Come si cambia… cervello

Il costo metabolico del cervello umano per Kg è circa 9 volte quello della media del corpo.

Per mantenere questa fornace metabolica ci sono due vie evolutive:

1. Aumentare il metabolismo basale(BMR);
2. Compensare l'alta richiesta energetica con un minor tasso metabolico negli altri tessuti

I gorilla ricavano circa il 57% dell'energia dalla fermentazione batterica degli acidi grassi a catena corta (SCFAs) rispetto al 1,2-10% degli uomini occidentali

Table 2 Relative gut volume proportions for some primate species (percentage of total volume)

Species	Stomach	Small Intestine	Caecum	Colon
Gorilla	25	14	7	53
Orangutan	17	28	3	54
Chimpanzee	20	23	5	52
Gibbon	24	29	2	45
Human	17	67	na	17

Come si cambia… cervello

Alcuni autori fanno l'ipotesi che la possibilità di accedere a cibi acquatici abbia facilitato lo sviluppo del cervello tramite l'ingestione di DHA.

IL DHA è fondamentale per lo sviluppo cerebrale sia negli animali che nell'uomo.

In realtà i Neandertal non consumavano cibi acquatici ed avevano un cervello anche più grande dell'attuale.

C'è però la possibilità di una maggiore efficienza della FADS (fatty acid desaturase) che permette la conversione da alfa linolenico in DHA nelle popolazioni che non avevano accesso a cibi acquatici.

Come si cambia… cervello

In humans, eating predominantly animal foods, especially fatty animal foods, promote nutritional ketosis. This pattern provides generous amounts of bioavailable essential micronutrients with crucial roles in encephalization, such as zinc, heme iron, vitamin B12, and long-chain omega-3 and 6 fatty acids (DHA and arachidonic acid, respectively) (Cunnane & Crawford, 2003). Infants' brains meet all of their cholesterol needs in situ, with 30% to 70% of the required carbons being supplied by ketone bodies (Cunnane et al., 1999).

ELSEVIER

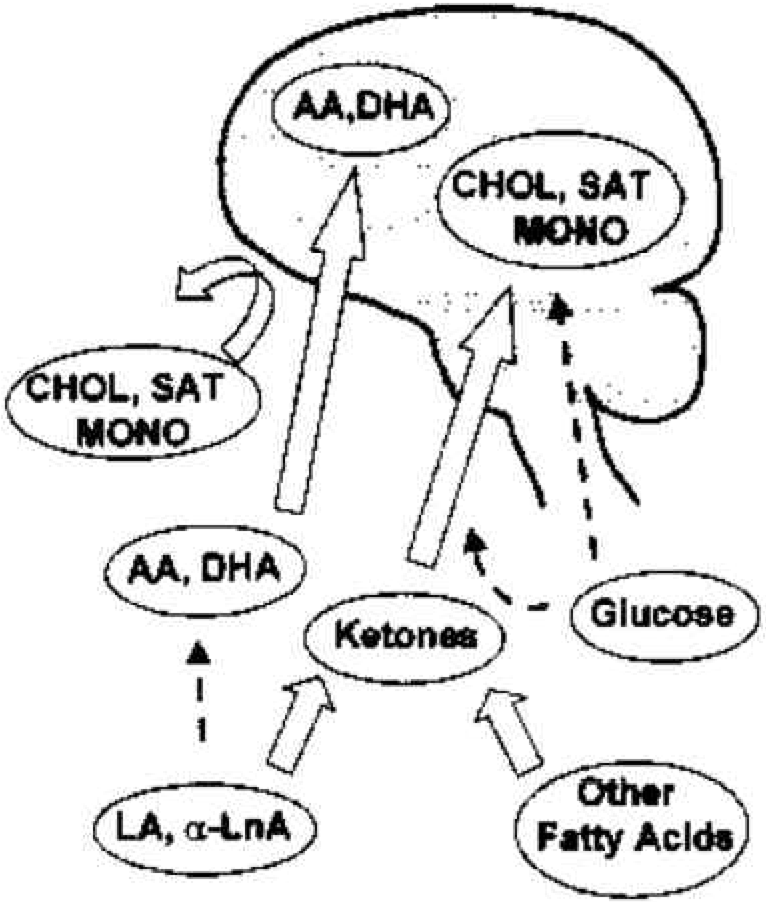
Comparative Biochemistry and Physiology Part A 136 (2003) 17–26

CBP

Review

Survival of the fattest: fat babies were the key to evolution of the large human brain

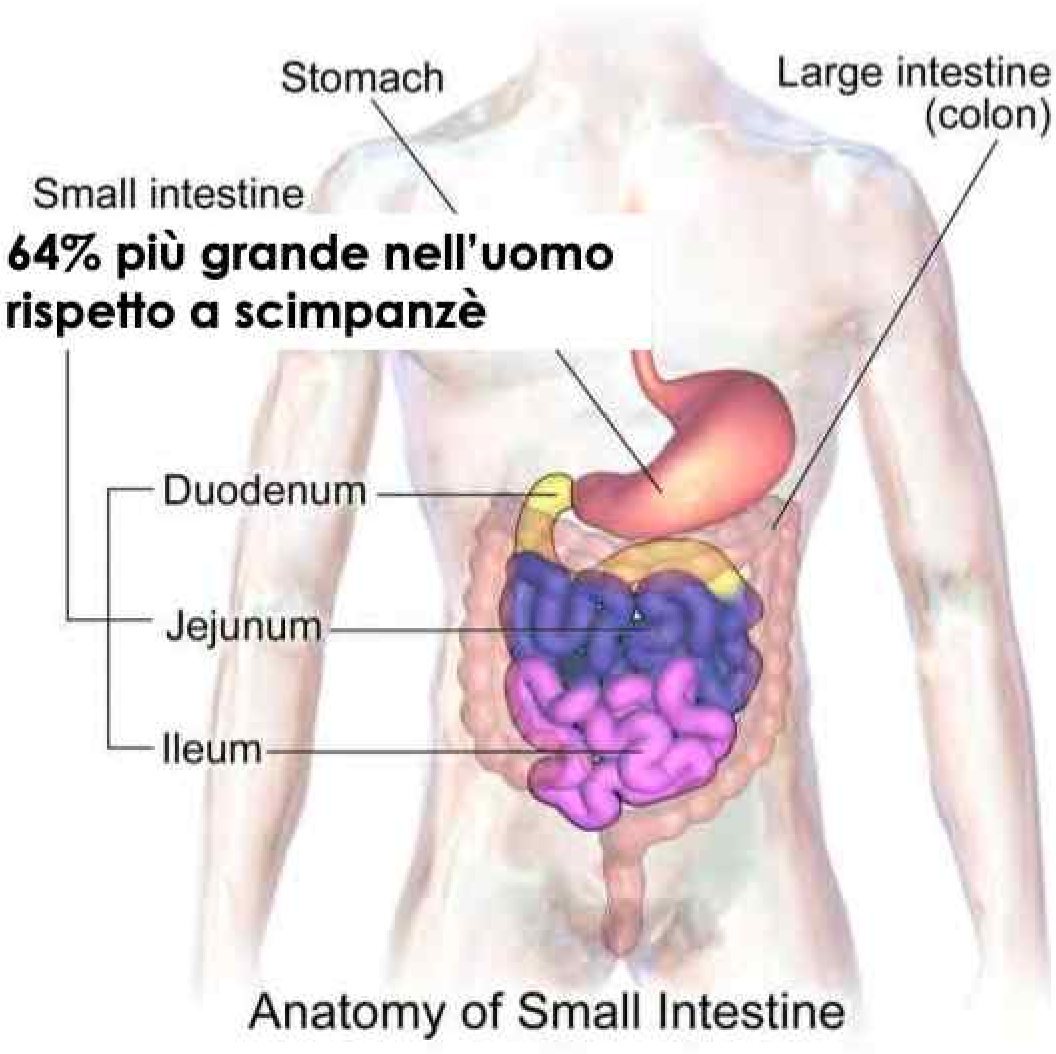
Stephen C. Cunnane[a,*], Michael A. Crawford[b]



Cunnane et al. Prostaglandins Leukot Essent Fatty Acids. 1999 May-Jun;60(5-6):387-92

 Ben-Dor et al. Am J Phys Anthropol. 2021 Aug;175 Suppl 72:27-56

Come si cambia… intestino



64% più grande nell'uomo rispetto a scimpanzè

77% più piccolo nell'uomo rispetto a scimpanzè

Colon più piccolo = solo 10% di energia da fermentazione delle fibre (alcuni suggeriscono 4%)

