LABORATORY REVIEW

Name_____ Period:_____ Date_____

Answer the questions clearly and concisely. It is not necessary to write in complete sentences.

Lab 1 Artificial Selection

The purpose of a particular investigation was to see the effects of varying salt concentrations of nutrient agar and its effect on colony formation. Below are the results:

Trial	No Treatment	1% Salt	3% Salt	5% Salt	7% Salt	9% Salt
1	47	41	25	28	24	5
2	46	42	32	23	21	6
3	34	32	28	21	18	3
4	57	44	24	25	17	2
5	41	39	27	25	21	4
Mean						
Standard Deviation						
SEM						
2 SEM						

-

1. Determine the mean, standard deviation, SEM and 2 SEM for various treatments. On the axis provided, create an appropriately labeled graph to illustrated the means for each group to within 95% confidence (i.e.samplemeans+2SEM). Remember that the number of colonies formed is dependent upon the concentration of salt in the agar. This is numerical data and not categorical data. It is better to make a line graph with this data than a bar graph.

2. Which concentration of NaCl agar had the greatest variation in the number of bacterial colonies formed and why?

_____
_____
_____
_____
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3. Which concentration of NaCl agar had the least amount of variation in the number of bacterial colonies formed and why?

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4. Determine the standard error of the mean (SEM) for all the various concentrations of salt agar.

Record these values and explain what those values are measuring.

_____
_____
_____
_____

5. Determine 2 SEM and record these values. Explain what those values are measuring.

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_____
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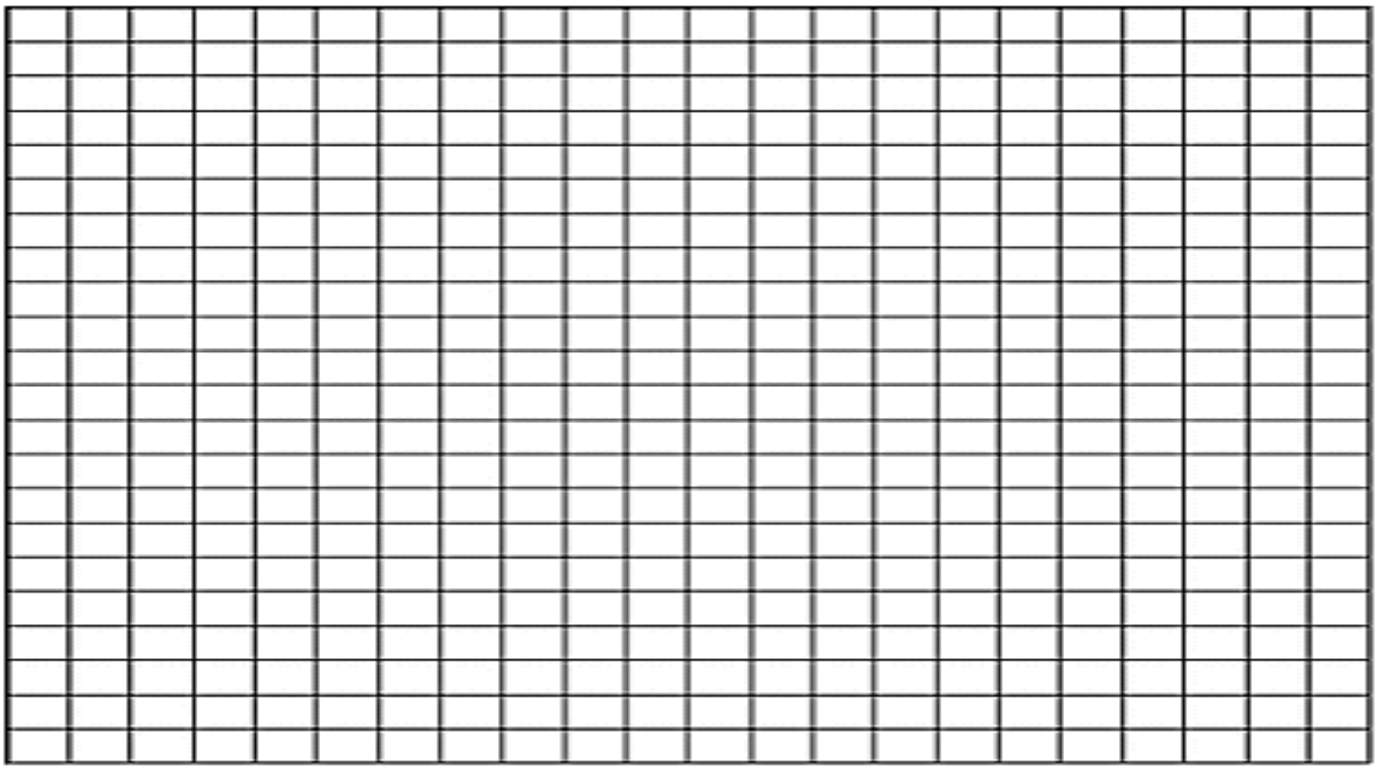
6. Place vertical SEM bars for each concentration of salt agar to represent + 2 SEM. Based on qualitative observation, is there a significant difference in the formation of bacterial colonies for bacteria grown on 0% NaCl agar or that grown on 1% NaCl agar? Justify your answer.



6. Based on qualitative observation, is there a significant difference in the formation of bacterial colonies for bacteria grown on 1% NaCl agar or that grown on 3% NaCl agar? Justify your answer.

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7. If a colony of bacteria selected was selected on the 9% NaCl agar was replated on another plate of agar that also contained 9% NaCl, would you predict that there would be fewer or more colonies on the second plate? Justify your prediction.

_____
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8. Explain how this is an example of artificial selection.

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9. Explain how this may happen as an example of natural selection

_____
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A student was investigating artificial selection of mung beans. Below are photographs of the plant and the mung beans.

The student massed a number of beans and found the following:



Bean Mass from Random Beans	
Trial	Mass in Grams (g)
1	0.052
2	0.053
3	0.063
4	0.048
5	0.076
6	0.08
7	0.074
8	0.064
9	0.092
10	0.075
11	0.08
12	0.093
Mean	
Standard Deviation	
SEM	
2 SEM	

1. Determine the mean for the mung bean seeds mass from the data above and determine the standard deviation for the mass of these seeds.

2. A student was interested in investigating the effect of seed mass on the mass of the progeny seeds. A simple investigation was designed in which the three seeds with the heaviest mass was determined and those seeds were planted The procedure was repeated with the three lightest seeds. Based on the mass of the seeds above, determine which seeds were selected and determine the mean for each group.

	Lightest Mass		Heaviest Mass
1		1	
2		2	
3		3	
Mean			

1. The plants from these seeds were grown under controlled conditions. The seeds from each group was harvested and massed to determine there was a significant difference in their mass. For simplicity only the mass from 15 seeds are shown from each group.

	Mass of Seeds Harvested from P Grown from the Lightest Seeds (		Mass of Seeds Harvested from Plants Grown from the Heaviest Seeds (g)
1	0.059	1	0.091
2	0.065	2	0.078
3	0.071	3	0.083
4	0.081	4	0.084
5	0.051	5	0.072
6	0.068	6	0.072
7	0.078	7	0.068
8	0.054	8	0.097
9	0.071	9	0.074
10	0.063	10	0.075
11	0.055	11	0.092
12	0.066	12	0.084
13	0.075	13	0.077
14	0.069	14	0.065
15	0.067	15	0.084
Mean		Mean	
Standard Deviation		Standard Deviation	
SEM		SEM	
2 SEM		2 SEM	

4. Determine the mean for each group of mung beans. Does it appear that the mean of the two different groups is different from original group? Justify your answer.

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_____
_____
_____
_____
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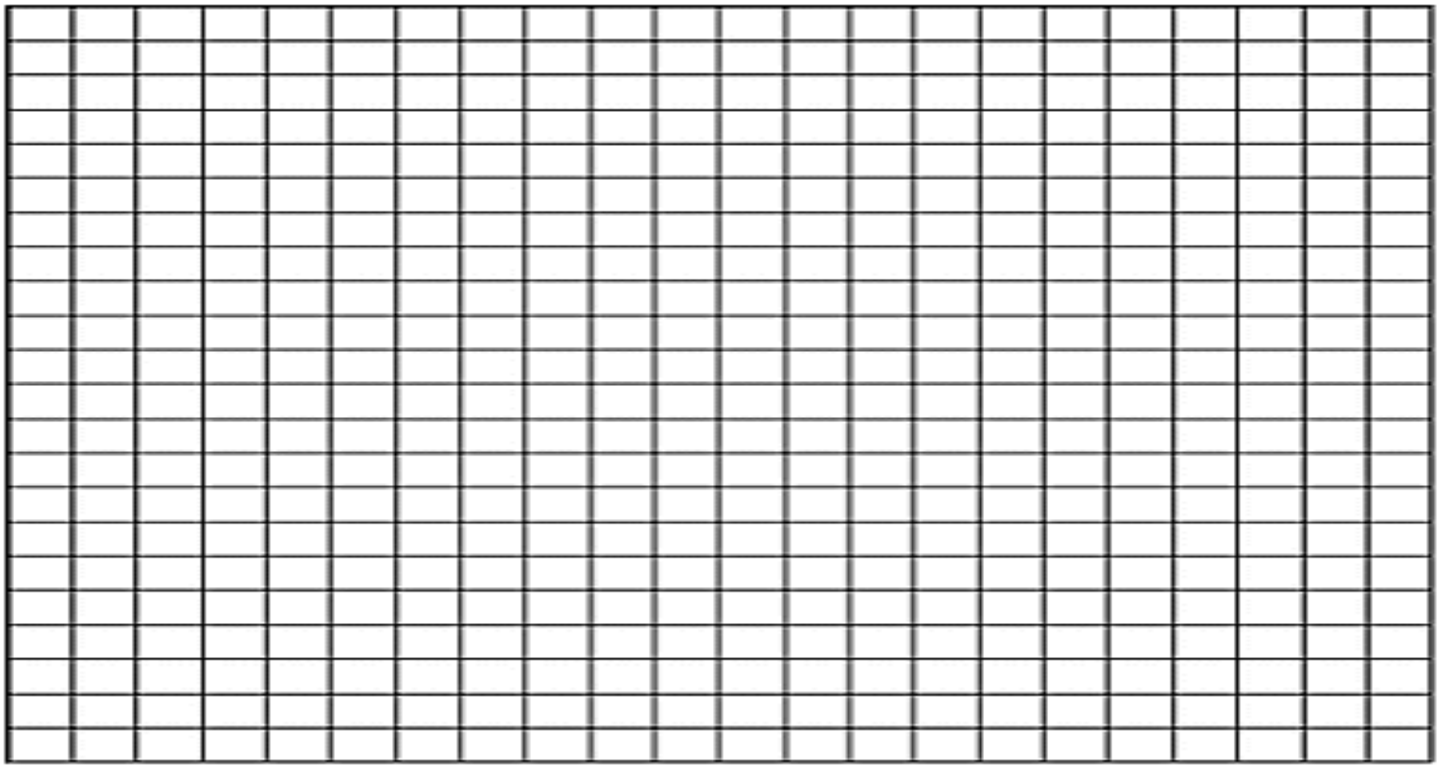
_____

5. Determine the standard deviation, SEM and 2 SEM for each group of seeds. On the axis provided, create an appropriately labeled graph to illustrated the means for each group to within 95% confidence (i.e.samplemeans+2SEM). Remember that the means of this data was derived on whether the seeds were harvested from the plants grown from the lighter seeds or the heavier seeds. This is categorical data and not numerical data. It is better to make a bar graph with this data than a than a line graph. One bar will represent the means of the seeds harvested from plants grown from the lighter seeds and the other bar will represent the means of the seeds harvested from plants grown from the heavier seeds. For a comparison, include a third bar which is the data from the bean mass from random beans.



6. Based on qualitative observation, does it appear there a significant difference in mass of the beans harvested from plants grown from lighter seeds or heavier seeds? Justify your answer.

_____
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7. Shown is a graph illustrating distribution of mung beans with regard to mass. Suppose there is change in the enviroment, and beans with a heavier mass has a slight advantage over those with a lighter mass in being able to survive and reproduce. Predict the change in the distribution of mung beans with regard to mass by drawing a new line on the graph below.

8. Explain how this example of artificial selection support evolution and natural selection.

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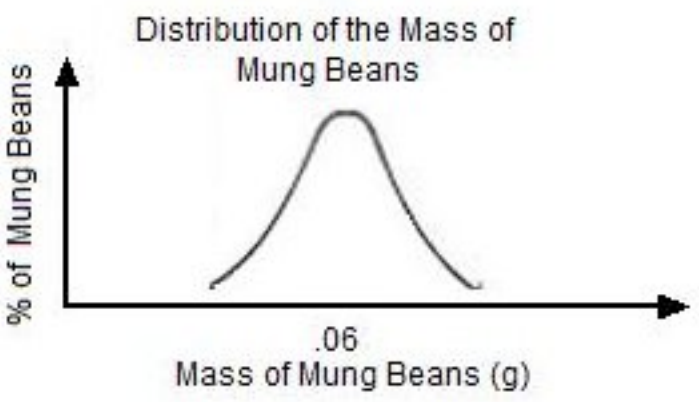


2014 AP® BIOLOGY FREE-RESPONSE QUESTIONS

BIOLOGY
Section II
8 Questions
Planning Time—10 minutes
Writing Time—80 minutes

Directions: Questions 1 and 2 are long free-response questions that require about 22 minutes each to answer and are worth 10 points each. Questions 3–8 are short free-response questions that require about 6 minutes each to answer. Questions 3–5 are worth 4 points each and questions 6–8 are worth 3 points each.

Read each question carefully and completely. Write your response in the space provided for each question. Only material written in the space provided will be scored. Answers must be written out in paragraph form. Outlines, bulleted lists, or diagrams alone are not acceptable.

1. Trichomes are hairlike outgrowths of the epidermis of plants that are thought to provide protection against being eaten by herbivores (herbivory). In a certain plant species, stem trichome density is genetically determined.

   To investigate variation in stem trichome density within the plant species, a student counted the number of trichomes on the stems of six plants in each of three different populations. The student used the data to calculate the mean trichome density (numbers of hairs per square centimeter) for each population. The results are provided in the table below.

   TRICHOME DENSITY IN THREE PLANT POPULATIONS (number of trichomes/cm^2)

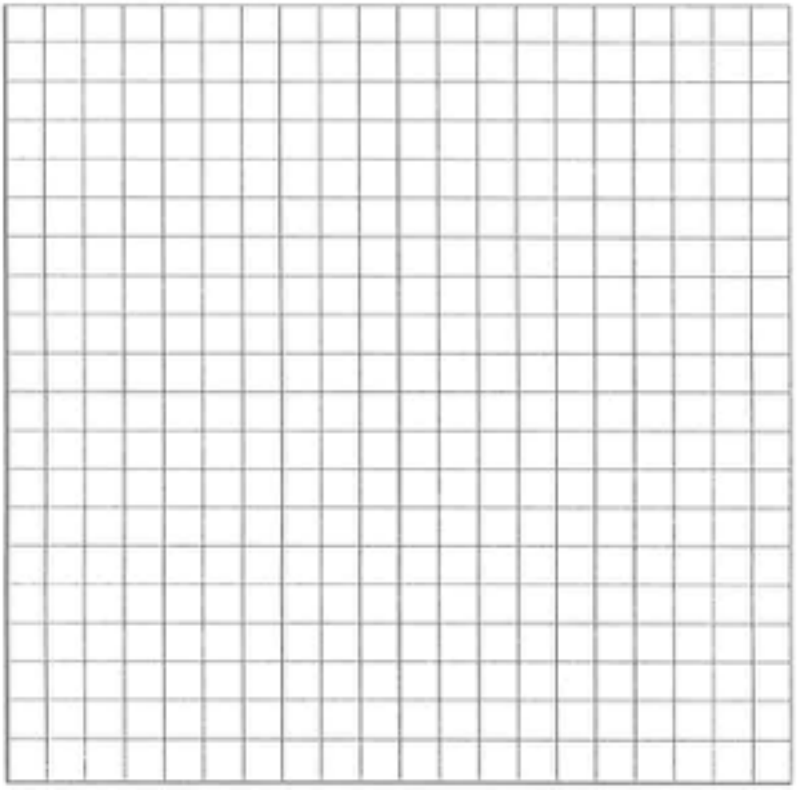
Population	Plant 1	Plant 2	Plant 3	Plant 4	Plant 5	Plant 6	Mean	Standard Error of the Mean (SEM)
I	8	11	9	10	8	6	9	1
II	12	6	15	9	13	8	11	1
III	13	17	9	14	12	16	14	1

   (a) On the axes provided, **create** an appropriately labeled graph to illustrate the sample means of the three populations to within 95% confidence (i.e., sample mean ± 2 SEM).

   (b) Based on the sample means and standard errors of the means, **identify** the two populations that are most likely to have statistically significant differences in the mean stem trichome densities. **Justify** your response.

   (c) **Describe** the independent and dependent variables and a control treatment for an experiment to test the hypothesis that higher trichome density in plants is selected for in the presence of herbivores. **Identify** an appropriate duration of the experiment to ensure that natural selection is measured, and **predict** the experimental results that would support the hypothesis.

2014 AP® BIOLOGY FREE-RESPONSE QUESTIONS



INVESTIGATION 2: MATHEMATICAL MODELING: HARDY-WEINBERG

1. State the Hardy-Weinberg Theorem:

2. What are the 5 assumptions for Hardy-Weinberg equilibrium?

   1)

   2)

   3)

   4)

   5)

3. Define the following:

   A) p^2

   B) q^2

   C) p^2+2pq

   D) p

   E) q

1. Within a population of butterflies, the color brown (B) is dominant over the color white (b). And, 40% of all butterflies are white. Given this simple information, calculate the following:
   (a) The percentage of butterflies in the population that are heterozygous.
   (b) The frequency of homozygous dominant individuals.

