

Sample Free-Response Questions

Directions: Question 1 is a long free-response question that should require about 20 minutes each to answer. Questions 2 through 4 are short free-response questions that should require about 6 minutes each to answer. Read each question carefully and write your response. Answers must be written out. Outline form is not acceptable. It is important that you read each question completely before you begin to write.

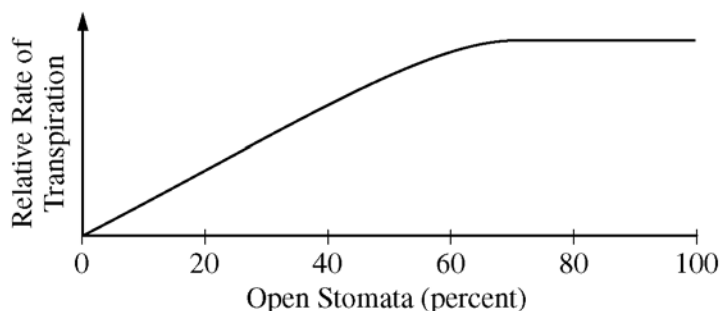
- Plants lose water from their aboveground surfaces in the process of transpiration. Most of this water is lost from stomata, microscopic openings in the leaves. Excess water loss can have a negative effect on the growth, development, and reproduction of a plant. Severe water loss can be fatal. Environmental factors have a major impact on the rate of plant transpiration.

TRANSPIRATION RATE VERSUS TEMPERATURE

Temperature (°C)	20	23	27	28
Transpiration rate (mmol/m ² • sec)	1.5	3	5	4.5

- Using the data above and the axes provided, **draw** a graph showing the effect of temperature change on the rate of transpiration. **Explain** the shape of the curve from 23 degrees to 28 degrees.
- Humidity is an environmental factor that affects transpiration rate. Using the axes provided, **draw** a curve that illustrates what you predict would be the rate of transpiration with increasing humidity and constant temperature. **Justify** the shape of the curve based on your prediction.
- The curve below illustrates the rate of transpiration related to the percent of open stomata on the leaf of a particular plant. **Explain** why the curve levels off with increasing percentage of open stomata per area of the leaf.

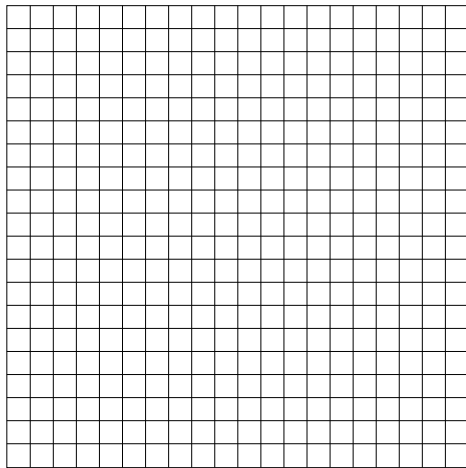
OPEN STOMATA VERSUS RATE OF TRANSPIRATION



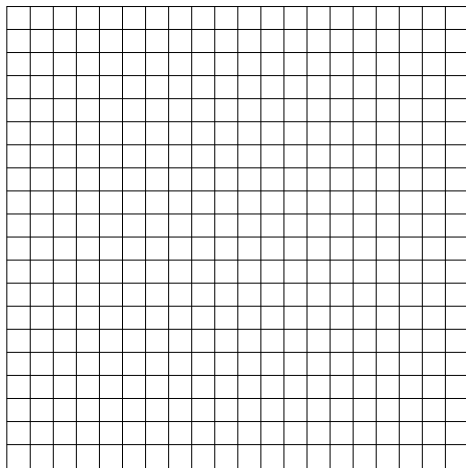
- (d) The data below show the density of stomata on the leaf surfaces of three different species of plants. **Describe** the environments in which each plant most likely evolved. **Justify** your descriptions.

Plant	Stomata Density (# of stomata/mm ²)	
	In Upper Epidermis	In Lower Epidermis
Anacharis	0	0
Water lily	420	0
Black walnut	0	465

Graph for part (a) showing the effect of temperature on the rate of transpiration.



