



HealthFerm

Innovative pulse and cereal-based food fermentations for human health and sustainable diets

How is our food digested?

Basic mechanisms of intestinal physiology

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Confederaziun svizra





The main nutrients in our food



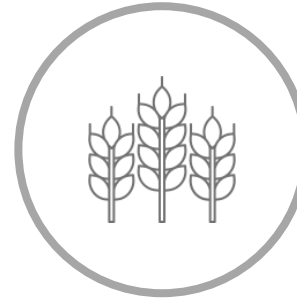
(Digestible)
carbohydrates &
sugars



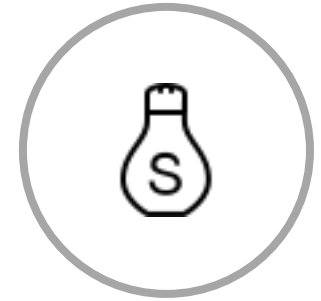
Proteins



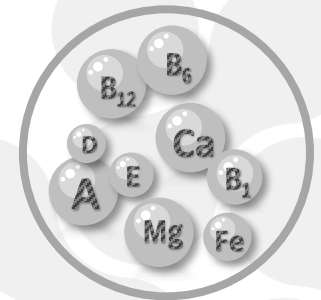
Lipids



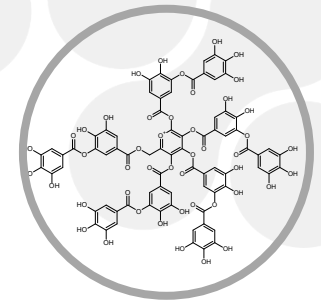
Fiber



Salt

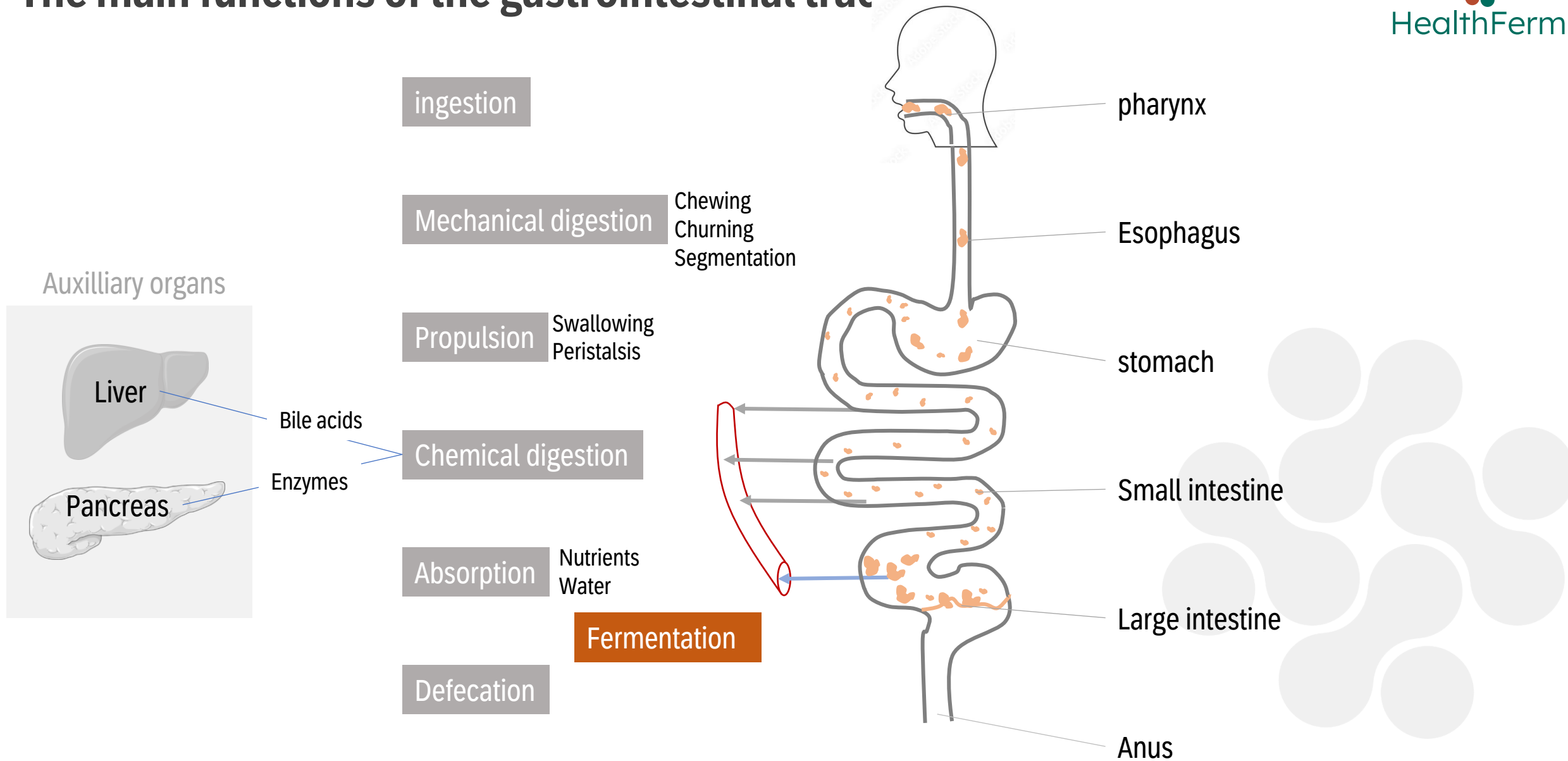


Vitamins
&
minerals

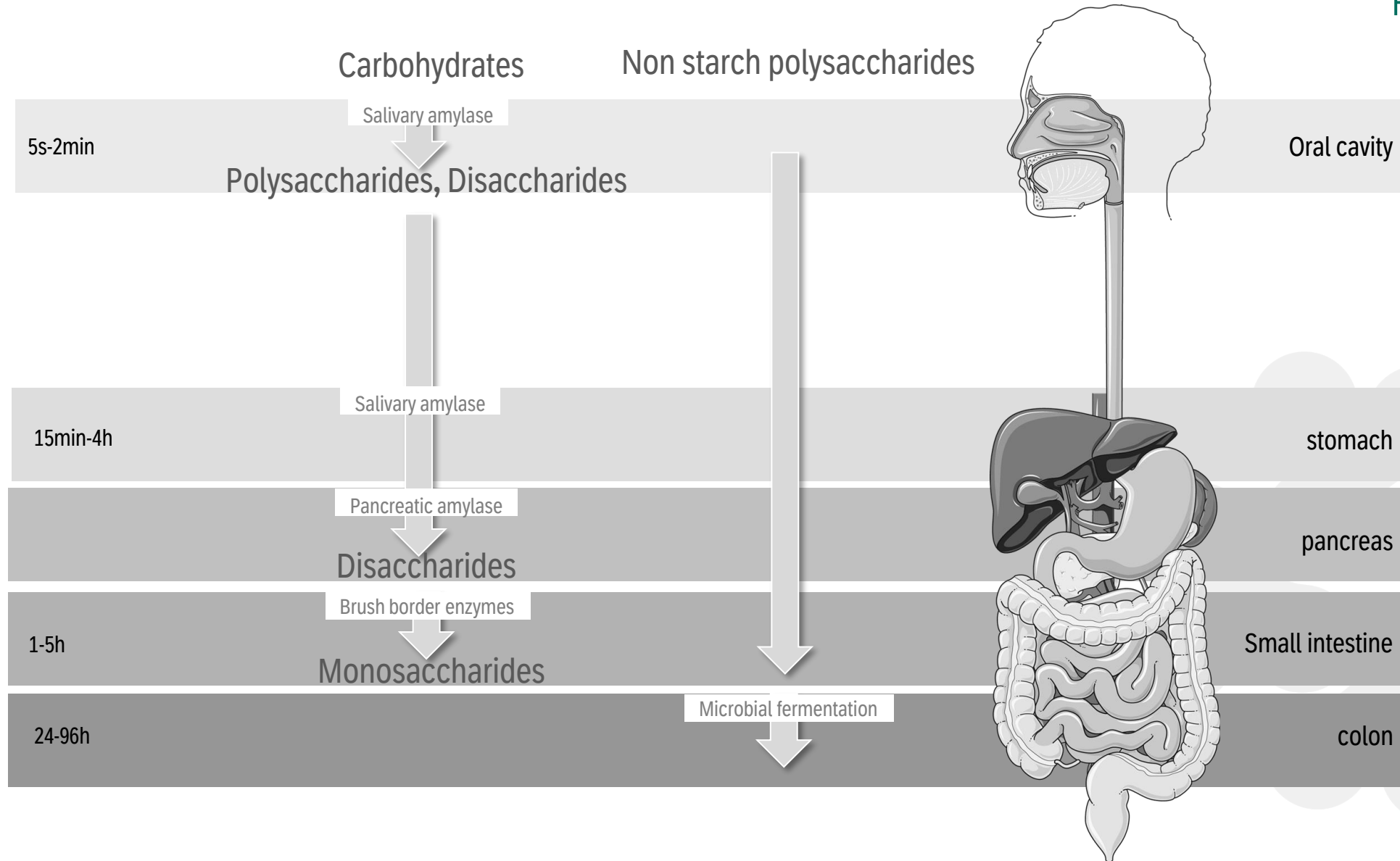


polyphenols

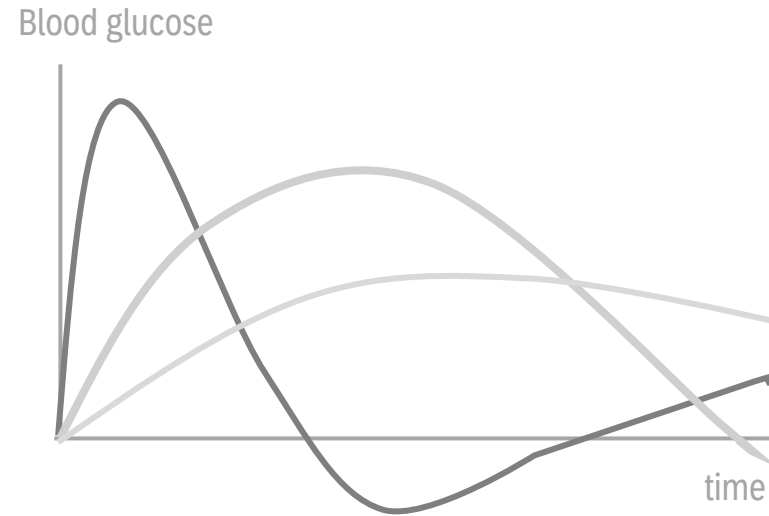
The main functions of the gastrointestinal tract*



