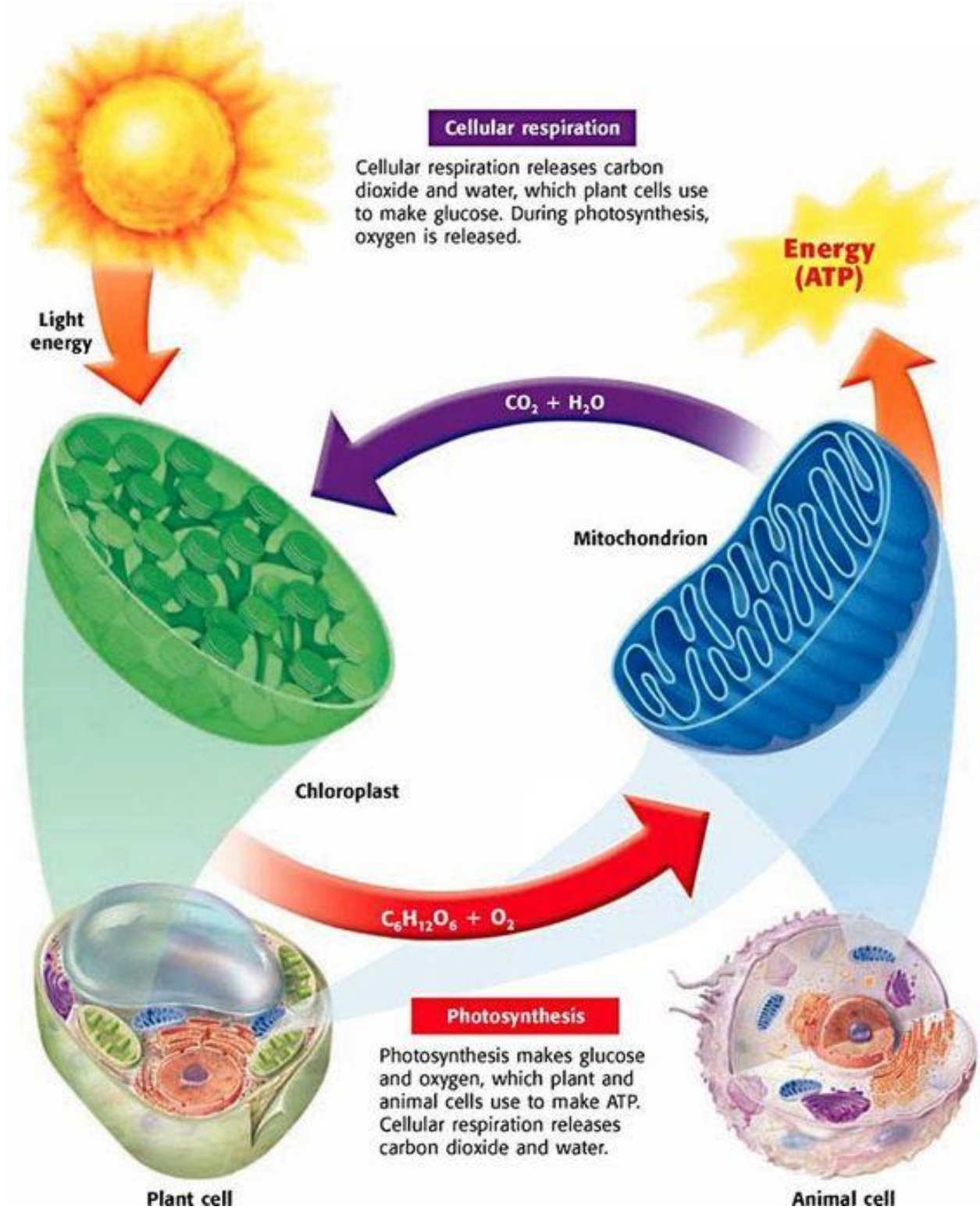


Unit 3: Cellular Respiration Review



Mitochondria Structural Features

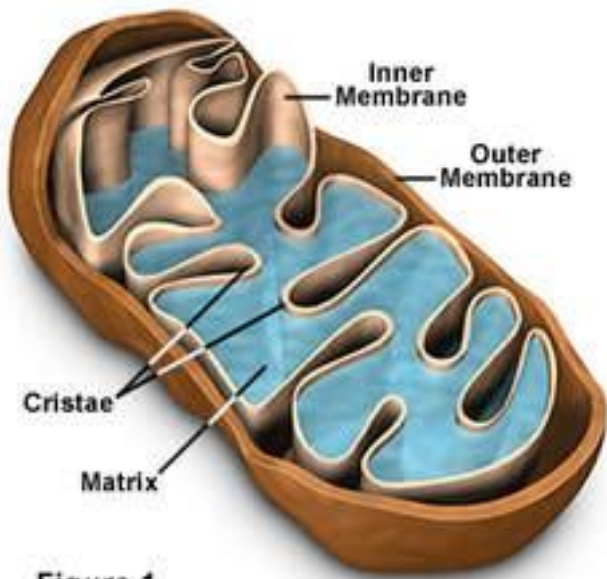
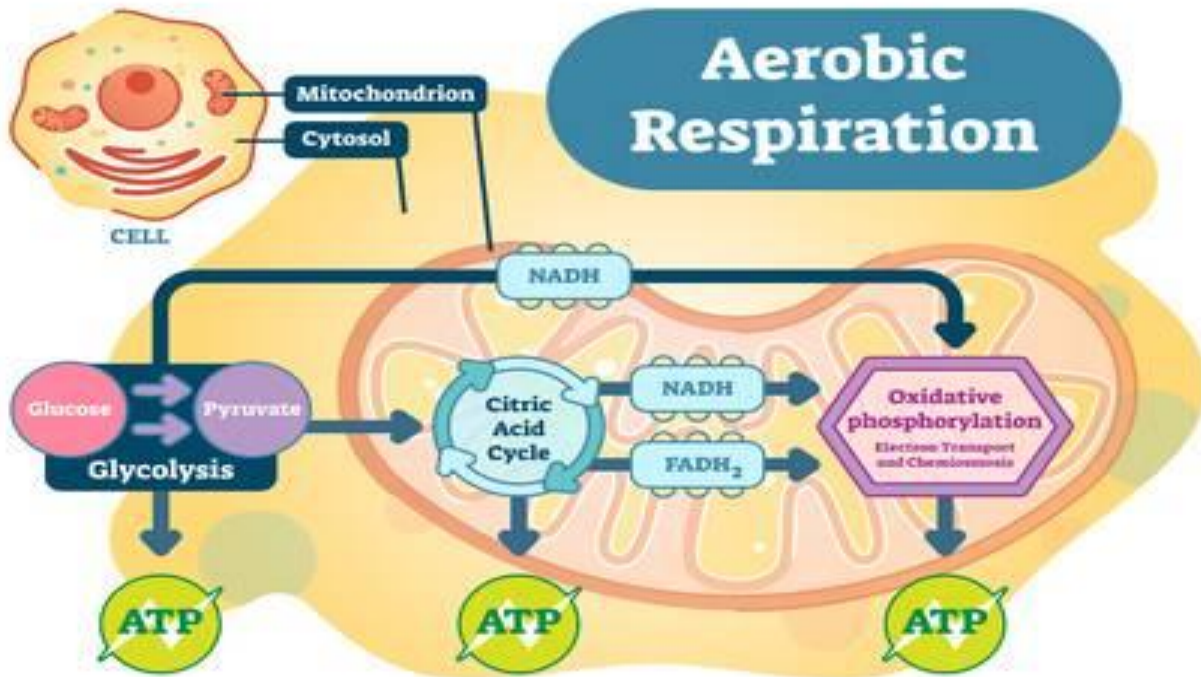
