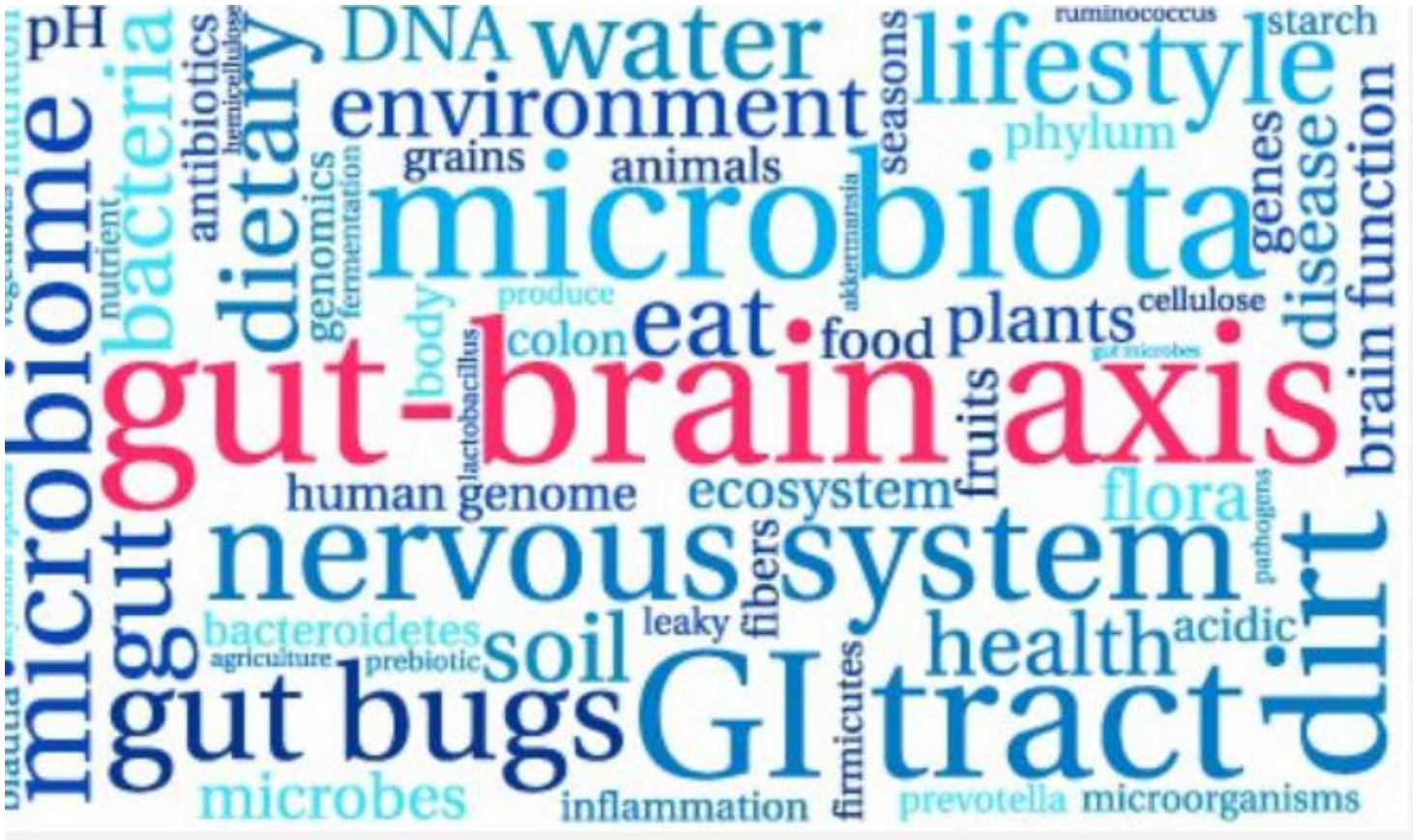
The Gut Microbiome



Importance of gut health

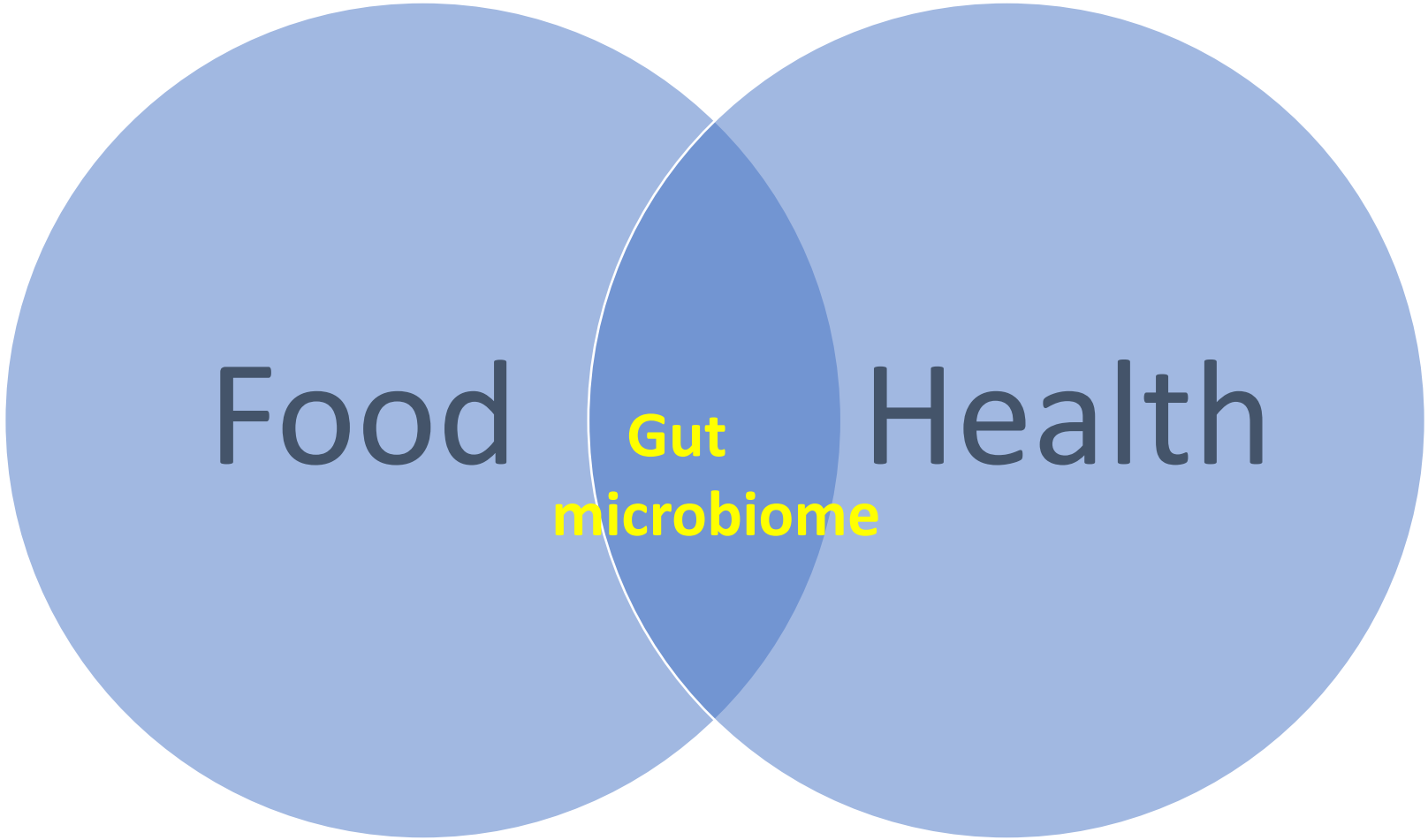
“All disease begins in the gut" is widely attributed to the ancient Greek physician **Hippocrates** (c. 460–370 BC)

“It’s a vital organ in your body and you need to look after it. If you do that, it will look after you,” **Professor Tim Spector**, an epidemiologist at King’s College London (on the gut microbiome)

“There's this rising pandemic of chronic diseases, and many of those are caused by problems in our immune systems. The microbiome is so important because it educates, and it teaches our immune system what's a friend, and what's the enemy. And if it's not set up right, our immune systems don't work well.” **Dr James Kinross** Consultant colo-rectal surgeon

