

# GUT INSTINCTS

*Dr. Heather Finley*

PART 2: COMMUNICATION PATHWAYS

# ABOUT ME

*Dr. Heather Finley*

## REGISTERED DIETITIAN

Experience in clinical settings, outpatient treatment and now virtual private practice

## GUT HEALTH EXPERT

Focused my doctorate training on gut related research and have my own personal experience with 20+ years of digestive issues



# TODAYS TOPICS

1

COMMUNICATION  
PATHWAYS

2

NERVOUS  
SYSTEM

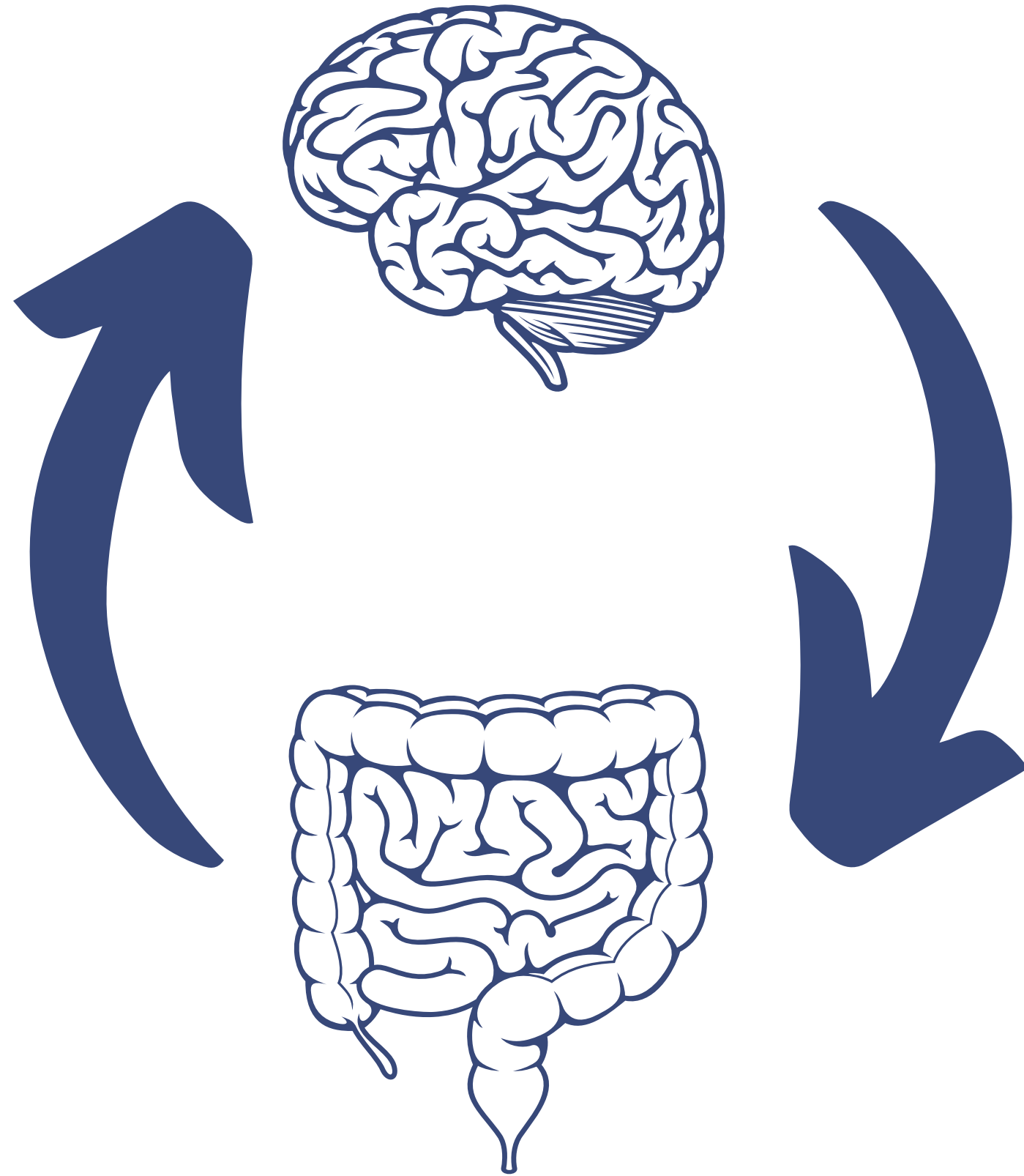
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STRESS IMPACT ON  
THE GUT

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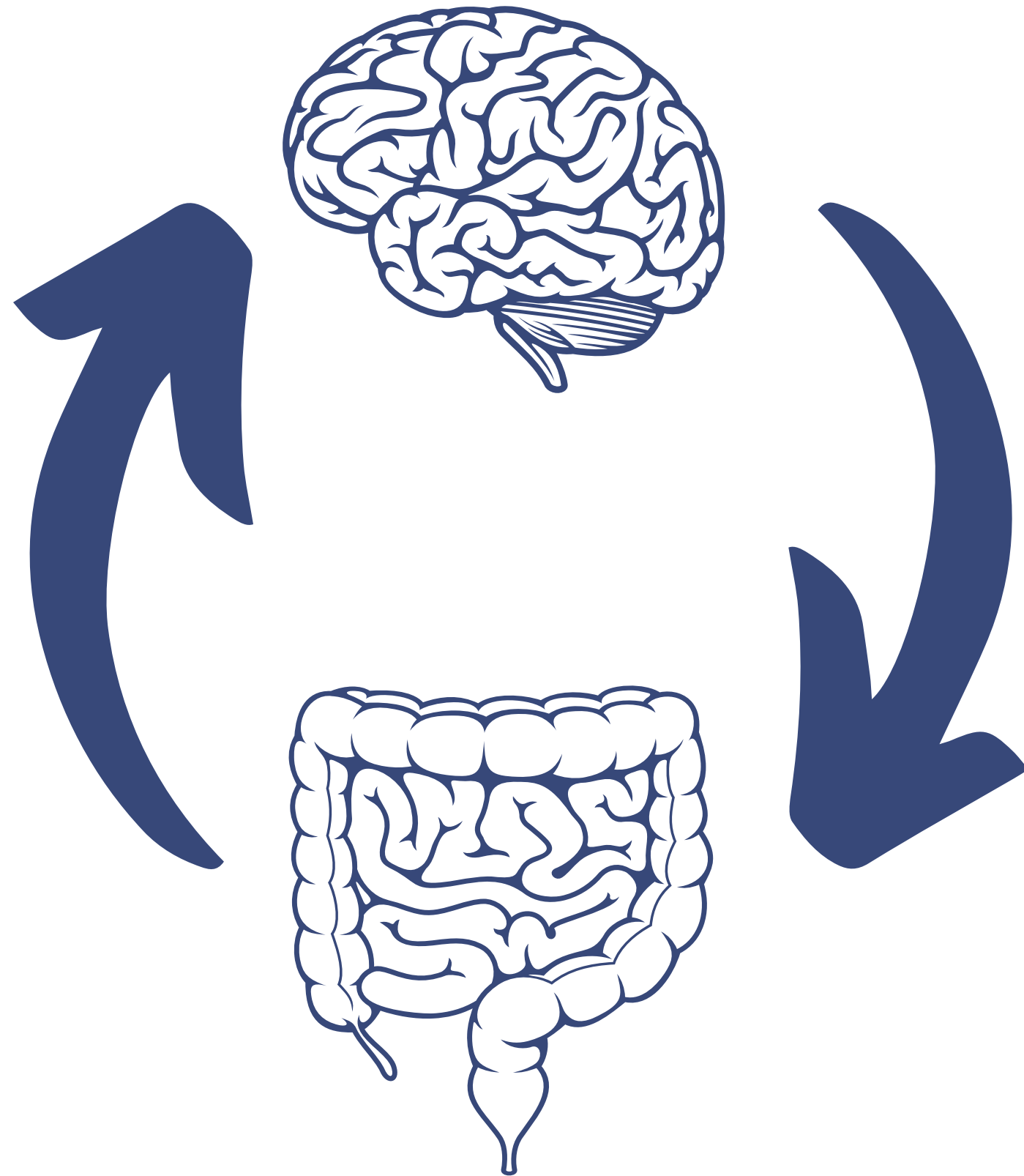
# Last Session Recap

- How digestion works
  - Different organs involved in digestion
  - Dysbiosis
  - Stomach acid
  - Importance of SCFA for gut health
  - Identifying trends in ED patients
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- Our digestive system is much more complex than we used to think
  - Resident gut microbes influence our emotions, pain sensitivity and social interactions
  - When you have a mood disorder it doesn't just exist in the brain
  - The gut and the brain are BFFs!
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# Gut-Brain Talk



## VAGUS NERVE

Gut is lined with the enteric nervous system (dense set of nerve endings); has more nerve endings than the spinal cord; Vagus nerve directly connects the gut and the brain

## IMMUNE SYSTEM

Immune system is housed in the gut (70–80% of immune tissue); Immune system response is communicated to the brain from the gut

## NEUROTRANSMITTERS

Neurotransmitters and small molecules in the blood that are made in the gut are directly absorbed into the circulatory system (blood) through the gut lining

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# Neurotransmitters

- Over 30 neurotransmitters in the gut
  - 90–95% serotonin made in the gut
  - 50% of dopamine made in the gut
  - These have an impact on mood, energy etc
  - There are certain probiotics that are involved in production of neurotransmitters
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# COMMUNICATION PATHWAYS

