Bacteria

Class 6 **Reference: Chapters 19**

Imagine if……

History of anti-TB drugs: streptomycin (1944), p-aminosalicylic acid (1949), isoniazid (1952), pyrazinamide (1954), cycloserine (1955), ethambutol (1962), and rifampin (rifampicin; 1963)

BEFORE

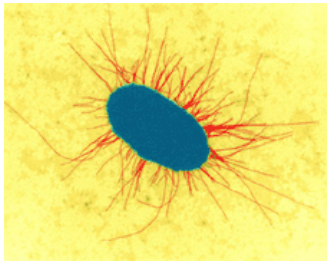
Jinnah died of TB at his home in Karachi on 11 September 1948, just over a year after Pakistan's creation.

AFTER

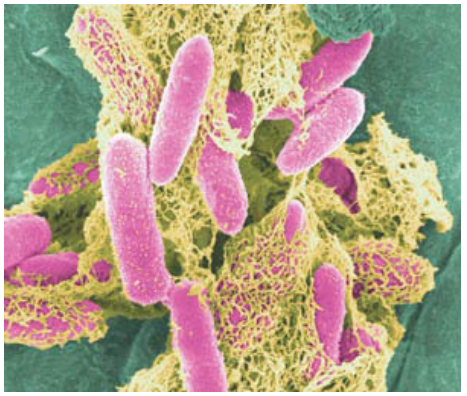
Mandela was diagnosed with TB in 1988 and successfully cured with antibiotics.

Bacteria

- Single celled organisms
- Very small
- Need a microscope to see
- Can be found on most materials and surfaces
  - Billions on and in your body right now!



This *E. coli* helps you digest food.

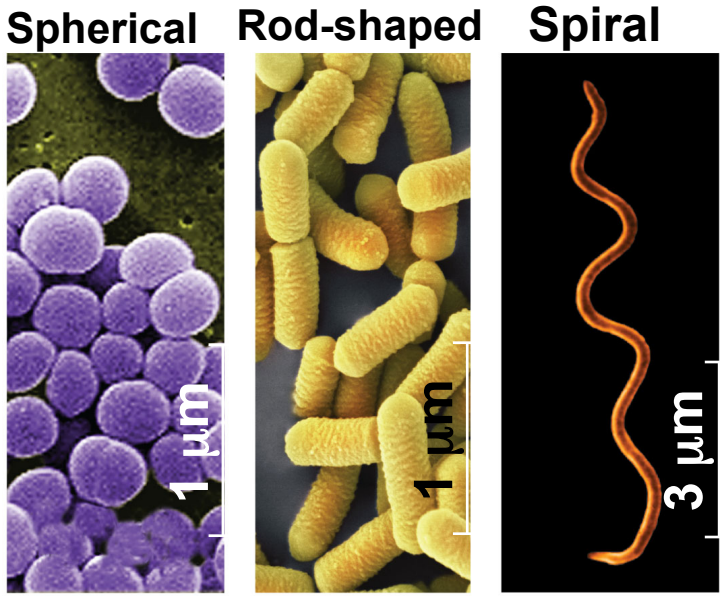


E. Coli O157:H7 can make you very sick.

Streptococcus can cause strep throat.

What do they look like?

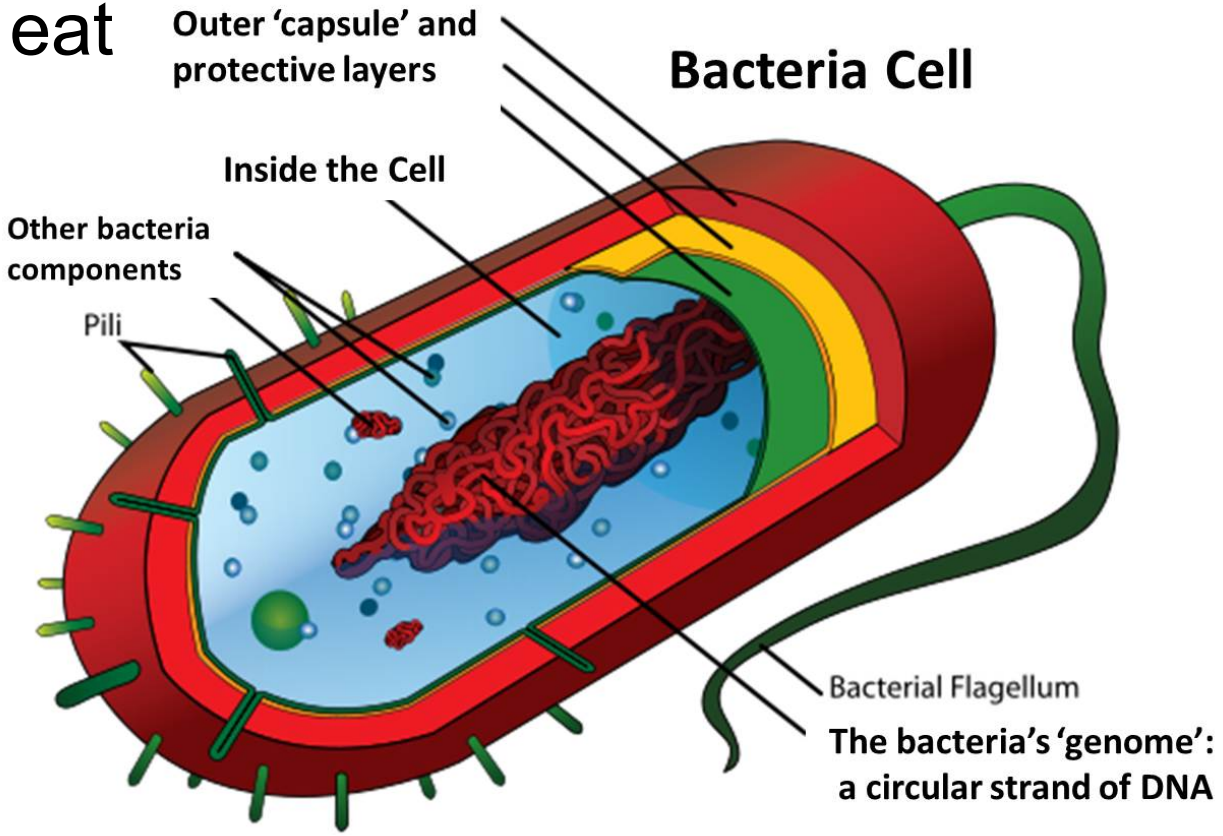
- Come in three basic shapes
- Earth's first organisms were likely prokaryotes
- Most prokaryotic cells are 0.5–5 µm, much smaller than the 10–100 µm of many eukaryotic cells



