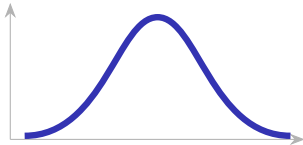


# Variation & Selection

IGCSE Biology ■ Topic 18

IGCSE Biology

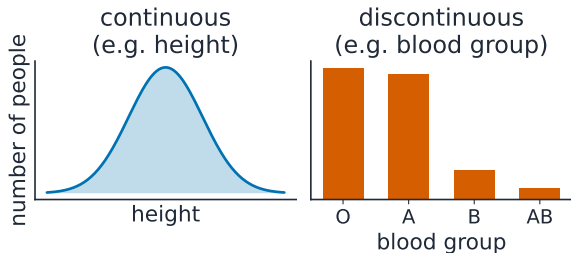


## What we will cover

- 1 Variation
- 2 Mutation & adaptation
- 3 Natural selection
- 4 Examples
- 5 Selective breeding



# Variation



continuous: smooth range · discontinuous: discrete groups

- **continuous variation** – a smooth range of **phenotypes** between two extremes (for example body length and body mass).
- **discontinuous variation** – a few separate phenotypes with nothing in between (for example **ABO blood groups**, or seed shape in peas).

# Mutation is where new variation comes from

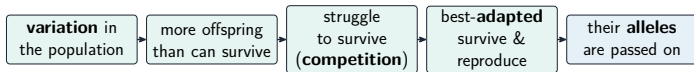
original: A T G C A  
mutated: A T T C A → a change in the  
bases = a new allele

A **mutation** is a genetic change. It is how **new alleles** are made, so it is the original source of *all* variation.

- **ionising radiation** (X-rays) and some chemicals raise the **rate**
- **(Supplement) meiosis** , random fertilisation and random mating then *shuffle* what mutation created



# Natural selection



over many generations the population becomes better adapted

## Natural selection :

- 1 variation in the population
- 2 more offspring than can survive
- 3 **competition** for **resources** – food, water, space
- 4 **best-adapted** survive & breed
- 5 helpful alleles spread

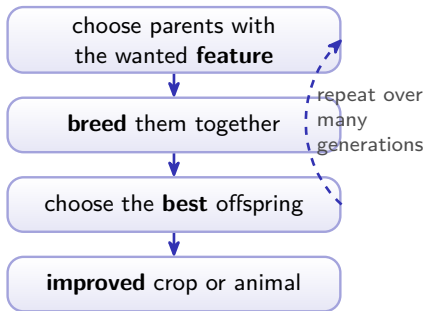
# Examples



The dark **peppered moth** was favoured on soot-darkened bark.

**Antibiotic** -resistant bacteria are natural selection happening fast.

# Selective breeding



humans choose which breed (not the environment)

In **selective breeding**, humans choose which organisms breed, over many generations (better crops & animals).

Natural selection: the **environment** decides. Selective breeding: **humans** decide.

# Adaptive features



A camel is adapted to desert life: it stores fat in its humps and can survive a long time without water

# Plants adapted to too much water, and to too little

## hydrophytes

water plants – **air spaces** to help them float, and stomata on the **upper** leaf surface, where the air is

## xerophytes

desert plants – a **thick waxy cuticle**, few small stomata, and the ability to **store water**

## the xerophyte logic

every feature reduces **transpiration**, because water is the scarce **resource**

## the hydrophyte logic

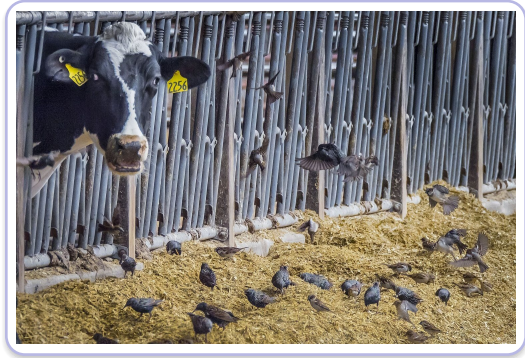
water is abundant, so the problems are **floating and gas exchange** instead

