Trauma, Nutrition, and Metabolic Resilience:

Implications for Diabetes Prevention and Care



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We are One Whole Person

Not parts of one person…

A Definition of Trauma

- When a situation overwhelms your capacity to cope.
- We may lack capacity if we experienced:
  - Emotional and physical neglect as a child
  - Poor parental examples as a child
  - Significant ACE Score (Adverse Childhood Events)
  - Poor nutrition at the time of and after a significant emotionally charged event
    - Or have a genomic SNP that would cause a functional deficiency

It is more important to know what sort of person has a disease than to know what sort of disease a person has.

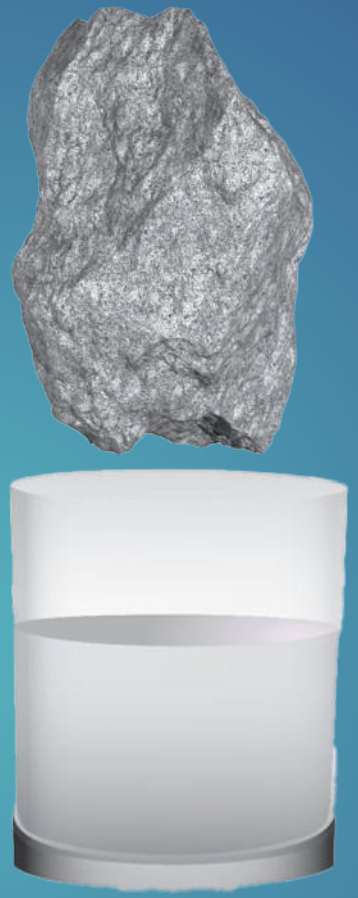
~Attributed to Hippocrates, unknown



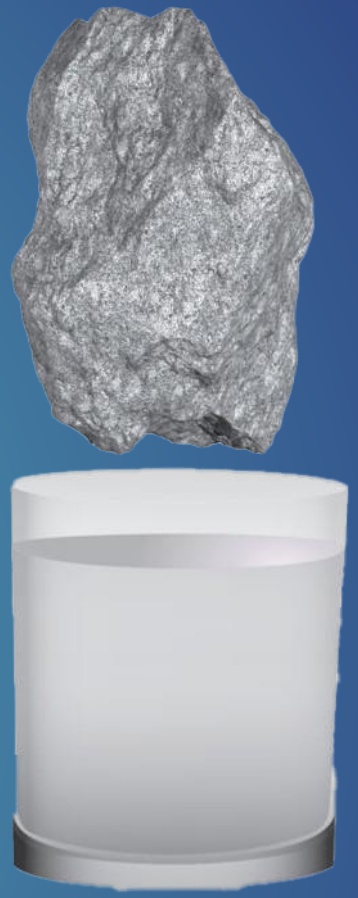
Strong social support
ACE score 0
Well nourished with variety of foods
Emotionally available parents



Typical social support
ACE score 1
Well nourished but limited variety foods
Parents work a lot, 1 parent reliably available emotionally.



Limited social support
ACE score 3
Diet is mostly processed, occasional vegetable or fruit
Parents are not available most of the time



Limited social support, bullied
ACE score 6
Diet is heavily processed
Single parent home, parent works 2 jobs

General Adaptation Syndrome

1. Alarm Reaction
- Shock, which leads to increased hormones and cortisol that cause:
  - Increased heart rate
  - Increased senses (hypervigilance)
  - Increased respiratory rate
  - Increased muscle tension
  - High OR low blood pressure
  - High OR low blood sugar
  - Gastrointestinal erosions
  - Tissue catabolism



2. Resistance
- Active coping
- For preservation, the body will overreact to compensate for the shock symptoms.
- Depletion occurs if resistance lasts for a longer time.
- Most people recover to normal from here.

3. Exhaustion Stage
- Failure to adapt and can no longer defend the self.
- Physical or mental illness sets in.

1. Alarm

2. Resistance

3. Exhaustion stage



Hypothalamus activates the sympathetic nervous system – adrenaline and cortisol increase (increases blood sugar)

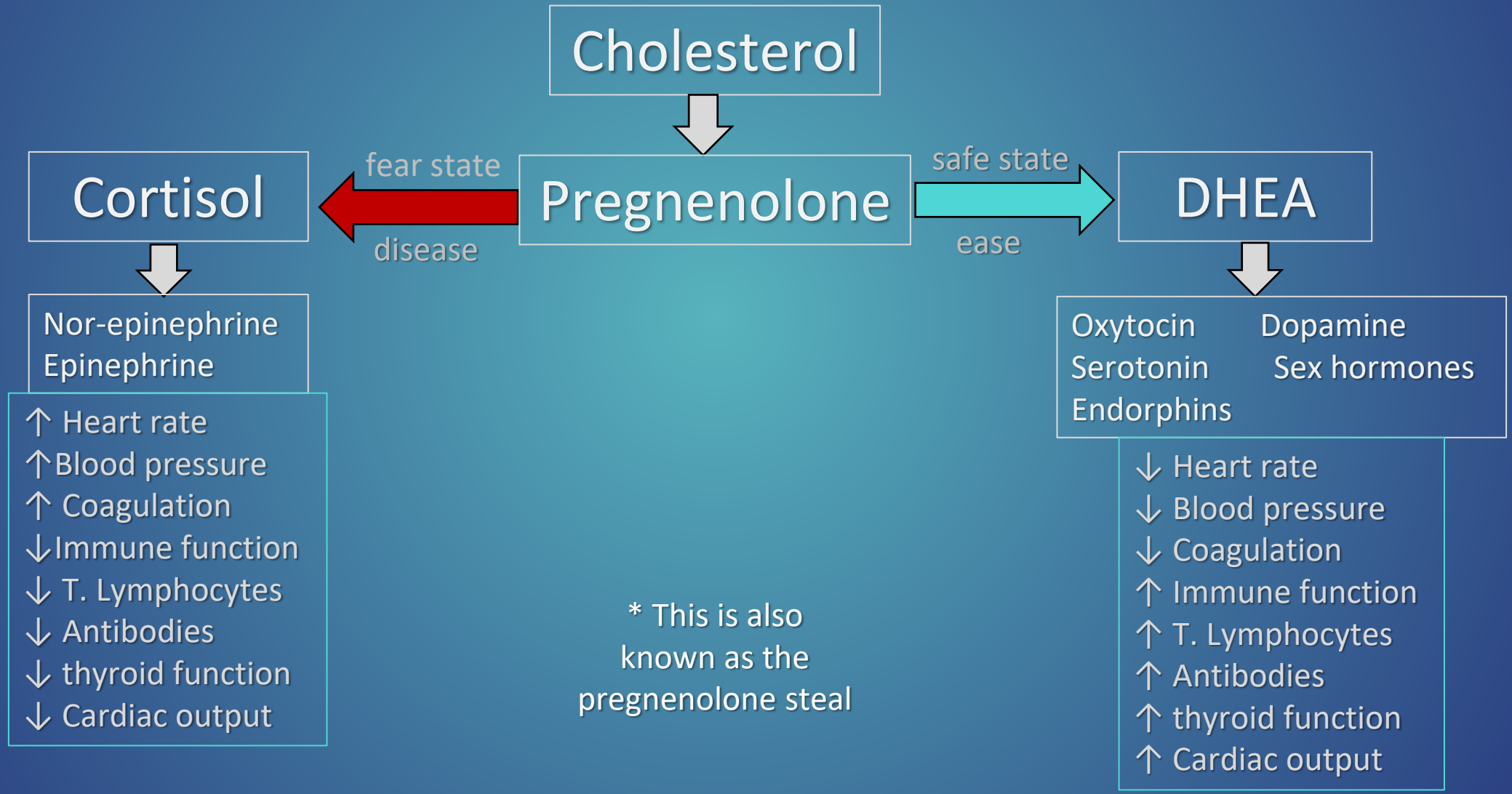
Within 72 hrs of a traumatic stressor gut microflora begins to be altered.

