

# 12 Ecosystem

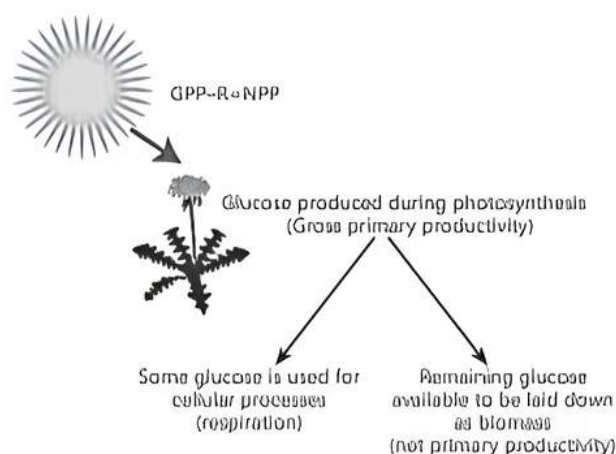
## Fastrack« Revision

- ▶ An **ecosystem** can be defined as a functional unit of nature, where living organisms interact among themselves and also with the surrounding physical environment.
- ▶ An ecosystem is divided into two basic categories:
  - **Terrestrial ecosystem:** Example- forest, desert.
  - **Aquatic ecosystem:** Example- pond, lake, wetland.
- ▶ **Ecosystem-Structure and Function**
  - ▶ The various components of the environment are **abiotic** and **biotic**.
  - ▶ Interaction of biotic and abiotic components results in a physical structure that is characteristic for each type of ecosystem.
  - ▶ Biotic components are the living beings and abiotic components are the non-living things of the ecosystem.
  - ▶ Vertical distribution of different species occupying different levels is called **stratification**.
  - ▶ **The functional components of ecosystem are:**
    - Productivity
    - Decomposition
    - Energy flow
    - Nutrient cycling
  - ▶ Example of functional components of ecosystem is a **pond ecosystem**.
  - ▶ The abiotic component is the water with all the dissolved inorganic and organic substances and the rich soil deposit at the bottom of the pond.
  - ▶ The solar input, the cycle of temperature, day-length and other climatic conditions regulate the rate of function of the entire pond.
  - ▶ The autotrophic components include the phytoplankton, some algae and the floating, submerged and marginal plants found at the edges.
  - ▶ The consumers are represented by the zooplankton, the free swimming and bottom dwelling forms.
  - ▶ The decomposers are the fungi, bacteria and flagellates especially abundant in the bottom of the pond.
- ▶ **Productivity**
  - ▶ The rate of biomass production is called **productivity**.
  - ▶ Productivity is of two types:
    - Primary productivity
    - Secondary productivity
  - ▶ **Primary productivity** is defined as the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis.
  - ▶ Primary productivity is expressed in terms of weight ( $\text{gm}^{-2}$ ) or energy ( $\text{kcal m}^{-2}$ ).
  - ▶ Primary productivity can be divided into:
    - Gross Primary Productivity (GPP)
    - Net Primary Productivity (NPP)

- ▶ **Gross primary productivity** of an ecosystem is the rate of production of organic matter during photosynthesis.
- ▶ Gross primary productivity minus respiration losses (R) is the **Net Primary Productivity (NPP)**.

$$\text{GPP} - \text{R} = \text{NPP}$$

- ▶ **Secondary productivity** is defined as the rate of formation of new organic matter by consumers.
- ▶ The annual net primary productivity of the whole biosphere is approximately 170 billion tonne (dry weight) of organic matter.



- ▶ **Decomposition**
  - ▶ Decomposers break down complex organic matter into inorganic substances like carbon dioxide, water and nutrients and the process is called **decomposition**.
  - ▶ Dead plant remains such as leaves, bark, flowers and dead remains of animals, including faecal matter is called **detritus**.
  - ▶ Detritus is the raw material for decomposition.

## Knowledge BOOSTER

*Detritivores are the organisms which break down detritus into smaller particles. e.g. millipedes, dung flies, woodlice, burying beetles.*

- ▶ The important steps in the process of decomposition are fragmentation, leaching, catabolism, humification and mineralisation.
- ▶ **Fragmentation** is the breaking down of detritus into smaller particles.
- ▶ The process by which water-soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts is called as **leaching**.
- ▶ The process by which bacterial and fungal enzymes degrade detritus into simpler inorganic substances is called as **catabolism**.



- **Humification** is the accumulation of a dark coloured amorphous substance called **humus**.
- The humus is further degraded by some microbes and release of inorganic nutrients occur by the process known as **mineralisation**.

#### ► Factors affecting the Rate of Decomposition

- Large amount of oxygen is required for decomposition as it is an energy requiring process.
- Chitin and lignin present in detritus slower the rate of decomposition.
- Nitrogen and water-soluble substances like sugars in detritus increase the rate of decomposition.
- Warm and moist environment favour decomposition whereas low temperature, dryness and anaerobiosis inhibit decomposition.

#### ► Energy Flow

- Sun is the only source of energy for all ecosystems on earth and except for the deep sea hydrothermal ecosystem.
- Less than 50 per cent of incident solar radiation is Photosynthetically Active Radiation (PAR).
- Plants capture only 2-10% of the PAR.
- All organisms are dependent for their food on producers.
- Flow of energy in the ecosystem is unidirectional.
- The green plant in the ecosystem are called **producers**. For example, in a terrestrial ecosystem, major producers are herbaceous and woody plants and in aquatic ecosystem, phytoplankton, algae and higher plants are producers.
- All animals depend on plants for their food needs. They are called **consumers**.
- Consumers which feed on the producers, they are called **primary consumers or herbivores**. e.g., grass
- The animals which eat herbivores are called **secondary consumers or primary carnivores**. e.g., goat.
- The animals which eat the primary carnivores are called **tertiary consumers or secondary carnivores**. e.g., man.
- Based on the source of their nutrition or food, organisms occupy a specific place in the food chain that is known as their trophic level.
- Producers belong to the first trophic level, herbivores (primary consumer) to the second and carnivores (secondary consumer) to the third trophic level.
- **Food chain** is the flow of energy from one trophic level to another trophic level by eating and being eaten.
- **Food chain is of two types:**
  - (i) Grazing Food Chain (GFC)
  - (ii) Detritus Food Chain (DFC)
- Food chain which starts from producers and ends on carnivores through herbivores is called **grazing food chain**.

