CHAPTER

14 ECOSYSTEM

Syllabus

➢ ***Ecosystems :*** *Patterns, components; productivity and decomposition; energy flow; pyramids of number, biomass, energy; nutrient cycles (carbon and phosphorus); ecological succession; ecological services – carbon fixation, pollination, seed dispersal, oxygen release (in brief).*

Chapter Analysis

List of Topics		2016		2017		2018
		D	OD	D	OD	D/OD
Ecosystem-Structure and Function	• Functioning of ecosystem		1 Q (5 M)			
Productivity	• Relationship between productivity, gross primary productivity and net production				1 Q (3 M)	
Energy Flow	• Food chain • Relationship between detritus food chain and grazing food chain. • Tropic levels • Standing crop	1 Q (3 M)				1 Q (5 M)
Ecological Pyramids					1 Q (5 M)	
Ecological succession	• Primary and secondary succession		1 Q (3 M)			
Ecosystem services				1 Q (5 M)		

- *On the basis of above analysis, it can concluded that important topics on which a long five mark questions can be asked are-Ecosystem functioning, Energy flow, Ecological pyramids and ecosystem services. Other important topics from this chapter are productivity, food chain, and ecological succession.*

TOPIC-1
Ecosystem – Structure and Function, Productivity and Decomposition

Revision Notes

➢ **Introduction**

(a) An ecosystem is a functional unit of nature, where living organisms interact among themselves and also with the surrounding physical environment.

(b) The entire biosphere can be regarded as a global ecosystem.

- **Types of Ecosystems**
  - **(a) Terrestrial ecosystem :** Forest, grassland, desert, etc.
  - **(b) Aquatic ecosystem :** Pond, lake, wetland, river, estuary and ocean.
  - **(c) Man-made ecosystem :** Crop fields and aquarium.
- **Ecosystem : Structure and Function**
  - **(a)** An ecosystem, consists of biotic and abiotic components. These components function as a unit. Unidirectional flow of energy takes place within these components of ecosystem.
  - **(b)** Vertical distribution of different species occupying different levels is called stratification. *E.g.* trees occupy top vertical strata (layer) of a forest, shrubs the second and herbs and grasses occupy the bottom layers.
- **Components of Ecosystem**

  There are four main functions of ecosystem :

  (i) Productivity **(ii)** Decomposition **(iii)** Energy flow **(iv)** Nutrient cycling
- **Pond - Aquatic Ecosystem**
  - **(a)** A pond is a shallow, simple, self-sustainable water body that exhibits all basic components of an ecosystem.
  - **(b)** Abiotic components in pond : Water and the soil which is deposited at the bottom.
  - **(c)** Climatic conditions : The solar input, the cycle of temperature, day-length, etc.
  - **(d)** Autotrophic components : Phytoplankton, some algae and the floating, submerged and marginal plants.
  - **(e)** Consumers (heterotrophs) : Zooplankton, free swimming and bottom dwelling forms.
  - **(f)** Decomposers : Fungi, bacteria and flagellates.
  - **(g) Pond performs all the functions of an ecosystem such as :**
    - **(i)** Conversion of inorganic into organic material with the help of the radiant energy of the sun by the autotrophs.
    - **(ii)** Consumption of the autotrophs by heterotrophs.
    - **(iii)** Decomposition and mineralization of the dead matter to release them back for reuse by the autotrophs.
  - **(h)** There is unidirectional movement of energy towards the higher trophic levels and its dissipation and loss as heat to the environment.
- **Productivity**
  - **(a)** A constant input of solar energy is the basic requirement for any ecosystem to function and sustain.
  - **(b)** The rate of biomass production is called productivity.
  - **(c)** The productivity is expressed in terms of $g^{-2}yr^{-1}$ or (kcal m^{-2}) yr^{-1}.
  - **(d)** It can be divided into gross primary productivity (GPP) and net primary productivity (NPP).
- **Primary Productivity**
  - **(a)** The amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis is called primary production.
  - **(b)** The primary production is expressed in terms of weight (g^{-2}) or energy (kcal m^{-2}).
- **Gross Primary Productivity**
  - **(a)** It is the rate of production of organic matter during photosynthesis.
  - **(b)** A considerable amount of GPP is utilized by plants in respiration.
  - **(c)** Gross primary productivity minus respiration losses (R) is the net primary productivity (NPP), *i.e.* NPP is the available biomass for the consumption of heterotrophs (herbivores and decomposers).

    $$NPP = GPP - R$$
  - **(d) Primary productivity depends on**
    - **(i)** The plant species inhabiting a particular area.
    - **(ii)** Environmental factors.
    - **(iii)** Availability of nutrients.
    - **(iv)** Photosynthetic capacity of plants.

    Therefore, it varies in different types of ecosystems.
  - **(e)** The annual net primary productivity of the whole biosphere is approximately 170 billion tons (dry weight) of organic matter.
  - **(f)** Of this, despite occupying about 70% of the surface, the productivity of the oceans is only 55 billion tons. Rest of course is on land.
- **Secondary Productivity**

  It is the rate of formation of new organic matter by consumers.

- **Decomposition :**
  - **(a)** It is the breakdown of complex organic matter by decomposers into inorganic substances like carbon dioxide, water and nutrients.
  - **(b)** It is largely an oxygen-requiring process.
  - **(c)** **Detritus** (dead plant remains such as leaves, bark, flowers and dead remains of animals, including faecal matter) is the raw material for decomposition.
- **Steps in decomposition**

The important steps in the process of decomposition are fragmentation, leaching, catabolism, humification and mineralisation.

(a) Fragmentation

It is the breakdown of detritus into smaller particles by detritivores (*e.g.* Earthworm).

(b) Leaching

In this process, water soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts.

(c) Catabolism

(i) Here, the degradation of detritus into simpler inorganic substances takes place by bacterial and fungal enzymes.

(ii) Fragmentation, leaching and catabolism operate simultaneously on the detritus.

(d) Humification

(i) It is the accumulation of humus (dark amorphous substance) in soil.

(ii) Humus is resistant to microbial action and so decomposes very slowly.

(iii) Being colloidal in nature, it serves as a reservoir of nutrients.

(e) Mineralization

It is the release of inorganic nutrients due to the degradation of humus by some microbes.

- **Factors Influencing Decomposition**

The rate of decomposition is controlled by chemical composition of detritus and climatic factors.

(a) Chemical composition of detritus:

Decomposition rate is slower if detritus is rich in lignin and chitin and quicker, if detritus is rich in nitrogen and water-soluble substances like sugars.

(b) Climatic factors like temperature and soil moisture :

– Temperature and soil moisture are the most important climatic factors that regulate decomposition through their effects on the activities of soil microbes.

– Warm and moist environment favours decomposition whereas low temperature and anaerobic conditions inhibits decomposition resulting in build up of organic materials.

Very Short Answer Type Questions (1 mark each)

AI **Q. 1. What does 'R' represent in the given equation for productivity in an ecosystem ?**
GPP — R = NPP.
R **[Delhi Set-I, Comptt., 2014]**

Ans. 'R' represents the loss of biomass due to respiration. **1**

Q. 2. How is 'stratification' represented in a forest ecosystem ? R **[Delhi Set-I, 2014]**

Ans. Stratification is the formation of different layers (strata where vegetation is dense such as tropical rain forest). It represents vertical distribution of species at different levels.

There may be many strata such as long trees, medium trees, short tress, shrubs, herbs and ground flora etc. Trees occupy vertical strata, shrubs the second layer and herbs / grasses occupy the bottom layers.

[CBSE Marking Scheme, 2014] 1

Q. 3. Write the equation that helps in deriving the net primary productivity of an ecosystem.
R **[Delhi Set-I, III, 2013]**

Ans. NPP = GPP – R

where, NPP : Net Primary Productivity.

GPP : Gross Primary Productivity.

R = Respiratory losses. **1**

Q. 4. Write a difference between net primary productivity and gross productivity.
U **[Outside Delhi Set-I, 2011]**

Ans. **Gross productivity –** Rate of production of organic matter during photosynthesis.

Net primary productivity – Available biomass for the consumption of heterotrophs.

GPP – R = NPP. **[CBSE Marking Scheme, 2011] 1**

Detailed Answer:

The rate of production of organic matter during photosynthesis represents the gross primary productivity (GPP) while the net primary productivity is the available biomass for the consumption by the heterotrophs.

GPP—R = NPP.

(Gross primary productivity–Respiration = Net primary productivity)

Commonly Made Error

- Students often get confused between technical terms like Gross primary productivity, Net primary productivity, secondary productivity. Learn them carefully.

Q. 5. What is secondary productivity? R **[Delhi 2009]**

Ans. Secondary productivity refers to the rate of formation of new organic matter by the consumers specially by the herbivores or primary consumers.

Answering Tip

- Writing practice must be given for all definitions like primary productivity, secondary productivity, standing crop etc. emphasizing on operative terms.

Q 6. Why are green algae not likely to be found in the deepest strata of the ocean ?

R **[Outside Delhi Set-I, 2013]**

OR

Why are green plants not found beyond certain depth in ocean? **[Delhi 2011]**

Ans. Green algae are not found beyond a certain depth in ocean because only about 1 percent of sunlight penetrates at this depth which is not sufficient for the plants to photosynthesize and thus grow and survive. **1**

Commonly Made Error

- Students often write incomplete and vague answers.

Answering Tip

- Always be specific and give clear and complete answers.

AI **Q. 7. All primary productivity is not available to herbivore. Give one reason.**

E & A **[Delhi Comptt., 2009]**

Ans. All primary productivity is not available to a herbivore because a considerable amount of it is utilized by the plants itself in respiration. **1**

Q. 8. Why is an earthworm called detrivore ?

A **[Foreign 2012]**

Ans. Earth worms are called detrivores because they break down the detritus i.e. the dead plant and animal remains including faecal matter into smaller particles. **1**

Short Answer Type Questions-I (2 marks each)

Q. 1. Write about 'humification' and the 'mineralisation' occurring during the process of decomposition.

R **[Delhi Set-I, II, Comptt., 2016]**

Ans. Humification leads to break down of complex organic matter and accumulation of humus in the form of a dark amorphous substance in soil.

