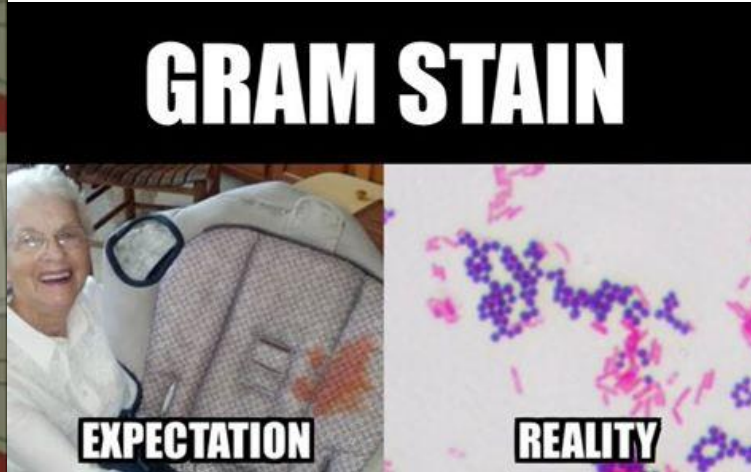
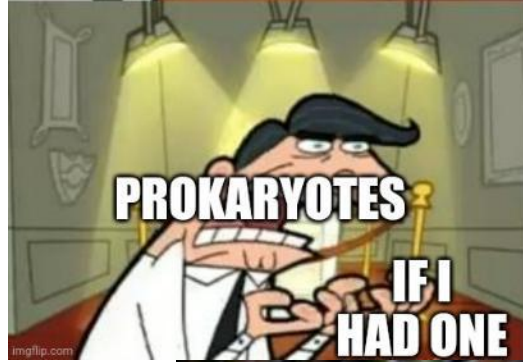
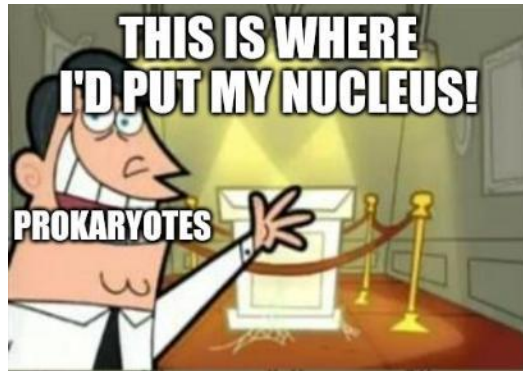




Kaitlyn Grando, Ph.D.

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Email:

kaitlyn.grando@temple.edu

Lab: Kresge 504

Health Sciences Campus

Objectives: Basic Bacteriology I

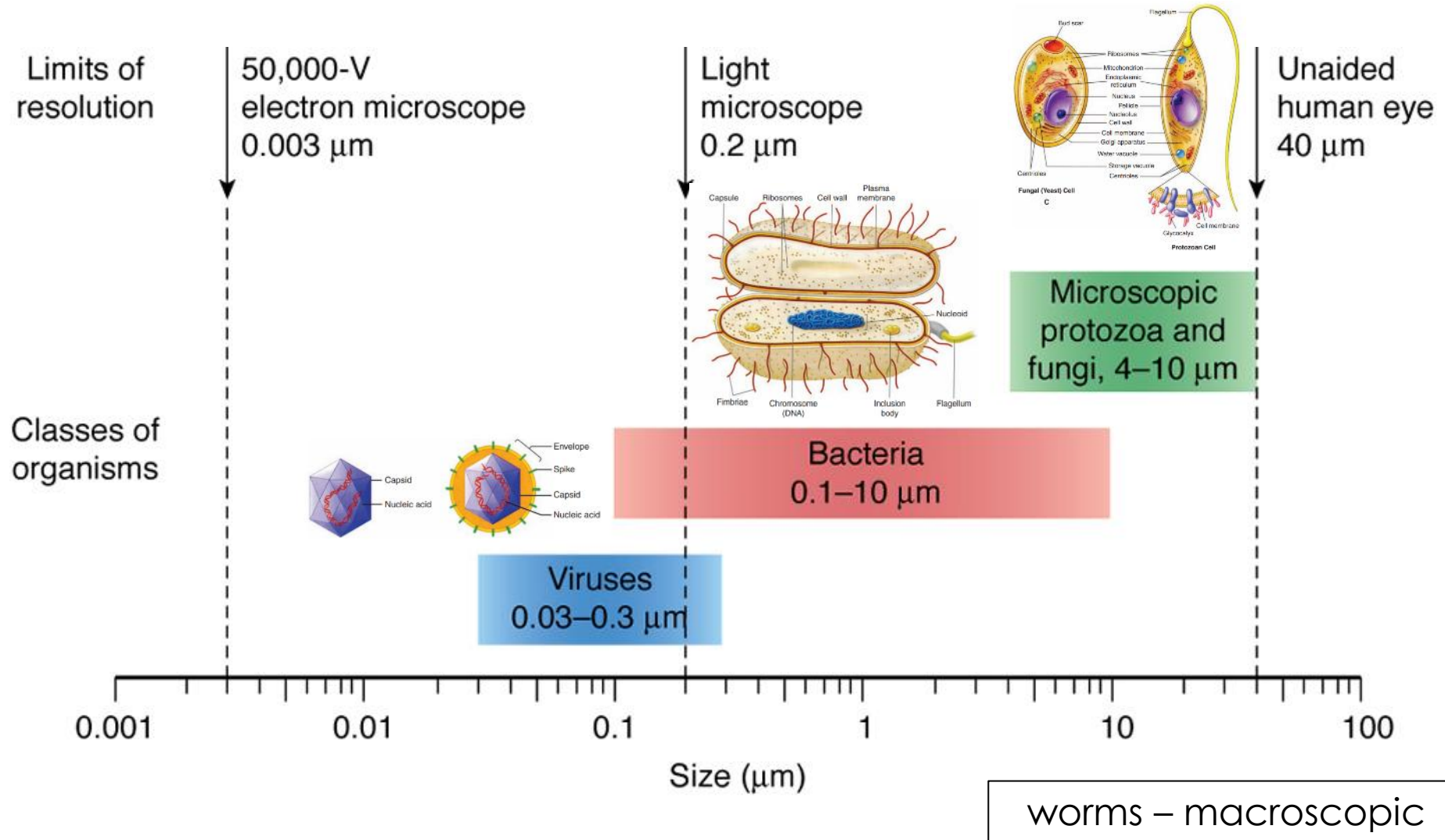
-  Define the taxonomy of bacteria in the phylogenetic tree, and bacterial naming conventions based on morphology
-  List the major structures of bacteria (e.g. cell wall, membrane, flagella, fimbriae/pili, capsule, matrix) and their role in bacterial physiology
-  Compare and contrast prokaryotic vs. eukaryotic cells
-  Explain the process of Gram-staining and the structures that are differentiated in Gram-positive vs. Gram-negative bacteria

What traits or characteristics come to mind when you think of bacteria?
(You can vote on the ideas submitted, or submit your own.)

Nobody has responded yet.

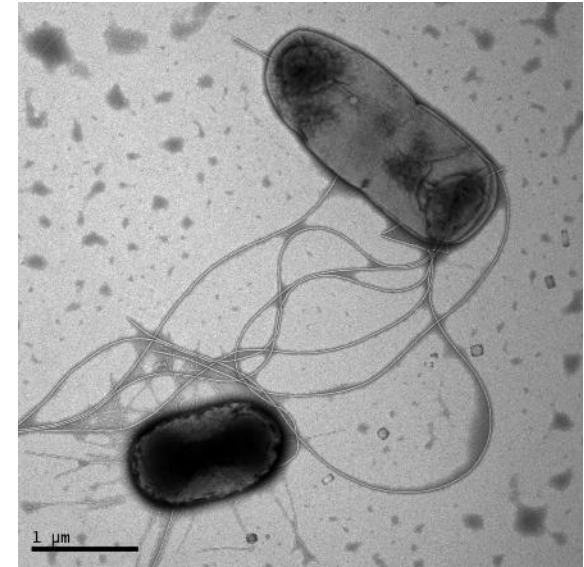
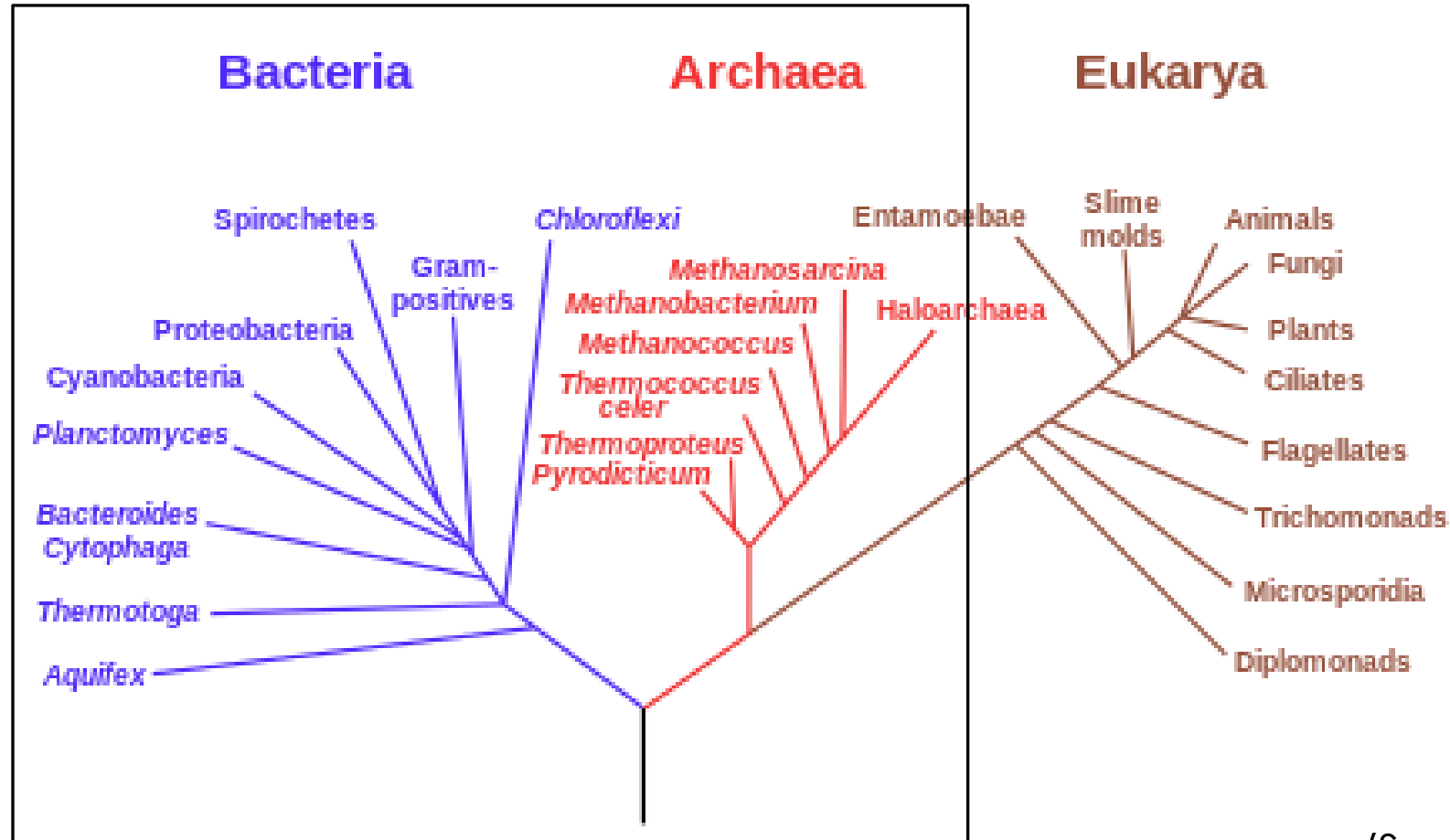
Hang tight! Responses are coming in.

