

※ 注意：請於試卷上「選擇題作答區」依序作答。

本試卷分選擇及問答兩類試題，請於答案卷依序作答，選擇題請填答於“選擇題作答區”，問答題請標明題號後作答！

一、選擇題 (共 30 題 60 分，每題 2 分)

- 1) Which of these statements is true about xylem and/or phloem?
  - A) Xylem and phloem cells are derived from the ground meristem cells.
  - B) Xylem is made of companion cells and vessel elements.
  - C) Xylem and phloem cells are derived from procambium cells.
  - D) Phloem cells do not contain cytoplasm.
  
- 2) What is an essential part of alternation of generations in plants?
  - A) meiosis to produce gametes
  - B) meiosis to produce gametophyte
  - C) mitosis to produce gametes
  - D) fertilization to produce spores
  
- 3) Which of the following cross-membrane transport mechanisms requires the expenditure of energy?
  - A) channel
  - B) antiporter
  - C) facilitated diffusion
  - D) carrier
  
- 4) As an undergraduate research assistant in the lab of the famous Dr. S. Nameerf, your duties involve measuring water potential in experimental soil-plant-atmosphere systems. Assume you make a series of measurements in a system under normal daylight conditions, with stomata open and photosynthesis occurring. Which of the following correctly depicts the trend your measurement data should follow if the cohesion-tension mechanism is operating?
  - A)  $\Psi_{\text{soil}} < \Psi_{\text{roots}} = \Psi_{\text{leaves}} < \Psi_{\text{atmosphere}}$
  - B)  $\Psi_{\text{atmosphere}} < \Psi_{\text{leaves}} = \Psi_{\text{roots}} < \Psi_{\text{soil}}$
  - C)  $\Psi_{\text{soil}} < \Psi_{\text{roots}} < \Psi_{\text{leaves}} < \Psi_{\text{atmosphere}}$
  - D)  $\Psi_{\text{atmosphere}} < \Psi_{\text{leaves}} < \Psi_{\text{roots}} < \Psi_{\text{soil}}$
  
- 5) Which criteria allow biologists to divide chemicals into macronutrients and micronutrients?
  - A) molecular weight of element or compound
  - B) the quantities required by plants
  - C) how they are used in metabolism
  - D) whether or not they are essential for plant growth

見背面

6) CAM and C<sub>4</sub> plants conduct photosynthesis in ways that allow them to live in drier areas than most C<sub>3</sub> plants can tolerate. The effectiveness of different plants in restricting water loss while still allowing for influx of adequate CO<sub>2</sub> can be compared using the transpiration ratio, which is calculated by dividing the amount of water transpired by the amount of CO<sub>2</sub> fixed by photosynthesis. If a typical transpiration ratio for a C<sub>3</sub> plant is 500, then possible values for CAM and C<sub>4</sub> plants could be \_\_\_\_\_.

- A) 750-1000
- B) 500
- C) 50-250
- D) 0-25

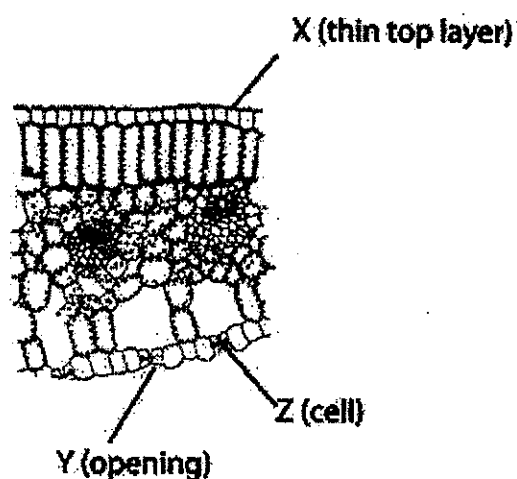
7) What is the function of proton pumps localized in the plant plasma membrane?

- A) to transfer phosphorus groups from ATP to proteins
- B) to transfer metal ions across the plasma membrane
- C) to transfer anions across the plasma membrane
- D) to create a membrane potential

8) The processes of water flow in xylem and sugar translocation in phloem differ in many respects. Which of the following is not a difference between xylem and phloem transport?

