**True or False:**
1. Reactions are called endergonic if they occur spontaneously and release free energy.
2. Enzymes catalyze chemical reactions by lowering the activation energy.
3. Biochemical pathways are a series of sequential chemical reactions in the cell.
4. Molecules that act as catalysts in biological systems are coenzymes.
5. The specificity of an enzyme is due to its binding site, which is shaped to fit a substrate.
6. Free energy is the amount of energy available for the cell to carry out its many chemical processes. It is the difference between the internal energy or enthalpy and _____ or disorder.

**Multiple Choice:**
1. At the conclusion of an enzyme catalyzed reaction
   A. it must be resynthesized from its amino acids
   B. it frees itself from the product and is ready to be reused
   C. it must be transported from outside of the cell
   D. its shape is changed into an active form
   E. its active site closes up and cannot bind to more substrate

2. Cells release energy from molecules such as glucose in a process very similar to inhalation of air and exhalation of carbon dioxide by humans. This process is known as cellular
   A. oxidation  B. reduction  C. photosynthesis
   D. radiation  E. respiration

3. ATP gives up energy when it is converted to
   A. DNA  B. NADP  C. NADH
   D. ADP and phosphate  E. RNA

4. Reactions that do not proceed spontaneously because they require energy from an outside source are called
   A. exergonic  B. xerogonic  C. metabolic
   D. endergonic  E. endocytic

5. Enzymes are very specific to substrates because each different enzyme has an active site that
   A. depends on unusual amino acids not common in proteins
   B. has a certain unique amino acid to fit each substrate
   C. is shaped to fit a certain substrate molecule
   D. is lined with glycolipids and glycoproteins
   E. passes electrons from one part of the substrate to another
6. One of the most important coenzymes that accepts electrons/hydrogens is
   A. NAD+   B. NADH   C. ATP
   D. NADPH   E. ribozyme

   Match each of the following.

7. ___The substance on which the enzyme works; the raw material of the reaction.
   A. active site

8. ___One or occasionally more; the main constituent of an enzyme.
   B. substrate

9. ___Allosteric inhibitor binds here; changes enzyme shape.
   C. polypeptide

10. ___Spot where raw material binds and is changed to product.
    D. coenzyme

11. ___Part of the complete enzyme; nonprotein, organic component.
    E. non-catalytic binding site

12. An electron transferred in a biological system is usually
    A. boosted to a higher light energy state
    B. converted into other chemical compounds
    C. accompanied by a proton
    D. given off as radiant energy
    E. lost to the system as heat

13. As energy is being reconverted through the many forms, it is continuously lost as
    A. electricity   B. light   C. sound
    D. heat   E. chemical energy

14. Cells employ biological catalysts called as ___ to speed up the various metabolic reactions.

15. The ability of an enzyme to catalyze a reaction can be affected by chemical and physical factors such as
    A. temperature   B. pH   C. salt concentration
    D. binding of specific regulatory molecules   E. all of the above

16. Fermentation can be described as a process
    A. that takes place only in the absence of oxygen
    B. in which the recipient of hydrogen atoms is an organic molecule
C. in which water is not one of the by-products
D. in which the Krebs cycle and electron transfer through ETS do not occur
E. all of the above are true

17. For further derivation of energy, aerobic cells must convert pyruvate into acetyl coenzyme A by stripping off a CO2 molecule. This process is known as ____________.

