

Variation and selection

IGCSE Biology 0610 · Topic 18 revision notes

Everything from the 4 lessons of this topic on a few pages: the key idea of each lesson, the diagram to remember, the points to learn and the traps examiners set. Read it, cover it, test yourself.

1. Variation

2. Adaptive features

3. Natural selection

4. Selective breeding

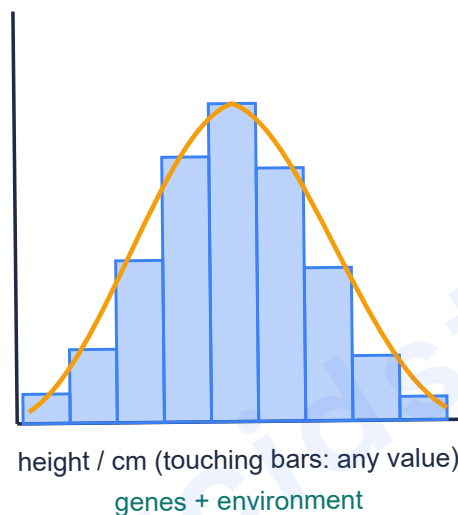
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1 Variation

Syllabus 18.1

Variation is the differences between individuals of the same species. **Continuous variation** gives a range of phenotypes between two extremes (body length, body mass) and is caused by both genes and the environment. **Discontinuous variation** gives a limited number of phenotypes with no intermediates (ABO blood groups, pea seed shape and colour) and is usually caused by genes only. **Mutation** is genetic change and is the way new alleles are formed.

Continuous: height



Discontinuous: blood group

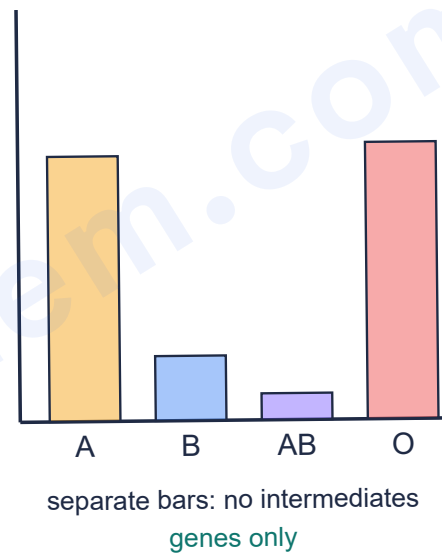


Fig. 1: continuous variation gives a histogram with a bell-shaped spread; discontinuous variation gives separate bars with nothing in between

Two kinds, two causes.

- ✓ **Continuous:** range between two extremes; genes and environment; histogram.
- ✓ **Discontinuous:** a few distinct phenotypes, no intermediates; usually genes only; bar chart.
- ✓ **Mutation:** genetic change; makes new alleles; rate raised by ionising radiation and some chemicals.
- ✓ **Extended:** sources of genetic variation are mutation, meiosis, random mating and random fertilisation.

Watch out!

Continuous variation is *not* caused by the environment alone. Set the diet slider to zero in the sim: the heights still vary, because the people have different genes.

A feature measured in numbers is not automatically continuous. Shoe size is recorded in whole sizes, but foot length is really continuous. Ask whether intermediate values exist in nature.

Mutagens do not aim at particular genes. They increase the rate of mutation, but which base changes is random.

2 Adaptive features

Syllabus 18.2

An **adaptive feature** is an **inherited feature that helps an organism to survive and reproduce in its environment**. To describe one, name the feature and link it to a problem in the habitat: cold, drought, predators, too much water. Extended: **xerophytes** are plants adapted to dry places and reduce water loss; **hydrophytes** are plants adapted to living in water.

