

Name _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 1) The sum of all biosynthetic reactions in a cell is known as 1) _____
A) synthatabolism. B) catabolism. C) metabolism. D) anabolism.

Answer: D

- 2) Phosphorus in microorganisms can be found in 2) _____
A) organic compounds.

B) inorganic compounds.

C) both organic and inorganic compounds.

D) neither organic nor inorganic compounds but in free elemental form in the cell.

Answer: C

- 3) Chemoorganotrophs use which of the following as an energy source? 3) _____
A) inorganic compounds

B) organic compounds

C) both organic and inorganic compounds

D) either organic or inorganic compounds, depending on the environment

Answer: B

- 4) Which statement is NOT true? 4) _____
A) Nitrogen is a major component of proteins and nucleic acids.

B) Some bacteria are able to use nitrates or nitrogen gas as their nitrogen source.

C) Most bacteria are capable of using ammonia as their sole nitrogen source.

D) Most available nitrogen is in organic forms.

Answer: D

- 5) All organisms require the macronutrients 5) _____
A) phosphorus, potassium, and sodium. B) phosphorus, potassium, and magnesium.

C) potassium, magnesium, and sodium.

D) calcium, potassium, and magnesium.

Answer: B

- 6) Which nutrient functions BOTH as an enzymatic cofactor and as a stabilizer of ribosomes and nucleic acids? 6) _____

A) magnesium

B) phosphorus

C) potassium

D) calcium

Answer: A

- 7) Regulation of an enzyme's activity occurs 7) _____
A) before the enzyme is produced.

B) at any point on the enzymatic production pathway.

C) when the enzyme already exists in the cell.

D) during the production of the enzyme.

Answer: C

- 8) Siderophores 8) _____
A) develop when errors in membrane synthesis occur.
B) are a key component in the cytochromes.
C) bind iron and transport it into the cell.
D) help maintain osmotic balance in seawater microbes.
Answer: C
- 9) Which statement is CORRECT? 9) _____
A) Micronutrients are metals, but growth factors are organic.
B) Both micronutrients and growth factors are essentially metals.
C) Micronutrients are organic, but growth factors are metals.
D) Both micronutrients and growth factors are organic compounds essential for cell growth.
Answer: A
- 10) Aseptic technique refers to 10) _____
A) the prevention of contamination.
B) the microbial inoculum placed into a test tube or onto a Petri plate.
C) cleanliness in the laboratory.
D) the autoclave and other sterilizing procedures.
Answer: A
- 11) Allosteric enzymes have two important binding sites. These are the 11) _____
A) allosteric and effector sites. B) active and allosteric sites.
C) active and inhibitory sites. D) allosteric and passive sites.
Answer: B
- 12) If $\Delta G^{0'}$ is negative, the reaction is 12) _____
A) endergonic and energy will be released.
B) exergonic and energy will be released.
C) endergonic and requires the input of energy.
D) exergonic and requires the input of energy.
Answer: B
- 13) Activation energy is the energy 13) _____
A) required to transform all reactants into their reactive state.
B) sometimes referred to as catabolic energy.
C) given off as the products in a chemical reaction are formed.
D) absorbed as $\Delta G^{0'}$ moves from negative to positive.
Answer: A
- 14) A catalyst 14) _____
A) changes the rate of the reaction but does not change the end amount of products.
B) changes both the rate of a reaction and the amount of the product that will be obtained as the reaction is completed.
C) increases the amount of reactants produced but does not change the rate.
D) makes possible otherwise impossible reactions.
Answer: A

