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# Bioaccumulation and Biomagnification of Chemicals

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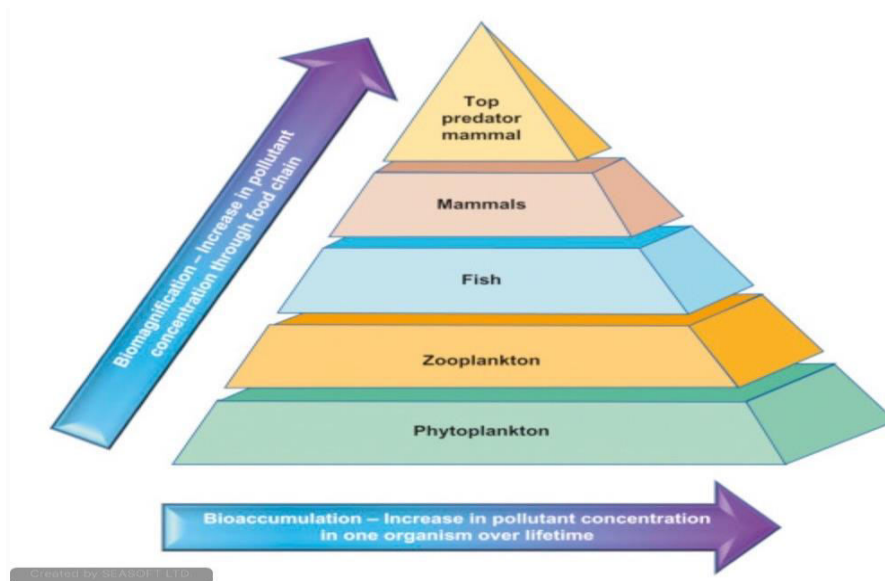
**ABSTRACT:** The process of a buildup of certain chemical substances or toxins at the higher trophic levels of a food chain is termed Biomagnification. This is also referred to as biological magnification. The chemical substances include certain toxins, heavy metals, mercury and other harmful products at a higher concentration. As these substances increase and accumulate, it moves up in the food chain. When these contaminated substances are consumed by different levels of organisms in a food chain, it results in severe health hazards. The process of accumulating toxic chemicals such as pollutants, pesticides and other toxins directly into the human body either through the air, water, food intake, or directly through the skin is termed Bioaccumulation. As this toxic compound accumulates within the human body, it increases the risk of chronic poisoning and other severe health disorders.

**KEYWORDS-**bioaccumulation, biomagnification, toxic, chemicals, health, food chain

## I.INTRODUCTION

### Bioaccumulation

- Bioaccumulation is the gradual accumulation of substances, such as pesticides or other chemicals, in an organism
- It occurs when an organism absorbs a substance at a rate faster than that at which the substance is lost or eliminated by catabolism and excretion
- Thus, the longer the biological half-life of a toxic substance, the greater the risk of chronic poisoning, even if environmental levels of the toxin are not very high [1,2,3]



### Biomagnification

- Biomagnification, also known as bio amplification or biological magnification, is any concentration of a toxin, such as pesticides, in the tissues of tolerant organisms at successively higher levels in a food chain
- This increase can occur as a result of:

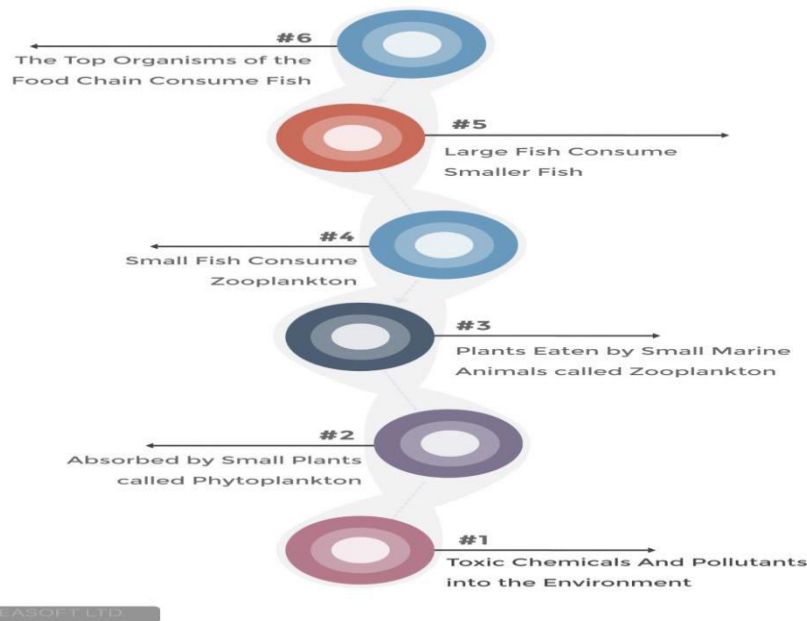
- Persistence – where the substance cannot be broken down by environmental processes
- Food chainenergetics – where the substance’s concentration increases progressively as it moves up a food chain
- Low or non-existent rate of internal degradation or excretion of the substance – mainly due to water-insolubility

