

# The Human Microbiome: Medical, Philosophical, and Theological Complexity

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**HEALTH**  
UNIVERSITY OF UTAH



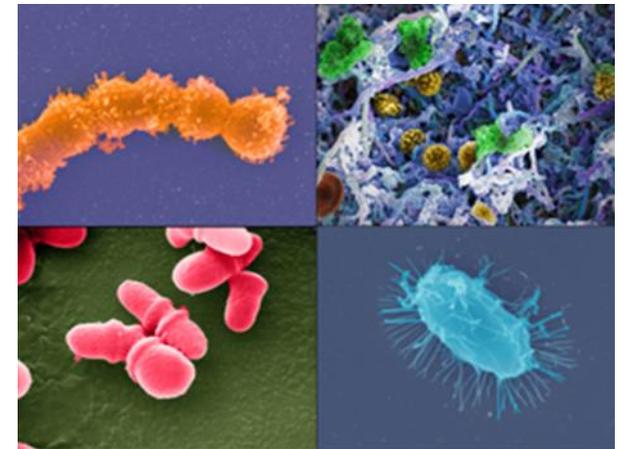
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# Disclosures

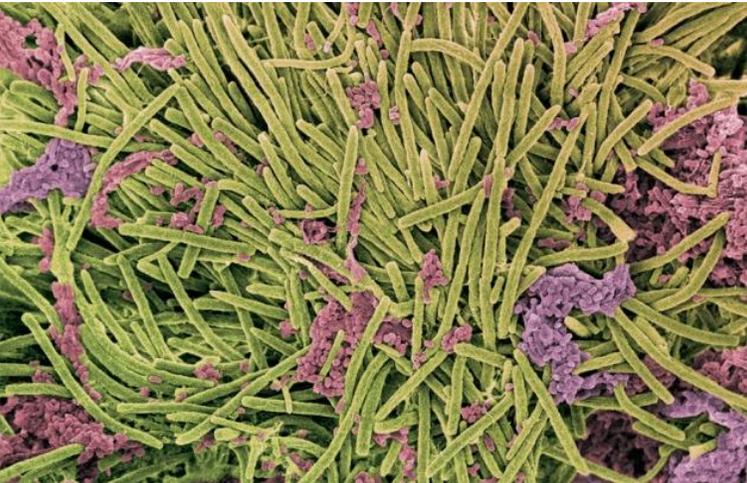
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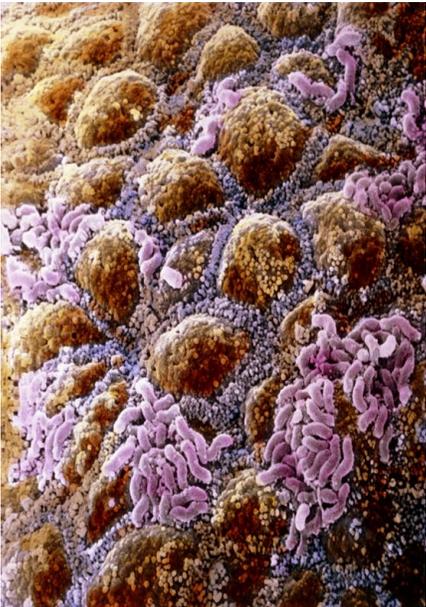
- I am a pediatric gastroenterologist.
- I am not a theologian.
- I am not a basic scientist or microbiologist.
- I am a Christian.



