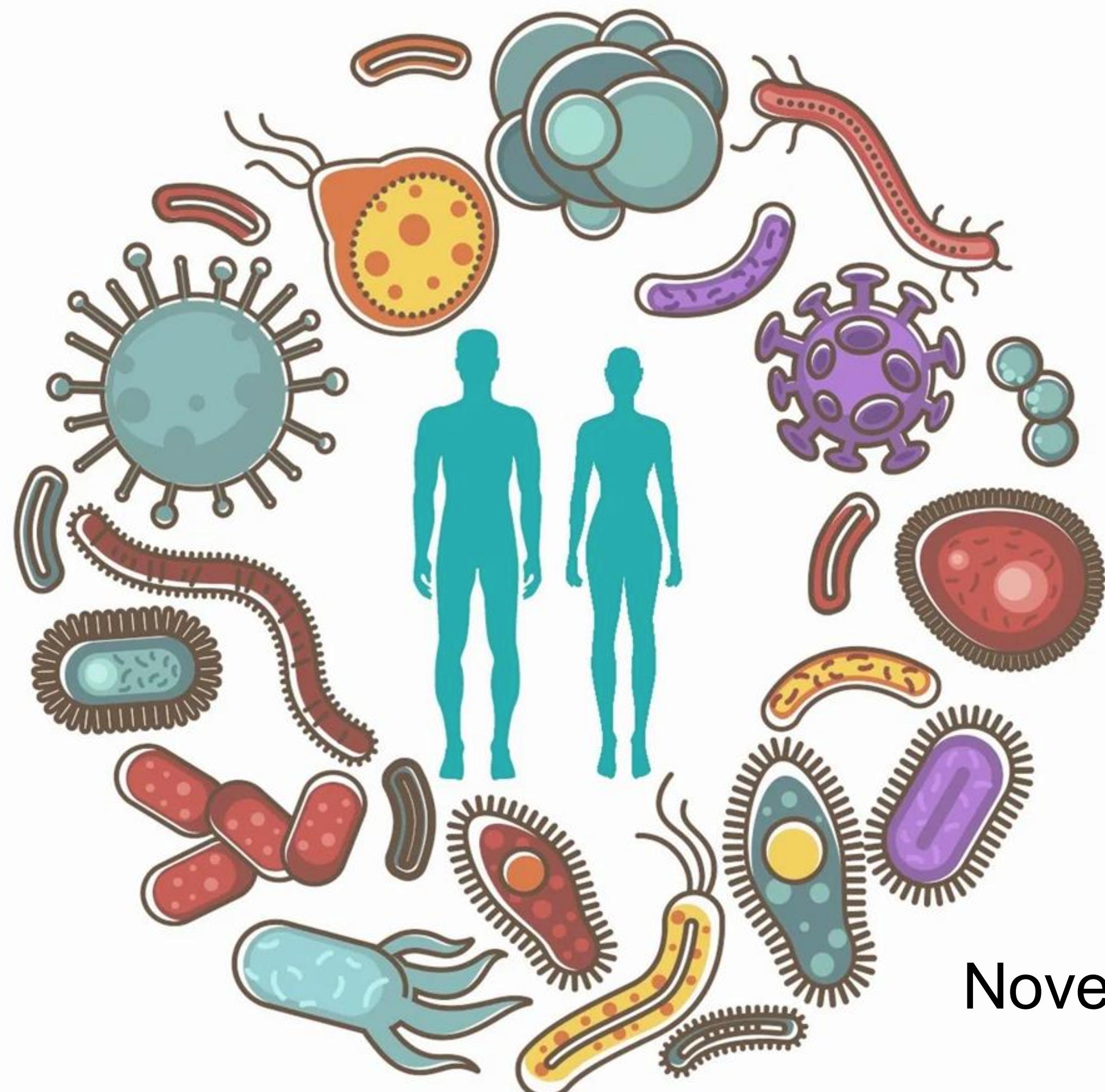


# Exploring Human Microbiome

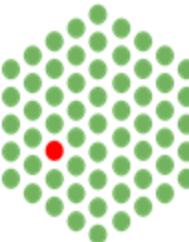
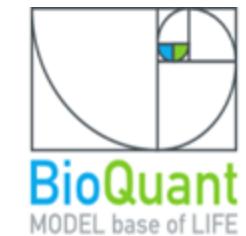


November 22, 2023

Ece Kartal

Postdoctoral Fellow, @psecekartal

Saez-Rodriguez Lab, Heidelberg University





# Instructors



Ece Kartal



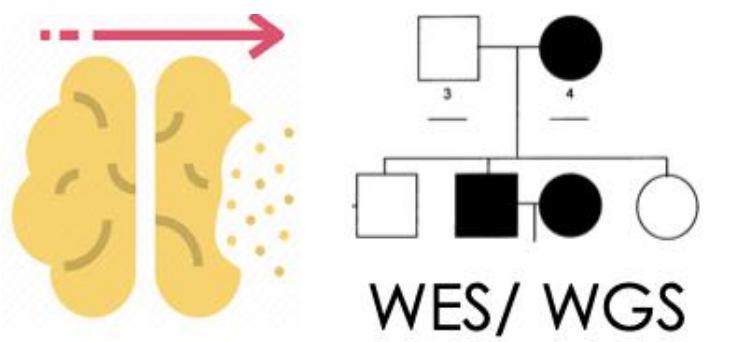
Martín Garrido  
Rodríguez-Córdoba



Robin Fallegger



# About me



**MSc**  
Mol. Biology & Genetics  
Istanbul, Turkey

2011

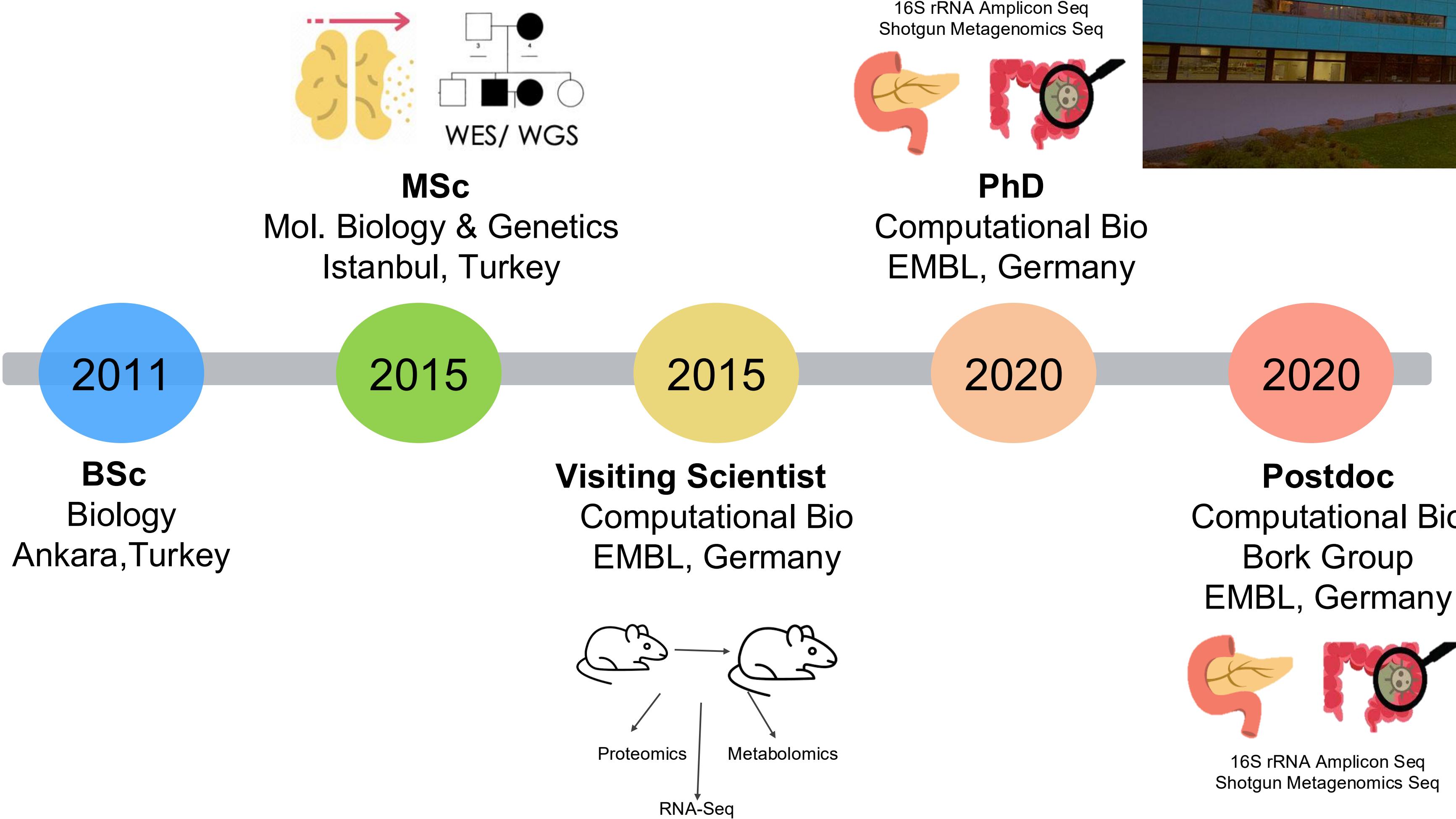
**BSc**  
Biology  
Ankara, Turkey

2015



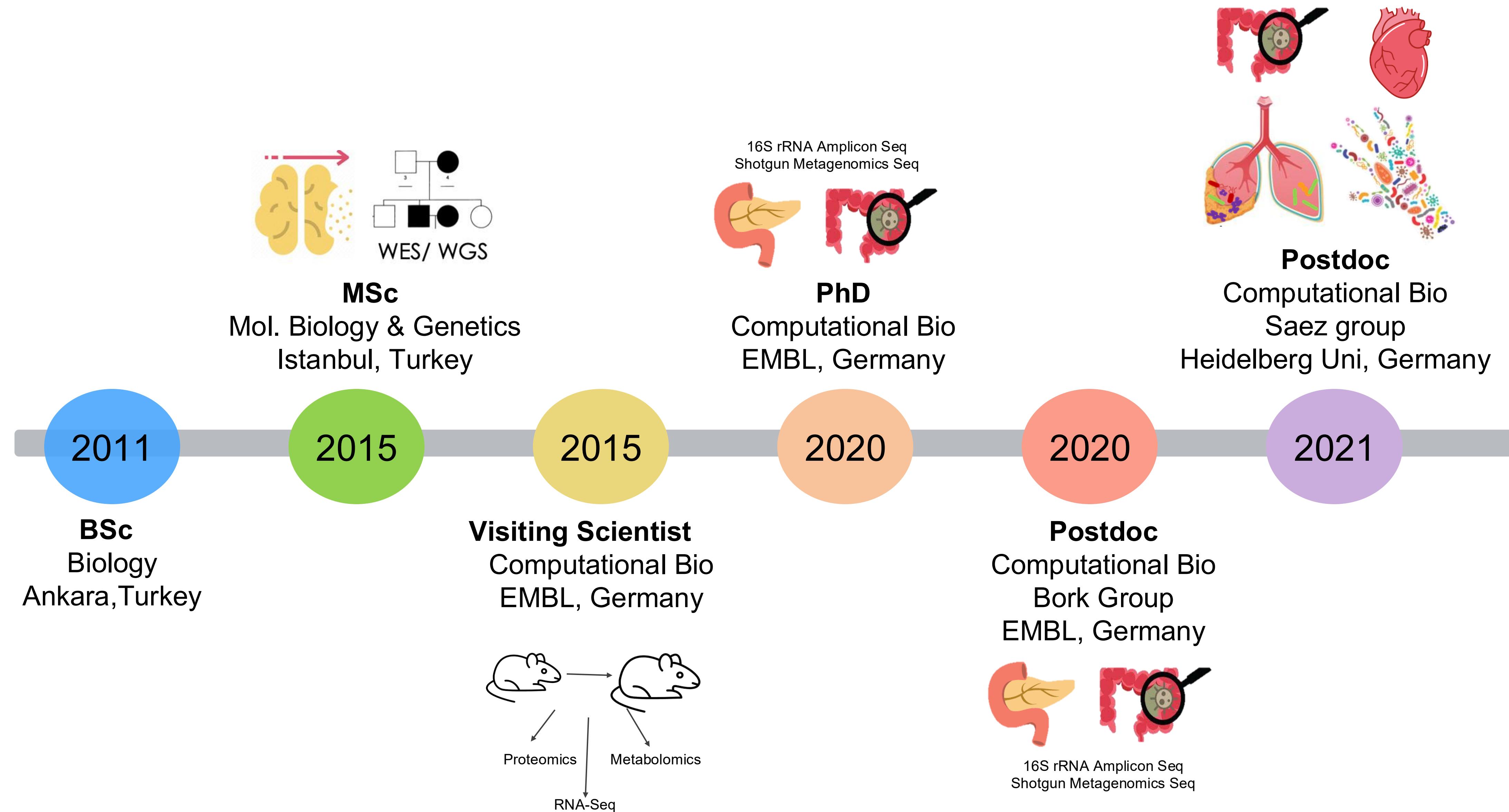


# About me





# About me





# Relationship between host and microbiome...

- The characteristics of microbiome
- Microbiome types: soil, marine and animal
- The role of human microbiome
- How do we study microbiome
- Can microbiome effect our health



