Chapter 19: Bacteria and Viruses

Section 1: Prokaryotes

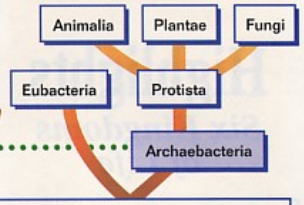
Classifying Prokaryotes

- Life is everywhere.
- What are the smallest and most common microorganisms?
- Prokaryotes.
- What are prokaryotes?
- Single-celled organisms lacking a nucleus.
- Referring to the classification of organisms, what is a kingdom?
- The largest group of closely related organisms.
- What kingdoms do the prokaryotes belong to?
- Archaebacteria and eubacteria.*

- Tell me a bit about eubacteria.
- They live almost everywhere, cells surrounded by a cell wall, the cell walls contain the carbohydrate peptidoglycan, and the cytoplasm is surrounded by a membrane.
- How are archaebacteria different from eubacteria?
- Archaebacteria lack peptidoglycan and sequences of key archaebacterial genes are more like those of eukaryotes than those of eubacteria.
- Archaebacteria are extremophiles living in harsh environments such as thick mud and digestive tracts of animals. They also tolerate high salinity and high temperatures approaching the boiling point of water.*

Highlights
Six Kingdoms of Life

Kingdom Archaebacteria



Characteristics of Archaebacteria

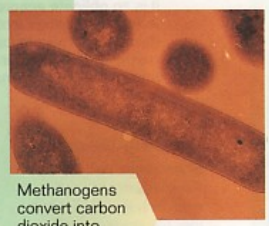
- Unicellular prokaryotes
- Cell walls lack peptidoglycan
- Genes have introns
- Unique lipids in plasma membranes
- Either heterotrophic or autotrophic
- May be ancestors of eukaryotic cells
- Three groups that live in extreme environments—methanogens, extreme halophiles, and thermoacidophiles

Morning glory pool

Methanogens

Methanogens make up the largest group of archaebacteria identified so far. They are among the most strictly **anaerobic** of all organisms, poisoned by even traces of oxygen. Methanogens convert carbon dioxide into methane. Their metabolism is ideally suited to the kind of atmosphere thought to have existed on the primitive Earth. This methanogen, *Methanobacterium formicum*, has a cell wall made mostly of protein.

In ancient times methanogens could have lived anywhere, but today they live only where oxygen has been excluded and hydrogen and carbon dioxide are available. Methanogens are found in stagnant water, in sewage treatment plants, and in the intestinal tracts of animals. They can be found living on the ocean bottom and in hot springs. In spite of their intolerance to oxygen, they are obviously distributed throughout the world.

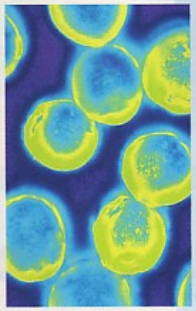


Methanogens convert carbon dioxide into methane

Sewage treatment plant

Thermoacidophiles

As their name implies, thermoacidophiles are archaebacteria that thrive in environments that are both **acidic** and **hot.** These bacteria flourish in temperatures between 60°C and 80°C (140°F and 176°F) and in pH between 2 and 4. The hot sulfur springs in Yellowstone National Park are inhabited by the thermoacidophile *Sulfolobus*, which obtains its energy by oxidizing sulfur.



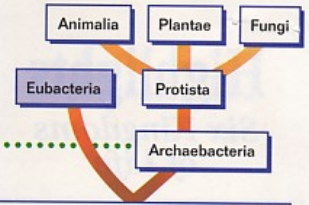
Halobacterium

Extreme Halophiles

The extreme halophiles are archaebacteria that require high concentrations of salt in order to survive. They grow in salty habitats along shorelines and in inland waters such as the Great Salt Lake and the Dead Sea. Some species require an environment 10 times saltier than sea water to grow. Colonies of halophiles often form in seawater evaporating ponds used in commercial salt production; the halophilic bacteria are harmless.

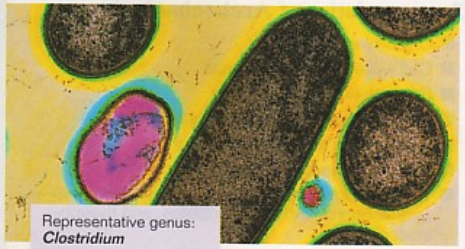
Highlights
Six Kingdoms of Life

Kingdom Eubacteria



Characteristics of Eubacteria

- Unicellular prokaryotes
- Cell walls contain peptidoglycan
- Genes lack introns
- Reproduce asexually by binary fission
- Either autotrophic or heterotrophic
- Extremely diversified groups
- Certain types may be ancestors of mitochondria



Representative genus: ***Clostridium***

Clostridium is a typical eubacterium that thrives in the soil. It is an **obligate anaerobe** (poisoned by oxygen) because it lacks the enzymes that break down the toxic peroxides produced by aerobic metabolism. *Clostridium* lives in tiny oxygen-free pockets in the soil, where it acts to decompose cellulose plant matter.