Types of microbes



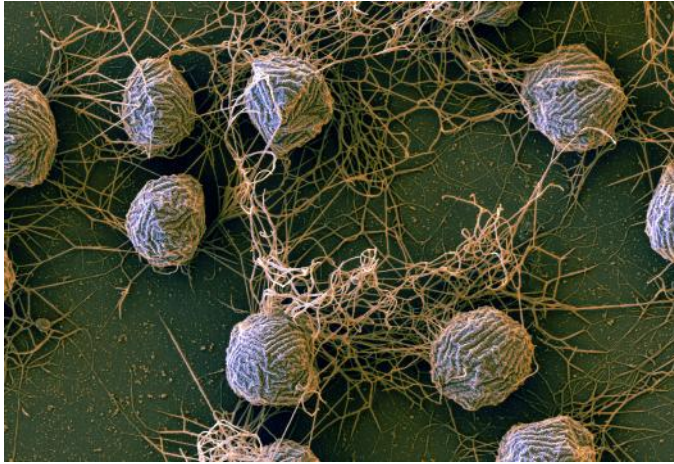
Bacterial taxonomy determined by phylogeny (evolution)

Prokaryotes – single celled organism with no nucleus nor organelles

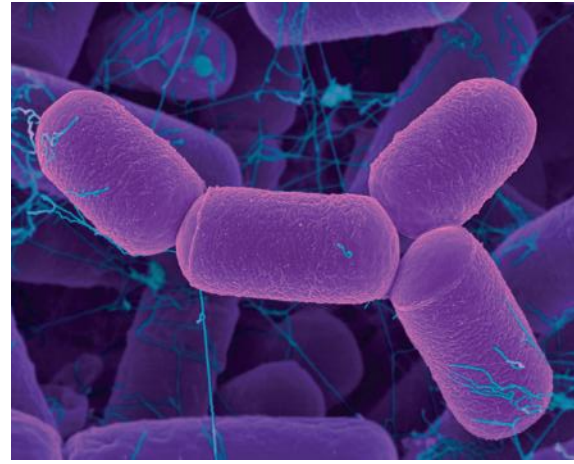


Domain	Bacteria
Kingdom	Bacteria
Phylum	Pseudomonadota
Class	Gammaproteobacteria
Order	Enterobacterales
Family	Enterobacteriaceae
Genus	<i>Escherichia</i>
Species	<i>coli</i>
(Serotype/Strain)	O157:H7

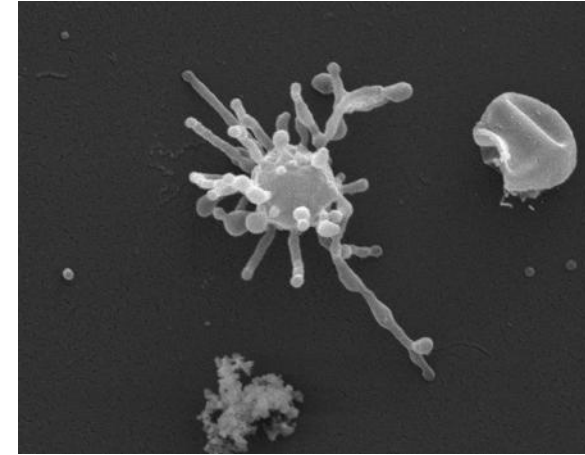
Archaea



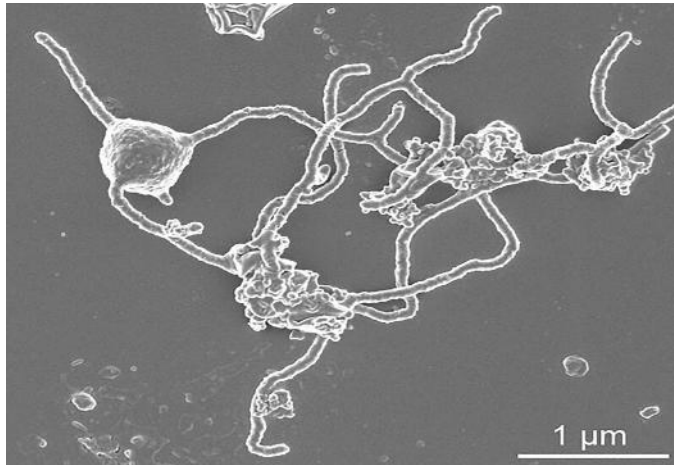
Methanocaldococcus villosus



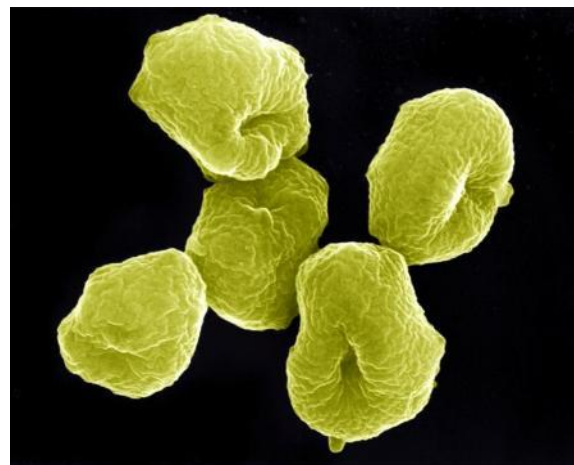
Methanobrevibacter smithii



Lokiarchaeum ossiferum



Promethearchaeum syntrophicum



Sulfolobus sp.



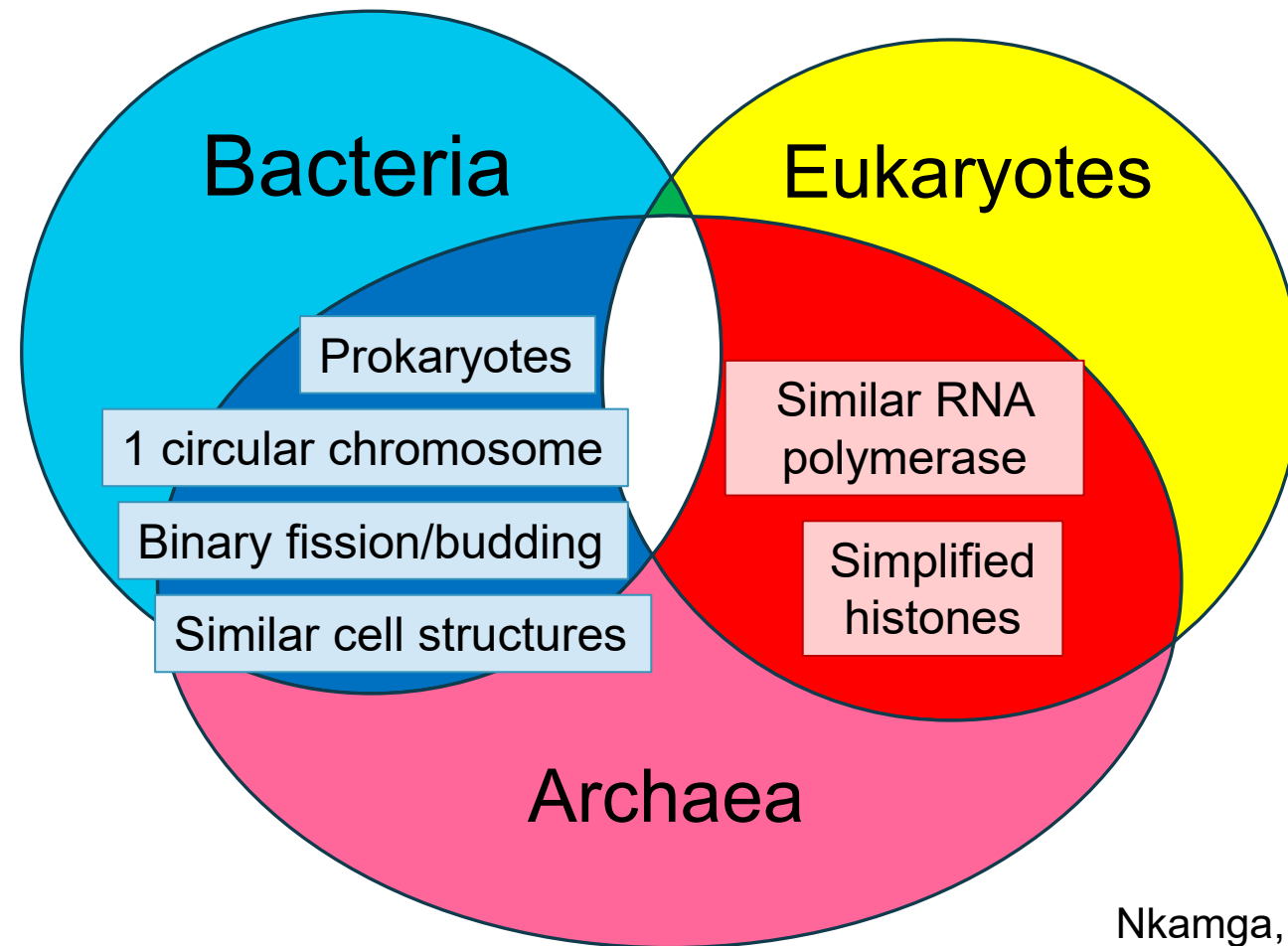
Halobacterium salinarum

Archaea characterized by:

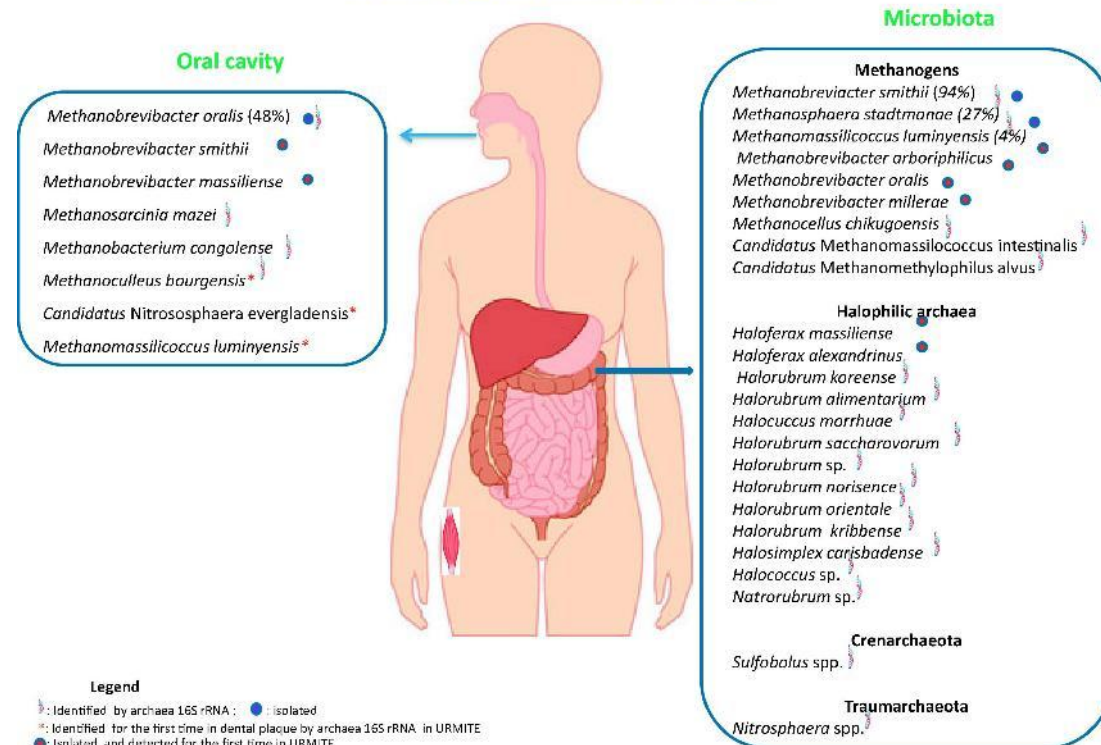
Able to use alternative energy sources like inorganic molecules or sunlight (photosynthesis)

Often extremophiles (but not always!)

