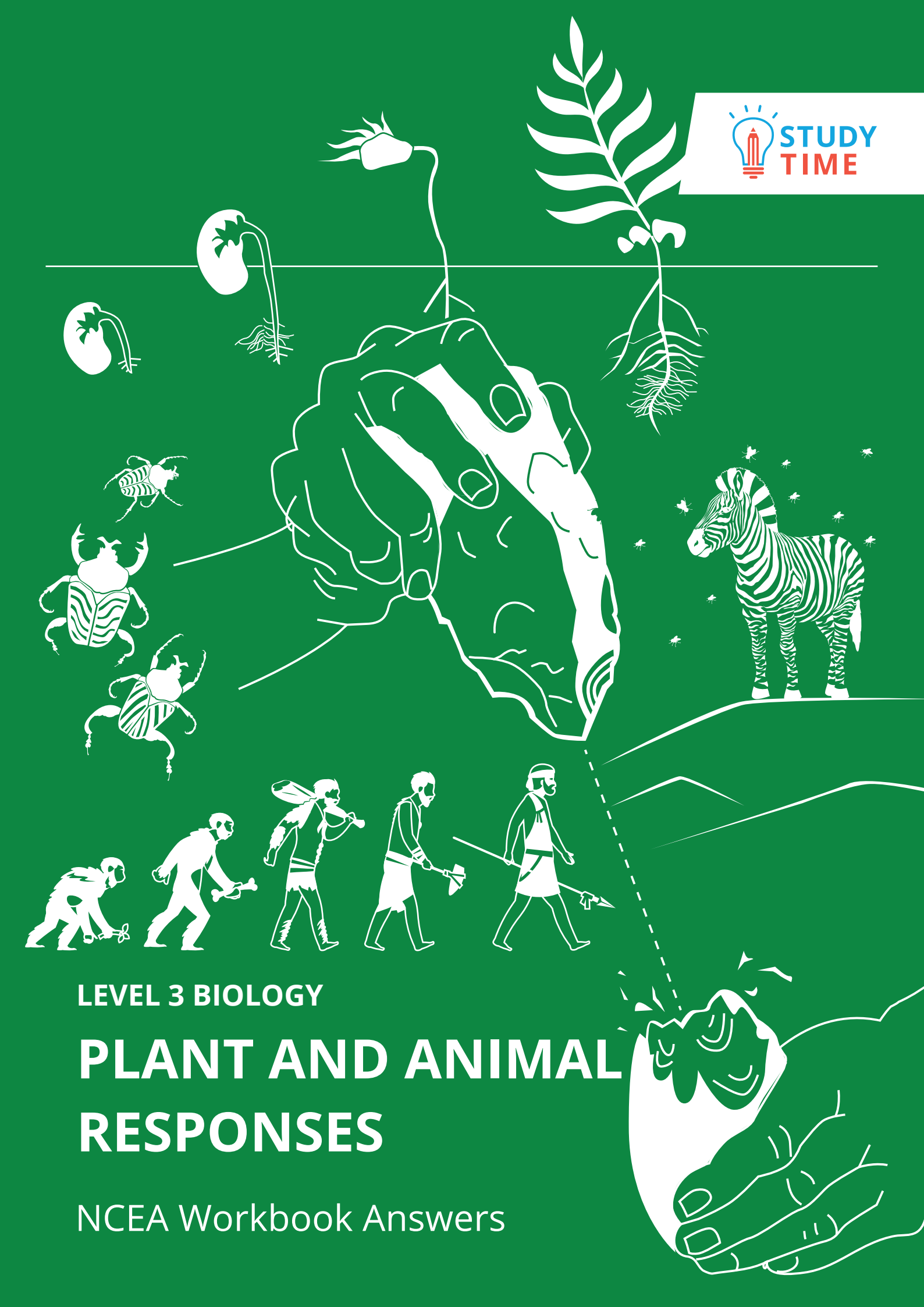


LEVEL 3 BIOLOGY

PLANT AND ANIMAL RESPONSES

NCEA Workbook Answers

Part One

The Basic Skills

1. Biological Rhythms

a. A biological rhythm is a self-sustaining natural cycle seen in living organisms also in plants due to predictable cyclical fluctuations in the environment.

b. *i.* The earth rotates on its axis so that it is always facing towards or away from the sun. This results in the day-night cycle.

ii. The moon has a gravitational pull on the oceans as it orbits around the earth. This causes tidal rhythms.

iii. The orbit of the earth around the sun and the tilt of the earth's axis causes changes in temperature, precipitation and photoperiod which relate to the earth's seasons.

c. *i.* Circadian rhythms have a free-running time period of about 24 hours as they are the daily rhythms linked to the day-night cycle. Circadian rhythms can be diurnal, nocturnal or crepuscular.

ii. Circannual rhythms have a length of 365-ish (365.25) days. Seasonal migration is an example of a circannual rhythm.

iii. Circatidal rhythms are cycles synchronised by the changes in the tides and have an approximate length of 12 hours. Most organisms living in the tidal zones are more likely to be active when the tide is high and will become inactive when the tide is low.

iv. Circalunar rhythms have an approximate length of 29.5 days. These are linked to the orbit of the moon around the Earth. Circalunar rhythms are not common in animals.

d. *i.* Organisms which are diurnal are active during hours of daylight. These organisms are less likely to lose heat energy and can see food sources easily.

ii. Organisms which are crepuscular are active during dawn and dusk. These organisms avoid predators that are active only in daylight and in darkness.

iii. Organisms which are nocturnal are active during hours of darkness. The organisms are less likely to suffer desiccation due to the cooler temperatures at night. They also avoid predation by diurnal predators which are reliant on sight.

e. Animals may not be able to migrate seasonally if the climate is extreme. Instead, these animals will hibernate. Hibernation is when an animal spends many weeks in a dormant state in a protected area. These animals are able to lower their body temperature and slow their breathing and heart rate.

