

BIOLOGY

Chapter 13: Organisms and Populations



Organisms and Populations

Ecology:

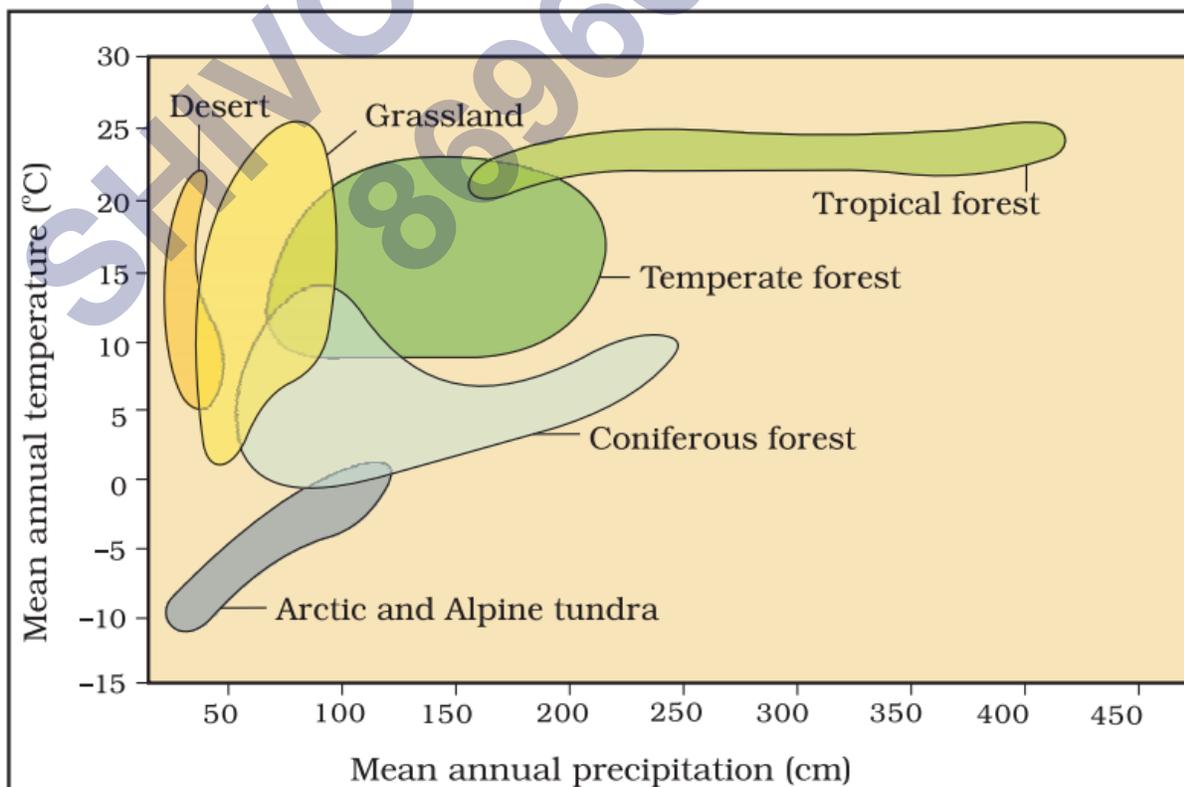
Ecology is the branch of biology that deals with the interactions among organisms and between the organism and its physical (abiotic) environment. Study of ecology is important to strike a balance between development and maintenance of natural environmental and biotic communities, use and conservation of resources, solve local, regional, and global environmental problems.

Organism and Its Environment:

The branch of science that studied the relationship between the organism and the environment is called ecology.

Various levels of the organization are:

- **Organism:** each individual belonging to the species.
- **Population:** The group of organisms that are capable of interbreeding.
- **Communities:** A combination of different populations combine together to form communities.
- **Biomes:** A large number of flora and fauna found in a climatic zone.



Major Abiotic Factor:

The most important biotic factor that affects the environment, as well as organisms, is the temperature. The temperature around the poles is lesser than the temperature found around the equator. The temperature of the polar region ranges from sub zero and increases up to $>50^{\circ}\text{C}$ in tropical deserts in summer. The temperature will affect the metabolism rate and physiology of the body as it affects enzyme kinetics. Those organisms that can tolerate a high range of temperature are called eurythermal. E.g., dog, cat, red algae, etc while a large number of organisms tolerate only a narrow range of temperature called stenothermal. E.g., python, crocodile, penguin. The temperature tolerance of organisms depends upon the type of geographical area they are found.

The other important abiotic factor is water on which life depends. The area where the amount of water is less are called deserts where only organisms that have special adaptations will be able to survive. In the aquatic organism, the composition and pH of the water are very important. The range of salinity for some organisms is quite high called euryhaline, e.g., green crab and molly fish while in some organisms the salinity level tolerance is very low called stenohaline e.g., haddock, goldfish, etc. The organisms of seawater are found to be less adaptive to the marine water and vice versa due to their different osmotic environment.