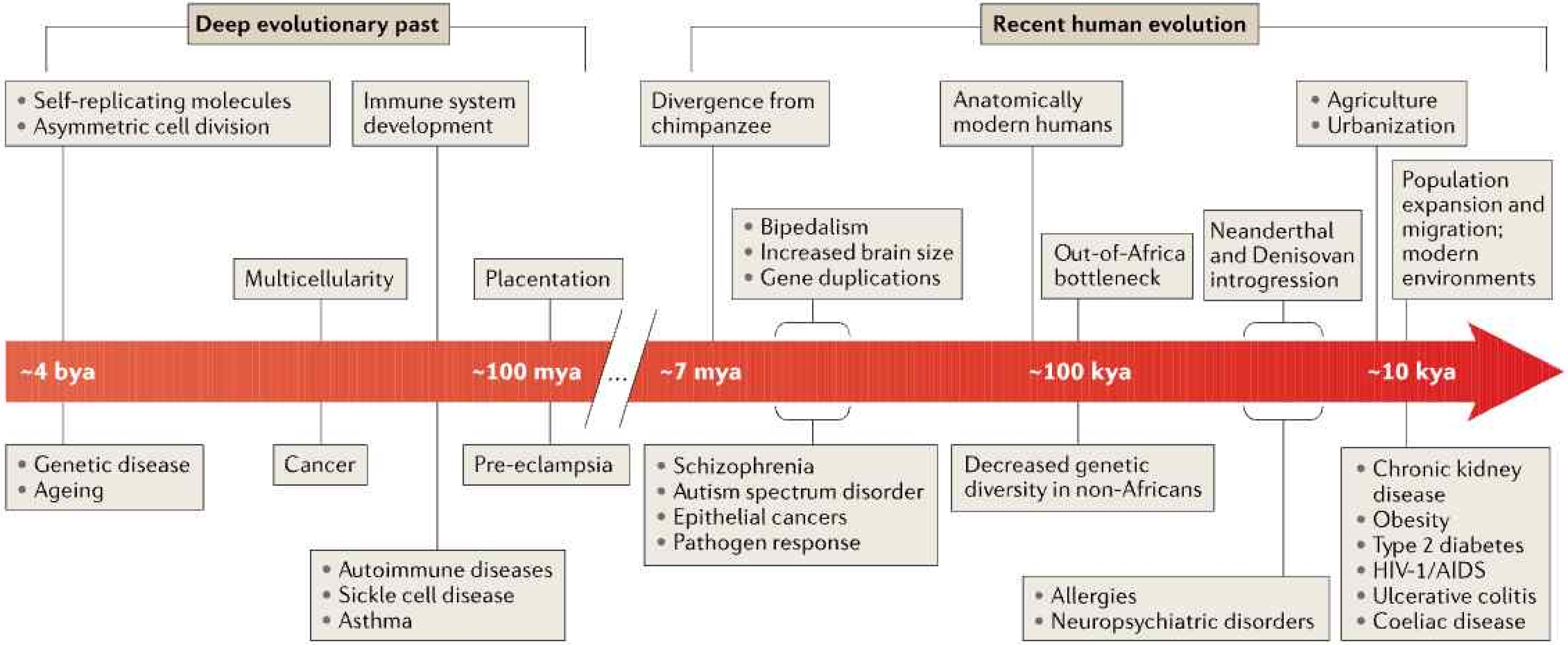
Piccolo intestino più grande= zuccheri, proteine e grassi, assorbimento più efficiente

Anche modifiche apparato masticatorio

(nell'H. erectus c'erano ancora strutture digerenti da carnivori)

Ben-Dor et al. Am J Phys Anthropol. 2021 Aug;175 Suppl 72:27-56

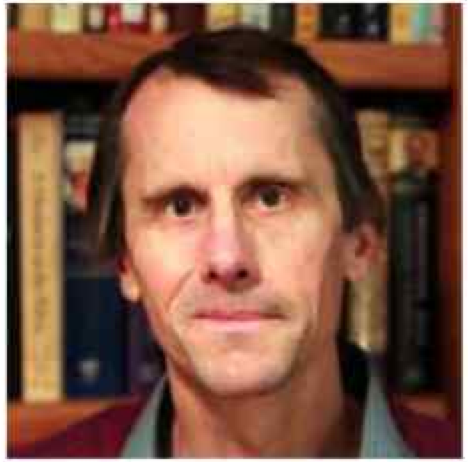
DOVE ANDIAMO



Benton et al. Nat Rev Genet. 2021 May;22(5):269-283

Dove andiamo

"L'invenzione dell'agrigoltura, la rivoluzione industriale e le nuove tecnologie che riducono la fatica fisica hanno portato ad una drammatica riduzione o eliminazione dell'esercizio fisico intenso e del digiuno lasciando il compito di stimolare il cervello solo alle sfide intellettive. In aggiunta alla riduzione delle risposte adattive cerebrali l'attuale l'indulgente stile di vita sedentario promuove obesità, diabete e CVD che a loro volta aumentano il rischio di AD.
Bisogna affrontare la realtà: c'è necessità di esercizio, periodi di digiuno e cahllenges intellettive per mantenere la salute del cervello."

