

# MOTHER'S MILK AND THE MICROBIOME

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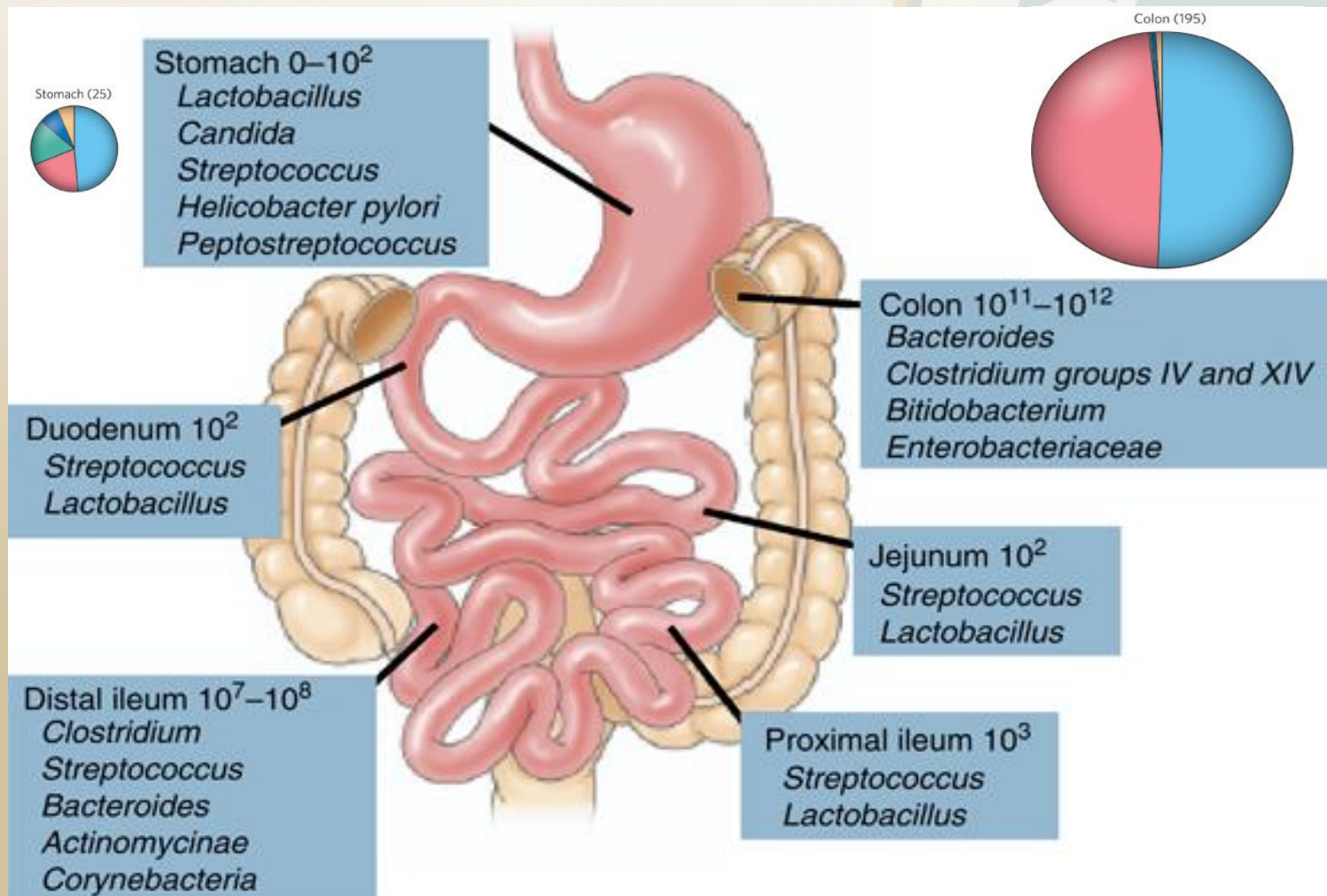


# WHAT IS THE MICROBIOME AND WHAT DOES IT DO?



# The Gut Microbiome

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# Gut Microbiota: Fun Facts

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## Getting to know your gut microbiota

A huge quantity (hundreds of trillions) of bacteria and other microorganisms inhabit your intestines fulfilling key functions for your health and wellbeing

- Gut microbiota's **weight** can reach up to

1 to 2 Kg

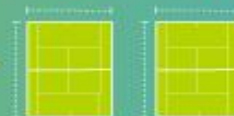
95%

of our bacteria located in the **gastrointestinal (GI) tract**



- The **GI tract** surface is as big as 2 tennis courts

400 m<sup>2</sup>



- Bacteria are **10 to 50** times smaller than human cells

bacteria

0.5 - 5 µm

human cell



- In our body, **microbes outnumber** human cells by

10:1



- Laid end to end, our body's bacteria would **circle the Earth**

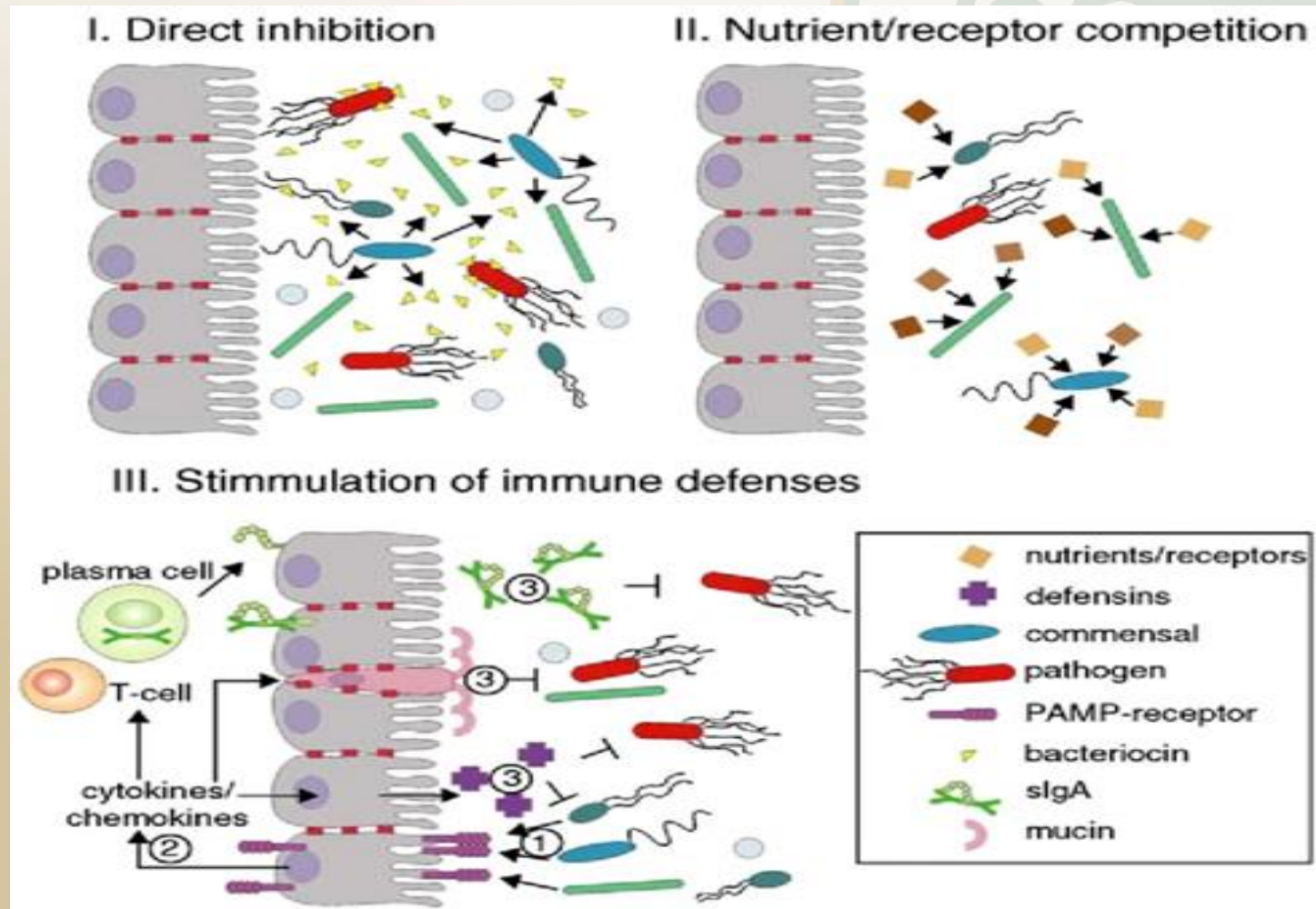
2,5 times





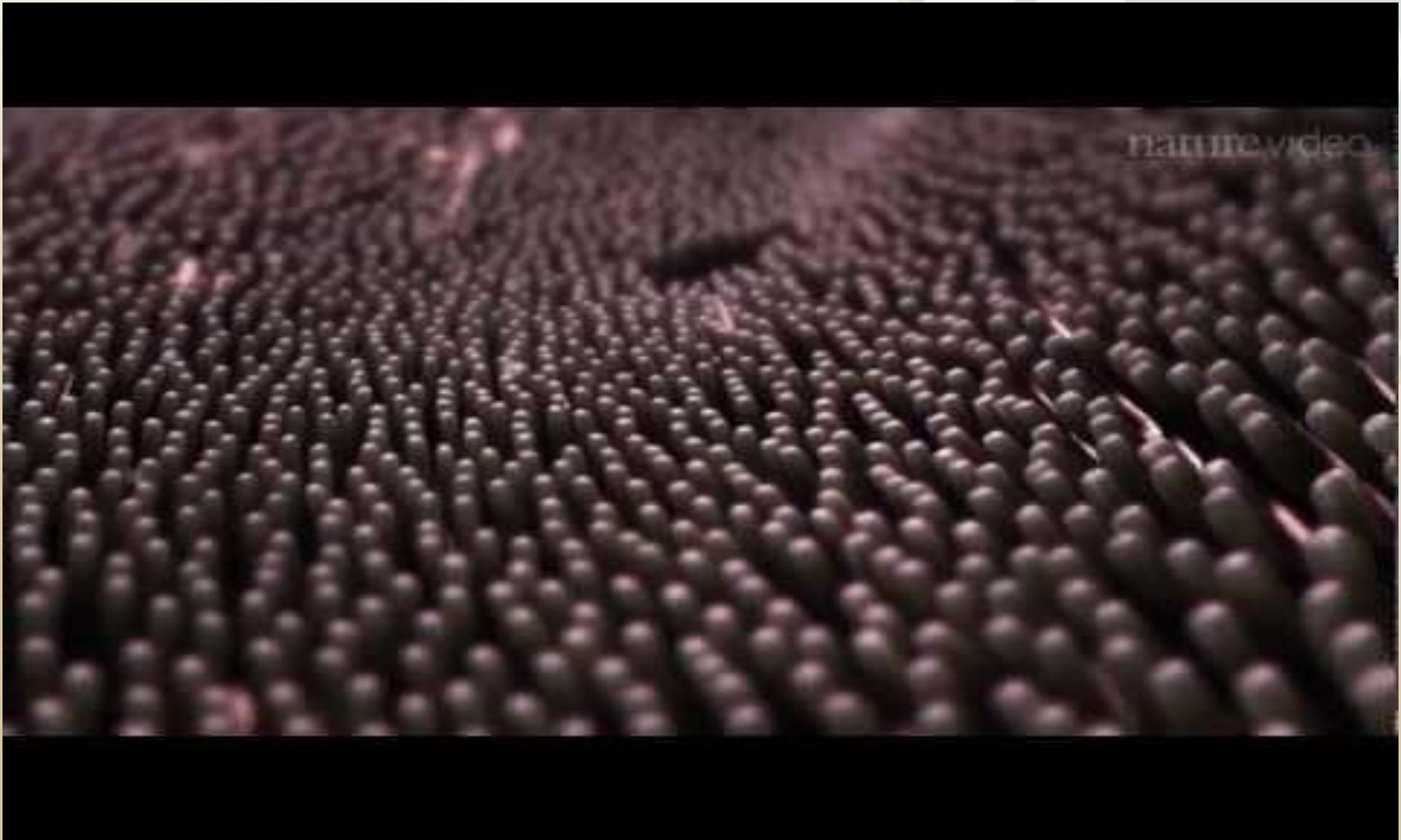
# Protective functions

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# Immune Regulation

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## Video Link

[http://link.brightcove.com/services/player/bcpid1966016696001?bckey=AQ~~,AAABByWTdmvk~,YEX2I6TuT0mdQPquhJg1bWcq9Ufv7FQ\\_&bclid=0&bctid=2144234478001](http://link.brightcove.com/services/player/bcpid1966016696001?bckey=AQ~~,AAABByWTdmvk~,YEX2I6TuT0mdQPquhJg1bWcq9Ufv7FQ_&bclid=0&bctid=2144234478001)



