Mitosis and the cell cycle

4.1.2.2 · Cell biology · revision notes

The three stages of the cell cycle, what happens in mitosis, and why mitosis matters for growth, development and repair. Expect 'describe the stages' questions, questions asking you to spot where mitosis is happening, and data questions on dividing cells.

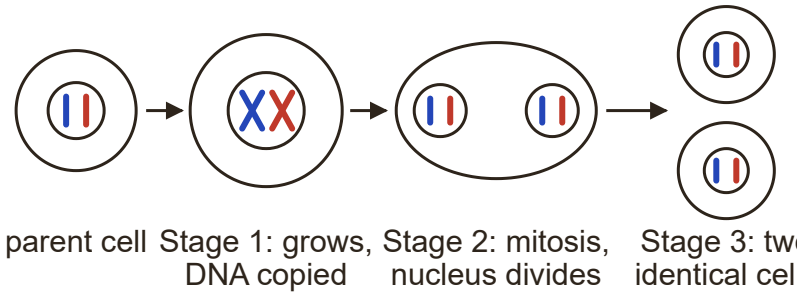
Key facts

- Cell cycle stage 1: cell grows, more ribosomes and mitochondria, DNA replicates
- Stage 3: cytoplasm and cell membrane divide
- Mitosis is for growth, development, repair and replacement (and asexual reproduction)
- Stage 2, mitosis: one set of chromosomes pulled to each end; nucleus divides
- Mitosis → two genetically identical cells with the same number of chromosomes as the parent
- Grade 7+ only DNA per cell: doubles before mitosis, halves when the cell divides

Notes

The cell cycle

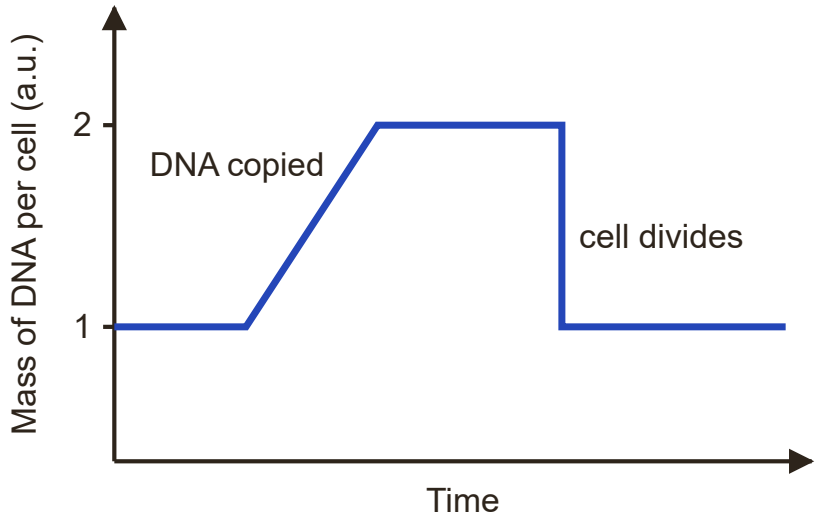
- Body cells divide in a series of stages called the **cell cycle**. The genetic material is doubled, then divided between two identical cells.
- **Stage 1: growth and DNA replication.** The cell grows and increases the number of sub-cellular structures, such as ribosomes and mitochondria. The DNA replicates, forming two copies of each chromosome.
- **Stage 2: mitosis.** One set of chromosomes is pulled to each end of the cell, and the nucleus divides.
- **Stage 3: cell division.** The cytoplasm and cell membrane divide to form two identical cells.



The cell cycle: each new cell gets one copy of every chromosome (blue from one parent, red from the other).

The result

- Mitosis produces two cells that are **genetically identical** to each other and to the parent cell.
- Each new cell has the same number of chromosomes as the parent cell: 46 in a human body cell.
- The mass of DNA in a cell doubles during stage 1, then halves when the cell divides. Grade 7+ only



The mass of DNA doubles when it is copied, then halves when the cell divides.

Grade 7+ only

Why mitosis matters

- **Growth and development** of multicellular organisms, e.g. an embryo developing or a root getting longer.
- **Repair and replacement** of damaged or worn-out cells, e.g. healing a cut or replacing skin cells.
- Asexual reproduction in some organisms, e.g. strawberry plants growing new plants on runners.
- Mitosis does not make gametes (sperm and egg cells): they are made by a different type of cell division, meiosis.