- 15) The portion of an enzyme to which substrates bind is referred to as the 15) _____
A) substrate complex. B) catalysis site.
C) junction of van der Waals forces. D) active site.
Answer: D
- 16) Which statement is TRUE? 16) _____
A) Coenzymes and prosthetic groups both bind tightly to their respective enzymes.
B) Coenzymes and prosthetic groups are technically not bound to their respective enzymes.
C) Coenzymes bind tightly to their respective enzymes.
D) Prosthetic groups bind tightly to their respective enzymes.
Answer: D
- 17) If an oxidation reaction occurs, a reduction reaction must also occur because 17) _____
A) that is what redox means.
B) Actually, reduction is not necessary if oxidation occurs.
C) electrons do not generally exist alone in solution.
D) half reactions are written that way.
Answer: C
- 18) NAD^+/NADH are involved primarily in _____ reactions, while $\text{NADP}^+/\text{NADPH}$ are involved 18) _____
in _____ reactions.
A) energy-generating (catabolic) / both energy-generating (catabolic) and biosynthetic (anabolic)
B) energy-generating (catabolic) / biosynthetic (anabolic)
C) biosynthetic (anabolic) / energy-generating (catabolic)
D) both energy-generating (catabolic) and biosynthetic (anabolic) / both energy-generating (catabolic) and biosynthetic (anabolic)
Answer: B
- 19) Covalent modification of an enzyme often includes 19) _____
A) binding of the enzyme to specific cytoplasmic ribosomes.
B) rearrangement of the components of the enzyme proper.
C) addition or deletion of some small molecule.
D) none of the above.
Answer: C
- 20) The most important high-energy phosphate compound in living organisms is 20) _____
A) GTP. B) RNA. C) glucose. D) ATP.
Answer: D
- 21) The Embden - Meyerhof - Parnas pathway is another name for 21) _____
A) NADH production. B) electron transport.
C) glycolysis. D) the citric acid cycle.
Answer: C
- 22) The net gain of ATP per molecule of glucose fermented is 22) _____
A) 1. B) 2. C) 4. D) 8.
Answer: B

- 23) The roadblock created by the formation of a reduced electron carrier is overcome in fermentation by the _____
A) oxidation of NADH back to NAD⁺. B) reduction of NAD⁺ back to NADH.
C) reduction of NADH back to NAD⁺. D) oxidation of NAD⁺ back to NADH.
Answer: A
- 24) When writing half reactions, _____
A) the final product(s) must be atomically balanced with the beginning substrate(s).
B) the units are in joules for $\Delta E_0'$.
C) the pH of the reaction should be described because it cannot be assumed to be 7.0.
D) the reduction potentials are by convention described in terms of oxidation.
Answer: A
- 25) From the standpoint of the microorganism, in glycolysis the crucial product is _____
A) ethanol or lactate; ATP is a waste product.
B) CO₂; ATP is a waste product.
C) not relevant because glycolysis is not a major pathway.
D) ATP; the fermentation products are waste products.
Answer: D
- 26) In aerobic respiration, the final electron acceptor is _____
A) oxygen. B) hydrogen. C) water. D) ATP.
Answer: A
- 27) Which of the following groups is NOT membrane associated? _____
A) NADH dehydrogenases B) cytochromes
C) flavoproteins D) All of these are membrane associated.
Answer: D
- 28) During electron transport reactions, _____
A) OH⁻ accumulates on the inside of the membrane while H⁺ accumulates on the outside.
B) OH⁻ accumulates on the outside of the membrane while H⁺ accumulates on the inside.
C) both OH⁻ and H⁺ accumulate on the inside of the membrane.
D) both OH⁻ and H⁺ accumulate on the outside of the membrane.
Answer: A
- 29) The rising of bread dough is the result of _____
A) flour gaining electrons. B) fermentation.
C) biotin production. D) oxygen being released.
Answer: B
- 30) The citric acid cycle _____
A) allows for the complete oxidation of glucose.
B) produces NADH as it progresses.
C) delineates the oxidation of pyruvate.
D) does all of the above.
Answer: D

