

# ECOSYSTEM

**Ecosystems** are functional units of nature where living organisms interact with each other and their physical environment. The concept of ecological systems was introduced by **Karl Mobius** in 1877, and the term “ecosystem” was coined by **A.G. Tansley** in 1935.

Tansley described an ecosystem as a system characterized by the interrelationships between the *abiotic* (*non-living*) and *biotic* (*living*) components of its environment. It is an interactive system that can exist in natural or artificial forms.

**Natural Ecosystems:** These ecosystems are self-sustaining and operate without human intervention. They can be further classified into *terrestrial* (land-based) and *aquatic* (water-based) types.

**Artificial Ecosystems:** These ecosystems are intentionally created and managed by humans for various purposes. Examples include *croplands* and *aquariums*.

By understanding the nature and dynamics of ecosystems, we can gain valuable insights into the intricate connections and dependencies between living organisms and their surroundings.

## Components of Ecosystem

The **ecosystem** is a complex system made up of various components that work together to maintain balance and support life. These components can be categorized into **biotic** and **abiotic** factors.

**Biotic components** refer to the living organisms within an ecosystem. They include animals, plants, and microorganisms. Within the biotic component, there are several important parts:

- **Producers:** These are the green plants and green algae that use sunlight, water, and carbon dioxide to produce their own food through the process of photosynthesis. They are also known as autotrophs, as they can synthesize organic compounds from inorganic substances.

- **Consumers:** Heterotrophic animals rely on producers for their energy and nutrients. Consumers can be classified into two main categories:

- a. **Herbivores:** These are animals that feed primarily on plant material. Examples include rabbits, rats, squirrels, goats, and cattle.
- b. **Carnivores:** These are animals that feed on other animals. They can be further divided into three types based on their position in the food chain:
  - i. **Primary Consumers:** These are herbivores that directly consume producers for their energy.
  - ii. **Secondary Consumers:** These are carnivores that prey on primary consumers.

iii. **Tertiary Consumers:** These are carnivores that feed on secondary consumers.

In addition to *herbivores* and *carnivores*, there are also *omnivores*, which have a diet consisting of both plant and animal matter. Examples of omnivores include pigs and bears.

**Detritivores** are another type of consumer that obtain their food by consuming dead and decaying organic matter. Vultures and *earthworms* are examples of detritivores.

• **Decomposers:** These organisms play a vital role in breaking down dead organic matter into simpler substances. *Bacteria* and *fungi* are the primary decomposers in an ecosystem. They break down complex organic compounds into their mineral components, which are then recycled back into the environment.

On the other hand, **abiotic components** refer to the *non-living* factors that influence the ecosystem. These components include temperature, water, light, and soil. Each of these factors has a significant impact on the distribution and abundance of living organisms within an ecosystem.

**Temperature** affects the *metabolic rates* and *physiological* processes of organisms. Different species have specific temperature ranges within which they can thrive.

**Water** availability is crucial for the survival of organisms. It serves as a habitat, a source of nutrients, and a medium for various biochemical reactions.

**Light** plays a fundamental role in photosynthesis, enabling producers to convert solar energy into chemical energy. It also influences the behavior and activity patterns of organisms.

**Soil** provides essential nutrients and acts as a medium for plant growth. Its composition, pH, and nutrient content affect the types of plants that can grow in a particular area.

These components work together to create a delicate balance that supports life and contributes to the overall health and sustainability of the ecosystem.

### **Structure and functions of an Ecosystem**

The structure and functions of an ecosystem are crucial for understanding its dynamics and the interactions between its components. Two key structural features of an ecosystem are **species composition** and **stratification**.

**Species composition** refers to the identification and enumeration of the various plants and animals present in an ecosystem. By studying the species composition, we can gain insights into the diversity and abundance of different organisms within the ecosystem.

**Stratification**, on the other hand, refers to the vertical distribution of species occupying different levels or layers within an ecosystem. For example, in a forest ecosystem, tall trees occupy the top layer, shrubs inhabit the second layer, and herbs and grasses are found in the bottom layer. This stratification creates distinct habitats for different species and allows for efficient resource utilization within the ecosystem.

## **Productivity of an ecosystem**

The productivity of an ecosystem can be divided into two categories: **primary productivity** and **secondary productivity**.

**Primary productivity** refers to the amount of biomass or organic matter produced by plants through photosynthesis per unit area over a given time period. It is typically measured in terms of *weight (grams per square meter)* or *energy (kcal/m<sup>2</sup>)*. The total amount of organic matter synthesized by primary producers, such as plants, through photosynthesis is known as **gross primary productivity**.

Primary producers, such as plants, capture energy from sunlight and convert it into organic matter through photosynthesis. Some of this organic matter is used by the plants themselves for their growth and maintenance, while the remaining portion is stored as biomass. This stored organic matter/energy, after the utilization of some energy for the plants' own needs, is known as **net primary productivity**.

**Secondary productivity**, on the other hand, refers to the rate at which consumers convert the organic matter produced by primary producers into their own biomass. It represents the energy transfer from one trophic level to another within the ecosystem. Secondary productivity is often measured in terms of the *biomass* accumulated by consumers, such as herbivores or carnivores, per unit area over a given time period.

**Decomposition** refers to the breakdown of complex organic matter into simpler inorganic substances, such as water, carbon dioxide, and nutrients, by decomposers. The raw material required for decomposition is called **detritus**.

The process of decomposition involves several steps:

- **Fragmentation**: Detritus is broken down into small particles by detritivores like earthworms.
- **Leaching**: Water-soluble inorganic nutrients are washed down into the soil and become unavailable salts.
- **Catabolism**: Bacterial and fungal enzymes degrade detritus into simple organic material, which is then converted into simpler inorganic compounds.
- **Humification**: This process results in the accumulation of a dark-colored, amorphous, and colloidal substance called humus. Humus is highly resistant to microbial action and decomposes at a very slow rate.
- **Mineralization**: Microbial activity breaks down humus, releasing inorganic nutrients.

