
ENV PRO
Co-funded by the
Erasmus+ Programme
of the European Union
The Environmental
Science Education
for Sustainable Human Health
in commemoration of Prof. Armen Saghatelyan
9 September 2021
UNIVERSITÀ DEGLI STUDI DELLA TUSCIA
GIRAF PM
NAS RA
INTERNATIONAL SCIENTIFIC EDUCATIONAL CENTER
MARTIN-LUTHER-UNIVERSITÄT HALLE-WITTENBERG
UNIVERSITY OF GEORGIA
TÉCNICO LISBOA
GRENA
GEORGIAN RESEARCH AND EDUCATIONAL NETWORKING ASSOCIATION

Co-funded by the
Erasmus+ Programme
of the European Union

Environmental Toxicology

Dr. Meline Beglaryan

PhD, Lecturer, The Department of
"Environmental Protection and Nature Management", ISEC
Head of Expert Group at the IACRA, CENS

UNIVERSITÀ DEGLI STUDI DELLA TUSCIA

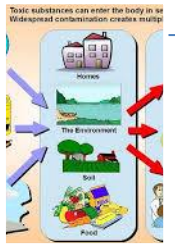
CENS

IACRA

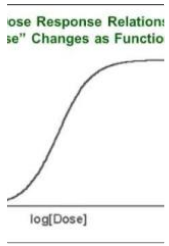
ISEC

ENV PRO

Environmental Toxicology Course

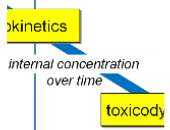


Essentials of Toxicology. Terminology.



Dose-Response Relationship.

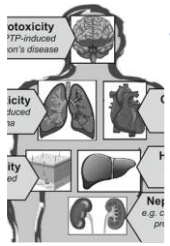
Toxins and Toxicants.



Toxicodynamics.

Toxicokinetics.

Toxicity.



Target Organ Toxicity.

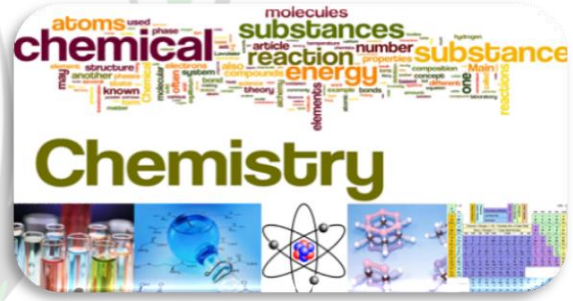
Exposure Pathway.

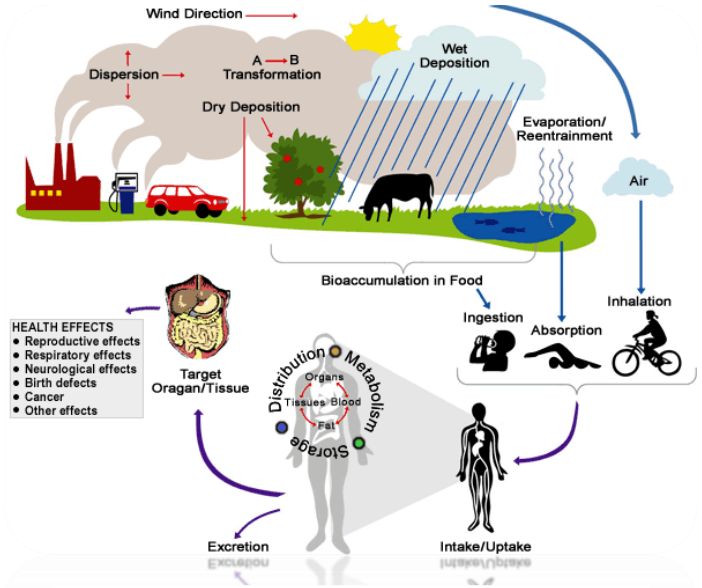
Route of Exposure.

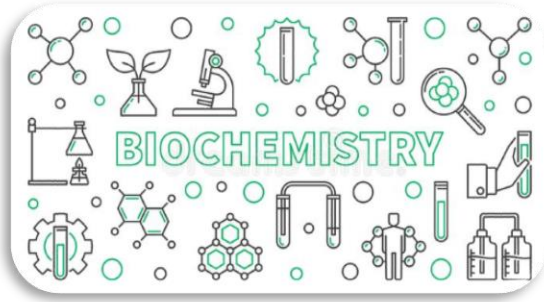
Why should we care?

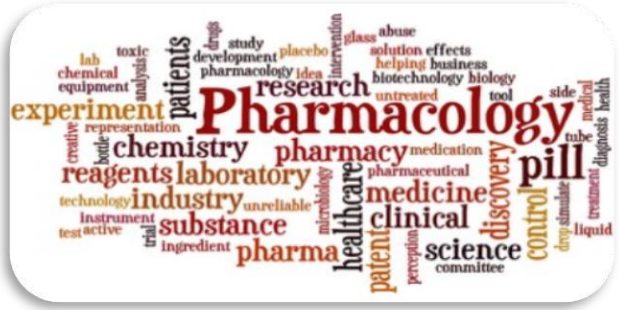
Environmental Toxicology

the study of poisons around us









Multidisciplinary science

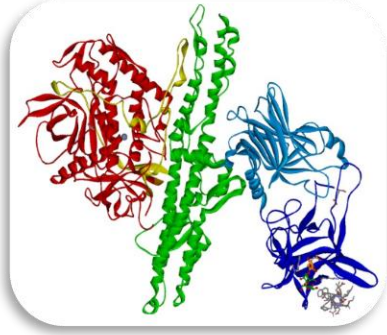
"upon" "study"
epidemiology
"people"

Toxins

Poisonous substances produced by…

animals
(zootoxins)

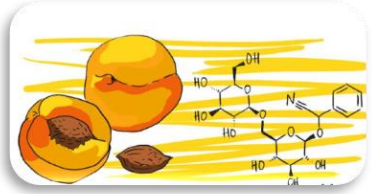
bacteria
(bacteriotoxins)



plants
Alkaloids ← *(phytotoxins)* → *Glycosides*

Solanine

Toxic mushrooms



Amigdaline

Toxicants

Xenobiotics ***(xenos – a stranger)***

substances, that are not naturally produced in organism

from a variety of industrial, automotive, agricultural, household, or natural sources

