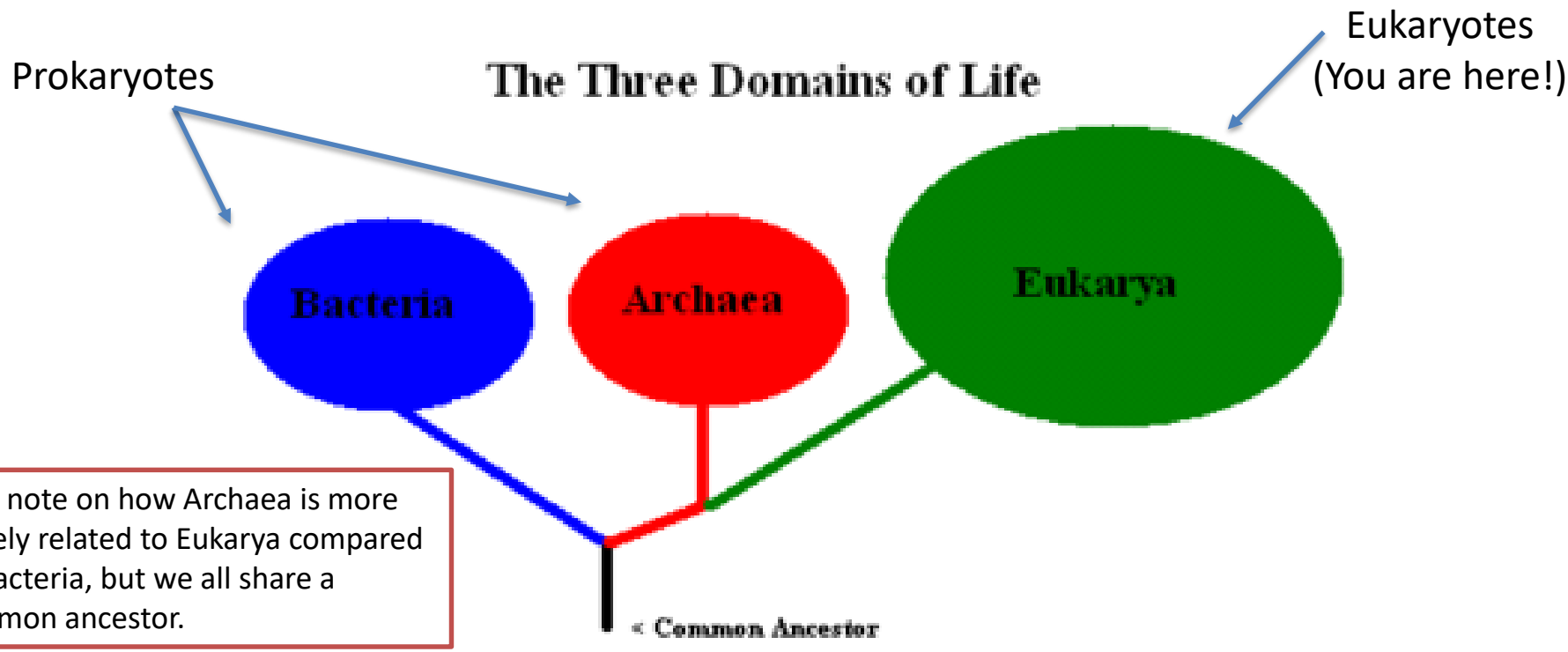
Week 2: Bacteria and Archaea

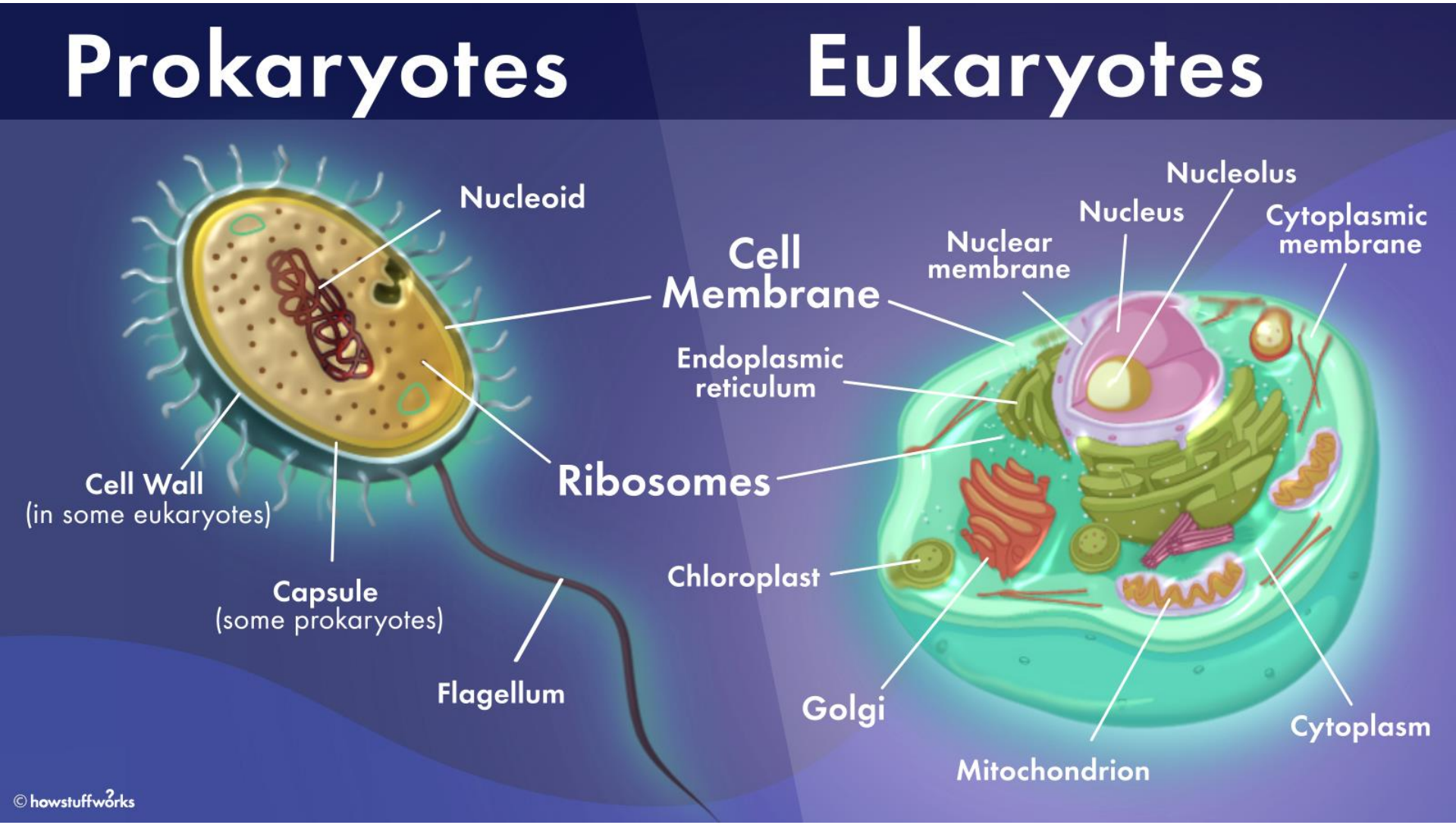
Context for Today

- Two types of cells: **Prokaryotes** and Eukaryotes
- Today we only focus on the two domains: Bacteria and Archaea



Take note on how Archaea is more closely related to Eukarya compared to Bacteria, but we all share a common ancestor.

Prokaryote vs Eukaryote



Also: Heterotrophic vs. Autotrophic

- Heterotrophic: organisms that cannot produce their own food and rely on other sources for nutrition.
  - Chemoheterotrophs: derives its energy from chemicals and must consume other organisms to live
  - Photoheterotrophs: uses light for energy but acquires carbon from other organisms

- Autotrophic: (aka primary producers) organisms that use energy from light and convert to chemical energy (photosynthesis).
  - Photoautotrophs: these use photosynthesis to convert light and carbon dioxide into energy.
