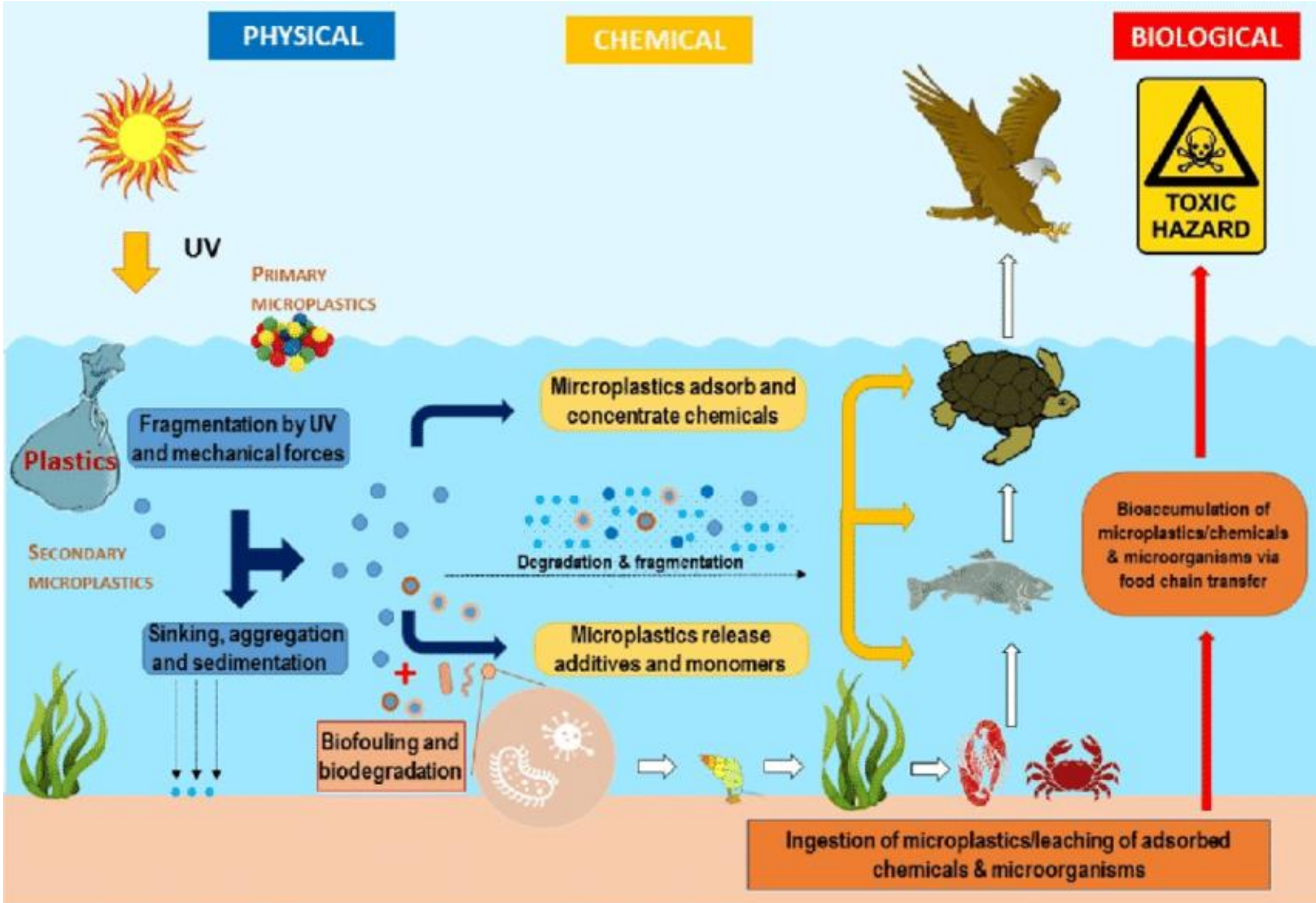
AQUATOXICOLOGY
&
ENVIRONMENTAL MONITORING

Prof. Dr. Christiaan Max Huisden

Chemical contaminants
Pesticides & Herbicides

Pesticides & Herbicides


PHYSICAL
CHEMICAL
BIOLOGICAL
UV
PRIMARY MICROPLASTICS
Plastics
Fragmentation by UV and mechanical forces
SECONDARY MICROPLASTICS
Sinking, aggregation and sedimentation
Mircroplastics adsorb and concentrate chemicals
Degradation & fragmentation
Microplastics release additives and monomers
Biofouling and biodegradation
TOXIC HAZARD
Bioaccumulation of microplastics/chemicals & microorganisms via food chain transfer
Ingestion of microplastics/leaching of adsorbed chemicals & microorganisms

The water quality

Chemical Properties

gases (oxygen, etc.), metals (iron, etc.), nutrients (nitrogen, etc.), pesticides and other organic compounds

Biological Properties

bacteria, viruses, protozoans, phytoplankton, zooplankton, insect, plant and fish etc.

Physical Properties

color, smell, temperature, taste and turbidity(TSS) etc.

Domestic Sewage

Mining Source

Agriculture Source

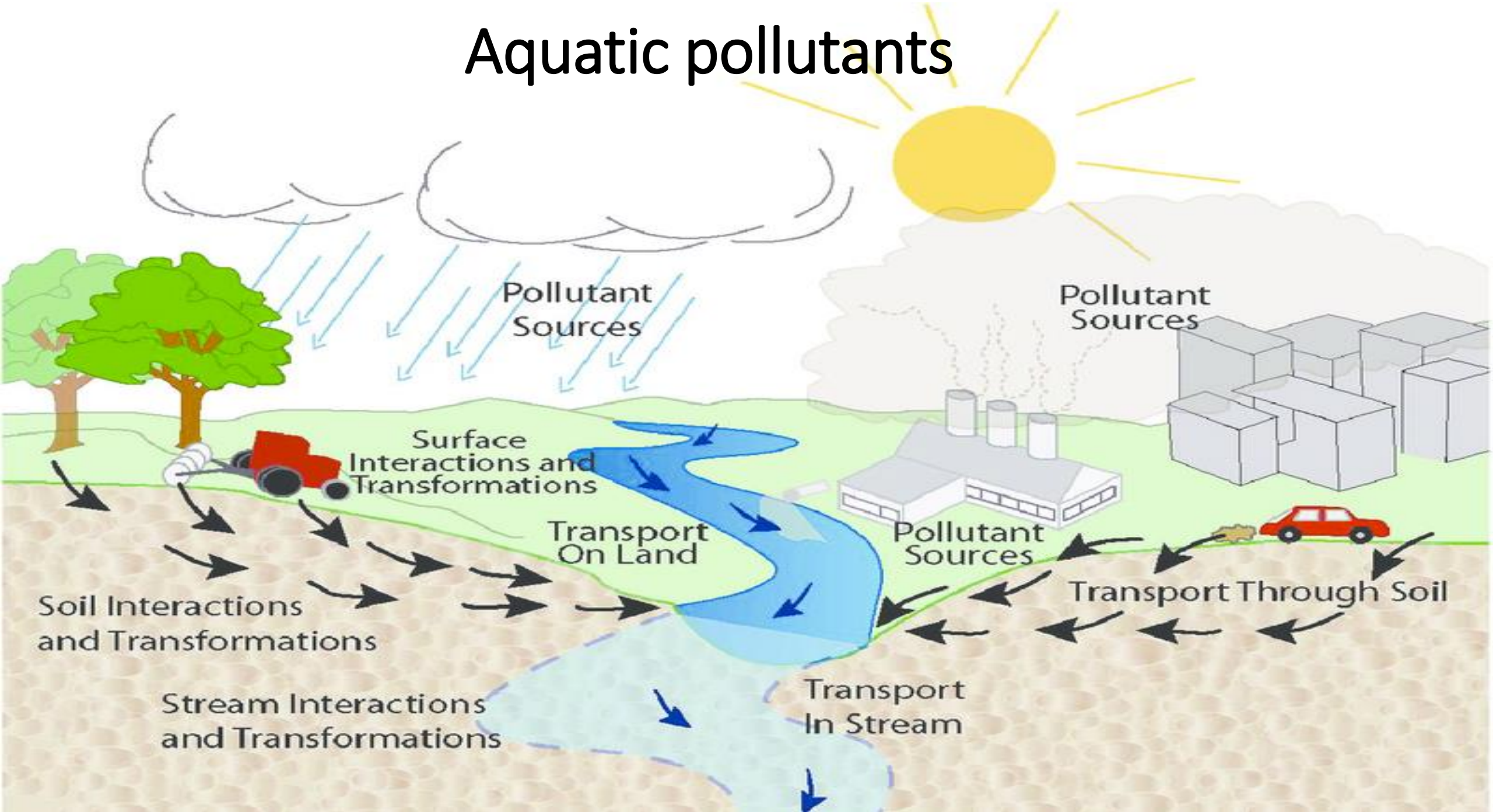
Sources of Contamination of Water

Natural Source

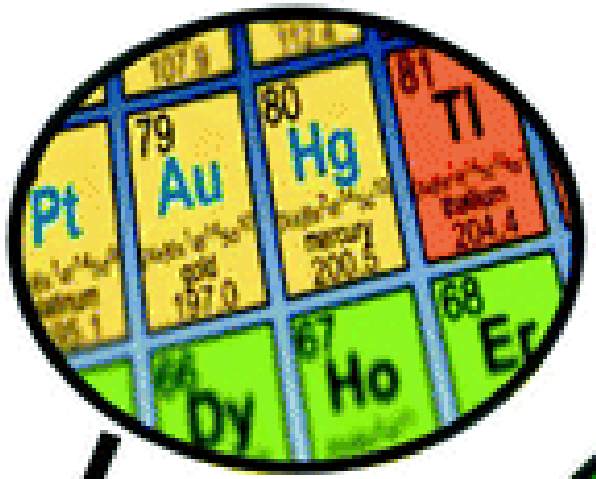
Industrial Source

Urbanization

Aquatic pollutants



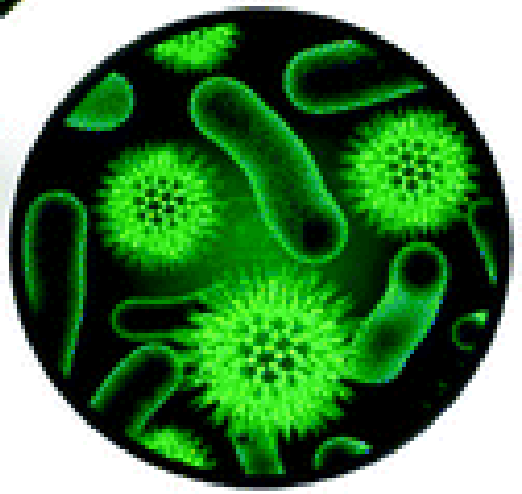
DYES



METALS

PHARMACEUTICALS

WATER POLLUTION

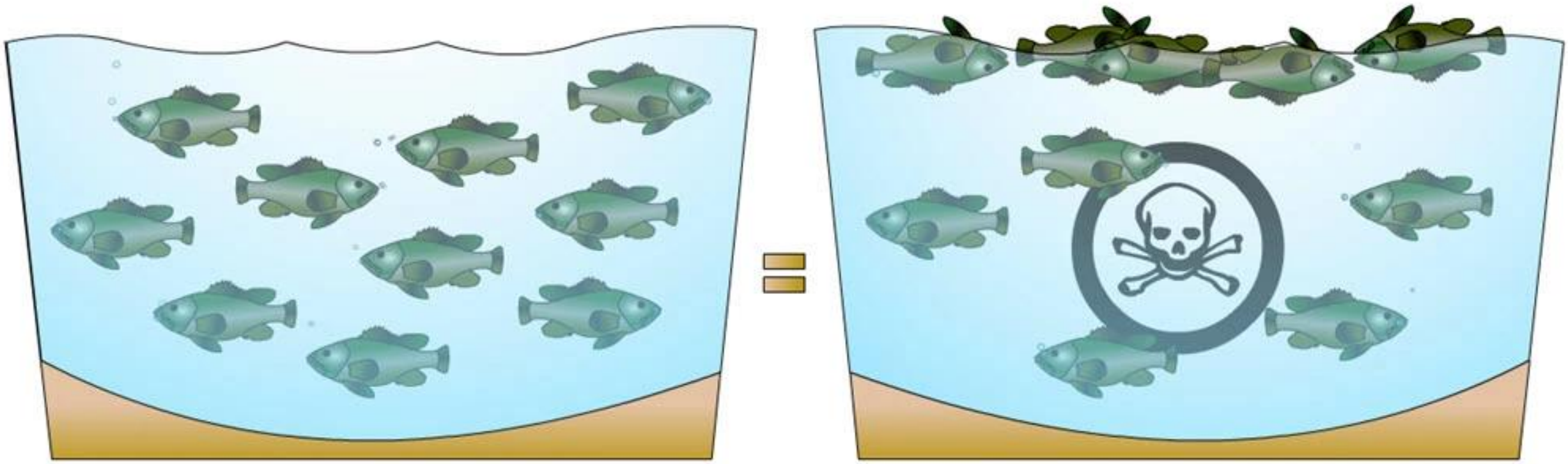


PATHOGENS

FLUORIDE

PESTICIDES

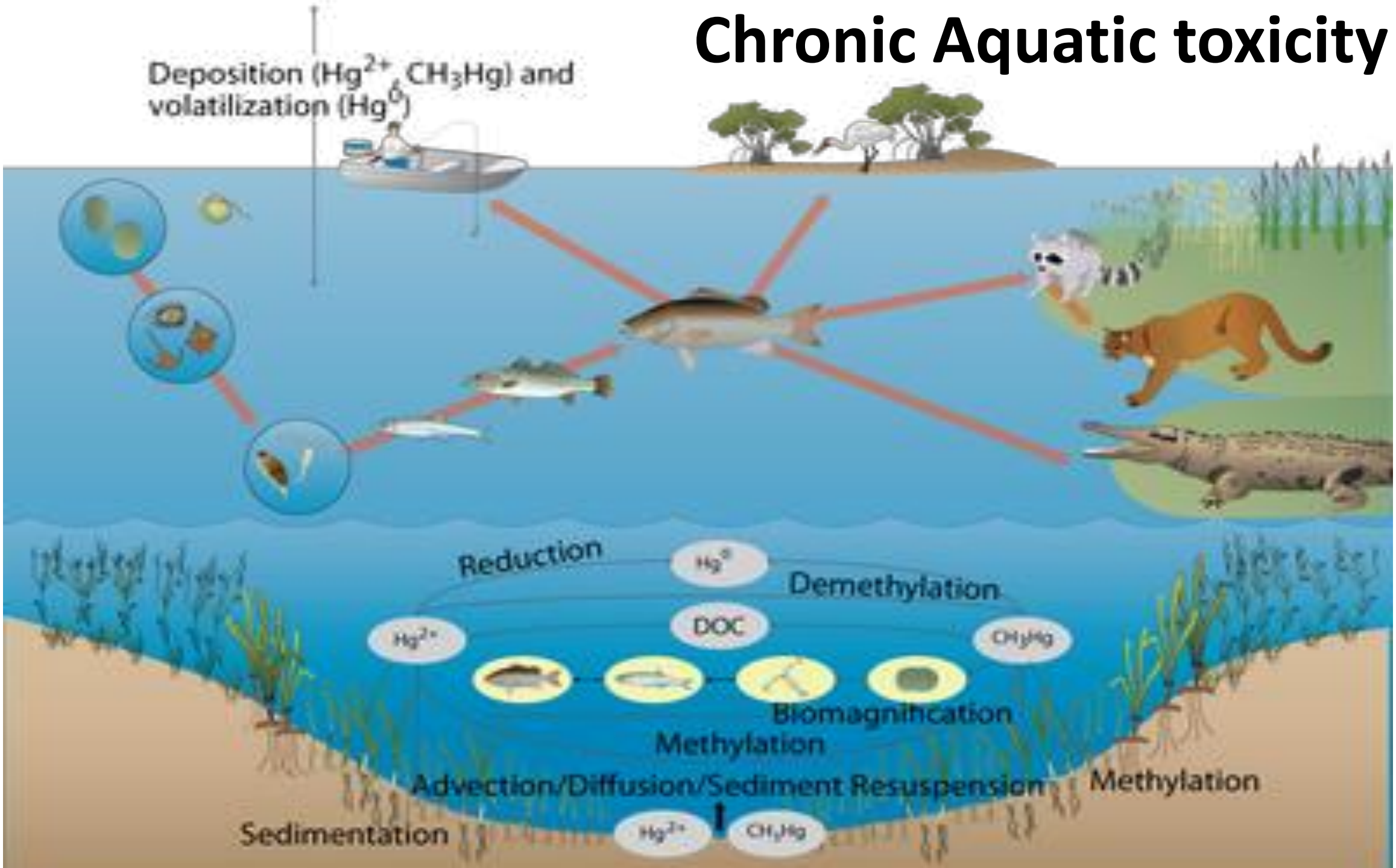
Acute Aquatic toxicity



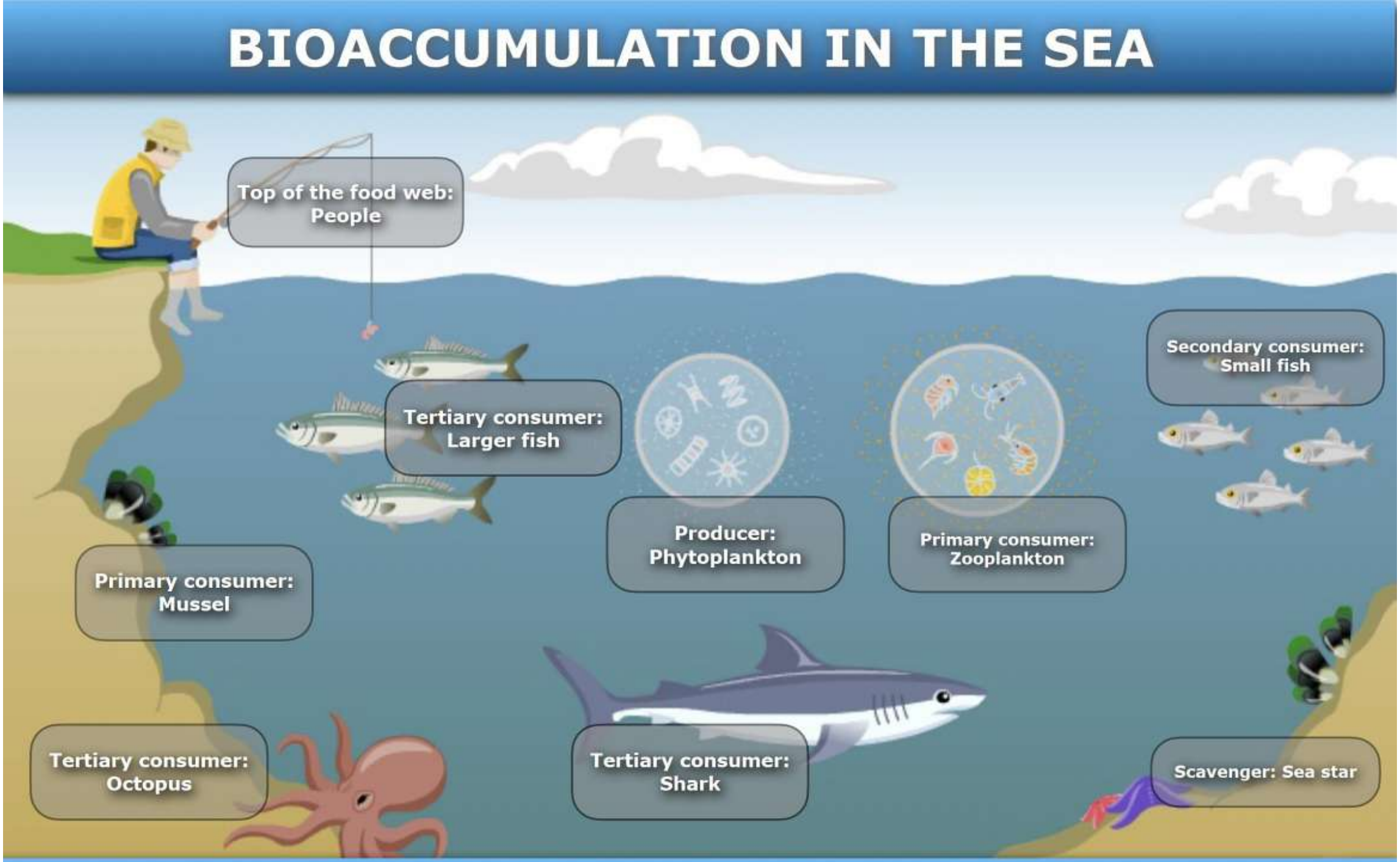
LC_{50} < 500 mg/l

Acute Aquatic Toxicity

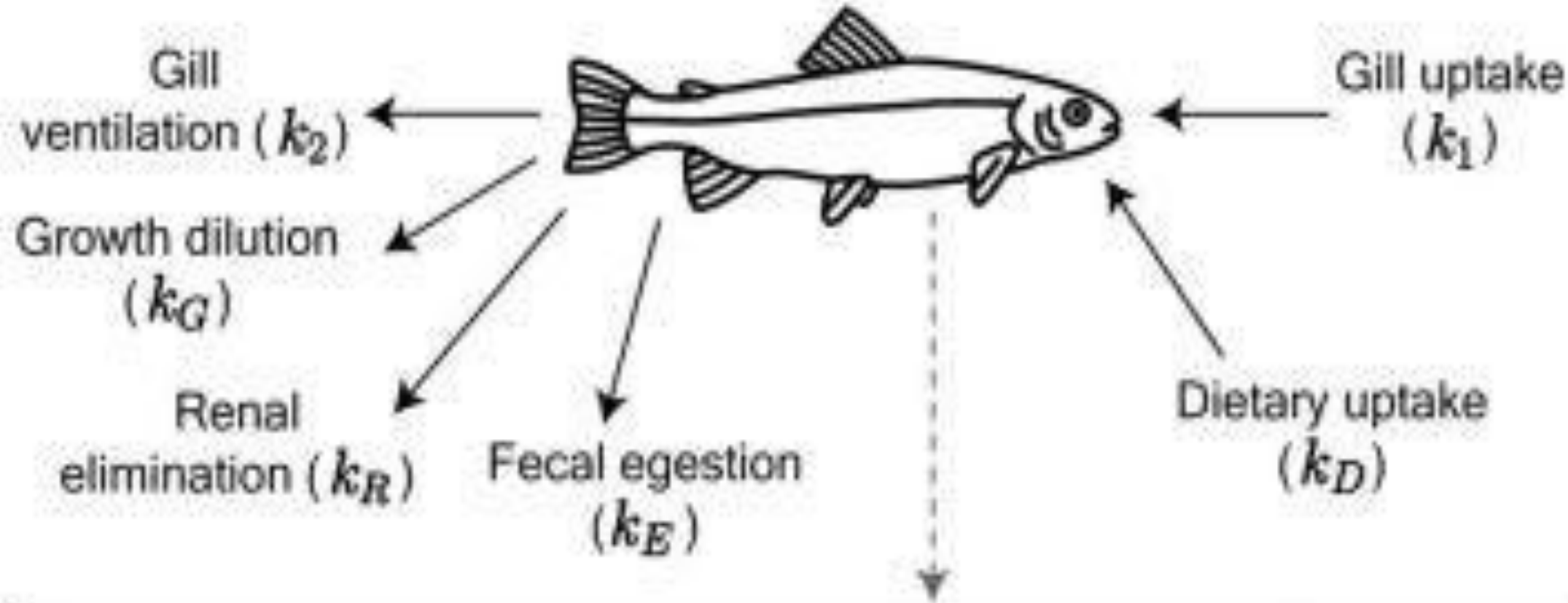
Chronic Aquatic toxicity



BIOACCUMULATION IN THE SEA

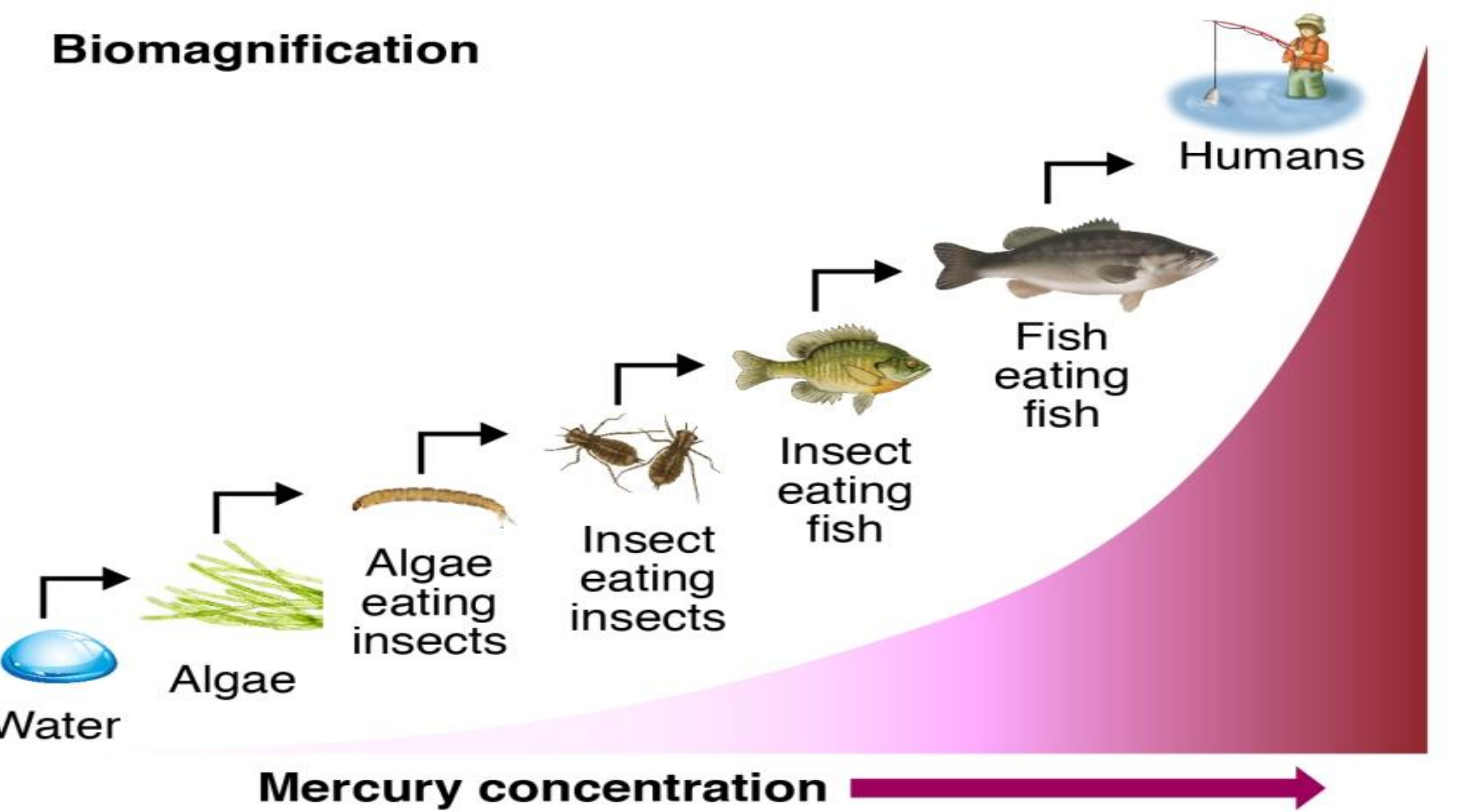


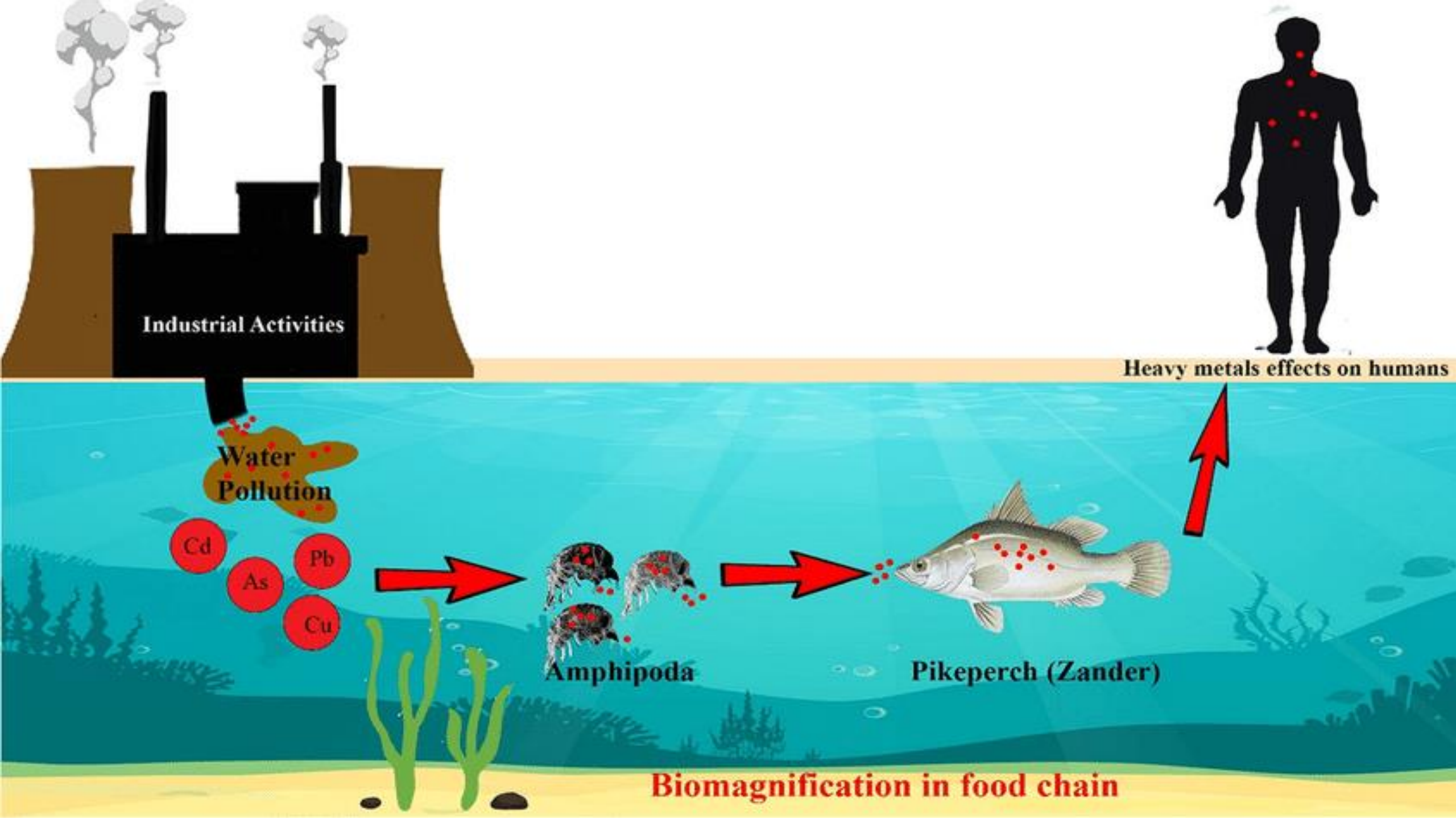
$$C_{fish} = \frac{k_1 C_{water} + k_D C_{diet}}{k_2 + k_E + k_G + k_R}$$



