Chapter

35 Organisms and Populations

Ecology is the study of interactions among organisms and between the organisms and its physical (abiotic) environment.

Ecology is concerned with four levels of biological organization:

- ➢ **Organisms:** Every individual of a species is known as organism. An organism is a self-reproducing system, which is capable of growing and maintaining itself. Organisms are also directly influenced by the surrounding environment.
- ➢ **Populations:** A population is a group of similar organisms living in a geographical area, sharing similar resources and capable of interbreeding. Population members bred with each other and live in the same area at the same time. The group of deer living in one forest or the group of fish living in one pond belong to one population.
- ➢ **Communities:** A community is made up of different populations in a certain area at a certain time. It includes assembly of population of all different species living in an area and interacting. For example all the living organisms in a pond belong to one community.
- ➢ **Biomes:** It includes large flora and fauna in a species climatic zone.

ORGANISM AND ITS ENVIRONMENT

- Environment is defined as the sum total of all biotic and abiotic factors that surround and influence an organism in its survival and reproduction.
- *Factors affecting environment are:*
  - ➢ The rotation of earth and the tilt of its axis cause annual variations in temperature, resulting into distinct seasons. This leads to the formation of various biomes such as desert, rain forest, tundra, Grassland, temperate forest etc.
  - ➢ Regional and local variations within each biome lead to the formation of different habitats.
  - ➢ Temperature, water, light and soil are the key elements that lead to so much variation in the physical and chemical conditions of habitats.
  - ➢ Both **abiotic** (physico-chemical) and **biotic** components (pathogen, parasites, predators, competitions) characterize the habitat of an organism.
- Life not only exists in favourable habitats but also in extreme and harsh conditions.
- *E.g.* Rajasthan desert, rain-soaked Meghalaya forests, deep ocean trenches, torrential streams, Polar Regions, high mountain tops, thermal springs, and compost pits.
- Our intestine also acts as a habitat for many microbes.

Components of environment

The environment of an organism can be divided into two components: Abiotic and Biotic components.

1. **Abiotic components:** The non-living things form the abiotic component of the environment. It can be classified into two categories:
   - **(i) Physical components:** They are the various climatic characteristics such as light, temperature, humidity, precipitation, pressure and soil profile.
   - **(ii) Chemical components:** It includes inorganic components and organic components.
     - **(a) Inorganic components:** Carbon, carbon dioxide, nitrogen, oxygen, phosphorus sulphur, zinc, water and many other minerals are the inorganic nutrients required by all living beings.
     - **(b) Organic components:** The complex molecules such as carbohydrates, proteins and lipids are the organic substances in an ecosystem.
2. **Biotic components:** The living organisms form the biotic component of the environment. The biotic components can be classified as producers, consumers and decomposers.

(a) **Producers:** Only plants are capable of capturing solar energy and transforming it into food energy for all the other living organisms are called as producers. These plants are also named as autotrophs since they make their own food.

(b) **Consumers:** Animals depend upon the plants directly or indirectly for their food and are called consumers. Their mode of nutrition is called heterotrophic. Consumers can be herbivores, carnivorous, omnivorous, and parasitic or scavengers.

(c) **Decomposers:** Decomposers feed on dead and decaying animals and plants. They are small microscopic organisms and help in recycling of nutrients in the environment.

Major abiotic factors:

(a) Temperature

- It is the most ecologically relevant environmental factor.
- The average temperature on land varies seasonally. It gradually decreases from the equator towards the poles and from plains to the mountain tops. It ranges from subzero levels (in polar areas and high altitudes) to >50°C (in tropical deserts).
- In habitats like thermal springs and deep-sea hydrothermal vents average temperatures exceed 100°C.
- Temperature affects kinetics of enzymes, basal metabolism and other physiological functions of the organism.
- **Based on range of thermal tolerance, organisms are of two types:**
  - ➢ **Eurythermal:** Organisms that can tolerate and thrive in a wide range of temperature.
  - ➢ **Stenothermal:** Organisms that can tolerate only a narrow range of temperature.

(b) Water

- Water is also an important factor influencing the life of organisms.
- Productivity and distribution of plants is dependent on water.
- For aquatic organisms the quality (chemical composition, pH) of water is important.
- The salinity varies in aquatic environment:
  - ➢ 5% in inland waters (fresh water)
  - ➢ 30-35 in sea water
  - ➢ More than 100 percent in hyper saline lagoons.
- Many freshwater animals cannot live for long in sea water and vice-versa because of the osmotic problems.
- **Based on the range of tolerance to salinity, organisms are or two types:**
  - ➢ **Euryhaline:** They can tolerate and thrive in a wide range of salinities.
  - ➢ **Stenohaline:** They can tolerate only a narrow range of salinity.

(c) Light

- Plants need sunlight for photosynthesis. Hence light is very important for autotrophs.
- Plant species like herbs and shrubs (canopied by tall plants) are adapted for photosynthesize under very low light.
- Many flowering plants are dependent on sunlight for photoperiodism.
- Many animals use the diurnal and seasonal variations in light intensity and photoperiod for timing their foraging, reproductive and migratory activities.
- Sun is the ultimate source for light and temperature on land. Deep (>500m) in the oceans, the environment is dark and there is no energy available from sun.
- The spectral quality of solar radiation is also important for life. The UV component of the spectrum is harmful to many organisms.

(d) Soil

- The nature and properties of soil in different places vary. It is dependent on the climate, the weathering process, sedimentation, method of soil development etc.
- The various characteristics of the soil like soil composition, grain size and aggregation, determine the percolation and water holding capacity of the soils.
- These characteristics along with parameters such as pH, mineral composition and topography determine the vegetation and animals in any area.

Responses to abiotic factors

- All organisms in order to sustain maximum functionality maintain a constant internal environment (homeostasis). **Homeostasis** is the process by which an organism maintains a constant internal environment in respect to changing external environment.
- *An organism may adopt one of the following strategies for homeostasis:*

(a) Regulate

- Certain animals have the ability to maintain a constant temperature and constant osmolarity to keep up their homeostasis. E.g. All birds and mammals, very few lower vertebrates and invertebrates.
- **Thermo regulation in mammals:** Mammals have a constant body temperature (37˚C) irrespective of the outside temperature. In summers, to maintain the temperature, we sweat and in winters we shiver to produce heat.

(b) Conform

- 99% of animals and nearly all plants cannot maintain a constant internal environment. Their body temperature or osmotic concentration change with the surrounding conditions. They are called **conformers. Hence, the** internal environment of conformers changes with external environment.

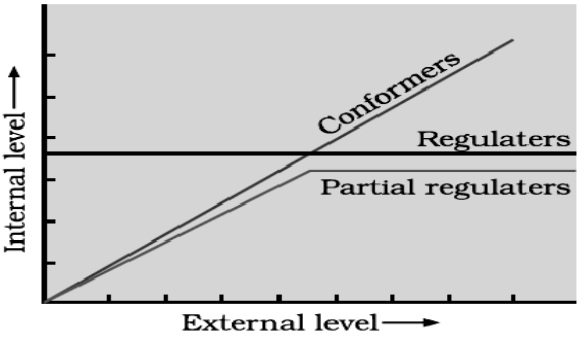


Fig. Diagrammatic representation of organismic response

- In aquatic animals, osmotic concentration of body fluids changes with that of the ambient osmotic concentration.
- Thermoregulation is energetically expensive especially for small animals like shrews, humming birds etc. Theycannot afford so much energy for thermoregulation.
- Heat loss or heat gain is a function of surface area. Small animals have a larger surface area relative to their volume.
- Small animals have larger surface area relative to their volume, so they tend to lose body heat very fast when it is cold outside; then has to expend much energy to generate body heat through metabolism.
- This is why very small animals are rarely found in Polar Regions.

(c) Migrate

- Many animals like birds move away temporarily from stressful habitat to a more hospitable area and return when stressful condition is over.
- For example, during winter, Keolado National Park (Bhartpur, Rajasthan) hosts migratory birds coming from Siberia and other extremely cold northern regions.

(d) Suspend

- In bacteria, fungi and lower plants, thick walled spores are formed which help them to overcome stressful, unfavourable conditions. Spores germinate when conditions are favourable.
- In higher plants, seeds and some other vegetative reproductive structures serve to tide over periods of stress. They reduce their metabolic activity and go into a state of 'dormancy'. They germinate under favourable moisture and temperature.
- **In animals:** Examples are
  - ♦ *Hibernation* of bears during winter. Hibernation or winter sleep is a resting stage where in animals escape winters (cold) by hiding themselves in their shelters. They escape the winter season by entering a state of inactivity by slowing their metabolism. The phenomenon of hibernation is exhibited by bats, squirrels, and other rodents.
  - ♦ *Aestivation* of some snails and fishes during summer.
  - ♦ *Diapause* of manyzooplanktons in lakes and ponds. Diapause is a stage of suspended development to cope with unfavourable conditions. Many species of zooplankton and insects exhibit diapause to tide over adverse conditions during their development.

Adaptations

- Adaptations are certain characteristics that organism develop in order to survive and reproduce better in their habitat. These adaptations may be morphological, physiological and behavioural attribute that enables an organism to survive and reproduce in its habitat.
- Many adaptations have evolved over a long evolutionary time and are genetically fixed.
- Adaptations of kangaroo rat in North American deserts:
  - ➢ Kangaroo rat meets their water requirement from oxidation of fat.
  - ➢ Also they have the ability to excrete concentrated urine so that minimal volume of water is used to remove excretory products.

Adaptations of desert plants (xerophytes):

- ➢ Presence of thick cuticle on leaf surfaces. Their stomata are arranged in deep pits to minimise water loss through transpiration.
- ➢ A special photosynthetic pathway (CAM) that enables their stomata to remain closed during day time and remains open during night.
- ➢ Desert plants like *Opuntia* have no leaves. Their leaves are reduced to spines. Photosynthesis takes place by means of flat green stems.

Adaptations of mammals:

- ➢ Mammals from colder climates have shorter ears and limbs to reduce heat loss. This is called *Allen's Rule*.
- ➢ Aquatic mammals like seals have a thick layer of fat (blubber) below their skin that acts as an insulator and reduces loss of body heat.

