

Lecture 7: Viruses and Bacteria

Important Concepts

- what are viruses and how are they constructed?
- what makes viruses different and how do they reproduce?
- there is tremendous bacterial and viral diversity
- what is the human microbiome?
- what makes bacteria different from each other and viruses?
- how are bacteria classified?
- what are archaeobacteria and where do they live?

What are viruses and how are they constructed?

- viruses are infection agents that only reproduce inside cells (cannot reproduce by themselves like bacteria)
- viruses infect all organisms and cells (plants, animals, bacteria)
- all viruses have nucleic acid genomes and protein “coats”

Virus Classification

Virus genomes can be:

- **Double stranded DNA:** adenovirus, herpes, smallpox, hepatitis
- **Single stranded DNA:** parvovirus
- **Double stranded RNA:** reovirus, rotavirus
- **Single stranded RNA:** norwalk, influenza, ebola, HIV
- once inside a host cell, DNA is transcribed by host machinery and RNA is translated by host ribosomes
- sometimes viral RNA is copied into DNA and integrated into host chromosomes (eg. HIV)

Viral Infection: How does a virus get into a cell?

- viruses have surface protein spikes ‘*protein epitopes*’ that can bind to cell receptors in host cell membrane
- every virus is unique and only binds certain receptors on specific cell types (eg lung, liver, brain)
- viruses enter a cell using a lock/key entry

Bacteria and Archaeobacteria

- no nucleus and some can photosynthesize
- archae live in extreme environments (eg. high salt, high temp)
- majority of bacteria are not harmful to humans
- bacterial population linked to human disease and immune system

Microbiome: bacterial community that shares our body space (10x more bacteria in/on you than cells in body)

Bacterial Structure and Function

Circular (Cocci): Streptococcus, staphylococcus

Rods (bacillus): E.coli

Spiral (spirochetes): vibrio cholerae, borrelia burgdorferi

Bacterial Cell Wall Structure

1884, Hans Gram developed stain to classify bacteria based on cell wall differences

- gram **positive** cells: stain **BLUE**. Thick cell wall made of peptidoglycan (protein/sugar material)
- gram **negative** cells: stain **PINK**. Thin cell wall and two cell membranes (inner and outer)

Gram Stain Procedure

1. treat cells with dye crystal violet (blue)
2. treat cells with iodine
3. treat with ethanol
4. treat cells with dye Safranin (pink)

Bacteria and Antibiotics

Why and how do antibiotics only kill bacteria?

1. target cell wall structure (peptidoglycan)
 - penicillins break up peptidoglycan (gram positive)
2. target translation machinery (ribosomes)
 - tetracycline stops bacterial protein synthesis
3. target DNA replication (DNA gyrase)
 - ciprofloxacin stops bacterial DNA replication

Antibiotic resistance: prolonged use of antibiotics can make bacteria resistant

Summary

Archaeobacteria:

- different cell structures that allow for survival in harsh environments
- archae membranes have different types of fatty acids
- archae are not pathogenic to humans

Extremophiles:

- **Hyperthermophiles:** Grow above 60°C, up to 100°C
- **Psychrophiles:** Grow less than 16°C
- **Halophiles:** Grow in very high salt concentrations
- **Acidophiles:** Grow in very low pH (acid)