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Environment Preview

Environment

PRELIMS & MAINS

For Civil Services Exams

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CHAPTER 1 ECOLOGY AND ECOSYSTEM

ECOLOGY

Every organism interacts with other organisms and its physical environment. The organism interacts with other organisms of the same species or of other species. The interaction among the organisms of the same species are called intra-species interactions. The example of intra-species interaction include copulation in order to produce offspring.

The example of inter-species interaction includes competition between two animals of different species for the same resource. In other words, competition between goat and deer for the same patch of grass is an example of inter-species competition.

The physical environment of an organism consists of land, water resources, climatic characteristics such as sunlight, temperature, humidity and so on. Like organisms interact with each other, they also interact with their physical environment. For instance, sunlight is essential for the plants to produce their food. In the absence of sunlight, plants may even die.

The above-mentioned interactions of organisms with each other and their physical environment is the subject matter of **ecology**. In other words, ecology is the study of how living organisms interact with each other and their environment.

If we break down this definition, then we can identify that the subject matter of ecology consists of three aspects:

1. Living organisms (Biotic component)
2. Physical environment (Abiotic component)
3. Interactions of organisms

Let us understand each aspect one by one.

Biotic Component

The word 'biotic' is derived from the word 'bio' which means life. The word 'biotic' literally means 'relating to living organisms'. Thus, the biotic component of the ecosystem refers to living organisms including human beings, animals, plants and microorganisms. The biotic component is the main focus of study of ecology. Biotic component can be further divided into autotrophs and heterotrophs on the basis of the ability of organisms to produce food

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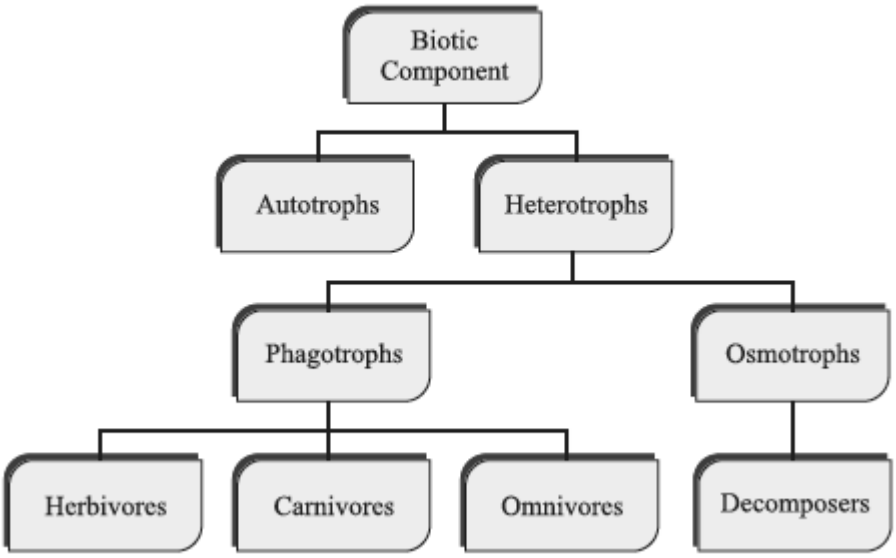

1. **Autotrophs:** Autotrophs are those organisms which have the ability to produce their own food. As these organisms have the ability to produce food, they are also called producers. Autotrophs are able to produce food by the process of photosynthesis. Examples of autotrophs include green plants and algae.

   Photosynthesis is the process in which the producers such as plants use CO_2 and water and convert them into carbohydrates and oxygen in the presence of sunlight and chlorophyll. The carbohydrates produced during the process of photosynthesis, provide energy to a plant to carry out its day-to-day activities. The unused carbohydrates are stored in the form of starch which serves as a food reserve. The oxygen produced by plants is released into the atmosphere. The process of photosynthesis can be depicted by the following formula:

$$\text{Carbon Dioxide} + \text{Water} \xrightarrow[\text{Sunlight}]{\text{Chlorophyll}} \text{Carbohydrates} + \text{Oxygen}$$

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2. Heterotrophs: Heterotrophs are those organisms which do not produce their own food. Heterotrophs consume plants or other animals, whether living or dead for their food requirements. Since heterotrophs cannot produce their own food, they are also regarded as consumers. All animals and plants which cannot cook their food are examples of heterotrophs.

When heterotrophs consume plants or other animals, they are able to secure carbohydrates. These carbohydrates act as energy sources for heterotrophs.

Heterotrophs can be further classified into phagotrophs and osmotrophs. They can also be classified into biophages and saprophytes.

Phagotrophs and Osmotrophs

Phagotrophs: As compared to osmotrophs, phagotrophs are more evolved organisms. They have the ability to digest complex food substances obtained from plants, animals or both. In other words, phagotrophs have the ability to undertake chemical breakdown of the complex food substances into simpler substances. Once the food substances are broken down into simpler substances, they are absorbed by phagotrophs.

It is to be noted that digestion is the process of chemical breakdown of the complex food substances into simpler substances. Once the process of digestion is complete, it is followed by absorption. In this process, food substances in their simpler forms are absorbed by the body.

Phagotrophs are also called macro-consumers. The word 'macro' means large. Phagotrophs are called macro-comsumers because they can consume large or complex food substances.

Phagotrophs are further of three types:
a. Herbivores: Herbivores literally mean those animals which feed on plants. In other words, a herbivore is an animal that gets its energy from eating plants only. Many herbivores have special digestive systems which let them digest all kinds of plants, including grasses. As herbivores need a lot of energy to survive, many of them such as cows and sheep eat for long hours. Thus, herbivores require a lot of plants in their environment for their survival.

b. Carnivores: Carnivores literally mean those animals which feed on other animals. In other words, a carnivore is an animal that gets food by eating other animals. Examples of carnivores include tiger, lion, wolf, leopard and hyena. Carnivores generally eat herbivores, but they can also eat omnivores, and even occasionally other carnivores.

Since carnivores survive on hunting other animals, they are strong and swift. Consequently, their energy requirements are high. This means that they have to eat many other animals over the course of their lifetime. Thus, for the survival of carnivores, it is essential that the number of herbivores and omnivores should exceed the number of carnivores.

c. Omnivores: Omnivores literally mean those animals which feed on both plants and

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animals. In other words, an omnivore is an animal that gets food by eating both animals and plants. Omnivores include a diverse group of animals. Examples of omnivores include birds, dogs, foxes, certain insects, and humans. Omnivores are regarded as opportunistic feeders since they derive their energy by both plants and animals.

Like herbivores, omnivores also eat plants. However, omnivores can't digest all the plants and plant parts. Omnivores generally eat only the fruits and vegetables produced by fruit-bearing plants. Omnivores usually do not eat grass.

Like carnivores, omnivores hunt and eat other animals. Usually, Omnivores eat herbivores and other omnivores. Some omnivores are scavengers. Scavengers are animals that feed on the remains of dead animals. For instance, bears eat twigs and berries apart from hunting small animals. Many omnivores also eat eggs of other animals.

It is to be noted that animals which eat other animals such as carnivores and omnivores are important to any ecosystem, because they prevent overpopulation of other species. At the same time, it is important that an ecosystem has enough herbivores, so that it can support the population of carnivores and omnivores.

Osmotrophs: As compared to phagotrophs, osmotrophs are less evolved organisms. They do not have the ability to break down complex food substances into simpler substances within their body. Consequently, they consume food only after it is broken down into simpler substances. In other words, osmotrophs undertake only absorption (not digestion) of food.

Thus, osmotrophs are those organisms who convert their food into simple substances outside their body and then absorb those substances. Osmotrophs are also called **micro-consumers**. The word 'micro' means small. Osmotrophs are called micro-consumers because they can consume only small or simple food substances.

Decomposers such as bacteria and fungi which decompose the organic matter to gain nutrients are also included within osmotrophs.

Biophages and Saprophytes

Heterotrophs can also be classified into biophages and saprophytes.

a. **Biophages:** Organisms that derive the nourishment for their existence from other living organisms are called biophages. In other words, these organisms hunt their prey down and consume them. Herbivores and carnivores such as tigers are examples of biophages.

b. **Saprophytes:** An organism that derives nourishment by feeding on dead organisms are called saprophytes. In other words, these organisms usually do not hunt other animals down in order to consume them. Decomposers, detritivores and scavengers are examples of saprophytes. Mushrooms, molds, yeast, *Aspergillus* and *Rhizopus* are examples of saprophytes.

Differences between Decomposers and Scavengers

Both the decomposers and scavengers survive on dead organisms. Scavengers are the organisms which consume large chunks of dead plants and animals and break down the

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dead plants and animals into smaller parts. Vultures are examples of scavengers. Scavengers do not break down dead organic matter into chemicals such as nitrogen and carbon.

