Country:	Student Code: _____

19th INTERNATIONAL BIOLOGY OLYMPIAD

13th – 20th July, 2008

Mumbai, INDIA

THEORETICAL TEST – PART A

理論題 - 第 A 部分

Write all answers in the **ANSWER SHEET**.

所有的答案都必須回答於答案卷上

Dear Participants 親愛的參賽者

- You have a total of 120 minutes for answering Part A.
  你有 120 分鐘作答。
- The questions in Part A have **only one** correct answer. Mark the correct answer with 'X' on the **Answer Sheet**, which is provided separately. The correct way of marking the cross is shown below. Use a dark pencil to mark your answers.
  本試題全部爲**單選**。**答題時在正確的空格內以深色鉛筆畫 'X'** 。可參考下圖範例。

Q. NO.	**a**	**b**	**c**	**d**	**e**
20		X			

- The answers written in the Question Paper will not be evaluated.
  作答於題目紙上不計分。
- Mark your answers clearly. Avoid any corrections in the Answer Sheet.
  作答應清楚，並避免汙染非答案區。

- NOTE: Some of the questions may be marked “Skipped” / “Deleted”. DO NOT attempt these questions. Also, read the question completely before attempting it as some questions may continue from one page to the next.
  注意：如有遇到跳過或刪除的題目，請勿作答。題目可能跨頁，請詳細讀完。
- The maximum number of points is **61.**
  總題數為 61。
- Your Answer Sheets will be collected at the end of the examination.
  答案卷在考完後將會被收回。

Good Luck!! **祝好運**

Country: _____

First name: _____

Middle name: _____

Family name: _____

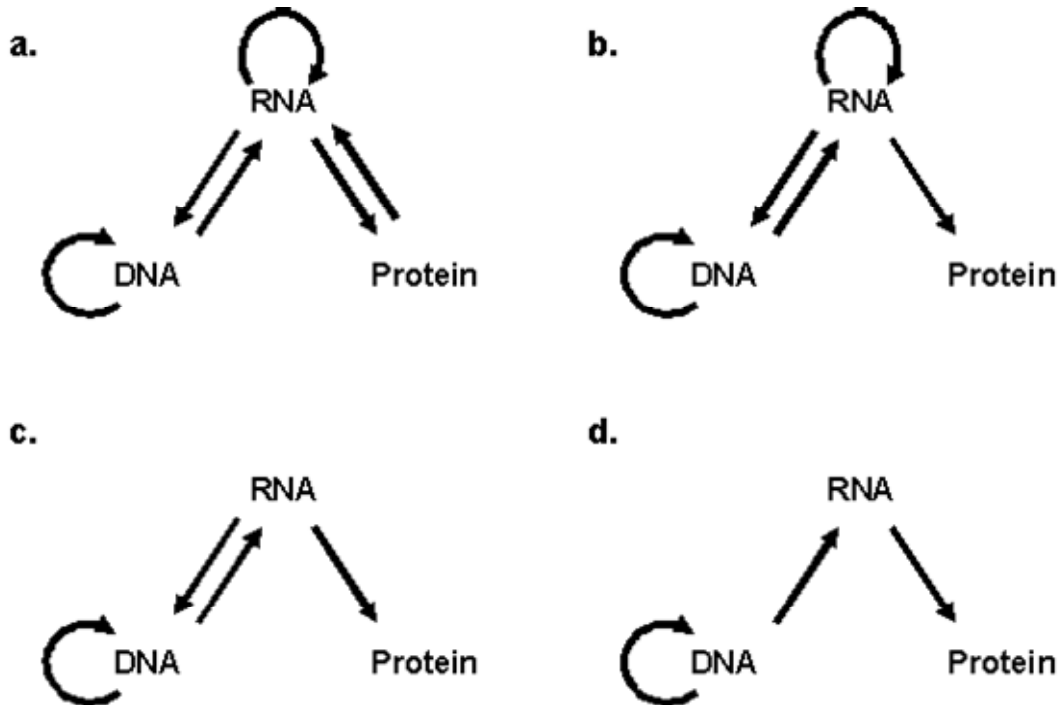
Student Code: _____

PART A

CELL BIOLOGY (13 points) 細胞學 (13 分)

1. (1 point) The central dogma originally proposed by Francis Crick has seen changes reflecting new insights obtained from time to time. Which one of the following schematics correctly depicts our current understanding of the replication of genetic material and the “flow of information” in biological systems?

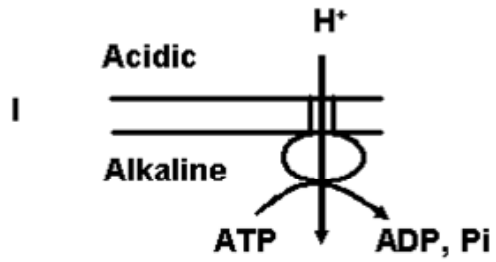
   (1 分) 中心教條 (central dogma) 最早由 Francis Crick 提出，下者何者能<u>正確</u>的代表現今遺傳物質的複製與訊息傳達？

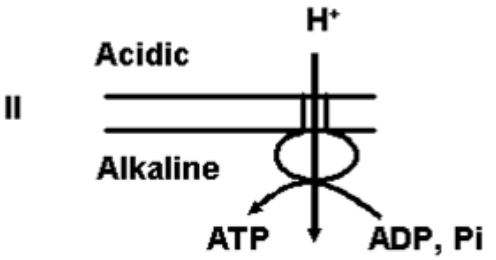


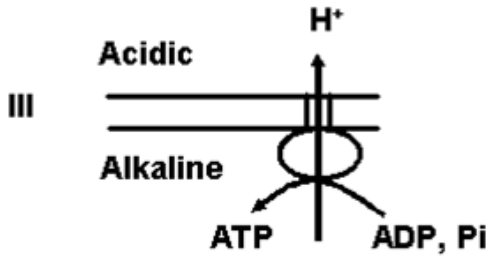
2. (1 point) In an experiment, mice were injected intravenously with uniformly labeled [^{14}C] – glucose. The molecules in the body where the ^{14}C would be found are:
   (1 分) 實驗中，小鼠自靜脈內注射含有 ^{14}C 標定的葡萄糖。請問 ^{14}C 會在下列何種分子中被發現：

a. essential amino acids and proteins.
   必需胺基酸與蛋白質
b. lipids and all vitamins.
   脂質與維他命
c. proteins and lipids.
   蛋白質與脂質
d. proteins and all vitamins.
   蛋白質與維他命

3. (1 point) The following schematics depict the orientation of F_1F_O-ATPase along with the direction of H^+-transport and ATP synthesis/hydrolysis.
(1 分) 下圖中所表示的是有關 F_1F_O-ATPase 中 H^+ 運輸方向與 ATP 合成 / 水解，請問下列何者<u>正確</u>：







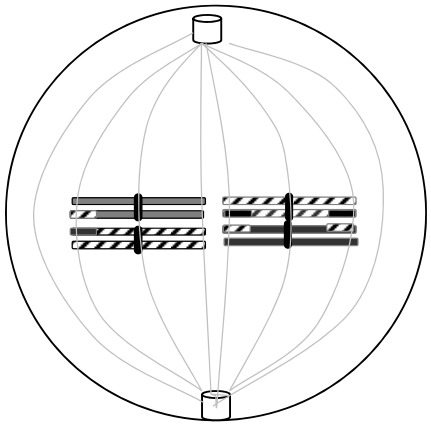
Of the above schematics,

a. Only I is correct. 只有 I 正確
b. Only II is correct. 只有 II 正確
c. Only III is correct. 只有 III 正確
d. Both I and III are correct. I 與 III 是正確

4. (1 point) A given DNA sample has 60% purines. The source of this DNA is most likely to be:
   (1 分) 在一種未知的 DNA 樣本中含有 60% 的嘌呤，此 DNA 可能源自於下列何種生物：

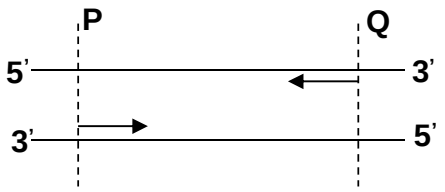
a. a eukaryotic cell.
   真核生物
b. a bacterial cell.
   細菌
c. a bacteriophage with double-stranded DNA.
   雙股 DNA 噬菌體
d. a bacteriophage with single-stranded DNA.
   單股 DNA 噬菌體

5. (1 point) The stage of cell division shown in the figure below represents:
   (1 分) 此圖爲細胞分裂的那一時期及染色體套數爲何：



a. Meiotic metaphase I with n = 4
   減數分裂中期 I，n = 4
b. Meiotic metaphase II with n = 4
   減數分裂中期 II，n = 4
c. Meiotic metaphase II with n = 8
   減數分裂中期 II，n = 8
d. Meiotic metaphase I with n = 2
   減數分裂中期 I，n = 2

6. (1 point) Polymerase Chain Reaction (PCR) is a technique for rapid amplification of DNA segments. If you are given double-stranded DNA with appropriate forward and reverse primers as shown in the figure below, the minimum number of cycles you will require to obtain at least one copy of the desired fragment PQ, as dsDNA without overhangs, will be:
(1 分) PCR 是一種能快速倍增 DNA 片段的技術。實驗中添加雙股 DNA 與適當的正、反向引子 (如下圖)， 在沒有添加過量 dsDNA 情況下，至少要有多少的 PCR 週期數才可獲得一個全新的 PQ 片段 ：



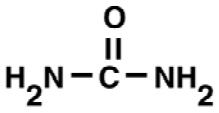
a. 1
b. 3
c. 4
d. 40

7. (1 point) Which of the primer pairs is the correct one to amplify the gene sequence below with PCR?
   (1 分) 以 PCR 實驗擴增下列序列時，下列引子組何者正確？

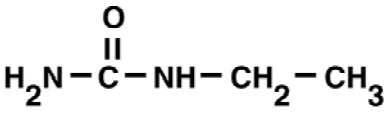
   5’-GCGTTGACGGTATCAAAACGTTAT… …TTTACCTGGTGGGCTGTTCTAATC-3’

a. 5’-GCGTTGACGGTATCA-3’ and 5’-TGGGCTGTTCTAATC-3’
b. 5’-CGCAACTGCCATAGT-3’ and 5’-TGGGCTGTTCTAATC-3’
c. 5’-GCGTTGACGGTATCA-3’ and 5’-GATTAGAACAGCCCA-3’
d. 5’-TGATACCGTCAACGC-3’ and 5’-GATTAGAACAGCCCA-3’

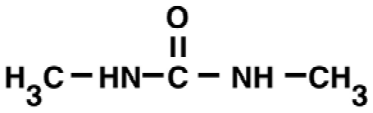
8. (1 point) Equimolar concentrations of urea, ethyl urea, and dimethyl urea were separately added to a suspension of red blood cells (RBC). The relative rates of diffusion of these molecules into RBCs will be:
(1 分)將等莫耳濃度的尿素 (1. Urea)，乙基尿素 (2. Ethyl urea) 與雙甲基尿素 (3. Dimethyl urea) 分別加入紅血球懸浮液中。上述不同分子進入紅血球的擴散速率比較，何者<u>正確</u>：