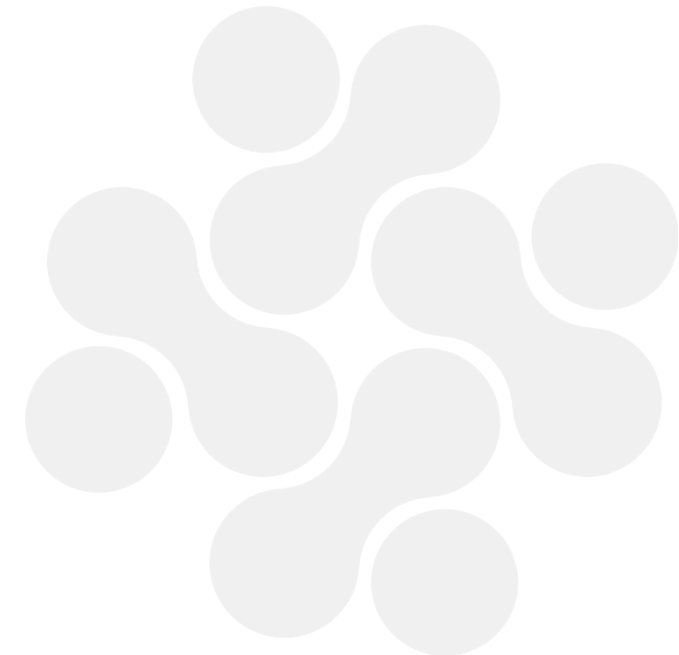
Digestion of Carbohydrates



Food properties influencing postprandial glycemic response



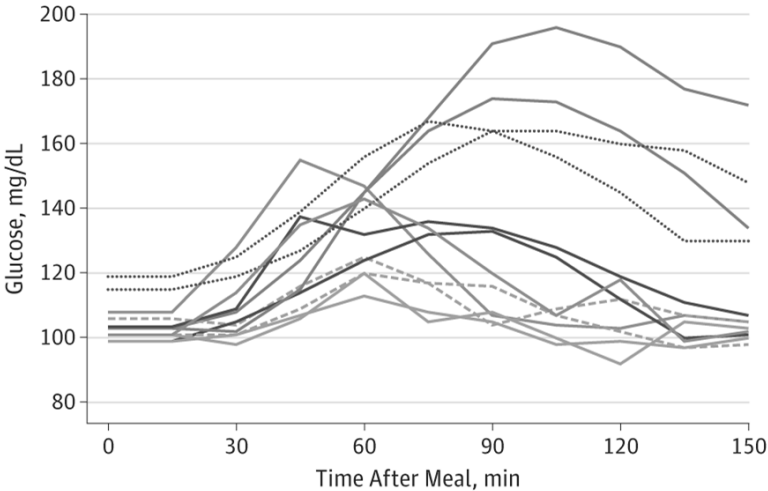
- Food texture \Rightarrow oral processing behaviour
- Starch crystallinity
- Botanical structure \Rightarrow accessibility of enzymes to starch
- Dietary fiber \Rightarrow viscous fiber reduces absorption of monosaccharides



Interindividual differences in postprandial glucose response

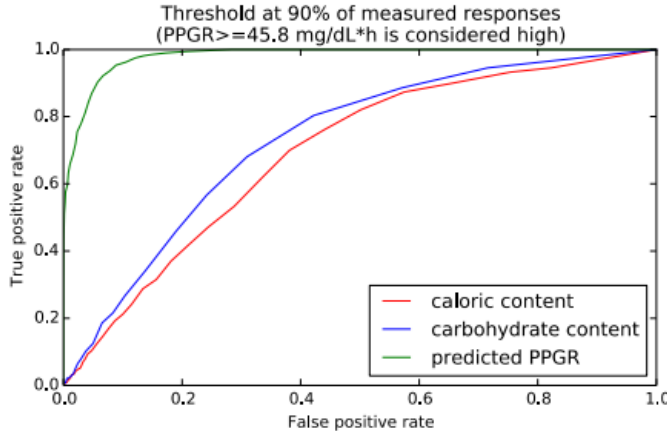
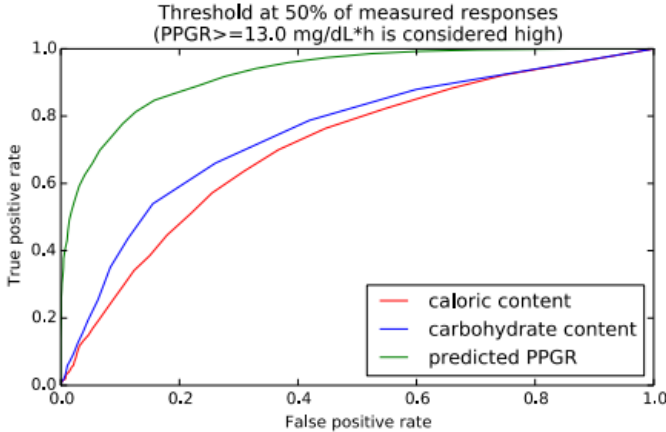


Glucose response to the same food in different participants



Predictive model (72 features)

- Meal features
- Meal context features
- blood tests
- personal features
- CGM derived features
- Microbiome features