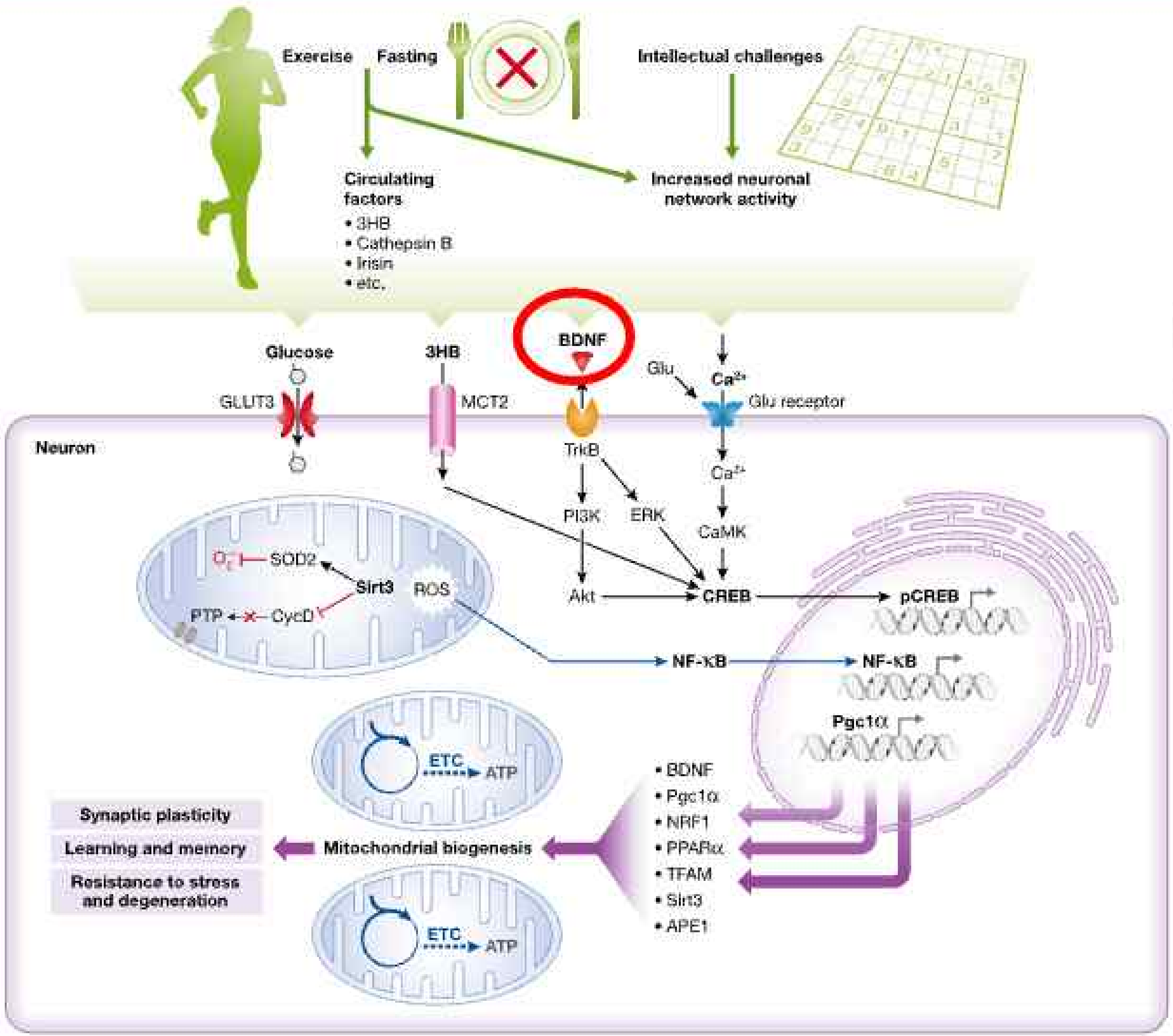


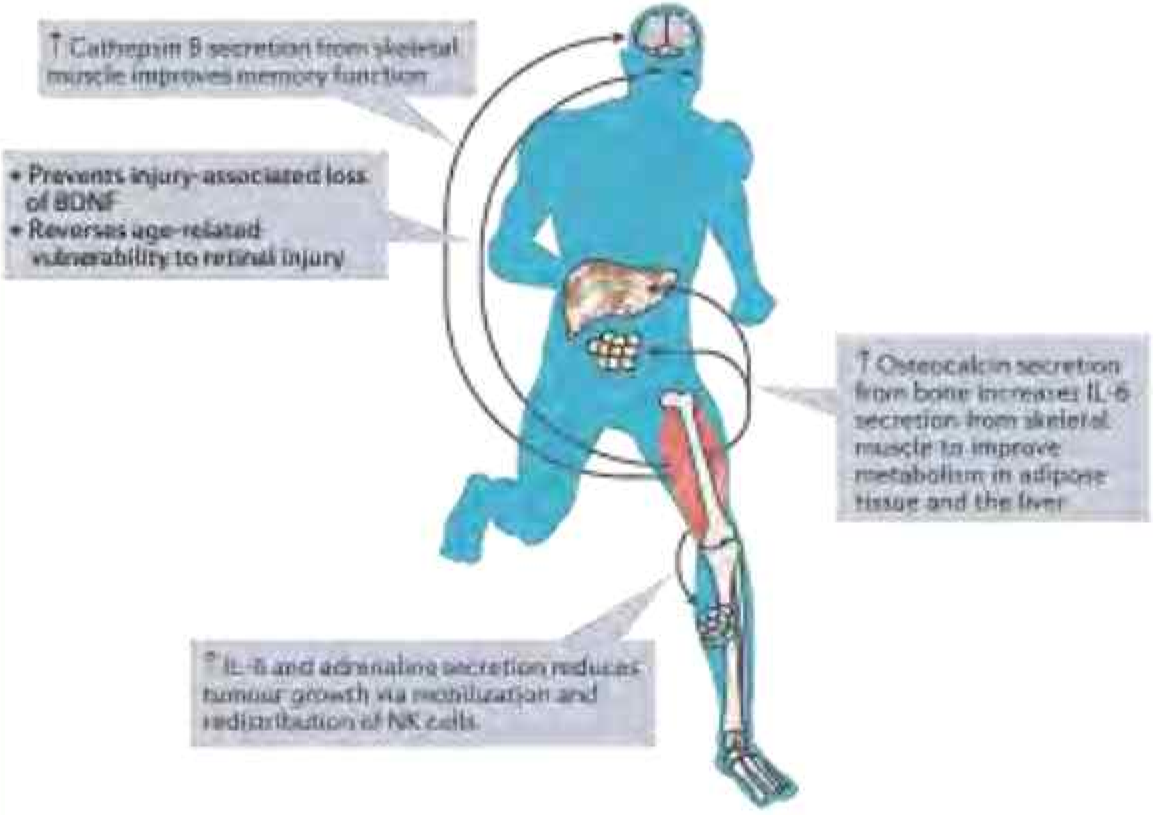
Mark P Mattson

Professor of Neuroscience at Johns Hopkins University
Former Chief of the Laboratory of Neurosciences at the National Institute on Aging.

