

Environmental Impacts on Health & Disease

The role of the natural environment and microenvironment

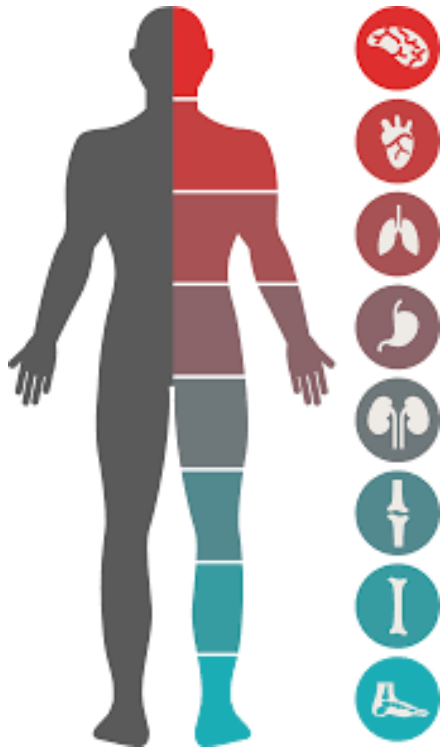


Dr Charles Teta

Lecture Outline

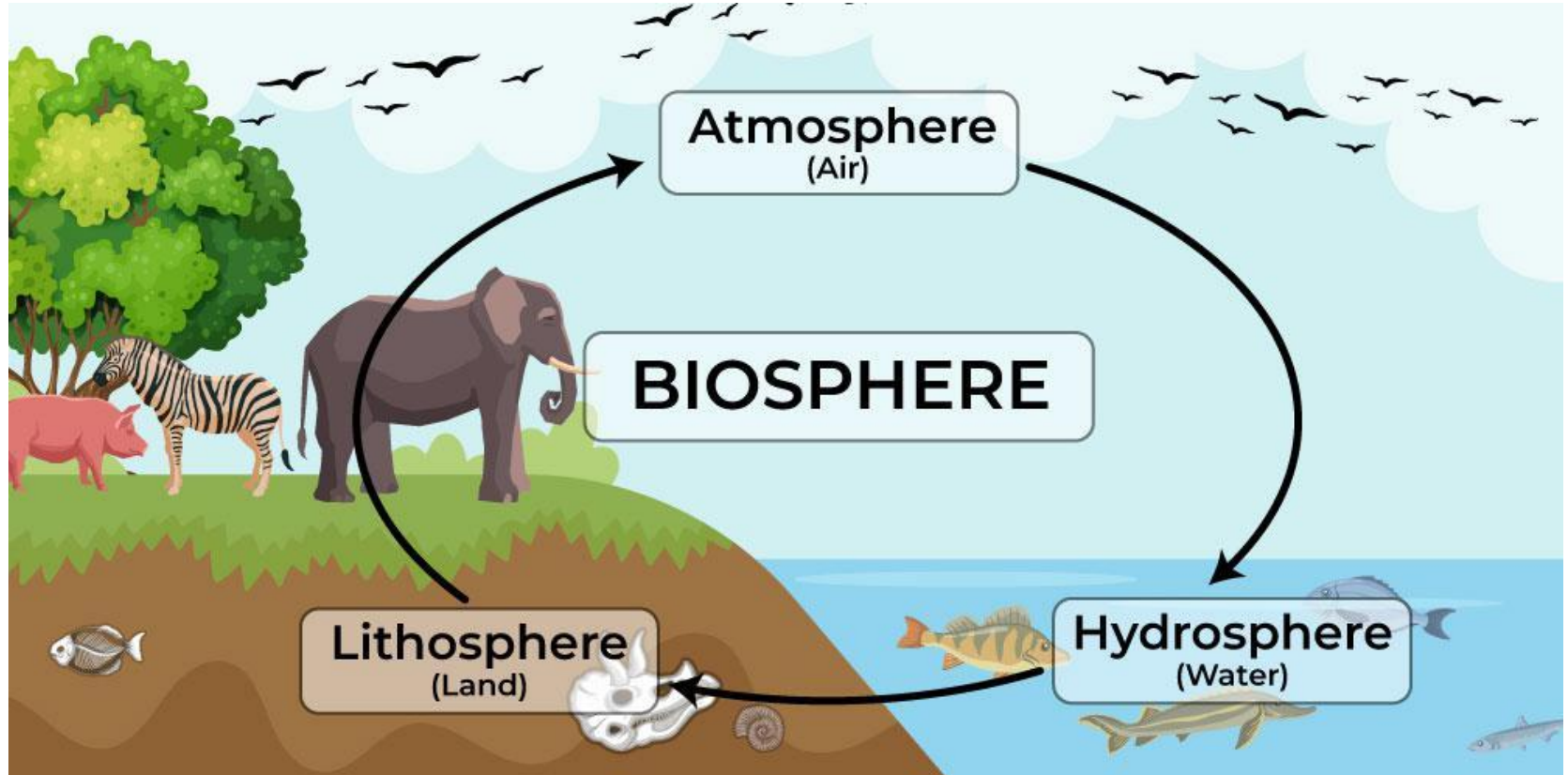
- Definitions
- The interconnectedness of environment and well-being.
- Nature and health
- Microorganisms and the environment
- Chemical Exposures and Environmental Toxins
- Bioaccumulation and biomagnification
- Contaminants of emerging concern
- ONE Health paradigm
- Conclusion

What is Health?



- “A state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.” (WHO, 1948)
- Encompasses various aspects of an individual's overall well-being,
 - Physical fitness,
 - Emotional and mental stability,
 - Social interactions,
 - Ability to adapt and cope with life’s challenges

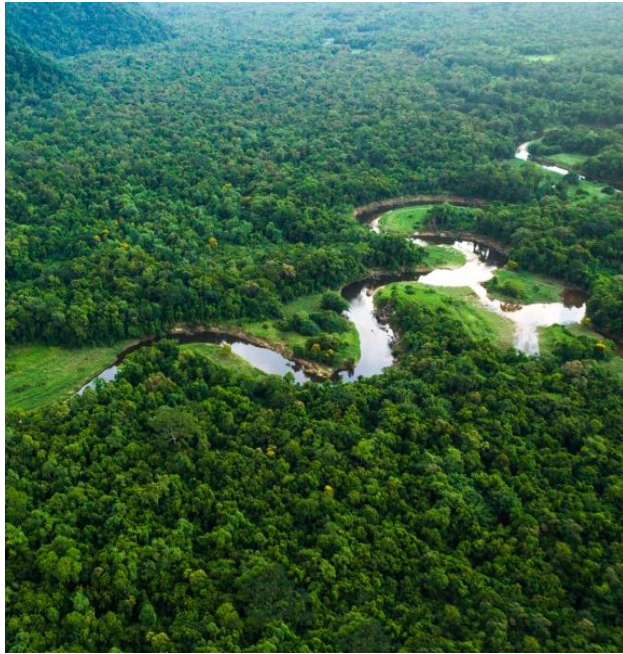
- The natural environment refers to the physical surroundings, including all living and non-living components
- It encompasses the Earth's ecosystems, landscapes, air, water, and biodiversity





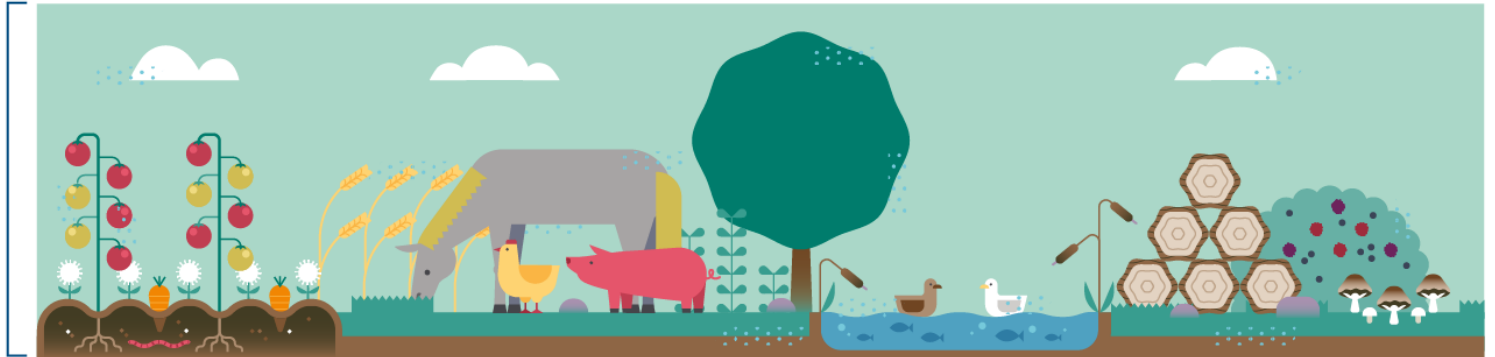
The natural environment plays a crucial role in sustaining life on Earth.

- It provides essential resources and ecosystem services that support the well-being of both humans and other living organisms.
- Offers recreational and aesthetic value, providing opportunities for outdoor activities, enjoyment of natural landscapes, and connection with nature.
- Serves as a habitat for countless plant and animal species, contributing to the planet's biodiversity and ecological balance.