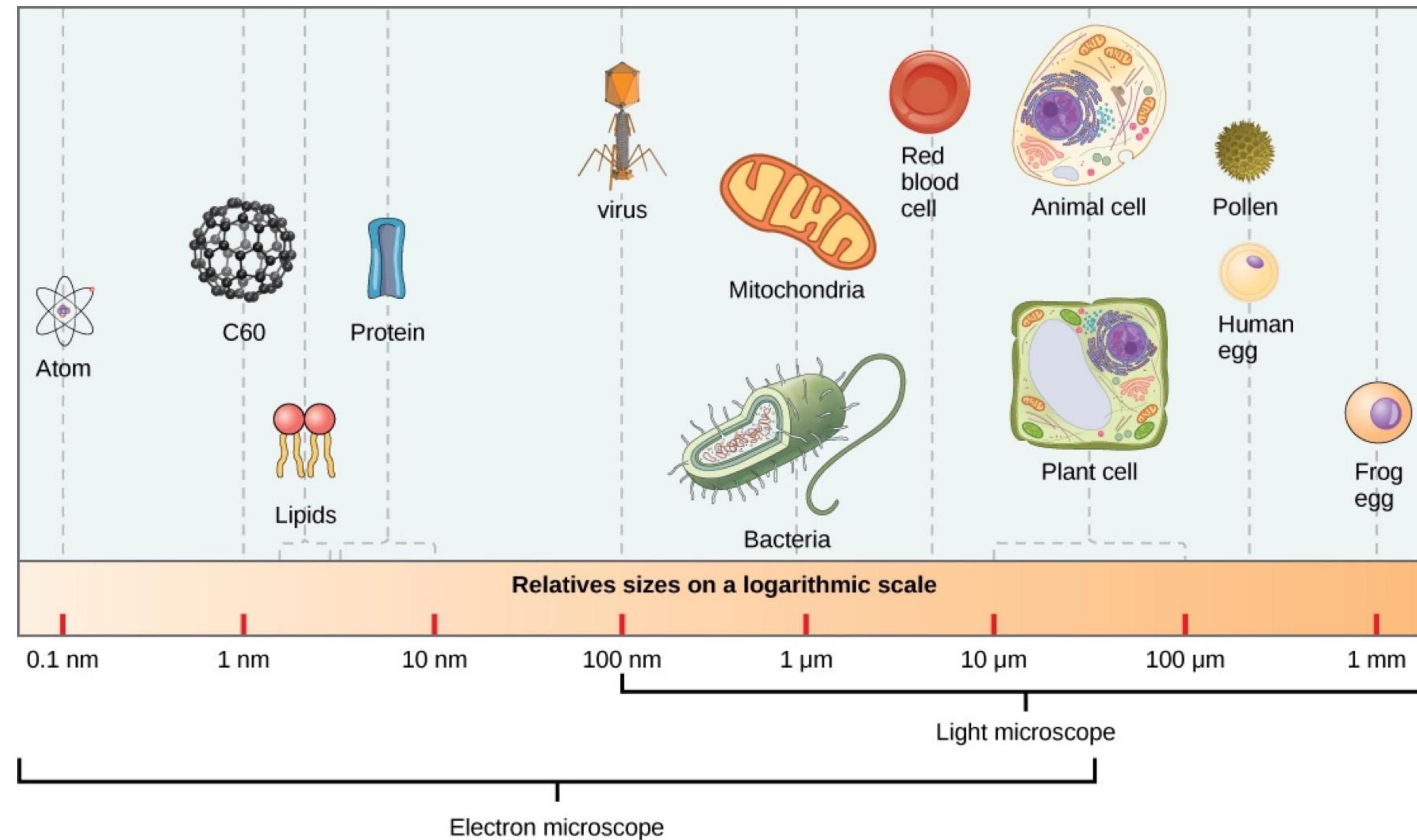
# Which microbiome...





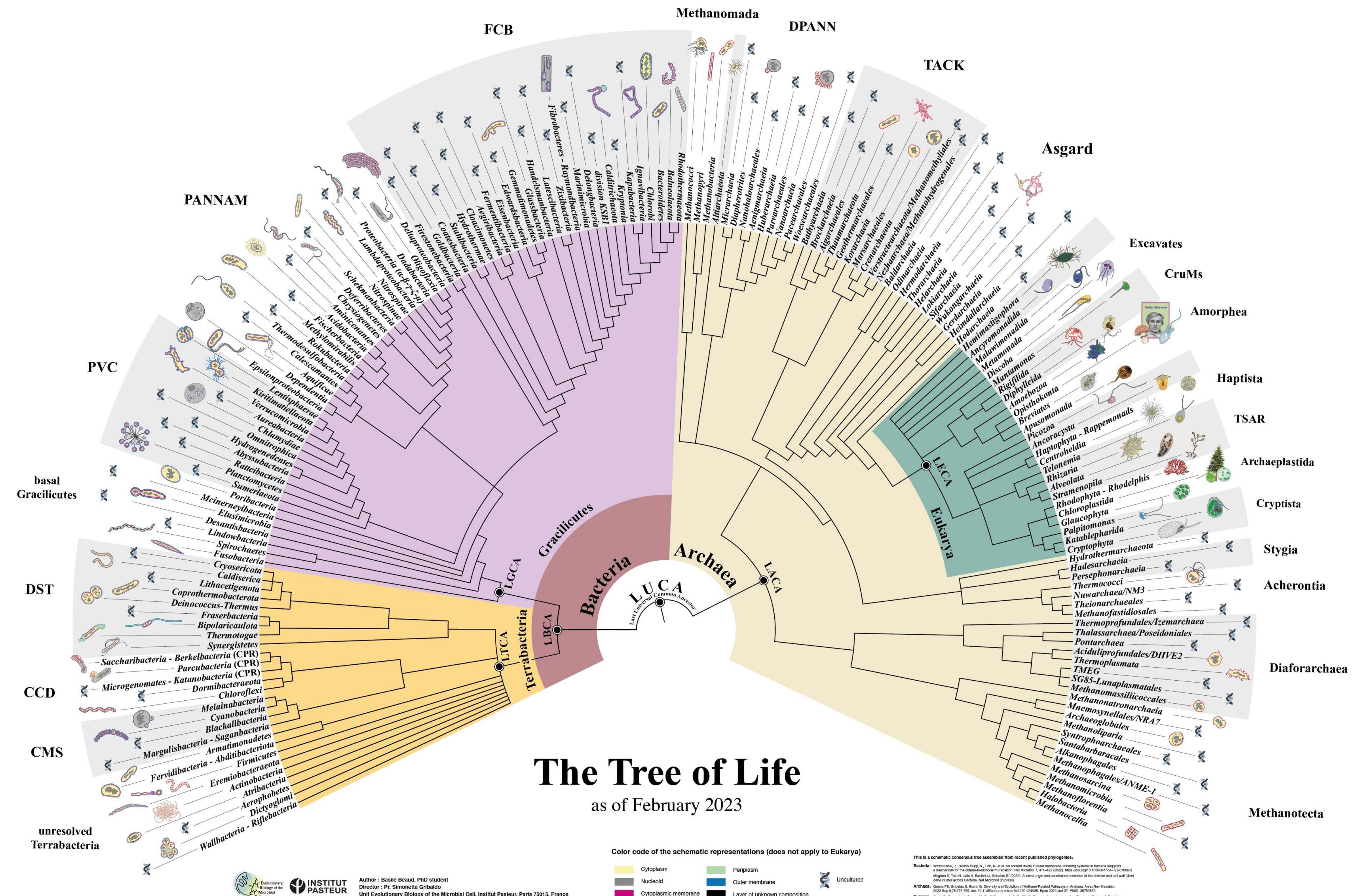
# The composition of microbiota

A complex ecosystem of many microscopic life forms, including virus, bacteria, archaea, fungi & protista



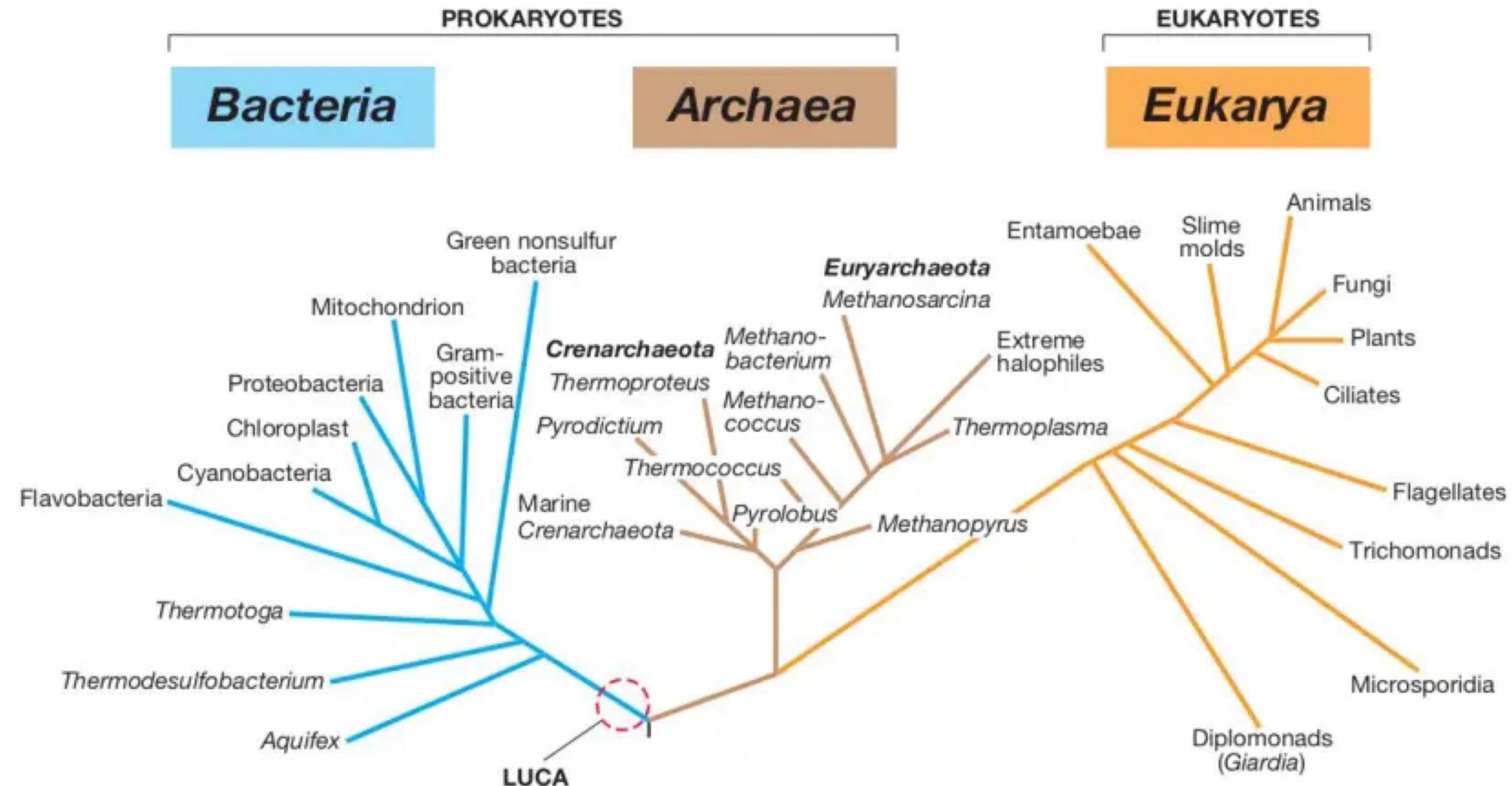


# The Tree of Life





# Archea





# Archea



Grand Prismatic Spring in Yellowstone Park, USA. The colours are due to microbial mats formed by thermophiles

