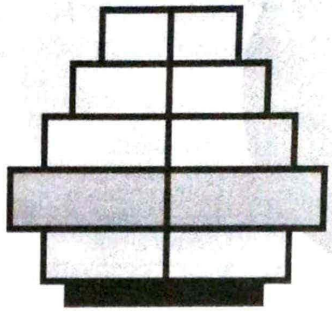
CHAPTER

11 Organisms and Populations



11.1. Populations

1. When will the population density increase, under special conditions?

When the number of:

(A) deaths exceeds number of births and also number of emigrants equals number of immigrants,

(B) births plus number of immigrants equals number of deaths plus number of emigrants.

(C) births plus number of emigrants is more than the number of deaths plus number of immigrants.

(D) births plus number of immigrants is more than the sum of number of deaths and number of emigrants.

[Re-NEET 2024]

2. Match List-I with List-II:

List-I	List-II
(a) Predator	(i) *Ophrys*
(b) Mutualism	(ii) *Pisaster*
(c) Parasitism	(iii) Female wasp and fig
(d) Sexual deceit	(iv) *Plasmodium*

Choose the correct answer from the options given below:

	(a)	(b)	(c)	(d)
(A)	(iii)	(ii)	(i)	(iv)
(B)	(iv)	(i)	(ii)	(iii)
(C)	(ii)	(iii)	(i)	(iv)
(D)	(ii)	(iii)	(iv)	(i)

[Re-NEET 2024]

3. Match List-I with List-II:

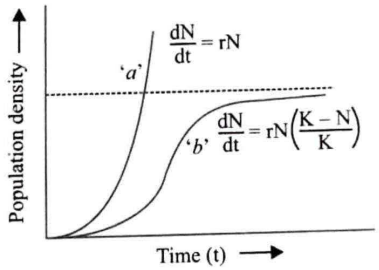
List-I	List-II
(a) Migratory flamingoes and resident fish in South American lakes	(i) Interference competition
(b) Abingdon tortoise became extinct after introduction of goats in their habitat	(ii) Competitive release
(c) *Chathamalus* expands its distributional range in the absence of *Balanus*	(iii)Resource Partitioning
(d) Five closely related species of Warblers feeding in different locations on same tree	(iv)Interspecific competition

Choose the correct answer from the options given below:

	(a)	(b)	(c)	(d)
(A)	(i)	(iv)	(iii)	(ii)
(B)	(iv)	(i)	(ii)	(iii)
(C)	(iii)	(i)	(ii)	(iv)
(D)	(ii)	(iv)	(iii)	(i)

[Re-NEET 2024]

4. What do '*a*' and '*b*' represent in the following population growth curve?



(A) '*a*' represents exponential growth when responses are not limiting the growth and '*b*' represents logistic growth when responses are limiting the growth.

(B) '*a*' represents logistic growth when responses are not limiting the growth '*b*' represents exponential growth when responses are limiting the growth.

(C) '*a*' represents carrying capacity and '*b*' shows logistic growth when responses are limiting the growth.

(D) '*a*' represents exponential growth when responses are not limiting the growth and '*b*' shows carrying capacity.

[Re-NEET 2024]

5. The equation of Verhulst-Pearl logistic growth $\frac{dN}{dt} = rN\left[\frac{K-N}{K}\right]$.

From this equation, K indicates:

(A) Biotic potential

(B) Carrying capacity

(C) Population density

(D) Intrinsic rate of natural increase **[NEET 2024]**

6. Match List I with List II:

List I (Interaction)	List II (Species A and B)
(a) Mutualism	(i) +(A), 0(B)
(b) Commensalism	(ii) –(A), 0(B)
(c) Amensalism	(iii) +(A), –(B)
(d) Parasitism	(iv) +(A), +(B)

Choose the correct answer from the options given below:

	(a)	(b)	(c)	(d)
(A)	(iv)	(iii)	(i)	(ii)
(B)	(iii)	(i)	(iv)	(ii)
(C)	(iv)	(ii)	(i)	(iii)
(D)	(iv)	(i)	(ii)	(iii)

[NEET 2023]

7. Match List I with List II.

List I (Interacting species)	List II (Name of interaction)
(a) A Leopard and a Lion in a forest/grassland	(i) Competition
(b) A Cuckoo laying egg in a Crow's nest	(ii) Brood parasitism
(c) Fungi and root of a higher plant in Mycorrhizae	(iii) Mutualism
(d) A cattle egret and a cattle in a field	(iv) Commensalism

Choose the correct answer from the options given below.

	(a)	(b)	(c)	(d)
(A)	(ii)	(iv)	(i)	(ii)
(B)	(ii)	(iii)	(i)	(iv)
(C)	(i)	(ii)	(iii)	(iv)
(D)	(i)	(ii)	(iv)	(iii)

[NEET 2023]

8. Match List I with List II.

List I	List II
(a) Logistic growth	(i) Unlimited resource availability condition.
(b) Exponential growth	(ii) Limited resource availability condition.
(c) Expanding age pyramid	(iii) The percent individuals of pre-reproductive age is largest followed by reproductive and post reproductive age groups.
(d) Stable age pyramid	(iv) The percent individuals of pre-reproductives and reproductive age group are same.

Choose the correct answer from the options given below:

	(a)	(b)	(c)	(d)
(A)	(ii)	(iv)	(i)	(iii)
(B)	(ii)	(iv)	(iii)	(i)
(C)	(ii)	(i)	(iii)	(iv)
(D)	(ii)	(iii)	(i)	(iv)

[NEET 2023]

9. Given below are two statements:

Statement I: Gause's 'Competitive Exclusion Principle' states that two closely related species competing for the same resources cannot co-exist indefinitely and competitively inferior one will be eliminated eventually.