Mineralisation is a process in which humus is degraded by microbes to release inorganic nutrients. **[CBSE Marking Scheme, 2016] 1+1**

Q. 2. How are productivity, gross productivity, net primary productivity and secondary productivity interrelated ? R **[Delhi Set-I, 2015]**

Ans. NPP = GPP – R

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

Gross productivity : It is the rate of production of organic matter by green plants per unit time per unit area. On the other hand we can say that it is the total amount of productivity.

Net Primary Productivity : It is the difference between gross primary productivity and the loss due to respiration.

Secondary Productivity : It is rate of production or formation of new organic matter by consumers especially the consumers of the first order or herbivores. **1 + 1 = 2**

[CBSE Marking Scheme, 2015]

AI **Q. 3. How does the dead organic matter get decomposed in nature ? Explain.**

U **[Outside Delhi Set, Comptt. 2012]**

Ans. In nature, the dead organic matter gets decomposed by the micro-organisms like bacteria and fungi. These microorganisms called decomposers break down the complex organic matter into simpler inorganic substances like CO_2, water and nutrients. **2**

Q. 4. Explain primary productivity and the factors that influence it.

R **[Delhi 2011]**

Ans. Primary productivity is the amount of biomass produced per unit area over a time period by green plants during photosynthesis. The factors that influence it are the plant species of the area, their photosynthetic activity, availability of nutrients, solar radiations, precipitation, soil types and the various environmental factors. **2**

Q. 5. What does secondary productivity in an ecosystem indicate ? List any two factors by which productivity is limited in an aquatic ecosystem.

R **[Delhi 2007]**

Ans. Secondary productivity indicates the organic matter synthesized by the consumers specially by the primary consumers or herbivores. The two factors by which the productivity is limited in an aquatic ecosystem are light and nutrient supply. **2**

Short Answer Type Questions-II (3 marks each)

Q. 1. Why is earthworm considered a farmer's friend? Explain humification and mineralisation occurring in decomposition cycle.

U **[Foreign 2015]**

Ans. Earthworms are called farmer's friends because they bring about the fragmentation of detritus and loosening of soil.

Humification is the process of formation of humus from detritus. Mineralization is the process of release of inorganic substances as both non-mineral and minerals from organic matter. **3**

Answering Tip

- Students must practice writing definition of humification and mineralisation, giving importance to operative words.

Q. 2. Describe how oxygen and chemical composition of detritus control decomposition ?

R **[Delhi 2011]**

Ans. Decomposition of detritus is an oxygen requiring process *i.e.* it takes place under aerobic condition in the presence of oxygen. Chemical composition of detritus affects decomposition. Detritus which is rich in nitrogen and water soluble substances decomposes rapidly whereas the detritus having chitin and lignin decomposes at a very slow rate. **3**

AI **Q. 3. (i) What is primary productivity ? Why does it vary in different types of ecosystems ?**

(ii) State the relation between gross and net primary productivity. R **[Delhi Set-I, 2011]**

Ans. **(i) Primary productivity :** Production of biomass / produced energy per unit area in a certain time period (per year) by plants during photosynthesis.

It depends upon – plant species inhabiting a particular area, environmental factors, availability of nutrients, photosynthetic capacity of plants.

(ii) GPP – R = NPP

where,

NPP = Net Primary Productivity

GPP = Gross Primary Productivity

R = Respiration Losses **3**

[CBSE Marking Scheme, 2011]

Commonly Made Error

- Students get confused between relationship between gross and net primary production.

Answering Tip

- Discuss the concept for proper understanding.

Q. 4. Describe the inter-relationship between productivity, gross primary productivity and net productivity.

R **[Outside Delhi - 2017, Set - I]**

Ans. Productivity is the rate of biomass production per unit area over a period of time, Gross primary productivity is the rate of production of organic matter during photosynthesis in an ecosystem.

Net productivity is the gross primary productivity minus respiration losses (R). **1 + 1 + 1**

[CBSE Marking Scheme, 2017]

OR

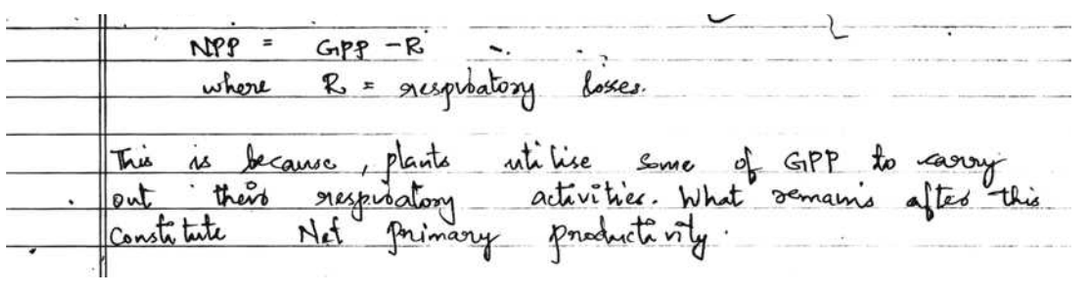
Ans.

12. Productivity can be defined as the rate of biomass production. This can be found at different trophic levels. In other words, the amount of biomass or organic produced per unit area per unit time is known as productivity.

Productivity considered at the producer level is referred to as primary productivity.

(GPP) Gross Primary productivity is the rate of formation of biomass or organic matter per unit area by plants through photosynthesis.

Whereas Net primary productivity (NPP) is the biomass that is available for consumption by the consumers of next trophic level i.e., herbivores.


NPP = GPP − R
where R = respiratory losses.
This is because, plants utilise some of GPP to carry out their respiratory activities. What remains after this constitute Net primary productivity.

[Topper's Answer, 2017]

Long Answer Type Questions **(5 marks each)**

Q. 1. (i) Explain primary productivity and the factors that influence it.

(ii) Describe how oxygen and chemical composition of detritus control decomposition.

R **[Delhi Set-I, 2014]**

Ans. (i) Primary productivity : Amount of biomass / organic matter produced per unit area over a time period by the plant during photosynthesis.

Factors : availability of nutrients / quality of light available / availability of water / temperature of the given place / type of plant species of the area / photosynthetic capacity of the plants.

(ii) Oxygen increases rate of decomposition.

Decomposition is an oxygen consuming process. It takes place under aerobic conditions *i.e.* in presence of oxygen.

Chemical decomposition is slow when chitin and lignin are present and fast when cellulose and water soluble substances are present.

[CBSE Marking Scheme, 2014] 5

AI **Q. 2. Describe the process of decomposition of detritus under the following headings: Fragmentation; leaching; catabolism; humification and mineralisation.** R **[Delhi Set-I, 2010, 2011]**

OR

Explain the different steps involved in the process of decomposition of detritus.

[Delhi Comptt., 2011]

Ans. The process of breaking down complex organic matter into inorganic substances like—CO_2, water and nutrient is called decomposition. The raw materials for decomposition is called detritus. They are dead remains of plants and animals.

Steps of decomposition :

Fragmentation : Breakdown of detritus into smaller particles *e.g.* earthworm.

Leaching : Water soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts.

Catabolism : Bacterial and fungal enzymes degrade detritus into simpler inorganic substances.

Humification : It leads to the accumulation of a dark coloured amorphous substance called humus that is highly resistant to microbial action and undergoes decomposition at an extremely slow rate.

Mineralisation : The humus is further degraded by some microbes and release inorganic substances by this process.

[CBSE Marking Scheme, 2010] 5

Answering Tip

- Write the steps of decomposition in proper sequence. Clear understanding of fragmentation, leaching, catabolism, humification and mineralization should be done. Students must practice writing definition or steps, giving importance to operative words.

Q. 3. Taking a small pond as an example of an ecosystem, list the four components of this ecosystem. How do these components function as a unit in a small pond ? A **[Delhi Set-I, II, III, Comptt., 2016]**

Ans. Four components of small pond ecosystem are:

Abiotic components - air, water, soil, light, temperature, other climatic conditions.

Biotic components - producers-phytoplanktons, some algae, floating and submerged plants.

Consumers of various order - Zooplanktons

Decomposers - Fungi, bacteria and other flagellates.

(any four-1 mark; any two-1/2 mark; atleast one biotic and abiotic components should be mentioned)

Components work as a unit for the following functions :

Productivity : Conversion of inorganic into organic material through photosynthesis with the help of solar energy and consumption of autotrophs by heterotrophs *i.e.* secondary productivity.

Decomposition : Decomposition and mineralisation of the dead matter.

Nutrient Cycling : To release the nutrients / elements back for use by autotrophs.

Energy Flow : Unidirectional flow of energy and its subsequent dissipation as one moves towards higher trophic levels.

[CBSE Marking Scheme, 2016] 5

Q. 4. Citing lake as an example of a simple aquatic ecosystem, interpret how various functions of this ecosystem are carried out. Make a food chain that is functional in this ecosystem.

A **[CBSE SQP, 2016-17]**

Ans. The components of lake ecosystem (viz : abiotic components, biotic components, consumers of various order and decomposers) function as an unit for various function of ecosystem as follows—

(i) Productivity—conversion of inorganic into organic material with the help of solar energy by the autotrophs. **½×2=1**

(ii) Energy flow—unidirectional movement of energy towards higher trophic level (and its dissipation and loss as heat to the environment). **½×2=1**

(iii) Decomposition—fragmentation, leaching, catabolism, humification, mineralization by bacteria, fungi and flagellates (abundant at the bottom of lake). **½×2=1**

(iv) Nutrient cycling—decomposition of dead matter to release the nutrients back to be re-used by the autotrophs. **½×2=1**

Food chain in aquatic ecosystem (lake):

Phytoplanktons ⇒ Zooplanktons ⇒ Small fish ⇒ Big fish. **1**

(Any other appropriate example)

[CBSE Marking Scheme, 2016]

AI **Q. 5. (i) Taking an example of a small pond, explain how the four components of an ecosystem function as a unit.**

(ii) Name the type of food chain that exists in a pond.

