12 CHAPTER

Ecosystem

Level - 1 CORE SUBJECTIVE QUESTIONS

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (C) is correct
Explanation: Secondary productivity refers to the rate of generation of biomass by heterotrophic (consumer) organisms, including herbivores and decomposers, from the organic matter they consume.
Net primary productivity (NPP) is the amount of organic matter available after producers (like plants) has used some energy for respiration, thus representing the biomass available for consumers.
2. Option (A) is correct
Explanation: In marine ecosystems, the pyramid of biomass can be inverted because the biomass of larger consumers, such as fish, can exceed that of the primary producers, like phytoplankton, at a given time. This is due to the rapid turnover of phytoplankton, which have a high reproductive rate but low biomass relative to the larger, more substantial biomass of the fish that feed on them.
3. Option (A) is correct
Explanation: The rate of biomass production is called productivity. It is expressed in terms of $gm^{-2}\ yr^{-1}$ or $(kcal\ m^{-2})\ yr^{-1}$.
4. Option (C) is correct
Explanation: An optimal moisture level enhances microbial activity, leading to faster decomposition, but excessive moisture creates anaerobic conditions that slow it down. Similarly, decomposition rates increase with temperature up to an optimal level, after which high temperatures can hinder microbial activity, resulting in a bell curve.
5. Option (C) is correct
Explanation: Humans can receive different amounts of energy from producers depending on their position in the food web. If humans are primary consumers (second trophic level), they typically receive about 10% of the energy from producers. If they are secondary consumers (third trophic level), they receive around 1%, and as tertiary consumers (fourth trophic level), they receive about 0.1%.
6. Option (D) is correct
Explanation: The pace of decomposition can vary significantly under the same environmental conditions due to differences in the composition of detritus. Decomposition tends to be sluggish when the debris contains high levels of lignin and chitin, which are resistant to breakdown. In contrast, detritus that is rich in nitrogen and sugars typically experiences a higher breakdown rate. Therefore, soil sample C, which has a high nitrogen and sugar content, will likely undergo decomposition at a faster rate compared to the other samples.
7. Option (C) is correct
Explanation: In terrestrial ecosystems, the detritus food chain is significant because it recycles nutrients through decomposers, breaking down dead organic matter whereas in aquatic ecosystems, the grazing food chain is predominant as it involves herbivorous organisms feeding on phytoplankton, which are primary producers in these environments.
8. Option (C) is correct
Explanation: In a food web, producers are organisms that create energy through photosynthesis or chemosynthesis, forming the base of the food chain. Since the arrows in the food web indicate the direction of energy flow, species VIII must be producing energy rather than consuming it.

ASSERTION-REASON QUESTIONS (1 Mark)

1. Option (D) is correct
Explanation: Gross primary productivity (GPP) refers to the total amount of organic matter produced by photosynthetic organisms, while net primary productivity (NPP) is the amount of organic matter left after the producers have used some for respiration. Therefore, GPP is always greater than NPP because some energy is lost as heat during respiration.
2. Option (B) is correct
Explanation: Detritus that is rich in lignin and cutin tends to decompose more slowly because these compounds are complex and resistant to breakdown by microbial enzymes. Lignin, in particular, is a structural component of plant cell walls that is difficult for decomposers to degrade. Decomposition is primarily carried out by aerobic microorganisms, which require oxygen for their metabolic processes.
3. Option (A) is correct

Explanation: In many food chains, especially those involving detritivores, the first trophic level is not occupied by living plants but rather by decomposing organic matter, which includes dead plants and animals. In detrital food chains, detritivores rely on dead plants and animals, making this organic matter the primary source of energy for them.

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

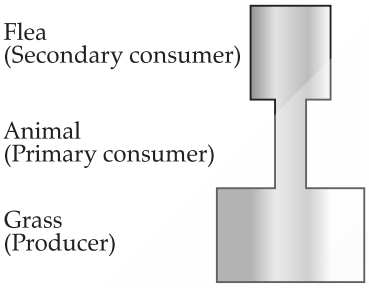
1. (i) NPP = GPP – R;
Given GPP = 400 J/m^2/day R = 150 J/m^2/day
NPP = 400 J/m^2/day – 150 J/m^2/day = 250 J/m^2/day

(ii) Pyramid of energy is always upright. As energy flows from one trophic level to the next trophic level some amount of energy is lost in each trophic level in the form of heat. Therefore, the pyramid of energy is always upright and can never be inverted.