2. After the AP exam, you and 19 of your closest friends (lets say 10 males and 10 females) charter a plane to go to Rio to meet the AP Chemistry students. Unfortunately, you all crash land (safely) on a deserted island. No one finds you and you start a new population totally isolated from the rest of the world. Two of your friends carry (i.e. are heterozygous for) the recessive cystic fibrosis allele (c). Assuming that the frequency of this allele does not change as the population grows, what will be the incidence of cystic fibrosis on your island?

3. Sickle-cell anemia is an interesting genetic disease. Normal homozygous individuals (SS) have normal blood cells that are easily infected with the malarial parasite. Thus, many of these individuals become very ill from the parasite and many die. Individuals homozygous for the sickle-cell trait (ss) have red blood cells that readily collapse when deoxygenated. Although malaria cannot grow in these red blood cells, individuals often die because of the genetic defect. However, individuals with the heterozygous condition (Ss) have some sickling of red blood cells, but generally not enough to cause mortality. In addition, malaria cannot survive well within these "partially defective" red blood cells. Thus, heterozygotes tend to survive better than either of the homozygous conditions. If 9% of an African population is born with a severe form of sickle-cell anemia (ss), what percentage of the population will be more resistant to malaria because they are heterozygous (Ss) for the sickle-cell gene?

4. Why is the heterozygous condition for sickle cell favorable against malaria? Explain the molecular origin of the sickle cell mutation.

Lab 3 Comparing DNA sequences

Below are strands of DNA from 4 different species. Based on the DNA sequence, answer the following questions.

I. A C C G G T T A A A C A T T A G G G A C C T T A T G G A A A A C T C A C G A G C C C G G A T T A G G C
II. A C C G G T T T A A C A T T A G G C A C C T T A T G G G A A A C T C A T G A G C C C G G A T T A G G C
III. A C C G G T T G A A C A T T A G G C A C C T T A T G G G A A A C T C A T G A G C C C G G A T T A G G G
IV. A T C G G T C G A A C A T T A G A C C T T A T G G G A A A C T C A T G A G C G C G C A T T A G G G

1. Which two species are most closely related and why?

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_____
_____
_____
_____

2. Which species is more distantly related to the other species and why?

_____
_____
_____
_____
_____

3. What sorts of mutations are found in the DNA of species # 2 when compared to species #3? How will that affect the resulting protein?

_____
_____
_____
_____

4. What sorts of mutation are found in the DNA of species #3 when compared to the species #4? How will that affect the resulting protein?

_____
_____
_____
_____

INVESTIGATION 4: DIFFUSION AND OSMOSIS

1. Using the data below, and assuming an open system, calculate the percent change in mass, graph the data, determine where the percent change in mass crosses the x-axis, determine the solute potential of the potato if room temperature is 24°C and finally determine the water potential of the potato.

$$\% \text{ change in mass} = \frac{\text{final mass} - \text{initial mass}}{\text{initial mass}} \times 100$$

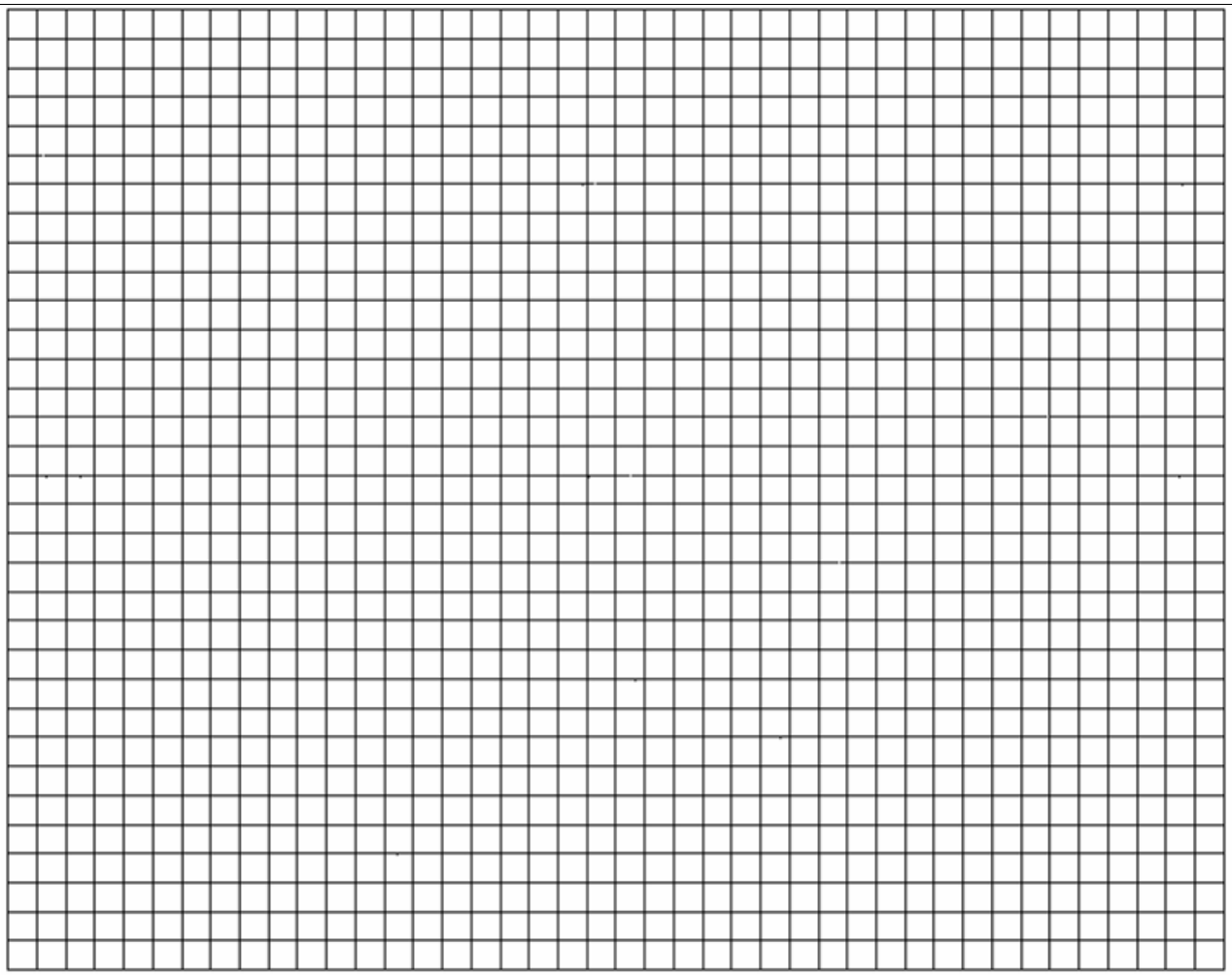
Concentration of Sucrose Solution (M)	Initial Mass of Potato Cores (grams)	Final Mass of Potato Cores (grams)	Percent Change in Mass
0.0	22.0	27.0	
0.2	24.6	26.4	
0.4	23.5	23.2	
0.6	23.7	20.4	
0.8	19.9	15.6	
1.0	21.3	16.2	

Water Potential = $\Psi = \Psi_s + \Psi_p$

$\Psi s = -iCRT$,

Where:

i =	The number of particles the molecule will make in water; for NaCl this would be 2; for sucrose or glucose, this number is 1
C =	Molar concentration (from your experimental data)
R =	Pressure constant = 0.0831 liter bar/mole K
T =	Temperature in degrees Kelvin = 273 + °C of solution



Water Potential = _____

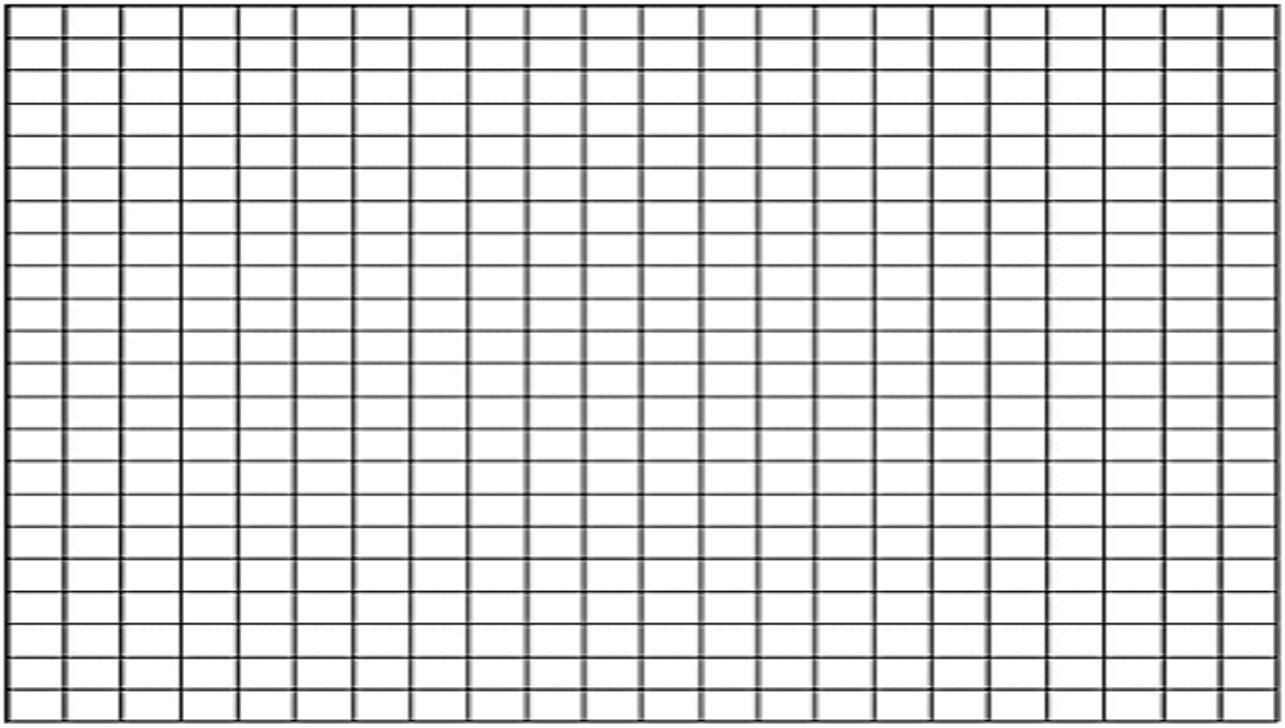
2. If Ψ_s for a sucrose solution in a dialysis bag is -6.25 bars and it is immersed in a cup of sucrose solution having a Ψ_s of -3.25 bars and if Ψ_p inside and outside the bag is zero, will the bag gain or lose mass? Explain your answer.

3. In the winter, grass often dries near roads that have been salted to remove ice. What causes this to happen?

Lab 4 Osmosis

Beaker	Initial Mass	Final Mass	Mass Difference	Percent Change in Mass	Molarity of Solution (M)	Water Potential of Solution
A	8.2	8.8				
B	8.7	8.6				
C	8.8	6.7				
D	7.6	6.6				
E	7.8	9.4				
F	9.1	7				

4. Graph the percent change in mass versus the molarities of the solutions. Determine if this data appears to be linear and if any points should be deleted. Justify the deletion of any points. Once the outliers are deleted, draw a line of best fit and determine the molarity where the potatoes were isotonic.



5. Using the molarity that is isotonic to the potatoes, determine the water potential of the potatoes.

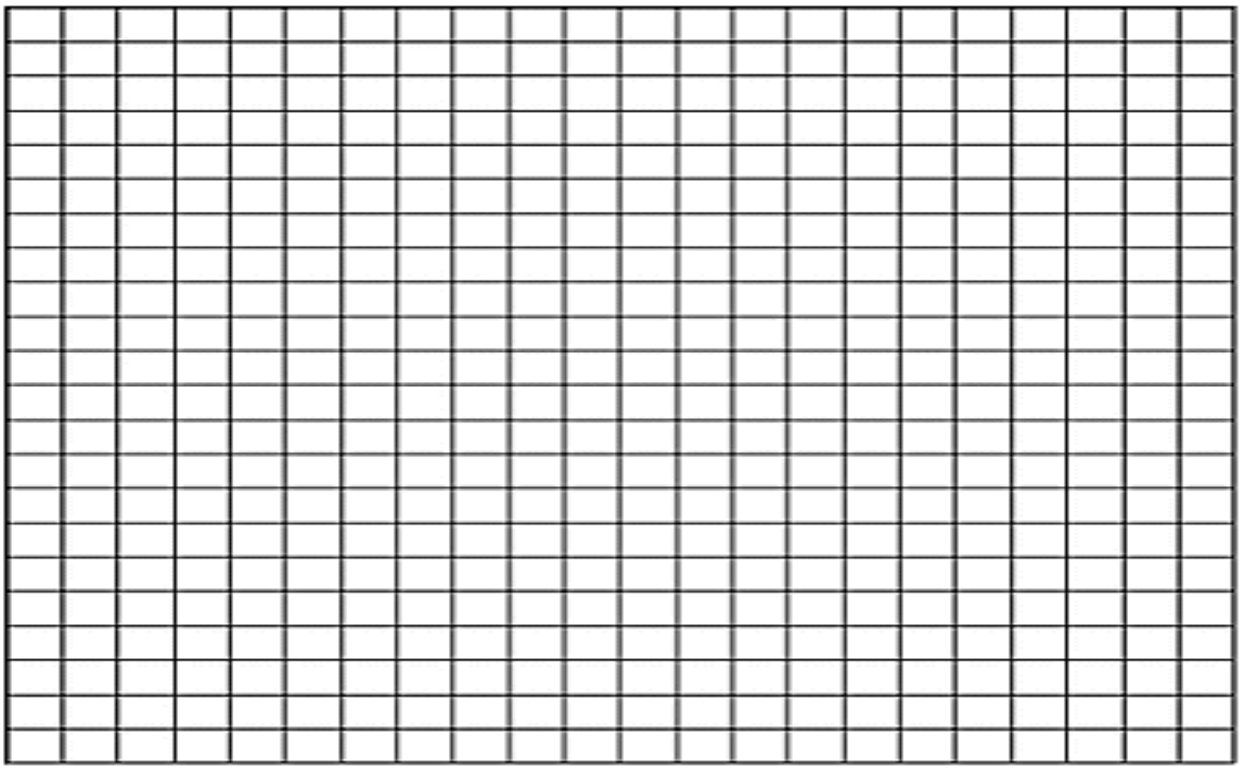
6. A dehydrated, unconscious person is brought into the emergency room. The patient is given an I.V. solution that is 0.9% (0.15 M) saline as it is isotonic to the patient's tissue and will not cause any damage. Determine the water potential of the patient's tissues. Hint- body temperature is 37^{o}C.

7. If the solution contained glucose instead at 0.15 M, would that be isotonic to the patient's tissues? If not, predict what would happen.

Students in a lab group wanted to investigate the effect that the age of the potato had on the water potential of the potato. Students were told that when potatoes came to the store on Wednesday, that the potatoes had been harvested a week earlier. Students designed an investigation that involved potatoes that were one week, three weeks and five weeks old. The students ran 10 trials (similar to one above) on the potatoes to determine their water potential and collected the data shown:

Trial	One Week Old Potatoes Water Potential (Ψ)	Two Week Old Potatoes Water Potential (Ψ)	Three Week Old Potatoes Water Potential (Ψ)
1	-6.5	-8.3	-9.0
2	-6.5	-8.5	-9.2
3	-6.8	-8.0	-8.9
4	-6.3	-8.4	-9.3
5	-6.9	-8.4	-9.0
6	-6.7	-8.3	-8.9
7	-6.6	-7.9	-9.1
8	-6.5	-8.5	-9.1
9	-6.8	-8.0	-9.0
10	-6.6	-8.1	-9.2
Mean			
SD			
1 SEM			
2 SEM			

8. Determine the standard deviation, SEM and 2 SEM for each group of potatoes. On the axis provided, create an appropriately labeled graph to illustrated the means for each group to within 95% confidence (i.e.samplemeans+2SEM). Remember that the means of this data was derived on the age that the potatoes since being harvested. This is continuous data and not categorical or discrete data. It is better to make a line graph with this data than a bar graph.



9. Does the data support that the age of the potato can have an effect on its water potential?

10. What is the null hypothesis for this experiment?

2002 AP® BIOLOGY FREE-RESPONSE QUESTION

The following experiment was designed to test whether different concentration gradients affect the rate of diffusion. In this experiment, four solutions (0% NaCl, 1% NaCl, 5% NaCl , and 10% NaCl) were tested under identical conditions. Fifteen milliliters (mL) of 0% NaCl were put into a bag formed of dialysis tubing that is permeable to Na^+, Cl^-, and water. The same was done for each NaCl solution. Each bag was submerged in a separate beaker containing 300 mL of distilled water. The concentration of NaCl in mg/L in the water outside each bag was measured at 40-second intervals.

The results from the 5% bag are shown in the table below.

