These review questions are for Bio 1 Respiration topic. The questions were adapted from several sources, including the textbook's review questions.

1) How many oxygen molecules (O_2) are required for each molecule of glucose ($C_6H_{12}O_6$) that is completely oxidized to carbon dioxide and water via cellular aerobic respiration?
A) 1
B) 3
C) 6
D) 12
E) 30

2) How many ATPs (the net gain) does the cell gain from one molecule of glucose going through aerobic respiration?
A) 1
B) 2
C) 12
D) 32
E) 60

3) Where does the glycolysis step in aerobic respiration take place in eukaryotic cells?
A) mitochondrial matrix
B) mitochondrial outer membrane
C) mitochondrial inner membrane
D) mitochondrial intermembrane space
E) cytoplasm

4) How many ATPs (the net gain) does the cell directly gain from one molecule of glucose going through glycolysis?
A) 1
B) 2
C) 8
D) 32
E) 36

5) How many ATPs (gross, not net) are directly made from one molecule of glucose going through glycolysis?
A) 1
B) 8
C) 4
D) 32
E) 36

6) In glycolysis, for each molecule of glucose broken down into pyruvate...
A) two molecules of ATP are used and two molecules of ATP are produced.
B) two molecules of ATP are used and four molecules of ATP are produced.
C) four molecules of ATP are used and two molecules of ATP are produced.
D) two molecules of ATP are used and six molecules of ATP are produced.
E) six molecules of ATP are used and six molecules of ATP are produced.

7) Which intermediate molecule of the glycolysis metabolic pathway is also an intermediate molecule of the photosynthesis Calvin cycle?
A) PGAL
B) RuBP
C) Glucose
D) None. The two metabolic pathways have no molecules in common

8) During glycolysis, when each molecule of glucose is broken down in to two molecules of pyruvate, most of the potential energy contained in glucose is
A) transferred to ADP, forming ATP.
B) transferred directly to ATP.
C) retained in the two pyruvates.
D) stored in the NADH produced.
E) used to phosphorylate fructose to form fructose 6-phosphate.

9) Which of the following is **not** a product of glycolysis?
A) ATP
B) Pyruvate
C) CO2
D) NADH

10) Starting with one molecule of glucose, the net products of glycolysis are...
A) 2 NAD^+, 2 pyruvate, and 2 ATP.
B) 2 NADH, 2 pyruvate, and 2 ATP.
C) 2 $FADH_2$, 2 pyruvate, and 4 ATP.
D) 6 CO2, 2 ATP, and 2 pyruvate.
E) 6 CO2, 30 ATP, and 2 pyruvate.

11) Which kind of metabolic poison would have the biggest impact on glycolysis making its usual products?
A) an agent that reacts with oxygen and depletes its concentration in the cell
B) an agent that binds to pyruvate and inactivates it

C) an agent that closely mimics the structure of glucose but is not broken down
D) an agent that reacts with NADH and oxidizes it to NAD^+
E) an agent that blocks the passage of electrons along the electron transport chain

12) High levels of citric acid inhibit the enzyme phosphofructokinase, a key enzyme in glycolysis. Citric acid binds to the enzyme at a different location from the active site. This is an example of...
A) competitive inhibition.
B) allosteric regulation.
C) the specificity of enzymes for their substrates.
D) an enzyme requiring a cofactor.
E) positive feedback regulation.

13) Phosphofructokinase is an allostericly-regulated enzyme enzyme that catalyzes the conversion of fructose 6-phosphate to fructose 1,6-bisphosphate, an early step of glycolysis. Considering that ATP is an end product of the aerobic respiration pathway, and based on your knowledge of feedback inhibition, an increase in the amount of ATP (to well above the normal level in the cell) would be expected to...
A) inhibit the enzyme and thus slow the rates of glycolysis
B) activate the enzyme and thus slow the rates of glycolysis
C) inhibit the enzyme and thus increase the rates of glycolysis
D) activate the enzyme and increase the rates of glycolysis

14) As pyruvate enters the mitochondria, it is changed into...
A) ATP and water
B) Water and carbon dioxide
C) Carbon dioxide and Acetyl CoA
D) Acetyl CoA and H+
E) H^+ and ATP

