Meiosis

4.6.1.2 · Inheritance, variation and evolution · revision notes

Meiosis is the cell division that makes gametes with a single set of chromosomes; fertilisation then restores the full number. Expect questions describing meiosis, comparing it with mitosis and explaining why gametes must have half the number of chromosomes.

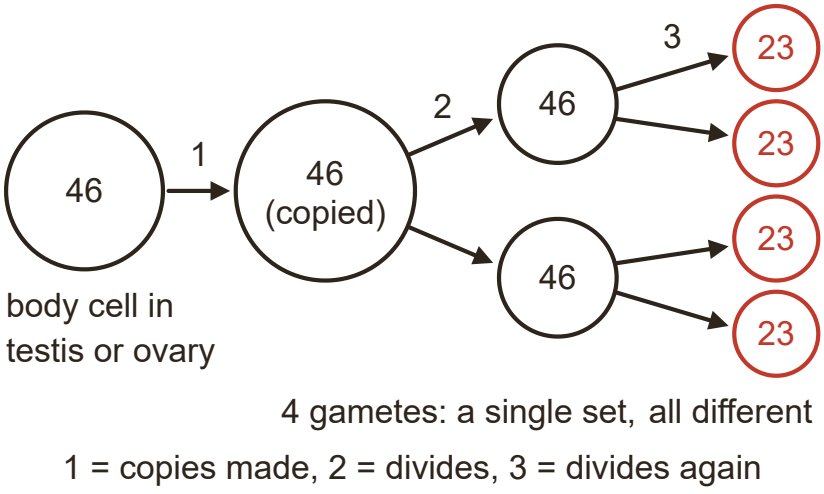
Key facts

- Meiosis happens in the reproductive organs and makes gametes
- Each gamete has a single set of chromosomes; all gametes are genetically different
- Fertilisation restores the normal number of chromosomes
- Mitosis: 1 division, 2 identical cells. Meiosis: 2 divisions, 4 genetically different cells
- Genetic information copied → cell divides twice → four gametes
- Human body cell: 46 chromosomes (23 pairs). Human gamete: 23 chromosomes
- After fertilisation: mitosis → more cells → cells differentiate as the embryo develops

Notes

What meiosis does

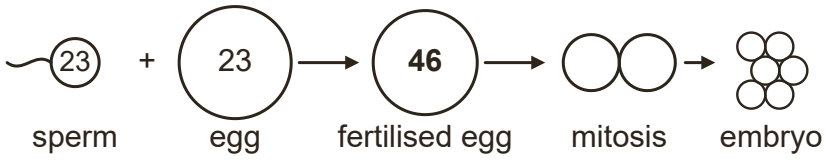
- Meiosis is a type of cell division that happens in the **reproductive organs** (e.g. the testes and ovaries in humans) to make **gametes**.
- First, **copies of the genetic information are made**.
- The cell then **divides twice**, forming **four gametes**.
- Each gamete has a **single set of chromosomes** (half the normal number). A human body cell has 46 chromosomes (23 pairs); a human gamete has 23.
- All the gametes are **genetically different** from each other.



Meiosis in humans: copy, then divide twice, giving four gametes with 23 chromosomes each.

Fertilisation and development

- At **fertilisation** a male gamete and a female gamete join. Each brings one set of chromosomes, so the **normal number of chromosomes is restored** (23 + 23 = 46 in humans).



Fertilisation restores the normal number: 23 + 23 = 46.

- If gametes had the full number of chromosomes, the number would double in every generation.
- The new cell divides by **mitosis**, so the number of cells increases.
- As the embryo develops, the cells **differentiate** (become specialised).

Meiosis compared with mitosis

- **Mitosis**: one division, two cells, full number of chromosomes (in pairs), cells genetically identical. Used for growth, repair and asexual reproduction.
- **Meiosis**: two divisions, four cells, a single set of chromosomes, cells genetically different. Used to make gametes.

How to answer each type of question

Describe how gametes are formed 3 marks **Grade 5**

1. Start with copying the genetic information.
2. Say the cell divides twice to make four gametes.
3. Finish with: each gamete has a single set of chromosomes and all are genetically different.

