Part I. Multiple choices (26%)
In the carbohydrate metabolism, all of the following enzymes may participate. Please select the correct answers from the following list to fit in the question 1 to 11.

A. frutokinase  N. hexokinase
B. fumarase  O. glycogen synthase
C. enolase  P. glycogen phosphorylase
D. glucose 6-phosphatase  Q. pyruvate kinase
E. succinate dehydrogenase  R. PEP carboxykinase
F. pyruvate carboxylase  S. α-Ketoglutarate dehydrogenase complex
G. phosphofructokinase-2  T. protein kinase C
H. phosphofructokinase-1  U. glyceraldehyde 3-phosphate dehydrogenase
I. glucokinase  V. isocitrate dehydrogenase
J. triose phosphate isomerase  W. phosphohexose isomerase
K. fructose 2,6-bisphosphatase  X. malate dehydrogenase
L. fructose 1,6-bisphosphatase  Y. pyruvate dehydrogenase complex
M. phosphorylase kinase  Z. glucose 6-phosphate dehydrogenase

1. Which of the enzymes involve in glycolysis?
2. Which of the enzymes involve in the irreversible steps of gluconeogenesis?
3. Which of the enzyme is the isoenzyme of hexokinase?
4. Which of the enzymes represents a major regulation point in glycolysis?
5. Which catalyzes a reaction in which ATP is consumed?
6. Which catalyzes a reaction in which NADH is produced?
7. Which catalyzes a reaction in which FADH₂ is produced?
8. Which catalyzes a reaction in which CO₂ is produced?
9. Which of the enzymes involve in the regulation of glycogen metabolism?
10. Which of the enzymes govern in the coordinated regulation of glycolysis and gluconeogenesis
11. Which of the enzymes involve in the first step of pantose phosphate pathway?

Part II. Short answer question (8%)
1. Which of the coenzyme involves in the catalytic reaction of pyruvate carboxylase
2. Which of the coenzymes involve in the catalytic reaction of pyruvate dehydrogenase complex
3. What are the most positive activator and inhibitor for phosphofructokinase-1
Part III: Short answer questions: (33 points)

1. The free-energy change ($\Delta G$) for the formation of a protein from the individual amino acids is positive and is thus an endergonic (energy-absorbing) reaction. How, then, do cells accomplish this process? (3 points)

2. Please explain the reason why we can use SDS polyacrylamide gel electrophoresis to estimate the molecular weight of a protein. (3 points)

3. Phe and/or Trp residues tend to disrupt an $\alpha$-helix when they occur next to each other in a protein, Why? (3 points)

4. Please describe the roles of water in protein folding. (3 points)

5. Please describe the principle of dialysis. (3 points)

6. In a typical cell fractionation, cells or tissues in solution are disrupted by gentle homogenization. When the homogenate is centrifuged at high speed, biomolecules and larger cell components sediment at different rates. Now we use this technique to separate ribosome, mitochondria and nuclei. Which one would sediment faster than the others? (3 points)

7. What is the difference between $in vitro$ and $in vivo$ studies? (3 points)

8. The isoleucine production pathway in the bacterium $E. coli$ has five steps catalyzed by five different enzymes. If a cell begins to produce more isoleucine than is needed for protein synthesis, the unused isoleucine accumulates and the increased concentration inhibits the catalytic activity of the first enzyme in the pathway, immediately slowing the production of isoleucine. Such kind of mechanism is named? (3 points)

9. The DNA sequence of myoglobin gene contains 450 nucleotides. Please estimate the molecular weight of myoglobin protein. (3 points)

10. Please describe the common method(s) to break disulfide bonds in proteins? (3 points)

11. How do we measure the enzyme purity during and after purification? (3 points)
Part VI: Multiple Choice: (On your answering sheet, please write down a, b, c, d, e, or f, which represents the answer of your choice. 33%)

1. Chaperons are involved in (a) protein secretion (b) protein folding (c) protein degradation (d) protein glycosylation (e) protein synthesis (f) none of the above

2. Ubiquitin is involved in (a) protein secretion (b) protein folding (c) protein degradation (d) protein glycosylation (e) protein synthesis (f) none of the above

3. Ribosome is involved in (a) protein secretion (b) protein folding (c) protein degradation (d) protein glycosylation (e) protein synthesis (f) none of the above

4. SRP is involved in (a) protein secretion (b) protein folding (c) protein degradation (d) protein glycosylation (e) protein synthesis (f) none of the above

5. Which of the following is ribonucleoprotein complex? (a) proteosome (b) DNA topoisomerase (c) RNA polymerase (d) telomerase (e) restriction endonuclease (f) none of the above

6. Which of the following describes DNA replication accurately? (a) sequence-specific (b) semi-discontinuous (c) semi-conservative (d) a & b (e) a & c (f) none of the above

7. Which amino acid residue is responsible for the attachment of a target protein to the carboxyl end of Ubiquitin? (a) S (b) T (c) R (d) K (e) C (f) A

8. Which of the following is unrelated to PCR? (a) Taq DNA polymerase (b) template (c) primer (d) annealing (e) recombination (f) none of the above

9. Which of the following makes tRNA^{Ala} aminoacylated with tyrosine, but not phenylalanine? (a) Trna^{Ala} of the anticodon (b) Alanyl-tRNA synthetase (c) tRNA^{Ala} (d) 16S rRNA (e) 23S rRNA (f) none of the above.

10. Which of the following is responsible for the high processive property of E. coli DNA polymerase III holoenzyme? (a) helicase (b) DNA polymerase I (c) γ complex (d) β clamp (e) DNA gyrase (f) none of the above.