Grand Prismatic Spring
in Yellowstone
(National Park Service)



Human gastrointestinal tract Archaea



Bacteria



Vibrio cholerae



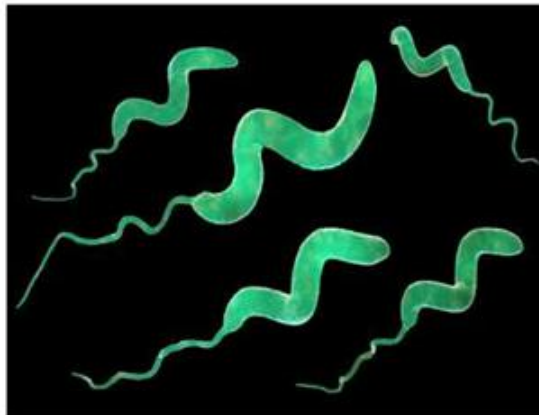
Escherichia coli



Enterococcus faecium



Clostridium botulinum



Campylobacter jejuni



Leptospira interrogans

Bacterial Cell Structures

Smaller size: (Bacteria: 0.1-10 microns;
Eukaryotes: 10-100 microns)

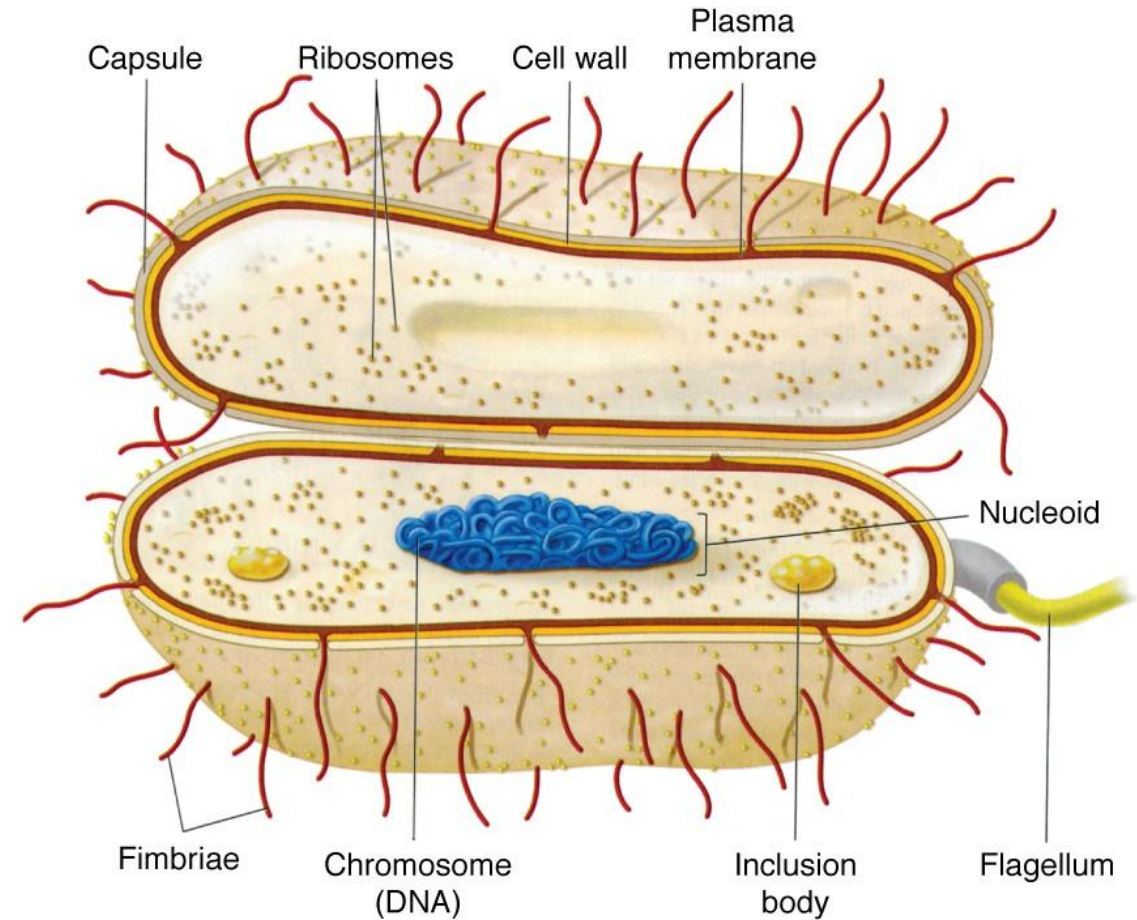
No membrane-bound organelles:

- Circular chromosome in **nucleoid**
- No ER – transcription and translation coupled
- No mitochondria – electron transport chain on cell membrane

Ribosomes (Bacteria: **30S/50S**;
Eukaryotes: 40S/60S)

Cell wall and cell membrane (Envelope)

Other external structures (species specific):
capsule, matrix, flagella, fimbriae/pili