2. Rhythms

a. An exogenous rhythm is a biological rhythm in animals and plants which is externally driven.

b. Exogenous rhythms are controlled by external factors such as changes in the environment. These environmental changes could be light availability in a day-night cycle, tide length in a circatidal rhythm, or the changing day length in circannual rhythms.

c. An endogenous rhythm is a biological rhythm in animals and plants which is internally driven. This can also be referred to as a biological clock.

d. An endogenous rhythm is driven internally. In complex animals, this involves the brain and nervous system.

e. A free-running period is when a biological rhythm is running during constant environmental conditions.

f. A zeitgeber is an environmental cue which can reset an organism's internal clock.

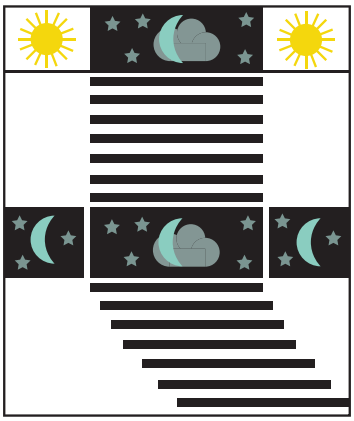
g. The purpose of a zeitgeber is to inform the endogenous mechanisms and influence the timing of the biological clock.

h. Entrainment is the act of resetting the internal, biological clock to match the environment. This is necessary as the endogenous rhythms in organisms are not the same length as the same cycle in the environment and will tend to become out of sync with the cycle in the environment if there is no entrainment.

i. Phase-shifting is when the time of activity or inactivity is pushed forward or backwards. Phase-shifting occurs as a result of entrainment.

j. An actogram is a graph showing when an organism is active and inactive over the course of each day, as well as any changes in the environment. We can use an actogram to figure out whether a rhythm is endogenous or exogenous, the length of the biological rhythm, and any entrainment and phase-shifting that occurs.

k.



i. The dark lines show periods of activity.

ii. The top half of the actogram shows when the animal is exposed to normal environmental conditions. The bottom half of the actogram shows when the animal is exposed to constant environmental conditions with the removal of light.

iii. The top half of the actogram indicates that the animal is entrained with a zeitgeber. This is shown by the cycle of activity and inactivity starting and stopping at the same time each day. The bottom half of the actogram shows that the animal becomes active later and later each day. This is due to the endogenous rhythm being slightly greater than 24 hours. When there is no external cue, since the endogenous rhythm is slightly longer than the environmental cycle, it starts to get out of sync.

l. The period of activity can be calculated by drawing a line from the first activity in constant conditions to the last activity. Use the time scale to determine how much the period of activity changes each day. If the organism is active earlier each day, the line you have drawn will have a positive gradient. The amount of time between the period of activity is then subtracted from 24 hours. If the organism is active later each day, the line you have drawn will have a negative gradient. The amount of time between the period of activity is then added to 24 hours.

m. Biological rhythms influence many biological functions and mechanisms within the body. These can include sleep-wake cycles, hormone release, eating habits, body temperature and many other functions.

3. Photoperiodism

a. Photoperiodism is the regulation of seasonal activities by the day length, such as the production of flowers or bulbs or shedding of leaves in plants.

b. Photoperiod is the relative lengths of day and night.

c. Long-day plants flower when the day length exceeds a particular length known as the critical day length. These long-day plants flower during summer.

d. Short-day plants flower when the day length is less than its particular critical day length. These plants flower during winter.

e. Day-neutral plants are not affected by day length and can flower any time during the year.

f. Phytochrome is a protein/pigment found in plants which is photosensitive. It helps plant respond to changes in the light during day and night.

g. Phytochrome has two forms. The active form is known as $P_{far\ red\ light}$ (P_{fr}). The inactive form is known as $P_{red\ light}$ (P_r)

h. During the day the inactive form of phytochrome, P_r, converts quickly to the active form of phytochrome, P_{fr}, due to the large amount of red light. In order to convert, it must absorb red light, and there's lots of red light available, so this happens quickly. During the night, the active form of phytochrome, P_{fr}, decays slowly back into the inactive form, P_r, because that is what it does in the absence of light.

i. During summer, the day length is longer and night length is shorter. Due to the shorter nights, the P_{fr} does not fully decay back to P_r, resulting in an accumulation of P_{fr}. During winter, the day length is shorter and night length is longer. As a result of the longer nights, the Pfr is able to fully decay into P_r, causing a lack of P_{fr}. In long-day plants, P_{fr} promotes flowering. Therefore, when night length is shorter in the summer, the accumulation of P_{fr} promotes flowering in the summer as opposed to the winter

j. During winter, the day length is shorter and night length is longer. As a result of the longer nights, the P_{fr} is able to fully decay into P_r, causing a lack of P_{fr}. During summer, the day length is longer and night length is shorter. Due to the shorter nights, the P_{fr} does not fully decay back to P_r, resulting in an accumulation of Pfr. In short-day plants, P_{fr} inhibits flowering. Therefore, when night length is longer in the winter, the lack of P_{fr} allows flowering to occur in the winter, as opposed to the summer.

k. Most plants depend on certain insects and pollinators to distribute their seeds at the same time every year when the chance of survival is highest. Therefore, plants flower when these insects are most active to encourage pollination. This greatly aids cross-pollination if all the plants of a species are flowering at about the same time, so syncing up their flowering to a reliable external cue, like day-length, helps them to get their timing all the same so that they all make and open flowers together and so the pollinators can cross-pollinate effectively. This is good for genetic diversity of the population.

