Student Code: _____

20th INTERNATIONAL BIOLOGY OLYMPIAD

Tsukuba, JAPAN 12th – 19th July, 2009

THEORETICAL TEST: PART A

Time available: 120 minutes；可用時間：120 分鐘

GENERAL INSTRUCTIONS

1. Write your 4-digit student code in every student code box.

   請在每一參賽生編號（Student Code）欄，寫下您的四碼編號。

2. The questions in Part A have only one correct answer. Mark the correct answer with "X" on the **Answer Sheet** clearly, as shown below.

   理論測試部分 A 之問題僅有一個正確答案。請如下所示，於**答題卷** （**Answer Sheet**）清楚地用"**X**"號標示出正確答案。

No.	A	B	C	D	E	F
A0			X			

3. Use pencils and erasers. You can use a ruler and a calculator provided.

   答題請用鉛筆及橡皮擦。您可以使用大會提供之測量尺與計算機。

4. Some of the questions may be marked “DELETED”. DO NOT answer these questions.

   標示爲“刪除”（“DELETED”）的問題**請勿作答**。

5. The maximal points of Part A is 81 (1.5 point each question).

   理論測試部分 A 計分共 81（每題 1.5 分）。

6. Stop answering and put down your pencil IMMEDIATELY after the end bell rings.

   終止鈴響後請**立即**停止作答並放下您的鉛筆。

GOOD LUCK!!

Cell Biology 細胞學

A1. Which treatment is most effective in breaking as many hydrogen bonds as possible in an aqueous solution (pH 7.0) of 1 mg/mL DNA and 10 mg/mL protein?

下列何種處理能最有效率的在水溶液 (pH 7.0) 狀態下，盡可能打斷水溶液中 1 mg/mL DNA 與 10 mg/mL 蛋白質分子內氫鍵

A. Addition of hydrochloric acid to make the pH 1.0.

利用鹽酸調整 pH 值到 1.0

B. Addition of sodium hydroxide solution to make the pH 13.0.

利用氫氧化鈉溶液調整 pH 值到 13.0

C. Addition of urea to a concentration of 6 mol/L.

添加尿素，並將溶液調到 6 mol/L

D. Addition of sodium dodecyl sulfate (a detergent) to a concentration of 10 mg/mL.

添加 SDS (一種清潔劑)，並將溶液濃度到 10 mol/L

E. Heating the solution to 121° C.

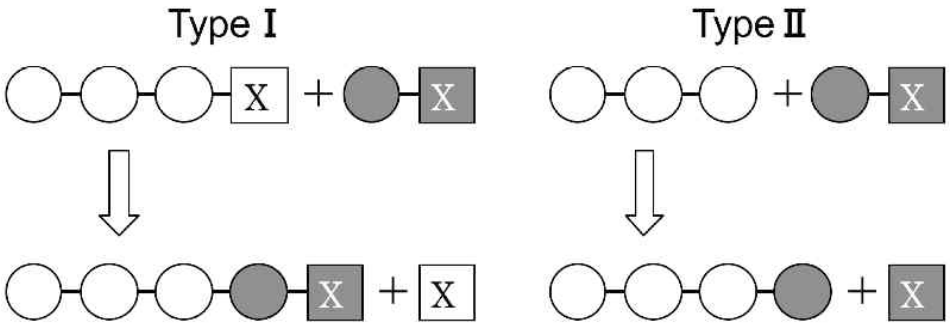
加熱到 121°C

F. Freezing the solution to -80° C.

冷凍到 -80°C

A2. For the elongation of biopolymer molecules, there are two basic mechanisms, as shown below. In Type I elongation, the activation group (marked with an X) is released from the chain of growth. In Type II elongation, the activation group is released from the unit which is coming into the chain of growth. By which of these mechanisms are DNA (D), RNA (R),and protein (P) biosynthesized?

造成生物聚合分子 (biopolymer molecular) 延長 (elongation) 的機制有兩種，分別圖示如下。第一型：官能基分子『X』(activation group) 會從已延長的分子中脫落，再接上新的單元分子。第二型：官能基分子『X』會先自單元分子脫落，再接上已延長的分子。試問，在 DNA (D) 與蛋白質 (P) 的生合成的過程分別隸屬上述何種機制？



	Type I	Type II
A	(D)	(R), (P)
B	(P)	(D), (R)
C	None	(D), (R), (P)
D	(R), (P)	(D)
E	(D), (R)	(P)
F	(D), (R), (P)	none

A3. The movement of a ciliated protozoan is controlled by a protein called RacerX. When this protein binds to another protein, Speed, found at the base of the cilia, it stimulates the cilia to beat faster and the protozoan to swim faster. Speed can only bind to RacerX after phosphorylation of a specific threonine residue. How would you expect the mutant protozoan to behave if this threonine residue in Speed is replaced by an alanine residue?

蛋白質 RacerX 會控制纖毛蟲的運動，當 RacerX 與纖毛底端的蛋白質 Speed 結合時，會加速纖毛的擺動，進而加快運動速度。只有在 Speed 蛋白質上特定位置的蘇胺酸 (threonine) 被磷酸化後，Speed 才會與 RacerX 結合。假設有一個突變種，Speed 上的蘇胺酸被丙胺酸 (alanine) 所取代，請問會發生下列何種現象？

A. Swims fast occasionally. 偶而能快速游泳

B. Always swims fast. 一直能快速游泳

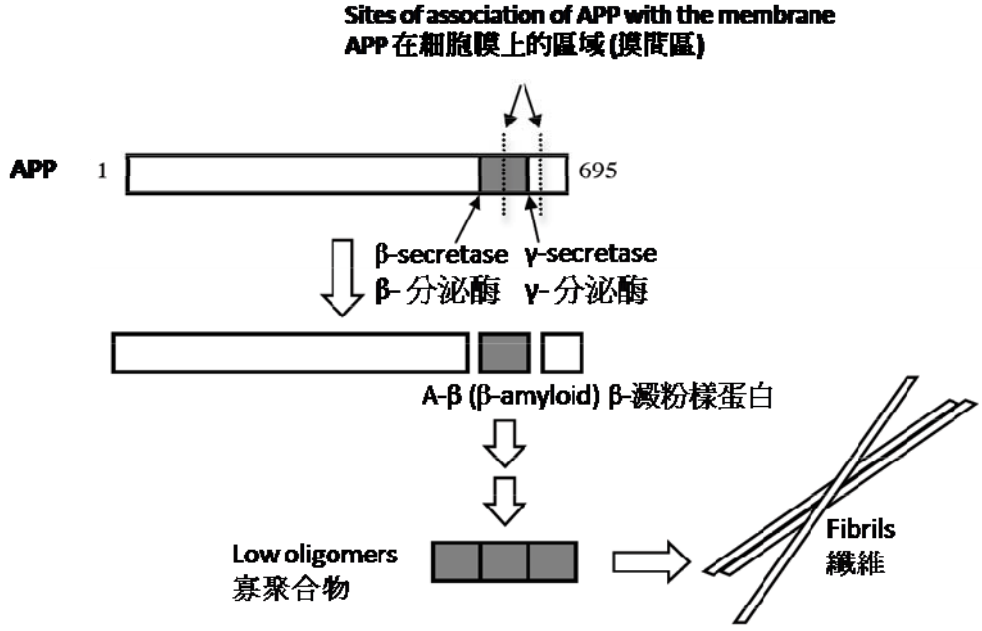
C. Never swims fast. 無法快速游泳

D. Switches rapidly back and forth between fast and slow swimming.
會以快速向前游動，慢速後退

E. Cannot move at all. 無法運動

A4. It is suggested that Alzheimer's disease is manifested by increased accumulation of a small peptide known as β-amyloid (A-β, 40-42 residues). Production of A-β occurs by proteolytic cleavage from a much longer protein APP, a membrane-inserted protein, by two proteases. The figure below shows the hypothesis for the production of the A-β molecule (the gray shaded box), displaying the sequential action of β-secretase to form the N-terminus of A-β and γ-secretase to cleave its substrate within a phospholipid membrane to produce the C-terminus of A-β. The produced A-β monomers then associate to form insoluble oligomers and toxic fibrils.

關於愛滋海默症 (Alzheimer's disease) 的成因有一種是因爲 β-澱粉樣蛋白 (β-amyloid, 簡寫爲 A-β, 由 40-42 個胺基酸所構成) 的累積所造成。A-β 是源自一個較長的蛋白質 APP (一種穿膜蛋白) 被兩種蛋白質水解酶水解而來。下圖所示爲水解過程。A-β 爲灰色的方格，A-β 的 N 端處會被 β-分泌酶 (β-secretase) 切開，A-β 的 C 端處會被 γ-分泌酶 (γ-secretase) 切開。A-β 便離開細胞膜，最終形成非水溶性的寡聚合物 (oligomer) 與毒性纖維累積，進而造成傷害。



Which of the following is effective as an anti-Alzheimer therapy based on the above mechanism?

由前面的敘述，下列何種敘述可以做爲愛滋海默症的治療方法？

I. Inhibiting the activity of β-secretase 抑制 β-分泌酶的活性

II. Inhibiting the membrane targeting of γ-secretase 抑制 γ-分泌酶在膜間區的作用

III. Inhibiting the oligomerization of A-β 抑制 A-β 的聚合

IV. Enhancing the cellular mechanism of removal and degradation of A-β oligomers
強化細胞排除與降解 A-β 寡聚合物的能力

A. Only I, II, IV

B. Only I, II, III

C. Only I, III, IV

D. Only II, III, IV

E. I, II, III, IV

A5. Human acetaldehyde dehydrogenase acts as a tetramer. Two alleles, *N* encoding a normal polypeptide and *M* encoding a mutant polypeptide, are known for the gene of this enzyme. Tetramers containing one or more mutant polypeptides have effectively no enzymatic activity. If the acetaldehyde dehydrogenase activity of the *NN* homozygote cells is 1, what is the activity of the *NM* heterozygote cells, assuming that both alleles are expressed at equal rates?

人類的乙醛去氫酶是一種四聚體蛋白，這個蛋白是由兩個對偶基因所製造。N 製成正常蛋白，M 製成突變蛋白。當四聚體中出現一個或一個以上的突變蛋白，酵素便會失去活性。假設對偶基因產生蛋白質的能力是相同的，若同型合子 NN 的酵素活性爲 1，則異型合子 NM 的酵素活性爲何？

A. 1/2

B. 1/4

C. 1/8

D. 1/16

E. 1/32

A6. In 1961 Mitchell proposed a highly original explanation for ATP synthesis, which he called the chemiosmotic coupling model. Which of the following is correct?

