

A microscopic image of various bacteria, primarily long, thin, rod-shaped structures in shades of blue and cyan. Scattered throughout are several smaller, spherical bacteria in orange and pink. The background is a dense, textured field of these microorganisms.

# Microbioom, immuun systeem en gezondheid

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Rotterdam, NL

20e compagnonscursus Antonius Ziekenhuis  
Landgoed Duin & Kruidberg, Santpoort, 6& 13  
november 2019

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## Disclaimer & Disclosure

The views as expressed in these slides are those of Hok Bing Thio.

The information shown in this slide deck may be outside the current indications of presented drugs. Please refer to the complete SmPCs for valid prescribing information.

Hok Bing Thio has been a consultant and invited speaker for Dr. Reddy, Biogen, Janssen, AbbVie, Celgene, Biologix, Galderma, Leopharma, Lilly, Almirall, TEVA, UCB and Novartis. He has received educational and research grants from AbbVie, Celgene, Janssen and Biogen.











A 3D visualization of a gut microbiome. The background is a dense field of pink, rounded, pill-like structures representing intestinal cells. Scattered throughout are numerous small, green, rod-shaped and blue, branched structures representing various types of bacteria and other microorganisms.

***Microbiota:*** This term refers to a collection of all taxa constituting microbial communities, such as bacteria, archaea, fungi and protists.

***Microbiome:*** This term was initially used to refer to the genes harboured by microbes; however, currently, the term 'microbiome' is also commonly used to refer to the microorganisms themselves (ie, the microbiota).

Patrice D Cani Gut 2018;67:1716-1725



# Microbiome

## IN NUMBERS

**100 Trillion**

syntiotic microbes live in and on every person and make up the human microbiota

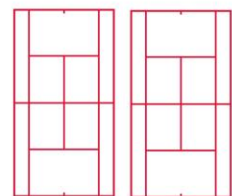
The human body has more microbes than there are stars in the milky way

**95%**

of our microbiota is located in the GI tract

**150:1**

The genes in your microbiome outnumber the genes in our genome by about 150 to one



The surface area of the **GI tract** is the same size as 2 tennis courts

You have

**1.3X**

more microbes than human cells

**>10,000**

Number of different microbial species that researchers have identified living in and on the human body

**2kg**

The gut microbiota can weigh up to 2Kg



*Interfacing Food & Medicine*

The microbiome is more medically accessible and manipulable than the human genome

**90%**

It is thought that of disease can be linked in some way back to the gut and health of the microbiome

**5:1**

**Viruses:Bacteria** in the gut microbiota



**2.5**

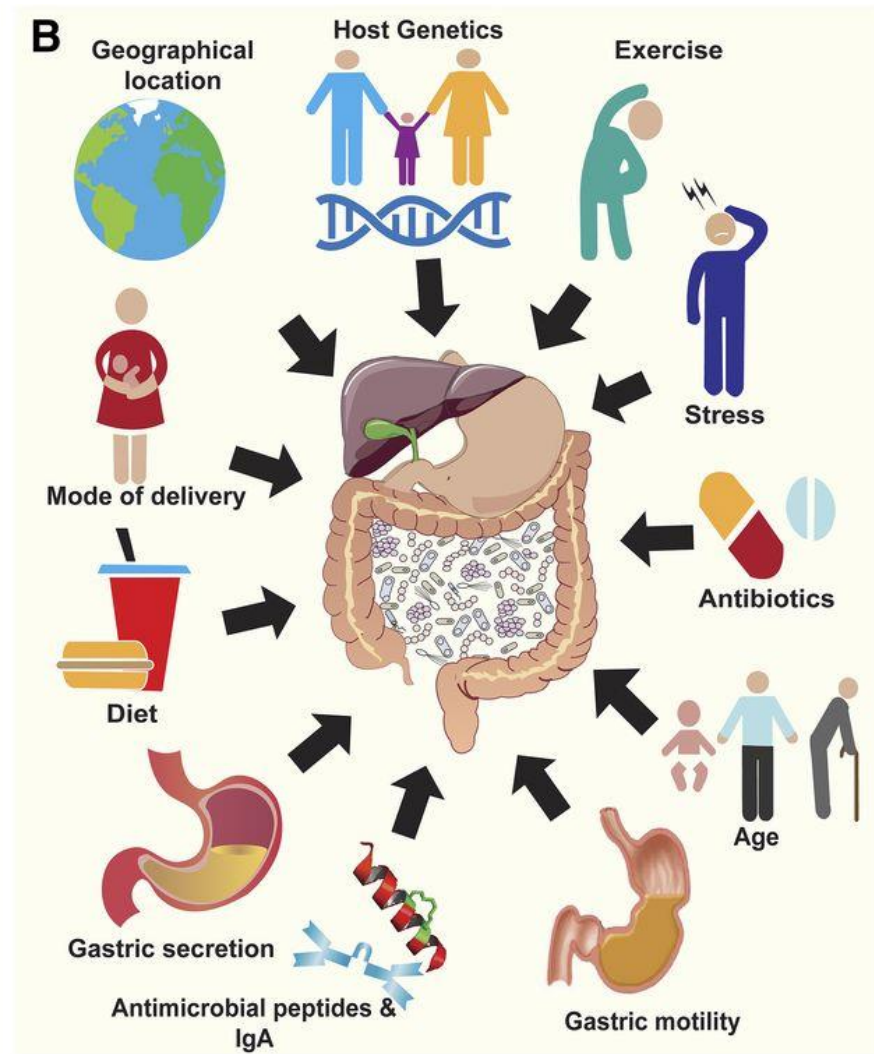
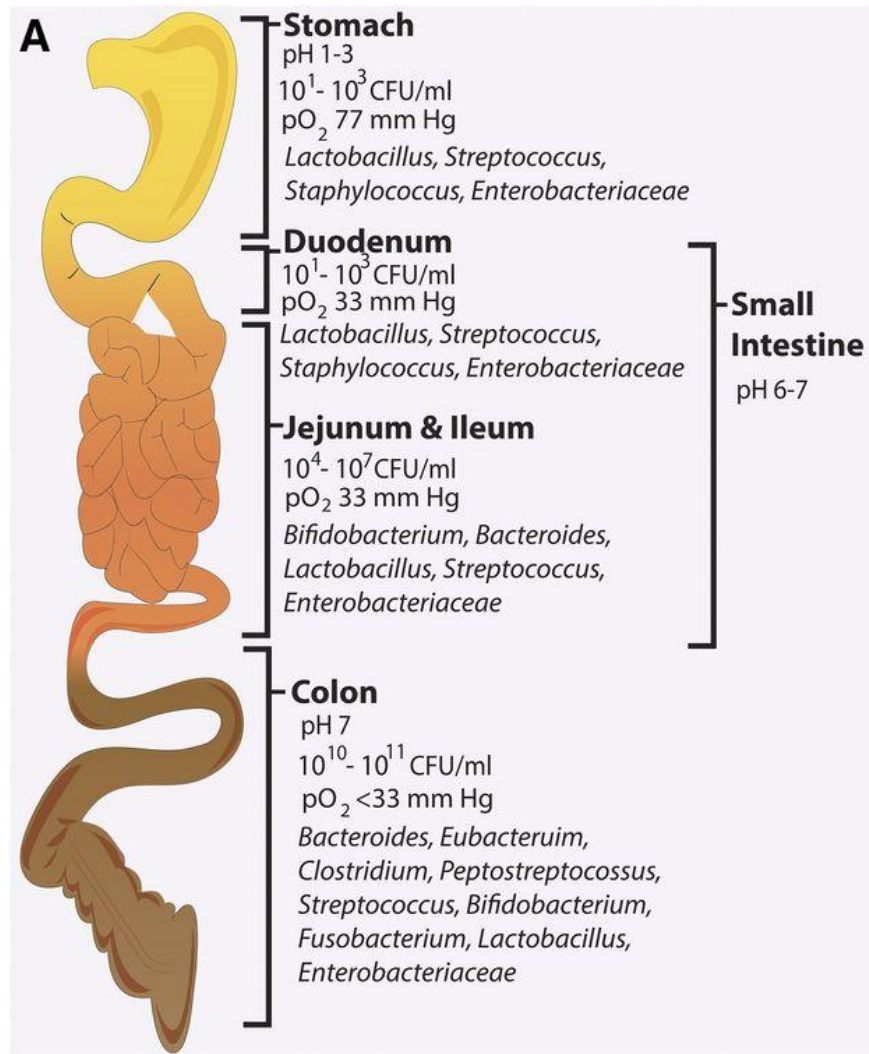
The number of times your body's microbes would circle the earth if positioned end to end

Each individual has a unique gut **microbiota**, as personal as a fingerprint



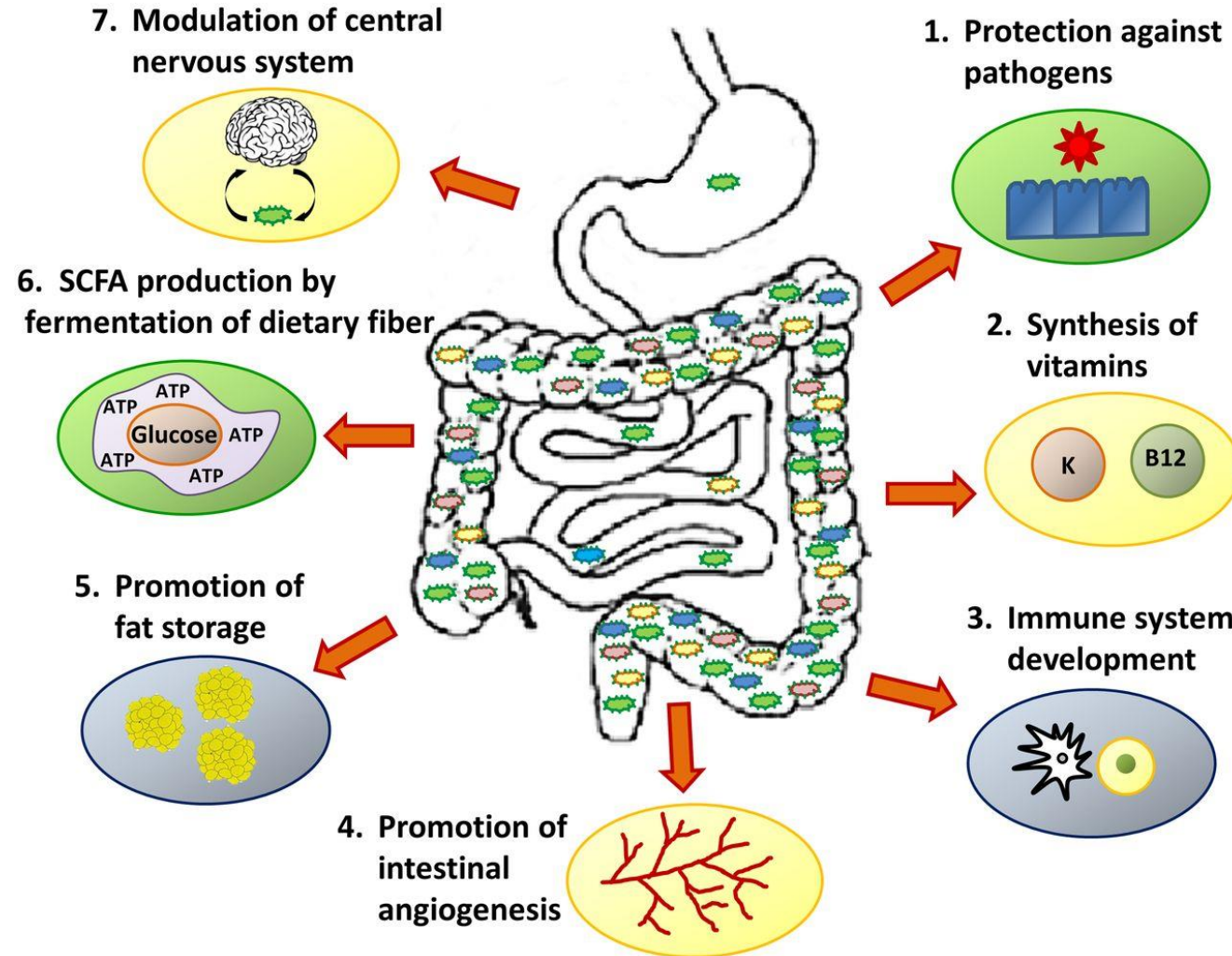


## (A) Metabolic niches in the gut microbiome.





# The human microbiome plays an important role in control of vital homeostatic mechanisms in the body.



Protima Amon, and Ian Sanderson Arch Dis Child Educ  
Pract Ed 2017;102:257-260



# Linking Gut to Skin

The Microbiome  
and Chronic  
Inflammatory  
Diseases

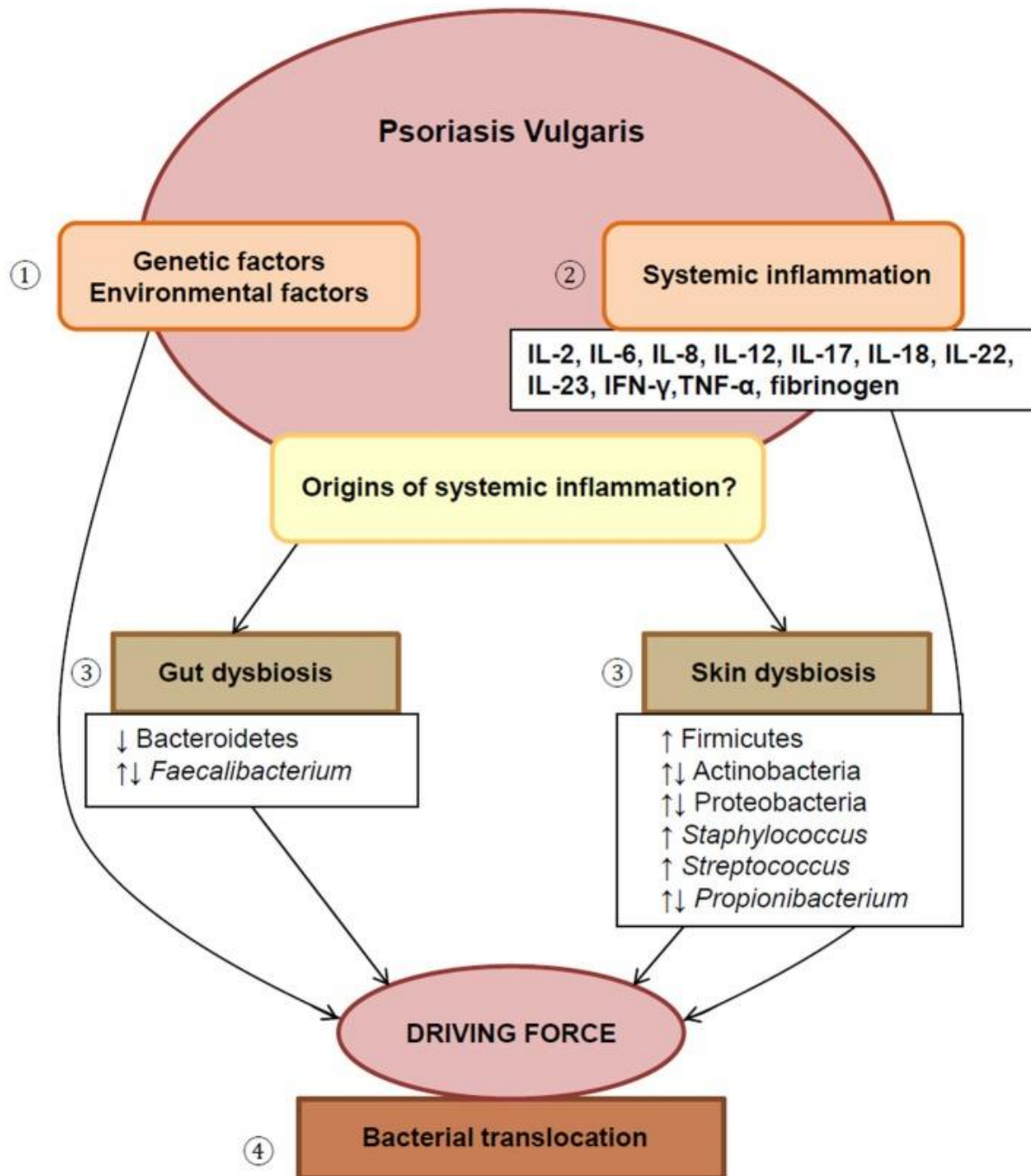
Hester Eppinga











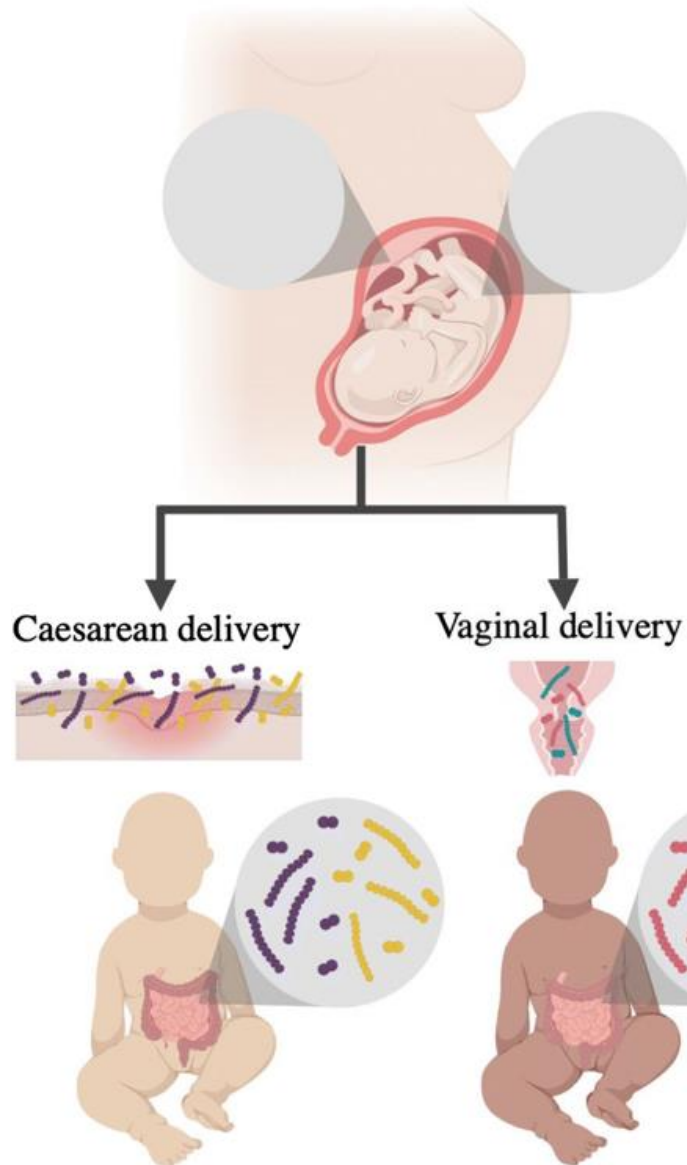
- (1) The etiology of psoriasis vulgaris involves complex interplay between genetic and environmental factors.
- (2) This disease displays localized as well as systemic inflammation, reflected by the presence of various dysregulated inflammatory markers.
- (3) Dysbiosis of both the gut and skin microbiome are suggested as possible drivers of chronic systemic inflammation,
- (4) by facilitating the translocation of bacteria from these sites into systemic circulation.

Bacterial Dysbiosis and Translocation in Psoriasis Vulgaris. Visser MJE, Kell DB, Pretorius E. Front Cell Infect Microbiol. 2019 Feb 4;9:7. doi: 10.3389/fcimb.2019.00007. eCollection 2019.



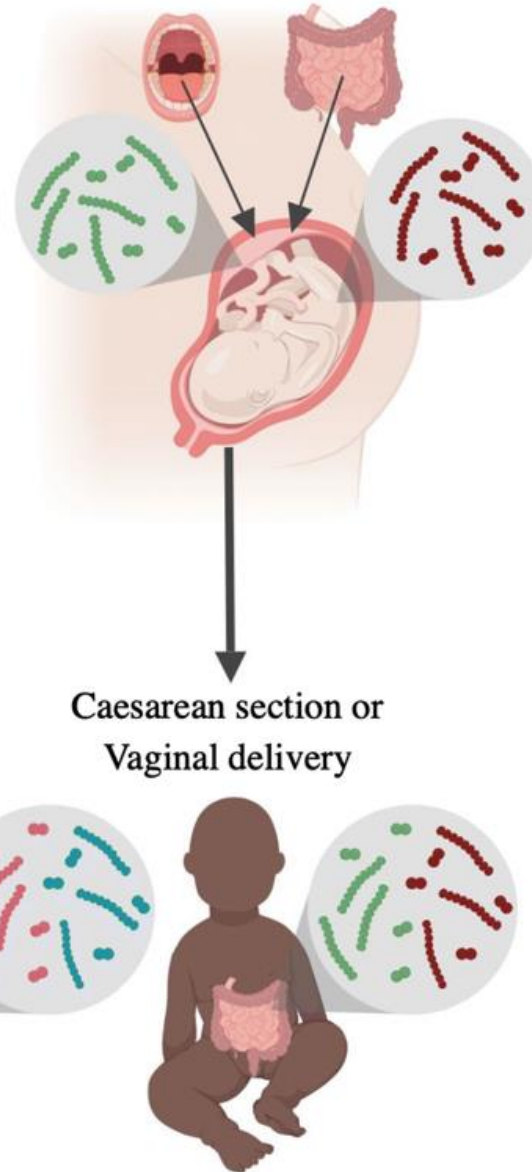
### **a** Sterile womb hypothesis

Uterine cavity and foetus are sterile. The foetus is colonized after birth



### **b** *In utero* colonization hypothesis

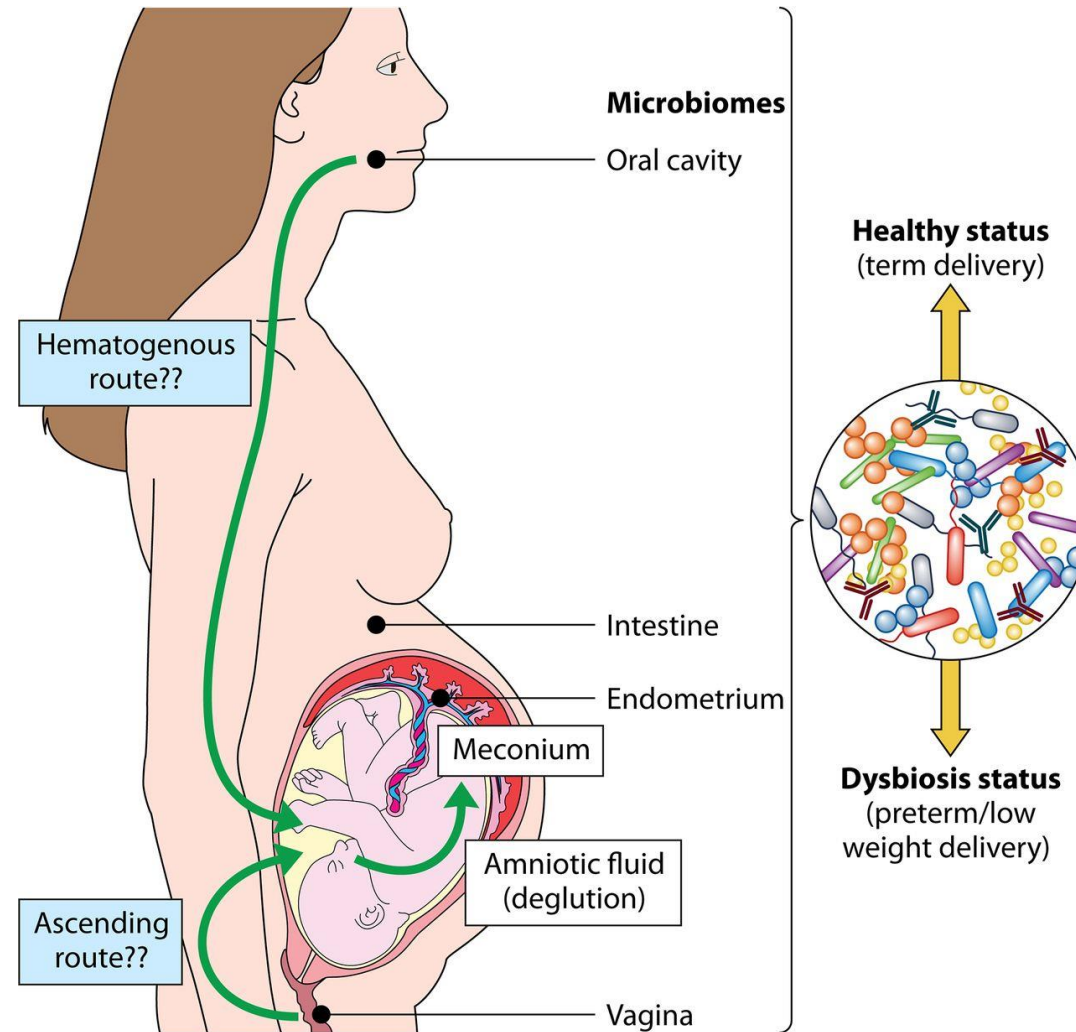
Mother's oral and intestinal microbiota are transported to the placenta. The foetus is born with a microbiota



The Gut Microbiota: A Clinically Impactful Factor in Patient Health and Disease  
David Avelar Rodriguez, et al. SN Comprehensive Clinical Medicine March 2019, Volume 1, Issue 3, pp 188–199