The other important abiotic factor is light which is useful for the process of photosynthesis and can be observed in the case of autotrophs. The main source of light, well known, is the sun. The requirement of light intensity varies from organism to organism as some organisms require high light intensity while some organisms require low light intensity. There are various types of plants categorized on the basis of the light intensity required, the short-day plants and long-day plants. In animals, the small fluctuation of light will affect the various plant activities that include migration, reproduction, and foraging. The quality of the spectrum of solar radiation is quite important for life. The spectrum consists of ultraviolet radiation which is very harmful to the organisms while the different colors of the visible spectrums are not available for marine organisms found at various depths of the oceans.

The other important abiotic factor affecting organisms and their population is soil. The soil nature and features vary depending upon the type of climate, and the process of weathering, the development of soil, transportation of soil, or whether it is sedimentary. There are various parameters that affect the type of soil that are pH, minerals present in the soil, and the topography. Apart from this, other parameters such as pH, mineral composition, and topography depend upon the type of vegetation and animals present.

Organisms: An organism refers to a contiguous living system that lives in an environment and has the ability to adapt and retain certain structure and behaviour. It includes fungi, bacteria, plants, animals, and humans. An organism collectively forms a population. The population forms a community which operates the ecosystem. The ecosystem consists of both biotic and abiotic factors.

Major abiotic factors which lead to variation in the physical and chemical conditions of different habitat are temperature, water, light, and soil.

Responses to Abiotic Factors:

Various organisms respond differently towards various abiotic factors.

The various abiotic factor responses are:

- **Regulators:** They are those organisms that are capable of maintaining homeostasis and regulation resulting in constant body temperature, osmotic concentration, etc. This property can be observed in the case of the birds and mammals along with few vertebrates and invertebrate species. In the case of humans, the body temperature is maintained at 37°C resulting in homeostasis. In the summer season when the temperature is very high then the body sweats profusely in order to maintain the body temperature which is similar to the process of evaporation resulting in cooling. In the winter season, the outer temperature is very low so the body saves continuously to maintain the inner body temperature making it warm. In the case of plants, this mechanism of maintaining the internal body temperature is absent.
- **Conformers:** They are those organisms that are unable to regulate their body temperature. Their body releases or absorbs heat that results in an increase or decrease in body temperature resulting in the process of thermoregulation which is an energetic process. In the case of small animals, the surface-to-volume ratio is larger so the heat of the body can be released quickly, thus, the animals are absent in the polar region. The process of evolution will result in various benefits.
- **Partial Regulators:** They are those species that are capable of regulation but only up to a certain limit depending upon the environmental conditions. The organisms simply undergo confirmation when they cross this limit.
- **Migration:** The movement of animals from one place to another depending upon their requirements. For example, the migratory birds that come every winter from Siberia to Keoladeo National Park (Bharatpur) in Rajasthan due to the stressful conditions in their habitat.
- **Spores:** There are certain microorganisms that include bacteria, fungi, etc to stop their growth during the unfavourable conditions of the environment. As in the winter season, the animals undergo winter sleep called hibernation while in summer they undergo summer sleep called aestivation.

Adaptations:

The feature that helps the organism to survive or to reproduce in their habitats is called

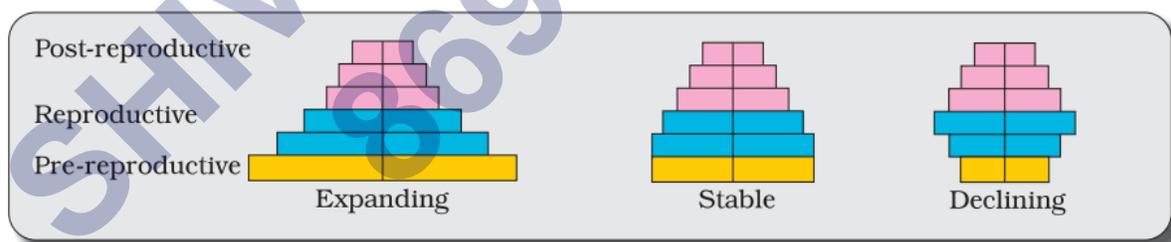
adaptation. It is observed that the organisms usually adapt themselves according to the environment they live in. For example, in the case of the desert plants like Opuntia, they have thick cuticles, leaves modified into spines, and sunken stomata so as to reduce the rate of transpiration and undergo photosynthesis with the help of the CAM pathway. While in the case of the higher altitudes like mountains and hills, humans have shown altitude sickness resulting in nausea, short breaths, fatigue, heart palpitations, etc. But after some time they acclimatize themselves according to the environment and results in the higher production of red blood cells so that more oxygen can bind to them and increases the rate of respiration. There are certain behavioural responses that can be observed in various animals based on the environmental conditions.

Population:

Population is defined as a group of individuals or organisms of any species living in a well-defined geographical area, at a specific time with the capability of interbreeding. For example, population of deer in a forest.

Population Attributes:

- **Birth rate:** Total number of individuals born in a given period of time.
- **Death rates:** Total number of deaths in a period of time.
- **Sex Ratio:** Total number of females and males per 1000 individuals.
- **Age pyramid:** A plot of age distribution.