# Digestion

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- Indigestible carbohydrates
  - Bacteria encode enzymes we lack
  - Polysaccharides---> SCFAs that “feed” colonic epithelial cells.
- Fat
  - New study (in zebrafish) demonstrates that Firmicutes assist in dietary fat absorption
- Protein
  - Proteolytic processes degrade proteins into amino acids
- Synthesis of essential amino acids
  - Microbially synthesized amino acids (leucine) can contribute 19-22% of daily requirements.
- Synthesis of vitamins
  - Intestinal microbes synthesize vitamin K and B vitamins, which are frequently absorbed directly through the intestinal epithelia.
  - B12: site of synthesis vs absorption
- Absorption of ions (Calcium, Magnesium, iron)



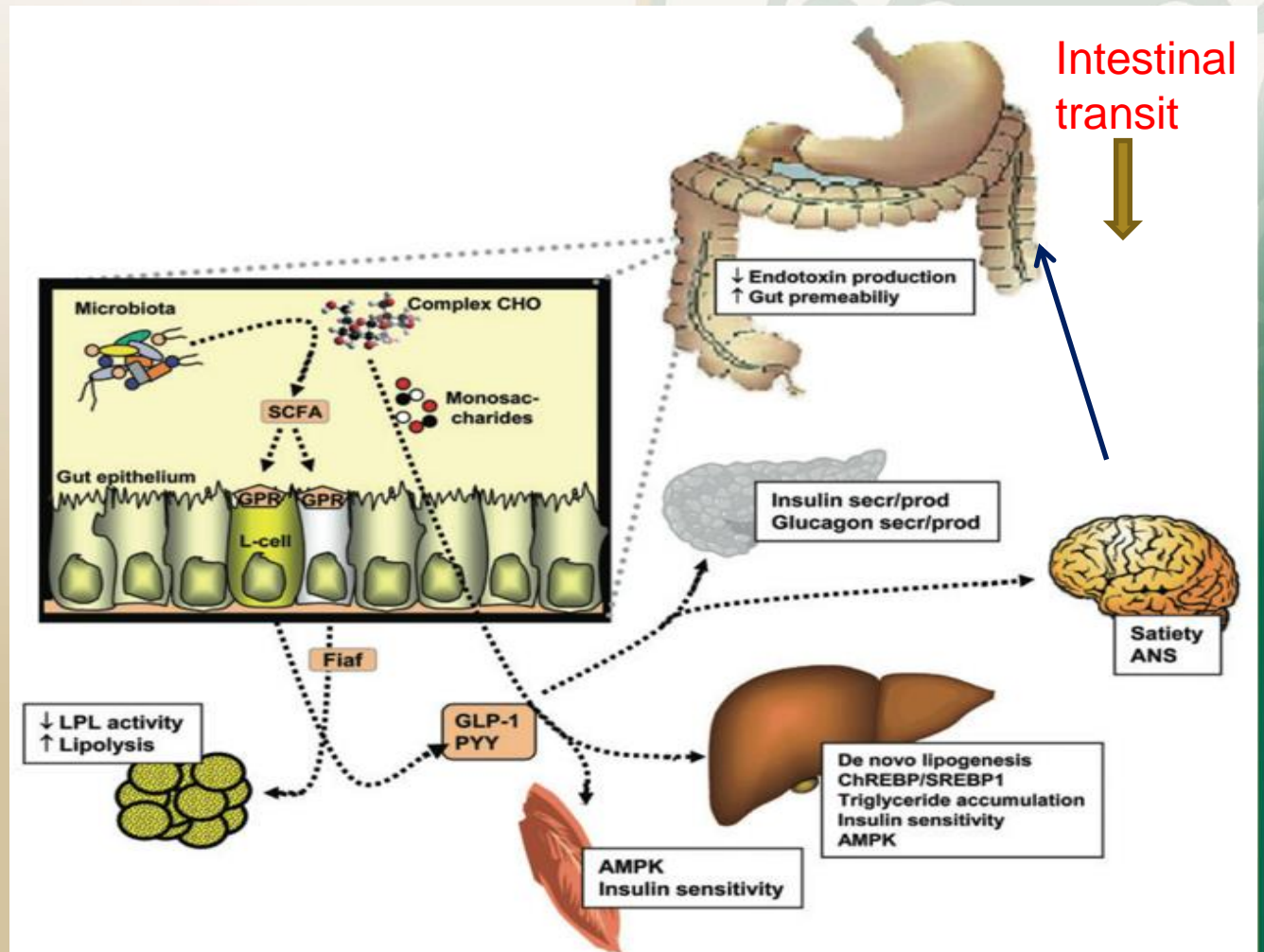


# Metabolism

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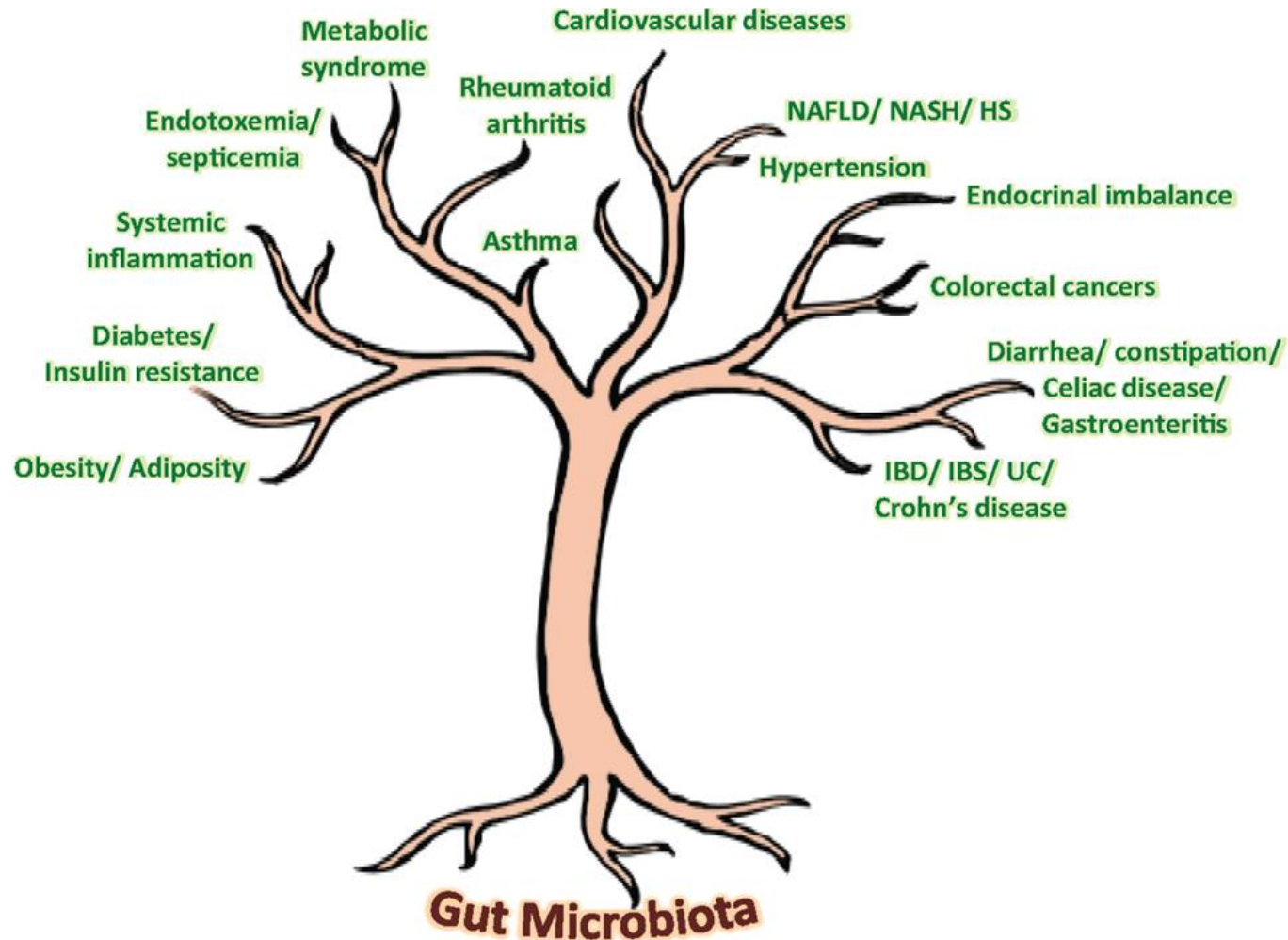
Microbial products interact with cells to regulate:

- Glucose use
- Fat storage
- Food transit
- Feelings of satiety



# Microbiota and Health

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# Obesity

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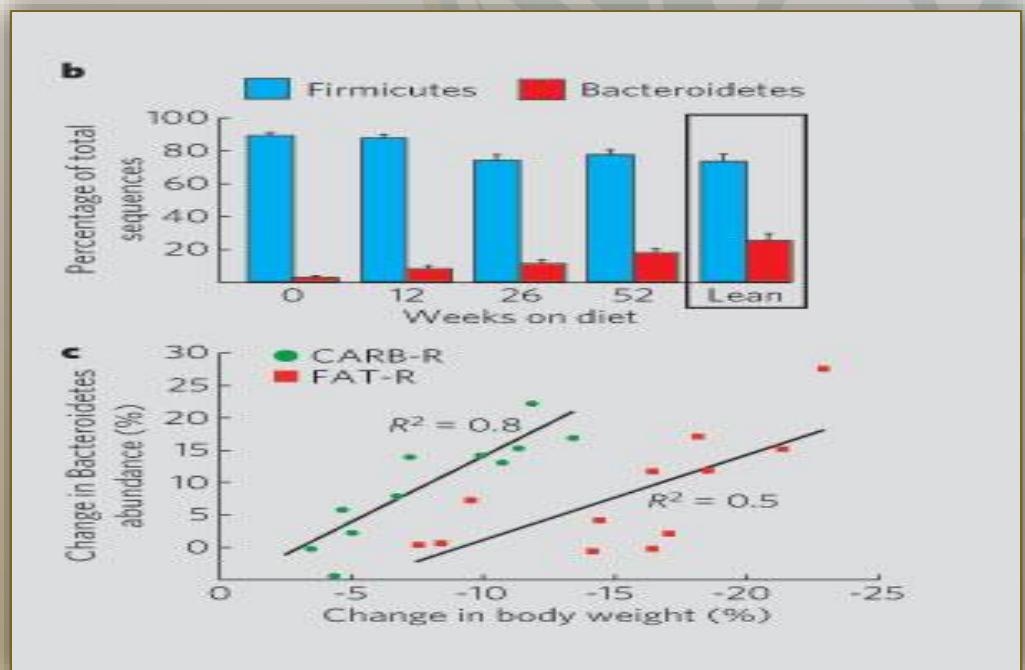
- Germ-free mice required 30% more calories to maintain same weight as normal littermates
- Germ-free mice transplanted with normal microflora gained weight.
- Increased energy harvest associated with higher levels of the phylum Firmicutes



