



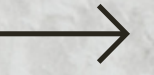
FOOD TOXICOLOGY

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CONTENTS



PRINCIPLE OF FOOD TOXICOLOGY

- **What is toxicology?**
- **Toxicity, Dose, and Response, Hormesis**

MAIN GROUPS OF FOOD TOXICANT

-

TOXICOLOGY

STUDY OF THE FORMATION, COMPOSITION, AND THE **ADVERSE EFFECTS OF CHEMICALS (TOXICANTS / TOXINS) ON BIOLOGICAL SYSTEM (ORGANISM, ORGANS, CELLS).**

"All substances are poisons; there is none that is not a poison. The right dose differentiates the poison from a remedy"

Paracelsus (1493 - 1541)

Founder of toxicology

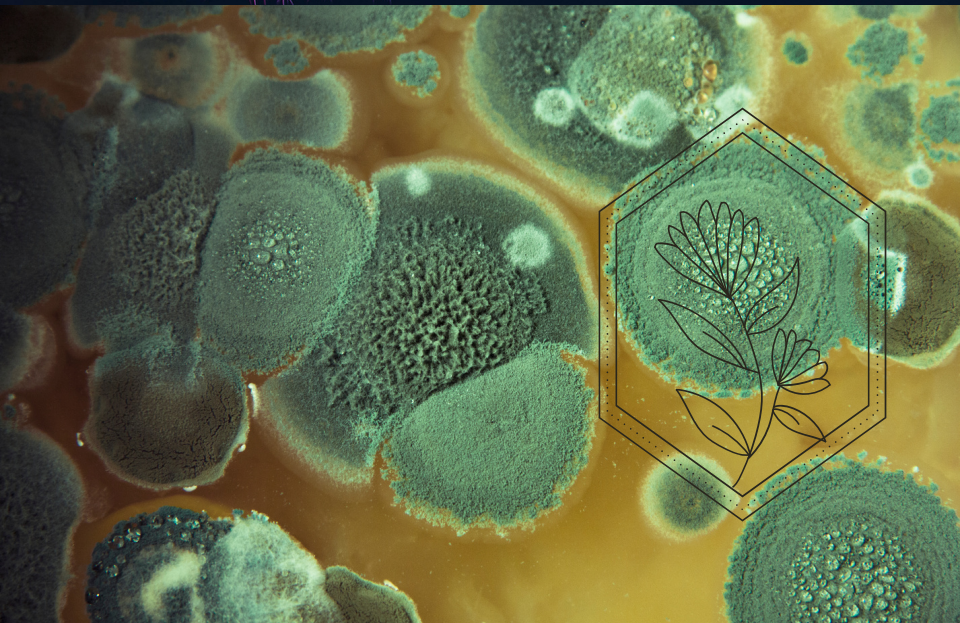




FOOD TOXICOLOGY →

FOCUS ON THE ANALYSIS OF TOXIC EFFECT OF CHEMICAL SUBSTANCE IN FOOD

- natural endogenous products
- contaminating organisms
- food production, processing, and preparation

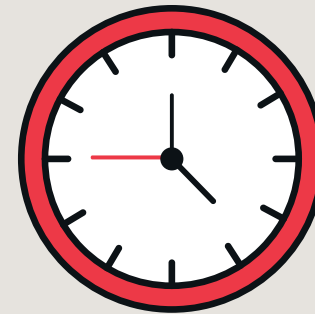
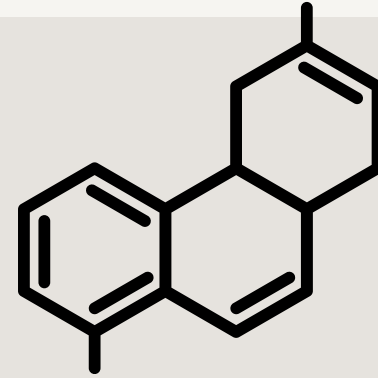


FACTORS AFFECTING THE TOXICITY



TOXICITY

IS THE CAPACITY OF A CHEMICAL SUBSTANCE TO CAUSE ADVERSE ON LIVING ORGANISM



Chemical structure

Polarity and reactivity of the compound

Routes of administration

Applied on skin ingested, inhaled, injected, etc..

