

I. Multiple choice: Choose the **one** alternative that best completes the statement or answers the question. (4 points each)

※ 注意：請於試卷內之「選擇題作答區」依序作答。

1. If in a population of 1,000,000 people, 100 albinos were found, how many **carrier individuals** will be found in the next generation under Hardy-Weinberg equilibrium conditions?

- A) 100
- B) 19,800
- C) 100,000
- D) 980,100
- E) 999,900

2. Which of the following is **not** one of the assumptions of the Hardy-Weinberg law?

- A) The population is very large.
- B) Mutations in the alleles do not occur.
- C) There is non-random mating within the population.
- D) No migration occurs into or out of the population.
- E) The ability of all genotypes for survival and reproduction is the same.

3. The total phenotype variance (VP) is:

- A) the difference between VG and VE.
- B) the sum of genetic variance (VG) and environmental variance (VE).
- C) not dependent on VE.
- D) not dependent on VG.
- E) always constant.

4. Which of the following populations is at Hardy-Weinberg equilibrium?

Population	AA	Aa	aa
A	0.27	0.74	0.09
B	0.48	0.36	0.16
C	0.49	0.42	0.09
D	0.70	0.28	0.02
E	0.46	0.50	0.04

5. Three populations of crickets look very similar, but the males have courtship songs that sound different. What function would this difference in song likely serve if the populations came in contact?

- A) a morphological isolating mechanism
- B) a postzygotic isolating mechanism
- C) a behavioral reproductive isolating mechanism
- D) a gametic reproductive isolating mechanism
- E) none of the above

6. There is an island in the middle of a large river that houses a large population of ants. Damming of the river causes the island to flood and only the highest points of the island are now above water. The ants cannot swim, so are now in multiple isolated populations. Which of the following best describes this event?

- A) isolation by dispersal
- B) isolation by vicariance
- C) a form of sympatric speciation
- D) only a rare development of polyploidy could lead to speciation in this case.
- E) speciation will not occur in this case because of gene flow

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7. Currently the only predators of Galápagos marine iguanas are Galápagos hawks. Iguana body size is not correlated with risk of hawk predation, although small iguanas can sprint faster than large iguanas. If predators (e.g., cats) that preferably catch and eat slower iguanas are introduced to the island, iguana body size is likely to \_\_\_\_\_ in the absence of other factors; the iguanas would then be under \_\_\_\_\_ selection.
- A) increase; directional
  - B) increase; disruptive
  - C) decrease; directional
  - D) decrease; disruptive
  - E) stay the same; stabilizing
8. In Kerr and Wright's experiment with 96 fruit-fly populations, only 4 males and 4 females bred in each generation. After 16 generations, 73% of their populations had only one allele present for the bristle morphology gene. Which of the following would you expect to occur if they allowed 10 males and 10 females to breed in each generation?
- A) About 73% of the populations would have only one allele for the bristle morphology gene.
  - B) More than 73% of the populations would have only one allele present.
  - C) Less than 73% of the populations would have only one allele present.
  - D) All of the populations would have only one allele present.
  - E) None of above.
9. Which of these conditions are always true of populations evolving due to natural selection?
- Condition 1: The population must vary in traits that are heritable.  
Condition 2: Some heritable traits must increase reproductive success.  
Condition 3: Individuals pass on all traits they acquire during their lifetime.
- A) Condition 1 only
  - B) Condition 2 only
  - C) Conditions 1 and 2
  - D) Conditions 2 and 3
  - E) Conditions 1, 2, and 3
10. Parasitic species tend to have simple morphologies. Which of the following statements best explains this observation?
- A) Parasites are lower organisms, and this is why they have simple morphologies.
  - B) Parasites do not live long enough to inherit acquired characteristics.
  - C) Simple morphologies have been naturally selected for in most parasites.
  - D) Parasites have not yet had time to progress, because they are young evolutionarily.
  - E) All of above
11. The antlers of the extinct Irish elk (*Megaceros giganteus*) is a well-known example of allometry. What is the major reason for this?
- A) Its antlers were larger, relative to body mass, than those of other deer.
  - B) Its antlers were smaller, relative to body mass, than those of other deer.
  - C) Its antlers were grown at a different time during ontogeny, compared to other deer.
  - D) Its antlers were at a different position from those of other deer.
  - E) Its antlers increased at the same rate as its body mass.
12. Many temperate plants and animals shifted their ranges during the Pleistocene, rather than adapt to climate change. This observation is consistent with
- A) community convergence.
  - B) habitat tracking.
  - C) phylogenetic signal.
  - D) local adaptation.
  - E) physiological tolerance.

13. Which of the following is not a monophyletic group according to current understanding?

- A) angiosperms.
- B) mammals.
- C) Aves (birds)
- D) monocotyledons
- E) warm-blooded animals (mammals and birds)

14. Many of the Gastropods survived through the end of Permian extinction have wider geographic and ecological distribution. This is due to

- A) random extinction.
- B) K/T extinction.
- C) selective extinction.
- D) microevolutionary change.
- E) species radiation.

15. Which of the following is not a form of asexual reproduction?

- A) Vegetative propagation.
- B) Budding.
- C) Apomixis.
- D) Agamospermic reproduction.
- E) Hermaphroditism

## II. Short answer questions

1. A genus of Antarctic fishes, *Channichthys*, lacks hemoglobin. In its relative *Trematomus*, hemoglobin serves its usual functions. Assuming that the gene encoding hemoglobin in *Channichthys* has no function, and is not transcribed, how might you expect the nucleotide sequence of this gene to differ between these two genera? (5 points)

2. (a) Please explain synonymous substitution rate ( $d_S$ ) and non-synonymous substitution rate ( $d_N$ ). (5 points) (b) Why do we use the ratio of  $d_N/d_S$  to evaluate if a gene is under positive selection, why don't we just compare  $d_N$  between sequences? (5 points)

3. Please explain genetic drift. (5 points)

4. It is possible for two different genes inferring different phylogenies due to lineage sorting of gene phylogeny. Explain the phenomenon by drawing gene trees imposed on species tree. (10 points)

5. Many of the spiders (e.g. *Latrodectus*) show cannibalism in which a female spider kills and eats a male of the same species during copulation. Some of the males' genitals (palps) break off in copulation and left in female's body. Speculate the benefits and trade-offs for male and female spiders in this special case of altruism. (10 points)