15) Which of the following molecules (generated from pyruvate) enters the Kreb's cycle (the citric acid cycle)?
A) lactate
B) PGAL
C) carbon dioxide
D) acetyl CoA
E) citrate

16) The reactions of the Krebs cycle occur in the...
A) Inner membrane of the mitochondria
B) Between the inner and outer membranes of the mitochondria

C) In the cytoplasm
D) In the innermost compartment of the mitochondria
E) Outer membrane of the mitochondria

17) How many carbon atoms are fed into the Krebs cycle per each molecule of pyruvate that is made by glycolysis?
A) two
B) four
C) six
D) eight
E) ten

18) The pyruvate molecules made by glycolysis undergo some reactions before they enter the mitochondria. The first reaction is that the pyruvate loses a carbon, which is given off as a molecule of CO2. The second reaction is that rest of the pyruvate molecule becomes a molecule of _____ as it enters the mitochrondria.
A) acetyl CoA
B) $FADH_2$
C) ATP
D) NADH

19) How many carbon dioxide molecules (CO_2) are produced for each molecule of glucose ($C_6H_{12}O_6$) that is completely oxidized to carbon dioxide and water via aerobic respiration?
A) 2
B) 4
C) 6
D) 32
E) 36

20) How many carbon dioxide molecules (CO_2) are produced **by the Krebs cycle** for each molecule of glucose ($C_6H_{12}O_6$) that is completely oxidized to carbon dioxide and water via aerobic respiration?
A) 1
B) 2
C) 4
D) 32
E) 36

21) How many ATP molecules can be made **directly** by the Krebs cycle from one molecule of acetyl Co-A?

A) 1
B) 2
C) 11
D) 12
E) 24

22) For each molecule of glucose oxidized by cellular aerobic respiration, how many molecules of ATP are made directly in the Krebs cycle?
A) 1
B) 2
C) 11
D) 12
E) 24

23) Which of the following combinations of products are directly produced by the Krebs cycle from two acetyl CoA molecules entering the Krebs cycle?
A) 1 ATP, 2 CO_2, 3 NADH, and 1 $FADH_2$
B) 2 ATP, 4 CO_2, 6 NADH, and 2 $FADH_2$
C) 3 ATP, 3 CO_2, 3 NADH, and 3 $FADH_2$
D) 3 ATP, 6 CO_2, 9 NADH, and 3 $FADH_2$
E) 38 ATP, 6 CO_2, 3 NADH, and 12 $FADH_2$

24) The molecule NADH is used by cells to carry...
A) carbon atoms
B) glucose
C) ribose
D) nicotine
E) electrons

25) In mitochondria, when ATP is made, H^+ moves from the _____ to the _____.
A) Matrix, Cytoplasm
B) Cytoplasm, Intermembrane space
C) Intermembrane space, Matrix
D) Intermembrane space, Cytoplasm
E) Cytoplasm, Matrix.

26) Where are the proteins of the mitochondria's electron transport system located?
A) cytoplasm
B) mitochondrial outer membrane
C) mitochondrial inner membrane
D) mitochondrial intermembrane space

E) mitochondrial matrix

27) In cellular respiration, the energy that directly drives most ATP synthesis is supplied by...
A) high energy phosphate bonds in organic molecules.
B) an H^+ gradient across a membrane.
C) converting oxygen to ATP.
D) converting glucose to pyruvate (glycolysis).
E) generating carbon dioxide and oxygen in the electron transport chain.

28) Which of the following donates electrons that move through only two of the three H^+ pumps of the mitochondria's electron transport chain?
A) NAD^+
B) NADH
C) ATP
D) ADP
E) $FADH_2$

29) The primary role of oxygen in cellular aerobic respiration is to
A) yield energy in the form of ATP as it is passed down the respiratory chain.
B) act as an acceptor for electrons and H^+ , forming water.
C) combine with carbon, forming CO2.
D) combine with lactate, forming pyruvate.
E) catalyze the reactions of glycolysis.

