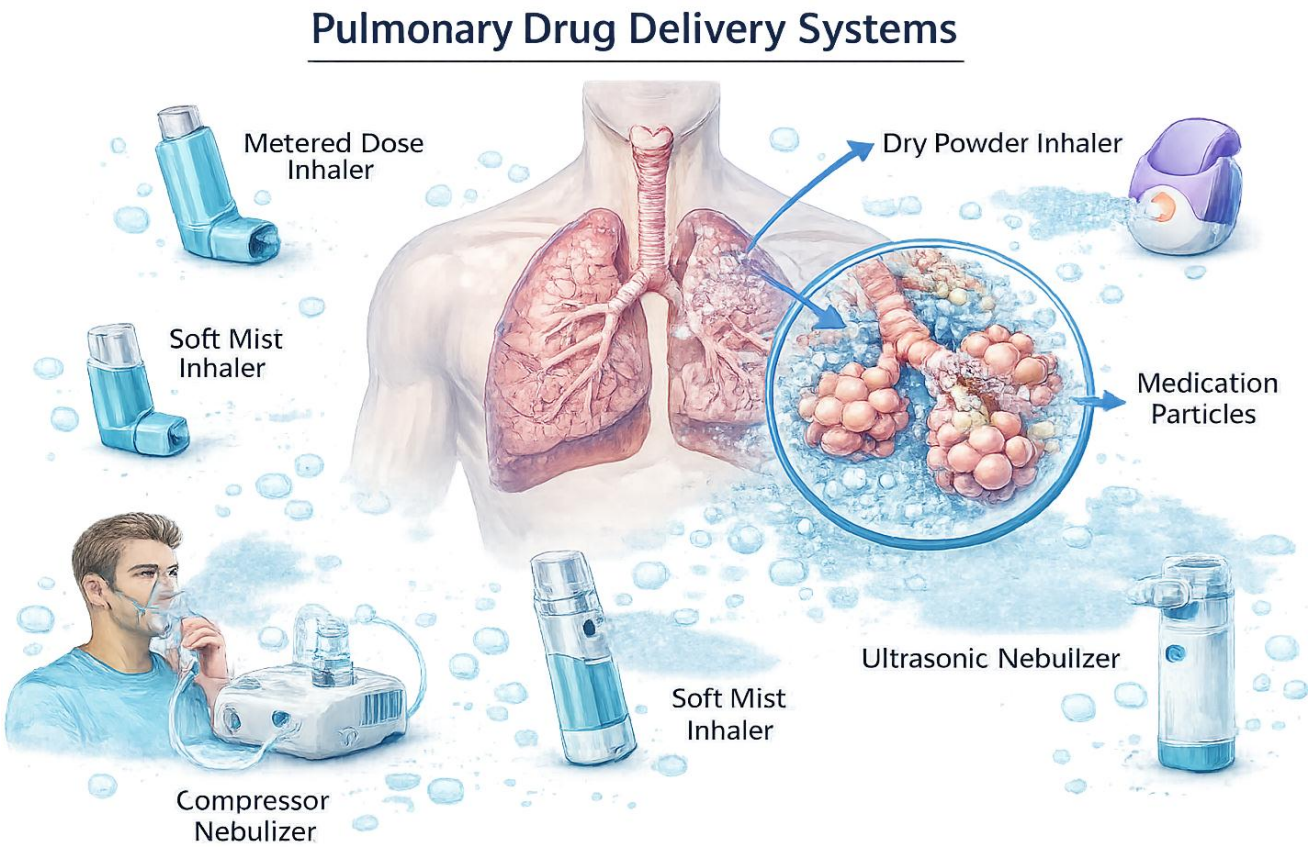
Pulmonary Drug Delivery Systems

Pulmonary Drug Delivery Systems

Introduction

- **Pulmonary drug** delivery systems are designed to deliver drugs directly into the lungs through inhalation.



- **This route** is mainly used for treating **respiratory diseases such as:**
  - Asthma
  - Chronic Obstructive Pulmonary Disease (COPD)
  - Tuberculosis
  - Lung infections
- **It can also be** used for systemic drug delivery, as drugs can enter the bloodstream through **lung tissues due to:**
  - Large surface area of the lungs
  - Rich blood supply

Advantages

- **Pulmonary drug delivery offers several benefits:**
  - Rapid onset of action
  - Direct delivery to the lungs

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- Large surface area for absorption
- Rich blood supply enhances drug uptake
- Lower dose required
- Reduced Systemic Side Effects
- Avoids first-pass metabolism (liver)

Limitations

- **Despite its advantages, this route has some challenges:**
  - Requires proper inhalation technique
  - Drug deposition depends on particle size
  - Possible irritation of airways

