

※ 考生請注意：本試題不可使用計算機。請於答案卷(卡)作答，於本試題紙上作答者，不予計分。

一、選擇題：(75分，每題3分)

1. What is the major structural difference between starch and glycogen?

- (A) the types of monosaccharide subunits in the molecules
- (B) the type of glycosidic linkages in the molecule
- (C) whether glucose is in the α or β form
- (D) the amount of branching that occurs in the molecule

2. A glycosidic linkage is analogous to which of the following in proteins?

- (A) an amino group
- (B) a peptide bond
- (C) a disulfide bond
- (D) a β pleated sheet

3. Which of the following statements is true about proteins?

- (A) Denaturation leads to bond disruption, and the molecule turns into liquid
- (B) Denaturation is always irreversible
- (C) Final folded structure can reveal the steps of protein folding
- (D) Some proteins form a complete 3-D structure only when they interact with their targets

4. Which of the following statements describes a central role that ATP plays in cellular metabolism?

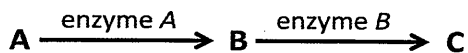
- (A) Hydrolysis of ATP provides an input of free energy for exergonic reactions.
- (B) ATP provides energy coupling between exergonic and endergonic reactions.
- (C) Hydrolysis of the terminal phosphate group stores free energy that is used for cellular work.
- (D) Its terminal phosphate bond is stronger than most covalent bonds in other biological macromolecules.

5. Which of the following statements describes a key component of the induced fit hypothesis of enzyme catalysis?

- (A) Substrate binds to an allosteric site rather than to the active site of an enzyme.
- (B) Binding of an activator molecule changes the shape of the active site of an enzyme.
- (C) The conformation of the active site is determined by the tertiary or quaternary structure of the enzyme.
- (D) Binding of substrate to the active site changes the shape of the active site of an enzyme.

6. How might a change of one amino acid at a site, distant from the active site of an enzyme, alter the substrate specificity of an enzyme?
- (A) by changing the stability of the enzyme
 - (B) by changing the three-dimensional conformation of the enzyme
 - (C) by changing the optimum pH for the enzyme
 - (D) by changing the binding site for a noncompetitive inhibitor
7. Leaf thickness represents a trade-off between _____.
- (A) light collection and carbon dioxide absorption
 - (B) water retention and carbon dioxide absorption
 - (C) water retention and oxygen absorption
 - (D) light collection and oxygen absorption
8. Starch and cellulose _____.
- (A) are polymers of glucose
 - (B) are *cis* and *trans* isomers of each other
 - (C) are used for energy storage in plants and animals
 - (D) are structural components of the plant cell wall
9. Cytosine makes up 42% of the nucleotides in a sample of DNA from an organism. Approximately what percentage of the nucleotides in this sample will be thymine?
- (A) 8%
 - (B) 16%
 - (C) 42%
 - (D) 58%
10. What is the function of the enzyme topoisomerase in DNA replication?
- (A) relieving strain in the DNA ahead of the replication fork caused by the untwisting of the double helix
 - (B) elongating new DNA at a replication fork by adding nucleotides to the existing chain
 - (C) reattaching the hydrogen bonds between the base pairs in the double helix
 - (D) building RNA primers using the parental DNA strand as a template
11. Which of the following statements correctly describes a ribozyme?
- (A) It is a catalyst that uses RNA as a substrate.
 - (B) It is an RNA with catalytic activity.
 - (C) It is an enzyme that catalyzes the association between the large and small ribosomal subunits.
 - (D) It is an enzyme that synthesizes RNA as part of the transcription process.

12. Use the figure to answer the question.



Refer to the metabolic pathway illustrated. If nutrients A, B, and C are all required for growth, a strain mutant for the gene encoding enzyme B would be able to grow on medium supplemented with which of the following nutrient(s)?

- (A) nutrient A only
- (B) nutrient B only
- (C) nutrient C only
- (D) nutrients A and C

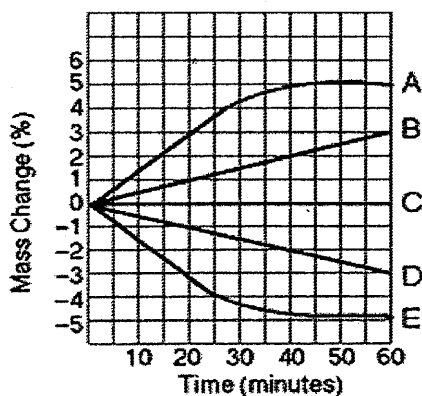
13. Which of the following processes generally requires protein phosphorylation?