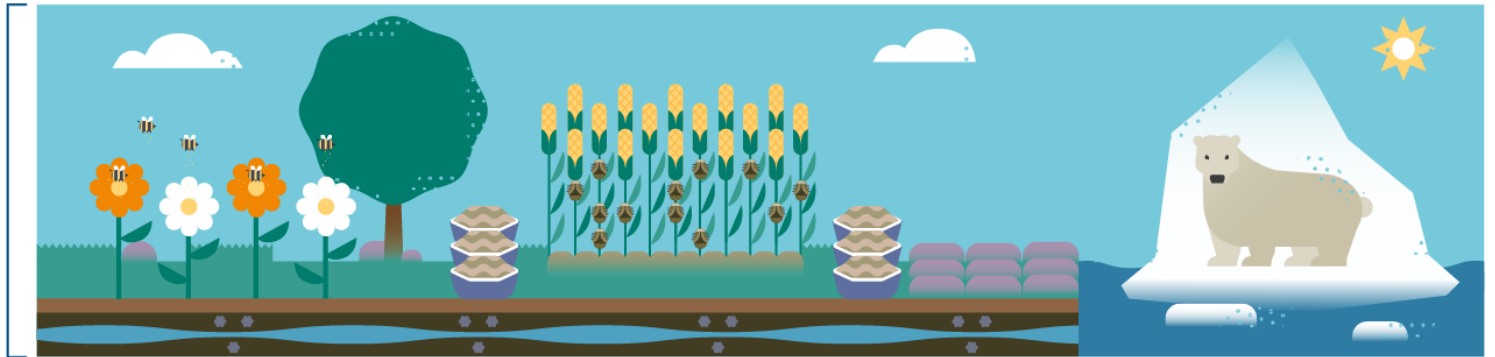


Ecosystem services

Provisioning services



Regulating services



Cultural services



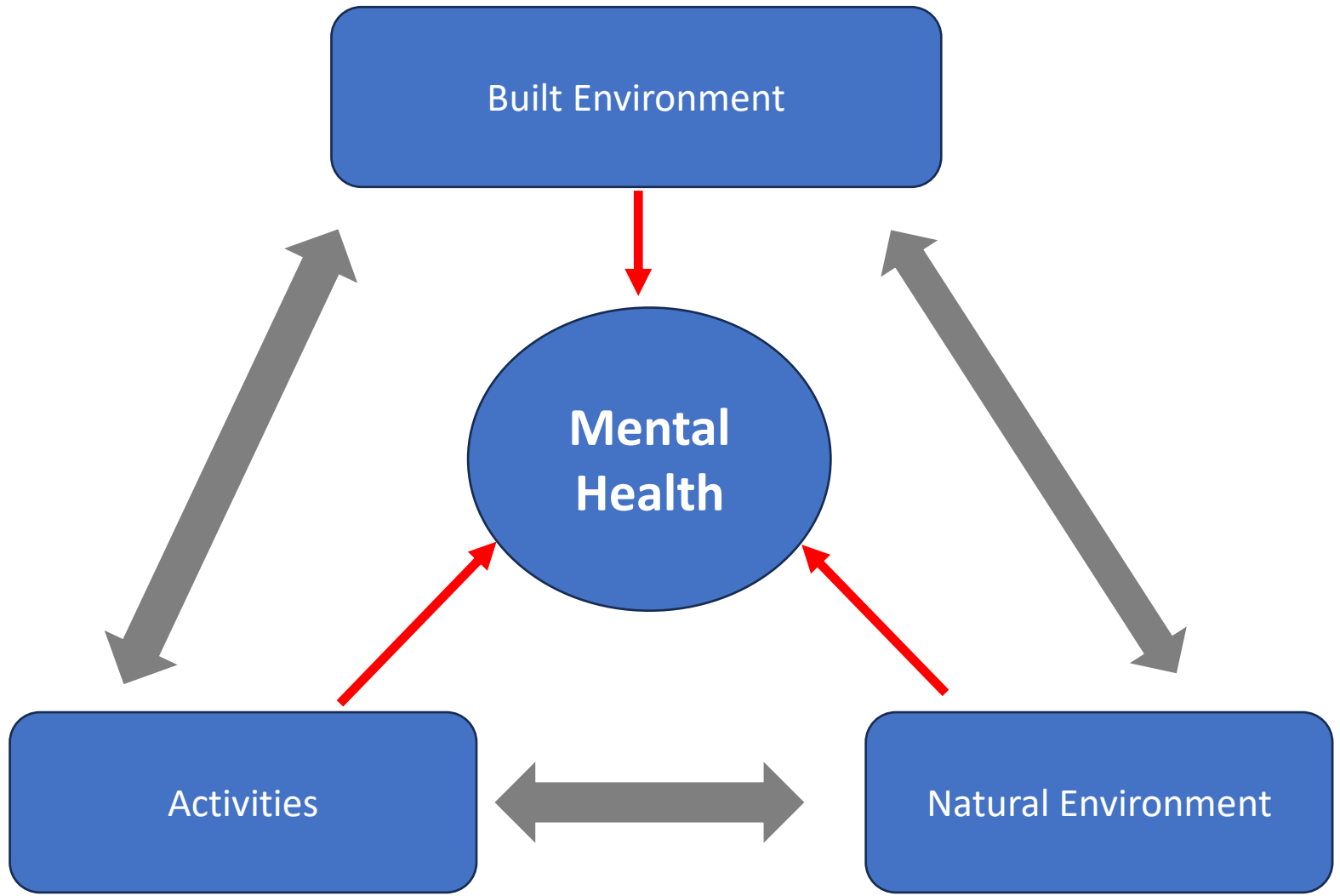


Nature and Health

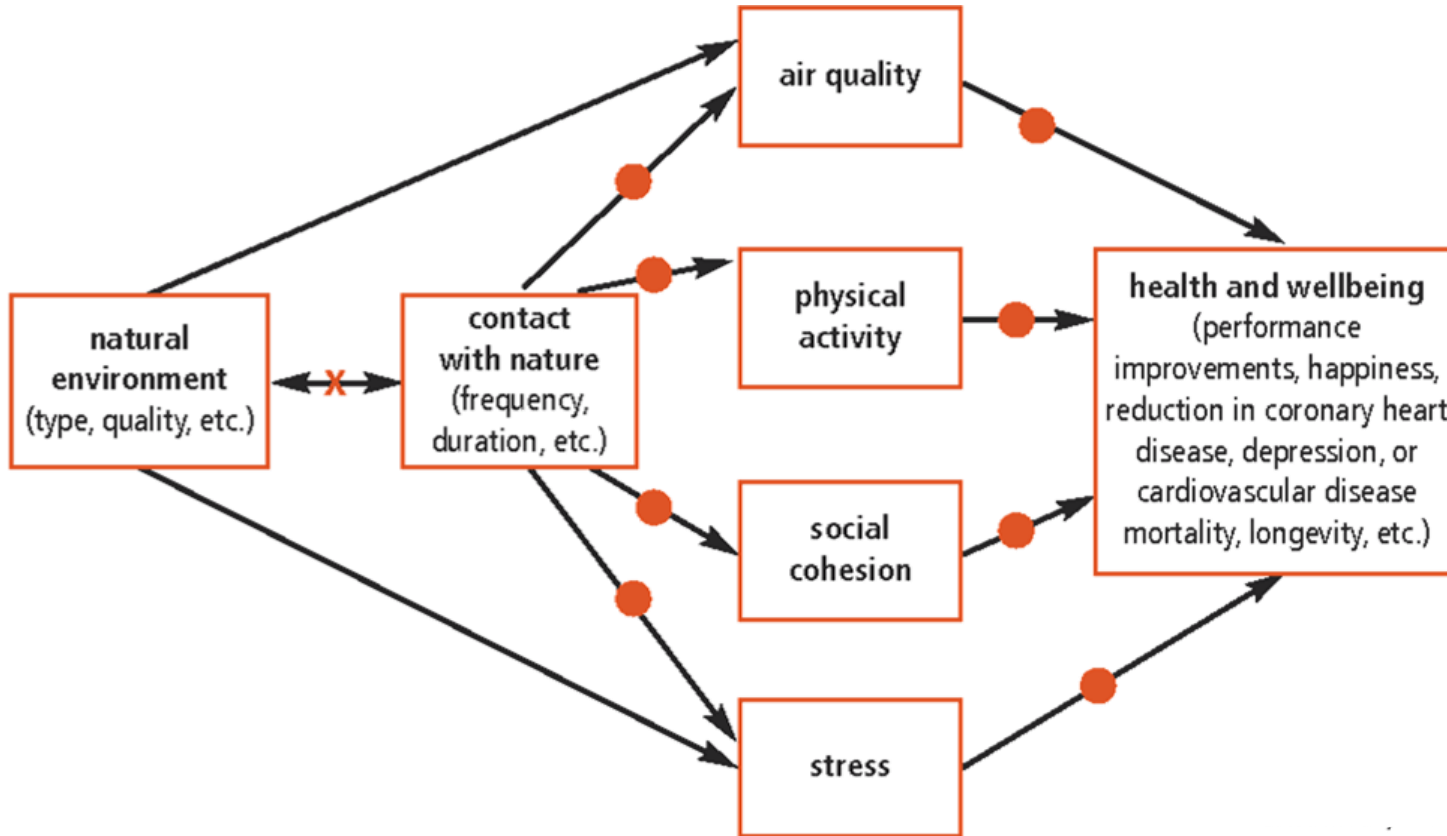
How does nature affect health?



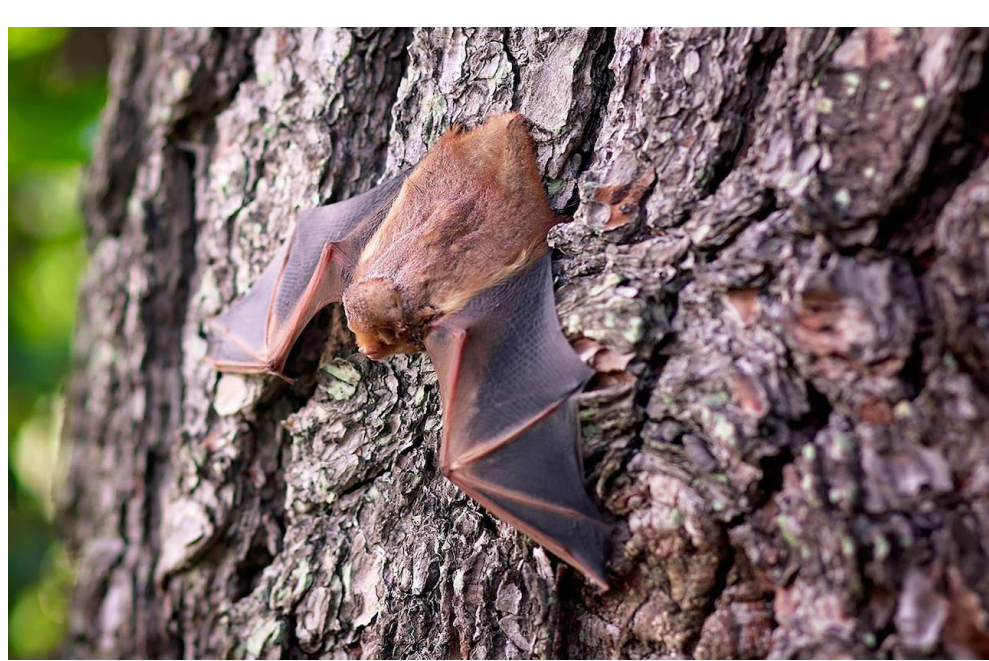
- Toxic chemicals, air pollution, and biological agents perceived as the central problem in environmental health.
- However, maintaining a healthy environment extends beyond controlling these hazards.
- How is biodiversity essential to human health.
 - Healthy diet
 - Compounds that are useful to the pharmacopoeia.
 - Vital for research and diagnostic tools,
 - Can be used as indicators of pollution-related disease.
- Research suggests that biodiversity may hold a key to the prevention and treatment of many diseases
- Enhancement of our physical, mental, and social well-being through our daily exposure to the natural environment.



Pathways through which green spaces affect health

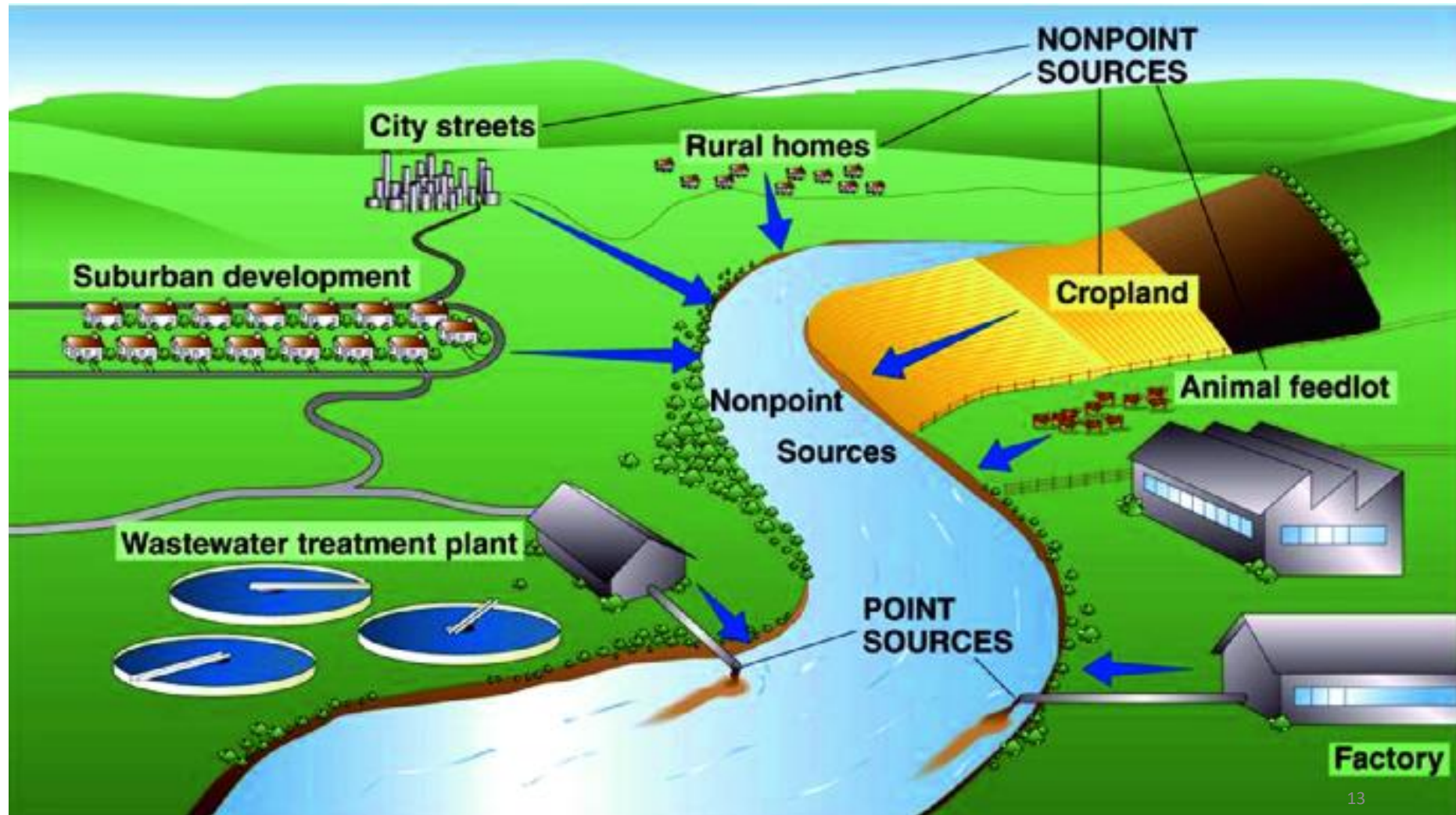


- Improved immunity – AMR
- Reduced uptake of antidepressants (and environmental benefits)