1. Urea



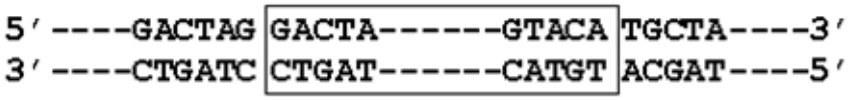
2. Ethyl urea



3. Dimethyl urea

a. 1 > 2 > 3
b. 1 > 2 = 3
c. 3 > 2 > 1
d. 3 = 2 > 1

9. (1 point) A region of a double-stranded DNA is represented in the following schematic and the hyphens denote sequences of unspecified lengths:
(1 分) 有一雙股 DNA 片段如下圖所示，



The region of DNA enclosed within the box undergoes inversion. Which one of the following correctly depicts the above DNA after inversion?
框中爲進行倒位 (inversion) 的區域，請問下列何者爲<u>正確</u>的倒位結果？

a.
5′----GACTAG ACATG------ATCAG TGCTA----3′
3′----CTGATC TGTAC------TAGTC ACGAT----5′

b.
5′----GACTAG ATCAG------ACATG TGCTA----3′
3′----CTGATC TAGTC------TGTAC ACGAT----5′

c.
5′----GACTAG TGTAC------TAGTC TGCTA----3′
3′----CTGATC ACATG------ATCAG ACGAT----5′

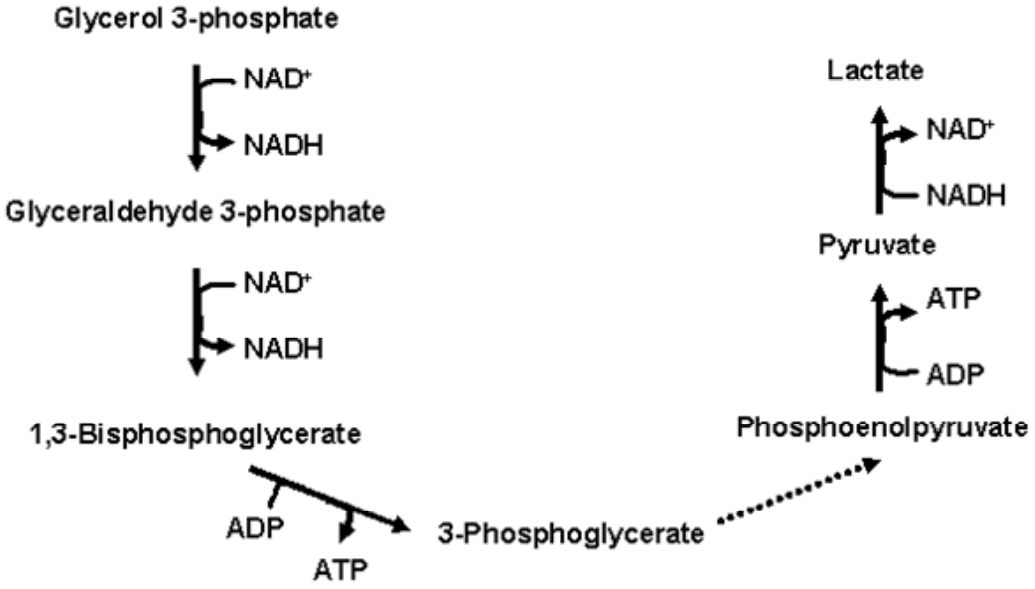
d.
5′----GACTAG CTGAT------CATGT TGCTA----3′
3′----CTGATC GACTA------GTACA ACGAT----5′

10. (1 point) A rare genetic disease is characterized by immuno-deficiency, developmental and growth delay, and microcephaly. Suppose you extract DNA from a patient with this syndrome and find almost equal quantities of long and very short DNA strands, which enzyme is likely to be defective in this patient?

    (1 分) 有一種罕見的遺傳疾病，臨床表現爲免疫發育缺損與生長遲緩。自病人身上所分離出的 DNA，出現等量的長片段與非常短的 DNA 片段。請問病人最可能缺乏下列何種酵素？

a. DNA ligase
   DNA 接合酶
b. Topoisomerase
   同型異構酶
c. DNA polymerase
   DNA 聚合酶
d. Helicase
   解旋酶

11. (1 point) A scientist has suggested that a homolactic fermenting organism grows anaerobically on glycerol 3-phosphate as the sole source of carbon, exclusively using the following pathway:
(1 分) 科學家發現一種均乳糖發酵生物，在無氧條件生長下 glycerol-3-phosphate (G3P) 是唯一的碳源，而且會利用下圖專屬的代謝路徑。



However, the scientific community rejected this suggestion because:
該科學家的理論被委員會駁回，下列何者爲<u>正確</u>的理由：

a. the number of ATP molecules produced is insufficient to support growth.
ATP 產生數目不敷生長所需

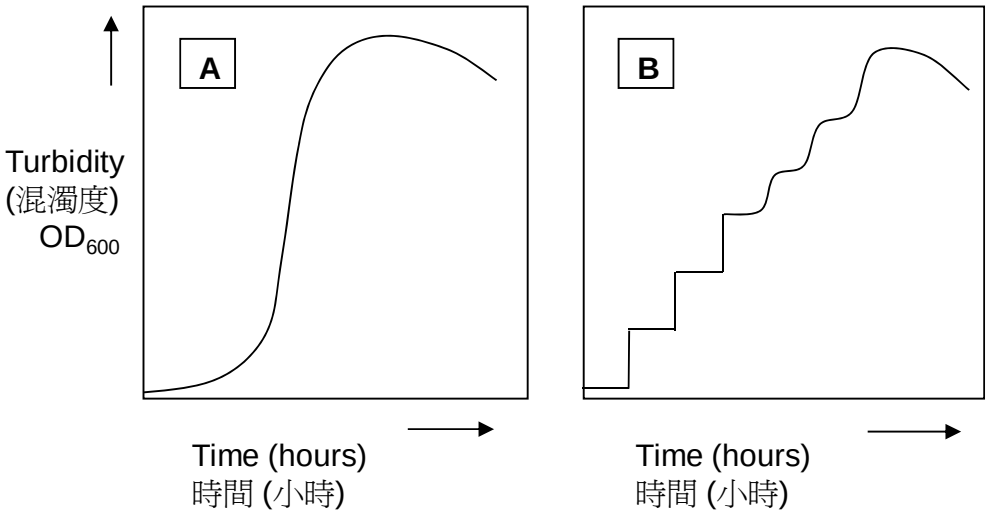
b. the number of NAD^+ that are reduced is not same as the number of NADH that are oxidized in the pathway.
代謝路徑中 NAD^+ 的還原數不等於 NADH 的氧化數

c. the carbon source is not as reduced as glucose and hence, cannot support growth.
碳源無法還原成葡萄糖，因此不能提供生長

d. the number of negative charges on lactic acid (which is being produced) is not the same as that on glycerol 3-phosphate (which is being consumed).
生成出帶負電荷的乳酸與消耗的 P3G 不等量

12. (1 point) The growth curve of a bacterial culture grown in a rich medium at 37°C is shown in Figure A. The same organism when exposed to 45°C for 30 min and then inoculated into a rich medium at 37°C, exhibited a growth curve shown in Figure B.

(1 分) 圖 A 爲細菌在 37°C 下的正常生長曲線。圖 B 爲該細菌被移到 45°C 培養 30 分鐘後，再移回 37°C 下的生長曲線。

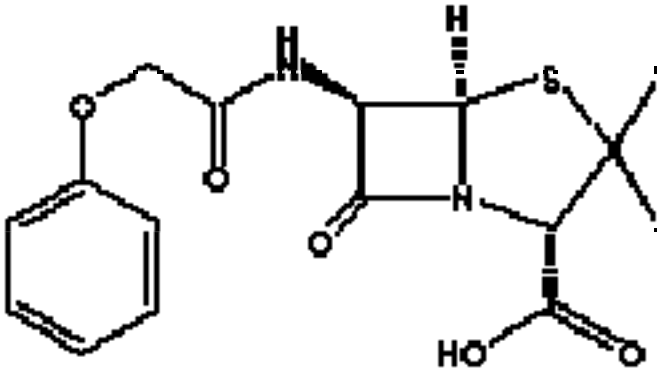


Which of the following statements is most likely to explain the growth pattern in Figure B?

下列何者爲對圖 B 的合理解釋？

a. Heat kills the original bacterial population and the growth pattern observed is due to a contaminating bacterial strain.
   熱會殺死原來的細菌，長出來的爲雜菌
b. Heat causes growth arrest at a particular stage, thereby synchronizing cells and resulting in all cells dividing at the same time.
   熱會使生長停滯於特別的階段，因此細菌會有同步化的現象，因而導致細胞會在同時間分裂。
c. Heat exposure alters surface properties of cells causing errors in turbidity measurements
   熱會改變細菌表面，因而影響濁度測量。.
d. The increase in turbidity is not due to growth but caused by increasing lysis of heat-treated cells with time.
   濁度的上升不是因爲細菌的生長，而是因熱殺死細菌後，溶菌結果造成。

13. (1 point) Absorption of a drug in the gastro-intestinal tract depends on a number of factors. Penicillin V, whose structure is shown below, is a weak acid (pKa = 2.7). The pH in stomach is about 2.0 and that in the intestine is 7.5. Most of the drug is absorbed in the intestine.
(1 分) 有許多的因子會影響藥物在胃腸道內的吸收。下圖爲盤尼西林 V 的結構式，該分子具弱酸的特性 (pKa = 2.7)，胃的 pH 值爲 2.0，腸道爲 7.5。藥物大部分會在腸道被吸收。



Choose the most likely reason for this from the following statements:
選出一正確的答案
：

a. The molecule of drug being hydrophobic in nature passes through gastric and intestinal membranes to a very small extent. However, because of the much greater surface area in the intestine, the major quantity of the drug is absorbed here.
藥物是疏水性的，由於腸道表面積較大，因此藥物在腸道被吸收。

b. The un-ionized form of the drug prevails in stomach, which slows down its absorption. Hence, the drug gets preferentially absorbed in the intestine.
藥物在胃內主要爲非離子化形式，吸收效果被降低。因此藥物在腸道優先被吸收。

c. The ionized form of the drug prevails in the intestine which hinders/slows down its absorption. However, owing to the large surface area available in the intestine, the drug is absorbed mainly here.
大部分的藥物會在腸道爲離子化形式，因此會阻撓或減緩吸收。但是由於腸道的面積大增，所以藥物主要能在腸道被吸收。

d. Due to rapid churning movement and the low pH in the stomach, the drug is completely broken down into smaller fragments, which are subsequently absorbed in the intestine.
由於胃內是酸性環境，藥物在此會被分解成小片段，而能在腸道被吸收。

