

※ 注意：請於試卷內之「選擇題作答區」依序作答。

I. Multiple choices: Choose the one best answer the question. (2 points each, 90 points total)

1. Prokaryotes are classified as belonging to two different domains. What are they?
 - A) Bacteria and Archaea
 - B) Bacteria and Eukarya
 - C) Archaea and Monera
 - D) Eukarya and Monera
 - E) Bacteria and Protista

2. What macromolecules will be labeled if a ^{14}C -labeled uridine triphosphate is added to the growth medium of cells, what macromolecules will be labeled?
 - A) RNA
 - B) DNA
 - C) phospholipids
 - D) both DNA and RNA
 - E) proteins

3. A bacterium engulfed by a white blood cell through phagocytosis will be digested by enzymes contained in
 - A) vacuoles.
 - B) lysosomes.
 - C) secretory vesicles.
 - D) peroxisomes.
 - E) Golgi vesicles.

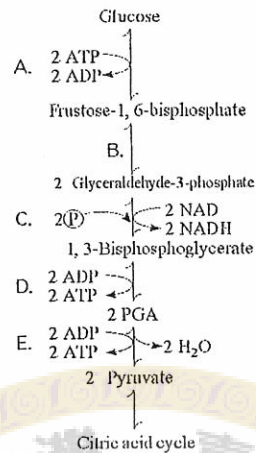
4. There are bacteria found in the hot springs and are active metabolically. It is because
 - A) they are able to maintain a low internal temperature.
 - B) their enzymes are completely insensitive to temperature.
 - C) their enzymes have high optimal temperature.
 - D) they use special molecules other than proteins or RNAs for catalytic reaction
 - E) they have unique cooling device on the membrane.

5. According to the fluid mosaic model of cell membranes, which of the following is a true statement about membrane phospholipids?
 - A) They frequently flip-flop from one side of the membrane to the other.
 - B) The membrane proteins restricted to the surface of the membrane.
 - C) They are free to depart from the membrane and dissolve in the surrounding solution.
 - D) They can move laterally along the plane of the membrane.
 - E) They have hydrophilic tails in the interior of the membrane.

6. Carotenoids can be found in many plants and are considered to have antioxidant properties in our daily nutrition. What related function in plants?
 - A) They serve as sensory pigments to increase light absorption.
 - B) They protect against oxidative damage from excessive light energy.
 - C) They shield the sensitive chromosomes from harmful ultraviolet radiation.
 - D) They reflect orange light and enhance red light absorption by chlorophyll.
 - E) They take up and remove toxins from the plant.

見背面

7. The figure on the right illustrates some of the steps of glycolysis in their proper sequence. Each step is lettered (A-E). Answer the questions accordingly. Glycolysis can be divided into an energy investment phase and an energy payoff phase. Which of the step(s) in the figure is the energy payoff phase?



- A) D and E
- B) B and C
- C) A only
- D) B only
- E) C only

8. Which of the following is *true* of a species that has a chromosome number of $2n = 48$?
- A) The species is diploid with 96 chromosomes per cell.
 - B) The species has 48 sets of chromosomes per cell.
 - C) Each cell has 24 homologous pairs.
 - D) During the S phase of the cell cycle there will be 96 separate chromosomes.
 - E) A gamete from this species has 12 chromosomes.
9. One possible result of chromosomal breakage is for a fragment to join a nonhomologous chromosome. What is this phenomenon called?
- A) inversion
 - B) deletion
 - C) transversion
 - D) translocation
 - E) duplication
10. What is the function of topoisomerase during DNA replication?
- A) elongating new DNA at a replication fork by adding nucleotides to the existing chain
 - B) adding methyl groups to bases of DNA
 - C) unwinding of the double helix
 - D) stabilizing single-stranded DNA at the replication fork
 - E) relieving strain in the DNA ahead of the replication fork
11. A transcription unit that is 9,000 nucleotides long may use 900 nucleotides to make a protein consisting of about 300 amino acids. This is best explained by the fact that
- A) many noncoding stretches of nucleotides are present in mRNA.
 - B) there is redundancy and ambiguity in the genetic code.
 - C) nucleotides break off and are lost during the transcription process.
 - D) many nucleotides are needed to code for each amino acid.
 - E) there are termination exons near the beginning of mRNA.
12. Which of the following is a representation of gene density?
- A) *C. elegans* has ~20,000 genes.
 - B) Humans have ~20,000 genes in 2,900 Mb.
 - C) Humans have 2,900 Mb per genome.
 - D) *Fritillaria* has a genome 40 times the size of a human.
 - E) Humans have 27,000 bp in introns.