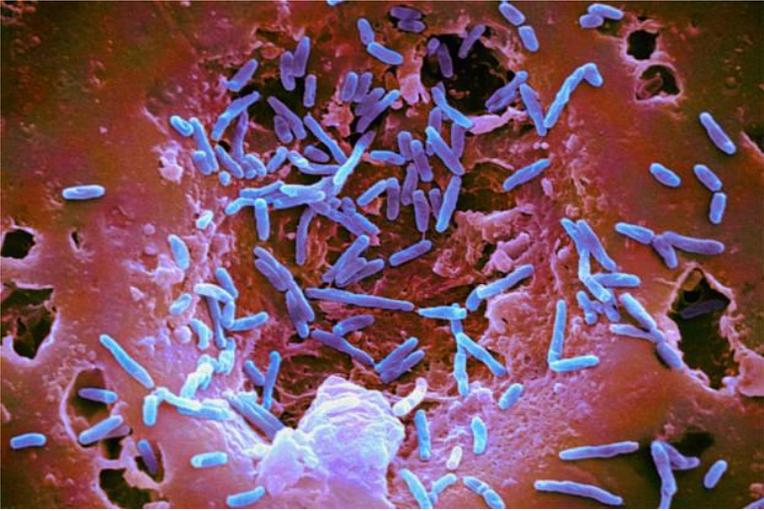
# The Microbiome and The Human Body



Tongue



Colon



Airway



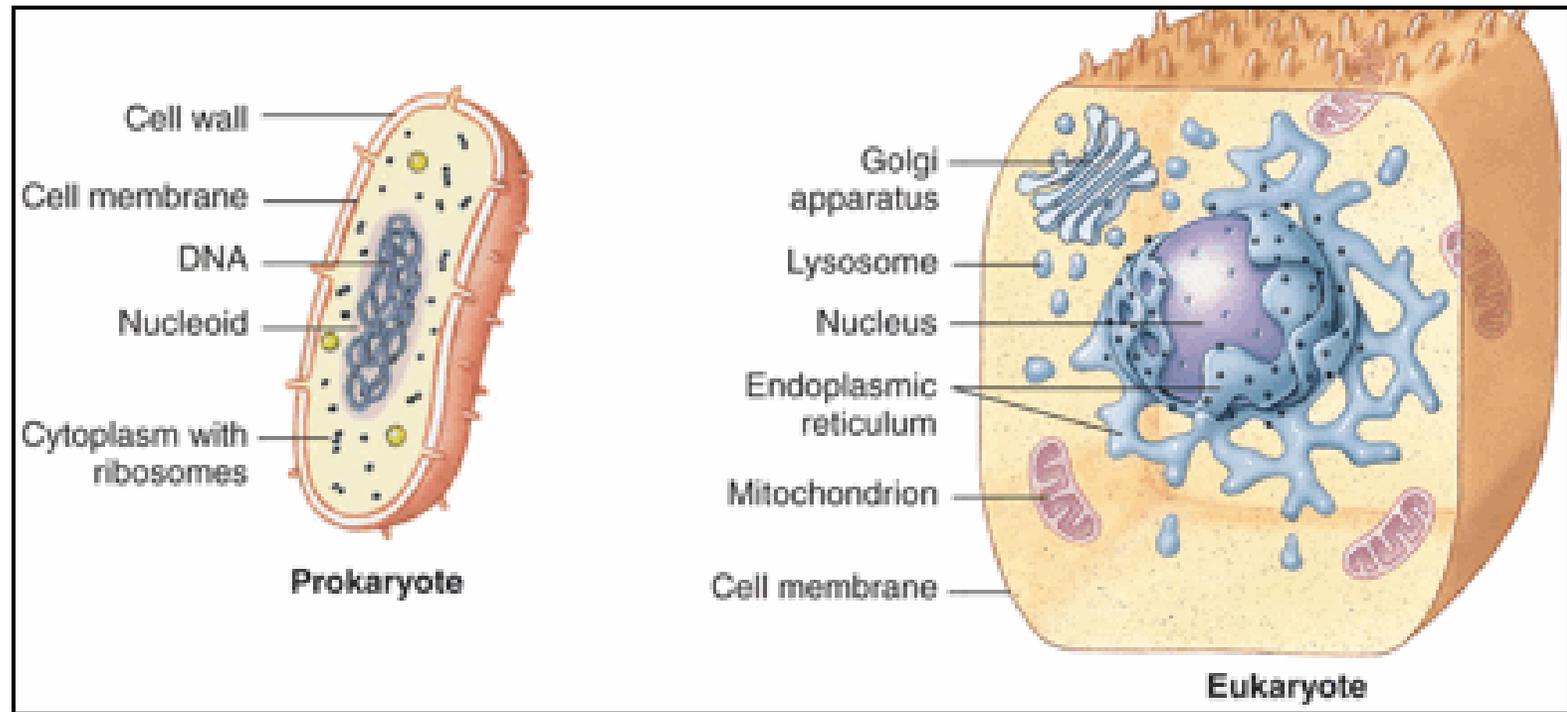
Skin

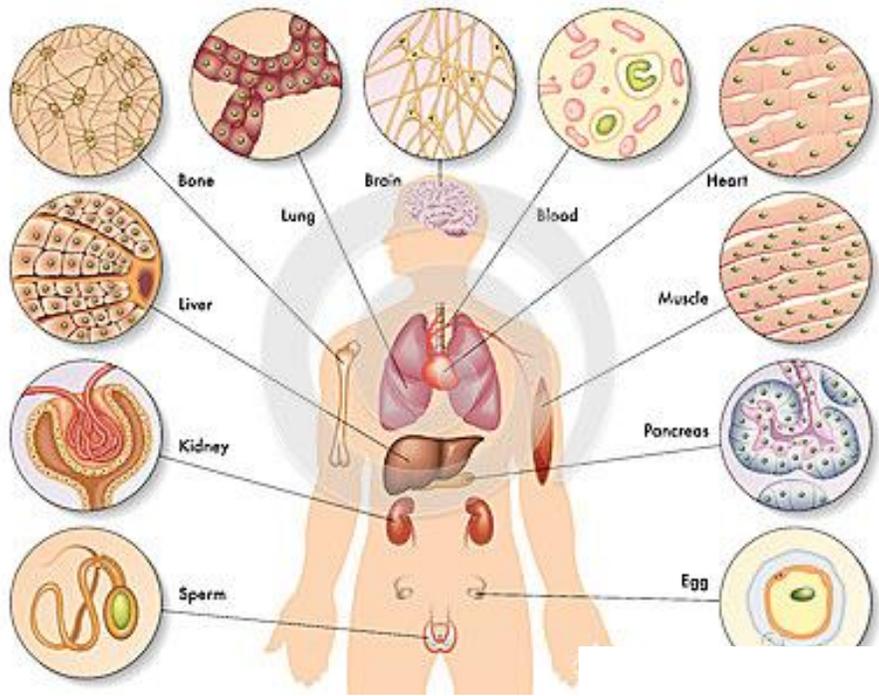
We are a mass of **eukaryote** cells:

1. Encapsulated nucleus
2. Organelles
3. More complex than our prokaryote friends (***the bacteria***)



**But are we really more complex?**





30 trillion human cells

**Microbiome species identified by the HMP**

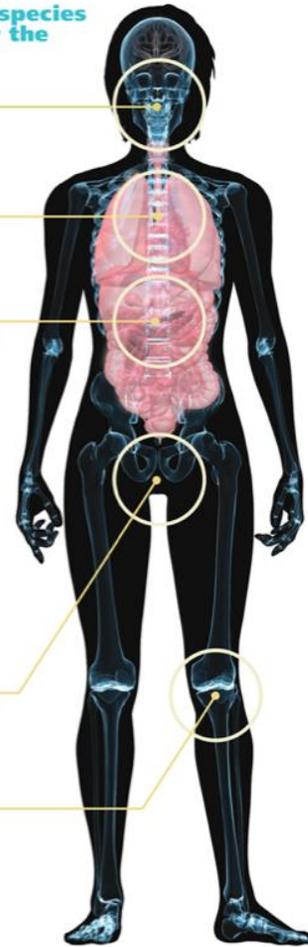
56  
Mouth

43  
Esophagus

220  
Gastrointestinal tract

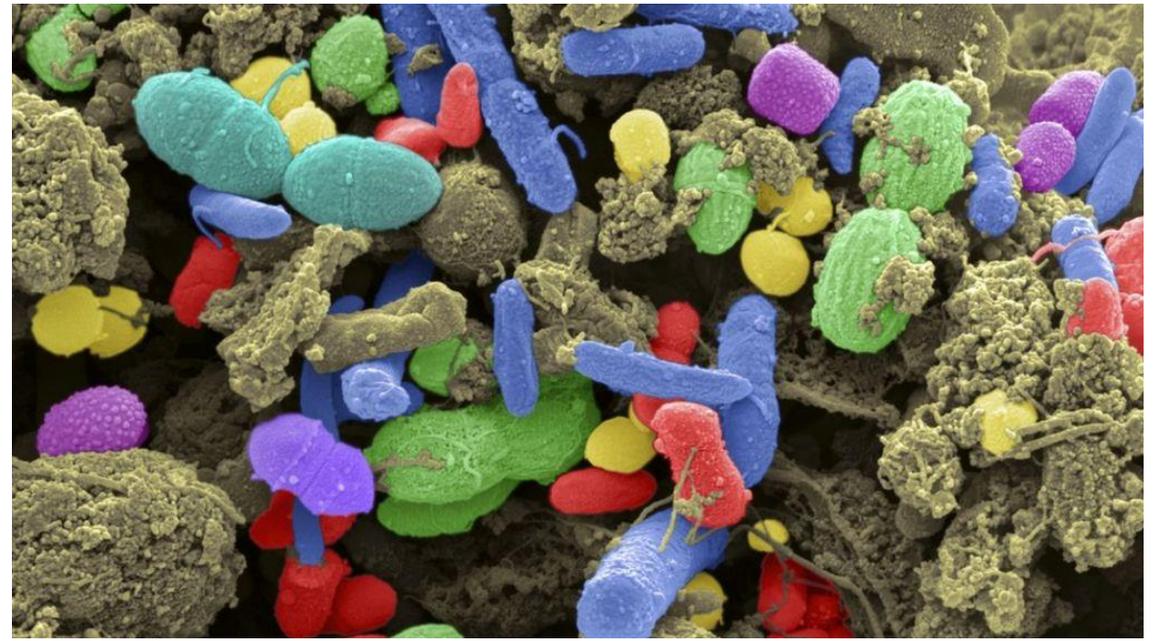
5  
Urogenital tract

48  
Skin



Billions (trillions) of “other”: viruses, bacteria, fungi, protists (ratio 1:1 to 3:1)

We are just beginning to understand these interactions.



