2017

AP CollegeBoard

# AP Biology

## Sample Student Responses and Scoring Commentary

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# AP® BIOLOGY
# 2017 SCORING GUIDELINES

## Question 7

Many species of bacteria grow in the mouths of animals and can form biofilms on teeth (plaque). Within plaque, the outer layers contain high levels of oxygen and the layers closest to the tooth contain low levels of oxygen. The surface of the tooth is covered in a hard layer of enamel, which can be dissolved under acidic conditions. When the enamel breaks down, the bacteria in plaque can extract nutrients from the tooth and cause cavities.

Certain types of bacteria (e.g., *Streptococcus mutans*) thrive in the innermost anaerobic layers of the plaque and are associated with cavities. Other types of bacteria (*Streptococcus sanguinis*) compete with *S. mutans* but are unable to thrive in acidic environments.

(a) **Identify** the biochemical pathway *S. mutans* uses for metabolizing sugar and **describe** how the pathway contributes to the low pH in the inner layers of plaque. **(2 points; both points must be earned from the same row.)**

| **Identification** | **Description** |
|---|---|
| fermentation | (lactic) acid/lactate |
| anaerobic respiration | acid |
| glycolysis | (pyruvic) acid/pyruvate |

(b) Normal tooth brushing effectively removes much of the plaque from the flat surfaces of teeth but cannot reach the surfaces between teeth. Many commercial toothpastes contain alkaline components, which raise the pH of the mouth. **Predict** how the population sizes of *S. mutans* AND *S. sanguinis* in the bacterial community in the plaque between the teeth are likely to change when these toothpastes are used. **(1 point)**

**Prediction (1 point)**

- *S. mutans* decreases AND *S. sanguinis* increases

7. Many species of bacteria grow in the mouths of animals and can form biofilms on teeth (plaque). Within plaque, the outer layers contain high levels of oxygen and the layers closest to the tooth contain low levels of oxygen. The surface of the tooth is covered in a hard layer of enamel, which can be dissolved under acidic conditions. When the enamel breaks down, the bacteria in plaque can extract nutrients from the tooth and cause cavities.

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PAGE FOR ANSWERING QUESTION 7

a.) The biochemical pathway S. mutans uses for metabolizing sugar is ~~anaerobic~~ fermentation since they live in anaerobic conditions which don't allow oxygen. Fermentation contributes to the low pH in the inner layers of plaque since fermentation generates acids such as latic acid ~~when the~~ when the bacterium undergoes glycolysis creating pyruvate and changing that into a type of acid lowering the pH in the inner layers of plaque.

b.) When alkaline toothpastes are used the population of S. sanguinis will increase since they are able to survive in non-acidic environments. The population of S. mutans

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ADDITIONAL PAGE FOR ANSWERING QUESTION 7

will decrease since S. mutans can't survive in alkaline conditions (only in acidic ones).

GO ON TO THE NEXT PAGE.

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PAGE FOR ANSWERING QUESTION 7

~~a) S. mutans use the biochemical pathway called [illegible] to metabolize sugar~~

a) S. mutans use the biochemical pathway called fermentation to metabolize sugar. During the process of fermentation, sugar is metabolized and results in the production of acid (lactic acid). The acid produced contributes to the low pH in the inner layers of plaque. S. mutans undergo fermentation because they inhabit an anaerobic environment; fermentation is an anaerobic process to metabolize sugar.

b) The population sizes of S. mutans and S. sanguinis would remain stable or increase in the bacterial community. S. mutans and S. sanguins can thrive in environments with high pH levels, because they are not acidic. Therefore, if the mouth has a high pH level, the bacteria can survive in the

ADDITIONAL PAGE FOR ANSWERING QUESTION 7

plaque between the teeth. The alkaline components in the toothpaste raises the pH, which, results in the survival of the S. mutan and S. sanguinis bacteria.

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PAGE FOR ANSWERING QUESTION 7

a) The S. mutans probably eat up all the oxygen in its area, making its surroundings acidic, which eat away the enamel, and result in food for the bacteria. Because the pathway eats up oxygen, the surroundings have a lower pH.

b) I predict the population sizes of the S. mutans will decrease because they cannot thrive without acidic conditions, but the population sizes of S. sanguinis will increase because not only is the environment no longer uninhabitably acidic (thanks to the toothpaste), but they no longer have to compete with the S. mutans.

# AP® BIOLOGY
# 2017 SCORING COMMENTARY

## Question 7

### Overview

This question focused on the growth of two bacterial species (*S. mutans* and *S. sanguinis*) found in biofilms (plaque) on teeth. Students were provided a description of the optimal growth environment for each bacterial species. Students were asked to identify the biochemical pathway used by *S. mutans* for metabolizing sugar and to describe how the pathway contributes to the low pH of the environment. Students were then asked to predict how the population size of each species would change if the pH in the mouth were raised due to the alkaline composition of toothpastes.

**Sample: 7A**
**Score: 3**

The response earned 1 point in part (a) for identifying the biochemical pathway as fermentation. The response earned 1 point in part (a) for describing that fermentation generates acids. The response earned 1 point in part (b) for predicting that the population of *S. sanguinis* will increase, and the population of *S. mutans* will decrease.

**Sample: 7B**
**Score: 2**

The response earned 1 point in part (a) for identifying the biochemical pathway as fermentation. The response earned 1 point in part (a) for describing that fermentation results in the production of acid.

**Sample: 7C**
**Score: 1**

The response earned 1 point in part (b) for predicting that the population sizes of *S. mutans* will decrease, and the population sizes of *S. sanguinis* will increase.