Chapter 8: The Cellular Basis of Reproduction and Inheritance

Guided Reading Activities

Big idea: Cell division and reproduction

Answer the following questions as you read modules 8.1–8.2:

1. This diagram represents one cell dividing to give rise to two new daughter cells. Each new daughter cell will be ____ identical ____ to each other and the parent cell.

2. Complete the table that compares asexual and sexual reproduction.

<table>
<thead>
<tr>
<th></th>
<th>Asexual reproduction</th>
<th>Sexual reproduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Requires egg and sperm?</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Requires one parent?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Produces genetically identical offspring?</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>Produces genetically different offspring?</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

3. Cell division will accomplish which of the following functions in your body?
   a. Growth and development
   b. Production of gametes
   c. Cell replacement
   d. All of the above
4. True or false: Binary fission is considered asexual reproduction. If false, make it a correct statement.
   True

Big idea: The eukaryotic cell cycle and mitosis

Answer the following questions as you read modules 8.3–8.10:

1. True or false: When chromatin is in its diffuse form, you cannot see it with a light microscope. If false, make it a correct statement.
   False, it would simply look like a large mass in which you could not distinguish individual chromosomes.

2. A common student misconception is about the relationship between chromatin and chromosomes. Briefly explain the relationship to a student who doesn’t understand it.
   A chromosome is an individual piece of chromatin. In other words, a chromosome is made of chromatin.

3. Briefly explain why the chromosome in this diagram has been duplicated.
   ![Diagram showing duplicated chromosome]
   You can tell this chromosome has been duplicated because it consists of sister chromatids connected by a centromere.

4. True or false: Certain cells in the adult human body do not undergo cell division. If false, make it a correct statement.
   True

5. Match the following terms with the best description: interphase, s-phase, cytokinesis, mitosis, and mitotic phase.

   Division of the cytoplasm: cytokinesis
   DNA replication occurs: s-phase
   The chromosomes divide: mitosis
   The cell is performing normal functions: interphase
   Accounts for only 10% of the cell cycle: mitotic phase
6. Every person starts off life as a single cell called a zygote. An adult human consists of trillions of cells. Briefly explain why it's so important that the zygote undergo mitosis properly. Because all cells come from the zygote, any mistake in the zygote during mitosis would get transferred to every cell descendant from it, which is all of them.

7. Place the following stages of mitosis in the correct order: metaphase, prometaphase, prophase, telophase, and anaphase. Prophase, prometaphase, metaphase, anaphase, and telophase

8. Use the generic cell outline provided to sketch a cell with five chromosomes in metaphase. Your drawing should include the following labeled terms: metaphase plate, mitotic spindle, and spindle microtubules.

9. A drug is known to freeze microtubules in place after they have fully formed. Which stage of cell division would most likely be affected? What critical process would be inhibited? Anaphase; separation of the chromosomes

10. A shallow groove in the cell known as a(n) **cleavage furrow** indicates that cytokinesis has begun.

11. A drug is known to inhibit the formation of the cell plate during cytokinesis. Would this drug affect human cells? Briefly explain your answer. No, because human cells do not have a cell plate; plant cells have a cell plate.

12. True or false: Cells that exhibit anchorage dependence divide only if they are in contact with a solid surface. If false, make it a correct statement. True

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13. Growth factors are necessary at certain times for proper growth and development. Can growth factors ever have an unintended negative effect? If so, briefly explain your answer. 
Yes, overproduction of certain growth factors has been known to lead to and exacerbate tumors.

14. The most important checkpoint of the cell cycle control system appears to be the ___________.
   G1 checkpoint

15. An adult human cardiac muscle cell does not undergo cell division. As such, this type of cell
   a. does not need to replicate its DNA.
   b. does not need to leave G1.
   c. is never found in G2.
   d. All of the above are correct statements regarding an adult human cardiac muscle cell.

16. Refer to Figure 8.8B on page 134 for help answering this question. Assume this cell has a
   mutated receptor protein that no longer binds the growth factor. Further assume that this is
   the only growth factor to which this cell responds. Briefly explain how this cell’s progression
   through the cell cycle would be affected.
   This cell would be inhibited from performing cell division.

17. Cancer can be described as loss of control over the cell cycle. Briefly explain how a car losing
   its brakes is a good analogy to describe the loss of protein checkpoints of the cell cycle.
   Because the brakes represent the cell checkpoints; if you lose the cell checkpoints, you lose
   control of the cell cycle (your car).

18. List three treatments for malignant tumors.
   Surgery, radiation, and chemotherapy

19. Complete the Venn diagram that compares benign and malignant tumors.

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20. A new cancer drug is administered to a patient with prostate cancer. It is found to have no effect on the cancer. Does this mean the new drug is useless? If not, briefly explain your answer. No, because certain people have mutations in their DNA that can make certain drugs more or less effective in treating cancer.

**Big idea: Meiosis and crossing over**

Answer the following questions as you read modules 8.11–8.17:

1. Are the two chromosomes in this diagram homologous? Briefly explain your answer either way.

   ![Diagram of chromosomes](image)

   No, they are clearly not homologous simply because they are not the same size.

2. True or false: All humans have 23 pairs of homologous chromosomes. If false, make it a correct statement. False, women have 23 pairs of homologous chromosomes, but a male’s 23rd pair is not homologous (X + Y).