Several factors influence the rate of ***decomposition***:

- (a) Chemical composition of detritus: Decomposition slows down if detritus contains high amounts of lignin and chitin. Conversely, decomposition is faster when detritus consists of nitrogen and sugar.
- (b) Climatic factors: Decomposition is favoured in warm and moist environments, while low temperatures and anaerobic conditions inhibit the process.

### **Energy Flow**

In all ecosystems on Earth, the **Sun** serves as the primary source of energy, with the exception of deep hydrothermal vents. Among the solar radiation that reaches the Earth, less than 50% of it is **Photosynthetically Active Radiation (PAR)**, which is essential for photosynthesis.

*Autotrophs*, including plants and photosynthetic bacteria, utilize a mere 2% of the Sun's radiant energy to convert simple inorganic materials into food through the process of photosynthesis

### **Food Chain**

A *food chain* represents the interconnected sequence of populations within an ecosystem, illustrating the transfer of food and energy as it flows through various levels. Each member of the chain serves as the food source for the subsequent member, creating a dynamic relationship of consumption and energy transfer.

In nature, there are two primary types of food chains:

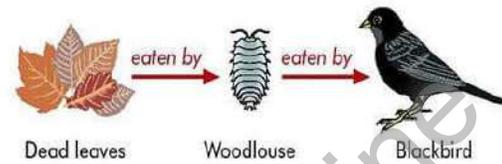
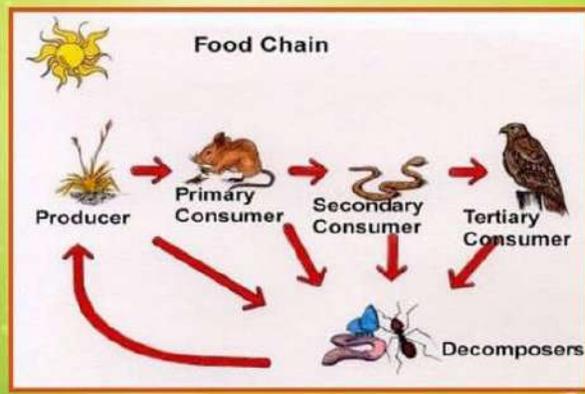
- **Grazing Food Chain (GFC)**: This type of food chain originates with producers, which are organisms capable of capturing solar energy and converting it into organic matter through the process of photosynthesis. The energy captured by the producers then passes on to the subsequent levels of the food chain through consumption. For example, a grazing food chain could be represented as follows: Grass (producer) is consumed by a Goat (primary consumer), and the Goat, in turn, becomes the food source for a Man (secondary consumer).
- **Detritus Food Chain (DFC)**: Unlike the grazing food chain, the detritus food chain begins with dead organic matter. Decomposers, primarily fungi and bacteria, play a crucial role in breaking down the detritus and releasing energy from it. The detritus acts as the initial source of energy for the decomposers. An example of a detritus food chain would involve Dead leaves (producer), which are consumed by Wood lice (primary consumer), and then the Wood lice are consumed by a Black bird (secondary consumer).

Both types of food chains highlight the flow of energy and nutrients within an ecosystem

## GRAZING FOOD CHAIN

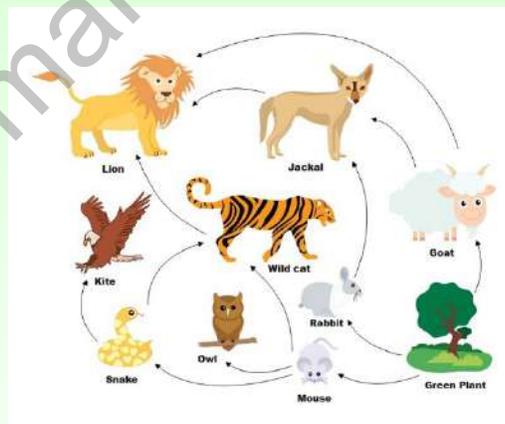
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## DETRITUS FOOD CHAIN



### Food Web

A *food web* refers to a complex network of interconnected food chains within an ecosystem, involving producers, consumers, and decomposers. It represents the intricate relationships and interactions among various organisms and their feeding habits. By encompassing multiple food chains, a food web contributes to the stability and equilibrium of an ecosystem, maintaining a state of homeostasis.



### Trophic Level

Trophic levels depict the hierarchical position that organisms occupy within their natural environment or community, based on their feeding relationships. Each organism in a food chain is assigned a specific trophic level that reflects its role in the transfer of energy and nutrients.

It is important to note the following:

- **Standing crop**: Standing crop refers to the amount of living material present at a particular trophic level within a specific timeframe. It is typically measured as the biomass, or the total mass of living organisms, per unit area.
- **Ten percent law**: The ten percent law, formulated by Lindemann in 1942, states that during the transfer of energy between trophic levels in a food chain, only 10% of the energy is passed on to the next level, while the remaining energy is lost as heat. This law highlights the decreasing energy efficiency as it moves up the trophic levels.

### **Ecological Pyramids**

Ecological pyramids provide a visual representation of essential ecological parameters, such as biomass, energy, or the number of individuals, across different trophic levels within a food chain. This concept was introduced by *Charles Elton* in 1927 and has since become a valuable tool for understanding the structure and dynamics of ecosystems.

