25th INTERNATIONAL BIOLOGY OLYMPIAD

5 – 13 July, 2014

INDONESIA

THEORETICAL TEST

理論題 B

PART B

QUESTION PAPER

試卷

Total points: **48**

Duration: 180 minutes

COUNTRY:	.....
STUDENT ID:	.....

INSTRUCTIONS:說明

1. Fill in your STUDENT ID and your country in the Answer Sheet.
   在答案卷上填入 STUDENT ID 與 country

2. Each question contains four statements which you must indicate as True or False.
   每題都有四小題，都必須回答正確或是錯誤
   - If you answer correctly to all four statements, you will receive 1 point.
     四題全對給 1 分
   - If you answer correctly to only three statements, you will receive 0.6 point.
     對三題給 0.6 分
   - If you answer correctly to only two statements, you will receive 0.2 point.
     對二題給 0.2 分
   - If there is only one statement with the correct answer, you will not receive any points (0).
     對一題不得分
   - There is no minus system. 沒有倒扣

3. Tick (√) the correct answer in your Answer Sheet using a pen (in ink). If you need to change an answer, you should strikethrough the wrong answer and write in the new one (see the example below). In the table, T=True, F=False.
   在答案紙上以打勾 (√) 方式回答。如果要更改答案，必須將先前答案以雙線劃除後，重新選擇。參考下圖示範。T = 正確, F = 錯誤.

No.	Statement	T	F
1.	A		√
	B	~~√~~	√
	C	√	
	D	√	~~√~~

4. You may use a calculator in your exam.
   可以使用計算機

5. GOOD LUCK.
   祝好運

CELL AND MOLECULAR BIOLOGY 細胞與分子生物學

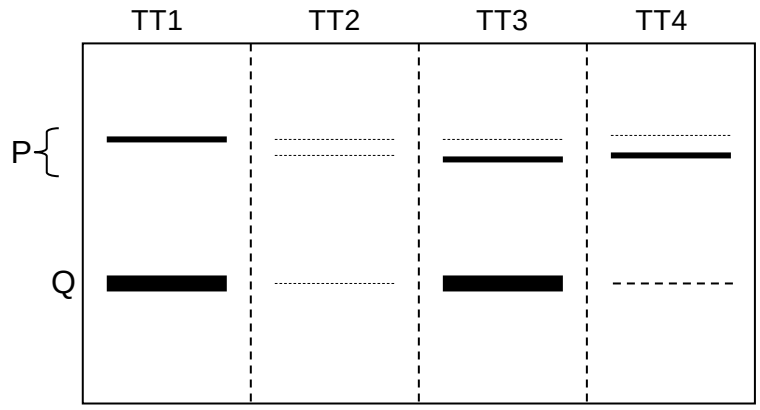
1. In order to study translation and translocation of proteins P and Q (both monomeric), *in vitro* experiments were carried out by Guenther Blobel and colleagues that eventually led to the Noble Prize in medicine. The following cell-free preparations were first obtained:
諾貝爾醫學獎得主 Guenther Blobel 與其同僚，為研究 P 蛋白與 Q 蛋白（兩者都為單體）的轉譯與易位，在試管中進行下列實驗。以下是各種製備液的說明：

- Preparation I(A): Isolation of functional ribosomes to which protein P synthesizing mRNA was still attached.
  製備液 I(A)：含有 P 蛋白 mRNA 附著且具功能性的核糖體
- Preparation I(B): Isolation of functional ribosomes to which protein Q synthesizing mRNA was still attached.
  製備液 I(B)：含有 Q 蛋白 mRNA 附著且具功能性的核糖體
- Preparation II: Isolation of microsomes [ER fraction] free from mRNA and ribosomes.
  製備液 II：不具 mRNA 與核糖體的微小體（來自 ER）
- Preparation III: Isolation of ribosomal subunits containing translation initiation factors.
  製備液 III：含轉譯啟始因子的核糖體次單位

The reaction mixtures were prepared in test tubes 1-4 as shown in the table below and the proteins synthesized were analyzed by SDS polyacrylamide gel electrophoresis followed by autoradiography.
將上述製備液的不同組合分別如下表，依序配置在試管 1-4 號中，並且讓蛋白質合成進行。產物經 SDS-PAGE 分離後，在以放射顯影法觀察實驗結果。

Test Tube [TT] No.	**1**	**2**	**3**	**4**
Preparation I (A)	+	+	+	+
Preparation I (B)	+	+	+	+
Preparation II	-	-	+	+
Preparation III	+	+	+	+
Radiolabelled amino acids and other factors required for translation 經放射線物質標定的氨基酸，與轉譯所需因子	+	+	+	+
Protease 蛋白酶	-	+	-	+

Results of autoradiography analysis are shown below.
放射顯影法結果如下



Indicate whether the following statements are true or false.
請分別回答下列有關敘述，是 **正確** 或 **錯誤**

A. Protein Q is post-translationally modified.
Q蛋白有轉譯後修飾

B. Protein P has a signal peptide sequence.
P蛋白有訊息胜肽序列

C. Protein Q is most likely to be cytoplasmic protein.
Q蛋白為細胞內蛋白

D. Protein P could be a secreted protein.
P蛋白可能為外泌型蛋白

2. A helix-wheel projection is a model of amino acid sequences of the alpha helix domain of a protein. The model can be used to show the distribution of amino acid residues along with its hydrophobicity throughout the helix. Reading the model is like looking at the helix vertically from the top so the helix will appear as a circle. The side group of each amino acid residue will face outwards as shown in **Figure 2.1**:
螺旋輪投影模型可以用來解釋蛋白質 α 螺旋結構域。此模型可觀察到氨基酸分子上的R團基沿著螺旋結構分佈而顯現出疏水性的特性。從頂端垂直鳥瞰此結構，會呈現出環形。氨基酸分子上的R團基如圖 2.1 中朝外排列。

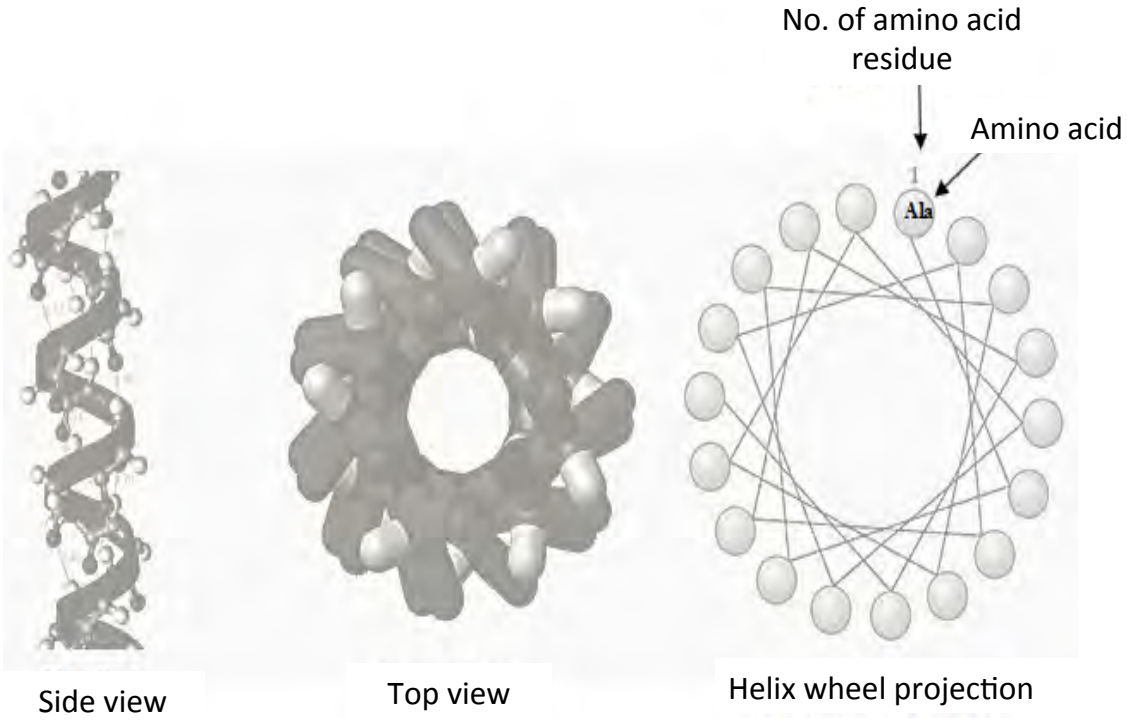


Figure 2.1. side view, top view, and helix-wheel projection of an alpha-helix protein
圖 2.1. α 螺旋蛋白結構的側視，鳥瞰與螺旋輪投影圖

