**Penguin population**



A small population of penguins is brought to an island.

The sea around the island contains fish for the penguins to eat.

There are no predators on the island that will eat the penguins.

**Part 1**

1. What do you think will happen to the size of the penguin population over the following years?

|  |  |
| --- | --- |
| **A** | It will keep getting bigger forever. |
| **B** | It will get smaller until there are no penguins left. |
| **C** | It will stay about the same size. |
| **D** | It will get bigger at first, and then stay about the same size after that. |

**Part 2**

1. The size of the penguin population increases over the first few years.

Why do you think this happens?

|  |  |
| --- | --- |
| **A** | The penguins move around and spread out all over the island. |
| **B** | The penguins eat fish from the sea around the island and grow bigger. |
| **C** | The penguins have plenty of food and there is nothing to stop them reproducing. |
| **D** | None of the penguins die. |

1. After a while, the size of the penguin population stops increasing and then stays about the same size.

Why do you think this happens?

|  |  |
| --- | --- |
| **A** | The penguins stop reproducing. |
| **B** | The penguins only give birth to enough babies to replace themselves. |
| **C** | All of the food in the sea around the island has been used up. |
| **D** | Food and other resources are limited, so not all the baby penguins that are born survive. |

**Part 3**

1. There are limited amounts of food and other resources that the penguins need to survive.

How do you think the penguins respond to this?

|  |  |
| --- | --- |
| **A** | The penguins cooperate and share the food so that there is enough for all of them. |
| **B** | The penguins compete for the food, and not all of them get enough to survive. |
| **C** | The penguins collaborate to make sure they find enough food. |
| **D** | The penguins compensate by eating less so that all of them can survive. |

1. Which penguins are most likely to get enough food to survive?

|  |  |
| --- | --- |
| **A** | All of the penguins. |
| **B** | Only the fastest penguins. |
| **C** | Only the biggest and strongest penguins. |
| **D** | The best adapted penguins. |

*Biology > Big idea BVE: Variation, adaptation and evolution > Topic BVE3: Evolution > Key concept BVE3.1: Explaining evolution*

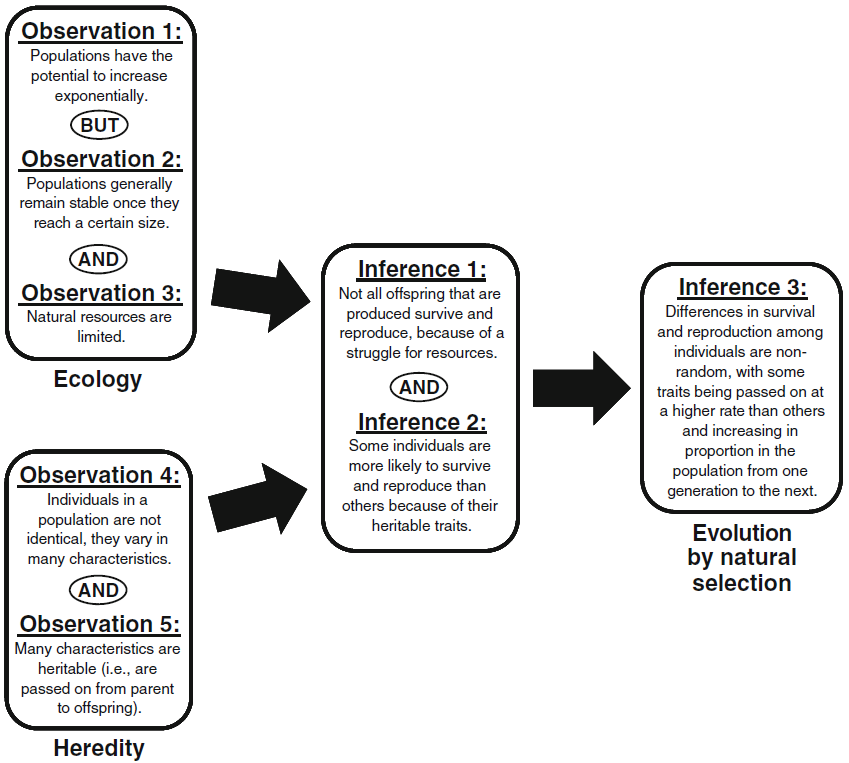
|  |
| --- |
| **Diagnostic question** |
| **Penguin population** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | The characteristics of a species can change over generations as advantageous adaptations become more common; this is evolution, and can be explained by a process of natural selection. |
| Observable learning outcome: | Recognise that organisms compete for limited resources, and that some individuals have traits that help them compete more successfully than other individuals in the same population. |
| Question type: | Simple multiple choice |
| Key words: | competition, population |

**What does the research say?**

The explanation for evolution developed by Charles Darwin, Alfred Russel Wallace and others, and described by Darwin in his book *On the Origin of Species by Means of Natural Selection* in 1859, have been summarised by Mayr (1982) and others into five observations (or facts) and three inferences.



