

※ 注意：全部題目均請作答於試卷內之「非選擇題作答區」，請標明題號依序作答。可用中文或英文作答。

一、選擇題 ((A)-(J)，每題 3 分，共 30 分)

*Interspecific interaction*

(A) is defined as a range of environmental conditions and growth limiting (B) with which a species can maintain its population. When the (A) is overlapped between two species, the interaction called "(C)" occurs. Furthermore, in theory, if the (A) is completely identical between two species, they cannot coexist and (D) happens. In natural environments, the (E) is often observed, which can prevent the (D). Another type of interspecific interaction is, for example, (F) with which two species affect positively each other.

Choose the appropriate terms for (A)-(F) from the following candidates.

[1] competitive exclusion, [2] mutualism, [3] excessive competition, [4] ecological position, [5] ecological niche, [6] interspecific competition, [7] competitive replacement, [8] character displacement, [9] overexploitation, [10] trait convergence, [11] predators, [12] growth limitation, [13] resources, [14] commensalism, [15] intraguild competition, [16] spaces

*Population Growth Model*

Thomas Robert Malthus is the British economist who proposed the exponential growth of human population. Let  $b$  and  $m$  denote the per capita birth rate and the per capita mortality, respectively. Assuming no migration and time lags, temporal changes in the population size  $N$  can be described as the following differential equation:

$$dN/dt = ( \text{(G)} ) N$$

When the population size at  $t = 0$  is  $N_0 (> 0)$ , the population size increases exponentially with time under the condition (H). In reality, the population growth rate often decreases with increasing population size. Therefore, when the per capita growth rate is not constant as ((G)) but decreases linearly with population size  $N$ , the population growth can be described by the following equation named '(I)'.

$$dN/dt = ( \text{(J)} ) N$$

where  $W (> 0)$  is the intrinsic growth rate and  $M (> 0)$  is called the carrying capacity.

Choose the appropriate terms or formula for (G)-(J) from the following candidates.

For (G) and (H): [1]  $bm$ , [2]  $b - m$ , [3]  $b - mN$ , [4]  $b/m$ , [5]  $b - m > 0$ , [6]  $b/m > 0$ , [7]  $bm > 1$ , [8]  $b > 0$ , [9]  $b - mN > 0$ , [10]  $b - m > 1$

For (I): [1] Malthusian growth model, [2] Volterra growth model, [3] logistic growth model, [4] finite growth model, [5] Kimura limiting growth model, [6] linear growth model

For (J): [1]  $W(1 - N/M)$ , [2]  $MN(1 - W)$ , [3]  $WN/(1 + MN)$ , [4]  $M(1 - N/W)$ , [5]  $M(1 + N/W)$

二、解釋名詞 (每題 5 分，共 20 分)

- Indeterminate growth
- RNA: DNA ratio
- Trait-mediated indirect interaction
- Hutchinson's paradox of the phytoplankton

見背面

三、簡答及計算題

1. (10 分) Describe compensatory density-dependence vs. depensatory density-dependence. Which density-dependent process above is the basis for logistic population growth?

2a. (8 分) Based on the trophic cascade hypothesis, draw arrows to describe changes in abundance for different trophic levels following fisheries' removal of top predators. (答案請填寫於試卷內，勿於試題上作答)



2b. (2 分) Suppose you are in charge of mitigating eutrophication of a local pond. Based on your answer for 2a and suggest a bio-control treatment to do this job.

3. (10 分) Describe two mechanisms with which population size fluctuates periodically or quasi-periodically.

4. (10 分) Describe two major processes of fixation of a new mutation in a small population.

5. (10 分) Natural selection: Consider an idealized diploid population with infinite size. If the fitness of the three genotypes  $AA$ ,  $Aa$ , and  $aa$  are 0.6, 0.9, and 1.2, and  $q(0) = 0.7$ , calculate  $q(1)$  for one generation of natural selection under random mating (where  $q(t)$  is the allele frequency of  $a$  in generation  $t$ ).

試題隨卷繳回