

Knowledge-based Learning Outcomes

Upon completion of *Meiosis Explored*, students should be able to:

1. Explain why meiosis occurs only in specialized cells (gametes), and that the overall goal of meiosis is to make haploid cells for sexual reproduction.
2. Outline the sequence of key chromosomal movements and rearrangements during the two meiotic divisions, identifying key similarities and differences between meiosis and mitosis.
3. Describe the ploidy of a cell before and after meiosis I and meiosis II, and how ploidy changes after separation of sister chromatids and homologous chromosomes.
4. Describe the principle of independent segregation.
5. Describe crossing over, including how pieces of homologous chromosomes are cut and reattached at the same location on both homologues, and how this randomizes which alleles are passed on to offspring. Additionally, identify the stage of meiosis in which crossing over occurs.
6. Identify when the spindle assembly checkpoints are satisfied, including the stages of meiosis in which they occur.
7. Summarize the composition of the meiotic spindle, what it does, and where it attaches to chromosomes.
8. Explain the distinction between genes and alleles, as well as their relationship to chromosomes and homologous chromosomes.
9. Identify homologous chromosomes and identify when during meiosis they are attached to each other and when they separate.
10. Describe how homologous chromosomes differ from the replication state of chromosomes and sister chromatids, and describe how this relates to ploidy.
11. Define ploidy, haploid, and diploid. Determine the number of alleles present for an individual gene in a haploid vs. diploid cell.
12. Describe aneuploidy, including what it is, how mistakes in meiosis can produce it, and why it generally has dire consequences for an individual.
13. Describe what sexual reproduction is, what gametes are, and the key differences between sexual and asexual reproduction.
14. Describe why fertilization can be viewed as the opposite of meiosis. Define polyspermy and explain why it is usually lethal for the resulting zygote.

Skills-based Learning Outcomes

Upon completion of *Meiosis Explored*, students should be able to:

1. Guide a cell through the events of crossing over, homologous chromosome separation, sister chromatid separation, cytokinesis, and spindle attachments for both divisions of meiosis as well as mitosis.
2. Compare and contrast meiosis I, meiosis II, and mitosis, including a discussion of their functional roles within an organism.
3. Identify chromosomes, homologous chromosomes, sister chromatids, genes, and alleles in a schematic of a homologous pair of chromosomes going through meiosis, and describe how they relate to each other.
4. Given a set of genes, predict and contrast the possible combinations of alleles resulting from independent segregation vs. crossing over.
5. Given a set of genes arranged on chromosomes, predict combinations of alleles that could be together in one cell after meiosis I and II, based on independent assortment and crossing over.
6. Visually identify the stage of meiosis from a photograph/schematic of chromosomes, nuclear envelope, and spindle.
7. Predict the alleles in daughter cells after a perturbation/mistake in meiosis, such as a crossing over error, spindle assembly checkpoint problem in meiosis I and II, or a broken chromosome.
8. Relate physical distance between genes on a chromosome to the likelihood that a pair of alleles will be passed on together to a daughter cell.