The link between gut health and athletic performance

Athletes are always seeking to improve their performance and increase their chances of winning the next competition or race. With the contribution of four industry experts, Estef Solar uncovers what may be an ergogenic aid to peak performance: gut health.

It is well known that exercise acts as a hormetic stressor, facilitating adaptation and improving condition. But not all exercise induces the same physiological and metabolic responses. Intensity, duration and recovery play an important role in how our body responds and adapts to the changes, either reaping the rewards of training or accumulating cellular damage.

One key factor influenced by intensity of training, and that affects athletic performance, is gut health. From the structure of the intestinal barrier to the ecosystem of the gut microbiota, there are several considerations to remember when preparing for an endurance event or when training at a high level. With one-quarter to one-half of elite athletes affected by gastrointestinal distress that may deter them from participating in training and competitive events (1), gut health is claiming a space in the spotlight.

Structural and metabolic considerations

The epithelial barrier is dynamic and tightly regulated to maintain gut homeostasis. Despite gut resilience against exercise-induced stress, when this is performed in extreme conditions (intensity, heat, dehydration or under-recovery), gastrointestinal disturbances may appear, including fast bowel transit, nausea, vomiting and bleeding. It has been proposed that strenuous exercise induces a rapid decrease in ATP production, while increasing the release of calcium ions (Ca²⁺) and reactive oxygen species (ROS) from the mitochondria. These higher concentrations of Ca²⁺ and ROS in the cytosol, together with a loss of tight junction control in the gut barrier, favour an increase in intestinal permeability that can lead to a host of undesired systemic effects.

In this scenario, dietary molecules pass through the lumen filter via the open channels in the tight junctions, resulting in neutrophil activation. The lymphocytes beneath the tight junctions secret interferon-γ, which then expands the opening between the junctions, activating macrophages and neutrophils.
“AN ALTERED MICROBIOME CAN AFFECT ENERGY METABOLISM, IMMUNE FUNCTION AND OXIDATIVE STRESS LOAD, ALL OF WHICH ARE VITAL FOR AN ATHLETE’S PERFORMANCE AND OVERALL HEALTH.”

![Diagram of gut microbiome and mitochondria](image)

Figure 1: The bidirectional crosstalk between gut microbiota and mitochondria.

Gut mitochondria axis
Mitochondria are fundamental for athletic performance, mainly due to their role in producing ATP through the electron transport chain. But beyond energy metabolism, a growing body of research points towards mitochondria being in constant synergy with the gut microbiota, using a bidirectional communication system (Figure 1). This may be a reason why both dysbiosis and mitochondrial dysfunction are associated with chronic intestinal inflammation.

While mitochondria coordinate many vital metabolic functions that condition the longevity of the microbiota, such as cellular respiration, fatty acid oxidation, and oxidative phosphorylation, gut microbiota signals can alter mitochondrial metabolism, activate immune cells, kickstart inflammatory responses, and modify epithelial barrier function. By fermenting indigestible dietary fibre, colon microbiota produce short-chain fatty acids (SCFAs), that are involved in immune function modulation, bone mass regulation, cholesterol production and glucose metabolism (8–9). These SCFAs also mediate mitochondrial ATP production, and are an active element in mitochondrial biogenesis (10). The biogenic link has also been suggested by the positive correlation between the presence of commercial butyrate producers in the gut and mitochondrial DNA expression in the host (11).

However, problems can arise when mitochondrial metabolism and microbiota signalling are imbalanced, or an example would be the microbiota releasing metabolites that can directly interfere with the mitochondrial respiratory chain and ATP production. For this reason, research is looking at the modulation of both the quantity and quality of microbiota to target mitochondrial ROS excess and inflammation in the gut (12).

Gut-brain axis
According to Mackinnon (2013), overtraining syndrome is identified by poor performance in competition, inability to maintain training loads, persistent fatigue, frequent illness, disturbed sleep and mood alterations (13). Psychological and physiological demands, to which athletes are subjected before and during competition, result in stress that goes beyond the hormonal definition and activates the autonomic nervous system. This translates into an HPA axis response, an increase in circulating levels of catecholamines, especially noradrenaline, and the release of neurotransmitters into gastrointestinal tract tissues. In this manner, the brain connects with the gut, modulating motility, immunity, permeability and secretion of mucus (14).

Meanwhile, through the action of the enteric nervous system, the gut responds to stress by releasing hormones like GABA, neuropeptide Y and dopamine, which have been labelled as gut-brain axis feature on pages 8-10 of this magazine.

Microbiome diversity
It is estimated that approximately 400 bacterial species and 100 trillion microbes live in the human intestinal tract, most exerting a positive effect on the health of the host. An altered microbiome can affect energy metabolism, immune function and oxidative stress load, which are all vital for an athlete’s performance and overall health.