Decomposers, on the other hand, take over the dead matter after the scavengers. This means, after scavengers break down the dead organic matter into smaller particles, decomposers further break the dead organic matter into chemical nutrients such as nitrogen and carbon. These chemical nutrients become part of the soil and can then be used by living plants and animals that consume them. Thus, decomposers play an important role in nutrient cycling. Bacteria, microbes and fungi are examples of decomposers. Decomposers (other than fungi) cannot be seen with naked eye and are observed only under a microscope.

Criteria	**Scavengers**	**Decomposers**
Definition	Scavengers consume large chunks of dead plants and animals and break down the dead plants and animals into smaller parts	After scavengers break down the dead organic matter into smaller particles, decomposers further break the dead organic matter into chemical nutrients such as nitrogen and carbon.
Conversion of dead remains	Scavengers break the dead remains into smaller particles	Decomposers further break these smaller particles into chemical nutrients such as nitrogen and carbon.
Example	Vultures	Bacteria, microbes and fungi

Difference between Decomposers and Detritivores

Detritus refers to dead organic matter or wastes such as fecal material. Though the terms detritivores and decomposers are used interchangeably, there exists a difference between them. Detritivores generally ingest the organic matter and digest them using their internal organs. Decomposers, on the other hand, externally break down the organic matter into simpler substances by secreting enzymes and thereafter absorb nutrients. Earthworms, beetles, woodlice and dung flies are examples of detritivores. Earthworms are detritivores which feed only on plant detritus.

Criteria	**Detritivores**	**Decomposers**
Digestion	Digestion takes place within the body due to evolved internal organs	Large part of digestion takes place outside the body. The organic matter is converted into simpler substances outside the body by secreting enzymes.
Example	Earthworms, beetles, woodlice and dung flies	Bacteria, microbes and fungi

Abiotic Component

The word 'abiotic' literally means relating to non-living things. Thus, the abiotic component refers to the physical environment of organisms, which includes sunlight, precipitation, humidity, wind pattern, topography, temperature and so on. The abiotic factors play a major role in determining the type of organisms that live in a particular ecosystem.

For instance, factor such as temperature play a critical role in determining the species

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composition of an ecosystem. Many organisms are accustomed to live in a particular range of temperature. Temperature affects the metabolic activity and other physiological functions of organisms. Organisms which can survive in a wide range of temperatures are called **eurythermal organisms**. Organisms which can survive in a narrow range of temperatures are called **stenothermal organisms**.

Other factors such as sunlight, precipitation and soil properties also determine the species composition of an ecosystem such as the nature of vegetation in a region. The vegetation of a region in turn determines the type of animals that can be supported. In terrestrial ecosystem, the temperature and precipitation play a major role. In aquatic ecosystem, sunlight penetration and difference in density of water play a major role.

Interactions Among Organisms

In an ecosystem, living organisms continuously interact with each other. Based on their outcome for the living organisms which are involved, interactions can be divided into positive interactions, negative interactions and neutral interactions.

Negative interactions

If any species suffers any harm on account of interaction, then it is regarded as a negative interaction. In some negative interactions, both the organisms may suffer harm. In other negative transactions, one organism may benefit and the other may suffer harm. Negative interactions are further classified into:

1. **Competition:** Competition is described as a relationship in which different individuals attempt to use the same limited resource. Competition usually has negative outcomes for all the individuals who are affected by it. Competition may occur among the individuals of the same species. It can also occur among the individuals of different species.

   Moreover, competition can occur both directly and indirectly. For example, indirect competition can occur between two birds that feed on the same insect, but one species eats at day and the other at night. Direct competition occurs between deer and goat in grassland for the same food sources and territory.

2. **Predation:** This type of interaction occurs when one organism, the 'predator' feeds upon another organism, known as 'prey'. In this interaction, one organism benefits while the other organism is harmed. Predation is a complex web to understand, for one predator can be the prey of many species.

3. **Parasitism:** The relationship between the parasite and the host is known as parasitism. Parasitism is similar to predation in that it does cause harm to its host but does not necessarily "kill" its host. Usually, parasite is dependent upon host for fulfilment of its nutrient requirements. Some common parasites are ticks, fleas, tapeworms and leeches.

   Parasites that survive on the external surface of the host organism are called **ectoparasites**. The most familiar examples of this group are the lice on humans and ticks on dogs. **Endoparasites** are those parasites that live inside the host body at different sites.

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Brood parasitism is another example of parasitism in which the parasitic bird lays its eggs in the nest of its host (bird who has made nest) and lets the host incubate them. The eggs of the parasitic bird resemble the host's egg size and colour. This makes it difficult for the host bird to detect and eject these eggs from the nest. The most familiar example of brood parasitism is female cuckoos laying their eggs in the nests of other bird species. The cuckoo's eggs hatch earlier than the crow's. The young cuckoo usually throws the other host eggs out of the nest, getting rid of any competition for the parent's attention.

4. **Amensalism** is any relationship between organisms of different species in which one organism is inhibited or destroyed while the other organism remains unaffected. A common example of amensalism is the release of chemical toxins by plants that can inhibit the growth of other plant species.

Stratification

Competition negatively impacts both the organisms in the interaction. Hence, to ensure optimal utilisation of the resources and minimise interspecies conflict, organisms use stratification as a strategy. Stratification means the arrangement or classification of something into groups.

For example, in forests, vegetation can be observed in distinct layers. The bottom layer is a ground layer made of mosses, liverworts, dead leaves and other organic matter. The next layer is the lower layer, which is made of grass, short and tall shrubs. The next layer is the middle layer consisting of shorter trees. The topmost layer consists of medium and taller trees.

On the ground level, soil fauna is present. In the lower layer, those animals live which descend to the floor for short periods. The middle layer is occupied by organisms, which rarely come down to the floor. The topmost layer is occupied by flying organisms. As a result of this stratification, interaction is minimised among the species occupying different layers. Each species depends on its respective layer to gather food and nutrients.

As different species occupy different layers of the vegetation, this reduces the chances of conflict. Hence, stratification is used as a practical strategy by the organisms to minimise the competition.

Positive interactions

The positive interactions are those in which either one organism is benefited and there is no effect on the other or both the organisms are benefited. In other words, in a positive interaction either one or more organisms are benefited and none of the organisms experience any harm.

1. Mutualism: Mutualism is an interaction in which both the species are benefited. In certain cases, mutualism between two species is so intimate that one cannot survive without the other. Such an interaction is called **symbiosis**. Example of symbiosis is termite and their intestinal flagellates. Termites feed on wood but they don't have the necessary enzymes to digest the wood. The flagellate protists (protozoans) in their intestines have the necessary enzymes to digest the cellulose of the wood eaten by termites. These flagellates convert it

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into sugar and use some of it for their metabolism, leaving enough for the termites. The flagellates and termite cannot survive without each other.

One more example of mutualism is the presence of intestinal bacteria in the human body. In the human body, intestinal bacteria use the warm, nutrient rich walls of the intestine for its survival. In turn, the bacteria improve our digestion by breaking down the foods which we cannot digest on our own.

2. Commensalism: There are also certain relationships in which one organism benefits, while the other organism involved in the relationship is not affected. This is known as commensalism. For example, vultures closely follow tigers, to feed on the tiger's kills.

Neutral interactions

Neutral Interactions or neutralism refers to those interactions in which there is no effect on either of the species. However, in nature, it is difficult to find an absolutely neutral interaction. Hence, the usage of this term is restricted to those interactions which have insignificant or negligible impact on the organisms.

Interactions with Abiotic Components

The organisms adapt in multiple ways to the changes in their abiotic environment. Particularly significant is the way in which different organisms respond to changes in temperature. The organisms cope with the changes in environment by various mechanisms such as:

1. Homeostasis: For efficient physiological and biochemical reactions in the body, evolved organisms maintain a relatively constant internal environment such as constant temperature, osmotic pressure and so on. Even when the external environmental conditions vary, organisms try to maintain a constant internal environment. This maintenance of constant internal environment is called homeostasis.

2. Regulate: Organisms attempt to attain homeostasis by regulating their body variables such as temperature, fluid balance and so on. Regulation refers to responding with suitable reactions in order to make adjustment to the external or internal environment. For example, humans maintain a constant body temperature of 37°C. In summers, when the temperature is high, sweating occurs. Sweating cools down the body, reducing its temperature. In winter, shivering generates heat and raises body temperature. Such mechanisms are generally used by mammals. Plants and less evolved animals don't have such mechanisms in place.

3. Conform: Majority of organisms (99%) cannot maintain a constant internal environment. They conform to the external changes. In these organisms, their body temperatures and osmotic concentrations change with changes in the external environment. Thus, such organisms can survive with the changes in the external environment, only if the changes in the external environment are favourable to them.

Conform explains why smaller animals are normally not found in polar regions. As the surface area of smaller animals is larger, relative to their volume, they tend to lose heat

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quickly in colder temperatures. In some cases, when the organisms cannot regulate or conform, they either migrate or suspend certain body functions.

4. Migrate: Organisms temporarily move to a different place and return back to the original place when the environment is more suitable. For instance, during winters, Siberia is extremely cold. As a result, Siberian cranes migrate to India during winters. As summers approach, these birds fly back to Siberia.

