Organisms & Populations

1. Explain how it is ensured that the orchid Ophrys is pollinated by a specific species of bee. (2024)

Ans.

- Orchid Ophrys employs 'Sexual Deceit'to get pollinated by a species of bee

- one petal of flower resembles female of bee in size, colour and markings

- Male bee attracted and pseudocopulates the flower and gets dusted with pollens.

- When same bee 'pseudocopulates' with other flower, it transfers the pollens to it.

2. Describe co-evolution with the help of this example. (2024)

Ans. If female bee pattern changes during evolution the flower needs to co-evolve to resemble the female bee to get pollinated.

Previous Years' CBSE Board Questions

11.1 Populations

MCQ

Population: Attributes and Growth

1. Important attributes belonging to a population but not to an individual are

(i) birth rate and death rate

(ii) male and female

(iii) birth and death

(iv) sex-ratio.

Select the correct option from the given options.

(a) (i) only

(b) (ii) only

(c) (ii) and (iii)

(d) (i) and (iv)

(2023)

VSA (1 mark)

2. Construct an age pyramid which reflects an expanding growth status of human population.

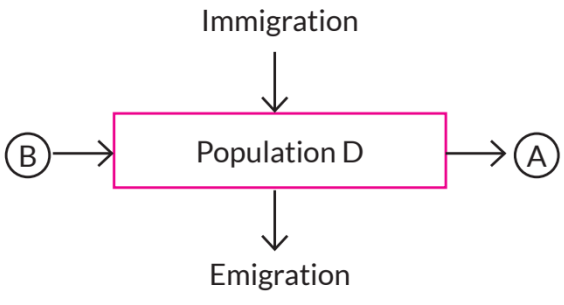
(Al 2014)

SA I (2 marks)

3. List and explain any two factors that lead to a decrease in the population density of an area. **(2023)**

4. As per a recent newspaper report, a particular country showed declining population growth rate. According to you, what could be the two most possible reasons for this decline and why? **(Term II, 2021-22)**

5.

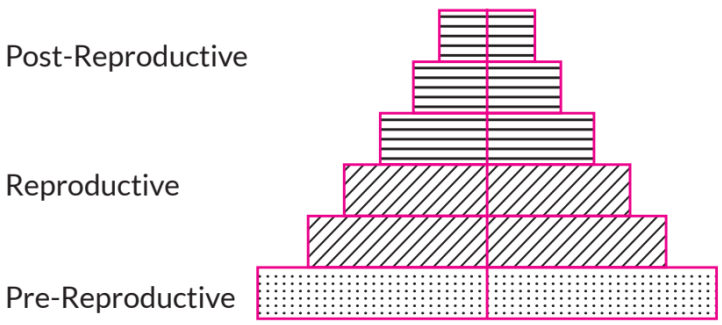


Observe the schematic representation given above and answer the following questions:

(i) Identify A and B.

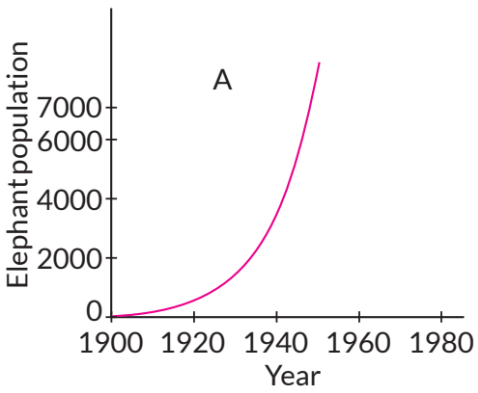
(ii) Calculate the growth rate of bacteria in a curd sample, where 1 million bacteria increased to two million, within a period of one hour.
(Term II, 2021-22)

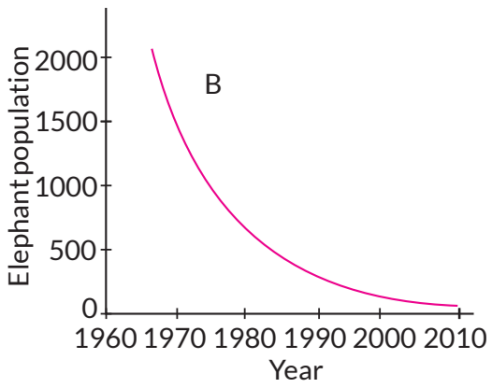
6.



