Organisms and Populations

QUICK RECAP

- The term **'ecology'** is derived from two Greek words-*oikos* means 'house or place to live' and *logos* means 'a discussion or study'.
- The German biologist **Ernst Haeckel** (1869) is credited for the coinage of the term ecology.
- Ecology may be defined broadly as the science of interrelation between living organisms and their environments including both the physical and biotic environments.
- The **aquatic ecology** includes freshwater ecology, eustuarine ecology and marine ecology.
- **Terrestrial ecology** is subdivided further into forest ecology, grassland ecology, cropland ecology and desert ecology. Ecology is basically concerned with various levels of biological organisation – organisms, populations, communities, ecosystems and biomes.

- **Population** is a group of individuals of the same species living together in a common area at a particular time. The different populations of the same kind of organisms are often referred to as **local population**.
- Members of a local population may be genetically adapted to their specific environment, such a population is called **ecotype**.
- **Biotic community** is an assemblage of populations of different species of plants, animals, bacteria and fungi which live in a particular area and interact with one another through competition, predation, mutualism, etc.
- **Ecosystem** is a segment of nature consisting of a biological community and its physical environment both interacting and exchanging materials as well as energy.
- **Landscape** is a unit of land distinguished by a natural boundary and having patches of different ecosystems, *e.g.*, Southern peninsula.
- **Biome** is a large regional unit delimited by a specific climatic zone, having a particular major vegetation zone and its associated fauna, *e.g.*, tundra desert, temperate deciduous forest, tropical rain forest, ocean.
- **Biosphere** is biologically inhabited part of earth along with its physical environment consisting of lower atmosphere, land and water bodies.

Table : Major biomes and their characteristics

	Biome	Characteristics
1.	Tropical rain forests	Tropical rain forests occur in regions of moderate temperature (average 23-27°C) and high rainfall (200–500 cm per year). This biome is characterised by multistoreyed vegetation. Further, the biodiversity and the productivity of this biome is very high.
2.	Savannahs	The grasslands with well developed grass cover interspersed with scattered shrubs and small trees. Distributed in warmer parts of India, Africa and Australia having less annual rainfall (90-150 cm per year). Abundance of C_4 photosynthetic grasses.
3.	Deserts	They receive 25 cm (10 inches) or less of precipitation annually. Deserts can be cold (*e.g.*, Tibet, Gobi) and hot (*e.g.*, Thar and Sahara). In true deserts, rainfall is less than 12 cm per year while in extreme desert, it is even lesser than 7 cm per year.
4.	Grasslands	They occur in all types of climate. *e.g.*, **prairies** of USA, **pampas** of South America, **steppes** of Eurasia, **tussocks** of New Zealand, etc. are characterised by perennial grasses and herbs of grazing mammals. They experience greater amount of rainfall than deserts.
5.	Tropical deciduous forests	Tropical deciduous forests occur in areas having warm summers, cold winters and moderate amount of precipitation (75–150 cm annually). Leaf fall occurs during autumn.
6.	Tundra	It is located in the north of timberline or 60° N latitude below the polar ice, extending across North America, Europe and Asia. Tundra receives very little precipitation (less than 25 cm annually), winters are extremely long and cold and summers are short and warm. The subsoil remains frozen except upper few inches in the summers. The condition is called permafrost.
7.	Taiga	It stretches as an East-West band just South of tundra. The characteristic feature of this biome is the presence of numerous lakes and it consists of evergreen, cone bearing trees like spruce, hemlock and fir. It has long winters with little precipitation.

ORGANISMS AND ITS ENVIRONMENT

- No organism can live alone. It has to interact with its immediate surroundings which include both biotic and abiotic factors.
- **Environment** is the sum total of all biotic and abiotic factors, substances and conditions that surround and potentially influence organisms without becoming their constituent part.
- **Climate** is a long term property of the atmosphere which is the same over a larger area and remains the same over a long period of time. Climate determines the flora and fauna of a place.
- **Microclimate** refers to the climatic conditions present at local scale *i.e.,* within an area of limited size.
- **Habitat** is a specific place or locality delimited by a combination of factors, physical features and barriers where a community resides.
- **Microhabitat** is a part of the habitat having a specific property, *e.g.,* forest floor, tree canopy, tree trunk, edge of a pond.
- **Niche** or **ecological niche** (**Grinnel**, 1917) is a specific part of habitat occupied by individuals of a species which is circumscribed by its range of tolerance, range of movement, microclimate, type of food and its availability, shelter, type of predator, and timing of activity. In other words, ecological niche means the total interaction of a species with its environment, or its functional position or status in an ecosystem.
- Ecological niche depends on the species' structural adaptations, physical responses and behaviour.
- Any external thing, substance or condition which has effect on living organism is called **ecological factor** and totality of all these factors constitute environmental complex or environment. There are four major types of factors:
  - **Climatic factors :** These are related to climate like, light, temperature, humidity, precipitation, wind, atmosphere and fire.
  - **Topographic factors :** These are related with physical geography of earth and are also called physiographic factors, *e.g.,* altitude, direction of mountain and valleys, etc.
  - **Edaphic or soil factors :** These factors affect through soil.
  - **Biotic or living factors :** Living organisms have effect on other organisms and these constitute biotic factors.

Abiotic Factors

Light

- Light is an important ecological factor as it affects different physiological processes of plants, *e.g.,* photosynthesis, transpiration, movements, flowering, seed germination, etc.
- Light is responsible for daily rhythm in animals. Photoperiodism controls migration in birds, hibernation and breeding in animals whereas in plants it controls flowering and vegetative growth.

Temperature

- Not only the physiological functions but also the geographical distribution of many plants and animals is governed by temperature. It influences the living organisms in the following manner:
  - **Metabolic activities :** Different metabolic activities of plants are controlled by different enzymes which are affected by temperature hence these metabolic activities are affected by temperature, *e.g.*, photosynthesis, respiration, etc.
  - **Flowering in plants :** Temperature is also an important factor affecting flowering in plants. Low temperature treatment (0-6°C), *i.e.*, vernalisation is responsible for enhancing flowering in plants.
  - **Growth and development :** Growth and development are adversely affected by very low and high temperatures.

Water

- Water is an important component of protoplasm being used as a general solvent, a reactant, a metabolic by-product and an essential material for maintaining turgidity.

Water is a resource, a condition and a habitat in itself. The productivity and distribution of plants is also heavily dependent on water.

- Plants of aquatic habitats are called **hydrophytes.** For aquatic organisms the quality (chemical composition, pH) of water is important. Mesophytes are plants of moist habitats whereas xerophytes are plants of dry habitats.
- Some organisms are tolerant of a wide range of salinities (**euryhaline**, *e.g.*, salmon) but others are restricted to a narrow range of salinities (**stenohaline**, *e.g.*, shark). Many freshwater animals cannot live for long in sea water and *vice versa* because of the osmotic problems they would face.

Soil

- Soil is very important ecological factor as it provides water, minerals or nutrients and support to the producers (plants).
- **Mineral particles** are the chief components of soil complex and are formed by weathering of rocks. Depending upon size of mineral particles, soils are of following types :
  - **Clay :** If particle size is less than 0.002 mm
  - **Silt :** If particle size is 0.002-0.02 mm
  - **Fine sand :** If the particle size is 0.02-0.2 mm
  - **Coarse sand :** 0.2-2 mm
  - **Gravel or Stone :** More than 2 mm
- The appearance of different layers superposed one above the other in a vertical section of soil from surface downward to the parent rock is called **soil profile**.
- The horizons of soil are O, A, B and C. Unbroken and unweathered parent bed rock lies below C horizon.

Responses to Abiotic Factors

- A process by which the organism keeps the internal environment constant despite drastic changes in external conditions is called **homeostasis**.
- **Regulators :** Some organisms are able to maintain a constant body temperature and constant osmotic concentration despite changes in the external environment. They are called as regulators.
- **Conformers :** Organisms whose body temperature changes with the surrounding temperature (ectotherms) are called conformers. In aquatic animals and plants the osmotic concentration and temperature of body changes according to ambient conditions of water are also called conformers.
- Some species are **partial regulators.** They have the ability to regulate body functions to a limited extent. Beyond that limit they become conformers.
- **Migration :** The organisms can migrate temporarily from the unfavourable habitat to more favourable area and return when unfavourable period is over.
- **Suspension :** Various kinds of thick-walled spores are formed in bacteria, fungi and lower plants which help them survive under unfavourable conditions. These germinate on return of suitable conditions.
- In animals, the organism, if unable to migrate, might avoid the unfavourable environment by escaping in time. For example, polar bears go into **hibernation** during winter season to escape extreme cold. Some snails and fish undergo **aestivation** to avoid summer-related problems like heat and desiccation. Under favourable conditions many zooplankton in lakes and ponds are known to enter **diapause** *i.e.*, a stage of suspended development.
- **Adaptation** is any attribute of the organism (morphological, physiological behavioural) that enables it to survive and reproduce in its habitat. They develop due to natural selection of suitable variations, which appear through mutation and recombination. (*Adaptations in plants and animals are discussed in the form of flow chart on next page.*)

POPULATION

- The term population has its origin in the Latin word *populus*, meaning people. In

Adaptations

Adaptations in plants

According to water requirement

Plants which grow in water or water rich substratum are called **hydrophytes**. The plant body is covered with mucilage and roots are absent or poorly developed, *e.g.*, *Hydrilla*, *Utricularia*. Hydrophytes can be submerged, suspended and floating (free floating, fixed floating).