  - Chemoautotrophs: derives energy from the oxidation of inorganic compounds.

In Summary

		Carbon source	
		Inorganic carbon (organism is capable of fixing carbon from non-biological sources)	Organic carbon (organism must obtain carbon from biological sources)
Energy source	Energy from light (organism uses light as the energy source to catalyze biochemical reactions)	Photoautotroph	Photoheterotroph
	Energy from chemical oxidation (organism uses chemical reactions the energy source to catalyze biochemical reactions)	Chemoautotroph	Chemoheterotroph

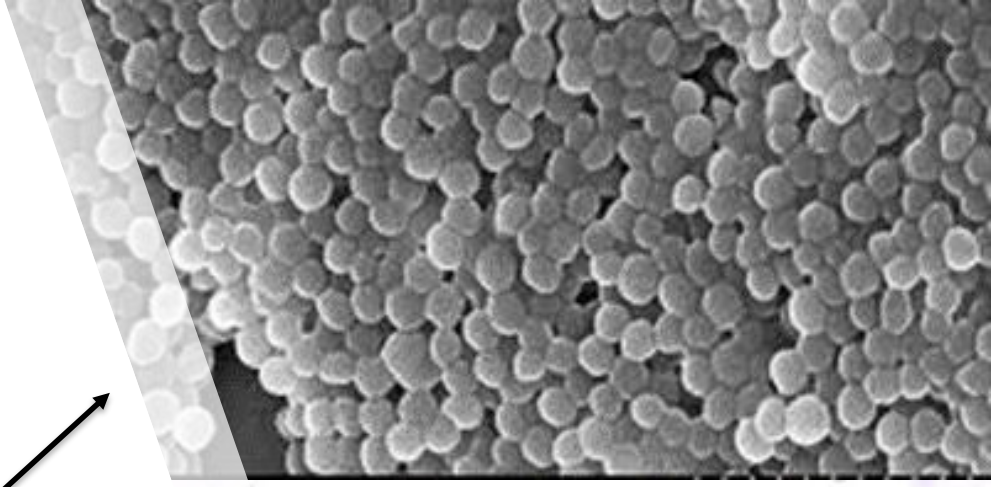
Checklist

- ❑ Domain: Bacteria
  - ❑ Size & shape of bacteria
  - ❑ Gram positive & gram negative bacteria
  - ❑ Antiseptics and Antibiotics measurements (McGraw Hill Connect)
  - ❑ Bacteria
    - ❑ Enzyme production
    - ❑ Root nodules
    - ❑ Cyanobacteria – *Oscillatoria*
    - ❑ Cyanobacteria – *Anabaena*
- ❑ Domain: Archaea
- ❑ Antibiotic Resistance

