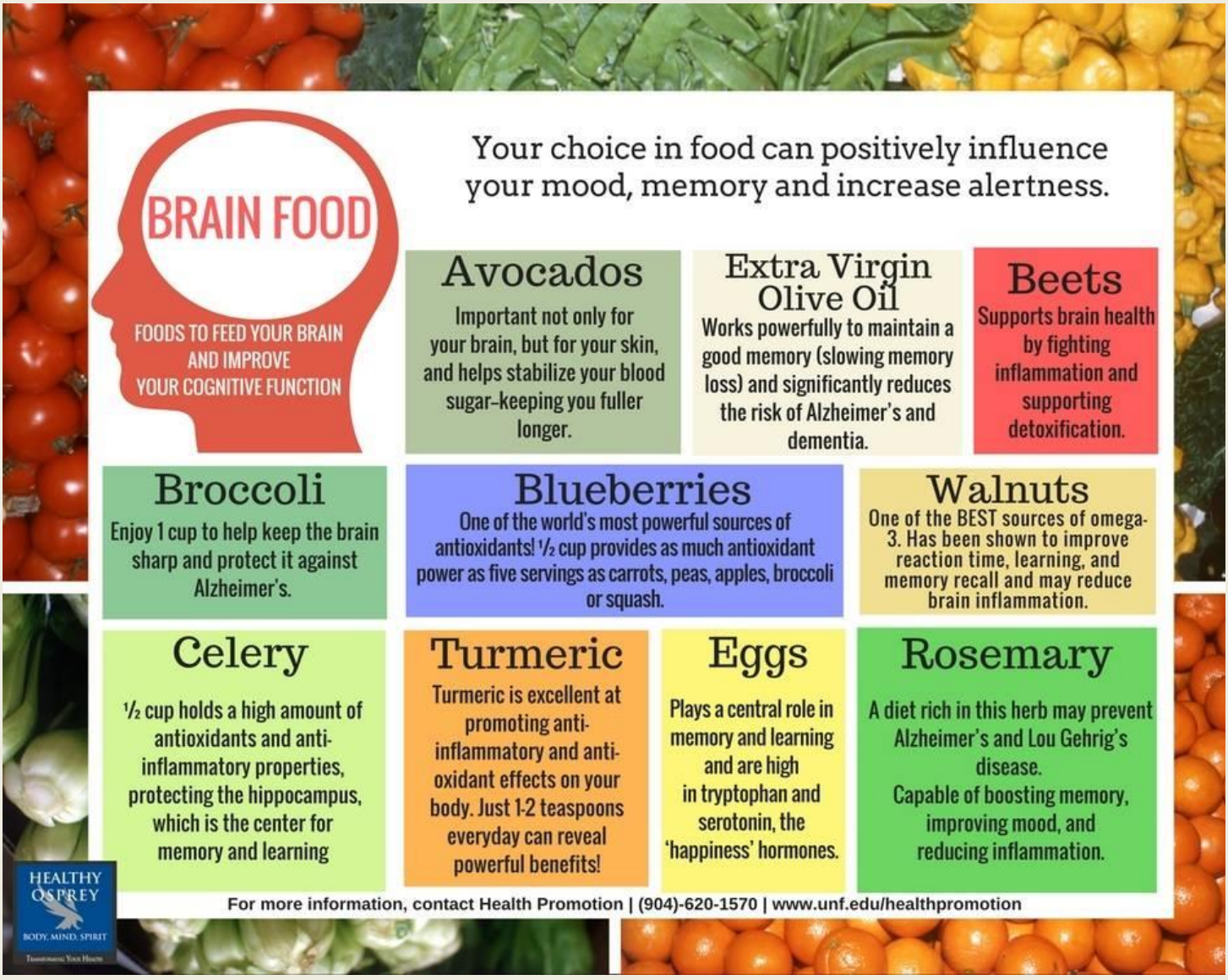
- **Get a good night's sleep.** Stress can result in sleep difficulties, and the resulting lack of sleep can make stress worse. "Sleep deprivation makes parts of the brain that handle higher-order functions work less well," says Dr. Ressler. Having healthy sleep habits can help. This includes going to bed and waking up at the same time each day, avoiding caffeine after noon, and creating a relaxing sleep environment.

- **Get organized.** Using strategies to help manage your workload can also reduce stress. For example, each day, create a concrete list of tasks you need to accomplish. This way, your duties won't seem overwhelming. Making a list also gives you a clear end point so you know when you are done. "Laying tasks out like this helps reduce the feeling that the brain is being bombarded," he says. It can also help you predict when you are likely to be stressed.

- **Get help if you need it.** Reaching out can help you become more resilient and better able to manage stress, which may ultimately protect your brain health. Earlier intervention may reduce disability caused by stress-related complications later on.

- **Change your attitude toward stress.** "A life without stress is not only impossible, but also would likely be pretty uninteresting — in fact, a certain degree of stress is helpful for growth," says Dr. Ressler. So, rather than striving for no stress, strive for healthier responses to stress.

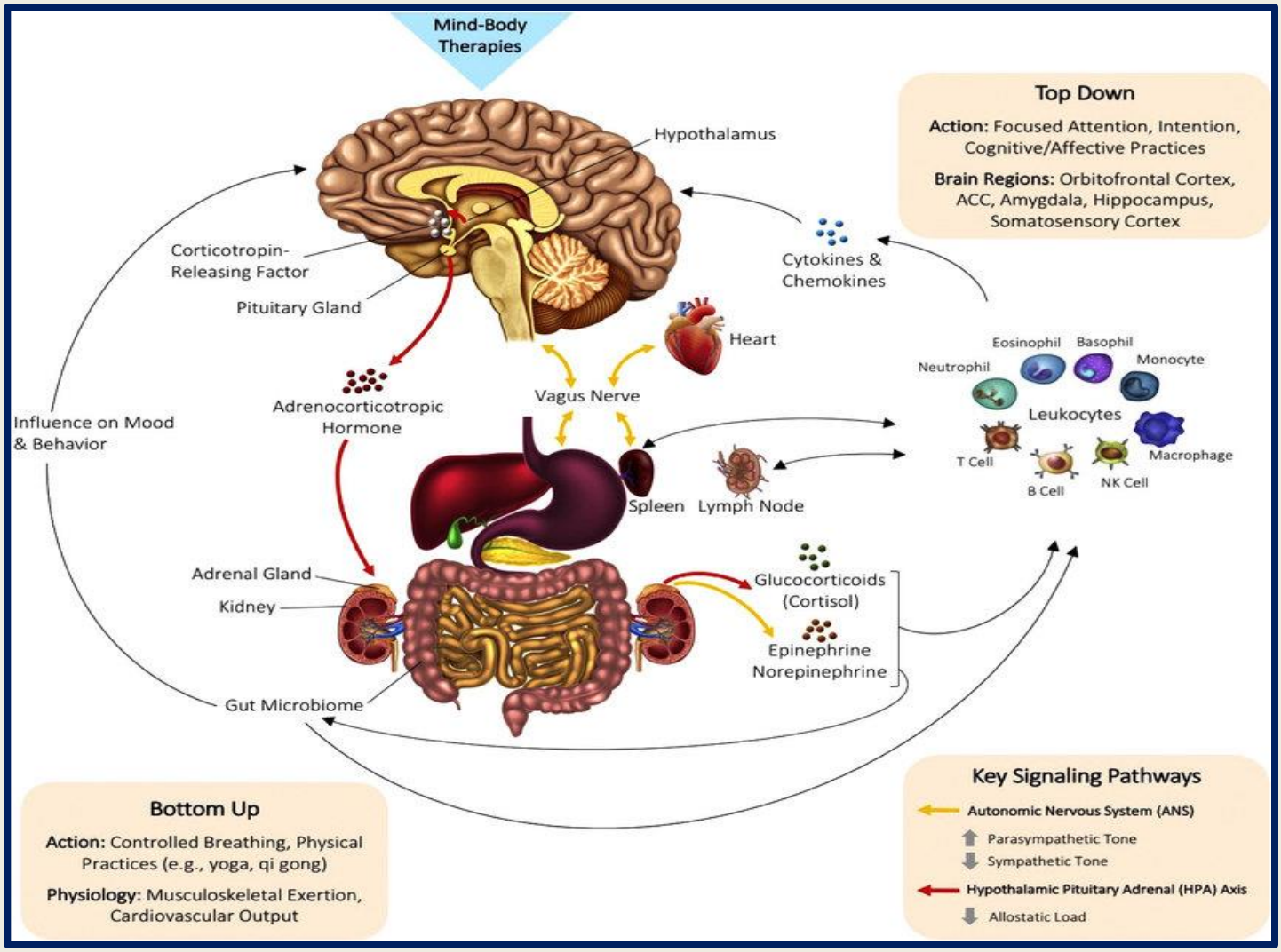
Just as we have discovered for our body processes, coping skills in managing stress become very important in preventing brain degeneration through accumulated stressors. So far in the Stress series, we have provided numerous means and methods that elicit relaxation responses by boosting our parasympathetic system (check out this issue's Countermeasures for a final Harvard-based installment to round out this discussion) and focused on the dietary power of fruit-&-veggie-derived antioxidants to chemically scrub free radical damages in our Wellness Wizard this month.



We can also give our brains support and help mitigate stress by capitalizing on effective mental, physical and social strategies.

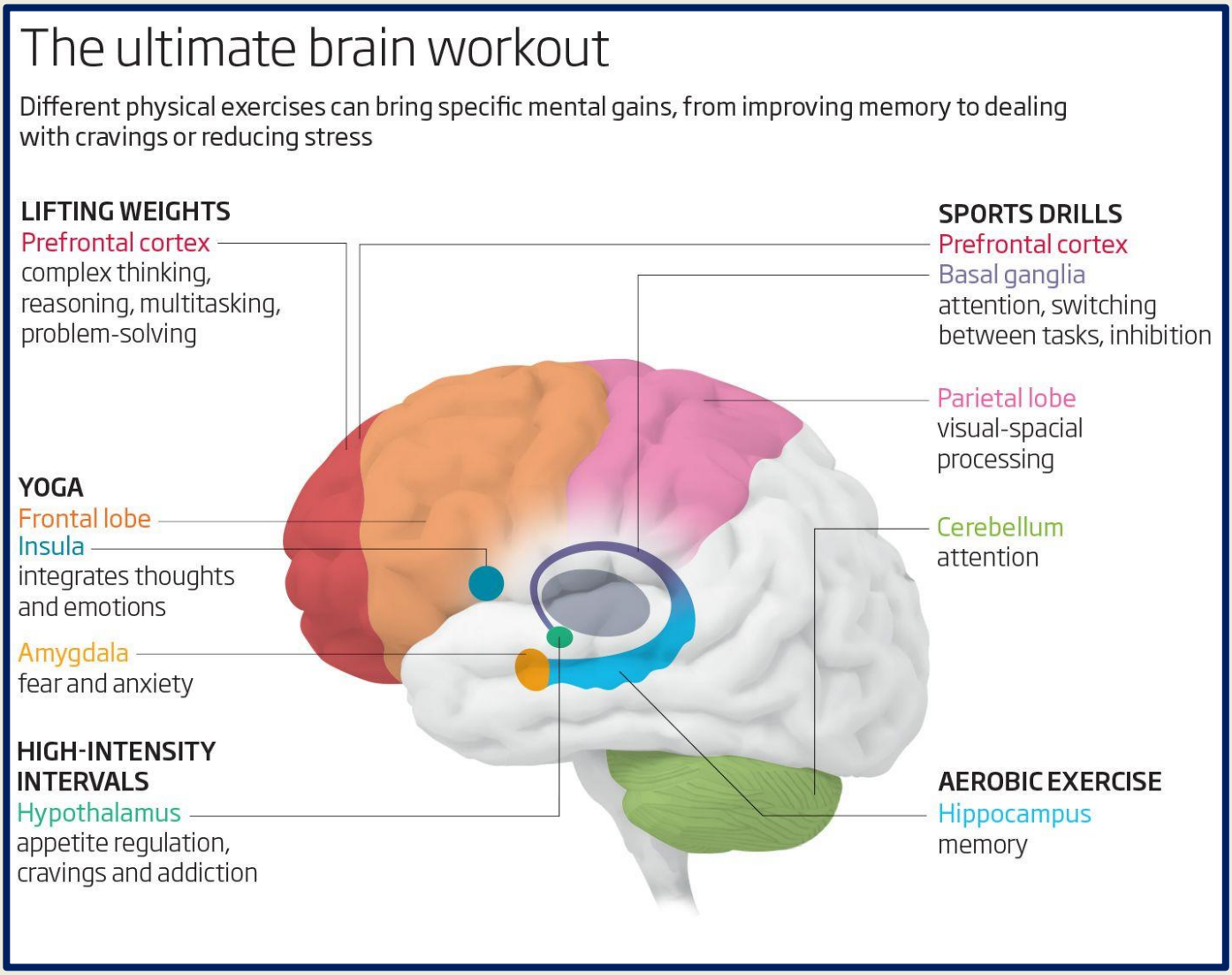
MENTAL STRATEGIES: *Reframing Your Thinking About the Stressor*

Stress in your body and brain amounts to INTERNAL responses from perceived EXTERNAL stressors. We can't always avoid externally driven stressors but we do have control when it comes to how we respond and deal with them, which means we must retrain how we think about stressful events and practice flipping our perspective. For example, if you're stuck in traffic: instead of stewing in feelings of frustration and/or anger, flip the perspective to see an opportunity to relax and enjoy some of your favorite music. Most stressors, regardless of form, are not something we can change easily or avoid immediately. What helps to temper our "fight or flight" responses is if we can accept our lack of control and reframe our thoughts and perspective on events instead. Sometimes the power of positive thinking and perspective fall short when the intensity, scope or duration stressors leaves us reeling. In cases where we hit our limit and find ourselves in danger of becoming overwhelmed, taking a time out to breathe, to relax, to let go, even if for minutes at a time, can work wonders. It can provide a sanity call for regrasping rational thought or a platform for subconsious detection of a stubbornly elusive solution.

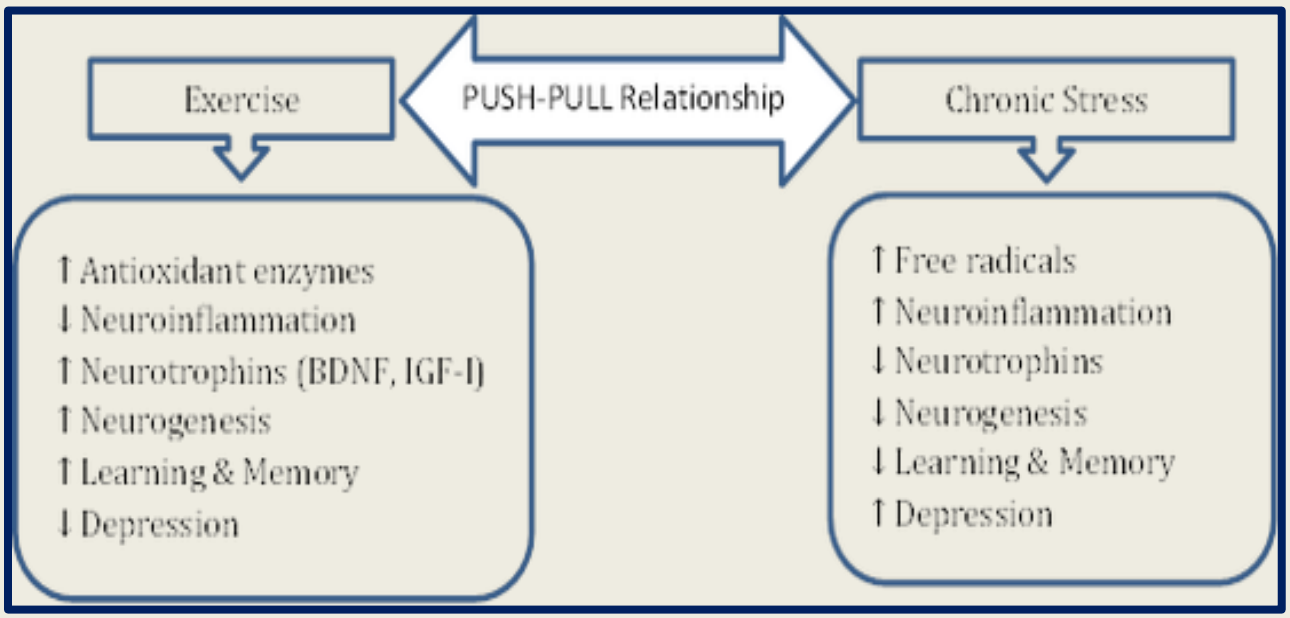


PHYSICAL STRATEGIES: *Bolster Your Brain through Exercise*

All types of exercise can increase BDNF, or brain-derived growth (neurotropic) factor. Whereas chronic stress and depression disrupt the BBB shield protecting the nervous system from infection and inflammatory cells circulating throughout the body, exercise seems to work in the opposite direction: reducing inflammation, increasing antioxidant activity and enhancing production of neurotrophins, such as BDNF. Most research in the field is consistent with the concept that exercise is a potential treatment to reverse or limit the neuroimmune mechanisms related to stress-associated depression. The Cochrane Collaboration, an enormous network of scientific experts around the world, recently published a review of 28 articles studying the effects of exercise on depression symptoms with a total of 1101 participants that showed exercise signficantly improved symptoms of depression with long-lasting benefits (http://summaries.cochrane.org/CD004366/exercise-for-depression). Although reports vary over definitive intensity, duration and type of exercise required to accrue maximal benefit, the general trend is a moderate (fast walking), regular (almost every day) approach.