4. Orientation responses in Plants

a. "Tropisms are directional growth responses in plants to a directional external stimulus. The plant grows towards or away from the stimulus.

b. The growth results from cell elongation occurring at different rates on different sides of the plant, so that the plant bends in one direction

c. A plant growing towards the stimulus.

d. A plant growing away from a stimulus.

e. Tropisms are very important as they contribute to the survival of the plant. These directional responses allow plants to grow towards sunlight and water, and grow away from dangerous chemicals and other harmful substances which may harm the plant.

f. A nastic response is a non-directional response to the intensity of the stimulus.

g. A nastic response occurs due to stimuli causing a change in cell turgor pressure.

h. A tropic response is a response to stimuli that results in the long-term growth of the plant towards or away from the stimulus, whereas a nastic response is a rapid and reversible response to the intensity of the stimuli due to a change in turgor pressure of the cells and the direction of the nastic movements is independent of the direction of the stimulus.

i. *i.* Photo-

ii. Thigmo-

iii. Geo-

iv. Chemo-

v. Hydro-

vi. Thermo-

vii. Nycti-

j. Auxin is a hormone that controls a number of plant functions, especially phototropisms.

k. Auxin is produced in the apical meristems which are the tips of shoots and roots of plants.

l. Auxin normally migrates evenly down both sides of a growing stem. When light from a certain direction reaches the apical meristem, most of the auxin produced migrates down the unlit side of the stem. This causes cells to elongate by increasing the elasticity of the cell and by promoting the intake of water. Therefore, although all cells will elongate to a certain point, the higher concentration of auxin on the unlit side of the stem will cause greater elongation. As a result, the stem will bend towards the light.

m. Positive gravitropism.

n. When a seed is planted underground and there is no exposure to light, the plumule (shoot) always grows upwards and the radicle (root) grows downwards. This happens because the plant can detect gravity. Radicles exhibit positive gravitropism, while plumules exhibit negative gravitropism.

o. Thigmotropism is where a plant moves or grows in response to touch or contact stimuli. Cells on the side of the plant touching the object produce auxin and transport it to the cells on the opposite side of the tendril. The high concentration of auxin stimulates elongation and faster growth rates, allowing the plant to coil around a solid object.

5. Orientation responses in animals

a. A taxis response is a directional response involving the movement of the animal either towards or away from the directional external stimulus.

b. A positive taxis is when the organism is attracted to and moves towards the stimulus.

c. A negative taxis is when the organism moves away from the stimulus.

d. Kinesis is an innate behavioural response to an external non-directional stimulus, such as humidity or temperature, where the rate of movement or activity is influenced by intensity of the external stimulus.

e. Orthokinesis involves a change in the speed of an animal's movement, where the movement is faster in unfavourable conditions but slower in favourable conditions. Klinokinesis involves a change in the rate of turning of an organism. The rate of turning is faster in unfavourable conditions but slower in favourable conditions. Orthokinesis and klinokinesis differ in the type of movement that changes.

f. Homing is the ability of an animal to return over unfamiliar territory to its home, usually on a regular basis. This could be anywhere between daily and annually.

g. Navigation is an innate mechanism that animals use to find their way home and/or migrate over unfamiliar territory.

h. Navigation requires:
- A sense of direction.
- A sense of location.

i. *i.* The animal recognises familiar landmarks and uses these to guide it to its destination.

ii. The sun moves across the sky from east to west, and during the day, many animals are able to use the sun as a compass. The animal must compensate for the sun's movement and change its orientation with respect to the sun.

iii. Animals are able to use the Earth's magnetic field lines to navigate.

iv. Animals are able to use chemical trails to navigate.

v. Bats and dolphins have the ability to find their way by echolocation. They emit sound waves which bounce back from objects.

j. Migration is the regular, mass movement of organisms of the same species, usually on a seasonal basis and typically to a predetermined location. Migration can be a cyclical event or a one-way event. Animals move in anticipation of more favourable conditions in the new location. These better conditions aren't sensed directly.

k. Animals tend to migrate to find more food, to find better shelter, avoid harsh climate conditions, search for a mate, give birth, lay eggs or raise young in favourable environmental conditions.

l. Migration is innate and genetically controlled, however, in most species, it is initiated by the environment. Migration cues can be external or internal.

m. *i.* Longer days in the summer or shorter days in the winter cue some animals to migrate. Less sunlight results in lower rates of photosynthesis and therefore, less food. It also means lower temperature.

ii. In many areas the temperature and levels of precipitation change during the year, resulting in distinct wet and dry seasons. These different environmental conditions can be a cue for animals to migrate.

iii. Lack of food and water as a result of extremes in temperature, lack of precipitation, or because of population pressures in areas reaching its capacity.