Statement II: In general, carnivores are more adversely affected by competition than herbivores.

In the light of the above statements, choose the correct answer from the given options:

(A) Statement I is correct Statement II is false.

(B) Statement I is incorrect but Statement II is true.

(C) Both Statement I and Statement II are true.

(D) Both Statement I and Statement II are false.

[NEET 2023]

10. Which one of the following statements cannot be connected to predation?

(A) It might lead to extinction of a species.

(B) Both the interacting species are negatively impacted.

(C) It is necessitated by nature to maintain the ecological balance.

(D) It helps in maintaining species diversity in a community.

[NEET 2022]

11. While explaining interspecific interaction of population, (+) sign is assigned for beneficial interaction, (–) sign is assigned for detrimental interaction and (0) for neutral interaction. Which of the following interactions can be assigned (+) for one species and (–) for another species involved in the interaction?

(A) Amensalism (B) Commensalism

(C) Competition (D) Predation **[NEET 2022]**

12. If '8' *Drosophila* in a laboratory population of '80' died during a week, the death rate in the population is individuals per *Drosophila* per week.

(A) 10 (B) 1.0

(C) zero (D) 0.1 **[NEET 2022]**

13. Amensalism can be represented as:

(A) Species A(–) ; Species B (0)

(B) Species A (+) ; Species B (+)

(C) Species A (–) ; Species B (–)

(D) Species A (+) ; Species B (+). **[NEET 2021]**

14. In the exponential growth equation $N_t = N_0e^{rt}$, e represents:
(A) The base of number logarithms
(B) The base of exponential logarithms
(C) The base of natural logarithms
(D) The base of geometric logarithms **[NEET 2021]**

15. The impact of immigration on population density is:
(A) negative
(B) both positive and negative
(C) neutralised by natality
(D) positive. **[NEET Oct. 2020]**

16. Match the items in Column I with those in Column II.

Column I	Column II
(a) Herbivores plants	(i) Commensalism
(b) Mycorrhiza plants	(ii) Mutualism
(c) Sheep cattle	(iii) Predation
(d) Orchid tree	(iv) Competition

Select the correct option.

	(a)	(b)	(c)	(d)
(A)	(iv)	(ii)	(i)	(iii)
(B)	(iii)	(ii)	(iv)	(i)
(C)	(ii)	(i)	(iii)	(iv)
(D)	(i)	(iii)	(iv)	(ii)

[NEET Oct. 2020]

17. Secondary metabolites such as nicotine, strychnine and caffeine are produced by plants for their:
(A) growth response
(B) defence action
(C) effect on reproduction
(D) nutritive value. **[NEET 2020]**

18. Which of the following is not an attribute of a population?
(A) Natality (B) Mortality
(C) Species interaction (D) Sex ratio **[NEET 2020]**

19. The process of growth is maximum during:
(A) lag phase (B) senescence
(C) dormancy (D) log phase **[NEET 2020]**

20. Between which among the following, the relationship is not an example of commensalism?
(A) Orchid and the tree on which it grows
(B) Cattle egret and grazing cattle
(C) Sea anemone and clown fish
(D) Female wasp and fig species **[NEET Odisha 2019]**

21. In a growing population of a country,
(A) reproductive and pre-reproductive individuals are equal in number
(B) reproductive individuals are less than the post-reproductive individuals
(C) pre-reproductive individuals are more than the reproductive individuals
(D) pre-reproductive individuals are less than the reproductive individuals. **[NEET 2018]**

22. Which one of the following plants shows a very close relationship with a species of moth, where none of the two can complete its life cycle without the other?
(A) Banana (B) *Yucca*
(C) *Hydrilla* (D) *Viola* **[NEET 2018]**

23. Which one of the following population interactions is widely used in medical science for the production of antibiotics?
(A) Parasitism (B) Mutualism
(C) Commensalism (D) Amensalism
[NEET 2018]

24. Mycorrhizae are the example of:
(A) fungistasis (B) amensalism
(C) antibiosis (D) mutualism **[NEET 2017]**

25. When does the growth rate of a population following the logistic model equal zero? The logistic model is given as $\frac{dN}{dt} = rN\left(\frac{1-N}{K}\right)$
(A) when N nears the carrying capacity of the habitat
(B) when $\frac{N}{K}$ equals zero
(C) when death rate is greater than birth rate
(D) when $\frac{N}{K}$ is exactly one **[NEET Phase-I 2016]**

26. If '+' sign is assigned to beneficial interaction, '–' sign to detrimental and '0' sign to neutral interaction, then the population interaction represented by '+' '–' refers to:
(A) mutualism (B) amensalism
(C) commensalism (D) parasitism
[NEET Phase-II 2016]

27. The principle of competitive exclusion was stated by:
(A) C. Darwin (B) G.F. Gause
(C) Mac Arthur (D) Verhulst and Pearl.
[NEET Phase-II 2016]

28. Gause's principle of competitive exclusion states that:
(A) more abundant species will exclude the less abundant species through competition
(B) competition for the same resources excludes species having different food preferences
(C) no two species can occupy the same niche indefinitely for the same limiting resources
(D) larger organisms exclude smaller ones through competition. **[NEET 2016]**

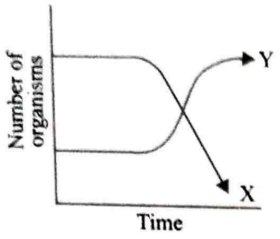
29. In which of the following interactions both partners are adversely affected?

(A) Competition (B) Predation

(C) Parasitism (D) Mutualism

[AIPMT Latest July 2015]

30. The following graph depicts changes in two populations (X and Y) of herbivores in grass field X possible reason for these changes is that:



(A) both plant populations in this habitat decreased

(B) population-Y competed more successfully for food than population-X

(C) population-X produced more offspring than population-Y

(D) population-X consumed the members of population-Y.