Graph for part (b) showing the predicted effect of humidity on the rate of transpiration.



Essential Knowledge	4.A.6: Interactions among living systems and with their environment result in the movement of matter and energy.
Science Practice	1.4: The student can use representations and models to analyze situations or solve problems qualitatively and quantitatively. 2.2: The student can apply mathematical routines to quantities that describe natural phenomena.
Learning Objective	4.14: The student is able to apply mathematical routines to quantities that describe interactions among living systems and their environment, which result in the movement of matter and energy. 4.15: The student is able to use visual representations to analyze situations or solve problems qualitatively to illustrate how interactions among living systems and with their environment result in the movement of matter and energy.

2. Populations of a plant species have been found growing in the mountains at altitudes above 2,500 meters. Populations of a plant that appears similar, with slight differences, have been found in the same mountains at altitudes below 2,300 meters.
- (a) **Describe** TWO kinds of data that could be collected to provide a direct answer to the question, do the populations growing above 2,500 meters and the populations growing below 2,300 meters represent a single species?
- (b) **Explain** how the data you suggested in part (a) would provide a direct answer to the question.

Essential Knowledge	1.C.2: Speciation may occur when two populations become reproductively isolated from each other.
Science Practice	4.1: The student can justify the selection of the kind of data needed to answer a particular scientific question.
Learning Objective	1.23: The student is able to justify the selection of data that address questions related to reproductive isolation and speciation.

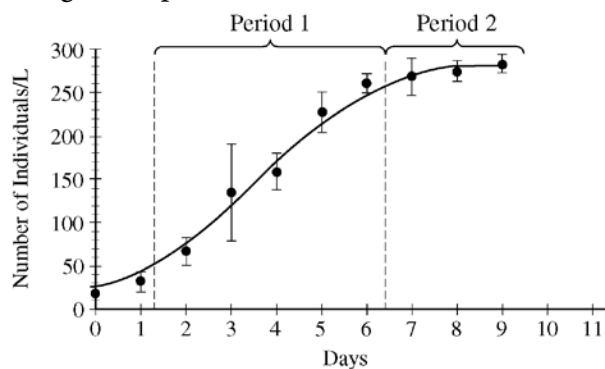
3. Fruit flies (*Drosophila melanogaster*) with a wild-type phenotype have gray bodies and red eyes. Certain mutations can cause changes to these traits. Mutant flies may have a black body and/or cinnabar eyes. To study the genetics of these traits, a researcher crossed a true-breeding wild-type male fly (with gray body and red eyes) with a true-breeding female fly with a black body and cinnabar eyes. All of the F_1 progeny displayed a wild-type phenotype.

Female flies from the F_1 generation were crossed with true-breeding male flies with black bodies and cinnabar eyes. The table on the next page represents the predicted outcome and the data obtained from the cross. **Explain** the difference between the expected data and the actual numbers observed.

F ₂ Generation Phenotypes			
Body Color	Eye Color	Number Predicted	Number Observed
Gray	Red	244	455
Black	Cinnabar	244	432
Gray	Cinnabar	244	42
Black	Red	244	47

Essential Knowledge	3.A.3: The chromosomal basis of inheritance provides an understanding of the pattern of passage (transmission) of genes from parent to offspring.
Science Practice	2.2: The student can apply mathematical routines to quantities that describe natural phenomena.
Learning Objective	3.14: The student is able to apply mathematical routines to determine Mendelian patterns of inheritance provided by data.

4. A population of microscopic eukaryotic organisms growing in a large flask had the growth pattern shown.



In one paragraph, **explain** the biological factors that determine the shape of the growth pattern shown above in both period 1 and period 2.

Essential Knowledge	2.D.1: All biological systems from cells and organisms to populations, communities, and ecosystems are affected by complex biotic and abiotic interactions involving exchange of matter and free energy.
Science Practice	5.1: The student can analyze data to identify patterns or relationships.
Learning Objective	2.24: The student is able to analyze data to identify patterns and relationships between a biotic or abiotic factor and a biological system (cells, organisms, populations, communities, or ecosystems).