

請清楚標示題號並依序作答於試卷上

I. 單選題: (每題 1.5 分, 45%) ※請作答於試卷內之「選擇題作答區」

1. You are asked to provide data that support the hypothesis that protein structure and function are correlated. The best set of data to support this hypothesis is \_\_\_\_\_.
  - (A) denatured proteins do not function normally
  - (B) enzymes tend to be globular in shape
  - (C) proteins function best at certain temperatures
  - (D) proteins have four distinct levels of structure and many functions
2. What holds cellulose molecules together in bundles large enough to form fibers?
  - (A) the cell wall
  - (B) peptide bonds
  - (C) hydrogen bonds
  - (D) hydrophobic interactions between different residues in the cellulose helix
3. Watson and Crick elucidated the structure of DNA in 1953. Their research built on and helped explain the findings of other scientists before them, including \_\_\_\_\_.
  - (A) X-ray diffraction studies by Rosalind Franklin and Maurice Wilkins.
  - (B) Replication studies by Meselson and Stahl.
  - (C) Okazaki's work on lagging-strand DNA fragments.
  - (D) All of the above were important considerations in the elucidation of the structure of DNA.
4. Put the following steps of DNA replication in chronological order (按時間的前後順序).
  1. Single-stranded binding proteins attach to DNA strands.
  2. Hydrogen bonds between base pairs of antiparallel strands are broken.
  3. Primase binds to the site of origin.
  4. DNA polymerase binds to the template strand.
  5. An RNA primer is created.
  - (A) 1, 2, 3, 4, 5
  - (B) 2, 1, 3, 5, 4
  - (C) 3, 2, 1, 5, 4
  - (D) 3, 1, 2, 4, 5
5. Positive control and negative control work together to control the *lac* operon of *E. coli* in the presence or absence of glucose and lactose. Full induction of the *lac* operon occurs when \_\_\_\_\_.
  - (A) lactose levels are low and glucose levels are low
  - (B) lactose levels are low and glucose levels are high
  - (C) lactose levels are high and glucose levels are low
  - (D) lactose levels are high and glucose levels are high
6. One way to detect alternative splicing of transcripts from a given gene is to \_\_\_\_\_.
  - (A) compare the DNA sequence of this gene to that of a gene known to be constitutively spliced
  - (B) measure the relative rates of transcription of this gene compared to that of a gene known to be constitutively spliced
  - (C) compare the sequences of different primary transcripts made from this gene
  - (D) compare the sequences of different mRNAs made from this gene

見背面

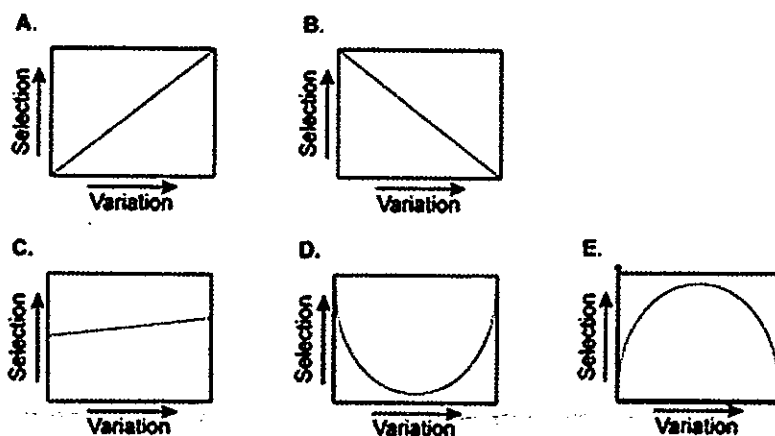
7. The reason for differences in the sets of proteins expressed in a nerve and a pancreatic cell of the same individual is that nerve and pancreatic cells contain different \_\_\_\_\_.
- (A) genes (B) regulatory sequences (C) sets of regulatory proteins (D) promoters
8. \_\_\_\_\_ prevents seeds from germinating until conditions are favorable for the growth of the plant.
- (A) Ethylene (B) Auxin (C) Zeaxanthin (D) Gibberellin (E) Abscisic acid
9. A certain bacterium infects a plant's upper leaves. A few days later, bacteria of the same species attempt to infect the same plant's roots but are unsuccessful. What process is responsible for the plant's ability to prevent this infection?
- (A) antivirulence response (B) pathogenesis resistance  
(C) systemic acquired resistance (D) sequential immunity
10. How would you expect the root system of a plant grown by hydroponics to compare to the root system of a plant grown in soil?
- (A) more developed (B) less developed (C) the same (D) absent
11. Root pressure can result in the early morning appearance of water droplets on leaves and flowers of low-growing plants. Which of the following does not contribute to the development of root pressure?
- (A) low water potential of atmosphere  
(B) closed stomata  
(C) accumulation of ions from the soil by root epidermal cells  
(D) movement of ions from epidermis to xylem  
(E) creation of a water potential gradient between the xylem (lower  $\psi$ ) and surrounding cells (higher  $\psi$ ) in the root
12. Which of the following features of plant cells allows for symplastic movement of water?
- (A) porous cell walls (B) plasmodesmata (C) central vacuole (D) endodermal cells
13. Monophyletic groups can be identified using the "one-snip test". It means that if you cut any branch on a phylogenetic tree, all of the branches and tips that fall off represent a monophyletic group. Why is this valid? (snip: 剪)
- (A) Monophyletic groups are nested on a tree—meaning that they are hierarchical.  
(B) Monophyletic groups can also be called clades or lineages.  
(C) Species are the smallest monophyletic groups on the tree of life.  
(D) One snip gets an ancestor and all of its descendants.
14. Suppose 64% of a remote mountain village can taste phenylthiocarbamide (PTC) and must therefore have at least one copy of the dominant PTC taster allele. If this population conforms to Hardy-Weinberg expectations for this gene, what percentage of the population must be heterozygous for this trait?
- (A) 16% (B) 32% (C) 40% (D) 48% (E) 60%