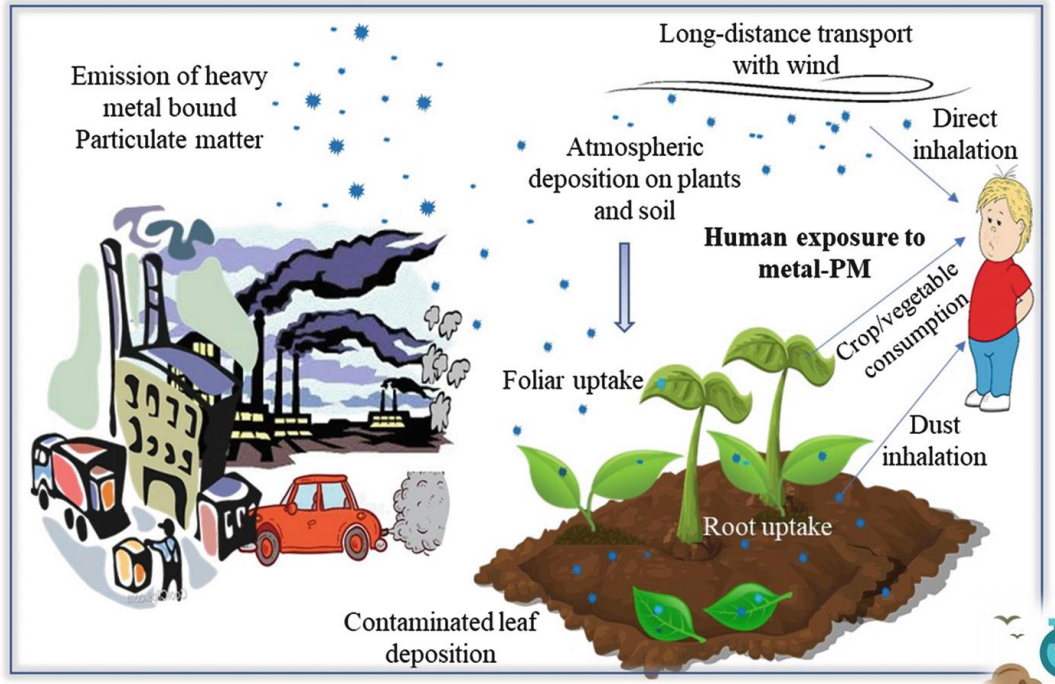
Xenobiotics

Classification	Categories
Physical state	Gas, liquid, solid
Chemical structure	Aromatic amines, aliphatics, glycols
General action	Air pollutants, chronic poisons, industrial toxins
Poisoning potential	Slightly toxic, moderately toxic, supertoxic
Effect	Carcinogens, mutagens, teratogens
Target organ	Neurotoxins, hepatotoxins, nephrotoxins
Mechanism of action	Stimulants, inhibitors
General or use class	Plastics, organic chemicals, heavy metals, food additive
Labeling requirements	Oxidizer, acid, explosive

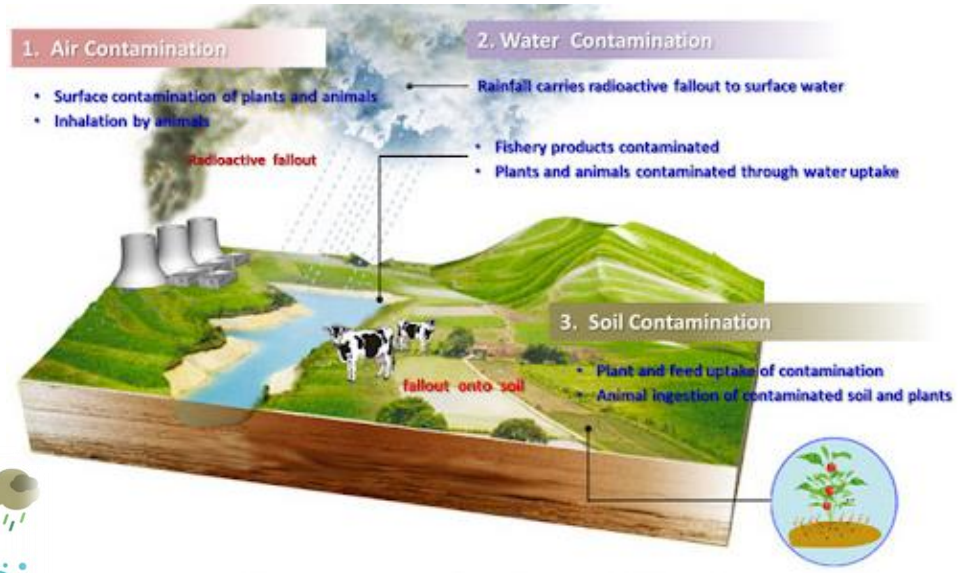
Environmental Toxicants

Hazardous substances that can have adverse effects...

Metals



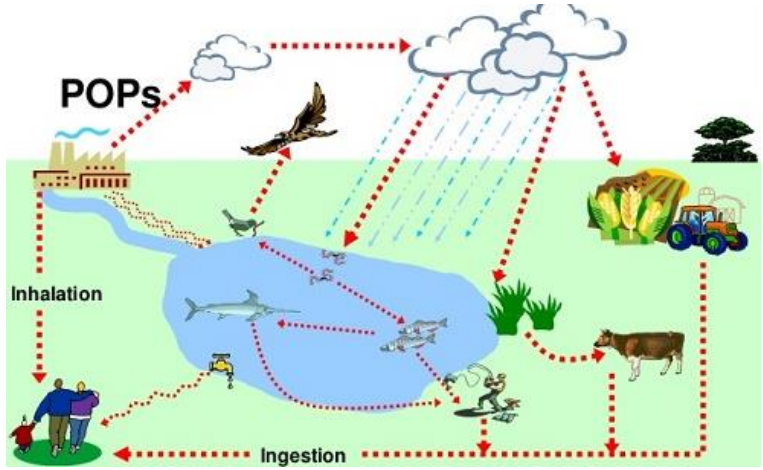
Radioactive contaminants



Environmental Toxicants *(2)*

Pesticides

Persistent Organic Pollutants



- Aldrin
- Dieldrin
- Endrin
- Toxaphene
- Heptachlor
- Mirex
- Chlordane
- PCBs
- HCB
- Dioxins & Furans
- DDT

Dirty dozen

PESTICIDES AND INDUSTRIAL CHEMICALS - ELIMINATION - (ANNEX A)

UNINTENTIONAL PRODUCTION - (ANNEX C)

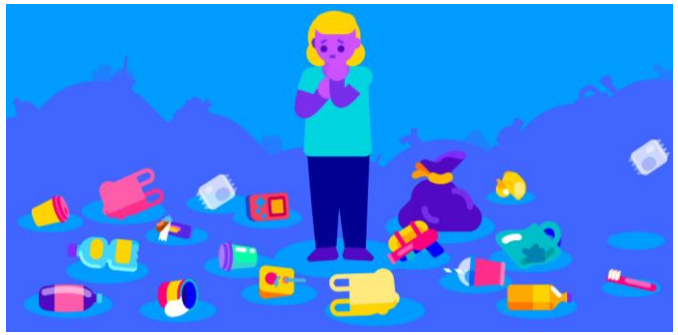
PESTICIDE - RESTRICTION - (ANNEX B)