PLANT SCIENCES (9 points)　植物部分

14. (1 point) Which of the following will harm a dicotyledonous plant the most?
下列何種處理對雙子葉植物傷害最多？

a. Removal of the central pith 移除中央的髓

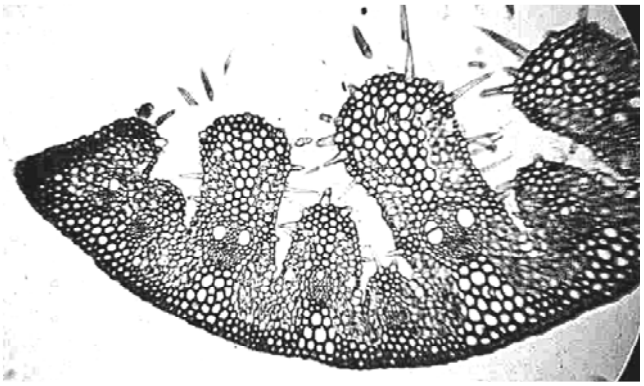
b. Removal of the cork 移除木栓層

c. Removal of the bark 移除皮樹

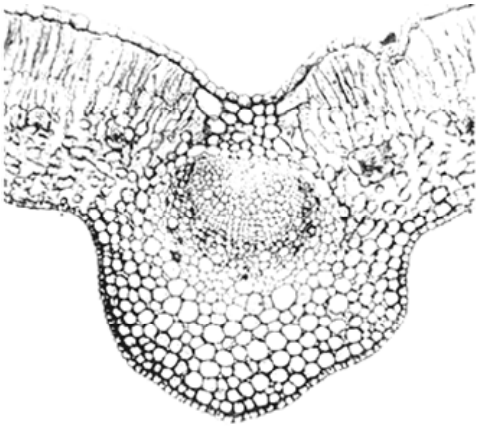
d. Removal of the cork cambium 移除木栓形成層

15. (1 point) The transverse sections of the leaves A and B given below represent, respectively: 下列分別爲植物 A 與 B 的葉片橫切面，試判此二植物分別爲何？

A



B



a. a xerophyte and a mesophyte. 旱生與中生植物
b. a xerophyte and a floating hydrophyte. 旱生與浮水性水生植物
c. a floating hydrophyte and a submerged hydrophyte. 浮水性與沉水性水生植物
d. a submerged hydrophyte and a xerophyte. 沉水性水生與旱生植物

16. (1 point) Certain plant species such as Red Oak (*Quercus rubra*) can tolerate severe drought over a long period of time without affecting its photosynthesis. Which of the following adaptations is likely to contribute to this ability?
有些植物如紅橡樹(*Quercus rubra*)可長期耐受嚴重乾旱而不影響其光合作用，下列何者可能是其所具有之適應特性？

a. Stomatal closure
氣孔關閉
b. Large negative leaf water potential
葉中的水勢負值較大
c. Bundle sheath cells with chloroplasts (Kranz leaf anatomy)
葉鞘細胞具葉綠體（C4的葉解剖）
d. Fibrous root system that increases root surface area
具鬚根系以增加根吸收面積

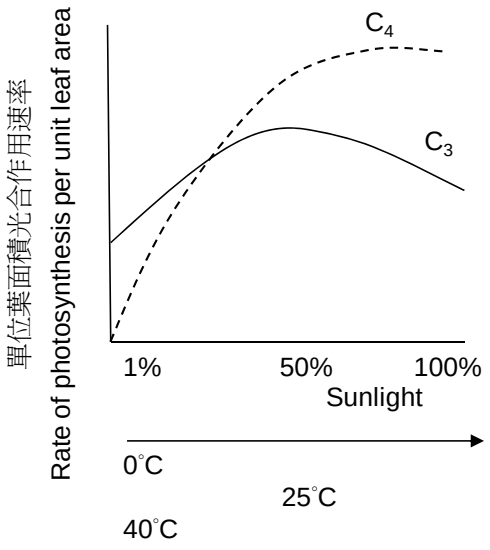
17. (1 point) The net assimilation of CO_2 of a plant is 0.5 moles when illuminated during the day. The net consumption of O_2 is 0.12 moles during the night. Assuming that all the gas exchange is due to photosynthesis and respiration of the biomass (equivalent molecular mass of 30), what is the net production or consumption of biomass in grams during a complete 12 h day:12 h night diurnal cycle?

在白天光照下，某植物的 CO_2 淨吸收量爲 0.5 莫耳；在夜晚，O_2 淨消耗量爲 0.12 莫耳。假設所有的氣體交換皆用於光合作用與呼吸作用之需（相當於分子量 30 之生物量）。試計算一天光週期爲白晝 12 小時、夜晚 12 小時之情況下，生物量的淨生產量或消耗量爲多少克？

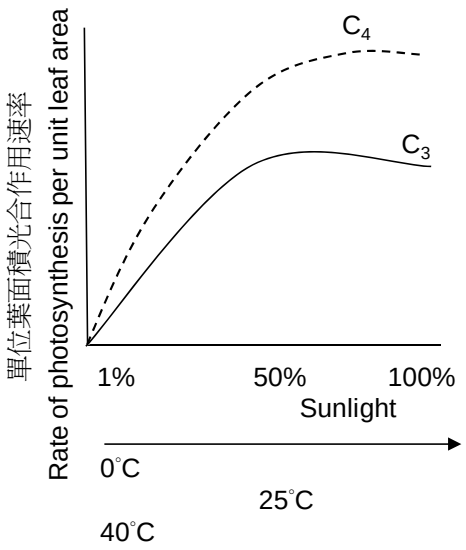
a. 3.6 g
b. 7.8 g
c. 11.4 g
d. 15.0 g

18. (1 point) Choose the figure that correctly represents the photosynthetic efficiencies of C_3 and C_4 plants. 下列何者可正確地代表 C_3 與 C_4 植物的光合作用效率圖？

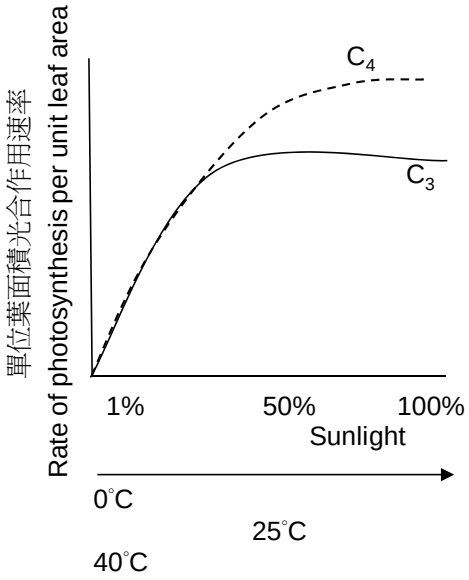
a.



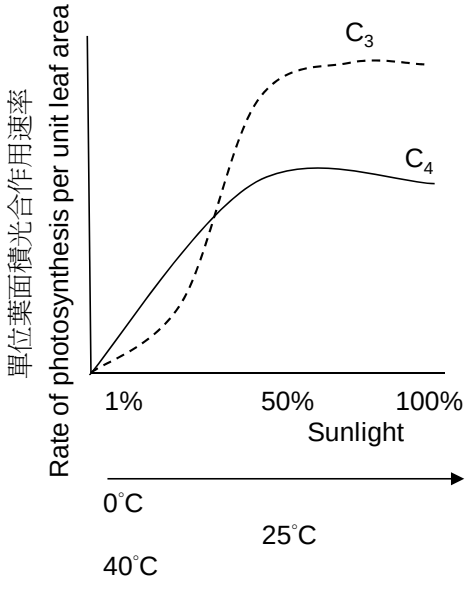
b.



c.



d.



19. (1 point) Plant chloroplasts are believed to have evolved from cyanobacteria-like progenitors through endosymbiosis. Which of the following statements support this hypothesis? 學者認爲植物的葉綠體可能是像藍綠菌的祖先經由內共生的過程演化而來。下列哪些敘述支持此假說？

I. Chloroplasts and cyanobacteria share similar photosynthetic pigments and thylakoid membranes.
葉綠體與藍綠菌具有相似的光合作用色素及囊狀膜

II. Cyanobacteria exhibit an oxygenic photosynthesis.
藍綠菌進行產氧性光合作用

III. Chloroplasts are maternally inherited.
葉綠體是傳自母系

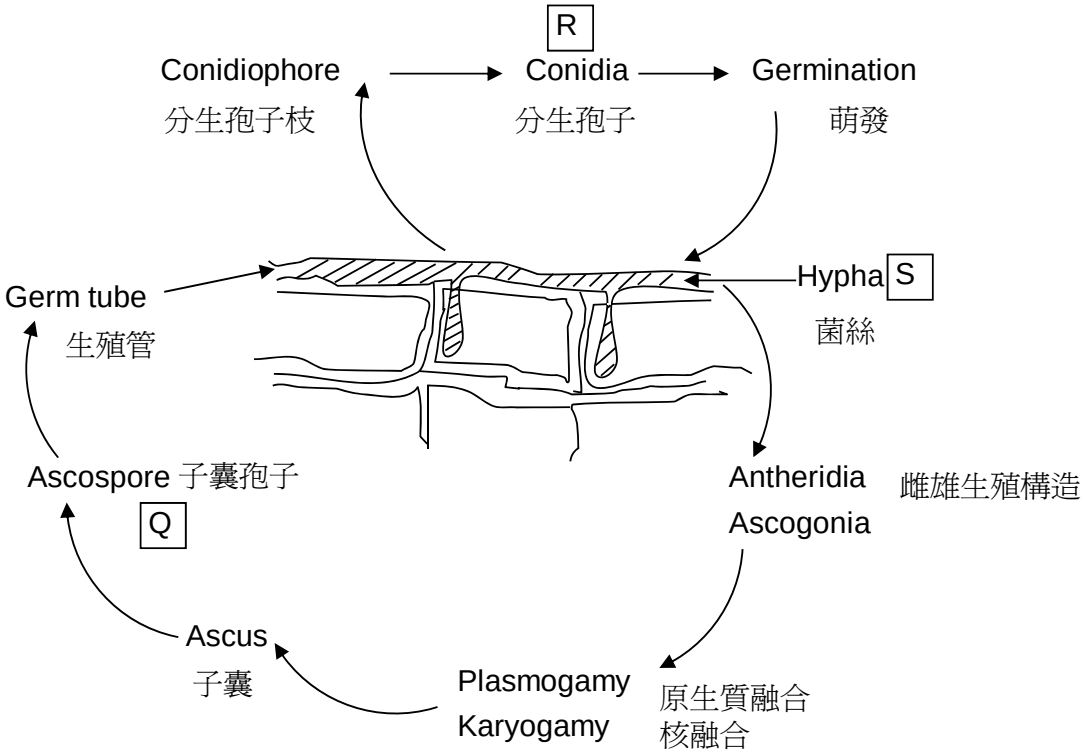
IV. Chloroplasts have their own DNA and ribosomes.
葉綠體有其本身的DNA及核糖體

V. Viable chloroplasts can be isolated from cells but cannot be cultured in vitro.
具活性的葉綠體可被分離出來，但不能在試管中培養

VI. Prokaryotic genes express well in chloroplasts.
葉綠體中的原核基因可正常表現

a. I, III, IV and V
b. I, II, IV and VI
c. I, II, III and V
d. II, IV, V and VI

20. (1 point) Powdery mildew is a plant disease caused by an ectoparasitic fungus. The fungal infection can spread to neighboring host cells in the following ways: 植物的粉銹病是因一種外寄生性的真菌，下圖表示出真菌在寄主細胞間傳染的過程：



The ploidy levels of the structures Q, R and S are, respectively:
圖中的 Q, R 及 S 構造之染色體套數分別爲？

a. 2n, n, n
b. n, n, n
c. 2n, n, 2n
d. n, n, 2n

21. (1 point) A few characteristics of photoautotrophs are tabulated below.

