4) 19/01/23

→ General Pharmacology ←

P.C. is the science of drugs including their origin, composition, Pharmacokinetics, therapeutic use & toxicology.

P. Dynamics – What drugs does to the body. includes → Physiological & biochem effects of drugs & their MOA on organ.

P. Kinetics – what body does to the drugs. like → alteration of drug in body, ~~abs~~, ADME.

Drug – Single, active, chemical entity present in medicine that is used for diagnosis, prevention & treatment/ cure of the disease.

→ Routes of drug Admⁿ ←

Selection of drug depends upon:-

1) **Phy/chem prop. of drug** –
2) **Site of desired action** – drug ka effect locally ek site par or whole body.
3) **Bioavaibility** ✱
4) Metabolism

GENERAL PHARMACOLOGY

Routes of Drug Adm.

LOCAL
- Topical
- Ocular drops
- Deeper tissue
- Intranasal
- Rectal
- Vaginal

SYSTEMIC

Enteral :
- → Oral
- → Sublingual

Parenteral
- → Injections
  - IV, IM, Subcutaneous
  - → ~~Intradermal~~
  - → ~~Intramuscular~~
  - → Intraarterial
  - → Intravenous
  - → Intraspinal
- → Body

1) **LOCAL** – A drug used locally affect mostly the parts of body it comes in contact with.

1) **Topical** – External application of the drug. In the form of lotions, ointments, cream, powder.
→ skin, ear, eye, Anal canal.

2) **Deeper tissues** – Certain deeper areas of tissues are approached here.
→ The systemic Abs. is used.
Eg – Hydrocortisone inj in knee joint.

2) **Enteral** – Most convenient & commonly used.

→ **Oral Route** – Safer & convenient **RODA**.
– Cheap, painless.

– Both solid & liq. dosage form can be given orally.

→ Self medication is possible
→ Abs. is selective as per need.

Disadvantage → → Onset of action is slow.
→ May cause SE. like – Nausea & vomitting.
→ Drugs can be destroyed by our digestive juice.
→ Drugs may form complexes with food.
→ Drugs can be destroyed or altered in GIT & also in liver. This is Class first pass effect.

2) Sublingual – The drug in the form of tablet is put under the tongue.

⇒ ONLY LIPID SOLUBLE & non-irritating drugs can be adm. by this route.

→ The drug is absorbed straight into Systemic circulation.

Eg – Glyceryl Trinitrite in Heart attack &
Isoprenaline in Asthma.

disadv – If drug is to be used in large amt. & after long then, route becomes inconvenient.

Parenteral — Here, the drug does NOT enter GIT, it directly passes into circulation

Adv — Quick onset of action.
→ can be given to unconscious patients.
→ Desired concentrations can be achieved.
→ Comparitively smaller doses are required for effect.
→ "By-pass" effect is avoided.
→ Drugs that irritate stomach or cannot be abs. from stomach or intestine, can be given by this route

Disadv. — Self medication is not possible.
→ It is painful.
→ Needs proper technique of adm.
→ It is a risk factor for diseases like AIDS
→ The syringes used must be in sterilized condition & non-contaminated.

⇒ 1) IV. — It is QUICKEST route for fastest action of drug.
- It goes directly into blood circulation.
- Irritant substances can also be given by this route
→ It is indicated in Emergency conditions, Blood transfusion, for Anaesthecs.
⇒ All drugs can be adm. by IV route.

2) I.M. — The muscle has rich lymphatic supply hence the absorption is very rapid.
- Irritant drugs & suspensions can be injected by this route.
→ The site of inj. shld be away from nerves.
eg- Penicillin

Eg - Vaccines, Hormonal agents, Abs are given via I.M.

3) Subcutaneous - Drugs are injected under the skin.
- their Abs. is slow.
Eg- Adrenaline, Implants, Insulin.
- A short needle is used to inject into the layer btwn skin & muscle.

4) Intracardiac - It is quickly given int cardiac muscle when heart action is ~~stop~~ stopped.
this method rarely succeed.

Pharmacokinetic Drug - Drug Interaction.

- when 2 or more drugs are taken at same time, there is a possibility that the therapeutic action or any other action in the body is modified by another drug or any substance.
Polypharmacy is the main cause of D-D-I.

D-D-I can be — Beneficial - Eg - levodopa + carbidopa
↘ Adverse - Eg -

→ Drugs may alter the ADME of other drugs.

Eg - If one drug inhibits the metabolism of another drug, the 2nd drug may accumulate in our body & can cause toxicity.
& Adrenaline, if one drug induces the metabolism of 2nd drug, then the 2nd drug may be metabolized more quickly.

