

一、選擇題（每題 2 分，共 60 分）

請選出一個最適答案。題目敘述較長，請把握時間作答。

1. In vertebrate genes, transcription regulatory regions that contain CpG islands are inactivated by which modification?
 - (A) Methylation
 - (B) Myristylation
 - (C) Phosphorylation
 - (D) Acetylation
 - (E) Ubiquitination

2. Which one of the following statements about DNA is correct?
 - (A) A consensus sequence is a common sequence found in a number of genes or DNA regions and has a very similar structure and implied common function.
 - (B) The chemical forces that contribute to the stability of the DNA due to the base stacking present in the DNA helix are hydrogen bonds.
 - (C) The hypochromism refers to the phenomenon that stacked bases in double-helical DNA absorbed more UV light than the unstacked bases in single-stranded DNA.
 - (D) The new RNA strand growth is always in the 5' to 3' direction while the new DNA strand growth is always in the 3' to 5' direction due to the anti-parallel directionality to the template strand.
 - (E) One TATA box about -25 and one CAAT box about -75 are the common promoter regions found in bacterial genes.

3. Which of the following statements about RNA is correct?
 - (A) mRNA is the most abundant type of RNA in a cell.
 - (B) In an amino acyl-tRNA, the amino acid is attached to the CCA sequence at the 3' end of the tRNA.
 - (C) In *E. coli* mRNA are formed by splicing together exons after removal of intervening sequences.
 - (D) Eukaryotic mRNA has a special nucleotide "cap" at the 5' end, while bacterial mRNA has a poly A tail at the 3' end.
 - (E) RNA polymerase requires a primer and has the nuclease "proofreading" capacity.

4. A silent mutation in a gene results in
- (A) no change in the nucleotide sequence of the mRNA encoded by the gene.
 - (B) no change in the amino acid sequence of the protein encoded by the gene.
 - (C) no expression of the protein encoded by the gene.
 - (D) an amino acid substitution that has a significant effect on the functional activity of the protein encoded by the gene.
 - (E) a shift of the translational reading frame.
5. Which of the following statements about carbohydrates are correct?
- I. Glycogen, starch, and cellulose are composed of different types of monosaccharides
 - II. N-linked and O-linked oligosaccharides can be covalently linked to proteins at the amino acid Asn and Ser, respectively.
 - III. Glycosyltransferases and glycosidase are responsible for removing and adding carbohydrate groups to a protein, respectively.
 - IV. Proteoglycans usually carry positive charges at the physiological condition.
 - V. Proteins that bind specific carbohydrates are called lectins.
- (A) I, II, III, IV, V (B) II, III, IV, V
(C) II, III, IV (D) III, IV, V
(E) II, V
6. Which of the following tripeptides would be expected to be the most hydrophobic?
- (A) KYA (B) KFA
(C) LFA (D) LFS
(E) DFS
7. Which one of the following statements about protein techniques is correct?
- (A) A phylogenetic tree depicts structural relationships of proteins.
 - (B) Gel filtration chromatography separates proteins primarily due to differences in size, while ion exchange chromatography separates proteins based on their charges.
 - (C) SDS-PAGE separates proteins primarily due to differences in net charges, while IEF electrophoresis separates proteins based on their molecular weight.
 - (D) Adding additional salt to a protein solution can cause a decrease in solubility called 'salting in'.
 - (E) The NMR spectrometry is an emerging technique for protein sequencing.

8. Which of these statements about protein structure is NOT true?
- (A) An alpha-helical conformation of a globular protein in solution can be determined by circular dichroism.
 - (B) Side chains are located both above and below the beta- sheet.
 - (C) Loops and turns located on the protein surface usually participate in interactions between protein and other molecules.
 - (D) Disulfide bonds are non-covalent linkage between two Cys residues of peptide chains.
 - (E) In large proteins, peptide chains ranging in size from several dozens to hundreds of amino acid residues can fold into a compact globular unit called the domain.
9. _____ tend to assemble into micelles in aqueous solution, while _____ are most likely to form a liposome.
- (A) Steroids; triacylglycerols
 - (B) Fatty acid anions; cholesterol
 - (C) Myristic acids; phosphatidylcholines
 - (D) Phospholipids; fatty acid anions
 - (E) Solvent-filled vesicles; lipid monolayers
10. Which of the following statements is consistent with the structure of biological membranes?
- (A) A biological membrane consists of proteins sandwiched between two layers of lipids, which are referred to as a lipid bilayer.
 - (B) All membrane proteins are integral and associate with the hydrophobic region of the membrane.
 - (C) Both proteins and lipids readily undergo transverse (“flip-flop”) diffusion from the inside to the outside of the membrane.
 - (D) The membrane fluidity is independent to the percentage of unsaturated fatty acids.
 - (E) Membranes are asymmetric in composition and properties.
11. Enzymes that bind reaction transition states with greater affinity than substrates or products
- (A) are inhibited by transition-state analogs
 - (B) increase reaction rates by decreasing the concentration of the transition state
 - (C) are regulated by allosteric effects
 - (D) increase the energy barrier of activation for the overall reaction
 - (E) are perfect examples explained by the “lock-and-key” model

