

THE GUT-SKIN AXIS: FROM MICROBIOTA TO SKIN HEALTH

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This article explores current understanding of the gut-skin axis, including how the gut and skin communicate, the links to inflammatory skin conditions, and how diet and lifestyle may support skin health by influencing the gut microbiota.

More than skin deep: introducing the skin microbiome

The skin is the body's largest organ and, like the gut, is home to a diverse community of microorganisms including bacteria, fungi and viruses, collectively known as the skin microbiome. The skin microbiome plays an important role in maintaining skin health by supporting skin barrier integrity, protecting against pathogens and interacting closely with the immune system.

The composition of the skin microbiome varies across the body depending on factors such as moisture, sebum production and environmental conditions. As a result, dry, moist and oily areas of skin each support distinct microbial communities.¹

When balanced, the skin microbiome contributes to skin homeostasis. Increasingly, research suggests that skin health is influenced not only by the microorganisms living on the skin itself, but also by those residing within the gut. This connection forms the basis of the gut-skin axis.

The gut-skin axis: how the gut and skin communicate

The gut-skin axis refers to the bidirectional relationship between the gut microbiota and skin health. Although distinct organs, the gut and skin share several important characteristics, including extensive networks of blood vessels and nerves, as well as their own diverse communities of microorganisms.

Evidence shows that some gut diseases can manifest via the skin, while certain skin conditions are associated with gut microbiota dysbiosis.² For example, coeliac disease may present with dermatitis herpetiformis³, while individuals with psoriasis are more likely to suffer from inflammatory bowel disease (IBD).⁴

Although the relationship is considered bidirectional, current evidence focuses more on how the gut microbiota influences skin health rather than the reverse.

Communication between the gut and skin occurs via several pathways, for example, immune signalling, vitamin D regulation, stress-related hormonal pathways and microbial metabolites.

The immune system is considered the primary communication route within the gut-skin axis. Around 70–80% of the body's immune cells reside within the gut-associated lymphoid tissue (GALT), where they interact with the gut microbiota.

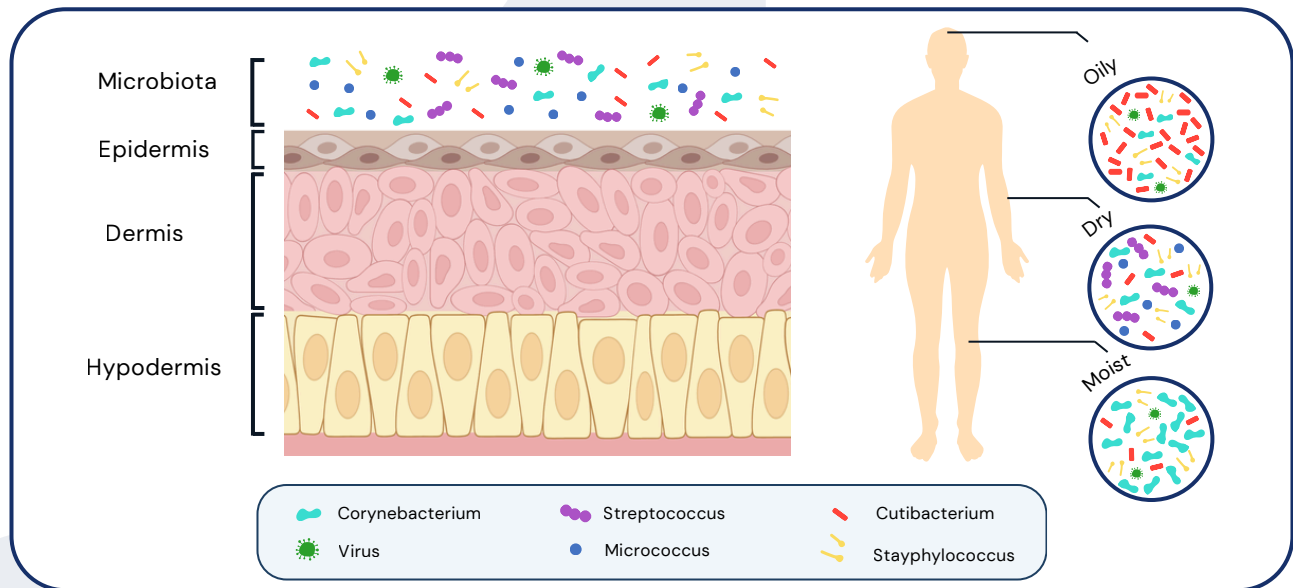


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Figure 1: Overview of the skin microbiota and variation across different body sites (from Yakult Science for Health resource, 'The Gut-Skin Axis HCP Resource')