下表爲一些光合作用自營性生物的特徵，

Group	Light compensation point (klux units) 光補償點	Light saturation point (klux units) 光飽和點	CO_2 compensation point (ppm) CO_2 補償點
I	1 – 3	> 80	0
II	1 – 2	50 – 80	> 40
III	0.2 – 0.5	5 – 10	> 40
IV	Data not available 無數據	1 – 2	Data not available 無數據

The four groups (I –IV) represent, respectively:

下列組別與植物種類的配對，何者正確？

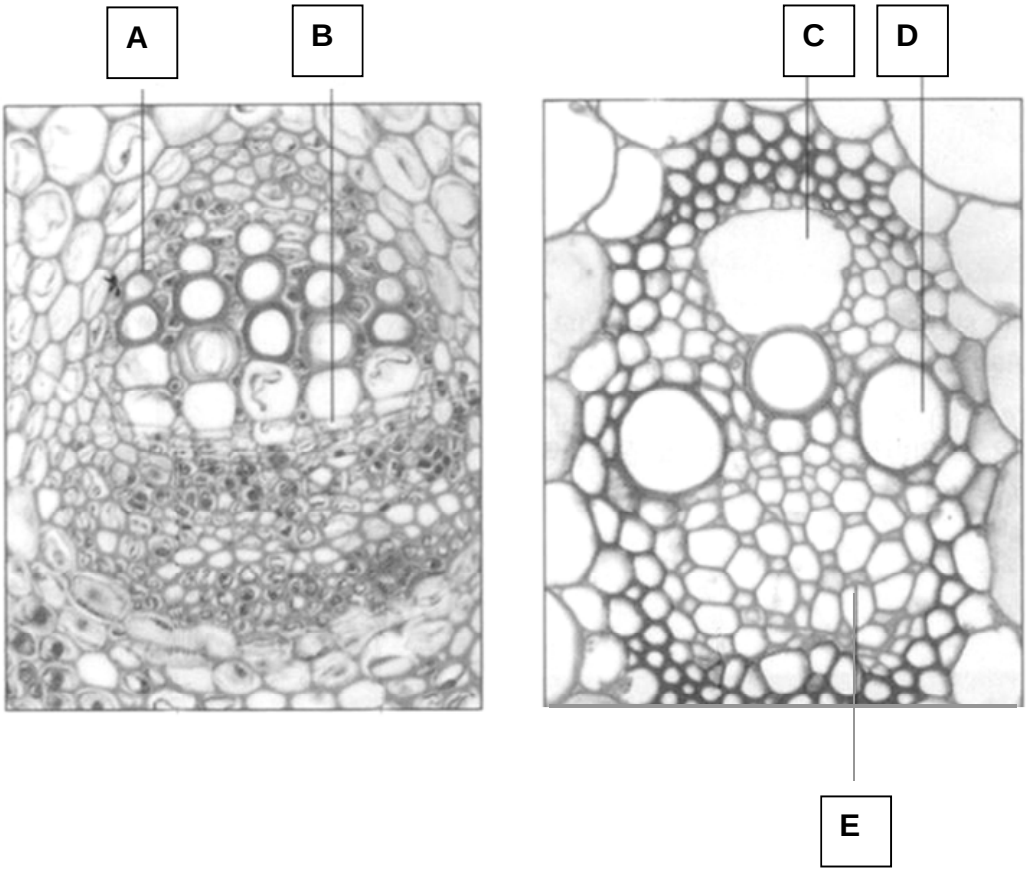
a. I: C_4 plants C_4植物 II: Sun-loving C_3 plants 陽性 C_3植物 III: Shade-loving C_3 plants 陰性 C_3植物 IV: Deep-sea algae 深海藻類

b. I: Sun-loving C_3 plants 陽性 C_3植物 II: Shade-loving C_3 plants 陰性 C_3植物 I: C_3 plants C_3植物 IV: Bryophytes 蘚苔類

c. I: C_4 plants C_4植物 II: Bryophytes 蘚苔類 III: Sun-loving C_3 plants 陽性 C_3植物 IV: Shade-loving C_3 plants 陰性 C_3植物

d. I: C_4 plants C_4植物 II: Sun-loving C_3 plants 陽性 C_3植物 III: Deep-sea algae 深海藻類 IV: Bryophytes 蘚苔類

22. (1 point) The stem of a lily plant was placed in water tinted with red ink to monitor the movement of water through it. Two transverse sections of stems are given below. In which of the labeled structures would you expect the red color? 百合植物的莖插在加入紅墨水的水中，以觀察水在莖中的移動情形，下圖爲兩種不同的莖橫切片，圖中所指的哪個構造才是真正會呈現紅色的部分？



a. A
b. B
c. C
d. D
e. E

ANIMAL SCIENCES (11 points) 動物學 (11 分)

23. (1 point) A few intact skeletons of birds were found during a field trip to the Pampas in Argentina. In all the skeletons examined, the sternum lacked a keel bone. These skeletons most likely belonged to:
於阿根廷大草原做田野研究時，發現幾個完整的鳥類骨骼，在檢查所有骨骼後，胸骨中缺少龍骨突起，這些應爲下列何者的骨骼？

a. terrestrial birds capable of short and powerful flight.
能作短程有力飛翔的陸生鳥類
b. flightless aquatic birds.
不會飛的水生鳥類
c. insectivorous flying birds.
吃蟲的的會飛鳥類
d. flightless terrestrial birds.
不會飛的陸生鳥類

24. (1 point) Which one of the following is a feature of a heterothermic endotherm?
下列何者是異溫型內溫動物的特徵？

a. Its body temperature can vary, but it produces heat from its own tissues.
體溫會變化，但由自身的組織產生熱量
b. Its body temperature varies because it gains most of the heat from sources outside its body.
體溫會變化，主要因爲由體外的來源得到熱量
c. Its body temperature does not vary because it produces heat from its own tissues.
體溫不會變化，因爲由自身的組織產生熱量
d. Its body temperature does not vary even though it gains heat from sources outside its body.
體溫不會變化，即使熱量來自體外的來源

25. (1 point) Which of the following will be an advantage of breathing in air over breathing in water?

I. As air is less dense than water, less energy is required to move air over respiratory surfaces.

II. Oxygen diffuse s faster through air than it does through water.

III. The oxygen content of air is greater than that of an equal volume of water.

下列何者是陸地呼吸優於水中呼吸的優點？

I. 因爲空氣的密度比水小，空氣通過呼吸表皮所需的能量較少

II. 氧在空氣中的擴散比在水中快

III. 空氣中氧含量比同體積的水高

a. Only I and II 只有 I 和 II

b. Only I and III 只有 I 和 III

c. Only II and III 只有 II 和 III

d. I, II and III

26. (1 point) Which characteristics would allow you to declare an organism found on a beach as an echinoderm?

下列何者是你能判斷一海邊生物爲棘皮動物的特徵？

a. Radially symmetric adults with presence of spines and tube feet.
輻射對稱，成體具有棘刺與管足
b. Radially symmetric adults with dorsal hollow notochord.
輻射對稱，成體背部有中空的脊索
c. Exoskeleton with pharyngeal gill-slits and tube feet.
具有外骨骼、咽鰓裂與管足
d. Radially symmetric adults with mantle cavity.
輻射對稱，成體具有外套腔

27. (1 point) In an individual X, the pituitary gland was found to function normally while the adrenal glands were atrophied. In another individual Y, both the pituitary and adrenal glands were found to be underdeveloped. If adrenocorticotropic hormone (ACTH) is administered to these individuals as a remedial measure, it will be effective in:
個體 X 的腦垂體正常，但腎上腺萎縮；個體 Y 的腦垂體及腎上腺發育均不全，如果用腎上腺皮質刺激素(ACTH)做補救治療，對何者有效？

a. individual X alone. 只對個體 X有效
b. individual Y alone. 只對個體 Y有效
c. both X and Y. 對個體X及Y均有效
d. neither X nor Y. 對個體X及Y均無效

28. (1 point) Which of the following are associated with stereoscopic vision?

I. Effect of the blind spot of one eye is cancelled by the other eye.

II. Total visual field of 360° and frontal visual field of 30°.

III. Likely to be observed in predatory birds.

IV. Centrally situated fovea that gives good visual acuity.

下列何者與立體視覺有關？

I. 一眼中的盲點可被另一眼所消掉

II. 全視野 360° 及前視野 30°

III. 最有可能在獵食性的鳥類發現

V. 黃斑位於中央而使視覺敏銳

a. I, II and IV
b. I, II and III
c. II, III and IV
d. I, III and IV

29. (1 point) The glycoside “Phloridzin” present in apple peel can block the normal reabsorption of glucose from kidney tubules. As a result, sugar is almost completely excreted through the urine. A mouse fed with Phloridzin along with sodium succinate will develop:
蘋果皮中含的醣苷“Phloridzin” 能阻斷葡萄糖在腎小管的再吸收，使糖幾乎全在尿液中排出，下列何種情況會在餵食 Phloridzin 及琥珀酸鈉的小鼠出現？

a. hypoglycemia and no sugar will be detected in the urine sample.
低血糖，尿液樣本不能檢出糖
b. hyperglycemia and urine test for sugar will be positive.
高血糖，糖在尿液檢查爲陽性
c. hyperglycemia and no sugar will be detected in the urine sample.
高血糖，尿液樣本不能檢出糖
d. hypoglycemia and urine test for sugar will be positive.
低血糖，糖在尿液檢查爲陽性

30. (1 point) Cardiac output is defined as the amount of blood pumped by each ventricle. It is determined by multiplying the heart rate and the stroke volume. The stroke volume is the amount of blood ejected by each ventricle with each beat. If the heart of a woman beats 56 times in a minute, the volume of blood in her heart is 120 ml at the end of diastole and 76 ml at the end of systole, what would be her cardiac output?
心輸出量爲心室每分鐘擠出的總血量，是由心搏量與心跳數的乘積所決定。心搏量是心室一次心跳擠出的血量。若一女性每分鐘心跳 56 下，她心臟中的血在舒張後爲 120 ml、收縮後爲 76 ml。她的心輸出量是多少？

a. 10.976 L/min
b. 2.464 L/min
c. 6.720 L/min
d. 4.256 L/min

31. (1 point) The drinking water consumed by a population is contaminated with a modified bisphenol-A, which is not degraded in the body. As a result, there are measurable levels of this compound in the blood. Which of the following would result if the modified bisphenol-A were an oestrogen-mimicking compound?