12. Which of the following hormones functions by binding to receptors that work directly as transcription factors?
- (A) cytokines (B) insulin
(C) epinephrine (D) glucagon
(E) steroids
13. Heterotrimeric G proteins
- (A) consist of three subunits: alpha, beta and gamma.
(B) hydrolyze GTP to GMP + PPI.
(C) typically interact with the single-span membrane protein receptor.
(D) bind to the extracellular ligand directly and changes their conformation upon binding.
(E) contain tyrosine kinase domains to initiate downstream phosphorylation cascades.
14. Retroviral oncogenes are probably aberrant forms of normal cellular genes that regulate cell proliferation. Which of the following gene products are LEAST likely to be encoded by an oncogene?
- (A) GTP-binding proteins (B) DNA-binding proteins
(C) Transmembrane proteins (D) Capsid proteins
(E) Tyrosine kinases
15. Which of the following about eukaryotic gene regulation is NOT true?
- (A) Structural components of the nucleosome include an octomer of core histone.
(B) In eukaryotes, DNA-binding proteins bind to DNA by domains such as zinc-finger, leucine zipper, or homeodomain.
(C) Coactivators mediate expression by loosening the histone complex formation.
(D) Enhancer sites are always located within a short distance from the transcription start site.
(E) The level of acetylation and methylation on core histone is an important regulation mechanism for the chromatin.
16. An amino acid that does *not* derive its carbon skeleton, at least in part, from α -ketoglutarate is:
- (A) arginine. (B) glutamate.
(C) glutamine. (D) proline.
(E) threonine

17. The synthesis of purine and pyrimidine nucleotides differ in that:
- (A) ATP is required in the synthesis of purines but not in the synthesis of pyrimidines.
 - (B) purine biosynthesis starts with the formation of PRPP, whereas pyrimidines incorporate the PRPP near the end of the pathway.
 - (C) purine formation requires a THF derivative, whereas pyrimidine formation does not.
 - (D) pyrimidine biosynthesis is tightly regulated in the cell, whereas purine biosynthesis is not.
 - (E) pyrimidines go through many steps, adding a single carbon or nitrogen each time, whereas the basic skeleton for purines is formed by two main precursors.
18. If a cell were unable to synthesize or obtain tetrahydrofolic acid (H_4 folate), it would probably be deficient in the biosynthesis of:
- (A) isoleucine.
 - (B) leucine.
 - (C) lysine.
 - (D) methionine.
 - (E) serine
19. The major site of formation of acetoacetate from fatty acids is the:
- (A) adipose tissue.
 - (B) intestinal mucosa.
 - (C) kidney.
 - (D) liver.
 - (E) muscle
20. Transport of fatty acids from the cytoplasm to the mitochondrial matrix requires:
- (A) ATP, carnitine, and coenzyme A.
 - (B) ATP, carnitine, and pyruvate dehydrogenase.
 - (C) ATP, coenzyme A, and hexokinase.
 - (D) ATP, coenzyme A, and pyruvate dehydrogenase.
 - (E) carnitine, coenzyme A, and hexokinase.
21. Which of these enzymes is *not* part of the Calvin cycle?
- (A) Aldolase
 - (B) Glyceraldehyde 3-phosphate dehydrogenase
 - (C) Phosphofructokinase-1
 - (D) Ribulose-5-phosphate kinase
 - (E) Transketolase
22. Glycogen is converted to monosaccharide units by:
- (A) glucokinase.
 - (B) glucose-6-phosphatase
 - (C) glycogen phosphorylase.
 - (D) glycogen synthase.
 - (E) glycogenase.