Period (time) of exposure

Number of exposure

Singe dose or multiple dose

Physical form of toxicants

Solid, liquid, gas

Individual's health



Exposure to the toxicant can be:



Acute

- Contact time below 24 h,
- severe symptom
- followed by death
- e.g. tetrodotoxin intoxication, botulism

Subacute

- Usually repeated contacts in 1 month
- same effect with acute but weaker symptom
- e.g. agricultural workers dealing with pesticides

Subchronic

Continuous contact during 1 – 3 months

Chronic

- Continuous > 3 month exposure to harmless daily dose of toxicant
- accumulation of toxicant in organism
- symptom develop slowly
- e.g. cancer due to ingestion of aflatoxin, heavy metal



Dose

**TOTAL AMOUNT OF TOXIC
COMPOUND ADMINISTERED TO
THE ORGANISM**

- Expressed in microgram or miligram per kg of the body weight



Response

BIOCHEMICAL OR PHYSIOLOGICAL
CHANGES IN THE ORGANISM
EXPOSED TO THE TOXIC
COMPOUNDS

- the intensity depends on the concentration of toxic compounds



THE VISCERA
IN POSITION

Toxicity test on animal



<https://www.iaapea.com/ld50-test-on-animals.php>

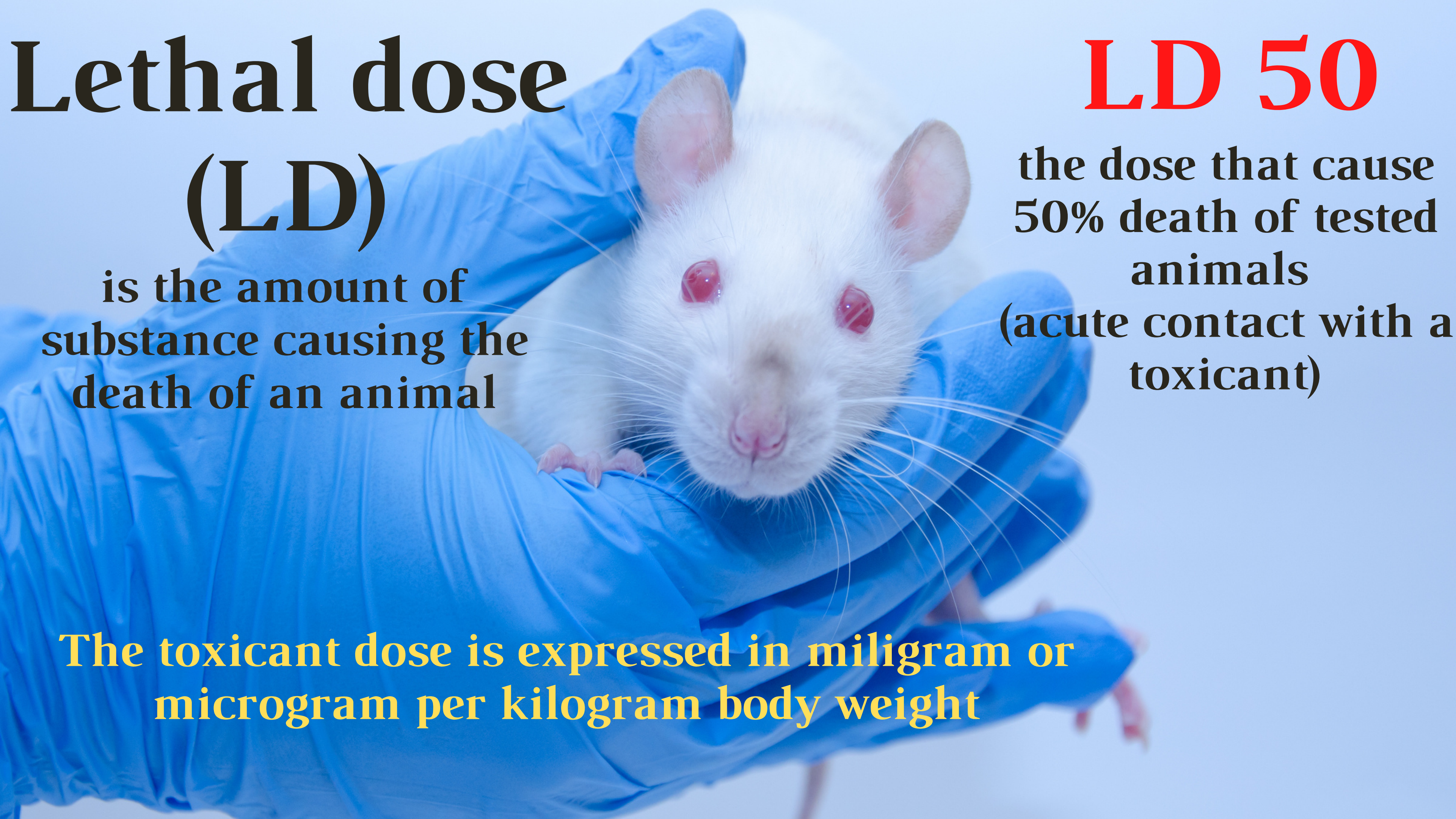
Lethal dose (LD)

is the amount of
substance causing the
death of an animal

LD 50

the dose that cause
50% death of tested
animals
(acute contact with a
toxicant)