Domain: Bacteria

Taxonomic Characteristics

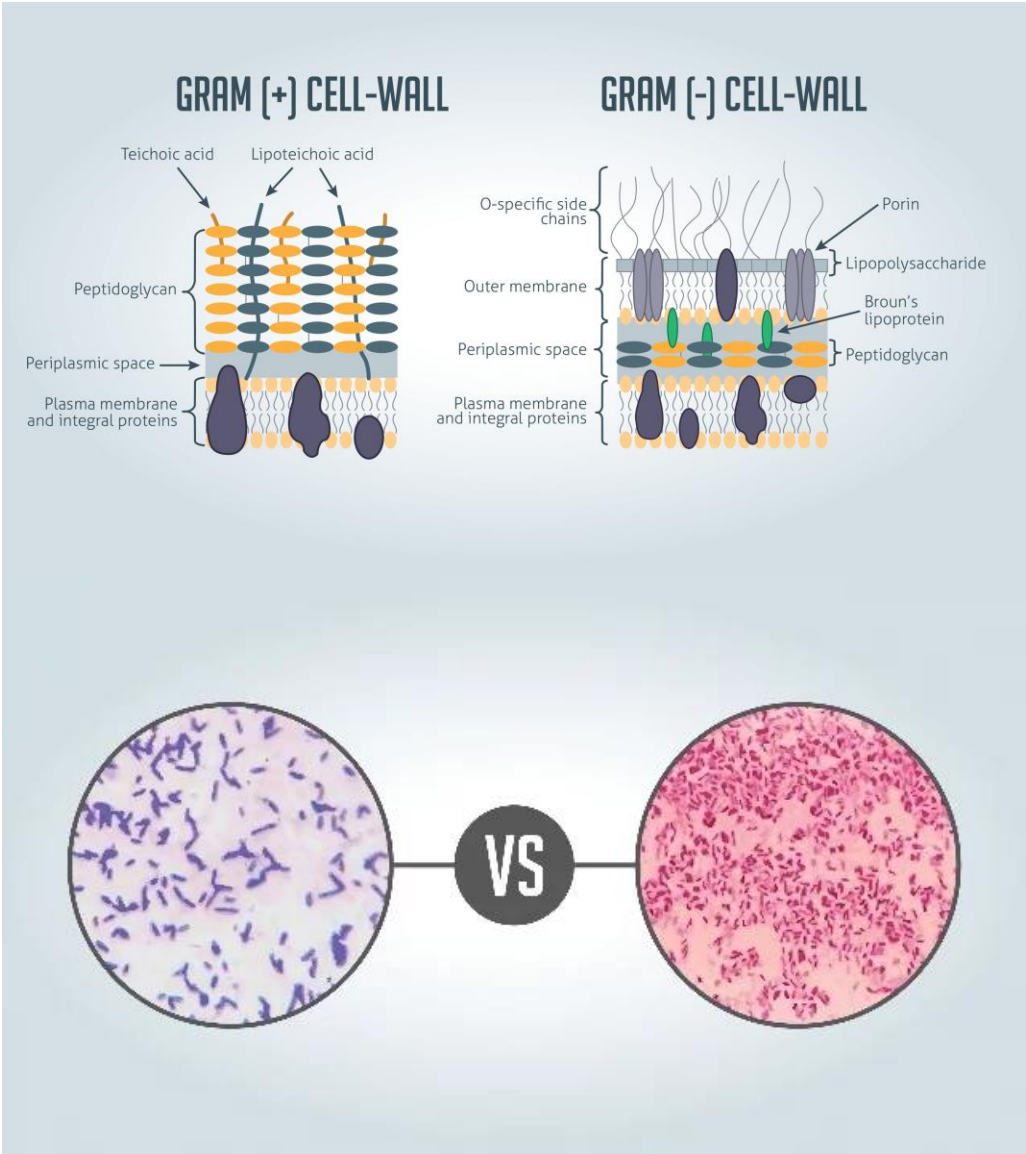
- Three different shapes of bacteria
  - Cocci: sphere-like bacteria
  - Spirillum: wavy/curly bacteria
  - Bacilli: rod-shaped bacteria