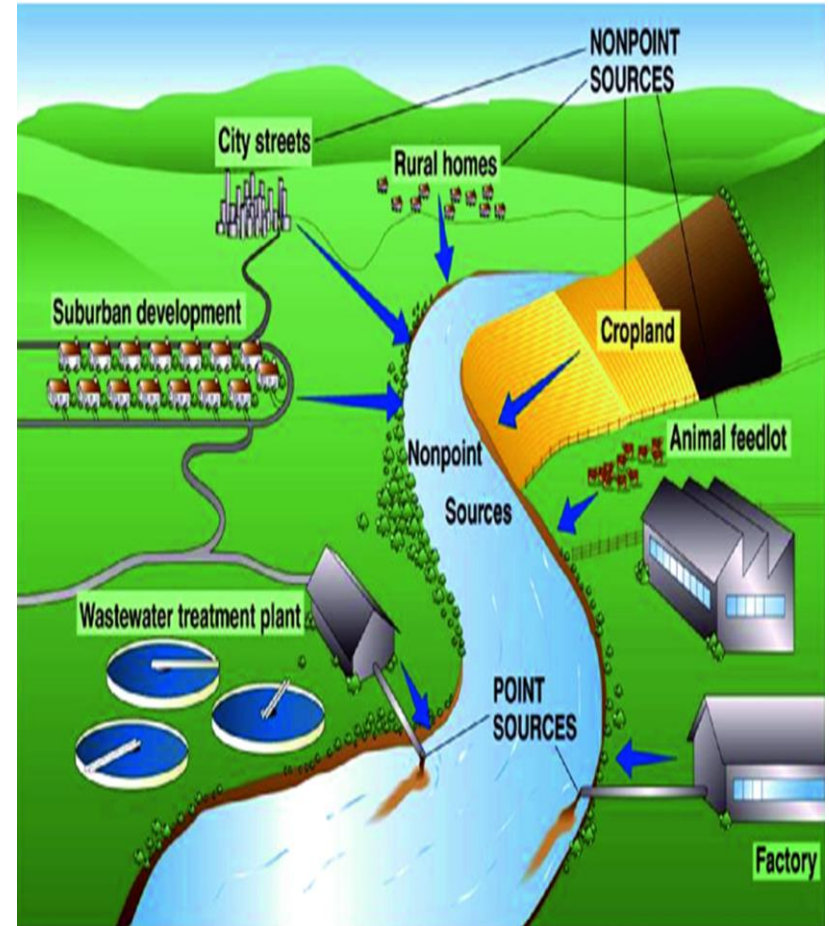
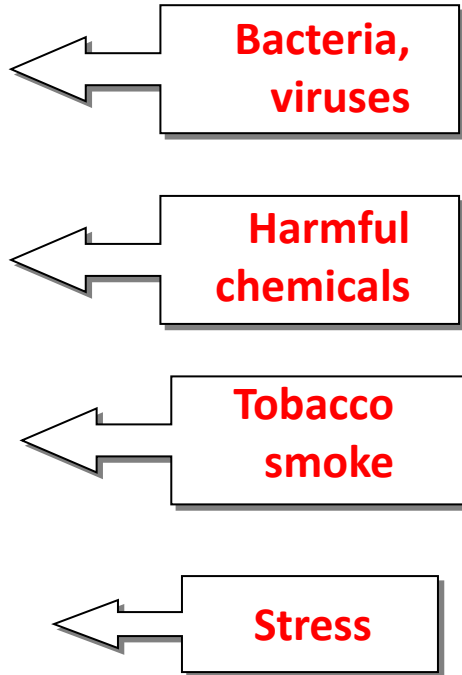
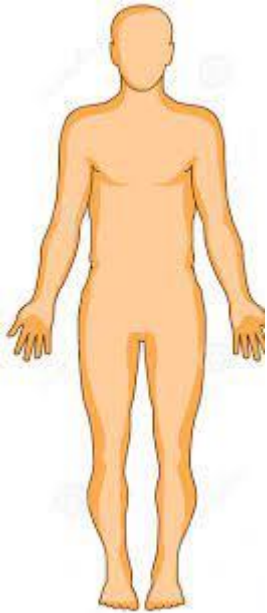


- Habitat loss and the risk of emerging zoonotic disease outbreak
- Zoonosis- disease transferred from animals to humans through direct contact or through food, water, and the environment
- Land-use change is an important pathway for pathogen transmission to humans
- Examples such of zoonotic disease are monkey pox virus, leishmaniasis and Lassa fever, COVID-19

Pollution and the natural environment



Hazards



A hazard is anything in the environment that can hurt you or make you sick.

Health effects of pollution

Air pollution



CO
Particulate matter
Ozone
SO₂
NO_x
Volatile organic compounds
Nerve damage
Lead

Headache
Fatigue

Respiratory illness

Cardio-vascular illness

Gastroenteritis

Cancer risk

Nausea

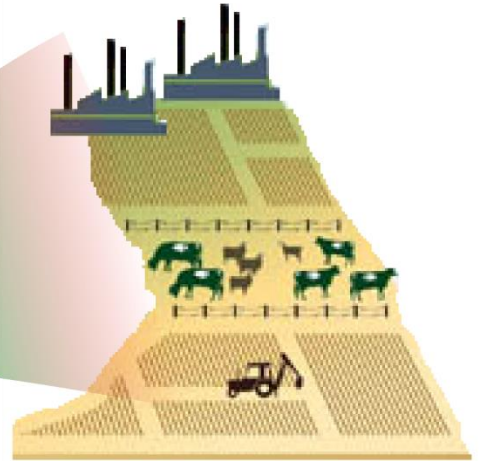
Skin irritation

Water pollution



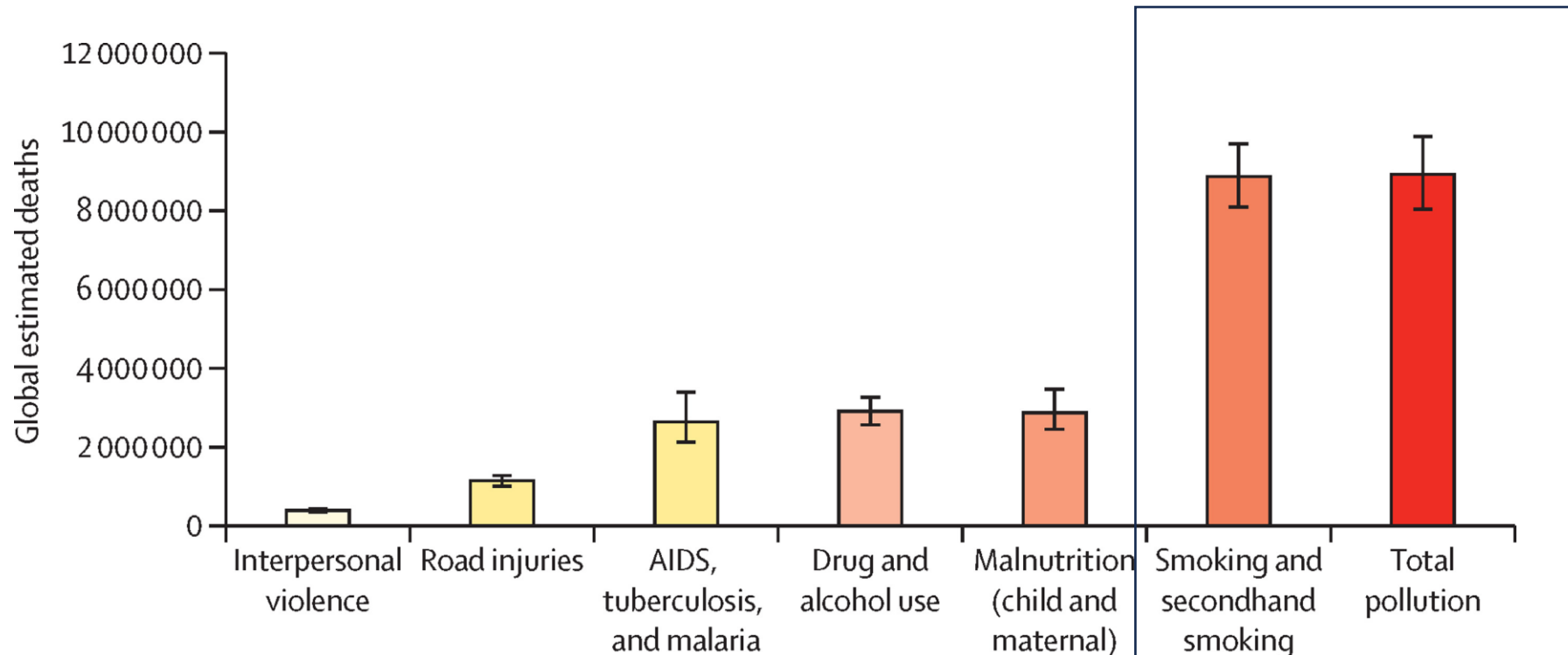
- Bacteria
- Parasites
- Chemicals

Soil contamination



Pesticides

Global estimated deaths by major risk factor or cause



(Data from Institute for Health Metrics and Evaluation and Global Burden of Diseases, Injuries, and Risk Factors)



Importance of preserving the natural environment

- Maintaining ecological integrity,
- Promoting sustainability, and
- Safeguarding the health and well-being

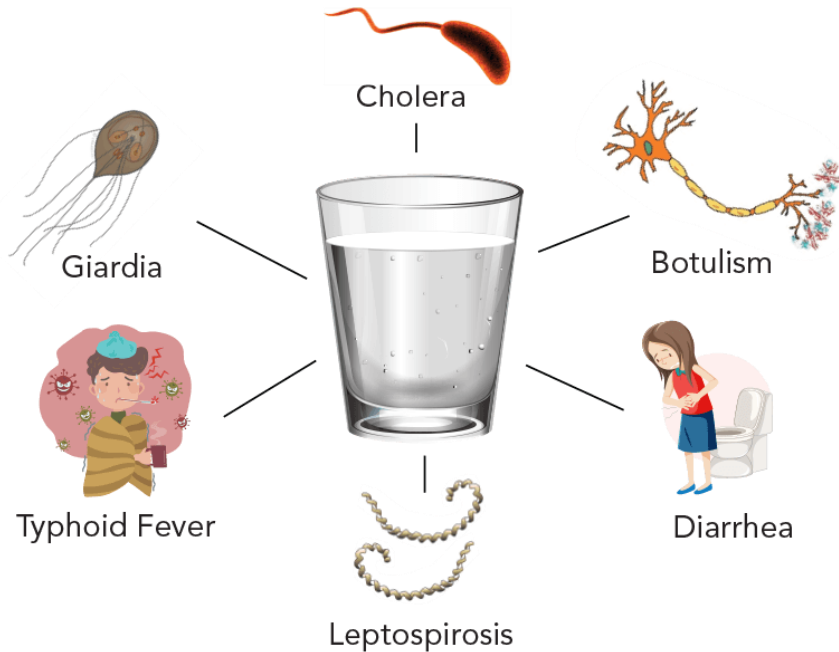


Harmful algal blooms (HAB)