We are somewhat like a coral reef.

## Terms:

- **Microbiome** (the microbes in our body and their genetic signature)
- **Microbiota** (the taxa identified with these microbes)
- **Probiotics**: Commensal bacteria or fungi interacting with humans (such as in the intestine). “**Good bacteria**” or “**good fungi**” (Lactobacillus, Bifidobacterium, Saccharomyces sp.). OTC supplements.
- **Prebiotics**: Non-absorbed substances which promote the growth of “good” bacteria (fiber, inulin, breast milk).
- **Synbiotics**: A combination of pro- and prebiotics.
- **ANTIBIOTICS** (a true medical miracle) → except when *overused*

# The Amount of Research in this Area is Staggering!

- “Microbiome” → 31,485 articles on PubMed
- “Probiotic” → 18,543 articles
- “Prebiotic” → 5693 articles
- “Synbiotic” → 838 articles



Why Would We Want to Change the Microbiome?

1. Compete for niche space against pathogenic bacteria
2. Provide anti-bacterial effects (antibodies in breast milk)
3. Effect the immune system (increase/decrease)

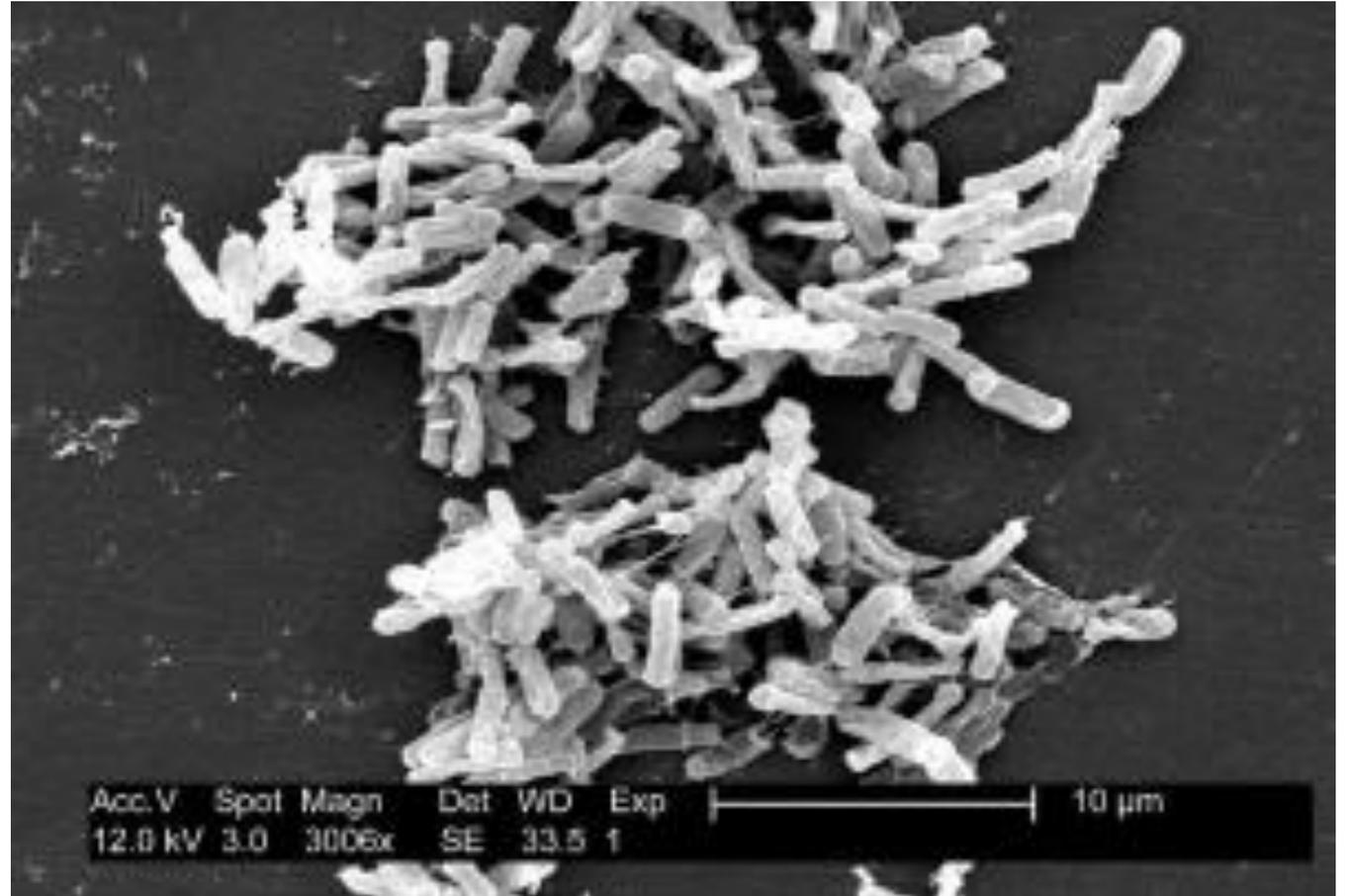


Image from NYU



Fecal transplant: From PCH

# As a Pediatric Gastroenterologist, Where do I Find the Microbiome Fascinating?

## POTENTIAL THERAPEUTICS:

1. Irritable bowel syndrome
2. Inflammatory bowel disease (Crohn disease, ulcerative colitis)
3. Celiac disease
4. Liver disease
5. Obesity
6. Starvation (especially in developing world scenarios)
7. GI cancer
8. And **MANY** others!



[Image from University of Pennsylvania]

Necrotizing Enterocolitis: Terrible problem among premature infants!



# Necrotizing Enterocolitis (N.E.C.)

- 1% – 7% of NICU admissions (typically premature infants, <1500 grams)
- **30% - 50% mortality rate**

Causes:

1. **Thin** bowel wall (“bacterial streaming”)
2. **Increased** blood clotting in vessels going to intestine.
3. **Dysregulated** immune system due to prematurity
- ★ 4. **Excess growth** of *pathogenic* bacteria and fungi in intestine (*Enterobacteriaceae, Staphylococci, Candida, etc.*)

# Necrotizing Enterocolitis (N.E.C.)



“Bowel rest”  
IV antibiotics  
Surgery  
Longer NICU time  
Higher healthcare costs



What about probiotics?