\* Turnbaugh and Bäckhed studies from Gordon lab (2006)

# Obesity

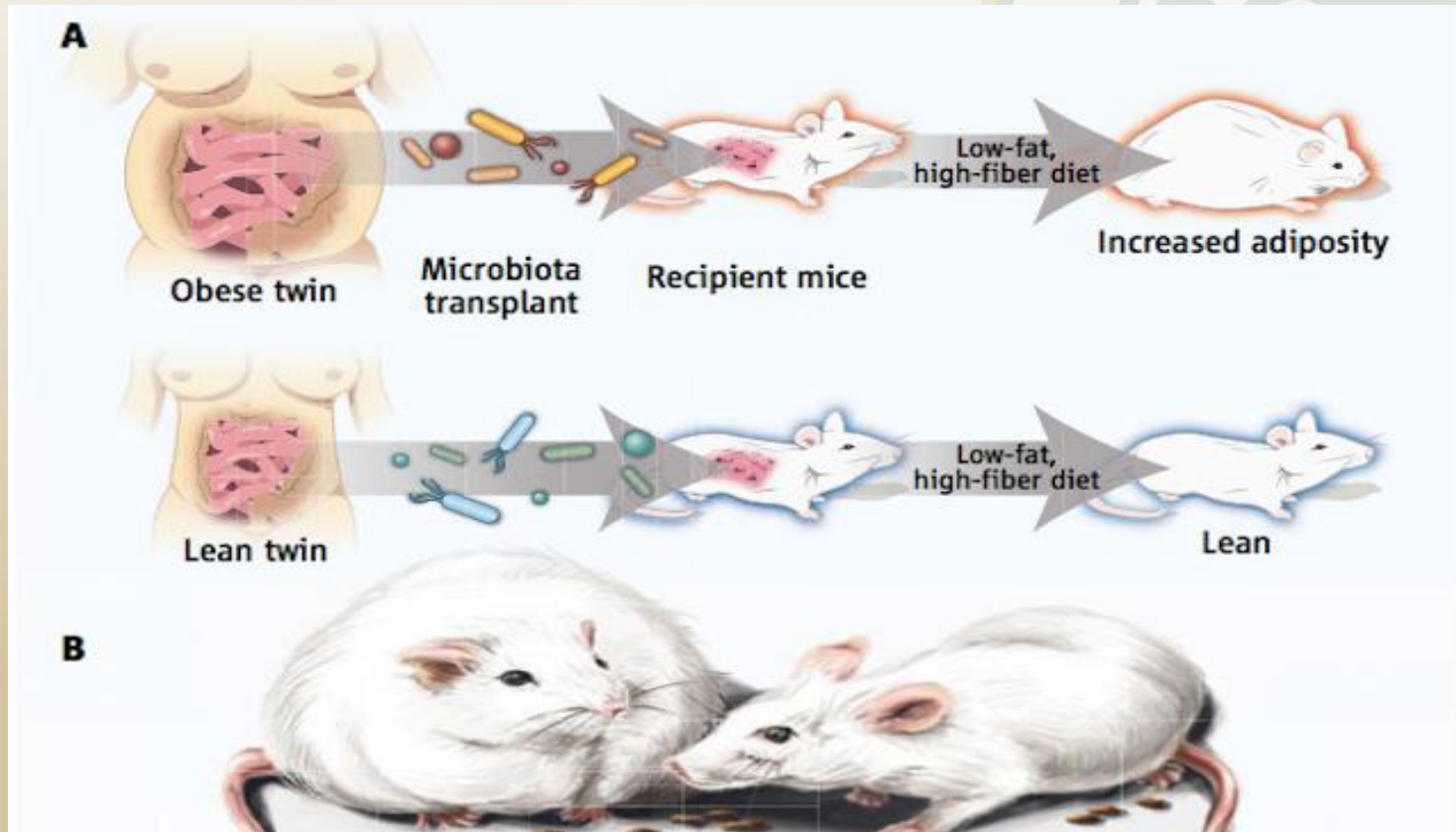
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# Obesity

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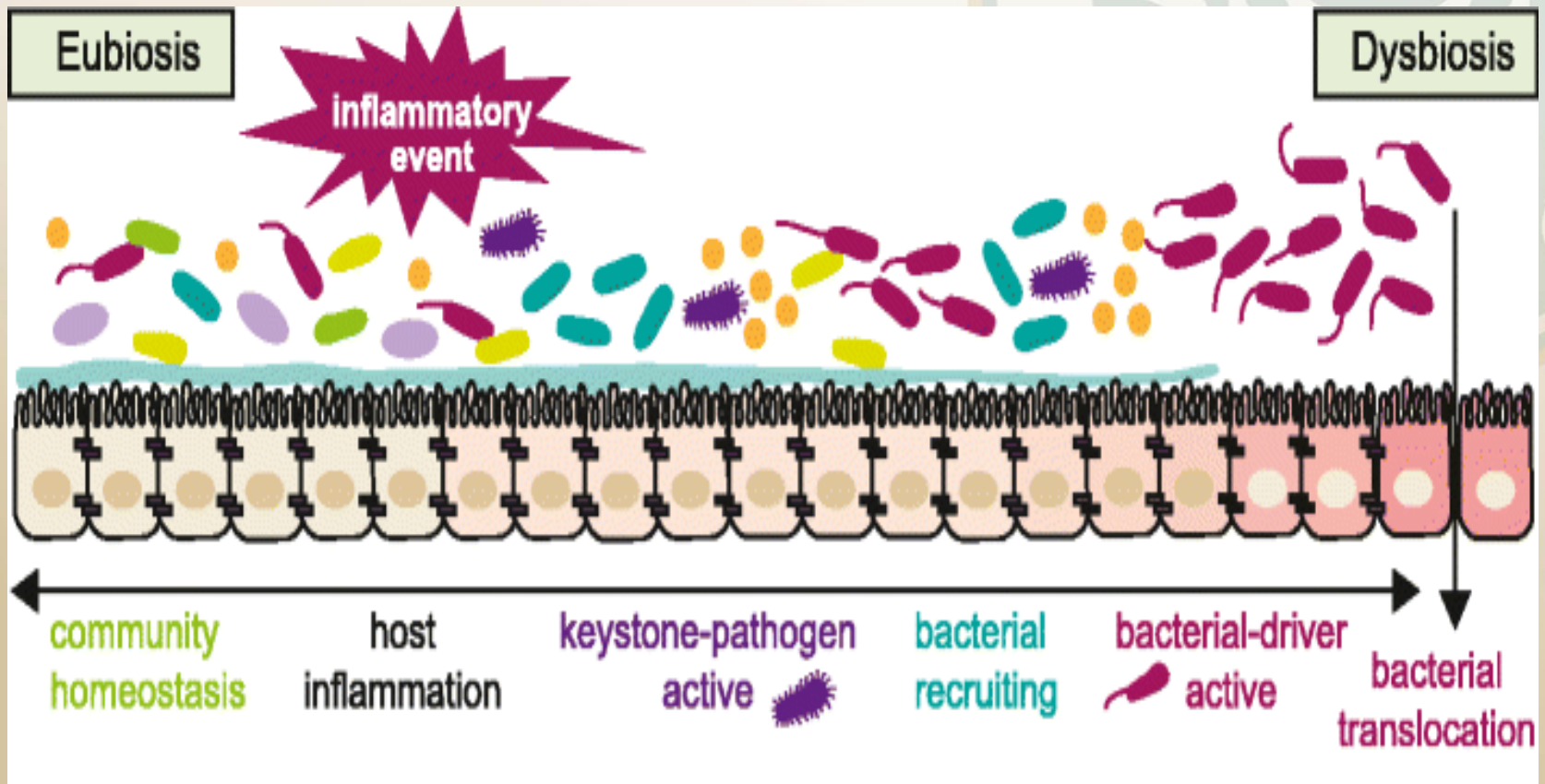


When co-housed the “lean” mice transferred their microbes and their phenotype to the “obese” animals!



# Balance in the Gut

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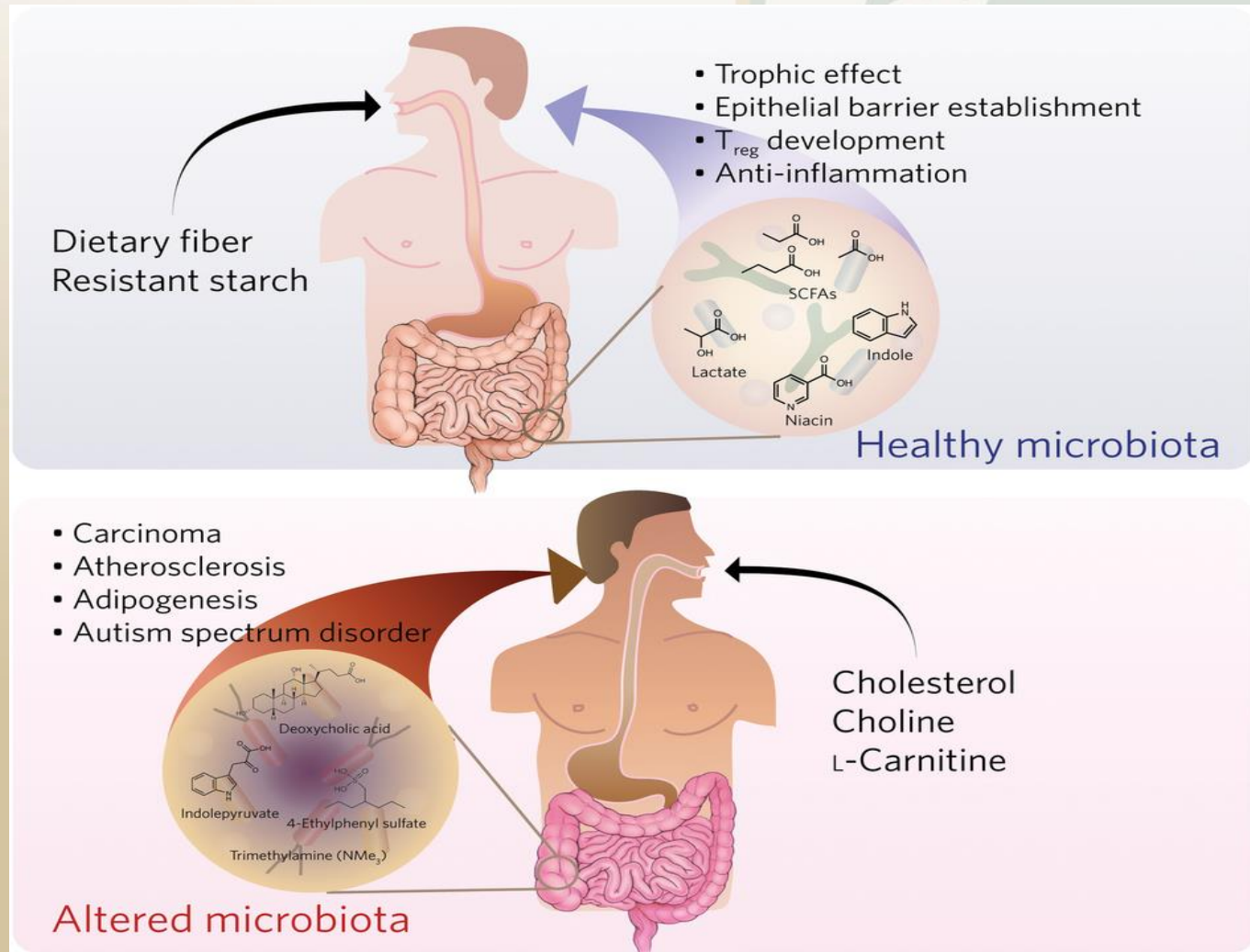


Sheflin et al. (2014) *Curr Oncol Reports* 16: 406.



