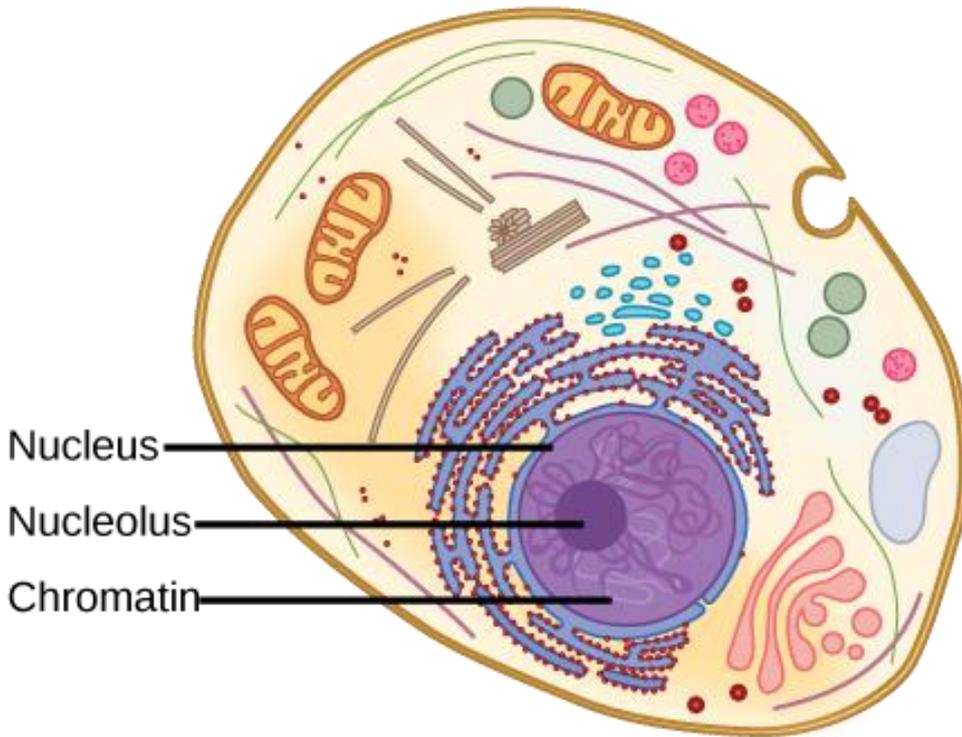
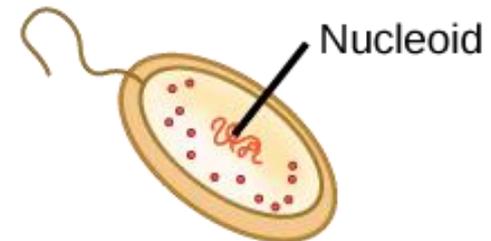


Basic Cell Types

All cells consist of a **cytoplasm** enclosed within a **membrane**.



Cells are typically categorized by how their genetic material is packaged:



Eukaryote - the DNA is **partitioned off** in its own membrane-bound room called the **nucleus**.

Prokaryote - the DNA within a cell is **not separated from the cytoplasm**.

What are bacteria?

Bacteria (sin. *bacterium*) is the **oldest and most abundant** living organism on earth.



- There are approximately **5×10^{30} bacteria on Earth.**
- Most bacteria are harmless, but a few are pathogens.
- A **gram of soil** typically contains about **40 million bacterial cells.**
- A **milliliter of fresh water** has about **a million bacterial cells** in it.

Most bacteria have not been characterized yet...

General Characteristics

Bacteria can be **found everywhere**: in air, water, land, and living organisms including people.