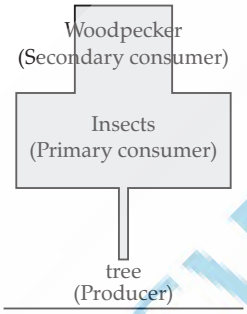
2. (i) If GPP is equal, then we can manipulate the NPP equation and solve.

- NPP = GPP – Respiration of plants;
- Respiration of Plants = GPP – NPP.
- This means that the smallest NPP corresponds to the largest respiration. That is forest C.

(ii) (a)



(b)



3. A – Zooplankton,
B – Phytoplankton,
Inverted pyramid of biomass,
Sea Ecosystem/ Aquatic ecosystem.

4.
- Detritus rich in lignin and chitin– slow decomposition,
  rich in nitrogen and water soluble substances like sugar – decomposition rate is faster.
- Warm environment – favour decomposition,
  low temperature – inhibit decomposition.

5. (1) Dark coloured,
(2) Amorphous,
(3) Highly resistant to microbial activities,
(4) Undergoes decomposition at slow rate,
(5) colloidal,
(6) reservoir of nutrients.

6. Sparrow
It is a primary consumer when it eats seeds or fruits.
It is a secondary consumer when eats insects and worms.

7. Humus is dark coloured amorphous substance which is resistant to microbial action and undergoes decomposition at an extremely slow rate.
It serves as reservoir of nutrients.

8. Limitations of ecological pyramids are:
(1) Doesn't take into account same species belonging to two or more trophic levels.
(2) Assumes a simple food chain which never exists in nature/does not accommodate a food web.
(3) Saprophytes are not given any place though they play an important ecological role.
(Any two points)

9. First law of thermodynamics: All organisms are dependent for their food on producers (who capture PAR) either directly or indirectly, unidirectional flow of energy from sun to the producers and then to consumers.
Second law of thermodynamics: Organisms need a constant supply of energy to synthesise the molecule they require, to counteract the universal tendency towards increasing disorderliness.

10. (i) Producers: 1/2/3
Carnivores: 6/7/8/9
(ii) No
Pyramid does not accommodate food web.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. (i)
- Primary productivity – It is the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis.
- Rate of biomass roduction by producers (gm^{-2} yr^{-1}) or (kcal m^{-2}) yr^{-1}

(ii) Primary productivity of a place in Rajasthan is low due to following factors.

(1) Lesser number of plant species at the particular place in Rajasthan.
(2) Lower availability of nutrients in Rajasthan.
(3) Lesser photosynthetic capacity of plants in Rajasthan
(4) Unfavourable enviornment like water scarcity or igh temperature etc. in Rajasthan.

2. (i)

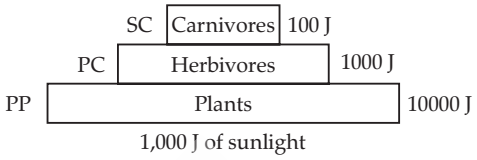
Grazing food chain	Detritus food chain
(1) Starts with green plants called producers as first tropic level.	Starts with dead organic matter and decomposers called saprotrophs.
(2) A large fraction of energy flows through aquatic ecosystem.	A much larger fraction of energy flows through terrestrial ecosystem.
(3) Energy for food chain comes from sun.	Energy for food chain comes from organic remains or detritus.

(ii)

Upright pyramid	Inverted pyramid
(1) It has wide base and narrow apex.	It as narrow base and wide apex.
(2) Producers are more in number and biomass than herbivore.	Producers are less in number and biomass than herbivore.
(3) Pyramid of energy is always upright.	Pyramid of biomass in sea is generally inverted.

3. Abiotic components (water, soil, sunlight),
Biotic components {Phytoplanktons (producers), Zooplanktons, free swimming forms, bottom dwellers and decomposers (Fungi, Bacteria, Flagellates)}
Conversion of inorganic into organic material with the help of the radiant energy of the sun by autotroph like phytoplanktons (productivity),
Consumptions of autotrophs by heterotrophs like zooplanktons/free swimming forms/bottom dwellers (flow of energy), decomposition and mineralisation of the dead organic matter, to release them back for reuse by te autotrophs. (Cycling of nutrients)

4. (i) Pyramid of energy is the ideal pyramid.