Identify the type of pyramid given above. Write the identifying feature on the basis of which you identified it.
(Term II, 2021-22)

7. The graph given below, A and B, represent population of elephants in two different National Parks (a hypothetical situation) at different times.





Study the graphs and comment upon the pattern of growth observed. Mention the possible reason for such patterns seen in nature.

(Term II, 2021-22)

8. What would be the best method to measure the total population density of the number of fishes in river and why?

(Term II, 2021-22)

9. (a) How will you measure population density of fish in a lake?

(b) In a pond, there are 100 frogs. 20 more were born in a year. Calculate the birth rate of this population.

(2019)

10. If 8 individuals in a population of 80 butterflies die in a week, calculate the death rate of population of butterflies during that period.

(2/5, 2018)

11. Construct an age pyramid which reflects a stable growth status of human population.

(Delhi 2014)

12. Explain Verhulst-Pearl logistic growth of a population.

(Foreign 2014)

SA II (3 marks)

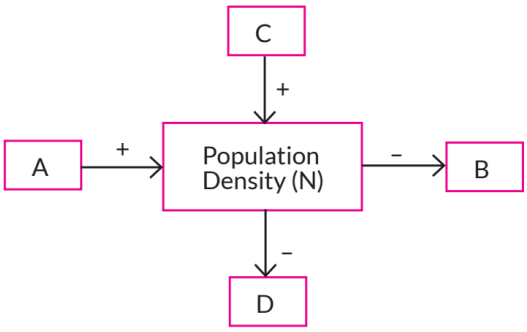
13. The population of a metro city experiences fluctuations in its population density over a period of time.

(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)

14.



Study the schematic representation given above and answer the following questions.

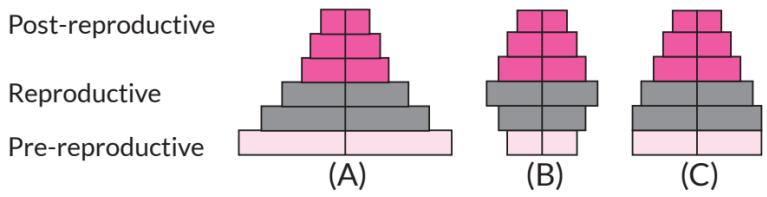
(a) Identify A in it.

(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)

15. Study the age pyramids 'A', 'B' and 'C' of the human population given below and answer the questions that follow:

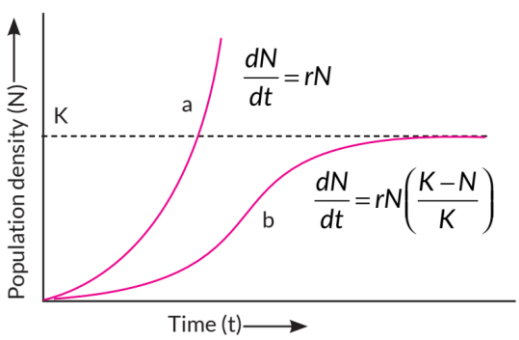


(a) Identify pyramids 'B' and 'C'.

(b) Write the basis on which the above pyramids are plotted.

(2020)

16. Study the graph given below showing the different types of growth curves of different species.



Answer the questions:

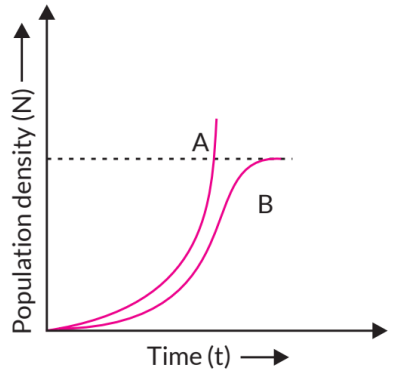
(a) Name the type of growth curve 'a' shown in the graph.

(b) State one reason why the growth curve 'b' is said to be logistic.

(c) What is 'K' representing in the equation $\frac{dN}{dt} = rN\left[\frac{K-N}{K}\right]$ given along the logistic curve.