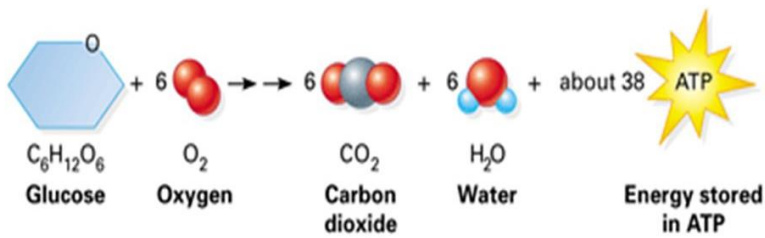
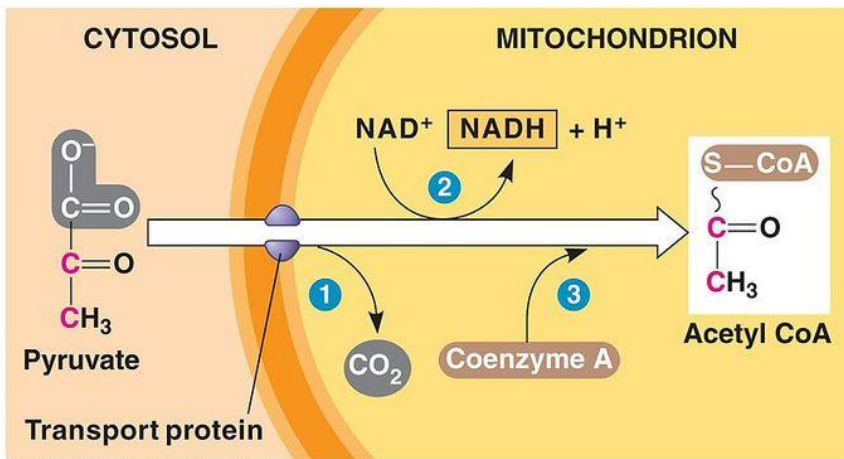
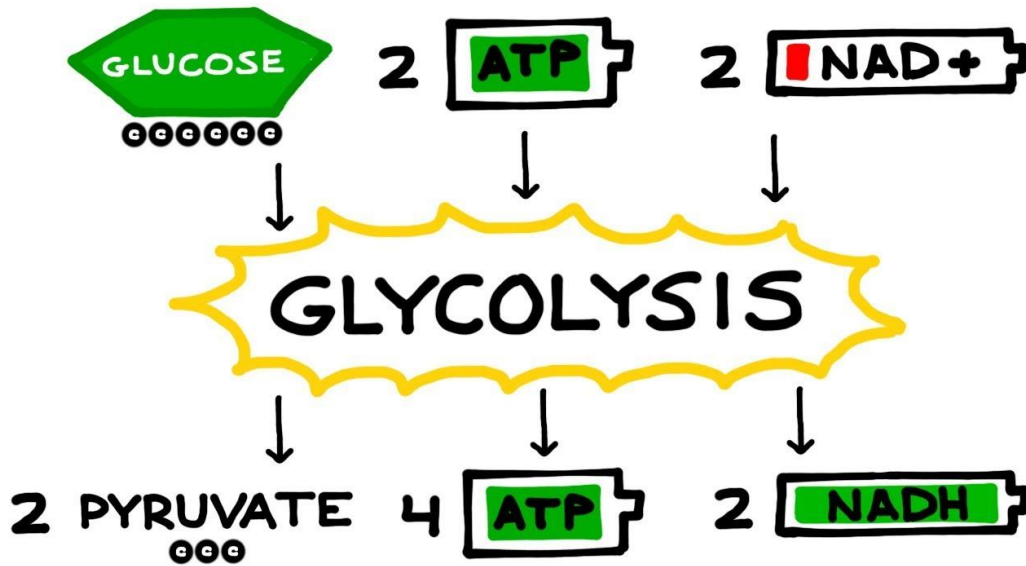
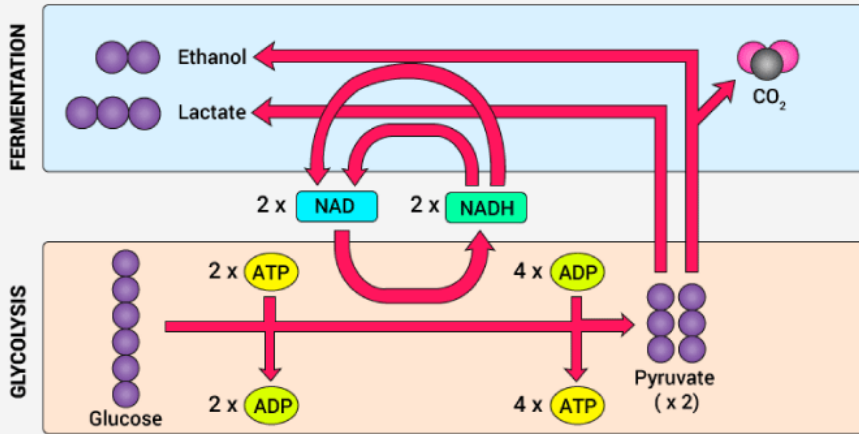