Physiological and biochemical adaptations:

- ➢ Archaebacteria (Thermophiles) are ancient forms of bacteria that are found in the hot springs and deep sea hydrothermal vents. They are able to survive in high temperatures (which far exceed 100˚C) because their bodies have adapted to such environmental conditions. These bacteria contain specialised thermo-resistant enzymes which carry out metabolic functions that do not get destroyed at such high temperatures.
- ➢ Many marine invertebrates and fishes live at great depths in the ocean where the pressure is >100 times the normal atmospheric pressure.
- ➢ At a high altitude place (>3,500 m) a person might develop *altitude sickness*. The symptoms of altitude

sickness are nausea, fatigue and heart palpitations. The sickness is due to low atmospheric pressure. As a result, the body does not get enough oxygen. Gradually, we acclimatize the situation and the body and breathing rate and decreasing the binding capacity of haemoglobin.

Behavioural adaptations:

- ➢ Desert lizards are conformer hence they cope with the stressful environment by behavioural adaptations. They bask in the sun and absorb heat when their body temperature is low, but move into shade when the ambient temperature starts increasing.
- ➢ Some species are capable of burrowing into the soil to hide and escape from the above-ground heat.

POPULATIONS

- A population is defined as a group of individuals of the same species that live in a particular geographical area at a particular time and functioning as a unit. For example, all human beings living at a particular place at a particular time constitute the population of humans. They share or compete for similar resources and potentially reproduce.
- Population ecology is an important area of ecology as it links ecology to population genetics and evolution.

Population Attributes

The main attributes or characteristics of a population residing in a given area are:

(i) Birth rate (Natality): It is the ratio of live births in an area to the population of an area. It is expressed as the number of individuals added to the population with respect to the members of the population.

E.g. Consider in a pond there are 20 lotus plants last year and through reproduction 8 new plants are added.

Hence, the current population = 28

The birth rate = 8/20 = 0.4 offspring per lotus per year.

(ii) Death rate (Mortality): It is the ratio of deaths in an area to the population of an area. It is expressed as the loss of individuals with respect to the members of the population.

E.g. Consider 4 individuals in a laboratory population of 40 fruit flies died during a week.

Hence, the death *rate* = 4/40 = 0.1 individuals per fruit fly per week.

(iii) Sex ratio: It is the number of males or females per thousand individuals. *E.g.* 60% of the population is females and 40% males.

(iv) Age distribution: It is the percentage of individuals of different ages in a given population. At any given time, the population is composed of individuals that are present in various age groups. The age distribution pattern is commonly represented through age pyramids.

(v) Population density: It is defined as the number of individuals of a population present per unit area at a given time.

Age pyramid: If the age distribution (% individuals of a given age or age group) is plotted for the population, the resulting structure is called an **age pyramid.** The shape of the pyramids reflects the growth status of the population like **growing, stable** or **declining.**

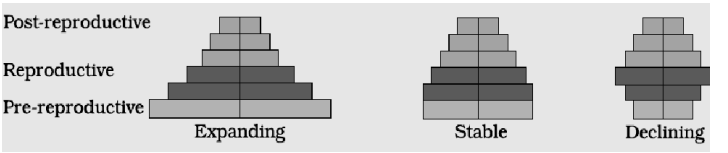


Fig. Representation of age pyramids for human population

Population size or population density (N)

- Population size or population density is the number of individuals of a species per unit area or volume. *E.g.* population density of Siberian cranes atBharatpur wetlands in any year is <10. It is millions for *Chlamydomonas* in a pond.
- In some cases, population size is measured in % cover or biomass. *E.g.* consider in an area, 200 *Parthenium*plants and a single huge banyan tree is seen. In such cases, the
- % cover or biomass is a more meaningful measure of the population size to show the importance of banyan tree.
- Total number is a difficult measure for a huge population. In such cases, relative population density (without knowing absolute population density) is used.
- *E.g.* the number of fish caught per trap indicates its total population density in the lake.
- In some other cases, indirect estimation of populationsizes is performed. *E.g.* Tiger census in national parks andtiger reserves based on pug marks andfecal pellets.

Population growth

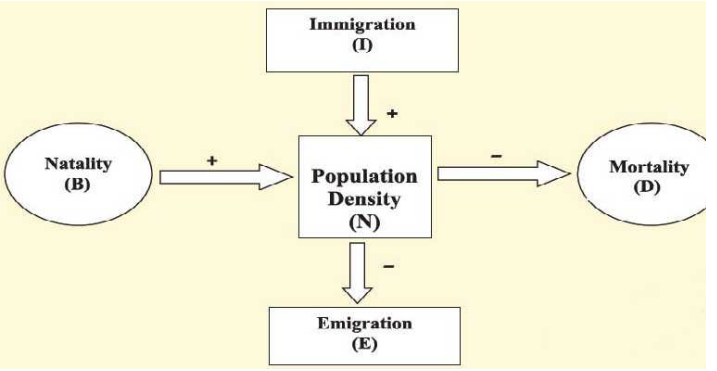
- The size of a population is ever changing aspect since it depends upon availability of food, predation, weather conditions, etc.
- This gives us an idea whether a certain population is growing or declining.
- The population size changes in time, depending on various factors like food availability, predation pressure and weather.
- Changes in population density give some idea about the population – whether it is flourishing or declining.
- *Population size fluctuates due to changes in four basic processes. They are:*

(i) Natality (B): It is the number of births during a given period in a population.

(ii) Mortality (D): It is the number of deaths in a population during a given period.

(iii) Emigration (E): It is the number of individuals of the population who left the habitat and gone elsewhere during a given time period.

(iv) Immigration (I): It is the number of individuals of the same species that have come into the habitat from elsewhere during a given time period.



- Natality and immigration increase the population density and mortality and emigration decrease the population density.
- If N is the population density at time t, then its density at time t +1 is:

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

where B = the number of births
I = the number of immigrants
D = the number of deaths
E = the number of emigrants.
N = Population density
r = Intrinsic rate of natural increase
t = Time period
K = Carrying capacity (The maximum population size that an environment can sustain)

- This equation indicates that population density increases if B + I is more than D + E. Otherwise it will decrease.

Growth models

(1)Exponential growth

- When resources are unlimited, each species realizes its innate potential to grow in number. Therefore, population grows exponentially.
- The Exponential growth equation is $N_t = N_0 e^{rt}$
  where,
  N_t = Population density after time t
  N_0 = Population density at time zero
  r = intrinsic rate of natural increase. For human population in 1981, r = 0.0205
  e = the base of natural logarithms (2.71828)
- In exponential growth, "J" shaped curve is obtained.
- The population grows in an exponential or geometric fashion
  - ➢ When resources are not limiting the growth.
  - ➢ If resources are unlimited, each species shows its full innate potential to grow in number
  - ➢ Growth is not so realistic.
  - ➢ If in a population of size N, the birth rates (*per capita* births) are represented as *b* and death rates (*per capita* deaths) as *d*, then the increase or decrease in N during aunit time period t (dN/dt) will be

    $dN/dt = (b – d) \times N$

    Let (b–d) = r, then

    $dN/dt = rN$
- The r ('intrinsic rate of natural increase') is an important parameter for assessing impacts of any biotic or abiotic factor on population growth.

(2.) Logistic growth

- A population with limited resources show initially a **lag phase,** followed by **phases of acceleration and deceleration** and finally an **asymptote,** when the population density reaches the carrying capacity. This type of population growth is called **Verhulst-Pearl Logistic Growth.**
- Verhulst-Pearl Logistic Growth is described by the

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

where, N = Population density at time t
r = Intrinsic rate of natural increase
K = Carrying capacity

Logistic Growth (Sigmoid curve is obtained)

- ➢ When responses are limiting the Growth.
- ➢ Resources for growth for most animal populations are finite and become limiting.
- ➢ The logistic growth model is a more realistic one.

Population growth curves:

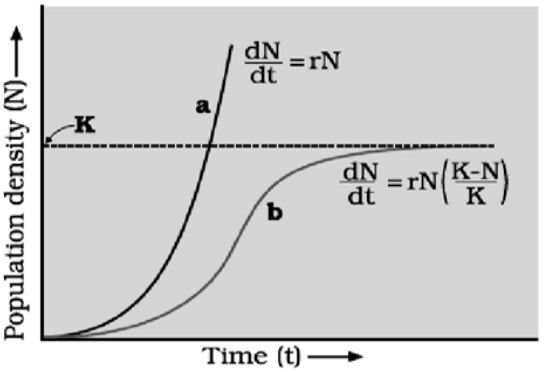


Fig. (a) Indicates exponential growth (J-shaped curve)
(b) Indicates logistic growth (Sigmoid curve).

Population Interactions

- A natural habitat consists of many organisms living together and these organisms communicate and interact with each other. For example, plants depend on insects for pollination.
- In nature, animals, plants and microbes interact in various ways to form a biological community.
- Inter specific interactions are interactions between two different species of organisms. They can be either beneficial or harmful to one or both partners. They arise from the interaction of populations of two different species. They include
  - **(i) Mutualism:** Both the species are benefitted (+).
  - **(ii) Competition:** Both the species are harmed (–).
  - **(iii) Parasitism:** One species (parasite) is benefitted and other species (host) is harmed.
  - **(iv) Predation:** One species (predator) is benefitted and other species (prey) is harmed.
  - **(v) Commensalism:** One species is benefitted and the other is neither benefitted nor harmed (0).
  - **(vi) Amensalism:** One species is harmed and the other is unaffected.

Species A	Species B	Name of the interaction
+	+	Mutualism
–	–	Competition
+	–	Predation
+	–	Parasitism
+	0	Commensalism
–	0	Amensalism

Note: + Positive effect – Detrimental effect 0 neutral effect

- In predation, parasitism and commensalisms, the interacting species live closely together.

(a) Predation

- Interspecific interaction where organism of higher trophic level (predator) feeds on organism of lower trophic level (prey) is called the predation.
- It is beneficial to the predator while the prey is harmed.
- It acts as a means of transfer of energy to the next trophic level and of maintaining balance in the ecosystem.
- In a broad ecological context, all carnivores, herbivores etc are predators. About 25 % of all insects are *phytophagous.*
- If a predator overexploits its prey, then the prey might become extinct. It results in the extinction of predator. This is the reason why predators in nature are 'prudent'.