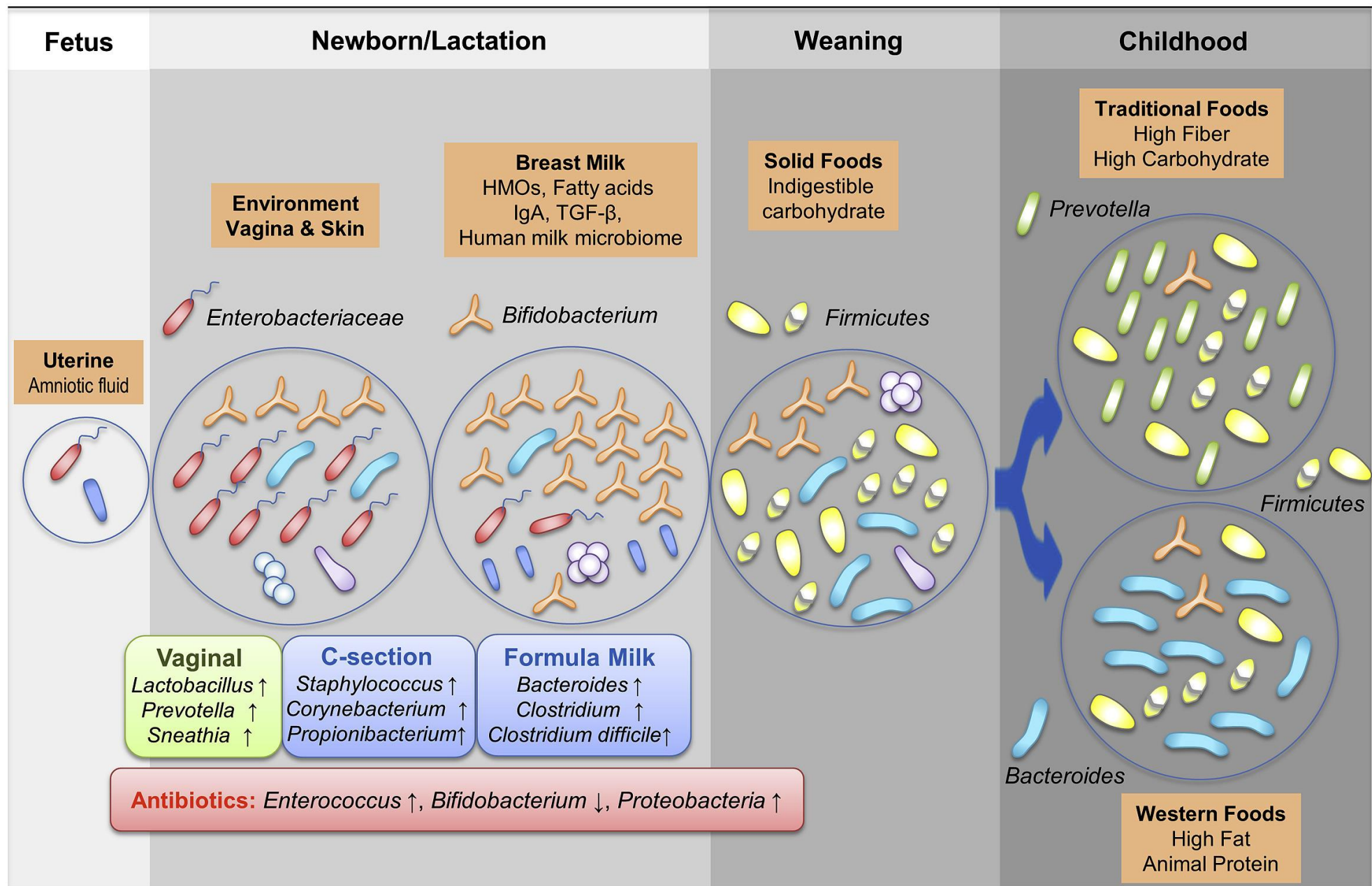


## Colonization routes of maternal microbiomes to the infant.

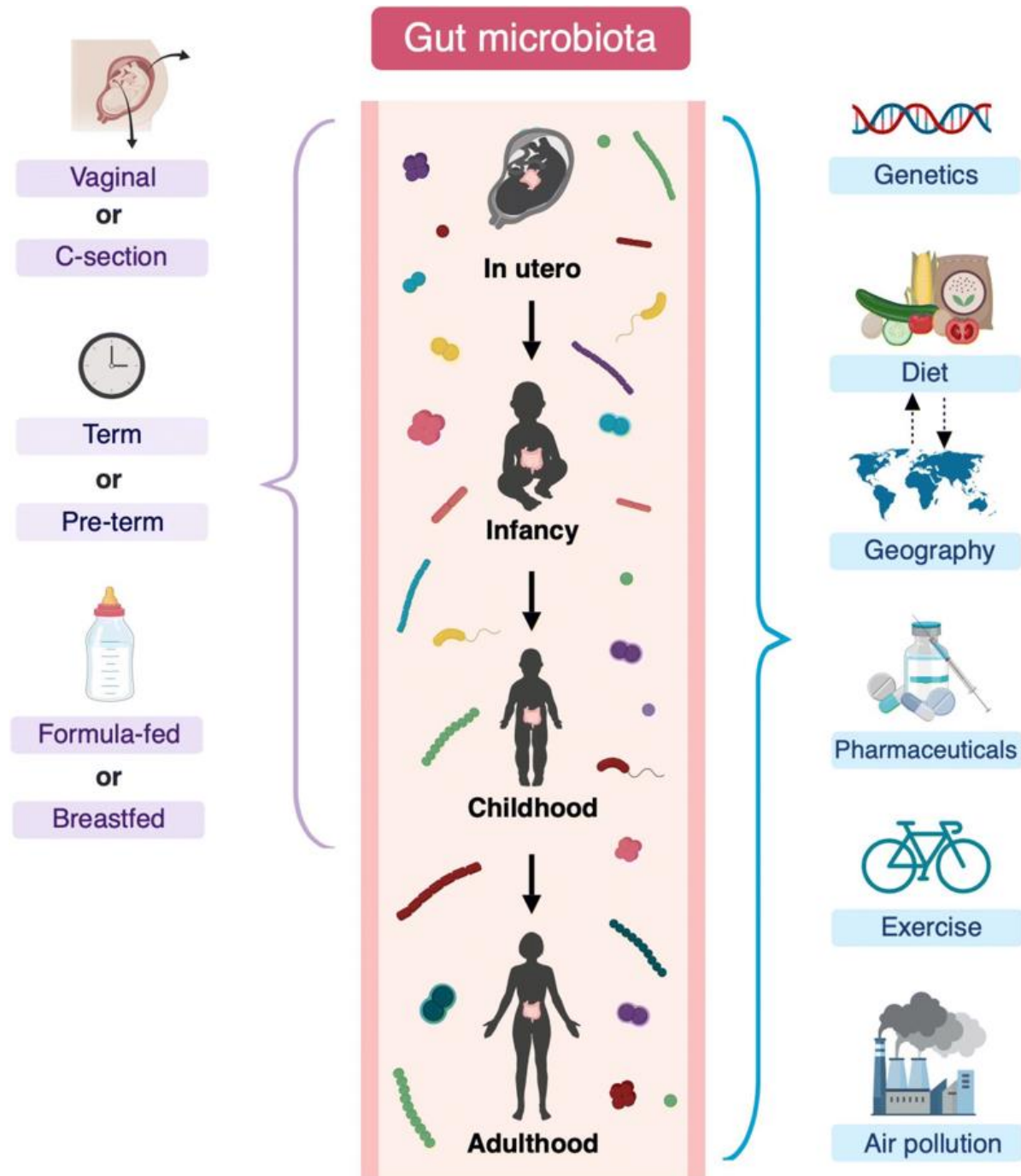


Christian Milani et al. *Microbiol. Mol. Biol. Rev.* 2017;  
doi:10.1128/MMBR.00036-17





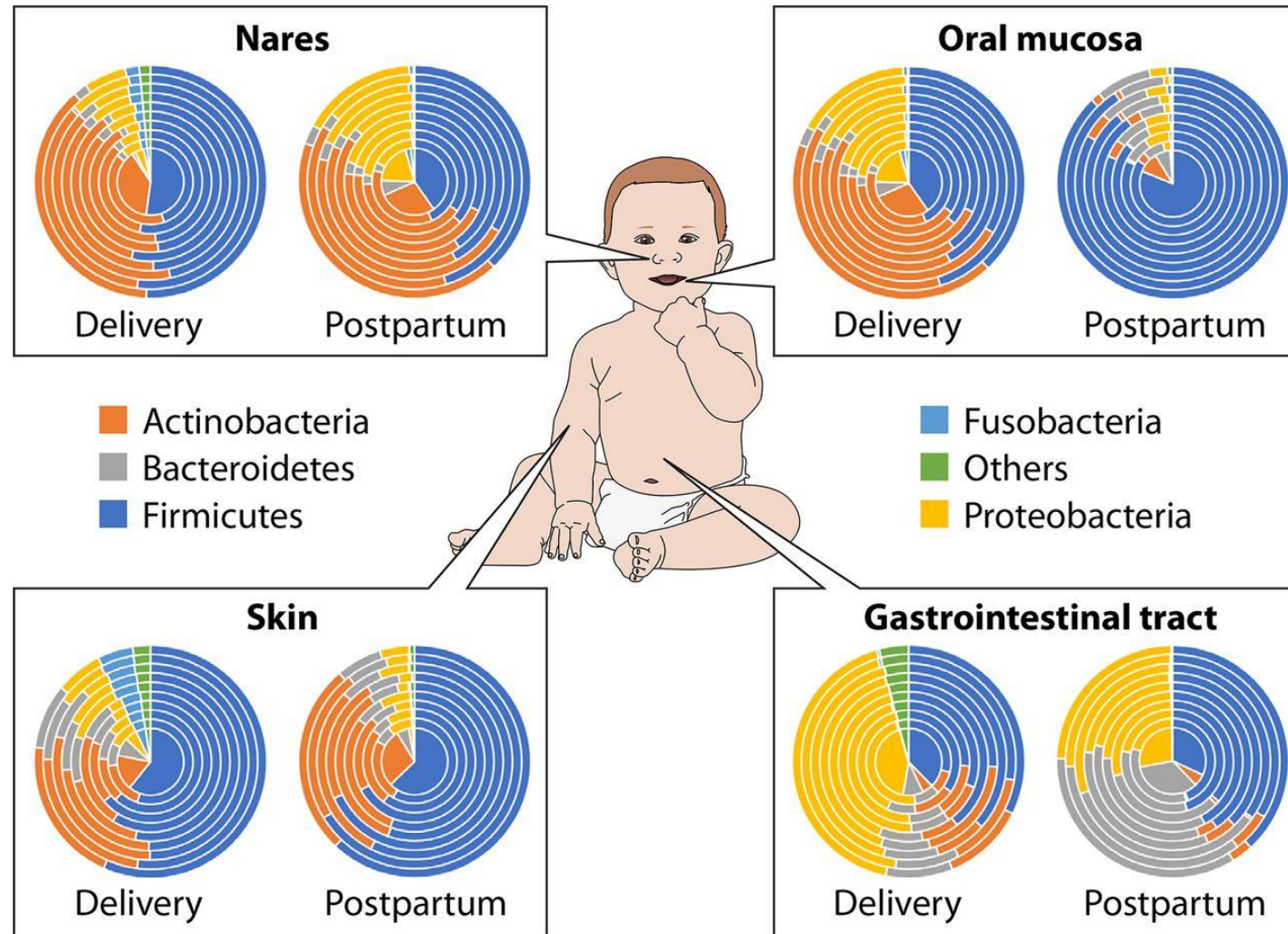




The Gut Microbiota: A Clinically Impactful Factor in Patient Health and Disease  
David Avelar Rodriguez, et al. SN Comprehensive Clinical Medicine March 2019, Volume 1, Issue 3, pp 188–199

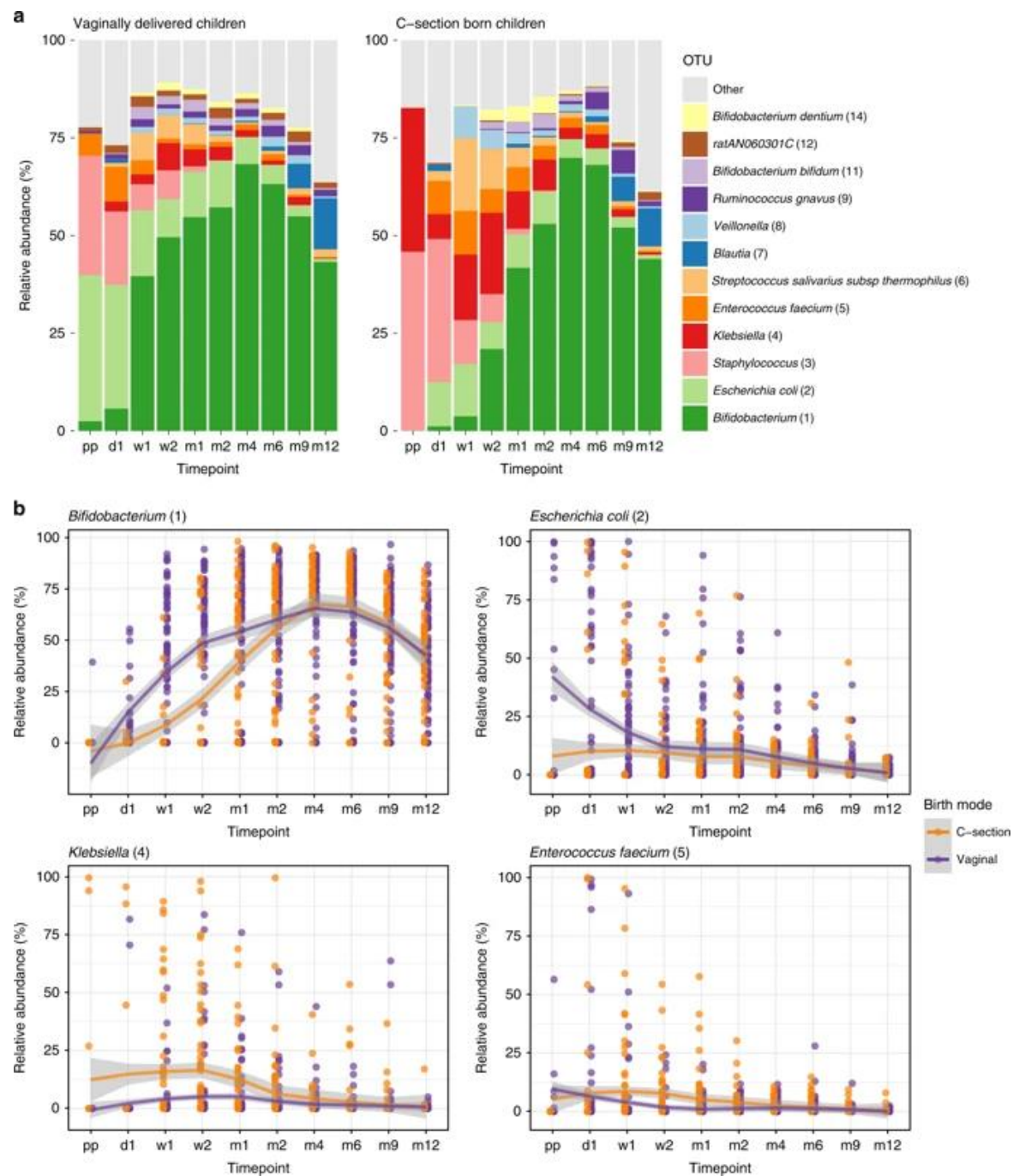


## Microbiota composition across the different infant body sites.



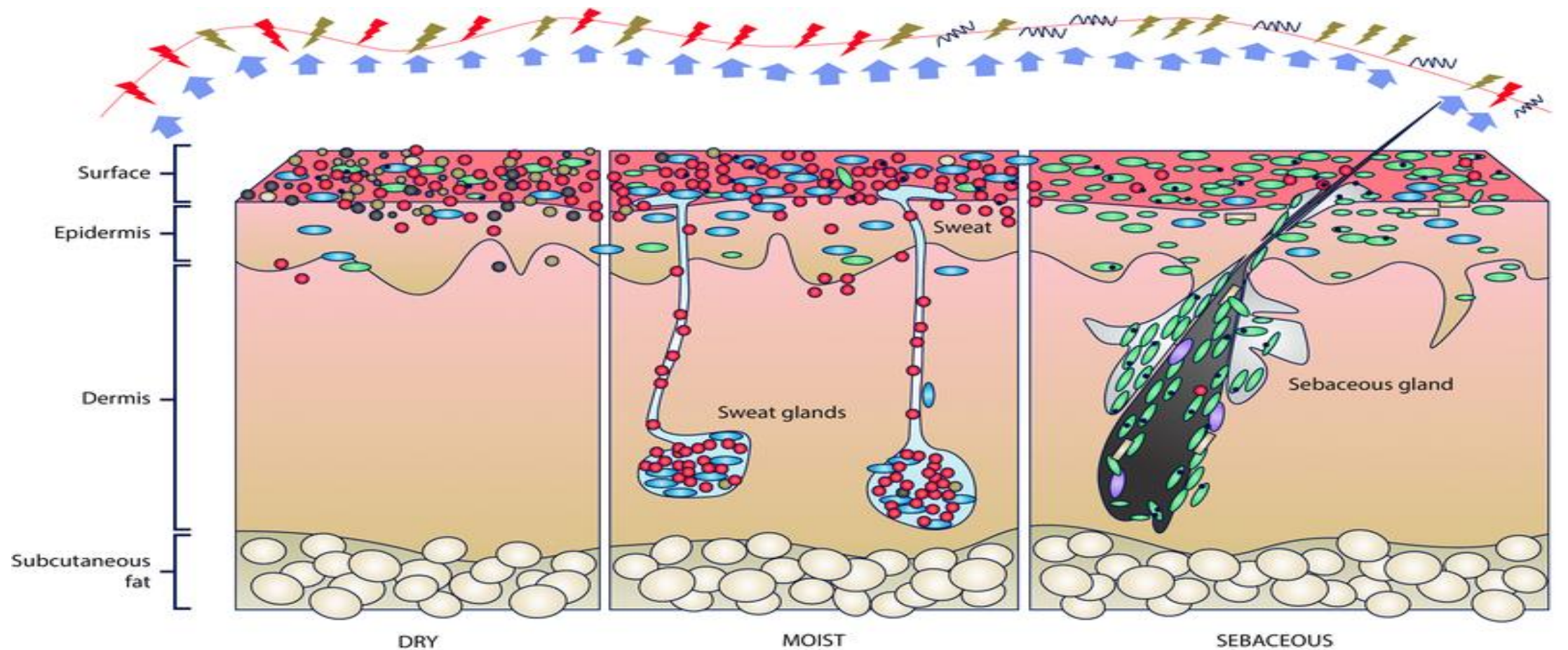
Christian Milani et al. *Microbiol. Mol. Biol. Rev.* 2017;  
doi:10.1128/MMBR.00036-17





Reyman, M., Houten, M.A., Baarle, D. et al. Impact of delivery mode-associated gut microbiota dynamics on health in the first year of life. Nat Commun 10, 4997 (2019) doi:10.1038/s41467-019-13014-7





The Journal of  
**Physiology**

Microbial diversity

**Bacteria:**

● *P. acnes*

● *S. epidermidis*

● *Corynebacterium* spp.

● *Streptococcus* spp.

● Proteobacteria

● Bacteroidetes

**Fungi:**

■ *Malassezia* spp.

**Parasites:**

● Demodex mites

**Viruses:**

● Bacteriophage

**Secreted molecules:**

⚡ Antimicrobial peptides (AMPs)

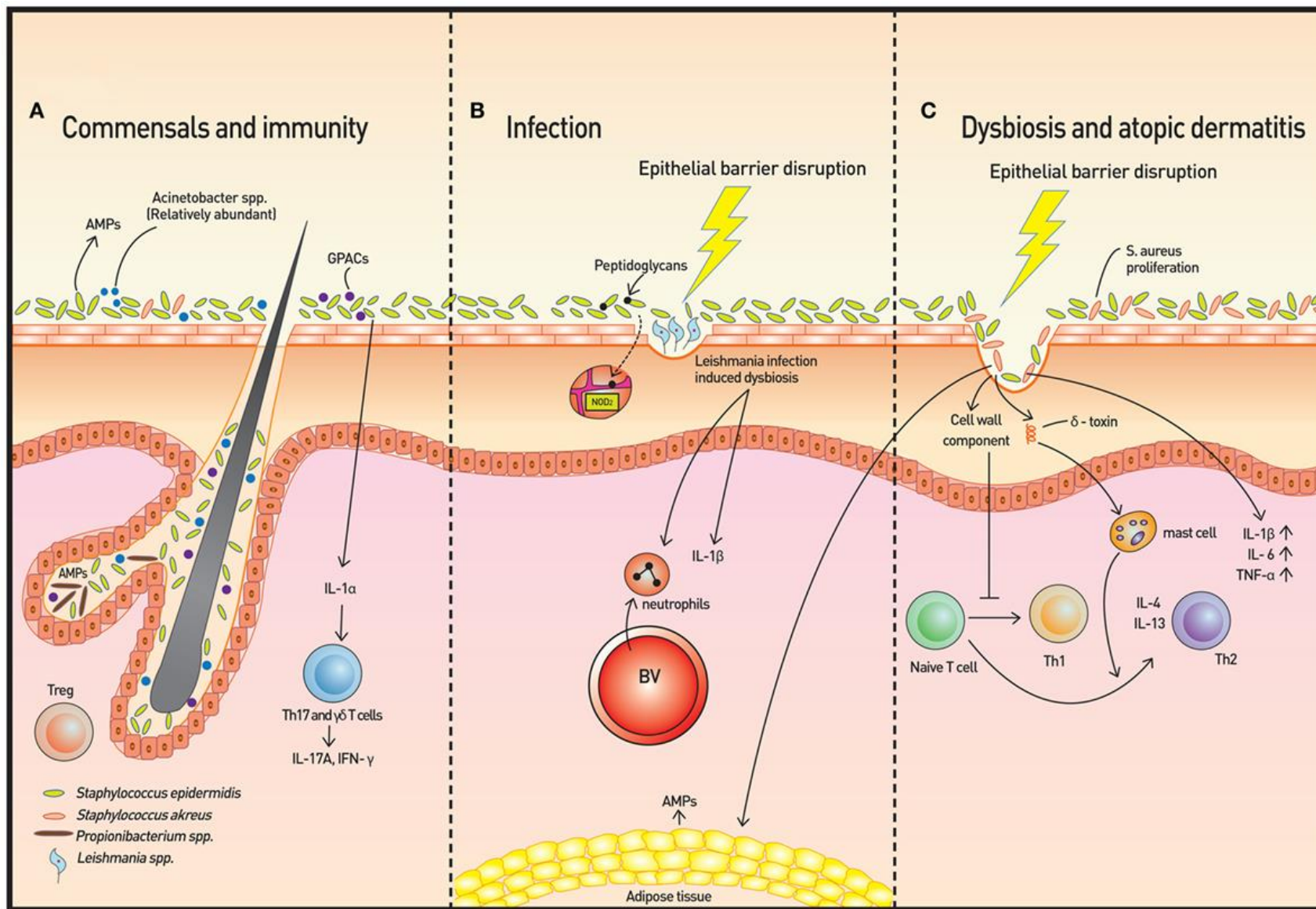
⚡ Bacteriocins

~ Short chain fatty acids (SCFA)







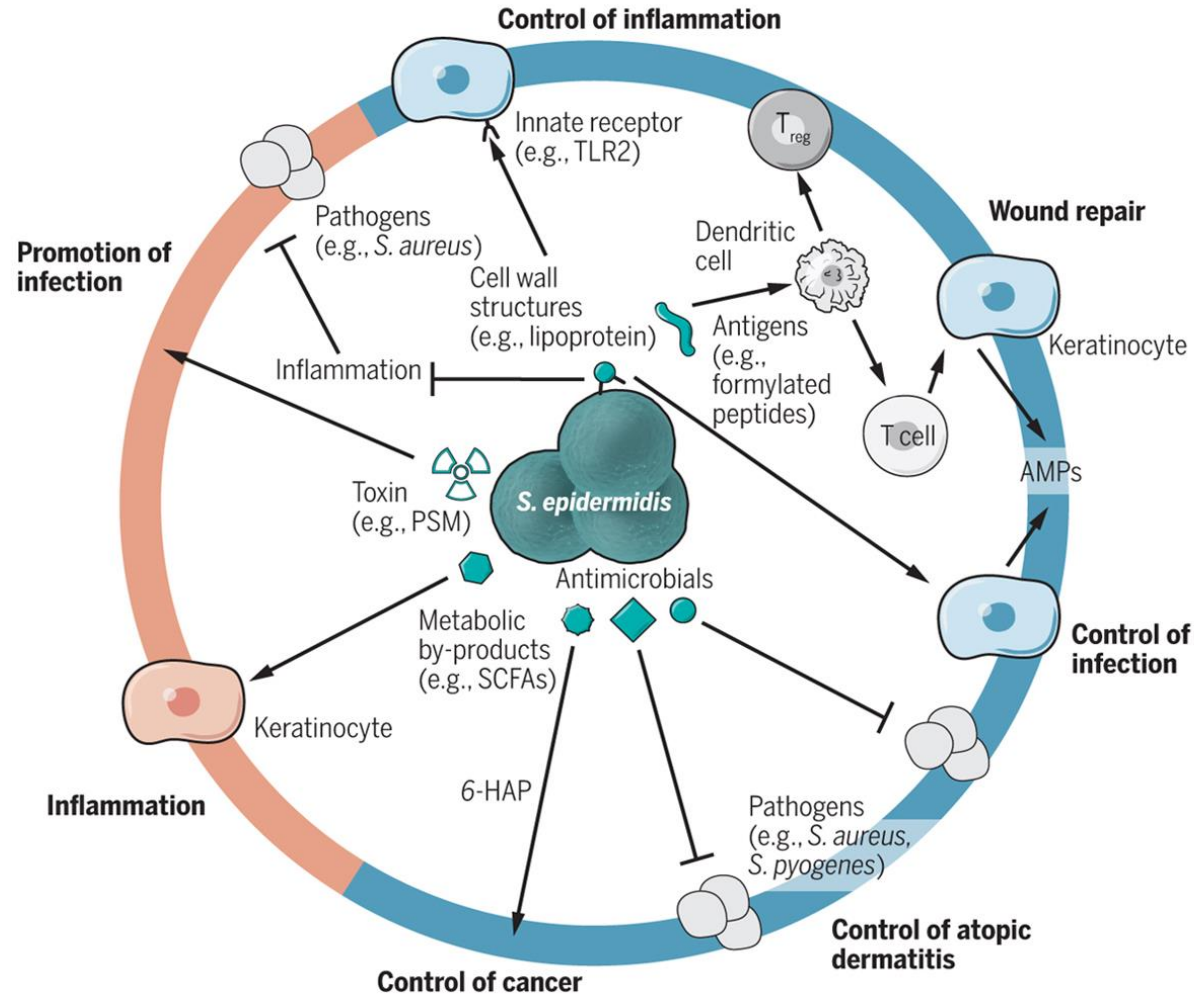


The Role of Skin and Orogenital Microbiota in Protective Immunity and Chronic Immune-Mediated Inflammatory Disease  
 Young Joon Park and Heung Kyu Lee. Front. Immunol., 10 January 2018 |



## The multifaceted roles of *S. epidermidis* in skin physiology

*S. epidermidis* guards skin against inflammation, infections, and cancer through interactions with keratinocytes, T cells, and other members of the skin microbiota. These interactions are strain- and context-dependent, with some leading to negative outcomes for the host, including inflammation and infection.



***S. epidermidis* has emerged as an influential, keystone member of the skin microbiota.**





Credit: Yang H. Ku/C&EN/Shutterstock

## Cosmetics: The next microbiome frontier

### ***THE MICROBIOME COMES TO COSMETICS***

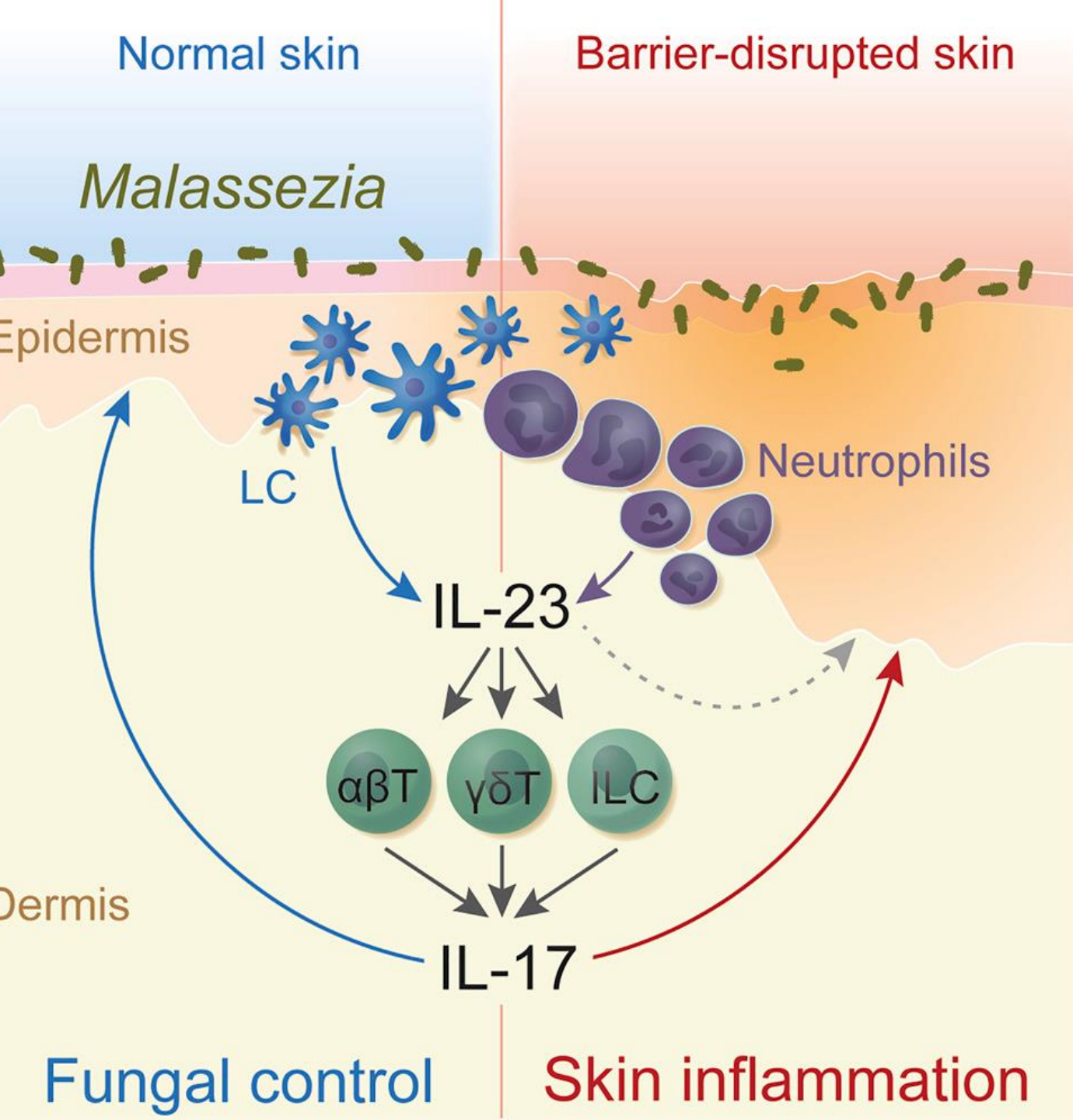
PERSONAL CARE COMPANIES RUSH  
TO HARNESS THE RELATIONSHIP BETWEEN  
THE MICROBIOME AND HEALTHY SKIN.  
BUT WILL IT WORK?

Credit: Yang H. Ku/C&EN

“Can we make people look 20 years younger by putting probiotics on their face? I’m not sure we’re there yet.”