Plants that live in mesic conditions *i.e.*, moderate water conditions are called **mesophytes**.

According to water scarcity and heat

Xerophytes show adaptations to dry habitats and high temperature conditions. These are of four types.

Ephemerals (drought escapers) : The plants live for a brief period during the rains. The rest of the year is passed in the form of seeds, *e.g. Euphorbia prostrata*.

Annuals (drought evaders): The plants live for a few week even after the stoppage of rains. Leaves have thick waxy, hairy coating with or without prickles to reduce transpiration, *e.g.*, *Echinops.*

Succulents (drought resistants): They have fleshy organs to store large amounts of water, thick cuticle, sunken stomata *e.g. Opuntia.* **Non-succulent perennial xerophytes**.

Drought endurers : True xerophytes, smaller shoot system, root system very extensive *e.g.*, *Nerium*, *Acacia*

Chaperonins (heat shock proteins) are also present, which protect other proteins from denaturation at high temperatures.

According to light

Plants that are adapted to bright sunlight are called sun plants or **heliophytes.**

Plants which grow in partial shade or low intensity light are called shade plants or **sciophytes.**

Adaptations in animals

- Animals also develop strategies to live better in their environment. Adaptation may be : **Short term** - temporary in nature like tanning of skin, increase in heart beat, etc. or **long term** - permanent in nature like typical specific type of beak, claw, etc.
- **Camouflage** is the ability to blend with the surroundings or background. It is difficult to distinguish leaf like grasshopper or praying mantis from the surrounding foliage.
- **Mimicry** is the resemblance of one species with another in order to obtain advantage, especially against predation.
- **Allen's rule** - According to this rule, in endothermal animals of colder areas, the extremities like feet, tail, ears, etc., tend to be smaller as compared to the animals in warmer regions. This minimises heat loss.
- Animals in colder areas possess thick fur, subcutaneous fat and small extremities.
- Animals facing **water scarcity** as found in arid or desert areas, show two types of adaptations : reduced water loss and ability to tolerate arid conditions. **Kangaroo rat** seldom drinks water and possesses a thick coat to minimise evaporative desiccation.
- **Desert lizards** show behavioural adaptation to cope with excessive heat. They enjoy sun and absorb heat when their body temperature drops below comfort zone but move into shade when surrounding temperature starts increasing.
- **Hibernation** or **winter sleep** and **aestivation** or **summer sleep** are quite common in ectothermal (cold blooded) animals.

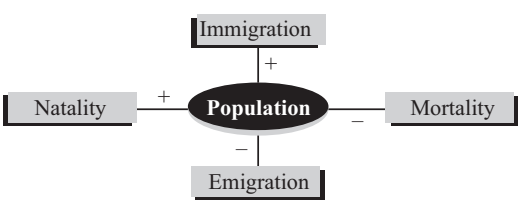
ecology, a **population** may be defined as a group of organisms of the same species occupying a particular space in a given time.

The ultimate constituents of the population are individual organisms that can potentially interbreed.

- Study of population size is called **demography**. Study of human population in a given area like-village, city, etc. is called human demography.
- All aspects of a population including density, size, natality, mortality, immigration, emigration, etc. is called **population ecology.**

Physical Characteristics of a Population

- The basic characteristic of a population is its **size** or **density** (number of individuals present per unit space in a given time) which is affected by four primary population parameters such as **natality, mortality, immigration** and **emigration.**
- **Natality/Birth rate :** Number of organisms born per unit population per unit time.
  - Natality rate depends on biotic potential *i.e.,* ability to produce young ones.
  - Total fertility rate (TFR) : Total number of offspring born per female during her life time.
- **Mortality rate / Death rate :** Number of death per unit population per unit time.
- **Migration :** Movement of individuals in or out of population is called **migration.** It may be in order to get food, space, shelter, job, to avoid predator, etc. It is of two types:
  - **Emigration :** It refers to moving out of individuals. It results in decrease of population size.
  - **Immigration :** It refers to moving in of individuals. It results in increase in population size.

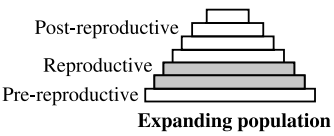


Types of Age Pyramid

Graphic representation of different age groups found in a population with pre-reproductive individuals at the base, reproductive ones in the middle and post reproductive groups at the top.

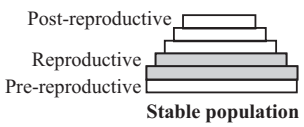
Triangular age pyramid

If number of pre-reproductive individuals is more than reproductive individuals and post reproductive individuals are lesser than these two, then the population size increases.



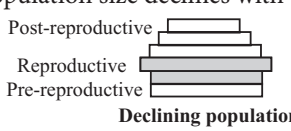
Bell-shaped age pyramid

If number of individuals in pre-reproductive and reproductive group are almost same then population size remains unchanged *i.e.,* zero population growth.



Urn shaped age pyramid

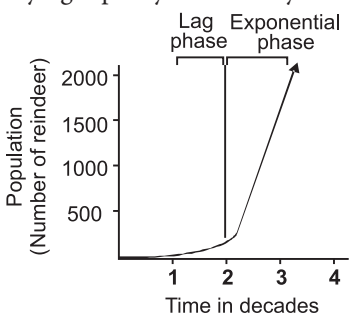
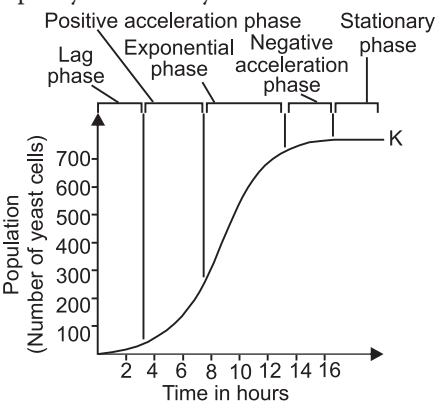
When individuals of pre-reproductive group are lesser than reproductive and post reproductive groups, then in future the population size declines with time.



Population Growth Forms

- Every population has a specific growth form *i.e.,* characteristic pattern of increase. There are 2 basic **population growth forms** *i.e.,* **S-shaped** and **J-shaped.**

Table : Differences between J-shaped and S-shaped growth forms of population

	J-shaped population growth form	S-shaped population growth form
1.	It occurs when the resources are abundant.	It occurs when the resources are limited.
2.	An equilibrium is never reached in population size.	An equilibrium is reached when the size of population approaches the carrying capacity of the ecosystem.
3.	Environmental resistance does not operate to slow down exponential phase.	Environmental resistance begins to operate to slow down exponential phase.
4.	Exponential phase is very rapid.	Exponential phase is comparatively less rapid.
5.	A phase of deceleration never occurs.	A phase of deceleration occurs before equilibrium is reached.
6.	It has 2 phases : lag and log.	It has 4 phases : lag, log, deceleration and steady.
7.	Population grows well beyond the carrying capacity of the ecosystem.  **Fig.:** The J-shaped growth curve of reindeer.	Population seldom grows beyond the carrying capacity of the ecosystem  **Fig.:** The S-shaped growth curve of yeast cells
8.	Equation for J-shaped growth curve $dN/dt = rN$ where, r = intrinsic rate of natural increase and N = population size.	S-shaped or sigmoid growth from is represented by the following equation. $$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$$ where N is the number of existing individuals, t is the time, r is the rate of natural increase and K is the carrying capacity of the ecosystem.

The **carrying capacity** of habitat/locality/ environment is the maximum number of individuals of a population that can be supported in a given time.

Population Interaction

- Organisms belonging to different populations interact for food, shelter and for the fulfillment of other necessities.
- The interaction among individuals of the same species is known as intra-specific interaction and among the organisms of different species is termed as inter-specific interaction.
- According to the nature of relationship, the interactions may be positive or negative. In positive interaction, no organism in relation is harmed and one or both may be benefitted. In negative interaction one or both the interacting organisms are harmed.

Table : Types of biotic interactions

Interaction	Species A	Species B	Nature of interaction	Examples
With positive effect				
Mutualism	+	+	Beneficial to both, obligatory	➤ Lichens, Mycorrhiza, etc.
Protocooperation	+	+	Beneficial to both, not obligatory	➤ Ox-pecker or tick bird and rhinoceros, crocodile bird and crocodile.
Commensalism	+	zero	One benefitted, other unaffected	➤ Cattle egret and grazing cattle, barnacle growing on the back of whale.
With negative effect				
Parasitism	+	–	Parasite (usually small) benefitted, host harmed	➤ *Cuscuta*, a parasitic plant derives its nutrition from host plant on which it parasitises.
Predator	+	–	Predator (generally larger) kills and feeds on prey (smaller)	➤ Carnivorous animals, insectivorous plants.
Competition	–	–	Mutual inhibition due to short supply of resources	➤ The Abingdon tortoise in Galapagos Islands became extinct within a decade after goats were introduced on the island, apparently due to the greater browsing efficiency of the goats.
Amensalism	–	zero	One inhibited, other unaffected	➤ *Penicillium* does not allow the growth of *Staphylococcus* bacterium.