13. Both ancestral birds and ancestral mammals shared a common ancestor that was terrestrial. Today, penguins (which are birds) and dolphins (which are mammals) have forelimbs adapted for swimming. What term best describes the flippers of penguins and dolphins?
- A) prototypic
 - B) apomorphic
 - C) analogous
 - D) homologous
 - E) aneuploidic
14. A kind of beetle is known to pollinate a particular plant by its flowers' bright red color, and the beetles also mate while inside of the flowers. A mutant plant with orange flowers arose and becomes more common with the passage of time. A particular variant of the beetle prefers the orange flowers to the red flowers. Over time, these two beetle variants diverge from each other to such an extent that interbreeding is no longer possible. What kind of speciation has occurred in this example, and what has driven it?
- A) allopatric speciation; behavioral isolation
 - B) allopatric speciation; ecological isolation
 - C) sympatric speciation; sexual selection
 - D) sympatric speciation; habitat differentiation
 - E) sympatric speciation; allopolyploidy
15. The most important feature that permits a gene to act as a molecular clock for evolutionary study is
- A) having a large number of base pairs.
 - B) having a reliable average rate of mutation.
 - C) its recent origin by a gene-duplication event.
 - D) its being acted upon by natural selection.
 - E) having a larger proportion of exonic DNA than of intronic DNA.
16. You are given the task of designing an aquatic protist that is a primary producer. It cannot swim on its own, yet must stay in well-lit surface waters, and it must be resistant to physical damage from wave action. It should be most similar to a(n)
- A) diatom.
 - B) dinoflagellate.
 - C) apicomplexan.
 - D) oomycete.
 - E) radiolarian.
17. The thalli of a liverwort is its
- A) haploid sporophyte
 - B) diploid sporophyte
 - C) haploid gametophyte
 - D) diploid gametophyte
 - E) a structure homologous to sporangia
18. What is true of sepals, petals, stamens, carpels, and pinecone scales?
- A) They are female reproductive parts.
 - B) They are capable of photosynthesis.
 - C) They are found on flowers.
 - D) They are found on gymnosperms.
 - E) They are modified leaves.

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19. What is the probable sequence in which the following clades of animals originated, from earliest to most recent?
1. tetrapods
 2. vertebrates
 3. deuterostomes
 4. amniotes
 5. bilaterians
- A) 5 → 3 → 2 → 4 → 1
B) 5 → 3 → 4 → 2 → 1
C) 3 → 5 → 4 → 2 → 1
D) 5 → 3 → 2 → 1 → 4
E) 3 → 5 → 2 → 1 → 4
20. Which group's members have had both lungs and gills during their adult lives?
- A) sharks, skates, and rays
B) lungfishes
C) lancelets
D) frogs
E) ichthyosaurs and plesiosaurs
21. Quantities of mineral nutrients in soils of tropical rain forests are relatively low because
- A) the standing crop is small
B) microorganisms that recycle chemicals are not very abundant in tropical soils
C) the decomposition of organic refuse and chemical re-assimilation by plants occur rapidly
D) nutrient cycles occur at a relatively slow rate in tropical soils
22. An example of Mullerian mimicry is
- A) a butterfly that resembles a leaf
B) two poisonous frogs that resemble each other in coloration
C) a minnow with spots that look like large eyes
D) a beetle that resembles a scorpion
23. A population's carrying capacity is
- A) the number of individuals in that population
B) reached when the number of deaths exceeds the number of births
C) inversely related to r_{max}
D) the population size that can be supported by available resources for that species within the habitat
24. Hummingbirds living at elevations above 4500 meters enter torpor when the sun sets and they are unable to forage. This reaction to environmental variation illustrates
- A) a morphological response
B) an endothermic response
C) accommodation
D) a physiological response
25. The role of calcium in muscle contraction is
- A) to bind with troponin, changing its shape so that the myosin binding sites on the actin filament are exposed
B) to transmit the action potential across through the T tubules
C) to spread the action potential across the neuromuscular junction
D) to re-establish the polarization of the plasma membrane following an action potential

