Metabolic Dysregulation:

Part 2:

The Brain-Gut Axis

&

Burnout

Dr Aron Gonshor: PhD, DDS, FRCD(C), FAO

FDN Educational Symposium

January 7, 2022

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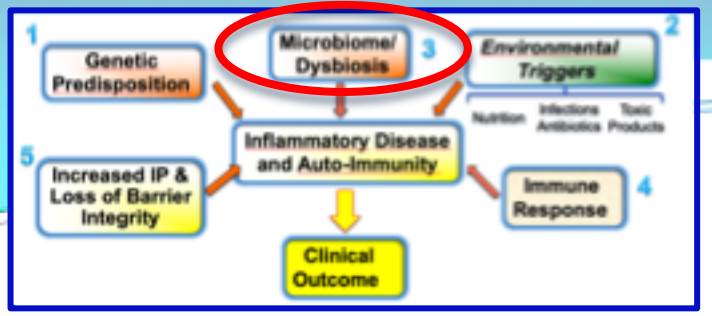
Part 1 Review



The Inner Environmental Ecosystem:
The Human Gut Microbiome

- **Cells**: Bacteria outnumber human **~10:1**
- **Genes**: Total bacterial outnumber human **> 150:1**
  - 3.3 million bacterial genes vs ~25,000 human genes (~1%)
- **Bacterial Species: >30,000 and counting**
- **Fungal Species: > 350,000**
- **Parasites & Protozoa Species: > 400,000 & 100,000**
- **Viruses: Millions of species**
- **> 50% of colonic content is bacterial**
  - **10^{11}-10^{12} bacteria/gm of colonic content** (>10^{14} total bacteria)

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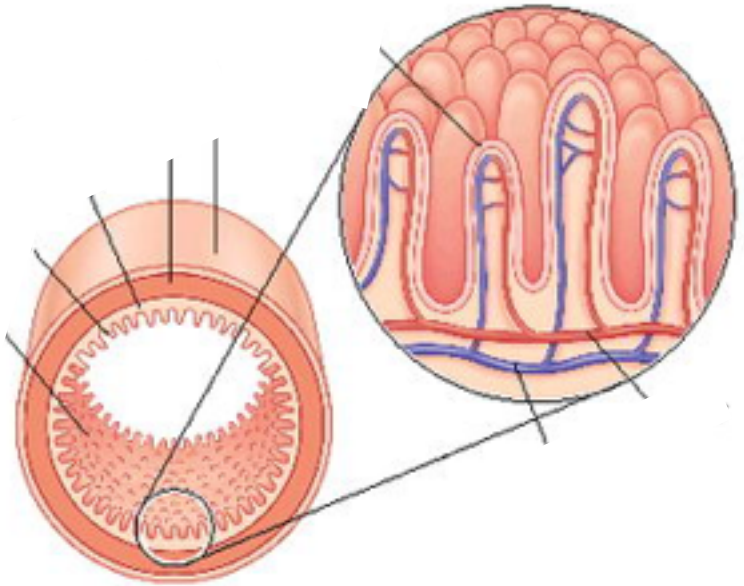
Enteric Nervous System - The Gut 'Brain'



- ~ 500 million nerve cells
- 20 neuronal types
- Autonomous microcircuits
- Chemical / Mechanical sensing
- Muscle movement control

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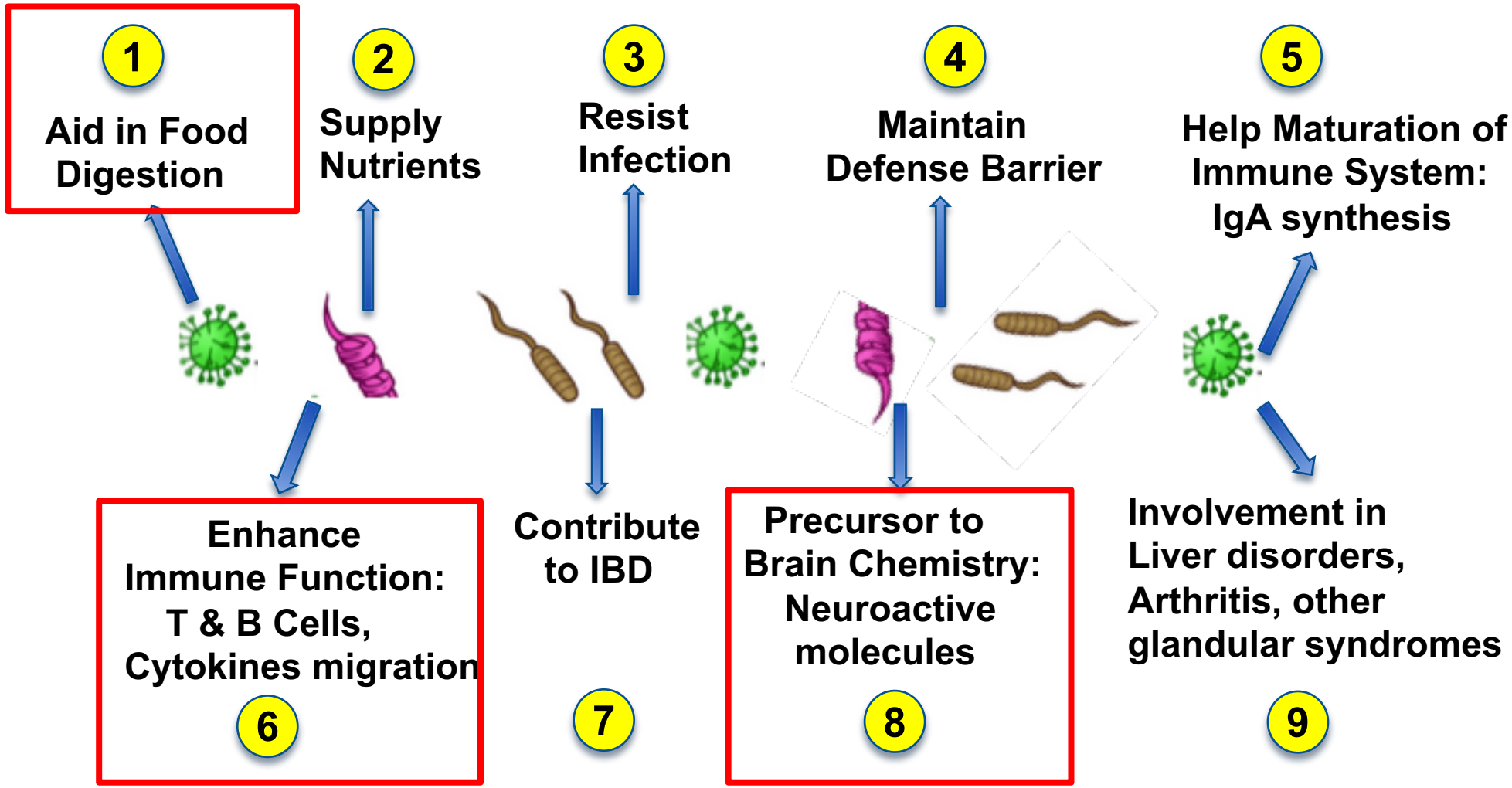
Watzke, 2015

Microbiome & Multiple Modulatory Effects



- Regulate the Intestinal T-reg Cells

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Kabat et al, 2014, Gannage, 2016

1 Aid in Food Digestion

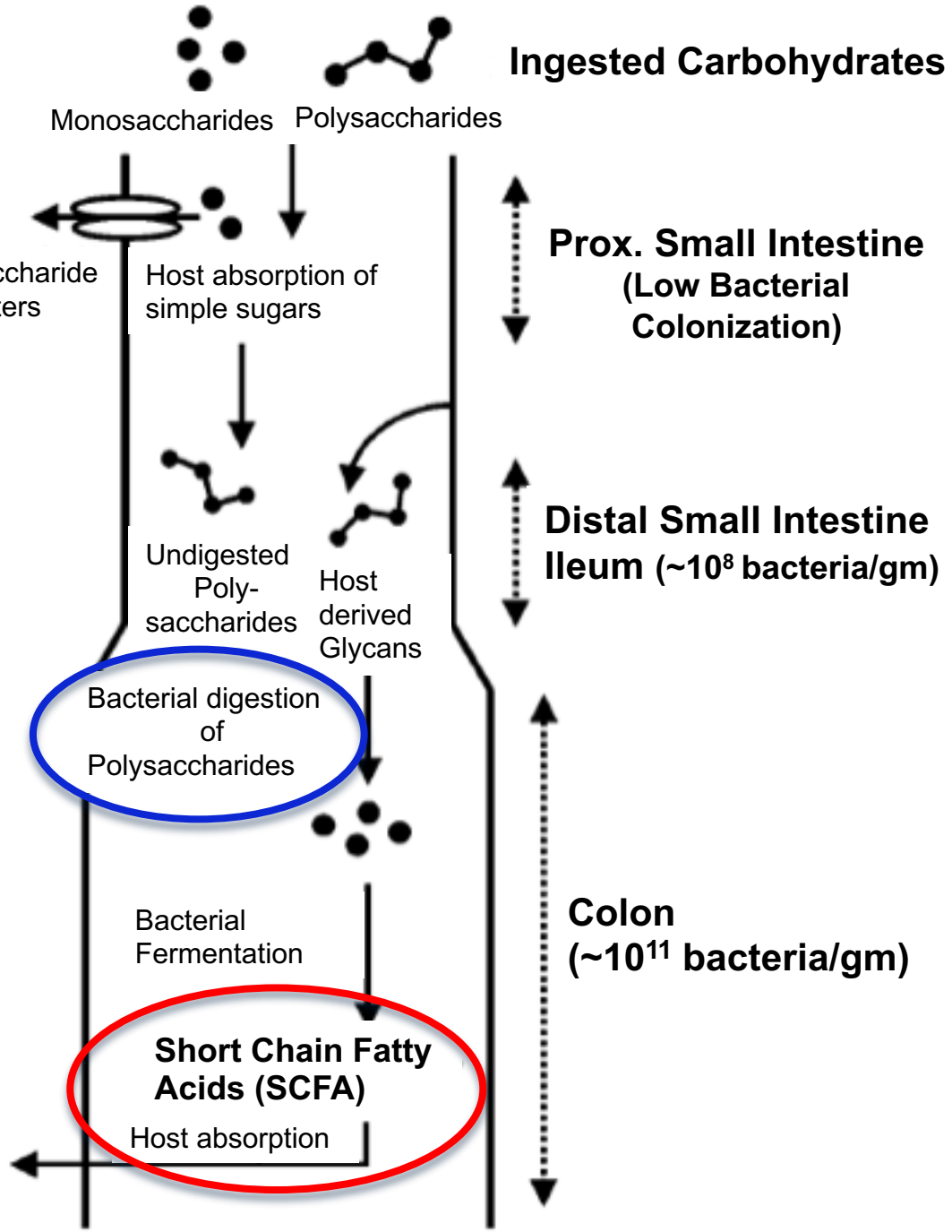
Host-Microbial Interaction

- **Humans**: only 20 genes encode for proteins that break down carbs

- ***Bacteroides*** alone: 260 genes
- 1000s of other bacterial species

Microbiota Essential for Digestive Function

SCFAs provide 5-15% daily energy needs in humans (~30% in some animals)



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Hooper et al, 2002

Enhance Immune Function: T & B Cells, Cytokines migration

6

Antibiotics

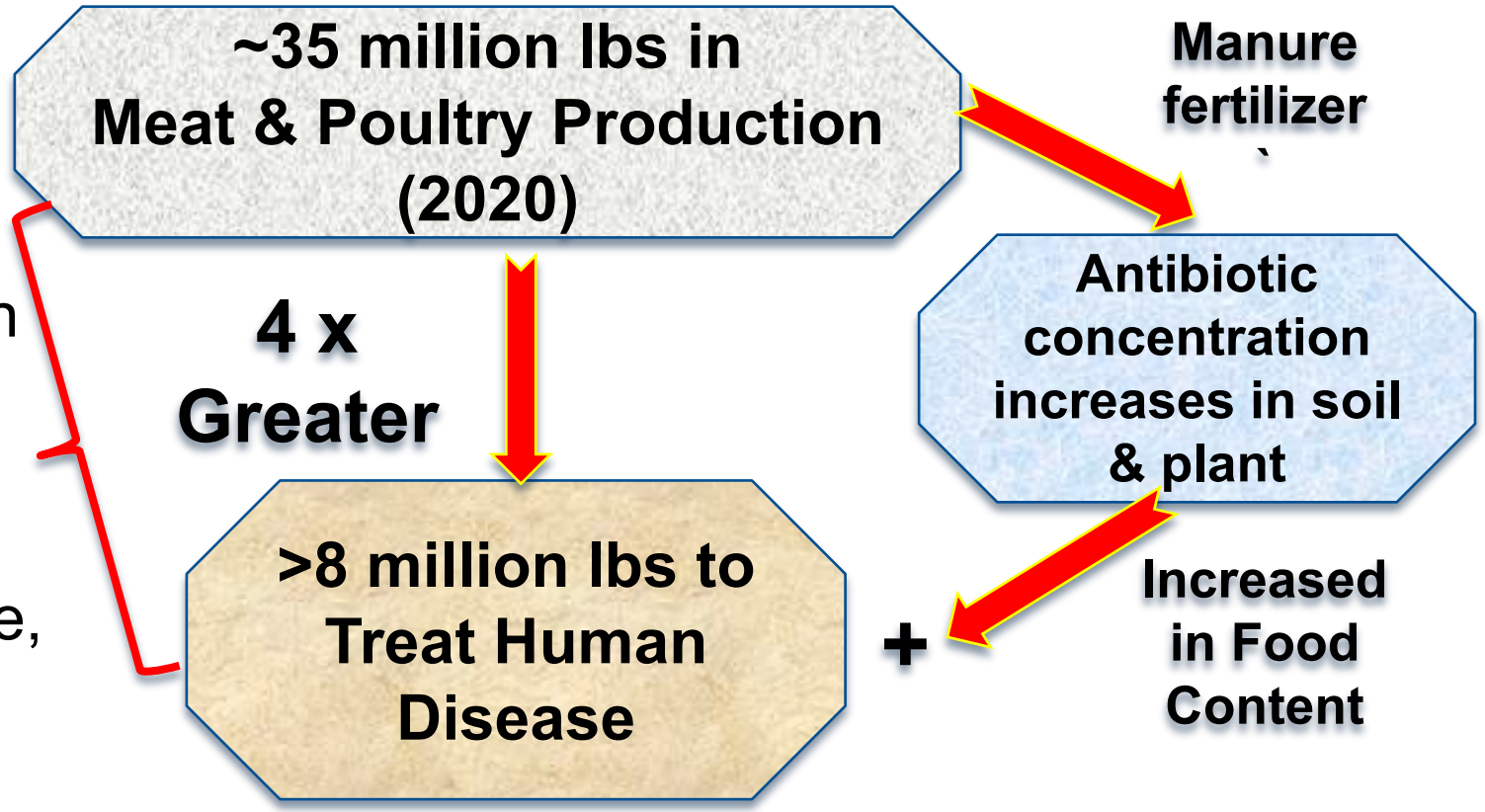
~ 80% sold in US for Animal Production

Reasons: 1. Decrease GI infections in cows
2. Increase weight of the animals

→ ~50% of Beef/Poultry still given antibiotics

Situation today:
Increased risk of
Allergies & Food Sensitivities
- Especially if antibiotics used in 1st 2-3 yrs of life (~7-10 regimes)

- Can adversely program body systems for the remainder of life, especially **Immune System**



