# INDEX

# UNIT 1

# INTRODUCTION TO PHARMACOLOGY

## DEFINITIONS & BRANCHES

**DEFINITION**

- The word Pharmacology is derived from Greek words **Pharmacon** means **drug** and **logos** means **knowledge** or **study**.
- By definition "Pharmacology is the science that deals with the study of drugs and their interaction with the living system".
- It deals with the interaction of exogenously administered chemical molecules with living systems, focusing on substances that produce a biological response (drugs).
- Rudolf Buchheim - "**Father of Pharmacology**".

**BRANCHES OF PHARMACOLOGY**

**Pharmacokinetics (what body does to drug):**

- Study of drug movement, absorption, distribution, metabolism, and excretion in the body.
- Focuses on understanding how the body processes drugs.
- Example: Chlorpromazine is absorbed faster parenterally than orally, undergoes metabolism in the liver, and is excreted in 15 to 30 hours.

**Pharmacodynamics (what drug does to body):**

- Study of physiological and biochemical effects of drugs and their mechanism of action at various levels (organ system, subcellular, and macromolecular).
- Examines the effects of drugs on the body's functions.
- Example: Adrenaline interacts with adrenoceptors, stimulates cell membrane-bound adenylyl cyclase via G-proteins, increases intracellular cyclic 3',5' AMP, leading to cardiac stimulation, hepatic glycogenolysis, and hyperglycemia.

**Other Branches are**

1. **Pharmacokinetics:**
    - Study of drug movement in the body, covering absorption, distribution, metabolism, and elimination.
2. **Pharmacodynamics:**
    - Study of how drugs act on living organisms, including pharmacologic response and duration/magnitude of response.
3. **Pharmacotherapeutics:**
    - Deals with the application of pharmacological information and disease knowledge for disease prevention and cure.
4. **Chemotherapy:**
    - Treatment using chemicals to kill microorganism and neoplastic cells.
    - Antibiotics (e.g., Erythromycin, Aminoglycans) and Antineoplastics (e.g., Methotrexate, Vinca alkaloids).

5. **Toxicology:**
    - Study of adverse effects of drugs on the body, including symptoms, mechanisms, treatment, and detection of poisoning.
6. **Clinical Pharmacology:**
    - Scientific study of drugs in humans, involving pharmacokinetic and pharmacodynamic investigations.
    - Objectives: Maximize drug effects, minimize adverse effects, promote safety of prescriptions.
7. **Pharmacoepidemiology:**
    - Examines the effects of drugs on large populations.
8. **Pharmacogenetics:**
    - Deals with genetic variations causing differences in drug response among individuals or populations.

## NATURE & SOURCES OF DRUGS

**Drug**:
A drug is a chemical that interacts with macromolecular targets (Receptor) to produce a biological response, it is used as medicine for diagnosis, prevention, and treatment of diseases.

- The World Health Organization (WHO) defines drugs as substances used to modify or explore physiological systems or pathological states for the recipient's therapeutic or diagnostic benefit.
- A chemical substance, typically of known structure, which, when administered to a living organism, produces a biological effect.
- A drug is any chemical substance which is given to people in order to treat or prevent an illness or disease.

**Medicine**:

- The term "medicine" generally refers to substances or treatments that are used to prevent, alleviate, or cure diseases, disorders, or medical conditions in humans and animals.
- Medicines are specifically designed to have therapeutic effects on the body. They are intended to provide benefits to health by treating or managing various health conditions.

**NATURE OF DRUGS:**

1. **Physical Properties:**
    - Solid (e.g., Aspirin), Liquid (e.g., Nicotine), Gas (e.g., Nitrous oxide).
2. **Chemical Properties:**
    - Organic (majority), Inorganic (e.g., Ferrous sulfate).
    - Organic drugs further classified based on behavior (e.g., weakly acidic, weakly basic, non-electrolytes).
3. **Drug Size:**
    - Most drugs fall within the range of 100-1000 daltons.
    - Size influences binding to specific sites.

**SOURCES OF DRUGS:**

1. **Plants:**
    - Examples: Digoxin, Quinine, Morphine.

2. **Animal Products:**
    - Examples: Insulin, Thyroxine, Growth Hormone.
3. **Minerals and Oils:**
    - Examples: Aluminium, Iron, Liquid Paraffin.
4. **Microorganisms:**
    - Examples: Penicillin, Chloramphenicol.
5. **Humans:**
    - Examples: Immunoglobulin, Growth Hormone.
6. **Genetic Engineering:**
    - Example: Human Insulin.
7. **Synthetics:**
    - Examples: Marijuana, Cocaine.
8. **Semisynthetics:**
    - Examples: Heroin, Codeine.

## DOSAGE FORMS AND ROUTES OF DRUG ADMINISTRATION

**DOSAGE FORMS:**

- Manner in which drug substances are presented in the market.
- Examples: Caplet, Capsule, Pills, Tablet, Lozenges, Suppository, Injections, Drops, Elixir, Syrup, Suspension, Lotion, Tincture, Emulsion, Cream, Ointment, Paste, Gel, etc.

**Properties of Dosage Forms:**

- Flexibility in different drug strengths.
- Convenient to handle, use, and store.
- Provides expected therapeutic effect.
- Stable during storage and use.

| Dosage Forms | Type | Examples/Descriptions |
|---|---|---|
| Solid | | |
| Caplet | Solid | A smooth, coated, oval-shaped medicinal tablet for easy swallowing. |
| Capsule | Solid | A small container made of gelatin that encloses a dose of medication. |
| Pills | Solid | Small, round solid dosage forms containing medication. |
| Tablet | Solid | A pressed or compacted solid dose containing active ingredients. |
| Lozenges | Solid | Hard or soft solid forms, dissolve slowly in the mouth to release medication. |
| Suppository | Solid | Solid dosage forms intended for insertion into body orifices. |
| Liquid | | |
| Injections | Liquid | Sterile preparations injected into the body. |
| Drops | Liquid | Liquid medication in a form to be administered in drops. |
| Elixir | Liquid | A clear, sweet-flavored liquid used for medicinal purposes. |
| Syrup | Liquid | Thick, viscous liquid containing medicinal substances. |

| | | |
|---|---|---|
| Suspension | Liquid | Liquid preparations containing solid particles dispersed throughout. |
| Lotion | Liquid | A low- to medium-viscosity topical preparation. |
| Tincture | Liquid | Alcohol or water-alcohol solutions prepared from vegetable materials or chemical substances. |
| Emulsion | Liquid | A mixture of two immiscible (unblendable) substances. |
| Mouthwashes | Liquid | Liquid designed to be rinsed around the mouth then spit out. |
| Solution | Liquid | A liquid mixture where a solid is dissolved into a liquid. |
| Liniments | Liquid | Liquid or semi-liquid preparations applied to the skin. |
| Semi-Solid | | |
| Ointment | Semi-Solid | A smooth, greasy, thick preparation applied to the skin. |
| Paste | Semi-Solid | A thick, stiff preparation often containing a higher concentration of solid. |
| Cream | Semi-Solid | An emulsion of oil and water in approximately equal proportions. |
| Gels | Semi-Solid | Jelly-like substances that are thicker than liquids but less dense than solids. |

## ROUTES OF DRUG ADMINISTRATION

There are various routes through which a drug can be administered.
The routes of drug administration can be classified as following:

- Enteral/
- Parenteral
- Local/Tropical

### 1. ENTERAL ROUTE

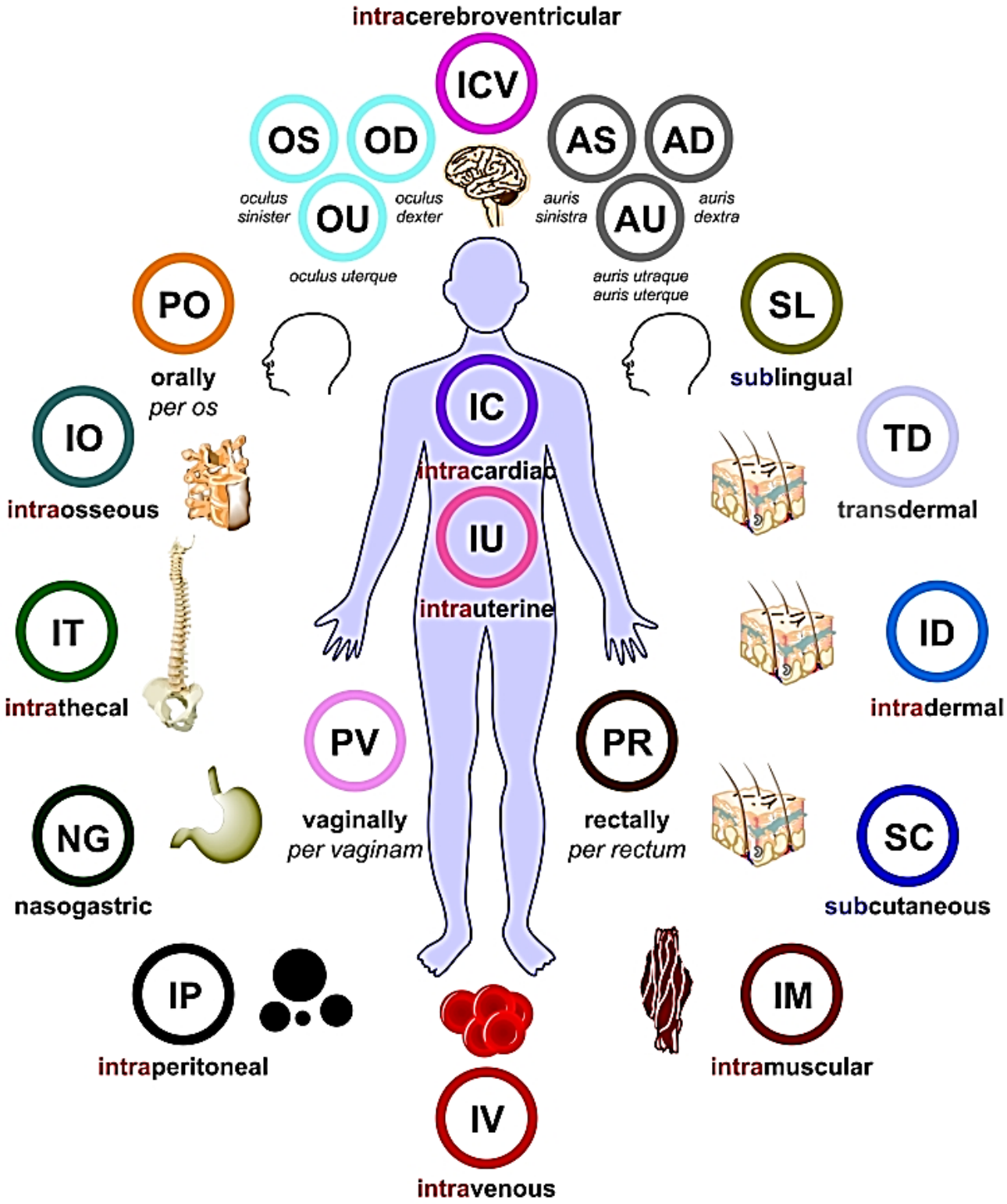
This route involves the oral ingestion of the drug and act as the safest route of drug administration.

**Advantages**

- Safest and non-invasive route
- Convenient and efficient route
- Self-administration of drug

**Disadvantages**

- Slower onset of action
- Irritant and unpleasant drugs cannot be administered
- Drugs with certain physical characteristics may not get absorbed, e.g. streptomycin GI tract irritation can cause vomiting
- Irregularities in absorption
- Gastric juices may destroy some drugs, e.g. insulin
- Not used in case of uncooperative and unconscious patients
- Extensive first pass metabolism of some drugs in liver may leave only a small amount for therapeutic purpose.




**2. PARENTERAL ROUTE**

When the drug is administered through any route other than the enteral route is known as parenteral route.

The drug can be administered to the muscle, mucosa, blood or skin.

Some of different routes of drug administration are:

A. Injection
B. Transmucosal
C. Transdermal
D. Inhalation

**Advantages**

- Rapid and predictable action
- Can be used in unconscious or uncooperative patient
- Gastric irritation can be avoided as irritants can
- Can be used in patients having difficulty in swallowing or vomiting be administered parenterally
- The first pass metabolism and digestion of the drugs by the gastric juices can be avoided Highly beneficial in the emergency conditions.

**Disadvantages**

- Needs asepsis to be maintained
- Injections may be painful to the patient
- Can be inconvenient and expensive
- Involves risk of injury to nerves and other tissue.

**A. Injections**

Drugs through injections can be administrated by various routes:

a) **Intramuscular**: It involves the injection of drug (solution) into large muscles.
The muscles used for intramuscular injections are deltoid muscle for small amount of drug administration, gluteus muscle for large amount in adults and vastus lateralis used in infants and small children.

b) **Subcutaneous (hypodermic):** Here drug is injected in the subcutaneous tissue, e.g. insulin and heparin is given through this route.
Subcutaneous tissue is less vascular, so the absorption of the drug is slow as well as largely uniform which makes it long acting.

c) **Intradermal**: The drug is administered above dermis and below epidermis.
This route is commonly used for BCG vaccination, drug hypersensitivity test and tuberculin test, etc.
Here very small amount of drug is administered.

d) **Intravenous**: The drug is injected into one of the superficial veins of the body so that it reaches the circulation directly and is available for immediate action. Through this route drugs can be given in bolus, slowly, slow infusion mode as per requirement.

e) **Intra-arterial:** In this route the drug is injected directly into the arteries and used in the treatment of peripheral vascular disease, local malignancies and diagnostic studies like angiographies.

f) **Intra-cardiac:** Here the drug is directly given into heart. This route is rarely used, since it involves several complications without any additional benefit.

g) **Intra-thecal or intra-spinal:** It involves the administration of the drug into the subarachnoid space for action on the CNS, e.g. spinal anesthetics.
Some antibiotics and corticosteroids can also be injected by this route to produce high local concentration.

h) **Intra-articular:** Here drugs are injected directly into a joint for the treatment of arthritis and other diseases of joint. Strict aseptic precautions are required, e.g. hydrocortisone is injected into the affected joint, in rheumatoid arthritis.
i) **Intraperitoneal**: A large surface area for absorption is being offered by peritoneum. In infants fluids are injected into peritoneum. This route can also be used for peritoneal dialysis.
j) **Intramedullary**: Here drug is injected into a bone marrow. It is rarely used nowadays.

**B. Transmucosal**

It involves the absorption of drugs across the mucous membranes. Transmucosal administration includes:

1. Sublingual
2. Rectal
3. Nasal

**1. Sublingual**

Here, the drug contained by a tablet or pellet is placed under the tongue.

The drug is dissolved and absorbed across the sublingual mucosa, e.g. nitroglycerine tablets, nifidipin, buprenorphine.

**Advantages**

- Rapid absorption; reaches circulation within minutes.
- Helps in avoiding of first pass metabolism.
- The drug can be spat out after obtaining the desired effects to avoid the unwanted effects.

**Disadvantages**

- Can cause buccal ulceration.

**2. Rectal**

Rectum has a rich blood supply; drugs administered through this route cross the rectal mucosa, to get absorbed and produce the local or systemic effects.

Drugs which can be given through this route are indomethacin, chlorpromazine, diazepam and paraldehyde. Some irritant drugs are given as rectal suppositories.

**Advantages**

- Gastric irritation can be avoided.
- Beneficial in older patients and can also be used in patient with vomiting and difficulty swallowing.

**Disadvantages**

- Can cause buccal ulceration.

**3. Nasal route**

Nasal route of drug administration can be used either for systemic absorption or for local effects,

e.g. oxytocin spray produces systemic effect, decongestant nasal drops like oxymetazoline used for local effect.

**C. Transdermal**

The drugs which are high lipid soluble can be applied to the skin for slow and prolonged absorption to achieve systemic effect, e.g. application of nitroglycerine ointment in angina pectoris.
Inunction, adhesive units, iontophoresis and jet injection are some forms of transdermal drug delivery methods.
Inunction: Here the drug is rubbed into the skin and gets absorbed to produce systemic effects.

**D. Inhalation**

Through inhalation, volatile liquids and gases are given in general anesthesia.
Also, the solutions of drug particles and the fine droplets are inhaled as aerosol, e.g. salbutamol.
Patient inhales the particles and fumes into the lung which produce local or systemic effect.

**Advantages**

- Rapid absorption.
- More effective and less harmful in case of pulmonary disease. Hepatic first pass metabolism is avoided.
- Conveniently controlled blood level of volatile anesthesia, as their absorption and excretion is through the lungs are governed by the laws of gases.

**Disadvantages**

- Irritant gases may enhance the production of pulmonary secretions.

**3. LOCAL ROUTES**

Drugs may be applied on the skin or mucous membrane for local action:
Local Dermal Application: As ointment, cream, gel, powder, and paste applied on skin to achieve local action.

a) **Instillation**: Instillation is putting a drug in liquid form into a body cavity such body orifice as ears, eyes as ointment, drops, and spray.
b) **Insertions**: It means introducing solid form of drugs into the body orifices, i.e. suppositories for rectum, bougie for urethra and pessary and douche for vagina.
c) **Insufflations**: It is administration of drugs in the form of powder, vapour or air into a wound or body cavity.