5. Suspend: Organisms may hibernate or aestivate under unfavourable conditions. If an organism sleeps and reduces bodily functions in winter, it is termed **hibernation**. Polar bears go into hibernation in winters. During this time, they don't eat much, their body temperature drops, and heartbeat and breathing slows down. As a result, they do not need much energy and can survive without going outside for food. **Aestivation** refers to organisms going into a dormant state in summers, to escape heat. Snails and fish go into aestivation. In other cases, organisms may delay their development. This is called **diapause**. Zooplankton species in ponds and lakes undergo diapause, as a response to unfavourable conditions.

6. Evolution: Any organism evolves over the course of time to live in a particular environment. Unlike regulate, conform and other adaptations mentioned above, adaptation by evolution is a long-term process. For instance, camels have evolved over millions of years to be able to live in deserts. An adaptation by evolution can be defined as certain characteristics that an organism develops over time which enables it to survive in a particular environment. It can be in the form of its physical appearance or behaviour evolved by an organism or even the way an organism lives.

Flowers that bloom at night are generally white in colour and fragrant. The white colour and fragrance enhance visibility of flowers to pollinating agents, which helps in attracting them. If these flowers would have been of dark colours, then they would be unnoticeable by the pollinating agents. The white colour and fragrance in flowers is an example of adaptation by evolution.

Levels of Study in Ecology

The interactions occur not just between individual organisms but also between species, population, community, ecosystem, biome, and even biosphere as a whole. Consequently, ecology not only studies the interactions of individual organisms with their environment, but also that of population, community, ecosystem, biome, and biosphere. Consequently, individual, species, population, community, ecosystem, biome, and biosphere comprise various levels in the study of ecology.

1. **Individual:** Individual refers to a single organism. It can be a plant, animal or any other living organism. An individual can belong to any species.
2. **Species:** The most common definition of a species is a group of organisms capable of interbreeding and producing an offspring. Thus, only member of a same species can reproduce through copulation. However, individuals of a species interact with other individuals, both intra and inter species, in a variety of ways.
3. **Population:** In ecology, population refers to all the organisms of the same species, which live in a given geographical area. In other words, we use the word 'population' to refer the number of

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organisms of a particular species within a given area.

From the above definition, we can say that the term 'population' is expressed with the help of three characteristics:

a. **Species:** The term population is used in reference to particular species. We have learnt that a particular species consists of all the individuals that have capability of interbreeding amongst themselves.
b. **Number of individuals:** The count of population is based on the number of individuals belonging to a particular species.
c. **Geographical area:** The term population is used to express the number of organisms of a particular species within a geographical area. Geographical area may be of any size. It may be a local region or the whole earth.

Let us take an example. We can say that the population of tigers in a particular forest is 40. Here, 'species' is tigers, 'area' is forest and the 'number of individuals' of the species is 40. Thus, the population is expressed with the help of three characteristics: description of species, geographical area and number of individuals in the species.

Characteristic features of Population group

Let us understand the features of every population group. These are as follows:

a. Every population group utilizes the common resources. For example, tigers in a forest feed upon the same group of organisms.
b. A small group of population has high chances of extinction than that of a large group. Moreover, it is important for the survival of species that the population of the species is dispersed across multiple regions. A species concentrated in a single region may get extinct with adverse effect on that particular region.
c. Members of a population are affected by same natural and man-made phenomena. For example, all the tigers in a forest get affected due to the reduced availability of prey.
d. In a population, individuals are of different age. The proportion of individuals in each age group is called **age structure of that population**.

COMMUNITY

In ecology, a community is an assemblage of populations of different species, interacting with one another. In other words, populations of different species which live and interact together in a given area, form a community.

Members of a particular community interact in various ways such as competition, predation, mutualism, etc. These interactions affect community structure. **Community structure** refers to composition of a community, including the number of species in that community and the number of individuals in each community. A community's structure is described with the help of two terms: Species richness and Species diversity.

Species richness refers to the number of species present in the community. For instance, a community with 124 species has less species richness than the community with 138 species.

Species diversity considers both species richness and species evenness. In other words, species diversity is calculated on the basis of both species richness and species evenness.

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Species evenness refers to the number of individuals in various species. In other words, species evenness refers to the relative numbers of various species.

ECOSYSTEM

An ecosystem is a community of living organisms in conjunction with the non-living components of their environment (such as air, water and soil). The community of living organisms (biotic component) continuously interacts with its physical environment (abiotic component). These biotic and abiotic components are linked together through nutrient cycles and energy flow.

Ecosystem can be of any size but usually encompass specific, limited spaces. Although, some scientists say that the entire planet is an ecosystem.

Difference between Ecology and Ecosystem

As we have discussed earlier, ecology is the study of interactions between individual living organisms and their environment. Ecosystem is the functional unit of nature in which organisms interact with each other and with their environment. In simple words, the ecosystem is the place where the interactions take place, and ecology studies these interactions.

BIOME

Biome refers to large regions sharing similar climatic conditions, soil type, flora and fauna. In other words, on account of similarity in terms of climatic conditions, soil type and flora and fauna, large region is grouped together as a biome. India has been divided into five major biomes. These biomes are:

a. **Tropical humid biome:** This type of biome is found in tropical regions with more than 200 cm of average annual rainfall such as Western Ghats and Eastern Himalayas.
b. **Tropical deciduous biome:** This type of biome is found in tropical regions with 50 to 200 cm of average annual rainfall. This type of biome covers the largest part of India.
c. **Desert and semi-desert type biome:** This type of biome is found in Southern Punjab, Central and Western Rajasthan where average annual rainfall is less than 50 cm.
d. **Coniferous biome:** This type of biome is found in colder climate of Himalayas between altitudes of 1500 m and 3000 m.
e. **Alpine biome:** Alpine biome start at an elevation of above 3000 m on Himalayas and grow up to the region which is just below the snowline.

BIOSPHERE

The biosphere (from Greek word '*bios*' = life and '*sphaira*' = sphere) is the layer of the planet Earth where life exists. This layer ranges upto the height of 10 kilometres above the sea level, used by some birds in flight, to ocean depths of more than 8 kilometres such as the Puerto Rico trench. The layer of the Earth containing life is thin because the upper atmosphere has little oxygen and very low temperature, which are not conducive for the survival of life. Similarly, ocean depths deeper than 1000 m are dark, cold and lack oxygen.

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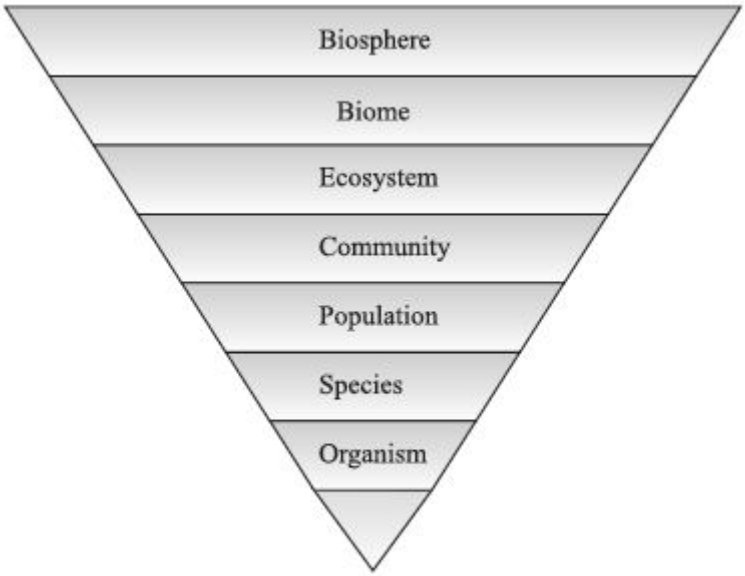

Levels of study in Ecology

Terminology related to Ecology and Ecosystem

Ecotone

Ecotone is a zone of junction between two or more diverse ecosystems. This zone can be local or regional, narrow or wide in size. In an ecotone, the conditions are intermediate of the two adjacent ecosystems. For instance, the coastal areas represent an ecotone between marine and terrestrial ecosystem.

Ecotone is also transition zone between two diverse ecosystems. In other words, there is no clear-cut boundary between two diverse ecosystems. Consider a coastal region. The exact boundary between land and sea is not clear because the level of the sea varies on account of multiple factors such as tides.

Let us take example of a forest. It is difficult to clearly demarcate the boundaries of a forest. Gradually, the density of a forest reduces and the forest land merges with the non-forest land. Thus, in most cases, the boundaries of ecosystems are not clearly defined.

Often, ecotone has ecological conditions to support species of adjoining ecosystems. In fact, an ecotone may possess species which are not present in adjoining ecosystems. Thus, ecotone may have larger biodiversity as compared to adjoining ecosystems. This phenomenon is called **edge effect**.

In other words, the edge effect is an ecological concept which explains why there is a greater diversity of life in the region where the edges of two adjacent ecosystems overlap.