## Necrotizing Enterocolitis (N.E.C.) – Probiotics?

### **Could probiotics be beneficial in NEC prevention in pre-term infants?**

Some studies suggest benefit:

- Meta-analysis of 25 studies (7345 premature infants) Chang H, et al. *PLoS One* 2017

# Necrotizing Enterocolitis (N.E.C.) – Probiotics?

## Problem:

- Maybe no benefit? 654 infants received Bifidobacterium vs 661 infants received placebo. No effect Costeloe K, *Health Technol Assess*, 2016.
- **No standardized dose**
- **No specific strain(s)**
- **Duration of use unknown**
- **No algorithm to determine high-risk infants**

# Necrotizing Enterocolitis (N.E.C.) – Probiotics?

Problem:

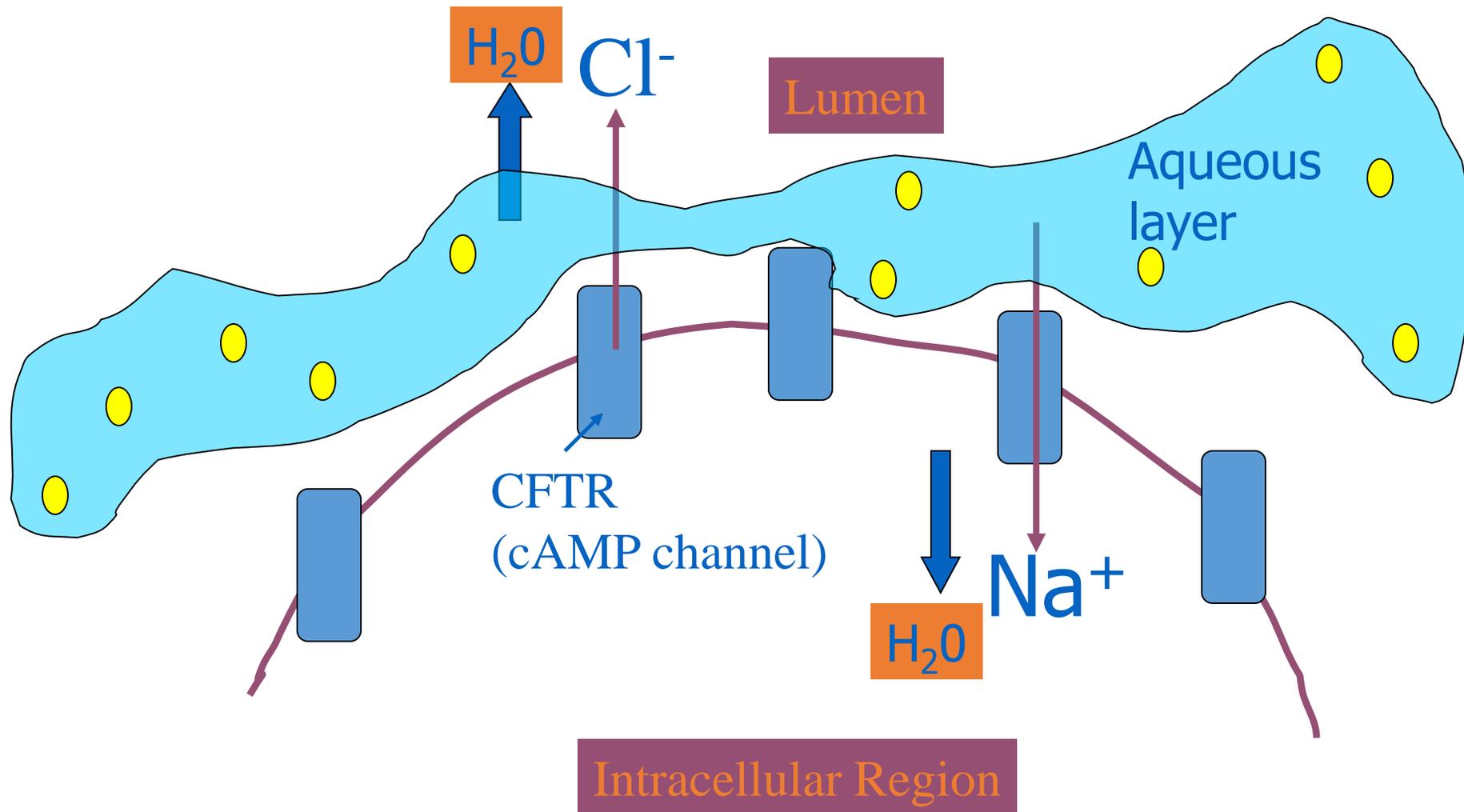
- Maybe no benefit? 654 infants received Bifidobacterium vs 661

Lots of potential. We need more research / better studies.

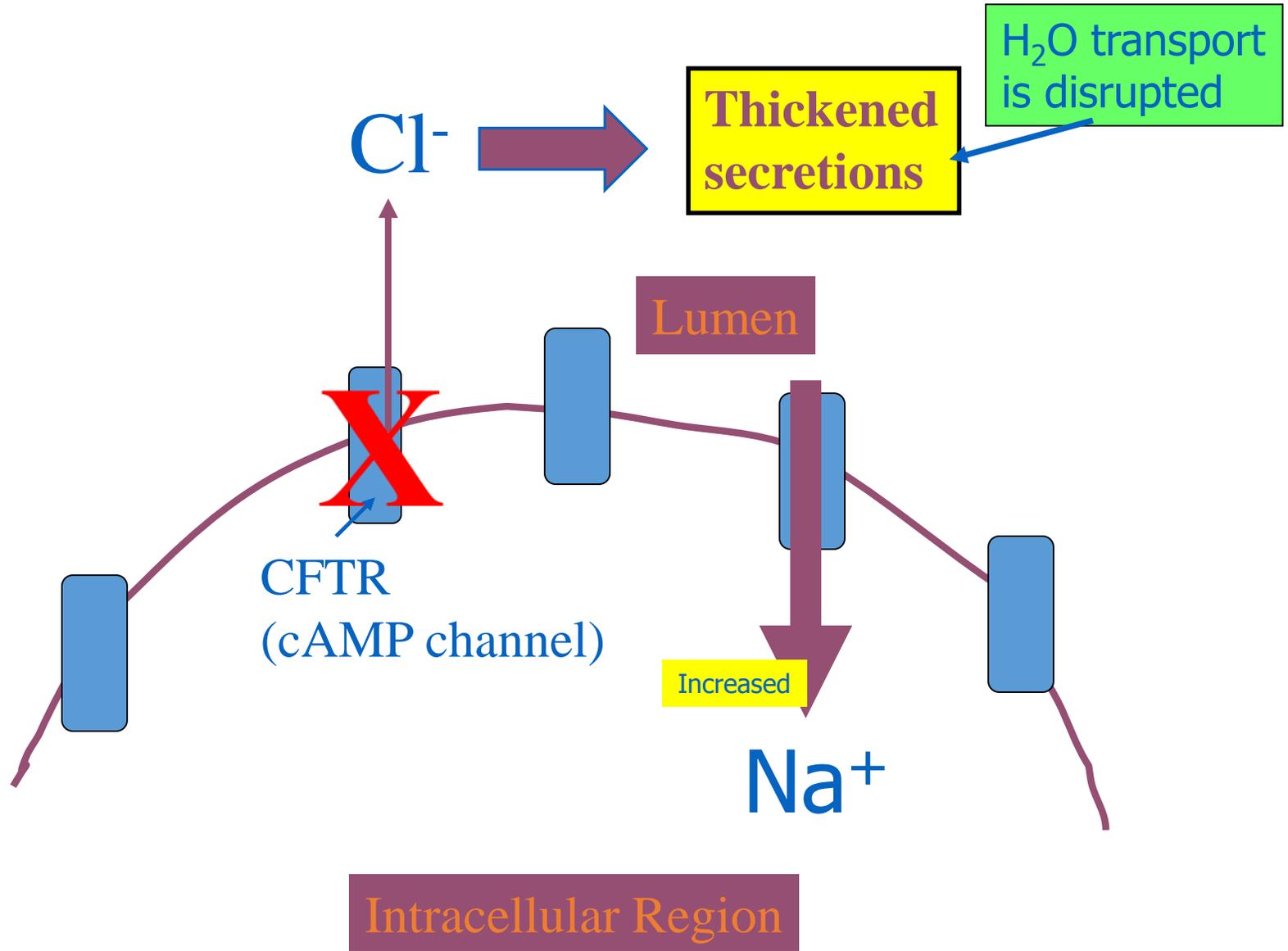
- **No specific strain(s)**
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# Cystic Fibrosis