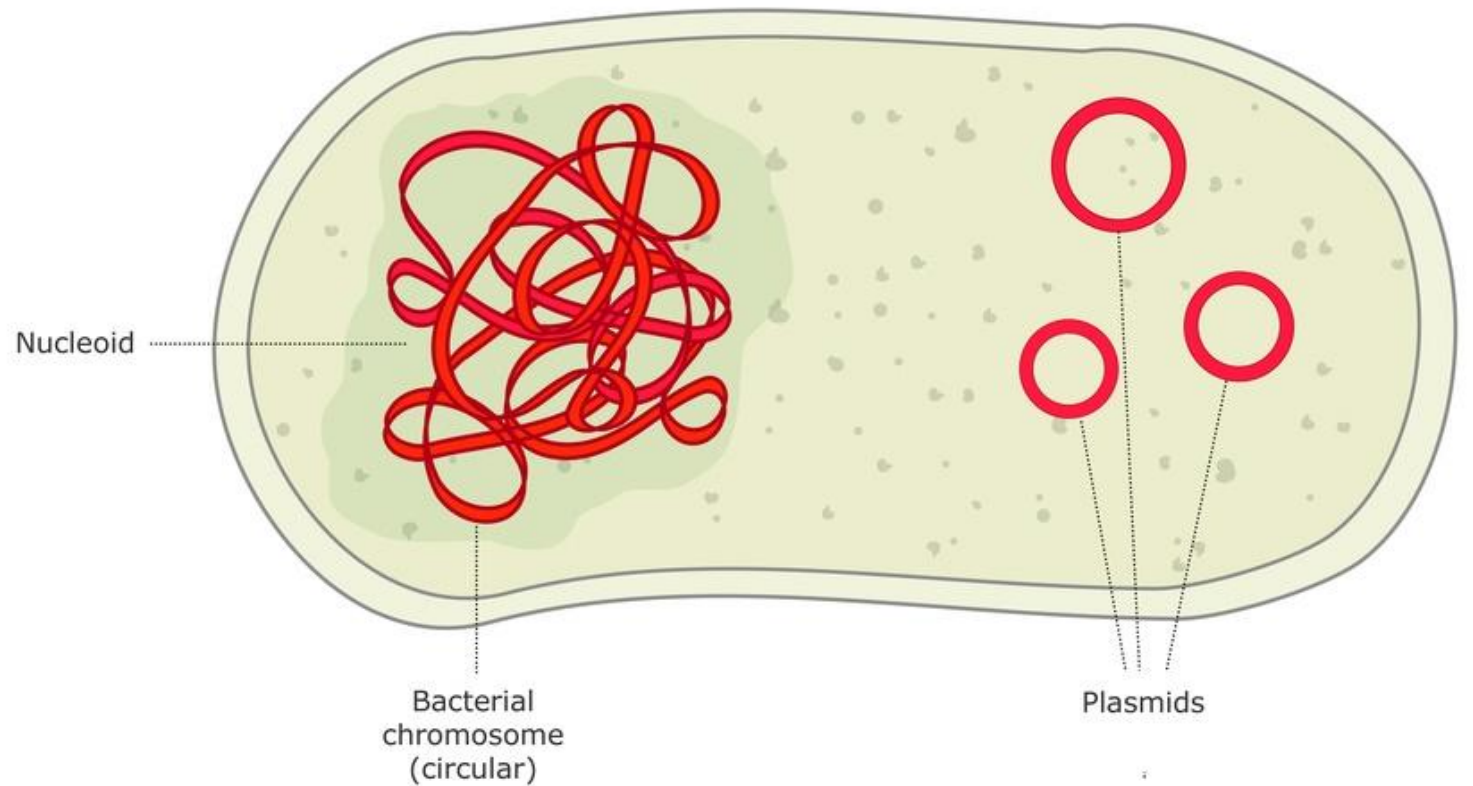


Bacterial DNA

Circular DNA in **nucleoid**

- Packaged by **supercoiling**
- **Haploid genome** – single chromosome

Plasmids –
extrachromosomal DNA

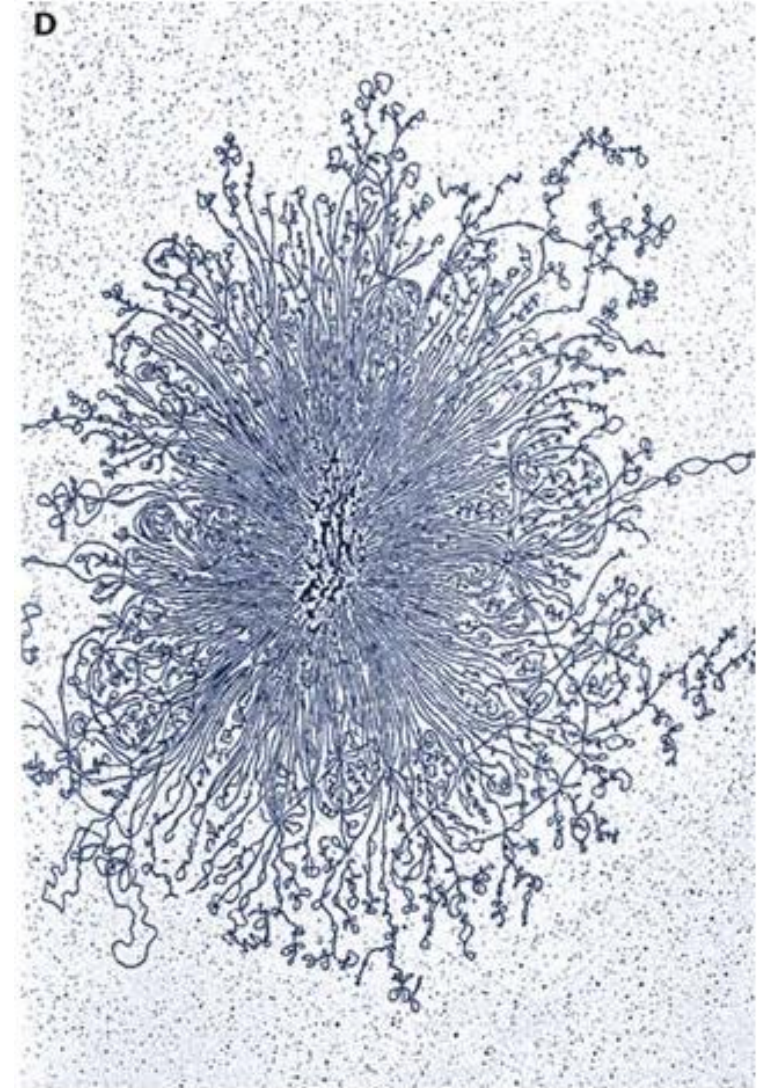
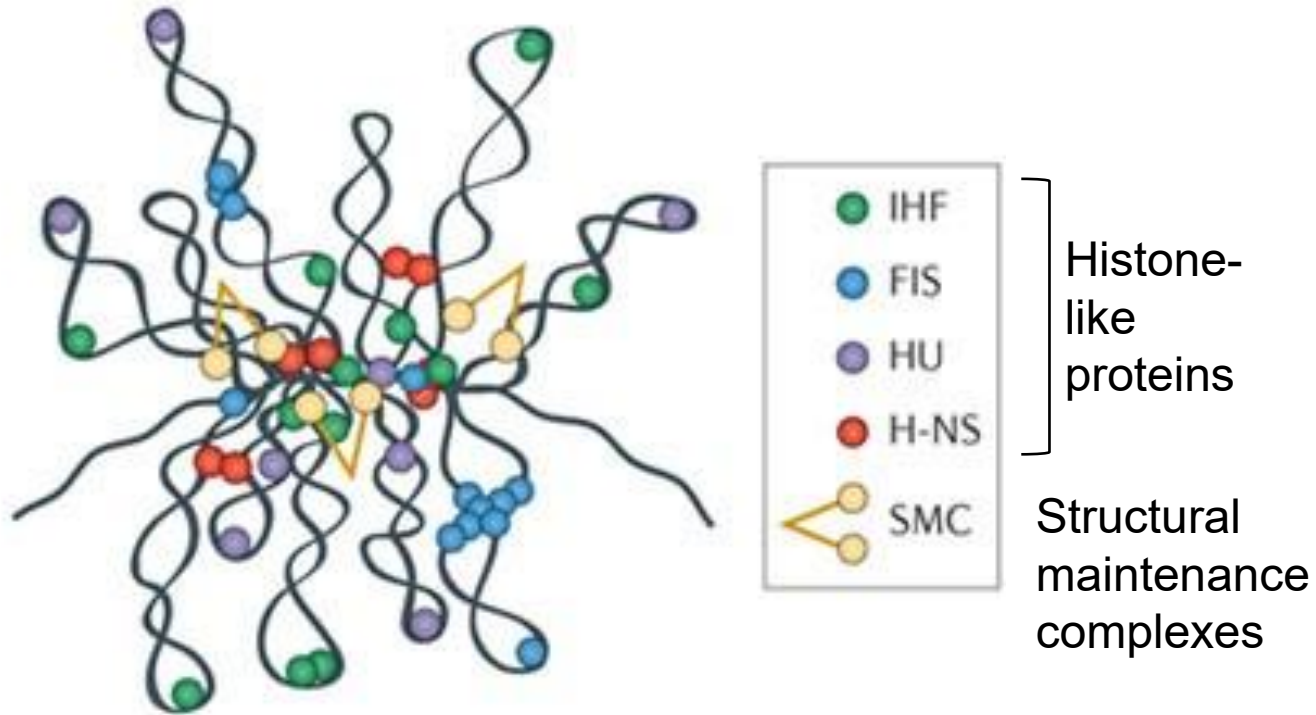


