Chapter 13: Our Environment

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In-text 1 — Eco-system and Its Components (Page 257)

Q1 Why are some substances biodegradable and some non-biodegradable?

SOLUTION

Substances are classified as biodegradable or non-biodegradable based on whether biological processes (enzymes produced by microorganisms) can break them down.

Biodegradable substances (such as paper, vegetable peels, cotton cloth) are broken down by the action of bacteria, fungi, and other decomposers. These organisms produce enzymes that can act on the chemical bonds in these materials, converting them into simpler, harmless substances that re-enter the nutrient cycles.

Non-biodegradable substances (such as plastics, DDT, heavy metals, glass) have chemical structures that no known enzyme produced by microorganisms can break down. Their molecular bonds are either too strong or too unfamiliar to biological systems.

The key factor is the chemical nature of the substance:
- Natural organic compounds have been present in the environment for millions of years, so microorganisms have evolved enzymes to decompose them.
- Synthetic man-made compounds (like plastics and pesticides) are relatively new, and microorganisms have not yet evolved the enzymatic machinery to break them down.

This is why non-biodegradable substances persist in the environment and cause pollution.

Answer: Substances are biodegradable if microorganisms have enzymes to break them down; synthetic substances are non-biodegradable because no biological enzymes can decompose their chemical bonds.

Q2 Give any two ways in which biodegradable substances would affect the environment.

SOLUTION

Two ways in which biodegradable substances affect the environment:

1. Nutrient recycling: When biodegradable substances (like dead leaves, animal waste, food scraps) decompose, they are broken down by microorganisms into simpler inorganic substances such as CO_2, water, and mineral salts. These nutrients are returned to the soil and atmosphere, making them available for plants and other organisms. This maintains the fertility of the soil and keeps biogeochemical cycles running.

2. Pollution from excessive accumulation: When large quantities of biodegradable waste accumulate faster than decomposers can break them down (e.g., sewage discharge into water bodies, organic waste in landfills), they cause problems:
- Decomposition of excess organic matter in water bodies uses up dissolved oxygen, leading to the death of aquatic organisms.
- Accumulation of rotting waste produces foul smell and breeds disease-causing organisms.
- Excessive organic matter can lead to eutrophication of water bodies.

Answer: Biodegradable substances recycle nutrients back into the ecosystem; however, their excessive accumulation can deplete dissolved oxygen in water bodies and breed pathogens.

Q3 Give any two ways in which non-biodegradable substances would affect the environment.

SOLUTION

Two ways in which non-biodegradable substances affect the environment:

1. Biological magnification (biomagnification): Non-biodegradable chemicals like pesticides (DDT) and heavy metals enter food chains and accumulate at progressively higher concentrations at each trophic level. For example, DDT

sprayed on crops enters water bodies, is absorbed by aquatic plants, and then accumulates in increasing concentrations through fish, birds, and other predators. Top-level consumers (including humans) end up with dangerously high concentrations, causing health problems such as kidney damage, reproductive failure, and cancer.

2. Soil and water pollution: Non-biodegradable substances like plastics, glass, and e-waste persist in the environment for hundreds or thousands of years. Plastics clog drains, contaminate soil, and break into microplastics that enter water supplies and food chains. Heavy metals from industrial waste leach into groundwater, making it unfit for drinking and irrigation. These substances cannot be broken down naturally, so they keep accumulating in the environment.

Answer: Non-biodegradable substances cause biological magnification through food chains and persist in soil and water for very long periods, causing lasting pollution.

In-text 2 — Food Chains and the Flow of Energy (Page 261)

Q1 What are trophic levels? Give an example of a food chain and state the different trophic levels in it.

SOLUTION

Each step or level in a food chain at which the transfer of food (and energy) takes place is called a trophic level.

The word 'trophic' comes from the Greek word 'trophe' meaning nourishment. Organisms at each trophic level share a common mode of obtaining food.

