Nanocarriers: sustained, controlled, targeted drug delivery systems

Nanocarriers are nanoscale drug delivery systems designed to improve the effectiveness and safety of drug therapies. They offer sustained, controlled, and targeted release of drugs, enhancing their bioavailability and minimizing side effects.

Key aspects of nanocarriers in drug delivery:

- **Sustained Release:**

Nanocarriers can be engineered to release drugs over an extended period, reducing the frequency of administration and maintaining therapeutic drug levels.

- **Controlled Release:**

They allow for precise control over the rate and timing of drug release, often responding to specific stimuli (e.g., pH, temperature, enzymes) for targeted delivery.

- **Targeted Delivery:**

Nanocarriers can be designed to specifically target diseased cells or tissues, minimizing drug exposure to healthy cells and reducing toxicity.

Types of Nanocarriers:

- **Liposomes:**

Lipid-based vesicles that can encapsulate both hydrophilic and hydrophobic drugs.

- **Polymeric Nanoparticles:**

Nanoparticles made from biocompatible polymers, offering versatility in drug loading and release.

- **Dendrimers:**

Tree-like macromolecules with a highly branched structure that can encapsulate drugs and target specific sites.

- **Micelles:**

Aggregates of amphiphilic molecules (containing both hydrophobic and hydrophilic parts) that can encapsulate drugs.

- **Inorganic Nanoparticles:**

Nanoparticles made from materials like gold or silver, which can be used for both drug delivery and diagnostic imaging.

Benefits of Nanocarrier-Based Drug Delivery:

- **Increased Drug Bioavailability:**

Nanocarriers can enhance the solubility and stability of drugs, leading to improved absorption and efficacy.

- **Reduced Toxicity:**

By targeting drug delivery to specific sites, nanocarriers can minimize the exposure of healthy tissues to toxic drugs, reducing side effects.

- **Improved Treatment Outcomes:**

Sustained and controlled release, combined with targeted delivery, can lead to better therapeutic outcomes.

- **Overcoming Biological Barriers:**

Nanocarriers can be designed to cross biological barriers like the blood-brain barrier, enabling the treatment of diseases in previously inaccessible areas.

Examples of Nanocarriers in Clinical Use:

- **Doxil:** Liposome-encapsulated doxorubicin, used for treating various cancers.
- **Abraxane:** Albumin-bound paclitaxel, used for breast cancer, non-small cell lung cancer, and pancreatic cancer.
- **Onivyde:** Liposome-encapsulated irinotecan, used for pancreatic cancer.