There are three primary types of ecological pyramids:

- **Pyramid of Number**: This pyramid illustrates the total number of organisms present at each trophic level. It represents the numerical abundance of individuals within a given food chain. Typically, the pyramid of numbers is upright, with each higher trophic level showing a decreasing number of organisms. However, in certain ecosystems, such as a tree ecosystem, the pyramid of numbers can be inverted, where the number of individuals at the higher trophic level exceeds the number at the lower trophic level.
- **Pyramid of Biomass**: The pyramid of biomass represents the total amount of living organic matter, or biomass, at each trophic level. It provides insight into the distribution of energy and resources among different levels of the food chain. Similar to the pyramid of numbers, the pyramid of biomass is typically upright, with decreasing biomass as you move up the trophic levels. However, exceptions may occur due to variations in the size and productivity of different organisms within the ecosystem.
- **Pyramid of Energy**: The pyramid of energy illustrates the flow of energy through the trophic levels of a food chain. It represents the total energy available or transferred at each level. As energy is lost during metabolic processes and heat production, the pyramid of energy is always upright, with a significant decrease in energy as you ascend the trophic levels. This pyramid emphasizes the fundamental principle that energy is not efficiently transferred from one trophic level to the next, resulting in a decrease in available energy with each step.

## **Ecological Succession**

**Ecological succession** refers to the gradual and predictable change in the species composition of an area over time. This process occurs in a sequential manner, with each stage of change known as a “**sere**,” and the individual communities within each stage called “**seral stages**” or “**seral communities**.” As ecological succession unfolds, the goal is to establish a state of equilibrium with the surrounding environment, known as the **climax community**.

The initial colonization of a barren area by species is carried out by **pioneer species**.

There are two main types of ecological succession: **primary** and **secondary succession**. Primary succession takes place in environments such as newly formed land, ponds or reservoirs, and recently cooled lava, where no previous life forms existed. On the other hand, secondary succession occurs in areas where natural communities were present in the past but have been disrupted or destroyed.

Based on the habitat’s characteristics, ecological succession can be categorized into two types: **hydrarch** and **xerarch** succession. Hydrarch succession occurs in wetter areas, with the successional series progressing from hydric (water-rich) to mesic (moderate moisture) conditions. In contrast, xerarch succession takes place in dry areas, with the series progressing from xeric (extremely dry) to mesic conditions. For example, xerarch succession may occur in environments such as sandy deserts or rock deserts.

## **Nutrient Cycling**

Nutrient cycling is vital for the functioning of organisms, as they require a continuous supply of nutrients for various bodily processes. The quantity of nutrients present in the soil at any given time is known as the “**standing state**.” Nutrient cycling, also referred to as biogeochemical cycles, involves the movement of nutrient elements through different components of an ecosystem.

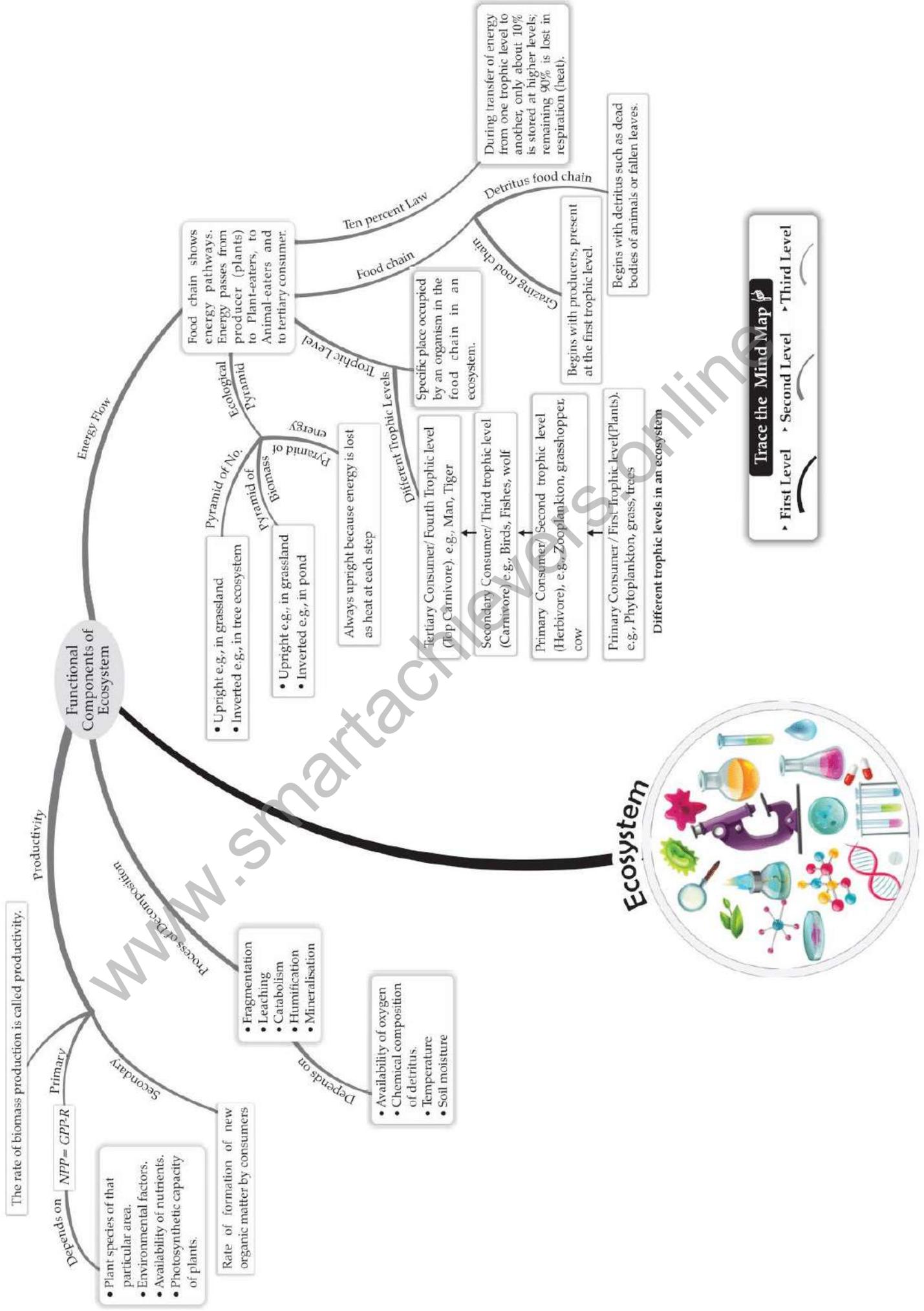
There are two main types of nutrient cycles: **gaseous cycles** and **sedimentary cycles**. Gaseous cycles encompass elements such as nitrogen and carbon, while sedimentary cycles involve elements like Sulphur and phosphorus.