## TERMINOLOGY USED

| Term | Definition |
|---|---|
| **Drug** | A substance used for diagnosis, treatment, or prevention of disease, or to affect the structure or function of the body. |
| **Adverse Drug Reaction** | A harmful and unintended response to a drug at normal doses for prophylaxis, diagnosis, therapy, or modification of physiological function. |
| **Pharmacokinetics** | The study of drug movement in the body, including absorption, distribution, metabolism, and elimination. |
| **Pharmacodynamics** | The study of how a drug acts on a living organism, including pharmacological response and its duration/magnitude. |
| **Pharmacovigilance** | The science of detecting, assessing, understanding, and preventing adverse effects or other drug-related problems. |

| | |
|---|---|
| **Pharmacopeia** | An official book listing drugs and their formulas, uses, dosages, and methods of preparation, approved by regulatory bodies like the BP, USP, IP. |
| **Clinical Pharmacology** | The sub-discipline dealing with drug effects in humans, covering pharmacokinetics and pharmacodynamics. |
| **Experimental Pharmacology** | The sub-discipline dealing with drug effects in animals, cell lines, or tissues, focusing on molecular research and mechanism of action. |
| **Receptors** | Macromolecules on the cell surface that bind to drugs, modulating their functions. |
| **Ligands** | Substances that bind to receptors. |
| **Affinity** | The ability of a drug to bind to its receptors. |
| **Competition** | When two different drugs target the same binding site. |
| **Effectiveness** | Measurement of the therapeutic effects generated by agents. |
| **Potency** | The dose of a drug required to produce desired effects; lower potency requires higher doses, and vice versa. |
| **Selectivity** | The ability of a drug to interact with specific macromolecules, ideally only one. |
| **Tolerance** | Reduced response to a drug after repeated administrations. |
| **Addiction** | Habitual use of a psychoactive drug due to repeated and continuous use. |
| **Side Effects** | Effects of drugs other than the intended therapeutic effects; harmful side effects are termed as adverse drug reactions. |
| **Agonist** | Substances that bind and activate a receptor, producing natural responses. |
| **Full Agonist** | Binds to a receptor and produces a maximum response with complete efficiency. |
| **Partial Agonist** | Binds and activates a receptor but only achieves partial efficiency; can act as a competitive antagonist. |
| **Inverse Agonist** | Binds to the same receptor as an agonist but produces the opposite effect. |
| **Antagonist** | A drug that blocks or decreases the effect of an agonist without producing a biological response itself. |
| **Competitive Antagonist** | Binds to the same receptor site as an agonist, competing for binding. |
| **Non-Competitive Antagonist** | Binds to a different site from the agonist, not directly competing with it. |

## CLASSIFICATION, ABBREVIATIONS, PRESCRIPTION, DRUG CALCULATION, WEIGHTS AND MEASURES

### CLASSIFICATION OF DRUGS BY ACTION:

- **Analgesics:** Relieve pain.
- **Anticoagulants:** Prevent blood clotting.
- **Antidepressants:** Treat depressive disorders.

- **Antibiotics:** Fight bacterial infections.
- **Antipyretics:** Reduce fever.
- **Antispasmodics:** Relieve involuntary muscle spasms.
- **Diuretics:** Increase urine flow.
- **Hypnotics:** Induce a sleep-like state.
- **Laxatives:** Stimulate bowel movement without cramping.
- **Antineoplastics:** Interfere with cell reproduction to reduce tumor cell production.

**ABBREVIATIONS AND SYMBOLS:**

| Category | Abbreviation | Meaning |
|---|---|---|
| **A. Time of Administration** | | |
| | a.c | Before meals |
| | p.c | After meals |
| | a.m | Before noon |
| | p.m | Afternoon/evening |
| | alt. die | Alternate days |
| | om | Every morning |
| | ad | Every day |
| | on | Every night |
| | hs | At bedtime |
| **B. Preparation of Drug** | | |
| | aa | Up to |
| | ad | With |
| | ad lib | As much as desired |
| | 5s, Fs | Half |
| | cm | Centimeter |
| **C. Route** | | |
| | AD | Right ear |
| | AS | Left ear |
| | AU | Each ear |
| | H | Hypodermic |
| | IM | Intramuscular |
| | INJ | Injection |
| | IV | Intravenous |
| | IVP | Intravenous push |
| | Rx | Take prescription |
| | OD | Right eye |
| | SC | Subcutaneously |
| | SQ | Subcutaneous |
| | OS | Left eye |
| | OU | Both eyes |
| | P | After, per |
| | PO | By mouth |
| | EC | Enteric coated |
| | elix | Elixir |

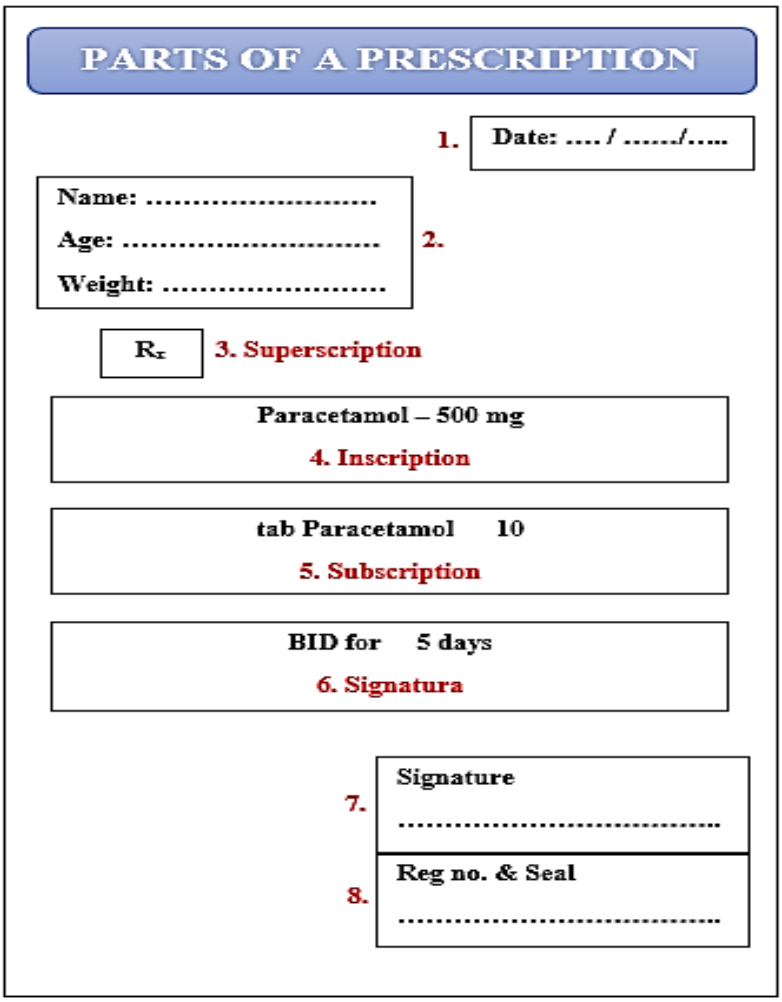
| | | |
|---|---|---|
| | ext | External, extract |
| | OS | Mouth |
| **Hours of Administration** | | |
| | Q6h | Every 6 hours |
| | T.D.S. | Thrice a day |
| | B.D. | Twice a day |
| | O.D. | Once a day |
| | H.S. | At bedtime |
| | Q8h | Every 8 hours |
| | Q12h | Every 12 hours |
| | alt h | Alternate hours |
| | qh | Every hour |
| | d | Day |
| | qod | Every other day |
| | Q3h | Every three hours |
| | Q1h | Every one hour |
| | Q2h | Every two hours |
| | noct | Night |

**PRESCRIPTION:**

A prescription is a written, verbal, or electronic order from a practitioner or designated agent to a pharmacist for a particular medication intended for a specific patient.

**Parts of Prescription:**

1. **Date**: This is the date when the prescription is written by the doctor.
2. **Patient's Information**: Includes the name, age, sex, body weight, and address of the patient. This helps in identifying the patient and customizing the treatment.
3. **Superscription**: This is usually the symbol "Rx", which stands for "recipe" in Latin, meaning "to take". It indicates that a medical prescription follows.
4. **Inscription**: This part lists the medicine and its ingredients. It's like the main body of the prescription, telling what drugs are prescribed.
5. **Subscription**: Here, the doctor writes the instructions to the pharmacist, explaining how to prepare and label the medicine.
6. **Signature**: This section is for the patient. It contains directions on how the patient should take the medicine. It includes dosage, frequency, and other specific instructions.
7. **Renewal Instructions**: These instructions indicate if and how the prescription can be renewed. It may include details like how many times the prescription can be refilled.
8. **Prescriber's Information**: This includes the signature, address, and registration number of the doctor or healthcare professional who wrote the prescription. This is important for verification and contact purposes.




**Prescribing Error:**

These are errors or mishaps that occur during the prescription of a drug.

**Contributing Factors for Prescribing Error:**

1. Lack of knowledge of the prescribed drug.
2. Illegible handwriting.
3. Inaccurate medication history taking.
4. Confusion with the drug name.
5. Inappropriate use of decimals, e.g., 0.1 mg.
6. Use of irrelevant abbreviations.
7. Use of verbal orders.
8. Work environment/pressure.
9. Poor communication within the team.
10. Organizational factors, such as inadequate training.

**Measures to Reduce Prescribing Errors:**

1. Use of electronic prescribing.
2. Regular training sessions and increased awareness.
3. Avoiding verbal orders.
4. Encouraging the use of standard abbreviations.

5. Maintaining a calm, quiet, and stress-free work environment.
6. Always using leading zeros for decimal points.

**Benefits of Prescription:**

- Improves beneficiary health outcomes.
- Enhances quality and efficiency.
- Reduces drug interactions.
- Saves the time of the pharmacist.

**Disadvantages of Prescription:**

- Accidental data entry errors.
- Inability to use electronic prescribing.
- Inadvertently divulging protected health information.