## ENTERIC NERVOUS SYSTEM

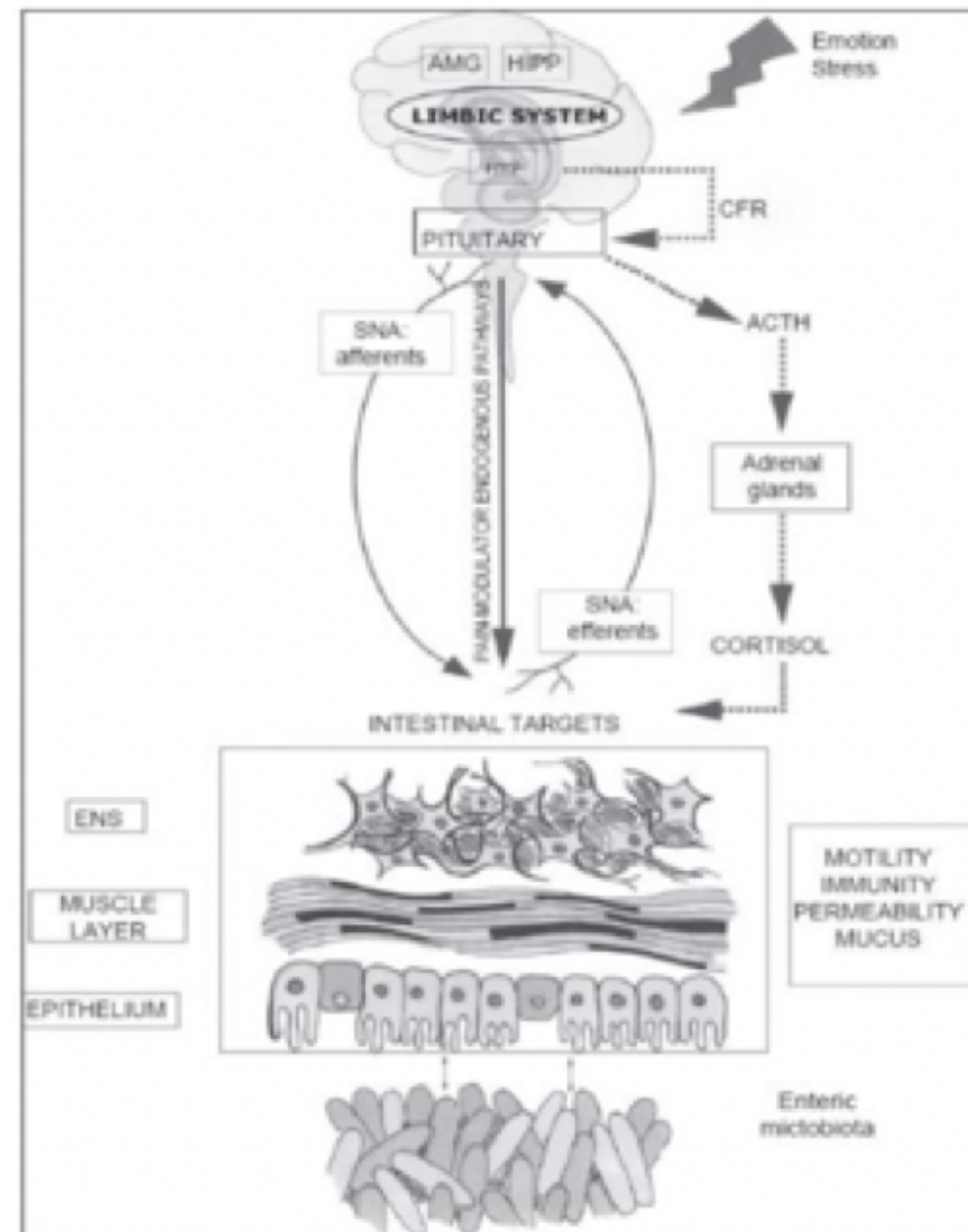
- Oversee's functions of GI tract
- Neuroendocrine
  - Microbiome
  - Migrating motor complex
  - Makes neurotransmitters and vitamins
  - The MORE DIVERSE the better!
  - MAKE SCFA that stimulate serotonin release

## AUTONOMIC NERVOUS SYSTEM

- 1) Parasympathetic nervous system: REST AND DIGEST
- 2) Sympathetic nervous system: FIGHT OR FLIGHT  
(digestion, heart rate, respiratory rate, sexual arousal, urination)



# ENTERIC NERVOUS SYSTEM



**01**

Can function on its own and has its own nervous system

**02**

100-500 million nerve cells (more than the spinal cord)

**03**

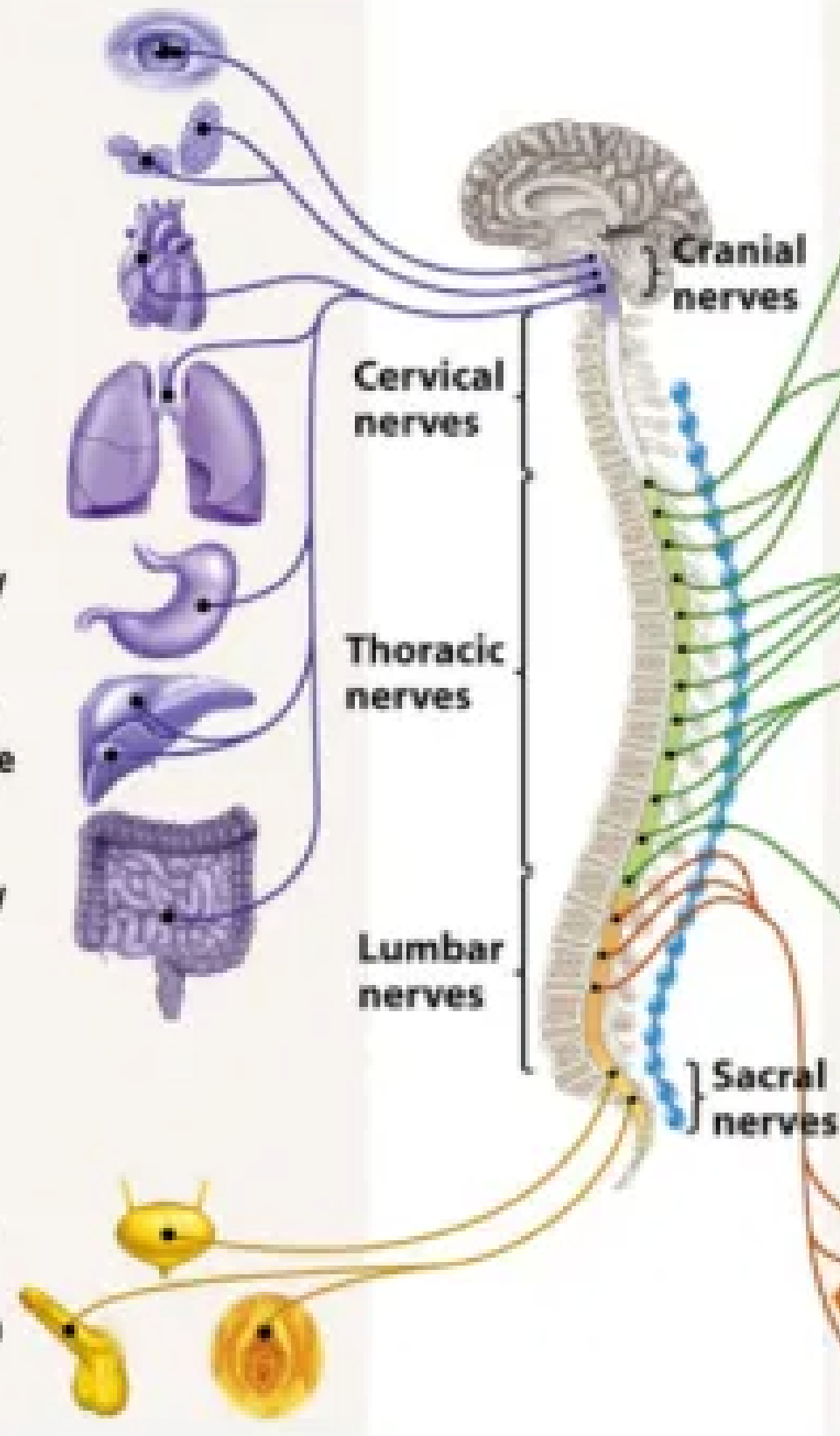
Largest component of your body's immune system; more immune cells in your gut than in blood or bone marrow

**04**

Largest storage facility for serotonin in our body

**PARASYMPATHETIC NERVES**  
"Rest and digest"

- Constrict pupils
- Stimulate saliva
- Slow heartbeat
- Constrict airways
- Stimulate activity of stomach
- Inhibit release of glucose; stimulate gallbladder
- Stimulate activity of intestines
- Contract bladder
- Promote erection of genitals



**SYMPATHETIC NERVES**  
"Fight or flight"

- Dilate pupils
- Inhibit salivation
- Increase heartbeat
- Relax airways
- Inhibit activity of stomach
- Stimulate release of glucose; inhibit gallbladder
- Inhibit activity of intestines
- Secrete epinephrine and norepinephrine
- Relax bladder
- Promote ejaculation and vaginal contraction



Figure 45-20 Biological Science, 2/e  
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# MIGRATING MOTOR COMPLEX

small intestines  
"dishwasher"

clears out  
undigested food in  
the GI tract

MMC can kick in  
after 90 minutes

noisy gurgling  
feeling

MMC needs to  
clean multiple  
times a day

impacts  
constipation and  
gut function



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# HPA Axis

- How the body responds to stress
  - Physical and mental stress
  - Major depression: blood plasma cortisol and corticotrophin releasing factor in cerebral spinal fluid are elevated
  - Chronic stress leads to gut imbalances
  - Stress shunts the MMC function
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# Gut Brain Connection

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- Regulated by the vagus nerve
  - Dorsal vagal complex: connects the organs underneath the diaphragm
  - Bi-directional pathway
  - Activation of the vagus nerve leads to release of acetylcholine
    - stimulates muscle contractions in parasympathetic system
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# Vagus Nerve

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- Provides innervation for swallowing and vocalization
  - Provides parasympathetic supply to heart to reduce heart rate
  - Stimulates contraction of the smooth muscles of intestines and glandular secretion
  - Responsible for regulation of digestion, heart rate, respiratory rate, vasomotor activity and reflex reactions (coughing, sneezing, vomiting)
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# Stress and the vagus nerve

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- Parasympathetic state: dilation of blood vessels and bronchioles
    - stimulation of salivary glands
    - increase in bowel motility
  - Sympathetic state: constriction of blood vessels, dilation of bronchioles, increase in heart rate
    - constriction of intestinal and urinary sphincters
    - reduced blood flow to the gut
    - more blood flow to the heart
-

