

※ 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：(每題 3 分，共 75 分)

1. Which of the following structures would decrease the electrochemical gradient across a membrane?

- (A) an aquaporin
- (B) a proton pump
- (C) a potassium channel
- (D) both a proton pump and a sodium channel

2. Which of the following statements is a reasonable explanation for why unsaturated fatty acids help keep a membrane more fluid at lower temperatures?

- (A) The double bonds form kinks in the fatty acid tails, preventing adjacent lipids from packing tightly.
- (B) Unsaturated fatty acids have a higher cholesterol content, which prevents adjacent lipids from packing tightly.
- (C) Unsaturated fatty acids are more nonpolar than saturated fatty acids.
- (D) The double bonds block interaction among the hydrophilic head groups of the lipids.

3. Exposing inner mitochondrial membranes to ultrasonic vibrations will disrupt the membranes. However, the fragments will reseal "inside out." The little vesicles that result can still transfer electrons from NADH to oxygen and synthesize ATP. After the disruption, which components involved in oxidative phosphorylation must be present for electron transfer and ATP synthesis to still occur?

- (A) only the electron transport system
- (B) only the ATP synthase system
- (C) all of the electron transport system and the proteins that add CoA to acetyl groups
- (D) all of the electron transport system and ATP synthase

4. Fatty acids usually have an even number of carbons in their structures. Catabolism of fatty acids produces two-carbon fragments that are converted to acetyl CoA molecules. What is the most likely way in which these acetyl CoA molecules would be metabolized in aerobic cellular respiration?

- (A) They would directly enter the electron transport chain.
- (B) They would directly enter the energy-yielding phase of glycolysis.
- (C) They would be converted to pyruvate and then undergo pyruvate oxidation upon transport into mitochondria.
- (D) They would directly enter the citric acid cycle.

5. 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
6. What would be a likely consequence of a mutation in plants that results in a photorespiration deficiency?
- (A) Photosynthetic efficiency would be reduced at low light intensities.
 - (B) Cells would carry on the Calvin cycle at a much slower rate.
 - (C) There would be more cellular damage from harmful products of the light reactions of photosynthesis.
 - (D) Less oxygen would be produced by photosynthesis.
7. The specific relationship between a legume and its mutualistic *Rhizobium* strain probably depends on _____.
- (A) each legume having a chemical dialogue with a fungus
 - (B) each *Rhizobium* strain having a form of nitrogenase that works only in the appropriate legume host
 - (C) each legume being found where the soil has only the *Rhizobium* specific to that legume
 - (D) specific recognition between the chemical signals and signal receptors of the *Rhizobium* strain and legume species
8. 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) nitrate-ATPase
 - (B) nitrate/proton antiporter
 - (C) nitrate/proton symporter
 - (D) nitrate channel
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%

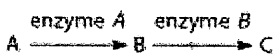
10. What is the function of the enzyme topoisomerase in DNA replication?

- (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 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?

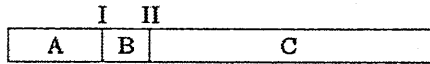
- (A) activation of receptor tyrosine kinases
- (B) activation of steroid hormone receptors
- (C) activation of G protein-coupled receptors
- (D) activation ligand-gated ion channels

14. When taken up by a cell, which of the following molecules binds to a repressor so that the repressor no longer binds to the operator?