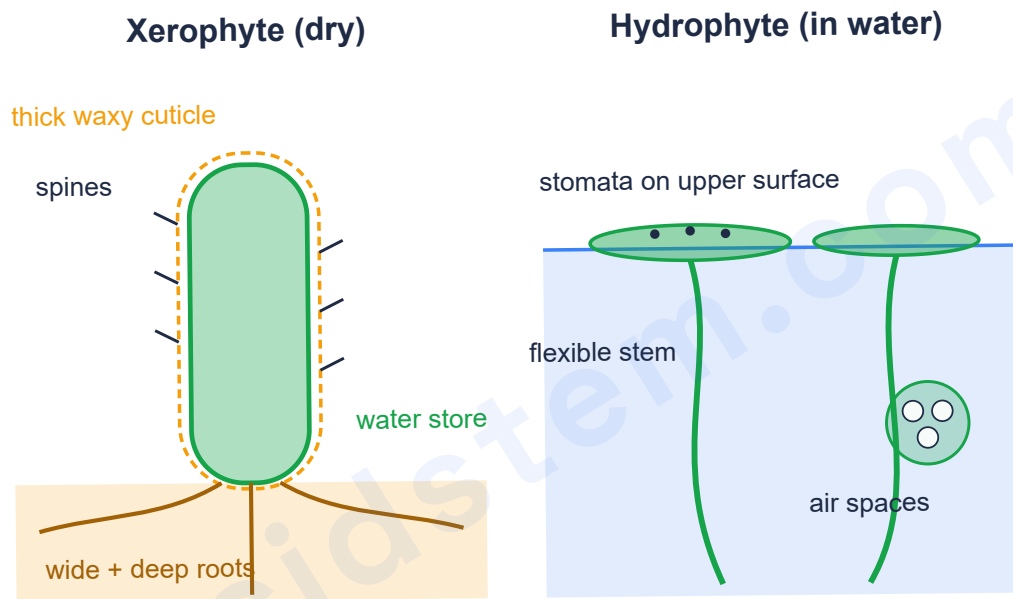


Fig. 1: a xerophyte reduces water loss and stores water; a hydrophyte floats its leaves to the light and keeps air spaces to get oxygen to submerged parts

Link every feature to the habitat.

- ✓ **Adaptive feature:** inherited, helps survival and reproduction in the environment.
- ✓ **Answer frame:** name the feature, say what it does, say why that matters in this habitat.
- ✓ **Xerophytes (Extended):** reduce water loss (spines, thick cuticle, sunken stomata, rolled leaves, hairs) and store or find water.
- ✓ **Hydrophytes (Extended):** air spaces, stomata on the upper surface, large floating leaves, flexible stems.

Watch out!

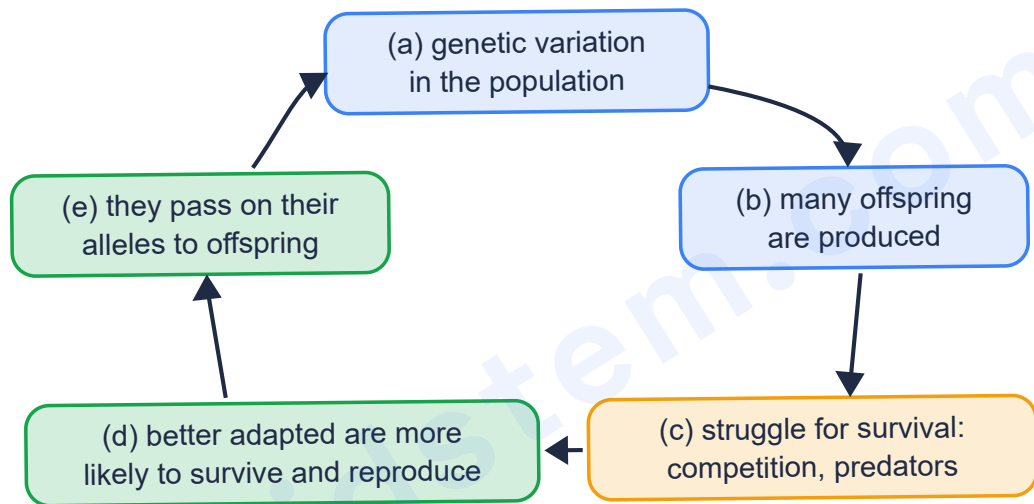
Always link the feature to the environment. "It has thick fur" earns nothing on its own; "thick fur traps air, which insulates the fox against the cold" is an explanation.

Sunken stomata and hairs do not stop water loss completely. They trap moist air, so the concentration gradient of water vapour is smaller and the rate of diffusion out of the leaf is lower.