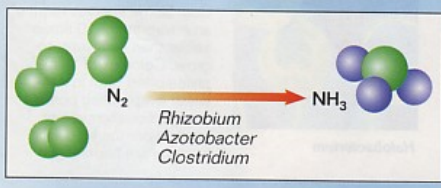
Forming Endospores

Clostridium is one of the few eubacteria able to form **endospores,** heat-resistant packages containing a copy of the DNA. The endospores can persist in the environment for as long as 50 years and then reinitiate growth.

Causing Diseases

Several species of *Clostridium* can cause disease in humans. For example, *Clostridium botulinum* causes a form of food poisoning called **botulism.** *C. botulinum* produces an extremely potent toxin that affects nerve activity. Additional diseases caused by other species of *Clostridium* include tetanus and gas gangrene.

Botulism-tainted peppers

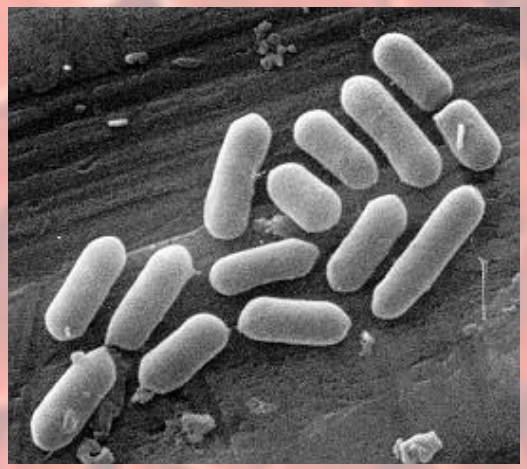


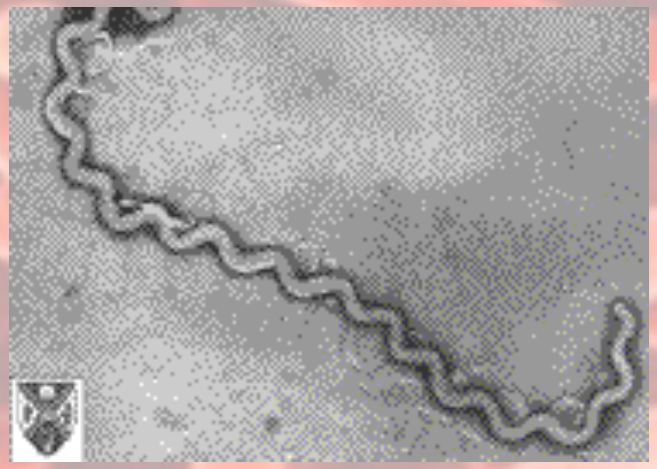
Fixing Nitrogen

A large portion of the Earth's **nitrogen fixation** is carried out by *Clostridium pasteurianum*, along with other eubacteria such as *Azotobacter* and *Rhizobium*. These eubacteria are able to convert nitrogen gas (N_2) into ammonia (NH_3).