Grass (Producer) → Goat (Primary consumer) → Man (Secondary consumer)

- Food chain which starts from dead organic matter and passes through detritivore to organisms feeding on detritivore is called **detritus food chain**.
- **Detritivores** are decomposers which meet their energy and nutrient requirements by degrading dead organic matter or detritus. These are also known as **saprotrophs**.

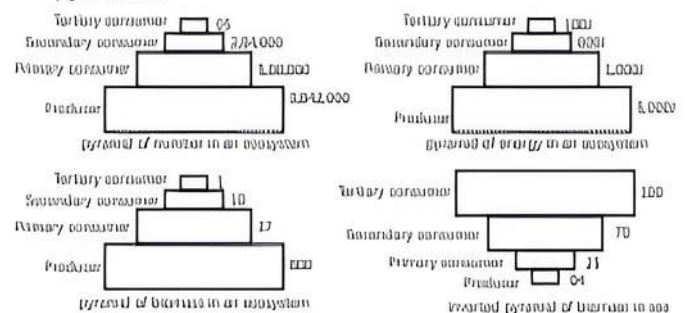
- Decomposers secrete digestive enzymes that breakdown dead and waste materials into simple and inorganic materials.
- The interconnected matrix of food chain is called **food web**. For example, Specific herbivore of one food chain may serve as food of carnivores in another food chain.
- Each trophic level has a certain mass of living material at a particular time called as the **standing crop**.
- The standing crop is measured as the mass of living organisms (**biomass**) or the number in a unit area.

#### ► Ecological Pyramid

- **Ecological pyramid** is the graphical representation of various trophic levels of food chain designed to show their number, biomass and energy.
- The base of a pyramid is broad and it narrows down at the apex.
- The base of each pyramid represents the producers or the first trophic level while the apex represents tertiary or top level consumer.
- The three ecological pyramids that are usually studied are:
  - (i) Pyramid of number
  - (ii) Pyramid of biomass
  - (iii) Pyramid of energy
- A given species may occupy more than one trophic level in the same ecosystem at the same time. For example, A sparrow is a primary consumer when it eats seeds, fruits, peas, and a secondary consumer when it eats insects and worms.
- Producers are more in number and biomass than the herbivores, and herbivores are more in number and biomass than the carnivores, so all the pyramids, of number, of energy and biomass are upright.
- The pyramid of biomass in sea is also generally inverted because the biomass of fishes far exceeds that of phytoplankton.
- Pyramid of energy is always upright and can never be inverted because when energy flows from a particular trophic level to the next trophic level, some energy is always lost as heat at each step.

#### ► Limitations of Ecological Pyramids

- It does not take into account the same species belonging to two or more trophic levels.
- It assumes a simple food chain, something that almost never exists in nature.
- It does not accommodate a food web.
- Saprophytes are not given any place in ecological pyramids.



#### ► Ecosystem Services

- The products of ecosystem processes are named as **ecosystem services**.





For example, Healthy forest ecosystems help to do the following:

- purify air and water
- mitigate droughts and floods
- cycle nutrients
- generate fertile soils
- provide wildlife habitat
- maintain biodiversity
- pollinate crops

- provide storage site for carbon and also provide aesthetic
  - cultural and spiritual values
- Out of the total cost of various ecosystem services, the soil formation accounts for about 50%, other services like recreation and nutrient cycling are less than 10% each and the cost of climate regulation and habitat for wildlife are about 6% each.