Chemotrophic

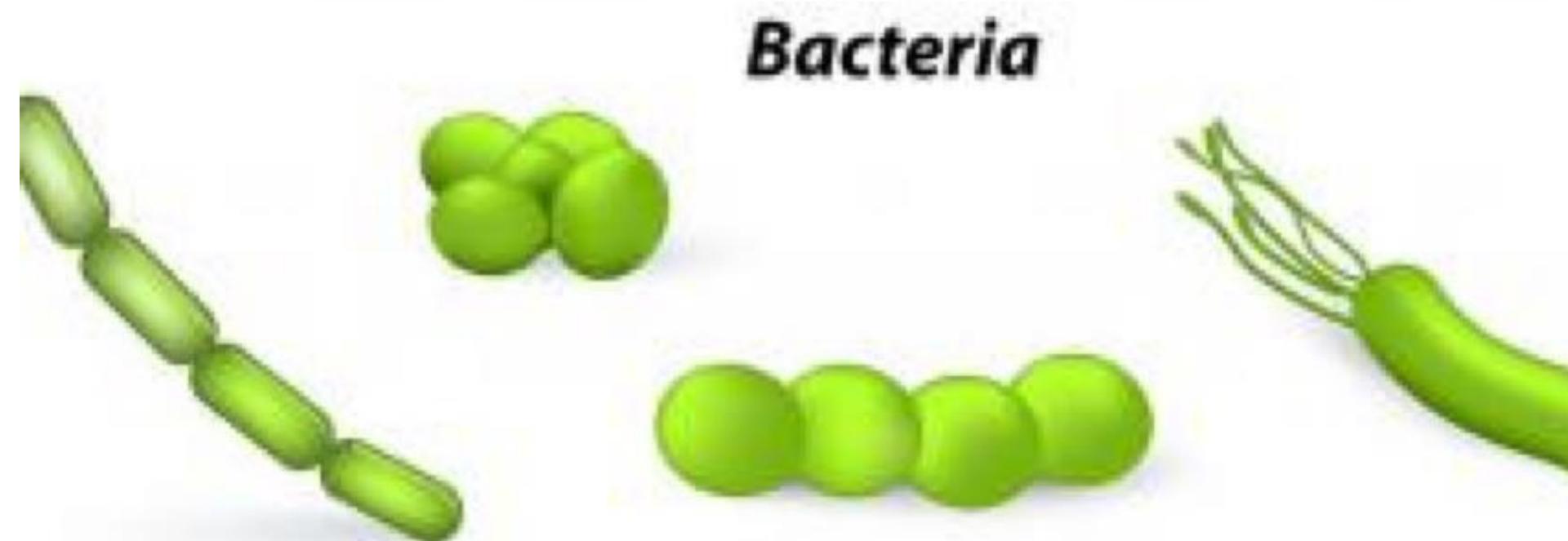
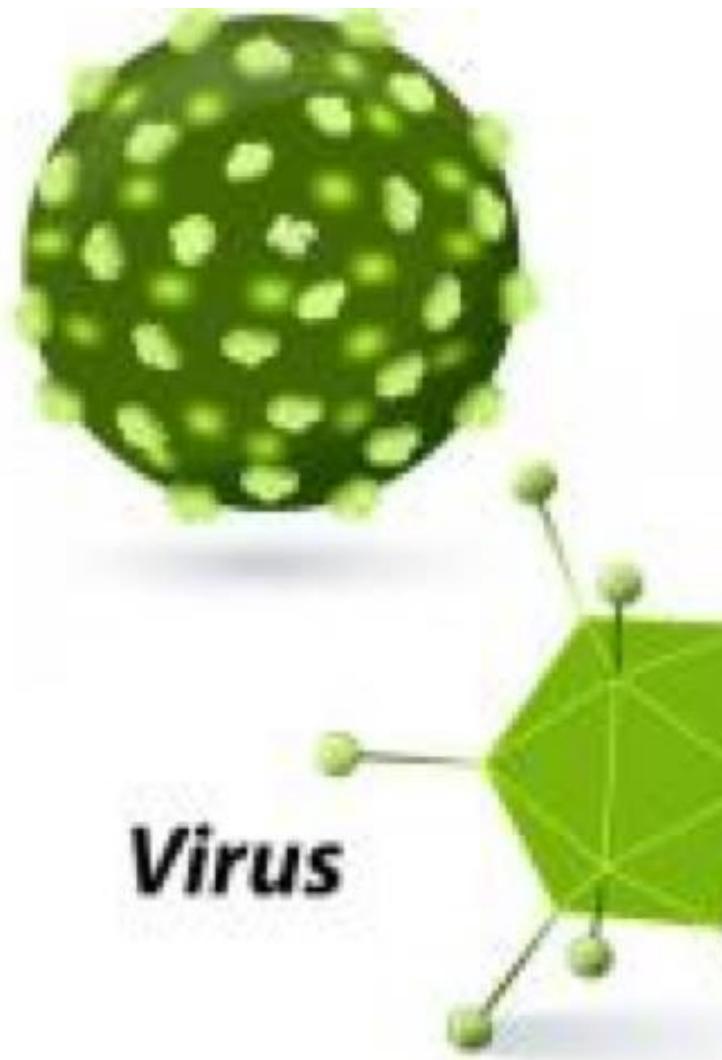
No nucleus

Live in extreme environments such as salty, freezing or hot environment

Use unique compounds like sulfur, e.g. methane producers in animal gut



# Bacteria vs Virus vs Fungi



**Virus**

Acellular,  
no cell wall, or ribosome  
Decompose organic material

**Fungi**

Eucaryote, can be small (yeast) or big  
characterized by chitin in the cell wall  
Decompose organic material



# The physical type of bacteria doesn't tell the truth

## SHAPES OF BACTERIA

SPHERICAL (COCCI)	ROD-SHAPED (BACILLI)	SPIRAL-SHAPED (AND OTHERS)
Streptococcus pneumoniae <i>causes Pneumonia</i>	Streptococcus pyogenes <i>causes Strep throat</i>	(Vibrio cholerae) <i>causes Cholera</i>
Micrococcus luteus <i>causes armpits to stink</i>	(Bacillus anthracis) <i>causes Anthrax</i>	(Helicobacter pylori) <i>can cause stomach ulcers</i>
Staphylococcus aureus <i>can cause sinus infections and food poisoning</i>	(Salmonella enterica) <i>causes Typhoid</i>	(Treponema pallidum) <i>causes Syphilis</i>
	(Clostridium botulinum) <i>causes Botulism</i>	

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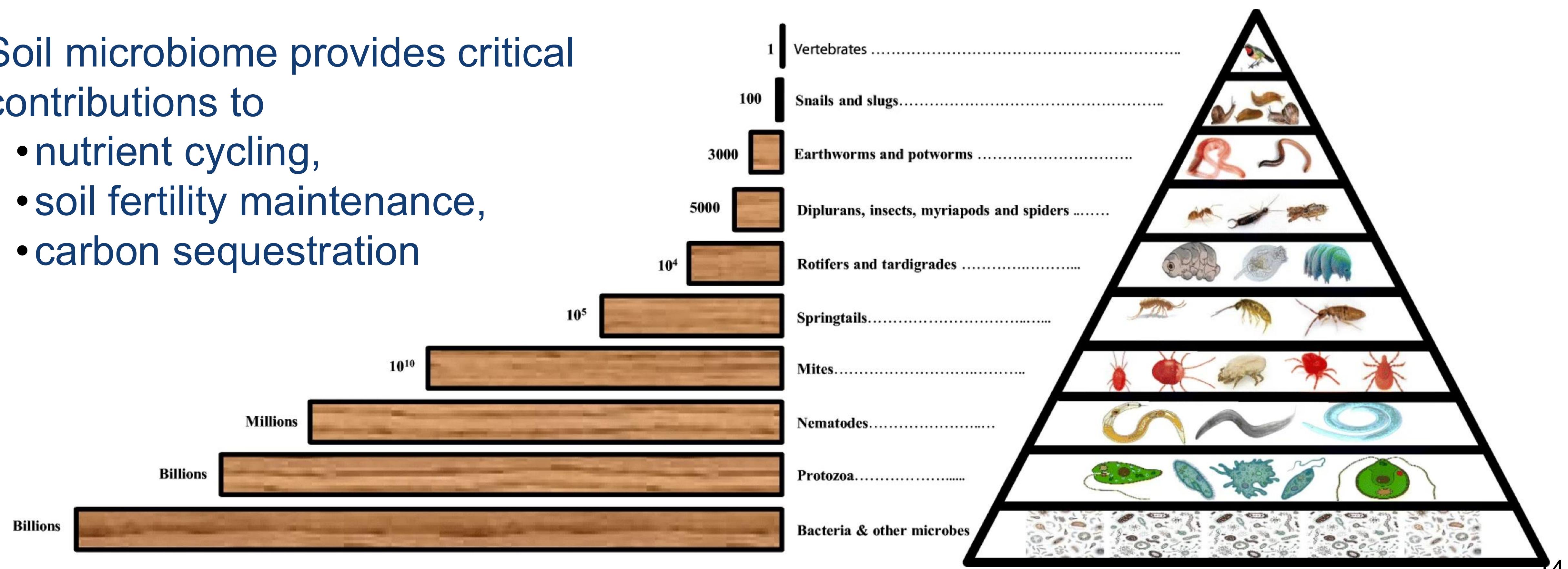


# Soil microbiome is one of the most important & complex ecosystem

The soil microbiome comprises one of the most important and complex components of all terrestrial ecosystems

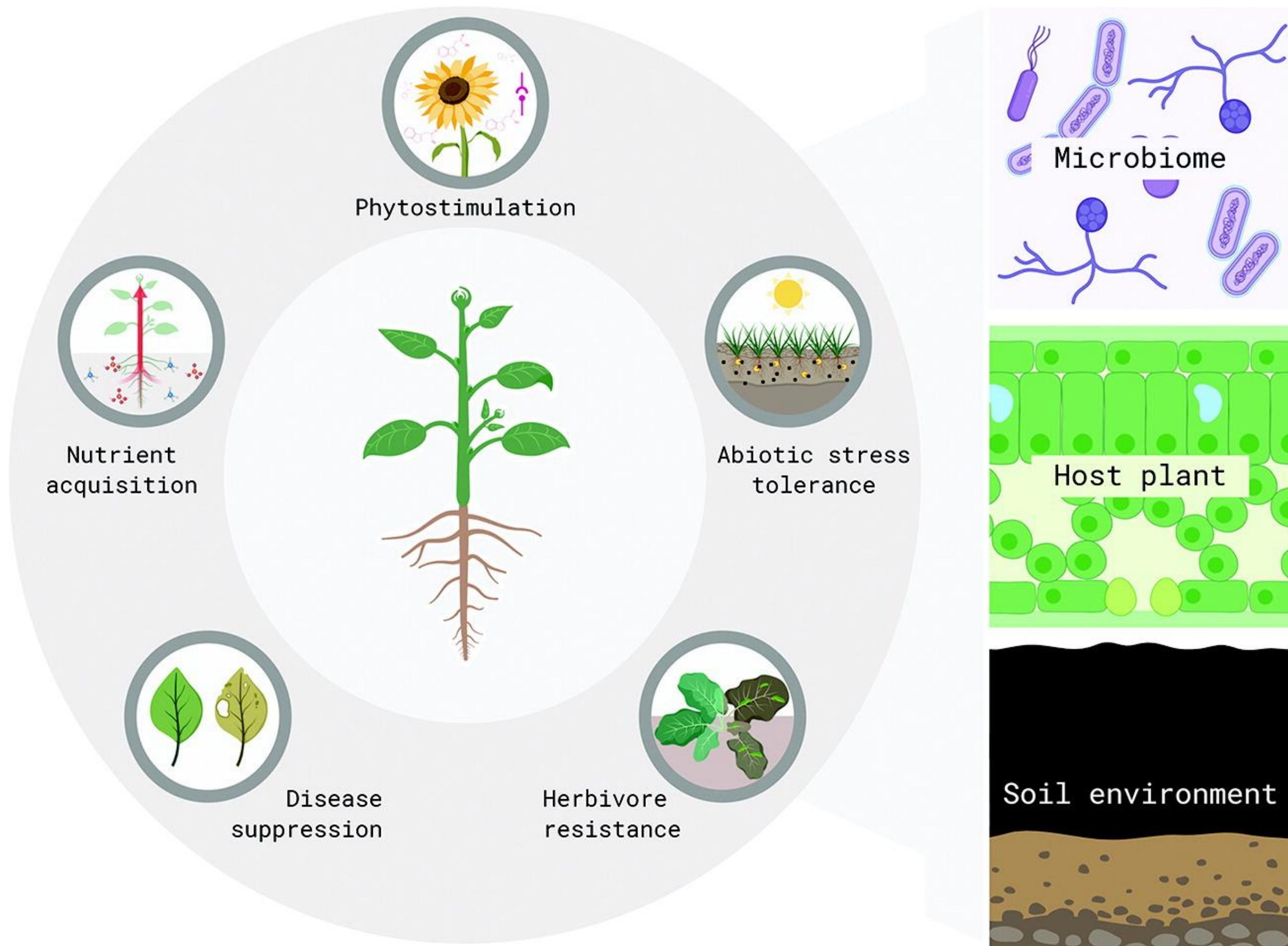
Soil microbiome provides critical contributions to