Pharmacokinetic DDI can also occur due to
→ GIT (1). Alteration in GIT function -
faster the drug passes thru the stomach & intestine, smaller the amt. of drug absorbed.
↓
this effects ADME of drugs.

Eg - ① Antacids & Antibiotics - AA can ↓ the abs. of Abs such as ~~tetracycline~~ tetracycline or ~~fluo~~ fluoroquinolones.

② ~~Grapefruit juice & statins~~

2) Ca^{+2} supplements & tetracycline - Ca^{+2} forms an insoluble complex with tetracycline in GIT which reduces the abs. of tetracycline, therefore it is recommended to seperate the adm. of tetracycline & Ca^{+2} supplements.

3) Atorvastatin & Ketoconazole & Erythromycin - Ator. is metabolized by liver enzyme, several medication like Erythromycin & ketoconazole, an antifungal drug inhibits this liver enzyme. & this ↑ the conc^{n} of Atorvastatin in blood.

(2) Due to Alteration in PH - PH can affect the ~~meta~~ pharmacokinetics of drugs in no. of ways. It can affect the conc^{n} & effectiveness of drugs.

Eg - (1) An antacid, $Al(OH)_3$, ↑ the pH of stomach which leads to reduction of abs. of certain Antibiotics like → tetracycline.

(2) Omeprazole & Ketoconazole - Omeprazole is an antacid, which ↑ the stomach PH. which reduces the abs. of ~~the~~ fluconazole.

(3) Due to Competition for plasma receptor sites:-

many drugs act by binding to specific receptors in the body, & when 2 drugs bind to the same receptor site, they can compete for binding, leading to altered drug effects.

Eg- Tramadol & An antidepressant, fluoxetine, both act by inhibiting the serotonin in brain. Then 2 drugs compete with each other,

↓

leading to ↓ in effectiveness of both drugs.

↓

↑ in serotonin.

(4) Due to Alteration in Mucosa:-

- NSAIDs & Anticoagulants, such as warfarin can both cause mucosal damage in GIT, leading to ↑ in bleeding risk.

5) Due to Alteration of transport Mechanism:-

- drug interaction may interfere in transport mechanism by competing in transport cycle.

Eg Methyldopa will be absorbed slowly in presence of certain Natural Amino acids.

Pharmacokinetics

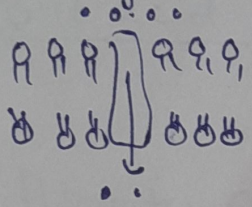
— P.K. is a part of Pharmacology which deals with the Absorption, Distribution, Metabolism & Excretion of drugs

1) ABSORPTION of drugs.

- It is the passage of drugs from its route of adm. to systemic circulation.

Drug Abs. ~~can occur~~ via mmb. can happen in 4 diff ways.

1) Passive diffusion- Drugs move from area of high conc^n → low conc^n



Most of the drugs are abs. by this mech.

- Energy Independent (No use of energy)

2) facilitated diffusion- Drugs esp. larger molecules will cross the mmb. by the help of ~~carrier~~ carrier protein. diffu^s via high conc^n → low conc^n

- Energy Independent

3) Active transport - Energy dependent.

Energy is used in the form of ATP.

- Movement of molecules from low conc^n to high conc^n.

- ATP

↓ Hydrolysis

ADP + IP ← High Energy is released here.

4) Endocytosis - Drugs of VERY large size gets transported via engulfment of cell mmb bcz of their large size, they would not fit in a channel or a small molecule.

X 19 IMP factors affecting Abs. of drugs:-

1) Particle size - Smaller the particle size, greater is the abs.

A tablet containing large aggregates cannot be abs easily & therefore their abs. is slow.

2) Route of Adm. - The way the drug is administered affect abs. Drugs adm. IV bypass the GIT & are rapidly absorbed. while drugs taken orally must pass through GIT before abs occurs.

3) Ionisation - Non-ionized drugs are more lipid soluble than ionized drugs which are less lipid soluble.

- The PH of our stomach is acidic, so, the drugs which are ~~weak~~ acidic are usually abs. from stomach. Eg - Salicylates.

- The PH of Intestine is Basic, so, the drugs which are basic in nature are abs. from intestine.

4) Physical State of the drug - Liquids are absorbed better than solids. Smaller the particle size, greater the abs.

5) Blood flow - Greater the blood supply, greater the abs. Tissues with higher blood supply such as lungs, have a faster rate of abs.

6) Foods & Drinks. - The presence of food ~~in the~~ retards the abs., so the drug is advised to be taken before meal. However, if drug cause irritation then its advised to be taken after meal.

