

Review the Concepts

Work through the following exercises to review the concepts in this chapter. For additional review, refer to the activities at www.mybiology.com. The website offers a pre-test that will help you plan your studies.

Exercise 1 (Introduction—Module 8.3)

Review the concepts introduced in these modules by filling in the blanks.

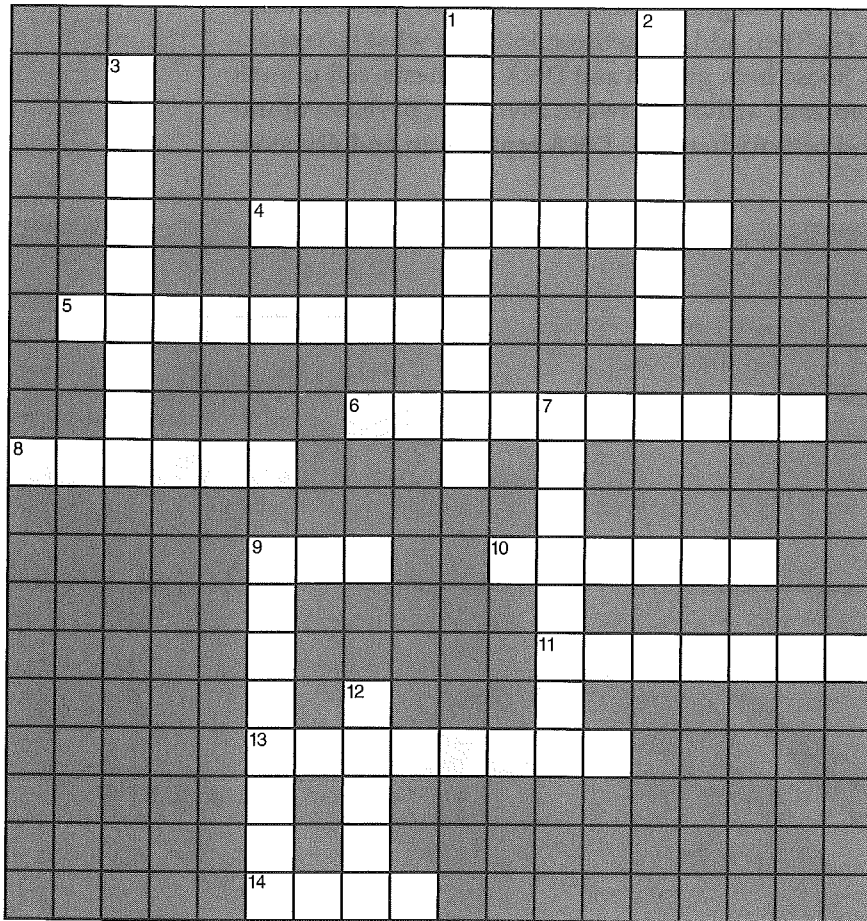
"Like begets ¹_____." This old saying means offspring look like their parents. Technically, only offspring produced by ²_____ reproduction look exactly like their parents, because they inherit all their ³_____ from a single parent. For example, when an amoeba divides, its ⁴_____ is duplicated, and identical sets of ⁵_____ (the structures that contain most of the amoeba's DNA) are allocated to opposite sides of the cell. The parent amoeba splits, and the two daughter amoebas that are formed are genetically ⁶_____ to each other and to the ⁷_____ cell.

Prokaryotes also reproduce asexually, via a type of cell division called ⁸_____. Most genes in a prokaryote are carried on a single ⁹_____ DNA molecule, which is much ¹⁰_____ than the multiple chromosomes of eukaryotes. The prokaryote ¹¹_____ its DNA, and the copies move toward opposite ends of the cell. As new ¹²_____ grows between them, the chromosomes become separated. Finally, the plasma membrane and cell ¹³_____ split the cell in two. Like the reproduction of an amoeba, binary fission produces daughter cells identical to the parent cell. Parent and offspring share identical ¹⁴_____, or sets of genetic information.

The offspring produced by sexual reproduction resemble their parents, but they are not identical to their parents or to each other. Sexual reproduction begins with the production of an ¹⁵_____ and a ¹⁶_____, specialized cells that join to produce an offspring. The egg and sperm fuse—a process called ¹⁷_____—and the fertilized egg inherits a unique combination of genes from both parents. Through repeated cell divisions, the fertilized egg develops into an organism with a unique combination of traits—for example, a cat with long, gray fur or a human with blue eyes and freckles. Thus, sexual reproduction produces ¹⁸_____ among offspring. Through sexual reproduction "like begets like," but not exactly.