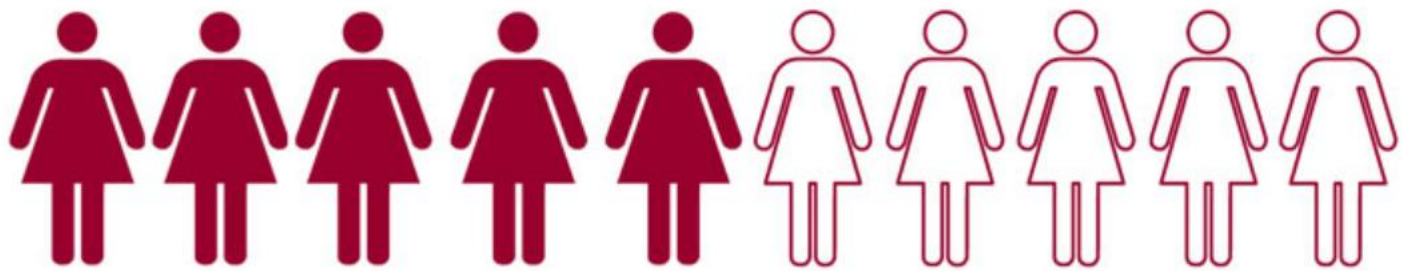
What is the gut microbiome?

- Collection of trillions of microorganisms (bacteria, viruses, fungi) in your gut- mainly bacteria
- Scientists have found over 1000 different species of bacteria in gut microbiome samples, although each individual only has around 160 of these species
- Your gut microbiome is the collection of all the genetic material from the microbes in your gut.
- It contains around 3 million genes, at least 150 times more genes than the human genome
- Weighs 1-2kg in an adult


Food
Gut microbiome
Health

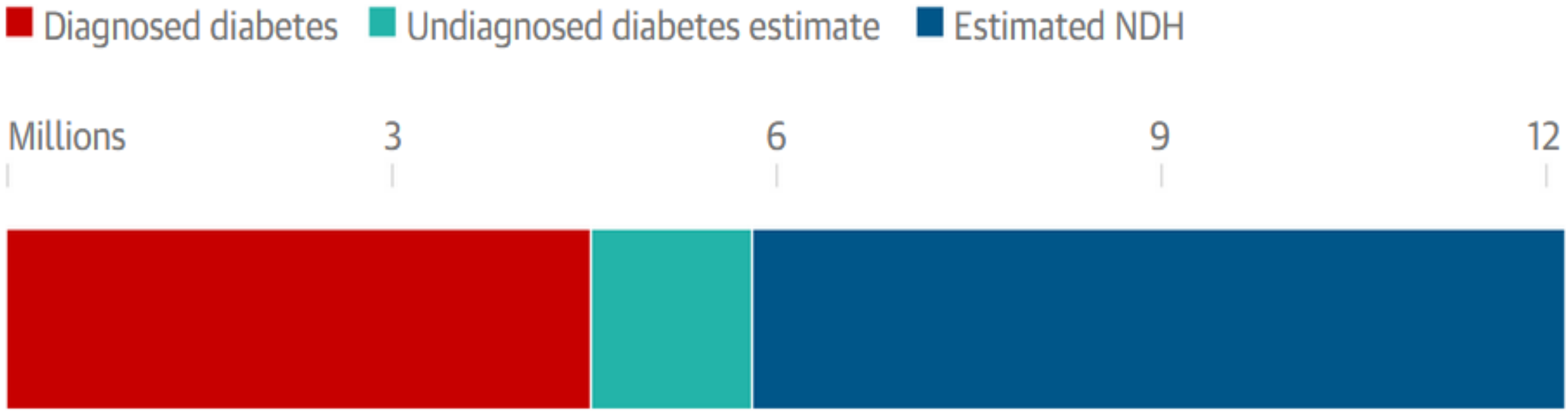
More than 6 out of 10 men are overweight or obese (66.2%)

