

Importance of Microbiome informatics in Ayurveda

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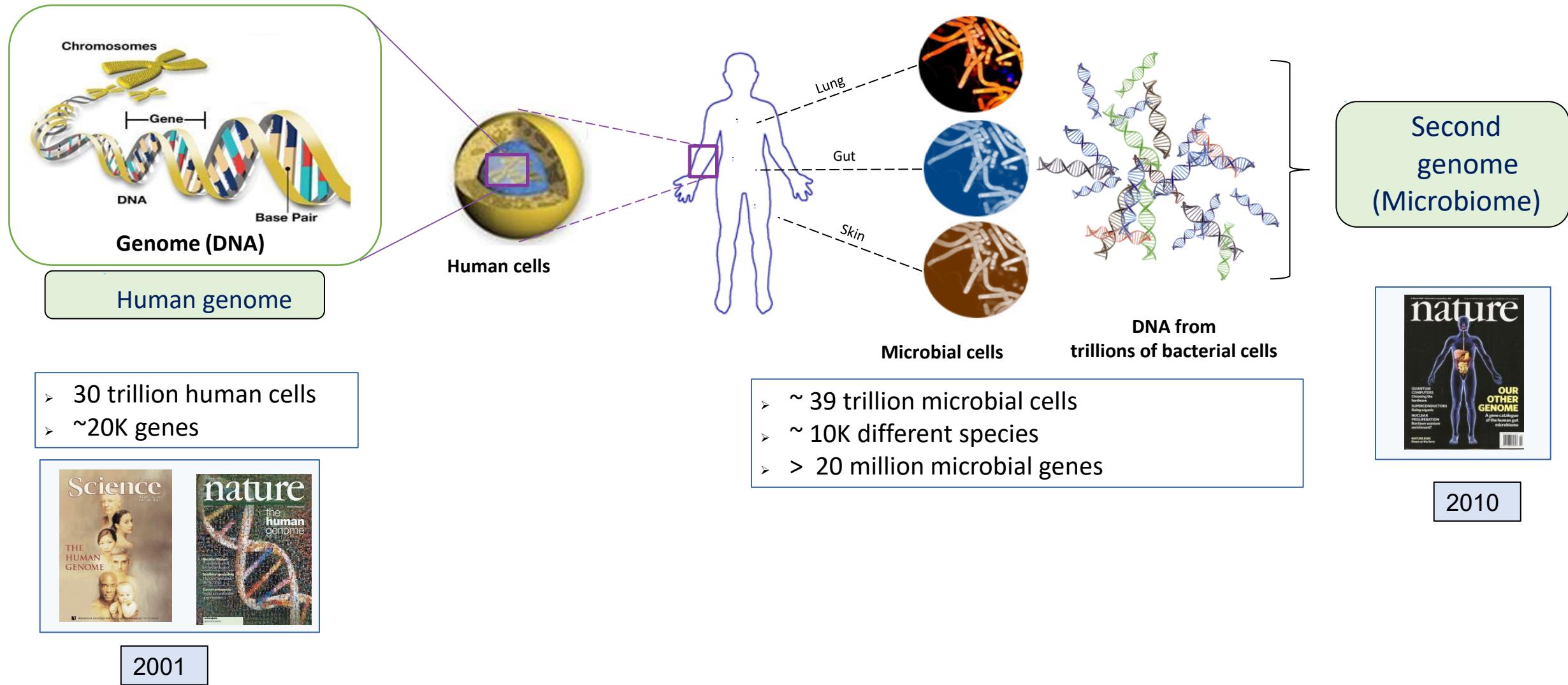
IISER-Thiruvananthapuram

(Former Distinguished Chief Scientist, TCS Research)

Outline

- Genome & Second Genome
- Gut Microbiome and Ayurvedic concepts (*Dipan, Pachan, Agni, Vata anuloman*)
- Microbiome-based therapeutics versus Ayurvedic concept (*Shodhana*)
- *Aushadha* –Microbiome interactions

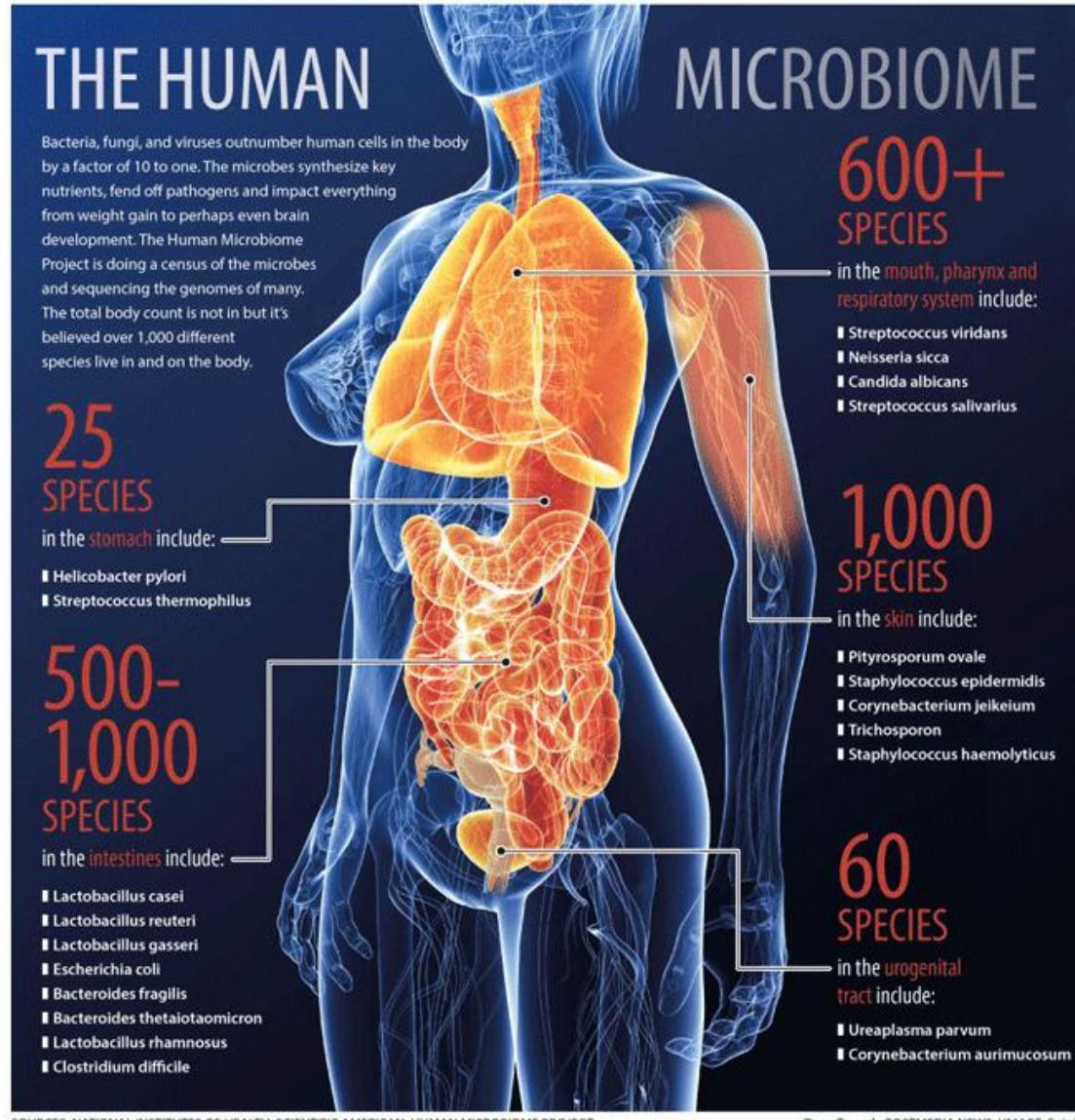
The blueprint of health



Human Microbiome

100 trillion symbiotic microbes

Microbial Cells:
Human Cells =
1.3:1



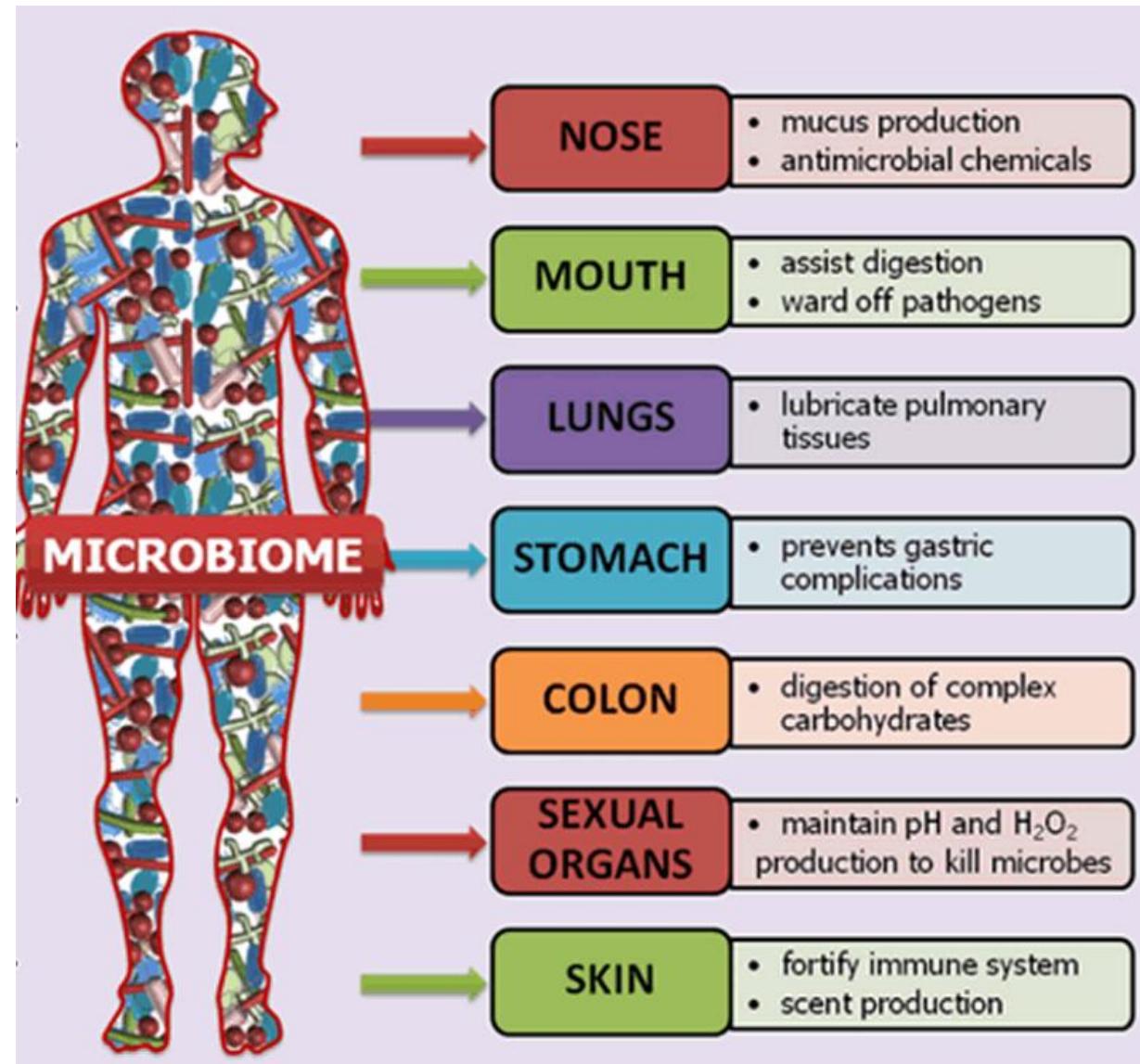
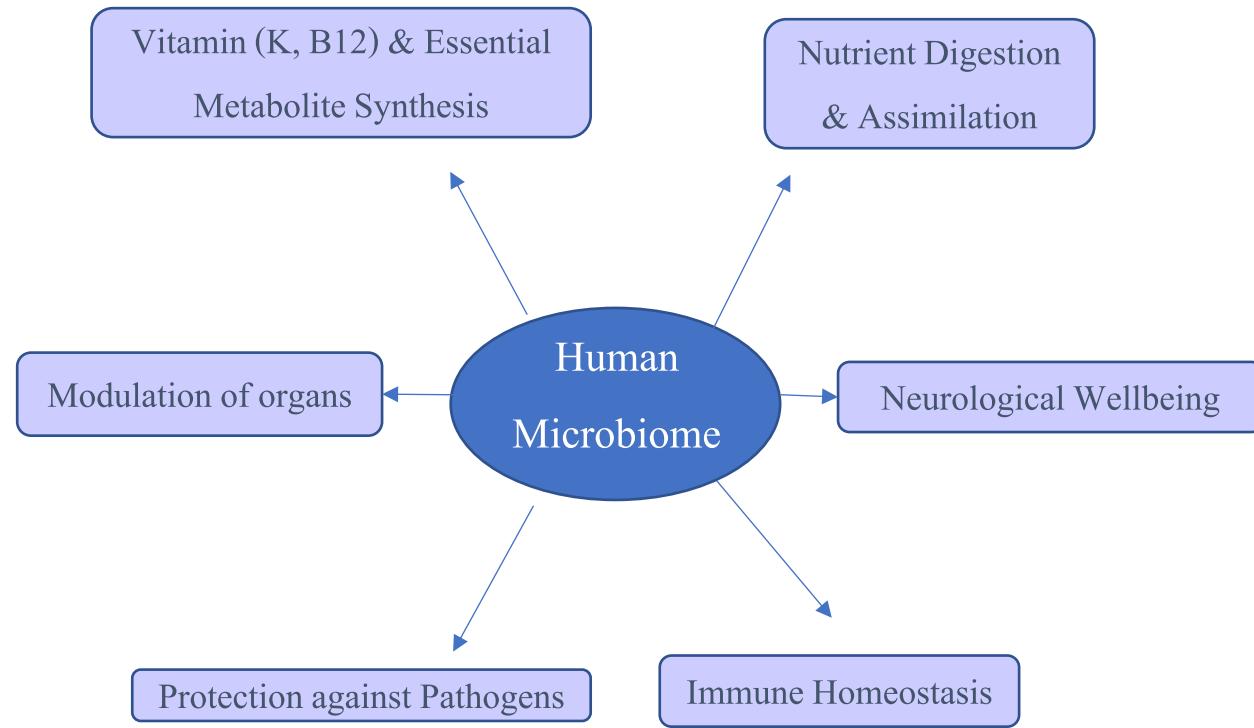
Bacteria, Archaea,
Fungi, Viruses &
Protists