飲用水被一種雙酚-A 衍生物污染，此化合物在人體中不能被分解，使血液中測得的含量增高，若雙酚-A 衍生物是動情素模擬物質，會有下列何種結㟜果？

a. Males would have decreased sperm production.
男性精子的產量減少
b. Males would have elevated levels of follicle-stimulating hormone.
男性濾泡刺激素的量增加
c. Females would have elevated levels of gonadotropin-releasing hormone.
女性的生殖腺刺激素釋放素量增加
d. Males would have elevated levels of blood testosterone.
男性血液中的睾固酮產量增加
e. Follicle stimulation would increase in females.
女性的濾泡刺激作用增加

32. (1 point) If a molecule of carbon dioxide released into the blood in your left foot travels out of your nose, it must pass through all of the following structures except the:
一個二氧化碳分子釋放到你左腳的血中，於血液運送最後由鼻孔釋出，此過程**不會**經過下列那一器官。

a. right atrium 右心房
b. pulmonary vein 肺靜脈
c. alveolus 肺泡
d. bronchus 支氣管
e. pulmonary artery 肺動脈

33. (1 point) The process of artificial kidney dialysis is shown schematically using the following symbols:

使用下列符號表示人工腎臟透析的過程圖

: erythrocyte 紅血球

: salts 鹽類

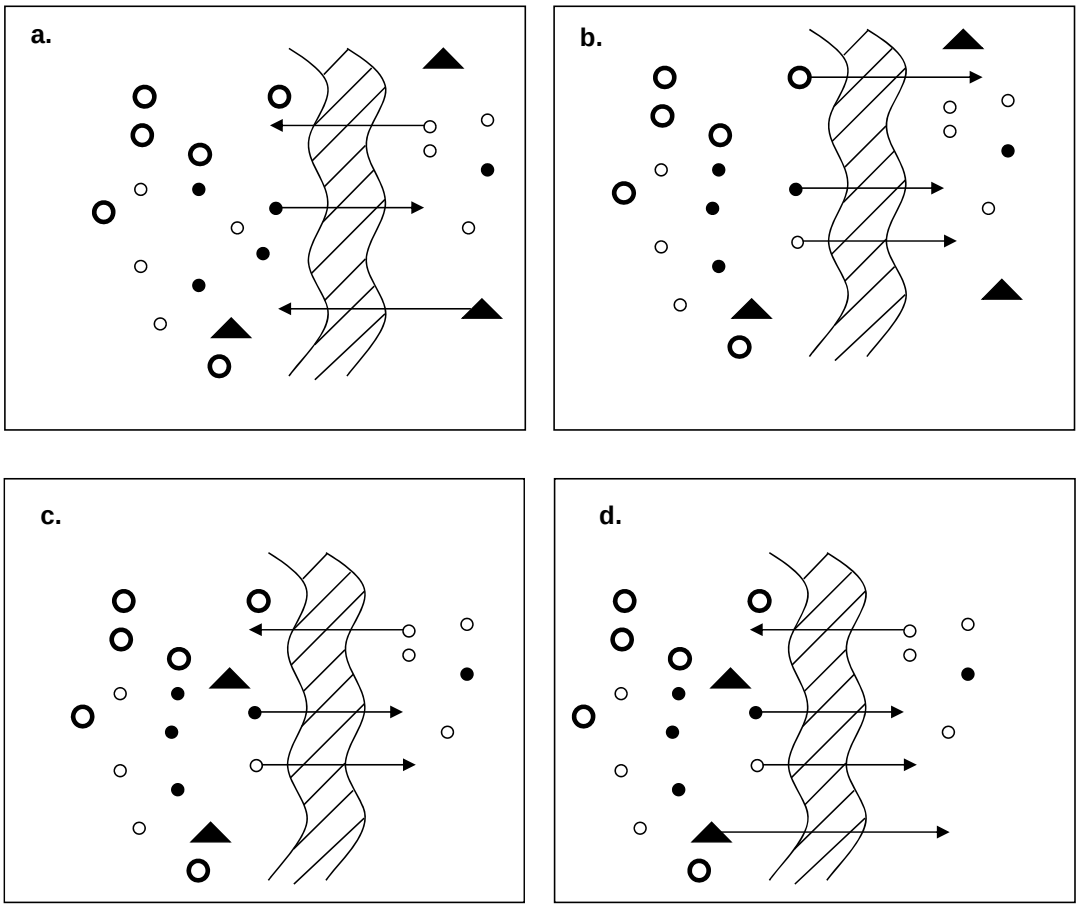
: semi-permeable membrane 半透膜

: urea 尿素

: proteins 蛋白質

Which of the following correctly depicts the process?

下列何者能正確描述此過程？



GENETICS AND EVOLUTION (17 points) 遺傳與演化 (17 分)

34. (1 point) A mutation results in the absence of sweat glands, a disease called anhidrotic ectodermal dysplasia. A woman suffering from this disease has a mosaic of skin patches lacking sweat glands. The woman is likely to be:
有種遺傳疾病是因爲突變而導致缺乏汗腺，其女性患者的特徵，爲皮膚上有許多沒有汗腺的斑塊鑲嵌於正常皮膚上。此女性患者可能是：

a. homozygous for an autosomal recessive mutation.
同型合子的隱性體染色體突變
b. heterozygous for an autosomal dominant mutation.
異型合子的顯性體染色體突變
c. homozygous for a X-linked recessive mutation.
同型合子的隱性 X 染色體突變
d. heterozygous for a X-linked recessive mutation.
異型合子的隱性 X 染色體突變

35. (1 point) A mink breeder allows random mating among his minks. He discovers that, on an average, 9% of his minks have rough fur that fetches less money when sold. So he decides to focus upon smooth fur and does not allow minks with rough fur to mate. Rough fur is linked to an autosomal recessive allele. What is the theoretical percentage of minks with rough fur that he will obtain in the next generation?
水貂飼養者讓其豢養的水貂個體間進行逢機交配，他發現平均有 9% 的毛較粗，因粗毛售價較差，故他僅讓具細毛個體交配，粗毛是體染色體的隱性對偶基因，理論上，在下一代中具粗毛的百分比將有多少？

a. 7.3
b. 5.3
c. 2.5
d. 1.2

36. (1 point) In a breed of rabbits, multiple alleles with the following dominance relationships control coat coloration:
C (agouti) > c^{ch} (chinchilla) > c^{h} (Himalayan) > c (albino).
An experimental cross between agouti and Himalayan produced 50% agouti and 50% Himalayan progeny. Which of the following crosses could produce this result?
一窩兔子中，控制毛色的複對偶基因之顯性關係如下：

C (深灰) > c^{ch} (灰) > c^{h} (灰白) > c (白).

深灰兔與灰白兔交配後，子代有 50% 深灰兔、50% 灰白兔。由此判斷親代的基因型可能爲下列哪些？

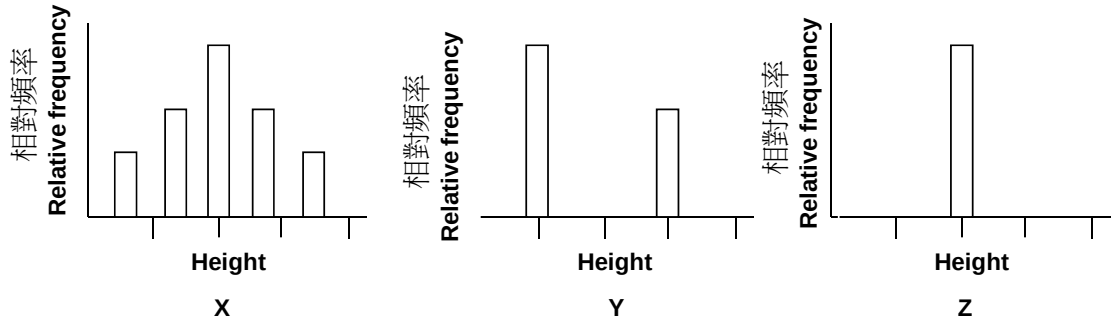
I. Cc^{h} X $c^{h}c^{h}$
II. Cc X $c^{h}c$
III. Cc^{h} X $c^{h}c$
IV. Cc X $c^{h}c^{h}$

a. I, II and III
b. II, III and IV
c. I, III and IV
d. I, II and IV

37. (1 point) Alleles I^A and I^B present on chromosome 9 are responsible for blood groups A and B, respectively. Blood group O results when these alleles are either absent or not expressed. The alleles I^A and I^B are expressed only if the H allele is present on chromosome 19, either in the homozygous or heterozygous condition, where h stands for the recessive allele.
Gilbert belongs to the AB blood group. His sister Helen belongs to the A group while their father belongs to the O group. Identify the maternal and paternal genotypes.
血型 A 與 B 在第 9 號染色體上的對偶基因分別爲 I^A 與 I^B，若沒有或沒表現此兩種對偶基因時，血型爲 O。當第 19 號染色體有對偶基因 H 時，對偶基因 I^A 與 I^B 才會表現，不論同型合子或異型合子，h 爲隱性。Gilbert 爲 AB 型，他妹妹是 A 型，爸爸是 O 型，判斷父母的基因型可能爲下列何種？

	Mother 母	**Father** 父
a.	H/H, I^A/I^B	H/h, I^O/I^O
b.	H/h, I^B/I^O	h/h, I^A/I^O
c.	h/h, I^O/I^O	h/h, I^A/I^O
d.	H/H, I^A/I^O	H/h, I^B/I^O
e.	h/h, I^B/I^O	H/h, I^O/I^O

38. (1 point) The phenotypes of three experimental populations of plants are shown in the following graphs.
三種實驗植物表現型如下圖：



The three populations X, Y and Z represent, respectively, to the generation.
上三圖中的 X, Y 與 Z 分別代表哪三代的族群？

a. F_1, F_2 and F_3 generations
b. P, F_1 and F_2 generations
c. F_2, P and F_1 generations
d. F_3, F_1 and F_2 generations

39. (1 point) In a population of mice, 40% of males showed a dominant X-linked trait. Assuming random mating, the most frequent mating is expected between the genotypes:
小鼠族群中，有 40% 表現出顯性 X 性聯特徵，在逢機交配下，下列何者是最常見的交配基因型？

a. X^BX^b and X^bY
b. X^BX^B and X^bY
c. X^BX^b and X^BY
d. X^bX^b and X^bY

40. (1 point) Hunting of Northern elephant seals reduced their population size to as few as 20 individuals at the end of the 19th century. Their population has since rebounded to over 30,000. But their genomes still carry the marks of this bottleneck when compared to the population of Southern elephant seals that was not so intensely hunted. Such bottlenecks are manifested in the form of:

十九世紀末，北方海象族群大小由 30,000 降至 20，但基因組仍保留一些瓶頸標記，故此瓶頸可能以何種方式被保留下來？

I. abundance of unique mutations.
大量的特殊突變
II. increased frequency of lethal recessive alleles.
致死性的隱性基因頻率增加
III. reduced genetic variation.
降低遺傳變異
IV. increased population size.
增加族群大小

a. Only I and II
b. Only III
c. I, II and IV
d. II and III

41. (1 point) What is true for both genetic drift and natural selection?