—Patricia K. Farris, board member, American Academy of Dermatology





The skin commensal yeast *Malassezia* drives type 17 immunity in the skin

*Malassezia*-specific human memory T cells display a Th17 phenotype

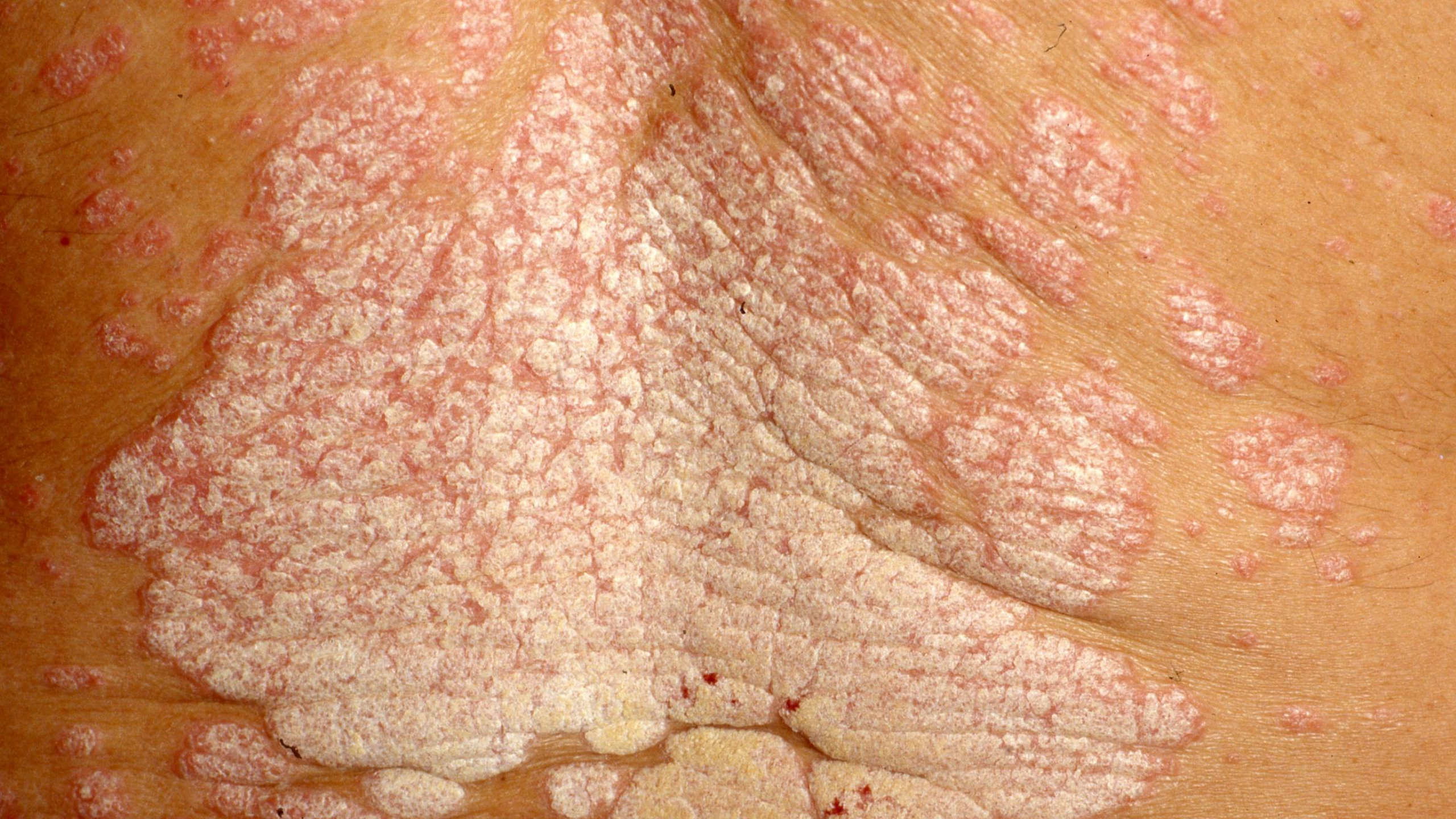
Mice deficient in IL-17AF or IL-23 show uncontrolled *Malassezia* growth on the skin

In the disrupted skin, IL-23 and IL-17AF promote *Malassezia*-induced inflammation

The Skin Commensal Yeast *Malassezia* Triggers a Type 17 Response that Coordinates Anti-fungal Immunity and Exacerbates Skin Inflammation.

Sparber F, et al. Cell Host Microbe. 2019 Mar 13;25(3):389-403.e6. doi: 10.1016/j.chom.2019.02.002.

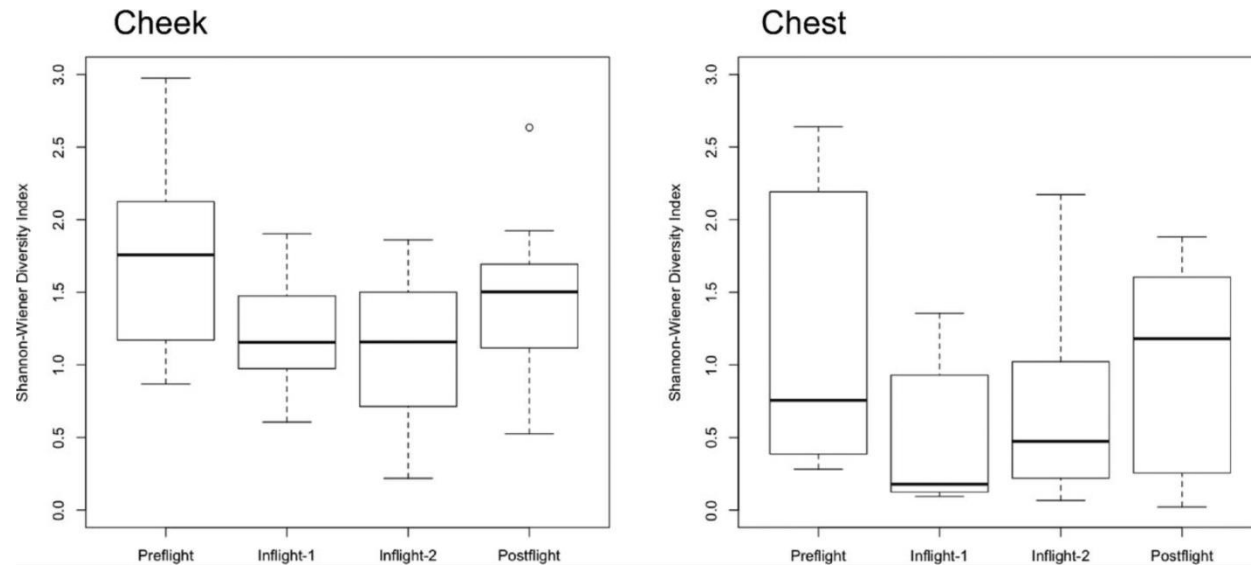










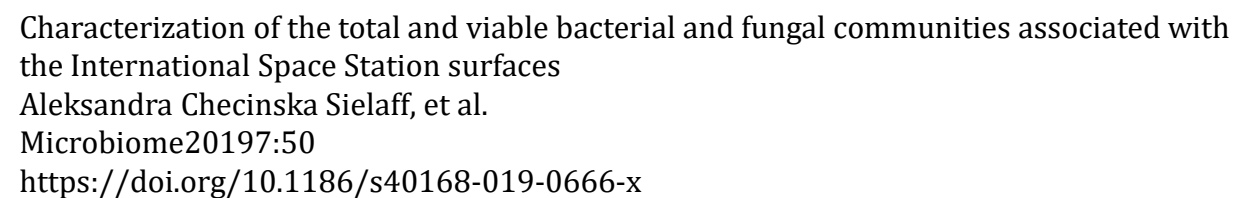


From: Comprehensive analysis of the skin fungal microbiota of astronauts during a half-year stay at the International Space Station

Med Mycol. 2016;54(3):232-239. doi:10.1093/mmy/myv121

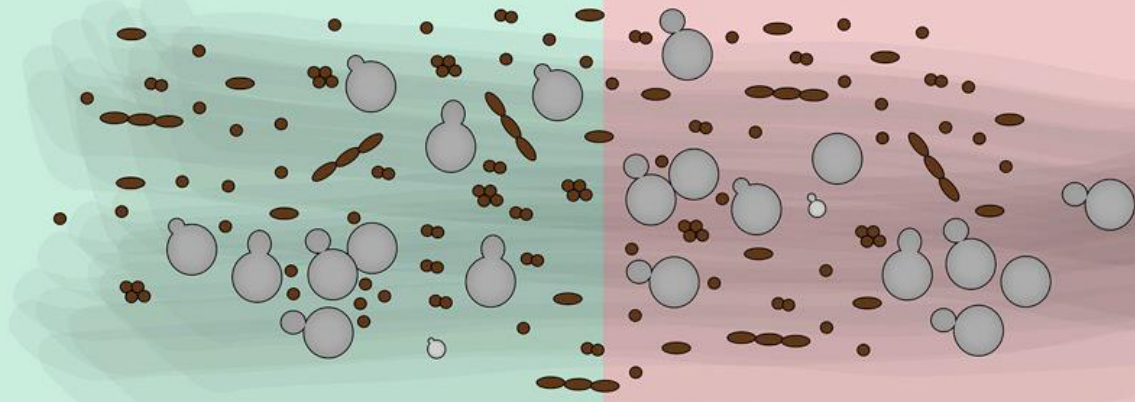
Med Mycol | © The Author 2016. Published by Oxford University Press on behalf of The International Society for Human and Animal Mycology. All rights reserved. For permissions, please e-mail: journals.permissions@oup.com



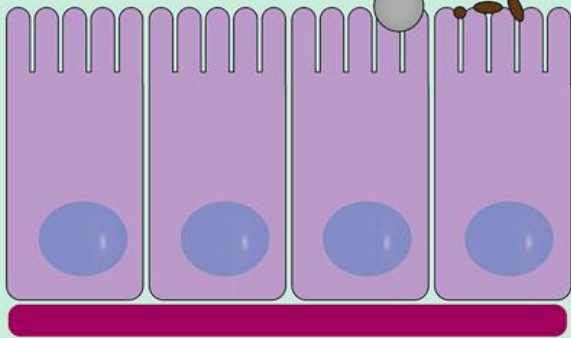




Luminal bacteria and fungi

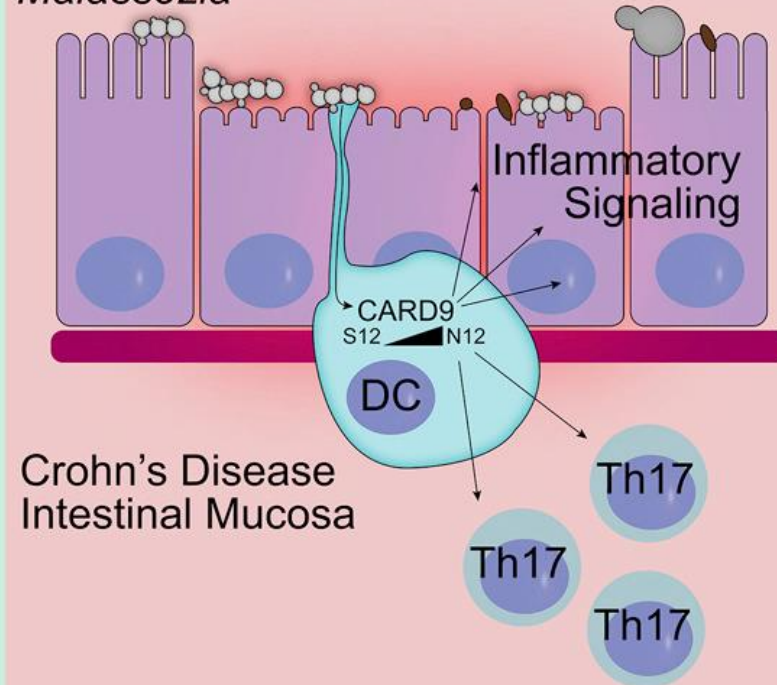


Mucosa-associated bacteria and fungi



Healthy Intestinal Mucosa

Mucosa-associated *Malassezia*



Crohn's Disease Intestinal Mucosa

*M. restricta* is associated with the colonic mucosa in Crohn's disease (CD) patients

*M. restricta* exacerbates colitis in wild-type and gnotobiotic mice

*M. restricta* is found in CD patients with a disease-linked polymorphism in CARD9

*Malassezia*-exacerbated colitis in mice requires signaling via CARD9

*Malassezia* Is Associated with Crohn's Disease and Exacerbates Colitis in Mouse Models.

Limon JJ et al. Cell Host Microbe. 2019 Mar 13;25(3):377-388.e6. doi: 10.1016/j.chom.2019.01.007. Epub 2019 Mar 5.





# nature

THE INTERNATIONAL WEEKLY JOURNAL OF SCIENCE

## INSIDE STORY

Results from the Integrative Human Microbiome Project

PAGES 599, 623, 632, 641, 655 & 663

SCIENCE PUBLISHING

**IMPACT  
FACTOR 2.0**

The path to better  
journal metrics

PAGE 621

ATOMIC PHYSICS

**GOING  
SUPERSONIC**

Hawking radiation from  
analogue black holes

PAGES 634 & 688

ELECTRONICS

**HUMAN  
TOUCH**

A tactile glove that senses  
how a hand grasps

PAGES 638 & 698

NATURE.COM

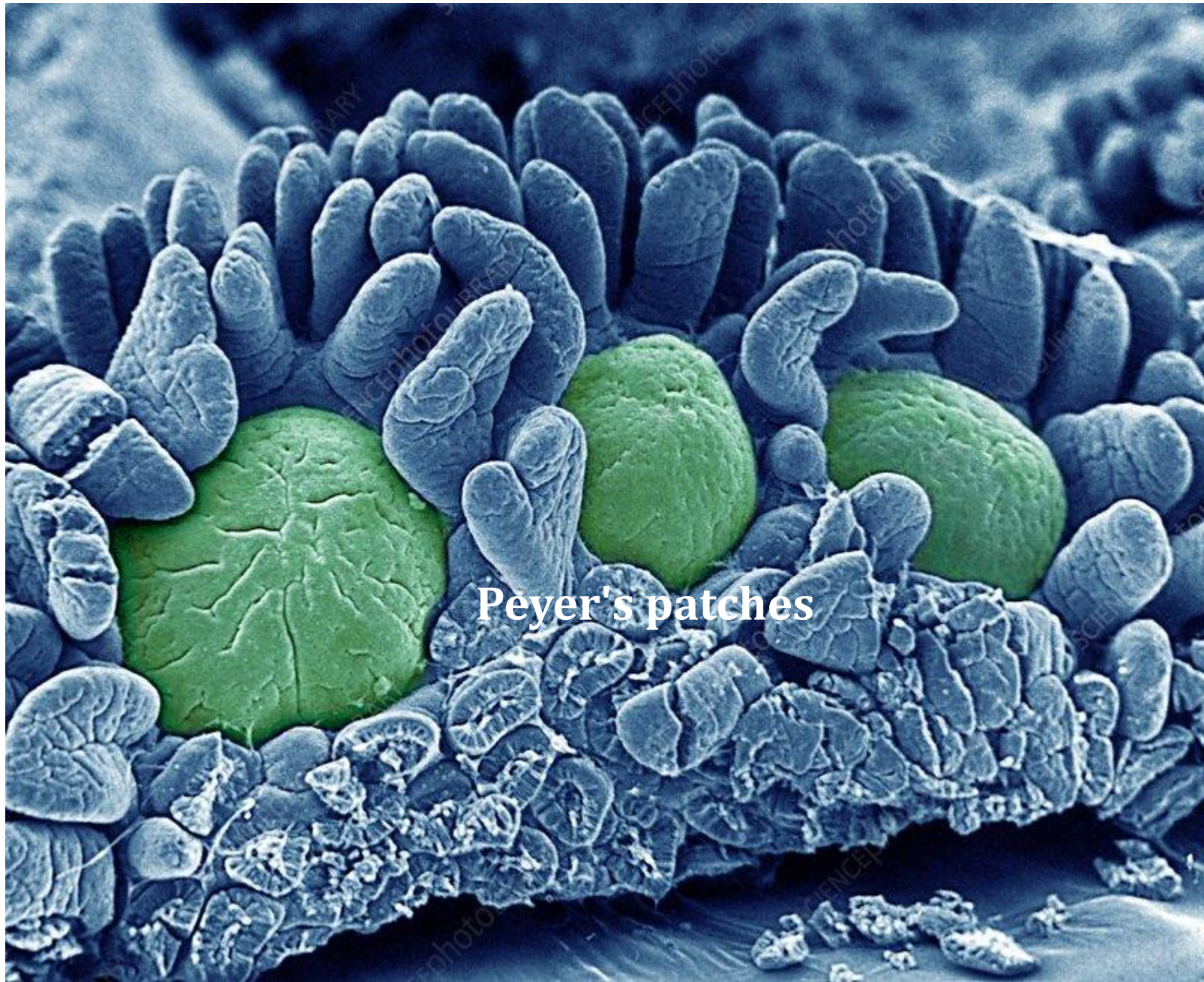
30 May 2019 £10

Vol. 569, No. 7758

 **axs studio**

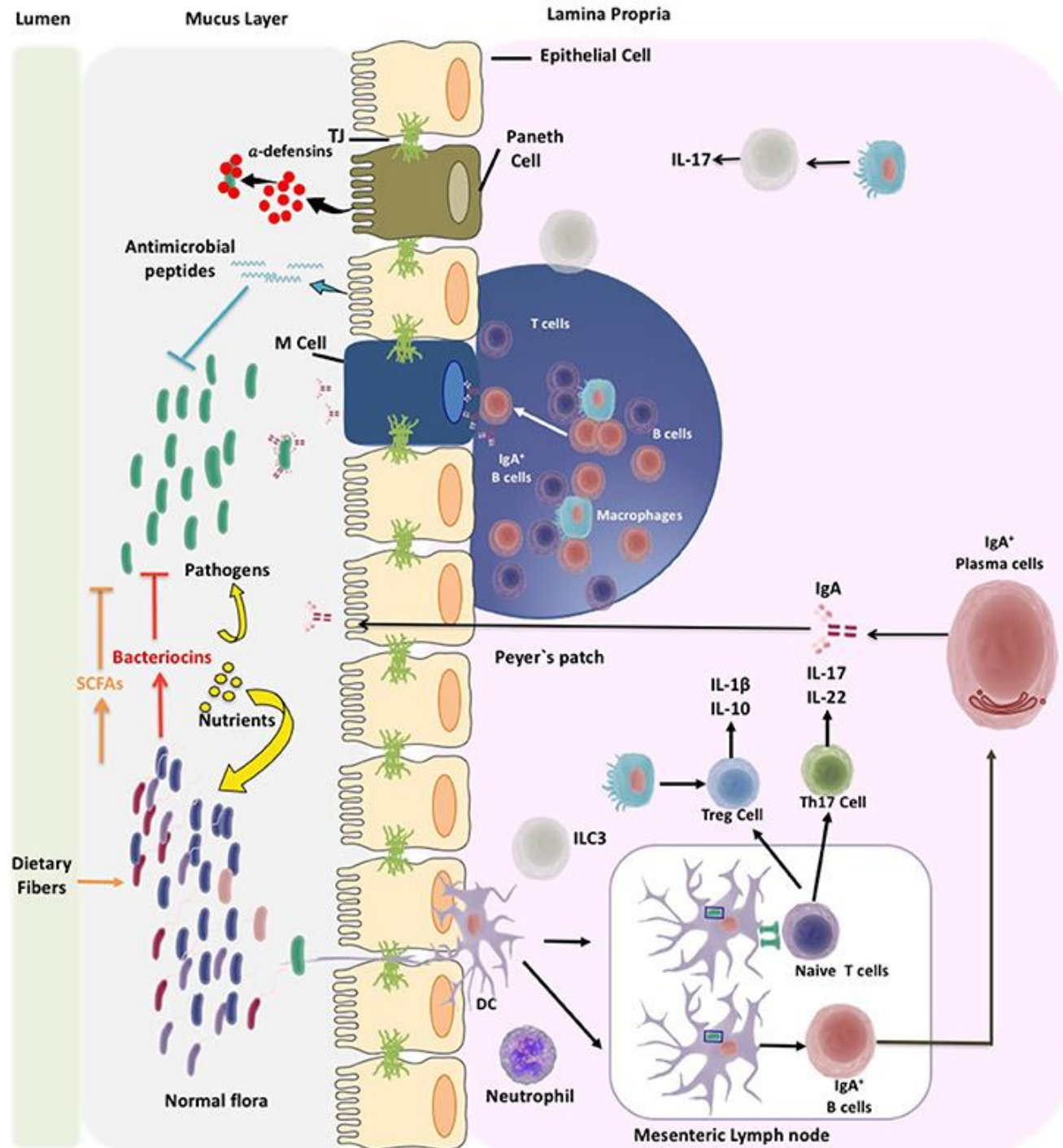
©2019 AXS Studio Inc.





Peyer's patches

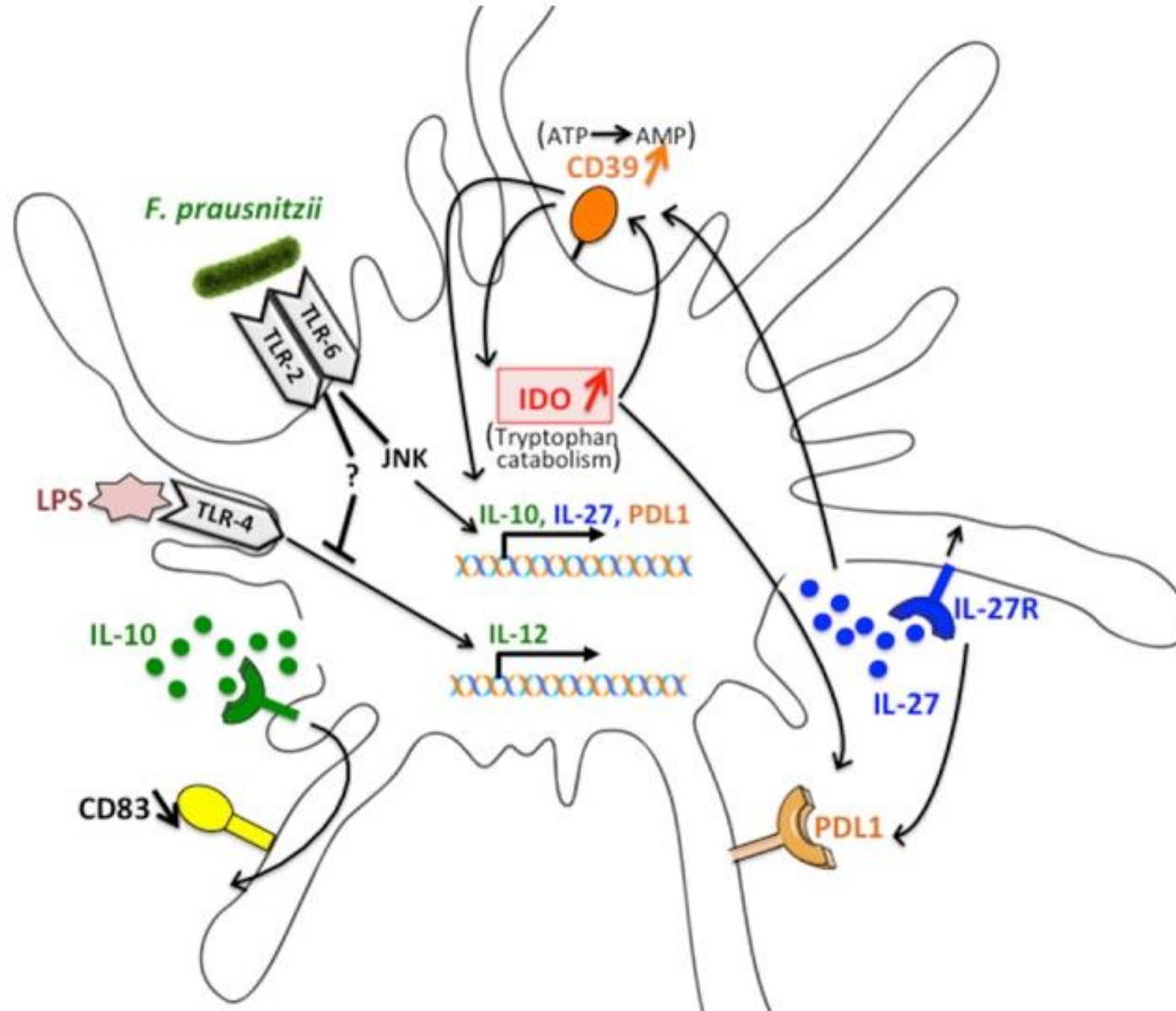




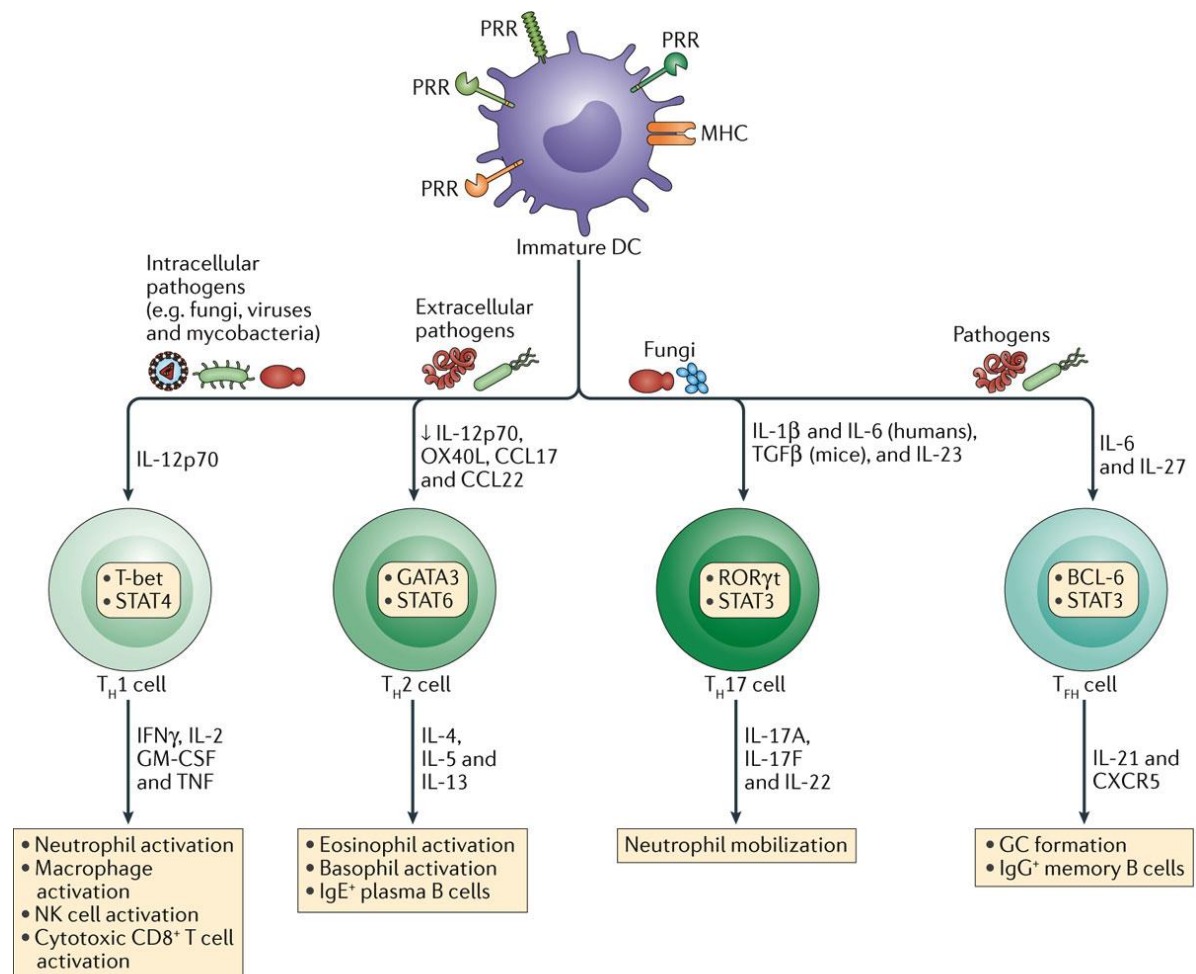
Front. Microbiol., 12 March 2018  
 Intestinal Microbiota Influences Non-intestinal Related Autoimmune Diseases  
 Maria C. Opazo et al.



# Faecalibacterium prausnitzii Skews Human DC to Prime IL10-Producing T Cells Through TLR2/6/JNK Signaling and IL-10, IL-27, CD39, and IDO-1 Induction.

