State Lab Review Packet

Lab #1: Diffusion Through a Membrane

Key Points:
1. The dialysis tubing is a model of the cell, with the tube representing the membrane.
2. The size of the molecule determines whether or not it moves through the membrane.
3. Indicators are chemicals that turn color to indicate the presence of a particular substance.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Substance</th>
<th>Color change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iodine</td>
<td>Starch</td>
<td>Amber → Black</td>
</tr>
<tr>
<td>Benedict’s Solution</td>
<td>Glucose</td>
<td>Blue → Red (after it is heated)</td>
</tr>
</tbody>
</table>

4. Molecules move from a region of high concentration to low concentration.
5. Water moves toward salt.
6. A cell placed in a salt solution will shrink.
7. A cell placed in 100% water (distilled) will swell.

Sample Diagrams:
Review the following diagrams. Try to describe what is happening in each diagram, and try to write your own questions where none have been provided.

What do you think is happening in each beaker?

A:

B:

C:

Draw what you think will happen to the contents of the cell in salt water.

Elodea cell in freshwater

Elodea cell in saltwater

Describe what you think happened to cell A and cell B.

A

B

Cell A

Cell B
Complete diagram B to show how the contents of the red onion cells should appear if the cell were then rinsed with distilled water for several minutes. [1]

A student prepared a wet-mount slide of red onion skin and observed it under high power of a compound light microscope (view A). After adding a substance to the slide and waiting one minute, the student observed that there were changes in the cells (view B).

<table>
<thead>
<tr>
<th>View A</th>
<th>View B</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="View A" /></td>
<td><img src="image2.png" alt="View B" /></td>
</tr>
</tbody>
</table>

64 In the box below, sketch how view B would appear when viewed under lower power of the same compound light microscope. [1]

Students prepared four models of cells by using dialysis tubing containing the same blue solution. Each of the model cells originally weighed 10 grams. They then placed each model cell in a beaker containing a different concentration of water. After 24 hours, they recorded the mass of the model cells as shown in the data table below.

<table>
<thead>
<tr>
<th>Concentration of Water Surrounding the Model Cell</th>
<th>Mass of Model Cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>100%</td>
<td>12 grams</td>
</tr>
<tr>
<td>90%</td>
<td>11 grams</td>
</tr>
<tr>
<td>80%</td>
<td>10 grams</td>
</tr>
<tr>
<td>70%</td>
<td>9 grams</td>
</tr>
</tbody>
</table>
1. Why did the model cell that was placed in 100% water increase in mass? [1]

2. What was the concentration of water in the original blue solution? State evidence in support of your answer. [1]

The diagram below represents a container of water and two different kinds of molecules, A and B, separated into two chambers by a membrane through which only water and molecule A can pass.

On the diagram of the container below, indicate the distribution of molecules A and B after the net movement of these molecules stops. [2]

Describe what happened in the cells at left.

How can we determine if starch has diffused out of the test tube?

Test tube
Beaker
Meniscus
Water
Starch-water mixture
Dialysis membrane
The diagram illustrates an investigation carried out in a laboratory activity on diffusion. The beaker and the artificial cell also contain water.

Predict what would happen over time by showing the location of molecules I, G, and S in diagram B below.
State Lab Review Packet

Lab #2 Beaks of Finches

Key Points:
1. Competition for resources stimulates the struggle for survival.
2. Certain variations give some organisms an advantage to survive.
3. The environment "naturally selects" which organisms are best suited to survive and reproduce.
4. The surviving organisms reproduce and pass on favorable traits to the next generation.
5. The different tools represent different beak shapes.
6. Migrating to another island represented adaptive radiation.

Base your answers to questions 1 and 2 on the information below and on your knowledge of biology.

In birds, the ability to crush and eat seeds is related to the size, shape, and thickness of the beak. Birds with larger, thicker beaks are better adapted to crush and open seeds that are larger.

One species of bird found in the Galapagos Islands is the medium ground finch. It is easier for most of the medium ground finches to pick up and crack open smaller seeds rather than larger seeds. When food is scarce, some of the birds have been observed eating larger seeds.