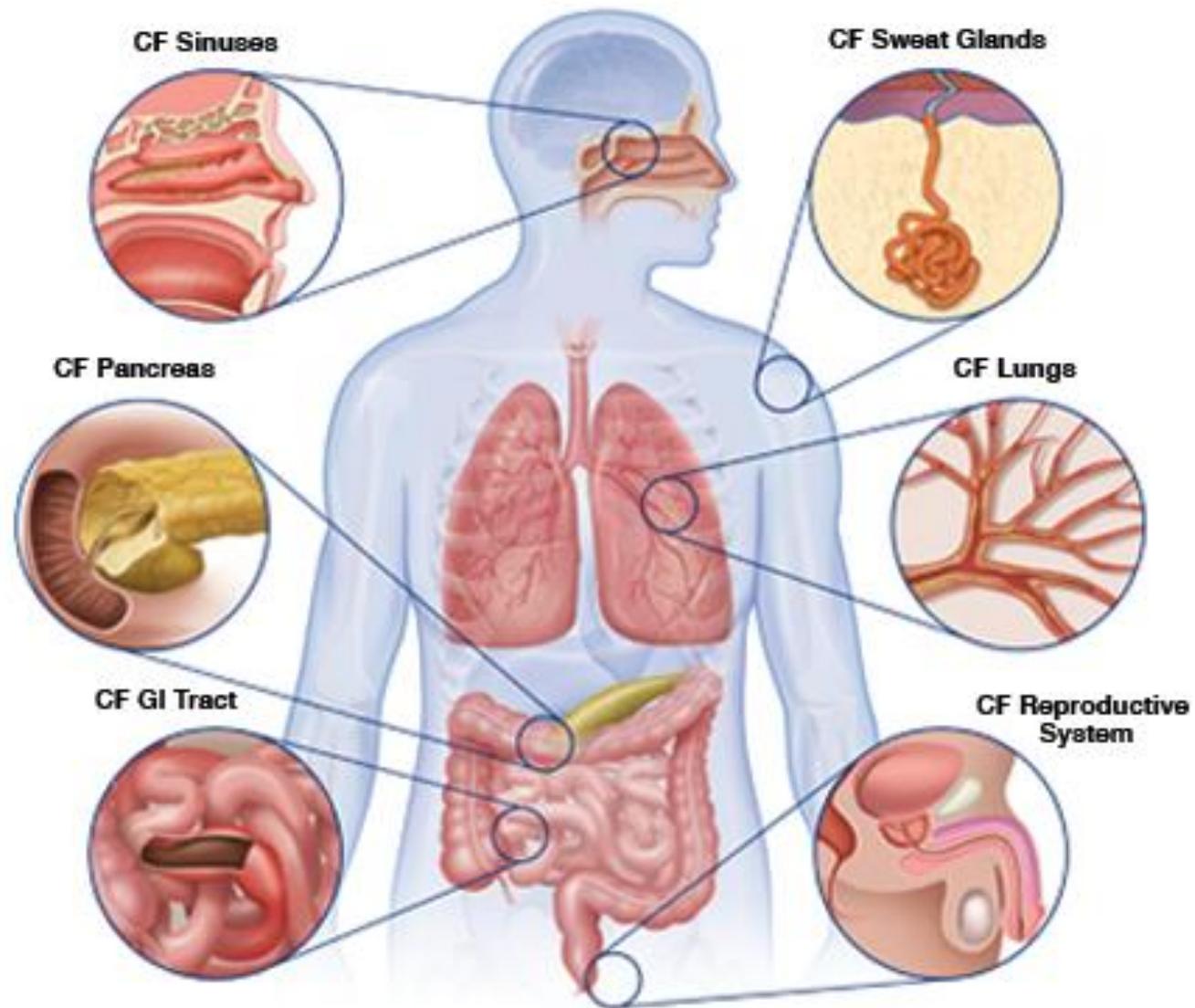


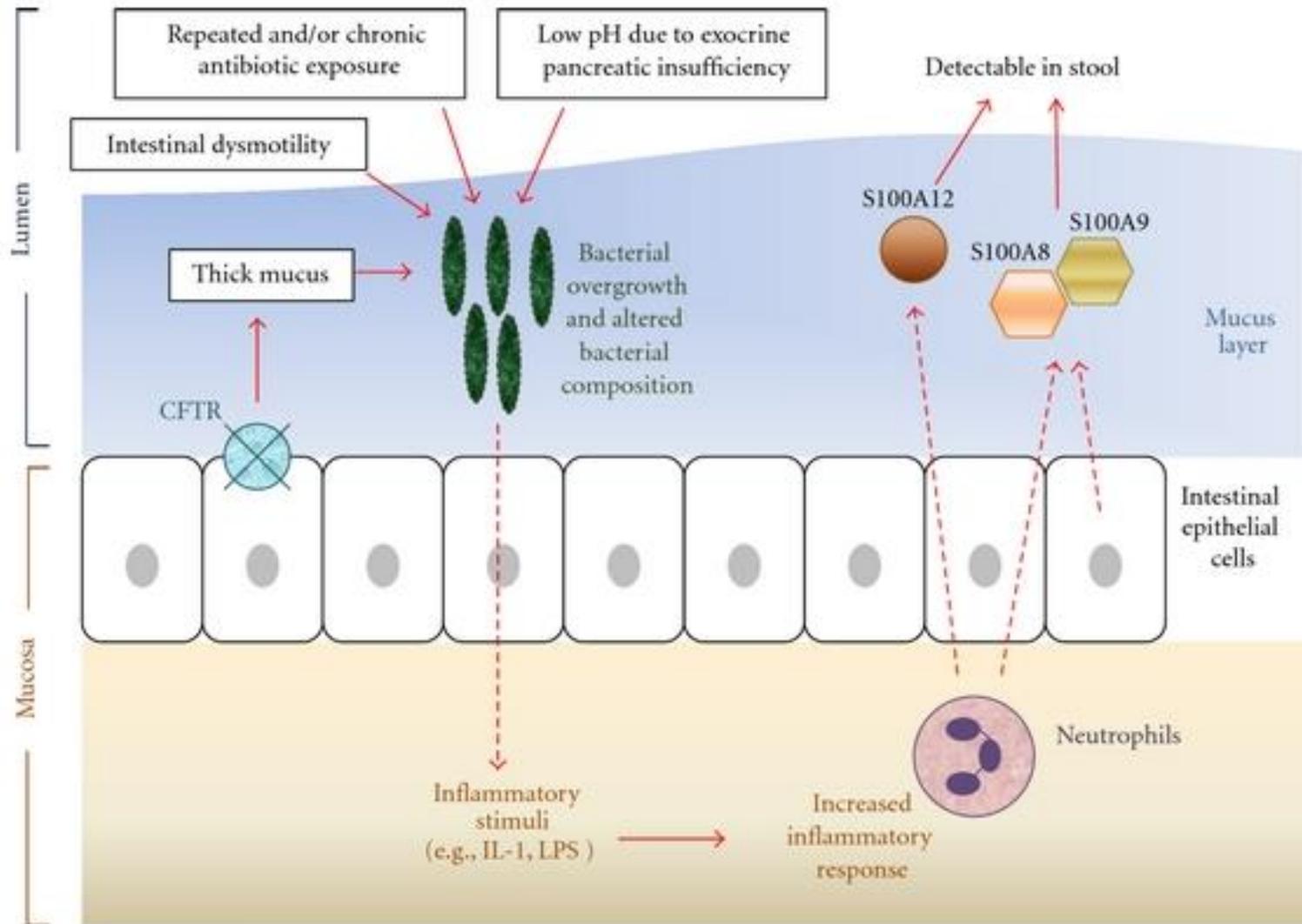


Cystic fibrosis transmembrane conductance regulator (CFTR)



# Cystic fibrosis is a **Multi-Organ Disease**.



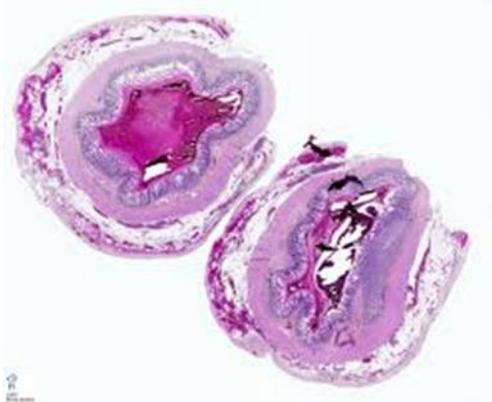


Many factors lead to intestinal inflammation in cystic fibrosis.