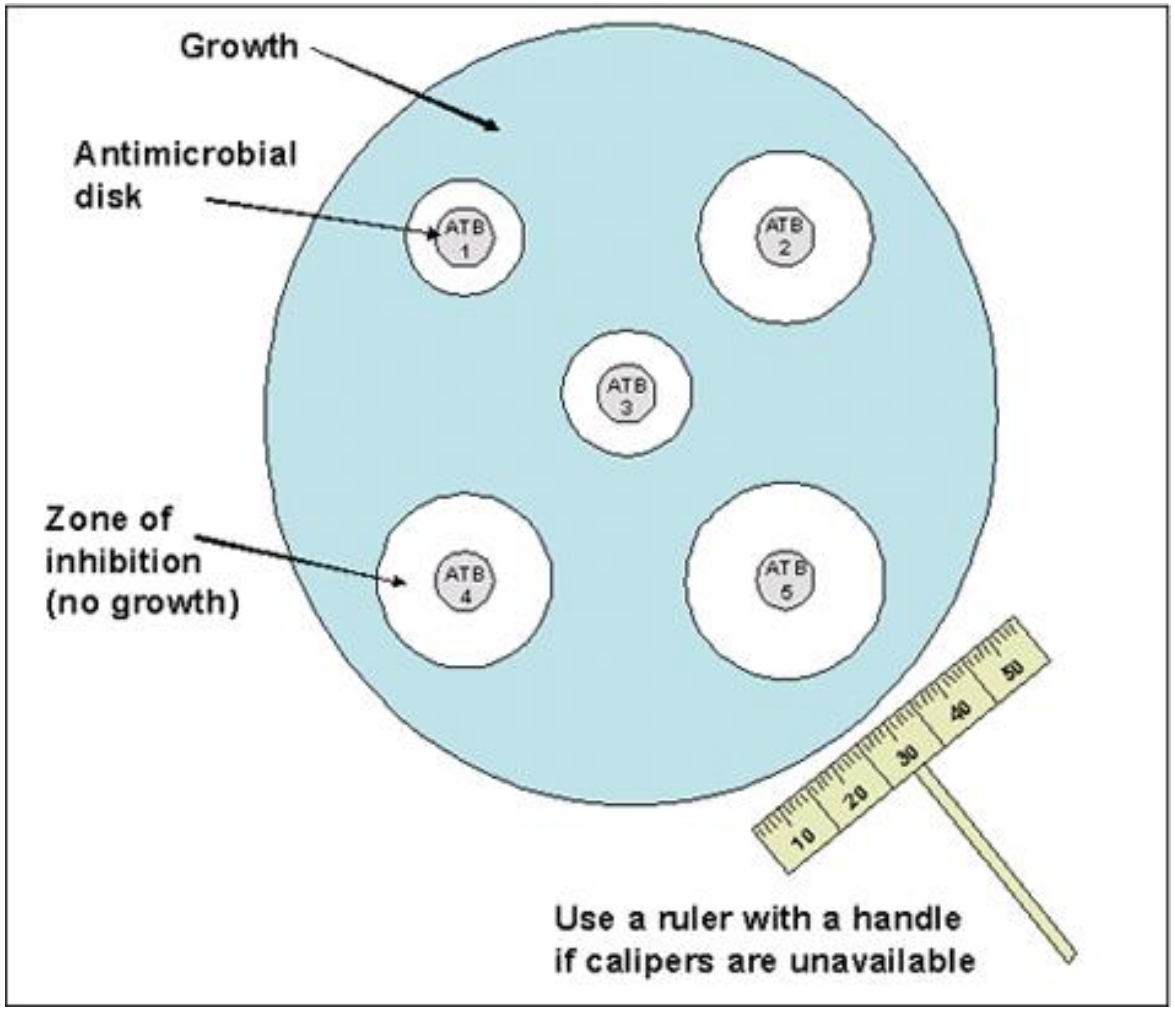


Gram (+) and Gram (-) Bacteria

Bacteria can be classified easier by how they appear in a gram stain test. Groups of bacteria appear differently because of how their cell wall is constructed.

- Gram + is darker (more purple) because it absorbs more of the stain.
- Gram – is brighter (pinker) because it absorbs less of the stain. They are more pathological and cause pneumonia or wound infections.