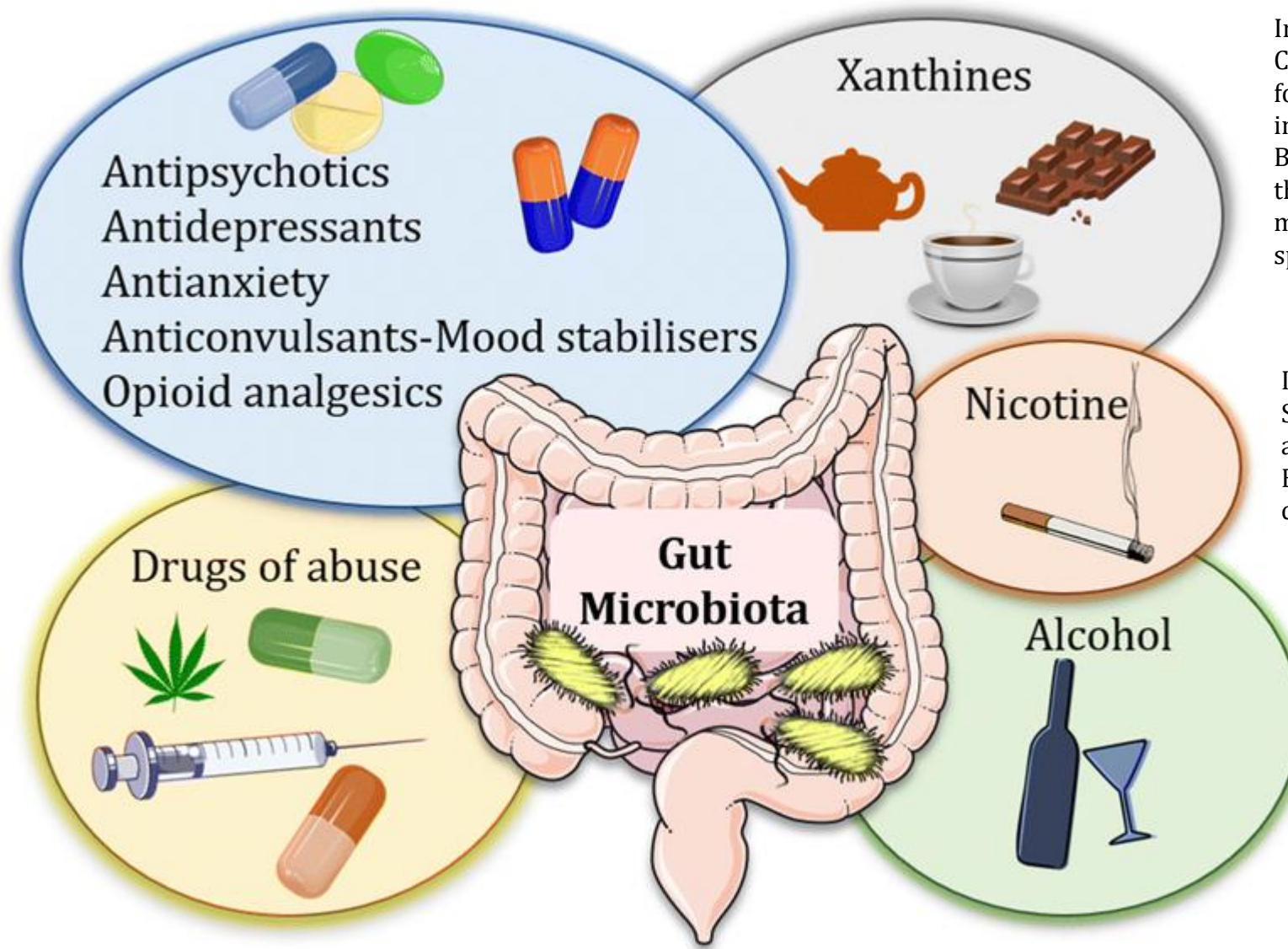






Nature Reviews | Immunology





In humans  
Consumption of 3 cups of coffee daily for 3 weeks in healthy volunteers increases the population of *Bifidobacterium* spp. In some subjects, there is a specific increase in the metabolic activity of *Bifidobacterium* spp.

In humans  
Smoking induces profound changes in the gut microbiome, with an increase of Firmicutes and Actinobacteria and a decrease of Bacteroidetes and Proteobacteria at the phylum level. Smoking cessation induces an increase in microbial diversity

In humans  
Human alcoholics with dysbiosis have lower abundances of Bacteroidetes and higher ones of Proteobacteria





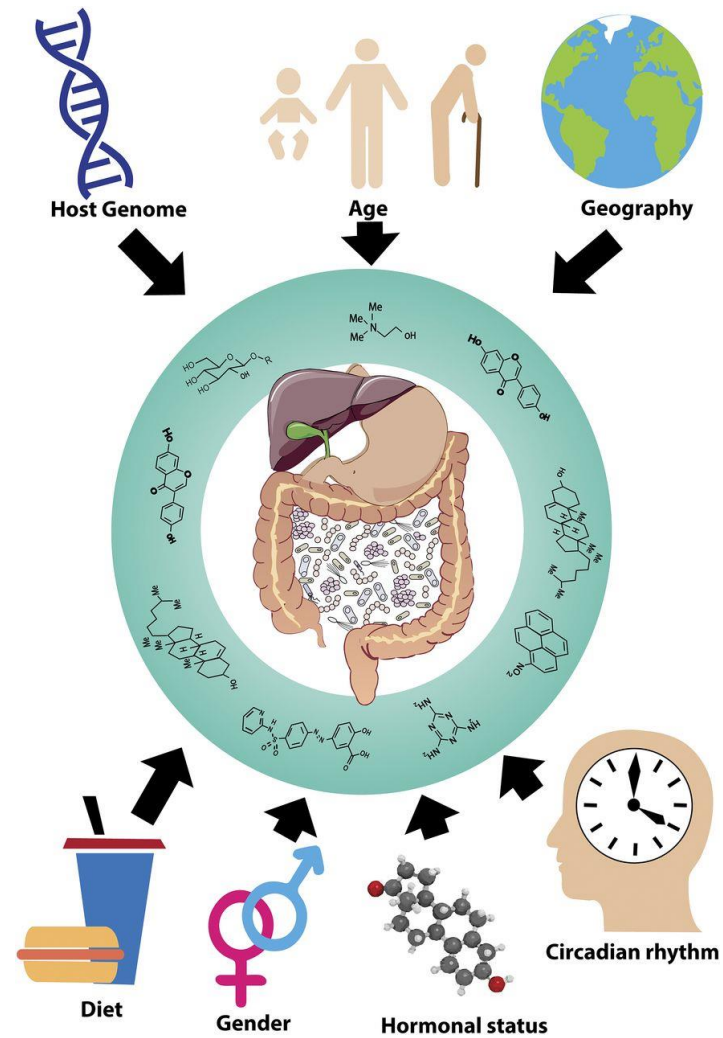


Higher caffeine consumption was associated with increased richness and evenness of the mucosa-associated gut microbiota, and higher relative abundance of anti-inflammatory bacteria, such as *Faecalibacterium* and *Roseburia* and lower levels of potentially harmful *Erysipelatoclostridium*. Furthermore, the researchers of this present study found higher levels of other bacteria "commonly detected in gut microbiomes" in high coffee consumers. These bacteria included *Odoribacter*, *Dialister*, *Fusicatenibactor*, *Alistipes*, *Blautia*, and various strains of *Lachnospiraceae*.

Dr. Li Jiao and Dr. Shawn Gurwara, Baylor College, at the American College of Gastroenterology (ACG) 2019 Annual Scientific Meeting, San Antonio, TX.



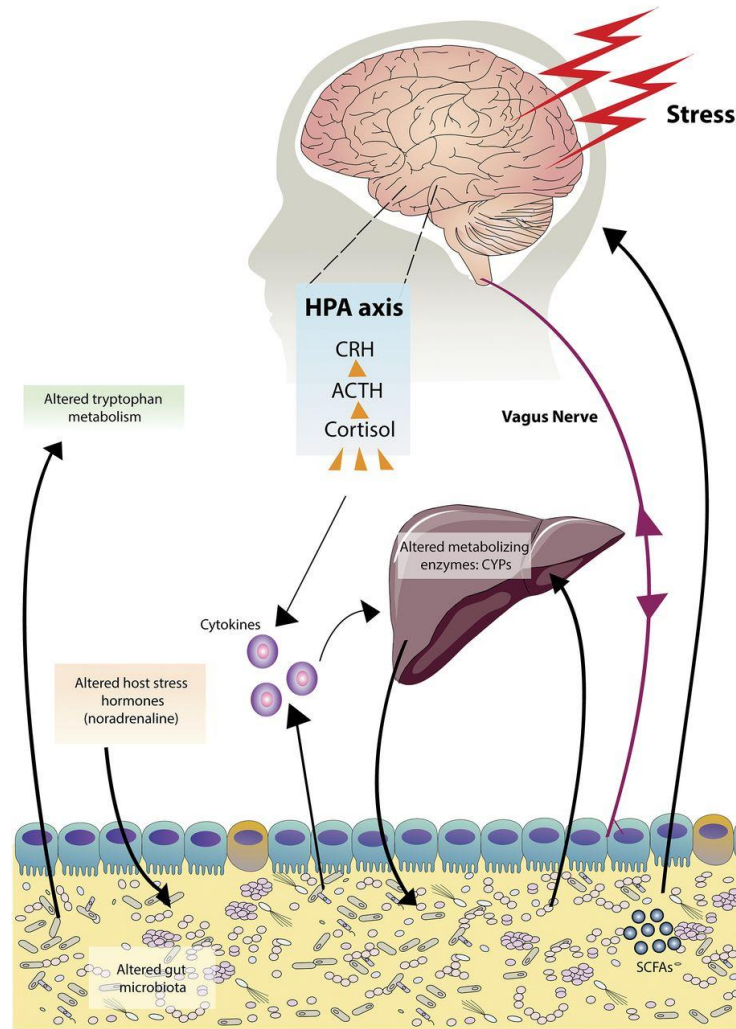
## Factors influencing gut microbiome xenobiotic metabolism.



Gerard Clarke et al. Pharmacol Rev 2019;71:198-224



## Stress and the gut microbiome.

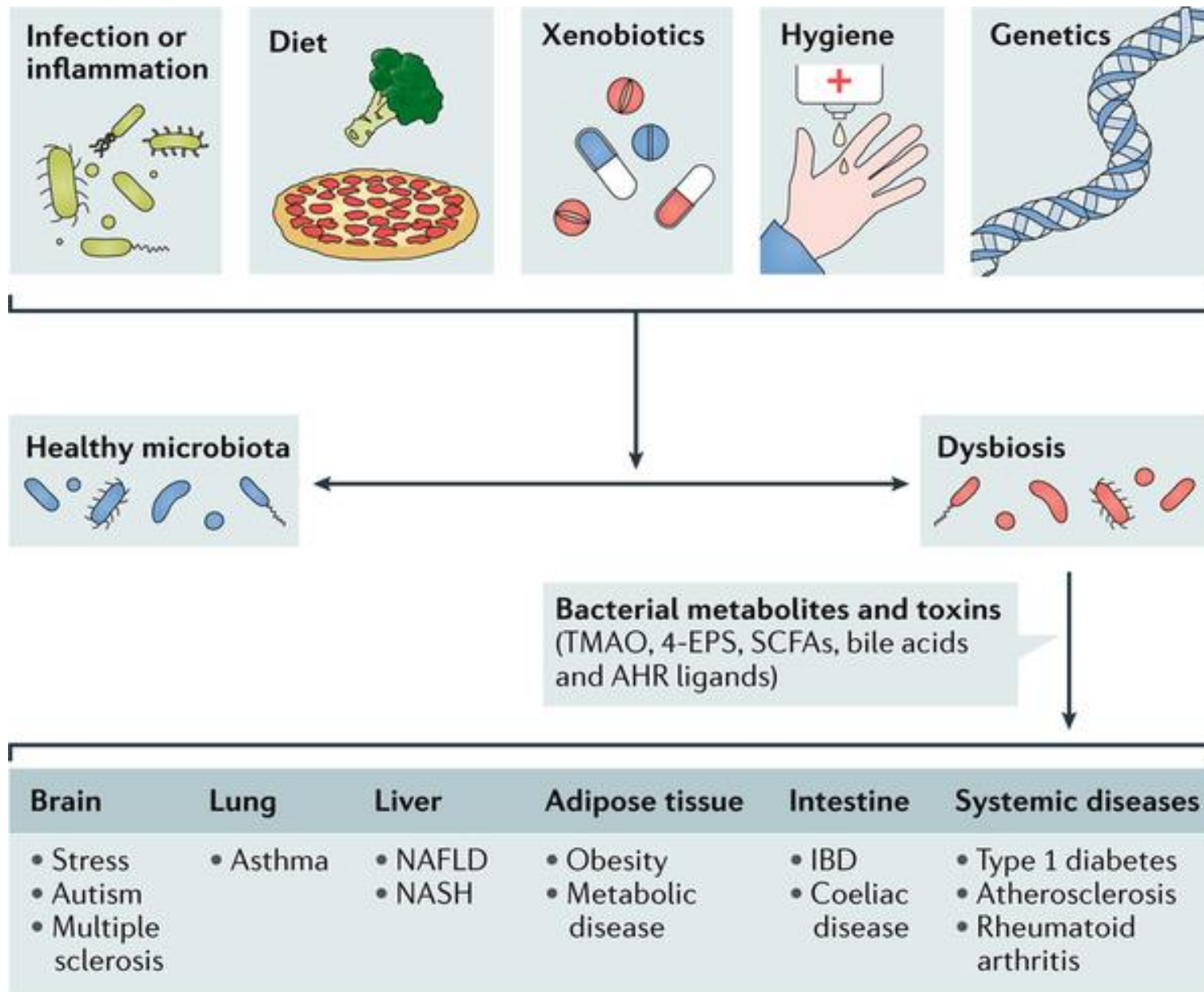


Gerard Clarke et al. Pharmacol Rev 2019;71:198-224

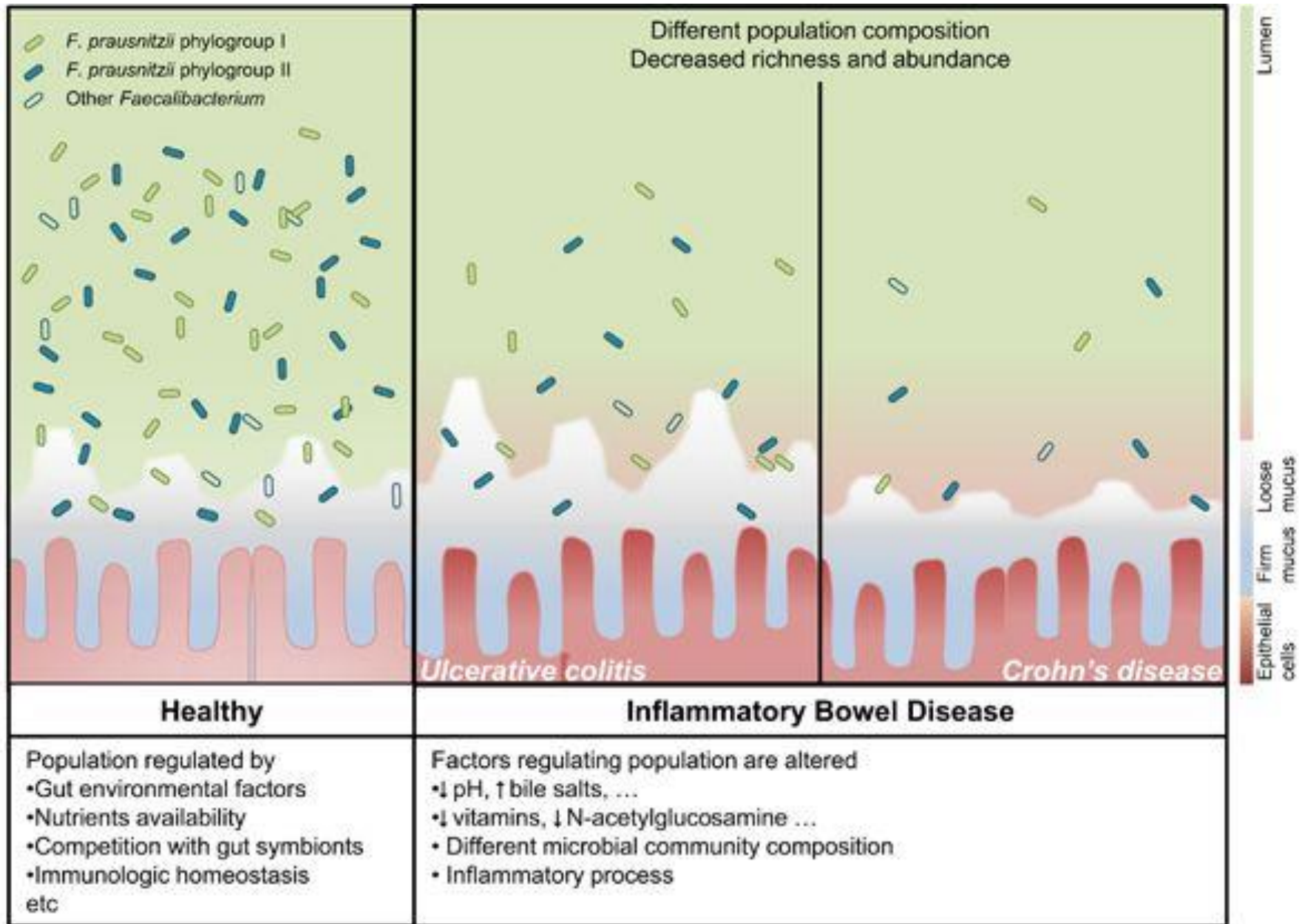
ASPET

PHARMACOLOGICAL  
REVIEWS

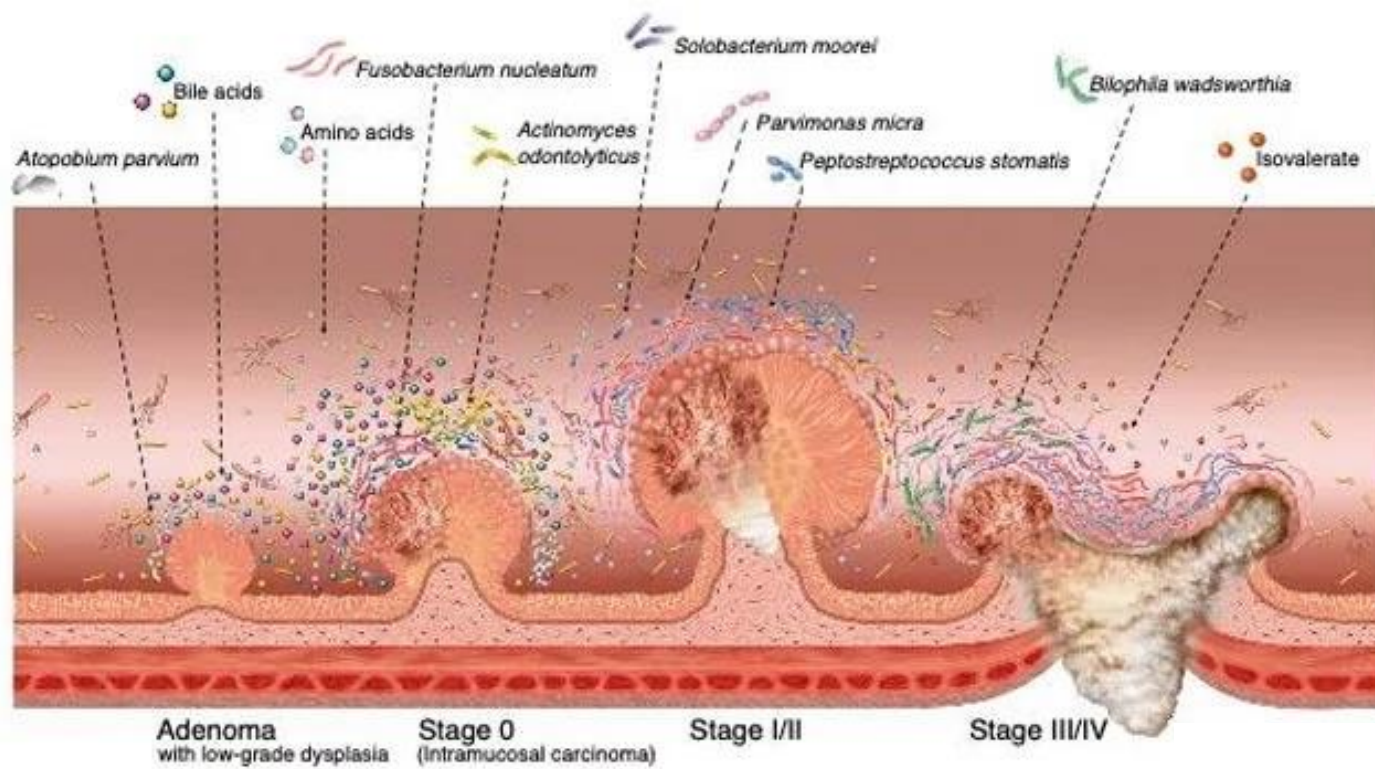
# Dysbiosis and the immune system



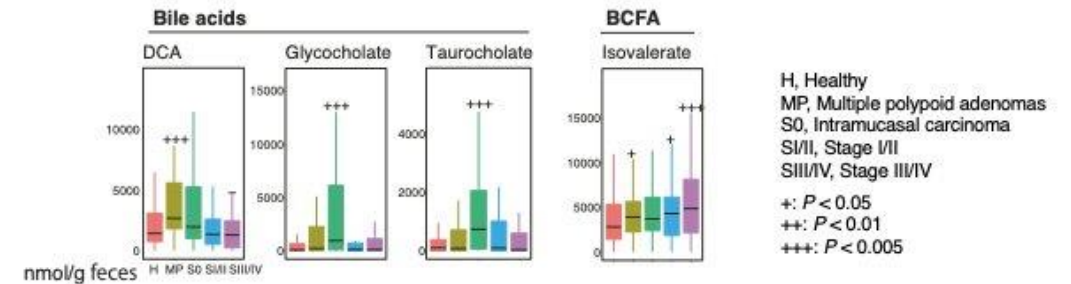
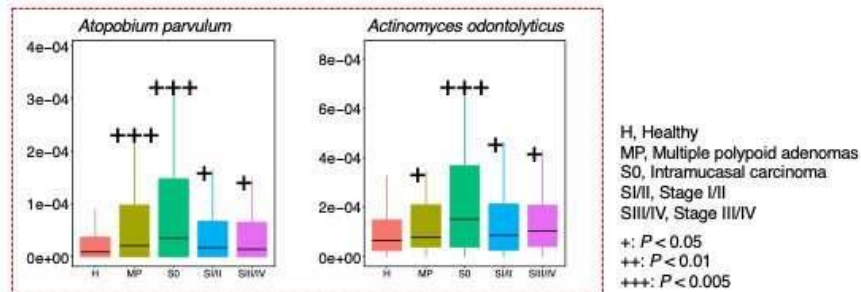
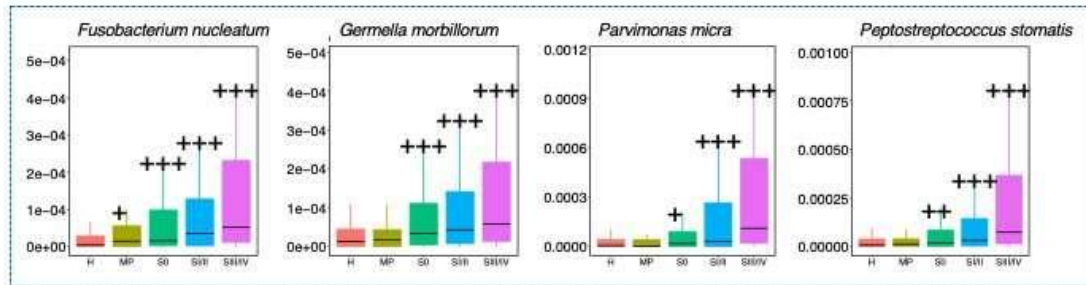




Faecalibacterium prausnitzii: from microbiology to diagnostics and prognostics  
 Mireia Lopez-Siles et al. ISME Journal volume 11, pages 841–852 (2017)

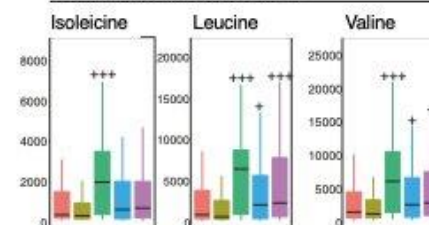


These are microbial dynamics during multistep colorectal cancer progression. Graphic representation of major microbial and metabolomic alterations during multistep colorectal cancer progression. Credit: Osaka University