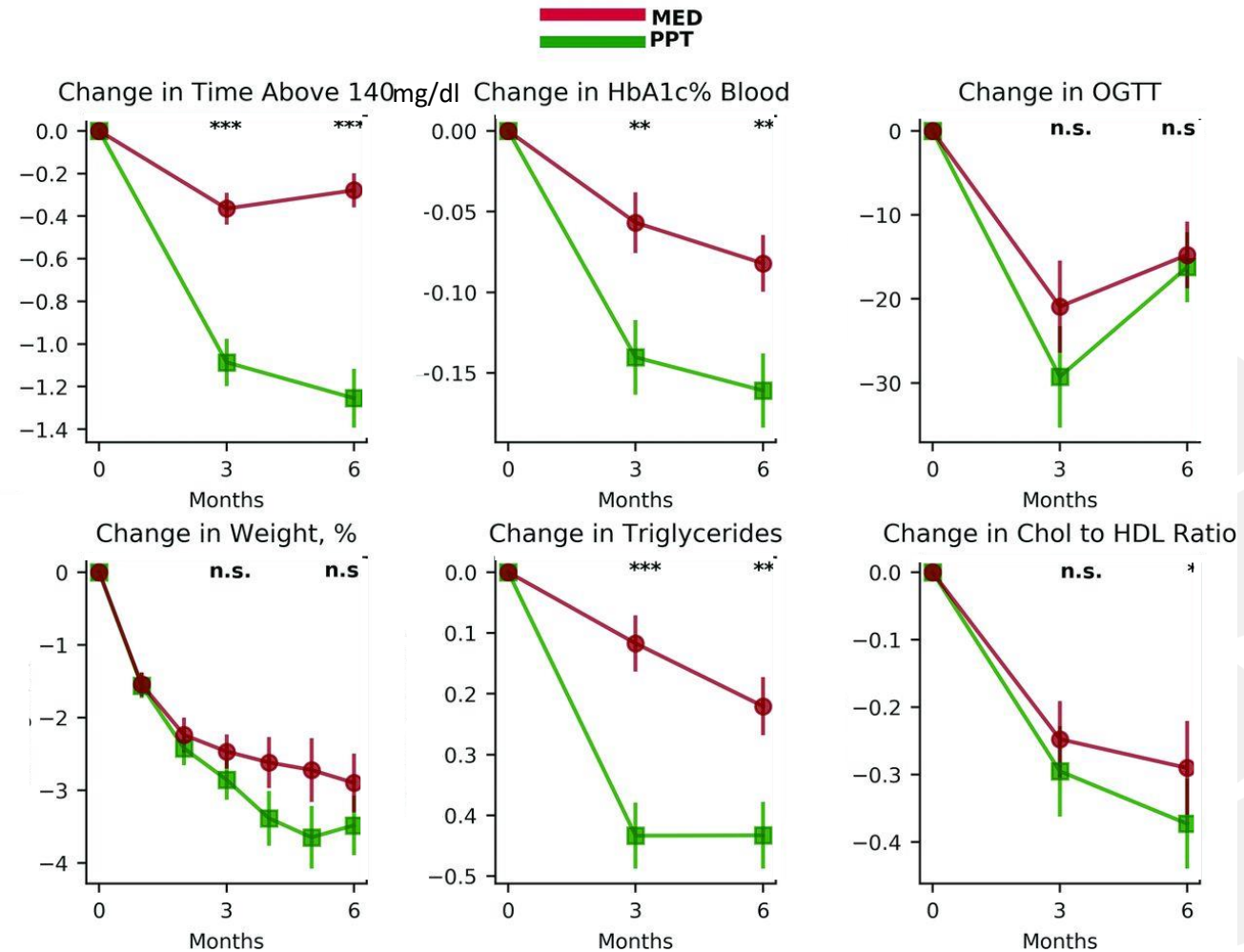


Personalised diet reduces PPGR more than mediterranean diet

N= 225
Prediabetes
Mediterranean diet: n=112
Personalised diet: n=113

6 month intervention

Personalised diet: meals were scored based on model features

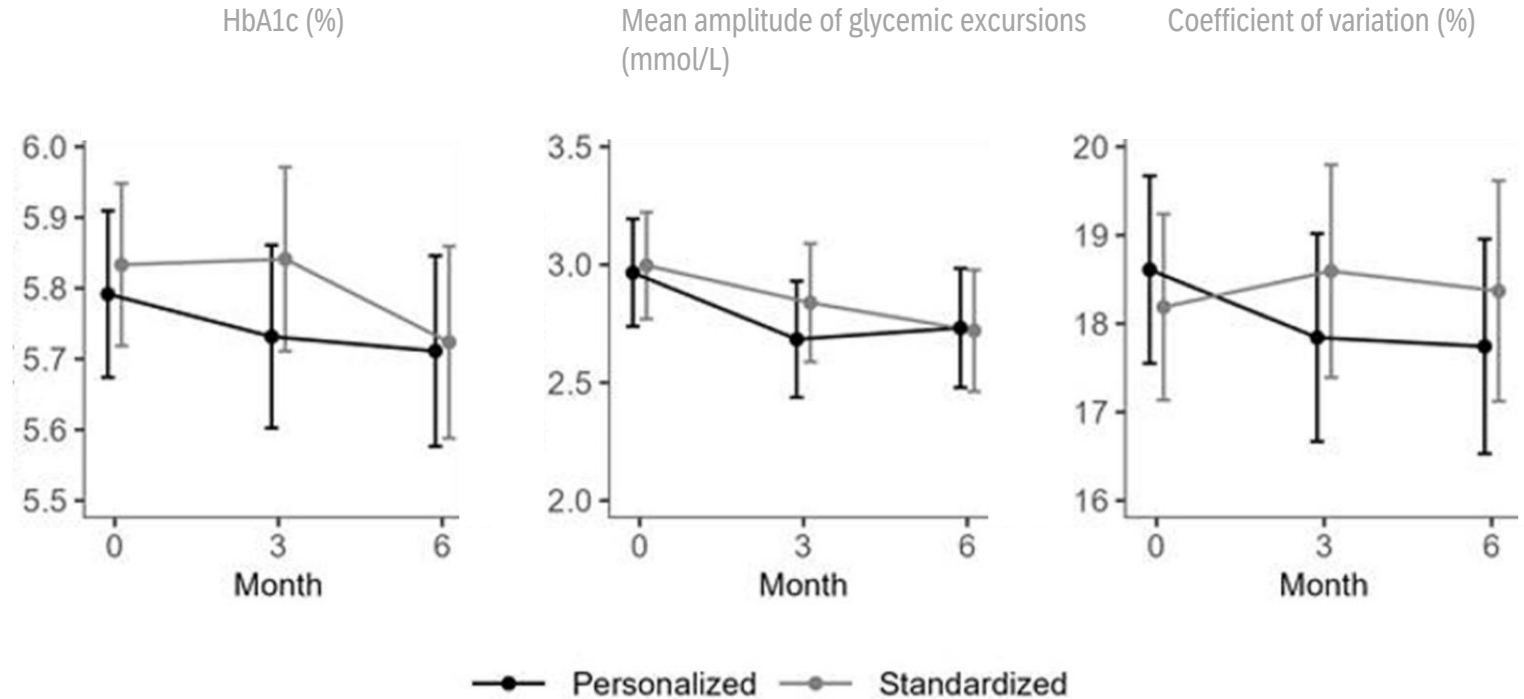


Combined with calorie-restriction: Personalised diet is not better than standardised diet to reduce PPGR

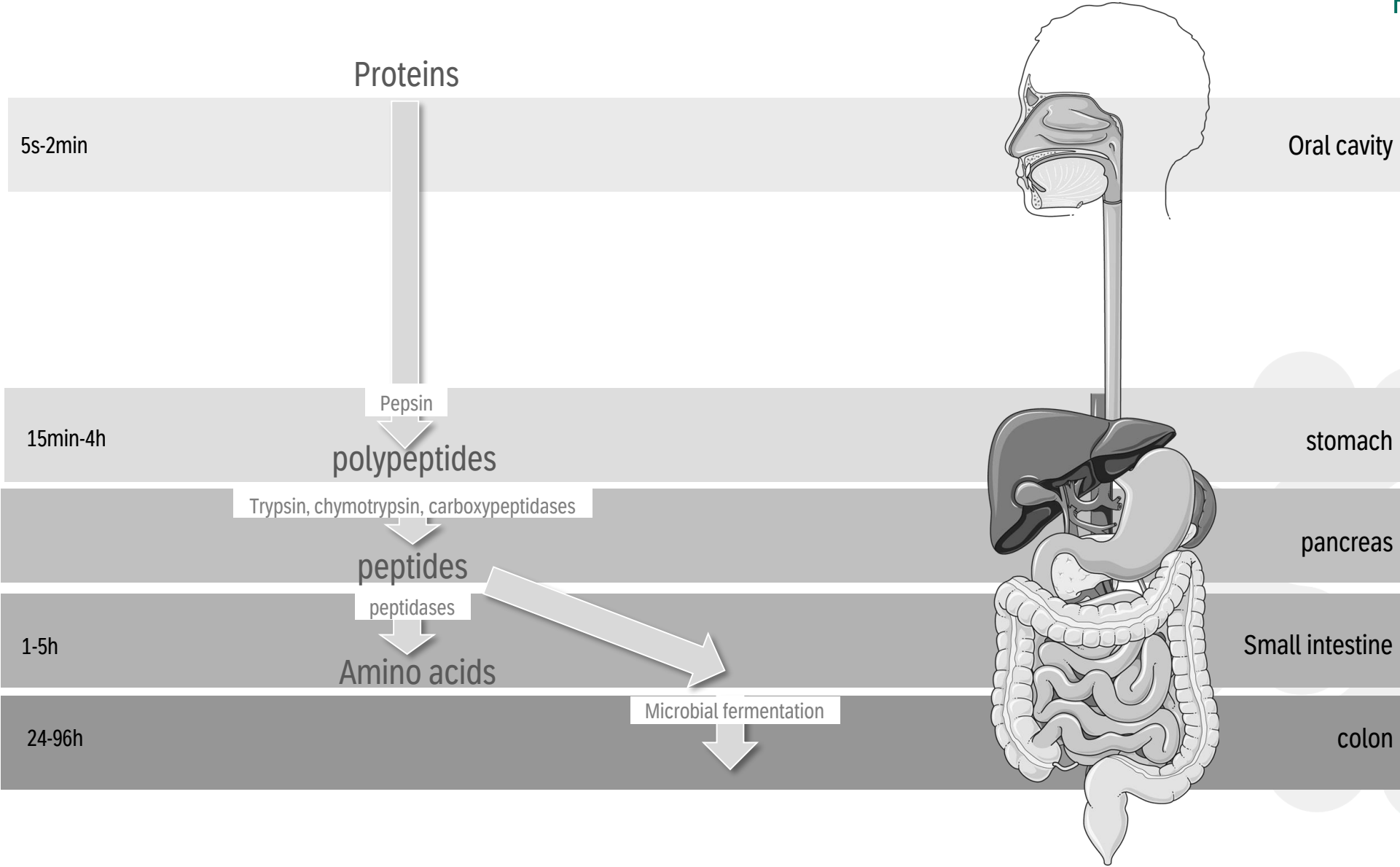
N=156
Prediabetes or moderately controlled T2D
Standardised diet: n=75
Personalised diet: n=81

6 month intervention

Diets: calorie deficit 500 kcal
Standardised diet: Low fat
Personalised diet: meals were scored based on model features
Intensive counselling



Digestion of proteins



Plant-based vs animal proteins

Less optimal AA composition
Cereals: deficient in lysine
Legumes: deficient in S-AA

Lower digestibility
75-80% vs 90-95%

Essential AA

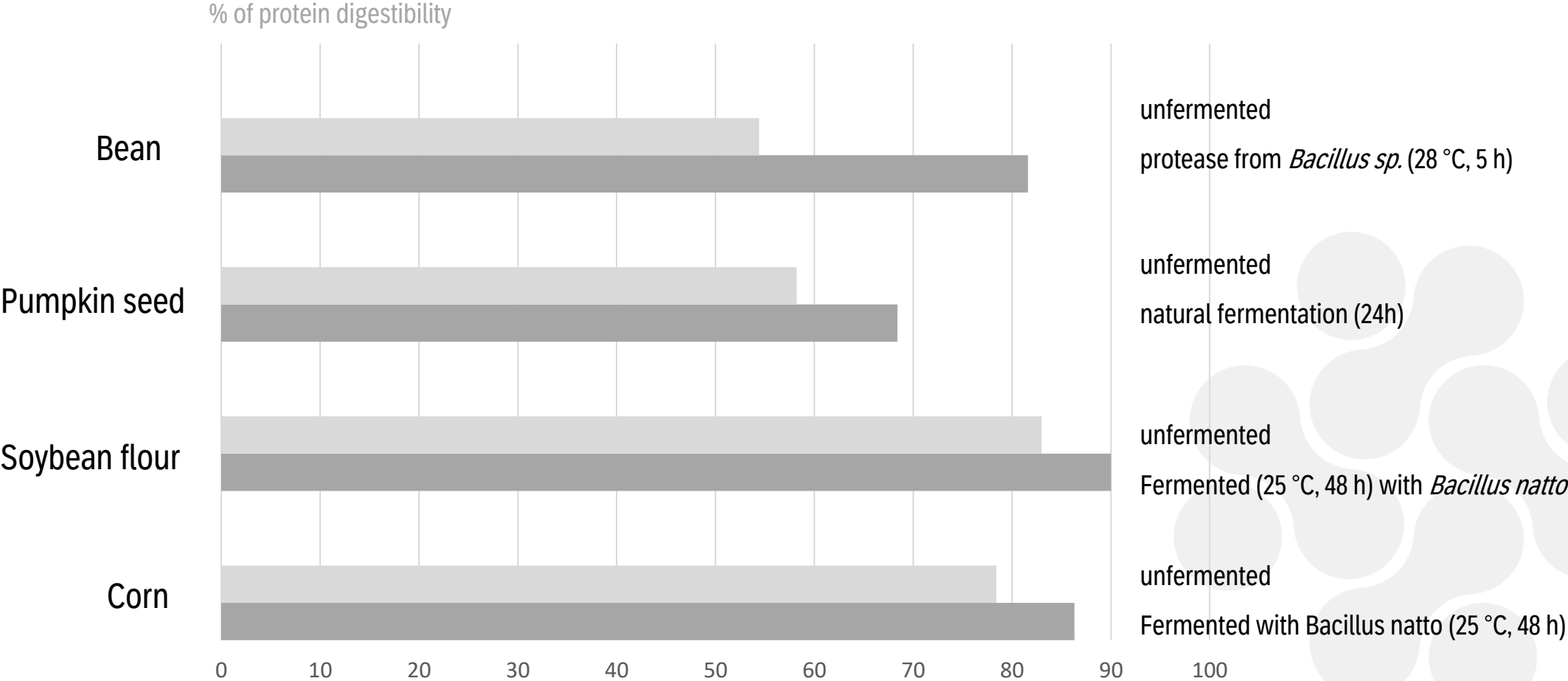
- histidine
- Isoleucine
- Leucine
- Lysine
- Methionine
- Phenylalanine
- Threonine
- Tryptophan
- valine