When the gut microbiota is balanced, it helps regulate immune responses and maintain homeostasis. In contrast, gut dysbiosis may increase intestinal permeability, allowing microbial components such as lipopolysaccharides (LPS) to enter the bloodstream and trigger systemic inflammation. This may

contribute to inflammatory processes involved in skin conditions such as acne, atopic dermatitis and psoriasis.⁵

Vitamin D, which is synthesised in the skin following exposure to UV-B radiation, has been shown to influence gut microbiota composition, with low vitamin D status linked to conditions such as IBD.⁶⁻⁸

Stress may influence the gut-skin axis through activation of the hypothalamic-pituitary-adrenal (HPA) axis. Increased production of cortisol and pro-inflammatory cytokines can disrupt gut microbiota composition,⁹ increase intestinal permeability and contribute to

systemic inflammation.¹⁰ These changes may help explain why stress is often associated with flare-ups of inflammatory skin conditions such as acne, atopic dermatitis, rosacea and psoriasis.¹¹ Microbial metabolites also act as important messengers within the gut-skin axis. Short-chain fatty acids (SCFAs), are produced when gut microbes ferment dietary fibre. These compounds can enter the circulation and exert anti-inflammatory effects throughout the body.

Gut dysbiosis and inflammatory skin conditions

An increasing body of evidence links dysbiosis, an imbalance in the gut and/or skin microbiota, with a range of inflammatory skin conditions. Alterations in microbial diversity and composition have been observed in both the gut and skin of individuals with atopic dermatitis, acne and psoriasis. However, the mechanisms

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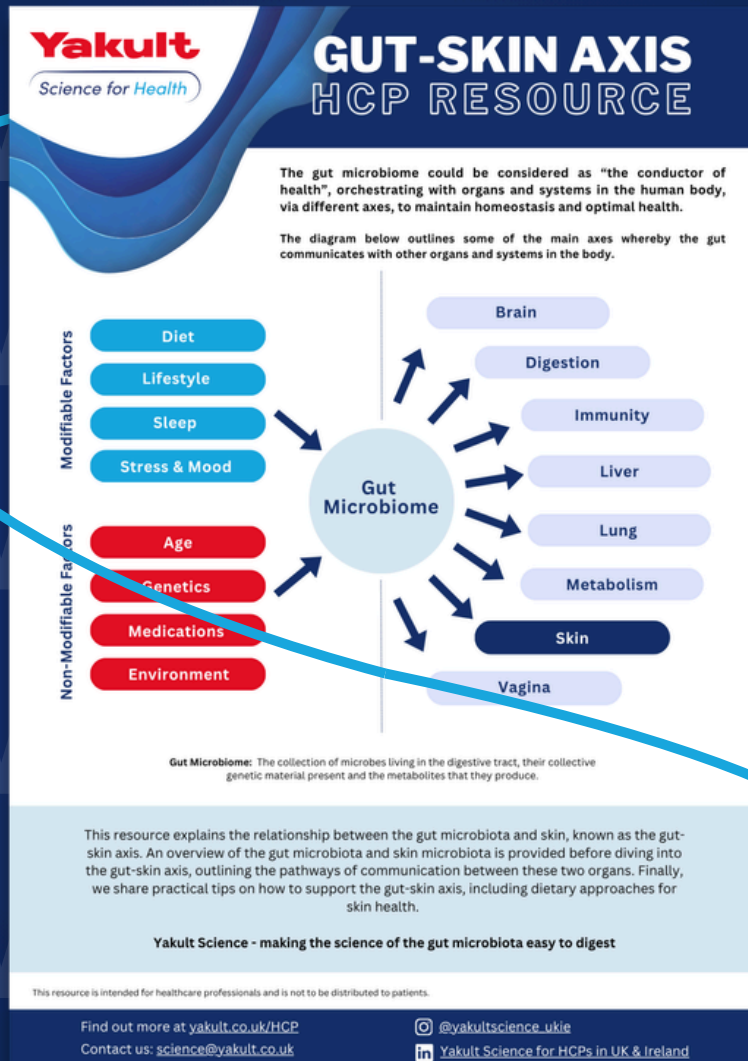
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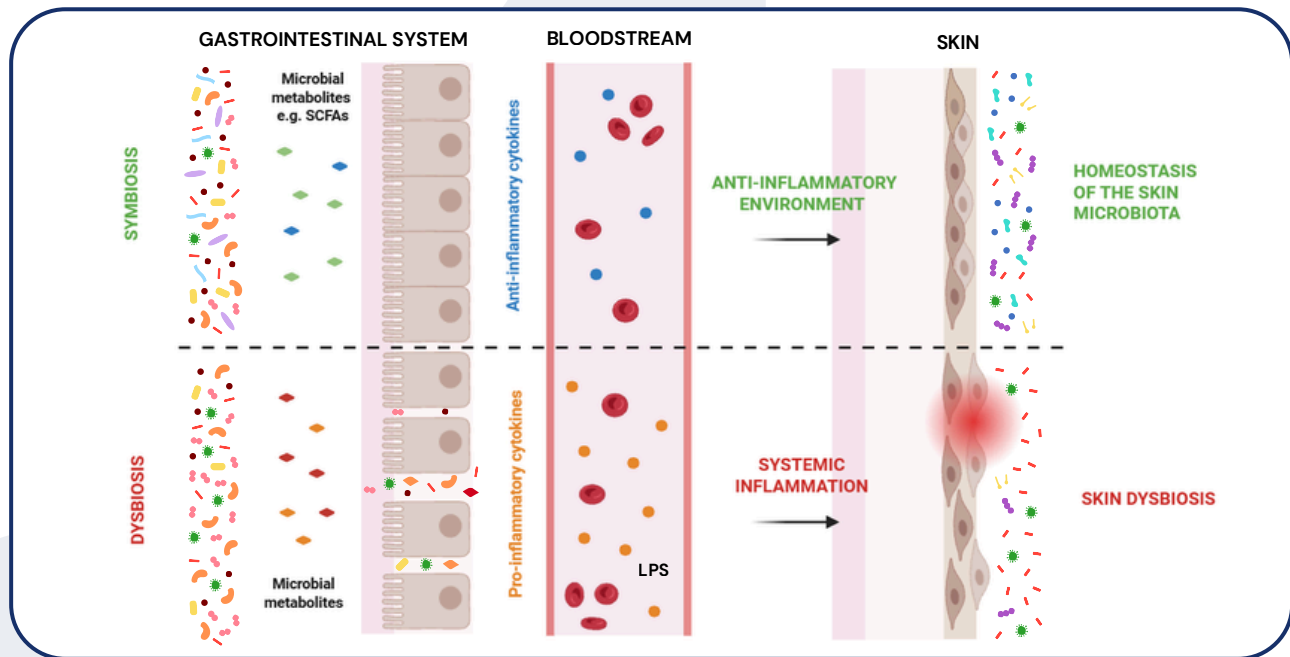
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Figure 2: Communication between the gut and skin (from Yakult Science for Health resource, 'The Gut-Skin Axis HCP Resource')



