Speciation

4.6.3.2 · Inheritance, variation and evolution · revision notes

The work of Alfred Russel Wallace and how new species form. This is in GCSE Biology only, not in Combined Science. Expect recall questions about Wallace and Darwin and 4 to 6 mark 'describe how a new species could form' questions about populations that have been separated.

Key facts

- Wallace independently proposed evolution by natural selection
- Wallace is best known for warning colouration in animals and his theory of speciation
- Speciation: isolation → variation → different conditions → natural selection → can no longer interbreed to produce fertile offspring
- 1858: joint writings with Darwin → 1859: Darwin published *On the Origin of Species*
- Species = organisms that can interbreed to produce fertile offspring

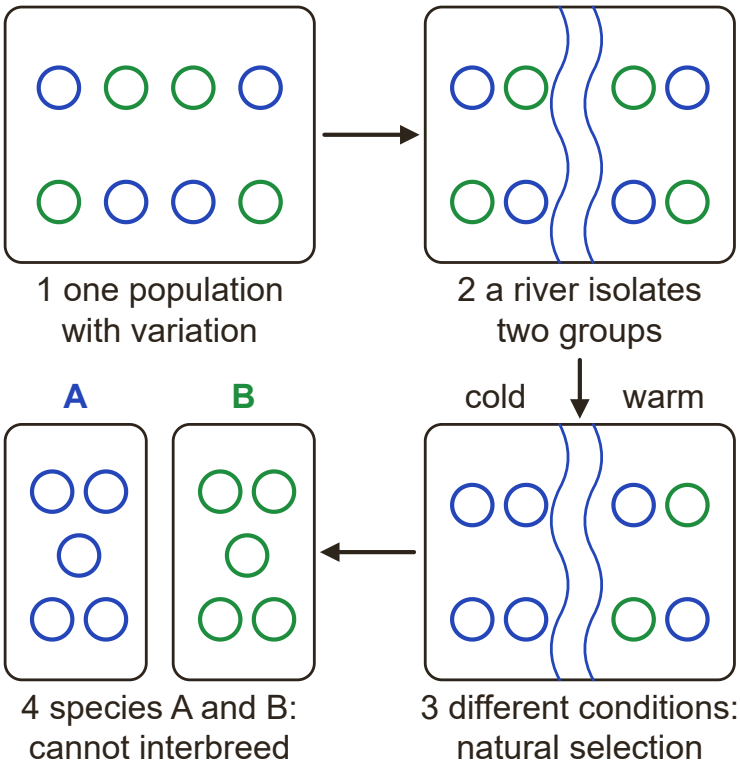
Notes

Alfred Russel Wallace

- **Alfred Russel Wallace** independently proposed the theory of evolution by natural selection.
- He published **joint writings with Darwin in 1858**, which prompted Darwin to publish *On the Origin of Species* (1859) the following year.
- Wallace worked worldwide gathering evidence for evolutionary theory. He is best known for his work on **warning colouration** in animals and his theory of **speciation**.
- Warning colouration: bright colours on animals that are poisonous or dangerous warn predators to leave them alone, so these colours can be favoured by natural selection.
- Wallace did much pioneering work on speciation, but more evidence over time has led to our current understanding of the theory of speciation.

How a new species forms

- **Isolation**: two populations of a species become separated, e.g. by a river, a mountain range or the sea, so they cannot interbreed.
- **Genetic variation**: there is variation within each population, caused by mutations.
- **Different conditions**: the environment is different for each population (e.g. climate, food or predators).
- **Natural selection**: in each population, the individuals best suited to their own environment are more likely to survive and reproduce, passing on their alleles. Different characteristics become common in each population.
- **Speciation**: eventually the populations become so different that they can no longer interbreed to produce fertile offspring. They are now two separate species.



How a new species forms: isolation, variation, different conditions, natural selection, speciation.