More than 5 out of 10 women are overweight or obese (57.6%)



There were an estimated 12.1 million cases of diabetes or non-diabetic hyperglycaemia (NDH) in the UK in 2023-24

Estimates are of people aged 16 and over



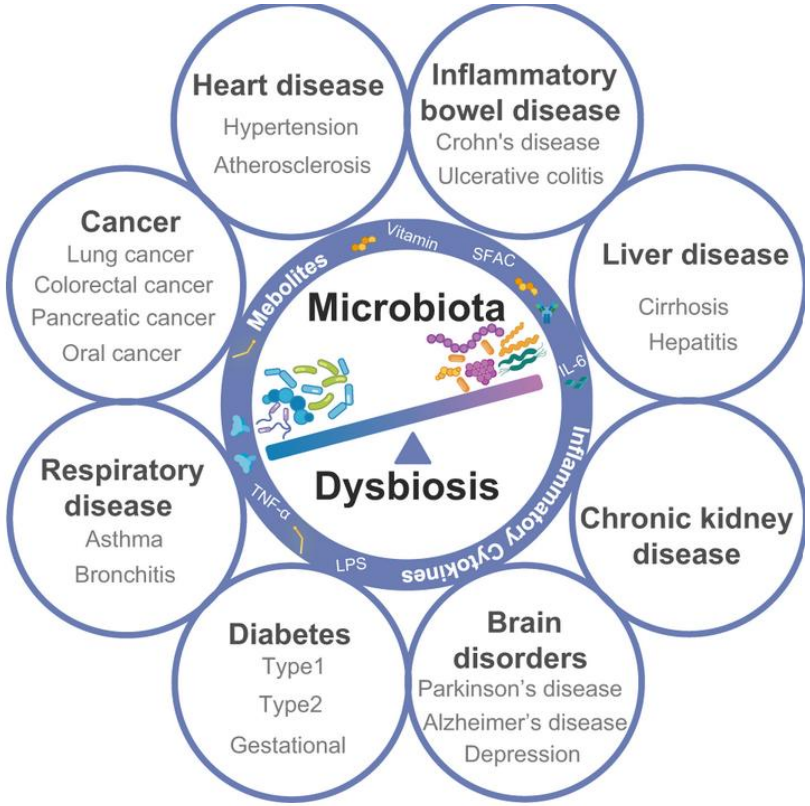
Guardian graphic. Source: Diabetes UK

Thriving at 70

- 70 years old
- No major chronic diseases (such as cancer, diabetes, heart disease, stroke, and dementia)
- Intact physical, mental, and cognitive functions

9.3%

Why we should all be interested?

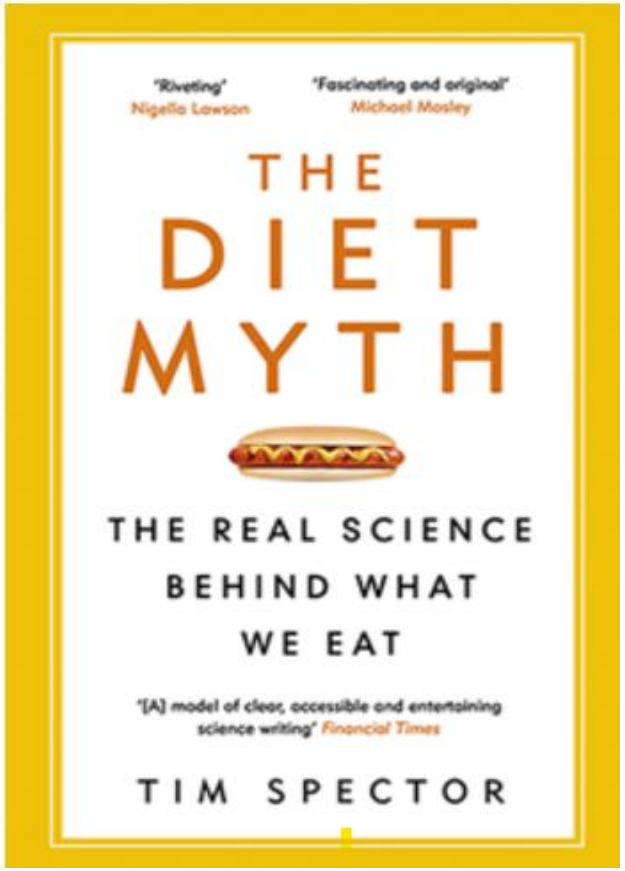


- Possibly involved in many and varied diseases
- Growth and cost of these diseases adversely affects our economy
- We can **change** some aspects of our microbiome