26. Receptor sites for neurotransmitters are located on the
- A) tips of axons
 - B) postsynaptic membrane
 - C) membranes of synaptic vesicles
 - D) presynaptic membrane
27. Amphibians, unlike reptiles, generally lay their eggs in water or moist places. This difference is related to the absence of _____ in amphibians.
- A) extraembryonic membrane
 - B) yolk
 - C) cleavage
 - D) gastrulation
28. Which of the following hormones is incorrectly paired with its action?
- A) oxytocin—stimulates uterine contraction during childbirth
 - B) thyroxine—stimulates metabolic processes
 - C) insulin—stimulates glycogen breakdown in the liver
 - D) melatonin—affects biological rhythms, seasonal reproduction
29. The key difference between an ectotherm and an endotherm is that
- A) ectotherms generate energy mainly from fermentation; endotherms mainly from cellular respiration
 - B) ectotherms are mostly aquatic animals; endotherms are mostly terrestrial
 - C) ectotherms warm their bodies mainly by absorbing environmental heat; endotherms mainly use metabolic heat to warm their bodies
 - D) ectotherms are cold-blooded animals with body temperatures that cannot reach the high body temperatures of endotherms
30. Which of the following is a characteristic of the early stages of local inflammation?
- A) precapillary arteriole constriction
 - B) fever
 - C) attack by cytotoxic cells
 - D) release of histamine
31. Blood returning to the mammalian heart in a pulmonary vein will drain first into the _____
- A) vena cava
 - B) left atrium
 - C) right atrium
 - D) right ventricle
32. Which of the following is not thought to be ancestral to humans?
- A) a reptile
 - B) a bony fish
 - C) a primate
 - D) a bird
33. A land snail, a clam, and an octopus all share
- A) a mantle
 - B) a radula
 - C) gills
 - D) embryonic torsion

34. Which of the following subdivisions of the animal kingdom encompasses all the others in the list?
- A) protostomes
 - B) bilateria
 - C) pseudocoelomates
 - D) coelomates
35. The developmental stage shared by plants, animals, and fungi is the
- A) blastula
 - B) gastrula
 - C) hypha
 - D) zygote.
36. The greatest absorption of nutrients into the bloodstream from the vertebrate digestive system involves the
- A) gall bladder and arteries
 - B) large intestine and veins
 - C) small intestine and capillaries
 - D) stomach and arterioles.
37. In land vertebrates the passage of air through the respiratory tract is increased by
- A) contraction of smooth muscles in the lungs causing changes in the size of the air sacs
 - B) contraction of cardiac muscle in the upper respiratory tract, causing an air current
 - C) movement of the diaphragm causing changes in the chest cavity air pressure
 - D) movement of the villi, causing an air current through the trachea.
38. The circulatory system that allows the least mixing of wastes leaving cells and nutrients to the cells is the
- A) open circulatory system
 - B) closed system with a 2-chambered heart
 - C) closed system with a 3-chambered heart
 - D) closed system with a 4-chambered heart.
39. In an example of a negative feedback loop, a low level of calcium ions in the bloodstream causes the parathyroid to produce calcitonin, and calcitonin causes the
- A) hypothalamus to increase the metabolic rate
 - B) osteoclasts to break down bone minerals
 - C) pancreas to produce more insulin, which then reduces the calcitonin
 - D) pituitary gland to produce growth hormone and increase bone production.
40. The part of the central nervous system that communicates most with the endocrine system is the
- A) cerebellum
 - B) efferent nerve
 - C) glial cell
 - D) hypothalamus
 - E) none of the above; the nervous and endocrine systems have separate communications.
41. Which of the following is not a similarity between communication by hormones and communication by nerves?
- A) Both allow cells in the same organism to coordinate their activities
 - B) Both can be triggered by changes in internal conditions in the organism
 - C) Both rely on receptor proteins on the surfaces of cells
 - D) Both use the bloodstream to transport chemical messages.

42. The part of the eye that starts a nerve impulse when struck by light is the
- A) cornea
 - B) iris
 - C) pupil
 - D) retina.
43. The place where B and T lymphocytes originate is the
- A) bone marrow
 - B) lymph node
 - C) lymph vessel
 - D) spleen.
44. Which of the following is an example of sexual reproduction?
- A) A bacterial cell receives new genetic information from another bacterium and then divides.
 - B) A plant stores food in a tuber at the base of its stem and a new plant grows from the tuber.
 - C) A male fish releases sperm into the water where a female fish has released eggs and baby fish are produced.
 - D) None of the above are examples of sexual reproduction.
45. The organ in which fertilization occurs in land vertebrates is the
- A) ovary
 - B) seminiferous tubule
 - C) uterine tube
 - D) vas deferens.

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II. Short answers (10 points total)

1. What is DNA methylation in regards of genetic imprinting and what is the relation to the Mendelian genetics? (6 points)
2. Give two examples of symbiosis and explain what benefits they gain on each side. (4 points)

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