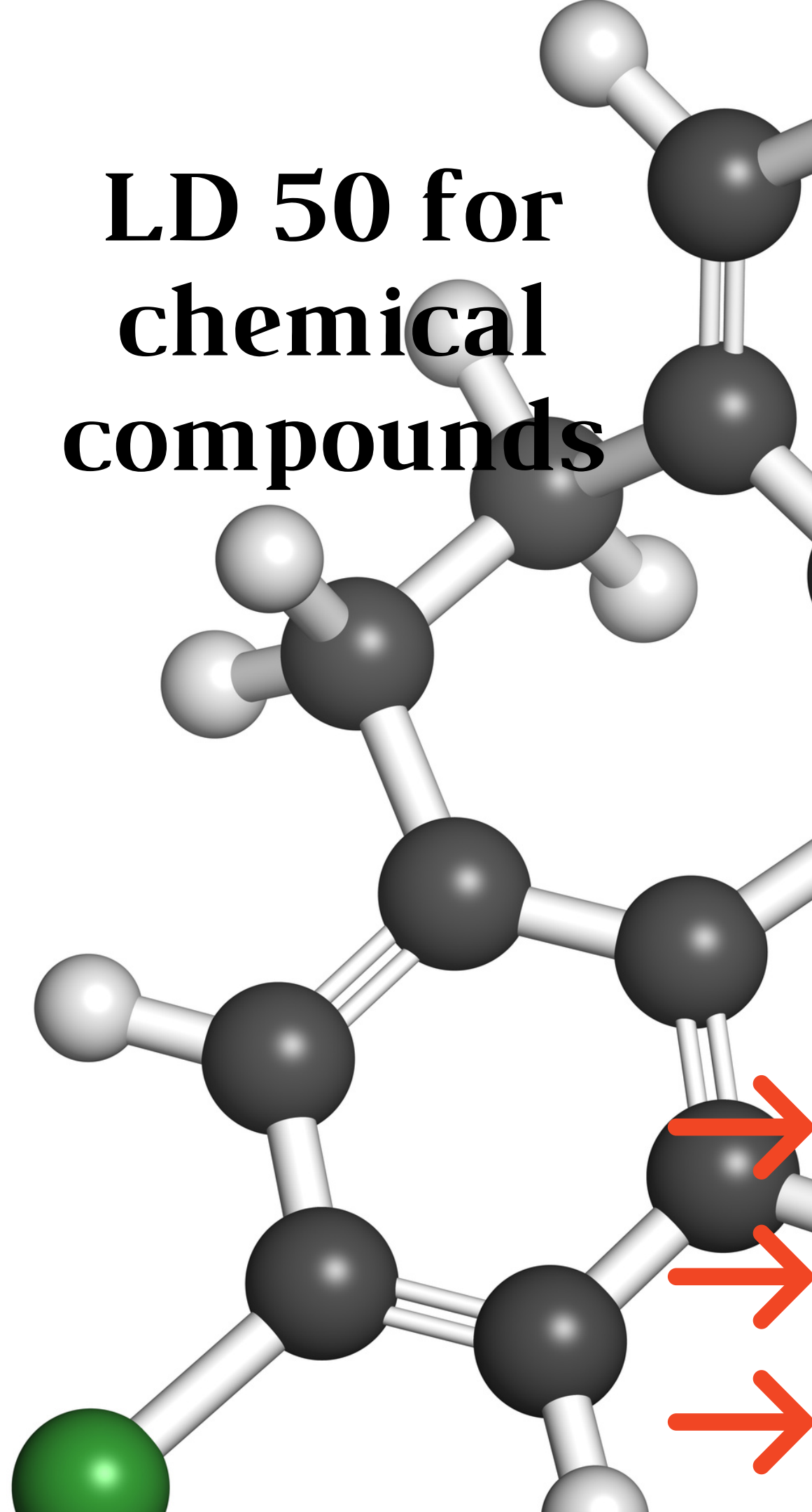
The toxicant dose is expressed in miligram or
microgram per kilogram body weight