Previous Years' CBSE Board Questions

13.1 Organism and Its Environment

VSA/MCQs (1 mark)

1. Give example of an organism that enters 'diapause' and why? (*Delhi 2014*)

2. Why are green algae not likely to be found in the deepest strata of the ocean? (*AI 2013*)

3. Mention how do bears escape from stressful time in winter. (*Delhi 2013C*)

4. How do seed bearing plants tide over dry and hot weather conditions? (*AI 2013C*)

5. How do snails escape from stressful time in summers? (*AI 2013C*)

6. Why are some organisms called as eurythermals and some others as stenohaline? (*Foreign 2012*)

7. Why green plants are not found beyond a certain depth in the ocean? (*Delhi 2011*)

8. Mention any two activities of animals which get cues from diurnal and seasonal variations in light intensity. (*Delhi 2011C*)

SA I (2 marks)

9. How is normal human body temperature of 37°C maintained during (i) summer and (ii) winter? Explain. *(2020)*

10. How do the following organisms pull through the adverse environmental conditions?
(a) Fungi
(b) Zooplankton
(c) Bear
(d) Snail *(2020)*

11. During a school trip to 'Rohtang Pass', one of your classmates suddenly developed 'altitude sickness'. But, she recovered after sometime.
(a) Mention one symptom to diagnose the sickness.
(b) What caused the sickness?
(c) How could she recover by herself after sometime? (*Delhi 2016*)

12. Why the plants that inhabit a desert are not found in a mangrove? Give reasons. (*Delhi 2016*)

13. Plants that inhabit a rainforest are not found in a wetland. Explain. (*Delhi 2016*)

14. Many freshwater animals cannot survive in marine environment. Explain. (*Delhi 2015*)

15. When you go for a trek/trip to any high altitude places, you are advised to take it easy and rest for the first two days. Comment, giving reasons. (*Foreign 2015*)

16. How does a desert plant adapt to the dry, warmer environmental conditions? (*Foreign 2015*)

17. Shark is eurythermal while polar bear is stenothermal. What is the advantage the former has and what is the constraint the later has? (*Delhi 2015C*)

18. How are mammals living in colder regions and seals living in polar regions able to reduce the loss of their body heat? (*Delhi 2015C*)

19. A student on a school trip started sneezing and wheezing soon after reaching the hill station for no explained reasons. But, on return to the plains, the symptoms disappeared. What is such a response called? How does the body produce it? (*Delhi 2013*)

20. Explain why very small animals are rarely found in polar region. (*Delhi 2013*)

21. Some organisms suspend their metabolic activities to survive in unfavourable conditions. Explain with the help of any four examples. (*Delhi 2012*)

22. When an organism is called a 'conformer'? Explain with the help of an example. (*AI 2012C*)

23. Write the normal body temperature of humans. How is it maintained during summers? (*AI 2012C*)

24. How do desert lizards cope with temperature variations in their environment? Explain. (*AI 2012C*)

25. Bear hibernates whereas some species of zooplanktons enters diapause to avoid stressful external conditions. How are these two ways different from each other? (*Foreign 2011*)

26. Why do we experience shivering during winters when the temperature is very low? (*Delhi 2011C*)

SA II (3 marks)

27. (a) "Organisms may be conformers or regulators". Explain this statement and give one example of each.
(b) Why are there more conformers than regulators in the animal world? (*AI 2017*)

28. In certain seasons we sweat profusely while in some other season we shiver. Explain. (*Delhi 2016*)

29. Explain with the help of suitable examples the three different ways by which organisms overcome their stressful conditions lasting for short duration. (*AI 2016*)

30. How do snails, seeds, bears, zooplanktons, fungi and bacteria adapt to conditions unfavourable for their survival? (*AI 2015*)

31. Why do tribes who live in high altitude of Himalayas experience discomfort in respiration? How do they get adapted to survive in such a situation? (*AI 2015C*)

32. (a) State how the constant internal environment is beneficial to organisms.
(b) Explain any two alternatives by which organisms can overcome stressful external conditions. (*AI 2014*)

33. List three symptoms of high altitude sickness and three adaptations to overcome it. (*Delhi 2012C*)

34. Water is very essential for life. Write any three features both for plants and animals which enable them to survive in water scarce environment. (*AI 2011*)

35. How do organisms cope with stressful external environmental conditions which are localised or of short duration? (*AI 2011*)

LA (5 marks)

36. (a) Explain giving reasons why the tourists visiting Rohtang pass or Mansarovar are advised to resume normal 'active life' only after a few days of reaching there.
(b) It is impossible to find small animals in the polar regions. Give reasons. (*AI 2012*)

13.2 Populations

VSA/MCQs (1 mark)

37. Mention the term used to describe a population interaction between an orchid growing on a forest tree. *(Delhi 2019)*

38. Name the interaction that exists between *Cuscuta* and shoe-flower plant. (*Delhi 2015C, AI 2014*)

39. Name the interaction that exists between sucker fish and shark. (*Delhi 2015C*)

40. Name the type of interaction that exists between barnacles and whale. (*Delhi 2015C*)

41. Name the type of interaction seen between fig and wasps. (*AI 2015C*)

42. State Gause's competitive exclusion principle. (*AI 2014*)

43. Name the type of association that the genus *Glomus* exhibits with higher plants. (*AI 2014*)

44. Describe the mutual relationship between fig tree and wasp and comment on the phenomenon that operates in their relationship. (*AI 2014*)

45. Construct an age pyramid which reflects an expanding growth status of human population. (*AI 2014*)

46. Name the interspecific interaction in which one is detrimental while the other is neutral. (*AI 2013C*)

47. Write what do phytophagous insects feed on. (*Delhi 2012*)

48. What is an interaction called when an orchid grows on a mango plant? (*Delhi 2012*)

49. Pollinating species of wasps show mutualism with specific fig plants. Mention the benefits the female wasps derive from the fig trees from such an interaction. (*AI 2011*)

50. Why are cattle and goats not seen browsing on *Calotropis* growing in the fields? (*Foreign 2011*)

SA I (2 marks)

51. Mention how have plants developed mechanical and chemical defence against herbivores to protect themselves with the help of one example of each. *(2020)*

52. Name and explain the interaction, that is seen between clownfish and sea anemones. *(AI 2019)*

53. What is mutualism? Mention any two examples where the organisms involved are commercially exploited in agriculture. (*AI 2015*)

54. Differentiate between parasitism and competition, giving one example of each. State the common characteristic they share. (*Foreign 2015*)

55. Construct an age pyramid which reflects a stable growth status of human population. (*Delhi 2014*)

56. Explain Verhulst-Pearl Logistic Growth of a population. (*Foreign 2014*)

57. Differentiate between commensalism and mutualism by taking one example each from plants only. (*Foreign 2014*)

58. Explain mutualism with the help of an example. (*Delhi 2014C*)

59. Why are a fig tree and its partner wasp considered a good example of mutualism? (*Delhi 2013C*)

60. Why do clown fish and sea anemone pair up? What is this relationship called? (*Delhi 2012*)

61. Explain brood parasitism with the help of an example. (*AI 2012*)

SA II (3 marks)

62. Study the table showing the population interaction between species Z and Y respectively. Assign the appropriate +/– signs for A, B, D, E and respective interactions for C and F.

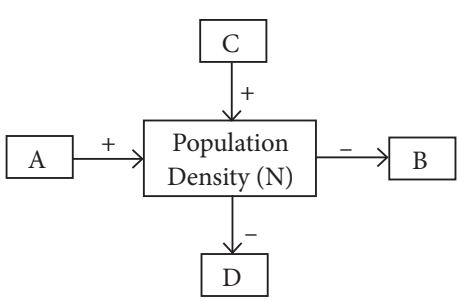
Species Z	Species Y	Name of interaction
A	B	Mutualism
–	–	C
D	E	Parasitism
+	0	F

(2020)

63. The population of a metro city experiences fluctuations in its population density over a period of time.
(a) When does the population in a metro city tend to increase?
(b) When does the population in a metro city tend to decline?
(c) If N is the population density at time 't', write the population density at time 't + 1'. *(2020)*

64. (a) Write how parasites have evolved with adaptation to co-exist with their host in an ecosystem.
(b) Parasites are host specific and tend to co-evolve. How would the parasite respond if the host evolve a certain mechanism to resist or reject the parasite? *(2020)*

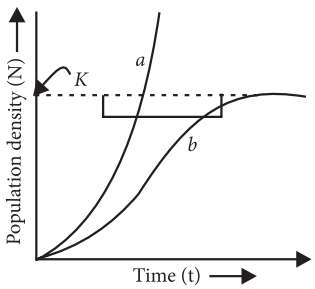
65.



