DNA and the genome

4.6.1.3 · Biology · revision notes

What DNA, chromosomes, genes and the genome are, how a gene codes for a protein, and why studying the human genome matters. Expect short recall and 'put these in order of size' questions, plus 2 to 3 mark questions on how the human genome is useful.

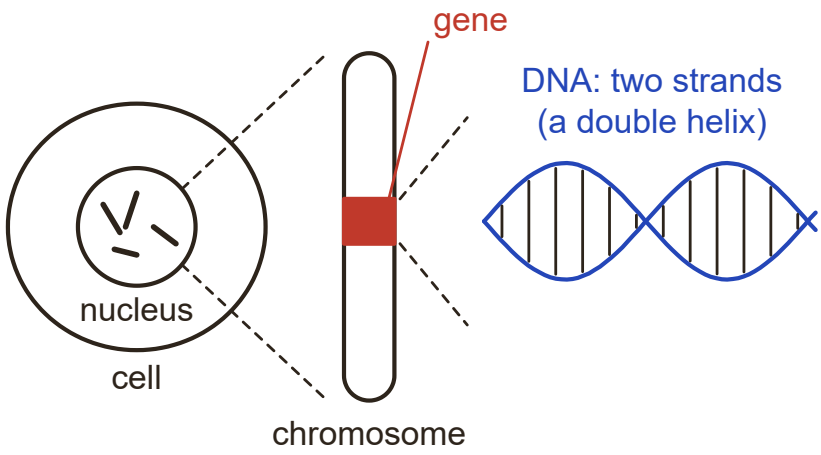
Key facts

- DNA = the genetic material in the nucleus
- Chromosome = structure that contains DNA
- Genome = the entire genetic material of an organism
- DNA = a polymer of two strands forming a double helix
- Gene = small section of DNA on a chromosome that codes for a particular sequence of amino acids, to make a specific protein
- Human genome uses: genes linked to disease; understanding and treating inherited disorders; tracing past human migration

Notes

DNA, chromosomes and genes

- The genetic material in the **nucleus** of a cell is a chemical called **DNA**.
- DNA is a **polymer** made up of **two strands** forming a **double helix**.
- DNA is contained in structures called **chromosomes**. Each chromosome contains one very long molecule of DNA.
- A **gene** is a small section of DNA on a chromosome.
- Each gene **codes for a particular sequence of amino acids**, to make a **specific protein**. Proteins such as enzymes control the characteristics of the organism.
- In order of size: nucleus → chromosome → gene.



Nucleus → chromosome → gene → DNA (double helix).

The genome

- The **genome** of an organism is the **entire genetic material** of that organism.
- The whole **human genome** has now been studied. This will be very important for medicine in the future.

Why understanding the human genome matters

- **Searching for genes linked to different types of disease**. People with a higher risk can be tested and treated or advised earlier.
- **Understanding and treating inherited disorders**, such as cystic fibrosis, which could lead to better treatments.
- **Tracing human migration patterns from the past**. Comparing the DNA of people from different parts of the world shows how groups are related and how early humans spread across the Earth.

How to answer each type of question

Recall: complete sentences or define the terms 1 to 4 marks **Grade 4**

1. Learn a one-line definition of DNA, chromosome, gene and genome.
2. Watch for distractors in a word box: gene and genome are easy to mix up.

Example. Complete the sentences using words from the box.
[chromosomes / double helix / gene / genome / protein]
DNA is a polymer made of two strands forming a _____. DNA is found in structures called _____. A _____ is a small section of DNA that codes for a specific _____. [4 marks]

Model answer. double helix (1); chromosomes (1); gene (1); protein (1)

Explain how a gene controls a characteristic 2 to 3 marks **Grade 6**

1. A gene is a section of DNA.
2. It codes for a particular sequence of amino acids.
3. The amino acids make a specific protein, which affects the characteristic (e.g. an enzyme that makes a pigment).

Example. A gene controls whether a rabbit's fur contains a brown pigment. The pigment is made in a reaction controlled by an enzyme.
Explain how the gene controls the colour of the rabbit's fur. [3 marks]

Model answer. The gene is a section of DNA that codes for a particular sequence of amino acids (1). This sequence of amino acids makes a specific protein, the enzyme (1). The enzyme controls the reaction that makes the brown pigment, so it decides whether the fur is brown (1).

Give uses of understanding the human genome 2 to 3 marks **Grade 5**

1. Give one use per mark: genes linked to disease, inherited disorders, human migration.
2. Add the benefit of each: earlier testing, new treatments, understanding our history.
3. Check whether the question says 'in medicine': migration is not a medical use.

Example. The whole human genome has been studied.
Give two ways this knowledge could be useful in medicine. [2 marks]

Model answer. Any two: finding genes linked to diseases, so people at risk can be tested or treated earlier (1); understanding inherited disorders such as cystic fibrosis, so better treatments can be developed (1).

Don't lose marks

- Saying a gene is bigger than a chromosome. A gene is a small section of the DNA on a chromosome.
- Saying a gene codes for 'a characteristic' or for 'an amino acid'. It codes for a sequence of amino acids that makes a specific protein.
- Confusing genome (all the genetic material) with gene.
- Saying DNA is a single strand. It has two strands forming a double helix.

More tips

Memory tricks

- Think of nesting boxes: the nucleus holds chromosomes, chromosomes are made of DNA, and genes are short sections of that DNA.
- Gene = one instruction (for one protein); genome = the whole instruction book.
- Uses of the human genome, 'DIM': Disease genes, Inherited disorders, Migration.

Exam technique

- When asked how a gene affects a characteristic, go through the chain: gene → sequence of amino acids → protein → characteristic.
- If asked for uses 'in medicine', don't give tracing human migration.
- Use the words polymer and double helix when describing DNA.

What each grade needs

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

Grade 3 **State where DNA is found**
The genetic material in the nucleus is a chemical called DNA, contained in chromosomes.

Grade 4 **Describe the structure of DNA simply**
DNA is a polymer made up of two strands forming a double helix.

Grade 4 **Put nucleus, chromosome and gene in size order**
Nucleus (largest), then chromosome, then gene (a small section of DNA on a chromosome).

Define gene and genome

Grade 5 A gene is a small section of DNA on a chromosome; the genome is all of an organism's genetic material.

Grade 5 **Explain how a gene makes a protein**
Each gene codes for a particular sequence of amino acids, which makes a specific protein.

Grade 5 **Give three uses of the human genome**
Finding genes linked to disease, understanding and treating inherited disorders, and tracing past human migration.

Grade 7 **Discuss the importance of the human genome**
Explain how each use could benefit people, especially in medicine.

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