LD 50 for chemical compounds

Table 1.1 Approximate LD₅₀ Values for a Selection of Chemical Compounds

Chemical Compound	LD ₅₀ (mg/kg, rat, orally)
Ethanol	10,000
Sodium chloride	4000
Paracetamol	1900
Malathione	1200
Lindane	1000
Morphine sulfate	900
Caffeine, aspirin	200
Sodium nitrite	180
DDT	100
Arsenic	48
Dieldrine	40
Strychnine sulfate	2
Aflatoxin B1	1.2
Nicotin	1
Tetrodotoxin	0.1
Tetrachlordibensodioxin (TCDD)	0.001
Botulinum toxin	0.00001



Dose-response curve

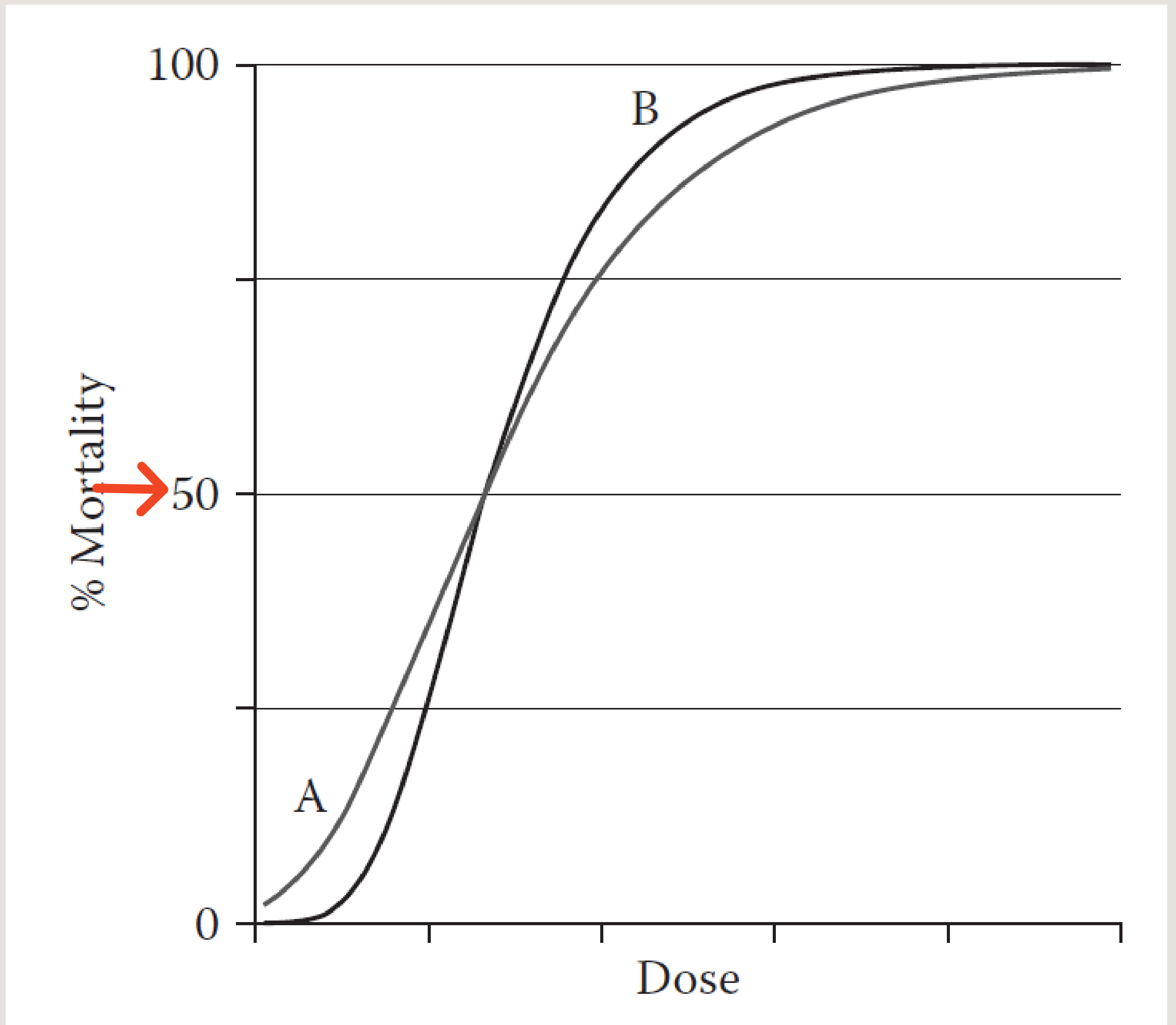
ESTIMATION AND COMPARISON OF ACUTE TOXICITIES OF SUBSTANCES

slope - predictability

steeper slope need smaller change of dose to produce the same response with the other toxicant