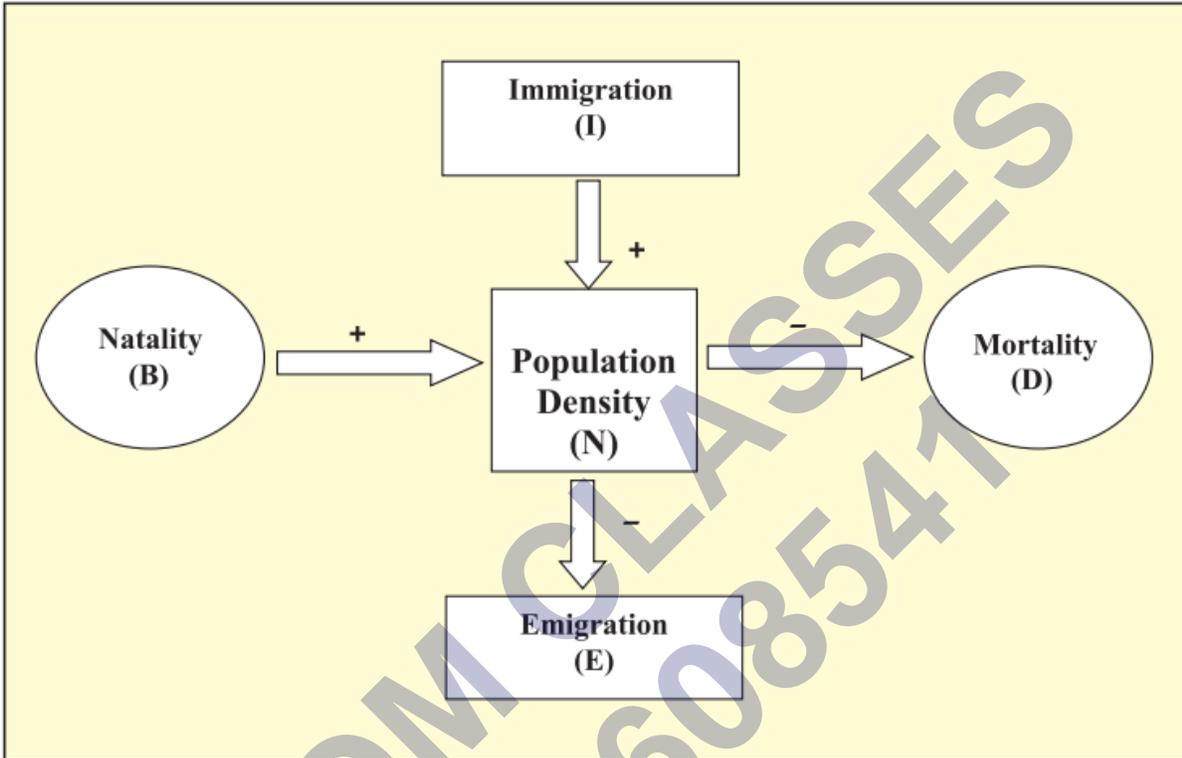
Population Growth:

Population growth refers to the increase in the number of individuals in a population. This depends on various factors such as weather, food availability, predator pressure, etc.

The population density changes due to the following factors:

- **Natality:** The number of births in a population in a given time period.
- **Mortality:** The number of deaths in a population in a given time period.

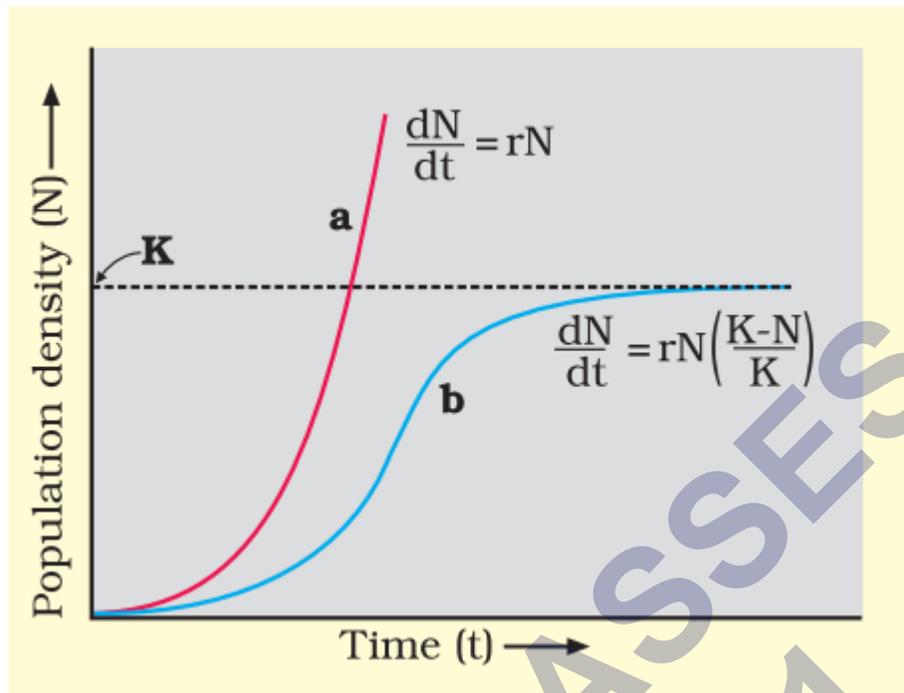
- **Emigration:** The number of individuals who moved to some other habitat in a certain time period.
- **Immigration:** The number of individuals who have come into the habitat from elsewhere in a certain period of time.