(2020C)

17. 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)

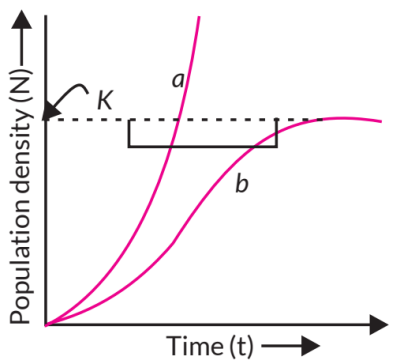
18. Differentiate between an 'Expanding age pyramid' and a 'Stable age pyramid'. Substantiate your answer with diagrams.
(2019)

19. (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)

20. Study the graph given below and answer the questions that follow. 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)

(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)

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

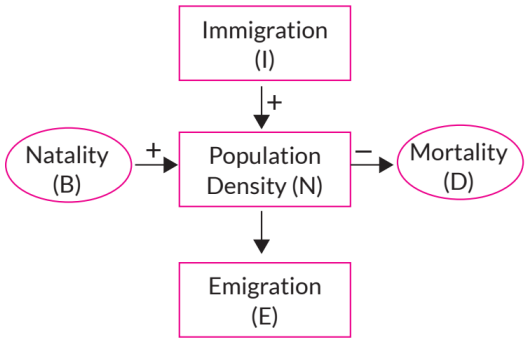
LA (5 marks)

22. (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)

23. (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.

24. (a) What is an age-pyramid?
(AI 2019)

(b) Name three representative kinds of age-pyramids for human population and list the characteristics for each one of them.
(Delhi 2017)

25. (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)

26. (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)

27. (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)

28. (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)

Population Interactions

MCQ

29. Assertion (A): The Monarch butterfly is highly distasteful to the predators.

Reason (R): The butterfly has a very rough skin which is not palatable.

(a) Both (A) and (R) are true and (R) is the correct explanation of (A).

(b) Both (A) and (R) are true and (R) is not the correct explanation of (A).

(c) (A) is true, but (R) is false.

(d) (A) is false, but (R) is true.
(2023)

30. A tight one-to-one relationship between many species of fig tree and certain wasps is an example of _____.

(a) commensalism (b) parasitism

(c) amensalism (d) mutualism.

(2023)

31. Read the following passage and answer any four questions from 31(i) to 31(v).

Acacia plants are particularly common in drier tropical and subtropical environments in the world. The swollen thorn acacias, which form obligate mutualisms with Pseudomyrmex, a species of ants, are restricted to the New World. Swollen thorn acacias show several characteristics related to their obligate association with ants, including enlarged thorns with a soft, easily excavated pith; year-round leaf production; enlarged foliar nectaries; and leaflet tips modified into concentrated food sources called Beltian bodies. The thorns provide living space, while the foliar nectaries provide a source of sugar and liquid. Beltian bodies are a source of oils and protein. Resident ants vigorously guard these resources against encroachment by nearly all comers, including other plants.

(i) The association between the genus of Acacia and Pseudomyrmex species of ants depict population interactions, known as

(a) Competition (b) Amensalism

(c) Mutualism (d) Predation.

(ii) In exchange for food and shelter, ants protect Acacias from the attacks of

(a) fungi (b) bacteria

(c) herbivore (d) carnivores.

(iii) The above interaction suggests that the relationship between the two species is an example of

(a) Competitive release (b) Competitive exclusion

(c) Co-evolution (d) Resource partitioning.

(iv) The removal of resident ants from the Acacias will lead to

I. Reduced growth of Acacias

II Increased growth of Acacias

III. Reduced population of ant species

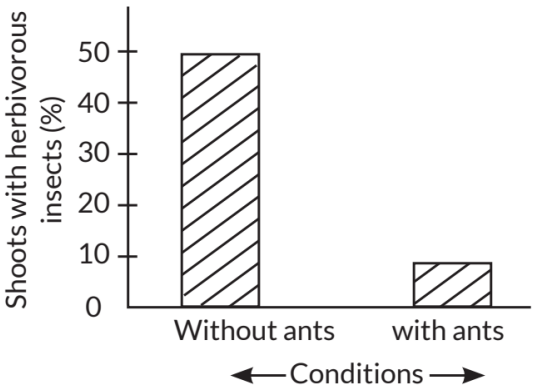
IV. Increased population of ant species.

Choose the correct alternative from the above statements.

(a) Only I is true. (b) I and III are true.

(c) III and IV are true. (d) I and IV are true.

(v) Given below is a graphical representation of ants and the Acacia shoots with abundance of herbivorous insects:



The conclusion drawn from the above data is

(a) Acacia shoots will have higher rates of growth with resident ant species.

(b) Acacia shoots will have neutral effect on growth with or without resident ants species.