- Simple photosynthetic organisms that live in the sea and freshwater
- Grow out of control while producing toxins or harmful effects on people, fish, shellfish, marine mammals, and birds
- Nutrient pollution from farming, urbanisation,
- E.g., red tide



Water and Sanitation related diseases



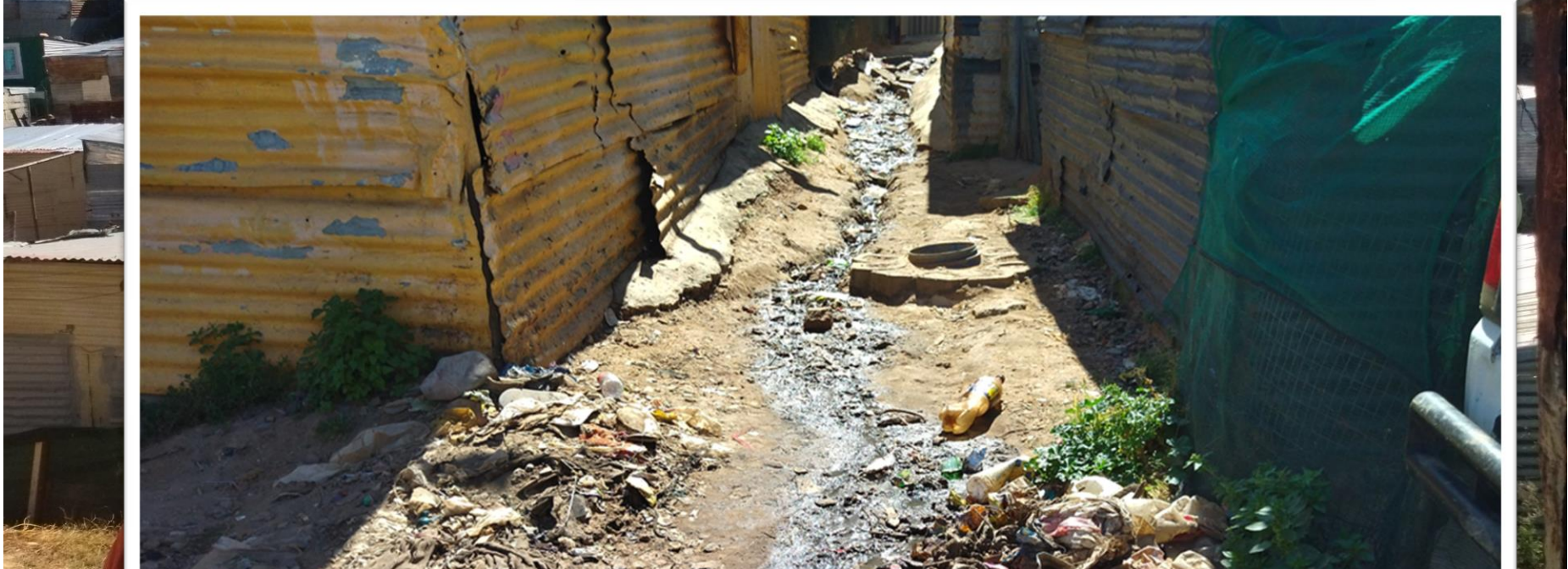
- Lack of clean water supply and sanitation

-*Escherichia coli*

-*Vibrio cholerae* (cholera)

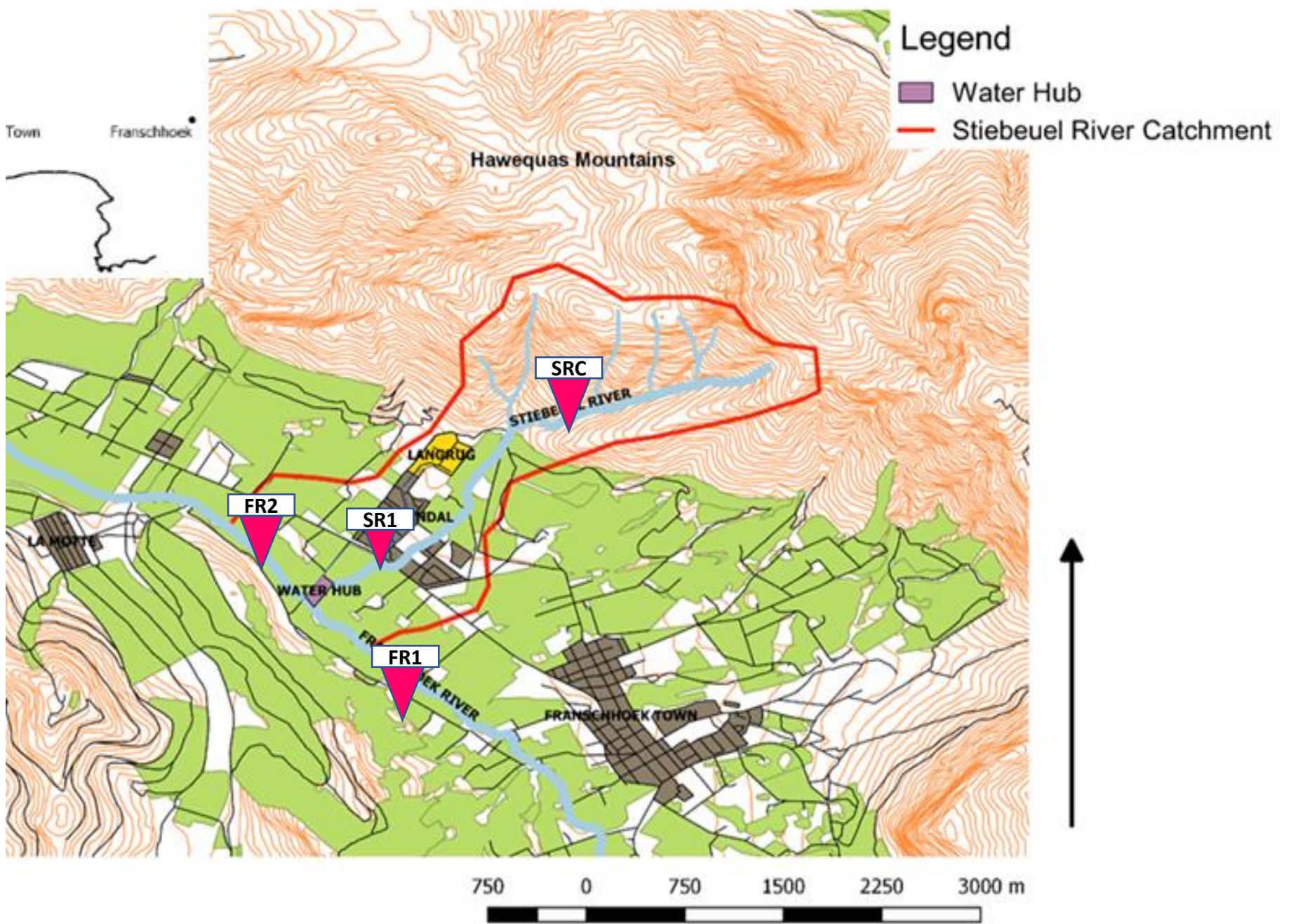
-*Shigella dysenteriae* (dysentery)

-*Salmonella typhi* (Typhoid)









E-Coli : SRC: 17 SR1: >200000 FR1: 237 FR2: >200000

WASH: burden of disease

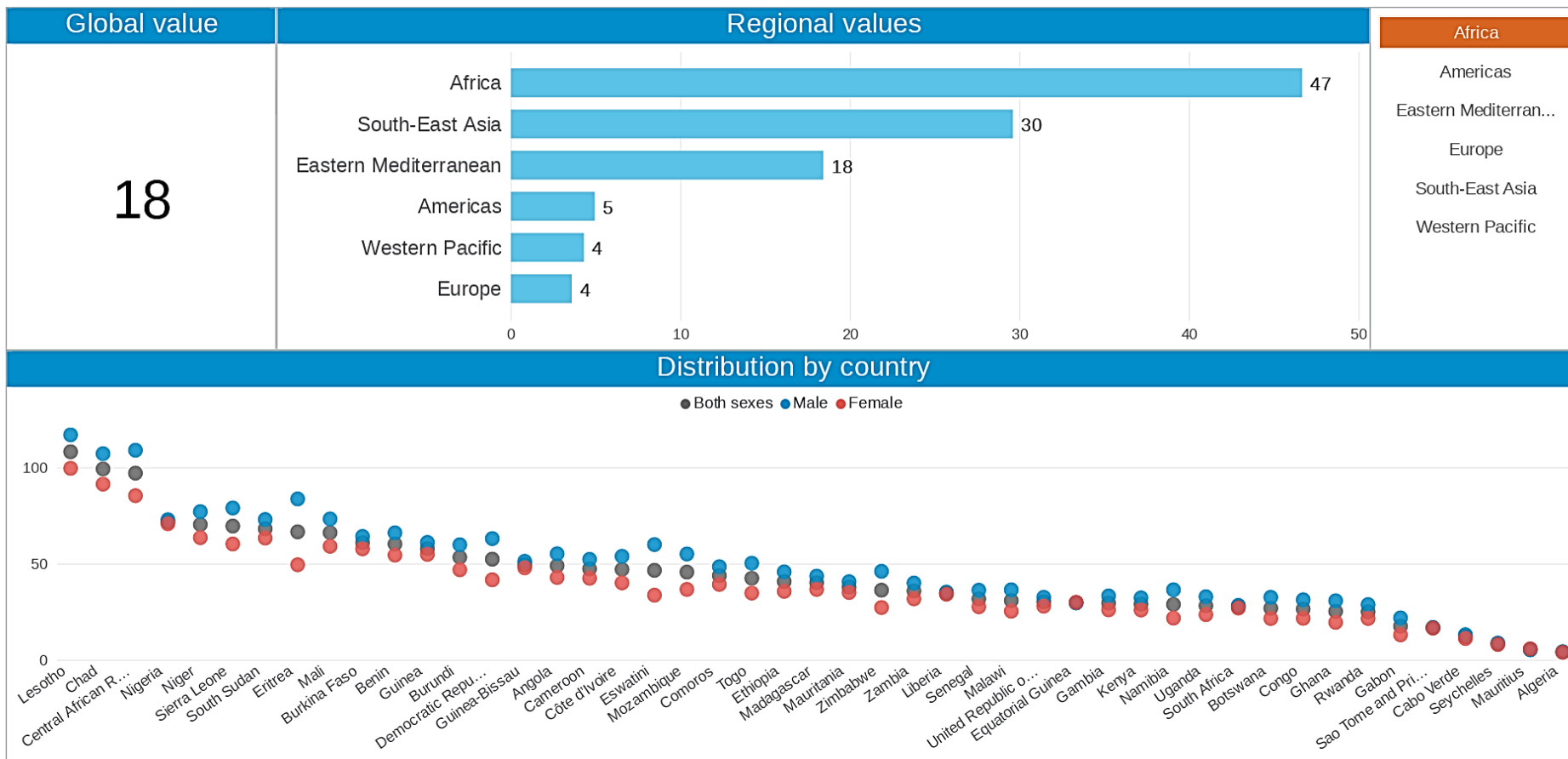
1.4 million deaths and , morbidity, 74 million in 2019 (WHO)

FILTERS

Mortality rate attributed to exposure to unsafe WASH services (per 100 000 population) (SDG 3.9.2)

Year
Latest

Disaggregation
Sex



Socio-economic factors of pollution

LMIC associated with failing wastewater and waste management

- Industrialization
- Raw effluent discharges
- Costs of pollution control/prevention
- Costs of water quality monitoring