n. *i.* The internal calendar in an animal's nervous system can help an animal know when to migrate.

ii. Low fat reserves may cue some species to move in search of food. In other species, migration only occurs after fat reserves have been built up.

iii. When an animal reaches sexual maturity, hormones may trigger an innate desire to migrate to breeding grounds.

o.
- Animals remain in favourable temperatures.
- Animals produce more offspring.
- Animals have a constant food supply.
- Migration may lead to colonisation of a new area.
- Migration reduces predation.
- Migration allows for greater genetic mixing and variation.
- Migration provides better breeding conditions for individuals

6. Intraspecific Relationships

a. *i.* A home range is an area in which an organism will search for food and resources that can not be found in its territory.

ii. A territory is the core area within the home range that contains a food supply, nesting site, water source and valuable resources. An animal will defend this area from other animals.

iii. A lek is a place where males (typically) come together and perform mating displays, often competitively, to attract female mates for the purpose of breeding. The individuals trying to attract a mate compete to establish favourable mating territories within the lek.

iv. The ecological niche is the physical and biological conditions or factors that a population/ species faces in its habitat. A niche is more like an organisms or a species 'way of life', where it lives (habitat) and the biotic and abiotic factors it is adapted to which it is exposed to in its habitat, how it gets its food (e.g. carnivore or herbivore, for plants, is it an epiphyte a climber or a tree), when it is active (nocturnal or diurnal) etc.

v. Gause's Law describes how no two species can coexist within the same ecological niche. This is because the two species living in the same location will be competing for the same food and resources.

b. The two species will be living in the same ecological niche, and therefore, will be continuously competing for food and other resources. Ultimately, one species is likely to have a slight advantage over the other, meaning this species will dominate while the other species will face extinction or undergo a change in ecological niche.

c. An intraspecific relationship describes the interactions between animals within the same species.

d. Intraspecific competition occurs due to members of the same species having the same ecological niche. This means space, food, mates and other resources will often be fought over.

e. Often intraspecific competition can lead to aggressive behaviour and fighting. This means the most dominant and strongest members of the species will receive the best resources. However, the downside is that the animals can get injured or even die. Therefore, the fighting tends to be ritualistic, being a show of strength rather than a fight to the death.

f. By living in a group, animals tend to be a lot safer as there is a larger number of animals to warn of or fight off predators. Animals can also help each other to find food, defend territories or even help to raise young. Living in a group can bring potential mates closer in proximity.

g. By living in a group, disease is more common amongst animals, there is an increase in competition for necessary resources, and bigger groups can even be more vulnerable to predators as large groups are more noticeable.

h. A hierarchy in a population is a ranking system, with the strongest and most dominant members on top and the weakest, most submissive members at the bottom of the ranking. Hierarchies are formed by members competing for rank.

i. Linear hierarchies are also known as pecking orders. Linear hierarchies involve a simple progression from the most dominant animal to the most submissive animal.

j. Complex hierarchies are structures involving different groups. These different groups include subordinate groups, family groups, bonding pairs and labour groups, often controlled by a dominant, alpha member.

k. Hierarchies are beneficial as each member knows its place in the hierarchy which reduces fighting and competition for food and other resources. Submissive members know they have to wait for the dominant members to eat first.

l. These positions are maintained by specific displays. Dominant displays make the animal look bigger by standing tall, holding their tails high and exposing teeth. Submissive displays involve trying to look non-threatening by lowering of the head, avoiding eye-contact and tucking the tail between the legs.

m. Monogamy and polygamy refer to the number of partners an animal has. Species that find a mate and stay together for at least one breeding season are monogamous. Individuals who have multiple mates in a season are polygamous. Polygamy can involve a male having multiple female mates, a female having multiple male mates and also both females and males having multiple partners. The difference between monogamy and polygamy refers to the number of mates an individual has.

n. Monogamy is more beneficial when the young require both parents to fully commit to raising them. Polygamy is more beneficial when parents of young only have to deposit their sperm or lay the eggs, therefore, long-term commitment is not required by the parents. If young are self-sufficient from hatching and do not require parental care to survive, long-term commitment is not needed.

o. R-strategists have a higher number of offspring as the parents do not have to care for the young, therefore, a larger number of offspring increases the chance of at least a few offspring surviving to carry on the population.

p. The pros of R strategy are that the parents only need to put in minimal energy per offspring and the parent's survival isn't jeopardised by looking after offspring. The cons of R strategy are that many of the offspring will die of starvation or be eaten by predators.

q. K-strategists have a low number of offspring. K strategy parents spent a lot of time and energy on each offspring, to raise them and bring them to adulthood.

r. The pros of K strategy are that the offspring are much more likely to survive. The cons of K strategy are that the parents spend a lot of time and energy looking after the offspring and preparing them for survival on their own.

s. K strategy offspring tend to be more helpless and less developed than R strategy offspring. This is because R strategy offspring are on their own without their parents as soon as they are born. However, K strategy offspring rely on their parents for a long time.

t. Courtship describes the mate-selection rituals that animals do to attract mates.

u. The advantages of courtship are that the strongest and fittest animals are the ones who pass on their alleles, therefore, a fit and healthy population is maintained.

v. The disadvantages of courtship are that it can be a dangerous period for some males as they can get hurt or injured. This is because courtship rituals can attract predators.

w. Courtship rituals can include songs, dances, fights with other males, visual displays of beauty or chemical production (pheromones).