Lee J, et al. *Mediators Inflamm* 2012

# Cystic fibrosis: What about the Microbiome?

- The intestines of patients with CF have ***different bacteria*** compared to healthy controls.

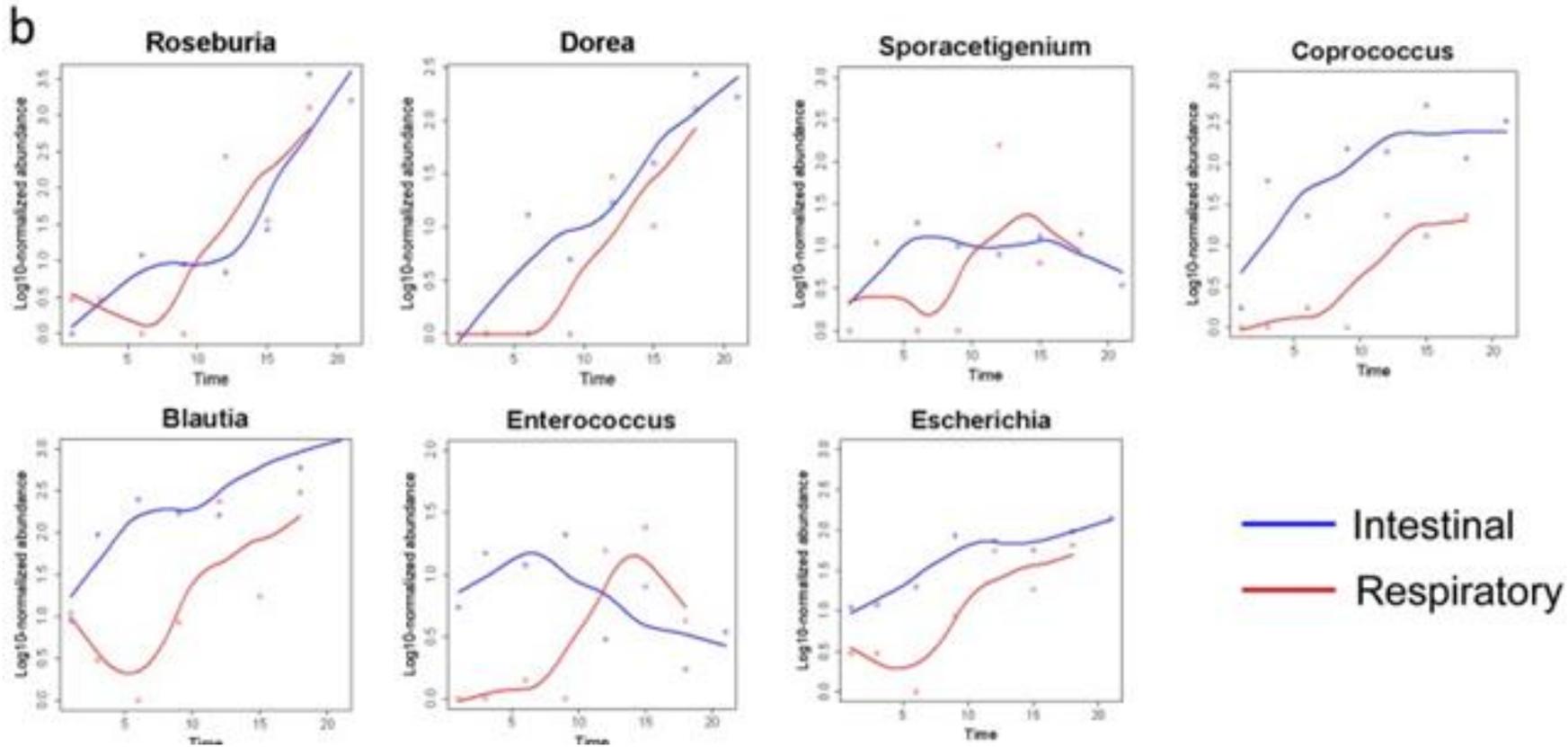


Weird! Could bacteria in the gut ***affect the lungs*** in patients with cystic fibrosis?