Antinutritional factors

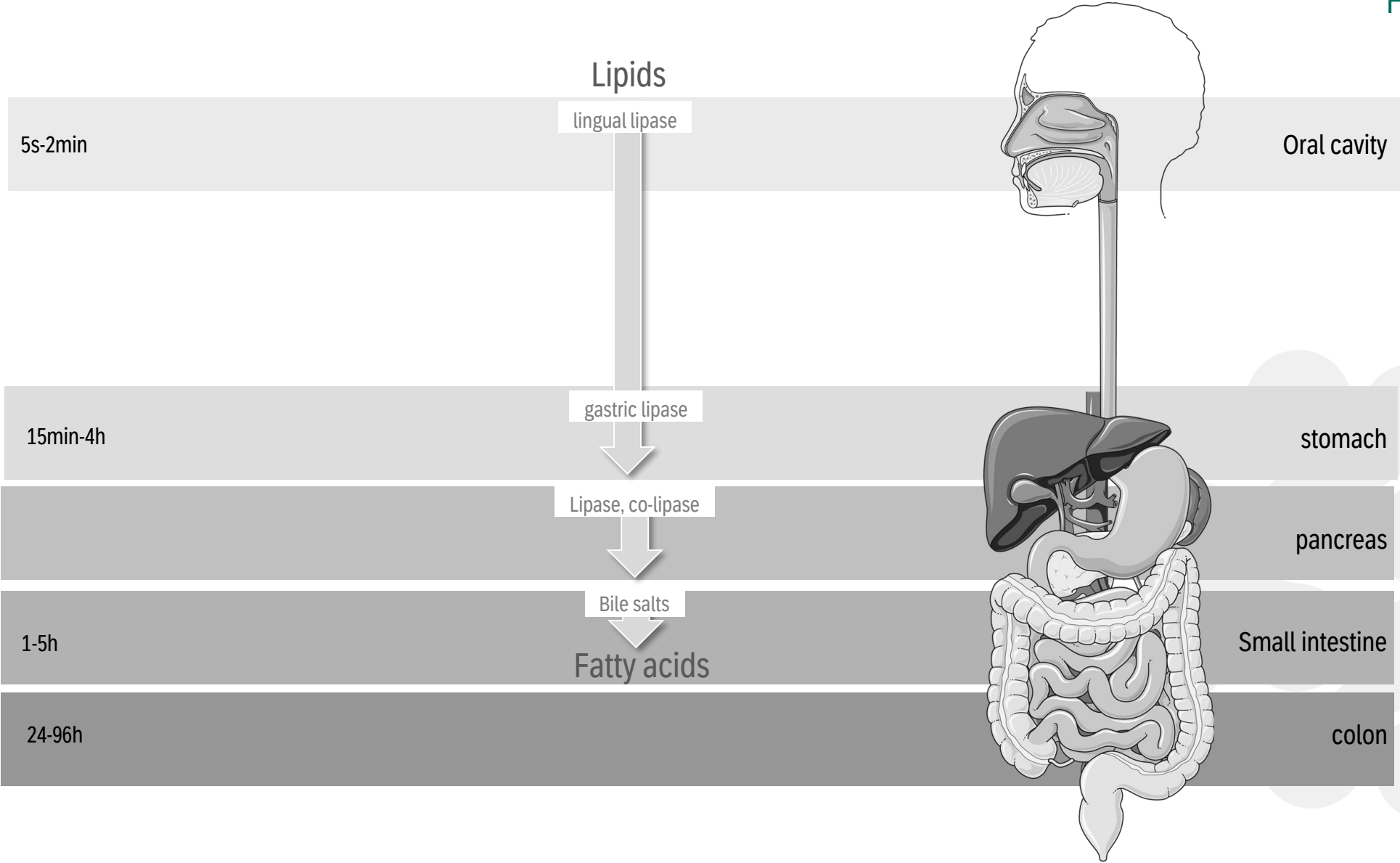
- Protease inhibitors
- Lectins
- Phytates
- Fibers
- Polyphenols



Fermentation to improve protein digestibility



Digestion of lipids



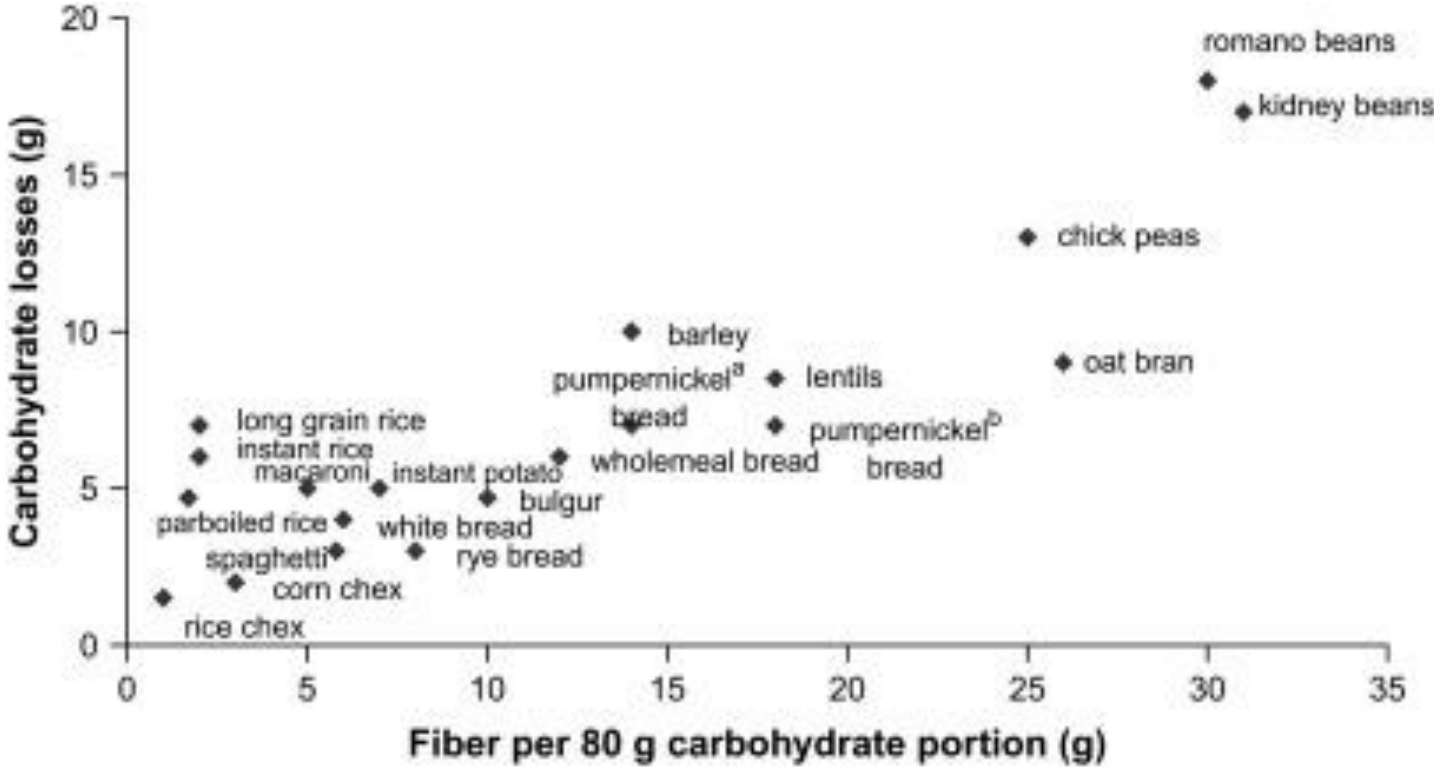
Undigested nutrients reach the colon



12-18 g
protein
(dietary +
endogenous)

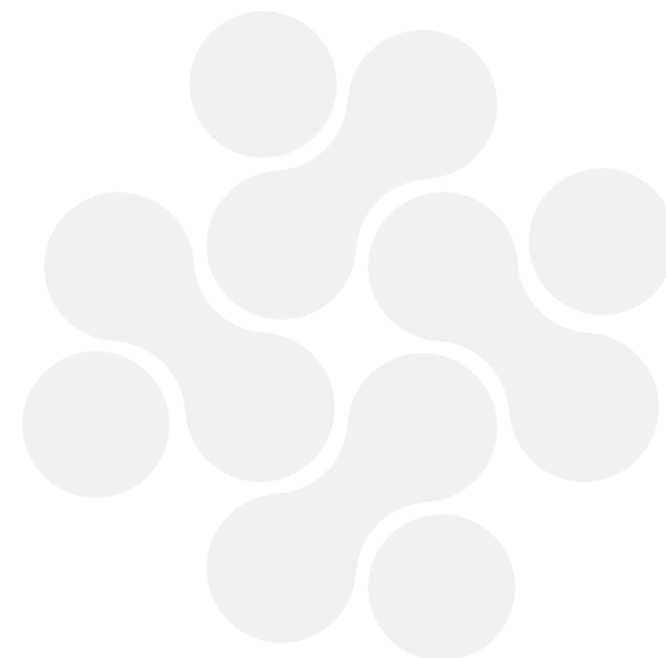
5-50 g
carbohydrate

Max 7g fat
(assuming a daily
intake of 100g)

