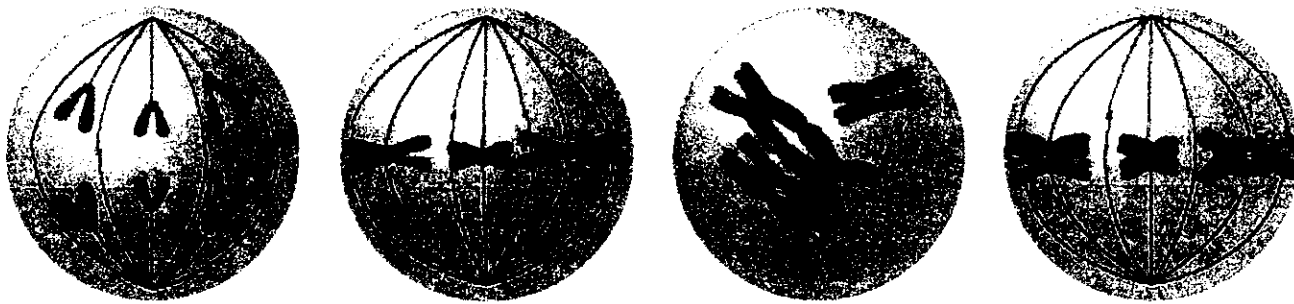


※ 注意：請於試卷上「非選擇題作答區」內依序作答，並應註明作答之大題及其題號。

**I. Fill in the blank (each 1%, total 16%)**

**1) Meiosis Mechanism**



A. Which phase of meiosis is represented in each cell?

A1 \_\_\_\_\_ A2 \_\_\_\_\_ A3 \_\_\_\_\_ A4 \_\_\_\_\_

B. Are the events or results of crossing over possible as shown in each cell (yes or no)?

B1 \_\_\_\_\_ B2 \_\_\_\_\_ B3 \_\_\_\_\_ B4 \_\_\_\_\_

2) \_\_\_\_\_: The differential survival and/or reproduction of classes of entities that differ in one or more characteristics.

3) \_\_\_\_\_: Evolutionary change of a feature within a lineage over an arbitrary period of time.

4) \_\_\_\_\_: The concept of a steady rate of change in DNA sequences over time, providing a basis for dating the time of divergence of lineages if the rate of change can be estimated.

5) \_\_\_\_\_: Pattern of inheritance involving differences in phenotype that are not due to differences in the nucleotide sequence of genes.

6) \_\_\_\_\_: The proposition that taxa become extinct at an approximately constant rate because they fail to evolve as fast as other species with which they have antagonistic interactions.

7) \_\_\_\_\_: A pattern of rapid evolutionary change in the phenotype of a lineage separated by long periods of little change; also, a hypothesis intended to explain such a pattern, whereby phenotypic change transpires rapidly in small populations, in concert with the evolution of reproductive isolation.

8) \_\_\_\_\_: A mutation that causes one body part to be substituted for another.

9) \_\_\_\_\_: Similarity among organisms of different species due to reasons other than common ancestry, such as convergent evolution.

※ 注意：請於試卷內之「選擇題作答區」依序作答。

**II. Multiple choices (each 1.5%, total 45%)**

1) Which of the following are qualities of any good scientific hypothesis? I. It is testable. II.

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It is falsifiable. III. It produces quantitative data. IV. It produces results that can be replicated.

A) I only; B) II only; C) III only; D) I and II; E) III and IV.