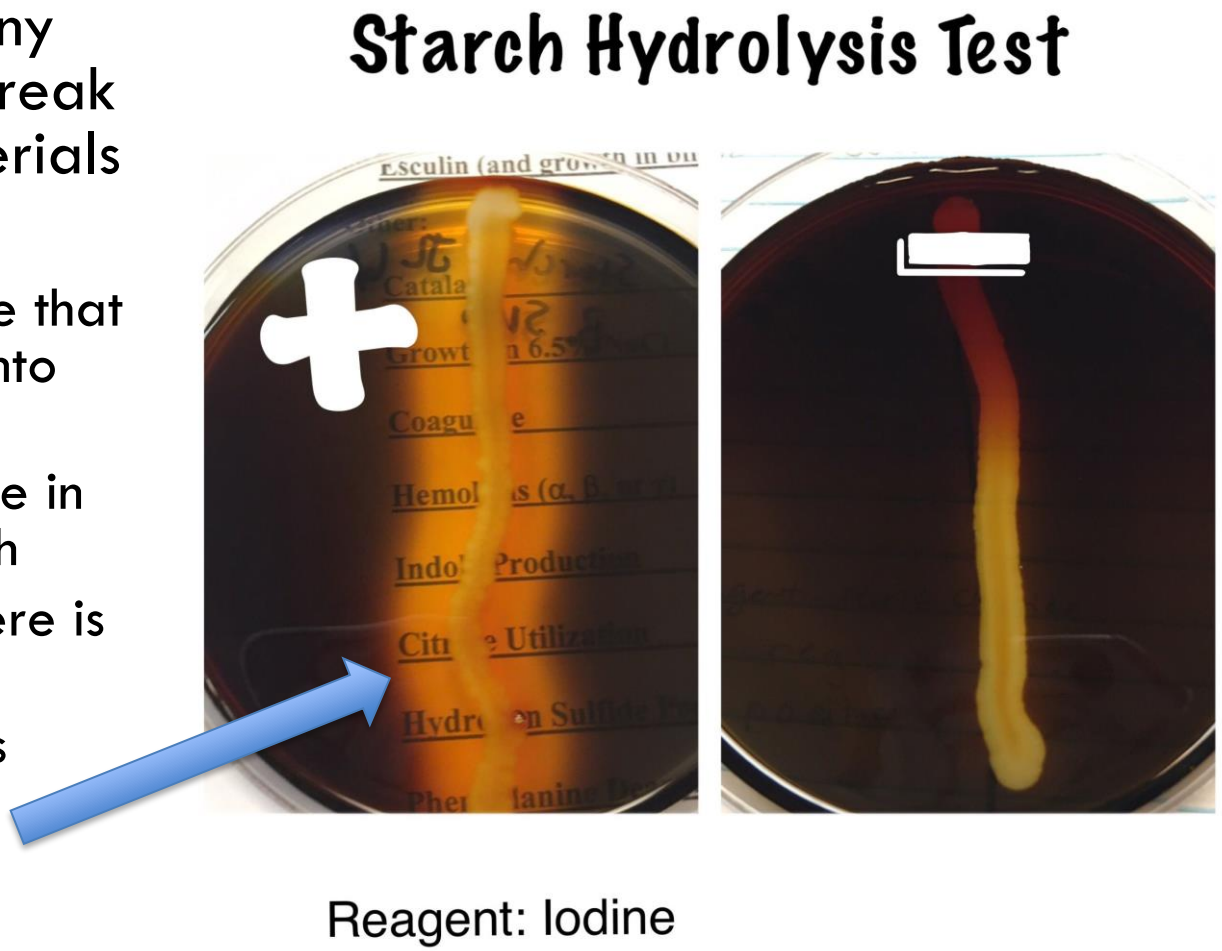




- Compare various petri dishes with colonies of bacteria in them to find out which antiseptic and antibiotic is most useful in killing bacteria
- Use metric system (centimeters) to measure effectiveness on different bacteria
- Bigger halo=more effective
- Refer to Antibiotic Resistance Activity on McGraw-Hill

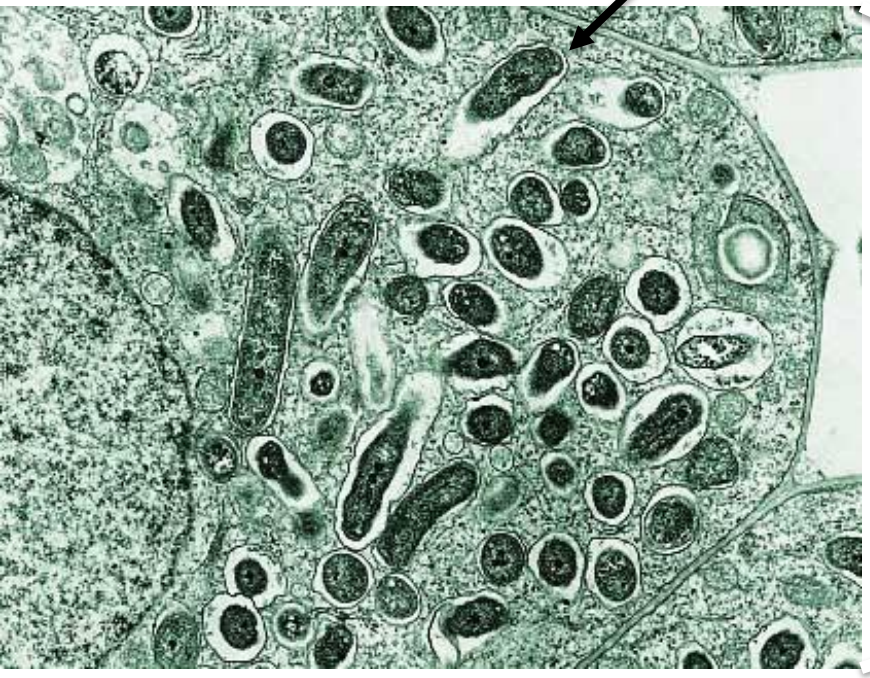
Enzyme Production

- Bacteria produces many kinds of enzymes to break down and digest materials
- In this demonstration:
  - Amylase is an enzyme that breaks down starch into simple sugars
  - Iodine turns black blue in the presence of starch
  - If black blue, then there is no amylase present.
  - A clear halo indicates bacteria producing amylase (diffusion)