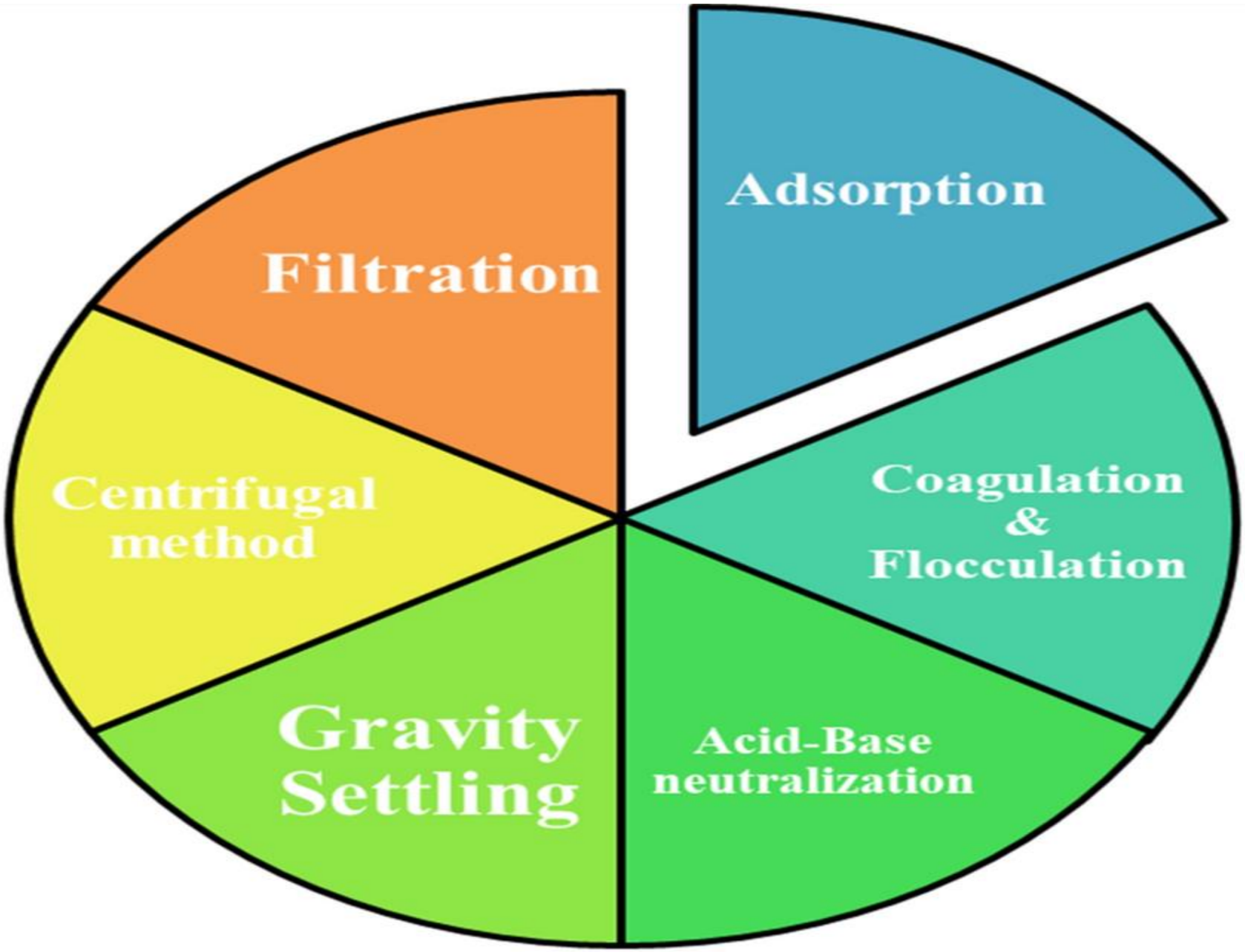
Tissue partitioning = phospho-lipid + blood plasma protein + neutral lipid + other organic matter + water

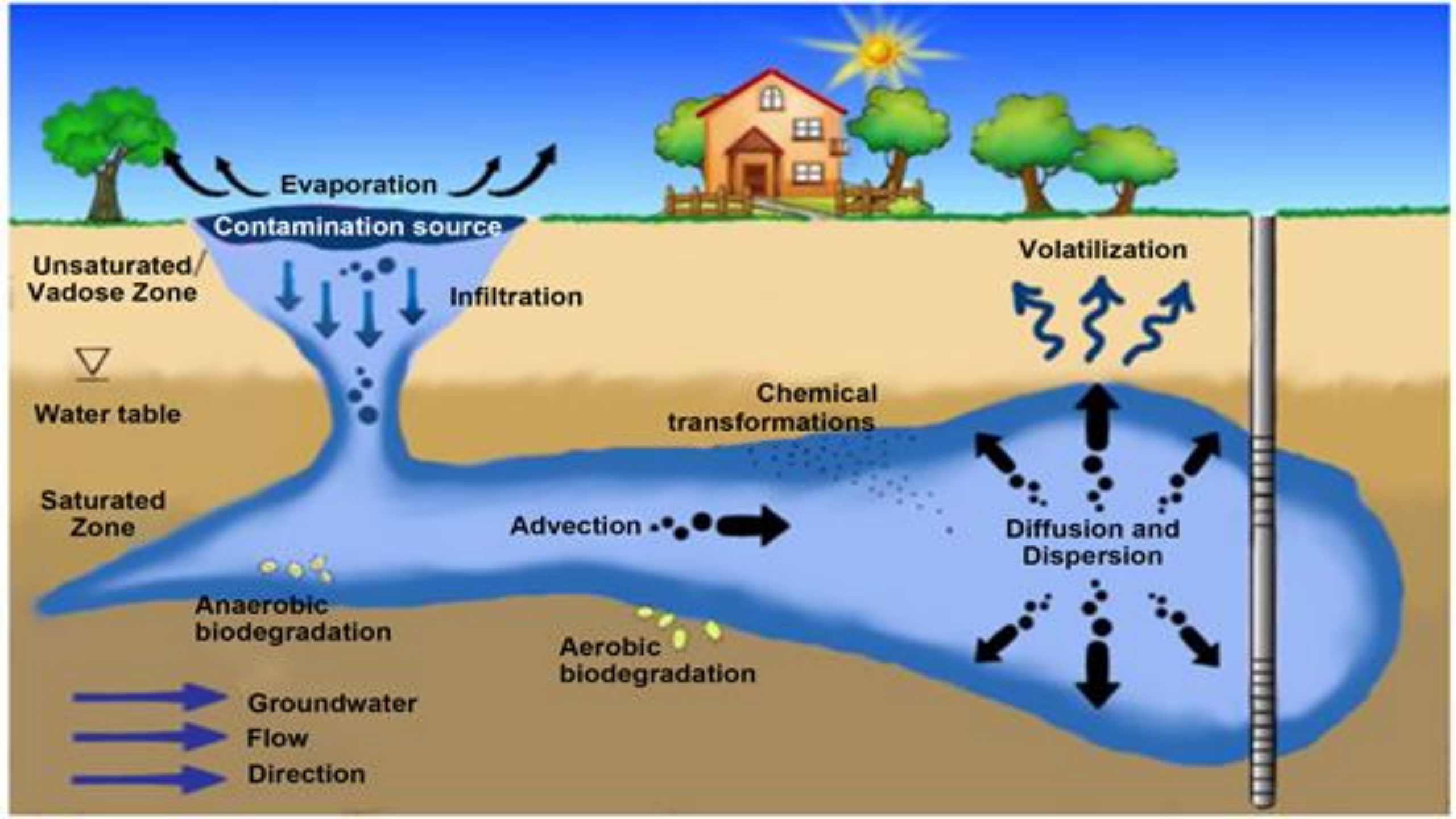
Biomagnification




Industrial Activities
Heavy metals effects on humans
Water Pollution
Cd
As
Pb
Cu
Amphipoda
Pikeperch (Zander)
Biomagnification in food chain

Aquatic Remediation




Evaporation
Contamination source
Unsaturated/
Vadose Zone
Infiltration
Volatilization
Water table
Chemical
transformations
Saturated
Zone
Advection
Diffusion and
Dispersion
Anaerobic
biodegradation
Aerobic
biodegradation
Groundwater
Flow
Direction

Water and Health

- 80% of sickness in the world is caused by inadequate water supply or sanitation
- 40% of the world population does not have access to safe drinking water
- It is estimated that water-borne diseases kill 25,000 people per day
- In many populated areas of the world, water-borne diseases represent the leading cause of death

Drinking Water Quality Control and Human Health

Microbial control

Chemical control

Drinking-water diseases

Public health

Contamination of water reservoirs:

- natural conditions
- human activities
- rainfall variability

Detoxification Pathways

Toxins

External Sources

Drugs, Pesticides, Plant toxins, Pollutants

Internal Sources

Breakdown products from hormones, neurotransmitters, etc

Phase I

Usually takes place in the liver

Metabolizes toxin into a metabolite

CYP450 Genes:
CYP1A1, CYP1A2, CYP2B6, CYP2C8, CYP2C19, CYP2D6, CYP3A4

Phase II

Binds with phase I metabolite to make it water soluble

Several ways this can happen

Genes include:
UGT's, NAT's, GST's, SOD1, and more

Elimination

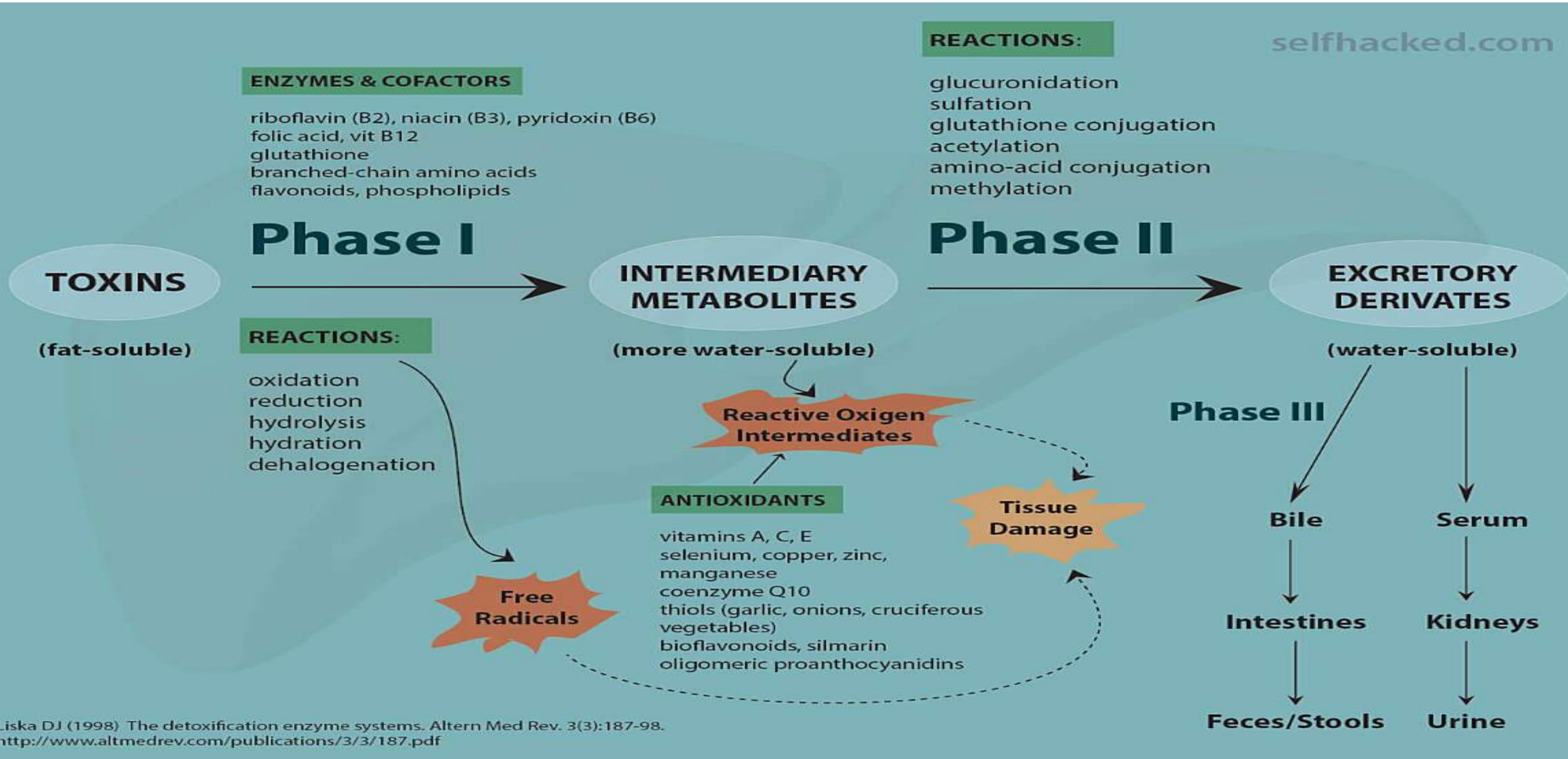
Through kidneys via urine

Through the skin via sweat

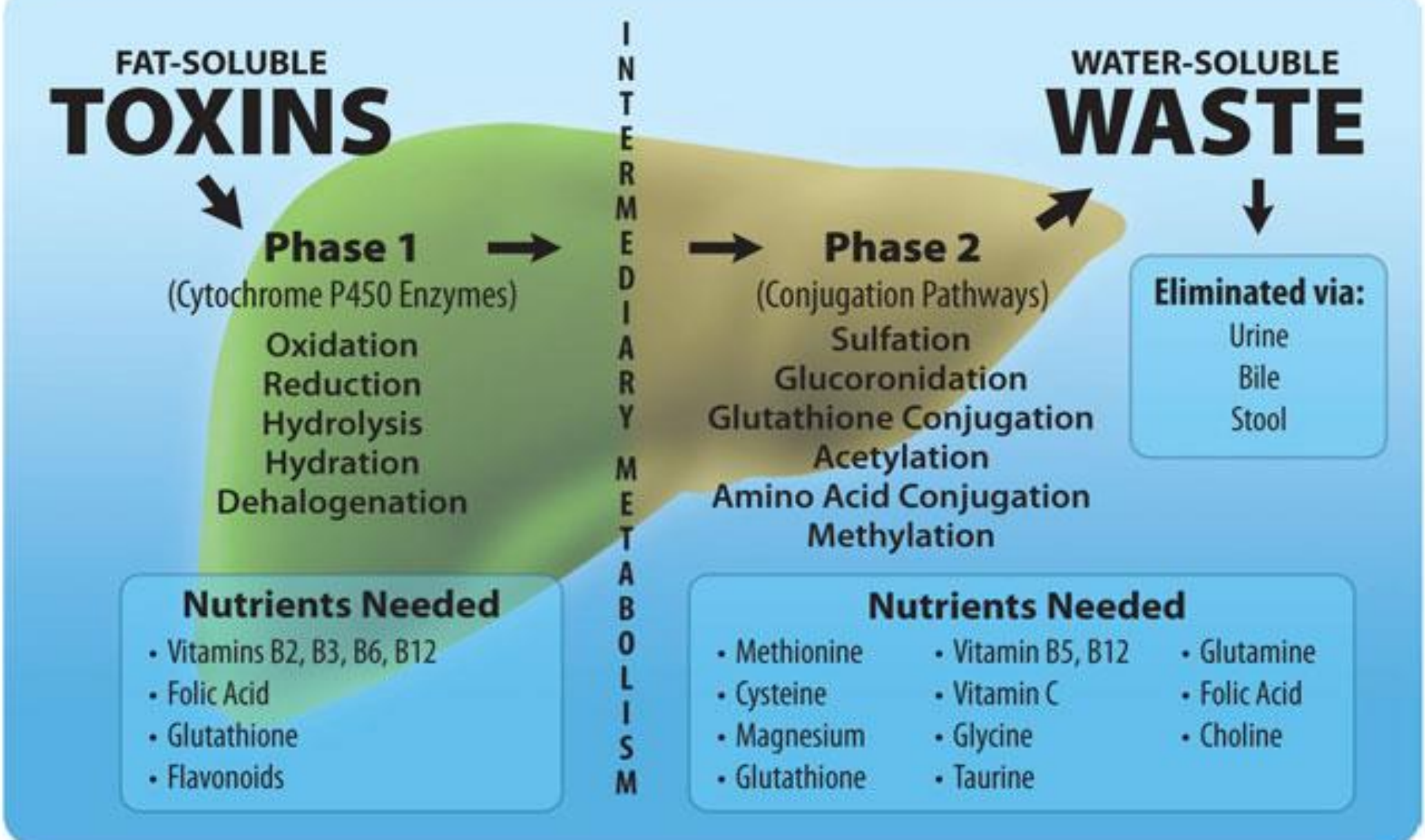
Through bile and intestines via feces

Genetic Lifehacks
Learn. Experiment. Optimize.

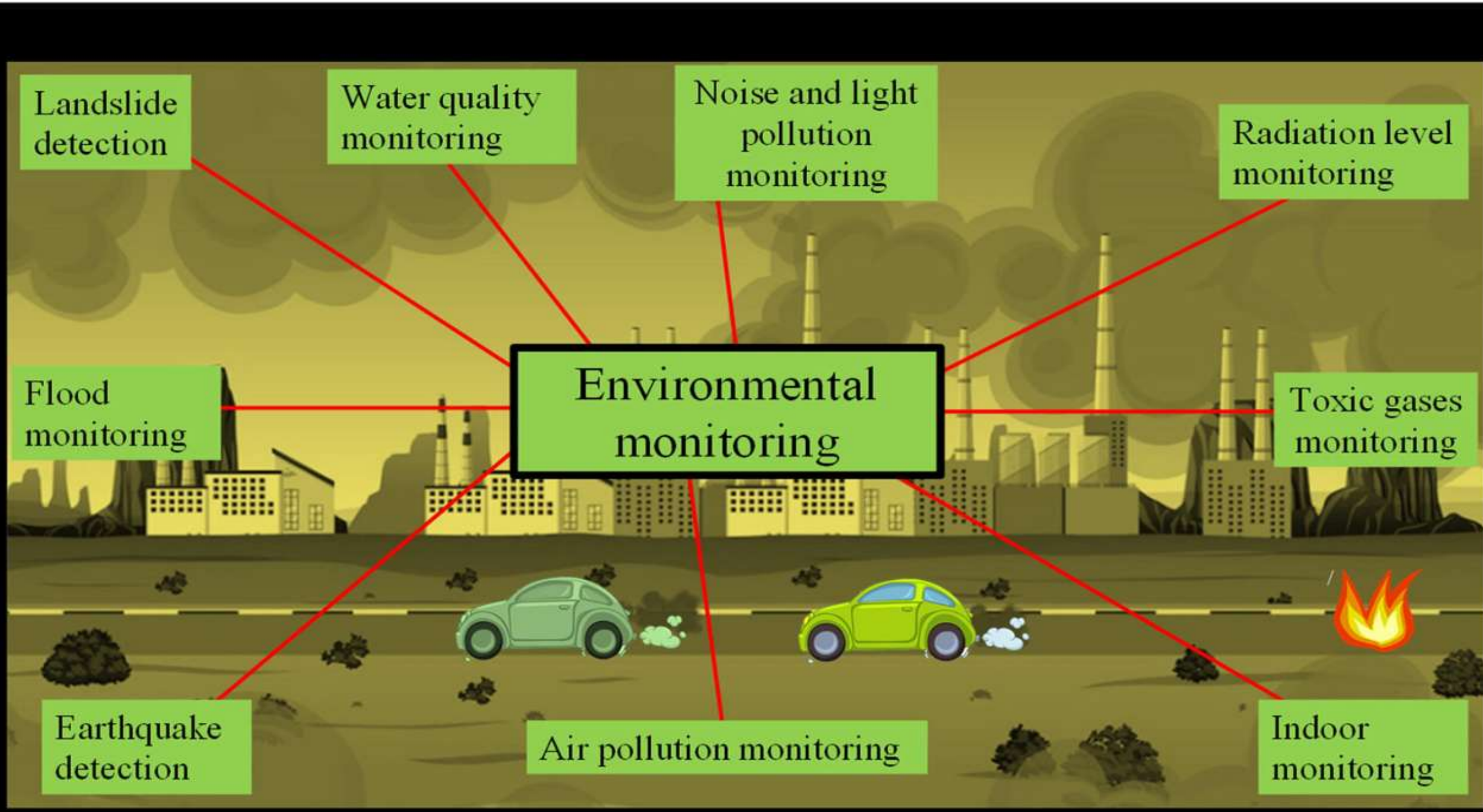
Detoxification phase 1 & 2



Liska DJ (1998) The detoxification enzyme systems. Altern Med Rev. 3(3):187-98.
http://www.altmedrev.com/publications/3/3/187.pdf


FAT-SOLUBLE
TOXINS
Phase 1
(Cytochrome P450 Enzymes)
Oxidation
Reduction
Hydrolysis
Hydration
Dehalogenation
INTERMEDIARY METABOLISM
Phase 2
(Conjugation Pathways)
Sulfation
Glucoronidation
Glutathione Conjugation
Acetylation
Amino Acid Conjugation
Methylation
WATER-SOLUBLE
WASTE
Eliminated via:
Urine
Bile
Stool
Nutrients Needed
• Vitamins B2, B3, B6, B12
• Folic Acid
• Glutathione
• Flavonoids
Nutrients Needed
• Methionine
• Cysteine
• Magnesium
• Glutathione
• Vitamin B5, B12
• Vitamin C
• Glycine
• Taurine
• Glutamine
• Folic Acid
• Choline

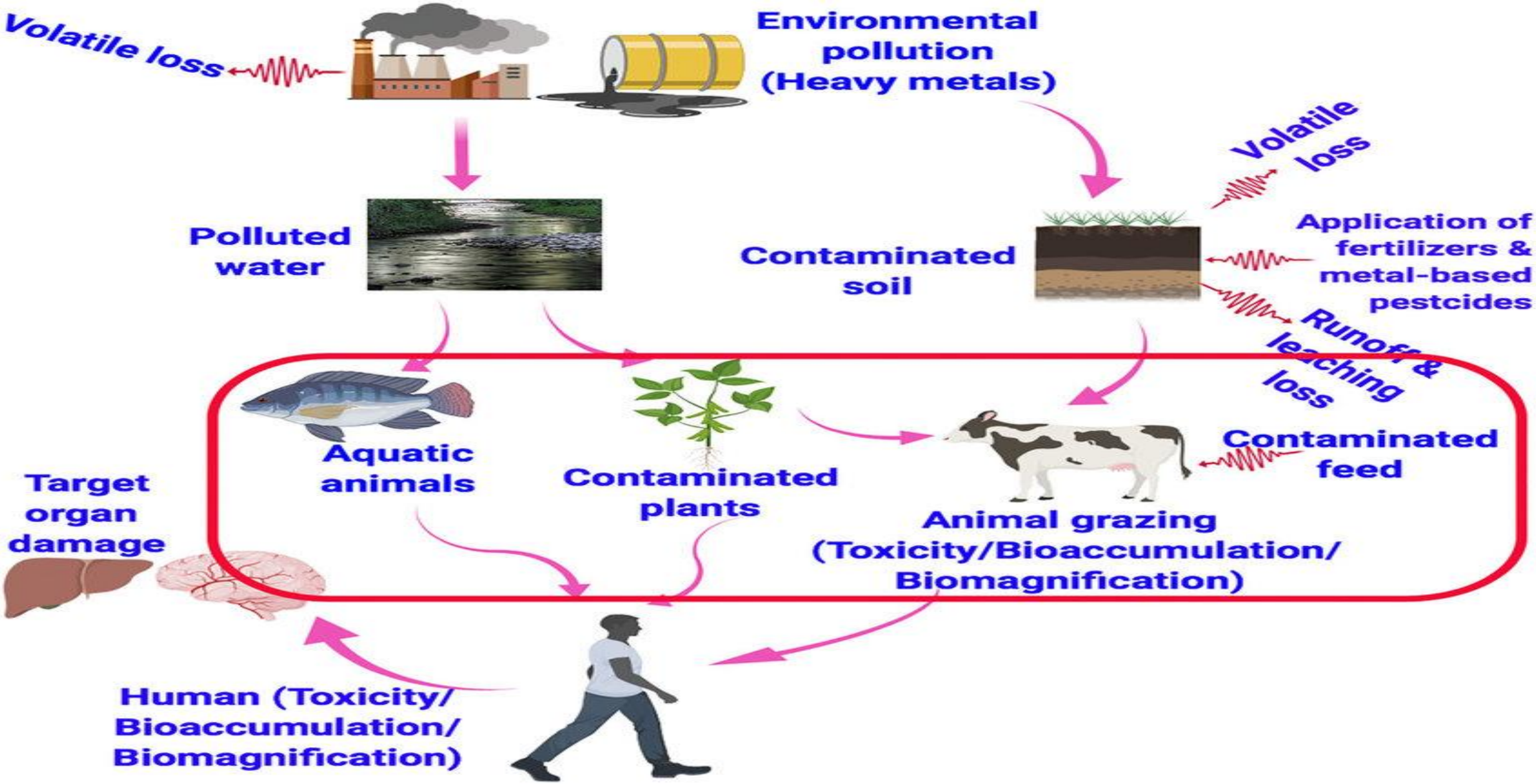
Forensic Science
Environmental Forensics
CSI --- eg CYANIDE


Landslide detection
Water quality monitoring
Noise and light pollution monitoring
Radiation level monitoring
Flood monitoring
Environmental monitoring
Toxic gases monitoring
Earthquake detection
Air pollution monitoring
Indoor monitoring