Importance of predators

- Predators keep prey populations under control.
- When certain exotic species are introduced into a geographical area, they spread fast due to the absence its natural predators in the invaded land. *E.g.* the prickly pear cactus introduced into Australia in the early 1920's caused havoc by spreading. Finally, the invasive cactus was brought under control only after a cactus-feeding predator (a moth) was introduced into the country.
- **Biological control** methods are based on the ability ofthe predator to regulate prey population.
- Predators also help in maintaining species diversity in a community, by reducing the intensity of competition among competingprey species. *E.g.* the starfish *Pisaster* is a predator in the rocky intertidal communities of the American Pacific Coast. In an experiment, when all the starfishes were removed from an enclosed intertidal area, more than 10species of invertebrates became extinct within a year, dueto interspecific competition.

Defense developed by prey against predators

(i) Animals:

- Some insects & frogs are *camouflaged* (cryptically coloured) to avoid being detected by the predator.
- Some are poisonous and therefore avoided by the predators.
- The Monarch butterfly is highly distasteful to its predator (bird) due to a special chemical in its body. This chemical is acquired during its caterpillar stage by feeding on a poisonous weed.

(ii) Plants:

- Several plants have evolved various mechanisms both morphological and chemical to protect themselves against herbivory.
- **Morphological defense mechanisms**
  - ➢ Cactus plants *(Opuntia*) are modified into sharp spines (thorns) to deter herbivores from feeding on them.
  - ➢ Sharp thorns along with leaves are present in Acacia to deter herbivores.
  - ➢ In some plants, the margins of their leaves are spiny or have sharp edges that prevent herbivores from feeding on them.
- **Chemical defense mechanisms**
  - ➢ All parts of *Caloptropis* weeds contain toxic glycosides, which can prove to be fatal if ingested by herbivores.
  - ➢ Chemical substances such as nicotine, caffeine, quinine and opium are produced in plants as a part of self-defence.

(b) Competition

- Interspecific competition is a potent force in organic evolution.
- Competition is a process in which fitness of one species (measured as 'r' value) is significantly lower in presence of another species.
- Competition generally occurs when closely related species compete for the same resources that are limiting, but this not entirely true:
- Competition occurs when closely related species compete for the same limited resources.
  - ➢ Unrelated species can also compete for the resource. E.g. Flamingos and fishes in some shallow South American lakes compete for zooplankton.

➢ Competition occurs in abundant resources also. E.g. In **interference competition,** the feeding efficiency of one species is reduced due to the interfering and inhibitory presence of other species, even if resources are abundant.

Evidences for competition

- The Abingdon tortoise in Galapagos Islands became extinct within a decade after goats were introduced on the island, due to greater browsing efficiency of the goats.
- **'Competitive release':** A species, restricted to a small geographical area (due to the presence of competitively superior species), expands its distributional range when the competing species is experimentally removed.
- Connell's field experiments showed that on the rocky sea coasts of Scotland, the larger and competitively superior barnacle *Balanus*dominates intertidal area, and excludes the smaller barnacle *Chathamalus*from that zone.

Gause's 'Competitive Exclusion Principle'

- It states that *two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior one will be eliminated eventually*.
- This may be true in limited resources, but not otherwise.
- Species facing competition may evolve mechanisms that promote co-existence rather than exclusion. *E.g.* 'resource partitioning'.
- **Resource partitioning**: If two species compete for thesame resource, they could avoid competition by choosingdifferent times for feeding or different foraging patterns.
- *E.g.* MacArthur showed that five closely related speciesof warblers living on the same tree were able to avoid competition and co-exist due to behavioural differences in their foraging activities.

(c) Parasitism

- Parasitism is an interaction between two species in which one species (parasite) derives benefit while the other species (host) is harmed. For example, ticks and lice (parasites) present on the human body represent this interaction where in the parasites receive benefit (as they derive nourishment by feeding on the blood of humans). On the other hand, these parasites reduce host fitness and cause harm to the human body.
- Many parasites have evolved to be host-specific (they can parasitize only a single species of host) in such a way that both host and the parasite tend to co-evolve. i.e., if the host evolves special mechanisms for rejecting or resisting the parasite, the parasite has to evolve mechanisms to counteract and neutralize them, in order to be successful with the same host species.

  Adaptations of parasites

  ➢ Loss of sense organs,

  ➢ Presence of adhesive organs or suckers to cling on to the host,

  ➢ Loss of digestive system,

  ➢ High reproductive capacity etc.
- Life cycles of parasites are often complex.
- ***E.g.***

  ➢ Human liver fluke depends on two intermediate hosts (a snail and a fish) to complete its life cycle.

  ➢ Malarial parasite needs mosquito to spread to other hosts.

  Effects of parasite

  ➢ Majority of the parasites harm the host.

  ➢ They may reduce the survival, population density, growth and reproduction of the host.

  ➢ They might render the host more vulnerable to predation by making it physically weak.

Types of parasites:

(i) Ectoparasites: Parasites that feed on the external surface of the host organism are called Ectoparasites. E.g. lice on humans and ticks on dogs. Many marine fish are infested with ectoparasitic copepods. *Cuscuta*, a parasitic plant that is commonly found growing on hedge plants, has lost its chlorophyll and leaves in the course of evolution. It derives its nutrition from the host plant which it parasitizes.

(ii) Endoparasites: Parasites that live inside the host body atdifferent sites (liver, kidney, lungs, RBC etc.) are called endoparasites.The life cycles of endoparasites are more complex. Theirmorphological and anatomical features are simplified with highly developed reproductive system.

Brood parasitism in birds

- It is a special type of parasitism found in birds.
- Here, the parasitic birds lay 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.
- *E.g.* Brood parasitism between cuckoo and crow.

(d) Commensalism

This is the interaction in which one species benefits and the other is neither benefited nor harmed.

Examples:

➢ Orchid (+) growing as *epiphyte* on a mango branch (0). Epiphytes are plants growing on other plants which however do not derive nutrition from them. Therefore, the relationship between mango tree and an orchid is an example of commensalism, where one species gets benefitted while the other remains unaffected. In the above interaction, the orchid is benefitted as it gets support while the mango tree remains unaffected.

- ♦ Barnacles (+) growing on the back of a whale (0).
- ♦ Cattle egret (+) and grazing cattle (0). The egrets for age close to where the cattle are grazing. As the cattle move, the vegetation insects come out. Otherwise it is difficult for the egrets to find and catch the insects.

- ♦ Sea anemone (0) and clown fish (+). The fish gets protection from predators with the help of stinging tentacles of seaanemone. The anemone has no any benefit.

(e) Mutualism

It is an interaction between two living organism where both are equally benefited. No one is harmed.

Examples:

- ➢ **Lichen:** It is an intimate mutualistic relationship between a fungus and photosynthesizing algae or cyanobacteria.
- ➢ **Mycorrhiza** is association between fungi and the roots of higher plants. The fungi help the plant in the absorption of essential nutrients from the soil while the plant provides the fungi with carbohydrates.
- ➢ Mutualism between plant and animal through pollination and seed dispersion:

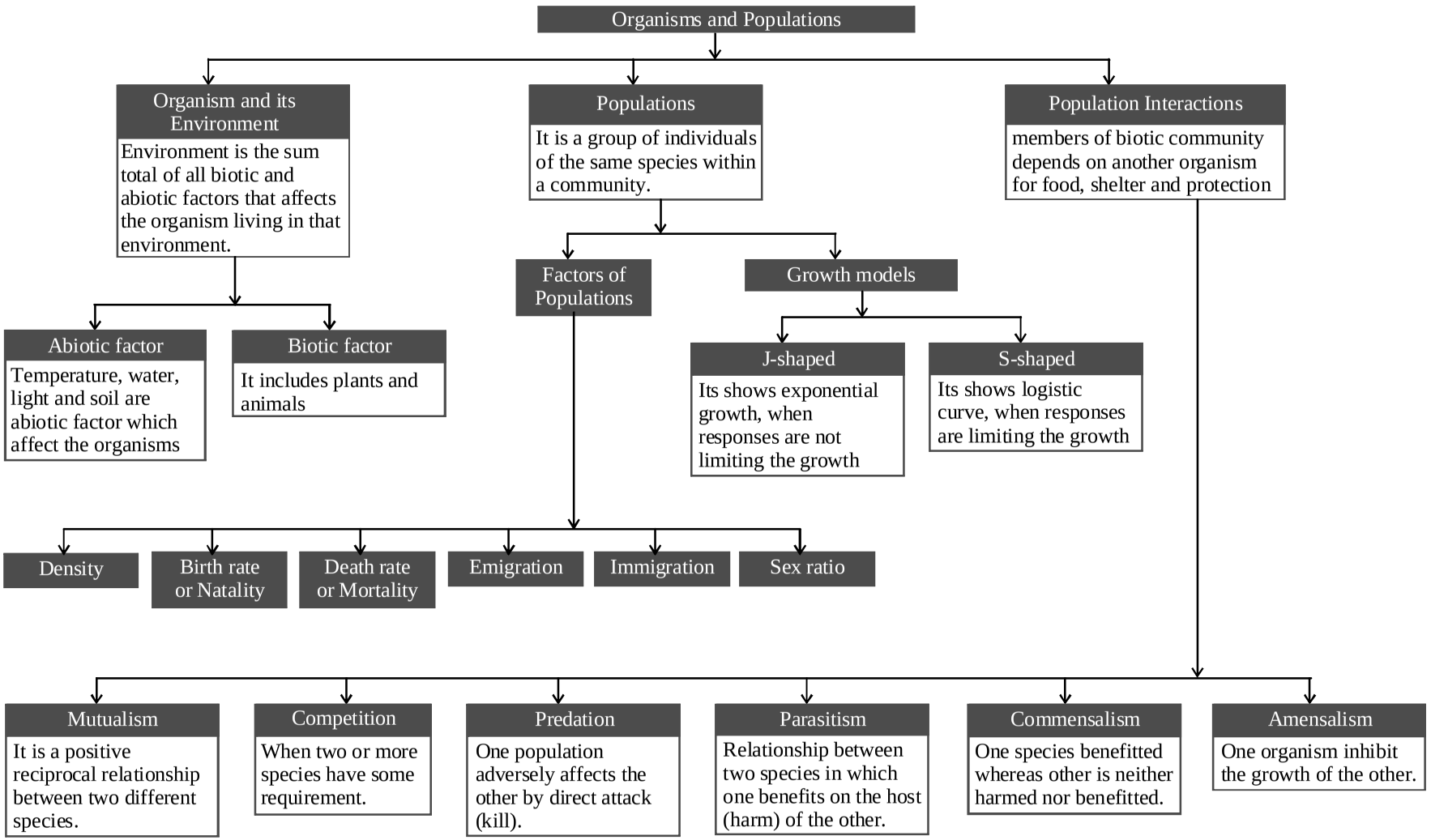
Examples:

- ♦ Many fig trees and wasps. The fig species is pollinated only by its 'partner' wasp species and no other species. The female wasp pollinates the fig inflorescence while searching for suitable egg-laying sites in fruits. The fig offers the wasp some developing seeds, as food for the wasp larvae.
- ♦ Orchids show diversity of floral patterns. They can attract the right pollinator insect (bees and bumblebees) to ensure pollination. Not all orchids offer rewards.