Population Growth Models:

The population growth models include:

- **Exponential Growth:** In the limited supply of food, the population follows an exponential growth.
- **Logistic Growth:** When the resources are finite and become limited sooner or later, the population growth is said to be logistic.



exponential growth equation as:

$$N_t = N_0 e^{rt}$$

Where,

N_t = Population density after time t

N_0 = Population density at time zero

r = intrinsic rate of natural increase

e = the base of natural logarithms (2.71828)

Population Interactions:

This refers to the interaction between different populations. There are various modes of population interaction.

These include:

- **Predation:** This is a type of interaction in which an organism kills and feeds on another organism. The one who kills is known as the predator and the one who is killed is the prey.
- **Competition:** This is the type of biological interaction between different animals or species in which both are harmed.
- **Parasitism:** Parasitism is a type of interaction between species in which the parasite

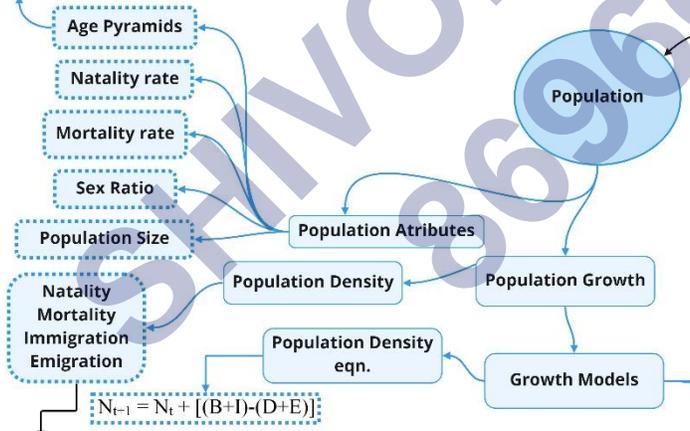
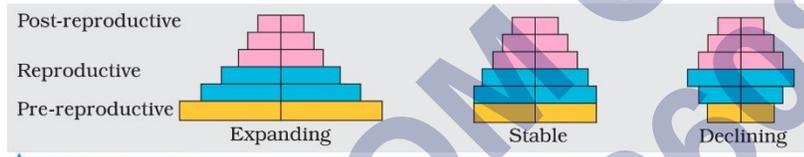
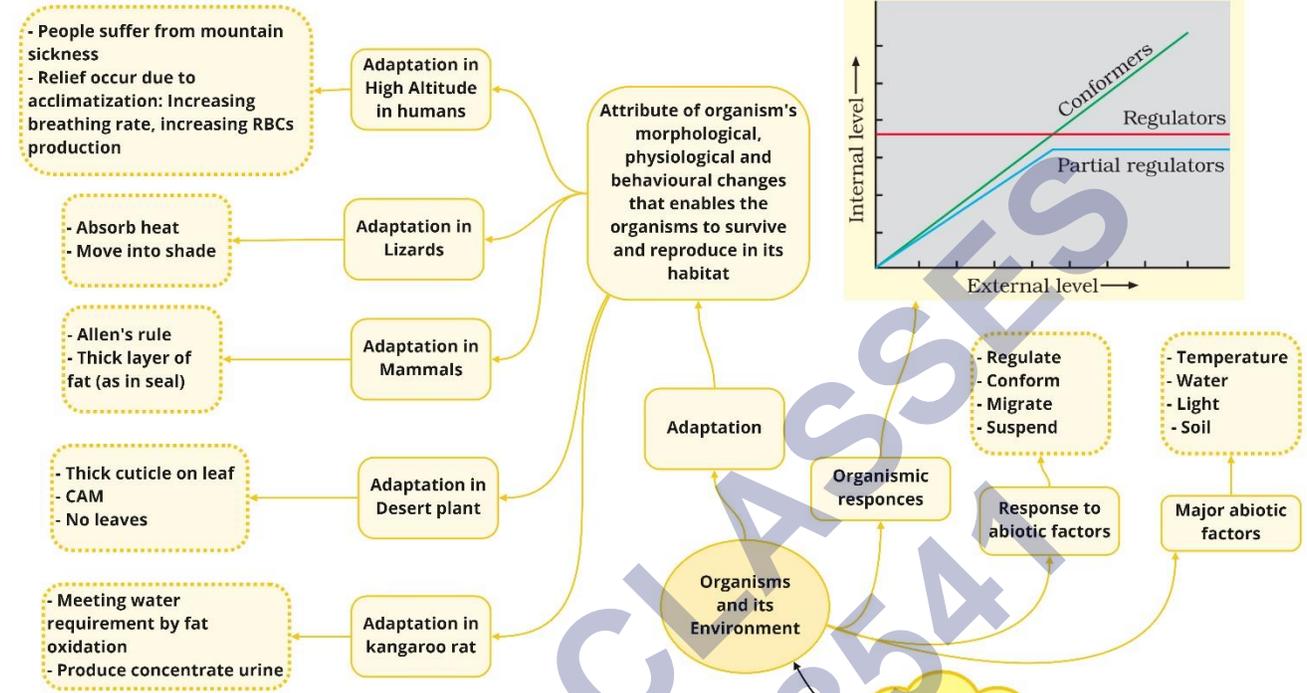
lives inside the body of another organism and cause harm to it.