ENVIRONMENTAL MONITORING

Some Techniques of Environmental Scanning & Monitoring

Sentinal organisms



Species group	Sentinel Species	Contaminants
Mammals[#]	Muskrat (*Ondatra zibethicus*) Beaver (*Castor canadensis*) American Marten (*Martes americana*) Mink (*Neovison vison*) River Otter (*Lontra canadensis*) Fisher (*Martes pennanti*)	Heavy metals, PACs, trace metals
Colonial Waterbirds	Caspian Tern (*Hydroprogne caspia*) Common Tern (*Sterna hirundeo*) Ring-billed Gull (*Larus delawarensis*) California Gull (*Larus californicus*) Herring Gull (*Larus argentatus*)	As, Hg, PACs
Amphibians	Wood Frog (*Lithobates sylvaticus*)	Hg, PACs
Plant health and community composition	Wetland/Upland Vegetation Communities	Trace metals, PACs
Migratory birds	Tree Swallow (*Tachycineta bicolor*)	PACs

[#]See Section S5.5.2 in the supplemental material

Environmental aquatic parameters

Aquatic water quality equipment

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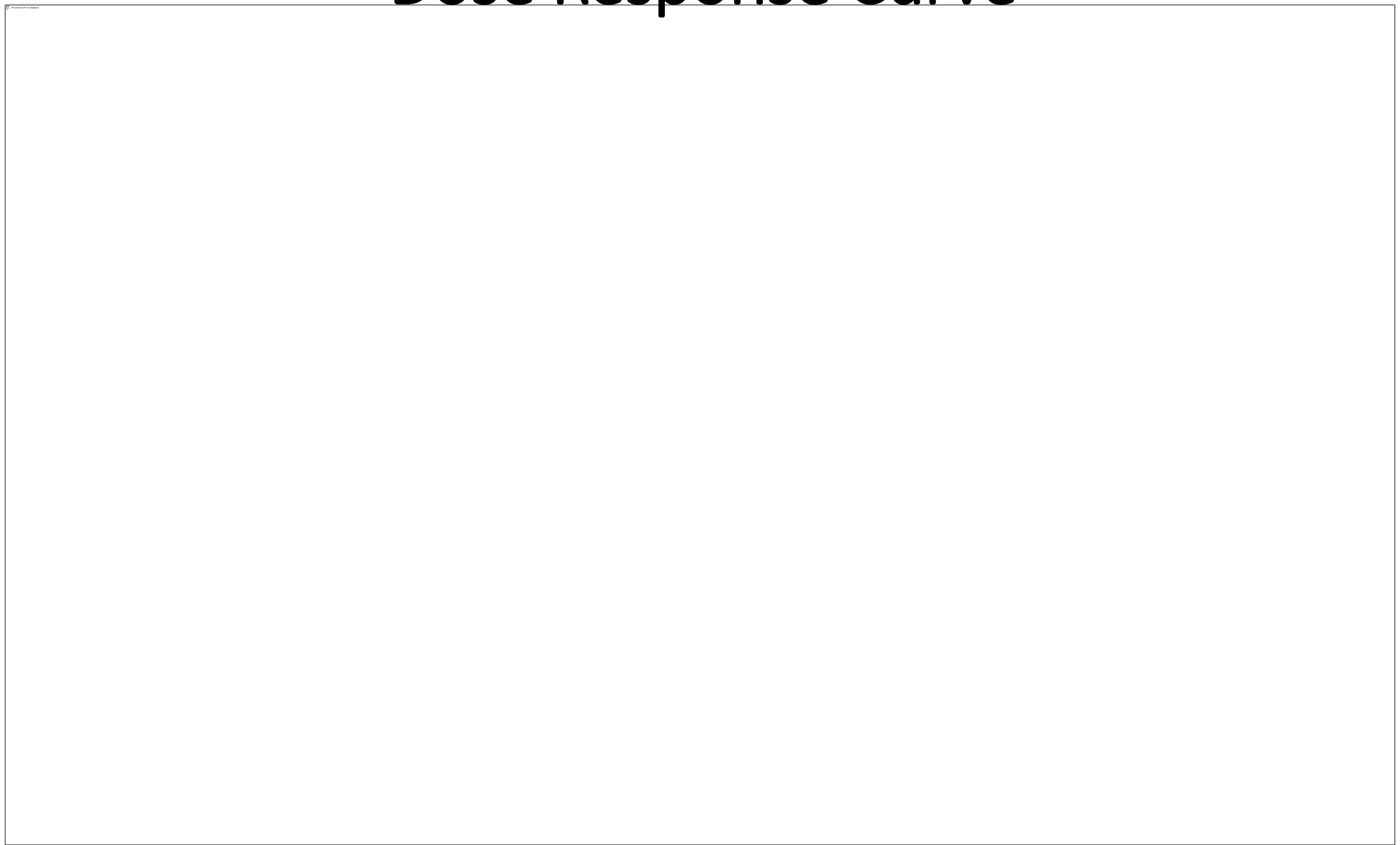
Dose Response Curve



Aquatic means of exposure

The picture cannot be displayed.

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Chemical Quality of water

EPA Parameters
Physical Parameters

The picture can't be displayed.

Biochemical impact on aquatic life

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Mercury Sources and Toxicity in Suriname

Peak mercury vapor concentrations inside firms and emissions into the atmosphere exceed acceptable limits

essment of mercury sources in Suriname and the level of contamination they cause to the three main environmental compartments: air, water and soil.

M. Huisden, T. van Ravenswaay, R. Kasantirto, E. Naipal and S. Algoe.

Mercury contamination forms a global threat to human health and the environment. In artisanal and small-scale gold mining (ASGM), mercury is used to form gold amalgams. The bulk of the gold amalgam is marketed to Paramaribo to be purified and sold at gold buyout firms. Mercury vapors are released during the purification process. . Mercury, once in the atmosphere, undergoes several chemical transformations making it water soluble, and allowing deposits to soil and water through precipitation.

The OBJECTIVE of this study was to assess the magnitude of Suriname's exposure to this toxic metal in the environmental compartments: air, water and soil.

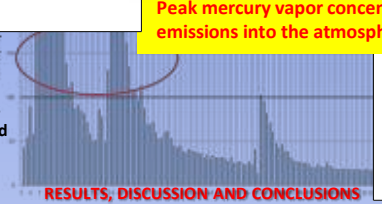
MATERIALS AND METHODS

The UNEP Toolkit for Identification and Quantificati
develop a national inventory. A mercury detector (MVI) allowed for mercury measurements; at 4 out of 29 gold buyout firms in Paramaribo North, quadruplicate readings per minute during 30 minute intervals at the exhaust pipe, operators seat and workroom were carried out randomly according to EN 15259 guidelines. In order to assess to what extend drink-water sources around Paramaribo are affected, 8 water sources used by the local water company (SWM), both treated and untreated, were sampled and Cold Vapor Atomic Fluorescence Spectrometry was used to measure mercury levels.

Source Category	TOTAL kg Hg/yr	Air	Water	Land
Gold extraction	39,247.3	15,740.9	12,496.8	11,009.7
Other mining activities	134,828.6	5,492.1	2,768.6	120,535.7

Sectors	Emission Estimate Maximum (kg Hg/yr)
Cement	16.461
Crematoria	0.792
large waste incinerators	0.100
Waste at landfill	32.202
Largescale gold production	1,255.391
ASGM	8,437.500

Peak mercury vapor concentrations inside firms and emissions into the atmosphere exceed acceptable limits



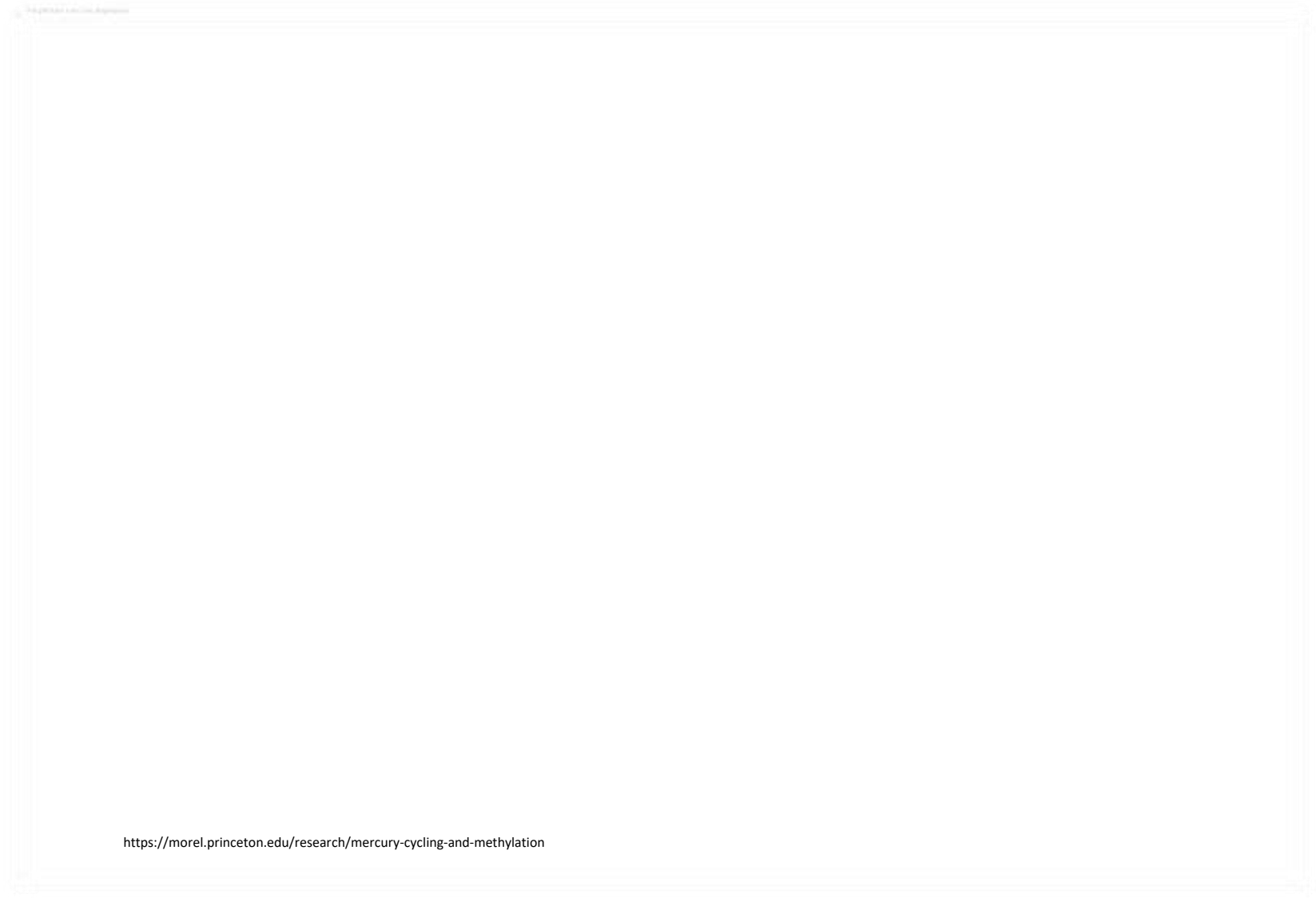
RESULTS, DISCUSSION AND CONCLUSIONS

In the work and seating space the mean mercury vapor concentrations were just below OSHA and NIOSH-limits of 100 µg/m3. However, during intermitted amalgam combustion, clients and employees of the gold buyout firms were exposed to peak mercury vapor concentrations exceeding the internationally accepted exposure limits. The average mercury vapor concentrations, emitted from the exhaust pipe, exceeded limits by far. Readings were as high as 1,775 µg/m3, while at times they exceeded the measuring range of the MVI (>2,000 µg/m3). This form of emission, gold extraction with mercury amalgamation, was found to be the largest contributor to mercury air pollution in Suriname, at approximately 15,700 kg Hg/yr.

Artisanal gold mining exerts vast impacts at 12,500 kg Hg/yr on fresh water, river and creek ecosystems. Over 5,000 km of water ways are directly impacted and over 8,000 km of waterways have been indirectly impacted by gold mining activities practiced in Suriname. Aquatic micro-organisms convert mercury into methyl-Hg, allowing for bio-accumulation up the food chain. In this study, none of the measurements to drinking water sources exceeded the standard of 0.05 µg/L. However, soil contamination with Mercury takes place at approximately 11,000 kg Hg/yr.

Mercury is mostly released from mining activities and due to its neurotoxic, nephrotoxic and teratogenic properties it affects the environment in Suriname and human health in a negative way. **An urgent call for responsible mining.**

* Deze poster is gedrukt met de financiële steun van het Minamata Initial Assessment Project van UNEP.



https://morel.princeton.edu/research/mercury-cycling-and-methylation

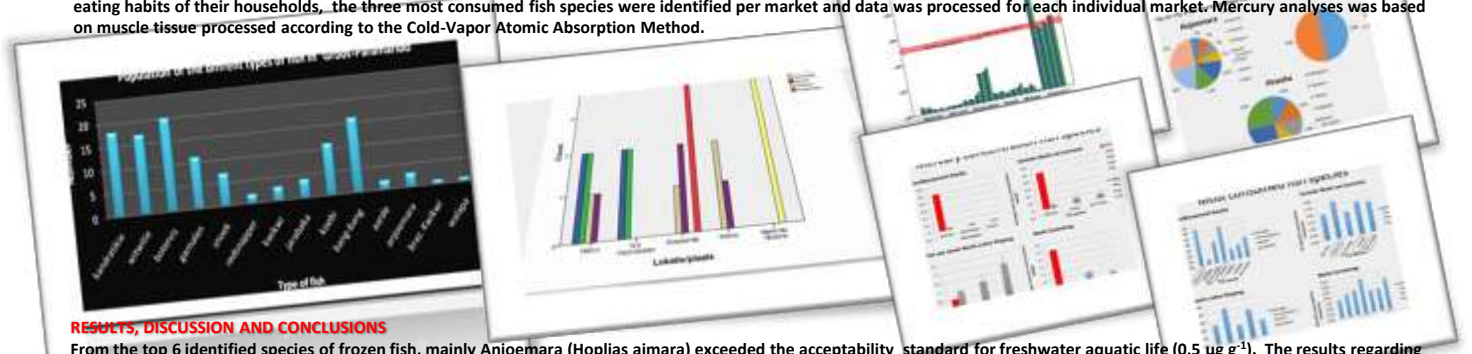
Mercury Exposure Assessment of Fish Consumers in Paramaribo and Surroundings.

M. Huisden, G. Landburg, A. Niram, S. Algoe, N. Dakriet and R. Halfhuid.

In Suriname, mercury is mostly used in the small scale gold mining. This activity has several negative consequences for the environment and for human and animal health.
The **OBJECTIVES** of this study were fourfold. First of all, to assess which types of fish are most commonly commercially processed and sold frozen in the supermarkets of Paramaribo, secondly which types are sold fresh at the markets of Paramaribo. Thirdly, to analyze to what extent these types of fish are contaminated with mercury and lastly, to study the levels of human exposure to mercury, based on fish consumption patterns.

MATERIALS AND METHODS

An overview of 18 commercial fish processing companies producing packaged frozen fish products using 14 different fish species, was made. Based on the "frozen fish inventory" of 50 randomly chosen supermarkets in Paramaribo, the six most consumed species for "frozen fish" were identified and marked for mercury analyses. On the other hand, fish sellers at 4 markets spread across Paramaribo City were surveyed; this provided information regarding the 5 to 7 most consumed species of "fresh fish" for each market. Although the exact origins of the fish species were not known, many fishing grounds are likely impacted by small-scale gold mining. In order to obtain fish consumption habits, only these 5 to 7 "best-selling fish species" were included in a fish consumer survey, studying detailed family eating patterns. After interviewing the fish consumers at each market regarding the eating habits of their households, the three most consumed fish species were identified per market and data was processed for each individual market. Mercury analyses was based on muscle tissue processed according to the Cold-Vapor Atomic Absorption Method.

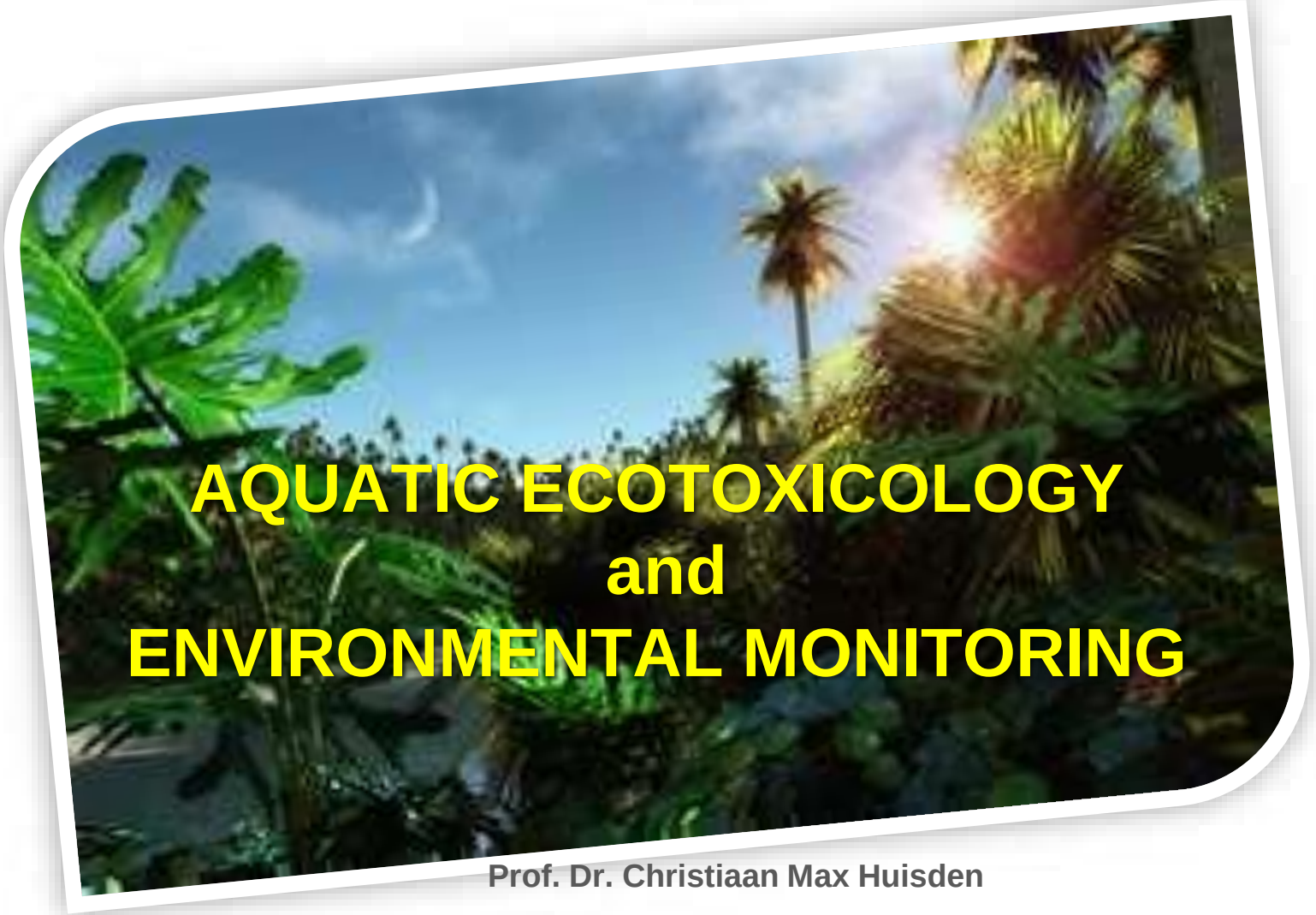


RESULTS, DISCUSSION AND CONCLUSIONS

From the top 6 identified species of frozen fish, mainly Anjoemara (Hoplias aimara) exceeded the acceptability standard for freshwater aquatic life (0,5 µg g^{-1}). The results regarding the fresh fish from the markets showed that not only Anjoemara, but also the fish species Koebi (Plagioscion surinamensis) and Piranha (Serrasalmus rhombeus) have mercury concentrations higher than 0,5 µg g^{-1}. A review of the consumer habits showed the average methylmercury intake per kilogram body weight per day for Anjoemara, Koebi and Piranha, to be higher than the reference dose (RfD) of 0.1 µg methylmercury kg bw^{-1} day^{-1} (U.S. EPA, 1997); it was concluded that each fish onsumer who consumes either one of these fish species is exposed to alarming methylmercury levels. Depending on cultural tradition and eating habits, daily consumption varies. The meal frequency was extrapolated in this study, only to consider eating habits that consist of multiple servings of fish per day; e.g. by the Indigenous. The methylmercury intake through the consumption of multiple fish meals consisting of these three fish species exceeds the RfD even more; this raises serious health concerns.

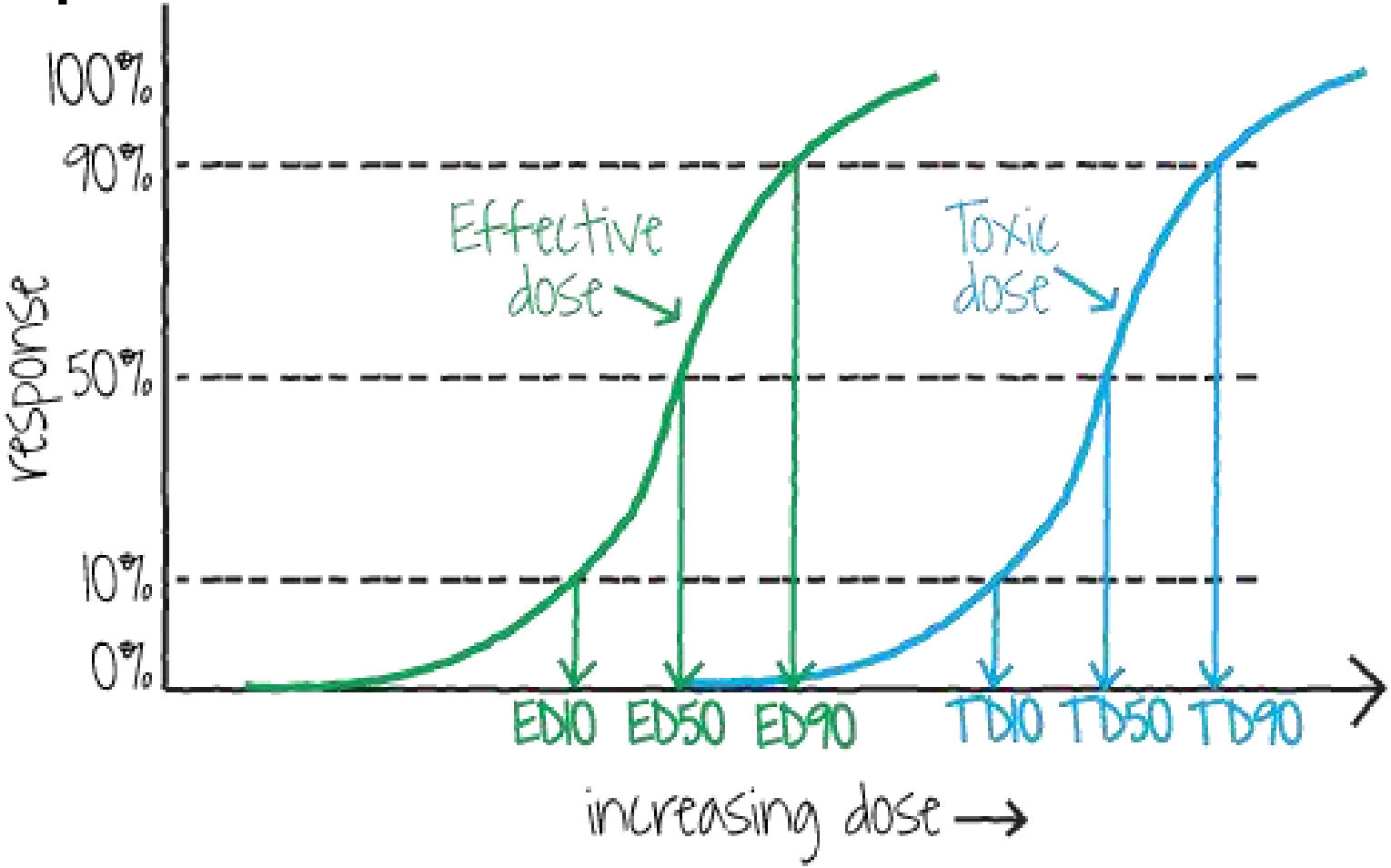
	Average amount of fish ingested per day (g/day)	Average mercury concentrations (µg/g)	Body-weight (kg)	Average mercury intake (µg mercury/kg body weight/day)	RfD (µg mercury /kg body weight/day)
Anjoemara	25.28	0.89	71.8	0.31	0.10
Koebi	61.61	1.18	71.8	1.01	0.10
Piranha	23.80	1.91	71.8	0.63	0.10

* Deze poster is gedrukt met de financiële steun van het Minamata Initial Assessenment Project onder het NIMOS



Prof. Dr. Christiaan Max Huisden

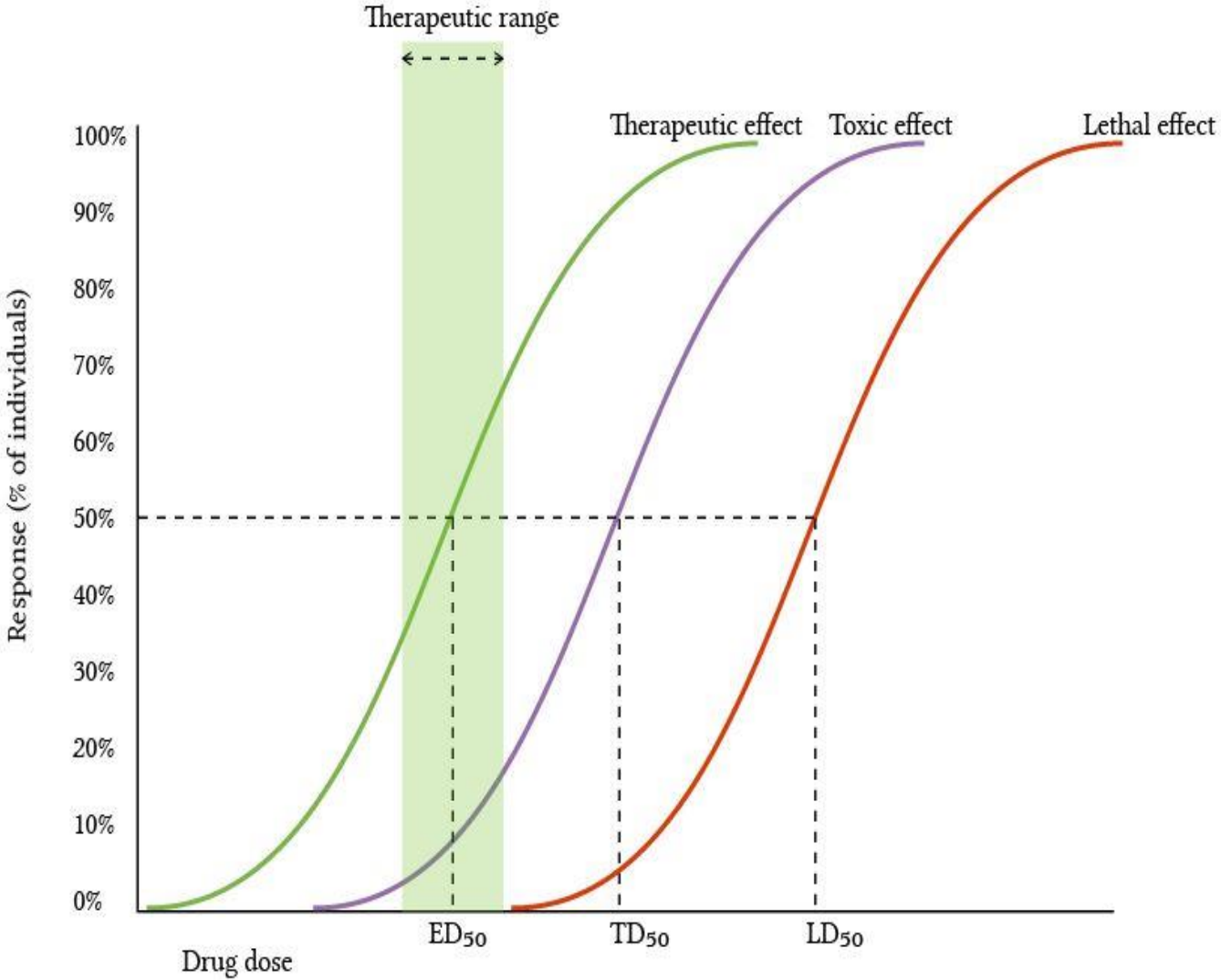
Dose response curve



ED50

TD 50

LD 50



In Vitro & In Vivo Research

In Silico

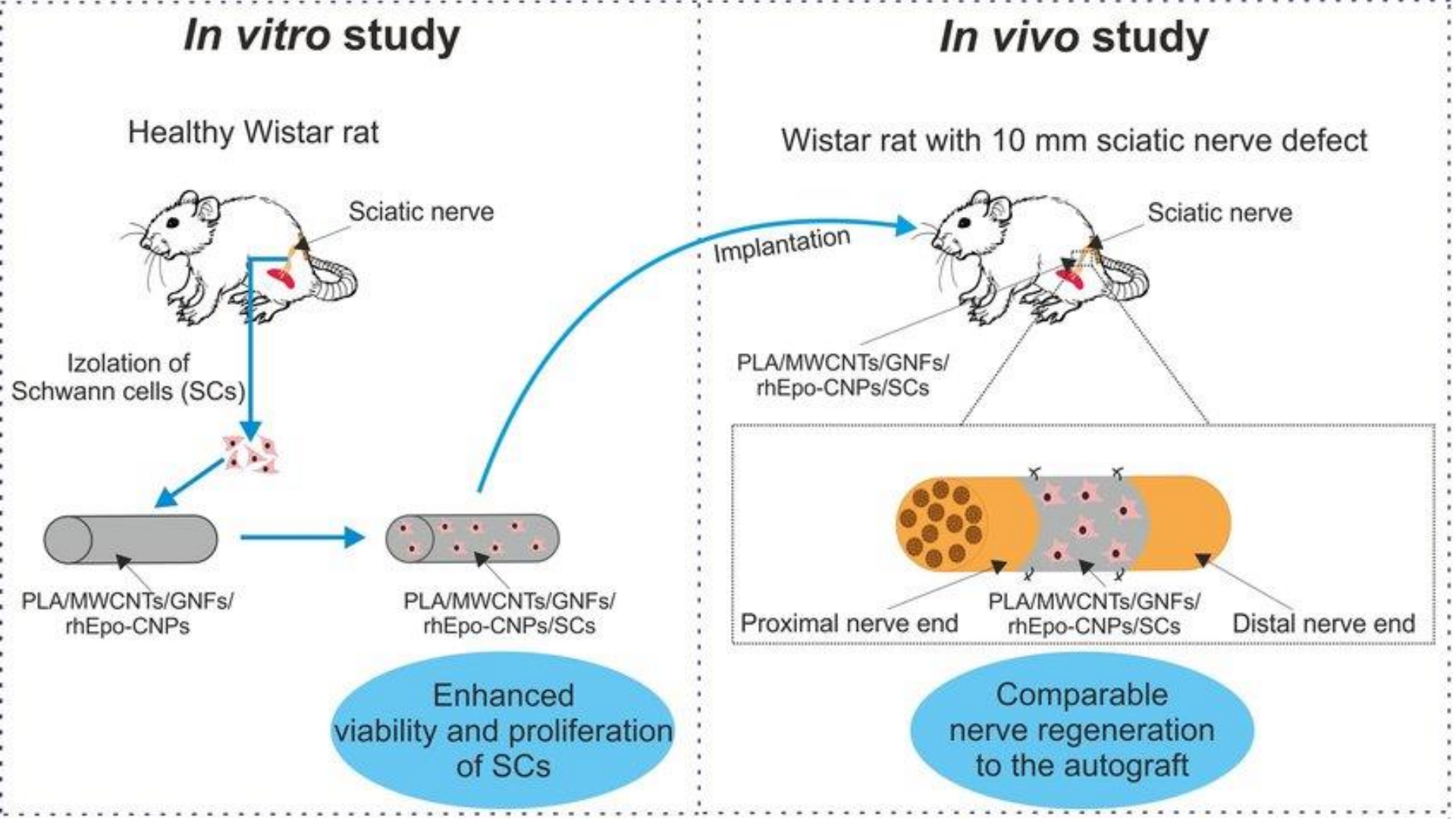
Performed in a **virtual setting**, a computer or virtual simulation.