- (A) inducer
- (B) promoter
- (C) repressor
- (D) corepressor

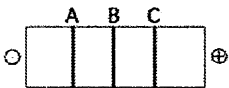
15. Which of the following conditions is most likely to cause the lactose operon to be transcribed?
- (A) There is more glucose in the cell than lactose.
 - (B) There is glucose but no lactose in the cell.
 - (C) The cyclic AMP and lactose levels are both high within the cell.
 - (D) The cAMP level is high and the lactose level is low.
16. Imagine that you've isolated a yeast mutant that contains histones resistant to acetylation. What phenotype would you predict for this mutant?
- (A) The mutant will grow rapidly.
 - (B) The mutant will require galactose for growth.
 - (C) The mutant will show decreased levels of gene expression.
 - (D) The mutant will show increased levels of gene expression.
17. Which of the following processes would allow the detection of alternative splicing of transcripts from a given gene?
- (A) Compare the DNA sequence of the given gene to that of a similar gene in a related organism.
 - (B) Measure the relative rates of transcription of the given gene compared to that of a gene known to be constitutively spliced.
 - (C) Compare the sequences of different primary transcripts made from the given gene.
 - (D) Compare the sequences of different mRNAs made from the given gene.
18. Which of the following statements best describes the characteristics of siRNA?
- (A) a double-stranded RNA, one of whose strands can complement and inactivate a sequence of mRNA
 - (B) a single-stranded RNA that can, where it has internal complementary base pairs, fold into cloverleaf patterns
 - (C) a double-stranded RNA that is formed by cleavage of hairpin loops in a larger precursor
 - (D) a portion of rRNA that allows it to bind to several ribosomal proteins in forming large or small subunits
19. In a comparison of two DNA sequences found in the same location on homologous chromosomes, one of the homologs carries the sequence 5'-AACTACGA-3', and the other homolog carries the sequence 5'-AACTTCGA-3'. Within a population, you discover that each of these sequences is common. Which of the following statements correctly describes these sequences?
- (A) They contain a SNP that may be useful for genetic mapping.
 - (B) They can identify a protein-coding region of a gene.
 - (C) They may cause disease.
 - (D) They may carry out RNA interference.

20. Use the figure to answer the following question.



The segment of DNA shown in the figure has restriction sites I and II, which create restriction fragments A, B, and C. Which of the gels produced by electrophoresis best represents the separation and identity of these fragments?

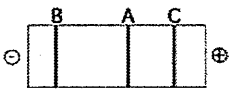
(A)



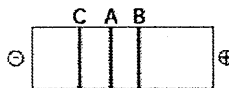
(B)



(C)



(D)



21. One possible use of transgenic plants is in the production of human proteins, such as vaccines. Which of the following issues is a possible hindrance that must be overcome in order for this process to work properly?

- (A) prevention of transmission of plant allergens to the vaccine recipients
- (B) prevention of vaccine-containing plants being consumed by insects
- (C) use of plant cells to translate non-plant-derived mRNA
- (D) inability of the human digestive system to accept plant-derived protein

22. Plants are more readily manipulated by genetic engineering than are animals because

- (A) plant genes do not contain introns.
- (B) more vectors are available for transferring recombinant DNA into plant cells.
- (C) a somatic plant cell can often give rise to a complete plant.
- (D) plant cells have larger nuclei.

23. Use the following information to answer the question.

Organisms share many conserved core processes and features, including transcription and translation, using a uniform genetic code. Scientists have used these shared processes and features in biotechnology. For example, for the process of some transformations, a plasmid is constructed when a eukaryotic gene of interest is added with an antibiotic resistant gene such as beta-lactamase, which is used for ampicillin resistance. This plasmid is then inserted into a prokaryotic bacterial cell, such as *E. coli*, through a transformation process that leads to the production of the product protein from the eukaryotic organism. To culture the bacteria and obtain the protein product, the bacteria must grow.

Select the appropriate condition to determine if the plasmid has entered the *E. coli* bacterial cell.

- (A) nutrient broth to which no antibiotic has been added
- (B) water to which ampicillin has been added
- (C) nutrient broth to which ampicillin has been added
- (D) nutrient broth to which other resistant bacteria have been added

24. What is metagenomics?

- (A) genomics as applied to a species that most typifies the average phenotype of its genus
- (B) the sequencing of one or two representative genes from several species
- (C) the sequencing of only the most highly conserved genes in a lineage
- (D) sequencing DNA from a group of species from the same ecosystem

25. Bioinformatics includes _____.

- I. using computer programs to align DNA sequences
- II. creating recombinant DNA from separate species
- III. developing computer-based tools for genome analysis
- IV. using mathematical tools to make sense of biological systems

- (A) I, II and III
- (B) I, II and IV
- (C) I, III, and IV
- (D) I, II, III, and IV

二、解釋名詞：(每題3分，共9分)

1. single nucleotide polymorphism (SNP)
2. Post-translational modification
3. cpDNA

三、問答題：(每題 8 分, 共 16 分)

1. Please describe how do C4 plants suppress photorespiration biochemically and structurally? (8 points)
2. What is GS/GOGAT cycle? Please describe the significance of GS/GOGAT cycle in plants. (8 points)