**WEIGHTS AND MEASURES**

1. **Apothecary System:**
    - **Definition**: The older system of measurement based on arbitrary units of measure.
    - **Symbols**: Common apothecary measures include pint (pt) and quart (qt).
    - **Example**: 1 quart (qt) equals 2 pints or 4 cups or 32 fluid ounces.
2. **Metric System:**
    - **Origin**: Invented in France, the basic units of measure are gram and liter.
    - **Units**: In addition to grams and liters, the metric system uses decimal, fractions, and Arabic numerals.
3. **Household System:**
    - **Basis**: Mainly based on familiar measures used in households.
    - **Accuracy**: Many measures in the household system are not accurate for medicines.

**Comparison:**

- The Apothecary system, with units like pint and quart, was gradually replaced by the more standardized metric system.
- The Metric system, with its base units of gram and liter, offers a more precise and universally accepted measurement system.
- The Household system, although based on familiar measures, is often less accurate for medications and is not commonly used in professional healthcare settings.

This system was gradually replaced by metric system. Common apothecary measures and symbols are:

- Drop gtt
- Minim m
- Dram 3
- Ounce (oz) ⅓
- Pint pt
- Grain gr

Equivalents:

- 1 drop = 1 minim
- 15 drops = 1 grain
- 60 minims = 1 fluid dram

- 1 fluid ounce = 30 ml
- 16 fluid ounces = 1 pint

Metric system: It is a French invented system and basic units of measure are gram and litre, Other units include decimal, fractions and Arabic numerals. Common metric measures and symbols are:

- Gram g, gm or G
- Kilogram kg
- Milligram mg
- Milliliter ml
- Liter L or l

Equivalents:

- 1 gram = 1,000 milligrams
- 1 g = 1,000 mg
- 1 liter = 1,000 milliliters
- 1 L = 1,000 mL

Household system: This system is mainly based on the familiar measures used in home but most of the measures are not accurate for medicines. Common household measures and symbols are:

- Pint pt
- Teaspoon tsp
- Tablespoon T
- Quart qt

Equivalents:

- one Pt = 500 ml
- one tsp = 5 ml
- one T = 15 ml = 3 tsp
- one qt = 946.35 ml

## CALCULATION OF DOSES

**I. Converting milligrams to grains:**

For example, convert 120 milligrams to grains

$$\frac{1\text{ gr}}{\text{Mg in gr}} = \frac{\text{dose desired}}{\text{dose on hand}}$$

$$\frac{1}{60} = \frac{x}{120}$$

$$60x = 120$$

$$x = 2 \text{ grains}$$

**II. Calculation of oral doses:**

$$\frac{D}{H} = x$$

D = dose desired
H = dose on hand
x = dose to be administered

For example, Calculate the capsules to be administered when dose is 500 mg of antibiotic and dose on hand is 250 mg.

$$\frac{500\text{ mg}}{250\text{ mg}} = 2 \text{ capsules}$$

**III. Calculation of drug doses of liquid drugs:**

$$\frac{D}{H} \times Q = x$$

D = dose desired
H = dose on hand
Q = quantity
x = dose to be administered

For example, give 325 mg of ampicillin when it is supplied as 250 mg/5 mL.

$$\frac{325\text{ mg}}{250\text{ mg}} \times 5 = 6.5\text{ mL}$$

**Dosage calculations**

**Calculating Children's Dosages:**

When administering drugs to children, who are often prescribed adult doses, various methods are used to calculate appropriate dosages based on the child's age, weight, or other factors. Here are three commonly used methods:

**a. Young's Rule:**

- Applicable for children between 1 to 12 years old.
- It considers the age of the child.
- A modification factor is often applied to adjust the dosage based on the child's age.

- Young's rule: for children older than 1 year

$$\frac{\text{Child's age (in years)}}{\text{Child's age (years)} + 12} \times \text{adult dose}$$

**b. Clark's Rule:**

- Calculated based on the weight of the child.
- Suitable for children of all ages.
- Adjusts the dosage proportionally to the child's weight.

- Clark's rule: based on weight of child, which is much more accurate than either Young's or Fried's rules

$$\frac{\text{Child's weight (lb)}}{\text{Average adult's weight (150 lb)}} \times \text{adult dose}$$

**c. Friend's Rule:**

- Specifically used for children under one year of age.
- Tailored to the unique considerations of infants.
- Factors like weight, age, and physiological differences in this age group are taken into account.

- Fried's rule: for infants younger than 1 year: Upto 2 years of Age

$$\frac{\text{Child's age (in months)}}{\text{Average adult weight (150 lb)}} \times \text{adult dose}$$

## PHARMACODYNAMICS

**DRUG ACTION**

Pharmacodynamics is the study of how drugs affect the body and the mechanisms behind their actions.

The term "mechanisms of drug action" refers to the processes and interactions by which a drug produces its effects in the body.

These mechanisms explain how a drug, once introduced into the body, produces its therapeutic or pharmacological effects, alleviates symptoms, or modifies the course of a disease.

1. **Transport Process**: This is how drugs move in and out of cells.
   - **Proton Pump**: This is like a tiny machine inside stomach cells that pumps out acid for digestion. Some drugs can stop this pump to reduce stomach acid.
   - **Chloride Ion Channel**: Works with the proton pump to help make stomach acid.
   - **Sodium-Potassium Pump**: Keeps the balance of salts inside cells, important for many cell functions.
2. **Enzymes**: These are like workers in the body that help chemical reactions happen.
   - **Drug Metabolism**: Enzymes can change drugs in the body, making them work better or get rid of them.

- **Drug Activation**: Some drugs are like sleeping agents that need enzymes to wake them up to start working.
- **Drug Inactivation**: Enzymes can also turn off drugs.

3. **Ion Channels**: These are like gates that let salts and other ions in and out of cells.
    - **Ligand-Gated Channels**: These gates open when a specific molecule sticks to them, important for nerve signals.
    - **Voltage-Gated Channels**: These gates open and close when the electrical charge near them changes, important for nerve signals and muscle contractions.
4. **Receptors**: These are like special locks on the outside of cells that only certain keys (like drugs) can unlock.
    - **Ligand-Gated Ion Channels**: Open when a drug attaches to them, allowing ions to flow into the cell.
    - **G-Protein Coupled Receptors (GPCRs)**: Change cell activity when a drug attaches, affecting things like heart rate.
    - **Kinase-Linked Receptors**: Start a chain reaction inside the cell when a drug attaches, important for growth and metabolism.
    - **Nuclear Receptors**: When drugs attach, these receptors can change how cells make proteins.

**ANTAGONISM, SYNERGISM, TOLERANCE, RECEPTORS, THERAPEUTIC, ADVERSE, TOXIC EFFECTS, PHARMACOVIGILANCE**

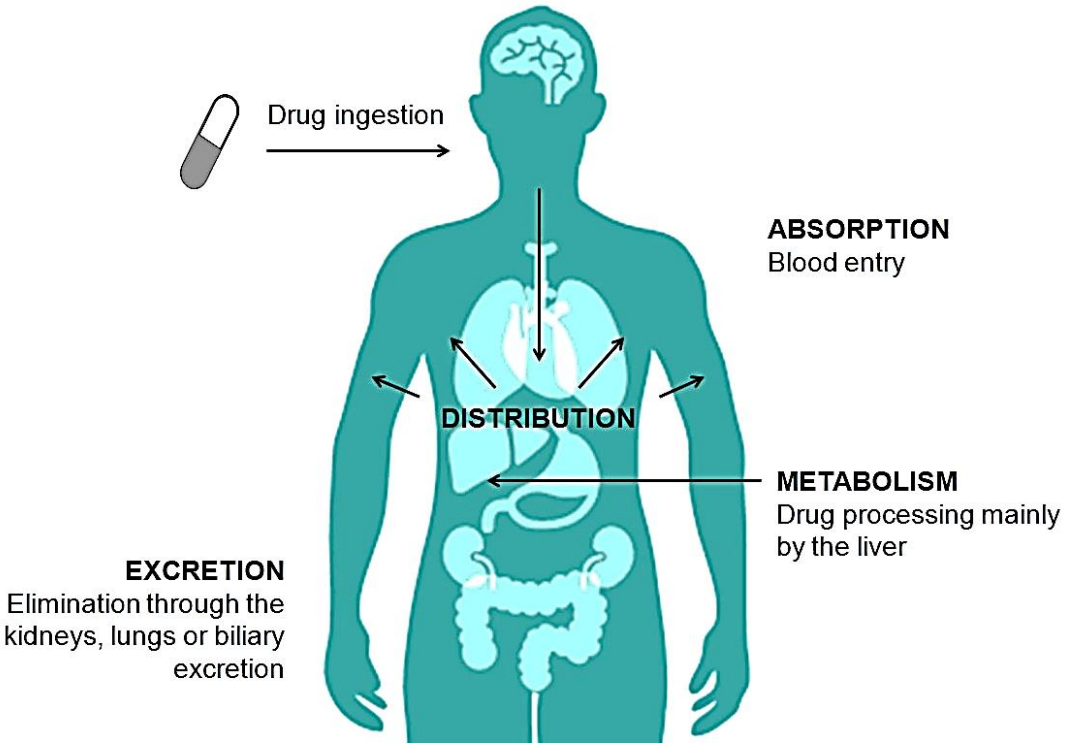
1. **Antagonism**:
    - **Explanation**: This is when the action of one drug is opposed by another.
    - **Example**: The drug naloxone acts as an antagonist to opioids like heroin. If someone overdoses on heroin, naloxone can be administered to counteract life-threatening depression of the central nervous system and respiratory system.
2. **Synergism**:
    - **Explanation**: Occurs when two drugs work together and enhance each other's effects.
    - **Example**: The antibiotic trimethoprim and sulfamethoxazole work together in the drug co-trimoxazole to treat bacterial infections. Each component enhances the efficacy of the other, making the combination more effective than either drug alone.
3. **Tolerance**:
    - **Explanation**: This happens when the body's response to a drug decreases over time, requiring higher doses to achieve the same effect.
    - **Example**: Patients with chronic pain often develop tolerance to opioids such as fentanyl, necessitating higher doses for pain relief, which also increases the risk of side effects.
4. **Receptors**:
    - **Explanation**: These are protein molecules in the body that drugs bind to in order to exert their effects.
    - **Example**: The anti-anxiety medication diazepam (Valium) works by binding to GABA receptors in the brain, enhancing the effect of the neurotransmitter GABA and producing a calming effect.
5. **Therapeutic effects**:
    - **Explanation**: These are the beneficial effects a drug has in treating a condition or symptom.

