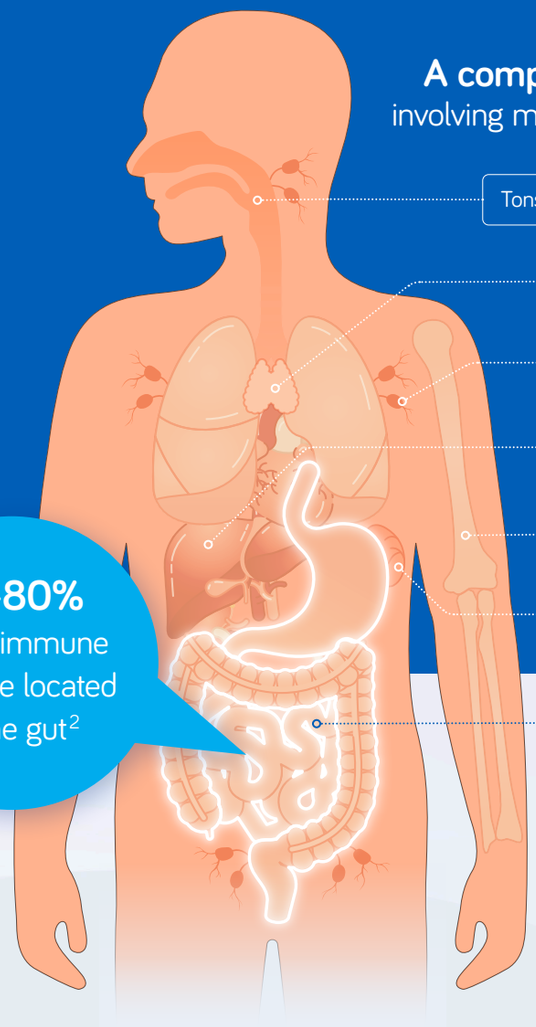
DANONE NUTRICIA RESEARCH

AN INTRODUCTION TO THE IMMUNE SYSTEM IN THE GUT

A complex system
involving multiple organs



70-80% of the immune cells are located in the gut[2]

The immune system needs **the right nutrition** to function[1]

In a healthy state the immune system defends us from harmful substances

It helps prevent disease and maintain good health

Immune fitness and resilience

Gastrointestinal Health

Positive influence on overall health
Based on Murphy 2016

Pathogens Toxins Allergens

But the immune system can also be impacted

Ageing Malnutrition Illness Faltering growth Altered Microbiota

This can cause serious health challenges

- Functional gastrointestinal disorders[4-6]
- Severe infection[4-6]
- Allergy[4-6]
- Non-communicable diseases[4-6]

4 INTERACTING ELEMENTS

Innate Immunity

This is the first line of defence. It consists of innate immune cells such as phagocytes and natural killer cells which travel fast through the body, recognize general parts of invading bacteria and viruses and then engulf and destroy these

Adaptive Immunity

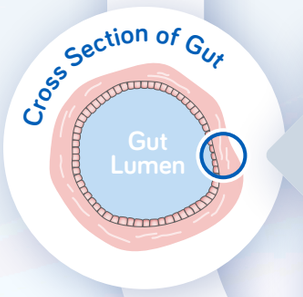
This part of the immune system consists of immune cells that are specialized in creating immunological memory to specific parts of invading pathogens (e.g. B-cells and T-cells). These cells are long-lived, pathogen-specific and produce antibodies which are crucial in prevention of re-infection

Gut Microbiome

This describes either the collective genomes of the microorganisms that reside in the gut, or the microorganisms themselves