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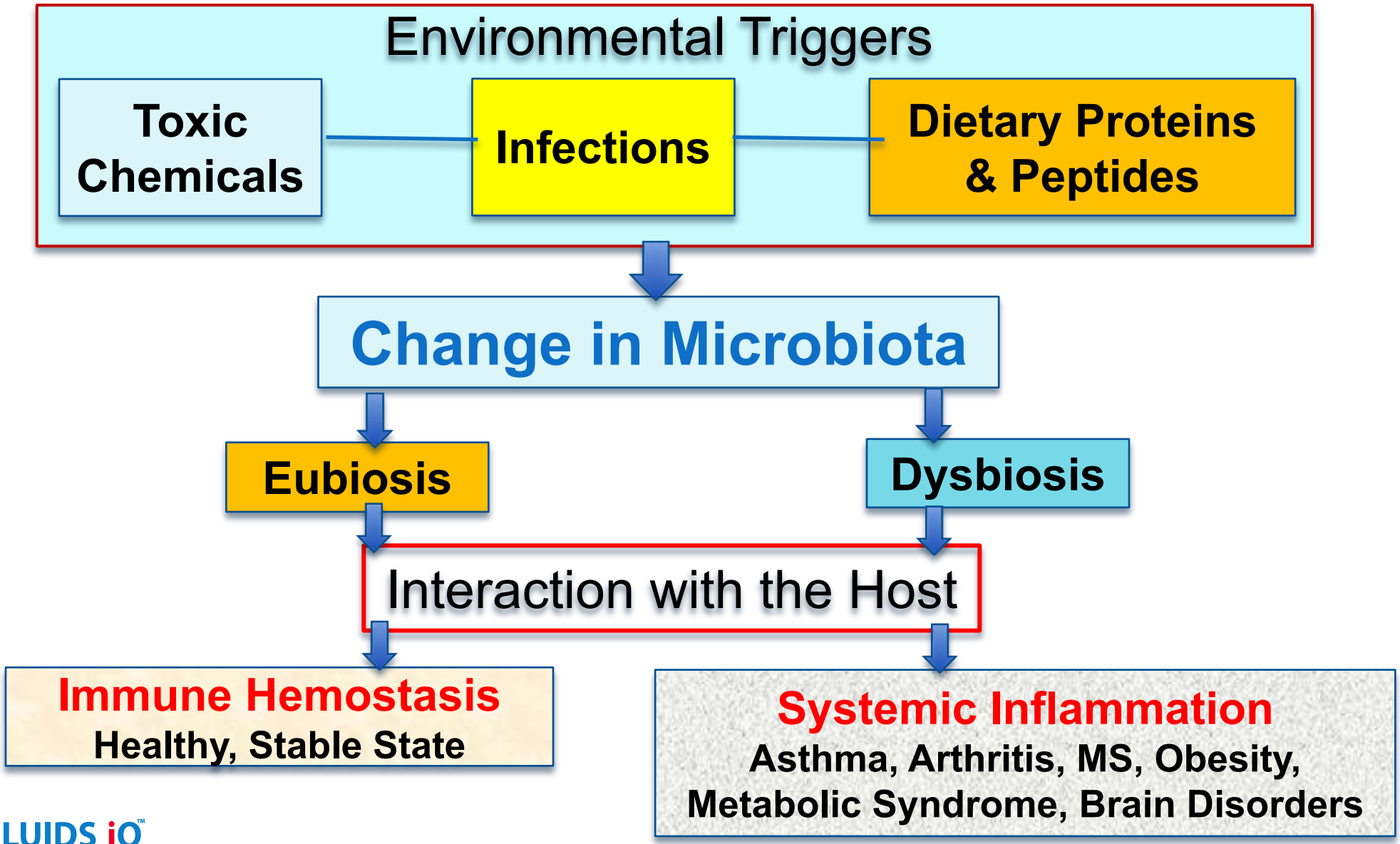
CIDRAP, 2020

Alteration in Gut Microbiota

Vojdani, 2015



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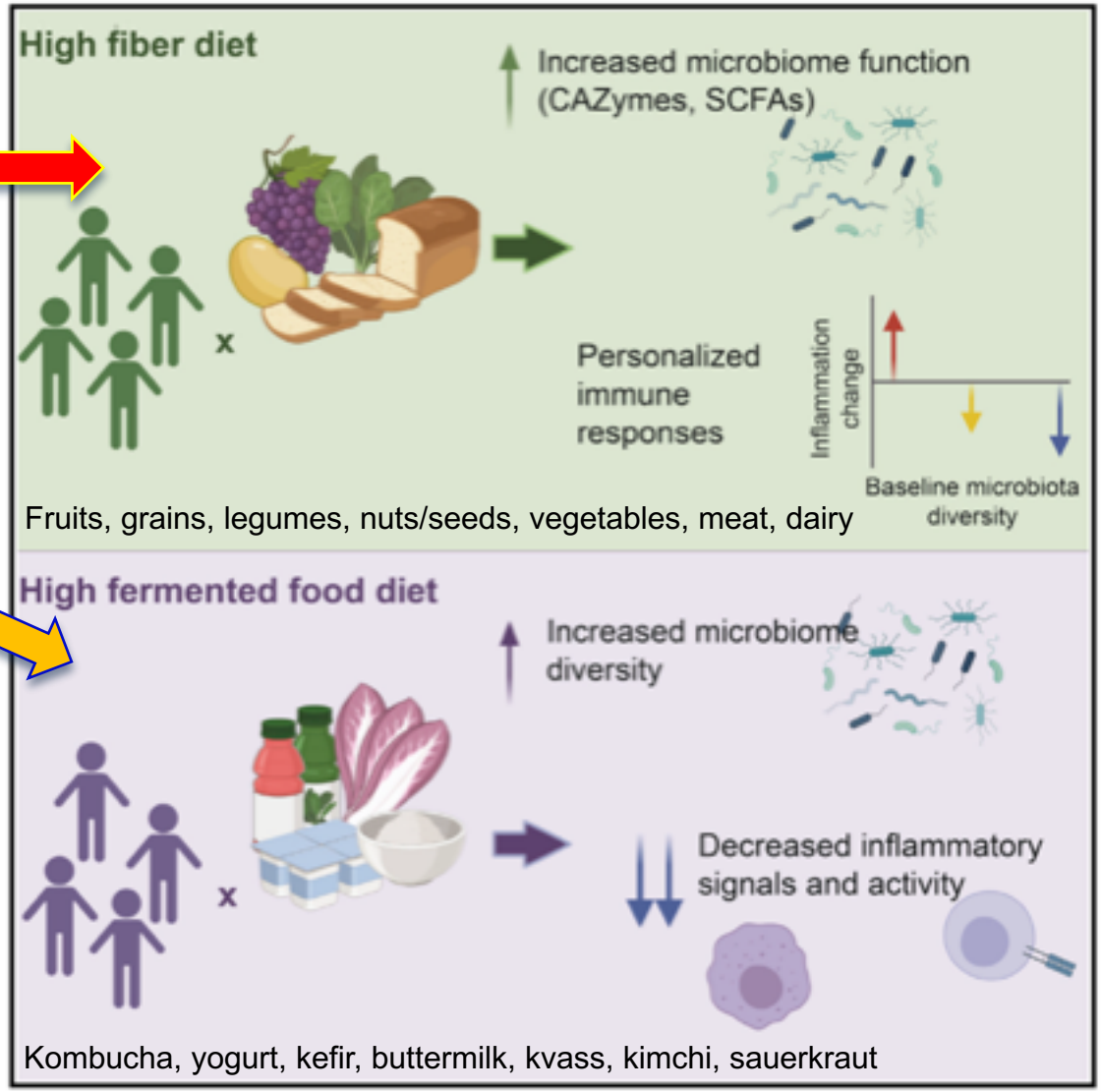
New Information

Wastyk et al, Cell, 2021

Gut Microbiota-targeted Diets Modulate Immune Status

- **Plant-based, High-fiber diet:** Increases some microbiome function & elicits personalized immune responses
- **High Fermented-food diet:** Increases microbiome diversity & decreases inflammation markers (19)
- **'Fermented Foods powerful modulators of human microbiome- immune system axis**
- **Provide avenue to combat Non-Communicable Chronic Diseases'**



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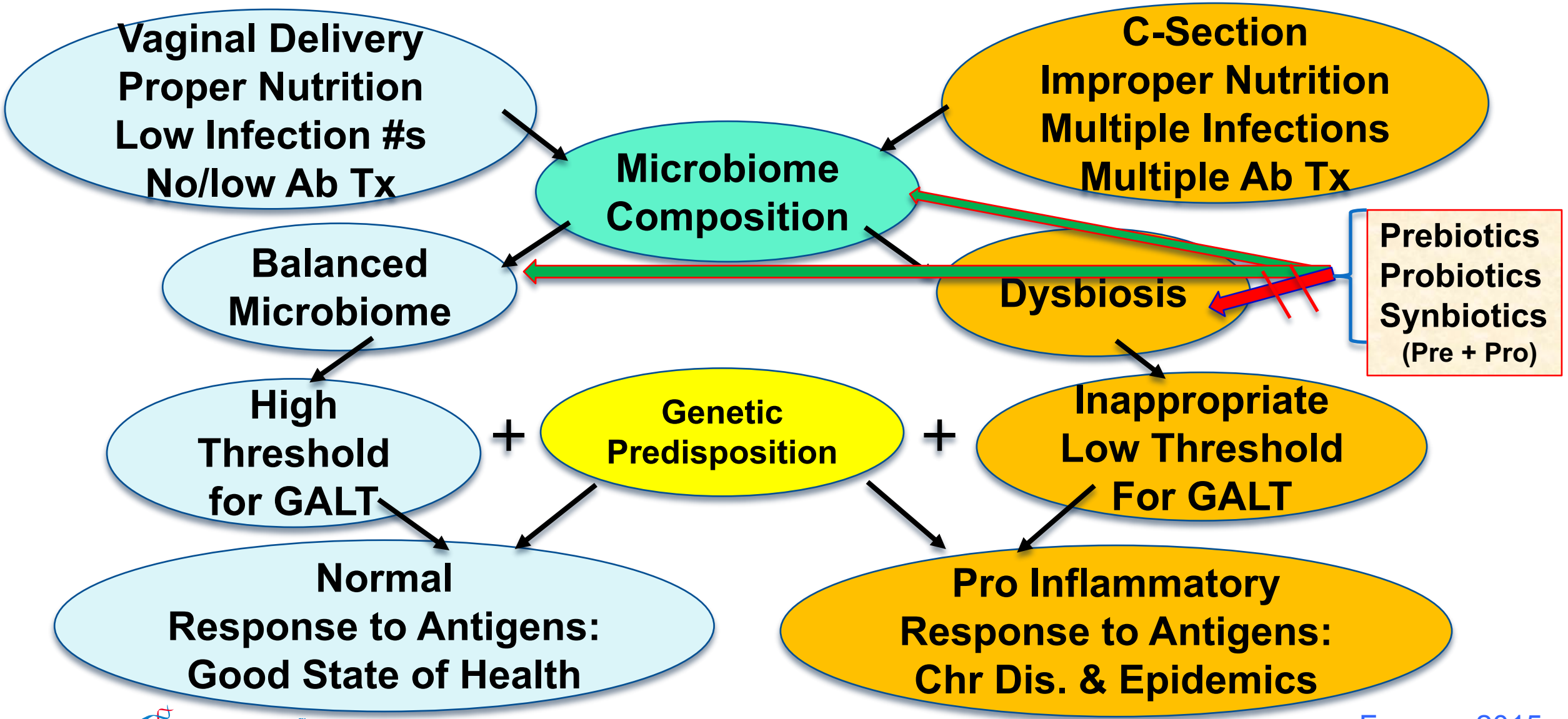
Importance of 1st 2-3 yrs in driving CID & AI Epidemic



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GALT=Gut-Associated Lymphoid Tissue

Fasano, 2015

Gut Instincts

Gut Feelings

‘Go with your Gut’

‘Always trust your Gut, it knows what your head hasn’t figured out yet’

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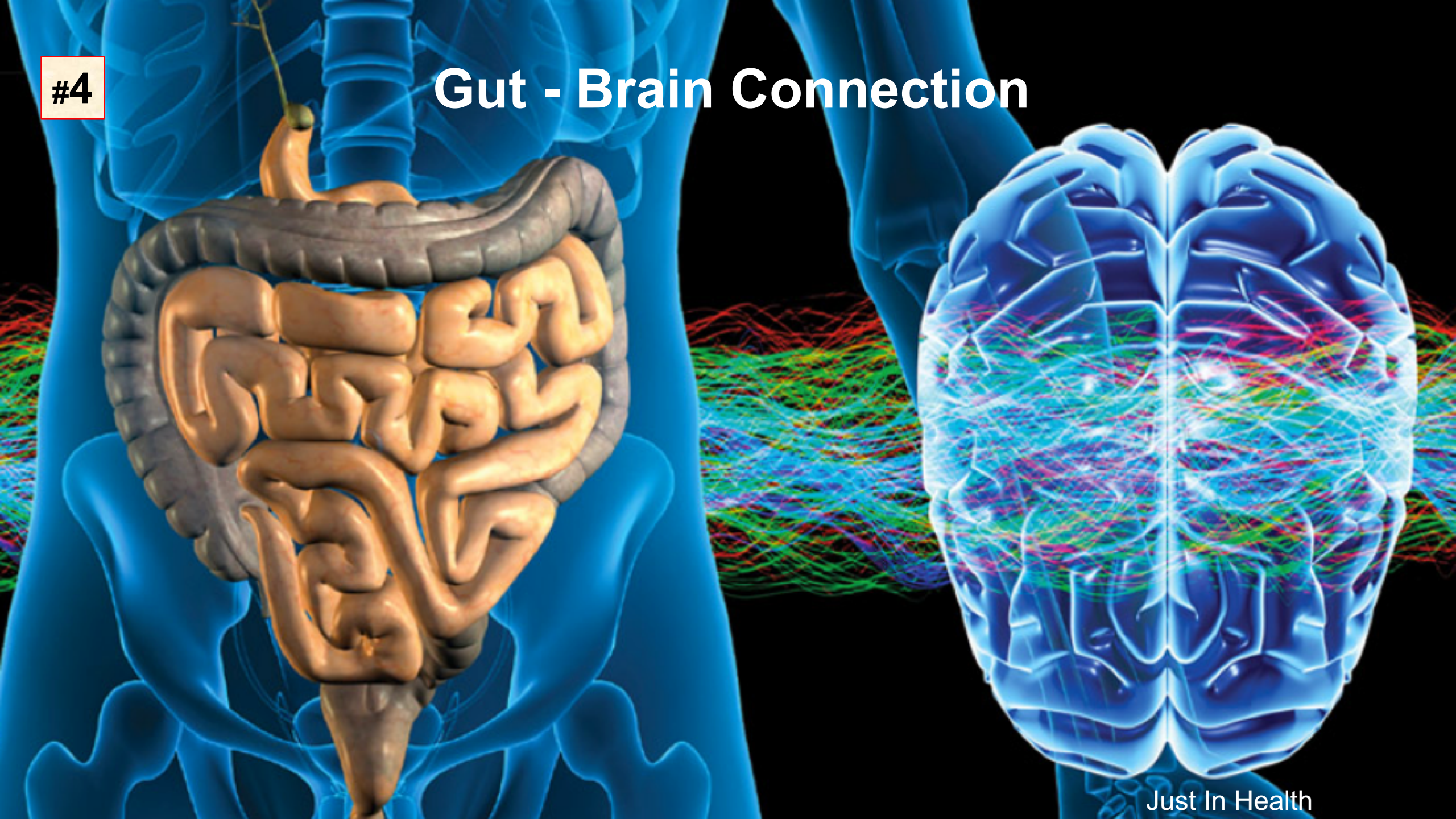
#4

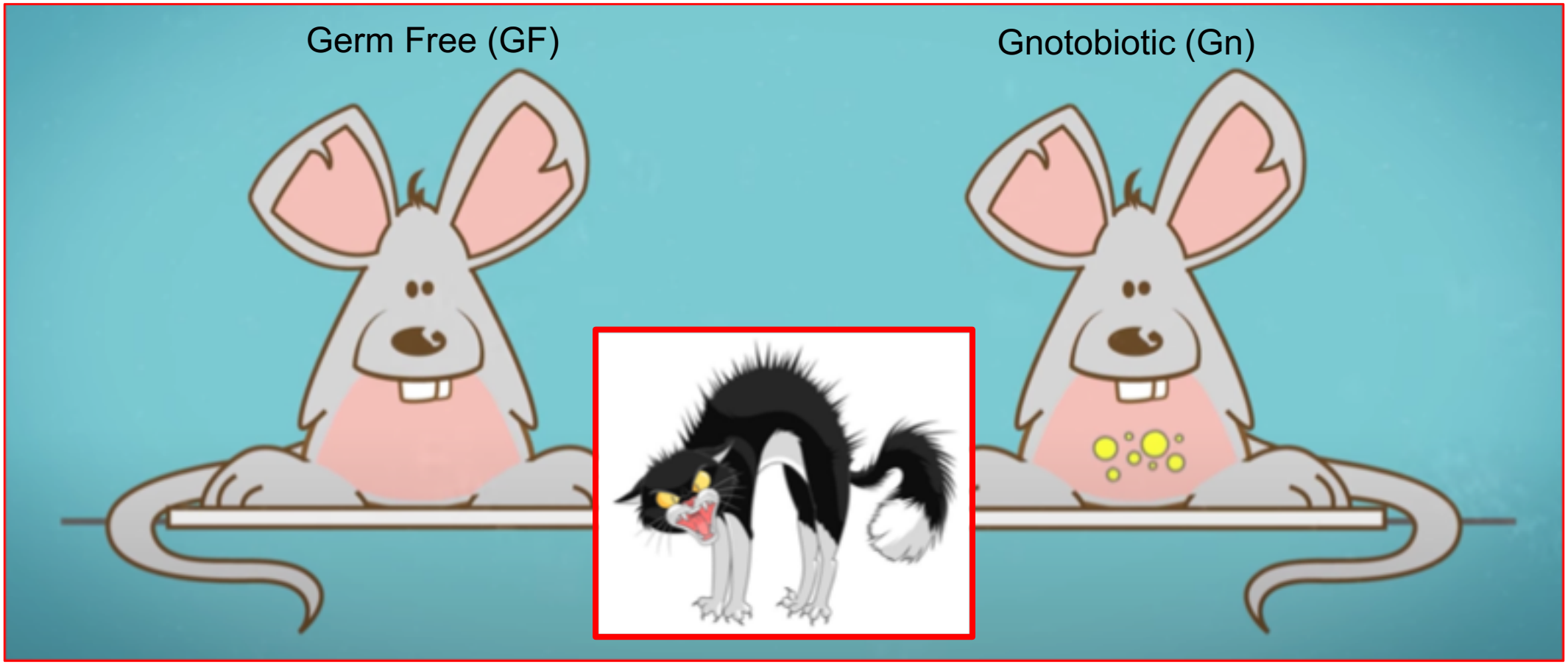
Gut - Brain Connection



Just In Health

The Brain - Gut – Microbiome Axis

- Exaggerated **HPA stress response** by GF mice
- Reversed by reconstitution with *Bifidobacterium infantis*