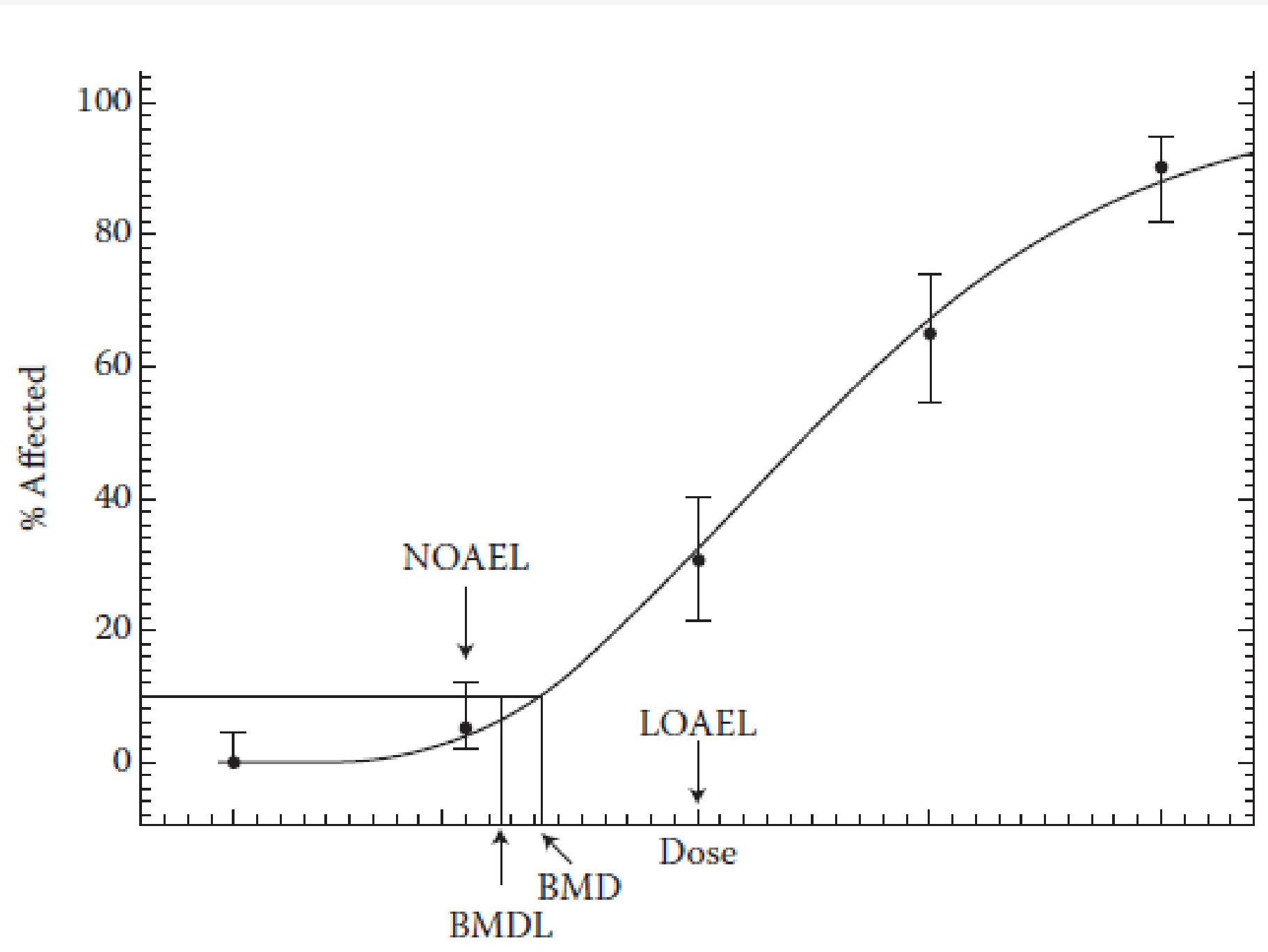
location - toxicity

higher toxicity is located more left



Threshold doses

- dose that induce acute severe intoxication
- always higher than the dose for chronic intoxication



NOEL (no-observed effect level)

Highest dose that does not causing any effect

NOAEL (no-observed adverse effect)

- Highest dose that does not causing any adverse effect
- the basis for counting of acceptable daily intake of food - safe consumption of food that contain pesticides, food additive, etc.