# Microbial Metabolites

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# HOW DO WE GET THESE MICROBES?

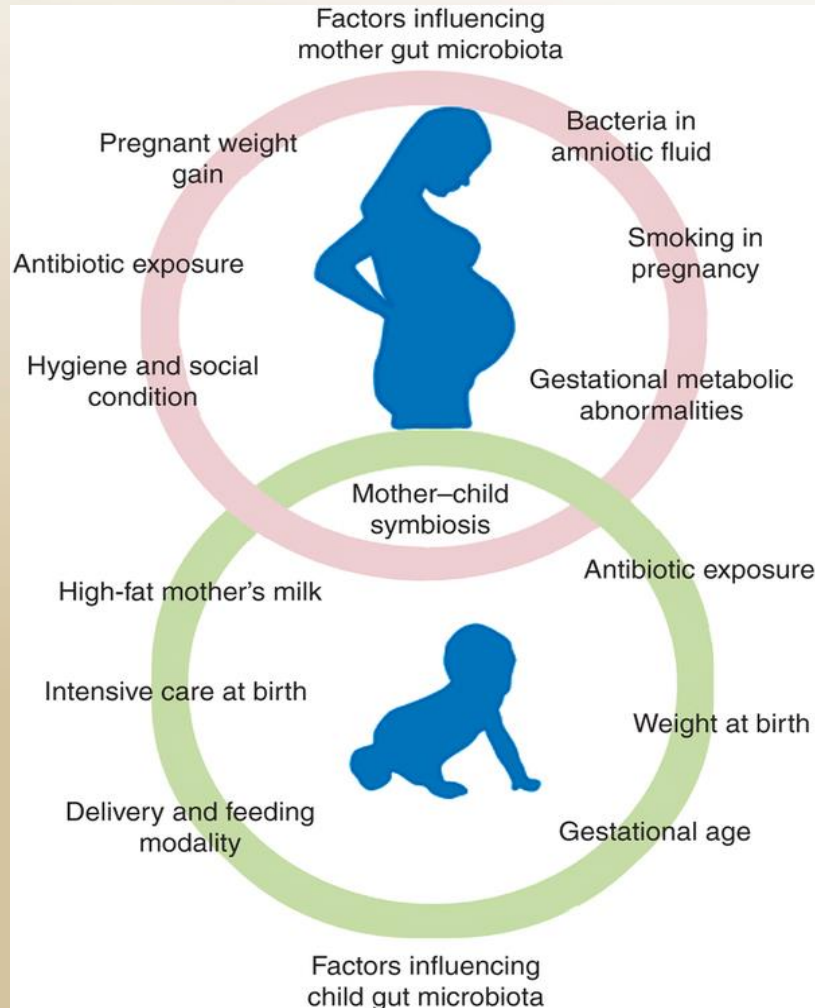
Why birth influences and early feeding patterns are **CRITICAL** for a healthy microbiome.





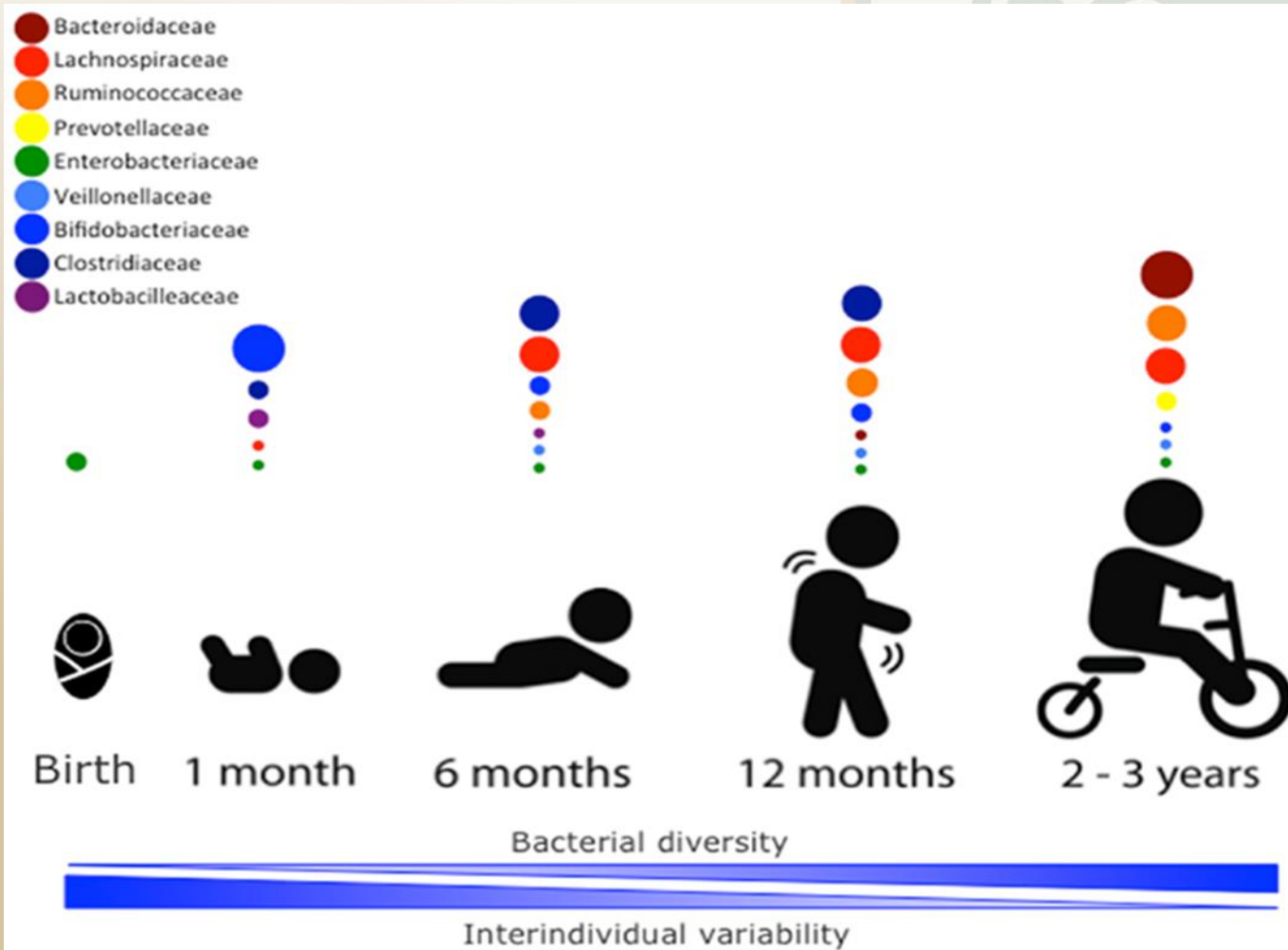
# Colonization Influences

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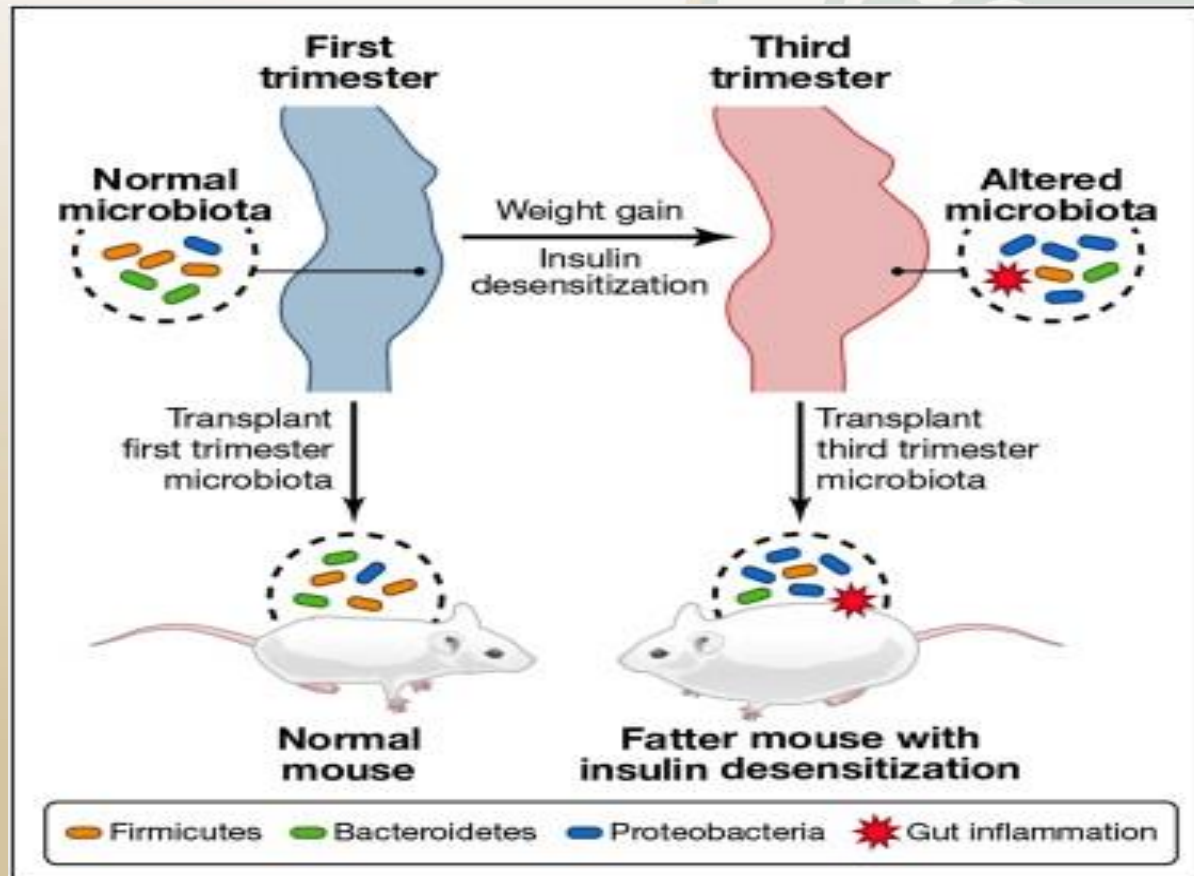
# Microbial Dynamics in Infancy

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# In the beginning....