# Vagus Nerve and ENS

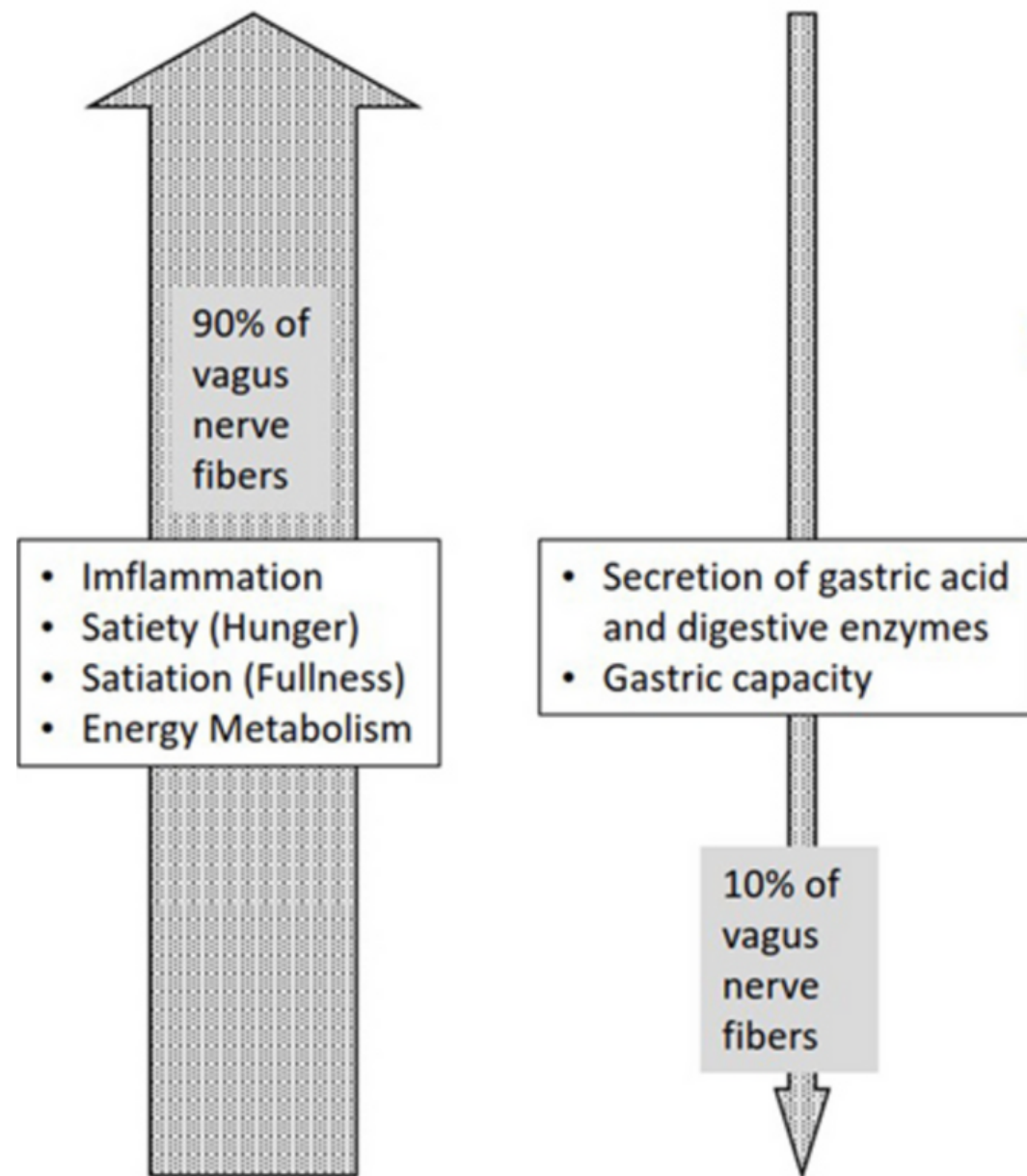
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- ENS is an intestinal barrier
    - Regulates immune response, detects nutrients, motility, microvascular circulation, epithelial secretion of fluids, ions, etc
  - Connects emotional and cognitive areas with peripheral intestinal functions
    - Immune activation
    - Intestinal permeability
    - Enteric reflex
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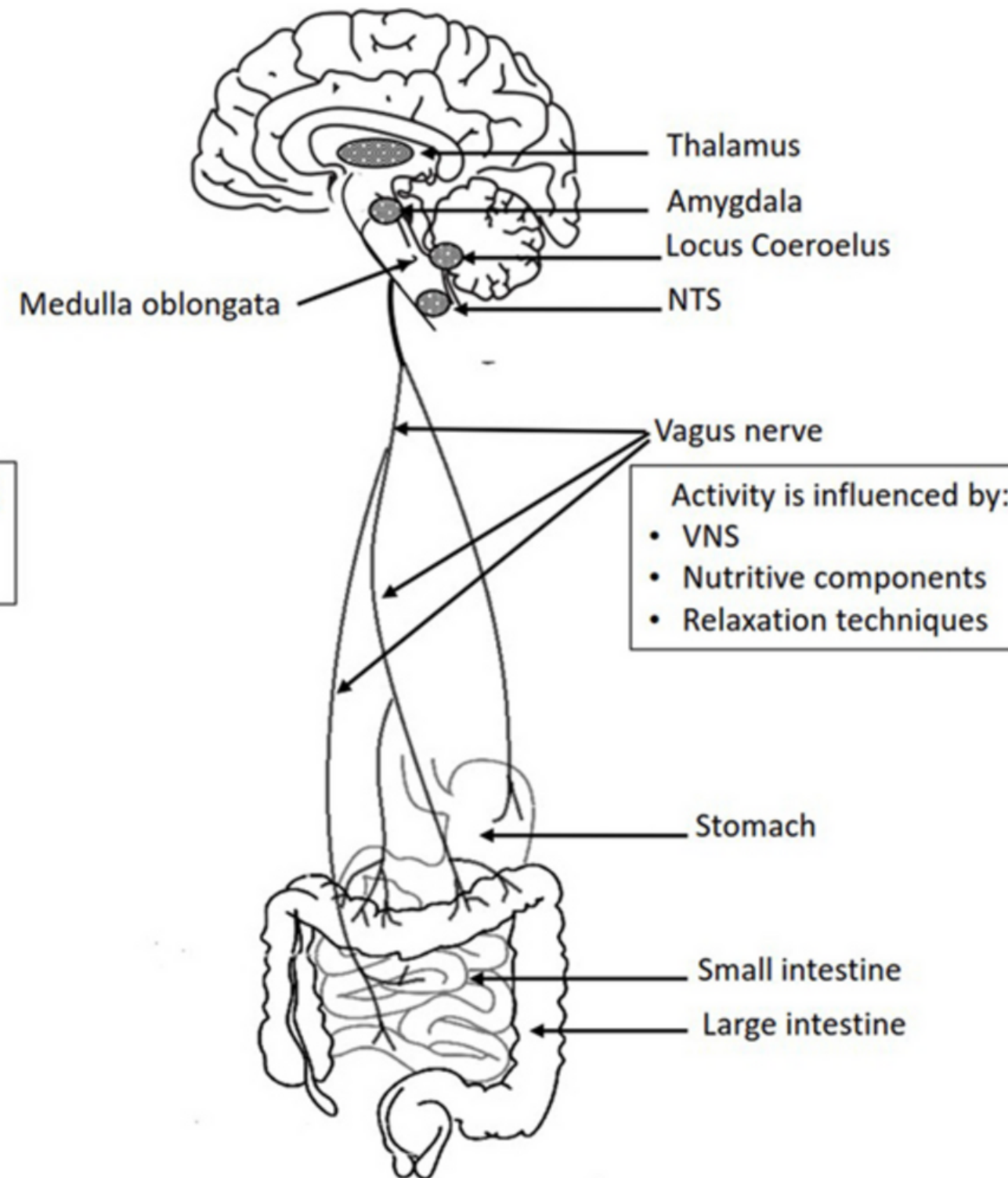
# The Gut Brain Axis

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- Includes:
    - Brain
    - Spinal Cord
    - Autonomic nervous system
      - Sympathetic
      - Parasympathetic
      - ENS
    - HPA Axis
  - Vagal efferents send signals down (10–20%)
  - Vagal afferents send signals up (80–90%)
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### Afferent and efferent connections