Example food chain: Grass => Grasshopper => Frog => Snake => Hawk

Trophic levels in this food chain:
- First trophic level (T1): Grass (Producers / Autotrophs) — They make their own food through photosynthesis.
- Second trophic level (T2): Grasshopper (Primary consumers / Herbivores) — They feed directly on producers.
- Third trophic level (T3): Frog (Secondary consumers / Primary carnivores) — They feed on primary consumers.
- Fourth trophic level (T4): Snake (Tertiary consumers / Secondary carnivores) — They feed on secondary consumers.
- Fifth trophic level (T5): Hawk (Quaternary consumers / Top carnivores) — They feed on tertiary consumers.

At each trophic level, energy is used for life processes and lost as heat, so only about 10% of energy is transferred to the next level. This limits the number of trophic levels in a food chain to 3-5.

Answer: Trophic levels are the steps in a food chain where energy transfer occurs. Example: Grass (T1 - producer) => Grasshopper (T2 - primary consumer) => Frog (T3 - secondary consumer) => Snake (T4 - tertiary consumer) => Hawk (T5 - top consumer).

Q2 What is the role of decomposers in the ecosystem?

SOLUTION

Decomposers are microorganisms (mainly bacteria and fungi) that break down the dead remains and waste products of organisms into simpler inorganic substances. Their role in the ecosystem is vital:

1. Nutrient recycling: Decomposers break down complex organic matter from dead plants, animals, and their waste products into simple inorganic substances like CO2, water, and mineral salts (nitrogen, phosphorus, etc.). These nutrients are released back into the soil and atmosphere, making them available for uptake by producers (plants). Without decomposers, these nutrients would remain locked up in dead matter.

2. Cleaning the environment: By decomposing dead organisms and organic waste, decomposers act as natural cleaners. Without them, dead bodies and waste would accumulate endlessly, making the environment uninhabitable.

3. Maintaining ecosystem balance: Decomposers complete the cycle of matter in an ecosystem. They connect the dead organic matter back to the abiotic environment, ensuring a continuous flow of nutrients through the ecosystem.

4. Soil formation and fertility: The decomposition process produces humus, which enriches the soil and improves its structure, water-holding capacity, and fertility.

Without decomposers, the cycling of nutrients would stop, dead matter would pile up, and life as we know it would eventually cease.

Answer: Decomposers break down dead organisms and waste into simple inorganic substances, recycling nutrients back into the ecosystem and keeping the environment clean.

In-text 3 — Ozone Layer and Garbage Management (Page 264)

Q1 What is ozone and how does it affect any ecosystem?

SOLUTION

Ozone (O3) is a molecule made up of three atoms of oxygen. It is found in the upper atmosphere (stratosphere) at about 15-35 km above the Earth's surface, forming the ozone layer.

Formation of ozone:
- High-energy ultraviolet (UV) radiation from the Sun splits molecular oxygen (O2) into free oxygen atoms: O2 --UV--> O + O
- These free oxygen atoms combine with O2 molecules to form ozone: O + O2 --> O3

How ozone affects the ecosystem:

Protective role: The ozone layer acts as a shield that absorbs harmful ultraviolet (UV) radiation from the Sun before it reaches the Earth's surface. UV radiation is extremely damaging to living organisms:
- In humans, it causes skin cancer, cataracts, weakened immune system, and sunburns.
- In plants, it reduces photosynthesis, damages leaves, and decreases crop yields.
- In aquatic ecosystems, it kills phytoplankton (the base of aquatic food chains), disrupting the entire ecosystem.

Threat from depletion: Synthetic chemicals called chlorofluorocarbons (CFCs), used in refrigerators, air conditioners, and aerosol sprays, break down ozone molecules in the stratosphere. This has led to thinning of the ozone layer (the 'ozone hole' over Antarctica). A depleted ozone layer allows more UV radiation to reach the Earth, threatening all life forms.