Figure 1



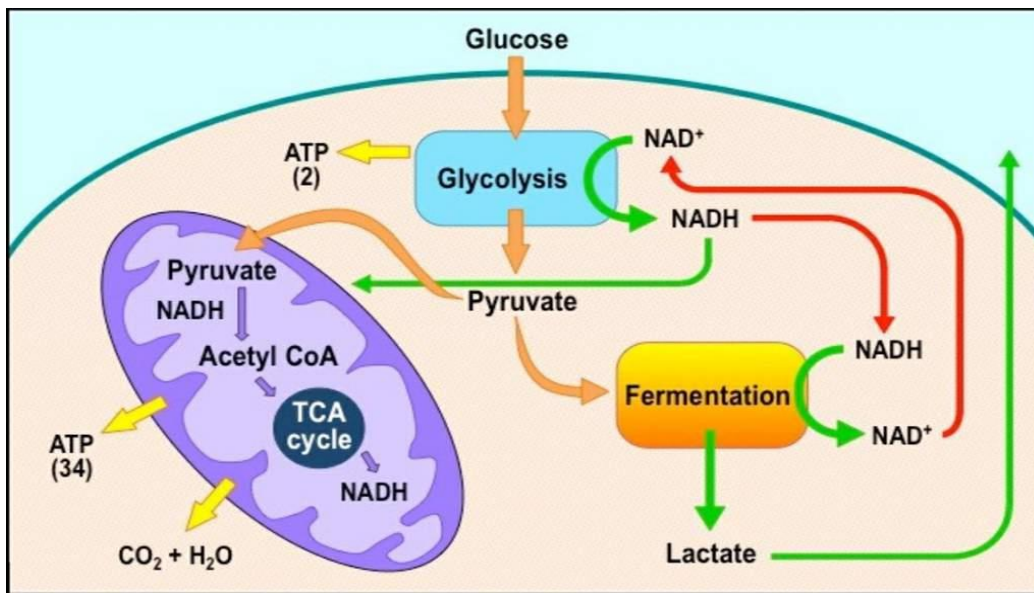
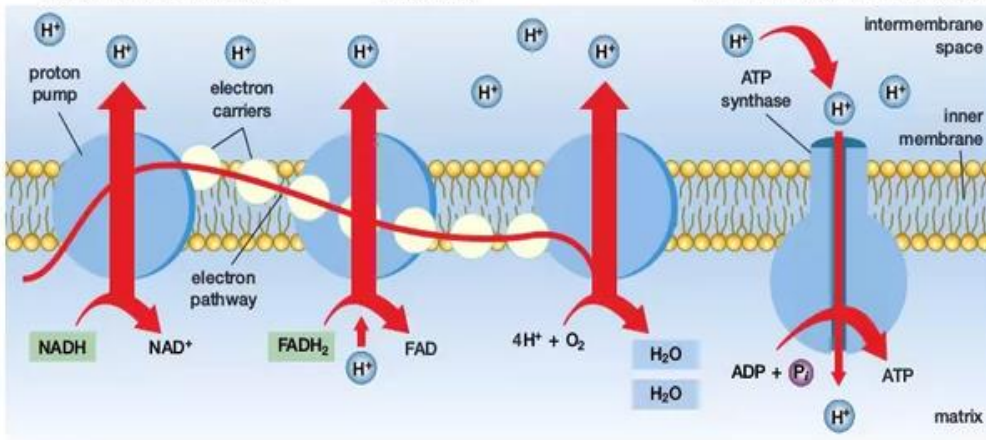
ANAEROBIC RESPIRATION



A As electrons (e^-) move through the electron transport chain, hydrogen ions (H^+) are pumped from the matrix into the intermembrane space.

B A hydrogen ion gradient is formed, with a higher concentration of ions in the intermembrane space than in the matrix.

C When hydrogen ions flow back into the matrix down their concentration gradient, ATP is synthesized from $ADP + P_i$ by an ATP synthase complex.



<u>Term</u>	<u>Definition/Explanation</u>
(1) Endergonic Process:	
(2) Exergonic Process:	
(3) Mitochondrion:	
(4) Cristae:	
(5) Matrix:	
(6) Chemical Potential Energy:	
(7) Glycolysis:	

<u>Term</u>	<u>Definition/Explanation</u>
(8) Glucose:	
(9) Pyruvate:	
(10) Acetyl CoA:	
(11) Carbon Dioxide:	
(12) Krebs Cycle:	
(13) Citric Acid:	
(14) Electron Transport Chain:	

<u>Term</u>	<u>Definition/Explanation</u>
(15) Chemiosmosis:	
(16) Aerobic Respiration:	
(17) Anaerobic Respiration:	
(18) Lactic Acid / Ethanol:	

--Free Response Questions--

19. Draw a diagram / model to summarize your notes.

Make sure to include:

- Initial Energy Source & Type
- Cell
- Mitochondrion & Internal Structures
- The different reactions / processes inside the Mitochondrion
- The main starting compounds / reactants, and the main products of each process
- The names of each process

20. Predict what would happen to the level of ATP production if you made the cristae membrane permeable to protons across its entire length and why.