- 2) Which of these provides evidence of the common ancestry of all life?  
A) ubiquitous use of catalysts by living systems; B) near universality of the genetic code; C) structure of the nucleus; D) structure of cilia; E) structure of chloroplasts.
- 3) Stanley Miller's 1953 experiments supported the hypothesis that \_\_\_\_\_.  
A) life on Earth arose from simple inorganic molecules; B) life on Earth arose from simple organic molecules, with energy from lightning and volcanoes; C) organic molecules can be synthesized abiotically under conditions that may have existed on early Earth; D) the conditions on early Earth were conducive to the origin of life; E) the conditions on early Earth were conducive to the abiotic synthesis of organic molecules.
- 4) Changing a single amino acid in a protein consisting of 325 amino acids would \_\_\_\_\_.  
A) alter the primary structure of the protein but not its tertiary structure or function; B) cause the tertiary structure of the protein to unfold; C) always alter the biological activity or function of the protein; D) always alter the secondary structure of the protein and disrupt its biological activity; E) always alter the primary structure of the protein, sometimes alter the tertiary structure of the protein, and sometimes affect its biological activity.
- 5) If a DNA sample were composed of 10% thymine, what would be the percentage of guanine?  
A) 10; B) 20; C) 40; D) 80; E) It is impossible to tell from the information given.
- 6) Which of the following processes includes all others?  
A) osmosis B) diffusion of a solute across a membrane C) facilitated diffusion D) passive transport E) transport of an ion down its electrochemical gradient
- 7) Which structure-function pair is mismatched?  
A) nucleolus — production of ribosomal subunits; B) lysosome — intracellular digestion; C) ribosome — protein synthesis; D) Golgi — protein trafficking; E) microtubule — muscle contraction.
- 8) Some bacteria are metabolically active in hot springs because \_\_\_\_\_.  
A) they are able to maintain a lower internal temperature; B) high temperatures make catalysis unnecessary; C) their enzymes have high optimal temperatures; D) their enzymes are completely insensitive to temperature; E) they use molecules other than proteins or RNAs as their main catalysts.
- 9) Which process in eukaryotic cells will proceed normally whether oxygen (O<sub>2</sub>) is present or absent?  
A) electron transport; B) glycolysis; C) the citric acid cycle; D) oxidative phosphorylation; E) chemiosmosis.
- 10) Some photosynthetic organisms contain chloroplasts that lack photosystem II, yet are able to survive. The best way to detect the lack of photosystem II in these organisms

would be to \_\_\_\_\_.

A) determine if they have thylakoids in the chloroplasts; B) test for liberation of O<sub>2</sub> in the light; C) test for CO<sub>2</sub> fixation in the dark; D) do experiments to generate an action spectrum; E) test for production of either sucrose or starch.

11) Protists and bacteria are grouped into different domains because \_\_\_\_\_.

A) protists eat bacteria; B) bacteria are not made of cells; C) protists have a membrane-bounded nucleus, which bacterial cells lack; D) bacteria decompose protists; E) protists are photosynthetic

12) The value for  $\Psi$  in root tissue was found to be -0.15 MPa. If you take the root tissue and place it in a 0.1 M solution of sucrose ( $\Psi = -0.23$  MPa), the net water flow would \_\_\_\_\_.

A) be from the tissue into the sucrose solution; B) be from the sucrose solution into the tissue; C) be in both directions and the concentration of water would remain equal; D) occur only as ATP was hydrolyzed in the tissue; E) be impossible to determine from the values given here.

13) As an undergraduate research assistant, you are assisting with a radioisotope tracer experiment. You expose a mature leaf on one side of the lower shoot of a sugar beet plant to <sup>14</sup>CO<sub>2</sub> and then track the movement of the <sup>14</sup>C atoms by radiography. Where are you LEAST likely to detect <sup>14</sup>C?

A) the treated leaf; B) the shoot apical meristem; C) the roots; D) a mature upper leaf on the opposite side of the plant from the treated leaf; E) a young leaf directly above the treated leaf.

14) Most of the dry mass of a plant is derived from \_\_\_\_\_.

A) NO<sub>3</sub><sup>-</sup> and CO<sub>2</sub>; B) K<sup>+</sup> and CO<sub>2</sub>; C) PO<sub>4</sub> and K<sup>+</sup>; D) H<sub>2</sub>O and K<sup>+</sup>; E) H<sub>2</sub>O and CO<sub>2</sub>.

15) Two groups of tomatoes were grown under laboratory conditions, one with humus added to the soil and one a control without humus. The leaves of the plants grown without humus were yellowish (less green) compared with those of the plants grown in the humus-enriched soil. The best explanation for this difference is that \_\_\_\_\_.

A) the healthy plants used the food in the decomposing leaves of the humus for energy to make chlorophyll; B) the humus made the soil more loosely packed, so water penetrated more easily to the roots; C) the humus contained minerals such as magnesium and iron, needed for the synthesis of chlorophyll; D) the heat released by the decomposing leaves of the humus caused more rapid growth and chlorophyll synthesis; E) the healthy plants absorbed chlorophyll from the humus.

16) Agricultural lands frequently require nutrient augmentation because \_\_\_\_\_.

A) nitrogen-fixing bacteria are not as plentiful in agricultural soils because of the use of pesticides; B) the nutrients that become the biomass of plants are not cycled back to the soil on lands where they are harvested; C) land that is available for agriculture tends to be nutrient-poor; D) grains raised for feeding livestock must be fortified, and thus require additional nutrients; E) cultivation of agricultural land inhibits the decomposition of organic matter.

17) What is a typical habitat for carnivorous plants?

A) wet areas with high salinity; B) wet areas with high levels of humus; C) wet areas with

low decomposition rates; D) dry areas with low levels of available oxygen; E) dry areas with high levels of peat.