Persistent chemical pollutants

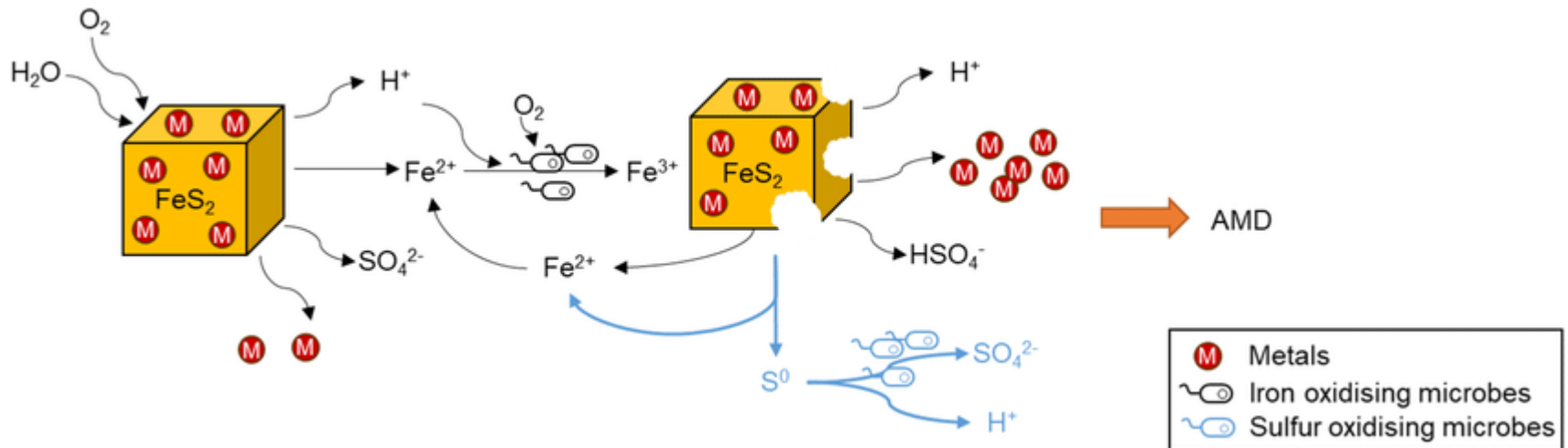


- Compounds that have toxic properties, persist in the environment, accumulate in food chains
- Pose a risk to human health and the environment
- Persistent organic pollutants (POPs)
 - Pesticides (DDT, Lindane, endosulfan)
 - Polychlorinated biphenyls (PCBs)
 - Hexachlorobenzene (HCB)
 - Polychlorinated naphthalenes
- Heavy metals (methyl mercury, lead, cadmium, chromium, arsenic etc)

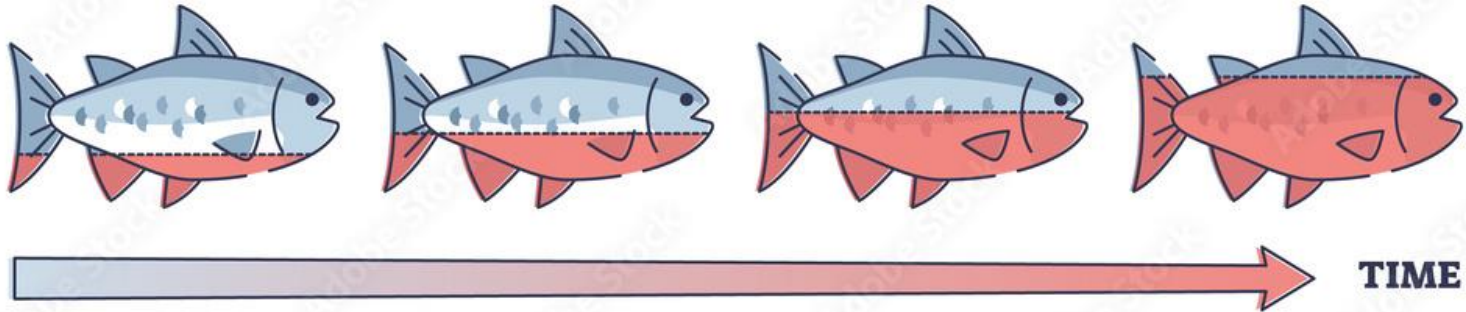
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Acid mine drainage and metals

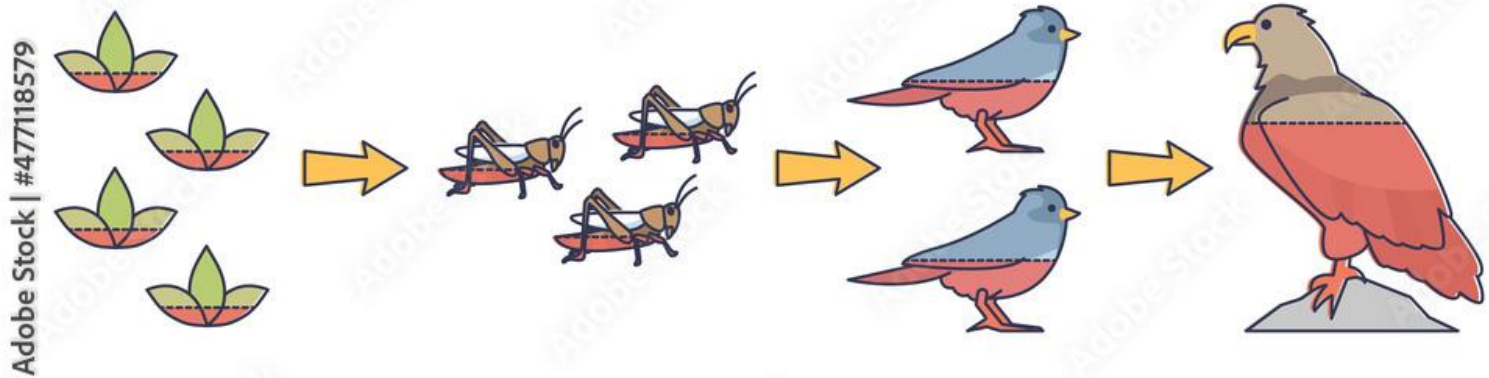


BIOACCUMULATION



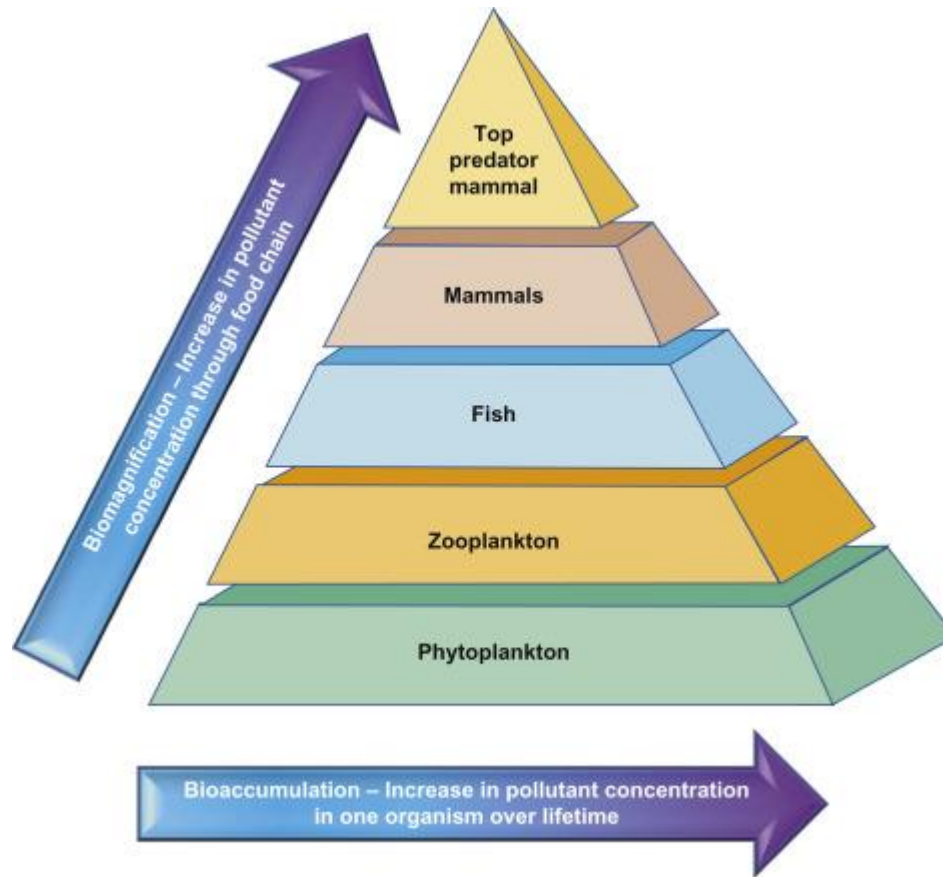
● CONTAMINANT

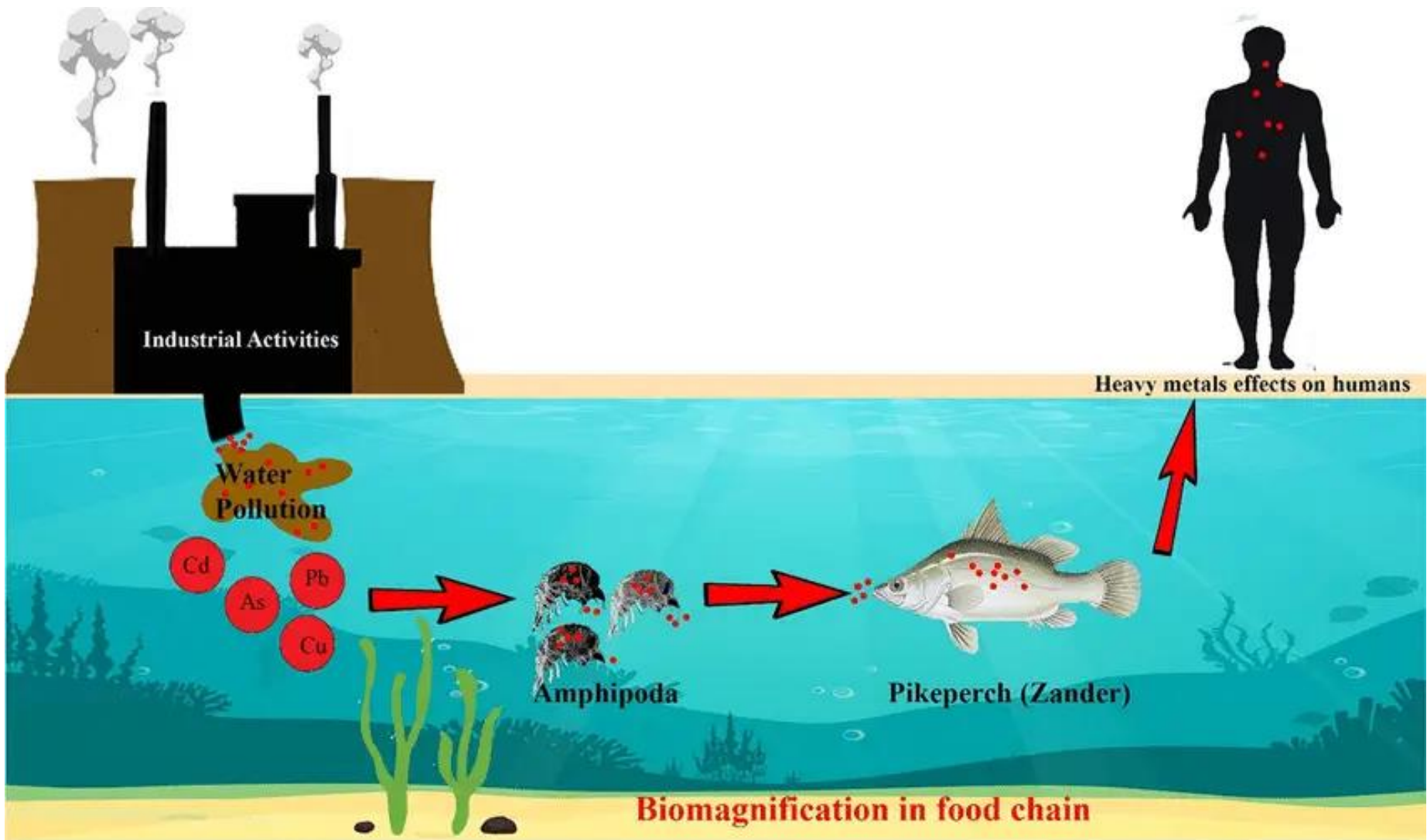
BIOMAGNIFICATION



Adobe Stock | #477118579

Persistent chemical pollutants







- Fish sampling for heavy metal risk assessment

Contaminants of emerging concern

- No laws exist yet
- Not normally monitored
- Little data exists
- Endocrine disrupting chemicals, pharmaceutical drugs, Antimicrobial resistance (AMR)