- nutrient cycling,
- soil fertility maintenance,
- carbon sequestration





# The role of soil microbiome

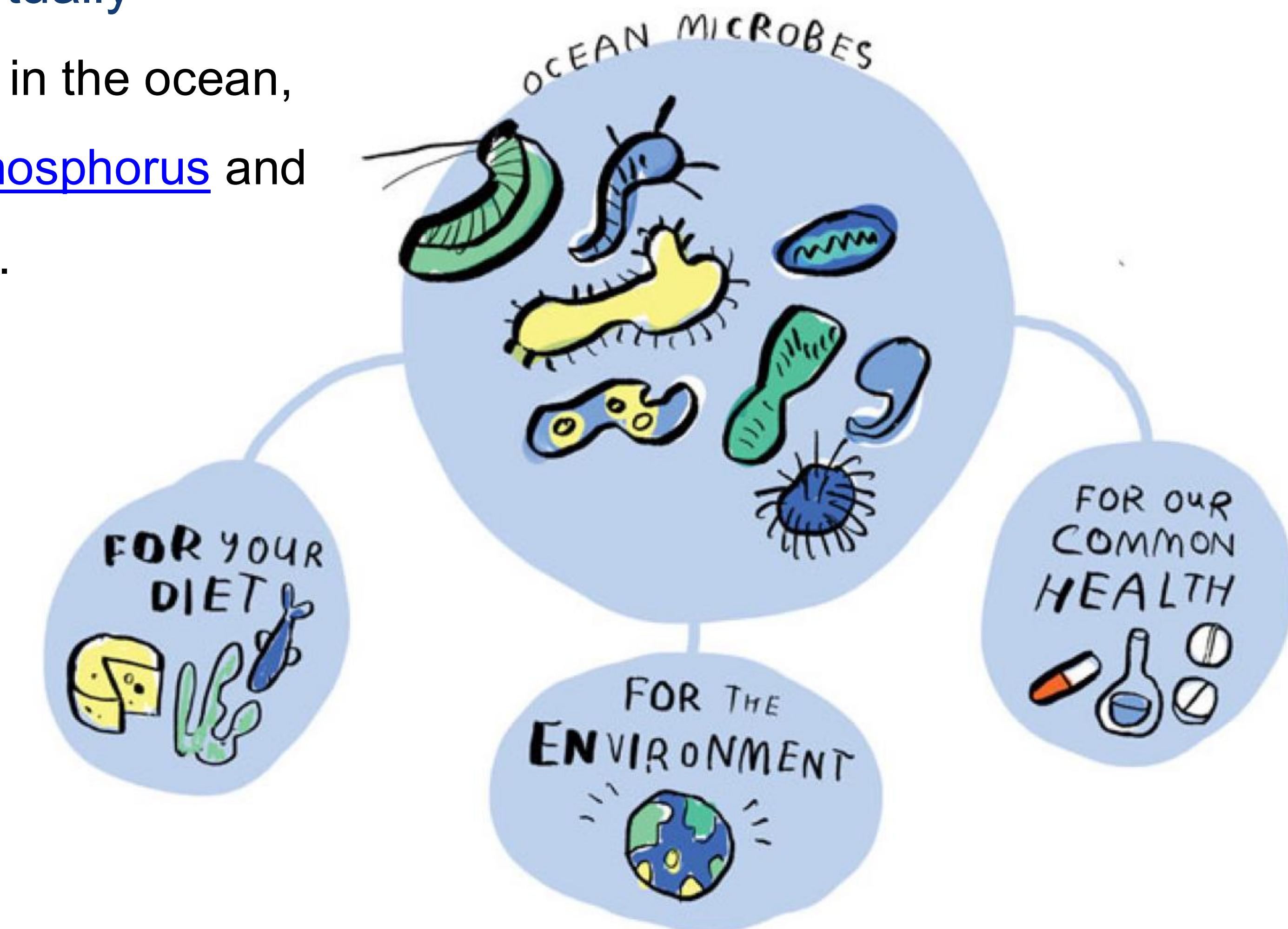




# Marine microbiome

Microbes are responsible for virtually

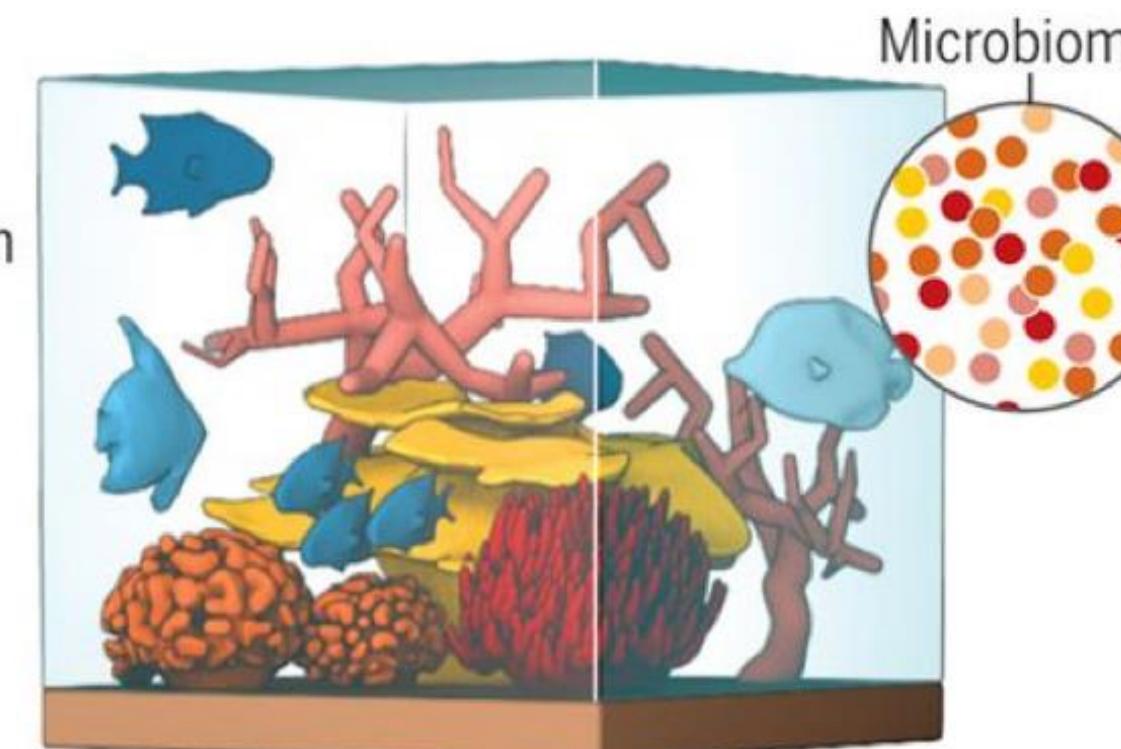
- all the photosynthesis that occurs in the ocean,
- the cycling of carbon, nitrogen, phosphorus and other nutrients and trace elements.



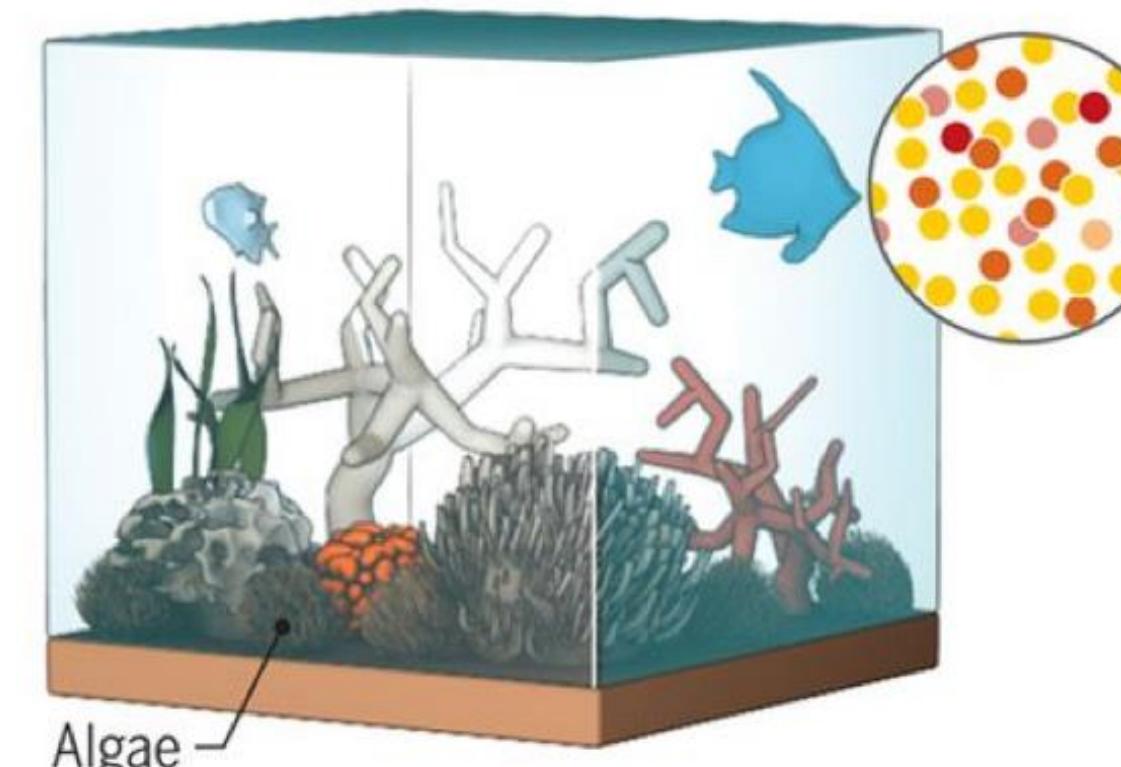


# Why should we care for marine microbiome

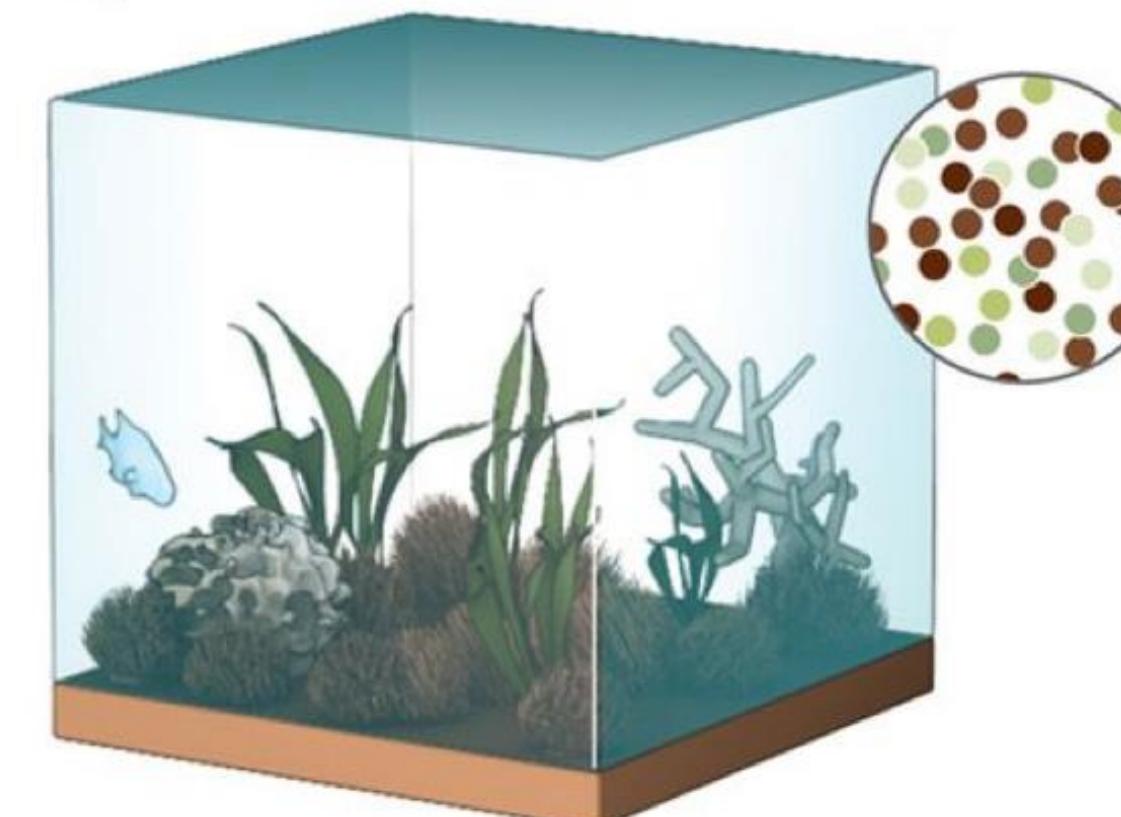
**Historic coral state**  
The health of a highly diverse reef ecosystem is supported by a complex microbiome.