Environmental Toxicants *(3)*

Organic Solvents

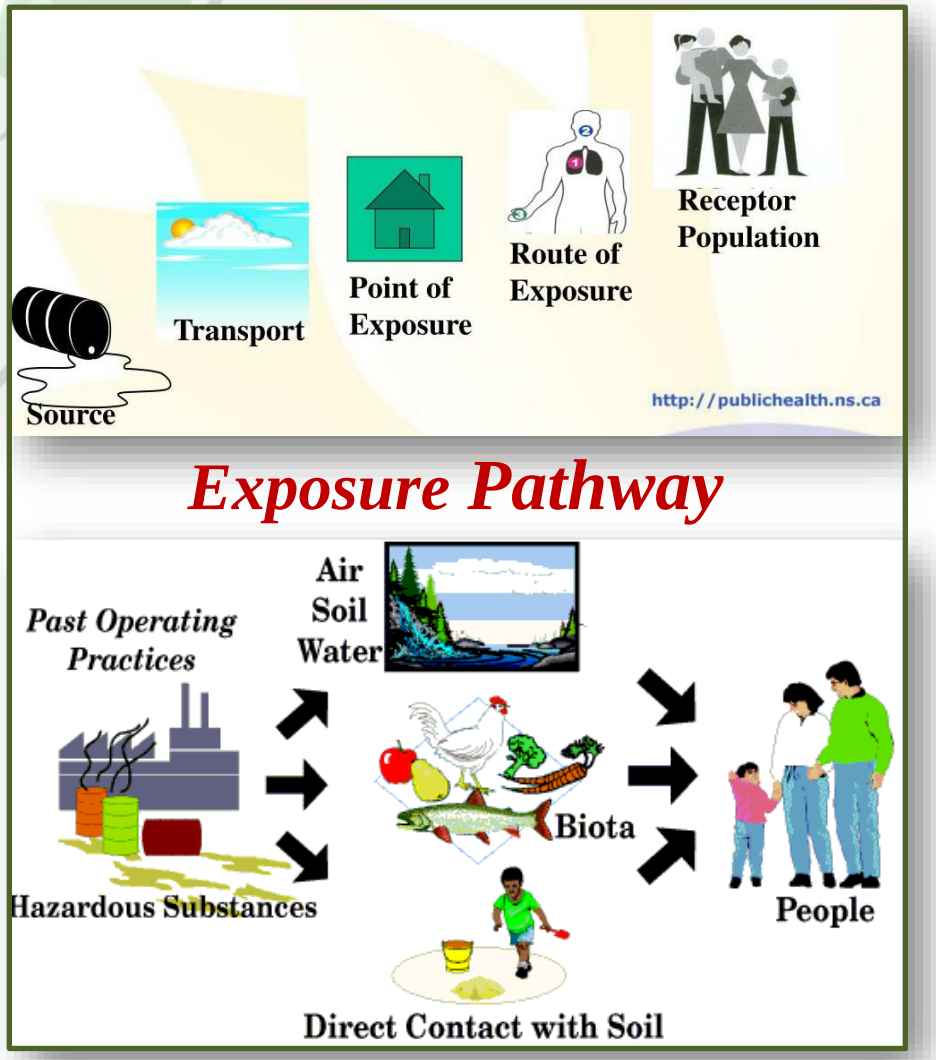
Solvents create quickly high concentrations of vapors

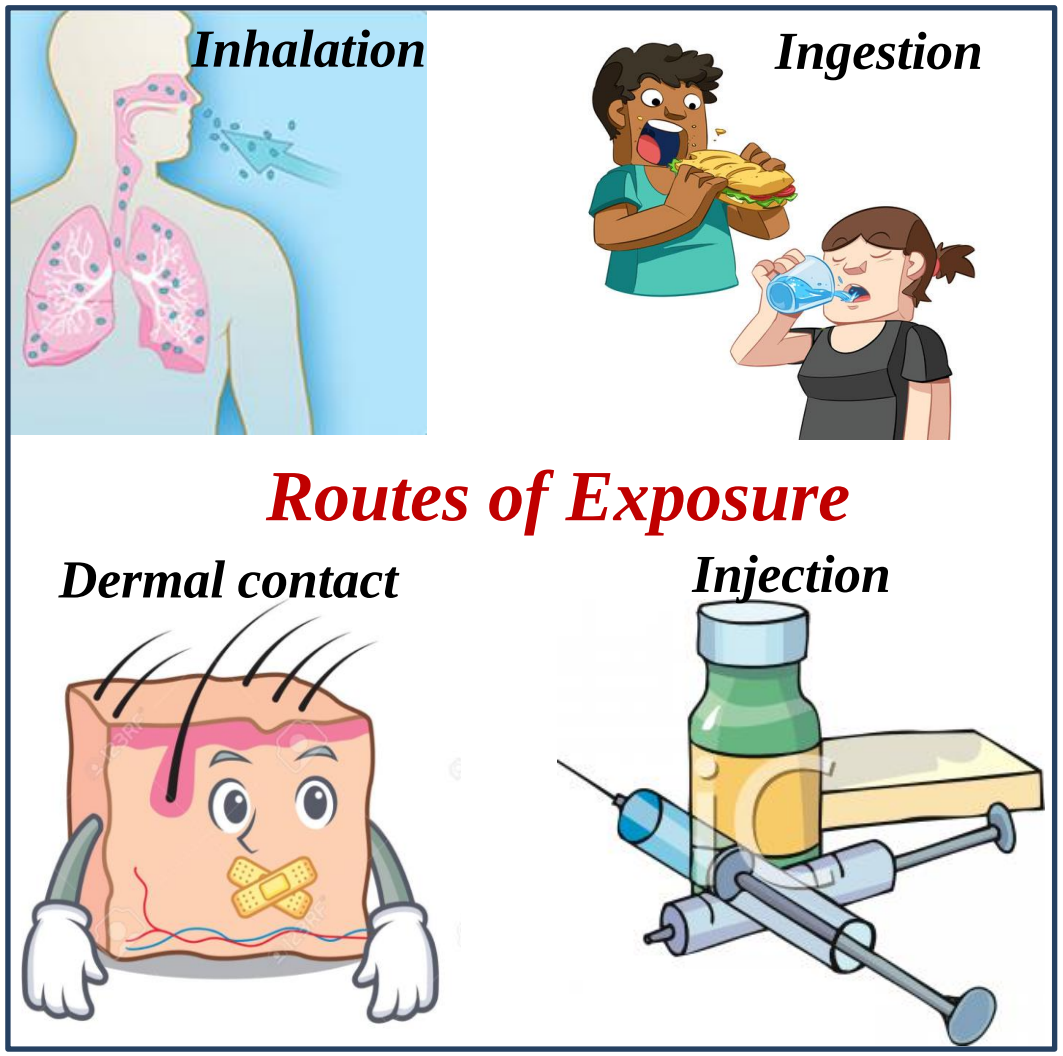
Plastic



Etc...

Exposure Pathway and Route of Exposure





Exposure Duration

Acute

less than 24 h

Subacute

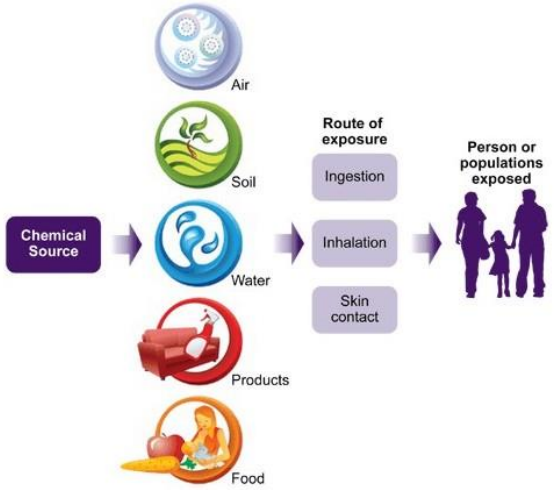
from several days to 1 month

Subchronic

generally 1-3 months

Chronic

greater than 3 months



Toxicity

The state of being poisonous and general term used to indicate ***adverse effects***

Duration

Acute toxicity - sudden symptoms last for a short period of time (~24h).

