Inhibiting Microbial Growth *in vivo*

CLS 212: Medical Microbiology

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Definitions

Chemotherapy

The use of any chemical (drug) to treat any disease or condition.

Chemotherapeutic Agent

Any drug used to treat any condition or disease.

Antimicrobial Agent

Any chemical (drug) used to treat an infectious disease, either by inhibiting or killing pathogens *in vivo*.

Antibiotics

A substance produced by a microorganism that is effective killing or inhibiting the growth of other microorganism.

Antimicrobial Agents

Antibacterial Agent

Drugs used to treat bacterial infections.

Antifungal Agent

Drugs used to treat fungal infections.

Antiprotozoal Agent

Drugs used to treat protozoal infections.

Antiviral Agent

Drugs used to treat viral infections.

Antibiotics

- Are primarily antibacterial agents and are used to treat bacterial diseases.
- Are produced by certain molds and bacteria usually living in the soil.
- Penicillin and cephalosporin are examples of anibiotics produced by molds.
- Bacitracin, eryhtromycin and chloramphenicol are examples of anibiotics produced by bacteria.

Semisynthetic Antibiotics

Are chemically modified antibiotics to kill a wider variety (more) pathogens or reduce side effects **e.g.** ampicillin.

Ideal Qualities of Antimicrobial Agent

Characteristics of a good Drug:

1. Kill or inhibit the growth of pathogens.
2. Cause no damage to the host.
3. Cause no allergic reaction in the host.
4. Stable to store in solid or liquid form.
5. Stay in target tissues for a long time to be effective.
6. Kill the pathogen before they become resistant to it.

How Antimicrobial Agents Work

- The antimicrobial agent must target a metabolic process or structure present in the pathogen and not in the host.

- **The five most common mechanisms of action of antimicrobial agents are:**

1. Inhibition of the cell wall synthesis (production).
2. Damage to the cell membrane.
3. Inhibition of the nucleic acid synthesis (DNA or RNA).
4. Inhibition of protein synthesis.
5. Inhibition of enzyme activity.

Antibacterial Agents

Bacteriostatic Agent

- Stop bacteria from growing and multiplying.
- Used **only** in healthy people.

Bactericidal Agents

- Kill the bacteria.
- Used in healthy and immunocompromised people.

Penicillin

- Will inhibit cell wall synthesis by interfering with the synthesis and cross linking of peptidoglycan.
- Will kill most gram positive bacteria.
- It cannot effect human cells because they don't have cell walls.

Antibacterial Agents

Narrow-spectrum Antibiotics

Antibiotics that can destruct **either** Gram positive **or** Gram negative bacteria.

e.g. vancomycin work on Gram positive bacteria only.

colistin work on Gram negative bacteria only.

Broad-spectrum Antibiotics

Antibiotics that can destruct **Both** Gram positive **and** Gram negative bacteria.

e.g. Ampicillin.

Multidrug Therapy

- The simultaneous use of two or more drugs to kill all the pathogens and prevent resistant pathogens from growing.

  e.g. Treatment of Tuberculosis (Tb)- 4 drugs are used.

Synergism

The use of two or more drugs that work together “team up” and the effect on pathogens is better than either drug alone.

Antagonism

The use of two or more drugs that work against each other and the effect on pathogens is less than either drug alone.

Antifungal and Antiprotozoal Agents

- Antimicrobial drugs against fungal and protozoal pathogens are difficult to use because they are eukaryotic cells like our cells so they tend to be toxic to the patient.

- **Mechanisms of action of Antifungal Agents are:**

1. Binding to cell membrane tresols.
2. Inhibiting tresol synthesis.
3. Inhibiting nucleic acid synthesis.

e.g. Amphotericin B

- **Mechanisms of action of Antiprotozoal Agents are:**

1. Inhibiting nucleic acid synthesis.
2. Inhibiting protozoal metabolism.

e.g. Metronidazole

Antiviral Agents

- Until recent years there were no drugs for the treatment of viral diseases.
- Antiviral drugs are specially very difficult to produce because viruses are intracellular pathogens.
- Only few drugs have been found to be effective in certain viral diseases. They work by inhibiting viral replication within cells.

e.g.

Acyclovir for the treatment of HSV.

"cocktail" of drugs including **lamivudine** for HIV.

Antimicrobial Resistance

- When microorganisms (mainly bacteria) become resistant to one or more antimicrobial agent.
- They make it difficult to treat the disease.
- The worst resistance is **Multidrug Resistance= resistance to many different antimicrobial drugs.**
- **Examples:**

a) **MRSA:** Methicillin Resistant Staphylococcus aureus.

b) **VRSA:** Vancomycin Resistant Staphylococcus aureus.

c) **MRTB:** Multi-drug Resistant *Mycobacterium tuberculosis.*

d) β-Lactamase resistant *Streptococcus pneumoniae.*

Note: some viruses, fungi , parasites have also shown resistance.

Resistance of Bacteria

Intrinsic Resistance

Some bacteria have natural resistance to some drugs because the drug cannot enter the bacterial cells or the bacteria doesn't have the target site specific to the drug.

Acquired Resistance

Bacteria can acquire resistance by one of these methods:

1. **Chromosomal Mutation**

   The drug cannot bind to or enter through the bacteria cell.

2. **To get a new Gene by conjugation, transduction, or transformation**

   The drug will be destroyed or pumped out of the bacterial cell.