- **Example**: Insulin provides the therapeutic effect of lowering blood glucose levels in people with diabetes.

6. **Adverse effects**:
   - **Explanation**: These are unwanted or harmful effects a drug may have.
   - **Example**: Corticosteroids like prednisone can cause adverse effects including increased susceptibility to infection, high blood sugar, and osteoporosis with long-term use.
7. **Toxic effects**:
   - **Explanation**: These are the dangerous effects that result from high doses of a drug or prolonged use.
   - **Example**: Overdosing on vitamin A can lead to toxic effects such as liver damage and neurological symptoms.
8. **Pharmacovigilance**:
   - **Explanation**: This is the science of collecting, monitoring, researching, assessing, and evaluating information from healthcare providers and patients on the adverse effects of medications.
   - **Example**: The discovery of increased cardiovascular risk associated with the anti-inflammatory drug Vioxx (rofecoxib) was a result of pharmacovigilance, leading to its withdrawal from the market.

## PHARMACOKINETICS

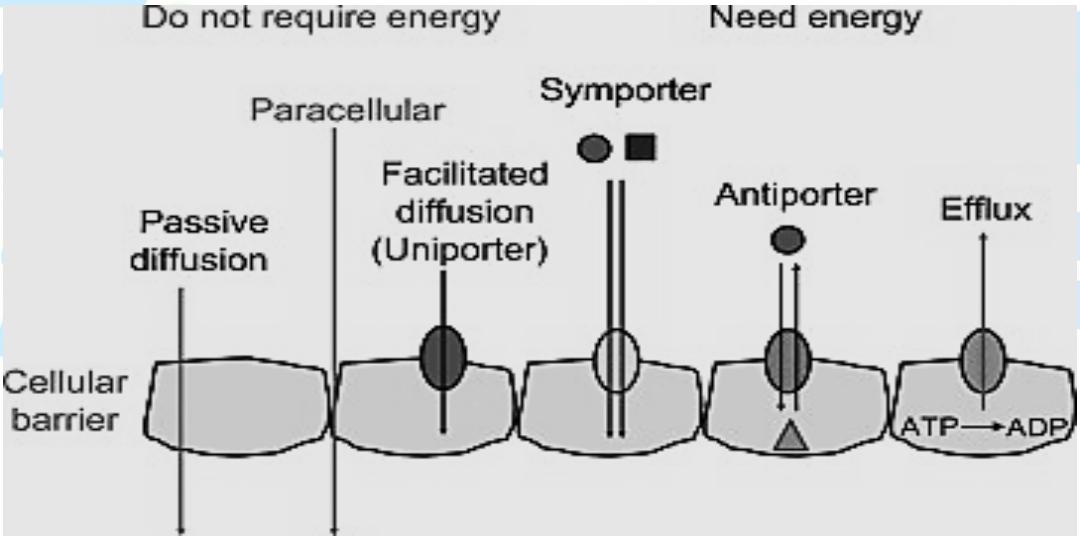
Pharmacokinetics is a branch of pharmacology dedicated to understanding how the body affects a specific drug after administration.
It involves the study of the time course of drug absorption, distribution, metabolism, and excretion (ADME).



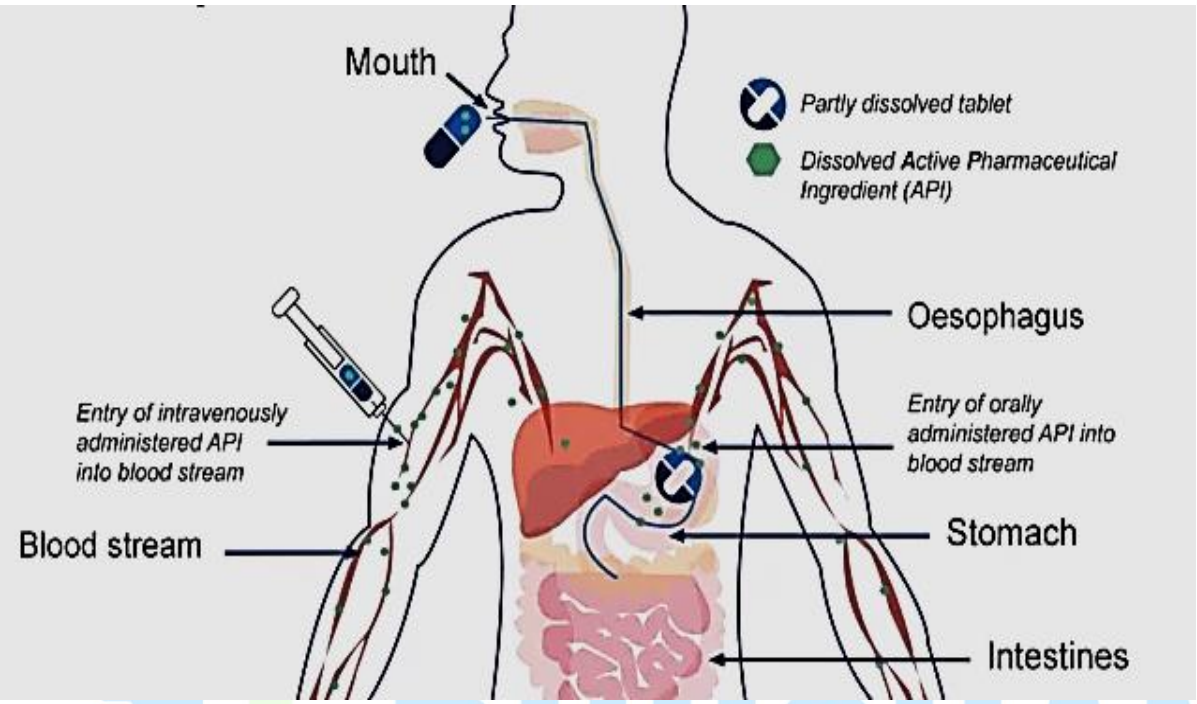
**ABSORPTION**:
**Definition:** Absorption is the process by which drugs enter the bloodstream from their site of administration.
It's a critical step determining the onset and intensity of a drug's effect.

**Key Points:**

1. **Routes of Administration:**
    - **Oral:** Drugs pass through the gastrointestinal tract. Absorption influenced by factors like gastric pH, presence of food, and gut motility.
    - **Intravenous (IV):** Directly into the bloodstream, offering 100% bioavailability.
    - **Topical, Transdermal, Inhalational, Subcutaneous, Intramuscular:** Absorption depends on tissue perfusion, drug concentration, and surface area.
2. **Mechanisms of Absorption:**
    - **Passive Diffusion:** Most common; drugs move from higher to lower concentration without energy use. Lipid solubility is a key factor.
    - **Facilitated Diffusion:** Involves carrier proteins, but no energy expenditure.
    - **Active Transport:** Against the concentration gradient, requiring energy. Important for drugs that resemble natural body substances.