- ➢ **Sexual deceit:**
  - ♦ Mediterranean orchid *Ophrys* employs **'sexual deceit'**.
  - ♦ One petal of its flower resembles female bee in size, colour and markings. So, male bee 'pseudo copulates' with the flower. The bee is dusted with pollen from the flower. When the same bee 'pseudo copulates' with another flower, it transfers pollen to it.
  - ♦ If the female bee's colour patterns change slightly during evolution, pollination success will be reduced unless the orchid flower co-evolves to maintain the resemblance of its petal to the female bee.

(f) Amensalism

It is an interaction between two different species, in which one species is harmed and the other species is neither harmed nor benefitted.


Organisms and Populations
Organism and its Environment
Environment is the sum total of all biotic and abiotic factors that affects the organism living in that environment.
Abiotic factor
Temperature, water, light and soil are abiotic factor which affect the organisms
Biotic factor
It includes plants and animals
Populations
It is a group of individuals of the same species within a community.
Factors of Populations
Growth models
J-shaped
Its shows exponential growth, when responses are not limiting the growth
S-shaped
Its shows logistic curve, when responses are limiting the growth
Density
Birth rate or Natality
Death rate or Mortality
Emigration
Immigration
Sex ratio
Population Interactions
members of biotic community depends on another organism for food, shelter and protection
Mutualism
It is a positive reciprocal relationship between two different species.
Competition
When two or more species have some requirement.
Predation
One population adversely affects the other by direct attack (kill).
Parasitism
Relationship between two species in which one benefits on the host (harm) of the other.
Commensalism
One species benefitted whereas other is neither harmed nor benefitted.
Amensalism
One organism inhibit the growth of the other.

EXERCISE - 1
Conceptual Questions

1. Pedology is the study of –
(a) Locomotion of animals
(b) Rocks
(c) Soil
(d) Reproduction

2. Sequence of humification and mineralisation is-
(a) Dead organic matter → Litter → Duff → Humus → Minerals
(b) Humus → Minerals → Litter → Duff
(c) Minerals → Humus → Litter → Duff
(d) Dead organic matter → Duff → Litter → Minerals → Humus

3. Soil is composed of –
(a) Mineral + Water + Air
(b) Mineral + Organic matter + Water
(c) Mineral + Organic matter + Air + Water
(d) Organic matter + Water

4. Who employed the term ecology for study plants ?
(a) Haeckel (b) Odum
(c) Warming (d) Dudgeon

5. Biotic factors are –
(a) Chemical factors of soil which effect life
(b) Physical factors of soil which effect life
(c) All living organisms which influence other organisms
(d) Atmospheric factors which influence life

6. The age of pyramid with broad base indicates
(a) High percentage of young individuals
(b) Low percentage of young individuals
(c) High percentage of old individuals
(d) Low percentage of old individuals

7. Permafrost is the most distinctive feature of
(a) Taiga (b) Temperate grasslands
(c) Tundra (d) Pacific northwest

8. Which statement does not reflect a reason why grasses predominate in savannas ?
(a) There are few native herbivores in this biome.
(b) Grasses grow well in fine, sandy soils.
(c) The above ground portions of grass plants die during dry seasons.
(d) The deep roots of the grasses can survive many months of drought.

9. Desert regions are characterized by ___ centimeters of rainfall per year.
(a) less than 5 (b) less than 15
(c) less than 25 (d) over 50

10. For plants inhabiting a tropical rain forest, the critical competition is for
(a) soil nutrients (b) water
(c) space (d) light

11. Resemblance of one organism to another for protection and hiding is
(a) Mimicry (b) Predation
(c) Adaptation (d) Camouflage

12. Biome is
(a) sum of ecosystems in a geographical area.
(b) sum of ecosystems of the whole earth.
(c) biotic component of an ecosystem.
(d) biotic potential of a population.

13. Select all of the following that are not adaptation to seasonal changes in habitat quality.
(a) Migration
(b) Expansion of the species range
(c) Production of seeds
(d) Hibernation

14. Keystone species in an ecosystem are those
(a) present in maximum number.
(b) that are most frequent.
(c) attaining a large biomass.
(d) contributing to ecosystem properties.

15. What is the most important factor for the success of animal population?
(a) Natality (b) Unlimited food
(c) Adaptability (d) Inter-species activity

16. In a population, unrestricted reproductive capacity is called
(a) Biotic potential (b) Fertility
(c) Carrying capacity (d) Birth rate

17. Which part of the world has a high density of organisms?
(a) Grasslands (b) Savannahs
(c) Deciduous forests (d) Tropical rain forests

18. Which one of the following pairs is **mismatched**?
(a) Tundra - Low rainfall
(b) Savanna - *Acacia* trees
(c) Prairie - Grassland
(d) Coniferous forest - Evergreen trees

19. Which is not a part of atmosphere ?
(a) Light (b) Temperature
(c) Edaphic factor (d) Precipitation

20. Which bioligical factors is responsible for poor vegetation in deserts ?
(a) Grazing by animals and goats
(b) Low rainfall
(c) Poor fertility of soil
(d) Native mankind

21. The most important factor which determined the increase in human population in India during the 20th century
(a) Natality (b) Mortality
(c) Immigration (d) Emigration

22. The sun loving plants are referred to as
(a) Halophytes (b) Heliophytes
(c) Heterotrophs (d) Sciophytes

23. A majority of organisms are restricted to a narrow range of temperature, and are called
(a) Stenothermal (b) Endothermal
(c) Ectothermal (d) Eurythermal

24. The foraging, reproductive and migratory activities of the organisms are primarily dependent upon
(a) Light (b) Temperature
(c) Water (d) Soil

25. Mark the correct statement
(a) The case of bear, going into hibernation during winter, is an example of 'escape in time'
(b) To prevent desiccation some snails and fishes enter into diapause
(c) Under unfavourable conditions many zooplankton species go into aestivation
(d) All of these

26. The mammals can thrive in Antarctica on one hand and in Sahara desert on the other. This success of mammals is largely due to the fact that they are
(a) Conformers
(b) Regulators
(c) Partially regulators
(d) Partially conformers

27. Bell-shaped polygonal pyramid indicates
(a) High percentage of young individuals
(b) Moderate percentage of young individuals
(c) Low percentage of young individuals
(d) Low percentage of old individuals

28. Rhododendron is characteristic of vegetation of-
(a) Gangetic plains (b) Tropical zone
(c) Alpine zone (d) Mangrove zone

29. Which type of plants are found in Taiga & Tundra?
(a) Halophytes (b) Xerophytes
(c) Epiphytes (d) Psychrophytes

30. Forests, called "Nation's green gold", they are important as –
(a) They provide timber and medicine
(b) They provide shelter to animals
(c) They prevent erosion of soil
(d) All of the above

31. Succulents occur in –
(a) Deserts
(b) Tundra
(c) Temperate deciduous forests
(d) Tropical rain forests

32. In wild populations, individuals most often show a _____ pattern of dispersion.
(a) random (b) density-dependent
(c) equilibrial (d) clumped

33. A population would grow exponentially
(a) if it were limited only by density-dependent factors.
(b) until it reaches carrying capacity.
(c) if there were no limiting factors.
(d) if it were a population with an equilibrial life history.

34. Which one of the following pairs is mismatched?
(a) Tundra - permafrost
(b) Savanna - *Acacia* trees
(c) Prairie - epiphytes
(d) Coniferous forest - evergreen trees

35. The effects of which of the following environmental factors would probably not change as a population grows?
(a) Disease
(b) Limited food supply
(c) Competition for nesting sites
(d) Weather

36. A broad-based, pyramid-shaped age-structure diagram is characteristic of a population that is
(a) growing rapidly.
(b) at carrying capacity.
(c) stable.
(d) limited by density-dependent factors.

37. A population grows rapidly at first and then levels off at carrying capacity if it is
(a) limited by density-dependent factors.
(b) limited by density-independent factors.
(c) an opportunistic species.
(d) limited by both density-dependent or density-independent factors.

38. If birth rate is 100, death rate is 10 and number of individual in population group is 1000, then what will be the percentage of natural growth rate?
(a) 0.09% (b) 9.0%
(c) 0.9% (d) 90%

39. In the models that describe population growth, *r* stands for
(a) population density.
(b) a time interval.
(c) total number of individuals in the population.
(d) growth rate.

40. A particular species of tropical fish has only a few offspring and takes care of them for an extended period. We might also expect the fish population to
(a) be controlled mostly by density independent factors.
(b) show exponential growth.
(c) live in a harsh environment.
(d) be relatively stable, near carrying capacity.

41. Chimpanzees have a relatively low birth rate. They take good care of their young, and most chimps live a long life. The chimp survivorship curve would look like a
(a) line that slopes gradually upward.
(b) relatively flat line that drops steeply at the end.
(c) line that drops steeply at first, then flattens out.
(d) line that slopes gradually downward.

42. An ecologist would suspect that a population is growing rapidly if it
(a) contains many more pre-reproductive than reproductive individuals.
(b) is near its carrying capacity.
(c) is limited only by density-dependent factors.
(d) shows a clumped pattern of dispersion.

43. When birth rate equals death rate,
(a) a population grows rapidly.
(b) the size of a population remains constant.
(c) density-dependent limiting factors do not affect the population.
(d) a population is in danger of extinction.

