

Variation

4.6.2.1 · Inheritance, variation and evolution · revision notes

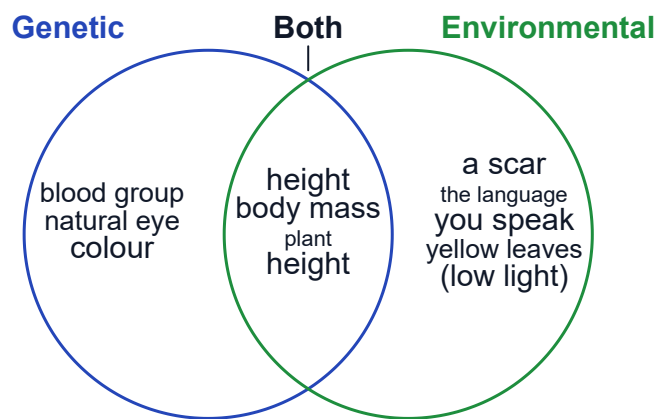
Variation is the differences in characteristics between individuals, caused by genes, the environment or both. You need to know that all genetic variants arise from mutations and how the genome and the environment together shape the phenotype. It is often tested with data on twins or plants grown in different conditions.

Key facts

- Variation = differences in the characteristics of individuals in a population
- Genome + environment → phenotype
- All variants arise from mutations; mutations occur continuously
- A rare new phenotype suited to an environmental change → relatively rapid change in the species
- Causes: genetic, environmental, or a combination
- There is usually extensive genetic variation within a population
- Most mutations have no effect on the phenotype; some influence it; very few determine it
- Identical twins have the same genes, so their differences are environmental

Causes of variation

- **Variation** is the differences in the characteristics of individuals in a population.
- It may be due to differences in the **genes** they have inherited (genetic causes), the **conditions** in which they have developed (environmental causes), or a **combination** of genes and the environment.
- Genetic examples: blood group, natural eye colour.
- Environmental examples: a scar, the language you speak, a plant's leaves turning yellow because of a lack of light.
- Both: human height and body mass; the height of a plant, which depends on its genes and on light, water and mineral ions.



Causes of variation: genes, environment, or both.

- Your **genome** sets what is possible; your **environment** affects how those genes develop into your **phenotype**.

Mutations and variants

- There is usually **extensive genetic variation** within a population of a species.
- All genetic variants arise from **mutations**, which occur continuously.
- **Most** variants have **no effect** on the phenotype; **some influence** the phenotype; **very few determine** the phenotype.
- Very rarely a mutation leads to a **new phenotype**. If the new phenotype suits a change in the environment, it can lead to a **relatively rapid change** in the species.

Separating genes from environment

- Identical twins have the same genes, so any differences between them are caused by the environment.
- Non-identical twins have different genes, so they usually differ more.
- In plants, grow genetically identical plants (clones) in different conditions: any differences must be caused by the environment.

How to answer each type of question

Classify variation as genetic, environmental or both

1 to 3 marks

Grade 4

1. Ask: can this change during life because of conditions? If yes, the environment plays a part.
2. Ask: is it inherited? If yes, genes play a part.
3. Most measurable features, such as height and mass, are caused by both.

Example. Give the cause of each of these types of variation: genetic, environmental or both.

- (a) A person's blood group
- (b) A scar on a person's arm
- (c) A person's body mass [3 marks]

Model answer. (a) Genetic (1)

(b) Environmental (1)

(c) Both (1)

Don't lose marks

- ✗ Saying variation is only caused by genes. Many characteristics depend on both genes and the environment.
- ✗ Saying mutations are always harmful. Most have no effect on the phenotype.
- ✗ Saying identical twins have no variation. They can differ because of their environment.
- ✗ Classifying height or body mass as purely genetic.

More tips

Memory tricks

- Mutation effects from most to fewest: no effect → influence → determine (most, some, very few).
- Could it change during your life? Then the environment plays a part.
- Twins test: identical twins have the same genes, so any difference is environmental.

Exam technique

- In data questions, quote numbers and say what they show about genes compared with the environment.
- Use the words genotype, phenotype and environment accurately.
- When explaining a rapid change in a species, link mutation → new phenotype → suits a changed environment → natural selection.

What each grade needs

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

Grade 3

Define variation

Differences in the characteristics of individuals in a population.

Grade 4

Classify causes of variation

Genetic (genes inherited), environmental (conditions of development) or a combination of both.

Grade 5

Give examples of each cause

Blood group is genetic, a scar is environmental, and body mass depends on both.

Grade 5

State that populations show genetic variation

There is usually extensive genetic variation within a population of a species.

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