11 CHAPTER

Organisms and Population

Level - 1 CORE SUBJECTIVE QUESTIONS

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (C) is correct

   Explanation: When a population grows in a geometric or exponential fashion with unlimited resources, it follows an exponential growth curve, which is represented as a J-shaped curve on a graph.

   In this scenario, the growth rate of the population is proportional to its current size, leading to a rapid increase in population size over time. Since resources are not limiting, there are no constraints on the growth, allowing the population to continue expanding exponentially.

2. Option (D) is correct

   Explanation: Lice, Tick, and Copepod are all parasites because they live on or inside a host organism and derive nutrients at the host's expense.

3. Option (C) is correct

   Explanation: Statement (i) is true because both a lion eating a deer and a sparrow feeding on grains are consumers, relying on other organisms for food. Statement (ii) is also true, as the predator starfish *Pisaster* helps maintain species diversity among invertebrates by preying on dominant species.

4. Option (A) is correct

   Explanation: Amensalism is a type of population interaction where one species is harmed, while the other species is unaffected.

5. Option (A) is correct

   Explanation: The human age pyramid reflects a declining population, typically characterised by a narrow base that indicates a smaller number of young individuals.

6. Option (C) is correct

   Explanation: Female Anopheles mosquitoes do not exhibit a typical parasitic relationship like the others. In contrast, head lice in humans represent a parasitic relationship where lice feed on the blood of their human host. *Cuscuta*, or dodder, is a parasitic plant that wraps around its host (such as a mango tree) to extract nutrients. Similarly, ticks are parasites that feed on the blood of their dog hosts, causing harm in the process.

7. Option (D) is correct

   Explanation: In mutualism, both species benefit from the interaction. In this case:

   - **Fig Trees:** The fig trees benefit from the wasps' pollination, which is essential for their reproduction.
   - **Wasps:** The wasps benefit by laying their eggs inside the fig flowers, providing a food source for their larvae.

8. Option (D) is correct

   Explanation: Birth rate, death rate, and sex ratio are characteristics of a population, indicating its growth and structure, unlike "male and female" or "birth and death," which refer to individual organisms.

9. Option (C) is correct

   Explanation: In the asymptote state, a population reaches a stable equilibrium where the birth rate equals the death rate, resulting in little to no net change in population size over time. This means the population stabilises at a certain level, neither increasing nor decreasing significantly.

ASSERTION-REASON QUESTIONS (1 Mark)

1. Option (A) is correct

   Explanation: A cattle egret and grazing cattle have a commensal relationship because the egret benefits from the presence of the cattle without harming them. As the cattle graze, they disturb the vegetation, flushing out insects that the egrets can then catch and eat more easily.

2. Option (C) is correct

   Explanation: Cattle and goats are never seen browsing on *Calotropis* growing in abandoned fields as they avoid it primarily due to its toxic compounds, which can be harmful to them. Although the offensive smell of its flowers may also deter them, the presence of toxins is the main reason these animals do not graze on *Calotropis*.

3. Option (C) is correct

Explanation: The Mediterranean orchid Ophrys indeed employs sexual deceit by mimicking the appearance and scent of female bees to attract male bees for pollination. This strategy ensures that the male bee attempts to mate with the flower, thereby facilitating pollination. The female bee does not change its colour based on temperature but bee colouration is generally determined by genetics.

4. Option (A) is correct

Explanation: A stable population typically exhibits a balance between the number of individuals in the pre-reproductive, reproductive, and post-reproductive age groups. In this case, the pre-reproductive and reproductive individuals are nearly equal in number, while the post-reproductive individuals are relatively fewer. This structure indicates that there are sufficient young individuals to replace the aging population, contributing to overall population stability.

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. They show mutualism, where 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. In return the wasp pollinates the fig inflorescence.

   Co-evolution is the phenomenon that operates in their relationship.

2. Brood Parasitism – The parasitic bird lays its egg in the nest of its host and lets the host incubate them.

   Example: Cuckoo (koel) lays their egg in the nest of crow which resemble the host's egg in size and color.

3. *Calotropis* plant produces highly poisonous, cardiac glycosides.

4. **(i)** Carrying capacity is the maximum possible number of organisms (beyond which no further growth is possible) in a habitat.