The United Nations Environment Programme (UNEP) led efforts that resulted in an international agreement (Montreal Protocol, 1987) to limit the production and use of CFCs.

Answer: Ozone (O3) is a three-atom oxygen molecule in the stratosphere that shields life from harmful UV radiation. Its depletion by CFCs allows more UV to reach Earth, causing cancer, crop damage, and ecosystem disruption.

Q2 How can you help in reducing the problem of waste disposal? Give any two methods.

SOLUTION

Two methods to help reduce the problem of waste disposal:

1. Reduce and reuse: The most effective approach is to reduce the generation of waste in the first place and reuse items wherever possible.
- Carry cloth bags or jute bags instead of polythene bags while shopping.
- Use refillable containers and bottles instead of single-use plastic ones.
- Donate old clothes, books, and furniture instead of throwing them away.
- Avoid buying products with excessive packaging.
- Repair and reuse items (electronics, appliances) rather than discarding them.

2. Segregation and composting: Separate biodegradable waste from non-biodegradable waste at the source (at home).
- Biodegradable waste (kitchen scraps, vegetable peels, garden waste) can be composted at home using a compost pit or vermicomposting (using earthworms). The compost produced enriches soil and reduces the need for chemical fertilisers.
- Non-biodegradable waste (plastics, metals, glass) should be sent for recycling rather than dumping in landfills.

These methods reduce the volume of waste going to landfills, conserve resources, reduce pollution, and promote a cleaner environment.

Answer: Reduce and reuse items (carry cloth bags, use refillable bottles); segregate waste and compost biodegradable waste at home while sending non-biodegradable waste for recycling.

Exercise — End-of-Chapter Exercise (Page 266)

Q1 Which of the following groups contain only biodegradable items?
(a) Grass, flowers and leather
(b) Grass, wood and plastic
(c) Fruit-peels, cake and lime-juice
(d) Cake, wood and grass

SOLUTION

Let us check each option:

(a) Grass, flowers and leather — All three are biodegradable. Grass and flowers are plant materials, and leather is made from animal hide. All can be decomposed by microorganisms. This is a correct group.

(b) Grass, wood and plastic — Grass and wood are biodegradable, but plastic is non-biodegradable. Plastic cannot be broken down by biological processes. This group is incorrect.

(c) Fruit-peels, cake and lime-juice — All three are biodegradable. Fruit-peels are plant waste, cake is made from organic ingredients, and lime-juice is organic. All can be decomposed. This is a correct group.

(d) Cake, wood and grass — All three are biodegradable. Cake is made from organic materials, wood is plant material, and grass is plant material. All can be decomposed. This is a correct group.

The correct answers are (a), (c), and (d). All three groups contain only biodegradable items. Option (b) is the only group that contains a non-biodegradable item (plastic).

Answer: (a), (c), and (d)

Q2 Which of the following constitute a food-chain?
(a) Grass, wheat and mango
(b) Grass, goat and human
(c) Goat, cow and elephant
(d) Grass, fish and goat

SOLUTION

A food chain shows the transfer of food energy from one organism to another in a linear sequence, starting from a producer.

Let us analyse each option:

(a) Grass, wheat and mango — All three are producers (plants). There is no consumer feeding on another organism. This is NOT a food chain.

(b) Grass, goat and human — Grass is a producer (first trophic level), goat is a primary consumer/herbivore that eats grass (second trophic level), and human is a secondary consumer that eats goat (third trophic level). This forms a valid food chain: Grass => Goat => Human.

(c) Goat, cow and elephant — All three are primary consumers (herbivores). None of them feeds on the other, and there is no producer in the chain. This is NOT a food chain.

(d) Grass, fish and goat — Grass is a producer, but fish (aquatic) and goat (terrestrial) do not form a feeding sequence. Fish does not eat grass (a terrestrial plant), and goat does not eat fish. This is NOT a valid food chain.