A full circle of a helix consists of 3.6 amino acid residues. The following sequences show one alpha helix domain consisting of 18 amino acids from three different proteins (A-C). Information about the hydrophobicity of all 20 common amino acids is shown in **Figure 2.2.**
螺旋結構的每一個環是由 3.6 個氨基酸構成。三個由 18 個氨基酸構成的蛋白 (protein A-C) 其氨基酸序列分別如下，有關各個氨基酸的結構則參考圖 2.2。

```
Protein A: MLQSMVSLLQSLVSSIIQ
Protein B: TGAAAYAVVLFIMAYYMS
Protein C: KSSRKTPKKATARKSQRT
```

You will be provided with an extra sheet of paper with empty helix wheel projections for fragments of proteins A, B, C
你將拿到一張額外的試卷，這試卷上會有關於蛋白 A-C 的空白螺旋輪投影。

Indicate whether the following statements are true or false. An alpha helix:

請分別回答下列有關敘述，是 **正確** 或 **錯誤**

有關各蛋白的 α 螺旋：

A. similar to the one in protein A can be found in the transmembrane region of water-channel proteins i.e. aquaporins.
Ａ蛋白可以在水通道蛋白的穿膜區域處被發現，如 aquaporins

B. similar to the one in protein C can be found in the outer surface of cytosolic proteins.
Ｃ蛋白能在細胞質蛋白表面被發現

C. similar to the one in protein C is amphipathic.
Ｃ蛋白是兼具親水性與疏水性

D. similar to the one in protein B might be found in the transmembrane domain of a receptor.
Ｂ蛋白能在受體的穿膜區域中被發現

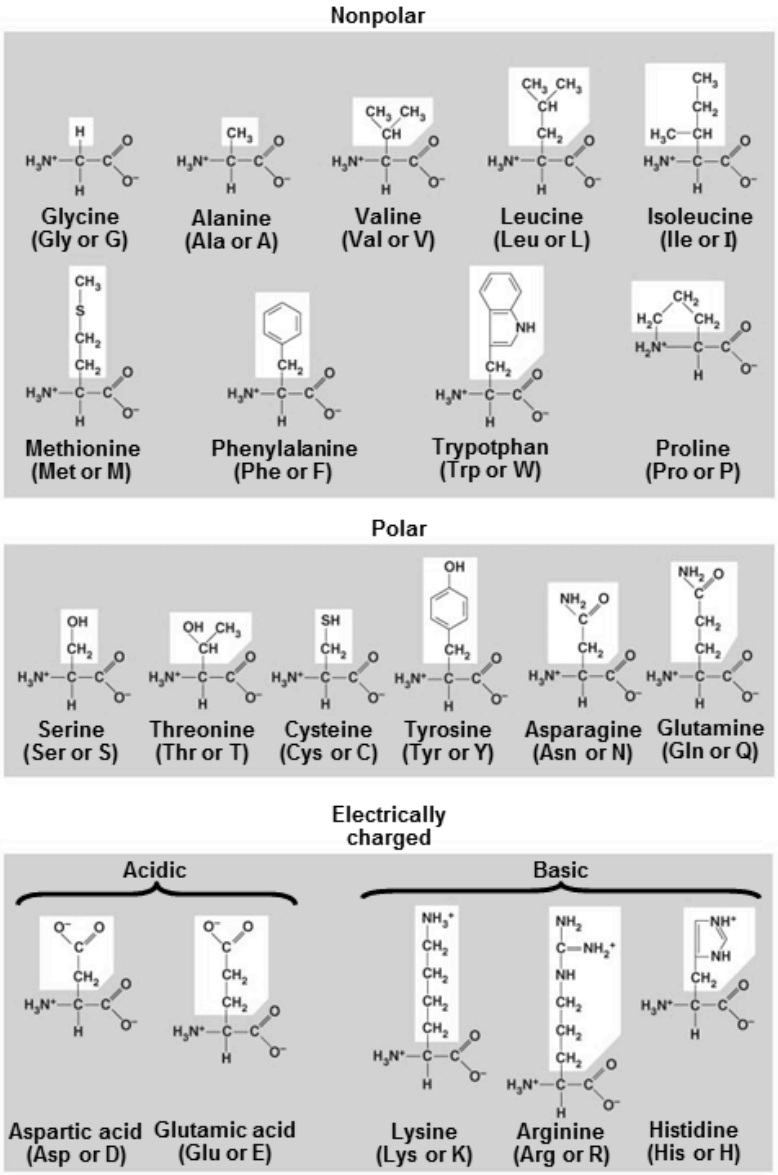


Figure 2.2. Structure of 20 common amino acids

3. A researcher was asked to evaluate the purity of three *Eco*RI restriction enzymes from three different companies (Antigen Co., Genomics Co., and Expression Co.). Some contaminant enzymes which were thought to be present in the *Eco*RI tubes were exonuclease and phosphatase. Exonuclease cuts the overhang base (single strand) from the restriction product of *Eco*RI while phosphatase removes the free phosphate group on the 5' end of a DNA strand. The evaluation was performed in three steps:
研究者想評估分別來自三家供應商 (Antigen Co., Genomics Co., and Expression Co.) 所提供的 *Eco*RI 限制酶的純度，因為有時裝有 *Eco*RI 的試管會有核酸外切酶與磷酸酶的污染。核酸外切酶會切掉經由 *Eco*RI 作用後裸露出來的懸基（單股）結構，磷酸酶則會在 DNA 片段的 5' 端移除磷酸根。評估將分別經由以下三個步驟進行。

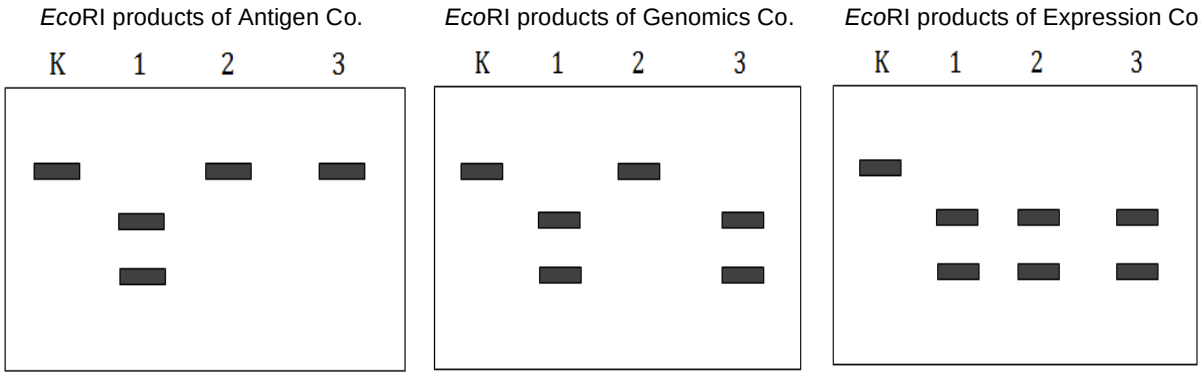
- Step I: Plasmid X which contains two *Eco*RI restriction sites was incubated with *Eco*RI from each of the three companies, resulting in 5'-P-overhang.
  步驟 I：X質體有兩個 *Eco*RI 限制切位，分別與三家供應商的 *Eco*RI 作用後，露出 5' 端的懸基，如下圖：

  5′-G　　5′-AATTC-3′
  3′-CTTAA-5′　　G-5′

- Step II: Plasmid X from step I was ligated again using DNA ligase.
  步驟 II：將上述切割過的X質體，以 DNA 連接酶進行連接。

- Step III: The ligated plasmid X was once again cut by *Eco*RI from the respective company.
  步驟 III：將連接後的質體，再以各家供應商的 *Eco*RI 進行限制酶切割

The researcher ensured that he performed the reactions so well that there was no partial digestion. The resulting fragments from each step were then analyzed by gel electrophoresis shown below.
測試者確信所有的結果都已經完全切割，這些片段分別以電泳進行檢測，如下圖所示。



▬ = DNA band （DNA 帶）

K = Control, plasmid X without cutting by *Eco*RI （對照組，未經 *Eco*RI 切割的X質體）

1 = DNA fragment from results of Step I （步驟 I 的 DNA 片段電泳結果）

2 = DNA fragment from results of Step II （步驟 II 的 DNA 片段電泳結果）

3 = DNA fragment from results of Step III （步驟 III 的 DNA 片段電泳結果）

Indicate whether the following statements are true or false.
請分別回答下列有關敘述，是 **正確** 或 **錯誤**