22. The following chart shows the energy products produced in various stages of the breakdown of glucose.

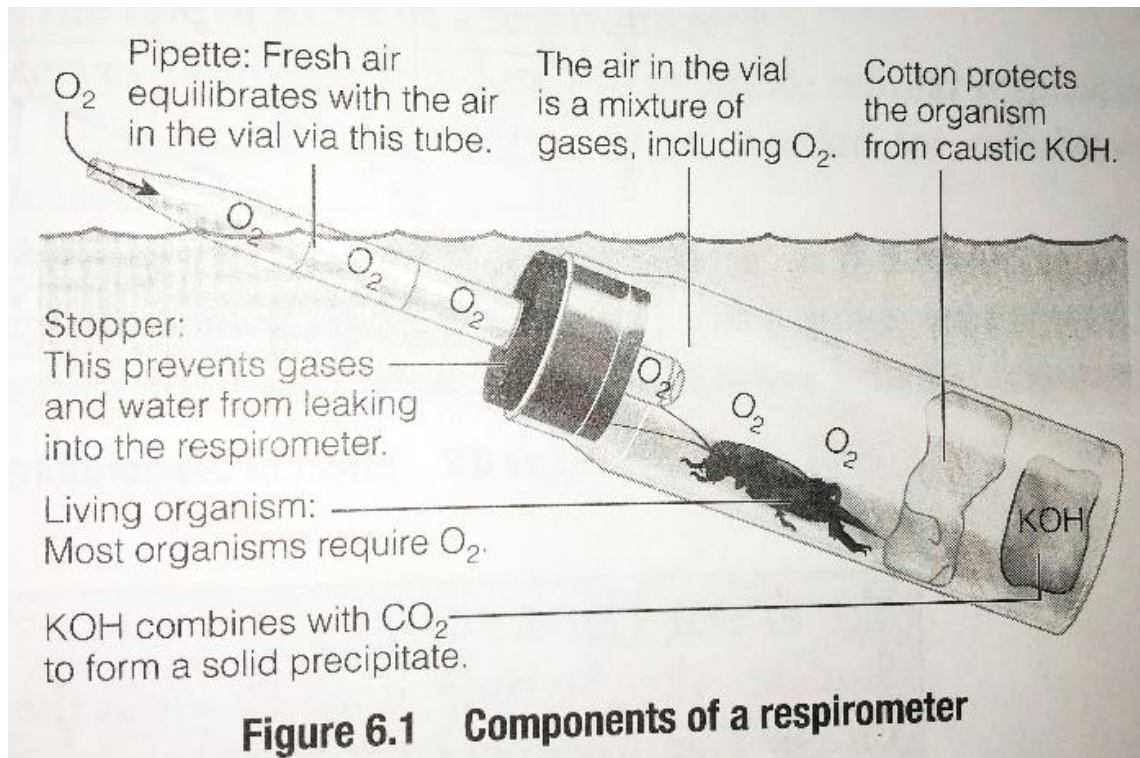
Process	ATP Produced	NADH/FADH₂ Produced
Glycolysis	2	2 NADH
Pyruvate Oxidation (per molecule of pyruvate)	?	1 NADH
Citric Acid Cycle / Krebs Cycle (per molecule of pyruvate)	1	3 NADH 1 FADH ₂

Each molecule of NADH results in approximately 2.5 molecules of ATP, whereas each molecule of FADH₂ results in approximately 1.5 molecules of ATP when these molecules are fed into the electron transport chain.

- a. What is the difference in the total number of ATP molecules produced between 3 molecules of glucose that undergo fermentation compared to 3 molecules of glucose that undergo aerobic respiration?
(Should see ACTUAL MATH 😊)

- b. Glutamine is formed from glutamic acid by adding an ammonium molecule to glutamine. The overall reaction is endergonic, requiring 3.4kcal/mole. The energy for the reaction comes from the exergonic splitting of a phosphate from ATP to form ADP, which releases 7.3kcal/mole. What is the free energy change for this coupled reaction.
(Should see ACTUAL MATH 😊)

23. It is theorized that glycolysis was the first metabolic pathway for the production of ATP. Glycolysis begins the process of making ATP by breaking glucose into 2 molecules of pyruvate. Justify this claim with 3 pieces of evidence that support this point.



24. What are some ways that the rate of cellular respiration could be measured in this experiment?

25. Looking at the diagram, what is a respirometer?

26. What do you think the experimental question is in this set up?

27. What could be experimental variables that you could alter, between different set ups?

28. What could be constants between different set ups?

29. What could be your hypothesis for this experiment?

30. What will happen with the Oxygen Gas entering the respirometer?

31. What will happen with the Carbon Dioxide Gas being produced by the grasshopper?

32. Describe how you could set up this experiment to test the production of water.

33. What is another chemical we have used, in Unit 2, that we could use in this experiment to test the production of CO₂? Describe in detail how the chemical would be used, what you would expect to see and why.

Sprouted seeds absorb water and are larger than unsprouted seeds. Nongerminating (dry) seeds simply refer to seeds that lie dormant until given the proper nutrients to sprout and germinate.

You set up an experiment similar to the respirometer + grasshopper, but with plants instead of animals:

34. Why can you use plants just as easily as animals, to test the productivity of cellular respiration?

You set up the following experiments:

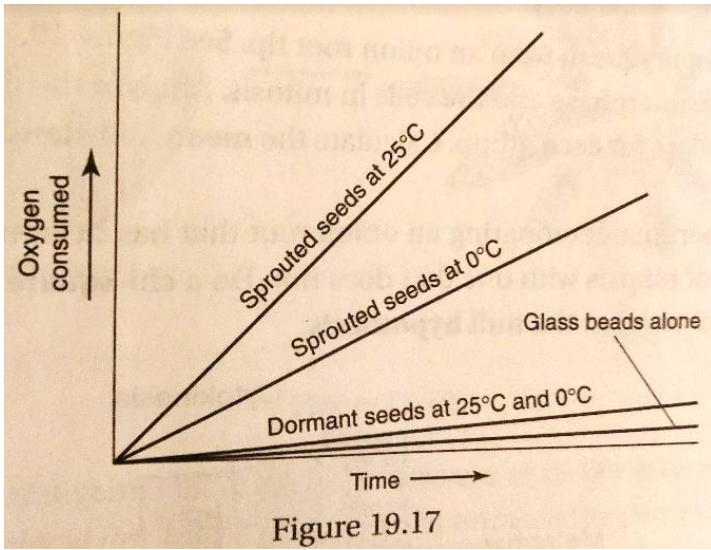
Table 19.1

Effects of Temperature on Respiration Rate

Respirometer	Temperature of Water	Contents
1	25°C	Germinating seeds
2	25°C	Dry seeds + beads
3	25°C	Glass beads alone
4	10°C	Germinating seeds
5	10°C	Dry seeds + beads
6	10°C	Glass beads alone

35. What purpose do you think the glass beads serve in this experiment?

36. You graph the following results from the experiment. Why do these results make sense to you?



--Multiple Choice Questions--

- 37. Which of the following is correct about the role of oxygen during cellular respiration?**
- Oxygen transports CO₂ from the citric acid cycle and out of the body.
 - Oxygen is the necessary raw material for the Krebs cycle.
 - Oxygen provides electrons for the electron transport chain.
 - Oxygen pulls electrons through the electron transport chain and ultimately bonds with them.
- 38. Which of the following harvests the most energy during cellular respiration?**
- Krebs Cycle
 - Chemiosmosis
 - $2 \text{ ATP} + 1 \text{ Glucose} \rightarrow 2 \text{ Pyruvate} + 4 \text{ ATP}$
 - Electron Transport Chain
- 39. All of the following processes produce ATP except,**
- Lactic Acid Formation
 - Oxidative Phosphorylation
 - Glycolysis
 - Krebs Cycle
- 40. After strenuous exercise, a muscle cell would contain decreased amounts of _____ and increased amounts of _____.**
- Glucose ; ATP
 - ATP ; Glucose
 - Oxygen ; Lactic Acid
 - Lactic Acid ; ATP

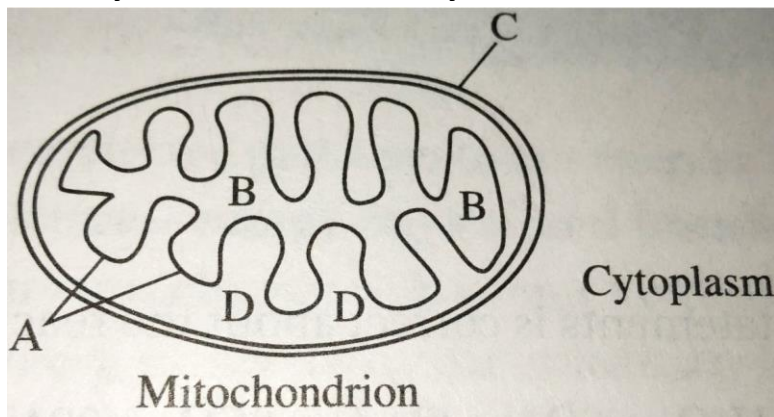
41. Which of the following is correct about the processes shown?

Each process, represents a process within aerobic respiration.

Glucose → Process A → Process B → Process C → CO₂ + H₂O

- a. Process A takes place in mitochondria.
- b. Process B produces ATP by substrate level phosphorylation.
- c. Process B releases NAD⁺.
- d. Process B produces the most ATP of all the processes.

42. Identify the site of the ATP synthase in the sketch of a mitochondrion shown below.



43. Each NADH molecule carrying hydrogen to the electron transport chain can produce a maximum of _____ molecules of ATP.

- a. 1
- b. 2
- c. 3
- d. 4

44. Which is true of aerobic respiration but not true of anaerobic respiration?

- a. CO₂ is produced
- b. ATP is produced
- c. Water is produced
- d. Alcohol is produced

45. Which of the following is the most important thing that happens during aerobic respiration?

- a. Electrons move down the electron transport chain in a series of redox reactions.
- b. Acetyl-CoA enters the Krebs Cycle.
- c. NAD carries hydrogen to the electron transport chain.
- d. ATP is produced.

46. In addition to ATP, what is produced during glycolysis?

- a. Pyruvate and NADH
- b. CO₂ and Water
- c. CO₂ and Ethyl Alcohol
- d. CO₂ and NADH

47. Which of the following probably evolved first?

- a. Krebs Cycle
- b. Oxidative Phosphorylation
- c. Glycolysis
- d. Electron Transport Chain

48. During Cell Respiration, most ATP is formed as a direct result of the net movement of

- a. Electrons flowing against a gradient.
- b. Electrons flowing through a channel.
- c. Protons flowing through a channel.
- d. Protons flowing against a gradient.

49. Glycolysis is the first phase of aerobic cellular respiration. It is a complex enzyme-controlled set of reactions in which glucose molecules are broken down into pyruvate in the absence of oxygen. Although it does not produce much ATP, glycolysis is important because pyruvate is the raw material for the next phase of cellular respiration, which will ultimately produce large amounts of ATP by oxidative phosphorylation. One of the enzymes at the beginning of glycolysis is PFK, phosphofructokinase, an allosteric enzyme. When ATP binds to the allosteric site on PFK, the enzyme changes shape and no longer functions. **Which of the following statements best explains the importance of the enzyme PFK in glycolysis?**

- a. PFK inhibits glycolysis when oxygen levels are high.
- b. PFK enables glycolysis to continue when no oxygen is present.
- c. PFK inhibits the production of ATP when ATP levels are high.
- d. PFK enhances the production of ATP when ATP levels are high.

50. Which of the following statements about cell respiration is NOT correct?

- a. Glycolysis does not utilize oxygen.
- b. The electron transport chain occurs in the cristae membranes of mitochondria.
- c. The outer compartment of a mitochondrion has a lower pH than does the inner matrix.
- d. The citric acid cycle produces pyruvate.