The correct answer is (b) Grass, goat and human.

Answer: (b) Grass, goat and human

Q3 Which of the following are environment-friendly practices?
(a) Carrying cloth-bags to put purchases in while shopping
(b) Switching off unnecessary lights and fans
(c) Walking to school instead of getting your mother to drop you on her scooter
(d) All of the above

SOLUTION

Let us evaluate each practice:

(a) Carrying cloth-bags to put purchases in while shopping — This is environment-friendly because it reduces the use of polythene bags, which are non-biodegradable and cause soil and water pollution.

(b) Switching off unnecessary lights and fans — This is environment-friendly because it conserves electricity. Most electricity is generated by burning fossil fuels, which releases CO2 and other pollutants. Saving electricity reduces air pollution and slows down resource depletion.

(c) Walking to school instead of getting your mother to drop you on her scooter — This is environment-friendly because it reduces the burning of petrol/diesel, which causes air pollution (CO2, CO, nitrogen oxides, particulate matter). Walking also

reduces noise pollution and traffic congestion.

Since all three practices (a), (b), and (c) are environment-friendly, the correct answer is (d) All of the above.

Answer: (d) All of the above

Q4 What will happen if we kill all the organisms in one trophic level?

SOLUTION

If all organisms at one trophic level are killed, it will severely disrupt the entire ecosystem. The effects depend on which trophic level is removed:

If producers (first trophic level) are removed:
- Primary consumers (herbivores) will have no food and will starve and die.
- This will cause a cascade — secondary consumers, tertiary consumers, and so on will all die due to lack of food.
- Decomposers will eventually run out of dead matter to decompose.
- The entire ecosystem will collapse because producers are the foundation of all food chains.

If primary consumers (herbivores) are removed:
- Producers (plants) will overgrow without any check, leading to intense competition for sunlight, water, and nutrients.
- Secondary consumers (carnivores) that depend on herbivores for food will starve and die.
- Higher trophic levels will also be affected as a cascade effect moves up the food chain.

If secondary or higher consumers are removed:
- The organisms at the level just below will increase in population without any natural predator to control them.
- This overpopulation will put pressure on the trophic level below that, and so on.

In all cases, the food web is disrupted, the balance of the ecosystem is destroyed, and the effects cascade through multiple trophic levels. No single trophic level exists in isolation — each depends on the others for the proper functioning of the ecosystem.

Answer: Removing all organisms at one trophic level disrupts the entire food chain — levels above starve while levels below overpopulate, destabilising the whole ecosystem.

Q5 Will the impact of removing all the organisms in a trophic level be different for different trophic levels? Can the organisms of any trophic level be removed without causing any damage to the ecosystem?

SOLUTION

Yes, the impact of removing all organisms will be different for different trophic levels:

Removing producers (T1) — Most catastrophic:
- Producers convert solar energy into chemical energy (food) through photosynthesis. They are the base of every food chain.
- Removing them would cut off the energy supply to the entire ecosystem, causing total collapse.
- Additionally, oxygen production and CO_2 absorption would stop.

Removing primary consumers (T2) — Very severe:
- Producers would overgrow without herbivores to control them.
- All higher trophic levels (secondary consumers, tertiary consumers) would lose their food supply and perish.

Removing secondary consumers (T3) — Moderately severe:
- Primary consumers would increase uncontrollably, leading to overgrazing and destruction of vegetation.
- Top predators would lose food, but some might adapt by feeding on other prey.

Removing top consumers (T4/T5) — Less immediate but still significant:
- The trophic level below would experience a population explosion, causing a cascading imbalance down the chain.
- However, the immediate damage is less severe since top consumers are fewer in number.

Can any trophic level be removed without damage?
No. No trophic level can be completely removed without causing some damage to the ecosystem. Each trophic level plays an essential role:
- Producers provide energy and oxygen.
- Consumers regulate populations at lower levels.