From a performance perspective, some secondary effects of synergistic bacterial activity in the gut, that could positively affect athletic development, are enhanced recovery, better immune function, and maintenance of healthy gastrointestinal tract function (15). Lactobacillus (shannonus and paracasei) can lower oxidative stress caused by intense exercise (17); other families of Lactobacillus and Bifidobacterium help minimise gut permeability in endurance athletes. Bacteroides stimulate

ABOUT THE AUTHOR
ESTEF SOLAR became a Registered Nutritionist in 2017, and runs her practice online and from Corduff, with a special interest in energy metabolism and chronic illness. A trained journalist with more than 10 years’ experience in marketing and communications, Estef has been recently appointed Brand Manager for Regenerative – Where Forward Health Industries’ neurovascular division. www.beconrecoverytrix.co.uk

WWW.FSNNMAG.COM | FSN | NOVEMBER/DECEMBER 2019
What the supplement experts say

Although we need more sport-specific research on supplemental interventions for improving an athlete’s gut health, there are some unique and ethical supplements that can help improve and maintain an athlete’s gut health. Let’s take a look.

- **Symprove, restoring the gut’s natural balance**
  
  Dr Sammy Gill, scientific advisor for Symprove, gave us some insights into how these bacteria help improve the gut.

- **Nucleotide Nutrition, supporting the gut lining**
  
  Rachel Hoyle, product development specialist for Nucleotide Nutrition, highlighted the importance of nucleotides for the maintenance and repair processes in the gut. The intestinal tract has the highest rate of cellular turnover in the body and this increases further during periods of infection, or when the gut mucosa has been damaged and needs repair. Additionally, the 100 trillion or so microbes that make up the gut’s microbiome turn over even more rapidly, and have an irreplaceable requirement for nucleotides to build RNA and DNA within the nucleus of every new cell. There is approximately 1000 times more RNA in a typical cell than DNA; most of it present as messenger (mRNA), transfer (tRNA) and ribosomal (rRNA) RNA, with the all-important mRNA usually comprising just around one to five percent of total cellular RNA. One might ask why would we benefit from supplemental nucleotides rather than food-based sources. Rachel listed three main reasons:
  
  - Purified nucleotides (extracted from yeast RNA-DNA) are much better absorbed through the gut.
  - The richest sources of dietary nucleotides are offal meats, and gut bacteria can ferment foods such as traditionally fermented tofu, tempeh and natto. However, most of us eat little of these foods nowadays. Most plant foods also contain very low levels of nucleotides, with broccoli being an exception.
  - Pyrimidine-type nucleotides are more deficient than purine-type nucleotides in the diet.

- **Biimuno, feeding beneficial gut bacteria**
  
  Clasado BioSciences have developed a unique prebiotic supplement called Biimuno, which contains galactooligosaccharides (GOS) derived from lactose and considered as a prebiotic (inulin, resistant starch and oligofructose) and one of the most advanced forms of prebiotics.

  The research journey for GOS and its application in Biimuno started at the University of Reading, by demonstrating how beneficial endogenous bacteria can be selectively grown in the colon in a replicable way. Clasado BioSciences has published human clinical trials on Biimuno since 2008.

  Biimuno has been shown to beneficially affect the human gut microbiome through its selective stimulation of bifidobacteria. The data for Biimuno has been repeatedly demonstrated in studies in healthy adult populations (003,132), an irritable bowel syndrome cohort (33) and overweight adults (43).

  Biimuno also helps to modulate the modulation of the gut microbiome by Biimuno and have also been demonstrated: Improvements in immunity have been measured in terms of an increase in natural killer cells activity, an increase in anti-inflammatory cytokines interleukin-10 and interleukin-8, and a decrease in the pro-inflammatory cytokines interleukinc-1β (18). Additional studies have also highlighted the role of Biimuno in reducing the risk of traveller’s diarrhoea, using a randomised, placebo-controlled double-blind trial (53). Another study on a population with a phenotype of asthma and exercise-induced bronchoconstriction, found that in improving asthma symptoms, over two times to due be reduced systemic concentrations of Th2-d driven inflammatory markers (53).

  Biimuno has recently received informed Sport accreditation, becoming the only probiotic supplement confirmed suitable for competitive athletes that are drug tested.

**ProVen Probiotics, supporting the gut microbiome**

Asthme Benjamn is a registered nutritionist and marketing manager for ProVen Probiotics, launched in 2012 using the Lab4 consortium of four friendly bacteria strains. The Lab4 consortium was developed in 2003 by worldwide expert Dr Nigel Plummer and his team at Cultech Ltd, ProVen’s parent company, and is sold to other companies around the world – Cultech manufactures probiotics using both the Lab4 and other strains for companies in the US, Australia, Europe and elsewhere.

The first clinical trial on the efficacy of these four combined strains in 2006 revealed a 46% reduction in the occurrence of Coenobium difficile diarrhea in hospitalised patients (37). This was closely followed by clinical studies into the use of Lab4 probiotics alongside antibiotics (38) and in IBS sufferers (39).

These trials showed positive results, and more recently, the Lab4 group of bacteria was re-established in the recent trials in Ireland and overall, the Lab4 strain was shown to provide an effective and durable treatment for IBS symptoms (40). In 2016, a study looked into gut microorganisms in a randomised trial using the Lab4 probiotics and showed a reduction in gut inflammation, endotoxin levels, intestinal permeability and race times (40). And this year, a study was published showing that supplementing with Lab4 probiotics protects endurance runners from gastrointestinal disturbances during a marathon race and may even help to maintain running pace during the latter stages of racing (43).

Lab4 is subject to a continuous programme of research, with over a dozen clinical trials published in January 2020. The body of evidence behind the Lab4 probiotics now encompasses over 15 clinical trials, supporting the widest range of clinical benefits of any probiotic globally.