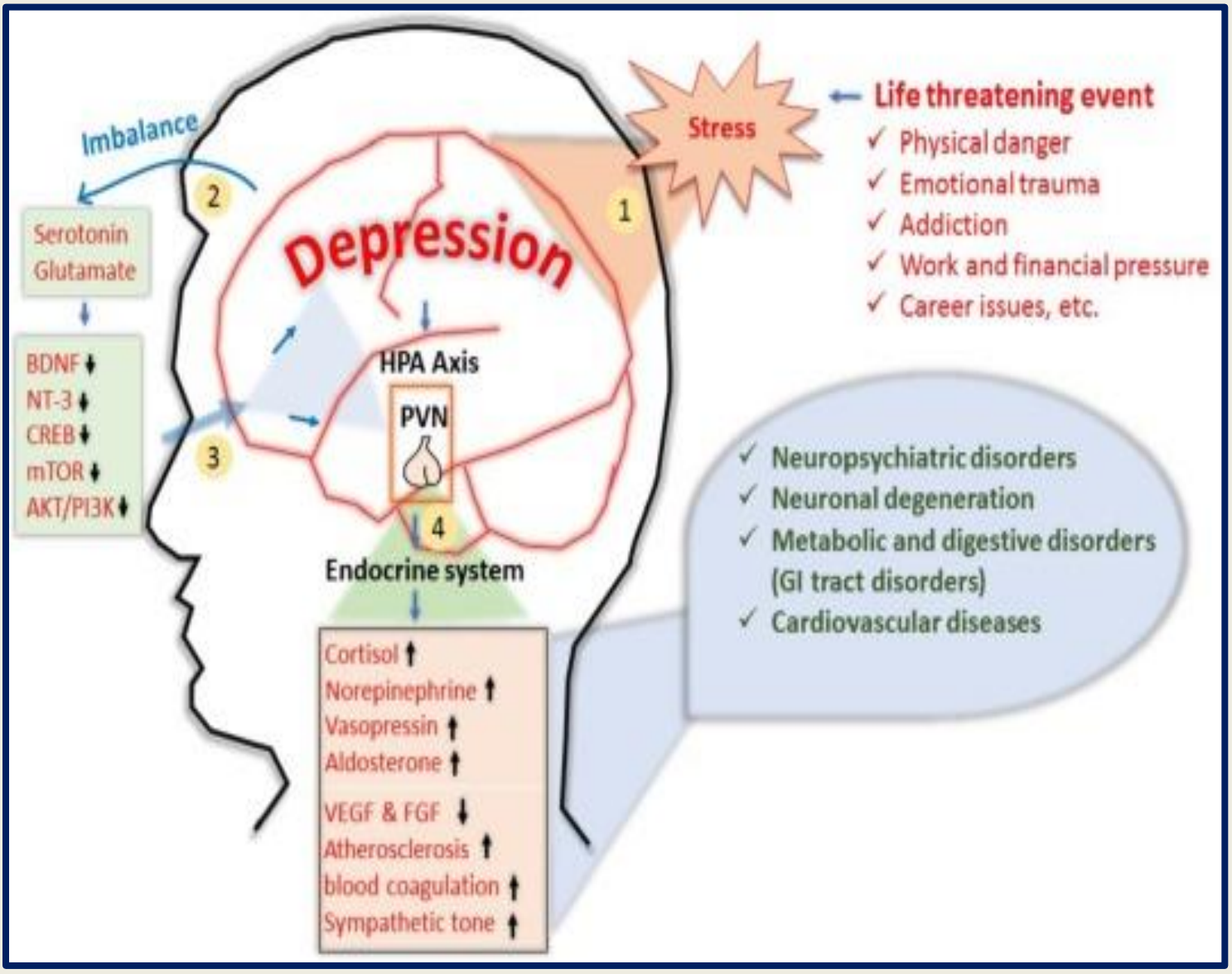


Socializing while getting some exericse gives an added benefit through the release of oxytocin, aka the relaxing "love" hormone. Learning something new or trying something you haven't done for a while stimulates neurogenesis (formation of new neurons). Incorporating activities that involve physical coordination, agility and balance challenges are excellent for building the same coordination and flexibility within the brain. Interval training (cycles of intense movements and recovery periods), aka burst training, has been proven to increase BDNF. For example, do 45 seconds of jumping jacks or jumping ropes or deep knee bends, then walk slowly for 2 minutes. Repeat 4-5 times and repeat 2 times per week.

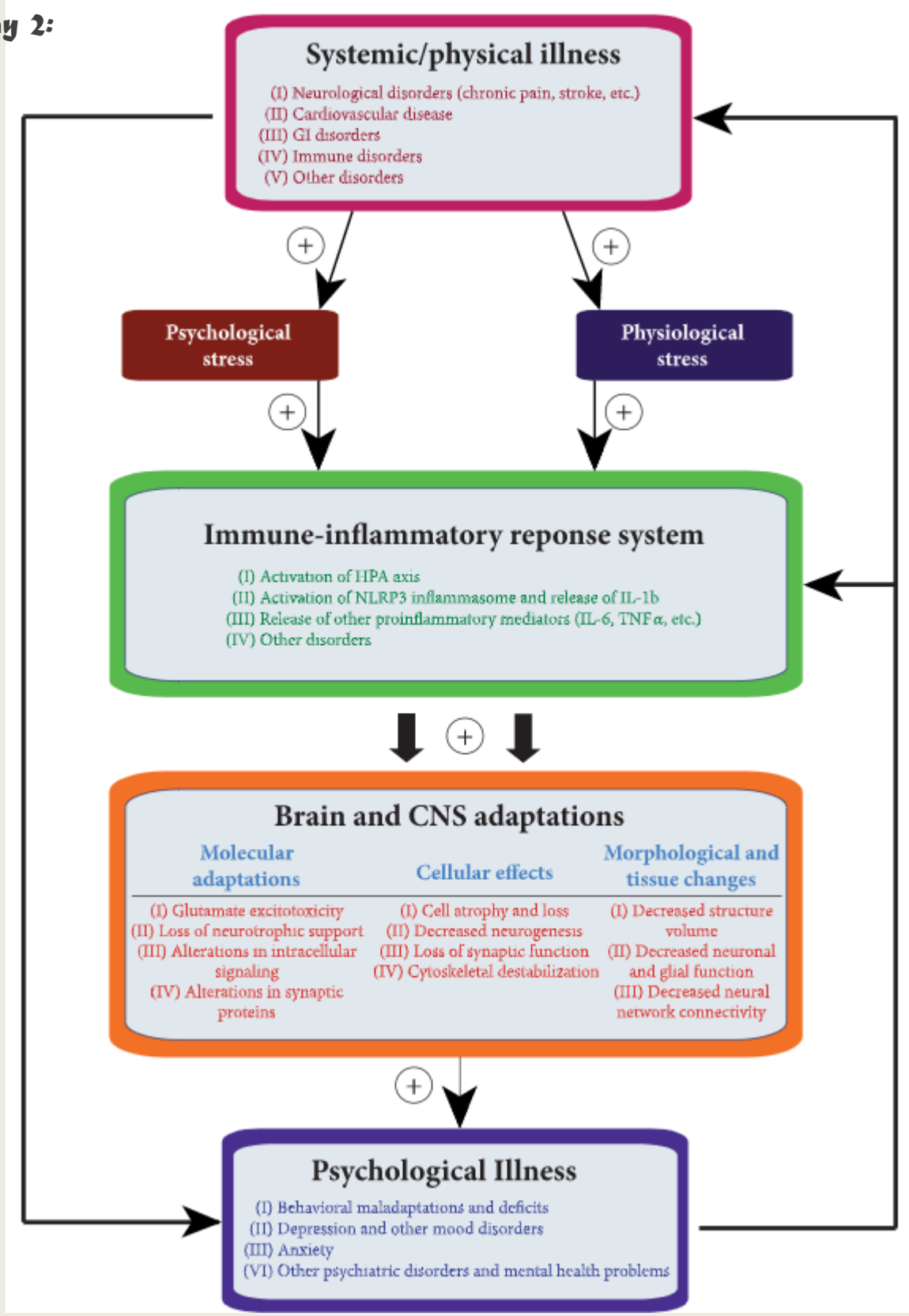


SOCIAL STRATEGIES: **Check out this integral component in our upcoming December issue where we will discover how building relationships and social networks supports our mental, physical and immune reponses and assists in alleviation of stress.**

Takeaway 1:


Imbalance
Serotonin
Glutamate
BDNF
NT-3
CREB
mTOR
AKT/PI3K
2
3
Depression
HPA Axis
PVN
4
Endocrine system
Cortisol
Norepinephrine
Vasopressin
Aldosterone
VEGF & FGF
Atherosclerosis
blood coagulation
Sympathetic tone
Stress
1
Life threatening event
Physical danger
Emotional trauma
Addiction
Work and financial pressure
Career issues, etc.
Neuropsychiatric disorders
Neuronal degeneration
Metabolic and digestive disorders (GI tract disorders)
Cardiovascular diseases

Takeaway 2:



Bidirectional relationship between systemic illness and psychiatric disorders. Physical and/or psychological stress associated with systemic illness can lead to activation of immune response system resulting in increased local and systemic release of proinflammatory cytokines. Increased levels of inflammatory mediators in the CNS are potentially key contributors to the damaging cellular and morphological adaptations that underlie development of comorbid mental illness.

Takeaway 3:

AVOID THESE ANXIETY TRIGGERS LURKING IN YOUR FRIDGE

Too much caffeine can increase anxiety since caffeine stimulates the body's **"fight or flight"** response.

These symptoms typically occur when people consume **four or more cups of coffee.**

Sugar can create changes in the body by destabilizing brain activity—which heightens **symptoms of anxiety** and can even **trigger anxiety attacks.**

Alcohol changes levels of **serotonin** in the brain.

Serotonin is a **feel-good chemical** for the body.

Eating foods with too much salt **increases blood pressure,** which makes the heart need to **pump harder.**

When that happens, the body releases the stress hormone **adrenaline**—which paves the way for **anxious feelings.**

Studies show a **connection** between processed food and an increase in **anxiety levels.**

Another study showed a link between a diet of **processed and fatty foods** and depression.

Resources: *Excerpts within this article taken from the following texts:

Vanja Duric, Sarah Clayton, Mai Lan Leong, and Li-Lian Yuan. "Comorbidity Factors and Brain Mechanisms Linkin Chronic Stress and Systemic Illness.' Neural Plasicity. 2016. https://www.hindawi.com/journals/np/2016/5460732/

Kathleen Perry, DC. 5 Ways Chronic Stress Ages Your Brain. (Internet Article). https://drkathleenperry.com/5-ways-chronic-stress-ages-your-brain/

Sansom. Stress Might be Shrinking your Brain. Mission. April 25, 2019. https://magazines.uthscsa.edu/mission/stress-might-be-shrinking-your-brain/

Sandeep Kumar Vashist and E. Marion Schneider. 'Depression: An Insight and Need for Personalized Psychological Stress Monitoring and Management.' Journal of Basic & Applied Sciences; 2014. 10: 177-182

'Exercise counteracts the harmful effects of chronic stress and depression on the brain.' Heal Your Brain. Internet post.

https://healyourbrain.wordpress.com/2012/11/28/exercise-counteracts-the-harmful-effects-of-chronic-stress-and-depression-on-the-brain/

Protect Your Brain from Stress: Stress management may reduce health problems linked to stress, which include cognitive problems and a higher risk for Alzheimer's disease and dementia. Harvard Women's Health Watch. August 2018

https://www.health.harvard.edu/mind-and-mood/protect-your-brain-from-stress

The health & wellbeing needs of veterans: a rapid review @www.ncbi.nih.gov/pmc/articles

Counteractions: Now & Zen

How mindfulness can change your brain and improve your health

In spring of 2016 Harvard Medical School hosted a seminar series featuring a variety of presenters and a compilation of topics reviewing stress, mind-body interventions and the benefits accumulated from their practice. The following section is a dedicated copy of that seminar content in its entirety, complete with references and sources. Articles presented are unconnected so the reader may flip through to select those of interest or proceed through comprehensively. This presentation is reader-friendly, loaded with resources, and although the information presented is diverse in range, our previous newsletters have been broad enough in depth and scope that even the technical material should be an enjoyable read.

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Now and Zen: How mindfulness can change your brain and improve your health
Longwood Seminars, March 8, 2016

Yoga and meditation offer health care savings—and you can do them at home

Posted November 18, 2015

Marlynn Wei, MD, JD
Contributing Editor

A new research study shows that a little yoga or meditation a day might just keep the doctor away.

Stress-related health problems are responsible for up to 80% of visits to the doctor and account for the third highest health care expenditures, behind only heart disease and cancer. But as few as 3% of doctors actually talk to patients about how to reduce stress.

Mind-body practices like yoga and meditation have been shown to reduce your body's stress response by strengthening your relaxation response and lowering stress hormones like cortisol. Yoga has been shown to have many health benefits, including improving heart health and helping relieve depression and anxiety.

But the cost-effectiveness of these therapies has been less well demonstrated — until now.

The study

Dr. James E. Stahl and his team of Harvard researchers studied a mind-body relaxation program offered through the Benson-Henry Institute for Mind Body Medicine at Massachusetts General Hospital. The 8-week program taught participants several different mind-body approaches, including meditation, yoga, mindfulness, cognitive behavioral skills, and positive psychology. The study volunteers participated in weekly sessions and practiced at home as well.

The researchers found that people in the relaxation program used 43% fewer medical services than they did the previous year, saving on average $2,360 per person in emergency room visits alone. This means that such yoga and meditation programs could translate into health care savings of anywhere from $640 to as much as $25,500 per patient each year.

"There are many ways to get to the well state — many gates to wellness, but not every gate is open to every person. One of the strengths of the program is that it draws upon many different tools that reinforce each other and allow many gates to be opened to a wide array of people," says principal

investigator Dr. Stahl, who is now section chief of general internal medicine at Dartmouth-Hitchcock Medical Center.

Yoga and meditation are soaring in popularity — but will insurance pay?

Yoga and meditation programs are gaining wide appeal. Nearly one in 10 Americans practices yoga, and 45% of adults who don't practice yoga say they are interested in trying it. Americans are also using other forms of complementary health therapies, such as meditation (8%) and deep breathing (11%).

Many health care plans do not cover yoga or meditation, although some provide discounts for fitness programs including yoga or tai chi. States like Washington require private health insurers to cover licensed complementary health care providers, but the majority of states do not. However, that may soon change.

A recent article in the *Harvard Business Review* recommends that health insurers cover wellness and prevention-oriented therapies that are both low-cost and evidence-based, as both yoga and meditation are. The article discusses a study of Aetna employees who participated in the company's mindfulness program and enjoyed a 28% reduction in stress, 20% better sleep, and 19% less pain, as well as an increase in worker productivity worth an estimated $3,000 per employee per year. The company offers free yoga and meditation programs to its employees.

"There are a lot of great studies on the biologic side, just not enough on the economics," notes Dr. Stahl, who is looking to change that with his ongoing research. As the evidence for the health benefits and cost-effectiveness of yoga and meditation programs continues to grow, we can expect to see more interest from health care insurers.

"If I have a tool that works in clinical medicine that has very little side effects and considerable benefit, why would I not use the tool?" Dr. Stahl says.

Keep reading for a guide that will help you incorporate mindfulness skills into your daily life.

To learn more...
This information was prepared by the editors of the Harvard Health Publications division of Harvard Medical School. It is excerpted from our Harvard Health Blog, available at health.harvard.edu/blog.

Now and Zen: How mindfulness can change your brain and improve your health
Longwood Seminars, March 8, 2016

You can practice mindfulness in as little as 15 minutes a day

By Marlynn Wei, MD, JD

In the research conducted by Dr. James E. Stahl and his team of Harvard researchers, study volunteers participated in an 8-week mind-body relaxation program offered through the Benson-Henry Institute for Mind Body Medicine at Massachusetts General Hospital. The program taught a range of mind-body skills.

