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3

91605



916050



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Level 3 Biology 2022

91605 Demonstrate understanding of evolutionary processes leading to speciation

Credits: Four

| Achievement | Achievement with Merit | Achievement with Excellence |
|----------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| Demonstrate understanding of evolutionary processes leading to speciation. | Demonstrate in-depth understanding of evolutionary processes leading to speciation. | Demonstrate comprehensive understanding of evolutionary processes leading to speciation. |

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.

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

Do not write in any cross-hatched area (▨). This area may be cut off when the booklet is marked.

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

Achievement

TOTAL

10

QUESTION ONE: POISON**Pufferfish**

Source: www.scienceabc.com/nature/animals/what-are-pufferfish-and-are-they-toxic.htm

Blue-ringed octopus

Source: www.nhm.ac.uk/discover/blue-ringed-octopus-small-vibrant-deadly.html

Rough-skinned newt

Source: www.sciencenewsforstudents.org/article/toxic-germs-on-its-skin-make-this-newt-deadly

The most important poison found in newts, the blue ringed octopus, and pufferfish is tetrodotoxin (TTX). It is one of the most dangerous toxins known. It acts on the nervous system of prey, and can result in muscles not being able to work, leading to death. It is used by the animals as an antipredator defence.

An adaptation of extreme resistance to this chemical has come about in several species of snakes that eat newts.

Snakes living in areas where there are prey who make TTX, have a protein expressed with a different amino acid which prevents nerve and muscle tissue being affected. Some snakes, such as the garter snake (*Thamnophis sirtalis*), are able to eat highly toxic newts because they have developed resistance to TTX, due to changes in a number of protein coding genes.

Researchers studied the success of snakes in eating newts in an area. They gave a percentage performance score based on the survival of the snake population in the survey area, as shown in the graph below. A score of 85% meant that 85% of the snakes in the area survived and reproduced.

Source: www.newscientist.com/article/dn13438-toxic-newts-lose-war-against-super-immune-snakes/

Source: <https://evolution4e.sinauer.com/exercise1301.html>

Discuss how both coevolution and convergent evolution are demonstrated in this example of animals with TTX- producing genes and those with resistance to TTX.

In your answer

- define the terms coevolution, convergent evolution, and mutation
- explain how the octopus, the pufferfish and the newt each having TTX is an example of convergent evolution
- using data from the graph, discuss how coevolution has led to an increase in TTX production in newts, and evaluate the implications of this for the survival and success of the newt species.

Coevolution refers to the phenomenon in which two ~~etc~~ distinct species evolve ⁱⁿ ~~at~~ a similar ^{way} ~~and~~ in accordance to the relationship shared. These three species have undergone convergent evolution, a process by which ~~a~~ unrelated species adapt to possess superficially similar traits as a result to their shared selection pressures. In this case all species have acquired dangerous toxins in order protect themselves. The coevolution of these species is demonstrated through the existence of the several toxin-resistant snakes that have evolved to be able to eat them. This evolution is likely to result of mutation, in which ~~a~~ ^{the} genetic sequence of the animal is altered resulting in ~~a~~ ^a phenotypic alteration. In this case the mutation ~~may~~ ^{would} have affected some of the snakes while not affecting others. This is shown by the 85% of snakes that survived, meaning that 15% of the snakes did not possess the toxin resistant gene.

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QUESTION TWO: TRIPLE-FINNED FISH



Source: www.researchgate.net/figure/Triplefin-species-used-in-this-study-and-their-respective-distributions-Bellapiscis_fig2_351878084

Approximately 130 species of triplefin have been identified worldwide living in many habitats, such as in tropical, subtropical, temperate, subantarctic, and the Antarctic Peninsula polar sea regions. In New Zealand, we see a large diversity of triplefin species. New Zealand has over 20 species of triplefin, all of which are endemic. ^{Unique to native}

Discuss how the New Zealand triplefins are an example of adaptive radiation.

In your answer:

- describe what is meant by the terms endemic and species
- explain how temperature may act as a selection pressure, and leads to different species being found at different zones of the beach, such as the three species of triplefin that are shown in the diagram above
- discuss how the process of natural selection has resulted in such a large number ^{of} species of triplefin here.