23. CMP, UMP, and TMP all have _____ as a common precursor.
- (A) adenosine (B) aspartate
(C) glutamine (D) inosine
(E) *S*-adenosyl methionine
24. Which one of the following statements is true?
- (A) The brain prefers glucose as an energy source, but can use ketone bodies.
(B) Muscle cannot use fatty acids as an energy source.
(C) In a well-fed human, about equal amounts of energy are stored as glycogen and as triacylglycerol.
(D) Fatty acids cannot be used as an energy source in humans because humans lack the enzymes of the glyoxylate cycle.
(E) Amino acids are a preferable energy source over fatty acids
25. An elevated insulin level in the blood:
- (A) inhibits glucose uptake by the liver.
(B) inhibits glycogen synthesis in the liver and muscle.
(C) results from a below-normal blood glucose level.
(D) stimulates glycogen breakdown in the liver.
(E) stimulates synthesis of fatty acids and triac
26. If glucose labeled with ^{14}C in C-1 were fed to yeast carrying out the ethanol fermentation, where would the ^{14}C label be in the products?
- (A) In C-1 of ethanol and CO_2
(B) In C-1 of ethanol only
(C) In C-2 (methyl group) of ethanol only
(D) In C-2 of ethanol and CO_2
(E) In CO_2 only
27. Which of the following is *not* true of the reaction catalyzed by the pyruvate dehydrogenase complex?
- (A) Biotin participates in the decarboxylation.
(B) Both NAD^+ and a flavin nucleotide act as electron carriers.
(C) The reaction occurs in the mitochondrial matrix.
(D) The substrate is held by the lipoyl-lysine “swinging arm.”
(E) Two different cofactors containing -SH groups participate.

28. Which of the following cofactors is required for the conversion of succinate to fumarate in the citric acid cycle?
- (A) ATP
 - (B) Biotin
 - (C) FAD
 - (D) NAD^+
 - (E) NADP^+
29. Which of the following best characterizes NADH and NADPH?
- (A) NADH and NADPH are interchangeably used for both ATP generation and biosynthesis.
 - (B) NADH is primarily used for ATP generation, whereas NADPH is primarily used for biosynthesis.
 - (C) NADPH is primarily used for ATP generation, whereas NADH is primarily used for biosynthesis.
 - (D) Both ATP generation and biosynthesis preferentially use NADH over NADPH.
 - (E) Both ATP generation and biosynthesis preferentially use NADPH over NADH.
30. Which one of the following best describes the role of mitochondria in apoptosis?
- (A) Escape of cytochrome *c* into the cytoplasm.
 - (B) Increased rate of fatty acid -oxidation.
 - (C) Increase in permeability of outer membrane.
 - (D) Uncoupling of oxidative phosphorylation.
 - (E) Both A and C are correct.

二、問答題 (共 40 分)

1. TE buffer 成分是 10 mM Tris (pH 7.5) 與 1 mM EDTA。
- (1) 若手邊有 1 M Tris (pH 7.5) 與 0.5 M EDTA 之預配溶液各一瓶，要如何利用這些溶液以及純水，配製出 500 ml 的 TE buffer? 應簡述計算方法與理由。(3 分)
 - (2) 若 1 M Tris (pH 7.5) 預配溶液恰好用完了，而實驗室內有一罐 Tris 晶體。已知 Tris 的分子量為 121 g/mol, pKa 為 8.07。請問如何利用這些配製 100 ml 的 1 M Tris? 應加入 HCl 或 NaOH 去調整 pH 至 7.5? 應簡述計算方法與理由。(3 分)

2. 請說明 RNA interference 之作用機制及參與的主要蛋白質。(6分)
3. 研究酵素動力學時，常用雙倒數之 Lineweaver-Burk plot 來分析。若某酵素反應滿足 Michaelis-Menten equation 的條件，並以符號[S]表示受質(substrate)濃度，V 表示反應速率， V_{max} 表示最大反應速率，以及 K_M 表示 Michaelis 常數。
- (1) 請繪出 Lineweaver-Burk plot 的標準反應圖形，標示兩軸，並分別說明兩截距，以及斜率所代表的意義為何？(5分)
- (2) 加入此酵素之競爭型抑制物(competitive inhibitor)後，會如何改變？請在圖中用虛線繪製第二條反應曲線來說明。(3分)
4. Write a balanced equation for the β -oxidation of palmitoyl-CoA, a 16-carbon, fully saturated fatty acid, and indicate how much of each product is formed. (6分)
5. Describe the oxygenase activity of ribulose 1, 5-bisphosphate carboxylase/oxygenase (rubisco) and explain why this reaction is undesirable from the point of view of a plant. (8分)
6. What are the biological functions of the pentose phosphate pathway? (6分)