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**GUIDED EXPLANATION**

AQA GCSE Biology | Spec Ref: 4.1.2

**HIGHER TIER**

# Cell Division

### Key Learning Objectives

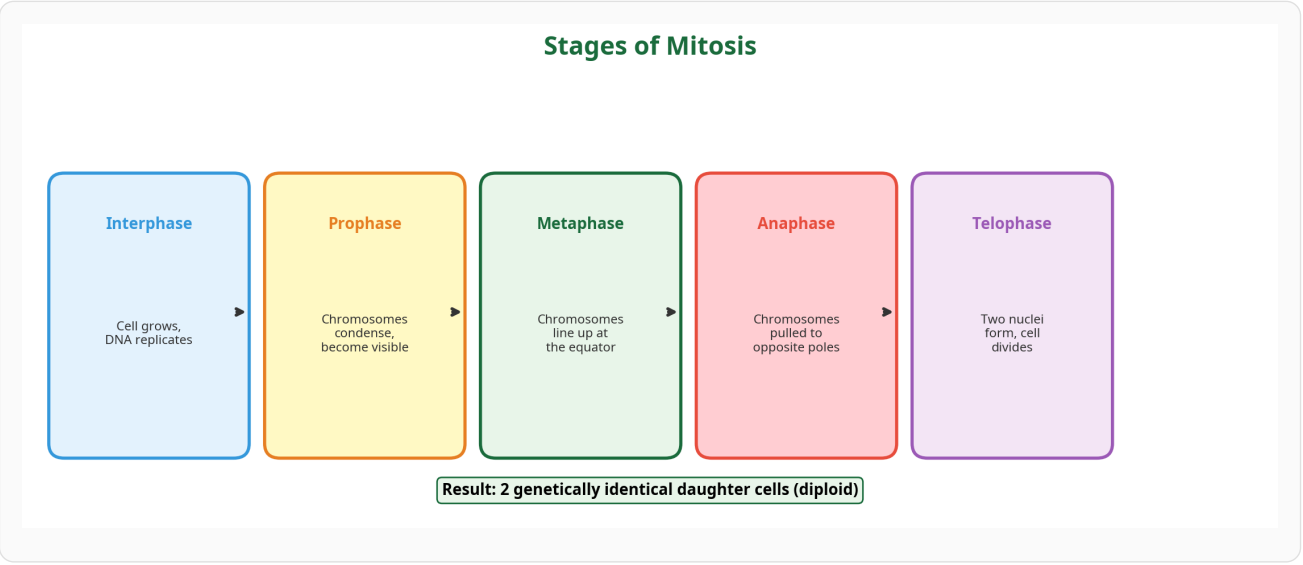
1. Describe the structure of chromosomes and their role in cells
2. Explain the stages of the cell cycle, including mitosis
3. Describe the function of stem cells from embryos and adult bone marrow
4. Explain the process and potential uses of therapeutic cloning
5. Discuss the ethical and medical issues surrounding the use of stem cells
6. Describe stem cells in plants and their uses

# Cell Division

## 1. Chromosomes

The nucleus of a cell contains chromosomes made of DNA molecules. Each chromosome carries a large number of genes. In body cells, the chromosomes are normally found in pairs (one from the mother and one from the father). Human body cells have 23 pairs of chromosomes, making 46 in total.

> **Key Definition: Gene**
>
> A **gene** is a small section of DNA on a chromosome that codes for a specific sequence of amino acids, to make a specific protein.




## 2. Mitosis and the Cell Cycle

Cells divide in a series of stages called the **cell cycle**. During the cell cycle, the genetic material is doubled and then divided into 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 to form 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 (Division):** The cytoplasm and cell membranes divide to form two identical daughter cells.

Cell division by mitosis is important in the growth and development of multicellular organisms, and for repairing damaged tissues.

## 3. Stem Cells

**Key Definition: Stem Cell**

A **stem cell** is an undifferentiated cell of an organism which is capable of giving rise to many more cells of the same type, and from which certain other cells can arise from differentiation.

There are different types of stem cells:

- **Embryonic stem cells:** Found in early human embryos. They can differentiate into most different types of human cells.
- **Adult stem cells:** Found in adult bone marrow. They can form many types of cells including blood cells, but cannot differentiate into any type of cell.
- **Plant meristem cells:** Found in the meristem tissue of plants (tips of roots and shoots). They can differentiate into any type of plant cell throughout the life of the plant.

## 4. Uses of Stem Cells

Stem cells can be used in medicine and agriculture:

- **Medical treatments:** Stem cells from human embryos and adult bone marrow can be cloned and made to differentiate into many different types of human cells. They can help treat conditions such as diabetes and paralysis.
- **Therapeutic cloning:** An embryo is produced with the same genes as the patient. Stem cells from the embryo are not rejected by the patient's body so they may be used for medical treatment.
- **Plant cloning:** Stem cells from meristems in plants can be used to produce clones of plants quickly and economically. This can be used to protect rare species from extinction or to clone crop plants with special features such as disease resistance.

## 5. Issues with Stem Cells

The use of stem cells has potential risks and ethical issues:

- **Clinical risks:** There is a risk of transferring viral infections during stem cell treatments.
- **Ethical issues:** Some people have ethical or religious objections to using embryonic stem cells, as they believe life begins at conception and the embryo has a right to life.

## Common Mistakes

**Common Mistake**

Confusing mitosis with meiosis. Mitosis produces two identical diploid cells for growth and repair. Meiosis produces four non-identical haploid cells (gametes) for sexual reproduction.

**Common Mistake**

Forgetting that DNA must replicate *before* mitosis begins. The chromosomes must double so that each daughter cell gets a full set.

## Exam Tips

**Exam Tip**

When asked about the cell cycle, remember there are three main stages: growth/replication, mitosis (nucleus dividing), and cell division (cytoplasm dividing). Don't just say 'the cell divides'.

**Exam Tip**

For questions evaluating stem cell use, ensure you give both advantages (e.g., treating untreatable conditions) and disadvantages (e.g., ethical issues, risk of viral infection).

## Summary

**Summary**

Chromosomes carry genetic information. The cell cycle involves cell growth, DNA replication, and mitosis, resulting in two genetically identical daughter cells used for growth and repair. Stem cells are undifferentiated cells that can become specialized. Embryonic stem cells can become most cell types, while adult stem cells are more limited. Therapeutic cloning produces stem cells with the patient's genes to avoid rejection. Stem cells can treat conditions like diabetes and paralysis but carry risks of viral infection and raise ethical concerns. Plant meristems allow quick and economic cloning of plants.