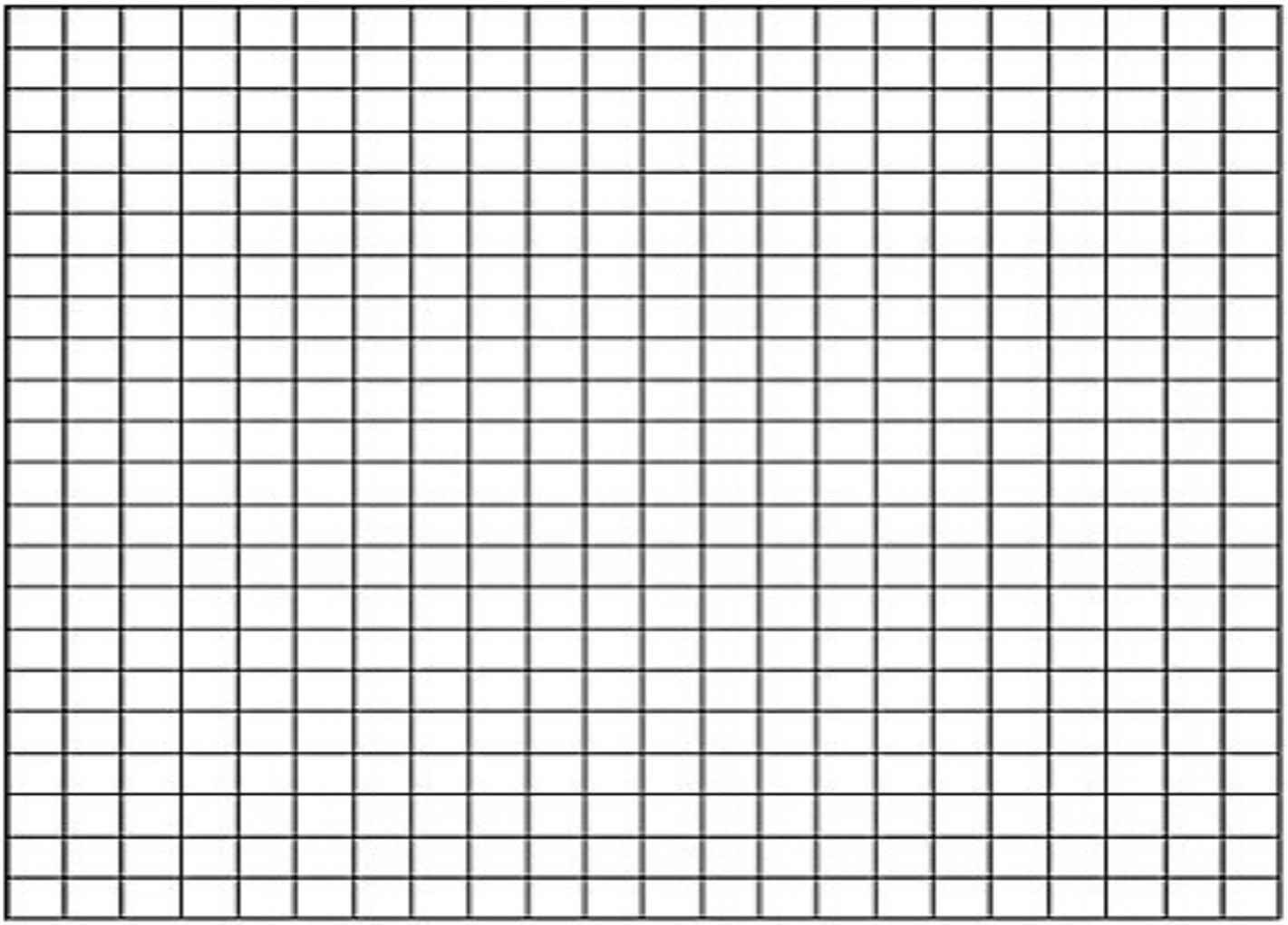
CONCENTRATION IN mg/L OF NaCl OUTSIDE THE 5% NaCl BAG

Time (seconds)	NaCl (mg/L)
0	0
40	130
80	220
120	320
160	400

(a) On the axes provided, graph the data for the 5% NaCl solution.

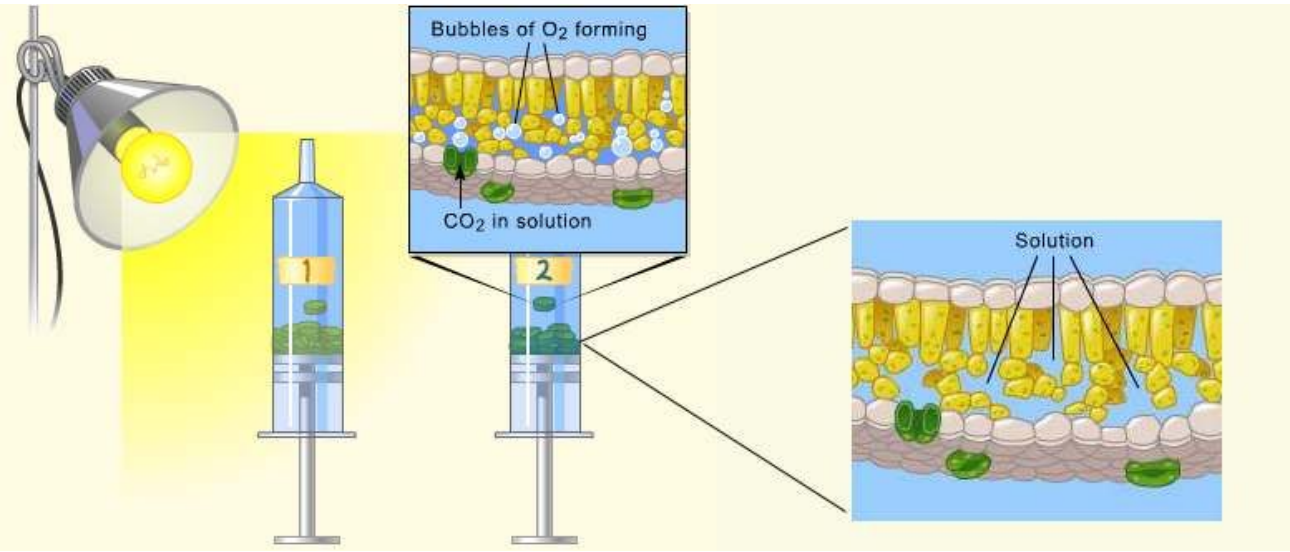
(b) Using the same set of axes, draw and label three additional lines representing the results that you would predict for the 0% NaCl, 1% NaCl, and 10% NaCl solutions. Explain your predictions.

(c) Farmlands located near coastal regions are being threatened by encroaching seawater seeping into the soil. In terms of water movement into or out of plant cells, explain why seawater could decrease crop production. Include a discussion of water potential in your answer.



INVESTIGATION 5: PHOTOSYNTHESIS: FLOATING LEAF DISK ASSAY

In this experiment, we looked at floating leaf disks to measure the rate of photosynthesis. Leaf disks float, normally. When the air spaces are infiltrated with solution the overall density of the leaf disk increases and the disk sinks. The infiltration solution includes a small amount of Sodium bicarbonate. Bicarbonate ion serves as the carbon source for photosynthesis. As photosynthesis proceeds oxygen is released into the interior of the leaf which changes the buoyancy--causing the disks to rise. Since cellular respiration is taking place at the same time, consuming oxygen, the rate that the disks rise is an indirect measurement of the net rate of photosynthesis.

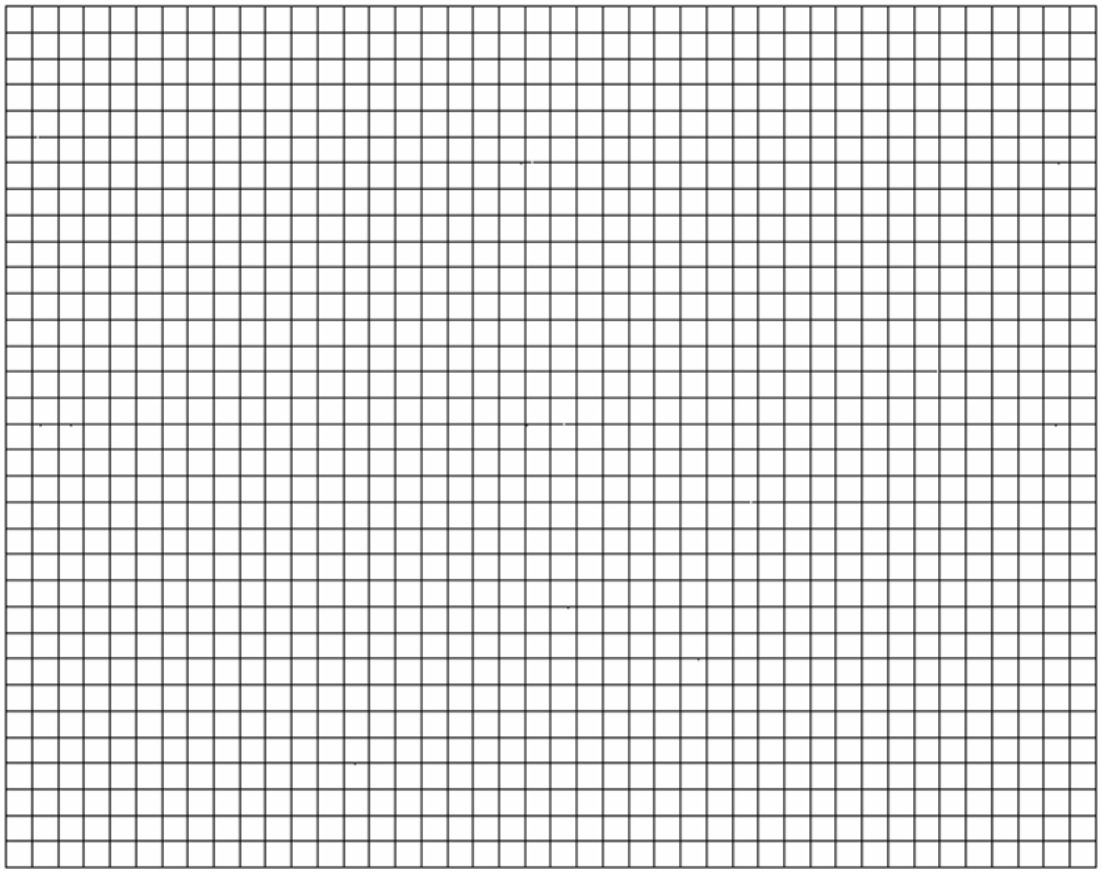


1. Compare (i.e., both similarities and differences) the energy transfers that occur in plant's mitochondria during cellular respiration and in their chloroplasts during photosynthesis.

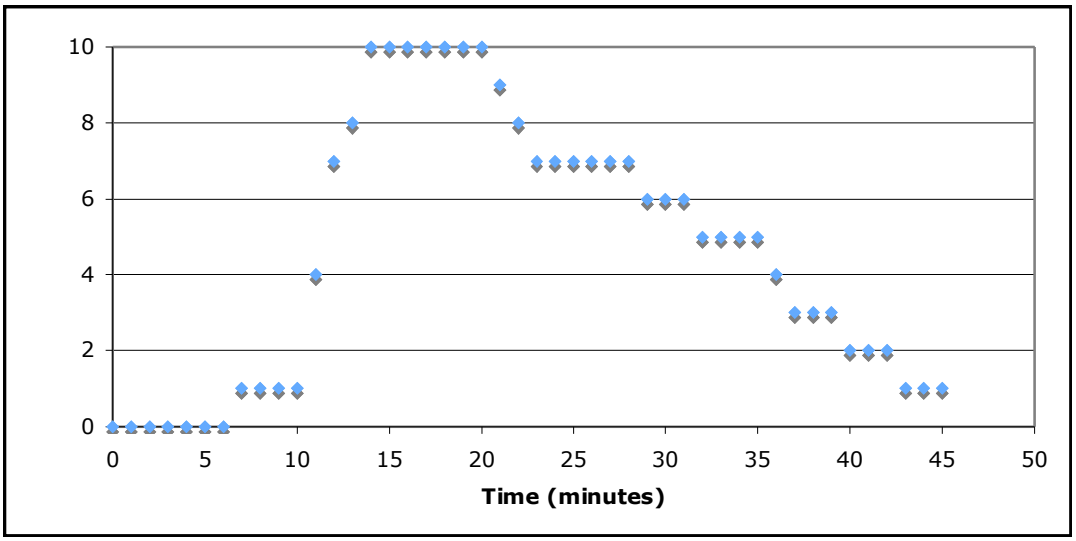
2. An experiment was done in which three (3) groups of ten (10) disks each were put into cups that were put into different intensities of light. The data from the experiment are shown below.

	Light	Ambient Light	Dark
Time (min)	**# of leaf disks floating**	**# of leaf disks floating**	**# of leaf disks floating**
1	0	0	0
5	3	0	0
10	7	0	0
15	10	2	0
20	10	2	0
25	10	3	0
30	10	5	0
35	10	6	0
40	10	7	0
45	10	8	0
50	10	10	0
55	10	10	0
60	10	10	0

Plot these results below. Be sure to provide a key.



3. The same experiment was conducted where 10 leaf disks were placed in a sodium bicarbonate solution and placed in the light. Every minute, the number of floating disks were counted and recorded. After 14 minutes, the leaf disks were moved into the dark and the number of floating disks were recorded every minute. Below is a graphical representation of the data.



   a. Why did the leaf disks begin to sink after being placed in the dark?

   b. What could the rate of leaf disks sinking be correlated to?

   c. What can you deduce about the intensity of light used to obtain the data in the graph?

4. Discuss the electromagnetic spectrum and photosynthesis. How might photosynthesis be different if red cabbage is used in this experiment.

5. List four (4) possible variables that could be tested in a controlled experiment demonstrating photosynthesis via the floating leaf disk assay. Develop a hypothesis for each potential experiment.

Variable	Hypothesis

Variable	Hypothesis

Variable	Hypothesis

Variable	Hypothesis

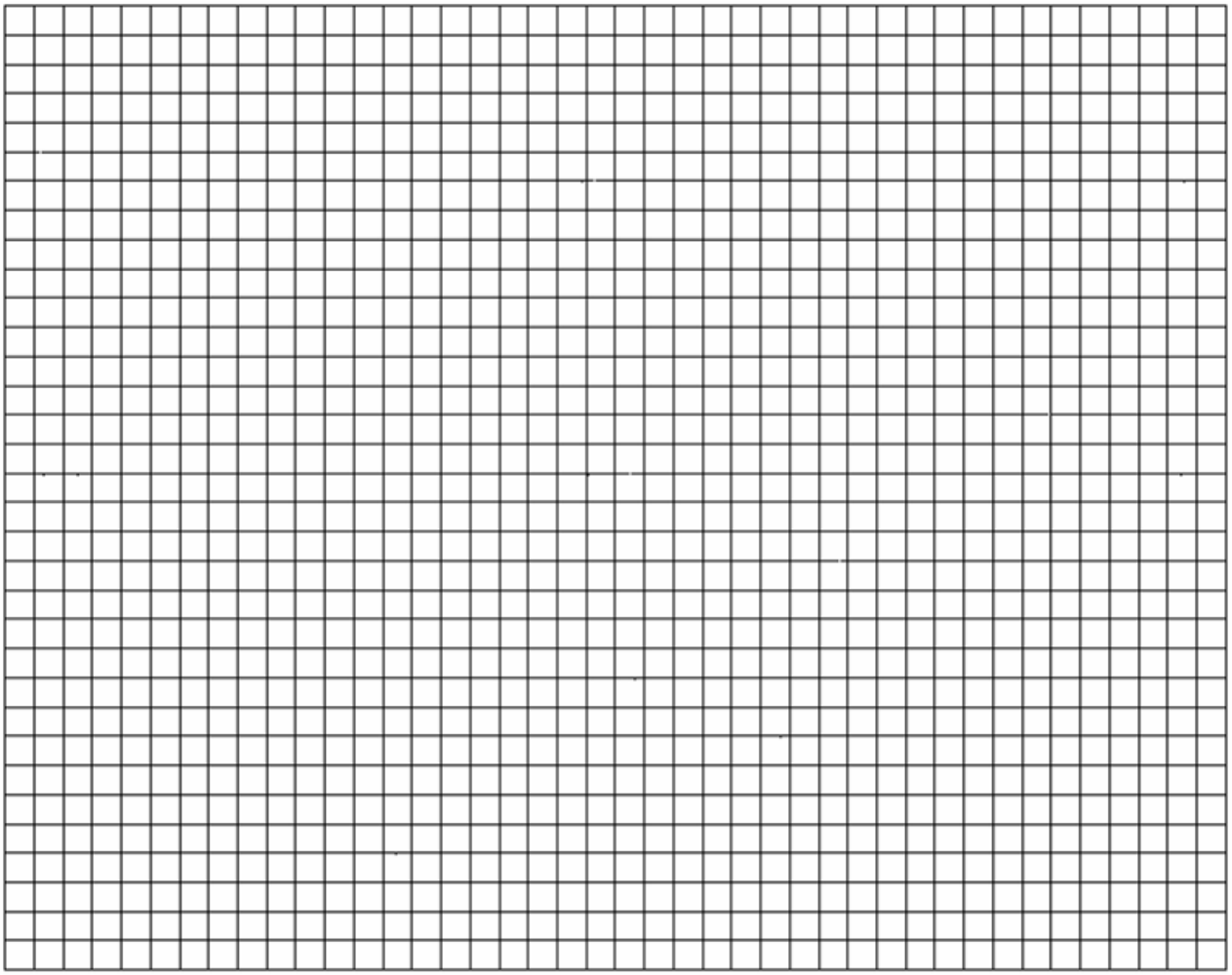
6. Select one hypothesis from your list above. Design an experiment to test your hypothesis.