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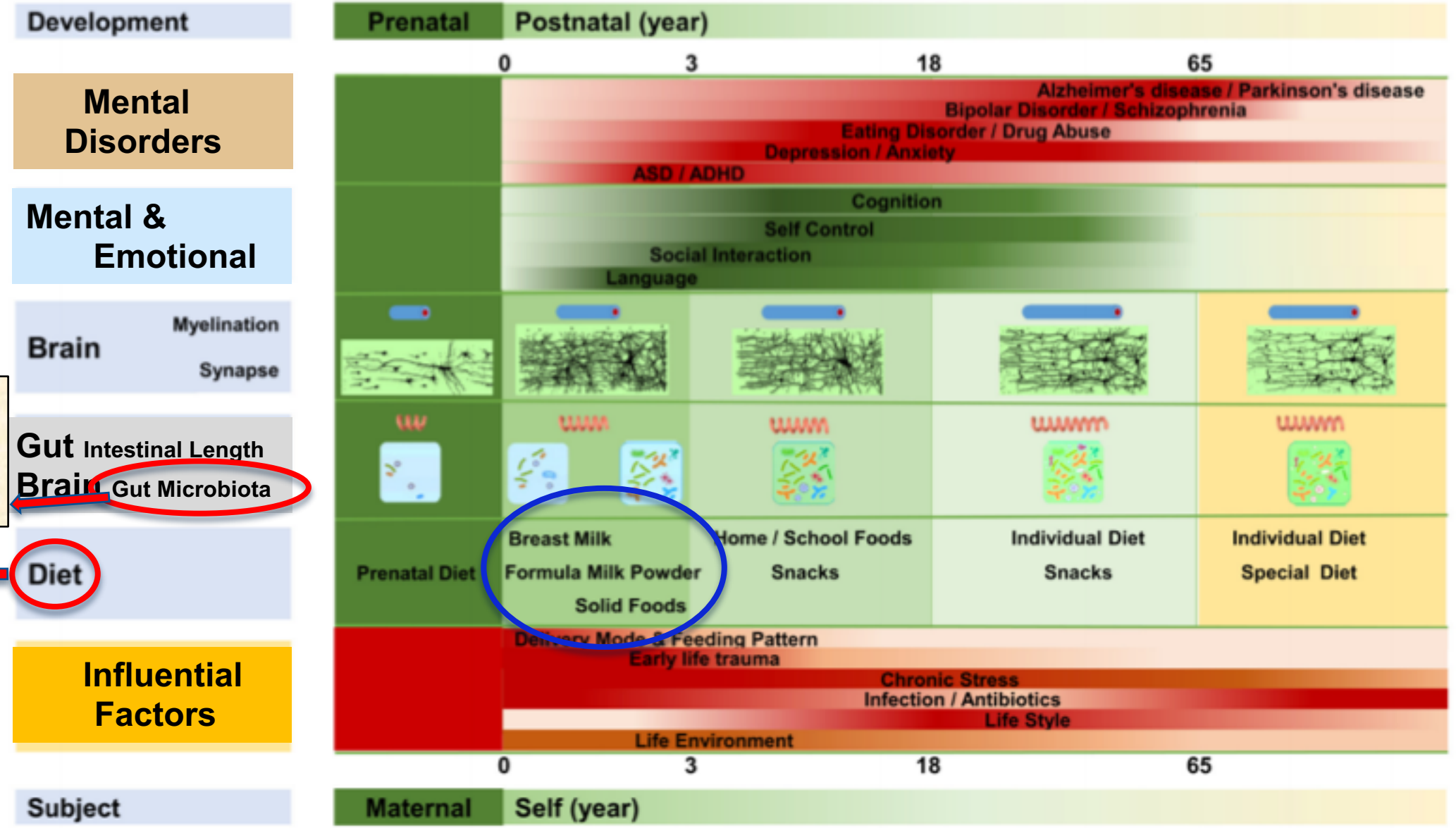
Gnotobiotic Mice = Microorganisms known and controlled

Sudo et al, J Physiol, 2004

Liang. Front Integ Neurosc, 2018

Gut-Brain Development & Interaction through Life



If Dysbiotic:
↑ ed incidence of Mental Disorders

Key Role

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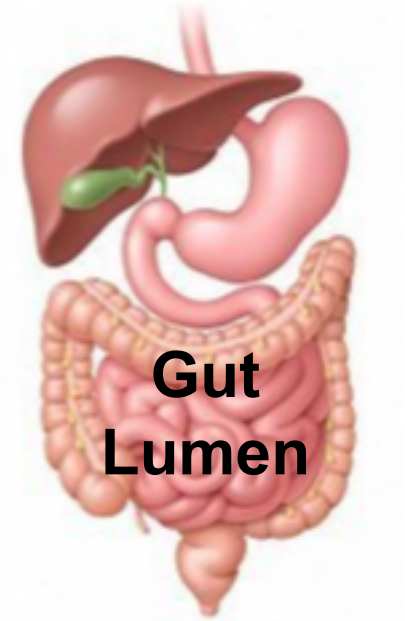
Gut-Brain Axis



Chemical

&/or

Mechanical Signals

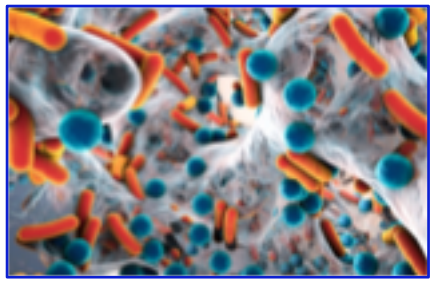
CNS
- Integration
- Behavior

–

Hunger (Ghrelin)

or

Satiation (Leptin) **Signals**



Gut "Brain"
- Digestion
- Immune Defense

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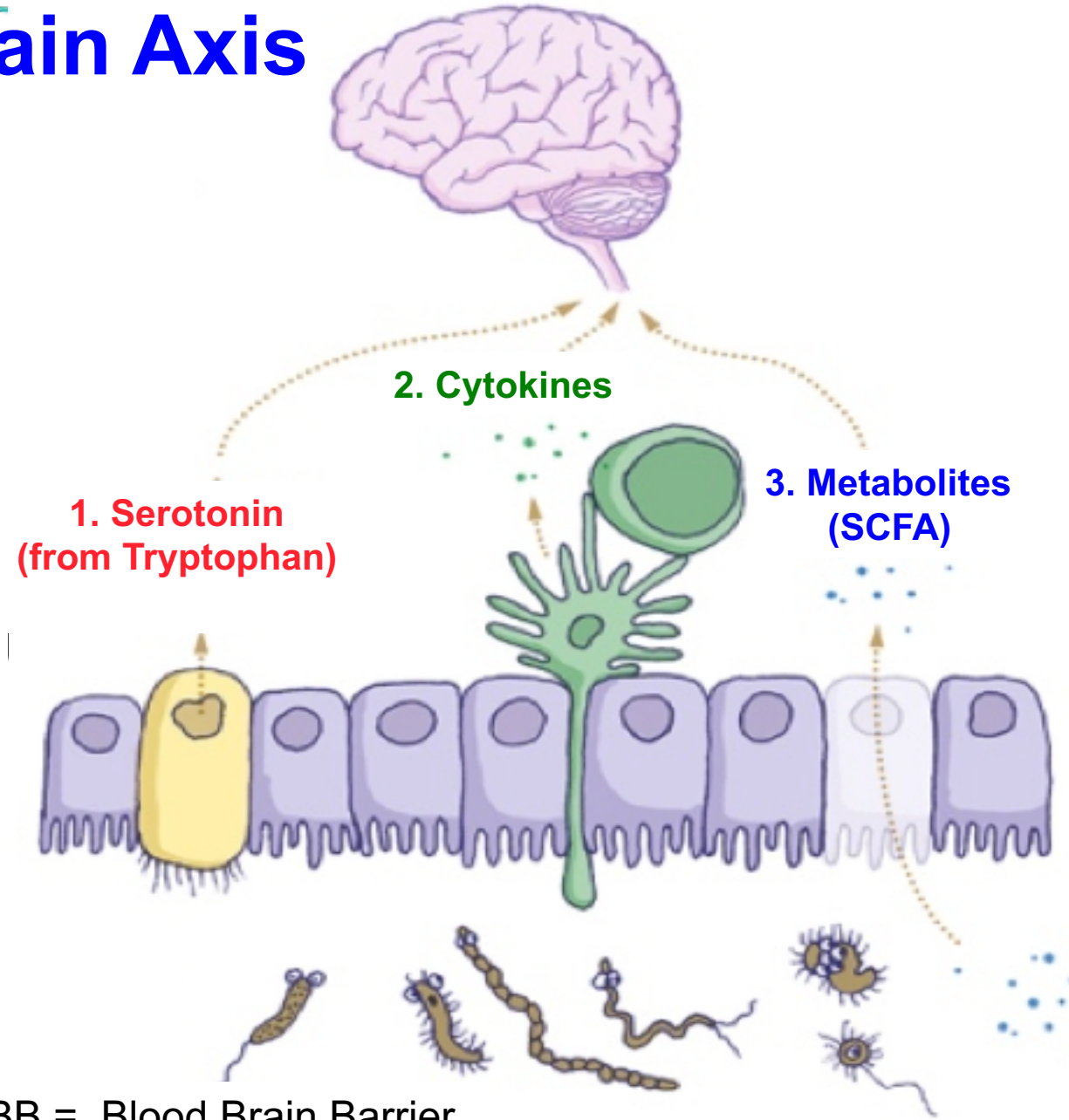
Watzke, 2015

Gut-Brain Axis

- 1. **Peripheral Serotonin**
  - Gut cells produce large quantities of Tryptophan, which forms Serotonin
  - Affect brain signalling
- 2. **Immune System**
  - Microbiome prompts immune cells to produce **cytokines**
  - Influences Neurophysiology
- 3. **Bacterial Molecules**
  - Microbes produce **Metabolites:**

    Break down Carbohydrates to Short Chain Fatty Acids (SCFA) like **Butyrate**
    Fortifies BBB* by tightening cell connections



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* BBB = Blood Brain Barrier

Precursor to Brain Chemistry: Neuroactive molecules

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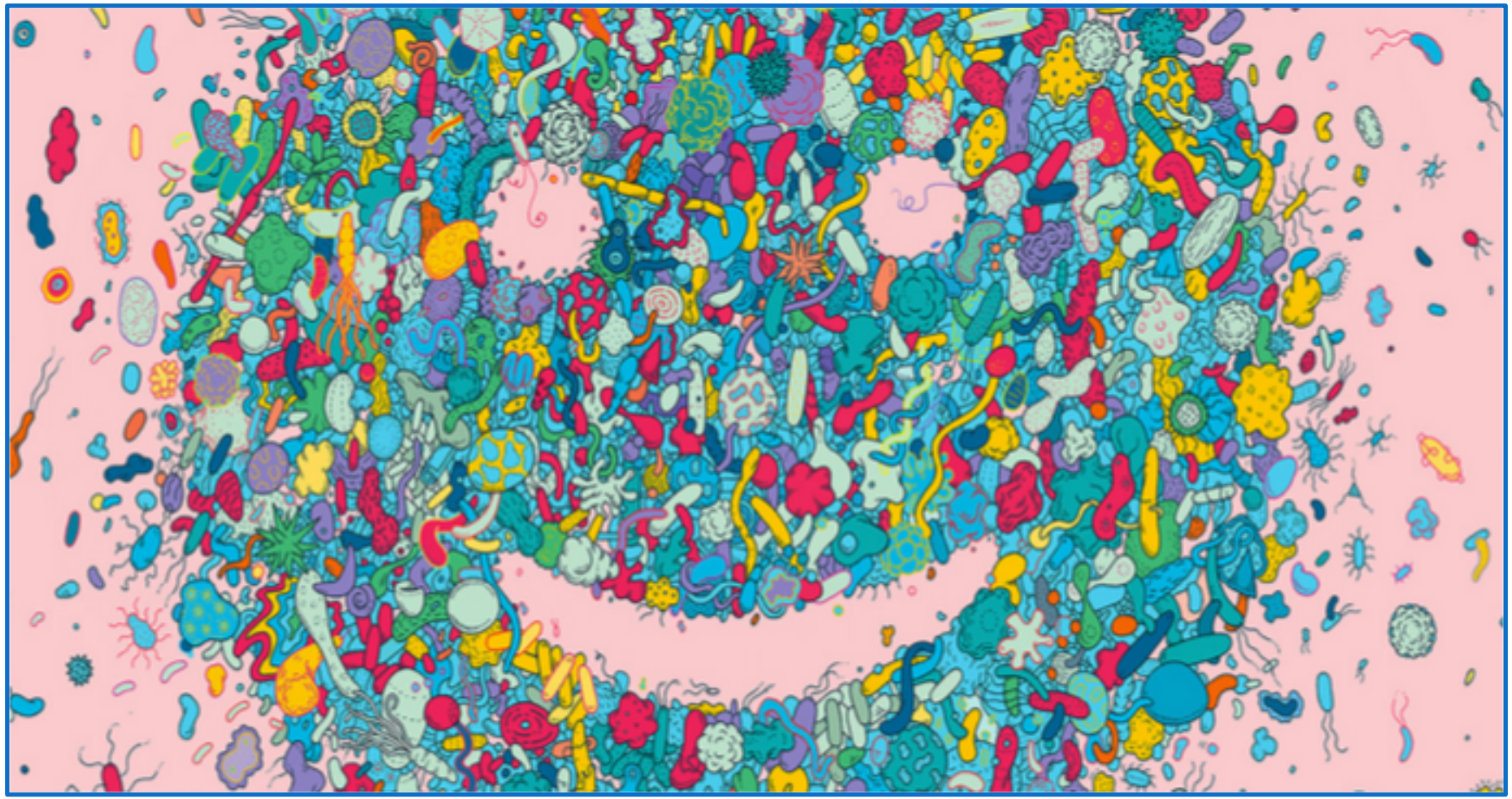
Gut Bacteria and Mood



P.A. Smith: NY Times - June, 2015

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Gut Neurotransmitter Production

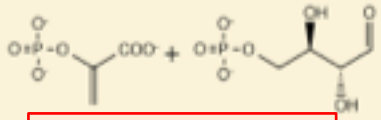
- Bacteria synthesize Tryptophan from a protein precursor for AAAs*, essential for many bacterial metabolic pathways called:

Chorismate

Tryptophan → **Serotonin** → **Melatonin**

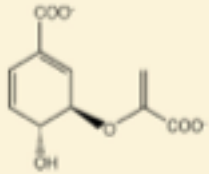
Tyrosine → *p*-Tyramine → **Dopamine** → **Norepinephrine** → **Epinephrine**