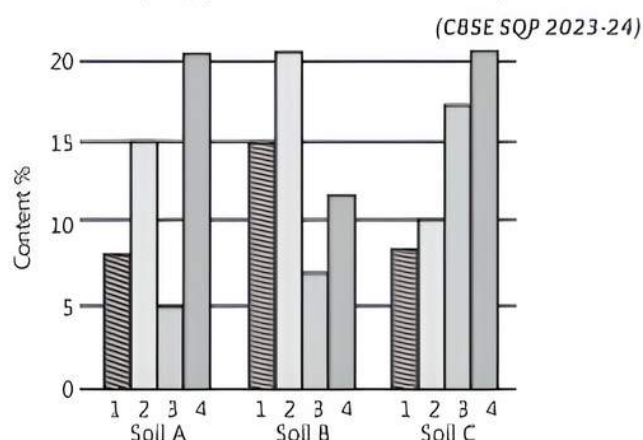
## Practice Exercise



### Multiple Choice Questions

- Q 1. Which of the following pairs is not correct?
- E. Haeckel – Coined the term 'Ecology'
  - Tansley – Coined the term 'Ecosystem'
  - R. Mishra – Father of Indian Ecology
  - None of the above
- Q 2. The rate of conversion of light energy into chemical energy of organic molecules in an ecosystem is:
- net primary productivity
  - gross primary productivity
  - secondary productivity
  - gross secondary productivity
- Q 3. Which of the following is not a producer?
- Spirogyra*
  - Agaricus*
  - Volvox*
  - Nostoc*
- Q 4. Which one of the following exhibits least productivity?
- Salty marshes
  - Grasslands
  - Open oceans
  - Coral reefs
- Q 5. Which one of the following is the most productive ecosystem?
- Temperate forest
  - Grassland
  - Desert
  - Tropical rainforest
- Q 6. Percentage of Photosynthetically Active Radiation (PAR) in the incident solar radiation is:
- 1 - 5%
  - 2 - 10%
  - less than 50%
  - approx. 100%
- Q 7. If 10 Joules of energy is available at the producer level, then amount of energy present at the level of secondary consumers is:
- 10 J
  - 1J
  - 0.1 J
  - 0.01 J
- Q 8. The energy and biomass relationship between the organisms at different trophic levels can better expressed by:
- food chain
  - food web
  - ecological pyramids
  - energy cycle
- Q 9. Organisms which are associated with first as well as third trophic level are:
- macrophytes
  - phytoplanktons
  - chemoautotrophs
  - Insectivorous plants
- Q 10. The primary productivity in an ecosystem is expressed as: (CBSE 2023)
- $\text{gm}^{-2} \text{yr}^{-1}$
  - $\text{gm}^{-2} \text{yr}$
  - $\text{K cal m}^{-2} \text{yr}^{-1}$
  - $\text{K cal m}^{-2}$

- Q 11. Observe the contents 1, 2, 3 and 4 of soil samples A, B and C shown in the graph. If the temperature and soil moisture of all soil samples are identical, which soil sample (s) will show faster decomposition?



1 indicates lignin content, 2 indicates chitin, 3 indicates Nitrogen content and 4 indicates sugar content

- Soil Sample A
  - Soil Sample B
  - Soil Samples A and B Both
  - Soil Sample C
- Q 12. Which one of the following animals may occupy more than one trophic levels in the same ecosystem at the same time?
- Sparrow
  - Lion
  - Goat
  - Frog
- Q 13. Out of the total proposed cost of various ecosystem services, cost of climate regulations and habitat for wildlife are:
- 50%
  - 10%
  - 6%
  - 25%
- Q 14. These belong to the category of primary consumers:
- Insects and cattles
  - eagle and snakes
  - water Insects
  - snakes and frogs
- Q 15. In a food chain, the maximum population is of which organisms?
- Producers
  - Primary consumers
  - Secondary consumers
  - Decomposers
- Q 16. Given below is one of the type of ecological pyramids. This type represents:
- pyramid of numbers in a grassland
  - pyramid of biomass in a follow land
  - pyramid of biomass in a lake
  - energy pyramid in a spring





## Assertion & Reason Type Questions

**Directions (Q.Nos. 17-27):** Each of the following questions consists of two statements, one is Assertion (A) and the other is Reason (R). Select the correct answer to these questions from the codes a, b, c and d as given below.

- Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
- Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
- Assertion is true but Reason is false.
- Assertion is false but reason is true.

**Q 17. Assertion (A):** The pyramid of number of a pond ecosystem is upright.

**Reason (R):** Phytoplanktons are maximum and secondary consumers are least in number.

**Q 18. Assertion (A):** The rate of decomposition of detritus is reduced in the regions of high altitude.

**Reason (R):** It happens due to immobilisation of nutrients.

**Q 19. Assertion (A):** The rate of energy storage at consumer levels is referred to as secondary productivities.

**Reason (R):** Net primary productivity is the total gross productivity and the energy used up in the metabolic process.

**Q 20. Assertion (A):** The biotic community and non-living environment of an area function together to form an ecosystem.

**Reason (R):** The change in abiotic components causes a change in biotic components also.

**Q 21. Assertion (A):** Green plants are producers.  
**Reason (R):** Microconsumers break down the dead protoplasm into simpler ones. They are first in the sequence of food chain.

**Q 22. Assertion (A):** Decomposition process is slower if detritus is rich in lignin and cutin.

**Reason (R):** Decomposition is largely an oxygen requiring process. (CBSE 2023)

**Q 23. Assertion (A):** A food chain is a group of organisms in which there is a transfer of food energy through a series of repeated eating and being eaten.

**Reason (R):** Interlocking pattern of several food chains is known as food web.

**Q 24. Assertion (A):** Each food level in an ecosystem is called trophic level.

**Reason (R):** When one organism benefits the other in a chain, it is called commensalism.

**Q 25. Assertion (A):** There is a gradual decrease in the energy content in the successive trophic levels from producers to consumers.

**Reason (R):** Pyramid of energy does not show energy accumulation pattern at different trophic levels.

**Q 26. Assertion (A):** Ecological pyramid of biomass is generally inverted in sea/ocean.

**Reason (R):** Biomass of fishes far exceeds that of phytoplanktons.

**Q 27. Assertion (A):** Pyramid biomass is always upright for single tree ecosystem.

**Reason (R):** Total biomass of a tree in a specific area is more than that of herbivores.

## Answers

1. (d) None of the above

2. (b) gross primary productivity

Gross primary productivity of an ecosystem is the rate of production of organic matter during photosynthesis, i.e., the rate at which light energy converted into chemical energy. A considerable amount of GPP is utilised by plants in respiration.

3. (b) *Agaricus*

4. (c) Open oceans

In oceans, there are lots of nutrients but no sufficient sunlight is available in deep areas. Hence, oceans have the least productivity. Grasslands are less productive ecosystem with annual productivity of 200-100 gm/m<sup>2</sup>. Maximum productivity can be seen in coral reefs followed by estuaries.

5. (d) Tropical rainforest

6. (c) less than 50%

7. (c) 0.1 J

Only 10% of energy is transferred from one trophic level to the next trophic level of a food chain (10% law, given by Lindeman). In present case, energy available at producer level is 10 J. Hence, energy at primary consumer level would be 1 J (10% of 10 J). Similarly, at secondary consumer level energy present will be 0.1 J (10% of 1 J).