44. From an ecologist's point of view, population structure does not include the
(a) distribution of genotypes within a population.
(b) population density.
(c) spacing of population members.
(d) biomass of the population.

45. Which of the following would probably not be true of a population whose dynamics are primarily influenced by density- independent factors?
(a) The population's growth pattern is similar to the logistic growth curve.
(b) The birth rate of the population is dependent on the nutritional status of its adult females.
(c) The most important source of mortality in the population is unfavourable weather conditions.
(d) Both (a) and (b)

46. If the number of deaths in a population equals the number of births, it is
(a) Plateau phase (b) Log phase
(c) Lag phase (d) Exponential phase

47. Choose the collection of terms that completes the following sentence : Plants are____ organisms, they frequently show a _____ spatial distribution, and their population density is most appropriately expressed in terms of _____ .
(a) modular; clumped; biomass
(b) modular; random; individuals per unit area
(c) modular; uniform; biomass
(d) unitary; uniform; biomass

48. At carrying capacity, a population _____.
(a) increases rapidly
(b) decreases slowly
(c) decreases rapidly
(d) fluctuates around a median number

49. In the formula G = rN (K – N)/K, the factor rN tends to cause the population to _____.
(a) remain stable at the carrying capacity
(b) grow at a slower rate than the (K – N/K) factor
(c) grow increasingly rapidly
(d) decrease in size

50. Explosive growth in human population size can be attributed largely to . . .
(a) declining death rates due to improved medical care.
(b) proliferation of fast-food outlets, leading to easier access to nutrients.
(c) increasing birth rates due to better health and fertility.
(d) declining death rates due to declining incidence of war.

51. Human population growth _____.
(a) has an S-shaped curve
(b) is currently in a logistic phase
(c) is currently exponential
(d) has reached carrying capacity

52. The age-structure diagram of a country like Mexico, which has a high population growth rate, has the shape of _____.
(a) a triangle with the point at the bottom
(b) a rectangle tapered at the top
(c) a pyramid
(d) an hour glass

53. The number of individuals per unit area or volume is known as . . .
(a) population density
(b) population growth
(c) community ecology
(d) population distribution

54. All of the following population would likely result in a uniform dispersion pattern **except** :
(a) nesting penguins on a small beach
(b) territories of bears in a forest
(c) perennial shrubs (of a given species) growing in a desert habitat
(d) lions on the savanna

55. A population of 500 that experiences 55 births and 5 deaths during a one-year period. What is the reproductive rate for the population during the one-year period ?
(a) 0.01/year (b) 0.05/year
(c) 0.1/year (d) 50/year

56. A population of 600 that experiences 65 births and 5 deaths during a one-year period. If the population maintains the current growth pattern, a plot of its growth would resemble
(a) exponential growth (b) fluctuating growth
(c) K-selected growth (d) logistic growth

57. The maximum expansion rate of a population under the best conditions is referred to as _____. There are abundant resources that last forever and no limits on growth.
(a) biotic potential (b) cohort
(c) mortality rate (d) biome

58. The formula for the line would best be written as
(a) dN/dT = r(N–K/N) N.
(b) dN/dT = r(K–N/N) K.
(c) dN/dT = r(N–K/K) N.
(d) dN/dT = r(K–N/K) N.

59. Which one of the following ecosystem types has the highest annual net primary productivity?
(a) Tropical deciduous forest
(b) Temperate evergreen forest
(c) Temperate deciduous forest
(d) Tropical rain forest.

60. In a population unrestricted reproductive capacity is called as
(a) biotic potential (b) fertility
(c) carrying capacity (d) birth rate

61. The equation $\frac{\Delta N_n}{\Delta N_t} = B$ represents which of the following
(a) Natality (b) Growth rate
(c) Mortality (d) All of these

62. In an age pyramid, the number of individuals of reproductive age is lesser than prereproductive but higher than post reproductive ones. The population is
(a) Growing (b) Declining
(c) Stable (d) Can not be predicted

63. The term 'precipitation' includes
(a) Rain
(b) Hails
(c) Snow
(d) All forms of water that fall to the ground

64. Ratio of natality and mortality of a population is expressed in percentage as
(a) Vital index (b) Growth rate
(c) Survival rate (d) Biotic potential

65. In which animal green foliage type of mimic is found ?
(a) *Carausisius* (b) *Rhyllium*
(c) Praying mantis (d) *Kalima*

66. In commensalism –
(a) Population of commensal and host remains unaffected
(b) Population of commensal may increase while that of host remains unaffected
(c) Population of both commensal and host increases
(d) Population of commensal increases while the population of host gradually decreases

67. A bird eats the fruit of a plant species. The seeds are not digested and germinate in the bird's excreta at some distance from the parent plant. This is an example of
(a) predation (b) competition
(c) commensalism (d) mutualism

68. The salinity in sea water in parts per thousand (ppt) ranges between
(a) 5-15 % (b) 30-35%
(c) 50-75% (d) More than 100 %

69. According to the principle of competitive exclusion, two species cannot continue to occupy the same . . .
(a) biome.
(b) ecological niche.
(c) environmental habitat.
(d) range.

70. Which of the following type of interactions occur in predation and parasitism ?
(a) (+, +) (b) (+, 0)
(c) (+, –) (d) (–, –)

71. Interactions in which the consumer lives within the host and does slow damage to the host are referred to as
(a) commensalism. (b) parasitism.
(c) mutualism. (d) competition.

72. The relationship between hermit crab and sea anemone is
(a) symbiosis (b) mutualism
(c) parasitism (d) commensalism

73. The foraging, reproductive and migratory activities of the organisms are primarily dependent upon
(a) Light (b) Temperature
(c) Water (d) Soil

74. Small fish get stuck near the bottom of a shark and derives its nutrition from it. This kind of association is called as
(a) Symbiosis (b) Commensalism
(c) Predation (d) Parasitism

75. An assocation between two individuals or population where both the benefitted and where neither can survive without the other is
(a) Commensalism (b) Amensalism
(c) Proto-cooperation (d) Mutualism

EXERCISE - 2
Applied Questions

1. Niche overlap indicates
(a) two different parasites on the same host
(b) sharing of one or more resources between the two species
(c) mutualism between two species
(d) active cooperation between two species

2. The formula for exponential population growth is
(a) dN/*r*N = dt (b) *r*N / dN = dt
(c) dN / dt = *r*N (d) dt / dN = *r*N

3. Geometric representation of age structure is a characteristic of
(a) population (b) landscape
(c) ecosystem (d) biotic community.

4. The population of an insect species shows an explosive increase in numbers during rainy season followed by its disappearance at the end of the season. What does this show?
(a) The food plants mature and die at the end of the rainy season
(b) Its population growth curve is of J-type
(c) The population of its predators increases enormously
(d) S-shaped or sigmoid growth of this insect.

5. Two plants can be conclusively said to belong to the same species if they
(a) have more than 90 per cent similar genes
(b) look similar and possess identical secondary metabolites
(c) have same number of chromosomes
(d) can reproduce freely with each other and form seeds.

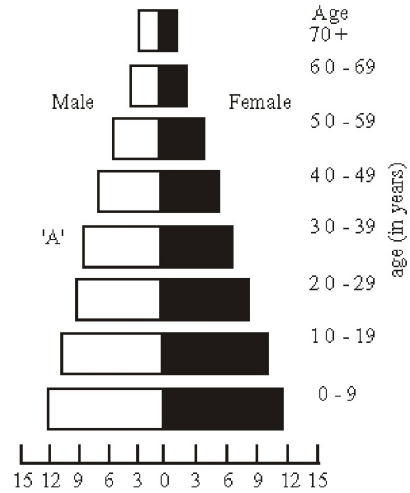
6. What is true about the isolated small tribal populations?
(a) There is a decline in population as boys marry girls only from their own tribe
(b) Hereditary diseases like colour blindness do not spread in the isolated population
(c) Wrestlers who develop strong body muscles in their life time pass this character on to their progeny
(d) There is no change in population size as they have a large gene pool

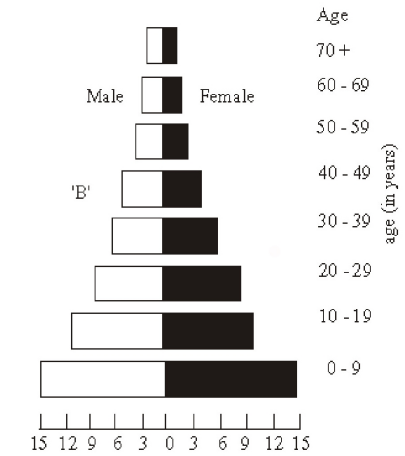
7. In the case of peppered moth (*Biston betularia*) the black - coloured form became dominant over the light- coloured form in England during industrial revolution.
This is an example of:
(a) appearance of the darker coloured individuals due to very poor sunlight
(b) protective mimicry
(c) inheritance of darker colour character acquired due to the darker environment
(d) natural selection whereby the darker forms were selected

8. Large woody vines are more commonly found in :
(a) temperate forest (b) mangroves
(c) tropical rainforests (d) alpine forests

9. Consider the following four conditions (i) - (iv) and select the correct pair of them as adaptation to environment in desert lizards.
The conditions :
(i) Burrowing in soil to escape high temperature
(ii) Losing heat rapidly from the body during high temperature
(iii) Bask in sun when temperature is low
(iv) Insulating body due to thick fatty dermis
Options :
(a) (iii) and (iv) (b) (i)
(c) (iii), (ii) and (iv) (d) (i) and (ii)

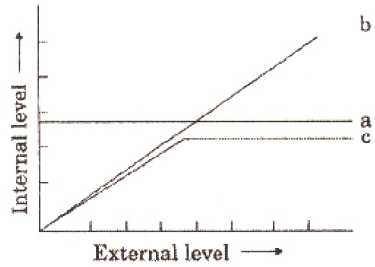
10. A country with a high rate of population growth took measures to reduce it. The Figure below shows age-sex pyramids of populations A and B twenty years apart.
Select the correct interpretation about them: Interpretations:





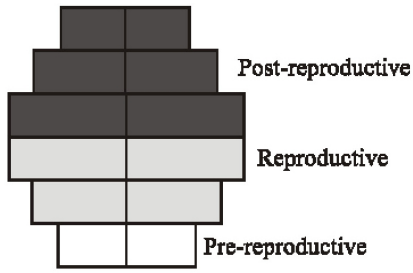
(a) "B" is earlier pyramid and shows stabilised growth rate..
(b) "B" is more recent showing that population is very young.
(c) "A" is the earlier pyramid and no change has occurred in the growth rate.
(d) "A" is more recent and shows slight reduction in the growth rate.

