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EQUINE LEAKY GUT SYNDROME

— part 2

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A leaky gut allows undesirable molecules into your horse's body. In part two of this series, we highlight nutrients important to GIT barrier function and health, including specific amino and fatty acids.

A healthy gastrointestinal tract (GIT) provides a true physical barrier that keeps out harmful compounds either ingested by your horse, or produced by pathogenic bacteria. Failure to maintain barrier function results in a leaky gut (increased permeability) and contributes to several diseases. In the second part of this series, we'll focus on nutrients important to GIT barrier health, such as certain amino and fatty acids.

The best way to correct a leaky gut is through good nutrition. If you and your vet have determined that your horse suffers from leaky gut syndrome (LGS), examine his diet carefully. You may think your horse already enjoys good nutrition, but his diet may actually be deficient in certain nutrients.

LUMINAL NUTRIENTS FEED THE GIT

Luminal nutrients have positive effects on your horse's GIT, without being absorbed into the blood (see Figure 1). Their benefits include:

- Providing fuel (glutamine) to intestinal epithelial cells (IECs)
- Stimulating the growth and proliferation of new IECs
- Stimulating the release of gut hormones
- Acting as molecular signals to increase or decrease nutrient transport
- Stimulating intestinal mucus production.

Vitamins, amino acids, nucleic acids, carbohydrates (sugars) and fatty acids all have beneficial effects on GIT mucosa and

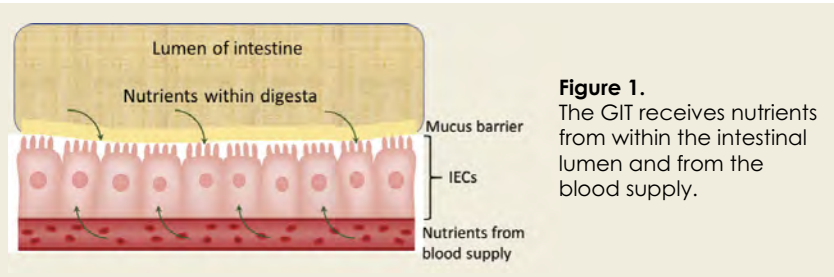


Figure 1. The GIT receives nutrients from within the intestinal lumen and from the blood supply.

Amino acids –	IEC energy source, IEC growth, barrier function, protein synthesis, cell repair, immunostimulant, intestinal immune system
Butyrate –	IEC tight junctions, mucosal barrier, energy source, immune system, nervous system
Fatty acids –	oleic acid, linoleic acid, palmitic acid are closely associated with immunological function of the intestinal mucosa

Figure 2. Key sites of action of specific GIT-beneficial nutrients.

within complete feeds, there are still nutritional gaps that cannot be met from feeds alone. Let's take a closer look at the roles of key amino acids, butyrate and long-chain fatty acids in enhancing adaptive responses in the GIT.

A. Amino acids

Amino acids normally come from the breakdown of dietary protein, but you can supplement to meet specific amino acid needs. Intestinal epithelial cells use 20% of luminal amino acids for the mucous barrier, and the remainder for other IEC processes. Three amino acids are important for GIT health and barrier function: glutamine, arginine, and threonine.

1. Glutamine

Glutamine is highly digestible and can be considered “essential” in GIT regulation of gene expression, protein synthesis and turnover, IEC growth and repair, neuronal excitability, cellular metabolism and immunity. Dietary glutamine is transported into IECs along the entire length of the GIT, with up to two-thirds entering the small intestine, to be used as fuel. Inadequate

WHY PERFORMANCE HORSES MAY SUFFER FROM GASTROINTESTINAL ISSUES

Performance horses are subjected to periods of training, transport and competition. Stress from the heat and exercise related to these activities may contribute to intestinal dysfunction. These stressors result in a loss of barrier function, and compromised immune responses.

Arginine supplementation in mice subjected to exercise and heat stress prevented increases in intestinal permeability and bacterial translocation; the researchers concluded that “dietary l-arginine supplementation preserves the integrity of the intestinal epithelium during exercise under heat stress.”

Arginine is used by the IECs lining the large intestine to produce polyamines required for maintaining barrier function and for repairing impaired barrier function. Arginine also stimulates intestinal immune system activity, which combats inflammation.

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glutamine impairs cell growth and proliferation, resulting in a breakdown of tight junctions with loss of barrier function, leading to a leaky gut.

2. Arginine

Arginine is also highly digestible. It is metabolized within IECs and absorbed into the blood. When arginine is low (less than 1% of the diet), supplementary arginine (up to 2%) may stimulate growth of IECs, and preserve or restore intestinal barrier function.

3. Threonine

Threonine – one of nine indispensable amino acids – cannot be synthesized, so animals must get it from their diets. It is highly digestible, metabolized within IECs, specifically used for mucin production, and actively absorbed into the blood. A threonine imbalance reduces the growth of the small intestine, liver and skeletal muscle in young animals, and reduces protein synthesis and mucin production in the GIT. Mucin forms an essential part of the intestinal immune system that's responsible for protecting the organism from physical and chemical attack. Optimum dietary threonine is about 1% of the digestible protein. Providing supplementary threonine results in improved growth performance, health, immunity and gastrointestinal function.