[AIPMT Cancelled 2015]

31. A sedentary sea anemone gets attached to the shell lining of hermit crab. The association is:

(A) ectoparasitism (B) symbiosis

(C) commensalism (D) amensalism **[NEET 2013]**

32. A biologist studied the population of rats in a barn. He found that the average natality was 250, average mortality 240, immigration 20 and emigration 30. The net increase in population is:

(A) 10 (B) 15

(C) 05 (D) zero. **[NEET 2013]**

33. Which one of the following is categorised as a parasite in true sense?

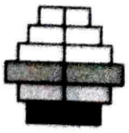
(A) Human foetus developing inside the uterus draws nourishment from the mother.

(B) Head louse living on the human scalp as well as laying eggs on human hair.

(C) The cuckoo (koel) lays its eggs in crow's nest.

(D) The female *Anopheles* bites and sucks blood from humans. **[AIPMT Screening 2011]**

34. What type of human population is represented by the following age pyramid?



(A) Stable population

(B) Declining population

(C) Expanding population

(D) Vanishing population **[AIPMT Screening 2011]**

35. Consider the following statements (I)-(IV) each with one or two blanks.

(I) Bears go into .....(1).....during winter to.....(2) ..... cold weather.

(II) A conical age pyramid with a broad represents .....(3)..... human population.

(III) A wasp pollinating a fig flower is an example of .....(4)..... .

(IV) An area with high levels of species richness is known as .....(5)..... .

Which one of the following options give the correct fill up the respective blanks numbers from (1) to (5) in the statements?

(A) (2) stable, (4) commensalism, (5) marsh

(B) (1) aestivation, (5) escape, (3) stable, (4) mutualism

(C) (3) expanding, (4) commensalism, (5) biodiversity park

(D) (1) hibernation, (2) escape, (3) expanding, (5) hot spot **[AIPMT Mains 2011]**

36. The logistic population growth is expressed by the equation:

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

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

[AIPMT Mains 2011]

37. Which one of the following is most appropriately defined?

(A) Host is an organism, which provides food to another organism.

(B) Amensalism is a relationship in which one species is benefited whereas the other is unaffected.

(C) Predator is an organism that catches and kills other organism for food.

(D) Parasite is an organism, which always lives inside the body of other organism and may kill it.

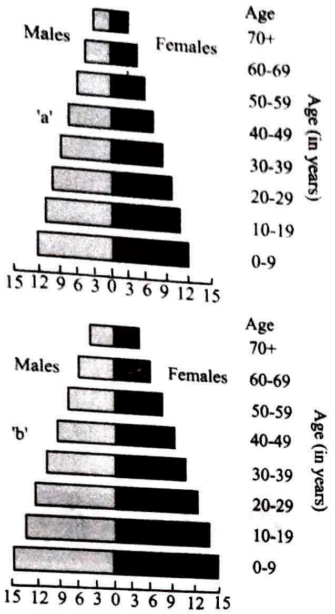
[AIPMT Mains 2010]

38. Which one of the following is one of the characteristics of a biological community?

(A) Stratification (B) Natality

(C) Mortality (D) Sex ratio **[AIPMT 2010]**

39. A country with a high rate of population growth took measures to reduce it. The figure below shows age sex pyramids of populations, a and b twenty years apart. Select the correct interpretation about them.



(A) 'a' is more recent and shows slight reduction in the growth rate.

(B) 'b' is earlier pyramid and shows stabilised growth rate.

(C) 'b' is more recent showing that population is very young.

(D) 'a' is the earlier pyramid and no change has occurred in the growth rate. **[AIPMT Screening 2009]**

40. In the mean and the median pertaining to a certain character of a population arc of the same value, the following is most likely to occur:

(A) a bi-modal distribution

(B) a T-shaped curve

(C) a skewed curve

(D) a normal distribution. **[AIPMT 2007]**

41. A high density of elephant population in an area can result in:

(A) intra specific competition

(B) inter specific competition

(C) predation on one another

(D) mutualism. **[AIPMT 2007]**

42. The formula for exponential population growth is:

(A) $\frac{dN}{dt} = rN$ (B) $\frac{dt}{dN} = rN$

(C) $\frac{dN}{rN} = dt$ (D) $\frac{rN}{dN} = dt$ **[AIPMT 2006]**

43. Animals have the innate ability to escape from predation. Examples for the same are given below. Select the incorrect example.

(A) Colour change in chameleon

(B) Enlargement of body size by swallowing air in puffer fish

(C) Poison fangs in snakes

(D) Melanism in moths **[AIPMT 2005]**

44. Certain characteristic demographic features of developing countries are:

(A) high fertility, low or rapidly falling mortality rate, rapid population growth and a very young age distribution

(B) high fertility, high density, rapidly rising mortality rate and a very young age distribution

(C) high infant mortality, low fertility, uneven population growth and a very young age distribution

(D) high mortality, high density, uneven population growth and a very old age distribution.

[AIPMT 2004]

45. The maximum growth rate occurs in:

(A) stationary phase (B) senescent phase

(C) lag phase (D) exponential phase.

[AIPMT 2004]

46. Two opposite forces operate in the growth and development of every population. One of them relates to the ability to reproduce at a given rate. The force opposing it is called:

(A) morbidity (B) fecundity

(C) biotic potential (D) environmental resistance.