A **[Outside Delhi Set-I, 2016]**

Ans. (i) Productivity : Conversion of inorganic substances into organic material with the help of radiant energy / sunlight by the autotrophs / producers (phytoplankton, algae, floating, submerged plants). **1**

Decomposition : Decomposers (fungi, bacteria, flagellates) breakdown dead decayed organic matter into simpler compounds. **1**

Energy flow : Unidirectional movement of energy towards higher trophic levels (producer to consumer) and its dissipation and loss as heat to the environment. **1**

Nutrient cycle : Mineralisation of dead matter to release them back for reuse of autotrophs. **1**

(ii) Grazing food chain / detritus food chain. **1**

[CBSE Marking Scheme, 2016]

Detailed Answer :

(i) The various aspects taken into consideration to study the functioning of ecosystem are : Productivity, decomposition, energy flow and nutrient cycling. The four components of ecosystem (viz : abiotic, biotic, consumers and decomposers) function as a unit as follows :

(a) Productivity : If we take the example of pond ecosystem, the phytoplanktons are the organisms that capture the solar energy to perform photosynthesis. Thus, they contribute to primary productivity.

(b) Energy flow : They are then consumed by the zooplanktons. Zooplanktons are eaten by small fishes, which are in turn eaten by big fishes. Hence, there is constant unidirectional flow of energy between different trophic levels from producer to consumers.

(c) Decomposition and Nutrient cycling : When any organisms dies at any trophic level, the various microbes present in the pond water decompose the dead remains. The nutrients that are released in the process of decomposition are again available to the producers for the primary productivity.

(ii) Grazing detritus type of food chain is present in a pond ecosystem.

TOPIC-2
Energy Flow and Ecological Succession

Revision Notes

➢ **Energy Flow**

- Sun is the only source of energy for all ecosystems on the earth.
- Of the incident solar radiation less than 50% of it is photosynthetically active radiation (PAR).
- Plants, photosynthetic and chemosynthetic bacteria (autotrophs) fix solar radiant energy to make food.
- Plants capture only 2-10% of the PAR and this small amount of energy sustains the entire living world. So, it is very important to know how the solar energy captured by plants flows through different organisms of an ecosystem.
- Ecosystem obeys first and second Law of Thermodynamics.
- The energy of ecosystem is constant.
- They need a constant supply of energy to synthesize the molecules they require, to counteract the universal tendency toward increasing disorderliness.

- **Producers**
  - The green plants in the ecosystem which capture the solar energy and convert it into chemically bound energy are called producers.
  - All organisms are dependent for their food on producers (green plants), either directly or indirectly.
  - In a terrestrial ecosystem, major producers are herbaceous and woody plants.
  - Primary producers in an aquatic ecosystem are phytoplankton, algae and higher plants.
  - The energy trapped by the producer is either passed on to a consumer or the organism dies.
  - Death of organism is the beginning of the detritus food chain / web.
- **Consumers (Heterotrophs)**
  - These are all animals that depend on plants (directly or indirectly) for their food.
  - **They include :**
    - **(a) Primary Consumers**
      - These are herbivores that feed on plants.
      - *E.g.* Insects, birds and mammals in terrestrial ecosystem and molluscs in aquatic ecosystem.
    - **(b) Secondary Consumers**
      - These are primary carnivores that feed on herbivores *e.g.* Frog, fox, man etc.
    - **(c) Tertiary Consumers**
      - These are secondary carnivores that feed on primary carnivores.
- **Grazing Food Chain**
  - A simple grazing food chain (GFC) is depicted below :

    Grass - - - - - - - - - - → Goat — - - - - - - - - - - → Man

    (Producer) (Primary Consumer) (Secondary Consumer)
- **Detritus Food Chain (DFC)**
  - It begins with dead organic matter.
  - It is made up of decomposers (saprotrophs) which are heterotrophic organisms *e.g.* fungi and bacteria.
  - They meet their energy and nutrient requirements by degrading dead organic matter or detritus.
  - Decomposers secrete digestive enzymes that breakdown dead and waste materials into simple, inorganic materials, which are subsequently absorbed by them.
- In an aquatic ecosystem, GFC is the major conduit for energy flow.
- In a terrestrial ecosystem, a much larger fraction of energy flows through the DFC than through the GFC.
- DFC may be connected with GFC at some levels : some of the organisms of DFC are prey to the GFC animals.
- Some animals (cockroaches, crows etc.) are omnivores.
- These interconnections of food chains make a food web.
- Organisms occupy a place in the natural surroundings or in a community according to their feeding relationship.
- A specific place of organisms in the food chain is known as their trophic level.
- Producers belong to the first trophic level, herbivores to the second and carnivores to the third.
- The amount of energy decreases at successive trophic levels.
- When an organism dies it becomes dead biomass (detritus) that serves as an energy source for decomposers.
- Organisms at each trophic level depend on those at the lower trophic level for their energy demands.
- 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. Biomass of a species is expressed in terms of fresh or dry weight.
- Measurement of biomass in terms of dry weight is more accurate.
- The number of trophic levels in the grazing food chain is restricted as the transfer of energy follows Lindeman's 10 % law –only 10% of the energy is transferred to each trophic level from the lower trophic level.
- In nature, it is possible to have so many levels – producer, herbivore, primary carnivore, secondary carnivore in the grazing food chain.
- **Ecological Pyramids**
  - The representation of a food chain in the form of a pyramid is called ecological pyramid. It is the relationship between the producers and consumers of various order represented graphically.

- The base of each pyramid represents the producers (first trophic level) while the apex represents tertiary or top level consumer or the last trophic level.
- **Ecological pyramids are of three types :**
  (a) Pyramid of number
  (b) Pyramid of biomass
  (c) Pyramid of energy
- Any calculations of energy content, biomass or numbers has to include all organisms at that trophic level.
- The trophic level represents a functional level, not a species as such.
- A given species may occupy more than one trophic level in the same ecosystem at the same time. *E.g.* A sparrow is a primary consumer when it eats seeds, fruits, peas, and a secondary consumer when it eats insects and worms.
- In most ecosystems, all the pyramids are upright *i.e.* producers are more in number and biomass than the herbivores and herbivores are more in number and biomass than the carnivores.
- Also energy at a lower trophic level is always more than at a higher level.
- Example of inverted pyramids includes insects feeding on a big tree.
- Pyramid of biomass in sea is generally inverted because the biomass of fishes far exceeds that of phytoplankton.
- Pyramid of energy is always upright, because when energy flows from a trophic level to the next trophic level, as some energy is always lost as heat at each step.

➢ **Limitations of Ecological Pyramids**

(a) It does not take into account the same species belonging to two or more trophic levels.
(b) It assumes a simple food chain that almost never exists in nature, it does not accommodate a food web.
(c) Saprophytes are not included in ecological pyramids even though they play a vital role in the ecosystem.

➢ **Ecological Succession**

- It is a gradual, slow and predictable change in the species composition of an area leading to a climax community (community that is in equilibrium with the environment).
- During succession some species colonize an area and become more numerous, whereas populations of other species decline and disappear.
- The entire sequences of communities that successively change in a given area are called **sere**.
- The individual transitional communities are termed seral stages (seral communities).
- In the successive seral stages, there is a change in the diversity of species, increase in the number of species and organisms and an increase in the total biomass.
- The present day communities are the results of succession that occurred over millions of years.
- Succession and evolution would have been parallel processes at that time.

➢ **Types of Succession**

(a) Primary Succession

- The succession taking place in areas where no living organisms ever existed is known as primary succession.
- *E.g.* newly cooled lava, bare rock, newly created pond or reservoir.
- Before a biotic community is established, there must be formation of fertile soil through natural processes. So, the primary succession is a very slow process.

(b) Secondary Succession

- The succession taking place in an area after the existed organisms are lost is known as secondary succession.
- *E.g.* abandoned farm lands, burned or cut forests, lands that have been flooded.
- Since some soil or sediment is present, succession is faster than primary succession.
- The species that invade depends on the condition of the soil, availability of water etc.
- In succession, changes in vegetation affect food and shelter of various animals.
- Thus, as succession proceeds, the number and types of animals and decomposers also change.
- Natural or human induced disturbances (deforestation, fire etc.), can convert a particular seral stage of succession to an earlier stage.
- Such disturbances create new conditions that encourage some species and discourage or eliminate other species.

➢ **Succession of Plants**

- Based on the nature of the habitat, succession of plants is of two types namely hydrarch and xerarch.

(a) Hydrarch Succession

- It takes place in wetter areas.
- The successional series progress from hydric to mesic conditions.

(b) Xerarch Succession

- It takes place in dry areas.
- The series progress from xeric to mesic conditions.
- Hence, all successions (both hydrarch and xerarch) lead to medium water conditions (mesic, the climax community).
- The species invading a bare area are called pioneer species.

➢ **Primary Succession on Rocks (Xerophytic Habitat)**

- The species that invade a bare area are called pioneer species.
- In primary succession on rocks, lichens are the pioneer species which secrete acids to dissolve rock, helping in weathering and soil formation.
- These result in some very small plants like bryophytes, which take hold in the small amount of soil.
- With the passage of time, these are succeeded by bigger plants and after several more stages, ultimately as stable climax forest community is formed.
- The climax community remains stable as long as the environment remains unchanged.
- With time, the xerophytic habitat gets converted into a mesophytic one.