Edge effect is possible because ecotone offers unique ecological conditions which are not there in the adjoining ecosystems. For instance, coastal regions have larger biodiversity as compared to the adjoining terrestrial and marine ecosystem.

Ecocline

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Ecocline is a physical transition zone. It represents a zone that occurs due to variations in the physico- chemical environment. In other words, ecocline is formed when there is change in one or two physico- chemical factors. Such physico-chemical factors include temperature, chemicals, salinity level and so on. Changes in any one or more of these factors create an ecocline. An ecocline can be a thermocline (caused due to temperature gradient), chemocline (caused due to chemical gradient), halocline (caused to salinity gradient) or pycnocline (caused due to variations in density of water induced by temperature or salinity). Example of thermocline is change of water temperature in a pond. Water on the surface of the pond is warmer than the water at the lower levels in the pond.

Types of Ecocline	**Reason behind formation of Ecocline**
Thermocline	Change in temperature
Chemocline	Change in chemical intensity
Halocline	Change in Salinity
Pycnocline	Change in density of water

Difference between Ecotone and Ecocline

Ecotone is a transition zone between two ecosystems. It is the place where communities of adjacent ecosystems co-exist. On the other hand, Ecocline is a physical transition zone. It refers to variation in the physico-chemical environment due to change in one or more physico-chemical factors.

To conclude, ecotone is related with the variation in prevalence of species while ecocline is related with the variation in the physico-chemical environment.

Niche or Ecological Niche

A *niche* refers to the unique functional role of a species in an ecosystem. It describes the role of species in production and consumption of food resources. A species' niche also includes the physical, biological and chemical environment to which it is adapted. In other words, the role of species is understood in context of its physical, biological and chemical environment.

Niche construction is the process by which an organism alters its own (or another species) environment. These alterations can be a physical change to the organism's environment or can even happen when an organism leaves one habitat for another.

Fundamental and Realized Niche

Both fundamental and realized niche are related to the conditions needed for the survival of a given organism and its role in an ecosystem. However, there are significant differences between the two terms.

Fundamental niche is the entire set of conditions under which an organism can survive and reproduce itself. **Realized niche** is the set of conditions actually used by a given organism, after taking into account interactions (especially competition) with other species.

The set of conditions described under fundamental niche consider the various potential roles of the species. On the other hand, the set of conditions described under the realized niche consider the actual roles performed by the species. Thus, the fundamental niche is

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larger than the realized niche. The realized niche can be called as a subset of fundamental niche. When the species interact with other species, they face various pressures. Thus, they are forced to live in narrower niche. This narrower niche is the realized niche. In other words, it is the realized niche where a species actually exist.

Criteria	Fundamental niche	Realized niche
Definition	Entire set of conditions under which an organism can survive and reproduce itself	Actually available conditions under which an organism would survive or grow
Wider/Narrower	Fundamental niche is wider in scope because it considers potential conditions	Realized niche is narrower in scope because it considers actual available conditions
Relation with Organism	If an organism lives under Fundamental niche, then it can perform larger roles.	An organism in the realized niche performs limited roles. In other words, due to various restrictions and limitations, the actual roles performed by an organism are limited.
Example	If there is no competition, an organism would have more choices and availability of prey.	Due to competition and other constraints, the freedom to reproduce and the availability of prey is limited.

Niche width and Realized niche width

The niche width of an organism refers to the potential space which a given organism can inhabit to live and to use in order to access the resources. Niche width does not consider competition. The niche width is determined on the basis of biotic and abiotic factors such as availability of food sources and suitability of climate respectively.

The niche width often differs from the area that a species actually inhabits. *Realized niche width* is used to define the actual space that an organism inhabits and uses to access the resources on account of pressure from other organisms such as competition for same space.

Thus, the realized niche width is the actual space where organisms live and access the resources that are not used by other species. Within realized niche width, all the fundamental requirements of an organism are fulfilled in order to make successful living such as food, mate, and shelter. An organism's realized niche width is much narrower than its theoretical niche width as it is forced to adapt its niche on account of competition from other organisms.

Niche overlap

Niche overlap occurs when two organisms use the same resources or other environmental variables. The organisms which experience niche overlap engage in interactions with each other. These interactions may result in symbiotic relationships, competition, predation and so on. Niche overlap is studied to determine which species can coexist in a single habitat.

Habitat

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A habitat is an ecological or environmental area that is inhabited by a particular species of animal, plant, or any other type of organism. The term typically refers to the zone in which the organism lives and where it can find food, shelter, protection and mates for reproduction.

Home Range

A home range is the area in which an animal lives and moves on a periodic basis. An associated concept is the **utilization distribution** which examines where the animal is likely to be at any given time. Earlier, data for mapping a home range used to be gathered by careful observation, but nowadays, the animal is fitted with a transmission collar or a GPS device.

Home range includes the territory of an animal. **Territory** is an area which an animal, or group of animals, protects from incursions by other members of its species. Territorial boundaries may be marked by sounds such as bird song, or scents such as pheromones secreted by the skin glands of many mammals.

Speciation and Extinction

The species present in the world today are a result of speciation and extinction. Speciation refers to formation of new species. Speciation can occur on account of one or more factors such as geographic isolation, ecological isolation, reproductive isolation and mutation.

Geographic isolation: When different populations of a species are isolated due to a geographic barrier such as mountain, ocean, river, etc., it is termed as geographic isolation. Because of the physical barrier, the populations cannot interbreed with each other. Over time they evolve as distinct species incapable of interbreeding. The most common way a population undergoes speciation is by geographic isolation.

Example: One of the best examples of speciation is Kaibab squirrels and Abert squirrels that live on opposite sides of the Grand Canyon. Though they originally belong to the same species, they evolved into two distinct species over a course of time. It is assumed that about a million years ago, when the Colorado river changed its course, the original population of squirrels was split into two, creating a geographical barrier. As a result of different environment on either side of the canyon, the two populations developed distinct characteristics. Over the years, the genetic differences became so large that the two populations of squirrels emerged as two separate species. These species look different from each other and are not capable of interbreeding.

Ecological isolation: When different populations of a species are isolated from each other as a result of differences in temperature, humidity, pH level etc in the environment, it is termed as ecological isolation.

Reproductive isolation: When different populations of a species cannot interbreed due to a reproductive barrier, it is termed as reproductive isolation. This may occur when two populations become sexually receptive at different times, members are not attracted towards one another or failure of pollination mechanisms. For example, though they occur in the same area, the population of frogs that breed in May is reproductively isolated from frogs that

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breed in July.

Extinction

Extinction refers to the disappearance of a species' population from an area or the disappearance of complete species itself. It can be a result of natural or anthropogenic (man-made) factors. In recent times, threats to different species as a result of human actions, has become a major global concern. Natural factors such as tsunami, volcano etc may result in extinction of species. In certain cases, extinction may happen at a faster rate than speciation. At a particular point of time, widespread extinction may occur leading to disappearance of a wide range of species. Such events are termed as mass extinctions. So far, Earth has witnessed five mass extinctions.

Scientists argue that anthropogenic activities such as over exploitation of resources, global warming and climate change are leading to the ongoing sixth mass extinction, also known as Anthropocene extinction. While the earlier five mass extinctions were believed to be caused by natural reasons, the sixth one is seen to be a result of human activities.

Ecological Succession

Ecological succession refers to progressive changes in the species composition of a particular area with the passage of time. In other words, plant and animal communities in a particular area are replaced over time by a series of different communities.

Ecological succession undergo more or less orderly and predictable changes. For instance, in a barren land, rainfall and bird droppings lead to growth of lichens. Lichens are composite organisms of algae and fungi and/or cyanobacteria. The first species to grow in an area are called **pioneer species**. In our example, lichens are the pioneer species. Pioneer species is the first to colonize an area and it also sets the foundation for development of other species.

Lichens secrete acid that breaks down rock and soil formation takes place. As lichens die, their mass add organic matter to the soil. Thereafter, mosses develop in the area. They trap soil blown by the winds. When mosses die, they add more organic matter to the soil.

Thereafter, seeds arrive in the area, which are either dropped by birds or by winds, begin germinating and eventually develop into small plants. These small plants are gradually replaced by large and complex plants with passage of time.

At each stage, new species adds to the community and replace the previous species. This way, this progressive succession reaches a stable point when there is no more change in the species composition of a place. This stable point is called **Climax of the Ecosystem**.

The time scale for ecological succession can be decades (for example, after a wildfire), or even millions of years after a mass extinction, or the initial colonization of a new habitat.