Chronic toxicity - symptoms that are of a long, continuous duration.

Location

Local toxicity - the symptoms are restricted to the site of initial exposure.

Systemic toxicity - adverse effects occur at sites far from the initial site of exposure

How is toxicity determined since chemicals vary in toxicity?

"upon" "study"

epidemiology

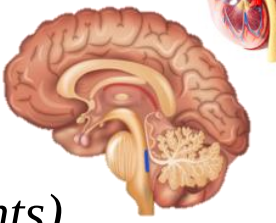
"people"

Target Organ Toxicity

Each organ will respond to a toxicant in a different way.

- **Hematotoxicity** *(e.g. by benzene, chlordane, naphthalene)*
- **Hepatotoxicity** *(e.g. chronic ethanol toxicity, organic chemicals)*
- **Nephrotoxicity** *(e.g. some xenobiotics, such as lead, cadmium, heroin)*
- **Neurotoxicity** *(e.g. botulin toxin, tetrodotoxin, hexachlorophene)*
- **Dermatotoxicity** *(e.g. organic solvents, numerous industrial agents)*
- **Pulmonotoxicity** *(e.g. asbestos fibers, coal dust, beryllium)*




Dose

How harmful a chemical is depends on:

- **Size of dose** over a certain period of time
- **How often** exposure occurs, who is exposed
- How well the body's **detoxification system** work
- Substance's **properties** (e.g. solubility, persistence)

"**All substances are poisons**; there is none which is not a poison. The **right dose differentiates** a poison and a remedy."

Dose

Effective Dose
at which the desirable response is observed

Toxic Dose
at which toxicity is present in test organisms

Lethal Dose
resulting in the death of the test organism

Don't compare the dose at which an **LD_{01}** occurs for toxicant **A** with the dose at which an **LD_{50}** occurs for toxicant **B**.

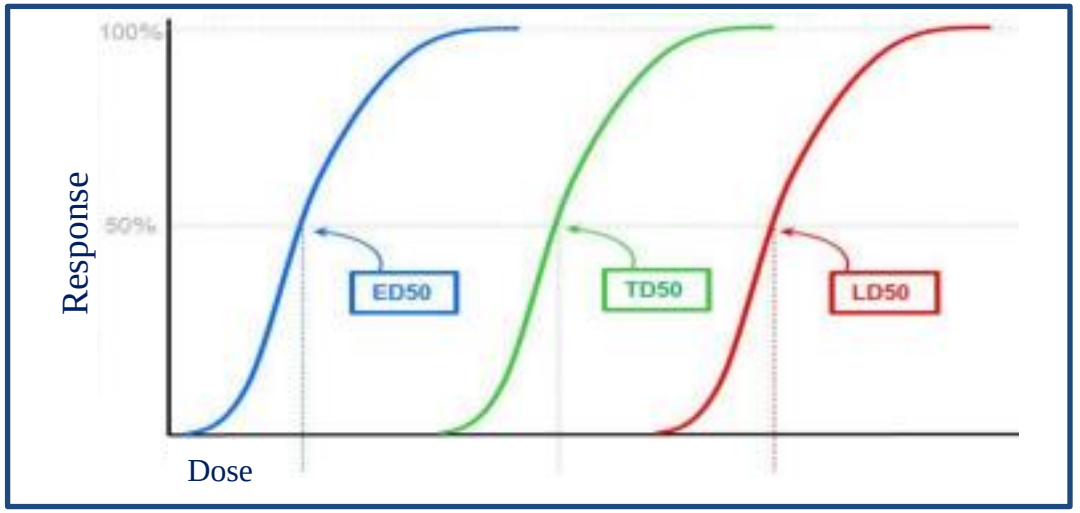
LD_{01} ***vs*** LD_{50}

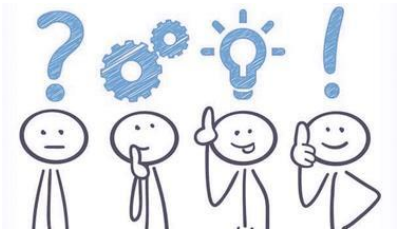
EXAMPLE

Agent	LD_{50} (mg/kg)	Toxicity
Ethyl alcohol	9,000	
Sodium chloride	4,000	
BHA/BHT (antioxidants)	2,000	Slight
Morphine sulfate	900	
Caffeine	200	Moderate
Nicotine	1	High
Curare	0.5	
Shellfish toxin	0.01	
Dioxin	0.001	
Botulinum toxin	0.00001	Extreme

Dose-Response Relationship

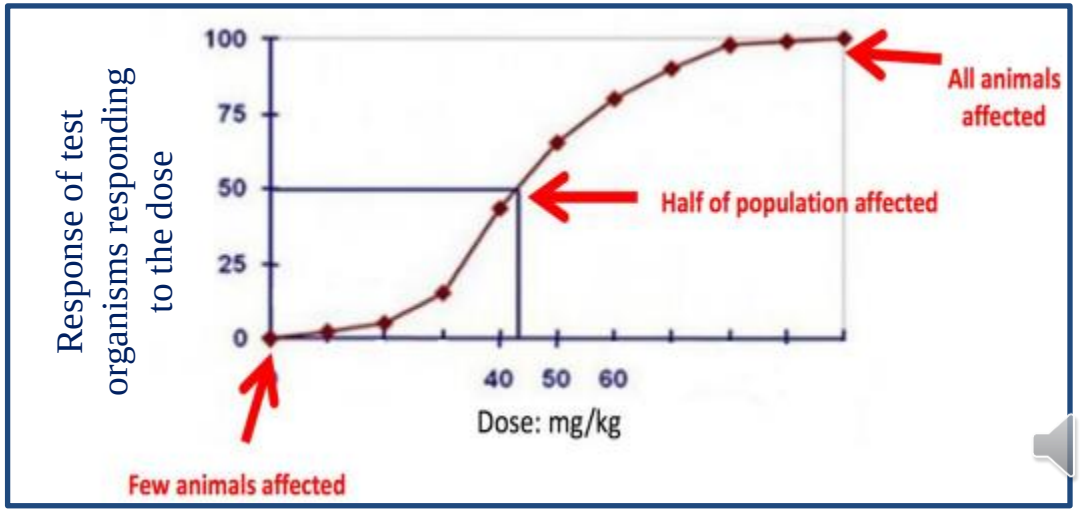
Dose-response relationship – when a consistent mathematical relationship describes the **proportion of test organisms responding to a specific dose** for a given exposure period.





What is LD_{50} ?

The individual dose required to kill **50%** of a population of test animals.