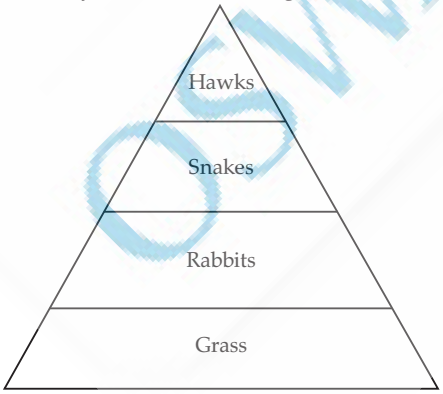
(ii) (From sun to primary producer 1%)
10, 00,000J from sun, (1%) = 10,000 J
10,000 J → 1000J → 100 J
First trophic level Third trophic level

5. Differences between a natural terrestrial ecosystem and man-made ecosystem are:
(1) Natural ecosystems are self-sustaining whereas man-made ecosystems require the assistance of humans.
(2) The nutrient cycle starts and ends in the same ecosystem in natural ecosystems whereas in man-made ecosystems the nutrient cycle may begin in one place and end in another.
(3) Individuals of a species may be scattered throughout the geography in natural ecosystems whereas species are present in close proximity in man-made ecosystems.
(4) Interactions are spontaneous in natural ecosystems whereas they are controlled by humans in man-made ecosystems. (Any three)

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. (i) Pyramid of biomass in grassland ecosystem can be upright or inverted while Pyramid of biomass in sea - (generally) inverted.
Pyramid of biomass of grassland

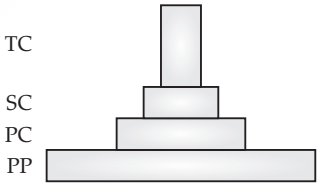
Pyramid of biomass of grassland



(ii) Primary producers -phytoplankytton
Primary consumers - fishes/zooplanktons
(iii) Each trophic level has a certain mass of living material at a particular time called as the standing crop.

2. Pyramid of biomass in Sea : PC

Pyramid of biomass in a Forest : TC



Sea - Inverted, because biomass of fish /other aquatic animals exceeds that of phytoplanktons//small standing crop of phytoplankton supports large standing crop of zooplankton
Forest - Upright, because biomass of producers exceeds that of herbivores/carnivores//allows the sharp decrease in biomass at higher trophic levels.

3. (i) Specific place of an organism in a food chain , mass of living material (biomass) at each trophic level at a particular time.
(ii) First trophic level has producers/autotrophs, which trap solar energy/to produce food (photosynthesis)
(iii) Organisms of the Detritus food chain (DFC) are the prey to the Grazing food chain (GFC) organism;

the dead remains of GFC are decomposed into simple inorganic materials which are absorbed by DFC organisms.

4. An ecological pyramid is a graphical representation of the relationship between different organisms in an ecosystem.
   (1) Pyramid of Number example = grassland ecosystem. Producers are more in number than herbivores and carnivores.
   (2) Pyramid of Biomass example = forest/tree ecosystem.
   Producers have more biomass than herbivores/ carnivores.
   Pyramid of biomass shows a sharp decrease in biomass in higher trophic levels.
   (3) Pyramid of energy : example = Grassland ecosystem.
   Producers have more energy than herbivores / carnivores.