How to answer each type of question

Recognise where mitosis is happening

1 to 2 marks | Grade 5

1. Look for cells being made to grow, repair or replace tissue: that is mitosis.
2. Making sperm or egg cells is not mitosis.

Example. Which **two** of these involve cell division by mitosis?
Tick (✓) **two** boxes.
☐ A cut in the skin healing
☐ Egg cells being made in an ovary
☐ A seedling's root getting longer
☐ Sperm cells being made in the testes

Model answer.

A cut in the skin healing (1)
A seedling's root getting longer (1)

Describe the stages of the cell cycle

3 to 4 marks | Grade 5

1. Go in order: growth, mitosis, division of the cell.
2. In stage 1 mention growth, more sub-cellular structures and DNA replication.
3. In mitosis, say one set of chromosomes is pulled to each end and the nucleus divides.
4. Finish with the cytoplasm and cell membrane dividing to form two identical cells.

Example. Describe what happens during the cell cycle. [4 marks]

Model answer. The cell grows and the number of sub-cellular structures, such as mitochondria and ribosomes, increases (1). The DNA replicates / each chromosome is copied (1). One set of chromosomes is pulled to each end of the cell and the nucleus divides (1). The cytoplasm and cell membrane divide to form two identical cells (1).

Explain why the new cells are genetically identical

2 marks | Grade 6

1. Say that the DNA is copied (replicated) exactly before the cell divides.
2. Say that each new cell receives one copy of every chromosome.

Example. Explain why the two cells produced by mitosis are genetically identical.

Model answer. The DNA / each chromosome is copied exactly before the cell divides (1). Each new cell receives one copy of every chromosome (1).

Use data on the number of cells dividing

2 to 3 marks | Grade 7

1. Percentage = number of cells in the stage ÷ total number of cells × 100.
2. The fraction of cells seen in a stage is the fraction of the cycle that stage lasts.
3. Multiply that fraction by the length of the whole cycle, then convert units if asked.

Example. A student looked at 200 cells from an onion root tip. 18 of the cells were in mitosis. One full cell cycle in these cells takes 20 hours.
(a) Calculate the percentage of cells in mitosis.
(b) Estimate how long mitosis lasts in these cells. Give your answer in minutes.

Model answer.

(a) 18 ÷ 200 × 100 = 9% (1)
(b) 0.09 × 20 = 1.8 hours (1)
1.8 × 60 = 108 minutes (1)

Don’t lose marks

- Leaving out DNA replication, or putting it after mitosis. The DNA is copied **before** the nucleus divides.
- Saying mitosis makes gametes. Gametes are made by meiosis.
- Saying the new cells have half the number of chromosomes. Mitosis keeps the number the same.
- Using 'mitosis' to mean the whole cell splitting. Mitosis is the division of the nucleus; the cytoplasm and membrane divide afterwards.
- Writing that the chromosomes 'split in half'. Say one set of chromosomes is pulled to each end of the cell.

More tips

Memory tricks

- Order of the stages: Grow and copy, then split the nucleus, then split the cell.
- Mi**T**osis makes **T**wo identical cells; m**E**iosis makes **E**ggs (and sperm).
- Sense check: after mitosis each human body cell still has 46 chromosomes.

Exam technique

- For 'describe' questions, give the stages in order and use the key phrases: 'DNA replicates', 'nucleus divides', 'two identical cells'.
- In context questions (a cut healing, a root growing), look for new cells being made for growth or repair.
- Show each step of a cell cycle calculation, including the percentage and any unit conversion.

What each grade needs

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

State what mitosis produces

Grade 3 Two genetically identical cells.

Grade 4 **Name the three stages of the cell cycle**
Growth and DNA replication; mitosis; division of the cytoplasm and cell membrane.

Grade 5 **Describe what happens in each stage**
The cell grows, copies its sub-cellular structures and DNA, divides its nucleus, then splits in two.

Grade 5 **State why mitosis is important**
For the growth and development of multicellular organisms, and to repair and replace cells.

Grade 5 **Recognise where mitosis is happening**
e.g. a root tip growing, a cut healing, an embryo developing.

Grade 7 **Explain why the new cells are identical**
The DNA is copied exactly, and one copy of every chromosome goes to each new cell.

Grade 7 **Interpret data on dividing cells**
e.g. use the percentage of cells in mitosis to estimate how long mitosis lasts.

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