**Carbon cycling** occurs through various pathways, including the atmosphere, oceans, and living and deceased organisms. A substantial amount of carbon is released back into the atmosphere as CO<sub>2</sub> through processes such as respiratory activities of producers and consumers, decomposition by decomposers, forest fires, and the combustion of organic matter.

**Phosphorus**, a crucial component of biological membranes, nucleic acids, cellular energy transfer systems (ATP), as well as shells, bones, and teeth, follows the phosphorus cycle. The primary reservoir of phosphorus is rocks, which contain phosphates. Phosphate-solubilizing bacteria play a significant role in the decomposition of waste products and deceased organisms, releasing phosphorus into the soil.

**Ecosystem services** refer to the valuable outputs generated by the processes within an ecosystem. These services encompass a wide range of benefits, such as the pollination of crops, the fixation of CO<sub>2</sub>, and the purification of air and water by forests, among others.

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**Trace the Mind Map**

► First Level ► Second Level ► Third Level

## Practice Questions

1. Which units are used to express primary production?

- (a) Weight ( $\text{gm}^{-2}$ ) or energy ( $\text{kcal m}^{-2}$ )                      (b) Volume ( $\text{cm}^3$ ) or length (m)  
(c) Temperature ( $^{\circ}\text{C}$ ) or pressure (Pa)                      (d) None of the above

2. What is primary productivity?

- (a) The amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis.  
(b) The rate at which predators consume prey in an ecosystem.  
(c) The process of converting inorganic nutrients into organic compounds.  
(d) None of the above.

3. What factors influence primary productivity?

- (a) Availability of nutrients                      (b) Photosynthetic capacity of plants  
(c) Both (a) and (b)                      (d) None of the above. Neither (a) nor (b)

4. Which of the following is an example of a detritivore?

- (a) Millipedes                      (b) Earthworms                      (c) Fiddler crabs                      (d) All of the above

5. What is the term for organisms that physically and chemically break down complex dead organic remains?

- (a) Scavengers                      (b) Decomposers                      (c) Both (a) and (b)                      (d) Parasites

6. What is the process called when water-soluble inorganic nutrients move down into the soil horizon and become unavailable salts?

- (a) Fragmentation                      (b) Leaching                      (c) Catabolism                      (d) Mineralization

7. How does mineralization by microorganisms contribute to nutrient release?

- (a) Inorganic nutrients from humus are released.
- (b) Both organic and inorganic nutrients from detritus are released.
- (c) Organic nutrients from humus are released.
- (d) Inorganic nutrients from detritus are released, and humus is formed.

8. Which term describes the purification of air and water by forests?

- (a) Ecosystem services
- (b) Secondary productivity
- (c) Nutrient cycling
- (d) Biodiversity conservation

9. What is the role of pollination in ecosystem services?

- (a) Facilitating the transfer of pollen between flowers for plant reproduction.
- (b) Regulating the climate through carbon sequestration.
- (c) Maintaining soil fertility through nutrient cycling.
- (d) None of the above.

10. What is CO<sub>2</sub> fixation in the context of ecosystem services?

- (a) The process of converting carbon dioxide into organic compounds by plants during photosynthesis.
- (b) The removal of excess carbon dioxide from the atmosphere by human activities.
- (c) The release of carbon dioxide during cellular respiration by animals.
- (d) None of the above.

11. Which term describes the transfer of energy from one trophic level to another in an ecological food chain?

- (a) Biomagnification
- (b) Energy conversion
- (c) Trophic transfer
- (d) Nutrient cycling

12. What is the primary source of energy in most aquatic ecosystems?

- (a) Sunlight                      (b) Decomposers                      (c) Predators      (d) Organic matter

13. How do omnivores contribute to food chains?

- (a) They consume only plants.                      (b) They consume only animals.  
(c) They consume both plants and animals.                      (d) They are decomposers.

14. Which component of an ecosystem represents the total mass of living organisms present in a particular trophic level?

- (a) Species diversity      (b) Ecological niche      (c) Standing crop      (d) Trophic efficiency

15. What is the term used to describe the process by which plants convert sunlight into chemical energy?

- (a) Photosynthesis      (b) Respiration                      (c) Decomposition      (d) Predation

16. Which level of a food chain typically has the highest biomass?

- (a) Primary producers                      (b) Primary consumers  
(c) Secondary consumers                      (d) Tertiary consumers

17. How does the introduction of a new predator into an ecosystem affect the food chain?

- (a) It increases the population of primary producers.  
(b) It disrupts the balance of the food chain.  
(c) It decreases the number of decomposers.  
(d) It has no effect on the food chain.

18. What is the term used to describe the interconnected feeding relationships in an ecosystem?

- (a) Food chain                      (b) Trophic web  
(c) Ecological network                      (d) Food pyramid

19. What is the main difference between a food chain and a food web?

- (a) Food chains are simpler than food webs.
- (b) Food webs include only plants and animals.
- (c) Food webs are composed of multiple food chains.
- (d) Food chains represent energy flow, while food webs represent nutrient cycling.

20. How does the efficiency of energy transfer between trophic levels affect the length of a food chain?

- (a) Higher energy transfer efficiency leads to shorter food chains.
- (b) Lower energy transfer efficiency leads to shorter food chains.
- (c) Higher energy transfer efficiency leads to longer food chains.
- (d) Lower energy transfer efficiency leads to longer food chains.

21. What happens to the energy that is not transferred to the next trophic level in a food chain?

- (a) It is converted into biomass.
- (b) It is lost as heat.
- (c) It is stored as potential energy.
- (d) It is recycled through decomposers.