- A) Water potential gradients are required for xylem transport to occur, but not for phloem transport.
- B) Xylem transport is a wholly passive process; phloem transport includes active (energy-requiring) processes.
- C) Cells through which xylem transport occurs are "dead" at maturity; those in phloem transport are "alive."
- D) Xylem transport always occurs in the same direction; phloem transport does not.

The following diagram is of a cross section of a plant leaf. Use the diagram to answer the questions 9 and 10.



- 9) The main function associated with structure X is \_\_\_\_\_.  
A) absorption of carbon dioxide  
B) retention of water  
C) collection of light  
D) release of carbon dioxide
- 10) The main function associated with structure Y is \_\_\_\_\_.  
A) absorption of carbon dioxide  
B) retention of water  
C) collection of light  
D) release of carbon dioxide
- 11) Increasing the number of stomata per unit surface area of a leaf when atmospheric carbon dioxide levels decline is most analogous to a human \_\_\_\_\_.  
A) breathing faster as atmospheric carbon dioxide levels increase  
B) putting more red blood cells into circulation when atmospheric oxygen levels decline  
C) removing red blood cells from circulation when atmospheric oxygen levels increase  
D) increasing the volume of its lungs when atmospheric carbon dioxide levels increase
- 12) Water potential of plants during night is \_\_\_\_\_ compared to day water potential due to \_\_\_\_\_.  
A) increased; open stomata  
B) increased; closed stomata  
C) decreased; open stomata  
D) decreased; closed stomata
- 13) Double fertilization means that \_\_\_\_\_.  
A) flowers must be pollinated twice to yield fruits and seeds  
B) one sperm is needed to fertilize the egg, and a second sperm is needed to fertilize the polar nuclei  
C) the egg of the embryo sac is diploid  
D) every sperm has two nuclei
- 14) Early investigators thought the oxygen produced by photosynthetic plants came from carbon dioxide. In fact, it comes from \_\_\_\_\_.  
A) water  
B) glucose  
C) air  
D) electrons from NADPH

- 15) Plant hormones produce their effects by \_\_\_\_.
- I) altering the expression of genes
  - II) modifying the permeability of the plasma membrane
  - III) modifying the structure of the nuclear envelope membrane
- A) only I
  - B) only II
  - C) only III
  - D) only I and II
- 16) Mendel's second law of independent assortment has its basis in which of the following events of meiosis I?
- A) separation of homologs at anaphase
  - B) synapsis of homologous chromosomes
  - C) separation of cells at telophase
  - D) alignment of tetrads at the equator
- 17) Two true-breeding stocks of pea plants are crossed. One parent has red, axial flowers and the other has white, terminal flowers; all  $F_1$  individuals have red, axial flowers. The genes for flower color and location assort independently. Among the  $F_2$  offspring, what is the probability of plants with white axial flowers?
- A) 9/16
  - B) 1/16
  - C) 1/8
  - D) 3/16
- 18) All female mammals have one active X chromosome per cell instead of two. What causes this?
- A) activation of the BARR gene on one X chromosome, which then becomes inactive
  - B) crossing over between the XIST gene on one X chromosome and a related gene on an autosome
  - C) activation of the XIST gene on the X chromosome that will become the Barr body
  - D) inactivation of the XIST gene on the X chromosome derived from the male parent
- 19) A particular triplet of bases in the coding sequence of DNA is AAA. The anticodon on the tRNA that binds the mRNA codon is
- A) AAA.
  - B) UUU.
  - C) TTT.
  - D) UUA.