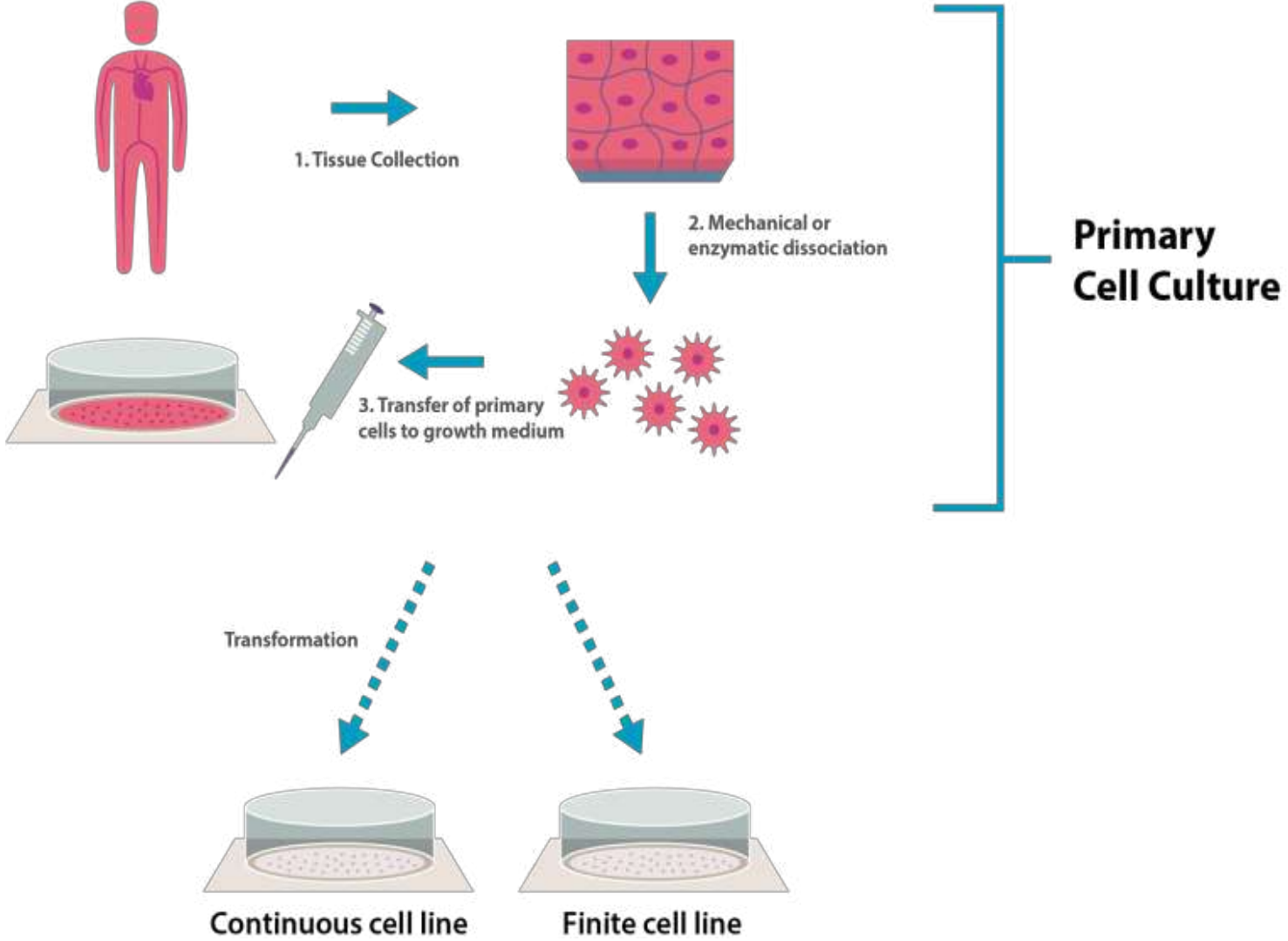
In Vitro

"In glass", meaning the study takes place in a test tube.

In Vivo

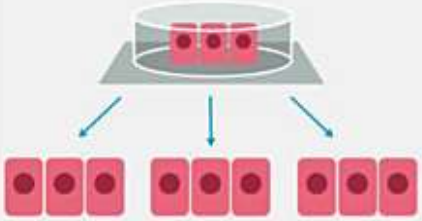
"In life", meaning the study takes place in a living organism.


In vitro study
Healthy Wistar rat
Sciatic nerve
Izolation of
Schwann cells (SCs)
PLA/MWCNTs/GNFs/
rhEpo-CNPs
PLA/MWCNTs/GNFs/
rhEpo-CNPs/SCs
Enhanced
viability and proliferation
of SCs
In vivo study
Wistar rat with 10 mm sciatic nerve defect
Implantation
Sciatic nerve
PLA/MWCNTs/GNFs/
rhEpo-CNPs/SCs
Proximal nerve end
PLA/MWCNTs/GNFs/
rhEpo-CNPs/SCs
Distal nerve end
Comparable
nerve regeneration
to the autograft


1. Tissue Collection
2. Mechanical or enzymatic dissociation
3. Transfer of primary cells to growth medium
Primary Cell Culture
Transformation
Continuous cell line
Finite cell line

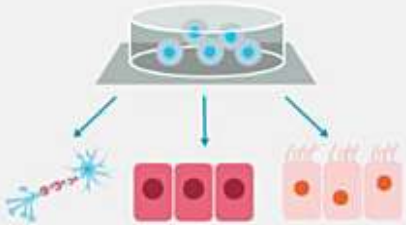
Primary cell culture: By cell differentiation

Differentiated cell culture



Differentiated cells that have lost capacity to further differentiate

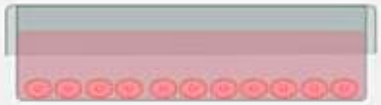
Stem cell culture



Undifferentiated cells that are able to differentiate into other cell types

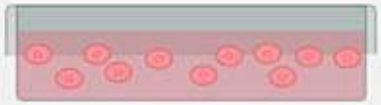
Primary cell culture: By adhesion

Monolayer cultures



Anchorage-dependent, usually one cell thick, with continuous cell layer on culture vessel

Suspension



Cells grow free-floating in the medium

Primary cell culture: By cell type/morphological structure

Epithelial

Polygonal-shape, appear flattened, attach to a substrate and form a continuous thin layer

Endothelial

Round outline, do not form sheets, or attach to substrates

Fibroblast-like

Angular-shape, elongated and form open network of cells that attach to substrate

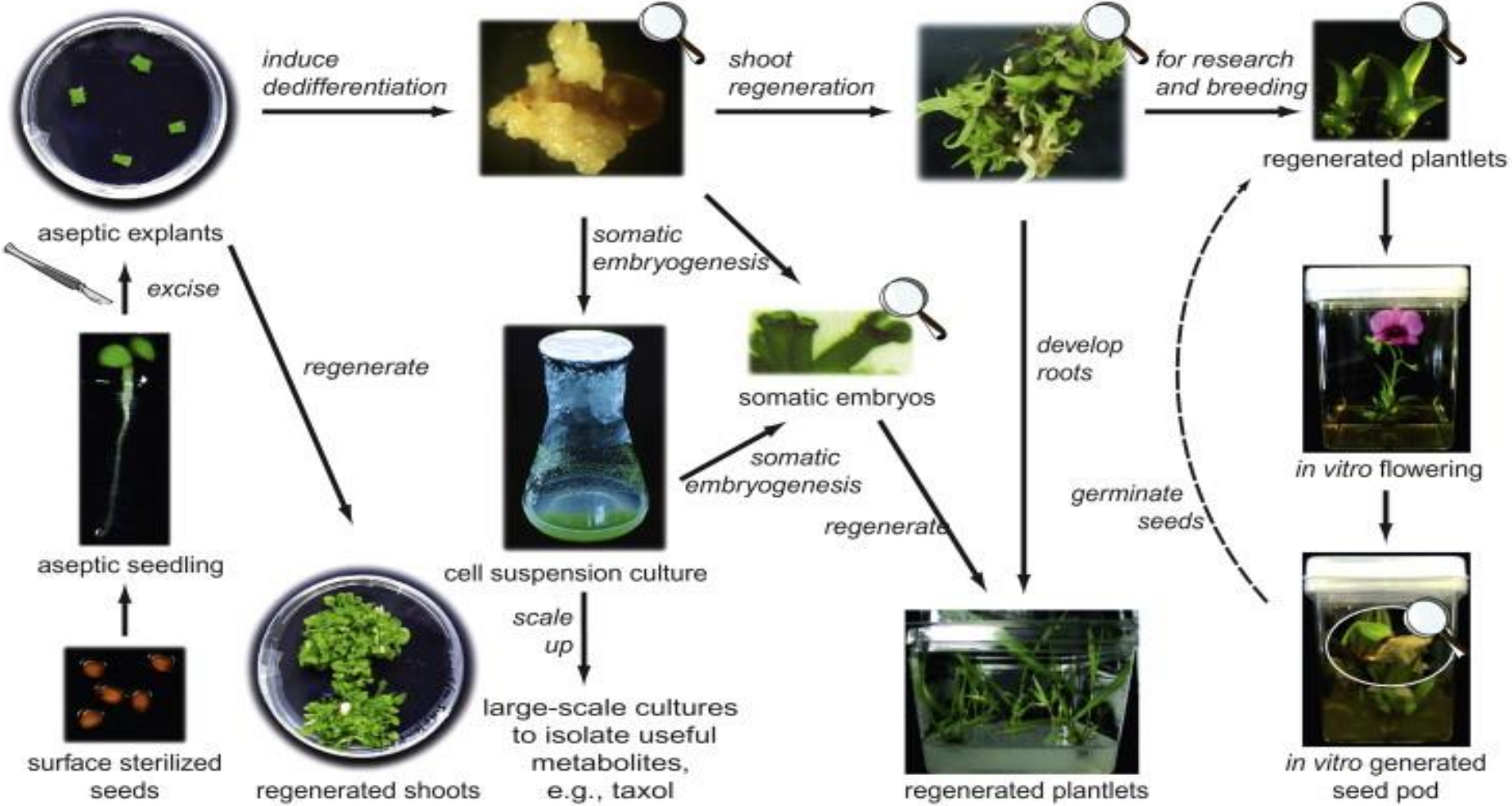
Lymphoblast-like

Spherical-shape, ranging from large cells with fine nuclear chromatin to smaller cells with condensed chromatin

Neuronal

Round, pyramidal or spindle-shaped cell body, with branching dendrites

Tissue culture



Animal research

The 3 R's of Animal Research

Reduce

Reduce the number of animals used

Refine

Refine tests to cause animals less stress

Replace

Replace animal studies with other methods

RockStep

Risk assessment

Risk Assessment

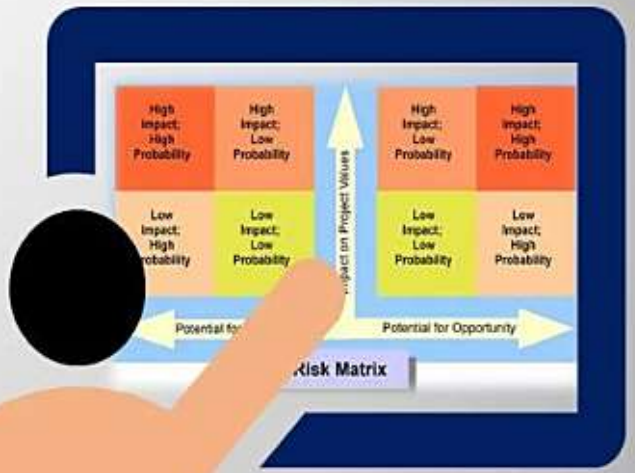
1. **IDENTIFY**
   Identify the Hazards

2. **DETERMINE**
   Determine Who Might Be at Risk (and How)

3. **ASSESS**
   Assess the Likelihood and Severity of the Risks

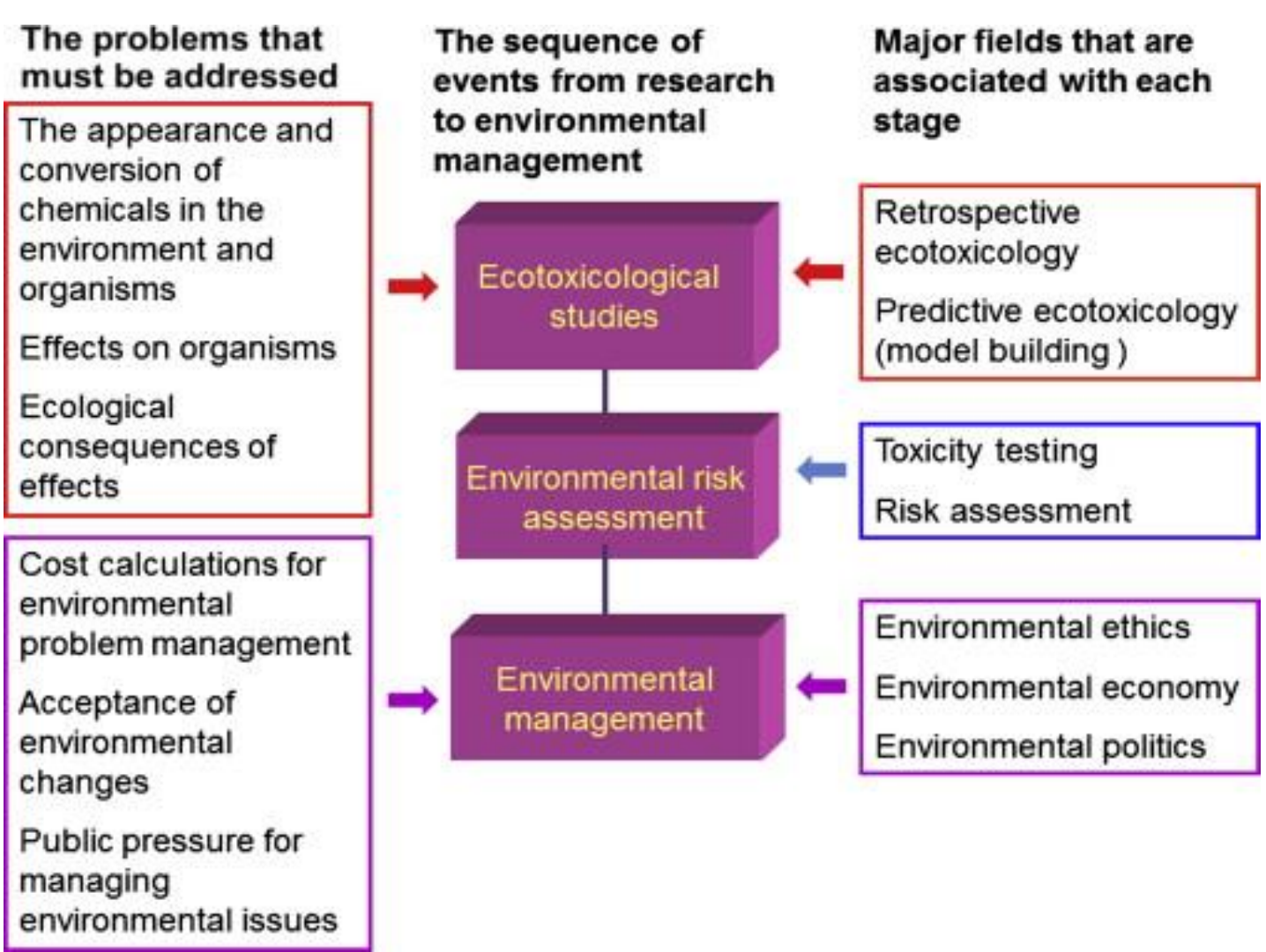
4. **ACTIONS**
   Identify Actions to Eliminate or Control the Risks

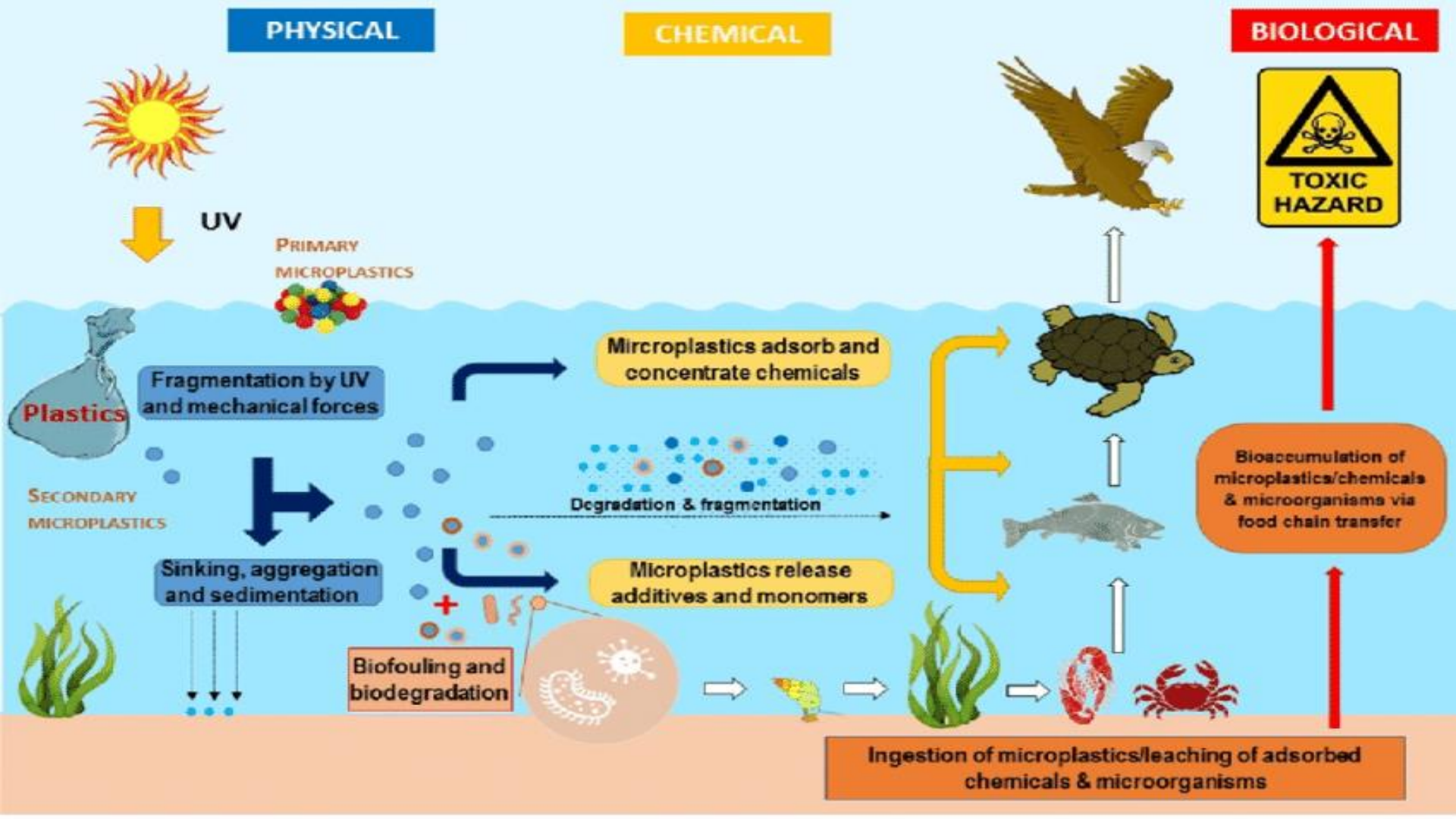
5. **EVALUATE**
   Conduct an Evaluation