Study the schematic representation given above and answer the following questions.
(a) Identify A in it.
(b) Identify B in it.
(c) When population density at time t is N as shown above, write the population density at time t + 1 in the form of an equation using appropriate symbols. *(2020)*

66. Mention the special adaptations evolved in parasites and why? *(Delhi 2019)*

67. Study the graph given below and answer the questions that follow:



(i) The curve '*b*' is described by the following equation:

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

What does '*K*' stand for in this equation? Mention its significance.
(ii) Which one of the two curves is considered a more realistic one for most of the animal populations?
(iii) Which curve would depict the population of a species of deer if there are no predators in the habitat? Why is it so? *(AI 2019)*

68. Name and explain the type of interaction that exists in mycorrhizae and between cattle egret and cattle. (*AI 2016*)

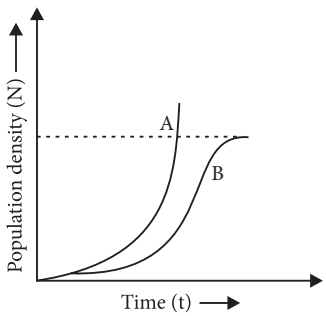
69. Predation is usually referred to as detrimental association. State any three positive roles that a predator plays in an ecosystem. (*AI 2016*)

70. Explain parasitism and co-evolution with the help of one example of each. (*AI 2016*)

71. (a) Name the two growth models that represent population growth and draw the respective growth curves they represent.
(b) State the basis for the difference in the shape of these curves.
(c) Which one of the curves represent the human population growth at present? Do you think such a curve is sustainable? Give reason in support of your answer. *(AI 2016)*

72. Differentiate between mutualism, parasitism and commensalism. Provide one example for each of them. (*Foreign 2015*)

73. Study the graph given below and answer the questions that follow.



(a) Write the status of food and space in the curves A and B.
(b) In the absence of predators, which one of the two curves would appropriately depict the prey population?
(c) Time has been shown on X-axis and there is a parallel dotted line above it. Give the significance of this dotted line.
(*Delhi 2014*)

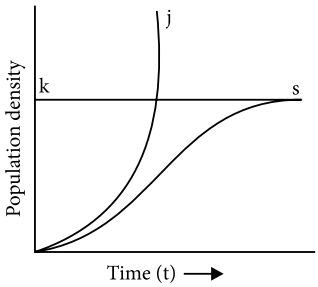
74. Draw and explain expanding age pyramids of human population. Why is it so called?
(*AI 2014C*)

75. (a) Write the importance of measuring the size of a population in a habitat or an ecosystem.
(b) Explain with the help of an example how the percentage cover is a more meaningful measure of population size than more numbers. (*AI 2013*)

76. (a) Explain "birth rate" in a population by taking a suitable example.
(b) Write the other two characterstics which only a population shows but an individual cannot. (*AI 2013*)

77. (a) Explain "death rate" in a population by taking a suitable example.
(b) Write the other two characterstics which only a population shows but an individual cannot. (*AI 2013*)

78.



A forest hardly has any carnivores. Census of herbivorous mammals was taken and plotted as a graph shown above. Identify the curve that will explain the population growth of herbivores. Give reason to your answer.
(AI 2013C)

79. (a) List any three ways of measuring population density of a habitat.
(b) Mention the essential information that can be obtained by studying the population density of an organism. *(AI 2012)*

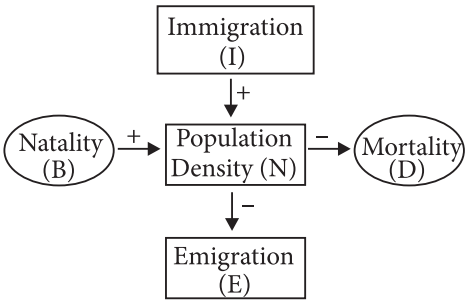
80. Explain with the help of an example each of the three population interactions where the organisms live closely together. (*AI 2011C*)

81. (a) Explain the birth rate and death rate in the population with the help of an example each.
(b) What is age-pyramid? Draw an age-pyramid of an expanding population.
(*AI 2011C*)

LA (5 marks)

82. (a) What is "population" according to you as a biology student?
(b) "The size of a population for any species is not a static parameter". Justify the statement with specific reference to fluctuations in the population density of a region in a given period of time. *(Delhi 2019)*

83. (a) Study the given flow chart and complete the equation that follows by identifying 1, 2, 3 and 4.



$N_{t+1} = N_t + \{(1 + 2) - (3 + 4)\}$

(b) Mention the different ways by which the population density of different species can be measured. *(AI 2019)*

84. (a) Following are the responses of different animals to various abiotic factors. Describe each one with the help of an example.
(i) Regulate (ii) Conform
(iii) Migrate (iv) Suspend
(b) If 8 individuals in a population of 80 butterflies die in a week, calculate the death rate of population of butterflies during that period. *(2018)*

85. (a) What is an age-pyramid?
(b) Name three representative kinds of age-pyramids for human population and list the characteristics for each one of them.
(*Delhi 2017*)

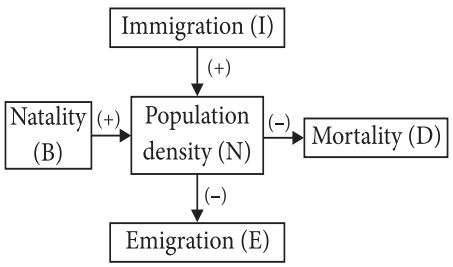
86. (a) Compare, giving reasons, the J-shaped and S-shaped models of population growth of a species.
(b) Explain "fitness of a species" as mentioned by Darwin. (*AI 2017*)

87. (a) Represent diagrammatically three kinds of age pyramids for human populations.
(b) How does an age pyramid for human population at given point of time help the policy-makers in planning for future.
(Delhi 2016)

88. (a) List the different attributes that a population has and not an individual organism.
(b) What is population density? Explain any three different ways the population density can be measured, with the help of an example each. (*AI 2015*)

89. (a) Name the population growth pattern the equation $\left\{\frac{dN}{dt} = rN\right\}$ represents.
What does "r" represent in the equation? Write its importance in population growth.
(b) Explain the principle of carrying capacity by using population Verhulst-Pearl logistic growth curve. (*AI 2014C*)

90. (a) Explain the equation:
$N_{t+1} = N_t + [(B + I) - (D + E)]$
on the basis of the flow chart given below:



(b) Mention the different ways by which the population density of different species can be measured. (*Delhi 2011C*)

91. Study the table given below in regard to population interactions and answer the questions that follow:

Species A	Species B	Name of Interaction
–	0	(a)
+	–	(b)
–	–	(c)
+	+	(d)
+	0	(e)

[Note : (+) plus = beneficial interaction; (–) minus = detrimental interaction; (0) zero = neutral interaction]

(i) Identify the interactions (a) to (e).

(ii) Explain each one of them.

(*Delhi 2011C*)

Detailed Solutions

1. *Bombyx mori* (silk moth) is an insect that enters diapause due to some adverse environmental conditions such as drought, extreme temperature, reduced food availability; which, in turn, delays the overall development. The physiological and metabolic activities diminish at this particular time.

2. Green algae are photosynthetic in nature. In the deepest strata of the ocean *i.e.,* benthic zone, light does not penetrate therefore, this zone is in perpetual darkness and photosynthetic organisms such as green algae cannot survive in this region.

3. Bears undergo hibernation to escape from stressful time in winter. In hibernation, they seek a warm shelter and remain dormant, their respiration rate turns low and they consume stored food.

4. Mesophytic seed bearing plants sometimes have to face hot and dry weather conditions. They survive such adverse conditions by forming underground perennating structures such as corms, rhizomes, tubers, etc. Xerophytic plants on the other hand have to face hot and dry conditions throughout the year. They show various adaptations like sunken stomata, fleshy organs, leaves reduced to spines, extensive root system, etc.

5. Snails undergo aestivation to escape from stressful time in summers.

6. Some organisms can tolerate a wide range of temperature variations, *e.g.,* most mammals and birds. They are called eurythermals while other organisms live within narrow range of temperature because of their requirement of nearly constant temperature throughout the year, *e.g.,* polar bear, lizards, amphibians, and are called stenothermals.

7. Green plants are photosynthetic and show autotrophic mode of nutrition. They require sunlight to photosynthesise. Light does not

penetrate beyond a certain depth in oceans and hence very deep layers remain in perpetual darkness. In the absence of sunlight green plants cannot manufacture their food and hence cannot survive. Therefore, they are found in those regions of the ocean where sunlight is available.

8. Most animals are active during a particular period of the day, *e.g.,* butterflies and most birds are active during day time hence called diurnal whereas few animals like rat, cockroaches and birds like owl are active during night hence called nocturnal.
Various activities like flowering in plants and migration in birds and animals are affected by seasonal variations.

9. Human beings are able to maintain a constant body temperature at about ~37°C.

(i) During summers the external temperature may rise upto 45°C. Humans begin to sweat profusely when external temperature rises above 37°C. Cooling of the body occurs as sweat evaporates.

(ii) During winter, when external temperature is low, our body inadvertently starts shivering. It is an exercise that raises body temperature.

10. (a) Fungi : They form various kinds of thick walled spores that are capable of surviving in adverse conditions and germinate on arrival of favourable conditions to give rise to new fungal hyphae.

(b) Zooplankton : Under unfavourable conditions many zooplanktons enter diapause, *i.e*., a stage of suspended development.

(c) Bear : Polar bears go into hibernation (winter sleep) during winter season to escape extreme cold.

(d) Snail : Snails undergo aestivation (summer sleep) to avoid summer related problems like heat and desiccation.

11. (a) Heart palpitation

(b) Sickness is due to low atmospheric pressure of high altitudes, as body does not get enough oxygen.