- 20) Which of the following is true of transcription in domain Archaea?
- A) There is only one kind of RNA polymerase.
  - B) It involves promoters are identical to those in domain Eukarya.
  - C) It is regulated in the same way as in domain Bacteria.
  - D) It terminates in a manner similar to that in bacteria.
- 21) Which of the following statements about ribozymes is/are correct?
- A) In some genes, intron RNA functions as a ribozyme and catalyzes its own excision.
  - B) A ribosome can be regarded as one large ribozyme.
  - C) Ribozymes are RNA molecules that function as enzymes.
  - D) All of above
- 22) Which of the following mechanisms is (are) used to coordinate the expression of multiple, related genes in eukaryotic cells?
- A) Environmental signals enter the cell and bind directly to promoters.
  - B) The genes share a single common enhancer, which allows appropriate activators to turn on their transcription at the same time.
  - C) A specific combination of control elements in each gene's enhancer coordinates the simultaneous activation of the genes.
  - D) A single repressor is able to turn off several related genes.
- 23) Which noncoding RNAs are correctly matched with their function?
- A) Small interfering RNAs (siRNAs) bind to complementary sequences in mRNA and block its translation.
  - B) MicroRNAs (miRNAs) bind to complementary sequences in mRNA and block its translation.
  - C) Piwi-associated RNAs (piRNAs) reestablish appropriate methylation patterns in the genome during gamete formation.
  - D) All of above
- 24) What is the current hypothetical sequence of these events, from earliest to most recent, in the evolution of life on Earth?
1. origin of mitochondria
  2. origin of multicellular eukaryotes
  3. origin of chloroplasts
  4. origin of cyanobacteria
  5. origin of fungal-plant symbioses
- A) 4, 3, 1, 2, 5
  - B) 4, 1, 2, 3, 5
  - C) 4, 1, 3, 2, 5
  - D) 4, 3, 1, 5, 2

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- 25) In the year 2500, five male space colonists and five female space colonists (all unrelated to each other) settle on an uninhabited Earthlike planet in the Andromeda galaxy. The colonists and their offspring randomly mate for generations. All ten of the original colonists had free earlobes, and two were heterozygous for that trait. The allele for free earlobes is dominant to the allele for attached earlobes. If four of the original colonists died before they produced offspring, the ratios of genotypes could be quite different in the subsequent generations. This would be an example of
- A) disruptive selection.
  - B) stabilizing selection.
  - C) genetic drift.
  - D) gene flow.

Answer the following questions (26-30), based on what you have learned about *Drosophila* development.

- 26) Which of the following is not a body segment of the fruit fly embryo?
- A) Antenna
  - B) Head
  - C) Thorax
  - D) Abdomen
- 27) Which of the following statements about a gene that shows maternal effect inheritance is true?
- A) Embryonic cells transcribe the gene.
  - B) Offspring will have a mutant phenotype if the father has a mutant genotype.
  - C) Offspring will show a mutant phenotype if the mother has a mutant genotype.
  - D) Offspring will always show a mutant phenotype if they have a mutant genotype.
- 28) *bicoid* is a maternal transcript which is localized at the anterior part of the embryo. Which body part develops in regions with a low concentration of Bicoid protein?
- A) Thorax
  - B) Abdomen
  - C) Head
  - D) None of above
- 29) If *bicoid* mRNA is injected at the anterior end of an egg from a *bicoid* mutant mother, what would the phenotype of the resulting larva be?
- A) The larva would be normal with one head at the posterior pole.
  - B) The larva would be normal with one head at the anterior pole.
  - C) The larva would have two heads, one at the anterior pole and one in the middle of its body.
  - D) The larva would have a head at each pole of its body.

30) Suppose you found several *Drosophila* mutants that possessed additional legs growing out of their head segments. The probable mutation would be found in \_\_\_\_\_.

- A) gap genes
- B) homeotic genes
- C) pair-rule genes
- D) segment-polarity genes

二、問答題 (共 4 題 40 分，每題 10 分) ※ 注意：請於試卷上「非選擇題作答區」標明題號並依序作答

- 1) The major function of cytoskeleton is to give mechanical support to the cell membrane to maintain its shape. Please (1) give the names of three major types of cytoskeleton proteins, and describe their respective (2) structure and (3) protein subunit.
- 2) The epinephrine-induced glycogen breakdown (EIGB) is one of the key responses for animals facing dangers. Please describe the cytoplasmic response for EIGB, including the following three phases: reception, transduction and responses.
- 3) Innate and acquired immunity are two major types of immune responses against pathogens. Please describe and compare these two immunity and give a specific example for each.
- 4) Define and compare dominant species and keystone species.

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