Dr. Stahl, who is now at Dartmouth-Hitchcock Medical Center, teaches his own patients mindfulness and meditation skills in his internal medicine practice and encourages people to practice daily. He says that you don't need to enroll in a formal program, or even spend a lot of time practicing — 10 to 15 minutes a day will do. Consistency is the key.

Here are just a few ways to incorporate mindfulness skills into your daily life:

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Relax at the end of your day with a 15-minute guided meditation.
Keep guided meditations or podcasts on your phone or tablet for easy access. Guided meditations are available through:

- apps like Headspace (http://hvrd.me/YFb38) or Meditation Oasis (http://hvrd.me/YFbe3)
- the UCLA Mindful Awareness Research Center (http://hvrd.me/YFbip)
- the Chopra Center (http://hvrd.me/YFboO)
- meditation teachers like Tara Brach (http://hvrd.me/YFbsR)

Start your day with a basic Sun Salutation yoga sequence: http://hvrd.me/YFc2b
(If you're a beginner, try the modifications listed below and shown in this video: http://hvrd.me/YFbW3)

- Step back into Plank pose (http://hvrd.me/YFc2b me, instead of jumping back.
- Drop your knees to the floor in Low Plank (Four-limbed Staff) Pose (http://hvrd.me/YFcdY) to support and build your core muscles.
- Substitute Cobra Pose (http://hvrd.me/YFciB) instead of Upward Facing Dog Pose (http://hvrd.me/YFcmw) for the first few salutation cycles to warm up your lower back.

Check in with your breath for 10 to 15 minutes for a midday break. Close your eyes and notice where you store stress in your body. As your breath becomes slower and smoother, imagine sending your breath to that area on your inhalation. Imagine a knot loosening as you exhale. Repeat this cycle with each inhalation and exhalation.

Do a body scan for 10 to 15 minutes. Find a comfortable seat or lie down. Close your eyes and breathe more deeply and slowly. First, focus your attention on your feet. Notice any tension, pain, or stress. Take deep, slow breaths as you focus your awareness on that area of your body. As if you are scanning your body with light, move your attention slowly upward. Notice how each section of your body feels as you continue to breathe slowly: your shins and knees, thighs and hips, lower back and abdomen, chest and upper back, neck and shoulders, and finally your head.

Try a variety of approaches to find what sticks. Daily practice works best, but if you have a busy schedule, aim to practice at least three or four times a week. And don't give up if you feel like it's not working right away. These techniques are like any other skill or workout — the more you do it, the stronger you will get.

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Add mindfulness to your day

in only 10-15 minutes

Here are 4 ways to add mindfulness to you schedule, each way only takes 10-15 minutes of your time:

*Remember, consistency is key.

Created and presented by Harvard Health Publications.

Harvard Women's Health Watch

What meditation can do for your mind, mood, and health

Dr. Anne Fabiny
Former Editor in Chief, *Harvard Women's Health Watch*

August 2014

Taking a few minutes to focus your mind each day can reduce stress, pain, depression, and more.

You can't see or touch stress, but you can feel its effects on your mind and body. In the short term, stress quickens your heart rate and breathing and increases your blood pressure. When you're constantly under stress, your adrenal glands overproduce the hormone cortisol. Overexposure to this hormone can affect the function of your brain, immune system, and other organs. Chronic stress can contribute to headaches, anxiety, depression, heart disease, and even premature death.

Though you may not be able to eradicate the roots of stress, you can minimize its effects on your body. One of the easiest and most achievable stress-relieving techniques is meditation, a program in which you focus your attention inward to induce a state of deep relaxation.

Although the practice of meditation is thousands of years old, research on its health benefits is relatively new, but promising. A research review published in *JAMA Internal Medicine* in January 2014 found meditation helpful for relieving anxiety, pain, and depression. For depression, meditation was about as effective as an antidepressant.

Meditation is thought to work via its effects on the sympathetic nervous system, which increases heart rate, breathing, and blood pressure during times of stress. Yet meditating has a spiritual purpose, too. "True, it will help you lower your blood pressure, but so much more: it can help your creativity, your intuition, your connection with your inner self," says Burke Lennihan, a registered nurse who teaches meditation at the Harvard University Center for Wellness.

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Types of meditation

Meditation comes in many forms, including the following:

- **Concentration meditation** teaches you how to focus your mind. It's the foundation for other forms of meditation.
- **Heart-centered meditation** involves quieting the mind and bringing the awareness to the heart, an energy center in the middle of the chest.
- **Mindfulness meditation** encourages you to focus objectively on negative thoughts as they move through your mind, so you can achieve a state of calm.
- **Tai chi and qigong** are moving forms of meditation that combine physical exercise with breathing and focus.
- **Transcendental meditation** is a well-known technique in which you repeat a mantra — a word, phrase, or sound — to quiet your thoughts and achieve greater awareness.
- **Walking meditation** turns your focus to both body and mind as you breathe in time with your footsteps.

Lennihan suggests trying different types of meditation classes to see which technique best suits you. "Meditating with a group of people is a much more powerful experience, and having a teacher talk you through the technique will make it much easier at first," she says. Many meditation classes are free or inexpensive, which is a sign that the teacher is truly devoted to the practice.

Starting your practice

The beauty and simplicity of meditation is that you don't need any equipment. All that's required is a quiet space and a few minutes each day. "Start with 10 minutes, or even commit to five minutes twice a day," Lennihan says. "Preferably meditate at the same time every morning. That way you'll establish the habit, and pretty soon you'll always meditate in the morning, just like brushing your teeth."

The specifics of your practice will depend on which type of meditation you choose, but here are some general guidelines to get you started:

- Set aside a place to meditate. "You'll build up a special feeling there, making it easier to get into a meditative state more quickly," Lennihan says. Surround your meditation spot with candles, flesh flowers, incense, or any objects you can use to focus your practice (such as a photo, crystal, or religious symbol).
- Sit comfortably in a chair or on the floor with your back straight.
- Close your eyes, or focus your gaze on the object you've chosen.
- Breathe slowly, deeply, and gently.
- Keep your mind focused inward or on the object. If it wanders, gently steer it back to center.

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- Breathe peace and quiet into your heart and mind. "While you're breathing out, imagine your breath as a river or a tide that's carrying your thoughts away," Lennihan says.

You can also chant out loud. Many people use the Sanskrit word "shanti," which means "peace." Or choose a word from your own religious tradition. "Chanting out loud can help drown out thoughts," Lennihan says.

Within just a week or two of regular meditation, you should see a noticeable change in your mood and stress level. "People will start to feel some inner peace and inner poise, even in the midst of their busy lives," says Lennihan.

To learn more...
This information was prepared by the editors of the Harvard Health Publications division of Harvard Medical School. It is excerpted from the August 2014 issue of the *Harvard Women's Health Watch*, available at http://hvrd.me/YFhaD.

Now and Zen: How mindfulness can change your brain and improve your health
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Understanding the stress response

Stress is an unavoidable part of life. But learning to manage it successfully can do much to improve your mental and physical health.

That's why it helps to understand just how your body reacts to stressful situations — and why the so-called fight-or-flight response, which can be life-saving in the case of an immediate physical threat, becomes detrimental when stress is a chronic feature of daily life.

What is stress?

We all encounter stress in our lives, though we might use different examples to describe it. But whether the particular stressor you're confronting is a sudden car crash, a loud argument, or the ache of arthritis, each potential or actual threat triggers a cascade of stress hormones that produce well-orchestrated physiological changes.

You know these sensations well. Your heart pounds. Muscles tense. Breathing quickens, and beads of sweat appear. But although the physical effects may seem simple, these reactions — collectively dubbed the "fight or flight" response — require an intricate coordination of many different body systems.

A look inside the stress response

Our response to threats begins in the brain, which receives and processes information — perhaps the sight of your boss bearing down with an ominous expression, or the sound of an explosion. Instantly, a signal from the motor cortex in the brain speeds down nerve pathways to muscles, which tense and tighten, bracing for trouble. Another signal comes from the hypothalamus, a portion of the brain perched above the brainstem. It relays the warning to the nearby pituitary gland, which sends a chemical messenger via the bloodstream to the adrenal glands. In response, the adrenal glands secrete a series of stress hormones, including epinephrine, better known as adrenaline. (You're probably familiar with the so-called "adrenaline rush" that helps rev up your body. This is part of the stress response.)

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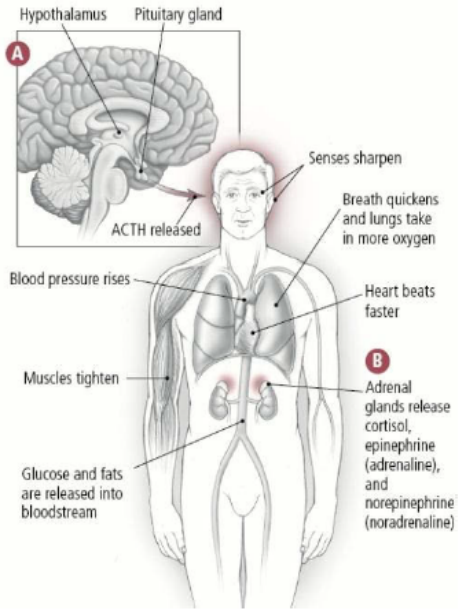
The stress response



Collectively, the hypothalamus, pituitary gland, and adrenal glands make up the HPA axis, which plays a pivotal role in triggering the stress response. The hypothalamus sends a chemical messenger (corticotropin-releasing factor, or CRF) to the nearby pituitary gland, which then releases its own chemical messenger (adrenocorticotropic hormone, or ACTH) into the bloodstream **(A)**. ACTH travels to the adrenal glands, which respond by releasing a number of stress hormones into the bloodstream **(B)**.

At the same time, the sympathetic nervous system releases stress hormones, too (not shown). The combined effects of these hormones are widespread, as this illustration reveals. Senses become sharper, muscles tighten, the heart beats faster, blood pressure rises, and breathing quickens. All of this prepares you to fight or flee in the face of danger.

Simultaneously, the hypothalamus fires up the autonomic nervous system. This network of nerves relays the warning down through the spinal cord and from there to nerves throughout the body. In response, nerve endings in organs, blood vessels, the skin, and even sweat glands release epinephrine and norepinephrine.

This tandem surge of hormones primes your body to react to the imminent threat. In the case of an immediate physical danger, such as the sudden appearance of a prowling wild animal or an armed enemy, you respond by either preparing to stand your ground and fight, or else fleeing to safety. Either way, you need to gear up for action, which is precisely what stress hormones enable you to do.

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Your breath quickens as your body takes in extra oxygen to help fuel your muscles. Likewise, energy-boosting glucose and fats are released from storage sites into your bloodstream. Sharpened senses, such as sight and hearing, make you more alert.

Your heart pounds — beating up to two to three times as quickly as normal — and your blood pressure rises. Certain blood vessels constrict, which helps direct blood flow to your muscles and brain and away from your skin and other organs.

Blood cells called platelets become stickier, so clots can form more easily to minimize bleeding from potential injuries. Immune system activity picks up. Your muscles — even the tiny hair-raising muscles beneath your skin — tighten, preparing you to spring into action.

Body systems not needed for the immediate emergency are suppressed in order to focus energy where it's needed. The stomach and intestines cease operations. Sexual arousal lessens. Repair and growth of body tissues slows.

Defusing the stress response

The autonomic nervous system, it turns out, is divided into two parts with opposite effects. The sympathetic nervous system revs up the body in response to perceived dangers, as described above. Its counterpart, the parasympathetic nervous system, calms the body after the danger has passed. But in today's society, stressors often pile up one after another in a combination of traffic jams, deadlines, money woes, and a host of other challenges that fill our days, rather than passing rapidly, like the wild animal that eventually lumbers away. As a result, the sympathetic system often remains engaged long after it should have yielded to the soothing influence of the parasympathetic system. The results can be damaging in many ways.

When your body repeatedly experiences the stress response, or when arousal following a terrible trauma is never fully switched off, your body's stress response can be described as maladaptive, or unhealthy. In this situation, the stress response kicks in sooner or more frequently than normal, increasing the burden your body must handle. Maladaptive stress responses can lead to worrisome health problems. A prime example of this is high blood pressure, or hypertension, which is a major risk factor for coronary artery disease. Another is suppression of the immune system, which increases susceptibility to colds and other common illnesses.

Even faced with chronic stress, however, you can benefit from stress management techniques. Regular use of these techniques can help you tamp down the sympathetic nervous system when it is not truly needed and restore balance.

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The importance of stress reduction

Skeptics have long believed that meditation and other stress reduction techniques are nice but ineffectual practices that do little for you. Nothing could be further from the truth — and now we have the science to prove it.

Intriguing new research suggests that regularly eliciting the relaxation response — a natural counterbalance to the stress response — can act on our genes in ways that may evoke multiple health benefits and help reduce the harmful effects of stress. Small studies of various stress reduction techniques, as well as comprehensive programs, suggest that it's quite possible to improve many measures of health by making the strong mind-body connection work in your favor.

Genes and the relaxation response

Exciting new research from the Benson-Henry Institute for Mind Body Medicine at Massachusetts General Hospital suggests that the simple act of eliciting the relaxation response (and thereby dialing back the stress response) temporarily changes the activity of certain genes in ways that may benefit health. For starters, it switches off genes associated with chronic inflammatory responses. Many experts believe these inflammatory responses stress the body, possibly contributing to a host of chronic ailments, such as heart disease, inflammatory bowel disease, and diabetes. At the same time, it switches on genes linked with a variety of functions: the use of energy in the body, the release of insulin (which helps regulate blood sugar), the maintenance of telomeres (protective end-caps on our chromosomes that erode with age until a cell dies), and the functions of tiny cellular powerhouses called mitochondria. The researchers speculate that the latter may create energy reserves that help the body counter oxidative stress that can harm cells.

For this study, the researchers recruited two small groups of healthy subjects: long-term practitioners of techniques like yoga, meditation, and repetitive prayer that elicit the relaxation response; and novices who hadn't used these techniques before. The novices learned a sequence of relaxation response techniques, which they practiced for 20 minutes a day, guided by a CD, over eight weeks. This sequence included diaphragmatic breathing (also known as breath focus), body scan, mantra repetition, and mindfulness meditation.

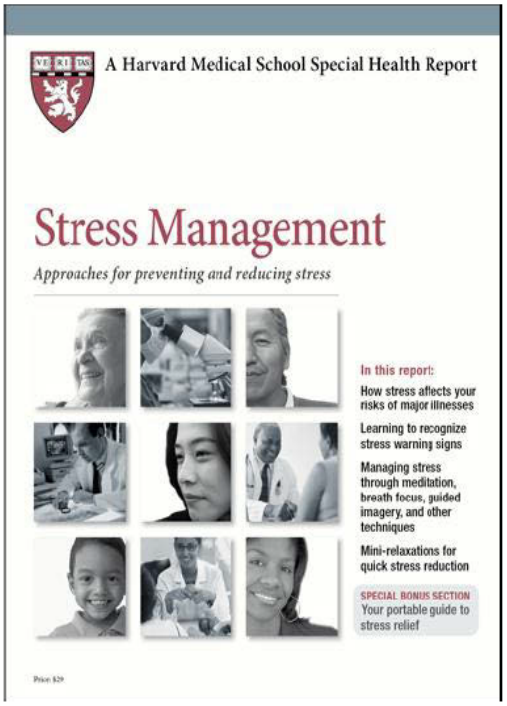
To gauge the changes in gene activity, the researchers obtained blood samples from the groups immediately before a single relaxation response session, immediately afterward, and 15 minutes afterward. While the long-term practitioners had the most profound changes in gene activity, the group with eight weeks of training also experienced significant changes in gene activity compared with the results they'd posted as complete novices.

These results built on the findings of an earlier study conducted by the Genomics Center at Beth Israel Deaconess Medical Center and the Benson-Henry Institute for Mind Body Medicine that found similar results, with changes in the activity of genes controlling how the body handles free radicals,

inflammatory processes, and cell death. Once again, greater changes were seen in the long-term practitioners than in the novices.

Aiming for lasting benefits

Gene activity isn't altered forever by yoga or repetitive prayer. One lesson gleaned from these studies is that the relaxation response must be regularly elicited in order to make beneficial changes persist. Additional research needs to be done to learn whether similar changes occur in people who use relaxation response techniques to help treat stress-related illnesses. Already, studies examining the effects of relaxation techniques on hypertension, inflammatory bowel syndrome, and multiple myeloma are under way.



To learn more...

This information was prepared by the editors of the Harvard Health Publications division of Harvard Medical School. It is excerpted from our Special Health Report *Stress Management*, available at http://hvrd.me/YFn9u.