Mattson MP. Ageing Res Rev. 2015 Mar;20:37-45

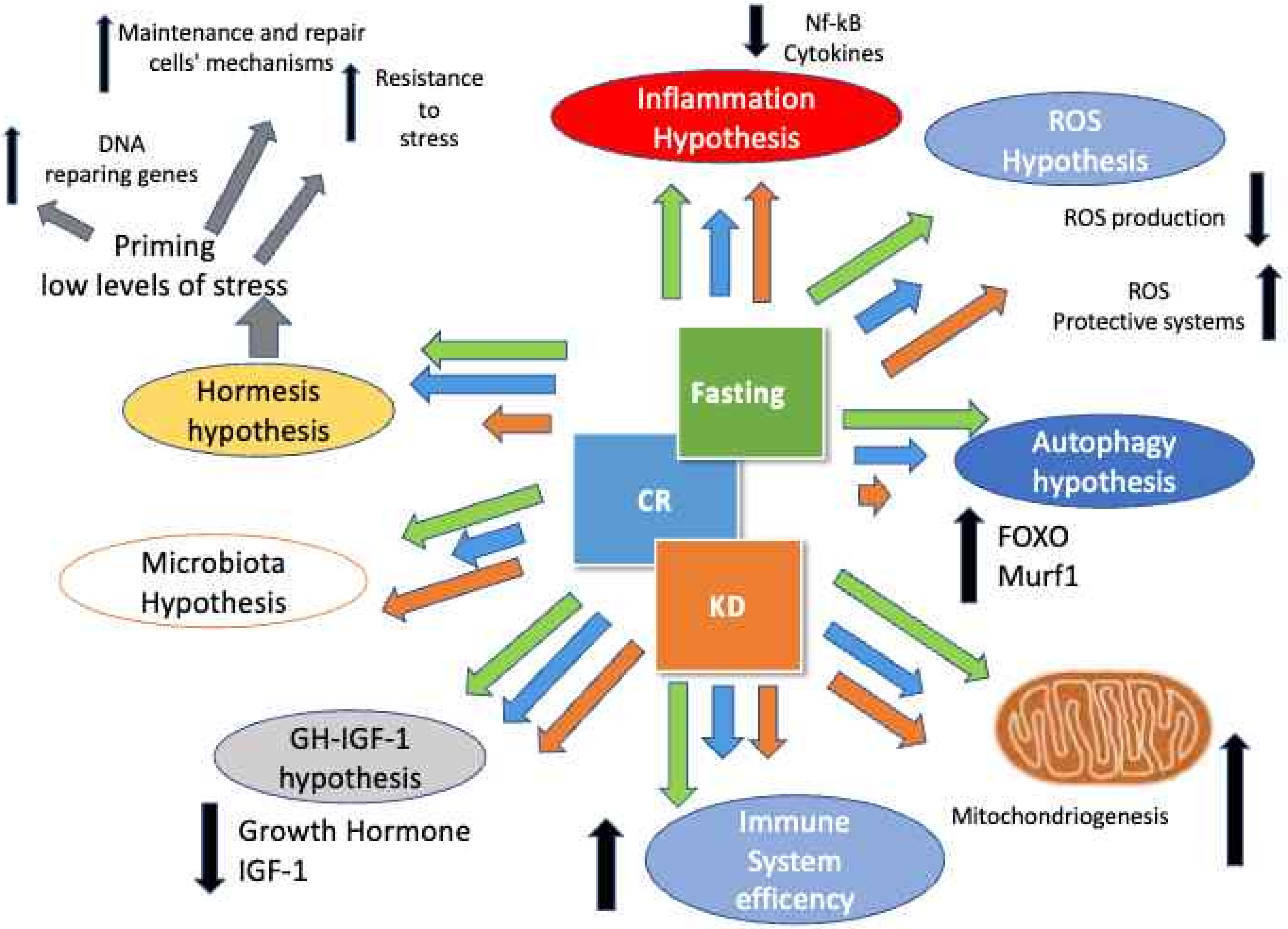
Dove andiamo





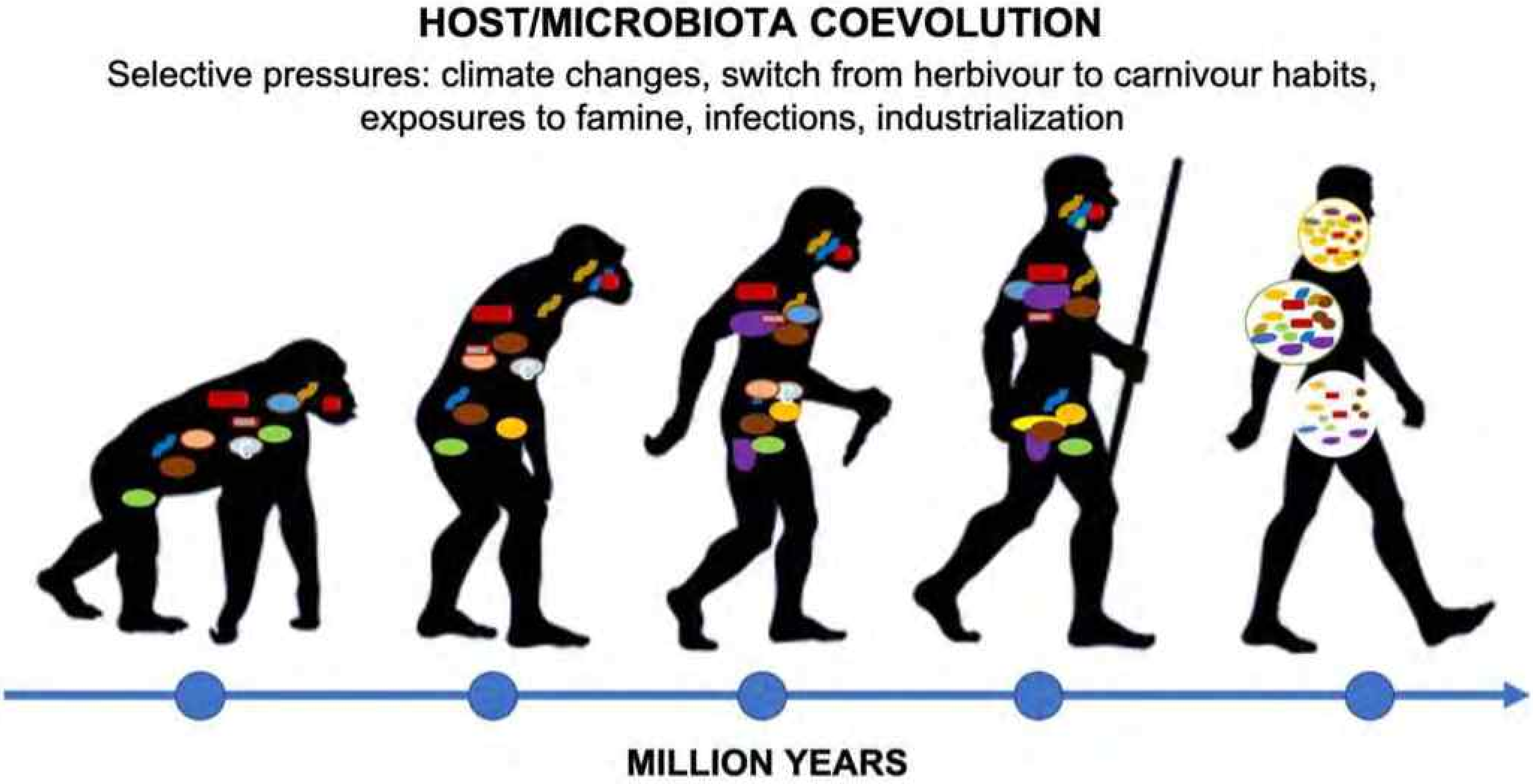
Febbraio MA. Nat Rev Endocrinol. 2017 Feb;13(2):72-74

Dove andiamo



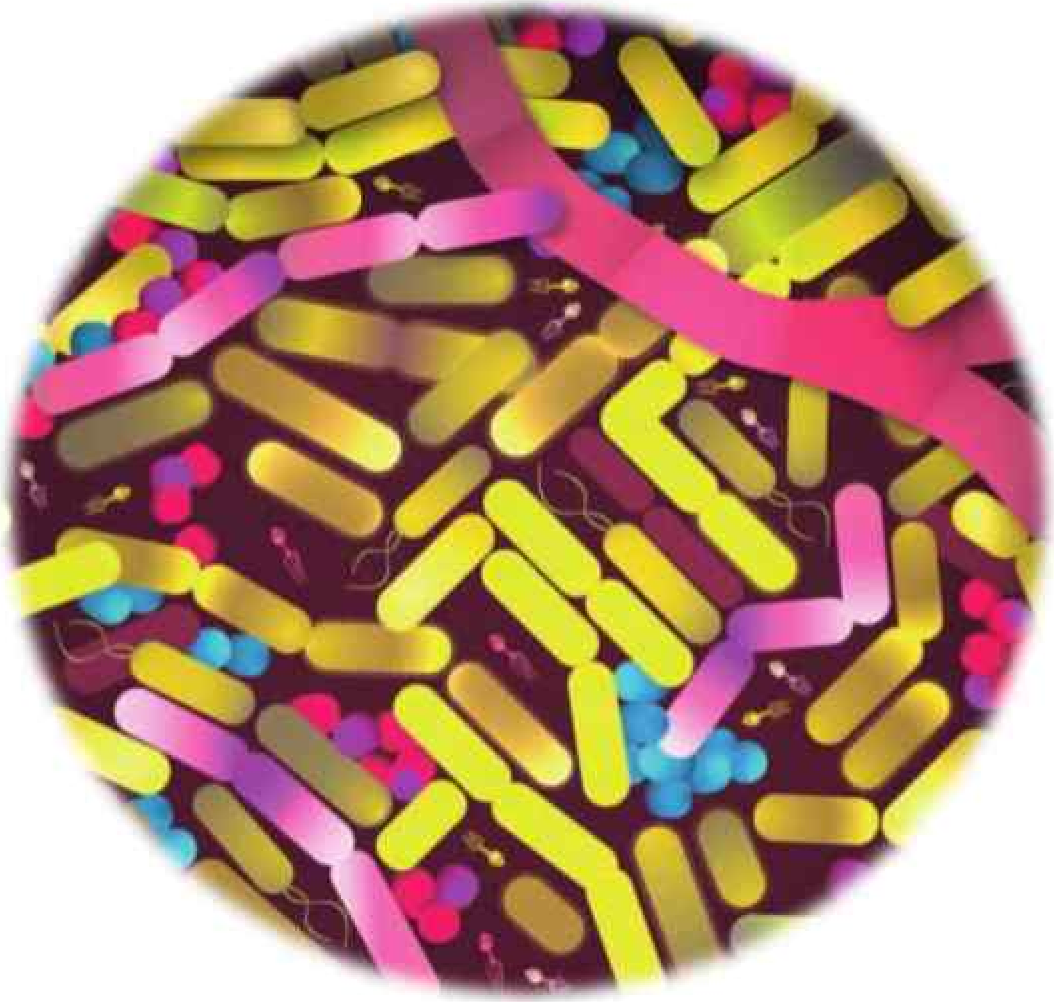
Paoli et al. Nutrients 2019, Mar 28;11(4)