INVESTIGATION 5: PHOTOSYNTHESIS: DPIP - OPTIONAL

1. Some chloroplasts are collected. Half of them are boiled and the other half are left unboiled. Half of each of these collections are then placed into either dark or lighted situations. They are allowed to incubate and grow, and then they are placed into a spectrophotometer to measure the percent transmittance. Data from the experiment is in the table below

Cuvette	0	5	10	15
unboiled/dark	31.3	32.5	35.5	34.8
unboiled/light	32.7	54.5	63.7	65.1
boiled/light	32.7	32.9	33.1	32.5
no chloroplasts (control)	31.3	31.3	31.3	31.3

2. Plot these results below. Be sure to provide a key.



3. Explain the slope of each line; in other words, why did the chloroplasts respond the way they did in each condition?

4. What was the function of DPIP in the experiment? What molecule did it replace?

5. What is the source of the electrons that will reduce DPIP?

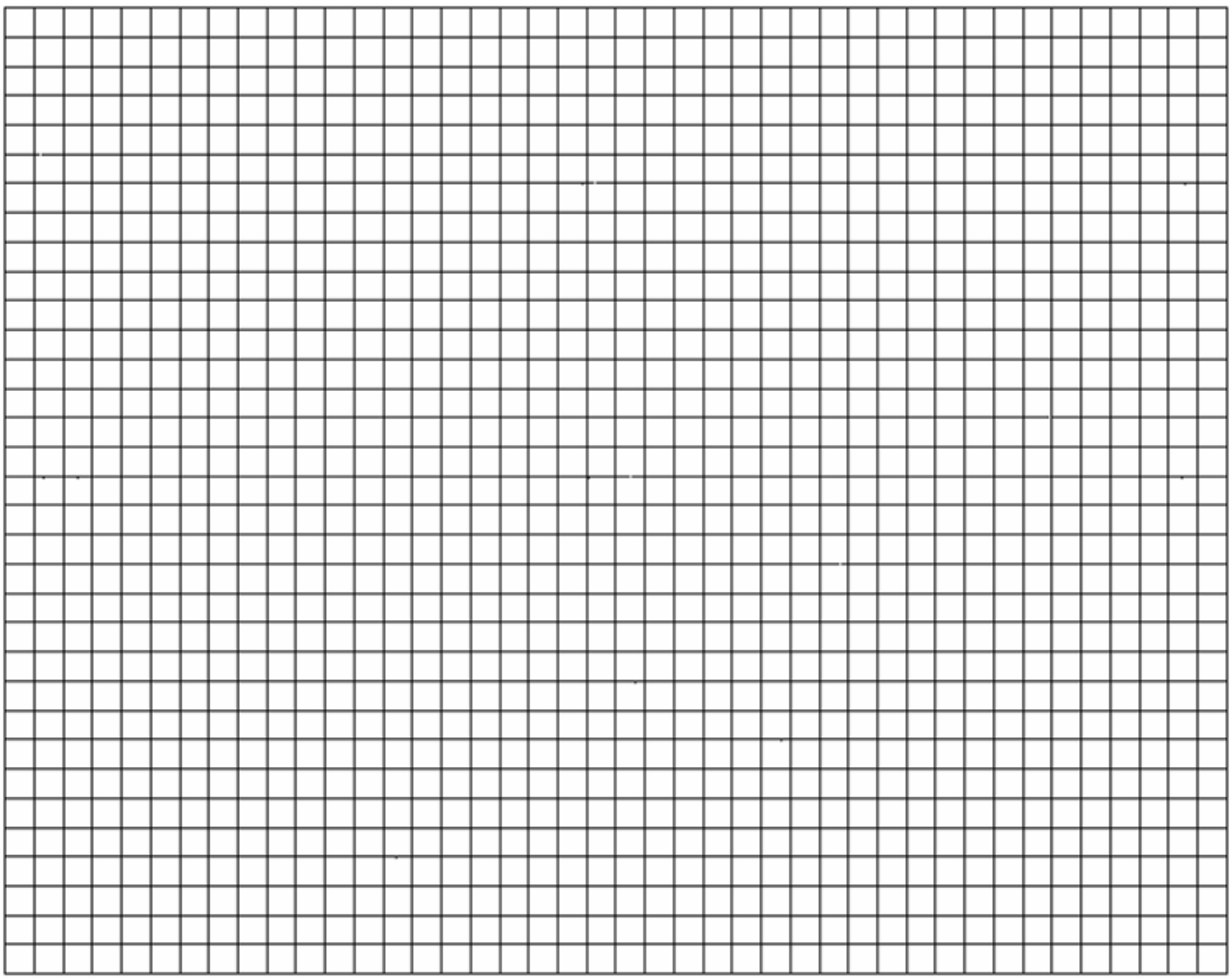
6. Explain the effect of boiling the chloroplasts on the rate of photosynthesis?

INVESTIGATION 6: CELLULAR RESPIRATION

1. An experiment was done in which germinating and non-germinating peas were put into respirometers, at room temperature (~25 °C) and at 5 °C. The data from the experiment are shown below:

	mL O_2 consumed			
Conditions	**0**	**5**	**10**	**15**
Germinating peas @ 5 °C	0.08	0.22	0.27	0.30
Germinating peas @ 22 °C	0.17	0.22	0.42	0.57
Dry peas @ 5 °C	0.01	0.01	0.01	0.01
Dry peas @22 °C	0.01	0.02	0.02	0.02

2. Plot these results below. Be sure to provide a key.



3. Calculate the rate of O_2 consumption for each group.

Conditions	mL oxygen consumed per minute
Germinating peas @ 5 degrees Celsius	
Germinating peas @ room temperature	
Dry peas @ 5 degrees Celsius	
Dry peas @ room temperature	

4. Explain the rate of the peas in each condition.

Conditions	Explanation
Germinating peas @ 5 degrees Celsius	
Germinating peas @ room temperature	
Dry peas @ 5 degrees Celsius	
Dry peas @ room temperature	

5. In this experiment both the effects of germination vs. non-germination, and warm temperature vs. cold temperature on respiration rate were investigated. Identify two hypotheses being tested in this experiment.

6. What conditions in this experiment must remain constant? Why?

7. If you used the same experimental design to compare the rates of respiration of an earthworm or a cricket, what results would you expect? Justify your answer.

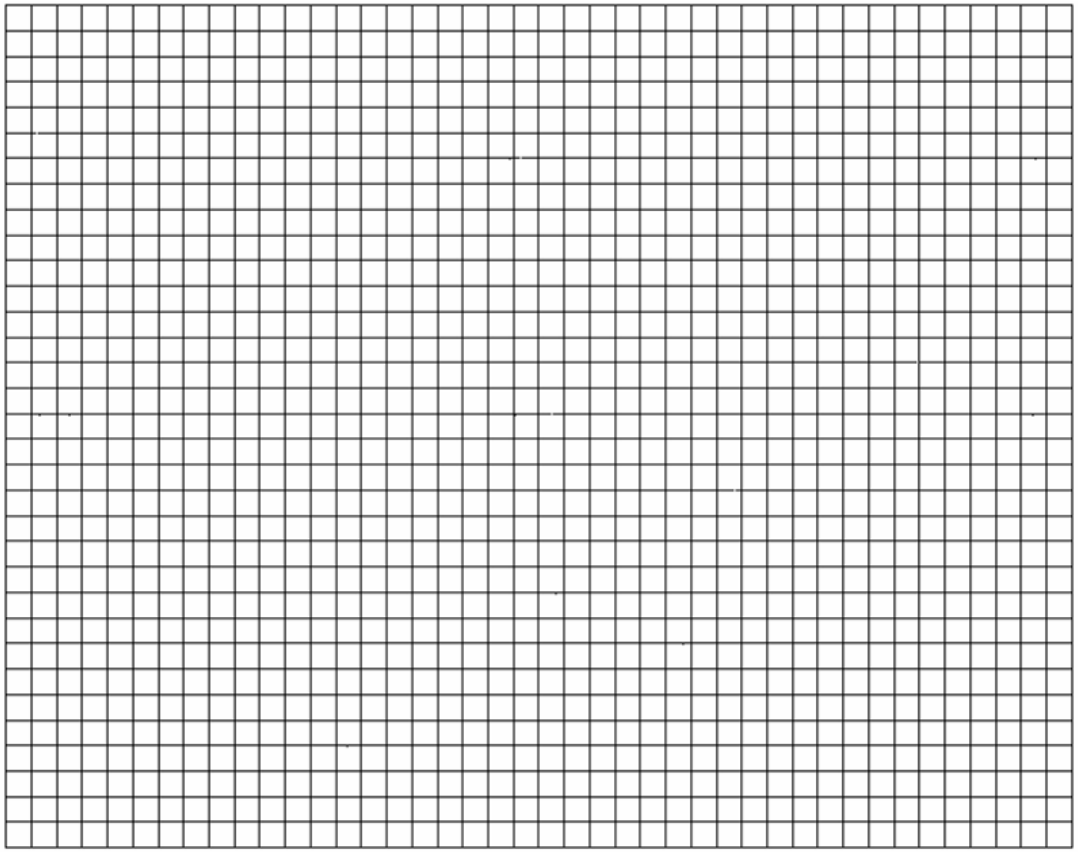
8. What if you used this same experimental design to test a 25 g reptile and a 25 g mammal at 10 ^{o}C? What results would you expect? Justify your answer.

Answer the following <u>LONG</u> FRQ:

Yeast cells are placed in an apparatus with a solution of sugar (a major nutrient for yeast metabolism). The apparatus detects bubbles of gas released by the yeast cells. The rate of respiration varies with the surrounding temperatures as indicated by the data below.

Temperature (^{o}C)	0	10	20	30	40	50	60	70
Number of bubbles of gas produced per minute	0	3	7	12	7	4	1	0

1. Graph the results on the axes provided. Determine the optimum temperature for respiration in the yeast.



2. Respiration is a series of enzyme-catalyzed reactions. Using your knowledge of enzymes and the data above, analyze and explain the results of this experiment.

3. Design an experiment to test the effect of varying the pH of the sugar solution on the rate of respiration. Include a prediction of the expected results.

INVESTIGATION 7: MITOSIS AND MEIOSIS

1. List the stages of mitosis and describe what happens to the chromosomal material in each step.

Stage	Events

2. Complete the table below:

Phase of Cell Cycle	# of cells in field 1	# of cells in field 2	# of cells in field 3	Total # of cells	% of total cells counted
Interphase	100	120	96		
Prophase	10	11	22		
Metaphase	4	6	7		
Anaphase	2	4	8		
Telophase	1	2	4		
			Total		

In a 24-hour period, how long does each stage last?

Interphase	Prophase	Metaphase	Anaphase	Telophase

2. Do caffeine and lectin have an effect on mitosis in onion root tips? Formulate a hypothesis below:

3. Scallions were treated, fixed and slides prepared as described in *AP Biology Investigative Labs* on page S87-S88. The treatment groups were as follows:

- control (water)
- lectin (5 mg/100 ml)
- 1, 5, 10, 100 mM caffeine (in water)

The slides were observed under a microscope at 400 x magnification and the results obtained are below:

In the control roots (water), 79% of cells were in interphase; 21% in mitosis.

Tip Treatment	Number of Cells				
	Interphase	Prophase	Metaphase	Anaphase/Telophase	Total
Control	423	65	11	36	535
Lectin	417	117	51	41	626
1 mM caffeine	549	18	3	5	575
5 mM caffeine	449	11	2	7	469
10 mM caffeine	330	9	3	0	342
100 mM caffeine	Cytotoxic				

Use Chi-Square analysis to support or reject your hypothesis.

Lectin treatment

	o	e	(o-e)	$(o-e)^2$	$\frac{(o-e)^2}{e}$
interphase					
mitosis					

χ^2 =

Caffeine, 1 mM

	o	e	(o-e)	$(o-e)^2$	$\frac{(o-e)^2}{e}$
interphase					
mitosis					

χ^2 =

Caffeine, 5 mM

	o	e	(o-e)	$(o-e)^2$	$\frac{(o-e)^2}{e}$
interphase					
mitosis					

χ^2 =

Caffeine, 10 mM

	o	e	(o-e)	$(o-e)^2$	$\frac{(o-e)^2}{e}$
interphase					
mitosis					

χ^2 =

Conclusion:

Degrees of Freedom	Probability of a larger value of x^2								
	0.99	0.95	0.90	0.75	0.50	0.25	0.10	0.05	0.01
1	0.000	0.004	0.016	0.102	0.455	1.32	2.71	3.84	6.63
2	0.020	0.103	0.211	0.575	1.386	2.77	4.61	5.99	9.21
3	0.115	0.352	0.584	1.212	2.366	4.11	6.25	7.81	11.34
4	0.297	0.711	1.064	1.923	3.357	5.39	7.78	9.49	13.28
5	0.554	1.145	1.610	2.675	4.351	6.63	9.24	11.07	15.09
6	0.872	1.635	2.204	3.455	5.348	7.84	10.64	12.59	16.81
7	1.239	2.167	2.833	4.255	6.346	9.04	12.02	14.07	18.48
8	1.647	2.733	3.490	5.071	7.344	10.22	13.36	15.51	20.09
9	2.088	3.325	4.168	5.899	8.343	11.39	14.68	16.92	21.67
10	2.558	3.940	4.865	6.737	9.342	12.55	15.99	18.31	23.21
11	3.053	4.575	5.578	7.584	10.341	13.70	17.28	19.68	24.72
12	3.571	5.226	6.304	8.438	11.340	14.85	18.55	21.03	26.22
13	4.107	5.892	7.042	9.299	12.340	15.98	19.81	22.36	27.69
14	4.660	6.571	7.790	10.165	13.339	17.12	21.06	23.68	29.14
15	5.229	7.261	8.547	11.037	14.339	18.25	22.31	25.00	30.58
16	5.812	7.962	9.312	11.912	15.338	19.37	23.54	26.30	32.00
17	6.408	8.672	10.085	12.792	16.338	20.49	24.77	27.59	33.41
18	7.015	9.390	10.865	13.675	17.338	21.60	25.99	28.87	34.80
19	7.633	10.117	11.651	14.562	18.338	22.72	27.20	30.14	36.19
20	8.260	10.851	12.443	15.452	19.337	23.83	28.41	31.41	37.57
22	9.542	12.338	14.041	17.240	21.337	26.04	30.81	33.92	40.29
24	10.856	13.848	15.659	19.037	23.337	28.24	33.20	36.42	42.98
26	12.198	15.379	17.292	20.843	25.336	30.43	35.56	38.89	45.64
28	13.565	16.928	18.939	22.657	27.336	32.62	37.92	41.34	48.28
30	14.953	18.493	20.599	24.478	29.336	34.80	40.26	43.77	50.89
40	22.164	26.509	29.051	33.660	39.335	45.62	51.80	55.76	63.69
50	27.707	34.764	37.689	42.942	49.335	56.33	63.17	67.50	76.15
60	37.485	43.188	46.459	52.294	59.335	66.98	74.40	79.08	88.38

http://passel.unl.edu/Image/Namuth-CovertDeana956176274/chi-sqaure%20distribution%20table.PNG

4. What is crossing over?

5. Under a microscope you notice that about 33% of the asci show crossover. Calculate the number of map units. Show your work.

6. Draw a pair of chromosomes in MI and MII, and show how you would get a 2:2:2:2 arrangement of ascospores by crossing over.

GENETICS PROBLEMS & CHI-SQUARE

1. What are the chances of getting an offspring of genotype of *AaBBCC* from a cross of *AaBbCC x AaBBCc*?

2. After graduating from college, you decide to put your biology skills to work at a local company that does genetic counseling. Your first case is working with a couple that is trying to decide if it would be wise to conceive a child given the family's genetic history with Huntington's disease. This is a very damaging neurological disorder that usually strikes individuals later in life. Huntington's disease allele is a dominant allele (represented as "H"). Individuals who will not develop Huntington's disease carry two copies of the recessive allele (represented as "h"). After testing both the wife and the husband, you determine that the wife's genotype is hh and the husband's genotype is Hh.

    a. Which of them will eventually develop Huntington's disease? Explain.

    b. What are the possible genotypes for their children? What is the chance that their child will inherit Huntington's disease?

3. Your second case at your new job is to counsel another couple who have a son with cystic fibrosis. Cystic fibrosis is a recessive disease that affects has a high incidence in the Caucasian population (1 in every 2500 births). Individuals with cystic fibrosis produce a thick mucus in the lungs and pancreas that can severely compromise breathing. The couple is unaffected (neither of them have cystic fibrosis themselves). "C" is used to represent the normal allele and "c" is used to represent the cystic fibrosis allele. (adapted from Genetics by P. Hedrick & R. Weaver)

    a. What must be the genotype of the couple's affected son?

    b. What are the genotypes for the couple?

    c. What are the chances that the couple's second child would also have cystic fibrosis?

d. Treatments for cystic fibrosis are now available. Many individuals are able to survive to adulthood and have children of their own. If the couple's son eventually marries a woman who does not have cystic fibrosis allele, what are the chances that their children will have cystic fibrosis?

4. Feeling the need for a change, you move to the company's paternity testing department. In your first case, Mr. Chan's former girlfriend claims that he is the father of her child. The child has O type blood. The child's mother has B type blood. After testing a sample of Mr. Chan's blood, you find that he has AB type blood.

   a. What must the genotype of the child's mother be?

   b. Could Mr. Chan possibly be the father of the child? Explain your answer using genetics and Punnet squares.