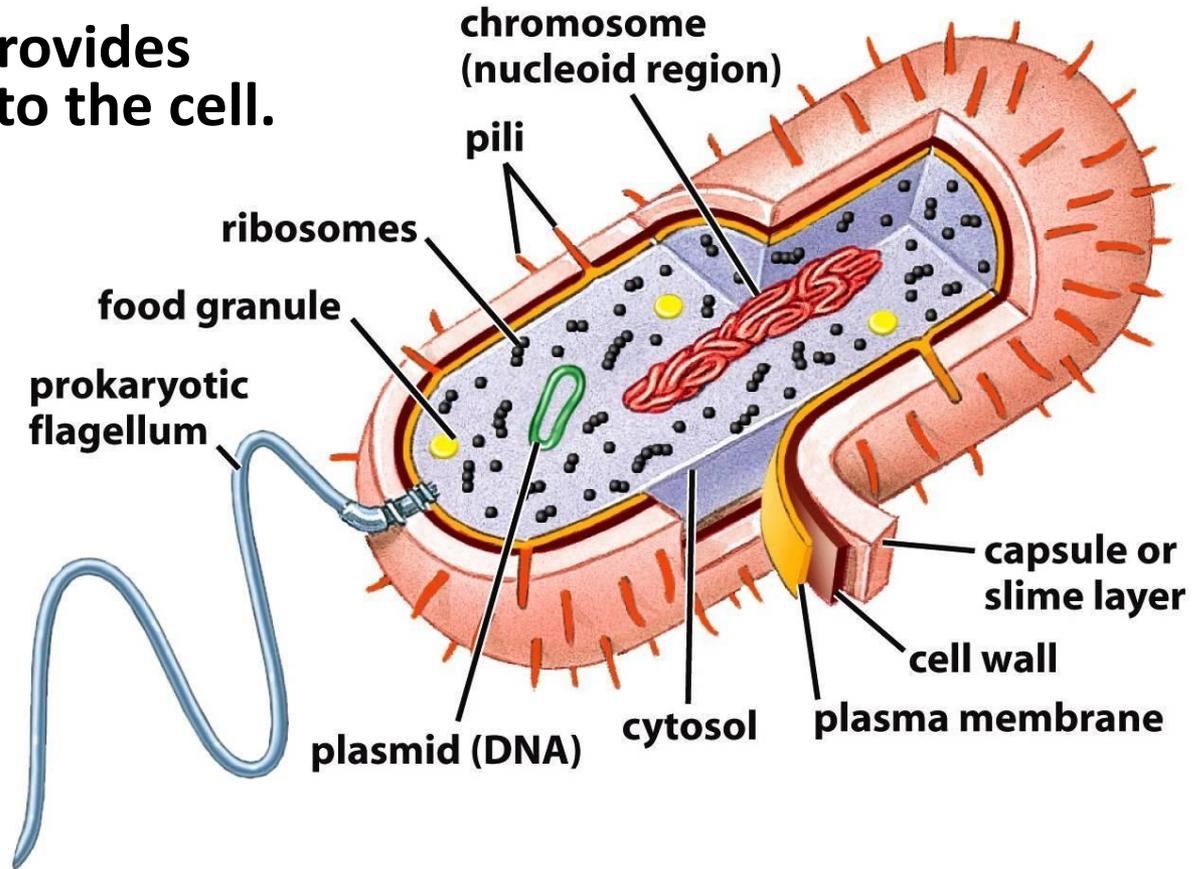
1. All are **unicellular** (one-celled structural level).
2. All are **prokaryotic** (lack nucleus).
3. All have **cell walls** (made of complex sugars and proteins).
4. Exceptional **diversity** in size, shape, and metabolism.
5. Can live in both **aerobic** (with O₂) and **anaerobic** (without O₂) environments.
6. Bacteria **reproduce** (make more of themselves).
7. Bacteria **need food**.

**Billions on and inside
your body right now!**

Typical Structure

- Bacterial cell wall provides **structural integrity** to the cell.