- **Commensalism:** In this type of interaction one organism benefits while the other is neither benefitted nor harmed.
- **Mutualism:** In this type of interaction, both the species or organisms are benefitted from each other.

Species A	Species B	Name of Interaction
+	+	<i>Mutualism</i>
-	-	<i>Competition</i>
+	-	<i>Predation</i>
+	-	<i>Parasitism</i>
+	0	<i>Commensalism</i>
-	0	<i>Amensalism</i>

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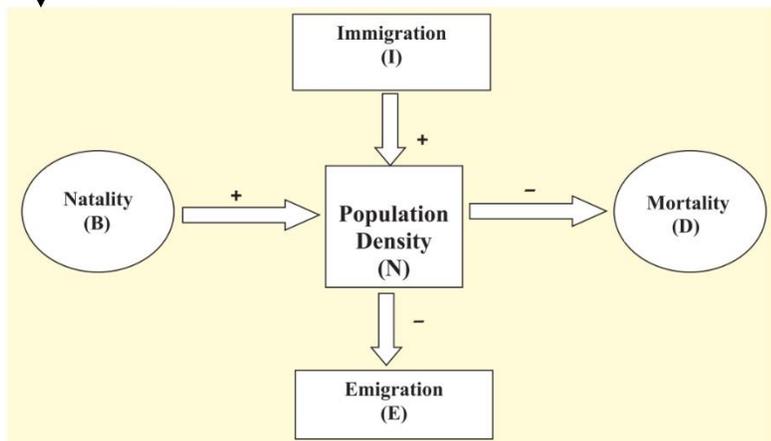
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Chapter- 13 : Organisms and Populations



Organisms and Populations

Population Interaction

Species A	Species B	Name of Interaction
+	+	Mutualism
-	-	Competition
+	-	Predation
+	-	Parasitism
+	0	Commensalism
-	0	Amensalism

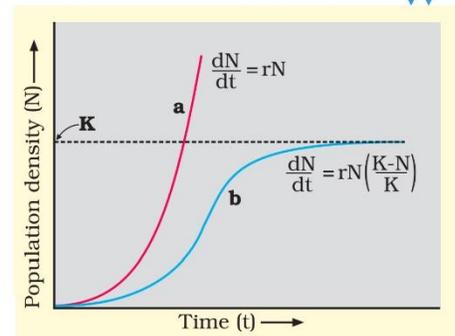


Logistic Growth

$$\frac{dN}{dt} = rN \left(\frac{K-N}{K} \right)$$

Exponential Growth

$$N_t = N_0 e^{rt}$$



Important Questions

➤ Multiple Choice Questions:

1. Autecology is the
 - (a) relation of a population to its environment
 - (b) relation of an individual to its environment
 - (c) relation of a community to its environment
 - (d) relation of a biome to its environment.
2. Ecotone is:
 - (a) A polluted area
 - (b) The bottom of a lake
 - (c) A zone of transition between two communities
 - (d) A zone of developing community.
3. Biosphere is:
 - (a) A component in the ecosystem
 - (b) Composed of the plants present in the soil
 - (c) Life in the outer space
 - (d) Composed of all living organisms present on the earth which interact with the physical environment.
4. Ecological niche is:
 - (a) the surface area of the ocean
 - (b) a an ecologically adapted zone
 - (c) the physical position and functional role of a species within the community
 - (d) formed of all plants and animals living at the bottom of a lake.
5. According to Allen's Rule, the mammals from colder climates have:
 - (a) shorter ears and longer limbs
 - (b) longer ears and shorter limbs
 - (c) longer ears and longer limbs
 - (d) shorter ears and shorter limbs.
6. Salt concentration (salinity) of the sea measured in parts per thousand is:
 - (a) 10-15
 - (b) 30-70
 - (c) 0-5
 - (d) 30-35.
7. Formation of tropical forests needs mean annual temperature and mean annual

precipitation as:

- (a) 18-25°C and 150-400 cm
 - (b) 5-15°C and 50-100 cm
 - (c) 30-50°C and 100-150 cm
 - (d) 5-15°C and 100-200 cm.
8. Which of the following forest plants controls the light conditions at the ground?
- (a) Lianas and climbers
 - (b) Shrubs
 - (c) Tall trees
 - (d) Herbs.
9. What will happen to a well growing herbaceous plant in the forest if it is transplanted outside the forest in a park?
- (a) It will grow normally
 - (b) It will grow well because it is planted in the same locality
 - (c) It may not survive because of change in its microclimate
 - (d) It grows very well because the plant gets more sunlight.
10. If a population of 50 paramecia present in a pool increases to 150 after an hour, what would be the growth rate of population?
- (a) 50 per hour
 - (b) 200 per hour
 - (c) 5 per hour
 - (d) 100 per hour.
11. What would be the per cent growth or birth rate per individual per hour for the same population mentioned in the previous question?
- (a) 100
 - (b) 200
 - (c) 50
 - (d) 150.
12. A population has more young individuals compared to the older individuals. What would be the status of the population after some years?
- (a) It will decline.
 - (b) It will stabilize.
 - (c) It will increase.
 - (d) It will first decline and then stabilize.
13. What parameters are used for tiger census in our country's national parks and

sanctuaries?

- (a) Pugmarks only
- (b) Pug marks and faecal pellets
- (c) Faecal pellets only
- (d) Actual head counts.

14. Which of the following would necessarily decrease the density of a population in a given habitat?
- (a) Natality > mortality
 - (b) Immigration > emigration
 - (c) Mortality and emigration
 - (d) Natality and immigration.
15. A protozoan reproduces by binary fission. What will be the number of protozoans in its population after six generations?
- (a) 128
 - (b) 24
 - (c) 64
 - (d) 32.

➤ **Very Short Question:**

1. Which are the factor responsible for the wide variety of habitat formed within each biome?
2. Fresh water animals are unable to survive for long in sea water. Give reason.
3. With which population growth model is the Verhulst Pearl equation associated?
4. Define diapause. Which organisms exhibit it?
5. Calculate the death rate if 6 individuals in a laboratory population of 60 fruit flies died during a particular week.
6. In biological control method, one living organism is used against another to check its uncontrolled growth. Which kind of population interaction is involved in this?
7. Write what do phytophagous insects feed on?
8. Why do leaves contains Sunken stomata?
9. Name the type of interaction that is detrimental to both the interaction.
10. What type of interaction is shown by sparrows eating the seeds?

➤ **Short Questions:**

1. What are the four levels of biological organisation with which ecology basically deals?

2. Differentiate between stenohaline and euryhaline organisms.
3. List four features which enable the Xeric plants to survive in the desert conditions.
4. Mention the attributes which a population has but not an individual organism.
5. Differentiate between stenothermal and eurythermal organisms.
6. What are the four ways through which the living organisms respond to abiotic factors?
7. Why do clown fish and sea anemone pair up? What is this relationship called?
8. Distinguish between ectotherms & Endotherms?

➤ Long Questions:

1. Explain the ecological hierarchy.
2. Why do all the freshwater organisms have contractile vacuoles whereas the majority of marine organisms lack them?
3. Discuss life-history traits of an organism that have evolved in relation to the constraints imposed by biotic and abiotic factors in their habitat.

➤ Assertion & Reason Questions

1. For question two statements are given-one labelled Assertion and the other labelled Reason. Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.
 - a. Both assertion and reason are true and reason is the correct explanation of assertion.
 - b. Both assertion and reason are true but reason is not the correct explanation of assertion.
 - c. Assertion is true but reason is false.
 - d. Both assertion and reason are false.

Assertion: Mycorrhizal relation exists between Boletus and Pinus.

Reason: It is a symbiotic interaction.

2. For question two statements are given-one labelled Assertion and the other labelled Reason. Select the correct answer to these questions from the codes (a), (b), (c) and (d) as given below.
 - a. Both assertion and reason are true and reason is the correct explanation of assertion.
 - b. Both assertion and reason are true but reason is not the correct explanation of assertion.
 - c. Assertion is true but reason is false.
 - d. Both assertion and reason are false.

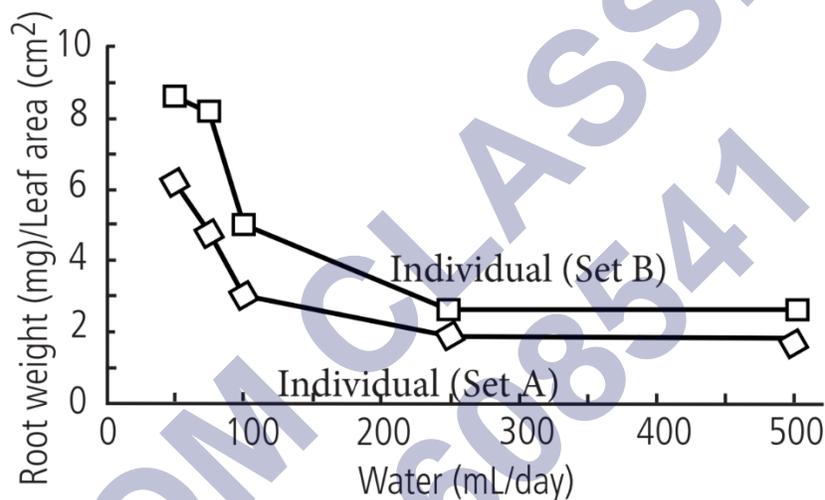
Assertion: Amensalism is a negative interaction between two living individuals.