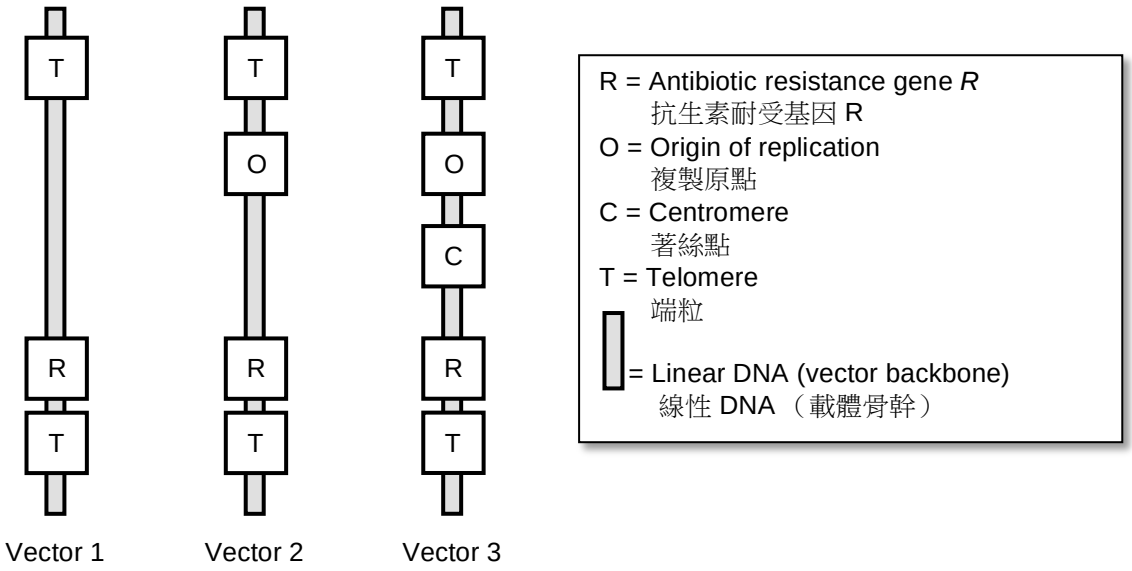
A. *Eco*RI from Expression Co. contains exonuclease as contaminant.
Expression Co. 的 *Eco*RI 受到核酸外切酶的污染

B. DNA ligase only joins overhanging DNA ends.
DNA 連接酶只參與具有懸基的 DNA 端的連接

C. *Eco*RI from Antigen Co. contains phosphatase as contaminant.
Antigen Co. 的 *Eco*RI 受到磷酸酶的污染

D. *Eco*RI from Genomics Co. is free from exonuclease and phosphatase as contaminant.
Genomics Co. 的 *Eco*RI 沒有受到核酸外切酶與磷酸酶的污染

4. The diagram below shows three DNA vectors containing an antibiotic resistance gene, *R*.
下圖為三個含有抗生素耐受基因 R 的 DNA 載體示意圖



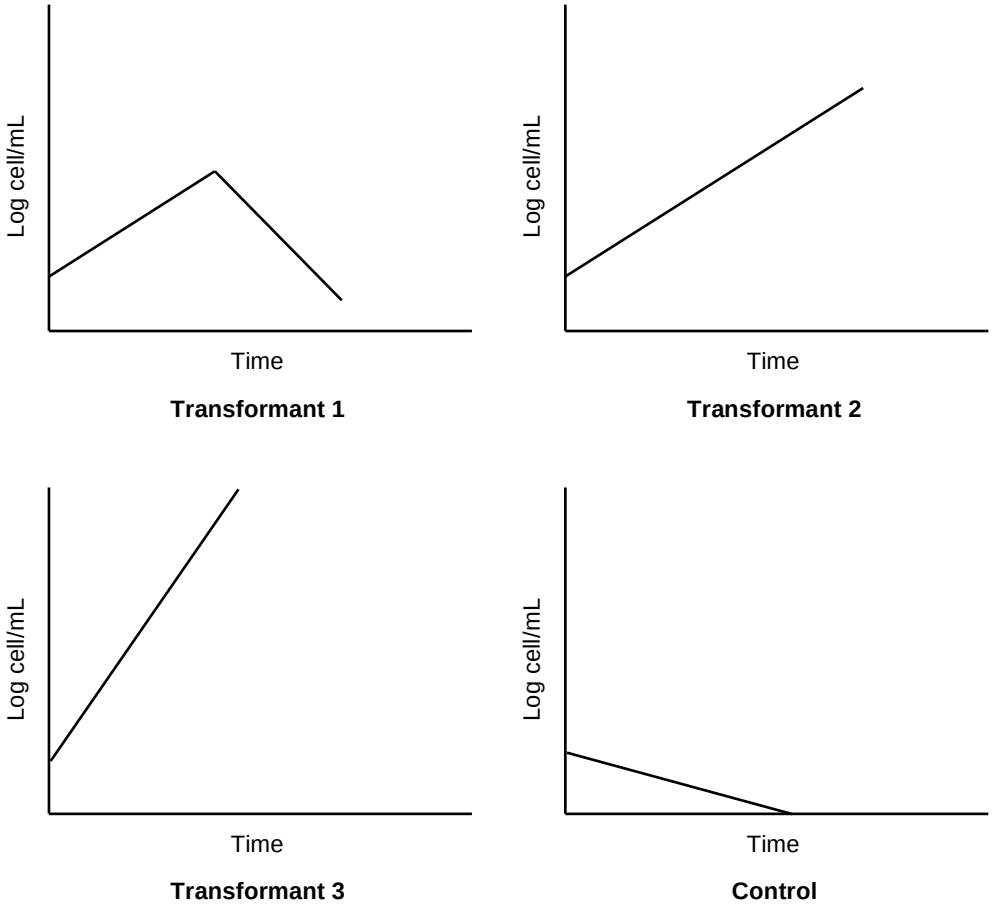
You then transformed each of the vectors into a yeast culture in three following steps:
由以下三個步驟，分別將他們轉殖進入酵母菌中，

- Step I: Three batches of competent yeast cells were made.
  步驟 I：分別準備三批勝任細胞

- Step II: Each batch was mixed with one of the vectors and transformed
  步驟 II：每批細胞混入單一種載體，並進行轉殖

- Step III: Transformed yeast cells were then grown in selective liquid culture containing the antibiotics and the cell concentration (cell/mL) was measured. As a control, untransformed yeast culture was used. The initial cell concentration for each transformed culture and the control was set at the same value.
  步驟 III：轉殖後的酵母細胞培養於含有抗生素的液體培養基中，並計算細胞濃度 (cell/mL)。未轉殖的細胞則作為對照組。所有的細胞濃度在實驗開始時都調整為相同。

Growth of the yeast cultures is shown on the graphs below. All axis are on the same scale for each graph. Transformant 1, 2, and 3 were transformed by Vector 1, 2, and 3, respectively.
個別生長曲線如下圖所示。Transformant 1, 2 與 3，分別代表為 Vector 1, 2 與 3 的轉殖結果



Indicate whether the following statements are true or false.
請分別回答下列有關敘述，是 **正確** 或 **錯誤**

A. In Transformant 2, the vector was not evenly distributed during cell division. Only the daughter cells containing Vector 2 were able to survive and grow.
Transformant 2 在細胞分裂時，載體未能平均分配。僅含有 Vector 2 的子細胞才能生存與生長

B. In Transformant 3, daughter cells containing more copy of Vector 3 than the parent cells can be found.
Transformant 3 子細胞較親代細胞含有較多複製套數的 Vector 3。

C. The inheritance of Vector 1 into each daughter cells of Transformant 1 only happened at the initial stage of cell growth in the liquid culture.
Transformant 1 所含的 Vector 1 只能在培養初期分配到子細胞中

D. The presence of centromeres and telomeres in Vector 3 helps the vector to be completely inherited from the parent cells by the daughter cells.
Vector 3 因為有著絲點與端粒，因此能夠協助載體由親代細胞遺傳到子細胞中

5. Five intracellular molecules A, B, C, D, and E are normally synthesized at a constant rate of 1000 molecules/second but with different lifetimes or survival rates inside the cell. The lifetimes of molecule A = 300 s, B = 200 s, C = 100 s, D = 50 s, and E = 10 s. The presence of signal X increases the synthesis rate of all five molecules by ten times without changing their lifetime.
五種細胞內分子 A, B, C, D 與 E，在細胞中具有相同且正常的合成速率 1000 molecules/second，但是他們各自的壽命（或存活速率）並不相同。本題中個別的存活速率分別為 molecule A = 300 s, B = 200 s, C = 100 s, D = 50 s, and E = 10 s。此時，有一個特Ｘ訊號刺激後，會影響這些分子的合成速率，但是並不會改變他們的存活速率。

Indicate whether the following statements are true or false.
請分別回答下列有關敘述，是 **正確** 或 **錯誤**

A. E has the highest intracellular concentration at the steady-state
Ｅ在恆定狀態有最高的細胞內濃度

B. The number of molecule B at the steady-state is 200,000.
Ｂ在恆定狀態的數目為 200,000

C. One second after signaling by X, molecule A will have the largest increase in concentration.
X 信號刺激後，Ａ的濃度增加最大

D. One second after signaling by X, the amount of E is less than twice as much as the steady state.
X 信號刺激後一秒鐘，Ｅ的數量是小於恆定狀態的兩倍