30) During aerobic respiration, H_2O is formed. Where does the oxygen atom for the formation of the water come from?
A) carbon dioxide
B) glucose
C) molecular oxygen (O_2)
D) pyruvate ($C_3H_3O_3^-$)
E) lactate ($C_3H_5O_3^-$)

31) The energy of the electrons that move through the mitochondrial electron transport system is **directly** used to make...
A) CO2
B) NADH
C) Water
D) an H^+ gradient

32) The electron energy that moves through the electron transport chain is used to pump H^+ into which location in eukaryotic cells?
A) cytoplasm
B) mitochondrial outer membrane
C) mitochondrial inner membrane
D) mitochondrial intermembrane space
E) mitochondrial matrix

33) Where is ATP synthase enzyme located in the mitochondrion?
A) cytoplasm
B) outer membrane
C) inner membrane
D) mitochondrial matrix

34) The synthesis of ATP using the energy released by movement of H^+ across the membrane down their concentration gradient, is an example of
A) active transport.
B) facilitated diffusion.
C) competitive inhibition.
D) osmosis.
E) allosteric regulation.

35) The electrons of NADH and $FADH_2$ are
A) Pumped into the intermembrane space to form an electron concentration gradient
B) Transferred to the ATP synthase enzyme
C) Transferred to cytochrome proteins in the inner membrane of the mitochondria
D) Used to split water molecules into oxygen molecules

36) What happens to the electrons at the end of the mitochondrial electron transport system?
A) 2 electrons combine with H^+ and a molecule of NAD^+.
B) 2 electrons combine with an oxygen atom and two H^+.
C) 4 electrons combine with a molecule of CO2 and 4 H^+.
D) 4 electrons combine with four H^+ and two ATP molecules.
E) 1 electron combines with a molecule of O2 and a H^+.

37) The direct energy source that drives ATP synthesis by ATP synthase enzyme in the mitochondria is...
A) oxidation of glucose and other organic compounds.
B) flow of electrons down the electron transport chain.
C) affinity of oxygen for electrons.

D) H^+ concentration across the membrane holding ATP synthase.
E) transfer of phosphate to ADP.

38) The electrons moving through the mitochondria's electron transport system end up as part of which molecule?
A) Carbon dioxide
B) Water.
C) NAD^+.
D) pyruvate.
E) ADP.

39) When electrons flow along the electron transport system of mitochondria, which of the following changes occurs?
A) The pH of the matrix increases.
B) ATP synthase pumps protons by active transport.
C) The electrons gain energy.
D) The electron carriers use ADP to form ATP.
E) NADH is generated.

40) Prokaryotes as well as eukaryotes, can perform aerobic respiration. Where would you guess that the respiratory electron transport system is located in prokaryotic cells?
A) in the mitochondrial inner membrane.
B) in the mitochondrial outer membrane.
C) in the plasma membrane.
D) in the cytoplasm.
E) in the bacterial cell wall.

41) Which of the following produces the most ATP when glucose is completely oxidized to carbon dioxide and water?
A) glycolysis proteins
B) fermentation
C) the transition step (oxidation of pyruvate to acetyl CoA) proteins
D) citric acid cycle proteins
E) the proteins in the inner membrane

42) During aerobic respiration, which answer lists the correct sequence of molecules that electrons travel through?
A) food -> Krebs cycle -> ATP -> NAD^+
B) food -> NADH -> electron transport chain -> oxygen
C) glucose -> pyruvate -> ATP -> oxygen
D) glucose -> ATP -> electron transport chain -> NADH

E) food -> glycolysis -> Krebs cycle cycle -> NADH -> ATP

43) Carbon dioxide is created during which of the following stages of cellular aerobic respiration?
A) glycolysis and the oxidation of pyruvate to acetyl CoA
B) oxidation of pyruvate to acetyl CoA and the Krebs cycle
C) the Krebs cycle and ATP production
D) ATP production and the electron transport system
E) alcohol production

44) Most CO2 from aerobic respiration is created during...
A) glycolysis.
B) the Krebs cycle.
C) lactate fermentation.
D) electron transport.
E) activity of ATP synthase enzyme.