The three most common shapes are spheres (cocci), rods (bacilli), and spirals

Bacteria are ALIVE!

- What does it mean to be alive?
  - They reproduce (make more of themselves)
  - They need to eat

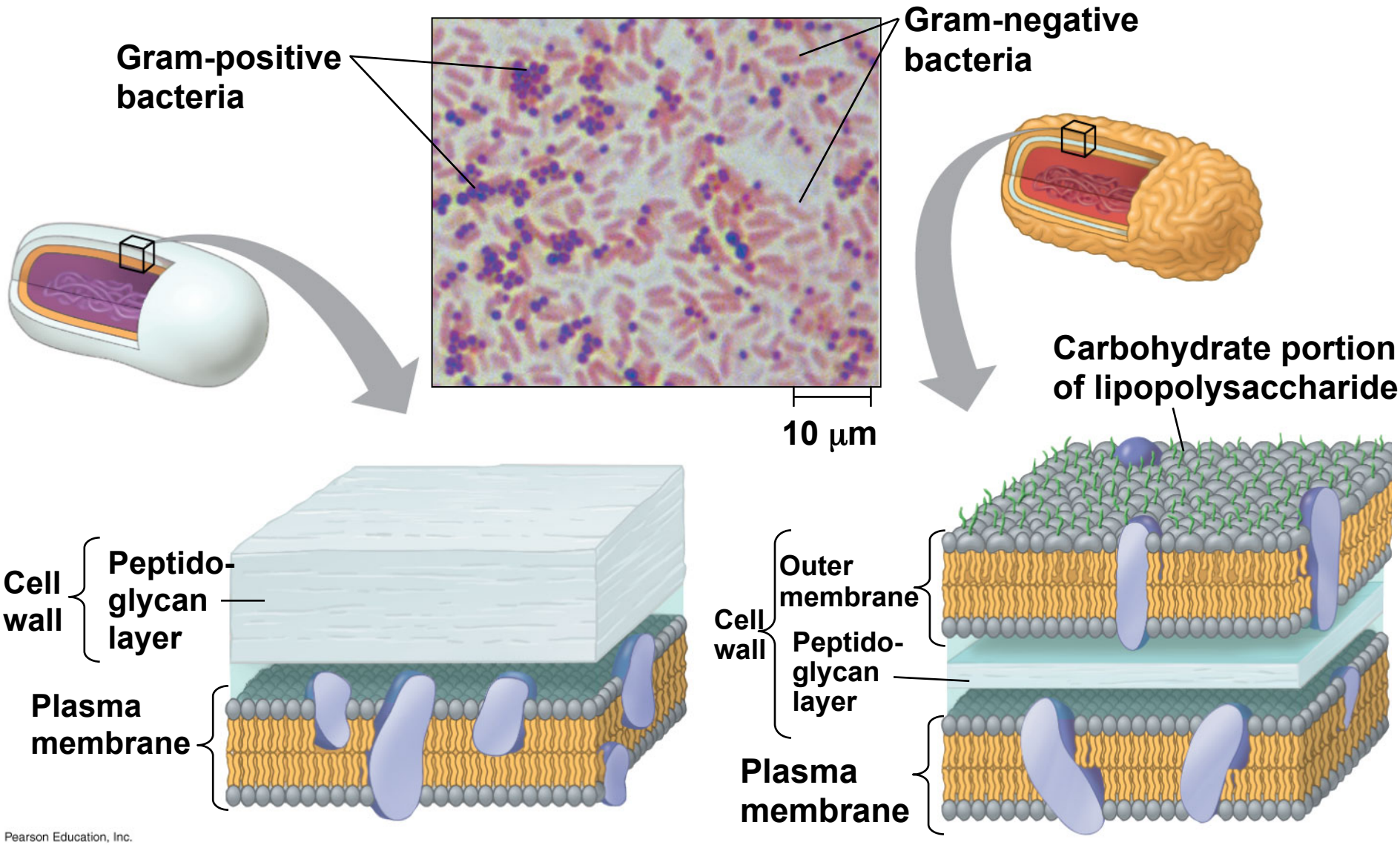


http://www.scilogs.com/from_the_lab_bench/computers-and-electrifying-bacteria/

How do bacteria eat?