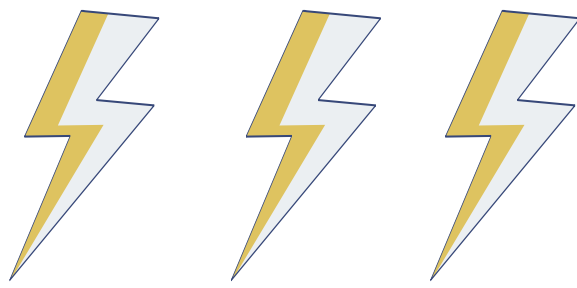
### Anatomy



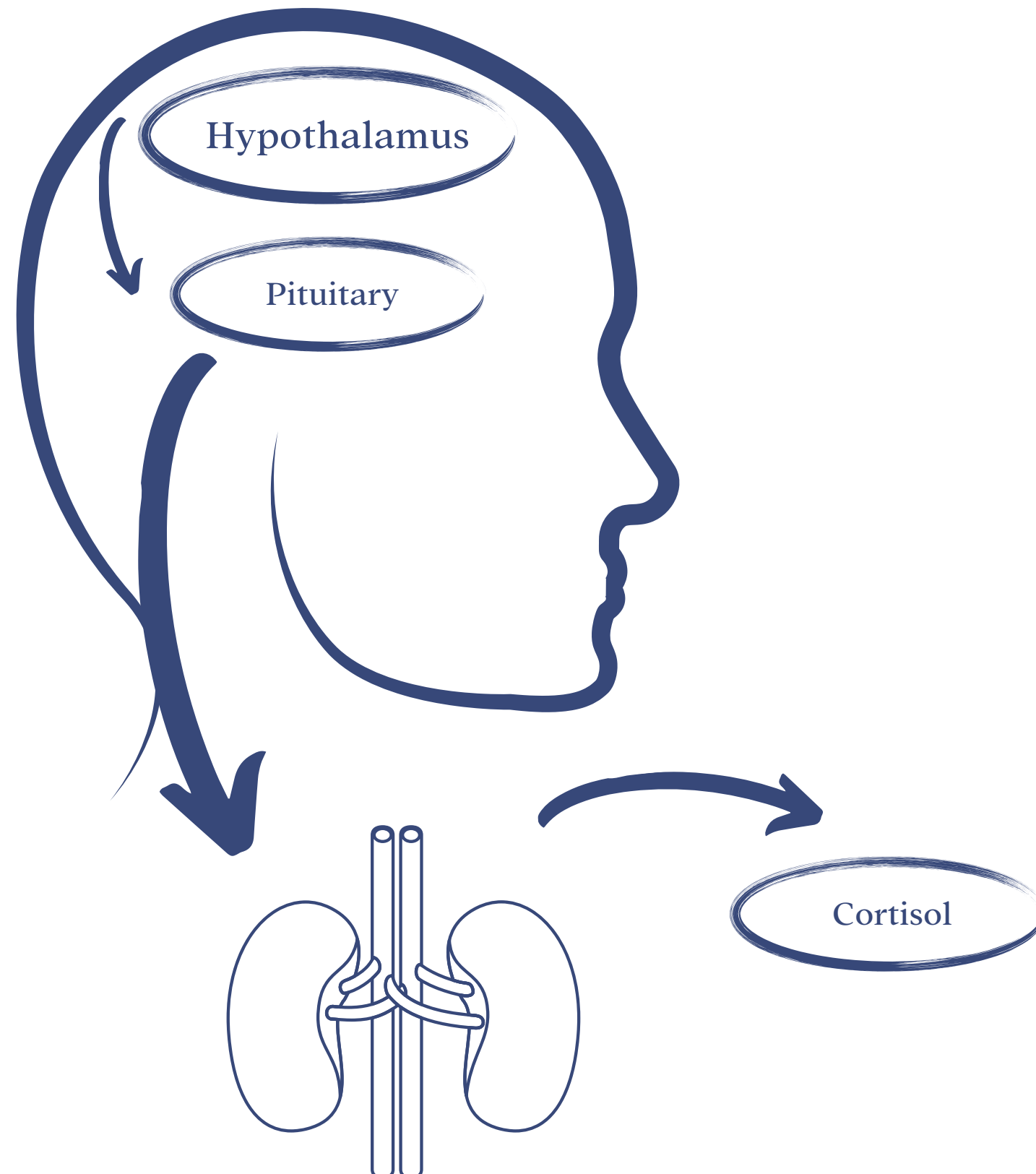
### Disorders

- Psychiatric disorders
- Major depression
  - PTSD

- Inflammatory GI Disorders
- Ulcerative Colitis
  - Crohn's Disease



# Vagal Afferent Pathway



- Activates the HPA Axis through corticotropin-releasing factor (CRF) from the hypothalamus
  - Adaptive responses
  - Environmental stress
  - Pro-inflammatory cytokines
- CRF release stimulates adrenocorticotropic hormone (ACTH) from the pituitary gland
- Cortisol release from the adrenal glands
- Cortisol is a stress hormone

# Gut Microbiota Influence

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- Important impact on the brain
    - Directly impacts neuroendocrine and metabolic symptoms
  - Influences anxiety and depressive-like behaviors
  - Microbiota influence stress reactivity and regulate set point for HPA activity
    - Increase stress response

# Food Intake

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- Afferent: innervate GI tract
    - Provide rapid and discrete account of digestible food as well as circulating and stored fuels
  - Efferent: determine rate of nutrient absorption, storage and mobilization
  - CCK, grehlin, leptin are sensitive to nutrient content in the gut and involved in short term feelings of hunger and satiety

# CCK

- 
- Regulates GI function
  - Gastric emptying
  - Food intake
  - Important for secretion of pancreatic fluid
  - Important for gastric acid production
  - As a result of protein digestion CCK is released from the small intestine
  - Short chain fatty acids activate vagal afferents

Little TJ, Horowitz M, Feinle-Bisset C. Role of cholecystokinin in appetite control and body weight regulation. *Obes Rev* (2005) 6:297–306. doi:10.1111/j.1467-789X.2005.00212.x

Lal S, Kirkup AJ, Brunsten AM, Thompson DG, Grundy D. Vagal afferent responses to fatty acids of different chain length in the rat. *Am J Physiol Gastrointest Liver Physiol* (2001) 281:G907–15. doi:10.1152/ajpgi.2001.281.4.G907

MacIntosh CG, Morley JE, Wishart J, Morris H, Jansen JB, Horowitz M, et al. Effect of exogenous cholecystokinin (CCK)-8 on food intake and plasma CCK, leptin, and insulin concentrations in older and young adults: evidence for increased CCK activity as a cause of the anorexia of aging. *J Clin Endocrinol Metab* (2001) 86:5830–7. doi:10.1210/jcem.86.12.8107

# Ghrelin & Leptin

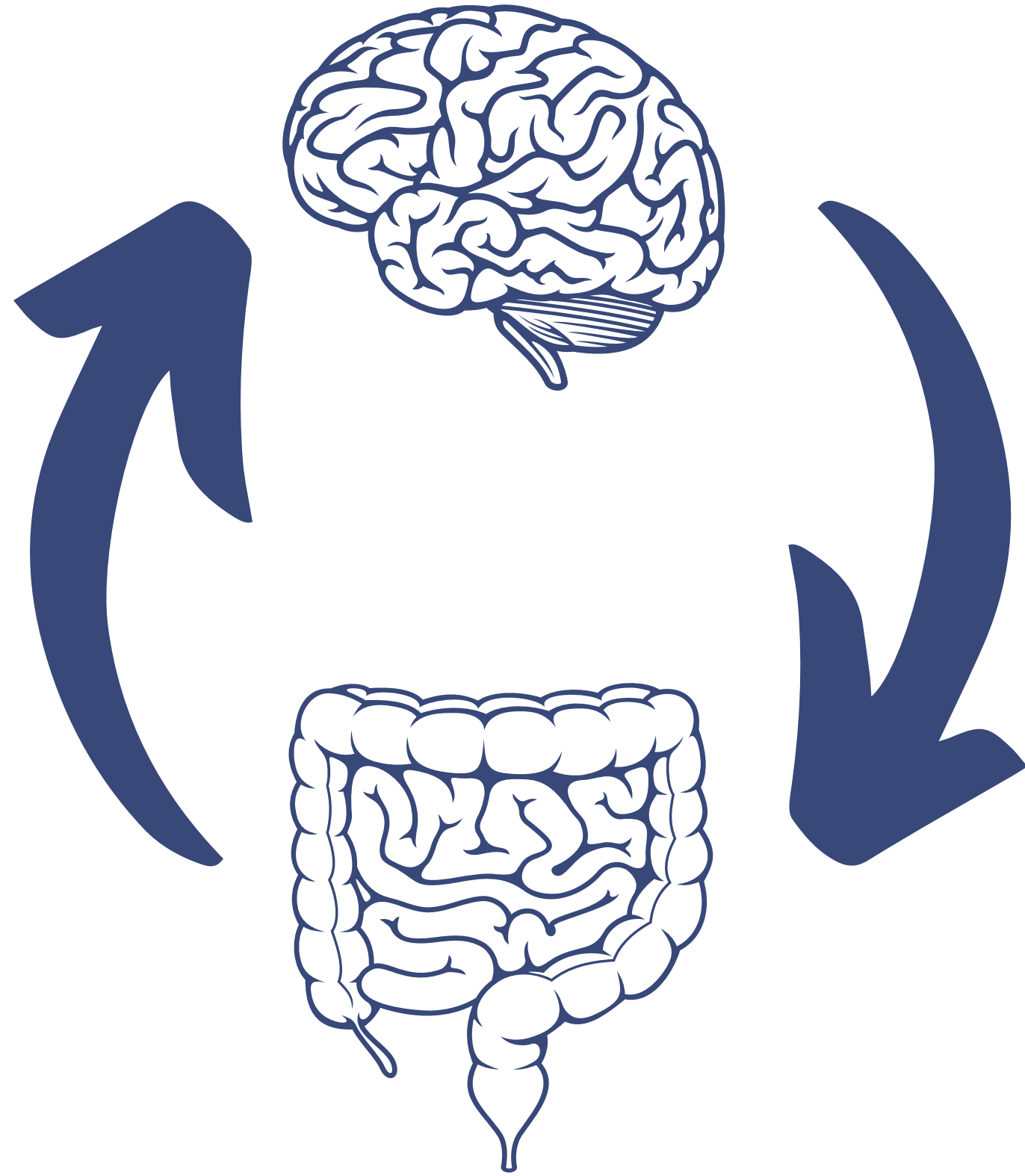
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- Ghrelin:
    - Regulates food intake by inhibiting vagal afferent firing
    - Increased by fasting and fall after a meal
    - Bitter food affects vagus nerve
  - Leptin:
    - Receptors also identified in vagus nerve
    - Works with CCK to induce short term inhibition of food intake

Janssen S, Laermans J, Verhulst P-J, Thijs T, Tack J, Depoortere I. Bitter taste receptors and  $\alpha$ -gustducin regulate the secretion of ghrelin with functional effects on food intake and gastric emptying. *Proc Natl Acad Sci U S A* (2011) 108:2094–9. doi:10.1073/pnas.1011508108

Jeon T-I, Seo Y-K, Osborne TF. Gut bitter taste receptor signalling induces ABCB1 through a mechanism involving CCK. *Biochem J* (2011) 438:33–7. doi:10.1042/BJ20110009

Alamri BN, Shin K, Chappe V, Anini Y. The role of ghrelin in the regulation of glucose homeostasis. *Horm Mol Biol Clin Investig* (2016) 26:3–11. doi:10.1515/hmbci-2016-0018

