RLP-BIOA · RLP Biology A — Cells, Energy and Heredity

Unit 3: Growth, Division and the Code of Life

Practice Workbook. The same problems, in the same order, as the Practice sections of the online lessons.

Name _____ Period _____

Lesson 3.1 — Phenomenon: How Does a Five-Lined Skink Regrow Its Tail?

FLUENCY

1. Put the stages in order, starting after interphase: anaphase, prophase, telophase, metaphase.

2. In which part of the cell cycle is DNA copied?

3. Starting from one cell, how many cells could there be after 20 rounds of doubling?

4. A body cell of an onion has 16 chromosomes. How many chromosomes does each daughter cell have after mitosis?

APPLICATION

5. Cells in a wound divide every 20 hours. How long would it take one cell to produce about 1,000 cells, and about how many days is that?

6. About how many rounds of doubling are needed to turn one cell into one million cells?

7. A muscle cell and a skin cell from the same lizard have the same DNA. Explain why they make different proteins.

CHALLENGE

8. A regrowing tail needs roughly 10^8 cells (an illustrative figure), starting from about 10^4 dividing cells at the wound. If every cell divides once every 24 hours and none die, how many days would regrowth take? Why is the real time longer?

REVIEW

9. Using $6CO_2 + 6H_2O \rightarrow C_6H_{12}O_6 + 6O_2$, how many molecules of CO_2 are needed to make 3 molecules of glucose?

Lesson 3.2 — Onion Root Tips: Counting the Cell Cycle

FLUENCY

1. For the data 8, 10, 11, 15, 29, 31, 33, 39, 39: find the mean, median, range and interquartile range. (Find the quartiles as the medians of the lower and upper halves, leaving out the overall median when the count is odd.)

2. A sample of 100 root tip cells has 88 in interphase, 7 in prophase, 2 in metaphase, 1 in anaphase and 2 in telophase. Find the mitotic index.

3. In the same sample, assume a 16-hour cycle. How long does prophase last?

4. In the same sample and 16-hour cycle, how long does anaphase last?

APPLICATION

5. At the root tip, 45 of 250 cells are in mitosis; 2 mm back, 3 of 50 are. Compare the mitotic indexes and state what they show about where the root grows.

6. Using the lesson's counts (205, 26, 9, 4, 6 of 250) and a 24-hour cycle, how many hours does interphase last?

7. A student counts only 30 cells and finds none in anaphase. She concludes that anaphase takes no time. Evaluate her conclusion.

CHALLENGE

8. In another tissue, 2 of 150 cells are in anaphase, and anaphase is known to last about 20 minutes. Estimate the length of the whole cell cycle.

REVIEW

9. Leaf disks under a lamp had ET_{50} = 10 minutes. What is the rate $1/ET_{50}$?

Lesson 3.3 — Same Genome, Different Cells: The Strawberry DNA Argument

FLUENCY

1. A DNA sample is 30% adenine. Give the percentages of T, G and C.

2. A DNA sample is 18% adenine. Give the percentages of T, G and C.

3. A DNA sample is 35% adenine. Give the percentages of T, G and C.

4. Write the complementary DNA strand for 5′-ATGCCGTA-3′.

APPLICATION

5. Each base pair adds about 0.34 nm to the length of DNA. Estimate the length of the 3.1 billion base pairs in one set of human chromosomes, and of the two sets in a body cell.

6. Cultivated strawberries have eight sets of 7 chromosomes. How many chromosomes are in a body cell, and why does this help the extraction lab?

7. State the purpose of the soap, the salt and the cold alcohol in the DNA extraction.

CHALLENGE

8. A student argues: “Red blood cells have no nucleus, so specialized cells lose their genes.” Write a two-sentence rebuttal using evidence from the lesson.

REVIEW

9. How many moles are in 50.0 g of $C_6H_{12}O_6$?

Lesson 3.4 — From Gene to Protein: Modeling Transcription and Translation

FLUENCY

1. Transcribe the DNA template TAC AAA CCG TTT ATT into mRNA.

2. Translate the mRNA AUG UUU GGC AAA UAA using the genetic code.

3. Transcribe and translate the template TAC CTT AAA CCG ACT.

4. How many different codons are possible with four bases taken three at a time?

APPLICATION

5. A protein has 300 amino acids. How many mRNA bases code for it, including the stop codon?

6. Classify each change to the mRNA codon GAA (Glu): (a) GAG; (b) GUA; (c) UAA.

7. Explain how the change from GAG to GUG in the β-globin gene changes the function of hemoglobin.

8. Label each change as most likely neutral, harmful or beneficial, and give the reason: (a) GAA → GAG in a gene for a muscle protein; (b) two copies of the GAG → GUG β-globin variant; (c) one copy of the same variant in a region where malaria is common.

CHALLENGE

9. The mRNA AUG UUU GGC AAA UAA loses its seventh base (the first G of GGC). Write the new reading frame and the resulting amino acids, and explain why this mutation is more serious than a substitution.

REVIEW

10. Why must a cell copy its DNA before mitosis?

Unit 3 checkpoint

1. In which stage do chromosomes line up across the middle of the cell?
   A. Prophase
   B. Metaphase
   C. Anaphase
   D. Telophase
2. True or false: Mitosis produces two daughter cells with the same chromosomes as the parent cell.
3. If 18 of 200 cells are in mitosis, the mitotic index is _____%.

4. Why is the fraction of cells in a stage used to estimate the stage's duration?
   A. Longer stages have bigger cells
   B. If cells divide at random times, a snapshot catches each stage in proportion to how long it lasts
   C. Stains only work on long stages
   D. Short stages are invisible

5. Muscle and skin cells in the same animal differ mainly because:
   A. They contain different genes
   B. They express different genes
   C. One has DNA and the other does not
   D. They have different numbers of chromosomes

6. If DNA is 26% guanine, it is _____% cytosine and _____% adenine.

7. A gene is best described as:
   A. A whole chromosome
   B. A segment of DNA carrying the instructions for a product such as a protein
   C. A protein
   D. A single base pair

8. The DNA template TAC GGA CTT codes for the mRNA _____.

9. A mutation changes a codon to UAG. What type is it?
   A. Silent
   B. Missense
   C. Nonsense
   D. Frameshift

10. True or false: Changing one amino acid can change a protein's shape and function.

11. Where does translation take place?
   A. In the nucleus, on the DNA
   B. At ribosomes in the cytoplasm
   C. In the cell wall
   D. In the vacuole