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Level 3 Biology, 2017

91603 Demonstrate understanding of the responses of plants and animals to their external environment

9.30 a.m. Thursday 16 November 2017
Credits: Five

Achievement	Achievement with Merit	Achievement with Excellence
Demonstrate understanding of the responses of plants and animals to their external environment.	Demonstrate in-depth understanding of the responses of plants and animals to their external environment.	Demonstrate comprehensive understanding of the responses of plants and animals to their external environment.

Check that the National Student Number (NSN) on your admission slip is the same as the number at the top of this page.

You should attempt ALL the questions in this booklet.

If you need more room for any answer, use the extra space provided at the back of this booklet and clearly number the question.

Check that this booklet has pages 2–12 in the correct order and that none of these pages is blank.

YOU MUST HAND THIS BOOKLET TO THE SUPERVISOR AT THE END OF THE EXAMINATION.

Excellence

TOTAL 21

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QUESTION ONE

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Mānuka seeds.
www.amazon.co.uk/Manuka-tree-leptospermum-scoparium-seeds/dp/B01BP3WCGA

Mānuka seeds germinating.
http://slideplayer.com/slide/5661375/

Mānuka seedlings after 2 months.
http://www.treeproject.org.au/seedling-database/leptospermum-scoparium

When the mānuka (*Leptospermum scoparium*) seed germinates below the soil surface, two different plant responses occur at the radical and plumule. ↗ ± gravitropism

Mature mānuka trees release leptospermone, a chemical that acts as a natural herbicide. → allelochemical

Discuss how the different responses that the mānuka plant displays in germination and early growth are beneficial to the survival of the plant.

In your answer:

- identify and describe the two different responses shown by the mānuka seedling as it germinates below the soil → ± gravitropism
- explain the type of interaction between the mature mānuka and other plants growing nearby, due to the release of leptospermone into the soil → antibiosis → allelopathy
- explain how these responses occur below the soil as the mānuka germinates → auxin
- discuss the adaptive advantage of these two responses below the soil, and compare them with the response once the plumule is exposed to light.

You may use annotated diagrams as a part of your answer.

The ~~growth~~ responses shown by ~~in the~~ radical and plumule ~~(are)~~ when the seed germinates below the soil surface (as there is no light to detect) are both growth responses (tropisms) ~~in response~~ to the force of gravity - they are both gravitropisms. The radical displays positive gravitropism as it grows downwards, with the force of gravity, while the plumule shows negative gravitropism as it grows upwards, against the force of gravity.

The mature mānuka tree releases leptosperome, which acts as a natural herbicide. Thus, this chemical inhibits the growth of other plants growing (

nearby. Leptosperome is an allelochemical, and the interaction between the mānuka and other plants is an example of allelopathy - where one plant (the mānuka here) releases a chemical (an allelochemical, leptosperome here) that influences (inhibits here) the growth of other plants.

The positive and negative gravitropisms displayed by the radical and plumule are a result of the hormone auxin, which is produced in the apical meristem (tip of roots & shoots) and moves according to the force of gravity. Auxin promotes cell elongation in the plumule, and inhibits cell elongation in the radical. In the plumule, auxin is produced in the tip & migrates downwards. There is a higher concentration of auxin on the part of the plumule that is deeper below the surface of the soil, meaning that the rate of cell elongation here is faster than in the higher parts, causing the plumule to bend upwards. Once the plumule is vertical, auxin will migrate evenly down both sides of the plumule, meaning the rate of cell elongation will be equal on both sides of the plumule so it grows directly, vertically upwards. In the radical, auxin will accumulate on the lower side of the radical (following the statolith hypothesis) so the rate of cell elongation will be faster on the upper side of the radicle, causing the radicle to bend downwards.

Once the mānuka is mature, it will release leptosperome through its

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roots into the soil, allowing it to grow (wide) while inhibiting the growth of other plants. Thus, it will gain all the resources it needs for survival & reproduction while excluding any competitors from the area, reducing competition thus increasing its chances of survival.

Both gravitropisms displayed by the radical & plumule offer adaptive advantages to the mānuka. Firstly, it ensures that the plumule will always grow upwards, towards the surface of the soil. Access to light is essential to the survival of the mānuka so it can photosynthesise & so produce the energy it needs to survive and reproduce. However, there is no light to detect to grow towards underground. Hence, by ensuring the plumule grows upwards, the mānuka increases its chances of breaking the surface where there is the light it needs for energy to grow and reproduce, thereby increasing the chances of survival for both the individual & the species. The negative gravitropism also provides an adaptive advantage as it ensures the radical grows downwards. This means that the mānuka is ~~likely~~ likelier to reach and gain access to essential nutrients & water (which is needed for photosynthesis). As well as this, it allows the mānuka to anchor itself

(*extra paper)

QUESTION TWO

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http://www.nzbirdsonline.org.nz/species/sooty-shearwater http://www.teara.govt.nz/files/5484-enz_0.jpg

The sooty shearwater or mutton bird (*Puffinus griseus*) leaves New Zealand in the Southern Hemisphere's winter – summer in the Northern Hemisphere – and takes advantage of prevailing winds along different portions of their migration route.