➢ **Primary Succession in Water**

- In primary succession in water, the pioneer species are the small phytoplanktons.
- With the time, these are replaced by free-floating angiosperms, then by rooted hydrophytes, sedges, grasses and finally the trees.
- The climax again would be a forest.
- With time, the water body is converted into land.

➢ **Secondary Succession**

- In secondary succession, the species that invade depend on the condition of the soil, availability of water, the environment and also on the seeds or other propagules present.
- Since soil is already present, the rate of succession is much faster and hence, climax is also reached more quickly.

IMPORTANT DIAGRAMS:

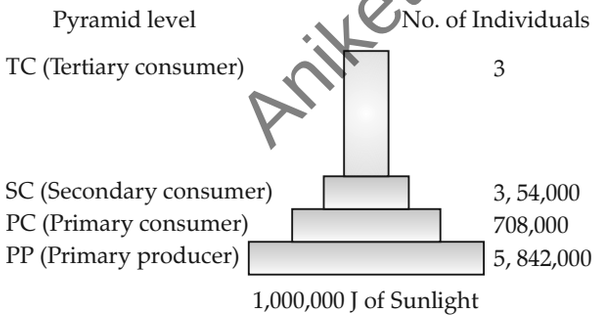


Fig 14.1 : Pyramid of numbers in a grassland ecosystem

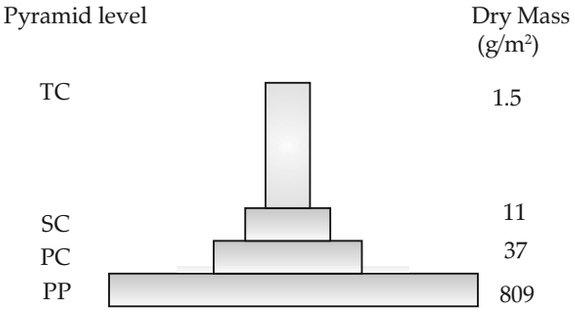


Fig 14.2 : Pyramid of Biomass in most Ecosystem

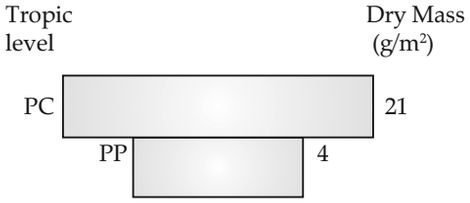


Fig 14.3 : Inverted Pyramid of Biomass in Sea

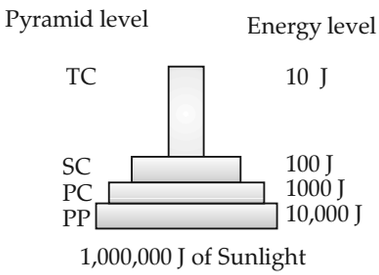


Fig 14.4 : An ideal pyramid of energy

Very Short Answer Type Questions (1 mark each)

Q. 1. Define Standing Crop. R **[CBSE SQP]**

Ans. Each trophic level has a certain mass of living material at a particular time called as the standing crop. **[CBSE Marking Scheme, 2018] 1**

AI **Q. 2. 'Man is a primary as well as the secondary consumer'. Justify this statement.**

U **[Foreign 2015]**

Ans. The man is a primary consumer when he eats plants or their products and is a secondary consumer when he eats animals. Man is in fact omnivore because he eats both plants as well as animals. **1**

Q. 3. What is detritus food chain made up of ? How do they meet their energy and nutritional requirements ? R **[Outside Delhi Set III, 2013]**

Ans. Detritus food chain is made up of decomposer organisms, which are mainly the microorganisms like bacteria and fungi. They meet their energy and nutritional requirements by degrading dead organic matter or detritus. **1**

Q. 4. 'It is possible that a species may occupy more than one trophic level in the same ecosystem at the same time.' Explain with the help of one example. A **[Outside Delhi Set-I, II, III, 2013]**

Ans. Yes, it is possible because the trophic level of a species represents the functional role of the organism in energy flow, which is determined by the food it takes. For example, sparrow is an omnivore. When it eats seeds, fruits or any other plant product, it occupies the primary trophic level. whereas, when it eats worms and any other insects, It occupies the secondary trophic level. Thus, it occupies more than one trophic level in the same ecosystem. **1**

Answering Tip

- While studying food chains, ecological pyramids and food webs, highlight the exact place occupied by a species and the specific role played by that species in that particular ecosystem as sometimes the same species may occupy a different trophic level in one ecosystem and the other in some other ecosystem. Explain trophic levels by means of diagrams and examples.

Q. 5. State what does 'standing crop' of a trophic level represent.

R **[Outside Delhi Set-I, II, III, 2013]**

Ans. It is the total amount of living matter or organic matter present in an ecosystem in a unit area and unit time. It is measured as the mass of living organisms *i.e.* biomass or their number in unit area. The biomass of a species is expressed in terms of dry or fresh weight. **1**

Q. 6.

Identify the type of the given ecological pyramid and give one example each of pyramid of number and pyramid of biomass in such cases.

A **[Delhi Set-I, 2011]**

Ans. Inverted pyramid

Inverted pyramid of biomass in a lake – Phytoplankton → Zooplankton → Fishes. ½

Inverted pyramid of number – tree → insects → Birds. **[CBSE Marking Scheme, 2011]** ½

Commonly Made Error

- Students could not draw the correct logical sequence.

Answering Tip

- Practice drawing all ecological pyramids.

Q. 7. What is the starting point of a detritus food chain. R **[Delhi 2007]**

Ans. Detritus food chain (DFC) start from detritus or dead and decaying organic matter *i.e.* dead plants and animals waste and animal faeces. Detrivores and decomposers feed over it. **1**

Answering Tip

- Carefully understand the differences between detritus food chain and grazing food chain with example for proper understanding and retention.

Q. 8. Mr. Galgotia eats curd/yoghurt. In this case, which trophic level will he occupy ?

E & A **[CBSE SQP, 2010]**

Ans. He would occupy third trophic level in this case. **1**

Q. 9. Write the basis on which an organism occupies a space in its community/natural surroundings.

U **[Outside Delhi 2013]**

Ans. Feeding relationship with other organisms. **1**

Short Answer Type Questions-I (2 marks each)

AI **Q. 1. Why is the pyramid of energy always upright? Explain.** A **[Delhi Set-I, III, 2013]**

OR

It is stated that the pyramid of energy is always upright. Justify. [Delhi Comptt, 2008]

Ans. The pyramid of energy is always upright because there is a gradual decrease in the energy contents in successive trophic levels from producers to consumers of various order. According to Lindeman's 10% law, only 10% of the total energy is available to the next higher trophic level. **2**

Commonly Made Error

- Students often give incorrect explanation.

Q. 2. Why is it difficult to get rid of 'water hyacinth' from a water body ? Name one abiotic component and one biotic component of the ecosystem that get affected by its spread in the water body.

R **[Delhi Comptt. 2011]**

Ans. Water hyacinth have caused havoc by their excessive growth. They grow abundantly in eutrophic water bodies and lead to an imbalance in the ecosystem dynamics of the water body.

Abiotic component : Water hyacinth impacts water flow and blocks oxygen.

Biotic component : This plant blocks sunlight from reaching native aquatic plants and poses threats to them. **2**

Commonly Made Error

- Students often get confused between technical terms like biotic and abiotic.

Q. 3. Why are herbivores considered similar to predators in ecological context ? Explain.

A **[Outside Delhi, 2010]**

Ans. The herbivores are considered like predators in ecological context because they feed on plants for their energy and nutritional requirements just as the predators feed on their prey for their food requirement. **2**

Q. 4. List the features that make a stable biological community. U **[Outside Delhi, 2010]**

Ans. Following features make the biological community stable :

(i) The community is an equilibrium with the biotic and abiotic factors.

(ii) In a community there is a large number of small and larger sized organisms.

(iii) The organisms in a stable community have longer life span. **(Any two) 2**

Q. 5. State the difference between the first trophic levels of detritus food chain and grazing food chain.

U **[Outside Delhi, 2008]**

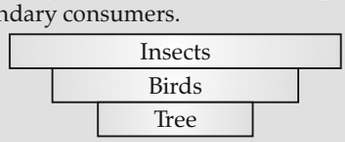
Ans. In detritus food chain, the detrivores and decomposers constitute the first trophic level whereas in grazing food chain the producers *i.e.* the autotrophic green and photosynthetic plants constitute the first trophic level. **2**

Short Answer Type Questions-II (3 marks each)

Q. 1. In a botanical garden of a city there is a huge banyan tree growing on which hundreds of birds and thousands of insects live. Draw the pyramids of numbers and also biomass represented by this community. Comment giving reasons on the two different pyramids drawn.

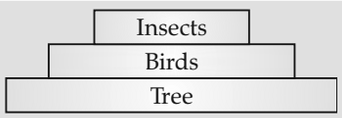
E & A **[Outside Delhi, Set-III, Comptt., 2016]**

Ans. Pyramid of Numbers – Inverted, number is increasing as one moves from producers to secondary consumers.



(Shape, labeling, reason) ½×3=1½

Pyramids of Biomass - upright - a huge tree with maximum biomass supports several birds with lesser biomass and insects with even lesser biomass.



(Shape, labeling, reason) ½×3=1½

[CBSE Marking Scheme, 2016]

Answering Tip

- Practice self-explanatory diagrams with proper labelling, arrows and headings

AI **Q. 2. Draw a pyramid of biomass and pyramid of energy in sea. Give your comments on the type of pyramids drawn.** U **[Foreign Set-I, 2016]**

Ans. Refer : Topic 2/ Revision Notes/ Important Diagrams/ Fig 14.3 and Fig 14.4 **2**

The pyramid of biomass in sea is inverted. ½

The pyramid of energy in sea is upright. ½

[CBSE Marking Scheme, 2016]

Q. 3. Differentiate between primary and secondary succession. Provide one example of each.

U **[Outside Delhi Set-I, 2016]**

Ans.