DNA is compacted to fit in the bacterial cell

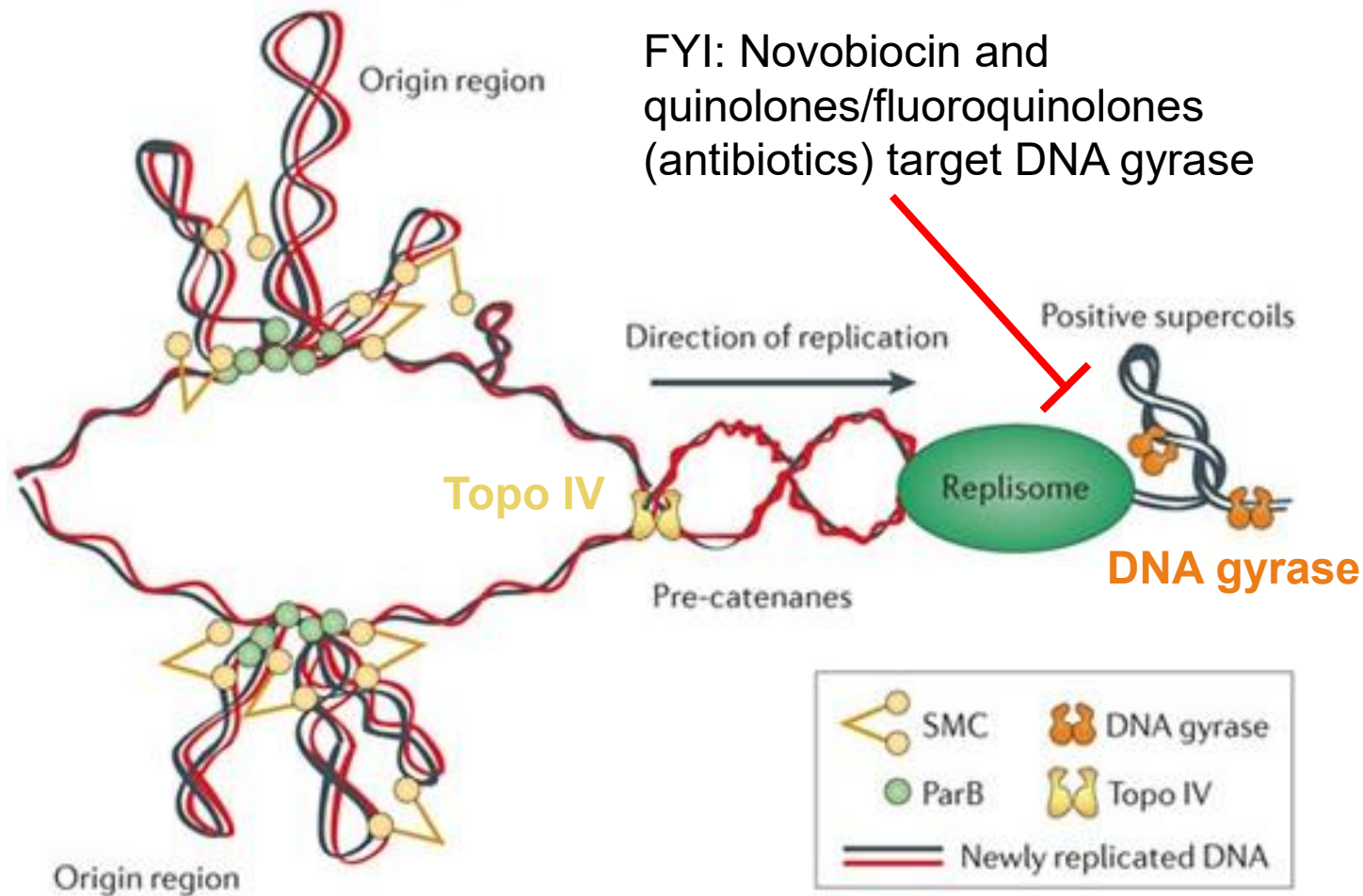
Most bacterial chromosomes are circular

Supercoiling compacts DNA

Histone-like proteins protect, bend, and bridge DNA

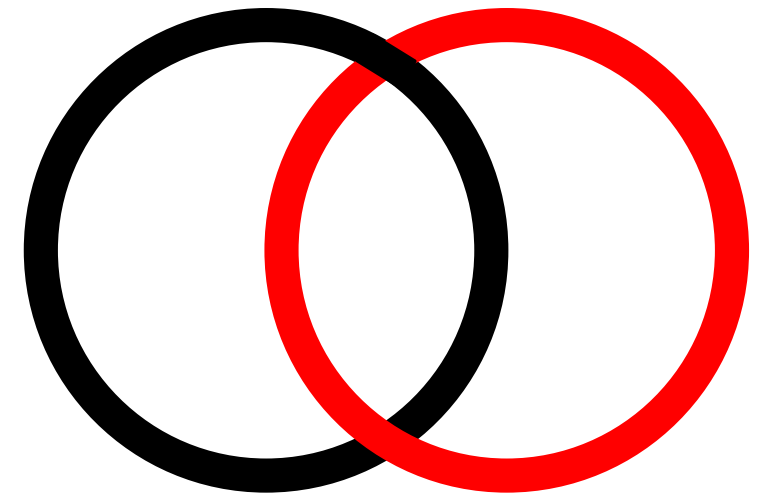


Gyrase and topoisomerase IV allow for DNA replication



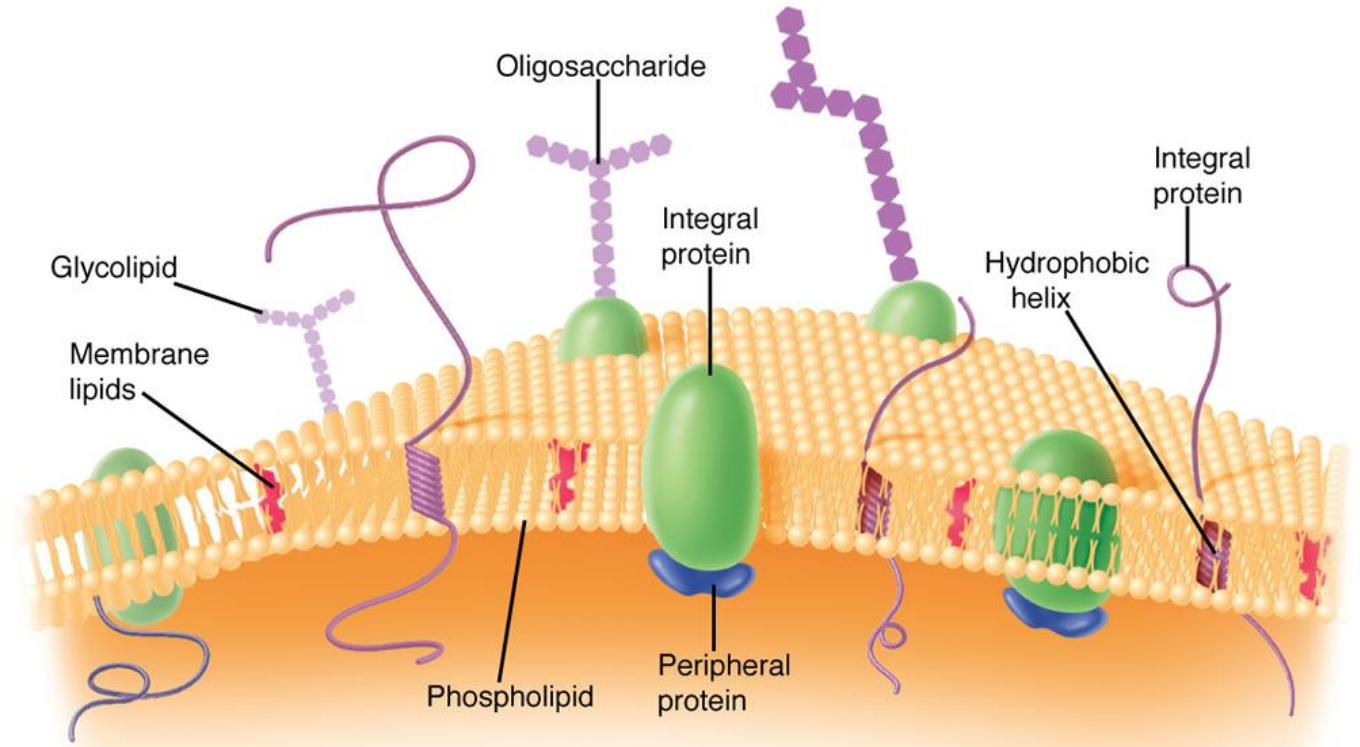
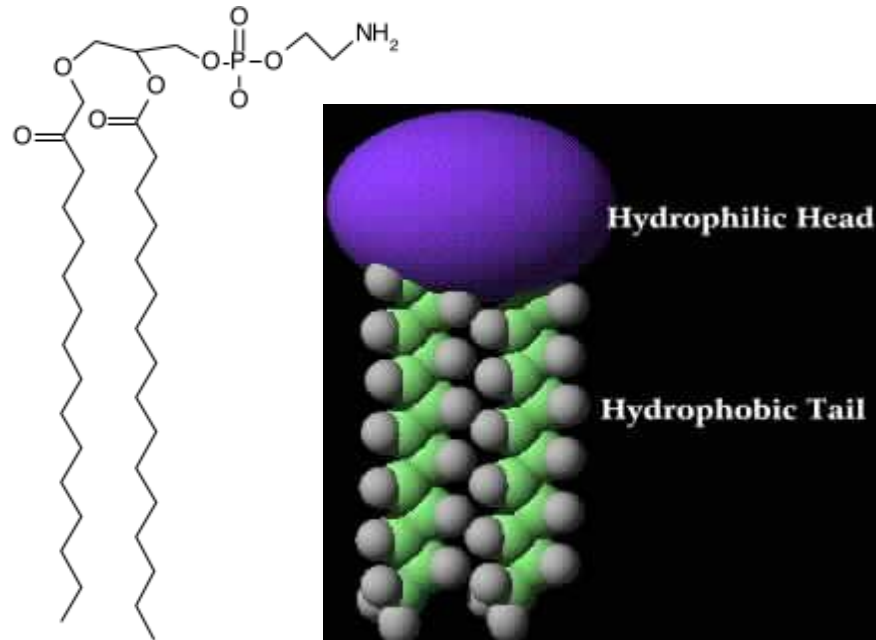
DNA gyrase - negative supercoils to counteract positive supercoils introduced by replication fork

Topoisomerase IV - cuts new daughter DNA behind replication fork to prevent interlocking circular chromosomes ("catenanes")



Envelope: Cell Membrane

composed of **phospholipids**



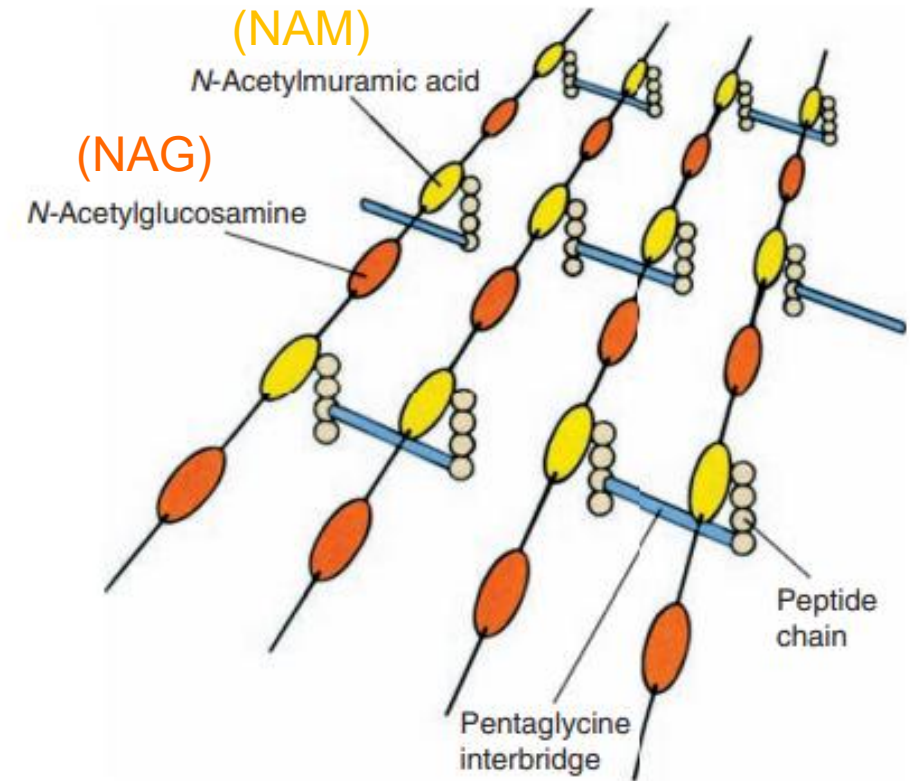
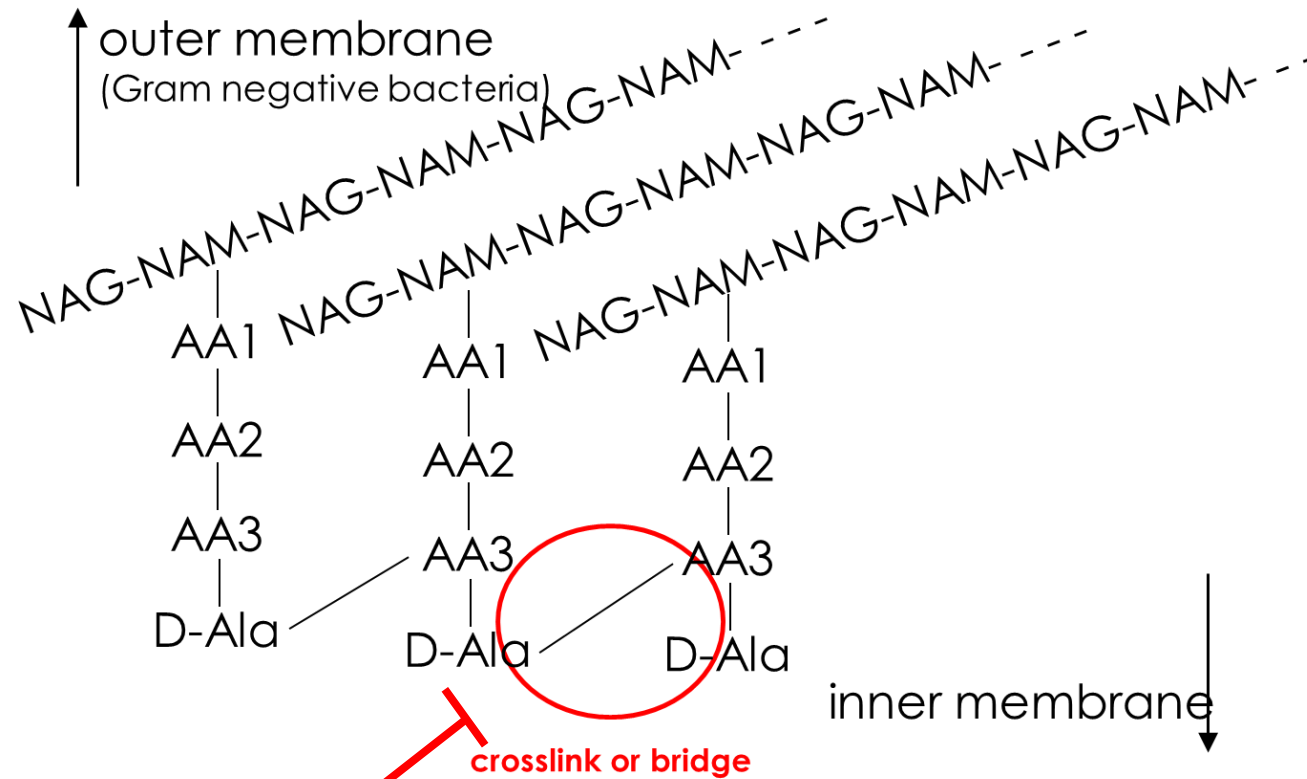
phosphatidylethanolamine (PE) and phosphatidylglycerol (PG)

Lack of sterols (except *Mycoplasma*, which take sterols from environment) causes weaker plasma membranes more prone to lysing than eukaryotic cells

Envelope: Cell Wall

Composed of **peptidoglycan**

- Resistance to lysis
- Confers shape (e.g. cocci vs. bacilli)



FYI: β -lactams and vancomycin antibiotics inhibit crosslinking of peptidoglycan cell wall

Activity: Imagine you are one of the first microbiologists discovering and categorizing and naming these tiny creatures. How would you sort them? How would you name them?



Imagine you are one of the first microbiologists, discovering and naming these tiny creatures.
How would you begin to name them and classify them?
(You can vote on the ideas submitted, or submit your own)

Nobody has responded yet.

Hang tight! Responses are coming in.