[AIPMT 2003]

47. In a population, unrestricted reproductive capacity is called as:

(A) biotic potential (B) fertility

(C) carrying capacity (D) birth rate **[AIPMT 2002]**

48. Choose the correct sequence of stages of the growth curve bacteria.

(A) Lag, log, stationary, decline phase

(B) Lag, log, stationary phase

(C) Stationary, lag, log, decline phase

(D) Decline, lag, log phase **[AIPMT 2002]**

49. Which of the following is a correct pair?

(A) *Cuscuta* – Parasite

(B) *Dischidia* – Insectivorous

(C) *Opuntia* – Predator

(D) *Capsella* – Hydrophyte

[AIPMT 2002]

50. Which type of association is found in between entomophilous flower and pollinating agent?

(A) Mutualism (B) Commensalism

(C) Cooperation (D) Co-evolution

[AIPMT 2002]

51. Two different species cannot live for long duration in the same niche or habitat. This law is:

(A) Allen's law (B) Gause's hypothesis

(C) Dollo's rule (D) Weisman's theory.

[AIPMT 2002]

52. A pair of insectivorous plants is:

(A) *Drosera* and *Rafflesia*

(B) *Nepenthes* and Bladderwort

(C) *Dionaea* and *Viscum*

(D) Venus flytrap and *Rafflesia*. **[AIPMT 1999]**

53. An interesting modification of flower shape for insect pollination occurs in some orchids in which a male insect mistakes the pattern on the orchid flower for the female of his species and tries to copulate with it, thereby pollinating the flower. This phenomenon is called:

(A) mimcry (B) pseudopollination

(C) pseudocopulation (D) pseudoparthenocarpy

[AIPMT 1998]

54. Human population growth in India:

(A) tends to follow a sigmoid curve as in case of many other animal species

(B) tends to reach a zero population growth as in case of some animal species

(C) can be reduced by permitting natural calamities and enforcing birth control measures

(D) can be regulated by following the National programme of family planning. **[AIPMT 1996]**

55. Association of animals when both partners are benefitted:

(A) colony (B) mutualism

(C) commensalism (D) amensalism

[AIPMT 1993, 88]

SOLUTIONS

1. (D) 'N' is the population density at time t, then its density at time $t + 1$ is

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

Population density will increase when the number of births plus the number of immigrants is more than the number of deaths plus the number of emigrants.

⚠ Caution

➥ *Students often get confused between immigration and emigration. Immigration means the act of coming to your own country. While, emigration means the act of leaving your own country.*

2. (D) Star fish *Pisaster* is a well-known predator that hunt and kill other organisms for food.

Mutualism involves a symbiotic relationship in which both species involved gain benefits. Female wasp and fig is an example of mutualism, where the wasp pollinates the fig, and the fig provides habitat and food for the wasp.

Parasitism is a relationship where one organism (the parasite) benefits at the expense of the other (the host). *Plasmodium* is a parasitic organism responsible for causing malaria in humans.

Sexual deceit is a strategy where one organism deceives another in a reproductive context. *Ophrys* is a genus of orchids that deceives pollinators by mimicking female insects.

3. (B) Migratory flamingoes and resident fish in South American lakes – Interspecific competition.

Abingdon tortoise become extinct after introduction of goats in their habitat – Interference competition

Chathamalus expands its distributional range in the absence of *Balanus* – Competitive release

Five closely related species of warblers feeding in different locations on same tree – Resource partitioning.

4. (A) In the given population growth curve:

Curve 'a' represents exponential growth when responses are not limiting the growth and the population grows rapidly without any environmental constraints. The growth rate is constant. This is described by the equation $\frac{dN}{dt} = rN$, where r is the intrinsic rate of increase and N is the population size.

Curve 'b' represents logistic growth. In this phase, the population growth slows down as it approaches the carrying capacity (K) of the environment. The growth rate decreases as resources become limited and environmental resistance increases. This is described by the equation $\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$, where K is the carrying capacity.

5. (B) The equation of Verhulst-Pearl logistic growth is a model used to describe populations as they approach a limiting value. It is described by the following equation:

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

Where,

- $\frac{dN}{dt}$ represents the rate of change of the population size over time,
- r is the intrinsic rate of natural increase,
- N is the current population size,
- K is the carrying capacity of the environment that is the maximum population size that the environment can sustain indefinitely.

6. (D) In mutualism, both species benefit from the interaction.

In commensalism, one species benefits from the interaction, while the other species is neither benefited nor harmed.

In amensalism, one species is negatively affected by the interaction, while the other species is neither benefited nor harmed.

In parasitism, one species (the parasite) benefits from the interaction, while the other species (the host) is harmed.

7. (C) A Leopard and a Lion in a forest/grassland is an example of interspecific competition. In this case, both the leopard and the lion compete for the same resources, such as food, water, and territory.

A Cuckoo laying egg in a Crow's nest is an example of brood parasitism. The cuckoo lays its eggs in the nest of a crow, which raises the cuckoo chick as its own.

Fungi and root of a higher plant in mycorrhizae is an example of mutualism. In this interaction, fungi form a mutualistic association with the roots of higher plants. Fungi help the plant absorb nutrients from the soil, while the plant provides the fungus with carbohydrates.

A cattle egret and a cattle in a field is an example of commensalism. Cattle egrets follow cattle and other large animals and feed on the insects that are disturbed by their movement. The cattle are unaffected by the presence of the egrets.

8. (C) In logistic growth, the population growth rate initially increases rapidly due to unlimited resource availability, and then slows down and reaches a plateau phase due to limited resource availability. Therefore, logistic growth is associated with limited resource availability.

Exponential growth is a pattern of population growth where the population increases at an exponential rate, which means the growth rate is proportional to the current population size. It is associated with unlimited resource availability.

In an expanding age pyramid, the percentage of individuals in the pre-reproductive age group is the largest, followed by the reproductive and post-reproductive age groups.

In a stable age pyramid, the percentage of individuals in the pre-reproductive and reproductive age groups are the same, and the percentage of individuals in the post-reproductive age group is smaller.