1. Describe one change in beak characteristics that would most likely occur in the medium ground finch population after many generations when an environmental change results in a permanent shortage of small seeds. [1]

2. Explain this long-term change in beak characteristics using the concepts of:
   - competition [1]
   - survival of the fittest [1]
   - inheritance [1]
3. Identify one bird that would most likely compete for food with the large tree finch. Support your answer. [1]

4. Identify one trait, other than beak characteristics, that would contribute to the survival of a finch species and state one way this trait contributes to the success of this species. [2]

When Charles Darwin traveled to the Galapagos Islands, he observed 14 distinct varieties of finches on the islands. Darwin also observed that each finch variety ate a different type of food and lived in a slightly different habitat from the other finches. Darwin concluded that the finches all shared a common ancestor but had developed different beak structures.
5. The 14 varieties of finches are most likely the result of

   (1) absence of biodiversity
   (2) biological evolution
   (3) asexual reproduction
   (4) lack of competition

6. The second sentence best describes

   (1) an ecosystem
   (2) a food web
   (3) a niche
   (4) a predator/prey relationship

7. The different beak structures mentioned in the last sentence were most likely influenced by

   (1) selection for favorable variations
   (2) environmental conditions identical to those of the common ancestor
   (3) abnormal mitotic cell division
   (4) characteristics that are acquired during the bird's lifetime

8. Beak structures differ between individuals of one species of bird. These differences most likely indicate

   (1) the presence of a variety of food sources
   (2) a reduced rate of reproduction
   (3) a large supply of one kind of food
   (4) an abundance of predators
9. Using information provided in the chart, identify two birds that would most likely compete for food in times of food shortage and explain why they would compete. [2]

_________________________ and _________________________

10. Even though the finches on the various Galapagos Islands require different biotic and abiotic factors for their survival, these finches would most likely be grouped in the same

(1) species, but found in different habitats

(2) kingdom, but found in different ecological niches

(3) species and found in the same biosphere

(4) population, but found in different ecosystems
7. In members of a bird species living on a remote island, the greatest number of beak variations in the population would most likely be found when

(1) there is a high level of competition for limited resources
(2) homeostasis is limited by a severe climate
(3) they have a large and varied food supply
(4) they are prey for a large number of predators

8. The different tools used during the beaks of finches lab represented

(1) feeding adaptations in finches
(2) nest construction adaptations
(3) variations in seed size
(4) variations in ecosystems

9. A hawk has a genetic trait that gives it much better eyesight than other hawks of the same species in the same area. Explain how this could lead to evolutionary change within this species of hawk over a long period of time. In your answer, be sure to include an explanation of:

- competition within the hawk population [1]
- survival of various individuals in the population [1]
- how the frequency of the better-eyesight trait would be expected to change over time within the population [1]
- what would most likely happen to the hawks having the better-eyesight trait if they also had unusually weak wing muscles [1]
Key Points:
1. Resting pulse varies with each individual
2. Pulse rate increases under physical or emotional stress.
3. Increase in activity produces muscle fatigue.
4. By collecting data scientists can help to answer questions they have proposed.
5. Use the scientific method to solve a problem.
6. Ask a question, state a hypothesis, design a controlled experiment, collect the data, organize the data, make conclusions based on the data.
7. Two ways to improve any experiment include repeating the experiment and increasing the sample size.

Practice questions:

Base your answers to questions 1 to 3 on the information and data table below and on your knowledge of biology.

Two students collected data on their pulse rates while performing different activities. Their average results are shown in the data table below.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Average Pulse Rate (beats/min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>sitting quietly</td>
<td>70</td>
</tr>
<tr>
<td>walking</td>
<td>98</td>
</tr>
<tr>
<td>running</td>
<td>120</td>
</tr>
</tbody>
</table>

1. State the relationship between activity and pulse rate.

2. State one way that this investigation could be improved. [1]

Base your answers to questions 3 through 5 on the information and graph below and on your knowledge of biology.

