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並不得書寫、畫記、作答。

國立清華大學 111 學年度碩士班考試入學試題

系所班組別：生命科學院

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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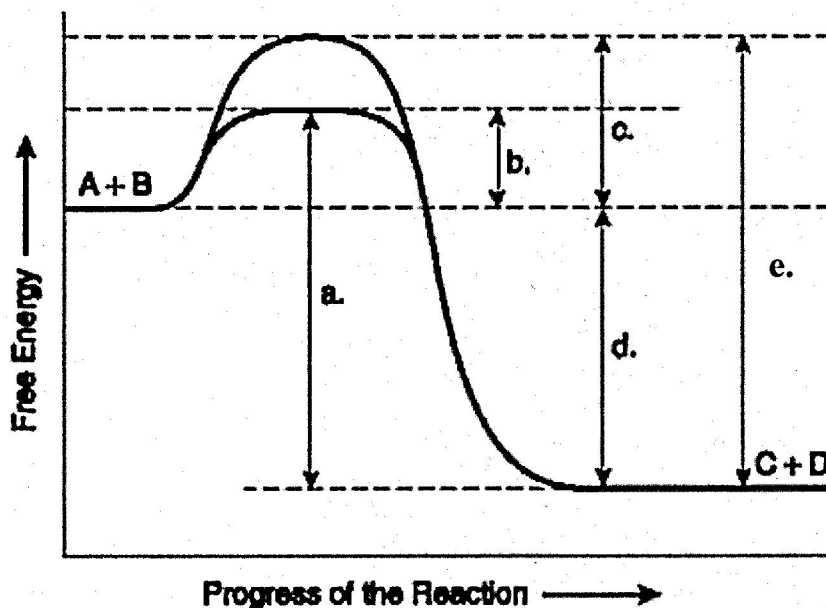
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單選題(每題 2 分，共 100 分)

1. What is the major structural difference between starch and glycogen?
(A) the types of monosaccharide subunits in the molecules
(B) the type of glycosidic linkages in the molecule
(C) whether glucose is in the α or β form
(D) the amount of branching that occurs in the molecule
2. What makes lipids/fats hydrophobic?
(A) their long carbon skeleton
(B) the carboxyl group at one end of the molecule
(C) the glycerol moiety
(D) presence of relatively nonpolar C—H bonds
3. Which of the following is a major difference between RNA and DNA?
(A) type of sugar
(B) type of phosphate
(C) type of purines
(D) type of glycosidic bond
4. Use the following information to answer the question below.



The figure illustrates the energy states associated with the reaction $A + B \leftrightarrow C + D$. Which of the following terms best describes the forward reaction in the figure?

- (A) endergonic, $\Delta G > 0$
- (B) exergonic, $\Delta G < 0$
- (C) endergonic, $\Delta G < 0$
- (D) exergonic, $\Delta G > 0$

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5. Which of the following statements describes a central role that ATP plays in cellular metabolism?

- (A) Hydrolysis of ATP provides an input of free energy for exergonic reactions.
- (B) ATP provides energy coupling between exergonic and endergonic reactions.
- (C) Hydrolysis of the terminal phosphate group stores free energy that is used for cellular work.
- (D) Its terminal phosphate bond is stronger than most covalent bonds in other biological macromolecules.

6. Which of the following statements about enzyme function is true?

- (A) Enzyme function is generally increased if the three-dimensional structure or conformation of an enzyme is altered.
- (B) Enzyme function is independent of physical and chemical environmental factors such as pH and temperature.
- (C) Enzymes increase the rate of chemical reactions by lowering activation energy barriers.
- (D) Enzymes increase the rate of chemical reactions by providing activation energy to the substrate.

7. Ions can travel directly from the cytoplasm of one animal cell to the cytoplasm of an adjacent cell through _____.

- (A) plasmodesmata
- (B) tight junctions
- (C) desmosomes
- (D) gap junctions

8. A mutation that disrupts the ability of an animal cell to add polysaccharide modifications to proteins would most likely cause defects in which of the following organelles or structures?

- (A) nuclear matrix and extracellular matrix
- (B) mitochondria and Golgi apparatus
- (C) Golgi apparatus and extracellular matrix
- (D) nuclear pores and secretory vesicles

9. Cilia and flagella bend because of _____.

- (A) conformational changes in ATP that thrust microtubules laterally
- (B) a motor protein called radial spokes
- (C) contraction by myosin
- (D) a motor protein called dynein

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10. In an Covid-19-infected cell producing Covid-19 virus particles, the viral glycoprotein is expressed on the plasma membrane. How do the viral glycoproteins get to the plasma membrane? They are synthesized _____.

