Lecture 6. Antimicrobial agents

Learning objectives

Upon completion of this lecture, student should be able to:

1. Define antibiotics and chemotherapeutic agent.
2. Define and differentiate between bactericidal and bacteriostatic agents.
3. List the mechanisms of action of antimicrobial drugs.

Introduction

Antibiotics: are **chemically** synthesized or **natural** substances produced by the natural metabolic processes of some microorganisms, which can **inhibit** or **destroy** other microorganisms.

Chemotherapeutic drug (**agent**)**:** any chemical used in **treatment**, **relief**, or **prophylaxis** of disease.

Depending on the type of organisms targeted, antibiotics can be described as; **antibacterial**, **antifungal**, **antiparasitic**, or **antiviral** agents.

Bacteriostatic agents: antimicrobial agents that **inhibit** bacterial growth, but generally **do not kill** the organism.

- These agents effectively **reduce the growth rate** of an organism therefore, providing an **adequate protection** in individuals whose immune system is capable of removing the agent of infection.

Bactericidal agents: antimicrobial agents that usually **kill** target organisms.

- These agents are more effective against organisms that are **more difficult** to control **in combination with the host's immune system**.

M.Sc. Mariem N. Mohammed Ali

Bactericidal drugs are very much useful in:

a. life- threatening situations

b. endocarditis

c. patients with low polymorphonuclear count (below 500/ L)

d. conditions in which bacteriostatic drugs do not cause a cure

Antimicrobial drugs

Antimicrobial drugs vary in their spectrum of activities. They may be:

1. **Broad-spectrum antibiotics**

- Active against a wider range of different microbes.
- For example, tetracyclines are active against a variety of Gram-positive and Gram-negative bacteria, *rickettsiae*, *mycoplasmas*, and even protozoa.

2. **Narrow-spectrum antibiotics**

- Effective against one or very few microbes.
- For example, vancomycin is active against certain Gram-positive bacteria (such as *staphylococci* and *enterococci*) or griseofulvin, which is used only against fungal skin infections.

Basic steps in antimicrobial activity

1. **First**, the agent must be in an **active form**
    - This is ensured through the **pharmacodynamic design of the drug**, which takes into account the route by which the patient receives the agent (e.g., orally, intramuscularly, intravenously).
2. **Second**, the antibiotic agent must be able to achieve **sufficient levels or concentrations** at the site of infection so that it has a chance to **exert an antibacterial effect**.
    - The ability to achieve adequate levels depends on the **pharmacokinetic properties** of the agent, such as **rate of absorption**, **distribution**, **metabolism**, and **excretion of the agent's metabolites**.
3. The remaining steps in antimicrobial action relate to **direct interactions between the antibacterial agent and the bacterial cell.**

Mechanisms of action of antimicrobial drugs

Antibiotics act against bacteria by the following mechanisms:

1. **Inhibition of cell wall synthesis**
    - The lack of peptidoglycan in human cells, has made the cell wall the focus of attention for the development of bactericidal agents that are relatively nontoxic for humans.
    - β-lactam antibiotics (penicillins, cephalosporins) and vancomycin are the antibiotics that act against bacteria by interfering with their cell wall synthesis.

2. **Inhibition of protein synthesis**

- Bacteria have 30S and 50S ribosomal units, whereas mammalian cells have 80S ribosomes.
- Aminoglycosides and tetracyclines act at the level of 30S ribosomal subunits, whereas erythromycins, chloramphenicol, and clindamycins act at the level of 50S ribosomal subunits.

3. **Inhibition of nucleic acid synthesis**

- Sulfonamides, trimethoprim, quinolones, and rifampin are examples of drugs that act by inhibition of nucleic acid synthesis.

4. **Alteration of cell membrane function**

- If the functional integrity of the cytoplasmic membrane is disrupted, macromolecules and ions escape from the cell, leading to cell damage or death.
- The cytoplasmic membrane of bacteria has a structure different from that of animal cells and therefore, can be disrupted by certain agents (Polymyxin B).