- 31) As each molecule of pyruvate traverses the citric acid cycle, how many molecules of CO₂ are generated? 31) _____
A) 1 B) 2 C) 3 D) 4
Answer: C
- 32) Chemolithotrophs are 32) _____
A) autotrophs. B) organotrophs. C) phototrophs. D) heterotrophs.
Answer: A
- 33) For a carbon source, chemoorganotrophs generally use such compounds as 33) _____
A) glucose. B) triglycerides. C) sunlight. D) carbon dioxide.
Answer: A
- 34) Prokaryotic polysaccharides are synthesized from 34) _____
A) only one of two activated forms of glucose (UDPG and UDPG).
B) negative amino acids.
C) saturated fatty acids.
D) starch/glycogen complexes.
Answer: A
- 35) The process by which glucose is synthesized within the cell is 35) _____
A) glycolysis. B) pentose.
C) gluconeogenesis. D) peptidogenesis.
Answer: C
- 36) The macronutrient that comprises about 50% of the dry weight of a typical bacterial cell is 36) _____
A) nitrogen. B) protein. C) oxygen. D) carbon.
Answer: D
- 37) The joining of an enzyme and substrate(s) depends on weak bonds, such as 37) _____
A) hydrophobic interactions. B) van der Waals forces.
C) hydrogen bonds. D) all of the above.
Answer: D
- 38) The number of protons consumed by an ATPase per molecule of ATP formed is 38) _____
A) 1. B) 3-4. C) 6-8. D) 10.
Answer: B
- 39) Two specific cellular reactions in a cell that require energy from the proton motive force are 39) _____
A) ion transport and flagellar rotation. B) respiration and fermentation.
C) communication and metabolism. D) biosynthesis and polymerization.
Answer: A
- 40) One example of an electron acceptor that can be used in anaerobic respiration is 40) _____
A) NADH. B) nitrate. C) water. D) pyruvate.
Answer: B

TRUE/FALSE. Write 'T' if the statement is true and 'F' if the statement is false.

41) A chemotroph uses chemicals for energy, while a phototroph uses light for energy. 41) _____

Answer: ☒ True ☐ False

42) Carbon and nitrogen are considered micronutrients. 42) _____

Answer: ☐ True ☒ False

43) All prokaryotes require an organic carbon source. 43) _____

Answer: ☐ True ☒ False

44) Vitamins are NOT considered growth factors. 44) _____

Answer: ☐ True ☒ False

45) Most microorganisms have the same general nutritional requirements, so most microorganisms can grow on the same media. 45) _____

Answer: ☐ True ☒ False

46) Energy can be measured in kilojoules. 46) _____

Answer: ☒ True ☐ False

47) Regulation of the amount of enzyme synthesized occurs only at the gene level. 47) _____

Answer: ☐ True ☒ False

48) In a given chemical reaction, if the free energy of formation is known for each of the reactants and each of the products, the change in free energy can be calculated for the reaction. 48) _____

Answer: ☒ True ☐ False

49) Free-energy calculations are dependent on the rates of the reactions. 49) _____

Answer: ☐ True ☒ False

50) Enzymes are biological catalysts. 50) _____

Answer: ☒ True ☐ False

51) Theoretically, all enzyme-catalyzed reactions are reversible by the same enzyme. 51) _____

Answer: ☒ True ☐ False

52) If the name of a compound ends in "-ase," it is likely an enzyme. 52) _____

Answer: ☒ True ☐ False

53) If a substance is reduced, it gains electrons. 53) _____

Answer: ☒ True ☐ False

54) The tendency to become oxidized or reduced is expressed as the reduction potential in Volts. 54) _____

Answer: ☒ True ☐ False

55) In anaerobic metabolism, the electron donor is often referred to as an energy source. 55) _____

Answer: ☒ True ☐ False

- 56) Feedback inhibition or covalent modification is generally sufficient for the regulation of gene expression. 56) _____
Answer: True ☒ False
- 57) Coenzymes increase the diversity of chemical reactions possible in a cell. 57) _____
Answer: ☒ True False
- 58) The energy released from the hydrolysis of coenzyme A is conserved in the synthesis of ATP. 58) _____
Answer: ☒ True False
- 59) In substrate-level phosphorylation, ATP storage is depleted during the steps in catabolism of the fermentable compounds. 59) _____
Answer: True ☒ False
- 60) Whenever a bacterium undergoes fermentation, ethanol is a byproduct. 60) _____
Answer: True ☒ False
- 61) In electron transport systems, the electron carriers are membrane associated. 61) _____
Answer: ☒ True False
- 62) Heme prosthetic groups are involved in electron transfer with quinones. 62) _____
Answer: True ☒ False
- 63) During the electron transport process, protons and electrons become physically separated in the cell membrane. 63) _____
Answer: ☒ True False
- 64) AMP and methyl groups can play a part in covalent modification; ADP does not function in covalent modification. 64) _____
Answer: True ☒ False
- 65) The net result of electron transport is the generation of a pH gradient and an electrochemical potential across the membrane. 65) _____
Answer: ☒ True False
- 66) Inhibitors block both electron flow and the establishment of the proton motive force. 66) _____
Answer: ☒ True False
- 67) Oxalacetate, generated in the citric acid cycle, is important both in the generation of certain amino acids and in the formation of phosphoenolpyruvate. 67) _____
Answer: ☒ True False
- 68) Each molecule of NADPH^+ yields 3 molecules of ATP. 68) _____
Answer: True ☒ False
- 69) The theoretical maximum yield from each molecule of glucose during aerobic respiration is between 30 and 35 molecules of ATP. 69) _____
Answer: True ☒ False