In ecological succession the pioneer community gets replaced by another community, which is again replaced by a different community. This process continues until a final stable community evolves in the region. This final community is called the **climax community**. The transitional communities in between the primary and climax community are called **seral communities** or **intermediate communities**. The entire sequence of these successive

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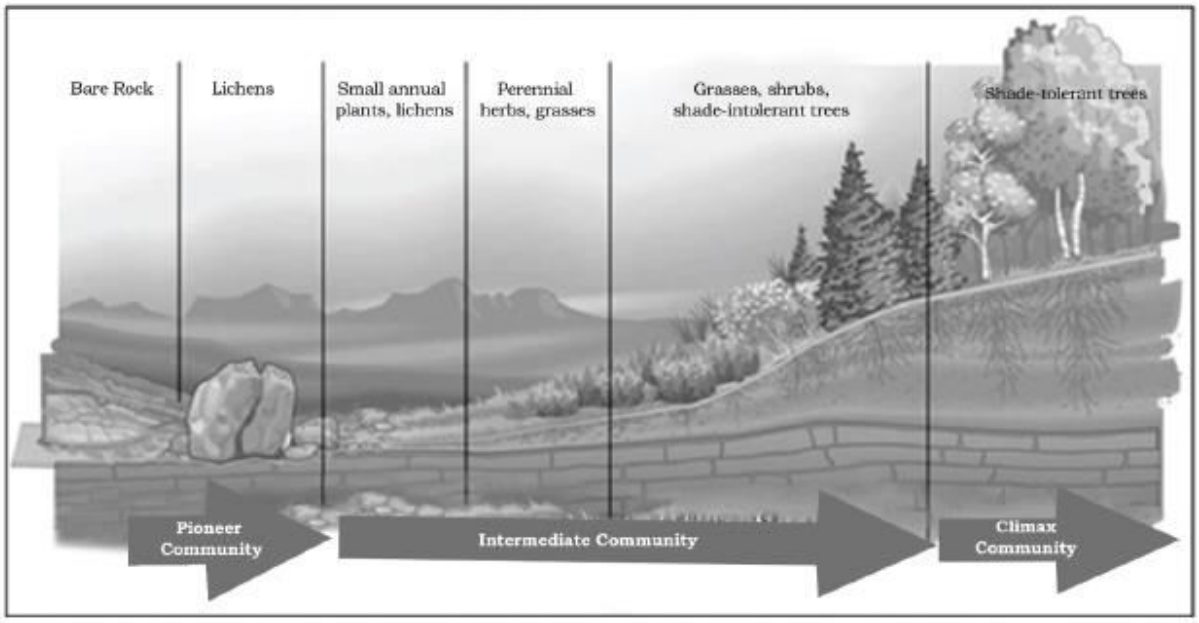
communities in a given area is termed sere. With each stage of succession, the biodiversity of species and the total biomass of the community tend to increase.



Kinds of Ecological succession

Succession may be initiated either in a new, unoccupied habitat or by some form of disturbance in an existing habitat. Succession that begins in new habitats, uninfluenced by pre-existing communities is called **primary succession**, whereas succession that takes place after disruption of a pre-existing community is called **secondary succession**.

Secondary succession unlike primary succession doesn't start from a bare land. In this type of succession, there was a community which existed previously. This earlier community may have been removed, disturbed or destroyed by natural reasons (hurricane, forest fire) or by anthropogenic reasons (tilling, harvesting of land). The formation of a new community after the existing community is destroyed or removed, is called secondary succession. Unlike primary succession, secondary succession is relatively fast as the necessary conditions such as soil and nutrients are already present.

It is to be noted that complete replacement of the existing species may or may not happen in a secondary succession. However, the dominant species of the community do undergo a change even in case of secondary succession.

Differences between Primary Ecological Succession and Secondary Ecological Succession

Criteria	**Primary ecological succession**	**Secondary ecological succession**
1. Definition	When barren land is colonized by living beings for the first time, it is called primary ecological succession.	This succession takes place in an area where a community had already existed previously. It is the development or succession of new community after the destruction of existing community.

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2. Determining factors	Soil formation takes place along with this kind of succession. This succession begins with most basic plant (pioneer) species. The time period of primary succession depends mainly upon climatic conditions.	Soil is already present for this kind of succession. Seeds, roots and other parts of plants may also be present. Thus, the time period for secondary succession depends upon the already present soil and plant species, and climatic conditions.
3. Speed of succession	The time period of primary ecological succession is usually longer as compared to secondary ecological succession. For instance, it takes millions of years for a barren land to transform into a forest.	The time scale of secondary ecological suc- cession is highly variable; it could be decades or even millions of years. For instance, after a forest fire, succession might take place in few decades. On the other hand, succession after mass extinction might take millions of years.

Some of the types of succession are given below:
Xerarch Succession: The succession that occurs on land with low moisture content is called xerarch succession. In xerarch succession, the succession moves from xerarch (dry) to mesic (medium water) conditions.

Hydrarch Succession: The succession that occurs in wet areas, water bodies such as ponds or lakes is called hydrarch succession. In hydrarch succession also, succession move from hydrarch to mesic conditions.

In both xerarch and hydrarch succession, the climax community is mesic i.e., community of medium water conditions.

Climax Ecosystem
The final stage of succession of an ecosystem is called Climax ecosystem. Ecological succession continues till a stable community structure is achieved. For example, a barren land over time transforms into a forest ecosystem. Here, the forest is a stable and mature stage of succession that resulted after millions of years and is an example of climax ecosystem.

It is important here to mention that climax ecosystem may still undergo change. It can be disturbed by changes in the climate or invasion of new species. In case, it happens, the process of ecological succession starts again.

Productivity (in Ecology)
In ecology, productivity or production refers to the rate of generation of biomass in an ecosystem. It is usually expressed in units of mass (or volume of biomass) per unit area per

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unit time, for instance grams of biomass per square metre per day. Productivity of autotrophs such as plants is called **primary productivity**, while that of heterotrophs such as animals is called **secondary productivity**.

Primary Productivity

Primary productivity is the rate of synthesis of new organic material from inorganic molecules such as water and carbon dioxide. It is dominated by the process of photosynthesis which uses sunlight to synthesise organic molecules such as sugars. Organisms responsible for primary production include plants, algae and some bacteria (including cyanobacteria).

Gross Primary Productivity (GPP)

GPP is the total amount of organic matter synthesized by producers per unit area in unit time. It also includes the organic matter which has been used by autotrophs to carry out respiration and other day to day functions. In other words, it refers to the total synthesis of organic matter by autotrophs including the energy utilized for respiration by the autotrophs.

Mathematically, **GPP** = Rate at which organic matter is synthesised by autotrophs =Rate at which organic matter is utilised by autotrophs to carry out day to day functions + Rate at which organic matter is retained (or stored) by autotrophs

It is to be noted that GPP is calculated with respect to a particular area and particular time period. The use of the word 'rate' in the formula implies that GPP is calculated with respect to a particular area and particular time period.

Net Primary Productivity (NPP)

It is the amount of organic matter stored (or retained) by autotrophs per unit area in unit time. In other words, if we exclude organic matter utilised by autotrophs to carry out day to day functions from total organic matter synthesis by autotrophs, we get Net Primary Productivity.

Mathematically, **NPP** = Rate at which organic matter is synthesised by autotrophs – Rate at which organic matter is utilised by autotrophs to carry out day to day functions

It is to be noted that NPP is also calculated with respect to a particular area and particular time period.

Secondary Productivity

Secondary productivity is the rate of generation of biomass by heterotrophs (consumers) in an ecosystem. Secondary productivity is driven by the transfer of organic material through the trophic levels in a food chain and represents the quantity of new tissue created due to consumption of food.

Organisms responsible for secondary productivity include animals, protists, fungi and many bacteria.

Determinants of Species Behaviour: Genotype and Phenotype

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Genotype is the complete heritable genetic identity. The word genotype can also refer just to a particular gene or set of genes carried by an individual. For example, if one carries a gene linked to diabetes, one may refer to his genotype just with respect to this mutation without consideration of all the other gene variants that one may carry.

In contrast, phenotype is a description of actual physical characteristics. This includes not only straightforward visible characteristics like height and eye colour, but also overall health, and even our behaviour.

Most phenotypes are influenced by both genotype and by the unique circumstances in which one has lived, including one's experiences. Thus, our phenotype is the result of two inputs: "nature," the unique genome we carry, and "nurture," the environment in which we have lived our life.

Types of Species

On the basis of the role played by species in their ecosystem, the species can be known by the following titles:

Keystone Species

A keystone species is a species that plays a critical role in maintaining the structure of an ecological community. In other words, keystone species affects many other species in an ecosystem and plays an important role in determining the types and numbers of various other species in the community. Without keystone species, the ecosystem would be dramatically different or cease to exist altogether. For instance, tigers are keystone species in the terrestrial ecosystem. If the population of tigers decreases in the ecosystem, the deer population would rise. The increase in deer population means more consumption of grass and thus, other species dependent upon grass may not be able to survive.

Flagship species

A flagship species is a species selected to act as an ambassador, icon or symbol for a defined habitat, issue, campaign or environmental cause. Flagship species are usually relatively large and considered to be charismatic.

The concept of flagship species has its genesis in the field of conservation biology. The flagship species concept holds that by raising the profile of a particular species, it can successfully leverage more support for biodiversity conservation.