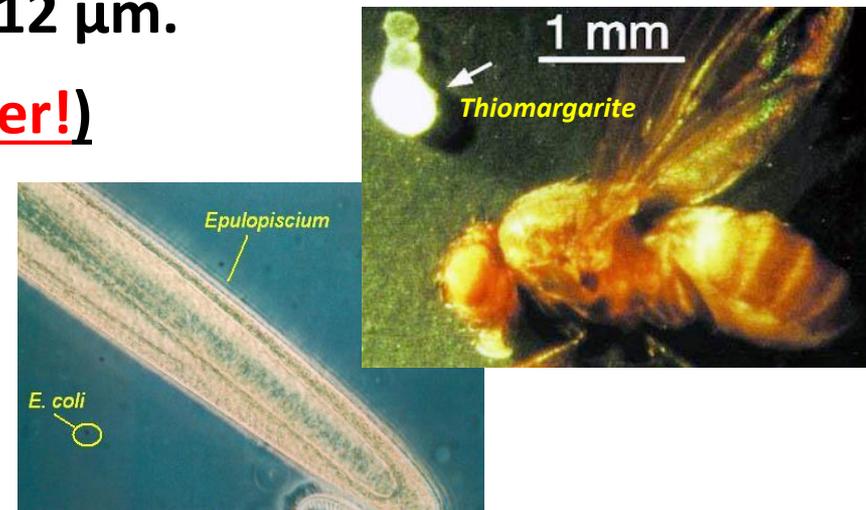
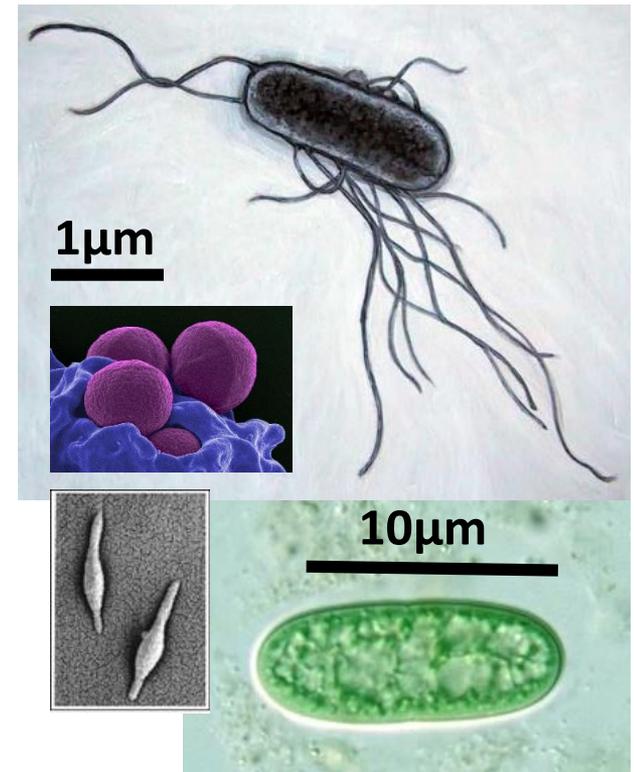
- Plasmids are **small independent “extra” pieces of DNA**, often coding for non-essential advantageous traits (can be easily *lost, gained* and *transferred* between bacterial cells).