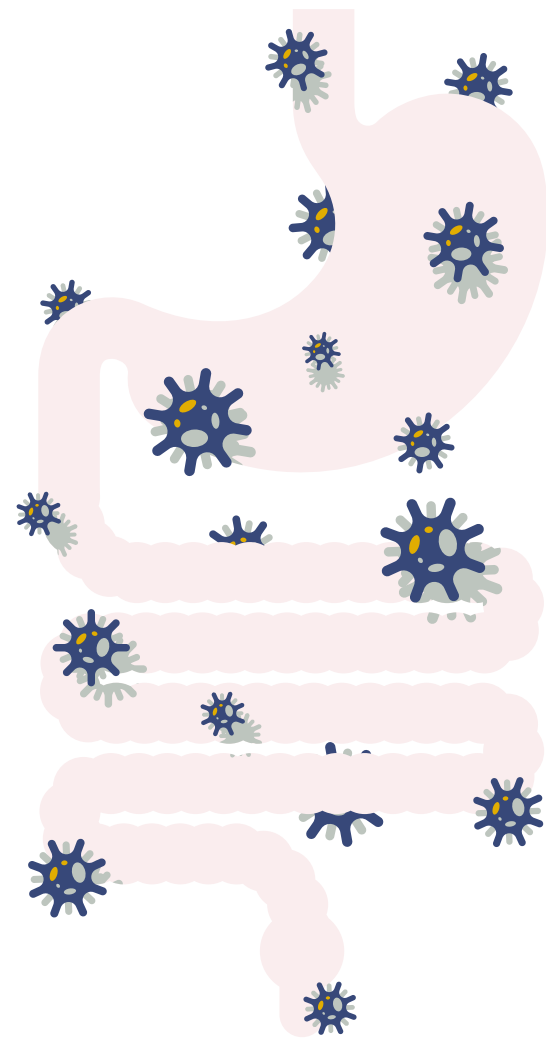




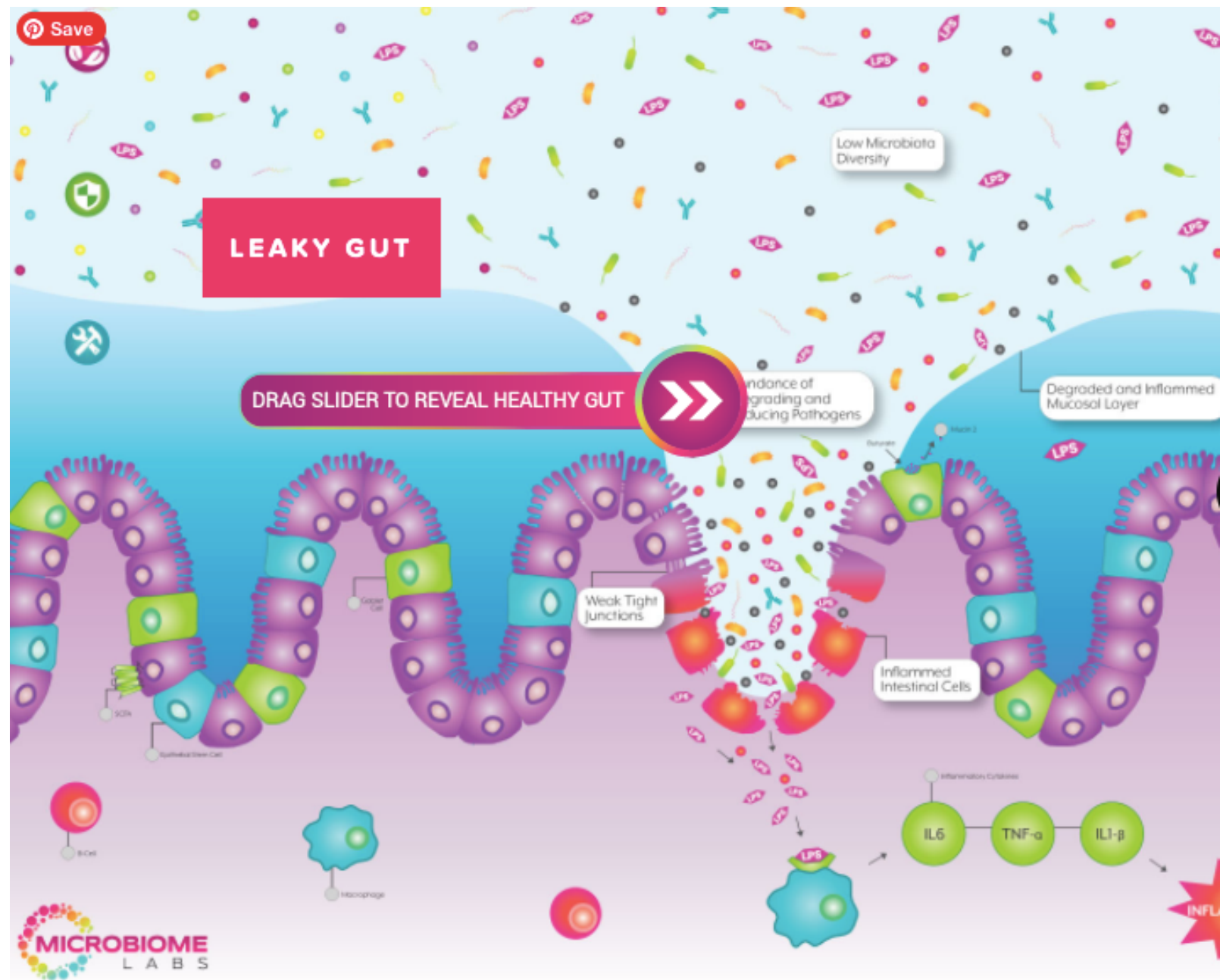
- Gut sensations such as fullness, nausea, discomfort and feelings of well-being
  - Triggers brain responses and sends it back to the gut
    - GUT REACTIONS
  - Gut feels are stored feelings which can later be accessed when making decisions
  - What we sense in our gut helps us make decisions about what to eat, who to spend time with, how we assess information, etc.
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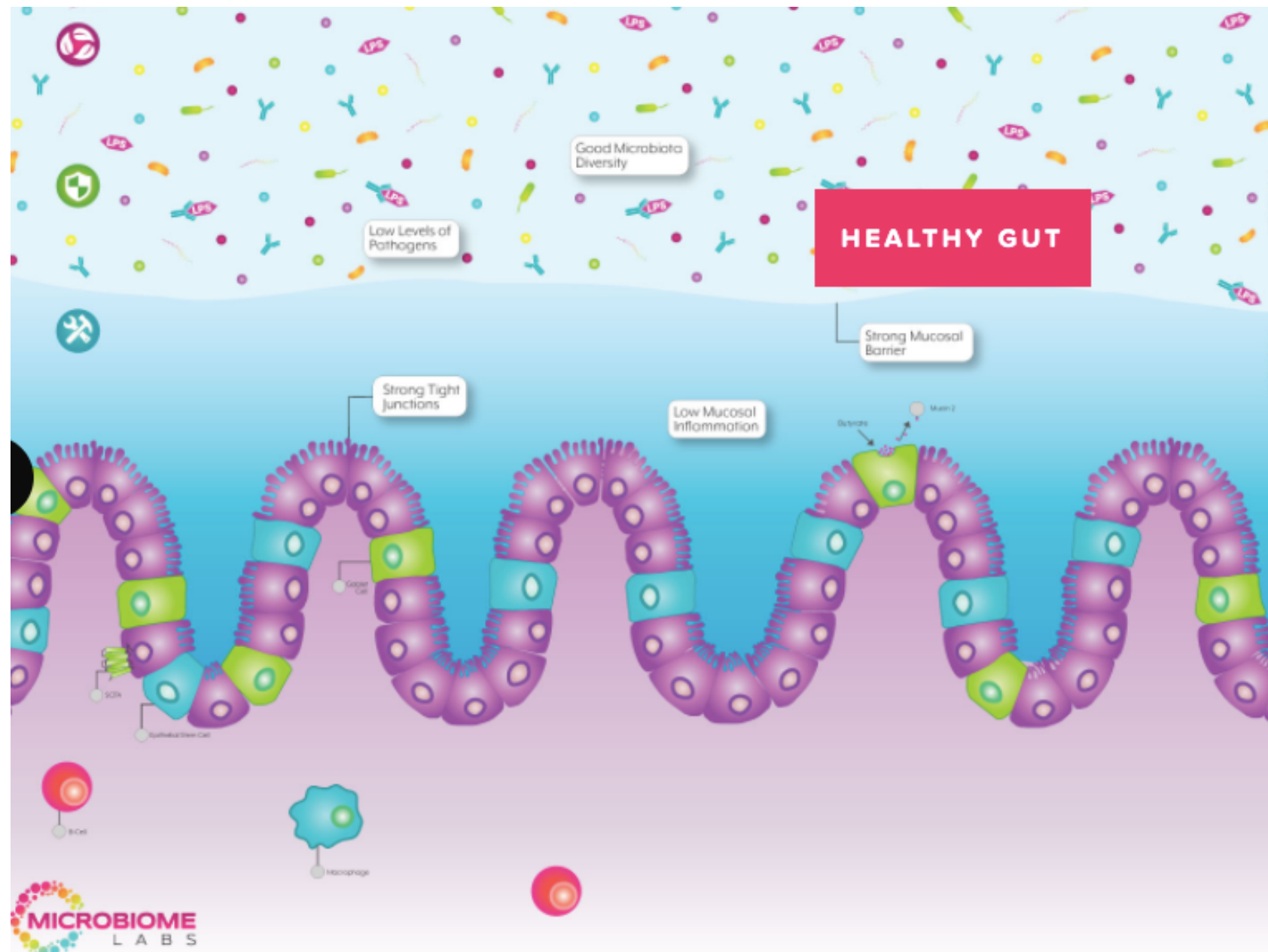
# Microbes



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- 100,000 times more microbes in your gut alone as there are people on earth
  - Much of what we know has been in the last decade
  - These microbes help with digestion of food components our guts cannot handle themselves
  - Disturbance and alterations are associated with IBD, diarrhea, asthma, autism, neurodegenerative brain disorders
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- Intestinal permeability:
  - Bacteria and endotoxins leak through physical holes in intestinal walls and end up in the blood stream
- Most common endotoxin is LPS (lipopolysaccharide)
  - When found in intestinal lumen it is mostly harmless
    - Once released into blood stream it is inflammatory
    - Can cross BBB



- Chronic alcohol consumption
- Chronic smoking
- Intense exercise
- Lack of sleep
- Overuse of medications
- NSAIDS
- PPI's
- Starvation or inconsistent eating
- Stress (mental, physical, emotional)
- Antibiotics
- Antibacterial

De Punder K, Pruimboom L. Stress induces endotoxemia and low-grade inflammation by increasing barrier permeability. *Front Immunol.* 2015;15(6):223.

