Free-Response Section

Scoring Guidelines

Question 1: Interpreting and Evaluating Experimental Results — 9 points

Learning Objectives: ENE-1.A ENE-1.G ENE-1.L

(A)

Describe how *C. parvum* obtains the glucose it needs for glycolysis after it has infected another cell. — **1 point** 1.A

- *C. parvum* absorbs glucose from its environment, which, in this case, takes glucose away from its host.

Explain the role of lactate dehydrogenase in enabling *C. parvum* to continue producing ATP by glycolysis. — **1 point** 1.C

- Lactate dehydrogenase allows fermentation to convert NADH to NAD^+, which is needed for glycolysis to continue making ATP.

Total for part (A) — **2 points**

(B)

Identify the independent variable used in the experiment — **1 point** 3.C

- The concentration of the chemical

Identify the difference between the control cells and the experimental cells used in the experiment. — **1 point** 3.C

- The control cells were the same type of cells, infected with the parasite, but not treated with any chemicals, as were the experimental cells.

Justify the researchers using a different range of concentrations for FX11 than was used for gossypol. — **1 point** 3.C

- FX11 had minimal impact on the growth of *C. parvum* until it reached a concentration of greater than 30µM, which was the maximum concentration of gossypol that was tested.

Total for part (B) — **3 points**

(C)

Based on the data in Figure 1, identify the concentration of gossypol that reduced *C. parvum* growth to 50% of that in control cells. — **1 point** 4.B

- 15µM

Total for part (C) — **1 point**

(D)	Researchers discovered a strain of *C. parvum* that expresses a functional variation of the lactate dehydrogenase gene. A DNA sequence comparison showed that the variant differs from the normal sequence in the region that codes for the enzyme's allosteric site. Predict the effect of FX11 treatment on *C. parvum* cells that express this variant of lactase dehydrogenase. • FX11 will have little to no effect.	**1 point** 3.B
	Provide reasoning to support your prediction. • The allosteric site is the region of the enzyme where a non-competitive inhibitor like FX11 would bind. It is likely that changing the sequence of this region would decrease inhibitor binding.	**1 point** 6.C
	Explain how gossypol and FX11 might be used as drugs to treat *C. parvum* infections in humans without negatively affecting human cells. • The drugs will prevent *C. parvum* from generating the ATP it needs to survive by inhibiting a key enzyme in fermentation. Since human cells have mitochondria and do not rely on fermentation to produce ATP, they are not likely to be harmed.	**1 point** 6.D
	Total for part (D)	**3 points**
	Total for question 1	**9 points**

Question 2: Interpreting and Evaluating Experimental Results with Graphing — 9 points

Learning Objectives: IST-1.C IST-1.O IST-2.E

(A)

Describe the situations in which a normal human cell would enter the cell cycle and undergo mitotic cell division. — **1 point** 1.A

- Cells divide by mitosis when the organism is growing or repairing tissues.

Explain how spindle fibers help ensure the products of mitosis are two identical cells with a full set of chromosomes. — **1 point** 1.C

- Spindle fibers attach to the center of each duplicated chromosome and assist in pulling one chromatid to each pole of the cell so that, when the cell divides, each daughter cell contains a copy of each chromosome.

Total for part (A) 2 points

(B)

Using the template in the space provided for your response, construct an appropriately labeled graph that represents the data shown in Table 1. — **3 points** 4.A

One point for each of the following:

- Correct axes and labeling
- Correctly plotted points and scaling
- Correctly plotted error bars

Based on the data, determine the concentration(s) of paclitaxel that is (are) most effective in causing tripolar cell division. — **1 point** 5.B

- A concentration of 6-8 nM

Total for part (B) 4 points

(C)

Based on the data, identify the lowest level of paclitaxel that will allow for at least 50% of the cells to be tripolar. — **1 point** 4.B

- 4 nM

From the start codon through the stop codon, the length of the fully processed AURKA mRNA is 1,212 nucleotides. Calculate the number of amino acids in the polypeptide chain coded for by the mRNA. — **1 point** 5.A

- 1,212 nucleotides minus 3 nucleotides (for the stop codon) equals 1,209. 1,209 divided by 3 nucleotides per amino acid equals 403 amino acids.