Reason: In amensalism, allochemicals are secreted by one individual.

➤ Case Study Questions:

1. Read the following and answer any four questions from (i) to (v) given below:

Ananya is a biologist, her research guide assigned project, i.e., to determine the effect of intra-specific competition on the growth of sapling of Eucalyptus. For this, she designed an experiment in which two sets of pots were used. In the first set (set A) only 1 sapling was planted per pot and in the other set (set B) 16 saplings were planted per pot. To check for the effect of intra-specific competition on allocation of resources, a decreasing amount of water was added to each set. The results have been graphically indicated. Which of the following conclusions can be indicated as follows:



- (i) Which of the following statements can be concluded from the given study?
- More resources are allocated to the root during low water conditions.
 - Competition for water among individuals of a population causes more root growth as compared to individuals who are growing alone.
 - Lesser leaves are formed under low water conditions.
 - Root growth is higher in individual grown singly as compared to individuals in populations.
- (ii) Which of the following associations is an example of competitions?
- Cuscuta and hedge plant.
 - Balanus and Cathamalus.
 - Cactus and moth.
 - Orchid and mango.
- (iii) If '+' sign is assigned to beneficial interaction, '-' sign to detrimental and O sign to neutral interaction, then the population interaction of competition refers to:
- +, +
 - , -
 - +, -

d) +, 0

(iv) Intraspecific competition is more severe due to:

- similar needs.
- similar adaptations.
- common resources.
- all of these.

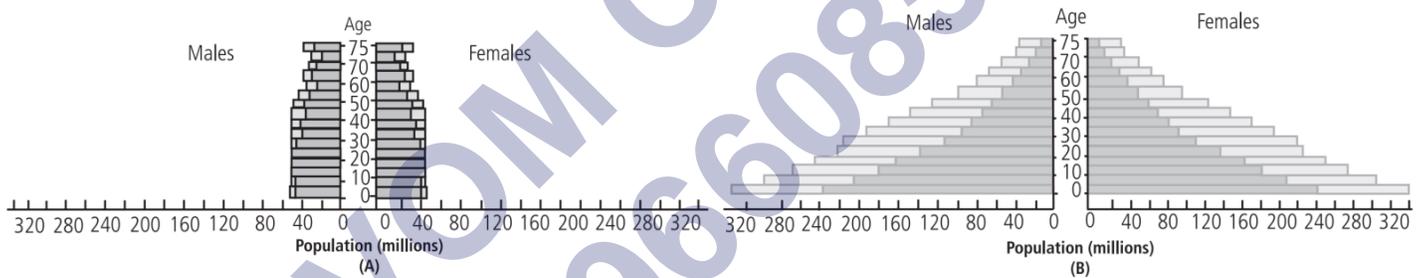
(v) **Assertion:** Two members of a competing species may co-exist.

Reason: Different individuals of a species have different resource requirements.

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

2. Read the following and answer any four questions from (i) to (v) given below:

Age sex structure of a population can be depicted in the form of a pyramid by plotting the percentage of population of each sex in each age class. Two age sex pyramids are as follows.



(i) Which of the following is correct regarding pyramid B?

- It represents stable population.
- It represents expanding population.
- It represents declining population.
- Both (a) and (b).

(ii) Total number of individuals of a species per unit area per unit time is called.

- Population size.
- Population density.
- Demography.
- Population dynamics.

(iii) Which of the following is correct regarding age sex pyramid A and B?

- A represents the age sex pyramid of developed country.
- B represents the age sex pyramid of developing country.
- A represents rapidly growing population.
- Both (a) and (b).

- (iv) A population with a large proportion of older individuals than younger ones will likely to:
- Grow larger first and then decline.
 - Continue to grow indefinitely.
 - Decline.
 - None of these.

- (v) **Assertion:** Bell shaped age pyramid represents a stable population.

Reason: In a stable population, proportion of individuals in reproductive age group is higher than the individuals in pre reproductive age group.

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

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✓ Answer Key-

➤ Multiple Choice Answers:

1. (b) relation of an individual to its environment
2. (c) A zone of transition between two communities
3. (d) Composed of all living organisms present on the earth which interact with the physical environment.
4. (c) the physical position and functional role of a species within the community
5. (d) shorter ears and shorter limbs.
6. (d) 30-35.
7. (a) 18-25°C and 150-400 cm
8. (c) Tall trees
9. (c) It may not survive because of change in its microclimate
10. (d) 100 per hour.
11. (b) 200
12. (c) It will increase.
13. (b) Pug marks and faecal pellets
14. (c) Mortality and emigration
15. (c) 64

➤ Very Short Answers:

1. Regional and local variations
2. Due to osmotic problems.
3. Logistic Growth.
4. A stage of suspended development, zooplanktons.
5. $6/60 = 0.1$ individuals per fruitfly per week.
6. Predation.
7. Plant sap and other parts of plant.
8. Leaves contains sunken stomata i.e. Stomata arranged in deep pits to minimizes water loss by transpiration.
9. Competition.
10. Predation.