- 70) Controlling the activity of an enzyme is an inefficient use of the organism's energy. 70) _____
Answer: True ☒ False
- 71) Polysaccharides are key cell wall constituents. 71) _____
Answer: ☒ True False
- 72) Amino acids can be grouped into structurally related families that have similar biosynthetic steps. 72) _____
Answer: ☒ True False
- 73) Inosinic acid is the precursor of the pyrimidines. 73) _____
Answer: True ☒ False
- 74) The distinguishing characteristic of an unsaturated fatty acid is the inclusion of one or more double bonds in the hydrophobic portion of the molecule. 74) _____
Answer: ☒ True False
- 75) The third carbon of a glycerol backbone usually contains a polar group in the *Bacteria* and the *Eukarya*. 75) _____
Answer: ☒ True False

SHORT ANSWER. Write the word or phrase that best completes each statement or answers the question.

- 76) The term used to refer to all the chemical processes taking place within a cell is _____. 76) _____
Answer: metabolism
- 77) _____ is the ability to do work. 77) _____
Answer: Energy
- 78) The _____ required or released to form a given molecule from its constituent elements is called _____. 78) _____
Answer: energy / free energy of formation
- 79) _____ is the term used to describe the temporary combination of the enzyme and the reactant. 79) _____
Answer: Enzyme-substrate complex
- 80) The Pasteur effect involves metabolically versatile microbes such as *Saccharomyces cerevisiae* that first perform _____ metabolism. After this process, the yeast switches to _____ metabolism where two byproducts are _____ and _____. 80) _____
Answer: aerobic or respiration / anaerobic or fermentation / carbon dioxide / ethanol (last two either order)
- 81) Energy released as a result of oxidation-reduction reactions is usually conserved in the _____. 81) _____
Answer: synthesis of energy-rich compounds
- 82) _____ are different enzymes that catalyze the same reaction but are subject to different regulatory controls. 82) _____
Answer: Isozymes

- 83) The enzyme responsible for splitting fructose 1,6-bisphosphate into two three-carbon molecules is _____. 83) _____
 Answer: aldolase
- 84) The enzyme that catalyzes the conversion of the proton motive force into ATP is _____, a molecule that contains two major parts, _____ and _____. This reaction is known as _____. 84) _____
 Answer: ATP synthase (ATPase) / F_1 / F_0 / oxidative phosphorylation (second and third in either order)
- 85) The process by which organisms synthesize the chemical substances of which they are composed is _____. 85) _____
 Answer: anabolism
- 86) An enzyme that moves an amino group from one molecule to another is known as a(n) _____. 86) _____
 Answer: transaminase
- 87) An enriched medium is a complex medium to which additional nutrients, such as _____ or _____, are added. 87) _____
 Answer: any two: beef extract, blood, casein, milk protein, peptone, serum, tryptone, yeast extract
- 88) In biochemistry, oxidations and reductions frequently involve the transfer of a(n) _____ along with a(n) _____. 88) _____
 Answer: electron / proton
- 89) Two mechanisms for energy conservation in chemoorganotrophs are _____ and _____. 89) _____
 Answer: fermentation / respiration (either order)
- 90) With regard to oxygen, glycolysis is a(n) _____ process. 90) _____
 Answer: anoxic (anaerobic)
- 91) Metabolic diversity in respiration and photosynthesis revolves around a common process, which is generation of a(n) _____. 91) _____
 Answer: proton motive force

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

- 92) Explain the difference between chemically defined and undefined (complex) media.