95% in our gut

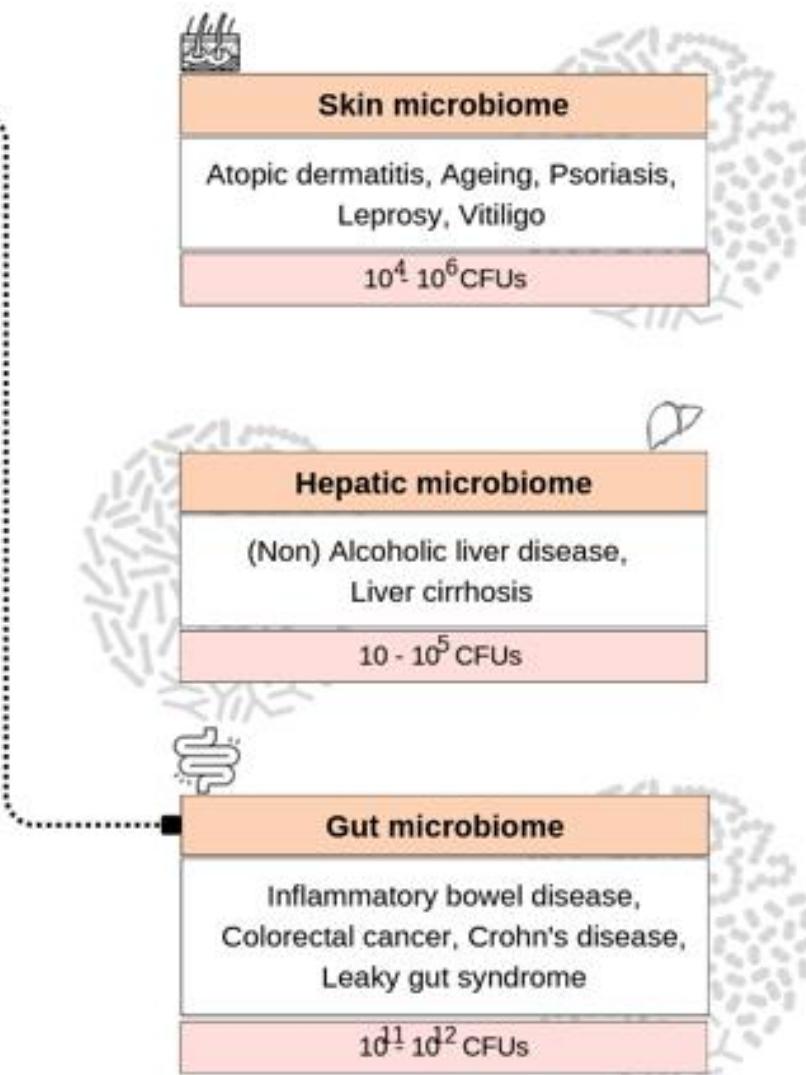
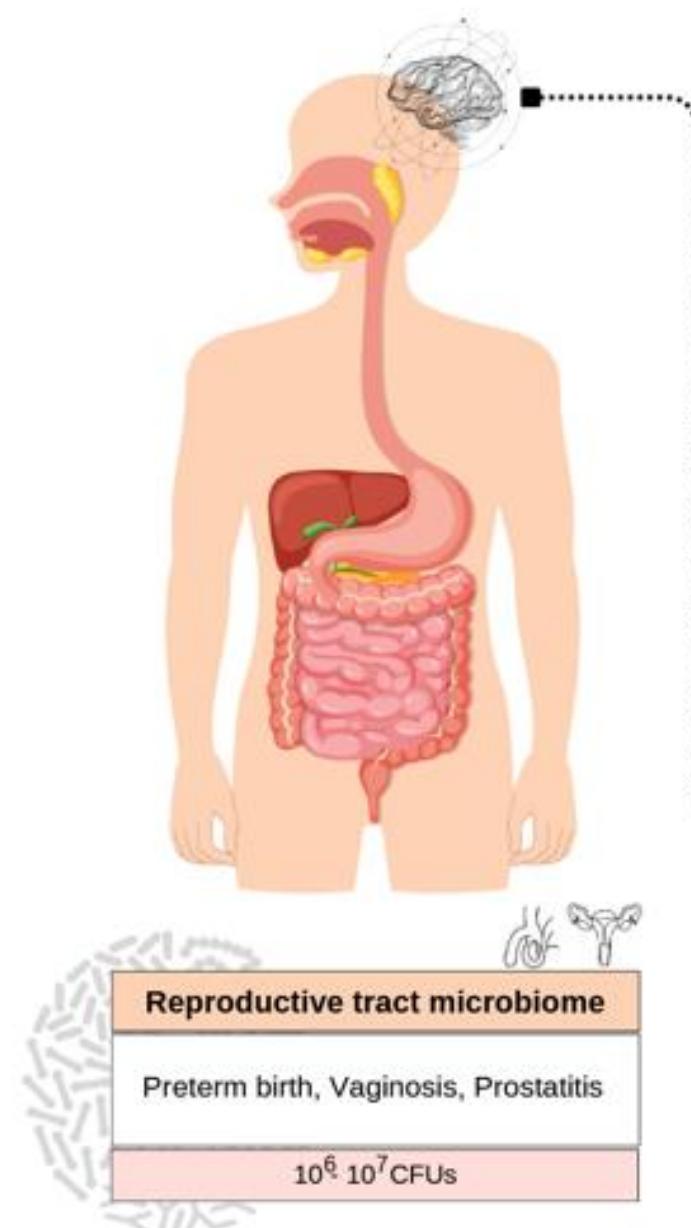
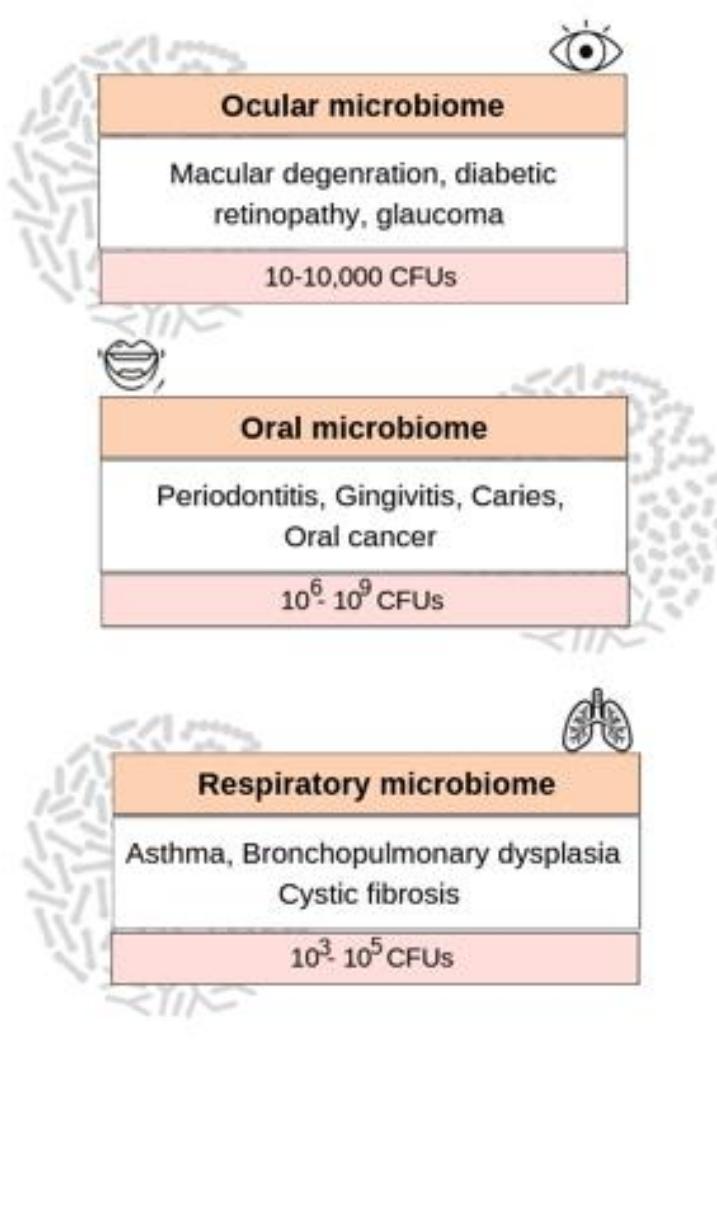
Microbial Genes:
Human Genes =
150:1

We are more Microbial than Human !!

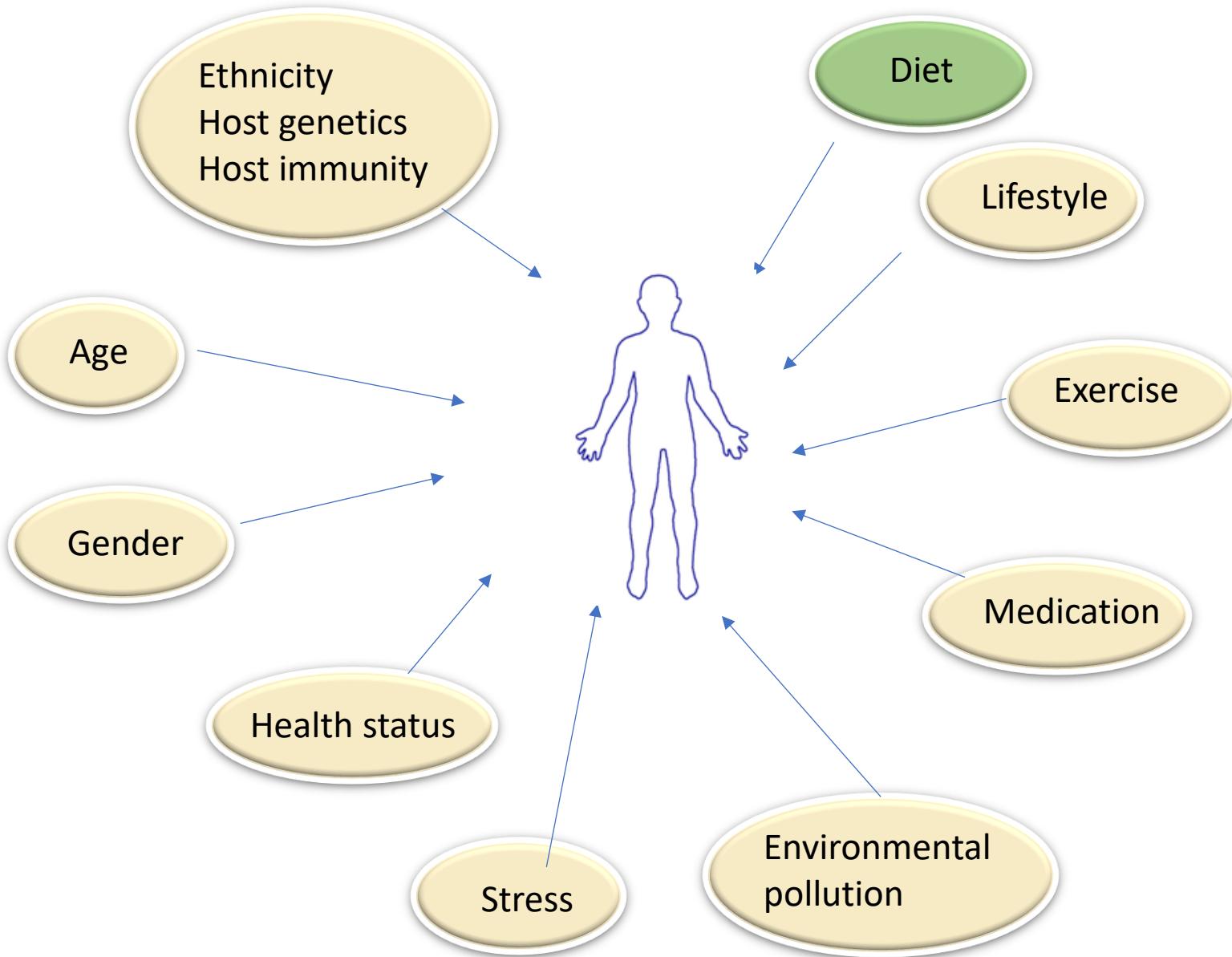
Role of human microbiome



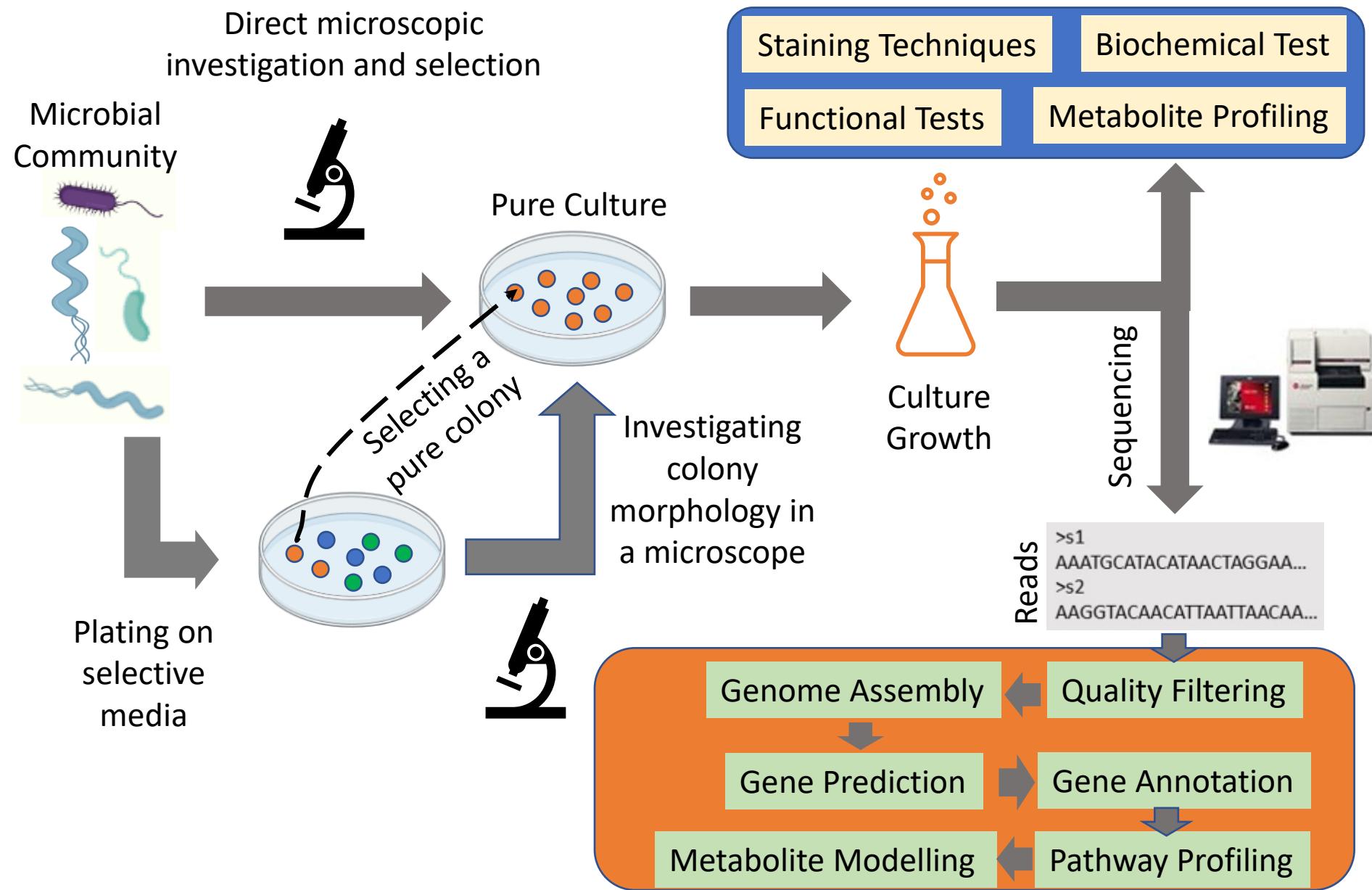
Microbiome linked perturbations associated with almost all major diseases



Factors influencing Human Microbiome



Historically, microbiology > pure culture based investigation



And what have we studied till date?

