

Darwin, natural selection and antibiotic resistance

Revision notes • How evolution by natural selection works, and how antibiotic-resistant bacteria are evidence for Darwin's theory.

For Edexcel GCSE Combined Science 1SC0. **Higher tier** is only on the Higher paper.

Darwin, natural selection and antibiotic resistance Spec 4.1B–4.3

Evolution by natural selection Spec 4.2

Evolution is a change in the inherited characteristics of a population over many generations. Darwin explained how it happens using natural selection.

1. Individuals in a population show **variation**. Some of this is genetic, caused by differences in alleles, which arise by **mutation**.
2. More offspring are born than can survive, so individuals **compete** for resources such as food, space and mates, and some are eaten or die of disease.
3. Individuals with characteristics that suit their environment are more likely to **survive and reproduce**.
4. They **pass on the alleles** for those characteristics to their offspring.
5. Over many generations, the proportion of the population with the advantageous alleles increases.

Individuals with a characteristic that gives an advantage are sometimes described as the 'fittest'. This means best suited to their environment, not strongest.

Natural selection	The process by which organisms better adapted to their environment are more likely to survive, reproduce and pass on their alleles.
Evolution	A change in the inherited characteristics of a population over many generations.

Common mistake: Individuals do not change during their lives to cope with their environment. The advantageous allele has to be there already, and the proportion of individuals with it increases over generations.

Exam tip: Write the full chain in your answer: variation (from mutation), survival and reproduction of the better adapted, alleles passed on, proportion increases.

Resistant organisms and antibiotic resistance Spec 4.3

The emergence of **resistant organisms** is an example of natural selection that can be seen happening within a human lifetime. Bacteria reproduce very quickly, so changes in a population happen fast.

1. In a population of bacteria, a **mutation** produces an allele that makes one bacterium resistant to an antibiotic. This is variation.
2. The antibiotic is used. It kills the non-resistant bacteria, but the resistant bacterium survives. The antibiotic is the **selection pressure**.
3. The resistant bacterium reproduces with less competition, and passes the resistance allele on to its offspring.

4. Over time the population is mostly resistant bacteria, so the antibiotic no longer works against the infection.

This supports Darwin's theory because all the steps of natural selection can be observed: variation, a selection pressure, survival and reproduction of the better adapted, and inheritance of the useful allele.

Percentage of resistant bacteria (practice data)

In a lab, 300 bacteria were sampled before treatment and 12 were resistant to an antibiotic. After several rounds of treatment, 300 bacteria were sampled again and 192 were resistant. Calculate the percentage resistant at each time, and the change.

1. Before: $12 \div 300 \times 100 = 4\%$
2. After: $192 \div 300 \times 100 = 64\%$
3. Change: $64 - 4 = 60$ percentage points

Answer: 4% before, 64% after, an increase of 60 percentage points.

Maths skill: You may be asked to plot such data as a bar chart or line graph. Choose scales that use at least half the grid, label both axes with units, and plot the independent variable (time or treatment) on the x-axis.

Common mistake: Antibiotics do not cause the mutation, and bacteria do not 'get used to' antibiotics. The resistant bacteria were there by chance and are selected by the antibiotic.

Quick check

1. What causes new alleles to appear in a population?
2. Give the four main steps of natural selection in order.
3. In antibiotic resistance, what is the selection pressure?
4. Why do populations of bacteria change quickly?

Quick check answers

Darwin, natural selection and antibiotic resistance

- 1 . Mutation.
- 2 . Variation, competition so some survive and reproduce, alleles passed on, proportion with the useful allele increases.
- 3 . The antibiotic.
- 4 . Bacteria reproduce very rapidly, so the resistance allele spreads in a short time.