- Epinephrine & cortisol interfere with good gut bacteria, causing harm to mucosa.
- Over time, SIBO forms with ↓ gastric acid, ↓ gut motility, altered immunoglobulins, ↑ pathogens, ↑ biofilm

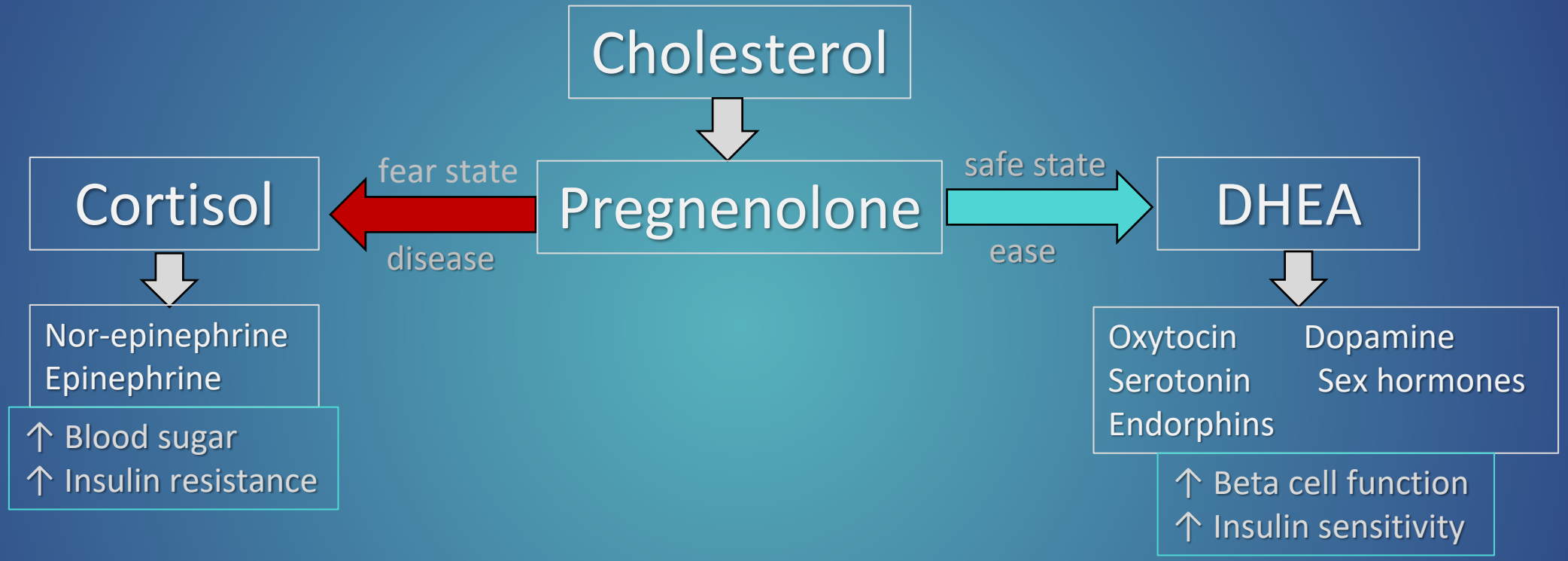
Meteorism, constipation, diarrhea, bowel incontinence, IBS, malabsorption of nutrients, continued ↑ cytokines

↑ risk of mental and physical pathologies that result from continued depletion, high levels of inflammation, & stress

Fear State vs Safe State



Fear State vs Safe State



* This is also known as the pregnenolone steal

The Three Circles of Health

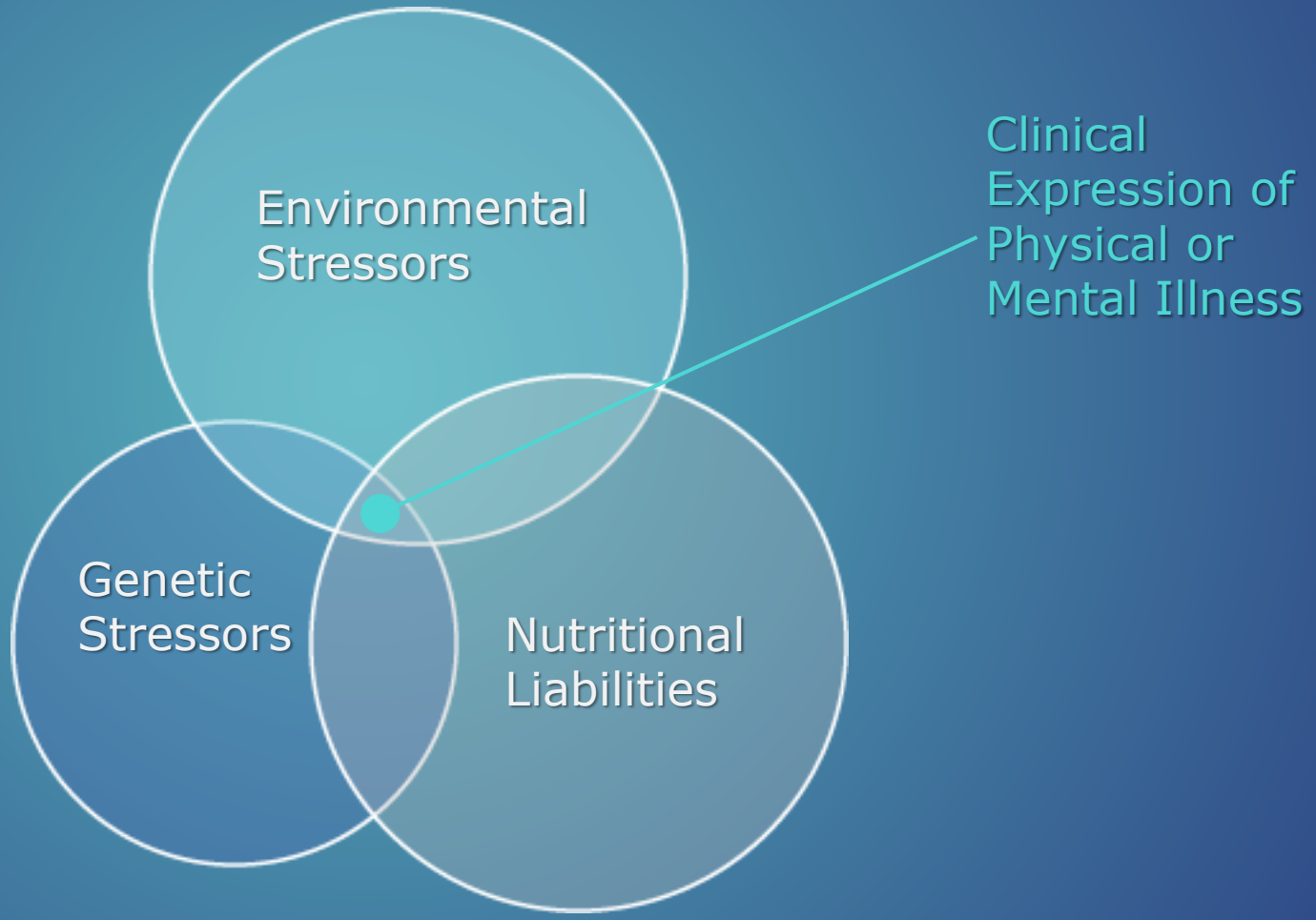


Diagram composed by E. Dean, adapted from text in Chapter 7 of Thiamine Deficiency Disease, Dysautonomia, and High Calorie Nutrition, 2017.

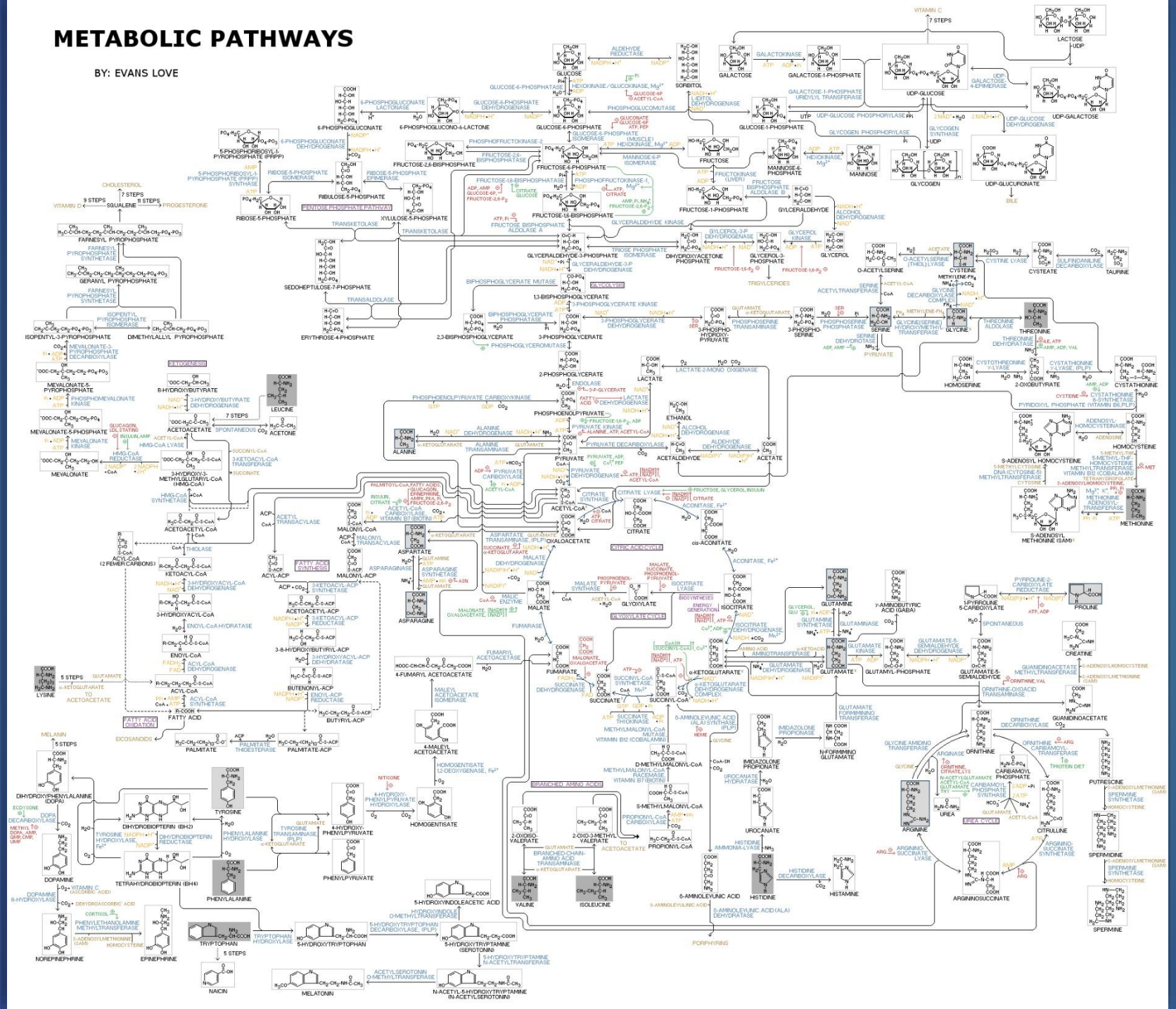
Standard American Diet











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Summary

INPUT:

Trauma / Chronic Stress

- ACEs
- Life events
- Ongoing stress

PHYSIOLOGY:

Stress Physiology

- ↑ Cortisol
- ↑ Sympathetic activation
- ↓ Parasympathetic tone

Metabolic Effects

- ↑ Inflammation
- ↑ Insulin resistance
- ↑ Blood glucose variability

Gut & Brain Axis

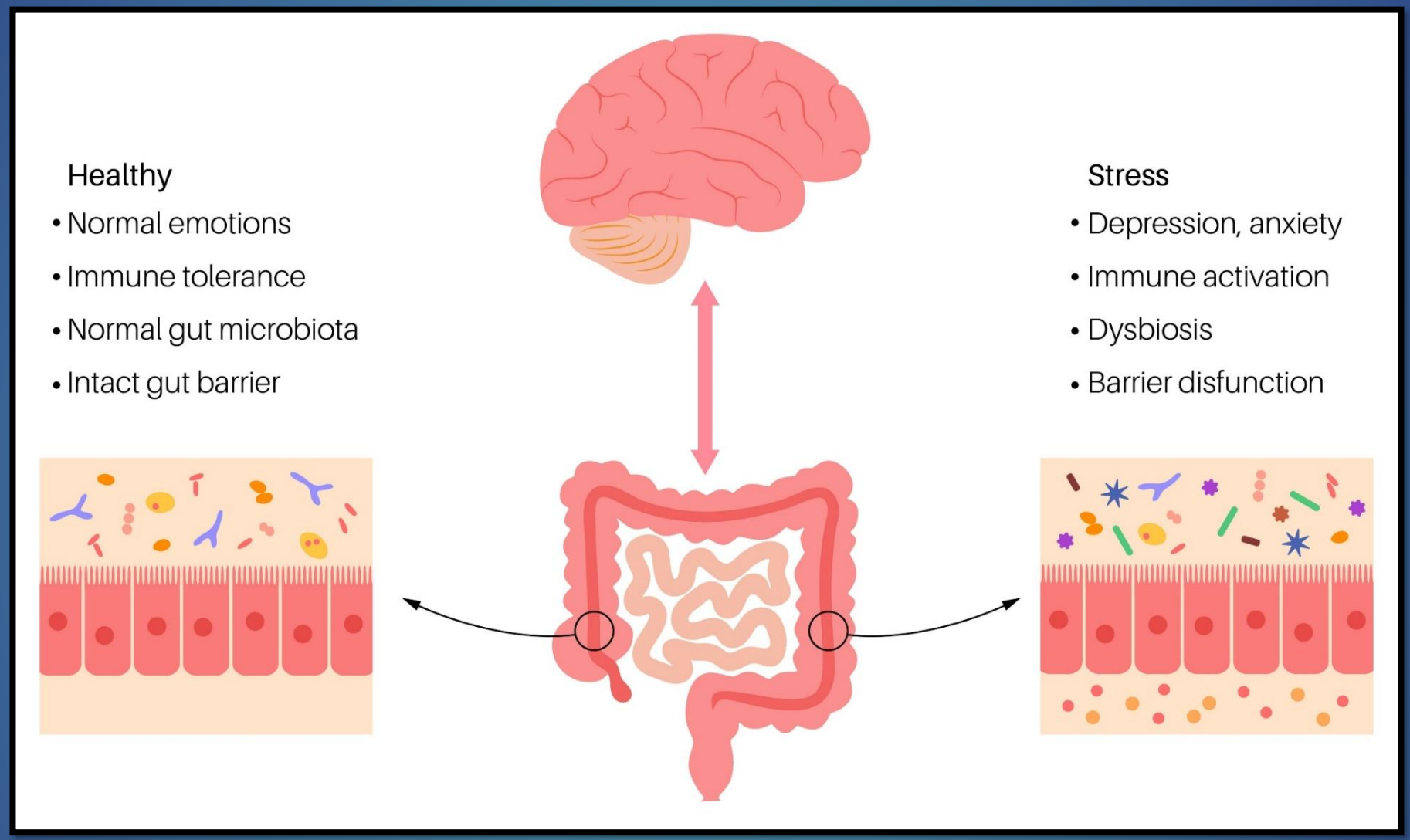
- Dysbiosis
- ↑ Intestinal permeability
- Altered neurotransmitters

OUTPUT:

Clinical Outcomes

- ↓ Resilience
- PTSD / chronic symptoms
- Type 2 diabetes risk & progression
- Other chronic condition risk

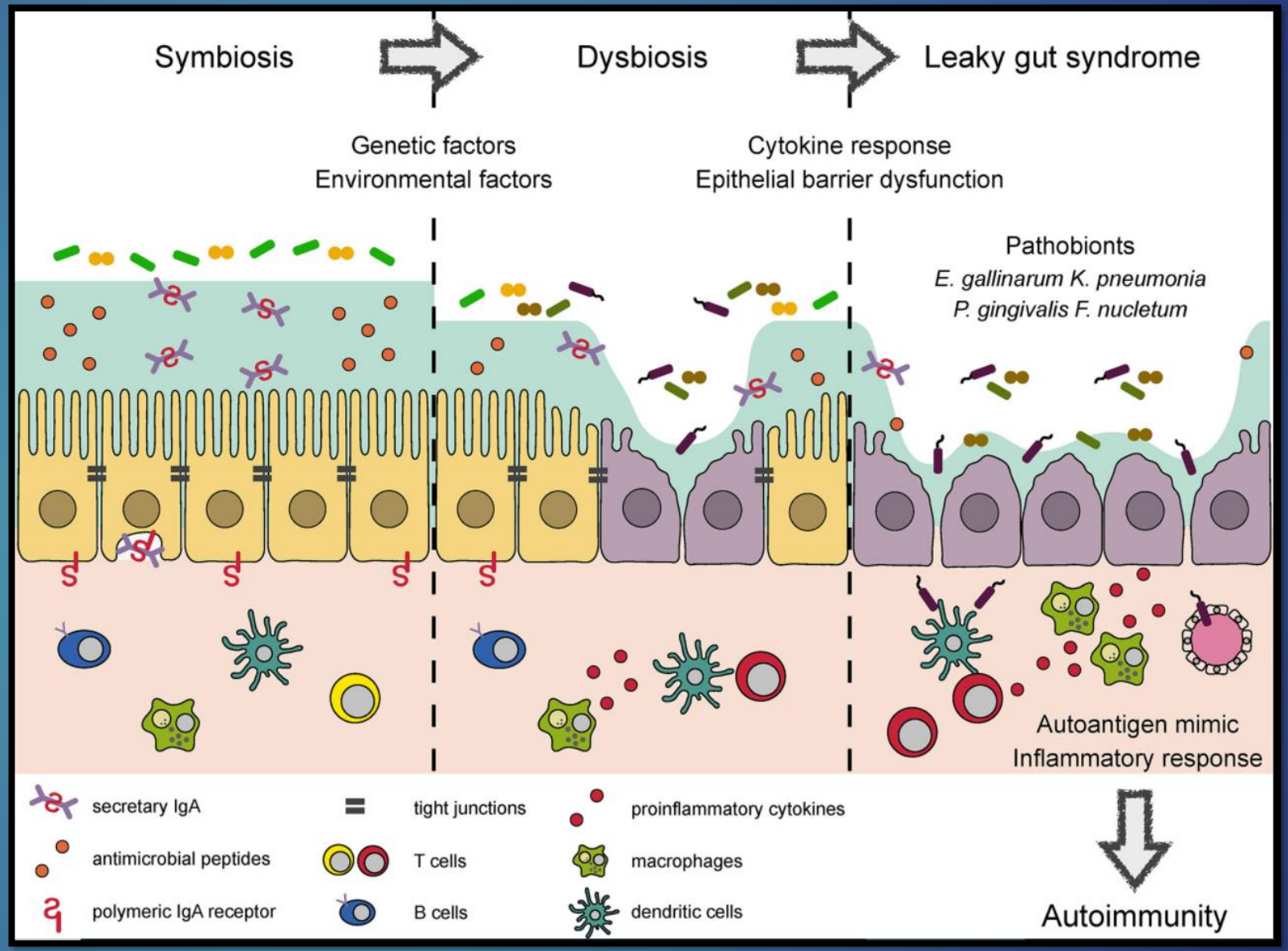
Nutrition modifiers at every step improve physiological resilience