6. Graft rejection often occurs following organ transplantation. The donor organ is damaged by the recipient's immune response which rejects the foreign antigen present on the organ. However, there is almost no case of graft rejection during transfusion of blood with the same blood type.
排斥作用經常發生在器官移植後。因為存在器官上的外來抗原所引發的排斥，使得捐贈者的器官受到接受者的免疫反應而損傷。 然而，很少有因同血型輸血而發生的排斥現象。

Indicate whether the following statements are true or false.
請分別回答下列有關敘述，是 **正確** 或 **錯誤**

A. Red blood cells can be recognized by recipient's Natural Killer (NK) cells but are not killed due to presence of inhibitory molecule at the surface.
紅血球能被接受者的自然殺手細胞 (NK) 辨識，但是因為紅血球表面具有抑制因子，故無法為 NK 細胞所殺死

B. Most proteins present on the surface of red blood cells are similar between different individuals.
大部份的紅血球表面蛋白在個體間非常相似

C. Red blood cells do not contain MHC I proteins.
紅血球缺乏 MHC I 蛋白

D. During blood transfusion, only the cellular component is transferred but not the plasma component.
輸血過程中，主要是細胞含量較多，血漿含量較少

7. *Helicobacter pylori* is a Gram-negative pathogenic bacterium which causes gastritis, stomach and duodenal ulcers. Its ability to colonize hostile environments within the stomach cavity is due to production of several virulence factors. At the initiation stage of infection, *H. pylori* secretes urease which acts as pH buffer to survive in the acidic environment. Urease also helps modify the mucus layer of the stomach by reducing its viscosity hence and facilitates bacterial penetration into the stomach epithelial cells. Another virulence factor produced by *H. pylori* is type-IV secretion system. This structure injects the bacterial toxin into the host epithelial cells.
幽門螺旋桿菌為一種致病性的格蘭氏陰性菌，感染後能引發胃炎，胃部與十二指腸潰瘍。它能長期存在宿主的胃腔中，並產生多種毒力因子。當受到幽門螺旋桿菌感染時，在初期細菌會分泌尿素酶，尿素酶會扮演 pH 緩衝物質讓細菌能存活於酸性的環境下。同時，尿素酶也會幫忙修飾胃的黏膜層，降低黏稠度以便加速細菌穿透到胃部的上皮細胞。另一種毒力因子會由細菌的第四型分泌系統產生，這種結構會讓細菌的毒素注射到宿主的上皮細胞中。

Indicate if each of the following statements is true or false.
請分別回答下列有關敘述，是 **正確** 或 **錯誤**

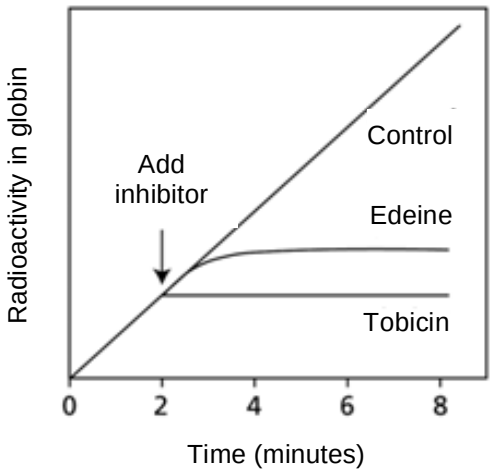
A. *H. pylori* is an acid tolerant, not an acidophilic bacteria.
幽門螺旋桿菌是一種耐酸細菌，而非嗜酸細菌

B. Concentrations of the CO_2 and ammonia in the stomach corelate with the abundance of *H. pylori*
胃部二氧化碳與氨的濃度與幽門螺旋桿菌的數量有關

C. Before injecting the toxin *H. pylory* is able to specifically recognize the epithelial cells.
幽門螺旋桿菌在注射毒素前，能準確的辨識出上皮細胞

D. Type IV secretion system of *H. pylori* is homologous with cilia in *Paramecium.*
幽門螺旋桿菌第四型分泌系統與草履蟲的纖毛同源

8. Prof. Tobi successfully isolated two new antibiotic candidates, **tobicin** and **edeine** from two different bacterial cultures and studied the effects on protein synthesis by detecting the presence of radioactive amino acid residues in globin using reticulocyte lysate (cell-free translation system), globin mRNA, and radioactive amino acids. The figure below suggests that these two antibiotics work by inhibiting protein synthesis. The arrow indicates the addition of inhibitor at a concentration of 10 microM. No inhibitor was added for the control.
Tobi 教授自不同的細菌培養中，成功地分離出兩種新型抗生素，分別為 **tobicin** 與 **edeine**。為了研究蛋白質合成的影響，他使用來自網織紅細胞裂解液（無細胞轉譯系統）中具放射線活性標定的球蛋白、球蛋白的 mRNA 與具放射線活性氨基酸進行實驗。下圖為兩種抗生素抑制蛋白質合成的結果。箭號處為添加 10 μM 濃度的抑制劑。對照組則不添加任何抑制劑。



Indicate if each of the following conclusions is true or false based on the result of the experiment.
請根據實驗結果，分別回答下列有關結論，是 **正確** 或 **錯誤**

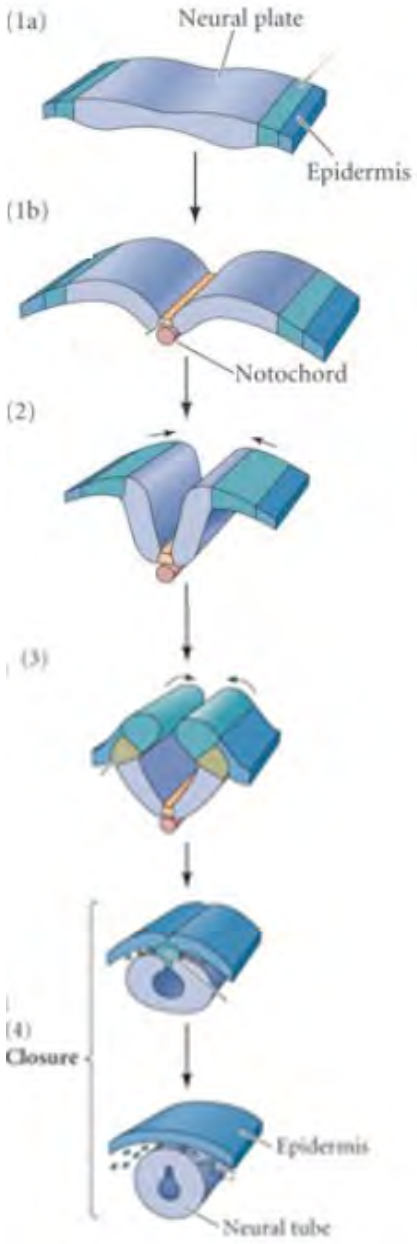
A. Tobicin inhibits the elongation of translation.
Tobicin 抑制轉譯的延長

B. Edeine is a competitive inhibitor with lower affinity to ribosome than tobicin.
Edeine 是一種競爭型抑制劑，它對核糖體的競爭性低於 tobicin

C. Edeine and tobicin are broad-spectrum antibiotics which inhibit growth of either Gram-positive or Gram-negative bacteria.
Edeine 與 tobicin 同屬於廣效型抗生素，對格蘭氏陽性細菌與陰性細菌都有效

D. Edeine inhibits the initiation of translation.
Edeine 在轉譯啟始便產生抑制效果

9. Formation of the neural tube involves a sharp ventral bend as shown in the diagram below. This bend is associated with formation of wedge-shaped cells of the “floorplate”.
神經管形成過程，會出現明顯地腹側彎曲，過程如下圖所示。這種彎曲會涉及楔形細胞在“樓承板”的形成有關。



As shown in the diagram above, the floorplate lies above a structure called the notochord.
如上圖所示，樓承板位於脊索的上方。

Indicate if each of the following statements is true or false.
請分別回答下列有關敘述，是 **正確** 或 **錯誤**