8. (c) ecological pyramids

9. (d) Insectivorous plants

10. (d) K cal m<sup>-2</sup>

11. (d) Soil Sample C

12. (a) Sparrow

An organism that may occupy more than one trophic level simultaneously is a sparrow. Sparrow is a primary consumer when it eats seeds, fruits, peas and a secondary consumer when it eats insects and worms.

13. (c) 6%

Out of the total cost of various ecosystem services, the soil formation accounts for about 50% and contributions of other services like recreation and nutrient cycling, are less than 10% each. The cost of climate regulation and habitat for wild life are about 6% each.

14. (a) Insects and cattles

15. (a) Producers

16. (c) pyramid of biomass in a lake

17. (a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

The pyramid of pond ecosystem is upright, because base of this pyramid is occupied by the maximum number of phytoplanktons (autotrophs) and number of individuals gradually decreases towards primary and secondary consumer respectively.



- Q 4. What does a biotic community called when it is regulated by abiotic components?**
- a. Biomass                      b. Biosphere  
c. Ecosystem                 d. Bio-geography
- Q 5. What makes an ecosystem healthy and maintained?**
- a. Bio-geochemical cycle    b. Energy-flow  
c. Cycling of nutrients        d. All of these

1. (a)      2. (c)      3. (d)      4. (c)      5. (b)

## Productivity

**Q 1. Its value depends on the chlorophyll content.**

- a. Primary productivity
- b. GPP
- c. NPP
- d. Secondary productivity

Q 2.  $GPP = \dots + \text{Respiratory loss.}$

- a. NPP
- b. Primary productivity
- c. Secondary productivity
- d. GPP

Q 8. The amount of storage of organic matter not used by heterotrophs (consumers) is known as

\*\*\*\*\*

- a. NPP
- b. Primary productivity
- c. Secondary productivity
- d. GPP

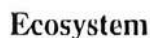
Q 4. In aquatic habitat, productivity ..... with the increasing depth.

- a. increases  
b. becomes high  
c. becomes low  
d. decreases

Q 5. What is right option for productivity in desert, grasslands and forest?

- a. High, medium, low  
b. Medium, high, low  
c. Low, medium, high  
d. High, low, medium

1. (b)      2. (a)      3. (c)      4. (d)      5. (c)



An ecosystem can simply be defined as the functional unit of nature with which living organisms survive and interact among them and with the physical environment that surrounds them. Ecosystems can broadly be classified into natural and man-made. Natural ecosystems can further be bifurcated into:

- (a) **Terrestrial Ecosystems:** These include grasslands, deserts, forests, etc. and

- (b) **Aquatic Ecosystems:** These ecosystems include water bodies such as wetland, lake, river, estuary, etc. On the other hand, aquariums, croplands etc. are man-made ecosystems. The major or primary function of an ecosystem is the conversion of inorganic materials to organic matter.

**Q 1. The term 'Ecosystem' was given by:**

- a. Odum  
b. A.G. Tansley  
c. Hatch & Slack  
d. Robert Hooke

Q 2. The biotic and abiotic components are linked with each other through ..... energy flow and ..... material flow.

- a. bidirectional, cyclic      b. cyclic, bidirectional  
c. unidirectional, cyclic      d. cyclic, unidirectional

**Q 8. Living organisms are produced through:**

- a. biological evolution      b. physical evolution  
c. bio-chemical evolution      d. chemical evolution



## Case Study 3

### Energy Flow

Living organisms, depend on each other for their food requirement and form a chain called food chain. The transfer of food energy from producers, through a series of organisms is known as food chain. (Herbivores - Carnivores - Decomposers). Food chain starts from primary producers and ends with carnivores. The animals are inter-dependent for food and they form a net which is termed as a food web. Trophic level is one kind of producer-consumer arrangement, where each food level provides "successive levels of nourishment in the food chain and food web of a community."

Q 1. Grazing food chain begins with .....

- a. decomposers                      b. carnivores
- c. producers                        d. consumers

Q 2. 'Detritus' means:

- a. primary source of energy is dead organic matter.
- b. secondary source of energy is dead organic matter.
- c. primary source of energy is living organic matter.
- d. primary source of energy is living inorganic matter.

Q 3. Which term is used for indicating interdependent food in net form?

- a. Food chain                      b. Food web
- c. Nutrient web                  d. All of these

Q 4. How do flow of energy and nutrient-cycling represented in an ecosystem?

- a. By structure and function
- b. By nutrient pyramid
- c. By composition of ecosystem
- d. Food chain

Q 5. In the arrangement of producers and consumers, each food level is known as:

- a. food chain                      b. food web
- c. trophic level                    d. food level

### Answers

1. (a)      2. (a)      3. (b)      4. (d)      5. (c)

## Case Study 4

### Decomposition

Decomposition is the breaking down of complex organic substrates into simpler inorganic forms by decomposers. The various steps of decomposition are:

**Fragmentation:** Breaking down of detritus into smaller particles by the action of detritivores such as fungi, earthworm, etc.

**Leaching:** Downward movement of water-soluble nutrients into the soil horizon and their precipitation as insoluble salts.

**Catabolism:** Break down of detritus into simpler inorganic forms by enzymes from fungi and bacteria.

**Humification:** Formation and continuous deposition of a dark amorphous substance known as the humus.

**Mineralisation:** The further breakdown of humus by some microorganisms to form simple inorganic nutrients.

*Read the given passage carefully and give the answer of the following questions:*

Q 1. What do you mean by decomposition?

Ans. The process by which dead or complex organic material is broken down into simpler forms of matter which mixes with soil is called decomposition.

Q 2. What do decomposers need to eat to live and grow?

Ans. Decomposers need dead matter to eat to live and grow.

Q 3. Name any three common decomposers of an ecosystem.

Ans. Bacteria, fungi, earthworms.