11. The figure given below is a diagrammatic representation of response of organisms to abiotic factors. What do a, b and c represent respectively?



	1	2	3
(a)	conformer	regulator	partial regulator
(b)	regulator	partial regulator	conformer
(c)	partical regulator	regulator	conformer
(d)	regulator	conformer	partial regulator

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



(a) Vanishing population
(b) Stable population
(c) Declining population
(d) Expanding population

13. A sedentary sea anemone gets attached to the shell lining of hermit crab. The association is :
(a) Symbiosis (b) Commensalism
(c) Amensalism (d) Ectoparasitism

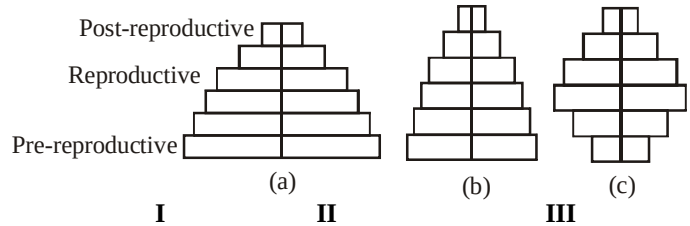
14. A biologist studied the population of rats in a barn. He found that the average natality was 250, average mortality 240, immigration 20 and emigration 30. The net increase in population is :
(a) 15 (b) 05
(c) zero (d) 10

15. Benthic organisms are affected most by
(a) Water-holding capacity of soil
(b) Light reaching the forest floor
(c) Surface turbulence of water
(d) Sediment characteristics of aquatic ecosystems

16. The age pyramid with broad base indicates
(a) High percentage of young individuals
(b) High percentage of old individuals
(c) Low percentage of young individuals
(d) A stable population

17. Which one of the following is **not** a parasitic adaptation?
(a) Loss of unnecessary sense organs
(b) Development of adhesive organs
(c) Loss of digestive organs
(d) Loss of reproductive capacity

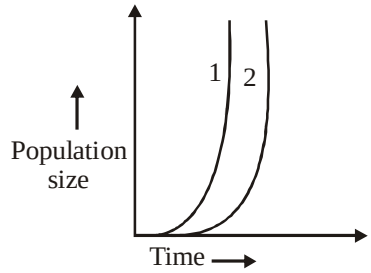
18. What does the shape of the given age pyramids (a to c) reflect about the growth status of populations ?



	I	II	III
(a)	Declining	Stable	Expanding
(b)	Stable	Expanding	Declining
(c)	Expanding	Stable	Declining
(d)	Declining	Expanding	Stable

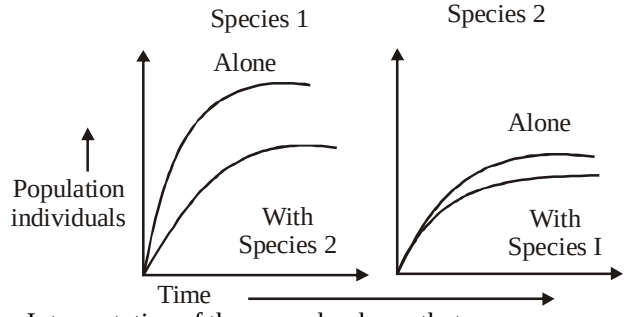
19. In the following graph, which of the expressions (a through d) of the exponential growth equation should be increased in order for curve 1 to become more like curve 2?

$$\frac{\Delta N}{\Delta t} = (b-d)N$$



(a) N (b) d
(c) b (d) (b – d)

20. In laboratory experiments, two species of the protist *Paramecium* were grown alone and in the presence of the other species. The following graphs show growth of species 1 (left) and species 2 (right), both along and when in mixed culture.



Interpretation of these graphs shows that –

(a) competitive exclusion occurred in the these experiments.
(b) both species are affected by interspecific competition but species 1 is affect less.
(c) both species are affected by interspecific competition but species 2 is affected less.
(d) both species are affected equally by interspecific competition.

21. Match Column I with Column II.

	Column I		**Column II**
A.	Mutualism	1.	Tiger and deer
B.	Commensalism	2.	*Cuscuta* on *Cissus*
C.	Parasitism	3.	Sucker fish and shark
D.	Predation	4.	Crab and sea anemone

(a) A → (1); B → (2); C → (3); D → (4)
(b) A → (4); B → (3); C → (2); D → (1)
(c) A → (2); B → (3); C → (1); D → (4)
(d) A → (4); B → (2); C → (3); D → (1)

22. Match Column I with Column II.

	Column I		**Column II**
A.	0.2 to 2.00 mm	1.	Silt
B.	Less than 0.002 mm	2.	Clay
C.	0.02 to 0.2 mm	3.	Coarse sand particle
D.	0.002 to 0.02 mm	4.	Fine sand particle

(a) A → (2); B → (3); C → (4); D → (1)
(b) A → (4); B → (1); C → (3); D → (2)
(c) A → (3); B → (2); C → (4); D → (1)
(d) A → (2); B → (3); C → (1); D → (4)

23. Which of the following statement(s) is/are correct?
(1) Organisms living in oceans, lakes and rivers do not face any water-related problems
(2) Euryhaline can tolerate a wide range of salinities
(3) Stenohaline are restricted to a narrow range of salinities
(4) No fresh water animals cannot live for long in sea water but sea animals can live in fresh water for long time because of osmotic balance
(a) All are correct (b) All are false
(c) Only (4) (d) (1), (3) and (4)

24. Which of the following statement(s) is/are correct?
(1) In a population growth rate curve the lag phase represents the period when a population is adjusting to a new environment.
(2) In a population growth rate curve the steepest part of growth phase represents the period when a population is growing exponentailly.
(3) In the stationary phase of a population growth rate curve the population is in dynamic equilibrium.
(4) Human have changed the carrying capacity of the earth.
(a) All of these (b) (1), (2) and (3)
(c) (2) and (3) (d) (1) and (4)

DIRECTIONS for Q. 25: This question contain STATEMENT-1 (Assertion) and STATEMENT-2 (Reason) and has 4 choices (a), (b), (c) and (d) out of which ONLY ONE is correct.
(a) Statement- 1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement -1
(b) Statement -1 is True, Statement -2 is True ; Statement-2 is NOT a correct explanation for Statement - 1
(c) Statement - 1 is True, Statement- 2 is False
(d) Both the Statements are False.

25. **Statement 1 :** No two species can occupy the same ecological niche in a habitat.
Statement 2: A habitat can contain only on ecological niche.

EXERCISE - 3
Exemplar & Past Years NEET/AIPMT Questions

Exemplar Questions

1. Autecology is the
(a) relation of a population to its environment
(b) relation of an individual to its environment
(c) relation of a community to its environment
(d) relation of a biome to its environment

2. Ecotone is
(a) a polluted area
(b) the bottom of a lake
(c) a zone of transition between two communities
(d) a zone of developing community

3. Biosphere is
(a) a component in the ecosystem
(b) composed of the plants present in the soil
(c) life in the outer space
(d) composed of all living organisms present on earth which interact with the physical environment

4. Ecological niche is
(a) the surface area of the ocean
(b) an ecologically adapted zone
(c) the physical position and functional role of a species within the community
(d) formed of all plants and animals living at the bottom of a lake

5. According to Allen's rule, the mammals from colder climates have
(a) shorter ears and longer limbs
(b) longer ears and shorter limbs
(c) longer ears and longer limbs
(d) shorter ears and shorter limbs

6. Salt concentration (salinity) of the sea measured in parts per thousand is
(a) 10 - 15 (b) 30 - 70
(c) 0 - 5 (d) 30 - 35

7. Formation of tropical forests needs mean annual temperature and mean annual precipitation as
(a) 18 - 25°C and 150 - 400 cm
(b) 5 - 15° C and 50 - 100 cm
(c) 30 - 50°C and 100 - 150 cm
(d) 5 - 15°C and 100 - 200 cm

8. Which of the following forest plants controls the light conditions at the ground?
(a) Lianas and climbers
(b) Shrubs
(c) Tall trees
(d) Herbs

9. What will happen to a well growing herbaceous plant in the forest if it is transplanted outside the forest in a park?
(a) It will grow normally
(b) It will grow well because it is planted in the same locality
(c) It may not survive because of change in its micro climate
(d) It grows very well because the plant gets more sunlight

10. If a population of 50 Paramecium present in a pool increases to 150 after an hour, what would be the growth rate of population?
(a) 50 per hour (b) 200 per hour
(c) 5 per hour (d) 100 per hour

11. What would be the percent growth or birth rate per individual per hour for the same population mentioned in the previous question (Question 10)?
(a) 100 (b) 200
(c) 50 (d) 150

12. A population has more young individuals compared to the older individuals. What would be the status of the population after some years?
(a) It will decline
(b) It will stabilise
(c) It will increase
(d) It will first decline and then stabilise

13. What parameters are used for tiger census in our country's national parks and sanctuaries?
(a) Pug marks only
(b) Pug marks and faecal pellets
(c) Faecal pellets only
(d) Actual head counts

14. Which of the following would necessarily decrease the density of a population in a given habitat?
(a) Natality > mortality
(b) Immigration > emigration
(c) Mortality and emigration
(d) Natality and immigration

15. A protozoan reproduces by binary fission. What will be the number of protozoans in its population after six generations?
(a) 128 (b) 24
(c) 64 (d) 32

16. In 2005, for each of the 14 million people present in a country, 0.028 were born and 0.008 died during the year. Using exponential equation, the number of people present in 2015 is predicted as
(a) 25 millions (b) 17 millions
(c) 20 millions (d) 18 millions

17. Amensalism is an association between two species where
(a) one species is harmed and other is benefitted
(b) one species is harmed and other is unaffected
(c) one species is benefitted and other is unaffected
(d) both the species are harmed.