   (ii) Limited resources lead to competition, fittest survives and reproduces

5. **(i)** A – Mortality/No. of deaths in population

   B – Natality/No. of births in population

   (ii) 1 bacteria per bacteria per hour

$$\left[\frac{\text{Growth rate} = 2 \text{ million} - 1 \text{ million}}{1 \text{ million}}\right] = 1$$

6. Expanding Age pyramid.

   The number of individuals in the 'pre-reproductive' age group is more than the 'reproductive' age group.

7. *Ophyrs* employs sexual deceit (to get pollination done).

   One petal of its flower (has uncanny) resemblance to the female bee in size / colour / markings.

   The male bee is attracted and '*pseudocopulates*' with the female flower achieving pollination.

   When this same bee 'pseudocopulates' with another flower, it transfers pollen to it and pollinates the flower.

8. **(i)** Exponential growth model / Geometric growth pattern.

   (ii) 'r' – intrinsic rate of natural increase.

   (iii) 'J' shaped curve.

   (iv) Unlimited resources.

9. Natality =

$$\frac{\text{Number of births during a given period (added in a population to the initial density)}}{\text{per capita birth}}$$

   Immigration = Number of individual (of the same species) that have come to the habitat from elsewhere during the time period.

10. Interaction in which one species benefits and other is neither harmed nor benefitted.

    Example: Barnacles growing on the back of the whale/ Cattle egret and growing cattle / Sea anemone and clown fish.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. **(A)**
   - They are able to co-exist by mechanism of 'resource partitioning'.
   - If two species compete for the same resource, they could avoid competition by choosing different foraging patterns.
   - MacArthur showed that five closely related species of Warblers living on the same tree were able to avoid competition and co-exist due to behavioural differences in their foraging activities.

   (B)
   - Gause's 'Competitive Exclusion Principle' states that two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior one will be eliminated eventually.
   - No

2. **(i)**
   - Orchid *Ophrys* employs 'Sexual Deceit' to gets pollinated by a species of bee.
   - One petal of flower resembles female of bee in size, colour and markings.
   - Male bee gets attracted and *pseudocopulates* the flower and gets dusted with pollens.
   - When same bee 'pseudocopulates' with other flower, it transfers the pollens to it.

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

3. The female wasp uses the fruit not only as an oviposition (egg laying) site, but uses the developing seeds without the fruit for nourishing the larvae. The wasp pollinates the fig inflorescence or flower, while reaching for the suitable egg laying sites.

4. **(i)** The age pyramid structure is formed when the age distribution is plotted for the population. The percent individuals of a given age or age group is plotted for the population age pyramid is formed.

(ii) When the pre-reproductive group is larger than the reproductive age groups or when reproductive group is smaller than pre reproductive age groups.

5. (i) Eggs of cuckoo (Koel) have evolved in time to resemble the eggs of the crow, koel lays eggs in the nest of the crow and lets them be hatched there, and cuckoo is the parasitic bird here exhibiting brood parasitism.

(Any other correct example) ½ × 3

(ii) When evolution of one species is tightly linked with the evolution of other species. ½

Plant pollinator interaction / fig species and wasp / any other relevant example. **1**

6. (i) The Mediterranean orchid *Ophrys* employs 'sexual deceit' to get pollination done by a species of bee, one petal of its flower bears an uncanny resemblance to the female of the bee in size, colour and markings. The male bee is attracted to what it perceives as a female 'pseudocopulates' with the flower, and during this process is dusted with pollen from the flower and transfer them to another flower.

(ii) Brood parasitism, the parasitic bird lays its eggs in the nest of its host and lets the host incubate them.

7. (i) It indicates exponential / geometric growth

(ii) Assesses impact of biotic and abiotic factors on population growth, indicates intrinsic rate of natural increase

8. (i) Does not have its natural predators.

(ii) Predators act as conduits for energy transfer across trophic levels. They keep prey population under control, predators help in maintaining species diversity in a community by reducing competition among prey species. If a predator is too efficient and over exploits its prey then the prey become extinct followed by predator. Predators are prudent in nature.

9. When a species becomes extinct, the plant and animal species associated with it in an obligatory way also becomes extinct.

Examples:

(1) When a host (fish) species becomes extinct, the plant and animal species associated with it in an obligatory way also become extinct.

(2) Co-evolved plant-pollinator mutualism where extinction of one leads to the extinction of other.

10. Three positive roles are:

(1) Predators act as conduits for energy transfer across trophic levels. For example: Grass → Goat → Lion / Lion (Predator) transfers the energy fixed by plants and the Ecosystem.