Exercise 2 (Module 8.4)

Test your knowledge of chromosomes by completing this crossword puzzle.

**Across**

4. ____ cells have more chromosomes and genes than prokaryotes do.
5. A typical ____ has about 3,000 genes.
6. Chromosome duplication produces two sister ____.
8. A prokaryote has a ____ simple chromosome.
9. A chromosome contains one long ____ molecule.
10. Chromosomes are named for their attraction to colored ____ used in microscopy.
11. Eukaryotic chromosomes involve more ____ molecules than those of bacteria.
13. When a chromosome divides, one sister chromatid goes to each ____ cell.
14. Proteins help determine chromosome structure and control ____ activity.

Down

1. Sister chromatids are joined at the ____.
2. The number of chromosomes in a eukaryotic cell depends on the ____.
3. When a cell is not dividing, chromosomes form long, thin fibers called ____.
7. Genes in eukaryotic cells are grouped into ____ chromosomes.
9. Chromosomes are clearly visible only when a cell is ____.
12. ____ cells carry about 25,000 genes in 46 chromosomes.

Exercise 6 (Module 8.6)

Match each structure on the left with its correct role in mitosis in an animal cell on the right.

- | | |
|-------------------------------|--|
| _____ 1. Metaphase plate | A. Where spindle microtubules attach to chromosomes |
| _____ 2. Kinetochore | B. Move chromosomes |
| _____ 3. Sister chromatids | C. Pulled apart by spindle microtubules |
| _____ 4. Spindle microtubules | D. Material around centrioles from which mitotic spindle grows |
| _____ 5. Centrosome | E. "Walk" chromosomes along microtubules toward cell poles |
| _____ 6. Motor proteins | F. Chromosomes come to rest here during metaphase |

Exercise 7 (Module 8.7)

Read this module and then write a statement containing exactly 30 words (no more, no less!) comparing cytokinesis in plant and animal cells. (Writing *exactly* 30 words will help you to think about the processes and choose your words carefully. It's fun to try it.)

Exercise 8 (Modules 8.8–8.11)

Review the functions of cell division and the factors that control it by filling in the blanks below.

Mitotic cell division has several important functions. Some animals rely on cell division for ¹ _____ reproduction. *Hydra*, for example, produces buds that detach from the parent and take up life on their own. Cell division is also responsible for ² _____, as seen in human embryos and plant roots. In an adult human, some cells, such as most nerve and muscle cells, cease to divide. Others, such as cells of the ³ _____, divide only if the organ is damaged. This process ⁴ _____ wounds. Some cells, such as those on the surface of the ⁵ _____ and the lining of the ⁶ _____, are constantly being abraded and lost. These cells are ⁷ _____ by cell division. In each of these cases, the new cells have exactly the same ⁸ _____ and ⁹ _____ of chromosomes as the parent cells because of the way duplicated chromosomes divide in the process of ¹⁰ _____.

Growth, cell replacement, and reproduction require control of the rate and timing of cell division. Much has been learned by studying cells grown in laboratory ¹¹ _____. Cells growing in a laboratory dish will divide only when in contact with a solid ¹² _____. In the body, this ¹³ _____ dependence may keep normal cells from dividing if separated from their normal surroundings. Cells will multiply only until they touch one another, a phenomenon known as ¹⁴ _____. Apparently, cells rely on proteins called ¹⁵ _____ to tell them when to divide, and will stop when cells are crowded and these substances are depleted.

It appears that growth factors influence cell division by acting on the cell-cycle ¹⁶ _____ system, a set of molecules that triggers and coordinates events in the cell cycle. The system automatically ¹⁷ _____ cell division at several major checkpoints unless the “brakes” are overridden by go-ahead signals. There are checkpoints in the G₂ and M phases of the cell cycle, but the most important checkpoint for many cells is the ¹⁸ _____ checkpoint. If a cell receives a go-ahead signal in the form of a growth factor at the G₁ checkpoint, the cell will proceed into the ¹⁹ _____ phase of the cell cycle, replicate its DNA, and eventually divide. A growth factor probably acts on a cell by attaching to a ²⁰ _____ protein in the cell membrane. This protein in turn generates a signal that acts on the cell cycle control system within the cell. In the absence of a go-ahead signal, a cell will cease dividing. Many of our cells that can no longer divide—²¹ _____ cells, for example—are stopped at the G₁ checkpoint.