Phenylalanine → Tyrosine



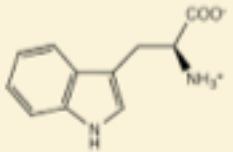
Sugar precursors

E. Coli & Protobacteria
Bifdobacteria species



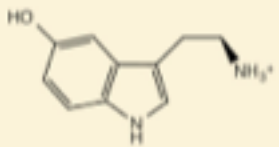
Chorismate

E. coli & Proteobacteria
B. subtillis & Firmicutes
Mycobacterium /Actinobacteria



Tryptophan

Intestinal epithelial cells



Serotonin

Bacteria have a Key Role in Neurotransmitter Production & Function

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*AAA=Aromatic Amino Acids

Sharon, Gill et al. 2014

Microbiota production of Neurotransmitters

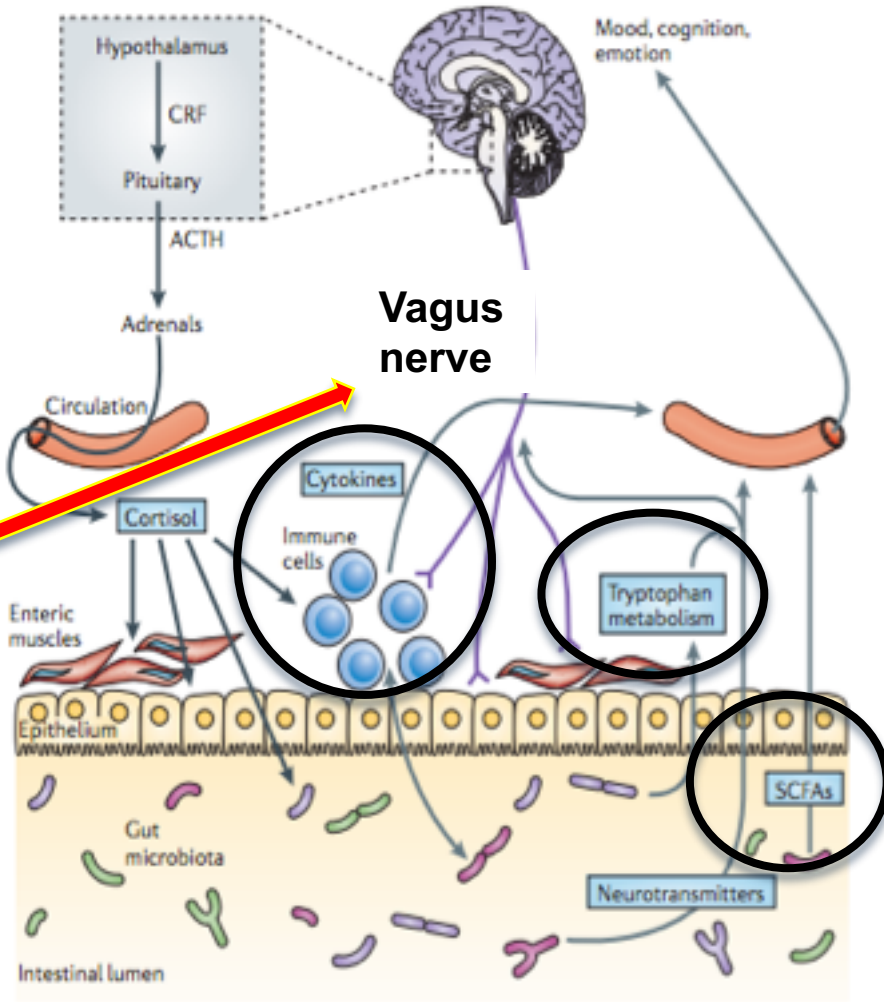
Anxiety Reduction via Vagus & GABA

Bravo et al, 2011

- *Lacto & Bifido:* **GABA** (main inhibitory neurotransmitter)
  - Alterations in central GABA receptor expression implicated in anxiety/depression

- *Escherichia, Bacillus, Saccharo*^{myses}: **Norepineph**
  Lactobacillus: **Acetylcholine**
- *Bacillus & Serratia*: **Dopamine**
- Candida, Strepto, Entero, *Escherichia*: **Serotonin**

- Neurochemical and behavioral effects not found in vagotomized mice.
  - **Vagus**: Major communication pathway between bacteria exposed to the gut & brain



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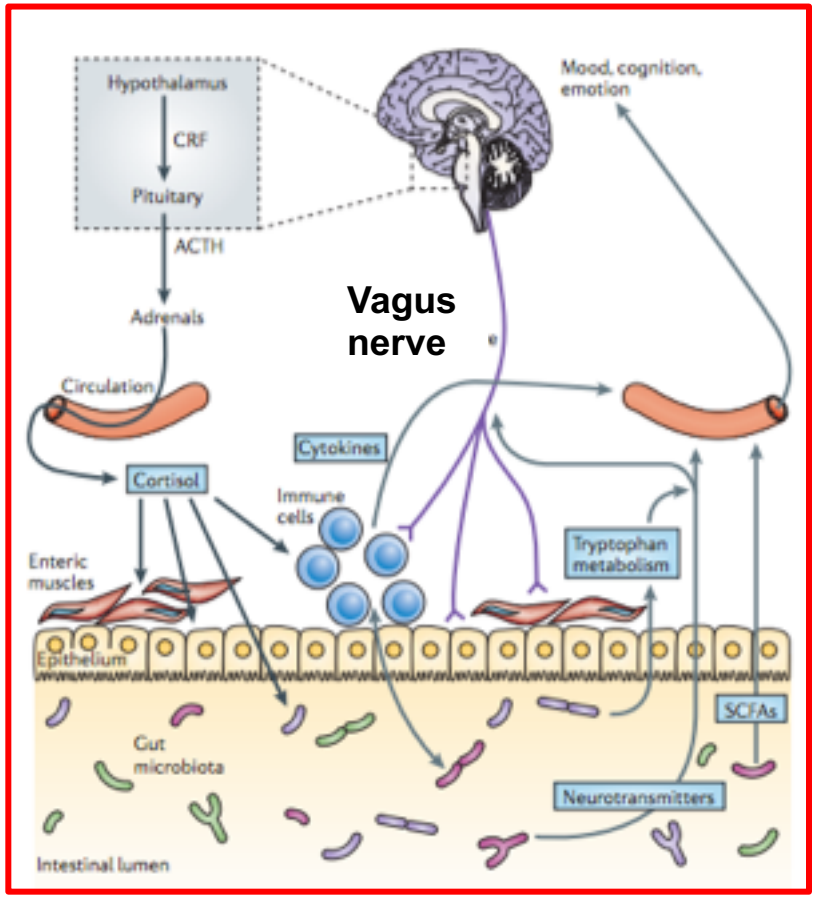
Gut Permeability, Bacteria, Inflammation, Brain & Behaviour

- **With Increased Intestinal Permeability, LPS translocation induces depressive symptoms**
- **Gut microbiota & probiotics can alter brain neurochemistry**
  - eg: *Lacto-farciminis* probiotic Tx prevented both stress-induced hypersensitivity & colonic paracellular hyperpermeability (rat model)
    - Prevents HPA axis stress response & neuroinflammation Belganoui, 2012



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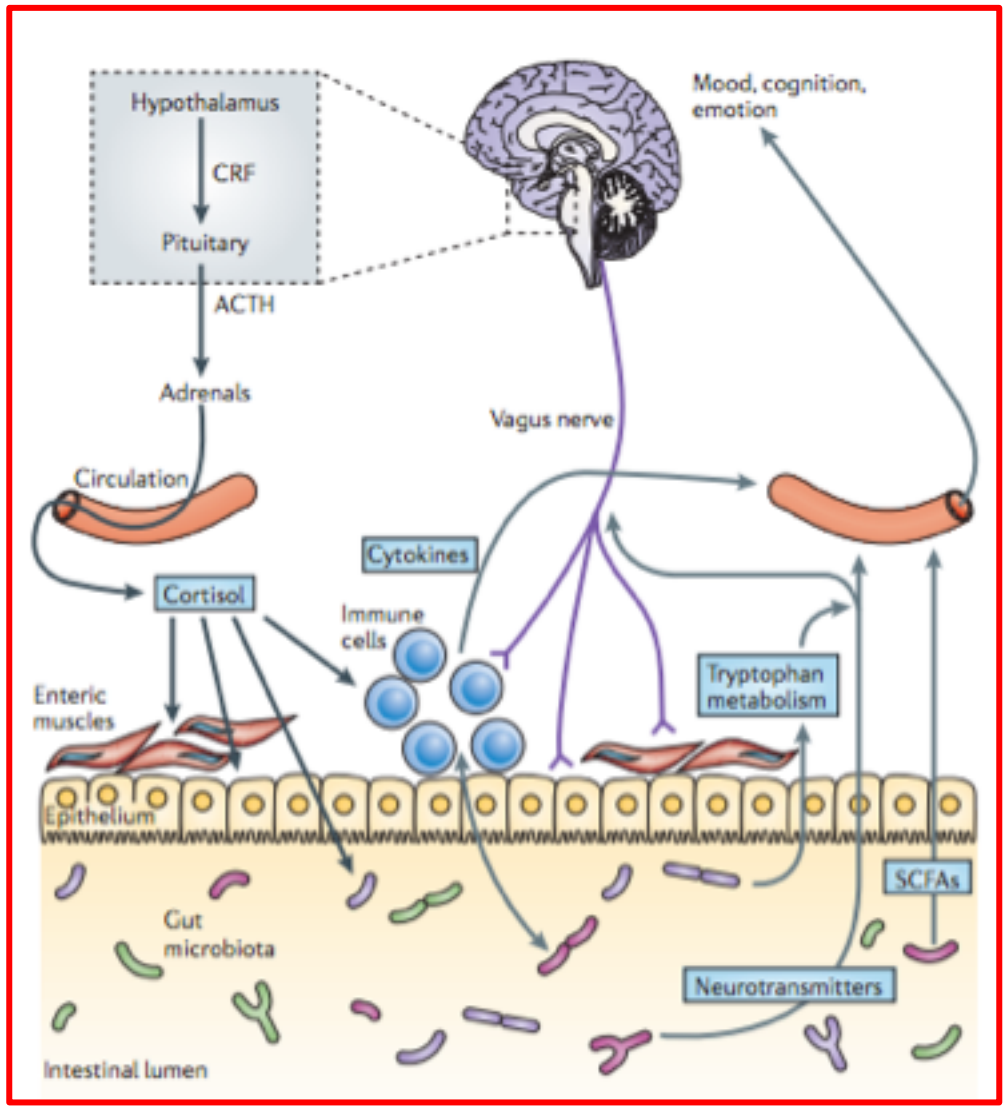
LPS = Lipopolysaccarides

Grenham et al, 2011; Cryan & Dinan, 2012

Microbiota production of Neurotransmitters

- **Conclusion:**
- Bacteria play an important role in bidirectional communication of the gut-brain axis.
- **Certain organisms may be useful therapeutic adjuncts in stress related disorders, such as anxiety & depression.**



Bravo et al, 2011

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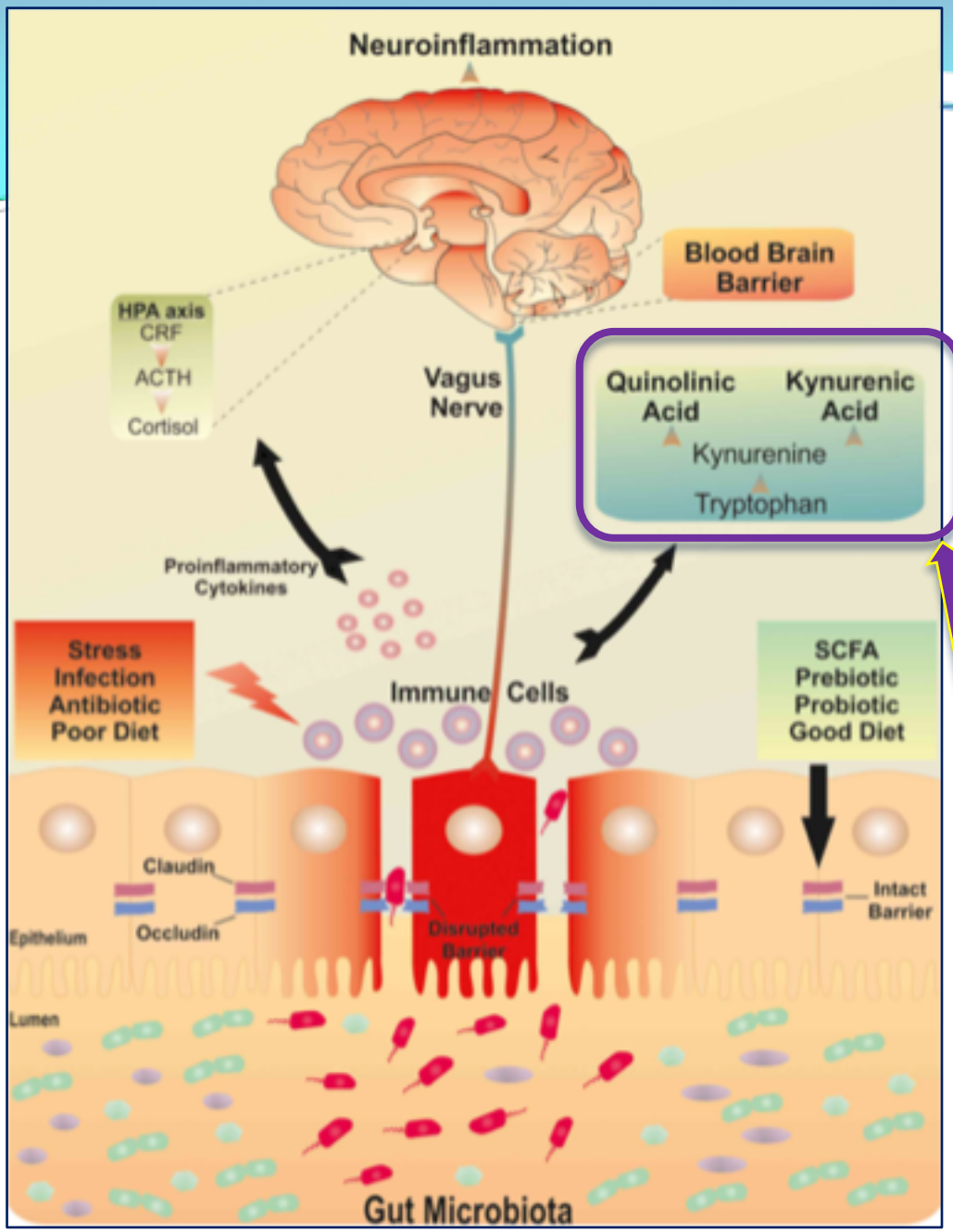
The Brain-Gut-Microbiota Axis during Dysfunction



" A dysfunctional intestinal barrier could permit a microbiota-driven proinflammatory state, with implications for neuroinflammation."

Tryptophan's normal pathway leads to production of:
Serotonin & **Melatonin**

If barrier dysfunction: Upregulates **Kynurenine pathway**
(by-product Quinolinic acid, catabolizes Tryptophan in liver)
Neurotoxin, gliotoxin, pro-oxidant & proinflammatory mediator

Kelly et al. Breaking down the barriers: the gut microbiome, intestinal permeability and stress-related psychiatric disorders. Frontiers in Cellular Neuroscience. 2015

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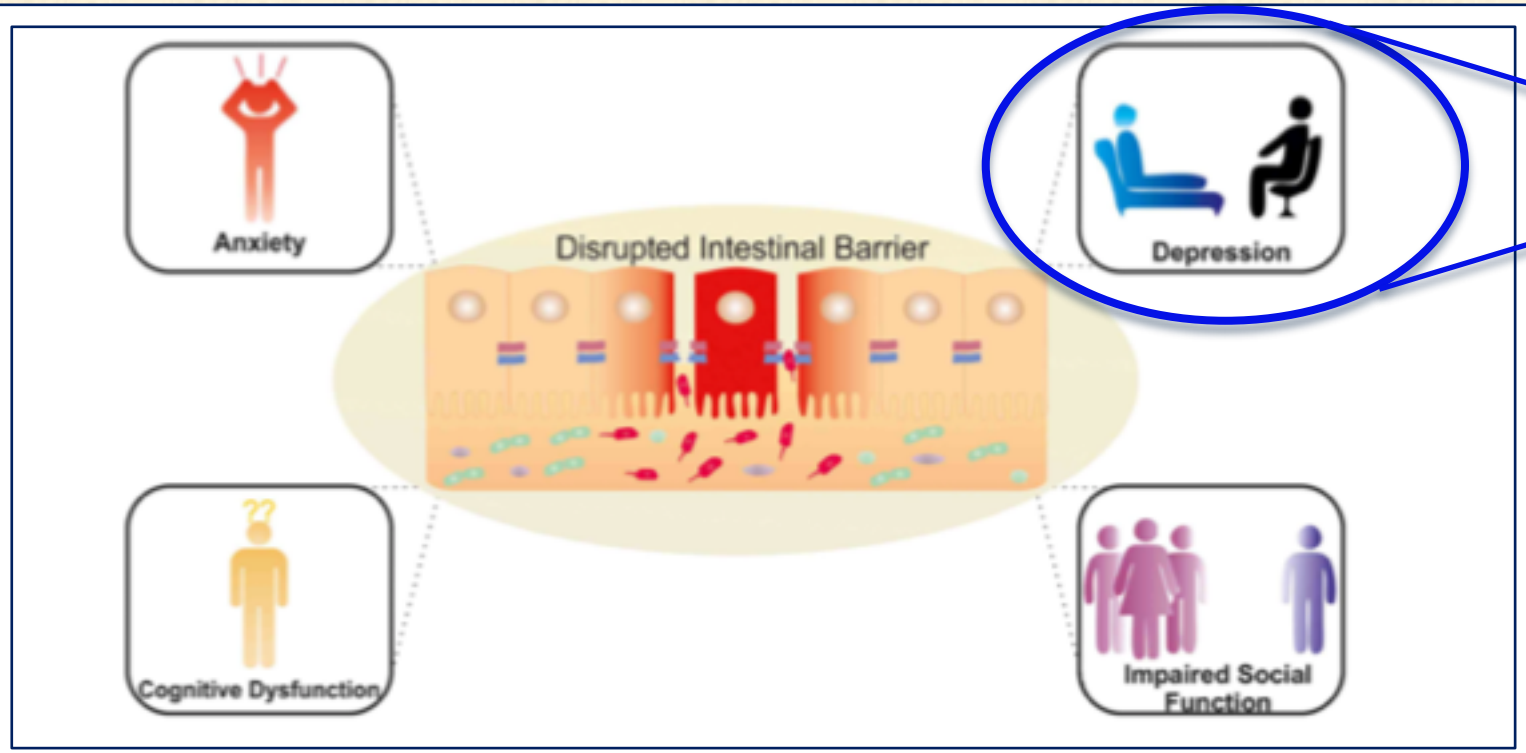
Intestinal Barrier Dysregulation