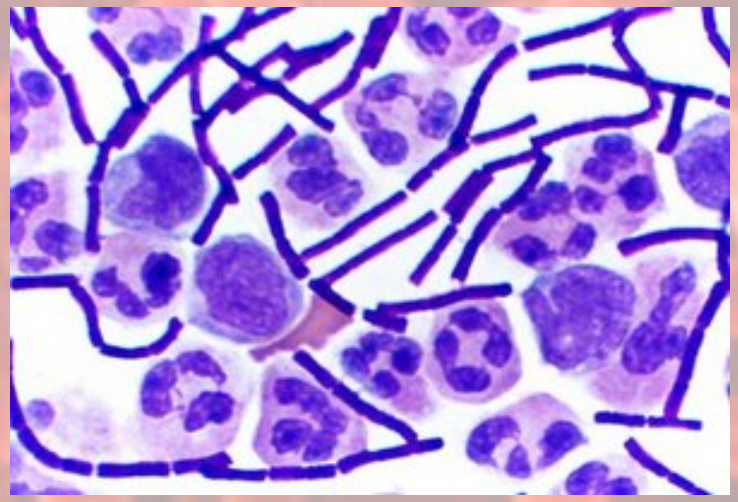
Identifying Prokaryotes

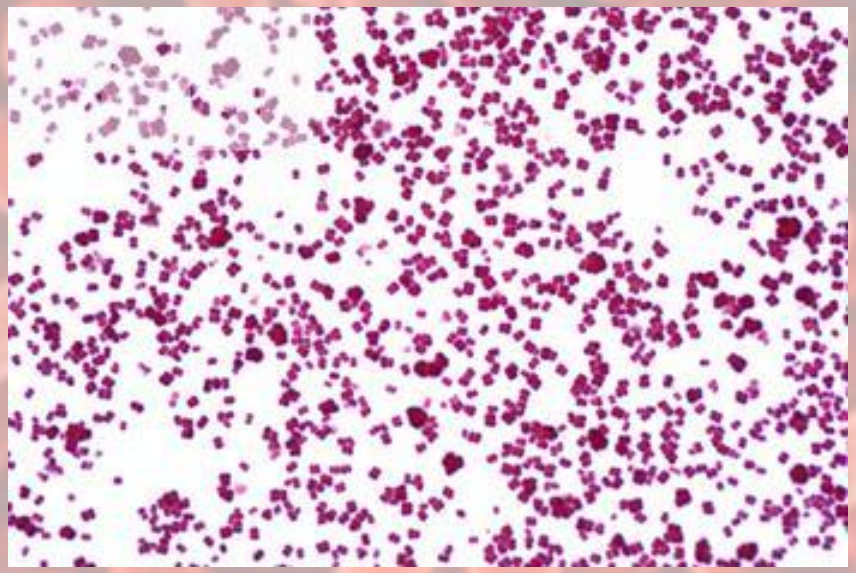
- What characteristics do we use to identify prokaryotes?
- Prokaryotes are identified by their shapes, the chemical natures of their cell walls, the ways they move, and the ways they obtain energy.
- What are the three shapes of prokaryotes?
- Rod shaped called bacilli, spherical shaped called cocci, or spiral called spirilla.
- Some form clumps or long chains.*



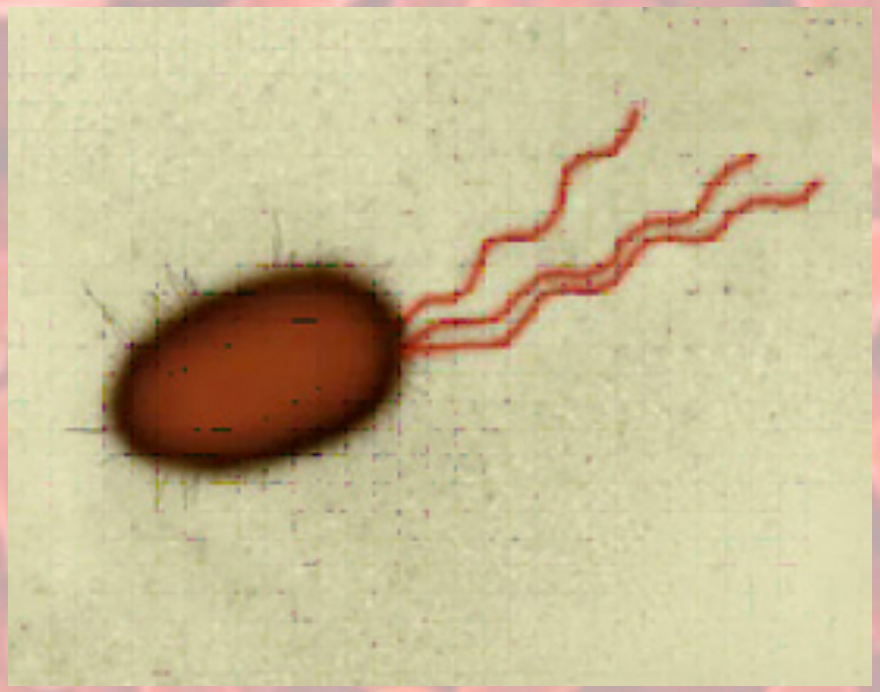


- How can we determine which of the two cell walls an unknown bacteria has?
- Gram staining.
- Gram-positive cells have cell walls containing mainly peptidoglycan and will stain purple.
- Gram-negative cells have an extra wall layer of lipid and carbohydrates which pickup a red stain.*





- What different ways do bacterial move?
- By flagella, a whip-like tail, some spiral around, and others move on slime they secrete. Other don't move at all.



Obtaining Energy

- What are the two types of autotrophic bacteria?
- Photoautotrophs and chemoautotrophs.
- Photo “light” and chemo “chemical” sources of energy.
- Some prokaryotes are also heterotrophic.
- What do we call the small unique group who both eat and capture sunlight?
- Photoheterotrophs.
- Auto = “self”, hetero “other” or “different”, troph = “nourishment”.*

Prokaryotes and Oxygen

- What are bacteria which require oxygen called?
- Obligate aerobes.
- What are bacteria called which can't tolerate oxygen?
- Obligate anaerobes. (*Clostridium botulinum*)
- What are bacteria called which can survive with or without oxygen?
- Facultative anaerobes. (able to live almost anywhere).*

Growth and Reproduction

- How do prokaryotes reproduce?
- By binary fission.
- Is genetic information exchanged in binary fission?
- No.
- What is conjugation?
- Exchange of genetic information before binary fission in some prokaryotes.
- What benefit would this have?
- It increases the genetic diversity of the population.
- When growth conditions become unfavorable what can some bacteria form?
- Endospores to allow bacteria to remain dormant for as long as many centuries.*

Section 19-1 Review

- Compare and contrast the two kingdoms of prokaryotes.
- What three factors can be used to identify prokaryotes?
- What are some of the different ways that prokaryotes obtain energy?
- Describe how prokaryotes reproduce and exchange genetic information.
- Why might an infection by Gram-negative bacteria be more difficult to treat that a Gram-positive bacterial infection?