S. No.	Primary Succession	Secondary Succession
(i)	It takes place in area where no living organisms ever existed.	It takes place in areas which have lost all life forms due to any destructions like floods.
(ii)	Process of establishment of biotic community is very slow, as there is no fertile soil present.	Since, some soil or sediment is present, it is faster than primary succession.
(iii)	Example: Succession on newly cooled lava and bare rock.	Example : Succession in abandoned farm lands and burnt forest.

1+1+1=3

OR

Ans.

PRIMARY SUCESSION

Takes place in those areas where living organisms never existed in the history.

Is much slower and takes thousands of years, as soil has to be formed by natural processes, before living organisms can colonise and soil formation takes a long time.

eg. newly exposed habitats like newly cooled lava, bare rock, newly formed pond etc

SECONDARY SUCESSION

- Takes place in those areas which somehow lost all the living organisms which existed there.
- Since, some soil or sediment is already present, it is faster as compared to primary succession.

eg. burned down forests, flooded lands etc.

[Topper's Answer, 2016]

Q. 4. "In a food-chain, a trophic level represents a functional level, not a species." Explain.

A **[Delhi Set-I, 2016]**

Ans. Position of a species in any trophic level is determined by the function performed by that mode of nutrition of species in a particular food chain / 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, 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.

Similar value points explained with the help of a suitable example. **½ × 6 = 3**

[CBSE Marking Scheme, 2016]

Detailed Answer :

The organisms can be divided on the basis of their feeding relationships. On the basis of sources of their nutrition, organisms occupy a specific position in the food chain called their trophic level. More than one species of organisms can occupy the same trophic level in a food chain, for example in a grassland ecosystem, rabbits and butterflies occupy the same trophic level, while both are different species. Thus, in a food chain, a trophic level represents a functional level, not a species.

Q. 5. Explain successions of plants in xerophytic habitat until it reaches climax community.

U **[Delhi Set-I, Comptt. 2015]**

Ans. Lichens on bare rock, secrete acids to dissolve rock (weathering of soil), Bryophytes to hold soil, water, grass, small plants/shrubs, tree-forest (Climax community). **½ × 6 = 3**

[CBSE Marking Scheme, 2015]

Detailed Answer:

The species that invade a bare area are called pioneer species. In primary succession on rocks, lichens are the pioneer species which secrete acids to dissolve rock, helping in weathering and soil formation. These result in some very small plants like bryophytes, which take hold in the small amount of soil. With the passage of time, these are succeeded by bigger plants and after several more stages, ultimately a stable climax forest community is formed. The climax community remains stable as long as the environment remains unchanged.

Q. 6. What is ecological succession ? Where and why would the rate of succession be faster in newly created pond or a forest destroyed by a forest fire?

U **[Outside Delhi Set-I, Comptt. 2015]**

Ans. Gradual / predictable change in the species composition of given area. Rate of succession would be faster in a forest destroyed by a forest fire. Such disturbances create new conditions that encourage some species and discourage or eliminate other species / since after a forest fire some soil is already present, so, succession is faster than primary succession. **1×3=3**

[CBSE Marking Scheme, 2015]

Q. 7. How does a detritivore differ from a decomposer ? Explain each with an example.

U **[Delhi Set-I, Comptt. 2015]**

Ans.

S. No.	Detritivore	Decomposer
(i)	Feeds on waste dead plant and animal remains including faecal matter.	Degrades dead organic matter.
(ii)	Breaks feeding material into fragments.	Secretes enzymes into dead organic matter for decomposition.
(iii)	*e.g.,* Earthworm.	*e.g.,* Bacteria / Fungi.

1×3=3

Answering Tip

- Understand the differences between Detritivore and decomposers with examples.

Q. 8. Construct labelled grazing and detritus food chains with minimum three trophic levels each.

A **[Outside Delhi Set-I, II, Comptt. 2013]**

Ans. Grazing food chain :

Autotrophs → Herbivores → Primary carnivores → secondary carnivores.

Detritus food chain :

Decay and excretory materials from the grazing food chain. → decomposer organism → soil animal which consume other soil organisms.

1½ + 1½ = 3

Q. 9. Differentiate between two different types of pyramids of biomass with the help of one example of each. U **[Outside Delhi Set-I, II, 2013]**

Ans. Pyramids of biomass are of both types, upright and inverted. Upright pyramid of biomass can be found in forest and grassland ecosystems, while inverted pyramid of biomass is seen in lake and ocean ecosystem. Biomass on next trophic level is higher than previous trophic level in inverted pyramid.

Diagram: Refer Topic 2/ Revision Notes/ Important diagrams/ Fig 14.2 and Fig 14.3 **1 + 2**

Answering Tip

- Understand trophic levels by means of diagrams and examples.

AI **Q. 10.Name the pioneer species on a bare rock. How do they help in establishing the next type of vegetation ? Mention the type of climax community that will ultimately get established.**

U **[Delhi Set-I, II, III, 2011]**

Ans. The pioneer species on a bare rock are usually lichen, mosses and annual grass stage and blue-green algae. In primary succession on rocks, lichens are able to secrete acids to dissolve rocks, helping in weathering and soil formation. It paves way to some very small plants like bryophytes, which are able to take hold in the small amount of soil. They are with time, succeeded by bigger plants.

Several hard and light demanding trees grow in the area occupied by shrubs. Slowly environment becomes more moist and shadier so that plants of climax community can spread in this area. The type of climax community that will ultimately get established are shrubs and trees. **3**

Q. 11. Match the column A with any two of the two column B.

	Column A	Column B
A.	**Community**	**1.** Interacting population **2.** Energy flow **3.** Biomass
B.	**Upright pyramid**	**4.** Solar energy **5.** Gravity
C.	**Hydrologic cycle**	**6.** Food chain **7.** H.S. Glisson

R **[Delhi Set, 2005]**

Ans.

	Column A	Column B
A.	Community	1. Interacting population 6. Food chain
B.	Upright pyramid	2. Energy flow 3. Biomass
C.	Hydrologic cycle	4. Solar energy 5. Gravity.

1 × 3 = 3

Long Answer Type Questions

(5 marks each)

AI **Q. 1. (i) Colonization of a rocky terrain is a natural process. Mention the group of organisms which invade this area first. Give an example.**

(ii) Over the years, it has been observed that some of the lakes are disappearing due to urbanization. In absence of human interference, depict by making a flow chart, how do the successional series progress from hydric to mesic condition.

(iii) Identify the climax community of hydrarch and xerarch succession. A **[CBSE SQP, 2016-17]**

Ans. **(i)** Pioneer species, lichen **½×2=1**

(ii) Phytoplankton-hydric **½×7=3½**

⇓

Submerged plant stage

⇓

Submerged free floating plant stage

⇓

Reed swamp stage

⇓

Marsh-meadow stage

⇓

Shrub stage

⇓

Forest stage-Mesic

(iii) Forest **[CBSE Marking Scheme, 2017] ½**

Answering Tip

- Graphic representations should be in the proper sequence.

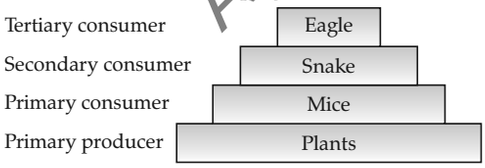
Q. 2. It is often said that the pyramid of energy is always upright. On the other hand, the pyramid of biomass can be both upright and inverted. Explain with the help of examples and sketches.

U **[Delhi Set-I, 2015]**

Ans. **For diagram:** Refer Topic 2/ Revision Notes/ Important Diagram/ Fig 14.4

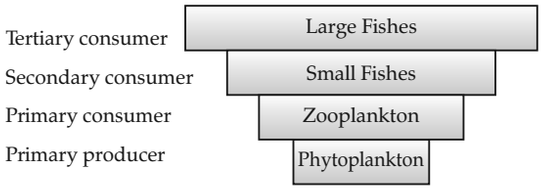
The pyramid of energy represents the total amount of energy consumed by each trophic level in a given food chain. An energy pyramid is always upright because the total amount of energy available for utilisation in the top levels is less than the energy available in the lower levels. This happens because according to the 10% law of energy flow, only 10% of the total energy is transferred from one trophic level to another.

The pyramid of biomass is a graphical representation of total amount of living matter present at each trophic level of an ecosystem. The pyramid of biomass can be both upright and inverted.



Grassland Ecosystem
(Upright)

The pyramid of biomass is upright in grasslands and forest ecosystems because the amount of biomass present at the producer level is higher than at the top carnivore level.



Pond Ecosystem
(Inverted)

The pyramid of biomass is inverted in a pond ecosystem as the biomass of fishes exceeds the biomass of zooplankton (upon which they feed). **5**

Q. 3. (i) Differentiate between primary and secondary ecological succession.

(ii) Explain the different steps of xerarch succession occurring in nature.

U **[Delhi Set-II, III, 2014]**

Ans. **(i)** Refer SAQ-II/ Q.3.

(Any two) [1 mark each difference]

(ii) Xerarch Succession :

(a) Takes place in dry area hence progress from xeric to mesic condition.

(b) Pioneer species such as lichens secrete acids to break rocks, initiate soil formation.

(c) lichens pave way to bryophytes.

(d) which are succeeded by bigger plants. Ultimately, stable mesic community is formed. **2 + 3 = 5**

[CBSE Marking Scheme, 2014]

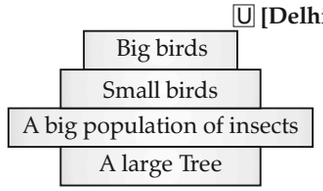
Q. 4. (i) Construct a pyramid of numbers considering a big banyan tree supporting a population of insects, small birds and their predators.

[Outside Delhi Set-I, II, Comptt. 2013]

(ii) Differentiate, giving reason, between the pyramid of biomass of the above situation and the pyramid of numbers that you have drawn.