LOAEL (lowest-observed adverse effect)

lowest dose that causing an observable effect

BMD - benchmark dose for low toxicant doses

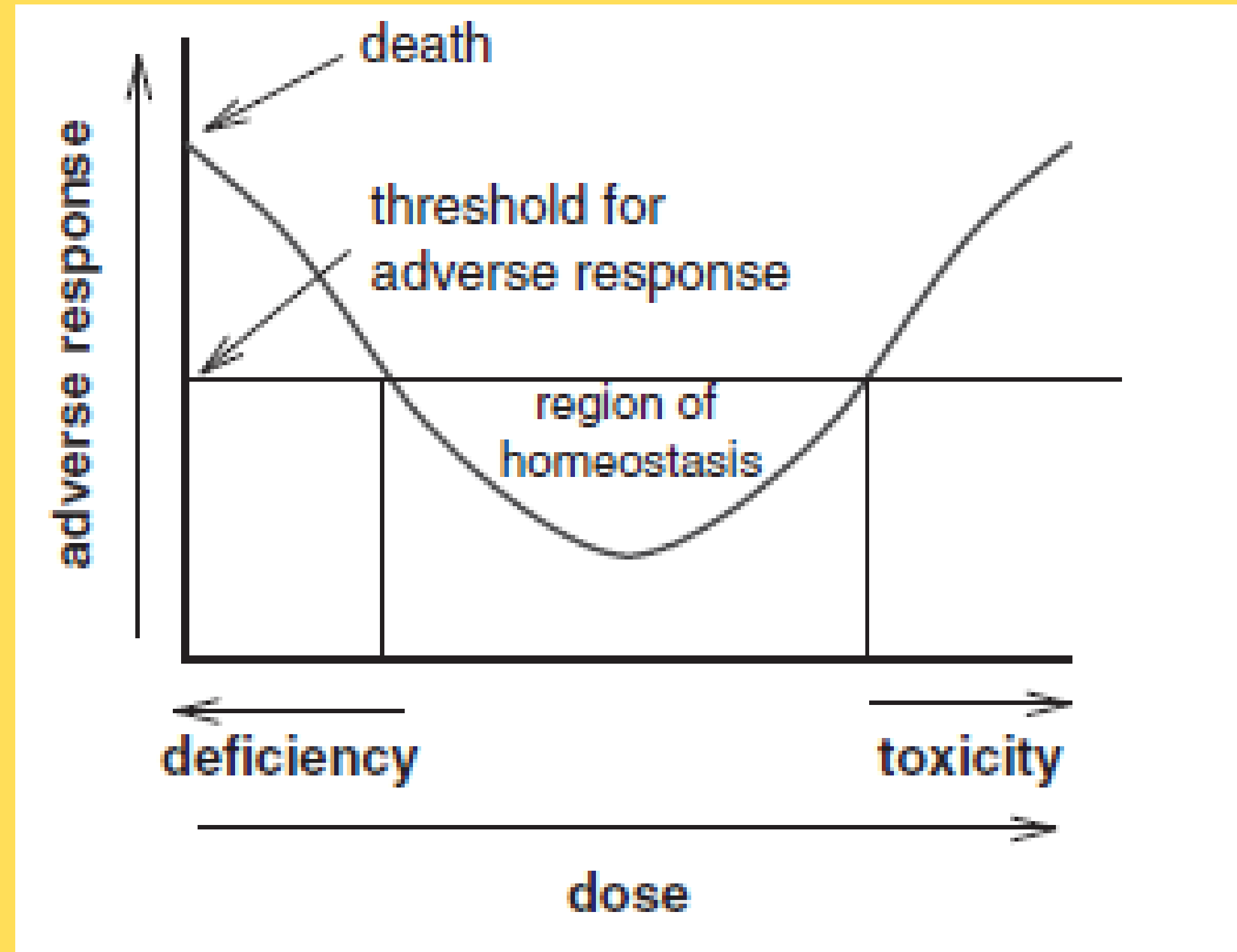
HORMESIS

The dose-response relationship is characterized by:

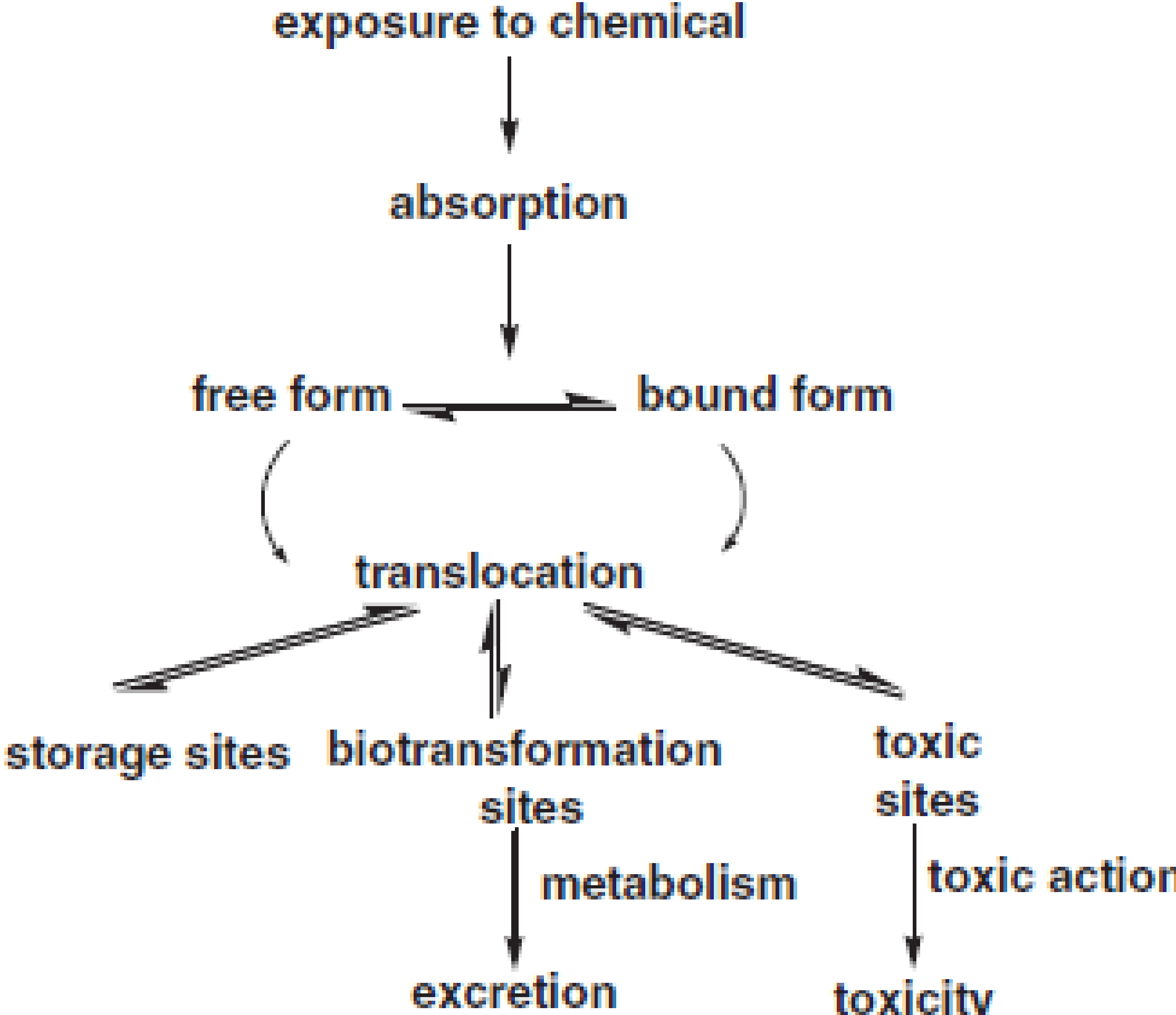
- low dose - beneficial effect
- very low dose: adverse effect (deficiency)
- high dose - toxic effect

E.g. Vitamin A

- low dose - contribute to night blindness
- high dose - liver toxicity & birth defect



Biological processes that can modulate response (beneficial & adverse) to an administered chemical





NATURAL CONTAMINANT

- Endogenous plant toxicant
- Mycotoxin
- Microbial toxin
- Shellfish toxins
- Scombroid fish poisoning
- Tetrodotoxin in puffer fish

UNINTENTIONAL CONTAMINANTS

Synthesized during food processing (PAH, HCA, acrylamide, etc.), from food contact material (phthalate, bisphenol), environment (heavy metal, pesticides)

INTENTIONALLY ADDED CHEMICAL

Food additives

MAIN GROUP OF FOOD TOXICANTS

Endogenous plant toxicant

Alkaloid

Solanine in green and sprouting potatoes
Caffeine in coffee
theobromine in cocoa bean