Chapter 19

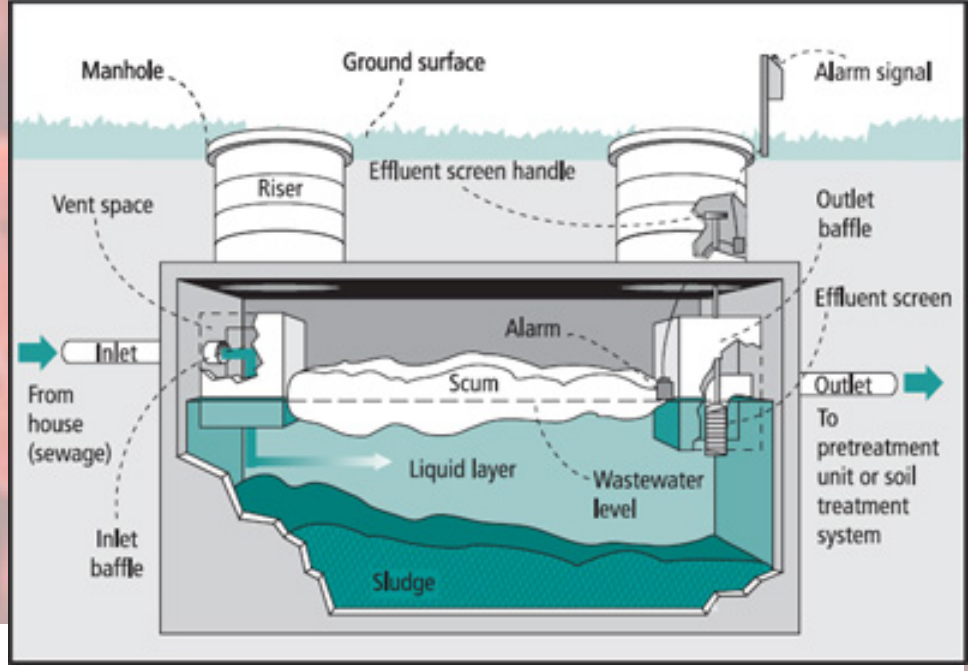
Section 2: Bacteria in Nature

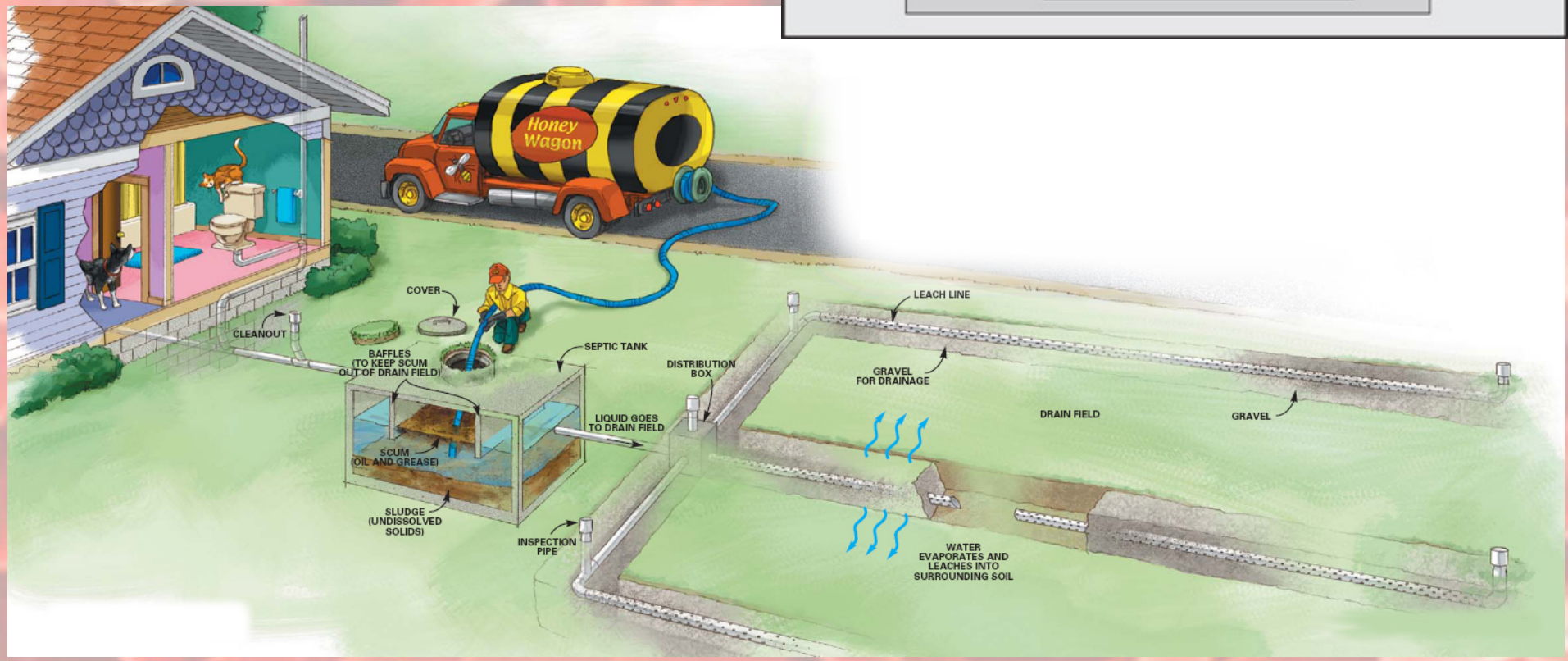
Decomposers

- Bacteria are vital to maintaining the living world. Some are producers that capture energy by photosynthesis. Others help to break down the nutrients in dead matter and the atmosphere, allowing other organisms to use the nutrients.
- How do bacteria help ecosystem?
- They recycle nutrients, break down complex nutrients into simpler ones, they are the primary worker in sewage treatment, cleaning water, and fixing nitrogen to name but a few.*


© WildNatureImages.com

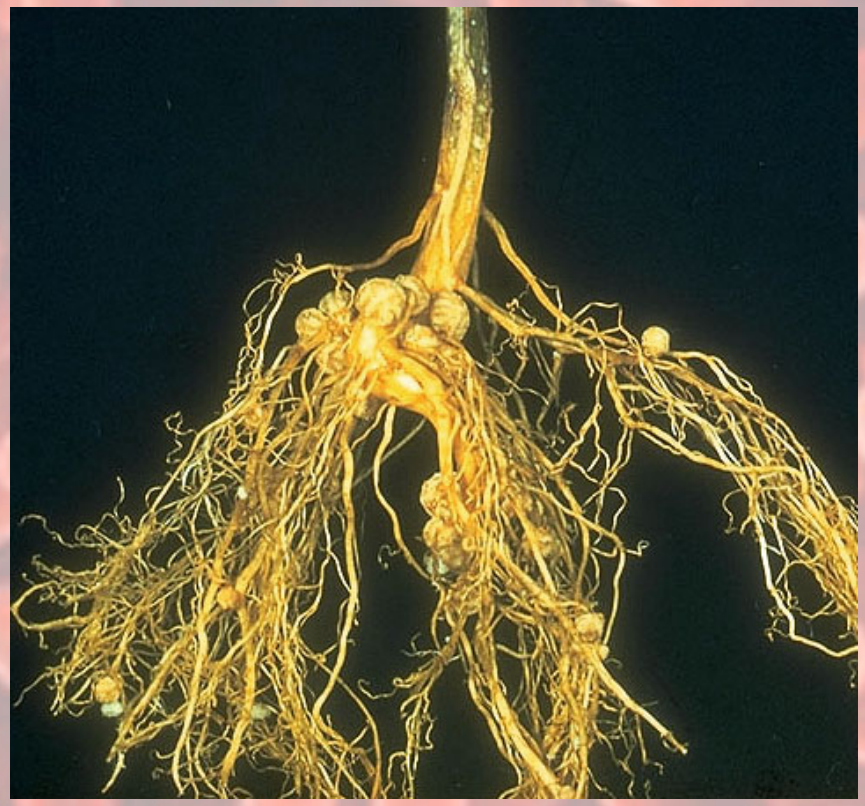

ainMaster
RATED DRAIN CLEANER
DrainMa
ccls
SEPTIC TANK AND CESSPOOL
SAFE FOR THE ENVIRONMENT


Manhole
Ground surface
Alarm signal
Riser
Effluent screen handle
Vent space
Outlet baffle
Effluent screen
Alarm
Inlet
Scum
From house (sewage)
Outlet
To pretreatment unit or soil treatment system
Liquid layer
Wastewater level
Inlet baffle
Sludge


Honey Wagon
COVER
CLEANOUT
BAFFLES (TO KEEP SCUM OUT OF DRAIN FIELD)
SEPTIC TANK
DISTRIBUTION BOX
LEACH LINE
GRAVEL FOR DRAINAGE
DRAIN FIELD
GRAVEL
LIQUID GOES TO DRAIN FIELD
SCUM (OIL AND GREASE)
SLUDGE (UNDISSOLVED SOLIDS)
INSPECTION PIPE
WATER EVAPORATES AND LEACHES INTO SURROUNDING SOIL

Nitrogen Fixers

- What is nitrogen fixation?
- The process of converting atmospheric nitrogen into a form plants can use.
- What bacteria, common in soybeans and other legumes, is present in their nodules and works to fix nitrogen?
- *Rhizobium* (the genus).
- Rhizobium acts like a fertilizer factory within the plant.*



Bacteria and Disease

- Bacteria cause disease in one of two general ways. Some damage the tissues of the infected organism directly by breaking them down for food. Other bacteria release toxins that harm the body.
- Do most bacteria cause disease?
- No. Bacteria are everywhere but help more than hurt.
- What is a pathogen?
- A disease causing agent.
- What are some diseases caused by bacteria?
- Tuberculosis, food poisoning, strep throat, scarlet fever.
- What is an antibiotic?
- Compounds that block the growth and reproduction of bacteria.*