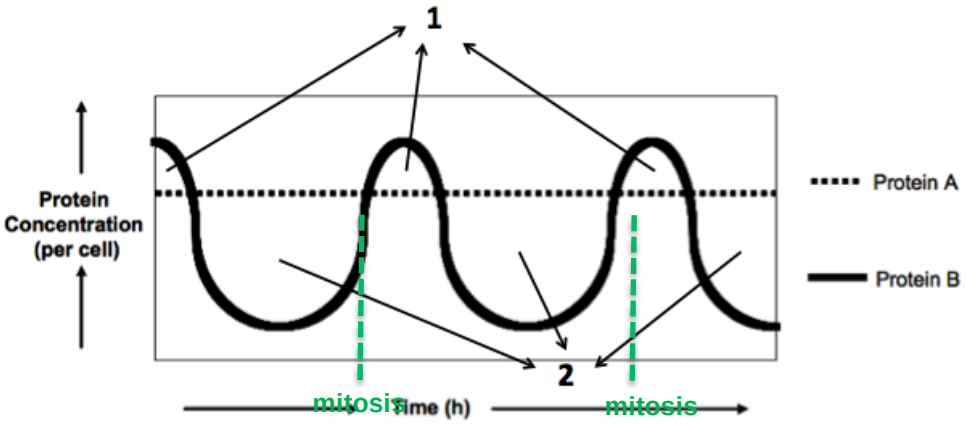
A. If the notochord is removed, invagination of the neural ectoderm will still occur.
移除脊索，神經外胚層內陷仍會持續進行

B. Microtubule orientation would be expected to change in the floorplate cells as they become wedge-shaped.
微管排列的方向性會使樓承板細胞變成楔形

C. Adding blebbistatin, a chemical which inhibits myosin function, to the developing floorplate, wedge cell formation would continue.
添加一種抑制肌球蛋白功能的化學藥品“blebbistatin”，樓承板發育與楔形細胞形成不受影響

D. Administration of EDTA disrupts neural tube formation.
添加 EDTA 會阻擾神經管形成

10. Two temperature-sensitive yeast strains are unable to enter the mitosis prophase at non-permissive temperature. Mutations in both mutants are related to different genes. Analysis shows that a mutation in one strain inhibits the expression of Protein A, while mutation in another strain inhibits the expression of Protein B. Observing the abundance of each proteins in wild-type cells, the following result are seen.
兩株對溫度敏感的酵母菌在非適當溫度時，無法進入有絲分裂前期。這兩株酵母菌都是突變株，而且在不同基因上發生突變。經分析後發現，一株突變株A蛋白表達被抑制，另一株突變株則是B蛋白表達被抑制。下圖為兩種蛋白（A、B）在野生型表達的結果。



In the wild-type cells, Protein A is a kinase which phosphorylates other proteins. Protein A is only active when Protein B concentration exceeds the concentration of Protein A.
野生型中，A蛋白是一種激酶，會磷酸化其他蛋白。當B蛋白濃度超過A蛋白濃度時，A蛋白才會活化。

Indicate if each of the following statements is true or false.
請分別回答下列有關敘述，是 **正確** 或 **錯誤**

A. Protein A could be phosphorylated.
A蛋白能被磷酸化

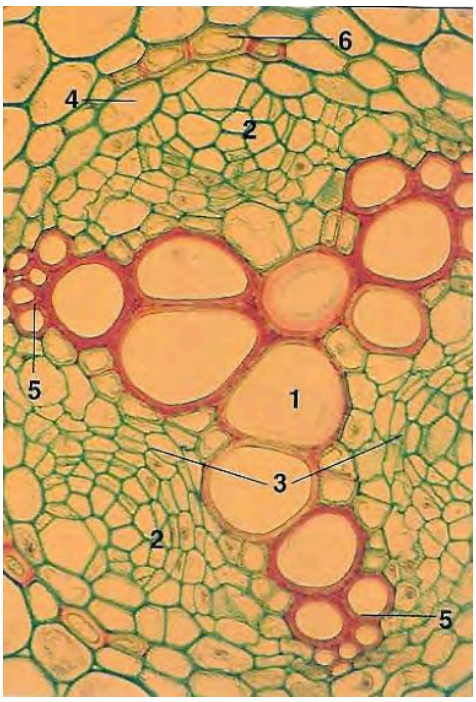
B. If kinase activity is required for cell cycle progression, the yeast cell with mutated Protein A will be arrested at G2-M boundary.
假設細胞週期進展需要有激酶的活性，A蛋白突變株會出現 G2-M 停滯現象

C. If a mutant expressed Protein B in high level constitutively, cells are likely to become smaller each generation.
B蛋白高表達突變株，每個世代的細胞會越來越小

D. In real cells, the complex between A and B could be inactivated by tumour supressors
在真實的細胞中，A蛋白與B蛋白複合物會被腫瘤抑制因子去活化

PLANT ANATOMY AND PHYSIOLOGY 植物解剖及生理學

11. The figure shows a representative cross section of an angiosperm plant.
下圖顯示某種被子植物構造的橫切面。



Indicate if each of the following statements is true or false. 判斷下列各敘述的真偽。

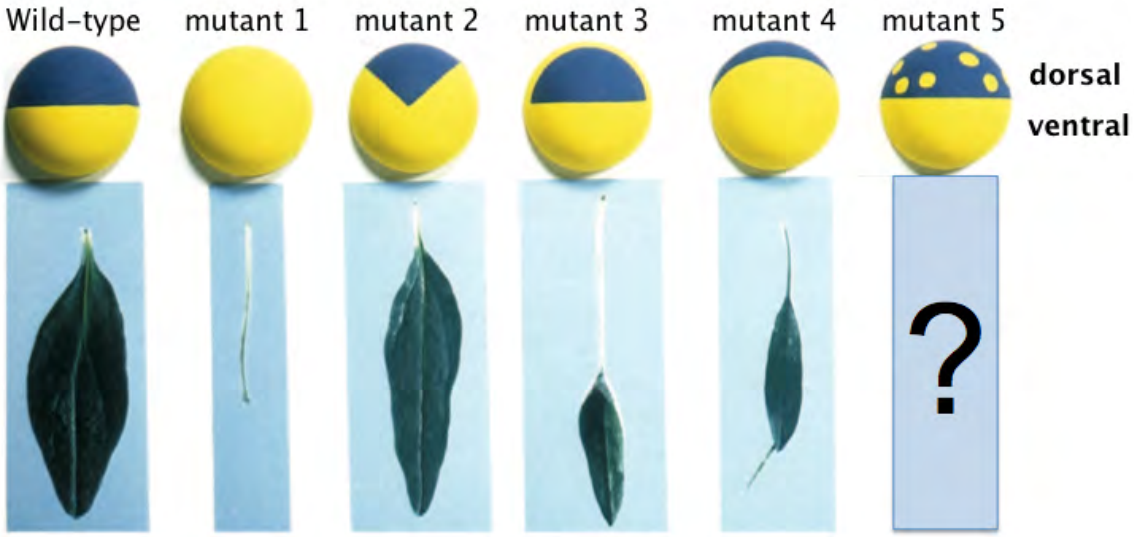
A. This structure most likely represents a dicotyledon plant.
此構造很有可能是來自雙子葉植物。

B. Cells of number 5 have thickened walls made of lignin.
編號5的細胞之厚細胞壁含有木質素。

C. Number 2 will differentiate into a lateral root.
編號2的細胞將特化為支根。

D. Based on physiological age, tissue number 5 is older than tissue number 1.
根據細胞生理年齡，編號5的細胞較編號1的細胞老。

12. Mutation at the *phantastica* (*phan*) locus has been identified and characterized in *Antirrhinum majus*. Each *phan* mutant produces a variety of leaf phenotypes. The figure shows a model developed to study the effect of *phan* mutation and the action of dorsalizing function (DF) in leaf development. Early leaf primordia are depicted as yellow hemispheres viewed from a distal position. Dorsal areas of the primordia experiencing DF expression are coloured blue. Different leaf morphologies are shown below the patterns of expression of *phan* mutants.
金魚草(*Antirrhinum majus*)在*phantastica* (*phan*)基因座的突變情況如下所示。每個*phan*突變株會表現出不同的葉子外形，圖中為*phan*突變的作用模式以及葉子發育的**葉背化作用**(dorsalizing function (DF))。從遠軸面(腹面)來看，初期葉原體以黃色表示；背面範圍則以藍色表示。圖下方為不同*phan*突變株表現出的葉子形態。



Indicate if each of the following statements is true or false. 判斷下列各敘述的真偽。

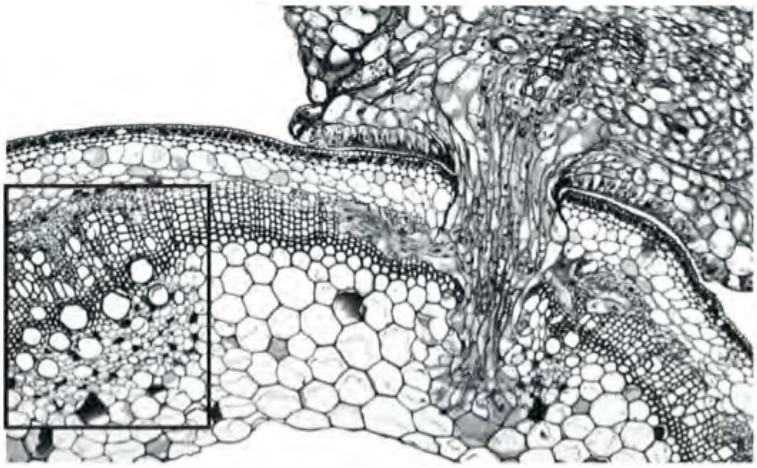
A. These variations show polarity of leaf development.
這些變異顯示葉子發育的極性。