18. Lichens are the associations of :
(a) bacteria and fungus
(b) algae and bacterium
(c) fungus and algae
(d) fungus and virus

19. Which of the following is a partial root parasite?
(a) Sandal wood (b) *Mistletoe*
(c) *Orobanche* (d) *Ganoderma*

20. Which one of the following organisms reproduces sexually only once in its life time?
(a) Banana plant (b) Mango
(c) Tomato (d) Eucalyptus

NEET/AIPMT (2013-2017) Questions

21. A sedentary sea anemone gets attached to the shell lining of hermit crab. The association is : ***[2013]***
(a) Symbiosis (b) Commensalism
(c) Amensalism (d) Ectoparasitism

22. 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 : ***[2013]***
(a) 15 (b) 05
(c) zero (d) 10

23. Benthic organisms are affected most by ***[NEET Kar. 2013]***
(a) Water-holding capacity of soil
(b) Light reaching the forest floor
(c) Surface turbulence of water
(d) Sediment characteristics of aquatic ecosystems

24. Which one of the following is **not** a parasitic adaptation?
(a) Loss of unnecessary sense organs ***[NEET Kar. 2013]***
(b) Development of adhesive organs
(c) Loss of digestive organs
(d) Loss of reproductive capacity

25. Most animals are tree dwellers in a: ***[2015 RS]***
(a) Thorn woodland
(b) Temperate deciduous forest
(c) Tropical rain forest
(d) Coniferous forest

26. In which of the following interactions both partners are adversely affected ? ***[2015 RS]***
(a) Predation (b) Parasitism
(c) Mutualism (d) Competition

27. The following graph depicts changes in two populations (A and B) of herbivores in a grassy field A possible reason for these changes is that: ***[2015 RS]***

(a) Population B competed more successfully for food than population A
(b) Population A produced more offspring than population B
(c) Population A consumed the members of population B
(d) Both plant populations in this habitat decreased

28. Gause's principle of competitive exclusion states that : ***[2016]***

(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.

29. When does the growth rate of a population following the logistic model equal zero ? The logistic model is given as $dN/dt = rN(1–N/K)$ ***[2016]***

(a) when N/K is exactly one.
(b) when N nears the carrying capacity of the habitat.
(c) when N/K equals zero.
(d) when death rate is greater than birth rate.

30. Asymptote in a logistic growth curve is obtained when : ***[2017]***

(a) $K = N$
(b) $K > N$
(c) $K < N$
(d) The value of 'r' approaches zero

31. Artificial selection to obtain cows yielding higher milk output represents : ***[2017]***

(a) Directional as it pushes the mean of the character in one direction
(b) Disruptive as it splits the population into two, one yielding higher output and the other lower output
(c) Stabilizing followed by disruptive as it stabilizes the population to produce higher yielding cows
(d) Stabilizing selection as it stabilizes this character in the population

32. Select the mismatch : ***[2017]***

(a) *Rhodospirillum* - Mycorrhiza
(b) *Anabaena* - Nitrogen fixer
(c) *Rhizobium* - Alfalfa
(d) *Frankia - Alnus*

33. Presence of plants arranged into well defined vertical layers depending on their height can be seen best in: ***[2017]***

(a) Tropical Rain Forest
(b) Grassland
(c) Temperate Forest
(d) Tropical Savannah

34. Mycorrhizae are the example of: ***[2017]***

(a) Amensalism (b) Antibiosis
(c) Mutualism (d) Fungistasis

Hints & Solutions

EXERCISE - 1

1. (c) 2. (a) 3. (c) 4. (c) 5. (c) 6. (a)
7. (c) Permafrost, a permanently frozen subsoil, is a distinctive characteristic of the tundra.
8. (a) Grasslands are typically maintained by grazing herbivores and by periodic fires. Overgrazing, such as may occur if agricultural livestock are introduced, can lead to destruction of the grassland.
9. (c) Deserts have less than 25 centimeters of rainfall per year.
10. (d) Competition for light is a critical survival factor among plants living in tropical rain forests.
11. (a)
12. (a) A biome is a major ecological community of organisms that extends over a large geographical area characterized by a dominant type of vegetation.
13. (b) Expansion of a species range is a long-term population change and not a response to seasonal changes habitat quality.
14. (d) The keystone species in an ecosystem are those who are the main contributors to the ecosystem.
15. (c) Adaptability refers to the capacity of the organisms to adapt themselves to their environment.
16. (a)
17. (d) Tropical rain forests occur in equatorial and subequatorial regions. The forests receive all the external inputs for optimum plant growth. Due to abundant plant growth, a large number of animals live in tropical rain forests. In grasslands fire occur periodically which prevent tree growth. In savannah periods of drought are common. In deciduous forests are found predominantly broad leaved hard wood deciduous trees.
18. (a) In Tundra much of the ground stays frozen round the year, this condition is called permafrost.
19. (c) Because edaphic factors affects through soil and rest are the climatic factors.
20. (b) Deserts have 25 cm (10 inches) or less of precipitation and show poor biodiversity and their productivity is minimum.
21. (a)
22. (b) The plants which grow best in full sunlight are called sun plants or heliophytes.
23. (a) 24. (a) 25. (a) 26. (b) 27. (b) 28. (c)
29. (d) 30. (d) 31. (a)
32. (d) Individuals are often found clumped about a resource.
33. (c)
34. (c) Prairies is a grassland whereas epiphytes and ephemerals are found in desert. In Tundra much of the ground stays frozen round the year, this condition is called permafrost. The *Acacia* trees are common in African savannas. In coniferous forest all plants do not shed their leaves at the same time hence forest remain ever green.
35. (d) With the exception of humans, a population should have no effect on the weather as it grows.
36. (a) Such a population has many pre-reproductive individuals.
37. (a) As population size increases, the effects of density-dependent factors become more apparent.
38. (b)
39. (d) *r* is the intrinsic rate of increase of an organism.
40. (d) Such a population exhibits an equilibrial life history.
41. (b) This describes a population that exhibits a Type I survivorship curve.
42. (a) This would indicate that a larger number of individuals will be entering their reproductive years than are currently reproducing.
43. (b) When birth rate is equal to death rate individuals are being added to the population at the same rate at which they are being removed from the population (note that this fails to consider migration).
44. (d) Population structure includes numbers, spacing and age distribution of genotypes. Biomass is often the best measure of density for some organisms like plants.
45. (d) The logistic growth curve describes density-dependent growth because the rate of increase in the size the population steadily decreases as the carrying capacity is approached. The nutritional status of the females of the population would depend on the availability of food and hence would be density-dependent. Unfavourable weather, on the other hand, generally occurs without any predictable relationship to the size of a population and thus is a density-independent factor.
46. (a) 47. (c)
48. (d) Ecologists define carrying capacity as the maximum population size that a particular environment can support with no net increase or decrease over a relatively long period of time. Many populations oscillate about their carrying capacity or overshoot it at least once before attaining a relatively stable size.
49. (c) The difference between birth rate and death rate is symbolized as r. N is the population size. So rN is the population growth rate.
50. (a) Human death rates have decreased due to declining infant mortality that has resulted from improved nutrition, medical advances, and better sanitation.
51. (c) The exponential growth model virtually describes the population explosion of humans.
52. (c) The age structure of Mexico has a large fraction of individuals who are young and likely to reproduce in the near future. The overall shape is that of a pyramid.
53. (a) 54. (d)
55. (c) The rate of growth, *r*, equals (55 births – 5 deaths)/ 500 per year, or 0.1/year.
56. (a) If the reproductive rate is greater than zero (r>0), then the population is growing exponentially.

57. (a) The mortality rate is a percentage of individuals that began a specific year alive but have passed away before the conclusion of the same year. Biotic potential of a species is influenced by the following length of reproductive life, how often reproduction occurs, how many progeny are created at each birth occurrence, what is the reproductive age, and how many live to actually reproduce.
58. (d)
59. (d) They are found in the equatorial regions (rainfall exceeds 140 cm.). The warm humid climate supports broad leaved evergreen plants. Productivity is very high (12000 k. cal/m^2/ year). The vegetation show stratification into two or more well defined layers.
60. (a) 61. (b) 62. (a) 63. (d) 64. (a) 65. (c)
66. (b)
67 (d) Both species have benefitted; the bird dispersed and provided fertilizer for the plant's seed, the plant provided food for the bird.
68. (b)
69. (b) The competitive exclusion principle is the concept that when the populations of two species compete for the same limited resources, one population will use the resources more efficiently and have a reproductive advantage that will eventually lead to the elimination of the other species.
70. (c) Predation occurs when members of one species eat the other species, while parasitism occurs when one member of a species parasite on the other body. In this case one member of a species are benefitted (+) while the other member of a species are harmed (–).
71. (b) This is the classic definition of a parasitic interaction.
72. (d) Commensalism is a relationship between organism and its host in which the host neither benefits nor suffers from the association, *e.g.*, hermit crab and sea anemone.
73. (a)
74. (b) Commensalism is an association between 2 organisms in which one is benefitted without the other being harmed *e.g.*, Sucker fish has a hold fast and attached itself underside of shark and thus remains protected and also get food left over when shark is feeding on its prey.
75. (d)

EXERCISE - 2

1. (b) Niche indicate the habitat of a particular species and the interaction of that species with the resources present in the habitat. Niche overlap means that two or more species sharing the resources present in a particular niche.
2. (c) The formula of exponential growth is $\frac{dN}{dt} = rN$ where $\frac{dN}{dt}$ is the rate of change in population size, *r* is the biotic potential and N is the population size.
3. (a) Geometric representation of age structure a characteristic of population.
4. (b) If a population (*e.g.* reindeer population) is allowed to grow in a predator free environment, the population grows beyond carrying capacity and there occurs population crash due to sudden shortage of food. Such growth curves also occur in insect populations during rainy season, and in algal blooms.
5. (d) When the members of a species are inter - fertile and produce fertile offsprings.
6. (a) There is a decline in population as boys marry girls only from their own tribe in the isolated small tribal populations.
7. (d) In the case of peppered moth *(Biston betularia)* the black coloured form became dominant over the light coloured form in England during industrial revolution. This is an example of natural selection. This group is about species that gain protection from predators due to selection caused by nature.
8. (c) Large woody vines are more commonly found in tropical rain forests. This is a common concern in the high humidity climatic condition.
9. (b) Some species make permanent burrows deep into the soil to escape high temperature or sunlight and some cold blooded animals often like to bask in the sun to warm up their body.
10. (d) 'A' is more recent and shows slight reduction in growth rate.
11. (d) In the graph, the line a represents regulator, line b represents conformer and line c represents partial regulator. Organisms that are able to maintain homeostasis by physiological means that ensures constant body temperature are called regulators. Organism that are not able to maintain a constant internal temperature are called conformers.
    Partial regulators are organisms that have the ability to regulate, but only over a limited range of environmental conditions, beyond which they simply conform.
12. (c) This age pyramid represents the declining population of any organism. Population decline is the reduction over time in region's census. It can be caused for several reasons that includes heavy immigration disease, famine or sub-replacement fertility.
13. (b) Commensalism is an interaction where one species is benefitted and other is neither benefitted nor harmed.
14. (c) Net increase in population : (Natality + Immigration) – (Mortality + Emigration)
    (250 + 20) – (240 + 30) = 270 – 270 = 0
15. (d) The sediment characteristics often determine the type of benthic animals that can thrive there.
16. (a) Age pyramid is a graphic representation of different age groups of population with pre-reproductive groups at the base, reproductive ones in the middle and post-reproductive groups at the top. In Triangular age pyramid, the number of pre-reproduction individual is very large while reproductive are moderate and post-reproductive are fewer.