Level - 2 ADVANCED COMPETENCY FOCUSED QUESTIONS

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (C) is correct
   Explanation: Eutrophication is the enrichment of a water body with excess nutrients (mainly nitrogen and phosphorus), often from fertiliser runoff or sewage discharge. This leads to excessive algal growth (algal bloom). When algae die and decompose, decomposers consume oxygen, causing oxygen depletion (hypoxia). As a result, aquatic life, especially fish, dies due to lack of dissolved oxygen.
2. Option (B) is correct
   Explanation: Net Primary Productivity (NPP) is the amount of energy (or biomass) produced by autotrophs (like grasses) after subtracting the energy used in respiration. Increased rainfall and moderate sunlight provide favourable abiotic conditions for photosynthesis, enhancing plant growth and thus increasing NPP.
3. Option (D) is correct
   Explanation: In a food chain, energy decreases at each successive trophic level due to the 10% law: only ~ 10% of energy is transferred to the next level; the rest is lost as heat, respiration, etc. Trophic levels in the given food chain:
   Grass – Producer (most energy)
   Grasshopper – Primary consumer
   Frog – Secondary consumer
   Snake – Tertiary consumer
   Hawk – Quaternary consumer (least energy)
   So, the hawk, being at the highest trophic level, receives the least amount of energy.
4. Option (B) is correct
   Explanation: Leguminous plants (like peas, beans, or clover) form symbiotic relationships with *Rhizobium* bacteria in their root nodules. These bacteria fix atmospheric nitrogen (N_2) into ammonia (NH_3), which is then converted into usable nitrogen compounds for plants. This enhances soil nitrogen content, improving soil fertility in crop rotation.
5. Option (C) is correct
   Explanation: Pyramid of numbers shows the number of organisms at each trophic level. In some ecosystems like a tree ecosystem, one large producer (a tree) may support many herbivores (insects, birds), creating an inverted pyramid of numbers.
6. Option (C) is correct
   Explanation: Decomposers (such as fungi and bacteria) break down dead organisms and organic waste, converting them into simple inorganic nutrients like nitrates, phosphates, and carbon dioxide. These nutrients are then recycled back into the ecosystem, supporting plant growth and maintaining nutrient cycling.
7. Option (B) is correct
   Explanation: Carbon sequestration is the process of capturing and storing atmospheric carbon dioxide (CO_2). Trees and plants absorb CO_2 during photosynthesis, storing carbon in their biomass (leaves, wood, roots) and in the soil. Therefore, planting trees increases vegetation cover, which directly enhances carbon sequestration, helping mitigate climate change.

ASSERTION-REASON QUESTIONS (1 Mark)

1. Option (A) is correct
   Explanation: Assertion is true. Energy in an ecosystem flows in one direction — from the sun — producers (autotrophs) → consumers → decomposers — and is not recycled.
   Reason is also true. Energy captured by autotrophs (like plants through photosynthesis) moves to the next trophic level, but does not flow backward to earlier levels.
2. Option (A) is correct
   Explanation: Assertion is true. The pyramid of energy is always upright because energy flow in ecosystems is unidirectional and decreases with each successive trophic level.
   Reason is also true. According to the 10% law (proposed by Lindeman), only about 10% of the energy at one trophic level is transferred to the next, while the rest is lost as heat or used in metabolism.
   Since each level gets less energy than the one before, the energy pyramid must always be upright, and the reason correctly explains the assertion.
3. Option (A) is correct
   Explanation: Assertion is true. Eutrophication can cause the death of aquatic animals, especially fish.
   Reason is also true. Excess nutrients (like nitrates and phosphates) from fertilisers or sewage lead to algal blooms. When algae die and decompose, microbial activity increases, consuming dissolved oxygen in the

water. This leads to hypoxia (oxygen depletion), which causes aquatic animals to suffocate and die.

4. Option (D) is correct

Explanation: Assertion is false. In a grassland ecosystem, the pyramid of biomass is typically upright, not inverted.

Reason is true. It is true that producers in grasslands have less individual mass compared to some large herbivores, but in terms of total biomass, grasses still outweigh consumers.

5. Option (A) is correct

Explanation: Assertion is true. Nutrient cycling ensures that essential elements like nitrogen, phosphorus, and carbon are reused and recycled within ecosystems, maintaining long-term sustainability.

Reason is also true. Decomposers (bacteria and fungi) break down organic matter, converting it into inorganic nutrients that can be reused by producers (like plants).

