

Cell Biology and Genetics: Mitosis, Meiosis, DNA, and Respiration

75 POINTS

Name _____

QUESTION 1 5 POINTS

In which of the following processes does the chromosome number of the daughter cells become half that of the parent cell?

- (A) Mitosis only
- (B) Meiosis II only
- (C) Meiosis I only
- (D) Both mitosis and meiosis I
- (E) Both meiosis I and meiosis II

QUESTION 2 10 POINTS

In pea plants, the allele for tall stems (*T*) is dominant over the allele for short stems (*t*). A heterozygous tall plant is crossed with another heterozygous tall plant. Complete a Punnett square for this cross and determine the percentage of offspring that are expected to be heterozygous. Write your answer as a percentage (e.g., 25%, 50%, 75%, or 100%).

Percentage of heterozygous offspring: _____

QUESTION 3 5 POINTS

Which of the following correctly describes the complementary base pairing rules in DNA structure?

- (A) Adenine pairs with guanine, and cytosine pairs with thymine.
- (B) Adenine pairs with cytosine, and guanine pairs with thymine.
- (C) Adenine pairs with thymine, and guanine pairs with cytosine.
- (D) Adenine pairs with uracil, and guanine pairs with cytosine.

QUESTION 4 8 POINTS

Cellular respiration is a catabolic process that breaks down glucose to produce ATP. Write the overall balanced chemical equation for aerobic cellular respiration, including the names of all reactants and products. Then, for each reactant and product, state where it enters or exits the process in a eukaryotic cell (e.g., cytoplasm, mitochondrial matrix, intermembrane space, or across the plasma membrane). Finally, explain why oxygen is essential for this process and what happens to the carbon atoms from glucose.

QUESTION 5 6 POINTS

Match each phase of meiosis in Column A with its correct key event in Column B. Write the letter of the event next to the phase number. Each event is used only once.

Column A (Phases)	Column B (Key Events)
1. Prophase I	A. Homologous chromosomes separate and move to opposite poles.
2. Metaphase I	B. Two haploid daughter cells form, each with half the original chromosome number.
3. Anaphase I	C. Homologous chromosomes pair up and crossing over occurs.
4. Telophase I	D. Chromosomes condense again, but no crossing over occurs.
5. Prophase II	E. Homologous pairs align at the metaphase plate.
6. Metaphase II	F. Individual chromosomes align at the metaphase plate.

Write your answers below:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____

QUESTION 6 12 POINTS

In pea plants, the allele for round seeds (R) is dominant over the allele for wrinkled seeds (r), and the allele for yellow seeds (Y) is dominant over the allele for green seeds (y). A plant that is heterozygous for both seed shape and seed color is crossed with another plant that is also heterozygous for both traits. Using a Punnett square, determine the expected phenotypic ratio of the offspring. Show all work and clearly state the ratio of round yellow : round green : wrinkled yellow : wrinkled green seeds.

QUESTION 7 5 POINTS

Meselson and Stahl grew bacteria in a medium containing heavy nitrogen (^{15}N) for many generations, then transferred them to a medium with light nitrogen (^{14}N). After one round of DNA replication, they extracted DNA and analyzed it by density gradient centrifugation. Which of the following best describes the expected results if DNA replication is semiconservative?

- (A) One band at the heavy density ($^{15}\text{N}/^{15}\text{N}$) only.
- (B) One band at an intermediate density ($^{15}\text{N}/^{14}\text{N}$) only.
- (C) Two bands: one at heavy density and one at light density.

- (D) Two bands: one at intermediate density and one at light density.
(E) One band at the light density ($^{14}\text{N}/^{14}\text{N}$) only.
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QUESTION 8 8 POINTS

In eukaryotic cells, the electron transport chain of cellular respiration is embedded in the
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QUESTION 9 10 POINTS

Compare and contrast mitosis and meiosis by describing the number of daughter cells produced, the chromosome number of the daughter cells relative to the parent cell, and the genetic identity of the daughter cells. In your answer, explain the key events that lead to these differences.

QUESTION 10 6 POINTS

Match each term related to DNA replication and cell division in Column A with its correct description in Column B. Write the letter of the description next to the number of the term. Each description is used only once.

Column A (Terms)	Column B (Descriptions)
1. DNA replication	A. The phase of the cell cycle when DNA is copied.
2. S phase	B. The process of nuclear division that separates duplicated chromosomes.
3. Mitosis	C. The process by which a cell makes an identical copy of its DNA.
4. Cytokinesis	D. The division of the cytoplasm to form two daughter cells.
5. Helicase	E. An enzyme that unwinds the DNA double helix during replication.
6. DNA polymerase	F. An enzyme that adds nucleotides to a growing DNA strand during replication.

Answers:

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____