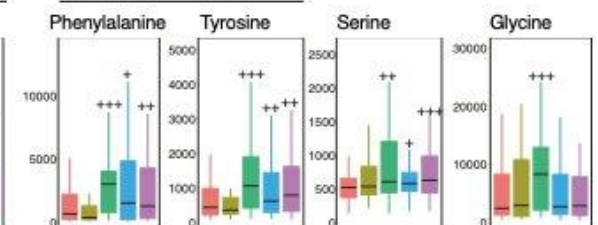


#### Amino acids

##### Branched chain amino acids

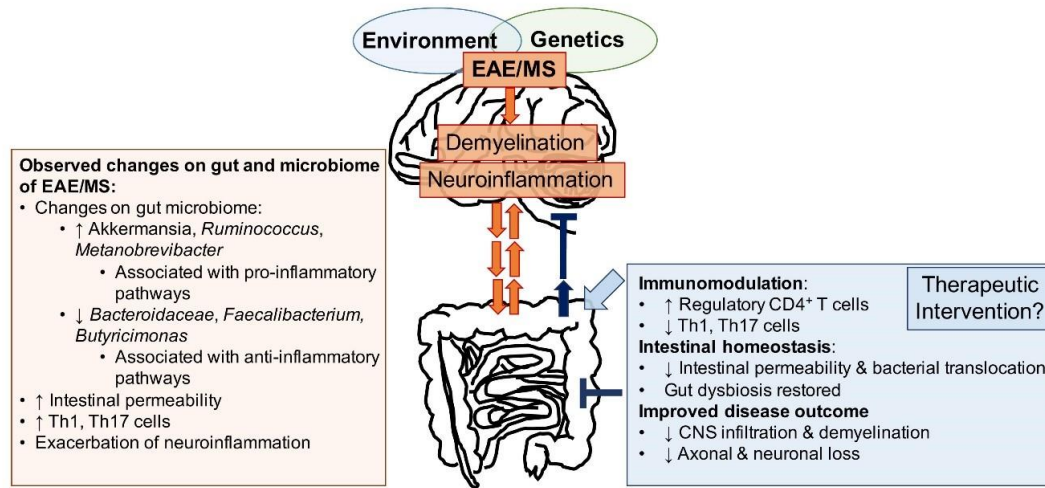


##### Aromatic amino acids

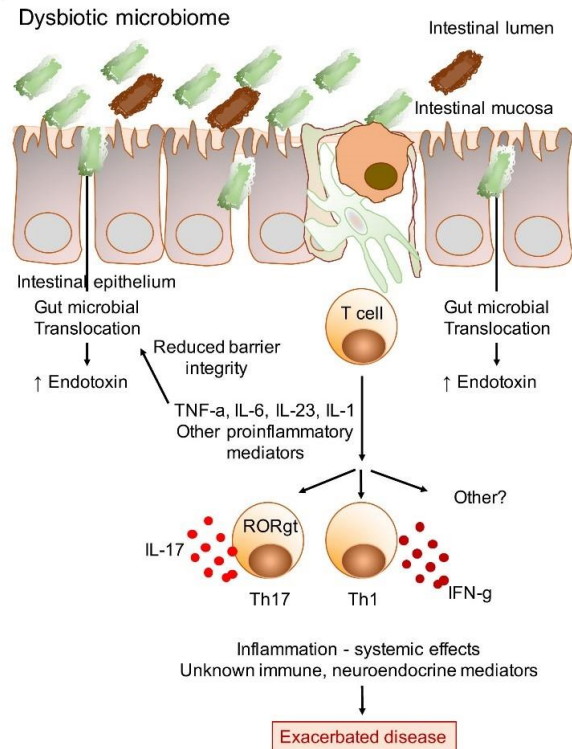




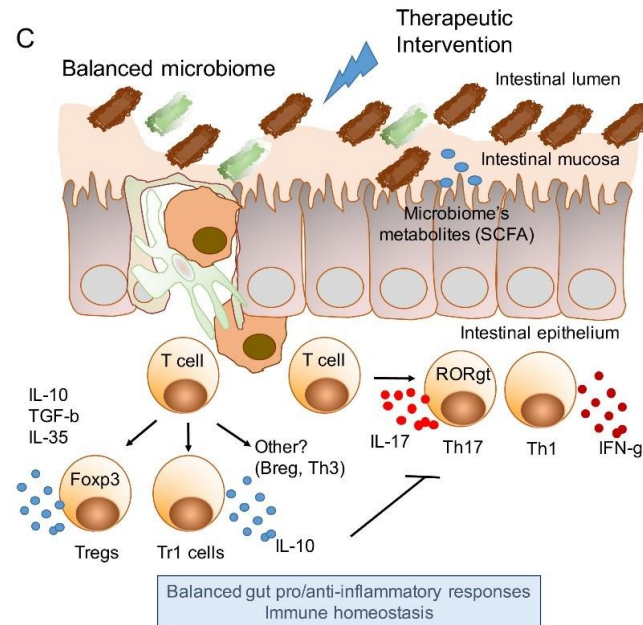
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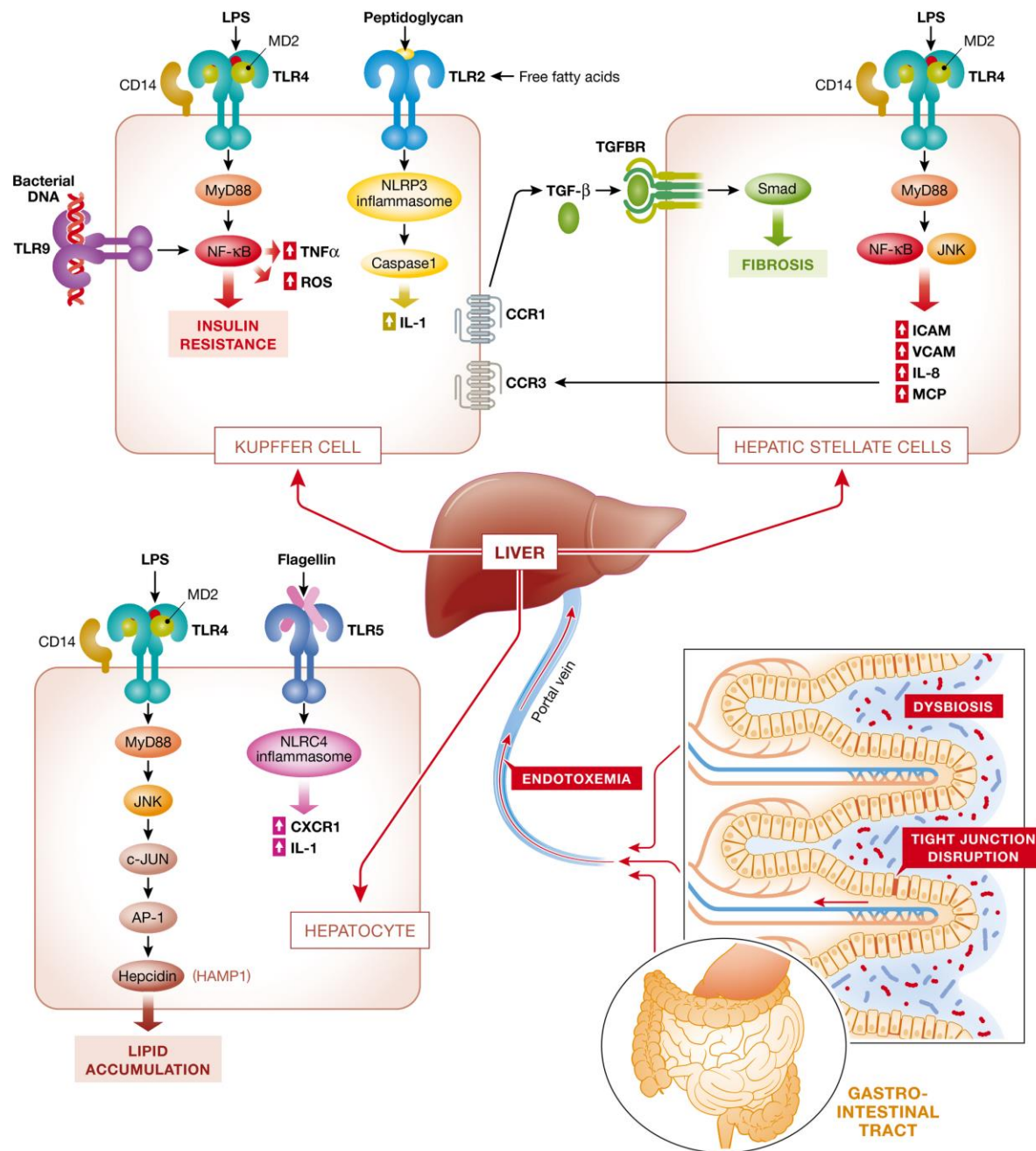
B



C

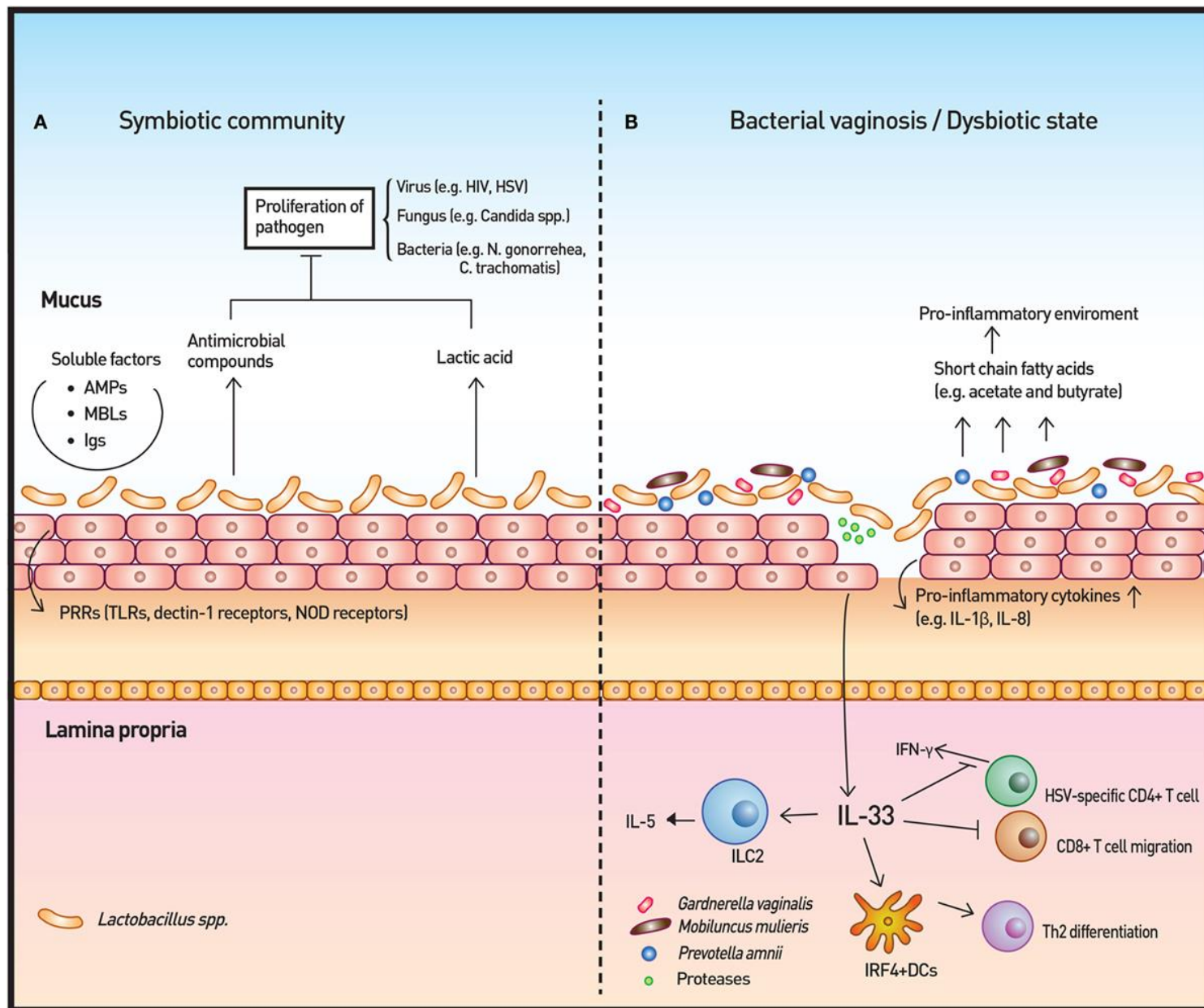


The Gut Microbiome in Multiple Sclerosis: A Potential Therapeutic Avenue  
 Trevor O. Kirby and Javier Ochoa-Repáraz \*  
 Med. Sci. 2018, 6(3), 69



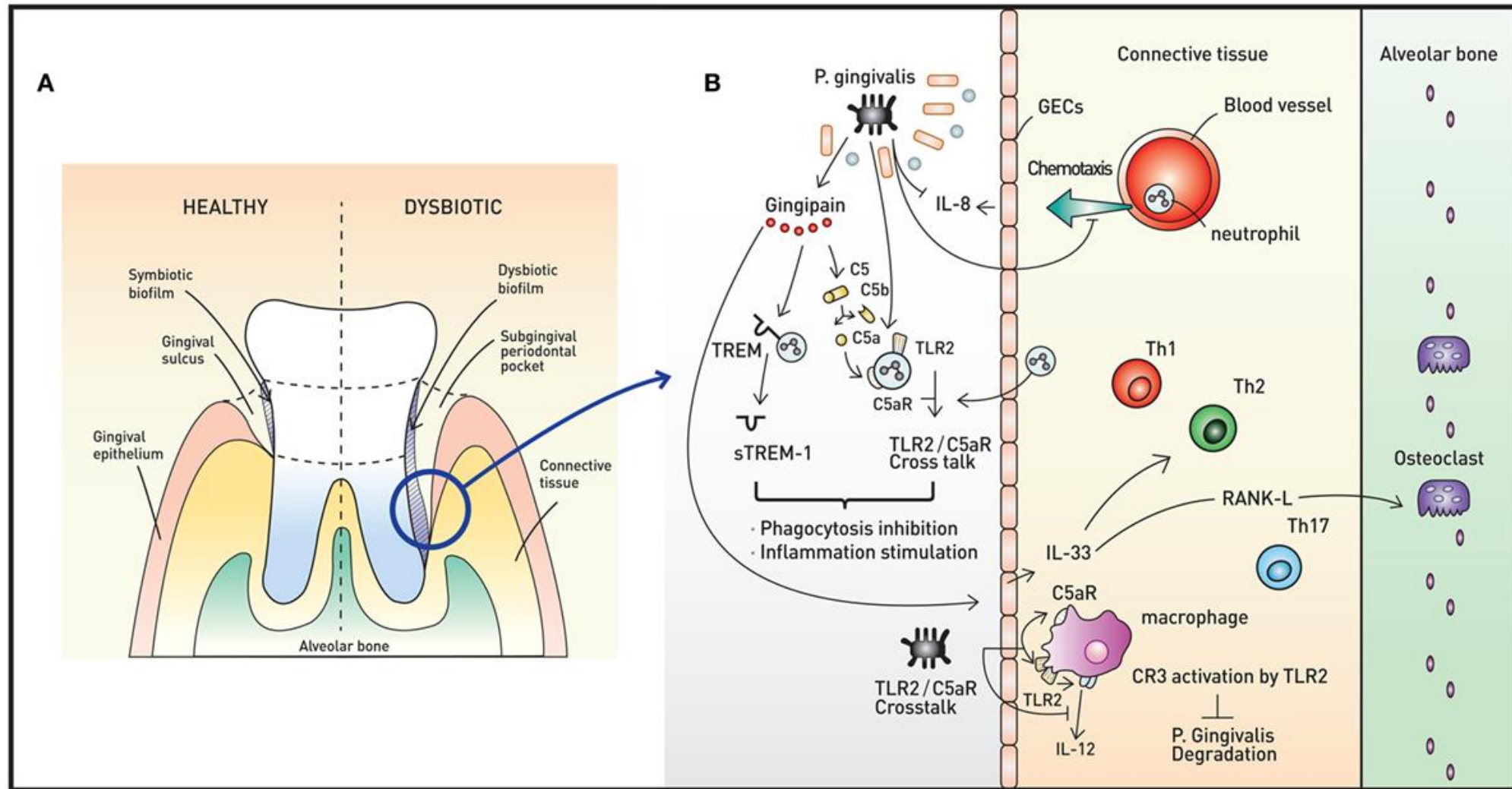
## The role of the microbiome in NAFLD and NASH





The Role of Skin and Orogenital Microbiota in Protective Immunity and Chronic Immune-Mediated Inflammatory Disease

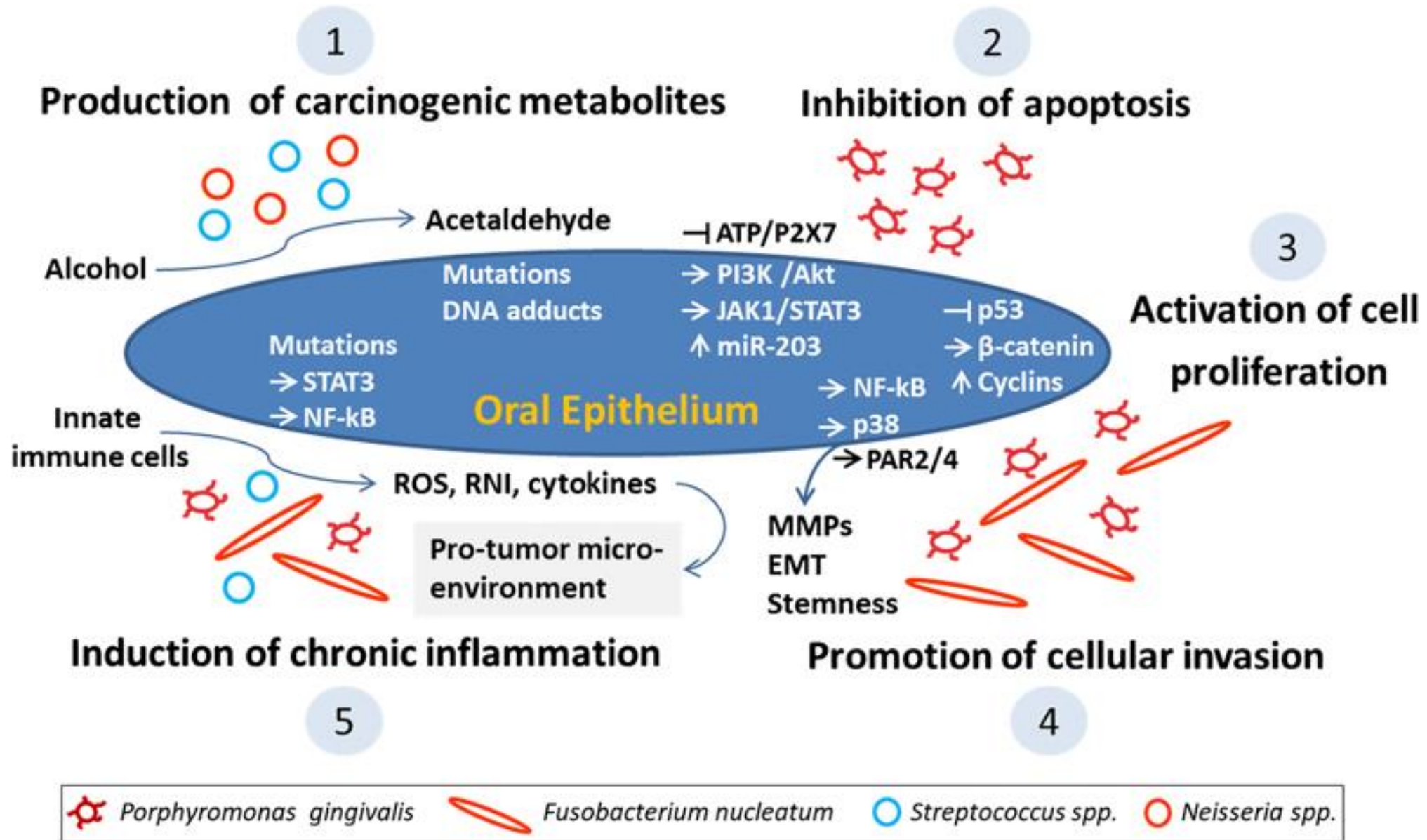
Young Joon Park and Heung Kyu Lee. Front. Immunol., 10 January 2018 |



The Role of Skin and Orogenital Microbiota in Protective Immunity and Chronic Immune-Mediated Inflammatory Disease

Young Joon Park and Heung Kyu Lee. Front. Immunol., 10 January 2018 |

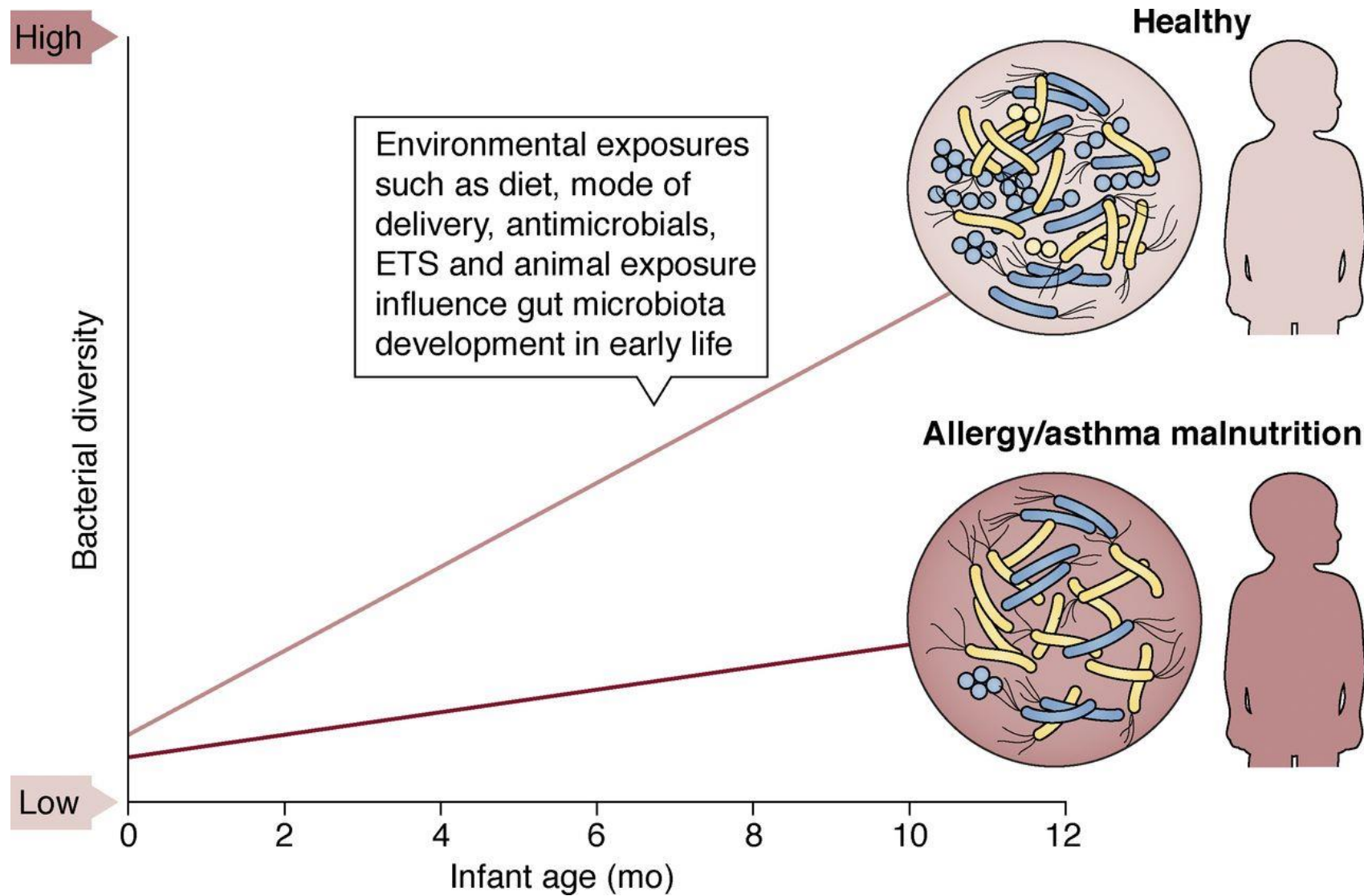


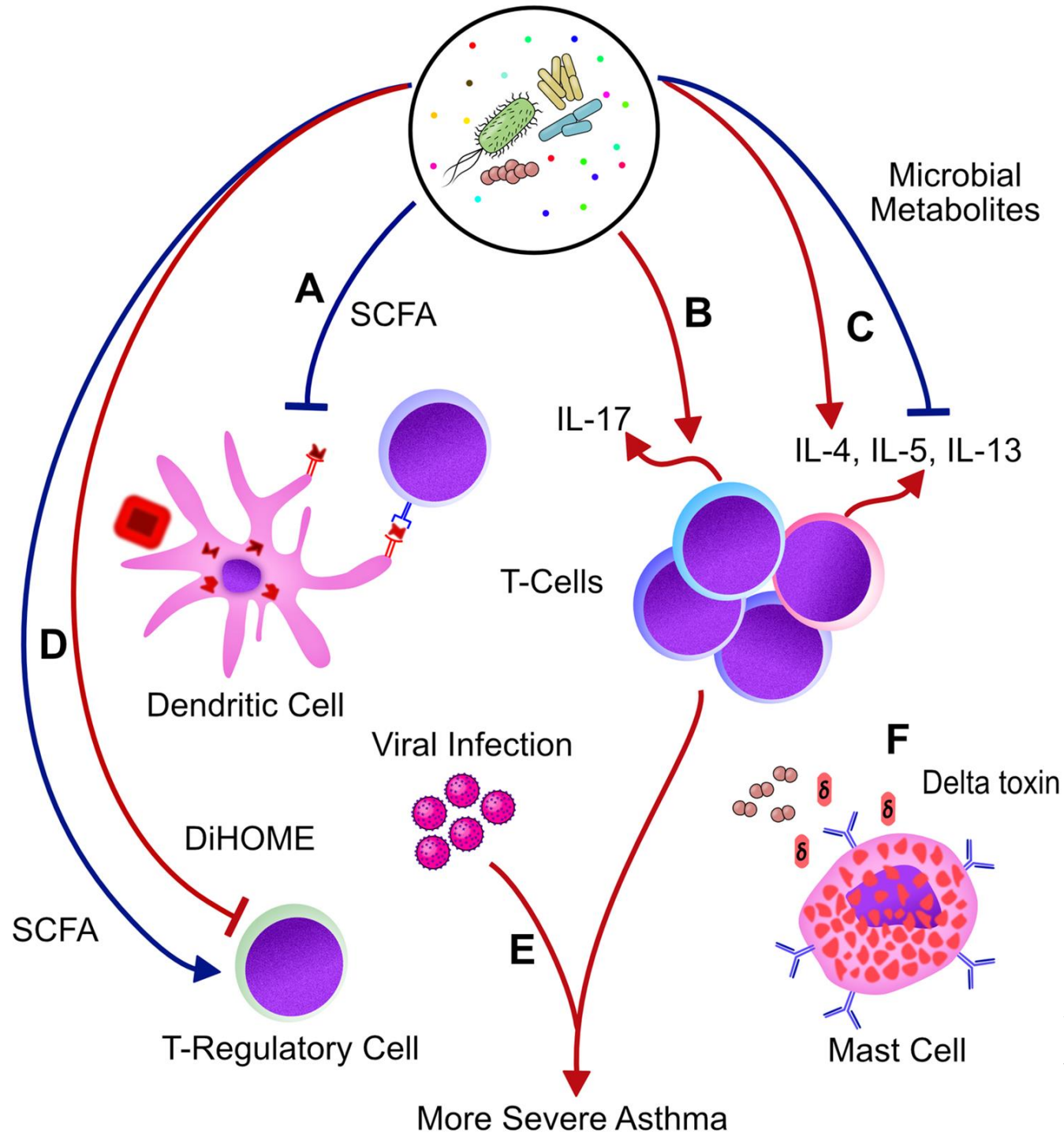


Shi, B., Lux, R., Klokkevold, P. et al.  
The subgingival microbiome  
associated with periodontitis in type 2  
diabetes mellitus.

ISME J (2019) doi:10.1038/s41396-  
019-0544-3

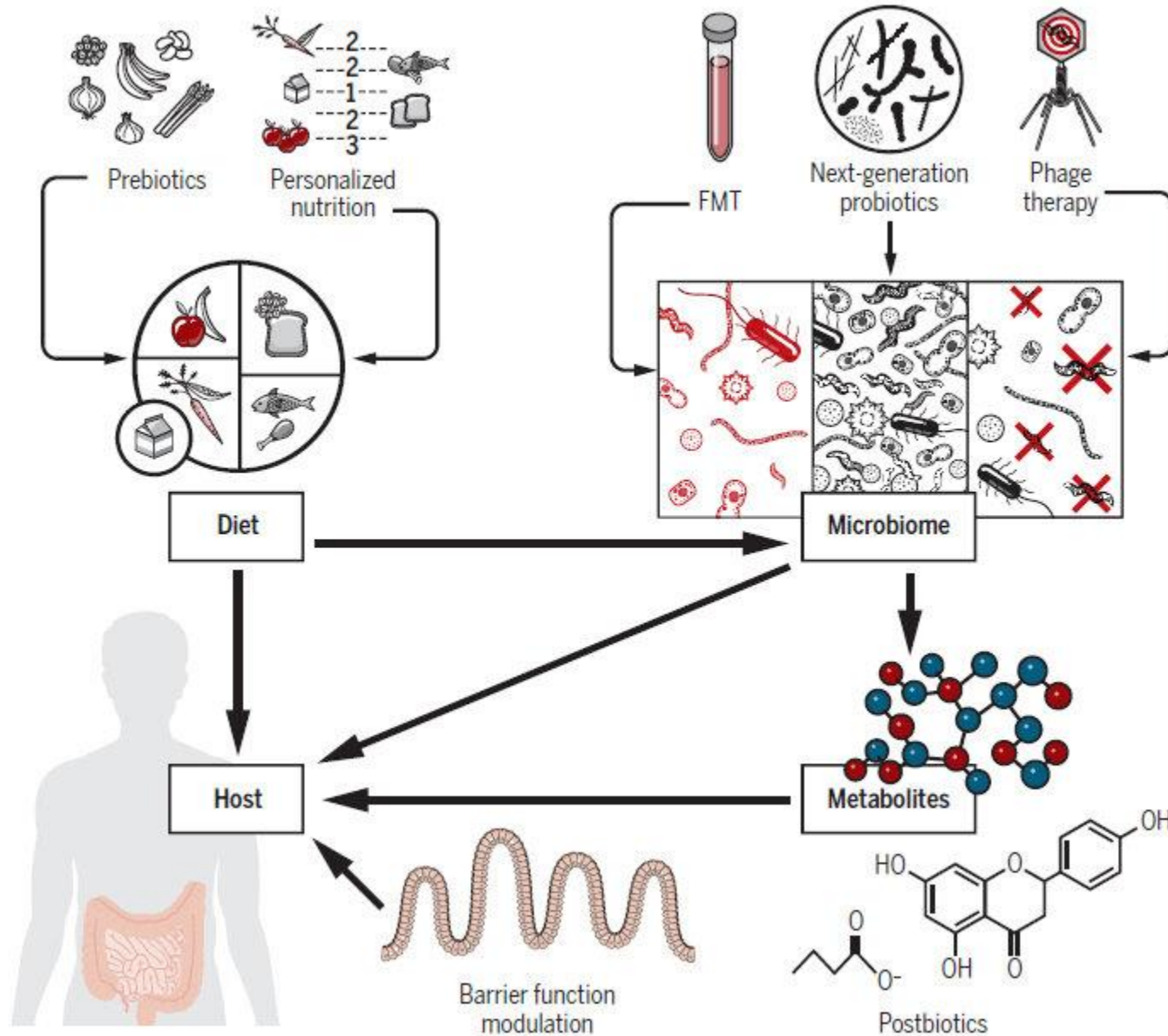






Wilson NG, Hernandez-Leyva A, Kau AL (2019) The ABCs of wheeze: Asthma and bacterial communities. PLoS Pathog 15(4): e1007645. <https://doi.org/10.1371/journal.ppat.1007645>