- (A) on ribosomes on the plasma membrane
- (B) by ribosomes in the rough ER and arrive at the plasma membrane in the membrane of secretory vesicles
- (C) on free cytoplasmic ribosomes and then inserted into the plasma membrane
- (D) by ribosomes in the rough ER, secreted from the cell, and inserted into the plasma membrane from the outside

11. Which of the following factors would tend to increase membrane fluidity?

- (A) a greater proportion of unsaturated phospholipids
- (B) a greater proportion of saturated phospholipids
- (C) a lower temperature
- (D) a relatively high protein content in the membrane

12. Lipid-soluble signaling molecules, such as aldosterone, cross the membranes of all cells but affect only target cells because

- (A) only target cells retain the appropriate DNA segments.
- (B) intracellular receptors are present only in target cells.
- (C) only target cells have enzymes that break down aldosterone.
- (D) only in target cells is aldosterone able to initiate the phosphorylation cascade that turns genes on.

13. Why has *C. elegans* proven to be a useful model for understanding apoptosis?

- (A) *C. elegans* does not naturally use apoptosis, but can be induced to do so in the laboratory.
- (B) *C. elegans* undergoes a fixed and easy-to-visualize number of apoptotic events during its normal development.
- (C) *C. elegans* has large cells wherein apoptosis is easily observed without the aid of a microscope.
- (D) As *C. elegans* ages, its cells die progressively until the whole organism is dead.

14. Which metabolic pathway is common to both fermentation and cellular respiration of a glucose molecule?

- (A) the citric acid cycle
- (B) the electron transport chain
- (C) glycolysis
- (D) reduction of pyruvate to lactate

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15. The *immediate* energy source that drives ATP synthesis by ATP synthase during oxidative phosphorylation is the

- (A) oxidation of glucose and other organic compounds.
- (B) flow of electrons down the electron transport chain.
- (C) H^+ concentration gradient across the membrane holding ATP synthase.
- (D) transfer of phosphate to ADP.

16. Which of the following does *not* occur during the Calvin cycle?

- (A) carbon fixation
- (B) oxidation of NADPH
- (C) release of oxygen
- (D) regeneration of the CO_2 acceptor

17. CAM plants keep stomata closed in the daytime, thus reducing loss of water. They can do this because they _____.

- (A) fix CO_2 into organic acids during the night
- (B) fix CO_2 into sugars in the bundle-sheath cells
- (C) fix CO_2 into pyruvate in the mesophyll cells
- (D) use photosystem I and photosystem II at night

18. Which of the following events occurs during interphase of the cell cycle?

- (A) condensation of the chromosomes
- (B) separation of the spindle poles
- (C) spindle formation
- (D) replication of the DNA

19. Movement of the chromosomes during anaphase would be most affected by a drug that prevents which of the following events in mitosis and cell division?

- (A) nuclear envelope breakdown
- (B) elongation of microtubules
- (C) shortening of microtubules
- (D) formation of a cleavage furrow

20. Genetic variation leads to genetic diversity in populations and is the raw material for evolution. Biological systems have multiple processes, such as reproduction, that affect genetic variation. They are evolutionarily conserved and shared by various organisms. Which of the following statements best represents the connection between reproduction and evolution?

- (A) Plants that use sexual reproduction are rare since this type of reproduction in plants does not contribute to genetic diversity.
- (B) In order to increase genetic diversity for evolution in sexually reproducing organisms, mutations must occur in the zygote after fertilization.
- (C) Since prokaryotic organisms reproduce asexually, there is no mechanism for them to add genetic diversity for evolution.
- (D) Sexual reproduction increases genetic variation because random mutations can be shuffled between organisms.

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21. Crossing over of chromosomes normally takes place during which of the following processes?

- (A) meiosis II
- (B) meiosis I
- (C) mitosis
- (D) mitosis and meiosis II

22. Marfan syndrome in humans is caused by an abnormality of the connective tissue protein fibrillin. Patients are usually very tall and thin, with long spindly fingers, curvature of the spine, sometimes weakened arterial walls, and sometimes eye problems, such as lens dislocation. Which of the following would you conclude about Marfan syndrome from this information?