- Overuse of antibiotics can lead to antibiotic-resistant bacteria, which in turn could lead to a bacterial epidemic.
- Advantages of restricted use of antibiotics will lower the risk of resistant strains of bacteria forming.
- Disadvantages include the likelihood of more deaths and suffering and a reduction in the food supply.*

Table 3
Examples of Drug-Resistant Infectious Agents and Percentage of Infections That Are Drug Resistant, by Country or Region

Pathogen	Drug	Country/Region	Percentage of Drug-Resistant Infections
Streptococcus pneumoniae	Penicillin	United States Asia, Chile, Spain, Hungary	10 to 35 20 58
Staphylococcus aureus	Methicillin Multidrug	United States Japan	32 60
Mycobacterium tuberculosis	Any drug Any drug Multidrug	United States New York City Eastern Europe	13 16 20
Plasmodium falciparum malaria	Chloroquine Mephloquine	Kenya Ghana Zimbabwe Burkina Faso Thailand	65 45 59 17 45
Shigella dysenteride	Multidrug	Burundi, Rwanda	100

Human Uses of Bacteria

Controlling Bacteria

- What is bacterial sterilization?
- Destroying bacteria by subjecting them to either great heat or chemical action.
- What is a disinfectant?
- A chemical solution that kills bacteria.
- How does refrigeration control bacteria?
- Slowing it's growth.
- Canning and cooking food also inhibits growth.
- Also treating food with vinegar, salt, sugar will preserve it.*

Section 19-2 Review

- What is the importance of bacteria in the environment?
- How do bacteria cause disease?
- How are bacterial infections often treated?
- Describe three methods of preventing bacterial growth in food.
- Should uses of antibiotics be restricted to serious health issues of humans only?*

Chapter 19

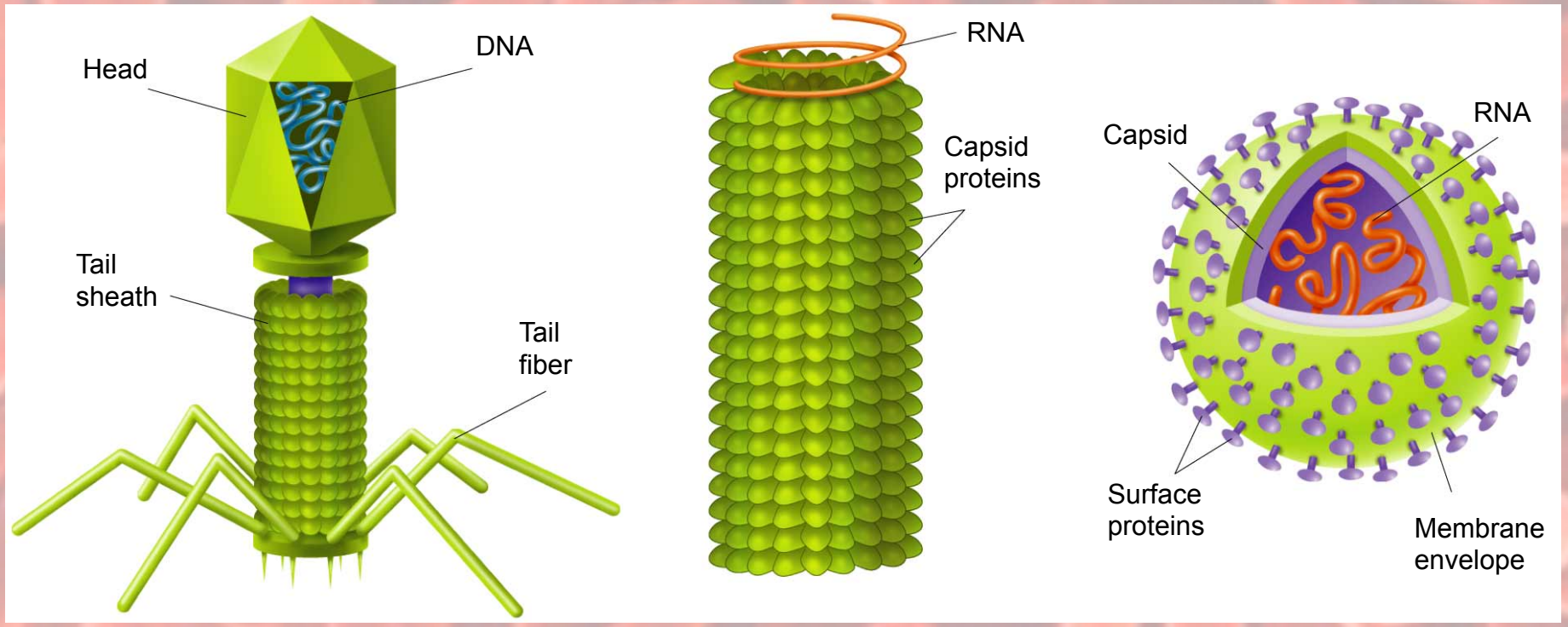
Section 3: Viruses

What is a Virus?