Tetracycline forms a complex with Ca^{+2}, hence it is advised to be taken with water & not with milk & Ca^{+2}

7) Diseased cond^n – certain diseases can affect the abs. of drug.
Eg – Intestinal disease that affect the lining of GIT can decrease the abs.
while liver disease affects metabolism
– In diarrhea, there is increased peristalic activity
So, the abs. of drug is reduced.

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2) DISTRIBUTION OF DRUGS.

– when the drug is absorbed, it is distributed ~~to various part~~ throughout the body fluids & tissues.

factors affecting Dist. of Drugs:-

1) Lipophilicity – lipophilic drugs tends to dissolve the mmb more easily than hydrophilic drugs.
– lipophilic drugs tend to accumulate in fatty tissues while, Hydrophilic drug tend to distribute more to Aqueous tissues.

2) Blood flow – some organs such as Brain, receive more blood flow than skin.
So, the drug which crosses BBB tends to more distributed in brain compared to skin

3) Protein Binding – It is an VIMP factor.
– Many drugs binds to Plasma proteins – such as – ~~Albumin~~ Albumin.

Protein binding of the drug is a reversible interaction btw^n drug & plasma protein.
~~Drugs that tightly bound to protein~~
– Protein binding serves as storage of drugs.
So, the drug half life gets longer & its dist. is decreased.

4) Tissue Binding – Certain drugs are bound to particular tissues. i.e. There is localization of drugs. Eg- Cardiac glycosides are localised in cardiac proteins.

5) PLACENTAL Barrier - The placental exchanges materials btwn maternal & foetus. So, most of drugs already abs. in foetal circulation. the placental mmb is lipid soluble, so the drug can easily cross placenta via simple diffusion.

6) Vol. of Dist. (Vd) – It is the ratio btwn the amt. of drug in the body & the conc^n of drug in plasma.

$$V_D = \frac{\text{Amt of drug in the body}}{\text{conc}^n \text{ of drug in plasma}}$$

The high value of Vd indicates that the drug is widely dist. thruout the body.
while, the low Vd indicates the drug is mainly confined to blood plasma ~~or d fp tissue~~. :-(

→ VD is an IMP parameter
↓
It is used to determine the t1/2 & dose of a drug.

3) BIOTRANSFORMATION of DRUGS -

(Also klas Metabolism)

- It is the process by which the drugs are generally inactivated & their nature is changed.

~~to make them more easily~~

so that they are easily excreted.

- This process occur mainly via liver (tho other organs are involved too)

- Biotransfn helps the drug → more water soluble, less toxic, less bound to plasma proteins.

→ Terminologies:-

1) Prodrug - It is a pharmacologically ~~inactive~~ inactive compound that is converted in the body into a pharmacologically active drug.

It is used to → 1) Improve the ~~dd~~ Pharmacokinetics of drugs.

2) to ↓ toxicity

3) To target the drug to a sp. tissue

Eg - Codeine - It is a prodrug of Morphine.
- used to treat cough. Morphine is converted to codeine by liver enzymes

- Prednisone - It is a prodrug of Prednisolone.
used to treat inflamm^{n}. Prednisone is converted to Prednisolone by liver enzymes.

2) Microsomal enzymes - Also klas Mixed function oxidases.

- are the gp. of enzymes found in E.R. of liver cells.
These enzymes are responsible for metabolising a wide range of compounds.

The most well known is Cytochrome P450 (CYP 450).

3) Enzyme Induction- Certain drugs activate the microsomal enzymes by either increasing in formⁿ of these enzymes i.e protein synthesis or by inducing synthesis of cytochrome C reductase. This activation is cled- enzyme induction.

4) Enzyme Inhibitor - Various drugs inhibits the activity of Microsomal enzymes. & hence retard the biotransformation of their own as well as other drugs. This is cled enzyme inhibition.

Biotrafⁿ of drugs occur via 2 phases. - Phase I
- Phase II

Phase I

oxidⁿ → most common pathway

drug - R → Hydrolysis, Redⁿ occurs

Phase II

conjugation, Acetylation, sulfation occurs.

factors effecting Biotrafⁿ of drugs :-

1) Dose & adm. of drugs.
2) Age - childrens have lesser quantity of enzymes. younger individuals tend to metabolize drugs more quicky than older individuals.
3) Enzyme Inhibitⁿ & Induction.
4) Liver disease - Liver metabolizes larger amt of drug. any liver disease can impair the bodys ability to metabolize drugs. which may lead to toxicity & adverse effects.
5) Exposure to toxins, cigarettes, smoke & pollution effect drug metⁿ.
6) Hepatic blood circulation.