(c) After sometimes, body compensates for low oxygen availabilty by increasing red blood cell production, decreasing binding capacity of haemoglobin and by increasing breathing rate.

12. Plants inhabiting desert (xerophytes) are not found in mangroves, because xerophytic plants are adapted to dry and hot environment. They possess various physical modifications to tolerate extreme water scarcity and heat, like extensive root system, succulent organs, leaf reduced to spines, etc. Mangrove swamp is a region of vegetation where soil is highly saline and water logged. Only halophytes can survive in such regions as they possess aerial roots called pneumatophores through which gaseous exchange occurs. Roots of xerophytes are positively geotropic and will suffocate and die in such badly aerated soil ultimately leading the whole plant to death.

13. Plants that inhabit rainforest are not able to germinate in wetland due to presence of excess water and anaerobic conditions (due to water logging). Wetlands are marshy areas and plants growing there have negatively geotropic roots, called pneumatophores which help in gaseous exchange. Pneumatophores are not present in plants inhabiting rainforests.

14. If a freshwater animal is placed in marine environment, then it will not be able to survive because of osmoregulation problem. The freshwater animal is adapted to live in fresh environment, so, if it is kept in saline water, it will not be able to cope with outside hypertonic environment and it would face death.

15. Atmospheric pressure is low at higher altitudes as compared to plains. When we go for a trek/trip on high altitude, then due to low atmospheric pressure our body does not get enough oxygen, as a result of which we experience nausea, fatigue and heart palpitation (altitude sickness). But by taking rest for first two days, body gets acclimatised to high altitude conditions. The body compensates low oxygen availability by increasing red blood cell production, decreasing binding capacity of haemoglobin and increasing breathing rate. Hence, we will automatically stop experiencing altitude sickness.

16. Desert plants or xerophytes have various adaptations to cope with dry, hot environmental conditions such as leaves with thick waxy, hairy coating to reduce transpiration, leaves reduced to spines and photosynthetic stems, fleshy organs to

store water, sunken stomata that open only during night and deep penetrating roots that reach water table.

17. Sharks being eurythermal can tolerate wide range of temperature variations and thus have wider distribution on earth, on the other hand, polar bear being stenothermal can tolerate only narrow range of temperature and is restricted to specific regions only.

18. Animals inhabiting cold areas possess thick coat of hairs, feathers and subcutaneous fat to reduce loss of body heat.

19. *Refer to answer 15.*

20. Small animals have large surface area relative to volume, so they tend to lose body heat very fast in cold environment as compared to large animals. They have to spend more energy to generate body heat through metabolism. Thus, considering the difficulty of maintaining constant internal temperature, small animals are rarely found in polar regions.

21. To tide over unfavourable conditions, some organisms suspend their metabolic activities. These are discussed as follows :

(i) Bacteria, fungi and lower plants develop thick walled spores, which germinate during suitable conditions.

(ii) Polar bears go into hibernation during winter season to escape cold.

(iii) Some snails and fish undergo aestivation to avoid summer related problems like heat and dessication.

(iv) During unfavourable conditions, zooplanktons in lakes and ponds are known to enter diapause, *i.e.,* stage of suspended development.

22. The organism in which osmotic concentration of body fluids and body temperature changes according to ambient conditions is called conformer. *E.g.,* in aquatic animal *Asterias*, the osmotic concentration of body fluids changes according to the osmotic concentration of the surrounding water.

23. Normal body temperature of humans is about 37°C. Humans maintain constant body temperature by homeostasis. During summer, when external temperature rises, we begin to sweat profusely. As sweat evaporates, cooling of body occurs.

24. Desert lizards lack the physiological ability that mammals have to deal with the high temperature. They keep their body temperature fairly constant by behavioural means. They enjoy in the sun and absorb heat when their body temperature drops below the comfort zone, but move into shade when the surrounding temperature starts increasing. Some species are capable of burrowing into the soil to hide and escape from too much heat.

25. Bear undergo hibernation during winters to escape extreme cold. It is characterised by low body temperature, slow breathing and heart rate and low metabolic rate. However, diapause is a stage of suspended development or growth occurring in many insects and other invertebrates during which metabolism is greatly decreased. Diapause is often triggered by seasonal changes and regulated by inborn rhythm.

26. When the ambient temperature is very low, our body starts shivering. It is an exercise that raises body temperature and helps to maintain constant internal body temperature at about 37°C, by mechanism of homeostasis.

27. (a) Organisms may be conformers or regulators.

Conformers are the organisms that have following characteristics:

(i) A constant internal environment or homeostasis is absent in them.

(ii) Their body temperature changes according to that of the environment.

(iii) Osmotic concentration of body fluids varies according to that of external medium.

(iv) They consume lesser amount of energy.

(v) They have a narrow range of distribution.

(vi) They are less active. Example : *Asterias*

Regulators are the organisms that have following characteristics:

(i) They possess homeostasis.

(ii) They maintain their body temperature.

(iii) Their body fluids have a fixed osmotic concentration.

(iv) They consume large amount of energy.

(v) They have a wide range of distribution.

(vi) They are more active. Example : Human beings

(b) During the course of evolution, the cost

and benefits of maintaining a constant internal environment were taken into consideration. Considering the huge cost of maintaining a fixed body temperature and osmotic concentration of body fluids, many organisms have not evolved homeostasis. Therefore, an overwhelming majority (99%) of animals are conformers. Their body temperature changes with the ambient temperature. Due to this reason, there are more conformers than regulators in the animal world.

28. *Refer to answer 9.*

29. Physiological and behavioural adaptations help organisms to manage stressful conditions. These include migration, hibernation, aestivation, camouflage, mimicry, etc. Caribou migrate during winter to warmer places for search of food. Some animals like Northern ground squirrels undergo hibernation during winter to avoid low temperature whereas others undergo aestivation to avoid extreme heat. Viceroy butterfly mimics unpalatable toxic monarch butterfly in order to get protection against predator.

30. Ecological adaptations are special characteristics evolved or developed by organisms in order to live comfortably and successfully under a prevailing set of environmental conditions. Adaptations may be morphological, physiological or behavioural or a combination of them. The ultimate aim of all adaptations is to make the individual fit to obtain food and space for its survival, opportunities for its reproduction and rearing of young ones.

Various kinds of thick walled spores are formed in bacteria, fungi and lower plants which help them survive under unfavourable conditions. These germinate on return of suitable conditions. Some organisms retard their metabolic activities under stress conditions and undergo hibernation or aestivation. For example, polar bears go into hibernation during winter season to escape extreme cold. Some snails and fish undergo aestivation to avoid summer-related problems like heat and dessication. Under unfavourable conditions many zooplanktons in lakes and ponds are known to enter diapause, *i.e.,* a stage of suspended growth and development. Seeds remain dormant in unfavourable conditions. They break dormancy and germinate in favourable environmental conditions.

31. *Refer to answer 15.*

32. (a) Regulators are organisms which maintain constant internal environment despite changes in external conditions through thermoregulation and osmoregulation. Such organisms generally have wide range of distribution.

(b) Organisms can overcome stressful external conditions by following adaptation :

(i) Migration - Birds of colder areas of northern hemisphere begin their southward migration as the day length begins to shorten.

(ii) Aestivation - Ground squirrels undergo aestivation to avoid heat by spending dry hot period in burrows.

33. *Refer to answer 15.*

34. Water is very essential for life. Plants and animals show various adaptations to cope up with water scarcity in the area where they are found. Some of the adaptations seen in plants which enable them to survive in water scarce environment are as follows:

- Some plants have deep tap root system which is capable of absorbing water from deep soil *e.g., Prosopis, Acacia,* etc.
- Cacti and succulents, have fleshy leaves and stems to store water.
- Many tropical plants, which grow in hot and arid climates possess C_4 pathway of photosynthesis. So, these plants perform better in low soil water environments. Such plants, use less water to achieve higher rates of photosynthesis.

Some of the adaptations seen in animals which enable them to survive in water scarce environment are as follows:

- Desert lizards keep their body temperature fairly constant by behavioural means. They enjoy in the sun and absorb heat when their body temperature drops below the comfort zone but move into shade when the surrounding temperature starts increasing.
- The Kangaroo rat conserves water by excreting nearly solid urine and can live from birth to death without even drinking water.

– The camels shows tolerance to wide fluctuations in body temperature and are able to maintain blood stream moisture even during extreme heat stress.

35. Living organisms cope with stressful conditions by any of the following methods:

(i) Migration : The organism can migrate temporarily from the unfavourable habitat to more favourable area and return when unfavourable period is over, *e.g.,* Siberian birds migrate from Siberia to other parts every winter.

(ii) Hibernation : The phenomenon of spending extreme cold period of the year in an inactive stage by an animal, *e.g.,* polar bears undergo hibernation during winter season to escape extreme cold.

(iii) Aestivation : The phenomenon of spending dry hot period of the year in an inactive stage by an animal *e.g.,* snails and fish.

(iv) Diapause : It is a dormant stage of suspended development of an organism. During this period there is reduction in the amount of free water.