Total estimated no. of microbial species on Earth - **1 trillion**

No. of microbial genomes completely sequenced till date ~400K microbes



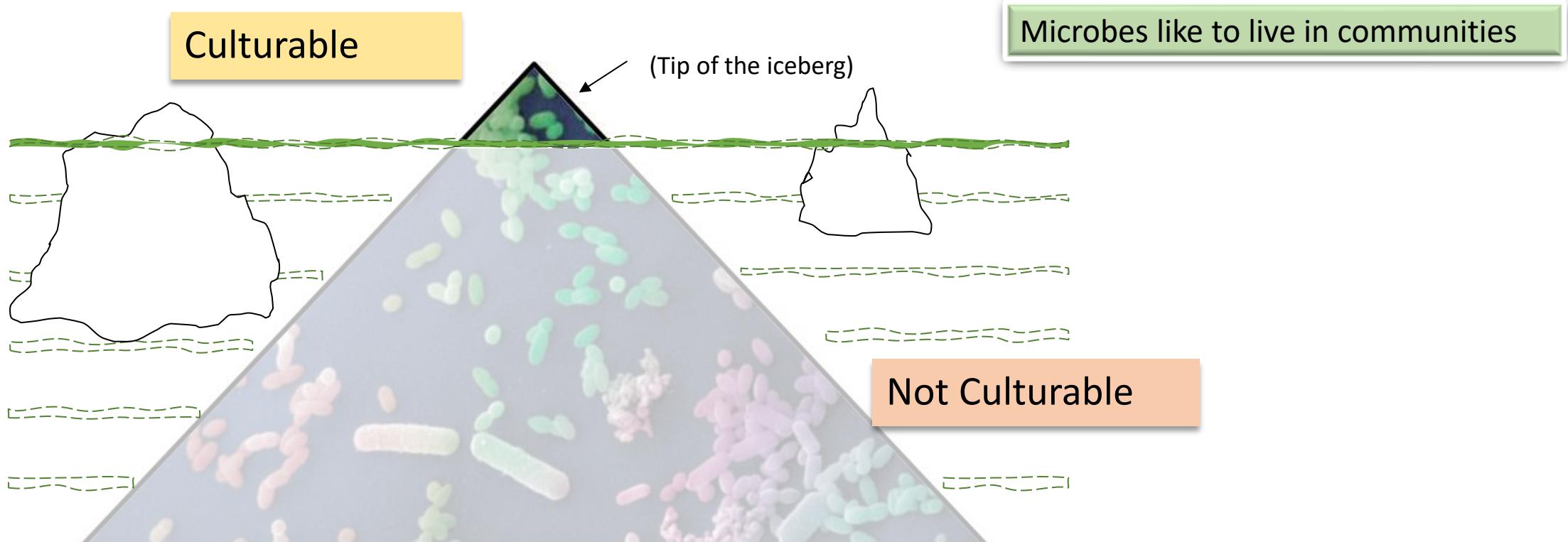
Tag cloud showing the host/habitat of sequenced microbes

Word size proportional to the habitat (e.g. ~150K microbes isolated from human host)

Why do we know so little about microbes?

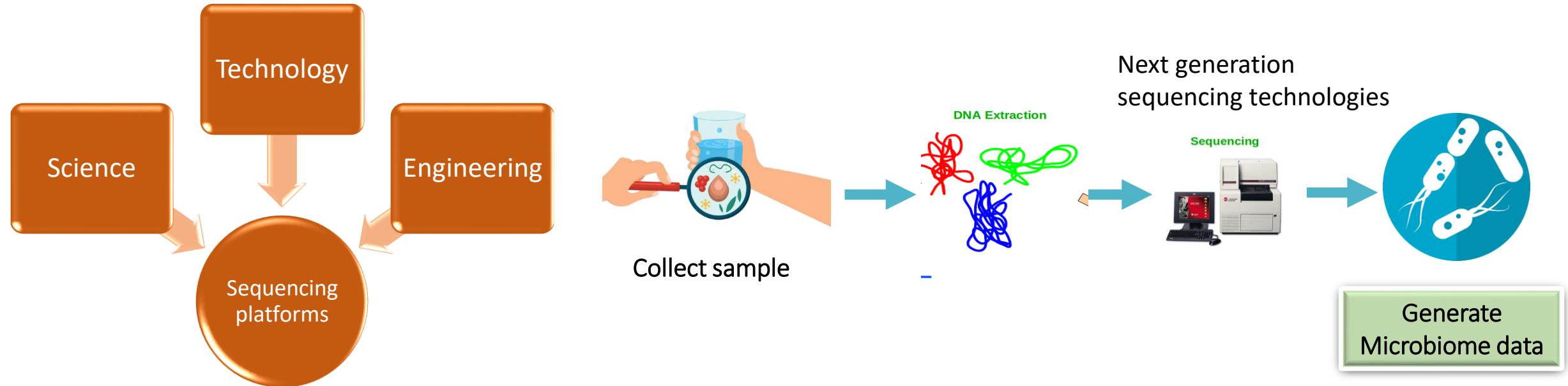
Total estimated no. of microbial species on Earth - **1 trillion**

A majority of microbes in most micro-environments are not culturable using standard laboratory based culturing



How do we study microbial community (Microbiome)

Metagenomics approach



What microbes are there and what are their relative proportions?

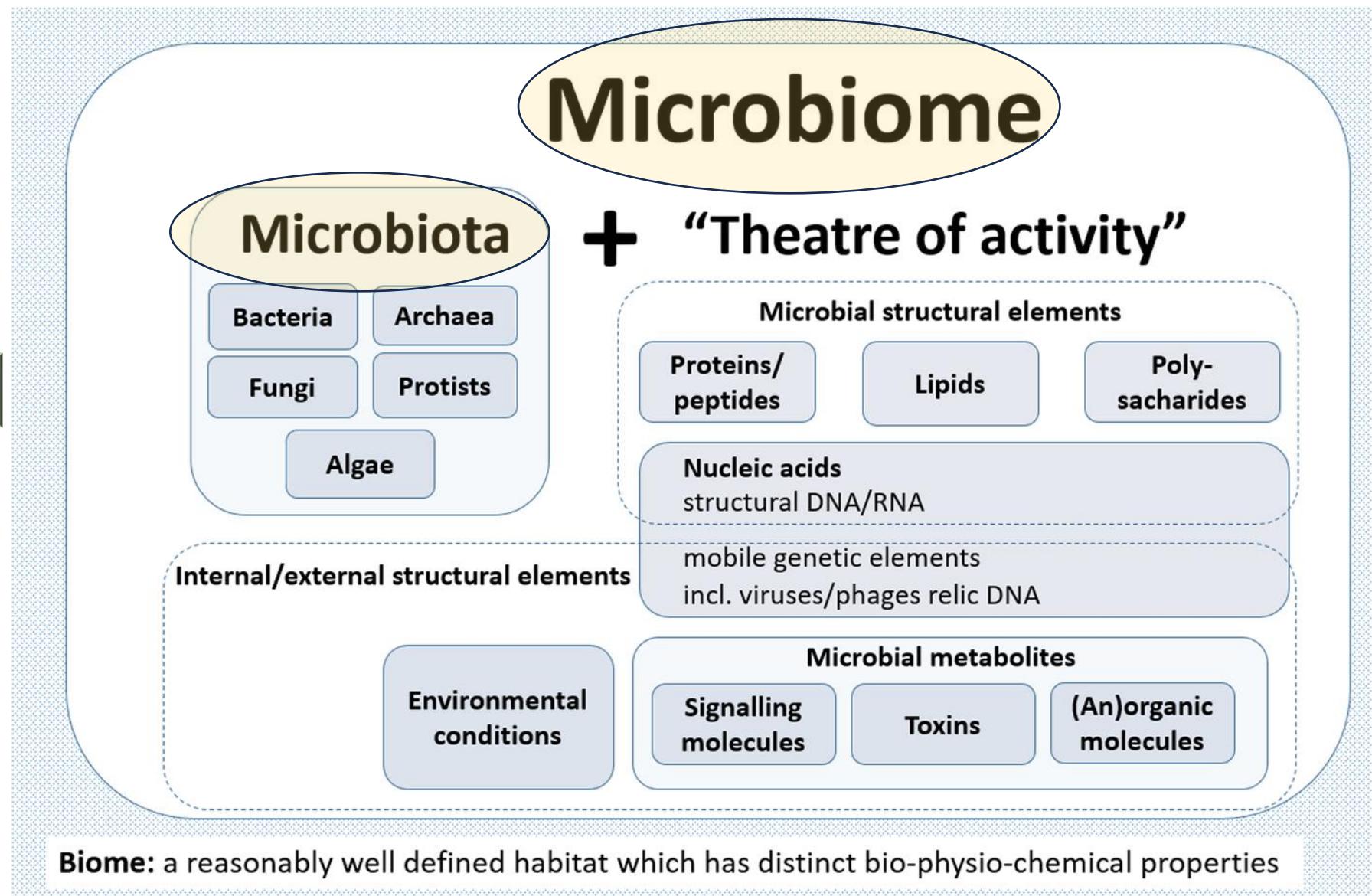
What are they doing?

Why are they doing what are they doing?

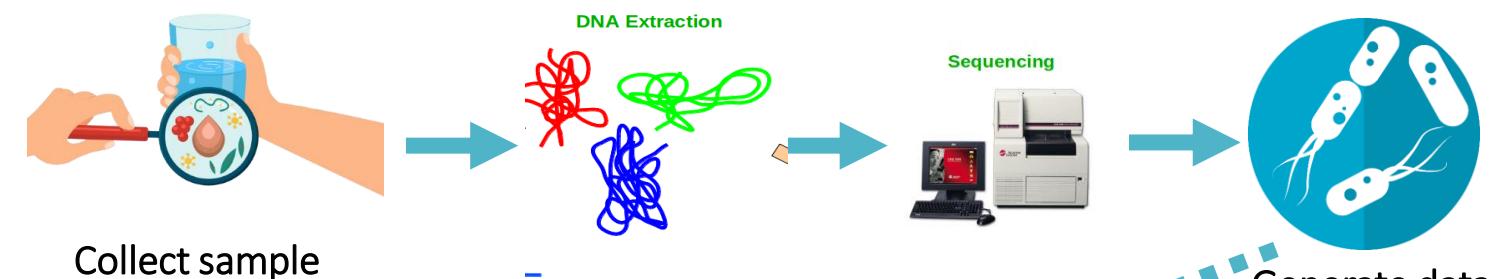
How do they interact?

Microbial CommunityMicrobiota & Microbiome

Microbial communities



Obtaining microbiome data



Properties / Features

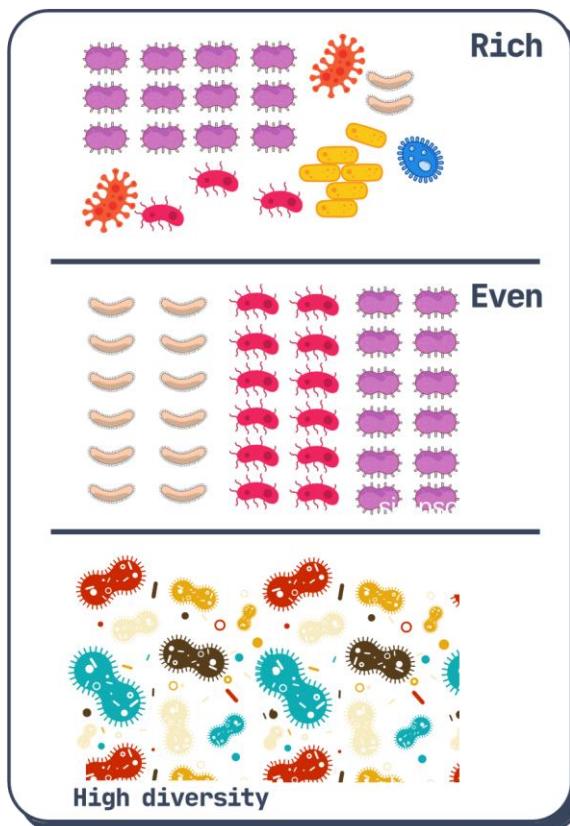
1. Bacteria 1 (F1)
2. Bacteria 2 (F2)
3. Bacteria 3 (F3)
4. Bacteria 4 (F4)
5. Bacteria 5 (F5)
6. Bacteria 6 (F6)
7. Bacteria 7 (F7)

Features

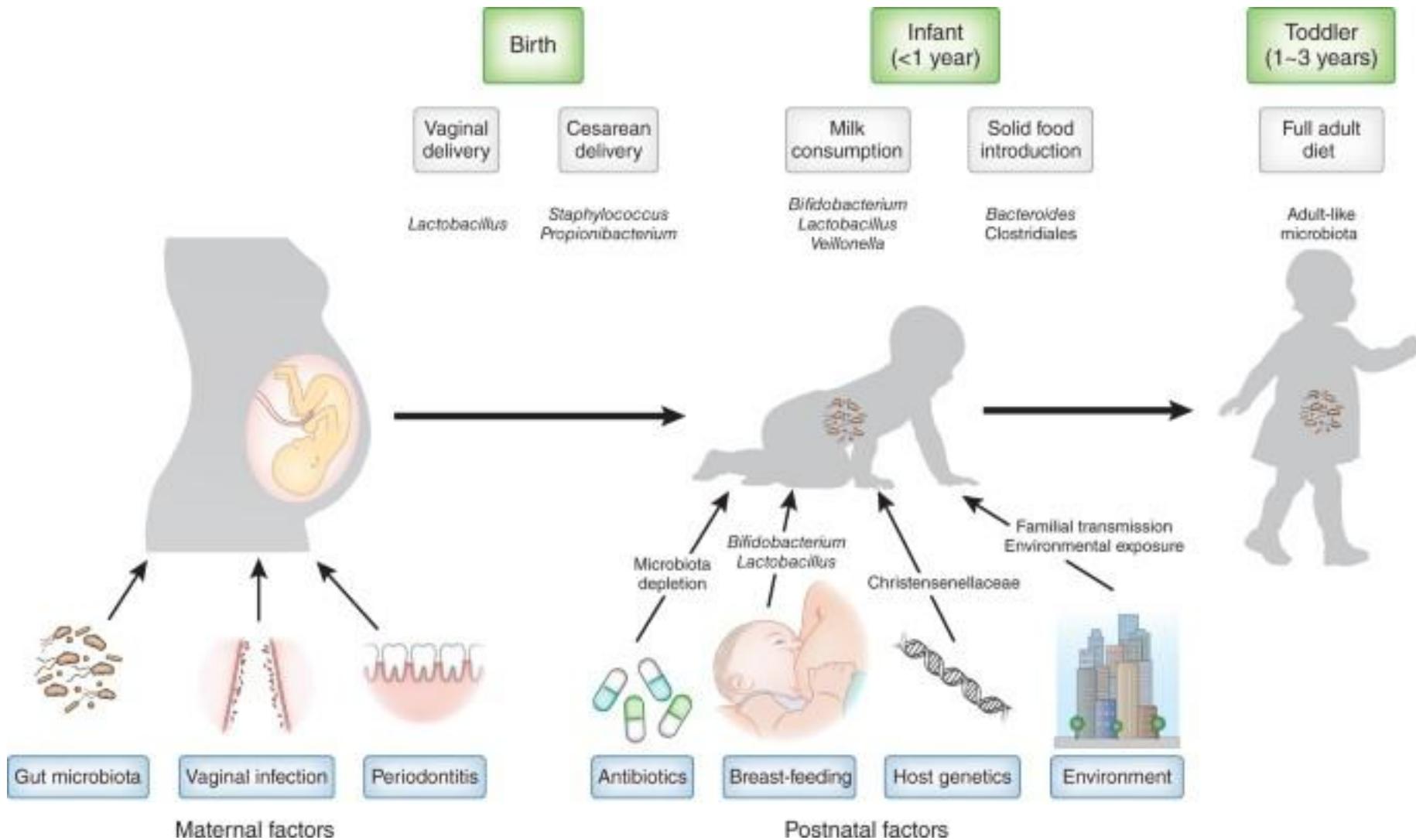
I	A1	...	An	B1	...	Bn	C1	..	Cn
F1	Ecosystem 1			Ecosystem 2			Ecosystem 3		
.									
Fn									