Potential Neuropsychiatric Consequences

Important role for gut microbiome in brain function & behavior Kelly, 2015



Stress, linked to compromised barrier function & microbiota disruption, may lead to systemic inflammation, mediating neuropsychiatric symptoms

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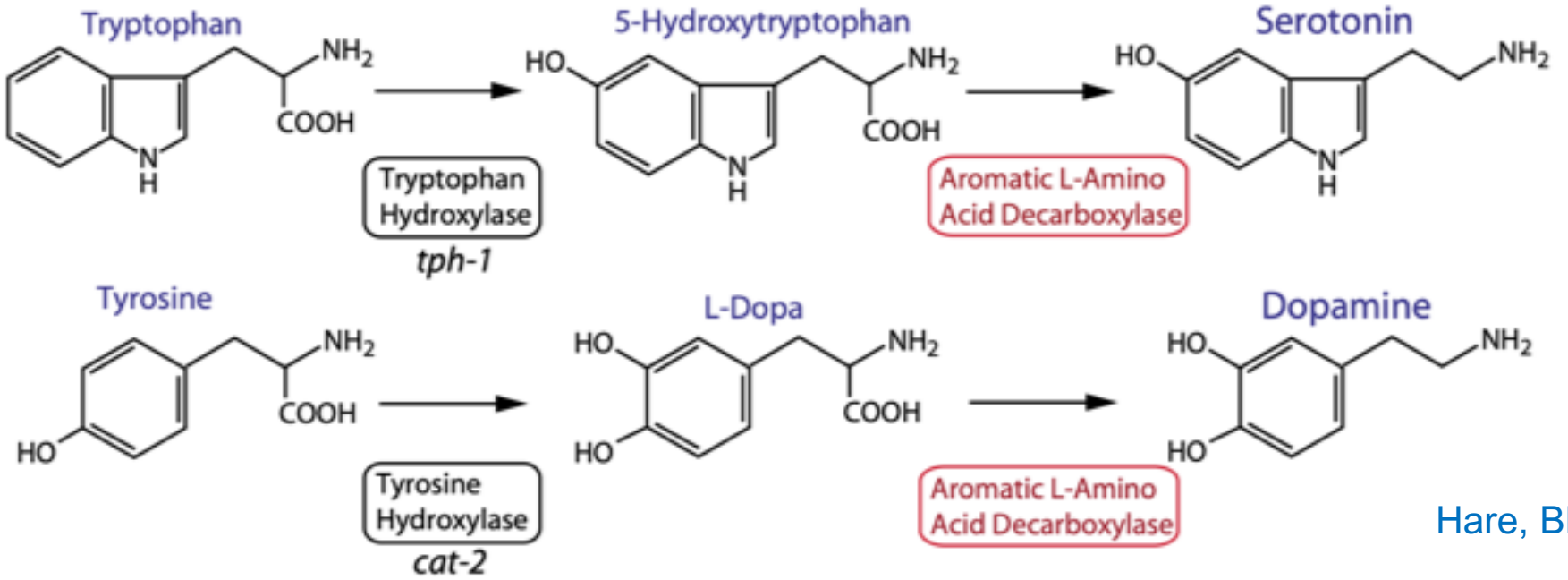
Kelly et al. Frontiers in Cellular Neuroscience. 2015

What is Depression?

A decrease in the speed of brain function

- **Reason? Imbalance** 1 2 3
  - Digestion (low essential AA), Insulin & blood sugar, Increased Intestinal Permeability
  - All lead to insufficient 'fuel' uptake from the **gut**
    - Often due to a dysbiotic environment & many rounds of **Antibiotics** 4
- **Result:**
  - Insufficient Neurotransmitters; leads to slower & abnormal brain function
- **Signs and Symptoms:**
  - Sleepy, 'brain fog', anxiety, **depression**; or the contrary imbalance of..
  - Insomnia, panic and aggression

Bacteria & the Serotonin/Dopamine Biosynthetic Pathways



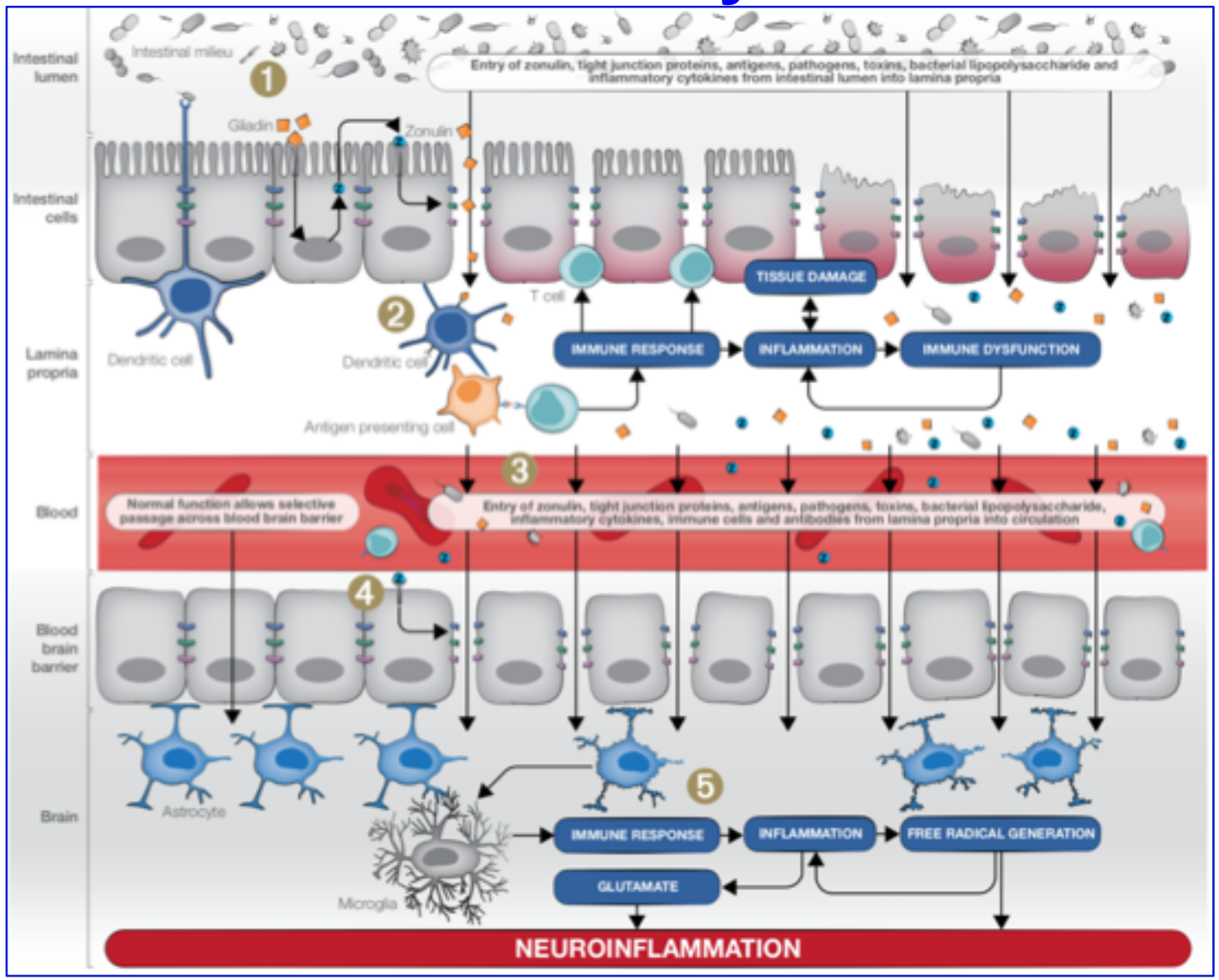
Hare, BMC Evol Biol, 2004

- Tryptophan & Tyrosine are 2 of 9 **'Essential Amino Acids'**

  Must come from **food or bacteria**
- Bacteria metabolize foods we cannot digest. Their resulting 'waste' is Tryptophan & Tyrosine, the precursors to **Serotonin** & **Dopamine**

Gut & Brain Permeability: Role of Zonulin

Lee, 2016



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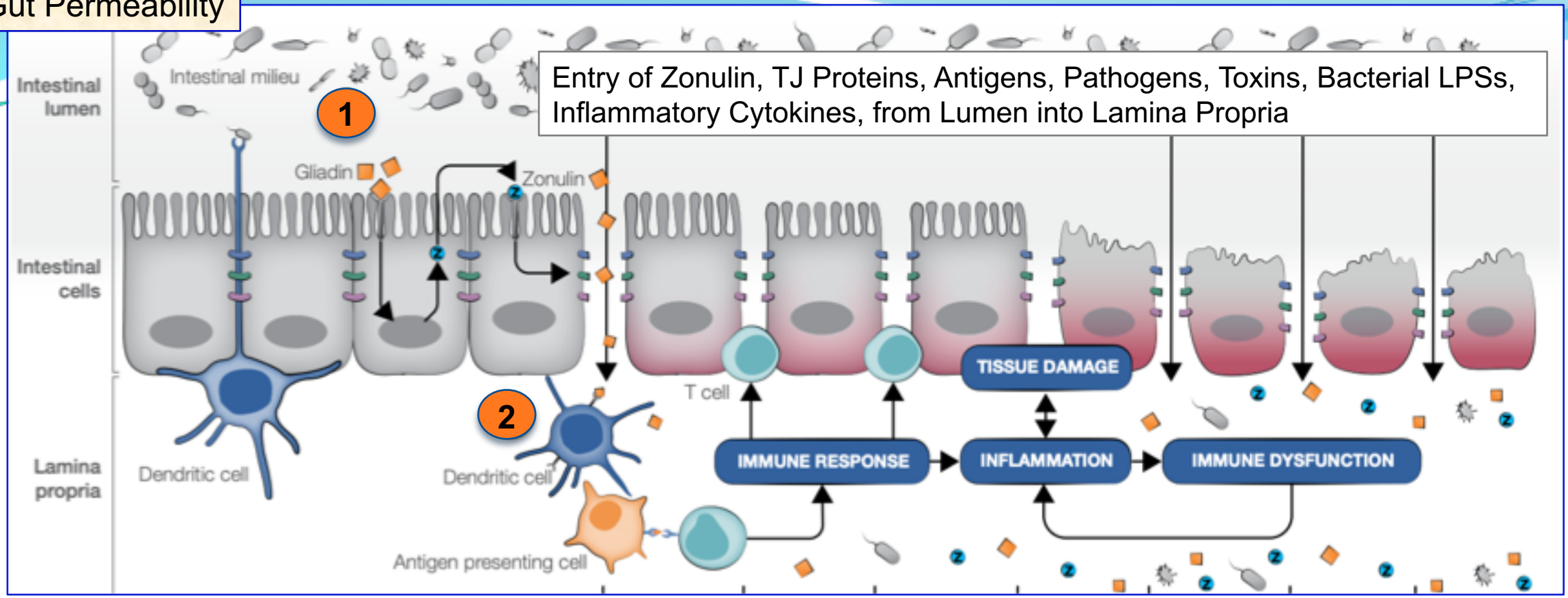
3 Gut Permeability



1 Zonulin:

- Triggered by pathogenic bacteria & food antigens, such as gliadin
- Opens TJs & increases permeability
- Result: Increased passage of stressors into lamina propria

2 Development of Immune Response:

- Exposure to stressors triggers immune response & inflammation
- Inflammation & tissue damage increase IP, creating even greater passage of stressors & immune response
- Interaction with HPA axis & neurotransmitter metabolism

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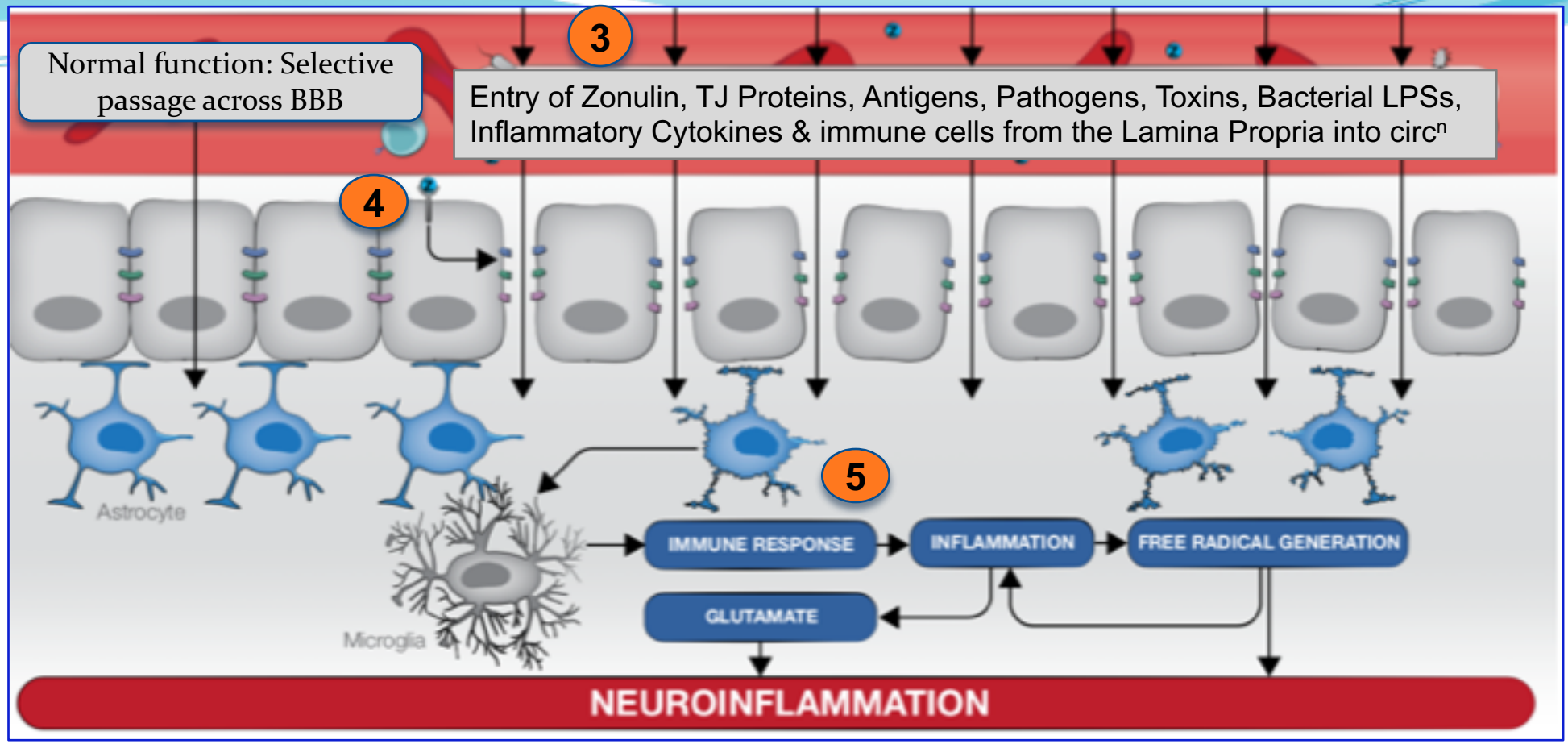
Lee, 2016

3 Gut Permeability



3

Stressors enter Circulation:

Zonulin, TJ proteins, antigens, pathogens, bacterial LPS, toxins, inflammatory cytokines, immune cells & antibodies

4

BBB Dysfunction:

- Zonulin binds to BBB receptors, stimulating TJ opening & increasing permeability

5

Immune Response - Neuroinflammation:

- Damage to astrocytes. Immune response stimulated by microglia
- Passage of stressors, inflammation & ROS - **Neuroinflammation**
  - Mood disorders, cognitive decline & neurological dysfunction

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BBB = Blood Brain Barrier

Lee, 2016

Lurie et al. J Clin Psychiatry 2015;76(11):1522–1528

Antibiotic Exposure & Risk for Depression, Anxiety, or Psychosis:

- Changes in microbiota (dysbiosis) increase risk of several psychiatric conditions through neurologic, metabolic, and immunologic pathways.