OR

When humus is degraded, salts and ions are released in the forms which are available to plants. What is this called?

Ans. Mineralisation



### Very Short Answer Type Questions

Q 1. All the primary productivity is not available to a herbivore. Give one reason.

Ans. All the primary productivity is not available to a herbivore because a considerable amount is utilised by the plant through respiration.

Q 2. Write the equation that helps in deriving the net primary productivity of an ecosystem.

Ans. The required equation is:  $GPP - R = NPP$



### TIP

Learn the equation properly with all its abbreviations and concepts involved.

Q 3. Write a difference between net primary productivity and gross primary productivity.

Ans. Gross Primary Productivity (GPP) is the rate of production of organic matter during photosynthesis. On the other hand, Net Primary Productivity (NPP) is the available biomass for the consumption by heterotrophs.

$$GPP - R = NPP$$

Q 4. What is secondary productivity?

Ans. Secondary productivity is defined as the rate of formation of new organic matter by consumers.





Q 5. Name the basic requirement of any ecosystem to function and sustain properly.

Ans. A constant input of solar energy is the ultimate source of all energy and requirement of any ecosystem to function and sustain properly.

Q 6. Expand PAR.

Ans. Photosynthetic Active Radiation.

Q 7. State what 'standing crop' of a trophic level represents.

Ans. 'Standing crop' of a trophic level represents the mass of living material (biomass) at a particular time.

Q 8. List any two ways of measuring the standing crop of a trophic level.

Ans. Standing crop is measured in the following two ways:  
(i) Biomass of living organisms in a unit area.  
(ii) Number in a unit area.

Q 9. Differentiate between standing state and standing crop in an ecosystem.

Ans. In an ecosystem, standing crop is the mass of living material in each trophic level at a particular time. Whereas standing state refers to the amount of nutrients in the soil at any given time.

Q 10. What is detritus?

Ans. Dead organic matter or remains of plants such as leaves, bark, flower and dead remains of animals, including faecal matter constitute detritus.

Q 11. What is a detritus food chain made up of? How do they meet their energy and nutritional requirements?

Ans. A detritus food chain is made up of dead plants and animal remains and their faecal matter. They obtain energy and nutritional requirements by decomposing the dead materials.

Q 12. Why an earthworm is called a detritivore?

Ans. This is because earthworm breaks down detritus into smaller particles.

Q 13. Why is the pyramid of biomass inverted in a pond ecosystem?

Ans. The pyramid of biomass is inverted in a pond ecosystem because the biomass of fish (consumer) is far, larger than the producers (phytoplanktons).

Q 14. Name one example of inverted pyramid of number.

Ans. Pyramid of number is observed inverted in tree ecosystem.

Q 15. Why is food web formed in nature?

Ans. Many organisms occupy positions in different food chains and several food chains therefore, become interconnected to form a food web.

Q 16. What is meant by 10% law?

Ans. 10% law states that only 10% energy of a trophic level is transferred to the next higher trophic level.

Q 17. Define trophic level.

Ans. Each energy step or level in a food chain is called a trophic level.

Q 18. "Man can be a primary as well as a secondary consumer." Justify this statement.

Ans. Man has a varied diet. When on a vegetarian diet, they are primary consumers and when on a non-vegetarian diet, they are secondary consumers.

### COMMON ERROR

*Students do not justify the given statement and given irrelevant answer not defining the topic.*

Q 19. How is 'stratification' represented in a forest ecosystem?

Ans. 'Stratification' is the vertical distribution of species occupying different levels. Trees occupy vertical strata, shrubs the second layer and herbs/ grasses occupy the bottom layers.

Q 20. Arrange the following as you observe in vertical stratification of a forest—Grass, Shrubby plants, Teak, *Amaranthus*.

Ans. Grass, *Amaranthus*, Shrubby plants, Teak.



### Short Answer Type Questions

Q 1. How are productivity, gross productivity, net primary productivity and secondary productivity interrelated? (CBSE 2015)

Ans. Productivity is the rate of production of biomass at any trophic level at any given interval of time.

$$NPP = GPP - R$$

Gross productivity is the rate of production of organic matter by green plants per unit time per unit area.

Net primary productivity is the difference between gross primary productivity and the loss due to respiration. Secondary productivity is the rate of production of formation of new organic matter by consumers especially that of the first order or herbivores.



### TIP

*Provide definitions and inter-related equations to explain the terms.*

Q 2. Primary productivity varies from ecosystem to ecosystem. Explain. (CBSE 2015)

Ans. Primary productivity varies from ecosystem to ecosystem because it depends on the plant species inhabiting the area and their photosynthetic activity. It also depends on various environmental factors.

Q 3. The number of trophic levels in an ecosystem are limited. Comment. (CBSE 2015)

Ans. In a food chain, only 10% of the total amount of energy is passed on to the next trophic level from the previous trophic level. So, there is a decrease in the amount of energy available at the successive trophic levels. As we move higher up in the food chain, the amount of energy diminishes to a level at which it cannot sustain any trophic level thereby limiting the number of trophic levels.





**Q 4. Justify the importance of decomposers in an ecosystem.** (CBSE 2015)

**Ans.** Decomposers, which are heterotrophic organisms, mainly fungi and bacteria have the following importance:

- (i) They breakdown complex organic matter into inorganic substances like carbon dioxide, water and nutrients. They meet their energy and nutrient requirements by degrading dead organic matter or detritus. These are also known as saprotrophs.
- (ii) Decomposers secrete digestive enzymes that breakdown dead and waste materials into simple, inorganic materials, which are subsequently absorbed by them.