- (A) It is recessive.
- (B) It is dominant.
- (C) It is pleiotropic.
- (D) It is epistatic.

23. Radish flowers may be red, purple, or white. A cross between a red-flowered plant and a white-flowered plant yields all-purple offspring. The flower color trait in radishes is an example of which of the following inheritance patterns?

- (A) a multiple allelic system
- (B) sex linkage
- (C) codominance
- (D) incomplete dominance

24. One possible result of chromosomal breakage is for a fragment to join a nonhomologous chromosome. What is this type of chromosomal alteration called?

- (A) deletion
- (B) inversion
- (C) translocation
- (D) duplication

25. The elongation of the leading strand during DNA synthesis

- (A) progresses away from the replication fork.
- (B) occurs in the 3' → 5' direction.
- (C) produces Okazaki fragments.
- (D) depends on the action of DNA polymerase.

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26. The lagging strand is characterized by a series of short segments of DNA (Okazaki fragments) that will be joined together to form a finished lagging strand. The experiments that led to the discovery of Okazaki fragments gave evidence for which of the following ideas?

- (A) DNA polymerase is an enzyme that synthesizes leading and lagging strands during replication only in one direction.
- (B) DNA is a polymer consisting of four monomers: adenine, thymine, guanine, and cytosine.
- (C) DNA is the genetic material.
- (D) Bacterial replication is fundamentally different from eukaryotic replication. The key should not be way longer than the distractors.

27. Which of the following statements best describes the termination of transcription in prokaryotes?

- (A) RNA polymerase transcribes through the polyadenylation signal, causing proteins to associate with the transcript and cut it free from the polymerase.
- (B) RNA polymerase transcribes through the terminator sequence, causing the polymerase to separate from the DNA and release the transcript.
- (C) Once transcription has initiated, RNA polymerase transcribes until it reaches the end of the chromosome.
- (D) RNA polymerase transcribes through a stop codon, causing the polymerase to stop advancing through the gene and release the mRNA.

28. In bacteria, there are 61 mRNA codons that specify an amino acid, but only 45 tRNAs. Which of the following statements explains this fact?

- (A) Some tRNAs have anticodons that recognize four or more different codons.
- (B) The rules for base pairing between the third base of a codon and tRNA are flexible.
- (C) Many codons are never used, so the tRNAs that recognize them are dispensable.
- (D) The DNA codes for all 61 tRNAs, but some are then destroyed.

29. Which of the following methods is utilized by eukaryotes to control their gene expression that is different from the type of control found in bacteria?

- (A) control of chromatin remodeling
- (B) control of RNA splicing
- (C) control of transcription
- (D) control of both RNA splicing and chromatin remodeling

30. DNA methylation and histone acetylation are examples of which of the following processes?

- (A) genetic mutation
- (B) chromosomal rearrangements
- (C) epigenetic phenomena
- (D) translocation

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31. Why might using retroviral vectors for gene therapy increase the patient's risk of developing cancer?

- (A) Retroviral vectors may introduce proteins from the virus.
- (B) Retroviral vectors do not express the genes that were introduced into a patient's cells.
- (C) Retroviral vectors do not integrate their recombinant DNA into the patient's genome.
- (D) Retroviral vectors integrate recombinant DNA into the genome in ways that may misregulate the expression of genes at or near the site of integration.

32. DNA technology has many medical applications. Which of the following is *not* done routinely at present?

- (A) production of hormones for treating diabetes and dwarfism
- (B) analysis of gene expression for more informed cancer treatments
- (C) gene editing by the CRISPR-Cas9 system in viable human embryos to correct genetic diseases
- (D) prenatal identification of genetic disease alleles

33. Which of the following statements correctly describes one of the characteristics of alternative splicing in vertebrate genomes?

- (A) Vertebrate genomes can produce more than one polypeptide from a single gene.
- (B) Vertebrate genomes can produce only one polypeptide from a single gene.
- (C) Vertebrate genomes are always smaller than other organisms.
- (D) Alternative splicing leaves introns in vertebrate genes after they are transcribed.

34. Why is sequencing of eukaryotic genomes more difficult than sequencing genomes of bacteria or archaea?

- (A) It is due to the large size of eukaryotic proteins.
- (B) Eukaryotic genomes contain sequences for hard-to-find proteins.
- (C) There is a high proportion of G-C base pairs in eukaryotic DNA, which makes sequencing difficult to complete.
- (D) The large size of eukaryotic genomes and the large amount of eukaryotic repetitive DNA make sequencing difficult.