11. Which of the following enzymes does not require “primer” for its enzyme activity? (a) E. coli DNA polymerase I (b) Klenow enzyme (c) Taq DNA polymerase (d) E. coli DNA polymerase III holoenzyme (e) E. coli RNA polymerase (f) none of the above.

12. Which of the following codons start and stop translation respectively? (a) AUU, UAG (b) UGG, GGU (c) UAA, UAG (d) GGU, GUA (e) AUG, UAA (f) none of the above.

13. Loss of function in which of the following enzyme activities will cause E. coli to die? (a) the polymerase activity of DNA polymerase I (b) the polymerase activity of DNA polymerase III (c) the 5’-exonuclease activity of DNA polymerase I (d) a & b & c (e) a & b & f (f) b & c.

14. Which of the following RNAs has the shortest half-lives, but the lowest abundance and the most varieties? (a) snRNA (b) tRNA (c) mRNA (d) rRNA (e) 5S rRNA (f) none of the above.

15. Repressor could bind to (a) effector (b) promoter (c) operator (d) a & b & c (e) a & b & f (f) a & c.

16. The process of introducing purified DNA into CaCl2-treated E. coli is called (a) transduction (b) conjugation (c) transformation (d) induction (e) ligation (f) none of the above.

17. If one protein in the E. coli RNA polymerase holoenzyme is absent, transcription will be initiated anywhere on DNA. Which of the following is the determinant for transcription initiation at specific site? (a) α (b) β (c) β’ (d) γ (e) σ (f) none of the above.

18. What is the polarity for the covalent linkage of the 5’ cap with the first nucleotide of mRNA? (a) 5’-5’ (b) 3’-5’ (c) 2’-5’ (d) 5’-2’ (e) 2’-2’ (f) 3’-3’.

19. cDNA could be synthesized in the test tubes from RNA isolated from cells. Isolation and storage of mRNA were made possible by cloning cDNA into vector and transformed into E. coli. Which of the following is utilized for the synthesis of cDNA from RNA? (a) DNA polymerase (b) RNA ligase (c) reverse transcriptase (d) RNA polymerase (e) poly (A) polymerase (f) none of the above.
20. Which of the following is required for *E. coli* DNA replication? (a) DNA polymerase III holoenzyme (b) Klenow enzyme (c) DNA polymerase I (d) a & b (e) a & c (f) b & c.

21. Nuclear gene transcripts containing introns are processed for intron removal. This process occurs in (a) cytoplasm (b) nucleus (c) mitochondria (d) chloroplast (e) ER (f) none of the above.

22. In the translation process of prokaryotic cells, ribosome chooses the correct start codon by recognizing a 'ribosome binding site' on mRNA. Which of the following element is involved in such recognition? (a) tRNA^{Met} anticonodon (b) the 3' end of 23S rRNA (c) the 5' end of 23S rRNA (d) the 3' end of 16S rRNA (e) the 5' end of 16S rRNA (f) none of the above.

23. Which of the following element serves as carrier for carrying amino acid to the ribosome while translating genetic codes in mRNA into amino acids in protein? (a) snRNA (b) 5S RNA (c) 16S rRNA (d) 23S rRNA (e) tRNA (f) none of the above.

24. Peptide bond formation between amino acid residues occurring in the *E. coli* ribosome is catalyzed by (a) 23S rRNA (b) 16S rRNA (c) protein synthetase (d) ribosomal protein of large subunit (e) ribosomal protein of small subunit (f) none of the above.

25. Which of the following is used as building materials for synthesizing DNA in cells? (a) dNTP (b) NTP (c) NDP (d) NMP (e) ddNTP (f) none of the above.

26. Inducer is the substance that induces *E. coli* transcription initiation. Which of the following binds DNA less efficiently because of the presence of inducer? (a) RNA polymerase (b) σ factor (c) repressor (d) operator (e) enhancer (f) none of the above.

27. Which of the following terms describes the structure that is located at each end of the linear eukaryotic chromosome and appears as thousands of consecutive repeated sequences? (a) spliceosome (b) centromere (c) chromomere (d) ribosome (e) telomere (f) none of the above.

28. Prokaryotic RNA polymerase holoenzyme recognizes and binds a specific sequence in DNA before transcription could be initiated. For a regulated gene, transcription cannot be initiated when the sequence adjacent to the RNA polymerase-binding site is bound by (a) operator (b) enhancer (c) inducer (d) repressor (e) promoter (f) none of the above.

29. Which of the following listed enzymes cuts double-stranded DNA at specific sequence? (a) S1 nuclease (b) DNA topoisomerase II (c) *Bam*HI (d) topoisomerase I (e) exonuclease (f) none of the above.

30. Attenuation is utilized by bacteria to stop initiated transcription before the structural genes are transcribed. Which of the following triggers attenuation to occur? (a) rRNA (b) specific uncharged-tRNA (c) mRNA (d) dNTP (e) specific amino acid (f) none of the above.

31. In eukaryotic cells, post-translational glycosylation occurs in (a) Mitochondria (b) Golgi (c) ER (d) a & b (e) b & c (f) a & c.

32. Which one of the following factors is responsible for delivering charged tRNA into A site. (a) EFTu (b) EFTs (c) EFG (d) IF2 (e) RF3

33. Which one of the following translation factors can help delivering charged tRNA directly into P site. (a) EFTu (b) EFTs (c) EFG (d) IF2 (e) RF3