關於 1961 年 Mitchell 提出有關 ATP 合成之化學滲透假說 (chemiosmotic coupling model)，下列敘述何者正確？

A. ATP synthesis in mitochondria can be explained by the chemiosomotic model, but in chloroplasts it cannot.

只適用在粒線體，葉綠體則否

B. ATP synthesis in mitochondria and chloroplasts can be explained by the chemiosomotic model only when the concentration of H^+ ions in the cell is higher than 0.1 mmol/L.

粒線體與葉綠體均適用，惟細胞的氫離子濃度必須超過 0.1 mol/L

C. The energy source for mitochondria is electrons from nutrients, but for chloroplasts the energy source is electrons from water.

粒線體的電子來自於食物提供，葉綠體的電子來自於水

D. In mitochondria H^+ ions are pumped into the matrix, but in chloroplasts they are pumped into the thylakoid lumen.

粒線體的氫離子會被送入基質，葉綠體則被送入葉綠囊腔中

E. H^+ ions are transferred through ATP synthase both in mitochondria and chloroplasts.

在粒線體與葉綠體中，氫離子都是靠 ATP 合成酶來運輸

A7. A scientist, studying the process of photosynthesis, illuminates a culture of unicellular green algae for a certain period of time. Then she turns off the light and adds radioactive CO_2 by bubbling it in the culture for 30 minutes. Immediately she measures radioactivity in the cells. What is she likely to observe?

單細胞綠藻常被用來研究光合作用。在有光的情況下，培養一段時間的綠藻。關燈後，添加具有放射線性的 CO_2，培養 30 分鐘後。此時立刻進行細胞的放射線活性測量，下列敘述何者正確？

A. No radioactivity in the cells, because light is necessary to produce sugars starting from CO_2 and water.

細胞無放射線活性，因爲在利用 CO_2 與水產生糖時，光線是必需的

B. No radioactivity in the cells, because CO_2 is used to produce O_2 during the light-dependent reactions.

細胞無放射線活性，因爲光反應是利用 CO_2

C. No radioactivity in the cells, because CO_2 is taken by the plant cells only during illumination.

細胞無放射線活性，因爲 CO_2 的吸收與照光是有關的

D. Radioactivity in the cells, because CO_2 is used to produce sugars even in the dark.

細胞具有放射線活性，因爲黑暗培養時，仍可利用 CO_2 產生糖

E. Radioactivity in the cells, because CO_2 is incorporated into NADPH in the dark.

細胞具有放射線活性，因爲黑暗培養時，CO_2 會與 NADPH 結合

A8. Which of the following are true for the relative permeabilities of human red blood cells and artificial phospholipid bilayer vesicles (called artificial vesicles hereafter) to glucose and ethanol?

比較人類紅血球與人造雙層磷脂球 (artificial phospholipid bilayer vesicle) 對於葡萄糖與酒精通透性的敘述，下列何者正確？

I. Both red blood cells and artificial vesicles are more permeable to glucose than to ethanol.
葡萄糖較酒精容易通過紅血球與人造雙層磷脂球

II. Both red blood cells and artificial vesicles are more permeable to ethanol than to glucose.
酒精較葡萄糖容易通過紅血球與人造雙層磷脂球

III. In both red blood cells and artificial vesicles, the permeability to ethanol is almost the same as that to glucose.
在通過紅血球與人造雙層磷脂球，葡萄糖與酒精兩者無差別

IV. While red blood cells and artificial vesicles show almost the same permeability to glucose, red blood cells have a higher permeability to ethanol than artificial vesicles.
在通過紅血球與人造雙層磷脂球，葡萄糖無差別。酒精較容易通過紅血球

V. While red blood cells and artificial vesicles show almost the same permeability to ethanol, red blood cells have a higher permeability to glucose than artificial vesicles.
在通過紅血球與人造雙層磷脂球，酒精無差別。葡萄糖較容易通過紅血球

A. I, IV
B. I, V
C. II, IV
D. II, V
E. III, IV
F. III, V

A9. A previously unknown organism that lacks nuclear membrane and mitochondria has just been discovered. Which of the following would this organism most likely possess?

有一種新發現的未知生物，該生物缺乏核膜與粒線體。請問該生物最可能具有下列何種胞器？

A. Lysosome 溶小體

B. Cilium 纖毛

C. Endoplasmic reticulum 內質網

D. Chloroplast 葉綠體

E. Ribosome 核糖體

A10. In eukaryotic cells, the oxidative phosphorylation reactions are catalyzed by various enzymes. Which of the following is correct?

真核細胞中，氧化磷酸反應會被許多酵素所催化。下列敘述何者正確？

A. All of these enzymes are coded in nuclear DNA, synthesized in ribosomes and imported into mitochondria.

全部的酵素基因都存在細胞核中的 DNA，酵素會在核糖體上被合成，合成的酵素會被送入粒線體

B. Some of these enzymes are coded in mitochondrial DNA. Their messenger RNA is exported outside mitochondria and the enzymes are synthesized in ribosomes. The enzymes are then imported back into mitochondria.

有些酵素的基因存在粒線體 DNA 中，mRNA 會被送出粒線體外，酵素在核糖體上被合成，合成完成的酵素會被送入粒線體

C. Some of them are coded in mitochondrial DNA and synthesized in mitochondrial ribosomes.

有些酵素的基因存在粒線體 DNA 中，酵素在粒線體內的核糖體上被合成

D. All of them are coded in mitochondrial DNA and synthesized in mitochondrial ribosomes.

全部的酵素基因都存在粒線體 DNA 中，酵素在粒線體內的核糖體上被合成

E. A copy of mitochondrial DNA is exported outside mitochondria. The synthesized enzymes are imported into mitochondria.

一套完整的粒線體 DNA 會被送出粒線體到細胞質中。酵素合成完後會被送回粒線體

A11. Jellyfish-derived genes encoding fluorescent proteins, such as green fluorescent protein (GFP), are widely used in molecular biological studies particularly for the purpose of tagging and visualizing proteins of interest. PLX is a plant gene encoding an unknown protein. A chimeric gene consisting of the PLX gene and the GFP gene was constructed to produce a PLX-GFP fusion protein under an inducible promoter, and introduced into mesophyll protoplasts by electroporation. The following figures show schematic images of fluorescence micrographs of the same protoplast at various times after the induction of PLX-GFP expression.

一種自水母身上發現的綠色螢光蛋白 (green fluorescent protein, GFP)，常被用來作爲標示及檢視蛋白質存在之用。PLX 是一種植物基因，會表現出一種未知蛋白。現有一個重組基因 PLX-GFP，它是由 PLX 與 GFP 兩種基因所共同構築，且能被啓動子調控而有蛋白質表現。該重組基因利用電穿孔送入葉肉細胞的原生質體中。下圖爲不同時間中，在相同的原生質體中，所表現 PLX-GFP 重組蛋白的螢光照片。

Before the induction (dotted line indicates the protoplast outline)
基因轉殖前 (虛線表示原生質體外緣)

Shortly after the induction
經過短時間後的觀察

Long after the induction
經過長時間後的觀察

In consideration of the change in the spatial pattern of the fluorescent signals, speculate which of the following cell structures most likely corresponds to the fluorescent signals in the middle picture.

觀察上述螢光圖片後，試問中間圖片中的螢光訊號可能爲下列何種構造？

A. Nucleoli 核仁

B. Mitochondria 粒線體

C. Golgi apparatuses 高基氏體

D. Nuclear pores 核孔

E. Chloroplasts 葉綠體

F. Peroxisomes 過氧化氫小體

A12. The recognition sequence for the restriction endonuclease *Ava*I is CYCGRG, where Y is any pyrimidine and R is any purine. What is the expected distance (in bp = base pairs) between the restriction sites of *Ava*I in a long, random DNA sequence?

限制酶 *Ava*I 的辨識位置爲 CYCGRG，Y 可以爲任一種嘧啶，R 可以爲任一種嘌呤。請在任意的長鏈 DNA 中，預估每隔多少的鹼基對會出現一個 *Ava*I 的辨識位置？

A. 4096 bp

B. 2048 bp

C. 1024 bp

D. 512 bp

E. 256 bp

F. 64 bp

A13. The arabinose operon of *Escherichia coli* is not expressed in the absence of arabinose. This is attributable to the AraC protein, which binds to the promoter of the arabinose operon and acts as a suppressor to prevent its transcription. Normally the arabinose operon is expressed in the presence of arabinose. In mutants that lack the *AraC* gene, however, the arabinose operon is not expressed even in the presence of arabinose. Based on this information, which of the following can be reasonably inferred with respect to AraC?

大腸菌中，當缺乏阿拉伯糖時，阿拉伯糖操縱子將不會被表現。AraC 蛋白會與操縱子的啓動子結合，同時抑制操縱子的轉錄作用。正常狀況下，阿拉伯糖操縱子會因爲阿拉伯糖的存在而表現。在缺乏 AraC 基因的突變種中，既使存在有阿拉伯糖下也無法表現。根據上述資訊，有關 AraC 的敘述，何者**正確**？

A. The transcription of the *AraC* gene is induced by arabinose

   AraC 基因的轉錄，會被阿拉伯糖所誘導

B. The transcription of the *AraC* gene is blocked by arabinose

   AraC 基因的轉錄，會被阿拉伯糖所抑制

C. The AraC protein is converted into an activator in the presence of arabinose

   當阿拉伯糖存在時，AraC 會轉變成爲具有活化阿拉伯糖操縱子的角色

D. The AraC protein is degraded in the presence of arabinose

   當阿拉伯糖存在時，AraC 會被降解

A14. Nucleotide sequence duplications in a gene cause severe effects on its function in some cases while they do not in other cases. Which of the following duplication events would most likely result in the synthesis of a **non-functional** protein?

基因中的部分核苷酸序列的重複出現，對功能影響的程度各有不同，下列何者與出現重複序列的敘述與合成『**非功能性**』蛋白最具關聯性。

A. A base pair is duplicated just before the translation initiation site.

在轉譯起始位置前，先出現一個鹼基對的重複

B. Three base pairs are duplicated just before the translation initiation site.

在轉譯起始位置前，先出現三個鹼基對的重複

C. A base pair is duplicated in the coding region near the translation initiation site.

靠近轉譯起始位置的編碼區內，出現一個鹼基對的重複

D. Three base pairs are duplicated in the coding region near the translation initiation site.

靠近轉譯起始位置的編碼區內，出現三個鹼基對的重複

E. A base pair is duplicated in the coding region near the stop codon.

靠近終止密碼的編碼區內，出現一個鹼基對的重複

F. Three base pairs are duplicated in the coding region near the stop codon.

靠近終止密碼的編碼區內，出現三個鹼基對的重複

Plant Anatomy and Physiology

植物解剖與生理

A15. Cell walls of vessels and tracheids of vascular plants contain a phenolic polymer called "lignin", which together with cellulose confers mechanical strength to these water-conducting tissues. If vessels/tracheids are deficient in lignin, they:

A15.維管束植物的導管與管胞 (假導管) 之細胞壁含有木質素(lignin，屬於酚類聚合物)，細胞壁藉由木質素與纖維素混合，以增強其輸水組織的機械強度。倘若導管/管胞缺乏木質素，則：

A. burst outward when transpiration is very active.

A. 當蒸散作用強時，細胞會撐破

B. burst outward when transpiration is very inactive.

B. 當蒸散作用弱時，細胞會撐破

C.collapse inward when transpiration is very active.