36. (a) Tourists visiting high altitude areas such as Rohtang Pass or Mansarovar, experience altitude sickness. Its symptoms include nausea, fatigue and heart palpitations. This is because in the low atmospheric pressure of high altitudes, the body does not get enough oxygen. But, gradually it gets acclimatised and stops experiencing altitude sickness. The body compensates low oxygen availability by increasing red blood cell production, decreasing the binding affinity of haemoglobin and increasing breathing rate. Thus, the visitors are advised to resume their normal active life involving heavy works only after few days because for doing heavy tasks our body needs energy and this energy is obtained by the oxidation of glucose. This oxygen is carried to the cells by haemoglobin present in RBCs. As oxygen is the limiting factor in high altitudes, more carrier molecules, *i.e.,* haemoglobin is needed to provide sufficient amount of oxygen to cells. Thus, increased RBC production that starts in a few days after reaching high altitudes prepares the tourist to lead a normal active life.

(b) According to Bergman's rule, temperature affects the absolute size of an animal and the relative proportion of various body parts. Birds and mammals attain greater body size in cold regions than in warm areas . Thus, smaller animals are rarely found in polar regions. It can be explained as that small animals have a larger surface area relative to their volume and they tend to loose body heat very fast when it is cold outside. Due to higher heat loss they have to spend much energy to generate body heat through metabolism. Greater body size reduces surface area to volume ratio and decreases heat loss which is very essential for surviving in cold polar regions.

37. The population interaction is commensalism between an orchid growing on a forest tree in which orchid is benefitted and forest tree remains unaffected.

38. Parasitism

39. Commensalism

40. Commensalism

41. Mutualism

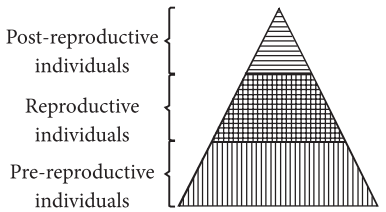
42. Gause's competitive exclusion principle states that two or more species with similar niche requirements cannot coexist indefinitely in the same area and one of the two gets eliminated.

43. Members of fungal genus *Glomus* often form symbiotic association with the roots of higher plants. These associations are termed as mycorrhizae.

Fungus helps the plant root in absorption of water and minerals and also helps the plants to increase tolerance to salinity and drought. In return plant provides food to the fungus.

44. Many species of fig trees have mutual relationship with the pollinator species of wasp. A given fig species can be pollinated only by its partner wasp species and not by other species. The female wasp uses the fruit not only as an oviposition (egg laying) site but also uses the developing seeds within the fruit for nourishing its larvae. The wasp pollinates the fig inflorescence while searching for suitable egg-laying sites. In return the fig offers the wasp some of its developing seeds as food for the developing wasp larvae.

45. An age pyramid for expanding human population is as follows:



46. Amensalism

47. Phytophagous insects feed on plant sap and other parts of plants.

48. Commensalism

49. *Refer to answer 44.*

50. Cattle and goats are never seen grazing on *Calotropis*, because *Calotropis* is a weed that produces highly poisonous cardiac glycosides. It is a harmful chemical that makes herbivores sick, inhibits feeding or digestion, disrupts reproduction or even kills them.

51. Plants cannot run away from their predators or herbivores. They therefore have evolved an astonishing variety of morphological (mechanical) and chemical defences against herbivores. Thorns and spines (*Acacia*, Cactus) are the most common morphological means of defence. Many plants produce and store chemicals that make the herbivores sick when eaten, inhibit feeding or digestion, disrupt its reproduction or even kill it. *E.g. Calotropis* produces highly poisonous cardiac glycosides to prevent herbivory.

52. Commensalism is the interaction between clownfish and sea anemone. The clownfish lives among the stinging tentacles of sea anemone and gets protection from its predators which stay away from the stinging tentacles. The sea anemone does not appear to derive any benefit by hosting the clownfish.

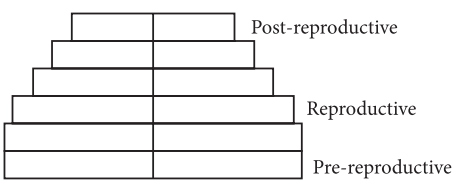
53. Mutualism is an interaction between two organisms of different species where both the partners are benefitted and the association is obligatory. *E.g.,* : nitrogen fixation in root nodule of legume by *Rhizobium* bacteria and pollination of orchid flower *Ophrys* by bee.

54. Differences between parasitism and competition are as follows:

	Parasitism	**Competition**
(i)	It is relationship between two living organisms of different species in which one organism obtains food from another living organism.	It is rivarly between two or more organisms of same or different species for obtaining the same resources
(ii)	*E.g.,* lice, an ectoparasite sucks blood of animals and *Trypanosoma*, an endoparasite feeds on body fluid.	*E.g.,* in forest areas, trees, shrubs, herbs and vines compete with each other for sunlight, nutrients, water, pollinators, etc.

Both parasitism and competition are negative population interactions. In parasitism, one organism (parasite) has negative effect on other organism (host) and in competition, both species are negatively affected.

55. The bell-shaped age pyramid reflects a stable growth status of human population. It can be represented as follows:



56. According to Verhulst-Pearl logistic growth, population increases in size in sigmoid fashion. S-shaped growth form is found in stable population. It shows population growth in a habitat with limited resources. Population shows initially a lag phase, followed by phases of increase and decrease and finally the population density reaches the carrying capacity. A plot of N in relation to time (t) results in a sigmoid curve. This type of population growth is called Verhulst-Pearl logistic growth as explained by the following equation :

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

Where N = population density at a time t; r = intrinsic rate of natural increase and; K = carrying capacity.

57. The differences between mutualism and commensalism are as follows :

	Mutualism	**Commensalism**
(i)	It is an association between two organisms in which both are benefitted.	It is an association between two organisms in which only one is benefitted. The second is neither benefitted nor harmed.
(ii)	Contact between the two organism is obligatory.	Contact between commensal and its benefactor may be periodic or continuous.
(iii)	Nitrogen fixing blue -green alga or cyanobacterium called *Anabaena* is associated with water fern *Azolla* in a mutualistic interaction.	Many epiphytes,*e.g.,* orchids, are found growing on the branches and in the forks of trees. These epiphytes use the trees only for attachment and manufacture their own food by photosynthesis.

58. Mutualism is an interaction between two organisms of different species where both the partners are benefitted and none of the two are capable of living separately. *E.g.,* lichen is a composite entity which is formed jointly by an alga (phycobiont) and a fungus (mycobiont). The main body of the lichen is formed of fungus. The fungus also provides fixation, water, minerals and shelter to the alga. The alga manufactures food not only for itself but also for the fungus. This interaction or relationship allows the lichen to grow in highly hostile environment like bare rock.

59. *Refer to answer 44.*

60. *Refer to answer 52.*

61. Brood parasitism in birds is a fascinating example of parasitism in which the parasitic bird lays its eggs in the nest of its host and lets the host incubate them. During the course of evolution, the eggs of the parasitic bird have evolved to resemble the host's eggs in size and colour to reduce the chances of the host bird detecting the foreign eggs and ejecting them from the nest. Laying eggs by koel in crow's nest is an example of brood parasitism.

62. In the given table A and B both are benefitted as they show mutualism.

So, A = +

B = +

In parasitism, parasite species is benefitted and host species is harmed which can be indicated as follows:

D = +

E = –

When both the species are harmed in an interaction then it could be competition wherein they could mutually inhibit each other as is the case of direct competition or are inhibited due to short supply of resources as is the case of indirect competition. So C is competition.

In commensalism, indicated by F in the given table one species is benefitted (commensal) whereas the other species remain unaffected.

63. (a) Population of a metro city tends to increase when natality rate exceeds mortality rate due to better health services and also due to lack of unplanned population control measures. Also when immigration exceeds emigration, population of a city tends to increase.

(b) Population of a city tends to decline when mortality rate is higher than natality rate and emigration exceeds immigration.

(c) If N is the population density of time t, then its density at time t + 1 will be

$$N_{t+1} = N_t + [(B + I) - (D + E)]$$

Where B = Natality

I = Immigration

D = Mortality

E = Emigration

64. (a) Parasitism is a negative interaction wherein parasite depends on its host organism partially or completely for survival and perpetuation. Accordingly, parasites are classified as partial or hemiparasites and complete or holoparasites. Also they could be ectoparasites (on host's body) or endoparasites (inside host's body). Parasites are adapted vividly on the basis of their dependability on host.

In accordance with their life styles, parasites evolved special adaptations such as:

(i) anaerobic respiration in internal parasites

(ii) loss of unnecessary sense organs

(iii) presence of adhesive organs (*e.g.,* suckers in tapeworm) to cling on to the host

(iv) loss of certain organs (*e.g.*, bedbugs lack wings, *Taenia* loses digestive system)

(v) excessive multiplication

(vi) resistant cysts and eggs for safe transfer of their progeny to new hosts

(vii) high reproductive capacity.

(b) If host evolves a certain mechanism to resist or reject the parasite then parasite will also undergo certain physiological or morphological changes so that it could coexist with its host species to counteract and neutralise them.

65. (a) In the given figure, A is Natality.

(b) In the given figure, B is Mortality.

(c) *Refer to answer 63 (c).*

66. *Refer to answer 64 (a).*

67. (i) In the given graph, 'a' represents exponential or J-shaped growth and 'b' represents logistic or sigmoid growth. The equation $\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$, represents logistic growth form and '*K*' represents carrying capacity for a particular species in the given habitat. In nature, a given habitat has resources to support a certain number of individuals of a population, beyond which no further growth is possible. This limit is called nature's carrying capacity (*K*) for that species in that habitat.