**Q 5. "Cattle and goats do not browse the Calotropis plant." Justify the statement giving reasons.**

**Ans.** Organisms to survive in the complex food web have evolved characters to support their living and prevent them from predators. One of such example is *Calotropis*. *Calotropis* plant also known as milkweed produce a chemical compound cardiac glycoside that affects the mammalian heart. It is the defence mechanism in *Calotropis* plant to keep cattle stay away from it. This is the reason why cattle and goats do not feed/browse on this plant.

**Q 6. Construct a grazing food chain and detritus food chain using the following, with 5 links each: Earthworm, bird, snake, vulture, grass, grasshopper, frog, decaying plant matter.**

**Ans.** Grazing food chain: Grass → Grasshopper → Frog → Snake → Vulture

OR

Grass → Grasshopper → Bird → Snake → Vulture

Detritus food chain: Decaying plant matter → Earthworm → Bird → Snake → Vulture

**Q 7. "In a food-chain, a trophic level represents a functional level, not a species." Explain.** (CBSE 2016)

**Ans.** A given species may occupy more than one trophic level in the same ecosystem (in different food chains) at the given time. If the function of the mode of nutrition of species changes, its position shall change in the trophic levels. The same species can be at primary consumer level in one food chain and at secondary consumer level in another food chain in the same ecosystem at the given time.

**Q 8. Apart from plants and animals, microbes form a permanent biotic component in an ecosystem. While plants have been referred to as autotrophs and animals as heterotrophs, what are microbes referred to as? How do these microbes fulfil their energy requirements?**

**Ans.** Microbes are referred to as heterotrophs and saprotrophs. They fulfil their energy requirements by feeding on dead remains of plants and animals through the process of decomposition.

**Q 9. Differentiate between two different types of pyramids of biomass with the help of one example of each.**

**Ans.**

S. No.	Basis of difference	Upright pyramid of biomass	Inverted pyramid of biomass
(i)	Amount of biomass	The biomass of producers is more than that of consumers.	The biomass of the producers (phytoplankton) is less than that of consumers (fish).
(ii)	Example	Forest ecosystem.	Aquatic ecosystem.

### COMMON ERROR

Students don't give answer in tabular form or forget to give examples.

**Q 10. Due to uncontrolled excessive hunting, the population of tiger in a forest becomes zero. Discuss the long-term effects of this situation in the population of deer in that forest.**

**Ans.** The reduction in population of tiger (predator) will result in an increase in deer (prey) population. The increased deer population will give more pressure on vegetation due to overgrazing. As a result, the plant population will decrease and lead to decreased deer population due to starvation, death and migration. As a result, the ecological balance will be disturbed, but in the long run, these relationships stabilise the prey and predator population in a community.

**Q 11. Sometimes due to biotic/abiotic factor, the climax remain in a particular seral stage (preclimax) without reaching the climax. Do you agree with this statement? If yes, give a suitable example.**

**Ans.** It is true that any change in the abiotic/biotic factor will arrest a particular seral stage leading to a preclimax condition before the climax stage is achieved. This can happen in cases of forest fires, landslide, change in soil characteristics, and increase in herbivore population leading to overgrazing.

**Q 12. Why earthworm is considered a farmer's friend? Explain humification and mineralisation occurring in a decomposition cycle.**

**Ans.** Earthworms help in breakdown of complex organic matter as well as loosening of the soil. This helps in the proper growth of the crops. Therefore, they are considered as a farmer's friend.

**Humification:** The process of accumulation of a dark coloured amorphous substance called humus that is highly resistant to microbial action and undergoes decomposition at an extremely slow rate is called humification.

**Mineralisation:** The process by which humus is further degraded by some microbes to release inorganic nutrients is called mineralisation.





**Q 13. Mention four significant services that a healthy forest ecosystem provides.** (CBSE 2019)

**Ans.** Ecosystem services provided by healthy forest ecosystems are:

- Purification of air.
- Maintenance of biodiversity.
- Provide wildlife habitat.
- Storage site for carbon.
- Cycling of nutrients.
- Mitigate droughts and floods.



## TiP

Construct a proper pyramid showing trophic levels with accurate labels and names.

**Q 3. Describe the inter-relationship between productivity, gross primary productivity and net primary productivity.** (CBSE 2017)

**Ans.** The rate of biomass production per unit area, over a time period by plant during photosynthesis is called productivity. It is expressed as  $(\text{kcal m}^{-2}) \text{ yr}^{-1}$  or  $\text{g/m}^2/\text{yr}$  or  $\text{g m}^{-2} \text{ yr}^{-1}$ .

The amount of biomass or organic matter produced per unit area over a time period in plants during photosynthesis is called primary productivity. It includes Gross Primary Productivity (GPP) and Net Primary Productivity (NPP).

Gross Primary Productivity is the rate of production of organic matter during photosynthesis in an ecosystem. Some of GPP is utilised in respiration.

Net Primary Productivity is the weight of the organic matter stored by the producer in a unit area/volume per unit time.

$$\text{NPP} = \text{GPP} - \text{R}$$

where, R = Respiration losses.

**Q 4. (i) Write how parasites have evolved with adaptation to co-exist with their hosts in an ecosystem.**

(ii) Parasites are host specific and tend to co-evolve. How would the parasite respond if the host evolves a certain mechanism to resist or reject the parasite? (CBSE 2020)

**Ans.** (i) Parasites have evolved with the following adaptation:

- Loss of unnecessary sense organs and presence of adhesive organs/suckers.
- Loss of the digestive system and high reproductive capacity.

(ii) The parasite has to evolve a mechanism to counteract and neutralise them.

**Q 5. Distinguish between**

(i) Upright and Inverted pyramid

(ii) Food chain and Food web.