➤ Short Answer:

1. Organisms, population, communities and biomes.
2. Euryhaline: Organisms tolerant in wide range of salinities.
Stenohaline: Organisms tolerant to narrow range of salinities.
3.
 - (i) thick cuticle
 - (ii) Stomata in deep pits
 - (iii) Stomata closed during day time
 - (iv) leaves reduced to spines (CAM photosynthetic pathway).
4. Birth rate, Death rate, Sex ratio, age groups.
5. Eurythermal: Organisms that can tolerate and thrive in wide range of temperatures
Stenothermal: Organisms restricted to a narrow range of temperature.
6. (i) Regulate (ii) Conform (iii) migrate (iv) Suspend
7. Clown fish lives in tentacles of sea Anemone and gets protection from predators.
Interaction – commensalism.
8. Ectotherms are those animals whose body temperature changes & matches with that of environment in which they are living whereas Endotherms are those animal whose body temperature is maintained relatively constant by physiological regulation.

➤ Long Answer:

1. Ecological hierarchy: It is a series of graded ecological categories.
Characteristics of ecological hierarchy:
 - i. A biological unit at each level has a specific structure and function.
 - ii. In this hierarchy, smaller biological units coordinate to form the next higher level of organization.
 - iii. Only the organisms show free existence.
 - iv. Organisms cannot live in isolation.
 - v. At each level, different units show interdependence.
 - vi. At each level, the unit shows interaction with the physical environment (energy and matter).
 - vii. The biological units are successfully adapted to their environment.
2. Contractile vacuole helps in maintaining salt and water level called osmoregulation. Because of the cellular environment of a freshwater organism such as Amoeba, Paramecium etc. being hypertonic, the water diffuses inside the cell constantly and gets collected in the contractile vacuole, which squeezes the extra water out of the cell

periodically.

While in the case of marine protozoan's organisms, this does not occur due to high salt concentration. These organisms live in isotonic conditions in seawater. Thus, there is no need for contractile vacuole.

3. According to ecologists, life-history traits of an organism have evolved in relation to the constraints imposed by the biotic and abiotic factors in their habitats.
 - i. It can be illustrated with vast variations and life history.
 - ii. The evolution of populations aims at improving reproductive fitness or Darwinian fitness to the maximum in their habitats.
 - iii. They evolve towards the most efficient reproductive strategy.
 - iv. Organisms like Pacific Salmon fish and bamboo breed only once in their lifetime.
 - v. Most birds and mammals breed many times during their lifetime.
 - vi. Oysters and pelagic fishes produce a large number of small-sized offspring.
 - vii. Birds and mammals produce a small number of large-sized offspring.

➤ Assertion & Reason Answers

1. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.

Explanation:

Mycorrhiza is a mutualistic or symbiotic interaction in which a fungus (e.g. Boletus) and a root of plant (e.g. Pinus) are involved. The root provides food and shelter to the fungus. The fungus helps the plant in solubilization and absorption of minerals, water uptake and protection against pathogenic fungi.

2. (b) Both assertion and reason are true but reason is not the correct explanation of assertion.

Explanation:

Amensalism is an interaction between two living individuals of different species in which an organism does not allow other organism to grow or live near it. Inhibition is achieved through the secretion of chemicals called allochemicals.

➤ Case Study Answers:

1.

- (i) (b) Competition for water among individuals of a population causes more root growth as compared to individuals who are growing alone.

Explanation:

Competition is a sort of rivalry among two or more organisms for obtaining the same resources. The competition among individuals of the same species is called intraspecific competition and among members of different species is called interspecific competition. Intraspecific competition is more severe than interspecific competition due to similar needs. Now, according to the given graph, competition for water in a population leads to more root weight (mg) per leaf area (cm^2). This is because competition causes more root growth so that each sapling can derive more water from the pot.

(ii) (b) Balanus and Cathamalus.

Explanation:

The association or interactions of Cuscuta and hedge plant is parasitism, cactus and moth is predation and orchid and mango is commensalism.

(iii) (b) -, -

(iv) (d) all of these.

Explanation:

Intraspecific competition is more severe because of common resource, similar needs and similar adaptations.

(v) (d) Both assertion and reason are false.

2.

(i) (b) It represents expanding population.

(ii) (b) Population density

Explanation:

Population density is the number of individual present per unit area at a given time.

(iii) (d) Both (a) and (b).

Explanation:

A represents nearly stable population whereas B represents rapidly growing population.

(iv) (c) Decline.

Explanation:

A population with large number of older individuals than younger ones is likely to decline since older individuals do not take part in reproduction.

(v) (C) Assertion is true but reason is false.

Explanation:

In a bell-shaped age pyramid, the number of pre-reproductive and reproductive individuals is almost equal. Post-reproductive individuals are comparatively fewer. It represents a stable population.

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