

1. Consider a hypothetical insect species. Eggs are laid into water and hatch after one week. The probability that an egg successfully hatches is 0.4. Nymphs develop in the water and become adults after one week. The probability that a nymph successfully becomes an adult is 0.5. Adults fly and live outside the water. Adults can live at most two weeks and lay eggs once a week. The probability that an adult survives the first week is 0.6. An average adult female produces 3 female offspring in the first week and 1 female offspring in the second week.

- a. Complete the life table based on the information provided above (i.e., answer the numbers for A to L in the table).  $S_x$  = proportion of individuals of age  $x$  that survive to age  $x+1$ .  $l_x$  = proportion of individuals that survive from birth (age 0) to age  $x$ .  $b_x$  = average number of female offspring born to a female while she is of age  $x$ . (3 %)

Age (in weeks), $x$	Stage	Fecundity, $b_x$	Survival rate, $S_x$	Survivorship, $l_x$
0	Egg	A	E	I
1	Nymph	B	F	J
2	Adult	C	G	K
3	Adult	D	H	L

- b. Net reproductive rate ( $R_0$ ) is the mean number of female offspring produced by a female over her life time. It is calculated as  $R_0 = \sum l_x b_x$ . What is the net reproductive rate of the species? Is the population size increasing or decreasing? Show all your calculations and explain your answer in English. (6 %)
- c. You are working for a conservation agency and want to increase the population growth rate of the species. Because of the budget limitation, you have to select one of the following two options. The first option protects the aquatic habitat and increases the survival probability of each aquatic stage by 0.1 (i.e.,  $S_0$  and  $S_1$  increase by 0.1). The second option protects the terrestrial habitat and increases the survival probability of adults (i.e.,  $S_2$ ) by 0.3 (i.e., still no adults can live more than two weeks). Which option do you take? Show all your calculations and explain your answer in English. (10 %)

見背面

2. The dynamics of a predator and its prey ( $N$  is the prey density and  $P$  is the predator density) can be described using the following equations:

$$\frac{dN}{dt} = rN \left(1 - \frac{N}{K}\right) - aNP$$

$$\frac{dP}{dt} = baNP - mP$$

where  $r$  is the intrinsic rate of increase of the prey,  $K$  is the carrying capacity of the environment,  $a$  is the attack rate of the predator,  $b$  is the conversion efficiency of the predator, and  $m$  is the mortality rate of the predator.

- a. Draw the phase-plane diagram. Completely label the diagram and indicate the coexistence equilibrium. (10 %)
  - b. If the carrying capacity increases, what will happen to the coexistence equilibrium? Answer in English using the phase-plane diagram. (6 %)
3. What is the cell cycle? Please list the various stages of the cell cycle and function? (8 %)
  4. What is the cell theory and endosymbiont theory? (8 %)
  5. Where are plasmodesmata found? What cellular constituents are found in plasmodesmata? (7 %)
  6. Please explain the differences between C3, C4 and CAM plants. (7 %)
7. 請寫出下列常見之分子生物學專有名詞之英文全名：(5%)  
(1) DNA; (2) mRNA; (3) cDNA; (4) PCR; (5) RNAi
  8. 請回答下列有關基因選殖和 DNA 定序的基本問題：(14%)
    - (1) 請寫出“限制酶”的英文全名，並且說明這類酵素為何被命名為“限制酶”(意即：“限制酶”的意涵為何)? (3%)
    - (2) 請簡述為何一個“cloning vector”要含有“antibiotics resistance gene”? (3%)
    - (3) 請寫出以 DNA 合成原理發明 DNA 定序方法的科學家的英文名字(至少寫出其姓氏)，並且以簡圖畫出、指出 dNTP 與 ddNTP 在結構上之差異。(4%)

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(4) 以下的卡通圖為某一次之 DNA 定序結果。請寫出這段 DNA 之序列 (注意：須寫出哪一端是 5'、哪一端是 3'，而且須由 5' 寫至 3')。(4%)



9. 請回答下列有關 Transcription、Splicing 和 Translation 的基本問題：(13%)

- (1) 請寫出在真核生物的細胞當中，Transcription 和 Translation 分別在哪裡進行？(2%)
- (2) 在原核生物中，合成 mRNA、rRNA、tRNA 的酵素是否為同一個？或是分別個有一個？請寫出酵素(們)的英文全名。(3%)
- (3) RNA splicing 在細胞中的哪個胞器進行？splicing 要剔除 mRNA 的 intron 或 exon 序列？構成 splicing factors 的分子主體為 protein 或是 RNA？(3%)
- (4) 構成 ribosome 的分子主體為 protein 或是 RNA？不論你的答案為 protein 或是 RNA，都請簡述“small subunit of ribosome”和“large subunit of ribosome”的主要功能。(5%)

10. 請簡述為何真核生物比原核生物合成 DNA 的速度慢了許多？(3%)

試題隨卷繳回