Explosion in microbiome research

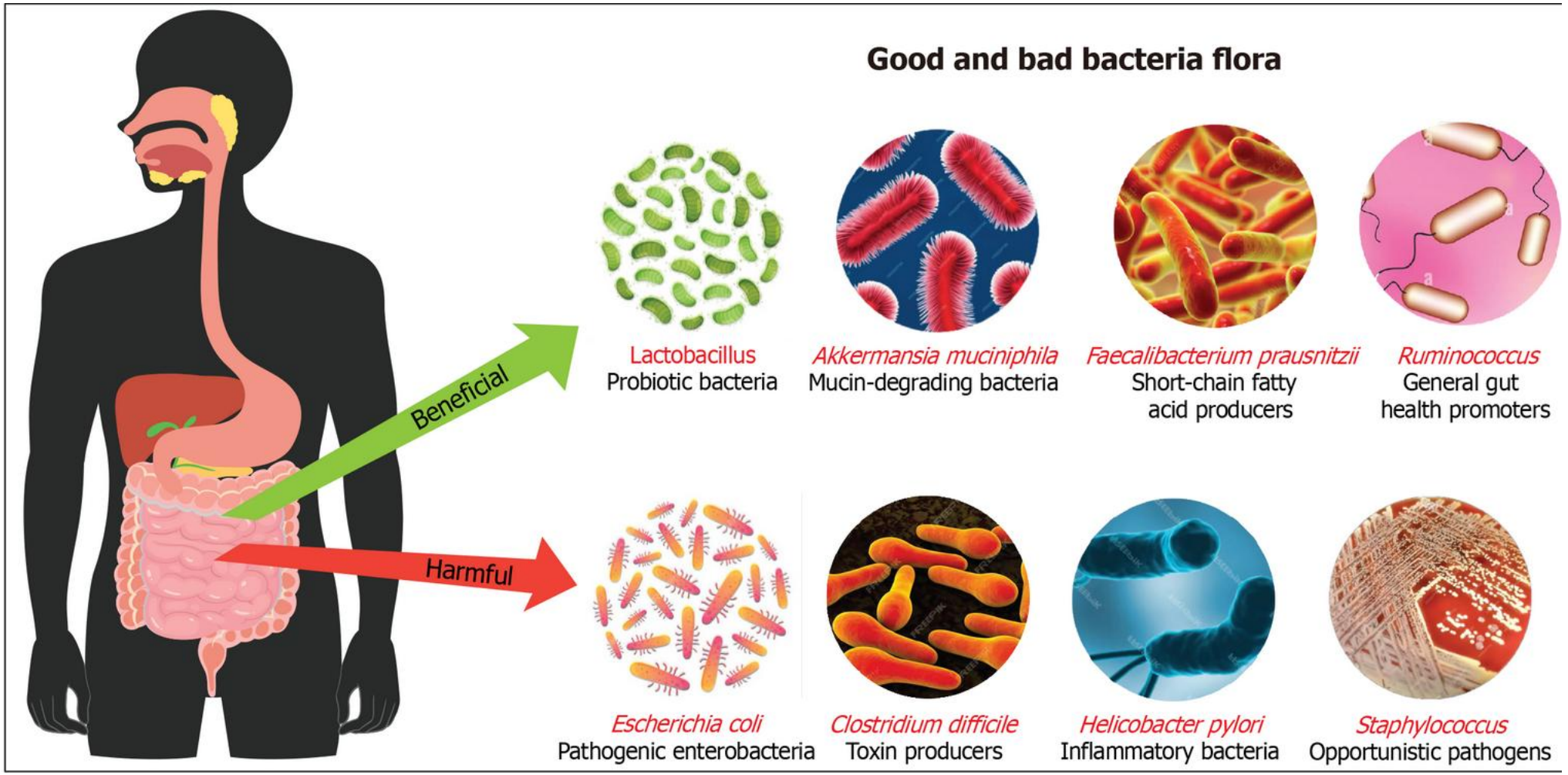
- High-Throughput DNA Sequencing (Next Generation Sequencing)
- Multi-Omics Technologies
- Advancements in Computational Biology & AI