(2) Predators keep prey populations under control. E.g. Cactus feeding predator (moth) controls the spreading of the prickly pear cactus.

(3) Predators help in maintaining species diversity by reducing the intensity of competition among competing prey species. E.g. extinction of more than 10 species of invertebrates due to removal of starfish *Pisaster* (predator).

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. (i) $$\text{Birth rate} = \left(\frac{\text{Number of births}}{\text{Total population}}\right)$$

$$= \left(\frac{250}{10000}\right) \times 1000$$

$$= 0.025 \times 1000$$

= 25 births per 1000 people **1**

(ii) $$\text{Death rate} = \left(\frac{\text{Number of deaths}}{\text{Total population}}\right) \times 1000$$

$$= \left(\frac{970}{10000}\right) \times 1000$$

$$= 0.097 \times 1000$$

= 97 deaths per 1000 people **1**

(iii) • Declining ½

• Lesser than ½

(iv) • Immigration. Entry of individuals of the same species into the habitat.

• Emigration. Exit of individuals of the same species from the habitat.

2. (i) The number of predators and prey cycle over generations.

(ii) • The number of wolves will increase.

• As the population of rabbits increases, there will be plenty of food for the wolves to eat and consequently reproduce.

(iii) • Camouflage ½

• Some organisms blend in with their surroundings because of their colour.

OR

• Poisonous.

• Some organisms are highly distasteful to their predators because of special chemicals present in their body.

(iv) • The vegetation will decline.

• In the absence of predator, the population of rabbits will no longer be in check.

As the population of rabbits increases, the vegetation will reduce.

(v) Competition with another species

3. (a) • Amensalism

(b) • Predation

Justifications:

• Nature's way of transferring energy fixed by plants to higher trophic levels/conduits for energy transfer.

• Keep prey population under control.

• Predators help in maintaining species diversity in a community, by reducing the intensity of competition among competing prey species.

4. **(i)** **(1)** **Parasitism:** Interaction between species when the parasite species gets shelter and derives nutrition from the host and is benefited whereas the host is always harmed as there is reduction in survival , growth reproduction and population density of the host.

Example: The human liver fluke (a trematode parasite) depends on two intermediate hosts (a snail and a fish) to complete its life cycle / The malarial parasite needs a vector (mosquito) to spread to other hosts many marine fish are infested with ectoparasitic copepods/ Parasitic plant Cuscuta is commonly found growing on hedge plants has lost its chlorophyll and leaves in the course of evolution derives its nutrition from the host plant / endoparasites that live inside the host body at different sites like liver, kidney, lungs, red blood cells, etc./ parasitic bird cuckoo lays its eggs in the nest of its host crow and lets the host incubate them / lice on human / ticks on dogs.

(2) **Commensalism:** This is the interaction in which one species benefits and the other is neither harmed nor benefited.

Example: An orchid growing as an epiphyte on a mango branch while the mango tree derives no apparent benefit / barnacles growing on the back of a whale benefit while the whale derives no apparent benefit/ the egrets always forage close to where the cattle are grazing because the cattle as they move stir up and flush out insects from the vegetation that otherwise might be difficult for the egrets to find and catch / sea anemone that has stinging tentacles and the clown fish that lives among them gets protection from predators which stay away from the stinging tentacles and the anemone does not appear to derive any benefit by hosting the clown fish.

(3) **Predation:** Interaction in which the prey species is eaten by the predator and it is the conduit for energy transfer across trophic levels.

Example: the tiger eats the deer / sparrow eating any seed / herbivores or animals eating plants.

(4) **Competition:** Interaction between two closely related or unrelated species that competes for the same resource. ½

Example: In some shallow South American lakes visiting flamingoes and resident fishes compete for their common food, the zooplankton in the lake / the Abingdon tortoise in Galapagos Islands became extinct within a decade after goats were introduced on the island apparently due to the greater browsing efficiency of the goats/ on the rocky sea coasts of Scotland the larger and competitively superior barnacle Balanus dominates the intertidal area, and excludes the smaller barnacle Chathamalus from that zone.

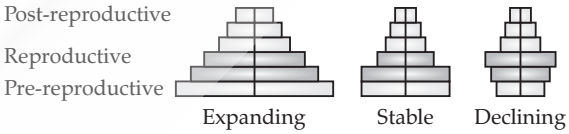
(ii) One of the interacting species is always benefitted / the interacting species live closely together.

5. **(i)** If the age distribution (per cent individuals of a given age or age group) is plotted for the population the resulting structure is called the age pyramid.