3. Briefly explain why your chromosomes come in pairs.
   Your chromosomes come in pairs because you get one chromosome of each pair from each parent.

4. Complete the following diagram by labeling it with the following terms: gamete, zygote, n and 2n (some terms may be used more than once).

   ![Diagram of cell division](image)

5. A cell has 22 autosomes and an X chromosome.
   a. The cell could be a human sperm.
   b. The cell is a human somate.
   c. The cell could be a human egg.
   d. A and C are both possible.
6. List the process that cells undergoing meiosis perform. It is the same process as that in a cell undergoing mitosis.
Cells that perform meiosis undergo a round of DNA replication prior to division. It is the same process as in a cell undergoing mitosis.

7. Meiosis is necessary to maintain an organism’s proper diploid number across generations. What would happen to an organism’s total number of chromosomes every generation if mitosis produced gametes?
The chromosome number would double.

8. Use the generic cell outline provided to sketch a cell with six chromosomes in metaphase I. Your drawing should include the following labeled terms: metaphase plate, spindle, and spindle microtubules.

9. Complete the following table that compares mitosis with meiosis.

<table>
<thead>
<tr>
<th></th>
<th>Mitosis</th>
<th>Meiosis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rounds of DNA replication</strong></td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Rounds of cell division</strong></td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Separation of sister chromatids?</strong></td>
<td>Yes</td>
<td>Yes, second round</td>
</tr>
<tr>
<td><strong>Separation of homologous chromosomes?</strong></td>
<td>No</td>
<td>Yes, first round</td>
</tr>
<tr>
<td><strong>Result</strong></td>
<td>2 genetically identical diploid cells</td>
<td>4 genetically different haploid cells</td>
</tr>
<tr>
<td><strong>Uses</strong></td>
<td>Cell replacement and growth and development</td>
<td>Production of gametes</td>
</tr>
</tbody>
</table>
10. True or false: In a human male, the X and Y chromosomes act as a homologous pair during meiosis. If false, make it a correct statement.
   True

11. How many possible gamete combinations are there for an organism that has a diploid number of 8?
   \[2^4 = 2 \times 2 \times 2 \times 2 = 16\] different combinations.

12. Homologous chromosomes
   a. are the same size.
   b. have the same genes at the same loci.
   c. can contain different versions of the same gene at the same loci.
   d. All of the above are true statements regarding homologous chromosomes.

13. True or false: Crossing over can occur between nonhomologous chromosomes. If false, make it a correct statement.
   False, because nonhomologous chromosomes do not carry the same genes.

14. Match the following terms with their description: tetrad, chiasma, sister chromatids, crossing over, and genetic recombination.

   Exchange of genes between homologous chromosomes: crossing over
   Chromosomes that are identical and connected by a centromere: sister chromatids
   Formation of two duplicated homologous chromosomes: tetrad
   Physical site of crossing over: chiasma
   Gene combinations in chromosomes that are different from the original: genetic recombination

**Big idea:** Alteration of chromosome number and structure

Answer the following questions as you read modules 8.18–8.23:

1. True or false: Nondisjunction can occur in either round of meiosis. If false, make it a correct statement.
   True
2. Could a normal gamete still be produced even if a nondisjunction event occurred? Briefly explain your answer either way.
   Yes, as long as the nondisjunction event occurred during meiosis II. If it did, 50% of the gametes would be normal.
3. A(n) ___karyotype___ is an ordered display of an organism’s chromosomes.

4. Which of the following could be determined by a karyotype?
   a. Down’s syndrome
   b. An individual that has three copies of chromosome 18
   c. Gender
   d. All of the above

5. A person with Down’s syndrome has how many total chromosomes?
   a. 46
   b. 47
   c. 45
   d. 23

6. A common student misconception is that the father cannot be the parent who contributed the gamete that leads to Down’s syndrome. Briefly explain how this is, in fact, possible.
   The father could have nondisjunction occur and produce a sperm with two chromosome 21s in it. If it fertilized a normal female gamete, then the resulting zygote would have three chromosome 21s.

7. True or false: Nondisjunction can lead to an incorrect number of autosomes or sex chromosomes. If false, make it a correct statement.
   True

8. A karyotype determines that an individual has four sex chromosomes: XXXY. What is the gender of this individual and how many total chromosomes does the individual have?
   Male; 48

9. A male organism of a species produces a sperm that is 4n, and the female produces an egg that is also 4n. If those two gametes fused, what would the resulting zygote be?
   8n
10. Match the following terms with their descriptions: inversion, duplication, deletion, and translocation.

   A piece of a chromosome separates and then reattaches in the opposite orientation: inversion

   A piece of a chromosome gets permanently removed: deletion

   A piece of a chromosome gets attached to a nonhomologous chromosome: translocation

   A piece of a chromosome gets copied and inserted into a chromosome: duplication

11. Briefly explain how a deletion could lead to a duplication.

    A deleted portion of a chromosome can become attached to its sister chromatid or its homologous chromosome.

CONNECTING THE BIG IDEAS

Use your knowledge of the information contained within this chapter’s “Big Ideas” to answer this question.

Methotrexate is a drug that inhibits the production of the nitrogenous base thymine within a cell. Would this be an effective drug to treat cancer? If so, what effect on cell division would it have?