Professor Tim Spector

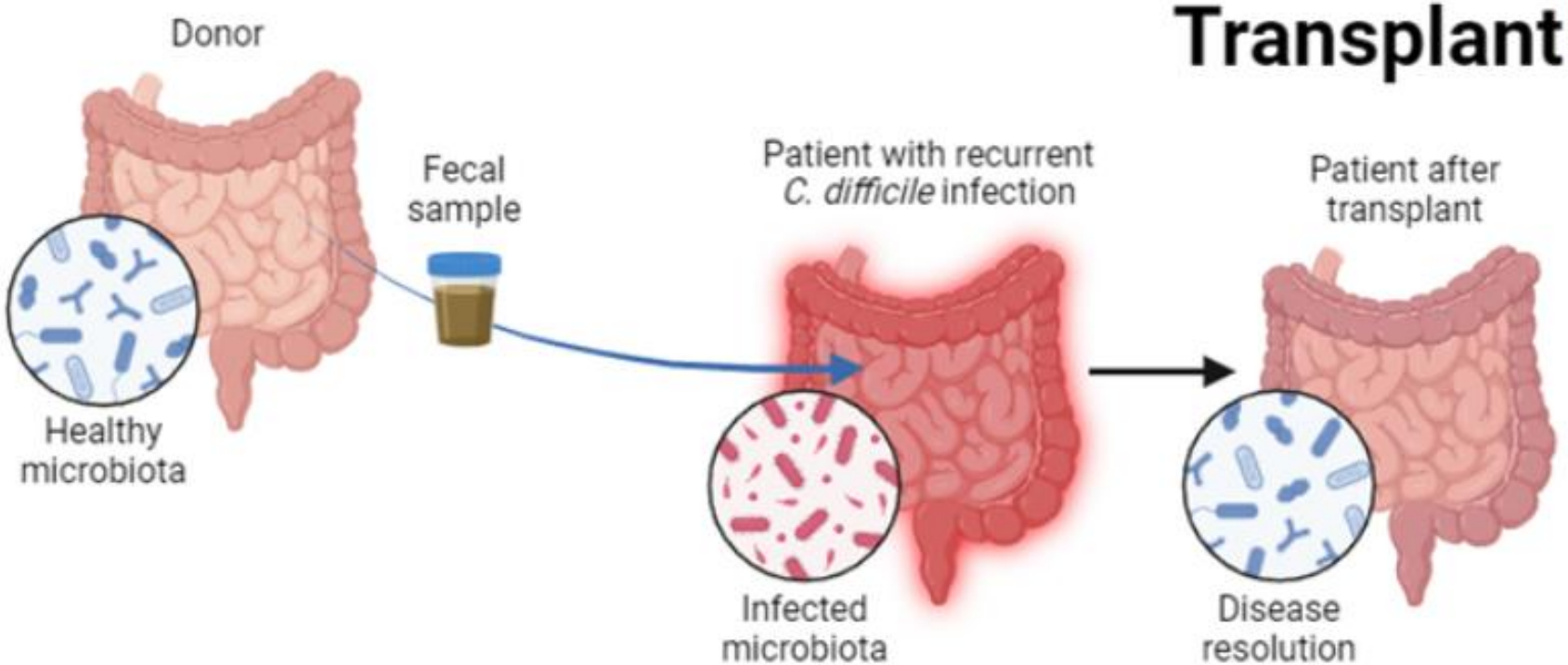


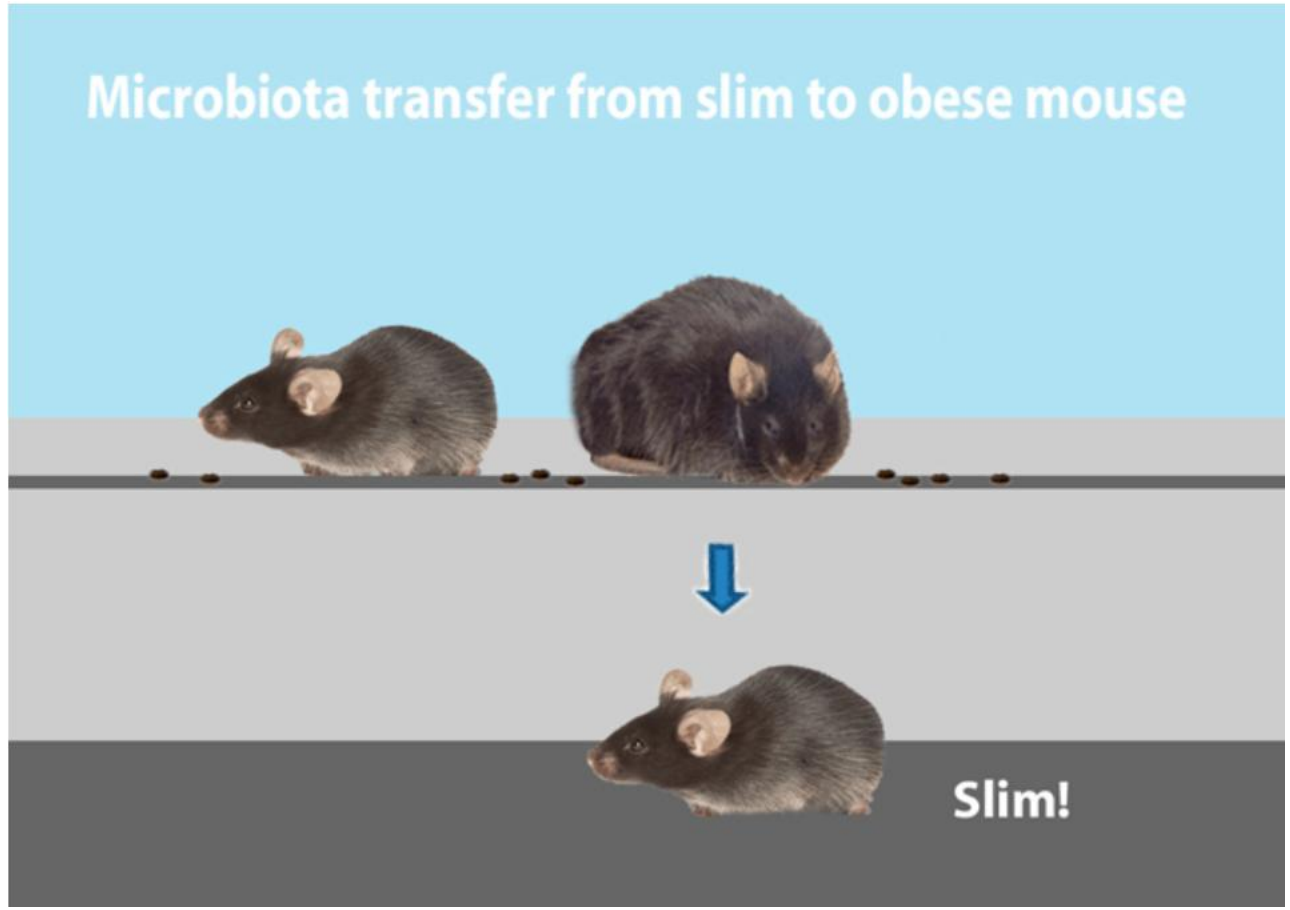
Microbiome signature

- Each person's is unique to them
- Unrelated people share 30% of gut bacterial species- identical twins 34%
- People living in different areas e.g. rural versus urban
- Balance of "good" bacteria and "bad" bacteria


