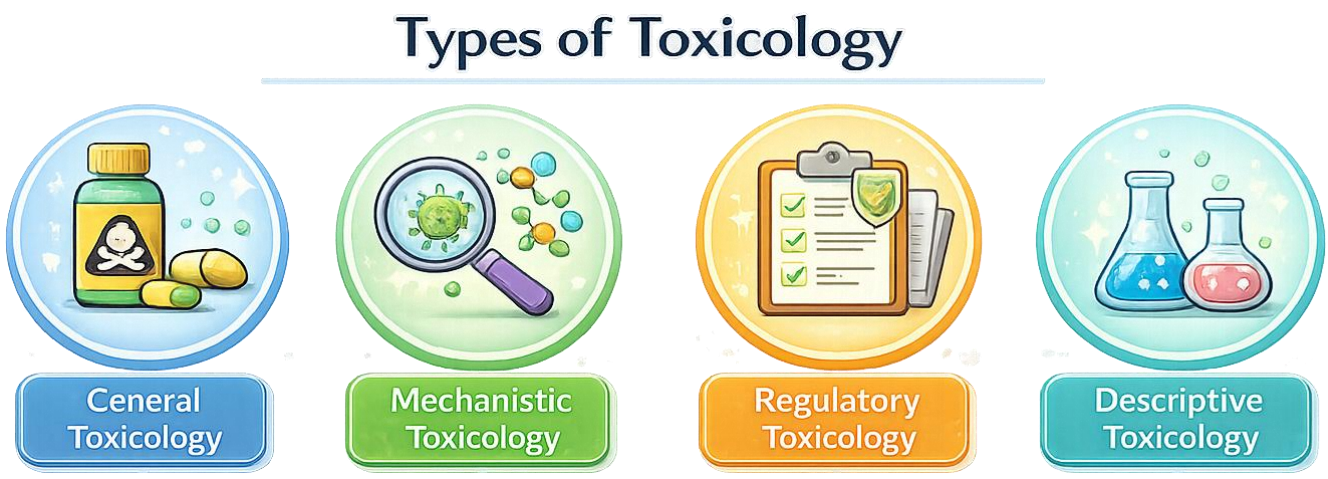
Toxicology

Basic Definition of Toxicology

- Toxicology is the branch of science that studies the harmful effects of chemicals, drugs, poisons, and other substances on living organisms.
- Toxicology helps in understanding how different substances produce injury, disease, or death in humans and animals.
- In Pharmacological and Toxicological Screening Methods, toxicology is important for detecting the safety and harmful effects of new drugs before they are used in humans.
- **Toxicology studies include:**
  - Identification of toxic substances
  - Study of dose and toxic effect relationship
  - Detection of target organs affected by toxins
  - Evaluation of poisoning symptoms
  - Assessment of safety limits of drugs and chemicals
- **Toxicological screening methods are used during preclinical studies to evaluate:**
  - Acute toxicity
  - Chronic toxicity
  - Organ toxicity
  - Neurotoxicity
  - Reproductive toxicity
  - Carcinogenicity
  - Mutagenicity
- Toxicology also helps in developing antidotes and safety guidelines for chemicals and medicines.

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Types of Toxicology



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- General Toxicology
- Mechanistic Toxicology
- Regulatory Toxicology
- Descriptive Toxicology

General Toxicology

Definition

- General toxicology studies the overall harmful effects of chemicals, drugs, and toxic substances on the body.

Main Areas Studied

1. Toxicokinetic Processes

- Absorption of toxic substances
- Distribution in body tissues
- Metabolism of toxic compounds
- Excretion of toxic substances

2. Routes of Exposure

- Oral route (swallowing)
- Inhalation (breathing)
- Skin absorption/contact
- Injection

3. Exposure Duration

- Acute exposure
- Subacute exposure
- Chronic or long-term exposure

4. Dose–Response Relationship

- Dose is the amount of substance given to the body.
- Higher doses usually produce greater toxic effects.
- Toxicity is the ability of a substance to produce harmful effects.

Importance in Screening Methods

- It helps researchers identify whether a substance is toxic or safe.
- It provides basic information about toxic symptoms, toxic dose, and affected organs.

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- General toxicology is widely used during preclinical drug testing.

Parameters Observed

- Body weight changes
- Food and water intake
- Behavioral changes
- Mortality
- Organ damage
- Blood and biochemical changes

Examples

- Studying liver toxicity caused by paracetamol overdose.
- Studying kidney damage caused by heavy metals.

Mechanistic Toxicology

Definition

- Mechanistic toxicology studies the exact mechanism by which a toxic substance produces harmful effects in the body.

Importance in Screening Methods

- It helps scientists understand how toxicity develops at cellular and molecular levels.
- It helps in designing safer drugs with fewer side effects.
- It also helps identify biomarkers of toxicity.

Main Focus of Mechanistic Toxicology

- **Mechanistic toxicology studies:**
    - Biochemical changes
    - Cellular injury
    - Enzyme inhibition
    - Oxidative stress
    - DNA damage

Common Mechanisms of Toxicity

1. Enzyme Inhibition

- Some toxic substances block important enzymes required for normal body function.

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- Organophosphate poisoning inhibits acetylcholinesterase enzyme and causes excessive nerve stimulation.

2. Free Radical Formation

- Certain chemicals produce free radicals that damage cells and tissues.
- Free radicals can damage proteins, lipids, and DNA.

3. DNA Damage

- Some toxic agents damage genetic material and may cause mutations or cancer.

4. Cell Membrane Damage

- Toxic substances may destroy cell membranes and cause cell death.

Cellular Targets

- Cell membrane
- Mitochondria
- Nucleus
- Proteins
- Enzymes

Methods Used

- Cell culture studies
- Molecular biology techniques
- Biochemical assays
- Enzyme activity tests

Examples

- Carbon tetrachloride causes liver toxicity by free radical formation.
- Organophosphates cause toxicity by inhibiting acetylcholinesterase enzyme.

Application in Toxicological Screening

- **Mechanistic studies are used in:**
  - Hepatotoxicity studies
  - Neurotoxicity studies
  - Genotoxicity testing
  - Carcinogenicity studies

Regulatory Toxicology

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Definition

- Regulatory toxicology deals with the development and application of safety rules, laws, and guidelines for chemicals and drugs.

Importance in Screening Methods

- It ensures that drugs and chemicals are safe before marketing and public use.
- It helps government agencies evaluate risk and approve products.

Main Objectives

- Protection of human health
- Protection of the environment
- Establishment of safe exposure limits
- Risk assessment of chemicals

Regulatory Agencies

- US FDA (Food and Drug Administration)
- WHO (World Health Organization)
- EMA (European Medicines Agency)
- CDSCO (Central Drugs Standard Control Organization)

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Toxicity Studies Required

- Acute toxicity studies
- Repeated dose toxicity studies
- Reproductive toxicity studies
- Genotoxicity studies
- Carcinogenicity studies

Guidelines Commonly Used

- OECD guidelines
- ICH guidelines
- GLP (Good Laboratory Practice)

Examples

- Safety testing of pesticides before agricultural use.
- Approval process of a new pharmaceutical drug.

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