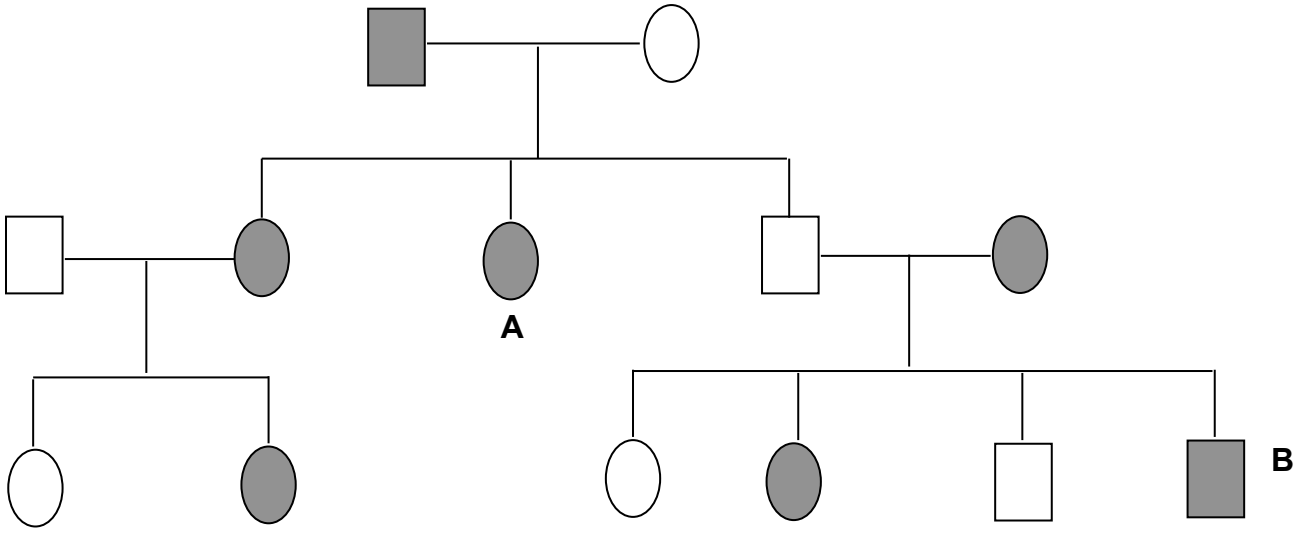
5. A couple has two children. The father has A type blood. The mother has B type blood. The older daughter has AB type blood. The younger brother has never been bloodtyped. What are all of the possible blood types for the younger brother? Explain each of your answers.

6. The allele for color-blindness is carried on the X chromosome, making color blindness(a recessive trait)an X-linked trait. A normal male and a female who is a carrier for color blindness (but is not colorblind herself) have a child.

   a. What is the chance that their son will be color blind?

   b. What is the chance that their daughter will be color blind?

7. Look at the following pedigree for a sex-linked trait to answer the questions below.



   a. Is the allele for this trait found on the X or the Y chromosome?

   b. Is this a dominant or a recessive trait?

   c. If individual A has children with an unaffected male, what are the chances that her children will have the trait?

   d. Individual B marries an unaffected woman. What are the chances that they will have affected children?

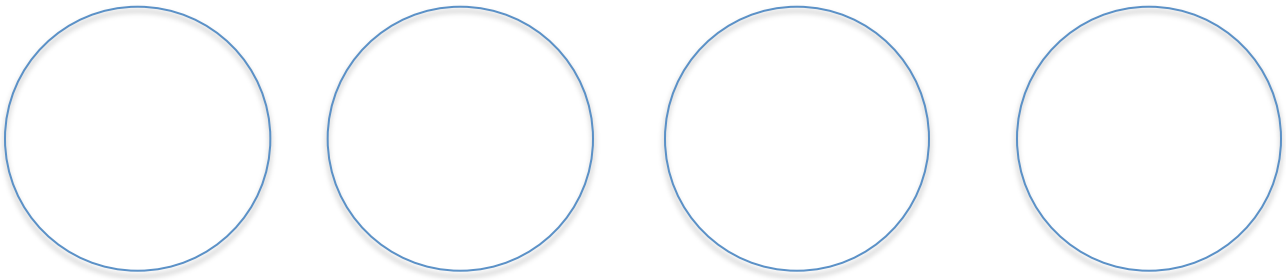
8. In the garden pea, yellow cotyledon color is dominant to green, and inflated pod shape is dominant to the constricted form. Considering both of these traits jointly in self-fertilized dihybrids, the progeny appeared in the following numbers:

   193 green, inflated
   184 yellow constricted
   556 yellow, inflated
   61 green, constricted

   Do these genes assort independently? Support your answer using Chi-square analysis.

Lab 8 – Bacterial Transformation

Begin by drawing the expected results of the experiment.



1. Calculate the transformation efficiency of the following experiment using the information and the results listed below:

1. DNA plasmid concentration: 0.08 µg/µl
2. 250 µl CaCl2 transformation solution
3. 10 µl pGLO plasmid solution
4. 250 µl LB broth
5. 100 µl cells spread on agar
6. 227 colonies of transformants

2. If a particular experiment were known to have a transformation efficiency of 5×10^2 bacteria/µg of DNA, how many transformant colonies would be expected to grow on the LB/amp/ara plate?

You can assume that the concentration of DNA and fraction of cells spread on the LB agar are the same as that of the pGLO laboratory.

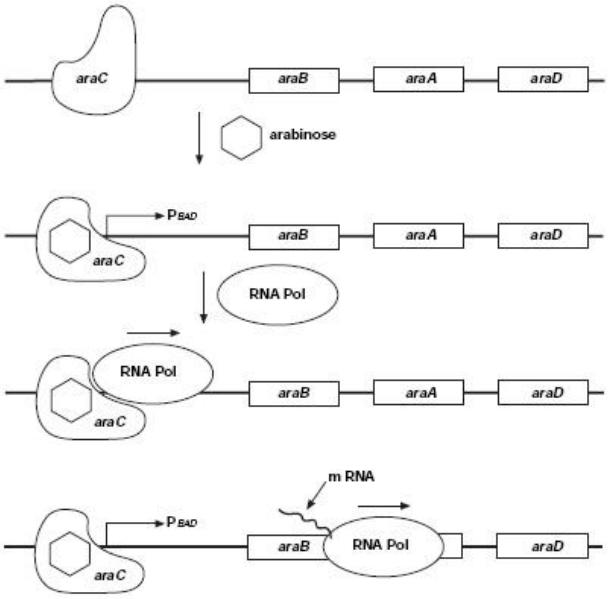
Number of colonies on LB/amp/ara plate =

Micrograms of DNA spread on the plates =

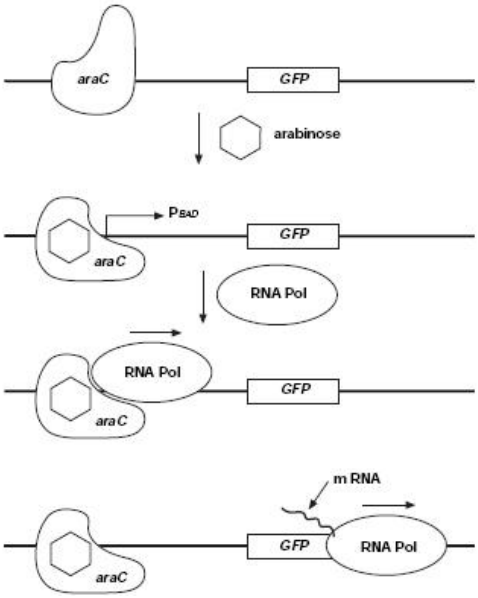
Transformation efficiency =

3. The following diagram shows the ara operon. **Explain the regulation of the expression of the pGLO genes that was seen in the pGLO Transformation experiment.**

The Arabinose Operon

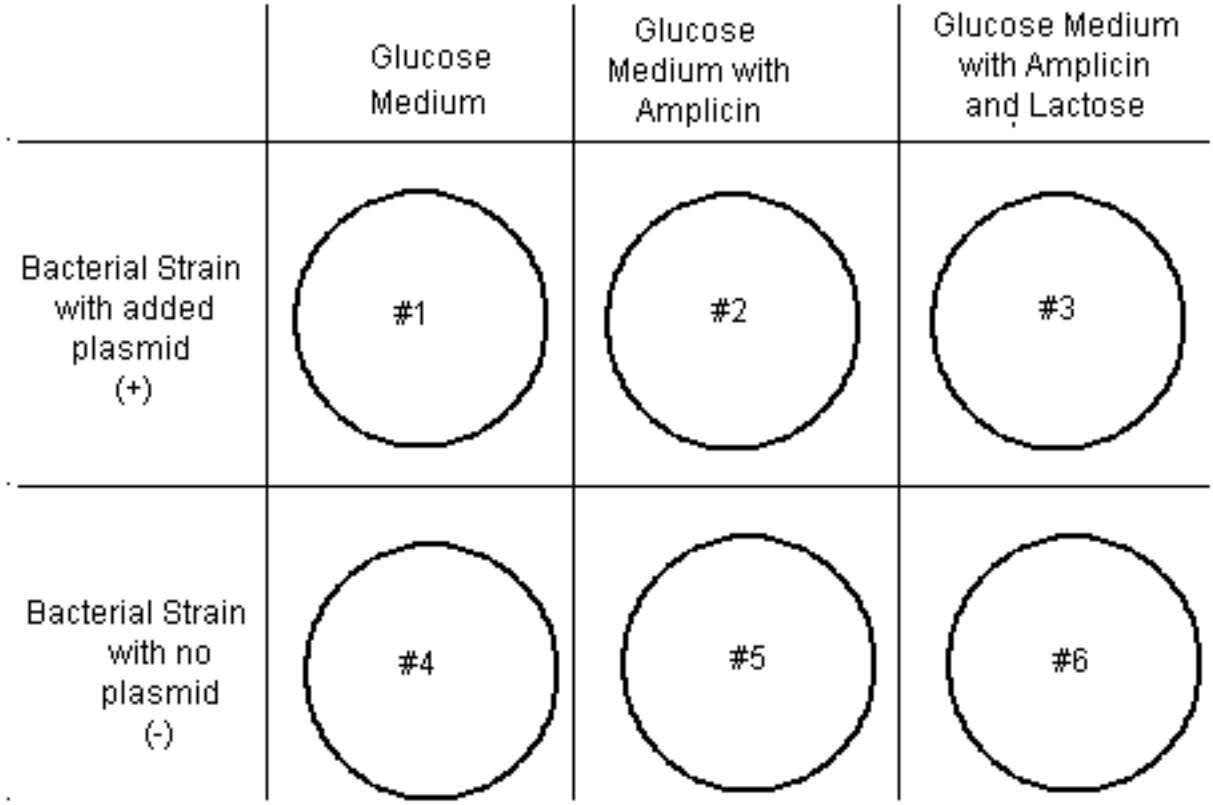


Expression of Green Fluorescent Protein



Lab 8

A scientist is using an amplicillin-sensitive strain of bacteria that cannot use lactose because it has a nonfunctional gene in the lac operation. She has two plasmids. One contains a functional copy of the affected gene of the lac operon, and the other contains the gene for amplicillin resistance. Using restriction enzymes and DNA ligase, she forms a recombinant plasmid containing both genes. She then adds a high concentration of the plasmid to a tube of the bacteria in a medium for bacterial growth that contains glucose as the only energy source. This tube (+) and a control tube (-) with similar bacteria but no plasmid are both incubated under the appropriate conditions for growth and plasmid uptake. The scientist then spreads a sample of each bacterial culture (+ and -) on each of the three types of plates indicated below.



1. If no new mutations occur, it would be most reasonable to expect bacterial growth on which of the following plates and be sure to justify your answer

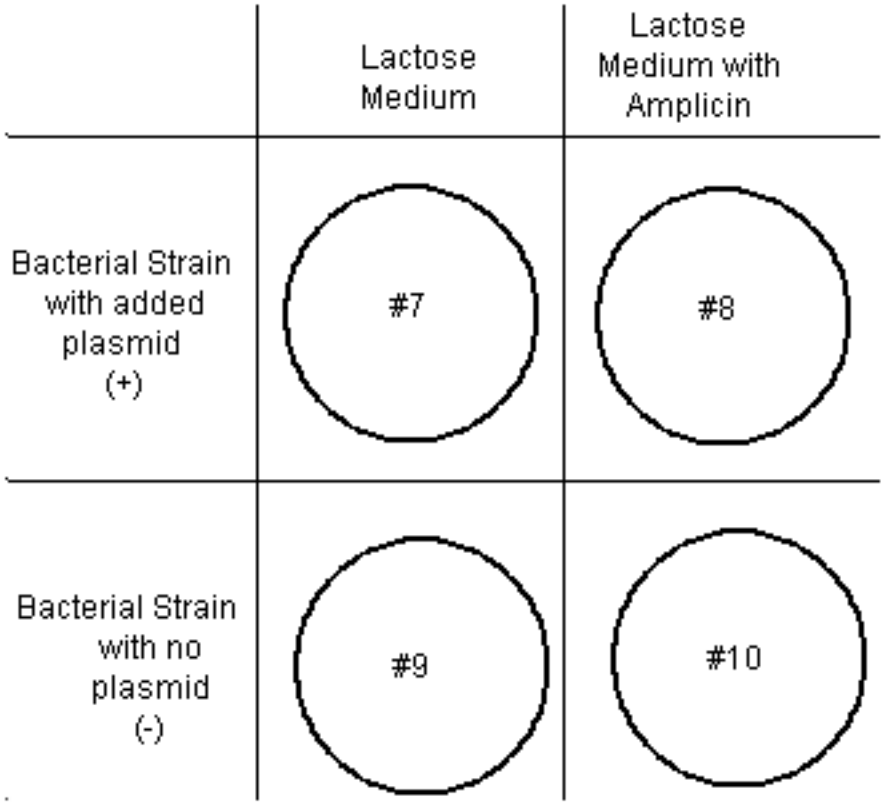
_____
_____
_____

2. Why were restriction enzymes used in this experiment?

_____
_____
_____

3. If DNA ligase was not used during the preparation of the recombinant plasmid, bacterial growth would most likely have occurred on which plates and justify your answer.

_____
_____



4. If another experiment was done with the cultures as shown above, using medium that contained lactose as the only energy source, growth would most likely occur on which of the following plates?

INVESTIGATION 9: BIOTECHNOLOGY: RESTRICTION ENZYME ANALYSIS OF DNA

1. Follow the directions:
   (a) For the gel below, measure the distance (in mm) of each HindIII fragment that migrated from the well. Measure from the Bottom of the well to the Bottom of each band and record the data in Table 1.
   (b) Set up the semi-log graph paper with the distance migrated on the x-axis. Plot the distance migrated vs. the bp length for each HindIII fragement.
   (c) Draw a best-fit line.
   (d) Measure the EcoRI fragments the same way and record the data in Table 2.
   (e) Interpolate the bp length of the EcoRI fragements using the graph you generated for the Hind III fragments.

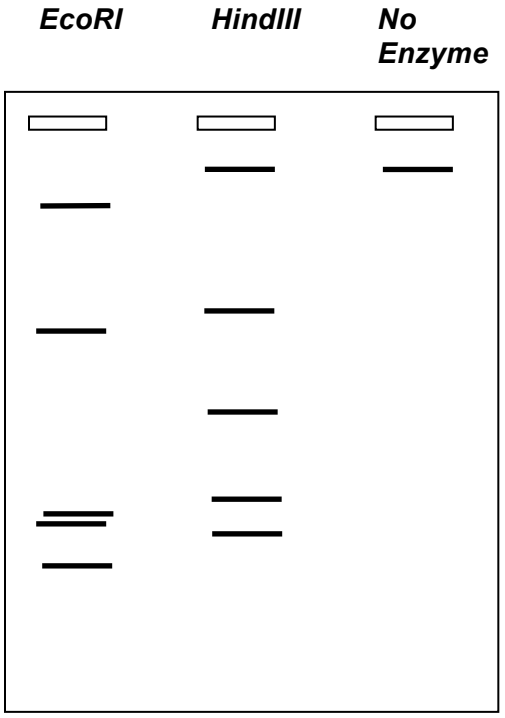


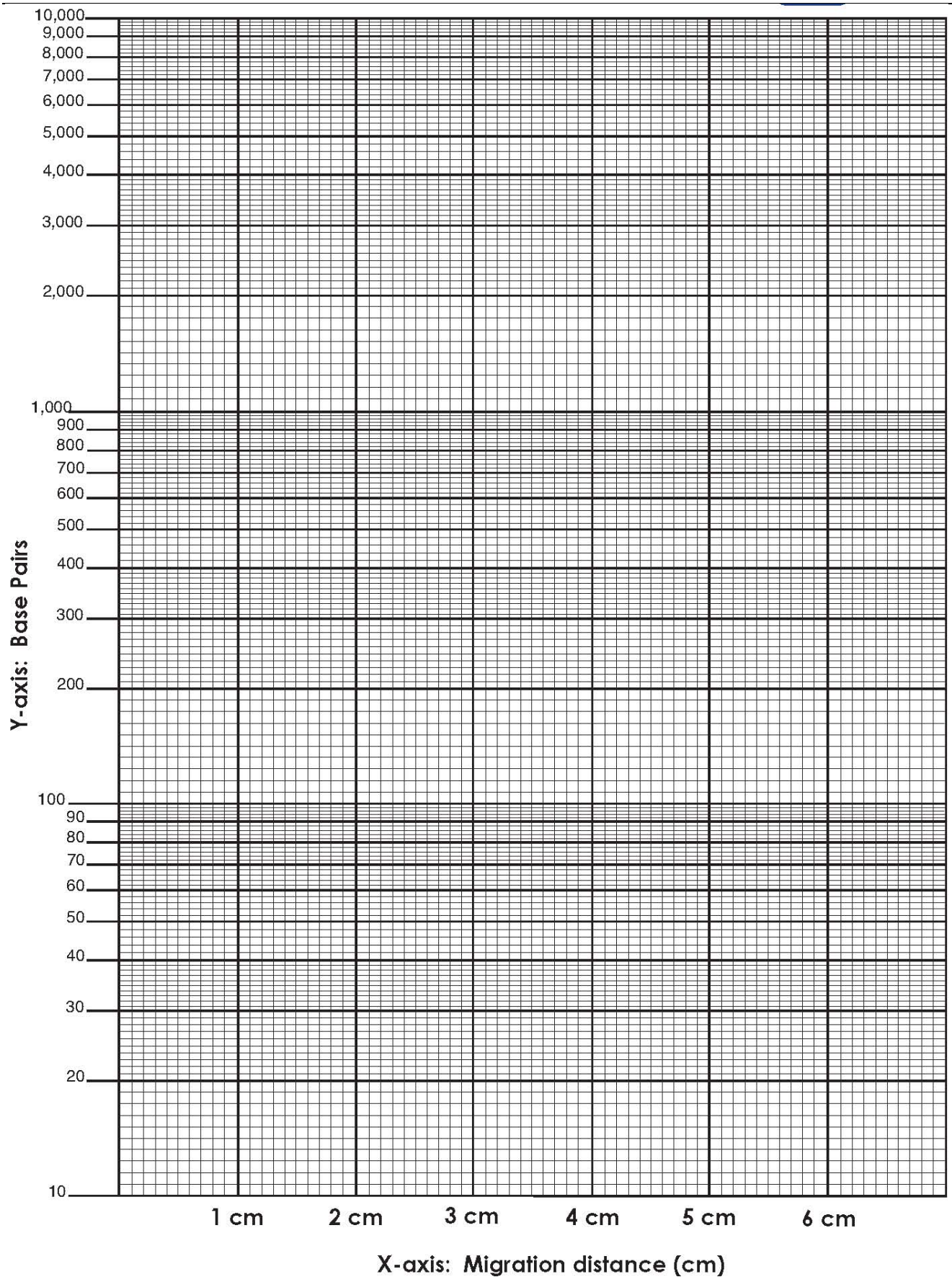
Table 1: HindIII Distance and Size

Distance	Actual Base Pair Length
	9416
	6682
	4361
	2322
	2027
	**564
	**125

*** Does not appear on this gel*

Table 2: EcoRI Distance and Size

Distance	Interpolated Base Pair Length


10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
10
Y-axis: Base Pairs
1 cm
2 cm
3 cm
4 cm
5 cm
6 cm
X-axis: Migration distance (cm)