7. Interspecific Relationships

a. An interspecific relationship describes the interactions between organisms from different species.

b. Interspecific competition occurs due to members of different species fighting for a shared food source or a shared territory.

c. Interspecific competition in animals results in aggressive behaviours and fighting. Interspecific competition is more likely to result in the death of one or both animals. In plants, some plants may be shaded out by other plants or not receive enough nutrients or water to survive to reproduce due to interspecific competition

d. Interspecific competition is more likely to involve the animals fighting to the death, whereas intraspecific competition tends to be more of a show of strength. This is because it is not beneficial for animals to harm and kill members of their own species (this is known as kinship), however, it is beneficial for members from different species to harm and kill one another.

e. Exploitation is the relationship between two different species where one species benefits while the other is harmed.

f.
- Predation
- Herbivory
- Parasitism

g. Predation occurs when one animal hunts and feeds on another. Herbivory is a type of predation which involves one animal species feeding on a plant species. Parasitism involves an organism, known as the parasite, living on or inside another species, known as the host. These three types of exploitation all involve one species benefiting, while another species is harmed or killed, however, the different ways this is carried out result in the three types of exploitation.

h. Commensalism is the relationship between two species where one benefits from the relationship, while the other species is unaffected.

i. An example of commensalism is where birds feed on the insects found on the backs of certain mammals. This relationship benefits the birds as they have a food source, while the mammals are unaffected.

j. Mutualism is the relationship between two different species, where both species benefit and help each other out.

k. An example of mutualism can be found in humans. Humans have gut bacteria that aid with the digestion of food. This provides humans with good digestion and the development of a gut immune system, while the gut bacteria are provided with a place to live and a food source.

l. Mimicry is when one species resembles another species to avoid predation. This could involve mimicking appearance, behaviour, sounds or even smells.

m. Batesian mimicry is where a harmless species mimics a dangerous or poisonous species.

n. Batesian mimicry protects a vulnerable and harmless species from predators as they are mistakenly recognised as being poisonous and dangerous.

o. Müllerian mimicry is where two unpalatable or harmful species mimic each other's warning signals and develop similar appearances.

p. Müllerian mimicry benefits both species as they resemble each other. This results in predators learning to not eat a species because it is distasteful or harmful, and therefore, effectively learning not to eat both species as the species resemble each other.

q. Aggressive mimicry is where predators and parasites share similar warning signals to a harmless organism.

r. Aggressive mimicry allows predators and parasites to avoid being correctly identified by their prey or host. This means that they will be recognised as harmless by their prey, when in fact, they are harmful.

s. Batesian mimicry protects a harmless species from predation as it resembles a harmful species, however, Müllerian mimicry protects harmful and distasteful species from predation as they resemble another species which is also harmful and distasteful, allowing predators to effectively learn not to eat both species.

Section Two

Exam Skills & Mixed Practice

Question One

The shoot is negatively gravitropic as it grows upwards against gravity irrespective of its orientation when it emerges from the seed. After the shoot emerges from the ground, it continues to exhibit negative gravitropism and continues to grow upward, and it also exhibits positive phototropism as it grows towards the direction of the light source.

Auxin is a plant hormone which increases the plasticity and elasticity of the cell walls in plants, allowing the cells to elongate more when they are exposed to higher levels of auxin. If auxin accumulates on one side of the shoot or the stem, these cells will elongate more, and those on the opposite side will elongate less. This means that shoots will bend away from the side with the highest auxin concentration.

Auxin is produced in the meristem of the shoot, which is a group of actively dividing cells in the stem tip. Auxin is transported from the meristem in a polar direction away from the meristem, and also laterally across the stem.

The lateral movement of auxin is influenced by gravity as auxin accumulates on the 'lower' sides of the cells of stems. These cells elongate more on one side and the stem bends upwards as a result.

The lateral movement of auxin is also influenced by light as auxin is transported away from light towards the darker side of the stem. As the auxin accumulates here, these cells elongate more, causing the stem to bend towards the light.

A shoot from a bean seed will orientate itself to try to reach sufficient light intensity for photosynthesis to occur. In order to reach light, the plant must grow upwards towards the sun, avoid the shading of competing plants by growing towards the direction of highest light intensity, and grow upright and out-compete other plants so that it can expose its flowers to pollinators. By reaching maximum light intensity, the plant is able to optimise its photosynthesis levels and growth so it can out-compete other plants, survive and reproduce.

Question Two

The most likely environmental cue in both plants and animals is photoperiod. Photoperiod refers to the period of time each day that an organism receives light, also known as the day length. Photoperiod is the most reliable environmental cue as it is a primary cue and does not have a secondary effect.

Individual plants of the same species, such as the New Zealand tree fuchsia, tend to flower at the same time so that flowering can occur when pollinators are available, when the environmental conditions are suitable for the growth of fruit and dispersal of seeds, and because co-ordinated flowering increases the chances of cross-pollination. Flowering also occurs when there is the least competition between different flowering plants for pollinators. This gives the flowering plant species the best chance of survival.

Individuals of the same animal species such as the tui time their reproduction for many reasons. One reason is so that the maturation of sex organs and coordinated production of gametes occurs at the same time for all individuals, which increases the chances of fertilisation. In the case of the tui, reproduction and feeding of the young also coincide with a seasonal peak in food availability (nectar from the fuchsia flowers). Reproduction also occurs at a time of year that allows time for growth and development of the young so they will be independent and able to migrate before the unfavourable weather of winter sets in. This gives animals the greatest chance of survival to a reproducible age.