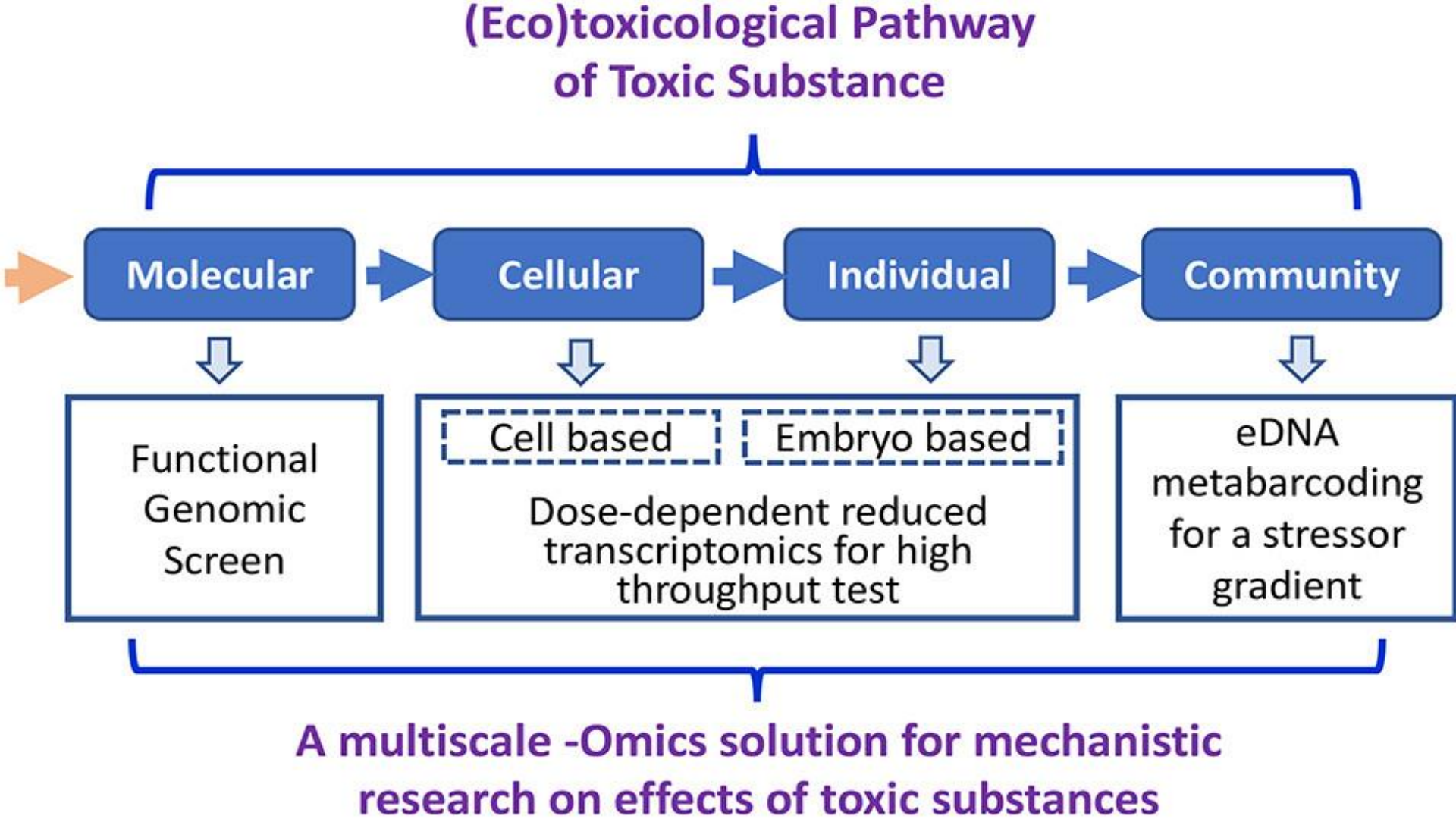


HSSE WORLD
Health, Safety, Security and Environment

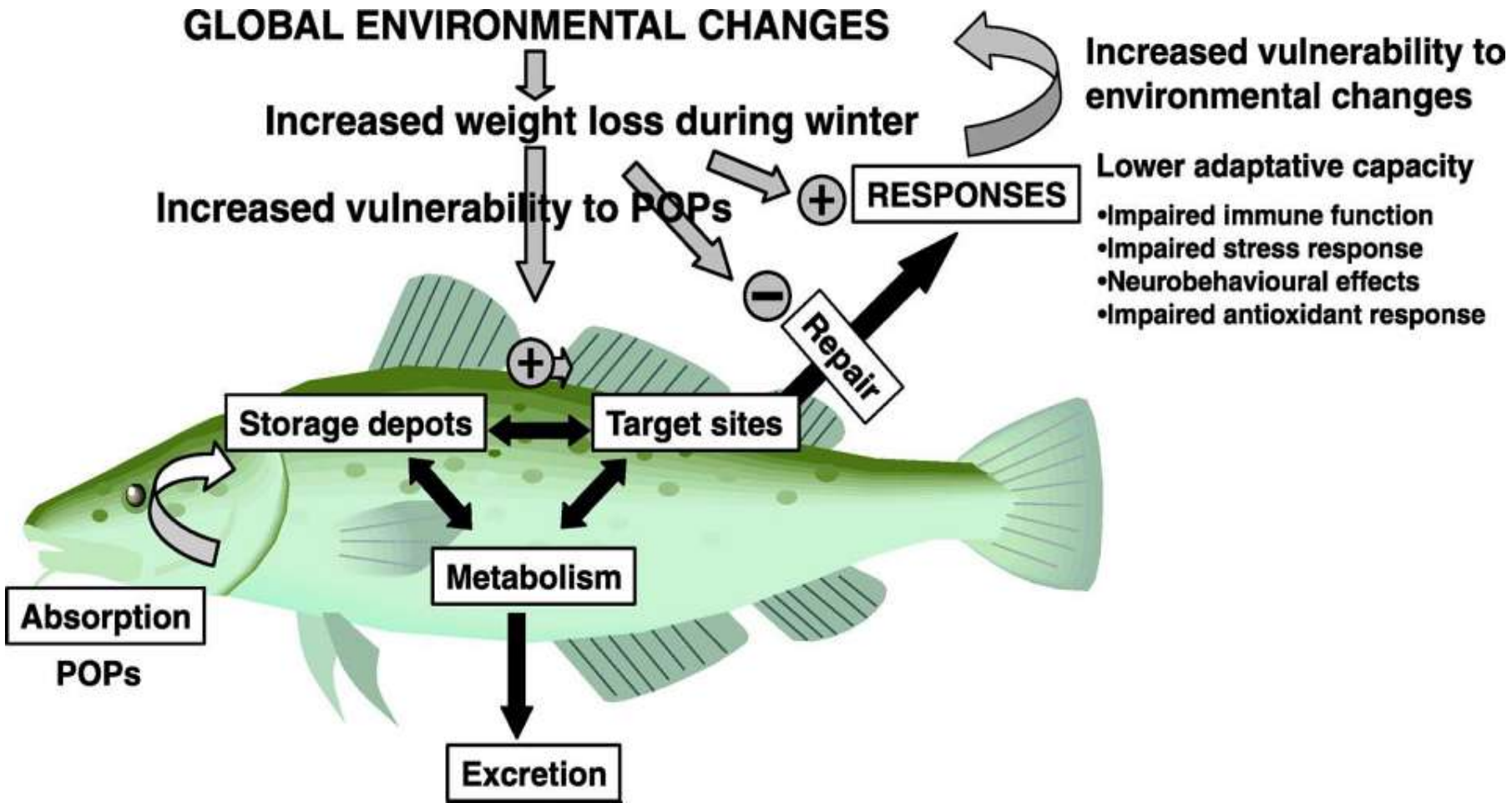
Aquatic toxicology



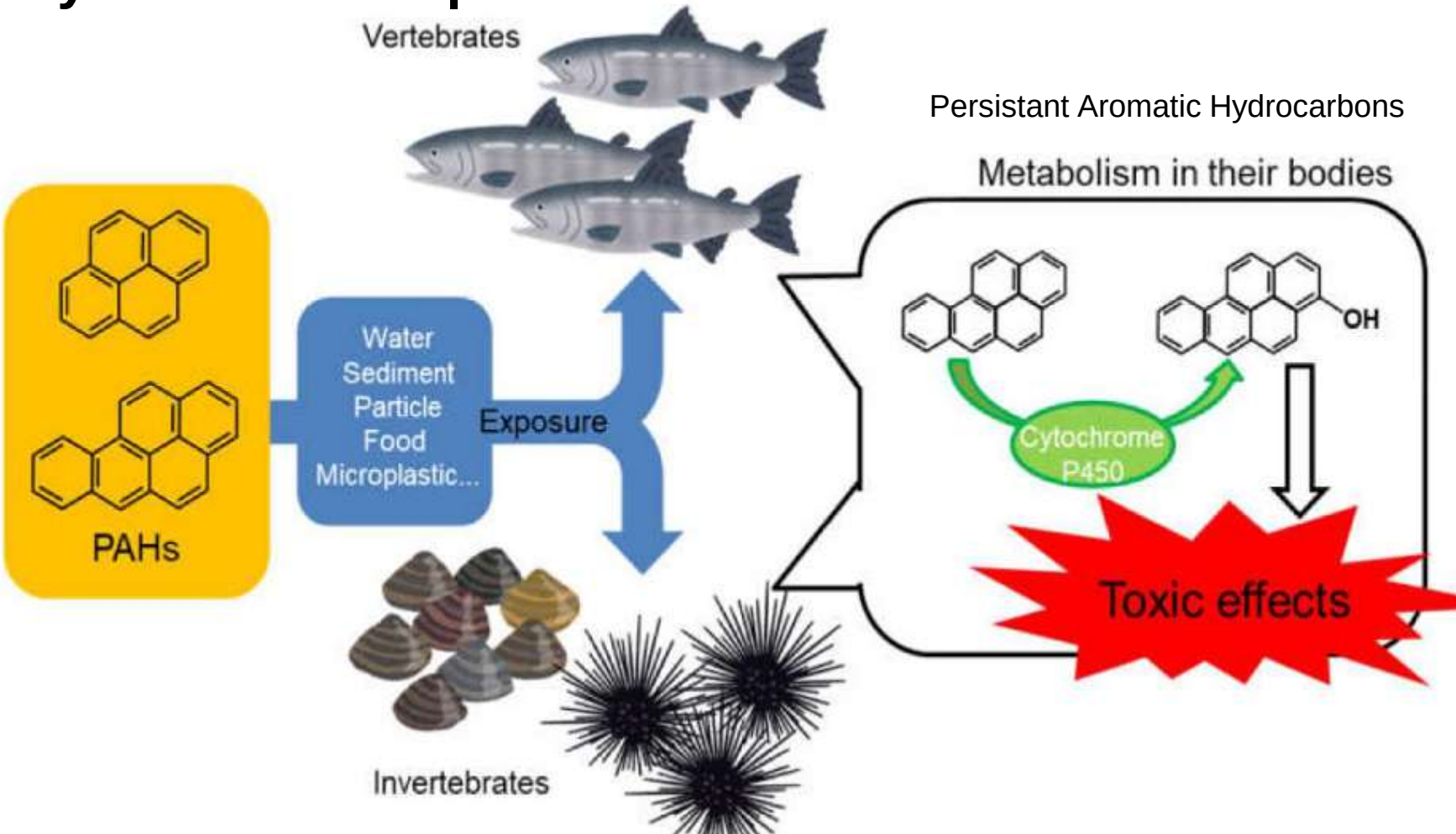

PHYSICAL
CHEMICAL
BIOLOGICAL
UV
PRIMARY MICROPLASTICS
Plastics
Fragmentation by UV and mechanical forces
SECONDARY MICROPLASTICS
Sinking, aggregation and sedimentation
Mircroplastics adsorb and concentrate chemicals
Degradation & fragmentation
Microplastics release additives and monomers
Biofouling and biodegradation
TOXIC HAZARD
Bioaccumulation of microplastics/chemicals & microorganisms via food chain transfer
Ingestion of microplastics/leaching of adsorbed chemicals & microorganisms


(Eco)toxicological Pathway
of Toxic Substance
Molecular
Cellular
Individual
Community
Functional
Genomic
Screen
Cell based
Embryo based
Dose-dependent reduced
transcriptomics for high
throughput test
eDNA
metabarcoding
for a stressor
gradient
A multiscale -Omics solution for mechanistic
research on effects of toxic substances

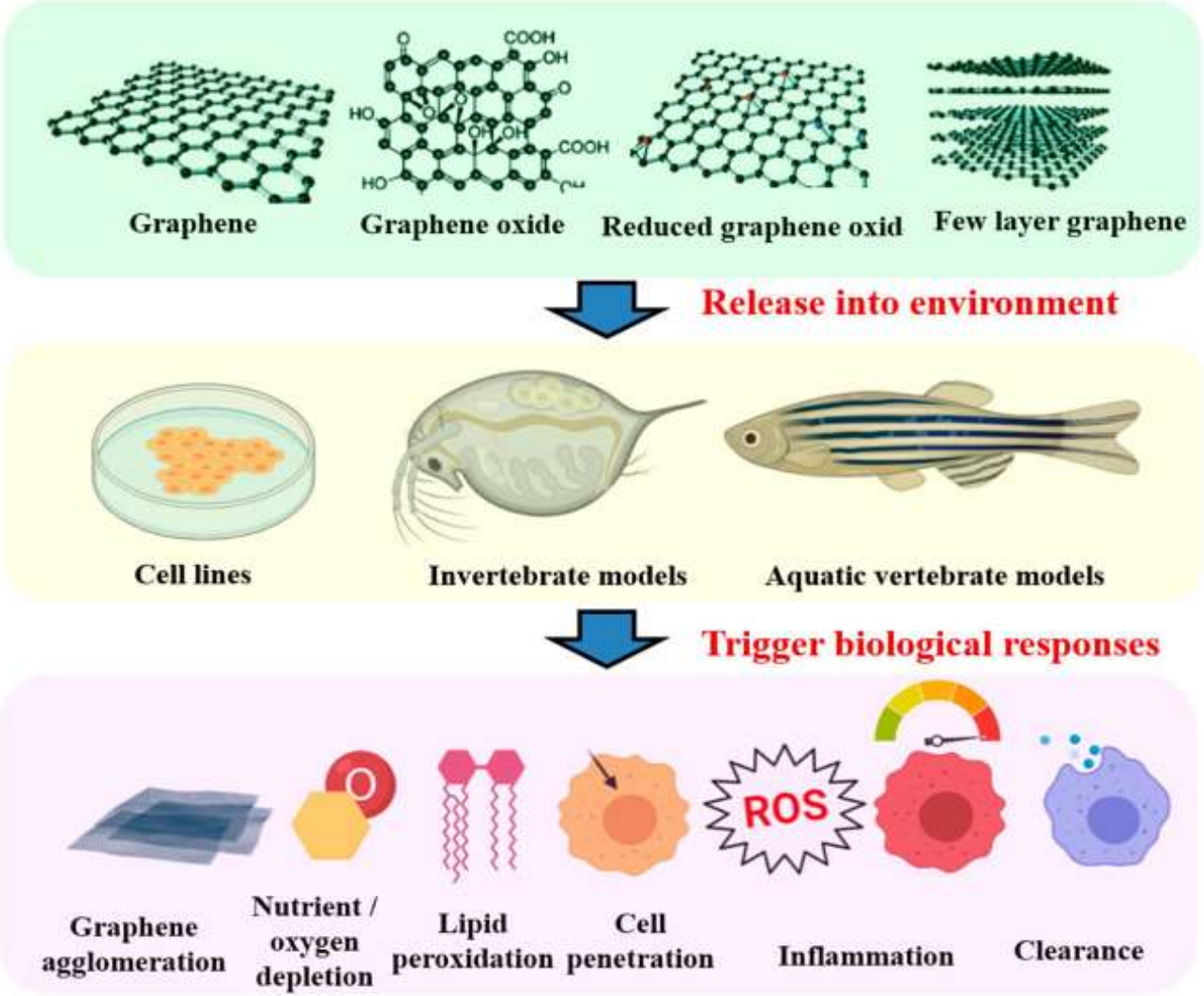
Research Toxicity in aquatic life



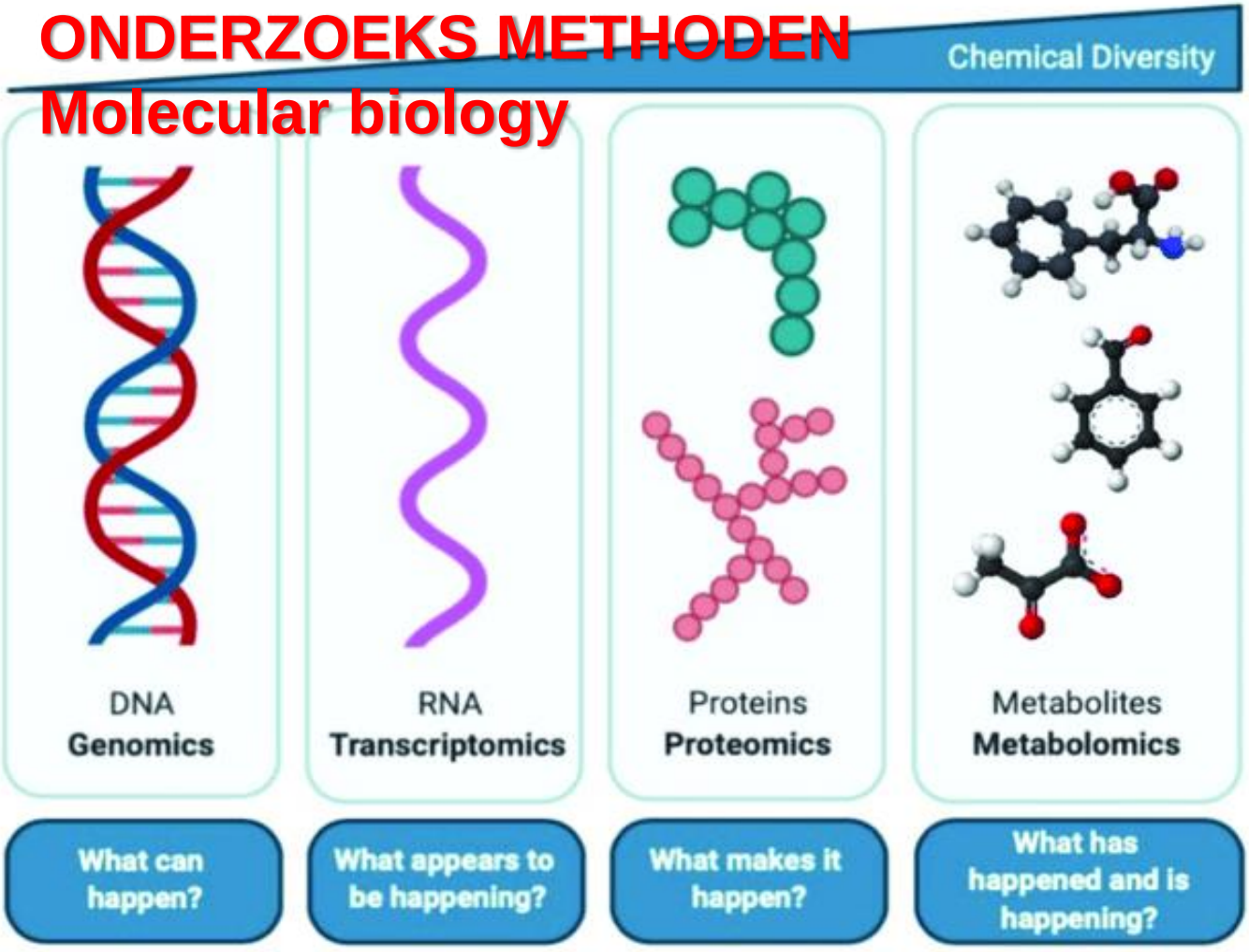
Toxicity of PAH for aquatic animals



Nanomaterials in Aquatic organisms



ONDERZOEKS METHODEN
Molecular biology



Q-PCR

QUANTITATIVE ANALYSIS
OF GENE EXPRESSION

VALIDATING DNA
MICROARRAY RESULTS

qPCR

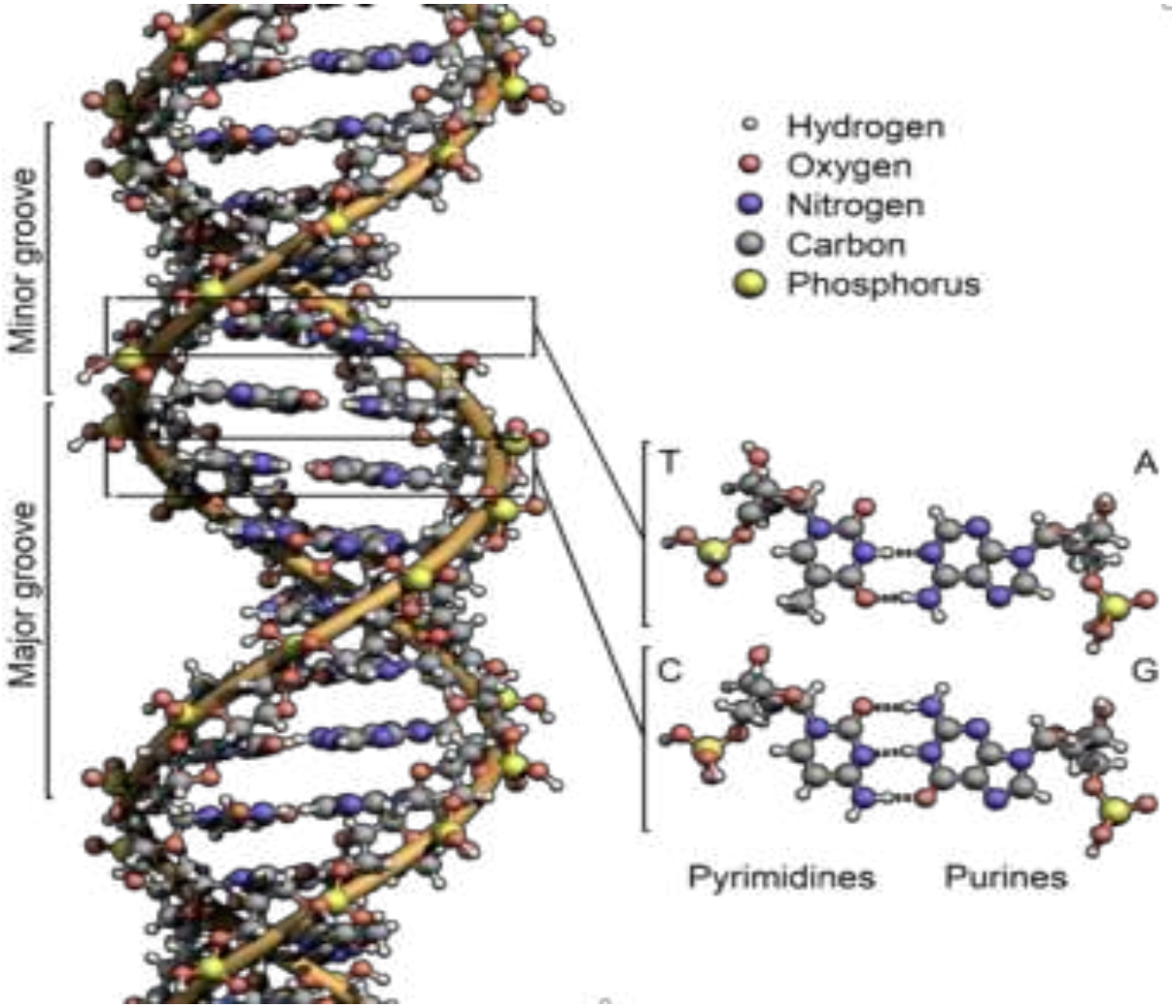
QUANTIFYING:

FUNGUS

VIRUS

BACTERIA

PCR + QUANTITATIVE PCR


Minor groove
Major groove
Hydrogen
Oxygen
Nitrogen
Carbon
Phosphorus
T
A
C
G
Pyrimidines
Purines