Total for part (C) 2 points

(D)	Predict the effect of a mutation that prevents the expression of AURKA on a normal (noncancerous) cell. • The cell will be unable to undergo mitosis.	**1 point** 6.E
	Total for part (D)	**1 point**
	Total for question 2	**9 points**

Question 3: Scientific Investigation — 4 points

Learning Objectives: EVO-1.E EVO-1.D

(A)	Describe the way the scientists will determine the evolutionary fitness of the mice in the experiment. • By determining whether the mice survive to successfully reproduce.	**1 point** 1.A
(B)	Identify the independent variable in the scientists' experiment. • The color of the ground in each of the enclosures	**1 point** 3.C
(C)	State the null hypothesis of this experiment. • The color of the enclosure ground will not affect the frequency of light and dark mice in the population.	**1 point** 3.B
(D)	The scientists claim that the changes in the frequency of fur color were the result of natural selection. Justify the researchers' claim. • Mice with a fur color that helped them blend into the environment were able to avoid predation and reproduce, increasing the frequency of their genes in the population.	**1 point** 6.C
	Total for question 3	**4 points**

Question 4: Conceptual Analysis — 4 points

Learning Objectives: ENE-4.B ENE-4.C

(A)	Describe the relationship between a parasite and its host. • The parasite will benefit while the host will be harmed.	**1 point** 1.A
(B)	Explain how producing the enzymes that digest α-pinene is beneficial to the bacterial species living within the nematodes. • By producing the enzymes that digest α-pinene, the bacteria increase the survival rate of the nematodes. This ensures that the nematodes continue provide a protected habitat and resources for the bacteria.	**1 point** 1.C
(C)	Predict the effect of the antibiotic treatments on the mortality rate of the nematodes when exposed to α-pinene. • The mortality rate of the nematodes will increase after the nematodes are treated with antibiotics.	**1 point** 6.E
(D)	Provide reasoning to justify your prediction in part (c). • Antibiotics will reduce the bacterial population thereby preventing the degradation of α-pinene. As a result, there will be more α-pinene to negatively affect the nematodes and more nematodes will die.	**1 point** 6.C

Total for question 4 — 4 points

Question 5: Analyze Model or Visual Representation of a Biological Concept or Process — 4 points

Learning Objectives: SYI-1.F SYI-1.D

(A)	Describe the major process that takes place in this eukaryotic organelle. • Light provides the energy to fix carbon into organic molecules	**1 point** 1.A
(B)	Explain the function of the structure labeled with an X in Figure 1. • Specific metabolic functions are more efficiently carried out because the outer membrane enables the compartmentalization of chemical reactions.	**1 point** 2.B
(C)	On the template in the space provided for your response, represent the location where carbon fixation takes place by writing "CF" and the location of the electron transport proteins by writing "ETP." • "CF" must be marked in the stroma and "ETP" must be marked on a thylakoid membrane.	**1 point** 2.D
(D)	Explain how the shape and stacking of the thylakoids contributes to the rate of carbon fixation by the chloroplast. • The thin and stacked nature of the thylakoids increases the surface area of the thylakoid membrane, allowing for a greater number of chlorophyll molecules and electron transport proteins.	**1 point** 2.C

Total for question 5 — 4 points

Question 6: Analyze Data — 4 points

Learning Objectives: IST-1.J

(A)	Identify the genotypes of the male and female flies used in cross 2. • X^rX^r and X^RY	**1 point** 4.B
(B)	Identify the cross in which the female parent was most likely heterozygous. • Cross 3	**1 point** 4.B
(C)	The researchers hypothesize that crossing any unaffected female and an affected male will result in a 0% chance of producing an affected male offspring. Evaluate the validity of the hypothesis. • This hypothesis is not supported. If the unaffected mother is heterozygous, she can pass on the recessive allele and the male offspring will be affected.	**1 point** 5.D
(D)	Explain how the results exclude the possibility that the trait is encoded by a mitochondrial gene. • Traits encoded by mitochondrial genes are inherited from the female parent only, resulting in offspring that all have the same genotype as their mother.	**1 point** 6.D

Total for question 6 — 4 points