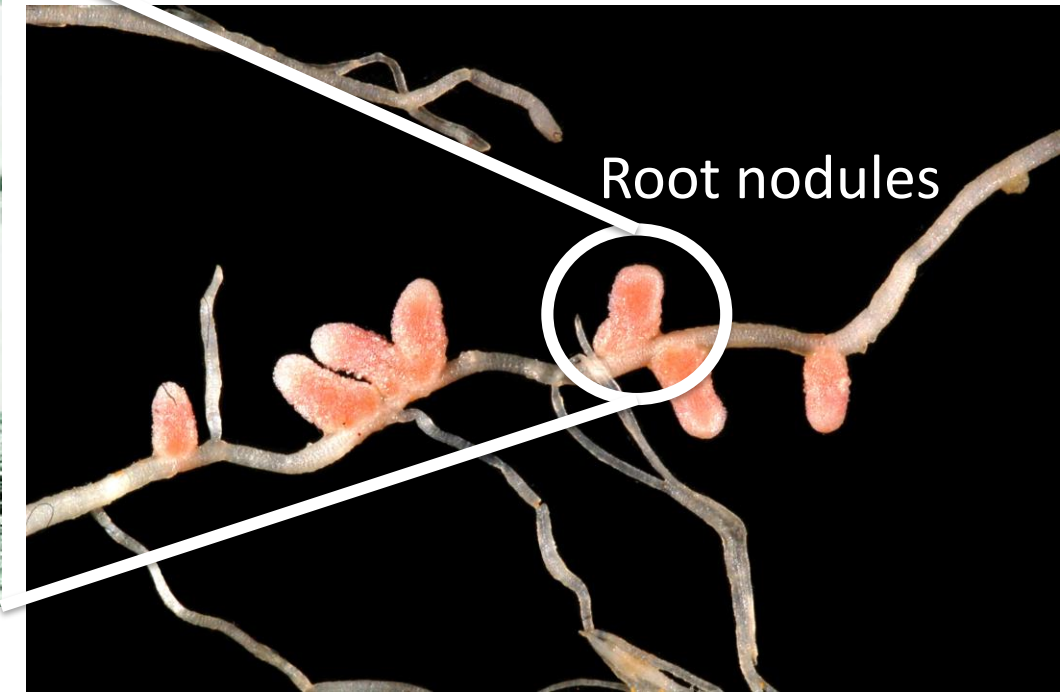


Nitrogen-fixing Bacteria

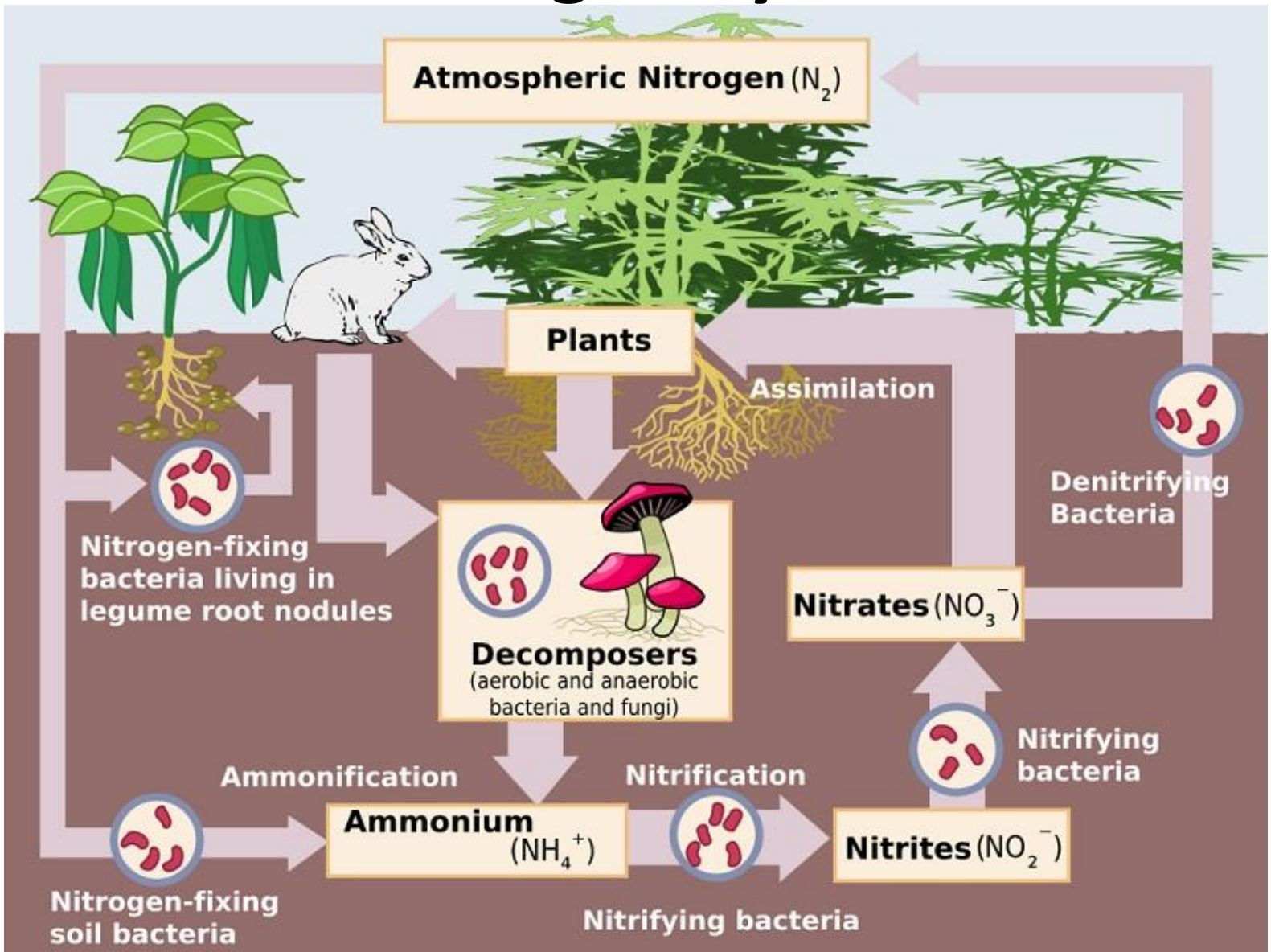
- Mutualistic relationship between plants and bacteria housed in the roots
- Plants are unable to fix nitrogen, but the bacteria can
- The plant benefits by obtaining ammonia, and the bacteria benefits by absorbing carbohydrates from plant
- Should be able to see the bacteria even though they are small since they are stained