15. A gene is a \_\_\_\_\_.

- (A) protein-coding sequence of DNA
- (B) sequence of DNA capable of directing the synthesis of a polypeptide
- (C) sequence of DNA capable of directing the synthesis of one or more related polypeptides or RNAs
- (D) sequence of DNA capable of directing the synthesis of one or more related biological molecules of any type

16. Which of the graphs (A-E) best represents the relationship between the intensity of directional selection and the genetic variation present within a population?

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



17. Which of the following lines of evidence would allow you to classify the worm as a nematode (roundworm) and not an annelid?

- (A) It undergoes protostome development.
- (B) It is segmented.
- (C) It is triploblastic.
- (D) It has a coelom.
- (E) It sheds its external skeleton to grow.

18. If a viral host cell has a mutation that interferes with the addition of carbohydrates to proteins in the Golgi, which of the following could likely result?

- (A) The viral envelope proteins will not be glycosylated and may not arrive at the host plasma membrane.
- (B) The viral capsid proteins will not be glycosylated and may not arrive at the host plasma membrane.
- (C) The viral core proteins will not be glycosylated and may not arrive at the host plasma membrane.
- (D) The virus would be unable to reproduce within the host cell.

19. In 2005, a spot 1 centimeter from the center of a woody stem is in the bark. In what tissue will the same spot (1 cm from the center) be in 2050?

- (A) bark
- (B) secondary phloem
- (C) vascular cambium
- (D) secondary xylem

20. A recessive allele on the X chromosome is responsible for red-green color blindness in humans. A woman with normal vision whose father is color blind marries a color-blind male. What is the probability that this couple's first son will be color blind?

- (A) 25%
- (B) 50%
- (C) about 66%
- (D) 75%
- (E) about 33%

21. Put the steps of the process of signal transduction in the order they occur:
1. A conformational change in the signal-receptor complex activates an enzyme.
  2. Protein kinases are activated.
  3. A signal molecule binds to a receptor.
  4. Target proteins are phosphorylated.
  5. Second messenger molecules are released.
- (A) 1, 2, 3, 4, 5      (B) 3, 1, 2, 4, 5      (C) 3, 1, 5, 2, 4      (D) 1, 2, 5, 3, 4
22. Pemphigus vulgaris is an autoimmune disorder in humans in which antibodies are produced against the cadherins of desmosomes. The blistering of the skin and mucous membranes characteristic of this disorder is probably a result of \_\_\_\_\_.
- (A) a decrease in flexibility of the cell membrane  
(B) an inadequate number of G-protein receptors  
(C) inadequate production of cytoskeletal proteins  
(D) a loss in cell-cell adhesion
23. What is the main purpose of the light-dependent reactions of photosynthesis?
- (A) to generate oxygen by "splitting" H<sub>2</sub>O      (B) to produce NADPH and ATP  
(C) to produce NADPH for use in respiration      (D) to use ATP to make glucose
24. A plant developed a mineral deficiency after being treated with a fungicide. What is the most probable cause of the deficiency?
- (A) Mineral receptor proteins in the plant membrane were not functioning.  
(B) Mycorrhizal fungi were killed.  
(C) Active transport of minerals was inhibited.  
(D) Proton pumps reversed the membrane potential.
25. Some dioecious species have the XY genotype for male and XX for female. After double fertilization, what would be the genotypes of the embryos and endosperm nuclei?
- (A) embryo XY/endosperm XXX or embryo XX/endosperm XXY  
(B) embryo XX/endosperm XX or embryo XY/endosperm XY  
(C) embryo XX/endosperm XXX or embryo XY/endosperm XYY  
(D) embryo XX/endosperm XXX or embryo XY/endosperm XXY
26. The black dots that cover strawberries are actually fruits formed from the separate carpels of a single flower. The fleshy and tasty portion of a strawberry derives from the receptacle of a flower with many separate carpels. Therefore, a strawberry is
- (A) a simple fruit with many seeds.  
(B) both a multiple fruit and an accessory fruit.  
(C) both an aggregate fruit and an accessory fruit.  
(D) both a simple fruit and an aggregate fruit.
27. For cells to divide more rapidly, increased production would likely be required of each of the following proteins except \_\_\_\_\_.
- (A) p53      (B) cyclins      (C) activated MPF      (D) PDGF