A multivariate data with bacteria as features

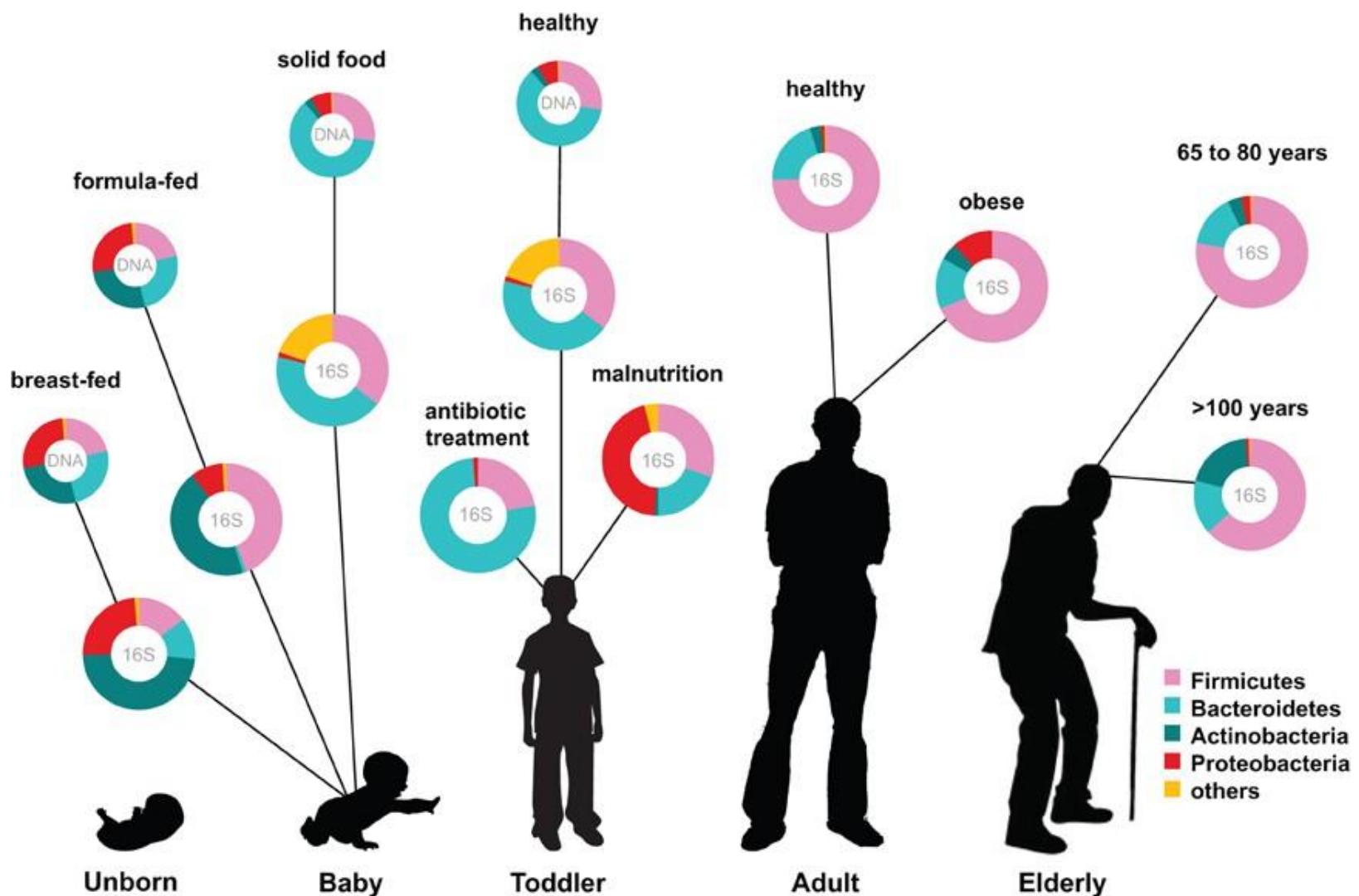
- What microbes are there and what are their relative proportions?
- How do they function?
- What functional genes do they have?
- Discover signatures



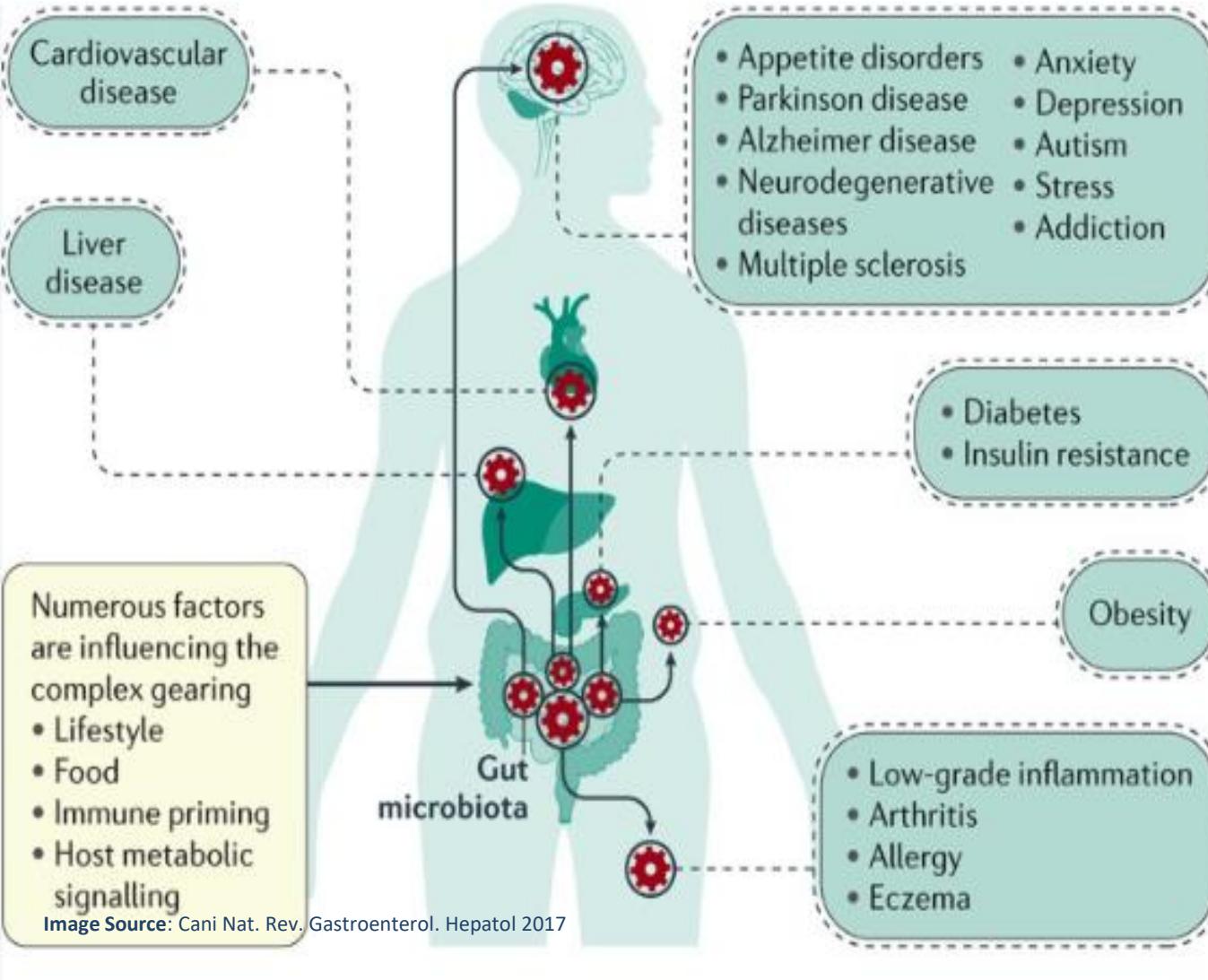
Development of human microbiome (from birth.....)



Gut microbiome: Diversity across various life stages



Importance of Gut microbiome



We are what we eat

Diet, Microbiota and Gut-Lung Connection

Swadha Anand and Sharmila S. Mande*

ORIGINAL RESEARCH
published: 18 December 2019
doi: 10.3389/fnins.2019.01365

Tryptophan Metabolism by Gut Microbiome and Gut-Brain-Axis: An *in silico* Analysis

Harrisham Kaur¹, Chandrani Bose¹ and Sharmila S. Mande*

npj | biofilms and
microbiomes

www.nature.com/npjbiofilms

REVIEW ARTICLE OPEN

Host-microbiome interactions: Gut-Liver axis and its connection with other organs

Swadha Anand^{1,2} and Sharmila S. Mande^{3,4}

[Check for updates](#)

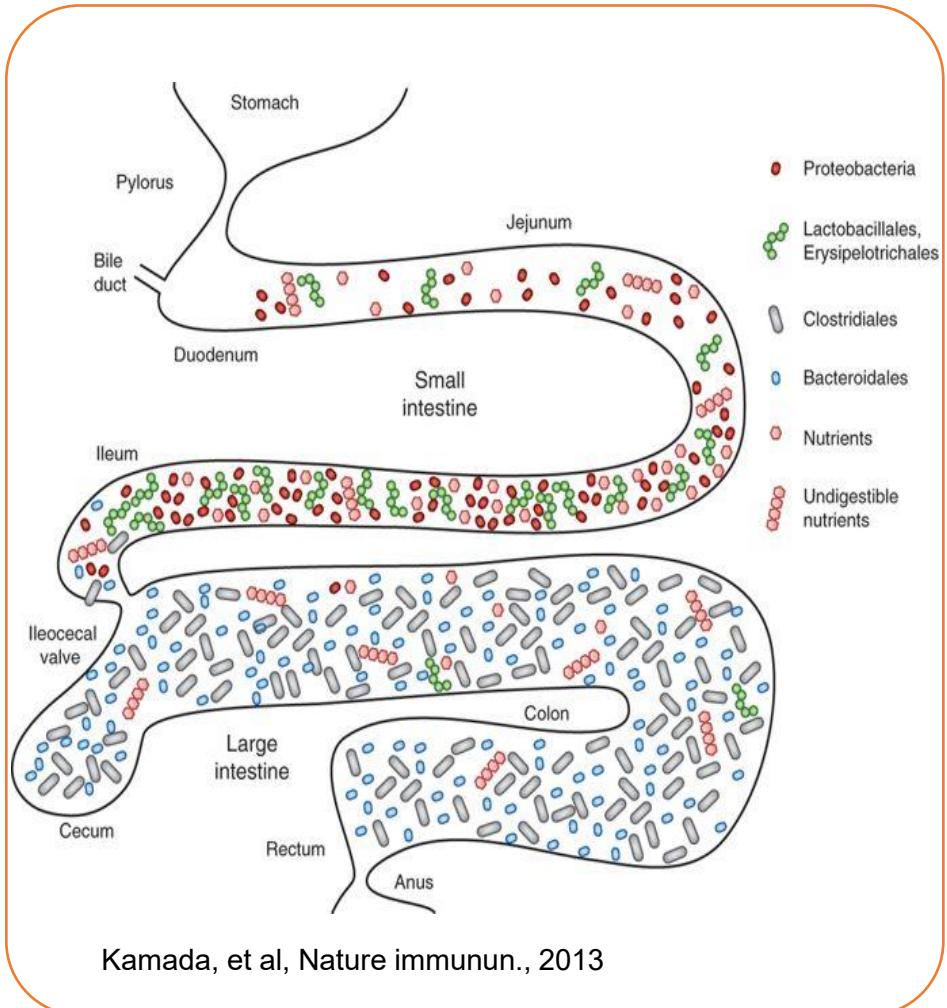
Ayurveda concepts

Pachakaagni (Digestion)

Dhatvaagni (cellular activity)

Bhutagni (Sub-cellular activity)

Diet, Digestion, Gut microbiome and *Doshas*



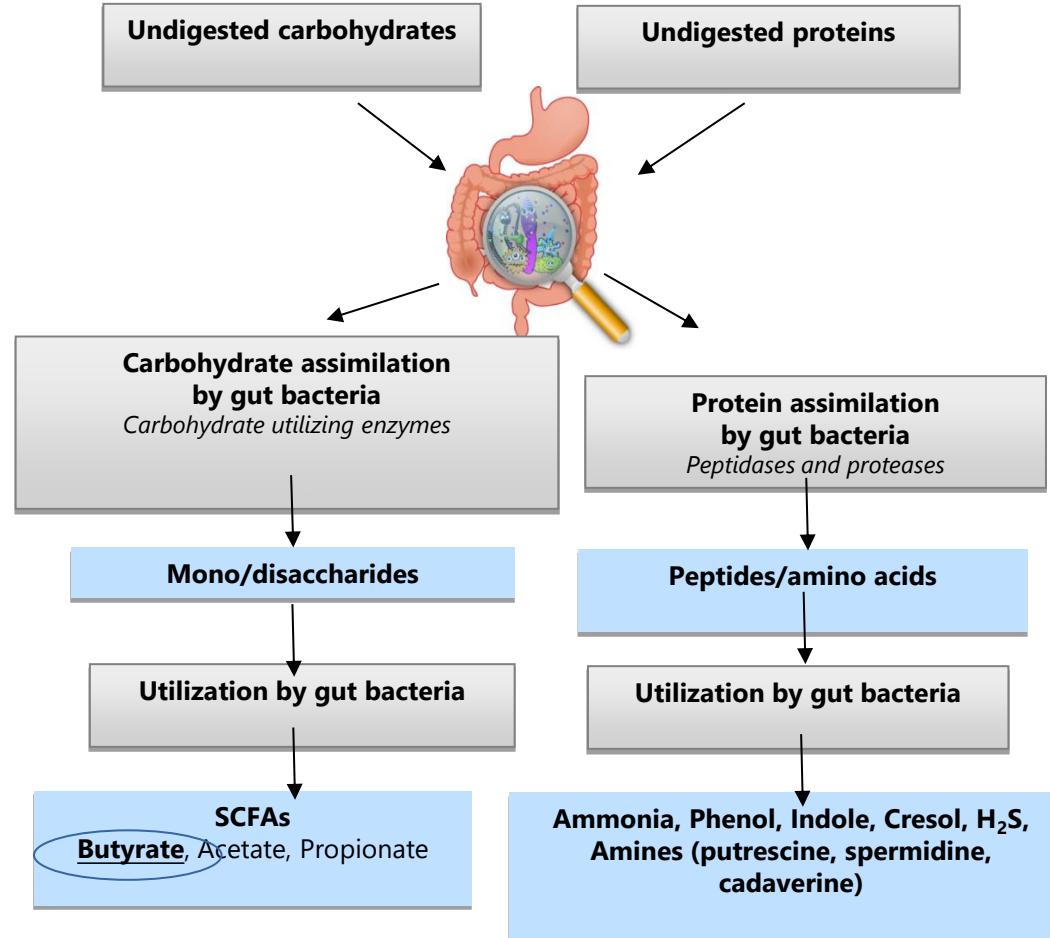
Ayurveda Concepts

Digestive capability of *doshas* phenotypes

Vata
Pitta
Kapha

Importance of understanding gut microbiome's functions

Understanding functional potential of Gut microbiome



Ayurveda concepts

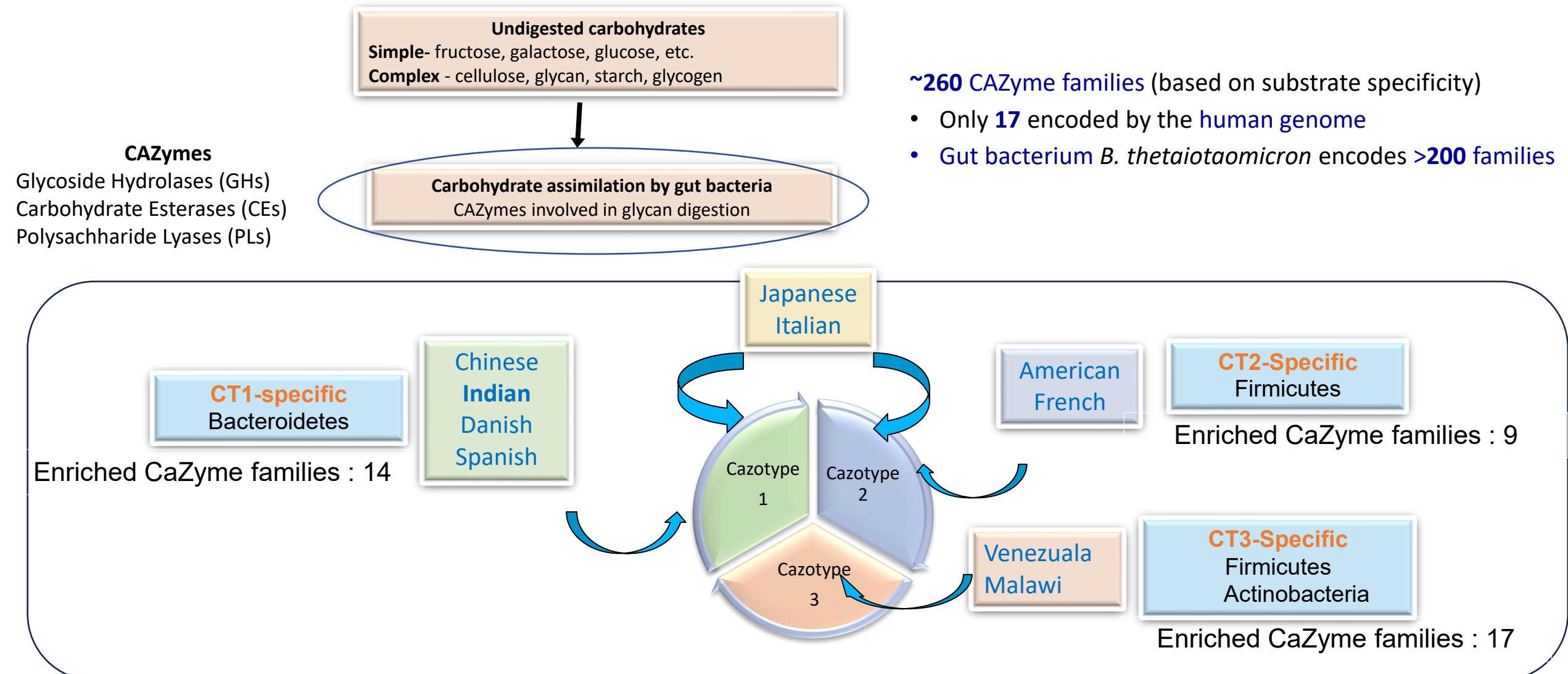
Dipan (digestion)
Pachan (assimilation)