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. Green rooftops and vertical gardens contribute to ecosystem functions by:
   - **(1)** Improving air quality and carbon sequestration through photosynthesis, thereby reducing urban pollution and mitigating climate change.
   - **(2)** Regulating temperature and microclimate, reducing the urban heat island effect and providing habitat for birds and pollinators.
2. Organic waste in water bodies increases microbial decomposition, which consumes dissolved oxygen. This leads to oxygen depletion (hypoxia), harming aquatic life such as fish and disrupting the aquatic food chain.
3. Using compost and cow dung improves soil fertility by enriching it with natural nutrients and supporting soil microbe activity. It also reduces pollution from chemical runoff, promoting a sustainable and balanced ecosystem.
4. Excessive use of pesticides can kill non-target organisms, including beneficial insects and natural predators of pests. This disrupts the balance of the food chain and may lead to bioaccumulation of toxins in higher trophic levels, harming biodiversity.
5. Decomposers break down dead plants, animals, and organic waste, converting them into inorganic nutrients like nitrates and phosphates. This recycles nutrients back into the soil, supporting plant growth and maintaining ecosystem balance and sustainability.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. Biodiversity parks and wetlands in urban areas provide the following ecosystem services:
   - **(1)** Air purification and carbon sequestration: Trees and plants absorb carbon dioxide and pollutants, improving air quality.
   - **(2)** Water regulation and purification: Wetlands act as natural filters, removing toxins and replenishing groundwater.
   - **(3)** Biodiversity conservation and habitat support: These green zones provide shelter for birds, insects, and other wildlife, promoting ecological balance in cities.
2. The fish kill was likely caused by eutrophication, an ecological process where excess fertilisers, rich in nitrates and phosphates, enter the lake, promoting rapid algal growth, algal bloom. When algae die, their decomposition by microbes consumes dissolved oxygen, leading to oxygen depletion. This results in the death of fish and other aquatic organisms, disrupting the aquatic food chain and reducing biodiversity.
3. Vermicomposting uses earthworms to decompose organic waste into nutrient-rich compost, which:
   - **(1)** Enhances soil fertility by adding natural nutrients and improving soil structure.
   - **(2)** Promotes microbial activity, supporting healthy nutrient cycling and plant growth.
   - **(3)** Reduces reliance on chemical fertilisers, thus minimising soil and water pollution and supporting a sustainable ecosystem.
4. A decline in top carnivores (like tigers or lions) disrupts trophic regulation by:
   - **(1)** It leads to an increase in herbivore populations, as predation pressure decreases.
   - **(2)** Overgrazing by herbivores causes vegetation loss, affecting primary productivity and leading to soil erosion.
   - **(3)** This creates a trophic cascade, reducing biodiversity and compromising the stability and resilience of the entire ecosystem.
5. Ecological pyramids, especially the pyramid of energy, show that only ~10% of energy is transferred from one trophic level to the next. In marine ecosystems:
   - **(1)** Top predators (like tuna or sharks) receive the least energy, making them more vulnerable to overfishing.
   - **(2)** Understanding the pyramid helps policy makers avoid disrupting the energy flow and food web by overharvesting higher trophic levels.
   - **(3)** It encourages sustainable fishing of lower trophic species and supports ecosystem balance and long-term productivity.

CASE BASED QUESTIONS (4 Mark)

1. (i) Option (B) is correct
Explanation: Coconut husks have a higher lignin content (50%) compared to dried grass (20%), and lignin is more resistant to decomposition, thus slowing down the process.

(ii) Option (B) is correct
Explanation: Lignin's complex structure makes it more resistant to microbial decomposition, thus slowing down the process.

(iii) Option (B) is correct
Explanation: Marshy soils often have anaerobic conditions due to lower oxygen availability, which slows down the rate of decomposition.

(iv) Option (C) is correct
Explanation: Marshy soils typically have reduced oxygen levels, creating anaerobic conditions that slow down the decomposition of organic matter like dried grass and coconut husks.

2. (i) Gross Primary Productivity is 45000 + 40367 = 85367 $KJm^{-2}y^{-1}$

(ii) Net production is gradually reducing as we move from producers to consumers due to heat loss/ respiration /10% law.

(iii) (a) The of Factors that affect are:

(i) It depends on the plant species inhabiting a particular area.

(ii) It depends on environmental factors such as temperature, light, water, precipitation etc.

(iii) It depends on availability of nutrients.

(iv) It also depends on the photosynthetic capacity of plants.

OR

(b) Energy flow in an ecosystem is always unidirectional, meaning that energy is transferred from one trophic level to the next without reverting back. For example, energy from the sun is captured by producers (plants) through photosynthesis. These producers are then consumed by primary consumers (herbivores), transferring energy to the next trophic level. This one-way flow continues up the food chain, ultimately reaching top consumers (carnivores), but energy is never recycled back to lower levels.