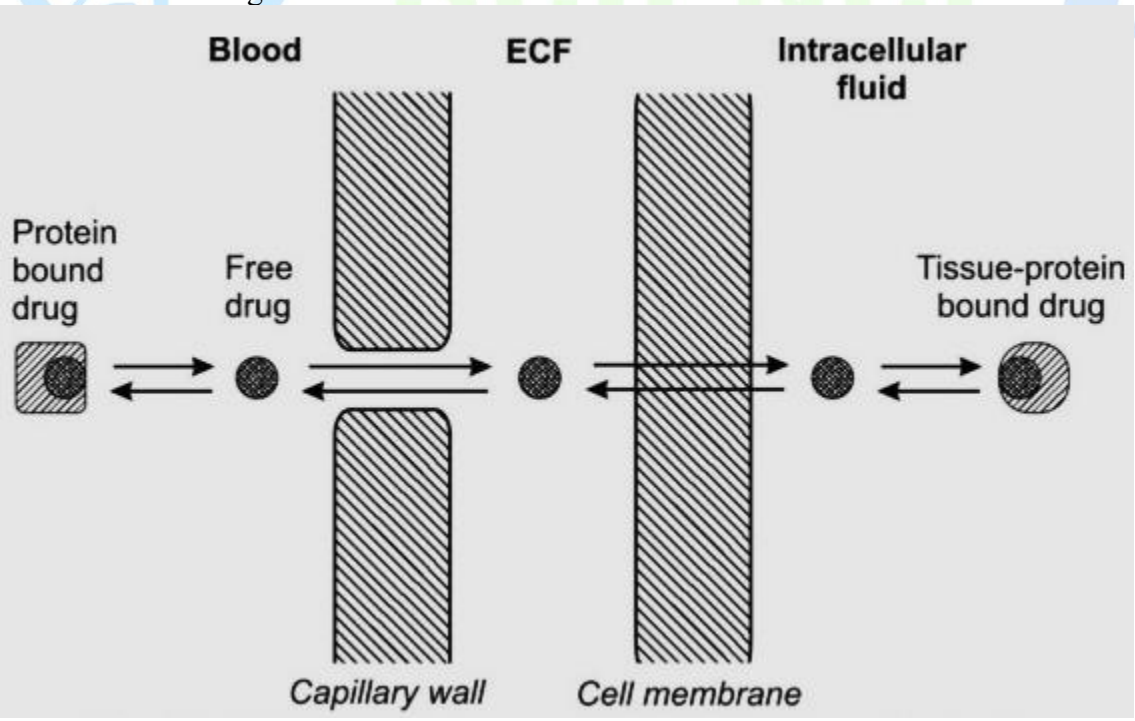

3. **Factors Influencing Absorption:**
    - **Drug Formulation and Particle Size:** Smaller particles and certain formulations enhance absorption.
    - **Blood Flow to Absorption Site:** Higher blood flow increases absorption.
    - **pH and Drug Ionization:** Ionization state affects absorption; non-ionized forms generally absorb better.
    - **Surface Area for Absorption:** Larger areas (like the intestines) provide more absorption capacity.
4. **Bioavailability:**
    - Refers to the fraction of an administered dose that reaches systemic circulation in its active form.
    - Oral drugs often have lower bioavailability due to breakdown in the GI tract and first-pass metabolism in the liver.




5. **First-Pass Effect:**
    - Oral drugs are metabolized in the liver before reaching systemic circulation, reducing their effective concentration.

**DRUG DISTRIBUTION**:

**Definition:** Drug distribution refers to the process by which a drug is dispersed throughout the body after absorption. It involves the transportation of the drug to its site of action, as well as to other tissues and organs.



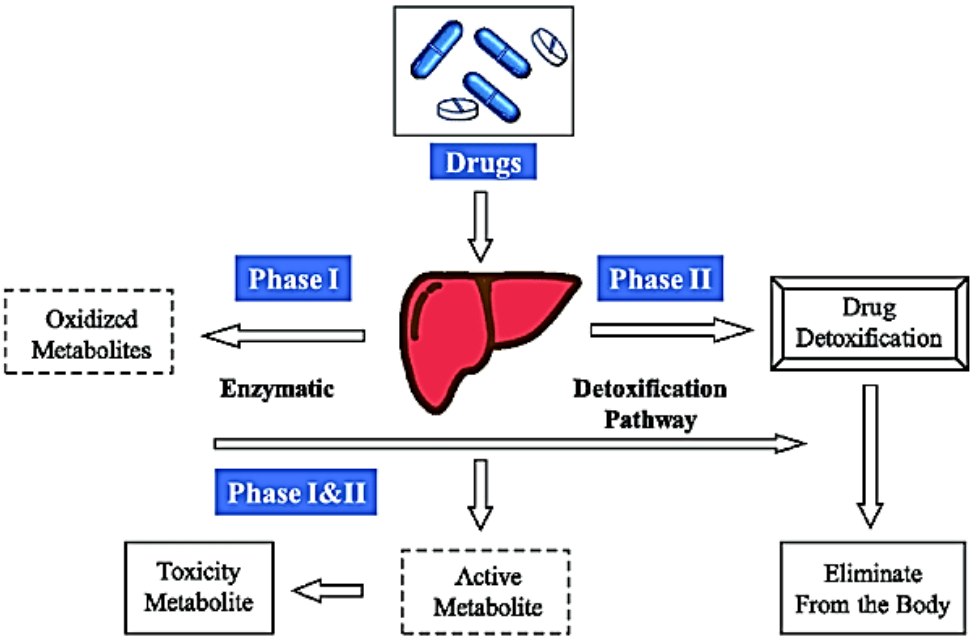
**Key Points:**

1. **Bloodstream Transport:**
   - Once absorbed, drugs are carried by the bloodstream to various body tissues.
   - The extent and rate depend on the drug's chemical properties and the body's physiology.
2. **Protein Binding:**
   - Many drugs bind to plasma proteins (like albumin) in the blood.
   - Only the unbound (free) drug can exert a pharmacological effect or be metabolized and excreted.
3. **Tissue Permeability:**
   - Drugs must pass through tissue membranes to reach their target cells.
   - Lipid-soluble drugs easily penetrate cell membranes, while water-soluble drugs may require transport mechanisms.
4. **Blood-Brain Barrier:**
   - A selective barrier that limits drug entry into the brain.
   - Only drugs that are lipid-soluble or have a transport system can cross effectively.
5. **Volume of Distribution (Vd):**
   - A pharmacokinetic parameter indicating the extent of drug distribution.
   - It's the theoretical volume required to contain the total drug amount in the body at the same concentration as in the plasma.
6. **Factors Affecting Distribution:**
   - **Cardiac Output:** Influences the rate at which drugs are delivered to different tissues.
   - **Local Blood Flow:** Areas with higher blood flow receive the drug more rapidly.
   - **Tissue Binding:** Drugs may accumulate in certain tissues, affecting their concentration in plasma and other tissues.
7. **Drug Reservoirs:**
   - Some drugs accumulate in specific tissues (like fat or bone), creating reservoirs from which the drug is slowly released.

**METABOLISM**:

**Definition:** Drug metabolism refers to the biochemical modification of pharmaceutical substances by living organisms, usually through specialized enzymatic systems.

This process primarily occurs in the liver and affects a drug's pharmacological activity and its elimination from the body.




**Key Points:**

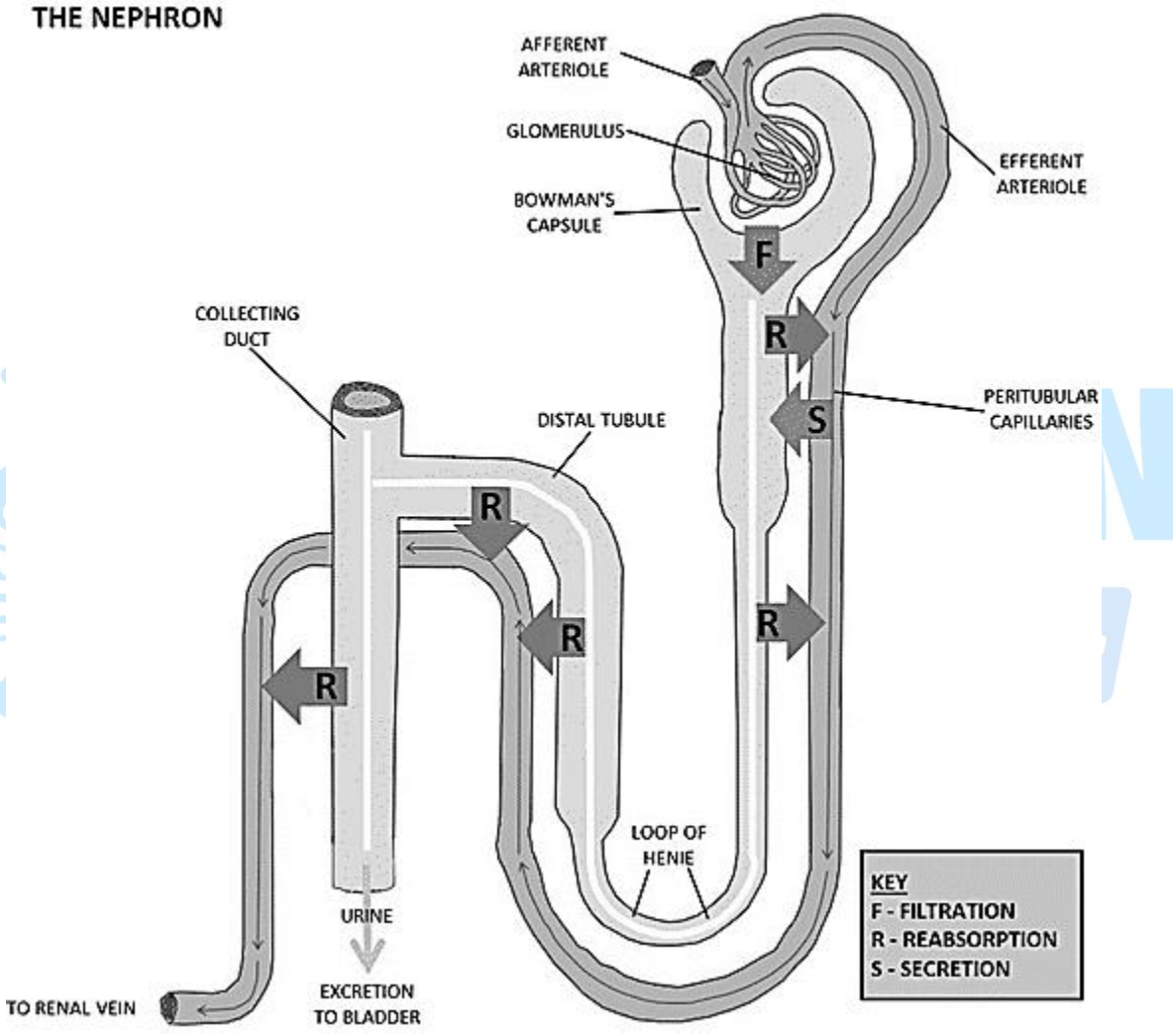
1. **Primary Location - Liver:**
   - The liver is the main site for drug metabolism, involving enzyme systems like Cytochrome P450 (CYP450).
   - Metabolism transforms lipophilic substances into more hydrophilic compounds for easier excretion.
2. **Phases of Metabolism:**
   - **Phase I Reactions (Functionalization):** Include oxidation, reduction, and hydrolysis. These reactions introduce or unmask functional groups (like -OH, -NH2).
   - **Phase II Reactions (Conjugation):** Involve conjugation with an endogenous substance (like glucuronic acid, sulfate, glycine) making the drug more water-soluble.
3. **Enzyme Induction and Inhibition:**
   - Some drugs can induce or inhibit metabolic enzymes, affecting the metabolism of other drugs and leading to interactions.
4. **First-Pass Effect:**
   - Oral drugs may undergo extensive metabolism in the liver before reaching the systemic circulation, reducing their bioavailability.
5. **Factors Influencing Metabolism:**
   - **Genetics:** Genetic variations can affect enzyme activity.
   - **Age and Health:** Metabolic rate varies with age, liver function, and certain health conditions.
   - **Drug Interactions:** Concurrent medications can affect metabolic rates.
   - **Diet and Lifestyle:** Diet and habits like smoking can influence drug metabolism.
6. **Metabolites:**
   - Metabolism often results in drug inactivation, but some drugs become active or toxic after metabolism.