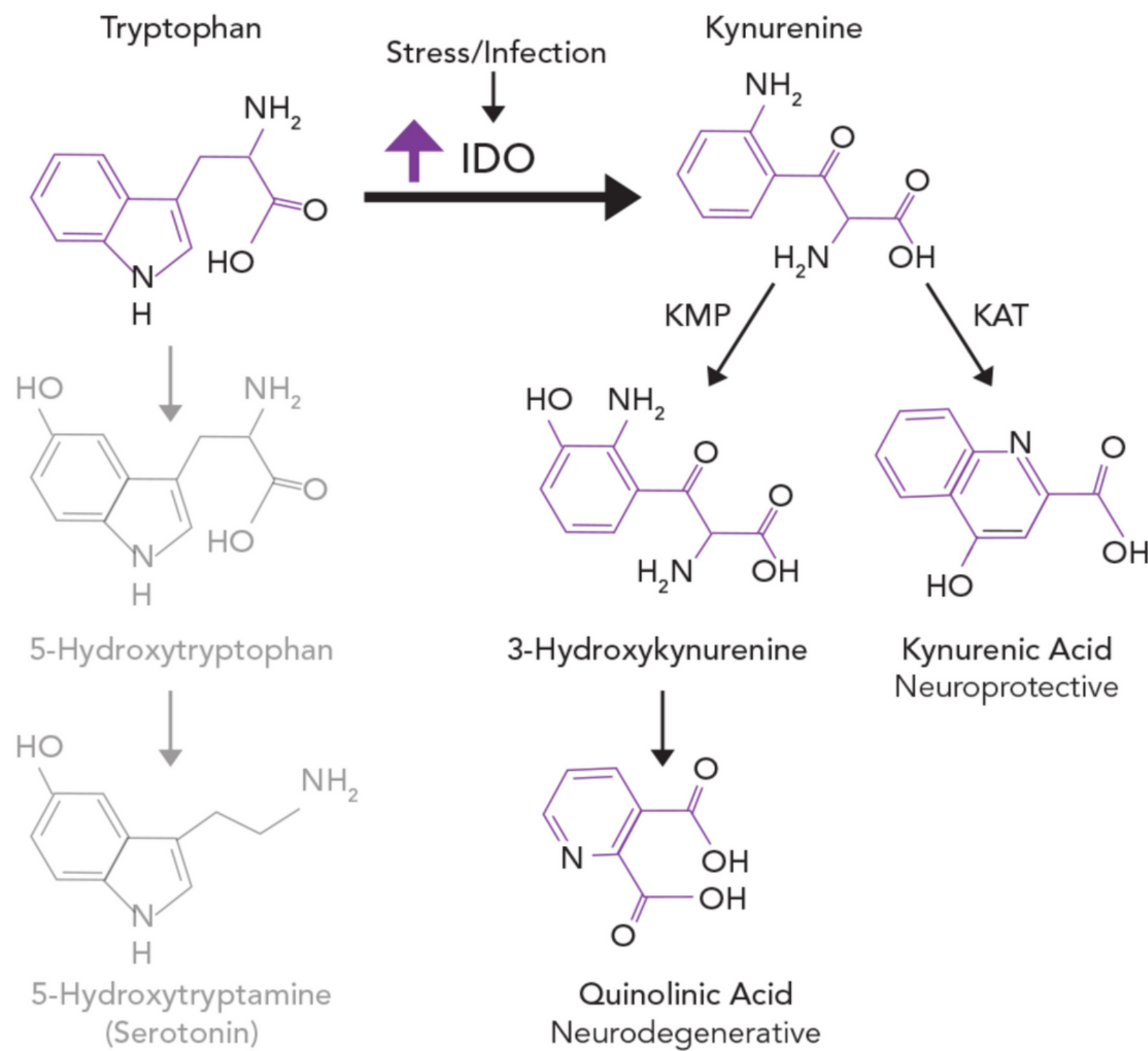
Konturek PC, Brzozowski T, Konturek SJ. Stress and The Gut: Pathophysiology, Clinical Consequences, Diagnostic Approach and Treatment Options. *J Physiol Pharm.* 2011;62(6):591-599.

Yoshikawa K, Kurihara C, Furuhashi H, et al. Psychological stress exacerbates NSAID-induced small bowel injury by inducing changes in intestinal microbiota and permeability via glucocorticoid receptor signaling. *J Gastroenterol.* 2017;52(1):61-71

# Serotonin

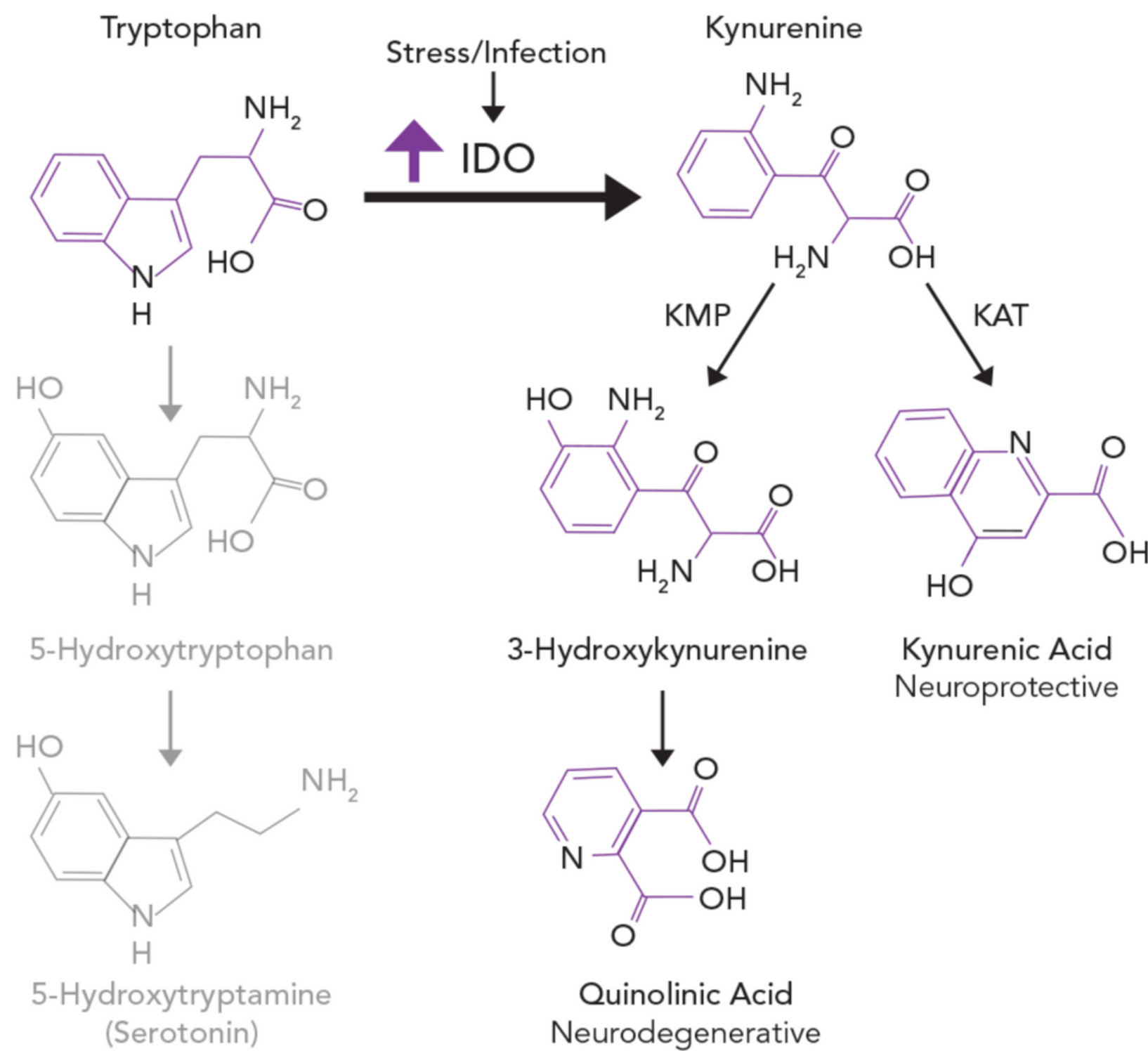


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- Helps with normal intestinal functions
    - Peristalsis
  - Plays a role with sleep, appetite, pain sensitivity and overall well-being
  - Main target of antidepressants (SSRI's)
  - If our gut's sole responsibility was digestion why does it contain these signaling systems?
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- We make serotonin from tryptophan in the gut
  - LPS shunts tryptophan to quinolinic acid
- Dimmer switch: holes between cells
  - substances, proteins, toxins leak through the gut to cause inflammation
- Cytokines cross the BBB





- Things are crossing the BBB that shouldn't
- Immune system is educating itself about what is foreign and what is not
- Suspicious paranoid system wants to shut down anything causing harm
- Decrease production of "post-biotics"
- Quinolinic acid is an excitotoxin in the CNS