Good and bad bacteria flora
Beneficial
Harmful
Lactobacillus
Probiotic bacteria
Akkermansia muciniphila
Mucin-degrading bacteria
Faecalibacterium prausnitzii
Short-chain fatty acid producers
Ruminococcus
General gut health promoters
Escherichia coli
Pathogenic enterobacteria
Clostridium difficile
Toxin producers
Helicobacter pylori
Inflammatory bacteria
Staphylococcus
Opportunistic pathogens

Fecal Microbiota Transplant




Microbiota transfer from slim to obese mouse
Slim!

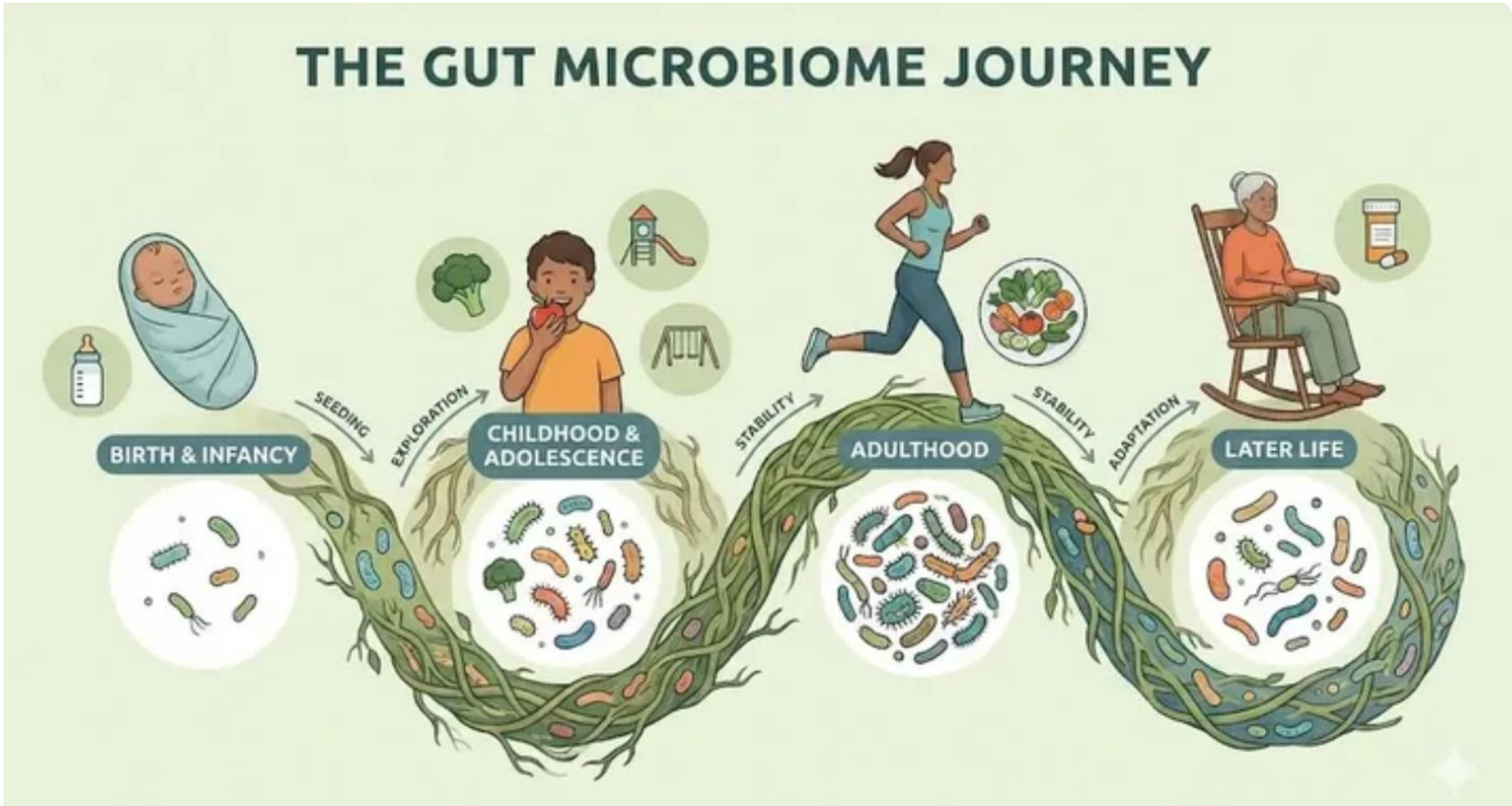

Microbiota transfer from
twins discordant
for obesity
Genetically identical
germ-free mice
Slim
Obese

A healthy microbiome?