7. **Excretion:**
    - Metabolized drugs are usually excreted via the kidneys (urine) or in the bile (feces).

**EXCRETION**:

**Definition:** Drug excretion is the process through which the body eliminates drugs and their metabolites.

It is a critical phase of pharmacokinetics, ensuring that drugs and their by-products are safely removed to prevent toxicity.




**Key Points:**

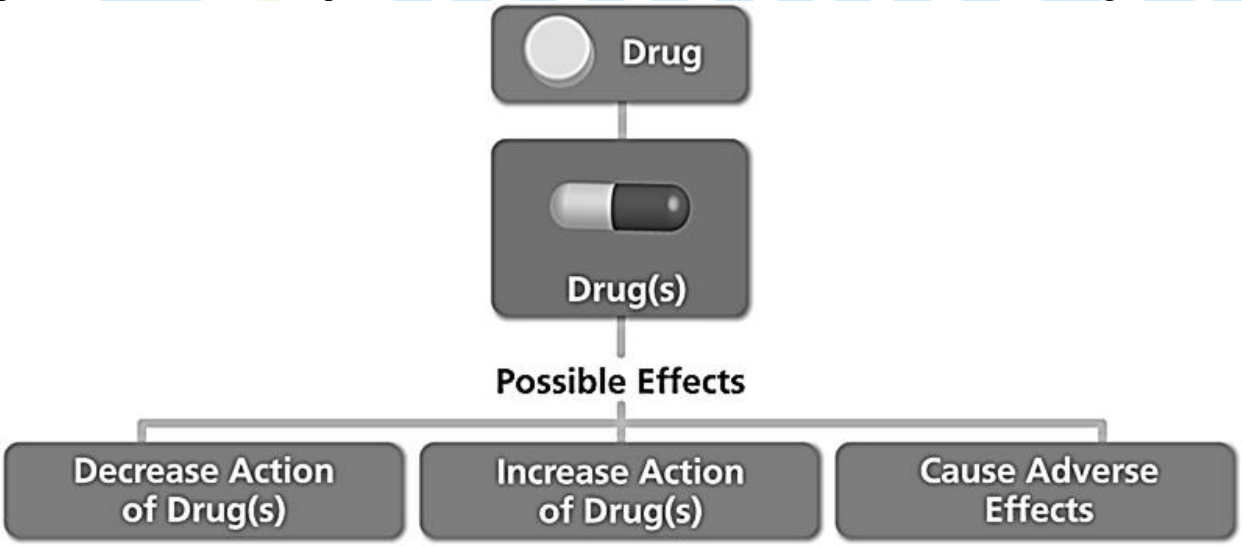
1. **Main Routes of Excretion:**
    - **Kidneys (Urine):** The primary route for most drugs, especially water-soluble compounds and their metabolites.
    - **Liver (Bile and Feces):** Drugs and metabolites can be excreted into bile and eliminated in feces, especially for lipid-soluble compounds.
    - **Others:** Additional routes include lungs (for volatile substances), sweat, saliva, and breast milk.
2. **Renal Excretion Process:**
    - Involves glomerular filtration, tubular secretion, and tubular reabsorption.

- Water-soluble substances are easily filtered and excreted in urine.
- Tubular secretion actively transports drugs into urine.
- Tubular reabsorption allows for the return of some substances to the bloodstream.

3. **Factors Affecting Renal Excretion:**
   - **Kidney Function:** Impaired renal function can reduce drug clearance.
   - **Urine pH:** Alters the ionization state of drugs, affecting reabsorption.
   - **Age:** Infants and elderly individuals often have reduced excretion capacity.
4. **Biliary Excretion:**
   - Drugs excreted into bile may undergo enterohepatic recirculation, prolonging their presence in the body.
5. **Importance of Excretion Rate:**
   - Determines the overall elimination half-life of a drug.
   - Affects drug dosing and frequency to avoid accumulation and toxicity.
6. **Drug Clearance:**
   - Refers to the volume of plasma cleared of the drug per unit time.
   - Indicates the efficiency of the excretion process.

**INTERACTION**

Pharmacokinetic interactions between drugs happen when one drug influences the pharmacokinetics—absorption, distribution, metabolism, or excretion—of another drug.




Here's a more detailed look at each stage with examples:

1. **Absorption**:
   - **Interaction**: When drugs alter the environment in the gastrointestinal tract, they can impact how other drugs are absorbed.
   - **Example**: Calcium supplements may reduce the absorption of the thyroid medication levothyroxine. Calcium binds to levothyroxine in the gut, making it less available to the body.
2. **Distribution**:
   - **Interaction**: Some drugs can displace others from protein binding sites in the blood, altering the free (active) concentration of the displaced drug.

- **Example**: The anti-inflammatory drug ibuprofen can displace warfarin from its protein binding sites, potentially increasing the risk of bleeding because more active warfarin is left circulating in the bloodstream.

3. **Metabolism**:
   - **Interaction**: Drugs can affect the activity of enzymes that metabolize other drugs, usually those involved in the cytochrome P450 system.
   - **Example**: Grapefruit juice contains compounds that inhibit CYP3A4, an enzyme that helps metabolize many medications, such as certain statins. Drinking grapefruit juice while taking these statins can lead to higher statin levels in the blood and increase the risk of side effects.
4. **Excretion**:
   - **Interaction**: Drugs can affect the filtration, reabsorption, or active secretion of other drugs in the kidneys, altering their elimination from the body.
   - **Example**: The diuretic furosemide can increase the elimination of lithium, potentially leading to decreased lithium levels in the body and reduced effectiveness of lithium for treating bipolar disorder.

## REVIEW: PRINCIPLES OF DRUG ADMINISTRATION AND TREATMENT INDIVIDUALIZATION

1. **Understanding Drug Administration**:
   - **Fundamentals**: Involves ensuring that medications are administered safely and effectively, following the Six Rights of Drug Administration (Right Medication, Dose, Time, Route, Patient, and Documentation).
   - **Patient Safety**: Paramount in drug administration, focusing on avoiding medication errors and adverse drug reactions.
2. **Treatment Individualization**:
   - **Patient-Specific Factors**: Includes tailoring medication regimens based on patient age, weight, organ function (especially kidney and liver), genetics, allergies, and concurrent medications.
   - **Disease Considerations**: Takes into account the specific type and stage of the disease, potential drug-disease interactions, and the therapeutic goals.
3. **Effective Communication**:
   - **With Patients**: Essential for ensuring understanding of medication purpose, dosing schedules, potential side effects, and addressing concerns or misconceptions.
   - **Among Healthcare Providers**: Critical for coordinating care, especially when multiple providers are involved in a patient's treatment.
4. **Monitoring and Follow-Up**:
   - **Assessment of Effectiveness**: Regular evaluation of the treatment's impact on the disease or condition.
   - **Side Effects and Adverse Reactions**: Monitoring for any unwanted effects and adjusting therapy as needed.
5. **Educational Aspects**:
   - **Patient Education**: Instructing patients on proper medication use, storage, and what to do in case of missed doses or side effects.

- **Health Literacy**: Understanding the patient's level of health literacy to tailor the communication effectively.