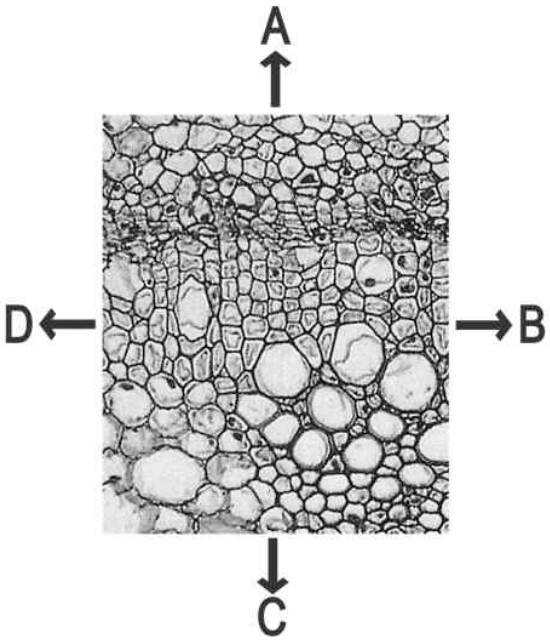
C. 當蒸散作用強時，細胞會萎縮

D.collapse inward when transpiration is very inactive.

D. 當蒸散作用弱時，細胞會萎縮

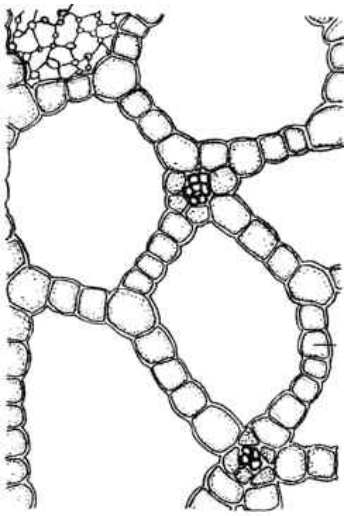
A16. The following micrograph shows a part of the transverse section of the stem of a dicot plant. Which arrow indicates the direction towards the center of the stem?

A16.下圖是雙子葉植物莖的橫切面，哪一個箭頭所指的方向是指向莖的中心？



A17. The plant tissue shown below is likely to be from a:

A17.下圖的植物組織顯示此植物屬於：



A. xerophyte 旱生植物

B. mesophyte 中生植物

C.halophyte 鹽生植物

D.hydrophyte 水生植物

E.epiphyte 附生植物

A18. To examine the effect of phytohormones in plant tissue culture, leaf segments were excised from plants grown under the light, placed on medium that contained P1 and/or P2, and cultured in the dark. As a control experiment, leaf segments were cultured without P1 or P2 in the dark.

爲檢視植物組織培養中植物激素 P1 及 P2 的作用，取一小片生長於光照下的植物葉片，將之放在含有 P1 及/或 P2 的培養基中，並在黑暗中培養。對照組則使用不含 P1 或 P2 的培養基，並在黑暗中培養。培養基成分及葉片生長的情形如下表：

(a) When only P1 was added to the medium, adventitious roots formed on the explants.
(b) When only P2 was added to the medium, neither organogenesis nor callus formation occurred. The explants retained green color for a longer period than the explants of the control experiment.
(c) When both P1 and P2 were added to the medium, callus formed on the explants.

(a) 在只含 P1 的培養基中，此一小片葉上長出不定根
(b) 在只含 P2 的培養基中，此一小片葉既沒有任何器官分化也沒有癒傷組織形成，但此一小片葉較對照組的葉片，可維持綠色的時間較久。
(c) 在含 P1 與 P2 的培養基中，此一小片葉上長出癒傷組織

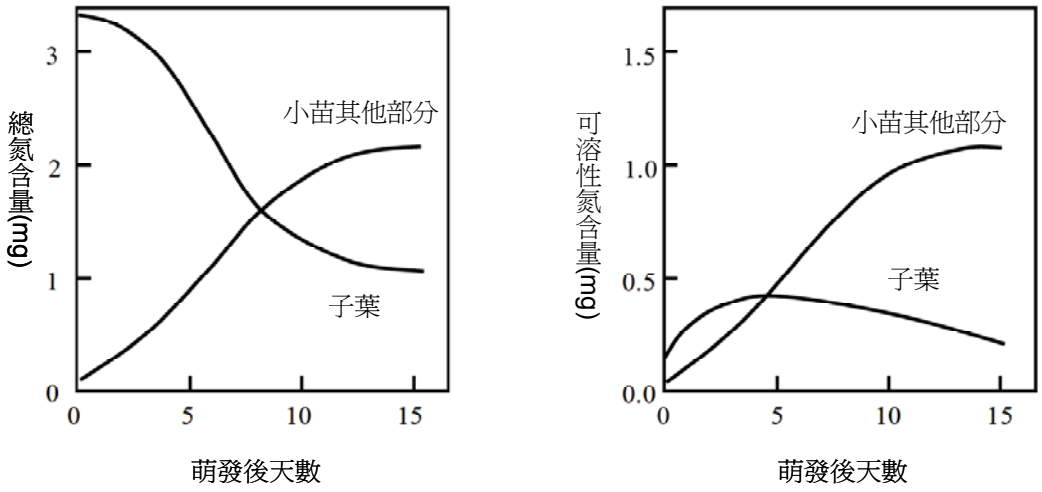
Based on this information, P1 and P2 were:

根據以上結果，P1 及 P2 分別是：

	P1	P2
A	Auxin 植物生長素	Gibberellin 吉貝素
B	Auxin 植物生長素	Cytokinin 細胞分裂素
C	Gibberellin 吉貝素	Auxin 植物生長素
D	Gibberellin 吉貝素	Cytokinin 細胞分裂素
E	Cytokinin 細胞分裂素	Gibberellin 吉貝素
F	Cytokinin 細胞分裂素	Auxin 植物生長素

A19. Exalbuminous (endospermless) seeds of a certain plant species were immersed in pure water, germinated, and grown in the dark. Total nitrogen content and soluble nitrogen content (nitrogen in low-molecular-weight compounds such as amino acids) were measured for cotyledons and the other parts of the seedlings. The results are shown in the following figures. With respect to the nitrogen metabolism in seedlings of this plant, which of the following statements is the most appropriate explanation?

A19.將某種植物的無胚乳種子以純水浸泡、使其萌發並在黑暗中生長後。估算幼苗的子葉及其他部分之總含氮量及可溶性氮（如胺基酸等小分子的含氮化合物）含量。結果如下圖所示。請考量此植物幼苗的氮代謝情形，選出下列敘述中何者爲最適當？



Proteins in cotyledons were degraded to produce amino acids,

A. which were eventually consumed as nitrogen sources for the growth of cotyledons.
B. which were eventually excreted from seedlings as wastes.
C. which were translocated and provided almost all of the nitrogen sources required for the initial growth of seedlings.
D. which were translocated and provided about half of the nitrogen sources required for the initial growth of seedlings.

子葉中的蛋白質分解所形成的胺基酸，

A. 被用作爲子葉生長所需的氮源
B. 被幼苗當作廢棄物排出體外
C. 大部分被轉運至幼苗，以供其初期生長之需
D. 約有一半被轉運至幼苗，以供其初期生長之需

A20. Two alleles *G* and *g* are present at a particular locus of a fern species. Spores were collected from a heterozygous sporophyte with *Gg* genotype of the fern species. Gametophytes were grown from the spores and self-fertilized by isolating each sexually matured gametophyte. What is the expected ratio of the *GG* : *Gg* : *gg* genotypes of the sporophytes?

A20.某種蕨類植物的某基因座上有 *G*、*g* 兩個對偶基因。收集異型合子基因型(*Gg*)的蕨類孢子體的孢子，使孢子萌發成的配子體，然後一一隔離培養這些配子體，以利配子體自交產生下一代的孢子體。試問：理論上，由配子體自交所產生的下一代孢子體基因型 *GG* : *Gg* : *gg* 之比例爲何？

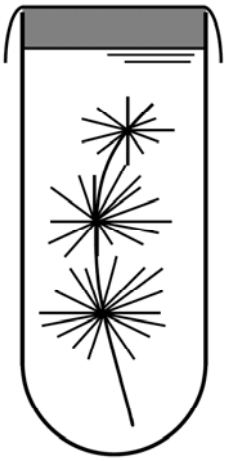
A. 1 : 2 : 1
B. 2 : 1 : 1
C. 3 : 0 : 1
D. 0 : 3 : 1
E. 1 : 0 : 1
F. 0 : 1 : 1

A21. Totally submerged aquatic plants can cause a pH change in the surrounding water when they carry out photosynthesis. What pH change happens and what causes it?

A21.沉水性水生植物在行光合作用時，會改變水中的 pH 值。試問 pH值 會如何改變，且改變的原因爲何？

A. The pH falls because carbon dioxide is absorbed.
B. The pH rises because carbon dioxide is absorbed.
C. The pH falls because oxygen is released.
D. The pH rises because oxygen is released.