## further xerophyte features

sunken stomata, rolled leaves, hairs – all trapping humid air next to the stomata

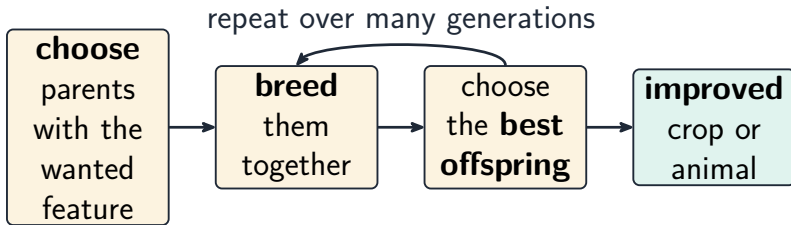
State the feature, then **what it does about water**. “Thick waxy cuticle” alone is a description; “so less water evaporates from the leaf” is the mark.

## Selective breeding in practice



Dairy cattle: generations of selective breeding for milk yield

## Selective breeding, continued



**humans** choose which breed (not the environment)

In selective breeding, humans choose which organisms breed, over many generations

# Selective breeding, step by step

- 1. select** choose the individuals with the **desired characteristic**
  - 2. cross** breed them together to produce the next generation
  - 3. select again** choose the offspring showing the characteristic most strongly
  - 4. repeat** over **many generations**, until the characteristic is reliable
- used for crops** a higher yield, disease **resistance** , or better taste
- and for animals** cows that give more milk, sheep with more wool

The difference from natural selection is **who does the selecting**: a farmer choosing, against the environment choosing. The mechanism is otherwise identical.

## Variation, continued



People show wide variation in many inherited features.

# Two kinds of variation

**variation**

the differences between individuals of the same **species**

**continuous**

a **range** of values with no distinct groups – height, mass.  
Affected by genes *and* environment

**discontinuous**

a small number of **distinct** categories – blood group, ability  
to roll the tongue. Genes alone

**where new variation comes from**

**gene mutation** – a change in the **base sequence** of DNA

**the plot**

continuous data give a bell-shaped histogram; discontinuous data give separate bars

If the categories can be counted, it is discontinuous; if the values fall anywhere on a scale, it is continuous. That test decides the graph you draw.

## Exam tips

- Continuous variation = a range (genes + environment); discontinuous = separate groups (genes only).
- Mutation makes new alleles – the source of all variation. Radiation and some chemicals raise the mutation rate.
- Natural selection: variation → too many offspring → struggle and competition → the best-adapted survive and reproduce → they pass on their alleles.
- Antibiotic resistance in bacteria is natural selection in action.
- Selective breeding (artificial selection): humans pick the parents; in natural selection, the environment “picks”.



## Worked example – explaining natural selection

**Dark moths became common in a sooty industrial area. Explain using natural selection.**

- **Variation:** the population already had pale and dark moths (from mutation).
- Soot darkens the bark, so **dark moths are better camouflaged**.
- Birds eat more pale moths  $\Rightarrow$  dark moths **survive and reproduce**, passing on the allele.
- Over many generations, **the dark allele becomes more common**.

Four steps, always: **variation**  $\rightarrow$  **selection pressure**  $\rightarrow$  **the better-adapted survive and breed**  $\rightarrow$  **the allele's frequency rises**.  
Name the pressure.

## Topic 18 – key takeaways

1

### Variation

continuous (range) vs  
discontinuous (groups)

2

### Mutation

makes new alleles – the source of  
variation

3

### Natural selection

best-adapted survive & pass on  
alleles

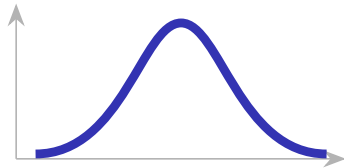
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### Breeding

humans choose the parents

## Check yourself

- 1 Which variation gives a smooth range?
- 2 What is the original source of all variation?
- 3 Who survives in natural selection?
- 4 Who chooses the parents in selective breeding?



**Answers** 1. continuous variation 2. mutation 3. the best-adapted 4. humans