Answer: Defined media are prepared by adding individual "pure" chemicals in known quantities. In this way, the medium itself can be explicitly defined. For example, 5 mM NaCl, 3 mM KH_2PO_4 , 1.5 mM NH_4Cl , 2.5% glucose, and 3% acetate is a defined medium, because each ingredient added is at a known concentration and the chemicals present are known. Complex media needs only to contain one undefined product to be considered complex or undefined. An example of an undefined medium is 5 mM NaCl, 2.5% tryptone and 2.5% yeast extract, because both tryptone and yeast extract are not individual chemical structures but instead contain an assortment of compounds at unknown (imprecise) quantities.

93) Explain the circumstances under which the same substance (molecule) can be either an electron donor or an electron acceptor.

Answer: Answers should explain that not all molecules are strictly one or the other, and each molecule must be compared to the other in a pair to determine the electron acceptor and which is an electron donor.

94) Explain the difference between fermentation and respiration in terms of electron transfer.

Answer: Respiration should be distinguished as using oxygen (or an oxygen substitute) as its terminal electron acceptor, while fermentation uses other compounds, such as carbonate, ferric iron, and nitrate, as electron transferring agents.

95) Describe the biochemical events found in the Embden - Meyerhof - Parnas pathway. Include the major reactants, products, and enzymes. Include such terms as: aldolase, glyceraldehyde 3-phosphate, 1,3-bisphosphoglyceric acid, phosphoenolpyruvate, and pyruvate.

Answer: Figure 4.14 in the textbook illustrates a complete answer.

96) Discuss why energy yield in an organism undergoing anaerobic respiration is less than that of an organism undergoing aerobic respiration.

Answer: One possible explanation could point to the substrate-level phosphorylation process itself as being less energy yielding than (aerobic) oxidative phosphorylation. Another reason is the fate of pyruvate itself, where fermentation is unable to take it through the higher energy yielding process, which requires O_2 as a terminal electron acceptor. Other answers could discuss the E_0' being greatest with the O_2/H_2O redox couple in aerobic metabolism compared to anaerobic redox couples.

97) Explain briefly the biosynthetic and bioenergetic roles of the citric acid cycle.

Answer: Some of the molecules generated during the citric acid cycle, such as α -ketoglutarate, oxalacetate, and succinyl-CoA, can serve as precursors for the biosynthesis of critical cellular components such as amino acids, chlorophyll, and cytochromes. The bioenergetic component of the cycle should be described in the context of FADH and NADH electron donors storing energy potential, usable in electron transport where O_2 is reduced to water.

98) Write a brief definition of feedback inhibition.

Answer: Answers will vary, but the emphasis should be on the role of accumulated products that bind to allosteric sites in enzymes. This allosteric binding interaction changes the protein into an inactive conformation, and therefore does not permit access for new substrates to bind to the active sites on the same enzymes. Students should also explain that the absence of bound allosteric sites permits active site binding and consequently allows the pathway to be uninhibited.

99) Explain exergonic and endergonic in terms of free-energy calculations.

Answer: A positive change in free energy ($\Delta G^0'$) means the reaction needs energy input to occur (called endergonic), whereas a negative $\Delta G^0'$ needs no energy input and actually releases excess energy (called exergonic).

100) Explain what an enzyme must accomplish to catalyze a specific reaction.

Answer: Answers will vary, but the focus of the answer should be on overcoming the required activation energy.

101) Explain in general terms the principle of allostery.

Answer: Answers will vary but should explain that conformational (protein folding) changes occur depending on what binds/interacts with a proteinaceous enzyme. An underlying principle that should be addressed is that only certain enzyme conformations are "active," while others are not active.

102) Explain why the amount of energy released in a redox reaction depends on the nature of both the electron donor and the electron acceptor.

Answer: Answers should emphasize that energy does not come from specific molecules but rather from the difference in reduction potential between two molecules. For example, assigning arbitrary values and subtracting them from one another by comparing two different electron acceptors to one donor would indicate differences in energy for an electron acceptor. In a similar way, this could also be shown to mathematically explain electron donors having an equal role in determining $\Delta E_0'$.