51. Which of the following is NOT correct about NADH and/or FADH₂?

- a. They both carry protons to the electron transport chain from the citric acid cycle.
- b. FADH₂ results in the production of more ATP than does NADH.
- c. They are both vitamin derivatives.
- d. NADH is a reduced form of NAD⁺.

52. Which of the following correct describes the immediate source of energy that drives ATP synthesis in the mitochondrion?

- a. The flow of electrons down the electron transport chain.
- b. The H⁺ concentration gradient across the cristae membrane.
- c. The affinity of oxygen for electrons flowing through the electron transport chain.
- d. ATP → ADP

53. Oxidative phosphorylation is said to couple two reactions. Which two reactions does it bring together?

- a. The endergonic flow of electrons through the ETC with the exergonic movement of protons across the cristae membrane to create a proton gradient.
- b. The exergonic flow of electrons through the ETC with the endergonic pumping of protons across the cristae membrane to create a proton gradient.
- c. The flow of protons from glycolysis to the citric acid cycle.
- d. The production of ATP from the anaerobic phase with the aerobic phase.

54. In a hydroelectric power plant, the energy of falling water turns a turbine, converting kinetic energy to mechanical energy. Next a generator converts the mechanical energy from the turbine into electrical energy. Which process in the production of ATP in cellular respiration is the most similar to this process in a hydroelectric plant?

- a. Citric Acid Cycle
- b. Glycolysis
- c. Oxidative Phosphorylation
- d. Fermentation

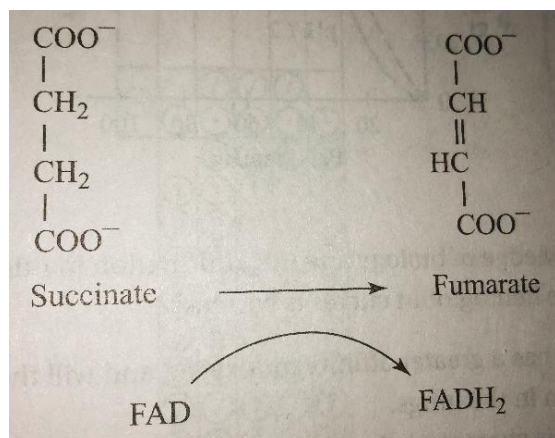
55. Yeast cells carry out both aerobic and anaerobic respiration. A yeast cell that is fed on glucose is moved from an aerobic to an anaerobic environment. Which of the following statements is correct and gives the correct reason for it?

- a. The cells die because it cannot make ATP.
- b. The cell would need to consume glucose at a much greater rate because aerobic respiration is much more efficient as compared with anaerobic respiration.
- c. The cell would need to consume another food source other than glucose because it will not be able to make adequate ATP with only glucose.
- d. The cell will begin to divide rapidly because larger cells require more oxygen and glucose than smaller ones.

56. Energy is harvested during cellular respiration in stages. Which of the following correctly states which phase of cellular respiration harvests the most energy and the correct explanation why?

- The most energy is released during the Krebs Cycle because it is here that pyruvate is completely broken down into CO₂.
- The most energy is released during the Krebs Cycle because in addition to the production of ATP, both FADH₂ and NADH are produced. Each of those molecules will release 2 ATPs and 3ATPs, respectively.
- The most energy is released during oxidative phosphorylation because in addition to the phosphorylation of ADP into ATP, all the potential energy held in NADH and FADH is transferred to ATP.
- The most energy is released during oxidative phosphorylation because H₂O is completely broken down into H⁺ and O₂.

57. The following reaction occurs in the citric acid cycle. Study the reaction as it is shown here.



Which of the following statements is correct?

- This reaction is also part of the Calvin Cycle.
- The reaction occurs in the cristae membrane of mitochondria.
- The reaction is an oxidation reaction because protons are lost from succinate.
- FAD acts as an enzyme.

58. Many different fermentation pathways occur in different organisms in nature. For example, skeletal muscle cells convert pyruvate into lactic acid when no oxygen is present. Yeast cells can produce alcohol and carbon dioxide under the same circumstances. **However, regardless of the specific reactions, the purpose of glycolysis is an important one. Which statement best describes the importance of glycolysis?**

- a. It produces large amounts of ATP by substrate level phosphorylation.
- b. It reoxidizes NADH so that glycolysis can continue.
- c. It produces pyruvate, which is the raw material for oxidative phosphorylation.
- d. It occurs in the cytoplasm.

59. During oxidative phosphorylation, the energy needed to drive ATP synthesis comes from one source. Which of the following statements states the immediate source of that energy?

- a. Electrons flow down an electron transport chain as they are attracted to oxygen?
- b. The transfer of a phosphate group to ADP is exergonic.
- c. The bonding of electrons to oxygen at the end of the chain releases energy.
- d. The proton gradient across the membrane where the ATP synthase is embedded represents potential energy.

60. Which of the following statements about cellular respiration is correct?

- a. Most CO₂ produced during cellular respiration is released from glycolysis.
- b. Protons are pumped through ATP synthase by active transport.
- c. The final electron acceptor of the electron transport chain is NAD⁺.
- d. ATP is formed because an endergonic reaction is coupled with an exergonic reaction.

61. The purpose of cellular respiration in a eukaryotic cell is to:

- a. Synthesize carbohydrates from CO₂.
- b. Synthesize fats and proteins from CO₂.
- c. Break down carbohydrates to provide energy for the cell in the form of ATP.
- d. Provide oxygen to the cell.

62. One glucose molecule provides enough carbons for 2 trips through the citric acid cycle. How many molecules of ATP are directly produced in 2 trips through the citric acid cycle?