Dove andiamo

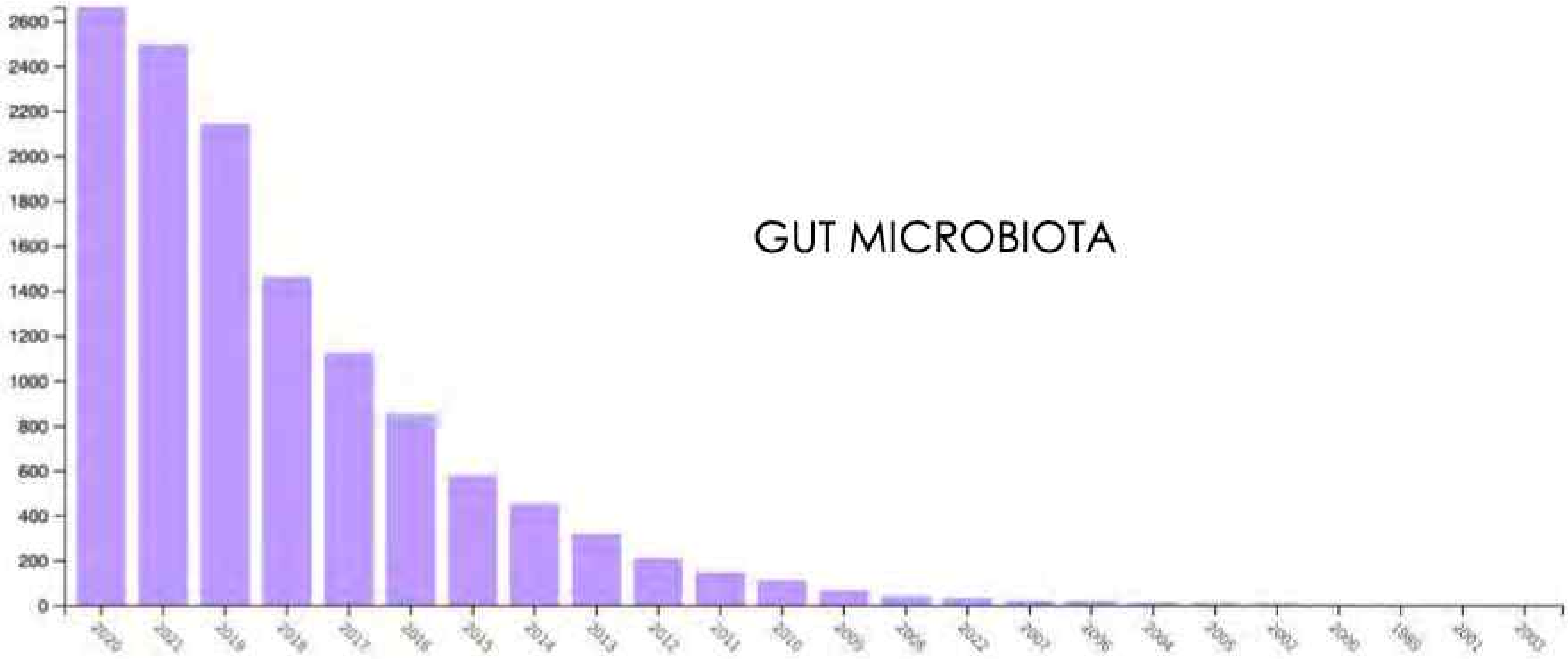


Santoro et al. Semin Immunopathol. 2020 Oct;42(5):589-605

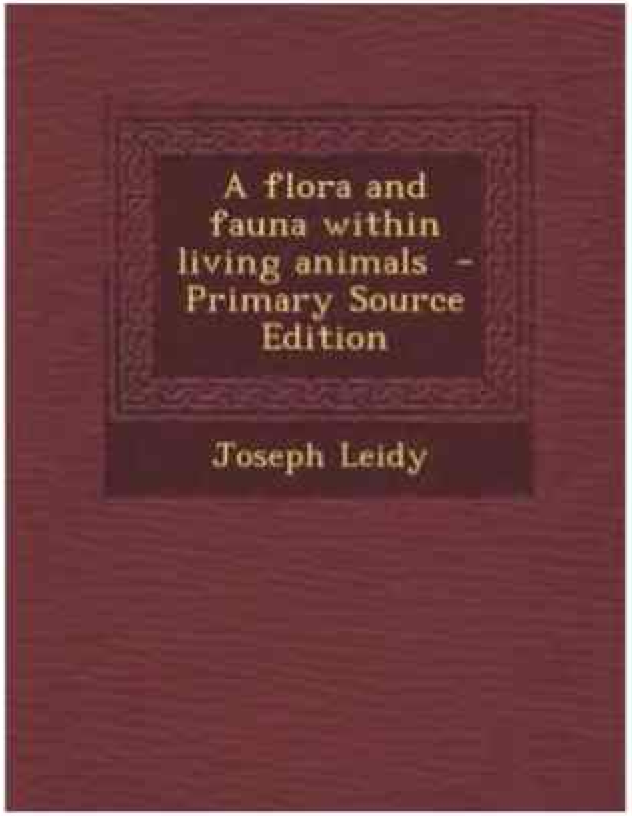
MICROBIOTA, ESERCIZIO E…



Microbiota ed esercizio…



GUT MICROBIOTA



Microbiota ed esercizio…

Microbiome—the collective genomes of the micro-organisms in a particular environment

Microbiota—the community of micro-organisms themselves

An increasing number of different gut microbial species are now postulated to regulate brain function in health and disease.

Microbiome/microbiota is "*the ecological community of commensal, symbiotic, and pathogenic microorganisms that share our body space*" Joshua Lederberg - Scientist. 2001 15:8

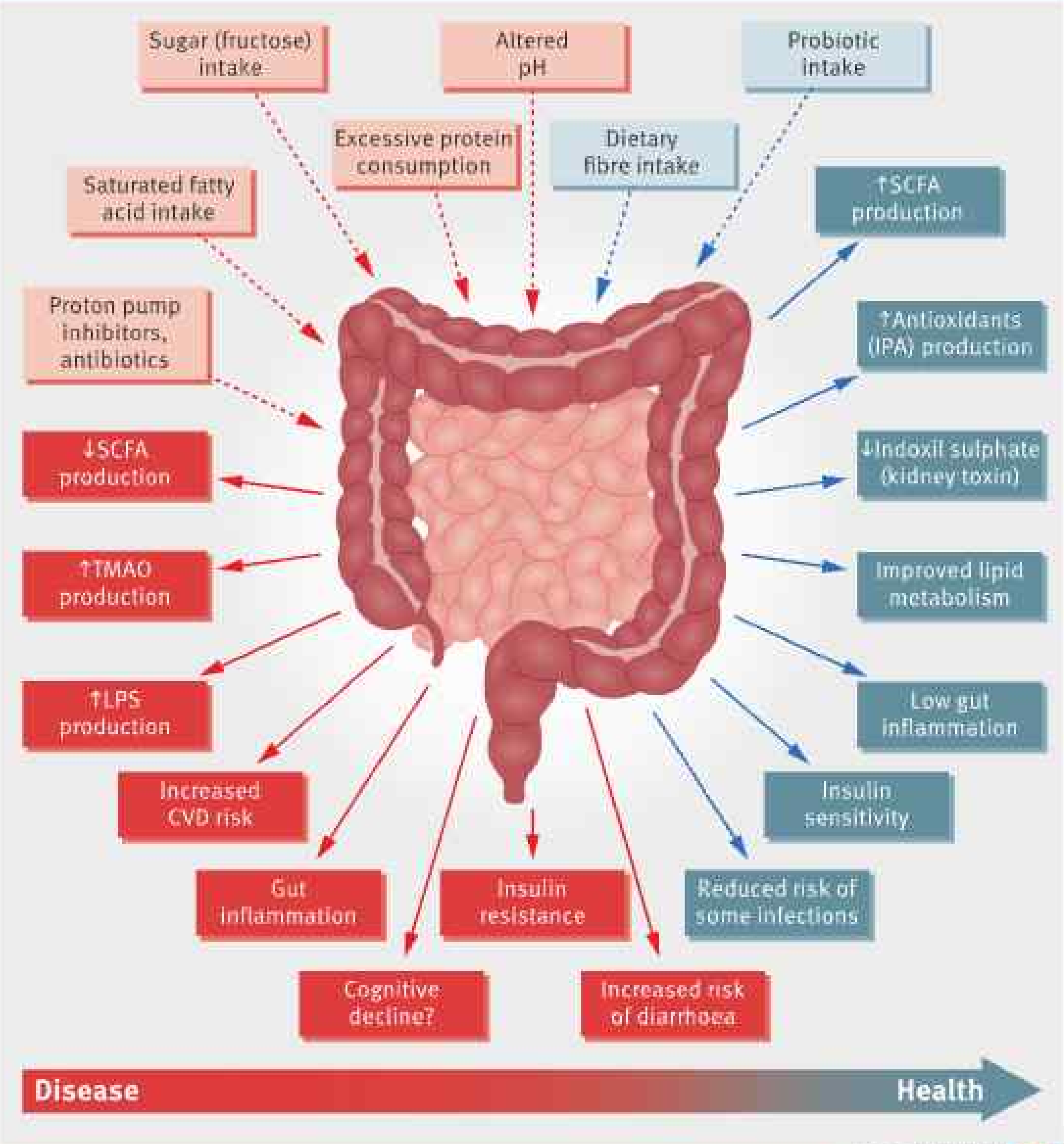
Microbiota ed esercizio…

- The human gastrointestinal tract harbors trillions of micro-organisms, termed “the gut microbiota"
- The gut microbes play a pivotal role in the development of immune and nervous system and are beneficial for host homeostasis, physiology and health
- The gut microbiota being in a symbiotic relationship with the host plays an important role in maintaining metabolic homeostasis through the production of many metabolites
- The human genome consists of about 23 000 genes, whereas the microbiome encodes over three million genes producing thousands of metabolites, which replace many of the functions of the host, consequently influencing the host’s fitness,

Microbiota ed esercizio…

Recent studies on the microbiome show that its composition is highly heterogeneous and that rapid changes in the relative abundances in the main microbial populations occur in individuals.