Factors Influencing Dose-Response

- Route of exposure, exposure conditions
- Age and gender characteristics
- Genetic and health status

- **Effects of chemical interaction**

chemical interactions can decrease or multiply the harmful effects of a toxin

Effect	Relative Toxicity (hypothetical)	Example
Additive	2 + 3 = 5	Organophosphate pesticides
Synergistic	2 + 3 = 20	Cigarette smoking + asbestos
Potentiation	2 + 0 = 10	Alcohol + carbon tetrachloride
Antagonism	6 + 6 = 8 or 5 + (–5) = 0 or 10 + 0 = 2	Toluene + benzene or caffeine + alcohol or BAL + mercury

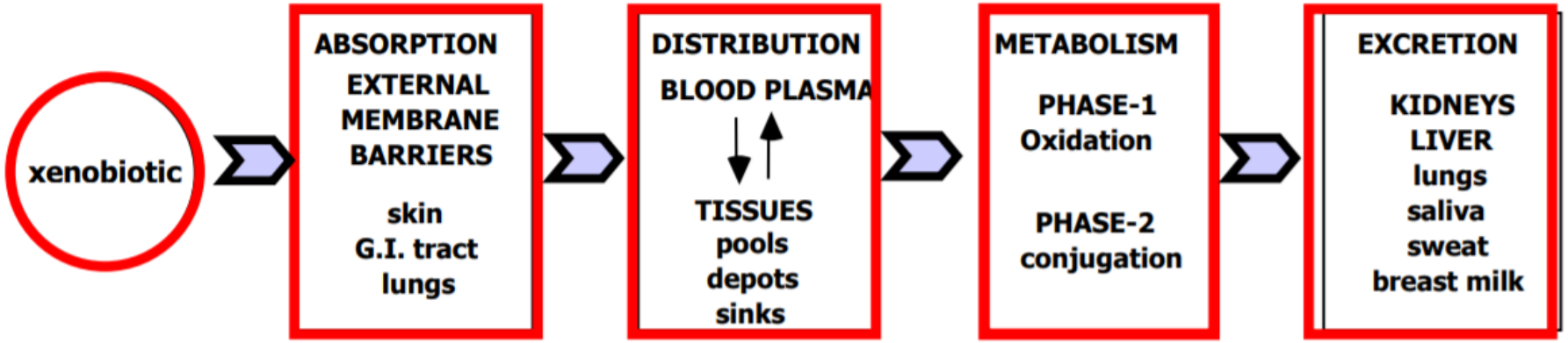
Mathematical Representation of Chemical Interaction

Toxicokinetics

Toxicodynamics

A substance gets into the body and **what happens to it** in the body.

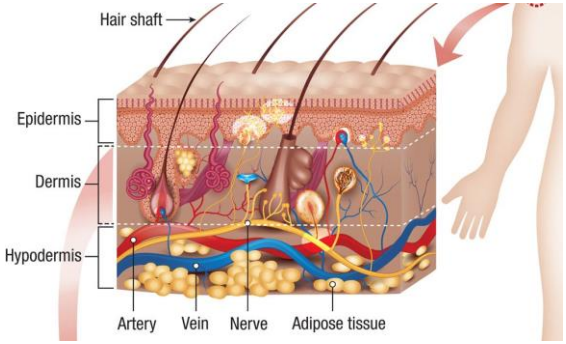
It is concerned with **what** the **toxicant do** to the body.