A. pH 值會下降，因爲吸收二氧化碳
B. pH 值會上升，因爲吸收二氧化碳
C. pH 值會下降，因爲釋出氧
D. pH 值會上升，因爲釋出氧



A22. If the ambient temperature rises by 5°C, photorespiration would:

A22.若環境溫度升高 5°C，則下列不同植物的光呼吸作用(photorespiration)將會如何變化：

A. Increase in rice, decrease in maize
B. Increase in maize, decrease in rice
C. Increase in rice, little effects on maize
D. Increase in maize, little effects on rice
E. Increase in both species
F. Decrease in both species

A. 在水稻會升高；在玉米會下降
B. 在玉米會升高；在水稻會下降
C. 在水稻會升高；在玉米則不受影響
D. 在玉米會升高；在水稻則不受影響
E. 兩種植物都升高
F. 兩種植物都下降

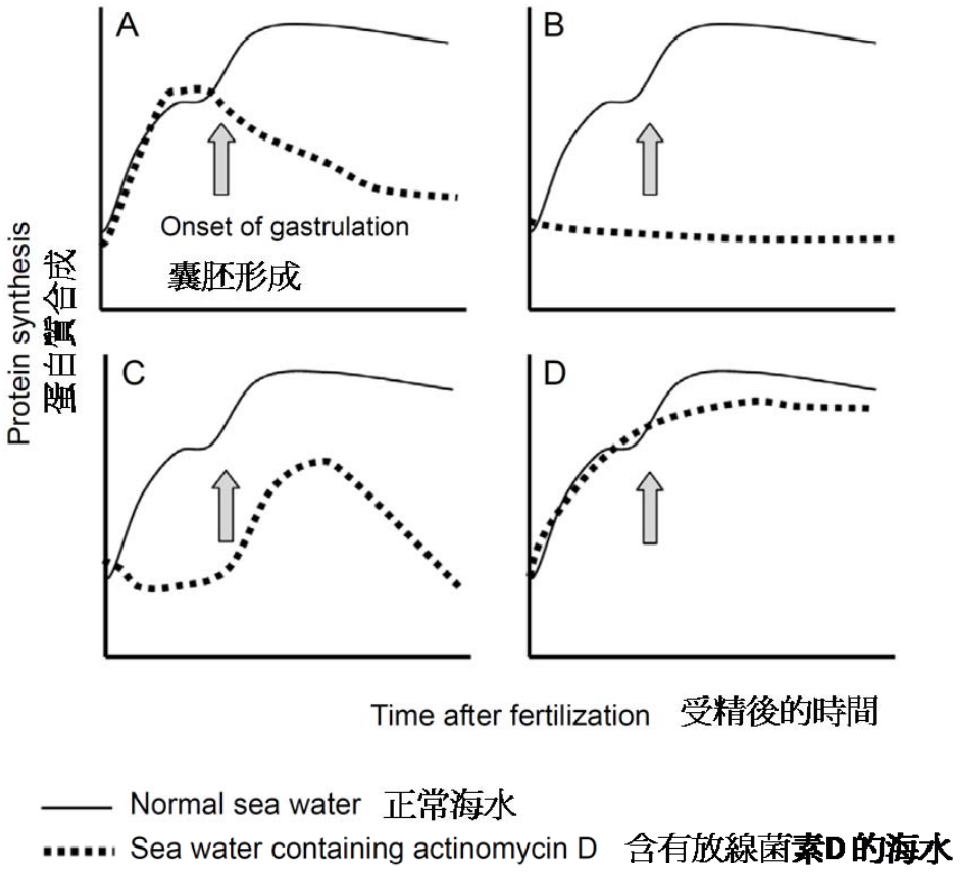
Animal Anatomy and Physiology 動物解剖與生理

A23. When fertilized sea urchin eggs were reared in sea water containing actinomycin D, an inhibitor of transcription, eggs developed normally until the blastula stage, but stopped development after that. This is due to the fact that in embryos the process of transcription does not take place during the cleavage period, and the proteins necessary for the development are translated from mRNA stored in the eggs.

A23. 將已受精海膽卵放在含有會抑制轉錄的放線菌素 D 的海水中培養，受精卵的發生在囊胚(胚胞)期前一切正常，囊胚期後停止發育。卵裂期的胚胎發育無轉錄發生，因爲製造此階段發育所需蛋白質的 mRNA，早已存在卵中。

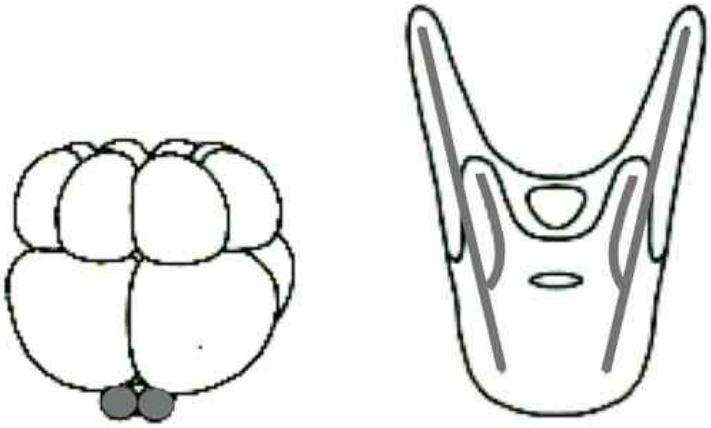
If protein synthesis is measured during this experiment, which of the following graphs would be obtained?

在此實驗中測量蛋白質合成，會得到下列何圖所示結果？



A24. At the 16-cell stage, the sea urchin embryo consists of three types of cells: eight mesomeres, four macromeres and four micromeres, from animal pole to vegetal pole. When four micromeres were labeled by fluorescent dye, all the spicule forming cells in the resulting 2-day-old larva were fluorescent (see figure).

A24. 海膽胚胎在 16-細胞期時具有三類細胞：由動物極向植物極分別爲 8 個中細胞、4 個大細胞和 4 個小細胞。以螢光染色 4 個小細胞，所有 2-天大幼體的骨針形成細胞均出現螢光(見圖)。



Thus, in normal larvae, spicule forming cells are derived solely from micromeres. However, even if all the micromeres are removed from a 16-cell embryo, spiculogenesis still occurs in 2-day-old larva. From this we can conclude that:

A. all the cells in a 16-cell-stage embryo can form spicules when receiving an appropriate signal from micromeres.
B. all the cells in a 16-cell-stage embryo can form spicules when the micromeres are removed.
C. micromeres or their descendent cells send a spiculogenesis-inhibiting signal to other cells.
D. micromeres or their descendent cells send a spiculogenesis-inducing signal to other cells.

因此，正常幼體的骨針形成細胞是由小細胞發育而來，但即使將 16 細胞期時的 4 個小細胞全都移除，2 天大的海膽幼體仍會進行骨針形成。由此可做出以下哪一結論？

A. 若接受適當的信號，所有 16-細胞期的細胞均能形成骨針。
B. 若小細胞被移除，所有 16-細胞期的細胞均能形成骨針。
C. 小細胞或其衍生細胞能對其他細胞發出骨針形成的抑制信號。
D. 小細胞或其衍生細胞能對其他細胞發出骨針形成的誘導信號。

A25. The crab-eating frog is a unique amphibian which has adapted to the marine habitat and lives in mangroves. Different from marine bony fish, these frogs deal with the osmotic problem by:

A. drinking sea water and excreting excess salt.

B. excreting a large amount of excess water as urine.

C. excreting nitrogen waste as ammonia.

D. storing urea in their body fluid.

A25. 生活在紅樹林中會吃螃蟹的蛙，是一種適應海水環境的特殊兩生類，與海生硬骨魚的不同，這些蛙如何解決滲透壓調節的問題？

A. 喝海水並排過量的鹽

B. 以尿液方式排大量的海水

C. 以氨的形式排含氮廢物

D. 在其體液中儲存尿素

A26. Which of the following states occurs if the lung alveoli lose their elasticity?

I. Residual volume decreases

II. pO_2 in the air inhaled has to increase in order to keep the saturation of hemoglobin at the same level

III. Blo od pH increases

A. only I
B. only II
C. only III
D. I and II
E. I and III
F. II and III

A26. 如果肺泡失去彈性，會發生以下何種狀況？

I. 殘留容積減少

II. 吸入空氣中 O_2 的分壓必須增加，以保持血紅素在相同飽和度

III. 血液 pH 值增加

A. 只有 I
B. 只有 II
C. 只有 III
D. I and II
E. I and III
F. II and III

A27. Which of the following statements about skeletal muscle is NOT correct?

A. The length (distance) of a single muscle contraction depends on the concentration of Ca^{2+} ions in the sarcoplasmic reticulum.
B. Muscles with short sarcomeres contract faster than muscles with long sarcomeres.
C. The velocity of muscle contractions is determined by myosine-ATPase activity.
D. Tetanus is the effect of repeated stimulations within a very short interval.
E. Rigor mortis (death rigidity) appears when the concentration of Ca^{2+} in cytoplasm is high but ATP is lacking.

A27. 下列有關骨骼肌的敘述，何者錯誤？

A. 單一肌肉收縮的長度(距離)與肌質網中的鈣離子濃度有關
B. 具有短的肌小節的肌肉收縮速率較具有長的肌小節之肌肉快
C. 肌肉收縮的速率決定於其肌凝蛋白-ATPase 的活性
D. 極短時間內的連續刺激，可造成強直性痙攣的結果
E. 屍僵 (rigor mortis) 的成因，是細胞質中的鈣離子濃度高但卻缺乏 ATP

A28. Which of the following would occur if a neuron was experimentally stimulated simultaneously at both ends?

A. The action potentials would pass in the middle and travel to the opposite ends.
B. The action potentials would meet in the middle and then be propagated back to their starting positions.
C. The action potentials would stop as they meet in the middle.
D. The stronger action potential would override the weaker action potential.
E. Summation would occur when the action potentials meet in the middle, resulting in a larger action potential.

A28. 如果同時刺激一神經元的兩端，下列何種狀況會發生？

A. 動作電位將經過中央傳到相對端
B. 動作電位將在中央相遇，再回傳到起始位置
C. 動作電位將在中央相遇並停止傳導
D. 較強的動作電位將超越較弱的動作電位
E. 動作電位在中央相遇，形成一個更大的動作電位

A29 What happens when the pancreatic duct of a certain mammal is temporarily ligated for an experiment. Note that carbohydrate and other nutrients in the diet are in proper amounts and ligation of the pancreatic duct is not critical for survival of the animal.

The amount of carbohydrate:

A. increases in feces, decreases in urine.

B. increases in feces, does not change in urine.

C. decreases in feces, increases in urine.

D. decreases in feces, does not change in urine.

E. increases both in feces and urine.

F. decreases both in feces and urine.

A29 若給某哺乳動物的胰腺管作暫時的結紮，會發生什麼事？注意食物中的醣類與其他養分均爲適量，且胰腺管結紮對此動物生存影響不大。

醣類的量將會：

A. 在糞中增加、在尿中減少

B. 在糞中增加、在尿中不變.

C. 在糞中減少、在尿中增加

D. 在糞中減少、在尿中不變.

E. 在糞中及尿中均增加.

F. 在糞中及尿中均減少.

A30. Shown is the change of glucose concentration in the blood, measured by taking small blood samples from the fingertip of a person who drank a solution containing 50 g of glucose.

