2019

AP® CollegeBoard

AP® Biology

Sample Student Responses and Scoring Commentary

Inside:

Free Response Question 6

- ☑ **Scoring Guideline**
- ☑ **Student Samples**
- ☑ **Scoring Commentary**

AP® BIOLOGY
2019 SCORING GUIDELINES

Question 6

		STRAINS		
	MEDIUM	Wild Type	Mutant 1	Mutant 2
Treatment I	All amino acids present	+	+	+
Treatment II	No amino acids present	+	−	−
Treatment III	All amino acids present EXCEPT methionine	+	−	+
Treatment IV	All amino acids present EXCEPT leucine	+	+	−

Table 1. The data show the growth of haploid *Saccharomyces cerevisiae* yeast strains on media that differ in amino acid content. A plus sign (+) indicates that the yeast strains grow, and a minus sign (−) indicates that the strains do not grow.

The yeast *Saccharomyces cerevisiae* is a single-celled organism. Amino acid synthesis in yeast cells occurs through metabolic pathways, and enzymes in the synthesis pathways are encoded by different genes. The synthesis of a particular amino acid can be prevented by mutation of a gene encoding an enzyme in the required pathway.

A researcher conducted an experiment to determine the ability of yeast to grow on media that differ in amino acid content. Yeast can grow as both haploid and diploid cells. The researcher tested two different haploid yeast strains (Mutant 1 and Mutant 2), each of which has a single recessive mutation, and a haploid wild-type strain. The resulting data are shown in Table 1.

(a) **Identify** the role of treatment I in the experiment.

Identification (1 point)

- (Positive) control (for yeast growth).
- To test the viability of all yeast strains.
- Treatment I allows the researcher to be confident that changes in experimental outcome are due to differences in treatments.

(b) **Provide reasoning** to explain how Mutant 1 can grow on treatment I medium but cannot grow on treatment III medium.

Reasoning (1 point)

- Mutant 1 can use methionine when it is present in the medium, but Mutant 1 cannot synthesize methionine.

(c) Yeast mate by fusing two haploid cells to make a diploid cell. In a second experiment, the researcher mates the Mutant 1 and Mutant 2 haploid strains to produce diploid cells. Using the table provided, **predict** whether the diploid cells will grow on each of the four media. Use a plus sign (+) to indicate growth and a minus sign (−) to indicate no growth.

Prediction (1 Point)

- There will be growth (+) in all four cells of the fourth column.

6A

PAGE FOR ANSWERING QUESTION 6

	MEDIUM	STRAINS			
		Wild Type (haploid)	Mutant 1 (haploid)	Mutant 2 (haploid)	Diploid Cells Produced by Mating Mutant 1 and Mutant 2
Treatment I	All amino acids present	+	+	+	+
Treatment II	No amino acids present	+	−	−	+
Treatment III	All amino acids present EXCEPT methionine	+	−	+	+
Treatment IV	All amino acids present EXCEPT leucine	+	+	−	+

a) Treatment I is a control. It ensures that all of the yeasts can reproduce in a normal setting.
b) Mutant 1 has a single recessive mutation that prevents it from synthesizing methionine. It survives in treatment I because all of the amino acids are present but it cannot survive in treatment III because methionine is not present

GO ON TO THE NEXT PAGE.

6B

	MEDIUM	STRAINS			
		Wild Type (haploid)	Mutant 1 (haploid)	Mutant 2 (haploid)	Diploid Cells Produced by Mating Mutant 1 and Mutant 2
Treatment I	All amino acids present	+	+	+	+
Treatment II	No amino acids present	+	−	−	−
Treatment III	All amino acids present EXCEPT methionine	+	−	+	+
Treatment IV	All amino acids present EXCEPT leucine	+	+	−	+

a) The role of treatment I in the experiment was to act as the control.

b). Mutant 1 can grow on treatment I medium but cannot grow on treatment III medium because it has a mutation that blocks the synthesis of the amino acid methionine, meaning that it requires already synthesized methionine from its environment, and since treatment III lacked methionine and treatment I didn't, Mutant 1 couldn't grow on treatment III.

6C

PAGE FOR ANSWERING QUESTION 6

	MEDIUM	STRAINS			
		Wild Type (haploid)	Mutant 1 (haploid)	Mutant 2 (haploid)	Diploid Cells Produced by Mating Mutant 1 and Mutant 2
Treatment I	All amino acids present	+	+	+	+
Treatment II	No amino acids present	+	−	−	−
Treatment III	All amino acids present EXCEPT methionine	+	−	+	−
Treatment IV	All amino acids present EXCEPT leucine	+	+	−	−

(a) Treatment I serves as a control that will be used to compare the other treatments to.

(b) Mutant I requires methionine to be present in order to grow. The only variable between Treatment I and Treatment III is the presence of methionine. Therefore, its absence in Treatment III is what caused Mutant I to not grow.

(c)

AP® BIOLOGY
2019 SCORING COMMENTARY

Question 6

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

Overview

This question presented students with a data table indicating the growth of three different haploid strains of yeast: a wild type strain and two different recessive mutants (Mutant 1 and Mutant 2). The table showed the growth (+) or no growth (−) of the yeast in four different treatment groups based on media containing: all amino acids, no amino acids, all amino acids except methionine, and all amino acids except leucine. Students were asked to identify the role in the experiment of growing all yeast strains in the medium with all amino acids present. Then they were asked to provide reasoning to explain how Mutant 1 could grow in a medium with all amino acids but not in a medium without methionine. Finally, students were asked to complete the table to predict if diploid cells produced by mating Mutants 1 and 2 would grow in the different media. The students used their understanding of experimental design to help respond to this question. They also needed a basic understanding that cells must obtain nutrients from the environment if they cannot synthesize them and that information about growth in specific environments can help determine what mutations are present. In addition, students needed to understand the inheritance of recessive traits and to apply an understanding of the expression of recessive mutations to haploid and diploid cells.

Sample: 6A
Score: 3

The response earned 1 point in part (a) for identifying the role of treatment 1 as that of a control. The response earned 1 point in part (b) for explaining that Mutant 1 has a mutation that prevents it from synthesizing methionine, but it survives when all of the amino acids are present. The response earned 1 point in part (c) for predicting in all four cells of the fourth column that there will be growth (+).

Sample: 6B
Score: 2

The response earned 1 point in part (a) for identifying the role of treatment 1 as that of a control. The response earned 1 point in part (b) for explaining that Mutant 1 "has a mutation that blocks the synthesis of … methionine, meaning that it requires already synthesized methionine from its environment."

Sample: 6C
Score: 1

The response earned 1 point in part (a) for identifying the role of treatment 1 as that of a control.