A Overview to General Principles of Pharmacology and Toxicology

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What is Pharmacology?

Pharmacology is the study of drugs and their interactions with living Systems. It comes from the Greek: *pharmakon* (drug), *Logos* (studies)

Samuel Dale in 1693 wrote the 1st book of Pharmacology.

Oswald Schmiedberg (1838-1921) is the father of Modern Pharmacology.
Why Do We Study Pharmacology?

A. It’s good for you
B. You will be able to use fancy terms like ‘bioavailability’
C. My instructor likes torture
D. We must understand why our patient is getting a medication, and HOW IT WORKS
How Do We Study Pharmacology?

**Drug Delivery**

*Pharmacokinetics* (how the body absorbs, distributes, metabolizes, and excretes drugs)

*Pharmacodynamics* (study the mechanisms by which drugs work, also study endogenous agents)

Experimental Pharmacology deals with the study of drug effects in laboratory animals.

- In vitro – Isolated tissue
- In vivo – Intact organism

Clinical Pharmacology deals with the study of drug effects in human beings, (healthy volunteers and patients)
Areas of Pharmacology

*Pharmacotherapeutics*: use of drugs to diagnose, prevent and treat disorders; the emphasis is on clinical management

*Pharmacoepidemiology*: study of the effect of drugs on populations; questions dealing with the influence of genetics are particularly important

*Pharmacoeconomics*: study of the cost-effectiveness of drug treatments; the cost of medications is of worldwide concern, particularly among certain groups such as the elderly and AIDS patients
We are talking about drug, what is a drug?

A drug is a chemical substance that affects processes in living organism & used for treatment, prophylaxis (prevention) or diagnosis of the disease.

WHO defines a drug as a chemical substance or biological product that is used or intended to be used to modify or explore physiological systems or pathological states for the benefit of the recipient.
Drugs & Medications

Drug is called medicine when used in proper dosage form for safe administration.

All medicines are drugs but All drugs are not medicines
Types of Drugs

*Essential drugs* are those drugs which satisfy health care needs of the majority of the population, be available at all times in adequate amounts, in appropriate dosage forms and at reasonable cost.

*Orphan Drugs:* When a drug is not developed into a usable medicine because the costs will not be recovered by the developer then it is known as orphan drug & the disease is an orphan disease. Orphan drugs are those which are used for treatment, prevention or diagnosis of rare diseases like Kala-Azar, Cancers, Viral diseases, Heavy metal Poisoning.

*Official Drugs:* An official book published by authorized body in a country containing description of commonly used drugs with their sources, properties, uses, doses, purity and potency is called Pharmacopoeia. Drugs contained in pharmacopoeia are official drugs. (I.P. – Indian pharmacopoeia; B.P. – British pharmacopoeia, U.S.P. – United states pharmacopoeia.)
Sources of Drugs

Natural

Synthetic

Semi-synthetic

Biosynthetic

Gene based therapy (Gene therapy)
Natural Drugs

Natural Drugs

• Plants (e.g. Morphine from Poppy capsules; Atropine from belladonna leaves; Quinine from Cinchona bark; Castor oil from castor seeds).

• Animals (e.g. Insulin from Pig or Ox pancreas; Thyroxine from Pig or Ox thyroi gland; Heparin from Pig or Ox liver; Cod Liver Oil from Cod fish Liver).

• Microorganisms (e.g. Penicillin from Penicillium notatum; Streptomycin from Streptomyces griseus; Bacitracin from Bacillus subtilis, Diastase from Aspergillus orzae).

• Minerals (e.g. Calcium, Magnesium, Aluminium, Sodium, Potassium & Iron salts
  – Liquid paraffin from petroleum.)
Synthetic – Semi Synthetic Drugs

Synthetic Drugs are prepared by chemical synthesis in pharmaceutical laboratories.

- Sulphonamides
- Salicylates
- Barbiturates
- Benzodiazepines

Semi-Synthetic Drugs are prepared by chemical modification of natural drugs in labs.

- Ampicillin from Penicillin-G.
- Dihydroergotamine from Ergotamine.
- Dehydroemetine from Emetine.
Bio-Synthetic Drugs

Bio-Synthetic Drugs are prepared by cloning of human DNA into bacteria like E.Coli.

• CLONING means production of identical subjects like parent.
• TECHNIQUE is called Recombinant DNA technology or Genetic Engineering.

