2024

# AP® Biology

## Sample Student Responses and Scoring Commentary

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**Free-Response Question 3**

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## Question 3: Scientific Investigation — 4 points

To investigate whether red blood cells of animals lose the ability to take in glucose from their environment as they age, scientists collected red blood cells from guinea pigs that ranged in age from one day old to seven months old. Scientists incubated an equal number of red blood cells in separate culture dishes that contained a $300\ \text{nM}$ solution of radioactively labeled glucose. The amount of radioactively labeled glucose present inside the red blood cells of each group was measured over time.

**(a)** **Describe** a difference between passive transport and active transport. **1 point**

Accept one of the following:

- Active transport requires energy/ATP (while passive transport does not).
- Passive transport does not require energy/ATP (while active transport does).
- In passive transport, substances move from a high concentration to a low concentration, (while in active transport substances move from a low concentration to a high concentration).
- In active transport, substances move from a low concentration to a high concentration (while in passive transport substances move from a high concentration to a low concentration).

**(b)** **Justify** why the scientists used an equal number of red blood cells in each culture dish as a control. **1 point**

Accept one of the following:

- (Scientists used an equal number of cells) to attribute differences in results/glucose transport to guinea pig age, (rather than to the number of cells used in the experiment).
- (Scientists used an equal number of cells) to compare results from the different dishes (containing cells from guinea pigs of different ages).
- (Scientists used an equal number of cells) to eliminate the number of cells as a variable (that might affect the amount of glucose in each group).
- (Scientists used an equal number of cells) because the number of cells used might affect the results/amount of glucose (present inside the red blood cells).

**(c)** Glucose transporters are required for the facilitated diffusion of glucose into red blood cells. The scientists claim that the expression of the gene encoding these transporters decreases as guinea pigs age. If the scientists' claim is supported by experimental data, **predict** the effect of increased age on the amount of radioactively labeled glucose present inside the cells of each group. **1 point**

- (As guinea pig age increases) the amount of glucose (inside the cells) decreases.

**(d)** **Justify** your prediction in part (c). **1 point**

- With fewer transporters, fewer glucose molecules will be moved into the cells.

**Total for question 3** **4 points**

**BEGIN Question 3**

Begin your response to **QUESTION 3** on this page. Do not skip lines.

a) Passive transport does not require the use of energy (ATP), while active transport does require ATP.

b) The scientists used an equal number of red blood cells in each culture dish to ensure that the amount of glucose ~~[illegible]~~ taken up by the cells was not affected by the number of blood cells and only by the age of the guinea pig.

c) As ~~[illegible]~~ age increases, there is less radioactively labled glucose present inside the cell.

d) Since there are less glucose transporters because expression of its gene decreases with age, less glucose can be transported into the cell.



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Use a pen with black or dark blue ink only. Do NOT write your name. Do NOT write outside the box.

**BEGIN Question 3**

Begin your response to **QUESTION 3** on this page. Do not skip lines.

a) Passive transport does not require energy and active transport requires energy.

b) The scientists used an equal number of red blood cells to be a control because if there were different numbers from each then it would throw off results and make them innacurate. Having the same number creates the highest chance of accurate results.

c) As the guinea pigs increase in age, the amount of radioactively labeled glucose will decrease.

d) The glucose will decrease or become lower as the guinea pigs get older because the animals lose the ability to take in glucose from their environment as they age. They become weaker and cannot take more in as they did when they were younger.




**GO ON TO THE NEXT PAGE.**

Use a pen with black or dark blue ink only. Do NOT write your name. Do NOT write outside the box.

**BEGIN Question 3**

Begin your response to **QUESTION 3** on this page. Do not skip lines.

a) passive transport doesn't require energy to transport. Active transport does require energy to transport

b) They used an equal amout of red blood cells because the amount of red blood cells taken can affect the glucose ~~[illegible]~~ recorded

c) Increased age increases the glucose present

d) Change in gene encoding decreases as the guinea pigs age and the glucose can ~~affect~~ the guinea pigs age.

# Question 3

**Note:** Student samples are quoted verbatim and may contain spelling and grammatical errors.

## Overview

Question 3 described an experiment in which scientists collected red blood cells from guinea pigs that ranged in age from one day old to seven months old. The cells were incubated with radioactively labeled glucose to determine the effect of guinea pig age on glucose uptake by the cells.

Part (a) expected responses to "describe a difference between passive transport and active transport" (Skill 1.A; LO ENE-2.E).

Part (b) expected responses to justify the experimental control of using "an equal number of red blood cells in each culture dish" (Skill 3.C).

Part (c) presented a claim that "the expression of the gene encoding [glucose] transporters decreases as guinea pigs age." Responses were expected to "predict the effect of increased age on the amount of radioactively labeled glucose present" in cells from animals of different ages (Skill 3.B).

In part (d), responses were expected to justify the prediction in part (c) by reasoning that there would be fewer glucose transporters and thus less glucose uptake (Skill 6.C; LO ENE-2.G).

## Sample: 3A
## Score: 4

The response earned 1 point in part (a) for describing that "Passive transport does not require the use of energy..." The response earned 1 point in part (b) for justifying that an equal number of cells was used to "ensure that the amount of glucose taken up by the cells was not affected by the number of blood cells and only by the age of the guinea pig." The response earned 1 point in part (c) for predicting "As age increases, there is less radioactively labled glucose present..." The response earned 1 point in part (d) for justifying that "Since there are less glucose transporters...less glucose can be transported into the cell."

## Sample: 3B
## Score: 3

The response earned 1 point in part (a) for describing that "Passive transport does not require energy..." The response earned 1 point in part (b) for justifying the use of an equal number of cells because different numbers would "throw off results." The response earned 1 point in part (c) for predicting that "As the guinea pigs increase in age, the amount of radioactively labeled glucose will decrease." The response did not earn a point in part (d) because it does not correctly justify the prediction.

## Sample: 3C
## Score: 2

The response earned 1 point in part (a) for describing that "passive transport doesn't require energy...." The response earned 1 point in part (b) for justifying the use of an equal number of cells because the response states "the amount of red blood cells taken can affect the glucose recorded." The response did not earn a point in part (c) for incorrectly predicting the effect of guinea pig increased age. The response did not earn a point in part (d) because it does not correctly justify the prediction.