underlying these associations remain unclear. *Cutibacterium acnes* and lower overall microbial diversity.^{18–20}

Atopic dermatitis (eczema)

Atopic dermatitis (AD) is one of the most extensively studied conditions within the gut-skin axis literature. Individuals with AD have been shown to have lower levels of beneficial gut bacteria, such as *Bifidobacterium*,¹² and higher levels of potentially pro-inflammatory species, like *Clostridium* and *Escherichia coli*.¹³ Alterations in the skin microbiota are also common, including decreased bacterial diversity and a marked overgrowth of *Staphylococcus aureus*, particularly during disease flare-ups.^{14,15} The higher abundance of *S. aureus* has been associated with greater symptom severity.¹⁶

Acne

Acne has also been linked to changes in both the gut and skin microbiota. Studies have reported reduced gut microbial diversity in individuals with acne, alongside alterations in the abundance of specific bacterial groups.¹⁷ On the skin, acne is associated with a higher abundance of specific pro-inflammatory strains of

Psoriasis

Psoriasis is a chronic inflammatory skin condition that has also been associated with gut and skin microbiota dysbiosis. Research suggests individuals with psoriasis have lower levels of beneficial gut bacteria (eg, *Akkermansia muciniphila*, *Faecalibacterium prausnitzii*) and an increased abundance of pro-inflammatory species (eg, *E. coli* and *Ruminococcus gnavus*).²¹ Alterations in the skin microbiota have also been reported, including increased levels of *S. aureus*^{22,23} and decreased levels of *Cutibacterium acnes*.^{24,25} However, further research is needed to better understand the role of these microbial changes in disease development and progression.

Can diet influence skin health through the gut?

