ILLUSTRATION: CLAIRE SHORROCK

The gut-brain connection

Could the bugs we carry in our body influence our mood, behaviour, and neurological health? It certainly seems so. Naturopath Tania Flack reports.

IT SOUNDS like something from a science fiction movie: being infected with a living organism that changes the way you think, feel and act. That's too far-fetched for the real world - or is it? An explosion of new research provides mounting evidence that the human gut microbiome plays an important role in many neurological conditions affecting brain function, mood, and behaviour. The link between the gut microbiome and depression, schizophrenia, Alzheimer's, Parkinson's, autism, multiple sclerosis, and cognitive decline is now being investigated. Even our appetite is influenced by our microbes. The gut and brain are so intimately connected that the gut has been dubbed 'the second brain'. So: can we improve our brain health by fixing our gut?

The term 'microbiome' describes the vast population of microorganisms - bacteria, viruses and parasites - that share our body. How we perceive the human body changed forever in 2012, with the release of the findings of the Human Microbiome Project. This study used DNA sequencing to map our microbial landscape and found that the majority of our DNA is, in fact, microbial, accounting for approximately 90 percent of all human genes. The human gut contains the vast majority of our inner zoo and is home to approximately 100 trillion microorganisms, creating the most diverse and complex ecosystem on the planet, and it is this diversity that seems to dictate many aspects of human health, particularly brain health. These microbes have sophisticated ways in which they interact with each other and influence their environment - namely us.

How it works

We know that increases in stress hormones impact gut movement, leading to what are known as 'functional gut disorders', which include irritable bowel syndrome, constipation, and functional dyspepsia. Stress also changes the gut's mucous membranes, which in turn negatively affects the balance of the gut microbiome.

However, it's not the one-way street we once thought. We now know that what happens in the gut does not stay in the gut, but rather has a significant impact on brain health via a complex superhighway of bidirectional signalling between the two organs. Hormones, neurotransmitters and myriad of electrical signals are passed between complex networks of nerves, including the vagus nerve, which directly connects the gut and the brain.

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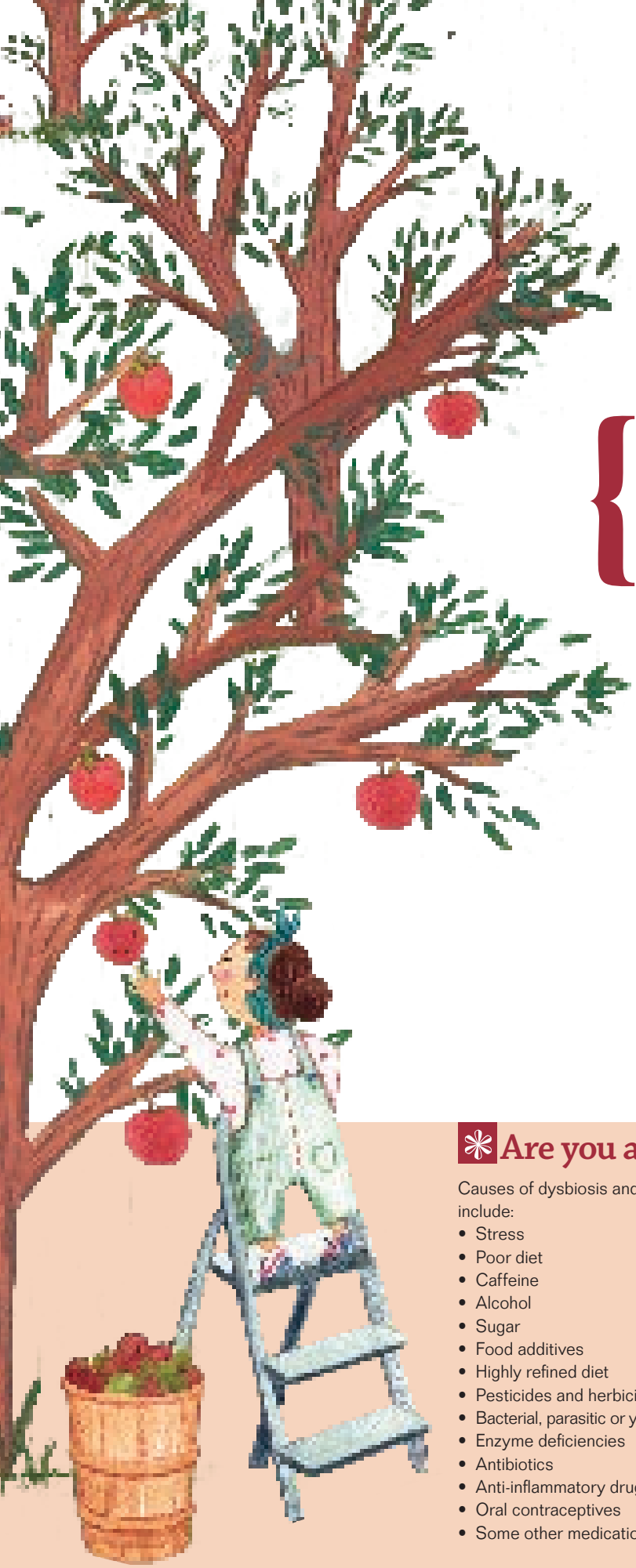
The enteric nervous system of the gut springs forth from the same tissue as the brain and central nervous system during foetal development. This explains the incredible structural and chemical similarities between the two organs, including their combined ability to produce neurotransmitters. Around 95 percent of the body's serotonin, a mood-regulating neurotransmitter, is actually produced in the