22. What factor primarily determines the number of trophic levels in an ecosystem?

- (a) Climate conditions
- (b) Available sunlight
- (c) Soil fertility
- (d) Predation pressure

23. What is the term used to describe the process by which pollutants become more concentrated as they move up the food chain?

- (a) Biomagnification
- (b) Bioaccumulation
- (c) Trophic amplification
- (d) Ecological enrichment

24. How do human activities, such as deforestation and pollution, impact food chains in ecosystems?

- (a) They enhance biodiversity within food chains.
- (b) They disrupt energy flow within food chains.
- (c) They promote stability and balance in food chains.
- (d) They have no effect on food chains.

25. What does PAR stand for in the context of photosynthesis?

- (a) Photosynthesis Active Reaction
- (b) Photosynthesis Absorb Radiation
- (c) Photosynthetically Active Radiation
- (d) Photosynthetically Active Reaction

26. What is the term used to describe green plants in an ecosystem that can convert solar energy into chemical bond energy?

- (a) producer
- (b) decomposer
- (c) consumer
- (d) predator

27. Why do ecosystems require a constant supply of energy?

- (a) to counteract increasing disorderliness
- (b) to counteract decreasing disorderliness
- (c) to synthesize molecules
- (d) Both (a) and (c)

28. Fill in the blanks correctly: I. Herbivores are also called ...A... II. Secondary consumers are eaten by larger ...B... III. ...C... consumers eat the secondary consumers. IV. A network of many food chains is called a ...D.... Choose the correct option for A, B, C, and D.

- (a) A–secondary consumers, B–top predator, C–Quaternary, D–food web
- (b) A–primary consumer, B–predators, C–Tertiary consumer, D–food web
- (c) A–tertiary consumers, B–natural enemies, C–Primary consumer, D–food web
- (d) A–quaternary consumers, B–alligator, C–Top consumer, D–food web

29. Which two organisms are considered producers?

- (a) Plants and phytoplankton's
- (b) Plants and consumers
- (c) Zooplanktons and phytoplankton's
- (d) Phytoplankton's and chlorophylls

30. What does the term “food chain” refer to?

- (a) a number of humans forming a chain for food
- (b) animals gathered near a source of food
- (c) the transfer of energy from producers to consumers
- (d) None of the above

31. The components of an ecosystem that consist of living organisms are collectively known as:

- a) Abiotic components
- b) Biotic components
- c) Physical components
- d) Chemical components

32. The term used to describe the rate of biomass production per unit area over a specific time period by plants during photosynthesis is:

- a) Gross primary productivity
- b) Net primary productivity
- c) Secondary productivity
- d) Decomposition

33. The decomposition rate is highest when detritus is rich in:

- a) Nitrogen and sugar
- b) Phosphorus and sugar
- c) Calcium and sugar
- d) Both (b) and (c)

34. A human-made ecosystem generally exhibits:

- a) Less diversity
- b) More diversity
- c) Ecosystems are not made by humans
- d) Greater stability compared to natural ecosystems

35. The green plants in an ecosystem that can convert solar energy into chemical bond energy are known as:

- a) Producers
- b) Decomposers
- c) Consumers
- d) Predators

36. A person who primarily consumes vegetables acts as a:

- a) Primary producer
- b) Primary consumer
- c) Secondary consumer
- d) Tertiary consumer

37. Consider the following statements about food chains: I. The transfer of energy from producers to top consumers through a series of organisms is referred to as a food chain. II. A food chain is typically linear and progresses in a straight line. III. In a food chain, there is a unidirectional flow of energy from the sun to producers and subsequently to different types of consumers.

Which of the statements above are correct?

- A) I and II
- b) I and III
- c) II and III
- d) I, II, and III

38. A food chain consists of:

- a) Plants
- b) Herbivores
- c) Carnivores
- d) All of these

39. Among the following ecosystems (Pond, Terrestrial, Oceans, Forest), which one(s) will have a grazing food chain?

- A) Pond ecosystem
- b) Terrestrial ecosystem
- c) Ocean ecosystem
- d) All of these

40. In aquatic ecosystems, a significant proportion of energy flows through the:

- a) Grazing food chain
- b) Detritus food chain
- c) Complex food chain
- d) Food web

41. Which of the following options best describes the conformity of energy flow and energy transformation in living systems?

- A) Law of limiting factors
- b) Liebig's law of minimum
- c) Laws of thermodynamics
- d) Shelford's law of tolerance

42. Phosphorus is essential for the formation of which of the following? I. Shells II. Bones III. Teeth

Select the correct option:

- a) I and II                      b) I and III                      c) II and III                      d) I, II, and III

43. What is the term used to describe the species that colonize a bare area during ecological succession?

- A) Benthos                      b) Biological species                      c) Seral species                      d) Pioneer species

44. In the context of a pond ecosystem, what does the term “benthos” refer to?

- A) Primary consumers in the depths of a pond                      b) Viruses  
c) Zooplankton on the water surface                      d) Bacteria

45. Select the option that correctly differentiates between gross primary productivity (GPP) and net primary productivity (NPP): I. The total organic matter synthesized by producers through photosynthesis per unit time and area is known as gross primary productivity. II. Net primary productivity is the weight of organic matter stored by producers in a unit area/volume per unit time.

- A) I am true, while II is false.  
B) II is true, while I am false.  
C) Both I and II are true.  
D) Both I and II are false.