Endocrine disrupting chemicals

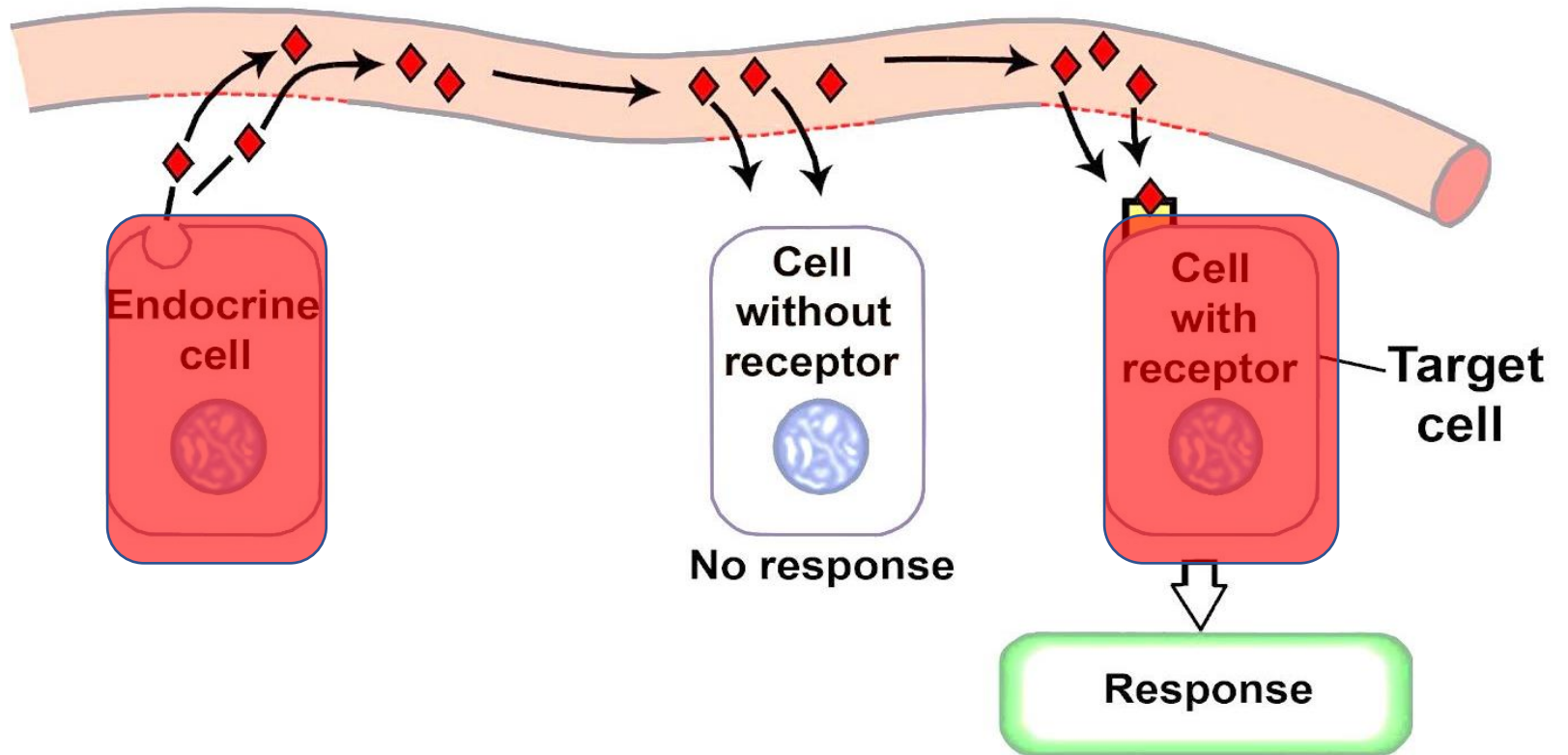
“an exogenous substance or mixture that alters function(s) of the endocrine system and consequently causes adverse health effects in an intact organism, or its progeny, or (sub)populations.”

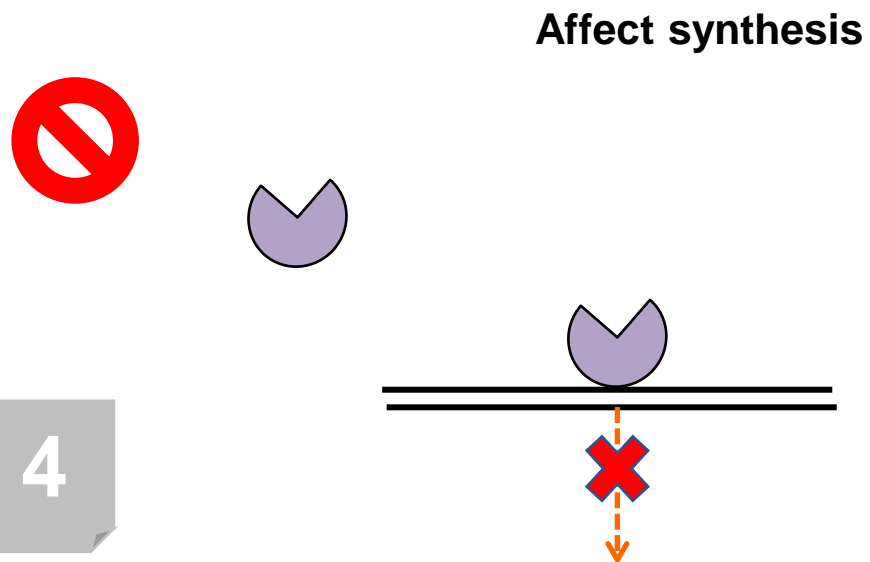
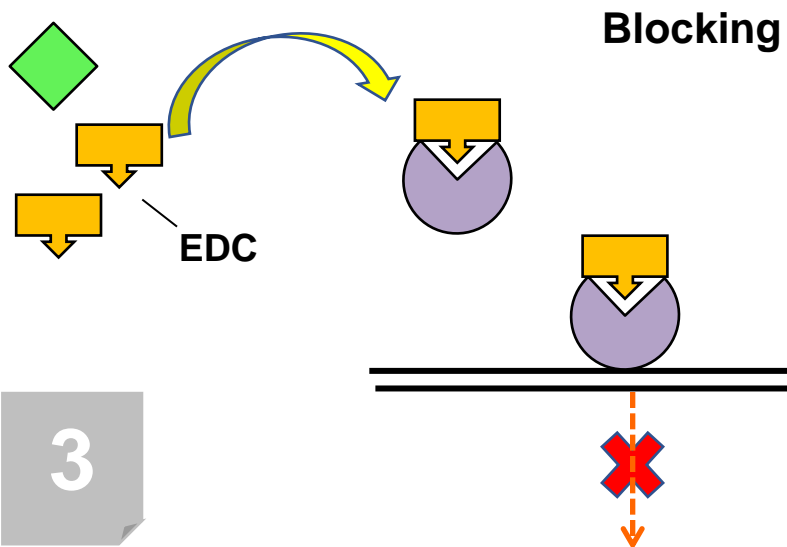
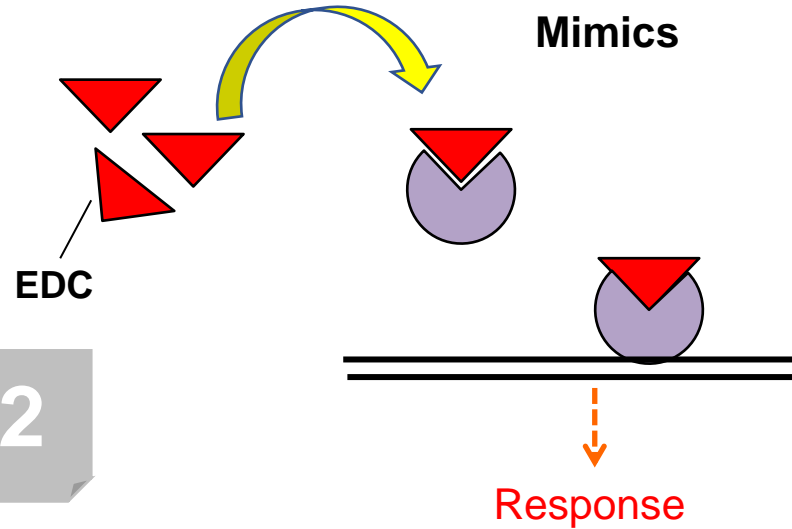
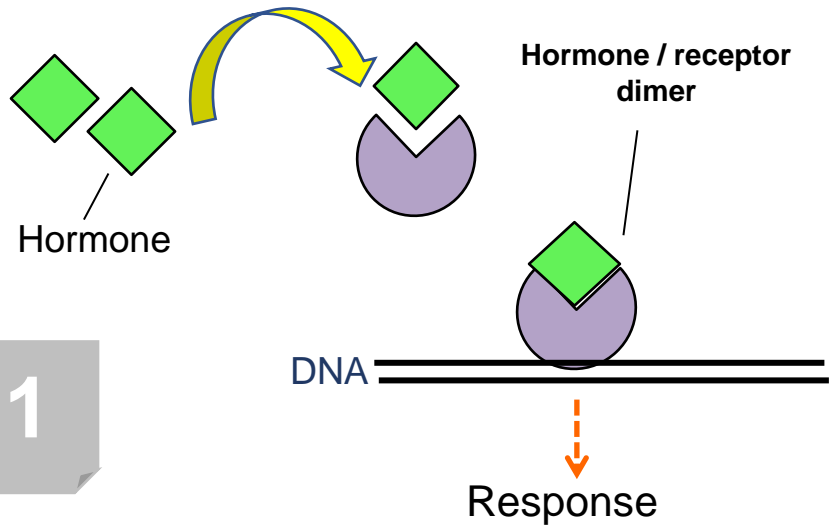
(International Programme on Chemical Safety, 2002)

Some landmark 'discoveries'

- **Howell *et al* 1980**: Female fish downstream of a paper-mill showed male sexual characteristics
- **1984-1987**: In Florida USA - Lake had 90% less crocodiles; low testosterone, in male crocs; Later found was polluted.
- **Purdon *et al*, 1994**: – In UK, treated sewage was shown to be estrogenic – now proven worldwide
- **Jobling *et al*, 2006**: - in UK rivers - Prevalence & severity of intersex in wild fish correlated with oestrogen levels

