

Module 08: Cell Division — Mitosis & Meiosis — Keys to Success

Key Learning Objectives

1. The Cell Cycle

- Describe the stages of the cell cycle (G1, S, G2, M)
- Explain what happens during interphase (growth, DNA replication, preparation)
- Understand why cells need to divide (growth, repair, reproduction)
- Compare cell division in different cell types

2. Chromosome Structure

- Define chromatin, chromosomes, and chromatids
- Explain the structure of a duplicated chromosome (two sister chromatids joined at a centromere)
- Distinguish between diploid ($2n$) and haploid (n) cells
- Explain homologous chromosomes and how they differ from sister chromatids

3. Mitosis: Dividing for Growth and Repair

- Describe the events of each phase: prophase, metaphase, anaphase, telophase (PMAT)
- Explain the role of the mitotic spindle in separating chromosomes
- Describe cytokinesis in plant cells (cell plate) vs. animal cells (cleavage furrow)
- State the result: **2 genetically identical diploid daughter cells**
- Explain the purpose of mitosis: growth, tissue repair, asexual reproduction

4. Meiosis I: Separating Homologous Chromosomes

- Explain why sexual reproduction requires meiosis
- Describe prophase I, including synapsis, tetrad formation, and crossing over

- Describe metaphase I (random alignment of homologs), anaphase I (homologs separate), telophase I
- State the result of meiosis I: **2 haploid cells, each with one chromosome from each homologous pair**

5. Meiosis II: Separating Sister Chromatids

- Explain that meiosis II resembles mitosis but starts with haploid cells
- Describe PMAT II stages
- State the final result: **4 genetically unique haploid cells (gametes)**

6. Mitosis vs. Meiosis — Key Comparisons

Feature	Mitosis	Meiosis
Purpose	Growth & repair	Gamete production
Number of divisions	1	2
Starting cell	Diploid (2n)	Diploid (2n)
Resulting cells	2 diploid (2n)	4 haploid (n)
Genetic outcome	Identical to parent	Genetically unique
Crossing over?	No	Yes (prophase I)
Where it occurs	Somatic cells	Gonads (ovaries, testes)

7. Sources of Genetic Variation

- Explain crossing over and when it occurs (prophase I)
- Describe independent assortment (metaphase I) and calculate possible combinations (2^n)
- Understand how random fertilization further increases variation
- Connect genetic variation to natural selection and evolution

8. Cell Cycle Regulation and Errors

- Describe the role of checkpoints in the cell cycle (G1, G2, M)
 - Explain how cyclins and CDKs control the cell cycle
 - Understand how uncontrolled cell division leads to cancer
 - Define nondisjunction and its consequences (e.g., Down syndrome, Turner syndrome)
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Study Tips

1. **Use the mnemonic PMAT** to remember mitosis phases (Prophase, Metaphase, Anaphase, Telophase)
2. **Create side-by-side comparison charts** of mitosis and meiosis
3. **Draw and label each stage** — for both mitosis and meiosis I/II
4. **Use colored pencils** to track individual chromosomes and alleles through division
5. **Practice calculating 2^n** combinations for independent assortment
6. **Watch animations** of cell division to see the dynamic movements of chromosomes
7. **Trace alleles** through an entire meiosis to see how genetic diversity arises