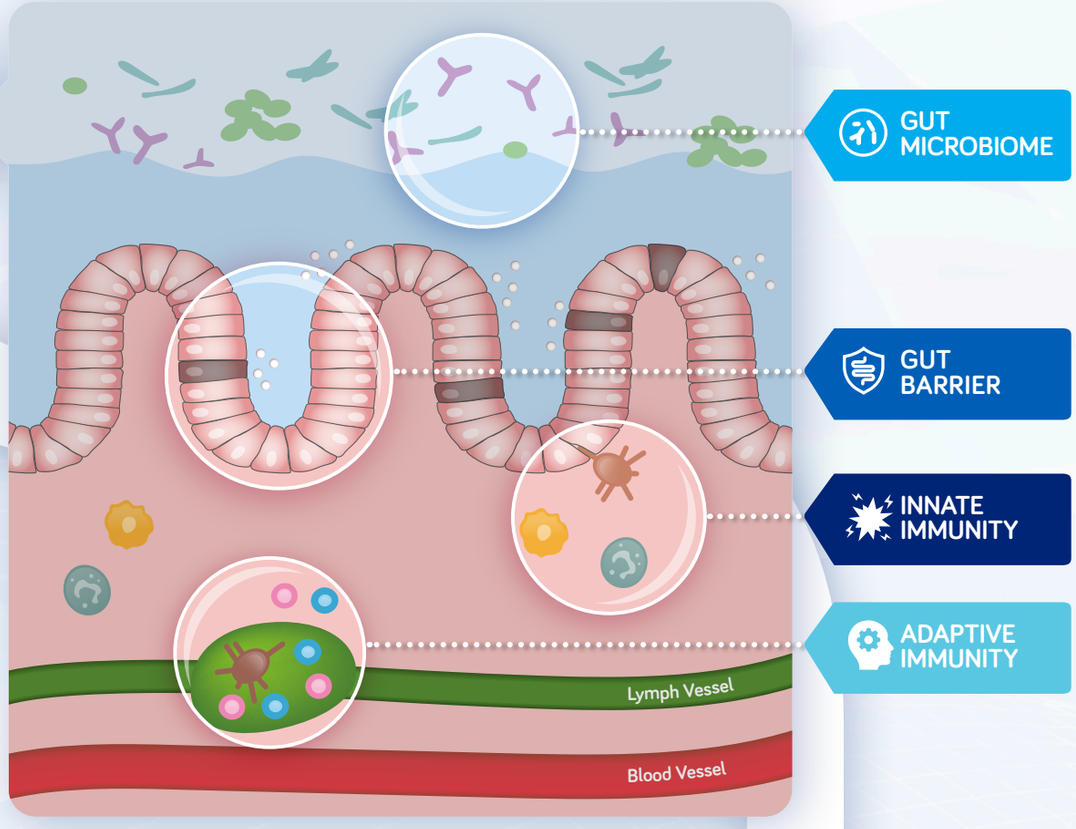
Gut Barrier

This is a critical barrier between the environment and our internal milieu. Here, millions of microbes and environmental antigens come in close contact with our immune system



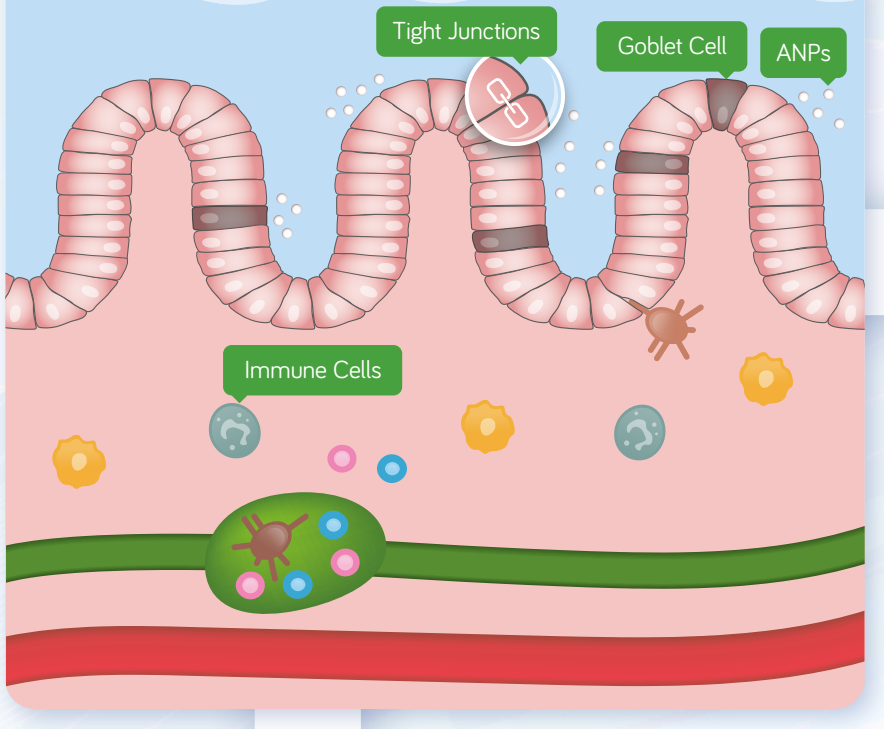
WHERE IS THE IMMUNE SYSTEM ACTIVE IN THE GUT?