Sometimes cells escape these control mechanisms, divide uncontrollably, and invade other body tissues. These ²² _____ cells can kill the organism. In cell culture, they can grow without being attached to a solid surface, are unaffected by density-dependent inhibition, and are less affected than normal cells by growth factors and ²³ _____ signals. Cancer cells can go on dividing indefinitely (unlike normal cells, which can divide in culture for only ²⁴ _____ generations). A mass of cancer cells is called a ²⁵ _____. If the cells of a tumor remain at the original site, the tumor is called a ²⁶ _____ tumor; if the cells spread, it is a ²⁷ _____ tumor. The spread of cancer cells is called ²⁸ _____. Carcinomas are cancers that arise in body coverings, such as the skin. ²⁹ _____ arise in support tissues, such as muscle or bone. ³⁰ _____ are cancers of blood-forming tissues.

Cancer treatments, such as ³¹ _____ and ³² _____, slow cancer by interfering with ³³ _____. The anticancer drugs vinblastin and taxol prevent cell division by disrupting the mitotic ³⁴ _____.

Exercise 9 (Modules 8.12–8.13)

Describe the relationship between the terms or items in each of the following pairs.

1. Sex chromosomes and autosomes
2. The two chromosomes of a homologous pair
3. The two sister chromatids of a single chromosome
4. A diploid cell and a haploid cell
5. A somatic cell and a gamete
6. An egg and a zygote
7. Fertilization and meiosis
8. Mitosis and meiosis
9. X and Y chromosomes
10. Gene and locus

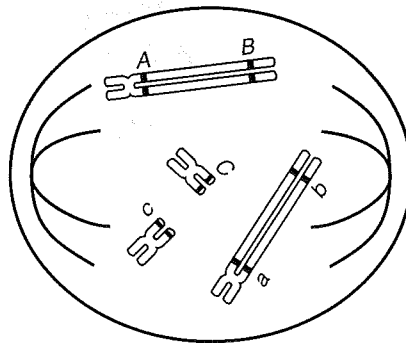
Exercise 11 (Module 8.15)

Compare mitosis and meiosis by completing this chart.

<i>Mitosis</i>	<i>Meiosis</i>
1.	Produces haploid daughter cells unlike parent cell
Involves one cell division	2.
Produces two daughter cells	3.
4.	Homologous chromosomes pair and then separate
Individual chromosomes line up at metaphase plate	5.
No crossing over occurs	6.
7.	Needed for sexual reproduction

Exercise 12 (Modules 8.16–8.18)

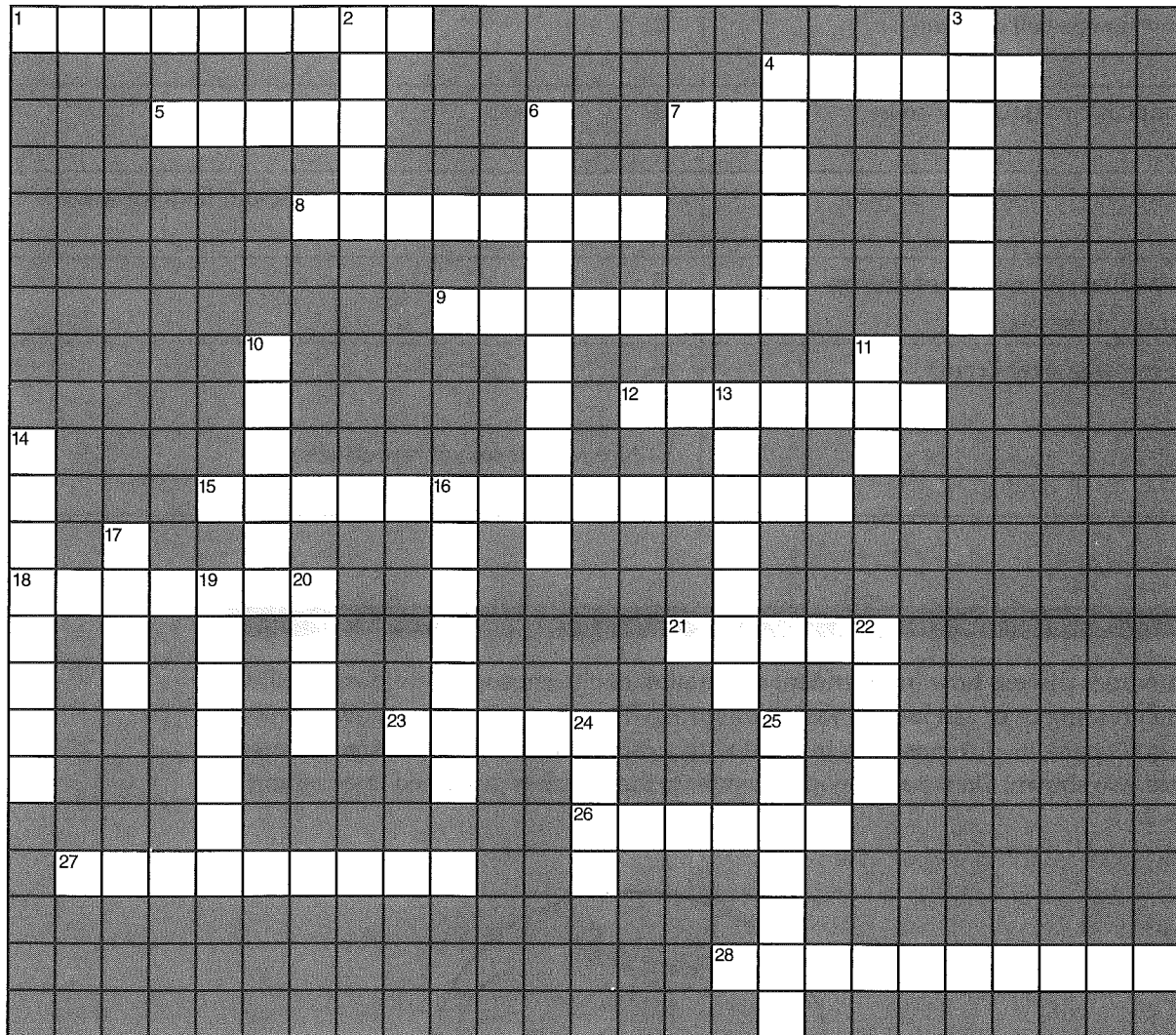
These modules discuss how independent orientation of chromosomes, random fertilization, and crossing over can lead to varied offspring. The diagram below shows the two homologous pairs of chromosomes in a cell with a diploid number of 4. Three different genes are also shown. On separate paper, complete the sketches described in questions 1 through 3.