U **[Delhi Set-II, 2012]**

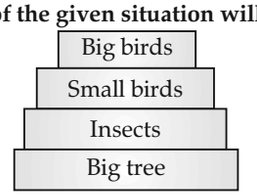
Ans. **(i)**



This is a spindle-shaped Pyramid.

In the above pyramid, the population of insects is more than the tree, therefore, the size of pyramid increases, but the number of small birds is lesser than the insects. The pyramid size becomes narrow. Further, big birds are lesser than small birds. So the size of pyramid becomes narrower.

(ii) Actually, the pyramids of numbers do not give a true picture of the food chain, as they are not very functional. They do not indicate the relative effect of the geometric food chain and size. Here, the size of the pyramid becomes variable. **The pyramid of biomass of the given situation will be :**



The pyramid of biomass in this ecosystem is upright because the biomass decreases at each trophic level. **2½ + 2½ = 5**

Q. 5. (i) Explain the significance of ecological pyramids with the help of an example.

(ii) Why are the pyramids referred to as 'upright' or 'inverted' ? Explain. A **[Delhi Set-II, 2012]**

Ans. **(i)** Significance of ecological pyramids:

(a) Helps in comparing different ecosystems.

(b) Helps in studying seasonal variations and changes in ecosystem.

(c) Helps in studying amount of energy transfer, biomass production, number of organisms at each trophic level in ecosystems.

For e.g. pyramid of number in grassland: In this type of ecological pyramid, the number of producers is followed by number of herbivores, which in turn are followed by number of secondary and tertiary carnivores. Hence, the number of individuals at the producer level will be maximum while the number of individuals present at top carnivores will be least.

Refer: Topic 2 / Revision Notes / Important Diagrams /Fig. 14.1.

(ii) Pyramids can be upright or inverted. For e.g. Pyramid of energy is always upright as only 10% energy is transferred from one trophic level to the next while pyramid of biomass is inverted in pond ecosystem. Inverted pyramid shows less number / biomass of producers when compared to primary consumers. **3 + 2 = 5**

Q. 6. Explain how xerarch succession progresses from xeric to mesic condition and forms a stable climax community. You may use a flow chart.

A **[Outside Delhi Comptt. 2011]**

Ans. **Xerarch succession :** Xerarch succession takes place in dry areas and the series progress from xeric to mesic condition.

In primary succession on rocks, the pioneer species i.e. lichens secrete acids to dissolve rock, helping in weathering and soil formation. These later pave way to some very small plants like bryophytes which are able to take hold in the small amount of soil. They are with time, succeeded by bigger plants and after several more stages ultimately a stable climax forest community is formed.

The climax community remains stable as long as the environment remains unchanged. With time the xerophytic habitat gets converted into a mesophytic one.

The stages in xerarch succession are as follows :

Lichens (Pioneer community)
↓
Bryophytes (mosses) (Serial communities)
↓
Herbaceous plants
↓
Shrubs (bushes)
↓
Trees (Climax community)

In secondary succession, the species that invade depends on the condition of the soil, availability of water, the environment and also on the seeds or other propagules present. Since soil is already there, the rate of succession is much faster and hence, climax is also reached more quickly. Primary succession is a slow process, taking about thousands of years for the climax to be reached. Another important fact is to understand that all succession, whether taking place in water or on land, proceed to a similar climax community, the mesic. **5**

Commonly Made Error

- Students often get confused between hydrarch and xerarch succession. Instead of xerarch, they write description of hydrarch succession and loose marks.

Answering Tip

- Learn the concept of xerarch and hydrach carefully. Practice showing the stages in xerarch and hydrarch with proper flow chart.

AI **Q. 7. (i) Draw an ideal pyramid of energy upto four trophic levels where 10,000 J are available from sunlight to the primary producer. Indicate the amount of end product available at each trophic level.**

(ii) Why is pyramid of energy always upright? Explain.

(iii) Mention the limitations of an ecological pyramid.

U **[Outside Delhi Comptt. 2011]**

Ans. **(i)** **(a) Please note:** In fig. 14.4 the energy from sunlight mentioned is 1000,000 J. However, in question it is 10,000 J. Hence, there will be change in the energy transferred at different tropic levels. Energy Levels will start from100, 10 and 1

(b) Figure 14.4 shows an ideal pyramid of energy. Observe that primary producers convert only 1% of the energy in the sunlight available to them into NPP.

(ii) Pyramid of energy is always upright, can never be inverted, because when energy flows from a particular trophic level to the next tropic level, some energy is always lost as heat at each step. Each bar in the energy pyramid indicates the amount of energy present at each trophic level in a given time or annually per unit area.

(iii) There are certain limitations of ecological pyramids such as :

(a) It does not take into account the same species belonging to two or more trophic levels.

(b) It assumes a simple food chain, something that almost never exists in nature.

(c) It does not accommodate a food web.

(d) Moreover, saprophytes are not given any place in ecological pyramids even though they play a vital role in the ecosystem. **1 + 2 + 2 = 5**

Q. 8. (i) What is an ecological pyramid ? Compare the pyramids of energy, biomass and numbers.

(ii) Write any two limitations of ecological pyramids. U **[Outside Delhi 2017, Set - I, II, III]**

Ans. **(i)** Graphical representation of the relationship among the organisms at different trophic level **2**

Pyramid of Energy	Pyramid of Biomass	Pyramid of Numbers
Shows transfer of Energy from one tropic level to other.	Shows transfer of amount of food / biomass from one tropic level to other.	Pyramid of Numbers shows numbers of organism at each tropic level.
Always upright.	Mostly upright but can be inverted.	Mostly upright can be inverted.

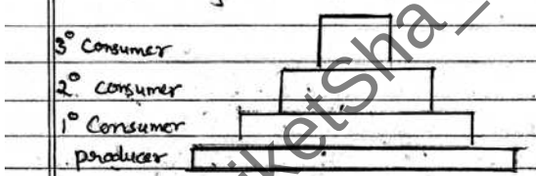
(ii) Refer LAQ/ Q.7 (iii). **3**

OR

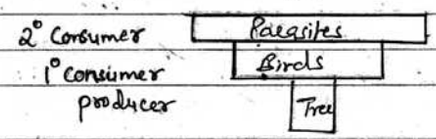
Ans. a) An ecological pyramid is a graphical representation of different trophic levels of a food chain in an ecosystem, reflecting any one of the parameters like number, biomass, energy etc.

A pyramid of number indicates the number of organisms involved in each trophic level.
These pyramids may be upright, inverted or spindle-shaped

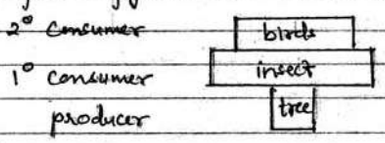
For a grassland ecosystem, the number pyramid is upright. The number of ~~producers~~ producers i.e. plants and trees are far greater than the primary consumers - herbivore which feed up on these plants and trees. The herbivores are greater in number than the 2° consumers - i.e. carnivores who in turn have greater number when compared to 3° consumers - top carnivores. Hence the pyramid can be depicted as:



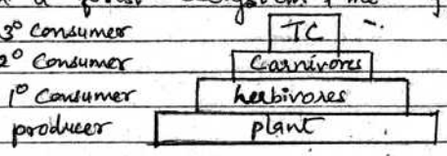
When a single tree is considered and the birds feeding on the tree will be greater in number. The parasites which reside in the body of birds will be still higher in number. Thus such a food chain gives an inverted number pyramid



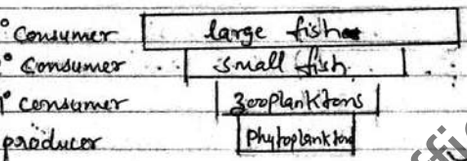
Again, consider a single tree and the no: of insects feeding on it will be higher. The number of birds in turn feeding on insects will be lower. Hence it gives a spindle shaped pyramid



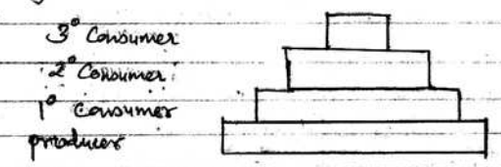
A pyramid of biomass indicates the biomass of ~~different~~ organisms occupying ~~at~~ different trophic levels.
In a forest ecosystem, the pyramid of biomass is ~~inverted~~ upright



In a sea ecosystem, the pyramid of biomass is inverted
Considering the food chain phytoplanktons → zooplanktons → small fishes → large fishes
the biomass of phytoplanktons which are microscopic, is far less than that of zooplanktons though being abundant. The biomass of fishes feeding on zooplanktons is in turn higher while the largest fishes feeding on small fishes have still higher biomass
∴ The pyramid is depicted as:



A pyramid of energy depicts the energy at the each trophic level. Such a pyramid is always upright. Because, according to 10% law, only 10% energy is transferred to a trophic level from lower trophic level. Hence some energy is always lost in the form of heat etc during transfer. This makes energy at higher trophic level less than the lower one



d) The limitations of ecological pyramids are:-
i) it does not take into account the same species belonging to different trophic levels
ii) it assumes a simple food chain, which ~~takes~~ never exists in nature, it does not accomodate a food web
iii) saprotrophs are not given any place.

[Topper's Answer, 2017]

Q. 9. (i) Comment on the pattern in which all communities undergo a change in composition and structure with changing environmental conditions.

(ii) Explain 'Climax community' and 'sere'.

(iii) Differentiate between primary and secondary succession with examples.

[U] [Outside Delhi - 2017, Set - I, II]

Ans. (i) Orderly and sequential changes, parallel with changes in physical environment **1**

(ii) Climax community - changes finally, lead to a community that is in equilibrium with environment. **1**

Sere - the entire sequence of communities that successively change in a given area. **1**

(iii) Primary succession

(i) Occurs in newly cooled lava / bare rock / newly created pond.