17. (d) In Parasitism, one species (parasite) is benefitted and the other (host) is harmed. Parasites have very high reproduction capacity. The life cycles of parasites are often complex, involving one or two intermediate hosts or vectors to facilitate parasitisation of its primary host.

18. (c) 19. (b) 20. (c) 21. (b)

22. (c) The texture of soil is determined by the proportions of particles of different sizes. Coarse sand particles are of 0.2 to 2.00 mm in size; 0.002 to 0.02 particles represent silt and particles smaller than 0.002 mm are called clay.

23. (c) 24. (a)

25. (c) The place where an organism lives is called its habitat. Habitats are characterised by conspicuous physical features, which may include the dominant forms of plant and animal life. Habitat may also refer to the place occupied by an entire biological community. For example, a large number of species are found in a forest habitat. On the other hand, the ecological niche of an organism represents (i) the range of conditions it can tolerate (ii) the resources it utilises, and (iii) its functional role in the ecological system. A habitat can contain many ecological niches and support a variety of species. Each species has a distinct niche, and no two species are believed to occupy exactly the same niche.

EXERCISE - 3

Exemplar Questions

1. (b) The study of relationship of an individual is called autecology. So, the relation of a population or community to its environment is called synecology and the rest options are irrelevant.

2. (c) These adjacent biotic communities, generally do not possess a fine demarcation edge or line between them. The transition zone between two communities is referred as **ecotone**.

3. (d) Biosphere is composed of all living organisms present on earth which interact with their physical environment. The other three options, represents only a part of ecosystem.

4. (c) The specific place of habitat occupied by individual of a species is ecological niche. It in turn is determined by factors such as by the range of tolerance. *i.e.*, the physical position and functional role of a species within the community, etc. Rest of the options are not correct.

5. (d) According to Allen's rule, the mammals (endothermal animals) from colder climates or areas show shorter extremities like ears and limbs as compared to the mammals of warm region. The shorter extremities of mammals in colder region helps them. To minimise heat loss and maintain homeostasis.
   Rest of the other options does not follow Allen's rule.

6. (d) Water is an important abiotic component influencing the life of an organisms other than temperature. In an oceanic ecosystem, the organisms face water related problems like pH, salinity of water. The salt concentration (salinity) of sea measured in parts per thousand is 30-35. The salinity is less than 5 in land water, 30-35 in sea water and >100 do in some hypersaline water bodies like lagons.
   The other three options are incorrect.

7. (a) Formation of that tropical forest need annual temperature 18-25°C and annual rainfall (precipitation)above 140 cm, usually between 150 - 400 cm and reach upto 1000 cm/year. Tropical forest or evergreen forest mainly occurs in equatorial or subequatorial region like Amazon, Central America and Orinco and Congo river basins of South America and Africa respectively. The other options are incorrect.

8. (c) Light is an important abiotic component that controls a number of life processes in organism in a forest ecosystem. Its intensity, duration and quality at ground is controlled by tall trees, that have higher productivity than shrubs and herbs growing underneath. Lianas and climber are woody vines which make commensalism association with tall trees. Herbs and shrubs occupy lower strata of forest.

9. (c) In a forest ecosystem the light condition is controlled by tall trees of forest plants i.e., intensity, duration and quality of light at the ground. A well growing herbaceous plant in forest receive less intensity, duration and quality of light, but when it is transplanted in a park outside the uninterrupted light will be received.
   So because of change in its microclimate, it may not survive. Other options are incorrect.

10. (d) The natural capacity of a population to multiply at its maximum rate under favourable environmental conditions is known as biotic potentials. Population of *Paramecium* shows 100 per hour growth, i.e., two individuals are produced by one.

11. (b) Growth rate is 200% as one organism is producing two individuals at a time.

12. (c) A population of more young individual than older individuals, will cause positive growth in future (after some years), *i.e.*, after some time it will increase.
    Rest of the options are incorrect.

13. (b) The parameters used for tiger census in our country's national park and sancturaries are foot prints i.e. pug marks and faecal pallets of conserved animals.

14. (c) The number of individuals present per unit volume/area at given time is population density.
    Thus, mortality and emigration would necessarily decrease the density of a population in a given habitat because of loss of individual result from mortality (deaths) and emigration. When natality rate will be more than mortality rate and increased immigration rate mould necessarily increase the density of a population.

15. (c) Binary fission is a mode of asexual reproduction in which protozoan produces two offsprings from parent individual.

So,

$$\underset{\text{(1st generation)}}{\text{Single protozoan}} \xrightarrow{\text{Multiplied}} \underset{\text{(ii)}}{\text{Two (2 individual)}} \rightarrow$$

$$\underset{(iii)}{4} \longrightarrow \underset{(iv)}{8} \longrightarrow \underset{(v)}{16} \longrightarrow \underset{(vi)}{32} \longrightarrow 64\ Nos$$

Thus, the population of protozoan will be 64, after six generations.

16. (b) Exponential equation
$dN/dt = (b - d) \times N$
$dN/10 = (0.028 - 0.008) \times 14\ (0.020) \times 14$
$dN/10 = 0.28$
$dN = 0.28 \times 10$
$dN = 2.8$
= 14 million + 2.8 million
= 16.8 million = 17 million
So, the number of people present in 2015 is predicted as 17 millions.

17. (b) When one species is harmed or destoryed and other remains unaffected in an association between two species, it is called amensalism. In commensalism, one species is benefitted and other is unaffected.
The other options are incorrect because when one species is harmed and other is benefitted, the relationship is termed as parasitism.

18. (c) Lichens represent a beneficial interaction between two different species, one fungus and another algae.

19. (a) Sandal wood (*Santalum album*) is partial root parasite. Mistletoe (*Viscum*) is considered as hermiparasite that derive a part of nourishment from host plant. *Orobanche* is a holo parasite that infects species from fabaceae i.e., beans, loranthus. Ganoderma are parasite, basidiocarpic mushrooms.

20. (a) Those plants which flower once in their life are monocarpic plants *e.g.*, all annuals (wheat, rice), biennials like carrot and radish, perennial like bamboo. Banana is a monocarpic plant, so reproduces sexually once in its lifetime. Rest of the options are incorrect.

NEET/AIPMT (2013-2017) Questions

21. (b) Commensalism is a interaction where one species is benefitted and other is neither benefitted nor harmed.

22. (c) Net increase in population :
(Natality + Immigration) – (Mortality + Emigration)
(250 + 20) – (240 + 30) = 270 – 270 = 0

23. (d) The sediment characteristics often determine the type of benthic animals that can thrive there.

24. (d) In Parasitism, one species (parasite) is benefitted and the other (host) is harmed. Parasites have very high reproduction capacity. The life cycles of parasites are often complex, involving one or two intermediate hosts or vectors to facilitate parasitisation of its primary host.

25. (c) In tropical rain forest zone, most of the animals prefer to live on trees. The reason is that the floor of forest is full of humidity, decomposing leaves and other organic matters and is the habitat of insects etc.

26. (d) Competition occurs for light, food and space among organisms in which all partners are adversely affected in an ecosystem.

27. (a) The given graph illustrates that population B got success in the grassy field in comparison to population A.

28. (c) Gause's principle of competitive exclusion can be restated to say that no two species can occupy the same niche indefinitely when resources are limiting. Certainly species can and do coexist while competing for some of the same resources. Nevertheless, Gause's theory predicts that when two species coexist on a long-term basis, either resources must not be limited or their niches will always differ in one or more features; otherwise, one species will outcompete the other and the extinction of the second species will inevitably result, a process referred to as competitive exclusion.

29. (a) In logistic growth model population growth equation is described as

$$\frac{dN}{dt} = rN\left(1 - \frac{N}{K}\right)$$

N = population density at time t;
r = Intrinsic rate of natural increase;
K = carrying capacity

When N/K = 1; $1 - \frac{N}{K} = 0$

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

30. (a) In logistic growth curve, the curve has an upper a symptote known as carrying capacity (K) is obtained when the maximum population size is at $\frac{dN}{dt} = 0$. A population growing in a habitat with limited resources shows logistic growth curve.
For logistic growth

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

If K = N then $\frac{K - N}{K} = 0$

$\therefore$ the $\frac{dN}{dt} = 0$.
the population reaches asymptote.

31. (a) Artificial selection to obtain cow yielding higher milk output will shift the peak to one direction, so this represent an example of Directional selection. In stabilizing selection, the organisms with the mean value of the trait are selected. In disruptive selection, both extremes get selected.

32. (a) Rhodospirillum is facultative anaerobe and free living nitrogen fixer. Mycorrhiza show symbiotic relationship between fungi and roots of higher plants.

33. (a) The tropical rain forest have five vertical strata on the basis of plants height i.e., ground vegetation, shrubs, short canopy trees, tall canopy trees and tall emergent trees.

34. (c) Mycorrhizae is a symbiotic association between fungi and roots of higher plants.