B. The dorsal area of leaf primordia determines the development of laminae.
葉原體的背面範圍決定葉片外形的發育。

C. The ventralized leaf primordia will result in *phan* mutants lacking laminae.
葉原體的腹面化會導致*phan*突變株沒有葉片 。

D. If patches of ventral cells are attached on dorsal area shown in mutant 5, it will result in *phan* mutants lacking laminae.
若葉原體的背面範圍有點狀分布的腹面細胞(如突變株5所示)，會導致*phan*突變株沒有葉片 。

13. The figure shows a cross section of parasitic plant haustoria penetrating the vascular bundle of the host plant. The intact vascular bundle is shown in the inserted diagram.
下方之橫切面圖顯示寄生植物的吸器入侵寄主植物的維管束。正常的維管束構造如左下方格中所示。



Indicate if each of the following statements is true or false. 判斷下列各敘述的真偽。

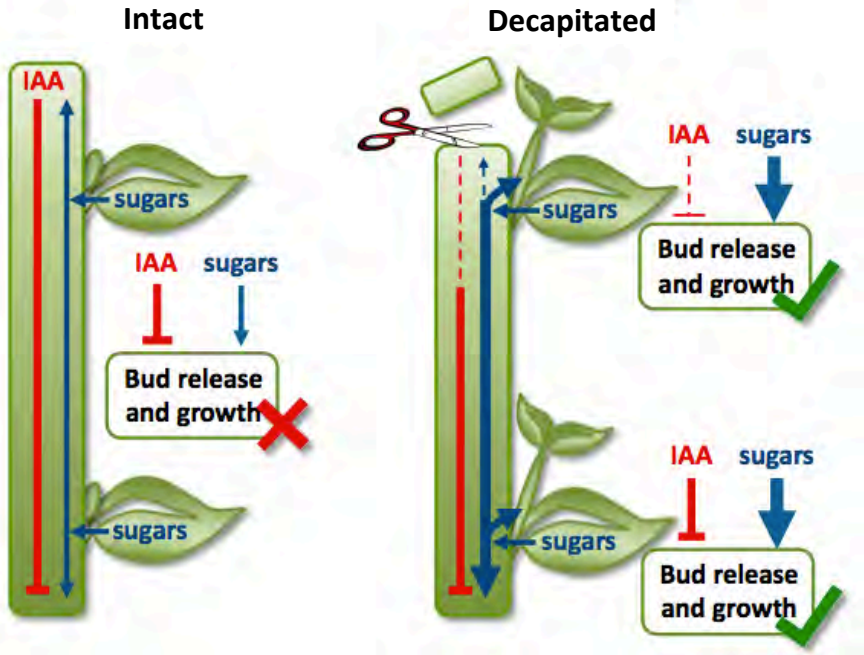
A. This parasitic plant is probably photosynthetic, because its haustoria penetrate the host´s phloem only.
此寄生植物可行光合作用，因為其吸器僅入侵至寄主的韌皮部。

B. The haustorium of this parasite is a modified leaf.
此寄生植物的吸器是一種變態葉。

C. The interaction of the host and parasite is likely to be obligate.
對寄生植物而言，與寄主發生交互作用是必需的。

D. The host plant is a dicot.
此寄主為雙子葉植物。

14. The diagram shows a model of apical dominance in intact and decapitated plants. Next to each plant is a model description of bud release and growth as it relates to the regulation by the IAA (auxin) and sugars. At each axillary bud, the width of solid lines indicates high levels of abundance and dashed lines indicate low.
下圖為頂端優勢的模式，顯示完整植株(intact)及去頂植株(decapitated)的結果。圖中植株右側描述芽端釋出物與生長情形，此與 IAA 及糖分的調控有關。在每個側芽處，實線的寬度代表其含量高，虛線代表含量低。



Indicate if each of the following statements is true or false. 判斷下列各敘述的真偽。

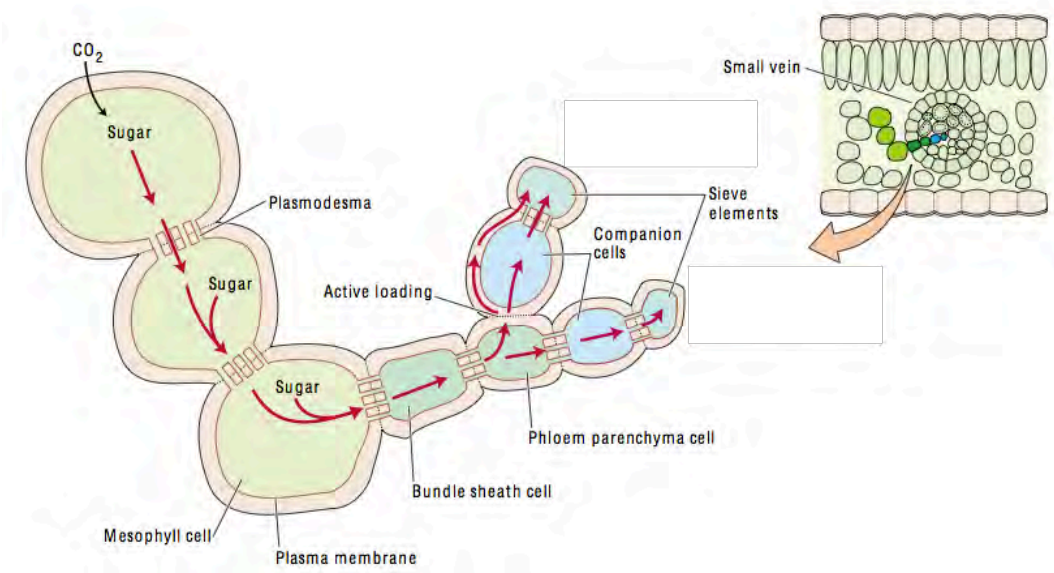
A. Auxin is the only hormone involved in axillary bud growth induction.
IAA是誘導側芽生長的唯一激素。

B. Decapitation will cause sugar accumulation in axillary buds.
去頂芽會造成側芽的糖分累積。

C. Axillary buds on a decapitated stem will serve as a new auxin source.
在去頂芽的莖上，側芽會成為新的IAA供源。

D. From this model, apical dominance is maintained in intact plants predominantly by the limitation of axillary bud's access to sugar.
根據此模式，在完整植株中，藉由限制側芽獲得糖分，其頂端優勢即可持續存在。

15. The diagram shows how sugar translocation occur in leaf phloem.
下圖顯示葉片韌皮部中的糖分輸送情形。



Indicate if each of the following statements is true or false. 判斷下列各敘述的真偽。

A. Similar to water transport through xylem, photosynthate is also translocated through dead cells, but with different mechanism.
如木質部運送水分，光合作用產物也會經由死細胞輸送，但其機制不同。

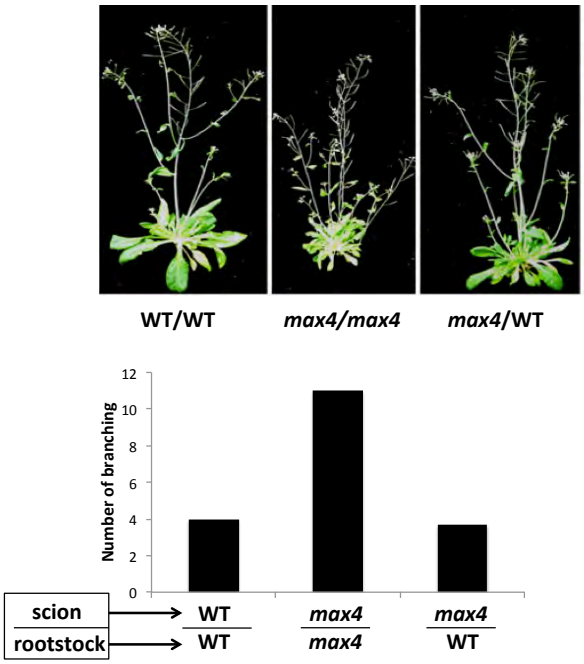
B. Photosynthate is transported symplastically and apoplastically to the sieve elements and companion cells.