1. Show how two different orientations of the chromosomes during metaphase I of meiosis could lead to four different combinations of genes in gametes (assuming crossing over does not occur). (You don't need to show meiosis step by step—just the outcome.)
2. Show how crossing over could recombine genes on the larger pair of chromosomes, producing different gametes.
3. How many different combinations of genes in gametes are possible if these two processes happen simultaneously? Try to sketch all of them.

Exercise 13 (Modules 8.19–8.23)

Errors in meiosis can produce gametes with extra or missing chromosomes. Fertilization of these abnormal gametes produces offspring with genetic abnormalities. Sometimes new species arise from chromosomal errors. A karyotype is an inventory of chromosomes. Review alterations in chromosome number and karyotyping by completing this crossword puzzle.



Across

1. An abnormal number of chromosomes often results in ____.
4. A woman with only one X chromosome is said to have ____ syndrome.
5. The Y chromosome carries ____ genes than the X chromosome.
7. The incidence of Down syndrome increases with the ____ of the mother.
8. Down syndrome individuals are prone to ____ and Alzheimer's disease.
9. A single Y chromosome is enough to produce "____."
12. Nondisjunction results in extra or missing chromosomes in ____.
15. ____ is when members of a pair of chromosomes fail to separate during meiosis.
18. Most human offspring with abnormal numbers of chromosomes are spontaneously ____.
21. Down syndrome is the most serious common ____ defect in the United States.
23. Pregnant women over 35 years of age are candidates for ____ testing.
26. In meiosis II, ____ chromatids may fail to separate.
27. A ____ is a photographic inventory of an individual's chromosomes.
28. A plant whose cells have four sets of chromosomes is said to be ____.

Down

2. A person with Down syndrome has ____ number 21 chromosomes.
3. ____ who are lacking an X chromosome are designated XO.
4. XXY or XXYY males have small ____ and feminine body contours.
6. In meiosis I, a pair of ____ chromosomes may fail to separate.
10. If a sperm fertilizes an egg with an extra chromosome, the ____ will have an extra chromosome.
11. Nondisjunction can alter the number of ____ chromosomes, as well as autosomes.
13. Chromosomal defects usually result from errors in ____.
14. Individuals with Down syndrome are usually mentally ____.
16. People with Down syndrome live ____-than-normal life spans.
17. Meiosis begins in a woman's ovaries before she is ____ and is completed years later.
19. An extra chromosome 21 is called ____ 21.
20. A person with an extra number 21 chromosome has ____ syndrome.
22. ____ of the eggs of a Down syndrome woman will have an extra chromosome.
24. An unusual number of sex chromosomes has ____ effect than an unusual number of autosomes.
25. Many new ____ of plants seem to have arisen from errors in cell division.