The impact of Darwin and Wallace

- Their theory explains how the huge variety of living things evolved from common ancestors, and it is the basis of how biologists study and classify living things today.
- Scientific ideas such as the theory of speciation are changed and improved as more evidence is gathered.

How to answer each type of question

Recall the work of Wallace

1 to 3 marks | **Grade 5**

1. Wallace independently proposed natural selection.
2. Joint writings with Darwin in 1858; *On the Origin of Species* in 1859.
3. He is best known for warning colouration and speciation.

Example. (a) Give one area of biology that Alfred Russel Wallace is best known for.
(b) Explain how Wallace's work affected when Darwin published *On the Origin of Species*. [3 marks]

Model answer.

(a) Warning colouration in animals / speciation (1)

(b) Wallace and Darwin published joint writings in 1858 (1), which prompted Darwin to publish *On the Origin of Species* the following year, in 1859 (1).

Describe how a new species could form

4 to 6 marks | **Grade 7**

1. Isolation: name the barrier from the question.
2. Variation within each population, caused by mutations.
3. Different conditions, so different characteristics are useful in each place.
4. Natural selection: the best suited survive, reproduce and pass on their alleles.
5. Eventually the populations cannot interbreed to produce fertile offspring.

Example. A population of beetles lived in a forest. A wide river formed and divided the forest into two parts. The northern part became colder and wetter than the southern part.
Describe how the two populations could have become two different species. [5 marks]

Model answer. The river isolated the two populations, so they could not interbreed (1). There was genetic variation in each population, caused by mutations (1). The conditions were different on each side of the river (1). In each area, the beetles best suited to their environment were more likely to survive and reproduce, passing on their alleles (natural selection) (1). Over a long time the populations became so different that they could no longer interbreed to produce fertile offspring (1).

Describe how to test whether populations are separate species

2 marks | Grade 8

1. Breed individuals from the two populations together.
2. If they cannot produce fertile offspring, they are different species.

Example. Scientists want to find out whether the northern and southern beetles are now different species.
Describe how they could do this. [2 marks]

Model answer. Try to breed a beetle from the northern population with a beetle from the southern population (1). If they do not produce fertile offspring, they are different species (1).

Don't lose marks

- Leaving out the word 'fertile'. Horses and donkeys can breed, but their offspring (mules) are infertile, so they are different species.
- Missing the isolation step, or not saying that the populations cannot interbreed.
- Saying the organisms 'changed to suit the new environment'. Natural selection acts on variation caused by mutations.
- Saying Wallace copied Darwin. Wallace proposed the theory independently, and they published joint writings in 1858.

More tips

Memory tricks

- Speciation steps: Isolation, Variation, Different conditions, Natural selection, Species can't interbreed ('I Very Definitely Need Sleep').
- Wallace = Warning colours (W for W).
- 1858 joint writings, then 1859 *On the Origin of Species*.

Exam technique

- Use the information in the question (the barrier, and how the conditions differ) in your steps.
- Include the key words: isolated, variation, mutation, natural selection, alleles, fertile offspring.
- Give the steps in order; a 5-mark answer needs all five.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **State what Wallace independently proposed**
Wallace independently proposed the theory of evolution by natural selection.

Grade 4 — **Recall what Wallace is best known for**
His work on warning colouration in animals and his theory of speciation.

Grade 5 — **Describe how Wallace influenced Darwin**
Their joint writings in 1858 prompted Darwin to publish *On the Origin of Species* in 1859.

Grade 5 — **Define a species**

A group of organisms that can interbreed to produce fertile offspring.

Grade 6 **Explain the impact of their ideas**

Natural selection explains how the variety of life evolved and is the basis of modern biology.

Grade 7 **Describe the steps that produce a new species**

Isolation, genetic variation, different conditions, natural selection, and finally no fertile offspring between the populations.

Grade 8 **Apply speciation to an unfamiliar example**

Use the barrier and the different conditions described in the question in each step.

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