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Pregnancy leads to alterations in a woman's microbiota that increase metabolic challenges.

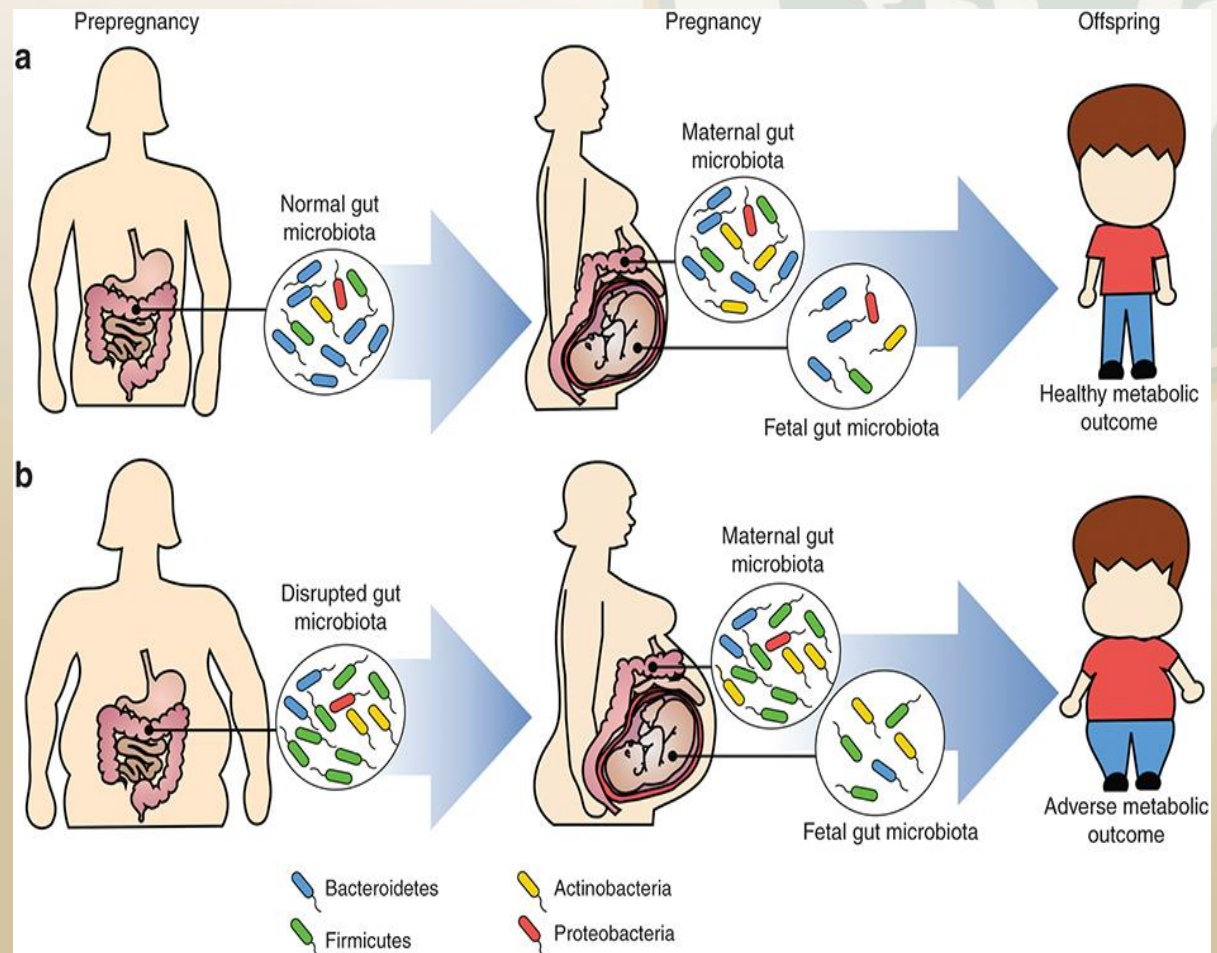




# Fetal Programming

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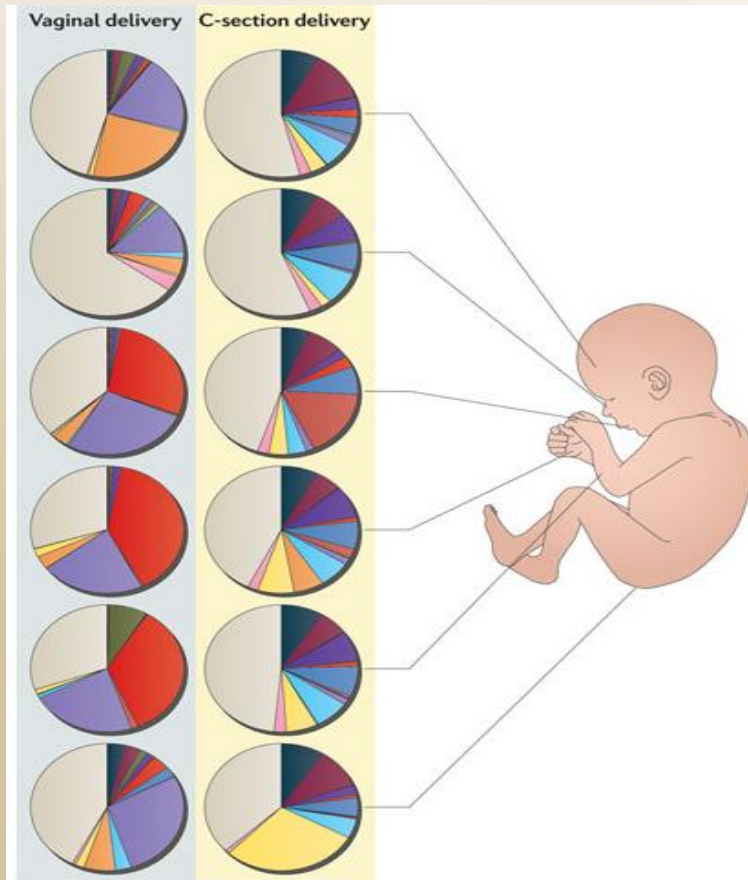
Maternal obesity is a strong predictive factor of childhood obesity and may be due to microbiota effects.





# Mode of Delivery

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**Table 1**

## Cesarean Delivery Associated Childhood Diseases<sup>1,2</sup>

### **Allergic Rhinitis**

*All Cesareans*

1.37 (1.14-1.63)

*Repeat Cesareans Only*

1.78 (1.34-2.37)

### **Asthma**

*All Cesareans*

1.24 (1.01-1.53)

*Female*

1.53 (1.10-2.10)

*Female & Repeat Cesarean*<sup>3</sup>

1.83 (1.13-2.97)

### **Celiac Disease**

1.80 (1.13-2.88)

### **Diabetes Mellitus (Type 1)**

1.19 (1.04-1.36)

### **Gastroenteritis**<sup>4</sup>

1.31 (1.24-1.38)

### **Gastroenteritis AND Asthma**

1.74 (1.36-2.23)

<sup>1</sup>Data from references<sup>46, 47, 50</sup>

<sup>2</sup>Odds Ratio (OR) with 95% CI versus vaginal delivery

# Restoring Microbiota

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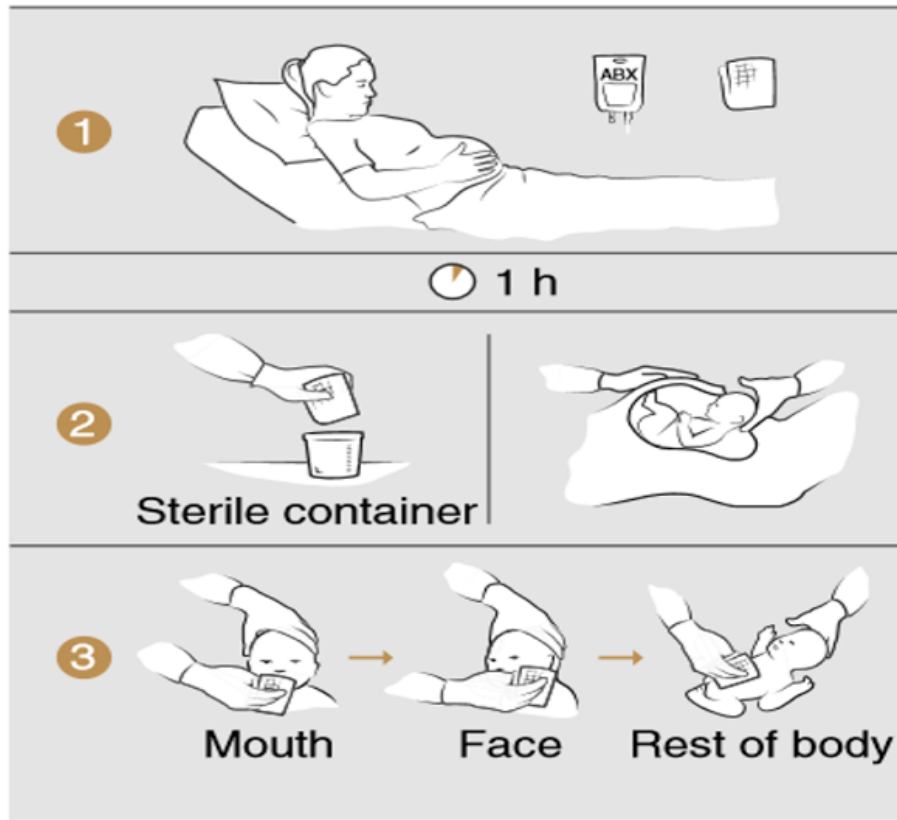
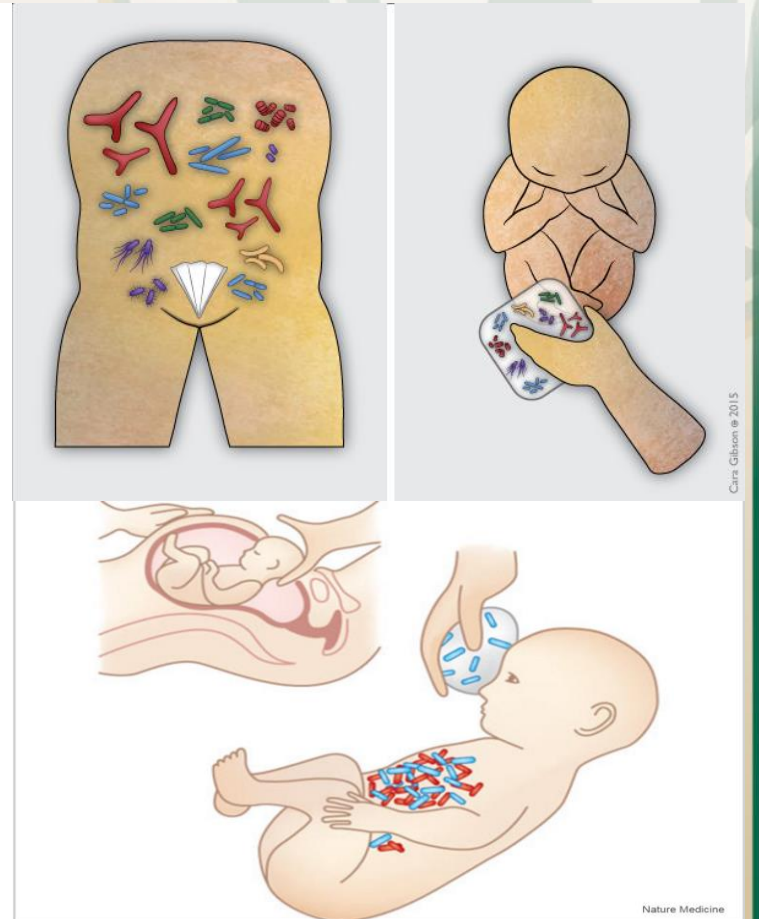
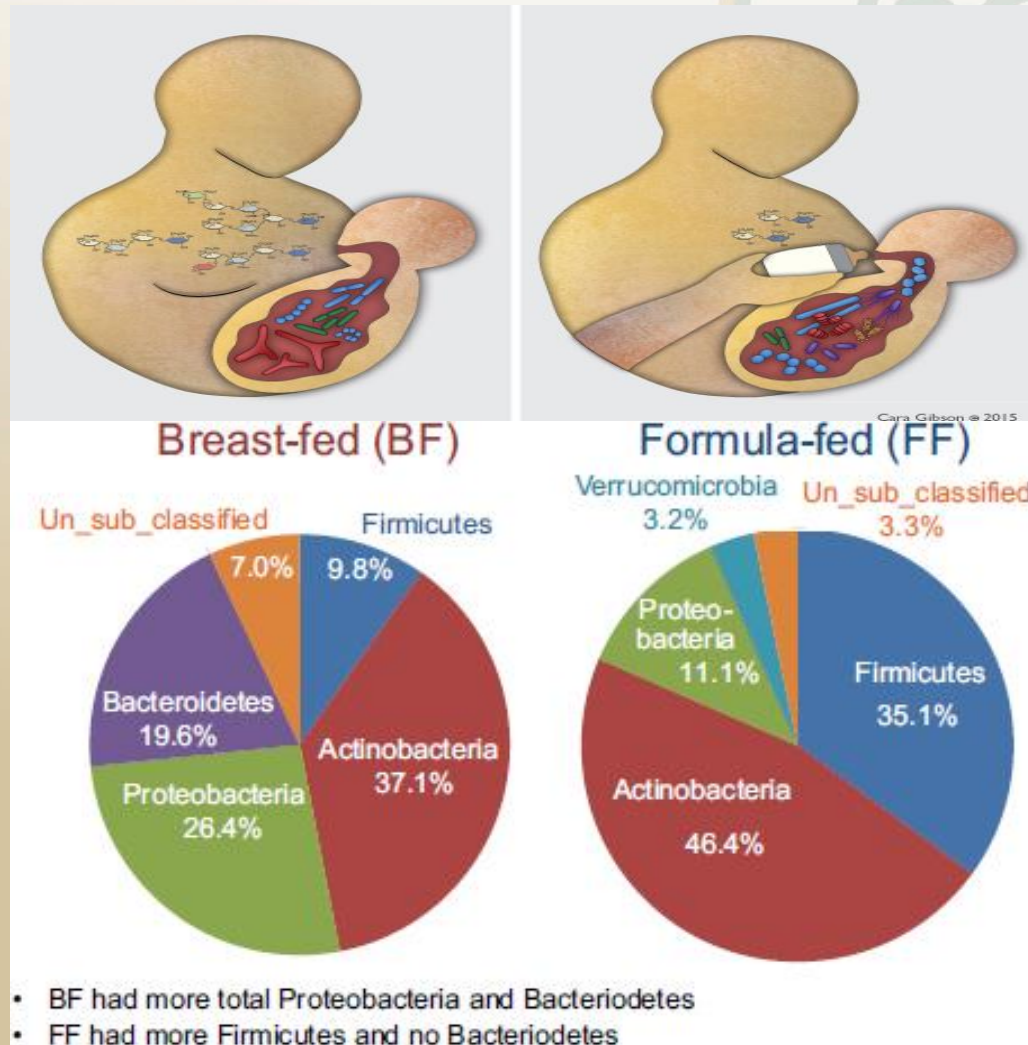