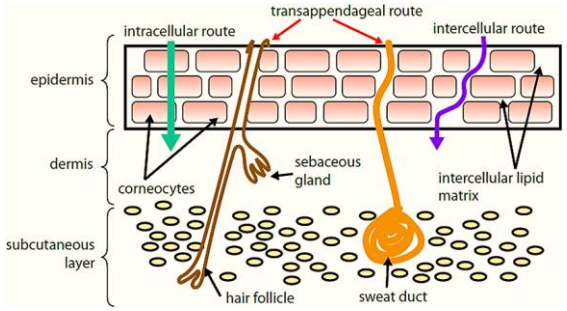


Absorption

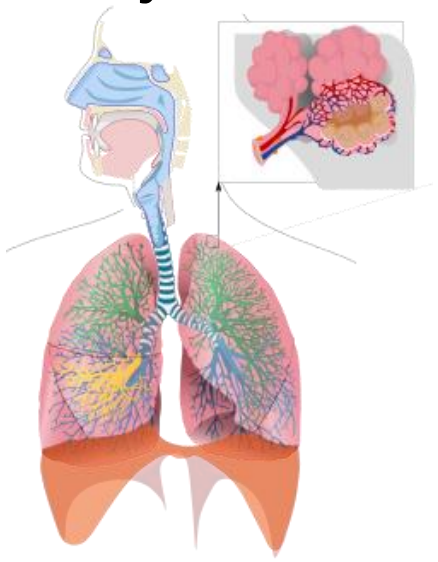
3 primary routes of absorption

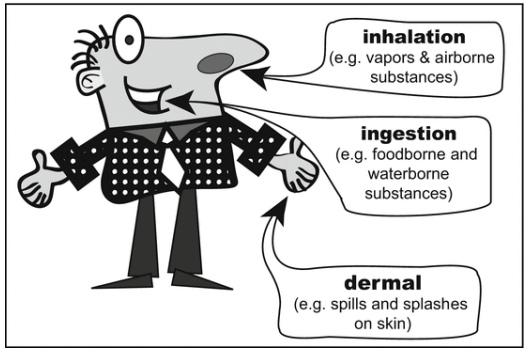
1. Integumentary system



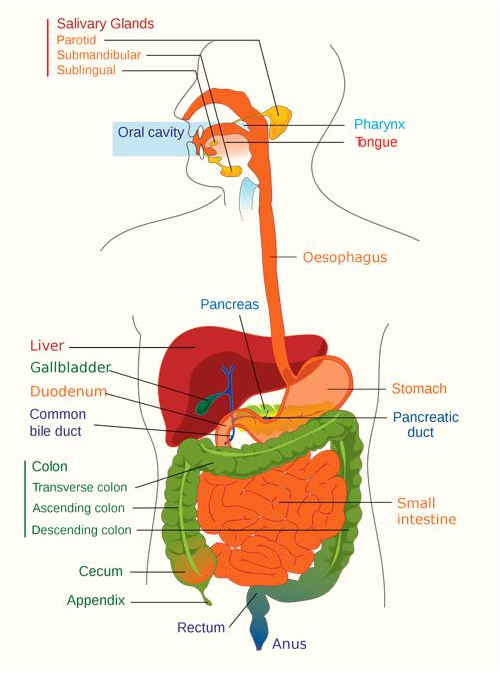


2. Respiratory system



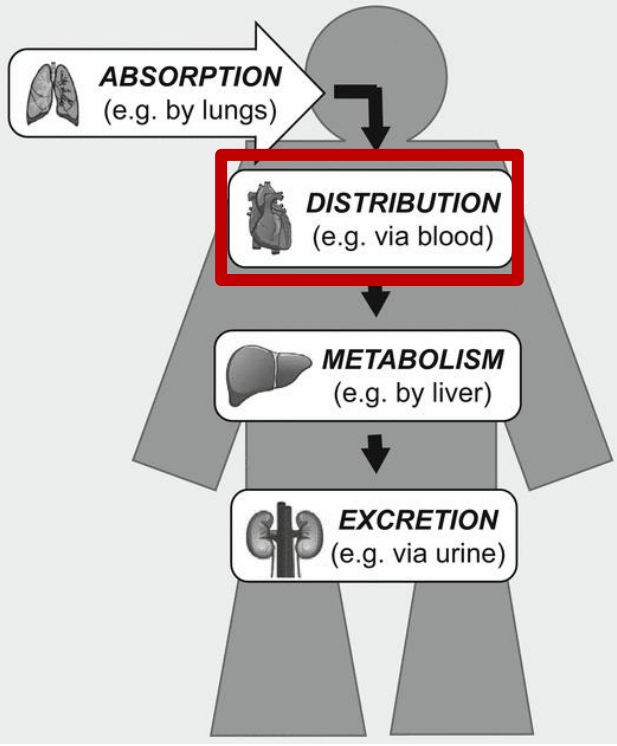


3. Digestive system

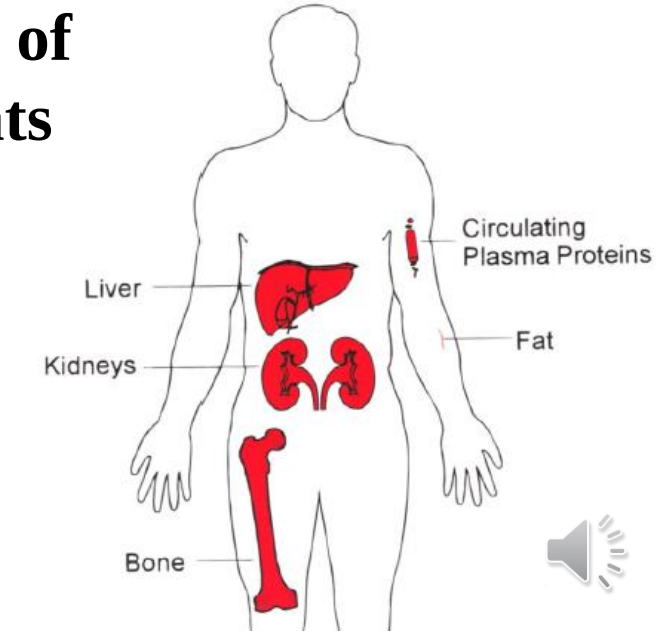


Distribution

- physical and chemical properties of the toxicant
- concentration of the toxicant in the blood and in the tissues
- volume of blood flowing through a specific tissue
- tissue specificity or preference of the toxicant
- presence of special “barriers” to slow down toxicant entrance



Storage of Toxicants



Metabolism (biotransformation)

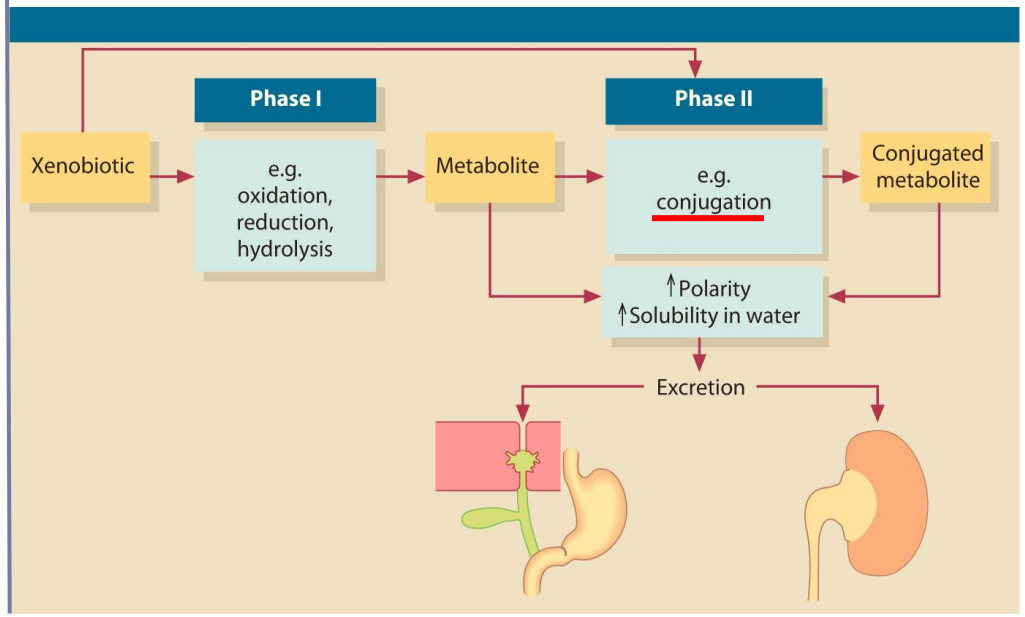
Biotransformation Reactions

Detoxification

Metabolic Activation

(bioactivation)

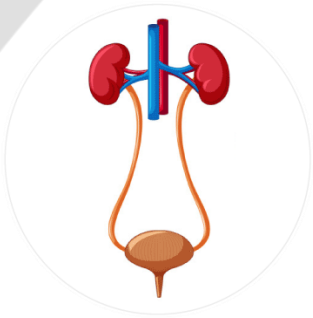
The goal is to facilitate detoxication, thus producing water-soluble metabolites - more readily eliminated by the urinary and biliary systems.

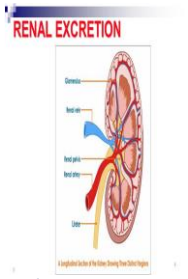


The highest capacity for biotransformation is in the liver.

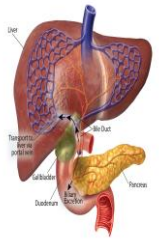
Excretion

Toxicants or their metabolites are eliminated from the body by many different routes.

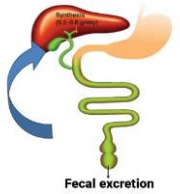


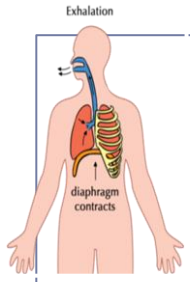


Urinary, *renal*

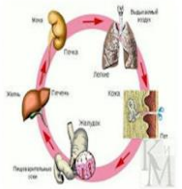


Fecal, *biliary*





Respiratory (*exhalation*)