(ii) The curve 'b' is considered to be more realistic growth model for most of the animal population because resources are limited in this type of growth curve. Whereas, in case of curve 'a', the resources (such as food, space, etc.) are unlimited.

(iii) The curve 'a' would depict the population of a species of deer in absence of predators in the habitat as the population increases exponentially. In absence of predators, the resources will be unlimited for the deer population and it can reach high population densities in a short time. This type of growth pattern of a population results in J-shaped curve.

68. Mycorrhiza is a mutualistic interaction between fungus and roots of higher plants. The root provides food and shelter to the fungus. The fungus helps the plant in solubilisation and absorption of minerals, water uptake and protection against pathogenic fungi.

The egret and grazing cattle in close association is an example of commensalism. Commensalism is the interaction in which one organism is benefitted and other organism is neither harmed nor benefitted. The egrets always forage close to where the cattle are grazing because the cattle, as they move, stir up and flush out insects from the vegetation that otherwise might be difficult for the egrets to find and catch.

69. Predators play important role in ecosystem. These are discussed as follows:

(i) Maintaining prey population : In nature, the population of predator is quite small as compared to that of the prey. The prey has high reproductive potential. If, for some time, the prey population is allowed to grow without predation, then it would grow beyond the carrying capacity of the environment. The predator keeps the population of the prey under check so that an equilibrium is maintained. Example, the prickly pear cactus introduced in Australia in the early 1920's caused havoc by spreading rapidly into millions of hectares of rangeland. Finally, the invasive cactus was brought under control only after a cactus-feeding predator (a moth) from its natural habitat was introduced into the country.

(ii) Maintaining species diversity : Predators also help in maintaining species diversity in a community, by reducing the intensity of competition among competing prey species. Example, in the rocky intertidal communities of the American Pacific Coast, the starfish *Pisaster* is an important predator.

When all the starfish were removed from an enclosed intertidal area, more than 10 species of invertebrates became extinct within a year because of interspecific competition.

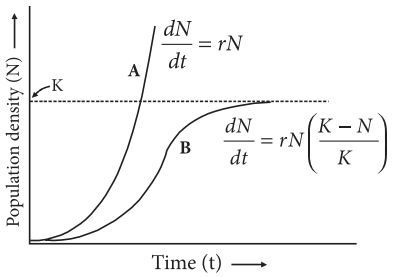
(iii) Vegetation : Predation helps in growth of vegetation all over the globe by restricting population of herbivores.

70. Parasitism is the interspecific interaction where one of species (called parasite) depends on the other species (host) for food and shelter and damages the host. *E.g.,* malarial parasite in blood cells of humans. Co-evolution in parasitism refers to the process in which parasite evolves mechanism to interact and neutralise the mechanism evolved by the host to reject or resist parasite.

71. (a) Two growth models of population growth are as follows :

(i) J-shaped curve showing exponential growth

(ii) S-shaped curve showing logistic growth



A exponential, **B** logistic.

(b) Difference in shape of curves is due to difference in amount of resources available.

(c) Human population growth represents logistic growth form. This curve is sustainable as resources are limited and environment cannot support population beyond carrying capacity.

72. Differences between mutualism, commensalism and parasitism are as follows:

	Mutualism	**Commensalism**	**Parasitism**
(i)	It is an association between two organisms in which both are benefitted.	It is an association between two organisms in which only one is benefitted. The second is neither benefitted nor harmed.	It is an interaction between two living organisms of different species in which one organism called parasite obtains its food from another living organism called host, *i.e.,* one is benefitted and other is harmed.
(ii)	Contact between the two organisms is obligatory.	Contact between commensal and its benefactor may be periodic or continuous.	Contact between host and parasite may be temporary or permanent.
(iii)	Nitrogen fixing blue-green alga or cyanobacterium called *Anabaena* is associated with water fern *Azolla* in a mutualistic interaction.	Many epiphytes, *e.g.,* orchids, are found growing on the branches and in the forks of trees. These epiphytes use the trees only for attachment and manufacture their own food by photosynthesis.	*E.g., Cuscuta* is a total stem parasite, malarial parasite can be intracellular (endoparasite), etc.

73. (a) There is ample food and space for the population depicted by the curve A. When the resources are unlimited, the curve is exponential. There is limited food and space for the population depicted by the curve B. When the resources are limiting, the curve becomes sigmoid.

(b) In the absence of predators, curve B would appropriately depict the prey population.

(c) The dotted line represents the carrying capacity of the environment. The carrying capacity represents the size of population that the environment can hold by providing necessary resources. When a population reaches this line its population size is stabilised by various environmental factors.

74. *For diagram refer to answer 45.*

Pyramid with broad base or triangular shape indicates a rapidly expanding population with a high percentage of pre-reproductive individuals followed by reproductive then post-reproductive individuals. Thus, in rapidly growing population, birth rate is high and population keeps growing.

75. (a) It is important to measure population size of habitat because it indicates that whether population is flourishing or declining.

(b) The percentage cover or biomass is a more meaningful measure of the population size in a forest area, where only a single huge banyan tree is accompanied by large number of *Parthenium* plants.

76. (a) Birth rate refers to per capita births, *i.e.,* average number of individuals produced per unit time. For example, if in a pond there were 20 lotus plants last year and through reproduction 8 new plants are added, then taking the current population to 28, we calculate the birth rate as 8/20 = 0.4 offspring per lotus per year.

(b) Other attributes of population which individuals cannot show include -

(i) Death rate - An individual dies but a population has death rate. It refers to per capita deaths, *i.e.,* average number of individuals that die per unit time. If 4 individuals in a laboratory population of 40 fruitflies died during a specified time interval (say a week), the death rate in the population during that period is 4/40 = 0.1 individuals per fruitfly per week.

(ii) Sex ratio - An individual has sex but a population has sex ratio, *i.e.,* number of females and males per 1000 individuals. *E.g.,* 60% of population are females and 40% are males.

77. (a) *Refer to answer 76 (b-i).*

(b) *Refer to answers 76 (a) and (b).*

78. The population growth of herbivores will have J-shaped curve, as population increases exponentially. In absence of predators, *i.e.,* carnivores, Exponential growth is represented by equation ; $\frac{dN}{dt} = rN$

N - Population density at time *t*

t - Time

r - Intrinsic rate of natural increase

79. (a) Population density means number of individuals present per unit area or per unit volume of the environment in which the population exists. We can find out population density of a habitat by determining the population size.

The different methods to study population size are as follows:

- Quadrat method : It is a method which involves the use of square of particular dimension to measure number of organisms. For example, the number of *Parthenium* plants in a given area can be measured using the quadrat method.
- Direct observation: It involves counting of organisms. For example, in order to determine the number of bacteria growing in a petri dish, their colonies are counted.
- Indirect method : The number of fishes caught per trap gives the measure of their total density in a given water body.

(b) Population has attributes that individual organisms do not. These include birth rate, death rate, sex ratio and age distribution. The proportion of different age groups of males and females in a population is often presented graphically as age pyramid; its shape indicates whether a population is stationary, growing or declining. Ecological effects of any factor on a population are generally reflected in its size (population density), which may be expressed in different ways (numbers, biomass, percent cover, etc.) depending on the species. The size of the population tells us a lot about its status. By studying the population of an organism, we can also know how population grows through births and immigration and declines through deaths and emigration.

80. Population interaction is the interaction among individuals of the same species or of different species, in which individual may get benefitted, harmed or remain unaffected.

Three population interactions are -

(i) Mutualism - It is an interaction between individuals of two different species where both are benefitted and none is capable of living separately. *E.g.,* association of *Rhizobium* bacterium with root nodules of leguminous plants for nitrogen fixation.

(ii) Commensalism - It is an interaction where two animals live together without any physiological dependence between them, where one gets benefit and other remains unaffected *e.g.,* close association between cattle egret and cattle.

(iii) Proto-cooperation - Two organisms are mutually benefitted by each other. But the association is non-obligatory. *E.g.* association between crocodile and bird. Crocodile bird enters the open mouth of crocodile and feeds on leeches present there and helps crocodile in getting rid of leeches.

81. (a) The birth rate (natality) of a population refers to the average number of young ones produced by birth, hatching or germination per unit time (usually per year). In the case of humans, it is commonly expressed as the number of births per 1,000 individuals in the population per year.

The death rate (mortality) of a population is the average number of individuals that die per unit time (usually per year). In humans, it is commonly expressed as the number of deaths per 1,000 persons in a population per year.

(b) Age pyramid is a model representing geometrically the proportion of different age groups in the population of any organism. It is a vertical bar graph in which the number or proportion of individuals in various age ranging at any given time is shown from youngest at the bottom of the graph to oldest at the top.

For diagram refer to answer 45.

82. (a) According to me as a biology student, population is defined as the total number of interbreeding individuals of a species found in a geographical area who share and compete for similar resources.

(b) The population density is the number of individuals of a species per unit area/space at a given time. The size of a population (population density) is not a static parameter. It keeps changing with time, depending upon a number of factors : abiotic and biotic, food availability, predation pressure, etc. The density of a population changes due to four basic processes:

(i) Natality : Number of births during a given period per unit population.