9. (A) Gause's competitive exclusion principle, which states that two species competing for the same limiting resource cannot co-exist indefinitely and the more efficient competitor will exclude the other. In general herbivores and plants appear to be more adversely affected by competition than others.

10. (B) Predators maintain control over their prey. The prey may go extinct if a predator is overly effective and overuses its prey. They occasionally alter prey habitat and behaviour as well. Due to interspecific competition, prey also suffer if there is no predator in the area. Predation therefore always favours one party at the expense of another. In competition both the interacting species are negatively interacted.

11. (D) Association of organisms which benefits one of the partners at the expense of other is called as predation and is denoted by +/–.

12. (D) The death rate is equal to ratios of the number of people to the total number of people, as explained.

Number of Drosophila's in laboratory = 80

Number of death of Drosophila's in a week = 8

Fruit fly population mortality rate is $\frac{8}{18}$, or 0.1 individuals per Drosophila's per week.

13. (A) Amensalism is the relationship between two organisms, where one species is harmed while other is unaffected.

Related Theory

There are two modes of amensalism:

(1) ***Competition:*** *A larger, physically stronger organism deprives a smaller, weaker organism from food or space.*

(2) ***Antibiosis:*** *An organism is either damaged or killed by a chemical secretion of another organism.*

14. (C) Ideally, when resources in the habitat are unlimited, each species has the ability to realise fully its innate potential to grow in number, as Darwin observed while developing his theory of natural selection. Then, the population grows in an exponential or geometric fashion.

$\ln N_t = P\, N_0 e^{rt}$

t = time (number of periods)

N_t = Population density after time t

N_0 = Population density at initial time (t = 0)

e = base of the natural logarithms

= Euler's number

= 2.71628 (approx)

Related Theory

The log phase (or logarithmic phase or the exponential phase) is a period characterised by cell doubling.

15. (D) Population density is the number of individuals per unit area at a given time. Population density is affected by addition of individuals into the population (by natality rate and immigration), providing positive impact or by loss of individuals from the population (by mortality rate and emigration), providing negative impact.

Related Theory

Populations grow at geometric or exponential rates in the presence of unlimited resources. Geometric populations grow through pulsed reproduction while exponential populations grow continuously, with reproduction occurring at any time, such as among humans. However, geometrical or exponential growth cannot continue indefinitely. In nature, population growth must eventually slow, and population size ceases to increase. As resources are depleted, population growth rate slows and eventually stops. This is known as logistic growth. The population size at which growth stops is generally called the carrying capacity (K), which is the number of individuals of a particular population that the environment can support at carrying capacity, because population size is approximately constant, birth rates must equal death rates, and population growth is zero.

16. (B) The relationship between herbivore and plants is prey-predator type (predation), where herbivores predate on plants (prey). Mycorrhizae are a symbiotic association between plant roots and fungi. Mycorrhizae improve the host plant's nutrient and water acquisition and help in defence of root pathogens, whereas plants in return provide food and shelter to the organism. The sheep and cattle show interspecific competition for food (grass) and shelter. Orchid-tree shows commensalism, as roots of epiphytes orchids which act as epiphytes stay on the bark of the tree but they do not take water or nutrients from the tree. The tree lifts the relatively small plant up off the ground and into the air so it can reach the sunlight. This helps the orchid survive in the dense canopy conditions of the tropical forest. During this, trees are neither harmed nor benefitted.

Related Theory

Symbiosis is a relationship that exists between two organisms. There are three types of symbiotic relationships, namely: Mutualism (both the involved organisms benefit from each other), Commensalism (only one organism benefits, while the other is neither benefitted nor harmed), Parasitism (one organism is benefitted while the other organism is harmed). Understanding symbiotic relationships are important, as it helps us understand how various organisms are dependent on each other for survival.

17. (B) Secondary metabolites such as nicotine, strychnine, and caffeine are produced by plants for their defense action.

Related Theory

Secondary metabolites nicotine produced by the tobacco plants, Strychnine produced by Strychnos nux-vomica, and caffeine produced majorly by coffee plants. These secondary metabolites are alkaloids for defending themselves from herbivores.

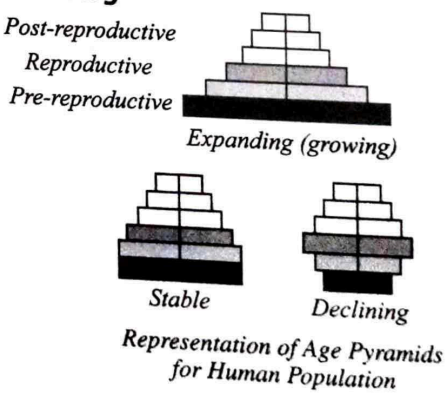
18. (C) Population characteristics include natality, mortality, and sex ratio. Interspecific or intraspecific species interactions are possible when a population of a species is constrained by physical boundaries or other environmental constraints.

19. (D) Lag phase (slow growth phase), log phase (exponential growth phase), and steady or plateau or stationary phase are the three stages of growth. Therefore, in a sigmoid growth curve, growth is at its highest at the log phase.

20. (D) In commensalism, one species is benefitted, while other remains neutral. However, female wasp and fig species shows mutualism (both components are benefitted). Fig flower is pollinated by wasp and wasp lays eggs into the fruit and leaves them for development. On other hand, Orchid is an epiphyte which grows on the bark of other plant, but the plant on which it grow is neither harm or benfitted. Grazing cattle, in grassland stir up the flies and insects in the grass, and paves the way for cattle egret to feed on them. Sea anemone provides the clownfish with protection and shelter, being unaffected by the presence of fish.