A summary of Darwin’s theory of evolution by natural selection; adapted from Mayr (1982) by Gregory (2009).

**Heredity and variation**

**Ecology**

**Competition and natural selection**

**Evolution**

Science education researchers have created a series of diagnostic questions called the ‘conceptual inventory of natural selection’ (CINS) designed to assess understanding of the five observations and three inferences as well as modern understanding of the genetics of variation and inheritance (Anderson, Fisher and Norman, 2002). Although the CINS questions are designed for undergraduate students, they have provided inspiration for some of the diagnostic questions developed for BEST.

This activity probes students’ understanding of observations 1-3 and inferences 1 and 2.

Evolution-related terminology can be associated with misunderstandings (Andersson and Wallin, 2006). The phrase “survival of the fittest” is often used without (or in order to avoid having to demonstrate) understanding of the mechanisms involved, and many students incorrectly think “fittest” refers to the most athletic or strongest individuals rather than to the individuals best adapted to compete and survive to reproduce in their environment (Gregory, 2009).

**Ways to use this question**

The diagnostic questions in this activity are inspired by questions 1, 2, 3 and 5 in the ‘conceptual inventory of natural selection’ (CINS) (Anderson et al., 2002). The context used in the CINS is Galápagos finches; this has been changed in this activity to penguins, which may be more familiar to students, but the context could be edited as you see fit to suit your own students.

Students should complete the questions individually. This could be a pencil and paper exercise, or you could use the presentation with an electronic voting system or mini white boards.

*Differentiation*

You may choose to read the questions to the class, so that everyone can focus on the science. In some situations it may be more appropriate for a teaching assistant to read for one or two students.

**Expected answers**

1. **D** – It will get bigger at first, and then stay about the same size after that.
2. **C** – The penguins have plenty of food and there is nothing to stop them reproducing.
3. **D** – Food and other resources are limited, so not all the baby penguins that are born survive.

Note: Questions 1-3 probe students’ understanding of observations 1-3 and inference 1 from the diagram on page 1 of these teacher notes.

1. **B** – The penguins compete for the food, and not all of them get enough to survive.

Note: Question 4 probes students’ understanding of inference 1 from the diagram on page 1 of these teacher notes.

1. **D** – The best adapted penguins.

Note: Question 4 probes students’ understanding of inference 2 from the diagram on page 1 of these teacher notes. Students who select answer 5B (“Only the fastest penguins”) or 5C (“Only the biggest and strongest penguins”) may have heard the term “fittest” in relation to competition (e.g. in the phrase “survival of the fittest”) and may have the common misunderstanding that it refers to the most athletic or strongest individuals rather than to the individuals best adapted to compete and survive in their environment.

**How to respond - what next?**

If there is a range of answers, you may choose to respond through structured class discussion. Ask one student to explain why they gave the answer they did; ask another student to explain why they agree with them; ask another to explain why they disagree, and so on. This sort of discussion gives students the opportunity to explore their thinking and for you to really understand their learning needs. Responses often work best when the activities involve paired or small group discussions, which encourage social construction of new ideas (meaning making) through dialogue.

If students have misunderstandings about competition, how it operates in populations, and what organisms compete for, the following BEST ‘response activity’ allows them to develop their understanding through small group discussion and concept mapping, and could be used in follow-up to this diagnostic question:

* Response activity: The struggle for existence

**Acknowledgments**

Developed by Alistair Moore (UYSEG), adapted from questions included in the ‘conceptual inventory of natural selection’ (Anderson et al., 2002).

Images: pixabay.com/Djwosa (4515809)

**References**

Anderson, D. L., Fisher, K. M. and Norman, G. J. (2002). Development and evaluation of the conceptual inventory of natural selection. *Journal of Research in Science Teaching,* 39(10)**,** 952-978.

Andersson, B. and Wallin, A. (2006). On developing content-oriented theories taking biological evolution as an example. *International Journal of Science Education,* 28(6)**,** 673-695.

Gregory, T. R. (2009). Understanding natural selection: essential concepts and common misconceptions. *Evolution: Education and Outreach,* 2**,** 156-175.

Mayr, E. (1982). *The growth of biological thought,* Cambridge, MA: Harvard University Press.