(c) Acacia shoots will have higher rates of growth without resident ant species.

(d) Growth of Acacia shoots is independent of resident ant species.
(2021 C)

VSA (1 mark)

32. Why do cattle and goats generally not browse on Calotropis plants growing an abandoned field? Give any one reason.
(2021 C)

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

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

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

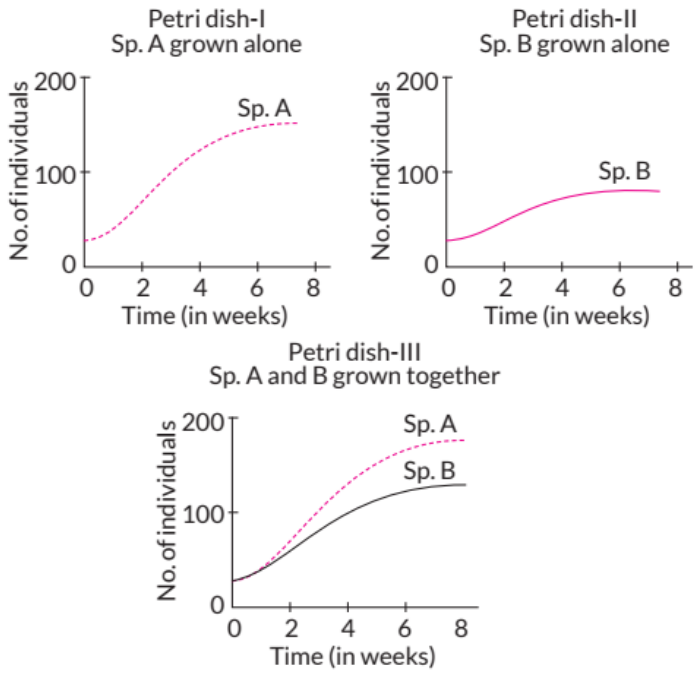
36. Name the type of association that the genus Glomus exhibits with higher plants. **(AI 2014)**

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

SA I (2 marks)

38. "Cattle and goats do not browse the Calotropis plant." Justify the statement giving reasons. **(2023)**

39. The figure given below show the results of a lab experiment in which two microbial species A and B belonging to same genus were grown in three petri dishes having same culture medium. In Petri dish-l, Species-A was grown alone for 8 weeks. In Petri dish-II, Species-B was grown alone for 8 weeks. In Petri dish-III, both the species were grown together with the same number as Petri dish-I and Petri dish-Il for 8 weeks.



What conclusion will you draw from the graphs in terms of impact of interaction on growth? Explain, giving reason.
(Term II, 2021-22)

40. (i) Write the observations made at the end of Connell's field experiment on barnacles on the rocky sea coasts of Scotland.

(ii) Name any two categories of organisms that in general are adversely affected by competition. **(Term II, 2021-22)**

41. Explain the pollination mechanism involved in co-evolution of the two species, namely Ophrys (orchid) and its insect pollinator bees (and bumble bees). **(Term II, 2021-22C)**

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

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

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

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

SA II (3 marks)

46. Explain the following population interactions with the help of one example each :

(a) Brood parasitism

(b) Co-evolution of mutualists
(2023)

47. (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)

48. Mention the special adaptations evolved in parasites and why? **(NCERT Exemplar, Delhi 2019)**

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

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

CBSE Sample Questions

11.1 Populations

MCQ

1. Swathi was growing a bacterial colony in a culture flask under ideal laboratory conditions where the resources are replenished. Which of the following equations will represent the growth in this case?

(Where population size is N, birth rate is b, death rate is d, unit time period is t, and carrying capacity is K).

(a) $dN/dt = KN$

(b) $dN/dt = r\ N$

(c) $dN/dt = r\ N(K\text{-}N/K)$

(d) $dN/dt = r\ N(K+N/K)$

(2022-23)

2. Sea anemone gets attached to the surface of the hermit crab. The kind of population interaction exhibited in this case is

(a) amensalism

(b) commensalism

(c) mutualism

(d) parasitism.

(2022-23)

3. Given is the age pyramid of population in one of the states in India as per 2011 census. It depicts the male population on the left-hand side, female population on the right-hand side, newborns towards the base and gradually increasing age groups as we move from base to the top, with the oldest population at the top. Study this pyramid and comment upon the appropriateness of the Assertion and the Reason.

Assertion (A): It is a stable population.