- 18) Plant hormonal regulation differs from animal hormonal regulation in that \_\_\_\_\_.  
A) there are no dedicated hormone-producing organs in plants as there are in animals; B) all production of hormones is local in plants with little long-distance transport; C) plants do not exhibit feedback mechanisms like animals; D) only animal hormone concentrations are developmentally regulated; E) only animal hormones may have either external or internal receptors.
- 19) You observe a houseplant on your window sill bending toward the bright afternoon sunlight. Being knowledgeable, you wish to explain the molecular events of the phototropic response to your friend. What is the correct sequence that you would describe? I. PHOT1 attains a phosphate group, and changes shape; II. cell elongation occurs on the shady side of the plant; III. auxin binds its receptor at target tissues; IV. light strikes PHOT1; V. PHOT1 stimulates downward auxin transport on the shady side of the plant; VI. light strikes stomates, which close, minimizing water loss; VII. cells on the illuminated side of the plant become shorter.  
A) VI, VII, II; B) VII, II, III, I; C) IV, I, V, III, II; D) IV, VI, III, VII; E) any of these sequences can initiate phototropism.
- 20) You grow two trays of Arabidopsis plants under identical conditions, except that one tray of plants is exposed to a gentle breeze for several hours each day. Compared to plants grown in calm conditions what would you expect to see in the wind-exposed plants? I. changes in the expression of many genes; II. taller flower stalks; III. shorter flower stalks; IV. more flexible cell walls; V. no changes in 2nd messengers; VI. increases in 2nd messengers and/or phosphorylated proteins; VII. increased levels of Pfr; VIII. stiffer cell walls.  
A) I, III, VI, VIII; B) II, IV, V, VII; C) III, IV, VII; D) VI, VII, VIII; E) wind has no effect on plant development.
- 21) Which of the following is the strongest evidence that cytokinins regulate cell divisions? There is \_\_\_\_\_.  
A) an increase of cyclin gene expression in tissues exposed to cytokinin; B) a decrease of cyclin gene expression in tissues exposed to cytokinin; C) an induction of shoot growths in tissues exposed to cytokinin; D) an induction of root growths in tissues exposed to cytokinin; E) an ability of cytokinin to interact with auxin at the molecular level and change auxin biosynthesis and transport.
- 22) Which of the following is the most likely plant response to an attack by herbivores?  
A) leaf abscission to prevent further loss of tissue; B) early flowering to reproduce before being eaten; C) production of chemical compounds for defense or to attract predators; D) production of physical defenses, such as thorns; E) production of thicker bark and cuticle to make it more difficult to eat.
- 23) Classic experiments suggested that a floral stimulus, florigen, could move across a graft from an induced plant to a noninduced plant and trigger flowering. Recent evidence using Arabidopsis has recently shown that florigen is probably \_\_\_\_\_.  
A) a phytochrome molecule that is activated by red light; B) a protein that is synthesized in

leaves, travels to the shoot apical meristems, and initiates flowering; C) a membrane signal that travels through the symplast from leaves to buds; D) a second messenger that induces  $Ca^{++}$  ions to change membrane potential; E) a transcription factor that controls the activation of florigen-specific genes.

- 24) Among plants known as legumes (beans, peas, alfalfa, clover, for example) the seeds are contained in a fruit that is itself called a legume, better known as a pod. Upon opening such pods, it is commonly observed that some ovules have become mature seeds, whereas other ovules have not. Thus, which of the following statements is (are) true? 1. The flowers that gave rise to such pods were not pollinated. 2. Pollen tubes did not enter all of the ovules in such pods. 3. There was apparently not enough endosperm to distribute to all of the ovules in such pods. 4. The ovules that failed to develop into seeds were derived from sterile floral parts. 5. Fruit can develop, even if all ovules within have not been fertilized.  
A) 1 only B) 1 and 5 C) 2 and 4 D) 2 and 5 E) 3 and 5
- 25) Which of the following is a true statement regarding species diversity and taxonomic diversity?  
A) Species diversity measures the relative frequency of all alleles present in a species; B) In taxonomic diversity, the evolutionary relationships of species in a lineage are important; C) In species diversity, the number of animals in a particular lineage is important; D) The variety of species in a given area represents taxonomic diversity.
- 26) Ecosystem services include processes that increase the quality of the abiotic environment. Which of the following processes would fall under this category? I) Keystone predators have a marked effect on species diversity. II) Green plants produce the oxygen we breathe. III) The presence of land plants builds soil. IV) The presence of diverse wetlands helps in flood control.  
A) only I and III; B) only II and IV; C) only I, II, and IV; D) only II, III, and IV
- 27) In house sparrows (*Passer domesticus*) it is generally found that both males and females care for the eggs and young. However, some male house sparrows do not provide parental care. In addition, it is known that young that receive parental care from both the male and female are more likely to survive to fledging (leaving the nest). Which of the following activities by males that do not provide parental care would represent the most beneficial trade-off for the reduced survival of their offspring?  
A) attacking the nests of neighboring males; B) mating with additional females and fathering more eggs; C) eating to build up energy stores for migration; D) grooming to eliminate parasites from their feathers
- 28) Some bird bones are hollow rather than honeycombed. The hollow bones mostly contain air sacs. The replacement of bone marrow with air sacs is properly understood as an adaptation that \_\_\_\_\_. 1) reduces the weight of the bird 2) facilitates flight 3) eliminates the functions of bone marrow  
A) only 1; B) only 2 C) 1, 2, and 3 D) 1 and 2
- 29) Why is the pharmacological reactivation of fetal hemoglobin in a patient with sickle-cell anemia often a successful treatment? Fetal hemoglobin \_\_\_\_\_.  
A) binds more carbon dioxide molecules than adult hemoglobin; B) is better able to