Foundation Species

Foundation species is a species that plays an important role in determining composition of a community. A foundation species can be at any trophic level in a food web. In other words, foundation species can be primary producers, herbivores or predators.

Since foundation species has an important role in determining composition of a community, impact on foundation species also has impact on the overall community. Thus, environmentalists focus on foundation species to rapidly understand how a community as a whole would react to disturbances, such as pollution or introduction of alien species, instead of choosing the extremely difficult task of tracking the responses of all community members

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simultaneously.

Indicator species

An indicator species is any biological species that defines a trait or characteristic of the environment. For example, a species may delineate an ecoregion or indicate an environmental condition such as a disease outbreak, pollution, species competition or climate change. Indicator species can be among the most sensitive species in a region, and sometimes act as an early warning to monitoring biologists. For instance, coral bleaching (or whitening of corals) is considered as an indication of climate change.

Indigenous species

In biogeography, a species is defined as indigenous or native to a given region or ecosystem if its presence in that region is the result of only natural process, with no human intervention. A species may be introduced by human activity; it is then referred to as an introduced or alien species .

Endemic Species

In ecology, endemic means exclusively native to a particular region. In other words, an endemic species is exclusive to a particular region or utmost a few regions. An indigenous species may occur in areas other than the one under consideration. Thus, an indigenous species is not necessarily endemic.

The terms "endemic" and "indigenous" do not imply that an organism necessarily originated or evolved where it is found.

Introduced or Exotic species

An introduced, alien, exotic, non-indigenous, or non-native species, or simply an introduction, is a species living outside its native distributional range, which has arrived there by natural or human activity, either deliberate or accidental. Non-native species can have positive, negative or no effects on the local ecosystem. One popular example of exotic species having a negative effect on the ecosystem is that of Water hyacinth.

Water hyacinth (scientifically referred to as *Eichhornia crassipes*) is an exotic shrub and an aquatic plant which survives well in hot and humid conditions. It is mainly found in the parts of Bengal. It is callled the terror of Bengal because it destroys other plant and animal species especially fish population in its vicinity.

In comparison to other species, Water hyacinth utilises and consumes aquatic nutrients at a fast pace. This fast utilisation and consumption of nutrients leads to higher Water hyacinth biomass production and reduces the availability of nutrients for other species. Fish is the vital food in Bengal. However, due to higher consumption of nutrients by water hyacinth, the nutrients available for fish are few, leading to decline in the fish population.

Invasive species

Introduced species that become established and spread beyond the place of introduction are called invasive species. Most introduced species may have no negative effect or only minor impact on native species. However, some invasive species may bring significant changes in

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community structure of an ecosystem.

Edge species

Evolutionarily Distinct and Globally Endangered (EDGE) species represent a disproportionate amount of unique evolutionary history. They have few close relatives, are often the only surviving member of their genus, and sometimes the last surviving genus of their evolutionary family. Some examples of EDGE species are elephants and pandas.

Species are identified as EDGE species on the basis of the following process:

1. Every species in a particular taxonomic group (e.g. mammals or amphibians) is given an ED score and GE score. **ED (Evolutionary Distinctiveness)** score is given according to the uniqueness of evolutionary history and **GE (Global Endangerment)** score is given according to its conservation status.
2. These scores are then combined to calculate an EDGE score of each species.
3. Those species with high ED and GE get the highest EDGE scores and are generally prioritised for conservation efforts.

Umbrella Species

Umbrella species are species selected for making conservation-related decisions, typically because protecting these species indirectly protects the many other species that make up the ecological community of its habitat.

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Practice Questions

1. The biomass available for consumption by the herbivores is called:
(a) Gross primary production
(b) Net primary production
(c) Secondary production
(d) None of the above

2. Amensalism is an association between two species where:
(a) One species is harmed and the other is benefitted.
(b) One species is harmed and the other is unaffected.
(c) One species is benefitted and the other is unaffected.
(d) Both the species are harmed.

3. A high density of tiger population in an area can result in:
(a) Predation on one another
(b) Mutualism
(c) Intra species competition
(d) Inter species competition

4. Which one of the following terms is related to the impact of an organism on biotic and abiotic components of its ecosystem?
(a) Ecotone
(b) Ecological niche
(c) Ecocline
(d) Trophic level

5. A transition zone or region separating two biomes is known as:
(a) Ecocline
(b) Ecological niche
(c) Ecotone
(d) Ecotype

6. Which of the following statements correctly explains the phenomenon of amensalism?
(a) One species kills to feed on the other species.
(b) An organism benefiting from the other organisms.
(c) Production of secretions by an organism which is harmful to other organisms.
(d) Competition between organisms of the same species.

7. Which among the following correctly describes 'homeostasis'?
(a) It refers to the gradual process by which communities in the ecosystems change and develop over time.
(b) It is the process by which an organism maintains a stable internal environment despite changes in external conditions.
(c) It is the process of transfer of energy from one trophic level to another in a grazing food chain.
(d) It is the gradual process through which energy requirement in an ecosystem is balanced with the energy available to the ecosystem.

8. Which of the following best describes an indicator species?
(a) It is a species that has a disproportionately large effect on the ecosystem in which it occurs.
(b) It is a species which is of invasive nature.
(c) It is a species which is introduced to balance the species composition in an ecosystem.
(d) It is a species whose presence, absence or abundance reflects a specific environmental condition.

9. Which one of the following is the best description of the term 'ecosystem'?
(a) Flora of a particular geographical area.
(b) Flora and fauna of a geographical area.
(c) Flora and Fauna along with their environment.
(d) Flora and fauna of a continent.

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10. The ability of an ecosystem to self-regulate itself is
(a) Accommodation
(b) Adaptation
(c) Homeostasis
(d) Evolution

11. In an ecotone, the species which is expanding to other ecosystems on its own are called:
(a) Invasive species
(b) Edge species
(c) Keystone species
(d) Adaptive species

12. Two animals can be conclusively said to belong to the same species if they:
(a) Have same biological evolution
(b) Have similar genetic makeup
(c) Look similar and possess similar physical makeup
(d) Can reproduce freely with each other

13. Which of the following is not an example of mutualism?
(a) Algae and fungus
(b) Rhizobium bacteria and leguminous plants
(c) Coral polyps and Zooxanthellae algae
(d) Leech and cattle

14. Consider the following pairs:

Interaction	Explanation
1 Mutualism	Both the species are benefitted
2 Competition	Both the species are harmed
3 Commensalism	One species is harmed and the other is unaffected
4 Amensalism	One species is benefitted and the other is unaffected

Which of the pairs given above is/are correctly matched?
(a) 1 and 2 only
(b) 3 and 4 only
(c) 1, 2 and 3 only
(d) 1, 2, 3 and 4

15. With reference to keystone species, consider the following statements:
1. A keystone species exhibits disproportionately large effect on its environment relative to its abundance.
2. Tigers are keystone species as they determine the species composition in a forest.
Select the correct answer using the codes given below:
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

16. Which of the following is/are the types of positive interaction in a biotic community?
1. Colonisation
2. Competition
3. Protocooperation
Select the correct answer using the codes given below:
(a) 1 and 2 only
(b) 2 and 3 only
(c) 3 only
(d) 1 and 3 only
Note: Colonisation or colonization is the process in biology by which a species spreads to new areas. Colonisation often refers to successful immigration, where a population becomes integrated into a community, having resisted initial local extinction.

Protocooperation is a form of interaction which is beneficial for the interacting species. It is to be noted that though protocooperation is beneficial for the interacting species, it is not necessary for

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growth and survival of interacting species. In other words, protocooperation is a form of mutualism, but the interacting species do not depend on each other for survival.
Interaction between flowers of plants and insects is an example of protocooperation. The plants, especially those with large, bright, colourful flowers bearing nectar glands, undergo pollination because of the activities of the insects. This interaction is also beneficial to the insects as they get the food supply of pollen and nectar.

17. Consider the following statements with reference to primary productivity of ecosystem:
1. Net primary productivity is gross primary productivity minus the amount of biomass consumed by the primary consumers.
2. Primary productivity of water bodies is more than the terrestrial environment.
Which of the statements given above is/ are correct?
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2
Note: Presently, 85% of biomass is produced in terrestrial environment and only 15% biomass is produced in aquatic environment.

