KEY CONCEPT

Infections can be caused in several ways.
Viruses, bacteria, viroids, and prions can all cause infection.

- Any disease-causing agent is called a pathogen.
• A virus is made of DNA or RNA and a protein coat.
  – non-living pathogen
  – can infect many organisms
• A viroid is made only of single-stranded RNA.
  – causes disease in plants
  – passed through seeds or pollen
• A prion is made only of proteins.
  – causes misfolding of other proteins
  – results in diseases of the brain
KEY CONCEPT
Viruses exist in a variety of shapes and sizes.
Viruses differ in shape and in ways of entering host cells.

- Viruses have a simple structure.
  - genetic material
  - capsid, a protein shell
  - maybe a lipid envelope, a protective outer coat

![Diagram of virus structures: enveloped (influenza), helical (rabies), polyhedral (foot-and-mouth disease).]
• Bacteriophages infect bacteria.
Viruses enter cells in various ways.
- bacteriophages pierce host cells
• Viruses enter cells in various ways.
  – viruses of eukaryotes enter by endocytosis
• Viruses enter cells in various ways.
  – viruses of eukaryotes also fuse with membrane
Viruses cause two types of infections.

- A lytic infection causes the host cell to burst.

The host bacterium breaks apart, or lyses. Bacteriophages are able to infect new host cells.

The bacteriophage attaches and injects its DNA into a host bacterium.

The viral DNA forms a circle.

The viral DNA directs the host cell to produce new viral parts. The parts assemble into new bacteriophages.

The virus may enter the lysogenic cycle, in which the host cell is not destroyed.
• A lysogenic infection does no immediate harm.

The prophage may leave the host’s DNA and enter the lytic cycle.

The viral DNA is called a prophage when it combines with the host cell’s DNA.

Many cell divisions produce a colony of bacteria infected with prophage.

Although the prophage is not active, it replicates along with the host cell’s DNA.
KEY CONCEPT
Some viral diseases can be prevented with vaccines.
Viruses cause many infectious diseases

- There are many examples of viral infections.
  - common cold
Viruses cause many infectious diseases

- There are many examples of viral infections.
  - common cold
  - influenza
Viruses cause many infectious diseases

- There are many examples of viral infections.
  - common cold
  - influenza
  - SARS
Viruses cause many infectious diseases

- There are many examples of viral infections.
  - HIV
- The body has natural defenses against viruses.
Vaccines are made from weakened pathogens.

- A vaccine stimulates the body’s own immune response.
- Vaccines prepare the immune system for a future attack.

### Table: Common Viral Infections

<table>
<thead>
<tr>
<th>VIRAL INFECTION</th>
<th>SYMPTOMS OF DISEASE</th>
<th>TRANSMISSION OF DISEASE</th>
<th>U.S. VACCINE RECOMMENDATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chickenpox</td>
<td>rash, itchy skin, fever, fatigue</td>
<td>contact with rash, droplet inhalation</td>
<td>for children between 12 and 18 months</td>
</tr>
<tr>
<td>Hepatitis A</td>
<td>yellow skin, fatigue, abdominal pain</td>
<td>contact with contaminated feces</td>
<td>for people traveling to infected locations and protection during outbreaks</td>
</tr>
<tr>
<td>Mumps</td>
<td>painful swelling in salivary glands, fever</td>
<td>droplet inhalation</td>
<td>for children between 12 and 15 months and again at 4 to 6 years</td>
</tr>
<tr>
<td>Rabies</td>
<td>anxiety, paralysis, fear of water</td>
<td>bite from infected animal</td>
<td>for veterinarians and biologists in contact with wildlife</td>
</tr>
<tr>
<td>West Nile</td>
<td>fever, headache, body ache</td>
<td>bite from infected mosquito</td>
<td>no available vaccine</td>
</tr>
</tbody>
</table>

- Vaccines are the only way to control the spread of viral disease.
KEY CONCEPT

Bacteria and archaea are both single-celled prokaryotes.
Prokaryotes are widespread on Earth.