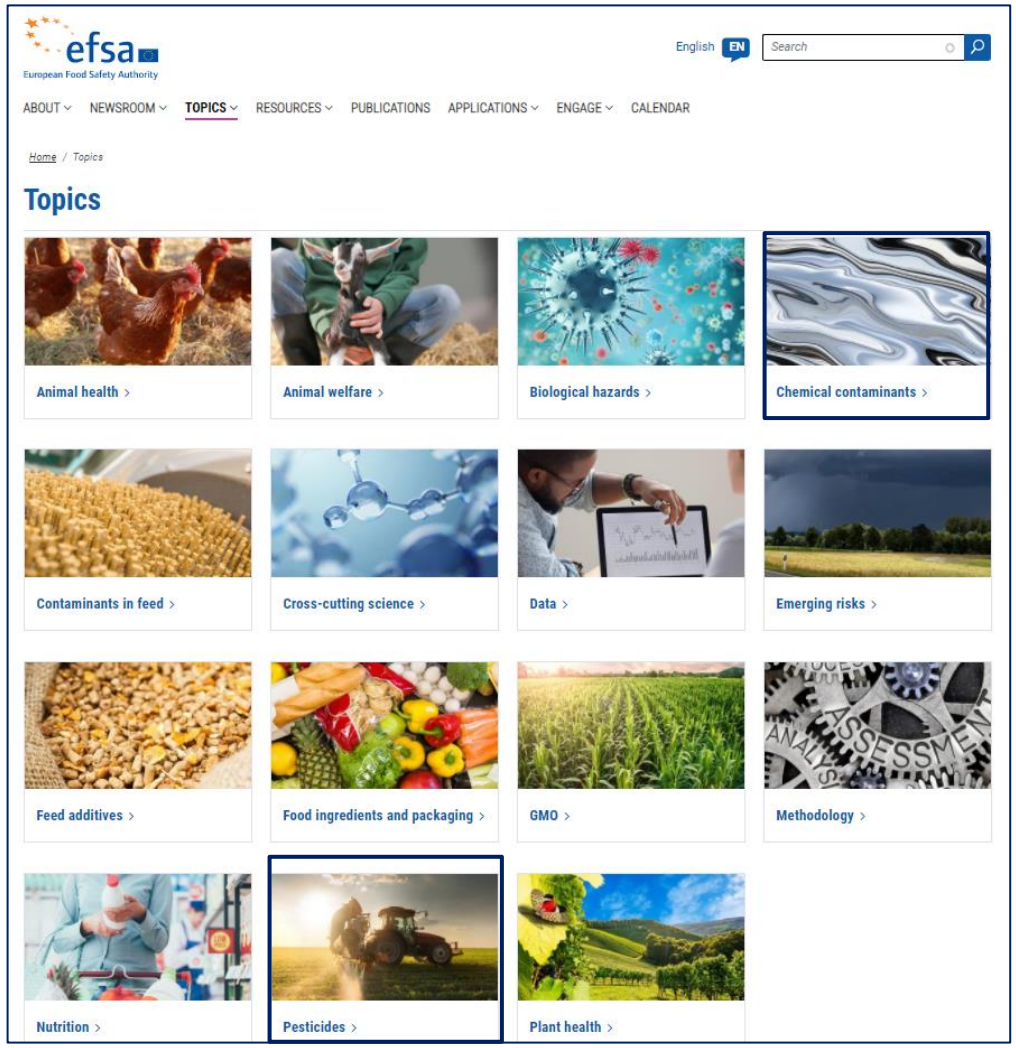
Additional Routes

(saliva, sweat, hair, skin, nails, milk)