The Gut Brain Axis

Gut Dysbiosis & Permeability

- Within 72 hours of a traumatic stressor, gut microflora begins to be altered.
- Epinephrine and cortisol interfere with healthy bacteria growth, which harms mucosa.
- Leaky gut leads to increased immune activation and depression.
- Overtime, illness can set in.



https://www.frontiersin.org/articles/10.3389/fimmu.2021.673708/full. Accessed 1/27/2022

Gut Microbiome

- Gut microbiota is strongly affected by diet.
- There is evidence that gut microbiota influences neurobiology and behavior.
  - There are cells in the gut that signal the nervous system.
- Specific dietary patterns have been identified that impact depression and anxiety.
  - High fat diets decrease beneficial bacteria and increase gut permeability.
- 1 in 5 people with gastrointestinal symptoms are affected by PTSD.
- Stress and depression can also alter taste perception and food choice.

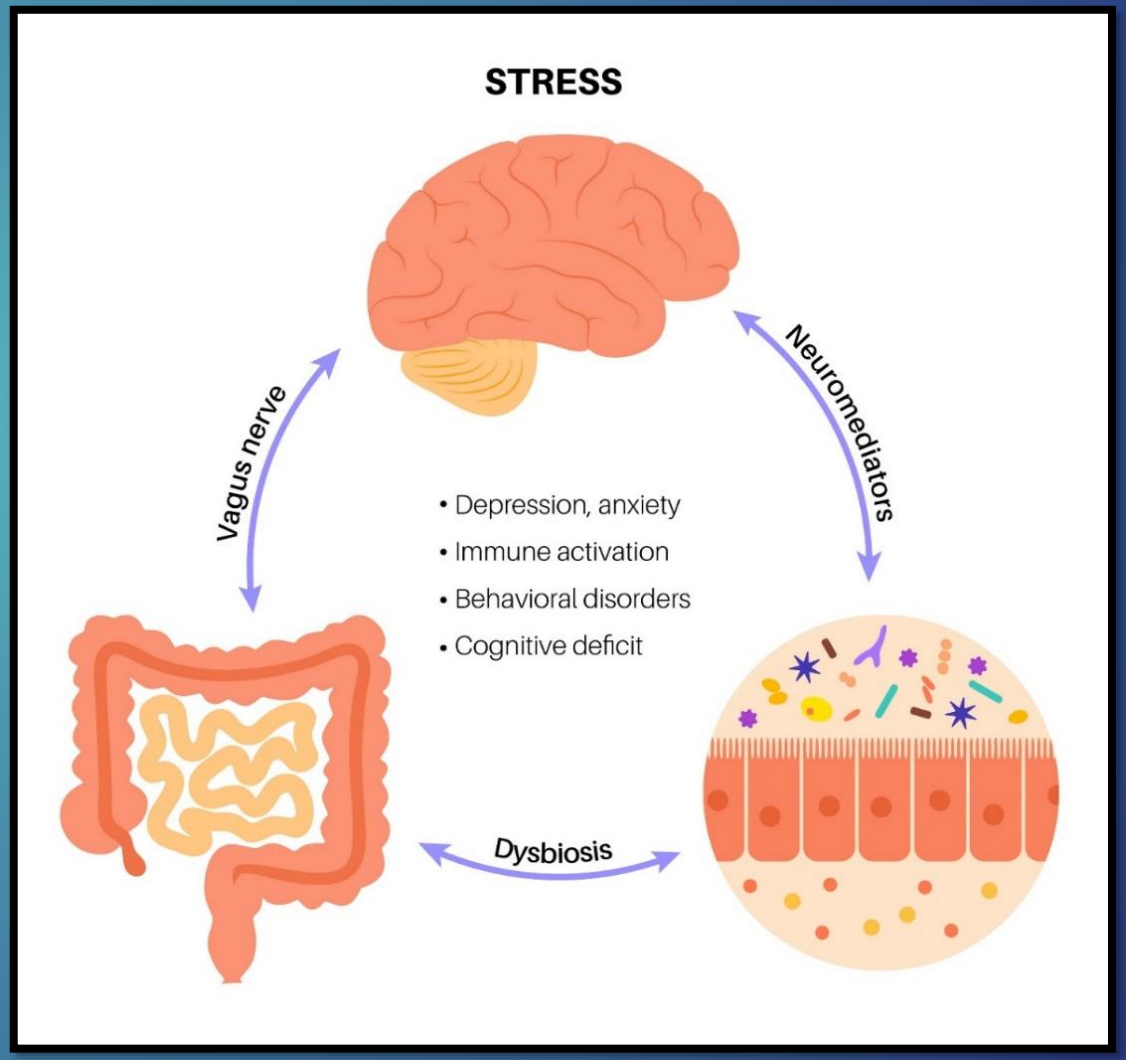
Gut Microbiome

- This is important as many people with diabetes struggle with depression and anxiety.

- Dietary patterns high in ultra-processed foods and saturated fat are associated with decreased microbial diversity and increased gut permeability.
- These same dietary patterns are also associated with increased risk of insulin resistance and type 2 diabetes.
- Conversely, fiber-rich, plant-forward dietary patterns support microbiota diversity and improved glycemic outcomes.

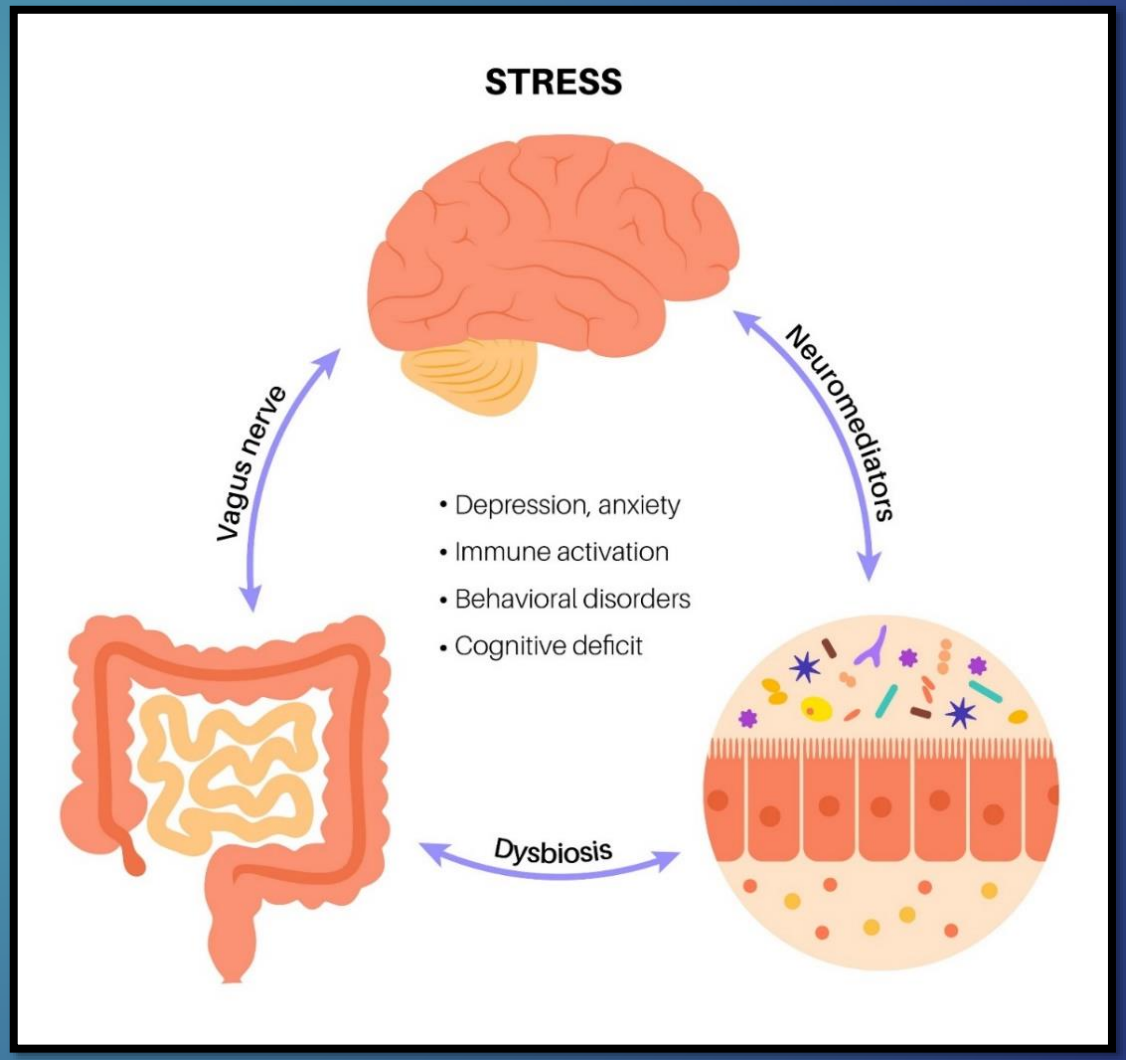
I Feel It in My Gut!

