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國立清華大學 112 學年度碩士班考試入學試題

系所班組別：生命科學暨醫學院
甲組(生物與醫學科學組)

科目代碼：0402

考試科目：生物學

—作答注意事項—

1. 請核對答案卷(卡)上之准考證號、科目名稱是否正確。
2. 考試開始後，請於作答前先翻閱整份試題，是否有污損或試題印刷不清，得舉手請監試人員處理，但不得要求解釋題意。
3. 考生限在答案卷上標記「 由此開始作答」區內作答，且不可書寫姓名、准考證號或與作答無關之其他文字或符號。
4. 答案卷用盡不得要求加頁。
5. 答案卷可用任何書寫工具作答，惟為方便閱卷辨識，請儘量使用藍色或黑色書寫；答案卡限用 2B 鉛筆畫記；如畫記不清(含未依範例畫記)致光學閱讀機無法辨識答案者，其後果一律由考生自行負責。
6. 其他應考規則、違規處理及扣分方式，請自行詳閱准考證明上「國立清華大學試場規則及違規處理辦法」，無法因本試題封面作答注意事項中未列明而稱未知悉。

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*請在【答案卡】作答

單選題 (共 50 題，每題 2 分)

1. Which of the following solute contributes to the osmolarity of the interstitial fluid in the kidney?
(A) NH_4^+
(B) HCO_3^-
(C) Urea
(D) KCl
2. Which of the following hormone is NOT secreted from the anterior pituitary gland?
(A) Adrenocorticotrophic hormone (ACTH)
(B) Thyroid stimulating hormone (TSH)
(C) Thyrotropin-releasing hormone (TRH)
(D) Growth hormone (GH)
3. Which of the following is NOT the main function of antibody in the immune system?
(A) Neutralization of viral toxicity
(B) Binding to antigen on the surface of bacteria to promote phagocytosis
(C) Activation of the complement system
(D) Activation of phagocytic cells, including neutrophils and macrophages
4. Which of the following organelles is present in both plant cells and animal cells?
(A) Plasmodesmata
(B) Central vacuole
(C) Mitochondria
(D) Chloroplast
5. About mitosis and meiosis, which of the following statements are NOT TRUE?
(A) Mitosis conserves the number of chromosome sets, producing cells that are genetically identical to the parent cell
(B) Meiosis is a special type of mitosis producing reproductive cells that occurs only in animal cells
(C) Meiosis reduces the number of chromosomes sets from two (diploid) to one (haploid)
(D) Meiosis produces cells that differ genetically from each other and from the parental cell

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6. When a yeast cell releases a mating factor, which of the following **DOES NOT** occur
- (A) diffuses through the membranes to opposite type of cells, causing them to produce factors that initiate long-distance migrations
 - (B) binds to receptors on the membranes of opposite type of yeast cells
 - (C) transduces signals through G-protein coupled receptor
 - (D) Changes the shape of the opposite type of yeast cells
7. Which of the following about nucleosomes is **NOT TRUE**
- (A) A nucleosome is the basic structural unit of DNA packing in eukaryotes
 - (B) The structure of a nucleosome consists of a segment of DNA wound around histone proteins
 - (C) The nucleosome is the fundamental subunit of euchromatin but not heterochromatin
 - (D) Nucleosomes carry epigenetic information in the form of covalent modifications of their histone proteins
8. Which of the following about viruses is **NOT TRUE**?
- (A) They have both RNA and DNA
 - (B) They use the host cell to copy themselves and make viral proteins
 - (C) Phage is a type of virus that infects bacteria
 - (D) Enveloped viruses have a phospholipid membrane outside their capsid, whereas nonenveloped viruses do not have a phospholipid membrane
9. Which of the following statements is a **CORRECT** distinction between autotrophs and heterotrophs?
- (A) Cellular respiration is unique to heterotrophs
 - (B) Only heterotrophs have mitochondria
 - (C) The most common way that autotrophs make their own food is converting inorganic molecules into usable components by sunlight through photosynthesis
 - (D) Only heterotrophs require oxygen
10. Which of the following is **NOT** the correct match of the scientists and their discovery?
- (A) Erwin Chargaff discovered that in DNA from any species, the amount of adenine equals the amount of thymine, and the amount of guanine equals the amount of cytosine
 - (B) Mathew Meselson and Franklin Stahl discovered that RNA can be converted to DNA by reverse transcriptase
 - (C) James Watson and Francis Crick discovered that DNA is a double helix in structure
 - (D) Alfred Hershey and Martha Chase discovered that DNA is the genetic material

