Notes for teachers

At a glance

The following activity provides an opportunity to for students to review their understanding of, and practice their explanations for, evolution by natural selection and the process of speciation. The background of cat species evolution provides a context for the activity and provides a link for students to also practice comparative genetics (gel electrophoresis results), interpreting phylogenetic trees and fossils as evidence for evolution. Given the range of activities and GCSE concepts covered, this activity is suited to review lessons rather than first teaching of the content.

Learning Outcomes

- Students review and practice explanations for speciation and evolution
- Students practice interpreting gel electrophoresis results and phylogenetic trees
- Students apply conceptual knowledge of animal adaptations to idea of speciation

Each student will need

- A copy of the student worksheet
Possible Lesson Activities

- **Starter activity**
  - Big question: “Why are there so many species?”
    - Use questioning to explore lines of thinking and direct to the concept of speciation and evolution.

- **Main activity: Conservation of Scottish Wildcats**
  - Show Oxford Sparks animation ‘When did cats arrive in Britain?’ (see web links below).
  - Hand out student worksheets.
  - Circulate while students’ complete task to assess, direct and extend student ideas.

- **Main activity: Conservation of Scottish Wildcats**
  - Q - Outline the theory of evolution by natural selection first proposed by Charles Darwin in 1859.
    - A – Due to random mutations causing genetic differences, species show a wide range of variation. Individuals with characteristics most suited to their environment have an advantage and are more likely to survive and reproduce. This is commonly known as 'survival of the fittest'. Individuals with alleles that confer an advantage within their environment are more likely to reproduce successfully and so pass these alleles to their offspring. This results in these specific alleles becoming more common in the next generation. Those that are poorly adapted to their environment are less likely to survive and reproduce. Their genes are less likely to be passed on to the next generation. In this way, favourable alleles are said to be selected for. Over a period of time (in future generations), these favourable alleles become more common and so a species will gradually evolve.
  - Q – What is a species?
    - A - A species is a group of organisms that can interbreed to produce fertile offspring.
  - Q - What is a population?
    - A – A group of organisms of a species that can freely interbreed.
  - Q – Missing word
    - A – Reproductively.
  - Q - Some scientists argue that Scottish wildcats are, due to the process of speciation, now, a different species from their European wildcat ancestors. Suggest a practical way that they could test this.
    - A – They could attempt to breed Scottish and European Wildcat populations. If they are still the same species, they will be able reproduce successfully to produce fertile offspring. If speciation has occurred, they will no longer be able to interbreed.
  - Q - Analysis of Scottish wildcats reveals that they are in fact not yet a separate species from European wildcats despite being reproductively isolated. Based on the information given, what is the most likely explanation for this?
    - A – The populations have only been isolated for 9000 years. Evolution is a very slow and gradual process and so this is unlikely to be long enough for sufficient mutations to have built up for them to become separate species.
• Q - Suggest and explain 4 adaptations European wildcats are likely to develop due to evolution by natural selection.
  • A – Any of;
    • thicker fur for insulation,
    • fat deposits for insulation and thermogenesis,
    • smaller ears or other external features to reduce SA for heat loss,
    • increase in size to improve SA:volume,
    • change of fur colour for camouflage,
    • any other sensible suggestion.
• Q - Complete the diagram suggesting the likely results of the domestic cat.
  • A – Students should suggest a fragment pattern that shares some fragments with the European Wildcat (due to a recent common ancestor) but include some significant differences (as they are different species). The fragment pattern should show less similarity to the ancient sample than is shown by the European Wildcat.
• Q - Suggest from which species of wildcat the domestic cat has descended? Explain your answer.
  • A – African Wildcat as fragment pattern is most similar.
• Q - Suggest which species of wild cat share a common descendent most distantly. Explain your choice.
  • A – African Wildcat and the European Wildcat as they share the fewest common fragments (their fragment patterns are the most dissimilar).
• Q – According to above diagram, which two species of cat would you expect to share the least common DNA?
  • A – Panthera and Felis will share the least DNA as they share a common ancestor most distantly.
• Q – Which two cat species would you expect to share the most?
  • A – African wildcat and domestic will share the most DNA as they share a common ancestor most recently.
• Q - What do scientists have to rely on to provide evidence for ancient speciation events (such as those mentioned above)?
  • A – Fossil record.
• Q - Detail how this evidence might be formed.
  • A - A fossil is the preserved remains of a dead organism from millions of years ago. Fossils are found in rocks and can be formed from:
    • a) Hard body parts, such as bones and shells, which do not decay easily or are replaced by minerals as they decay.
    • b) Parts of organisms that have not decayed because one or more of the conditions needed for decay are absent. For example, dead animals and plants can be preserved in amber, peat bogs, tar pits, or in ice.
    • c) Preserved traces of organisms, such as footprints, burrows and rootlet traces - these become covered by layers of sediment, which eventually become rock
• Q - Why might there be less evidence available to scientists for older speciation events than more recent ones?
  • A – Fossils may become damaged or destroyed over time.
• Plenary
  • One sentence at a time...
    ○ Pose the questions asking students to explain the concepts covered in the activity (e.g. speciation, evolution, fossil formation etc). Pick one student at a time to provide one sentence of the explanation, with the next student picking up the explanation where it was left off and adding the next sentence until complete.
    ○ Restarting the explanation each time there is an error can be a good way to keep students engaged and gamify the activity.

Web links

• Oxford sparks animation: Our immune system – the battle within
  https://www.oxfordsparks.ox.ac.uk/content/when-did-cats-arrive-britain