Example

- Case of DDT
  - When an animal consumes food having DDT residue, the DDT accumulates in the tissue of the animal by a process called bioaccumulation.[4,5,6]
  - The higher an animal is on the food chain (e.g. tertiary consumer such as seals), the greater the concentration of DDT in their body as a result of a process called biomagnification
- Case of Indian Rivers
- India’s 42 rivers have at least two toxic heavy metals beyond the permissible limit, says a research conducted by Central Water Commission
- Ganga, the national river, was found to be polluted with five heavy metals—chromium, copper, nickel, lead and iron
- In this pursuance, the concentrations of toxic metals in grains and vegetables have grown in contaminated soils, and have increased at alarming rates.
- This poses a serious threat to humans and the environment because of its toxicity, non-biodegradability and bioaccumulation[7,8,9]

II.DISCUSSION

Process of Bioaccumulation and Biomagnification



This is what happens:

- Small amounts of toxic substances – often pesticides or pollution from human activity – are absorbed by plants.
- These plants are eaten by primary consumers in low concentrations.
- The toxin cannot be excreted so when the primary consumers are eaten by secondary consumers all the toxin is absorbed by the secondary consumers.
- This repeats as secondary consumers are eaten by higher level consumers.



- At each trophic level of the food chain, the toxins remain in the tissues of the animals – so the concentration of toxin becomes most concentrated in the body tissues of the animals at the top of the food chain

### III. RESULTS

#### Causes of Bioaccumulation/Biomagnification

- Agricultural Products
  - The chemicals used in the agricultural sector contain highly toxic substances that mainly result in biomagnification.
  - These chemicals come from herbicides, pesticides, fungicides, and inorganic fertilizers.
  - These chemicals penetrate into the soil where they accumulate to toxic levels and also find their way into the rivers and lakes through surface runoff
- Organic Contaminants
  - Organic substances such as biosolids and manures have essential nutrients that are used by plants such as nitrogen, phosphorous, and carbon
  - The biosolids that are used in agriculture farms are treated using toxic chemicals that may contain heavy metals.
  - When these organic substances are released into the farms they release harmful substances that are absorbed by the primary consumers and later accumulate in other organisms
- Plastic Pollution
  - Disposal of plastic waste near or in water bodies may not only be directly harmful to aquatic organisms but also other animals up the trophic level in general
    - The pollution in oceans caused by ‘Ghost Nets’ – these are fishing nets that have been abandoned, lost or otherwise discarded in the ocean; are also contributing for the issue
  - Research shows that plastic contains a harmful chemical called Bisphenol A which is one of the major contaminants released into the water bodies
- Mining
  - When mining substances such as zinc, copper, cobalt, lead, and other chemicals, these mineral deposits may be released into the aquatic and adjacent farm environment where their toxicity levels rise tremendously upon absorption by aquatic and farm animals or crops
- Toxic Gases and Air Pollution
  - The release of gases into the environment can also contribute to Biomagnification. Exhaust gases from vehicles and industries that manufacture and refine oil into the air do not only cause air pollution but they can be dissolved by the rainwater and fall as acidic rain
  - The chemicals in the acid rain are absorbed by soil and water bodies. They are then absorbed by primary consumers and later find their way up the food chain