**Degraded state**  
After disturbance, diversity of corals, fish, and microbiome is reduced, lowering resilience.



**Alternate algal state**  
An algal-dominated ecosystem without living corals has a different microbiome.

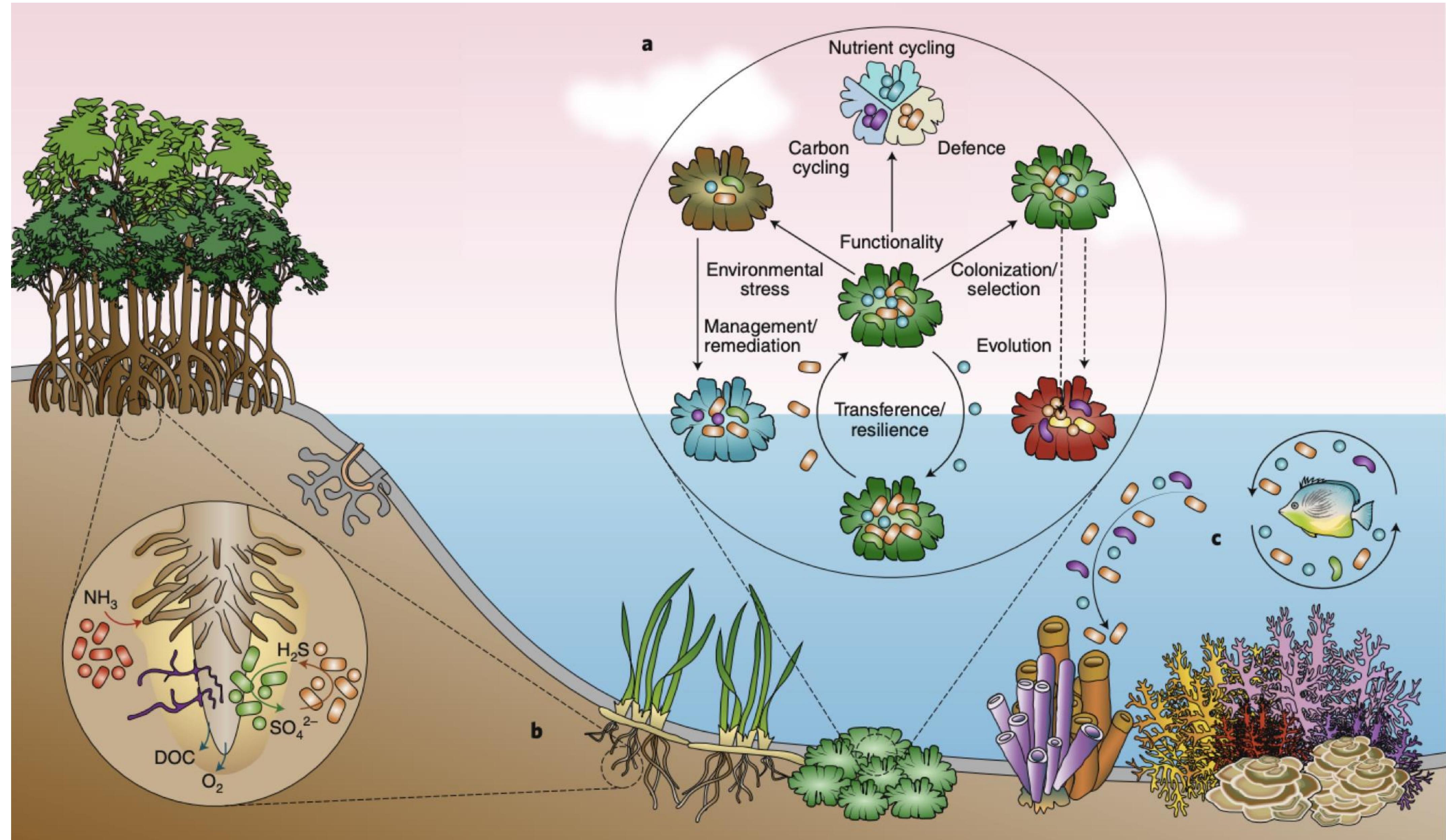


Microorganisms make up about 70% of the marine biomass

Marine microorganisms recycle the major chemical elements



# Interactions between different biomes



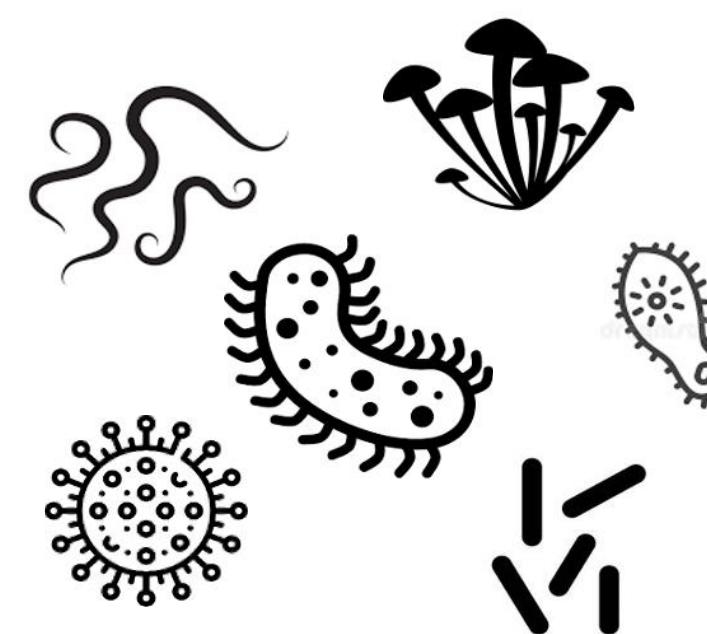
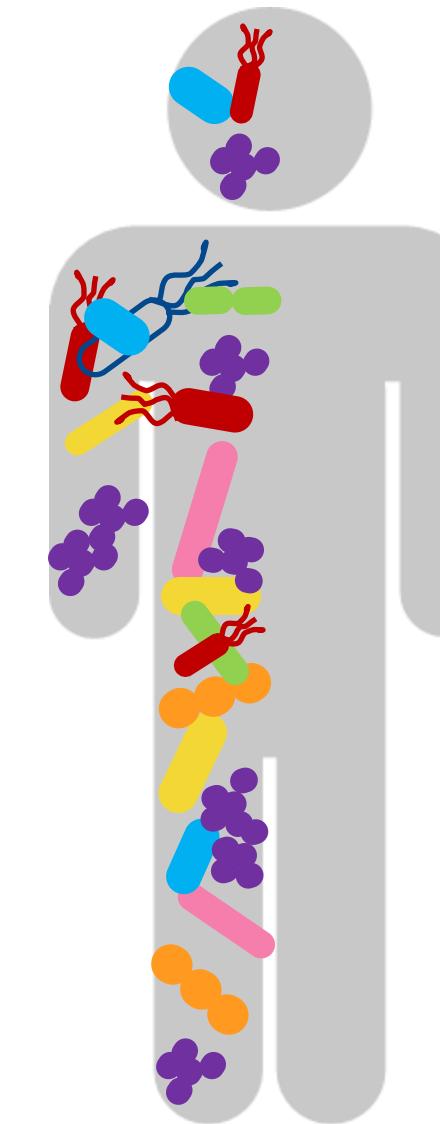


# Relationship between host and microbiome





# What is the human microbiome?



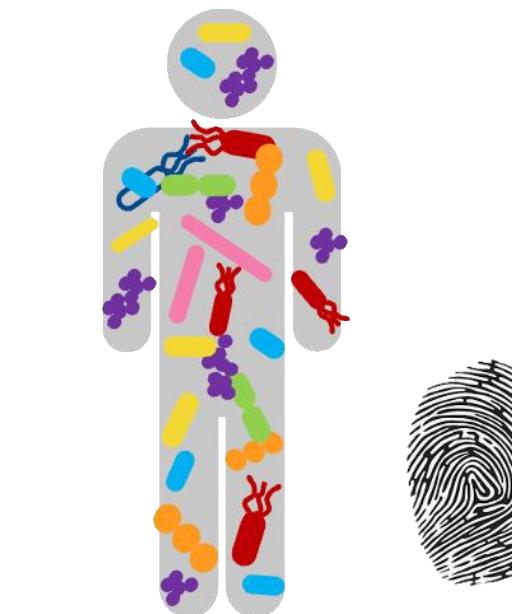
Abundant



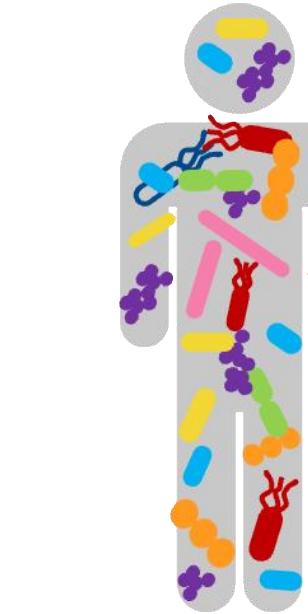
0.5-1kg



1:1



unique



>500 species



>50 mio  
non-redundant  
genes



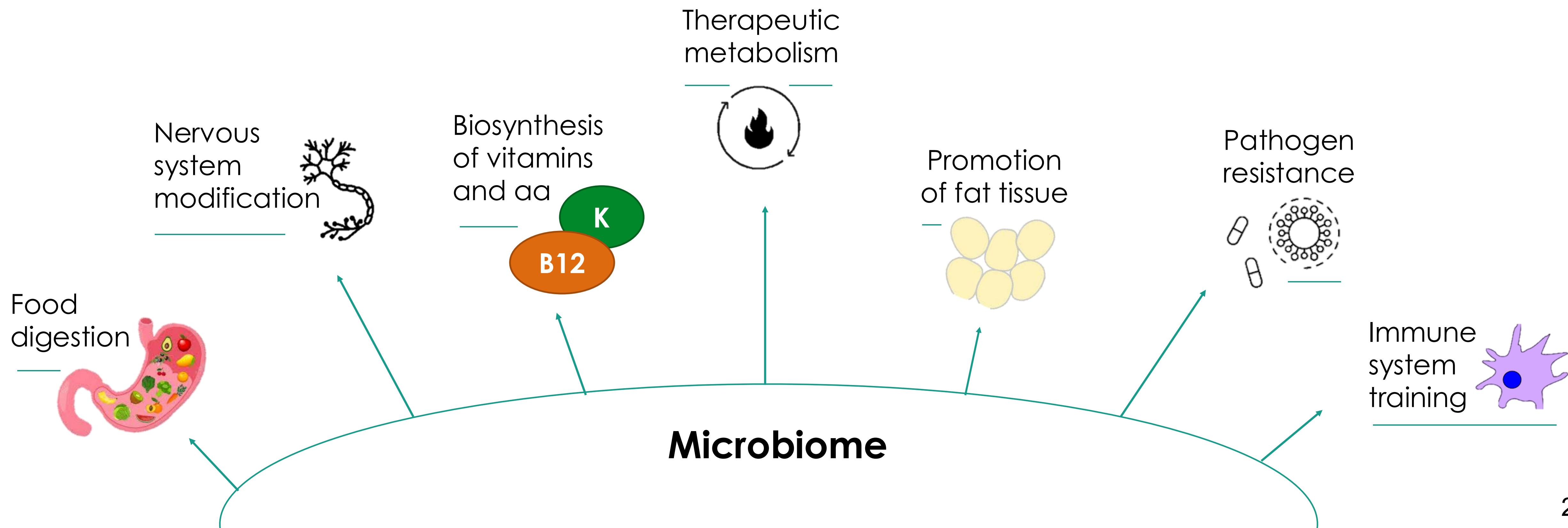
# Relationship between host and microbiome...

it's complicated.



