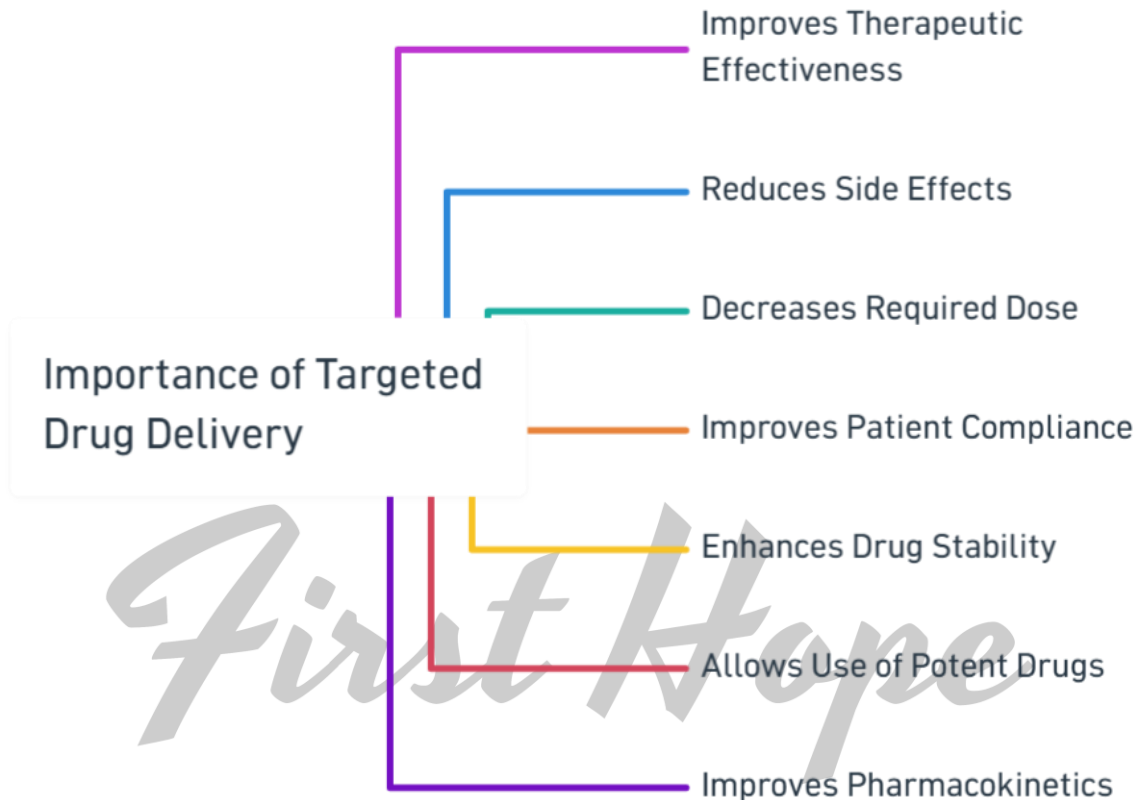


Targeted Drug Delivery Systems

Targeted Drug Delivery Systems – Importance

- Targeted drug delivery systems are designed to deliver a drug specifically to the site of action (such as a diseased organ, tissue, or cell) instead of distributing it throughout the entire body.

Why it is important:



1. Improves therapeutic effectiveness

- Drug reaches the exact site where it is needed
- Higher local concentration at target site
- Better treatment outcomes even with smaller doses

2. Reduces side effects

- Conventional drugs affect both healthy and diseased tissues
- Targeted delivery minimizes exposure to healthy cells
- Especially important in diseases like cancer where toxic drugs are used

3. Decreases required dose

- Since drug is concentrated at target site, lower dose is sufficient
- Reduces drug wastage in non-target tissues

4. Improves patient compliance

- Fewer side effects and reduced dosing frequency

- More convenient for long-term therapies

5. Enhances drug stability

- Protects drug from degradation (e.g., enzymes, pH changes)
- Useful for sensitive drugs like proteins and peptides

6. Allows use of potent drugs

- Toxic drugs (e.g., anticancer agents) can be safely used
- Controlled and localized delivery prevents systemic toxicity

7. Improve pharmacokinetics

- Better absorption, distribution, and retention at target site
- Controlled and sustained release possible

Targeted Drug Delivery Systems – Concept

- The basic idea is to deliver the right drug, at the right place, at the right time, in the right amount.

Core concept:

- Drug is combined with a **carrier system**
- Carrier transports the drug through the body
- Drug is released only at the **target site**

Key components:

1. Drug (Active agent)

- The therapeutic substance
- Example: anticancer drug, antibiotic, protein drug

2. Carrier (Delivery system)

- Help transport and protect the drug
- **Examples:**
 - Nanoparticles
 - Liposomes
 - Microspheres

3. Targeting mechanism

- Ensures drug reaches specific site
- **Two main types:**

- Passive targeting
- Active targeting

Types of targeting:

1. Passive targeting

- Based on natural body processes
- Example: tumor tissues have leaky blood vessels → nanoparticles accumulate there (EPR effect)

2. Active targeting

- Uses ligands (antibodies, peptides) attached to carrier
- These bind specifically to receptors on target cells

Levels of targeting:

- **Organ level** (e.g., liver targeting)
- **Tissue level** (e.g., tumor tissue)
- **Cellular level** (specific cells)
- **Subcellular level** (e.g., nucleus, mitochondria)