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11. Much of the animal diversity is a result of the evolution of novel ways to

- (A) Reproduce
- (B) Sense, feed, and move
- (C) Arrange cells into tissues
- (D) Form an embryo and establish a basic body plan

12. In addition to seeds, which of the following characteristics is unique to the seed-producing plants?

- (A) Sporopollenin (a component of spore outer walls)
- (B) Lignin present in cell walls
- (C) Pollen
- (D) Megaphylls

13. Which of the following tools of DNA technology is incorrectly paired with its use?

- (A) DNA polymerase—polymerase chain reaction to amplify specific DNA fragments
- (B) Agarose gel Electrophoresis—separation of DNA fragments by size
- (C) Restriction enzyme—cutting DNA to create DNA segments with specific ends
- (D) RNA polymerase—use mRNA to synthesize DNA

14. Which of the following statement is the most likely explanation to support these observations? “The upper forelimbs of humans and bats have fairly similar skeletal structures, whereas the corresponding bones in whales have very different shapes and proportions. However, genetic data suggest that all three kinds of organisms diverged from a common ancestor at about the same time.”

- (A) Forelimb evolution was adaptive in people and bats, but not in whales
- (B) Whales are not properly classified as mammals
- (C) Genes mutate faster in whales than in humans or bats
- (D) Natural selection in an aquatic environment resulted in significant changes to whale forelimb anatomy

15. Lipid-soluble signaling molecules, such as aldosterone, can diffuse across the cell membranes but affect only target cells because?

- (A) Only target cells have responsive DNA segments
- (B) Only target cells have enzymes that convert aldosterone to active form
- (C) Aldosterone-responsive genes are only present in the target cells
- (D) Intracellular receptors are present only in target cells

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16. A genetic mutation causes frame shift because?
(A) a change of a nucleotide in a gene does not affect the amino acid sequence of a protein
(B) a mutation changes a codon into a stop codon leading to protein truncation
(C) a mutation results in a change in an amino acid of a protein
(D) a mutation causes a loss or addition of nucleotides in a gene
17. Which of the following about anaerobic and aerobic respirations is **NOT TRUE**?
(A) Both use glycolysis as first stage of glucose oxidation
(B) Both use NAD^+ as electron carrier
(C) Aerobic respiration produces ATP only by oxidative phosphorylation, whereas anaerobic respiration produces ATP by substrate-level phosphorylation
(D) Aerobic respiration produces about 30-32 ATP, whereas anaerobic respiration produces 2 ATP
18. Which of the following about enzyme is **NOT TRUE**?
(A) All enzymes are proteins
(B) The active site is the region where the substrate binds
(C) The allosteric site is the region that either activates or inhibits enzyme activity
(D) Optimal conditions usually favor the most stable and active conformation for the enzyme for its catalytic activity
19. Which of the following descriptions best fits the class of molecules known as nucleotides
(A) a nitrogenous base and a phosphate group
(B) a nitrogenous base and a ribose
(C) a nitrogenous base, a phosphate group, and a ribose
(D) a ribose and a purine or pyrimidine
20. What is the tertiary structure of a protein
(A) order in which amino acids are joined in a polypeptide chain
(B) unique three-dimensional shape of the fully folded polypeptide
(C) organization of a polypeptide chain into an α -helix or β -pleated sheet
(D) overall protein structure resulting from the aggregation of two or more polypeptide subunits
21. What is the advantage of light microscopy over electron microscopy
(A) light microscopy provides for higher magnification than electron microscopy
(B) light microscopy provides for higher resolving power than electron microscopy
(C) light microscopy allows one to view dynamic processes in living cells
(D) light microscopy provides higher contrast than electron microscopy