Human Insulins
Human Growth Hormones (Somatrem, Somatropin)
Human Interferons, alpha & beta.
Tissue plasminogen activator (Alteplase)
Human BCG vaccine.
Human Hepatitis-B Vaccine
Properties of Ideal Drug - Main

1) Effective:
   • A drug that elicits the response. No effect=no justification of use

2) Safety:
   • Safe even at high concentrations and for long periods of administration; No habit forming aspects; No side effects
     (excessive dosage of opioid analgesics carries a risk of respiratory failure, cancer drugs increase infections, aspirin
     causes gastric ulcer etc…)

3) Selectivity:
   • One that elicits only the response for which it is given
   • Selective for specific reaction with no side effects (Drowsiness can be caused by antihistamines; Morning sickness, cramps, and
     depression can be caused by oral contraceptives)
Properties of Ideal Drug - Additional

1. Reversible action
   • Effects be reversible, i.e., removal/subside w/i specific time (1/2 life is short but potent during that time)
   • Example: General Anesthetic; Contraceptives

2. Predictability
   • Know how patient will respond

3. Ease of Administration
   • Number of doses should be low and easy to administer
   • 1. increase compliance & 2. decrease errors
     • Diabetic patient: Multiple daily injection of insulin
     • Intravenous infusion
Properties of Ideal Drug - Additional

4. Freedom from drug interactions
   • Should not augment or decrease action of other drugs or have adverse combined effects
     • Respiratory depression caused by diazepam (valium), which is normally minimal, can greatly be intensified by alcohol.
     • Antibacterial effects of Tetracycline can be greatly reduced by taking iron or calcium supplements

5. Low Cost
   • Easy to afford (especially with chronic illness)
     • Growth hormone (somatrem)
     • Lifelong medication: hypertension, arthritis, diabetes
Properties of Ideal Drug - Additional

6. Chemical Stability
   • No lose of effectiveness with storage

7. Possession of a simple generic name
   • Easy to remember and pronounce
     • Example: Viagra (sildenafil); Tylenol (acetaminophen)
Do we have an ideal drug?

NO!

All members of health care team (pharmacists, physicians, or nurses) must exercise care avoiding errors in administration routes and dosage at wrong time to promote therapeutic effects and minimize drug induced harm.

To promote desired effects and minimize adverse effects, we need to understand

- Pharmakokinetics
- Pharmacodynamics
- In addition
  - Sources of individual variation in drug response
Sources of individual variation

Each patient is unique in ability to respond and to how they each respond, but formation of “IDEAL DRUG” will lessen this variation.

Age- very important factor
Sex- due to hormonal differences
Weight- less effective and longer lasting in obese individuals
Kidney & liver functions - elimination of drug
Genetic variables- tolerance, allergy (not always genetic)

Pharmacokinetics
Pharmacodynamics
Pharmacokinetics

Kinesis means movement

Pharmacokinetics means what the body does to the drug.

• Absorption
• Distribution
• Biotransformation (Metabolism)
• Excretion
Pharmacodynamics

Dynamics means power

Pharmacodynamics is what the drug does to the body or the study of the biochemical & physiological effects of drugs & their mechanism of action.

Receptors, Enzymes, Selectivity
Dose response, Potency
Therapeutic efficacy, Tolerance
Ways of administration

Oral
Parenteral
  • Subcutaneous
  • Intramuscular
  • Intravenous
  • Epidural
  • Intraperional
Transdermal/dermal
Pulmonal
Nasal
Buccal/sublingual
Rectal
Vaginal
Ocular
Steps in Manufacture of Drugs

- Scientific Research to discover/synthesize new compounds, or improve existing compounds (R & D)
- Develop safe and effective applications of promising compounds
- Screen compounds in bacterial cultures or animal subjects
- Clinical trials on humans
Clinical Trials

• In Phase I trials, researchers test a new drug or treatment in a small group of people (20-80) for the first time to evaluate its safety, determine a safe dosage range, and identify side effects.

• In Phase II trials, the study drug or treatment is given to a larger group of people (100-300) to see if it is effective and to further evaluate its safety.

• In Phase III trials, the study drug or treatment is given to large groups of people (1,000-3,000) to confirm its effectiveness, monitor side effects, compare it to commonly used treatments, and collect information that will allow the drug or treatment to be used safely.

• In Phase IV trials, post marketing studies delineate additional information including the drug's risks, benefits, and optimal use.
Toxicology

Toxicology is the study of the untoward effects of chemical agents on living systems & their treatment. It is usually considered an area of pharmacology.