- **Objective**: Does exposure to specific **antibiotic** groups increase the risk for depression, anxiety, or psychosis.

- **Results**: Risk for Depression/ Anxiety with all 7 antibiotic groups in study
  - Single antibiotic course / year associated with **~20 % > risk**
  - > 5 courses of antibiotics / year associated with **~50 % > risk**
  - ***Conclusion:*** **'Recurrent antibiotic exposure is associated with increased risk for depression and anxiety, but not for psychosis.'**

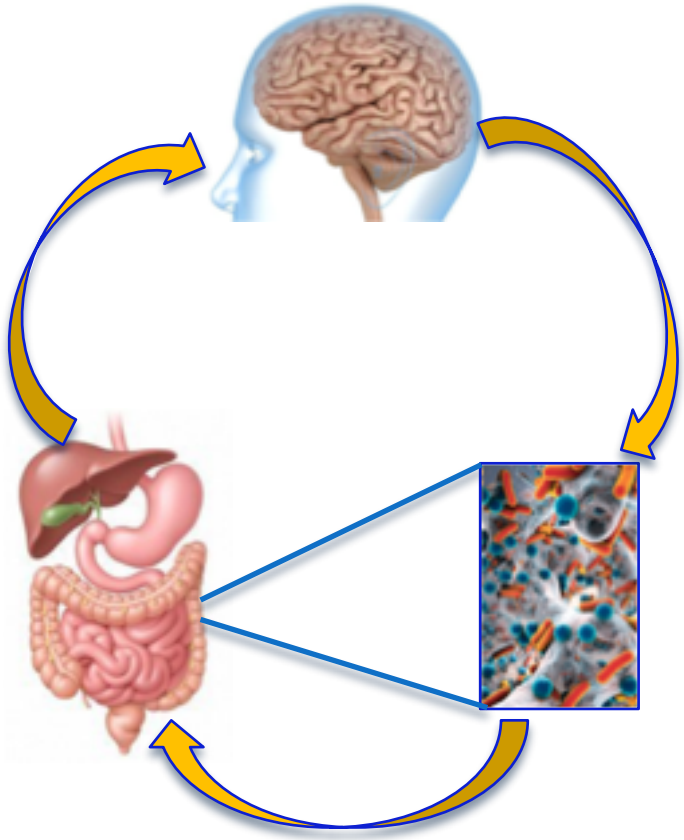
The Bidirectional Gut-Microbiota-Brain Connection

Ability of Microbiota to influence Brain: Behavior, Mood

Activation of Gut Neural Pathways to Brain

Activation of Gut Mucosal Immune Responses

Gut Metabolite Production directly affecting brain



Ability of Brain to influence Intestine & Microbiota

Modulation of Normal Gut Habitat via Stress-induced changes

- Enteric Cell Function
- Mucin Function
- Motility

Release of Neurotransmitters

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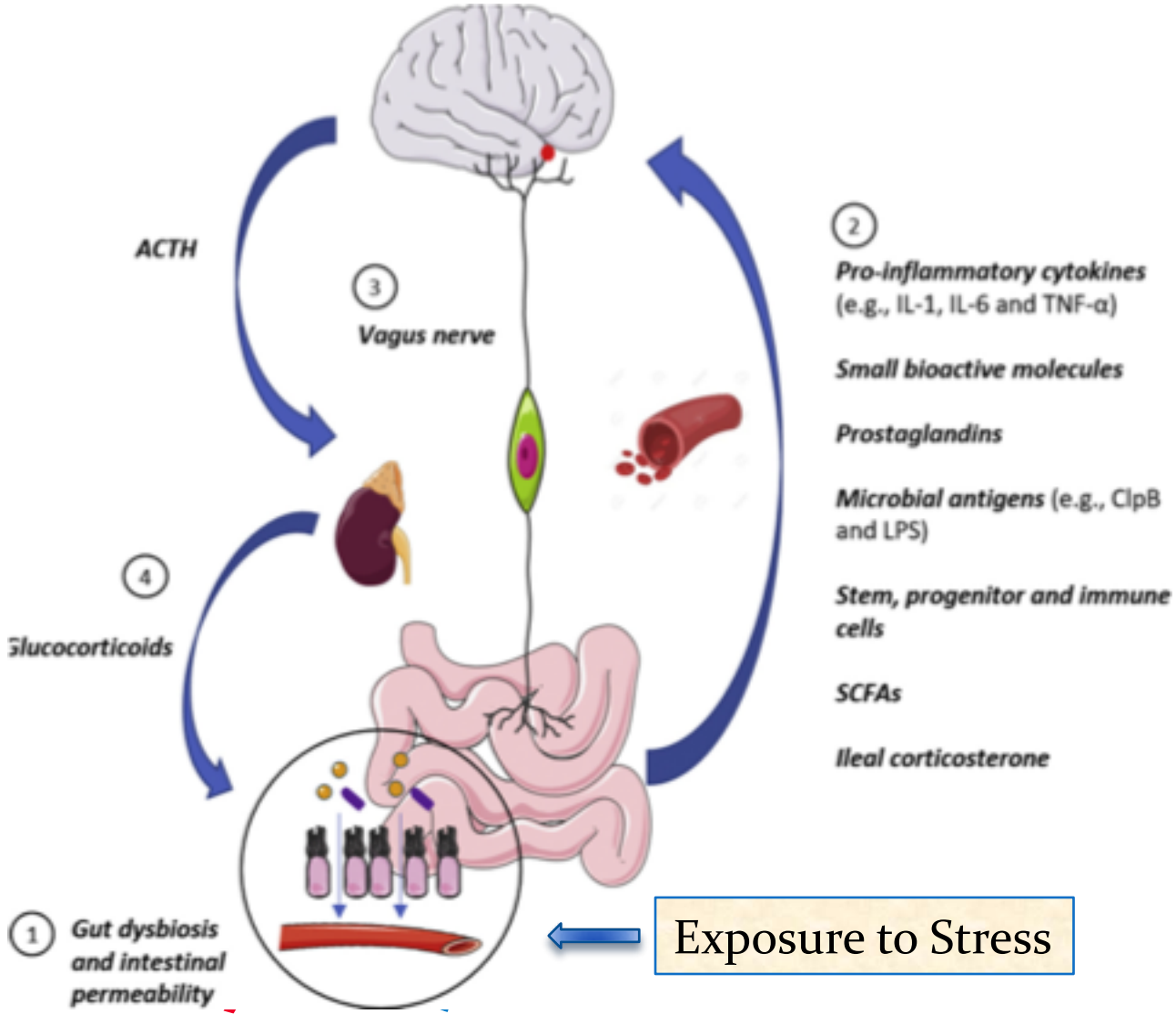
Grenham et al, 2011

New Information

Gut Microbiota & HPA axis: The Link

Misiak et al., 2020



- Bidirectional connection*: Endocrine/neural/immune/metabolic
- HPA axis dysfunction:
  - Subclinical inflammation, intestinal permeability & dysbiosis in pts with psychotic & mood disorders**
    - major depression, bipolar disorders, schizophrenia

- Lacto, bifido: **GABA & Acetylcholine**
- Escherichia, Bacillus, Sacchro: **Norep.**
- Escherichia, Enteroc: **Serotonin**
- Bacillus, Serratia: **Dopamine**

*Sun et al., 2019; **Pariante, 2017

For those who want more information on healing opportunities

#5

Natural Treatment of Anxiety & Depression

1. • **Meal Times**: Increase frequency to balance insulin levels
2. • **Supplements**: for gut repair & neurotransmitter support
3. • **Food choices**: Reduction of gut & body inflammation:
4. • **Exercise & Metabolism**

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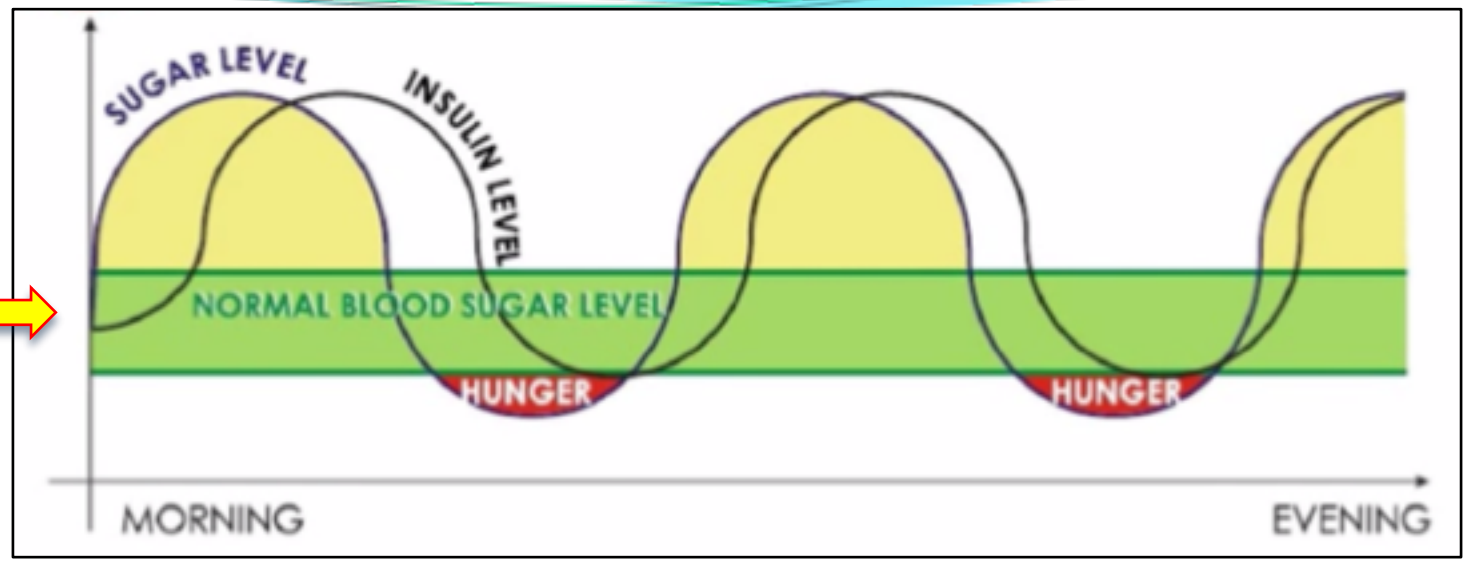
Balancing Sugars

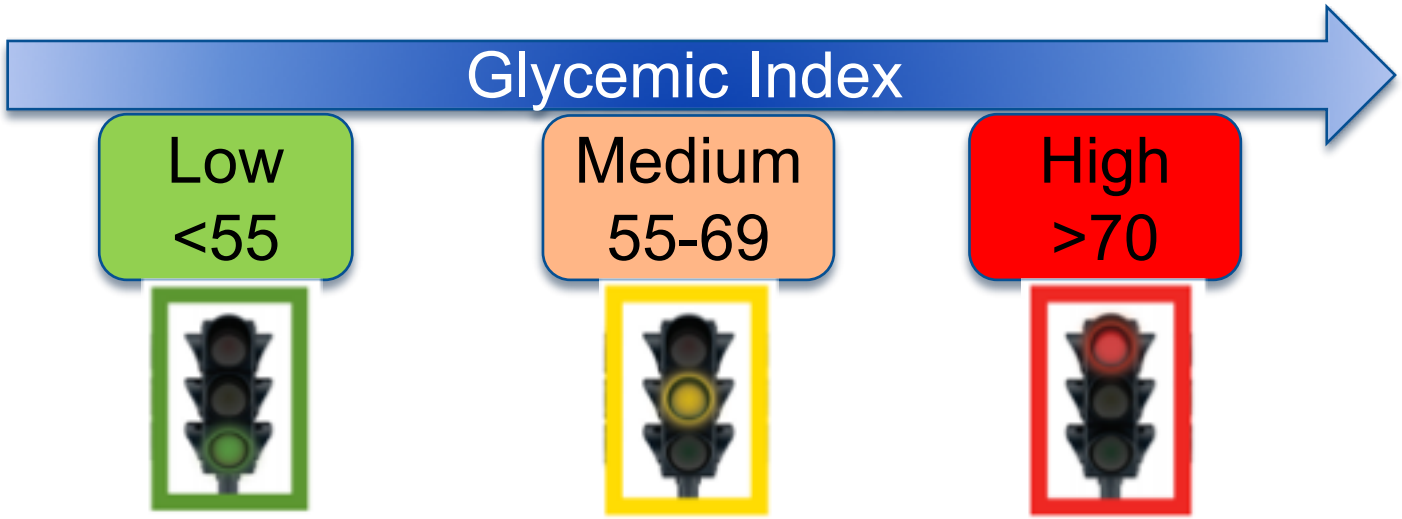
Brain requires balanced insulin & blood sugar levels to produce neurotransmitters



- Avoid high swings in blood sugar, since may cause:
  - Insulin resistance, inflammation & release of Stress hormones
  - Rise in epinephrine & cortisol levels, especially at bed time. Disrupts sleep cycle
- Skipping meals haphazardly can lower blood sugar, which may thin the gut wall, leading to allergies, bloating & pain

Rostenberg, 2016

Glycemic Index (GI): Food Choices



- GI: Scale that ranks carbohydrate-containing food or drink by how much they raise blood sugar levels after eating or drinking.
- Choose food combinations low in Refined Carbs & Starches.
- **Keep glycemic index as low as possible, to encourage steady energy production & fat burning metabolism.**

4 Key Supplements to help increase Serotonin levels

Melatonin: Lowers cortisol & catecholamines. Sleep essential for brain health

5-HTP: Crosses the BBB. Helps raise Serotonin & lower Dopamine

Methylation Factors: $B_{12, 9, 6}$ SAMe, TMG, Choline: Increase NT production

L-Theanine: AA that raises brain levels of GABA, Serotonin & Dopamine

5-HTP = 5-Hydroxytryptophan (AA in Biosynthesis of Serotonin)

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SAMe = S-adenosyl-L-methionine

TMG = Trimethylglycine (Betaine)

5 Key Supplements to help Gut Repair

Glutamine: Main AA for cell energy. In GI tract, helps reduce permeability

-Therapeutics: 30-100 gms/day for short periods

Probiotics: Strains of Lacto, Bifido, S. boulardii & Strept. thermophiles, in the presence of Fermented and Fiber-containing foods

Vit D_3: Reduces permeability by improving tight junction function

Betaine HCL: Helps optimize stomach acid levels: for digestion & absorption

HMOs: In breastmilk. Main nutrient for commensal **bacteria** in colon

- 22% women don't have it. Now available in powder form as a prebiotic

HMOs = Human Milk Oligosaccharides

S. boulardi = Saccharomyces boulardii (a yeast)

Organic Foods Essential: Pesticide levels 2021*

The Dirty Dozen

The Clean Fifteen

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*Environmental Working Group, 2021

Important Nutrients for Healing the Gut:

- **Bone Broth**: AAs & minerals, especially proline, glycine, L glutamine
  - Proline a precursor to collagen, needed for repair of cells & TJs. 8 oz: 2 x / day
- **Kifir**, or home made **Yogurt**: Fermented dairy the best prebiotic food
  - Contains lactobacillus which crowds out fungi
- **Fermented Vegetables**: Sauerkraut, kimchi, cocanut, kifir
- **Coconut oil**: Antimicrobial - Lauric & Capric acid: Medium chain triglyceride
- **Wild Fish**: Salmon, macheral, tuna; High Omega 3 FAs. Reduces inflammation
- **Sprouted Flax Seed**: High amount of soluble fiber (I tablespoon/day)
- **Steamed Vegetables**: Cauliflower, broccoli, squash, celery, carrots:
  - Nourishes spleen & colon

Aerobic Exercise and Metabolism

Exercise is essential for health and longevity

Aerobic fitness and endurance affects metabolism more than muscular strength

Kujala et al, JAMA, 2019

New Information

- Enzyme **NADPH oxidase 4 (NOX4)** essential for **exercise-induced ROS**.
- NOX4 (in mice)↑ in skeletal muscle after exercise, causing↑ **ROS.**
- Skeletal muscle NOX 4 abundance↓es with age & leads to↓ed insulin sensitivity
- Findings causally link NOX4-derived ROS in skeletal muscle **with adaptive responses** that promote muscle function and insulin sensitivity.
- These **adaptive responses** protect against developing insulin resistance, which otherwise occurs with aging or diet induced-obesity.