Assay design

Experimental set-up

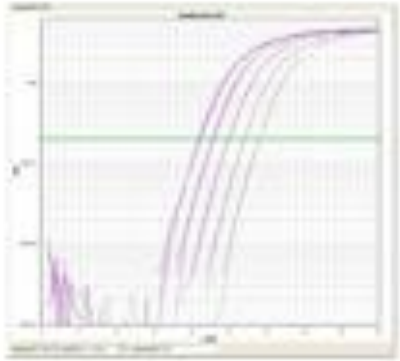
RNA, DNA—
isolate, purify, quantify

RNA

Reverse Transcription

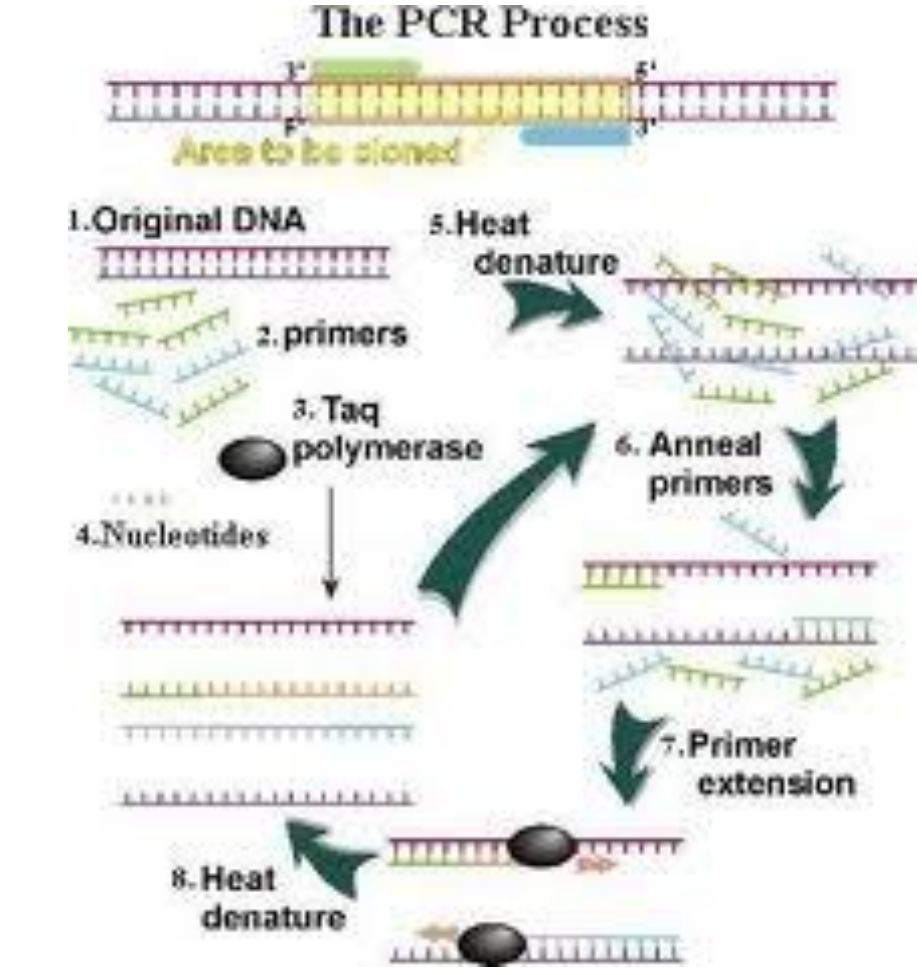
cDNA

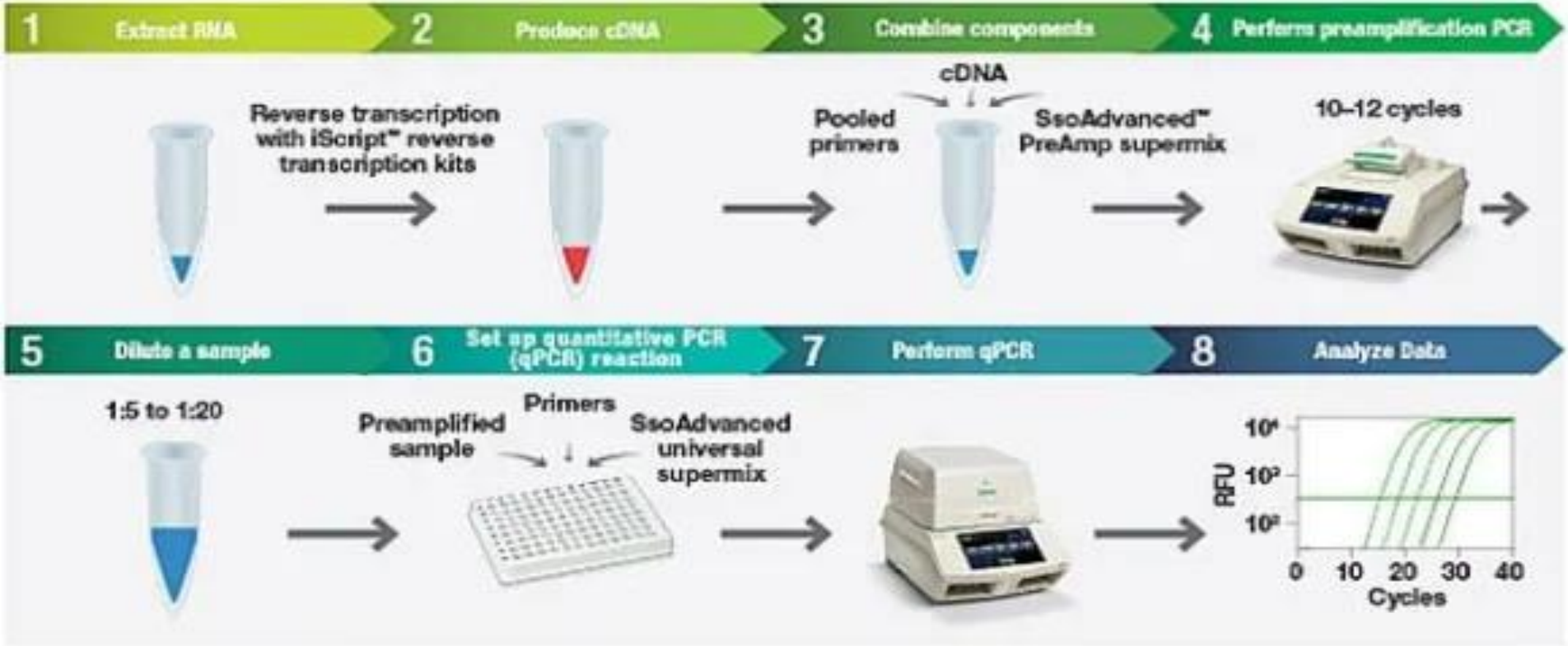
qPCR reaction set up



Analysis of data

Monitoring Environmental Drugs and Health

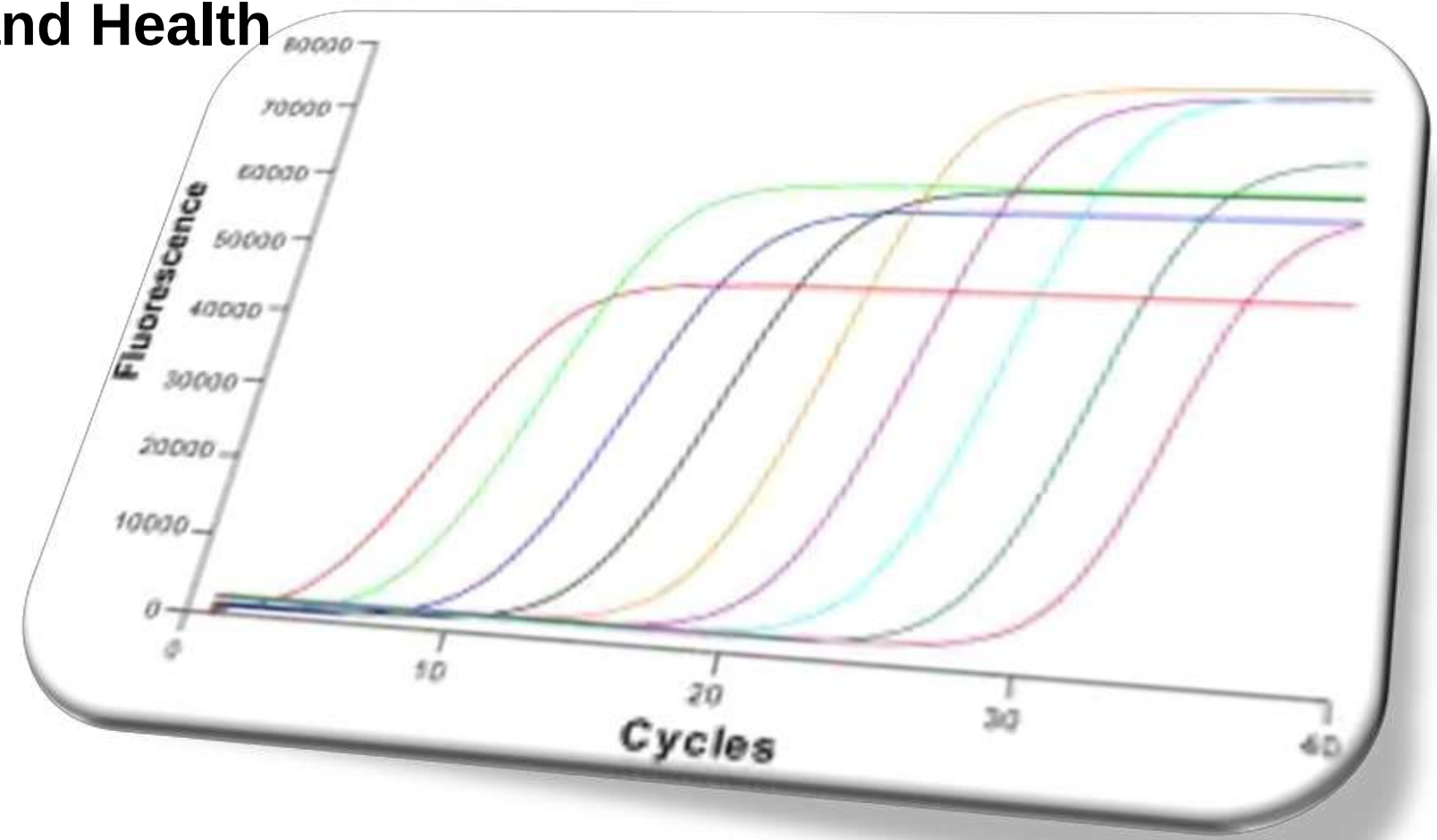




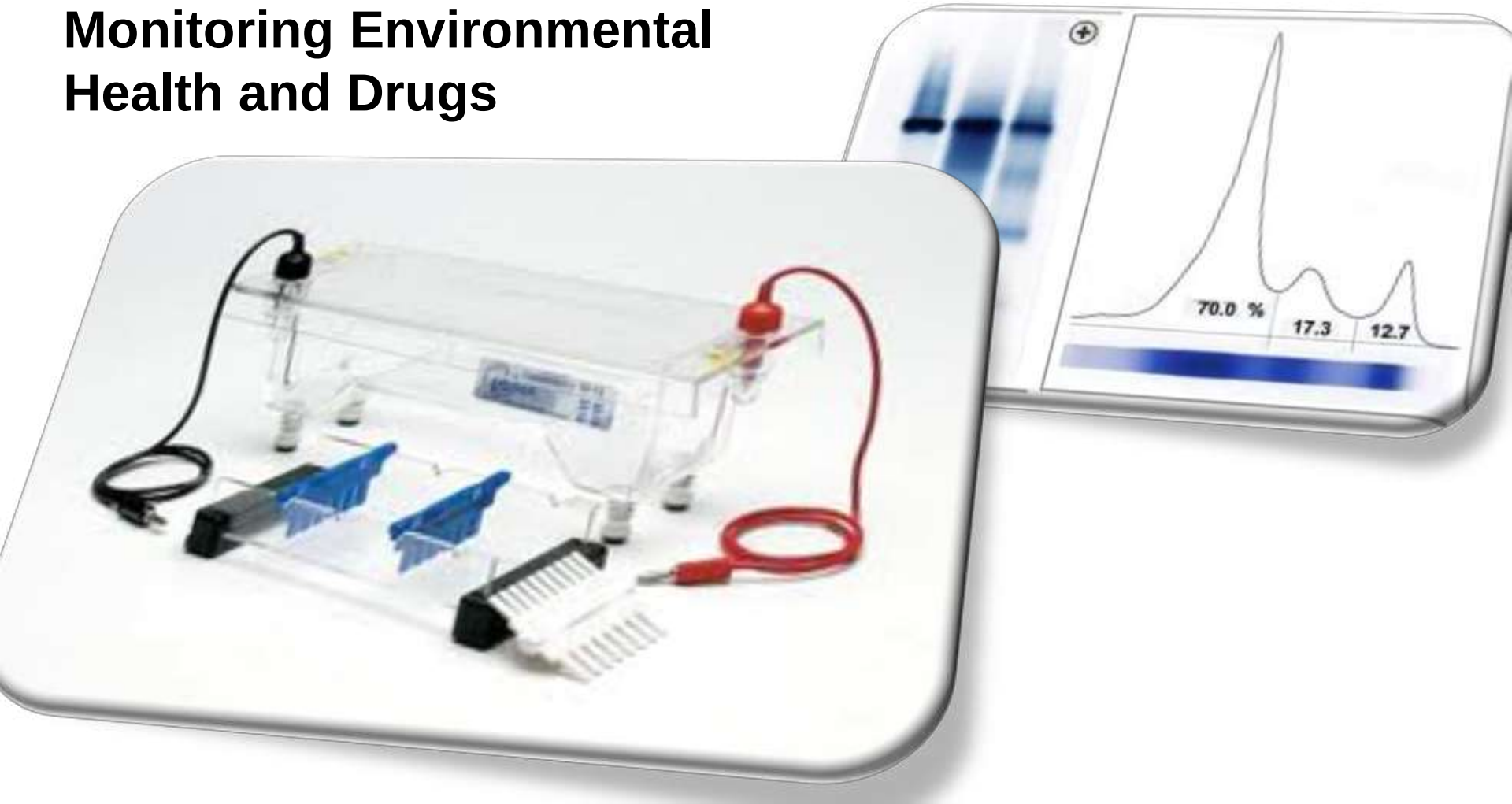
Preamplification workflow.

SsoAdvanced PreAmp Supermix preamplification workflow.

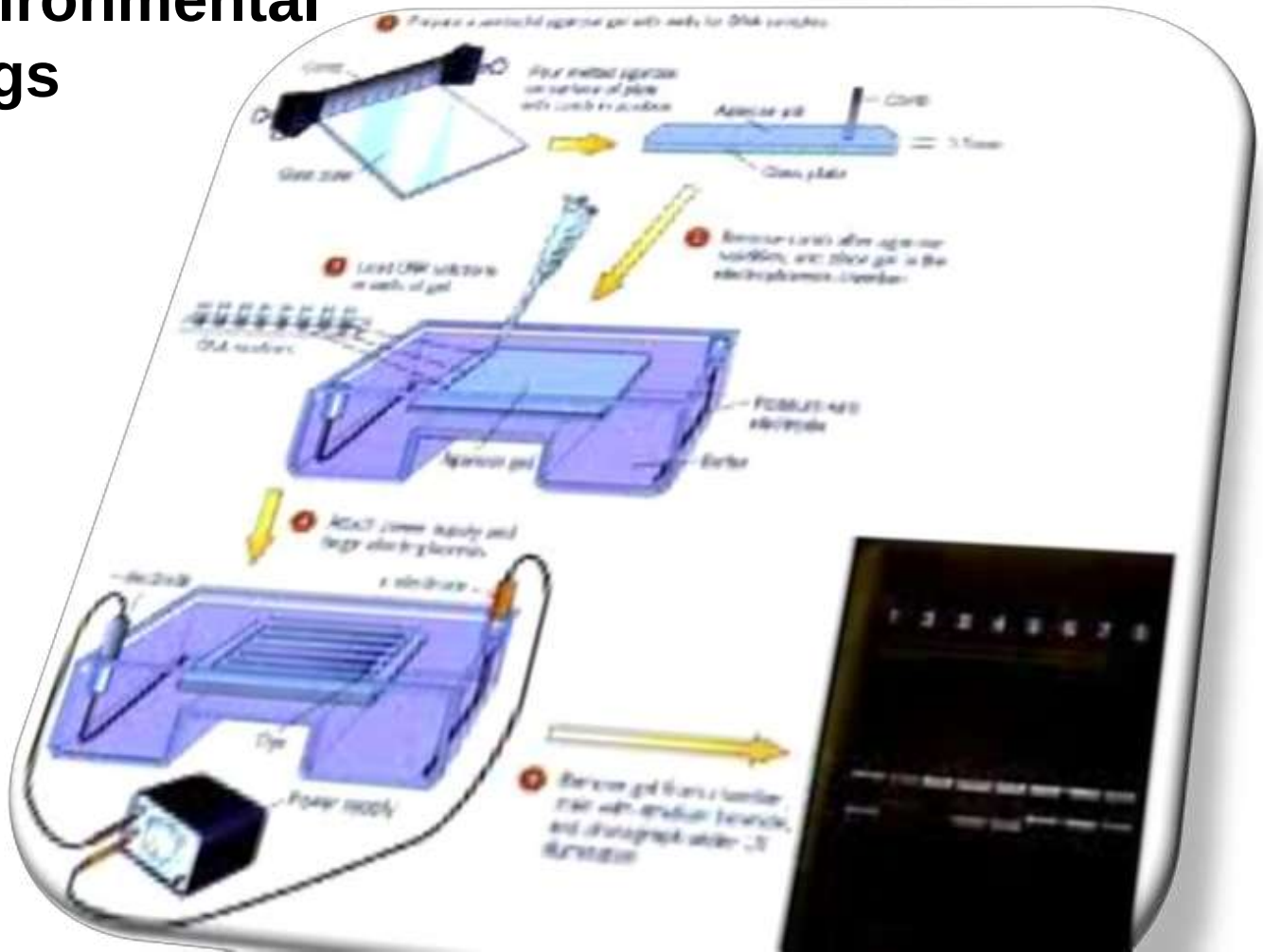
Monitoring Environmental
Drugs and Health



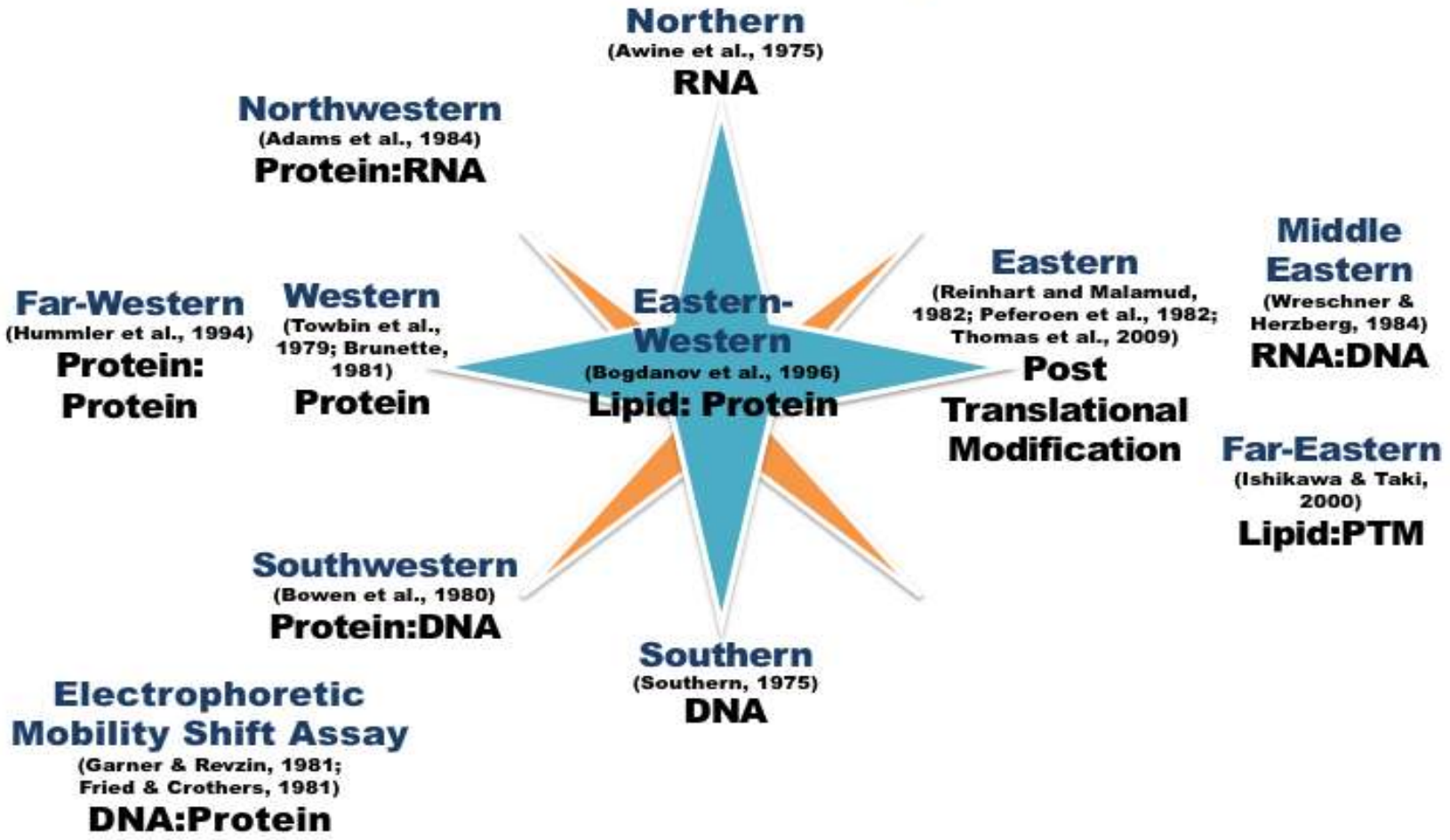
Monitoring Environmental Health and Drugs



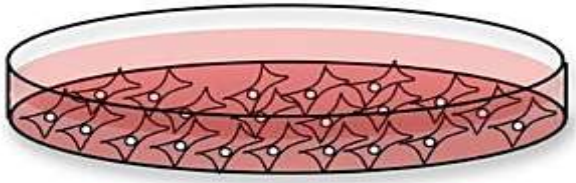
Monitoring Environmental Health and Drugs

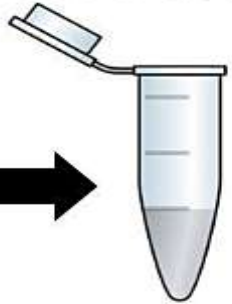


Blotting Compass

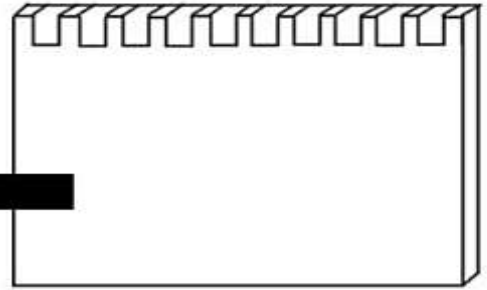


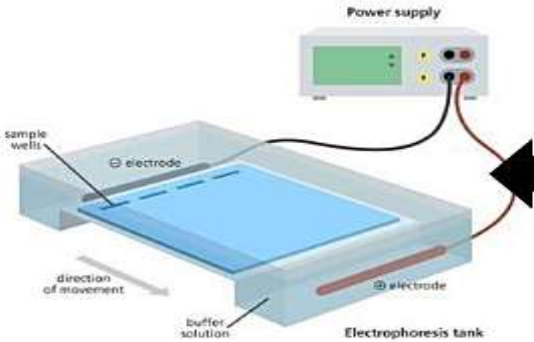
Northern blot

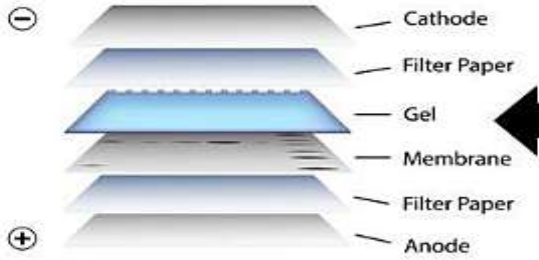




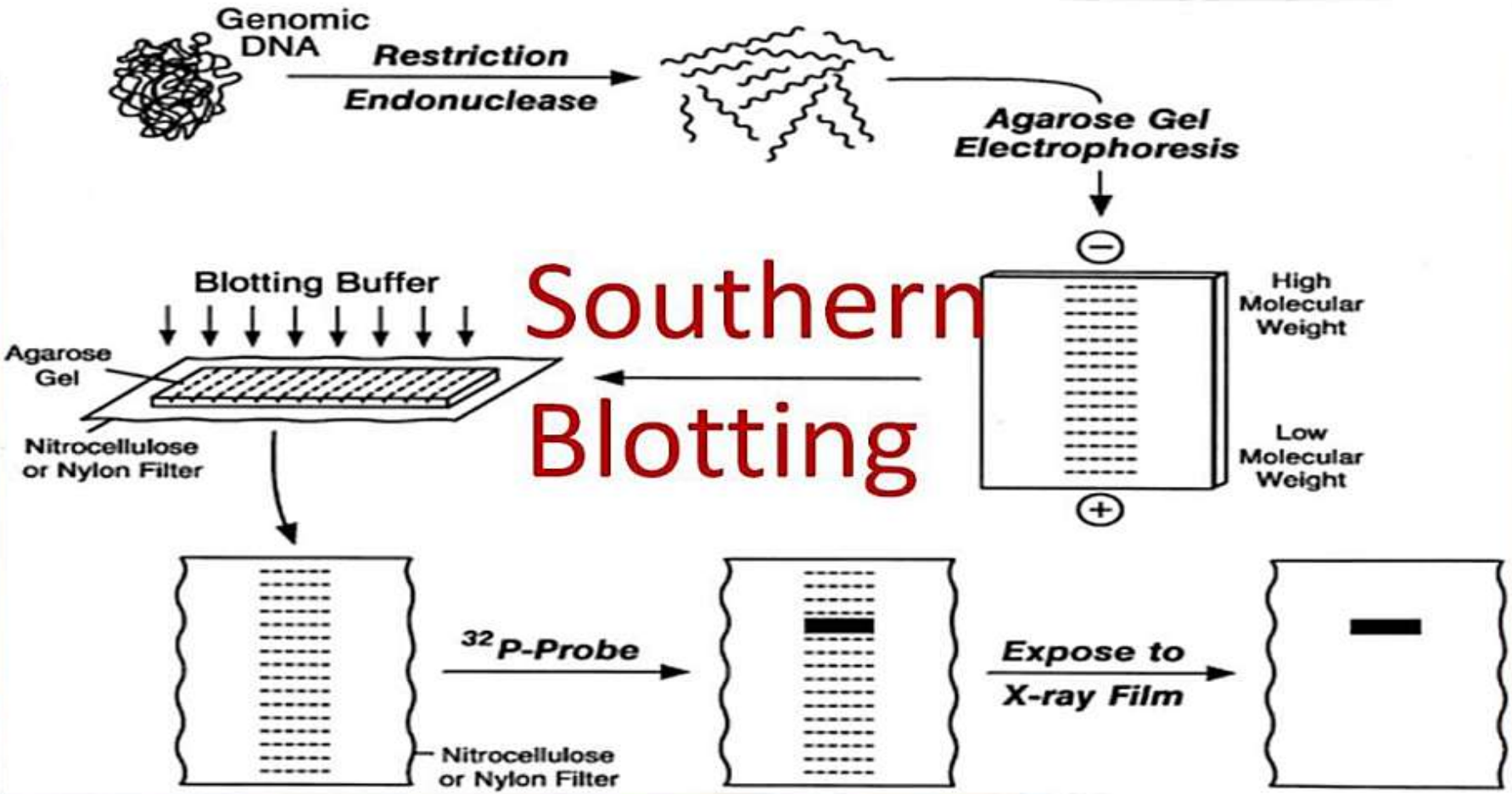
RNA extraction

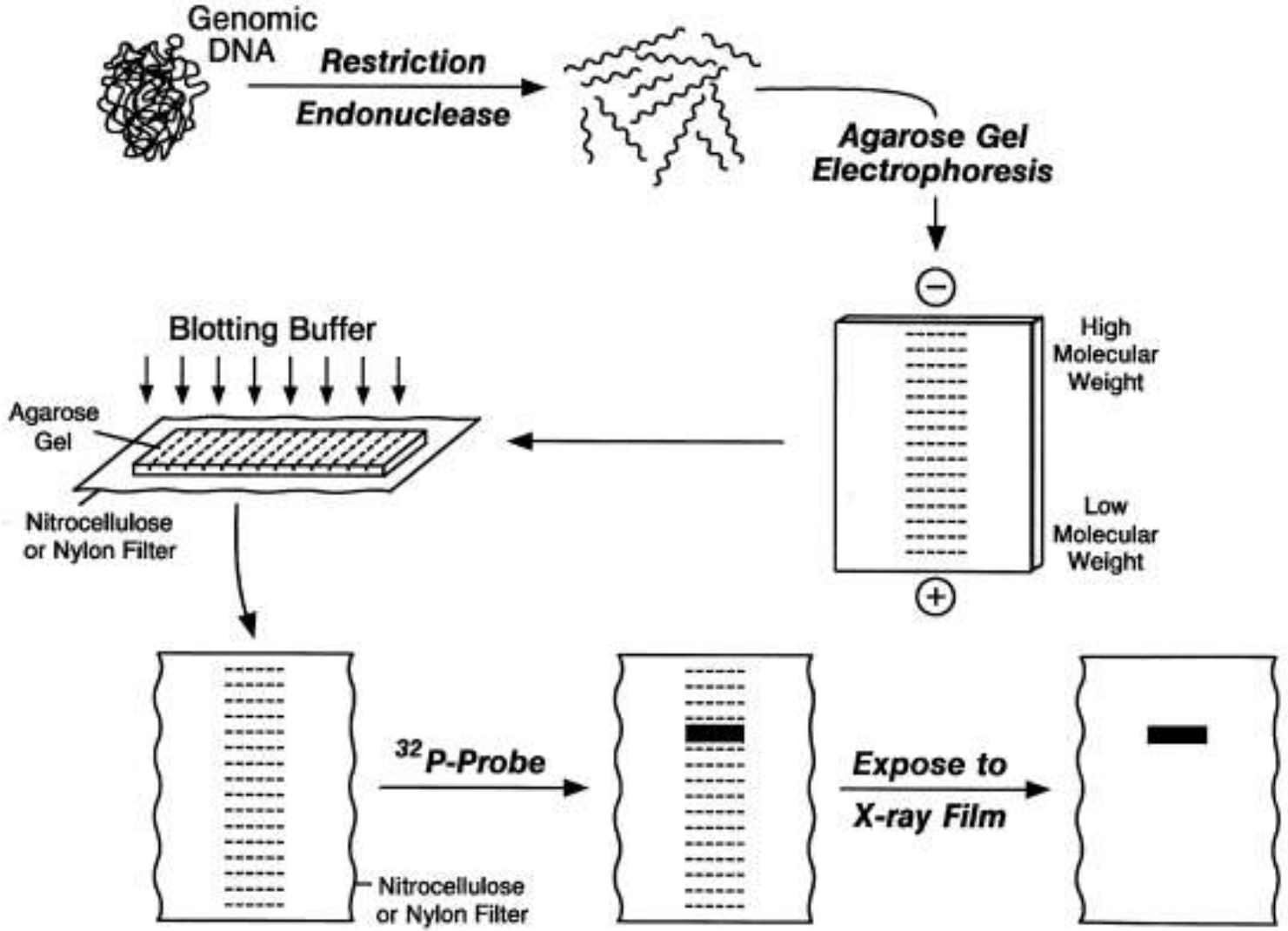




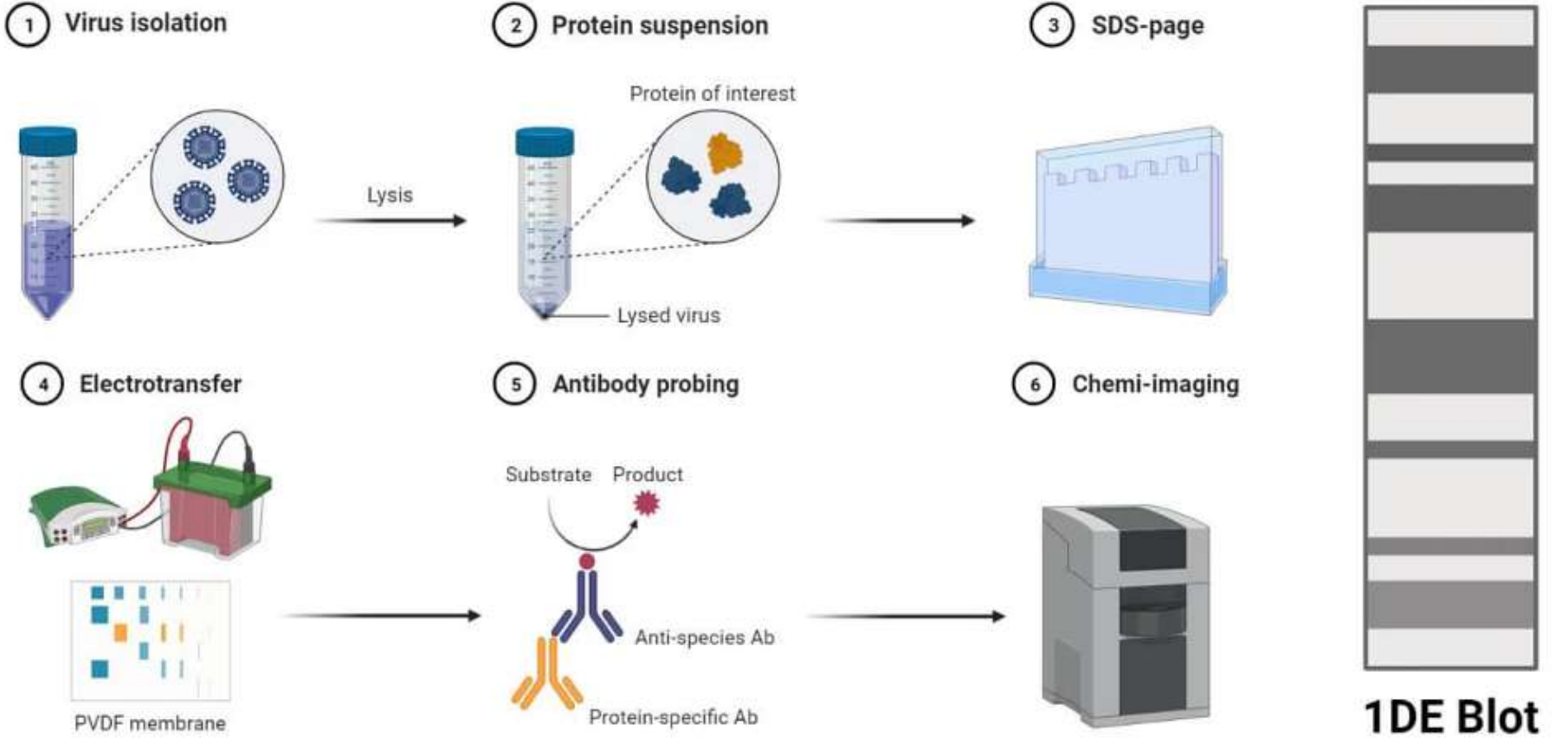


Southern blotting

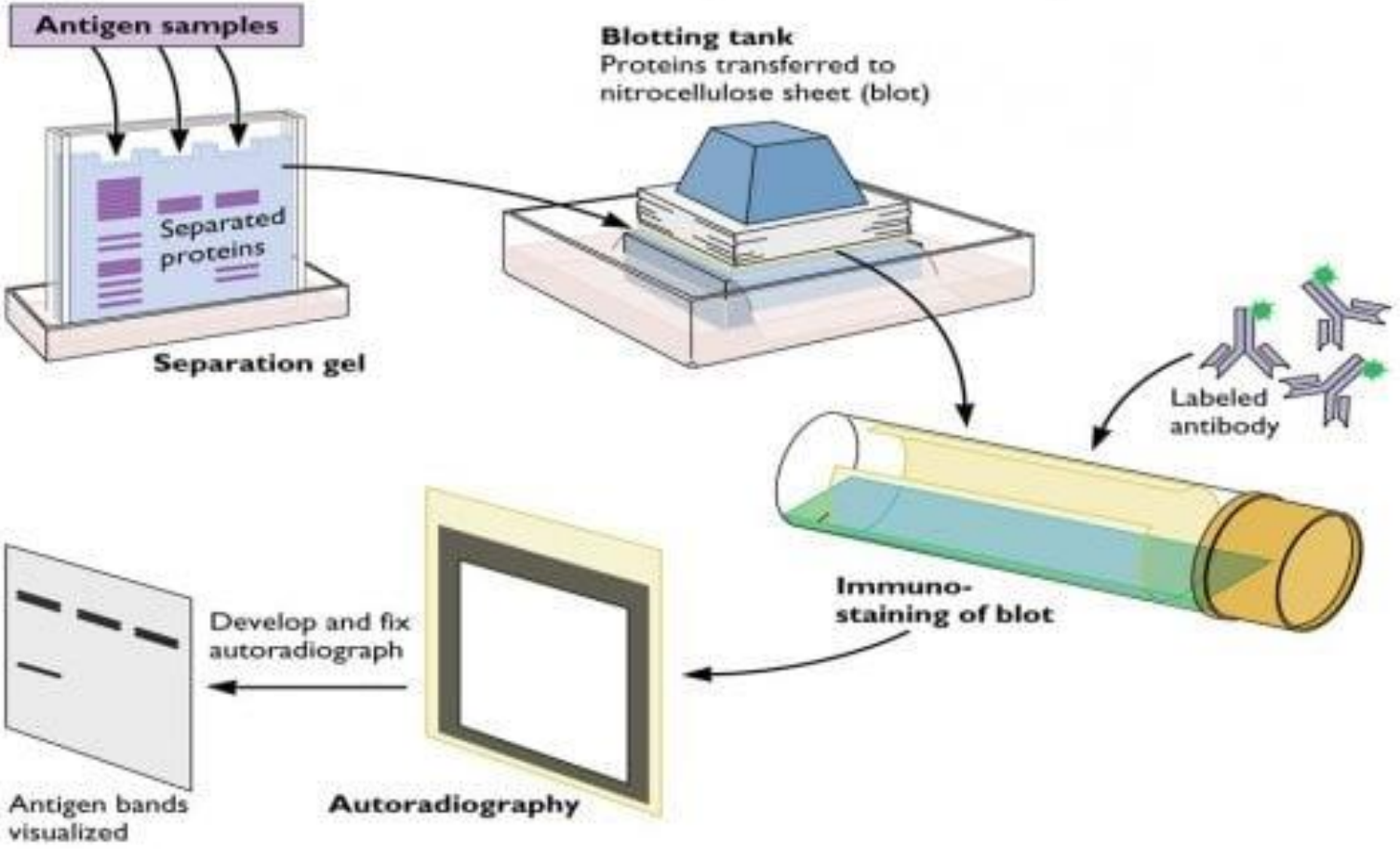



Genomic DNA
Restriction Endonuclease
Agarose Gel Electrophoresis
High Molecular Weight
Low Molecular Weight
Blotting Buffer
Agarose Gel
Nitrocellulose or Nylon Filter
32P-Probe
Nitrocellulose or Nylon Filter
Expose to X-ray Film