(ii) Expanding, pre reproductive population is greater than reproductive or post reproductive population / growing with maximum no. of individuals in pre reproductive phase and least no. in post reproductive phase.

Stable: Pre-reproductive & reproductive population are almost similar / ideal for population / maintains balanced continuity / no. of individuals in reproductive and pre reproductive phase is almost same and less no. of individuals in post reproductive phase

Declining: Pre-reproductive population is less than of individuals in pre reproductive phase than reproduction phase.



Level - 2 ADVANCED COMPETENCY FOCUSED QUESTIONS

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (D) is correct

Explanation: The black walnut plant secretes juglone, a chemical that inhibits the growth of other plants, such as pepper, within its root zone. In this interaction, the black walnut benefits by reducing competition for resources, while the other plants are harmed by the presence of juglone. This one-sided effect, where one species is negatively impacted while the other remains unaffected, exemplifies amensalism.

2. Option (C) is correct

Explanation: In the scenario described, the population of sparrows is decreasing despite the mortality being equal to natality (birth rate). This indicates that, while the number of births is matching the number of deaths, the overall population is still declining due to additional factors, likely including emigration. If the population is decreasing, it suggests that the number of sparrows leaving the population (emigrants) is greater than the number of those entering (immigrants).

3. Option (B) is correct

Explanation: $\frac{dN}{dt} = rN$

This is the equation for exponential growth, where r is the intrinsic growth rate and N is the population size.

4. Option (B) is correct
Explanation: The interaction between the sea anemone and the hermit crab is an example of commensalism. In this relationship, the sea anemone attaches itself to the hermit crab's shell, benefiting from the mobility and access to food particles. The hermit crab remains generally unaffected by the presence of the sea anemone, which means that one species gains benefits while the other is neither helped nor harmed.
5. Option (C) is correct
Explanation: The larvae of the African midge (*Polypedilum vanderplanki*) survive harsh dry conditions by entering a dormant state where all metabolic activity nearly stops. This is an adaptive response to abiotic stress like extreme desiccation. When water becomes available again, they revive and resume development. This type of stress response, where organisms temporarily suspend metabolic activities, is called suspension.
6. Option (C) is correct
Explanation: Rainforest trees experience heavy and frequent rainfall. They have developed broad leaves with drip tips to quickly shed excess water, and prevent fungal growth or leaf rot. Their thin bark is sufficient due to the humid environment, unlike in drier or colder regions. This is an example of structural adaptation for water regulation in a high-precipitation biome.
7. Option (B) is correct
Explanation: When a conservationist supplements natural births in a declining sea turtle population, the population is likely to initially grow rapidly because resources like nesting beaches and food are not yet limiting, there is low competition initially, and the population is recovering from a low baseline. This results in exponential (J-shaped) growth, where the population increases at a constant rate under ideal or near-ideal conditions.
8. Option (C) is correct
Explanation: In a reforestation project, when native trees and grasses are planted together, they help rebuild a degraded ecosystem step by step. This process of gradual replacement and development of plant communities is called ecological succession. Over time, pioneer species (like grasses) prepare the environment for larger species (like trees) to grow — an example of community succession.

ASSERTION-REASON QUESTIONS (1 Mark)

1. Option (A) is correct
Explanation: Assertion is true. Kangaroo rats live in arid desert environments and survive without drinking water.
Reason is also true. They rely on metabolic water, which is produced during the oxidation of fats in their body. They also excrete highly concentrated urine and dry *feces* to minimise water loss — a key physiological adaptation.
2. Option (D) is correct
Explanation: Assertion is false. Large animals like polar bears, walruses, and whales are commonly found in polar regions, not rarely. Their large body size is actually an advantage in cold climates.
Reason is true. Large animals have a small surface area-to-volume ratio, which helps them retain heat and minimise heat loss — an adaptation beneficial in cold environments.
3. Option (A) is correct
Explanation: Assertion is true. Many birds, such as Siberian cranes or Arctic terns, migrate to warmer regions during winter.
Reason is also true. Migration allows birds to escape cold climates, find food, and reproduce in more favourable conditions.
Since migration is a survival strategy to cope with stressful environmental conditions, the reason correctly explains the assertion.
4. Option (A) is correct
Explanation: Assertion is true. The logistic growth model is more realistic because it reflects how populations grow under natural conditions, where resources are limited.
Reason is also true. Logistic growth accounts for environmental resistance, including limiting factors like food, space, and predation, and introduces a carrying capacity (K) — the maximum population size the environment can support.
5. Option (D) is correct
Explanation: Assertion is false. In commensalism, one species benefits, while the other is neither harmed nor benefited. There is no negative impact on the host organism.
Reason is true. Commensalism is considered a positive ecological interaction because at least one organism benefits and none are harmed.