28. How has the avian lung adapted to the metabolic demands of flight?
- (A) Airflow through the avian lung is continuous and unidirectional during both inhalation and exhalation.
  - (B) There is more dead space within the avian lung so that oxygen can be stored for use.
  - (C) Countercurrent circulation is present in the avian lung.
  - (D) Gas exchange occurs in the anterior and posterior air sacs.
  - (E) The avian respiration is more frequent and shallow than the oxygen content in the blood increases.
29. Which of the following is correct about the left ventricle in humans?
- (A) It generates the same contractile force as the right ventricle.
  - (B) It experiences only systole.
  - (C) It pumps the same amount of blood as the right ventricle.
  - (D) It pumps blood into the pulmonary circuit.
  - (E) Its wall thickness is the same with that of right ventricle.
30. To understand how plant phototropic responses are regulated, a researcher exposed oat seedlings to light and then cut off tips of coleoptiles and placed them on agar blocks. Later the agar blocks were placed on decapitated coleoptiles of other individuals, and some seedlings were kept in the dark while others were exposed to light. Based on your knowledge of auxin synthesis and mode of action, predict in what cases the decapitated coleoptiles would bend to the right.
- (A) when the block was placed on the left side of the coleoptiles in both dark and light treatments
  - (B) when the block was placed on the right side of the coleoptiles in both dark and light treatments
  - (C) when the block was placed on the left side of the coleoptiles in dark only
  - (D) when the block was placed on the right side of the coleoptiles in dark only
  - (E) as long as light was coming from the right, decapitated coleoptiles bent to the right

※ 注意：請於試卷上「非選擇題作答區」標明題號並依序作答。

II. 解釋名詞：(每題 3 分，18%)

- |  |                              |
|--|------------------------------|
| 1. secondary active transport          | 4. spliceosome               |
| 2. equilibrium potential (of a neuron) | 5. cambium                   |
| 3. niche differentiation               | 6. Type I survivorship curve |

III. 簡答題 (17%)

1. What is quaternary structure of a protein? Give an example. (7%)
2. What is the central dogma of molecular biology? List 3 exceptions to the central dogma? (10%)

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IV. 選出一個最適當的答案選項 (2分)，並說明你選擇的理由 (2分)。(共 20 分)

1. If an anemic patient had lower hemoglobin (Hb) level (10 g/100 ml blood) but his lungs were functioning normally, \_\_\_\_\_. (Normal male Hb level: 14-18 g/100 ml)

- (A) the arterial oxygen content would be normal.
- (B) the arterial oxygen partial pressure would be normal.
- (C) stimulation of peripheral arterial chemoreceptors would be expected to increase.
- (D) arterial hemoglobin saturation (%) would be expected to decrease.
- (E) the venous reserve of oxygen would be normal.

2. Which would not occur if action potential propagation through the atrioventricular node (AV node) of the mammalian heart was blocked?

- (A) There could be a slowing of the frequency of contraction of the ventricles.
- (B) The atria would contract more frequently than the ventricles.
- (C) The SA node would no longer set the pace for atrial contraction.
- (D) The Purkinje fibers would not receive their typical action potentials from the bundle branches.
- (E) The atria and ventricles would no longer beat in synchrony.

3. All of the following statements about human vision are correct except:

- (A) Perception of visual information takes place in the brain.
- (B) Rods are more light sensitive than cones and are responsible for night vision.
- (C) Color vision results from the presence of three subclasses of cones in the retina, each with its own type of opsin associated with retinal.
- (D) All information from the left eye goes to the right visual cortex and all information from the right eye goes to the left visual brain.
- (E) Visual acuity is sharpest in the fovea.

4. How does the contraceptive pill (避孕丸) work to prevent pregnancy?

- (A) It is a barrier between the vagina and the cervix.
- (B) It delivers progesterone leading the ovary to discontinue ovulating a new oocyte.
- (C) It produces an acidic environment for sperm.
- (D) It discourages fertilization.

5. In a series of immune system experiments, the thymus glands were removed from baby mice. Which of the following would you predict as a likely result?

- (A) The mice suffered from numerous allergies.
- (B) The mice never developed cancerous tumors.
- (C) The mice suffered from autoimmune diseases.
- (D) The mice readily accepted tissue transplants.