

Dissolution

Theories of Dissolution

- Dissolution is the process by which a solid drug dissolves in a liquid medium to form a solution.
- It is a crucial step before drug absorption.
- Different theories explain how this process occurs at the molecular level.



1. Diffusion Layer Theory (Film Theory)

Concept

- When a solid drug particle is placed in a liquid, a thin stagnant liquid layer forms around it
- This is called the diffusion layer (boundary layer or film)

Steps Involved

- Drug dissolves at the surface of the particle
- A saturated solution forms around the particle
- Drug molecules diffuse from this layer into the bulk solution

Key Equation (Noyes–Whitney Equation)

- **Dissolution rate depends on:**
 - Surface area of drug
 - Diffusion coefficient
 - Thickness of diffusion layer
 - Concentration difference between surface and bulk

Important Points

- Thinner diffusion layer → faster dissolution
- Stirring/agitation reduces layer thickness → increases dissolution rate
- Most widely accepted theory

2. Penetration Theory

Concept

- No fixed diffusion layer exists
- Solvent molecules **continuously come in contact** with the drug surface

Process

- Each contact allows a small amount of drug to dissolve
- Continuous renewal of solvent increases dissolution

Important Points

- It depends on **mixing and agitation**
- More **dynamic** than diffusion layer theory

3. Surface Renewal Theory (Danckwerts' Theory)

Concept

- Combines diffusion and penetration concepts
- The liquid near the surface is **continuously replaced by fresh solvent**

Process

- Fresh solvent contacts the drug surface
- Saturated solution is replaced with unsaturated liquid
- Enhances dissolution rate

Importance

- Considered more **realistic** than fixed diffusion layer theory

4. Interfacial Barrier Theory

Concept

- Dissolution occurs at the interface between solid and liquid
- A barrier exists that drug molecules must cross

Key Idea

- **Drug molecules must:**
 - Break away from the solid surface
 - Move into the liquid phase

Importance of Dissolution Theories

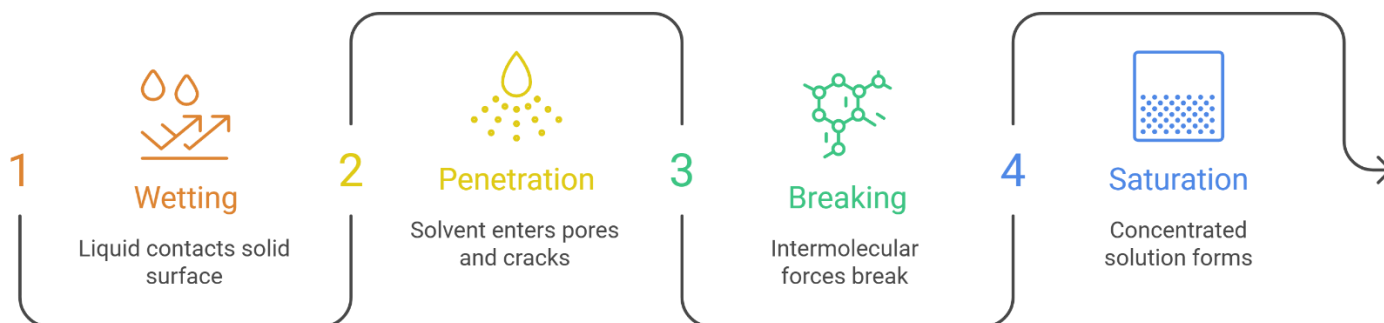
- Helps in designing effective formulations
- Explains factors affecting dissolution rate

- Guides methods to enhance drug release and bioavailability

Mechanisms of Dissolution

- Mechanism of dissolution describes the step-by-step process by which a drug particle dissolves in a solvent.
- It explains how drug molecules leave the solid form and enter the solution.

Steps in Dissolution of Solid Particles



A. Wetting of Particle

- Liquid comes in contact with the solid surface
- Good wetting is essential for effective dissolution

B. Penetration of Solvent

- Solvent enters pores and cracks of the particle
- Begins interaction with drug molecules

C. Breaking of Solid Structure

- Intermolecular forces (or crystal lattice) break
- Drug molecules separate from the solid

D. Formation of Saturated Layer

- A **concentrated (saturated) solution** forms near the surface

E. Diffusion into Bulk Solution

- **Drug moves from:**
 - High concentration (near surface)
 - To low concentration (bulk solution)

Types of Dissolution Mechanisms

1. Diffusion-Controlled Dissolution

- Rate depends on **diffusion of drug molecules** from surface to bulk

- Diffusion is the **rate-limiting step**

2. Surface Reaction-Controlled Dissolution

- Rate depends on how fast drug molecules **detach from the surface**
- Common in **poorly soluble drugs**

Based on Nature of Solid

1. Crystalline Solids

- Strong crystal lattice
- Requires more energy to break
- **Slower dissolution**

2. Amorphous Solids

- No definite crystal structure
- Molecules are loosely arranged
- **Faster dissolution**

3. Salts of Drugs

- Undergo **ionization in solution**
- Generally **faster dissolution** than neutral drugs

Factors Affecting Dissolution Mechanism

- Particle size (smaller → faster dissolution)
- Surface area
- Crystal form (polymorphism)
- Agitation (stirring)
- Temperature

Importance

- Helps understand drug release behavior
- Guides formulation design and optimization
- Improves bioavailability of drugs

In-vitro Dissolution Testing Models – Sink and Non-Sink Conditions

- Dissolution testing is performed in laboratory conditions to predict how drug dissolves in the body.

Sink Conditions

Definition

- The volume of dissolution medium is large enough to dissolve the drug completely

Criteria

- Volume should be at least 3 times the amount required to form a saturated solution

Characteristics

- Drug concentration remains low compared to solubility
- Maintains constant concentration gradient

Advantages

- Provides maximum dissolution rate
- Simulates ideal conditions

Example

- Highly soluble drugs in large volume medium

Non-Sink Conditions

Definition

- The amount of drug is high compared to solubility
- Medium becomes saturated

Characteristics

- Reduced concentration gradient
- Slower dissolution rate

Problems

- Drug may precipitate
- Difficult to interpret results

Importance

- Useful for poorly soluble drugs
- Simulates real biological conditions

Comparison

Feature	Sink	Non-sink
Medium volume	Large	Limited
Dissolution rate	High	Lower

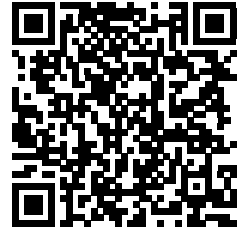


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