一、單選題（每題 2 分）※注意：請於試卷「選擇題作答區」依題號作答。※

1. Nitrogen (N) is much more electronegative than hydrogen (H). Which of the following statements is correct about the atoms in ammonia (NH_3)?
   (A) Each hydrogen atom has a partial positive charge.
   (B) The nitrogen atom has a strong positive charge.
   (C) Each hydrogen atom has a slight negative charge.
   (D) The nitrogen atom has a partial positive charge.
   (E) There are covalent bonds between the hydrogen atoms.

2. Why isn't the mitochondrion classified as part of the endomembrane system?
   (A) It only has two membrane layers. (B) Its structure is not derived from the ER.
   (C) It has too many vesicles. (D) It is not involved in protein synthesis.
   (E) It is not attached to the outer nuclear envelope.

3. How can one increase the rate of a chemical reaction?
   (A) Increase the activation energy needed. (B) Cool the reactants.
   (C) Decrease the concentration of the reactants. (D) Add a catalyst.
   (E) Increase the entropy of the reactants.

4. What are the products of the light reactions that are subsequently used by the Calvin cycle?
   (A) oxygen and carbon dioxide (B) carbon dioxide and RuBP
   (C) water and carbon (D) electrons and photons
   (E) ATP and NADPH

5. Which of the following are primarily responsible for cytokinesis in plant cells?
   (A) kinetochores (B) actin and myosin
   (C) Golgi-derived vesicles (D) centrioles and basal bodies
   (E) cyclin-dependent kinases

6. How many unique gametes could be produced through independent assortment by an individual with the genotype AaBbCCDdEE?
   (A) 4 (B) 8 (C) 16 (D) 32 (E) 64

7. Eukaryotic telomeres replicate differently than the rest of the chromosome. This is a consequence of which of the following?
   (A) The evolution of telomerase enzyme
   (B) DNA polymerase that cannot replicate the leading strand template to its 5' end
   (C) Gaps left at the 5' end of the lagging strand because of the need for a 3' onto which nucleotides can attach
   (D) Gaps left at the 3' end of the lagging strand because of the need for a primer
   (E) The "no ends" of a circular chromosome

見背面

8. A mutation that inactivates the regulatory gene of a repressible operon in an E. coli cell would result in ___.
   (A) continuous transcription of the structural gene controlled by that regulator
   (B) complete inhibition of transcription of the structural gene controlled by that regulator
   (C) irreversible binding of the repressor to the operator
   (D) inactivation of RNA polymerase by alteration of its active site
   (E) continuous translation of the mRNA because of alteration of its structure

9. The major advantage of using artificial chromosomes such as YACs and BACs for cloning genes is that ___.
   (A) plasmids are unable to replicate in cells
   (B) only one copy of a plasmid can be present in any given cell, whereas many copies of a YAC or BAC can coexist in a single cell
   (C) YACs and BACs can be used to express proteins encoded by inserted genes, but plasmids cannot
   (D) YACs and BACs can carry much larger DNA fragments than ordinary plasmids can
   (E) all of the above

10. Darwin's mechanism of natural selection required long time spans in order to modify species. From whom did Darwin get the concept of Earth's ancient age?
   (A) Georges Cuvier (B) John Henslow (C) Alfred Wallace (D) Thomas Malthus (E) Charles Lyell

11. Dog breeders maintain the purity of breeds by keeping dogs of different breeds apart when they are fertile. This kind of isolation is most similar to which of the following reproductive isolating mechanisms?
   (A) reduced hybrid fertility (B) hybrid breakdown (C) mechanical isolation
   (D) habitat isolation (E) gametic isolation

12. The four-chambered hearts of birds and the four-chambered hearts of mammals evolved independently of each other. If one were unaware of this independence, then one might logically conclude that _____.
   (A) the birds were the first to evolve a 4-chambered heart
   (B) birds and mammals are more distantly related than is actually the case
   (C) early mammals possessed feathers
   (D) birds and mammals should be placed in the same family
   (E) the common ancestor of birds and mammals had a four-chambered heart

13. Which group includes members that are important primary producers in ocean food webs, causes red tides that kill many fish, and may even be carnivorous?
   (A) ciliates (B) apicomplexans (C) dinoflagellates (D) brown algae (E) golden algae

14. In addition to seeds, which of the following characteristics are unique to the seed-producing plants?
   (A) sporopollenin (B) pollen (C) megaphylls
   (D) lignin present in cell walls (E) use of air currents as a dispersal agent

15. Cephalization is primarily associated with _____.
   (A) bilateral symmetry (B) method of reproduction (C) fate of the blastopore
   (D) type of digestive system (E) adaptation to dark environments

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16. What is the role of proton pumps in root hair cells?
(A) establish ATP gradients (B) acquire minerals from the soil (C) pressurize xylem transport
(D) eliminate excess electrons (E) A and D only

17. Interstitial fluid _____.
(A) is the fluid inside the gastrovascular cavity of Hydra
(B) is the internal environment found inside an animal's cells
(C) is composed of blood
(D) provides for the exchange of materials between blood and body cells
(E) is found inside the small intestine

18. Environmental cues that influence the timing of reproduction generally do so by _____.
(A) increasing the body temperature
(B) providing access to water for external fertilization
(C) increasing ambient temperature to that which is comfortable for sex
(D) direct effects on gonadal structures
(E) direct effects on hormonal control mechanisms

19. Which of the following is controlled by the magnitude of a receptor potential?
(A) the rate of production of an action potential (B) the rate of reaction of the brain
(C) the rate of response to a sensory neuron (D) perception
(E) adaptation

20. Which of the following terms includes all of the others?
(A) species diversity (B) genetic diversity (C) biodiversity
(D) ecosystem diversity (E) species richness

見背面

※下列題目請標明題號，依序作答於試卷內「非選擇題作答區」。※

二、名詞解釋（每題 4 分）

1. Competitive inhibitor
2. Feedback regulation
3. *In situ* hybridization
4. Metastasis
5. Osmoregulator
6. Photoautotroph
7. Refractory period (of a neuron)
8. Self-incompatibility (of a seed plant)
9. Transposon

三、簡答題（每題 8 分）

1. 今年度唐獎的生技醫藥獎頒發給三位發展 CRISPR/Cas9 平台的學者，請說明 CRISPR/Cas9 平台具有什麼功能，並舉一例說明它未來的應用方向。

2. 開發癌症疫苗為許多新創生技公司的主要研發方向，試說明如何判斷癌症疫苗是否有效。

3. 請將以下文章翻釋成中文。

Mosquitoes can transmit arbo (arthropod-borne) viruses, notably yellow fever found predominantly in tropical and subtropical areas in South America and Africa; a vaccine against yellow fever is available and is needed for anyone travelling to endemic areas. Mosquitoes can also transmit dengue fever (which infects nearly 400 million people each year, causing an estimated 25,000 deaths). Two related mosquito species, *Aedes aegypti* (the yellow fever mosquito) and *Aedes albopictus* (the Asian tiger mosquito) transmit yellow fever, dengue, and chikungunya (an infection similar to dengue). Relatively recently it has become evident that mosquitoes can also transmit other arboviruses – such as West Nile and Zika viruses.

提示：yellow fever 黃熱病；dengue fever 登革熱；chikungunya 屈公病；West Nile 西尼羅河

試題隨卷繳回