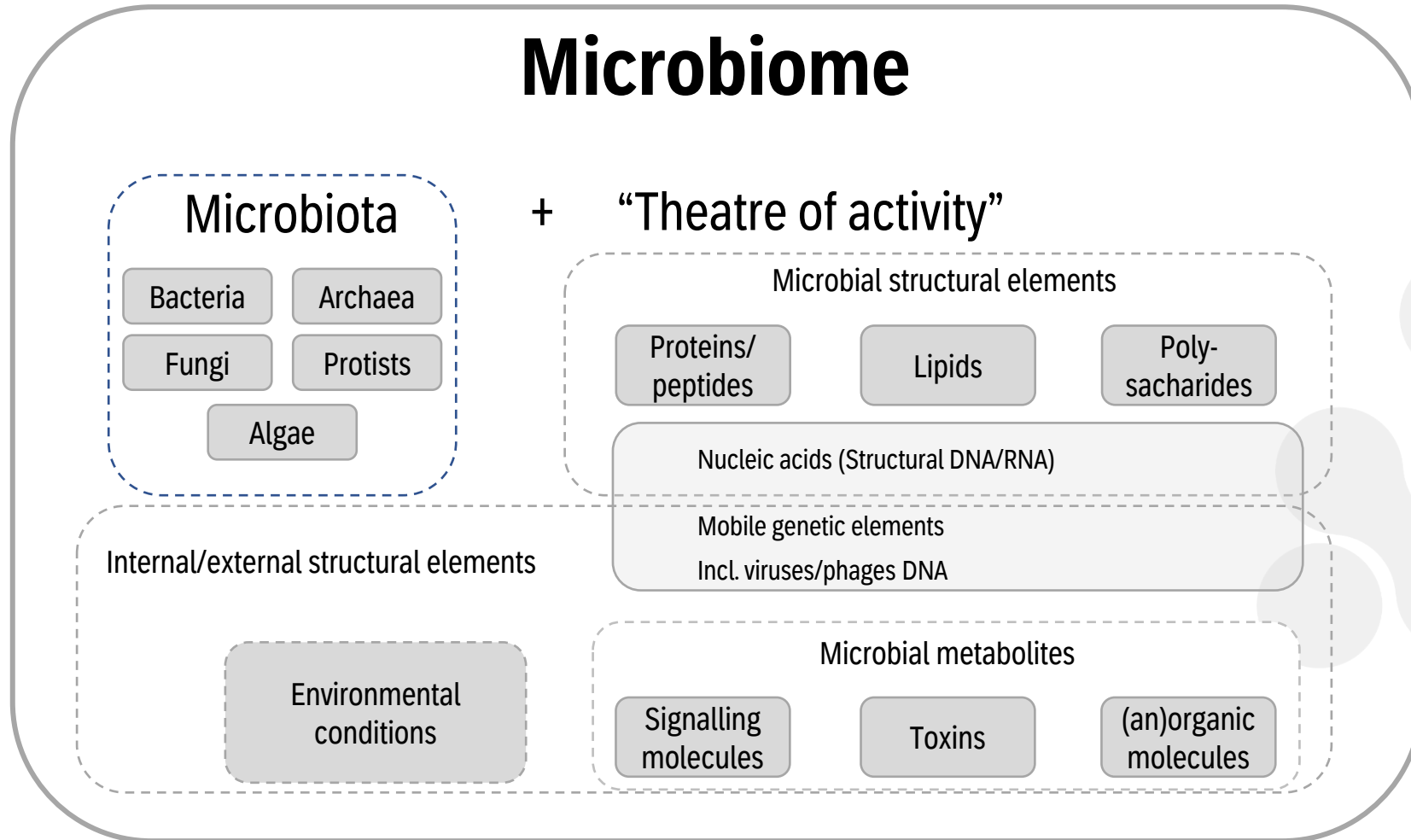


Chacko et al. Gut 1988; Jenkins, Am J Clin Nutr 1987

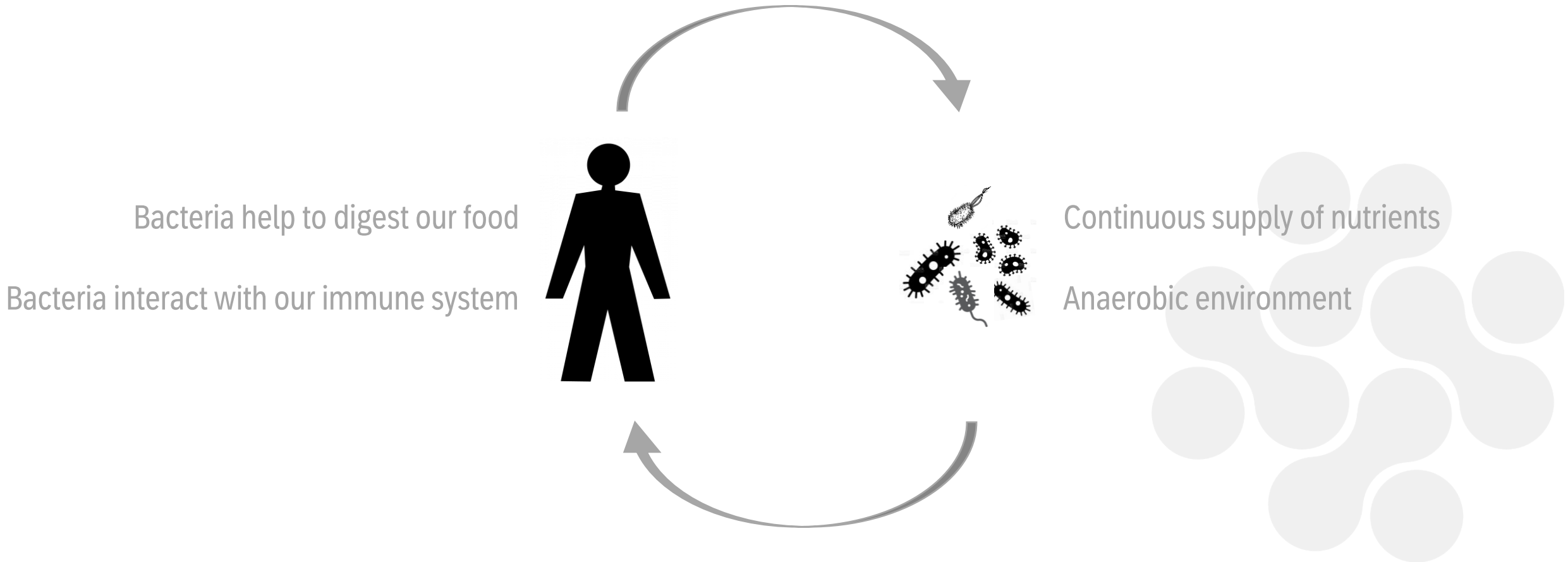
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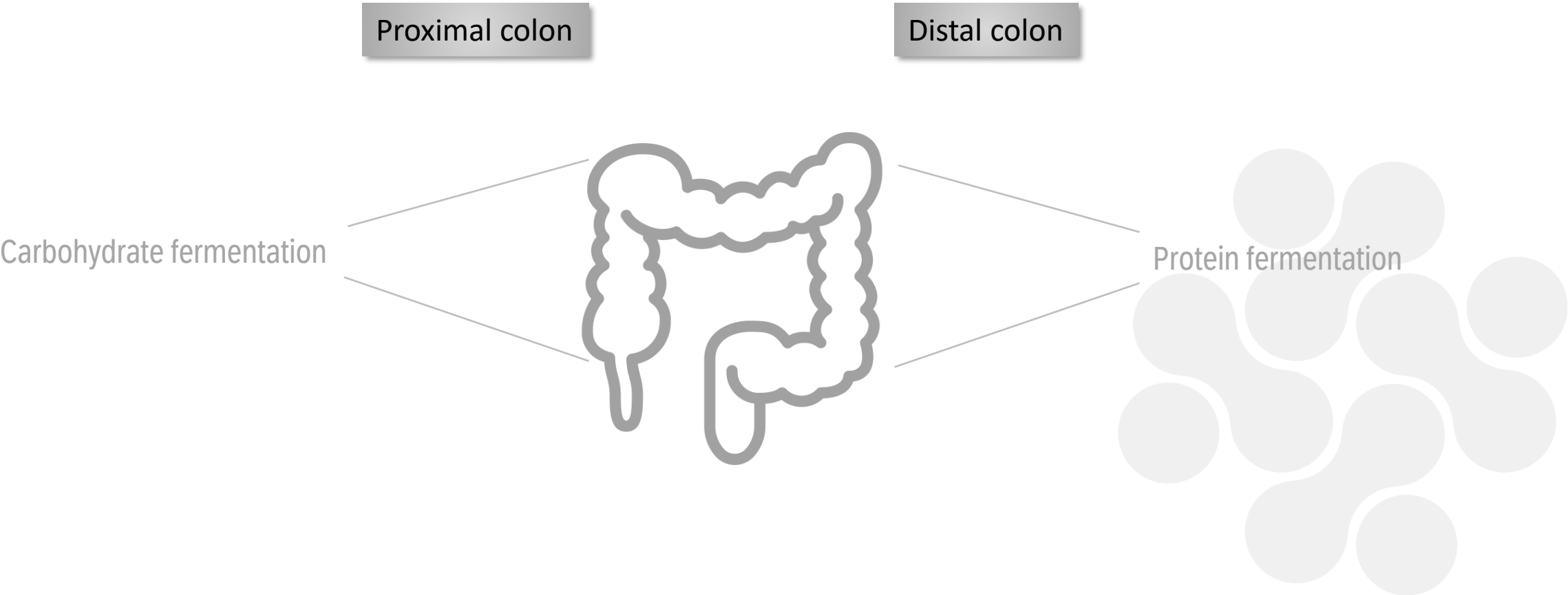
Is it microbiota or microbiome?



