13a

Infectious Disease
Infectious Disease

OUTLINE:

- Pathogens
- Spread of a Disease
- Infectious Diseases as a Continued Threat
Pathogens

- Disease-causing organisms
- Include bacteria, viruses, protozoans, fungi, parasitic worms, and prions

Virulence

- The relative ability of a pathogen to cause disease
- Determined by
  - Ease with which pathogen enters the body
  - Degree and type of damage to cells
Bacteria

- Prokaryotes: lack a nucleus and other membrane-bound organelles
  - Cell wall of peptidoglycan
- Three shapes
  - Sphere (coccus)
  - Rod (bacillus)
  - Spiral (spirilla)
Bacteria

- Reproduction
  - Very rapid, asexually, by binary fission

- Offensive mechanisms
  - Enzymes: cause direct tissue damage
  - Toxins: affect particular tissues (example: \(C. \text{botulinum}\) toxin affects nervous tissue)
Figure 13a.1 *Three basic shapes of bacteria.*

(a) Spherical bacteria are called cocci.

(b) Rod-shaped bacteria are called bacilli.

(c) Spiral-shaped bacteria are called spirilla.
Beneficial Bacteria

- Food production (yogurt, cheese)
- Environment (decomposers, chemical cycles)
- Genetic engineering
- Normal inhabitants of the body that keep harmful organisms in check
Antibiotics

- Chemicals that inhibit the growth of bacteria
  - Disrupt processes in bacteria but not in human cells
  - Prevent synthesis of cell walls (our cells lack cell walls)
  - Block protein synthesis (our ribosomes are slightly different)
Antibiotics

- Antibiotic resistance
  - When bacteria become resistant, antibiotics are no longer effective
  - Caused largely by overuse and misuse of antibiotics (example: MRSA: methicillin-resistant *Staphylococcus aureus*)
Viruses

- Responsible for many human illnesses
- Not considered living organisms
- Structure
  - Much smaller than bacteria
  - Genetic material (DNA or RNA) surrounded by a protein coat (capsid)
  - Some have an outer envelope studded with glycoproteins
Figure 13a.2 (a) The structure of a typical virus.
Viruses

- Steps in viral replication

1. Attachment—virus attaches to particular receptors on the host cell (responsible for host specificity)
2. Penetration—virus enters host cell and loses capsid
3. Production of viral genetic information (DNA or RNA) and proteins
4. Assembly of new viruses
5. Release of viruses from the host cell
   - Budding
   - Rupture of host cell membrane
Figure 13a.2 (b) Steps in viral replication.

**Step 1: Attachment**
The virus attaches to a specific receptor on the host cell. This is responsible for host specificity.

**Step 2: Penetration**
All or part of the virus enters the host cell. In the case of animal cells, the entire virus enters the cell.

**Step 3: Production of viral genetic information and proteins**
The virus directs structures in the host cell to make parts of new viruses.

**Step 4: Assembly of new viruses**
Newly synthesized viral genetic information and proteins are used to form new viruses.

**Step 5: Release**
New viruses leave the cell. Some viruses leave by a process called budding (or shedding), as shown here.
Viruses

- Release of new viruses from host cell
  - Rapid release can cause cell death
  - Slow release leads to persistent infections
- Some viruses remain dormant in the host cell for long periods and cause latent infections
  - At any time, the virus can begin replicating and cause cell death upon release of new viruses
Some viruses cause cancer

- Insert cancer-causing genes (oncogenes) into host cell chromosomes
- Disrupt functioning of host cell genes that regulate cell division
Viruses

- Viruses are difficult to destroy
  - Hard to kill a virus inside a host cell without killing the host cell itself
  - Antiviral drugs often block a step in viral replication
- Best to prevent viral infections through vaccination
Viruses

Structure and Reproduction of Viruses

Viruses are not considered to be true living organisms because they cannot replicate themselves without the aid of a host cell. Hosts for viral infections include many organisms other than human, such as bacteria and plants. In this tutorial, we will explore the structure of viruses and describe how they are able to replicate using the protein synthesis machinery of their host cell.

Press "PLAY" to begin Animation.
**Table 13a.1 Possible Effects of Animal Virus on Cells**

<table>
<thead>
<tr>
<th>Type of Infection</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lytic infection</td>
<td>Rapid release of new viruses from infected cell causes cell death. Symptoms of the disease depend on which cells are killed.</td>
</tr>
<tr>
<td>Persistent infection</td>
<td>Slow release of new viruses causes cell to remain alive and continue to produce new viruses for a prolonged period of time.</td>
</tr>
<tr>
<td>Latent infection</td>
<td>Delay between infection and symptoms. Virus is present in the cell without harming the cell. Symptoms begin when the virus begins actively replicating, and new viruses exiting the host cell can cause cell death.</td>
</tr>
<tr>
<td>Transformation to cancerous cell</td>
<td>Certain viruses insert their genetic information into host cell chromosomes. Some carry oncogenes (cancer-causing genes) that are active in the host cell. Some disrupt the functioning of the host cell’s genes that regulate cell division, causing the cell to become cancerous.</td>
</tr>
</tbody>
</table>
Protozoans

- Single-celled eukaryotic organisms
- Cause disease by producing toxins and enzymes that prevent normal functioning of host cells
- Responsible for many diseases, including sleeping sickness, amebic dysentery, giardiasis, and malaria
Protozoans

The Life Cycle of *Plasmodium*, the Malaria Parasite

Malaria is a disease caused by the parasitic protozoan *Plasmodium*. In humans, the parasite destroys red blood cells, resulting in severe anemia and sometimes death. This tutorial describes the *Plasmodium* life cycle, which involves three species in a complex interaction that results in malaria in humans.

