I. Terminology (use 1-2 sentences to define the terminology in biology, 20%)

1. The Red Queen Hypothesis
2. Genetic drift
3. Speciation
4. Synthetic biology
5. Recombination
6. Stem Cell
7. Epigenetics
8. Endosymbiosis
9. Body clocks
10. Homology

II. Multiple Choice (Choose the one alternative that best completes the statement or answers the question, 30%)

1. Which of the following assumptions must be made regarding the mark-recapture estimate of population size?

I) Marked and unmarked individuals have the same probability of being trapped.

II) The marked individuals have thoroughly mixed with the population after being marked.

III) No individuals have entered or left the population by immigration or emigration, and no individuals have been added by birth or eliminated by death during the course of the estimate.

A) I only
B) II only
C) I and II only
D) I, II, and III

2. In terms of community ecology, why are pathogens often more virulent now than in the past?

A) Human activities are transporting pathogens into new habitats (or communities) at an unprecedented rate.
B) More new pathogens have recently evolved.
C) Host organisms have become more susceptible because of weakened immune systems.
D) Medicines for treating pathogenic disease are in short supply.

3. Which of the following is a widely supported explanation for the tendency of tropical communities to have greater species diversity than temperate or polar communities?

A) Tropical communities are low in altitude, whereas temperate and polar communities are high in altitude.
B) More competitive dominant species have evolved in temperate and polar communities.
C) There are fewer parasites to negatively affect the health of tropical communities.
D) Tropical communities have higher sunlight and precipitation, and are generally older than temperate or polar communities.

4. Food chains are sometimes short because _____.

A) only a single species of herbivore feeds on each plant species
B) most of the energy in a trophic level is lost as it passes to the next higher level
C) predator species tend to be less diverse and less abundant than prey species
D) local extinction of a species causes extinction of the other species in its food chain

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5. If two species are close competitors, and one species is experimentally removed from the community, the remaining species would be expected to _____.
A) become the target of specialized parasites
B) expand its realized niche
C) change its fundamental niche
D) decline in abundance

6. Resource partitioning would be most likely to occur between _____.
A) allopatric populations of species with similar ecological niches
B) allopatric populations of the same animal species
C) sympatric populations of a flowering plant and its specialized insect pollinator
D) sympatric populations of species with similar ecological niches

7. In onions (*Allium*), cells of the sporophyte have 16 chromosomes within each nucleus. Match the number of chromosomes present in each of the following onion tissues. How many chromosomes should be in an endosperm nucleus?
A) 8
B) 16
C) 24
D) 32

8. The presence of vascular tissue allowed plants to _____.
A) transport nutrients and water from below-ground tissues to above-ground tissues and grow taller
B) release toxins into the soil that reduced competition with other plants by poisoning nearby plants
C) transport nutrients and water from below-ground tissues and use them to protect developing embryos
D) absorb nutrients from the soil and form a symbiosis with fungi

9. A botanist discovers a new species of plant in a tropical rain forest. Investigation of its anatomy and life cycle shows the following characteristics: flagellated sperm, xylem with tracheids, separate gametophyte, and sporophyte generations with the sporophyte dominant, and no seeds. This plant is probably most closely related to _____.
A) mosses
B) gymnosperms
C) flowering plants
D) ferns

10. Why do moderate levels of disturbance result in an increase in community diversity?
A) Competitively dominant species infrequently exclude less competitive species after a moderate disturbance.
B) Habitats are opened up for less competitive species.
C) Less-competitive species evolve strategies to compete with dominant species.
D) The resulting uniform habitat supports stability, which in turn supports diversity.

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11. Eukaryotic sexual life cycles show tremendous variation. Which of the following characteristics do all sexual life cycles have in common?

i. Alternation of generations
ii. Meiosis
iii. Fertilization
iv. Gametes
v. Spores

A) I, II, and IV
B) II, III, and IV
C) II, IV, and V
D) I, II, III, IV, and V

12. Which of the following processes would result from a mutation that deactivates a regulatory gene of a repressible operon in an *E. coli* cell?