光合作用產物會藉由**質體內(**symplastically**)**及**質體外(**apoplastically**)**兩種運輸方式送至篩管細胞及伴細胞。

C. Symplastic sugar translocation requires ATP.
質體內糖分運送需消耗ATP。

D. In leaves, sugars become more concentrated in the sieve elements and companion cells than in the mesophyll cells.
在葉中，篩管細胞及伴細胞中的糖分濃度較葉肉細胞高。

16. In addition to auxin and cytokinin involvement in branching, the *MAX4* gene is known to control the production of the signal molecule strigolactone and its derivatives which inhibit branching. To investigate its influence on branching, graft of *max4* mutants and wild type plant were made as shown in the figure below:
除了植物生長素及細胞分裂素會影響分枝的形成，阿拉伯芥的*MAX4*基因可控制strigolactone此訊息分子及其衍生物的產生，且這些物質可抑制分枝。為探討基因對分枝的影響，*max4*突變株與野生型的各種嫁接情形及其對應結果如下圖所示。



Indicate if each of the following statements is true or false. 判斷下列各敘述的真偽。

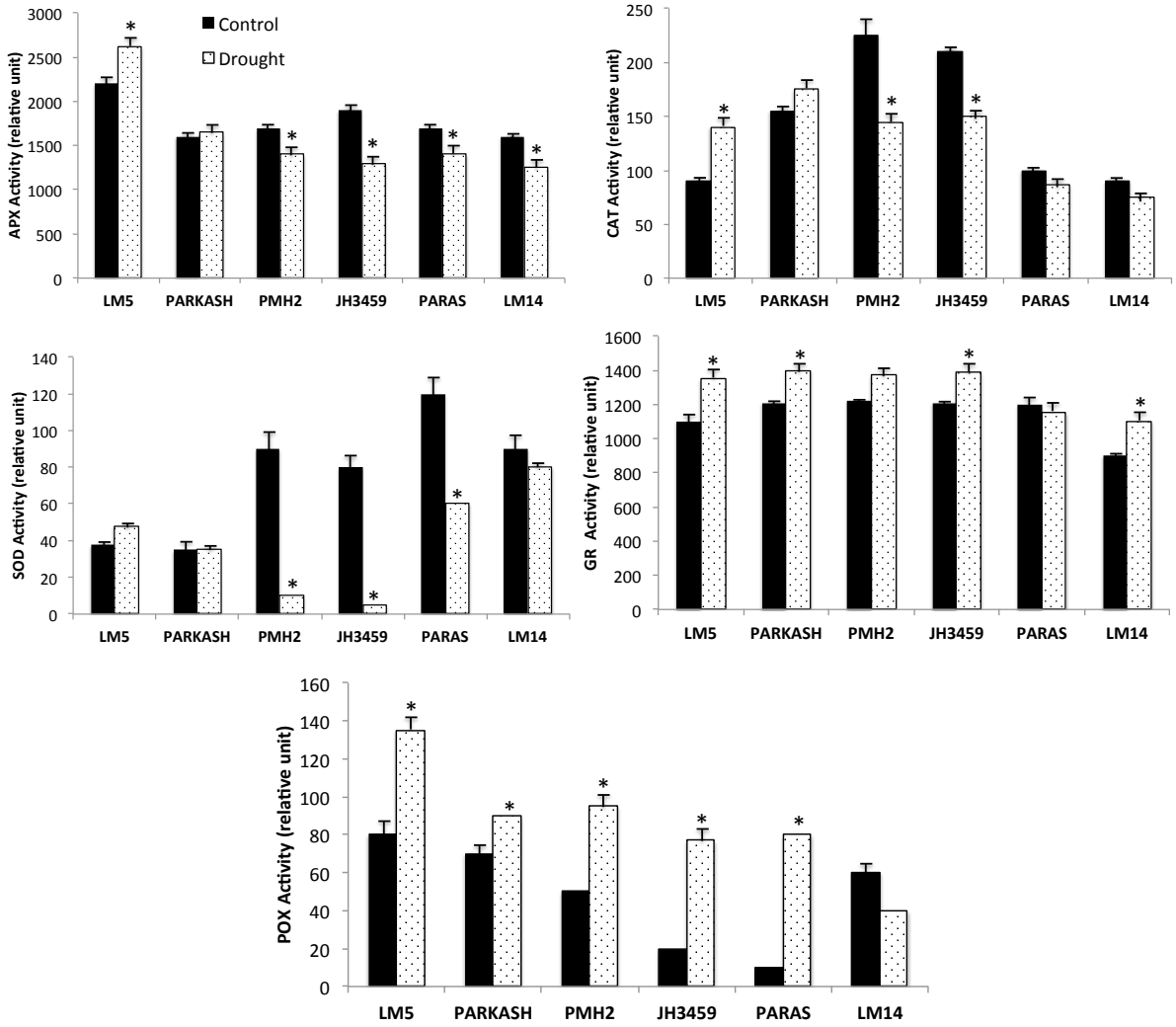
A. In this experiment, number of branchings is determined by the substance produced in roots.
此實驗中，所形成的分枝數是由根部的產物所決定。

B. Mutant *max4* does not produce strigolactone and resulted in higher numbers of branching.
max4 突變株不產生 strigolactone，導致形成很多分枝。

C. Grafting WT scion with *max4* rootstock will produce less branching compared to WT/WT graft.
相較於 WT/WT 嫁接，WT 接穗配上 *max4* 砧木會產生較少分枝。

D. The higher ratio of cytokinin to auxin will inhibit axillary branching compared to WT/WT graft.
相較於 WT/WT 嫁接，當細胞分裂素/植物生長素之比值高時，會抑制分枝。

17. Two leaf-stage maize seedlings with genotypes LM5, PARKASH, PMH2, JH3459, PARAS, and LM14 are exposed to drought condition for 72 hours. Figures show activity of several enzymes involved in the defense against leaf oxidative stress: i.e. ascorbate peroxidase (APX), catalase (CAT), superoxide dismutase (SOD), peroxidase (POX), and gluthatione reductase (GR). Vertical bars show standard deviation for the mean of three replicates. The asterisk indicates a significant difference between control and drought treatment within each genotype using t-test.
利用LM5, PARKASH, PMH2, JH3459, PARAS, 及 LM14不同基因型的玉米來進行實驗，將生長至兩片葉階段的小苗在乾旱下處理72小時。下圖顯示多種與葉片抗氧化逆境有關的酵素如: ascorbate peroxidase (APX), catalase (CAT), superoxide dismutase (SOD), peroxidase (POX), and gluthatione reductase (GR)。直條顯示三重複之平均值與標準差，星號代表該處理組(打點直條)與對照組(黑色直條)有顯著差異。



Indicate if each of the following statements is true or false. 判斷下列各敘述的真偽。

A. All genotypes responded similarly to drought stress.
所有基因型對乾旱逆境的反應相似。

B. Drought stress does significantly change the activity of GR in all genotypes.
所有基因型中，乾旱逆境對 GR 的活性有顯著改變。

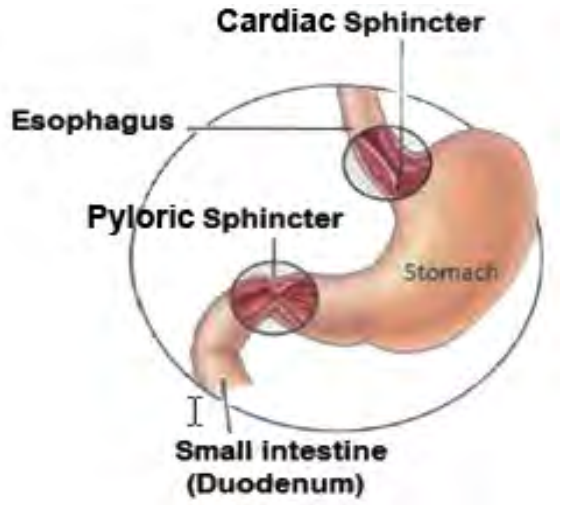
C. Peroxidase is an important enzyme to alleviate drought stress.
POX 是抵抗乾旱逆境的重要酵素。

D. Based on the activity of the five enzymes, LM5 and PARKASH are most likely to be the top two drought tolerant genotypes.
根據五種酵素的活性，LM5 及 PARKASH 是最能抵抗乾旱的基因型。

ANIMAL ANATOMY AND PHYSIOLOGY 動物解剖與生理

18. Stomach emptying is determined by the strength of antral peristaltic contractions and the resistance offered by the pyloric sphincter. The time taken to empty half the stomach contents was measured in one patient and compared with normal data.
胃排空受胃腔室蠕動收縮的強度及幽門括約肌的抗性所決定，某病人胃排空一半量時所需時間與正常人相比較。

Individual	Time taken for stomach to empty half its contents (min) 胃排空一半量時所需時間	
	Liquid	Solid
Normal	<20	<120
Patient	18	150



Indicate if each of the following statements is true or false.
指出下列敘述正確或錯誤

A. The patient has a higher risk of malnutrition as compared to healthy individual.
病人比健康人更容易發展營養不良

B. The patient is likely to experience an increase in acid reflux.
患者更容易發生胃酸逆流

C. An increase in pyloric sphincter resistance will accelerate the emptying of solids from the stomach.
幽門括約肌的抗性增加時會加速胃排空固態食物