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*請在【答案卡】作答

22. Telomere shortening puts a limit on the number of times a cell can divide. Research has shown that telomerase can extend the life span of cultured human cells. How might adding telomerase affect cellular aging?
- A) Telomerase will speed up the rate of cell proliferation
 - B) Telomerase shortens telomeres, which delays cellular aging
 - C) Telomerase eliminates telomere shortening and delays aging
 - D) Telomerase would have no effect on cellular aging
23. Which of the following consists of nine doublets of microtubules surrounding a pair of single microtubules (the 9 + 2 arrangement)
- A) motile cilia and nonmotile primary cilia
 - B) flagella and motile cilia
 - C) basal bodies and nonmotile primary cilia
 - D) centrioles and basal bodies
24. What is the difference between pinocytosis and receptor-mediated endocytosis
- A) pinocytosis brings only water molecules into the cell, but receptor-mediated endocytosis brings in other molecules as well
 - B) pinocytosis increases the surface area of the plasma membrane, whereas receptor-mediated endocytosis decreases the plasma membrane surface area.
 - C) pinocytosis is nonselective in the molecules it brings into the cell, whereas receptor-mediated endocytosis offers more selectivity
 - D) pinocytosis can concentrate substances from the extracellular fluid, but receptor-mediated endocytosis cannot
25. Why the sodium-potassium pump (Na^+/K^+ ATPase) is called an electrogenic pump
- A) It pumps equal quantities of Na^+ and K^+ across the membrane
 - B) It contributes to the membrane potential
 - C) It ionizes sodium and potassium atoms
 - D) It is used to drive the transport of other molecules against a concentration gradient
26. Besides turning enzymes on or off, what other means does a cell use to control enzymatic activity
- A) localization of enzymes into specific organelles or membranes
 - B) exporting enzymes out of the cell
 - C) connecting enzymes into large aggregates
 - D) hydrophobic interactions

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27. The synthesis of ATP by oxidative phosphorylation, using the energy released by movement of protons across the membrane down their electrochemical gradient, is an example of

- A) facilitated active transport
- B) an endergonic reaction coupled to an exergonic reaction
- C) a reaction with a positive ΔG
- D) allosteric reaction

28. Why are C₄ plants able to photosynthesize with no apparent photorespiration?

- A) They do not participate in the Calvin cycle.
- B) They use PEP carboxylase to initially fix CO₂.
- C) They conserve water more efficiently.
- D) They exclude oxygen from their tissues.

29. Which of the following sequences correctly represents the flow of electrons during photosynthesis?

- A) NADPH → O₂ → CO₂
- B) H₂O → NADPH → Calvin cycle
- C) NADPH → chlorophyll → Calvin cycle
- D) NADPH → electron transport chain → O₂

30. Which process is most directly driven by light energy

- A) creation of a pH gradient by pumping protons across the thylakoid membrane
- B) carbon fixation in the stroma
- C) reduction of NADP⁺ molecules
- D) removal of electrons from chlorophyll molecules

31. Binding of a signaling molecule to which type of receptor leads directly to a change in the distribution of ions on opposite sides of the membrane?

- A) receptor tyrosine kinase
- B) G protein-coupled receptor
- C) ligand-gated ion channel
- D) intracellular receptor

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32. How is plant cell cytokinesis different from animal cell cytokinesis?

- A) The contractile filaments found in plant cells are structures composed of carbohydrates; the cleavage furrow in animal cells is composed of contractile phospholipids.
- B) Plant cells deposit vesicles containing cell-wall building blocks on the metaphase plate; animal cells form a cleavage furrow.
- C) The structural proteins of plant cells separate the two cells; in animal cells, a cell membrane separates the two daughter cells.
- D) Plant cells divide after metaphase but before anaphase; animal cells divide after anaphase.

33. Which of the following **DOSE NOT** participate directly in the mitosis

- A) Actin
- B) Microtubule
- C) Intermediate filament
- D) Motor proteins

34. A given organism has 46 chromosomes in its nucleus. Therefore, we can conclude that it must

- A) be human
- B) be an animal
- C) reproduce sexually
- D) have gametes with 23 chromosomes

35. Homologous chromosomes

- A) are identical
- B) carry information for the same traits
- C) carry the same alleles
- D) align on the metaphase plate in meiosis II

36. Mendel crossed yellow-seeded and green-seeded pea plants and then allowed the offspring to self-pollinate to produce an F₂ generation. The results were as follows: 6022 yellow and 2001 green (8023 total). The allele for green seeds has what relationship to the allele for yellow seeds?