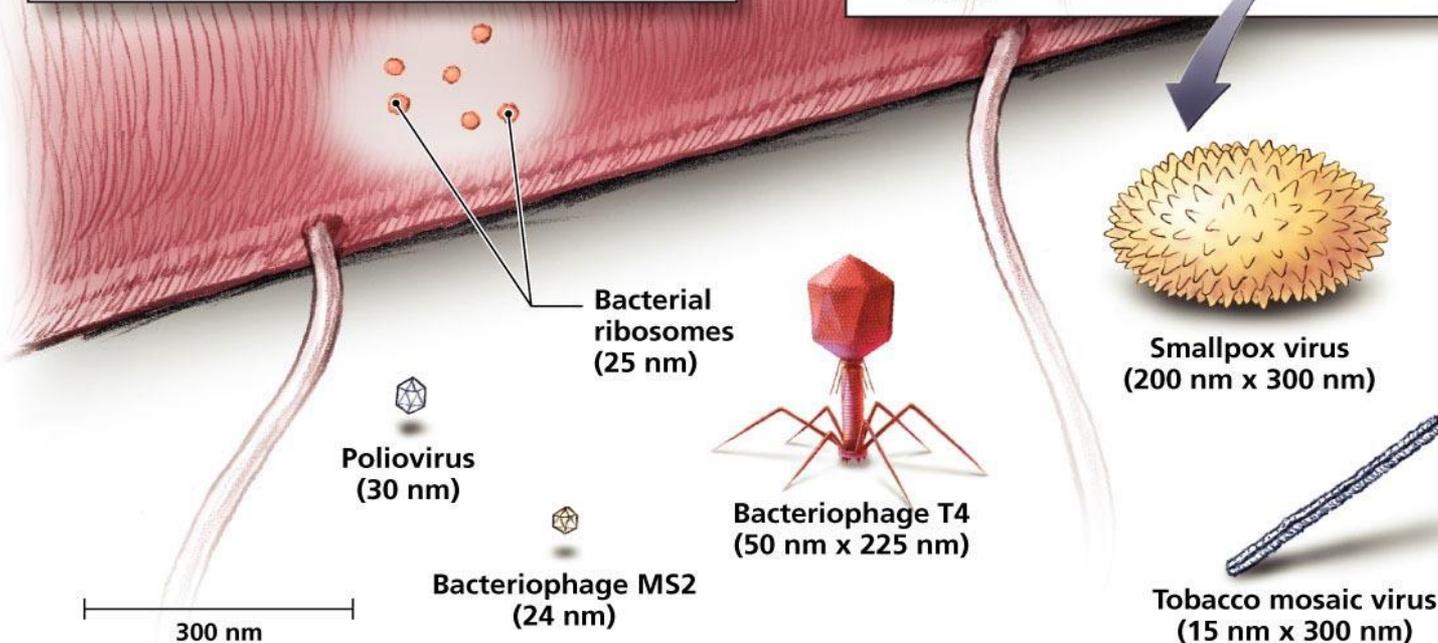
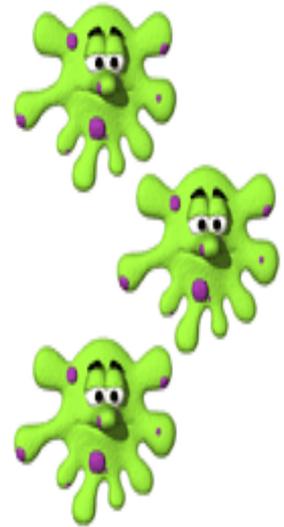
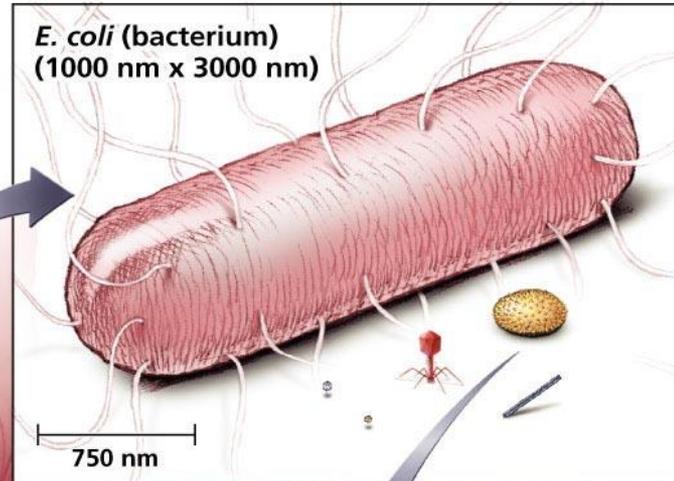
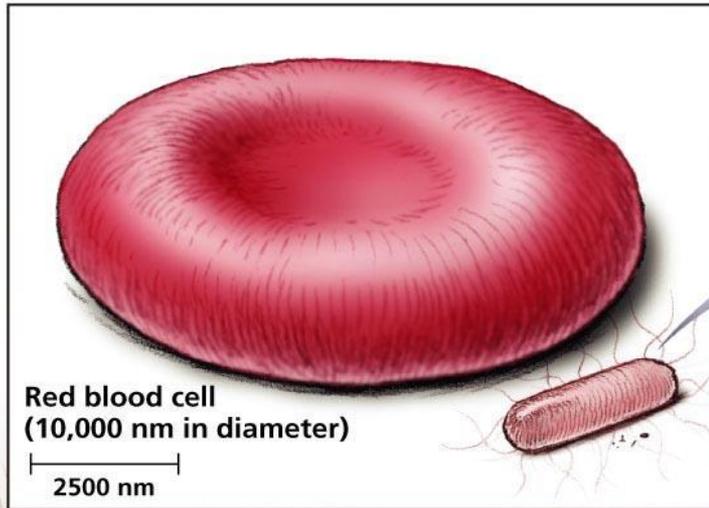
- Pili are *protein tubes* that extend out from the outer membrane; used for **attachment to surfaces** and **movement**.
- Flagella are whip-like *filament structures* protruding from the bacterial cell wall; responsible for **movement**.