21. (C) In a growing population, younger population or pre-reproductive population size is larger than the reproductive population (triangle shaped pyramid). When reproductive and pre-reproductive populations are equal in size, then population is stable (bell shaped pyramid). When reproductive population is smaller than post-reproductive population or pre-reproductive population is smaller than reproductive population, then the population is of declining type.

Related Theory



Representation of Age Pyramids for Human Population

Caution

In case of confusion, students should draw the age pyramid for visual representation.

22. (B) *Yucca gloriosa* has an obligate symbiotic relationship with moth *Pronuba yuccasella*. The moth cannot complete its life cycle without the association with *Yucca* flowers and in return *Yucca* has no pollinator. *Hydrilla* is a hydrophillous and *Viola* is an entomophillous plant. Banana is a parthenocarpic plant, and hence require no pollinators.

Related Theory

The female moth visits Yucca flowers at night and collects pollen in the form of balls. The moth then inserts its ovipositor into the ovary of the flowers to lay eggs. The temperature of the ovary is suitable for hatching the moth eggs. After that it climbs up to the style and pushes the pollen tube into the stylar canal, thus pollinating the flower.

23. (D) Amensalism is the type of interaction in which one of the species is inhibited or destroyed by the other species and other species remain unaffected. Amensalism is used in the production of antibiotics, which will inhibit or kill the other species in the association.

Related Theory

During production of antibiotics, secretion of chemicals called allochemics by one microbial group harm other microbes, e.g., Penicillium secretes chemicals to inhibit the growth of Staphylococcus bacteria. These chemicals can be used in medical science, for the treatment of certain diseases.

24. (D) Mycorrhiza is the symbiotic mutualistic relationship between fungal hyphae and roots of higher plants. Fungistasis is used to describe the widespread occurrence of fungal spore germination or hyphal growth inhibition in soils. Amensalism is the relationship between two organisms in which one organism is harmed and the other is unaffected.

Related Theory

In mycorrhiza, the fungal component helps in increasing the absorption of water and minerals from the soil while the plants in turn provides the fungi with energy yielding carbohydrates. Mycorrhizae permits the plant to obtain additional moisture and nutrients. This is particularly important in uptake of phosphorus, one of the major nutrients required by plants. When mycorrhizae are present, plants are less susceptible to water stress.

25. (D) According to logistic growth model of population,

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

Where, N = Population density at time t

r = Intrinsic rate of natural increase

K = Carrying capacity

When, $\frac{N}{K} = 1$ then $\frac{K-N}{K} = 0$

Therefore, $\frac{dN}{dt} = 0$

Thus, $\frac{dN}{dt}$ represents the change in population density with time.

26. (D) Parasitism is the relationship between two organisms in which one is benefitted, while the host is harmed (+, –). In mutualism, both organisms are in benefitted from each other (+, +). In amensalism, one organism is harmed while other in neutral (–, 0). In commensalism, one organism is benefitted while other in neutral (+, 0).

Related Theory

Proto-cooperation (or synergistic relationship) represents an association between two microbial populations in which both populations benefit from each other. It differs from the mutualism as it is not 'obligatory'. Both the populations of microbes are able to survive in their natural environment on their own.

27. (B) The Russian ecologist G.F. Gause gave the competitive exclusion principle which states that no two species can exploit the environment in exactly the same way and coexist – one of the species will be excluded. An ecological niche cannot be simultaneously and completely occupied by established populations of more than one species. Two species can live in same habitat but not in the same niche. More similar the two niches are, severe the competition is.

28. (C) No two species can permanently occupy the same niche indefinitely for the same limiting resources.

According to Gause's theory of competitive exclusion, two species competing for the same limited resource cannot live in the same niche for an extended period of time and eventually competitively inferior one will be eliminated. This may be true if resources are limiting.

29. (A) Competition is a negative interaction that occurs among organisms whenever two or more organisms require the same limited resource. In this, both the organisms are harmed one way or the other. In predation and parasitism, one organism is harmed while other is benefitted. In mutualism, both the organism are benefitted.

Related Theory

The way organisms compete with each other determines species distributions, population dynamics, community structure, food webs, and social dominance hierarchies. Competitive interactions over time manifest themselves in physical and behavioral adaptations that shape the evolution of a species. Human activity, invasive species, climate change, and environmental pressure are constant stressors on ecosystems, making resources less available and of less quality. These stressors affect the way that organisms compete with each other and their ability to survive and co-exist.

Caution

Though, both predation and parasitism are (+, -) type of interaction, they are significantly different. In predation, the predator is larger in size than the prey, while in parasitism, the parasite is smaller in size than the host.

30. (B) The individuals in population Y have increased because they have adapted better to their environment than population X. Thus, population Y have better survival and attainment of resources, leading to an increase in their number of offspring.

Related Theory

In the process of natural selection, individuals in a population who are well-adapted to a particular set of environmental conditions have an advantage over those who are not so well adapted. The advantage comes in the form of survival and reproductive success. For example, those individuals who are better able to find and use a food resource well, on average, live longer and produce more offspring than those who are less successful at finding food. Inherited traits that increase individuals' fitness are then passed to their offspring, thus giving the offspring the same advantages.

31. (C) The interaction between sea anemone that has stinging tentacles and the clown fish that lives among them is an example of commensalism. The fish gets protection from predators which stay away from the stinging tentacles. The anemone does not appear to derive any benefit by hosting the clown fish. Parasitism is the relationship between two organisms in which one benefitted, while the host is harmed (+, –). In mutualism symbiosis, both organisms are benefitted from each other (+, +). In amensalism, one organism is harmed while other in neutral (–, 0). In commensalism, one organism is benefitted while other is neutral (+, 0).