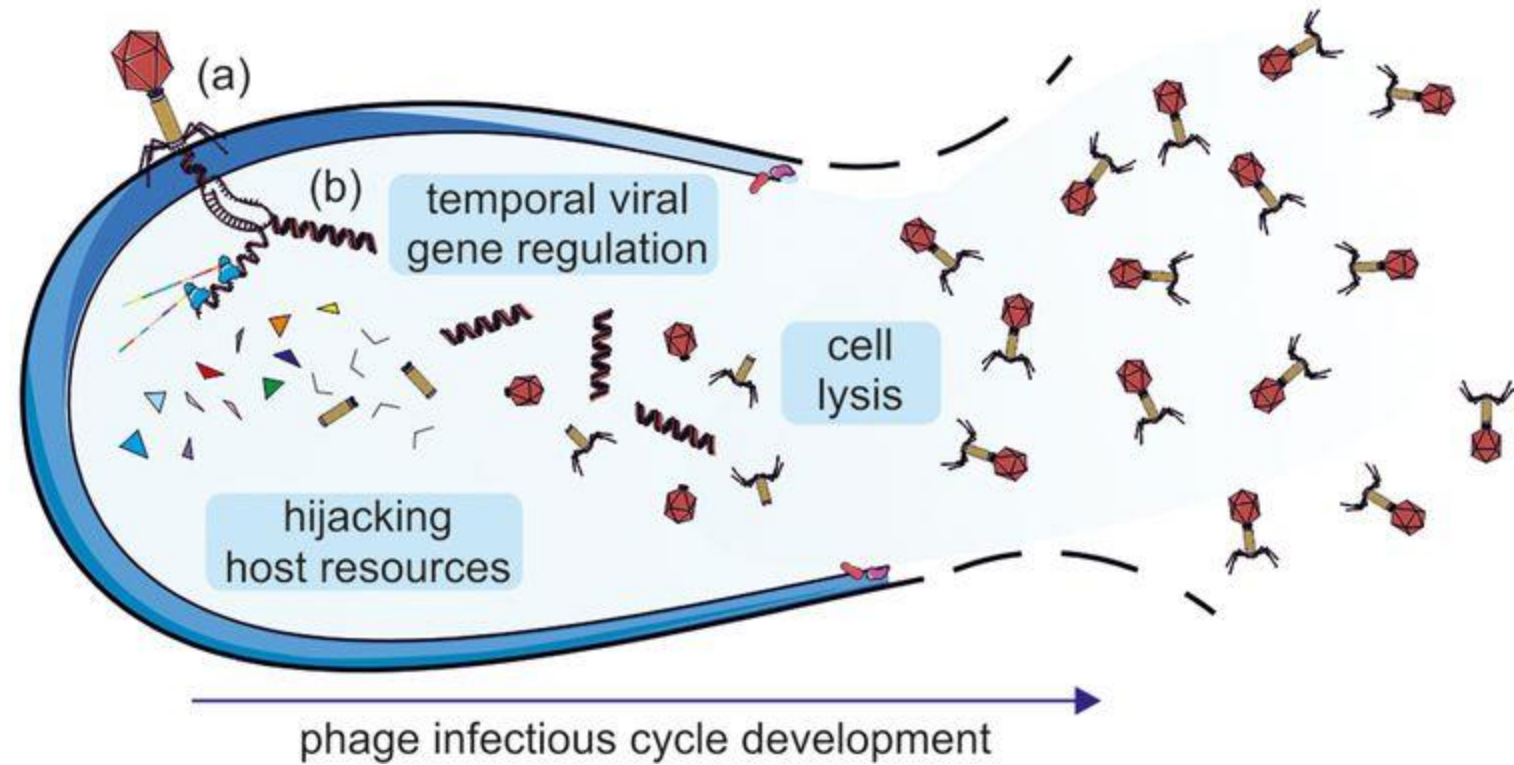
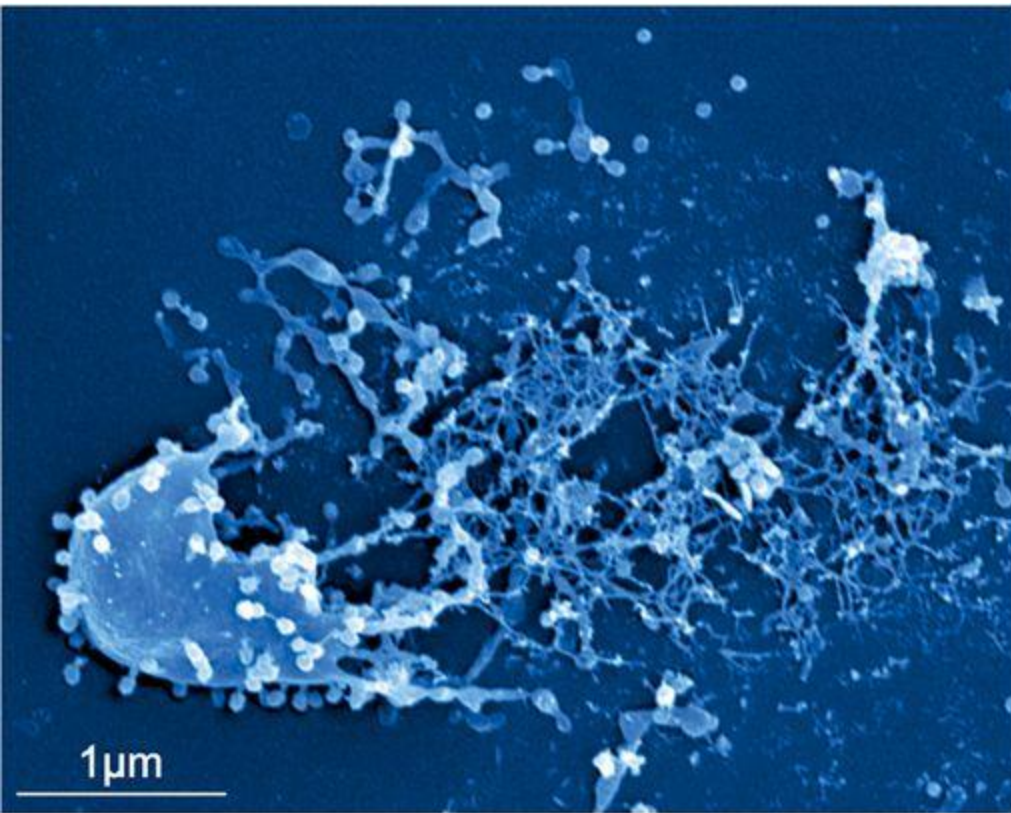




Recent studies have identified new gut microbiome interventions to promote human health and combat disease, such as phage therapy and personalized nutrition.

Credit: N. Zmora et al., Science Translational Medicine (2018)

# Phage therapy: awakening a sleeping giant





What the U.S. elections  
mean for science p. 30

Dendrite turnover in  
Down syndrome neurons p. 797

Social networks drive  
success in art p. 825

# Science

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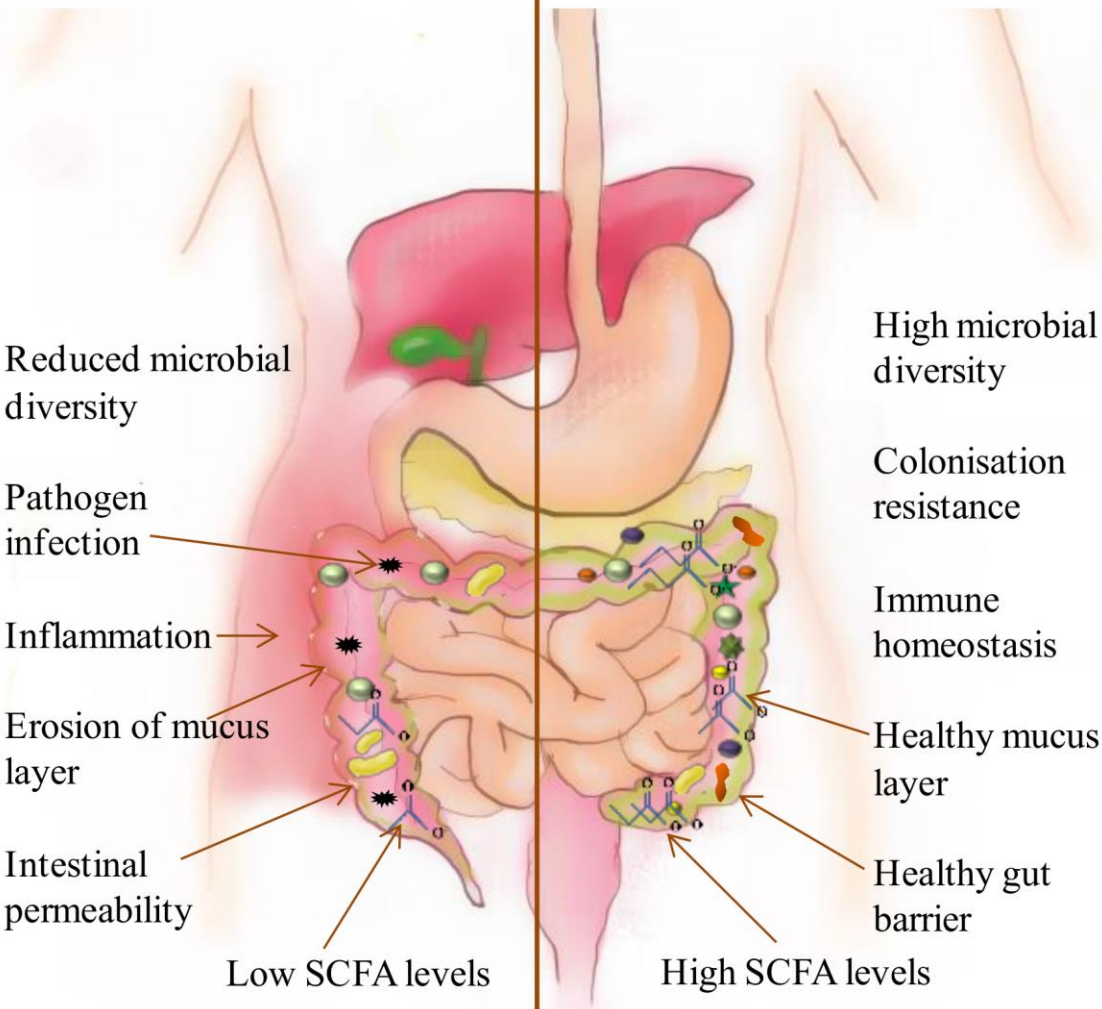


SPECIAL ISSUE

## DIET AND HEALTH

Optimizing human  
metabolism

The millennials may be onto something. Their favored avocado toast features a mixture of healthy fats, seeds, and grains recommended by nutrition experts in a consensus reading of available scientific studies. This special issue explores what we know—and what we need to learn—about defining a healthy diet that can sustain a strong body and protect against age-associated diseases. Photo: Scott Suchman; Styling: Nichole Bryant

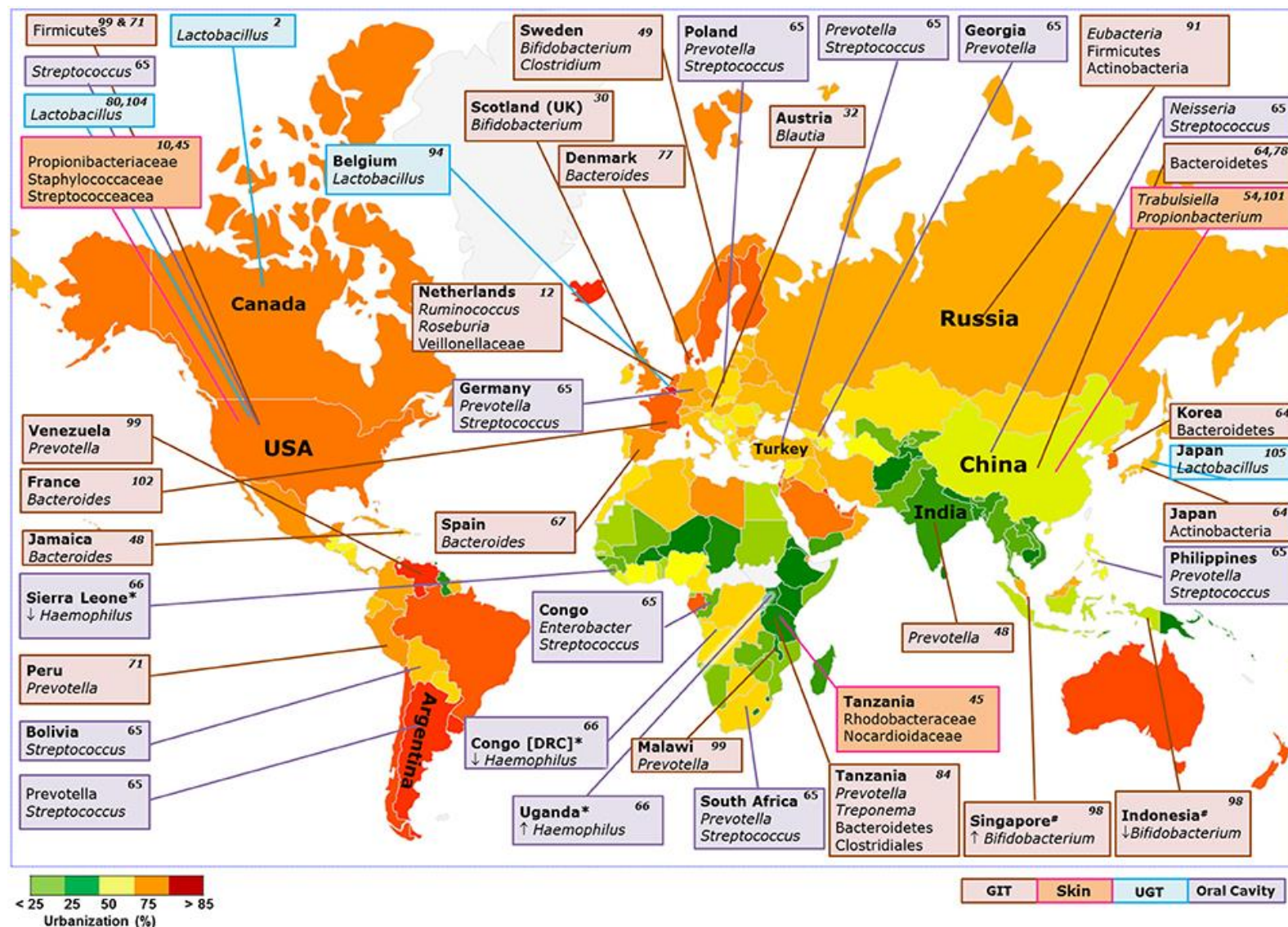
Poor Quality Diet	Consequences		Healthy Diet
<p>Predominant foods</p> <ul style="list-style-type: none"> <li>▪ Animal-derived protein (meat &amp; processed meat)</li> <li>▪ Saturated fats</li> <li>▪ Refined grains</li> <li>▪ Sugar</li> <li>▪ Salt</li> <li>▪ Alcohol</li> <li>▪ Corn-derived fructose</li> </ul>			<p>Predominant foods</p> <ul style="list-style-type: none"> <li>▪ Fruits</li> <li>▪ Vegetables</li> <li>▪ Fibre</li> <li>▪ Plant-derived protein</li> <li>▪ MUFAs</li> <li>▪ n-3 PUFAs</li> </ul>



Carmody, R.N., Bisanz, J.E., Bowen, B.P. et al. Cooking shapes the structure and function of the gut microbiome. Nat Microbiol (2019) doi:10.1038/s41564-019-0569-4

Abigail J. Johnson et al. Daily Sampling Reveals Personalized Diet-Microbiome Associations in Humans, Cell Host & Microbe (2019). DOI: 10.1016/j.chom.2019.05.005

# Geography, Ethnicity or Subsistence-Specific Variations in Human Microbiome Composition and Diversity





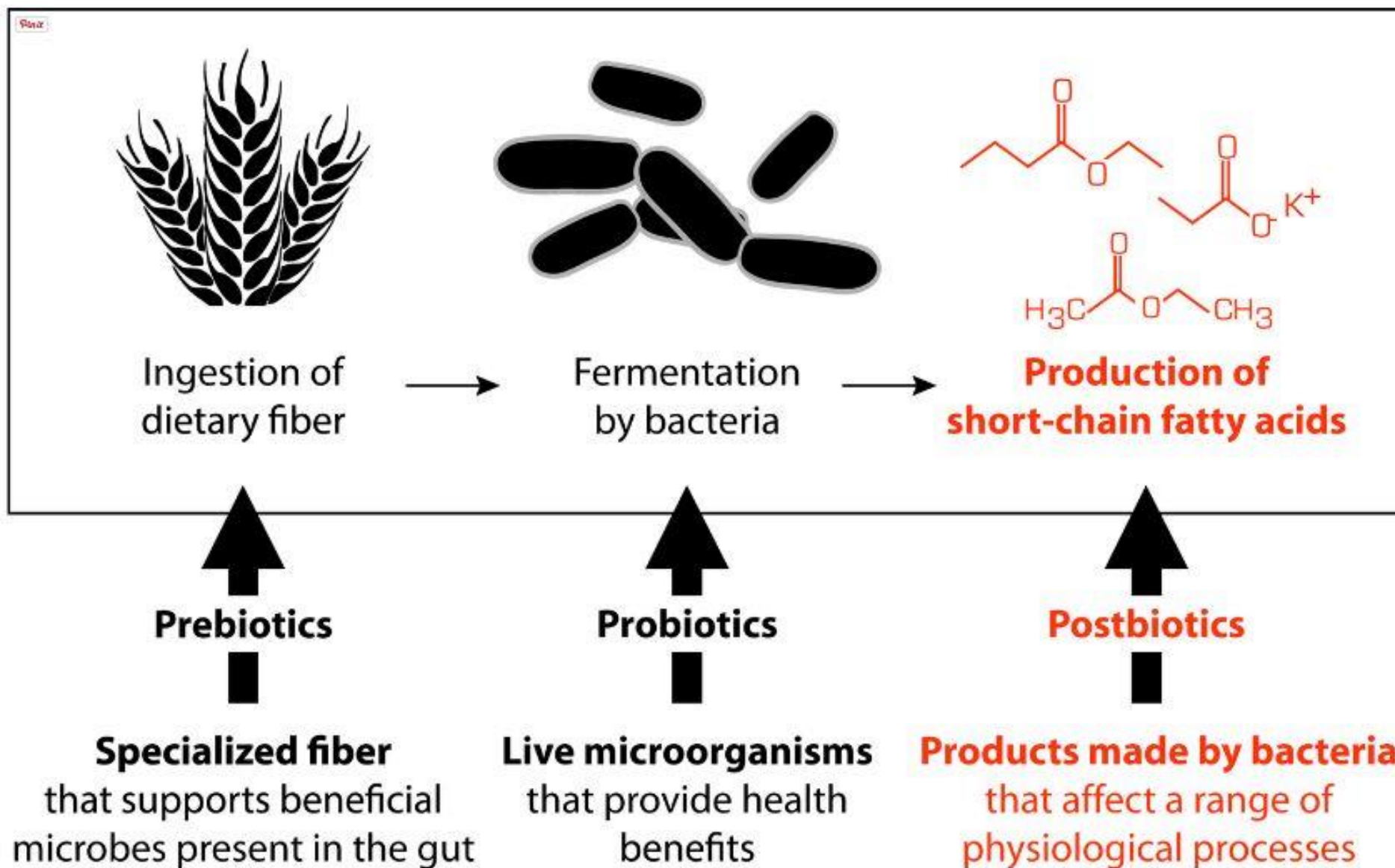


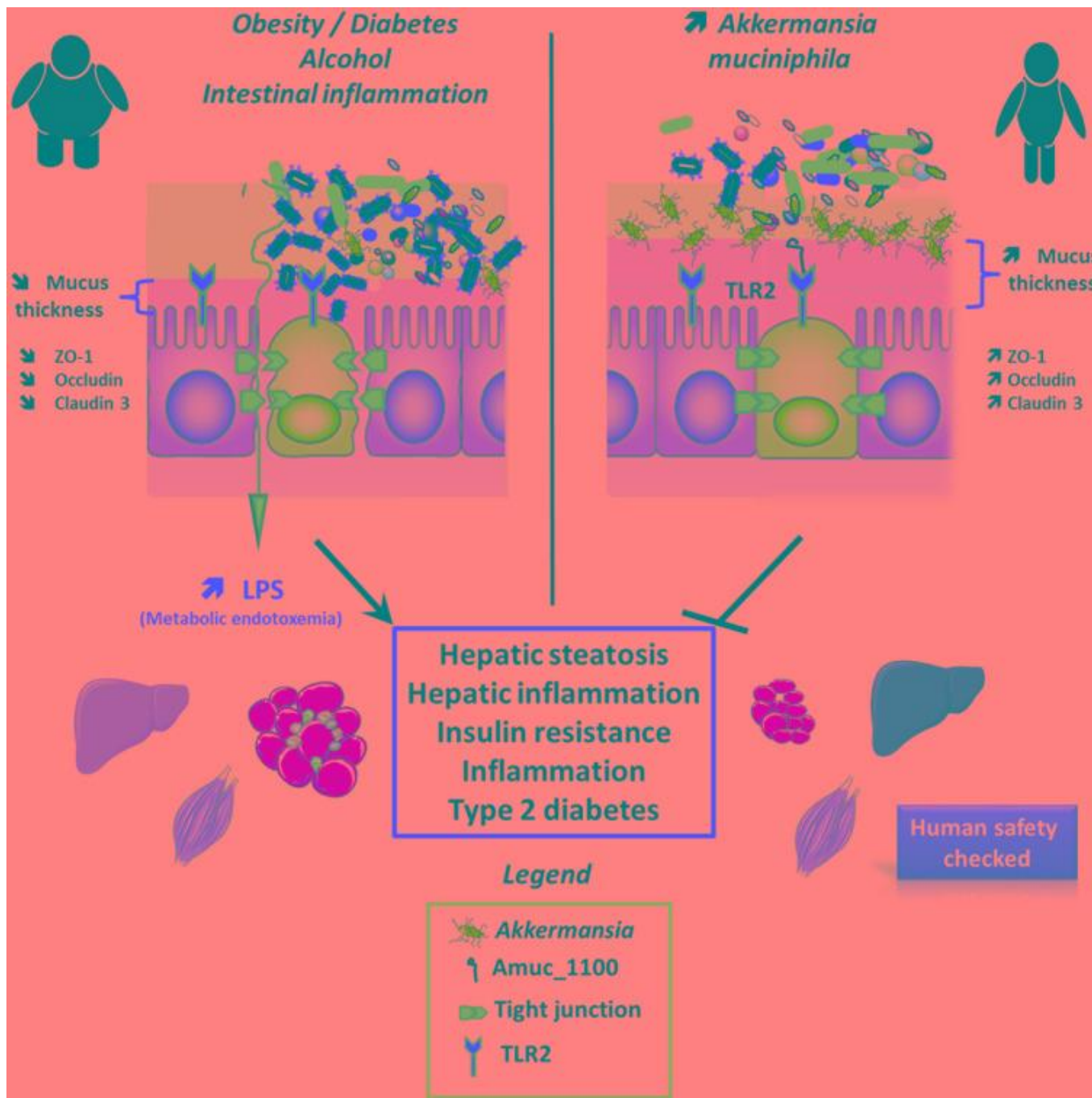
Plant-based foods and a Mediterranean-influenced diet help bacteria with anti-inflammatory properties to thrive.

Bolte added, “A diet characterized by nuts, fruit, greater vegetable and legume intake than animal protein, combined with moderate consumption of animal derived foods like fish, lean meat, poultry, fermented low fat dairy, and red wine, and a lower intake of red meat, processed meat and sweets, is beneficially associated with the gut ecosystem in our study.”

The findings were presented at the United European Gastroenterology Week 2019, the largest gastroenterology meeting in Europe.






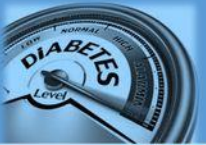





## Next-Generation Beneficial Microbes: The Case of *Akkermansia muciniphila*.

Cani PD, de Vos WM. Front Microbiol. 2017 Sep 22;8:1765.  
doi: 10.3389/fmicb.2017.01765. eCollection 2017.



**Association between Akkermansia muciniphila and several diseases: what is known? What are the major confounding factors. The picture illustrated different pathological situations where the abundance of the bacteria A. muciniphila has been found to be increased or decreased.**

					
	Obesity	Non treated Type 2 diabetic	Treated Type 2 diabetic	Gastric Bypass	Multiple sclerosis Parkinson disease
<i>A.muciniphila</i> levels	↓↓	↓↓	↑(↑)	↑↑↑	↑
<b>Major confounding factors</b>	Low level of fibers ingested  High fat diet : saturated and low polyunsaturated omega-3  Decreased mucus layer thickness / production ?		Metformin is an energy source for <i>A.muciniphila</i>  Metformin increases goblet cells number and changes the gut microbiota	High flux of undigested nutrients as energy source for <i>A.muciniphila</i>	Increased intestinal transit time and constipation  Drug treatments  Caloric restriction period or altered food intake (i.e., lower energy)
<b>Proof of concept of a direct link between the presence of <i>A.muciniphila</i> and the disease</b>	✓	✓	✓	✓	✗

Patrice D Cani Gut 2018;67:1716-1725





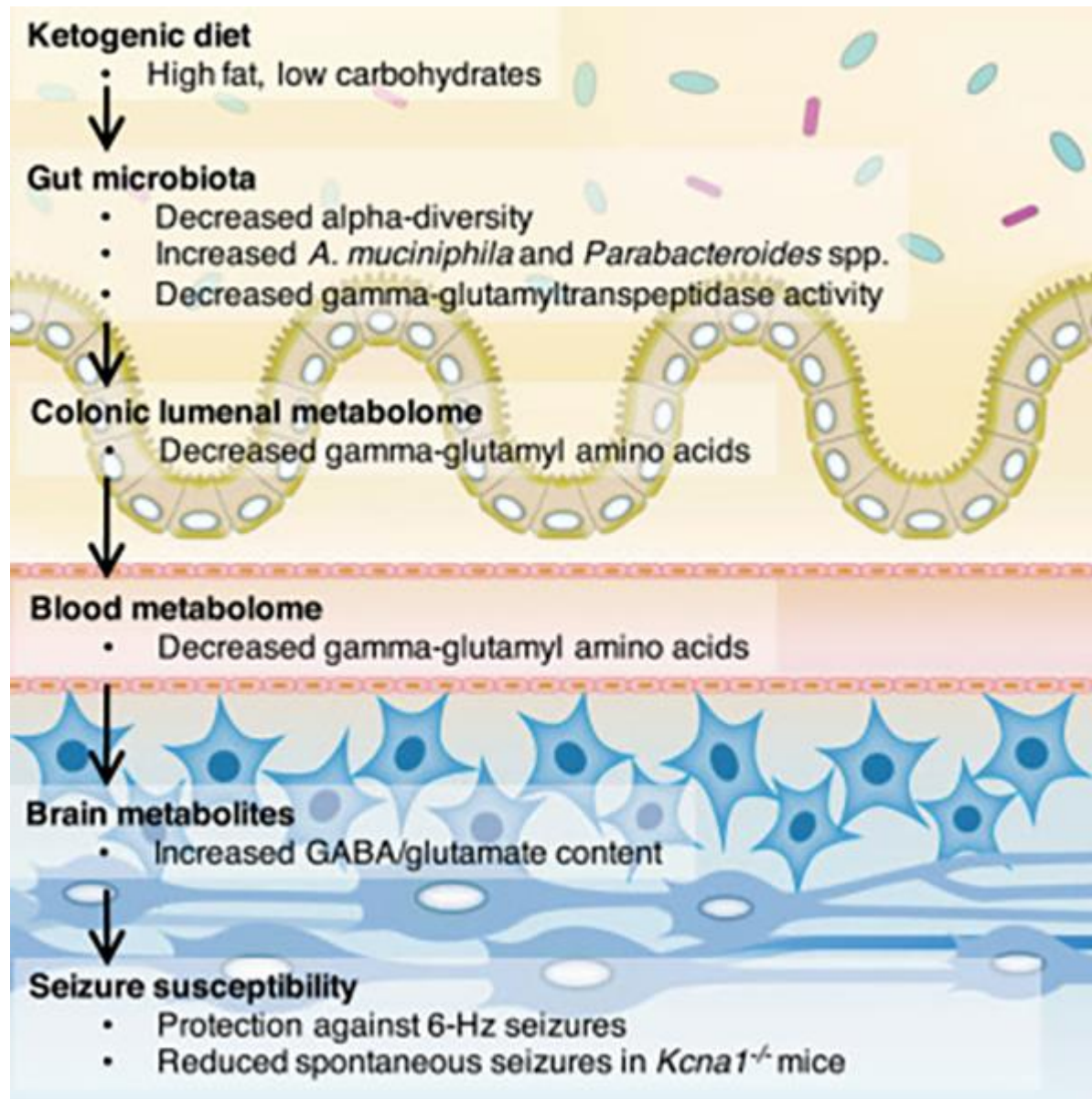




## Recommendation 2: Dietary Weight Reduction in Psoriasis

In overweight or obese adults with psoriasis (BMI,  $\geq 25$ ), we strongly recommend dietary weight reduction with a hypocaloric diet as an adjunctive intervention to standard medical therapies for psoriasis.