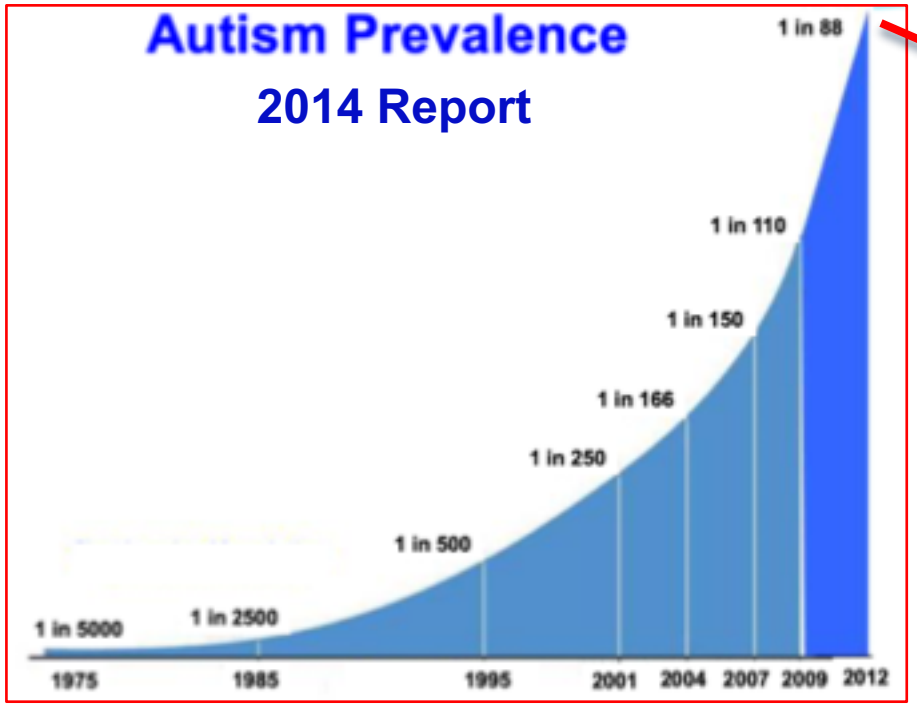
Conclusion:

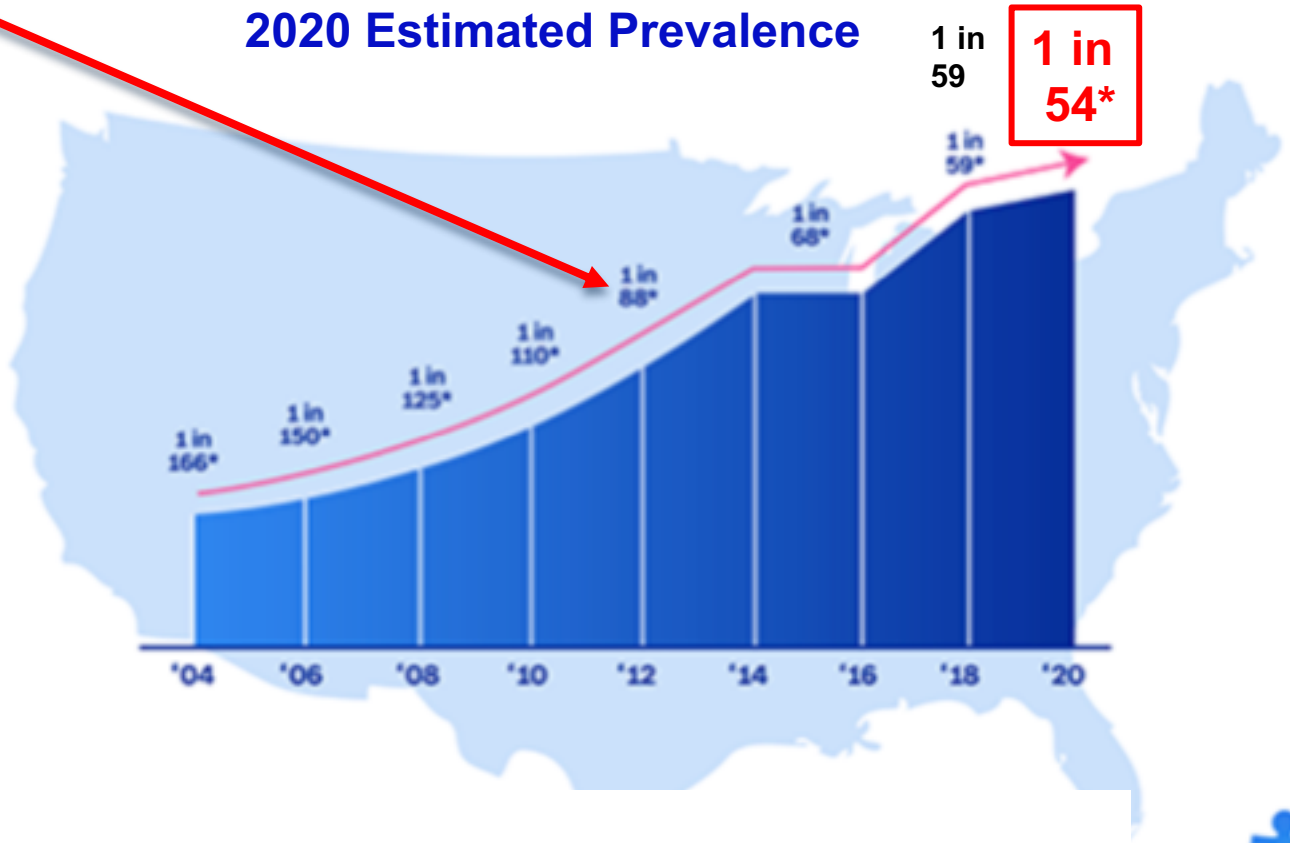
- **Importance of redox balance in metabolic health & new insight into pathophysiological mechanisms contributing to the T-2 DM epidemic in aging and with increasingly sedentary populations**

insulin resistance. Chrysovalantou et al. Science Advances. 7, Dec 2021

Back to the Main Topic: Gut-Brain Axis

Autism Spectrum Disorder (ASD) in USA:





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*CDC prevalence estimates are for 4 years prior to report date: eg, 2020 figures are from 2016.

autism speaks

New Information

The Microbiome and ASD

- "Apart from genetic factors, the gut microbiota…play a role in ASD"
- Children with ASD: **Distinctive & underdeveloped range, diversity & volume of gut bacteria**, not related to their diet.
- Microbiome functionalities associated with **neurotransmitter synthesis:** Markedly reduced in children with ASD.
  - May have profound consequences on the psychiatric abnormalities in ASD
- **Conclusion: 'Shifts in gut microbiota during early life development may have important functional roles in the pathogenesis of ASD.'**

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Siew et al, Gut, 2021

New Information

Autism Immune Problems Caused by Maternal Gut Bacteria

- Fetal exposure to maternal womb inflammation increases susceptibility to gut inflammation induced by bacteria, later in the life of the offspring
- During pregnancy, **IL-17A** (inflammation creator) is heightened following an infection
- Changes mother's microbiome & alters fetal brain development
- Affects offspring's immune system by altering the immune **CD4+ T cells**
- Change in immune development primes offspring for inflammatory attacks of the gut

- **Conclusion:**

  Maternal immune activation, due to infection during pregnancy, is a common environmental driver for the neurodevelopmental & immunological symptoms in individuals with ASD

Maternal gut bacteria drive intestinal inflammation in offspring with neurodevelopmental disorders by altering the chromatin landscape of CD4+ T cells. Kim et al. Immunity 55, 1–14, January 11, 2022

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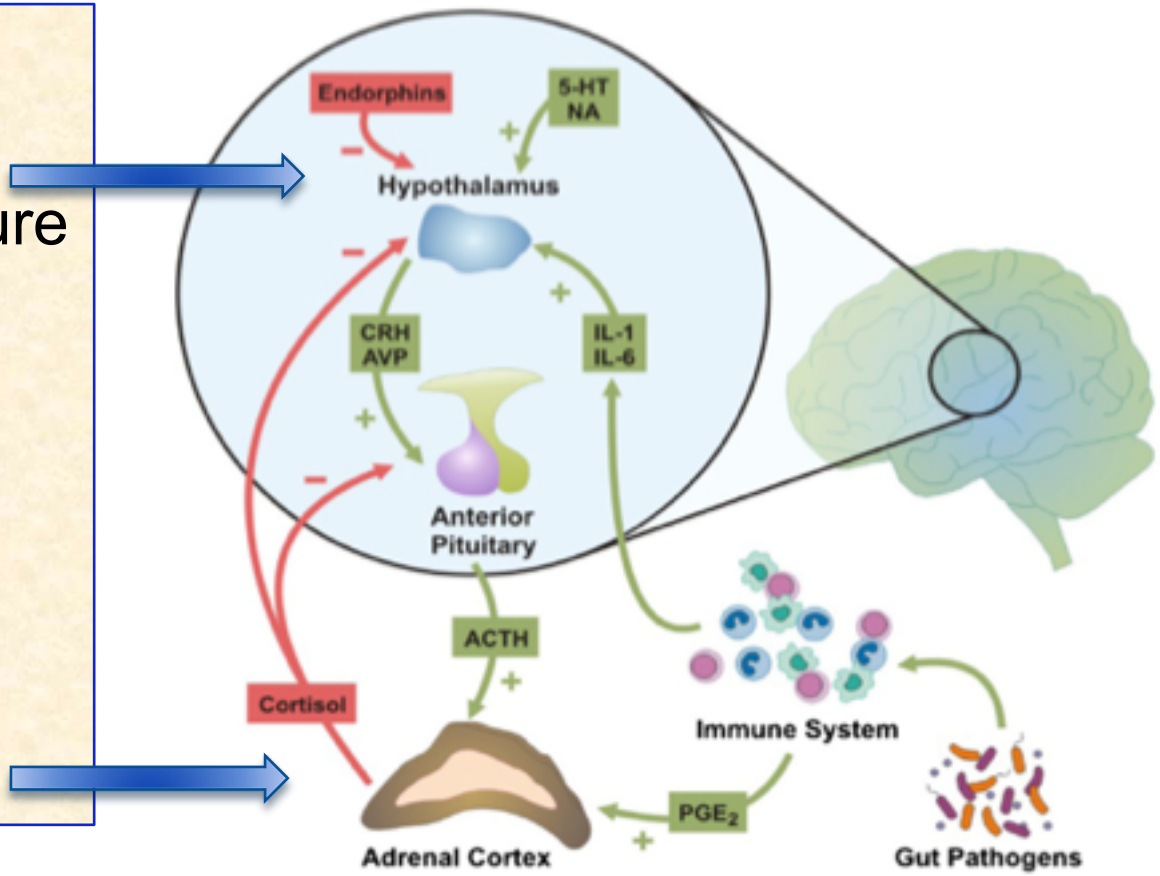
IL-17A: pro-inflammatory cytokine ASD = Autism Spectrum Disorder

For those who can't get enough of the science,
Enjoy this deeper dive

HPA Axis, Stress & Gut Pathogens: A Feedback Loop

- **1. Hypothalamic level**:
  Neurotransmitters & cytokines regulate CRH & AVP release into portal vasculature
  - Negative feedback loops from adrenals, through cortisol, control this forward drive

- **2. Gut Level**:
  The adrenal cortex also directly activated by PGE_2 from the immune system, stimulated by gut pathogens

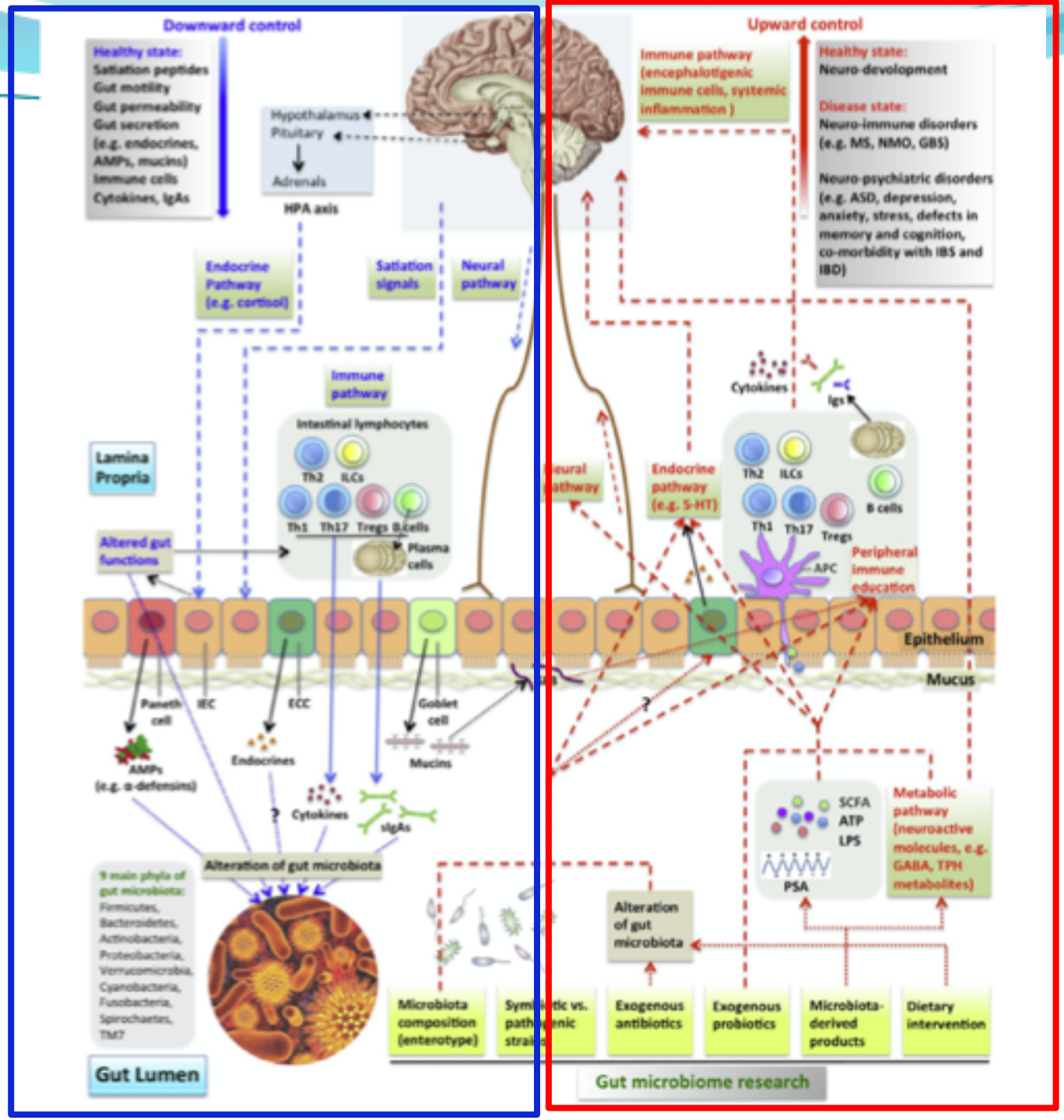


FLUIDS iQ™ CRH = Corticotrophin Releasing Hormone; AVP = Vasopressin; PGE_2 = Prostaglandin E_2

Dinan & Cryan, 2012

Microbiome–gut–brain axis in relation to CNS disorders

- Gut microbiome plays crucial role in bidirectional gut–brain axis that integrates gut & CNS activities