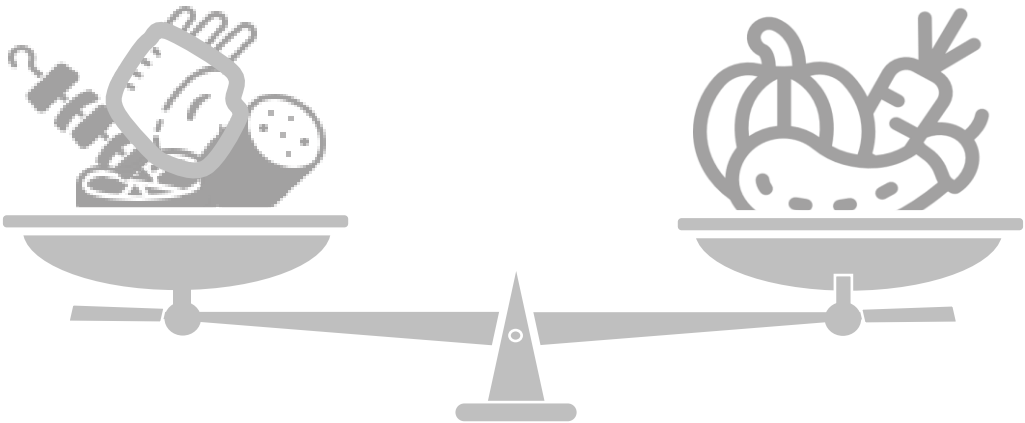
We need each other



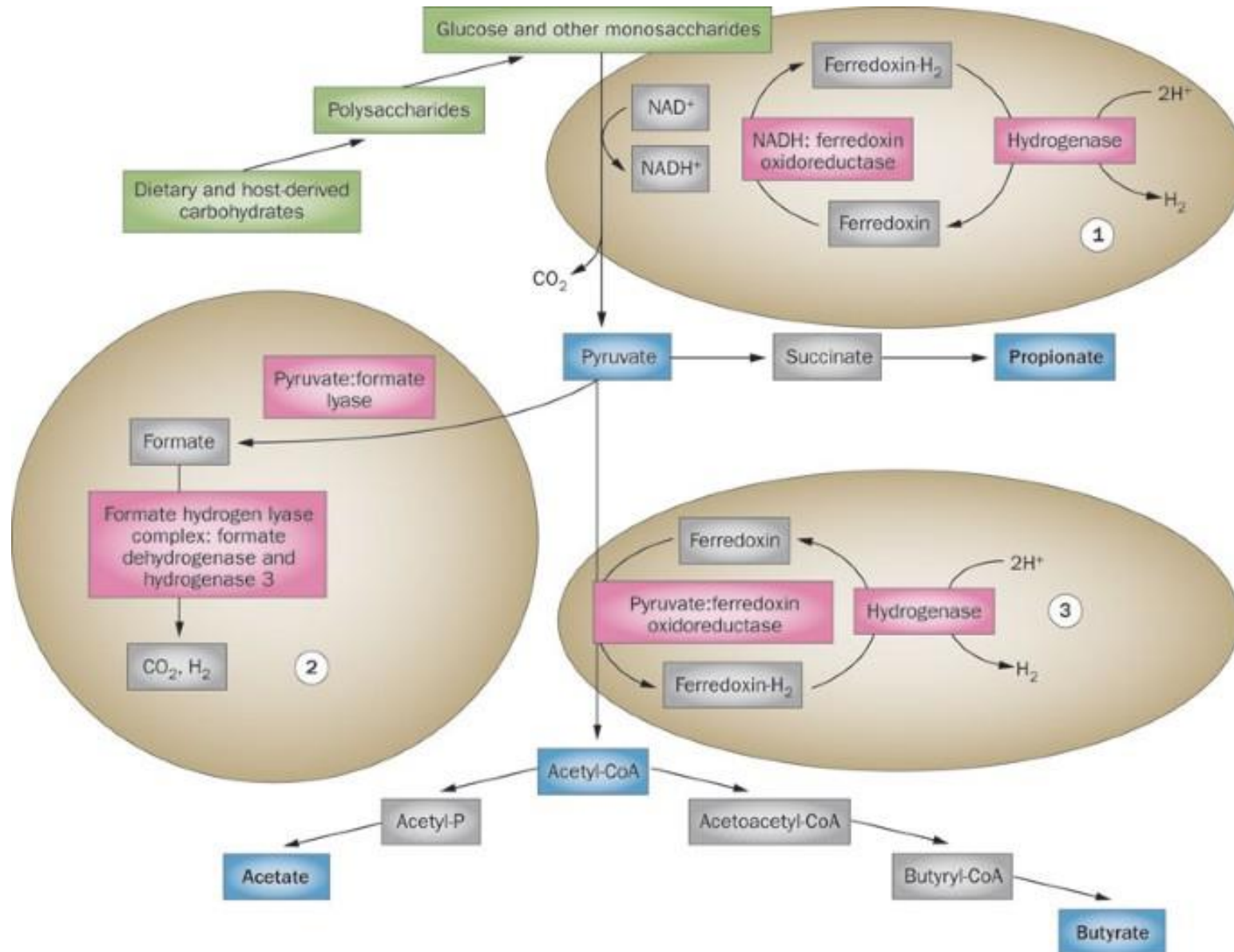
Regional differences in colonic fermentation



Diet and transit are the main modulators of the fermentation



Fermentation of undigested carbohydrates



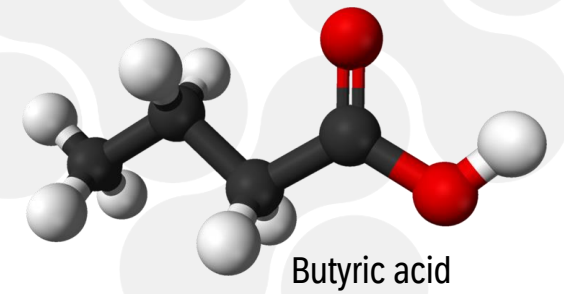
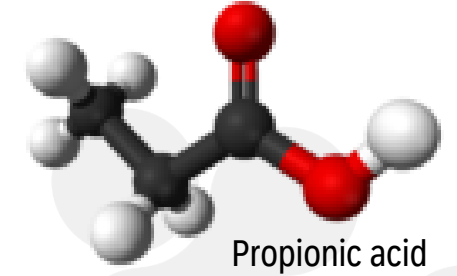
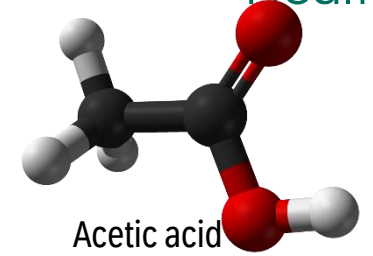
Hydrogenotrophic bacteria:

- Methanogens
- Reductive acetogens
- Sulfate reducing bacteria

SCFA are the main anions in the colon



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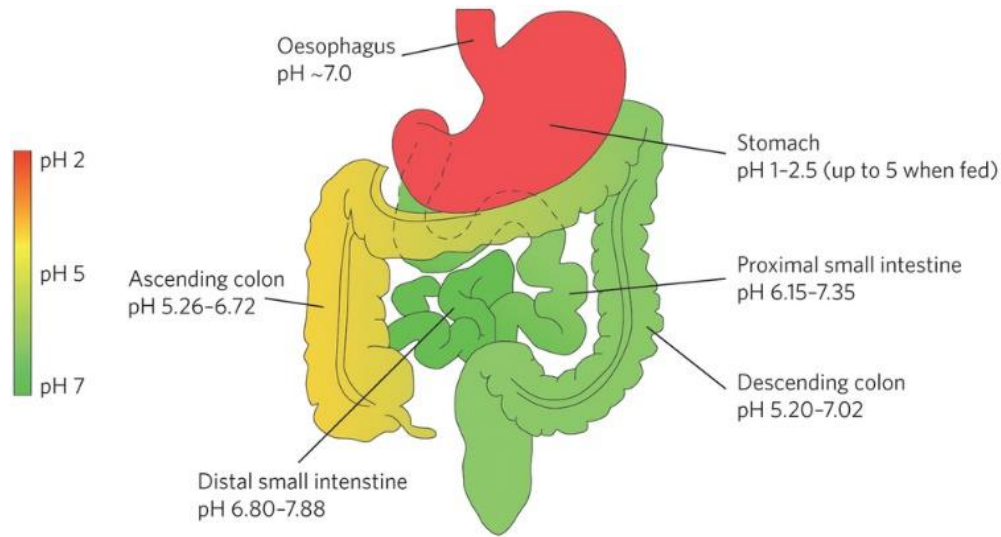


