

17.1 Variation

Name: _____ Class: _____ Date: _____ Total: 22 marks

KEY WORDS variation • genetic • continuous • discontinuous
• continuous variation

Objective

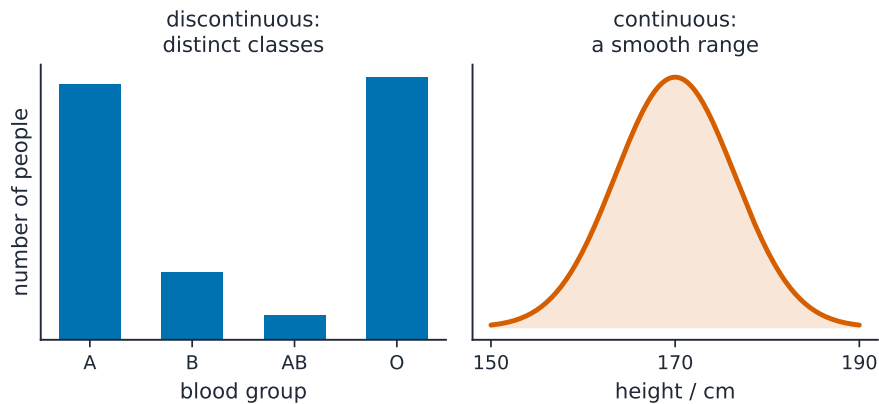
Build the skills to answer exam questions on **variation** – **genetic** and **environmental** causes, **continuous** and **discontinuous** variation, and comparing samples with the **t-test**.

You must be able to:

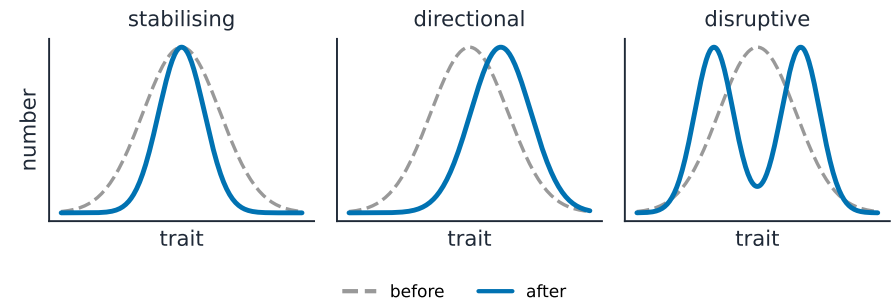
- explain genetic, environmental and combined causes of phenotypic variation
- explain continuous and discontinuous variation and their genetic basis
- use a t-test to compare the means of two samples

1 Key knowledge and worked examples

■ Causes and patterns of variation



Discontinuous variation falls into separate groups; continuous variation is a smooth range



stabilising: favours the mean • directional: one extreme • disruptive: both extremes

Variation is acted on by the types of selection

- **genetic only** – set by alleles (e.g. blood group); **environmental only** – set by surroundings (e.g. a scar); most features are a **combination** (e.g. height).
- **discontinuous**: separate categories, controlled by one or a few **genes**, little environmental effect.
- **continuous**: a smooth range, controlled by **many genes** plus the environment.

■ The t-test

The **t-test** compares the **means** of two samples to see whether their difference is real or just chance. A large *t* (beyond the critical value) means the difference is significant; a small *t* means it could be due to chance.

2 Practice

2.1 State whether each is continuous or discontinuous variation: human height; ABO blood group. [2]

2.2 Give **one** example of a feature caused by both genes and the environment. [1]

3 Exam-style questions

3.1 Which feature shows discontinuous variation? [1]

- ☐ **A** body mass
B ABO blood group
C height
D skin colour

3.2 Continuous variation is usually caused by: [1]

- ☐ **A** a single gene only
B many genes together, plus the environment
C the environment only
D a chromosome mutation

3.3 A student measures the heights of plants grown in sun and in shade and wants to know if the difference in mean height is significant.

(a) Name a statistical test the student should use. [1]

(b) The calculated t value is greater than the critical value at $p = 0.05$. State what this tells the student. [2]

3.4 Explain why two genetically identical plants can still differ in height. [2]

3.5 A student measured the height of 100 plants of one species growing in a field, and the number of plants of each of four flower colours.

(a) State, with a reason, whether height and flower colour show continuous or discontinuous variation. [4]

(b) Describe the causes of the variation in each characteristic. [3]

(c) The heights gave a mean of 42.0 cm and a standard deviation of 6.0 cm. Explain what the standard deviation tells you, and state approximately what percentage of the plants lie between 36.0 cm and 48.0 cm. [3]

(d) Explain why a t -test, rather than a comparison of means alone, would be used to compare this field with a second one. [2]

Solutions

Each answer shows the steps, then the **result**.

2.1

- height – continuous; ABO blood group – discontinuous

2.2

- e.g. height / body mass / skin colour

3.1 B

- ABO blood group falls into separate categories

3.2 B

- Continuous variation is polygenic and affected by the environment

3.3

(a)

- the t-test

(b)

- the difference between the means is significant; it is unlikely (less than 5% probability) to be due to chance

3.4

- the environment differs (e.g. light, water, minerals); environmental factors affect the phenotype as well as the genes

3.5

(a)

- Height is **continuous** – any value within a range is possible, and the data form a smooth distribution with no distinct categories. Flower colour is **discontinuous** – each plant falls into one of a few distinct categories with nothing in between

(b)

- Height is **polygenic**, controlled by many genes each of small effect, and it is strongly affected by the environment – light, water and minerals. Flower colour is controlled by one gene, or very few, with little or no environmental influence

(c)

- The standard deviation measures the **spread** of the values about the mean – a small value means the plants are closely grouped. 36.0 to 48.0 cm is one standard deviation either side of the mean; for a normal distribution that contains about **68%** of the plants

(d)

- The two samples will almost always have slightly different means by chance alone; the *t*-test uses the spread and the sample size to say whether the difference is larger than chance would explain, i.e. whether it is statistically significant