18. Beta oxidation of these molecules converts them into acetylCoA, which can then enter the Krebs cycle for energy derivation. These are
A. fatty acids  B. amino acids  C. ATP
D. nucleic acids  E. sugars

19. In muscle cells, fermentation produces not alcohol but
A. ATP  B. NADH  C. pyruvate
D. kinetic energy  E. lactate

20. Since membranes are relatively impermeable to ions, most of the protons re-enter the matrix by passing through special channels in the inner mitochondrial membrane. Because of the inward flow of protons these channels allow the synthesis of
A. ADP from ATP and Pi  B. ATP from ADP and Pi
C. glucose from pyruvate  D. acetylCoA from pyruvate
E. citrate from oxaloacetate and acetylCoA

21. Match each of the following.
1. ___Pyruvate oxidation; carrier of acetyl groups.
   A. ATP
2. ___Chief energy currency of cells; formed by chemiosmosis.
   B. FAD
3. ___Coenzyme electron carrier; associated with Krebs cycle only.
   C. G-3-P
4. ___Intermediate in glycolysis; finally oxidized to pyruvate.
   D. NAD+
5. ___Oxidized form of the most common electron carrier; needed in both glycolysis and Krebs cycle.
   E. acetylcoA

22. In oxidative respiration, energy is harvested from glucose molecules in a sequence of four major pathways. Which of the following is not one of these four pathways?
A. Krebs cycle  B. glycolysis
C. electron transfer through the transport chain  D. beta oxidation
E. pyruvate oxidation
23. The enzymes catalyzing the reactions of glycolysis occur in the
A. mitochondria  B. cytoplasm  C. chloroplasts
D. nucleus  E. Golgi apparatus

24. A single glucose molecule can drive the Krebs cycle
A. one turn  B. two turns  C. three turns
D. four turns  E. six turns

25. Energy is harvested from glucose molecules in a series of gradual steps in the cytoplasm, using _______ as an electron carrier.

26. In the cyclic sequence called the Krebs cycle, the following chemical events take place except
A. the acetyl group is joined with a four carbon molecule, oxaloacetate
B. the resulting six carbon molecule is oxidized
C. electrons generated are used to produce NADH
D. two carbons per cycle are made into CO2 molecules
E. pyruvate molecules are restored to the cycle

27. Regardless of the electron or hydrogen acceptor used, one of the products of fermentation is always:
A. ADP  B. ATP  C. NAD+
D. pyruvate  E. alcohol

28. The coenzyme electron carriers produced in the Krebs cycle are
A. ATP and ADP  B. pyruvate and acetylcoA
C. FADH2 and NADH  D. NAD and NADH  E. NADH and ATP

29. A process common to all living organisms, aerobic and anaerobic, is
A. glycolysis  B. fermentation  C. the Krebs cycle
D. electron transport chain reactions  E. pyruvate oxidation

30. In the absence of oxygen, eukaryotic cells are restricted to
A. chemiosmotic phosphorylation  B. cyclic photo phosphorylation
C. noncyclic photo phosphorylation  D. oxidative phosphorylation  E. substrate level phosphorylation

31. The reaction, $C_6H_6O_6 + 6O_2 = 6CO_2 + 6H_2O$, when it occurs in living cells is known as
A. aerobic fermentation  B. anaerobic fermentation
C. cellular respiration  
D. glycolysis  
E. oxidative phosphorylation  

32. The electron transport chain, a series of membrane-associated electron carriers, loses most of the energy by driving several transmembrane
A. proton pumps  
B. electron pumps  
C. sodium, potassium pumps  
D. active transport pumps  
E. water pumps  

33. The decarboxylation of pyruvate produces
A. NADH  
B. acetylcoA  
C. CO2  
D. ATP  
E. a, b, and c  

34. Yeast cells under anaerobic conditions
A. die  
B. produce ethyl alcohol (ethanol)  
C. produce oxygen  
D. switch to oxidative respiration  
E. push the glycolytic pathway backward  

35. The oxygen utilized in cellular respiration finally shows up as
A. CO2  
B. ATP  
C. new O2  
D. H2O  
E. part of a sugar  

36. The electron transport chain consists of all of the following except
A. NADH dehydrogenase  
B. cytochrome complex  
C. oxygenase  
D. cytochrome c oxidase  
E. ubiquinone, Q  

37. All of the following are the end products of glycolysis except
A. pyruvate  
B. ATP  
C. NADH  
D. NAD+  
E. energy  

38. The enzymes of the Krebs cycle are located in the
A. cytoplasm  
B. inter-membrane space of mitochondria  
C. vesicles of the ER  
D. outer membrane of the mitochondria  
E. matrix of the mitochondria  