Pulse-rate data were collected from some students during their lunch time for the lab activity, Making Connections. The data are represented in the histogram below.
3. The histogram includes data from a total of how many students?
   (1) 6 (2) 7 (3) 10 (4) 27

4. Describe one way in which a pulse rate below 45 would disrupt homeostasis in an individual whose average resting pulse rate falls in the range of 71-80. [1]

5. State one way the data would most likely be different if the pulse rates were collected immediately after exercising instead of during lunch. [1]

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Base your answers to questions 6 and 7 on the information below and on your knowledge of biology.

A student squeezes and releases a clothespin as often as possible for 2 minutes and then takes his pulse for 20 seconds. After a 2-minute rest, he repeats the procedure. This pattern is repeated one more time. The student’s 20-second pulse counts were 23, 26, and 21.

6. Complete the “Pulse/Min” column in the data table below for all three trials as well as the average pulse rate per minute. [1]

<table>
<thead>
<tr>
<th>Trial</th>
<th>20-Second Pulse Counts</th>
<th>Pulse/Min</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. What additional data should the student have collected in order to determine the effect of squeezing a clothespin on his pulse rate? [1]
Base your answers to questions 8 through 11 on the data table below and on your knowledge of biology.

A group of students obtained the following data:

<table>
<thead>
<tr>
<th>Student Tested</th>
<th>Pulse Rate at Rest</th>
<th>Pulse Rate After Exercising</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>70</td>
<td>97</td>
</tr>
<tr>
<td>2</td>
<td>75</td>
<td>106</td>
</tr>
<tr>
<td>3</td>
<td>84</td>
<td>120</td>
</tr>
<tr>
<td>4</td>
<td>60</td>
<td>91</td>
</tr>
<tr>
<td>5</td>
<td>78</td>
<td>122</td>
</tr>
</tbody>
</table>

8 The activity of which body system was measured to obtain these data? [1]

9. The activity of which other body system would be altered as a direct result of the exercise? [1]

10. What effect would exercise have on the system you identified in question 10?

11. Explain how this change in pulse rate helps maintain homeostasis in muscle cells.

12. A student hypothesizes that the pulse rate of a person and background music that is playing are related. The student designs an experiment to test this hypothesis. What would be an appropriate control for this experiment?

Base your answers to questions 14 and 15 on the information below and on your knowledge of biology.

In an investigation, 28 students in a class determined their pulse rates after performing each of three different activities. Each activity was performed three times during equal time intervals. The average results are shown in the graph below.

13. Before constructing the graph it would have been most helpful to organize the results of the investigation in
   (1) a research plan (2) an equation
   (3) a data table       (4) a generalization
14 Some students concluded that males always have a higher pulse rate than females. Does the graph support this conclusion? Justify your answer. [1]

15. When a person exercises, changes occur in muscle cells as they release more energy. Explain how increased blood flow helps these muscle cells release more energy. [1]

16 A student squeezed a clothespin as many times as possible in a 30-second time period. The student repeated this procedure nine more times in quick succession. The data obtained are in the chart below.

<table>
<thead>
<tr>
<th>Trial</th>
<th>Number of Squeezes In 30 Seconds</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32</td>
</tr>
<tr>
<td>2</td>
<td>29</td>
</tr>
<tr>
<td>3</td>
<td>28</td>
</tr>
<tr>
<td>4</td>
<td>27</td>
</tr>
<tr>
<td>5</td>
<td>26</td>
</tr>
<tr>
<td>6</td>
<td>25</td>
</tr>
<tr>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td>8</td>
<td>21</td>
</tr>
<tr>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>10</td>
<td>17</td>
</tr>
</tbody>
</table>

State one hypothesis that this data would support concerning the relationship between number of trials and number of squeezes in 30 seconds. [1]
Key Points:
1. Organisms with similar structural or molecular similarities may be related.
2. In order for a species to survive it must contain variety (diversity).
3. Proteins and enzymes are produced as a result of an organism's genetic code sequence.
4. The genetic code is carried out as follows:
   DNA → mRNA → tRNA → amino acid
5. Amino acids are the building blocks of proteins.
6. Chromatography is a technique that separates mixtures.
7. Gel electrophoresis uses restriction enzymes to cut DNA, then DNA is placed in wells, and the fragments move from the negative poles toward the positive poles.
8. Similar banding patterns suggest similar DNA which suggests closer relationships.