When plotted on a map, their paths look like giant figure eights over the Pacific Ocean (see map above).

They are spectacular long-distance migrants, travelling north up the western sides of the Pacific and Atlantic Oceans at the end of the nesting season in March–May, reaching subarctic waters in June–July, where they cross from west to east, then returning south down the eastern sides of the oceans in September–October, reaching the breeding colonies in November. They do not migrate as a flock, but rather as single individuals, associating only opportunistically.

Recent tagging experiments have shown that birds breeding in New Zealand may travel 74 000 km in a year, reaching Japan, Alaska, and California, averaging more than 500 km per day.

Discuss why migration is important to the health and survival of the sooty shearwater.

In your answer:

- describe migration ✓
- ✓ explain how the sooty shearwater might determine the time for migration, AND how they may navigate during migration → magn, stellar/solar
- ✓ discuss the costs and benefits of migration to the sooty shearwater. → favourable + breeding + parasites

photoperiod, temp.

energy, ~~food sources~~

Migration is the regular mass movement of a species, usually over long distances, to a predetermined location (and, usually, back to the first location).

Migration is initiated by one or more cues, usually environmental. The shearwater leaves New Zealand in the

There is more space for your answer to this question on the following pages.

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winter. Thus, it is likely that they use the change in photoperiod (day length) and/or the change in temperature associated with the change in season (shorter days, colder temperatures). However, the shearwater will also likely have an internal, endogenous biological clock (circannual rhythm) which will allow it to anticipate and prepare for the time to migrate, and which will be entrained (re-set or altered to synchronise with the environment's cycles - seasons here) by the above environmental cues. Thus, migration is initiated.

The shearwater's journey is very long, so it is crucial that it has an accurate system of navigation. It is likely the shearwater will use more than one form of navigation so it can 'cross-reference' its different systems against each other, increasing the reliability of navigation. It may use magnetic navigation (orientating themselves according to changes in Earth's magnetic field) in combination perhaps with solar and/or stellar (orientating to the sun &/or constellations or celestial poles) navigation (both the sun & constellations move, so a biological clock is needed to compensate). On cloudy days or nights, it will likely rely on magnetic navigation as the sun & the stars would not be visible.

This migration has both costs and

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benefits for the shearwater, but as the behaviour persists, meaning it has been selected for, the benefits must outweigh the costs.

One cost is that the lengthy journey requires a huge expenditure of energy. If food in New Zealand is scarce (as they must go long periods (potentially the whole journey) without feeding during migration as they fly over sea), shearwater birds may not build up sufficient fat reserves to sustain them for the entire journey or for them to arrive in a sufficiently good condition to reproduce successfully. Another cost is the potential for the birds to be blown off course by winds so they do not reach their destination, dying en route. However, a benefit of migration for the shearwater may be that it leaves behind an area in New Zealand drained of resources (eg. seasonal food supplies) & arrives in an area that is well resources. This means the shearwater can access more food, water, etc., while reducing intraspecific competition, thus increasing its chances of survival. The destination may also have fewer predators so newly hatched offspring are less likely to be predated, so they are likelier to survive to sexual maturity & reproduce, increasing the chances

(*extra paper)

QUESTION THREE

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http://howardcheek.photoshelter.com/image/I00005Pm3.HDRznI

http://cursa.ihmc.us/rid=1Q19NCQSR-1PH7VJX-2V1Q/flowering%20in%20plants.png

Mānuka (*Leptospermum scoparium*) are long-day plants which flower in spring and into summer. Flowering in the mānuka plant is controlled by the phytochrome system. The flowers are used by beekeepers to produce mānuka honey. Honeybees (*Apis mellifera*) seek their food within a circumference of 3 to 4 km around their hive. The bees navigate from the hive to the flowers using different cues during the day.

Relate the role of the phytochrome system to the survival of the mānuka plant population.

In your answer:

- ✓ identify and describe the relationship between the mānuka tree and the bees → mutualism
- ✓ describe the process of photoperiodism AND explain how the phytochrome system could work in the mānuka tree → Pr/Pfr
- ✓ discuss how photoperiodism in the mānuka tree provides an adaptive advantage to BOTH species. → breeding + weather

You may use annotated diagrams to support your answer.

