AP Biology – Cellular Energetics Exam
Life: The Science of Biology (Chapters 7-8)

For Questions 1-10, compare the light reactions with the Calvin cycle of photosynthesis in plants. Use the following key:

a. light reactions alone
b. the Calvin cycle alone
c. both the light reactions and the Calvin cycle
d. neither the light reactions nor the Calvin cycle
e. occurs in the chloroplast but is not part of photosynthesis

1. Produces molecular oxygen (O_2)
2. Forms a proton gradient
3. Requires ATP
4. Requires ADP
5. Produces NADH
6. Produces NADPH
7. Produces triose (3-carbon) sugars
8. Is inactive in the dark
9. Requires CO_2
10. Requires glucose

Questions 11-14 are based on the stages of glucose oxidation listed below.

a. stage I: glycolysis
b. stage II: oxidation of pyruvate to acetyl CoA
c. stage III: Krebs (CTA) cycle
d. stage IV: oxidative phosphorylation (chemiosmosis/ETC)

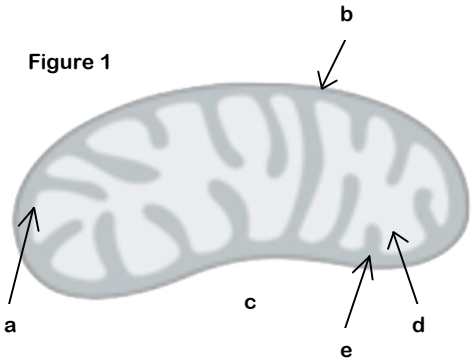
11. Which one of the stages produces the most ATP when glucose is completely oxidized to carbon dioxide and water?
12. Which one of the stages normally occurs whether or not oxygen is present?
13. Which one of the stages occurs in the cytosol of the cell?
14. Carbon dioxide is released during which stages?
    a. stage III only
    b. stages II and III
    c. stages III and IV
    d. stages I, II, and III
    e. stages II, III, and IV

Questions 15 and 16 are based on the following information. A series of enzymes catalyze the reaction X→Y→Z→A. Product "A" binds to the enzyme that converts X to Y at a position remote from its active site. This binding decreases the activity of the enzyme.

15. In this example, substance X is
    a. a coenzyme
    b. an allosteric inhibitor
    c. a substrate
    d. an intermediate
    e. the product
16. In this example ,substance A functions as
    a. a coenzyme
    b. an allosteric inhibitor
    c. the substrate
    d. an intermediate
    e. a competitive inhibitor

Refer to Figure 1 to answer the questions 17-19.

Figure 1



17. The electron transport chain energy is used to pump H+ ions into which location?
18. Glycolysis takes place in which location?
19. Where are the proteins of the electron transport chain located?

20. You are a research scientist studying photosynthesis. In an experiment performed during the day, you provide a new plant, just discovered in South America, with radioactive carbon (14C) dioxide as a metabolic tracer. The 14C is incorporated first into oxaloacetic acid. The plant is best characterized as
    a. a C4 plant.
    b. a C3 plant.
    c. a CAM plant.
    d. a heterotroph
    e. a chemoautotroph

21. In a plant cell, where is ATP synthase located?
    a. thylakoid membrane
    b. plasma membrane
    c. inner mitochondrial membrane
    d. a and c
    e. a, d, and c

22. Which of the following are products of the Calvin cycle and are utilized in the light reactions of photosynthesis?
    a. CO_2 and glucose
    b. H_2O and O_2
    c. ADP, P_i, and $NADP^+$
    d. electrons and H+
    e. Both c and d are correct

23. As a research scientist, you measure the amount of ATP and NADPH consumed by the Calvin cycle in 1 hour. You find 30,000 molecules of ATP consumed, but only 20,000 molecules of NADPH. Where did the extra ATP molecules come from?
    a. photosystem II
    b. photosystem I
    c. cyclic electron flow
    d. noncyclic electron flow
    e. chlorophyll

24. Which of the following events in the functioning of photosystem II is FALSE?
    a. Light energy excites electrons in an antenna pigment in a photosynthetic unit.
    b. The excitation is passed along to a molecule of P680 chlorophyll in the photosynthetic unit.
    c. The P680 chlorophyll donates a pair of protons to NADPH, which is thus converted to NADP+
    d. The electron vacancies in P680 are filled by electrons derived from water.
    e. The splitting if water yields molecular oxygen as a by-product.