4) Elimination of DRugs :-

- The last P.K. process is elimination. → which refers to clearing of drug from the body. ~~mainly~~ via Drugs are mostly excreted through → Urine (Kidney), or can be excreted thru Stool, Expiration (Lungs.).
Minor excretion of drugs also occur through sweat, bile, tears.

factors affecting Elimⁿ of drugs :-

1) Kidneys - ~~kidneys~~ they do this process via 3
   1) Glomerular filtration
   2) ~~tubular~~ selective reabsorption
   3) ~~Selective~~ Tubular secretion.

In G.f., Protein bound drugs are not filtered. hence, protein bound drug cannot be excreted. They're excreted only if they're released from protein.

→ Unionized drug can be reabsorbed well. so they are not excreted. while ionized drugs are excreted out.

2) General Anaesthetics like - Ether, Chloroform, Nitrous oxide are excreted thru lungs.

3) Dosage - Higher dose of drugs may take longer to be eliminated from the body

4) Age - The elimⁿ of drugs may be slower in older ppl. due to decline in kidney & liver function.

5) Metabolism - the quicker the metⁿ the faster the Elimination.

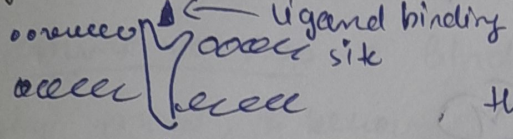
PHARMACODYNAMICS

- It explains the biochemical & physiological effects of drug in to our body. In short what a drug does to our body.

When drug enters the body, it starts interacting with cell receptors

Receptor types - 1) Ligand-gated ion channels
2) GPCR
3) Enzyme linked receptors
4) ~~Intracellular~~ Nuclear receptor