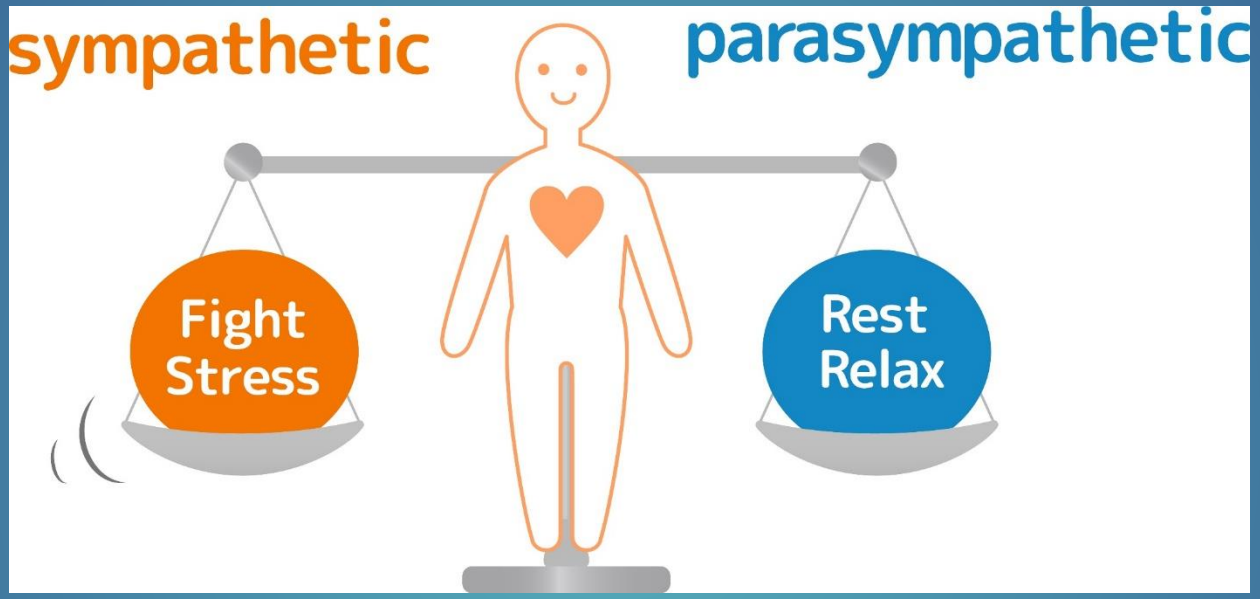
- We have a bidirectional relationship between our gut and our brain.
- Both stress and intestinal dysbiosis will contribute to vagus nerve dysfunction which can perpetuate a trigger response cycle.
- Optimal functioning of our neurons, brain, and gut health depend on nutrition.



I Feel It in My Gut!

- 80-90% signaling that happens in the gut-brain axis is from our gut to our brain via the vagus nerve.
- Over 90% of serotonin is made in the gut.
- Dopamine and Acetylcholine plays a role in the wave-like motion of the gut that pushes food through the intestines. Low levels can lead to leaky gut.