Stratifications of population

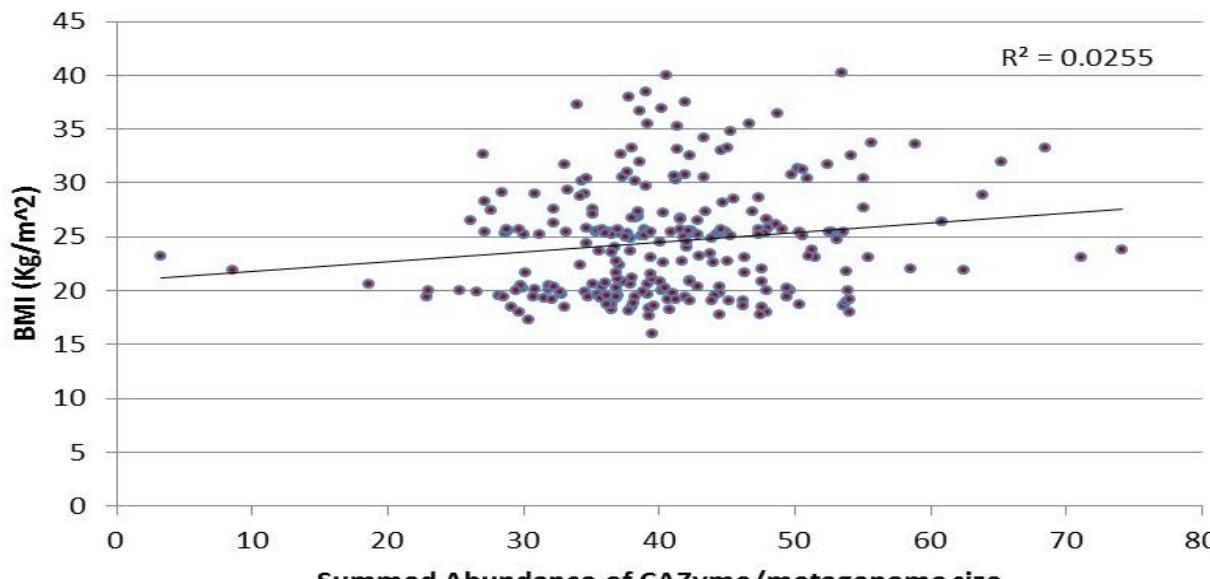
Dosha phenotype ↔ Gut microbiome signature

Can we derive a set of bacteria that can serve as reliable indicators of gut health status?

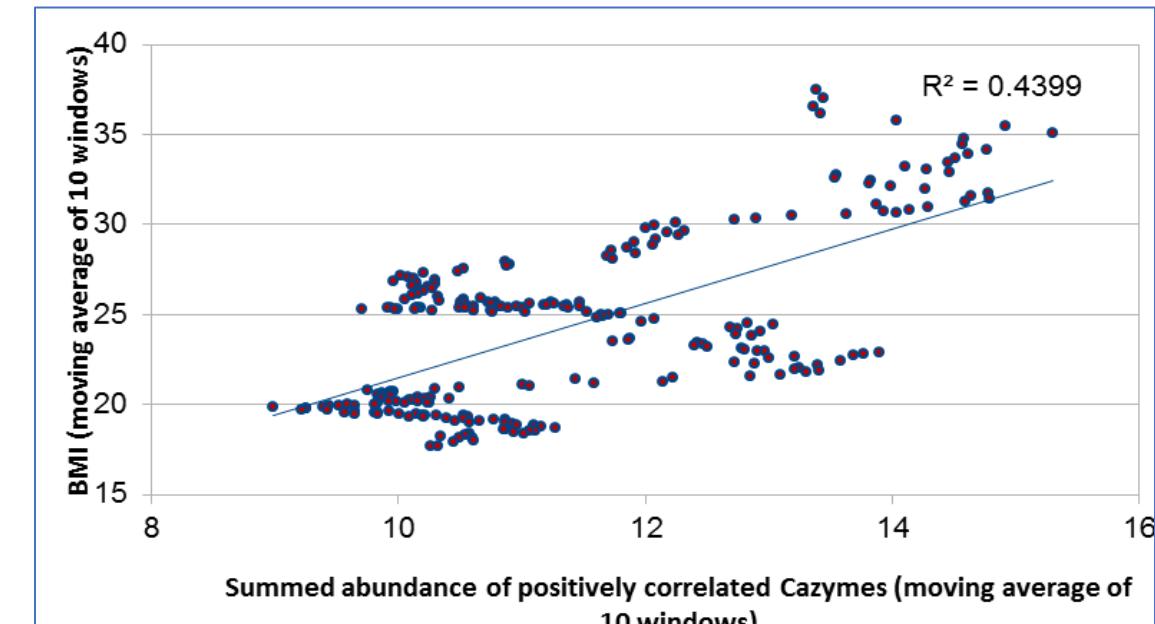
Assimilation of undigested carbohydrates by gut bacteria



Does BMI/Health status correlate with CAZyme profiles?



No correlation of gut CAZyme abundances with BMI



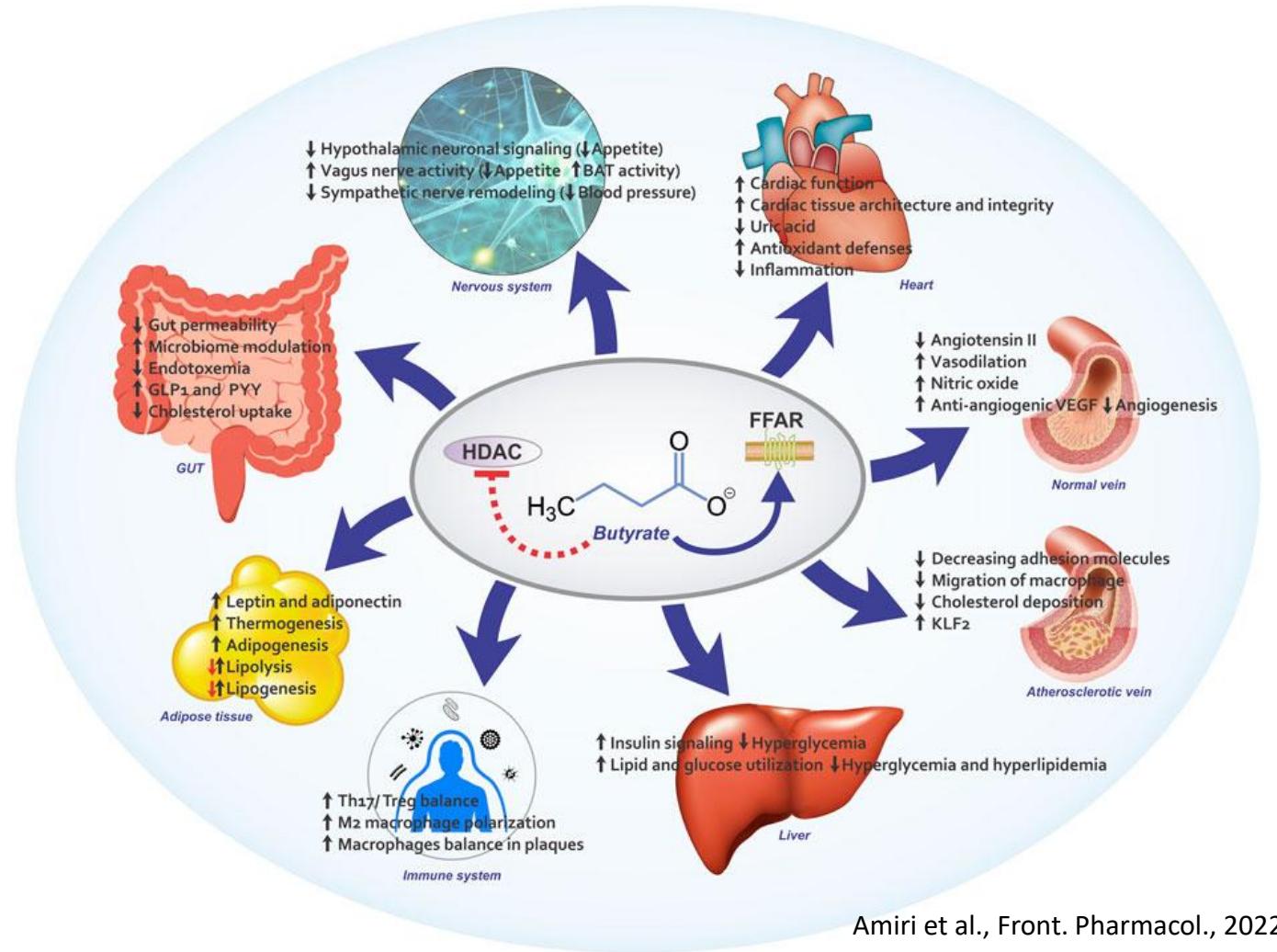
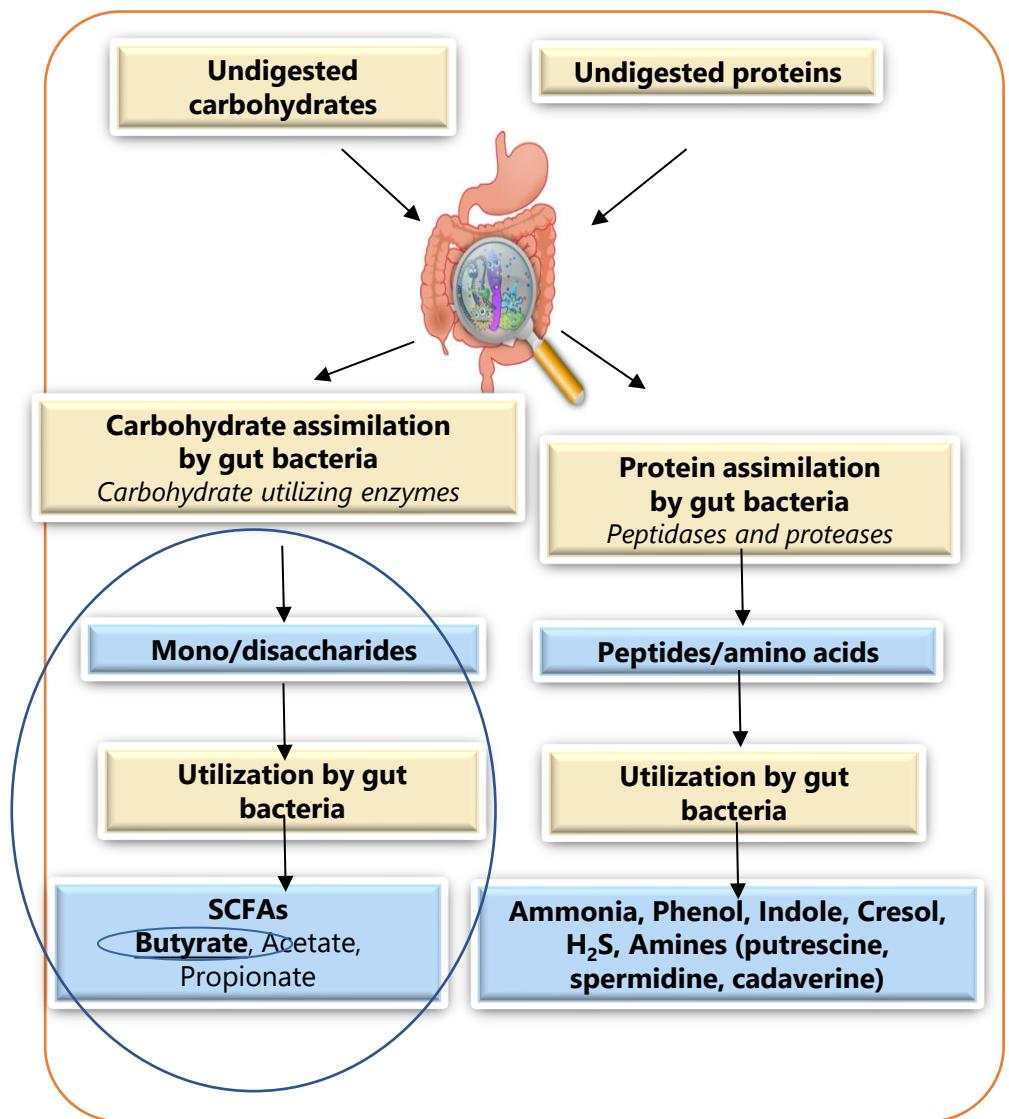
- 10 CAZyme families positively correlation with BMI
- Majority degrade Complex Carbohydrates

A specific group of CAZymes positively correlated with BMI

Firmicutes are the major contributors of the **BMI associated** families of CAZymes

CAZyme producers & obesity?