This strong recommendation (strength 1) is based on level A evidence, with consistent results among included studies and agreement with systematic reviews and meta-analysis.



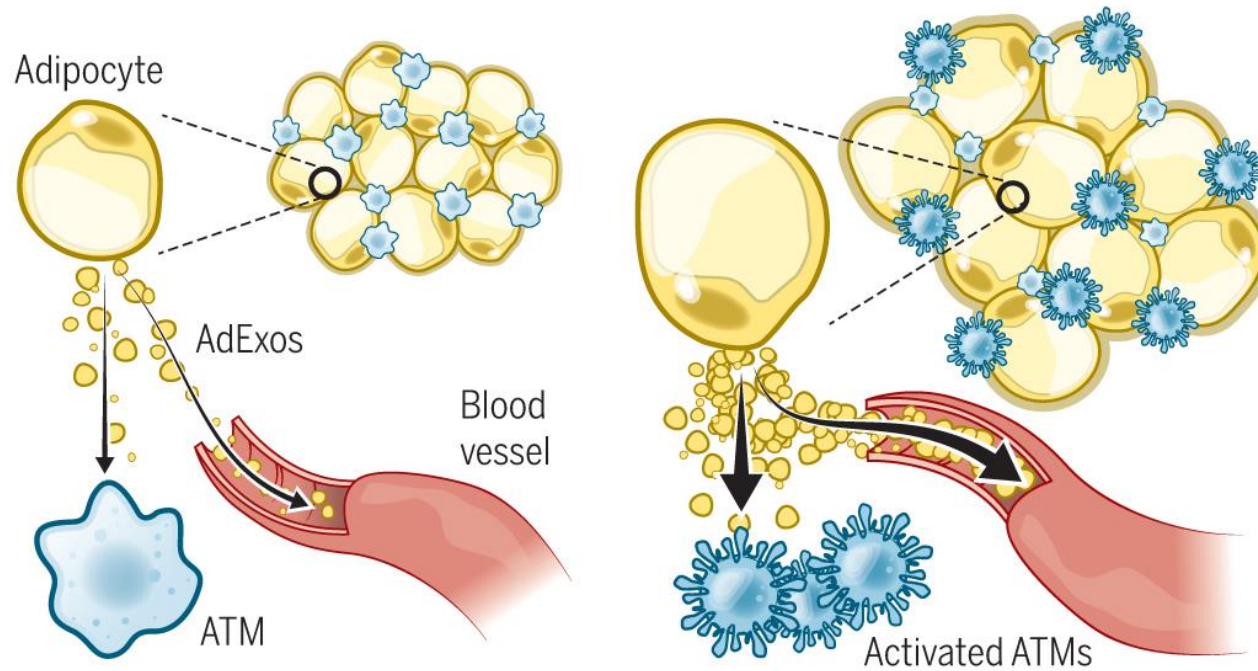
CELL, VOLUME 173, ISSUE 7, P1728-1741.E13, JUNE 14, 2018  
The Gut Microbiota Mediates the Anti-Seizure Effects of the Ketogenic Diet  
Christine A. Olson et al.





# Adipocyte-derived exosomes

Lipid-filled adipocyte-derived exosomes (AdExos) can influence the differentiation and numbers of adipose tissue macrophages (ATMs). AdExos may also enter the circulation and can influence distant metabolic tissues.



## Lean adipose tissue

Lean adipose tissue sheds lipid-filled AdExos, which transfer fat to, and drive differentiation of, ATMs.

## Obese adipose tissue

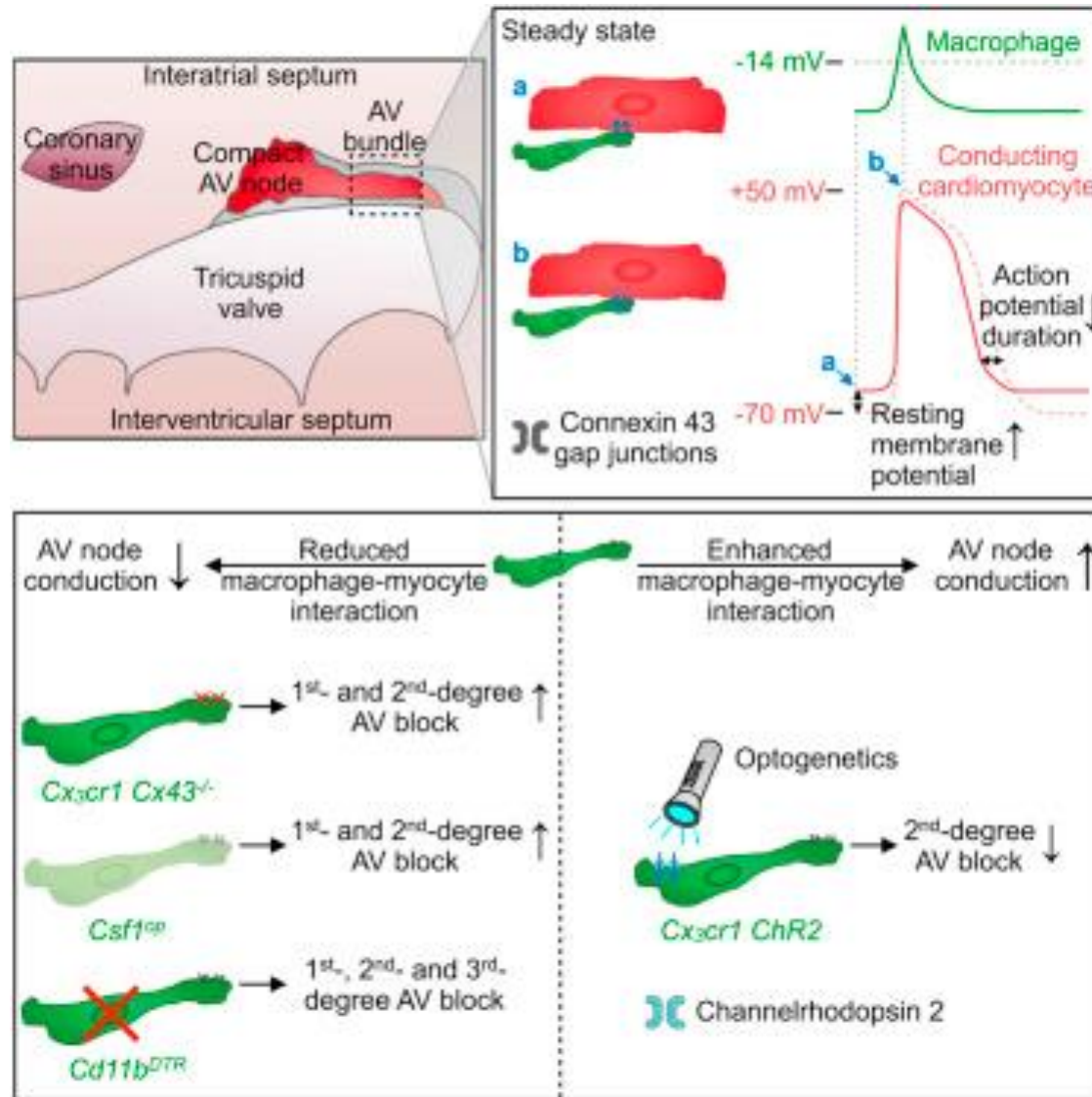
Obese adipose tissue sheds increased numbers of AdExos, which acquire a local and systemic proinflammatory activity, potentially contributing to obesity-associated pathologies, such as insulin resistance.

Science. 2019 Mar 1;363(6430):931-932. doi: 10.1126/science.aaw6765.

Lipid-filled vesicles modulate macrophages.  
Antonyak MA, Lukey MJ, Cerione RA.





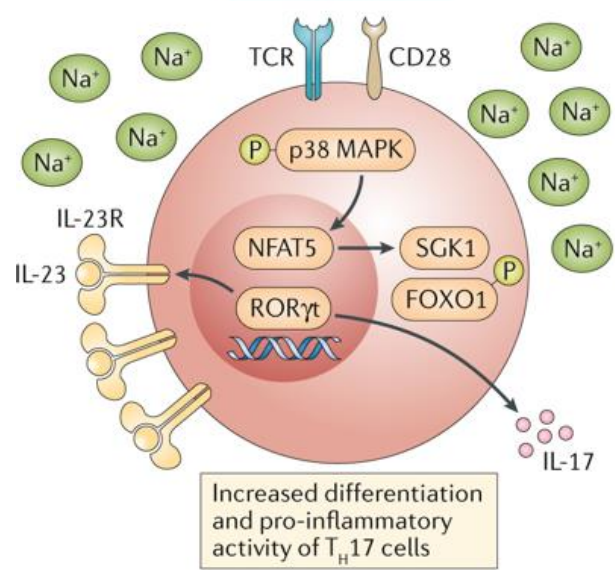


Maarten Hulsmans, Sebastian Clauss, Ling Xiao, Aaron D. Aguirre, Kevin R. King, Alan Hanley, William J. Hucker, Eike M. Wülfers, Gunnar Seemann, Gabriel Courties, Yoshiko Iwamoto, Yuan Sun, Andrej J. Savol, Hendrik B. Sager, Kory J. Lavine, Gregory A. Fishbein, Diane E. Capen, Nicolas Da Silva, Lucile Miquerol, Hiroko Wakimoto, Christine E. Seidman, Jonathan G. Seidman, Ruslan I. Sadreyev, Kamila Naxerova, Richard N. Mitchell, Dennis Brown, Peter Libby, Ralph Weissleder, Filip K. Swirski, Peter Kohl, Claudio Vinegoni, David J. Milan, Patrick T. Ellinor, Matthias Nahrendorf

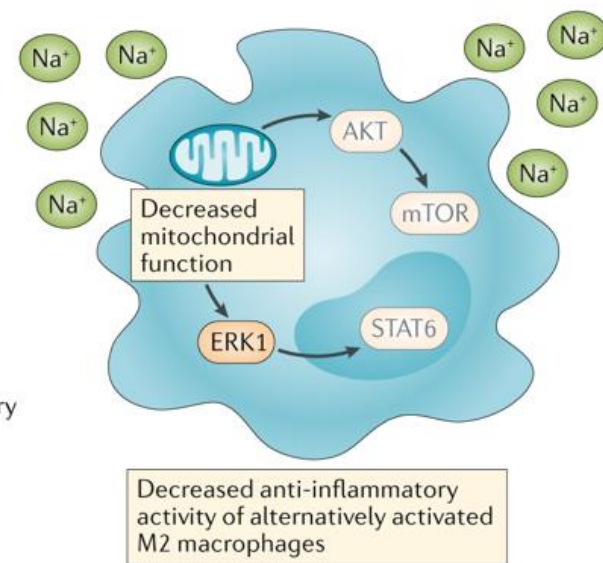
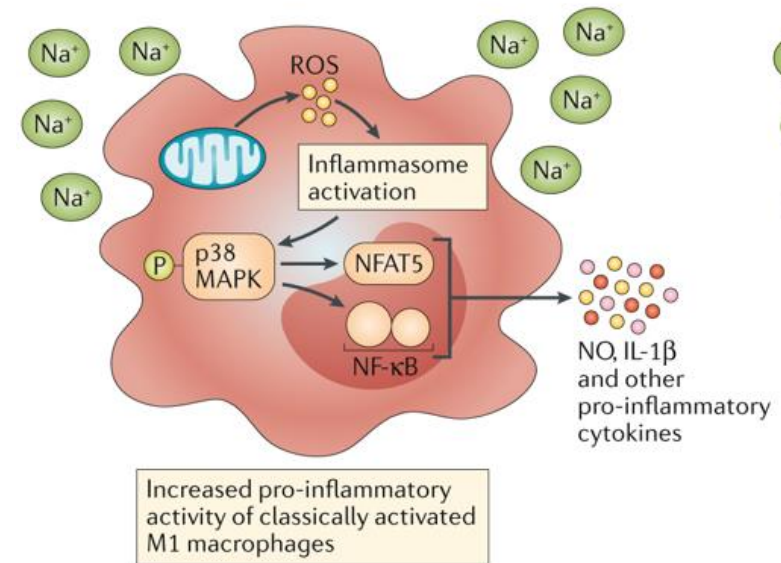
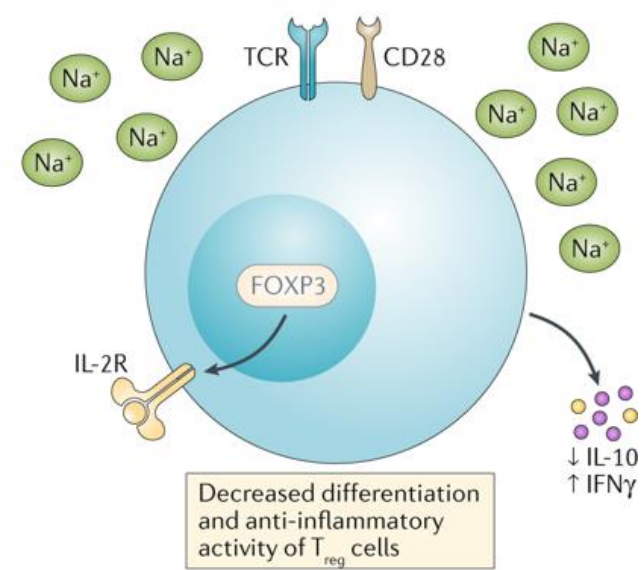
## Macrophages Facilitate Electrical Conduction in the Heart

Cell, Volume 169, Issue 3, 20 April 2017, Pages 510-522.e20

T<sub>H</sub>17 cell-inducing cytokine milieu



T<sub>reg</sub> cell-inducing cytokine milieu



Sodium in the microenvironment regulates immune responses and tissue homeostasis  
Dominik N. Müller, Nicola Wilck, Stefanie Haase, Markus Kleinewietfeld & Ralf A. Linker . Nature Reviews Immunology (2019)  
Published: 15 January 2019



Table 1. List of spices.		
Origin	Active ingredient	Mechanism of action
Turmeric	Curcumin	Anti-inflammation: Inhibits NF-kB pathway.
		Antioxidant: Reduces ROS and increases ROS scavenging enzymes.
		Anticarcinogenic:
		Suppresses TNF- $\alpha$ , PI3K/ AKT, mTOR, MAPK, and ERK signaling.
Ginger	Gingerols, shogaols	Antiemetic: Inhibits serotonin receptors.
		Antiangiogenic: Inhibits NF-kB pathway, IL-8, and VEGF-induced cell proliferation.
		Anti-inflammatory: Reduces expression of cytokines.
		Anticarcinogenic:
		Inhibits growth and tumor proliferation, reduces ROS, blocks NF-kB activation, and increases antioxidant enzymes.
Garlic	Allicin	Antioxidative: Prevents intracellular GSH depletion, inhibits NF-kB activation, and removes peroxides and upregulates antioxidant enzymes.
		Immunomodulatory effects: Inhibits both pro- and anti-inflammatory cytokines and regulates COX-2.
		Anticarcinogenic: Delays onset of tumorigenesis by modulating p53 and PI3K/AKT signaling pathway, promotes apoptosis, inhibits TNF- $\alpha$ , IL-6 production, and serum cytokine levels.
Cloves	Eugenol	Antioxidant: Reduces oxygen radicals, superoxide, hydrogen peroxide, and increases GSH.
		Antimicrobial: Denatures microbial proteins, reacts with cell membrane phospholipid and inhibits the growth of microbes.
		Anticarcinogenic: Inhibits proliferation, inhibits activation of COX-2, c-myc, H-ras, upregulates proapoptotic proteins, and downregulates antiapoptotic proteins.
Rosemary	Rosemarinic acid, carnosic acid	Antioxidative: Causes free radical scavenging reduces lipid peroxidation and inhibits DPPH radicals.
		Anti-inflammatory: Inhibits secretion of proinflammatory cytokines and TNF- $\alpha$ .
		Anticarcinogenic: Inhibits NF-kB activation, suppresses MMP-9, c-jun, ERK, AKT, and p38 signaling and metabolic activation of procarcinogens and induces ROS detoxification pathway such as GST.
Saffron	Crocins, crocetin	Antidepressant: Increases serotonin levels in the brain and inhibits serotonin reuptake in synapses.
		Antioxidant: Increases the levels of GST, catalase, SOD, and GPx and suppresses ROS formation.
		Anticarcinogenic: Inhibits growth of tumor cells via inhibiting nucleic acid and protein synthesis in malignant cells, induces apoptosis via activation of Bax-Bcl-2, and suppresses PI3K, AKT, Wnt, PKC activity.
Capsaicin	Capsaicin	Analgesic: Activates TRPV1 resulting in sensory neuronal depolarization and depletion of substance P.
		Anticarcinogenic: Inhibits ROS, induces apoptosis, and attenuates tumor cell migration and invasion through inhibition of NF-kB activity.











Turmeric  
Napa Cabbage  
Kimchi  
\$ 12.00



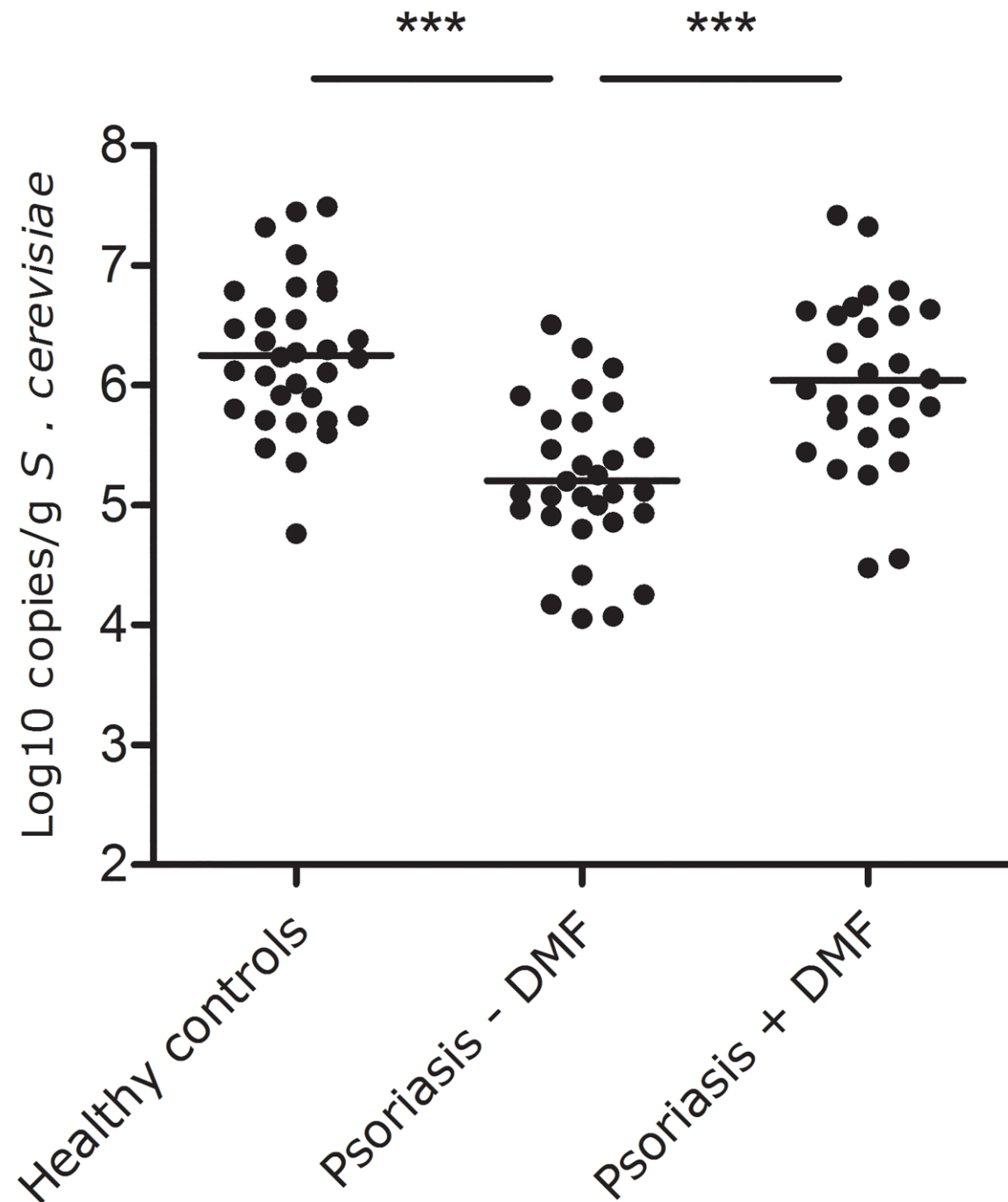
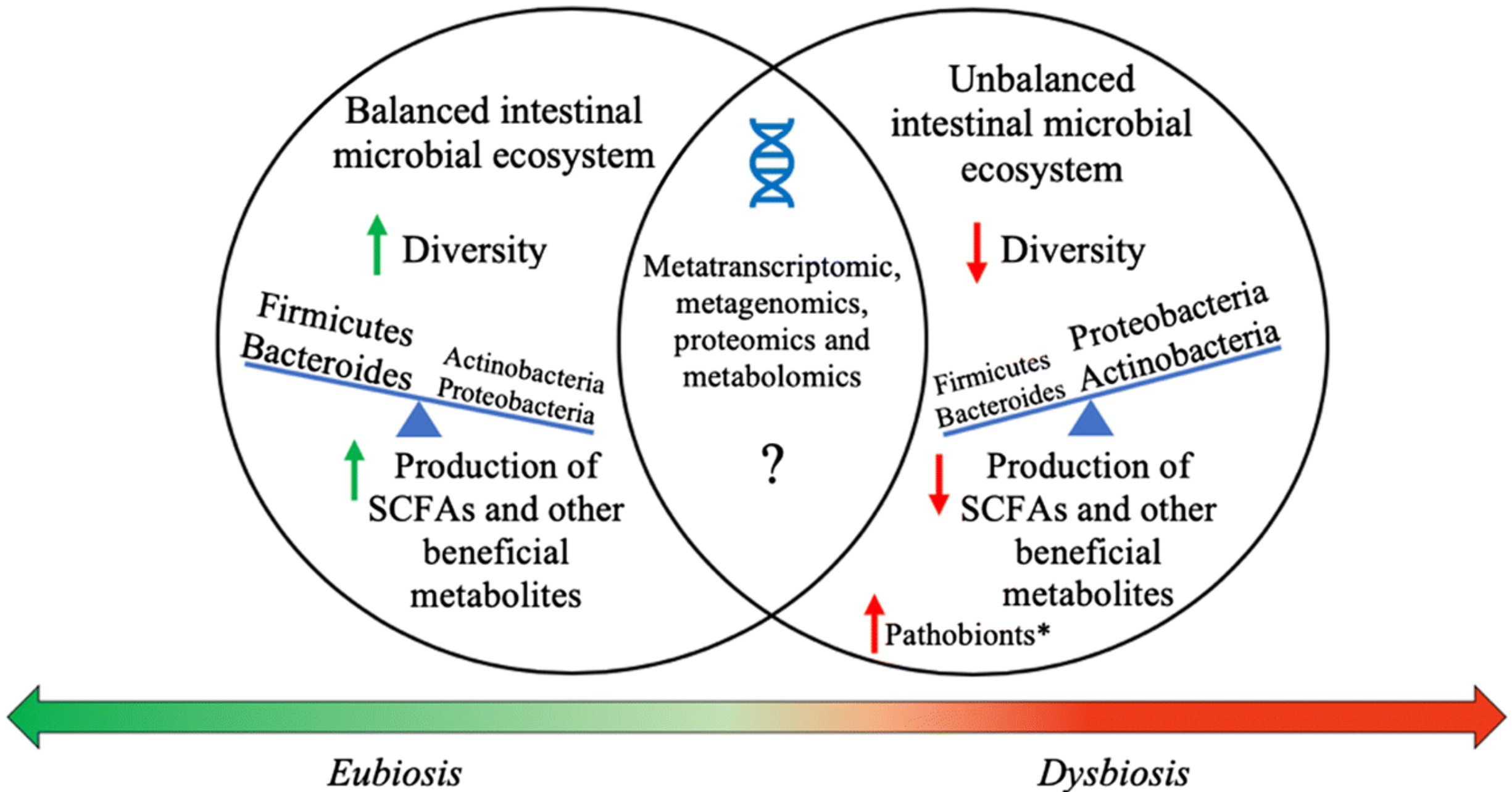
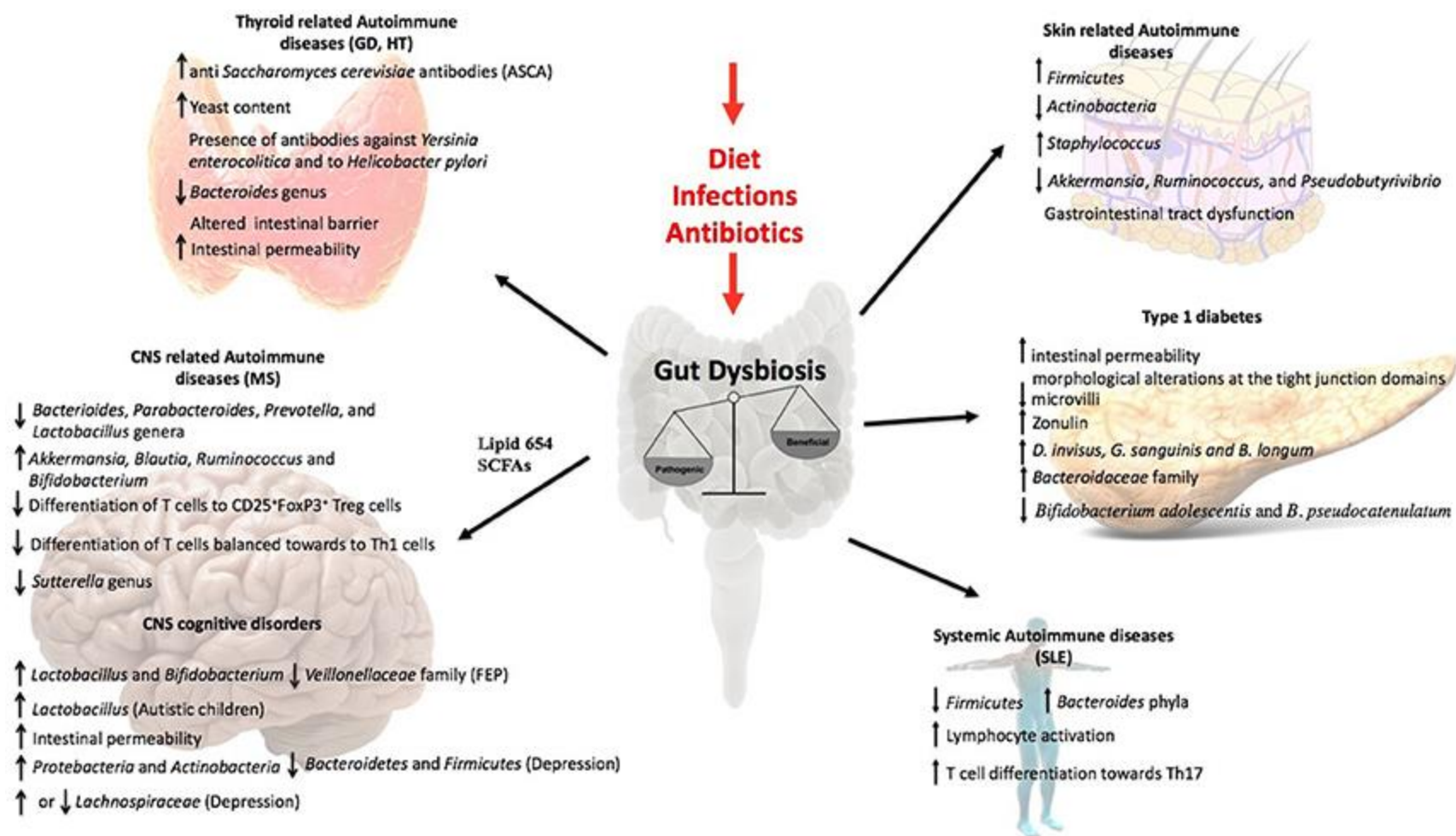


Fig 1. Psoriasis patients without DMF had a significantly lower faecal *Saccharomyces cerevisiae* abundance than healthy controls and psoriasis patients on DMF (both  $p < 0.001$ ). Psoriasis patients using DMF had similar *S. cerevisiae* abundance compared to healthy controls ( $p = 0.233$ ). The middle line represents the average abundance.

Eppinga H, Thio HB, Schreurs MWJ, Blakaj B, Tahitu RI, Konstantinov SR, et al. (2017) Depletion of *Saccharomyces cerevisiae* in psoriasis patients, restored by Dimethylfumarate therapy (DMF). PLoS ONE 12(5): e0176955.