Image: M.J. Schoen



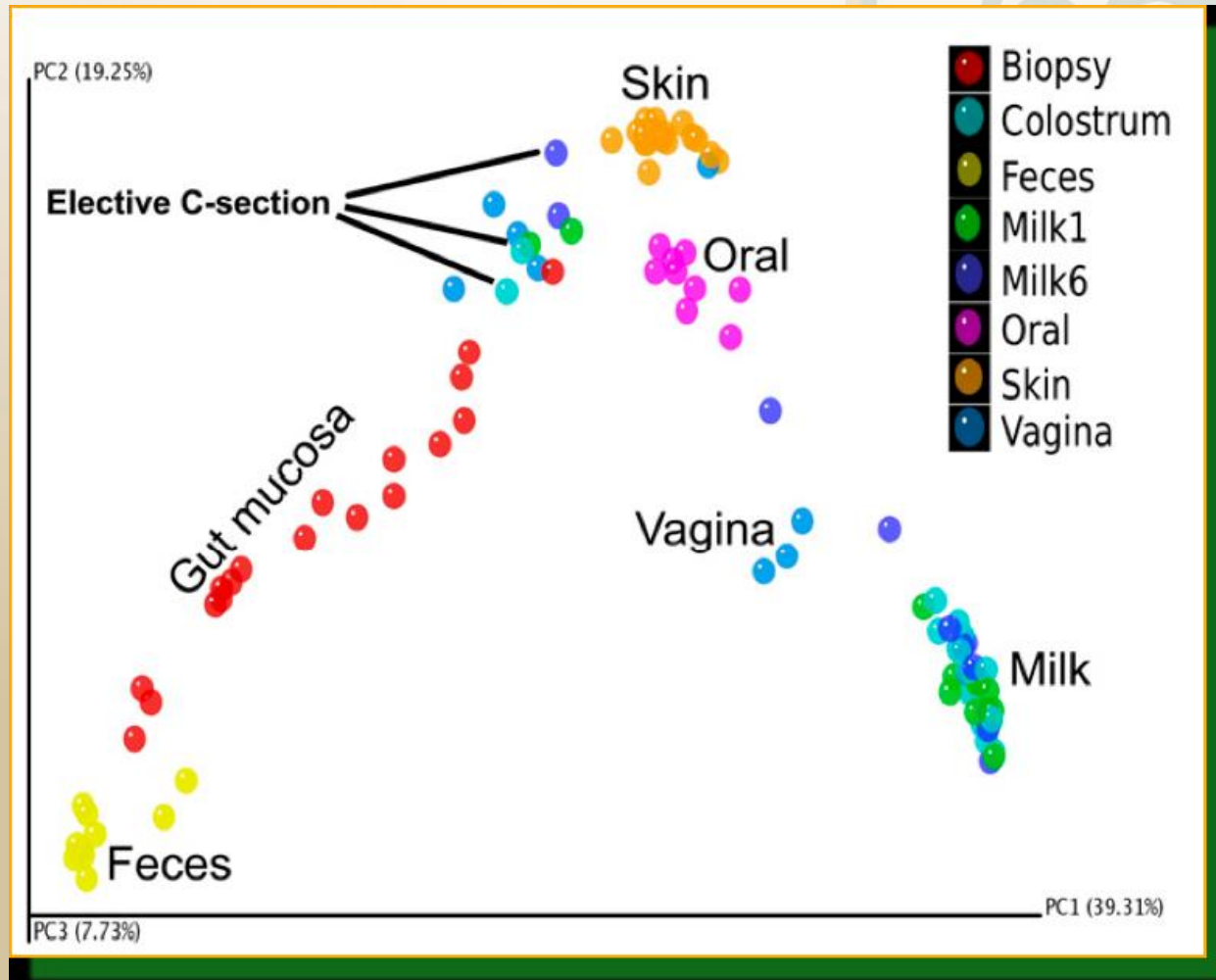
# Breast vs. Formula

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# Mother's Milk Microbiome

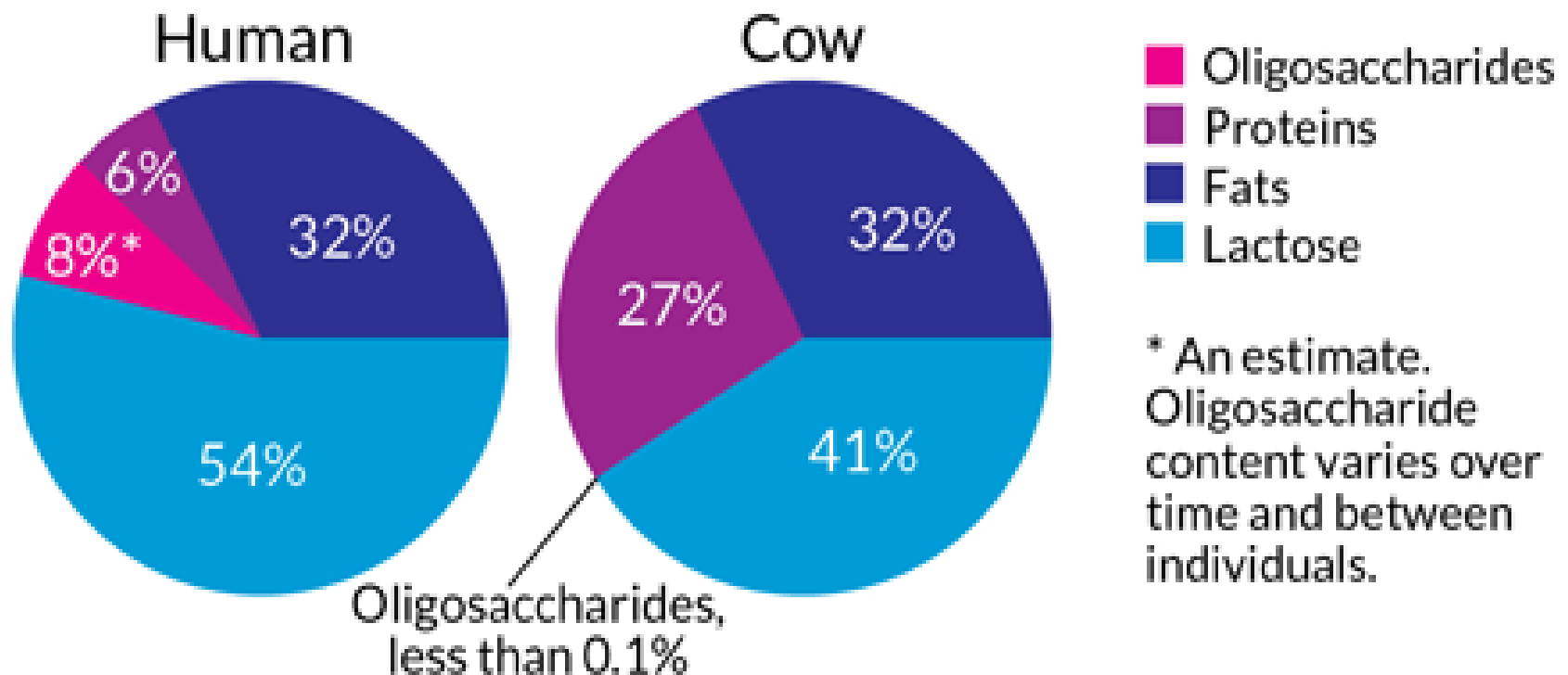
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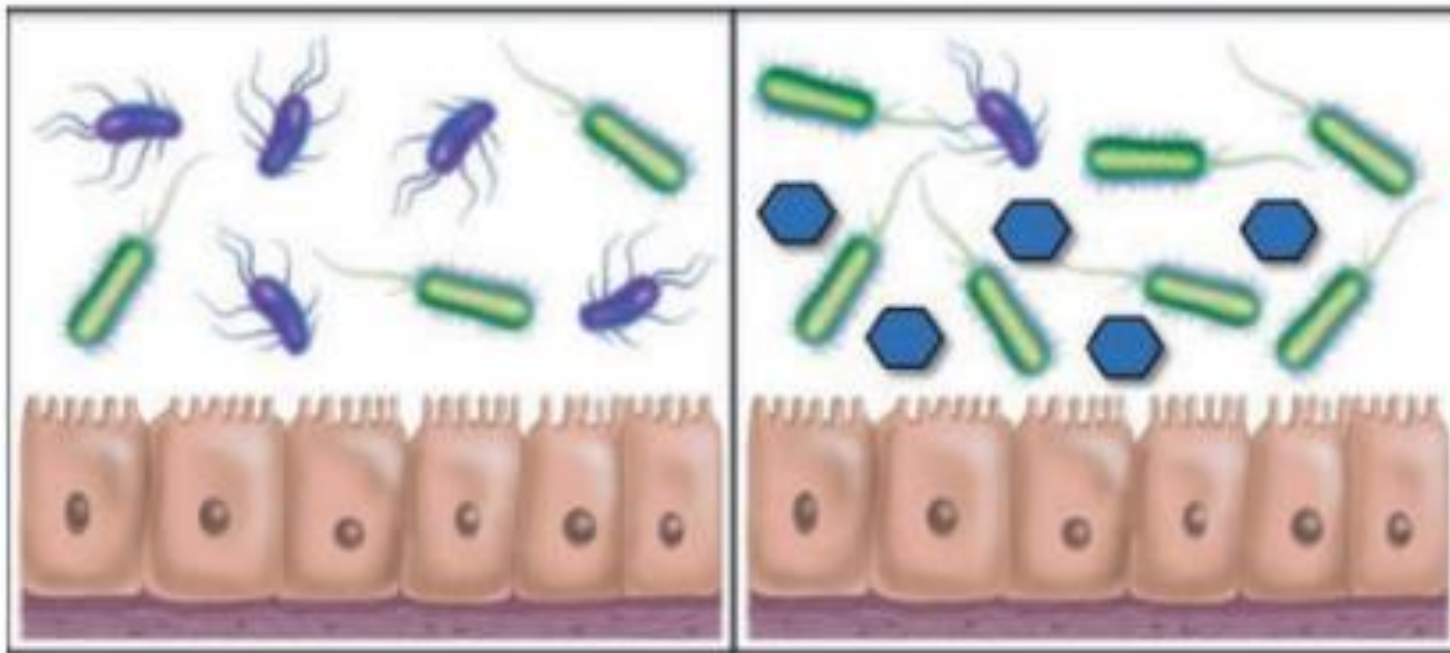
# Oligosaccharides