External factors influence the gut microbiome such as sleep, stress, smoking, drugs, exercise and diet, ***perhaps the most relevant influencing element when considering the composition of the microbiota***



Valdes et al. BMJ. 2018 Jun 13;361:k2179

Microbiota ed esercizio…

Microbiota of children growing up in rural areas of Africa, breastfed for two years and fed with a diet high in fibers and low in animal fat and dairy

compared with the

microbiota of samples isolated from children from urban areas of western Europe, breastfed for one year and then fed with a diet high in animal proteins and fat, processed sugars, and starch

The rural African gut microbiota showed an abundance of species belonging to the Phylum Bacteroidetes and a reduction in Firmicutes. And an had enhanced levels of short chain fatty acids (SCFA)

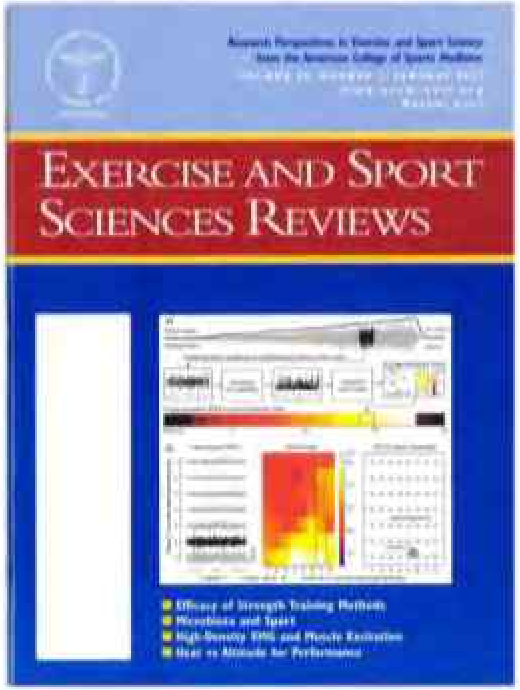
De Filippo et a l. Proc Natl Acad Sci U S A. 2010 Aug 17;107(33):14691-6

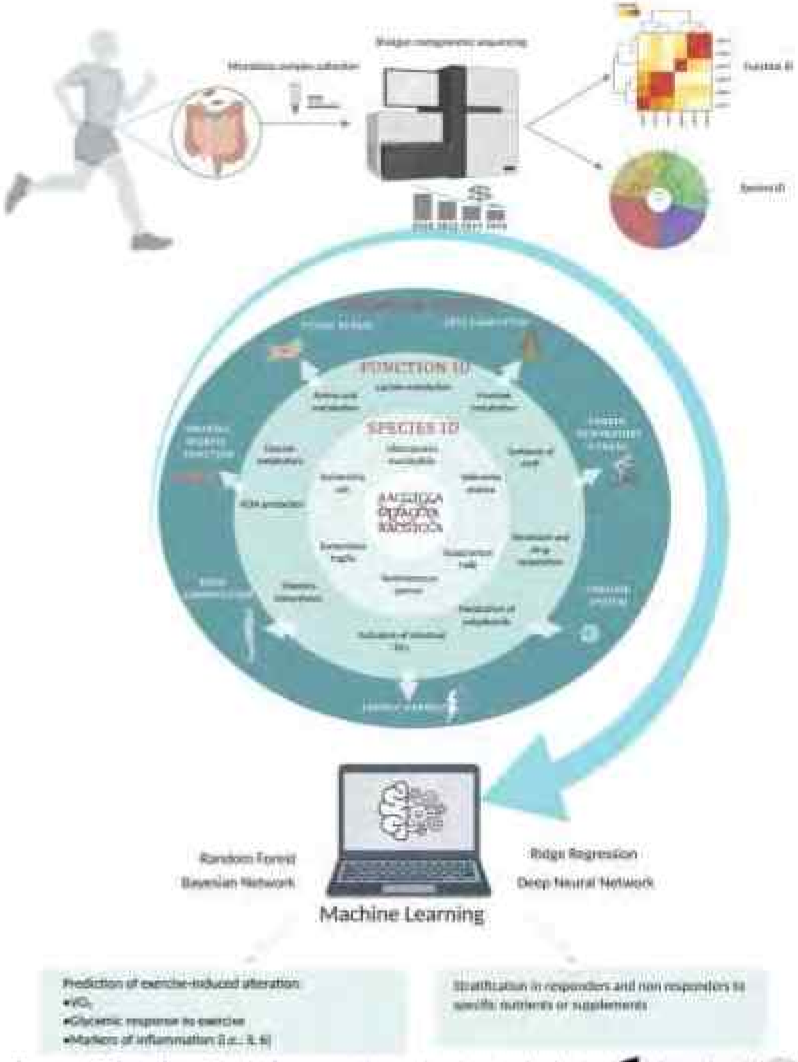
Microbiota ed esercizio…

ARTICLE

Optimizing Microbiota Profiles for Athletes

Laura Mancin[1,2], Ian Rollo[3,4], Joao Felipe Mota[5], Fabio Piccini[6], Mattia Carletti[2,7], Gian Antonio Susto[2,7], Giorgio Valle[8,9], and Antonio Paoli[1,2,10]





Microbiota ed esercizio…

Cross-sectional and longitudinal studies have shown that physical activity, independently from other extrinsic factors, may modulate the composition and functional activity of gut microbiome.

These studies together have revealed some positive but mixed results, indicating that there is no one "unique" effect of exercise on gut ecosystem.

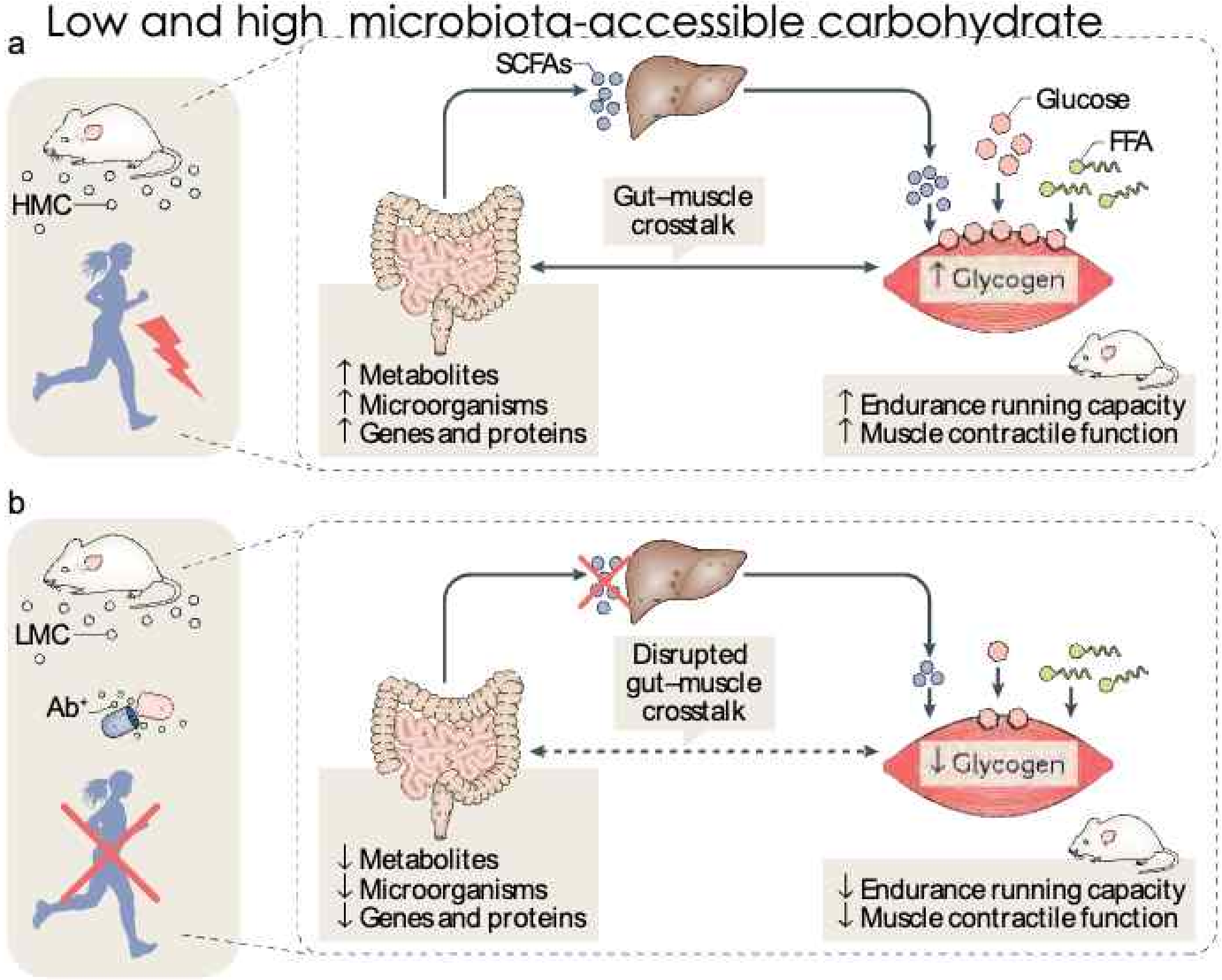
Microbiota ed esercizio…

There is **a two-way path** between microbiome and training and the metabolomic "print" of different sports and training modalities.

High-level athletes have an increased microbial a-diversity, greater growth in specific species such as **Akkermansia muciniphila**, higher microbial production of short chain fatty acids (**SCFAs**), direct association between cardiorespiratory fitness (VO_2max]) and the relative composition of microbiota (**Firmicutes/Bacteroides ratio**), and a greater metabolic capacity compared to matched sedentary controls

Can we modulating the microbiome for the sake of improving an athlete's health **AND** perforance?.