(ii) Mortality : Number of deaths in the population during a given period.

(iii) Immigration : Number of individuals of the same species moving inside a population during the time period.

(iv) Emigration : Number of individuals moving outside from a habitat during the time period.

Therefore, if N is the population density at time t, then its density at time t + 1 can be explained by the given equation :

$$N_{t+1} = N_t + [(B+I) - (D+E)]$$

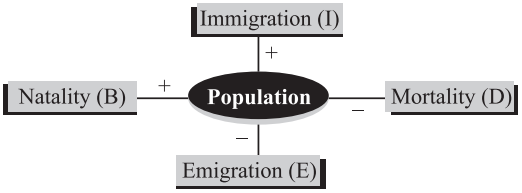
Where B represents natality or number of births;

I represents number of immigrants;

D represents mortality or number of deaths;

E represents number of emigrants.

From this equation, it is clear that population density increases if the number of births plus the number of immigrants (B + I) is more than the number of deaths plus the number of emigrants (D + E). Otherwise it will decrease.



83. (a) In the given equation, 1, 2, 3 and 4 respectively are B, I, D and E. Therefore, the equation will be

$$N_{t+1} = N_t + [(B + I) - (D + E)$$

(b) Population density is defined as number of individuals of a species per unit area or per unit volume of environment. Population density may be measured by :

(i) Numerical density calculated by number of individuals per unit area or volume. For example, if in a pond there were 20 lotus plants last year and through reproduction 8 new plants are added, taking the current population to 28, the birth rate will be calculated as 8/20 = 0.4 offspring per lotus per year.

(ii) Biomass density calculated as biomass per unit area or volume. For example, if in an area, there are 200 *Parthenium* plants but only a single huge banyan tree, then the percent cover or biomass is more meaningful measure of the population size.

(iii) Abundance or absolute number of population. For ecological investigations, population density is measured as absolute population densities or relative densities. For example the tiger census in our National parks and tiger reserves is often based on pug marks and fecal pellets.

84. (a) (i) Regulate : The organisms which can maintain a constant body temperature and constant osmotic concentration despite changes in the external environment are called regulators, such as human beings, birds, etc. They possess homeostasis mostly through thermoregulation and osmoregulation by physiological adjustments and rarely by behavioural changes. They have a wide range of distribution and are more active. For example, we maintain a constant body temperature of 37 °C. In summer, when outside

temperature is more than our body temperature, we sweat profusely. The resulting evaporative cooling, similar to what happens with a desert cooler in operation, brings down the body temperature. In winter when the temperature is much lower than 37 °C, we start to shiver, a kind of exercise which produces heat and raises the body temperature.

(ii) Conform : Some organisms conform to their external environment because they cannot maintain homeostasis internally, hence, they are called conformers. Their body temperature and osmotic concentration change according to their surroundings. They have a narrow range of distribution and consume lesser energy. *E.g.,* in aquatic animal *Asterias*, the osmotic concentration of body fluids changes according to the osmotic concentration of the surrounding water.

(iii) Migrate : Under unfavourable conditions, some organisms migrate to more favourable areas and return when the conditions are less hostile. The movement can be in search of food, climate, etc. Many animals, specially birds, migrate during winters to more favourable areas. *E.g.*, Arctic tern, Sea lamprey, etc. Every winter the Keoladeo National Park (Bharatpur) in Rajasthan receives thousands of migratory birds which comes from Siberia and other very cold northern regions.

(iv) Suspend : To tide over unfavourable conditions, some organisms suspend their metabolic activities. Bacteria, fungi and lower plants develop thick walled spores, which germinate during suitable conditions. Polar bears go into hibernation during winter season to escape cold. Some snails and fish undergo aestivation to avoid summer related problems like heat and dessication.

(b) Death rate is defined as the number of deaths per 1000 individuals of a population. Since, total number of butterflies = 80,

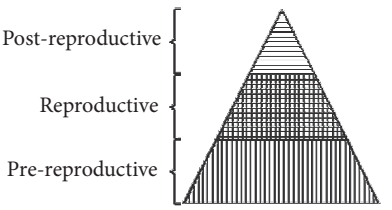
Number of butterflies that died = 8

$$\text{Death rate} = \frac{8}{80} = 0.1 \text{ butterflies per week}$$

85. (a) *Refer to answer 81 (b).*

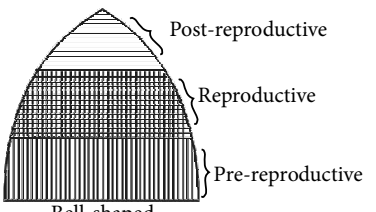
(b) There are three basic types of age pyramids :

(i) Triangular Age Pyramid : Pyramid with broad base or triangular structure indicates a rapidly expanding population with a high percentage of pre-reproductive individuals. Number of reproductive individuals is moderate while post-reproductive individuals are fewer. It can be shown as:



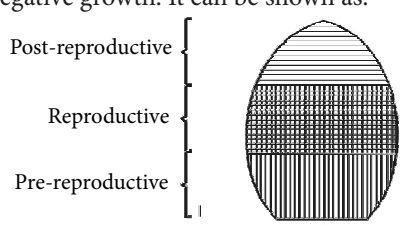
Triangular
(Expanding population)

(ii) Bell-Shaped Age Pyramid: The number of pre-reproductive and reproductive individuals is almost equal. Post-reproductive individuals are comparatively fewer. The population size remains stable, neither growing nor diminishing.



Bell-shaped
(Stable population)

(iii) Urn-shaped Age Pyramid : Proportion of reproductive age group is higher than the individuals in pre-reproductive age group. Number of post-reproductive individuals is also sizeable. It is declining or diminishing population with negative growth. It can be shown as:



Urn-shaped
(Declining population)

86. (a) The comparison between J-shaped or exponential growth and S-shaped or logistic growth model is as follows :

	Exponential or J-shaped growth	**Logistic or S-shaped growth**
(i)	It occurs when the resources are abundant.	It occurs when the resources are limited.
(ii)	Population passes well beyond the carrying capacity of the ecosystem.	Population seldom grows beyond the carrying capacity of ecosystem.

(iii)	A stationary or steady phase is seldom achieved.	A stationary or steady phase is reached.
(iv)	Population crashed ultimately due to mass mortality.	Population seldom crashes.
(v)	It has two phases, lag and log.	It has four phases—lag, log, deceleration and steady.
(vi)	It occurs in fewer organisms, *e.g.*, lemmings, algal bloom.	It is more common, *e.g.*, members of wildlife.

(b) The fitness, according to Darwin, refers ultimately and only to reproductive fitness. Hence, those who are better fit in an environment, leave more progeny than others. These, therefore, will survive more and hence are selected by nature. He called it natural selection and implied it as a mechanism of evolution.

87. (a) *Refer to answer 85 (b).*

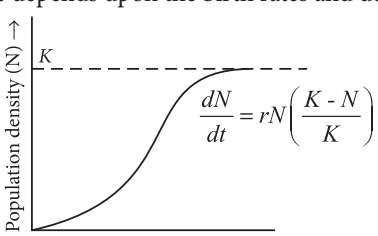
(b) Age pyramid is a graphic representation of different age groups in a population with pre-reproductive groups at base, reproductive ones in middle and post-reproductive groups at the top. Age pyramid helps policy makers in planning for future as it determines whether the population is expanding, stable or declining.

88. (a) *Refer to answers 76 and 79 (b).*

(b) *Refer to answer 83 (b).*

89. (a) The equation $\frac{dN}{dt} = rN$, represents exponential growth form. 'r' represents intrinsic rate of natural increase. It is a very important parameter chosen for assessing impacts of any biotic or abiotic factor on population growth. Its value depends upon the birth rates and death rates.

(b)



Logistic growth curve

In nature, a given habitat has resources to support a certain number of individuals of a population, beyond which no further growth is possible. This limit is called nature's carrying capacity (*K*) for that species in that habitat.

90. (a) The given equation is used to calculate population density at time "t + 1".

$$N_{t+1} = N_t + [(B + I) - (D + E)$$

where, N_t is population density at time t. Population size is determined by birth rate, death rate, immigration and emigration. Population density increases if number of births plus number of immigrants is more than number of deaths plus number of emigrants.

(b) *Refer to answer 83 (b).*

91. (i) (a) = Amensalism
(b) = Parasitism
(c) = Competition
(d) = Mutualism
(e) = Commensalism

(ii) (a) Amensalism is an association between organisms of different species that is detrimental to one of the species but has no effect on the other. A common example of amensalism is the release of chemical toxins by plants that can inhibit the growth of the other plant species (allelopathy).

(b) Parasitism is an association between organisms of different species in which one organism (the parasite) lives on or in the body of another organism (host), from which it obtains its nutrients. It is one sided relationship in which parasite is benefitted and host is harmed.

(c) Competition is a rivalry between two or more organisms for obtaining the same resources. It may be between individuals of same species (intraspecific) or of different species (interspecific).

(d) Mutualism is an interaction between two organisms of different species where both the partners are benefitted and the association is obligatory to both *e.g.,* lichen, mycorrhiza, etc.

(e) Commensalism is the interaction between two individuals of different species in which one is benefitted while the other remains unaffected, *e.g.,* association between shark and sucker fish.