25. Which of the following enzymes is probably the most abundant protein in the world?
    a. PEP carboxylase
    b. hexokinase
    c. RuBP carboxylase (Rubisco)
    d. aldolase
    e. pyruvate kinase

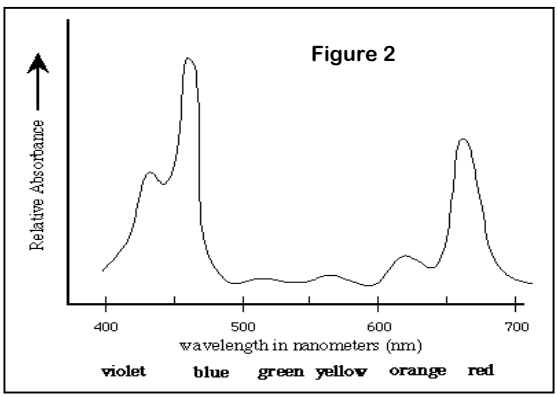
26. In C4 photosynthesis, carbon fixation takes place in the _____ cells, and then is transferred as malic or aspartic acid to _____ cells where carbon dioxide is released for entry into the Calvin cycle.
    a. mesophyll; bundle sheath
    b. stomatal; mesophyll
    c. bundle sheath; epidermal
    d. epidermal; mesophyll
    e. stomatal; epidermal

27. You have just discovered a new flower species that has a unique photosynthetic pigment. The leaves of this plant appear to be reddish yellow. What wavelengths of visible light are not being absorbed by this pigment?
    a. red and yellow
    b. blue and violet
    c. green and yellow
    d. blue, green, and red
    e. green, blue, and violet

28. The reactions of the Calvin cycle require all of the following molecules EXCEPT
    a. CO_2
    b. ATP
    c. RuBP
    d. glucose
    e. NADPH

29. The primary function of the light reactions of photosynthesis is
    a. to produce energy-rich glucose from carbon dioxide and water.
    b. to produce energy-rich ATP and NADPH
    c. to produce NADPH used in respiration.
    d. to convert light energy to the chemical energy of PGAL
    e. to use ATP to make glucose.

30. Of the following colors of light in Figure 2, the color of light LEAST effective in driving photosynthesis is
    a. blue
    b. red
    c. orange
    d. green
    e. yellow



31. Cyclic electron flow in the chloroplast produces
    a. ATP
    b. NADPH
    c. glucose
    d. Only a and b are correct
    e. a, b, and c are correct

32. CAM plants can keep stomata closed in daytime, thus reducing loss of water. They can do this because they can
    a. fix CO_2 into organic acids during the night.
    b. fix CO_2 into sugars in the bundle-sheath cells.
    c. fix CO_2 into pyruvic acid in the mesophyll cells.
    d. use the enzyme phosphofructokinase, which outcompetes rubisco for CO_2.
    e. outer membrane of the chloroplast.

33. When a chlorophyll molecule in photosystem I traps light, it loses an electron. In noncyclic electron flow, this electron is replaced
    a. from one of the antenna pigments.
    b. from the other end of photosystem I.
    c. by a donation from photosystem II.
    d. by a donation from an unexcited chlorophyll molecule.
    e. from one of the hydrogen atoms in NADP.

34. During cellular respiration, electrons travel downhill from
    a. food→Krebs cycle→ATP→NAD+
    b. food→NADH→electron transport chain→oxygen
    c. glucose→ATP→oxygen
    d. glucose→ATP→electron transport chain→NADH
    e. food→glycolysis→Krebs cycle→NADH→ATP

35. Cellular respiration harvests the most chemical energy by
    a. substrate-level phosphorylation.
    b. forming lactate from pyruvate.
    c. converting oxygen to ATP.
    d. transferring electrons from organic molecules to oxygen.
    e. generating carbon dioxide and oxygen in the electron transport chain.

