Cell Growth and Reproduction

Module B, Anchor 1

Key Concepts:

- The larger a cell becomes, the more demands the cell places on its DNA. In addition, a larger cell is less efficient in moving nutrients and waste materials across the cell membrane.
- Asexual reproduction is the production of genetically identical offspring from a single parent.
- Offspring produced by sexual reproduction inherit some of their genetic information from each parent.
- Chromosomes make it possible to separate DNA precisely during cell division.
- During the cell cycle, a cell grows, prepares for division, and divides to form two daughter cells.
- During prophase, the genetic material inside the nucleus condenses. During metaphase, the chromosomes line up across the center of the cell. During anaphase, the chromosomes separate and move along spindle fibers to opposite ends of the cell. During telophase, the chromosomes, which were distinct and condensed, begin to spread out into tangle of chromatin.
- The cell cycle is controlled by regulatory proteins both inside and outside the cell.
- Cancer cells do not respond to the signals that regulate the growth of most cells. As a result, the cells divide uncontrollably.
- The diploid cells of most adult organisms contain two complete sets of inherited chromosomes and two complete sets of genes.
- In prophase I, replicated chromosomes pair with corresponding homologous chromosomes. At metaphase I, paired chromosomes line up across the center of the cell. In anaphase I, chromosome pairs move toward opposite ends of the cell. In telophase I, a nuclear membrane forms around each cluster of chromosomes. Cytokinesis forms two new cells. As the cells enter prophase II, their chromosomes become visible. The final four phases of meiosis II result in four haploid daughter cells.
- In mitosis, when the two sets of genetic material separate, each daughter cell receives one complete set of chromosomes. In meiosis, homologous chromosomes line up and then move to separate daughter cells. Mitosis does not normally change the chromosome number of the original cell. Meiosis reduces the chromosome number by half. Mitosis results in the production of two genetically identical diploid cells, whereas meiosis produces four genetically different haploid cells.
- Alleles of different genes tend to be inherited together from one generation to the next when those genes are located on the same chromosome.

Vocabulary:

Cell division	asexual reproduction	sexual reproduction
Chromosome	chromatin	cell cycle
Interphase	mitosis	cytokinesis
Prophase	centromere	chromatid
Centriole	metaphase	anaphase
Telophase	cyclin	growth factor

Cancer	tumor	apoptosis
Homologous	tetrad	crossing-over
Haploid	diploid	meiosis

Cell Growth, Division, and Reproduction:

1. What are the reasons why cells divide? How does division address these issues?

2. Describe what is meant by each of the following: cell volume, cell surface area, ratio of surface area to volume. Why is the ratio of surface area to volume important to cell survival?

3. In order for cells to divide successfully, the cell must first
    A. duplicate its genetic information
    B. decrease its volume
    C. increase its number of chromosomes
    D. decrease its number of organelles

4. Compare and contrast sexual and asexual reproduction.

5. Which type of reproduction is best suited to a changing environment? Why?

Cell Cycle/mitosis:

1. List and describe the stages of interphase. Illustrate each description.

2. List and describe the stages of M phase. Illustrate each stage.

3. If a cell has 12 chromosomes before division, how many chromosomes will be in each of its daughter cells after mitosis and cytokinesis? Why is this important?

4. Describe how a eukaryotic cell's chromosomes change as a cell prepares to divide. Why is it advantageous to package DNA into chromosomes for cell division?

5. What is the relationship between interphase and cell division? Why must the DNA be duplicated before cell division can occur?

6. How is the process of cell division different in prokaryotes and eukaryotes?

7. Compare and contrast cell division in plant and animal cells.

8. What type of cells are produced by mitosis?

Meiosis:

1. List and describe the stages of meiosis I.

2. List and describe the phases of meiosis II.

3. Compare and contrast meiosis I and meiosis II.

4. What type of cells are produced by meiosis? How do the end products of meiosis differ in males and females?

5. Compare and contrast meiosis and mitosis.

6. What events ensure that the cells produced by mitosis are genetically identical diploids, while the cells produced by meiosis are genetically different haploids?

8. Why does mitosis produce diploid cells, while meiosis produces haploid cells?

Regulating the Cell Cycle:

1. The timing in the cell cycle in eukaryotic cells is believed to be controlled by a group of closely related proteins known as:
    A. chromatids
    B. cyclins
    C. centromeres
    D. centrioles

2. Compare and contrast internal and external regulators. Give examples of each.

3. How do cancer cells differ from noncancerous cells? How are they similar?

4. What is apoptosis? What is the role of apoptosis in regulating the cell cycle?

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Cell Growth, Division, and Reproduction:

1. What are the reasons why cells divide? How does division address these issues?
Materials Exchange – As cells grown, their volume increases faster than their surface area. This prevents them from effectively exchanging materials with their environments. Dividing brings the SA:V ratio back into alignment, allowing for more effective exchange of materials.

DNA overload – As the cell grows, the demand on the DNA increases. Dividing decreases the demands on the DNA.

2. Describe what is meant by each of the following: cell volume, cell surface area, ratio of surface area to volume. Why is the ratio of surface area to volume important to cell survival?
Cell volume – amount on space inside the cell membrane
Cell surface area – amount of space taken up by cell membrane
SA:V ratio – relationship between the amount of surface area and the amount of volume.
SA:V ratio is related to materials exchange within the cell.