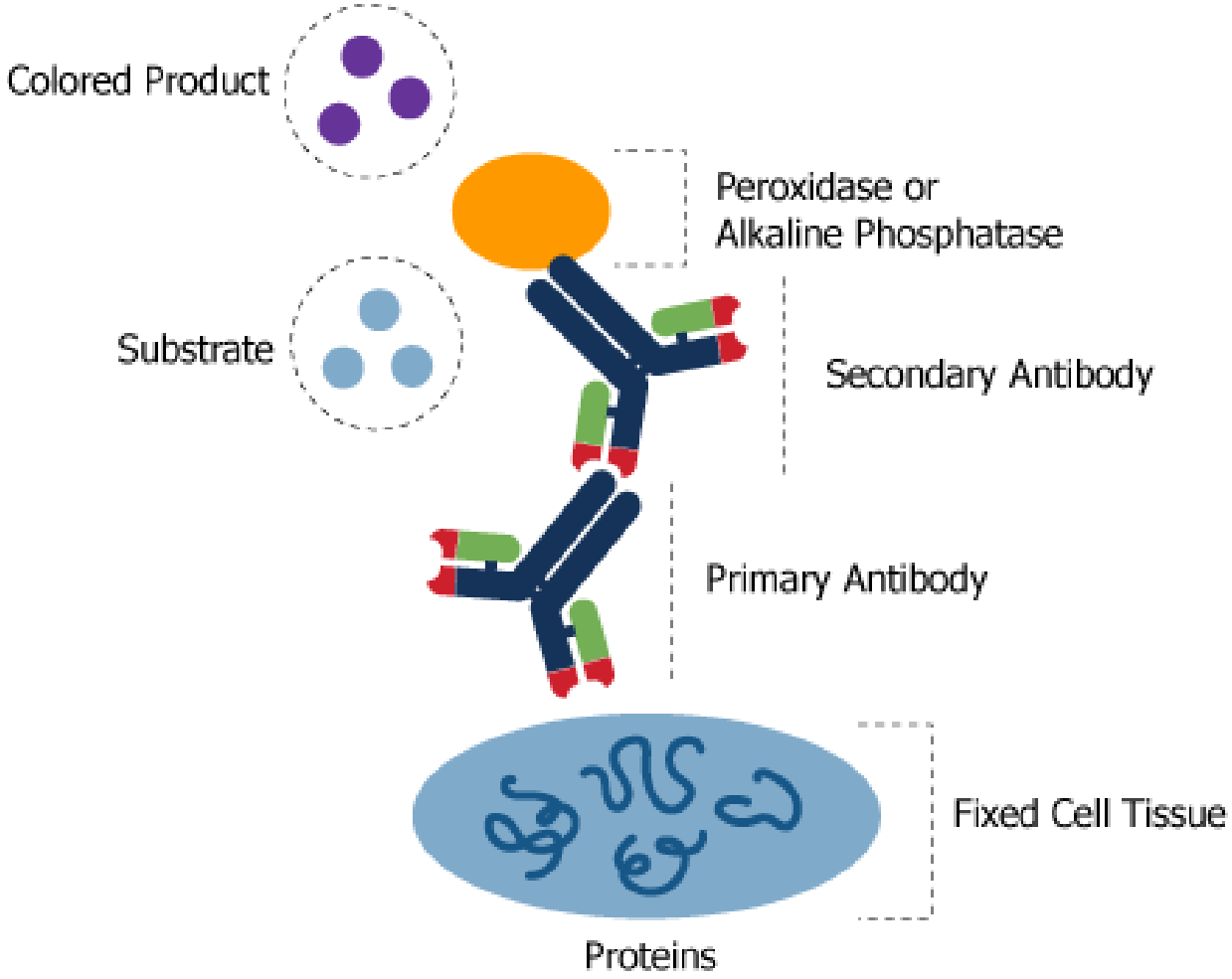
Western Blot- Definition, Principle, Procedure, Results, Applications



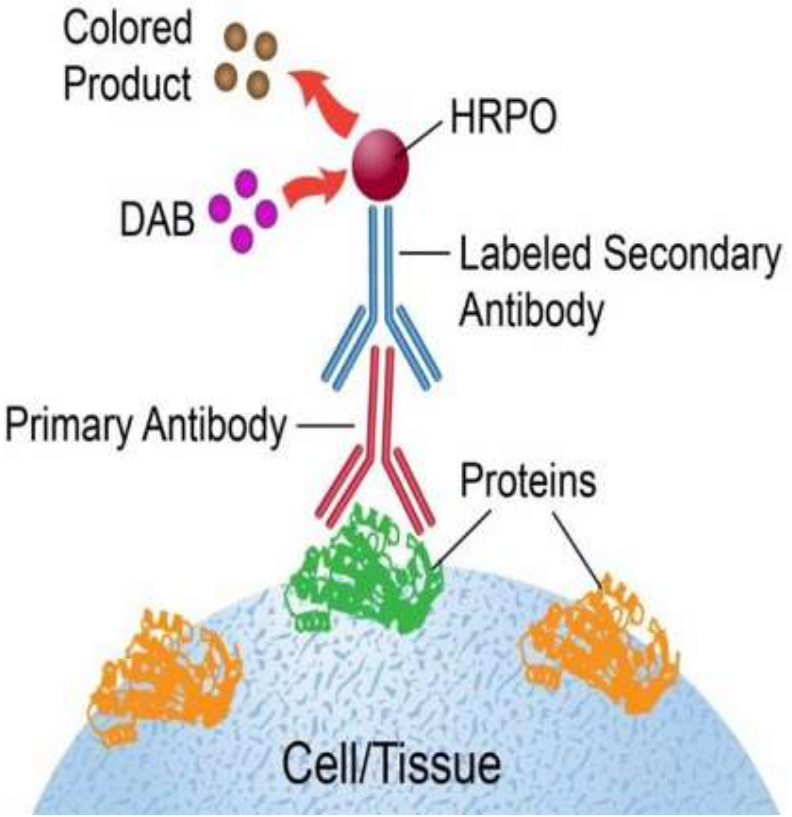
Western Blotting Technique



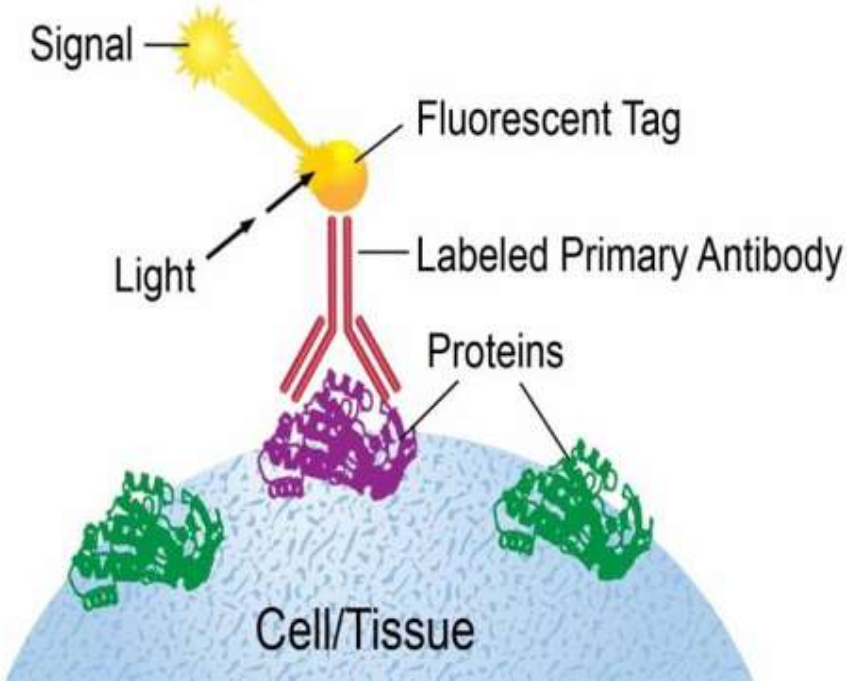
Immunohistochemistry Schematic



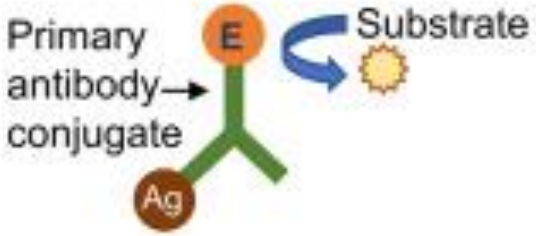
Indirect Immunohistochemistry



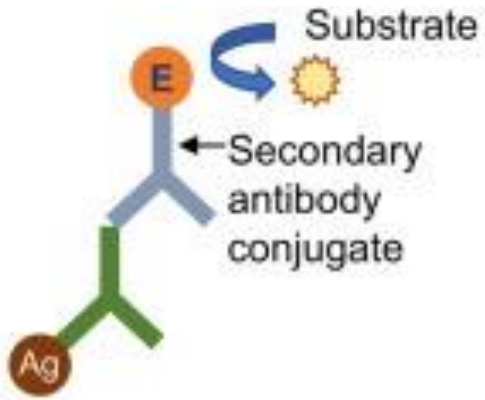
Immunofluorescence



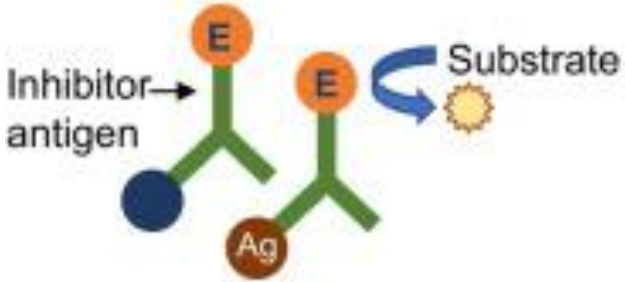
ELISA



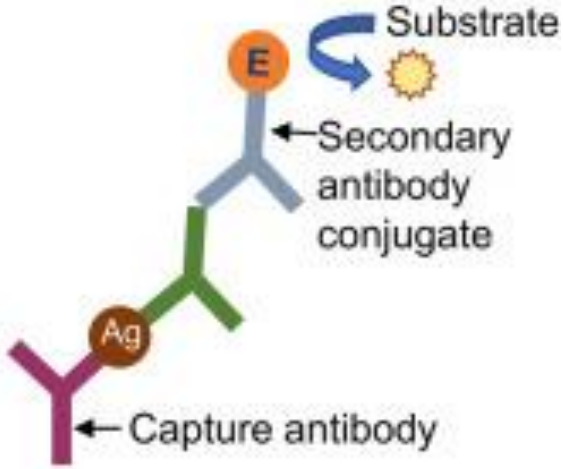
Direct ELISA



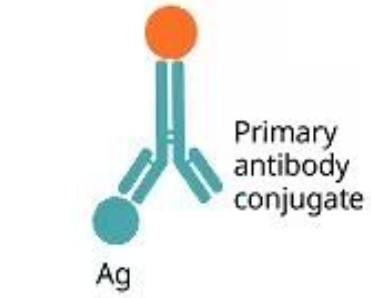
Indirect ELISA

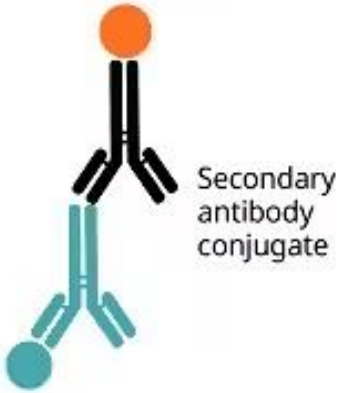


Competitive ELISA



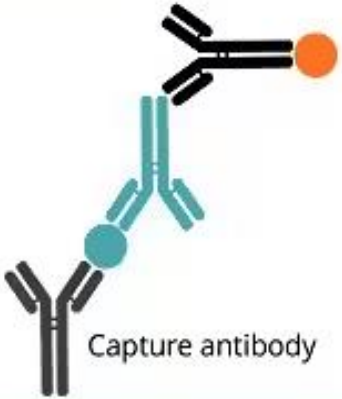
Sandwich ELISA

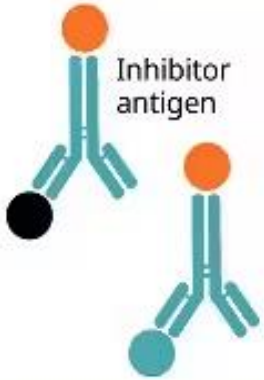




Direct ELISA

Indirect ELISA

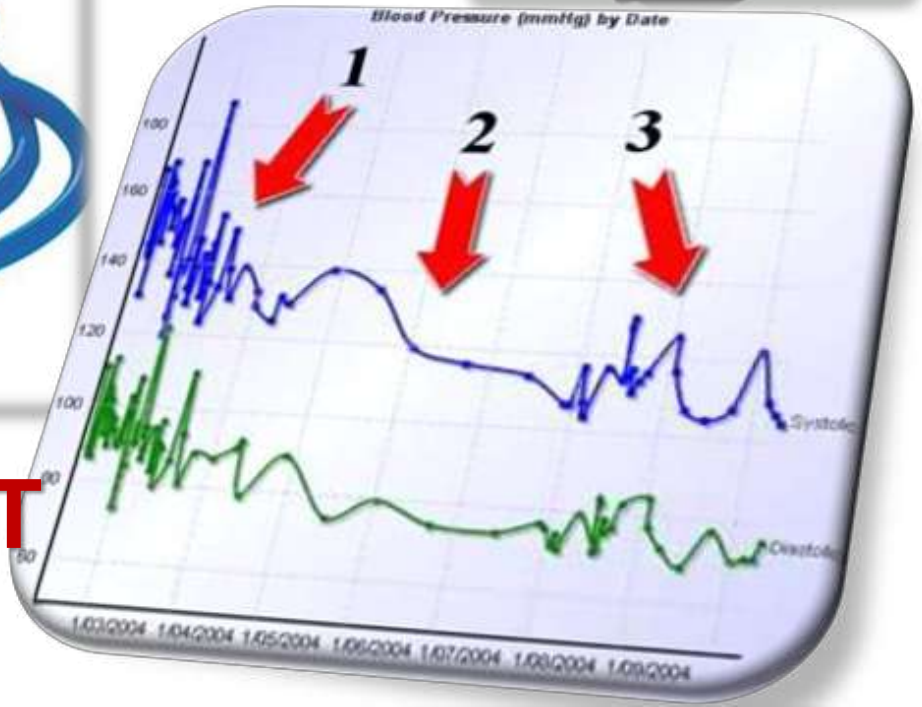




Sandwich ELISA

Competitive ELISA

Monitoring the VITAL SIGNS of our Environment



..... IS THAT SUFFICIENT?

A Call for Monitoring Critical Environmental Indicators

- Scientific Literature
- Evidence Based Practice
- **LINK** with **EFFECTIVE** Environmental Policy Making in Suriname

- **MEASURING:**
  - ✓ Critical Environmental Indicators
  - ✓ Biological Health Indicators
  - ✓ Environmental Drugs and other Pollutants

A Call for Monitoring Critical Environmental Indicators

NEED FOR Critical and EFFECTIVE :

- ✓ Sentinel Species Monitoring
- ✓ Environmental Research
- ✓ Environmental Policy
- ✓ Environmental Law Enforcement
- ✓ EVIDENCE BASED REQUIRES

Environmental Health

Environmental Forensics

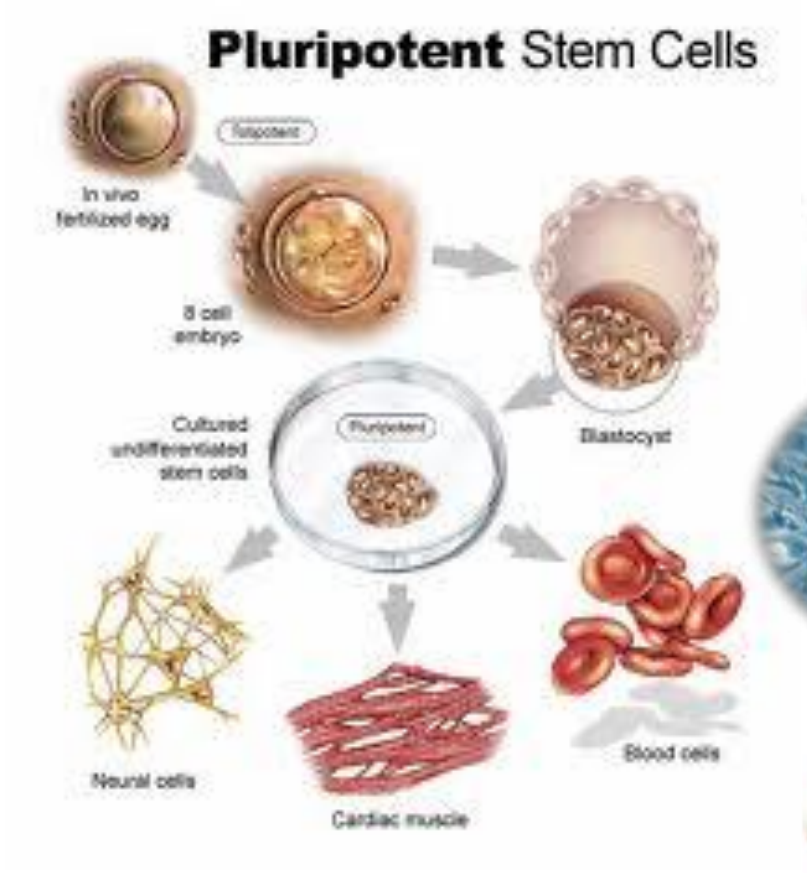
EVIDENCE BASED

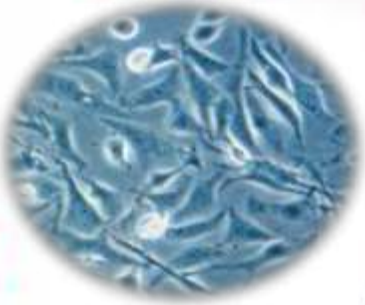
✓**Scientific Research:**

Identifying Critical Control Indicators
Monitoring Sentinel Organisms
Environmental Health Research
Environmental Forensics Research

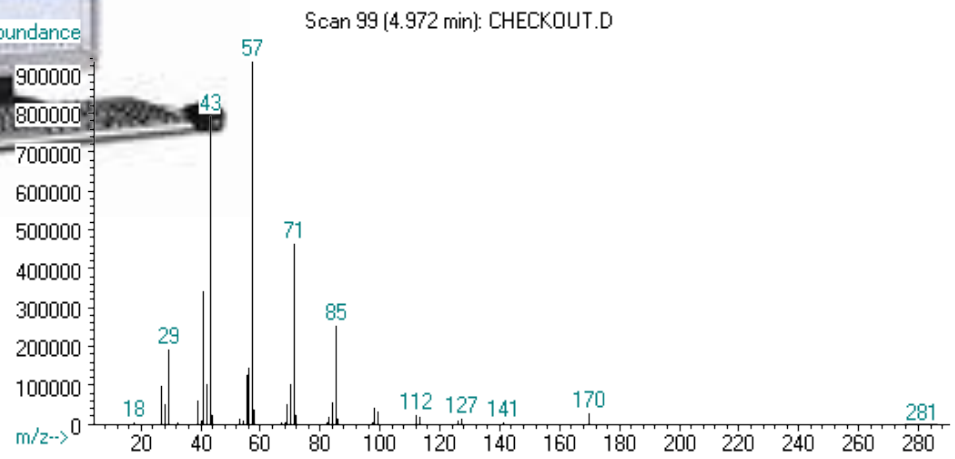
Monitoring Environmental Health: Sentinel Species

Monitoring Environmental Drugs and Health

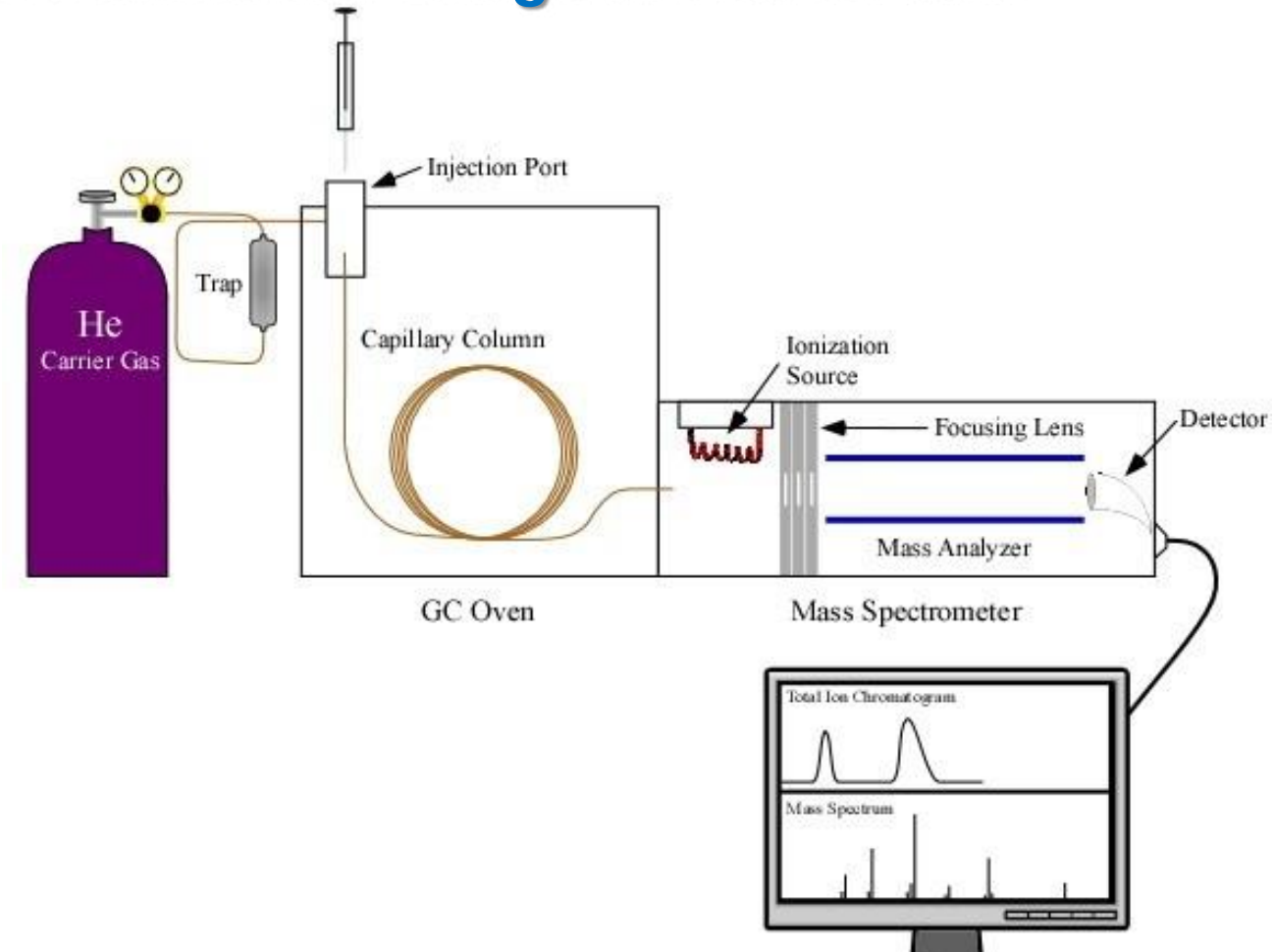




Measuring Environmental Drugs in Health and Forensics



Measuring Environmental Drugs in Health and Forensics



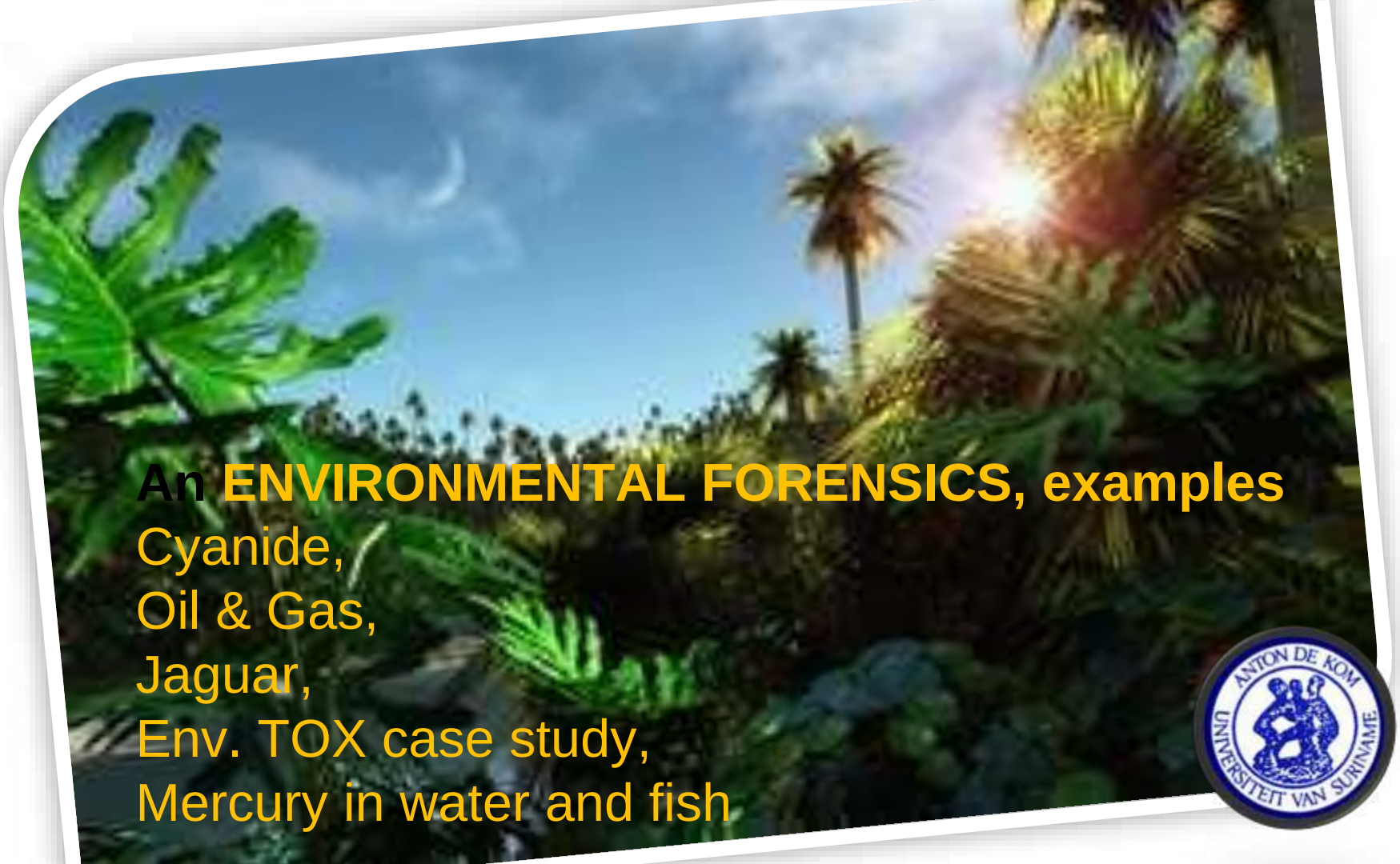
A Call for Monitoring Critical Environmental Indicators