1) Ligand-gated ion channel -

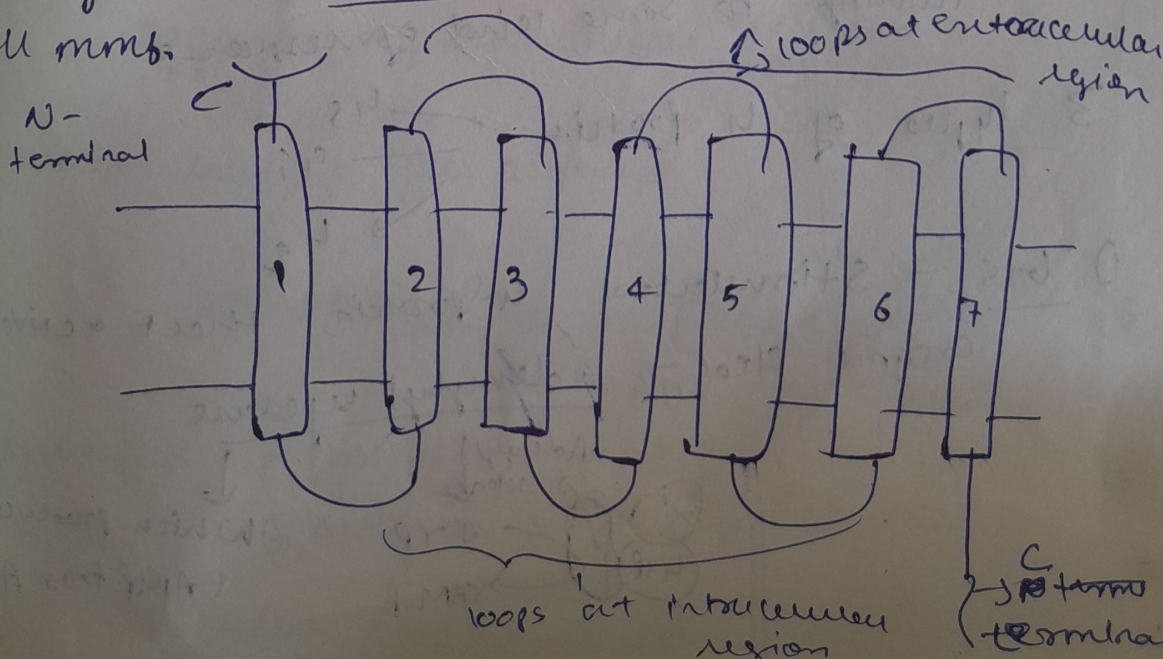


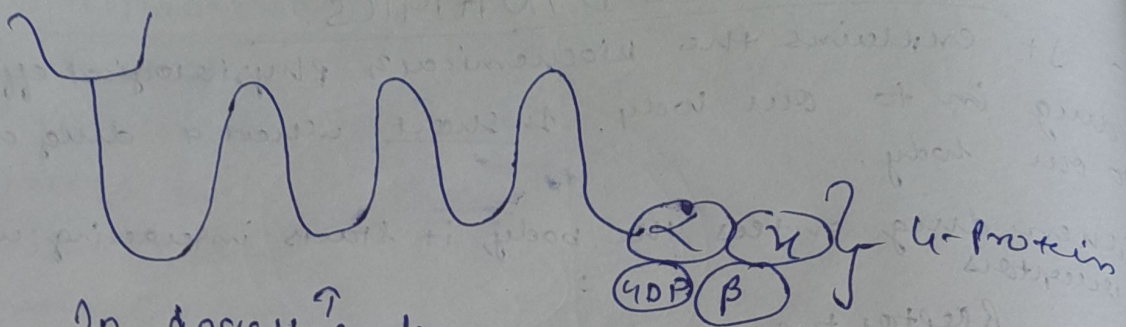
↓ when ligand binds to it, the channel opens ↓ which allows ions such as Na^+, K^+, Ca^{2+} to enter.

2) GPCR - G-Protein coupled receptor.

- It is a large family of membrane proteins. which plays a critical role in cell signaling.
- Also class → Seven-transmemb. receptor.

bcz they have 7 α-helical domains that span the cell memb.

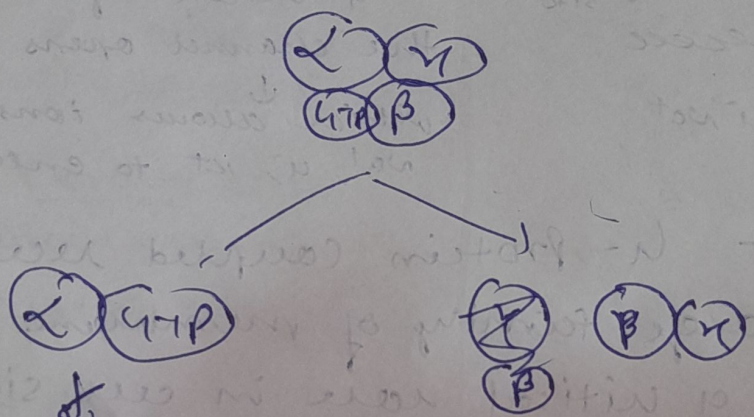




→ In inactive form.

↓

When ligand binds to receptor, affinity for GTP ↑, so then, GTP replaces GDP.



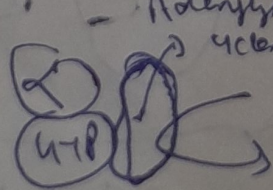
Both these complex interact with other enzymes ~~rotate~~

↓

leading to some kind of response

3 types of G-Protein - Gs
Gi
Gq

1) Gs - Stimulated G-protein, that activates enzyme clear - adenylyl cyclase



↓

Which produces cAMP from ATP

2) Gi - Inhibitory G protein, inhibits adenylyl cyclase
↓
lowers cAMP level.

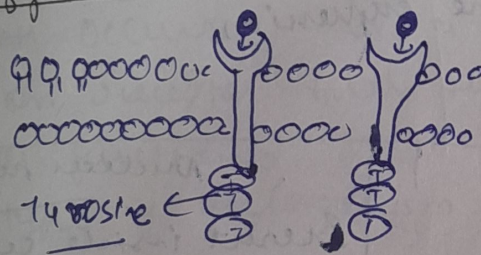
3) Gq activates phospholipases C enzymes (PLC)

There are many diff. GPCRs in humans, each with its own ligand specificity & signaling pathway.

eg 1) β- adrenergic Receptors - They Bind adr. & noradr. & are involved in regulating HR & BP.

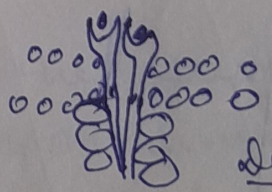
2) Dopamine receptors - Bind dopamine & are involved in regulating mood, & behaviour.

3) Enzyme Linked Receptor:-



when ligand binds to two of these receptors.

↓
Conformational change occurs
↓
aggregation of both receptors



dimer

↓
Tyrosine regions gets activated.
↓
~~ADP~~ ATP.