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Health problems that are linked to stress

Stress may contribute to or exacerbate health problems from A to Z (or at least to U). Among them:

- allergic skin reactions
- anxiety
- arthritis
- constipation
- cough
- depression
- diabetes
- dizziness
- gum disease
- headaches
- heart problems, such as angina (chest pains), arrhythmias, heart attack, and palpitations (pounding heart)
- heartburn
- high blood pressure
- infectious diseases, such as colds or herpes
- insomnia and resulting fatigue
- irritable bowel syndrome
- menopausal symptoms, such as hot flashes
- "morning sickness," the nausea and vomiting of pregnancy
- nervousness
- pain of any sort, including backaches, headaches, abdominal pain, muscle pain, joint aches, postoperative pain, and chronic pain caused by many conditions
- Parkinson's disease
- postoperative swelling
- premenstrual syndrome (PMS)
- side effects of AIDS
- side effects of cancer and cancer treatments
- slow wound healing
- ulcers

To the extent that stress worsens these ailments, the relaxation response (a state of profound rest) and other stress management methods can be healing.

Adapted from The Relaxation Revolution, *Herbert Benson, M.D., and William Proctor, J.D. (Scribner, 2010).*

Eight weeks to a better brain: Meditation study shows changes associated with awareness, stress

January 21, 2011

Sue McGreevey, MGH Communications
(From *Harvard Gazette*)

Participating in an eight-week mindfulness meditation program appears to make measurable changes in brain regions associated with memory, sense of self, empathy, and stress. In a study that will appear in the Jan. 30 issue of Psychiatry Research: Neuroimaging, a team led by Harvard-affiliated researchers at Massachusetts General Hospital (MGH) reported the results of their study, the first to document meditation-produced changes over time in the brain's gray matter.

"Although the practice of meditation is associated with a sense of peacefulness and physical relaxation, practitioners have long claimed that meditation also provides cognitive and psychological benefits that persist throughout the day," says study senior author Sara Lazar of the MGH Psychiatric Neuroimaging Research Program and a Harvard Medical School instructor in psychology. "This study demonstrates that changes in brain structure may underlie some of these reported improvements and that people are not just feeling better because they are spending time relaxing."

Previous studies from Lazar's group and others found structural differences between the brains of experienced meditation practitioners and individuals with no history of meditation, observing thickening of the cerebral cortex in areas associated with attention and emotional integration. But those investigations could not document that those differences were actually produced by meditation.

For the current study, magnetic resonance (MR) images were taken of the brain structure of 16 study participants two weeks before and after they took part in the eight-week Mindfulness-Based Stress Reduction (MBSR) Program at the University of Massachusetts Center for Mindfulness. In addition to weekly meetings that included practice of mindfulness meditation

— which focuses on nonjudgmental awareness of sensations, feelings, and state of mind — participants received audio recordings for guided meditation practice and were asked to keep track of how much time they practiced each day. A set of MR brain images was also taken of a control group of nonmeditators over a similar time interval.

Meditation group participants reported spending an average of 27 minutes each day practicing mindfulness exercises, and their responses to a mindfulness questionnaire indicated significant improvements compared with pre-participation responses. The analysis of MR images, which focused on areas where meditation-associated differences were seen in earlier studies, found increased gray-matter density in the hippocampus, known to be important for learning and memory, and in structures associated with self-awareness, compassion, and introspection.

Participant-reported reductions in stress also were correlated with decreased gray-matter density in the amygdala, which is known to play an important role in anxiety and stress. Although no change was seen in a self-awareness-associated structure called the insula, which had been identified in earlier studies, the authors suggest that longer-term meditation practice might be needed to produce changes in that area. None of these changes were seen in the control group, indicating that they had not resulted merely from the passage of time.

"It is fascinating to see the brain's plasticity and that, by practicing meditation, we can play an active role in changing the brain and can increase our well-being and quality of life," says Britta Hölzel, first author of the paper and a research fellow at MGH and Giessen University in Germany. "Other studies in different patient populations have shown that meditation can make significant improvements in a variety of symptoms, and we are now investigating the underlying mechanisms in the brain that facilitate this change."

Amishi Jha, a University of Miami neuroscientist who investigates mindfulness-training's effects on individuals in high-stress situations, says, "These results shed light on the mechanisms of action of mindfulness-based training. They demonstrate that the first-person experience of stress can not only be reduced with an eight-week mindfulness training program but that this experiential change corresponds with structural changes in the amygdala, a finding that opens doors to many possibilities for further research on

MBSR's potential to protect against stress-related disorders, such as post-traumatic stress disorder." Jha was not one of the study investigators. James Carmody of the Center for Mindfulness at University of Massachusetts Medical School is one of the co-authors of the study, which was supported by the National Institutes of Health, the British Broadcasting Company, and the Mind and Life Institute.

Reprinted from...
http://news.harvard.edu/gazette/story/2011/01/eight-weeks-to-a-better-brain/

Mindfulness Meditation: A mental workout to benefit the brain

By Elizabeth Brown, graduate student at Harvard University
(From Science in the News)

Meditation has ancient, religious roots, but it has also become a secular practice, implemented to promote wellbeing and to treat depression and anxiety. Skeptics might be wary of this jump from spiritual origins to medical treatment, but mounting evidence suggests that meditation can have tangible effects on the brain. In a practice called mindfulness meditation, people concentrate on the present moment: on breathing, physical sensations, sounds, thoughts, and emotions. To brains accustomed to planning, predicting, story-telling, wondering, remembering, regretting, and worrying, fixating on the present is unusual and challenging. However, spending time thinking in this new way produces measurable changes in both the white and gray matter that make up the brain.

Gray matter is the portion of the brain that is made up of nerve cell bodies, while white matter is made up of long and slender extensions of the cell bodies called "axons." The cell bodies of the gray matter release chemical or electrical signals in response to the electrical impulses of the nervous system, while white matter forms connections between the cells, allowing communication between different brain regions. This communication between the gray and white matter in the brain is what constitutes thinking. Changes in both gray and white matter can be measured with different types of magnetic resonance imaging (MRI) **(Figure 1)**, which detects differences in blood flow to brain regions by stimulating changes in the magnetic fields of iron atoms in the blood. Many studies have now been conducted using MRI to examine the effects of meditation on the brain. This research is starting to reveal how changes in the brains of meditators may translate into mental benefits.

Changes that matter

For example, after eight weeks of a mindfulness-based stress reduction class, participants exhibited increased gray matter in four regions of the brain: the left-hippocampus, the posterior cingulate cortex, the left temporoparietal junction, and the cerebellum **(Figure 1)**. These areas of the brain are involved

in the regulation of emotion, compassion, coordination, learning, and memory. Tellingly, defects and decreased gray matter in the hippocampus and cerebellum (the opposite of what is seen in meditators) have been associated with post-traumatic stress disorder, anxiety, depression, and sleep disorders. In addition, participants exhibited decreased gray matter in the amygdala—the region of the brain that controls the release of stress hormones **(Figure 1)**. So, in the hippocampus and cerebellum, more gray matter contributes to coordination, memory, and emotional regulation, while in the amygdala more gray matter contributes to stress. Meditators then, might be expected to have better emotional regulation and less stress compared to non-meditators. Indeed, these changes in gray matter over the eight-week period were not observed among control subjects who had no meditation experience before or during the study. The changes in gray matter observed in mindful meditators correspond to emotional and behavioral improvements, including decreased anxiety, decreased risk of depression relapse, decreased insomnia, and increased compassion. Importantly, improvements in anxiety and depression among mindful meditators have been observed in many studies, indicating that at least some mental health benefits from meditation have strong scientific support.

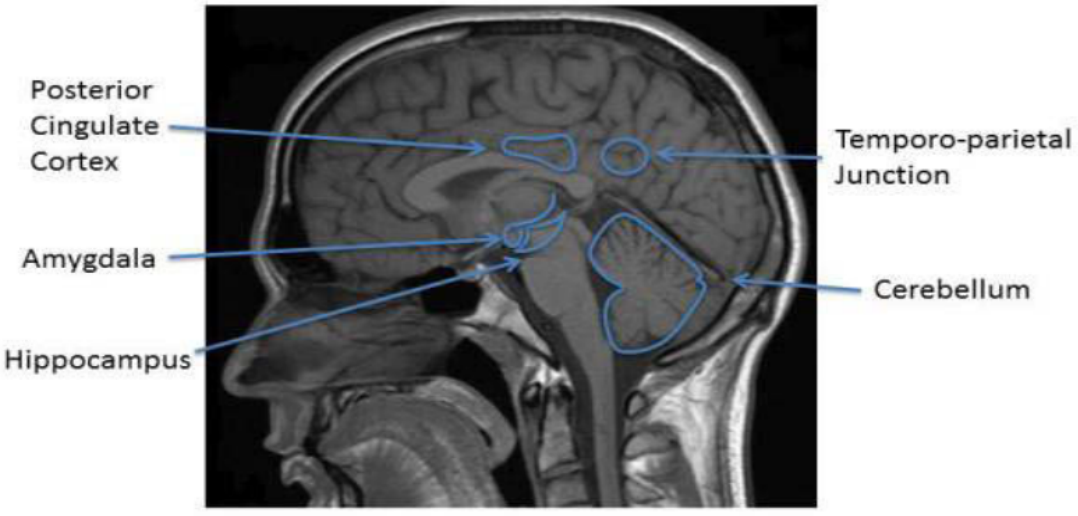

***Figure 1**. Profile of a human brain using an MRI. Regions outlined that change after eight weeks of mindfulness meditation training. Original image by Helmut Januschka, modified.*

Functional connectivity MRIs (fcMRIs) detect correlations in the changes of blood flow across the brain, and reflect white matter connectivity between different regions. They have also been used to examine the impact of mindfulness meditation. Using fcMRIs, experienced meditators in one study exhibited increased connectivity compared to non-meditators. Furthermore, another study using a type of MRI known as diffusion tensor imaging, which detects white matter fibers directly**(Figure 2)**, revealed that meditators have an increased density of axons, increased integrity of the protein sheaths surrounding the axons, and increased efficiency of signal transmission through the axons [4]. Researchers are still trying to figure out why increased connectivity results in some of the benefits of meditation.

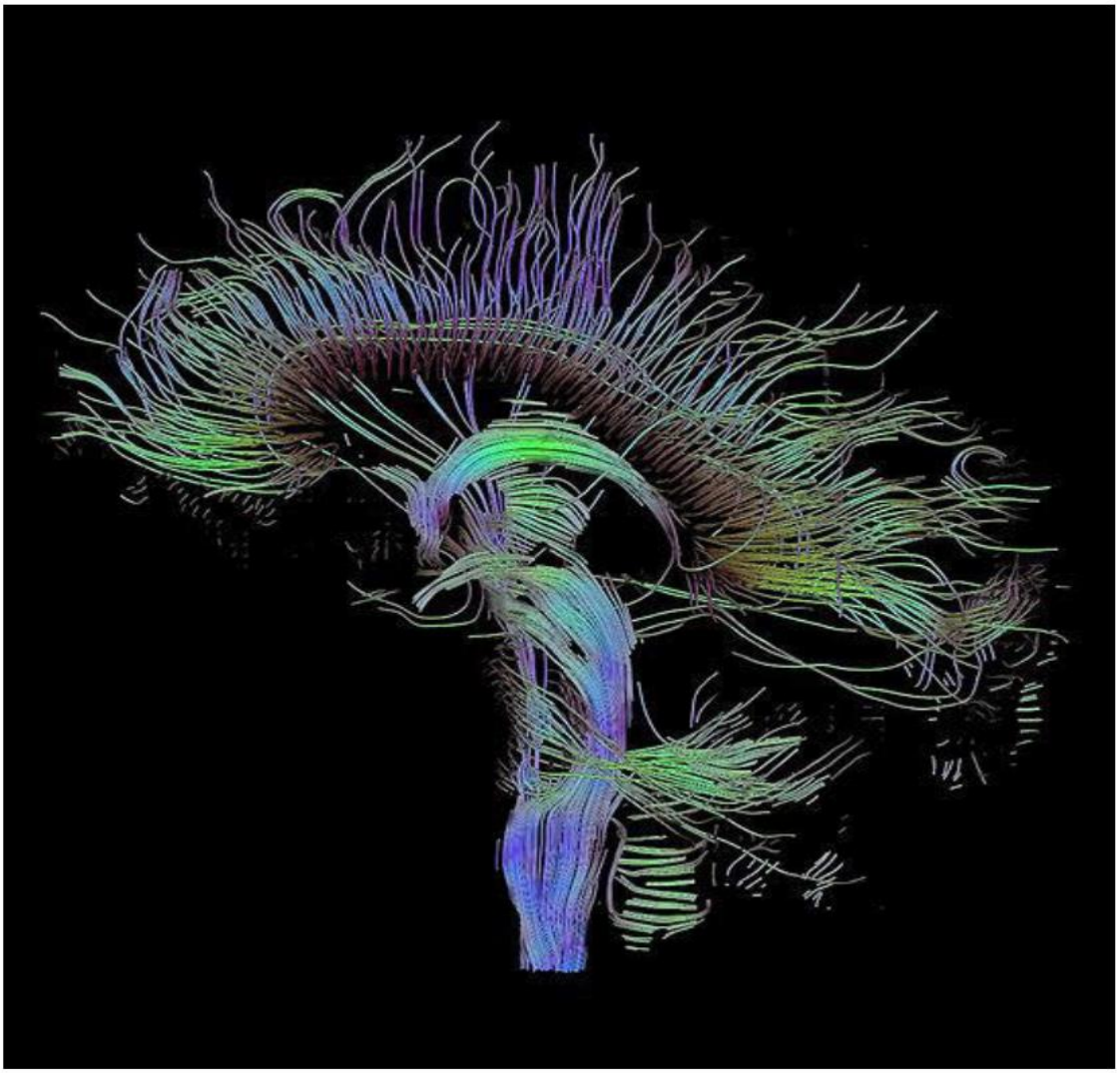

***Figure 2**. Profile of a human brain using diffusion tensor imaging, showing the white matter connections of the brain. Image by Thomas Schultz, http://www.sci.utah.edu/~gk/DTI-data/.*

Better Brainwaves

Researchers conducting these studies wondered whether this increased connectivity in meditators actually translates into better communication between different regions of the brain and enhanced efficiency in switching attention from one sensation or thought to the next. They investigated this by measuring alpha rhythms, the electrical signals or "brainwaves" that transmit sensory and motor information. They found that when asked to switch their focus of attention meditators exhibited alpha rhythms with greater amplitude than non-meditators, as measured by another MRI technique called magnetoencephalography. This increased amplitude is thought to indicate improved transmission of signals throughout the brain. Researchers hypothesize that this improved transmission may be responsible for the reductions in pain and negative thoughts reported by mindful meditators, as they may be better at changing focus from negative sensations or thoughts to positive or neutral stimuli. If so, this would explain why directing the focus of attention in meditation and improved connectivity leads to some of the observed mental benefits.

The potential for mindfulness meditation and related practices to change people's brains is a promising area of ongoing research. Replication of these brain-imaging studies in larger groups of people will be an important confirmation of results. Furthermore, basic research into the function of different brain regions and the significance of changes to brain matter density and connectivity will clarify how these changes to the brain impact people's moods, behaviors, and bodies. For instance, the effects of meditation may go beyond the brain. Earlier research, described in "Calming Your Nerves and Your Heart Through Meditation" supports a reduction in heart disease among people practicing transcendental meditation—another form of meditation that involves the use of mantras. Other current research is investigating whether mindfulness meditation can improve learning and boost the immune system. Such benefits may seem far-reaching for a simple thought exercise. However, these studies indicate that meditation may be like actual brain exercise, stimulating physical changes to neural fibers and having widespread ramifications for the body.

Reprinted from…
http://sitn.hms.harvard.edu/flash/2013/mindfulness-meditation-a-mental-workout-to-benefit-the-brain/

Meditation may relieve IBS and IBD

May 5, 2015

By Sue McGreevey, Massachusetts General Hospital Public Affairs
(From *Harvard Gazette*)

A pilot study has found that participating in a nine-week training program including elicitation of the relaxation response had a significant impact on clinical symptoms of the gastrointestinal disorders irritable bowel syndrome (IBS) and inflammatory bowel disease (IBD) and on the expression of genes related to inflammation and the body's response to stress.

The report from investigators at the Benson-Henry Institute for Mind Body Medicine at Massachusetts General Hospital (MGH) and at Beth Israel Deaconess Medical Center (BIDMC), both Harvard affiliates, is the first to study the use of the relaxation response in these disorders and the first to investigate the genomic effects of the relaxation response in individuals with any disorder. The report was published in the open-access journal PLOS ONE. "Our results suggest exciting possibilities for further developing and implementing this treatment in a wider group of patients with gastrointestinal illness," said Braden Kuo of the gastrointestinal unit in the MGH Department of Medicine, co-lead author of the report.