6. **Ethical and Legal Considerations**:
   - **Informed Consent**: Making sure patients understand the risks and benefits of their treatment.
   - **Privacy and Confidentiality**: Respecting patient privacy in all aspects of treatment and medication administration.
7. **Continual Learning and Updating Knowledge**:
   - **Staying Informed**: Keeping up-to-date with the latest in pharmacotherapy and treatment guidelines.
   - **Professional Development**: Engaging in ongoing education and training.

**FACTORS AFFECTING DOSE, ROUTE ETC**

1. **Patient Age**:
   - **Infants and Children**: Require lower doses due to smaller size, immature organ systems.
   - **Elderly**: Often need lower doses due to decreased organ function, altered drug metabolism.
2. **Body Weight and Body Surface Area**:
   - **Dosage Adjustment**: Heavier patients may require higher doses; some drugs are dosed based on body surface area, especially chemotherapeutic agents.
3. **Gender**:
   - **Physiological Differences**: Can influence drug distribution and metabolism; for example, hormonal differences can affect drug action.
4. **Organ Function**:
   - **Liver Function**: Critical for drug metabolism; impaired liver function can necessitate dose reduction.
   - **Kidney Function**: Essential for drug excretion; renal impairment may require dose adjustment to avoid toxicity.
5. **Genetic Factors**:
   - **Metabolic Enzymes**: Genetic variations can affect drug metabolism speed, impacting efficacy and risk of side effects.
   - **Receptors and Transporters**: Genetic differences can alter drug targets and transport, affecting drug response.
6. **Route of Administration**:
   - **Oral**: Convenient, but influenced by gastrointestinal factors like pH, presence of food.
   - **Intravenous**: Offers direct access to the bloodstream, suitable for drugs not absorbed orally.
   - **Intramuscular/Subcutaneous**: Used for slower absorption than IV; tissue perfusion can affect absorption rate.
7. **Drug Interactions**:
   - **Pharmacodynamic Interactions**: When two drugs have additive or opposing effects.
   - **Pharmacokinetic Interactions**: Affecting absorption, distribution, metabolism, or excretion of drugs.
8. **Disease State**:

- **Chronic Conditions**: Diseases like heart failure, liver cirrhosis, or diabetes can affect drug pharmacokinetics and pharmacodynamics.
- **Acute Illnesses**: Such as infections, can alter drug metabolism and excretion.

9. **Food and Nutritional Status**:
    - **Food Interactions**: Some drugs need to be taken with or without food; malnutrition can affect drug metabolism.
10. **Adherence to Therapy**:
    - **Ease of Administration**: Affects patient adherence; complex regimens may reduce compliance.
    - **Patient Education**: Understanding of medication purpose, dosing, and side effects influences adherence.
11. **Psychological Factors**:
    - **Placebo Effect**: Patient beliefs and expectations can affect drug response.
    - **Mental Health**: Conditions like depression or anxiety can influence drug response and adherence.
12. **Environmental Factors**:
    - **Exposure to Pollutants**: Can affect drug metabolism.
    - **Climate and Altitude**: Can influence drug stability and absorption.

## INDIAN PHARMACOPOEIA: LEGAL ISSUES, DRUG LAWS, SCHEDULE DRUGS

### INDIAN PHARMACOPOEIA (IP): LEGAL ISSUES

- The Indian Pharmacopoeia Commission (IPC) is an autonomous institution of the Ministry of Health and Family Welfare in India.
- IPC sets standards for all drugs manufactured, sold, and consumed in India.
- Central drug authority, based in Nirman Bhawan, New Delhi, formulates policies, while state drug authorities implement them.
- Three agencies regulate drug administration: Advisory agency, Analytical agency, and Executive agency.
- Drug laws are designed to ensure the quality, safety, and efficacy of drugs.

### DRUG LAWS:

1. **Opium Act, 1878:**
    - Regulates cultivation of poppy and activities related to opium.
2. **Poisons Act, 1919:**
    - Controls possession, import, and sale of poisons.
3. **Dangerous Drugs Act, 1930:**
    - Prohibits cultivation of opium plant, manufacturing, and sale of opium products.
    - Central government controls opium production, and transport is under state government control.
4. **Drugs and Cosmetics Act, 1940:**
    - Originally for Allopathic drugs, now includes Ayurvedic, Unani, Siddha, Homeopathic drugs, and Cosmetics.
5. **Pharmacy Act, 1948:**
    - Aims at better regulation of the pharmacy profession.
6. **Drugs and Magic Remedies (Objectionable Advertisements) Act, 1954:**

- Prevents misleading advertisements related to drugs and magic remedies.

7. **Medicinal and Toilet Preparations Act, 1955:**
   - Regulates preparations containing alcohol to prevent misuse.
8. **Narcotic Drugs and Psychotropic Substances Act, 1985:**
   - Prohibits cultivation, manufacture, sale, purchase, use, or transport of narcotic and psychotropic drugs.
9. **Drug (Price Control) Order, 1995:**
   - Under Essential Commodities Act, controls prices of bulk drugs and drug formulations.

**SCHEDULES OF DRUGS IN INDIA:**

1. **Schedule C:**
   - Includes biological and special intravenous products like vaccines, sera, antigens, insulin, adrenaline.
2. **Schedule $C_1$:**
   - Encompasses cardiac glycosides, ergot, hormones, and preparations not given parenterally.
3. **Schedule E:**
   - Includes poisonous drugs, regulating their storage and sale.
4. **Schedule F, $F_1$:**
   - Covers vaccines and sera.
5. **Schedule G:**
   - Warns that it is dangerous to take these drugs without medical supervision.
   - Examples: Anticancer drugs, antidiabetic drugs.
   - Containers should be labeled in red bottles against a white background.
6. **Schedule H:**
   - Drugs to be sold under physician prescription only.
   - Warning: "To be sold on the prescription of a Registered Medical Practitioner only."
   - Symbol R on the label's left top corner. If covered under The Narcotic Drugs and Psychotropic Substances Act, use symbol NR.
   - Examples: Acyclovir, alprazolam, amitriptyline, atenolol, azathioprine, barbiturates.
7. **Schedule J:**
   - Includes drugs used for incurable diseases like AIDS, cancer, and congenital malformations.
8. **Schedule L:**
   - Covers antibiotics; these drugs should be sold only on prescription.
9. **Schedule X:**
   - Includes psychotropic drugs.
   - Label warning: "Schedule X drug."
   - Warning: "To be sold on prescription of a registered medical practitioner only."
   - Examples: Amphetamine, barbiturates, methaqualone, glutethimide.
10. **Schedule Y:**
    - Includes new drugs under investigation.

## RATIONAL USE OF DRUGS

**Definition:** The rational use of medicines requires that patients receive their individual requirements for an adequate period, at the lowest cost to them and their community.

**Examples of Irrational Drug Use:**

1. Poly-pharmacy: Use of too many medicines per patient.
2. Inappropriate use of antimicrobials: Often in inadequate dosage for non-bacterial infections.
3. Over-use of injections: When oral formulations would be more appropriate.
4. Failure to prescribe in accordance with clinical guidelines.
5. Inappropriate self-medication: Often with prescription-only medicines.
6. Non-adherence to dosing regimens.

**Considerations for Rational Drug Use:**

1. **Clear Objective:**
   - Define the treatment objective before choosing drugs.
   - Example: For hypertension, the objective is to bring down blood pressure to prevent complications.
2. **Wisely Choose from Available Drugs:**
   - Make wise choices considering the availability of many drugs for various diseases.
   - Factors to consider: Age, presence of other diseases, renal and liver function, other administered drugs, and cost of therapy.
3. **Consider Therapeutic End Point:**
   - Define the therapeutic end point of treatment.
4. **Consider Combination Therapy:**
   - When using a combination of drugs, consider therapeutic benefits, avoid drugs with overlapping adverse effects, and consider the cost of therapy.
   - Avoid irrational combinations of drugs.

**Examples of Irrational Drug Combinations:**

1. **Ibuprofen with Paracetamol:**
   - No useful purpose; either medicine can be given based on the requirement.
2. **Diclofenac + Nimesulide:**
   - No useful purpose; either drug can be given based on the requirement.
3. **Ciprofloxacin + Tinidazole:**
   - Increased risk of toxicity, adds to the cost of therapy, and serves no useful purpose.

## PRINCIPLES OF THERAPEUTICS

**Principles of Therapeutics: Six Rights of Drug Administration:**

1. Right Medication
2. Right Dose
3. Right Time
4. Right Route

5. Right Patient
6. Right Documentation

1. **Right Medication**: Ensuring that the medication given is the one that was prescribed. This involves checking the medication label and the prescription.
2. **Right Dose**: The patient must receive the amount prescribed, no more or less. This involves measuring the medication accurately.
3. **Right Time**: Administering the medication at the correct time, as some medications need to be taken at specific times for the best effect or to maintain consistent levels in the bloodstream.
4. **Right Route**: Making sure the medication is given the way it was intended to be taken, whether orally, intravenously, topically, etc.
5. **Right Patient**: Verifying the identity of the patient before giving the medication to prevent administering the drug to the wrong person.
6. **Right Documentation**: Recording every detail of the medication administered (what, when, how much, by which route) to maintain an accurate medical record and to ensure proper follow-up and accountability.

# Next Portion of Notes will be available in PAID VERSION of Notes.



## Student Helpline 88189-52923