B. Free fatty acids

Horses don't normally consume much fat. However, dietary fat intake is closely associated with immunological function of the intestinal mucosa. Since intestinal barrier function is directly modified by cell membrane lipid content, providing beneficial dietary lipids is important. These may take the form of certain short chain fatty acids, as well as saturated and unsaturated free fatty acids, including those below:

1. Butyrate

Butyrate is a short chain fatty acid (SCFA) produced by microbial fermentation of dietary fibers (complex carbohydrates) within feedstuffs. Butyrate contributes to:

- IEC and whole-body glucose and energy homeostasis
- Regulation of IEC barrier function
- Regulation of immune responses and epithelial cell growth
- Modulation of nervous system activities.

Practitioners consider a butyrate deficiency (measured through feces) as an indirect indicator of altered barrier function. A high abundance of beneficial GIT microbiota (*Bifidobacterium*, *Lactobacillus* and *Clostridium leptum*) results in the healthy production of butyrate and other SCFAs. However, in many situations, such as stress and high-carbohydrate

feeding, the number of SCFA-producing microorganisms decreases, and that of pathogenic bacteria increases. This leads to poor epithelial barrier integrity, and a reduced ability to repair epithelial lesions and combat exercise-associated GIT barrier problems.

Several studies indicate that butyrate plays a primary role in reinforcing epithelial barrier function. It also contributes to the energetic balance of IECs, and is involved in the regulation of oxidative stress and the inflammatory status of cells.

Because of butyrate's recognized importance in many aspects of healthy GIT function, researchers have found ways to increase cecal and hindgut butyrate levels through dietary supplementation. Butyrate is rapidly taken up by IECs, however, so it is necessary to encapsulate the butyrate to protect it as it travels with digesta into the cecum and hindgut.

2. Oleic, linoleic and palmitic acids

As dietary supplements, unsaturated free fatty acids (oleic and linoleic acid) and the saturated free fatty acid (palmitic acid) are highly digestible in the small intestine. They can have a positive effect on intestinal microbiota, and help restore and maintain intestinal health and immunity in the face of pathogens.

Oleic acid contributes to IEC growth and increased mucosal mass, as well as immunoglobulin A (IgA) production. High IgA protects against pathogenic microorganisms by preventing their attachment to, and entrance into, IECs, and by neutralizing their toxins. Clinical trials showed that dietary polyunsaturated free fatty acids reduced GIT inflammatory

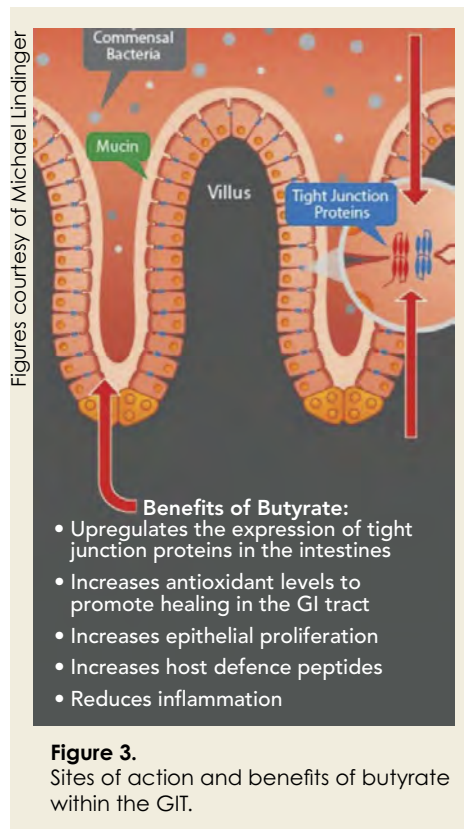
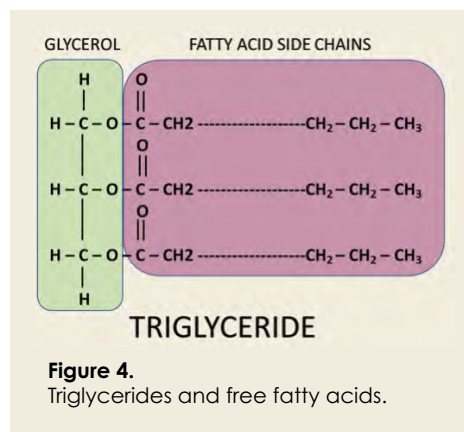


Figure 3. Sites of action and benefits of butyrate within the GIT.



activity in ulcerative colitis patients by generating and maintaining a protective layer overlying IECs, which helps re-establish an effective mucosal barrier.

Oat and sunflower oils are rich sources of palmitic acid, oleic acid and linoleic acid. Horses may also be fed Omega-3 PUFAs in the form of fish oil, but it is very important that the oil has been minimally oxidized by exposure to air. You may safely feed these dietary fats in a ratio of as much as 10% of the diet, but start with

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minimal amounts and gradually increase over a three-week period.

TAKE A BALANCED APPROACH

Taking an educated role in your horse's nutrition will help keep him healthy and protected from many avoidable conditions associated with leaky gut. Remember, balance is key. Being in the right (beneficial) range for the amount of each nutrient type is important. Carefully read labels and remember to consult with your veterinarian and other highly-trained professionals. Treatment is great – but prevention is better!

In Part 3 of this series (EW V13I5), we will consider probiotics and prebiotics. 🐾