Maximum performance or maximized health benefits require a nutritious mix of foods in the diet.

PHOTO: SCOTT SUCHMAN; STYLING: NICHOLE BRYANT

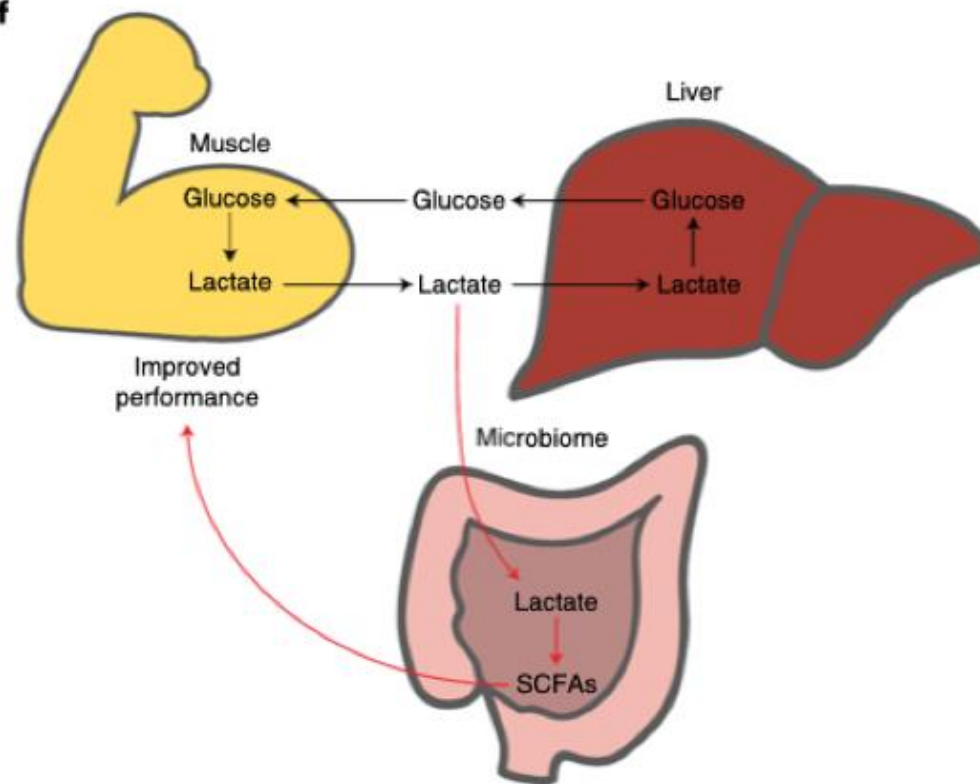




# Meta-omics analysis of elite athletes identifies a performance-enhancing microbe that functions via lactate metabolism.

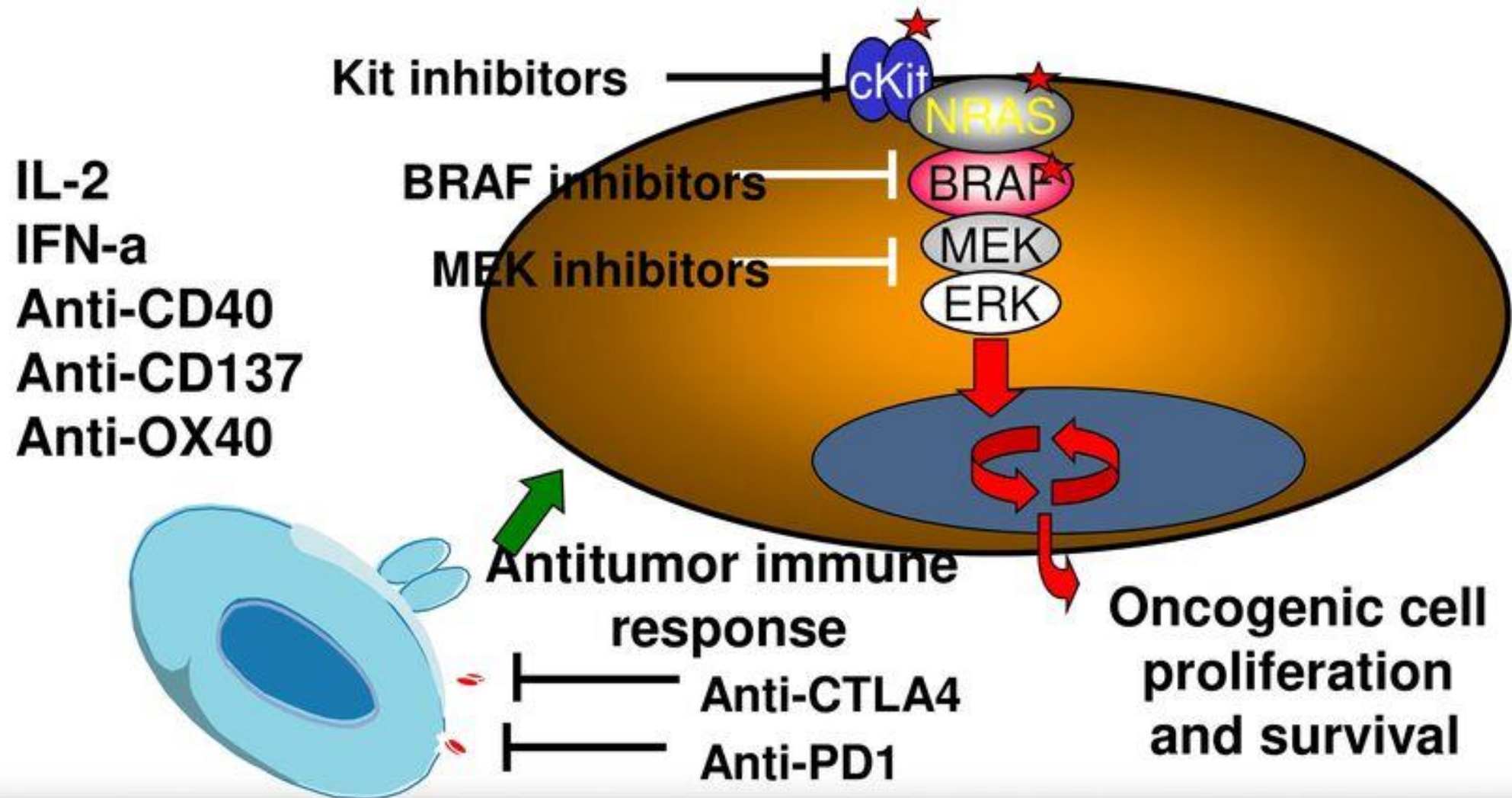
We observed an increase in *Veillonella* relative abundance in marathon runners postmarathon and isolated a strain of ***Veillonella atypica*** from stool samples. Inoculation of this strain into mice significantly increased exhaustive treadmill run time. *Veillonella* utilize lactate as their sole carbon source, which prompted us to perform a shotgun metagenomic analysis in a cohort of elite athletes, finding that every gene in a major pathway metabolizing lactate to propionate is at higher relative abundance postexercise. Using  $^{13}\text{C}$ -labeled lactate in mice, we demonstrate that serum lactate crosses the epithelial barrier into the lumen of the gut. We also show that intrarectal instillation of propionate is sufficient to reproduce the increased treadmill run time performance observed with *V. atypica* gavage. Taken together, these studies reveal that *V. atypica* improves run time via its metabolic conversion of exercise-induced lactate into propionate, thereby identifying a natural, microbiome-encoded enzymatic process that enhances athletic performance.

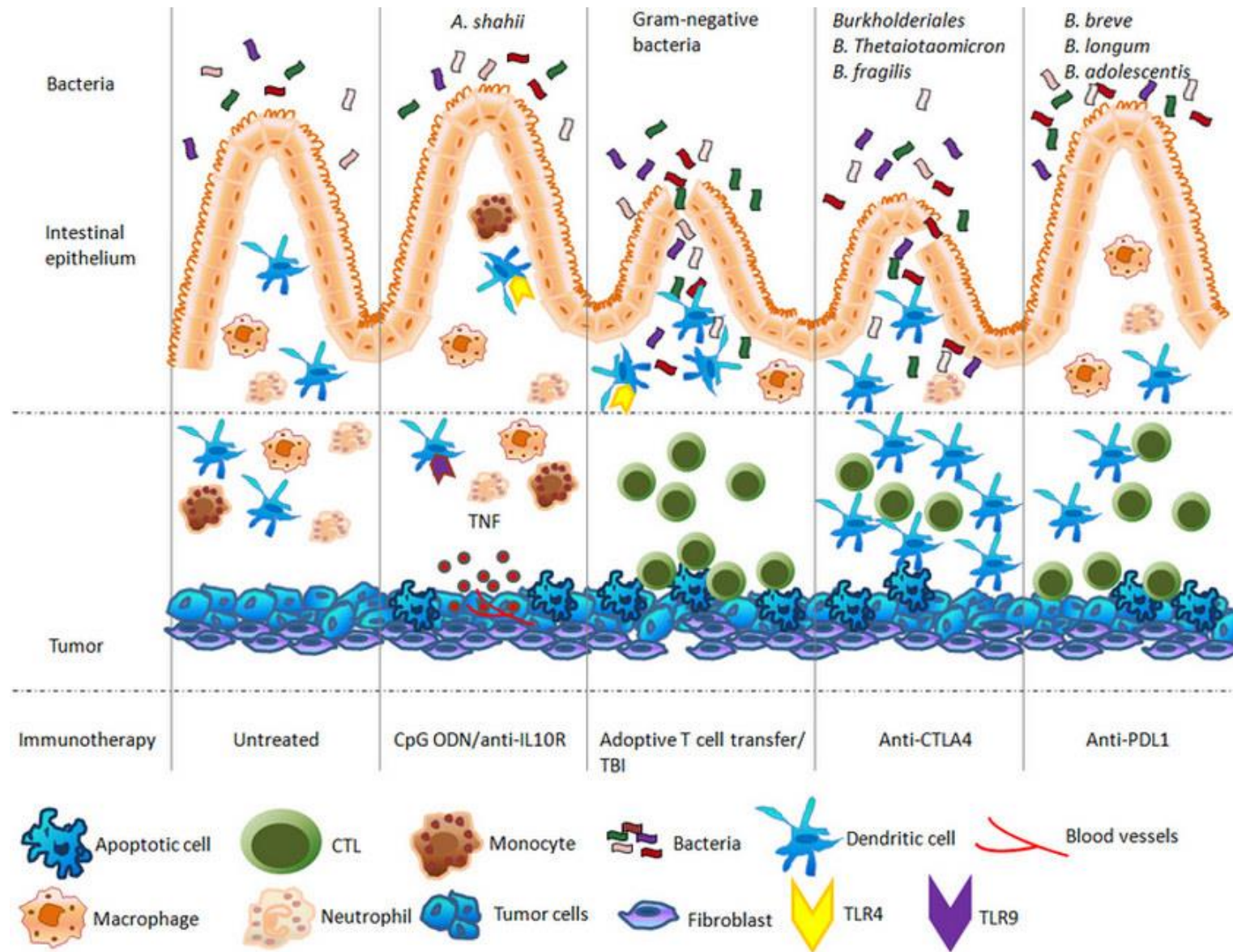
## Meta-omics analysis of elite athletes identifies a performance-enhancing microbe that functions via lactate metabolism

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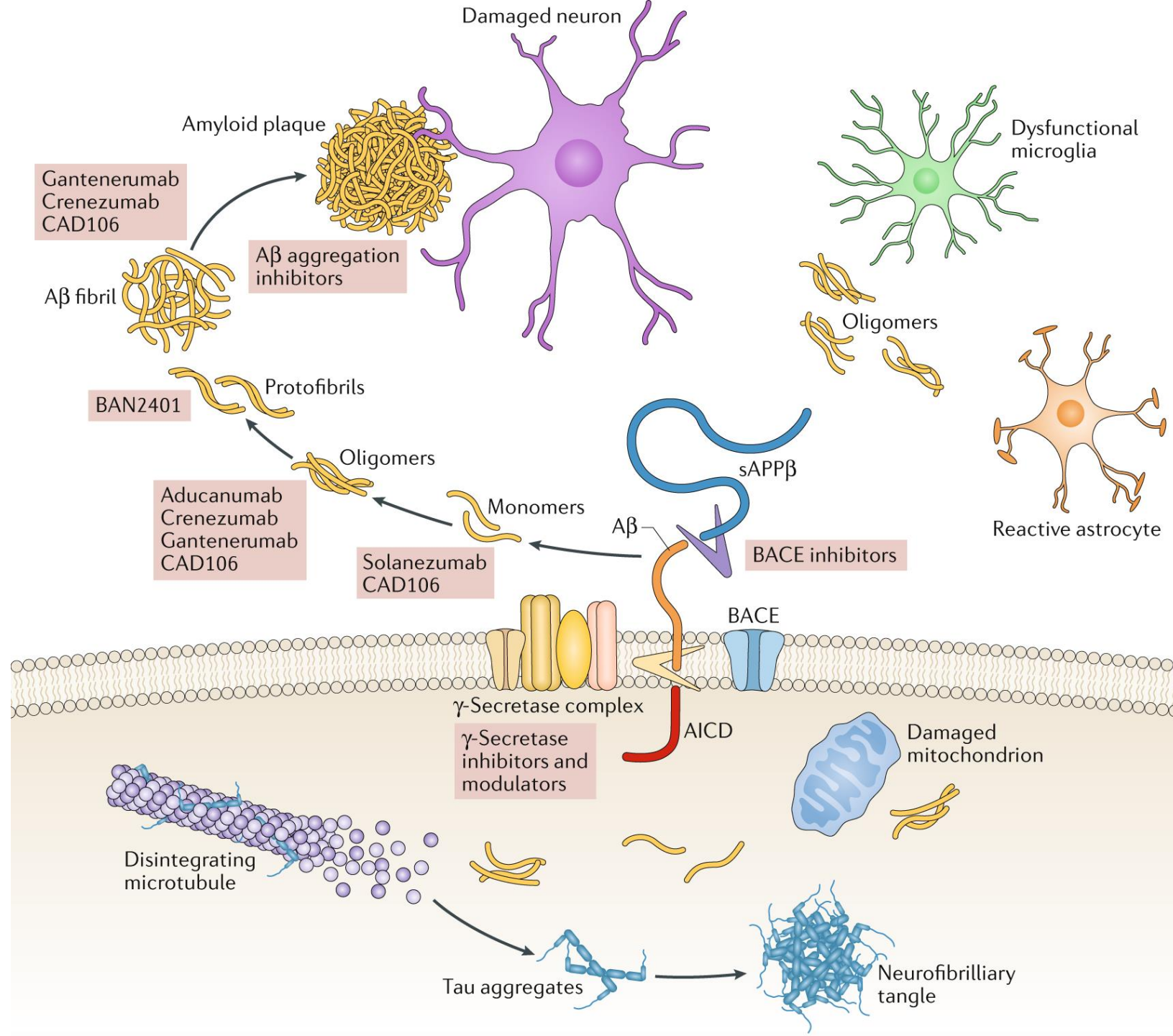


# Therapeutic Targets in Metastatic Melanoma

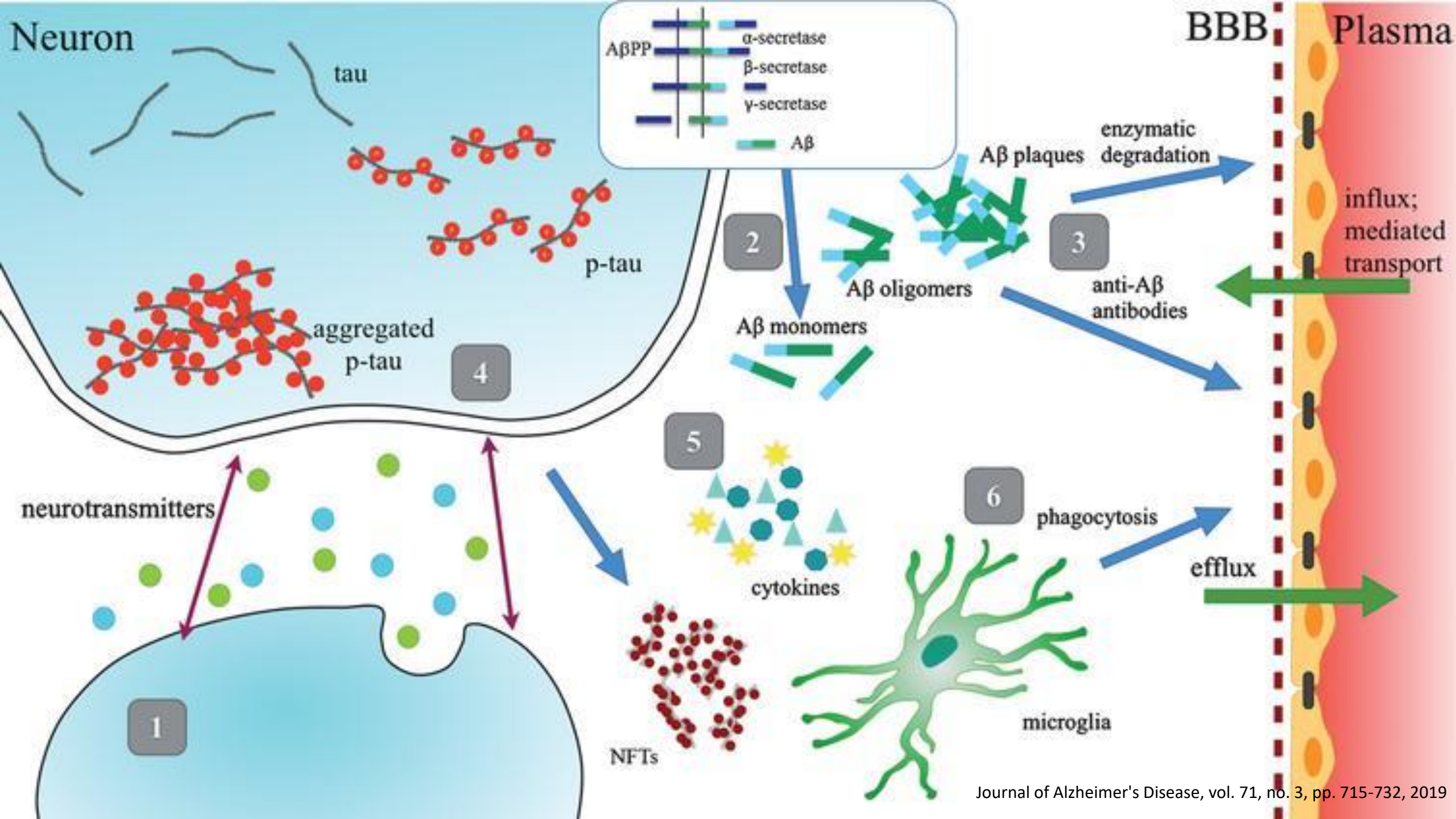




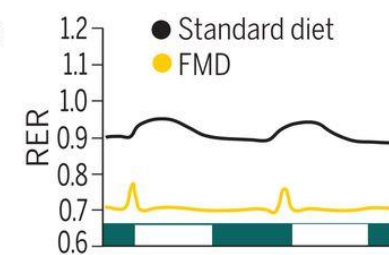
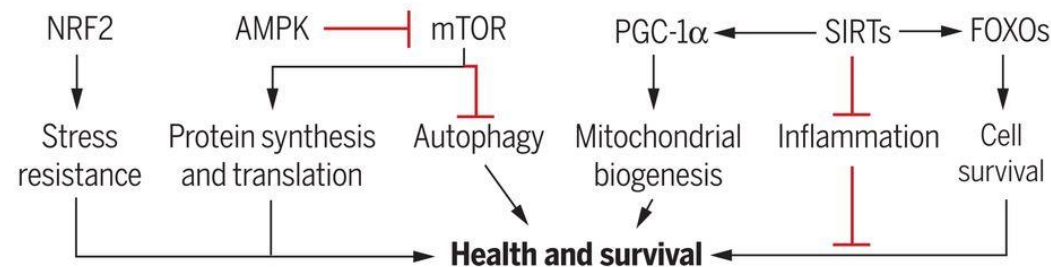
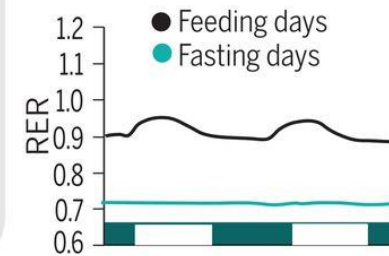
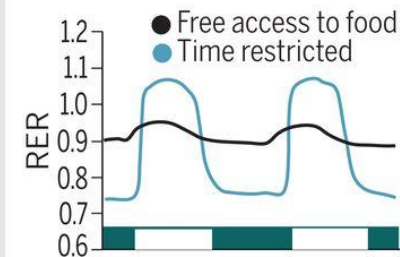
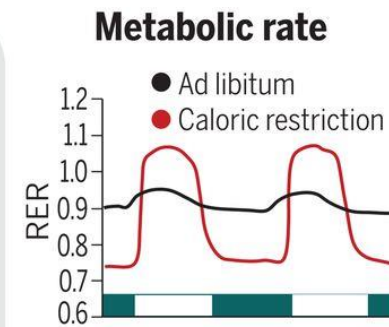
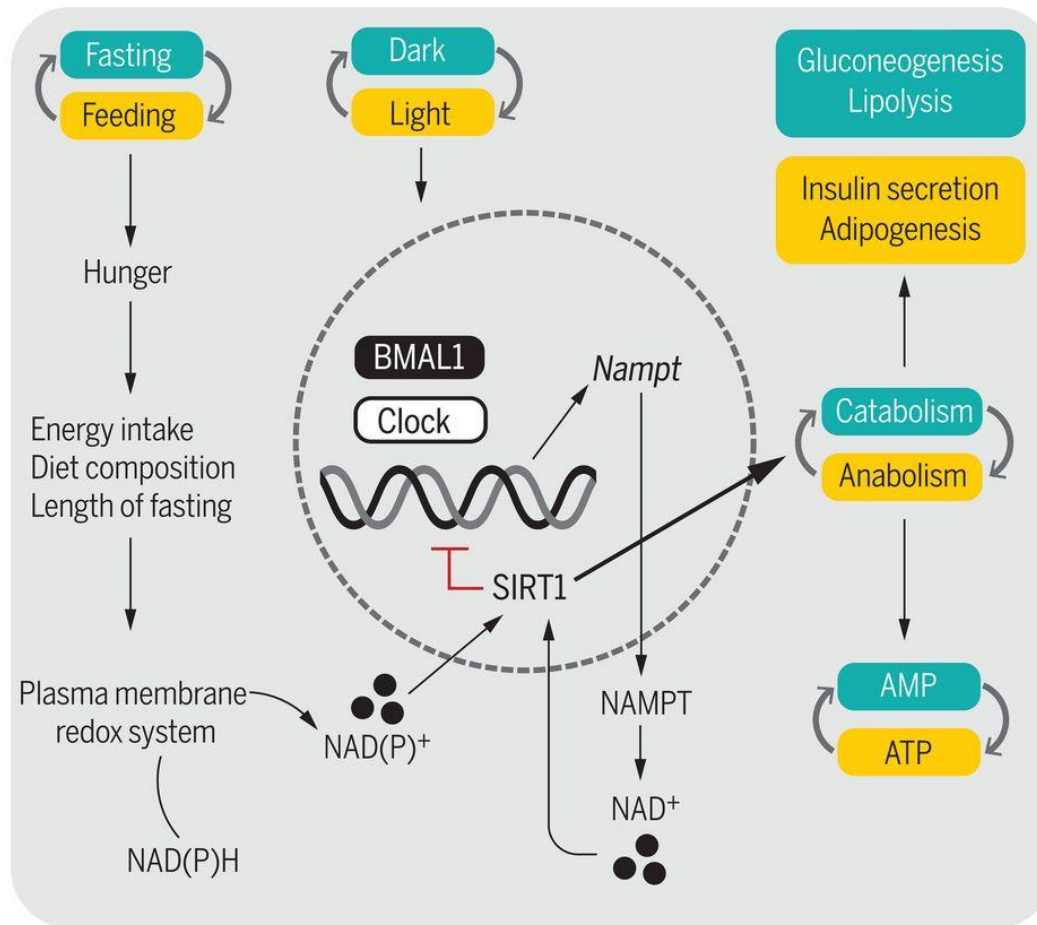




Panza, F., Lozupone, M., Logroscino, G. et al. A critical appraisal of amyloid- $\beta$ -targeting therapies for Alzheimer disease. *Nat Rev Neurol* 15, 73–88 (2019) doi:10.1038/s41582-018-0116-6

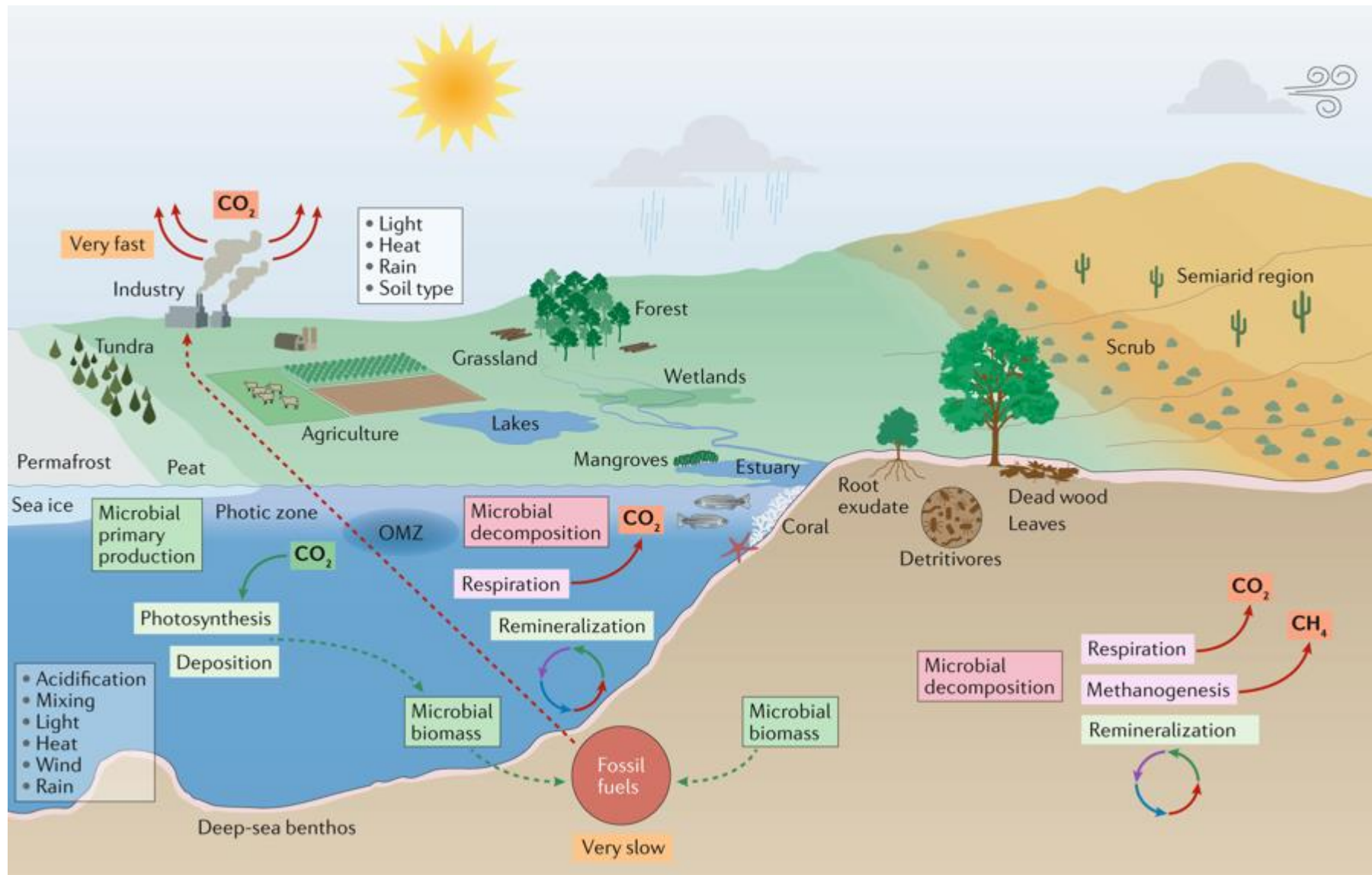






A time to fast

Andrea Di Francesco, et al. Science 16 Nov 2018: Vol. 362, Issue 6416, pp. 770-775



Consensus Statement. Published: 18 June 2019  
 Scientists' warning to humanity: microorganisms and climate change  
 Ricardo Cavicchioli, et al. Nature Reviews Microbiology volume17, Pages 569–586 (2019)



Dank!  
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