# What do we know so far?

- Infants with CF who breastfeed may have **delay in colonization** of harmful bacteria (Hoen A, et al. *J Pediatr* 2015).
- Diet changes in patients with CF affect lung bacteria suggesting that **gut bacteria signal / change the lung bacteria** (Madan J, et al. *Mbio* 2012).

**What could this mean for probiotic use???**



Cystic fibrosis: As intestinal bacteria **increase**, respiratory bacteria increases **follow**.

**Why?**

Clinical effect?

What if we gave probiotics?

# What do we know so far?

- Adults with CF: Bacterial diversity appears to greatly diminish over time → possibly due to antibiotics.
- Would probiotics help? [We know probiotics are being used in this population although the data is not clear.](#)

Burke D, et al. *BMC Microbiol*, 2017.

# The science of the microbiome continues to **grow!**

Danish population study (Danish Cause of Death Register):

Hospitalization for infection (esp. increased # of infections) associated with significantly ***elevated risk of suicide***. (*JAMA Psychiatry*, Lund-Sorensen et al. 2016).

**Theory: Do antibiotics change microbiome to affect CNS?**

# The science of the microbiome continues to **grow!**

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**Also:**

- **Probiotics may decrease overall inflammation in the elderly.**
- **Rats given probiotics may have less anxiety.**

# And the science continues to grow!

Irish study compared professional rugby players vs. controls → athletes have **more diverse microbiomes** associated with *less* risk of inflammation (Clarke S et al., *Gut* 2014)

# And the science continues to grow!

Stool from young killfish transplanted into older fish cause older fish to live longer. Microbiome of old fish then looked like young fish. ***Causative?***

**(Smith et al., bioRxiv 2017**

**<http://biorxiv.org/content/early/2017/03/27/120980>)**



# Let's Get Metaphysical!

What about philosophical and Theological consideration?





- There has been minimal work in this area.
- Needs theological / philosophical expertise
- I am a physician, not a theologian or philosopher.

**What initial ideas can be begin to explore?**

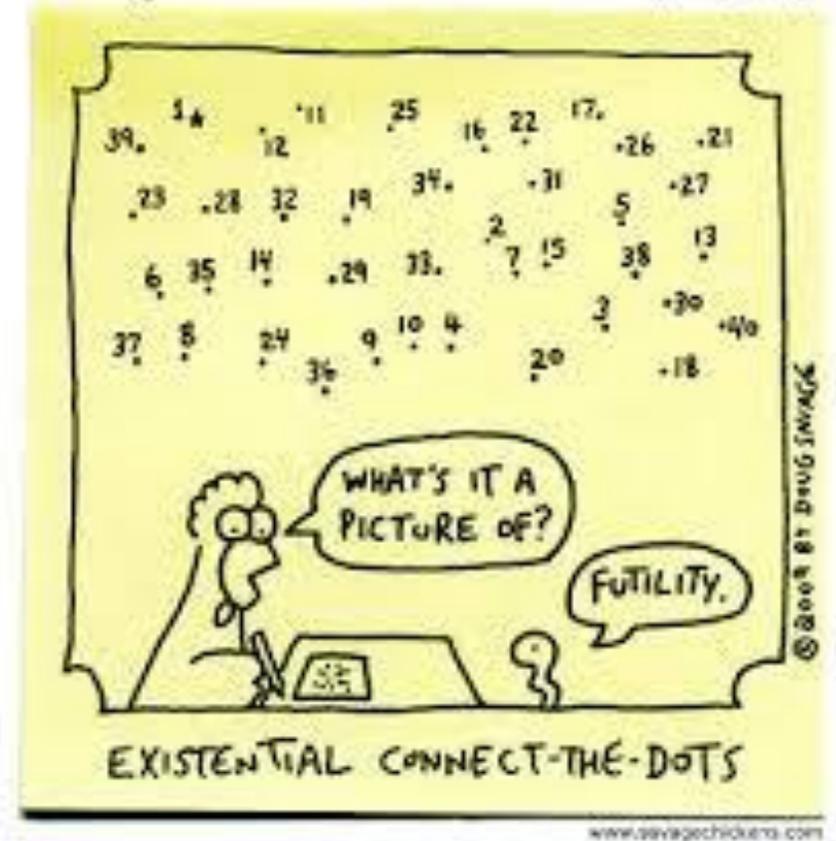
# Existentialism

## Spectrum of ideas here:

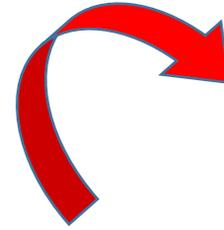
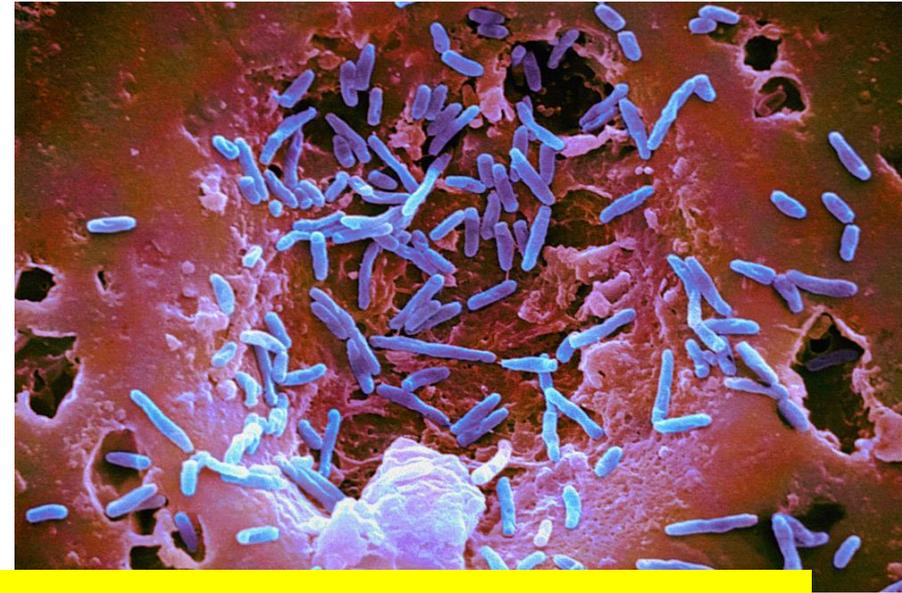
- Is the individual vs. society and/or world, responsible for giving meaning to life?