Reason (R): The pre-reproductive and reproductive individuals are almost in equal numbers and the post-reproductive individuals are relatively fewer.

(a) Both (A) and (R) are true and (R) is the correct explanation of (A).

(b) Both (A) and (R) are true and (R) is not the correct explanation of (A).

(c) (A) is true but (R) is false.

(d) (A) is false but (R) is true.

(2022-23)

SA I (2 marks)

4. An ecologist study an area with population A, thriving on unlimited resources and showing exponential growth, introduced population B and C to the same area. What will be the effect on the growth pattern of the population A, B and C when living together in the same habitat?

(Term II, 2021-22)

5. With the decline in the population of fig species it was noticed that the population of wasp species also started to decline. What is the relationship between the two and what could be the possible reason for decline of wasps?
(Term II, 2021-22)

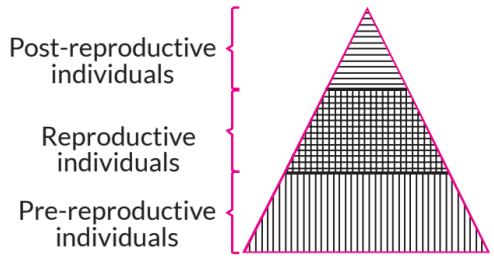
6. Define interference competition. Give one example that supports competitive exclusion occurring in nature.
(2020-21)

Detailed SOLUTIONS

Previous Years' CBSE Board Questions

1. (d) : Population has several characteristics or attributes which are a function of the whole group and not of an individual. Birth and death are attributes of individual whereas birth rate and death rate are attributes of population. Same as, sex (male and female) is attribute of individual but sex ratio (a ratio of male and female in a population) is an attribute of population.

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



3. Mortality and emigration are two factors that lead to decrease in the population density of an area. Mortality is the number of deaths in the population during a given period. Emigration is the number of individuals of the population who left the habitat and gone elsewhere during the time period under consideration.

4. There can be two most possible reasons for a country to show declining population growth rate:

(i) More death rate or mortality than birth rate or natality.

(ii) Emigration, i.e., number of individuals of the population who left the habitat and gone elsewhere during the time period under consideration exceeds immigration, i.e., number of individuals of the same species that have come into the habitat from elsewhere.

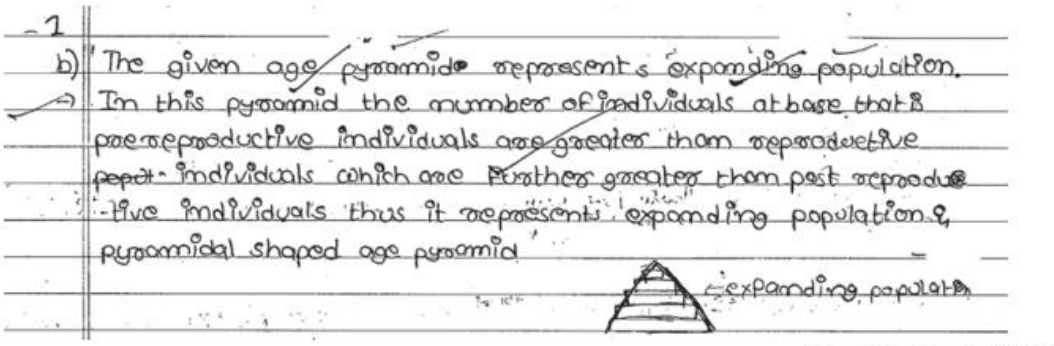
Hence, the population decreases when there is a greater number of deaths plus the number of emigrants (D + E) than the number of births plus the number of immigrants (B + I).

5. (i) A represents mortality and B represents natality.

(ii) $$\text{Growth rate} = \frac{\text{Number of individuals added}}{\text{Total population}}$$

$$= \frac{1\text{ million}}{2\text{ million}} = 0.5 \text{million per hour}$$

6.



[Topper's Answer, 2022]

7. The graph A represents the exponential or geometric growth pattern of the elephant population. In this National Park, the elephants are provided unlimited resources (food and space) in the habitat and hence, they reached enormous numbers in absence of checks. The graph B represents a declining curve where the number of elephants is decreasing from 1970 to 2010. There could be many reasons behind such graph like: lack of nutrient resources, competition, fragmentation, urbanisation, poaching, etc. The surge in poaching for Lvory that began around 1970s and 1980s has been the main reason of the decline, while habitat loss due to fragmentation and urbanisation poses an increasingly serious, long-term threat to the species.