"Several studies have found that stress management techniques and other psychological interventions can help patients with IBS, at least in the short term; and while the evidence for IBD is less apparent, some studies have suggested potential benefits. What is novel about our study is demonstration of the impact of a mind/body intervention on the genes controlling inflammatory factors that are known to play a major role in IBD and possibly in IBS," said Kuo, who is also a Harvard Medical School assistant professor of medicine.

Both IBS and IBD are chronic conditions that produce related symptoms, including abdominal pain and changes in bowel function such as diarrhea. But while IBD — which includes Crohn's disease and ulcerative colitis — is characterized by severe inflammation in all or part of the gastrointestinal tract, no inflammation or visible abnormality is present in IBS. Stress appears

to exacerbate both conditions, and since the symptoms themselves can increase stress in patients, finding ways to break that vicious cycle could have significant clinical benefits.

The relaxation response — a physiologic state of deep rest induced by practices such as meditation, yoga, and prayer — was first described more than 40 years ago by Herbert Benson, director *emeritus* of the Benson-Henry Institute and a co-author of the current paper. Many studies have shown that regular practice of the relaxation response not only alleviates stress and anxiety but also directly affects physiologic factors such as blood pressure, heart rate, and oxygen consumption. In reports published in 2008 and 2013, Benson, along with Towia Libermann and Manoj Bhasin — both of the BIDMC Genomics, Proteomics, Bioinformatics and Systems Biology Center — described how elicitation of the relaxation response in healthy individuals affected the expression of genes in pathways involved with the body's response to stress, inflammation, and energy metabolism. Libermann is co-senior author and Bhasin is co-lead author of the current study.

The current study was designed to investigate whether a relaxation-response-based intervention could improve the quality of life in patients with IBS or IBD and to analyze the intervention's effects on inflammatory markers and gene expression. The study enrolled 48 adult participants — 19 of whom had been diagnosed with IBS and 29 with IBD — who participated in a nine-week group program focused on stress reduction, cognitive skills, and health-enhancing behaviors. Each of the weekly sessions included relaxation response training, and participants were asked to practice relaxation response elicitation at home for 15 to 20 minutes each day. Along with aspects featured in other group programs offered at the Benson-Henry Institute, this program included a session specifically focused on gastrointestinal health.

Study participants were assessed at the outset, midway through, and at the end of the program, and then three weeks later. The assessments used standardized tools for measuring symptoms common to both disorders, assessing anxiety and pain, and determining the effects of the disorders on participants' quality of life. Blood samples were taken at baseline and a week after the study period's conclusion for purposes of profiling gene expression and measuring known inflammatory factors.

Both in patients with IBS and those with IBD, participation in the mind/body program appeared to have significantly improved disease-related symptoms, anxiety, and overall quality of life, not only at the end of the study period but also three weeks later. While there were no significant changes in inflammatory markers for either group of participants, changes in expression were observed in almost 200 genes among participants with IBS and more than 1,000 genes in those with IBD. Many of the genes with altered expression are known to contribute to pathways involved with stress response and inflammation.

"In both IBS and IBD, the pathway controlled by a protein called NF-κB emerged as one of those most significantly affected by the relaxation response, which confirms the findings of our previous genomic studies," said Libermann. "Indeed the relaxation response reduced the expression of a number of genes directly linked to the key inflammatory processes of IBD. While the mechanisms behind IBS are less well-defined, they most likely involve stress response, which also could be improved by relaxation response practice."

Co-senior author John Denninger of the Benson-Henry Institute at MGH noted, "One interesting clinical impact was a decrease in both IBS and IBD patients in what is called pain catastrophizing — a negative cognitive and emotional response to pain or the anticipation of pain. In other words, participants became more resilient in the face of the pain they were experiencing. But before we can offer a program like this to patients with these disorders, we'll need to conduct a longer, randomized trial with a control group and enough participants for statistically significant results."

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http://news.harvard.edu/gazette/story/2015/05/meditation-may-relieve-ibs-and-ibd/

Meditation found to increase brain size

February 2, 2006

By William J. Cromie, Harvard News Office
(From *Harvard Gazette*)

People who meditate grow bigger brains than those who don't. Researchers at Harvard, Yale, and the Massachusetts Institute of Technology have found the first evidence that meditation can alter the physical structure of our brains. Brain scans they conducted reveal that experienced meditators boasted increased thickness in parts of the brain that deal with attention and processing sensory input.

In one area of gray matter, the thickening turns out to be more pronounced in older than in younger people. That's intriguing because those sections of the human cortex, or thinking cap, normally get thinner as we age.

"Our data suggest that meditation practice can promote cortical plasticity in adults in areas important for cognitive and emotional processing and well-being," says Sara Lazar, leader of the study and a psychologist at Harvard Medical School. "These findings are consistent with other studies that demonstrated increased thickness of music areas in the brains of musicians, and visual and motor areas in the brains of jugglers. In other words, the structure of an adult brain can change in response to repeated practice."
The researchers compared brain scans of 20 experienced meditators with those of 15 nonmeditators. Four of the former taught meditation or yoga, but they were not monks living in seclusion. The rest worked in careers such as law, health care, and journalism. All the participants were white. During scanning, the meditators meditated; the others just relaxed and thought about whatever they wanted.

Meditators did Buddhist "insight meditation," which focuses on whatever is there, like noise or body sensations. It doesn't involve "om," other mantras, or chanting.

"The goal is to pay attention to sensory experience, rather than to your thoughts about the sensory experience," Lazar explains. "For example, if you

suddenly hear a noise, you just listen to it rather than thinking about it. If your leg falls asleep, you just notice the physical sensations. If nothing is there, you pay attention to your breathing." Successful meditators get used to not thinking or elaborating things in their mind.

Study participants meditated an average of about 40 minutes a day. Some had been doing it for only a year, others for decades. Depth of the meditation was measured by the slowing of breathing rates. Those most deeply involved in the meditation showed the greatest changes in brain structure. "This strongly suggests," Lazar concludes, "that the differences in brain structure were caused by the meditation, rather than that differences in brain thickness got them into meditation in the first place."

Lazar took up meditation about 10 years ago and now practices insight meditation about three times a week. At first she was not sure it would work. But "I have definitely experienced beneficial changes," she says. "It reduces stress [and] increases my clarity of thought and my tolerance for staying focused in difficult situations."

Controlling random thoughts

Insight meditation can be practiced anytime, anywhere. "People who do it quickly realize that much of what goes on in their heads involves random thoughts that often have little substance," Lazar comments. "The goal is not so much to 'empty' your head, but to not get caught up in random thoughts that pop into consciousness."

She uses this example: Facing an important deadline, people tend to worry about what will happen if they miss it, or if the end product will be good enough to suit the boss. You can drive yourself crazy with unproductive "what if" worry. "If, instead, you focus on the present moment, on what needs to be done and what is happening right now, then much of the feeling of stress goes away," Lazar says. "Feelings become less obstructive and more motivational." The increased thickness of gray matter is not very much, 4 to 8 thousandths of an inch. "These increases are proportional to the time a person has been meditating during their lives," Lazar notes. "This suggests that the thickness differences are acquired through extensive practice and not simply due to differences between meditators and nonmeditators."

As small as they are, you can bet those differences are going to lead to lots more studies to find out just what is going on and how meditation might better be used to improve health and well-being, and even slow aging.
More basic questions need to be answered. What causes the increased thickness? Does meditation produce more connections between brain cells, or more blood vessels? How does increased brain thickness influence daily behavior? Does it promote increased communication between intellectual and emotional areas of the brain?

To get answers, larger studies are planned at Massachusetts General Hospital, the Harvard-affiliated facility where Lazar is a research scientist and where these first studies were done. That work included only 20 meditators and their brains were scanned only once.

"The results were very encouraging," Lazar remarks. "But further research needs to be done using a larger number of people and testing them multiple times. We also need to examine their brains both before and after learning to meditate. Our group is currently planning to do this. Eventually, such research should reveal more about the function of the thickening; that is, how it affects emotions and knowing in terms of both awareness and judgment."

Slowing aging?

Since this type of meditation counteracts the natural thinning of the thinking surface of the brain, could it play a role in slowing – even reversing – aging? That could really be mind-boggling in the most positive sense.
Lazar is cautious in her answer. "Our data suggest that one small bit of brain appears to have a slower rate of cortical thinning, so meditation may help slow some aspects of cognitive aging," she agrees. "But it's important to remember that monks and yogis suffer from the same ailments as the rest of us. They get old and die, too. However, they do claim to enjoy an increased capacity for attention and memory."

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http://news.harvard.edu/gazette/story/2006/02/meditation-found-to-increase-brain-size/

Mindfulness Can Literally Change Your Brain

January 8, 2015

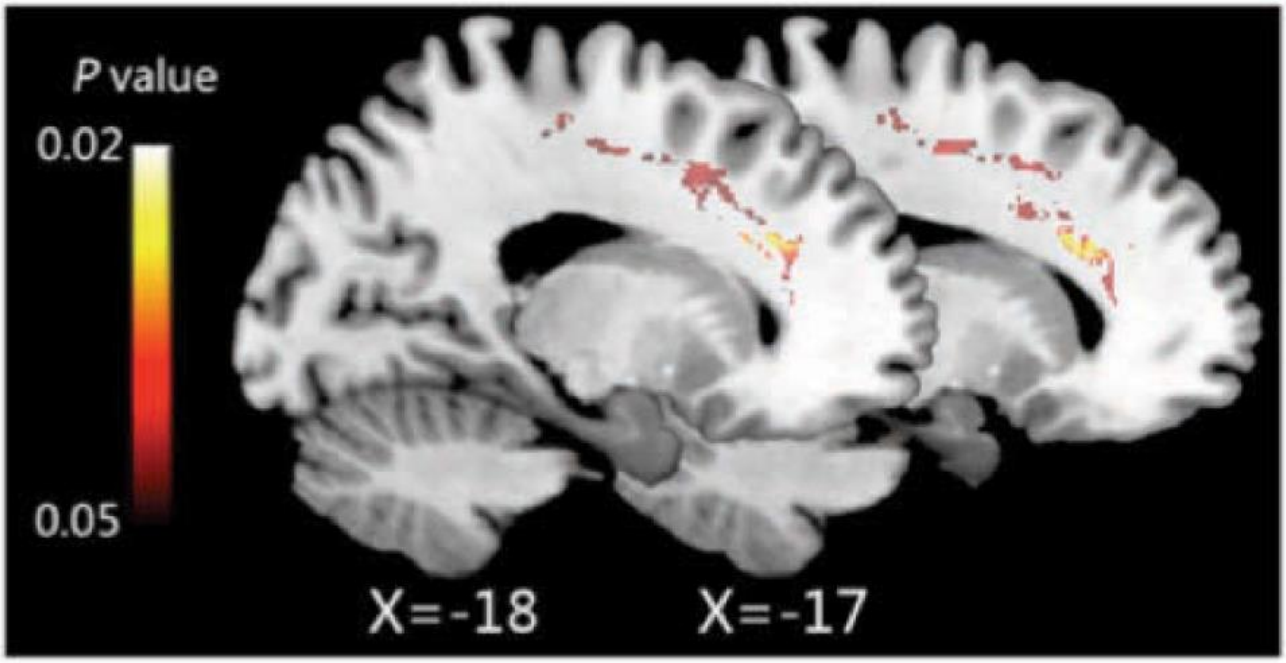
By Christina Congleton, Britta K. Hölzel and Sara W. Lazar
(From *Harvard Business Review*)

The business world is abuzz with mindfulness. But perhaps you haven't heard that the hype is backed by hard science. Recent research provides strong evidence that practicing non-judgmental, present-moment awareness (a.k.a. mindfulness) changes the brain, and it does so in ways that anyone working in today's complex business environment, and certainly every leader, should know about.

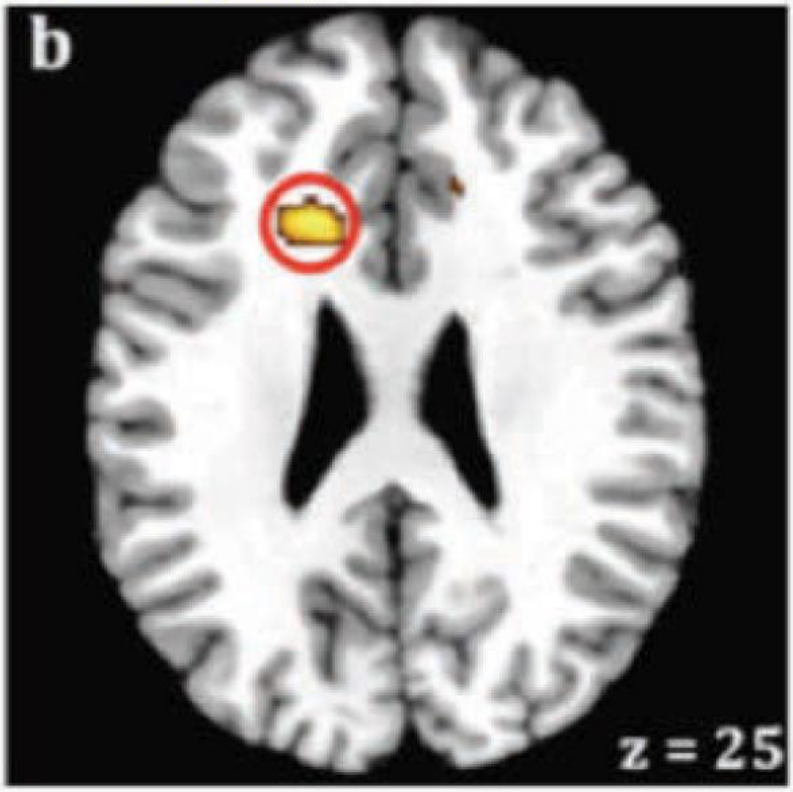
We contributed to this research in 2011 with a study on participants who completed an eight-week mindfulness program. We observed significant increases in the density of their gray matter. In the years since, other neuroscience laboratories from around the world have also investigated ways in which meditation, one key way to practice mindfulness, changes the brain. This year, a team of scientists from the University of British Columbia and the Chemnitz University of Technology were able to pool data from more than 20 studies to determine which areas of the brain are consistently affected. They identified at least eight different regions. Here we will focus on two that we believe to be of particular interest to business professionals.

The first is the anterior cingulate cortex (ACC), a structure located deep inside the forehead, behind the brain's frontal lobe. The ACC is associated with self-regulation, meaning the ability to purposefully direct attention and behavior, suppress inappropriate knee-jerk responses, and switch strategies flexibly. People with damage to the ACC show impulsivity and unchecked aggression, and those with impaired connections between this and other brain regions perform poorly on tests of mental flexibility: they hold onto ineffective problem-solving strategies rather than adapting their behavior. Meditators, on the other hand, demonstrate superior performance on tests of self-regulation, resisting distractions and making correct answers more often than non-meditators. They also show more activity in the ACC than non-meditators. In addition to self-regulation, the ACC is associated with learning from past experience to support optimal decision-making. Scientists point out that the

ACC may be particularly important in the face of uncertain and fast-changing conditions.

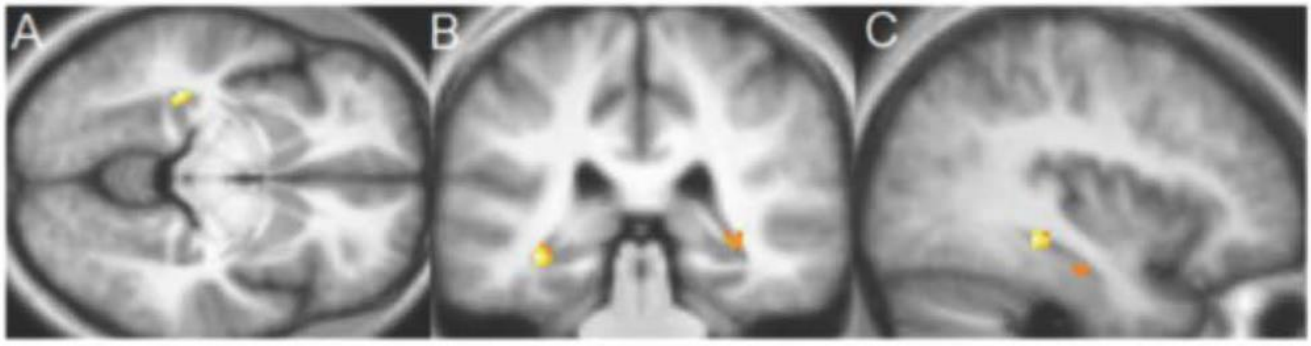


(Source: Tang et al.)



(Source: Fox et al.)