#### Effects

- On Human Health
  - In recent years, the consumption of seafood has been linked to certain types of cancer.
    - This is as a result of the accumulation of mercury and the Polycyclic Aromatic Hydrocarbons in the tissues of marine organisms
  - In addition, consumption of plants or aquatic animals that have assimilated heavy metals and toxic substances may lead to long-term effects such as Kidney failure, respiratory disorders, brain damage, birth defects and heart diseases
- On aquatic animals
  - The ingestion and subsequent accumulation of metals in the tissues of marine organisms have an adverse effect on their development and reproduction. [10,11,12]
  - Consumption of heavy toxic metals in seabirds has an effect on egg production.
    - The seabirds produce eggs with soft and thin shells which easily crashes as they try to incubate them
  - Other cases that result from contamination of water bodies with toxic chemicals such as Selenium and mercury include effects on reproductive process of fish
- Disruption of Food Chain

- Accumulation of substances that cause Biomagnification can disrupt the natural food chain that is essential for the survival of all animals in a given biosphere
- However, if a group of organisms was to die due to the toxic substances the natural flow of the food chains becomes disrupted. This may have a long-term effect which might not be noticed in the short term
- Destruction of Coral Reefs
  - Cyanide that is used in leaching gold and fishing is the main cause of the destruction of coral reefs
  - Their destruction affects the lives of many aquatic animals, as many of them depend on the coral habitats for their survival
- Contamination of the marine environment with microplastics (MPs; plastics < 5 mm) has been identified as an issue of global concern
- The uptake of MPs has been confirmed in wild populations of numerous marine organisms across all trophic levels collected from their natural habitat, as a result of Biomagnification
- According to United Nations Environment Programme(UNEP), In a recent study, a quarter of the marine fish sampled from markets in Indonesia and California, USA, were found to have plastic debris and fibres from textiles in their guts
- Besides seafood, emerging evidence shows that the microplastics, especially synthetic fibres, have been detected in a variety of foods, including drinking water, beer, honey, sugar, and table salt
- Further, The presence of microplastic in foodstuffs could potentially increase direct exposure of plastic-associated chemicals to humans and may present an attributable risk to human health[13,14,15]

#### IV.CONCLUSION

##### Effective solutions in this perspective

- - Eliminating Heavy Metals at source
  - Heavy metals can be found in almost every industrially manufactured product such as petroleum.
  - Therefore, toxic substances such as lead arsenic and mercury ought to be prohibited and completely eliminated and their usage in petroleum products and other industries banned.
  - Also, industries such as coal plants that produce and rely on various heavy metals should have preservation and wellsprings that will help in the reduction of this toxic substance.
  - Meanwhile, the coal industry needs to come up with innovative strategies to eliminate mercury emissions
  - Cleaning of contaminated locale
  - The government should identify areas that are contaminated with solid wastes and should be cleaned completely
  - They should then supplant them with waste decrease programs and carry out other programs that are aimed at treating and rehabilitating the soil for future use
  - Institutions should lead the way
  - Health sectors should eliminate the use of mercury-containing items and use more secure alternatives
  - The use of home products like PVC plumbing materials, lead paints, CCA and ACZA treated wood, and other products containing heavy metals like Mercury and Arsenic should be restricted[16,17,18]

##### Measures taken by Indian Government in this perspective

- CPCB- manual water quality monitoring network is being expanded. Establishment of network of real time water quality monitoring station on the rives like Ganga to ensure that water quality is monitored continuously.
- Efforts are being made by govt for strengthening of the compliance mechanisms, so that no untreated industrial effluent is discharged in the environment.
- Installation of online effluent and monitoring system in 17 categories of polluting Industries and data connectivity with SPCB/CPCB in a step towards self- monitoring and transparency.

- Efforts are being made by the government to improve the performance of existing sewage treatment plants and adopting non- conventional technologies that are in synergy with the conventional methods for improving the water quality.
- All the 726 grossly polluting Industries in the Ganga basin have been inspected and action has been taken against 611 GPIs non-compiling industries
- Government has launched many mass Awareness programmes and Training are conducted in various priority areas

#### Proposed Measures in this perspective in India

- - Strengthening of ambient of air, water and noise monitoring network
  - Development of standards for industrial sector
  - Action plan for polluted river stretches
  - Enhancement of IT infrastructure ( e-office, hazardous waste tracking system)
  - Surveillance of swages treatment plants
  - Implementation of various waste management rules[19]

#### Precaution/Remedies that are needed

- - Restricting dumping any kind of waste in the river
  - Preventing washing of clothes and animals in rivers, to reduce inflow of chemicals from soaps/detergents
  - Reducing disposal of Hazardous fishing net
  - Educating people and making them aware about the side effects
  - Elimination of use of heavy metal
  - Avoid usage of PVC[20]

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