Hydrogen cyanide

Cassava, almond, , apricots, apple



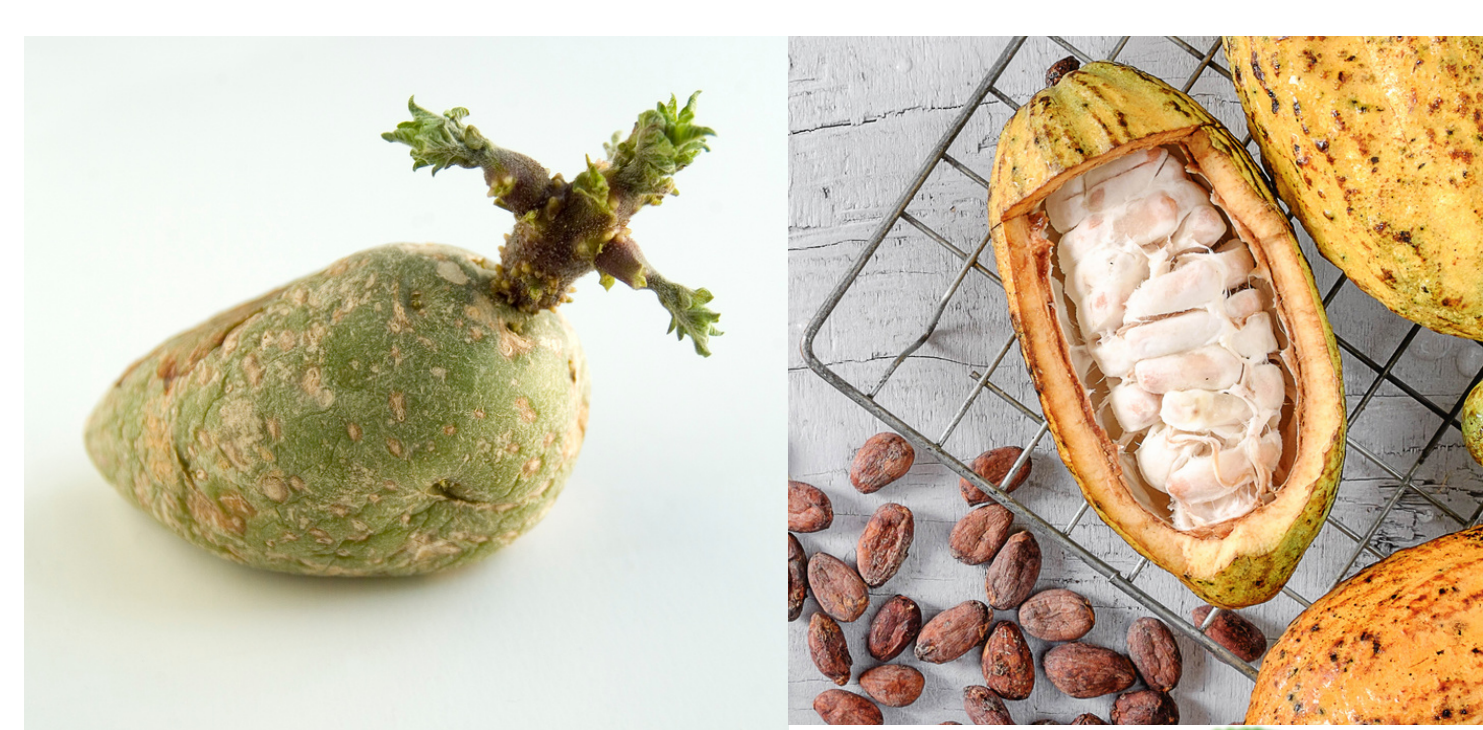
Coumarin

Cinnamon



Oxalate

Spinach, radish, parsley, taro leaves



Toxicant formed during processing



Maillard reaction product

Chemical reaction between compound containing amino acids, and reducing sugar produce furanes, aminocarbonyl, pyrazines



Heterocyclic amines (HCA)

Cooking meat at high temperature & long time



Polyunsaturated fatty acids (PUFAs)

Storage and/or thermal process



Nitrosamines

Frying food with high nitrite content



Polycyclic aromatic hydrocarbons (PAH)

Smoking of meat, fish, roasting coffee bean



Acrylamide

Fried potato product, bread and bakery product



Toxicant formed during processing



Transfatty acid (TFA)

originated from incomplete hydrogenation of edible vegetable oils
e. g. cakes, cookies, crackers, margarine, fried potatoes



3-MCPD

soybean extract that have been treated at high temperature with concentrated hydrochloric acid



Toxicant from food contact material



Phthalates

plastic bags, packaging materials, food container



Bisphenols

Protective coating of plastic bottles



Food Additives



Colorant



Artificial sweeteners



Preservatives



Glutamate

**List all the hazards
(biological, chemical,
physical) that might
present in:**

Satay

Peanut sauce

Cucumber & onions

Rice cube