The second brain region we want to highlight is the hippocampus, a region that showed increased amounts of gray matter in the brains of our 2011 mindfulness program participants. This seahorse-shaped area is buried inside the temple on each side of the brain and is part of the limbic system, a set of inner structures associated with emotion and memory. It is covered in receptors for the stress hormone cortisol, and studies have shown that it can be damaged by chronic stress, contributing to a harmful spiral in the body. Indeed, people with stress-related disorders like depression and PTSD tend to have a smaller hippocampus. All of this points to the importance of this brain area in resilience—another key skill in the current high-demand business world.



(Source: Hölzel et al.)

These findings are just the beginning of the story. Neuroscientists have also shown that practicing mindfulness affects brain areas related to perception, body awareness, pain tolerance, emotion regulation, introspection, complex thinking, and sense of self. While more research is needed to document these changes over time and to understand underlying mechanisms, the converging evidence is compelling.

Mindfulness should no longer be considered a "nice-to-have" for executives. It's a "must-have": a way to keep our brains healthy, to support self-regulation and effective decision-making capabilities, and to protect ourselves from toxic stress. It can be integrated into one's religious or spiritual life, or practiced as a form of secular mental training. When we take a seat, take a breath, and commit to being mindful, particularly when we gather with others who are doing the same, we have the potential to be changed.

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Harvard yoga scientists find proof of meditation benefit
November 21, 2013
Bloomberg Business
http://www.bloomberg.com/news/articles/2013-11-22/harvard-yoga-scientists-find-proof-of-meditation-benefit

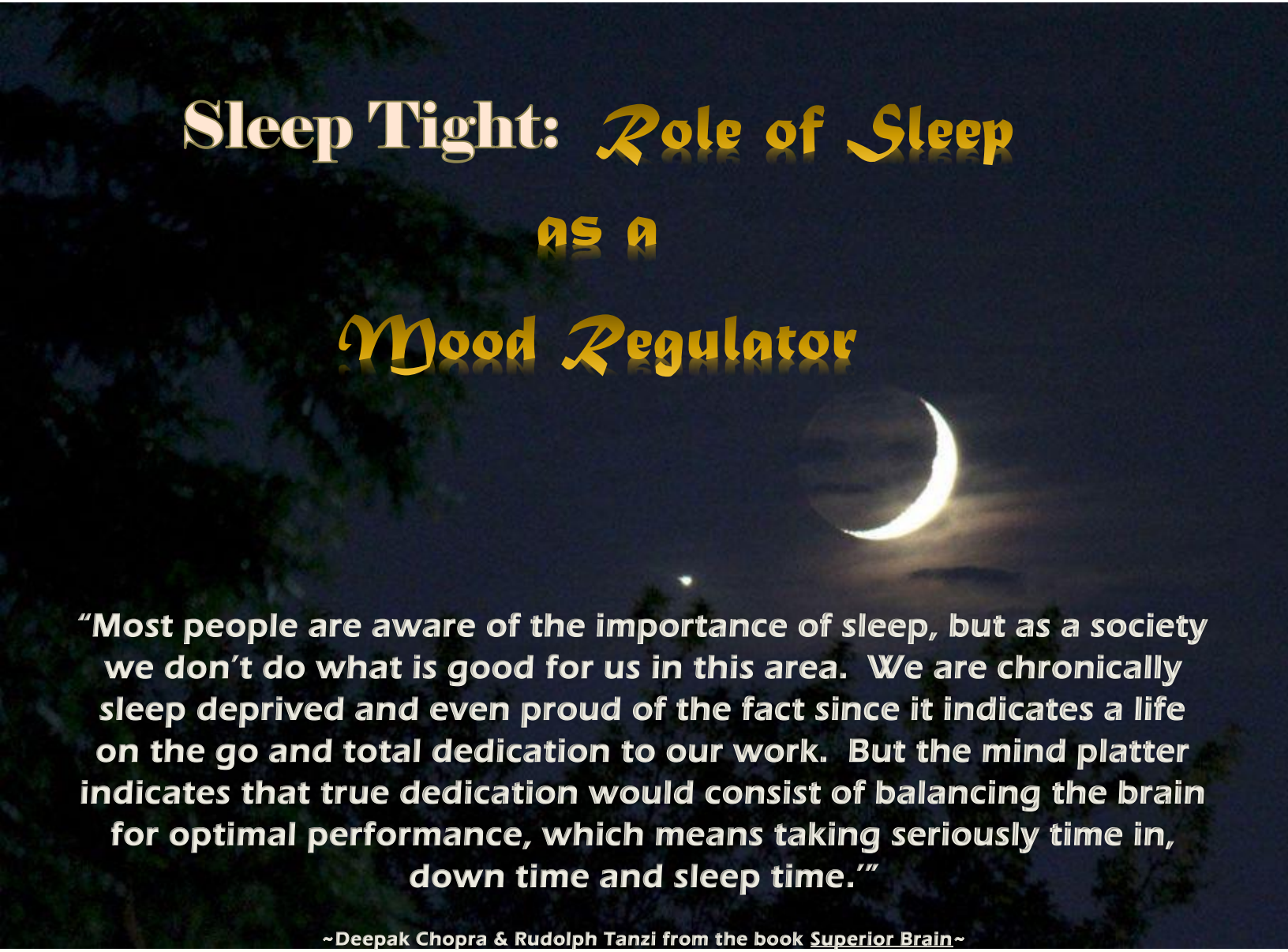
David R. Vago
Personal Blog
http://davidvago.bwh.harvard.edu/blog/
Starting a Meditation Practice
http://davidvago.bwh.harvard.edu/mindfulness-resources/starting-a-meditation-practice-retreat-centers-for-you/

Sara Lazar on how meditation can reshape our brains
March 14, 2012
TedXCambridge
http://www.tedxcambridge.com/speaker/sara-lazar/

Benson-Henry Institute for Mind Body Medicine
http://www.bensonhenryinstitute.org/

Why mindfulness has become a trend and how you can do it
February 24, 2016
ABC News
http://abcnews.go.com/Health/wireStory/mindfulness-trend-37170907

Studying yoga's effect on genes
December 2, 2013
Yoga Journal
http://www.yogajournal.com/meditation/studying-yogas-effect-on-genes/



Sleep Tight: Role of Sleep as a Mood Regulator

"Most people are aware of the importance of sleep, but as a society we don't do what is good for us in this area. We are chronically sleep deprived and even proud of the fact since it indicates a life on the go and total dedication to our work. But the mind platter indicates that true dedication would consist of balancing the brain for optimal performance, which means taking seriously time in, down time and sleep time.'"

~Deepak Chopra & Rudolph Tanzi from the book Superior Brain~

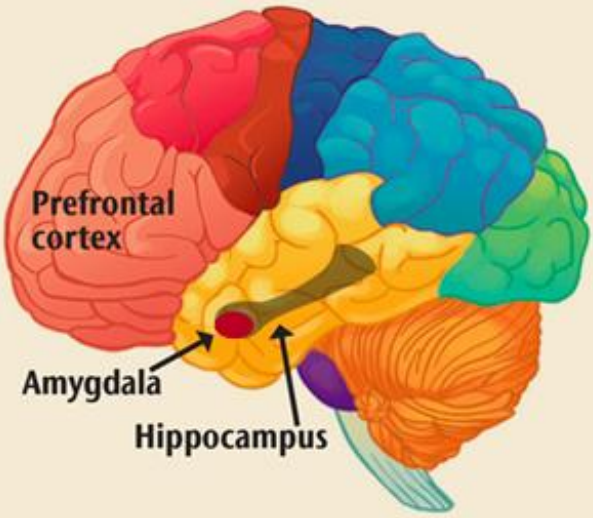
By now we should be familiar with the onslaught of repercussions that accompany sleep deprivation. We should also be comfortable with the mechanisms by which these responses are actuated: interactions and roles of hormones, neurotransmitters and immunoinflammatory mediators that drive conditions of the body and mind. In this final section, we will broaden the viewfinder and tap into the broader implications and consequence for our emotional status and behaviors.

The validity of focus on the sleep-sabotage pattern becomes self-evident at a glance: one only has to look as far as this morning's local traffic snarl incited by a hot-tempered fit of road rage, the latest meltdown by a frustrated shopper in the middle of a crowded store or the last angry outburst between husband and wife, employer and personnel or player against opponent. Fraught situations of more and more frequent emotional lability enacted over and over throughout society at every level, from our family homes to public domains to center stage on the nightly news.

What is not immediately evident is the relationship between the amygdala and the prefrontal cortex which is undermined and coopted to a radically different environment by the twin prongs of chronic stress and lack of adequate sleep so characteristic of modern life. Unhealthful digital exposure, nature deprivation and poor diet only add to the detriment in our individual and collective health.

Let's take a quick anatomical review.

When we imagine a human brain we typically picture lots of folds and creases. That's the cerebral cortex we're envisioning and the more folds, the greater the surface area, the more advanced its capabilities. It is this part of the brain that gives us our high-reasoning abilities—the ability to think analytically and logically, problem solve, plan for the future, and think abstractly. The cerebral cortex is reflective, contemplative, and methodical. It is our counterbalance, the part of the brain that regulates and attempts to control impulses of the more primitive limbic brain by its top-down functioning.



Prefrontal cortex: Highly developed part of the frontal lobe that plays a role in the regulation of complex cognitive, emotional, and behavioral functioning

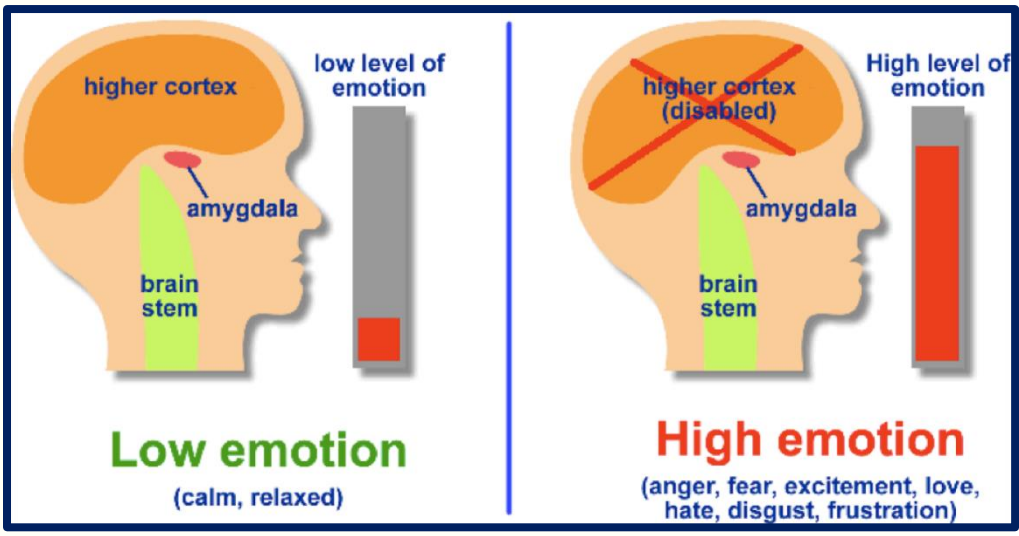
Amygdala: The emotional center of the brain

Hippocampus: Involved in forming, storing, and processing memory

The **prefrontal cortex** is a key component (one-third) of the cerebral cortex, occupying 10% of the entire brain volume. Like a high-powered CEO, the prefrontal cortex attempts to find the best possible response to incoming information. It allows us to make a plan that weighs alternatives instead of immediately reacting to circumstances. This process defines executive function and is the exact opposite of the functions carried out by the reactive amygdala. Scientific research on executive function is currently exploding and shows that many environmental factors within our control (i.e., sleep, stress, diet, activity, social interaction) can affect the health and functionality of the prefrontal cortex and ultimately our behavior and well-being.

The amygdala is a central influencer of emotion, impulsivity and reward. It is the control center of the threat-response and threat-interpretation system and modulates our memories of threatening events, real or perceived, as well as other emotion-filled experiences so that we can recognize similar events in the future. Memories, in general, whether they elicit strong emotions or not, also involve the prefrontal cortex. Interactions between the hippocampus and prefrontal cortex support the assimilation of new memories into preexisting networks of knowledge, ultimately providing the foundation of memory consolidation and retrieval.

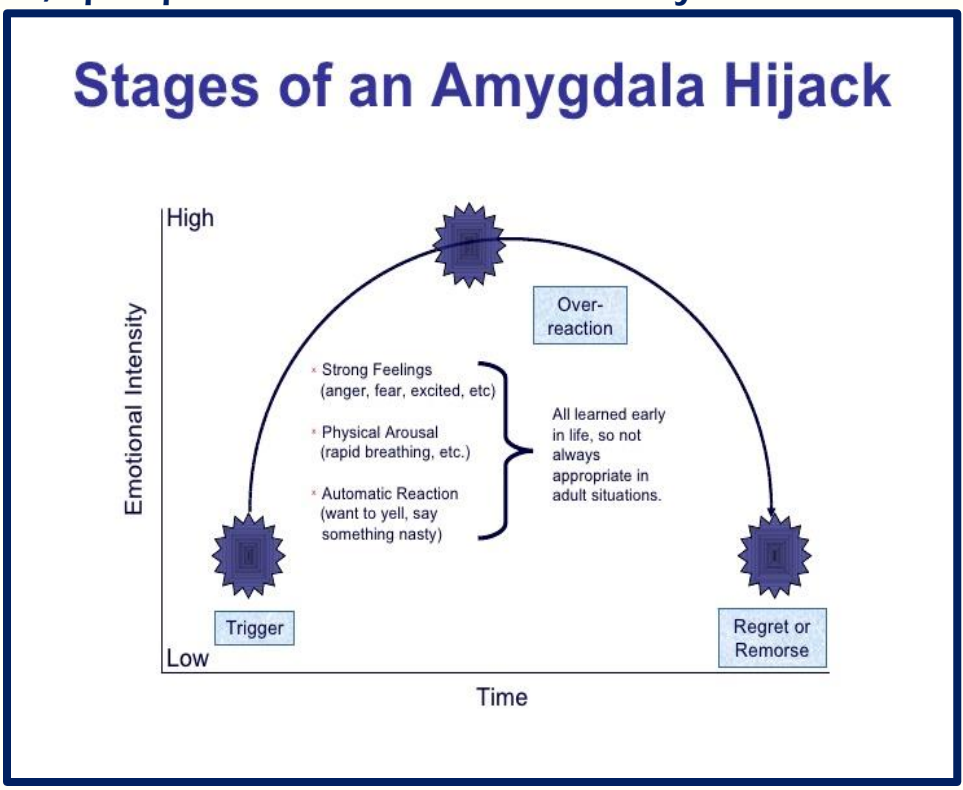
The amygdala and prefrontal cortex are in constant communication. The connection between these two areas influences our behavior as well as our ability to regulate impulsivity and emotion. When the balance of activity becomes too one-sided and the amygdala's primal responses dominate unchecked, trouble looms. For example, scientists have found that a weak connection between the amygdala and the prefrontal cortex is linked to anxiety. Likewise, an overreactive amygdala is an essential part of the story that has led us to our current histrionic societal predicament.



Abnormal functioning of the amygdala, resulting from developmental problems, neurotransmitter/hormonal imbalance or structural damage are linked to conditions such as depression, PTSD, phobias, anxiety and impulsivity. But even more critical to our understanding: the circuitry in the amygdala can be hacked or altered, even in an otherwise healthy brain. When an amygdala hijack occurs, big problems ensue.

The term 'amygdala hijack' was actually coined in 1995 by Daniel Goleman in 'Emotional Intelligence,' where he describes the violent or volatile reaction one develops in response to a situation. Moments of heightened rage, illogical behavior and disproportionate response that afterwards haunts us with feelings of regret, guilt and/or shame. Moments where, when we look back, we can only shake our heads and ask, "What was I thinking?"

Simply put, we weren't thinking at all. We were "amygdala-hijacked." When the nerves in the amygdala detect existing danger or threat and recognizes the stimulus as one that needs an immediate "fight-or-flight" response, the cortex is promptly bypassed and overridden, epinephrine is released and we may act out of character, out of the usual mode, with no restraint or control.



While this immediate instinctive pathway evolved to escape life-threatening dangers, the amygdala can be overreactive and overprotective, which also makes it inaccurate. This is why there is wisdom in trying to be mindful of our emotions before they take over the better part of us. It takes practice and experience to discern a situation and consciously engage the thinking brain (prefrontal cortex) so it takes control back from the emotional brain (amygdala), especially in the heat of the moment. This practiced ability to rein in the emotional brain and allow the thinking brain to take control to avoid hijacking is what constitutes emotional intelligence.