Microbiota ed esercizio…



Mice fed the LMC diet had reduced bacterial diversity, and the low fibre content altered the composition to favour bacteria that produce reduced amounts of SCFAs. After the LMC diet, plasma concentrations of acetate and propionate were ignificantly lower than after the HMC diet, while muscle mass of the tibialis anterior and treadmill run time to exhaustion were decreased.

Infusion of the SCFA acetate into Ab+ mice restored endurance exercise capacity, while running time to exhaustion was also improved in LMC-fed mice after faecal microbiota transplantation from mice fed the HMC diet and administered a single portion of fermentable fibre.

Hawley JA. Nat Rev Endocrinol. 2020 Feb;16(2):71-72

Microbiota ed esercizio…

A microbiome-unfriendly diet is characterized by a high intake of red meat and a low intake of indigestible fiber.

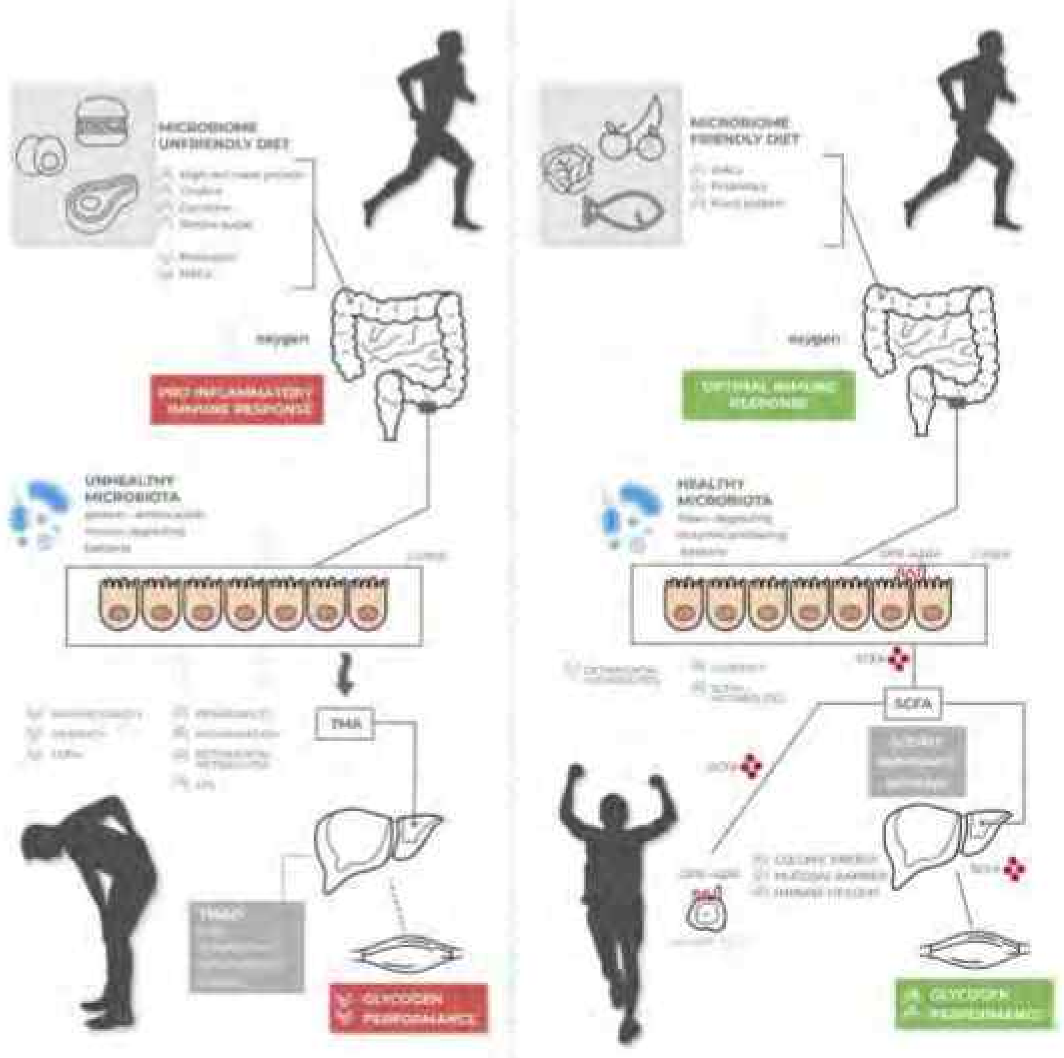
- impair the diversity of the microbiota;
- production of detrimental metabolites
- reduces the ability to generate SCFA.

The reduction in SCFA production increases the relative abundance of proteolytic microbes and mucus-degrading bacteria, which directly affects the gut barrier's function.

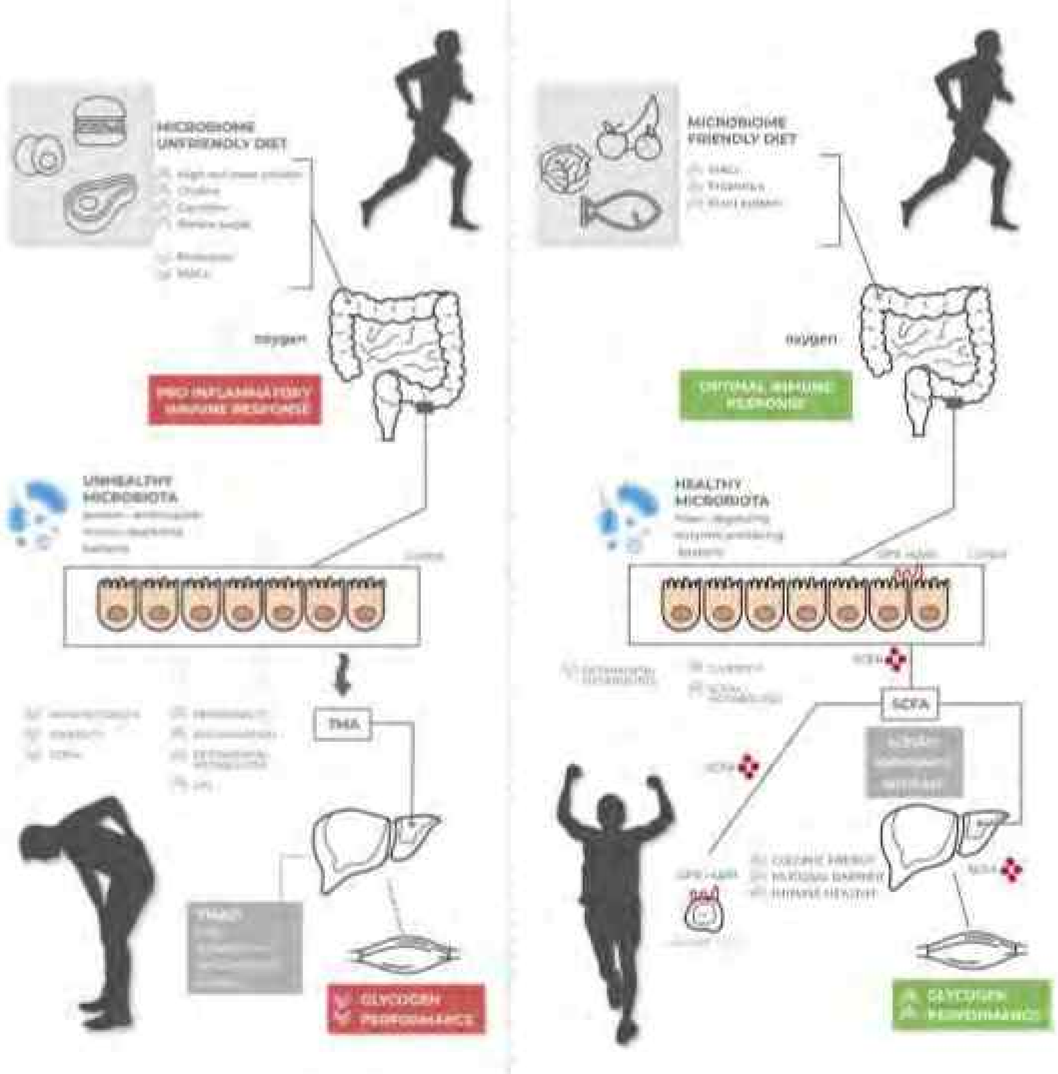
Proteolytic fermentation also generates many biocompounds that affect both host and colonic health.

Many methylamine-containing nutrients can also provide substrates for microbiota-derived generation of TMA, which is converted by the liver in TMAO, a metabolite linked with the acceleration of the atherosclerosis process.

Alow-fiber diet contributes to reducing muscle fuel availability and negatively impacts exercise capacity.