gut, where it modulates peristalsis. Studies show our bacteria play a crucial role in the production of serotonin in the gut. Short chain fatty acids, particularly butyrate, produced by bacteria when they break down starches, trigger the release of serotonin in the gut.

We can study the effect of gut microbes using specially bred 'germ-free mice' that are born without any bacteria in their gut. These animals differ significantly from their bacteria-laden

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counterparts in that they have very different brain chemistry and function: they have an exaggerated response to stress, produce far higher levels of stress hormone, and have lower levels of 'brain-derived neurotropic factor', a chemical that protects a region in the brain called the hippocampus, which is important in depression. Most interestingly, when we take bacteria from a normal mouse and put it into the gut of a germ-free mouse, all of their neurochemistry and stress responses normalise. Several studies investigating the microbiome of depressed patients have found patterns of microbial expression; they often have an over-representation of bacteroidetes and proteobacteria and an under-representation of lachnospiraceae and firmicutes. The same researchers also discovered that depressed patients had more of a bacteria called alistipes, which has been found in patients with IBS and chronic fatigue, both conditions associated with depression. Plus, the patients had an increase in another type of bacteria, oscillibacter, which produced a chemical that interacted with neurotransmitter receptors, which may be linked with depression.

A similar pattern exists in children with autism spectrum disorder, who have high levels of proteobacteria, bacteroidetes and clostridium species. Some human trials have investigated the effects of specific probiotic strains of bacteria on mood. Although this area of research is in its infancy, exciting first results show that certain probiotic bacteria relieve psychological distress and lower stress hormones, while others modulate brain activity.

Dysbiosis and leaky gut

Gut microbes impact neurological health directly, via the chemicals they excrete, and indirectly, due to their ability to induce systemic, low-grade inflammation and oxidative stress, which are two key driving factors in the development of many neurological problems. Imbalanced gut

Are you at risk?

Causes of dysbiosis and leaky gut include:

- Stress
- Poor diet
- Caffeine
- Alcohol
- Sugar
- Food additives
- Highly refined diet
- Pesticides and herbicides
- Bacterial, parasitic or yeast infection
- Enzyme deficiencies
- Antibiotics
- Anti-inflammatory drugs
- Oral contraceptives
- Some other medications

bacteria (dysbiosis) is a common cause of chronic inflammation. Dysbiosis is caused by many factors, including poor diet, stress, medications and a high intake of sugar and processed foods. Once dysbiosis is established it causes gut inflammation, which eventually triggers increased intestinal permeability, commonly known as 'leaky gut'.

Once the gut becomes leaky we start to absorb toxins, including highly inflammatory microscopic particles called lipopolysaccharides which are found in the outer membrane of gram-negative gut bacteria. When these particles cross the gut barrier they are set upon by the immune system, which is housed in the lymphoid tissue surrounding the gut. These cells launch a cascade of protective mechanisms, which ultimately leads to inflammation. Lipopolysaccharides have been shown to impact the brain and induce depressive-like behaviours in animal testts. In human studies, lipopolysaccharide levels have been shown to be significantly elevated in people suffering chronic depression.

People with depression sometimes use alcohol as a form of self-medication. Researchers investigating the influence of leaky gut and inflammation on alcohol withdrawal have found that subjects with the strongest alcohol cravings and highest depression scores had the greatest elevations of inflammatory markers and biomarkers for leaky gut. This indicates that alterations of the gut-brain axis may even play a role in alcohol dependence and substance abuse.