8. The best method to measure the total population density of the member of fishes in river is to count the number of fishes caught per trap. This is an indirect method of counting the population density, known as relative density. This method is adopted when there is large population of fish in a river and counting is almost impossible.

9. (a) Population density of a fish in a lake can be measured by the number of fish per trap in the lake.

(b) In a pond,

Total number of frogs = 100

Number of frogs born in a year = 20

Birth rate = 20/100 = 0.2 offspring of frog per year

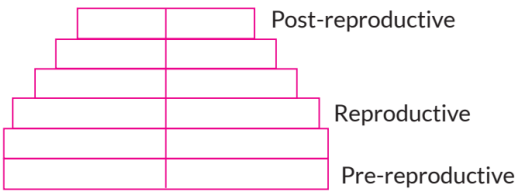
10. Death rate is defined as the number of deaths per 1000 individuals of a population.

Since, total number of butterflies = 80,

Number of butterflies that died = 80

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

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



12. 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.

13. (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 and E = Emigration.

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

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

(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 and E = Emigration.

15. (a) The given pyramids 'B' and 'C' respectively represent urn-shaped age pyramid with declining population and bell-shaped age pyramid with stable population.

(b) The graphical representation called, age-pyramids are plotted on the basis of individuals present in a population under the categories: Number of individuals of pre-reproductive age at base, reproductive in middle and post-reproductive age at top.

16. (a) 'a' is showing exponential population growth curve.

(b) Growth curve 'b' i.e., the logistic growth curve (S-shaped curve) occurs when resources are limited. The logistic growth curve is the more realistic one because the resources for growth for most animal populations are finite and become limiting sooner or later.

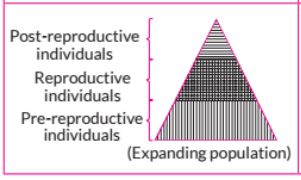
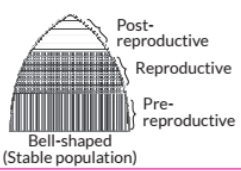
(c) K is carrying capacity which represents the size of population that the environment can hold by providing necessary resources.

17. (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 the 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.

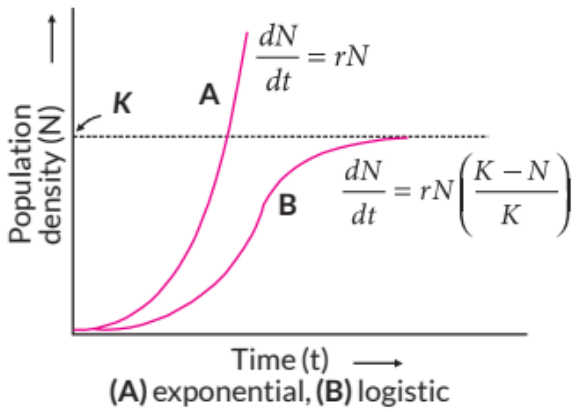
18.

Expanding age pyramid	Stable age pyramid
This type of graph has a triangular shape.	This type of graph has a bell shape.
High percentage of pre reproductive individuals, moderate number of reproductive individuals and few number of post reproductive individuals.	The number of pre- reproductive and reproductive individuals is almost equal. Post reproductive individuals are comparatively fewer.
 (Expanding population)	 Bell-shaped (Stable population)

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

(i) J-shaped curve showing exponential growth

(ii) S-shaped curve showing logistic growth



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

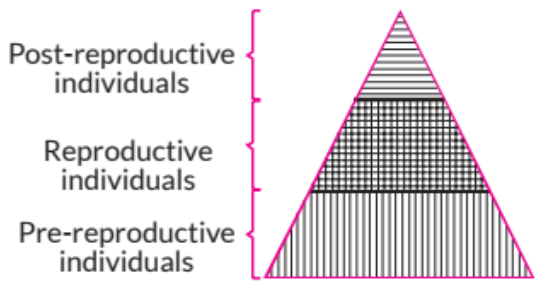
(c) Human population growth represents logistic growth form. This curve is sustainable as resources are limited and environment cannot support population beyond carrying capacity.

20. (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 (i.e., represented by 'K') 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.

21. An age pyramid for expanding human population isas follows:



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.