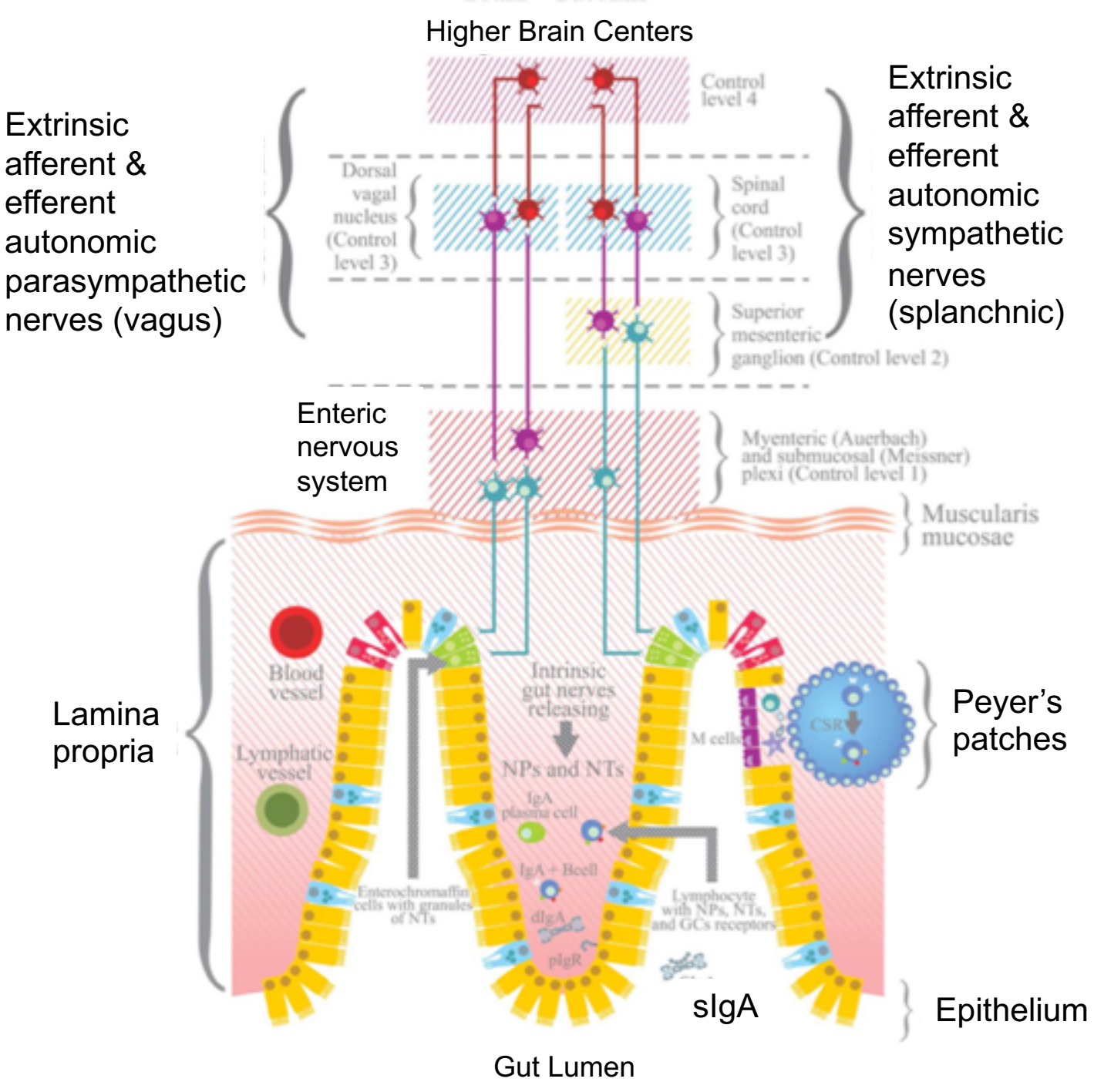
Wang et al. 2014

Campos-Rodríguez, 2013

Brain-Gut Axis (BGA) & Stress

Stress triggers activation of the enteric nervous system, including afferent and efferent intrinsic intestinal nerves

Stress response of the BGA influences the generation of pIgA and/or the pIgR mediated transcytosis, to create **sIgA**



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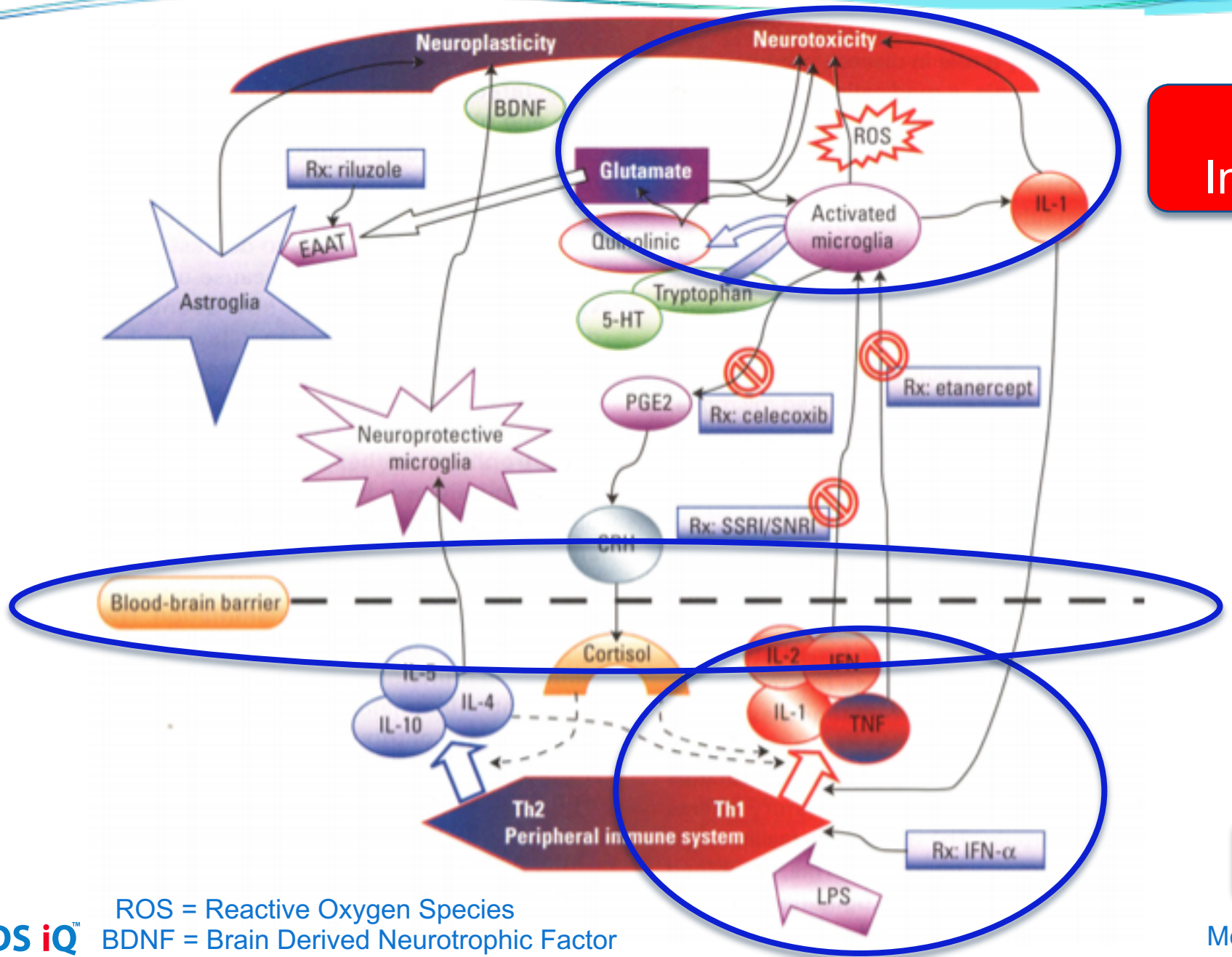
Neurotoxic & Neurotrophic actions of Microglia & Astrocytes



Brain Inflammation

Leaky Gut

ROS = Reactive Oxygen Species
BDNF = Brain Derived Neurotrophic Factor

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McNally, CNS Spectr, 2008


Burnout

Evaluating & Rebuilding the 'Burned-Out' Brain

'Burn-out'

- Syndrome resulting from chronic workplace stress, (but not other areas of life), that has not been successfully managed & is characterized by 3 dimensions*:
  - Feelings of energy depletion
  - Feelings of negativism related to job
  - Reduced professional efficacy

* ICD-11 (International Classification of Diseases 11th Revision)

‘Burned-Out Brain’: Symptoms

- Mental sluggishness
- Depression
- Anxiety
- Insomnia
- Fatigue

- Poor concentration
- Poor memory
- Attention deficits
- Irritability
- Apathy

Contributors to 'Burned-Out Brain'

1. **Mental & Emotional Stress**: Job, Remuneration, Relationships
2. **Sleep deprivation**: Delayed Onset, Frequent waking, Apnea
3. **Blood sugar instability**: Low levels, Skipped meals, High carb diet
4. **Chronic inflammation/infection**: Oral, Nasal, Intestinal

- Extended eating windows/ lack of fasting state
- Lack of exercise
- Lack of bright light during day / Excess blue light at bedtime
- Nutritional deficits
- Toxins: Biological, environmental, medications

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Circadian Rhythms of the Body

- **Nutrient absorption**: Each cell has a 24 hr circadian rhythm
- **Energy absorption/Use:**
  - Carb intake stops fat burn so body can store energy as glycogen or fat.
  - When carbs are depleted & glycogen stores used up, fat burning can resume
- **Cell maintenance & clean-up**: Body removes ROS through 'Autophagy'
  - Body 'cleans out' damaged cells
- **Repair & cell division**: 'Leaking' cells are replaced ***at night, during sleep***
- **Cell to cell communication**:
  - eg, Leptin levels rise, signaling 'fullness'. Based on rhythm & timing of prior meals

Interventions to Rebuild the 'Burned-Out' Brain

Sleep & Wake cycles: Circadian Rhythms

- Rule out Apnea
- Address hormone changes:
  - Low Progesterone, elevated bedtime Cortisol, Melatonin
- Block blue light 2 hrs before bedtime
- Keep bedroom cooler at night

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Interventions to Rebuild the 'Burned-Out' Brain

Glycemic Regulation

- 1st meal same time each day for best circadian rhythm of cellular uptake
- Carbohydrate restriction:
  - Diet formats: **Paleo -** lean meats, fish, fruits, vegetables, nuts and seeds

    Keto - very low carb, high fat
  - Carb to protein ratio of 2:1 for best insulin/glucagon secretion
- Eating with a 6 hr window, interspersed with fasting
- Nutritional Support: ALA, Lipoic Acid, Vanadyl Sulphate, Chromium, etc

ALA = Alpha Linolenic acid (Omega-3, essential fatty acid)

Interventions to Rebuild the 'Burned-Out' Brain

Avoid or Eliminate inflammatory foods

- Avoid Gluten, soy & dairy (minimal), alcohol

Other sources of Inflammation

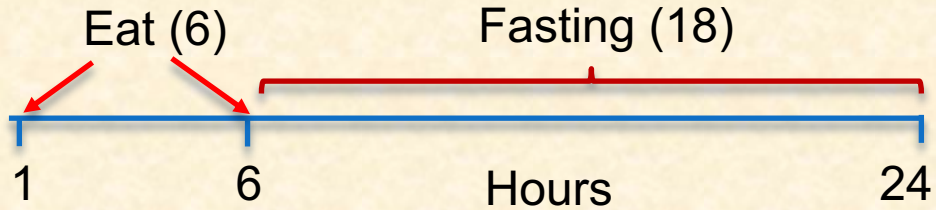
- LPS from gram negative bacteria
  - *H-Pylori, Enterobacter, Escherichia, Klebsiella, Pseudomonas, Prevotella*
- Gram positive Biotoxins (PGN/LTA*): Occurs with SIBO
- Endotoxins: *Clostridium difficile*
- Fungal Toxins: Mycotoxins - inhibit IL-10 (powerful anti-inflammatory cytokine)
  Candida – hyphal form

FLUIDS iQ™ *PGN/LTA = Peptidoglycans/lipoteichoic acids. In cell wall. Trigger immune stimulation/inflammation

Interventions to Rebuild the 'Burned-Out' Brain

Feeding & Fasting: Circadian Rhythms

- '6 -18', regular intermittent fasting:



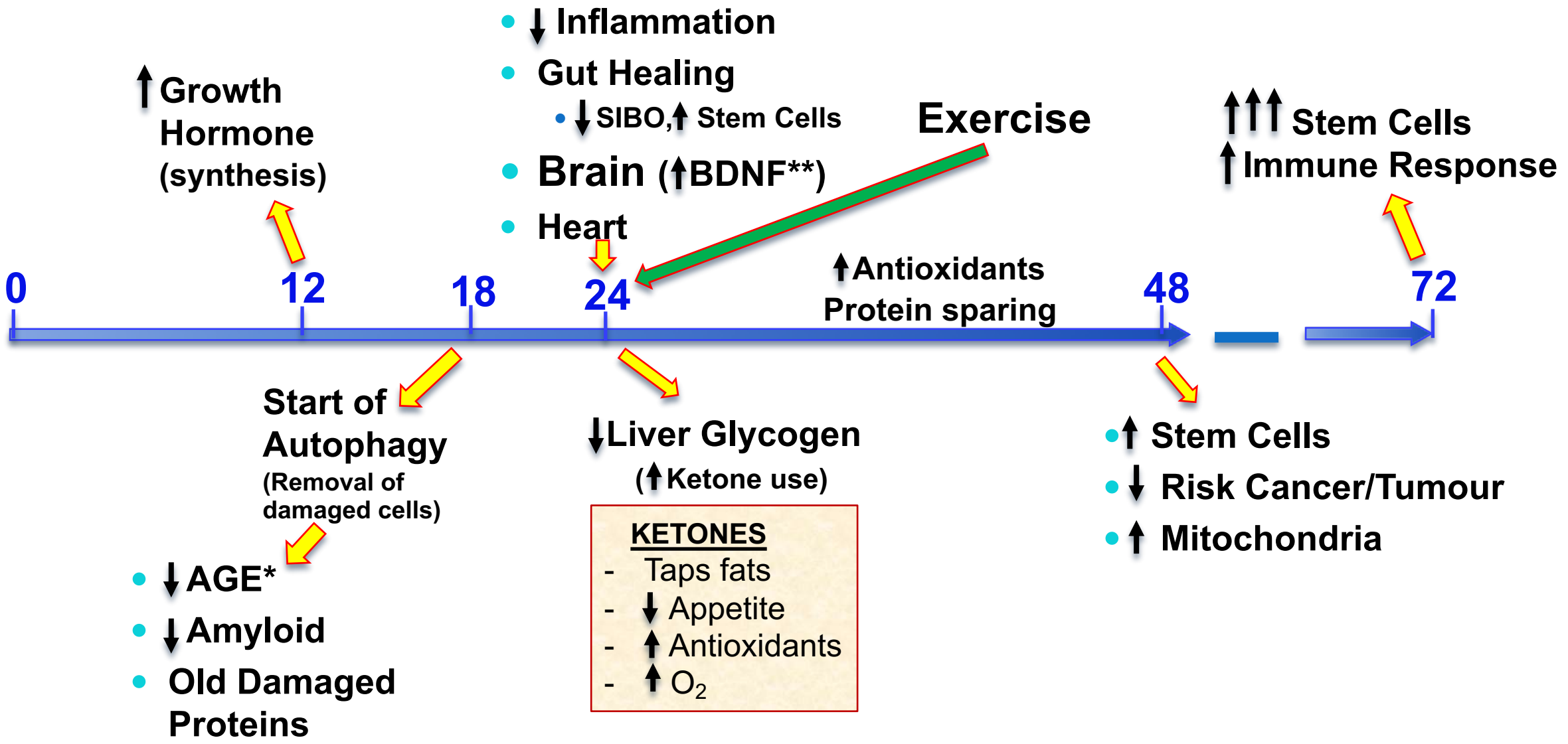
- Encourage BDNF* action: Protein that supports survival of existing neurons

  - Helps growth & differentiation of new neurons & synapses

- Eat 1st meal same time each day
- Control caffeine intake. 'Water' fasting with nutrients: Minerals, Vit B, Salt
- Cortisol in AM: Increases glucose. Do some exercise

*BDNF = Brain Derived Neurotrophic Factor

The Effect of Fasting



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* = Advanced Glycated End products ** = Brain Derived Neurotrophic Factor

Berg, 2019

Interventions to Rebuild the 'Burned-Out' Brain

Exercise & Movement: Circadian Rhythms

- Powerful for improving Neurotransmitter function & mood disorders
- Produces enhanced amounts of BDNF*
  - Accomplished with Continuous aerobic or HIIT** (slightly more with HIIT)

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*BDNF = Brain Derived Neurotrophic Factor

**HIIT = High Intensity Interval Training

Interventions to Rebuild the 'Burned-Out' Brain

Nutritional Support

- Conventional HPA axis support: Ashwagandha, Rhodiola, L-theanine
- NT Support: Mucana Pruriens, L-tyrosine, 5-HTP, 'Pharma GABA', Mg
- Mitochondrial Support: Mg, CoQ10, Lipoic acid, B-complex, Carnitine

Limited effectiveness if the source of the chronic stress is not identified & addressed

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CoQ10 = Coenzyme Q10 – antioxidant; Pharma GABA = Naturally-sourced, bioidentical GABA

Screening Assessments

- *Salivary Tests*:
  - **Diurnal Cortisol** (4 point measurement) & DHEA-S
  - Sex Hormones: Pg, Estradiol (E2), Testo (free fraction), Melatonin
- *Blood Tests*:
  - Thyroid: TSH, Free T4, Free T3, rT3
- *Patient Lifestyle Survey*:
  - Eating time window
  - Exposure to outdoor light & blue light (2 hrs pre bedtime)
  - Exercise regimes
  - Work & travel habits

Metabolic Dysregulation:

Part 2:

The Brain-Gut Axis

&

Burnout

Dr Aron Gonshor: PhD, DDS, FRCD(C), FAO

FDN Educational Symposium

January 7, 2022

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