35. Which one of the following statements best defines artificial selection?

- (A) Process that occurs when individuals inherit traits that enable them to survive and reproduce
- (B) Process where humans decide which plants and/or animals will not breed
- (C) Process of human directed breeding aimed to produce selective traits in selected species
- (D) Process that favors beneficial mutation

36. Darwin used the phrase "descent with modification" to explain _____.

- (A) unity of life
- (B) descent of all organisms from a single, ancient ancestor
- (C) that habitat differences stimulate change in organisms
- (D) evolution of the unity and diversity of life

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37. In a comparison of birds and mammals, the condition of having four limbs is
(A) a shared derived character.
(B) a shared ancestral character.
(C) a character useful for distinguishing birds from mammals.
(D) an example of analogy rather than homology.
38. Which of the following is the best modern definition of evolution?
(A) descent with modification
(B) change in the number of genes in a population over time
(C) survival of the fittest
(D) inheritance of acquired characters
39. According to the biological species concept, for speciation to occur, _____.
(A) the number of chromosomes in the gene pool must change
(B) changes to centromere location or chromosome size must occur
(C) large numbers of genes that affect numerous phenotypic traits must change
(D) at least one gene, affecting one reproductive barrier, must change
40. Which of the following processes can be effective in preventing the onset of viral infection in humans?
(A) taking vitamins before being exposed to various viruses
(B) getting vaccinated to certain viruses
(C) taking antibiotics to inhibit bacterial growth
(D) taking drugs that inhibit transcription
41. Spores and seeds have basically the same function—dispersal—but are vastly different because spores _____.
(A) have a protective outer covering; seeds do not
(B) have an embryo; seeds do not
(C) have stored nutrition; seeds do not
(D) are unicellular; seeds are not
42. In seed plants, which of the following is part of a pollen grain and has a function most like that of the seed coat?
(A) sporophyll
(B) sporopollenin
(C) stigma
(D) sporangium
43. Steroid and polypeptide hormones typically have in common _____.
(A) the building blocks from which they are synthesized
(B) their solubility in cell membranes
(C) their requirement for travel through the bloodstream
(D) their reliance on signal transduction in the cell

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44. A significant contribution of intestinal bacteria to human nutrition is the benefit of bacterial _____.

- (A) production of vitamins A and C
- (B) absorption of organic materials
- (C) production of vitamin K
- (D) recovery of water from fecal matter

45. In order for blood to always flow unidirectionally through a closed circulatory system, the _____.

- (A) blood vessels farthest from the heart must have valves
- (B) capillaries must have a thick endothelium
- (C) arteries must be elastic
- (D) pressure in all vessels must be equal

46. Which of the following is characteristic of juxtamedullary nephrons?

- (A) large Bowman's capsule
- (B) absence of proximal tubule
- (C) limited branching of vasa recta
- (D) long loop of Henle

47. Sexual reproduction _____.

- (A) allows animals to conserve resources and reproduce only during optimal conditions
- (B) can produce diverse phenotypes that may enhance survival of a population in a changing environment
- (C) enables males and females to remain isolated from each other while rapidly colonizing habitats
- (D) guarantees that both parents will provide care for each offspring

48. From earliest to latest, the overall sequence of early development proceeds in which of the following sequences?

- (A) first cell division → synthesis of embryo's DNA begins → acrosomal reaction → cortical reaction
- (B) cortical reaction → synthesis of embryo's DNA begins → acrosomal reaction → first cell division
- (C) cortical reaction → acrosomal reaction → first cell division → synthesis of embryo's DNA begins
- (D) acrosomal reaction → cortical reaction → synthesis of embryo's DNA begins → first cell division

49. The cells and signaling molecules involved in the initial stages of the inflammatory response are _____.

- (A) phagocytes and cytokines
- (B) dendritic cells and interferons
- (C) mast cells and histamines
- (D) lymphocytes and interferons

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50. Which of the following statements about action potentials is correct?

- (A) Action potentials for a given neuron vary in magnitude.
- (B) Action potentials for a given neuron vary in duration.
- (C) Action potentials are propagated down the length of the axon.
- (D) Movement of ions during the action potential occurs mostly through the sodium pump.