

Part I

選擇題(每題 1 分)

1. Stanley Miller's 1953 experiments proved that (A) life arose on Earth from simple inorganic molecules. (B) the conditions on early Earth were conducive to the abiotic synthesis of organic molecules. (C) the conditions on early Earth were conducive to the origin of life. (D) organic molecules can be synthesized abiotically under conditions that may have existed on early Earth.
2. Professor Jamey Marth at the University of California, Santa Barbara, identified 70 molecules that are used to build cellular macromolecules and structures. These include at least 34 saccharides, 8 nucleosides, and 20 amino acids. In theory, then, which class of biological polymer has the greatest information-coding capacity? (A) polysaccharides (B) proteins (C) DNA (D) RNA
3. Which of the following is true of the evolution of cell membranes? (A) An individual organism selects its preferred type of cell membrane for particular functions. (B) All components of membranes evolve in response to natural selection. (C) Cell membranes have stopped evolving now that they are fluid mosaics. (D) The evolution of cell membranes is driven by the evolution of glycoproteins and glycolipids.
4. Which statement best supports the hypothesis that glycolysis is an ancient metabolic pathway that originated before the last universal common ancestor of life on Earth? (A) Ancient prokaryotic cells, the most primitive of cells, made extensive use of glycolysis long before oxygen was present in Earth's atmosphere. (B) The enzymes of glycolysis are found in the cytosol rather than in a membrane-enclosed organelle. (C) Glycolysis is widespread and is found in the domains *Bacteria*, *Archaea*, and *Eukarya*. (D) Glycolysis neither uses nor needs O₂
5. For a newly evolving protist, what would be the advantage of using eukaryote-like cell division rather than binary fission? (A) Cell division would be faster than binary fission. (B) Cell division would allow for the orderly and efficient segregation of multiple linear chromosomes. (C) Binary fission would not allow for the formation of new organisms. (D) Binary fission would not allow the organism to have complex cells.
6. The fact that all seven of the pea plant traits studied by Mendel obeyed the principle of independent assortment most probably indicates which of the following? (A) None of the traits obeyed the law of segregation. (B) The formation of gametes in plants occurs by mitosis only. (C) All of the genes

- controlling the traits were located on the same chromosome. (D) All of the genes controlling the traits behaved as if they were on different chromosomes.
7. Eukaryotic telomeres replicate differently than the rest of the chromosome. This is a consequence of which of the following? (A) the "no ends" of a circular chromosome (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 (D) gaps left at the 3' end of the lagging strand because of the need for a primer
 8. The genetic code is essentially the same for all organisms. From this, one can logically assume which of the following? (A) All organisms have experienced convergent evolution. (B) A gene from an organism can theoretically be expressed by any other organism. (C) Different organisms have different numbers of different types of amino acids. (D) The same codons in different organisms translate into the different amino acids.
 9. Which of the following is the most probable fate of a newly emerging virus that causes high mortality in its host? (A) The newly emerging virus will die out rather quickly or will mutate to be far less lethal. (B) It is able to spread to a large number of new hosts quickly because the new hosts have no immunological memory of them. (C) The new virus replicates quickly and undergoes rapid adaptation to a series of divergent hosts. (D) A change in environmental conditions such as weather patterns quickly forces the new virus to invade new areas.
 10. RNAi methodology uses double-stranded pieces of RNA to trigger a breakdown or blocking of mRNA. For which of the following might it more possibly be useful? (A) to decrease the production from a harmful gain-of-function mutated gene (B) to form a knockout organism that will not pass the deleted sequence to its progeny (C) to raise the concentration of a desired protein (D) to raise the rate of production of a needed digestive enzyme
 11. A researcher is using adult stem cells and comparing them to other adult cells from the same tissue. Which of the following is a likely finding? (A) The cells from the two sources exhibit different patterns of DNA methylation. (B) The nonstem cells have fewer repressed genes. (C) The two kinds of cells have virtually identical gene expression patterns in microarrays. (D) Adult stem cells have more DNA nucleotides than their counterparts.
 12. In order to determine the probable function of a particular sequence of DNA in humans, what might be the most reasonable approach? (A) Look for a reasonably identical sequence in another species, prepare a knockout of this sequence in that species, and look for the consequences. (B) Genetically engineer a mouse with a copy of this sequence and examine its phenotype. (C)