32. (D) In a population, Average mortality = 240

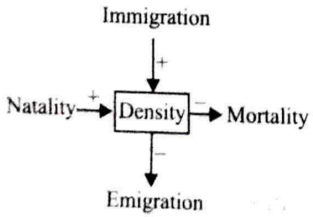
Average natality = 250

Immigration = 20

Emigration = 30

Net increase in population = (Natality + Immigration) – (Mortality + Emigration)

= (250 + 20) – (240 + 30) = 0

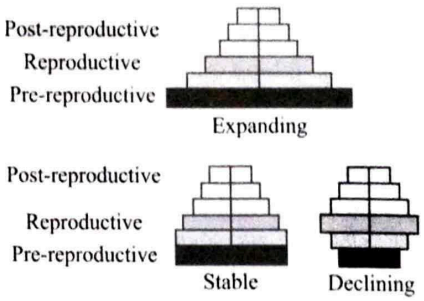


33. (B) Head louse living on the human scalp as well as laying eggs on human hair is an example of true parasite because head louse sucks blood from the scalp and is nourished by human blood. They obtain nutrition and reproduce on human scalp and hair. They lay eggs which remain attached to human hair which hatch and their life cycle continues.

Related Theory

Parasitism is considered when an organism depends on other (host) for the food and shelter. They could be ectoparasite or endoparasite.

34. (B) When the population of pre-reproductive individuals is lower than reproductive individuals, then the population is declining. When the population of pre-reproductive individuals is equal reproductive individuals, then the population is stable.



Representation of Age Pyramids for Human Population

35. (D) Bears go into hibernation during winter to escape cold weather. A conical age pyramid with a broad base represents expanding human population. When the population of pre reproductive individuals is higher than reproductive individuals, then the population is increasing. A wasp pollinating a fig flower is an example of mutualism. An area with high levels of species richness is known as hotspot. 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.

36. (B) Population growth rate is measured by the number of individuals in a population (N) over time (t). The term for population growth rate is written as $\left(\frac{dN}{dt}\right)$.

K represents the carrying capacity and r is the maximum per capita growth rate for a population. Thus, the exponential growth model is restricted by this factor to generate the logistic growth equation:

$$\frac{dN}{dt} = r_{max}\left(\frac{dN}{dT}\right) = r_{max}N\left[\frac{(K-N)}{K}\right].$$

Related Theory

The logistic model assumes that every individual within a population will have equal access to resources and, thus, an equal chance for survival. For plants, the amount of water, sunlight, nutrients, and the space to grow are the important

resources, whereas in animals, important resources include food, water, shelter, nesting space, and mates. Thus, it is a more-realistic model of population growth than exponential growth. Initially, growth is exponential because there are few individuals and ample resources available. Then, as resources begin to become limited, the growth rate decreases. Finally, growth levels off at the carrying capacity of the environment, with little change in population size over time.

37. (C) In predation, one organism known as predator captures, kills and eats another organism, called as prey. In parasitism, one organism obtains nourishment from another organism, called as host. In amensalism, one species is inhibited, while other species is neither benefited nor inhibited.

Related Theory

- *Symbiosis is a relationship that exists between two organisms. There are three types of symbiotic relationships, namely: Mutualism (both the involved organisms benefit from each other). Commensalism (only one organism benefits, while the other is neither benefited nor harmed), Parasitism (one organism is benefited while the other organism is harmed).*

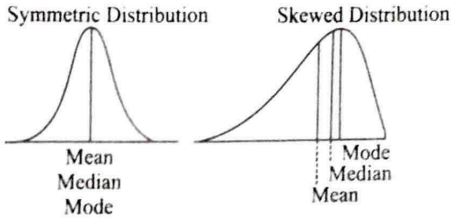
38. (A) The biological community is characterised by stratification. The concept of having multiple strata, particularly those generated by various plants and organisms in one location, is known as stratification. A forest may contain 5-7 layers, such as tall trees with a canopy, medium-sized trees, low trees, bushes, herbs, and ground vegetation. Stratification is advantageous because it allows for the coexistence of numerous species of various types and a more effective use of available resources. Ecological equivalents are animals that live in such comparable ecological niches or strata but are geographically separated.

39. (A) Comparing the pyramids given, pyramid 'a' has much narrower base than pyramid 'b'. This implies that the population 'a' is less than population 'b'. As measures were taken to reduce population size, then population 'a' must be more recent.

Related Theory

- *Pre-reproductive individuals are young individuals which will enter the reproductive age after sometime and contribute to increase in population. A high proportion of this age group in a population results in expanding population.*

40. (D) The normal distribution is a symmetrical, bell-shaped distribution in which the mean, median and mode are all equal. It is a central component of inferential statistics. The standard normal distribution is a normal distribution represented in z scores. It always has a mean of zero and a standard deviation of one.



Related Theory

- *If one tail is longer than another, the distribution is skewed. These distributions are sometimes called asymmetric or asymmetrical distributions as they don't show any kind of symmetry. Symmetry means that one half of the distribution is a mirror image of the other half.*

41. (A) The intraspecific competition is competition between individuals of same species. The intraspecific competition may be very severe because all the members of a species have similar requirements of food, habitat mate, *etc.*, and they also have similar adaptations to get their needs. An interaction between individuals of different species wherein both are negatively affected is interspecific competition. An interaction between two species wherein both species involved are benefited is mutualism. Predation is the act of preying on other animals is termed predation. The animal which hunts and kills other animals for food, is called the predator and the attacked animal is called the prey.

Related Theory

- *The principle of competitive exclusion was proposed by Gause which states that two species competing for the same resources cannot coexist. One population will drive off the other one. If any of the members of the depleted population remains, that would be because they have adapted themselves according to the different niche.*

42. (A) Exponential growth form can be represented mathematically by the following exponential equation:

$$\frac{dN}{dt} = (B - D) \times N$$

B = Birth rate, D = Death rate

Let (B – D) = r or intrinsic rate of growth.