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. Migratory birds move to favourable regions during harsh seasons (e.g., from colder to warmer regions in winter) to avoid extreme conditions and ensure access to food and breeding grounds. This helps them survive and reproduce more successfully.
2. This is an example of commensalism, where rats benefit from human food and shelter, while humans are generally unaffected (unless infestation occurs). It shows how species adapt to urban ecosystems.
3. Trees absorb CO_2, a greenhouse gas, through photosynthesis, helping regulate atmospheric temperature. They also provide microhabitats, stabilising local population dynamics and improving ecosystem health.
4. Due to low temperatures, high pressure, and low nutrient availability, metabolic rates are low. These stressful abiotic conditions lead to slower growth and reproductive rates, ensuring survival over time.
5. Understanding interactions like predation, mutualism, and competition allows farmers to use natural predators (e.g., ladybugs for aphids) instead of chemical pesticides, promoting eco-friendly pest control.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. **(i)** Predation
(ii) It is eco-friendly, avoids pesticide resistance, and protects non-target organisms.
(iii) Ladybird beetle preying on aphids.

2. **(i)** Behavioural adaptation
(ii) Avoids high daytime temperatures, conserves water and energy.
(iii) Desert fox or Kangaroo rat

3. **(i)** Population growth rate
(ii) It may cause eutrophication, depleting oxygen and harming aquatic life.
(iii) Nutrient enrichment or eutrophication

4. **(i)** Due to resource limitations like space, food, and water.
(ii) Maximum number of individuals the environment can support.
(iii) Housing shortages, pollution, or food scarcity

5. **(i)** Allen's Rule
(ii) Reduces surface area-to-volume ratio, minimizing heat loss.
(iii) Arctic fox, walrus

CASE BASED QUESTIONS (4 Mark)

1. **(i)** Option (C) is correct
Explanation: The association between the genus *Acacia* and *Pseudomyrmex* species of ants illustrates a population interaction known as mutualism. In this relationship, both species benefit: *Acacia* provides shelter and food (such as nectar and protein-rich structures) for the ants, while the ants protect the *Acacia* plants from herbivores and competing vegetation.

(ii) Option (C) is correct
Explanation: In exchange for food and shelter, ants protect *Acacia* trees from the attacks of herbivores. The Acacia provides the ants with nectar and special structures that serve as food sources, while the ants defend the trees by aggressively deterring herbivores and competing plants.

(iii) Option (C) is correct
Explanation: The interaction between *Acacia* trees and *Pseudomyrmex* ants suggests that their relationship is an example of co-evolution. In co-evolution, two or more species influence each other's evolutionary paths through their interactions. In this case, as *Acacia* trees evolved traits to attract and nourish the ants, such as specialised structures for food and shelter, the *Pseudomyrmex* ants concurrently developed behaviors and adaptations to effectively protect the trees from herbivores.

(iv) Option (B) is correct
Explanation: The removal of resident ants from *Acacia* trees will lead to reduced tree growth and a decline in ant population. Without the ants' protection, the trees become more vulnerable to herbivores, while the ants, reliant on the trees for food and shelter, may also decrease in number.

2. **(i)**
- Rwanda – very broad base of Rwanda's age distribution indicates a rapidly growing population/ population explosion/ increasing population/ expanding population.
- Because large number of individuals are in pre-reproduction age group.

(ii) It indicates that number of individuals in pre-reproductive and post-reproductive age groups are same.

(iii) **(a)** Declining age pyramid.
OR
(b) Expanding age pyramid

3. **(i)** *P. aurelia* species is competitively superior. *P. aurelia* grows in numbers more quickly than *P. caudatum* and shows more individuals in the same volume of culture/ 100 *Paramecia aurelia* in 6 days whereas 60 *P. caudatum* in 8 days.

(ii) Competitive Exclusion Principle, which states that two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior one will be eliminated. G.F. Gause.

