B.Sc. (Microbiology) IV sem

Pharmaceutical Microbiology

Unit – 2

Mechanism and Action of Antibiotics

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Classification of Antibiotics

Based on mechanism of action

- **Bactericidal:** Kills bacteria (e.g., Penicillins, Aminoglycosides).
  Bacteriostatic: Inhibits bacterial growth (e.g., Tetracyclines, Macrolides).
- **Based on Spectrum of Activity:**
- **Broad-spectrum:** Effective against multiple bacterial types (e.g., Fluoroquinolones).
- **Narrow-spectrum:** Targets specific bacteria (e.g., Vancomycin)

Based on Chemical Action

- **β-lactams:** Penicillins, Cephalosporins. **Aminoglycosides:** Streptomycin, Gentamicin.
- **Tetracyclines:** Doxycycline, Minocycline.
- **Macrolides:** Erythromycin, Azithromycin.

Introduction

- **Definition:** Antibiotics are chemical substances that inhibit or kill bacteria, preventing infections.
- **Importance:** They revolutionized medicine by treating bacterial infections effectively.
- **Brief History:**

 Discovered by **Alexander Fleming** in 1928 (*Penicillin*).

 Development of various antibiotic classes over the decades.

 Role in reducing mortality from bacterial diseases.

Mechanism of Action

Antibiotics work by targeting essential bacterial processes:

1. **Inhibition of Cell Wall Synthesis**
   - Prevents bacteria from forming a strong cell wall, leading to cell lysis.
   - **Examples:** Penicillins, Cephalosporins, Vancomycin.
2. **Disruption of Cell Membrane Function**
   - Alters membrane permeability, causing leakage of cellular contents.
   - **Examples:** Polymyxins, Daptomycin.

Mechanism of Action

3. Inhibition of Protein Synthesis

- Blocks bacterial ribosomes, preventing protein formation.
- **Examples:** Tetracyclines, Macrolides, Aminoglycosides.

4. Inhibition of Nucleic Acid Synthesis

- Prevents DNA replication and RNA transcription.
- **Examples:** Fluoroquinolones, Rifamycins.

5. Inhibition of Metabolic Pathways

- Blocks folic acid synthesis, essential for bacterial survival.
- **Examples:** Sulfonamides, Trimethoprim.

Mode of action of antibiotics

Cell wall synthesis inhibitors

β-lactams
Glycopeptides
Fosfomycin
Bacitracin
Alafosfalin

Cell membrane synthesis disruptors

Lipopeptides

Folate synthesis inhibitors

Sulfonamides

DNA gyrase inhibitors

Quinolones
Coumermycin antibiotics

Inhibition of DNA-dependent RNA polymerase

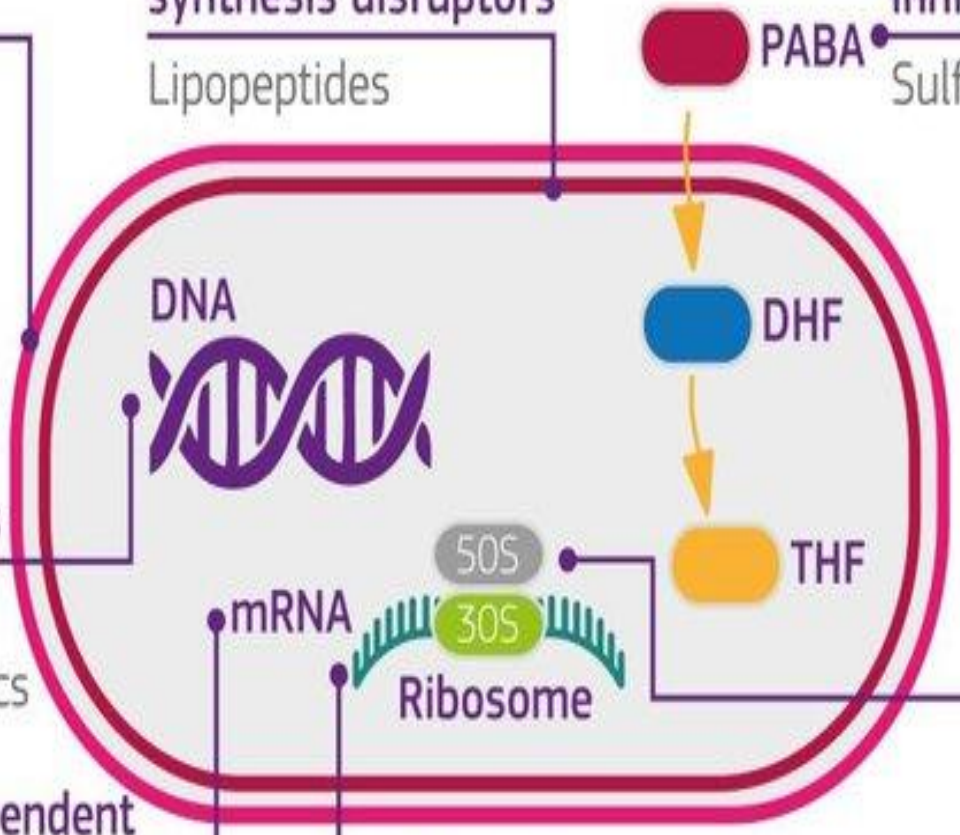
Rifampicin

RNA synthesis inhibitors

Ansamycines

Protein synthesis (30S and 50S inhibitors)

Tetracyclines
Aminoglycosides
Macrolides
Lincosamides
Amphenicols
Pleuromutilins
Oxazolidinones



Bactericidal vs. Bacteriostatic Antibiotics

- **Bactericidal:** Directly kills bacteria by disrupting essential functions.
  - **Examples:** Penicillins, Fluoroquinolones, Aminoglycosides.
- **Bacteriostatic:** Slows bacterial growth, allowing the immune system to eliminate infection.
- **Examples:** Tetracyclines, Macrolides, Sulfonamides.

Antibiotic Resistance

- **Causes: Overuse, misuse, incomplete treatment courses.**
- **Mechanisms:**
  - **Efflux Pumps:** Bacteria expel antibiotics.
  - **Enzyme Degradation:** Bacteria produce enzymes (e.g., β-lactamases) that destroy antibiotics.
  - **Target Modification:** Bacteria alter their structures to evade antibiotic action.
- **Strategies to Combat Resistance:**
  - Rational antibiotic use.
  - Development of new antibiotics.
  - Combination therapy.

Clinical Applications

- **Treatment of Bacterial Infections:** Pneumonia, Tuberculosis, UTIs.
- **Role in Surgery:** Prevents post-operative infections.
- **Use in Immunocompromised Patients:** Cancer, HIV, transplant recipients.
- **Future Prospects:**

 Personalized antibiotic therapy.

 Development of synthetic antibiotics.

Conclusion

- Antibiotics are **essential** in modern medicine. Understanding their **mechanisms** helps in effective treatment.
- **Antibiotic resistance** is a growing concern, proper usage is crucial.
- Future research aims to develop **novel antibiotics** to combat resistant bacteria.