3. In order for cells to divide successfully, the cell must first
A. duplicate its genetic information

4. Compare and contrast sexual and asexual reproduction.
Both types of reproduction create new organisms. Sexual reproduction involves the genetic material of two organisms. It creates new combinations of alleles not seen in previous organisms. Therefore, it produces offspring with different physical structures than their parents. Asexual reproduction requires only one organism. It produces offspring identical, both physically and genetically, to their parents.

5. Which type of reproduction is best suited to a changing environment? Why?
Sexual. Sexual reproduction produces offspring with a variety of phenotypes. This allows a greater chance of survival in a changing environment. If the organisms were produced via asexual reproduction, they would all be identical. If the environment changed in a way unfavorable to these organisms, they would all die.

Cell Cycle/mitosis:

1. List and describe the stages of interphase. Illustrate each description.
G1 phase – normal growth and cell activities
S phase – DNA replication
G2 phase – cell synthesizes organelles and chemicals needed for division

2. List and describe the stages of M phase. Illustrate each stage.
Prophase – Genetic material condenses and becomes visible, nuclear envelope disintegrates, centrioles begin to move to opposite sides of the cell.
Metaphase – chromosomes line up in the center of the cell, spindles attach
Anaphase – spindles pull sister chromatids to opposite sides of the cell

Telophase – nuclear envelop reforms around two new nuclei
Cytokinesis – cytoplasm divides into two identical cells

3. If a cell has 12 chromosomes before division, how many chromosomes will be in each of its daughter cells after mitosis and cytokinesis? Why is this important?
12 – so that no DNA is missing from any cell

4. Describe how a eukaryotic cell's chromosomes change as a cell prepares to divide. Why is it advantageous to package DNA into chromosomes for cell division?
Chromosomes duplicate and condense. Packaging DNA into chromosomes makes it easier to separate evenly.

5. What is the relationship between interphase and cell division? Why must the DNA be duplicated before cell division can occur?
Interphase prepares the cell for division. If the DNA was not replicated before division, each daughter cell would only receive half the appropriate amount of DNA.

6. How is the process of cell division different in prokaryotes and eukaryotes?
In prokaryotes, genetic material is not package in a nucleus. Like in eukaryotes, the DNA duplicates. In then attached to two different places on the cell membrane. A network of proteins forms between the areas, pinching in the membrane to divide.

7. Compare and contrast cell division in plant and animal cells.
Plants – cell wall cannot pinch in, therefore the cell builds a cell plate between the two nuclei

Animal cell – the cell membrane pinches in to form two new cells.

8. What type of cells are produced by mitosis?
Somatic/body cells

Meiosis:
1. List and describe the stages of meiosis I.
Prophase I – nuclear envelope disintegrates, chromosomes line up in tetrads, crossing-over occurs.
Metaphase I – chromosomes line up in tetrads across center of cell, spindles attach
Anaphase I – spindles pull chromosomes to opposite sides of the cell
Telophase I – nuclear envelopes reform around chromosome sets, producing two haploid neclei
Cytokinesis – cell splits into two haploid cells

2. List and describe the phases of meiosis II.
Prophase II – nuclear envelope disintegrates, centrioles move to opposite sides of the cell
Metaphase II – Chromosomes line up end to end, spindles attach
Anaphase II – sister chromatids are split and pulled to opposite ends of the cell
Telophase II – cytoplasm begins to divide, nuclear envelopes form around each nuclei
Cytokinesis – cell divides into four haploid gametes

3. Compare and contrast meiosis I and meiosis II.
Meiosis I – tetrads form, crossing-over occurs, cell begins diploid but ends haploid
Meiosis II – cells begin and end haploid, no tetrads or crossing-over

4. What type of cells are produced by meiosis? How do the end products of meiosis differ in males and females?
Gametes
Males produce four haploid gametes. Females produce one large haploid egg cell and three polar bodies.

5. Compare and contrast meiosis and mitosis.
Meiosis produces four haploid cells. The cells are not genetically identical to each other or to the parent cell.
Mitosis produces two diploid cells. The cells are identical to the parent cell and to each other.

6. What events ensure that the cells produced by mitosis are genetically identical diploids, while the cells produced by meiosis are genetically different haploids?
In mitosis, the chromosomes duplicate once and divide once. The chromosomes line up end to end, so that when they are pulled apart each cell receives a full set of genetic material.
In meiosis, the chromosomes duplicate once but divide twice. This reduces the amount of genetic material in each cell by half. When the cells divide the first time, chromosomes line up in pairs instead of end to end. This ensures that each cell receives half the genetic material.

8. Why does mitosis produce diploid cells, while meiosis produces haploid cells?
Mitosis is producing replacement body cells, so the cells need a full complement of DNA to function correctly. Meiosis is producing gametes. One gamete is fertilized by another to form offspring, therefore each must have only half the genetic material needed.

Regulating the Cell Cycle:
1. The timing in the cell cycle in eukaryotic cells is believed to be controlled by a group of closely related proteins known as:
B. cyclins

2. Compare and contrast internal and external regulators. Give examples of each.
Internal regulators respond to events inside the cell, such as the duplication of the DNA.
External regulators respond to events outside the cell, such as contact with other cells.

3. How do cancer cells differ from noncancerous cells? How are they similar?
Cancer cells no longer respond to growth regulators, therefore never stop dividing. Otherwise, they are like normal body cells.

4. What is apoptosis? What is the role of apoptosis in regulating the cell cycle?
Programmed cell death. Apoptosis plays a key role in removing damaged cells.