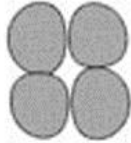
Bacterial shapes and nomenclature



Coccus



Diplococcus



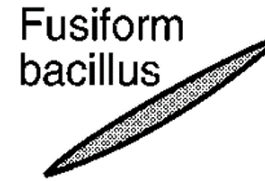
Tetrad



Bacillus



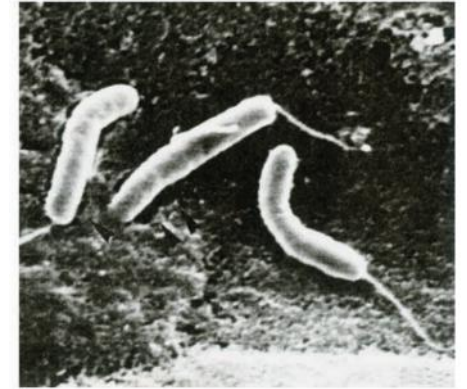
Coccobacillus



Fusiform
bacillus



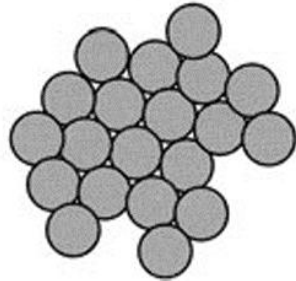
Vibrio



Vibrio cholerae



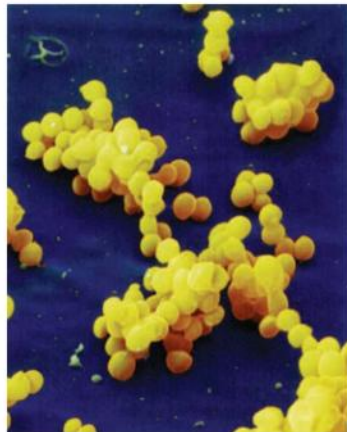
Streptococcus



Staphylococcus



Streptococcus agalactiae



Staphylococcus aureus



Bacillus anthracis

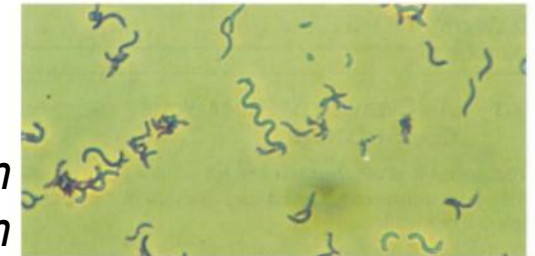


Spirochete



Spirillum

Rhodospirillum rubrum



Filamentous



Pleomorphic

Gram positive

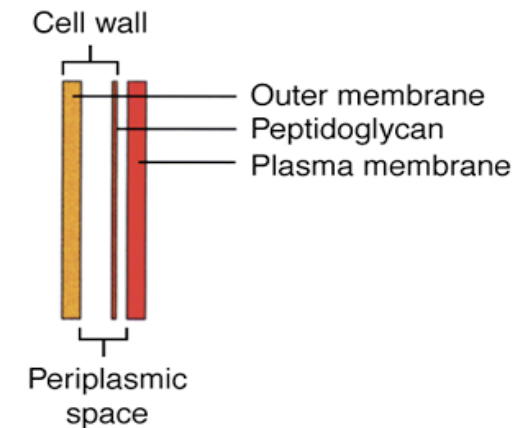
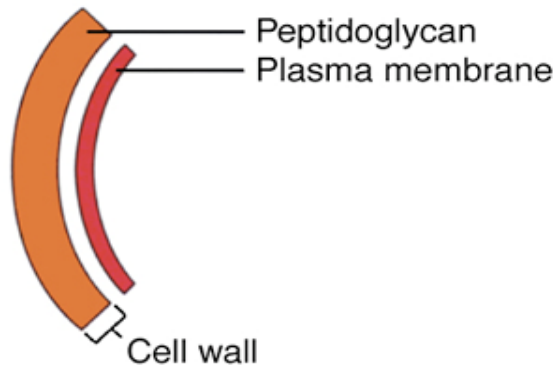
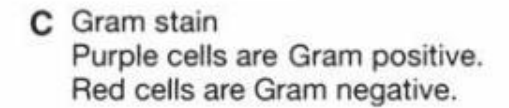


peptidoglycan

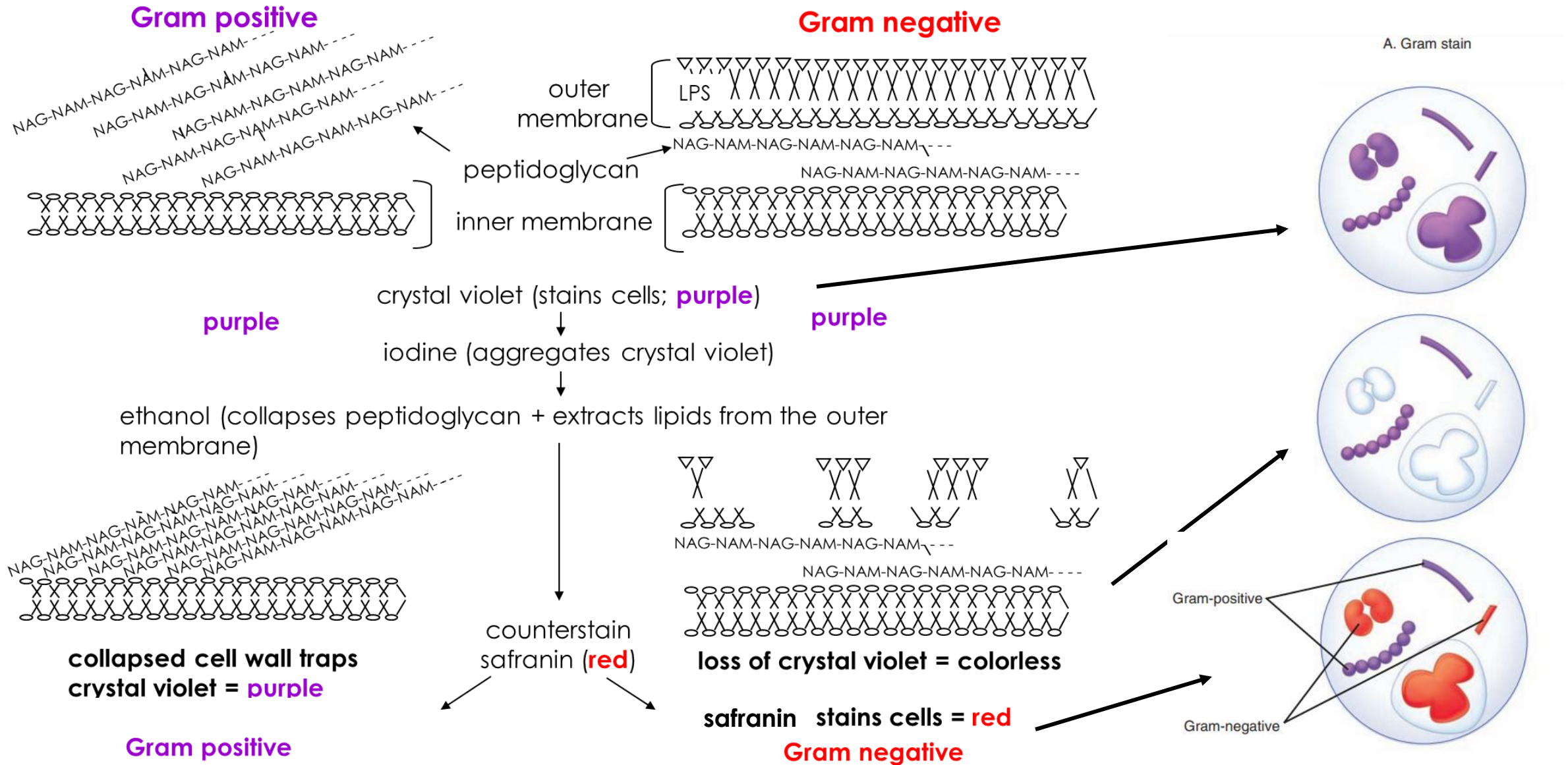
inner membrane



outer
membran



Gram staining protocol

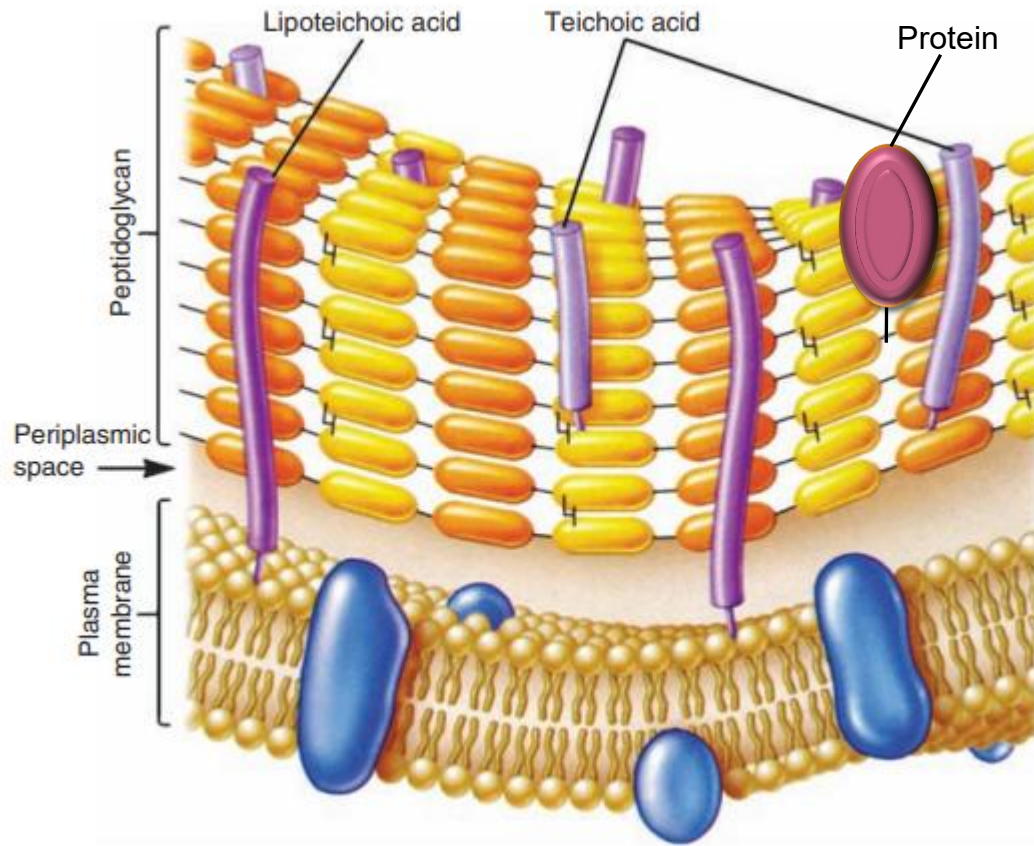


Some important organisms that
do not stain well with Gram reagents:

Organism	How visualized	Comment
<i>Mycobacteria</i>	Acid-fast stain	High lipid content in wall.
<i>Mycoplasma</i> , <i>Ureaplasma</i>	Culture and patient serology used for ID.	Lack cell wall. Too small for standard light microscopy
<i>Rickettsia</i> , <i>Chlamydia</i>	Gimenez, Giemsa, or Indirect Immunofluorescence to confirm, DNA probes or PCR (Visualization not routine for diagnosis)	Obligate intracellular parasites. Gram-cell wall structure.
Spirochetes	Darkfield microscopy used to be standard. Still used for <i>Leptospira</i> . <i>Treponema</i> and <i>Borrelia</i> use ELISA.	Most are too slender for standard light microscopy.

We'll talk more about these later...