Bacteria Size

- Average ~1 micrometer: an average-size rod bacterium (ex. *Escherichia coli* found in your intestine) is about 2-3 μm long and 0.5-1 μm across; the spherical cells of *Staphylococcus aureus* are up to 1 μm in diameter.
- Smallest ~0.1 micrometer: *Mycoplasma pneumonia* are just ~0.1-0.25 μm across.
- Large ~10 micrometers: cyanobacterium *Synechococcus* averages 6 μm by 12 μm .
- Giant (more than half a millimeter!) bacteria can be visible with the unaided eye: *Thiomargarita namibiensis* averages 750 μm in diameter; the rod-shaped *Epulopsicium fishelsoni* is 80 μm in diameter by 600 μm in length.



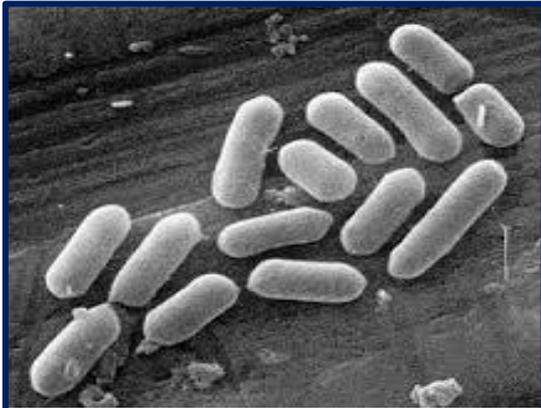
Scale Sense



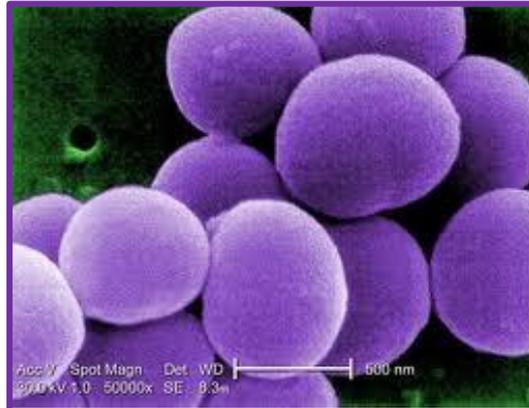
Average size (~1 μ m) *bacteria* are much **larger** in size than *viruses*.

Bacteria Shapes

- Three basic shapes:



Bacilli
(buh-sill-eye)
rod shaped



Cocci
(cox-eye)
round shaped

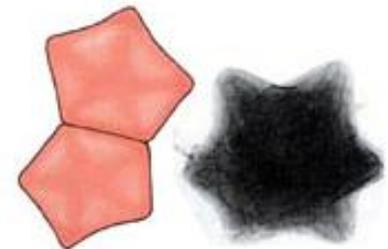
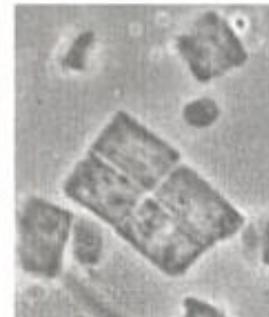


Curve shaped
(vibrio, spirilla,
spirochete)

- Some unusual shapes:



square

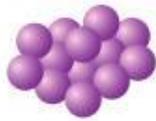


star-shaped

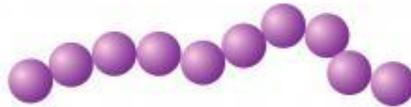
Do bacteria get together?

Many bacterial species exist simply as single cells, others **associate in characteristic patterns**:

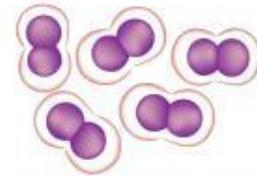
Clusters



Staphylococcus aureus

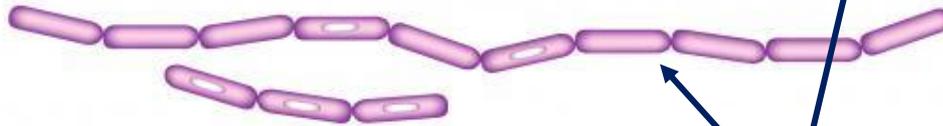


Streptococcus pyogenes



Pairs

Streptococcus pneumoniae



Bacillus cereus

Chains

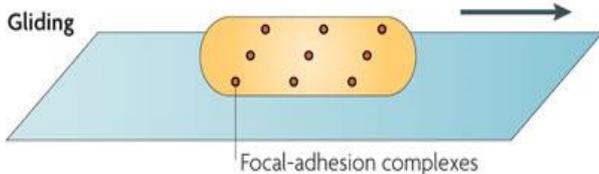
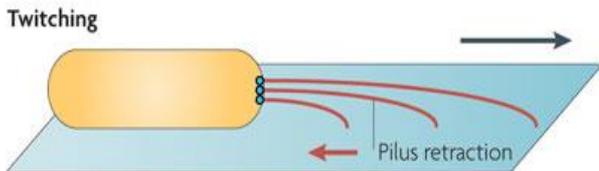
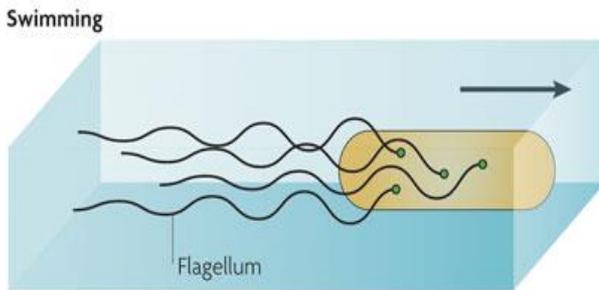
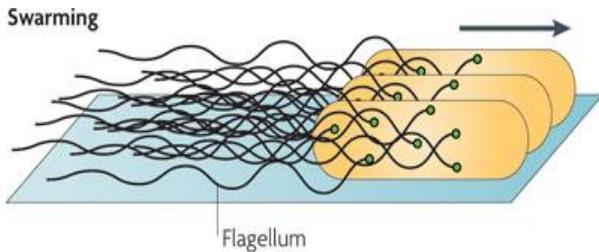
Many bacteria can form **aggregated structures** called **biofilms**:

- Organisms in biofilms often display substantially different properties from the same organism in the individual state.
- Biofilms can **communicate information** about population size and metabolic state.



Can bacteria move?

Many bacteria can move using a variety of mechanisms:

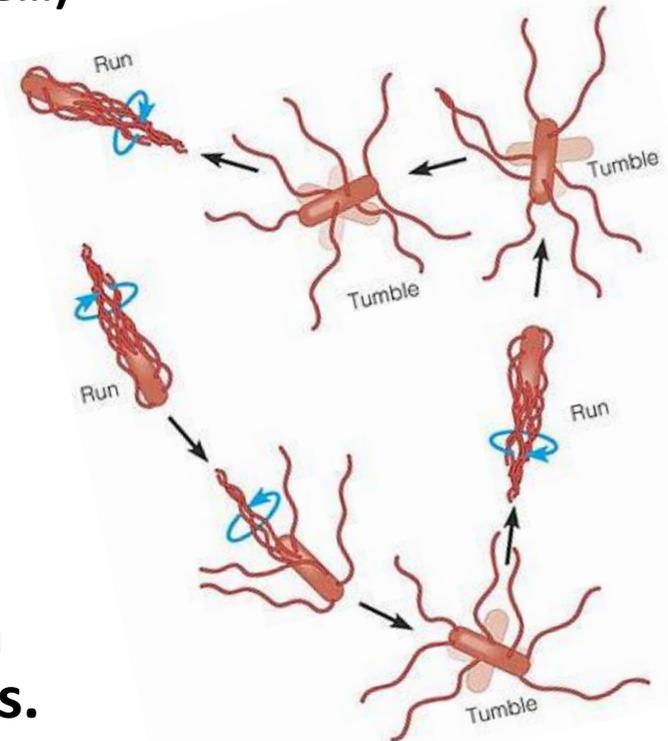


- ***Flagella*** are used for swimming through fluids as well as for “run and tumble”.

(swimming bacteria frequently move near **10 body lengths per second** and a few as fast as 100; this makes them at least as fast as fish, on a relative scale...)

- Changes of ***buoyancy*** allow vertical motion.

- ***Gliding and twitching*** (using *pili*) move bacteria across surfaces.