下表爲在血液中葡萄糖濃度的變化，受試者在喝下含有 50 克葡萄糖溶液後，在指尖採血後量測的結果

Time after drinking the solution 喝下溶液後經過的時間 (min)	Glucose conc. in the blood 血中葡萄糖的濃度 (mmol/L)
0	4.9
15	6.1
30	7.7
45	6.4
60	4.2
90	4.2
120	4.0
150	4.8

Has the glucose concentration at any time during the experiment been equal to or higher than 7.7 mmol/L in the hepatic portal vein and the hepatic vein?

試問在實驗進行的整個過程中，肝門靜脈與肝靜脈的血糖濃度曾經會有大於或等於 7.7 mmol/L 的嗎？請選出正確答案。

	hepatic portal vein (肝門靜脈)	hepatic vein (肝靜脈)
A.	no	no
B.	no	yes
C.	yes	no
D.	yes	yes

A31. A substance from the plant *Gymnema sylvestre* blocks the sweet taste of sugar and also blocks absorption of sugar by the small intestine. What can be assumed from these two phenomena?

A. It metabolizes sucrose to glucose and fructose.

B. It polymerizes sugar into oligosaccharides.

C. It binds with sugar receptors and transporters.

D. It binds with certain neurotransmitter receptors and transporters.

E. It binds with insulin receptors.

A31. 植物 *Gymnema sylvestre* 中的某一物質能阻斷人對糖的甜味味覺及小腸對糖的吸收，根據此二現象你可作何種假設？

A. 它能將糖蔗糖分解爲葡萄糖及果糖

B. 它能將糖聚合爲寡醣

C. 它能與糖的受體及輸送載體結合

D. 它能與某種神經傳導物質的受體及某些運輸載體結合

E. 它能與胰島素的受體結合

A32. When a species of poisonous fish was fertilized *in vitro* and cultured in an indoor plastic tank filled with artificial seawater, they were never poisonous. Young fish grown in this tank were next divided into two groups and placed in separate pens in a bay where they were exposed to real seawater. One pen had a horizontal net that prevented the fish from reaching the sea bottom, while the other pen had no horizontal net. Subsequently, no poison was detected from the fish cultured in the pen with the net, but poison was found in fish from the other pen.

What do you conclude from this experiment? To be toxic:

I. some component not in artificial seawater but in natural seawater is necessary.
II. it is necessary that they grow up to adults.
III. it is necessary that they can reach the sea bottom.

A. Only I
B. Only II
C. Only III
D. Both I and II
E. Both I and III
F. Both II and III

A32. 一種有毒的魚若經人工的試管內授精後，培養在裝有人工海水的一個室內塑膠缸中，即不再具有毒性。將養在此缸中的小魚分爲兩組，分兩區養在海灣中與真正海水接觸，一區架有水平網防止魚接觸水底，另一區則沒有水平網。其後的研究發現有網區的魚無毒，無網區的魚有毒。

從這研究你會得到什麼結論？魚要如何變成有毒：

I. 某種在人工海水無、但真的海水中有的成分是必須的
II. 必須成長到成體
III. 必須接觸到海底

A. 只有 I
B. 只有 II
C. 只有 III
D. I and II
E. I and III
F. II and III

A33. What can be most likely inferred from the following statements (1 to 4) about a disease of patient X?

1. Patient X has a disease that makes her very sensitive to infection by bacteria and viruses.
2. The IgG gene of this patient is normal.
3. This disease is caused by the abnormality of gene “x” which does not work at all.
4. When T cells of a normal person and B cells of patient X are mixed and cultured in the presence of reagents that activate these cells, IgG is secreted into the culture medium. However, when B cells of a normal person and T cells of patient X are combined, IgG is not secreted.

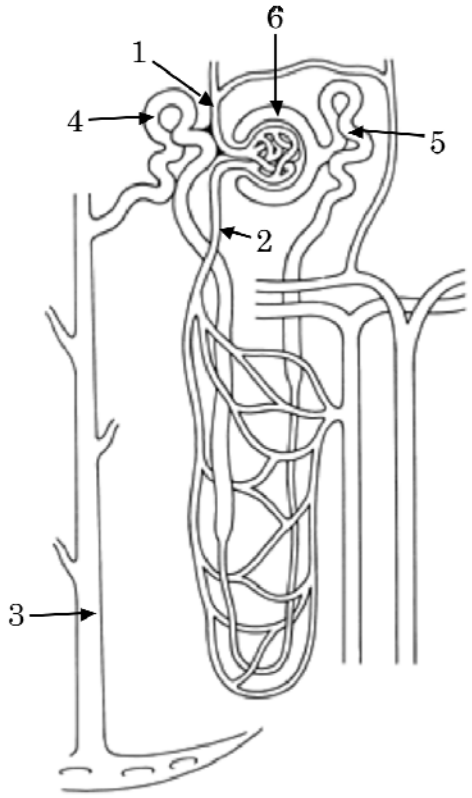
A. Gene “x” needs to be expressed in B cells for the production of IgG.
B. T cells of patient X are normal.
C. IgG is produced by T cells.
D. Gene products of gene “x” are necessary for T cells to induce B cells to produce IgG.
E. The genome of B cells does not contain gene “x”, while that of T cells does.

A33.由下列 4 個敘述來判斷，什麼會是對病人 X 的疾病最好的推論？

1. 病人 X 的病使她非常容易受到細菌及病毒的感染
2. 病人的 IgG 基因正常
3. 這病是起因於一沒有功用的異常基因 “x”
4. 將正常人的 T 細胞與病人 X 的 B 細胞混合，培養於存在有活化細胞的物質的條件下，IgG 會被分泌到培養液中；但若用正常人的 B 細胞與病人 X 的 T 細胞混合，則無 IgG 的分泌

A. 基因 “x” 在 B 細胞必須表現才能產生 IgG.
B. 病人 X 的 T 細胞是正常的.
C. IgG 是由 T 細胞生成的
D. 要誘導 B 細胞產生 IgG，基因“x”的產物對 T 細胞是必須的
E. B 細胞的基因組不含基因“x”，T 細胞的基因組則含.

A34. The diagram shows a simplified kidney tubule and associated blood vessels, and the table shows the presence or absence of substances (X, Y, Z) in each part (1–6) of the diagram. 【中文翻譯在下頁】

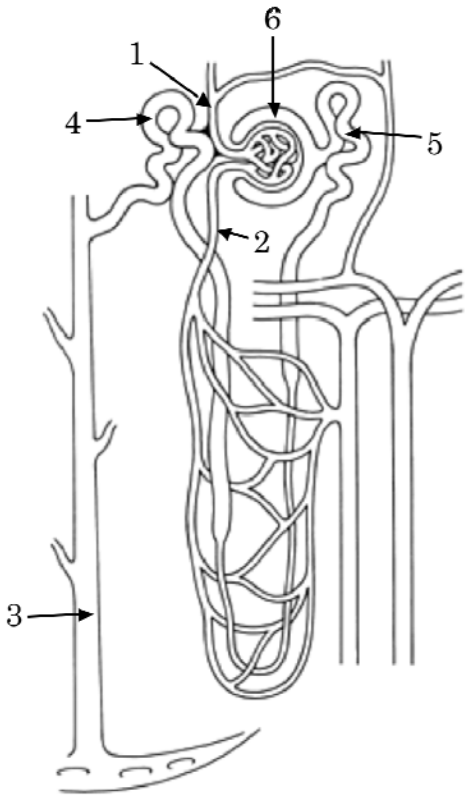


	X	Y	Z
1	Present	Present	Present
2	Present	Present	Present
3	Absent	Present	Absent
4	Absent	Present	Absent
5	Present	Present	Absent
6	Present	Present	Absent

Identify the substances X to Z.

	X	Y	Z
A	Urea	Glucose	Proteins
B	Urea	Proteins	Glucose
C	Glucose	Urea	Proteins
D	Glucose	Proteins	Urea
E	Proteins	Glucose	Urea
F	Proteins	Urea	Glucose

A34. 下面顯示一腎小管與相關血管的簡圖，而表中則顯示在該圖中 1–6 的部位是否有 X, Y, Z 等物質的存在



	X	Y	Z
1	Present	Present	Present
2	Present	Present	Present
3	Absent	Present	Absent
4	Absent	Present	Absent
5	Present	Present	Absent
6	Present	Present	Absent

請辨識此 X, Y, Z 三種物質爲何：

	X	Y	Z
A	尿素	葡萄糖	蛋白質
B	尿素	蛋白質	葡萄糖
C	葡萄糖	尿素	蛋白質
D	葡萄糖	蛋白質	尿素
E	蛋白質	葡萄糖	尿素
F	蛋白質	尿素	葡萄糖

Ethology 行爲學

A35. The vampire bat of Costa Rica is often not able to acquire blood from a mammal on a given night. Wilkinson (1984) trapped bats which were not allowed to feed for a night and found that they were given regurgitated blood by certain cave-mates. Based on this knowledge, which of the following observations are indispensable to confirm the occurrence of reciprocal altruism in this species?

A35.哥斯大黎加的吸血蝙蝠以哺乳動物的血爲食，但吸血蝙蝠不見得每天晚上都能獲得他們的食物，1984 年 Wilkinson 利用捕捉蝙蝠做實驗，若一晚不給蝙蝠吸血後，發現同一洞穴中某些的蝙蝠同伴會給它餵血，根據這個觀察，下列何種資料用來判斷此種蝙蝠所具有互惠式的利他行爲 (reciprocal altruism) 是必要的？

Data showing that:

I. blood is exchanged only between kin.

I. 血液的交換行爲只在有親源關係的個體間發生

II. blood is exchanged between non-kin.

II. 血液的交換行爲是在無親源關係的個體間發生

III. weak bats are frequently given blood even if they cannot give it to others.

III. 虛弱的蝙蝠縱使它不曾給其他蝙蝠餵血，亦會經常由其他個體獲得餵血

IV. bats who are given blood donate it to those who have given it to them before.

IV. 蝙蝠只會餵血給其他以前曾經餵血給它的個體

Combinations:

A. only I

B. only IV

C. I, III

D. I, IV

E. II, III

F. II, IV

A36. In a certain bird species, territory-holding males are sexually mature, have red chest feathers and aggressively drive out intruders. Several models, shown below, were built to test territory defense in this species. What is the most likely sequence of attack on these models in decreasing order of aggression?