- Prokaryotes can be grouped by their need for oxygen.
  - obligate anaerobes are poisoned by oxygen
  - obligate aerobes need oxygen
  - facultative aerobes can live with or without oxygen
Bacteria and archaea are structurally similar but have different molecular characteristics.

- Bacteria commonly come in three forms.
  - rod-shaped, called bacilli
  - spiral, called spirilla or spirochetes
  - spherical, called cocci

- Archaea have many shapes.
Bacteria and archaea have similar structures.
- plasmid
- flagellum
- pili

This diagram shows the typical structure of a prokaryote. Archaea and bacteria look very similar, although they have important molecular differences.
• Bacteria and archaea have molecular differences.
  – The amount of peptidoglycan within the cell wall can differ between bacteria
  – Archaea have different lipids entirely
• Gram staining identifies bacteria.
  – stains polymer peptidoglycan
  – gram-positive stains purple, more peptidoglycan
  – gram-negative stains pink, less peptidoglycan
Bacteria have various strategies for survival.

- Prokaryotes exchange genes during conjugation.
- Bacteria may survive by forming endospores.
KEY CONCEPT
Prokaryotes perform important functions for organisms and ecosystems.
Prokaryotes provide nutrients to humans and other animals.

- Prokaryotes live in digestive systems of animals.
  - make vitamins
  - break down food
  - fill niches
• Bacteria help ferment many foods.
  – yogurt, cheese
  – pickles, sauerkraut
  – soy sauce, vinegar
Prokaryotes play important roles in ecosystems.

- Prokaryotes have many functions in ecosystems.
  - photosynthesize
  - recycle carbon, nitrogen, hydrogen, sulfur
  - fix nitrogen
• Bioremediation uses prokaryotes to break down pollutants.
  – oil spills
  – biodegradable materials
KEY CONCEPT

Understanding bacteria is necessary to prevent and treat disease.
Some bacteria cause disease.

- Bacteria cause disease by invading tissues or making toxins.
- A toxin is a poison released by an organism.
• Normally harmless bacteria can become destructive.
  – may colonize new tissues
• Normally harmless bacteria can become destructive. 
  – immune system may be lowered

<table>
<thead>
<tr>
<th>INFECTION</th>
<th>BACTERIUM</th>
<th>SYMPTOMS</th>
<th>CAUSES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acne</td>
<td>Propionibacterium</td>
<td>chronic cysts, blackheads</td>
<td>increased oil production in skin</td>
</tr>
<tr>
<td>Anthrax</td>
<td>Bacillus anthracis</td>
<td>fever, trouble breathing</td>
<td>inhaling endospores</td>
</tr>
<tr>
<td>Lyme disease</td>
<td>Borrelia burgdorferi</td>
<td>rash, aching, fever, swelling of joints</td>
<td>bite from infected tick</td>
</tr>
<tr>
<td>Tetanus</td>
<td>Clostridium tetani</td>
<td>severe muscle spasms, fever, lockjaw</td>
<td>wound contaminated with soil</td>
</tr>
<tr>
<td>Tooth decay</td>
<td>Streptococcus mutans</td>
<td>tooth cavities</td>
<td>large populations of bacteria in mouth</td>
</tr>
</tbody>
</table>
Antibiotics are used to fight bacterial disease.

- Antibiotics may stop bacterial cell wall formation.
- Antibiotics do not work on viruses.
- Prevention is best method to fight bacterial disease.
Bacteria can evolve resistance to antibiotics.

- Bacteria are gaining resistance to antibiotics.
  - overuse
  - underuse
  - misuse
- Antibiotics must be used properly.

A bacterium carries genes for antibiotic resistance on a plasmid.

A copy of the plasmid is transferred through conjugation.

Resistance is quickly spread through many bacteria.