**Ans.** (i) Differences between upright and inverted pyramids are follows:

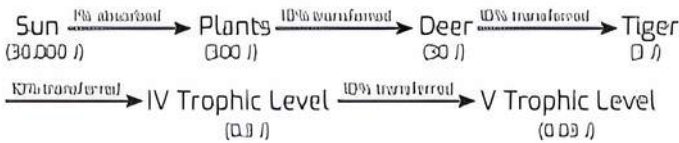
S.No	Upright Pyramid	Inverted Pyramid
(i)	In this type of pyramid, number and biomass of organisms at producer level is high, which keeps on decreasing at each trophic level.	In this type of pyramid, the number and biomass of organism at producer level is lowest and keeps on increasing at each trophic level.
(ii)	The base bar comprises of producers in large number.	The base bar comprises of producer in smallest number.



## Long Answer Type-I Questions

**Q 1. Why is the length of a food chain in an ecosystem generally limited to 3-4 trophic levels? Explain with an example.**

**Ans.** The amount of energy flow decreases with successive trophic levels as only 10% of energy is transferred from one trophic level to the next successive level. The energy is lost in the form of respiration and other vital activities to maintain life. If more trophic levels are present, the residual energy will be limited and decreased to such an extent that it cannot further support any trophic level by the flow of energy. So, the food chain is generally limited to 3-4 trophic levels only. For example,



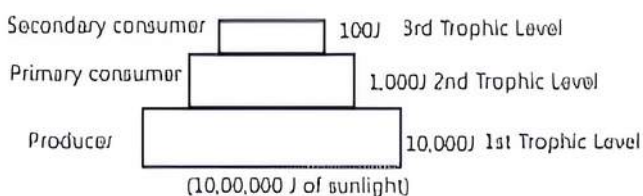
## COMMON ERROR

Students give example of food chain without mentioning the flow of energy or amount of energy transferred.

**Q 2. (i) Name an ideal pyramid existing in an ecosystem. Construct it up to its three trophic levels along with their names.**

(ii) The Sun provides 10,00,000 J of sunlight (solar energy) to an ecosystem. Write the amount of energy that is available to the first and third trophic levels, respectively. (CBSE 2020)

**Ans.** (i) Pyramid of energy is the ideal pyramid existing in an ecosystem.



(ii) 10,00,000 J from Sun, (1%) = 10,000 J  
 10,000 J ⇒ 1000 J ⇒ 100 J  
 First trophic level Third trophic level





(iii)	Energy pyramid is always upright.	Pyramid of numbers and pyramid of biomass can be inverted.
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(ii) Differences between food chain and food web are as follows:

S.No	Food Chain	Food Web
(i)	It is a <u>linear sequence of organisms.</u>	It is an <u>interconnection of many food chains.</u>
(ii)	Members present at higher trophic level feed on single types of organisms.	<u>One organism has alternate food sources.</u>
(iii)	The energy flow can be easily calculated.	Energy flow is difficult to calculate.
(iv)	Competition is limited only to members of same trophic level.	Competition is amongst members of same and different trophic levels.

## Long Answer Type-II Questions

- Q 1. (i) What is a trophic level in an ecosystem? What is 'standing crop' with reference to it?  
(ii) Explain the role of the 'first trophic level' in an ecosystem.  
(iii) How is the detritus food chain connected with the grazing food chain in a natural ecosystem?

(CBSE 2018)

- Ans. (i) Trophic level in an ecosystem is a specific place of an organism in a food chain. With reference to it, 'standing crop' is the 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. Also, the dead remains of GFC are decomposed into simple inorganic materials which are absorbed by DFC organisms.

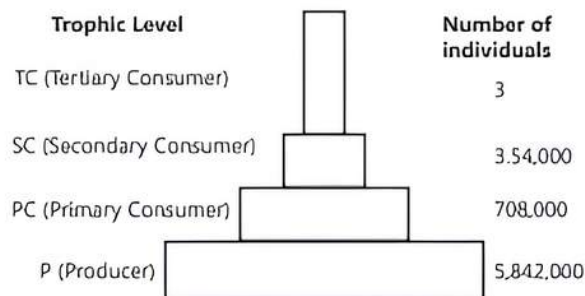
- Q 2. (i) What is an ecological pyramid? Compare the pyramids of energy, biomass and numbers.  
(ii) Write any two limitations of ecological pyramids.

(CBSE 2017)

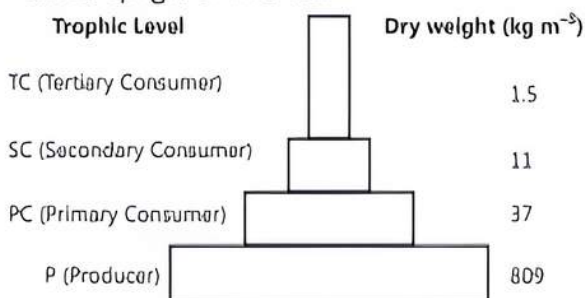
- Ans. (i) **Ecological pyramid:** The relation between producers and consumers in an ecosystem can be graphically represented in the form of a pyramid called ecological pyramid.

Ecological pyramids are of three types:

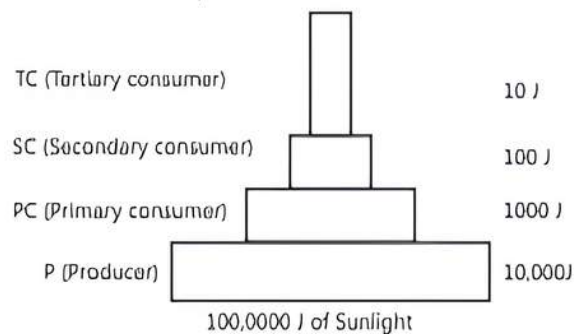
- (a) **Pyramid of number:** The relationship between producers and consumers in an ecosystem can be represented in the form of a pyramid in terms of number which is called pyramid of number.



- (b) **Pyramid of biomass:** The relationship between producers and consumers in an ecosystem can be represented in the form of a pyramid in terms of biomass which is called pyramid of biomass. It can be upright or inverted.