The Endocrine System

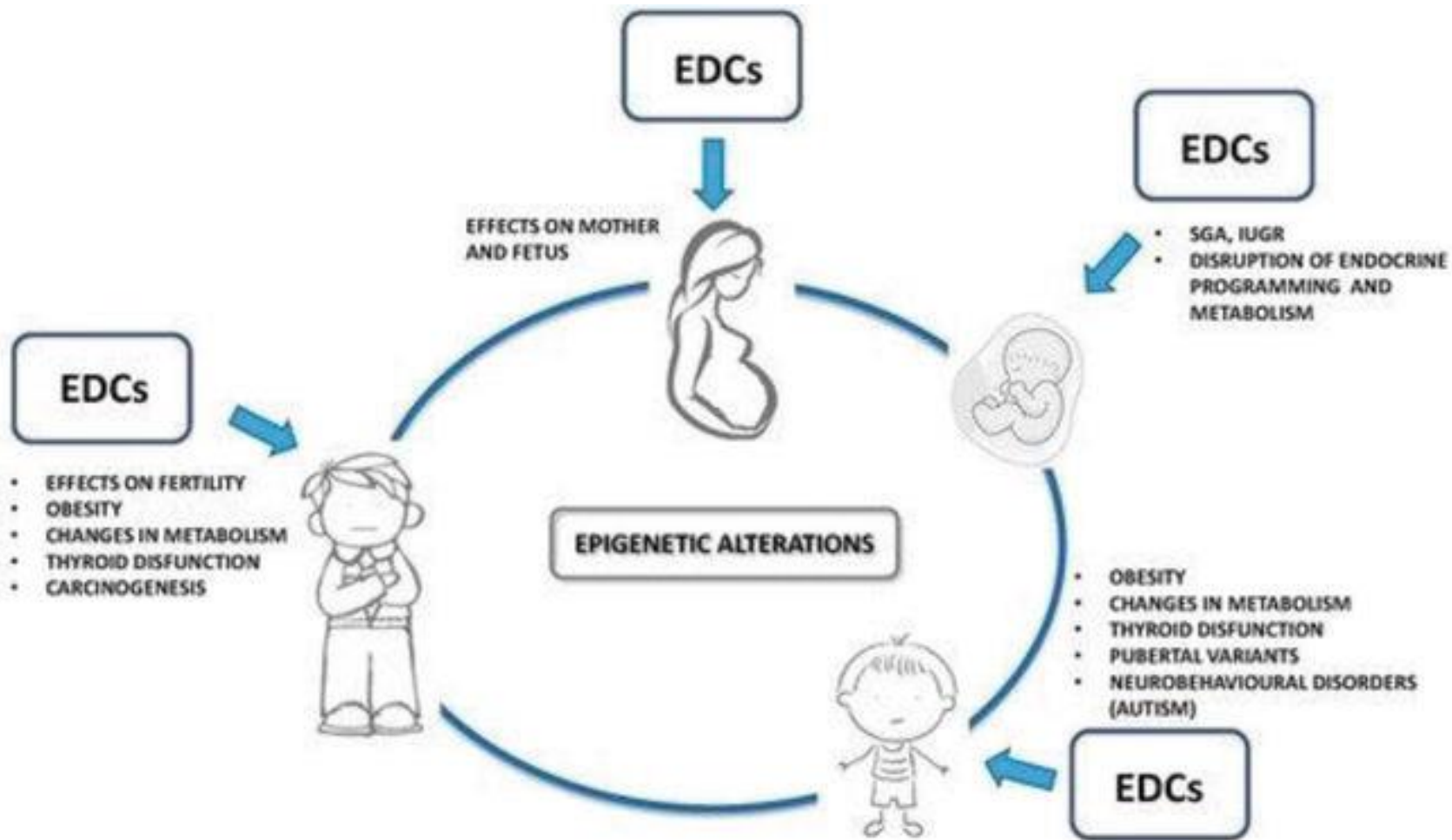




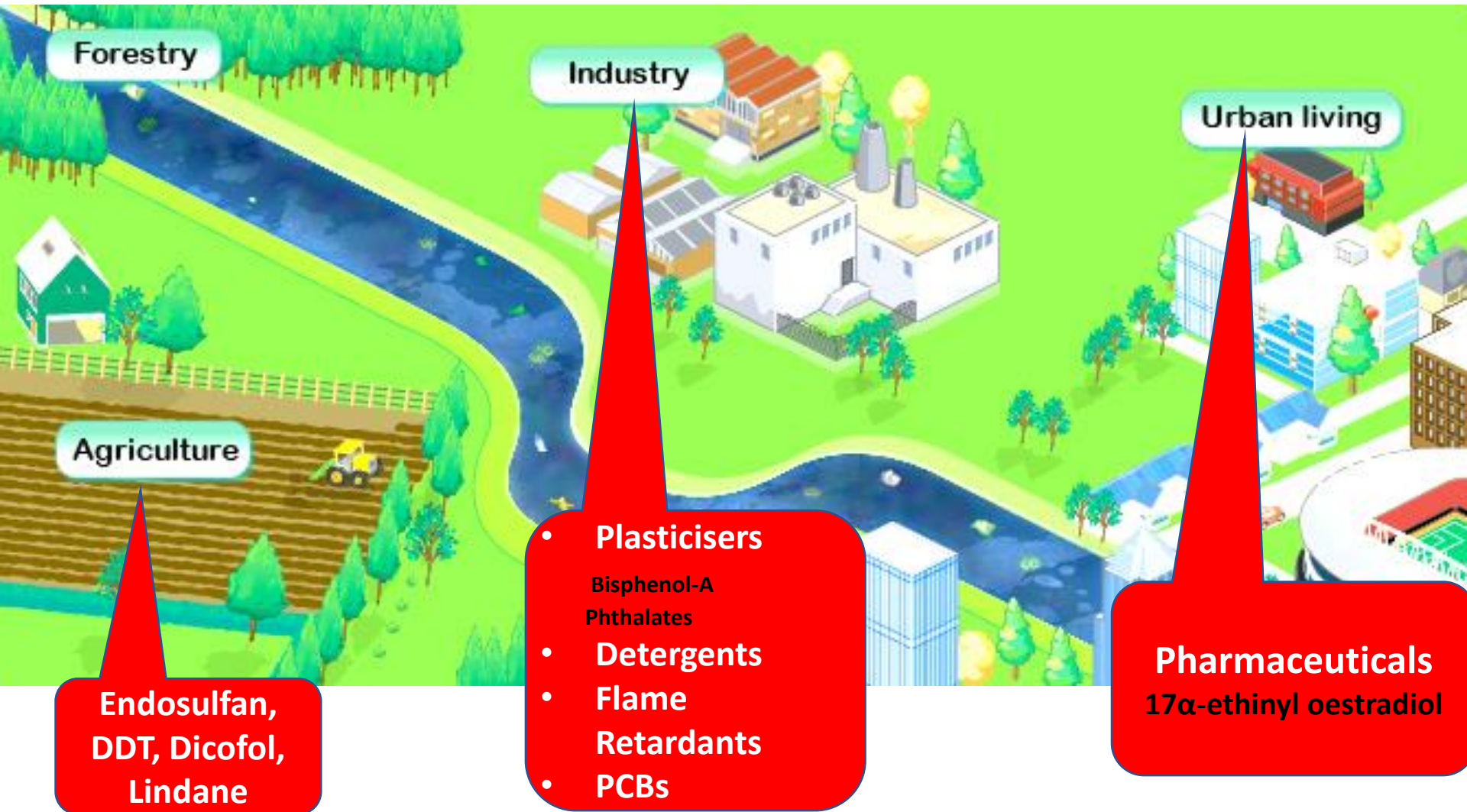
- Foetus and infants most vulnerable
- The prevalence of obesity, diabetes, thyroid disease and neurobehavioral, reproductive disorders, cancers, among others, has increased with the increased manufacture of organic chemicals.

Preda C, Ungureanu MC, Vulpoi C. Endocrine disruptors in the environment and their impact on human health. *Environmental Engineering and Management Journal*. 2012;11:1697-1706

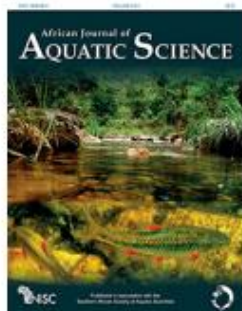
Encarnação T, Pais AACC, Campos MG, Burrows HD. Endocrine disrupting chemicals: Impact on human health, wildlife and the environment. *Science Progress*. 2019;102:3-42. DOI: 10.1177/0036850419826802



What are the sources of EDCs?



- Many more, >150 known EDCs
- **Most present in most conventionally treated effluent!**



Occurrence of oestrogenic pollutants and widespread feminisation of male tilapia in peri-urban dams in Bulawayo, Zimbabwe

C Teta, BF Holbech, L Norrgren & YS Naik

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To link to this article: <https://doi.org/10.2989/16085914.2017.1423269>



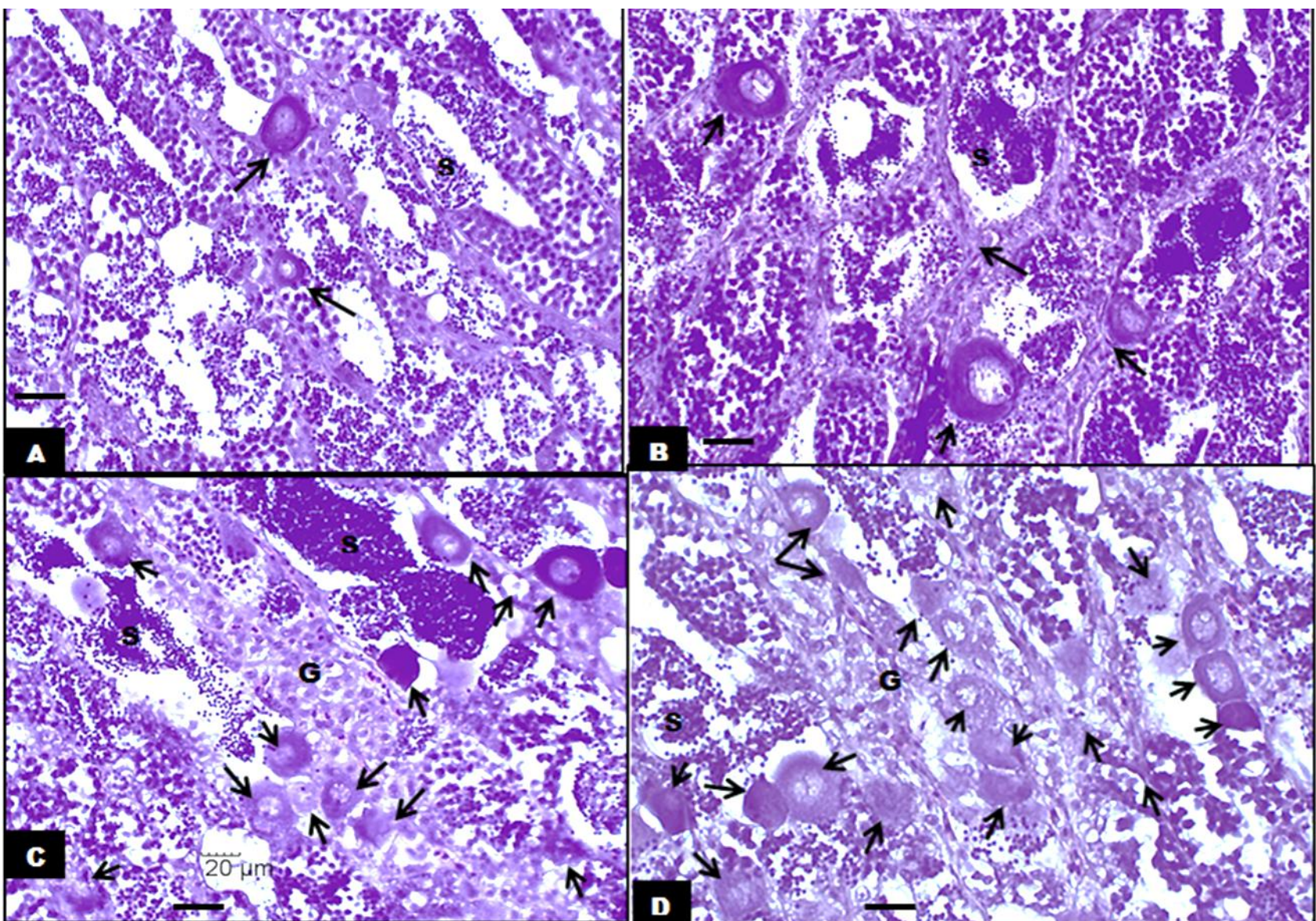
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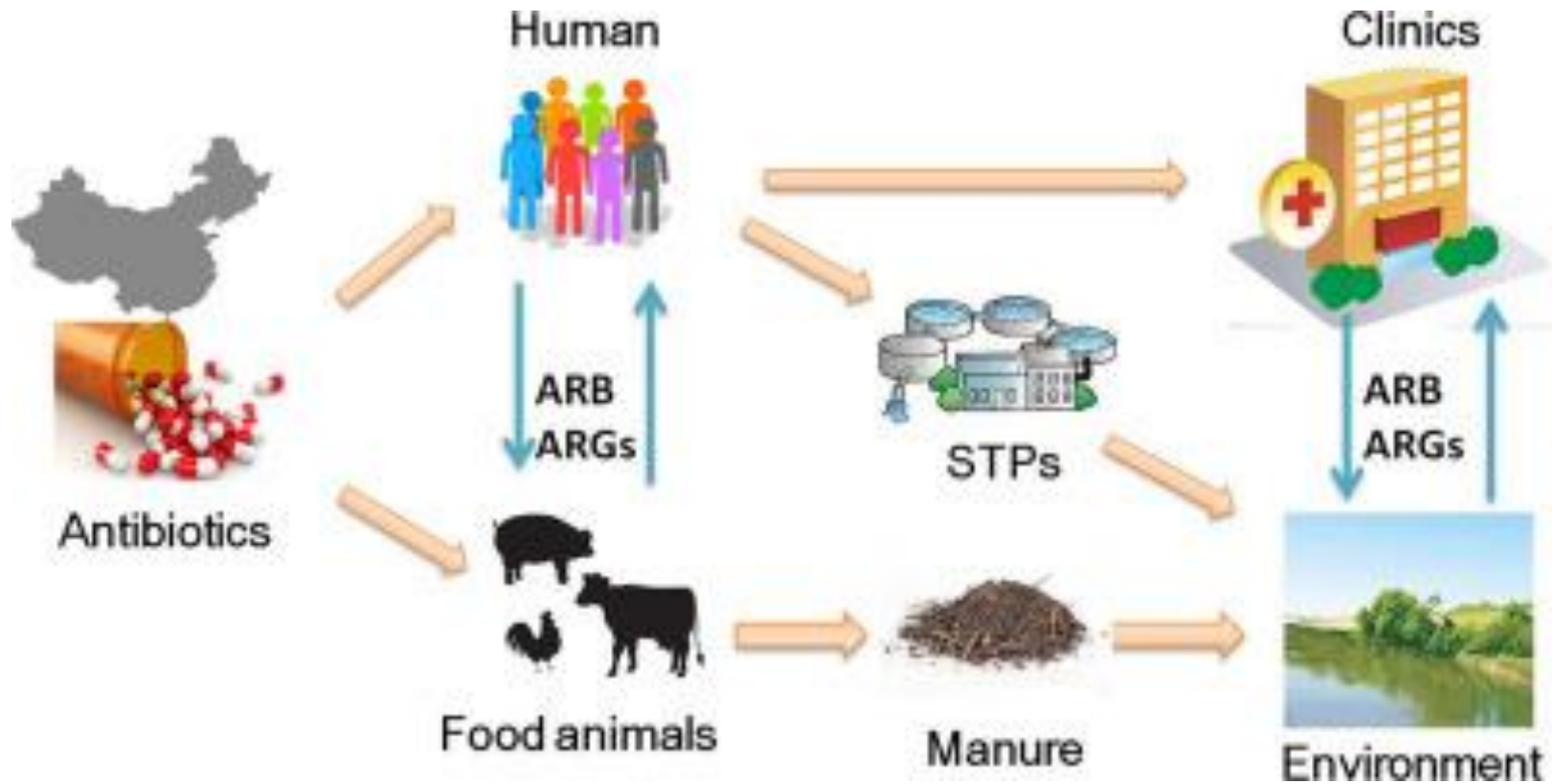
Tilapia testes (H&E x 400). (A & B) Mildly feminised fish showing small numbers of isolated developing oocytes (arrowed) among testicular tissue which has mainly mature spermatozoa [S]. (C & D) Severely feminised intersex fish from polluted Umguza Dam;⁴²