release oxygen than is adult hemoglobin; C) has a higher affinity for oxygen than does adult hemoglobin; D) is better able to release carbon dioxide than is adult hemoglobin.

- 30) Receptors for neurotransmitters are of primary functional importance in assuring one-way synaptic transmission because they are mostly found on the \_\_\_\_\_.  
 A) axonal membrane; B) axon hillock; C) postsynaptic membrane; D) mitochondrial membrane; E) presynaptic membrane

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III. Answer the following questions (39%)

- 1) Using a series of arrows, draw the branched metabolic reaction pathway described by the following statements, then answer the question at the end. Use arrows with minus signs to indicate inhibition. L: can form either M or N; M can form O; O: can form either P or R; P: can form Q; R: can form S; O: inhibits the reaction of L to form M; S: inhibits the reaction of O to form R.

Which reaction would prevail if both Q and S were present in the cell in high concentrations? a) L→M; b) L→N; c) M→O; d) O→P; e) R→S. (4%)

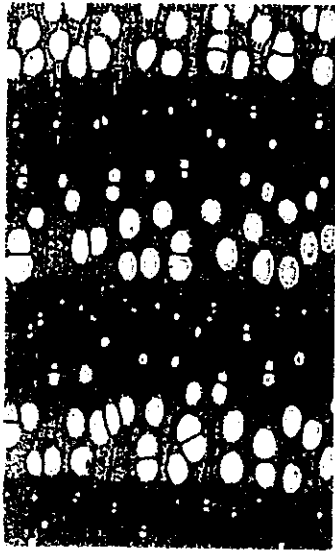
- 2) Construct a phylogenetic tree of Charophyte green algae, Mosses, Ferns, Gymnosperms and Angiosperms and use the letters A-D to label where on the each of the following derived characters appeared. A: embryos; B: flowers; C: vascular tissue; D: seeds. (4%)

- 3) The grass *Dichanthelium languinosum* lives in hot soils and houses fungi of the genus *Curvularia*. Regina Redman, of Montana State University, and colleagues performed field experiments to test the impact of *Curvularia* on the heat tolerance of this grass. They grew plants without (E-) and with (E+) *Curvularia* endophytes in soils of different temperatures and measured plant mass and the number of new shoots the plants produced. Draw a bar graph of the results for plant mass versus temperature and interpret it. (3%)

Soil Temp.	Curvularia Presense	Plant Mass (g)	Number of New Shoots
30°C	E-	16.2	32
	E+	22.8	60
35°C	E-	21.7	43
	E+	28.4	60
40°C	E-	8.8	10
	E+	22.2	37
45°C	E-	0	0
	E+	15.1	24

- 4) On this cross section from a woody eudicot, label a growth ring, late wood, early wood, and a vessel element. Then draw an arrow in the pith-to-cork direction. (3%)

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- 5) In *Drosophila*, maternal effect genes, such as *bicoid*, are important for early embryonic development. Explain how this type of mutation was discovered. (5 points) The subsequent experiments demonstrated that Bicoid is a transcription factor that regulates downstream genes. Why is this discovery important? (5 points) If a human trait is determined by a factor in the cytoplasm, would an offspring more resemble his/her mother or his/her father. Explain your answer. (5 points)
- 6) One hypothesis that has been proposed regarding the origin of life suggests that life evolved from an "RNA world." Explain the "RNA world" hypothesis and what evidence is consistent with this hypothesis (5 points).
- 7) Explain and illustrate the experimental procedures for animal cloning (5 points).

試題隨卷繳回