# TYPES OF STRESS

Physical stress

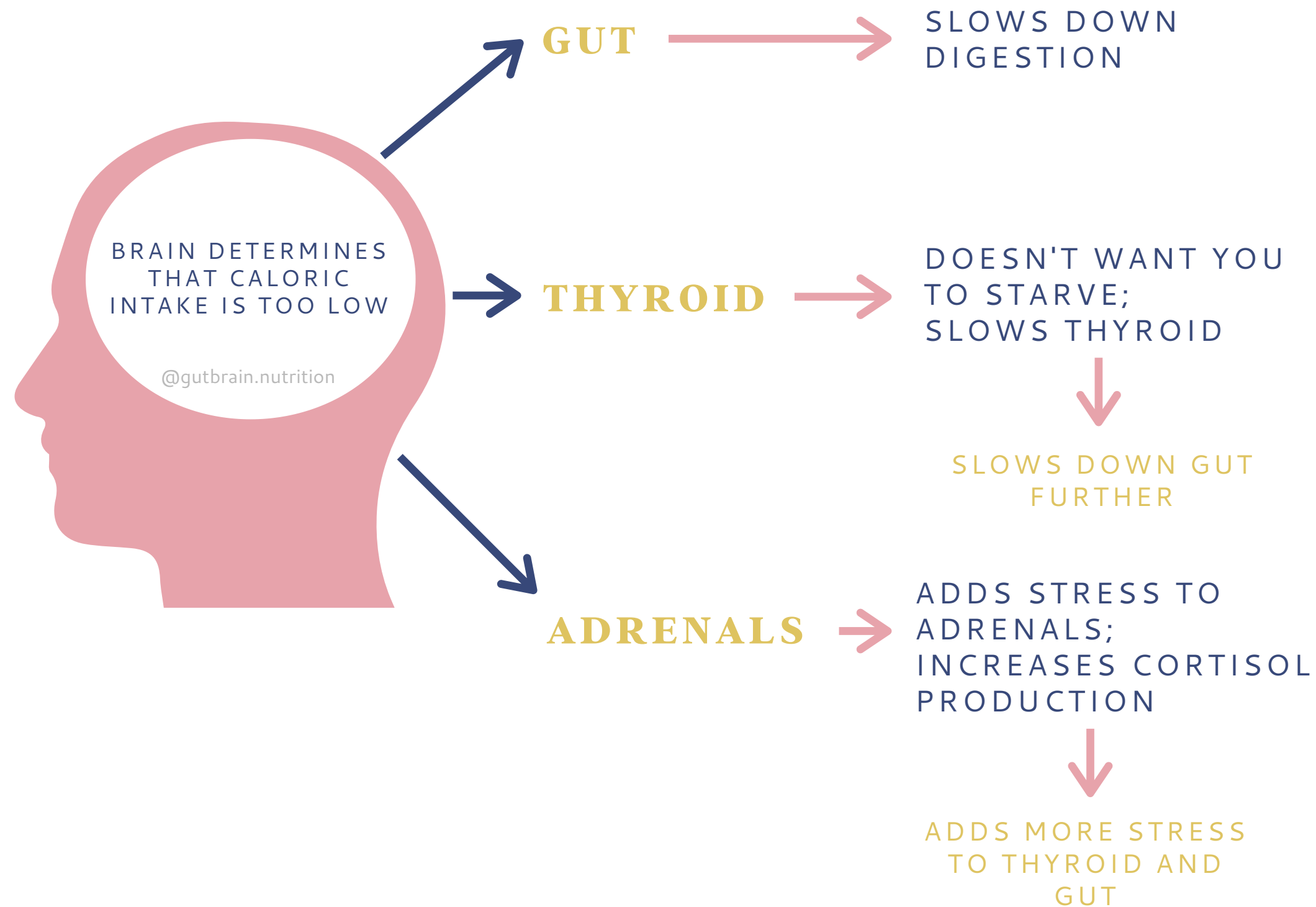
Psychological  
stress

Psychosocial  
stress

Physiological  
stress  
including  
under eating

# CHRONIC UNDEREATING

*and your gut*

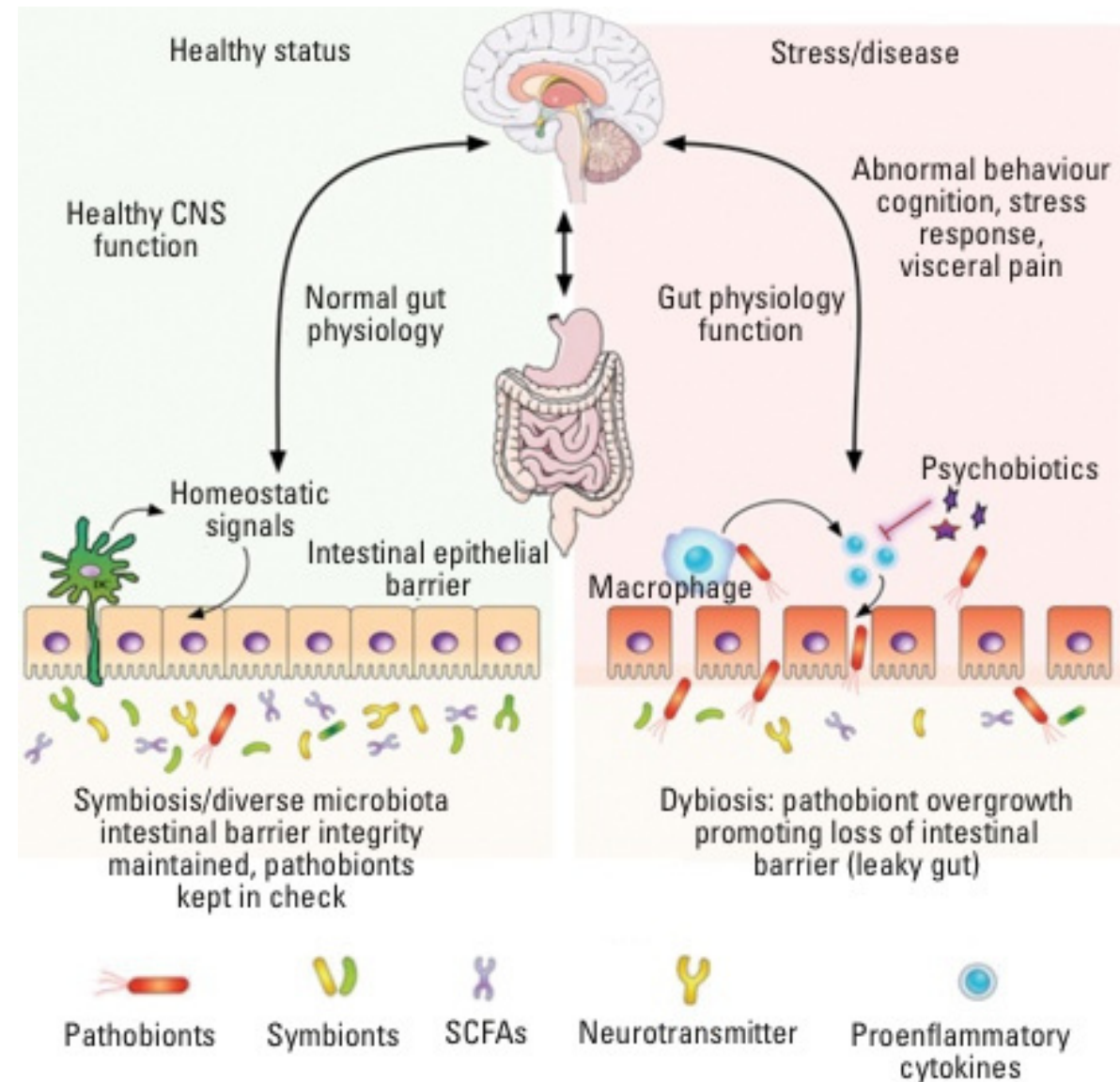




**BEFORE WE START  
ADDRESSING DIGESTIVE ISSUES  
WE HAVE TO GET THE ORGAN  
SYSTEM THE BRAIN AND CELLS  
BACK ONLINE!**

When the body is in a chronic fight or flight it cannot heal or "rest and digest"

# Digestion under stress



## SYMPATHETIC NERVOUS SYSTEM

Controls "FIGHT OR FLIGHT"