Then, $= r \times N$

where d is the rate of change, N = number of existing individuals.

t = time and r = intrinsic rate of natural increase represents the rate of change in population size.

43. (C) Colour change in chameleon and melanism in moths are examples of camouflage in animals adapted to prevent predation from prey. As a defence mechanism, puffers have the ability to inflate rapidly, filling their extremely elastic stomach with water (or air) until they are almost spherical. This

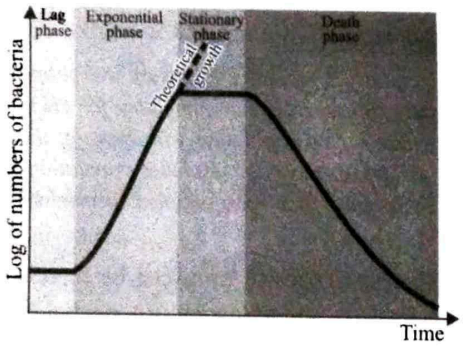
prevents them from being identified by the predator. But poison fangs in snakes are a method adopted for preying and not escaping predation.

Related Theory

Prey species have defense adaptations that help them escape predation. These defenses may be mechanical, chemical, physical, or behavioural. Camouflage is the ability of an organism to blend in with its surroundings. It can be as simple as being the predominant colour of surrounding vegetation, or it can define an organism's complete morphology, like this walking stick. It is considered as a great defensive strategy, as evidenced by its widespread use in nature.

44. (A) Developing countries show expanding population pyramid with maximum age distribution in pre-reproductive phase *i.e.*, a very young age distribution, high fertility and low mortality rate.

45. (D) In microbial growth curve, lag phase is characterized by cellular activity but not growth. Exponential or log phase is the time when the cells are dividing by binary fission and doubling in numbers after each generation time. In stationary phase, the growth curve begins to decline as the available nutrients become depleted and waste products start to accumulate. The terminal irreversible stage of ageing is called senescence. This is the last phase of life span, that ultimately leads to death.



Related Theory

Aging is a progressive decline with time whereas senescence occurs throughout the lifespan, including during embryogenesis.

46. (D) Two opposite forces operating in growth and development of every populations. One of them has ability to reproduce at a given rate. The opposing force is environmental resistance.

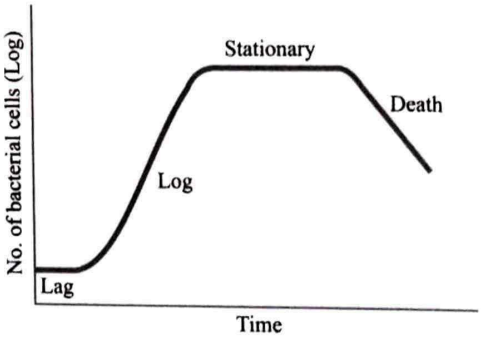
Environmental resistance is factors, that can limit the increase in a population. Common factors include predators, disease, competitors, and lack of food, water, and suitable habitat. Due to factors that contribute to environmental resistance, not all individuals that are born can survive to adulthood or reproductive age. As a result, the overall population of the species does not grow uncontrollably but instead is limited and controlled. All limiting factors in the environment that act on a particular population is termed as environmental resistance.

47. (A) Biotic potential is defined as the physiological capacity of organisms to produce their offspring under natural and environmentally optimum conditions. Biotic potential is the highest possible vital index of a species; therefore, when the species has its highest birth rate and lowest mortality rate.

Related Theory

The sum of total inhibitory environmental factors, both biotic and abiotic, which regulate population size and do not permit unlimited growth of population is called environmental resistance. Due to environmental resistance, the populations are unable to reach full biotic potential.

48. (A) Bacterial growth cycles in a growth curve consist of four phases: lag, exponential (log), stationary, and death.



49. (A) *Cuscuta* commonly known as dodder, is a parasitic plant. It belongs to order Solanales and family Convolvulaceae.

Dischidia is an epiphytic plant that grow on supports such as tree trunks or branches.

Opuntia commonly called prickly pear is xerophytic plants, consisting thorns.

Capsella also called as Shepherd's purse is a genus of herbaceous plant and biennial plants in the Family Brassicaceae.

50. (A) A mutualistic interaction exists between a plant and the pollinator. While the pollinator consumes the plant as food, the plant employs its pollinator to ensure cross-pollination.

51. (B) Two or more species with the same needs cannot coexist in the same location for an extended period of time because they will eventually compete with one another for the resource. This is known as the Gause's Competitive Exclusion Principle, which states that established populations of more than one species cannot occupy an ecological niche concurrently and completely. However, two species cannot coexist in the same niche. The more similar the two niches are the more competition is fiercer.

52. (B) Pitcher plants are known as *Nepenthes*, and *Utricularia* is more often known as Bladderwort. *Nepenthes* and *Utricularia* both consume insects. *Rafflesia* completely parasitizes the roots. Mistletoe is a common name for *Viscum*.

53. (C) Pseudocopulation is the term used to describe behaviours that resemble copulation but do not really involve the parties in a sexual union. These behaviours may have a reproductive purpose for one or both participants. It is most frequently used to describe a pollinator trying to mate with a flower. While certain flowers aesthetically imitate a potential female mate, the main sensations are frequently chemical and tactile. Pouyannian mimicry is the name for this type of mimicry in plants. This is a frequent way for orchids to reproduce.

54. (D) Despite being a very crowded and overpopulated country, India still has a national family planning programme that can be followed to control the population.

55. (B) Mutualism is a sort of association in which both parties gain from the relationship. This is an ongoing, necessary relationship involving physiological interdependence, such as in lichens.