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. (i) Ecosystem services are the benefits that humans derive from natural ecosystems. The two types of ecosystem services are:

(1) Regulating services (e.g., climate regulation, flood control)

(2) Supporting services (e.g., nutrient cycling, soil formation)

(ii) Wetlands act as natural sponges, absorbing excess rainwater and slowly releasing it. They reduce surface runoff, prevent flash floods, and help in groundwater recharge.

(iii) Loss of biodiversity (such as diverse wetland vegetation) reduces the ecosystem's ability to absorb water, stabilise soil, and filter pollutants, making cities more vulnerable to flooding and ecological degradation.

(iv) The ecosystem based strategies to reduce future flooding are:

(1) Restore wetlands and natural drainage systems to absorb and manage rainwater effectively.

(2) Promote green infrastructure, e.g., bioswales, rain gardens, permeable pavement, to mimic natural hydrology and reduce runoff.

2. (i) The phenomenon is eutrophication.
Eutrophication is a process where excess nutrients (mainly from organic waste) enter water bodies, leading to rapid algal growth (algal bloom).

(ii) When algae die, their decomposition by microbes consumes a large amount of dissolved oxygen (DO) in the water. This causes hypoxia (oxygen deficiency), leading to the death of fish and other aquatic organisms.

(iii) Decomposers like bacteria and fungi break down the dead algae and organic matter. In doing so, they use up oxygen during aerobic respiration, further reducing DO levels and worsening water quality.

(iv) The two long-term ecological solutions are:

(1) Install wastewater treatment plants to ensure that only treated water enters natural water bodies.

(2) Create buffer zones with vegetation around water bodies to absorb excess nutrients before they reach the pond.

3. (i) The predator-prey relationship is disrupted. Tigers (predators) regulate the population of deer (herbivores). Their removal allows herbivores to multiply unchecked.

(ii) Tigers act as a keystone species. Their presence helps maintain ecological balance. By controlling herbivore populations, they protect vegetation and support biodiversity. Without them, the structure and functioning of the ecosystem are destabilised.

(iii) An increase in deer leads to overgrazing, resulting in:

(1) Vegetation loss,
(2) Forest degradation,
(3) Soil erosion

This affects other organisms dependent on forest cover and reduces overall ecosystem productivity and resilience.

(iv) The conservation measures to restore ecological balance are:

(1) Strengthen anti-poaching laws and monitoring to protect top predators like tigers.

(2) Implement habitat restoration programs, including controlled grazing and reforestation, to recover degraded areas and restore natural food chains.

4. (i) Agroforestry integrates trees with crops and/or livestock on the same land. Trees prevent soil erosion, improve microclimate and moisture retention, and enhance biodiversity. This promotes a balanced and sustainable ecosystem.

(ii) Decomposers like bacteria, fungi, and earthworms break down organic farm waste (leaves, manure) into nutrient-rich compost, which improves soil fertility naturally.

(iii) Composting returns essential nutrients (like nitrogen, phosphorus, potassium) back to the soil. Trees in agroforestry also contribute organic matter through leaf litter, completing the nutrient cycle without synthetic inputs.

(iv) These practices:

(1) Improve soil structure and water retention, helping crops withstand droughts.

(2) Increase carbon sequestration through tree planting.

5. (i) The 10% law, proposed by Lindeman, states that only 10% of the energy at one trophic level is passed on to the next level, while the remaining 90% is lost as heat, movement, and metabolism.

(ii) Energy is lost due to:

(1) Heat production through respiration.

(2) Undigested food excreted as waste.

(3) Energy used for movement and reproduction

(iii) Energy pyramids are always upright because energy decreases at each successive level, higher trophic levels have less energy than lower ones. This unidirectional flow and consistent loss make energy pyramids always upright as energy never flows back to producers.

(iv) The ecological footprint through food choices can be reduced by:

(1) Understanding the energy pyramid shows that eating lower on the food chain (e.g., more plant-based foods) is more energy-efficient.

(2) Less energy is lost compared to consuming meat from higher trophic levels.

(3) Citizens can reduce resource use, greenhouse gas emissions, and land degradation, thus lowering their ecological footprint.