Reduces amount of "good" bacteria

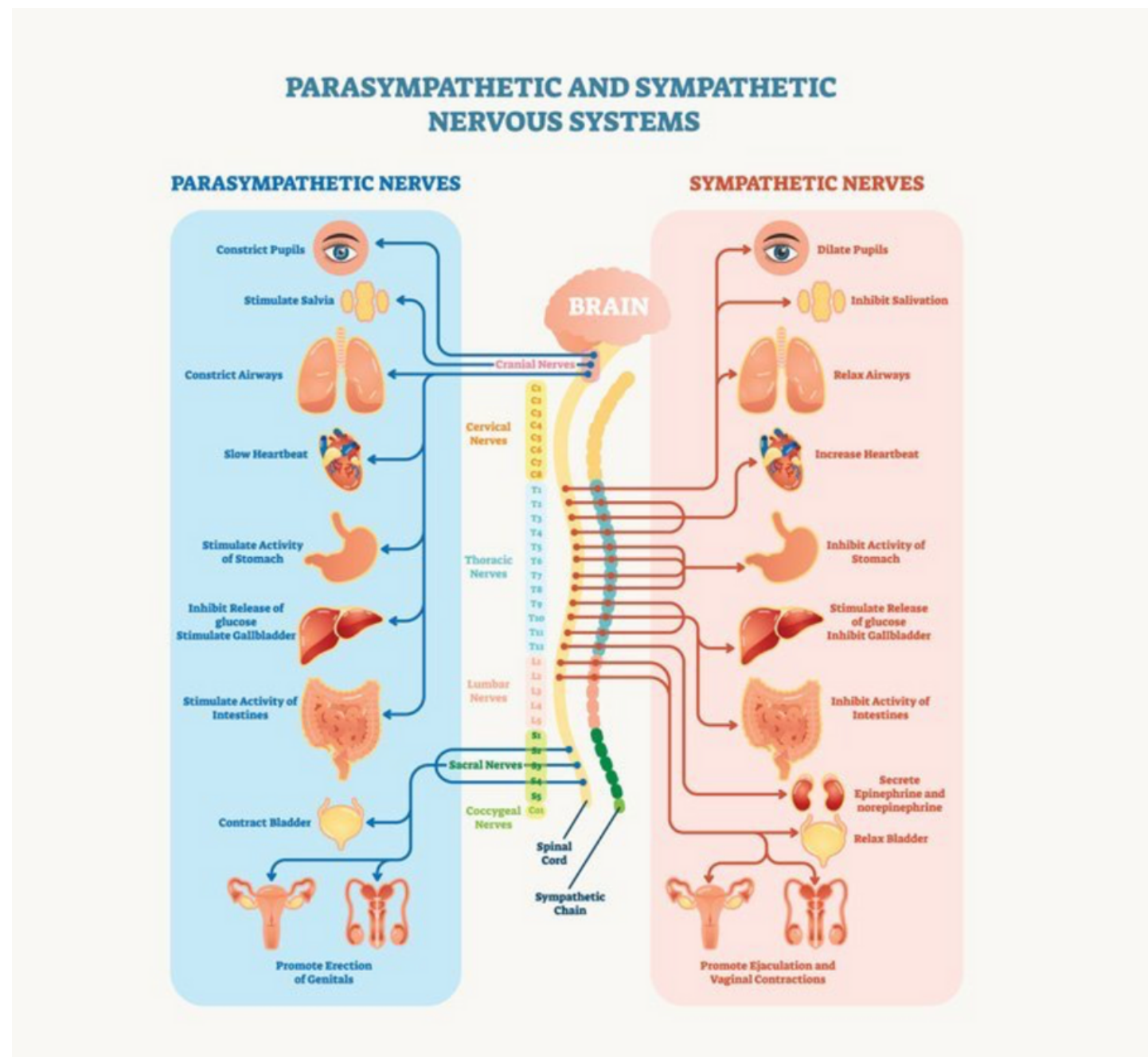
Increased susceptibility to pathogens

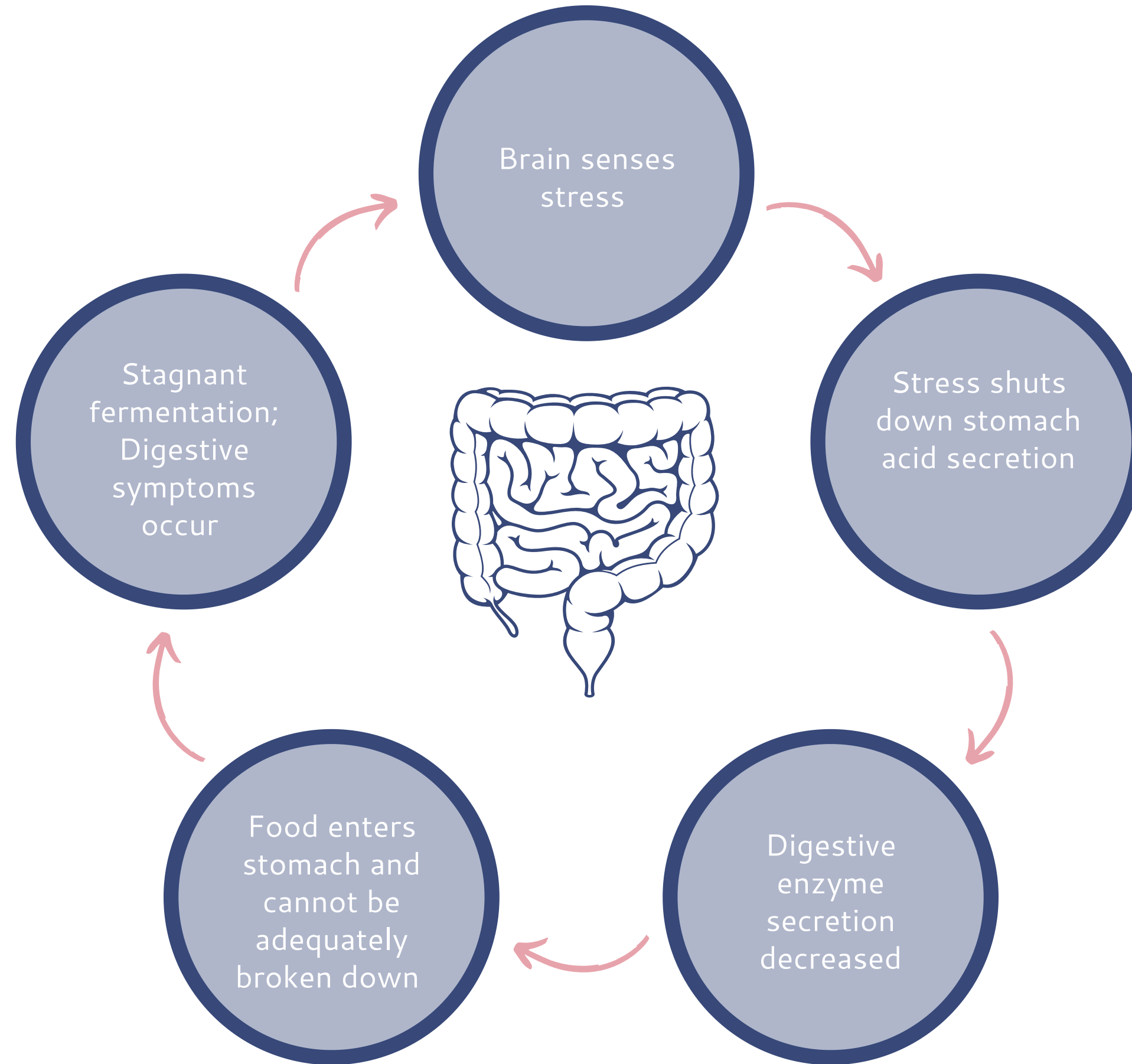
## STRESS MANAGEMENT IS KEY TO OPTIMIZING THE MICROBIOME

Low HCL can lead to B12 deficiency which makes anxiety worse

# Digestion under stress

- Less bacteria and enzyme support
- Slows food breakdown
- No "rest and digest"
- Lowers stomach acid
- Decreases blood flow to gut and moves to muscles
- Less saliva
- Immune system is less effective
- The body is no longer able to handle infections, etc.





# Vagal Tone

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- Yoga breathing (5 minutes daily)
  - Gargling (2–3 Min 2x daily)
  - Meditation
  - Probiotics
    - Lactobacillus species
      - Rhamnosus
    - Bifidobacteria
  - Psychobiotics: class of probiotics with anti-inflammatory effects
  - Hypnotherapy
  - Stay tuned for Part 4!
-

# STRESS AND DIGESTION

**01**

A STRESSED OUT GUT  
IS A STRESSED OUT  
BRAIN

**02**

A STRESSED OUT  
BRAIN IS A STRESSED  
OUT GUT

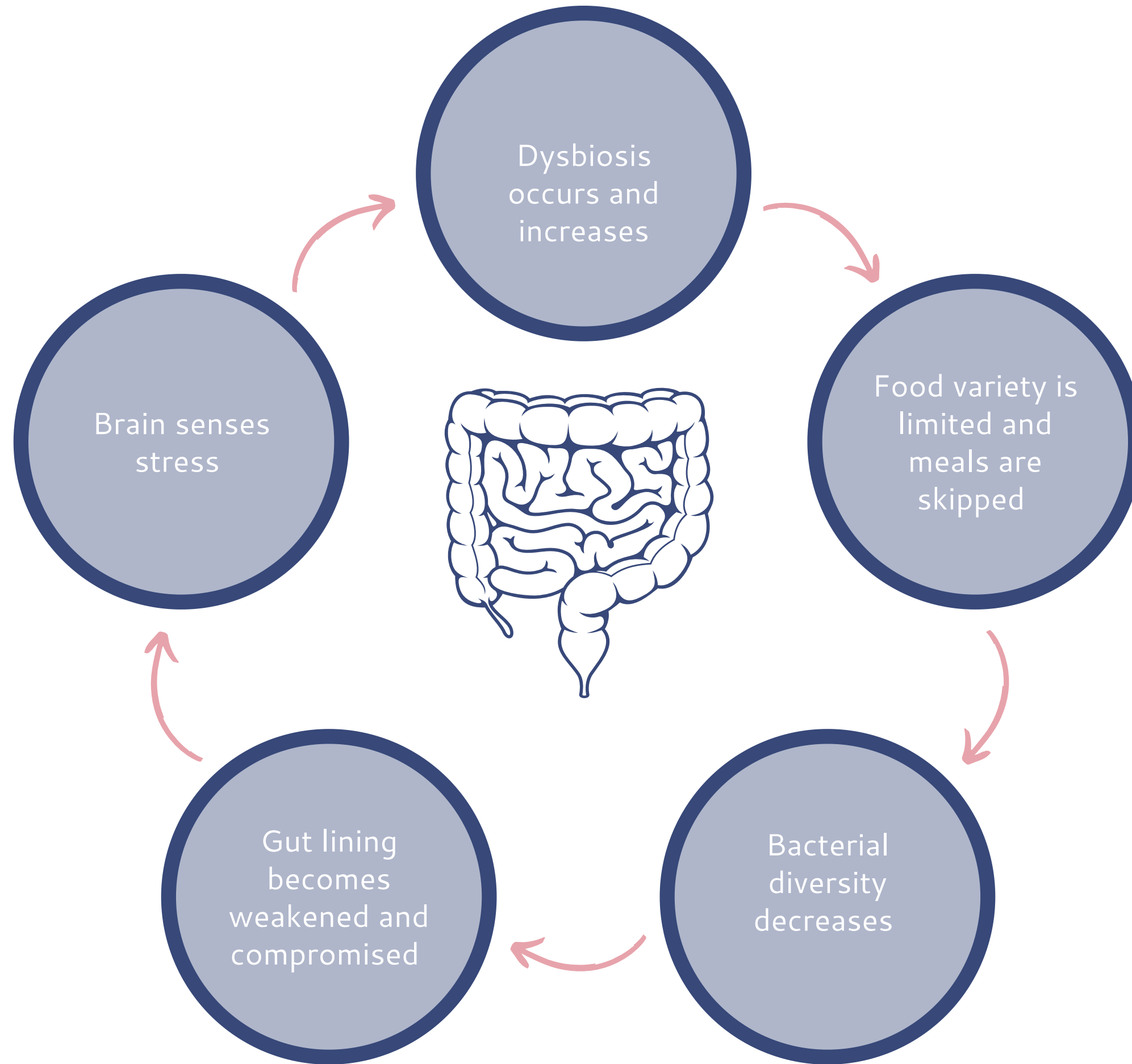
**03**

IMPROVE DIGESTIVE  
HEALTH STARTS WITH  
REDUCING STRESS,  
ADEQUATE CALORIE  
INTAKE AND IMPROVING  
VAGAL TONE

**04**

ADRENAL DEMAND  
IMPACTS DIGESTION,  
METABOLISM AND  
ANXIETY RESPONSE

TO IMPROVE DIGESTIVE HEALTH START WITH STRESS MANAGEMENT AND  
EATING ENOUGH CALORIES TO GET OUT OF SURVIVAL MODE





# HOW DOES THIS APPLY TO EATING DISORDER PATIENTS

**01**

If they have digestive symptoms first evaluate stressors including caloric intake, food variety and psychological stress

**02**

If undereating or overexercising start there

**03**

Add in mindfulness based practices to improve digestive health

**04**

Work with RD and therapist to improve food fear and stress

**ED PATIENTS HAVE STRESS IN VARIOUS FORMS. GET A MULTI  
DISCIPLINARY TEAM ON BOARD!**



**NEXT UP: March 25, 2021**  
**12:00pm MST**

**Gut Instincts Part 3:**  
**Trauma and the Gut**



# Questions



Until next time...find me on  
Instagram @gutbrain.nutrition