- A) dominant
- B) incomplete dominant
- C) recessive
- D) codominant

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37. When Thomas Hunt Morgan crossed his red-eyed F₁ generation flies to each other, the F₂ generation included both red- and white-eyed flies. Remarkably, all the white-eyed flies were male. What was the explanation for this result?
- A) The gene involved is on the Y chromosome.
 - B) The gene involved is on the X chromosome.
 - C) The gene involved is on an autosome, and only in males.
 - D) There are other male-specific factors that may influence eye color in flies.
38. Bioinformatics includes all of the following except
- A) using computer programs to align DNA sequences
 - B) creating recombinant DNA from separate species
 - C) developing computer-based tools for genome analysis
 - D) using mathematical tools to make sense of biological systems
39. Darwin and Wallace were the first to propose
- A) that evolution occurs
 - B) a mechanism for how evolution occurs
 - C) that Earth is older than a few thousand years
 - D) natural selection as the mechanism of evolution
40. Macroevolution is
- A) the same as microevolution, but includes the origin of new species
 - B) evolution above the species level
 - C) defined as the evolution of microscopic organisms into organisms that can be seen with the naked eye
 - D) defined as a change in allele or gene frequency over the course of many generations
41. Which of the following **DOES NOT** support “RNA world hypothesis”
- A) RNA is single-stranded
 - B) RNA can function as an enzyme
 - C) RNA can adopt a specific three-dimensional conformation
 - D) Nucleotides in RNA can base pair in standard (Watson-Crick) and non-standard ways
42. Which of the following traits do archaeans and bacteria share?
- A) composition of the cell wall
 - B) composition of the cell wall and lack of a nuclear envelope
 - C) lack of a nuclear envelope and presence of plasma membrane
 - D) presence of plasma membrane and composition of the cell wall

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43. Liverworts, hornworts, and mosses are grouped together as the Bryophytes. Besides not having vascular tissue, what do they all have in common?
- A) They are all wind pollinated.
 - B) They are heterosporous.
 - C) They can reproduce asexually by producing gemmae.
 - D) They require water for reproduction.
44. How did the evolution of the jaw contribute to diversification of early vertebrate lineages?
- A) It allowed for smaller body size.
 - B) It was the first stage in the development of a bony skull.
 - C) It made additional food sources available.
 - D) It increased the surface area for respiration and feeding.
45. The polarity of a plant is established when
- A) cotyledons form at the shoot end of the embryo
 - B) the shoot-root axis is established in the embryo
 - C) the primary root breaks through the seed coat
 - D) the shoot first breaks through the soil into the light as the seed germinates
46. One of the complications of Alzheimer's disease is an interference with learning and memory. This disease would most likely involve
- A) changes in the concentration of ions in the extracellular fluid surrounding neurons
 - B) changes in myelination of axons
 - C) molecular and structural changes at synapses
 - D) structural changes to ion channels in axons
47. Which of the following sensory receptors is correctly paired with its category?
- A) hair cell (ear) — mechanoreceptor
 - B) muscle spindle — electromagnetic receptor
 - C) taste receptor (gustatory cell) — mechanoreceptor
 - D) rod cell (eye) — chemoreceptor

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48. Behaviors are diverse and important for survival and reproduction. Some behaviors are learned, whereas other behaviors are innate. Which of the following statements supports the idea that behaviors are important in survival and therefore affect natural selection?

- A) Learned behaviors may not necessarily increase fitness. Baby warblers can learn the song of another species.
- B) Innate behaviors are the result of selection for individual survival and reproductive success.
- C) All behaviors are survival mechanisms that increase reproductive fitness by increasing mutation rates.
- D) Both innate and learned behaviors are entirely based on genes inherited from parents.

49. The oceans affect the biosphere by

- I) producing a substantial amount of the biosphere's oxygen
 - II) adding carbon dioxide to the atmosphere
 - III) being the source of most of Earth's rainfall
 - IV) regulating the pH of freshwater biomes and terrestrial groundwater
- A) only I and III
 - B) only II and IV
 - C) only I, II, and IV
 - D) only I, II, and III

50. The most plausible hypothesis to explain why species richness is higher in tropical than in temperate regions is that

- A) tropical communities are younger
- B) tropical regions generally have more available water and higher levels of solar radiation
- C) higher temperatures cause more rapid speciation
- D) tropical regions have very high rates of immigration and very low rates of extinction