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| **Evidence Statements** |
| **Task Component A*** I. Students make a statement that includes the following information: if none of the traits provided a reproductive advantage to the bacteria, then the frequency of each trait in the population will be around 25% at Time 4.
* I. Students use the following reasoning to support their statement:
	+ Because no one trait provides an advantage to a bacterium that could increase its chances of surviving and reproducing in the environment of the petri dish, the bacteria should increase in number equally.
	+ Because the number of bacteria with each trait type should increase equally, the frequency of traits should not change from the starting frequencies.
* II. Students calculate the frequencies of traits for Time 2, Time 3, and Time 4.
* II. Students create a graphical display that is an appropriate method of display for the data; correctly represents the change in frequencies over time; and includes a relevant scale, axis labels, unit labels, legend, and title.
* III. Students construct an explanation that includes that the measured frequencies are different than the predicted frequencies because some traits give the bacteria a higher probability of surviving and reproducing over others. Students connect this specific situation to the concept of natural selection.
* III. Students identify and describe, as evidence, the pattern from the plots that over time the bacterial populations with traits of “grows quickly” and “less cell death” increase in frequency relative to the frequency of the other two traits.
* III. Students logically connect the evidence using the following reasoning:
	+ The traits of “grows quickly” and “less cell death” provided an advantage to the bacteria with those traits because those traits helped those bacterial populations increase in number faster, using more food and space.
	+ Because the bacteria with traits for “grows quickly” and “less cell death” increased in number faster than the other bacteria, the frequency of the traits for “grows quickly” and “less cell death” in the population increased (greater than 25%) and the frequency of the other traits decreased (less than 25%)

**Task Component B*** I. Students create a scatterplot that correctly represents the Variant X and Y frequency numbers for each generation, with symbols distinguishing each variant and a relevant scale, axis labels, unit labels, legend, and title.
* I. Students describe how the frequencies of the traits in the population change according to the data, including at least one of the following descriptions of modeling the dataset:
	+ The entire dataset is best modeled by a non-linear function. The data for Variant X is described as increasing non-linearly, and the data for Variant Y is described as decreasing non-linearly.
	+ Only part of the dataset could be modeled with a linear function, with parts where the data for Variant X is increasing proportionally and the data for Variant Y is decreasing proportionally.
* I. In their description, students cite a low probability that bacteria with Variant Y display antibiotic resistance to streptomycin because the numbers are decreasing while there is a high probability that bacteria with Variant X are antibiotic resistant because the numbers are increasing.
* II. Students construct an explanation that includes the idea that there is a change in the frequency of the traits in the population because the new environmental conditions provide bacteria with Variant X with an advantage over bacteria with Variant Y, and therefore natural selection is acting on the bacterial populations.
* II. Students identify and describe the increase in the frequency of Variant X and the decrease in Variant Y on the plot over time in response to the new environmental conditions (added antibiotic) as evidence in support of the explanation.
* II. Students use reasoning to logically connect the evidence, including:
	+ Because bacteria with Variant Y are not resistant to the antibiotic, they will die and create fewer offspring in the new environment causing their numbers and the frequency of Variant Y in the population to decrease.
	+ Because bacteria with Variant X are antibiotic resistant to streptomycin, they will continue to multiply and thrive in the new environment causing their numbers and the frequency of Variant X in the population to increase.
	+ If there are fewer bacteria with Variant Y because they are dying and not reproducing and if bacteria with Variant X are unaffected and multiply, then the frequency of Variant Y will decrease and the frequency of Variant X will increase as seen in the plot.
* III. Students construct a scatterplot that shows Variant Y increasing non-linearly to frequencies near 98-99% and Variant X decreasing non-linearly to frequencies near 1-2% following the shape of the data in the plot created previously.

**Task Component C*** I. Students make a prediction that includes the following connections and lines of reasoning:
	+ Unknown B and D most likely correspond with “grows quickly” and “less cell death” (with B more likely to be “grows quickly”) because B and D had the highest frequencies in the group without antibiotics (with B slightly higher) and these traits also had the highest frequency in the data from Task Component A (with grows quickly slightly higher).
	+ Unknown C and E most likely correspond with “survives in toxic, heavy metal-rich environments” and “moves around more easily” (with equal likelihood that each trait is C or E) because C and E had the lowest frequencies in the group without antibiotics (nearly equal) and these traits also had the lowest frequency in the data from Task Component A.
	+ Unknown A most likely corresponds with antibiotic resistance because it is only high in frequency in a population given antibiotics (Antibiotic 1).
* II. Students make a claim that includes that the trait for antibiotic resistance provides protection from Antibiotic 1.
* II. In support of their claim, students identify and describe evidence, including the increased frequency in Trait A for antibiotic resistance in the population given Antibiotic 1.
* Students evaluate the evidence for relevance and sufficiency, including any limitations their evidence may pose (e.g., correlational).
* II. Students synthesize the relevant evidence using reasoning, including:
	+ Cause and effect relationships between environmental conditions and population growth. Specifically, students identify that because the antibiotics kill all the other bacteria types except the one with the trait for antibiotic resistance, people that take that antibiotic will be creating an environment in their bodies where those bacteria will preferentially thrive and the trait will increase in frequency within the population over time.
	+ Because only the people with Antibiotic 1 have high numbers of bacteria with that trait and because Trait A is only uniquely prevalent in a group given antibiotics, Trait A must provide antibiotic resistance to Antibiotic 1.

**Task Component D*** The list of criteria and constraints:
	+ Collectively define the problem of antibiotic resistance in hospitals and nursing homes.
	+ Addresses a solution(s) such as an object, tool, process, or system that prevents or combats antibiotic resistance in hospitals and nursing homes.
	+ Is based on sound scientific reasoning related to natural selection and the change in trait frequencies in response to the bacteria’s environment.
	+ Addresses long and short term economic considerations, environmental concerns, issues related to resource availability, societal or cultural concerns and impacts, and/or technological requirements related to the problem of antibiotic resistance places that provide care for the sick and elderly.
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