Plants use phytochrome to respond to photoperiods and keep time. There are two phytochrome pigments involved. Pr absorbs red light and is converted to Pfr during the day. The Pfr then decays back to Pr slowly during the night. Whether the Pfr fully decays back to Pr or only partially helps plants determine the night length, and therefore, day length as well. Plants such as tree fuchsia flower in the spring and are known as long-day plants, as flowering is initiated when the night length is shorter and the day length is longer. This is because the Pfr is not able to fully decay, meaning it accumulates and initiates flowering in long-day plants. The use of phytochrome and photoperiod in plants allows flowering to occur during specific times annually, meaning that plants are able to keep time.

Many birds and animals use endogenous circannual clocks. This is an internal timing mechanism which helps synchronise seasonal behaviours and physiological changes, such as mating and reproduction. The endogenous mechanism has a period of approximately one year, making it circannual.

This mechanism is entrained to synchronising cues known as zeitgebers, such as photoperiod and other cues. The endogenous mechanism prepares the animal, such as the tui, for upcoming events such as mating, egg-laying, hatching and rearing of young. This use of endogenous circannual clocks allows tuis to keep time, which increases the survival of their young, and therefore, the species.

Question Three

Parasitism is an interspecific relationship specifically a type of exploitation. It involves one species deriving a benefit from the other species, known as the host. The host is harmed but not killed in the relationship. The brown-headed cowbird is referred to as the parasite as it lays its eggs in the nest of the host, and as a result, the host adults raise the chick as their own. The host species is harmed because its time and reproductive efforts are diverted to the cowbird young instead of its own young.

The cowbird parents benefit from this relationship as it offers the species adaptive advantages. The cowbird parents are relieved of the time and effort of raising their own young, therefore, they can divert their reproductive efforts into producing more eggs.

This could allow the cowbird population to increase at a faster rate than if the cowbird parents were raising their own young. The cowbirds' ability to parasitise the nest of multiple host species is an advantage as it means the negative effect on the host species is minimised. This means that the geographic distribution of cowbirds is not limited to that of a single host species; different host species can be parasitised in different habitats.

The cowbird species also benefit from this relationship as the effect of nest predation is lessened. As the cowbirds spread their eggs around a number of nests, a single predation event will have less of an impact on the survival of the species, as opposed to if all the eggs from a female cowbird were placed in one nest. Having an egg in each of several nests is safer than having several eggs in one nest.

The ecological niche of the brown-headed cowbird means that this reproductive strategy is effective. The cowbirds follow herds of grazing animals and cover large distances daily. They feed on insects and can lay 40 eggs in a breeding season. The cowbird chicks usually hatch sooner and grow faster than the hosts' chicks. As the cowbirds move with herds and cover large distances, the time and energy required to return to a nest would be unreasonable. Therefore, staying in one place long enough to produce a nest and raise their own chicks is disadvantageous for both the cowbird parents and young. The cowbirds must keep moving to feed on the insects stirred up by the large herds they follow. The abandoning of their eggs to the care of the host birds overcomes the need to return to a nest. Cowbirds are also able to divert the time and energy they would have spent on building a nest and raising young into producing more eggs and more offspring will therefore be produced, increasing the reproductive potential of the species. The cowbird species are also at a lower risk of predation as they are not sitting and incubating their eggs, increasing the survival chances of the individuals.

The cowbird species may be contributing to the decline of songbirds, which are the host species. This might be due to the cowbird chicks hatching sooner and growing faster than their hosts' chicks. This gives the cowbird chicks a competitive advantage compared to the other chicks in the nest. The begging behaviour of the chicks will stimulate a feeding response, meaning they are likely to have better survivorship than the host chicks, which they do not grow as fast. This will have a negative impact on the host chicks as they are less likely to survive and reproduce, causing an overall decline in songbirds.

Question Four

*This answer will describe four behaviours displayed by gannets, however, you are only required to describe three behaviours.

The gannets display migratory behaviour. Migration is the regular, mass movement of organisms of the same species, usually on a seasonal basis and typically to a predetermined location. This means that the animals occupy two habitats. The second habitat is occupied when environmental conditions offer greater survival and/or reproductive chances than the first habitat. Gannets spend autumn and early winter in Australia where the environmental conditions and food availability are more suitable to gannets than in New Zealand. Gannets then spend late winter, spring and summer in New Zealand when the water temperature and food availability increase, meaning the conditions are more favourable for breeding in New Zealand than Australia. The gannets arrive in August to allow time to pair, mate and incubate eggs before spring, when food requirements increase as the chicks hatch.

The disadvantages of migration for gannets are energy expenditure, risk of getting lost or having insufficient resources to complete the journey, and risk of predators and unexpected dangers when migrating. The advantages of migration for gannets are the potential to make use of seasonally available food resources, avoidances of climatic extremes, and the ability to move large distances mean that the species is more likely to disperse into otherwise unoccupied habitats.

The gannets display territorial behaviour. Territorial behaviour is when animals defend an area from members of their own species. The territory for gannets is their nest site and the area surrounding this. Larger territories would not be beneficial as they serve no extra purpose and take more time and energy to defend. Their territory does not include their food source as they must fly out to sea and return, having fed themselves and with food for their chicks. Therefore, their territories remain small while their home ranges are huge.