22. (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:

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

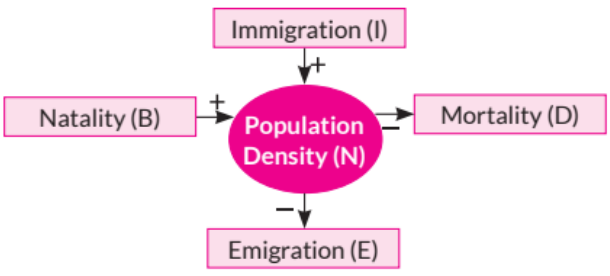
Where B represents natality or number of births;

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.



23. (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.

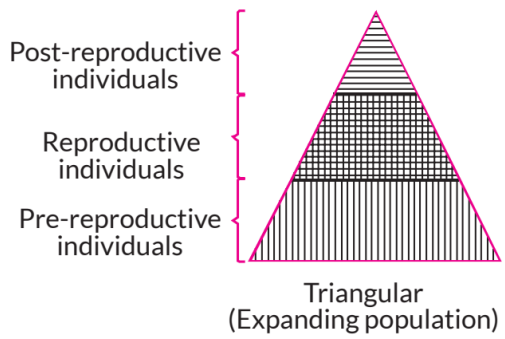
(ii) Biomass density calculated as biomass per unit area or volume. For example, if in an area, there are 200 Parthenium plants but only a single huge banyan tree, then the percent cover or biomass is more meaningful measure of the population size.

(iii) 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.

24. (a) 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.

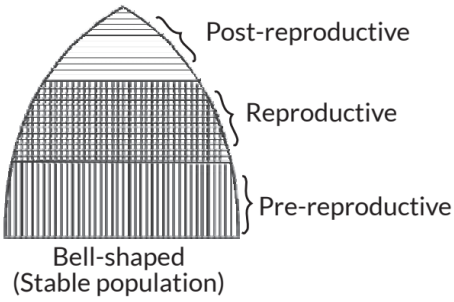
(b) There are three basic types of age pyramids :

(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:



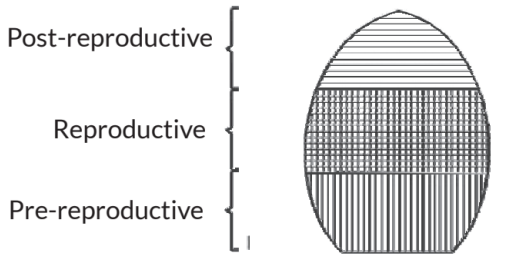
Triangular
(Expanding population)

(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 prereproductive 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)

25. (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 blooms.	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. Therefore, they will survive more and hence are selected by nature. He called it natural selection and implied it as a mechanism of evolution.

26. (a) Refer to Answer 24 (b).

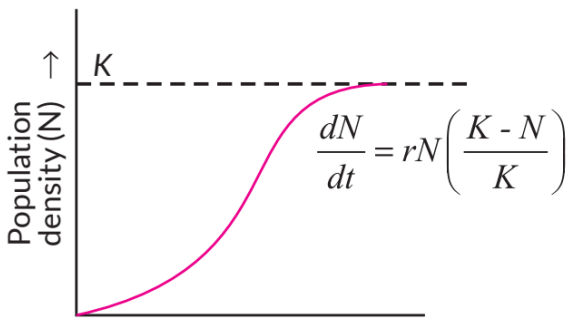
(b) Age pyramid is a graphic representation of different age groups in a population with pre-reproductive groups at base, reproductive ones in middle and post-reproductive groups at the top. Age pyramid helps policy makers in planning for future as it determines whether the population is expanding, stable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

27. (a) 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.

(b) Refer to Answer 23 (b).

28. (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 the species in that habitat.

29. (c): The Monarch butterfly is highly distasteful to its predator because of a special chemical present in its body.

30. (d): Female wasp and fig species shows example of mutualism. There is a tight one-to-one relationship with the pollinator species wasp and fig species. Fig can be pollinated only by wasp species.

31. (i) (c): The association between the genus of Acacia and Pseudomyrmex species of ants depict an example of mutualism.

(ii) (c): In exchange for food and shelter, ants protect Acacia from attack plant eating animals i.e., of herbivores.

(iii) (c)

(iv) (b): The removal of resident ants from the Acacia will lead to reduced growth of Acacia and reduced population of ant species.