Pharmaceuticals in the environment

Environmental effects

- Antimicrobial resistance (AMR) in the environment
- Endocrine disruption due to birth control pills
- Effects of Benzodiazepine anxiolytic drug Oxazepam on European perch

Antimicrobial Resistance and environment

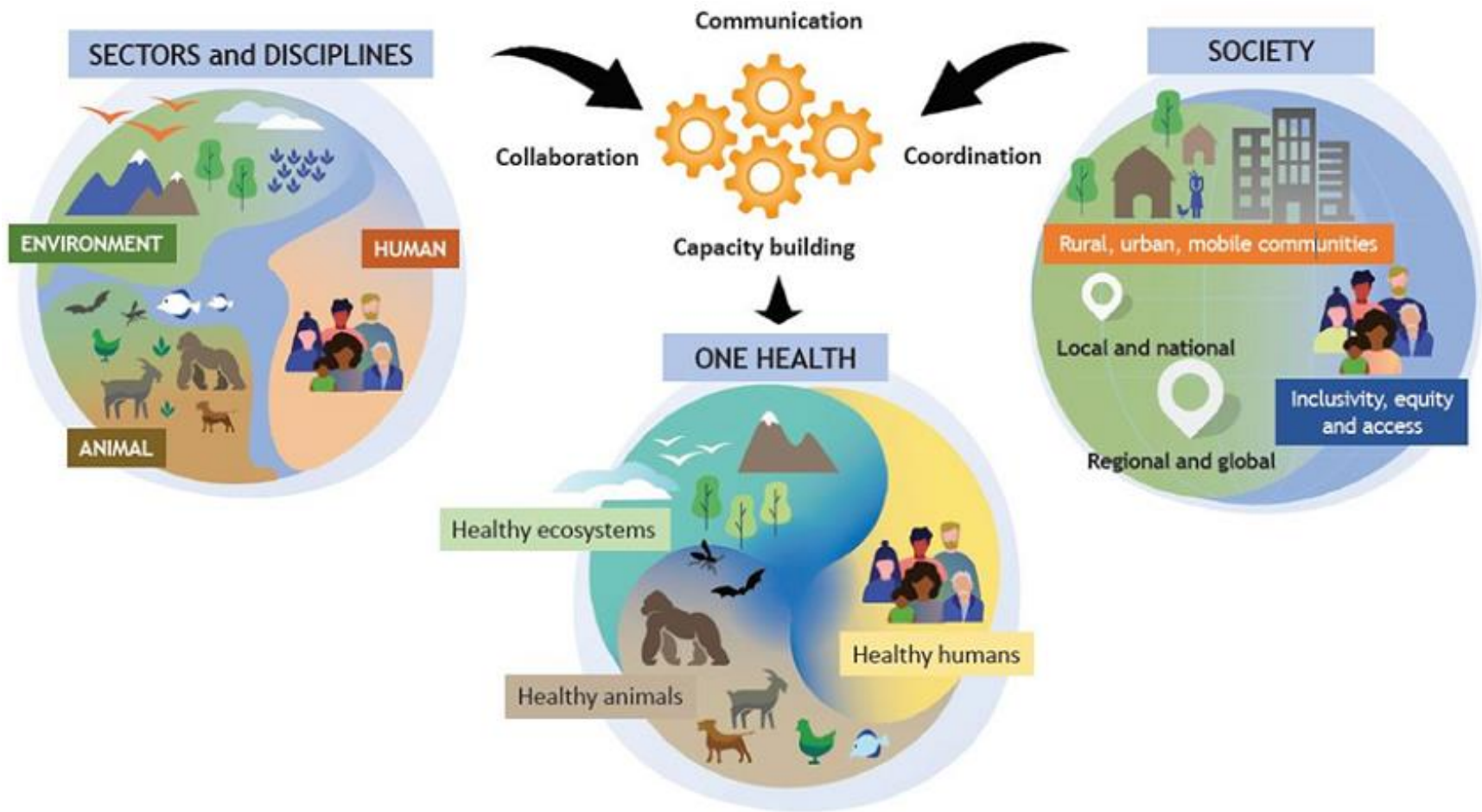


- Animals as reservoirs and vectors

One Health Paradigm



- Recognise the interconnection between people, animals, plants, and their shared environment
- A collaborative, multisectoral, and transdisciplinary approach
- Working at the local, regional, national, and global levels — with the goal of achieving optimal health outcomes

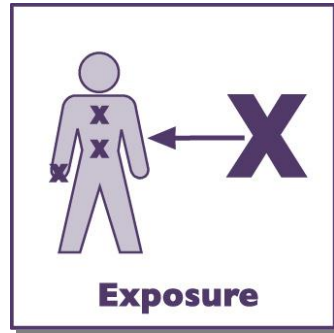


- Interactions between natural environments and people are multiple and complex, and require interdisciplinary attention and action

Conclusion

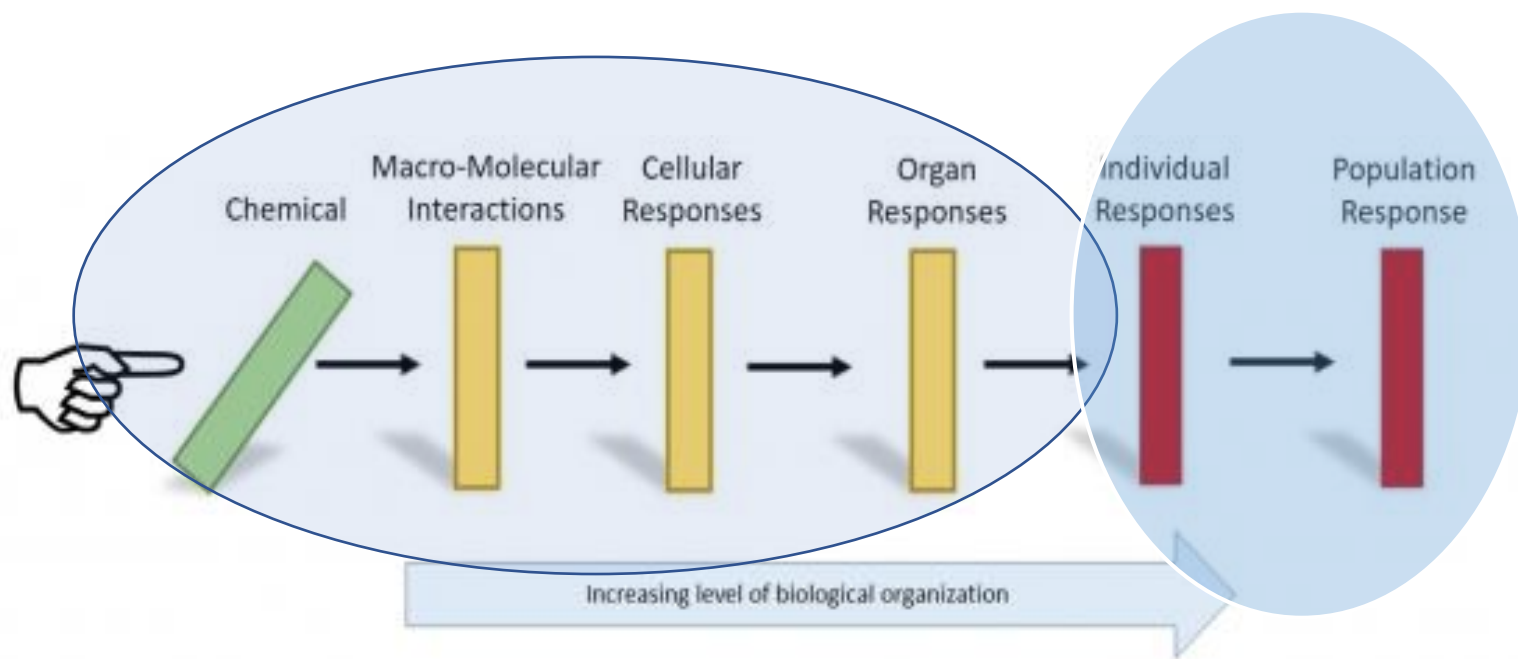
Benefits of Environmental Health





- Focus of research and legislation has been identifying and regulating environmental toxics to reduce harmful human exposures.
- Maintaining a healthy environment extends beyond controlling chemical and biological hazards.

Biological effects of pollutants



Biomarkers as early warning signals

Environmental quality monitoring

It reveals the health and composition at a snapshot as over in time

- Identify specific pollutants
- Identify sources
- Identify impacts
- Determine risks to health
- Plan & implement preventive and management measures
- Identifying trends, short and long-term,
- Compliance with international standards