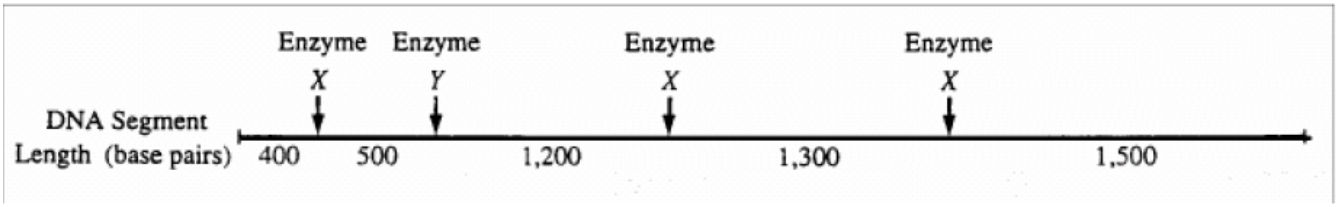
2. How does a restriction enzyme work?

3. At what location in the cell do restriction enzymes work?

4. Which fragments of DNA migrate further along a gel electrophoresis plate, long or short fragments? Why?

Answer the following <u>LONG</u> FRQ:

The diagram below shows a segment of DNA with a total length of 4,900 base pairs. The arrows indicate reaction sites for two restriction enzymes (enzyme X and enzyme Y).



a) Explain how the principles of gel electrophoresis allow for the separation of DNA fragments.

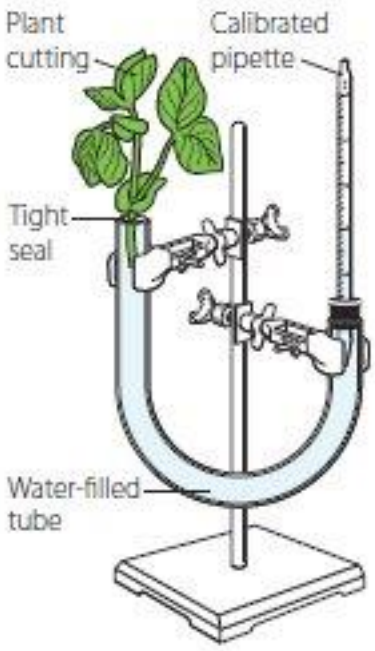
b) Describe the results you would expect from the electrophoretic separation of fragments from the following treatments of the DNA segment above. Assume that the digestion occurred under appropriate conditions and went to completion.
   - DNA digested with only enzyme X
   - DNA digested with only enzyme Y
   - DNA digested with enzyme X and enzyme Y combined
   - Undigested DNA

c) Explain both of the following.
   - The mechanism of action of restriction enzymes.
   - The different results you would expect if a mutation occurred at the recognition site for enzyme Y.

Lab 11

A lab group was investigating factors that may have an effect on the rate of transpiration. They used a potometer to measure the amount of water loss through transpiration as shown. In addition, oncet he experiment was complete, the students determined the surface area of the leaves on the plant.

They investigated the effect of light by putting the potometer under a fluorescent light. The effect of wind on transpiration was accomplished by putting the potometer in front of a fan. Lastly, the effect of transpiration was accomplished by misting the plant and putting a plastic bag over the plant in the potometer . They also used a control potometer. The data was collected and recorded in the data table below. Continue analyzing the data by determining he amount of water (mL) loss/M^2 of leaf surface area.

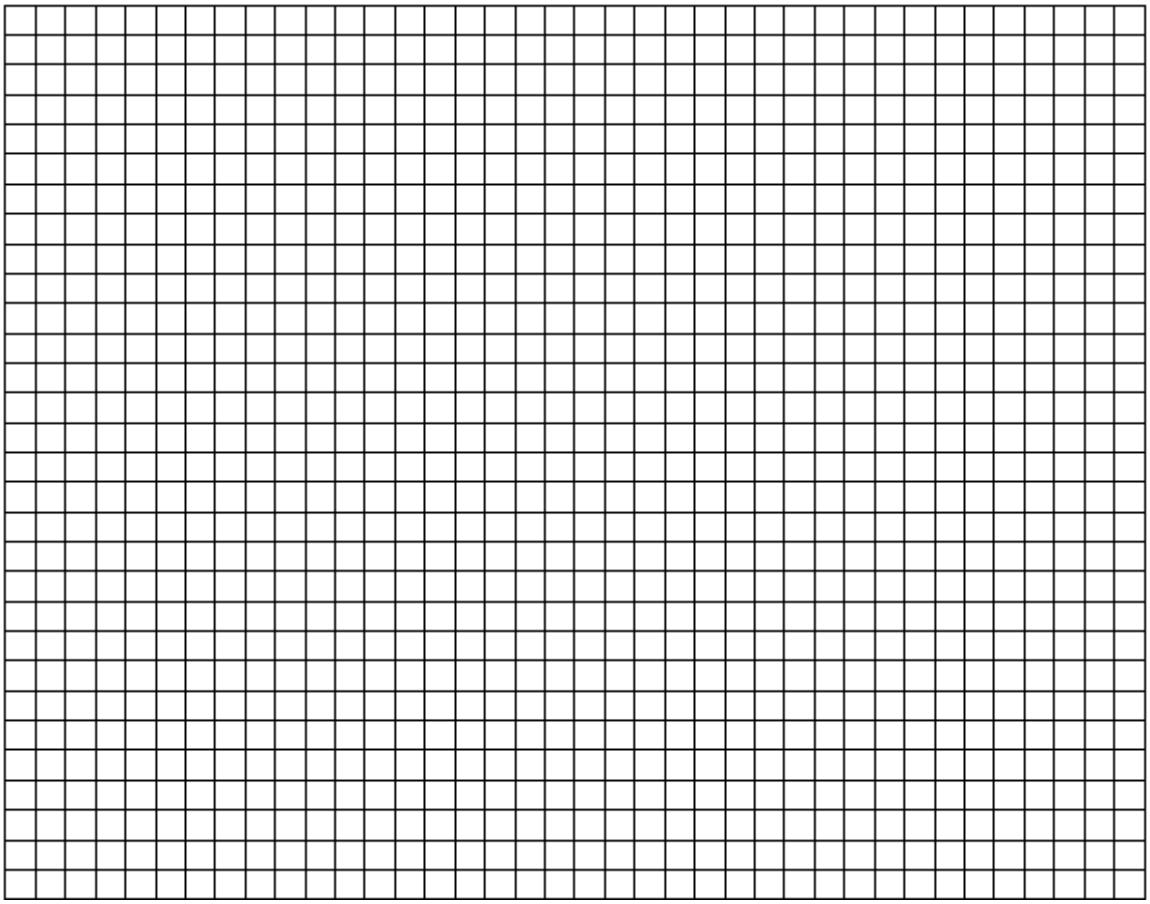


Potometer Assembly

	Water Loss mL Time (Minutes)				
Leaf Surface	Treatment	0	10	20	30
0.014	a. Room	0	0.03	0.064	0.092
0.016	b. Light	0	0.067	0.121	0.188
0.021	c. Fan	0	0.095	0.159	0.231
0.015	d. Mist	0	0.019	0.036	0.055

	Water Loss mL/ M^2 Time (Minutes)			
Treatment	0	10	20	30
a. Room				
b. Light				
c. Fan				
D. Mist				

Graph the data show and determine the average rate of transpiration for each treatment.



1. Explain the results of the lab in terms of water potential.

_____

_____

_____

_____

_____

2. Why was it important to divide the water loss by the surface area of the leaves?

_____

_____

_____

_____

INVESTIGATION 11: TRANSPIRATION

1. In terms of transpiration, write a short explanation of plant physiological responses because of environmental conditions.

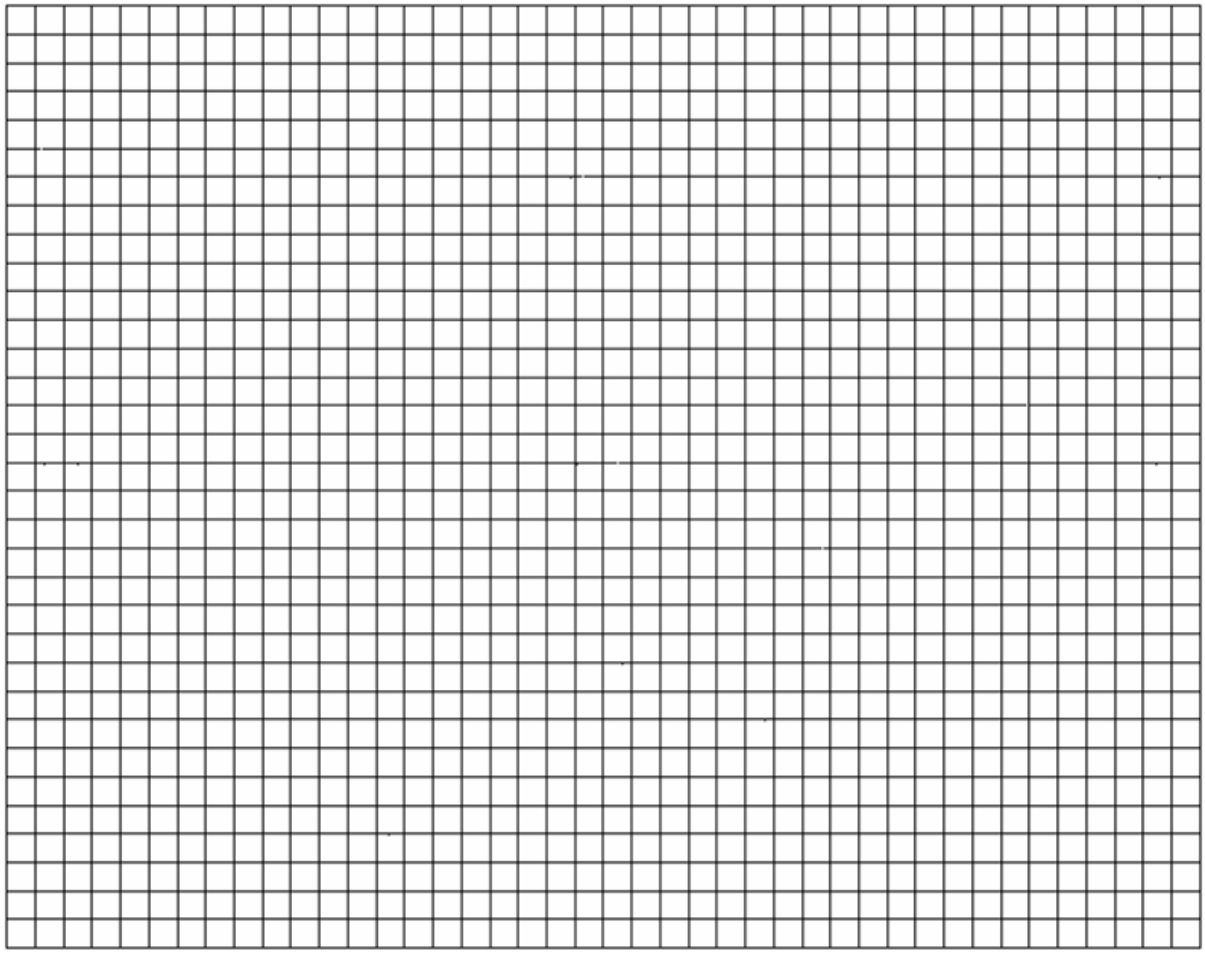
   A) a plant at room temperature

   B) a plant in humid conditions

   C) a plant in high light conditions

   D) a plant in very dry conditions

2. Using the conditions identified in question #1, create a graph showing the relationship between the amount of transpiration and time. Be sure to include a key.



4. What is the advantage of closed stomata to a plant when water is in short supply? What are the disadvantages? Explain why transpiration, then, is a mechanism that plants use to maintain homeostasis.

5. Explain the role of water potential in the movement of water from soil through the plant and into the air.

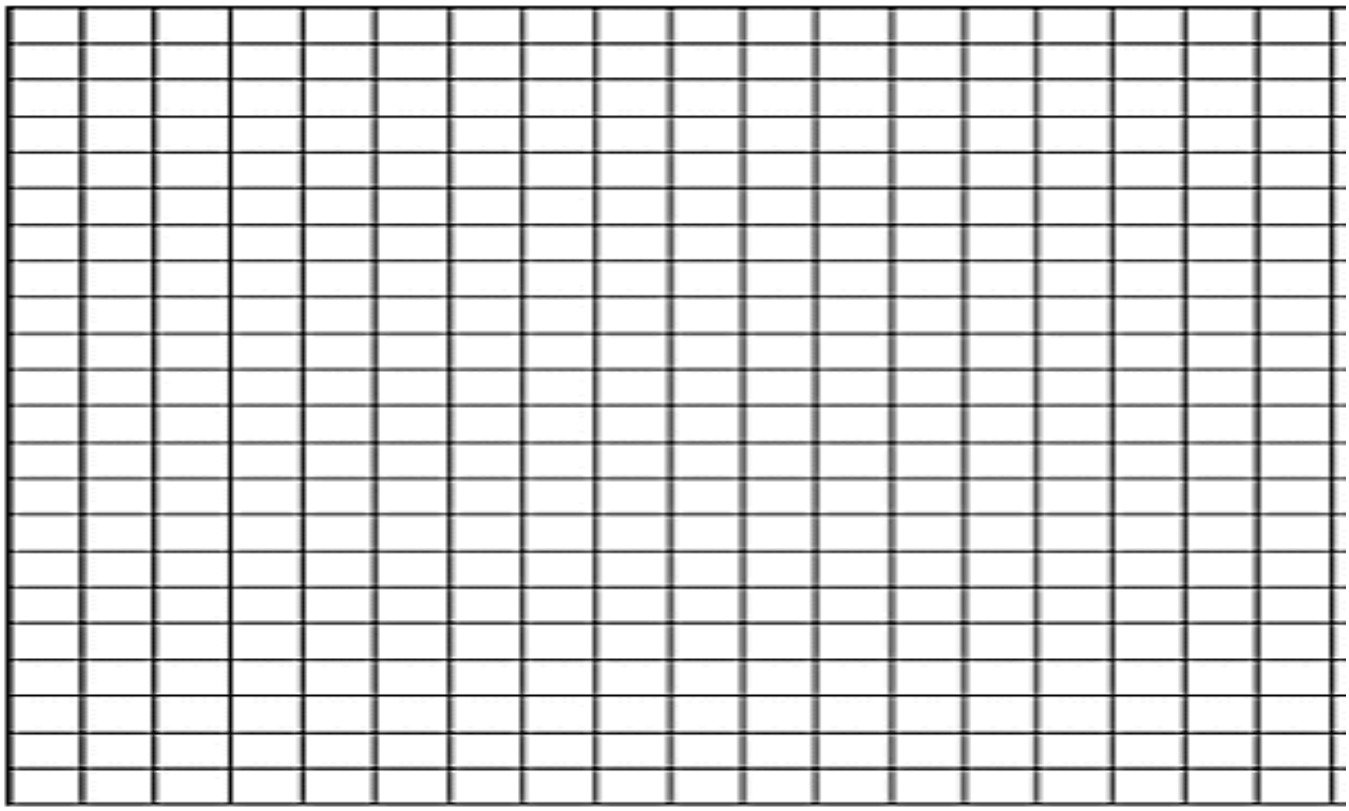
The experiment was repeated four more times for the untreated plant and the fan, and the average rate of transpiration was recorded as shown.