Information Sources

efsa
European Food Safety Authority

https://www.efsa.europa.eu/en



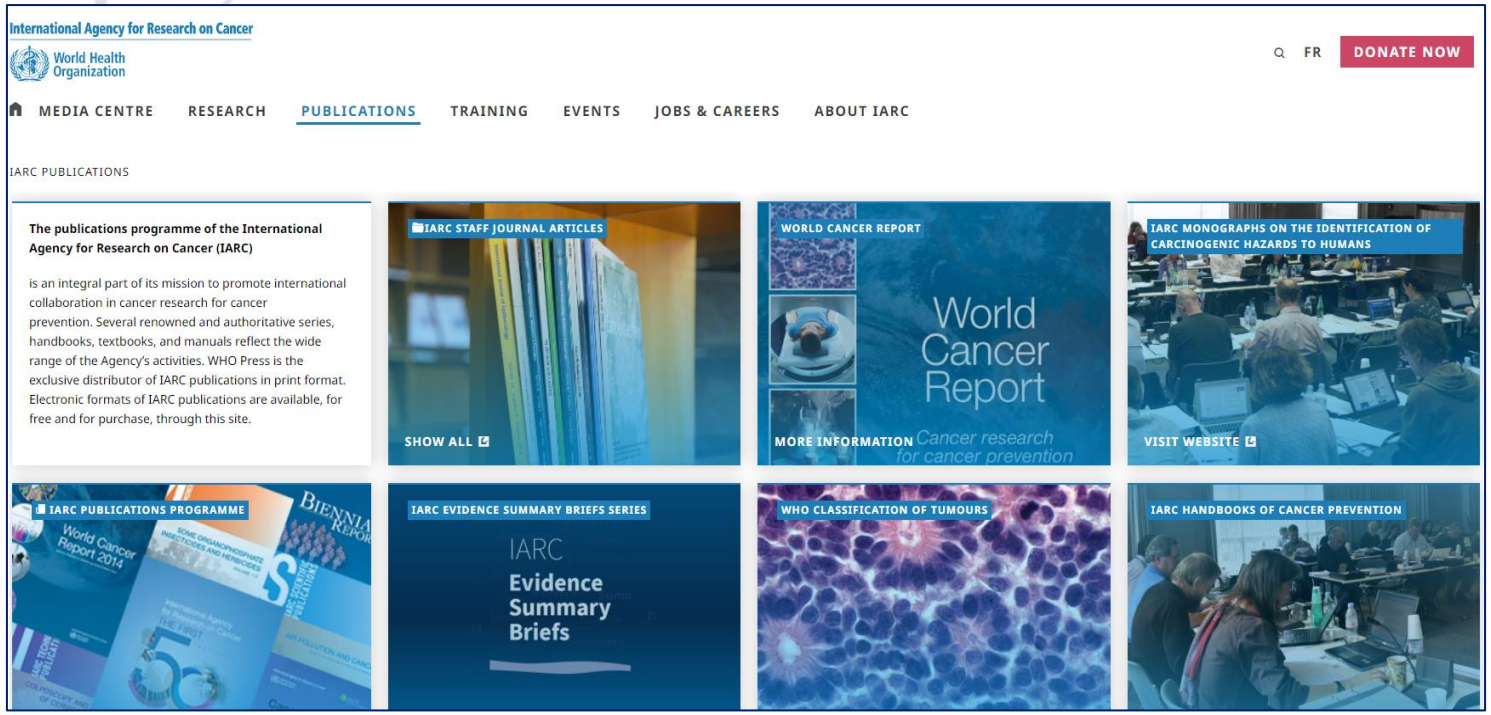
International Agency Research on Cancer

World Health Organization

IARC

https://www.iarc.who.int/cards_page/iarc-publications/

IARC MONOGRAPHS ON THE IDENTIFICATION OF CARCINOGENIC HAZARDS TO HUMANS



IARC Monographs on the Identification of Carcinogenic Hazards to Humans

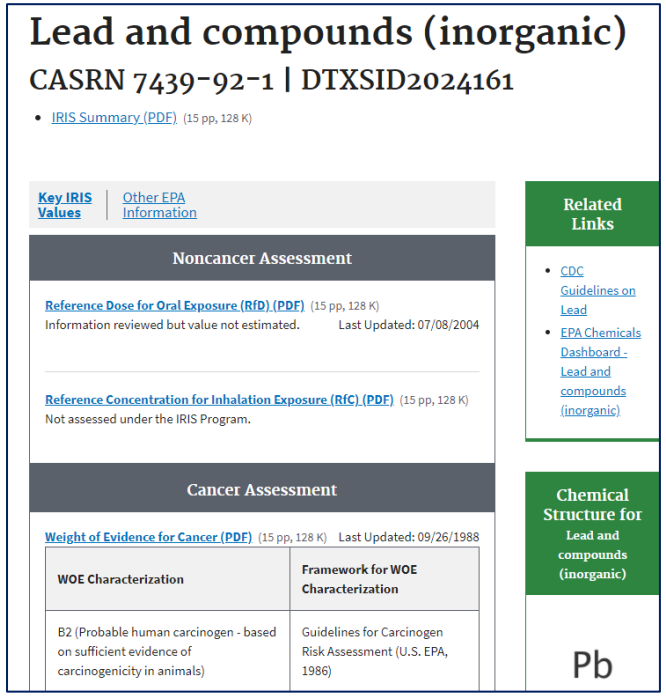
IARC Classifications

GROUP	WHAT IT MEANS	EXAMPLES
Group 1 Carcinogenic to Humans	There is sufficient evidence the agent causes cancer in humans.	Solar radiation, processed meats, alcoholic beverages, smoking, asbestos, talc-based baby powder contaminated with asbestos
Group 2A Probably Carcinogenic to Humans	There is sufficient evidence the agent causes cancer in humans.	Anabolic steroids, high temperature frying, HPV, red meat, Roundup (glyphosate), Actos (pioglitazone), N-nitrosodiethylamine (NDMA)
Group 2B Possibly Carcinogenic to Humans	Limited evidence in humans and less than sufficient evidence in animals.	Aloe vera leaf extract, marine diesel fuel, gasoline, engine exhaust, Asian pickled vegetables, progestin, perineal use of talc-based body powder
Group 3 Not Classifiable as to its Carcinogenicity in Humans	Evidence is inadequate in humans and inadequate or limited in animals.	Coffee, low-frequency electric fields, dental materials, ceramic implants, chlorinated drinking water, tea, printing inks

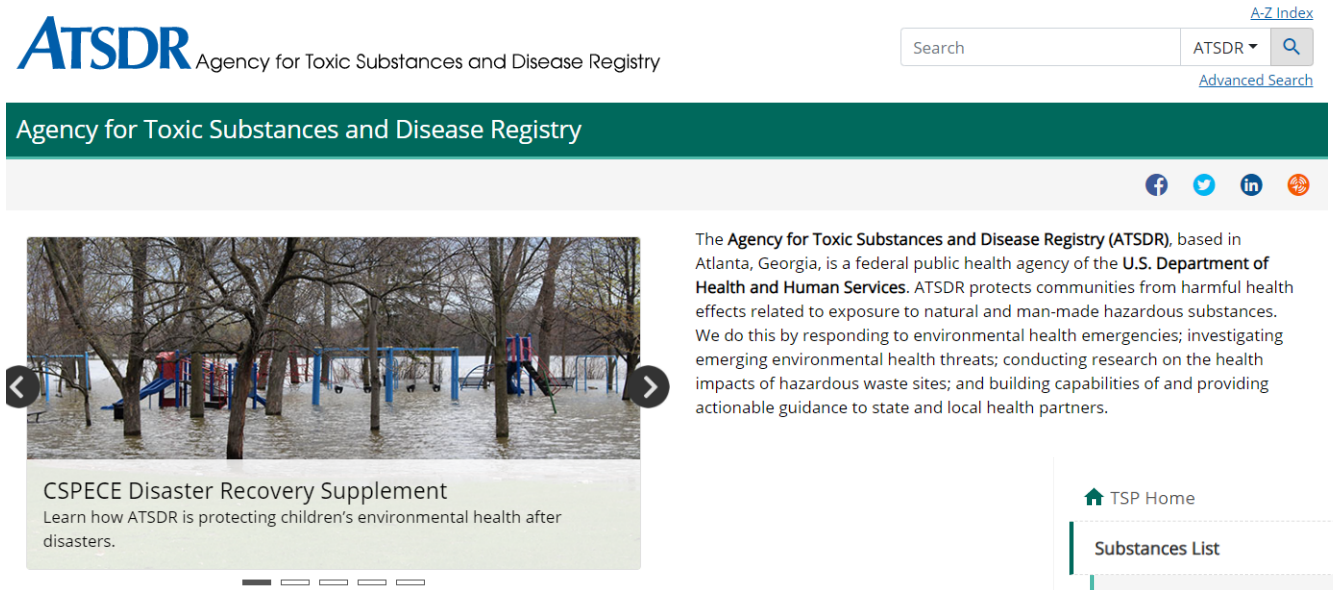
US EPA

https://www.epa.gov/

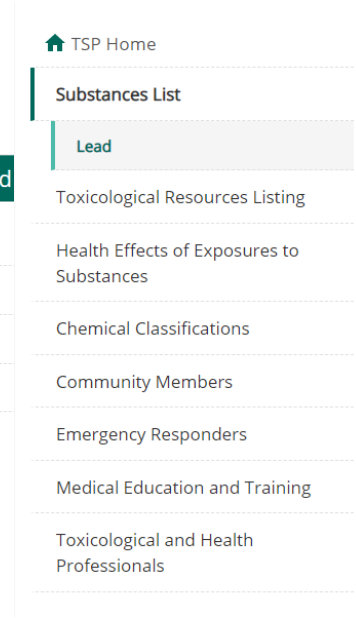
https://www.epa.gov/iris



ATSDR



https://www.atsdr.cdc.gov/



Lead

CAS ID#: 7439-92-1

Affected Organ Systems: Neurological (Nervous System), Renal (Urinary System or Kidneys)

Cancer Classification: Please contact NTP, IARC, or EPA with questions on cancer and cancer classification.

Chemical Classification: Inorganic substances

Summary: Lead is a naturally occurring bluish-gray metal found in small amounts in the earth's crust. Lead can be found in all parts of our environment. Much of it comes from human activities including burning fossil fuels, mining, and manufacturing. Lead has many different uses. It is used in the production of batteries, ammunition, metal products (solder and pipes), and devices to shield X-rays. Because of health concerns, lead from gasoline, paints and ceramic products, caulking, and pipe solder has been dramatically reduced in recent years.

*CDC has updated its recommendations on children's blood lead levels. Experts now use an upper reference level value of 97.5% of the population distribution for children's blood lead. In 2012-2015 that value is 5 micrograms per deciliter (µg/dL) to identify children with blood lead levels that are much higher than most children's levels. The information on this page refers to CDC's previous "blood lead level of concern" of 10 µg/dL. This information will be updated in future ToxProfile and ToxFAQ editions. To learn more about CDC's updated recommendations on children's blood lead levels, please visit: http://www.cdc.gov/nceh/lead/ACCLPP/blood_lead_levels.htm.

Co-funded by the Erasmus+ Programme of the European Union

Thank you for your kind attention!

UNIVERSITÀ DEGLI STUDI DELLA TUSCIA

Meline Beglaryan *meline.beglaryan@cens.am*

ENV PRO