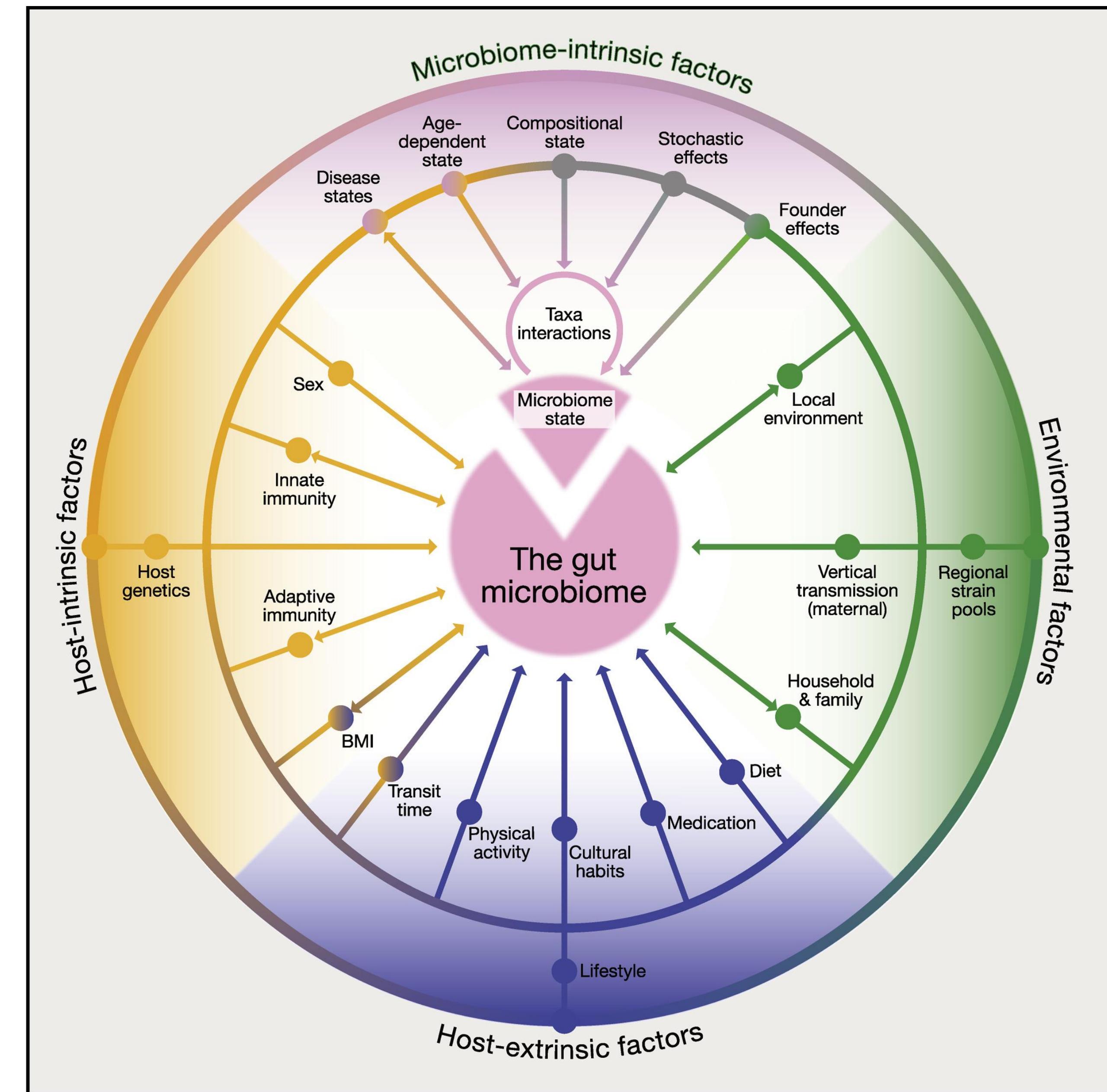


# The role of human microbiome?



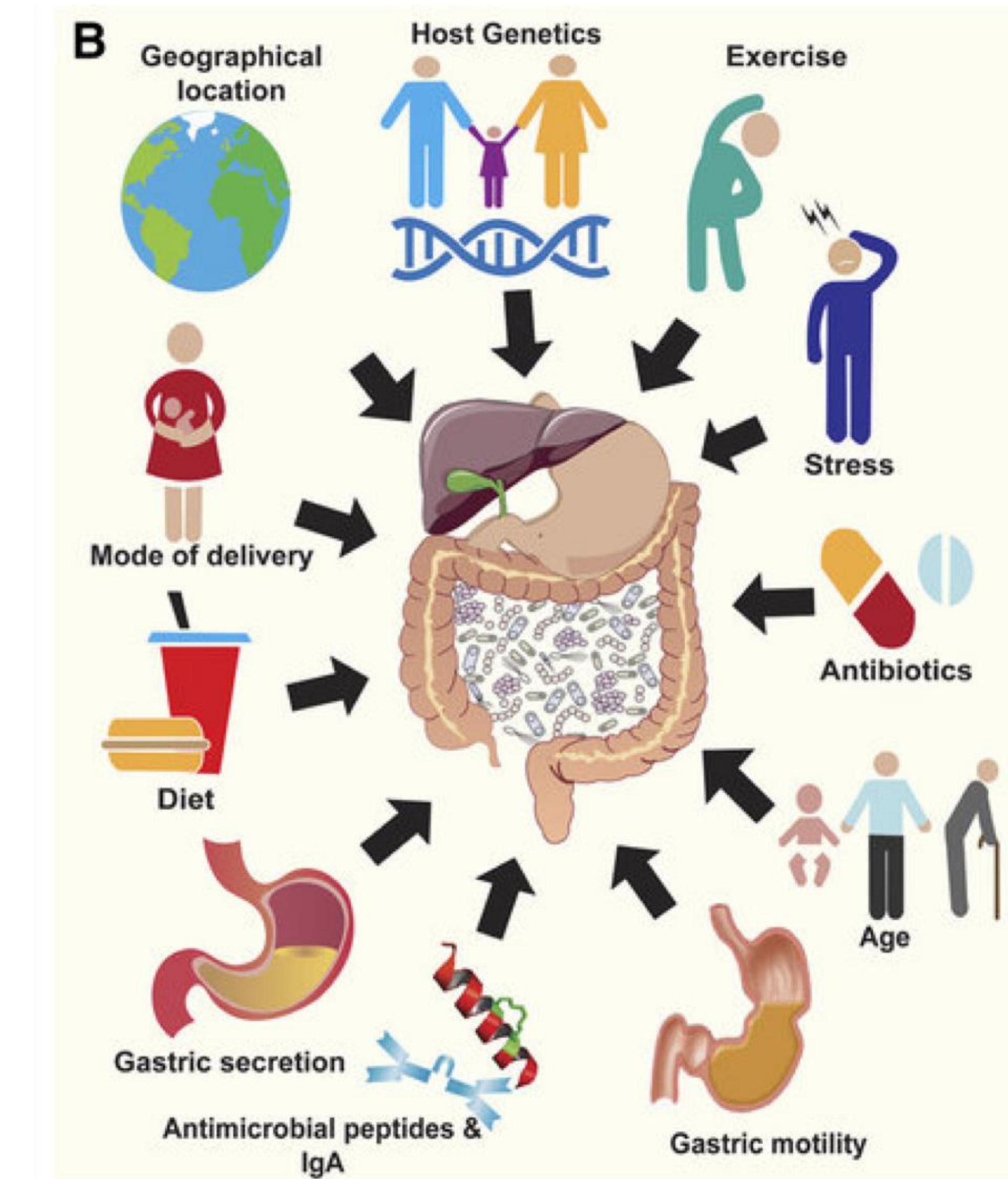


# Relationship between host and microbiome...





# Which forces shape the composition of the human microbiome





# Where do we get our microbiome starter kit

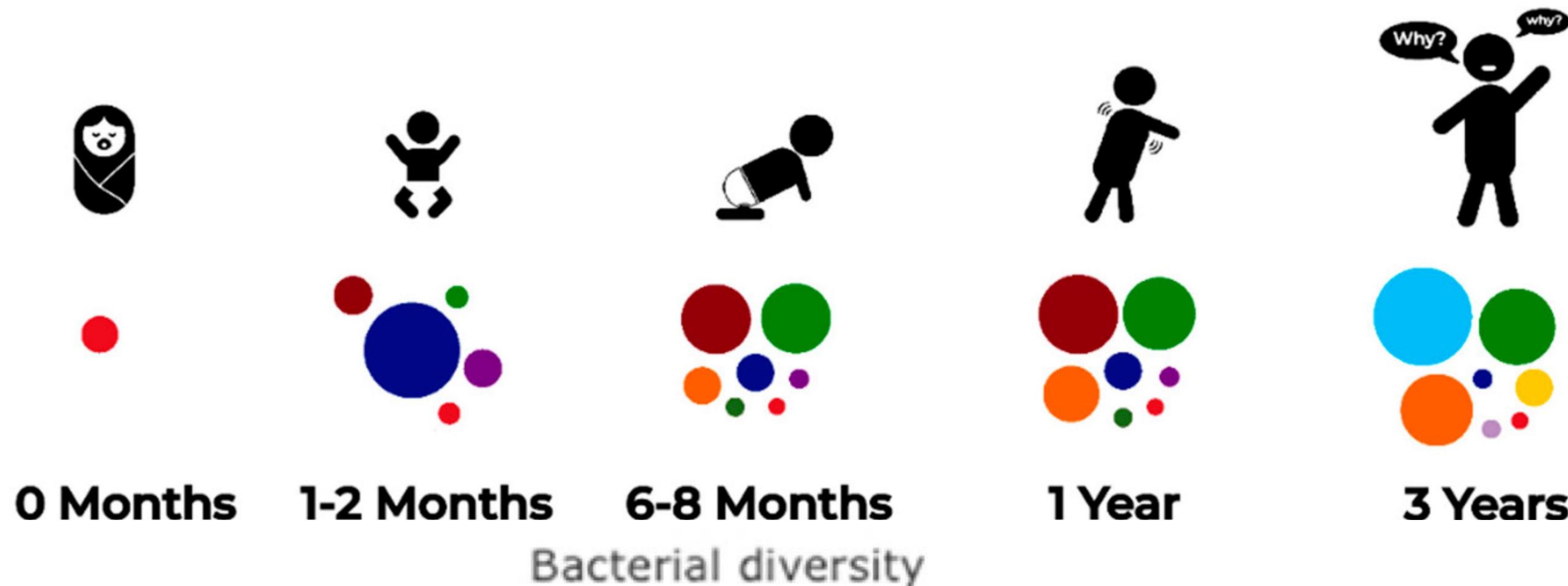
- The mouth, skin, and intestines of newborns delivered vaginally are rich in *Lactobacillus* which is the core of the maternal vaginal microbiota.
- The gut microbiota are responsible for the activation and development of the immune system, the development of the central nervous system (CNS), and the digestion and metabolism of food
- In 2–3 years after birth, the infant gut microbiota gradually develops towards the adult gut microbiota



# Where do we get our microbiome starter kit

## a) Gut microbiota composition during the first years of life

- *Enterobacteriaceae*
- *Clostridiaceae*
- *Bifidobacteriaceae*
- *Lachnospiraceae*
- *Lactobacillaceae*
- *Veillonellaceae*
- *Ruminococcaceae*
- *Bacteroidaceae*
- *Prevotellaceae*