- (A) activation of receptor tyrosine kinases
- (B) activation of steroid hormone receptors
- (C) activation of G protein-coupled receptors
- (D) activation ligand-gated ion channels

14. According to the fluid mosaic model of cell membranes, phospholipids _____.

- (A) can move laterally along the plane of the membrane
- (B) frequently flip-flop from one side of the membrane to the other
- (C) occur in an uninterrupted bilayer, with membrane proteins restricted to the surface of the membrane
- (D) have hydrophilic tails in the interior of the membrane

15. Five dialysis bags, constructed of a type of membrane that is permeable to water and impermeable to sucrose, were filled with various concentrations of sucrose and then placed in separate beakers containing an initial concentration of 0.6 M sucrose solution. At 10-minute intervals, the bags were weighed, and the percent change in mass of each bag was graphed.



Which line or lines in the graph represent(s) bags that contain a solution that is hypertonic at 50 minutes?

- (A) A and B
- (B) B
- (C) D
- (D) D and E

16. Which of the following compounds is not derived from amino acids?

- (A) Codeine
- (B) Morphine
- (C) Solanine
- (D) Tannin

17. In which reactions of cellular respiration and fermentation does substrate-level phosphorylation occur?

- (A) only in glycolysis
- (B) only in the citric acid cycle
- (C) only in the electron transport chain
- (D) in both glycolysis and the citric acid cycle

18. The free energy for the oxidation of glucose to CO_2 and water is -686 kcal/mol , and the free energy for the reduction of NAD^+ to NADH is $+53 \text{ kcal/mol}$. Why are only two molecules of NADH formed during glycolysis when it appears that as many as a dozen could be formed?

- (A) Most of the free energy available from the oxidation of glucose is used in the production of ATP in glycolysis.
- (B) Glycolysis is a very inefficient reaction, with much of the energy of glucose released as heat.
- (C) Most of the free energy available from the oxidation of glucose remains in pyruvate, one of the products of glycolysis.
- (D) There is no CO_2 or water produced as products of glycolysis.

19. Which of the following sequences describes the path by which electrons travel downhill energetically in aerobic respiration?

- (A) glucose \rightarrow NADH \rightarrow electron transport chain \rightarrow oxygen
- (B) glucose \rightarrow pyruvate \rightarrow ATP \rightarrow oxygen
- (C) glucose \rightarrow pyruvate \rightarrow electron transport chain \rightarrow NADH \rightarrow ATP
- (D) food \rightarrow glycolysis \rightarrow citric acid cycle \rightarrow NADH \rightarrow ATP

20. Which one of the following elements plays a critical role in the extraction of electrons from water molecules during photosynthesis?

- (A) magnesium
- (B) manganese
- (C) calcium
- (D) zinc

21. Which of the following statements is true in CAM plants?

- (A) The first compound produced is oxaloacetate.
- (B) The regulation of PEP carboxylase activity is similar to that in C₄ plants.
- (C) CAM is more efficient in the conversion of sunlight energy to chemical energy.
- (D) Rubisco is not required in CAM plants.

22. Which one of the following statements is wrong for light reaction of photosynthesis?

- (A) In the antenna system, high-energy electrons will be eventually transferred to the reaction centers.
- (B) Sometimes the energy absorbed will dissipate in the form of light.
- (C) There are two pathways for photosystem I cyclic electron transport
- (D) The energy conversion efficiency is lower than Calvin cycle.

23. Vacuole is a subcellular compartment for nitrate storage and its pH value is usually lower than that in the cytosol. Which of the following proteins would be more likely to transport nitrate into the vacuole?

- (A) H⁺-ATPase
- (B) nitrate/proton antiporter
- (C) nitrate/proton symporter
- (D) nitrate channel

24. Which one of the following statements is true for nitrogen fixation in plants?

- (A) For land plants, nitrogen fixation takes place only in legumes and *Rhizobium*.
- (B) Hydrogen gas will be produced sometimes.
- (C) The vegetative cells of *Anabaena* are capable of fixing nitrogen.
- (D) Leghemoglobin can convert nitrogen gas into ammonia.

25. Gaucher disease is the most common of lipid storage diseases in humans. It is caused by a deficiency of an enzyme necessary for the breakdown of lipids. This leads to the accumulation of fatty material in organs of the body including the spleen, liver, kidneys, lungs, brain, and bone marrow. Using your knowledge of the structure of eukaryotic cells, identify the statement below that best explains how internal membranes and the

organelles of cells may be involved in Gaucher disease.

(A) The mitochondria are most likely defective and do not produce adequate amounts of ATP needed for cellular energy.

(B) The rough endoplasmic reticulum contains too many ribosomes, which results in an overproduction of the enzyme involved in lipid breakdown.

(C) The lysosomes lack sufficient amounts of enzymes necessary for the metabolism of lipids.

(D) The Golgi apparatus produces vesicles with faulty membranes, which fail to be transported to the plasma membrane for secretion.

二、解釋名詞：(15分，每題5分)

1. Primary metabolite and Secondary metabolite
2. Chaperone and Co-chaperone
3. Q-cycle

三、問答題：(10分)

Please describe how does ammonium toxicity uncouple the formation of ATP?