Gram Positive Bacteria



Thick peptidoglycan layer

Interspersed **lipoteichoic acid (LTA)**

- Specific to Gram positive
- Elicits immune response
- Confer negative charge

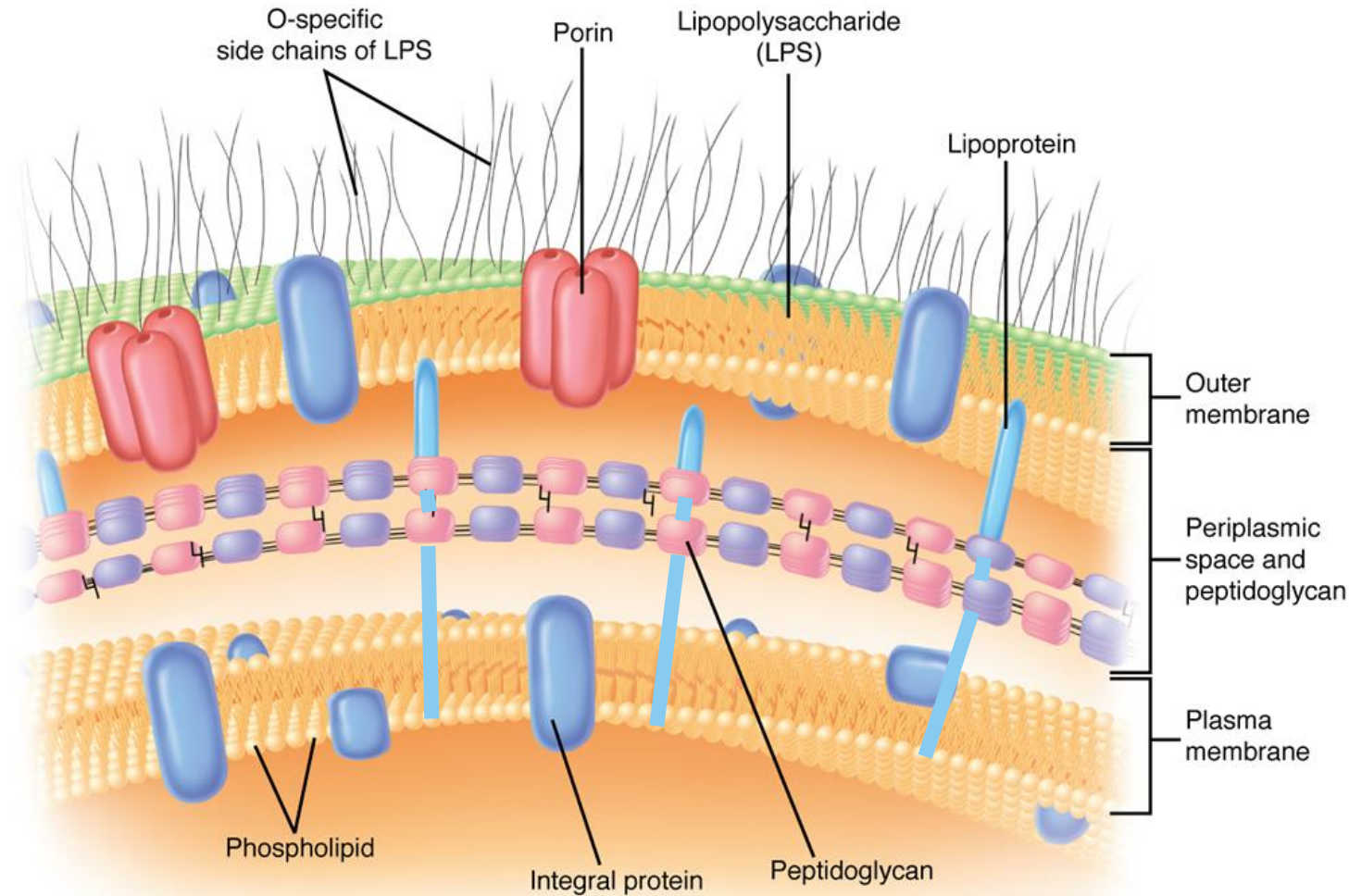
Can have other proteins covalently attached to peptide side chain (cell-wall anchored proteins)

Gram Negative Bacteria

Thin peptidoglycan layer

Outer membrane contains

- **lipopolysaccharide (LPS)** (aka endotoxin)
- **Porins** for transport



Endotoxin (Lipopolysaccharide; LPS)

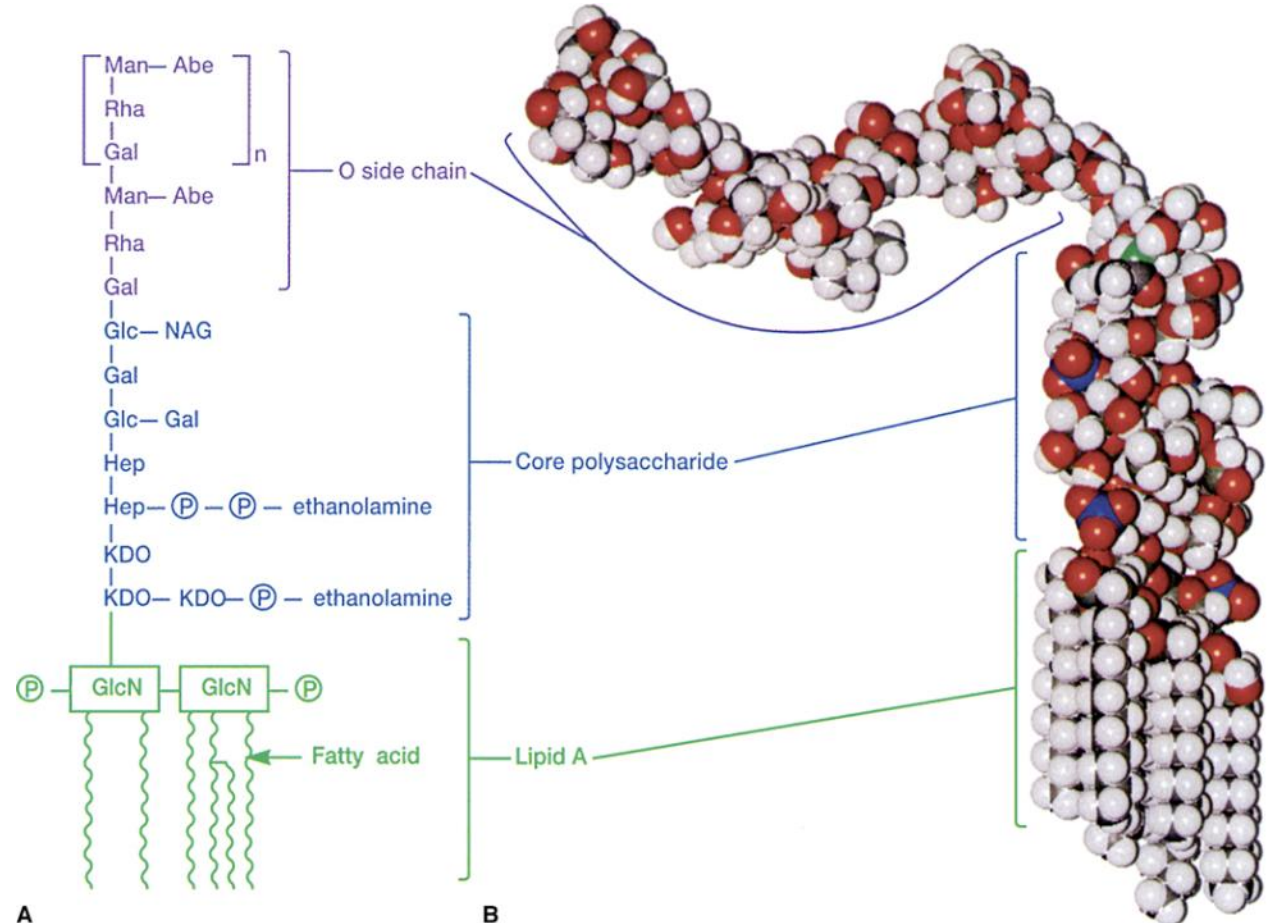
Specific to **Gram-negative**

Composed of:

- O-side chain
- Core polysaccharide
- Lipid A

Wide variability between and within species

Elicits a potent immune response (we'll talk about **sepsis** later...)



Select the correct statement regarding bacterial cell walls:

✓ 0

Most bacteria survive without cell walls.

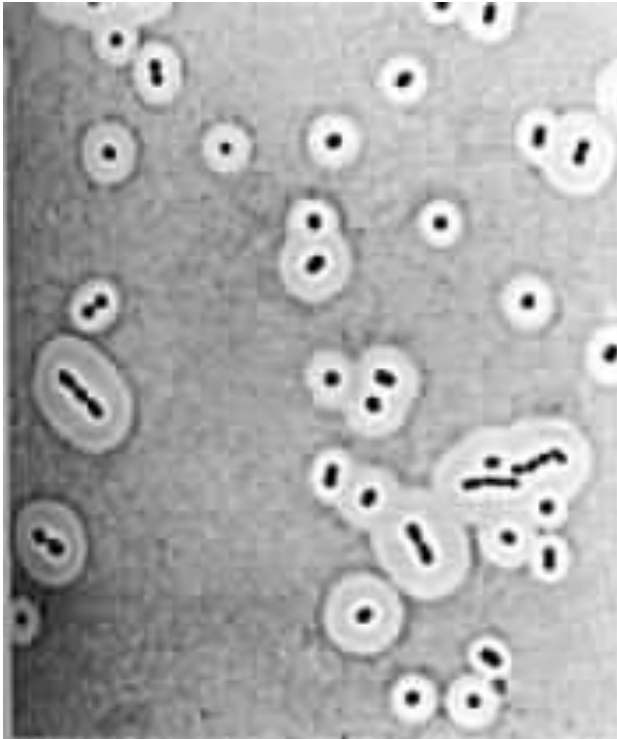
Antibiotics cannot penetrate cell walls.

Gram-negative bacteria do not have cell walls.

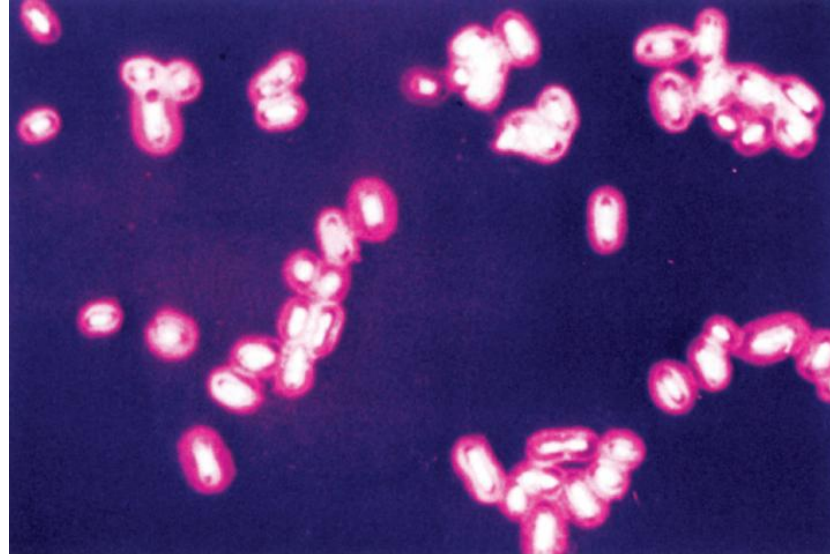
Cell walls confer bacterial shape and arrangement.