Table 27.1 Major Nutritional Modes

Mode	Energy Source	Carbon Source	Types of Organisms
AUTOTROPH			
Photoautotroph	Light	CO_2, HCO_3^-, or related compound	Photosynthetic prokaryotes (for example, cyanobacteria); plants; certain protists (for example, algae)
Chemoautotroph	Inorganic chemicals (such as H_2S, NH_3, or Fe^{2+})	CO_2, HCO_3^-, or related compound	Unique to certain prokaryotes (for example, *Sulfolobus*)
HETEROTROPH			
Photoheterotroph	Light	Organic compounds	Unique to certain aquatic and salt-loving prokaryotes (for example, *Rhodobacter*, *Chloroflexus*)
Chemoheterotroph	Organic compounds	Organic compounds	Many prokaryotes (for example, *Clostridium*) and protists; fungi; animals; some plants



Gram-positive bacteria: peptidoglycan traps crystal violet

Gram-negative bacteria: crystal violet is easily rinsed away, revealing red dye

Antibiotic targets

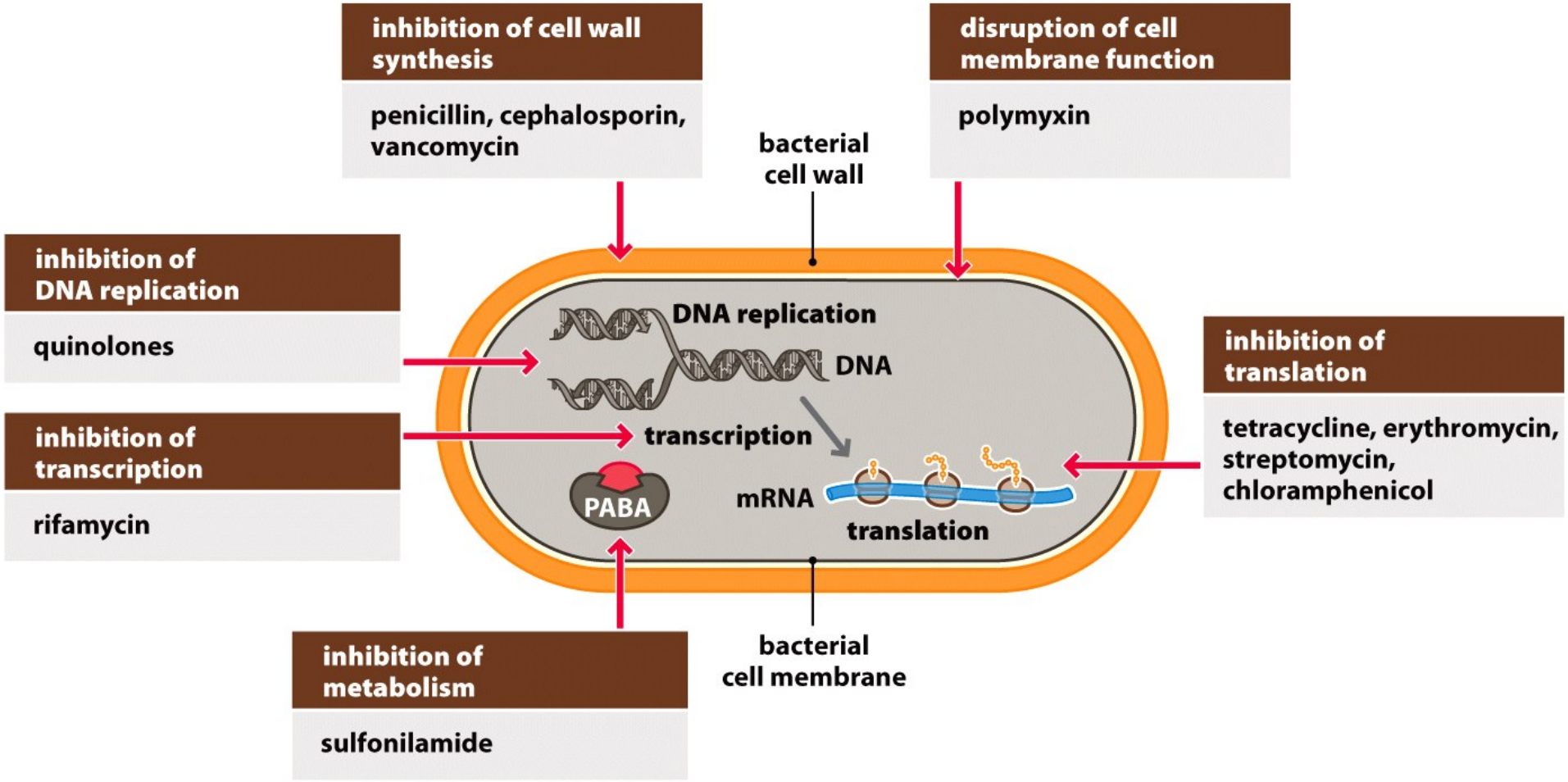
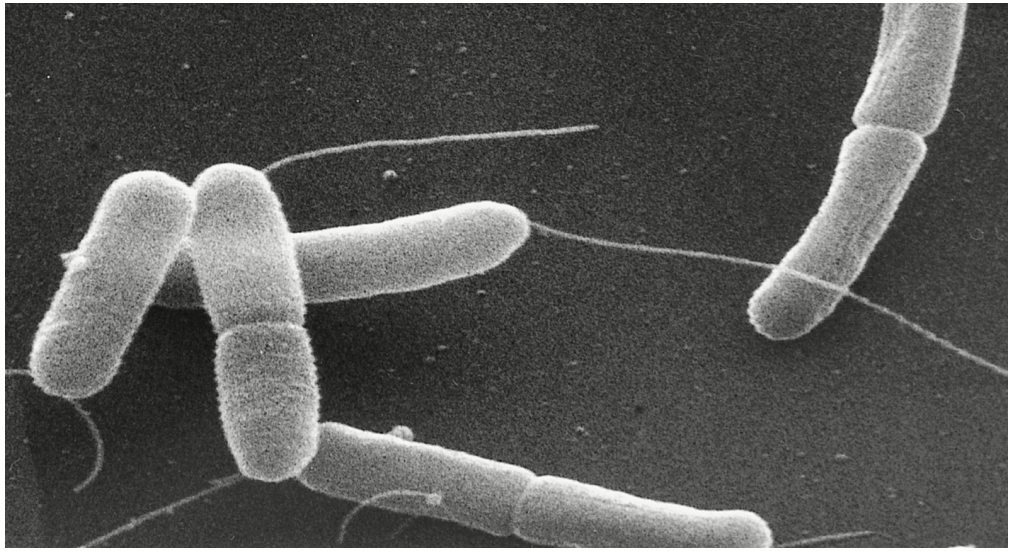