"One of the most revelatory discoveries of our lifetimes has been that the brain is plastic, meaning it can reorganize itself by forming new neural connections throughout a person's life. It's pliable, impressionable, *moldable*. This means you can change the wiring of your brain right now. As it is said in neurology circles, **neurons that fire together wire together**: when one brain cell sends signals to another, the connection between the two get stronger. The more signals sent between them, the more robust the connection becomes. Every time you experience something new, your brain slightly rewires to accommodate that new experience. And the more you engage in a particular activity, the more indelible and *influential* the connections needed to perform that activity become. In simplest terms, **the more you do something, the more you do something**.

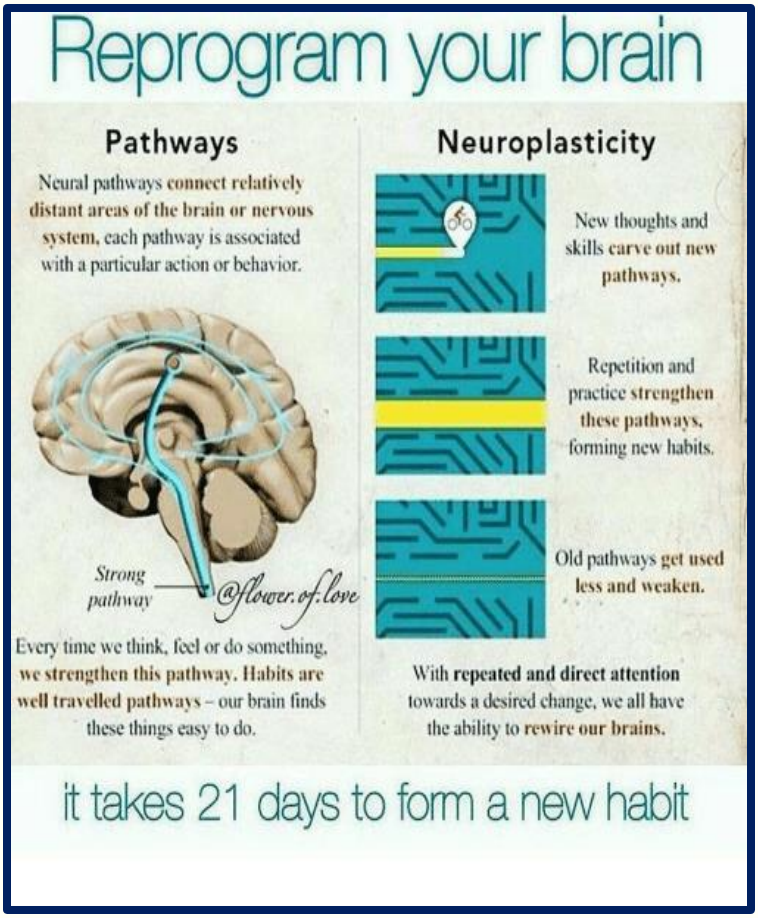
This is true whether something is good **or** bad for you." [Perlmutter & Perlmutter, p. 25]

"In fact, the way you choose to use your brain helps determine how your brain is organized overall. As you learn and experience the world, the links among your neurons are modified. New connections are created while unused connections die off. This is how we build a more efficient brain. It constantly and dynamically shapes and reshapes itself—both structurally and functionally—in response to experiences, learning and even injury." [Perlmutter & Perlmutter, p. 25-26]

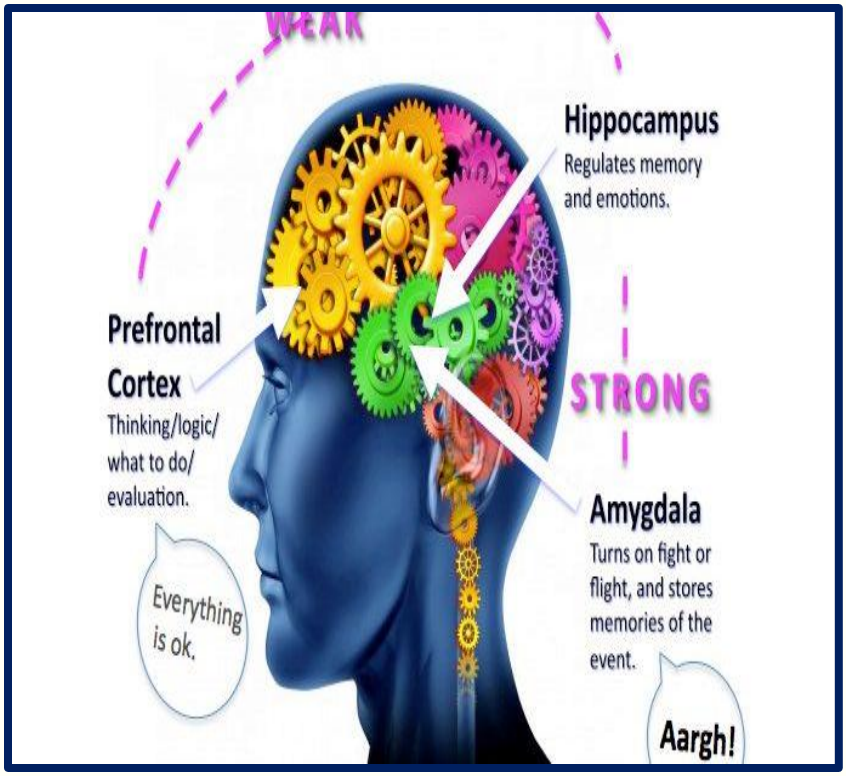
"This leaves us with a clear physiological fact...moment by moment we choose and sculpt how our ever-changing minds will work. We choose who we will be in the next moment in a very real sense, and these choices are left embossed in physical form in our material selves."

~Dr. Michael Merzenich, neuroscientist, neuroplasticity pioneer~

"If this is true, then neuroplasticity—the ability of the brain to form and organize synaptic connections—can either work for us or against us. That is, if we choose to engage in activities that constantly bombard us with negativity or provoke a sense of fear, our brains will be rewired to respond to this negativity and fear-driven state." [Perlmutter & Perlmutter, p. 26]

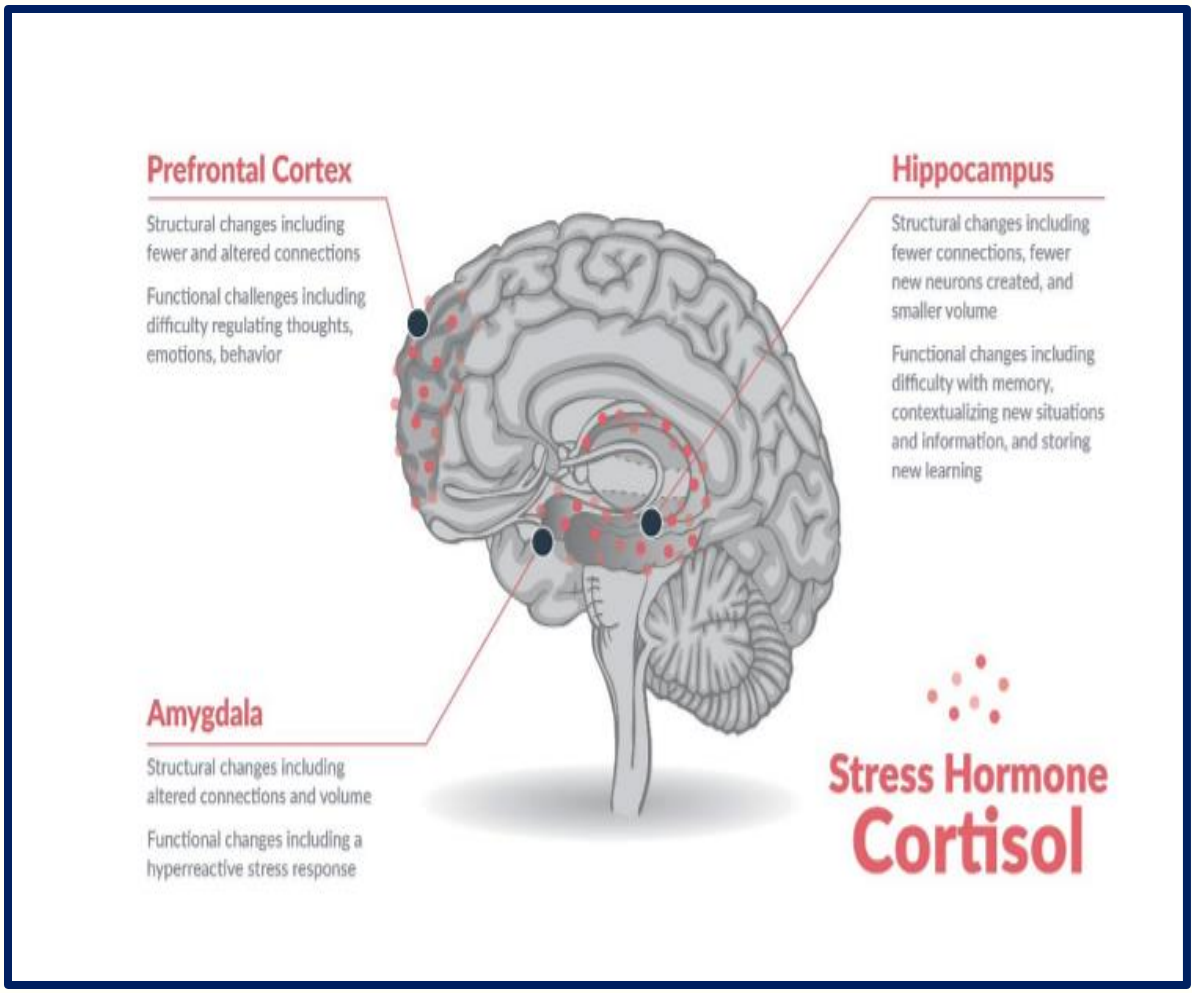


Likewise, when we perpetuate chronic stress and engage in maladaptive sleeping habits, we reinforce our brains amygdala-driven pathways. The amygdala activates stress pathways, which in turn impair prefrontal cortex regulation and strengthen amygdala function. This generates a vicious cycle in which high levels of stress keep the amygdala in the driver's seat. Our brain's response patterns switch from slow, thoughtful prefrontal cortex control to the reflexive and rapid emotional responses of the amygdala and related limbic structures. This explains why we become impulsive, irrational, and generally worse decision makers when we are stressed.

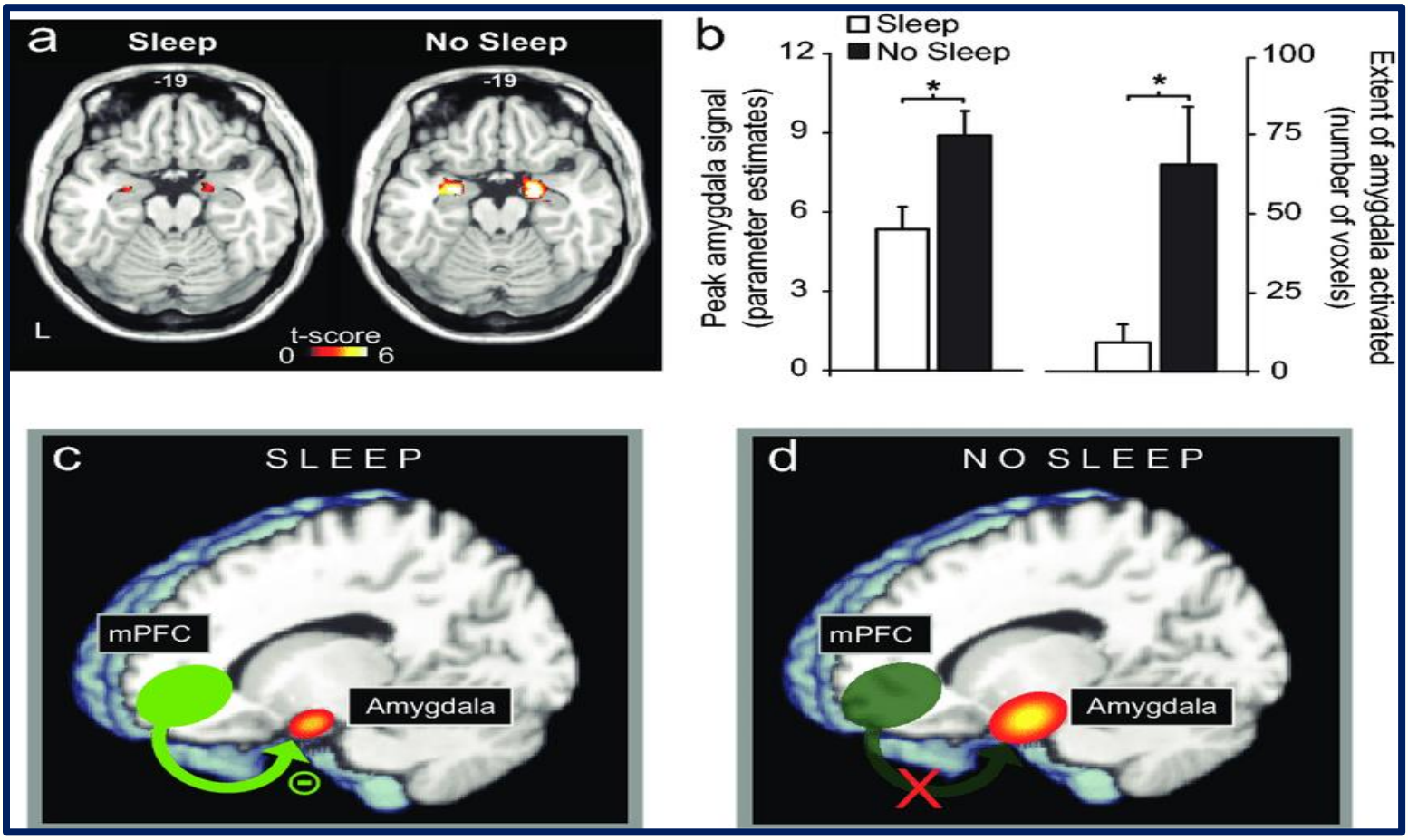


It should come as no surprise that lack of sleep, one of the ultimate systemic stressors, acts with the same critical misdirect as chronic stress: fuel for the amygdala and poison for the prefrontal cortex. We essentially give free license to the amygdala to take over and influence an increasing number of our decisions by changing the physical structure (and thus function) of the prefrontal cortex, rendering it increasingly unable to suppress the impulsive amygdala.

Meanwhile, chronic stress and lack of sleep promote new neuron growth in the amygdala, reinforcing its dominance. And what happens when the amygdala gets stronger? We have trouble making wise, well-thought-out decisions, creating more long-term stress and perpetuating the problem.

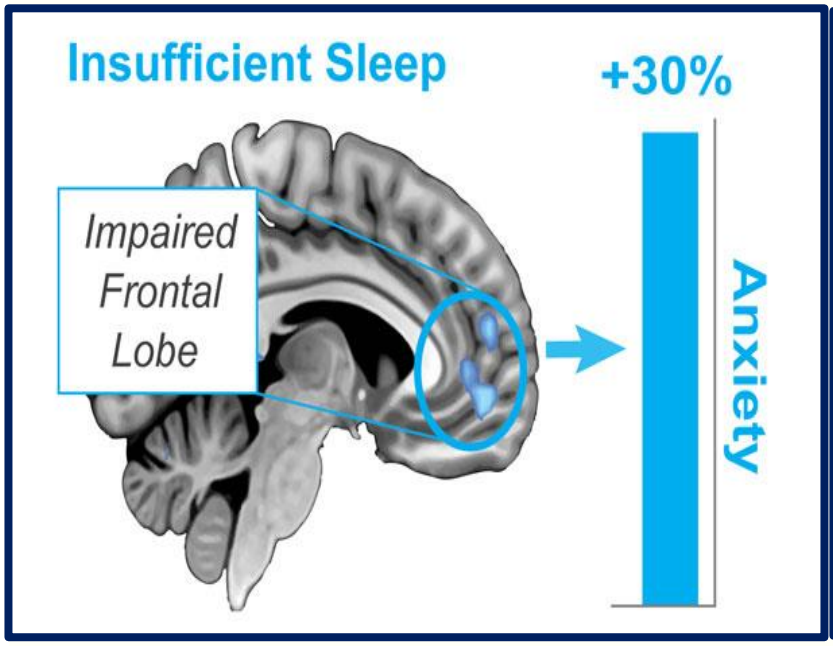


Sleep is critical to our ability to handle emotional stressors, and one stage in particular—REM (stage 4 below)—that is the key promotor of healthy emotional regulation. Even a quick REM-rich nap can help with this process. Studies conducted with groups who slept normally and those sleep-deprived for a full night showed why: sleep keeps the amygdala in check. While undergoing an MRI, both groups were shown highly negative images designed to stimulate the amygdala. Sleep-deprived individuals experienced a 60% higher activation in their amygdalas compared to those with a normal night's sleep. Furthermore, researchers were able to demonstrate that the non-sleep-deprived group had a much stronger connection between the amygdala and the prefrontal cortex.