Sample Questions:

To demonstrate techniques used in DNA analysis, a student was given two paper strip samples of DNA. The two DNA samples are shown below.

Sample 1: ATTCGGTAATCCGTAATC

Sample 2: ATTCGGTAATCCGTAATC

The student cut between the C and G in each of the shaded CCGG sequences in sample 1 and between the As in each of the shaded TAAT sequences in sample 2. Both sets of fragments were then arranged on a paper model of a gel.

1. The action of what kind of molecules was being demonstrated when the DNA samples were cut? [1]

2. Identify the technique that was being demonstrated when the fragments were arranged on the gel model.

3. The results of this type of DNA analysis are often used to help determine
   (1) the number of DNA molecules in an organism
   (2) if two species are closely related
   (3) the number of mRNA molecules in DNA
   (4) if two organisms contain carbohydrate molecules

4. State one way that the arrangement of the two samples on the gel model would differ.
The DNA of three different species of birds was analyzed to help determine if there is an evolutionary relationship between these species. The diagram shows the results of this analysis.

5. Identify the technique normally used to separate the DNA fragments to produce the patterns shown in the diagram.

6. The chart below contains amino acid sequences for part of a protein that is found in the feathers on each of these three species of birds.

<table>
<thead>
<tr>
<th>Species</th>
<th>Amino Acid Sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Arg-Leu-Glu-Gly-His-His-Pro-Lys-Arg</td>
</tr>
<tr>
<td>B</td>
<td>Arg-Gly-Glu-Gly-His-His-Pro-Lys-Arg</td>
</tr>
<tr>
<td>C</td>
<td>Arg-Leu-Glu-Gly-His-His-Pro-Lys-Arg</td>
</tr>
</tbody>
</table>

State one way this data supports the inference that these three bird species may be closely related.

7. State one type of additional information that could be used to determine if these three species are closely related.

8. R, S, and T are three species of birds. Species S and T show similar coloration. The enzymes found in species R and T show similarities. Species R and T also exhibit many of the same behavioral patterns. Show the relationship between species R, S, and T by placing the letter representing each species at the top of the appropriate branch on the diagram below.
9. Using the information given, fill in the missing mRNA base sequence for species B in the chart below.

10. Using the Universal Genetic Code Chart on page 21, fill in the missing amino acid sequence for species C in the chart below.

<table>
<thead>
<tr>
<th>Species</th>
<th>DNA base sequence</th>
<th>mRNA base sequence</th>
<th>Amino acid sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Species A</td>
<td>CCG</td>
<td>TGC</td>
<td>ATA</td>
</tr>
<tr>
<td>mRNA base sequence</td>
<td>GCC</td>
<td>AGC</td>
<td>UAU</td>
</tr>
<tr>
<td>Amino acid sequence</td>
<td>GLY</td>
<td>THR</td>
<td>TYR</td>
</tr>
<tr>
<td>Species B</td>
<td>TGC</td>
<td>TGC</td>
<td>ATA</td>
</tr>
<tr>
<td>mRNA base sequence</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>Amino acid sequence</td>
<td>THR</td>
<td>THR</td>
<td>TYR</td>
</tr>
<tr>
<td>Species C</td>
<td>CCG</td>
<td>TGC</td>
<td>ATA</td>
</tr>
<tr>
<td>mRNA base sequence</td>
<td>GCC</td>
<td>AGC</td>
<td>UAU</td>
</tr>
<tr>
<td>Amino acid sequence</td>
<td>___</td>
<td>___</td>
<td>___</td>
</tr>
<tr>
<td>Species D</td>
<td>CCT</td>
<td>TGT</td>
<td>AAG</td>
</tr>
<tr>
<td>mRNA base sequence</td>
<td>GGA</td>
<td>ACA</td>
<td>UAC</td>
</tr>
<tr>
<td>Amino acid sequence</td>
<td>GLY</td>
<td>THR</td>
<td>TYR</td>
</tr>
</tbody>
</table>