Balancing the biome

We've known for some time that inflammation impacts brain health. Studies have shown that people with major inflammatory conditions. such as autoimmune disease or infections, are significantly more likely to develop depression or suffer from cognitive decline. Patients with inflammatory bowel disease, for example, have a two-fold risk of anxiety and depression. There's even evidence that anti-inflammatory medicines can help in the treatment of depression. However, inflammation caused by leaky gut is a much more subtle process and we may not associate gut problems with brain health. The effects of inflammation on the brain are so profound it can change they way the neurons function and even cause certain areas of the brain to shrink over time. Studies have found a region of the brain called the hippocampus, which is responsible for emotions, learning and memory, is smaller in people who have suffered long-term depression, and this loss of neurons is thought to due to inflammation. Interestingly, this area returns to a normal size in people who have recovered from depression.

The foundations of a healthy gut and brain lie in a fibre-rich, wholefood diet, and long-term dietary change is needed to ensure a healthy microbiome is established and maintained. The bacteria in the gut act like a specialist workforce helping us break down food; the more diverse your diet, the more diverse your microbiome will be. Remember we are not just feeding ourselves; we are also feeding our inner zoo. Choose foods that are as close to their natural form as possible; if you can recognise it, then your bacteria will as well. Avoid processed and pre-packaged foods, as these contain additives that will slow microbiome repair.

Organic food is ideal: going organic even for one month will make a big difference, as it will reduce your exposure to herbicides and pesticides that damage the microbiome. A high vegetable intake will provide natural fibres to encourage bacterial growth and vitamins, minerals and antioxidants to promote gut health. Aim for between six to nine cups of vegetables per day. Fermented foods such as kimchi and sauerkraut can be introduced in small amounts initially and increased over time to provide the gut with friendly bacteria. Avoid unhealthy fats, such as processed seed oils, and stick to coconut, olive, and avocado oils. Lots of oily fish in the diet, such as salmon, sardines and mackerel will provide anti-inflammatory benefits. Mineral-rich bone broth can be easily made at home and is an ideal food to promote a healthy gut. Small amounts of whole grains should be used. Brown rice, corn or some of the seed-based alternatives like quinoa, buckwheat, millet and amaranth are good choices. Avoid all grains containing gluten.

It's likely that future treatment of neurological conditions and mental health problems will involve improving nutrition to balance the microbiome, address leaky gut and reduce inflammation. If you would like to improve your gut-brain health, many naturopaths, nutritionists and functional medicine doctors are specialising in this area and microbiome testing is now easy to access in Australia.

Prebiotic foods

These help to provide the microbiome with beneficial fibres to ensure healthy gut diversity. If you have a sensitive gut, introduce prebiotic foods to the diet slowly.

Vegetables

Jerusalem artichoke, garlic, onion, leek, shallots, sp… beetroot, fennel, green peas, snow peas, sweet corn, Savoy c…

Fruit

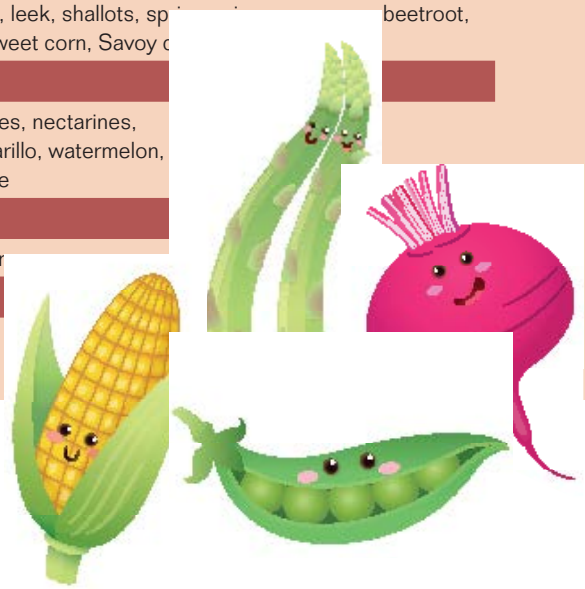
Lady finger bananas, custard apples, nectarines, white peaches, persimmons, tamarillo, watermelon, rambutan, grapefruit, pomegranate

Legumes

Chickpeas, lentils, red kidney bean…

Nuts

Almonds, cashews, pistachios



Tania Flack is a respected naturopath specialising in women's health and hormonal disorders.
www.taniaflack.com