Untreated Plant	Average Rate of Transpiration $mL/M^2/min$	(Difference from the Mean)^2	Fan	Average Rate of Transpiration $mL/M^2/min$	(Difference from the Mean)^2
Plant			Plant		
1	6.5		1	12.1	
2	5.4		2	13.2	
3	3.1		3	12.3	
4	6.8		4	14.1	
5	5.9		5	11.9	
Mean			Mean		
Standard Deviation			Standard Deviation		
SEM			SEM		
2X SEM			2X SEM		

2. Determine the standard deviation of each set of data, standard error of the mean and 2 SEM.

4. Which set of data (the untreated or fan) was observed to have the greatest amount of variation? Justify your answer.

5. On the axis provided, create an appropriately labeled graph to illustrate the means for each treatment to within 95% confidence(i.e.samplemeans+2SEM). Remember that the means of this data was whether the potometer was in front of a fan or not. This is categorical data and not numerical data. It is better to make a bar graph with this data than a than a line graph. One bar will represent the means of the means for the average rate of transpiration with no treatment and the other bar will represent the means average rate of transpiration when the potometer assembly was placed in front of a fan.



6. Does it appear qualitatively that the wind has an effect on the rate of transpiration? Justify your answer.

_____

_____

_____

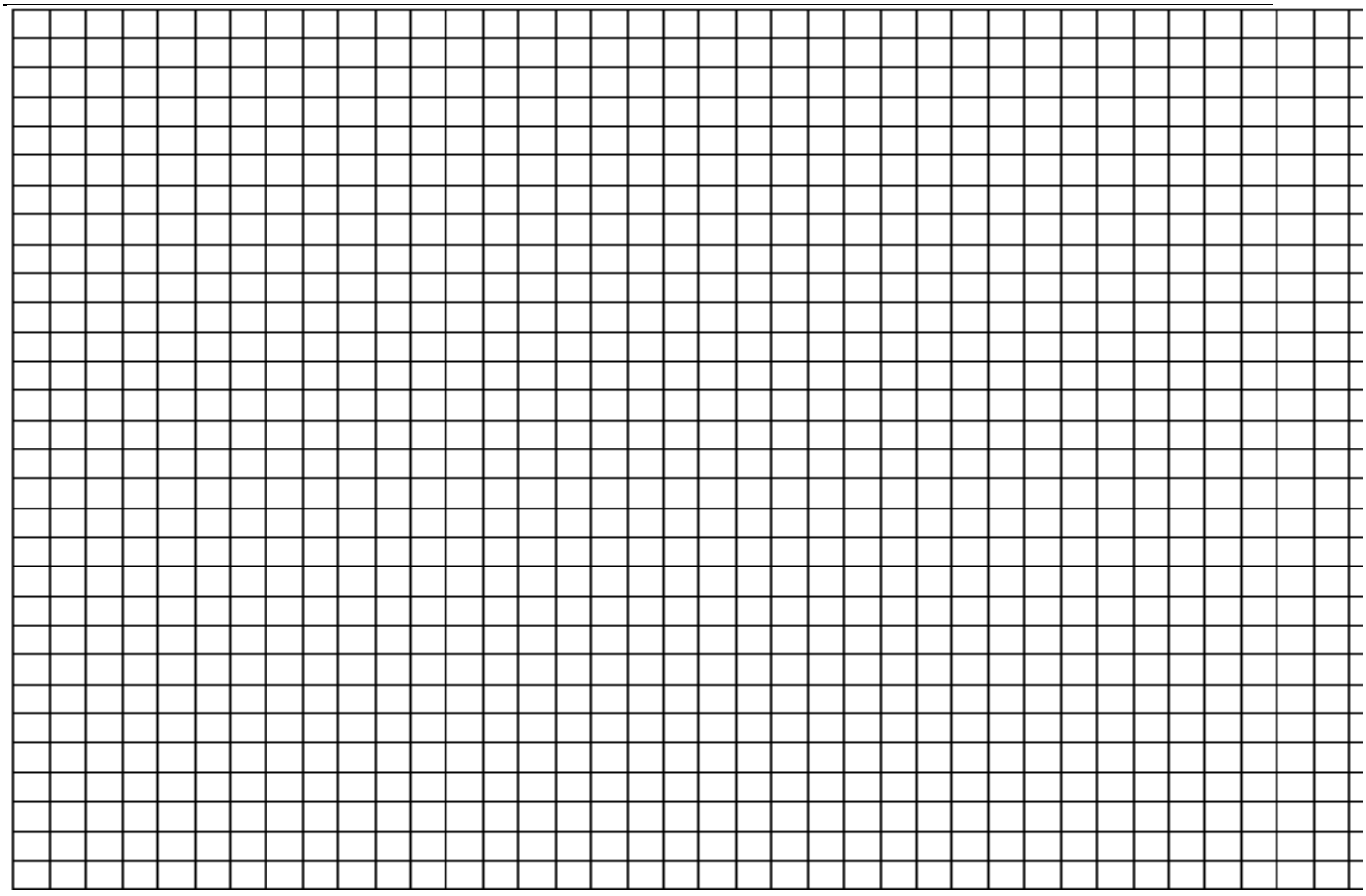
_____

Another lab group designed an investigation to determine if mung beans or black-eyed peas transpired at a faster rate. Six plants from each species of plant were used and the data collected is shown below. The surface area of the leaves from each plant was also determined.

Mung Beans								
	Time 0 Min.		Time 10 Min.		Time 20 Min.		Time 30 Min.	
Leaf Surface Area M^2	Volume of water transpired	Volume of Water Transpired /M^2	Volume of Water Transpired	Volume of Water Transpired /M^2	Volume of Water Transpired	Volume of Water Transpired /M^2	Volume of Water Transpir ed	Volume of Transpired/^{M2}e
0.015	0		0.06		0.14		0.18	
0.018	0		0.08		0.16		0.23	
0.017	0		0.07		0.15		0.22	
0.021	0		0.09		0.17		0.25	
0.018	0		0.09		0.18		0.25	
0.016	0		0.06		0.13		0.19	
Mean								
SD								
SEM								
2 SEM								

Black Eyed Peas								
	Time 0 Min		Time 10 Min		Time 20 Min		Time 30 Min.	
Leaf Surface Area M^2	Volume of water transpired	Volume of Water Transpired/M^2	Volume of Water Transpired	Volume of Water Transpired /M^2	Volume of Water Transpired	Volume of Water Transpired /M^2	Volume of Water Transpired	Volume of Water Transpired/M^2
0.018	0		0.08		0.18		0.27	
0.021	0		0.1		0.21		0.34	
0.02	0		0.11		0.22		0.30	
0.023	0		0.13		0.24		0.35	
0.022	0		0.12		0.24		0.37	
0.023	0		0.13		0.26		0.39	
Mean								
SD								
SEM								
2 SEM								

7. On the axis provided, create an appropriately labeled graph to illustrated the means for each treatment to within 95% confidence (i.e.samplemeans+2SEM). Remember that the means of this data is continuous data, meaning that it is measured. This is numerical data. It is better to make a line graph with this data rather than a bar graph. 2 SEM error bars can still be displayed on the graph.



8. Does it appear qualitatively that the rate of transpiration for the two different types of legumes is significant? Justify your answer.

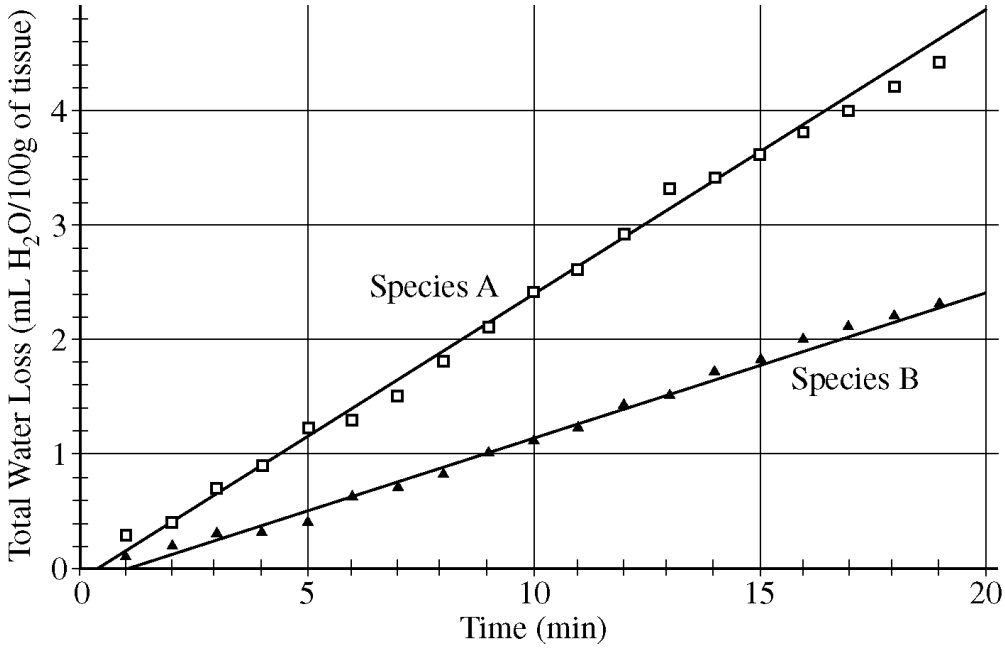
_____
_____
_____
_____

Answer the following <u>LONG</u> FRQ:

The regulation of transpiration is an important homeostatic mechanism in plants.

(a) Under controlled conditions, a transpiration experiment was conducted using two plant species. The data collected are shown in the figure below. Using the data from the experiment, **calculate** the rate of transpiration for species A and species B between the times of 5 and 15 minutes (show your work). **Summarize** the difference between the two transpiration rates.

WATER LOSS VERSUS TIME FOR TWO PLANT SPECIES



(b) **Identify** and **explain** THREE different structural or physiological adaptations that could account for the different transpiration rates of species A and B.

(c) Water potential (Ψ) is described by the following formulas.

$$\text{Water Potential} = \Psi = \Psi_s + \Psi_p$$

$$\Psi s = -iCRT$$

Discuss the variables in both formulas and how they affect water potential.

ANIMAL BEHAVIOR Lab 12

1. Define and give an example of **taxis.**

2. Define and give an example of **kinesis.**

3. Define and give an example of **phototaxis.**

4. In this lab, fruit flies were used. After the fruit flies have been in the choice chamber for 10 minutes, you might observe one of these situations:

   Situation A: Sugar: 15 Fruit flies; No sugar: 15 Fruit flies

   Situation B: Sugar : 17 Fruit Flies; No sugar: 13 Fruit Flies

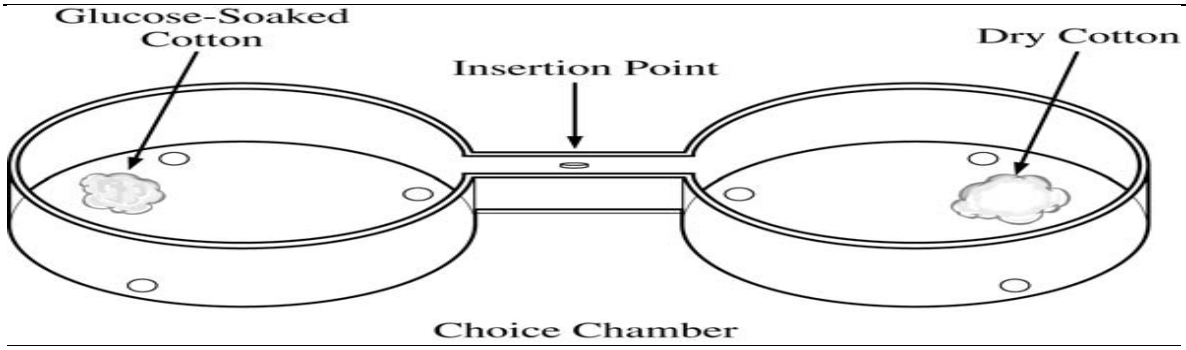
   Situation C: Sugar: 12 Fruit Flies; No sugar: 18 Fruit Flies

   Fruit Flies feed on rotten fruit. Because of this characteristic, which situation would you predict to occur: A, B, or C? Explain your answer.

   Are these data reliable? Perform a Chi Square Analysis on these data. Be sure to include your Null Hypothesis.

5. This brings us to an important consideration: The Fruit Fly exercise is not a controlled experiment. Without a control, it is very risky to state a conclusion. Explain why.

6. Courtship Behavior in Fruit Flies: Courtship between male and female animals usually is a ritual with specific behaviors. Is there an advantage to this for the species and/or individual? Explain your answer.



In an investigation of fruit-fly behavior, a covered choice chamber is used to test whether the spatial distribution of flies is affected by the presence of a substance placed at one end of the chamber. To test the flies' preference for glucose, 60 flies are introduced into the middle of the choice chamber at the insertion point indicated by the arrow in the figure above. A cotton ball soaked with a 10% glucose solution is placed at one end of the chamber, and a dry cotton ball with no solution is placed at the other end. The positions of flies are observed and recorded every minute for 10 minutes.

(a) Predict the distribution of flies in the chamber after 10 minutes and justify your prediction.

(b) Propose ONE specific improvement to each of the following parts of the experimental design and explain how the modification will affect the experiment.

- Experimental control
- Environmental factors

(c) The experiment described above is repeated with ripe bananas at one end and unripe bananas at the other end. Once again the positions of the flies are observed and recorded every minute for 10 minutes. The positions of flies after 1 minute and after 10 minutes are shown in the table below.

DISTRIBUTION OF FLIES IN CHOICE CHAMBER

Time (minutes)	Position in Chamber		
	End with Ripe Banana	Middle	End with Unripe Banana
1	21	18	21
10	45	3	12

Perform a chi-square test on the data for the 10-minute time point in the banana experiment. Specify the null hypothesis that you are testing and enter the values from your calculations in the table below.

Chi Square Calculation

Null Hypothesis:			
	Observed (o)	Expected (e)	$(o-e)^2/e$
End with ripe banana			
Middle			
End with unripe banana			
Total			

(d) Explain whether your hypothesis is supported by the chi-square test and justify your explanation.

(e) Briefly propose a model that describes how environmental cues affect the behavior of the flies in the choice chamber.

INVESTIGATION 13: ENZYME ACTIVITY

1. $2H_2O_2$ _----------→ Catalase $2H_2O + 2O_2$ Explain this equation in words.

2. What was the substrate in this experiment? The enzyme? The Product(s)?

3. What reaction does the enzyme in question #2 catalyze?

4. What was the enzyme in this experiment and how did it work?

5. How does the activity of the enzyme vary with pH? Why?

6. What is the pH at which the greatest catalase activity occurs?

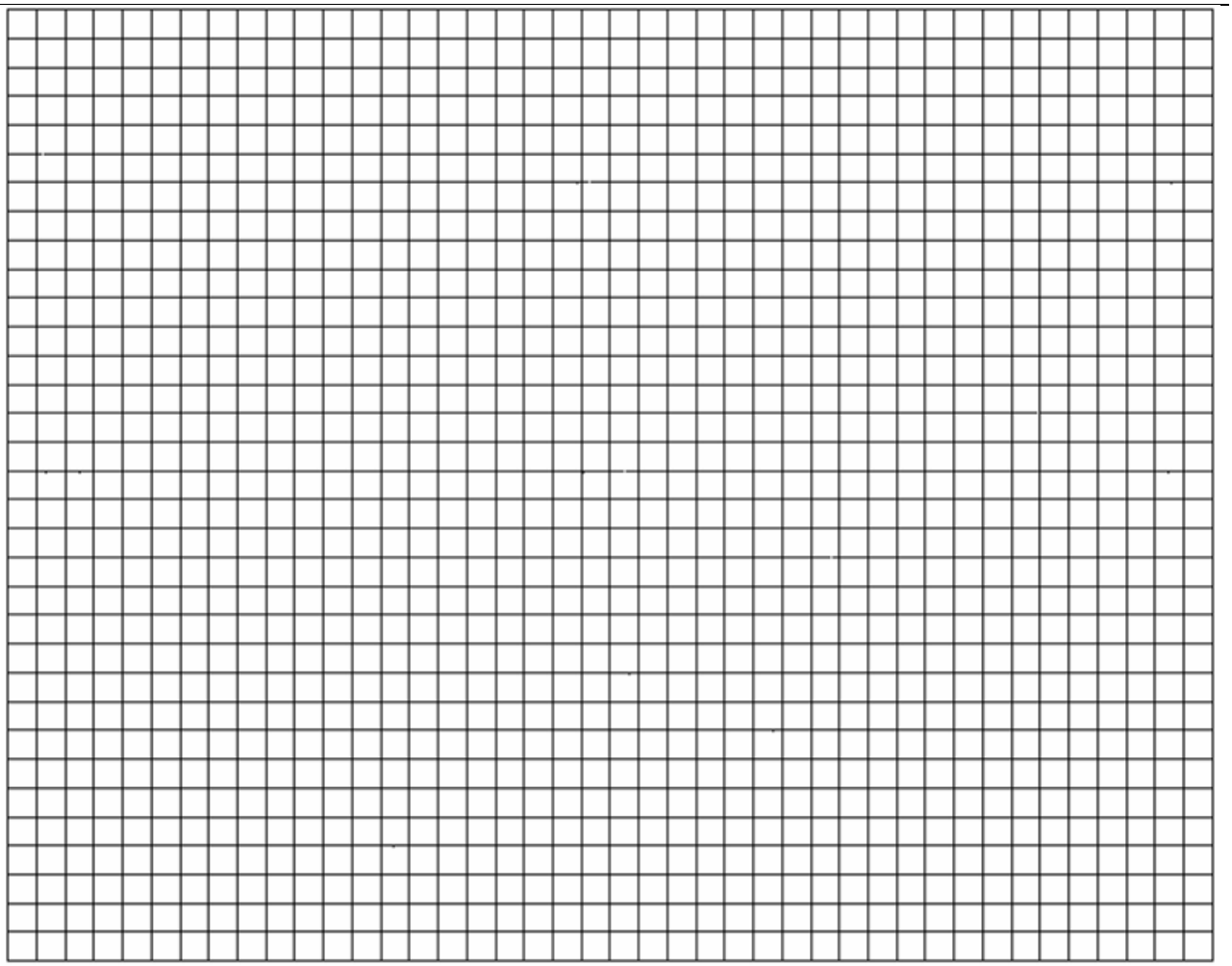
7. Do you think all enzymes would work well at the pH found in this experiment? Explain your answer.