Press "PLAY" to begin Animation.
Figure 13a.3 Giardia is a protozoan.
Fungi

- Eukaryotic organisms
- Often cause disease by secreting enzymes that digest cells
- Examples of fungal infections include histoplasmosis (lungs) and athlete’s foot and ringworm (skin)
- Most can be cured with antifungal drugs
  - Target fungal cell membranes, which are slightly different from those of human cells
Parasitic Worms

- Multicellular animals whose life cycle involves a close physical relationship with a host
  - Usually cause harm to, not death of, host
  - Examples include flukes, tapeworms, and roundworms
- Cause disease by releasing toxins, feeding on blood, or competing with the host for food
Prions

- Infectious particles of proteins
  - Misfolded versions of a protein normally found on the surface of nerve cells
- Prompt host protein to change its shape to the abnormal form
- Cause transmissible spongiform encephalopathies (TSEs), which result in brain degeneration and death
- Animal TSEs: mad cow disease, scrapie (sheep), chronic wasting disease (deer and elk)
- Human TSE: Creutzfeldt-Jakob disease (CJD)
Prions

- Humans can become infected with prions
- Eating contaminated material
- Tissue transplant
- Contaminated surgical instruments
Prions
Spread of a Disease

- Disease is transmitted through
  - Direct contact
    - Example: STDs
  - Indirect contact, including inhalation
    - Example: many respiratory infections
  - Contaminated food or water
    - Examples: hepatitis A, Legionnaires’ disease
  - Animal vectors
Spread of a Disease

Play abcNEWS | The Bird Flu Indonesian Outbreak
Figure 13a.4 *Pathogens can be spread through the air when an infected person sneezes or coughs.*
Spread of a Disease

- Focus on animal vectors
  - Lyme disease
    - Deer ticks are the vectors
    - Caused by a bacterium
    - Pain, swelling, and arthritis may develop
      - Cardiovascular and nervous system problems may follow the arthritis
Spread of a Disease

- Focus on animal vectors (cont’d)
  - West Nile virus
    - Mosquitoes are the vectors
    - Can cause meningitis and encephalitis
    - Can infect vertebrates, including humans, horses, birds, and occasionally dogs and cats
Figure 13a.5 The deer tick can transmit Lyme disease.
Figure 13a.6 The mosquito can transmit West Nile virus.
Infectious Diseases as a Continued Threat

- **Epidemic**
  - Large-scale outbreak of an infectious disease
  - Examples include bubonic plague and smallpox

- **Emerging disease**
  - Condition with clinically distinct symptoms whose incidence has increased over the last two decades
  - Examples include HIV, SARS, H1N1 influenza

- **Reemerging disease**
  - A disease that has reappeared after a decline in incidence
  - Example: tuberculosis

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Infectious Diseases as a Continued Threat

- Three factors play important roles in the emergence or reemergence of diseases
  1. Development of new or drug-resistant organisms
  2. Environmental change that affects the distribution of organisms
  3. Population growth
    - Allows diseases to spread more quickly
    - Air travel allows diseases to spread over great distances
Infectious Diseases as a Continued Threat

- Factors that determine where new infectious diseases are likely to emerge
  - Rate of human population growth
  - Density of the human population
  - Number of species of wild mammals

- Epidemiology
  - The study of the patterns of disease occurrence, distribution, and control
  - Epidemiologists try to determine why a disease is triggered at a particular time and place
Infectious Diseases as a Continued Threat

- Four patterns of disease
  1. Sporadic diseases
     - Occur occasionally at unpredictable intervals
     - Affect a few people within a restricted area
  2. Endemic diseases
     - Always present and pose little threat (example: common cold)
Infectious Diseases as a Continued Threat

- Four patterns of disease (cont’d)

  3. Epidemic diseases
    - Occur suddenly and spread rapidly to many people (example: smallpox)

  4. Pandemic
    - Global outbreak of disease (example: HIV/AIDS)
You Should Now Be Able To:

- Understand what are pathogens and describe
  - Bacteria and bacteria resistance
  - Viruses
  - Protozoans
  - Fungi
  - Parasitic worms
  - Prions
- Understand the mechanisms involved in the spread of a disease
- Understand why infectious diseases are a continued threat and know the basics of epidemiology