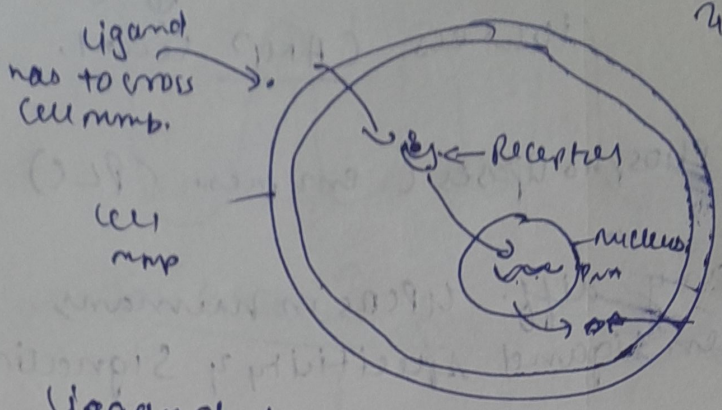
ATP → ADP + iP

ATP → ADP + iP

↓
Tyrosine picks up phosphate group
↓
activation
↓
Cellular Response occurs.

3) Nuclear Receptor

- These receptors are located INSIDE THE CELL.
- It regulates gene expression



Ligand has to first cross the cell mmb
↓
then it binds to Receptor.
↓
The receptor undergoes conformational changes that allows it to bind to a specific DNA Sequence
↓
It Regulates the gene expression.
↓
which forms proteins

GPCR	Nuclear receptor
present on cell mmb	present inside cell mmb
- on cell mmb.	- in nucleus

DRUG ANTAGONISM

It is a type of drug interaction, in which the effect of one drug is reduced or inhibited in presence of other drug.

2 types of antagonism — competitive
— Non-competitive.

- Competitive antagonism

It occurs when a drug competes with another substance (agonist) for binding to the same receptor site, resulting in reduction in agonist activity.

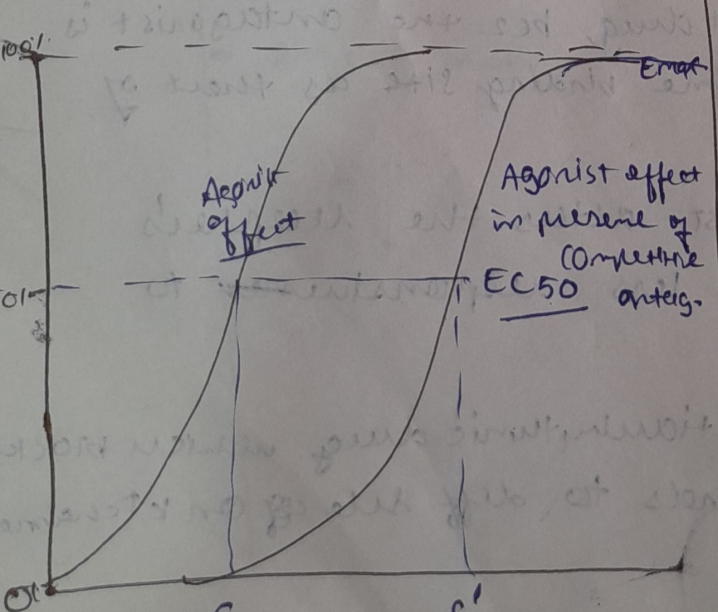
competitive antagonism can be overcome by ↑ the conc of agonist drug. Eg - Propranolol, a β-Blocker competes with Adr. & noradr. for binding to β-adrenergic receptors
Eg - ACh & Atropine,
~~- Adrenaline & propranolol~~

- ~~Non~~ Non-competitive antagonism -
~~Eg - Iron~~ occurs when a drug binds to a different site on receptor than the agonist & inhibits receptor function.
- This type of antagonism cannot be overcome by ↑ the conc of agonist drug bcz the antagonist is not competing for same binding site as that of agonist.
Instead, the antagonist alters the receptor's conformation, making it less responsive to the agonist
Eg - Amiodarone, an Antiarrhythmic drug which blocks K^+ channel in heart. It binds to diff site on K^+ channel & inhibits its function.

e) Ketamine an anaesthetic that produce its effect by blocking NMDA receptors in brain. Ketamine binds to diff. site on NMDA receptors than the agonist & inhibits the receptor function.