The disadvantages of territorial behaviour are that some adults will miss out on territories if space is limited and therefore, they will not be able to breed, and this leads to intraspecific competition. Intraspecific competition occurs due to members of the same species having the same ecological niche, meaning that food, mates and territories will often be fought over. This has an inherent risk if physical combat is involved, as gannets could get injured and possibly infected.

The advantages of territorial behaviour are that once the territories are established, birds tend to 'respect' boundaries and pairs are easily able to mate and raise their young in a peaceful environment. Natural selection is also utilised as it means that only the strongest, best-adapted gannets gain territories and breed. When territories are located in a large colony, a large number of nest and nesting birds provide a certain level of safety from predators.

Gannets display pair-bonding which occurs when a mating relationship lasts longer than a single breeding season, and it is usually of some benefit to the offspring. When the gannets return to the colony in early August, they establish breeding pairs. Birds which have previously pair-bonded will re-establish those bonds. Unpaired birds will need to establish a breeding pair and often use signals such as postures, movements and calls to initiate this.

A disadvantage of pair bonding is that it requires time and effort. A male will establish a territory and exclude other birds, however, this tendency must be overcome if the female is to remain in the territory and a bond pair is to be successfully established. The advantages of pair-bonding are that birds are able to synchronise gonad and gamete development to ensure successful fertilisation and that it allows birds to recognise each other and establish communications. This is important as cooperative behaviour is required for nesting and feeding.

Gannets also display parental care of chicks. Parental care is any behaviour that increases the survival chances of the offspring. The gannets prepare nests for their eggs so that they will not roll away and be lost. Both parents participate in the incubation, allowing one parent to feed while the other incubates. The gannet chick is cared for, defended, and fed by both parents until it is independent. Gannets are, therefore, K-strategists.

The disadvantages of parental care are that the gannets expend a lot of time and energy, birds remaining on the nest cannot feed and are subject to predation, the birds actively collecting food must collect for themselves and their chick, and the survival of the parents can be compromised. The advantage is that by having two parents involved in parental care, one can remain with the egg/chick at all times, increasing the survival chances of the chick.

The different behaviours of the gannets have an adaptive advantage as they increase the survival and reproductive success of the gannets. The behaviours described above do not happen in isolation as each behaviour is required. If one of the behaviours is not performed then a chick has a reduced likelihood of being successfully raised. Gannets migrate to breeding sites where territories safe from predators are available. After establishing territories, pair bonding and mating, breeding pairs hatch their eggs and care for their chicks using the abundant seasonal food supplies. Pair bonding allows one parent to be feeding while the other is available to protect the nest and chick.

Section Three

Practice Exam

Question One

Cooperative interaction describes members of a group or family working together towards a common goal for their mutual benefit or for the benefit of the group as a whole. Lionesses exhibit cooperative interactions as they hunt together, allowing them to catch and bring down prey that is much larger than any individual is likely to handle alone. The cooperative interactions that the lionesses display benefit the pride as the prey that are killed for food are much larger, and there is likely to be more food and resources than if the lionesses were hunting on their own. This improves the pride's overall chance of survival as well as the survival chances of each of the individual members in the pride. The cooperative hunting also benefits each individual lioness as they are less likely to be injured when hunting if they have the protection of the other lionesses.

The breeding behaviours of the pride are also described as cooperative interactions as all of the members in the pride care for the young cubs, as opposed to only their mothers caring for them. This increases the chance of survival of the cubs as they will have more protection. The more cubs that survive to adulthood, the larger and more successful the pride will be.

A hierarchy in a population is a ranking system, with the strongest and most dominant members on top and the weakest, most submissive members at the bottom. Hierarchies are formed by members competing for rank. In a pride of lions, there is one dominant alpha male. The hierarchy is often established and maintained through agonistic displays. These can range from snarling to swiping attacks, while the lions also try to avoid serious injury. The hierarchy determines the access of each member to the resources of the pride, with the most dominant individuals receiving a larger share of the resources and the submissive members receiving a smaller portion. However, the submissive members still receive more than if they were on their own. A hierarchy can also increase the overall fitness of the gene pool and pride. This is due to the fittest genes being passed down as the most dominant males get exclusive mating access to the females. This will benefit the pride and the wild lion species as the individuals will have the most desirable and successful traits.

A territory is the core area within the home range that contains a food supply, nesting site, water source and valuable resources. An animal will defend this area from other animals. Territoriality is the defence of a territory by a group or pride. The pride will have access to the territory, depending on their position in the hierarchy. The lionesses are highly territorial over the territory as it contains prey and resources that the pride needs to ensure its survival. As the lionesses are responsible for hunting, they are also territorial, as other predators may interfere with their hunting behaviours, resulting in less prey for the lionesses to hunt and present to the pride as a source of food.

Lionesses may also be very territorial over their cubs. This increases the chances that the cubs will reach adulthood and take up a role within the pride which would benefit the group.

Question Two

Plants and flowers that exhibit behaviours such as folding of the leaves and closing of the flowers during periods of darkness are nyctinastic. Nyctinasty is the reversible rhythmic movement of a plant in response to the onset of darkness. The petals of tulips and other nyctinastic plants close during darkness and open during daylight. This type of response is not dependent on the direction of light, only the presence of light.