Diet is one of the most important modifiable factors influencing the gut microbiota and has attracted considerable interest in gut-skin axis research. While no

single food or nutrient can prevent or treat inflammatory skin conditions, dietary patterns that support a diverse and resilient gut microbiota may also benefit skin health.

Higher adherence to a Mediterranean-style dietary pattern, characterised by vegetables, fruits, wholegrains, legumes, nuts, seeds and olive oil, has been associated with lower acne severity^{26,27} and improvements in psoriasis symptoms.^{28–30}

Rich in fibre, polyphenols and unsaturated fats, this dietary pattern may help support a diverse gut microbiota while reducing systemic inflammation.

Dietary fibre is fermented by the gut microbiota to produce short-chain fatty acids (SCFAs), including butyrate, acetate and propionate. Diets that include a wide variety of plant foods and are high in fibre have been associated with greater gut microbial richness and diversity, which is generally considered a marker of a healthy gut microbiota.^{31,32} Fermented foods, including fermented milk drinks, kimchi, sauerkraut and miso, may also help modulate the gut microbiota.^{33–36}

Among specific dietary factors, the relationship between diet and acne has received particular attention. Emerging evidence suggests that high-glycaemic index and glycaemic-load diets may be associated with a greater acne prevalence and severity.^{37,38} In contrast, evidence linking dairy products with acne remains mixed. A meta-analysis reported a positive association between overall milk consumption and acne, particularly skimmed milk.³⁹ Nonetheless, these findings do not establish causality and do not appear to extend to fermented dairy products such as yoghurt and cheese. Interest in microbiome-targeted interventions has also grown considerably.

Meta-analyses indicate probiotics (live microorganisms that confer a health benefit when consumed in adequate amounts)⁴⁰ may reduce disease severity in atopic dermatitis^{41–43}, while certain probiotic strains (eg, *Lactobacillus rhamnosus* SP1) have shown promise in acne.⁴⁴ Emerging evidence also suggests prebiotic supplements (substrates selectively utilised by host microorganisms that confer a health benefit)⁴⁵ may support skin health and reduce the risk of atopic dermatitis in high-risk infants.^{46,47} However, more research is needed to fully understand the potential role of probiotics and prebiotics in skin health, function and conditions.

Lifestyle factors beyond diet

While diet is often central to gut-skin axis discussions, other lifestyle factors may also influence gut and skin health. Chronic stress, for example, has been associated with flare-ups of inflammatory skin conditions (eg, acne, atopic dermatitis, rosacea and psoriasis).¹¹ Clinical research shows that stress management interventions may improve symptoms and quality of life in some inflammatory skin conditions, such as atopic dermatitis and psoriasis, when used alongside standard dermatological care.^{48–51}

Sleep is also another important factor. Poor sleep quality and disrupted sleep patterns can alter gut microbial balance⁵² and have been associated with impaired skin barrier function and increased signs of skin ageing.^{53,54}

While further research is needed, these findings highlight the importance of considering lifestyle factors alongside diet when supporting the gut-skin axis.

Looking to the future

Research into the gut-skin axis has

expanded considerably in recent years, with growing interest in the potential role of probiotics and prebiotics in supporting skin health. A recent scoping review conducted by Yakult Science for Health in partnership with King's College London identified 516 studies investigating these interventions, with atopic dermatitis emerging as the most extensively researched condition, followed by psoriasis and acne.⁵⁵

Despite this growing body of research, important evidence gaps remain. Less

evidence is available for conditions such as rosacea, alopecia and melasma, while older adults remain underrepresented in the literature. Further evidence synthesis is also needed for acne and psoriasis, investigating optimal strains, doses and treatment durations, to support potential translation into clinical guidelines.

As understanding of the gut-skin axis continues to evolve, microbiome-targeted approaches may offer new opportunities to support skin health alongside conventional dermatological care.

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Questions relating to: THE GUT-SKIN AXIS: FROM MICROBIOTA TO SKIN HEALTH

1. How does the skin microbiota vary depending on skin site?

2. What is the gut-skin axis?

3. Give four examples of communication pathways between the skin and the gut.

4. How does stress affect the gut-skin axis?

5. Explain how current research shows differences in skin microbiota composition in atopic dermatitis, acne and psoriasis.

6. How can you support the gut-skin axis through diet?

7. What does the current research suggest about the relationship between high-glycaemic diets, dairy consumption and acne, and how strong is the evidence supporting these associations?

8. How are probiotics defined, and what does the current evidence show about their use in supporting skin health and skin conditions?

9. What lifestyle factors beyond diet can support the gut-skin axis and how?

10. What gaps have been identified in the gut-skin axis literature?