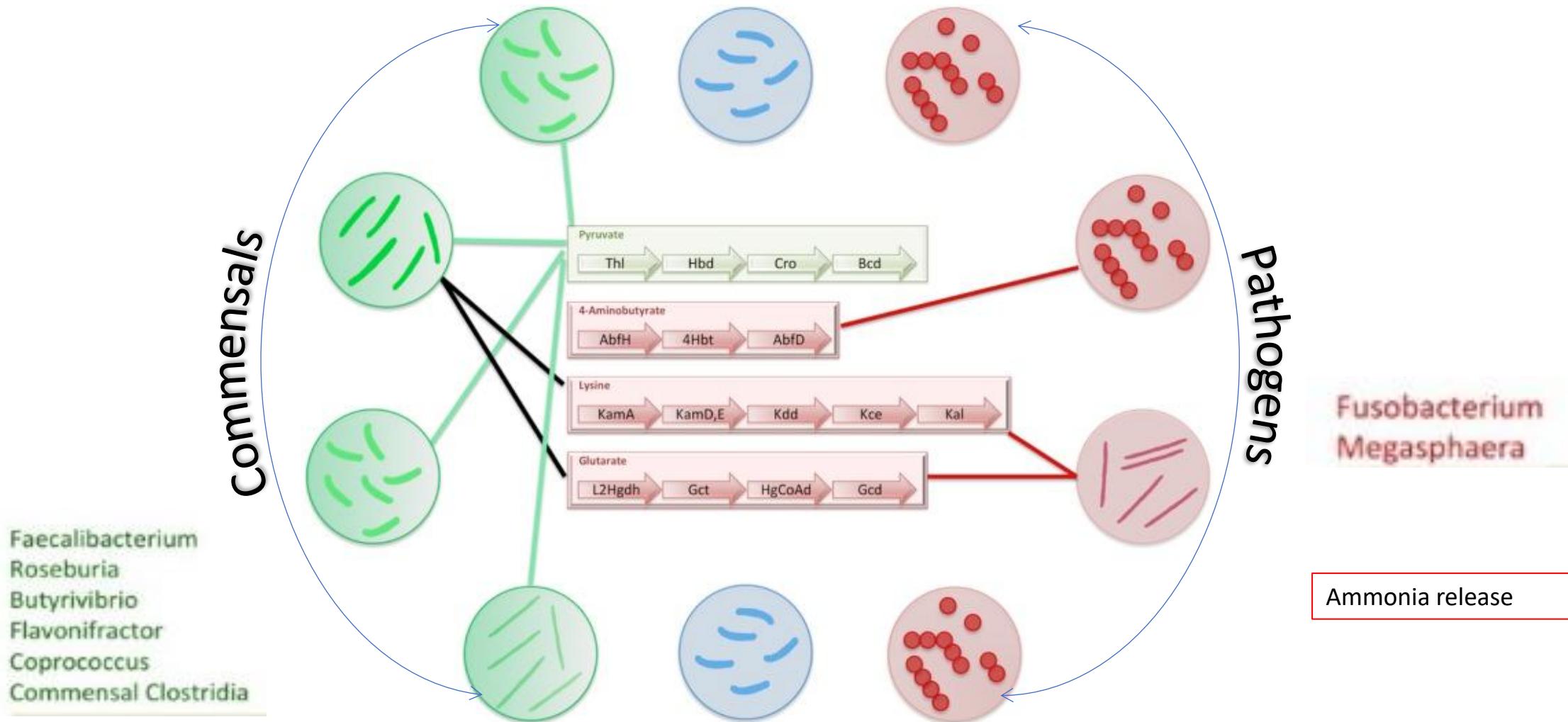
Conversion of Mono/disaccharides to SCFAs



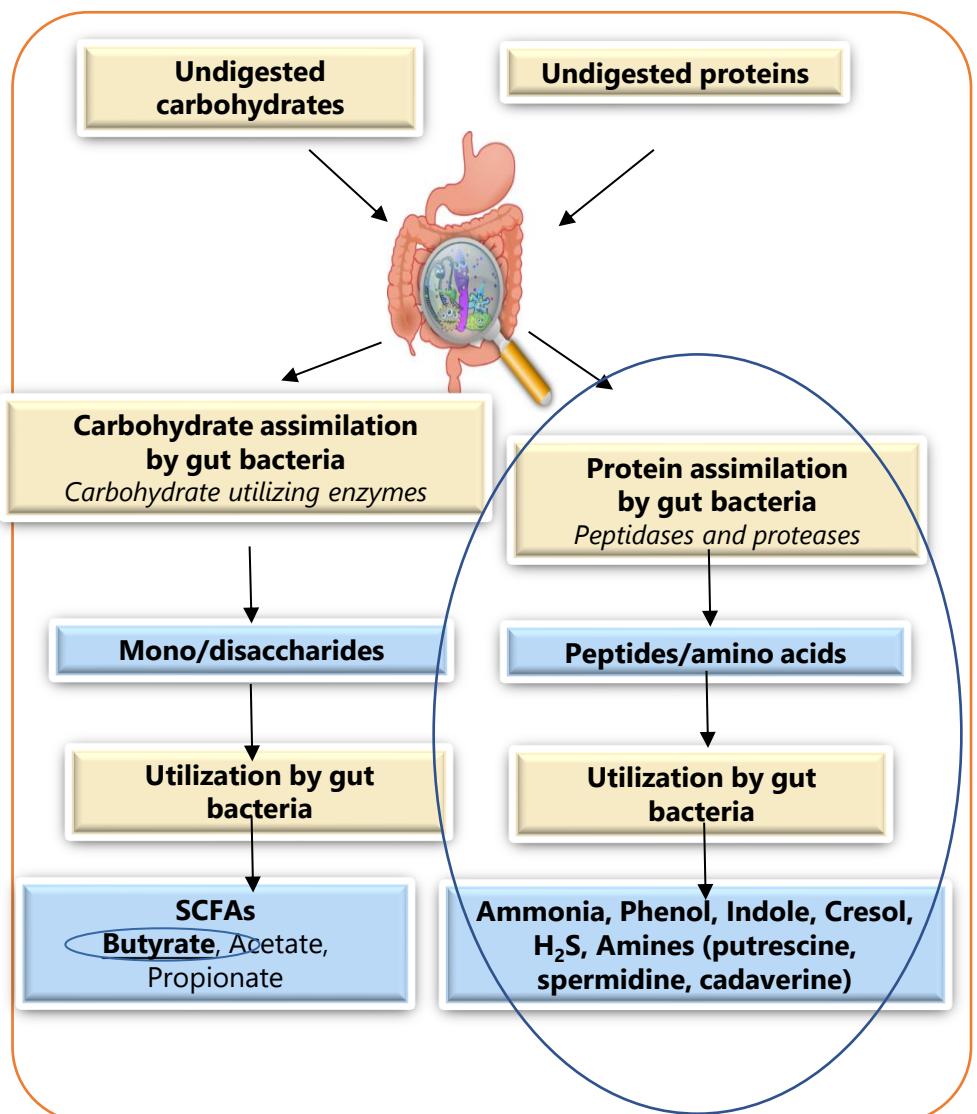
Amiri et al., Front. Pharmacol., 2022

Butyrate influences health of multiple organs

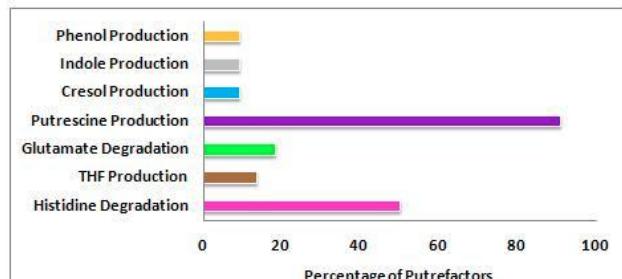
Butyrate producers by commensals and pathogens



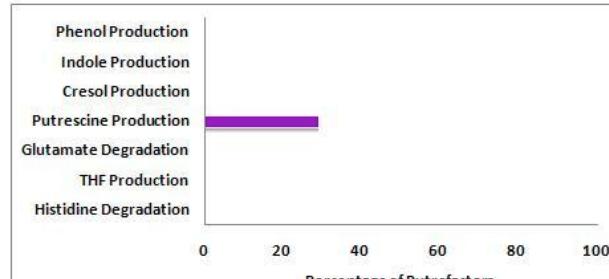
Putrefaction Pathways in commensals and pathogens



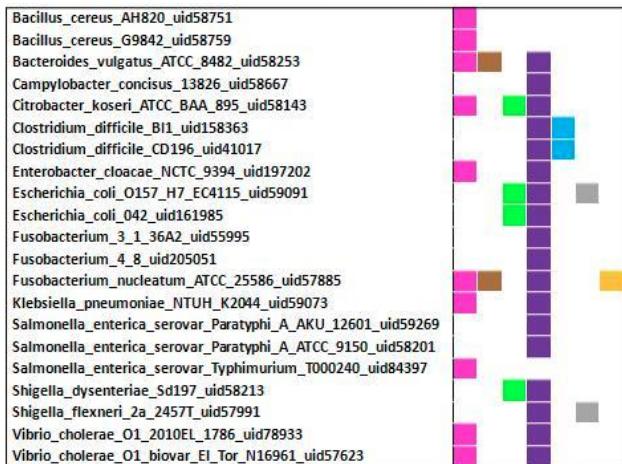
(A) Overall pathway profile of pathogenic group



(B) Overall pathway profile of commensal group



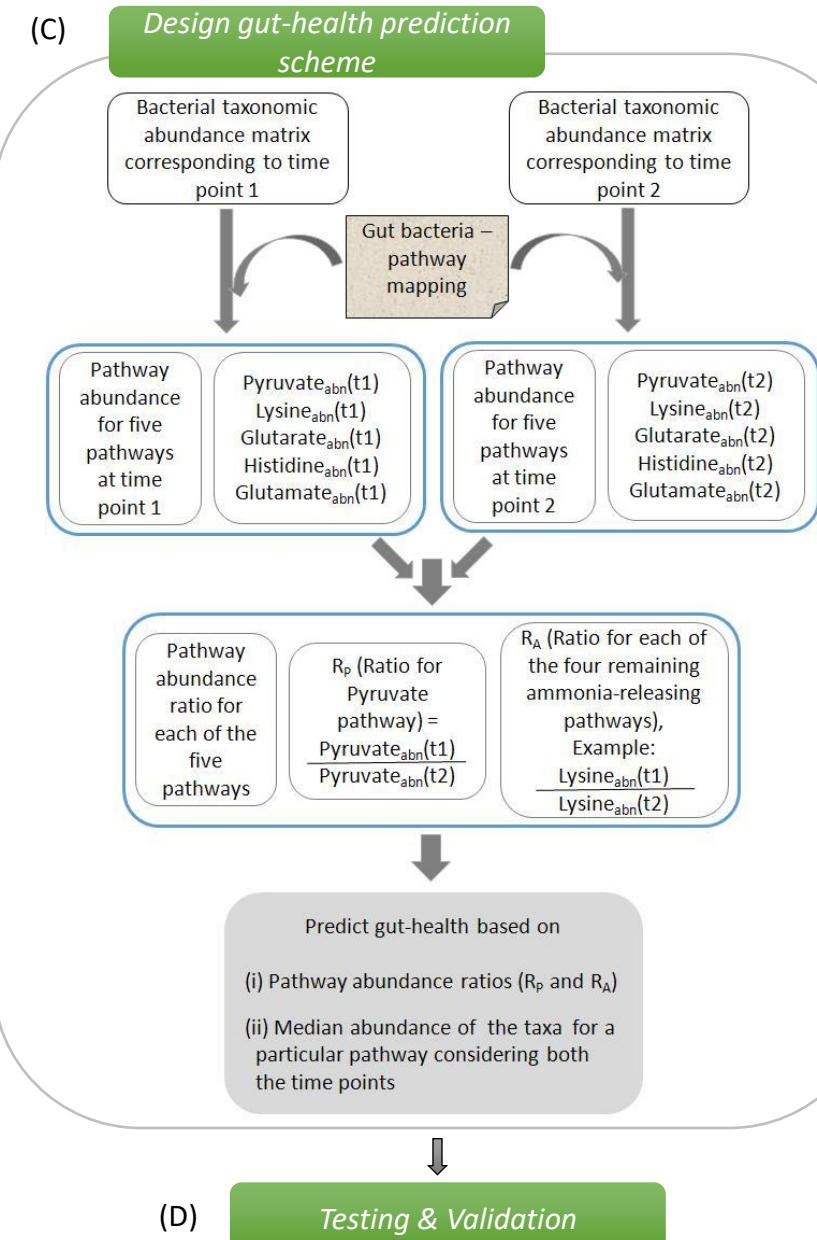
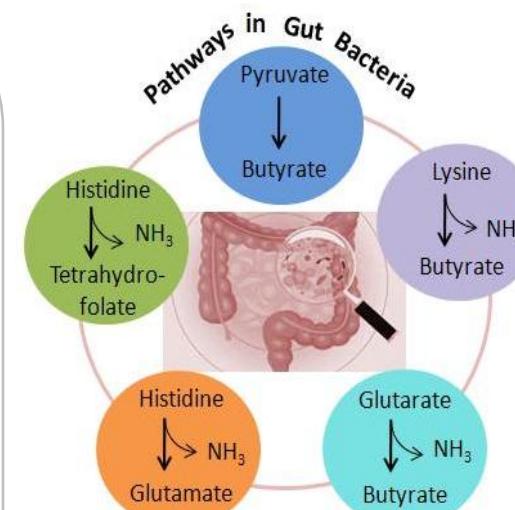
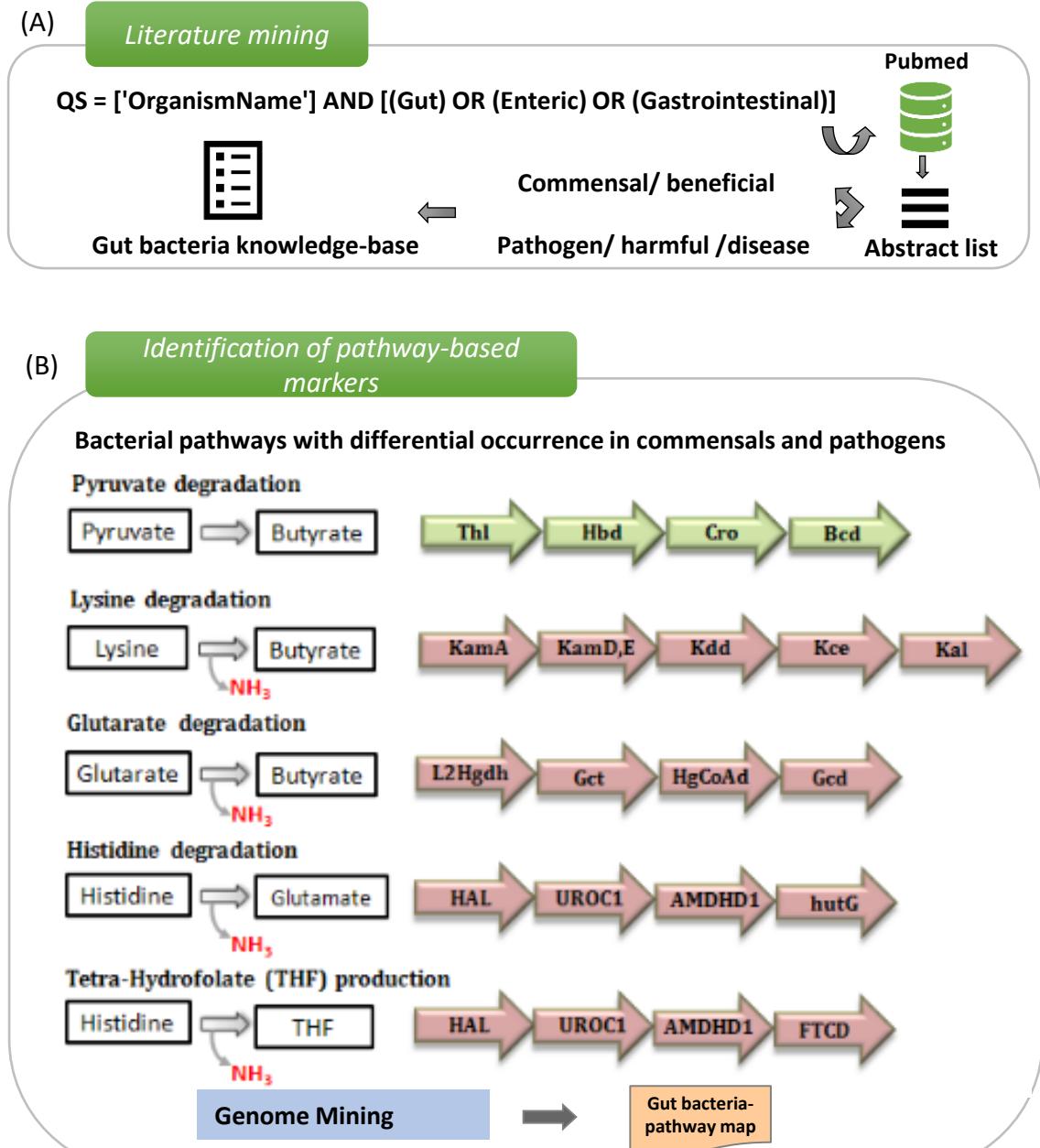
(C) Pathway profile in individual pathogen