When the plant senses a change in light intensity, this induces the flow of ions (potassium and chloride) from the cells on top of the pulvinus. This change in ion concentration induces a concentration gradient between the cells and the fluid surrounding them. This results in water also leaving the cells. The loss of water from the cells causes them to become flaccid and shrink. The cells located on the bottom of the pulvinus remain turgid causing the leaf and/or petals to fold upwards. When the light intensity increases due to daylight, this process is reversed, causing the leaves and/or petals to move horizontally again. This response is regularly repeated every 24 hours.

This response gives the plant and flowers several adaptive advantages. Heat loss is reduced from the plant and flower surfaces at night as there is less surface area exposed. This protects parts of the flower from cooler temperatures and dampness at night. Due to reduced heat loss and protection from cooler temperatures, the plant may be able to conserve energy. The closing of the flowers can also protect the plant from night-time predators that may damage the flowers or displace the pollen. It may also keep the pollen dry so that it is able to stick to pollinators.

Photoperiodism is the regulation of seasonal activities by the day length, such as the intensity of sunlight, temperature and levels of precipitation. The photoperiod is the relative length of day and night.

As iris plants flower in the summer months, when the day length is longer and the night length is shorter, they are considered long-day plants. As they flower when the day length exceeds a particular length, known as the critical day length. This is because poinsettia plants flower during the winter months, when the day length is shorter and the night length is longer, they are considered short-day plants as they flower when the day length is less than a particular critical day length.

Phytochrome is a pigment found in plants and which is photosensitive. Phytochrome has two forms, the active form which is known as $P_{\text{far red light}}$ (P_{fr}), and the inactive form which is known as $P_{\text{red light}}$ (P_r). During the day, the inactive form of phytochrome, P_r, converts quickly to the active form, P_{fr}, due to a large amount of red light. During the night, the active form of phytochrome decays slowly back into the inactive form, due to a larger amount of far red light. The level of P_{fr} in plants changes seasonally as the night length changes, and therefore, the amount of time available for the decay of P_{fr} to P_r changes. The accumulation of P_{fr} in long-day plants promotes flowering, however, the accumulation of P_{fr} in short-day plants inhibits flowering. This is why plants such as the iris and poinsettia flower at different times of the year.

Iris plants flower during the summer months when the day length is longer and the night length is shorter. This means that P_{fr} cannot fully decay into P_r due to shorter nights, causing an accumulation of P_{fr} which promotes flowering in long-day plants. In the winter months, the P_{fr} fully decays and the lack of P_{fr} does not allow the iris to flower.

Poinsettia plants flower during the winter months when the day length is shorter and the night length is longer. This means that P_{fr} is able to fully decay into P_r due to longer nights, causing an absence of P_{fr}. This allows the poinsettia plants to flower as there is no P_{fr} which would inhibit flowering in short-day plants. In the summer months, the P_{fr} does not fully decay-causing an accumulation. This inhibits flowering in the short-day plants.

The iris and poinsettia plants benefit from flowering during specific photoperiods as it ensures the synchronous flowering of all members of the population. This means that cross-pollination is more likely, leading to increased genetic variation and fitness. The flowering of plants can also be coordinated with the availability and activity of their pollinators, increasing the chances of cross-pollination. As the formation and maturation of the seeds are synchronised, there are optimal germination conditions in the following season.

Question Three

An interspecific relationship describes the interactions between organisms from different species. In the example of the human gastrointestinal microbiota, there are interspecific relationships between humans and the gut flora, and also between the individual species of microorganisms which make up the gut flora.

The relationship between humans and the gut flora is a mutualistic relationship as both the human and gut flora benefit from the relationship. The gut flora is provided with a constant food source and a safe place to live, while the human is provided with good digestion and the development of a gut immune system.

The relationship between the different microorganism species is interspecific competition. This occurs due to members of different species competing for a shared food source or a shared territory. Microorganisms can still attack and kill each other, it just doesn't look as dramatic as in animals - there can still be aggression though. So, I'm not sure I'd say that aggressive behaviours don't occur in microorganisms. It is also unlikely that this is a form of competition as the presence of different microorganisms in the gut flora is beneficial to the human, and therefore, helps to maintain a safe environment for all of the microorganisms. If one or two microorganism species were to 'outcompete' the remaining species, this would impact the health of the human greatly. This is why the cohabitation of the many species of microorganisms in the gut flora is beneficial.

Humans benefit from having a gastrointestinal microbiota as it aids with digestion and provides a barrier to pathogenic organisms. This helps humans to survive to adulthood when they are able to reproduce. If humans did not have this internal barrier to pathological organisms, it is likely that they would become sick and die.

The interspecific relationship between mosquitoes and mammals is parasitism. Parasitism is a symbiotic relationship in which one species benefits at the expense of a host species. The mosquitoes benefit from this relationship as they feed on the mammalian blood, "stealing" some of the nutrients that are being digested or transported by the mammals. Due to this, the mammals are harmed in the interspecific relationship as they are losing some of their nutrients and blood (and may have an annoying itchy-bite for the next few days). This relationship has a minimal harmful effect on most mammals, however, is still considered to harm the mammal.

Parasitism and mutualism are both types of interspecific symbiotic relationships in which at least one species benefits. The difference between these two relationships is the effect on the other species. In a parasitic relationship, the other species is harmed, however, in a mutualistic relationship, the other species also benefit from the relationship.

