Heavy Metals:

1. Introduction

Heavy metals are elements with high atomic weight and density that can be toxic even at very low concentrations.
Unlike organic pollutants ,they are non-biodegradable, persistent in the environment, and tend to bio accumulate and bio magnify through the food chain.
Monitoring heavy metals in water is essential for ensuring ecosystem safety and public health.

2. Common Heavy Metals in Water

- Mercury(Hg):Neurotoxin; causes Minamata disease.
- Lead (Pb):Affects brain development in children; damages kidneys and nervous system.
- Cadmium (Cd):Causes Itai-Itai disease (bone deformities, kidney failure).
- Arsenic (As): Carcinogenic; leads to skin lesions and internal cancers.
- Chromium(Cr): Cr^{6+} is highly toxic; causes respiratory,liver, and kidney damage.
- Nickel(Ni):Allergic reactions, lung damage at high doses.

3. Sources of Heavy Metal Pollution

- Industrial effluents(electroplating, tanneries, textiles).
- Mining and smelting operations.
- Pesticides and fertilizers.
- Battery manufacturing and e-waste disposal.
- Leaching from pipelines and natural geological sources.

4. Effects on Public Health

- Neurological disorders(mercury, lead).
- Kidney and liver damage(cadmium, chromium).
- Cancer and genetic mutations (arsenic, chromium).
- Developmental defects in children due to lead exposure.
- Immune suppression from long-term accumulation.

5. Effects on the Environment

- Toxicity to fish and aquatic organisms.
- Bioaccumulation in plants and animals.

- Disruption of aquatic food webs.
- Reduction in biodiversity and ecosystem stability.

6. Diagram: Pathway of Heavy Metal Pollution

Industrial / Agricultural Sources

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Entry into Water Bodies

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Absorption by Aquatic Plants

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Bioaccumulation in Fish &Animals

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Bio magnification in Top Predators

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Human Exposure & Health Risks

7. Methods for Detection of Heavy Metals

- Atomic Absorption Spectroscopy(AAS).
- Inductively Coupled Plasma Mass Spectrometry(ICP-MS).
- X-Ray Fluorescence (XRF).
- Electro chemical sensors.

8. Control and Prevention Measures

- Effluent treatment plants(ETPs)in industries.
- Chemical precipitation,ion exchange, and adsorption methods.
- Use of activated carbon and nano-filters.
- Phyto remediation: Plants(e.g.,water hyacinth)absorb heavy metals.
- Strict regulation of industrial discharges and pesticide use.

9. Conclusion

Heavy metals are toxic,persistent pollutants that pose serious risks to human health and aquatic ecosystems.

Their presence in water must be strictly monitored and controlled through advanced treatment

methods, sustainable industrial practices, and regulatory frameworks.
Preventing heavy metal contamination is crucial for ensuring safe drinking water and ecological balance.