COMPETITIVE

- Def. Py. page.
- Antagonist binds with the same receptor as that of agonist
- Intensity of Response depends upon both Agonist & antagonist
- No change in slope of curve.
- It can be overcome by ↑ the conc of agonist
- Eg - Py. Pg.
- competition occurs btw agonist & antagonist
- No conformational changes of receptors site
- Maximum efficacy is unchanged



The agonist potency ↓ in presence of competitive antagonist

Non-competitive

- "
- Binds to another site of receptor.
- depends upon the conc of antagonist

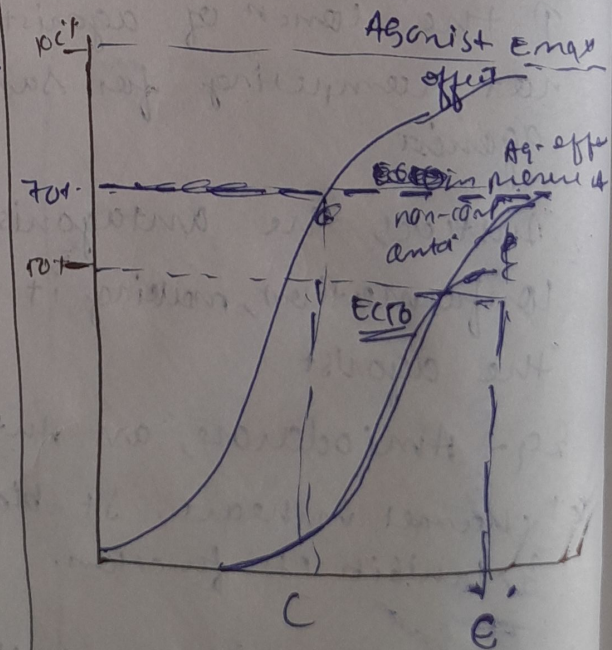
change in slope of curve.

It can be overcome by ↑ the conc of agonist

- Eg "
- No competition as anta binds to diff site.

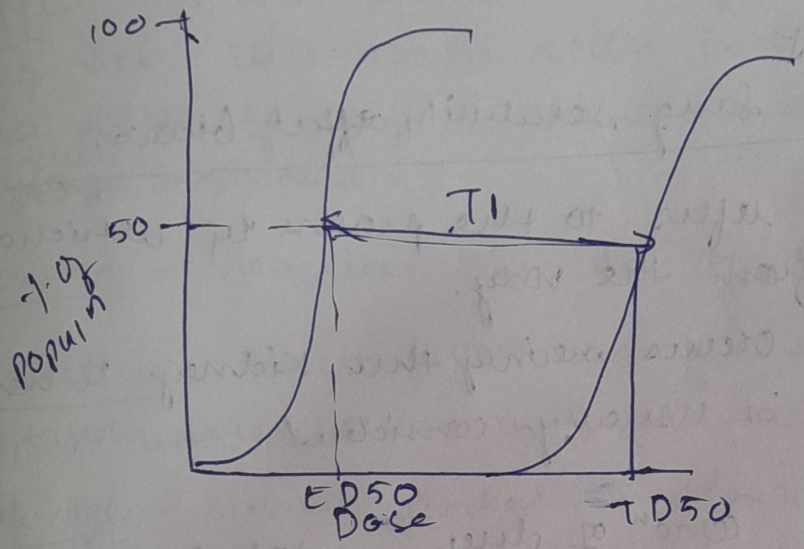
antagonist alters the conformational site

- Max. efficacy is reduced



- Therapeutic Index - It is a ratio of the dose of a drug that produces toxicity in 50% of the population to the dose of a drug that produce effective response in 50% of population.

$$T_I = \frac{TD50}{ED50}$$



Bioavaibility - It is the proportion of the drug that enters systemic circulation after adm. & is available to produce its pharmacological effect. ie the proportion of drug that reaches systemic circ^n in unchanged form & produce it effect.

The Bioav. of any drug adm. thru IV is 100%

factors affecting

1) First- Pass metabolism - Drugs abs. thru the GIT are first delivered to liver via portal vein, where they undergoes metabolism before entering systemic circulation & this reduces Bioavailability.

2) Stability - The stability of drug in GIT can affect Bioavai. Some drugs may be degraded by gastric acid before they can be absorbed.

3) Solubility - The solubility of drug in water or lipids affect its bioavai.
Lipophilic drugs are more readily abs. compared to hydrophilic drugs.

4) Dose of drug

5) Particle size & drug solubility affect bioava.

→ Clearance - It refers to the process by which drugs are eliminated from the body.
Elimⁿ of drug occurs mainly thru kidney & hence renal clearance is usually considered

$$\text{Renal clearance} = \frac{\text{Concⁿ of drug in urine} \times \text{Vol. of urine excreted}}{\text{Plasma drug concⁿ.}}$$

→ Biological half life - defined as the time required for the concⁿ of drug in the body to be reduced by one half (50%).

Importance - 1) It is used to determine the appropriate dose. A drug with short t1/2 may require frequent dosing. While a longer t1/2 may only need to be adm. once or twice a day.

