一、配合題 (30%, 2% each) ※ 注意：請於試卷內之「非選擇題作答區」標明題號依序作答。

A. Selection coefficient	B. Selection differential	C. Selection gradient
D. Selective sweep	E. Heritability	F. Homoplasy
G. Maternal effect	H. Founder effect	I. Red Queen hypothesis
J. Horizontal gene transfer	K. Monophyletic	L. Refugia
M. Vicariance	N. Homology	O. Allopatric

____ 1. A population occupying a location different from that of another population
____ 2. Regression slope between mean trait values of the offspring (vertical axis) and mean trait values of their parents (horizontal axis)
____ 3. Those who established a new population carry only part of the total genetic variation from the original population
____ 4. Similar phenotype of siblings due to common environments from the previous generation rather than inheritance
____ 5. Relative fitness of the most fit genotype minus relative fitness of another genotype
____ 6. Two or more species possess similar character states due to independent evolution instead of inherited from the common ancestor
____ 7. Two or more species possess similar character states due to inheritance from the common ancestor
____ 8. Movement of genetic materials between organisms rather than transmission from parents to offspring
____ 9. The separation of a continuously distributed population into separate groups due to a barrier
____ 10. A clade on the phylogenetic tree that includes all members descended from a common ancestor
____ 11. Rapid frequency increase of a beneficial allele resulted in the reduction of linked DNA polymorphism
____ 12. Regression slope between fitness (vertical axis) and phenotypic values (horizontal axis)
____ 13. A species persisted in this location but went extinct elsewhere
____ 14. Species need to keep evolving as fast as other species having negative interactions with them to prevent extinction
____ 15. Mean trait value of survivors after selection minus mean trait value of the original population

二、選擇題 (45%, 3% each) ※ 注意：請於試卷內之「選擇題作答區」依序作答。

____ 1. In many social animals, individuals would have altruistic behavior to increase the fitness of their relatives. This phenomenon is a type of:
(A) Stabilizing selection
(B) Disruptive selection
(C) Balancing selection
(D) Kin selection

____ 2. In a type of natural selection, a genotype or phenotype has a fitness advantage when it is rare. When its frequency increases, its fitness declines, and the other rare genotype or phenotype has higher fitness. This phenomenon is called:
(A) Negative frequency-dependent selection
(B) Positive frequency-dependent selection
(C) Disruptive selection
(D) Antagonistic pleiotropy

____ 3. Human birth weight is a type of:
(A) Disruptive selection
(B) Directional selection
(C) Stabilizing selection
(D) Balancing selection

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____ 4. Regarding the levels of genetic variation, which of the following has the opposite effect from genetic drift?
(A) Founder effect
(B) Population bottleneck
(C) Effective population size decline
(D) Balancing selection

____ 5. There are two populations of plant species. Population A inhabits regions with short growing seasons with less water, and population B inhabits regions with long growing seasons with abundant water supply. As a result, these populations diverge in several ecologically important traits, and immigrants to other environments have lower fitness. This is a case of:
(A) Hybrid sterility
(B) Gene flow
(C) Local adaptation
(D) isolation by distance

____ 6. There are a lot of endemic species or subspecies in Taiwan. With a lack of gene flow from the populations in the continent, the Taiwanese populations developed unique characteristics. This is a case of:
(A) Sympatric speciation
(B) Hybrid speciation
(C) Allopatric speciation
(D) Reinforcement in speciation

____ 7. Which of the following about sexual selection is TRUE?
(A) Phenotypic characteristics increasing the chance of mating success in one sex would not affect the other sex.
(B) Sometimes, sexual selection and natural selection work antagonistically
(C) In all cases of sexual selection, the preference evolved after the appearance of the preferred phenotypes
(D) Sexual reproduction evolved to prevent recombination from breaking advantageous combinations of alleles

____ 8. Sometimes, a phenotypic characteristic beneficial in one environment may be detrimental in another experiment. This is called:
(A) Trade-off
(B) Neutrality
(C) Epistasis
(D) Turnover

____ 9. Some time ago, scientists thought that anatomically modern humans migrated out of Africa and drove Neanderthals to extinction, probably due to both utilizing the same resources. Which term best describes this phenomenon?
(A) Convergent evolution
(B) Competitive exclusion
(C) Parasitism
(D) Reproductive isolation

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____ 10. The globin gene family is a good example of gene copy number evolution. After gene duplication, some new copies accumulated mutations afterward and became functionless. These functionless copies are called:
(A) Pseudogenes
(B) Orthologs
(C) Non-synonymous genes
(D) Retrogenes

____ 11. When deciding which phylogenetic tree is more likely, we calculated the number of character changes necessary for each tree topology and picked the one with the least changes. This is called:
(A) The rule of homology
(B) Oscar's razor
(C) The neighbor-joining rule
(D) The principle of parsimony

____ 12. Currently, most marsupial species are found in Australia and South America. Which of the following could be one of the explanations for this distribution pattern?
(A) Isolation by distance
(B) Hunting pressure from human
(C) Continental drift
(D) Asteroid impact

____ 13. Which of the following descriptions of human evolution is CORRECT?
(A) Neanderthals and Denisovans are different species from anatomically modern humans (*Homo sapiens*), and therefore there was no genetic introgression.
(B) Neanderthals evolved from the local ape species in Europe, which is now extinct.
(C) Among the current human populations, the European and Asian populations have the highest levels of overall genetic variation because they have received genetic introgressions from ancient humans such as Neanderthals.
(D) There are multiple waves of out-of-Africa migration events.

____ 14. Which of the following is CORRECT about "speciation with gene flow"?
(A) This is impossible because different species could not produce fertile hybrids.
(B) The F_{ST} of genes associated with species divergence may be higher than neutral genes.
(C) All genes in the genome will have the same phylogenetic tree.
(D) This happens more often in allopatric speciation, with a vicariance event separating populations.

____ 15. Different from the traditional view that species do not change, the idea of evolution emphasizes species could change due to many forces. Which of the following could be considered the most convincing evidence of evolution, in terms of whether we could truly observe the change of organisms through time?
(A) Fossil records
(B) Artificial selection of animals and plants
(C) The morphological differences among Darwin's finch species
(D) Grouping morphologically similar organisms into the same taxon

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三、問答題 (25%, 可用中文回答) ※ 注意：請於試卷內之「非選擇題作答區」標明題號依序作答。

1. (11%) In a population with ten thousand individuals, imagine a gene with two alleles, *A* and *a*. Individuals with genotype *AA* on average have 20 offspring, those with genotype *Aa* on average have *40* offspring, and those with genotype *aa* in average have 30 offspring.
(1) (3%) What are the relative fitness of these three genotypes?
(2) (4%) Given enough time, would you expect polymorphism to be maintained or eliminated in this gene? Why?
(3) (4%) If this population maintains the size with only 5 individuals through 50 generations, what may happen to this gene? Why?

2. (7%) Please draw a gene tree and explain "incomplete lineage sorting".

3. (7%) Cichlids (慈鯛) in the great lakes of Africa are often cited as good examples of rapid speciation. These lakes are called "great lakes" because they are very large, with some almost as large as Taiwan. A previously published study investigated the historical climate conditions: There were historical periods when the climate was wetter (resulting in larger and deeper lakes) or dry (resulting in smaller and shallower lakes). Combining the data with their estimated speciation rate, they found that speciation happened more rapidly when the climate was wet. Does this support allopatric or sympatric speciation? Please explain.

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