A36.在某種鳥類的個體中，佔有領域的雄鳥爲性成熟的個體，而胸部具有紅色羽毛者，則會對入侵者展現驅趕的行爲。下列幾個模型（I~IV）被用來測試此種鳥的領域佔有和防禦行爲，請問在幾種模型的組合方式（A~D）中，哪一個是依攻擊性由高至低的順序所排列出來的正確組合？

I. A model of a normal juvenile bird with brown chest feathers

I. 一個具有棕色胸羽的正常年輕幼鳥模型

II. A model of a normal adult bird with red chest feathers

II. 一個具有具有紅色胸羽的正常成鳥模型

III. A model of an adult bird with brown chest feathers

III. 一個具有棕色胸羽的成鳥模型

IV. A model of a juvenile bird with red chest feathers

IV. 一個具有具有紅色胸羽的年輕幼鳥模型

Sequences

A. I →III→IV →II

B. I →IV →III →II

C. II →III →IV →I

D. II →IV →III →I

Genetics and Evolution 遺傳及演化

A37. A man with a genetic disease marries a phenotypically normal woman. They have four girls and four boys; all of the girls have the same disease as their father, but none of the boys does. What is the most likely explanation?

患有遺傳疾病的男性與表型正常的女性結婚，他們生下四女四男，所有女兒皆與父親相同患有此病，但兒子都沒患病。下列何者最能解釋此情形？

The disease is caused by:

A. an autosomal dominant allele.
B. an autosomal recessive allele.
C. an X-linked dominant allele.
D. an X-linked recessive allele.
E. a Y-linked allele.

此疾病是由何基因造成的？

A. 體染色體顯性基因
B. 體染色體隱性基因
C. X-染色體之顯性性聯基因
D. X-染色體之隱性性聯基因
E. Y-染色體之性聯基因

A38. There is a degenerative disease which develops in people between 35 and 45 years old. It is caused by a dominant allele. A couple has two children, who are both younger than 20 years old. One parent has the disease (heterozygote), but the other parent, who is 50 years old, does not. What is the probability that the **both** children will develop this disease when they become older?

一種發生在35-45歲之間的退化性疾病，是因某顯性基因所造成。一對夫婦生有兩個還不到20歲的小孩。父母之一有此疾病（異型合子），但另一人沒有（此人年齡 50 歲）。**兩個** 小孩年長後都會患病的機率爲何？

A. 1/16
B. 3/16
C. 1/4
D. 9/16
E. 3/4

A39. There are n+1 alleles at a particular locus on an autosome. The frequency of one allele is 1/2 and the frequencies of the other alleles are all 1/(2n). Under the assumption of Hardy-Weinberg equilibrium, what is the total frequency of heterozygotes?

某條體染色體的某個特定基因座上有 n+1 個對偶基因，其中一個對偶基因的頻率爲 1/2，而其他 n 個對偶基因的頻率都是 1/(2n)。在符合哈溫定律之下，異型合子的總頻率是多少？

A. (n – 1)/(2n)
B. (2n – 1)/(3n)
C. (3n – 1)/(4n)
D. (4n – 1)/(5n)
E. (5n – 1)/(6n)

A40. At a locus for an enzyme which is inherited independently of sex, the frequencies of genotypes in a population were as follows.

某酵素的基因座不是性聯遺傳，各基因型在族群中的頻率如下表所示。

	FF	*FS*	*SS*
Female	30	60	10
Male	20	40	40

Predict the frequency of the *FS* genotype in the next generation, assuming that they will mate randomly.

假設交配爲逢機的，請推測下一子代的 *FS* 基因型頻率。

A. 0.46
B. 0.48
C. 0.50
D. 0.52
E. 0.54

A41. How does the occurrence of self-fertilization relative to cross-fertilization affect the fixation of an advantageous and recessive allele that newly appeared in a population by mutation?

A. The allele will be fixed most quickly when the relative occurrence of self-fertilization is highest.
B. The allele will be fixed most quickly when the relative occurrence of self-fertilization is lowest.
C. The allele will be fixed most quickly when the relative occurrence of self-fertilization is moderate.
D. The relative occurrence of self-fertilization does not affect the fixation of the allele.
E. The relative occurrence of self-fertilization affects the fixation of the allele only when the population is very small.

相對於異體交配，在一族群中自體交配，對保留突變新形成之有利適應性且爲隱性的對偶基因，是如何發揮其作用的？

A. 當自體交配的發生次數最高時，此新的對偶基因可最快留下來
B. 當自體交配的發生次數最低時，此新的對偶基因可最快留下來
C. 當自體交配的發生次數中等時，此新的對偶基因可最快留下來
D. 自體交配的發生次數不影響此新的對偶基因是否在族群中留下來
E. 當自體交配的發生次數僅在族群很小時，才會影響此新的對偶基因是否在族群中留下來

A42. The following table shows the number of estimated nucleotide substitutions that have occurred in a gene among seven species.

下表顯示在七個物種中的某一基因發生核苷酸取代的估計數目

The number of estimated nucleotide substitutions between each pair of species

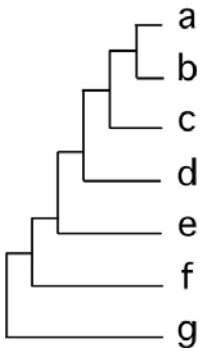
在二物種之間發生核苷酸取代的估計數目

	b	c	d	e	f	g
a	39	72	128	126	159	269
b		81	130	128	158	268
c			129	127	157	267
d				56	154	271
e					151	268
f						273

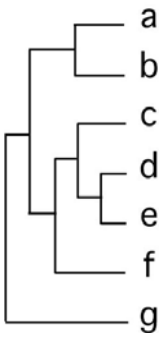
Which is the most appropriate tree that shows the phylogenetic relationship among these seven species?

下頁何者是最能顯示這七物種親緣最適合的關係樹？

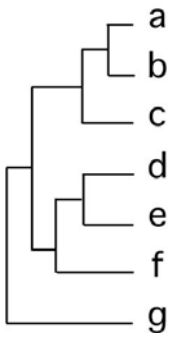
A.



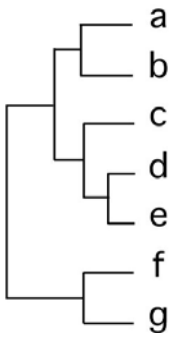
B.



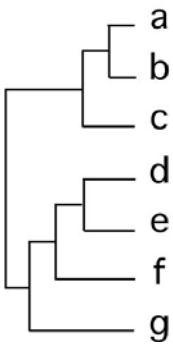
C.



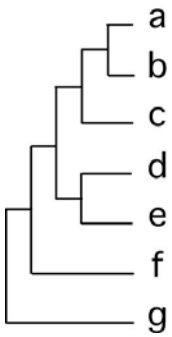
D.



E.



F.



A43. Suppose that at a neutrally evolving genomic region of a species the mutation rate from the base pair GC to AT is three-times the mutation rate from AT to GC. What is the expected GC content at equilibrium?

假設在某物種的中性演化基因區中，GC 突變成 AT 的機率是 AT 突變成 GC 的三倍。試問在平衡時，GC 含量的期望值爲何？

A. 1/2

B. 1/3

C. 1/4

D. 1/5

E. 1/6

A44. A species of insect was found to have developed resistance to a commonly used insecticide. Which of the following is the most likely explanation?

A44.一種昆蟲對一種常用的殺蟲劑產生抗藥性，下列何者是最可能的解釋？

A. Stabilizing selection caused development of resistance in the insect population.

A. 穩定性天擇(選汰)造成此種昆蟲族群發展出抗藥性

B. The original gene pool included genes that conferred resistance to the insecticide.

B. 此族群原有的基因庫內即有此抗藥基因

C. The insecticide stimulated development of resistance in certain individuals and this was inherited.

C. 此殺蟲劑刺激某些個體發展出抗藥性，而此種抗藥性是可遺傳的

D. The insecticide caused a mutation that was favorable to resistance and this was inherited.

D. 此殺蟲劑造成一個抗藥性的突變，而後被遺傳保存下來

A45. Darwin's finches are a prime example of adaptive radiation. Which of the following best describes this adaptive radiation correctly?

A45.各種達爾文雀爲輻射適應的一種典範，下列何種敘述能正確的描述輻射適應的現象？

A. The genetic variability that can be found among individuals of the same species.

A. 遺傳變異可在同種內不同個體間出現

B. The evolutionary process by which different forms, adapted to different niches, arose from a common ancestor.

B. 此是一種關於演化歷程的敘述，來自共同祖先的個體，爲適應不同環境發展出不同的型態

C. A sudden diversification of a group of organisms from closely related species.

C. 一群親源關係相近的生物，因爲一個突然的變異而造成分化

D. The evolutionary process that allows for the changes that occur within the same lineage.

D. 在同一個遺傳譜系內的生物，經由演化歷程所產生的各種改變(變異)

E. The evolutionary process of adaptation of species through a kind of polymorphism.

E. 演化後適應的結果，造成一個物種內的多態性呈現

A46. Multigene families are groups of two or more identical or very similar genes. Which of the following statements about multigene families is correct?

A. Globin gene families do not have pseudogenes, because globins are essential for oxygen transport.
B. Ribosomal RNA gene families in multicellular eukaryotes have many identical genes, because many ribosomes are required for active protein synthesis.
C. Compared with multicellular eukaryotes, prokaryotes have many multigene families, because prokaryotes have to reproduce very quickly.
D. The number of genes in a multigene family always increases by unequal crossing over.

A46. 多基因家族爲由兩個或兩個以上相同或極爲相似的基因所組成的基因群，下列有關多基因家族的敘述何者正確？

A. 球蛋白基因家族沒有僞基因，因爲球蛋白對氧的輸送極爲重要
B. 多細胞真核生物的 r RNA 基因家族具有許多相同的基因，因爲蛋白質的合成需要許多核糖體.
C. 與多細胞真核生物比較，原核生物具有許多多基因家族，因爲原核生物必須快速繁殖.
D. 因爲染色體非對稱性互換，多基因家族的基因數目會一直增加

Ecology 生態學

A47. The following table shows the net primary productivity and biomass without soil organic matter in five ecosystems.