Microbiota ed esercizio…



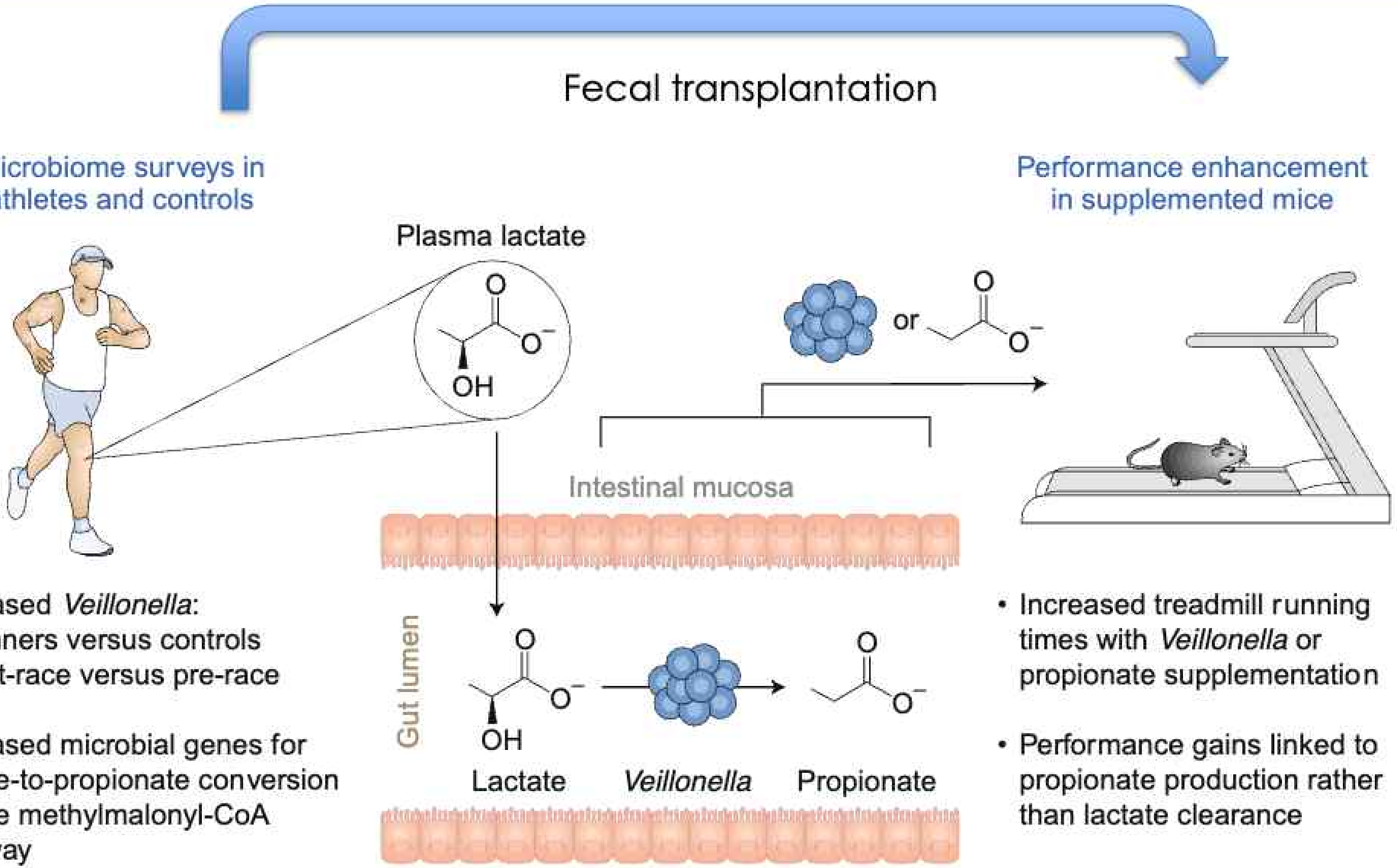
Dietary patterns rich in MAC and adequate intake of high-quality protein contribute to increase microbial diversity, function, and production of SCFA.

SCFA enhance intestinal barrier, nourish enterocytes, act as ligand of GPR41 and GPR43 on the surface of colonocytes and immune cells, suppress protein fermentation, and lower the pH that inhibits proteolytic enzymes.

The improvement of functional intestinal barrier contributes to improve metabolic profile and immunological responses as well.

High SCFA availability is also hypothesized to modulate endurance exercise capacity.

Microbiota ed esercizio…

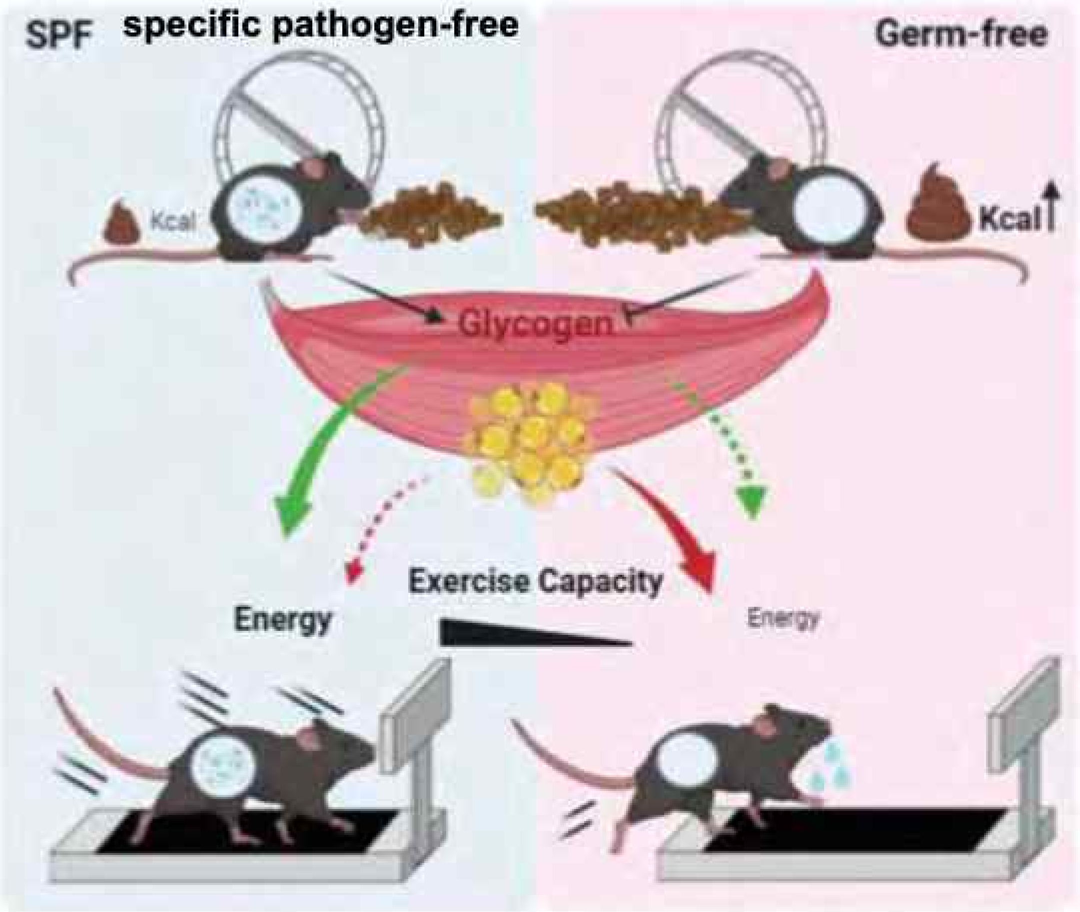


- Increased *Veillonella*:
  - Runners versus controls
  - Post-race versus pre-race
- Increased microbial genes for lactate-to-propionate conversion via the methylmalonyl-CoA pathway

- Increased treadmill running times with *Veillonella* or propionate supplementation
- Performance gains linked to propionate production rather than lactate clearance

Veillonella atypica vs Lactobacillus

Microbiota ed esercizio…



Microbiota influences host exercise capacity via modulation of skeletal muscle glucose metabolism in mice

Trained SPF and GF mice ate more food than untrained mice, but GF mice exhibited lower calorie absorption than SPF mice because their feces contained significantly more calories.

GF mice exhibited a diminished exercise capacity and ability to adapt to voluntary wheel running exercise training relative to SPF mice.

Decreased skeletal muscle glucose metabolism and glycogen storage were associated with impaired exercise capacity in GF conditions.

GF mice consumed more energy through increased usage of fat as an alternative energy source and increased adipose browning ability, which is thought to impair ATP production, causing decreased exercise capacity.

Kim.et al. Exp Mol Med. 2023 Aug;55(8):1820-1830