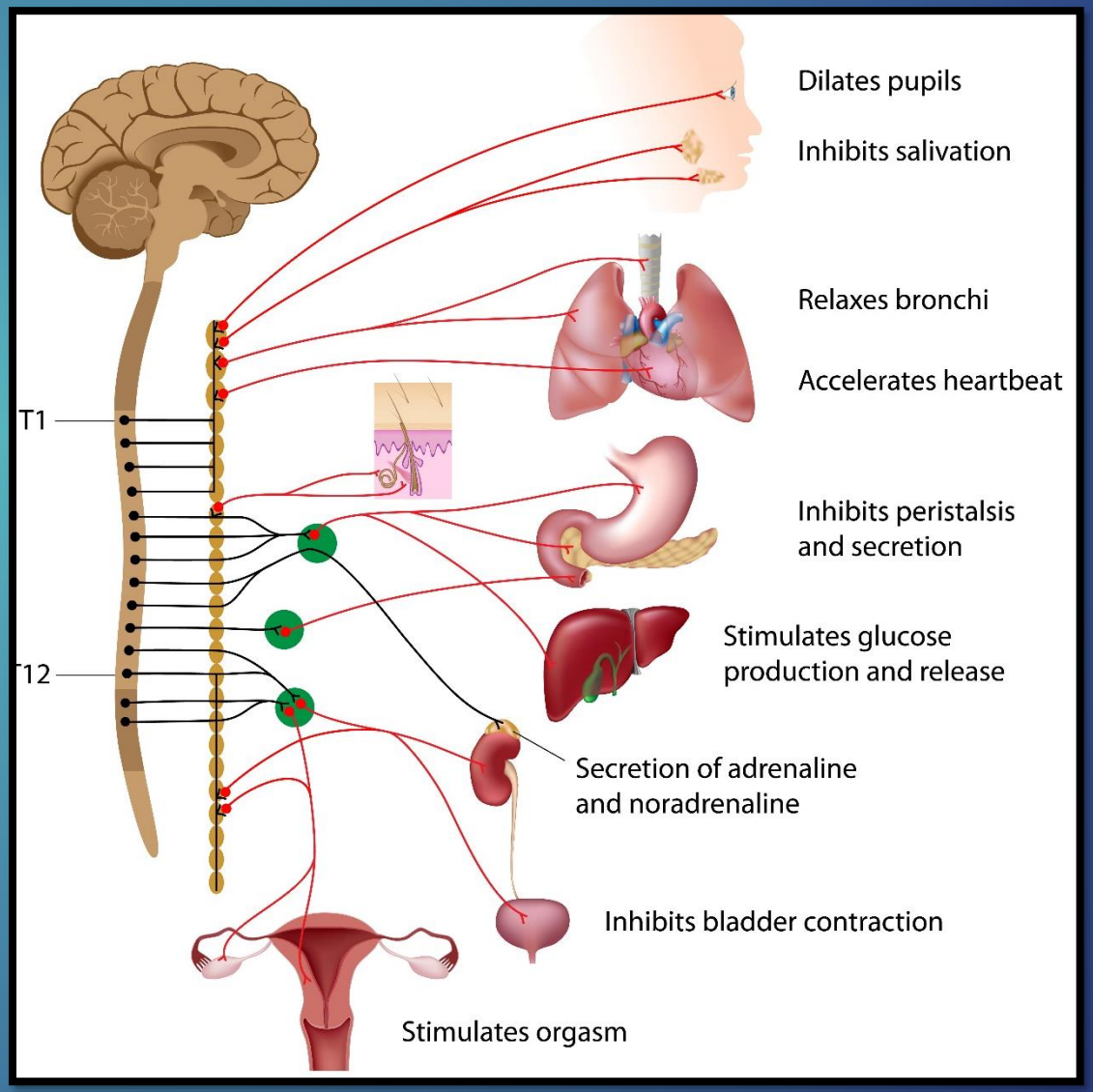


Nervous Signals

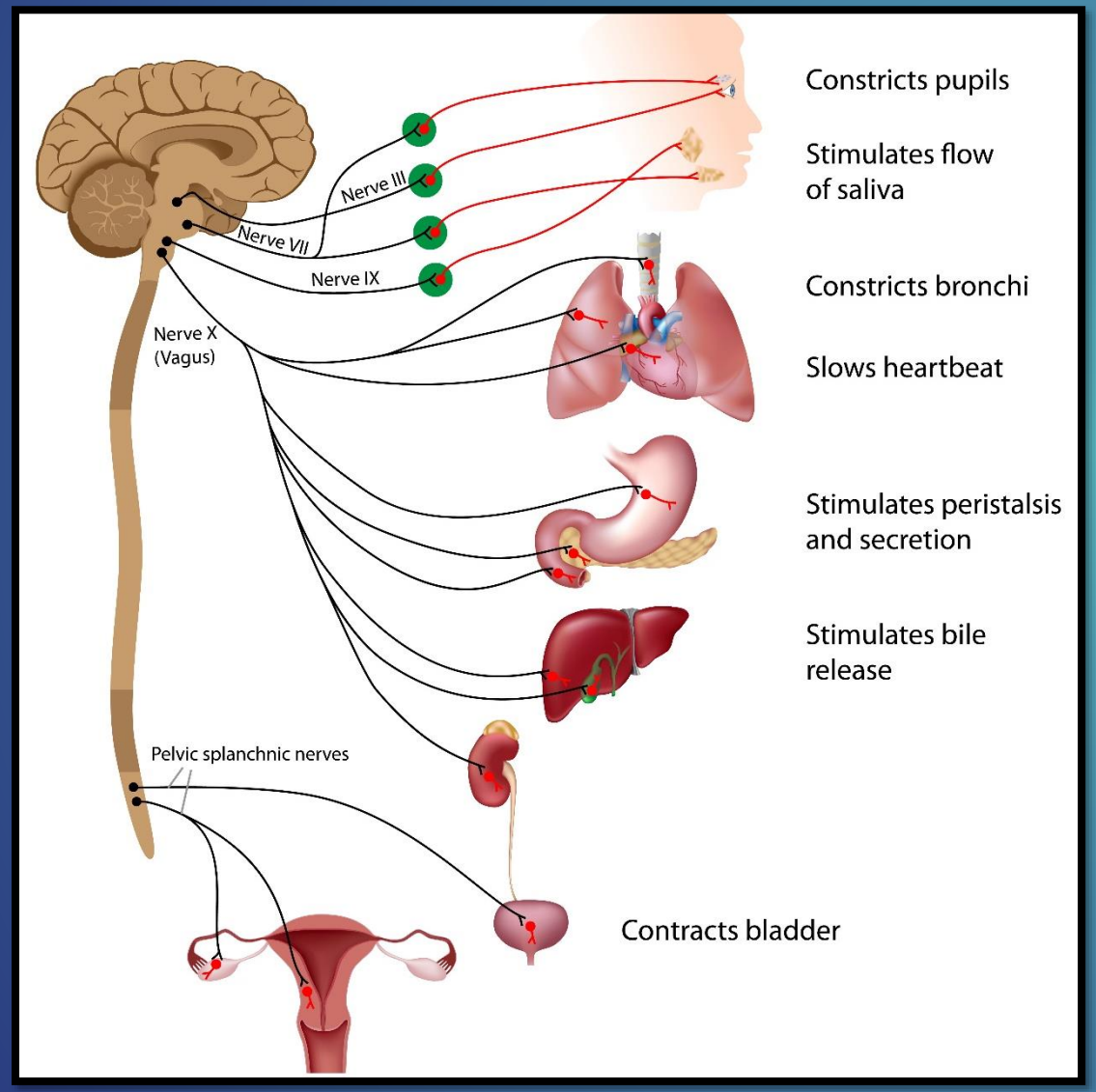
Autonomic Nervous System

Sympathetic Branch

- Fight or flight response
  - pupil dilation
  - increased sweating
  - increased heart rate
  - increased blood pressure
  - Increased adrenaline if stimulated for extended time
    - = INCREASED CIRCULATING BLOOD SUGAR
  - Hypervigilence



Autonomic Nervous System



Parasympathetic Branch

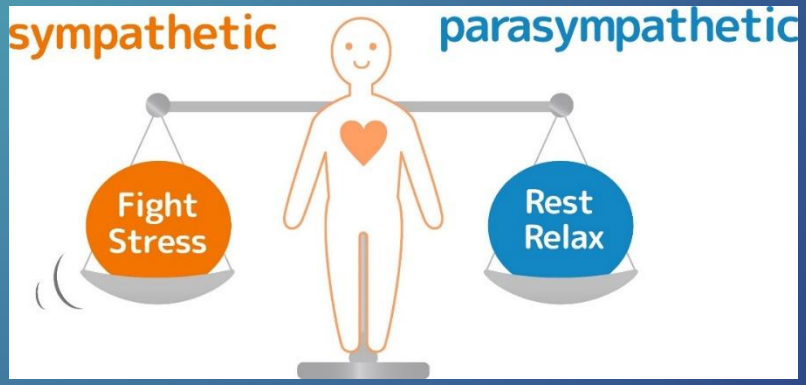
- Contains the Vagus nerve which connects to all the major organs.
- Rest and digest function
  - Stimulates saliva
  - Lubricates tears
  - Bladder contraction
  - Peristalsis
  - Bile acid release
  - Smooth muscle tone
  - Improved blood glucose regulation

What Happens in Vagus…

- An appropriately active vagus nerve is associated with
  - Health
  - Well-being
  - Relaxation
  - Emotions
  - Regulated blood sugar
- Low vagus function
  - Increased inflammation
  - Poor heart rate variability and increase risk of cardiac death
  - Immune dysfunction
  - Mitochondrial dysfunction
  - Dysregulated blood sugar

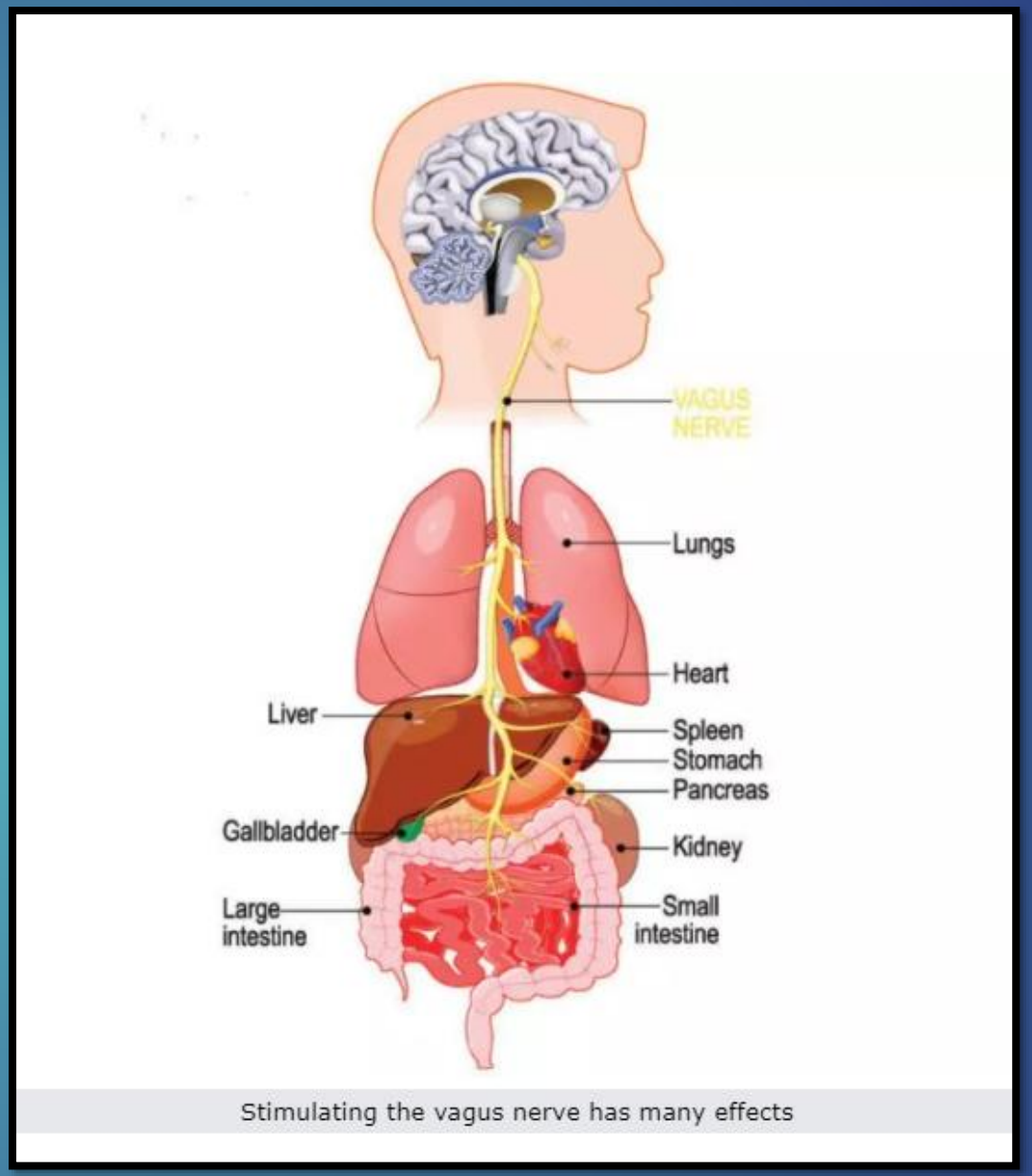
Balancing Act

- When there is a trauma or chronic high levels of stress, the autonomic nervous system (ANS) becomes inflexible and dysregulated.
  - This limits our ability to cope with new stressors or traumatic events.
- The sympathetic nervous system may be constantly scanning for danger with intent of protection but may trigger a reaction state when there is not an actual threat.
- The ANS can be rebalanced with vagus nerve stimulation.