Figure 19.4 Microbiology: A Clinical Approach (© Garland Science)

How do bacteria reproduce?

- Grow in number not in size
- Make copies of themselves by dividing in half asexually (binary fission)

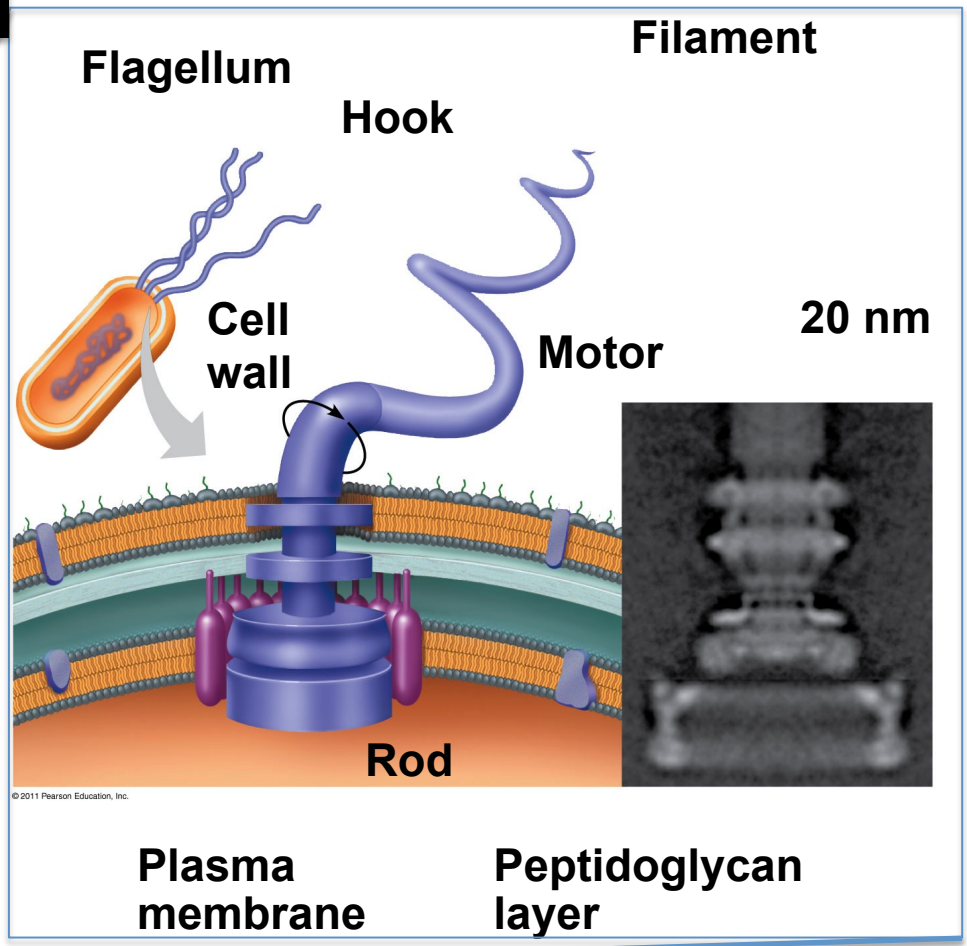


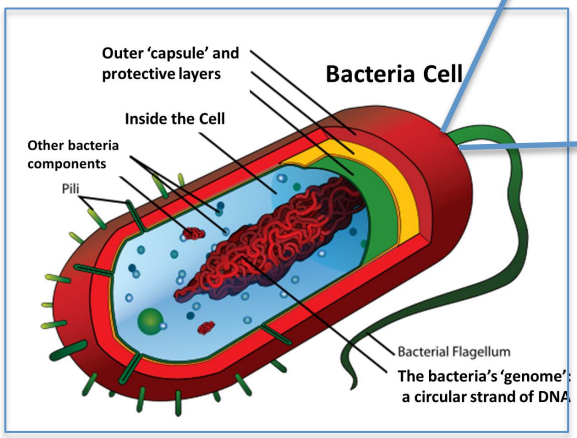
Escherichia coli bacteria dividing by binary fission

This salmonella bacterium is undergoing the process of binary fission. The cell divides resulting in the formation of two identical cells.
http://biology.about.com

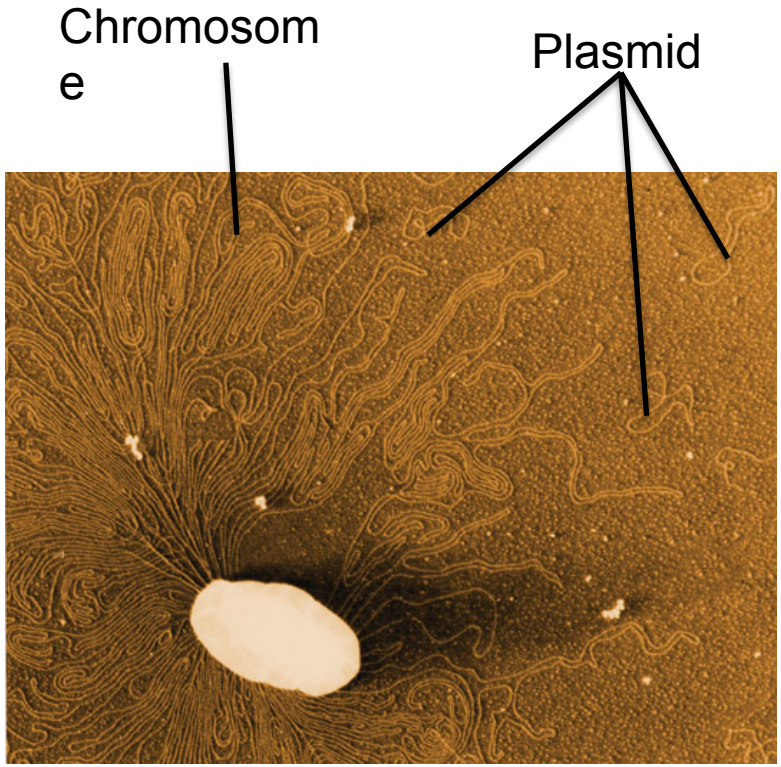
How do bacteria move?

