

題號： 468

國立臺灣大學 108 學年度碩士班招生考試試題

科目： 普通生物學(B)

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I. Match the following terminology with the most suitable explanation (2 points each)

bilaterian, biogeography, clade, exocytosis, fertility, foraging, genetic variation, heterochromatin, heredity, herbivory, karyotype, kinetochore, kin selection, monogamous, polymorphism, test cross, savanna, xylem, zoospore

1. A member of a clade of animals with bilateral symmetry and three germ layers
2. A display of the chromosome pairs of a cell arranged by size and shape
3. A tropical grassland biome with scattered individual trees and large herbivores and maintained by occasional fires and drought.
4. Natural selection that favors altruistic behavior by enhancing the reproductive success of relatives.
5. Flagellated spore found in chytrid fungi and some protists
6. The seeking and obtaining of food
7. The scientific study of the past and present geographic distributions of species
8. Referring to a type of relationship in which one male mates with just one female
9. The transmission of traits from one generation to the next.
10. An interaction in which an organism eats part of a plant or alga.
11. Vascular plant tissue consisting mainly of tubular dead cells that conduct most of the water and minerals upward from the roots to the rest of the plant
12. Eukaryotic chromatin that remains highly compacted during interphase and is generally not transcribed
13. A group of species that includes an ancestral species and all of its descendants. A clade is equivalent to a monophyletic group
14. A structure of proteins attached to the centromere that links each sister chromatid to the mitotic spindle
15. The cellular secretion of biological molecules by the fusion of vesicles containing them with the plasma membrane

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II. Multiple choice: select one best answer from the list of choices (2 points each) 請於試卷內之「非選擇題作答區」標明題號依序作答。

1. A neuron that transmits an impulse to the central nervous system after the neuron is stimulated by the environment is called a(n) _____.

- A. sensory neuron
- B. effector
- C. interneuron
- D. autonomic neuron
- E. motor neuron

2. Which of the following hormones is thought to act at the cellular level by inducing a change in gene expression?

- A. prostaglandin
- B. estrogen
- C. nitric oxide
- D. prothoracicotropic hormone (PTTH)
- E. epinephrine

3. The phenomenon responsible for maintaining the upward movement of water through vessels in a tree is _____.

- A. specific heat
- B. hydration shells
- C. surface tension
- D. cohesion
- E. adhesion

4. The source of the oxygen produced by photosynthesis has been identified through experiments using radioactive tracers. The oxygen comes from _____.

- A. radioisotopes
- B. water
- C. carbon dioxide
- D. light
- E. glucose

5. Which of the following statements about the phylum Echinodermata is true?

- A. One of the clades in this phylum is Asterozoa, which includes the sea stars and sea daisies.
- B. Many species possess an internal calcareous skeleton and spiny dermal projections.
- C. All possess a water vascular system, which permits movements via tube feet.
- D. Larval forms show evidence of bilateral symmetry, which is mostly lost in the adult form.
- E. All of the listed responses are correct.

6. Which of the following cells or structures are associated with asexual reproduction in fungi?

- A. ascospores
- B. basidiospores

- C. zygosporangia
- D. conidiophores
- E. ascocarps

7. Within six months of effectively using methicillin to treat *S. aureus* infections in a community, all new infections were caused by MRSA. How can this result best be explained?

- A. In response to the drug, *S. aureus* began making drug-resistant versions of the protein targeted by the drug.
- B. The drug caused the *S. aureus* DNA to change.
- C. A patient must have become infected with MRSA from another community.
- D. Some drug-resistant bacteria were present at the start of treatment, and natural selection increased their frequency.
- E. *S. aureus* can resist vaccines.

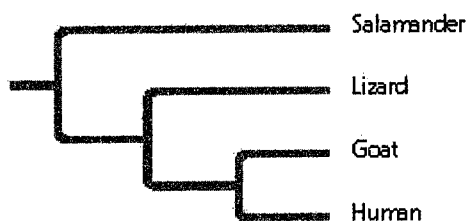
8. RNA viruses require their own supply of certain enzymes because

- A. these enzymes translate viral mRNA into proteins.
- B. these enzymes penetrate host cell membranes.
- C. host cells rapidly destroy the viruses.
- D. these enzymes cannot be made in host cells.
- E. host cells lack enzymes that can replicate the viral genome.

9. To apply parsimony to constructing a phylogenetic tree,

- A. choose the tree that assumes all evolutionary changes are equally probable.
- B. choose the tree with the fewest branch points.
- C. choose the tree in which the branch points are based on as many shared derived characters as possible.
- D. choose the tree that represents the fewest evolutionary changes, in either DNA sequences or morphology.
- E. base phylogenetic trees only on the fossil record, as this provides the simplest explanation for evolution.

10. Based on this tree, which statement is *not* correct?



- A. Salamanders are as closely related to goats as to humans.
- B. The salamander lineage is a basal taxon.
- C. Lizards are more closely related to salamanders than to humans.
- D. Salamanders are a sister group to the group containing lizards, goats, and humans.
- E. The group highlighted by shading is paraphyletic.