46. In an Eltonian pyramid, where is the lion positioned?

- A) Producer    b) Primary consumer                      c) Secondary consumer    d) Tertiary consumer

47. Which of the following is responsible for achieving maximum primary productivity in a pond?

- A) Phytoplankton    b) Zooplankton                      c) Floating plants                      d) Red algae

48. Through which medium does the carbon cycle take place?

- A) Atmosphere
- b) Ocean
- c) Living and dead organisms
- d) All of the above

49. The proper functioning of an enzyme requires which type of temperature?

- A) Low
- b) High
- c) Optimum
- d) None of the above

50. Which ecosystem exhibits the highest net productivity in the terrestrial environment?

- A) Rainforest
- b) Deciduous forest
- c) Mangrove plantation
- d) Both (a) and (b)

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## Answers

1. The correct answer is (a) Weight ( $\text{gm}^{-2}$ ) or energy ( $\text{kcal m}^{-2}$ ). Units used to express primary production are typically measured in terms of weight (grams per square meter) or energy (kilocalories per square meter). These units provide a measure of the amount of biomass or organic matter produced by plants through photosynthesis in a given area.

2. The correct answer is (a) The amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis. Primary productivity refers to the rate at which energy is converted by photosynthetic organisms (primarily plants) into organic substances through the process of photosynthesis. It is a measure of the amount of biomass or organic matter produced by plants in a given area and time period.

3. The correct answer is © Both (a) and (b). Factors that influence primary productivity include the availability of nutrients, such as nitrogen and phosphorus, which are essential for plant growth and photosynthesis. The photosynthetic capacity of plants, determined by factors like light availability and leaf area, also plays a significant role in primary productivity. Therefore, both the availability of nutrients and the photosynthetic capacity of plants are important factors influencing primary productivity.

4. The correct answer is (d) All of the above. Detritivores are organisms that feed on dead organic matter, such as leaf litter, and play a crucial role in the decomposition process. Millipedes, earthworms, and fiddler crabs are all examples of detritivores that help break down organic remains and facilitate nutrient recycling in ecosystems.

5. The correct answer is (b) Decomposers. Decomposers are organisms that physically and chemically break down complex dead organic remains, such as fallen leaves, dead plants, and animal carcasses. They play a vital role in the process of decomposition by breaking down organic matter into simpler inorganic compounds, releasing nutrients back into the ecosystem.

6. The correct answer is (b) Leaching. Leaching is the process by which water-soluble inorganic nutrients move down through the soil layers and become unavailable salts. This occurs when excessive rainfall or irrigation carries the nutrients downward, making them inaccessible to plants. Leaching can result in nutrient loss from the soil, affecting the availability of essential nutrients for plant growth.

7. The correct answer is (b) Both organic and inorganic nutrients from detritus are released. Mineralisation by microorganisms involves the breakdown of organic matter, such as detritus and humus, into simpler inorganic compounds, releasing both organic and inorganic nutrients. As microorganisms decompose organic matter, nutrients become available for uptake by plants and other organisms, contributing to nutrient cycling in ecosystems.

8. The correct answer is (a) Ecosystem services. The term that describes the purification of air and water by forests is “ecosystem services.” Forests provide various benefits to human societies and ecosystems, including the purification of air by absorbing pollutants and filtering particulate matter. They also contribute to water purification by reducing sediment runoff and filtering contaminants, thereby improving water quality.

9. The correct answer is (a) Facilitating the transfer of pollen between flowers for plant reproduction. Pollination plays a crucial role in ecosystem services by facilitating the transfer of pollen between flowers, enabling plant reproduction. This process is primarily carried out by pollinators, such as bees, butterflies, birds, and bats. Through pollination, plants can produce fruits, seeds, and new individuals, contributing to biodiversity and the maintenance of ecosystems.

10. The correct answer is (a) The process of converting carbon dioxide into organic compounds by plants during photosynthesis. CO<sub>2</sub> fixation refers to the process by which plants convert carbon dioxide CO<sub>2</sub>.

11.(c) Trophic transfer: The term “trophic transfer” describes the transfer of energy from one trophic level to another in an ecological food chain. As organisms consume other organisms for energy, energy is transferred from one level to the next. This transfer occurs as organisms at higher trophic levels feed on those at lower trophic levels, passing on the energy stored in their bodies.

12.(a) Sunlight: The primary source of energy in most aquatic ecosystems is sunlight. Sunlight is essential for photosynthesis, the process by which green plants and algae convert solar energy into chemical energy in the form of organic compounds. This energy then flows through the food chain as organisms consume the plants or other organisms that have consumed the plants.

13.(c) They consume both plants and animals: Omnivores contribute to food chains by consuming both plants and animals. They have a diverse diet and occupy an intermediate position in the food chain, feeding on primary producers (plants) as well as primary and secondary consumers (animals). This allows energy and nutrients to flow through multiple pathways in the ecosystem.

14.(c) Standing crop: The component of an ecosystem that represents the total mass of living organisms present in a particular trophic level is called the standing crop. It refers to the biomass (total weight) of organisms, such as plants or animals, at a specific trophic level in a given area or ecosystem. The standing crop is an important measure of the amount of energy available in a trophic level.

15.(a) Photosynthesis: The term used to describe the process by which plants convert sunlight into chemical energy is photosynthesis. In photosynthesis, plants use chlorophyll and other pigments to capture sunlight energy, which is then used to convert carbon dioxide and water into glucose (a form of chemical energy) and oxygen. This process is vital for the production of organic compounds and is the primary way energy enters most ecosystems.

16.(a) Primary producers: The level of a food chain that typically has the highest biomass is the primary producers. Primary producers, such as plants or algae, convert energy from the sun into chemical energy through photosynthesis. Since they are at the base of the food chain, they provide the primary source of energy for all other trophic levels, resulting in a higher biomass compared to higher trophic levels.

17.(b) It disrupts the balance of the food chain: The introduction of a new predator into an ecosystem can disrupt the balance of the food chain. Predators play a crucial role in regulating the populations of their prey species. When a new predator is introduced, it can impact the abundance and behavior of the prey, leading to changes in population sizes and the overall structure of the food chain.

18.(b) Trophic web: The term used to describe the interconnected feeding relationships in an ecosystem is a trophic web. A trophic web is a more complex representation of energy flow compared to a simple linear food chain. It shows the multiple feeding connections between different organisms, including the various pathways and interactions among producers, consumers, and decomposers within an ecosystem.