(v) (a): The conclusion drawn from the given data is higher growth rate of Acacia shoots in the presence of resident ant species while lower growth rate of Acacia shoots in the absence of ant species.

32. Calotropis plant produces highly poisonous glycosides as defence. Thus, cattle and goats do not browse on Calotropis plant growing in abandoned fields.

33. Parasitism

34. Mutualism

35. 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.

36. 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.

37. 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.

38. The weed Calotropis produces highly poisonous cardiac glycosides which act as defences against browsers and grazers. Cardiac glycosides make the grazers

such as cattle and goat sick while browsing, inhibit digestion, disrupt its reproduction or even kill. Thus, cattle and goats do not browse on Calotropis plant.

39. The given graph shows that species A and B are mutualists. Mutualism is an interaction between two organisms of different species where both the interacting species are benefitted from each other. Species A when grown alone in petridish I showed less number of individuals, however, its population increased when grown along with species B in peteridish III. Similar observations were made for species B. Hence, it can be concluded that they exhibit mutualism.

40. (i) At the end of Connell's field experiment on barnacles, it was observed that the larger and competitively superior barnacle Balanus dominates the intertidal area, and excludes the smaller barnacle Chthamalus from that zone. It is an example of competition.

(ii) The two categories of organisms that are adversely affected by competition are herbivores and plants.

41. The Mediterranean orchid, Ophrys employs 'sexual deceit' to get pollination done by a species of bee. One petal of its flower bears an uncanny resemblance to the female of the bee in size, colour and markings. The male bee pseudocopulates with the flower and thereby pollinates the flower.

42. 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.

43. 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.

44. 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.

Common characteristic: 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.

45. 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.

46. (a) Brood parasitism: Brood parasitism in birds is an example of parasitism in which the parasitic bird lays its eggs in the nest of its host and lets the host incubate them. During the course of evolution, the eggs of the parasitic bird have evolved to resemble the host's egg in size and colour to reduce the chances of the host bird detecting the foreign eggs and ejecting them from the nest. Example : Cuckoo laying eggs in crow's nest.

(b) Co-evolution of mutualists: Mutualism is an interaction between two organisms of different species where both the partners are benefitted with none of the two capable of living separately. Plant-animal interactions often involve co-evolution of the mutualists, that is, the evolutions of the flower and its pollinator species are tightly linked with one another.

For example, in many species of fig trees, there is a tight one-to-one relationship with the pollinator species of wasp. It means that a given fig species can be pollinated only by its 'partner' wasp species and no other species. The female wasp uses the fruit not only as an oviposition (egg-laying) site but 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 for the favour of pollination the fig offers the wasp some of its developing seeds, as food for the developing wasp larvae.

47. (a) Parasitism is a negative interaction where in parasite depends on its host organism partially or completely for survival and perpetuation. 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.

48. Refer to Answer 47 (a).

49. 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.

50. Parasitism is the interspecific interaction where one of species (called parasite) depends on the other species (host) for food and shelter and also harm the host by reducing its survival, growth and reproduction. E.g., malarial parasite

in blood cells of humans. Co-evolution is used to describe cases where two or more species reciprocally affect each other's evolution and do not survive in each other's absence. E.g., Many species of fig trees have mutual relationship with the pollinators species of wasp.

CBSE Sample Questions

1. (b) : Under ideal conditions, when resources are unlimited, population shows exponential growth which is expressed as $\frac{dN}{dt} = rN$.

2. (b)

3. (a): The given diagram shows bell-shaped age pyramid, where population size remains stable i.e., neither growing nor diminishing.

4. Introduction of population B and C into same area as of population A will lead to competition between the individuals of population A, B and C for resources. The resources for growth will become finite and limiting, and population growth will become realistic. Eventually, the 'fittest' individuals will survive and reproduce.

5. The relationship between the plant and pollinator is called mutualism.

Fig depends on wasp for pollination, and wasp depends on fig for food and shelter. With the decline in population of figs, wasp loses its source of food and shelter.

6. Interference competition is the feeding efficiency of one species which might be reduced due to the interfering and inhibitory presence of the other species, even if resources (food and space) are abundant.

Examples that support competitive exclusion occurring in nature are:

(i) The abingdon tortoise became extinct within a decade after goats were introduced on the island, apparently due to the greater browsing efficiency of the goats.

(ii) The larger and competitively superior barnacle Balanus dominates the intertidal area and excludes the smaller barnacle Chthamalus from that zone.