- Most motile bacteria propel themselves by flagella scattered about the surface or concentrated at one or both ends
- Many bacteria exhibit **taxis**, the ability to move toward or away from a stimulus
  - **Example-Chemotaxis** is the movement toward or away from a chemical stimulus





Internal Organization and DNA



Some species of bacteria also have smaller rings of DNA called **plasmids**

Many bacteria are human pathogens

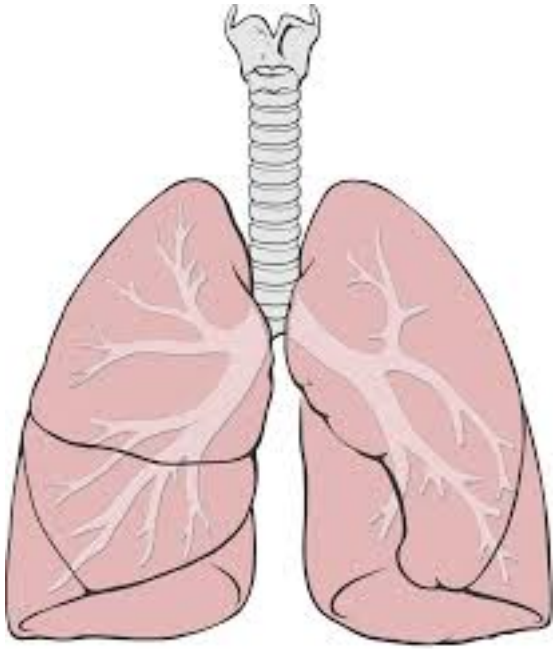
Pathogenic bacteria: Prokaryotes cause about half of all human diseases

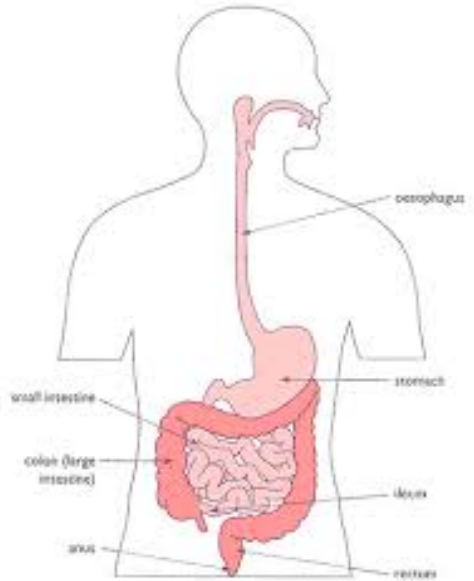
- For example: Bacillus anthracis causes Anthrax

How bacteria infect humans?

