

# Pharmacodynamics:

## (Principles & Basic Mechanisms of Drug Action)

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# Pharmacodynamics

- It is the study of physiological and biochemical effects of drugs and how these effects relate to a drug's mechanism of action.
- This aspect of Pharmacology deals with action of drugs within the body and, therefore, is concerned mainly with the interaction of drugs with their target sites.
- Correlation between pharmacological activity and chemical structure of the drug.

# Pharmacodynamics

contd...

➤ Paul Ehrlich saying:

*"Corpora non agunt nisi fixata",*

which means 'A drug will not work unless it is bound'.

- These critical binding sites are often referred to as 'DRUG TARGETS'.

# Principles of Drug Action

# Principles of Drug Action

- Drugs (except those gene based) do not impart new functions to any system, organ or cell.
- They only alter the pace of ongoing activity.
- Basic types of drug action :-
  - (i) Stimulation
  - (ii) Depression
  - (iii) Irritation
  - (iv) Replacement
  - (v) Cytotoxic action

# Principles of Drug Action contd...

## 1. STIMULATION

- It is a selective enhancement of the level of activity of specialized cells.
- Example - adrenaline stimulates heart, pilocarpine stimulates salivary glands.
- However, **excessive stimulation is often followed by depression** of that function. Example - High dose of picrotoxin, a CNS stimulant produces convulsions followed by coma and respiratory depression.

# Principles of Drug Action contd...

## 2. DEPRESSION

- It is a selective diminution of activity of specialized cells.
- Example - Barbiturates depress CNS, quinidine depresses heart.
- Certain drugs stimulate one type of cells but depress the other. Example - acetylcholine stimulates intestinal smooth muscles but depress the SA node in the heart.
- *Most drugs can not be just classed as stimulants or depressants.*

# Principles of Drug Action contd...

## 3. IRRITATION

- A non-selective, often **noxious effect** and is particularly applied to specialized cells like epithelium, connective tissue etc.
- **Mild irritation** may stimulate associated function like **bitters increase salivary and gastric secretions** and **counterirritants increase blood flow** to the site.
- But **strong irritation** results in inflammation, corrosion, necrosis and morphological damage. This may result in diminution or loss of function..

# Principles of Drug Action contd...

## 4. REPLACEMENT

- This refers to the use of natural metabolites, hormones or their congeners in **deficiency states** like **insulin in diabetes** and **fluids in dehydration**.

## 5. CYTOTOXIC ACTION

- Selective cytotoxic action for invading parasites or cancer cells, attenuating them without significantly affecting the host cells is utilized for cure or palliation of **infections and neoplasms**.

# Basic Mechanisms of Drug Action

# [I]. NON-CELLULAR MECHANISMS OF DRUG ACTION

## 1. Physical effects

- Examples include protective, adsorbent and lubricant properties of locally active agents that are applied to cutaneous and membrane surfaces.

## 2. Chemical reactions

- A number of drugs produce their effects through a chemical union with an endogenous or foreign substance.

## Non-cellular mechanisms of drug action contd...

### 3. Physicochemical mechanisms

- Certain drugs act by altering the physicochemical or biophysical properties of specific fluids or even components of cells.
- Examples of the former include the surface-active agents or **surfactants**.
- Detergents, emulsifiers, antifoaming agents and several antiseptics and disinfectants possess surfactant properties.

## Non-cellular mechanisms of drug action contd...

### 4. Modifications of the composition of body fluids:

- Several therapeutic manipulations involve the administration of substances that exert **osmotic effects across particular cell membranes**.
- Examples of osmotically active agents include magnesium sulphate as a purgative, mannitol as a diuretic, hypertonic poultices applied to the skin and use of dextran as plasma volume expander.

## [II]. CELLULAR MECHANISMS OF DRUG ACTION

### 1. Physicochemical and biophysical mechanisms

- Certain drugs appear to act by altering the physicochemical or biophysical characteristics of specific components of cells.
- Examples include the effect of general inhalant anaesthetics on the lipid matrix and perhaps the hydrophobic proteins in neuronal membranes within the CNS.

## Cellular mechanisms of drug action contd...

### 2. Modification of cell membrane structure and function

- Various drugs may influence either the structure or specific functional components of cell membranes and thereby initiate their characteristic effects. These mechanisms of action may also involve enzyme systems or receptor mediated reactions.
- A few examples include, **local anaesthetics** that bind to components of the sodium channels in excitable membranes and prevent depolarization, calcium channel blockers that inhibit the entry of calcium into cells.

## Cellular mechanisms of drug action contd...

### 3. Mechanisms associated with neurohumoural transmission

- A number of drugs interfere with the synthesis, release, effects or re-uptake of neurotransmitters. Once again enzyme and/or receptor mediated effects may be responsible.
- For example, reserpine blocks the transport system of adrenergic storage granules, while amphetamine displaces norepinephrine from axonal terminals. Botulinum toxin prevents the release of acetylcholine from cholinergic terminals and bretylium inhibits the release of norepinephrine from adrenergic terminals.

## Cellular mechanisms of drug action contd...

### 4. Enzyme Inhibition

- Certain enzymes exert their effects by inhibiting the activity of specific enzyme systems either in the host animal or the invading pathogens. This inhibition may be competitive or non-competitive. Non-competitive inhibition may be reversible or irreversible.

**Thank You**