(iii) **(a)** One such mechanism is 'resource partitioning'. If two species compete for the same resource, they could avoid competition by choosing different times for feeding or different foraging patterns, to avoid competition and co-exist due to behavioural differences in their foraging activities.
OR
(b) Graph A - As both species grow simultaneously

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. **(i)** *Interspecific* competition refers to the interaction where individuals of different species compete for the same limited resources such as light, water, nutrients, or space.
In this case, the invasive weed is competing with native plants and crops, leading to their decline. The invasive species likely has faster growth, better adaptability, or lack of natural predators, giving it a competitive advantage.

(ii) The ecological consequences of unchecked weed growth are:
(1) Loss of native biodiversity.

(2) Disruption of food chains due to the disappearance of native plants that support local herbivores.

(3) Soil degradation due to altered nutrient cycling.

(4) Decline in crop productivity affecting local agriculture and livelihoods.

(iii) The sustainable methods to control invasive species are:

(1) **Biological control:** Introducing a natural predator, herbivore, or pathogen specific to the invasive weed without harming native flora and fauna.

(2) **Manual or mechanical removal:** Regular monitoring and physical removal of invasive weeds before they spread extensively.

(iv) Native biodiversity enhances resilience of the ecosystem to disturbances like climate change or pest attacks. It ensures stable food webs, nutrient cycles, and pollination networks. Native species are adapted to the local environment, thus maintaining long-term ecological balance.

2. (i) Keystone species are species that have a disproportionate effect on the structure and functioning of an ecosystem. Their presence supports a wide variety of other organisms.

Niche specificity refers to the unique role or function a species plays in its ecosystem, including its interactions with other organisms.

In this context, the native trees may have acted as keystone species supporting specific insects and birds through food, shelter, and breeding grounds. Replacing them disrupted these critical ecological roles.

(ii) The non-native trees lacked co-evolved relationships with local insect species (e.g., did not provide suitable nectar, leaves, or shelter). This led to a decline in insect populations, which in turn affected bird diversity, as many birds depend on insects for food. The new species may also have produced chemicals or altered soil conditions, making the habitat unsuitable for native organisms.

(iii) The principle of ecological interdependence and habitat specificity was overlooked. Introducing non-native species without considering their ecological compatibility can disrupt existing biotic interactions, leading to biodiversity loss.

(iv) The corrective measures that promote ecosystem recovery are:

(1) **Restore native vegetation:** Replace non-native trees with locally adapted native species to restore food sources and habitat for insects and birds.

(2) **Implement ecological monitoring and succession planning:** Track recovery progress, and allow natural succession to guide the ecosystem toward balance.

3. (i) The initial rapid rise in deer population is best described by an exponential (J-shaped) growth curve, where the population grows without environmental resistance due to abundant resources.

(ii) Carrying capacity (K) is the maximum number of individuals of a species that an environment can sustainably support with available resources.

In this case, the deer population exceeded the carrying capacity, leading to overgrazing, vegetation loss, and eventually resource depletion.

(iii) The density-dependent factors that might restore balance are:

(1) **Food scarcity:** As vegetation is depleted, food becomes limited, leading to malnutrition, reduced reproduction, and higher mortality.

(2) **Predation or disease:** Higher population density can attract predators or increase the spread of diseases, reducing population size naturally.

(iv) The sanctuary management can ensure long-term population stability by:

(1) Introducing or conserving natural predators (like tigers or leopards) to control herbivore numbers.

(2) Restoring vegetation through reforestation and fencing off degraded areas.

(3) Monitoring population dynamics regularly and implement controlled relocation or sterilisation if needed.

4. (i) Physiological adaptations:

(1) Ability to concentrate urine to reduce water loss (e.g., kangaroo rats).

(2) Fat storage in humps (e.g., camels), which can be metabolised to release water.

Behavioural adaptation:

Nocturnal activity — animals remain inactive during the hot day and are active at night to avoid heat.

(ii) (1) Concentrated urine and dry feces minimise water excretion.

(2) Metabolic breakdown of stored fat produces metabolic water internally.

(3) Nocturnal behaviour reduces water loss through sweating or evaporation during peak daytime temperatures.

(iii) Regulation involves maintaining a constant internal environment (homeostasis) regardless of external changes, which requires energy. In harsh desert climates, the energy cost to keep body temperature and hydration levels constant can be extremely high. Therefore, most desert animals avoid or conform rather than regulate.

(iv) These adaptations show conformation (matching internal conditions to external ones) and avoidance (e.g., staying in burrows or being active at night). By not regulating, desert animals save energy and survive extreme conditions using passive strategies.