- Russian biologist Dmitir Ivanovski first coined the name “virus”, Latin for poison, while studying a tobacco disease transferred by juice from the tobacco leaf.
- Dutch scientist Martinus Beijerinck found the tiny particles in the juice and coined them “viruses”.
- In 1935 chemist Wendell Stanley purified and crystalized the tobacco virus.*

- What is a virus?
- Particles of nucleic acid, protein, and some cases lipids that can reproduce only by infecting living cells.
- Generally speaking, how do all viruses reproduce?
- They enter living cells and, once inside, use the machinery of the infected cell to produce more copies of itself.
- A typical virus is composed of a core of either DNA or RNA surrounded by a protein coat.
- What is capsid?
- A viruses protein coat that once bound to the surface of a cell tricks the cell into allowing the virus inside.*

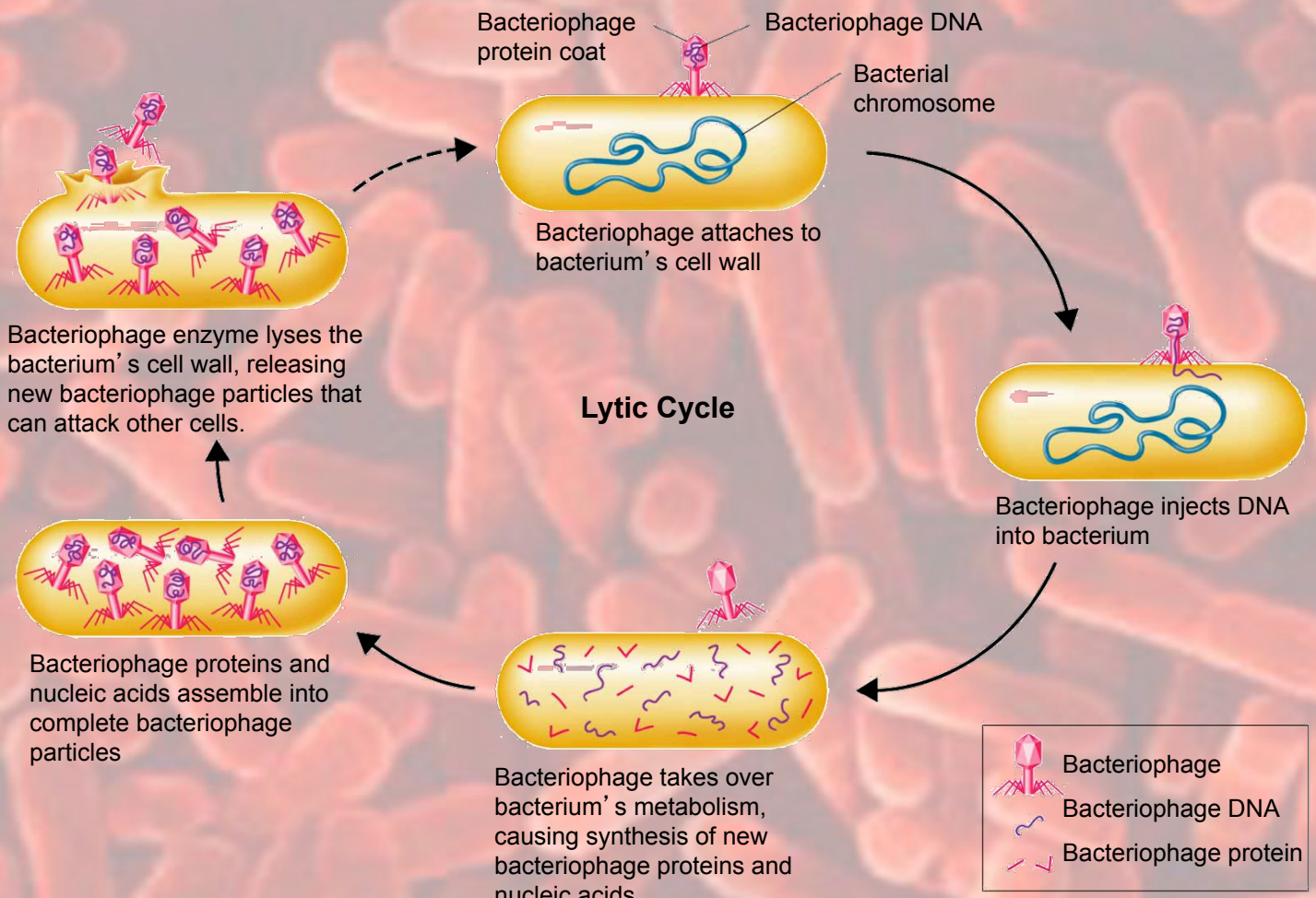
Figure 19-13 Virus Structures



Viral Infection

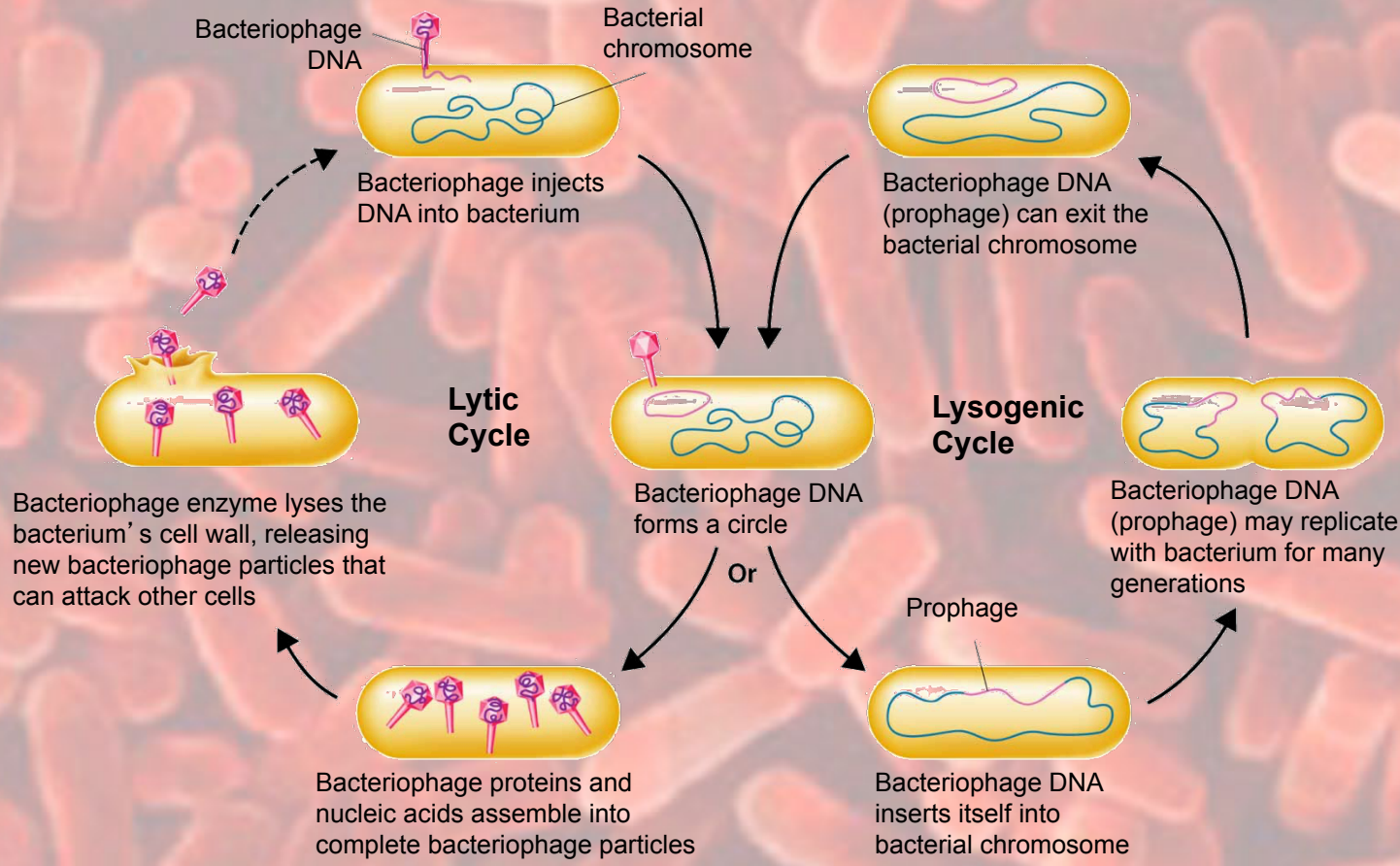
- Viruses are often specific to a host.
- What are bacteriophages?
- Viruses which attack only bacteria.
- What is a lytic infection?
- A virus, such as the T4 bacteriophage, enters a cell, makes copies of itself, and then lyses the cell or causes the cell to burst.
- What is this process called?
- A lytic infection.
- Remember the desperado analogy…..

Figure 19-14 The Lytic Cycle



- What is a lysogenic infection?
- A virus embeds it's DNA into the DNA of the host cell and is replicated along with the host cells DNA.
- How is lysogenic different from lysic?
- In lysogenic infections the cell isn't lysed right away.
- What do you call the viral DNA inserted into the host DNA?
- Prophage.
- Processes of infection for viruses in eukaryotic cells are similar to that of bacteriophages and are used as a model for eukaryotic infections.*

Figure 19-15 A Lysogenic Infection



Viruses and Disease

- What are some diseases caused by viruses?
- Polio, measles, AIDS, mumps, influenza, yellow fever, rabies, and colds.
- What are oncogenic viruses?
- Viruses which cause cancers.
- What is a retrovirus?
- Viruses that have their RNA produce DNA instead of the normal DNA to RNA.
- The AIDS virus is a retrovirus.
- What are prions?
- Disease causing agents made only of small bits of protein. Prions may cause "Mad Cow" disease.
- Are viruses alive?*

Section 19-3 Review

- What are the parts of a virus?
- Compare and contrast two ways that viruses cause infection.
- What is the difference between a bacteriophage and a prophage?
- What is a retrovirus?*