(ii) Slow process.

Secondary succession

(i) Occurs in abandoned / destroyed forest.

(ii) Fast process. **½ × 4 = 2**

[CBSE Marking Scheme, 2017]

Q. 10. What does an ecological pyramid indicate ? Explain the three different type of upright pyramids in nature with the help of an example each.

[U] [Delhi - 2017, Set - I, II, III]

Ans. It indicates food / energy relationship between organisms at different trophic levels

(i) Pyramid of Number = example : grassland ecosystem.

OR

Producers are more number than herbivores carnivores.

(ii) Pyramid of Biomass = example : forest / tree ecosystem.

OR

Producers have more biomass than herbivores / carnivores.

OR

Pyramid of biomass shows a sharp decrease in biomass in higher trophic levels.

(iii) Pyramid of energy = example : grassland ecosystem.

OR

Producers have more energy than herbivores / carnivores

[CBSE Marking Scheme, 2017] 5

Detailed Answer :

Ecological pyramids are the representation of a food chain in the form of a pyramid.

(i) Pyramid of Number : It represents the relationship between producers and consumers in an ecosystem in the form of a pyramid in terms of their numbers.

E.g. Grassland Ecosystem : **For diagram:** Refer: Topic 2/ Revision Notes/ Important Diagrams/ Fig 14.1

(ii) Pyramid of Biomass : It shows a sharp decrease in biomass at higher trophic levels. **For diagram:** Refer: Topic 2/ Revision Notes/ Important Diagrams/ Fig 14.2

(iii) Inverted Pyramid of Biomass : Small standing crop of phytoplankton supports large standing crop of zooplankton. **For diagram:** Refer- Topic 2/ Revision Notes/ Important Diagrams/ Fig 14.3

(iv) Pyramid of Energy : Primary producers convert only 1%of the energy in the sunlight available to them into NPP. **For diagram:** Refer: Topic 2/ Revision Notes/ Important Diagrams/ Fig 14.4

Q. 11. Draw the pyramids of biomass in sea and in a forest. Explain giving reasons why are the two pyramids different ?

[R] [Delhi/Outside Delhi, Comptt, Set 1,2,3, 2018]

Ans. Pyramid of biomass in Sea : Refer Topic 2/ Revision Notes/ Important Diagrams/ Fig 14.3 **1**

Pyramid of biomass in a Forest : Refer Topic 2/ Revision Notes/ Important Diagrams/ Fig 14.2 **1**

Sea - Inverted , because biomass of fish /other aquatic animals exceeds that of phytoplanktons / small standing crop of phytoplankton supports large standing crop of zooplankton. **½ + 1**

Forest - Upright, because biomass of producers exceeds that of herbivores / carnivores / allows the sharp decrease in biomass at higher trophic levels. **½ + 1**

[CBSE Marking Scheme, 2018]

Q. 12. (a) What is a trophic level in a ecosystem ? What is 'standing crop' with reference to it ?

(b) Explain the role of the 'first trophic level' in an ecosystem.

(c) How is the detritus food chain connected with the grazing food chain in a natural ecosystem ?

[R] [Delhi/Outside Delhi, 2018]

Ans. (a) Specific place of an organism in a food chain, mass of living material (biomass) at each trophic level at a particular time. **1 + 1**

(b) First trophic level has producers / autotrophs, which trap solar energy / to produce food (photosynthesis). **1 + 1**

(c) 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.

½ + ½

[2 + 2 + 1 = 5 marks]

[CBSE Marking Scheme, 2018]

Detailed Answer:

(a) A specific place of organisms in the food chain is known as their trophic level. Producers belong to the first trophic level, herbivores to the second and carnivores to the third.

Each trophic level has a certain mass of living material at a particular time called as the standing crop. Standing crop is the quantity or total weight of dried biomass of the organism which is present in a specific location at a particular time. It is measured as the mass of living organisms (biomass) or the number in a unit area.

(b) The first trophic level is the producer. At this level, the organisms are autotrophic. They prepare their own food with the help of sunlight. Producers have the ability to transform light energy into chemical energy so that it can be useful to other trophic levels and for the sustenance of the ecosystem.

In detritus food chain, energy comes from organic matter generated in trophic levels of the grazing food chain.

2 + 2 + 1

TOPIC-3
Nutrient Cycling and Ecosystem Services

Revision Notes

- **Nutrient Cycling :** The movement of nutrient elements through the various abiotic and biotic components of an ecosystem is called nutrient cycling. It is also called as biogeochemical cycles. The total amount of nutrients present in soil at anytime is called standing state. This varies with the type of ecosystem and season. There are two types of nutrient cycles :
  - **(i) Gaseous** – exist in atmosphere.
  - **(ii) Sedimentary** – exists in earth crust.
- Environmental factors like soil, moisture, pH, temperature regulate the rate of release of nutrients into the atmosphere. The function of reservoir is to meet with the deficit which occurs due to imbalance in the rate of influx and efflux.
- **Carbon Cycle :** Carbon cycling occurs through atmosphere, ocean and through living and dead organisms. Most of carbon is fixed by plants during the process of photosynthesis and returned to atmosphere in form of CO_2 during respiration. Burning of wood, forest fire and combustion of organic matter, fossil fuel and volcanic activity are other sources of releasing CO_2 in the atmosphere.
- **Phosphorus Cycle :** The natural reservoir of phosphorus is rock which contains phosphorus in the form of phosphates. On weathering, minute amount of phosphates dissolve in soil solution and is absorbed by the roots of the plants. The waste products of dead organisms are decomposed by bacteria to release phosphorus. Gaseous exchange between organism and environment is negligible as compared to carbon.
- **Ecosystem Services :** The products of ecosystem processes are called ecosystem services. It includes :
  - **(i)** The healthy forest ecosystem which purify air and water.
  - **(ii)** Mitigates floods and droughts.
  - **(iii)** Cycle nutrients.
  - **(iv)** Generate fertile soil.
  - **(v)** Provide wildlife habitat.
  - **(vi)** Maintain biodiversity etc.

  These fundamental ecosystem services are taken for granted because they are free although its value is twice the total global Gross National Product (GNP). Soil formation accounts for about 50% of total ecosystem services.

IMPORTANT DIAGRAMS:

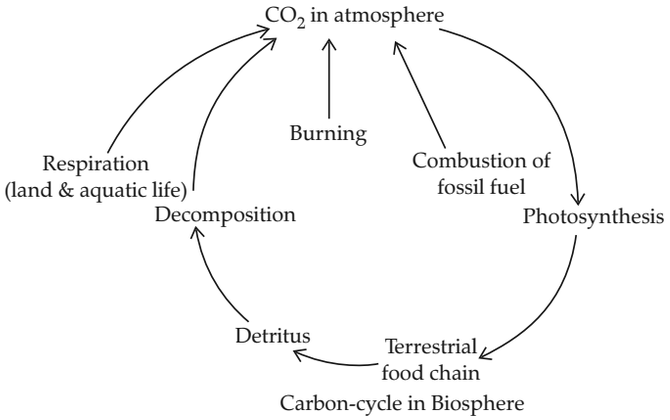


Fig 14.5 : Simplified model of Carbon cycle in the biosphere

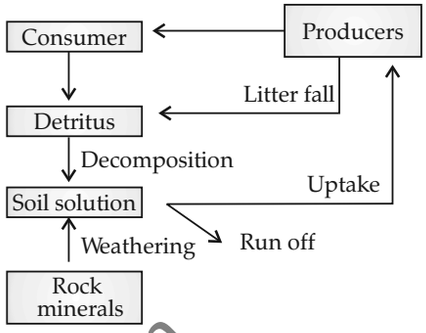


Fig 14.6 : Phosphorus cycling in a terrestrial ecosystem

Short Answer Type Questions-I

(2 marks each)

AI **Q. 1. Explain the functions of reservoirs in a nutrient cycle. List two types of nutrient cycles in nature.** U **[Outside Delhi Comptt., 2010]**

Ans. The two types of nutrient cycles are gaseous and sedimentary. Atmosphere is the reservoir for gaseous cycle and lithosphere is the reservoir of sedimentary cycle respectively. The reservoir is required to meet the deficiency of nutrients due to the imbalance in rate of influx and efflux. **2**

Q. 2. Name the two type of nutrient cycles existing in nature. Where are their reservoirs present ? State the functions of the reservoirs. U **[Delhi Comptt. 2010]**

Ans. The nutrients are never lost from an ecosystem but are recycled time to time and again indefinitely. **Nutrient cycles are of two types :**

(i) Gaseous cycles : The reservoir for gaseous cycles exists in the atmosphere e.g. carbon cycle, nitrogen cycle.

(ii) Sedimentary cycles : The reservoir for sedimentary cycles exists in the earth's crust *e.g* phosphorus cycle, sulphur cycle.

The function of the reservoir is to meet with the deficit, which occurs due to imbalance in the rate of influx and efflux. **1 + 1 = 2**

Q. 3. Global carbon is fixed in the biosphere through photosynthesis. Explain any two ways by which carbon is returned to the atmosphere. U **[Outside Delhi Comptt. 2010]**

Ans. The carbon is returned to the atmosphere through respiration by all living beings and burning fossil fuel. Considerable amount of carbon returns to the atmosphere as CO_2 through respiratory activities of the producers and consumers. Decomposers also contribute substantially to CO_2 pool by their processing of waste materials and dead organic matter of land or oceans.

Burning of wood, forest fire and combustion of organic matter, fossil fuel, volcanic activity are additional sources for releasing CO_2 in the atmosphere.