- a. 1
- b. 2
- c. 3
- d. 4

63. The process by which glucose is split into pyruvate producing 2 ATP and 2 NADH:

- a. Chemiosmosis
- b. Electron transport chain
- c. Fermentation
- d. Glycolysis

64. The process by which a proton (hydrogen ion) gradient is used to produce ATP:

- a. Chemiosmosis
- b. Electron transport chain
- c. Fermentation
- d. Glycolysis

65. A process by which glucose is split to produce 2 ATP and lactic acid:

- a. Chemiosmosis
- b. Electron transport chain
- c. Fermentation
- d. Glycolysis

66. A series of membrane-embedded electron carriers that ultimately create the hydrogen ion gradient to drive the synthesis of ATP:

- a. Chemiosmosis
- b. Electron transport chain
- c. Fermentation
- d. Glycolysis

As a scientist employed by the FDA, you've been asked to sit on a panel to evaluate a pharmaceutical company's application for approval of a new weight loss drug called Fat Away. The company has submitted a report summarizing the results of their animal and human testing. In the report, it was noted that Fat Away works by affecting the electron transport chain. It decreases the synthesis of ATP by making the mitochondrial membrane permeable to H^+ , which allows H^+ to leak from the intermembrane space to the mitochondrial matrix. This effect leads to weight loss.

67. Fat Away prevents ATP from being made by:

- a. Destroying the hydrogen ion gradient that allows ATP synthase to work.
- b. Preventing glycolysis from occurring.
- c. Preventing the conversion of NADH to NAD^+ .
- d. Slowing down the citric acid cycle.

68. Which of the following statements correctly describes a metabolic effect of cyanide, a poison that blocks the passage of electrons along the electron transport chain?

- a. The pH of the intermembrane space becomes much lower than normal.
- b. Alcohol would build up in the mitochondria.
- c. NADH supplies would be exhausted, and ATP synthesis would cease.
- d. No proton gradient would be produced, and ATP synthesis would cease.

69. Glycolysis releases free energy held in the bonds of glucose, and this energy is held in these molecules:

- a. ATP, NADH, and CO_2
- b. ATP, NADH, and pyruvate
- c. ATP, NADPH, and RUBP
- d. ATP, CO_2 , and H_2O

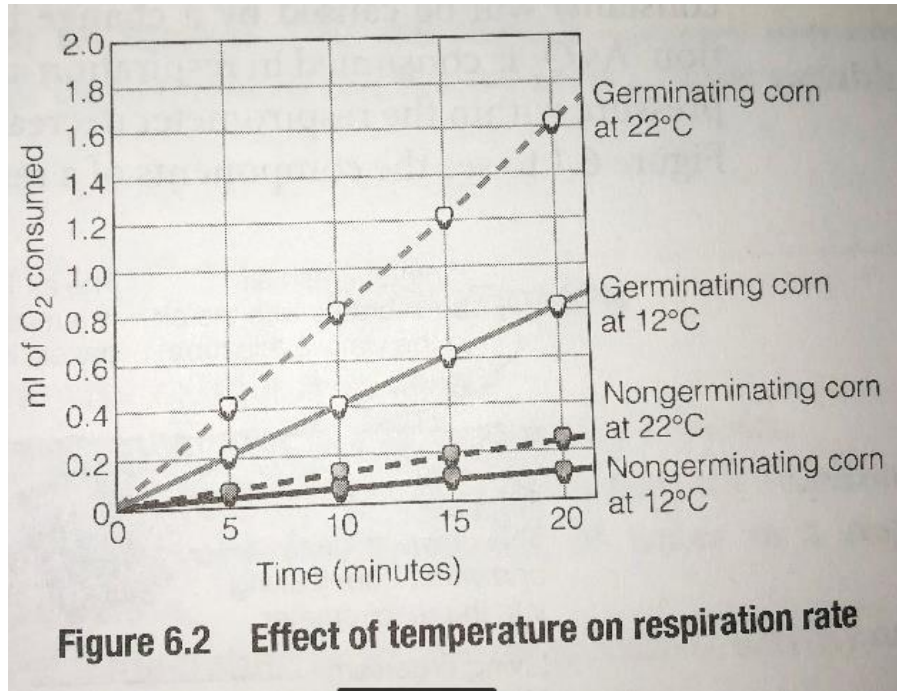
70. Which of the following provides evidence that glycolysis is one of the first metabolic pathways to have evolved?

- a. It relies on fermentation, which is characteristic of archaea and bacteria.
- b. It is found only in prokaryotes, whereas eukaryotes use mitochondria to produce ATP.
- c. It produces ATP only by oxidative phosphorylation and does not involve redox reactions.
- d. It is nearly universal, occurs in the cytosol, and does not involve O₂.

71. The release of the energy stored in glucose involves a series of reaction and processes. Which of the following correctly states the location and function of the process named?

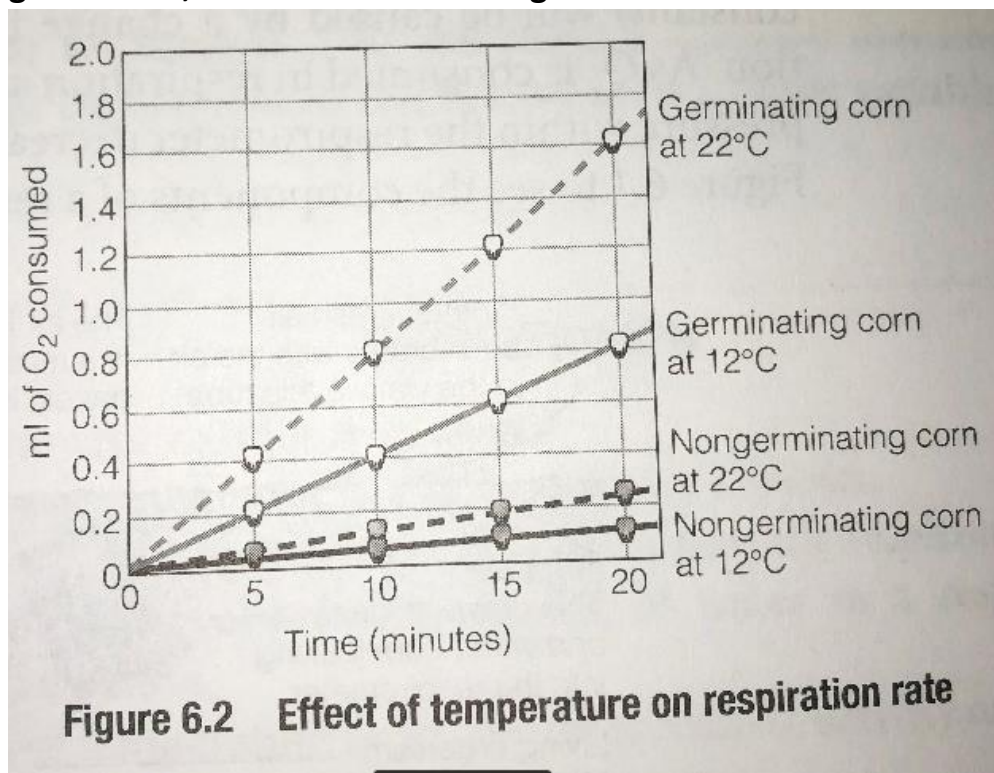
- a. Citric acid cycle releases carbon dioxide from organic intermediates and synthesizes ATP from ADP via substrate level phosphorylation.
- b. Glycolysis releases free energy from glucose to produce ATP by oxidative phosphorylation.
- c. Electron transport occurs in the cytoplasm and harvests the electrons from NADH and FADH₂ to establish the proton gradient.
- d. Chemiosmosis occurs when an enzyme in the inner mitochondrial membrane produces carbon dioxide and water from NADH and ATP.