Aerosols (Pulmonary Drug Delivery)

Definition / Introduction

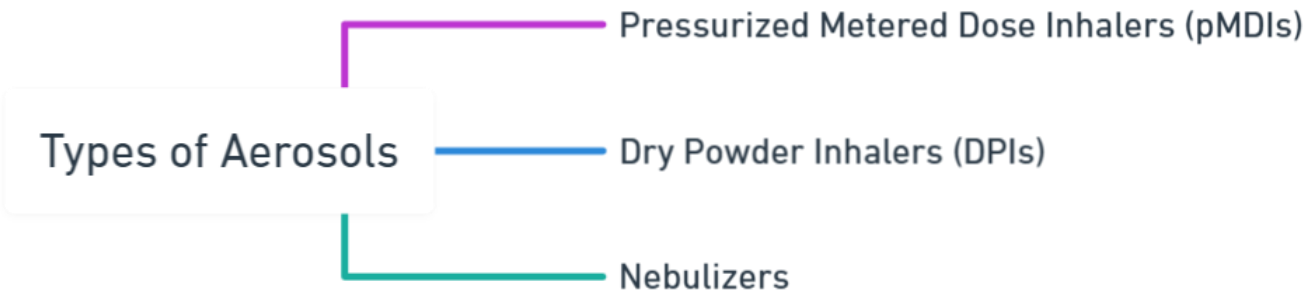
- **An aerosol is a system in which:**
  - Fine solid particles or liquid droplets are dispersed in a gas
  - The gas is usually air or a propellant
- **In pulmonary drug delivery:**
  - Aerosols are inhaled into the lungs
  - They deliver drugs directly to the respiratory tract

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Ideal Characteristics of an Aerosol

- **Proper particle size:**
  - 1–5 µm for effective lung deposition
- Uniform dose delivery
- Stability during storage

Types of Aerosols



1. Pressurized Metered Dose Inhalers (pMDIs)

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- Deliver a fixed dose of drug per actuation
- Use propellents to expel the drug
- Drug is released when the valve is pressed
- Compact and portable

2. Dry Powder Inhalers (DPIs)

- Deliver drug in dry powder form
- No propellents required
- Activated by patient's inhalation

3. Nebulizers

- Convert liquid drug into fine mist (aerosol)
- Used in hospitals or home care
- **Suitable for:**
  - Children
  - Elderly
  - Severe conditions
- **Types of Nebulizers:**
  - Jet nebulizers
  - Ultrasonic nebulizers
  - Mesh nebulizers

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Components of Aerosol Systems

- Drug (active ingredient)
- Propellant (in MDIs)
- Container
- Valve system

Particle Size and Deposition

- **Particle size plays a** crucial role in determining where the drug is **deposited in the respiratory tract:**
  - >10 µm → Deposited in mouth and throat
  - 5–10 µm → Upper airways
  - 1–5 µm → Lower respiratory tract (ideal range)
  - <1 µm → May be exhaled

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Propellents (in Aerosol Systems)

Introduction / Definition

- **Propellents are substances used in aerosol systems to:**
  - Generating pressure
  - Expel the drug from the container
- **They play an essential role in:**
  - Generating pressure
  - Producing a fine spray (aerosol)
  - Delivering an accurate and consistent dose

Types of Propellents



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1. Liquefied Gas Propellents

- **Exist as both:**
  - Liquid
  - Gas inside the container
- Maintain constant pressure during use
- Provide uniform drug delivery
- **Examples:**
  - Hydrofluoroalkanes (HFAs)
    - HFA-134a
    - HFA-227
  - Hydrocarbons

2. Compressed Gas Propellents

- Present only in gaseous form
- Pressure decreases as the product is used
- **Examples:**
  - Nitrogen

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- Carbon dioxide

3. Chlorofluorocarbons (CFCs)

- Previously widely used propellents
- **Now restricted due to:**
  - Ozone layer depletion
- **Replaced by safer alternatives such as:**
  - Hydrofluoroalkanes (HFAs)

Ideal Properties of Propellents

- **An ideal propellent should have the following characteristics:**
  - Non-toxic
  - Non-flammable
  - Chemically stable
  - Compatible with drug and container
  - Provide consistent pressure
  - Environmentally safe

Containers (Aerosol Systems)

Introduction

- **Containers are used to:**
  - Store aerosol formulations under pressure
  - Ensure safe and effective drug delivery

Types of Containers

1. Metal Containers

- **Made of:**
  - Aluminum
  - Stainless steel
- Strong and resistant to high pressure
- Durable and lightweight
- Most commonly used in aerosol systems

2. Glass Containers

- Chemically inert

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