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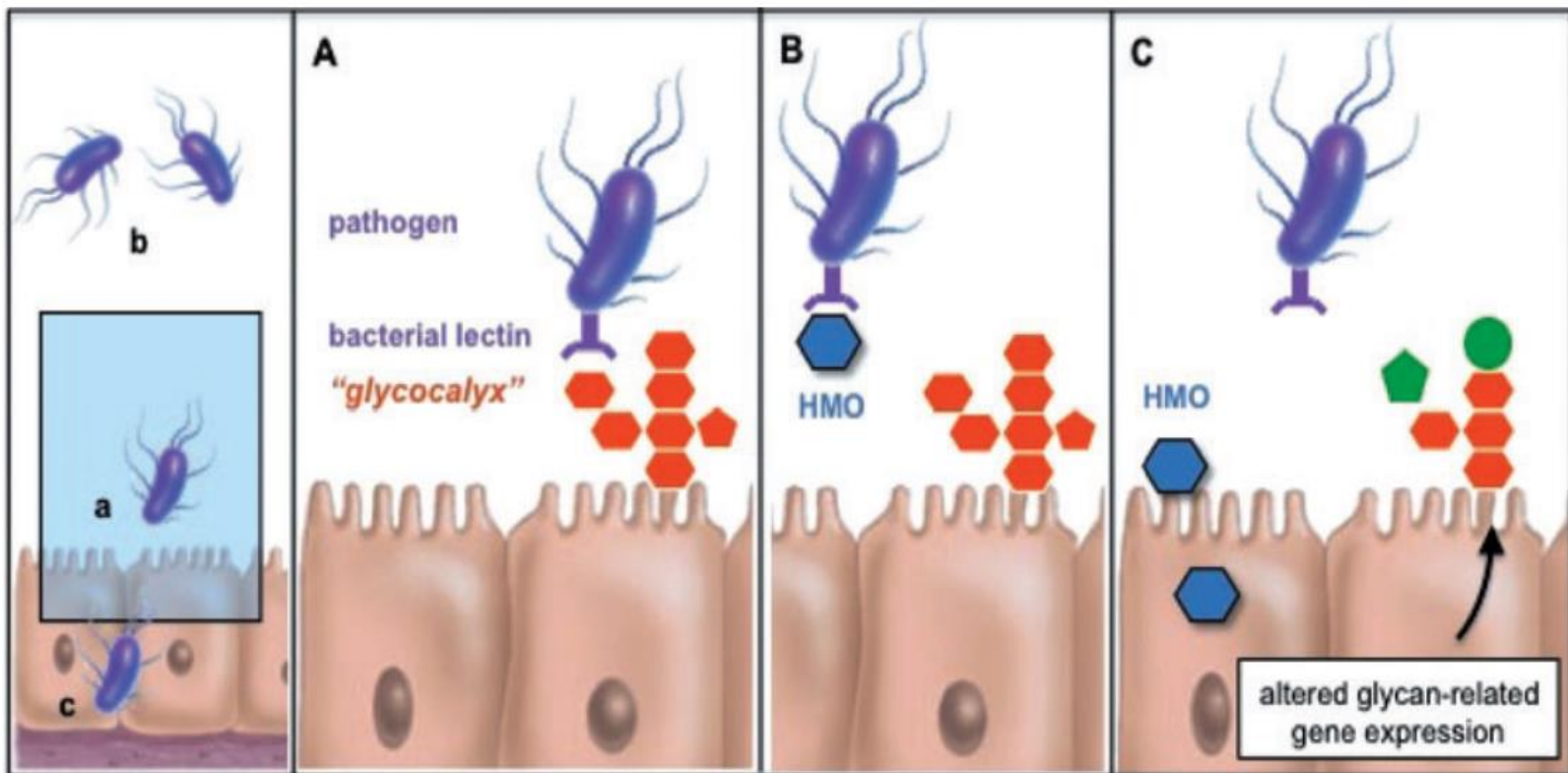
# How they work...

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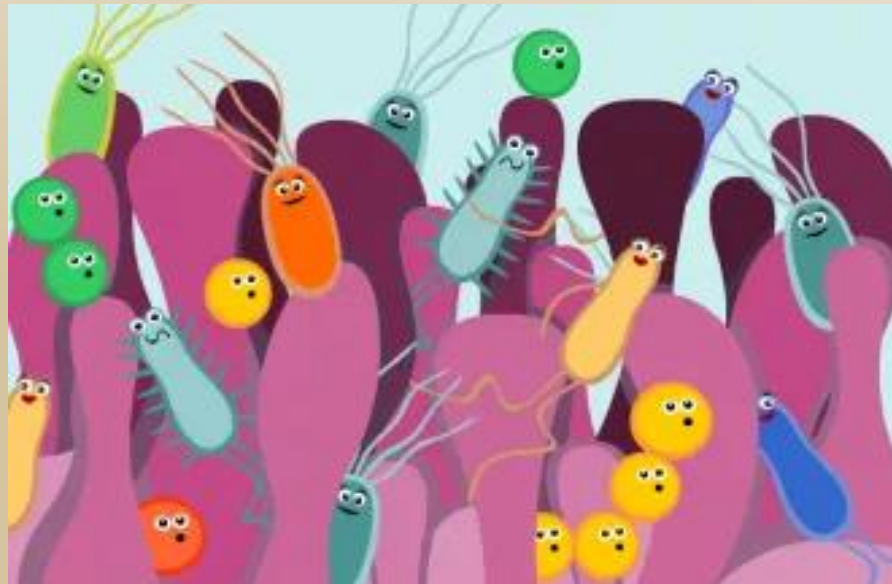


# How they work...

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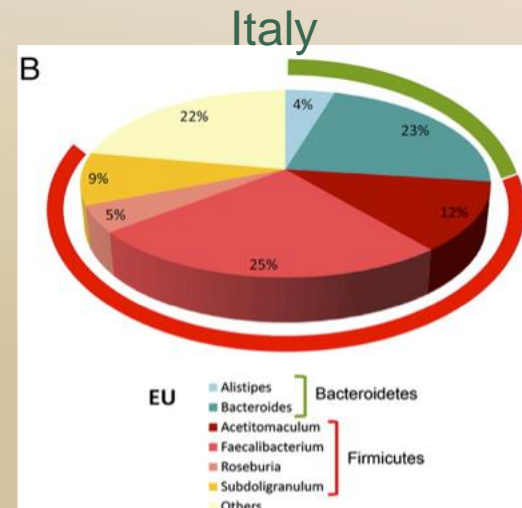
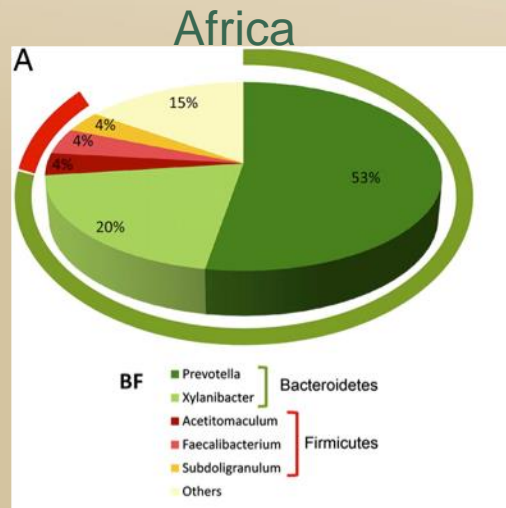
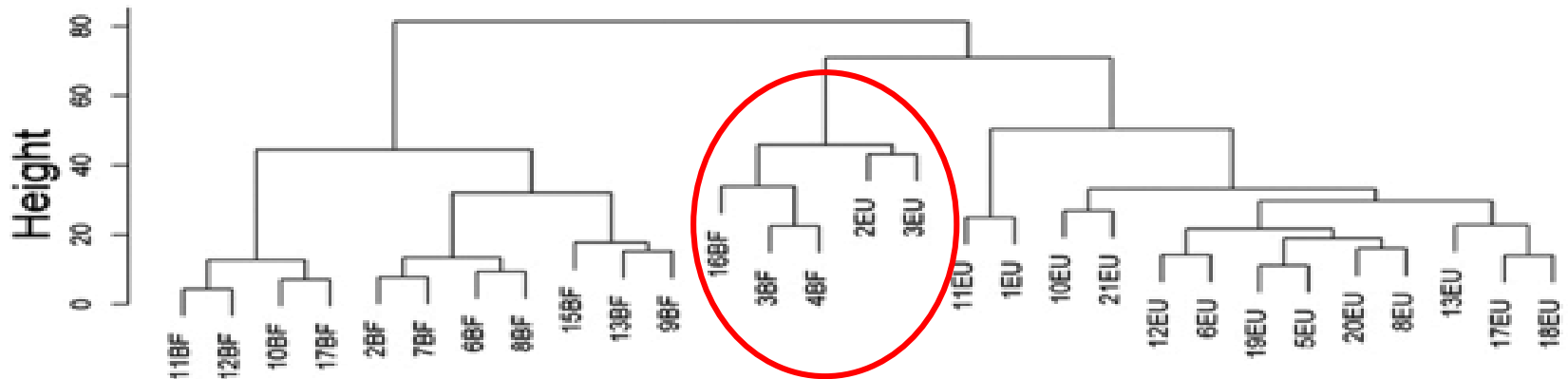
# Care and Feeding of the Microbiota