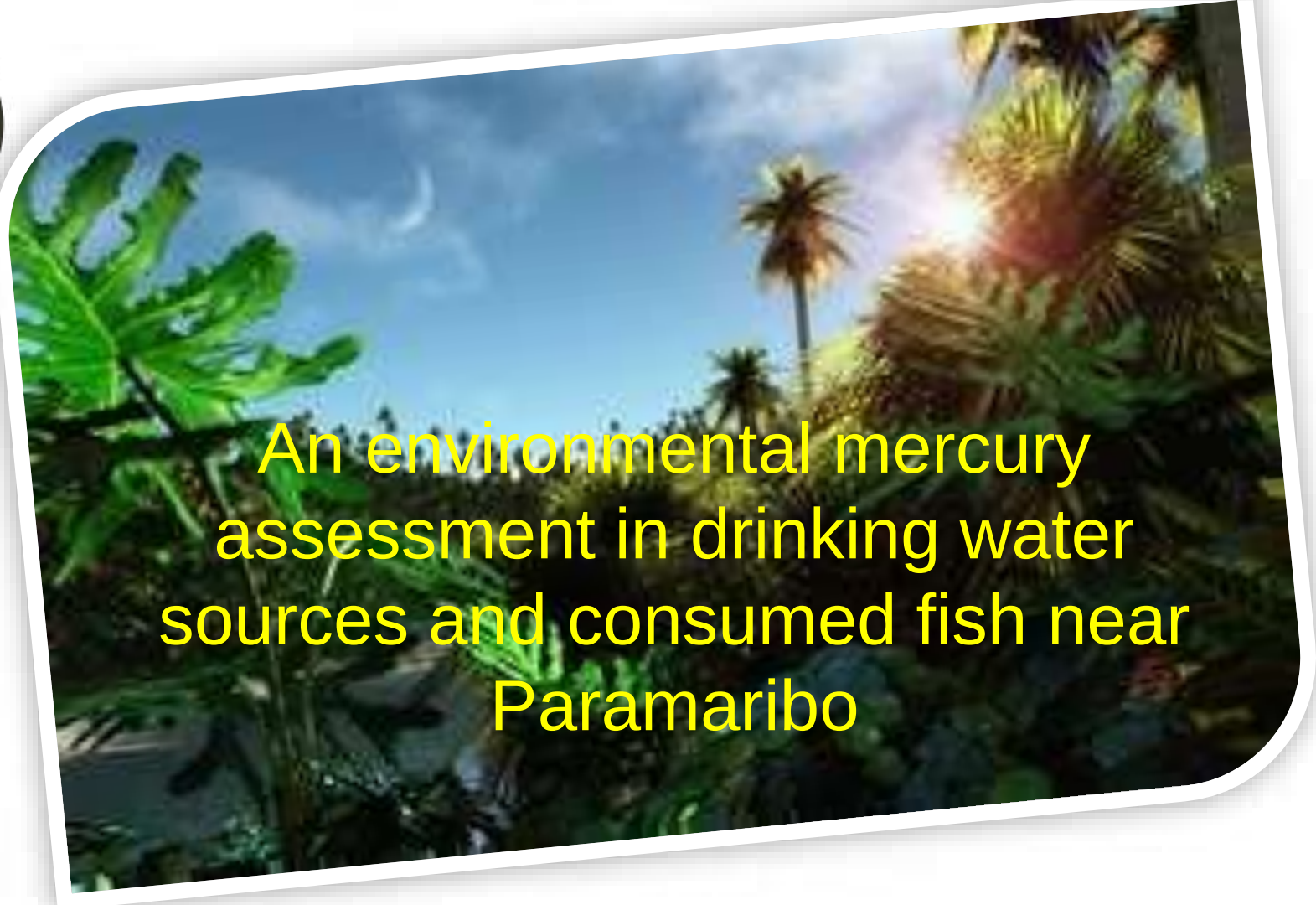
NEED FOR Critical and EFFECTIVE :

- ✓ Sentinel Species Monitoring
- ✓ Environmental Research
- ✓ Environmental Policy
- ✓ Environmental Law Enforcement
- ✓ EVIDENCE BASED REQUIRES

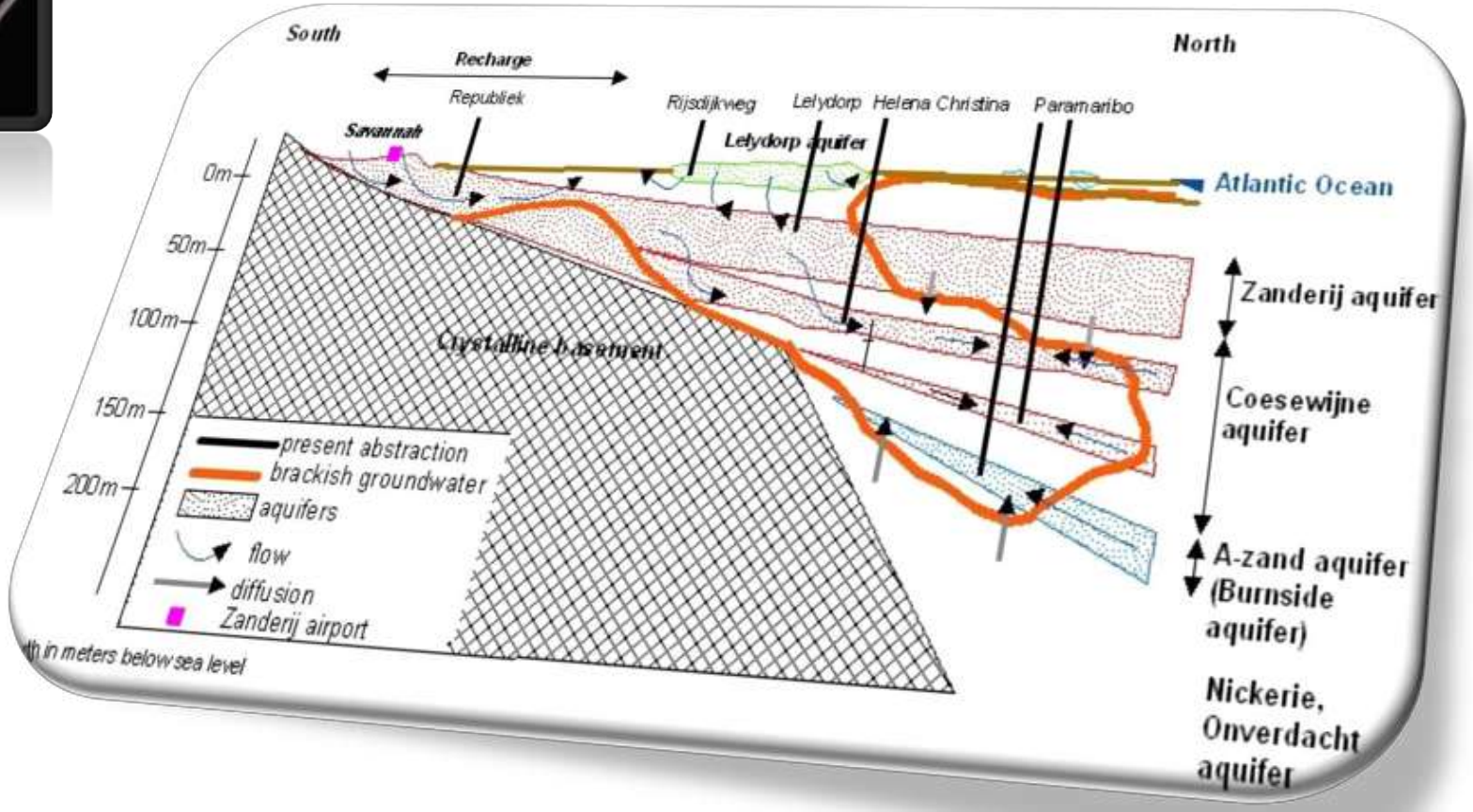
Environmental Health

Environmental Forensics

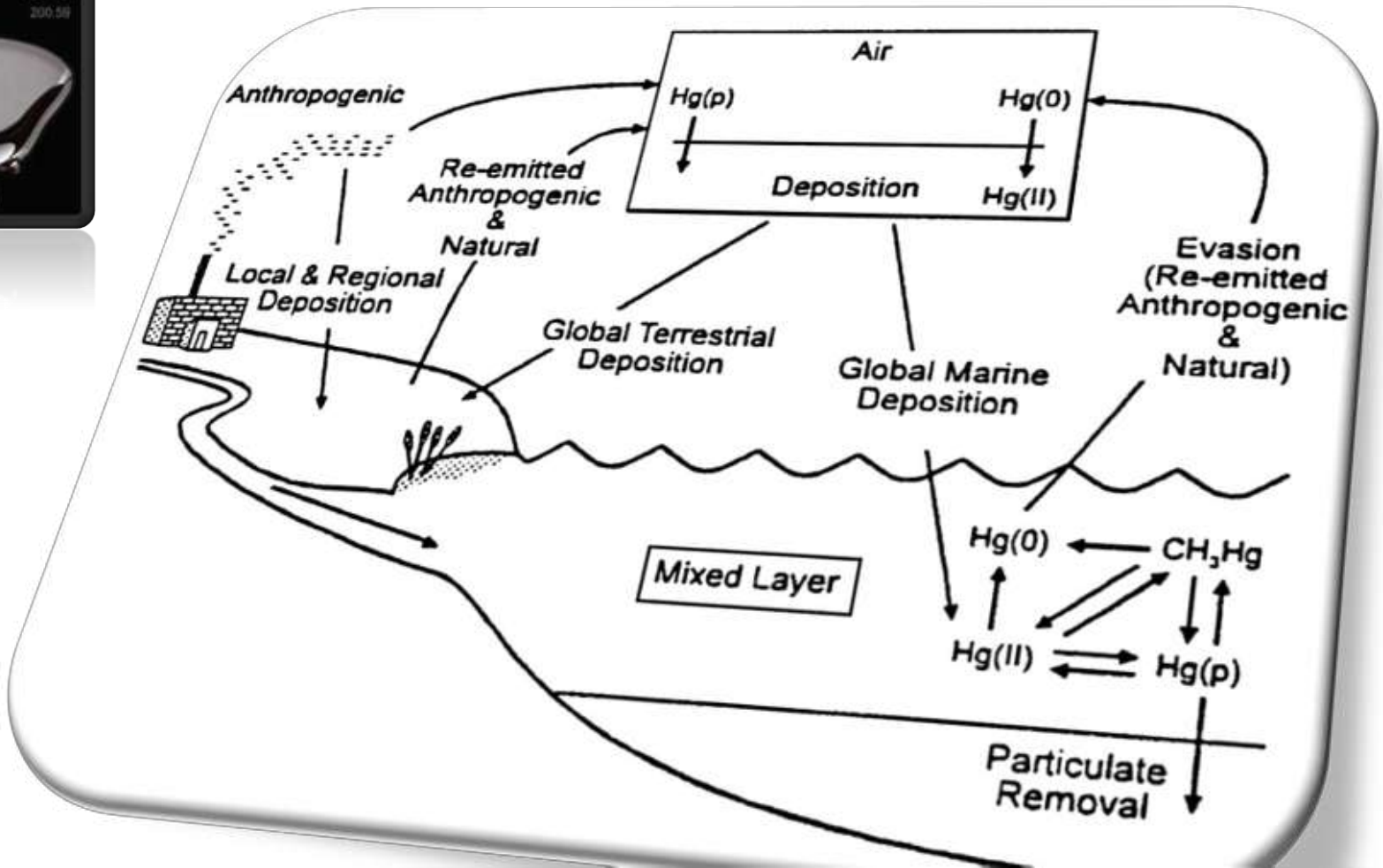

An ENVIRONMENTAL FORENSICS, examples
Cyanide,
Oil & Gas,
Jaguar,
Env. TOX case study,
Mercury in water and fish
ANTON DE KOM
UNIVERSITEIT VAN SURINAME


An environmental mercury assessment in drinking water sources and consumed fish near Paramaribo

Introduction




Hg
80
200.59
Mercury


Air
Hg(p)
Hg(0)
Deposition
Hg(II)
Anthropogenic
Re-emitted
Anthropogenic
&
Natural
Local & Regional
Deposition
Global Terrestrial
Deposition
Global Marine
Deposition
Evasion
(Re-emitted
Anthropogenic
&
Natural)
Mixed Layer
Hg(0)
CH3Hg
Hg(II)
Hg(p)
Particulate
Removal

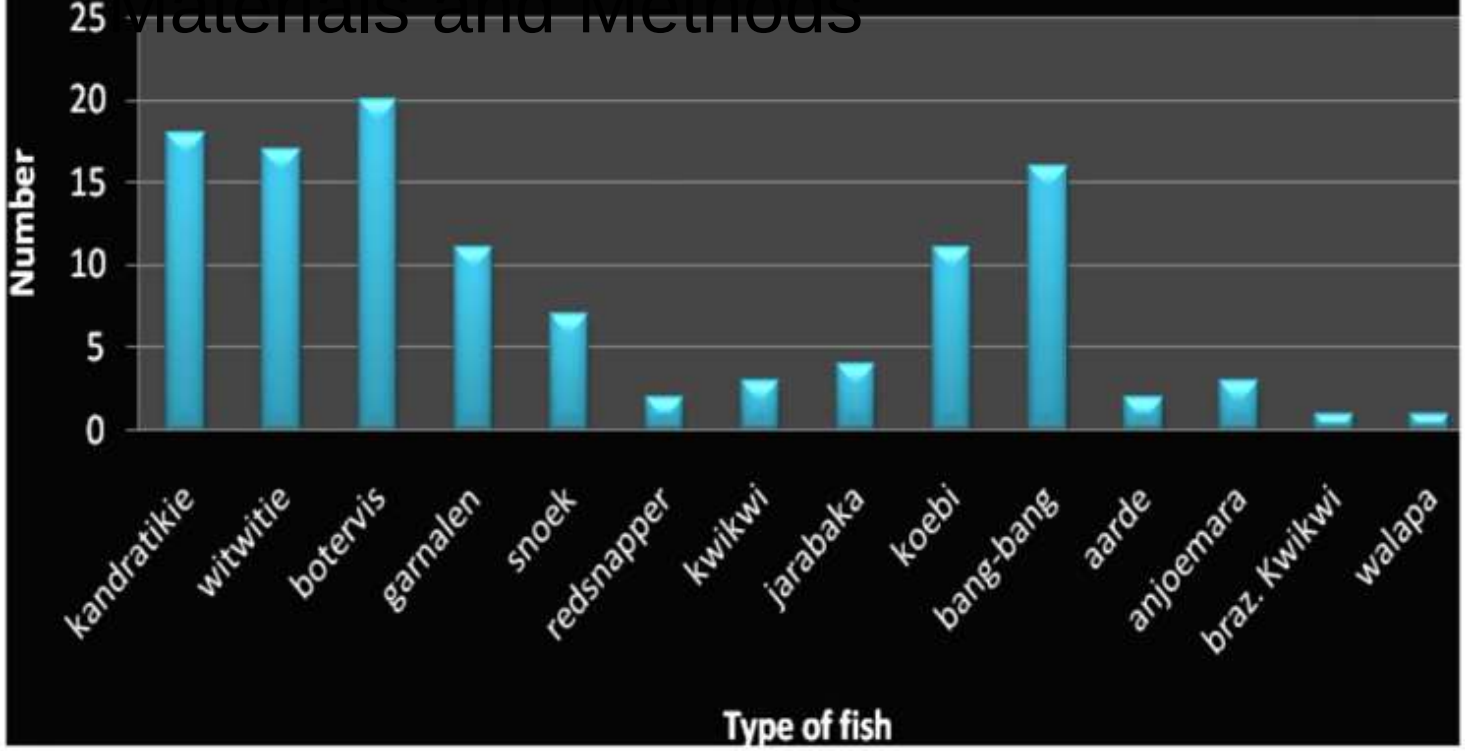
Objective and hypothesis

OBJECTIVE:

To assess the mercury exposure of Surinamers in urban coastal areas, mainly Paramaribo, through analysis of potentially contaminated drinking water sources and consumption fish

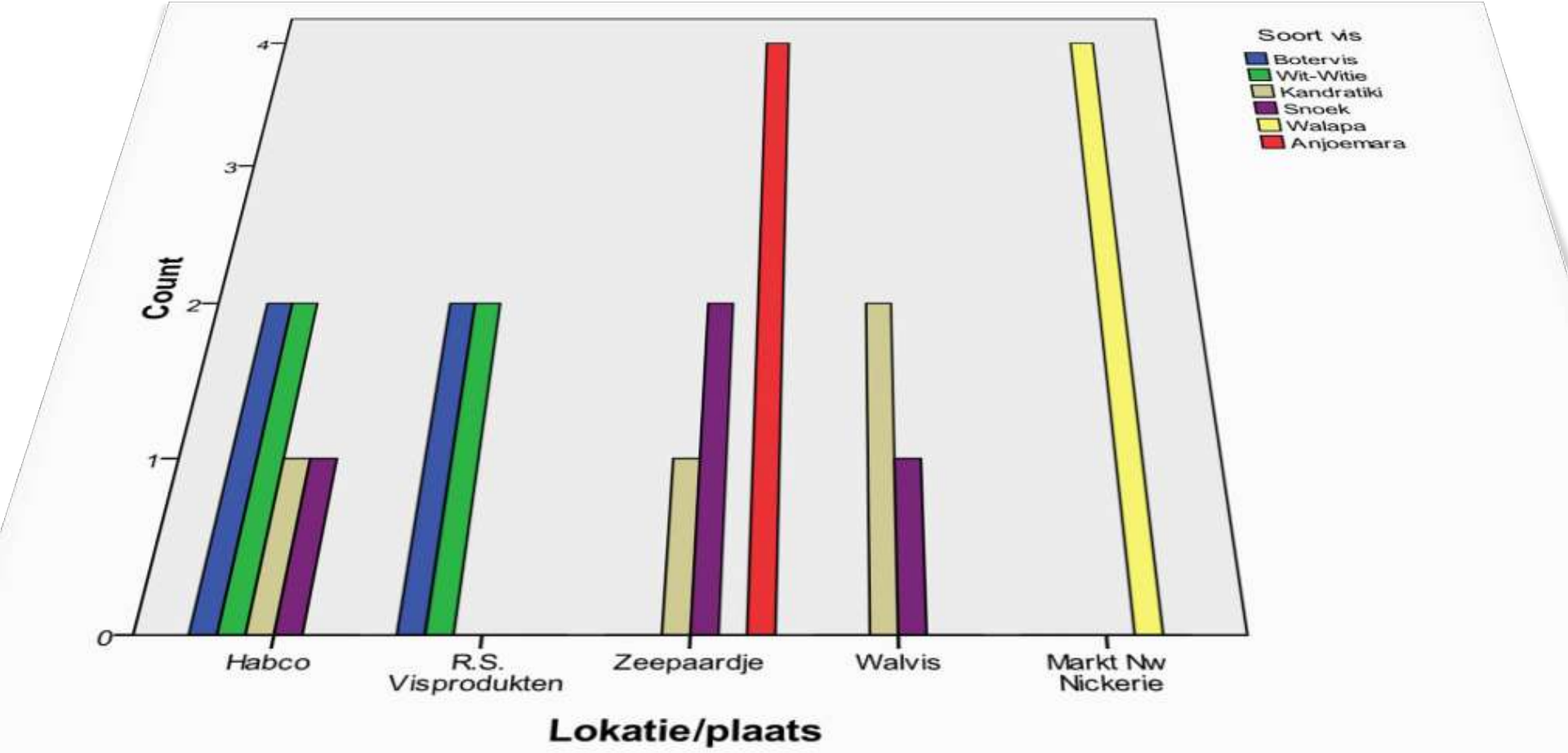
HYPOTHESIS:

Given the atmospheric distribution of mercury vapor which leads to wide spread deposition, drinking water sources and consumption fish may become contaminated, posing a health threat to the consumer in the coastal area, including Paramaribo



- **Random selection and evaluation of:**
  - **50 selling points**
  - **18 fish processing companies**

Materials and Methods

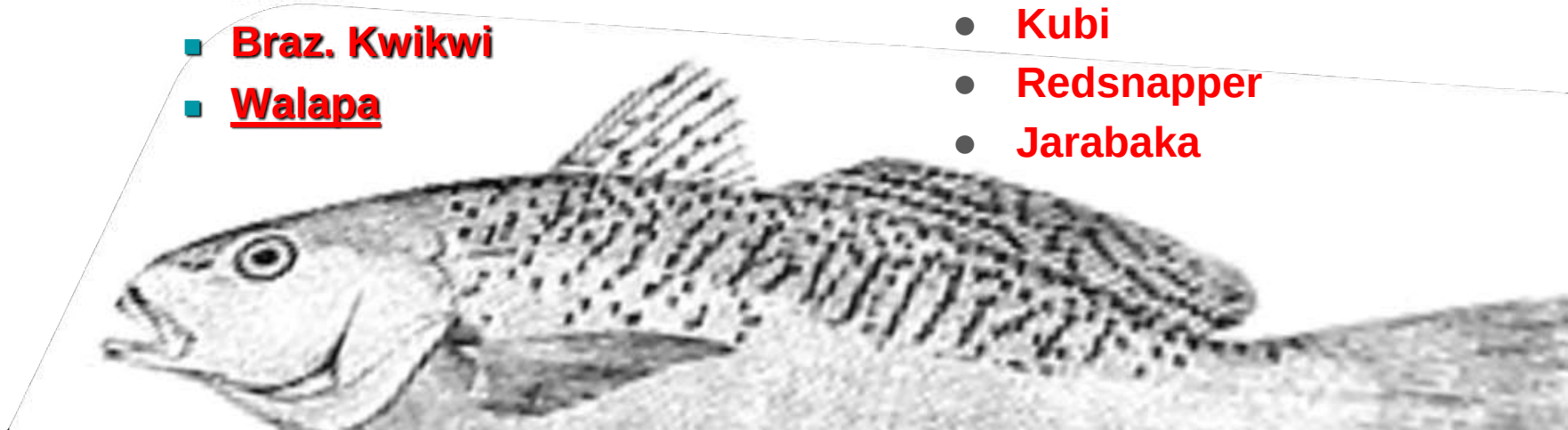


Materials and Methods

- **Most consumed 3 fresh water and 3 marine fish species**
- **Mercury analysis: N = 4 in duplicate**

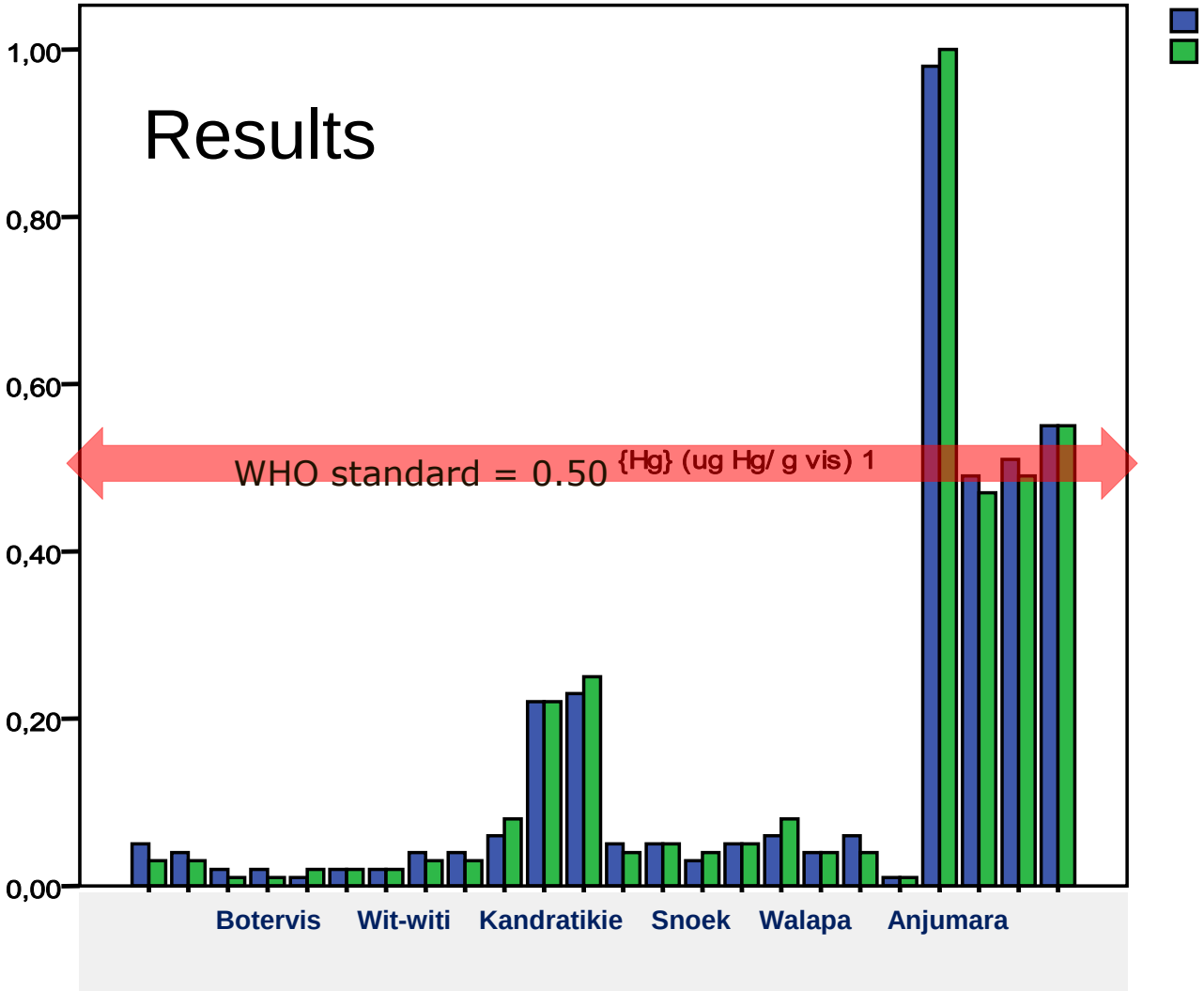
- **Snoek**
- **Anjumara**
- **Kwikwi**
- **Aarde**
- **Braz. Kwikwi**
- **Walapa**

- **Kandratikie**
- **Witwitie**
- **Botervis**
- **Ban-ban**
- **Kubi**
- **Redsnapper**
- **Jarabaka**




Analysis of
18 Fish Processing Sites
Paramaribo
Welgelegen
vispaleis zeepaardje
Henck Arron St
visbedrijf Walvis
Verlengde Gemenelandsweg
habco
Waterside
winkel Ou Chan (R.S visprodukt)
Jagernath Lachmon St
Van 't Hogerhuys St
Duisburglaan
Meerzorg
Jkl Hwy
Coesewijne St
Nieuw Weergevonden
Copernicus St

Results


1,00
0,80
0,60
0,40
0,20
0,00
WHO standard = 0.50
{Hg} (ug Hg/ g vis) 1
Botervis
Wit-witi
Kandratikie
Snoek
Walapa
Anjumara


Analysis of 8 Water Sources
Twee Kinderenweg (huis)
BC03 (swm)-voltastraat
Paramaribo
Welgelegen
Henck Arron St
Paramaribo
Leiding 9A NH
Leiding 11, Wanicaweg
Lw pp02-Adek
FR PP01 (station flora swm)
commisaris Weytingweg 332 (huis)
Soekaredjoweg, Paramaribo, Suriname
Pawon Singoredjostraat (huis)
Jules Wijdenboschbrug
Meerzorg
East-West Verbinding
Martin Luther Kingweg
Jk Hwy
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