A47.下表顯示五種生態系之淨基礎生量及生物量 (不含土壤中之有機物質)

Ecosystem	Net primary productivity 淨基礎生產量 ($g/m^2/year$)	Biomass 生物量 (kg/m^2)
Tropical rainforest 熱帶雨林	2200	45
I	2000	15
II	1200	30
III	900	4
Boreal forest 寒帶森林	800	20

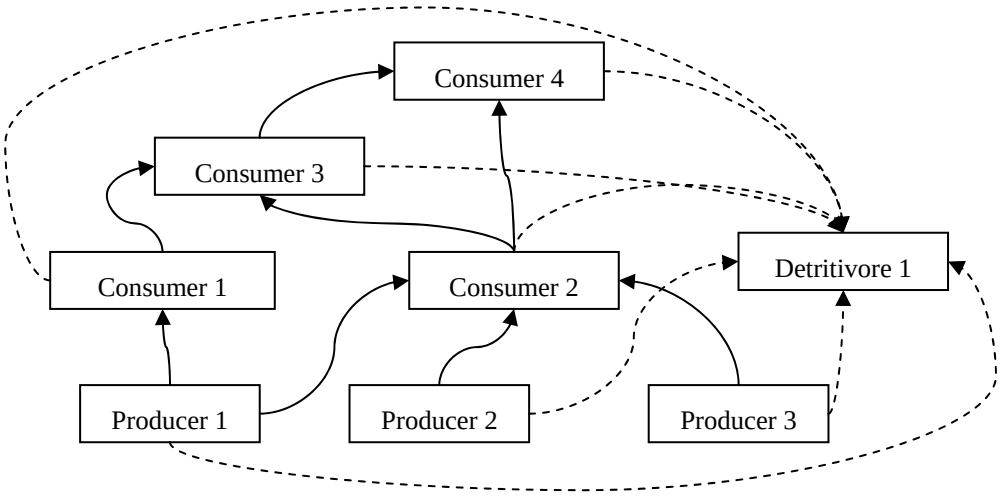
Choose from A to F in the table below the most appropriate combination of ecosystems for I, II and III above.

由下表 A 至 F 所提供的資料中，選擇其中與 I, II 及 III 的生態系對等的生態系。

	I	II	III
A	African dry savanna 非洲乾旱大草原	Tropical swamp & marsh 熱帶沼澤	Temperate deciduous forest 溫帶落葉林
B	African dry savanna 非洲乾旱大草原	Temperate deciduous forest 溫帶落葉林	Tropical swamp & marsh 熱帶沼澤
C	Temperate deciduous forest 溫帶落葉林	African dry savanna 非洲乾旱大草原	Tropical swamp & marsh 熱帶沼澤
D	Temperate deciduous forest 溫帶落葉林	Tropical swamp & marsh 熱帶沼澤	African dry savanna 非洲乾旱大草原
E	Tropical swamp & marsh 熱帶沼澤	African dry savanna 非洲乾旱大草原	Temperate deciduous forest 溫帶落葉林
F	Tropical swamp & marsh 熱帶沼澤	Temperate deciduous forest 溫帶落葉林	African dry savanna 非洲乾旱大草原

A48. The diagram below represents the relationships between organisms in a remote pond ecosystem.

A48. 下圖示顯示在一個偏僻的池塘生態系中，生活其中的生物個體間的關係。



From this information, which of the following is the most likely to be correct?

由上圖的關係中，下列何者爲最有可能的**正確**敘述？

A. DDT present in the ecosystem would accumulate to the highest concentrations in the tissues of Detritivore 1.

A.若 DDT 出現在此生態系中，攝食碎屑的生物體內將累積最高的 DDT 含量

B. The introduction of Consumer 4 individuals from an external population would lead to a temporary increase in numbers of Producer 2.

B. 若以外界移入的方式，來增加生態系中消費者 4 的個體數量，則會造成生產者 2 個體數量的短暫增加

C. Disease in the Producer 1 population would lead to an increase in the Producer 3 population.

C. 若生產者 1 的族群個體發生疾病時，會造成對生產者 3 族群的個體增加

D. Extermination of Consumer 3 would cause a sustained increase in the population of Consumer 2.

D. 若消費者 3 的族群被消滅後，會造成消費者 2 的族群個體數量

E. Consumer 1 is more adaptable with regard to its food source than Consumer 3.

E. 就食物來源而言，消費者 1 比消費者 3 的適應能力更強

A49. The table below shows the results of measurements of production in two ecosystems in the temperate zone: a rainforest and a field with an annual crop. All results are stated in MJ/m^2 / year (1 MJ = 10^6J).

下表爲溫帶二個生態系生產力的估算結果：雨林及一年生作物的耕地。所有的結果以 MJ/m^2 / year (1 MJ = 10^6J)單位表示。

	[I] Rainforest 雨林	[II] Field with an annual crop 一年生作物耕地
Gross Primary Production (GPP) 粗初級生產力	188	102
Respiration (autotrophs) 呼吸作用（自營性生物）	134	38
Respiration (heterotrophs) 呼吸作用（異營性生物）	54	3

Of these two ecosystems, which has a higher ratio of respiration by heterotrophic organisms to net primary production (NPP)? What is the reason? Choose the correct option from A to F.

在此二生態系中，異營生物之呼吸作用與淨基礎生產量(net primary production,NPP)的比值，何者較高？其理由爲何？由A - F選擇出正確的答案。

A. [I] < [II]：The rainforest has larger GPP and more consumers than the crop field.
雨林與作物區（一年生作物的耕地）相較，雨林有較高的GPP及更多的消費者

B. [I] < [II]：The rainforest has larger NPP and more consumers than the crop field.
雨林與作物區相較，雨林有較高之NPP及較多的消費者

C. [I] < [II]：The rainforest has larger NPP and less consumers than the crop field.
雨林與作物區相較，雨林有較高之NPP及較少的消費者

D. [II] < [I]：The rainforest has smaller GPP and more consumers than the crop field.
雨林與作物區相較，雨林有較低之GPP及較多的消費者

E. [II] < [I]：The rainforest has smaller NPP and more consumers than the crop field.
雨林與作物區相較，雨林有較低之NPP及較多的消費者

F. [II] < [I]：The rainforest has smaller NPP and less consumers than the crop field.
雨林與作物區相較，雨林有較低之NPP及較少的消費者

A50. What does the energy input into most food webs typically depend on? Choose the most likely factor from the following.

在絕大多數食物網中，輸入食物網的能量主要仰賴的方式爲何？選出下列敘述何者最有可能？

A. Grazing rate of the primary consumers

初級消費者的吃草速率

B. Material cycling efficiency rate of the whole ecosystem

整個生態系中的物質循環速率

C. Efficiency rate of producers converting solar radiation energy into chemical energy

生產者轉化太陽能爲化學能的速率

D. Action of nitrogen-fixing bacteria

固氮細菌的作用

E. Heat-energy costs due to respiration within each trophic level

在每一營養階層由於呼吸作用所造成的熱能散失

A51. Which factor most promotes the stability of population dynamics in a developed terrestrial ecosystem?

在一已經穩定的陸域生態系中，下列何種因素對維持此生態系中各個族群的穩定有增進作用？

A. Food webs that have many trophic levels each of which consists of few species only

食物網由許多營養階層所組成，但每一個營養階層內只有少數物種

B. A few species of producers with very high production rates

由一些生產者所組成，且其皆有非常高的生產率

C. Rapid nutrient recycling by active decomposers

活躍的分解者造成快速的營養循環

D. Food webs that have very few trophic levels and limited niche overlaps

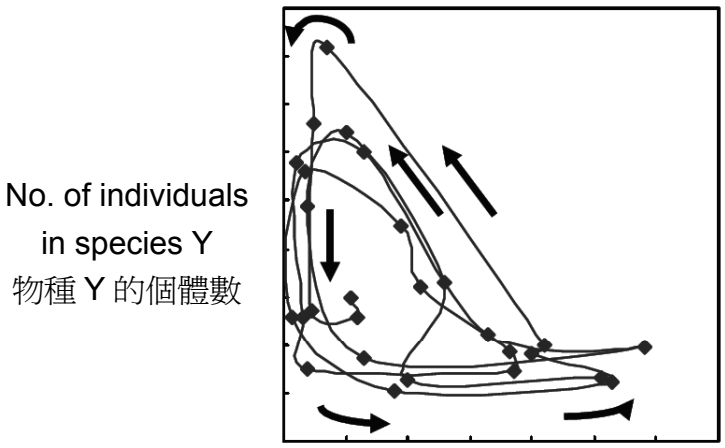
各個食物網中的營養階層簡單，且其中不同生物的生態地位之重疊性很有限

E. A few eminent and competitively-dominant species

具有一些突出及競爭性的優勢物種

A52. Animal species X and Y have a temporal negative correlation of population abundances, in which arrows indicate the anti-clock-wise (counter-clock-wise) orbit of population dynamics. Choose the most likely combination of explanation and its reasoning.

物種 X 及 Y 其族群大小會隨時間改變而呈負相關之現象。箭頭以逆時針方向的順序顯示二族群的動態，選擇最可能的解釋組合及其理由。



<table>
<tr><th></th><th>Relationship between species X and Y
X 及 Y 種間的關係</th><th>Reasoning
理由</th></tr>
<tr><td>A.</td><td>interspecific competition between X and Y
種間競爭</td><td>Y decreases at high density of X
Y 種個體在 X 種個體密度高時減少

Y increases at low density of X
Y 種個體在 X 種個體密度低時增加</td></tr>
<tr><td>B.</td><td>interspecific competition between X and Y
種間競爭</td><td>Y increases at intermediate density of X
Y 種個體在 X 種個體密度中等時增加

X decreases at intermediate density of Y
X 種個體在 Y 種個體密度中等時減少</td></tr>
<tr><td>C.</td><td>predator (X) and prey (Y)
掠食者(X)及獵物(Y)</td><td rowspan="2">Y decreases when X increases from low density
在密度低時，當 X 種個體增加時，Y 種減少