18. Which of the following are the abiotic components of the ecosystem?
1. Water
2. Insolation
3. Winds
4. Decomposers
5. Soil
Select the correct answer using the codes given below:
(a) 1 and 5 only
(b) 1, 2, 3 and 5 only
(c) 2, 3 and 4 only
(d) 1, 3, 4 and 5 only

19. Consider the following statements:
1. Ecotone is the transitional area between two biomes or diverse ecosystems.
2. Ecological niche is the role of a species in an ecosystem.
3. Ecocline refers to the combination of all physical and chemical factors that play a role in an ecosystem.
Which of the statements given above is/are correct?
(a) 1 only
(b) 2 and 3 only
(c) 1 and 2 only
(d) 1, 2 and 3

20. Consider the following statements:
1. A dominant species refers to a species which contributes to the highest percentage of biomass in an ecosystem.
2. A keystone species is one that has the greatest effect on all the other species in an ecosystem.
Which of the statements given above is/are correct?
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

21. In which of the following relationships does one species benefit by harming another species?
1. Parasitism
2. Predation
Select the correct answer using the codes given below:
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

22. Which of the following terms defines the gradual change in certain characteristics exhibited by communities along with the gradual change in one or more environmental gradients?
(a) Ecotone

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(b) Ecocline
(c) Ecotype
(d) Ecological niche

23. Which of the species became extinct because of anthropogenic factors?
(a) Dodo Bird
(b) Dinosaurs
(c) Mammoth
(d) Dire wolf

24. Which of the following is an example of saprophytic mode of nutrition?
1. Yeast
2. Aspergillus
3. Mushroom
Select the correct answer using the codes given below:
(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

25. **Assertion (A):** No two species in a habitat can have the same niche.
Reason (R): If two species occupy the same niche, they will compete with one another until one is displaced.
In the context of the above two statements, which one of the following is correct?
(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true and R is not the correct explanation of A
(c) A is true but R is false
(d) A is false but R is true

26. Which of the following pairs are correct?
1. Algae- Autotroph
2. Lice- Parasite
3. Cow- Phagotrophic
Select the correct answer using the codes given below:
(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

27. Which of the following correctly defines the term speciation?
(a) Speciation is the process by which nature selects a particular species.
(b) Speciation is the process by which biologists classify species into different categories.
(c) Speciation is the process by which new species are formed
(d) None of the above

28. The death of a variety of species due to phenomenon such as tsunami, volcano, environmental change or competition is termed:
(a) Natural selection
(b) Extinction
(c) Evolution
(d) Adaptation

29. Which of the following are examples of both plants as well as parasites?
1. Dodder plant
2. Mistletoe
3. Ascaris
Select the correct answer using the codes given below:
(a) 1 and 2 only
(b) 2 and 3 only
(c) Both 1 and 2
(d) Neither 1 nor 2

30. Consider the following statements:
1. Neutralism describes the relationship between two species which do interact but do not affect each other.
2. In nature, true neutralism is extremely unlikely and impossible to prove.
Which of the statements given above is/are correct?
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

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31. Which of the following is known as the 'terror of Bengal', on the basis of water pollution caused by it?
(a) Water Hyacinth
(b) Planktonic algae
(c) Prosopis juliflora
(d) Locust swarm

32. Parasites that feed on the external surface of the host organism are called:
(a) Ectoparasites
(b) Endoparasites
(c) Hyperparasites
(d) None of the above

33. A cuckoo lays its eggs in the nest of a crow and lets the crow incubate the eggs. This is an example of:
(a) Symbiosis
(b) Brood Parasitism
(c) Predation
(d) Competition

34. Consider the following statements:
1. EDGE species are usually extremely distinct in the way they look, live and behave as well as in their genetic make-up.
2. EDGE species are identified based on a combined score of their unique evolutionary history (calculated by Evolutionary Distinctiveness, or ED) and their conservation status (Global Endangerment, or GE).
Which of the statements given above is/are correct?
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

35. Which of the following correctly describes the relation between Gross primary productivity and Net Primary Productivity?
(a) Gross primary productivity is always less than Net Primary Productivity
(b) Gross primary productivity is always more than Net Primary Productivity
(c) Gross primary productivity is less than Net Primary Productivity only when the ecological pyramid is inverted
(d) None of the above

36. The net amount of primary productivity after the costs of respiration by plants, heterotrophs, and decomposers is called as:
(a) Gross Primary Productivity
(b) Net Primary Productivity
(c) Net Ecosystem Productivity
(d) Rate of photosynthesis

37. Corals are an example of:
(a) Keystone species
(b) Indicator Species
(c) EDGE Species
(d) Flagship Species

38. The 3 species of warbler birds search for insects as food in the forest at different levels of a tree. Blackburnian warbler relies on the topmost regions of the trees. Bay-breasted warbler feeds on the middle sections of the tree. Myrtle warbler feeds near the root region. These birds, hence, can be said to have:
1. Same habitat
2. Different niche
Select the correct answer using the codes given below:
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

39. Reproductive isolation plays an important role in creating new species. Two populations of a species may be unable to interbreed due to reproductive barrier. Which of the following, do you think, are the causes of reproductive isolation?

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1. Members of different populations of the same species are not attracted by courtship behaviour towards one another.
2. Two different populations become sexually receptive at different times of the year.
3. Pollination mechanism fails, between flowers of two populations.
Select the correct answer using the codes given below:
(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

40. Which of the following are the mechanisms used by organisms to cope or manage changes related to temperature in their environment?
1. Regulation
2. Diapause
3. Migration
4. Aestivation
5. Hibernation
Select the correct answer using the codes given below:
(a) 1, 2 and 3 only
(b) 3, 4 and 5 only
(c) 1, 3, 4 and 5 only
(d) 1, 2, 3, 4 and 5

41. Consider the following statements:
1. Hydrarch succession starts from wet areas and moves to mesic conditions.
2. Xerarch succession starts from mesic conditions and moves to wet areas.
Which of the statement(s) given above are correct?
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

42. Lichens, which invade a bare rock and secrete acids to dissolve rock, enable weathering and soil formation, are an example of:
(a) Pioneer species
(b) Climax species
(c) Intermediate species
(d) Invasive species

43. Which of the following best describes the stratification as a strategy used by the species?
(a) Minimise symbiotic association
(b) Minimise interspecies competition
(c) Maximise homeostasis
(d) None of the above

44. Which of the following is not an example of invasive species in India?
(a) Malabar Lily
(b) Prosopis juliflora
(c) Eucalyptus
(d) Acacia demissa (Wattle)

45. In an association known as mycorrhizal association between the fungus and plants, the fungus resides in the root tissues of the host plants. The term mycorrhiza refers to the role of the fungus in the plant's rhizosphere, the region of soil in the vicinity of plant roots. Fungus absorbs soil minerals and water and gives them to the plant roots and the plant roots provide food to fungus. This is an example of:
(a) Parasitism
(b) Predation
(c) Mutualism
(d) Competition

46. To conserve the Greater Yellowstone Ecosystem (GYE), the U.S. government eradicated Grey wolves from the GYE. The last remaining wolf pups in Yellowstone were killed in 1924. This resulted in a top-down trophic cascade in the Greater Yellowstone Ecosystem. Lacking an apex predator, elk populations in Yellowstone exploded. The competition among the Elk herds led to overgrazing and negatively impacted other species such as beaver,

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songbirds etc which also depend on the plants. Stream banks eroded as wetland plants failed to anchor valuable soil and sediments. Lake and river temperatures increased as trees and shrubs failed to provide shaded areas. Starting in the 1990s, the U.S. government began reintroducing wolves to the Greater Yellowstone Ecosystem. The results have been noteworthy. Elk populations have shrunk, willow heights have increased, and beaver and songbird populations have recovered. The Grey wolves, is an example of:
(a) Keystone species
(b) Flagship species
(c) Pioneer species
(d) Climax species

47. In an ecotone, there is a larger biodiversity compared to the adjoining ecosystems. This phenomenon is called:
(a) Edge effect
(b) Niche effect
(c) Speciation effect
(d) Evolution effect

48. Consider the following pairs:

Type of Ecocline	Explanation
1 Thermocline	Ecocline caused by temperature gradient
2 Halocline	Ecocline caused by salinity gradient
3 Pycnocline	Ecocline caused by chemical gradient

Which of the pairs given above is/are correctly matched?
(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

49. Two different populations of a species are isolated from each other as a result of differences in temperature, humidity, pH level etc in the environment. This is termed as:
(a) Ecological isolation
(b) Geographic isolation
(c) Reproductive isolation
(d) Chemical isolation

50. Consider the following statements:
1. Lichen is a symbiotic association of cyanobacteria and fungi.
2. The fungus provides the cyanobacteria protection from strong sunlight and gain nutrients in return.
Select the correct answer using the codes given below:
(a) 1 only
(b) 2 only
(c) Both 1 and 2
(d) Neither 1 nor 2

Perfecting Past Prelims

1. Which one of the following terms describe not only the physical space occupied by an organism, but also its functional role in the community of organisms? (2013)
(a) Ecotone
(b) Ecological niche
(c) Habitat
(d) Home range

2. Which one of the following is the best description of the term 'ecosystem'? (2015)
(a) A community of organisms interacting with one another.
(b) That part of the Earth which is inhabited by living organisms.
(c) A community of organisms together with the environment in which they live.
(d) The flora and fauna of a geographical area.