(D) Pathway profile in individual commensal

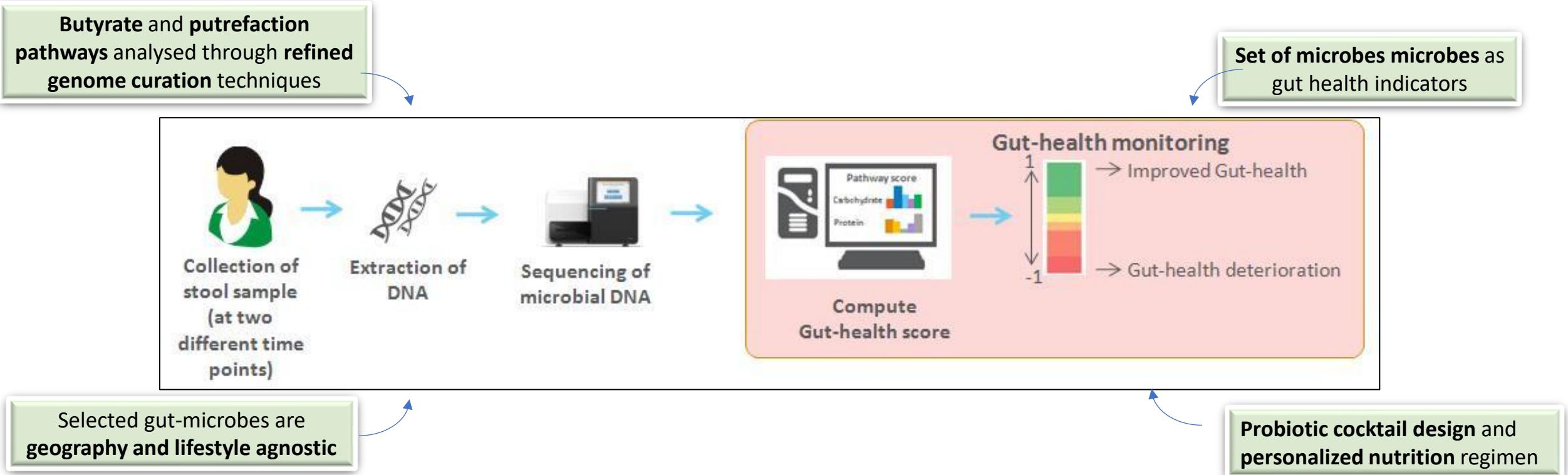


Gut Health using Pathway markers



Bhatt et al., **Front. Microbiol.**, 218
 Anand et al., **Bioinformatics**, 2019
 Kaur et al., **Front. Microbiol.**, 2017
 Anand et al., **FEBS Lett.**, 2021

Gutfeel: Monitoring Gut health



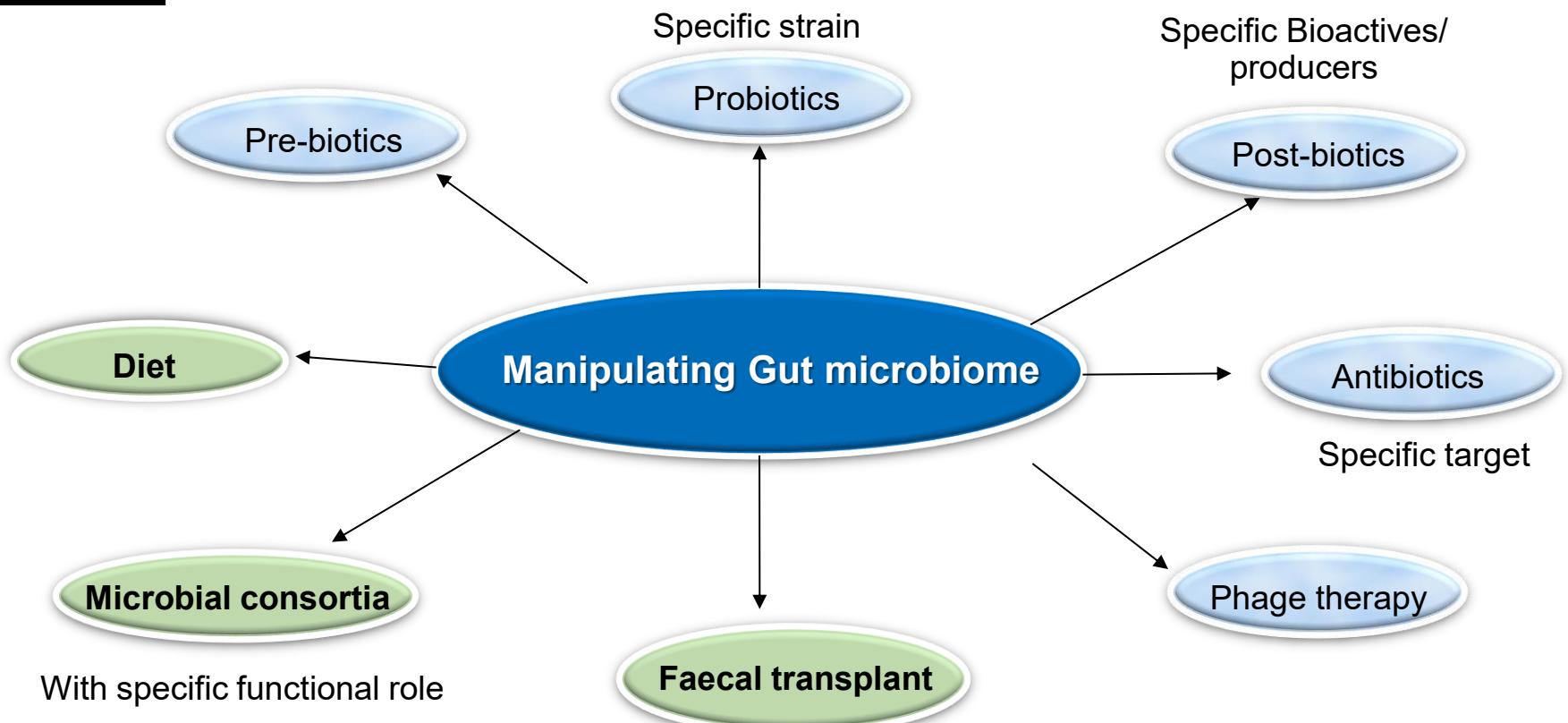
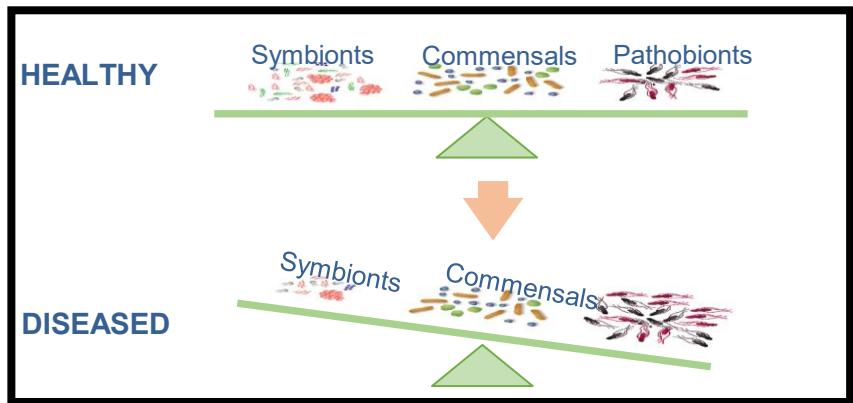
Validation on microbiome datasets from ~500 subjects suffering from diseases including-

- IBD
- Obesity
- Diabetes
- CRC
- *C.diff* infections
- NAFLD
- Asthma
- Cystic Fibrosis
- Parkinson's
- Autism

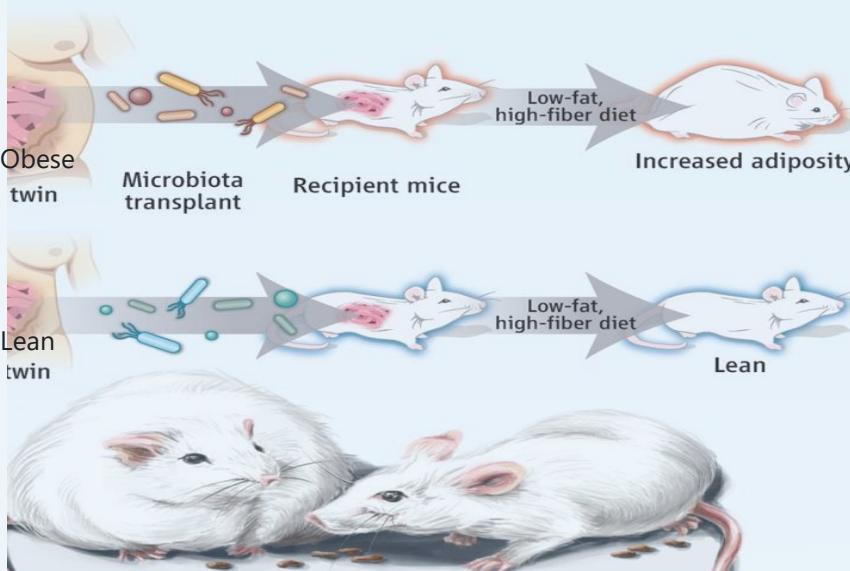
Ayurveda

Gut microbes post health improvement

Microbiome- based therapeutics



Altering Gut Microbiome: Faecal Transplant



Science, Vol. 341 no. 6150 (2013)



U.S. FOOD & DRUG ADMINISTRATION

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FDA NEWS RELEASE

FDA Approves First Orally Administered Fecal Microbiota Product for the Prevention of Recurrence of Clostridioides difficile Infection

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04/26/2023



Microbiome- based therapeutics

Ayurveda concepts

Pathya (Diet)

Dipan (Digestion)

Pachan (Assimilation)

Agni (digestive power) to restore proper metabolic process

Shodhana (Detoxification/purification)