Rapid deforestation and massive burning of fossil fuel for energy and transport have significantly increased the rate of release of carbon dioxide into the atmosphere. **2**

Short Answer Type Questions-II

(3 marks each)

Q. 1. State the function of a reservoir in a nutrient cycle. Explain the simplified model of carbon cycle in nature. U **[Outside Delhi Set-III, 2014]**

Ans. Function : To meet the deficit which occurs due to imbalance in the rate of influx and efflux. **1**

Carbon cycle : Refer Topic 3 / Revision Notes / Important Diagrams / Fig 14.5 **2**

[CBSE Marking Scheme, 2014]

Detailed Answer :

Function of reservoir : To make up for the imbalance caused (deficit) due to loss of balance in the efflux and influx of minerals.

Carbon Cycle : The carbon cycle is a gaseous cycle with its source and sink as the atmosphere and the oceans.

The carbon is present in atmosphere as carbon dioxide which is released by :

(i) Respiration by plants, animals and other living beings.

(ii) Burning of fossil fuels.

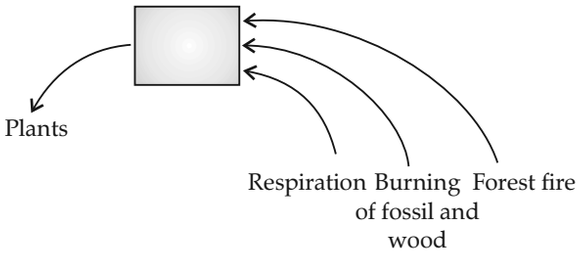
The fixation of carbon dioxide is carried out by plants (photosynthesis) so deforestation hampers cycle.

Carbon is also present in nature as calcareous sediments, on oceans (usually) and land (nutrients). **3**

Commonly Made Error

- Students fail to draw a model of carbon cycle. Make sure the lines are properly marked. Labeling lines should not cut each other. Lines which are not properly marked will deduct your marks.

Q. 2.



(i) (a) Name the biogeochemical (nutrient) cycle shown above.

(b) Name an activity of the living organisms not depicted in the cycle by which this nutrient is returned to the atmosphere.

(ii) How would the flow of the nutrient in the cycle be affected due to large scale deforestation ? Explain giving reasons.

(iii) Describe the effect of an increased level of this nutrient in the atmosphere on our environment.

E & A **[Delhi Set-I, II, III, 2011]**

Ans. (i) (a) Carbon cycle in biosphere.

(b) Volcanic activity and mining, microbial decomposition of organic matter.

(ii) Clearing of vast areas covered by forest, by man, is called deforestation. It is the main cause of soil erosion in India. Due to large scale deforestation, the flow of carbon in the environment will be disturbed because plants are the major consumers which utilise carbon for photosynthesis. This would lead to accumulation of carbon in the atmosphere.

(iii) Increase in the level of carbon in atmosphere will result in greenhouse effect. This will lead to heating of earth's surface and finally to global warming. Rise in temperature, results in odd climatic changes, which are harmful for the environment. **3**

Q. 3. (i) Healthy ecosystems are the base of wide range of (ecosystem) services. Justify.

(ii) Explain the difference and the similarities between hydrarch and xerarch successions of plants.

U **[Delhi Set-I, II, III, 2011]**

Ans. (i) Healthy ecosystems are the base for a wide range of economic, environmental and aesthetic goods and services. The products of ecosystem processes are named as ecosystem services. For examples, healthy forest ecosystem purifies air and water, minimize droughts and floods, cycle nutrients, generates fertile soils, provides wildlife habitat, maintains biodiversity, pollinate crops, provide storage site for carbon and also provide aesthetic, cultural and spiritual values. Though value of such services of biodiversity is difficult to determine, it seems reasonable to think that biodiversity should carry a healthy price tag.

(ii) Based on the nature of the habitat – whether it is water (or very wet areas) or it is on very dry areas – succession of plants is called hydrarch or xerarch, respectively.

Differences : Hydrarch succession takes place in wetter areas and the successional series progress from hydric to mesic conditions. As against this, xerarch succession takes place in dry areas and the series progress from xeric to mesic conditions.

Similarity : Both hydrarch and xerarch successions lead to medium water conditions (mesic), neither too dry (xeric) nor too wet (hydric). **3**

AI **Q. 4. Carbon cycle in nature is a biogeochemical cycle. Explain how is it different from phosphorus cycle.**

OR

Explain with the help of a flow chart recycling of phosphorus in nature. How is phosphorus cycle different from carbon cycle in nature ?

U **[Delhi Comptt. 2011]**

Ans. Recycling of phosphorus : Phosphorus is a major constituent of biological membranes, nucleic acids and cellular energy transfer system. The natural reservoir of phosphorus is rock, which contains phosphorus in the form of phosphates. When rocks are weathered, minute amount of these phosphates dissolve in soil solution and are absorbed by the roots of the plants. Herbivores and other animals obtain this element from plants. The waste products and the dead organisms are decomposed by phosphate-solubilizing bacteria releasing phosphorus. Unlike carbon cycle, there is no respiratory release of phosphorus into atmosphere.

Note : For diagram : Refer Topic 3/ Revision Notes/ Important diagrams/ Fig 14.6

Differences between carbon and phosphorus cycle : The major and important differences between carbon and phosphorus cycle are firstly, atmospheric inputs of phosphorus through rainfall are much smaller than carbon inputs and secondly, gaseous exchanges of phophorus between organisms and environment are negligible.

S. No.	Characters	Carbon cycle	Phosphorus cycle
(i)	Amount of atmospheric input	More in amounts	Less in amounts
(ii)	Degree of exchanges between organism and environment	High	Negligible
(iii)	Nature of cycle	Perfect cycle	Imperfect cycle

2+1

Answering Tip

- Understand the differences between carbon cycle and phosphorus cycle in tabular form.

Long Answer Type Questions (5 marks each)

AI **Q. 1. (i) Name the specific cellular components where phosphorus is in abundance in living organisms.**

(ii) Name the natural reservoir of phosphorus.

(iii) Explain the phosphorus cycle.

R **[Outside Delhi Set-I, II, III Comptt. 2016]**

Ans. (i) Phosphorus in living systems occur in biological membranes / nucleic acids / cellular energy transfer system / bones, teeth / in animal shells.

(Any two) ½ + ½ = 1

(ii) The natural reservoir of phosphorus is rock which contains it in the form of phosphates. **1**

(iii) Phosphorus cycle : The phosphates dissolved in soil solution are absorbed by the roots of higher plants. The dead organic remains of animals and plants are decomposed by microorganism like bacteria to release phosphorus again in the soil from where it is again absorbed by plants. **For diagram:** Refer to Topic 3/ Revision Notes/ Important diagrams/ Fig. 14.6. **3**

[CBSE Marking Scheme, 2016]

Q. 2. Discuss the role of healthy ecosystem services as a pre-requisite for a wide range of economic, environmental and aesthetic goods and services. C **[Delhi - 2017, Set - I, II, III]**

OR

Describe the advantages of keeping the ecosystems healthy. [Delhi Set-I, 2015]

Ans. The various advantages of keeping the ecosystem healthy are as follows :

(i) Healthy ecosystem is the base for a wide range of economic, environmental and aesthetic goods and services.

(ii) The products of ecosystem processes are named as ecosystem services, as they are of great help to the organisms living within an ecosystem.

(iii) Healthy forest ecosystem purify air and water.

(iv) It also mitigates droughts, floods and cycle nutrients.

(v) Healthy ecosystem generates fertile soil and provides wildlife habitat.

(vi) Maintenance of biodiversity is also an important aspect of healthy ecosystem.

(vii) It also provides aesthetic, cultural and spiritual values. **5**

Know the Terms

- **Ecosystem :** It is a functional unit of nature, where living organisms interact among themselves and also with the surrounding physical environment.
- **Scavengers :** These are animals which eat dead bodies of other animals.
- **Primary productivity :** It is the amount of biomass produced per unit area in a given time period by plants during photosynthesis.
- **Gross primary productivity :** It is the rate of production of organic matter during photosynthesis.
- **Net primary productivity :** Gross primary productivity minus respiration losses (R) is the net primary productivity (NPP).
- **Detritus :** Dead remains of plants and animals are called detritus.
- **Detrivores :** Animals that feed on decaying organic matter (detritus). Examples: earthworms, termites, snails etc.
- **Ten percent law :** It states that during transfer of energy from one trophic level to another, only about 10% is transferred higher levels, remaining 90% is lost in respiration (heat).
- **Grazing food chains :** It extends from producers through herbivores to carnivores.
- **Detritus food chains :** It begins with dead organic matter to the detrivores organisms which in turn make food for protozoan to carnivores.
- **Trophic level :** A specific place of organisms in the food chain is known as their trophic level.
- **Food chain :** It is a single linear sequence of organisms.
- **Food web :** It contains a number of interconnected food chain.
- **Ecological pyramids :** The representation of a food chain in the form of a pyramid is called ecological pyramid.

- **Pyramid of numbers :** It the graphical representation of the number of individuals present at each trophic level in a food chain of an ecosystem.
- **Pyramid of biomass :** A pyramid of energy is a graphical representation of the total amount of living matter present at each trophic level of an ecosystem.
- **Pyramid of energy :** A pyramid of biomass is a graphical representation of the amount of energy trapped per unit time and area in different trophic level of a food chain with producers forming the base and the top carnivores at the tip.
- **Ecological succession :** It is a gradual, slow and predictable change in the species composition of an area leading to a climax community.
- **Primary succession :** The succession that takes place in areas where no living organisms ever existed.
- **Secondary succession :** The succession that takes place in areas which have lost all life forms due to destructions and floods.
- **Hydrarch succession :** It takes place in water areas.
- **Xerarch succession :** It takes place in dry areas.
- **Biogeochemical cycle :** The cyclic flow of nutrients between non-living environment (soil, air and water) and the living organisms is called biogeochemical cycle.
- **Carbon cycle :** The cyclic flow of carbon in biosphere between its abiotic (soil, air and water) and biotic (plants and animals) components is called carbon cycle.
- **Ecosystem services :** The products of ecosystem processes are called ecosystem services.

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