36. The direct energy source that drives ATP synthesis during respiratory oxidative phosphorylation is
    a. oxidation of glucose to CO_2 and water.
    b. the thermodynamically favorable flow of electrons from NADH to the mitochondrial electron transport carriers.
    c. the final transfer of electrons to oxygen
    d. the difference in H+ concentrations on opposite sides of the inner mitochondrial membrane.
    e. thermodynamically favorable transfer of phosphate from glycolysis and Krebs cycle to molecules of ADP

37. What kind of metabolic poison would most directly interfere with glycolysis?
    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 nonmetabolic.
    d. an agent that reacts with NADH and oxidizes it to NAD+
    e. an agent that inhibits the formation of acetyl coenzyme A.

38. Suppose a yeast cell uses 10 moles of glucose for energy production. No oxygen is available. What will be the maximum net yield of ATP in moles?
    a. 12
    b. 15
    c. 20
    d. 30
    e. 36

39. Which product in eukaryotic cells will normally proceed whether O_2 is present or absent?
    a. fermentation
    b. glycolysis
    c. Krebs cycle
    d. oxidative phosphorylation
    e. electron transport

40. During oxidative phosphorylation, H_2O is formed. Where do the oxygen atoms in the H_2O come from?
    a. carbon dioxide
    b. glucose
    c. molecular oxygen
    d. pyruvate
    e. lactate

41. Which metabolic process is most closely associated with intracellular membranes?
    a. substrate-level phosphorylation
    b. oxidative phosphorylation
    c. glycolysis
    d. the Krebs cycle
    e. ethanolic fermentation

42. Which of the following statements about lactate fermentation is FALSE?
    a. Lactate fermentation produces ATP molecules in addition to the few produced by glycolysis.
    b. Lactate fermentation oxidizes NADH to NAD+ to keep glycolysis functioning.
    c. Lactate fermentation takes place in vigorously exercised muscle cells.
    d. Lactate fermentation can take place under anaerobic conditions.
    e. Lactate fermentation in muscle cells often creates a need for O_2 that must be satisfied later.

43. The end product of glycolysis is
    a. pyruvate
    b. the starting point for the citric acid cycle
    c. the starting point for the fermentation pathway
    d. both a and b
    e. a, b, and c

44. The drug 2, 4-dinitrophenol (DNP) destroys the proton gradient across the inner mitochondrial membrane. What would you expect to be the effect of incubating isolated mitochondria in a solution of DNP?
    a. Oxygen would no longer be reduced to water.
    b. No ATP would be made during transport of electrons down the respiratory chain.
    c. Mitochondria would show a burst of increased ATP synthesis.
    d. Glycolysis would stop.
    e. Mitochondria would switch from glycolysis to fermentation.

45. In human muscle cells, the fermentation process produces
    a. lactic acid
    b. 12 moles of ATP
    c. pyruvic acid
    d. an excessive amount of energy
    e. none of the above

46. The citric acid cycle begins with
    a. glucose
    b. pyruvate
    c. acetyl CoA
    d. NADH + H^+
    e. ATP synthase

47. When light strikes a blue pigment, blue light is
    a. reduced
    b. absorbed
    c. converted to chemical energy
    d. scattered or transmitted
    e. used to synthesize ATP

48. In cacti, CO_2 is stored for use in the Calvin-Benson cycle
    a. in the stems, roots, and leaves
    b. during the evening
    c. in glucose molecules
    d. in the stroma
    e. both a and d

49. When a photon is absorbed by a molecule, what happens to the photon?
    a. It loses the ability to generate any energy
    b. It raises the molecule from a ground state of low energy to an excited state
    c. The exact relationship of the photon to the molecule is not clearly understood
    d. It causes a change in the velocity of the wavelengths
    e. none of the above

50. How does rubisco “decide” whether to act as an oxygenase (fix O) or carboxylase (fix C)?
    a. If O_2 is relatively abundant, rubisco acts as a carboxylase
    b. If O2 predominates, rubisco fixes it, and the Calvin-Benson cycle occurs
    c. Photorespiration is more likely at low temperatures
    d. As the ratio of CO_2 to O_2 falls in the leaf, the reaction of rubisco with O_2 is favored and photorespiration proceeds

Extra Credit Questions

51. The three substrates (normal reactants) for the enzyme RuBP carboxylase (rubisco) are
    a. CO_2, O_2, and RuBP
    b. CO_2, glucose, and RuBP
    c. RuBP, ATP, and NADPH
    d. triose-P, glucose, and CO_2
    e. RuBP, CO_2, and ATP