Techniques to Stimulate the Vagus Nerve

- Yoga
- Massage
- Tai chi
- **Humming, singing, chanting**
- Breathing techniques



Stimulating the vagus nerve has many effects

https://biologydictionary.net/vagus-nerve. Accessed 1/27/2022

Nutrition to Support Vagus Function

- Choline – used to make acetylcholine, the main neurotransmitter of the vagus nerve
  - Liver, eggs, red meat, chicken, fish, sunflower seed, soy lecithin, full fat dairy
- Vitamin B12
  - Beef, poultry, fish, dairy, eggs, nutritional yeast, soy
- Magnesium
  - Dark leafy greens, nuts and seeds, beans, avocado, banana, whole grains, dark chocolate, nettle tea
- Calcium
  - Dairy, tofu, spinach, salmon, oranges, broccoli, kale, collard greens, nuts and seeds, beans
- Sodium
- Omega-3 fats
  - Sea foods, walnuts, chia, flax, soy

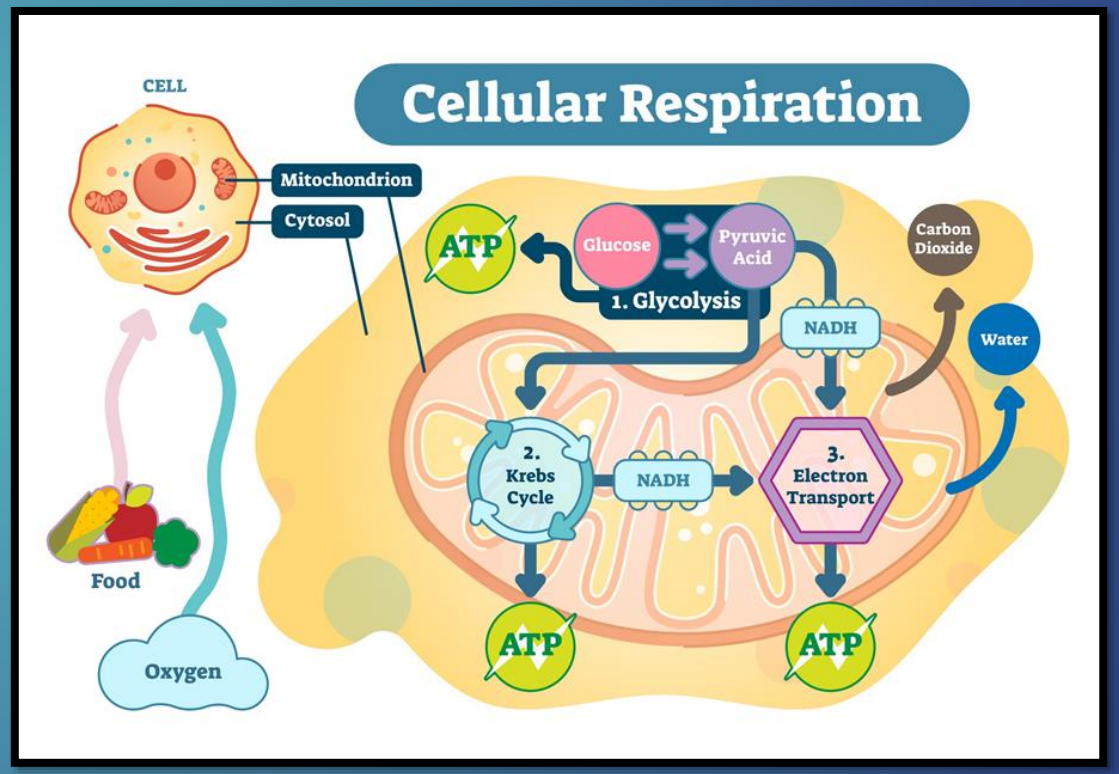
Nutrition to Support Vagus Function

- Probiotics
  - Yogurt, sour kraut, miso soup, kefir, sour dough bread, kimchi, tempeh, fermented sour pickles (not vinegar pickled), acidophilus milk
  - Supplemental probiotics

- High fiber/ pre-biotics that are characteristic of diets high in vegetables and whole grains. This will support production of:
  - Bifidobacteria
  - Lactobacillus
  - Butyrate-producing bacteria

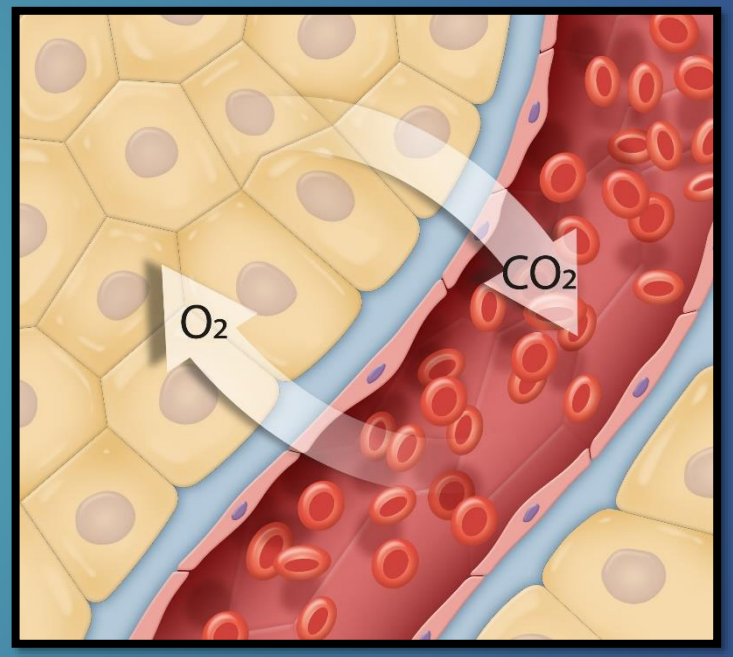
Sympathetic Triggers: Oxygen and Carbon Dioxide

- Oxygen in the cells are required for metabolism and mitochondrial function. Without it, we die in a short amount of time.
- Without adequate levels of CO2 in the blood, you cannot get oxygen into the cells. Hemoglobin will not release it. Both are substances required for metabolism and life.
- **Not getting oxygen (hypoxia) into the cells activates the sympathetic nervous system**



Sympathetic Triggers: Iron

- Iron is required to carry oxygen to cells for metabolism.
- Subclinical anemias can:
  - trigger anxiety or panic, lowering the capacity to tolerate an emotional or traumatic event
  - keep the sympathetic nervous system stimulated



Sympathetic Triggers: Iron

- What prevents iron from getting into heme to carry oxygen?
  - Iron deficiency- not consuming or absorbing enough iron from the GI
  - B12, folate, or B6 deficiencies- these vitamins are required to manufacture red blood cells which carry the oxygen
  - Riboflavin deficiency can lower iron absorption
  - Vitamin C assists iron absorption, therefore, deficiency may decrease iron absorption from food
  - Low protein status may cause low ferritin (iron stores)
  - Vitamin A deficiency may inhibit red blood cell production
  - Low copper impairs hemoglobin synthesis

Sympathetic Triggers: Iron

- Iron, both too high or too low, can also influence the ability to fight pathogenic bacteria in the digestive tract.
- Iron deficiency anemia can falsely elevate HbA1c independent of true glycemia.
- Iron overload states have been associated with insulin resistance and increased diabetes risk.

Iron status is relevant in both trauma recovery and diabetes management.

Broken Balance: Thiamine (B1)

- Glucose is the fuel that the nervous system uses almost exclusively. You cannot metabolize glucose if you have a thiamine deficiency.
  - Thiamine deficiency therefore inhibits function of nervous system.
  - And therefore, limits any adaptive responses, especially those needed in trauma.
- A highly processed carbohydrate diet, which can lead to high-calorie malnutrition, often leads to thiamine deficiency.
- Thiamine is key in acetylcholine production. Acetylcholine is the primary neurotransmitter in the vagus nerve.
- Deficiency is hard to identify because symptoms are broad

Broken Balance: Thiamine (B1)

- Deficiency is called beriberi- subclinical beriberi has life altering implications
  - It is way more common than we know!
  - It takes up to 6 months plus to correct with optimal supplementation.
  - Labile autonomic nervous system
    - Early stage parasympathetic tone increased (low heart rate and blood pressure, fainting)
    - Later stage increased sympathetic tone (high heart rate and blood pressure, adrenaline)
    - Recommend differential diagnosis to dysautonomia
  - Gastrointestinal motility becomes slow and stomach acid balance becomes disrupted
  - Neuropathy – peripheral and other places
  - Vertigo and ataxia

Broken Balance: Thiamine (B1)

- Deficiency is called beriberi, cont.
  - Defective transfer of oxygen into the cells
    - “pseudo hypoxia” – thiamine plays a role in oxygen being picked up in the lung and transferred from hemoglobin to the cell.
    - air hunger in spite of good O sats may be a sign
    - Sympathetic activation can be triggered by a cerebral hypoxia linked to thiamine induced disordered oxidative metabolism.
    - Pseudo hypoxia is associated with sympathetic nervous system stimulation



Key Vitamins and Minerals

For General Mental Health

Best Sources of Key Proteins

- Tyrosine
  - Non-essential, made from phenylalanine
  - Chicken, turkey, fish
  - Soy products: tofu, soy milk
  - Peanuts, almonds, pumpkin and sesame seeds
  - Avocados, bananas
  - Milk, cheese, yogurt, cottage cheese
- Tryptophan
  - Chicken, turkey, fish
  - Milk, cheese
  - Soy products: tofu, soymilk
  - Peanuts, pumpkin seeds, sunflower seeds
  - Egg whites
- Methionine
  - Brazil nuts, cashews, sunflower seeds
  - Beef, pork, chicken, turkey
  - Tuna, salmon, lobster, crab
  - Eggs
  - Legumes, soy products
  - Milk, cheese, yogurt
- Any amounts of other protein sources to help spare these for neurotransmitter function would also be helpful. Adequate amounts of total protein are key. Vegetarians and vegans may need more guidance.