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11. The distinction between sponges and other animal phyla is based mainly on the absence versus the presence of
- A. a body cavity.
 - B. a complete digestive tract.
 - C. true tissues.
 - D. mesoderm.
 - E. None of above
12. Two eukaryotic proteins have one domain in common but are otherwise very different. Which of the following processes is most likely to have contributed to this similarity?
- A. histone modification
 - B. RNA splicing
 - C. exon shuffling
 - D. gene duplication
 - E. random point mutations
13. Which of the following is *not* true of RNA processing?
- A. Ribozymes may function in RNA splicing.
 - B. Exons are cut out before mRNA leaves the nucleus.
 - C. RNA splicing can be catalyzed by spliceosomes.
 - D. Nucleotides may be added at both ends of the RNA.
 - E. A primary transcript is often much longer than the final RNA molecule that leaves the nucleus.
14. Which of the following mutations would be most likely to have a harmful effect on an organism?
- A. a deletion of three nucleotides near the middle of a gene
 - B. a single nucleotide insertion downstream of, and close to, the start of the coding sequence
 - C. a single nucleotide deletion in the middle of an intron
 - D. a nucleotide-pair substitution
 - E. a single nucleotide deletion near the end of the coding sequence
15. The principle of competitive exclusion states that
- A. two species will stop reproducing until one species leaves the habitat.
 - B. competition in a population promotes survival of the best-adapted individuals.
 - C. two species cannot coexist in the same habitat.
 - D. competition between two species always causes extinction or emigration of one species.
 - E. two species that have exactly the same niche cannot coexist in a community.
16. According to Hamilton's rule,
- A. natural selection is more likely to favor altruistic behavior that benefits an offspring than altruistic behavior that benefits a sibling.
 - B. natural selection does not favor altruistic behavior that causes the death of the altruist.
 - C. altruism is always reciprocal.

D. natural selection favors altruistic acts when the resulting benefit to the beneficiary, corrected for relatedness, exceeds the cost to the altruist.

E. the effects of kin selection are larger than the effects of direct natural selection on individuals.

17. In humans, identical twins are possible because

A. early blastomeres can form a complete embryo if isolated.

B. extraembryonic cells interact with the zygote nucleus.

C. cytoplasmic determinants are distributed unevenly in unfertilized eggs.

D. the gray crescent divides the dorsal-ventral axis into new cells.

E. convergent extension occurs.

F. right answer feedback:

18. Meiosis II is similar to mitosis in that

A. the chromosome number is reduced.

B. homologous chromosomes synapse.

C. sister chromatids separate during anaphase.

D. DNA replicates before the division.

E. the daughter cells are diploid.

19. Which of the following mechanisms can form entirely new alleles?

A. mutation

B. natural selection

C. genetic drift

D. sexual recombination

E. the environment

20. In a large population of bonobos, the frequency of the recessive allele is initially 0.1. There is no migration and no selection.

What is the frequency of the dominant allele? Assume that there are two alleles of this gene.

A. 0.1

B. 0.2

C. 0.5

D. 0.9

E. 0.99

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III. Open-end question

1. Describe the major transitions in the origin of life (5 points). What hypotheses were proposed to explain such transitions and if there are any evidences support these hypotheses (5 points).
2. What are the major breakthroughs in biology from the past 10 years (5 point)? How do these breakthroughs impact researchers in the field of ecology and evolution (5 points)?
3. An instructor asks undergraduate students read the following paragraph and propose a research project based on this study.
 - a. If you are a TA for this course, what background knowledge, such as genetic variation, you might provide to help their understanding of this research. List the relevant topics and how you might organize your introductory lecture to students. (5 points)
 - b. If you are interested in human skin color evolution, propose a follow-up experiment on skin color evolution of Taiwanese population . (5 points)

Walk down a busy street in most Latin American cities today and you'll see a palette of skin colors from dark brown to sepia to cream. For 500 years, people have assumed this variation comes from the meeting and mixing of Native Americans, Europeans, and Africans during colonial times and later. People with lighter skin are thought to have more European ancestry, whereas those with darker skin are taken to have more Native American or African ancestry—and are often targeted for discrimination.

Now, a new study of the genes of more than 6000 people from five Latin American countries undercuts the simplistic racial assumptions often made from skin color. An international team discovered a new genetic variant associated with lighter skin found only in Native American and East Asian populations. That means that in Latin America, lighter skin can reflect Native American as well as European ancestry.

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One variant was on MFSD12. Tishkoff recently linked reduced expression of this gene with darker skin in Africans. The new MFSD12 variant, however, is associated with lighter skin, and might instead enhance the gene's expression, Adhikari and Mendoza-Revilla report this week in Nature Communications. When they looked for the variant in other populations, they found it only in Native Americans and East Asians.

So the new variant sheds light on the genes underlying pale skin in East Asia. People at high latitudes in Europe and East Asia seem to have independently evolved lighter skin to produce vitamin D more efficiently with less sunlight, says Nina Jablonski, a biological anthropologist at Pennsylvania State University in University Park.

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