Produced from dietary fiber

Daily production: 500-600 mmol

May be the link that connects the diet, microbiota and the host

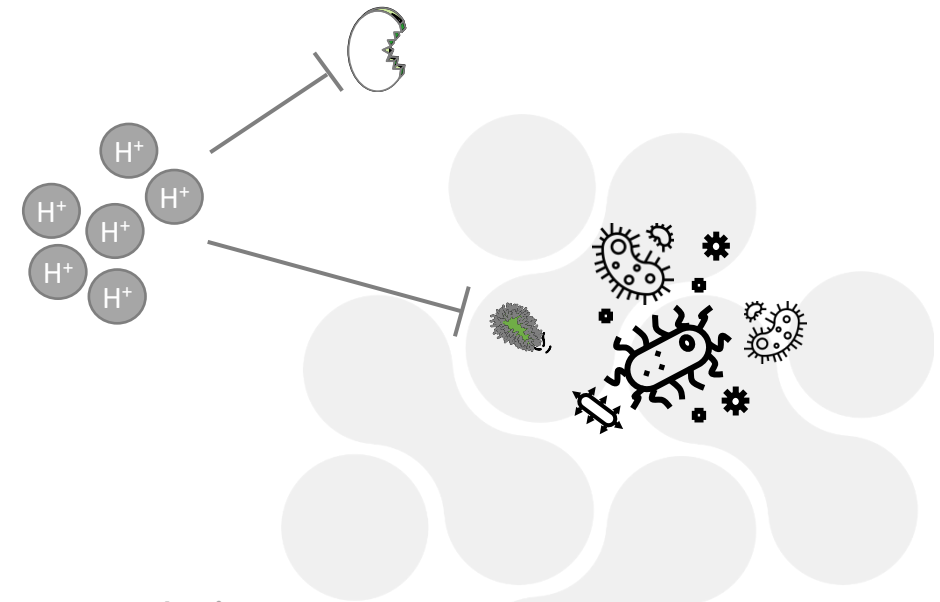
SCFA have local effects in the gut



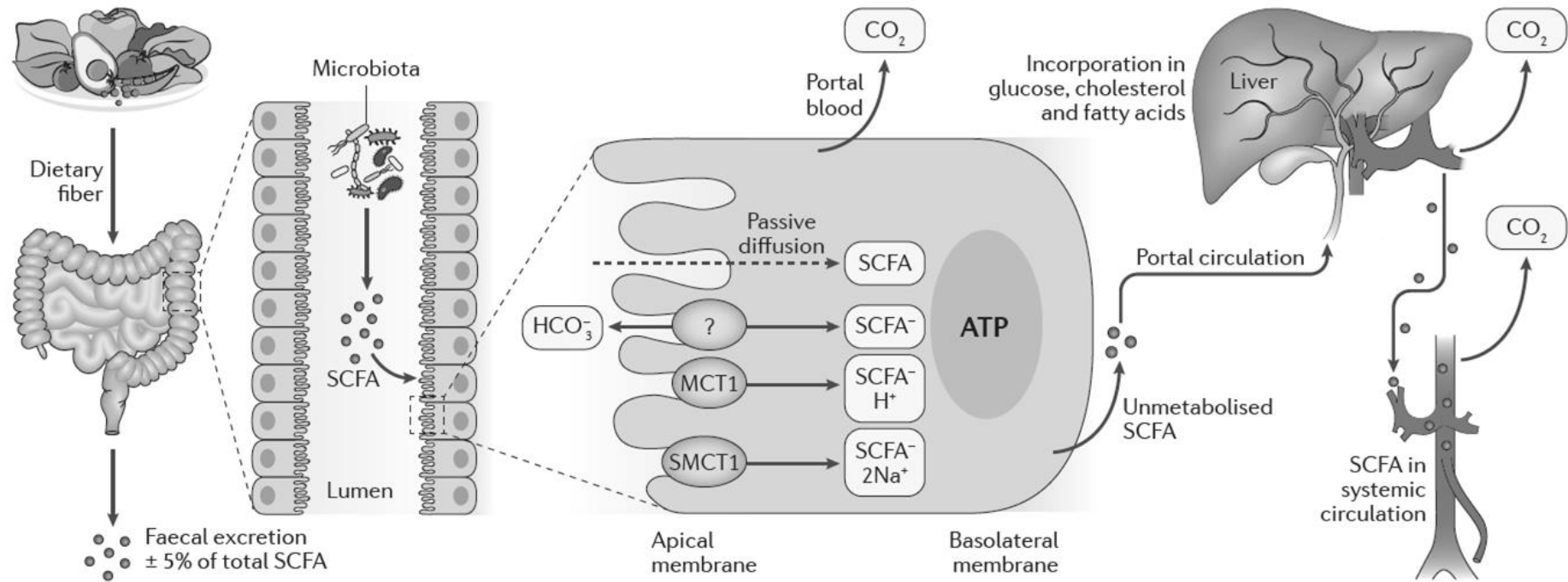
SCFA are responsible for the pH drop in the proximal colon