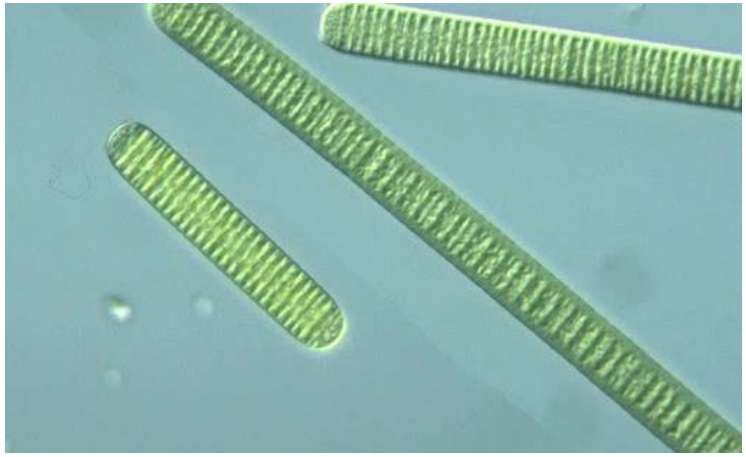
Cross section of root nodule/w bacteria



Look for where bacteria fit in the Nitrogen Cycle



Cyanobacteria

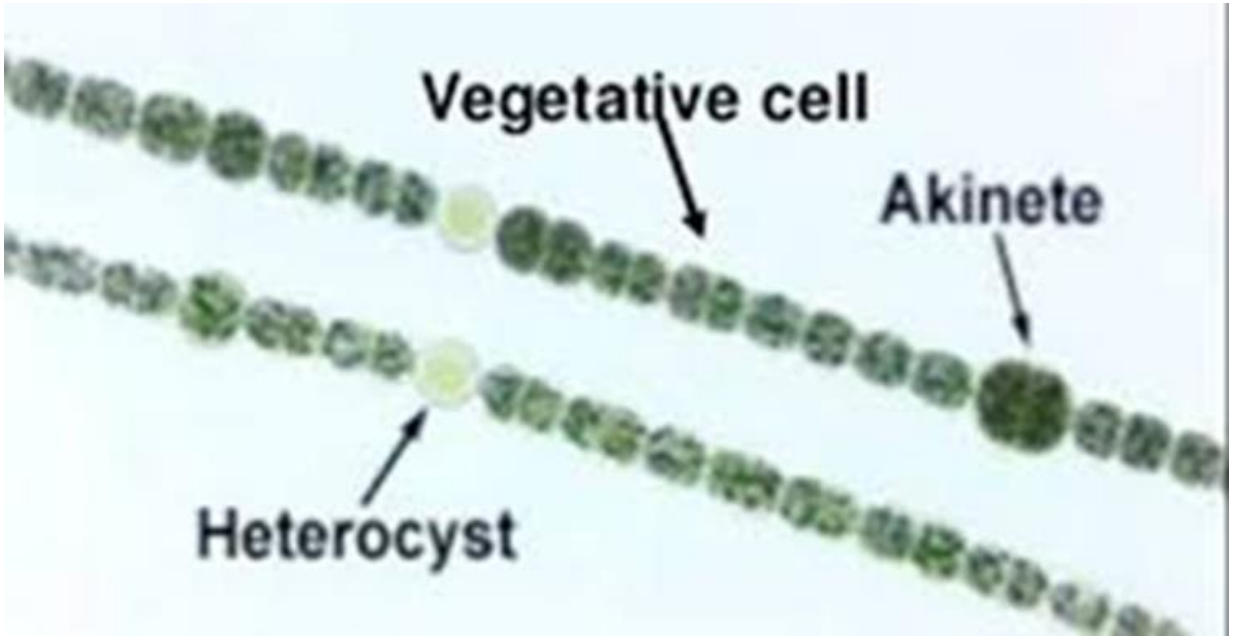


Oscillatoria

Anabaena

Normally these would have been on wet mounts, but instead we will provide you with images. They are considered a type of algae even though they are bacteria (we will go more about algae in week 4).

Anabaena



- **Vegetative Cell:** the cells that make up the structure of the organism
- **Heterocyst:** cells specialized for fixing nitrogen (= converting atmospheric nitrogen into ammonia). Has thick cell walls. Incorporates the ammonia into its own amino acids.
- **Akinete:** larger and more elongate dormant cells. They are resistant to desiccation and the cold. These cells are essential for survival in harsh times.

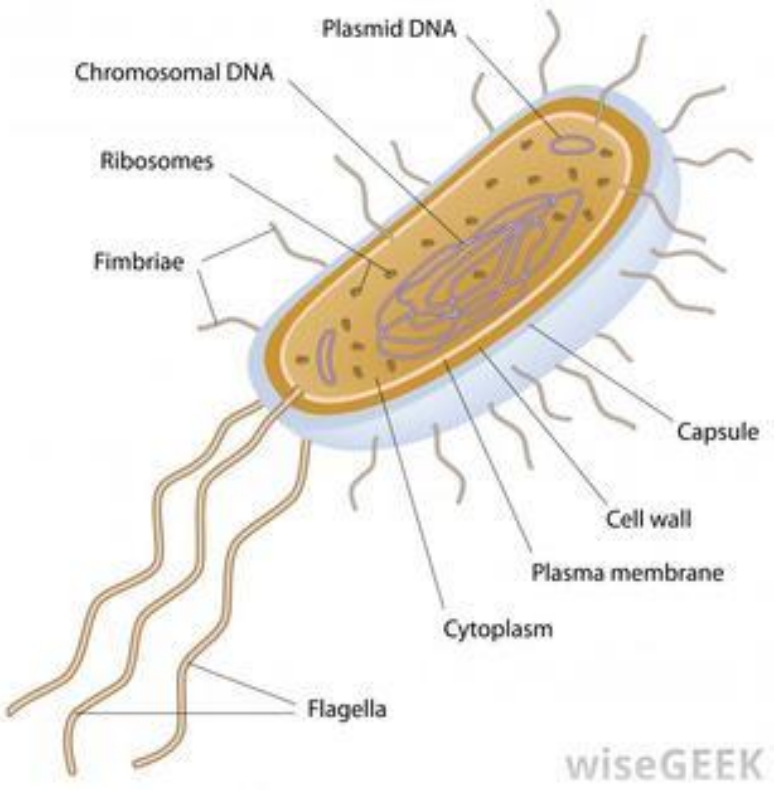
Oscillatoria

- Observe: What are the differences in appearance between Oscillatoria and Anabaena?
- How are they different from plants you see on land?

Domain Archaea

- Known extremophiles, meaning they can live in extreme environments that are difficult for others. Different types include:
  - Thermophiles: organisms that can live in temperatures from 41-122 degrees Celsius (e.g. hot springs).
  - Halophiles: organisms that live in high salt environments (e.g. The Dead Sea)