# Diet

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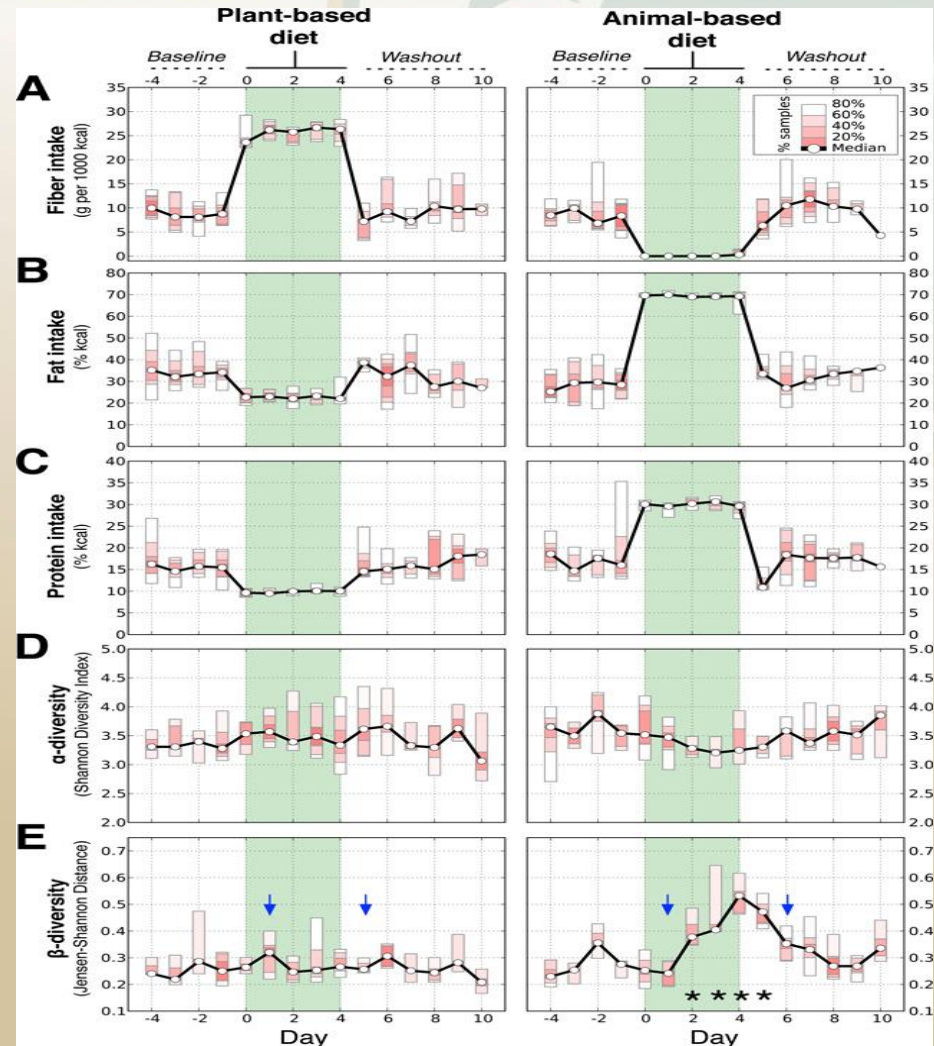
# Fat or Fiber?

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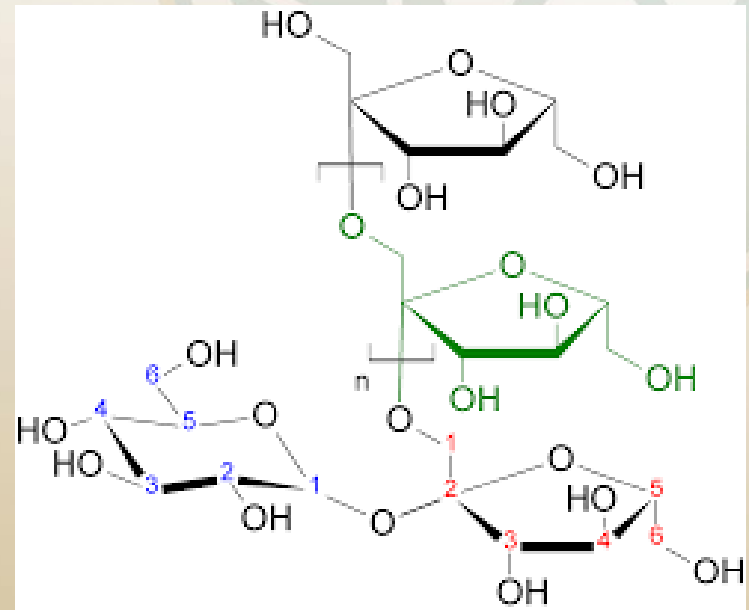
Animal-based diet: increased fat and protein, reduced fiber

Plant-based diet: increased fiber intake and decreased fat/protein

Change in community structure from baseline **was significant with animal-based diet**, but returned when normal diet resumed.



**Prebiotics** are non-living indigestible polysaccharides (food components) that stimulate the growth of beneficial bacteria.



# Prebiotic Sources

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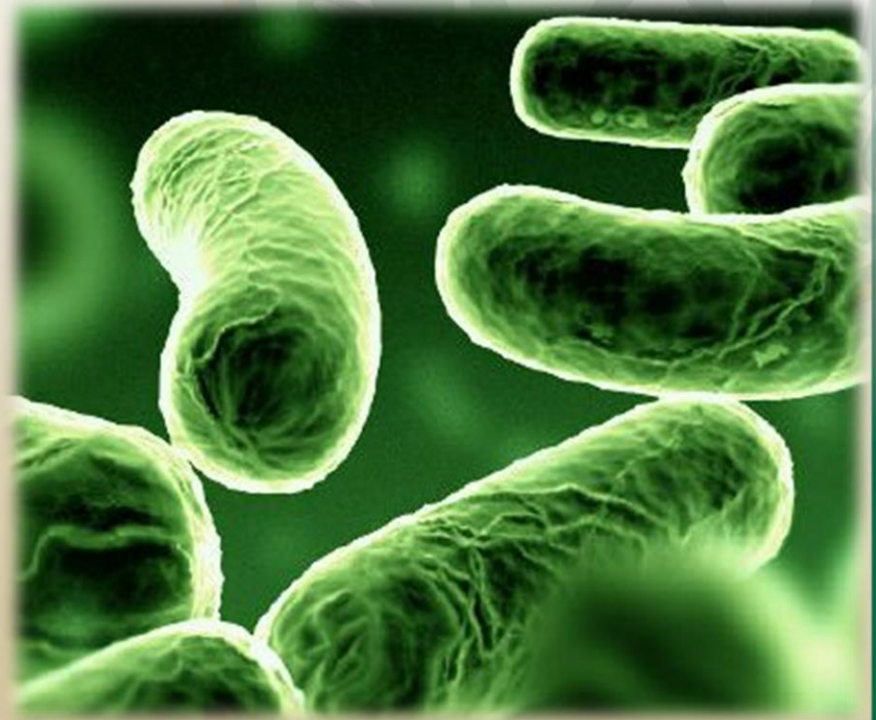
- Diet
  - Major dietary sources are consumed in limited amounts in a typical American diet
  - Studies may reveal “new” dietary prebiotics
- Supplements
- Fortification in foods
  - Yogurt
  - Infant formula
  - Artificial sweeteners

Foods with Prebiotics	Prebiotic fiber by weight	Amount needed for 6g serving
Chicory Root	64.6%	9.3 g
Jerusalem Artichoke	31.5%	19 g
Dandelion greens	24.3%	24.7 g
Raw garlic	17.5%	34.3 g
Raw leek	11.7%	51.3 g
Raw onion	8.6%	69.8 g
Cooked onion	5%	120 g
Raw asparagus	5%	120 g
Raw wheat bran	5%	120 g
Whole wheat flour,cooked	4.8%	125g
Raw banana	1%	600 g





**Probiotics** are live bacteria or yeast that when eaten in sufficient amounts can be beneficial for intestinal health.



# Probiotic sources

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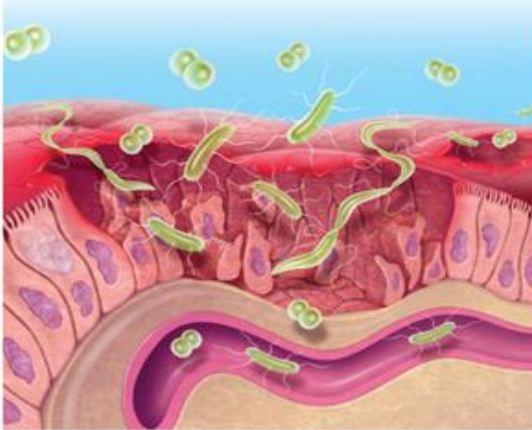
- Food sources:
  - Fermented dairy foods like yogurt, kefir products, and aged cheeses
  - Some fermented non-dairy foods including kimchi, sauerkraut, and kombucha
  - Supplemented non-fermented foods: Good Belly



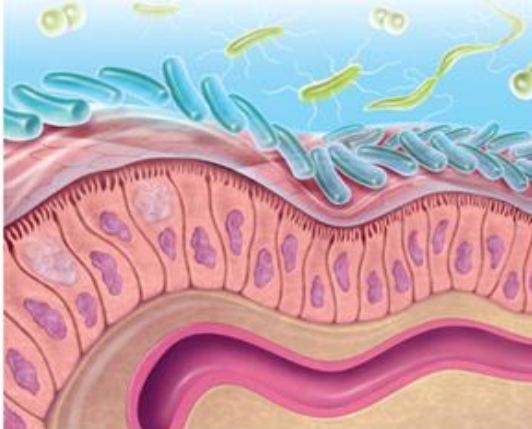
# VSL3: High Dose Probiotic

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Bad bacteria can damage the intestines causing irritation and reduced nutritional absorption



VSL#3 forms a barrier which protects the GI tract and allows nutrients to be absorbed<sup>26</sup>



- Currently approved in the US as a **medical food** to be used for the treatment of IBS
- Synergistic combination of common probiotic species
- Claims to deliver the highest number of live, active cells of any probiotic available.
  - Formulations range from 112.5-900 BILLION cells



# Summary

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- Both pre-pregnancy weight and weight gain during pregnancy may influence long-term metabolic function in the infants via microbiota influences.
- Consuming high fiber and fermented foods during pregnancy and limiting high fat foods may help with infant microbiota optimization.
- Unnecessary antibiotics (both during pregnancy and in infants) can compromise development of the microbiota.
- Breastfeeding provides the infant with pre- and probiotics necessary for early immune development.