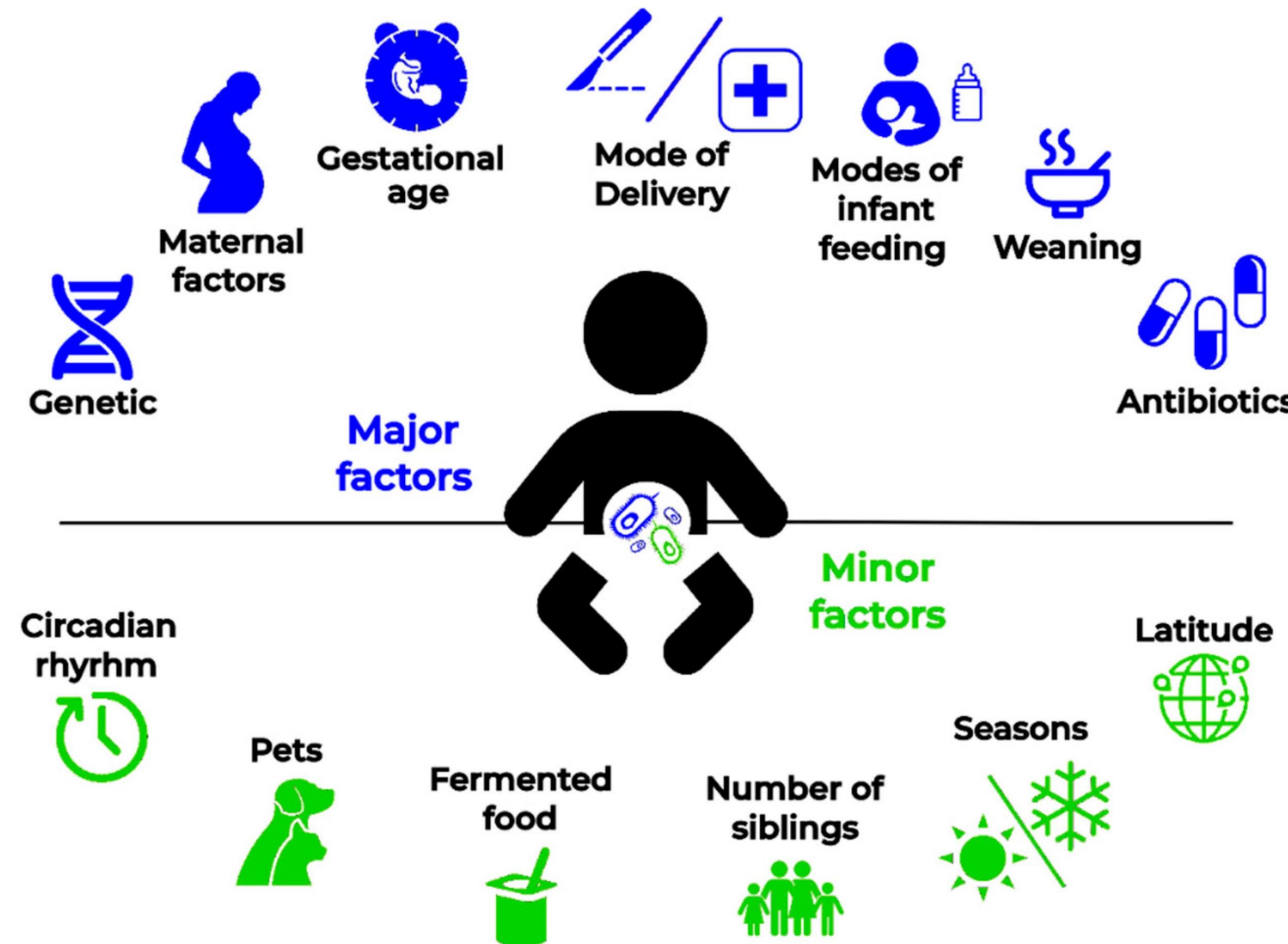


Interindividual variability



# Which factors shape infant microbiome

## b) Prenatal, perinatal and postnatal factors affecting microbiome composition

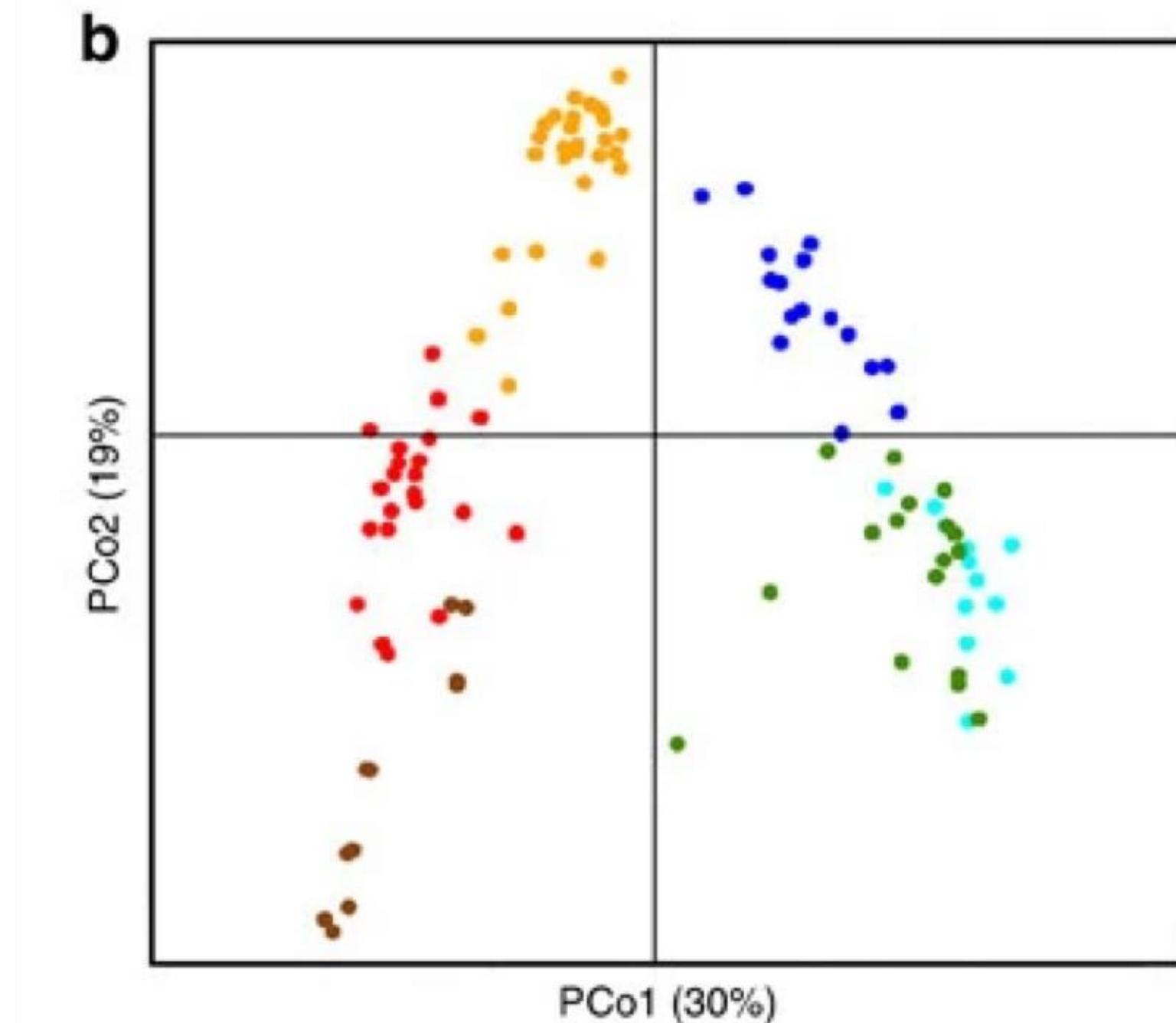
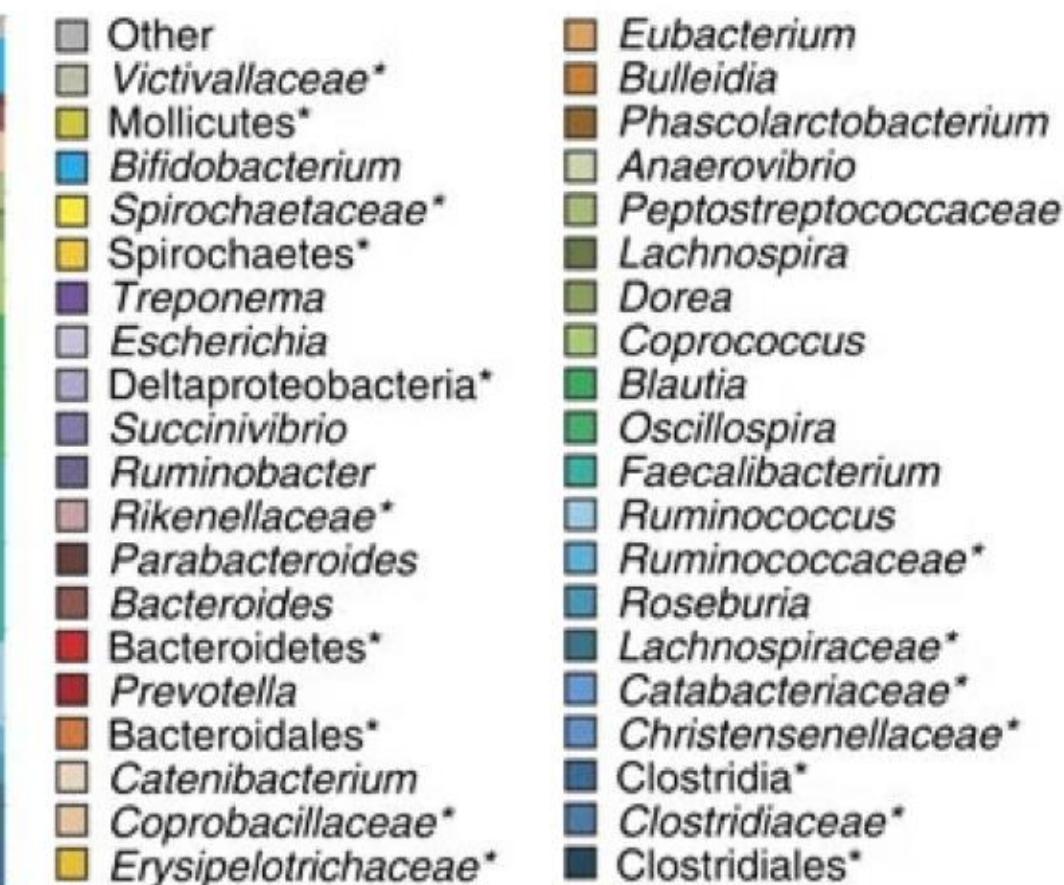
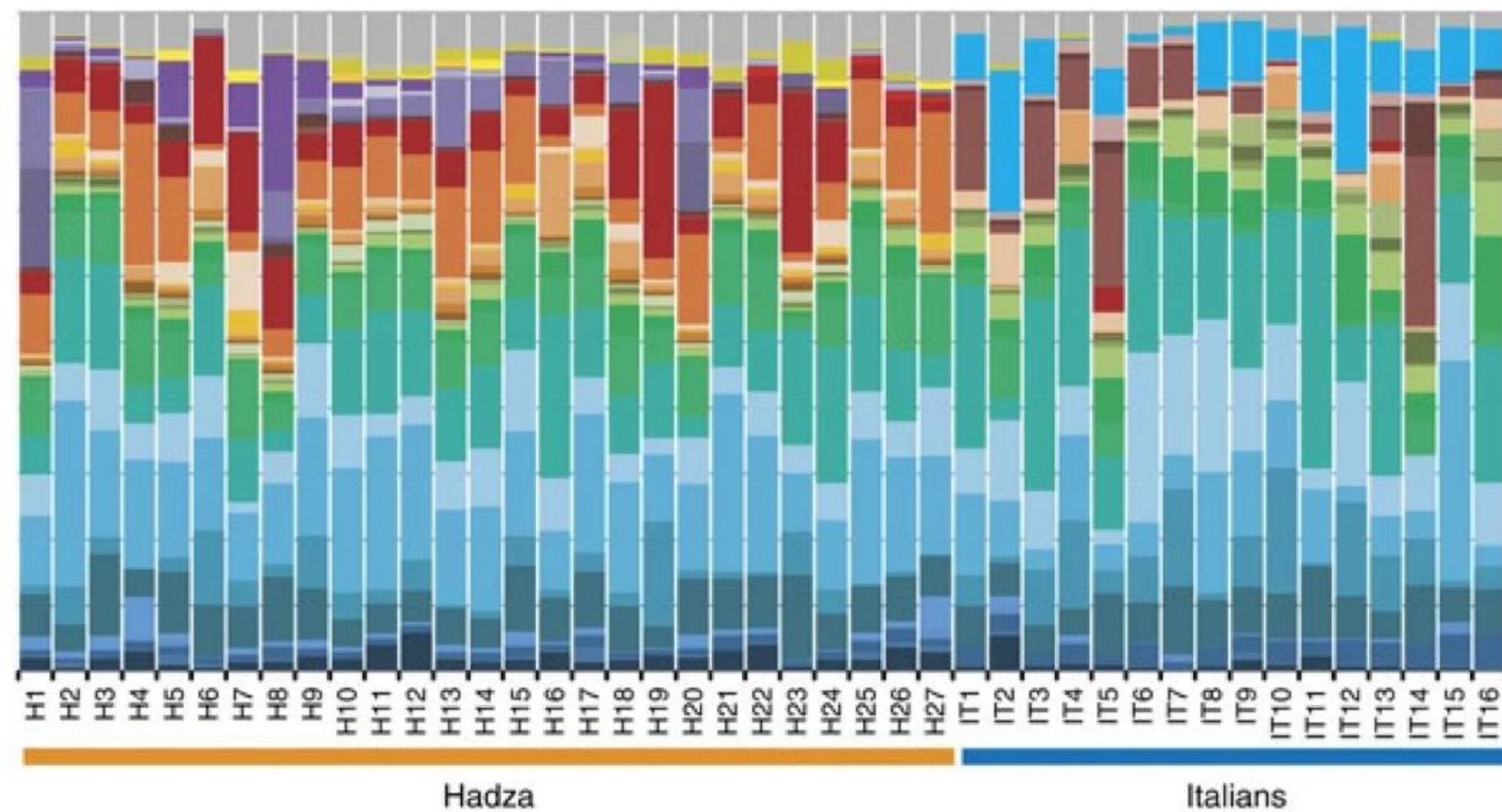




# What is healthy microbiome?

The Hadza, a population of hunter-gatherers living in Tanzania,

- eat 100–150 grams of dietary fiber daily (ten times as much as a typical person in the USA).
- eat only seasonal food depending on wet/dry seasons



HADZA  
BURKINA FASO  
MALAWI  
ITALIANS  
USA  
ITALIANS, ref.