52. During aerobic respiration, which of the following directly donates electrons to the ETC at the lowest energy level?
    a. NAD+
    b. NADH
    c. ATP
    d. ADP + P_i
    e. $FADH_2$

53. How many carbon atoms can each acetyl CoA feed into the Krebs cycle?
    a. 2
    b. 4
    c. 6
    d. 8
    e. 10

54. Which type of enzyme in cellular respiration is primarily responsible for removing electrons from organic molecules?
    a. decarboxylase
    b. ATP synthase
    c. deaminase
    d. dehydrogenase
    e. phosphofructokinase

55. Which of the following is true for exergonic reactions?
    a. The products have more free energy than the reactants.
    b. The products have less free energy than the reactants.
    c. Reactants will always be completely converted to products.
    d. A net input of energy from the surroundings is required for the reactions to proceed.
    e. The reactions upgrade the free energy in the products at the expense of energy from the surroundings.

56. The main control mechanism in glycolysis is the
    a. enzyme isocitrate dehydrogenase
    b. negative feedback of citrate accumulation
    c. presence or absence of oxygen
    d. the enzyme phosphofructokinase
    e. supply of NAD

57. An organism is discovered that consumes a considerable amount of sugar, yet does not gain much weight when denied air. Curiously, the consumption of sugar increases as air is removed from the organism's environment, but the organism seems to thrive even in the absence of air. When returned to normal air, the organism does fine. Which of the following best describes the organism?
    a. It must use a molecule other than oxygen to accept electrons from the electron transport chain.
    b. It is a normal eukaryotic organism.
    c. The organism obviously lacks the Krebs cycle and electron transport chain.
    d. It is an anaerobic organism.
    e. It is a facultative anaerobe.

58. Plants that fix CO2 into organic acids at night when the stoma are open and carry out the Calvin cycle during the day when the stoma are closed are called
    a. C3 plants
    b. C4 plants
    c. CAM plants
    d. Only a and b are correct
    e. a, b, and c are correct

59. Assume a thylakoid is somehow punctured so that the interior of the thylakoid is no longer separated from the stroma. This damage will have the most direct effect on which of the following processes?
    a. the splitting of water
    b. the absorption of light energy by chlorophyll
    c. the flow of electrons from photosystem II to photosystem I
    d. the synthesis of ATP
    e. the reduction of NADP+

60. Photorespiration lowers the efficiency of photosynthesis by removing which of the following from the Calvin cycle?
    a. carbon dioxide molecules
    b. glyceraldehyde phosphate molecules
    c. ATP molecules
    d. ribulose bisphosphate molecules
    e. RuBP carboxylase molecules

61. During a laboratory experiment, you discover that an enzyme-catalyzed reaction has a ▲G = -20kcal/mole. You double the amount of enzyme in the reaction and the ▲G now equals
    a. -10 kcal/mole
    b. -20 kcal/mole
    c. -40 kcal/mole
    d. +40 kcal/mole
    e. It is not possible to calculate the answer with the data given.

62. How can one increase the rate of a chemical reaction?
    a. increase the activation energy needed
    b. cool the reactants
    c. decrease the concentration of reactants
    d. add a catalyst
    e. increase entropy of reactants

63. A young relative of yours has never had much energy. He goes to a doctor for help and is sent to the hospital for some tests. There they discover his mitochondria can use only fatty acids and amino acids for respiration, and that his cells produce more lactate than normal. Of the following, which is the best explanation of his condition?
    a. His mitochondria lack the transport protein that moves pyruvate across the other mitochondrial membrane.
    b. His cells cannot move NADH from glycolysis into the mitochondria.
    c. His cells contain something that inhibits oxygen use in his mitochondria.
    d. His cells lack the enzyme in glycolysis that forms pyruvate.
    e. His cells have a defective electron transport chain, so glucose goes to lactate instead of to acetyl CoA.

64. In noncyclic photophosphorylation, the chlorophyll in photosystem I us reduced by
    a. water
    b. an electron from the transport chain of photosystem II
    c. two photons of light
    d. NADPH
    e. ATP

65. In C4 plants, the function of the four-carbon compound that is synthesized in the mesophyll cells is to
    a. reduce NADP+
    b. combine with CO_2 to produce glucose
    c. carry CO_2 to the bundle sheath cells
    d. drive the synthesis of ATP
    e. close the stomata