- Prepare a knockout mouse without a copy of this sequence and examine the mouse phenotype. (D) Prepare a genetically engineered bacterial culture with the sequence inserted and assess which new protein is synthesized.
13. There are those who claim that the theory of evolution cannot be true because the apes, which are supposed to be closely related to humans, do not likewise share the same large brains, capacity for complicated speech, and tool-making capability. They reason that if these features are generally beneficial, then the apes should have evolved them as well. Which of these provides the best argument against this misconception? (A) Evolution can be influenced by environmental change. (B) Adaptations are often compromises. (C) A population's evolution is limited by historical constraints. (D) Advantageous alleles do not arise on demand.
 14. Which of these observations gives the most support to the endosymbiotic theory for the origin of eukaryotic cells? (A) the size disparity between most prokaryotic cells and most eukaryotic cells (B) the observation that some eukaryotic cells lack mitochondria (C) the existence of structural and molecular differences between the plasma membranes of prokaryotes and the internal membranes of mitochondria and chloroplasts (D) the similarity in size between the cytosolic ribosomes of prokaryotes and the ribosomes within mitochondria and chloroplasts
 15. Which of the following habitats would most likely have a high proportion of species of plants that are in symbiotic association with nitrogen-fixing bacteria? (A) anoxic soils such as fens and bogs (B) agriculturally productive regions that have gone fallow (C) nutrient-limiting soils such as wet tropical rain forests (D) alpine coniferous forests
 16. Which of the following statements regarding flowering plants is false? (A) Pollination is the placing of pollen on the stigma of a carpel. (B) The food-storing endosperm is derived from the cell that contains two polar nuclei and one sperm nucleus. (C) Flowers produce fruits within the ovules. (D) Female gametophytes develop from megaspores within the anthers.
 17. Which of the following hormones would be most useful in promoting the rooting of plant cuttings? (A) auxins (B) gibberellins (C) abscisic acid (D) oligosaccharins
 18. The velocity of blood flow is the lowest in capillaries because (A) the capillary walls are not thin enough to allow oxygen to exchange with the cells. (B) the total cross-sectional area of the capillaries is greater than the total cross-sectional area of the arteries or any other part of the circulatory system. (C) the capillaries are far from the heart, and blood flow slows as distance from the heart increases.

- (D) the diastolic blood pressure is too low to deliver blood to the capillaries at a high flow rate.
19. The switch of one B cell from producing one class of antibody to another antibody class that is responsive to the same antigen is due to (A) the rearrangement of immunoglobulin heavy-chain C region DNA. (B) a switch in the kind of antigen-presenting cell that is involved in the immune response. (C) a patient's reaction to the first kind of antibody made by the plasma cells. (D) the rearrangement of V region genes in that clone of responsive B cells.
20. Osmoregulatory adjustment via the renin-angiotensin-aldosterone system can be triggered by (A) drinking several glasses of water. (B) eating a pizza with olives and pepperoni. (C) sleeping for one hour. (D) severe sweating on a hot day.
21. Asexual reproduction results in greater reproductive success than does sexual reproduction when (A) pathogens are rapidly diversifying. (B) a species is in stable and favorable environments. (C) a species has accumulated numerous deleterious mutations. (D) a species is expanding into diverse geographic settings.
22. The lateral line system in fish transduces sensory information in a manner that, among these choices, is most similar to (A) human olfaction. (B) human vestibular sense. (C) human vision. (D) human thermoreception.
23. "How do seed-eating animals affect the distribution and abundance of the trees?" This question (A) would require an elaborate experimental design to answer. (B) would be difficult to answer because a large experimental area would be required. (C) would be difficult to answer because a long-term experiment would be required. (D) All options are correct.
24. Which of the following causes populations to shift most quickly from an exponential to a logistic population growth? (A) competition for resources (B) increased birth rate (C) removal of predators (D) favorable climatic conditions
25. Which of the following studies would shed light on the mechanism of spread of H5N1 from Asia? (A) Test fecal samples for H5N1 in Asian waterfowl that live near domestic poultry farms in Asia. (B) Test for the presence of H5N1 in poultry used for human consumption worldwide. (C) Perform cloacal or saliva smears of migrating waterfowl to monitor whether any infected birds show up in Alaska. (D) Keep domestic and wild fowl from interacting with each other to minimize the probability that wild fowl could get infected and migrate out of Asia.

簡答題

26. In the peppered moth (*Biston betularia*), black individuals may be either homozygous (A_1A_1) or heterozygous (A_1A_2), whereas pale gray moths are homozygous (A_2A_2). Suppose that in a sample of 250 moths from one locality, 108 are black and 142 are gray. (a) Which allele is dominant? (b) Assuming that the locus is in Hardy-Weinberg equilibrium, what are the allele frequencies? (c) Under this assumption, please describe H_o (Observed heterozygosity), H_e (Expected heterozygosity) and F_{IS} . (6 分)
27. How to incorporate modern biology into high school biology class: using NGS (next generation sequencing) as an example. (4 分)

Part II

28. 請以文字與繪圖說明人類女性生殖週期的相關激素暨基礎體溫的變化與關聯性。(8 分)
29. 請舉例並說明張力溶液與滲透溶液的差異。(5 分)
30. 請說明與比較有氧呼吸、無氧呼吸、發酵作用的異同。(5 分)
31. 請說明從鐮骨振動開始，至引發大腦產生聽覺，過程中所參與的聽覺構造與神經傳遞路徑。(8 分)
32. 請說明課程、課程綱要、教材的差異。(9 分)
33. 學生對於許多較複雜概念的學習，常感到難以理解或不易記憶，現在以「後天獲得性防禦」為例，說明你對本概念的分析與教學策略。(9 分)
34. 由於升學管道的多樣性，因而同一班級學生的學習狀況差異日大，請問你要如何進行有效的差異化教學？(9 分)
35. 校外教學是提昇學習體驗的一種好方式，在辦理任課班級校外教學時，你會如何規劃、進行？(8 分)又有哪些事項要注意？(4 分)請儘量詳細說明細節。