19 © Food webs are composed of multiple food chains: The main difference between a food chain and a food web is that food webs are composed of multiple interconnected food chains. A food chain represents a linear sequence of organisms, each feeding on the one before it. In contrast, a food web includes multiple interconnected food chains, illustrating the complex feeding relationships and energy flow among various species within an ecosystem.

20.(a) Higher energy transfer efficiency leads to shorter food chains: The efficiency of energy transfer between trophic levels affects the length of a food chain.

21.(b) It is as heat: The energy that is not transferred to the next trophic level in a food chain is primarily lost as heat. As energy flows through an ecosystem, some of it is used by organisms for their own metabolic processes, such as respiration and movement. This energy is eventually released as heat into the environment, which cannot be utilized by other organisms in the food chain.

22. (d) Predation pressure: The number of trophic levels in an ecosystem is primarily determined by predation pressure. Predation pressure refers to the intensity and frequency of predation within an ecosystem. As predators feed on prey, they regulate the population sizes of the prey species. The availability of sufficient prey resources can support higher trophic levels, while lower predation pressure may limit the number of trophic levels.

23. (a) Biomagnification: The term used to describe the process by which pollutants become more concentrated as they move up the food chain is biomagnification. Pollutants, such as certain pesticides or heavy metals, are taken up by organisms at lower trophic levels. As these organisms are consumed by higher trophic level organisms, the concentration of pollutants increases due to the cumulative effect. This can have significant negative impacts on top predators.

24. (b) They disrupt energy flow within food chains: Human activities, such as deforestation and pollution, primarily disrupt energy flow within food chains in ecosystems. Deforestation can lead to the loss of habitats and food sources for various organisms, disrupting their interactions within the food chain. Pollution can introduce harmful substances into the environment, affecting the health and availability of organisms at different trophic levels, thus impacting energy flow.

25.(c) Photosynthetically Active Radiation: PAR stands for “Photosynthetically Active Radiation” in the context of photosynthesis. PAR refers to the portion of the electromagnetic spectrum (wavelengths between 400 and 700 nanometers) that is utilized by plants for photosynthesis. It represents the range of light wavelengths that are absorbed by chlorophyll and other pigments in plants to drive the process of photosynthesis.

26. (a) Producer: The term used to describe green plants in an ecosystem that can convert solar energy into chemical bond energy is “producer.” Producers, also known as autotrophs, are capable of synthesizing organic compounds, such as glucose, using energy from the sun through photosynthesis. They form the foundation of the food chain by providing energy and nutrients to other organisms.

27. (d) Both (a) and (c): Ecosystems require a constant supply of energy both to counteract increasing disorderliness (entropy) and to synthesize molecules. The flow of energy through an ecosystem allows organisms to maintain order and carry out vital processes, such as growth, reproduction, and maintaining homeostasis. Additionally, energy is required for the synthesis of organic molecules, including carbohydrates, proteins, and lipids, which are essential for the survival and functioning of organisms within the ecosystem.

28. (b) A–primary consumer, B–predators, C–Tertiary consumer, D–food web: I. Herbivores are also called primary consumers. II. Secondary consumers are eaten by larger predators. III. Tertiary consumers eat the secondary consumers. IV. A network of many food chains is called a food web.

29. (a) Plants and phytoplanktons: Plants and phytoplanktons are considered producers. Plants are the primary producers on land, utilizing sunlight through photosynthesis to produce organic compounds. Phytoplankton, consisting of microscopic photosynthetic organisms, are the primary producers in aquatic ecosystems, including oceans and freshwater bodies. Both plants and phytoplankton play a crucial.

30.(c) The term “food chain” refers to the transfer of energy from producers to consumers. A food chain is a linear sequence that represents the flow of energy and nutrients in an ecosystem. It starts with the primary producers, such as plants or phytoplankton, which convert sunlight into chemical energy through photosynthesis. The energy is then passed on to primary consumers (herbivores) that feed on the producers, followed by secondary consumers (carnivores or omnivores) that feed on the herbivores, and so on. Each organism in the food chain depends on the energy obtained from the previous organism.

31.(b) The components of an ecosystem that consist of living organisms are collectively known as biotic components. Biotic components include all living organisms, such as plants, animals, fungi, and microorganisms, and their interactions within an ecosystem. These components play essential roles in energy flow, nutrient cycling, and maintaining the overall balance and functioning of the ecosystem.

32 (b) The term used to describe the rate of biomass production per unit area over a specific time period by plants during photosynthesis is net primary productivity. Net primary productivity (NPP) represents the energy accumulated by plants as organic matter through photosynthesis, minus the energy they use in respiration. It is a measure of the energy available to support the growth and reproduction of primary producers and subsequent trophic levels.

33.(d) The decomposition rate is highest when detritus is rich in both phosphorus and calcium. Detritus refers to the dead organic matter, such as fallen leaves, decaying plant material, and animal carcasses, which serve as a source of nutrients for decomposers. While nitrogen is important for decomposition, the presence of phosphorus and calcium in detritus can further enhance microbial activity and accelerate the decomposition process.

34.(a) A human-made ecosystem generally exhibits less diversity compared to natural ecosystems. Human activities can result in habitat destruction, fragmentation, introduction of invasive species, and pollution, which can lead to a decline in species richness and diversity. Artificial ecosystems, such as monoculture agricultural fields or urban environments, often have simplified and less complex ecological communities compared to natural ecosystems.

35.(a) The green plants in an ecosystem that can convert solar energy into chemical bond energy are known as producers. Producers, also known as autotrophs, utilize sunlight, water, and carbon dioxide through photosynthesis to produce organic compounds, primarily carbohydrates. They are the primary source of energy in ecosystems, forming the base of the food chain and supporting other organisms.