72. What is the rate of oxygen consumption in germinating corn at 12 degrees Celsius, as shown in the figure below?



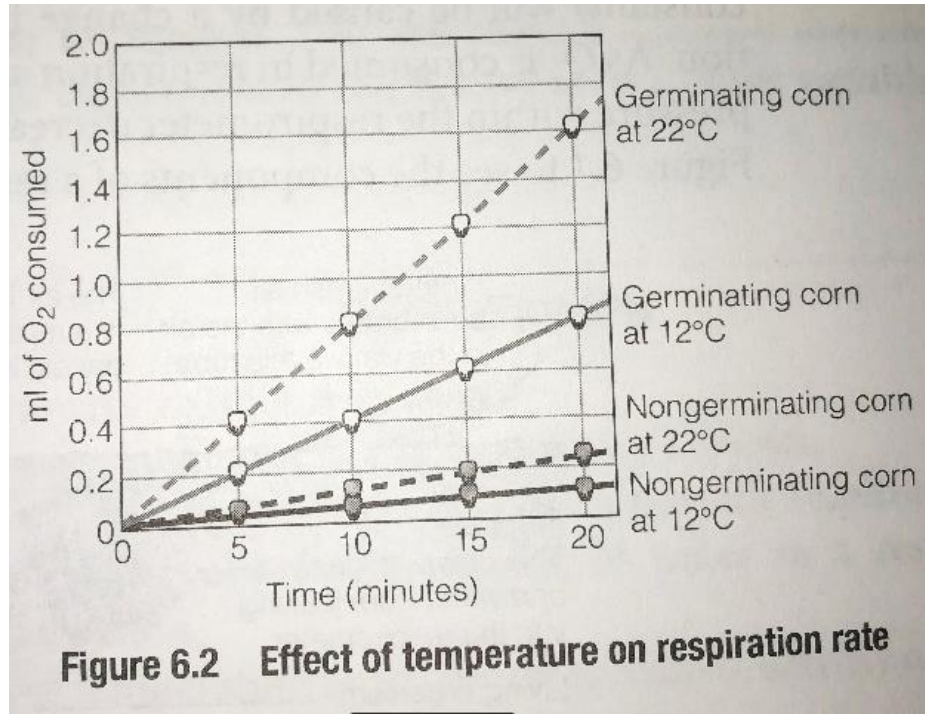
- a. 0.08mL/min
- b. 0.04mL/min
- c. 0.8mL/min
- d. 0.6mL/min

73. Using the figure below, which of the following is a true statement based on the data?



- a. The amount of oxygen consumed by germinating corn at 22 degrees Celsius, is approximately twice the amount of oxygen consumed by germinating corn at 12 degrees Celsius.
- b. The rate of oxygen consumption is the same in both germinating and nongerminating corn during the initial time period from 0 to 5 minutes.
- c. The rate of oxygen consumption in the germinating corn at 12 degrees Celsius at 10 minutes is 0.4mL O₂/minute.
- d. The rate of oxygen consumption is higher for nongerminating corn at 12 degrees Celsius than at 22 degrees Celsius.

74. Which of the following conclusions is supported by the data shown on the graph in the figure below?



- a. The rate of respiration is higher in nongerminating seeds than in germinating seeds.
- b. Nongerminating seeds are not alive and show no difference in rate of respiration at different temperatures.
- c. The rate of respiration in the germinating seeds would have been higher if the experiment were conducted in sunlight.
- d. The rate of respiration increases as the temperature increases in both germinating and nongerminating seeds.

75.DNP (dinitrophenol) is a poison that makes the membrane of the mitochondrion leaky to hydrogen ions. Which of the following results from this alteration of normal cellular respiration?

- a. The electron transport chain is no longer able to transfer electrons to oxygen and so its activity is halted.
- b. A hydrogen ion gradient cannot be established to drive the production of ATP by chemiosmosis.
- c. Hydrogen ions bind to the electron transport molecules and interfere with their ability to generate an electron gradient.
- d. Abnormally large quantities of water will be produced as a result of excess hydrogen ions in the matrix, leading to dehydration and death.

76.Oxidative Phosphorylation utilizes the energy held in electron carries (such as NADH) to produce ATP. Electron carriers from which process would NOT need to be transported in the cell prior to entering the electron transport chain?

- a. Fermentation
- b. Glycolysis
- c. Krebs Cycle
- d. Anaerobic Respiration

77.A pyruvate molecule produced by glycolysis

- a. Has the same number of carbon atoms as glucose.
- b. Is transported to the cytoplasm to the mitochondrial matrix.
- c. Is transported from the mitochondrial matrix to the intermembranous space of the mitochondrion.
- d. Can enter the Krebs Cycle.