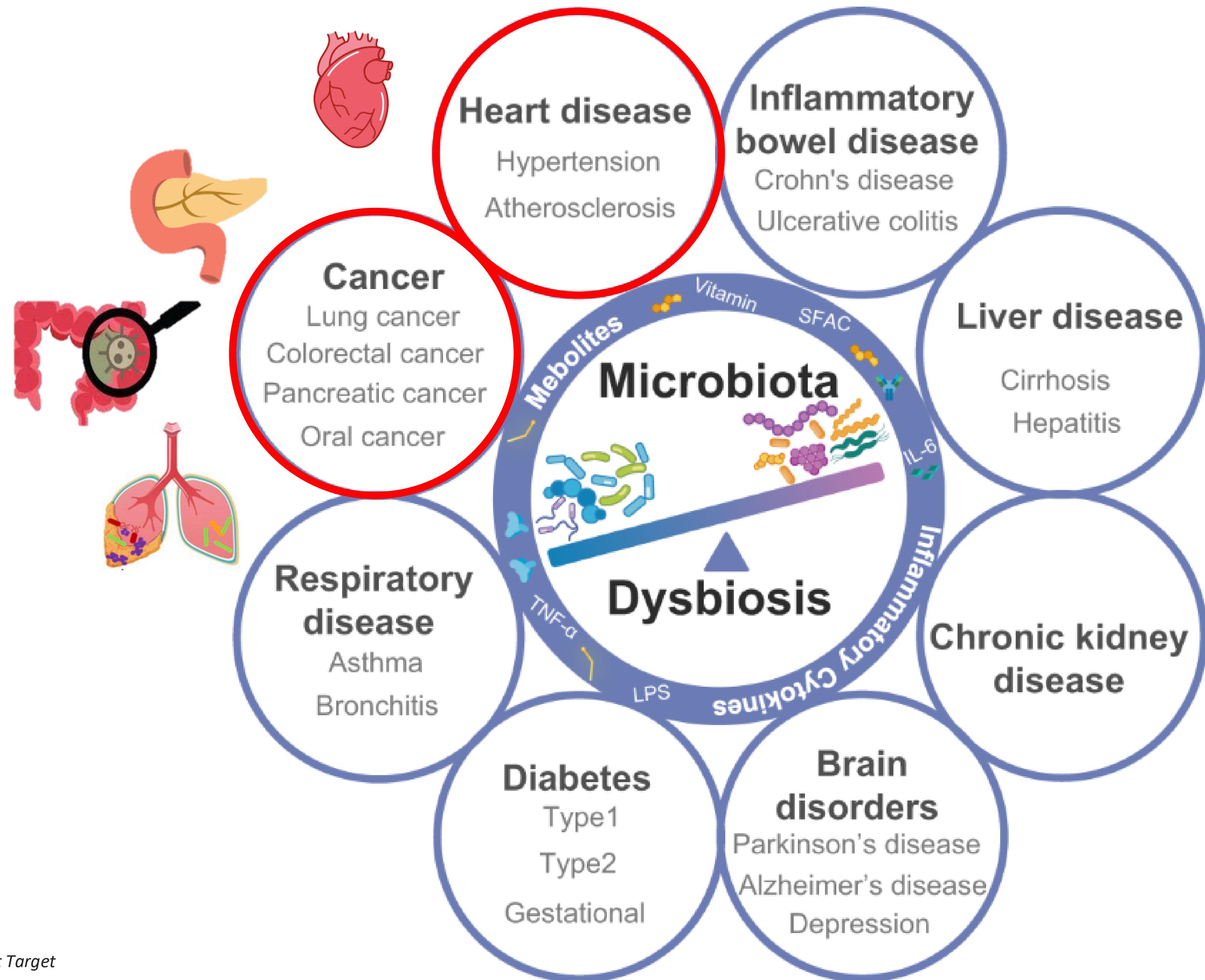


# Hadza tribe



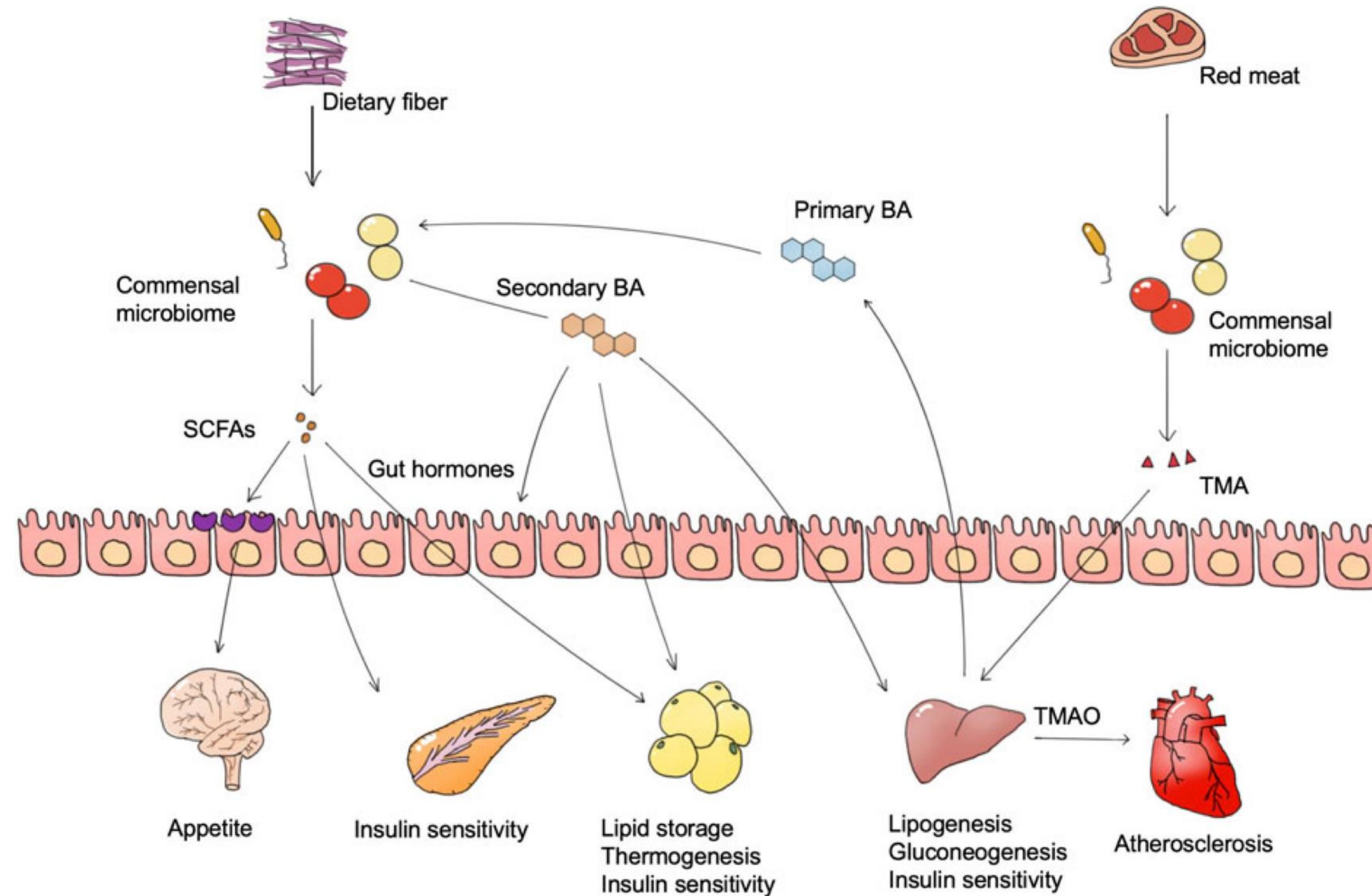


# The role of the microbiome on human health?





# Microbiome-derived metabolites and metabolic diseases



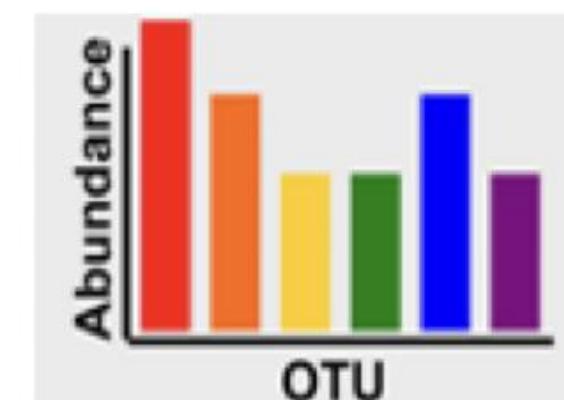


# How do we study the microbiome?

Who is there?  
What can they do?

16S rRNA  
Metagenomics

Composition



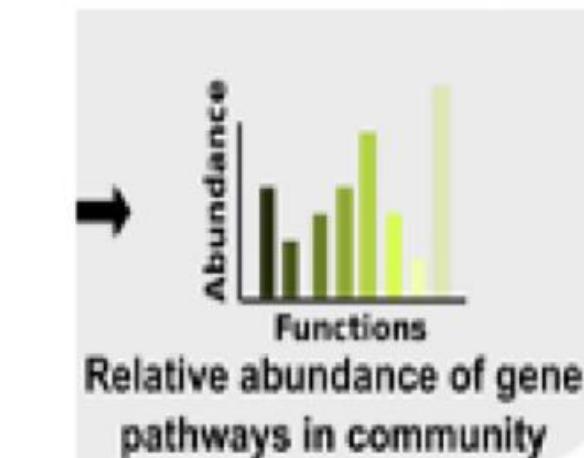
Functional capacity



What pathways/  
genes are active?

Metatranscriptomics

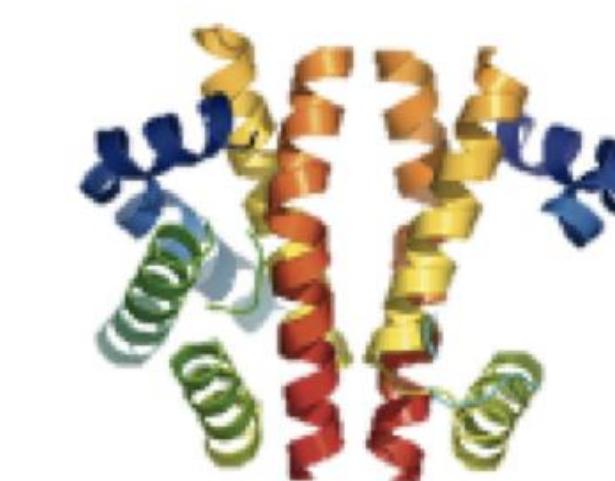
Gene expression



How do they  
interact with  
host?

Metaproteomics

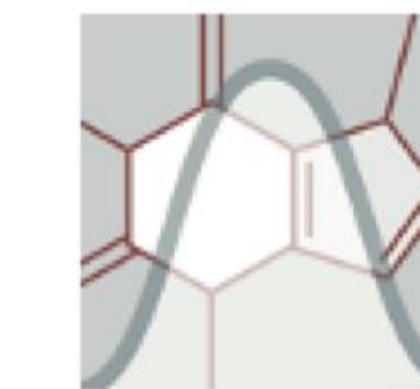
Catalytic Function



What are the  
chemical outcomes?

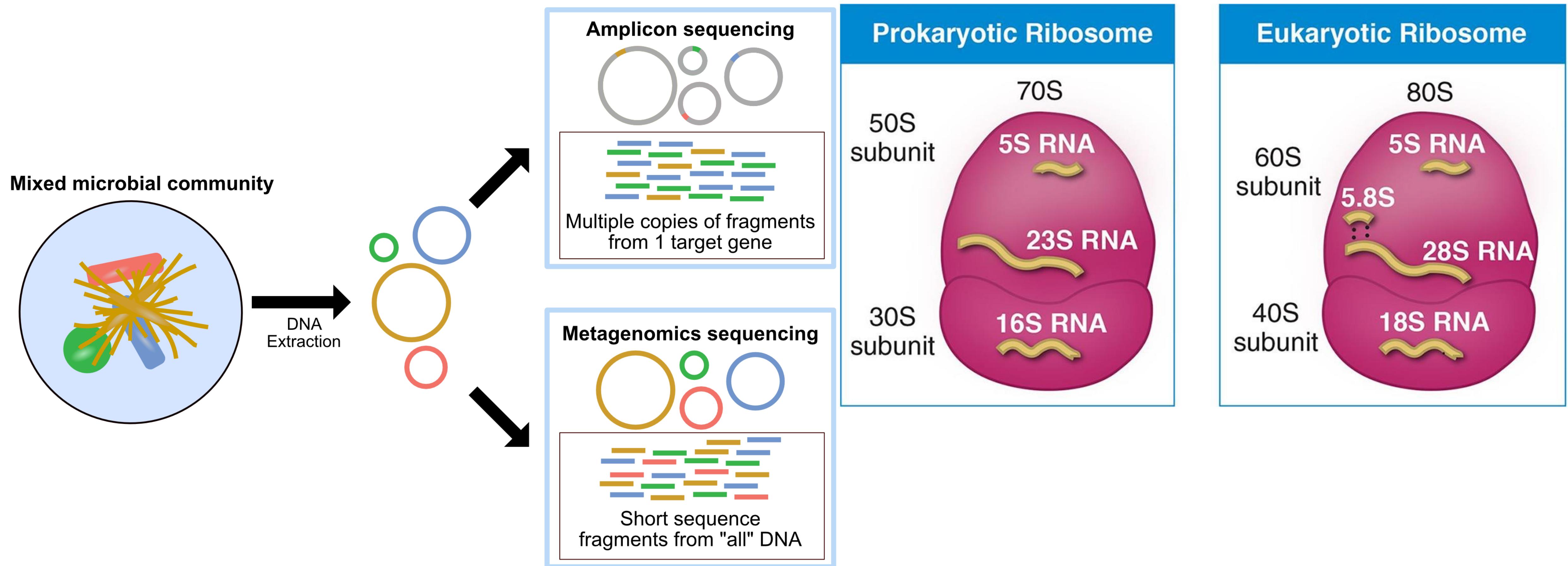
Metabolomics

Metabolic activity



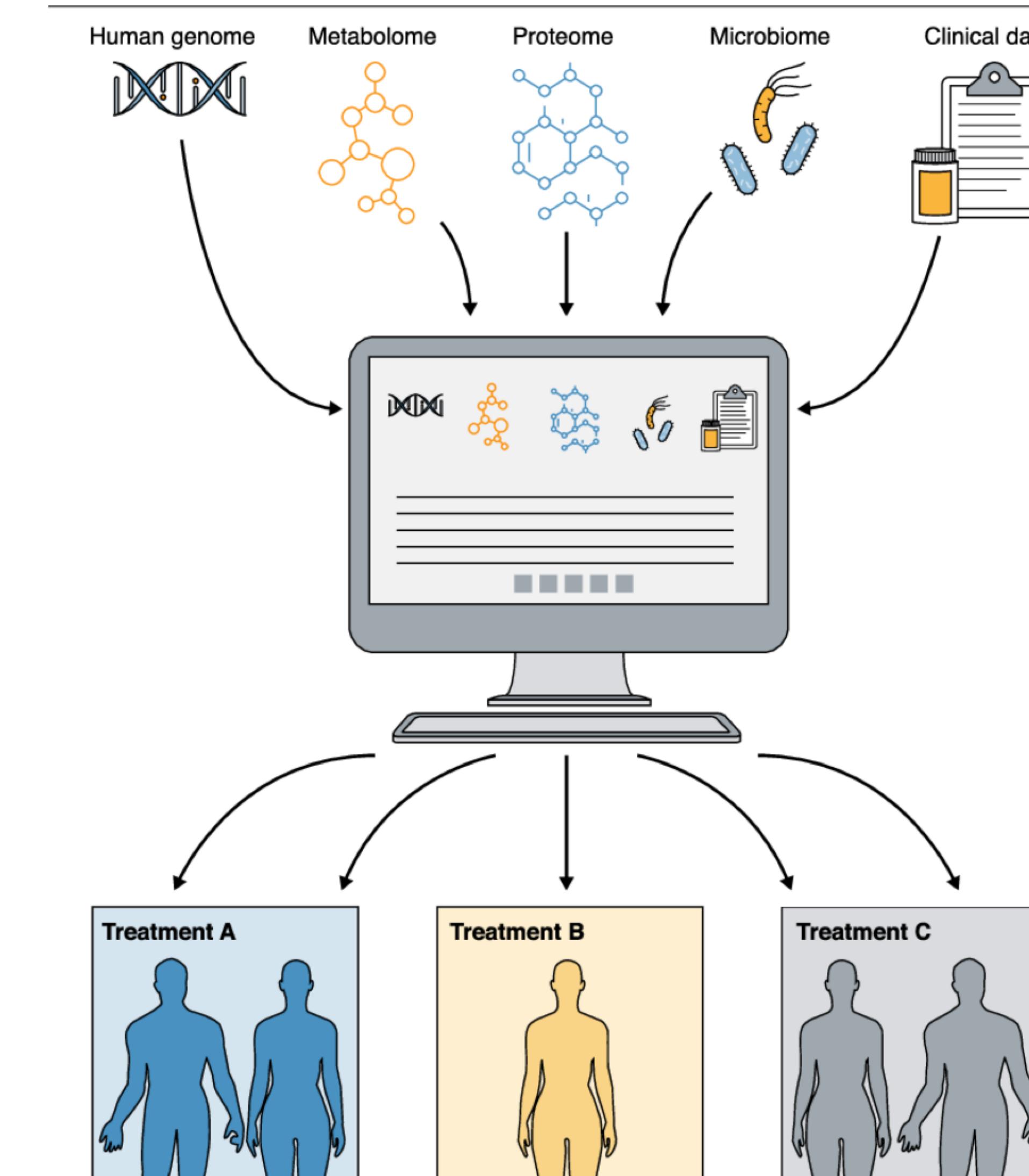


# How do we study the microbiome?





# Combining different omics data



# MICROBIOME





# Acknowledgements

**Julio Rodriguez-Saez**

**SaezLab members**

**How to funcomics**

Daniel Dimitrow

Aurelien Dugourd

Ahmet Sureyya Rifaioglu

Pau Badia I Mompel

Ricardo Ramirez



**Snakemake survivors**

Robin Fallegger

Lorna Wessels

Charlotte Boys

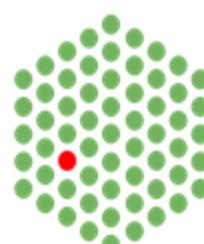
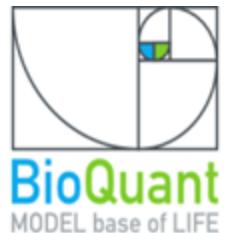
**How to Dream**

Rebecca Terrall Levinson

Attila Gabor

Jovan Tanevski

**Thanks to participants!**



**Prof. Dr. Peer Bork**  
Sebastian Schmidt

Matthias Kloor



Petra Schrotz-King



Hermann Brenner

Jonel Trebicka