- (c) **Pyramid of energy:** The relationship between producers and consumers in an ecosystem can be represented in the form of a pyramid in terms of flow of energy which is called pyramid of energy. It is always upright as energy is lost as heat at each step.



- (ii) **Limitations of ecological pyramids:**

- (a) It never takes into account the same species belonging to two or more trophic levels.  
(b) It assumes a simple food chain, which never exists in nature.

- Q 3. Describe the advantages for keeping the ecosystems healthy.

(CBSE 2015)

- Ans. By keeping the ecosystem healthy, we can take advantage of the ecosystem services which are the products of ecosystems. Following are the economic and environmental advantages that we obtain from the healthy ecosystem:

- (i) Healthy forest ecosystem purify air and water.  
(ii) It mitigates drought and floods and cycle nutrients.  
(iii) Healthy ecosystem generates fertile soil and provides wildlife habitat.



- (iv) It maintains biodiversity which is an important aspect of healthy ecosystem.
- (v) It pollinates crop and provides storage site for carbon.
- (vi) It provides aesthetic, cultural and spiritual values.
- (vii) It provides stable food chain and provides economically useful forest produces.
- (viii) It provides sustainable biological legacy to future generations.

**Q 4. Describe the process of decomposition of detritus under the following heads: Fragmentation, leaching, catabolism, humification and mineralisation.**

**Ans.** The process of breaking down complex organic matter into inorganic substances like water and nutrients is called decomposition. The raw material for decomposition is called detritus. They are dead remains of plants and animals.

The process of decomposition of detritus is as under:

- (i) **Fragmentation:** The process of breaking down of detritus into smaller particles is called fragmentation, e.g., earthworm.
- (ii) **Leaching:** The process by which water-soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts is called leaching.
- (iii) **Catabolism:** The enzymatic process by which degraded detritus is converted into simple inorganic substances is called catabolism.
- (iv) **Humification:** The process of accumulation of a dark coloured amorphous substance called humus that is highly resistant to microbial action and undergoes decomposition at an extremely slow rate is called humification.
- (v) **Mineralisation:** The process by which humus is further degraded by some microbes and release inorganic nutrients is called mineralisation.



## Chapter Test

### Multiple Choice Questions

Q1. Energy transferred from one trophic level to another:

- a. 5%                      b. 10%
- c. 15%                     d. 20%

**Q 2. Which of the following is called as a detritivore?**

- An animal feeding on decaying organic matter.
- An animal feeding on a plant.
- A plant feeding on an animal.
- An animal feeding on another animal.

**Q 3. Which is the most stable ecosystem?**

- a. Grasslands                      b. Forests  
c. Oceans                          d. Deserts

### Assertion and Reason Type Questions

**Directions (Q. Nos. 4-5):** Each of the following questions consists of two statements, one is Assertion (A) and the other is Reason (R). Select the correct answer to these questions from the codes a, b, c and d as given below.

- Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
- Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.
- Assertion is true but Reason is false.
- Both Assertion and Reason are false.

**Q 4. Assertion (A):** Stratification helps in accommodation of a large number and types of plants in the same area.

**Reason (R):** It is the occurrence of horizontal zonation in the ecosystem.

**Q 5. Assertion (A):** Decomposers are excluded from the food chains.

**Reason (R):** They act on all trophic levels of a food chain.

## Case Based Questions

## Case Study 1

**Q 6.** It is the process of breaking down of complex organic matter into inorganic substances like water, carbon dioxide and nutrients.

Detritus is the raw material for decomposition. It includes dead remains of plants (leaves, bark and flowers) and of animals including faecal matter. It is largely an aerobic process *i.e.*, requires oxygen for its processing.

- (i) **The process of breaking down of complex organic matter into inorganic substances is called:**
  - a. productivity
  - b. decomposition
  - c. mineralisation
  - d. None of these
- (ii) **The raw material for decomposition is called:**
  - a. nutrients
  - b. consumers
  - c. detritus
  - d. None of the above
- (iii) **Which of the following is/are an example(s) of detritus?**
  - a. Dead remains of plants
  - b. Dead remains of animals
  - c. Faecal matter of animals
  - d. All of the above



(iv) Decomposition is largely a type of:

- a. aerobic process
- b. anaerobic process
- c. physical process
- d. None of these

### Case Study 2

Q 7. Sun is the only source of energy for all the ecosystems on the earth except for deep sea hydrothermal ecosystem. Of the total incident solar energy, less than 50% is Photosynthetically Active Radiation (PAR). Plants utilise only 2-10% of PAR to sustain the entire living world.

Plants as well as photosynthetic and chemosynthetic bacteria fix sun's radiant energy to make food from simple inorganic molecules. Thus, are dependent on producers either directly or indirectly for their food.

*Read the given passage carefully and give the answer of the following questions:*

- (i) In an ecosystem, which is the ultimate source of energy?
- (ii) Expand PAR.
- (iii) What is the percentage of PAR utilised by plants?

OR

What do you mean by energy flow?

### Very Short Answer Type Questions

- Q 8. Name two basic categories of an ecosystem.
- Q 9. Give the relation between Gross Primary Productivity (GPP) and Net Primary Productivity (NPP).
- Q 10. List any two way of measuring the standing crop of a trophic level.

### Short Answer Type Questions

- Q 11. Primary productivity varies from ecosystem to ecosystem. Explain.
- Q 12. Explain the following terms.
  - (i) Stratification
  - (ii) Leaching

### Long Answer Type-I Question

- Q 13. Describe the components of an ecosystem.

### Long Answer Type-II Question

- Q 14. (i) Explain primary productivity and the factors that influence it.
- (ii) Describe how oxygen and chemical composition of detritus controls the decomposition.