- Decomposers recycle nutrients.

The ecosystem functions as an interconnected web. Removing any component creates an imbalance that affects the entire system.

Answer: Yes, impact varies — removing producers is most catastrophic, while removing top consumers is less immediately damaging. No trophic level can be removed without causing damage, as each plays an essential role in the ecosystem.

Q6 What is biological magnification? Will the levels of this magnification be different at different levels of the ecosystem?

SOLUTION

Biological magnification (biomagnification) is the phenomenon in which the concentration of harmful non-biodegradable chemicals (such as pesticides like DDT, and heavy metals like mercury) increases progressively at each successive trophic level in a food chain.

How it works:
- When pesticides like DDT are sprayed on crops, some of it washes into water bodies.
- Aquatic organisms (phytoplankton, small fish) absorb these chemicals from the water. Since these chemicals are non-biodegradable, they cannot be broken down or excreted by the organisms.
- At each trophic level, an organism eats many organisms from the level below. The chemicals from all the prey organisms accumulate in the body of the predator.
- This means the concentration keeps increasing as we move up the food chain.

Example with DDT concentration in an aquatic food chain:
- Water: 0.003 ppm (parts per million)
- Zooplankton: 0.04 ppm
- Small fish: 0.5 ppm
- Large fish: 2 ppm
- Fish-eating birds: 25 ppm

Yes, the levels of magnification are different at different trophic levels. The concentration of harmful chemicals increases as we go from lower to higher trophic levels:
- Organisms at the lowest trophic level have the least concentration.

- Organisms at the highest trophic level (top predators) have the maximum concentration.

This is why top predators like eagles, sharks, and humans are most affected by biological magnification. The harmful effects include reproductive failure, organ damage, cancer, and even death.

Answer: Biological magnification is the progressive increase in concentration of non-biodegradable chemicals at each trophic level. Yes, levels differ — concentration is lowest at producers and highest at top consumers.

Q7 What are the problems caused by the non-biodegradable wastes that we generate?

SOLUTION

Non-biodegradable wastes cause several serious environmental problems:

1. Biological magnification: Non-biodegradable chemicals like pesticides (DDT) and heavy metals (mercury, lead) enter food chains and accumulate at progressively higher concentrations at each trophic level. Top consumers, including humans, suffer from extremely high concentrations, leading to serious health problems like cancer, organ damage, and reproductive failure.

2. Soil pollution: Non-biodegradable wastes like plastics, polythene bags, and e-waste accumulate in soil. They reduce soil fertility by blocking the flow of water and air through the soil. Toxic chemicals from these wastes can leach into the soil and contaminate it.

3. Water pollution: Plastics and chemical wastes dumped into water bodies contaminate the water. Microplastics are consumed by aquatic organisms, harming them and entering the food chain. Industrial chemicals and heavy metals make water unfit for drinking and aquatic life.

4. Harm to animals: Animals (especially marine creatures) mistake plastic waste for food and ingest it, leading to choking, intestinal blockage, and death. Animals also get entangled in plastic waste.

5. Clogging of drains and waterways: Plastic bags and other non-biodegradable waste clog drains and sewage systems, leading to waterlogging and flooding during rains.

6. Long persistence: Since these wastes do not decompose naturally, they remain

in the environment for hundreds to thousands of years, making the problem worse over time.

7. Ozone depletion: CFCs (used in refrigerators and aerosols) are non-biodegradable gases that deplete the ozone layer, allowing harmful UV radiation to reach the Earth's surface.

Answer: Non-biodegradable wastes cause biological magnification, soil and water pollution, harm to animals, clogging of drains, and persist in the environment for centuries, making pollution problems progressively worse.

Q8 If all the waste we generate is biodegradable, will this have no impact on the environment?

SOLUTION

No, even if all waste generated were biodegradable, it would still have an impact on the environment. The impact would be reduced compared to non-biodegradable waste, but not eliminated.