2) Understanding the t1/2 of drug can help to identify the risk of toxicity of drug.

3) Used to determine the safety of drugs. If the drug has long t/½ it gets accumulated in body.

⇒ Bioequivalence - is the biochemical similarity of 2 drugs that share the same ingredients & produce the same effect. It is based on bioavailibility.

⇒ factors Modifying drug Effects:-

1) Age- As we age, our bodys ability to metabolize drug ↓es. This means older individuals may need lower doses of drugs to achieve same therapeutic effect as ~~younger~~ Adult individuals.

2) Gender - Requires lower dose of drugs in pregnancy

3) Genetics - Genetic factors can affect the way our bodies metabolize drugs, which can impact their efficacy & S.E.

4) Life style - smoking, alcohol consumption & physical activity can also impact how drugs are metabolized in our body.

5) Route adm. - If drug taken orally, then due to its first pass met^n it effect can decrease.
but, when given via IV, then it directly reaches systemic circulation.

6) Polypharmacy - When 2 or more drugs taken at same time then it may affect the pharmacological action of other drug.

7) Body Organs State - It depends upon persons body. If he/she's having any disease related to GIT, liver, kidney, stomach, intestine then, drug effect can be altered.

DRUG TOXICITY -

- Refers to the harmful effects that can occur when a person takes a medication. All medication causes some or other toxic effects. but the severity depends upon its dose, frequency & persons health ~~test~~ status.

→ Acute Toxicity - It refers to the harmful effects that can occur shortly after exposure to a single, high dose of a drug.

A.T. can occur by ingestion, Inhalation or skin contact & its severity vary depending upon the dose.

S/S - Nausea, vomiting, Headache, Respiratory distress, dizziness, seizures & even death in severe cases.

- The level of toxicity is often determined by its LD50 value, which is the amt. of substance that is lethal to 50% of test animals.
- To minimize the risk of A.T. it is imp to use the drugs acc. to the prescription & in limited dose.

Eg - Pesticides - These are used in agriculture & when entries in our body causes A.T.
S/S include N, V, Resp. distress, dizziness.

2) Household cleaning products - such as bleach, disinfectants. when inhaled causes A.T.

3) Carbon Monoxide (CO) It is a toxic gas we & by inhaling it, even death can occur.

→ Sub-Acute toxicity- Refers to harmful effects that occur after Repeated exposure to toxic substance over a period of weeks or months.

- It can affect multiple organs of our body

Ss - wt. loss, decreased appetite, lethargy & damage to organs such as - liver, kidney, N.S.

S.A.T testing is imp aspect for products safety evaluation esp. for the drug that may come in contact with humans over a long period of time.

Eg - 1) Industrial chemicals - Exposure of I.C. such as - paints & heavy metals can cause S.A.T. If workers are exposed for a longer period of time, then it may damage our body organ.

2) Environmental pollutants - such as air, water, soil pollu. like - cigarette smoke can cause liver damage. harmful gases released from vehicles & industries causes damage to body organs.

3) Prescription medication - If the P.M. are taken for longer period of time & often then it may damage our organs.

- such as - NSAIDS taken for longer period can damage & change liver function.

3) Chronic Toxicity - Refers to the harmful effects that occurs as a result of repeated or long term exposure to toxic substance. C.T. develops over a period of month or years.

It can affect various organs & systems in body → N.S, I.S, CVS & R.S. It can also ↑ the risk of developing chronic diseases such as - Cancer,

S/S - fatigue, weakness, N, V, Headache, skin rashes, Difficulty breathing, Joint pain, vision & hearing problems, G/I problems such as - diarrhea & constipation,

↑ed risk of cancer, liver disease.

Eg - 1) Radiation - Chronic exposure to ionizing radiation can lead to ↑ed risk of cancer & other health problems.

2) Alcohol - long term alcohol consumption can cause liver damage & ↑es the risk of liver damage

3) Industrial Chemicals - Exposure to chemicals such as - benzene can cause chronic toxicity. & then damages the organs.

4) Medications - Medicines such as - painkillers & Anti-inflamatory drugs can cause kidney problems.

5) Heavy Metals - Exposure to H.M. such as lead, Mercury can cause C.T.

These metals accumulate in body overtime,

→ Pre clinical Evaluation - Is a stage in the development of new drugs, medical devices & other products, where they're tested in laboratory & animal before moving to clinical trials on human.

- During Evaluation, ~~the~~ it is tested in vitro (in cells) & in vivo (in animals) to evaluate drug toxicity, Pharmacokinetics, Pharmacodynamics.

These test helps the researches to determine the dose, Frequency & Route of adm. of drug.