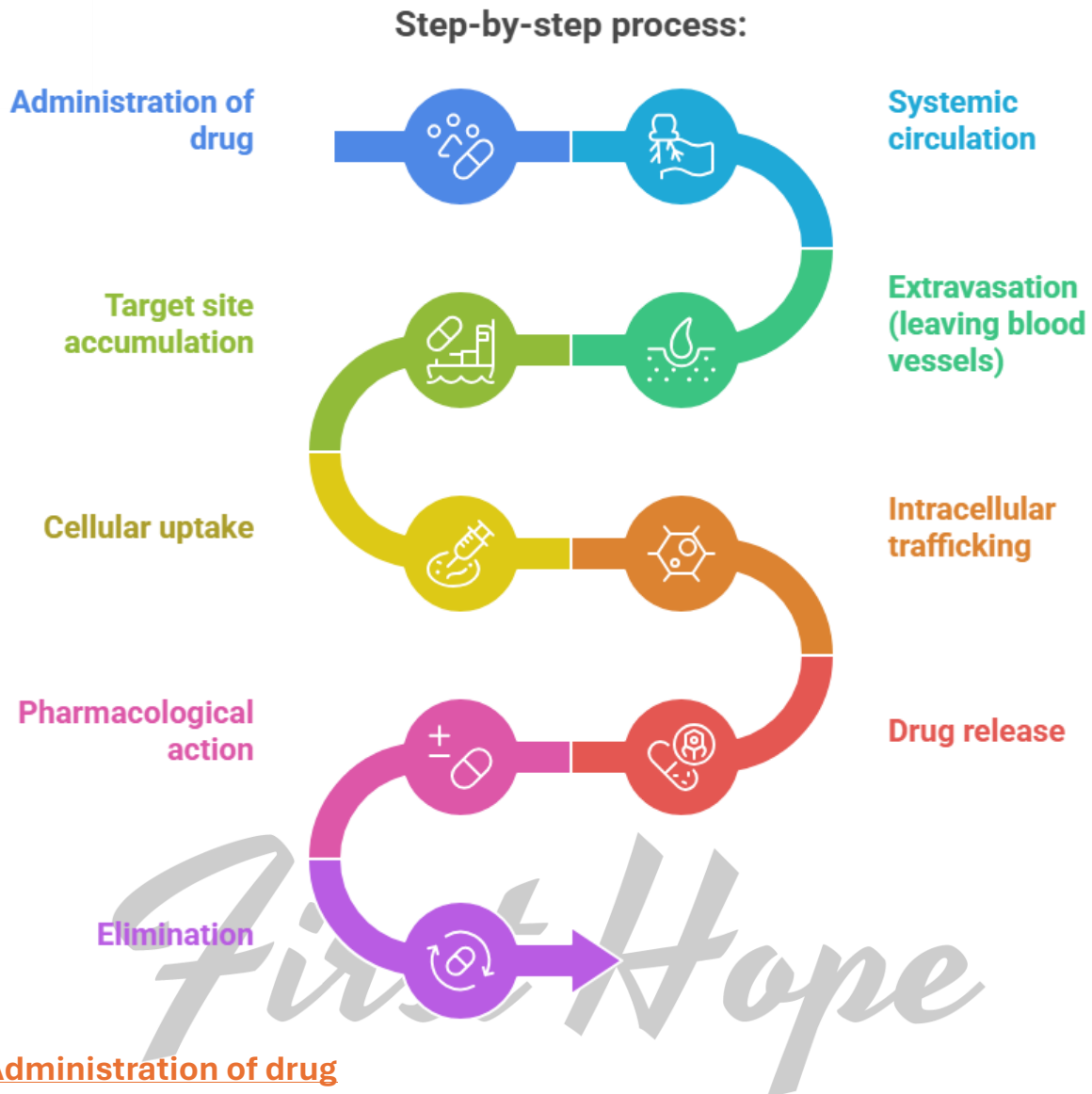
Ideal characteristics of a targeted system:

- Stable in blood circulation
- Non-toxic and biocompatible
- Able to recognize target cells
- Releases drug in controlled manner
- Avoids immune system clearance

Biological Process and Events Involved in Drug Targeting

- After administration, a targeted drug delivery system undergoes several steps before reaching its site of action.

Step-by-step process:



1. Administration of drug

- Drug is introduced into the body (IV, oral, subcutaneous, etc.)
- Carrier system protects drug from immediate degradation

2. Systemic circulation

- Drug-carrier complex travels through bloodstream
- **Must avoid:**
 - Enzymatic degradation
 - Immune system (macrophages, RES system)
- Surface modification (e.g., PEGylation) helps in longer circulation

3. Extravasation (leaving blood vessels)

- Drug moves from blood vessels into tissues
- **In tumors:**
 - Blood vessels are leaky
 - Allows large particles (nanoparticles) to enter easily

4. Target site accumulation

- **Drug accumulates at target site by:**
 - Passive targeting (EPR effect)
 - Active targeting (ligand-receptor binding)

5. Cellular uptake

- **Drug enters target cells through:**
 - Endocytosis (cell engulfs particle)
 - Receptor-mediated uptake (specific binding)

6. Intracellular trafficking

- Drug moves inside the cell to reach its site of action
- **May need to escape from:**
 - Endosomes
 - Lysosomes (to avoid degradation)

7. Drug release

- **Drug is released from carrier:**
 - By pH change
 - Enzyme action
 - Temperature or external trigger

8. Pharmacological action

- Drug interacts with target (receptor, enzyme, DNA)
- Produces therapeutic effect

9. Elimination

- Carrier and drug residues are removed from body
- **Via:**
 - Kidneys (urine)
 - Liver (bile)

Barriers in drug targeting:

- Blood circulation clearance
- Immune system attack
- Poor penetration into tissues
- Cellular membrane barrier



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