Reasons why biodegradable waste still impacts the environment:

1. Excessive volume: If biodegradable waste is produced in very large quantities, decomposers cannot break it down fast enough. The waste accumulates and causes pollution. For example, excessive sewage discharge into rivers causes serious water pollution even though sewage is biodegradable.

2. Oxygen depletion: When large amounts of biodegradable waste enter water bodies, decomposers use up large quantities of dissolved oxygen to break it down. This reduces the oxygen available for aquatic organisms like fish, leading to their death. This is called the Biological Oxygen Demand (BOD) problem.

3. Foul smell and disease: Accumulated biodegradable waste rots and produces foul-smelling gases (like hydrogen sulphide and methane). It also becomes a breeding ground for disease-causing organisms (pathogens) like flies, mosquitoes, rats, and bacteria.

4. Greenhouse gases: Decomposition of biodegradable waste (especially in landfills without proper aeration) produces methane (CH_4) and CO_2, which are greenhouse gases that contribute to global warming and climate change.

5. Eutrophication: Excess biodegradable waste (especially nutrient-rich waste) in water bodies leads to eutrophication — excessive growth of algae that depletes

oxygen and kills aquatic life.

Therefore, while biodegradable waste is certainly less harmful than non-biodegradable waste, proper waste management is still essential to minimize environmental damage.

Answer: No, even biodegradable waste would impact the environment — excessive amounts can cause oxygen depletion in water, foul smells, disease spread, greenhouse gas emissions, and eutrophication. Proper management remains essential.

Q9 Why is damage to the ozone layer a cause for concern? What steps are being taken to limit this damage?

SOLUTION

Why ozone layer damage is a cause for concern:

The ozone layer in the stratosphere acts as a protective shield that absorbs most of the harmful ultraviolet (UV) radiation from the Sun. Damage to this layer (ozone depletion) allows more UV radiation to reach the Earth's surface, which has serious consequences:

1. Health effects on humans:
- Skin cancer (especially melanoma)
- Cataracts and other eye damage
- Weakening of the immune system
- Sunburns and premature ageing of skin

2. Effects on ecosystems:
- UV radiation kills phytoplankton in oceans, which are the base of aquatic food chains and also produce a significant portion of the world's oxygen.
- It damages plant cells, reduces photosynthesis, and decreases crop yields.
- It disrupts the development and reproduction of many organisms.

3. Material damage: UV radiation degrades plastics, paints, and other materials faster.

The main cause of ozone depletion is the release of man-made chemicals called chlorofluorocarbons (CFCs), which were widely used in refrigerators, air conditioners, fire extinguishers, and aerosol sprays. CFCs rise to the stratosphere, where UV radiation breaks them apart, releasing chlorine atoms

that destroy ozone molecules. A single chlorine atom can destroy thousands of ozone molecules.

Steps being taken to limit this damage:

1. Montreal Protocol (1987): An international agreement signed by many countries to phase out the production and use of ozone-depleting substances (ODS), particularly CFCs. This is considered one of the most successful environmental agreements.

2. Ban on CFCs: Many countries have banned or severely restricted the use of CFCs. Alternative chemicals (hydrofluorocarbons, HFCs) that do not damage the ozone layer are now used in refrigerators and air conditioners.

3. UNEP initiatives: The United Nations Environment Programme (UNEP) has been instrumental in raising awareness, monitoring the ozone layer, and coordinating international action.

4. Public awareness: Educating people about the harmful effects of ozone depletion and encouraging the use of ozone-friendly products.

As a result of these efforts, the ozone layer has shown signs of recovery, though complete recovery is expected to take several more decades.

Answer: Ozone depletion allows harmful UV radiation to reach Earth, causing skin cancer, eye damage, crop damage, and ecosystem disruption. The Montreal Protocol and global CFC bans are key steps taken to limit this damage.