**Where does the microbiome fit in?**

- **Situatedness:** My freedom is present, but it is based on the foundation of my past, the Earth's past, the universe's past...**my microbiome?**



# Existentialism



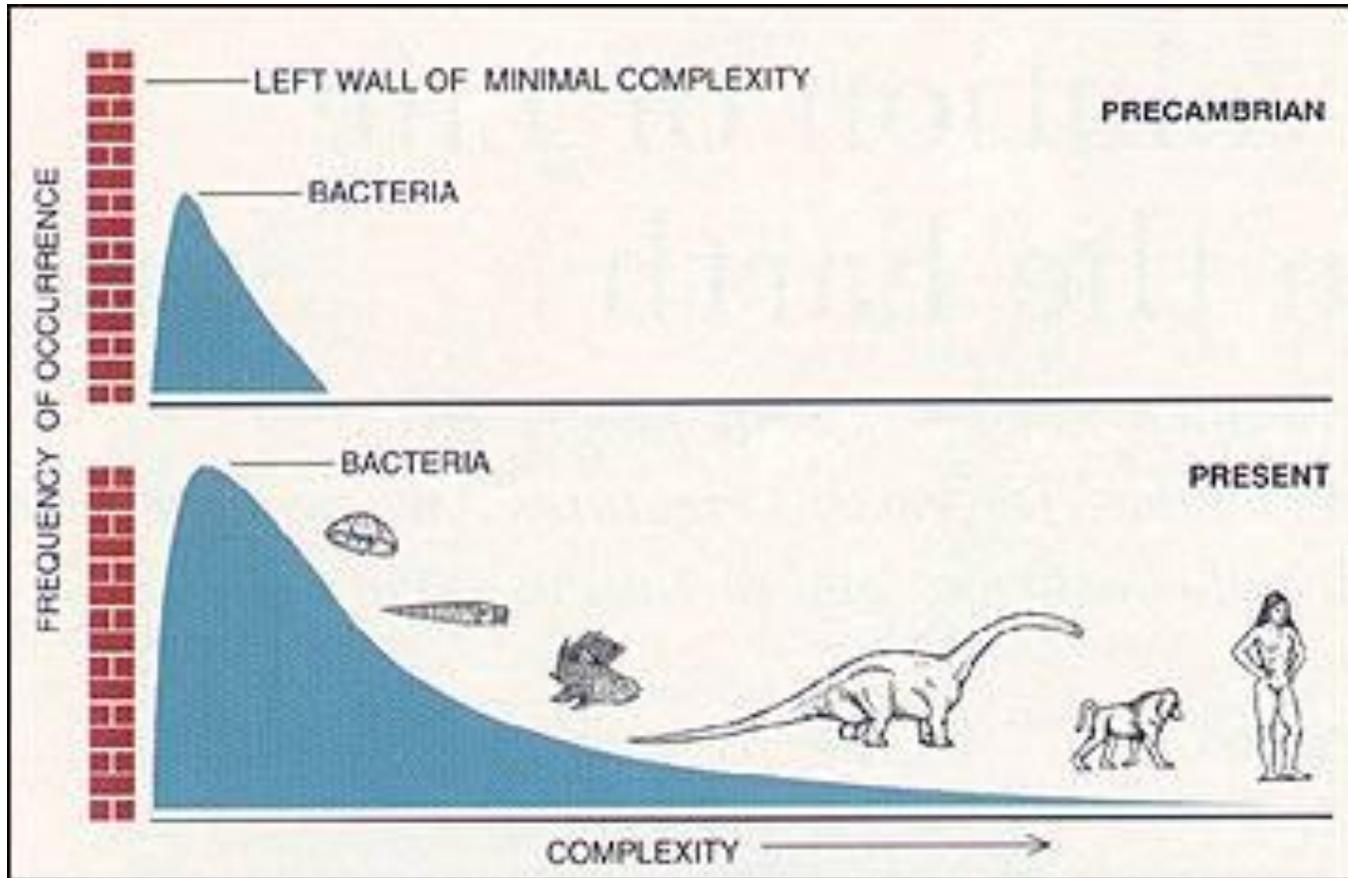
Is our freedom dependent on our microbiome?

1. For our health
2. Our environment and diet which change the microbiome
3. Communal/social interactions which change the microbiome
4. The history of the microbiome on every creature that has ever lived

**Open theism vs. Omniscience?**



# The “Left Wall of Evolution” by S. Gould



“Progress Does Not Rule”

Or

Maybe this is not the point?



# Dualism

- Idea of **separation** of the mind and the matter that the mind studies
- If our microbiome potentially interacts with all aspects of being human, can it affect our mental and emotional health?
- For example, germ-free mice spend less time socializing and more time self grooming compared to normal mouse controls (Desbonnet L et al., *Mol Psychiatry* 2014).

What correlation exists in humans?

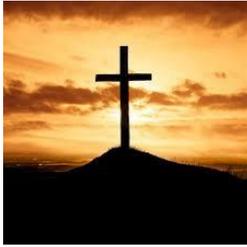


## Theology (My Daily Christian Walk)

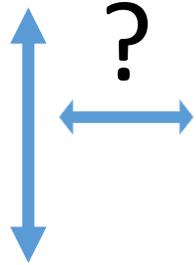
**“Just as a body, though one, has many parts, but all its many parts form one body, so it is with Christ. For we were all baptized by one Spirit so as to form one body—whether Jews or Gentiles, slave or free—and we were all given the one Spirit to drink. Even so the body is not made up of one part but of many.”** 1 Corinthians 12: 12-14 (NIV)

# The Body of Christ

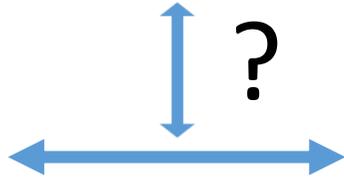
- We can be the foot, hand, or eye for the Body of Christ.
- But, perhaps, we can be *part of the microbiome* of the Body of Christ.
  1. We may feel insignificant or negligible compared to all of humanity.
  2. BUT, in reality, we are still important although not overtly obvious (like a bacteria in the microbiome – small but vital).
  3. “Do unto others as you have them do to you” → Learning that other bodies are possibly an extension of our body (**through the microbiome**) is profound.



God



You/Me



Neighbor

# Conclusions

1. The microbiome is an important part of human health.
2. The microbiome can affect disease outcomes and likely has an effect (not yet understood) with brain function and human emotions and interactions.
3. We need a better understanding of the microbiome and its relationship with the field of philosophy and theology.
4. We can use the microbiome as a metaphor of how we can influence the world around us in our daily Christian walk.
5. Absolutely ***groundbreaking work*** is ahead of us in this field!

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***Thank you to Robert Thoelen and Susan Pohl MD***

Thank you!