11. According to these amino acid sequences, which two plant species are the most closely related? Support your answer.

Species ________ and ________
Paper chromatography can be used to investigate evolutionary relationships. Leaves from a plant were ground and mixed with a solvent. The mixture of ground leaves and solvent was then filtered. Using a toothpick, twenty drops of the filtrate (material that passed through the filter) were placed at one spot on a strip of chromatography paper. This procedure was repeated using leaves from three other species of plant. A separate strip of chromatography paper was prepared for each plant species. Each of the four strips of chromatography paper was placed in a different beaker containing the same solvent for the same amount of time. One of the laboratory setups is shown below.

12. State one reason for using a new toothpick for the filtrate from each plant.

13. State one way the four strips would most likely be different from each other after being removed from the beakers. [1]

14. State how a comparison of these resulting strips could indicate evolutionary relationships.

Base your answer to question 15 on the portion of the mRNA codon chart and information below.

<table>
<thead>
<tr>
<th>AU U</th>
<th>AC U</th>
<th>AA U</th>
<th>AG U</th>
<th>SER</th>
</tr>
</thead>
<tbody>
<tr>
<td>I L E</td>
<td>TH R</td>
<td>A S N</td>
<td>(Isoleucine)</td>
<td>(Serine)</td>
</tr>
<tr>
<td>(AC C)</td>
<td>(Thr onine)</td>
<td>(Asparagine)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A U C</td>
<td>A A C</td>
<td>A G C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A U A</td>
<td>A A C</td>
<td>A G C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MET</td>
<td>L Y S</td>
<td>(Amino acid)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(M ethionine)</td>
<td>(Lysine)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A U G</td>
<td>A A G</td>
<td>A G G</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Series I represents three mRNA codons. Series II includes a mutation of series I.

Series I AGAUCAUGAGU

Series II ACAUCAUGAGU

15. How would the amino acid sequence produced by the mutant strand (series II) compare to the amino acid sequence produced by series I?
   (1) The amino acid sequence would be shorter.
   (2) One amino acid in the sequence would change.
   (3) The amino acid sequence would remain unchanged.
   (4) More than one amino acid in the sequence would change.
The four wells represented in the diagram were each injected with fragments that were prepared from DNA samples using identical techniques.

This laboratory procedure is known as
(1) cloning
(2) gel electrophoresis
(3) chromatography
(4) use of a dichotomous key

17. The arrow represents the direction of the movement of the DNA fragments. What is responsible for the movement of the DNA in this process?

18. The four samples of DNA were taken from four different individuals. Explain how this is evident from the results shown in the diagram.

19. Identify the substance that was used to treat the DNA to produce the fragments that were put into the wells.

Base your answers to questions 20 through 22 on the diagram below and on your knowledge of biology. Letters A through L represent different species of organisms. The arrows represent long periods of geologic time.

20. Which two species are the most closely related?
   (1) J and L
   (2) G and L
   (3) F and H
   (4) F and G

21. Which species was best adapted to changes that occurred in its environment over the longest period of time?
   (1) A
   (2) B
   (3) C
   (4) J
22. Which two species would most likely show the greatest similarity of DNA and proteins?
   (1) B and J
   (2) G and I
   (3) J and K
   (4) F and L

Based on their analysis of the differences in amino acid sequences of one kind of protein, scientists prepared the evolutionary tree shown below.

23. According to this diagram, the DNA of which pair of organisms would show the greatest similarity?
   (1) penguin and turtle
   (2) horse and donkey
   (3) snake and tuna
   (4) turtle and rabbit

24. Older systems of classification always placed penguins, chickens, ducks, and pigeons in the bird group and turtles and snakes in the reptile group. Does this diagram support the older system of classification? Explain your answer.

25. According to this diagram, is the pig more closely related to the dog or the kangaroo? Justify your answer.