45) The oxygen consumed during cellular respiration is involved directly in which process or event?
A) glycolysis
B) accepting electrons at the end of the electron transport chain
C) the Krebs cycle
D) changing pyruvate to acetyl CoA
E) the phosphorylation of ADP to form ATP

46) Which cellular respiration process in eukaryotic cells will proceed normally whether oxygen (O2)is present or absent?
A) electron transport
B) glycolysis
C) the Krebs cycle
D) the electron transport chain
E) the transition step

47) At a molecular level, what makes carbohydrates and fats high energy foods?
A) They have a lot of oxygen-carbon bonds.
B) They have no nitrogen in their makeup.
C) They can have very long carbon skeletons.
D) They have a lots of hydrogen-carbon bonds.
E) They have lots of nitrogen-carbon bonds.

48) The very end of the _____ step of aerobic respiration is the instant when all of the carbon atoms of glucose are fully oxidized into CO_2
A) The Krebs cycle
B) Glycolysis
C) Pyruvate oxidation (the transition step)
D) The electron transport system

49) For each molecule of glucose that is metabolized by aerobic respiration, what is the total number of NADH molecules produced?
A) 2
B) 4
C) 6
D) 10
E) 12

50) For each molecule of glucose that is metabolized by aerobic respiration, what is the total number of $FADH_2$ molecules produced?
A) 2
B) 4
C) 6
D) 10
E) 12

51) You have a friend who lost 7 kg (about 15 pounds) of fat on a regimen of strict dieting. How did the atoms of the fat molecules leave her body?
A) They were released as CO2 and H2O.
B) They were converted to heat and then released.
C) They were converted to ATP, which weighs much less than fat.
D) They were broken down to amino acids and eliminated from the body.
E) They were broken down to amino acids and converted into muscle protein.

52) When fatty acids are used as the fuel for aerobic respiration (instead of glucose, the normal fuel), each fatty acid molecule is broken apart by enzymes into several two-carbon molecules. Which aerobic respiration intermediate molecule do these two-carbon molecules become?
A) glucose
B) pyruvate
C) PGAL
D) ATP
E) Acetyl-CoA

53) Where do the catabolic products of fatty acid breakdown enter into the aerobic respiration pathway?
A) glycolysis
B) ATP production by ATP synthase enzyme
C) the transition step (oxidation of pyruvate to acetyl CoA)
D) The Krebs cycle
E) the electron transport system

54) A spaceship is designed to support animal life for a multiyear voyage to the outer planets of the solar system. Plants will be grown to provide oxygen and to recycle carbon dioxide. Since the spaceship will be too far from the sun for photosynthesis, an artificial light source will be needed. If the light source stops functioning, what will happen to CO_2 levels?
A) CO_2 will rise as a result of both animal and plant respiration.
B) CO_2 will rise as a result of animal respiration only.
C) CO_2 will remain balanced because plants will continue to fix CO_2 in the dark.
D) CO_2 will fall because plants will increase CO_2 fixation.
E) CO_2 will fall because plants will cease to respire in the dark.

55) In a plant cell, where are the ATP synthase complexes (the enzyme that makes ATP from a H^+ gradient) located?
A) thylakoid membrane only
B) plasma membrane only
C) inner mitochondrial membrane only
D) thylakoid membrane and inner mitochondrial membrane
E) thylakoid membrane and plasma membrane

56) Which of the following statements best describes the relationship between photosynthesis and respiration?
A) Respiration runs the biochemical pathways of photosynthesis in reverse.
B) Photosynthesis stores energy in glucose molecules, whereas respiration releases it.
C) Photosynthesis occurs only in plants and respiration occurs only in animals.
D) ATP molecules are produced in photosynthesis and used up in respiration.
E) Respiration is anabolic and photosynthesis is catabolic.

57) Where are electron transport systems found in plant cells?
A) thylakoid membrane only
B) plasma membrane only
C) inner mitochondrial membrane only
D) thylakoid membrane and inner mitochondrial membrane
E) thylakoid membrane and plasma membrane

58) Plants photosynthesize only in the light. Plants do cellular respiration...
A) in the dark only.
B) in the light only.
C) both in light and dark.
D) never–they get their ATP from photophosphorylation.
E) only when excessive light energy induces photorespiration.