39. Which of the following is common to both cellular respiration and the light reactions of photosynthesis?
A. the transfer of electrons to glucose  
B. the chemiosmotic formation of ATP  
C. oxygen is one of the byproducts  
D. mitochondria are essential organelles  
E. must have light
40. Molecules that absorb light are called
A. enzymes  B. electron carriers  C. pigments
D. photosynthesizers  E. absorbers

41. In the photosystem I photocenter, light energy captured by pigment molecules is passed on to a special molecule called
A. P680  B. P700  C. chlorophyll I
D. chlorophyll II  E. retinal

42. What products of light reactions of photosynthesis are used in the Calvin cycle?
A. oxygen and protons  B. carbon dioxide and water
C. ATP and NADPH  D. ADP and NADP
E. glucose and oxygen

43. The cyclic carbon fixation reactions are also known as the
A. Krebs cycle  B. Calvin cycle  C. citric acid cycle
D. tri carboxylic acid cycle  E. Blackman cycle

44. The dark reactions of photosynthesis are those that
A. convert chlorophylls into enzymes
B. convert enzymes into chlorophylls
C. convert water into hydrogen and oxygen
D. convert C02 into reduced molecules (sugars)
E. only occur in the dark

45. Light consists of units of energy called
A. electrons  B. photons  C. protons
D. neutrons  E. pigments

46. Which of the following two types of pigments are used in photosynthesis?
A. chloroplasts  B. carotenoids  C. chlorophylls
D. a and b  E. b and c

47. Match each of the following (some letters may be used more than once or not at all).
1. ___ Shortest wavelength and highest-energy photons within the visible spectrum; one of the regions where chlorophylls absorb.
   A. green
2. ___ Visible light not strongly absorbed by light.
   B. violet-blue
3. ___ High energy component of the electromagnetic spectrum; associated with sunburn.
   C. red
4. ___Apparent color of chlorophylls.
   D. ultraviolet

5. ___Visible light with longest wave length
   and lowest-energy photons; one of the
   regions where chlorophylls absorb.
   E. yellow-orange

48. How many revolutions of the Calvin cycle are required to produce the sugar glucose?
   A. 2    B. 3    C. 4    D. 5    E. 6

49. Photosystem I differs from photosystem II in that the following molecule is not made
    directly from the process:
   A. ATP
   B. NADH
   C. NADPH
   D. carbohydrates
   E. water

50. Which part of the chloroplasts contain the Calvin-cycle enzymes?
   A. stroma    B. thylakoids    C. grana
   D. envelope   E. cristae

51. In dark reactions, when CO₂ is added to a molecule of RUBP the product is
   A. citric acid   B. glucose
   C. glyceraldehyde-3-phosphate   D. glycerophosphate
   E. pyruvate

52. Chlorophyll b absorbs in green wavelengths of light that chlorophyll a cannot absorb. In this
    respect, chlorophyll b acts as
   A. an accessory pigment
   B. an energizer for photosynthetic bacteria
   C. a light absorber in the green light
   D. a more efficient pigment   E. all of the above are true

53. Photosystem ii absorbs protons that are slightly more energetic than photosystem I, but
    similarly pass this energy to a pigment called
   A. P₆₈₀   B. P₇₀₀   C. chlorophyll I
   D. chlorophyll II   E. retinal

54. The photosystem channels the excitation energy gathered by absorption of light by any one
    of the pigment molecules to a specific "reaction center chlorophyll," which in turn passes the
    energy to
   A. photosystem I   B. photosystem II
   C. the primary electron acceptor
   D. the secondary electron center   E. cytochrome
55. The photosynthetic electron transport causes the accumulation of protons in which part of the chloroplast?
A. matrix
B. stroma
C. envelope
D. outer membrane
E. internal thylakoid space