The immune system functions both in the gut lumen and in the intestinal tissue of the gut, and connects to the rest of the body via the lymph and blood vessels



HEALTHY STATE

In a healthy state the immune system is well balanced and protects us from disease



Well Balanced Gut Microbiota

Compete with potential pathogens and produce metabolites that can add to a beneficial local microenvironment

Tight Epithelial Barrier

Protective mechanical barrier between the internal and external environment, its cells can also have an immune function

Active Goblet Cells

Produce mucus and anti-microbial peptides (ANPs) that defend the organism against pathogenic invaders

Surveillance by Immune Cells

The innate and adaptive immune system in the intestinal tissue, blood vessels and lymph nodes are ready to respond when necessary

UNDER ATTACK

If there are invading pathogens that need 'immunological attention', this is provided by both the innate and adaptive system

INNATE IMMUNITY

Provides first line defence by engulfing and clearing invading pathogens or infected cells

Phagocytosis

Uptake of pathogens and neutralization of the pathogen

Natural Killer Cells

Destruction of infected cells

ADAPTIVE IMMUNITY

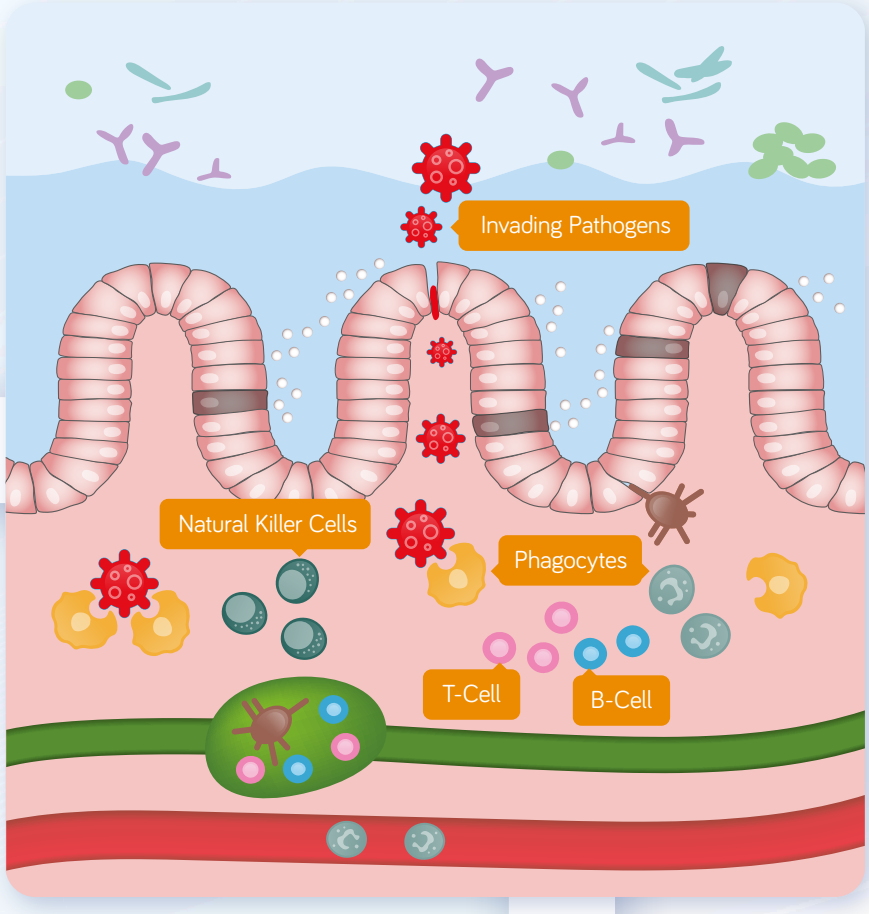
Targets specific pathogens and induces immunological memory

T-cells

Can directly kill infected cells, produce cytokines that signal and activate other parts of the immune system and/or form memory cells