8. How does raising the temperature of a solution affect the rate of an enzyme-catalyzed reaction? Explain.

9. Calculate the mean H_2O_2 used, SD and SEM for the data in the data table below. Create a graph of the mean amount of substrate used over time as a result of an enzymatic reaction.

Data Table for Enzyme Catalysis

H_2O_2 Used (mL) at each time point	Lab Group						Statistics		
	1	2	3	4	5	6	Mean H_2O_2 Used	Standard Deviation	SEM
10 Seconds	.9	.7	.8	.8	.9	.9			
30 Seconds	1.8	1.9	1.7	1.9	1.6	1.8			
60 Seconds	2.4	2.2	2.4	2.3	2.5	2.5			
90 Seconds	3.1	3.0	3.2	3.1	2.9	2.8			
120 Seconds	3.2	3.1	3.0	3.2	3.2	3.2			
180 Seconds	3.3	3.3	3.2	3.2	3.3	3.2			



10. How would this graph change if substrate concentration increased?

11. How would the graph change if a competitive inhibitor was added halfway through the experiment?

Determine the rate of this enzyme catalyzed reaction for each time interval and record your results

Time Interval (seconds)						
	0 to 10	10 to 30	30 to 60	60 to 90	90 to 120	120 to 180
Rate of Reaction $\frac{\Delta y}{\Delta x}$						

$$\text{Catechol} + \text{Oxygen} \xrightleftharpoons{\text{Polyphenol Oxidase}} \text{Benzoquinone} + \text{Water}$$

Catechol, a natural substance found in plants, reacts with oxygen to produce benzoquinone and water, as represented by the chemical equation above. The reaction is catalyzed in plants by the enzyme polyphenol oxidase. Accumulation of benzoquinone in plant tissue results in the gradual appearance of a brown color.

A student observes that lemon juice (pH 2) slows the browning of apple slices. The student claims that lemon juice slows the browning process by altering the activity of polyphenol oxidase. To test the claim, the student distributes equal amounts of a dilute catechol solution to 6 identical test tubes. The pH of each solution was adjusted as shown in the table, and the initial absorbance was recorded. Equal amounts of polyphenol oxidase were added to each reaction tube. After 10 minutes at room temperature the absorbance of 389 nm light (A_{389}) was measured for each sample. Solutions containing greater concentrations of benzoquinone absorb more light. The changes in A_{389} are shown in the table below.

POLYPHENOL OXIDASE ACTIVITY

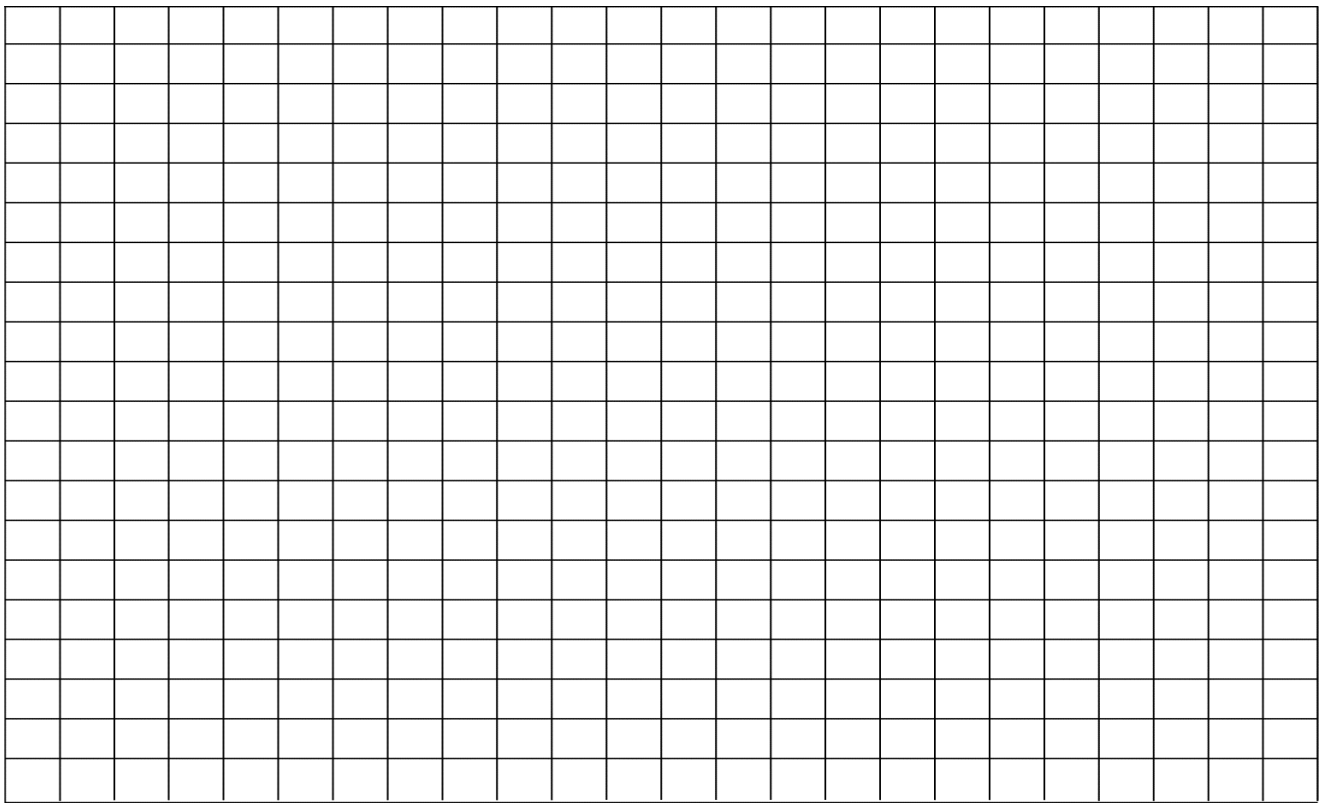
Test Tube	pH	Change in A_{389} After
A	1.0	0.06
B	3.0	0.09
C	5.0	0.23
D	7.0	0.83
E	9.0	0.32
F	11.0	0.10

(a) On the axes provided, **construct** an appropriately labeled bar graph to analyze the effect of pH on polyphenol oxidase activity.

(b) Based on the experimental results, **estimate** the optimal pH of the enzyme. **Explain** your estimate by connecting the experimental results to the structure and function of proteins.

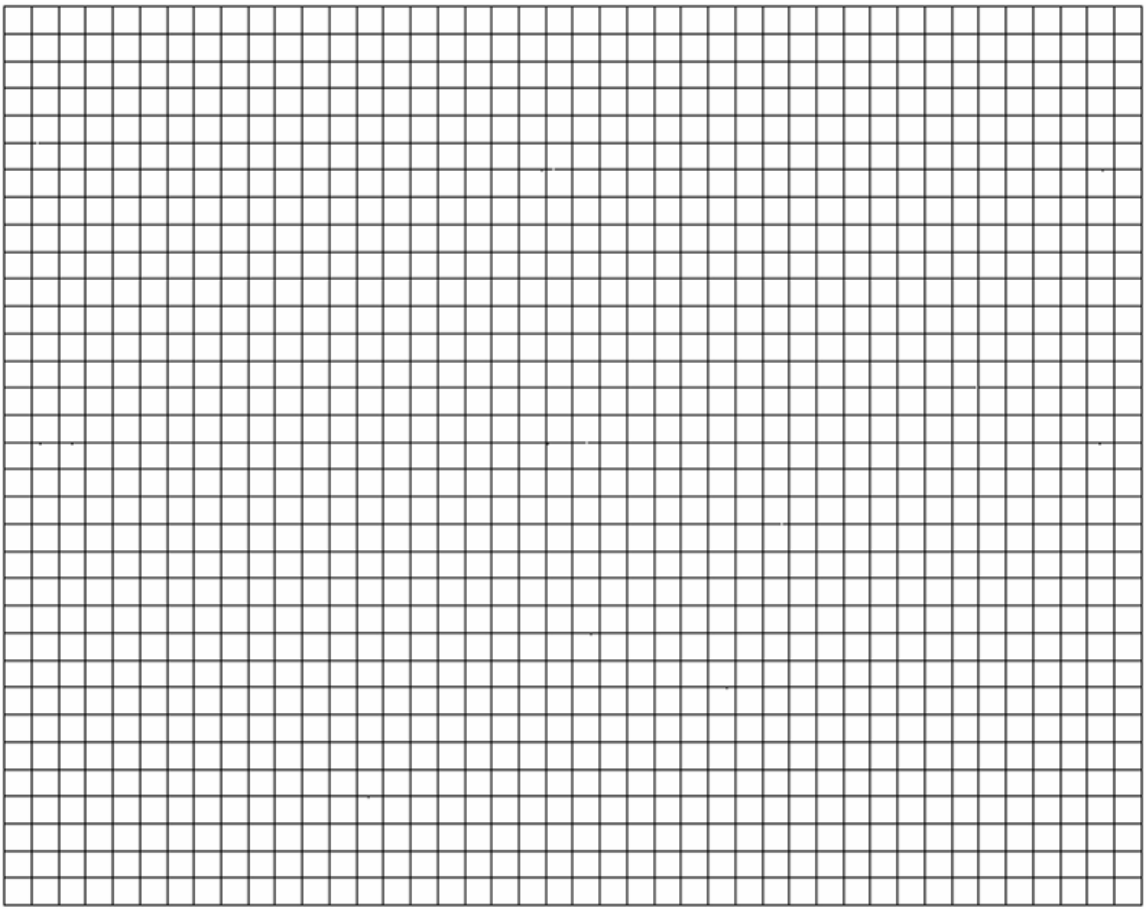
(c) **Propose** an appropriate control treatment for the experiment, and **describe** how the control treatment would increase the validity of the results.

(d) Genetic engineering can be used to disrupt specific genes in the genome of an organism. **Predict** how the browning of apple slices would be affected in a strain of apples that was genetically engineered to lack functional copies of the gene encoding polyphenol oxidase. **Justify** your response.

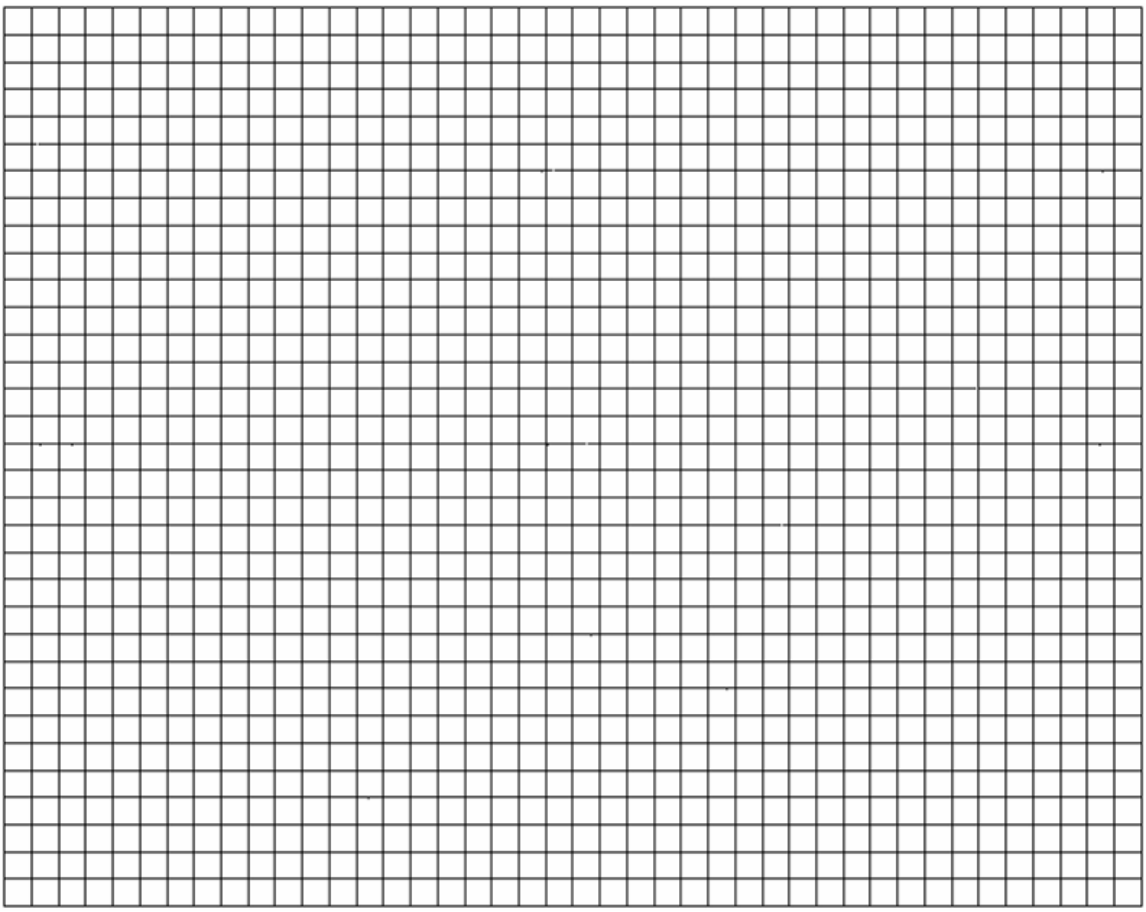


INVESTIGATION: DISSOLVED OXYGEN AND PRIMARY PRODUCTIVITY - OPTIONAL

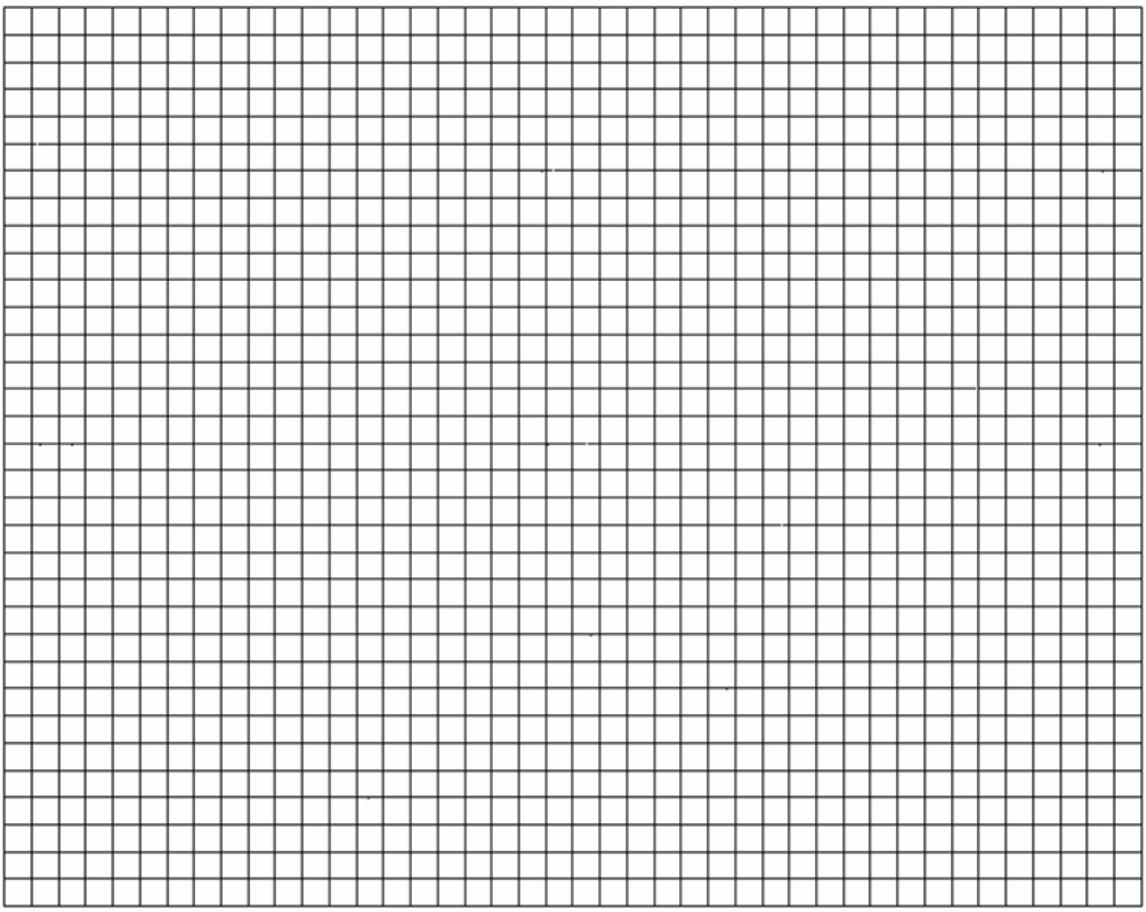
1. Create a graph showing the relationship between temperature and the percent saturation of dissolved oxygen.



2. Create a graph showing the relationship between the amount of light received and the amount of productivity.



3. Create a graph that shows the relationship between the amount of oxygen consumed by photosynthetic organisms and the amount of carbon fixed.



4. Why is net productivity lower than gross productivity?

5. What process occurs at night in water systems that lowers the amount of oxygen?