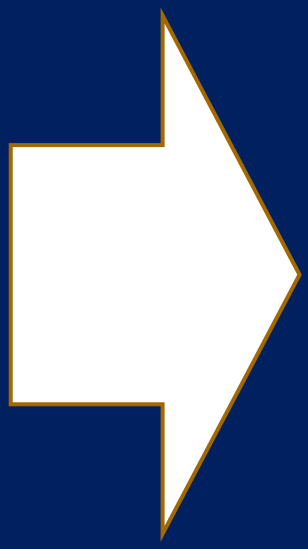
[Figure courtesy of Seung-Schik Yoo et. al, *Current Biology* 17(20): R877-8. October 2007]

<u>The Bottom Line:</u> Poor sleep makes us more emotionally reactive, detaching us from the ability to make rational, optimal decisions. Lack of sleep dials up anxiety and depression. What are the downstream effects of this? A decline in coping skills, intensification of stress and preferential tendencies towards an obesity-inducing diet, all of which in turn keep us from getting good sleep.



In 2009, researchers proposed a central theory about the way sleep changes our brain activation to favor low emotional reactivity, explaining that "a night of sleep may 'reset' the correct affective brain reactivity to next-day emotional challenges." How does it do this? By allowing the prefrontal cortex to suppress the amygdala. Indeed, as stated by Dr. Andrea N. Goldstein and Dr. Matthew Walker (2014), "without sleep, the ability to adequately regulate and express emotions is compromised at both a brain and behavioral level."

Poor sleep



↑ Impulsivity

↑ Poor food choices

↑ Blood sugar

↑ Weight

↑ Inflammation

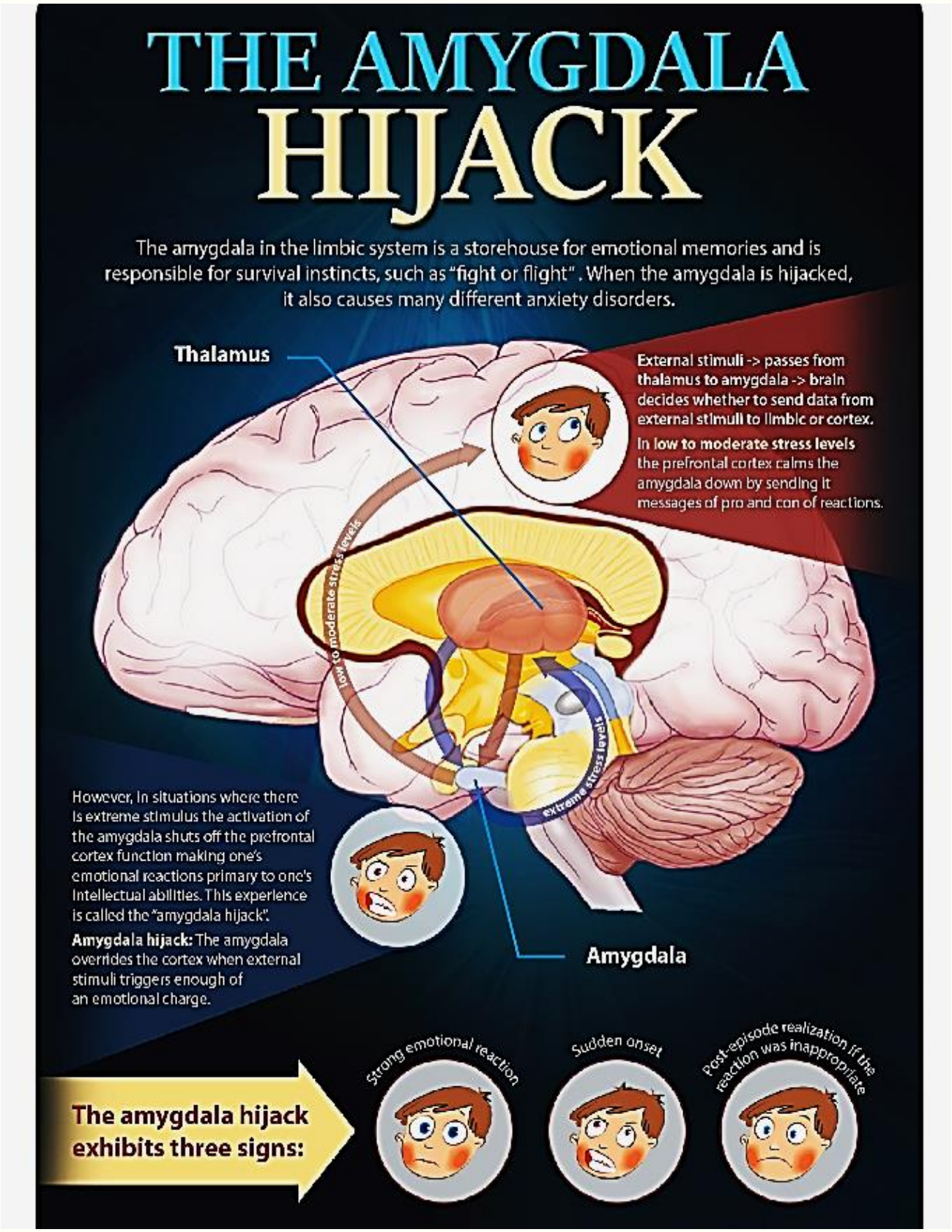
↑ Cortisol

↑ Amygdala activity

↓ Prefrontal cortex activity

Sleep deprivation leads to impulsivity, anxiety, an amygdala-prefrontal cortex disconnect, a multitude of damaging physical ramifications, social withdrawal and mental health maintenance. "The take-home message is simple: If we want to face the word with the best chance of success, and especially if we hope to break free from emotional instability, better sleep must be part of the plan." [Perlmutter & Perlmutter, p. 138]

Takeaway 1:


THE AMYGDALA HIJACK
The amygdala in the limbic system is a storehouse for emotional memories and is responsible for survival instincts, such as "fight or flight". When the amygdala is hijacked, it also causes many different anxiety disorders.
Thalamus
External stimuli -> passes from thalamus to amygdala -> brain decides whether to send data from external stimuli to limbic or cortex.
In low to moderate stress levels the prefrontal cortex calms the amygdala down by sending it messages of pro and con of reactions.
low to moderate stress levels
extreme stress levels
However, in situations where there is extreme stimulus the activation of the amygdala shuts off the prefrontal cortex function making one's emotional reactions primary to one's intellectual abilities. This experience is called the "amygdala hijack".
Amygdala hijack: The amygdala overrides the cortex when external stimuli triggers enough of an emotional charge.
Amygdala
The amygdala hijack exhibits three signs:
Strong emotional reaction
Sudden onset
Post-episode realization if the reaction was inappropriate

Takeaway 2:

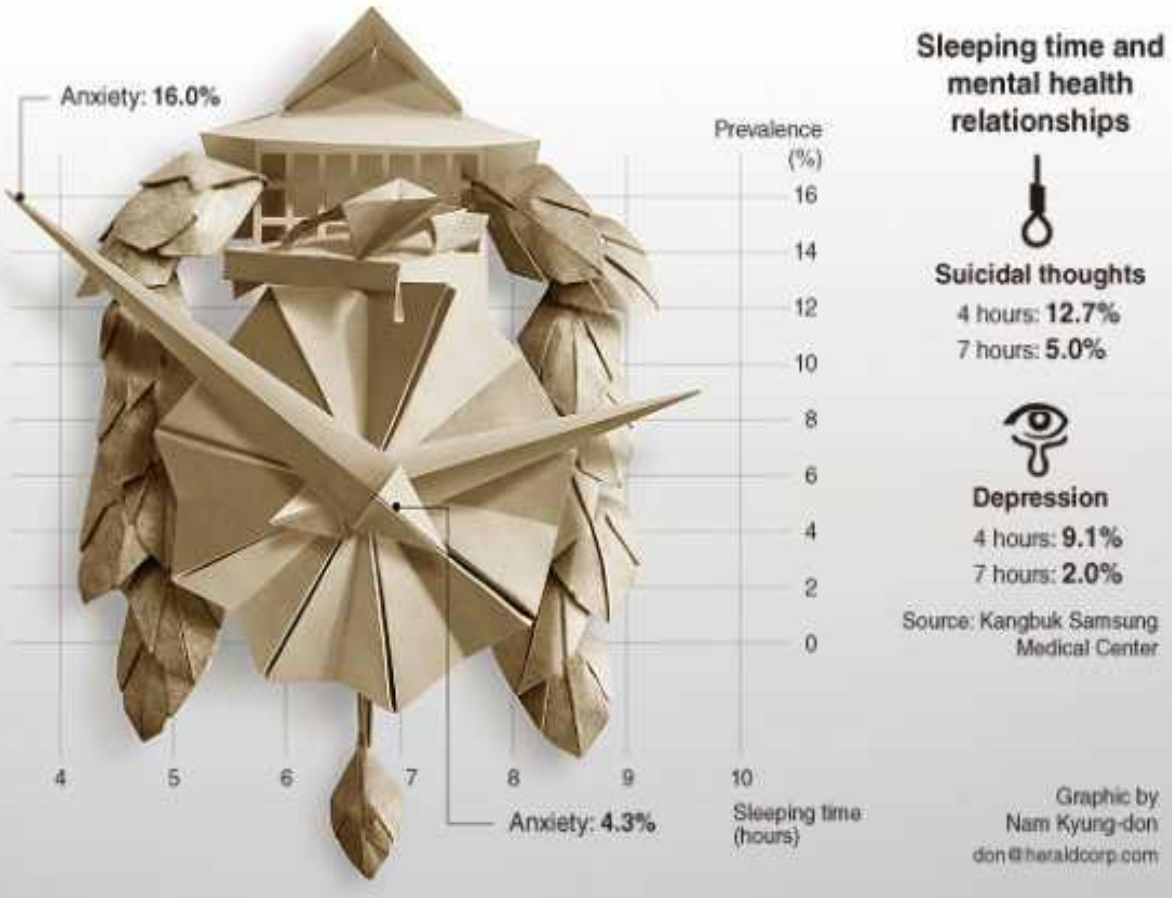
Lack of sleep linked to depression

ISSUE & DATA

The head of the Mental Health Institute at Kangbuk Samsung Medical Center surveyed 202,629 workers in their 20s, 30s and 40s who had visited the hospital for a health checkup in 2014. The study showed that among people who sleep four hours or less a day, the prevalence of depression was 9.1 percent, compared to 2 percent among people sleeping seven hours, the base condition set for the survey.

Prevalence of anxiety and suicidal thoughts for the same group were 16 percent and 12.7 percent, respectively, compared to 4.3 percent and 5 percent for people who sleep the standard seven hours, the study said.

Signs of mental harm, although to a lesser degree, also showed among people who sleep more than seven hours, according to the study.



Resources: *Excerpts within this article taken from the following texts:

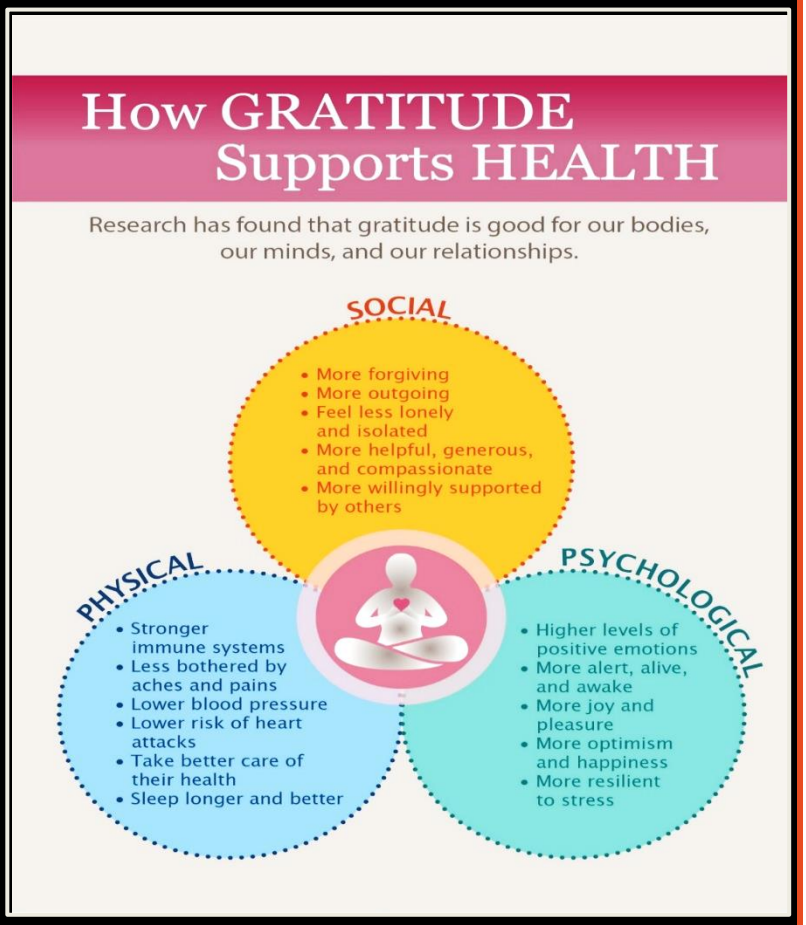
Saturnino P Javier, MD, FPCP, FPCC, FACC. 'Have you been hijacked?' (Internet article) Health & Lifestyle. Jan 2019. http://www.healthandlifestyle.com.ph/have-you-been-hijacked/

David Perlmutter, MD and Austin Perlmutter, MD. Brain Wash, pp. 23-33, 136-138

Editor's Note:

Regardless of our country of origin or what religious traditions we practice, the shortest days of the winter months are typically home to a multitude of cultural holidays all celebrating the light, where we reflect, remember, come together and look forward with those closest to our hearts. As the remainder of 2020 winds down and the season of celebration approaches, for most of us our usual sense of expectation has been replaced by one of shared trepidation.

As a global community, we have experienced unprecedented tumult, challenge and hardship that has ripped away predictability and left us unmoored, adrift, bereft, on edge, with our usual anticipation blunted after months of emotional volatility and with rising uncertainty facing the days ahead. This year's travel plans have been rescheduled, gatherings have been canceled and families are awash with worries and loss over families, sickness, jobs, finances, social unrest, lives they once had and loved ones now departed. In chaotic times like these, when doubt swirls around us like a whirlwind of autumn leaves, it is more important than ever to focus on upholding basic vitals—sleep, food, activity, social connections, and stress management. These are the tools by which we can forge strategies to hang in, hang on and eventually rise above and power beyond adversity.



The surprising force that stabilizes the ground beneath us and eases our passage onward lies in our appreciation for and gratitude of what we *do* have working for us (no matter how small), what resides deep inside us (no matter how neglected) and what has been established between us (no matter how distant). It is the power inhabiting a grateful heart that will help see us through our darker days and back into the light.

Bahram Akradi, founder and CEO of Life Time Fitness, writes this:
"In my own reflections, there are 3 perspectives I like to keep in mind:

1. **Gratitude:** We are all truly blessed, at minimum, with our life force and with the opportunity to live on this planet and at this time in history. If you are reading this, chances are high that you fall into an especially lucky group – one with the good fortune to be concerned primarily with what are often referred to as "first-world problems." Even if you are facing dire challenges, it's worth remembering just how much you have at your disposal. It's important to acknowledge the resources and support to which you have access, and the meaningful, potentially transformative choices that are within your reach.

2. **Consciousness:** In order to fully appreciate what we have, we must first acknowledge that it could just as easily be otherwise. Virtually everything we enjoy in our lifetimes is dependent on a thousand variables and relationships we tend to ignore or take for granted. Consider how many people regularly go without the things you never have to worry about and you will be humbled. Become conscious of the responsibilities with which your good fortune endows you and you will become more inspired to appreciate and give your greatest gifts.

3. **Preparedness:** The world we live in now is both unpredictable and volatile. Changes__technological, environmental, social__are occurring at an increasingly fast pace and with increasingly complex outcomes. While it is impossible to adequately prepare for every possible scenario, it makes sense to mentally and emotionally prepare for change in general. Undoubtedly, some of the changes we'll face over the coming decades will be challenging; others will be hopeful and encouraging. Developing skills and perspectives that build resilience, flexibility and creativity will stand you in good stead in all cases.

Should you ever feel you are losing your center or sense of perspective, I have one other piece of advice: Take a moment to go out at night in a place where you can still see the stars. Look up. Remember that you are part of something so much larger. Sometimes simply connecting with our own place within this immense universe of ours is all it takes to help us explore our challenges and blessings from a whole new point of view."

To all of our Readers ...