- Diversity
- Resilience
- Redundancy
- Metabolic flexibility

Hadza tribe

- Last hunter gatherers in N Tanzania
- Due to their diet have the most diverse human gut microbiomes on the planet
- 40% more species than ours, some extinct in ours
- Low rates obesity, diabetes and cardiovascular disease



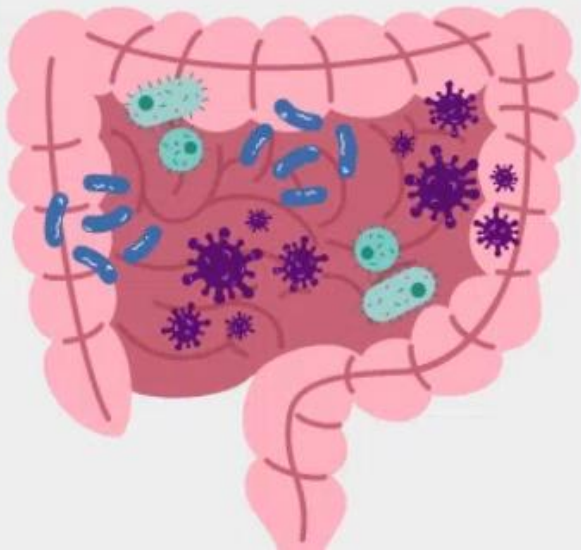
INFANT	CHILD	ADULT	OLDER ADULT
Low diversity, Bifidbacteria-dominant	Increasing diversity, solid food introduction	High diversity, stable & resilient	Decreased diversity, reduced resilience

WHAT DOES YOUR GUT MICROBIOME DO?

Help to break down food and it's components (e.g., fiber)

Protects your gut from pathogenic bacteria

Help to shape and regulate your immune system



Produce bioactive molecules, like short-chain fatty acids to support your gut cells

Synthesize essential vitamins (e.g., vitamin K and B group vitamins)

B12

K

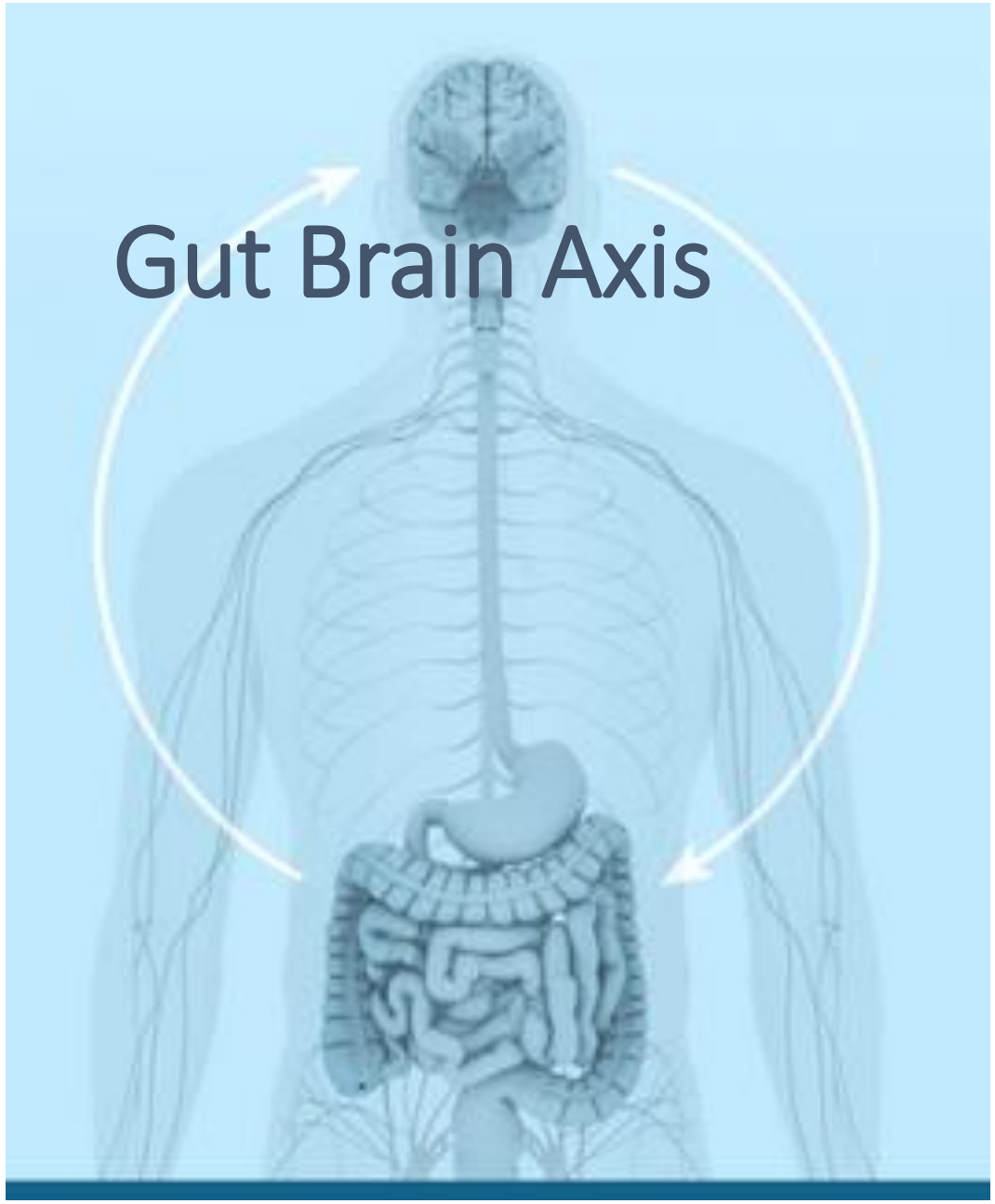
Short Chain Fatty Acids (SCFAs)

- Butyrate ($CH_3(CH_2)_2COOH$), propionate(CH_3CH_2COOH) and acetate($CH_3\ COOH$) most common in gut
- **Butyrate**- primary energy source for the cells lining the large intestine, keeping the gut barrier strong
- **Propionate**- appetite control, blood sugar management
- Other possible beneficial roles in immune function, communication with the brain and lipid management