3 Natural selection

Syllabus 18.3

Natural selection: there is **genetic variation** within a population; organisms produce **many offspring**; there is a **struggle for survival**, including competition for resources; individuals that are **better adapted** to the environment have a greater chance of surviving and reproducing; they **pass on their alleles** to the next generation. Extended: over many generations this makes populations more suited to their environment, a process called **adaptation**.



repeat each generation: the useful allele becomes more common
the population becomes more suited to its environment (adaptation)

Fig. 1: the five steps of natural selection; each turn of the cycle is one generation

Five steps, every time.

- ✓ **Variation:** genetic variation within the population (from mutation).
- ✓ **Overproduction and struggle:** many offspring; competition, predation, disease.
- ✓ **Selection:** better adapted individuals are more likely to survive and reproduce, and pass on their alleles.
- ✓ **Never** say the environment causes the useful mutation or that individuals change to adapt.

Watch out!

The moths do not turn dark because the bark is sooty, and they do not choose to change. The dark allele was already in the population; the environment only changes which moths survive to breed.

The antibiotic does not cause the resistance mutation. The mutation happens at random; the antibiotic only selects the bacteria that already carry it.

Individuals do not adapt during their lifetime in this sense. A single moth cannot change its wing colour; only the population changes, as alleles are passed on.

4 Selective breeding

Syllabus 18.3

In **selective breeding** (artificial selection) humans **select individuals with desirable features**, **cross** them to produce the next generation, and **select the offspring showing the desirable features**. Repeating this over **many generations** improves crop plants and domesticated animals. Extended: in natural selection the environment decides which individuals reproduce; in artificial selection humans decide.

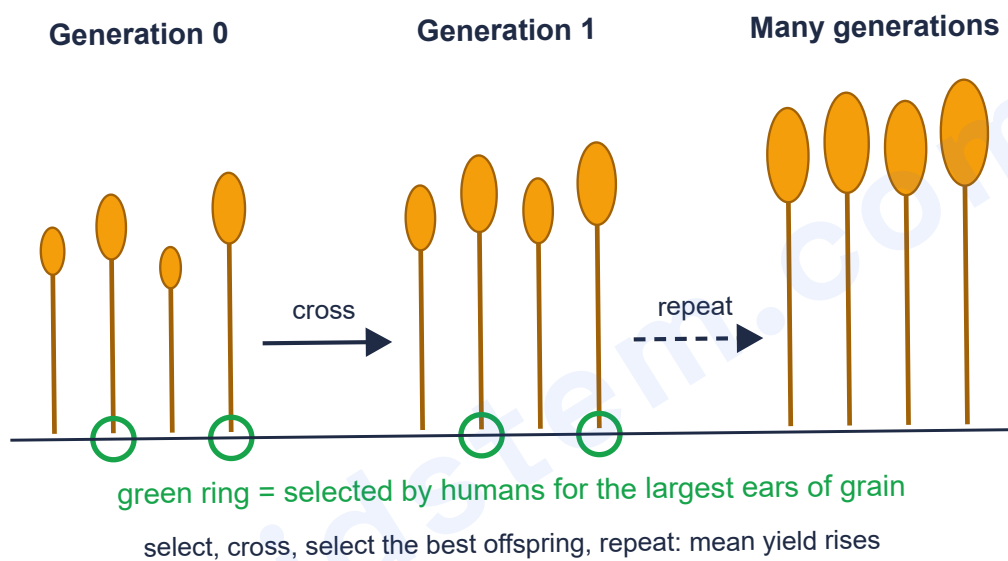


Fig. 1: selecting the wheat plants with the largest ears and crossing them, generation after generation, raises the mean yield

Humans choose the parents.

- ✓ **Step 1:** select individuals with the desirable feature.
- ✓ **Step 2:** cross them to produce the next generation.
- ✓ **Step 3:** select offspring showing the feature; repeat over many generations.
- ✓ **Extended:** natural selection is by the environment for survival; artificial selection is by humans for usefulness, and usually faster.

Watch out!

Selective breeding only works on *inherited* variation. A plant that is large only because it grew in richer soil will not pass that on, which is why the sim's yield climbs gradually rather than in one leap.

Artificial selection can make an organism *less* able to survive in the wild. Very high-yield crops may need fertiliser and pesticides, and some dog breeds have breathing problems.