下列那些敘述在遺傳漂變及天擇的情況下皆成立？

I. They are mechanisms of evolution.
皆屬演化的機制

II. They are entirely random processes.
是完全逢機的過程

III. They usually result in adaptations.
通常是適應的結果

IV. They affect the genetic make-up of the population.
會影響族群的遺傳組成

a. I and II
b. I and III
c. II and III
d. I and IV

42. (1 point) The frequencies of two codominant alleles with similar fitness values in a laboratory population of mice were 0.55 and 0.45. After 5 generations, the values changed to 0.35 and 0.65, respectively. Which two of the following mechanisms are likely to be responsible for this observation?
實驗用小鼠的兩個具有 類似適應性 的等顯性對偶基因頻率分別爲 0.55 and 0.45，將過五代之後，分別變成 0.35 and 0.65，下列機制中哪 兩種 可能造成此現象？

I. Point mutation 點突變
II. Nonrandom mating 非逢機交配
III. Genetic drift 遺傳漂變
IV. Selection pressure 天擇壓力

a. I and IV
b. II and IV
c. I and III
d. II and III

43. (1 point) In pea plants, the allele for yellow color of seeds (*Y*) is dominant over that for green color (*y*) while the allele for round seeds (*R*) is dominant over that for wrinkled seed (*r*). The results of an experimental cross with such garden pea plants are tabulated below:
豌豆種子黃色爲顯性(*Y*)、綠色隱性(*y*)；飽滿爲顯性(*R*)、皺縮隱性(*r*)，交配結果如下表

Seed phenotype 種子表現型	Number
Yellow and round 黃色、飽滿	32
Yellow and wrinkled 黃色、皺縮	28
Green and round 綠色、飽滿	12
Green and wrinkled 綠色、皺縮	9

The parental genotypes are likely to be: 親代基因型爲何？

a. *YyRr* and *Yyrr*
b. *Yyrr* and *YyRR*
c. *YyRr* and *YyRr*
d. *YyRR* and *yyRr*

44. (1 point) A population has 6 times as many heterozygous as homozygous recessive individuals. The frequency of the recessive allele will be:
族群中異型合子個體數是同型隱性合子個體數的 6 倍，隱性基因的頻率爲何？

a. 1/3
b. 1/4
c. 1/2
d. 1/6

45. (1 point) If you have data on genotypic frequencies for several generations of a population and if you apply the Hardy-Weinberg equation to it, which of the following can be deduced?
根據哈溫平衡定律，族群經過許多代之後，可推演出下列何者？

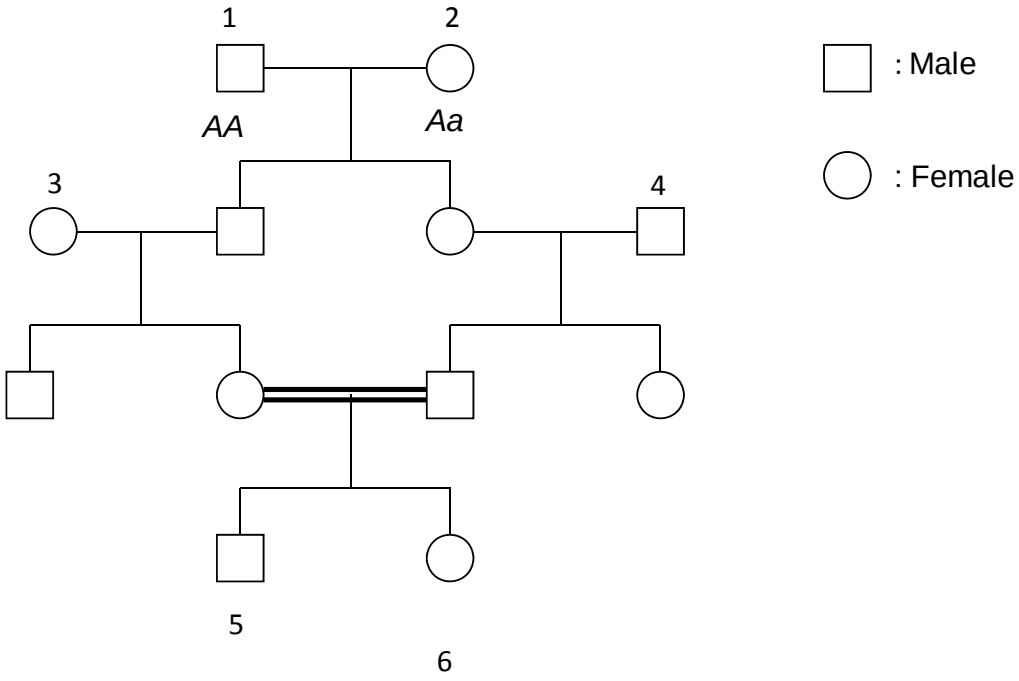
I. Whether evolution has occurred in the population.
演化是否發生
II. The direction of evolution, if it has occurred.
演化的方向
III. The cause of evolution, if it has occurred.
導致演化的原因

a. Only I and II
b. Only I and III
c. Only II and III
d. I, II and III

46. (1 point) The residues of mines often contain such high concentrations of toxic metals (e.g., copper, lead) that most plants are unable to grow on them. However, in a particular study, certain grasses were found to spread from the surrounding uncontaminated soil onto such waste heaps. These plants developed resistance to the toxic metals while their ability to grow on uncontaminated soil decreased. As grasses are wind-pollinated, breeding between the resistant and non-resistant populations went on. But eventually, the less resistant plants growing on contaminated soil and the more resistant plants growing on uncontaminated soil died out. This process is indicative of:
某些雜草的耐受礦區重金屬汙染能力增加，但在非污染區的生長能力卻下降。由於風媒傳粉，使耐重金屬汙染與無耐受性的族群得以交配，但兩種族群終究僅能在其適應的環境中生長，這過程表示何種現象已經發生？

a. mass extinction of species. 物種大滅絕
b. bottleneck effect. 瓶頸效應
c. divergent evolution. 趨異演化
d. disruptive selection. 分歧天擇

47. (1 point) A genetic disease is caused by an autosomal recessive allele. Individual 2 in the following pedigree is a carrier for this trait. Assuming that individuals 3 and 4 are normal homozygous, what is the probability that individual 6 will have the disease?
一種由體染色體隱性基因所導致的遺傳疾病，下圖中個體 2 是帶原者，個體 3 及 4 是正常同型合子，個體 6 得病的機率爲何？



a. 1/16
b. 1/32
c. 1/64
d. 1/128

48. (1 point) Note the following genotypes and corresponding phenotypes:

基因型及表現型對應如下

A–B– Agouti 深灰

A–bb Albino 白

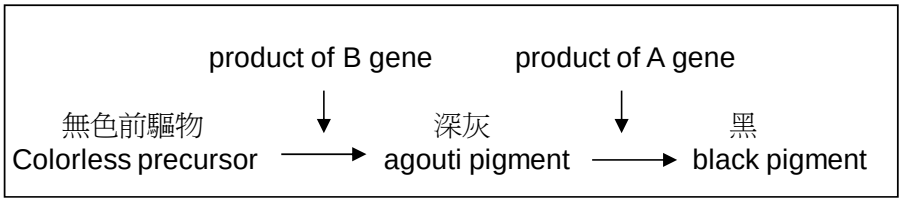
aaB– Black 黑

aabb Albino 白

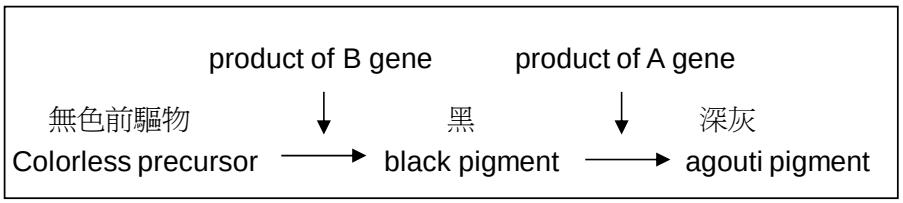
The biochemical process that can explain the above pattern is:

下列何者可以解釋上述模式的生化過程？

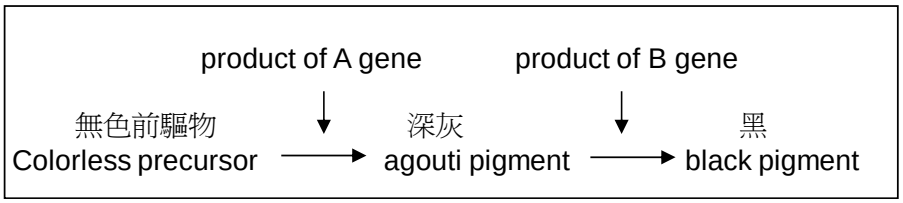
a.



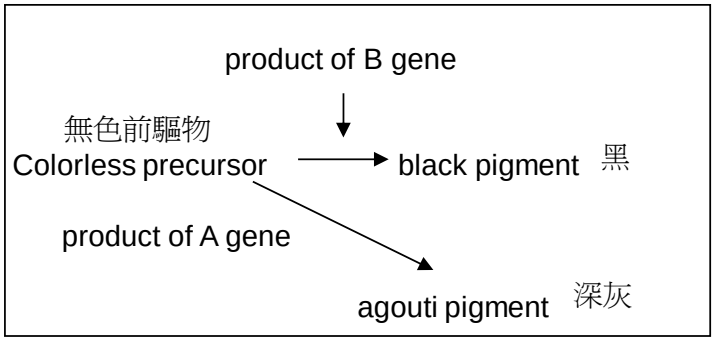
b.



c.



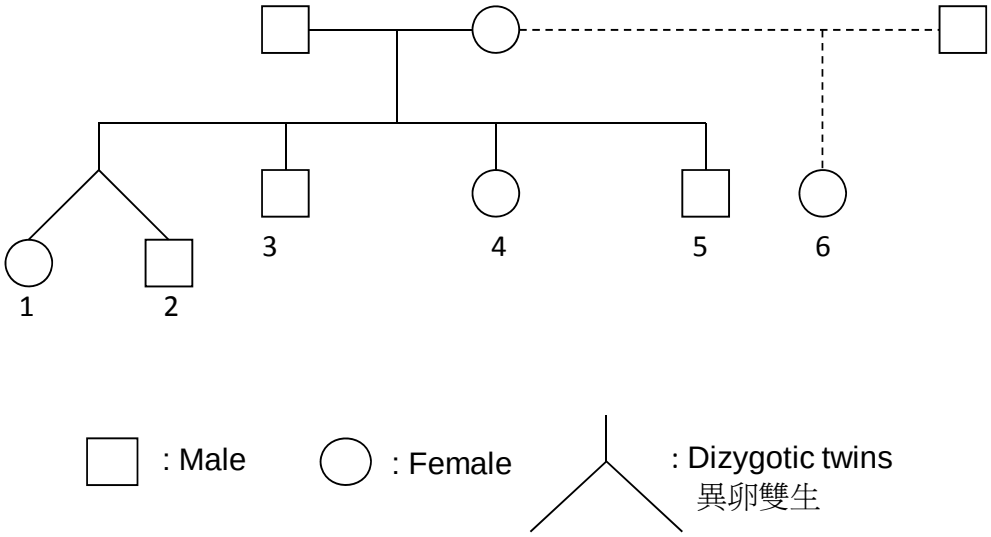
d.



49. (1 point) In a population, 90% of the alleles at the Rh locus are ‘R’. Another alternative form of this allele is ‘r’. Forty children from this population go to a particular play school. The probability that all are Rh positive is:
族群中，Rh 對偶基因中 90% 爲 ‘R’，另一型爲 ‘r’， 此族群的 40 個小孩都是 Rh 陽性的機率爲何？

a. $40^{0.81}$
b. 0.99^{40}
c. $40^{0.75}$
d. $1\text{-}0.81^{40}$

50. (1 point) Study the pedigree and answer the following question.