Capsule

= discrete layer associated with **individual cells**



Streptococcus pneumoniae

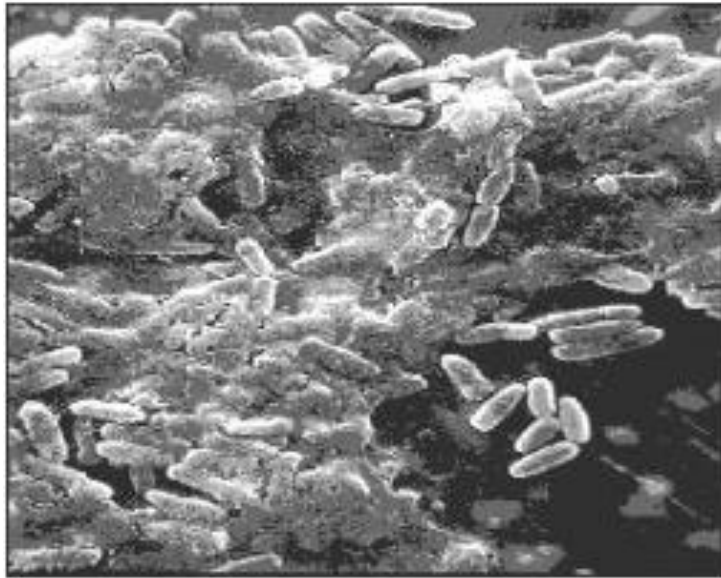


Klebsiella pneumoniae

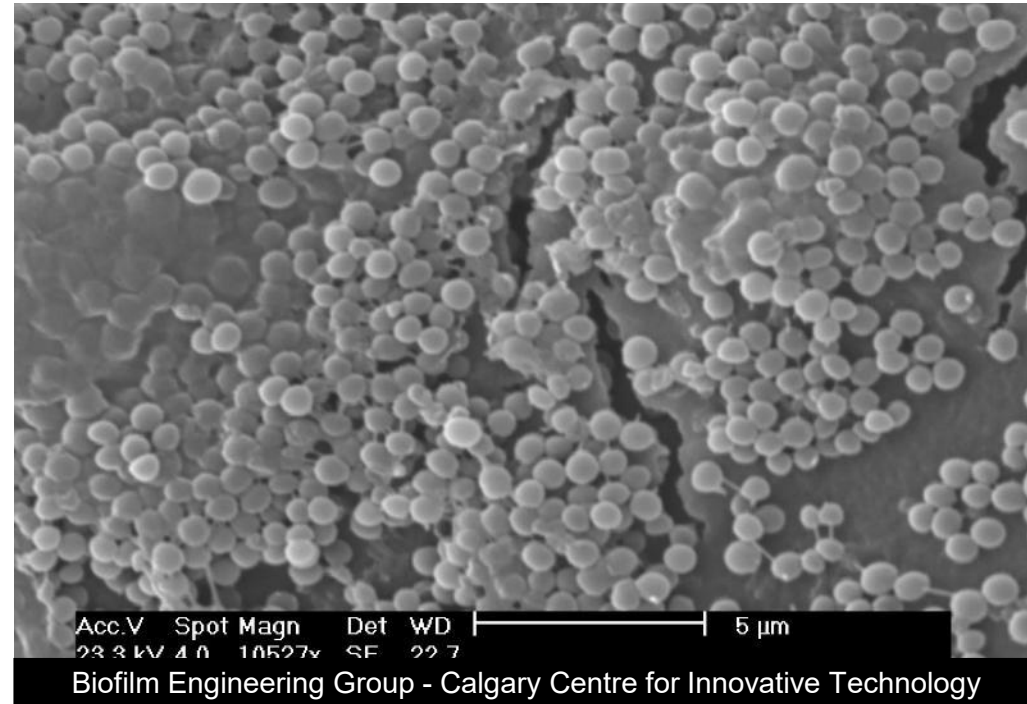
- mediate adherence
- protect from **phagocytosis** and block **complement** (alternative pathways)
- protect from drying

Matrix

(aka slime layer) = secreted layer which embeds **community** of bacteria



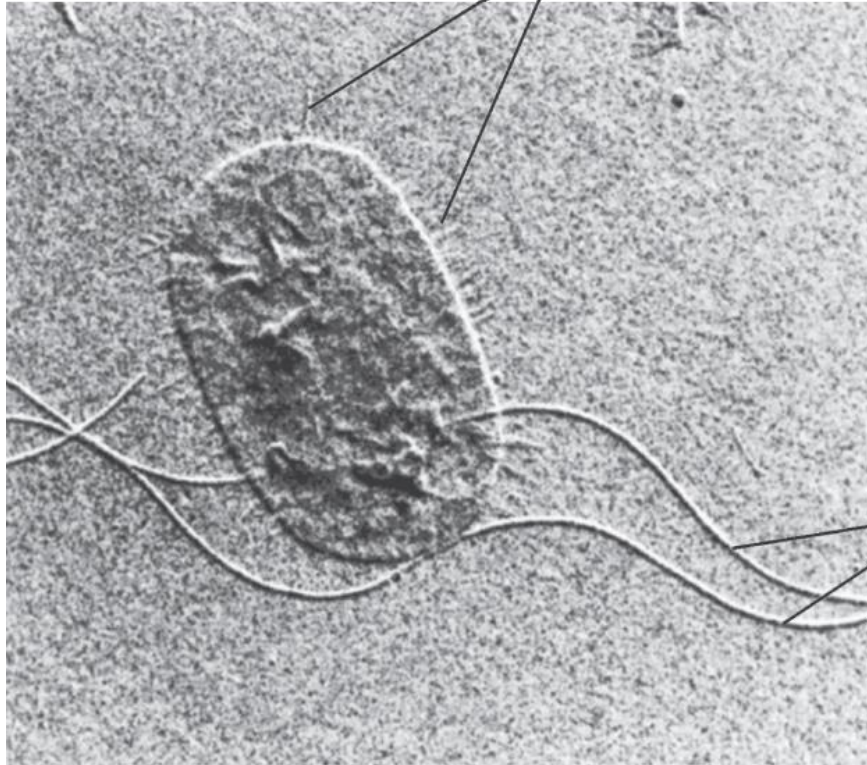
Pseudomonas aeruginosa infected catheter



MRSA infected catheter

- scaffolding for formation of **biofilms**
- reserve of carbohydrate for subsequent metabolism

composed of
proteins

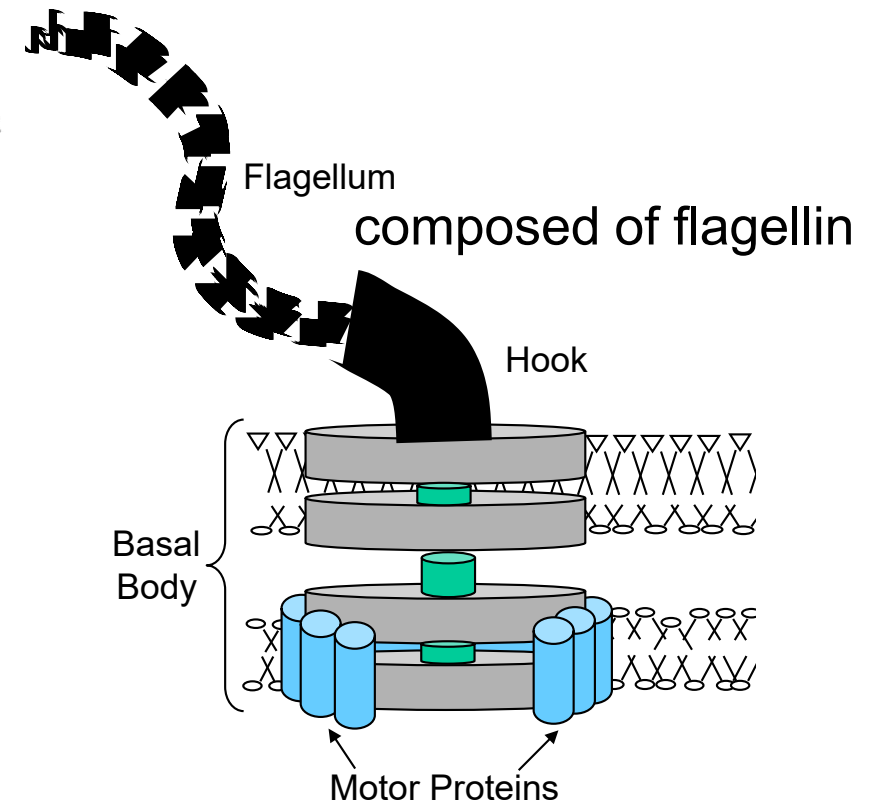


Pili/Fimbriae:

- attachment
- conjugation (DNA exchange)
- motility (gliding and twitching)

Flagella:

- Motility (powered by proton motive force)
- Sometimes attachment



Other extracellular structures

Eukaryotes and prokaryotes share which of the following cell structures?
(Even if the composition of said structures is not identical)

Mitochondria

0%

Cell wall

0%

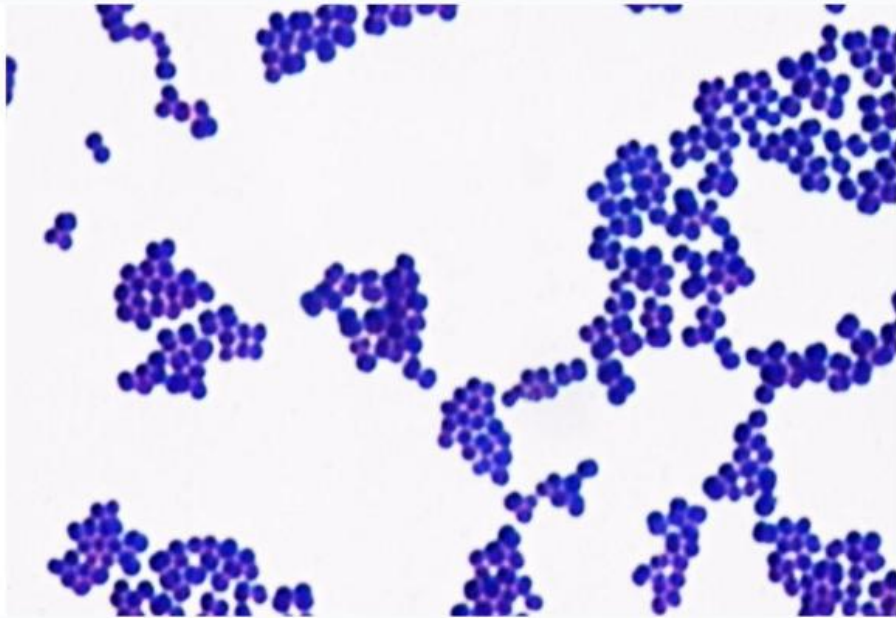
Nucleoid

0%

Golgi body

0%

You observe an unknown sphere-shaped bacterium under the microscope, which of these options may be its name?



Bacillus anthracis

0%

Staphylococcus aureus

0%

Spirillum minus

0%

Vibrio cholerae

0%