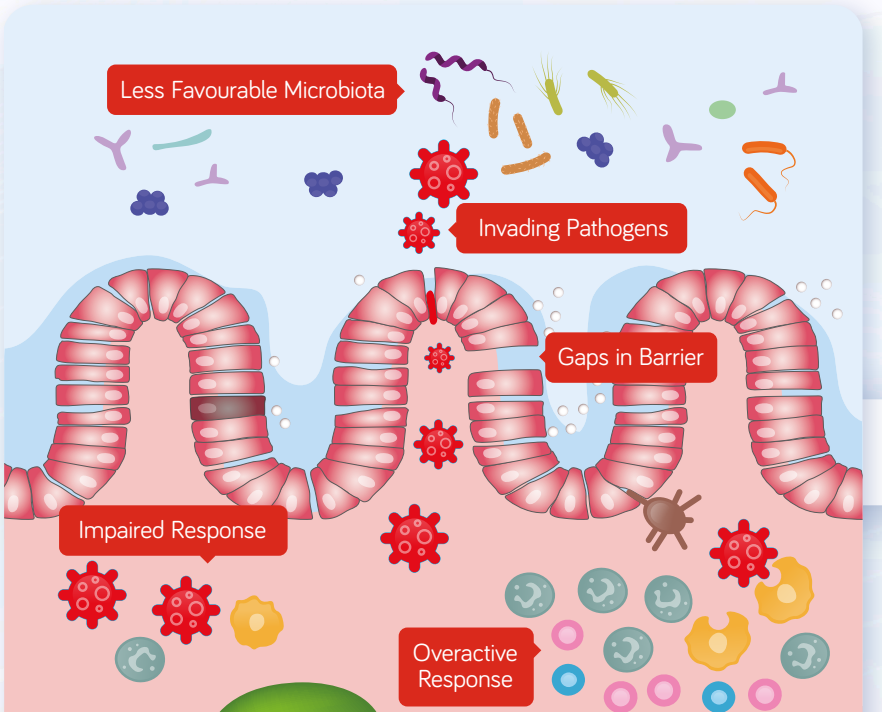
B-cells

Production of antibodies against pathogens and formation of memory cells



CHALLENGED STATE

When the balance is disrupted, the immune response can become too weak or too strong, and we become more vulnerable to infection and inflammation



Unbalanced Gut Microbiota

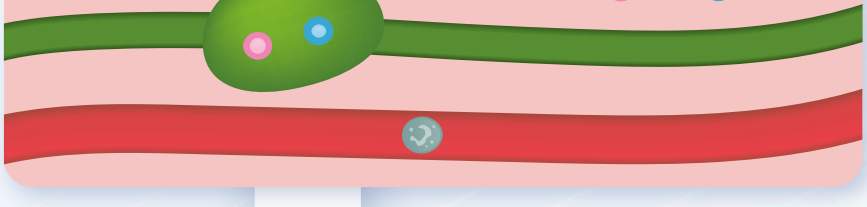
The mixture of bacteria may shift towards a less favourable composition, giving pathogens opportunities to attack the host

Leaky Gut Barrier

More permeable epithelial layer with less mucus and antimicrobial peptides, easier for pathogenic invaders to enter the host

Impaired Immune Response

A disturbed balance may lead to a reduced number of immune cells, their impaired capacity to kill pathogens or produce antibodies, leading, for example, to more infections



*These things can potentially happen during a disrupted balance. They do not alway occur, and not necessarily at the same time.

Overactive Immune Response

An overactive immune response can be too strong, take too long, and/or react to harmless substances, this can lead to damage to epithelial cells and exhaustion of immune cells

THE RIGHT NUTRITION CAN HAVE A POSITIVE EFFECT ON THE IMMUNE SYSTEM

INDIRECTLY

- Growth of beneficial bacteria and its metabolites[7]
- Optimal function of epithelial cells[8]

DIRECTLY

- Innate immunity[9,10]
- Adaptive immunity[9,10]

Thereby having a positive effect on our health:

- Prevention and management of immune-related disorders, such as allergy, recurrent infections and auto-immune diseases[11]
- The opportunity of nutrition in early life to reduce the incidence of non-communicable disease in later years[12]
- Positive clinical outcomes on patient recovery and/or severity or incidence of infections[13]

Examples of specific nutrients that can support the immune system:

OUR EXPERTISE

At Danone Nutricia Research we study how specific nutritional ingredients can support the immune system by identifying and unravelling the complex mechanisms of the immune system and studying new nutritional components

40+ **Years of expertise** in immunology research

Professorship in immunopharmacology

600+ **Publications** on immunology mechanisms or immune supporting nutrients

Partnerships in the field of immunology; working in an internationally recognised network

IMMUNOLOGY RESEARCH FOCUS AREAS

- Allergy
- General Immune Modulation
- Tolerance Development
- Environmental Challenges
- Inflammation Management
- Biomarker Discovery

✔ **This allows us to research and develop nutritional concepts that support the immune system throughout life, in both health and disease**

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