3. In nature, which of the following is/are most likely to be found surviving on a surface without soil? (2021)
1. Fern

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2. Lichen
3. Moss
4. Mushroom
Select the correct answer using the code given below:
(a) 1 and 4 only
(b) 2 only
(c) 2 and 3
(d) 1, 3 and 4

4. Which of the following are detritivores? (2021)
1. Earthworms
2. Jellyfish
3. Millipedes
4. Seahorses
5. Woodlice
Select the correct answer using the code given below:
(a) 1, 2 and 4 only
(b) 2, 3, 4 and 5 only
(c) 1, 3 and 5 only
(d) 1, 2, 3, 4 and 5

5. Which of the following have species that can establish a symbiotic relationship with other organisms?
1. Cnidarians
2. Fungi
3. Protozoa
Select the correct answer using the codes given below: (2021)
(a) 1 and 2 only
(b) 2 and 3 only
(c) 1 and 3 only
(d) 1, 2 and 3

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ANSWER KEYS

Practice Questions

1. (b)	2. (b)	3. (c)	4. (b)	5. (c)
6. (c)	7. (b)	8. (d)	9. (c)	10. (c)
11. (a)	12. (d)	13. (d)	14. (a)	15. (c)
16. (d)	17. (d)	18. (b)	19. (c)	20. (c)
21. (c)	22. (b)	23. (a)	24. (d)	25. (a)
26. (d)	27. (c)	28. (b)	29. (a)	30. (c)
31. (a)	32. (a)	33. (b)	34. (c)	35. (b)
36. (c)	37. (b)	38. (c)	39. (d)	40. (d)
41. (a)	42. (a)	43. (b)	44. (a)	45. (c)
46. (a)	47. (a)	48. (a)	49. (a)	50. (c)

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

Solutions

Practice Questions

3. (c) Intra-species competition is the competition between the same species. Increase in population of tigers will lead to an increase in competition among tigers for various resources.

4. (b) Ecological niche of an organism includes all of its interactions with the biotic and abiotic factors of its environment and the impact it has on them.

7. (b) Homeostasis is the maintenance of a constant internal environment of a system in response to changes in the external environment.

8. (d) An indicator species is any biological species that defines a trait or characteristic of the environment.

9. (c) An ecosystem is a community of living organisms in conjunction with the non-living components of their environment (things like air, water and mineral soil), interacting as a system.

12. (d) A species is a group of closely related organisms that can interbreed freely to produce offspring.

13. (d) Leech and cattle
Leech feeds on the blood of cattle; so cattle is harmed and leech is benefitted. Therefore, it is parasitism and not mutualism.

15. (c) Statement 1 is correct: A keystone species is a species that plays a critical role in maintaining the structure of an ecological community. Without keystone species, the ecosystem would be

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dramatically different or cease to exist altogether.

17. (d) Statement 1 is incorrect: Net primary productivity (NPP) is the amount of organic matter stored by producers per unit area in unit time. In other words, it refers to the net productivity that is converted into organic matter excluding the energy utilised for respiration and other purposes by the producers.
Statement 2 is incorrect: Presently, 85% of biomass is produced in the terrestrial environment and only 15% biomass is produced in the aquatic environment.

18. (b) Abiotic components are the non-living components; so decomposers are not included in the list.

19. (c) Statement 3 is incorrect: Ecocline is a variation in the physical and/or chemical environment. It is not the combination of all physical and chemical factors.

20. (c) Statement 1 is correct: Dominant species is that which predominates in an ecological community, particularly when they are in majority or form a bulk of biomass.

23. (a) Dodo bird, which inhabited the island of Mauritius, became extinct as a result of indiscriminate hunting by humans.

24. (d) Yeast, Aspergillus and Mushroom derive nutrition by feeding on dead organisms and thus, are examples of saprophytic mode of nutrition.

26. (d) Cow is a herbivore as it feeds on plants. Herbivores, carnivores and omnivores are sub-divisions of phagotrophs.

29. (a) Plants like the dodder plant (Cuscuta) and mistletoe (Loranthus) are parasites that live on flowering plants. Ascaris or roundworms (animal parasite) are internal parasites found in the human intestine.

33. (b) Brood parasitism is an example of parasitism in which the parasitic bird lays its eggs in the nest of its host and lets the host incubate them. The eggs of the parasitic bird resemble the host's egg size and colour, making it difficult for the host bird to detect and eject these eggs from the nest. Female cuckoos lay their eggs in the nests of other bird species. After the eggs are hatched, the young cuckoo may usually throw the other host eggs out of the nest, getting rid of any competition for the parent's attention. This is possible as cuckoo's eggs hatch earlier than the crow's eggs.

34. (c) Species are identified as EDGE species on the basis of the following process: every species in a particular taxonomic group (e.g. mammals or amphibians) is given a ED score and GE score. ED (Evolutionary Distinctiveness) score is given according to the uniqueness of evolutionary history and GE (Global Endangerment) score is given according to its conservation status. These scores are then combined to calculate an EDGE score of each species. Those species with high ED and GE get the highest EDGE scores and are generally prioritised for conservation efforts.

35. (b) The relationship between GPP and NPP is as follows: NPP= GPP- Respiratory Loss. Hence GPP is always more than NPP.

36. (c) Net Ecosystem Productivity, NEP, is the net amount of primary production after deducting respiration by plants, heterotrophs, and decomposers.
Therefore, NEP = GPP – (R_p + R_h + R_d)

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where
R_p = Respiration by plants
R_h = Respiration by heterotrophs
R_d = Respiration by decomposers (the microbes)

37. (b) Corals indicate the relative health and pollution levels a water body. When corals are stressed by changes in conditions such as temperature, light, or nutrients, they expel the symbiotic algae living in their tissues, causing them to turn completely white. This is called coral bleaching. Coral bleaching may indicate factors such as: increase in pollution, warming of waters, rise in acidity or salinity levels.

38. (c) Statement 1 is correct: 3 species of warbler birds, given in the question statement, share the same habitat because they feed on insects at trees. The term habitat typically refers to the zone in which the organism lives and where it can find food, shelter, protection and mates for reproduction.
Statement 2 is correct: 3 species of warbler birds have different niche because they feed on insects at different sections of trees. A niche refers to the unique functional role of a species in an ecosystem. A species' niche also includes the physical, biological and chemical environment to which it is adapted. Different sections of trees constitute the physical environment of the species.

40. (d) All the given mechanisms namely Regulation, Diapause, Migration, Aestivation and Hibernation are used by organisms to cope or manage changes related to temperature in their environment.

41. (a) Statement 2 is incorrect: Xerarch succession starts from dry conditions and moves to mesic conditions.

42. (a) Lichens are pioneer species because they are the first species to grow in an ecosystem.

43. (b) Stratification helps in minimising interspecies competition. For instance, some species survive on feeding insects in the soil and some other species survive on feeding insects at trees. The competition among these two types of species is negligible.

44. (a) Malabar Lily is endemic to India. Eucalyptus, Lantana, Prosopis juliflora, Parthenium hysterophorus, Eupatorium odoratum and wattle are examples of invasive species which are threatening the ecological diversity of Western Ghats.

45. (c) Both fungi and the plants are benefitted here. Hence, it is an example of mutualism. It is to be noted that in some cases, fungus acts as parasite in the plant roots.

48. (a) Pair 3 is not correctly matched. Pycnocline is caused due to variations in density of water induced by temperature or salinity.

50. (c) Lichen is a symbiotic association of a fungus and an algae or cyanobacteria. The fungus provides protection to cyanobacteria. The cyanobacteria are capable of photosynthesis and provides nutrients to the fungus.

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1. (b) An ecological niche refers to the unique functional role or place of a species in an ecosystem. A species niche includes the physical, biological and chemical environment to which it is adapted as well as its role as a producer and consumer of food resources.

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2. (c) An ecosystem is a community of living organisms in conjunction with the non-living components of their environment.

3. (b) In a barren land, rainfall and bird droppings lead to growth of lichens. Lichens are the pioneer species. Pioneer species is the first to colonize an area and it also sets the foundation for development of other species.

4. (c) Statement 1 is correct: Earthworms are an example of detritivores.
Statement 2 is incorrect: Jellyfish feed on small plants, shrimp, or fish. They are considered carnivores.
Statement 3 is correct: Millipedes are detritivores as they feed on decaying leaves and other dead plant matter.
Statement 4 is incorrect: Seahorses are carnivores. They feed on plankton, small fish, shrimp, copepods and the like.
Statement 5 is correct: Woodlice is an example of detritivores.

5. (d) Statement 1 is correct: Cnidarians refer to members of the phylum Cnidaria. Some of the examples of the members of this phylum include corals, sea anemones, jellyfish and hydra. Corals have a symbiotic relationship with zooxanthellae. Sea anemones, jellyfish and hydra are also found to have symbiotic relationships with algae.
Statement 2 is correct: Fungi can be found in symbiotic relationships with algae, plant roots etc. For instance, fungi and plant roots are in a symbiotic relationship in mycorrhiza. Another common example is lichens where fungi and cyanobacteria are in a symbiotic relationship.
Statement 3 is correct: Protozoa also exhibit symbiotic relationships. For instance, termites and protozoa that live in the insect's gut is an example of symbiotic relationship.

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