Example. Describe how a cell in a testis divides to form sperm cells. [3 marks]

Model answer. Copies of the genetic information are made (1). The cell divides twice to form four gametes (1). Each gamete has a single set of chromosomes / half the number of chromosomes, and the gametes are all genetically different (1).

Calculate chromosome numbers 1 to 2 marks **Grade 5**

1. Gamete = body cell number ÷ 2.
2. Fertilised egg cell = gamete + gamete = body cell number.

Example. A body cell of a dog contains 78 chromosomes.
(a) How many chromosomes are in a dog sperm cell?
(b) How many chromosomes are in a fertilised dog egg cell? [2 marks]

Model answer.

(a) 78 ÷ 2 = 39 (1)

(b) 39 + 39 = 78 (1)

Explain why gametes have half the number of chromosomes 2 marks **Grade 6**

1. Say what happens at fertilisation: two gametes join.
2. Say that this restores the normal number of chromosomes.
3. If it helps, add that otherwise the number would double every generation.

Example. A human egg cell contains 23 chromosomes.
Explain why it is important that egg cells contain 23 chromosomes and not 46. [2 marks]

Model answer. At fertilisation the egg cell joins with a sperm cell, which also contains 23 chromosomes (1). This restores the normal number of 46 chromosomes / if each gamete had 46, the fertilised egg would have 92 (1).

Compare meiosis and mitosis 3 to 4 marks **Grade 5**

1. Compare the number of divisions (2 v 1) and cells produced (4 v 2).
2. Compare the chromosome number: a single set v the full number.
3. Compare the genetics: different v identical.
4. Write each point as a comparison.

Example. Give three differences between meiosis and mitosis. [3 marks]

Model answer.

Meiosis involves two divisions, whereas mitosis involves one (1). Meiosis produces four cells, but mitosis produces two (1). Cells made by meiosis are genetically different, whereas cells made by mitosis are genetically identical (1).
Also allow: cells from meiosis have a single set of chromosomes, whereas cells from mitosis have the full number.

Don’t lose marks

- Saying meiosis divides once or makes two cells. It divides twice and makes four gametes.
- Saying a human gamete has 23 pairs of chromosomes. It has 23 single chromosomes; body cells have 23 pairs.
- Saying the embryo grows by meiosis. After fertilisation, cells divide by mitosis.
- Forgetting that the genetic information is copied before the cell divides.
- Writing 'the gametes are different' without saying 'genetically different'.

More tips

Memory tricks

- Mitosis is '1, 2, same': 1 division, 2 cells, genetically identical. Meiosis is '2, 4, different'.
- Gametes are 'half' cells: halve the body cell number to get the gamete number, and double it back at fertilisation.
- Meiosis happens only in the reproductive organs. If the question is about growth or repair, the answer is mitosis.

Exam technique

- For 'why do gametes have half' questions, the key idea is that fertilisation restores the normal number of chromosomes.
- In compare questions, give matched pairs of facts (meiosis ... whereas mitosis ...).
- Talk about the number of chromosomes halving, not the number of 'genes' or 'cells'.

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 and why meiosis happens**
Cells in the reproductive organs divide by meiosis to form gametes.

Grade 4 — **State how many gametes meiosis produces**
The cell divides twice to form four gametes.

Grade 5 — **Describe what happens in meiosis**
The genetic information is copied, then the cell divides twice to give four genetically different gametes, each with a single set of chromosomes.

Grade 5 — **Give chromosome numbers in body cells and gametes**
A human body cell has 46 chromosomes (23 pairs) and a human gamete has 23.

Grade 5 — **Compare meiosis with mitosis**
Compare the number of divisions, the number of cells made, the chromosome number and whether the cells are identical.

Grade 6 — **Explain why gametes have half the chromosomes**
So that fertilisation restores the normal number of chromosomes.

Grade 6 — **Describe development after fertilisation**
The new cell divides by mitosis, the number of cells increases and the cells differentiate as the embryo develops.

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