36.(b) A person who primarily consumes vegetables acts as a primary consumer. Primary consumers are herbivores that directly consume plants or plant-based materials for their energy and nutrient needs. As a vegetarian diet primarily consists of plant-based foods, individuals following such a diet can be categorized as primary consumers in the context of food chains.

37.(b) I and III: The correct statements are: I. The transfer of energy from producers to top consumers through a series of organisms is referred to as a food chain. III. In a food chain, there is a unidirectional flow of energy from the sun to producers and subsequently to different types of consumers. Statement II is incorrect as a food chain is not necessarily linear and can be interconnected in a food web.

38.(d) A food chain consists of plants, herbivores, and carnivores. It includes all trophic levels, starting from the primary producers (plants) that are consumed by herbivores (primary consumers), which, in turn, may be consumed by carnivores (secondary or higher-order consumers).

39.(d) All of these ecosystems (Pond, Terrestrial, Oceans, Forest) can have a grazing food chain. A grazing food chain consists of primary producers (plants) that are consumed by herbivores, which are then consumed by carnivores. In a pond ecosystem, for example, aquatic plants serve as primary producers, and herbivorous organisms such as zooplankton or small fish graze on the plants. These herbivores, in turn, become food for larger carnivorous organisms. Similarly, in terrestrial ecosystems, plants are grazed by herbivorous animals, which are then preyed upon by carnivores.

40.(a) In aquatic ecosystems, a significant proportion of energy flows through the grazing food chain. The grazing food chain starts with the primary producers, such as phytoplankton or aquatic plants, which are grazed upon by herbivores (zooplankton or small fish). These herbivores are then consumed by larger carnivorous organisms. The energy transfer occurs as organisms feed on each other, with energy being transferred from lower trophic levels to higher trophic levels.

41.(c) Laws of thermodynamics best describe the conformity of energy flow and energy transformation in living systems. The laws of thermodynamics govern energy transfer and transformation in all systems, including living organisms. These laws establish principles such as the conservation of energy (first law) and the tendency of energy to degrade and disperse (second law), providing a framework for understanding the flow and transformation of energy in biological processes.

42.(d) Phosphorus is essential for the formation of shells, bones, and teeth. Phosphorus is a vital nutrient required for various biological processes, including the formation and mineralization of skeletal structures. Shells, bones, and teeth contain calcium phosphate, a compound that provides strength and structure to these body parts.

43.(d) The term used to describe the species that colonize a bare area during ecological succession is pioneer species. Pioneer species are the first organisms to colonize and establish in an area that has been previously devoid of life, such as bare rock or a freshly formed volcanic island. These species play a crucial role in initiating ecological succession and creating suitable conditions for the establishment of other plant and animal species.

44.(d) In the context of a pond ecosystem, the term “benthos” refers to bacteria. Benthos includes organisms that inhabit the bottom of aquatic environments, such as ponds, lakes, or oceans. It comprises various organisms, including bacteria, fungi, algae, small invertebrates, and some fish species, that are adapted to the benthic (bottom) habitat.

45.(C) Both I and II are true. I. The total organic matter synthesized by producers through photosynthesis per unit time and area is known as gross primary productivity (GPP). II. Net primary productivity (NPP) is the weight of organic matter stored by producers in a unit area/volume per unit time. Gross primary productivity represents the total energy captured by producers, while net primary productivity represents the energy available for growth, reproduction, and storage after subtracting the energy used by producers in respiration.

46.(c) In an Eltonian pyramid, the lion would be positioned as a secondary consumer. An Eltonian pyramid is a graphical representation of energy flow and trophic levels in an ecosystem, with each level representing a different group of organisms. The producer level, which includes plants or primary producers, forms the base of the pyramid. The primary consumers, such as herbivores, occupy the second trophic level. The secondary consumers, which feed on herbivores, occupy the third trophic level.

47.(A) Phytoplankton is responsible for achieving maximum primary productivity in a pond. Phytoplankton are microscopic photosynthetic organisms, such as algae and cyanobacteria, that float near the water surface. They are the primary producers in aquatic ecosystems and play a crucial role in capturing sunlight and converting it into chemical energy through photosynthesis. Due to their high growth rates and efficient photosynthetic abilities, phytoplankton contribute significantly to the primary productivity of ponds by producing organic matter that serves as a food source for other organisms in the ecosystem.

48.(D) The carbon cycle takes place through all of the above mediums: atmosphere, ocean, and living and dead organisms. The carbon cycle is the biogeochemical cycle that describes the movement and exchange of carbon between different reservoirs on Earth. Carbon dioxide (CO<sub>2</sub>) is exchanged between the atmosphere and living organisms through photosynthesis and respiration. Carbon is also transferred to the ocean through processes such as dissolution and diffusion. Additionally, carbon is stored in living organisms as organic matter and in dead organic material, which can undergo decomposition and fossilization over long periods of time.

49.(C) The proper functioning of an enzyme requires an optimum temperature. Enzymes are biological catalysts that facilitate chemical reactions in living organisms. Each enzyme has an optimal temperature range at which it functions most efficiently. This temperature range allows the enzyme to achieve the maximum rate of reaction. Deviating from the optimum temperature can denature the enzyme, leading to a loss of its catalytic activity. While some enzymes may have specific temperature requirements, the concept of an optimum temperature applies to most enzymes.

50.(A) Rainforest ecosystems exhibit the highest net productivity in the terrestrial environment. Net productivity refers to the amount of organic matter produced by photosynthesis minus the amount of energy consumed by respiration in an ecosystem. Rainforests, with their high levels of biodiversity and abundant rainfall, have a high rate of primary productivity. They contain a large number of plant species, including tall trees, epiphytes, and understory plants, which collectively contribute to a high net primary productivity. The combination of favorable climatic conditions, nutrient availability, and diverse plant communities in rainforests leads to their exceptional productivity. Deciduous forests also exhibit relatively high productivity but generally lower than rainforests. Mangrove plantations, while productive in their own right, do not typically match the productivity levels of rainforests or deciduous forests.

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