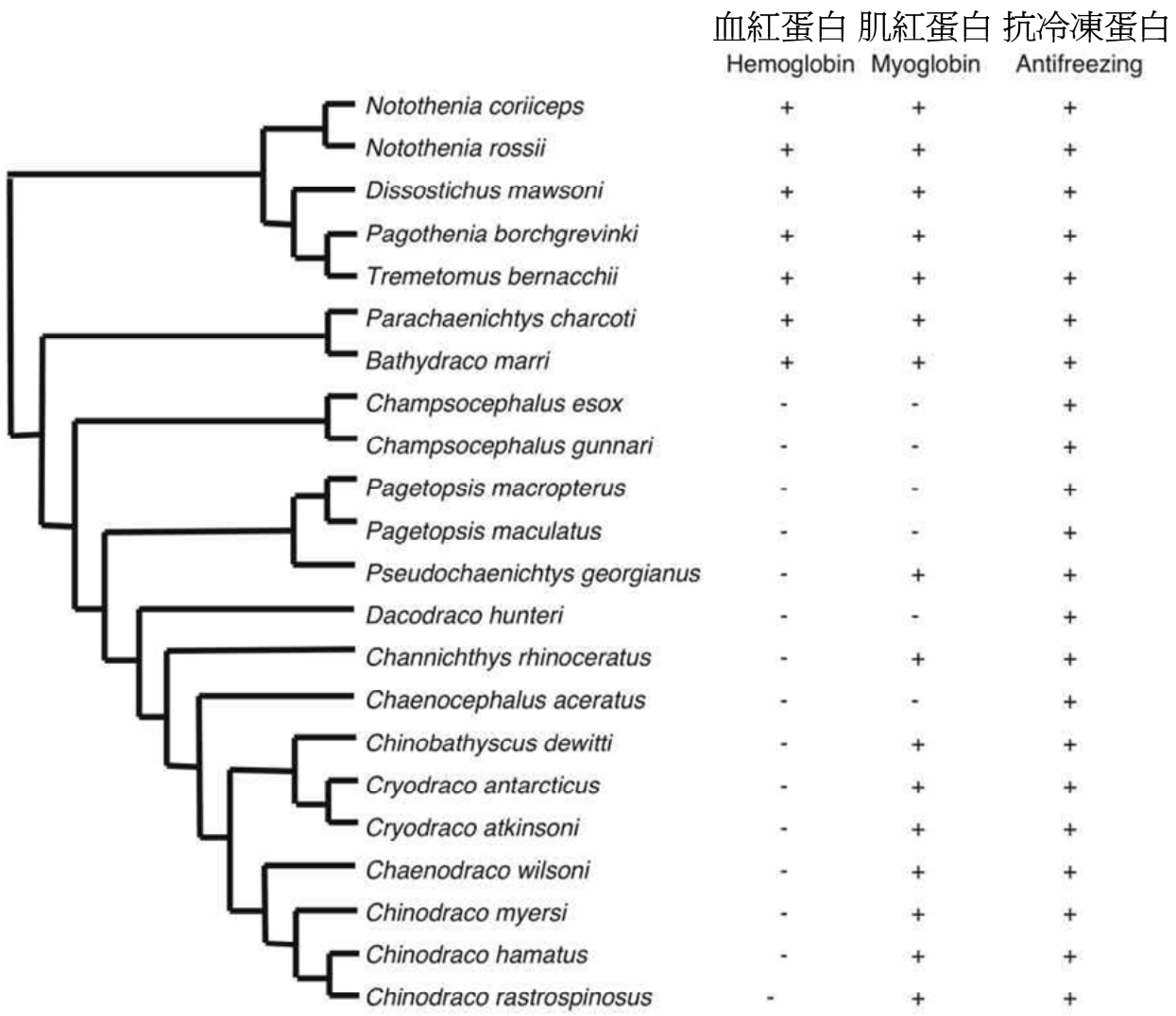
Y increases when X decreases from high density
在密度高時，當 X 種個體減少時，Y 種增加</td></tr>
<tr><td>D.</td><td>prey (X) and predator (Y)
獵物 (X)及掠食者(Y)</td></tr>
</table>

Biosystematics

生物系統分類

A53. The following phylogenetic tree shows the relationships among Antarctic icefish and their relatives. Icefish refer to all the species in the tree that have lost hemoglobin and thus possess clear blood. Some icefish species also lost myoglobin which is usually found in muscle cells. In these species, myoglobin lost its function due to distinct mutations. In addition, icefish and relatives possess an anti-freezing glycoprotein to arrest the growth of ice crystals in their tissues. To the right of the tree, whether or not each species possess hemoglobin, myoglobin and the anti-freezing glycoprotein is shown. What conclusion can you draw from the tree?

下圖的親緣關係樹顯示南極冰魚及其相近物種之間的親緣關係。在此，冰魚是指在此親緣關係樹中喪失血紅蛋白(hemoglobin)者，也因此，其血液是透明的。有些冰魚種類的肌肉細胞亦喪失肌紅蛋白 (myoglobin)，在這些冰魚中，肌紅蛋白是因特殊的突變而喪失其功能。此外，冰魚及其相近物種具有抗冷凍的糖蛋白以免在其組織內形成冰晶。在下圖親緣關係樹的右側列出各物種是否具有血紅蛋白、肌蛋白與抗冷凍蛋白。據此圖，下列何者正確？


血紅蛋白 肌紅蛋白 抗冷凍蛋白
Hemoglobin Myoglobin Antifreezing
Notothenia coriiceps + + +
Notothenia rossii + + +
Dissostichus mawsoni + + +
Pagothenia borchgrevinki + + +
Tremetomus bernacchii + + +
Parachaenichtys charcoti + + +
Bathydraco marri + + +
Champsocephalus esox - - +
Champsocephalus gunnari - - +
Pagetopsis macropterus - - +
Pagetopsis maculatus - - +
Pseudochaenichtys georgianus - + +
Dacodraco hunteri - - +
Channichthys rhinoceratus - + +
Chaenocephalus aceratus - - +
Chinobathyscus dewitti - + +
Cryodraco antarcticus - + +
Cryodraco atkinsoni - + +
Chaenodraco wilsoni - + +
Chinodraco myersi - + +
Chinodraco hamatus - + +
Chinodraco rastrospinosus - + +

A. Anti-freezing glycoprotein has originated in the icefish clade relatively recently.
B. Myoglobin was lost multiple times in the icefish clade.
C. The anti-freezing glycoprotein was necessary before the icefish could lose hemoglobin.
D. The loss of hemoglobin appears to be a more recent trait than the loss of myoglobin.
E. Because myoglobin can substitute for the functions of hemoglobin, icefish could lose hemoglobin.

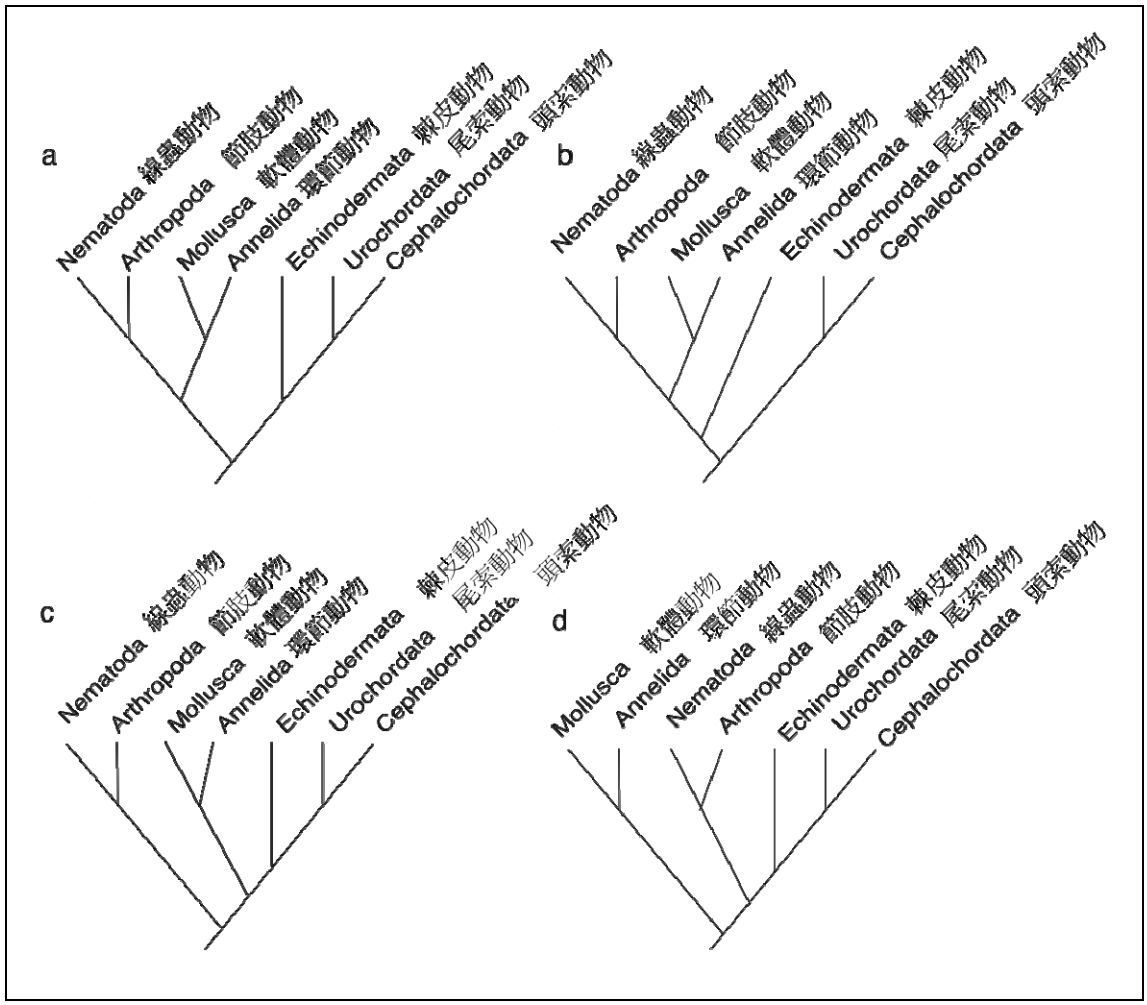
A. 在冰魚親緣關係分支中，抗冷凍蛋白是最近才出現的
B. 在冰魚親緣關係分支中，肌紅蛋白曾發生多次的喪失
C. 在冰魚喪失血紅蛋白之前，抗冷凍蛋白是必須的
D. 比起喪失肌紅蛋白，喪失血紅蛋白是最近才發生的特性
E. 因爲肌紅蛋白可取代血紅蛋白的功能，故冰魚可喪失血紅蛋白

A54. A list of the shared derived characters for some metazoan phyla is shown below. Identify **all** the phylogenetic tree(s) which are consistent with the statements below.

下列是各後生動物門所共有的衍生特徵（共衍徵）之敘述，哪些親源關係圖 **符合** 這些敘述？

I. Presence of trochophore larva is a shared derived character of the Mollusca and the Annelida.
II. Molting is a shared derived character of the Arthropoda and the Nematoda.
III. Presence of a notochord is a shared derived character of the Urochordata and Cephalochordata.
IV. Developmental fate of blastopore to form the anus is a shared derived character of the Urochordata, Cephalochordata and Echinodermata.

I. 具有擔輪幼蟲是軟體動物及環節動物的共衍徵
II. 蛻皮是節肢動物及線蟲動物的共衍徵
III. 具有脊索是尾索動物及頭索動物的共衍徵
IV. 由原口發育成肛門的歷程是尾索動物、頭索動物及棘皮動物的共衍徵



A. a
B. a, c
C. a, d
D. b, c
E. a, b, d
F. a, c, d.

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