The term endemic is used to refer to a species (or group of closely related individuals) that is strictly found within a specific area and originate from. The implications of temperature on the species is one that acts as a major selection pressure by enabling only a certain species to inhabit a certain area. This as a result actually reduces intraspecific competition by enabling

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each species to have its own space. Depending on the species they may be ^{inclined to} negative or positive thermotaxis. In this case the species *B. medius* appears to be positive phototaxis meaning this species will move to a warmer section of the beach, ^{(high-tide).} ~~whereas~~. Whereas, the species *F. varium* may be more inclined to move to a ~~colder~~ ^{colder} region (subtidal zone) because it is negative thermotaxis. In the middle ground there is that of thermokinesis in which species *F. lapidum* exhibits random movement in response to temperature, suggesting why it remains in the ~~inter~~ ^{intertidal} zone of the beach. The incorporation of natural ^{selection} ~~is~~ is one that dictates if a species/individual is best suited to an environment or not. In this case the triplefin is likely acclimated to differing temperatures and so those individuals who do not possess the desirable gene are removed from the gene pool.

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QUESTION THREE: POLYPLOIDY AND SPECIATION

When Māori arrived in New Zealand from tropical Polynesia around AD 1250, they brought with them a number of tree and root crops. Polyploidy is inferred in the origins of three of these species – kūmara (sweet potato), tī pore (the Pacific cabbage tree, now only found on Raoul Island, approximately 1000 km from New Zealand), and uwhi (yams). Polyploids are often larger than the species they are formed from, and are reproductively isolated from them.

Kūmara

Source: www.nature.com/articles/nature.2013.12257

Tī pore

Source: www.nzpcn.org.nz/flora/species/cordylina-fruticosa/?web=1&wdLOR=c5453C15F-CE62-0243-961A-E58D334D15C8

Uwhi

Source: <https://teara.govt.nz/en/photograph/17506/uwhi>

Discuss processes that result in new species.

You may use a diagram to support your answer.

In your answer:

- define the terms polyploid and reproductive isolation
- explain how polyploids are formed
- discuss how the process of polyploidy is an example of sympatric speciation, and explain how two **other** reproductive isolating mechanisms (RIMs) could have contributed to the speciation of the kūmara, tī pore, and uwhi.

polyploid refers to the phenomenon in which a complete set of chromosomes is doubled as a result of mutation. This phenomenon ~~etc almost always~~ results in instant speciation. This is largely due to the reproductive isolation that ~~occurs~~ ^{occurs} following ~~poly~~ ~~plord~~ ~~polyploidy~~. Reproductive isolation refers to ~~the~~ a factor or influence that inhibits the reproduction of a species. polyploids are formed as a result of error that occurs ^{with} ~~in~~ the spindle

fibres as they undergo segregation, this results in the creation of 2 sets of full chromosomes. This process is one that results in sympatric speciation in which a species is located within the same geographical area but are unable to reproduce ~~to~~^{due} to behavioural, temporal or other pre-zygotic barriers. In this case it is the genetic isolation that does not allow the species to reproduce, therefore making it a new species of its own. This speciation may ~~be~~^{also} be the likely cause of geographical isolation considering they are also found 1000 km away. As well the possibility of temporal isolation, meaning they have differing times when they are active.

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

QUESTION
NUMBER

91605

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|-----------------|--------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|--------------------|----|
| Standard | 91605 | Display ID | 62092511 | Total score | 10 |
| | | NSN | 137101097 | | |
| Q | Grade score | Annotation | | | |
| 1 | A4 | The candidate demonstrates an understanding of speciation by describing the following evolutionary concepts: mutation and convergent evolution. The candidate identified one trend in the graph and was able to describe TTX poison as selection pressure for resistance in snakes. | | | |
| 2 | N2 | The candidate demonstrates some understanding of speciation by describing the term endemic and described that species of the fish have 'preferred' temperature zones. | | | |
| 3 | A4 | The candidate demonstrates an understanding of speciation by describing the following evolutionary concepts: polyploidy, reproductive isolation, and sympatric speciation. | | | |