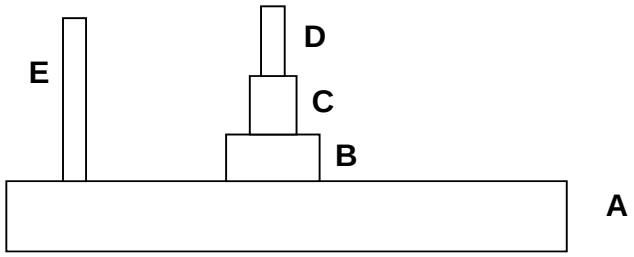
The genetic relatedness between individuals 1 and 2 and between individuals 5 and 6, respectively, is:

根據上面之譜系圖，個體 1 and 2 以及個體 5 and 6 的親緣相似率分別爲何？

a. 0.5 and 0.25
b. 0.25 and 0.5
c. 1.0 and 0.5
d. 1.0 and 0.25

ECOLOGY (7 points) 生態學 (7 分)

51. (1 point) A typical biomass pyramid is represented in the figure below.
If A represents a primary producer, then E is likely to be a:
下圖爲一典型的生物量塔，若 A 爲初級生產者，則 E 可能是：



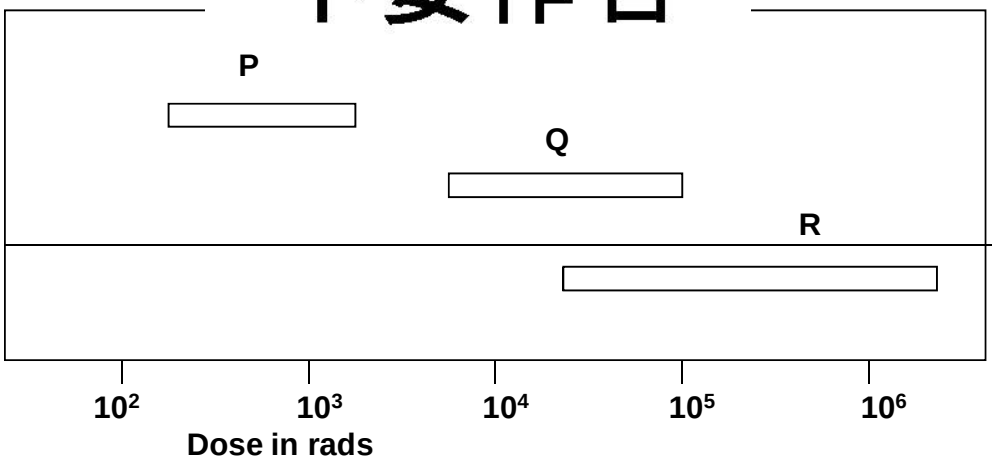
a. photo-litho-heterotroph.
光－岩石－異營者

b. chemo-organo-heterotroph.
化學－有機－異營者

c. chemo-litho-autotroph.
化學－岩石－自營者

d. photo-organo-heterotroph.
光－有機－異營者

52. (1 point) Comparative sensitivity of three groups of organisms to single large doses of x-or γ ray[illegible]n the figure below.
下圖爲 3 組不同的[illegible]照射之耐受度



The three groups P, Q, R respectively are:此 3 組 P、Q、R 按順序分別爲

a. insects, mammals and bacteria 昆蟲、哺乳動物、細菌

b. mammals, bacteria and insects 哺乳動物、細菌、昆蟲

c. bacteria, mammals and insects 細菌、哺乳動物、昆蟲

d. mammals, insects and bacteria 哺乳動物、昆蟲、細菌

53. (1 point) Hay is boiled in water and cooled. Some pond water, containing only heterotrophic protozoa, is added to it and kept in the dark for a long time. Which of the following are true?

I. Heterotrophic succession of protozoa will occur with increase in total biomass.
II. The energy of the system is maximum at the beginning.
III. Succession will occur, eventually reaching a steady state in which energy flow is maintained.
IV. The ecosystem may undergo succession but finally all organisms will die or go into resting stages.

乾草在水中煮沸置涼，將含有異營原生動物的池塘水加入此乾草液，長期置放在黑暗環境中，下列敘述何者爲真？

I.異營原生動物的演替將會發生，總生物量將會伴隨著增加

II 本系統的能量在開始時爲最大量

III 演替將發生，最後到一穩定狀態即維持能量循環

IV此生態系會進行演替，但最終所有的個體將會死去或進入休眠狀態

a. I and III
b. II and IV
c. II and III
d. I and IV

54. (1 point) An ecologist is comparing the growth of a herbaceous plant species growing in two different sites A and B. To compare the populations from the two sites, she has harvested 30 individuals from each site, then measured the root length, root biomass, and shoot biomass of each individual. A summary of those measurements are as follows:
生態學家比較一種草本植物在不同地區(A 區及 B 區)的生長情形，她在每一地區選取 30 棵植物來進行比較，測量每棵植物的根長、根生物量(重量)及莖生物量，下表爲測量結果

Location 地區	Mean root length (cm) 平均根長	Mean root biomass (g) 平均根重	Mean shoot biomass (g) 平均莖重
Site A	27.2 ± 0.2	348.7 ± 0.5	680.7 ± 0.1
Site B	13.4 ± 0.3	322.4 ± 0.6	708.9 ± 0.2

Based on the data presented, which of the following statements is likely to be true?
根據所得資料，下列敘述何者正確？

a. Soil water availability is lower in Site B than in Site A.
在 B 處的土壤含水可利用量小於 A 處的土壤
b. Plant productivity is higher in Site A than in Site B.
A 處的植物生長量大於 B 處
c. Soil water availability is lower in Site A than in Site B.
在 A 處的土壤含水可利用量小於 B 處的土壤
d. Soil nutrient availability is lower in Site B than in Site A.
在 B 處土壤的肥力(營養)小於 A 處的土壤

55. (1 point) In an aquatic ecosystem, the total dry biomass of each of three groups of organisms is as follows:

在一水生生態系 3 種動物的乾重量如下：

I. Ciliates 纖毛蟲: 1.1062 g

II. Midge larvae 蠓的幼蟲: 0.9623 g

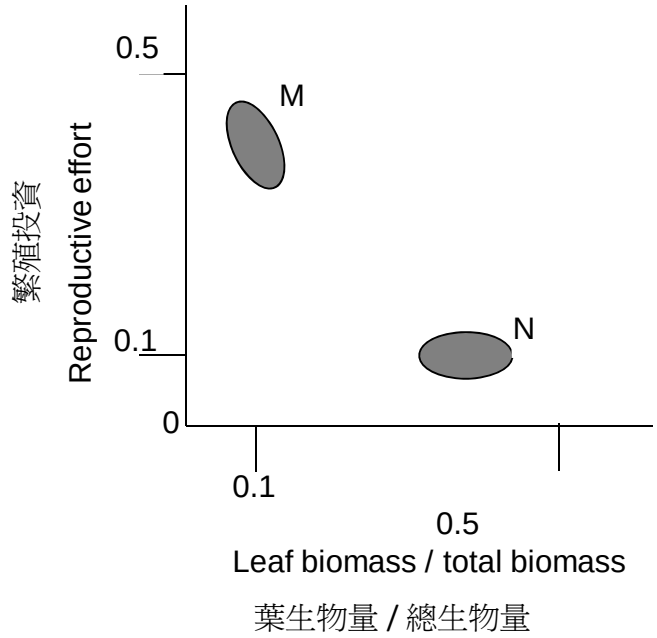
III. Oligochaetes: 貧毛類 1.005 g

The most likely food chain that they represent is:

此三種動物所組成最可能的食物鏈爲何？

a. I → II → III
b. II → I → III
c. I → III → II
d. III → II → I
e. II → III → I

56. (1 point) The reproductive effort of a plant is defined as the ratio of the dry weight of its reproductive organs to that of its above-ground tissues. The reproductive effort of two purely sexually reproducing plant species M and N, as compared to their relative leaf biomass is plotted in the graph below.
植物的繁殖投資以其繁殖器官與其在地上組織的乾重量比例來評估，兩種有性繁殖的植物 M 及 N 的繁殖投資與其葉之相對生物量與總生物量比值作成下圖：



Choose the correct interpretation.
選擇下列正確敘述

a. M is a r-strategist adapted to a highly disturbed habitat.
M是生長於高度干擾環境的 **r** 策略種類

b. N is a k-strategist adapted to a highly disturbed habitat.
N是生長於高度干擾環境的 **k** 策略種類

c. N is a r-strategist growing under favorable environmental conditions.
N是生長於良好環境的 **r** 策略種類

d. M is a k-strategist growing under favorable environmental conditions.
M是生長於高度干擾環境的 **k** 策略種類

57. (1 point) Prey-predator relationships are often considered analogous to a 'life-dinner' relationship in behavioural ecology. Which of the following statements best describe this analogy and the relative rates of evolution of the prey and predator species in a population?

不要作答

獵物－掠食者的關係在行爲生態學中與生命－餐點的關係是相似的，下列有關此種相似性及族群中獵物種及掠食種的的相對演化速率的描述，何者最適合？

I. This analogy indicates the fact that the prey species serves as the 'dinner' for the predator species, the 'life' of which depends on the former.
此相似性表述指出獵物種爲掠食種的餐點，掠食種的生命維繫依賴獵物種

II. This analogy indicates that a prey species caught by a predator loses its 'life' while a predator that fails to catch a prey only loses a 'dinner'.
此相似性表述指出獵物種被掠食者補食會喪失了牠的生命，然而掠食者捕不到獵物種只損失一頓餐點

III. The prey species is usually under greater selection pressure from its predators and tends to evolve faster than does a predator species.
獵物常承受較大的天擇壓力，故獵物種演化速快於掠食種

IV. The predator species is usually under greater selection pressure because of its dependence on a prey species for food and tends to evolve faster than does a prey species.
掠食種常面臨較大的天擇壓力，因爲牠們得靠獵物生活，故掠食種演化速快於獵物種

a. I and III
b. I and IV
c. II and III
d. II and IV

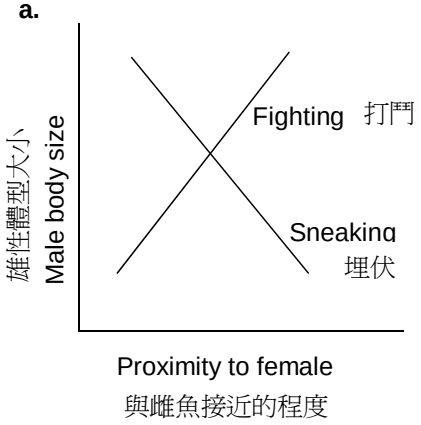
ETHOLOGY (4 points) 動物行爲 (4 分)

58. (1 point) Animals can use their circadian clocks to determine direction from the position of the sun. In a particular experiment conducted in Iceland, a bird, kept in a cage open to the sky, was trained to seek food on the western side. Its circadian rhythm was then phase-delayed by 6 hours and after phase shifting, the bird was returned to its open cage at 12.00 noon real time. It was observed to seek food in the:
動物可根據牠們體內的生物時鐘及太陽的位置來決定方向，在冰島進行的一項實驗中，一隻鳥置於露天的鳥籠中，訓練牠往西邊覓食。然後將牠的生物時鐘延遲6小時(phase-delayed by 6 hours)，於真實時間中午12：00將鳥放回籠中，此時鳥會飛往何方覓食？

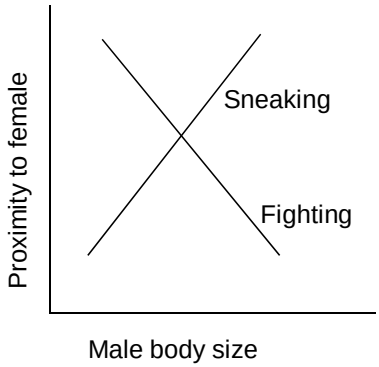
a. north.(北方)
b. south. (南方)
c. east. (東方)
d. west. (西方)

59. (1 point) Coho Salmon is a fish found in the freshwater streams of North America. The males of this species have two reproductive strategies to fertilize the eggs laid by females. Larger males are able to fight with each other successfully but smaller males are unable to do so. The latter adopt another strategy, that of sneaking, in which they hide behind rocks and quickly approach females to fertilize the eggs before the larger males are able to do so. Which of the following graphs depicts the correct strategies?
Coho
鮭是北美淡水溪流的魚種，雄魚在雌魚產卵時，有兩種策略來達到使卵受精的目的，體型大的雄魚可藉打鬥來達到目的，但體型小者則不行而採埋伏方式，藏在石頭後方突然出現於產卵的雌魚旁射精，造成其旁體型大的雄魚措手不及。下圖中，何者爲正確的表述：

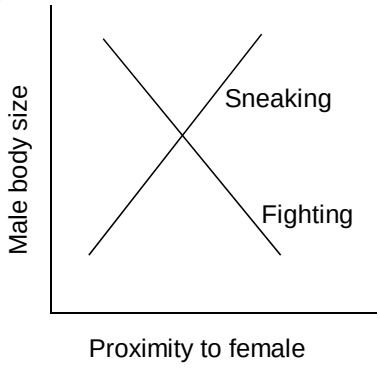
a.