A lower pH results in

- Lower activity of proteases
- Inactivation of some pathogens e.g. salmonella



SCFA are the main energy source for the colonocytes



Because SCFA reach the circulation, they can affect other organs



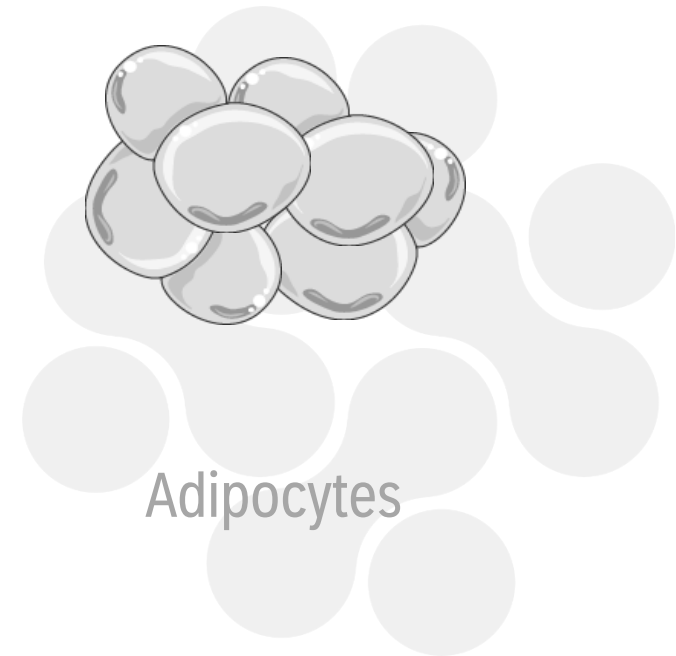
Liver



Pancreas

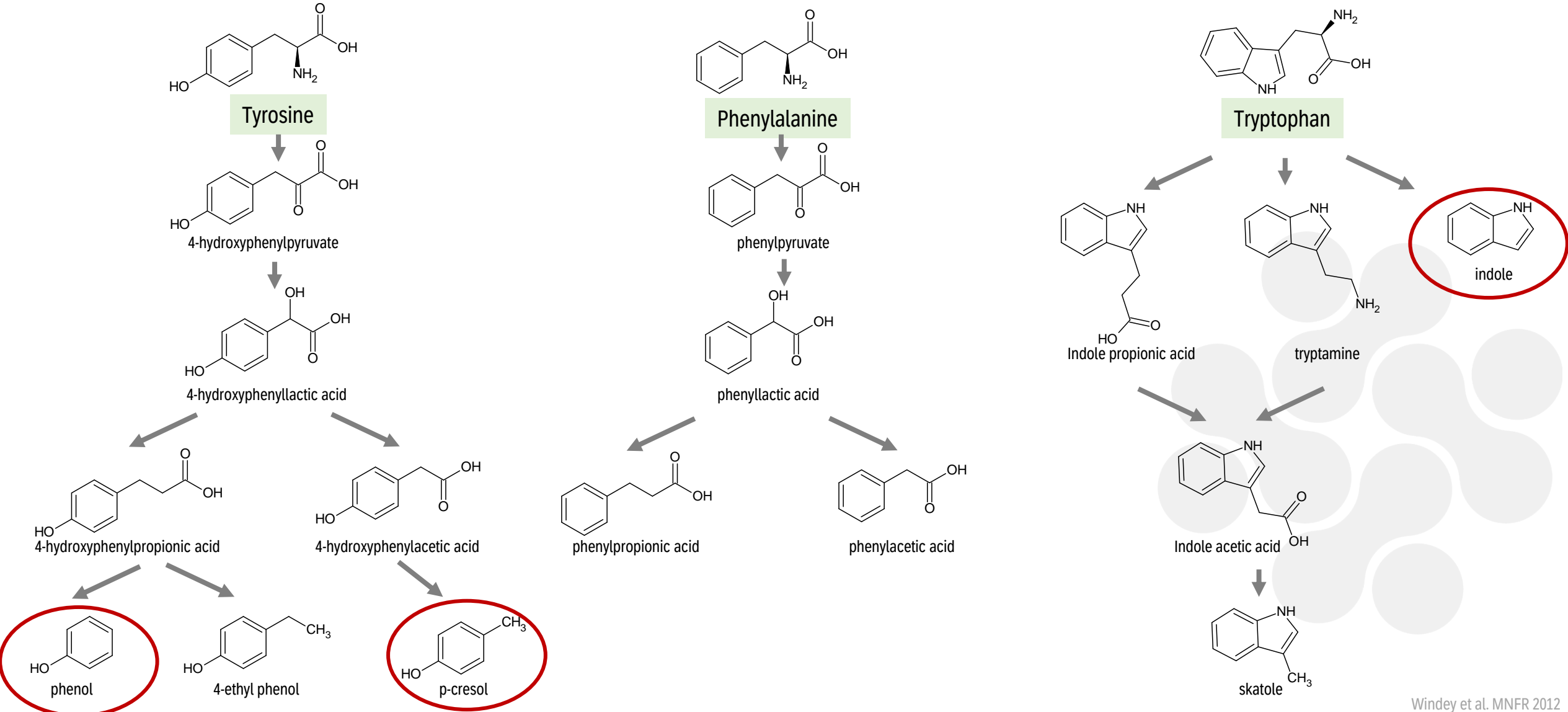


Brain

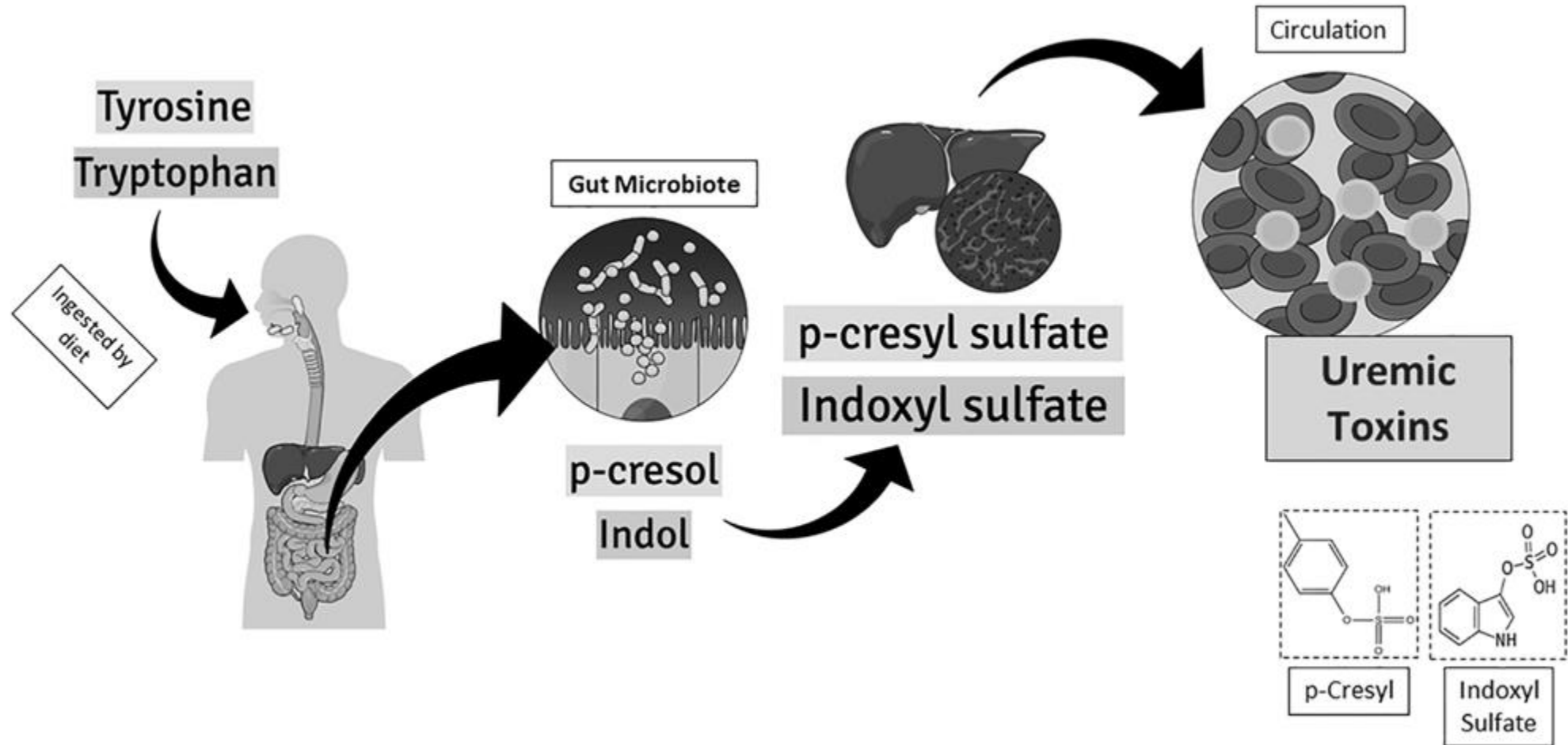


Adipocytes

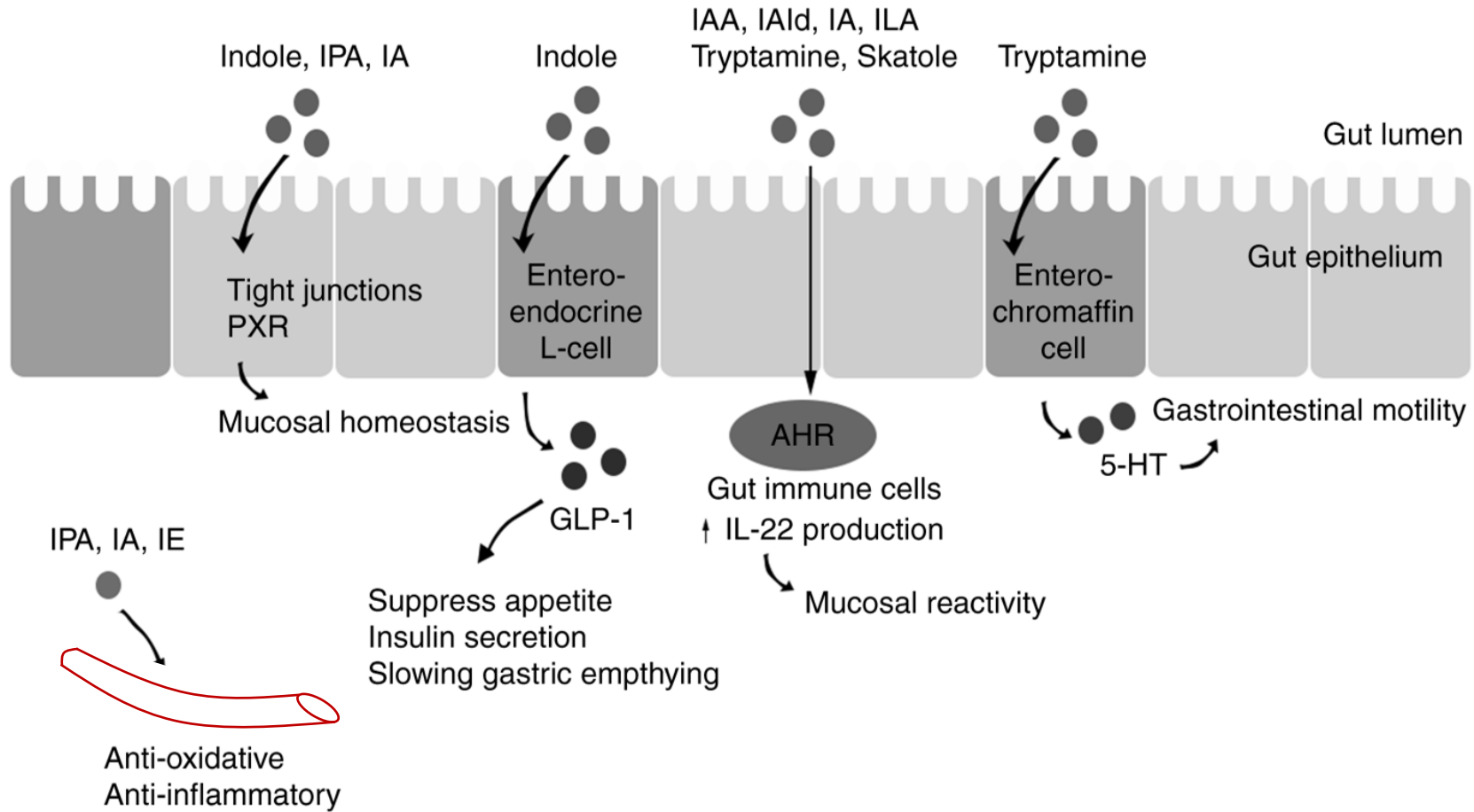
Metabolites of aromatic amino acids



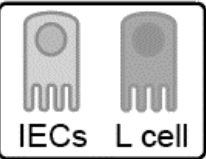
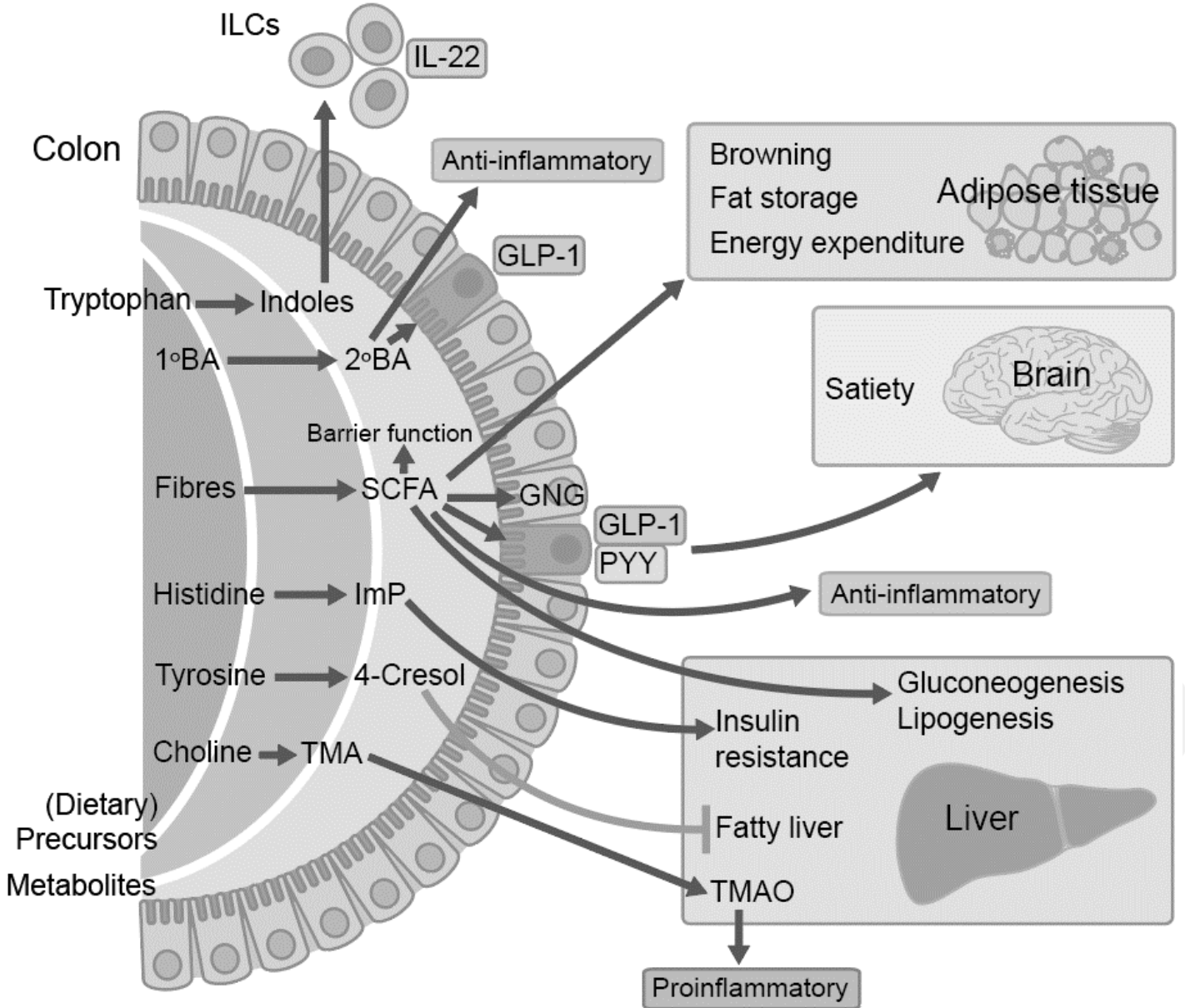
Uremic toxins originate from protein fermentation in the gut



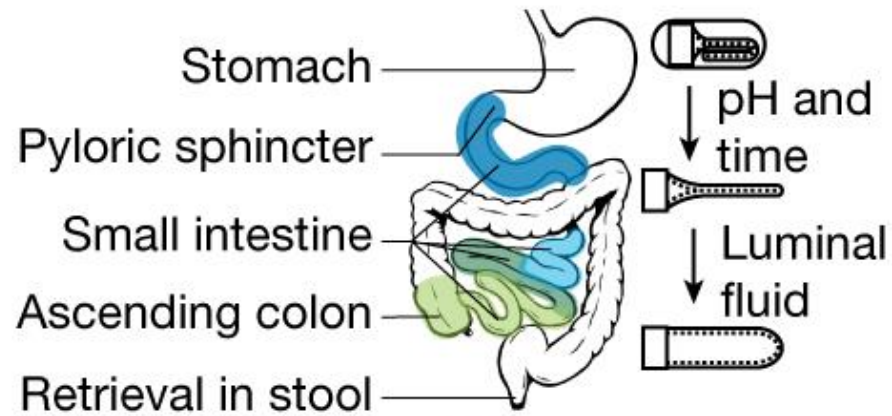
Tryptophan metabolites strenghten intestinal barrier and immune function



Bacteria produce a wide variety of metabolites that can affect the host



What we find in stools does not reflect what happens in the intestine



Spatial differences in microbial communities

Human protein abundance differs between stool and intestinal samples

Different bile acid profiles along the intestinal tract compared with stool



Take home messages

- In healthy conditions, our gastrointestinal tract works as a well-oiled machine
- Overall, digestion of macronutrients is very efficient
- Fermentation of undigested nutrients yields a wide variety of metabolites that can affect the host
- New emerging technologies to sample different locations within the gastrointestinal tract may further increase our knowledge