Major route of infection (entry into host):

- Skin
- Gastro-intestinal
- Respiratory system
- Mucosal membrane (exposed to environment





Reference: info in this slide is sufficient (not available in Campbell Biology)

How bacteria able to cause various diseases in humans?

Failure of Host Defense

1. **Pathogen**
   - **Subversion or avoidance of normal host immune responses**

2. **Host**
   - **Week immune system**
     - **Primary immunodeficiency**
     - **Acquired immunodeficiency**

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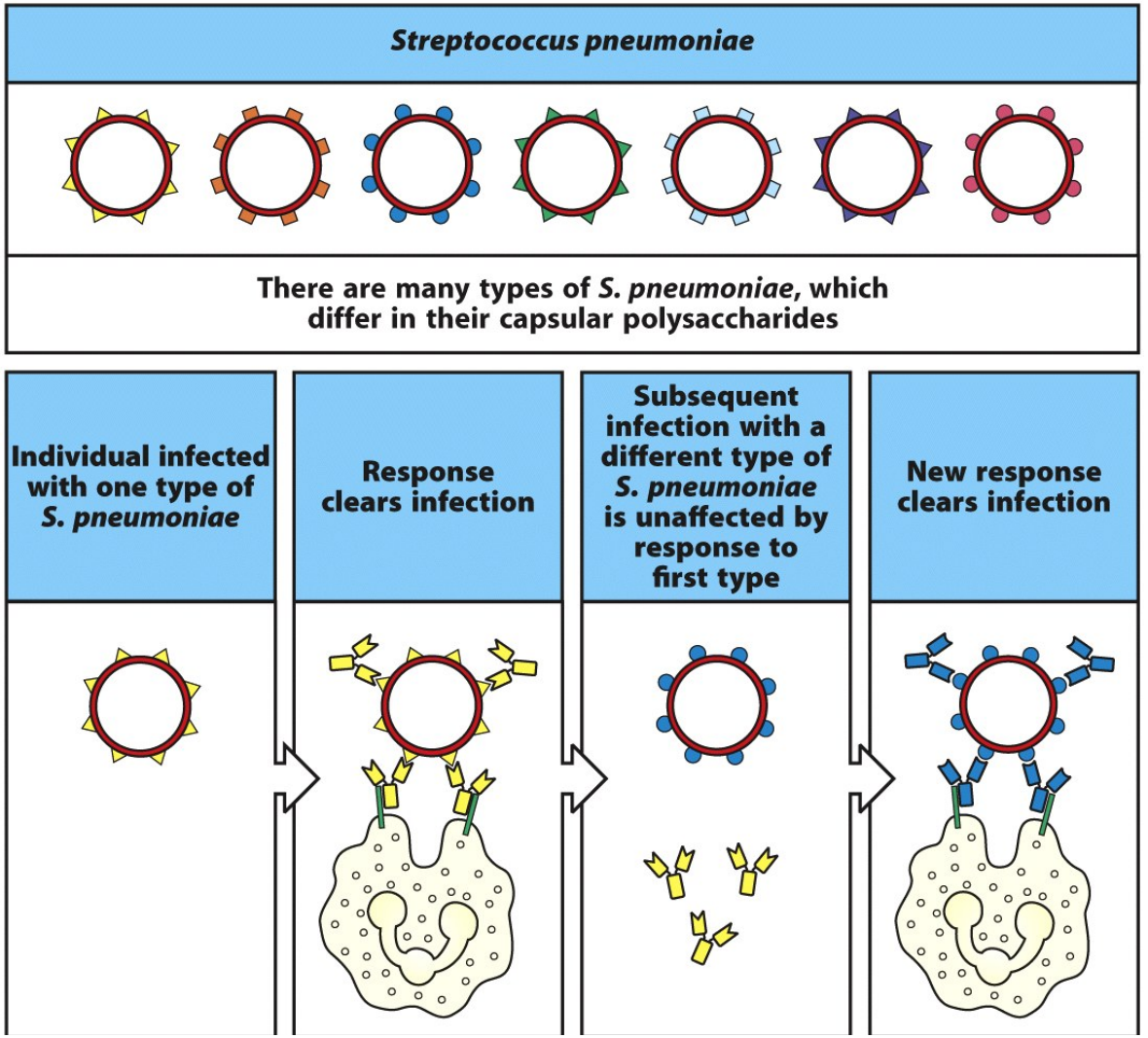
How bacteria escape from host immune system