59) In photosynthetic cells, synthesis of ATP occurs during
A) photosynthesis only.
B) respiration only.
C) both photosynthesis and respiration.
D) neither photosynthesis nor respiration.

60) In plants, formation of water molecules out of O_2 and H^+ and electrons occurs...
A) photosynthesis only.
B) respiration only.
C) both photosynthesis and respiration.
D) neither photosynthesis nor respiration.

61) The splitting of carbon dioxide to form oxygen gas and carbon compounds occurs during...
A) photosynthesis.
B) respiration.
C) both photosynthesis and respiration.
D) neither photosynthesis nor respiration.

62) Generation of an H^+ gradient across a membrane occurs during...
A) photosynthesis.
B) respiration.
C) both photosynthesis and respiration.
D) neither photosynthesis nor respiration.

63) Which of the following occurs in the cytoplasm of a eukaryotic cell?
A) glycolysis and anaerobic respiration
B) anaerobic respiration and ATP production by ATP synthase enzyme
C) the Krebs cycle
D) the electron transport system

64) Which metabolic pathway is common to both anaerobic and aerobic cellular

respiration of a glucose molecule?
A) the Krebs cycle
B) the electron transport system
C) glycolysis
D) synthesis of acetyl CoA from pyruvate
E) conversion of pyruvate to lactate

65) What is the normal fuel molecule that yeast cells metabolize to make ATP from ADP under anaerobic conditions?
A) glucose
B) ethanol
C) pyruvate
D) lactic acid
E) either ethanol or lactic acid

66) In the absence of oxygen, yeast cells can obtain energy by anaerobic respiration, resulting in the production of which end product molecules?
A) ATP, CO_2, and ethanol (ethyl alcohol).
B) ATP, CO_2, and lactate.
C) ATP, NADH, and pyruvate.
D) ATP, pyruvate, and oxygen.
E) ATP, pyruvate, and acetyl CoA.

67) How many ATPs (the net gain) does the cell gain from one molecule of glucose going through anaerobic respiration?
A) 1
B) 2
C) 4
D) 36
E) 60

68) How many lactic acid molecules does the cell make from one molecule of glucose going through anaerobic respiration?
A) 1
B) 2
C) 4
D) 36
E) 60

69) How many ethanol molecules does a yeast cell make from one molecule of glucose going through anaerobic respiration?

A) 1
B) 2
C) 4
D) 36
E) 60

70) How many CO2 molecules does a yeast cell make from one molecule of glucose going through anaerobic respiration?
A) 1
B) 2
C) 4
D) 36
E) 60

71) During intense exercise, muscle cells switch from using aerobic respiration to using anaerobic respiration. This results in...
A) More glucose being used in each muscle cell (compared to using aerobic respiration).
B) Less glucose being used in each muscle cell (compared to using aerobic respiration).
C) No change in the glucose being used in each muscle cell.
D) More oxygen being used in each muscle cell.

72) When muscle cells perform anaerobic respiration, they become fatigued and painful. This is now known to be caused by...
A) buildup of pyruvate.
B) buildup of lactic acid.
C) increase in sodium ions.
D) increase in potassium ions.
E) increase in ethanol.

Answers to review questions:

1) C
2) D
3) E
4) B
5) C
6) B
7) A
8) C
9) C
10) B

11) C
12) B
13) A
14) C
15) D
16) D
17) A
18) A
19) C
20) C
21) A
22) B
23) B
24) E
25) C
26) C
27) B
28) E
29) B
30) C
31) D
32) D
33) C
34) B
35) C
36) B
37) D
38) B
39) A
40) C
41) E
42) B
43) B
44) B
45) B
46) B
47) D
48) A
49) D
50) A
51) A
52) E
53) D
54) A
55) D
56) B

57) D
58) C
59) C
60) B
61) A
62) D
63) A
64) C
65) A
66) A
67) B
68) B
69) B
70) B
71) A
72) B