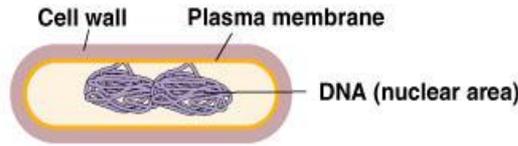


Reproduction

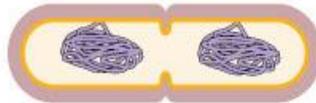
Bacteria **grow to a fixed size** and then **reproduce through binary fission**: bacterial cell divides in half, producing two genetically identical *clone* daughter cells.

Under optimal conditions, bacteria can **grow and divide extremely rapidly**: bacterial populations can double as quickly as every 9.8 minutes.

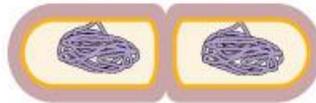
1. Cell elongation and DNA replication



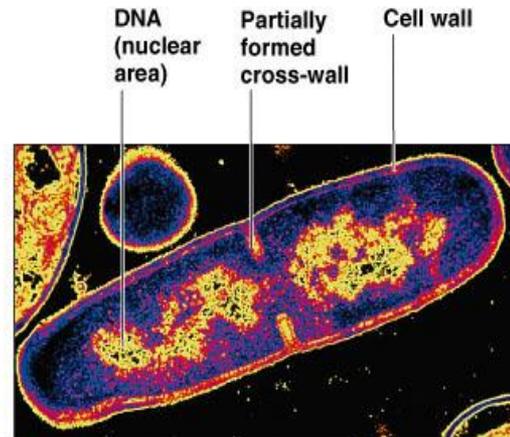
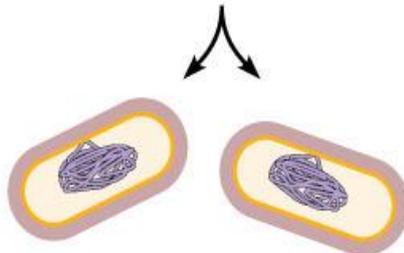
2. DNA separation



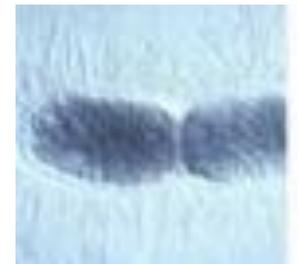
3. Cross-wall formation



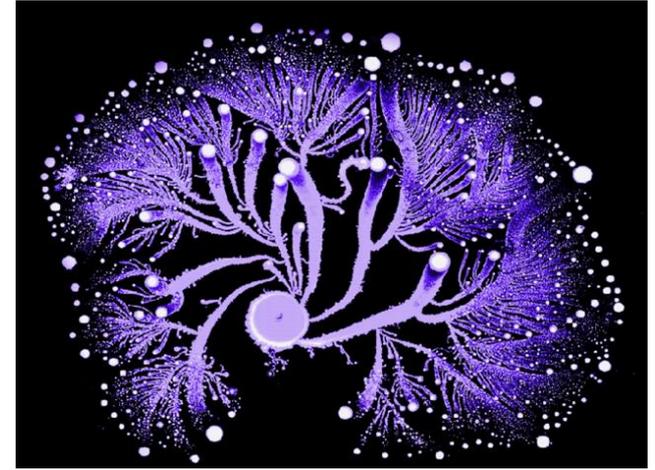
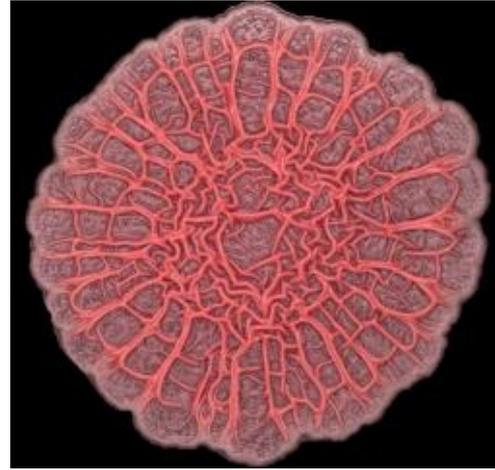
4. Daughter cells separation



micrograph of a dividing bacterial cell



Bacterial Colonies



In the laboratory, bacteria are usually grown using solid (*agar plates*) or liquid nutritious media.