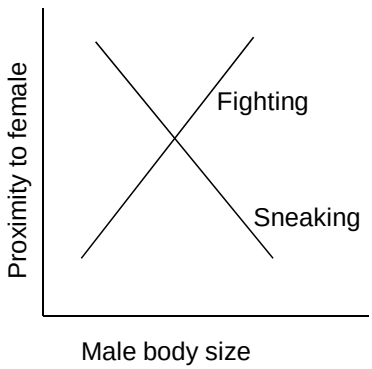
b.



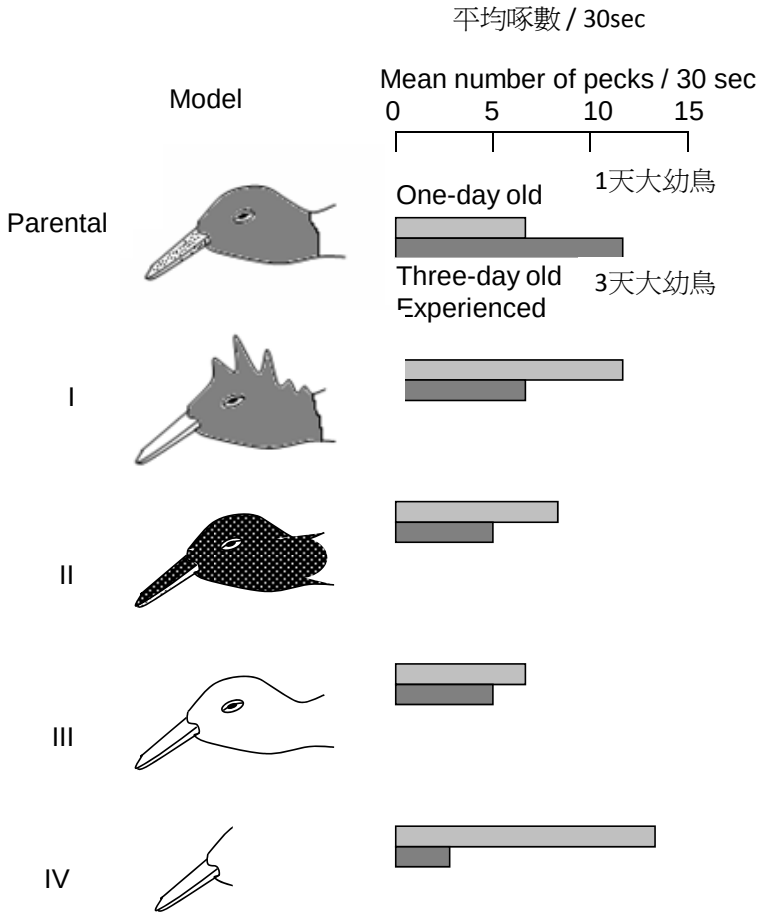
c.



d.



60. (1 point) Young laughing gull chicks peck at the tip of the parent's beak which, in turn, induces the adult gull to regurgitate food. Experiments were conducted with one-day old and three-day old chicks, the latter being reared with their parents. These chicks were presented with the following models of the parent head and the following responses were obtained:
海鷗幼鳥利用啄親鳥鳥喙以刺激親鳥吐出食物以獲得食物，利用 1 及 3 天大的幼鳥進行實驗，3 天大的幼鳥是由巢中與親鳥相處的幼鳥中所選取的 (有經驗)，這些幼鳥以不同的親鳥鳥頭模型來測試，記錄其反應如下：



Choose the correct interpretation of the experiment.

下列敘述有關此實驗的結果，何者正確？

a. Pecking behavior is a fixed action pattern where any long pointed object acts as an equally effective stimulus.

鳥的啄喙行爲是一種本能的制式行爲(fixed action pattern)，故使用任何尖長型的物品皆是一樣有效的刺激。

b. The pecking rate of laughing gull chicks increases with age.

鳥的啄喙速率隨年齡增加

c. The response of one-day old chicks is more pronounced when the model is closer to that of the parent.

1天大幼鳥對與親鳥愈相似的模型反應愈明顯（啄得愈多）

d. Act of pecking is an innate behavior while the discriminatory capacity of the chicks is a result of learning.

啄喙是一種本能，但幼鳥的辨識能力則來自學習的結果

61. (1 point) While studying the frogs of a certain species in their natural habitat in the night time during the mating season, you observe a chorus of male frogs in which some individuals are calling while others remain silent. On further observation, you see the silent frogs are sitting closer to those that are calling.

    Which of the following is most likely to explain the behavior of this chorus of frogs?

    研究某種蛙夜間在其棲地之繁殖情形，發現當蛙齊鳴時，某些個體會叫、某些不叫；進一步觀察發現不叫的個體會靠近會叫的個體。針對蛙的鳴叫，下列敘述何者正確？

a. The individuals who are not calling are staggering their calls with those of the others and are likely to call later in the season after the latter have finished mating.

    在蛙繁殖季結束後，這些不叫的個體可能會與其他的鳴叫個體一起鳴叫

b. The silent frogs are close genetic relatives of the calling individuals and do not expend valuable energy in calling as the offspring from the matings that the latter will receive would provide adequate indirect fitness to them.

    不叫的個體與會叫的個體有親緣關係，故其不需花精力鳴叫，因會叫個體獲得交配機會而有子代產生，對不會叫者而言，亦有間接的遺傳好處

c. The silent frogs have evaluated that their calls are inadequate in attracting females, as compared to those of the calling individuals, and lie in wait to sneak matings with the females that approach the calling males.

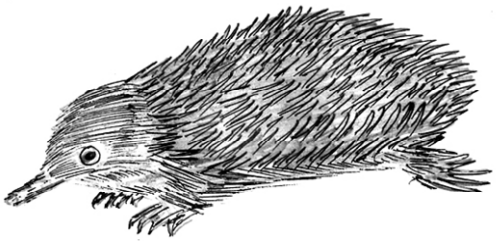
    會叫的青蛙評估自己的叫聲對雌性不具吸引力，故在會叫的雄性旁等待，雌性被吸引至會叫的雄蛙身旁時，則趁機交配

d. The silent frogs do not expend energy in themselves calling as the female frogs that are attracted to the calls of the others are anyway likely to visually inspect the closely-spaced males and then choose their mating partners.

    不叫的雄蛙不花力量在鳴叫上，待雌蛙被其它雄蛙吸引後，雌蛙會以視覺來評鑑聚集在一起的雄蛙以進行選擇

BIOSYSTEMATICS (2 points) 分類 (2 分)

62. (1 point) Although *Echidna* lays eggs, it has been classified as a mammal due to the presence of mammary glands. Which of the following additional features of the *Echidna* are also unique to the class Mammalia?
雖然鴨嘴獸產卵，但因有乳腺被歸爲哺乳類，下列還有那些特徵爲哺乳類特有的？

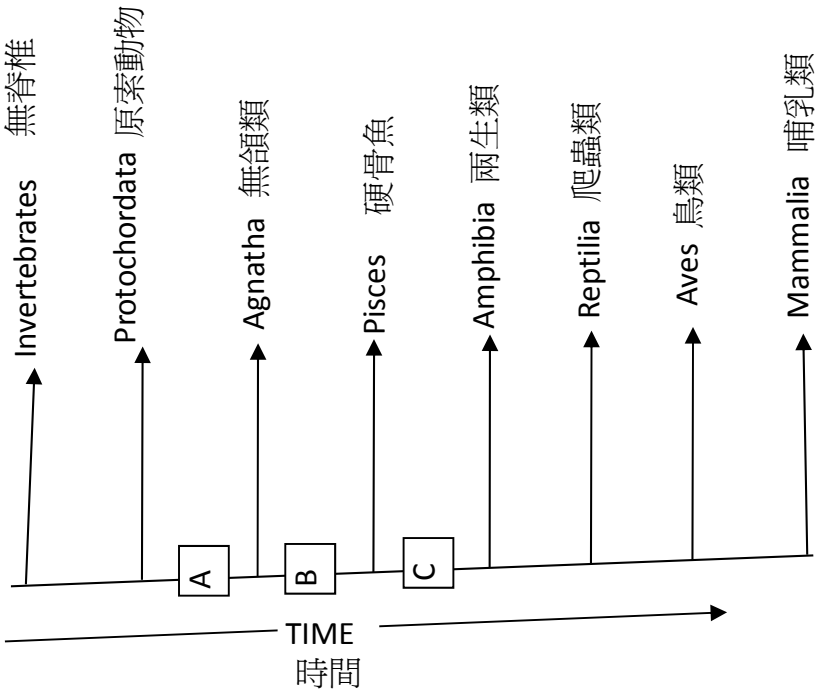


Echidna

I. Hair over parts of the body.全身有毛
II. Presence of pituitary and thyroid gland.具有腦下腺及甲狀腺
III. Complete separation of pulmonary and systemic circulation in a 4 - chambered heart.心臟有 4 個腔，且具完全分離的肺循環及體循環
IV. A diaphragm separating thoracic and abdominal cavities.具橫膈區分胸腔及腹腔
V. Regulation of body temperature irrespective of ambient temperature.體溫不受外界溫度影響(恆溫性)
VI. Enucleated red blood cells.紅血球不具細胞核
VII.

a. III and VI
b. I, IV and V
c. Only I and IV
d. I and II
e. I, IV and VI

63. (1 point) Study the adjoining schematically drawn evolutionary lineage. The derived characters A, B and C represent, respectively:
由下列鄰近演化圖式判別 ABC 三種衍生特性分別代表何種臟器？



a. vertebral column and cranium, jaw, pentadactyl limb 脊柱及頭顱、頜骨、具五趾的附肢
b. tail, heart, teeth.尾、心臟、牙齒
c. heart, gill, cranium.心臟、鰓、頭顱
d. cranium, cloaca, hepatic portal system. 頭顱、泄殖腔、肝門系統

問題結束

********** END OF PART A **********