The mānuka & the bees share the symbiotic relationship mutualism, where both species benefit. The mānuka benefits as the bee pollinates it, increasing its chances of reproductive success, while the bee benefits as the mānuka provides a source of nectar for the bees to produce honey, gaining energy, increasing chances of survival & reproductive success.

Photoperiodism is a physiological change (flowering here) in response to changes in photoperiod (relative day length). Plants detect photoperiod using the pigment phytochrome, which exists in two forms: 4

(absorbs red light)

phytochrome red (Pr), and phytochrome far-red (Pfr). ~~During the day~~ Sunlight contains ~~there is~~ more red light so Pr is converted to Pfr so Pfr predominates during the day. At night, there is a slow conversion of Pfr back to Pr, so the length of night determines how complete this conversion is, determining the ratio of Pr:Pfr. Mānuka is a long-day plant, ~~flowering~~ flowering in spring and into summer when the day length exceeds its critical day length (=shorter nights). Thus, when there is an excess of Pfr, the mānuka will flower.

Photoperiodism in the mānuka provides an adaptive advantage to both the mānuka itself and the bees. Photoperiodism allows the mānuka to time its flowering to correspond to certain ~~environmental seo~~ factors, both abiotic and biotic. The flowering of the mānuka is likely to coincide with the bees' breeding season. This ~~benef~~ provides an adaptive advantage to both the mānuka and the bees as it means that there will be more pollinators available for the mānuka, increasing its chances of pollination and thus reproductive success which increases the chances of survival for the species as a whole, while also meaning that there is more nectar and therefore food for the bees so they can invest more food in raising their offspring, increasing the chances of

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their offspring surviving to sexual maturity & reproducing ~~surviving~~, thus increasing the chances of survival of the species as a whole.
The weather in spring and summer is also drier and warmer which may also benefit both species as the mānuka's pollen is likelier to stay dry and so is likelier to stick to the bees, and as the bees will seek food in better conditions, reducing their chances of being blown away or dying, in turn increasing the mānuka's chances of pollination and thus successful reproduction.

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Extra paper if required.
Write the question number(s) if applicable.

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(1) in the soil so it is less likely to be uprooted by a ~~predator~~ herbivore or the wind and die as a seedling. Thus, it increases its chances of surviving to sexual maturity to reproduce and continue the species. Once the plumule is exposed to light, it will display a positive phototropism. it will grow towards light as auxin moves away from light, meaning there is a higher concentration of auxin on the unlit than the lit side of the plumule, so the rate of cell elongation is faster here, so the shoot bends towards the light. Both the negative gravitropism before breaking surface and the positive phototropism displayed by the plumule after reaching the surface are tropisms (growth responses) and ~~wa~~ offer an adaptive advantage to the mānuka as it ensures that the plumule will grow towards higher concentrations of light ~~so the~~ ~~rate~~ (and towards nutrients + water with the positive gravitropism of the radicle) so the rate of photosynthesis will increasing, increasing its & the species' chances of survival as there is more energy to invest in successful reproduction.

Extra paper if required.
Write the question number(s) if applicable.

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(2) of survival for the species as a whole. This is further increased by the fact that returning to the same location means hatchlings are likely to be well-adapted to the local conditions as their ancestors survived the same conditions. Another benefit is that it reduces the chances of parasitism as when the shearwater is gone from one location, ~~th~~ a potential parasite would have no birds to sustain them, so a parasite population would be unlikely to be established with the shearwater. This increases its chances of survival & reproductive success as it is less likely to be deprived of resources, so there are more resources left for the shearwater to invest in its own fitness & reproduction. Thus, the benefits outweigh the costs & the migration provides an adaptive advantage for the shearwater, increasing its chances of survival.

Seen

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Subject:	Biology	Standard:	91603	Total score:	21

Q	Grade score	Annotation
1	E7	This candidate thinks through their answer well, following the structure of the question and the scaffolding bullet points. E7 is awarded as the student clearly explains 2 tropisms and discusses their adaptive advantages. E8 is not awarded as the two gravitropisms are not clearly compared and contrasted with phototropism.
2	E7	Again, this student shows that they are reading the question through and taking the time to create a logical structure to their answer. This question is borderline E8. E8 required 2 costs and 2 benefits discussed and linked to overall survival advantage. While several benefits are explained at the Excellence level, only one cost is fully explained. This candidate could have easily gained E8 in this question with a little more detail. Overall, this would not impact on their grade.
3	E7	Another solid answer, confirming the student's ability at the Excellence level. Well structured, the points from the question are tackled in logical order. E7 awarded for discussing the adaptive advantage to the bee. Again, borderline E8, with the answer almost providing sufficient evidence for the adaptive advantage to the månuka. Linking to the phytochrome system could be clearer.