Antigenic variation

Streptococcus pneumonia

- 84 types (serotype)
- Altering antigen in extracellular pathogen



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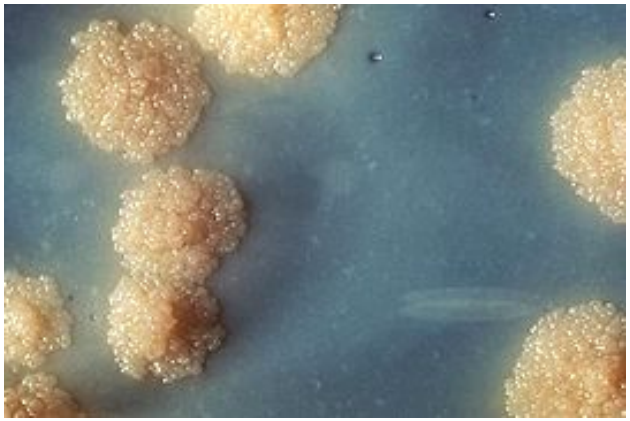
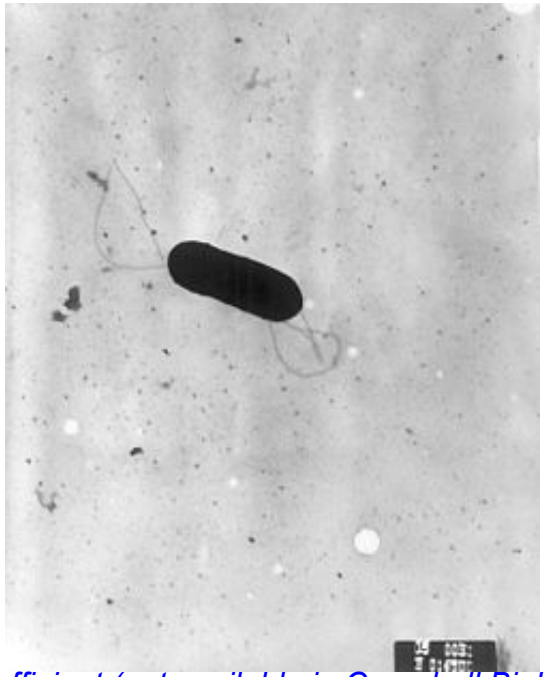
How bacteria escape from host immune system

Few pathogens resist destruction by host defense mechanisms or exploit them for their own purposes



Mycobacterium tuberculosis (Gram positive)

- prevents fusion of phagosome & lysosomes



Listeria monocytogens (Gram positive)

- one of the most virulent food-borne pathogen
- escape from phagosome into cytoplasm
- spread into other cells by hijacking the actins (cytoskeleton)

Reference: info in this slide is sufficient (not available in Campbell Biology)

How bacteria escape from host immune system

Immunosuppression:

Styphylococci

- produce Staphylococcal enterotoxins and toxic shock syndrome toxin-1: superantigens*
- Eliminate large numbers of immune cell (T cells) after uncontrolled activation

Inappropriate immune responses

Bacillus anthrasis

- *B. antrasis* endospores contracted by inhalation, contact, ingestion
- releases toxin-Anthrax lethal toxin
- Dissemination throughout the body: fatal
- Causes disruption in effector pathways by apoptosis of infected macrophages, abnormal maturation of DCs

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Prokaryotes in Research and Technology

- Experiments using prokaryotes have led to important advances in DNA technology
  - For example, *E. coli* is used in gene cloning
- Natural plastics, antibiotics, vitamins, ethanol production
- Bioremediation

Rapid reproduction, mutation, and genetic recombination contribute to the genetic diversity of bacteria

Bacteria allow researchers

-To investigate molecular genetics in the simplest true organisms

The bacterial chromosome

-Is usually a circular DNA molecule with few associated proteins

In addition to the chromosome

-Many bacteria have plasmids, smaller circular DNA molecules that can replicate independently of the bacterial chromosome

Mutation and genetic recombination as sources of genetic variation

Since bacteria can reproduce rapidly

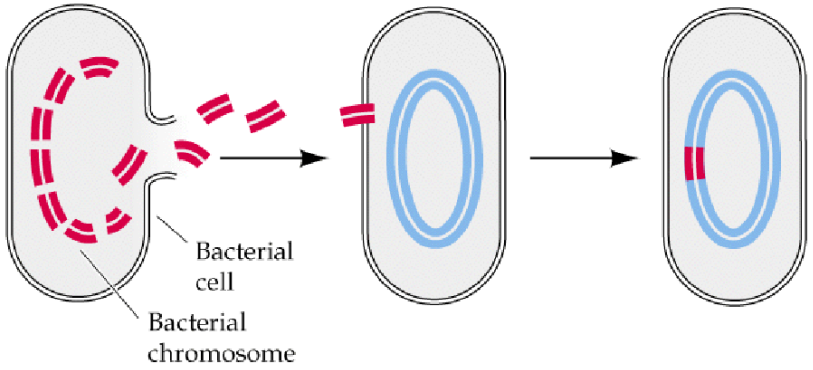
-New mutations can quickly increase a population's genetic diversity