Best Sources of Key Nutrients

- Nuts/ Seeds- Omega-3 fatty acids, Magnesium, Zinc, Selenium (Brazil nuts), Iron, Folate, Vitamin B1, Vitamin B2, Vitamin B6
- Dark leafy greens- Magnesium, Iron, Folate, Vitamin B2
- Cruciferous vegetables- Iron, Folate, Vitamin B2, Vitamin C
- Citrus, melons, tomato, potato- Vitamin C
- Eggs- Vitamin B1, Vitamin B2, Vitamin B12
- Whole grains- Magnesium, Zinc, Vitamin B1, Niacin
- Beans/ peas/ soy- Omega-3 fatty acids, Magnesium, Zinc, Iron, Folate, Vitamin B1, Vitamin B2, Niacin, Vitamin B6
- Yogurts and cheeses- Zinc, Vitamin B1, Vitamin B12
- Quality meats, poultry, and sea foods- Omega-3 fatty acids, Zinc, Selenium, Iron, Folate, Vitamin B1, Vitamin B2, Vitamin B3, Vitamin B6, Vitamin B12

Polyphenols

- Polyphenols are shown to reduce inflammatory cytokine activity. Cytokines can lower serotonin production and increase depression, agitation, and pain.
  - Cocoa, olive oil/olives, grapes, berries, coffee, tea, hazel nuts, pecans, plums, apples, spices & herbs, flax, almonds
  - Fruits and vegetables, eat a variety of colors!



Meals that Buffer Capacity and Resilience

Modern 3 Day Menu, Practical 3 Day Menu, and Pre-Colonial North American 3 Day Menu

Modern Mediterranean 3 Day Menu
(Breakfast & Lunch)

	Day 1	Day 2	Day 3
Breakfast	- Spinach and mushroom omelet cooked in olive oil (tryptophan and omega-3 fatty acids) - Whole grain toast with avocado (healthy fats and B vitamins)	- Overnight oats made with rolled oats, almond milk, chia seeds, and topped with sliced bananas and almonds (tryptophan, complex carbohydrates, and magnesium)	- Smoothie made with banana, spinach, almond milk, and a scoop of almond butter (tryptophan, magnesium, and healthy fats)
Lunch	- Grilled chicken breast with quinoa and steamed broccoli (tryptophan, protein, and complex carbohydrates) - Mixed green salad with walnuts and a lemon vinaigrette dressing (omega-3 fatty acids and vitamin C)	- Chickpea salad with mixed greens, cherry tomatoes, cucumbers, feta cheese, and a lemon-tahini dressing (protein, fiber, and vitamin C)	- Lentil soup with a side of mixed green salad (provides protein, fiber, and antioxidants) - Whole grain bread roll with olive oil (complex carbohydrates and healthy fats)

Modern Mediterranean 3 Day Menu
(Dinner & Snack)

	Day 1	Day 2	Day 3
Dinner	- Baked salmon with roasted sweet potatoes and asparagus (omega-3 fatty acids, vitamin B6, and magnesium) - Side of sautéed kale with garlic (magnesium and antioxidants)	- Grilled turkey burger on a whole grain bun with avocado and lettuce (tryptophan, lean protein, and healthy fats) - Roasted Brussels sprouts with olive oil and a sprinkle of parmesan cheese (fiber, vitamin C, and magnesium)	- Grilled chicken breast with brown rice and steamed asparagus (tryptophan, protein, and complex carbohydrates) - Grilled zucchini and bell peppers with a sprinkle of herbs (fiber, antioxidants, and magnesium)
Snack	- Greek yogurt with berries and a sprinkle of chia seeds (protein, antioxidants, and omega-3 fatty acids)	- Carrot sticks with hummus (fiber, protein, and magnesium)	- Almonds and dried blueberries (tryptophan, antioxidants, and healthy fats)

Practical 3 Day Menu (Breakfast & Lunch)

	Day 1	Day 2	Day 3
Breakfast	- Oatmeal with chopped nuts - Fruit cup (Fiber, magnesium, omega-6 fats, polyphenols, B vitamins)	- Eggs - Whole wheat toast or corn tortilla - Orange (Protein, choline, vitamin C, B vitamins)	- Yogurt or milk - Oats or low-sugar cereal - Banana (Calcium, potassium, fiber)
Lunch	- Bean and brown rice bowl with salsa and shredded cabbage (Fiber, plant protein, iron, folate, vitamin C, polyphenols)	- Tuna salad sandwich (whole grain bread) - Carrot sticks - Lettuce or tomato (Omega-3s, vitamin A, fiber, protein)	- Leftover chili or beans - Brown or wild rice - Side salad (lettuce + simple dressing) (Fiber, folate, vitamin C, polyphenols)

Practical 3 Day Menu (Dinner & Snack)

	Day 1	Day 2	Day 3
Dinner	- Baked chicken - Roasted potatoes - Green beans (canned or frozen) (Protein, potassium, vitamin C, B vitamins)	- Ground beef or turkey chili (with beans) - Corn tortilla - Side of frozen mixed vegetables (Protein, iron, zinc, fiber, vitamin A, polyphenols)	- Baked fish or canned salmon - Brown or wild Rice - Steamed broccoli or spinach (Omega-3s, iron, magnesium, vitamin K, folate)
Snack	- Apple - Sunflower seeds (Fiber, vitamin E, magnesium)	- Yogurt - Nuts (Calcium, protein, magnesium)	- Popcorn - Apple with peanut butter (Fiber, healthy fats)

Pre-Colonial North America 3 Day Menu (Breakfast & Lunch)

	Day 1	Day 2	Day 3
Breakfast	- Cornmeal porridge cooked with water or plant-based milk, sweetened with maple syrup (complex carbohydrates) - Fresh berries (provides antioxidants and fiber)	- Acorn or chestnut flour pancakes topped with berries and drizzled with pure maple syrup (complex carbohydrates and antioxidants)	- Wild rice with crushed walnuts and berries, lightly sweetened with honey *(omega-3 fatty acids, fiber, and antioxidants)*
Lunch	- Grilled venison or bison steak (protein and B vitamins) - Roasted root vegetables (such as sweet potatoes, turnips, and carrots) with herbs and spices (fiber and antioxidants)	- Three Sisters Soup made with corn, beans, and squash (protein, fiber, and vitamins) - Sunflower seed crackers (healthy fats and magnesium)	- Roasted rabbit or squirrel with roasted root vegetables (protein, fiber, and B vitamins)

Pre-Colonial North America 3 Day Menu (Dinner & Snack)

	Day 1	Day 2	Day 3
Dinner	- Baked salmon with a side of wild rice (omega-3 fatty acids and complex carbohydrates)	- Grilled wild turkey breast marinated in herbs and spices (protein and B vitamins) - Roasted corn salad with diced vegetables (such as peppers, onions, and tomatoes) (complex carbohydrates and fiber)	- Baked trout with a side of wild rice pilaf and steamed greens (omega-3 fatty acids, complex carbohydrates, and fiber)
Snack	- Roasted pumpkin seeds (magnesium and zinc)	- Fresh fruit salad with a variety of native fruits (such as blueberries, cranberries, and wild strawberries) (antioxidants and fiber)	- Dried berries and nuts trail mix (antioxidants, healthy fats, and protein)

How Can I Build Nutritional Capacity?

- You are already talking to your clients-patients about self care, so include high quality nutrition to the extent their budget and availability will allow.
- *Some* people who say they cannot afford healthy foods do not know how to cook them. They see pre-made health items, and those *are* more expensive.
  - Ask them about their cooking skills. Beans and dry whole grains are way more economical than ready-to-eat foods.
  - Your dietitian should be able to help with resources for cooking skills.
- **Refer to your dietitian(s) for nutrition therapy.**
- Get with your dietitian(s) about starting a food program in your clinic or community. Are there grants available? How can you bring community members together to be involved?

How Can I Build Nutritional Capacity?

- Get involved with your tribe, community, or clinic to foster more fresh food programs. Many tribes are doing great things. Meet to discuss and borrow ideas.
- If you donate to food banks or drives:
  - Provide whole grains, beans, nuts and seeds, canned fruits and vegetables.
  - Provide fresh produce if the receiving agency allows.
  - For shelf stable protein, provide canned chicken, salmon, tuna.
  - Avoid potted meats, Spam, Vienna sausage, etc.

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