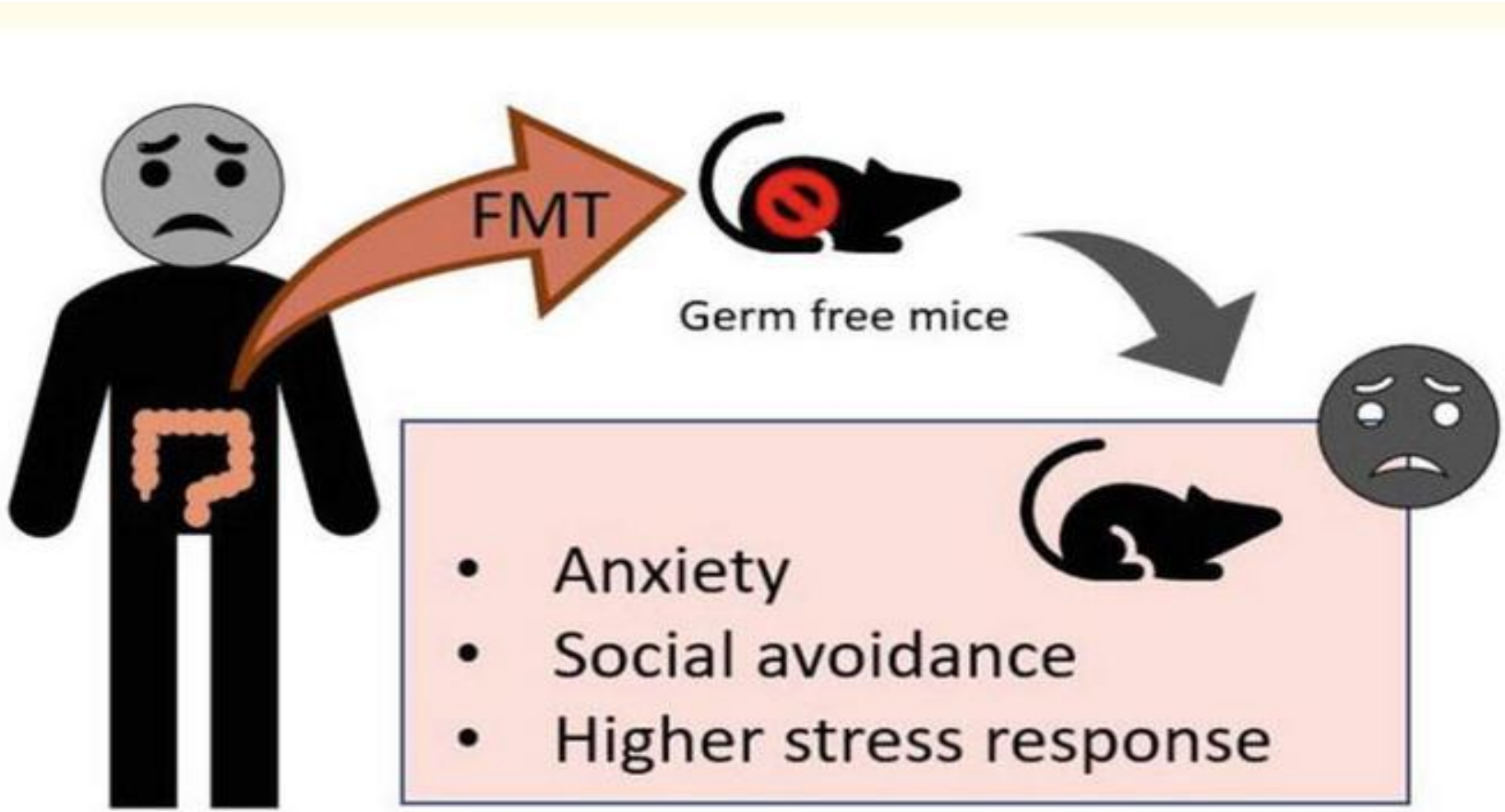
Microbiome and immune system

- 70% of the body's immune system resides in the gut
- Immune system “training” early in life
- SCFAs protect the gut and the immune tissue
- SCFAs trigger production of regulatory T cells

Gut Brain Axis



- Enteric nervous system (“second brain”)
- Vagus nerve
- Two way communication
- Microbes involved in neurotransmitter production


FMT
Germ free mice
• Anxiety
• Social avoidance
• Higher stress response

What’s good for your gut bacteria?

- Diet which feeds the “good” bacteria
- Movement
- Pets
- Soil
- Sleep
- Stress management
- Time restricted eating?

Probiotics versus prebiotics

- Probiotics are live beneficial bacteria found in fermented foods like yoghurt and sauerkraut and some supplements e.g. *Lactobacillus* or *Bifidobacterium*
- Prebiotics are fibres which feed the “good” bacteria - in foods like onions, garlic, mushrooms, oats, flaxseeds, apples, and almonds
- If your gut were a garden: probiotics are the new plants, and prebiotics are the fertilizer that helps them thrive

Foods for your microbiome

- 30g fibre a day
- 30 different **plants** per week
- Fermented foods daily

What is bad for your gut microbiome?

- Antibiotics, PPIs
- Low fibre in diet
- UPFs
- Artificial sweeteners, emulsifiers
- Smoking, air pollution
- Stress
- Poor sleep?

Was Hippocrates right?

The Future

- Personalisation
- Tailored probiotics
- Earlier diagnosis
- Functional nutrition
- Market opportunities
- AI
- Other microbiomes?