Virechana

Basti

Manipulating Gut microbiome

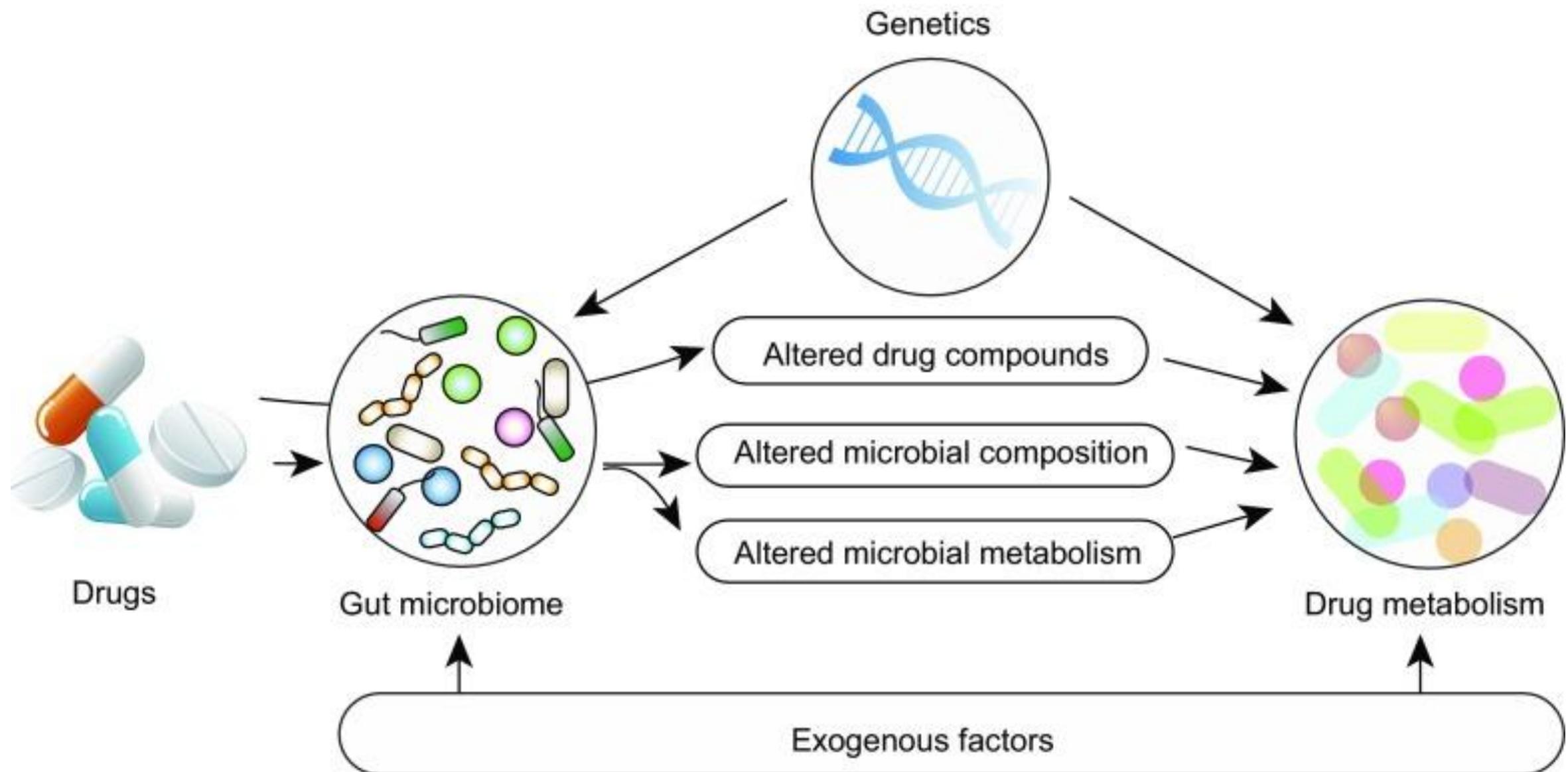
Faecal transplant

Microbial consortia

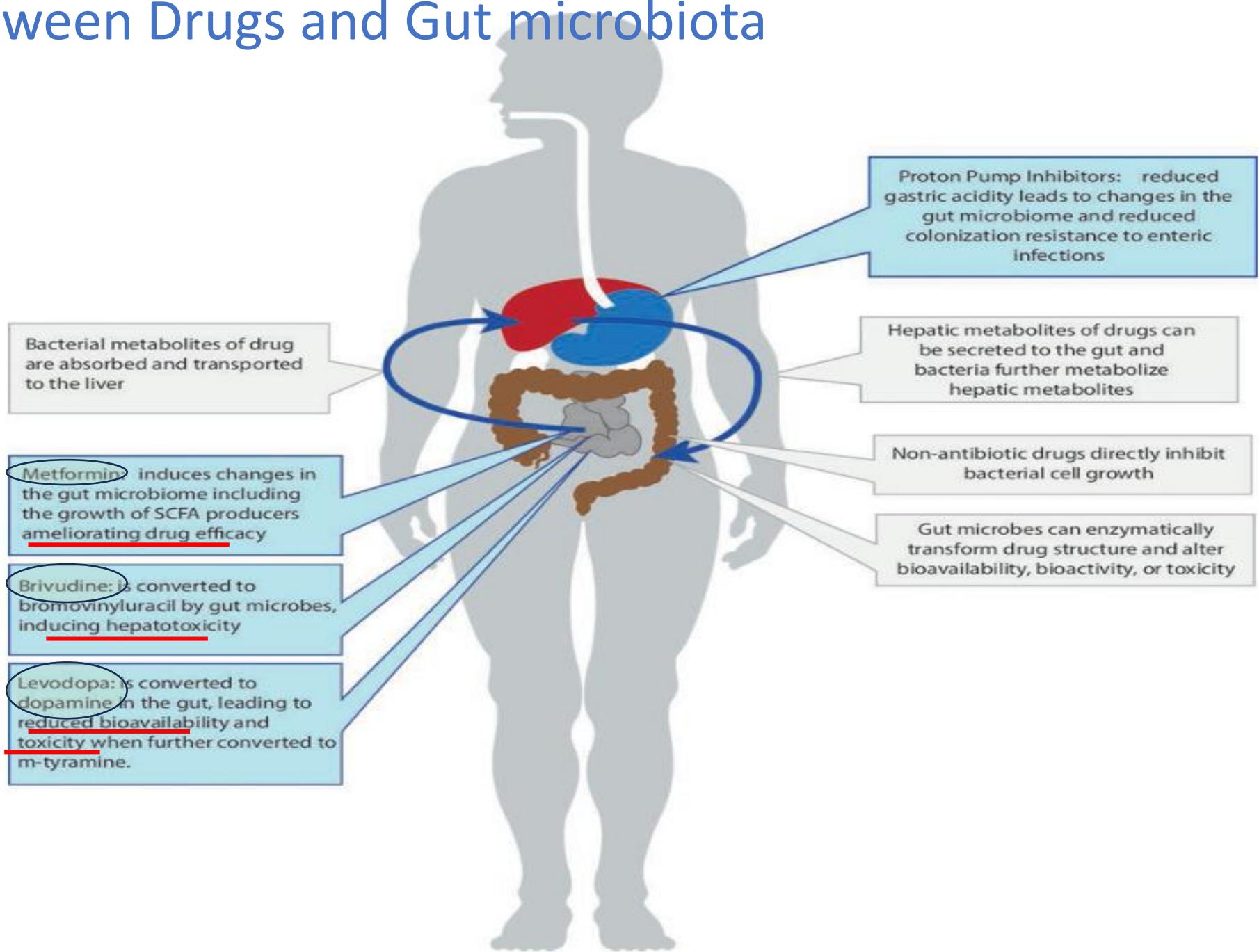
With specific
functional role

Diet

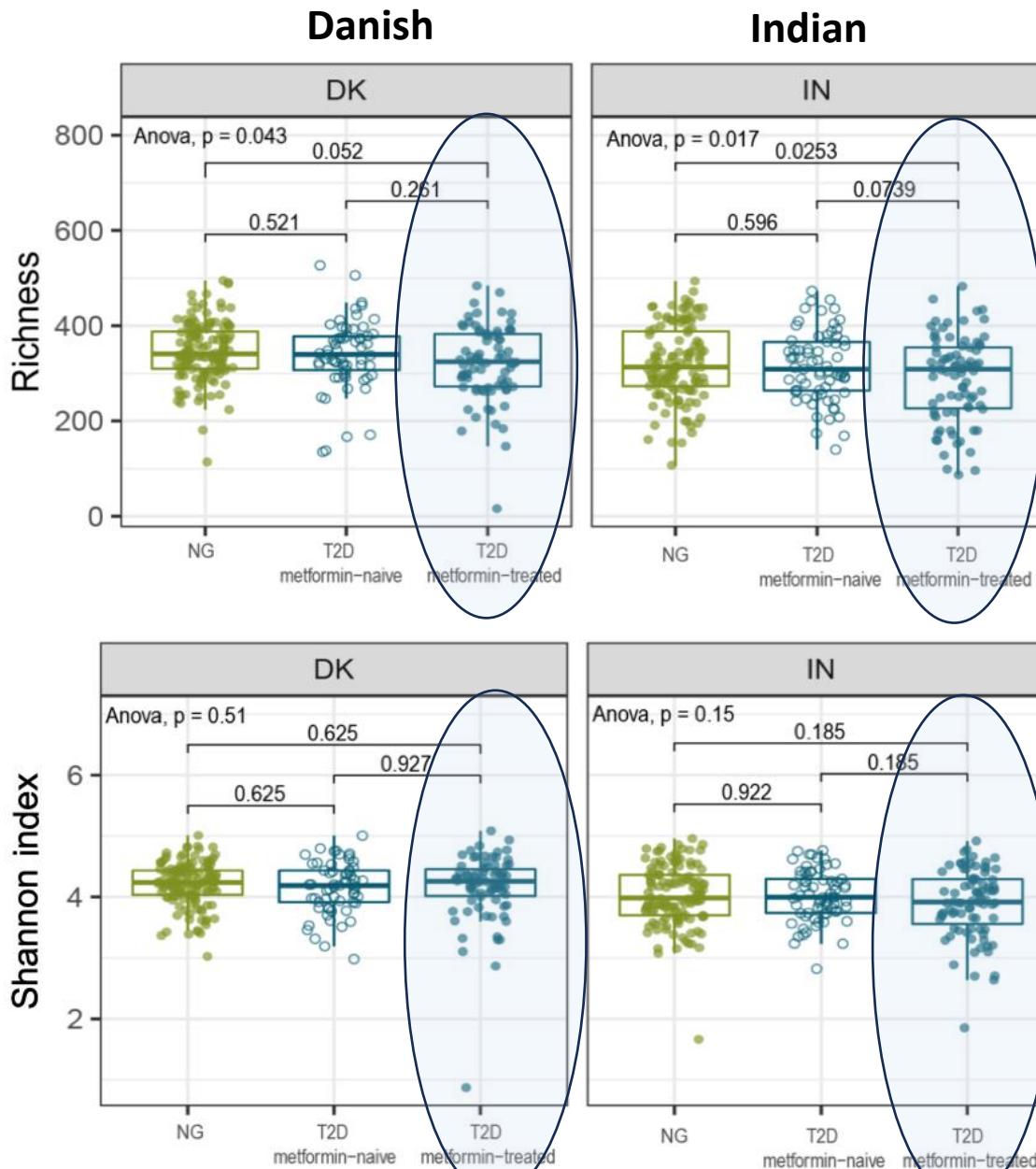
Aushadha-Microbiome interactions



Interactions between Drugs and Gut microbiota



Gut microbial richness of Metformin-treated T2D in India and Denmark



Danes and Indians

- Metformin alters gut microbial richness
- Gut microbial diversity reduced in metformin-treated T2D patients

Alvarez-Silva et al. *Genome Medicine* (2021) 13:37
<https://doi.org/10.1186/s13073-021-00856-4>

Genome Medicine

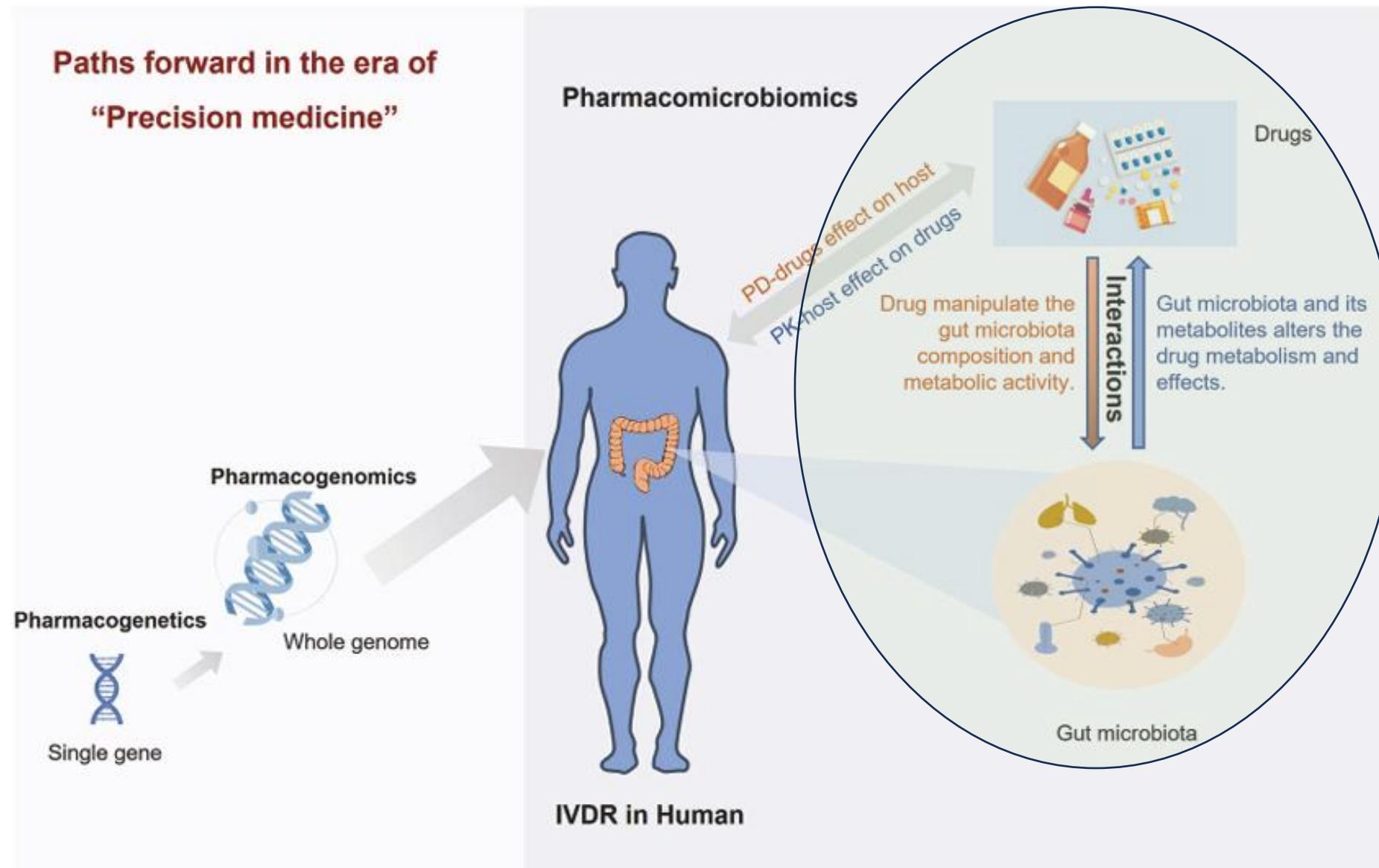
RESEARCH

Open Access

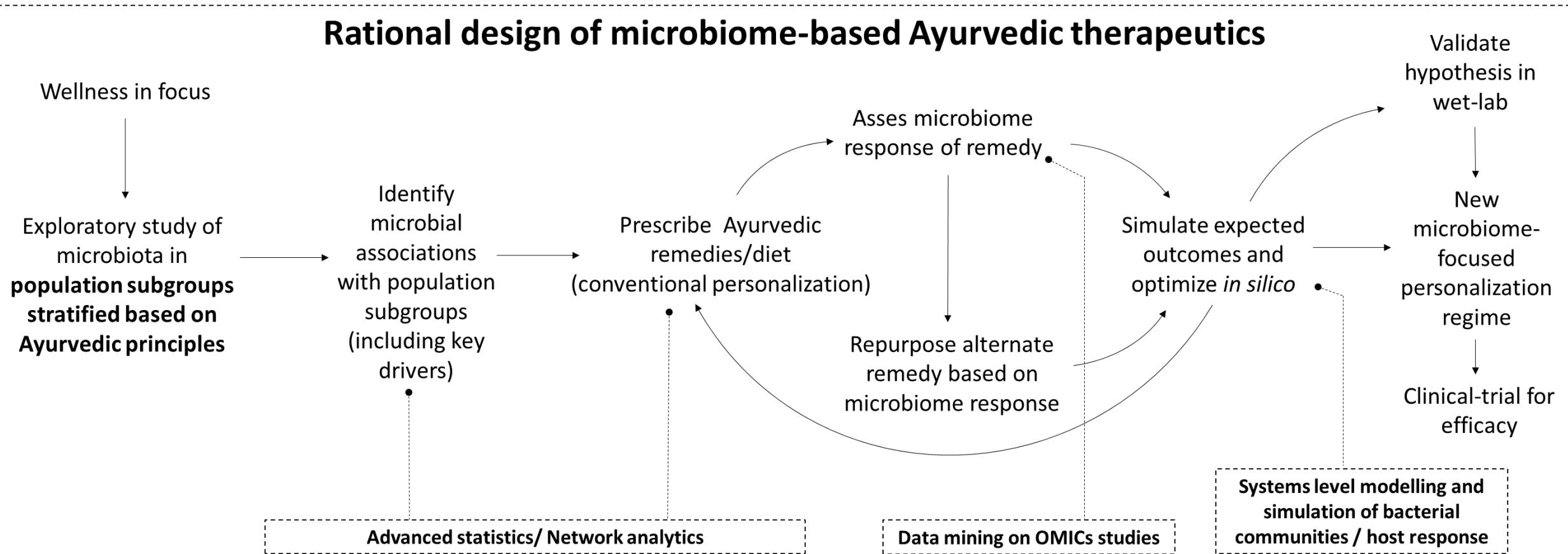
Trans-ethnic gut microbiota signatures of type 2 diabetes in Denmark and India



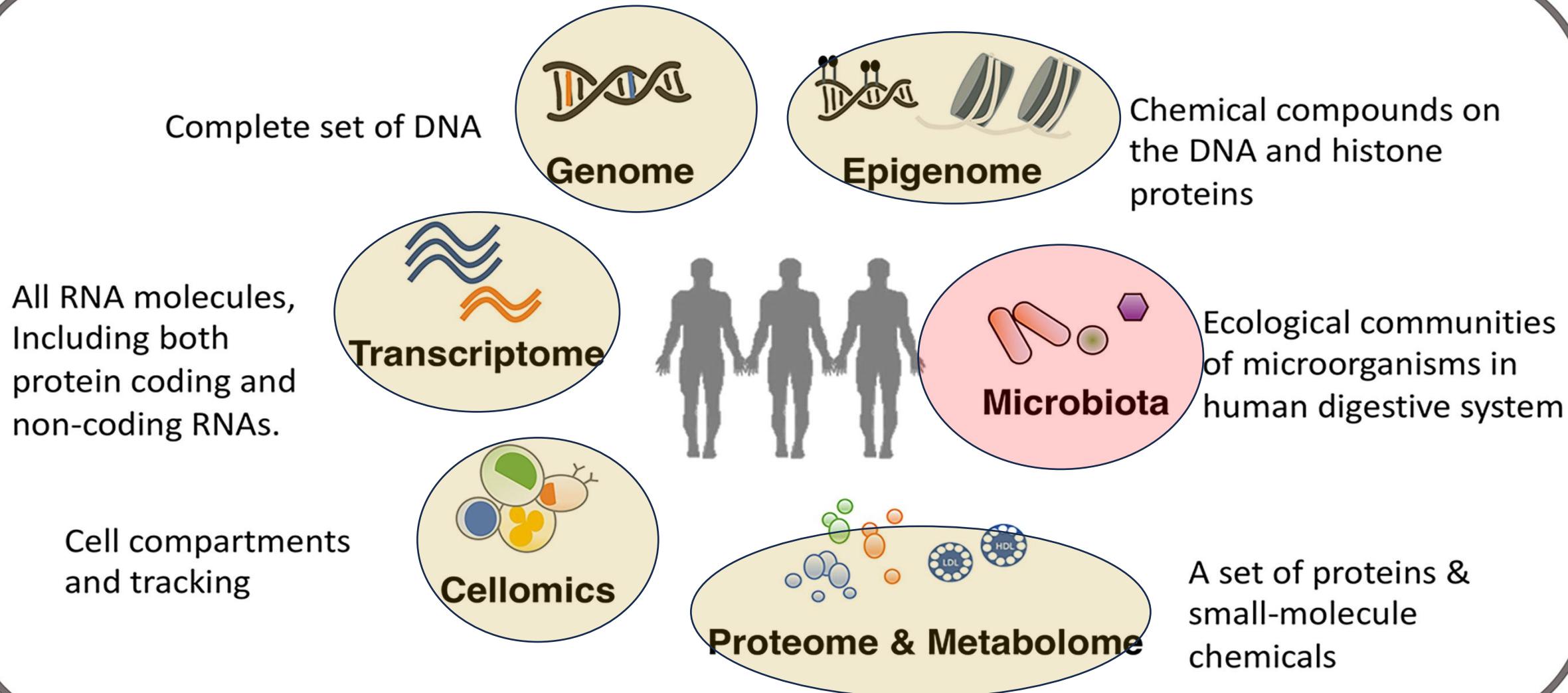
Importance of *Aushadha* – Microbiome interactions



Can we optimize gut health using Ayurvedic practices?



Understanding Health: Multi-Omics approach



Thank you