  - Note: it doesn't mean they can't be found in non-extreme environments
- Methanogens: produce methane from Carbon Dioxide. They live inside living organisms (e.g. cows) and can live in anaerobic wetlands.

Anatomy of Archaea



Eukarya vs. Bacteria vs. Archaea

Characteristic	Archaea	Bacteria	Eukarya
Membrane lipids with branched hydrocarbons	✔		
Chromosomes are circular	✔	✔	
Lacks nuclear envelopes	✔	✔	
Lacks membrane bound organelles	✔	✔	
Methionine is the initiator amino acid for protein synthesis	✔		✔
Lack peptidoglycan in the cell wall	✔		✔
Growth not inhibited by streptomycin and chloramphenicol	✔		✔
Histones are associated with DNA	✔		✔
Contains several types of RNA polymerase	✔		✔

Evolution of antibiotic resistance activity

- Mutations can lead to new functions
  - e.g. Study of tuskless-ness in Elephants from poaching by UCLA professor funded by National Geographic
- Speed up mutation rate of bacteria using UV light
- We will add streptomycin (an antibiotic) to *E. coli* mutated with UV light to see if any of the mutations led to streptomycin resistance
- For context on how the experiment was done, read page **49.**

What to do this week:

- ❑ Discussion!
- ❑ Lab Report!
- ❑ Quiz (Save quiz for last, it will be everything from this week and last week so take time to study – it will be timed!)