Further genetic diversity

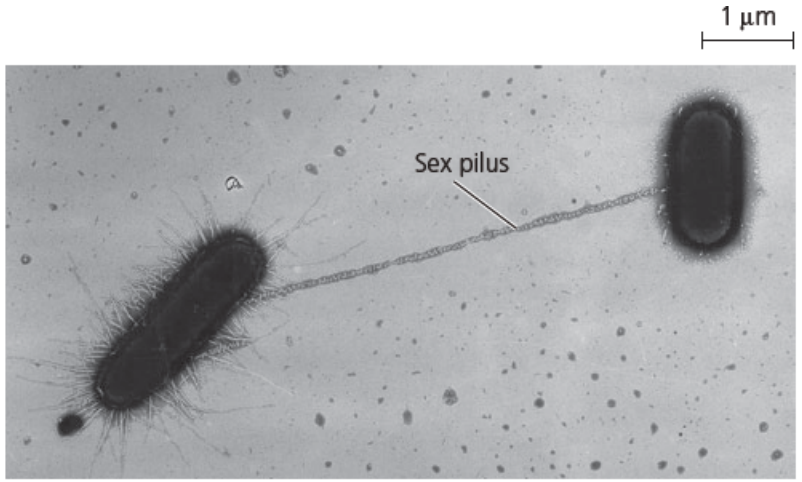
-can arise by recombination of the DNA from two different bacterial cells

Mechanisms of gene transfer and genetic recombination in bacteria

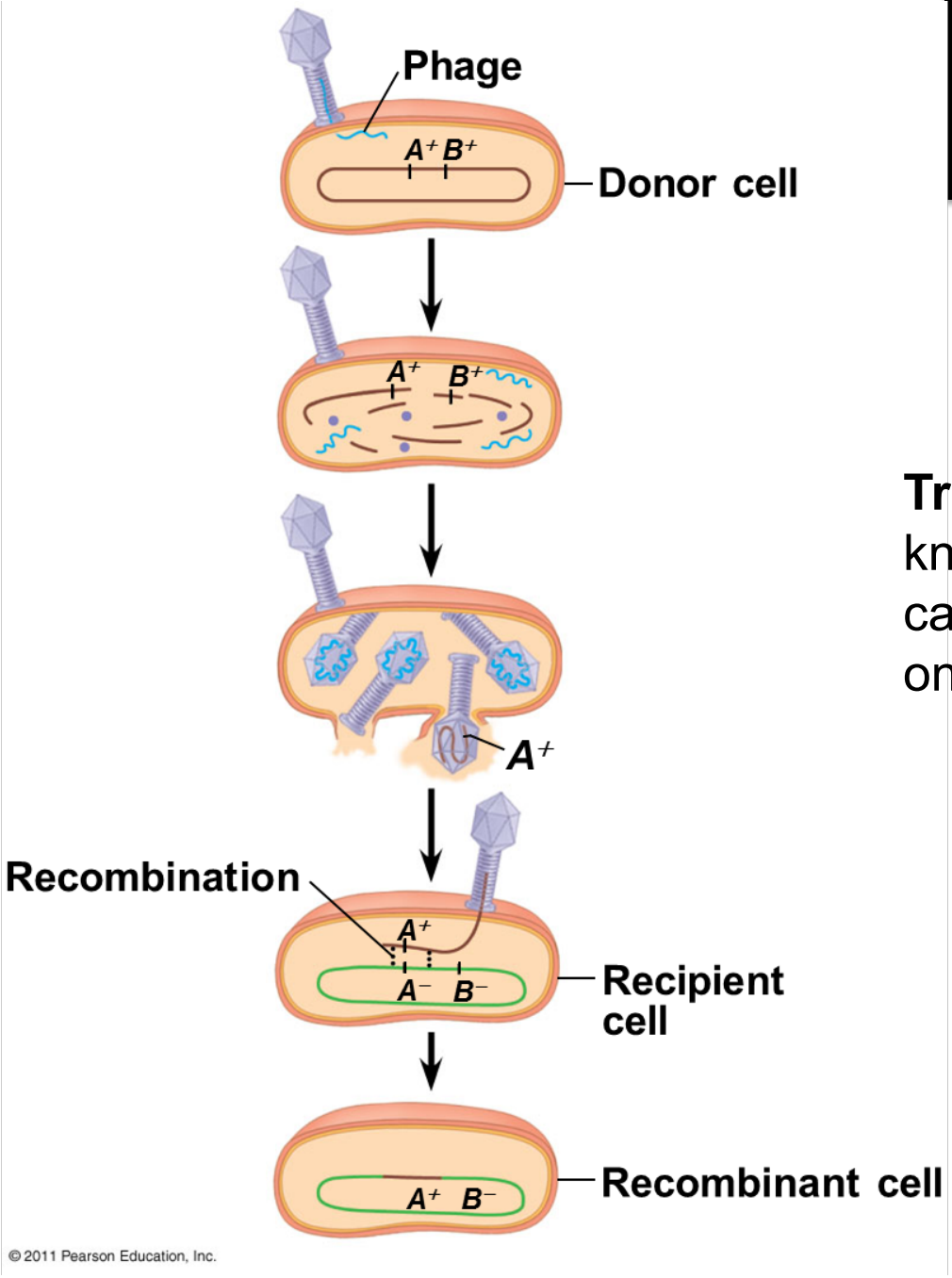
- **Transformation**-Is the alteration of a bacterial cell's genotype and possibly phenotype by the uptake of naked, foreign DNA from the surrounding environment



- **Conjugation**-Is the direct transfer of genetic material between bacterial cells that are temporarily joined



Mechanisms of gene transfer and genetic recombination in bacteria



Transduction-Through a process known as transduction phages carry (transfer) bacterial genes from one host cell to another