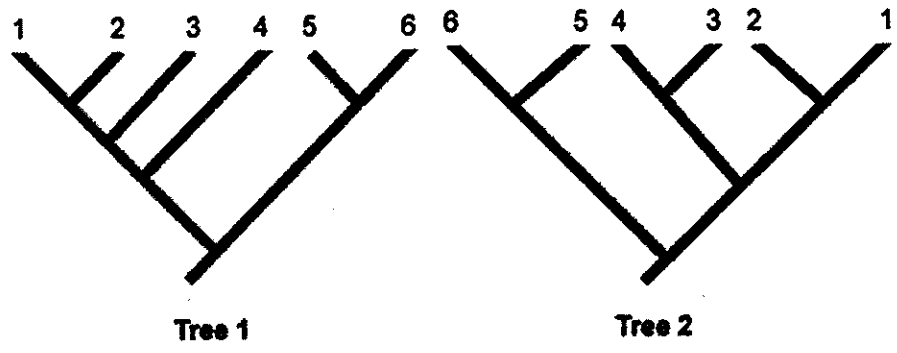
A) continuous transcription of the structural gene controlled by that regulator
B) complete inhibition of transcription of the structural gene controlled by that regulator
C) irreversible binding of the repressor to the operator
D) continuous translation of the mRNA because of alteration of its structure

13. What is metagenomics?

A) genomics as applied to a species that most typifies the average phenotype of its genus
B) the sequencing of one or two representative genes from several species
C) the sequencing of only the most highly conserved genes in a lineage
D) sequencing DNA from a group of species from the same ecosystem

14. In the phylogenetic trees, numbers represent species, and the same species are shown in both trees. Which two species are represented as sister species in Tree 2 but are not shown as sister species in Tree 1?

A) 1 and 2
B) 2 and 3
C) 3 and 4
D) 4 and 5



15. During metamorphosis, a tadpole's tail is reduced in size by the process of _____.

A) regeneration
B) apoptosis
C) oxidative phosphorylation
D) redifferentiation

見背面

Ⅲ. Short Answer (40%)

1. 畫出陸生植物主要類群的演化關係樹圖(5%)。類群的名稱必須以英文寫出(可參考下方列出的名詞)。並且也以英文列出專屬於各類群所特化衍生出來的形態結構特徵(5%)。

(答案可包括下列名詞但也可以自己增加: dominant sporophyte, ovule, seed, monilophytes, bryophytes, dominant gametophyte, lycophytes, ovary, fruit, angiosperm, flower, double fertilization, vascular bundle, stomata, microphyll, cuticle, apical meristem, sporopollenin, algae, megaphyll, bryophyte, gymnosperm, fruits, alternation of generations, charophytes)

2. 三十萬種開花植物的演化顯示，花兩側對稱的類群種數，通常遠比花輻射對稱的類群來的多，請推論可能的原因解釋是什麼(5%)? 又是否我們就可據此推斷花兩側對稱能夠促進種化，提出你的見解?(5%)

3. 離非洲很近的馬達加斯加島，以及離亞洲大陸很近的台灣，不僅物種數目多，特有種比例也高。試根據島嶼生物學理論及氣候地理位置等特性，解釋上述現象的成因(6%)。又馬達加斯加，及鄰近台灣的菲律賓群島，其特有種比例均高於台灣甚多，判斷這兩類島嶼為什麼比台灣有更高的特有種比例(4%)?

4. Fragments of DNA have been extracted from the remnants of extinct woolly mammoths, amplified, and sequenced. How can these fragments of DNA now be used? (5%)

5. What is the difference between adaptation, and acclimation? (5%)

IV Assay Question (10%)

Read the following abstract and write an paragraph about "the origins of evolutionary novelty"

"Understanding how novel complex traits originate is a foundational challenge in evolutionary biology. We investigated the origin of prothoracic horns in scarabaeine beetles, one of the most pronounced examples of secondary sexual traits in the animal kingdom. We show that prothoracic horns derive from bilateral source tissues; that diverse wing genes are functionally required for instructing this process; and that, in the absence of *Hox* input, prothoracic horn primordia transform to contribute to ectopic wings. Once induced, however, the transcriptional profile of prothoracic horns diverges markedly from that of wings and other wing serial homologs. Our results substantiate the serial homology between prothoracic horns and insects wings and suggest that other insect innovations may derive similarly from wing serial homologs and the concomitant establishment of structure-specific transcriptional landscapes." (Hu et al. 2019, Science)

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(your answer might include the definition of evolutionary novelty, how *Hox* genes specify body plan in arthropods or insects, change in gene expression leading to new function etc.)

試題隨卷繳回