D. If the patients vomits, the vomited material does contain bile.
若病人嘔吐，其嘔吐物中含有膽汁

19. Olympians, at least in sports, can run faster, leap higher and lift more than 'normal' humans. Such elite athletes earn their titles with an astonishing amount of hard work and support (like you in IBO), but many also have some unearned advantages: the right genes.
奥運參賽者較一般人跑得更快、跳得更高、舉得更重，這些運動員非常努力勤於練習，就像你參賽IBO一樣，但多數在天賦上另具其有利基因。

There is growing evidence that world-class athletes carry a minimum set of particular 'performance-enhancing' genes. For instance, almost every male Olympic sprinter and power athletes ever tested carried the wt 577R allele variant of the gene *ACTN3 (*alpha-Actinin 3).
有越來越多的證據顯示，這些世界級運動員具有'表現-增強'的特殊基因，幾乎所有接受檢驗的 賽男性跳高、跳遠及舉重等選手的 *ACTN3* 基因上都帶有 577R 的變異等位基因。

Actin filaments are stabilized by actin binding proteins including actinins of which there are two main types, type 2 and type 3. ACTN3 is expressed only in fast twitch fibers, ACTN2 is expressed in all skeletal muscle fibers and is essential for their function.
肌動蛋白纖維絲會被actinins等肌動蛋白的結合蛋白穩定，actinins包括兩種主要的型式：type 2 and type 3，ACTN3基因只會在快速抽動的纖維表現，ACTN2基因會在所有骨骼肌纖維表現，對骨骼肌的功能甚為重要。

In general population, there are people of:
在一般族群中，某些人為：

- XX - TYPE: homozygous for inactive *R577X*, associated with a natural predisposition to endurance events.
  XX 型：無活性的 *R577X* 同型合子，與耐力性競賽者的先天體質有關
- RR – TYPE: homozygous for wt *R577*, associated with a natural predisposition for sprint-power events.
  RR 型：wt *R577X* 同型合子，與爆發力性競賽者的先天體質有關
- RX - TYPE: heterozygous are equally but not optimally suited for both endurance and sprint-power events.
  RX型：異型合子，與耐力性或爆發力性競賽者均無特別相關性

Indicate if each of the following statements is true or false.

指出下列敘述正確或錯誤

A. These alleles are expected to be at very similar frequencies in all human populations
這些等位基因的基因頻率在所有不同的人類族群中極為相似

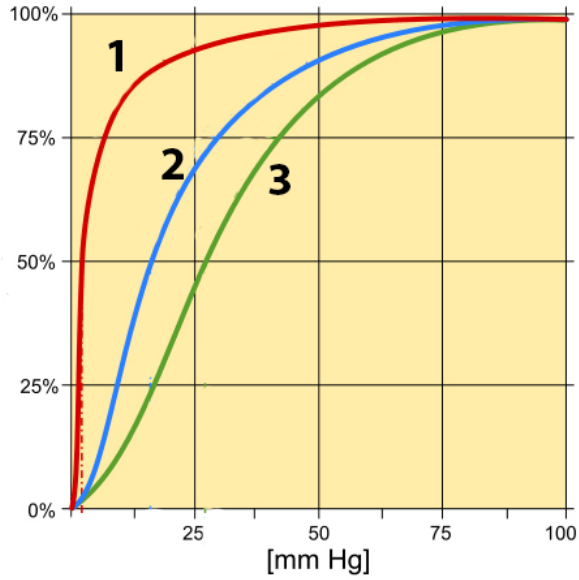
B. Selection will prevent a loss of function mutation in the gene ACTN2 to reach high frequencies
天擇作用可避免ACTN2基因功能發生突變，使其基因頻率提高

C. Similar the *R577X* variant is found in large cats (especially in cheetahs)
與*R577X* 相似的突變型可在大型貓科動物(特別是獵豹)中發現

D. Football forwards, must be able to accelerate quickly yet need to be able to run throughout the entire match, are most like to be of the RX-TYPE than XX – TYPE
足球前鋒必須能迅速加速且能跑從頭到尾整場比賽，可能比較像是RX型而非XX型

、

20. The graph shows three dissociation curves of oxygen binding proteins.
下圖顯示三條氧結合蛋白的解離曲線



Indicate if each of the following statements is true or false.
指出下列敘述正確或錯誤

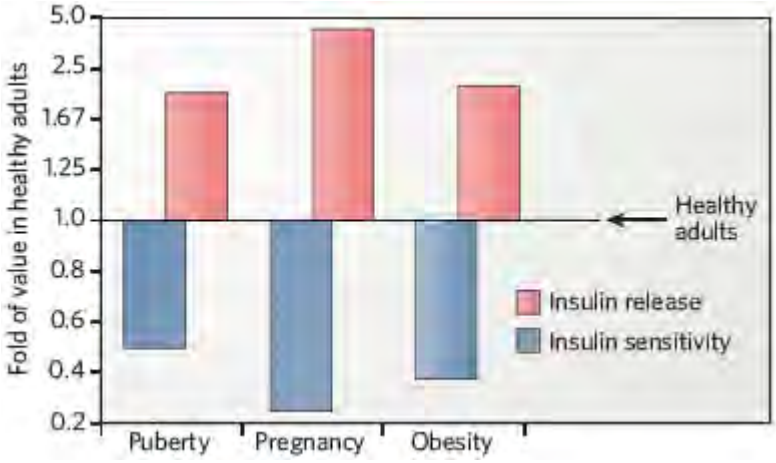
A. Curve 1 corresponds to the protein which is present in very high amounts in skeleton muscles of whales
曲線 1 代表某種在鯨魚骨骼肌中大量出現的蛋白質

B. Curve 2 could be found at acidosis in individual, normally displaying curve 3.
正常表現曲線 3 的人在酸中毒時會出現曲線 2

C. Curve 2 could be found at lower temperature in individual normally displaying curve 3.
正常表現曲線 3 的人在低溫時會表現曲線 2

D. Curve 2 belongs to fetal if curve 3 belong to maternal hemoglobin
若曲線 3 屬於母親的血紅素則曲線 2 屬於胎兒

21. Obesity is associated with several conditions, such as type 2 diabetes. Both obesity and type 2 diabetes are associated with insulin resistance as depicted in the figure below. Insulin sensitivity also modulates β-cell function and is almost always decreased in obesity.
肥胖與某些狀況有關，如第2型糖尿病。下圖顯示肥胖與第2型糖尿病皆與胰島素的抗性有關，胰島素的敏感性會改變 β-細胞的功能，肥胖時胰島素的敏感性會降低。



Indicate if each of the following statements is true or false.

指出下列敘述正確或錯誤

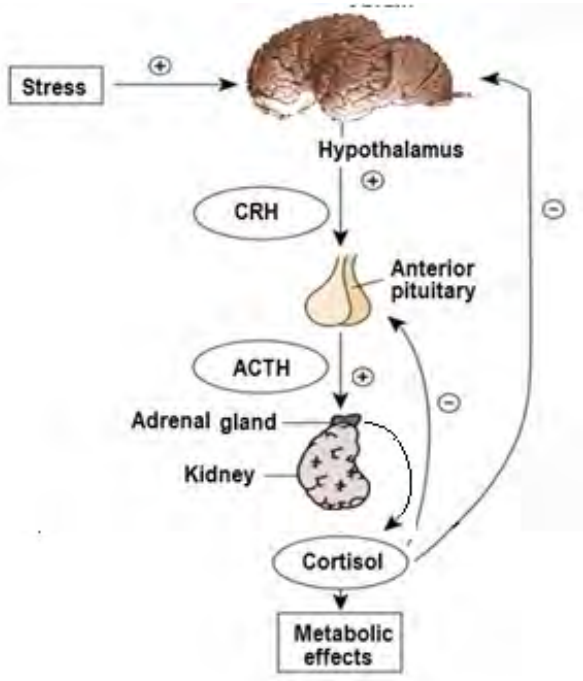
A. Obese individuals have greater insulin release and greater sensitivity at puberty.
肥胖者的胰島素分泌及敏感性皆比在青春期的少年為高

B. The data shown on the graph support the idea that insulin release could be correlated to insulin sensitivity.
圖中資料顯示支持胰島素分泌與胰島素敏感性相關的說法

C. Elevated blood glucose levels due to decreased insulin sensitivity usually causes the increased insulin release in obese individuals.
胰島素的敏感性降低所造成的血糖值升高，通常會使肥胖者的胰島素分泌升高

D. A trained athlete with type 1 diabetes would display lower release and higher sensitivity to those of healthy adult
第1型糖尿病的運動員比健康成人表現更少的胰島素分泌及更高的敏感性

22. The diagram outlines the feedback mechanisms regulating secretion of stress hormones in the human body.
下圖說明人體中調節壓力激素分泌的回饋機制



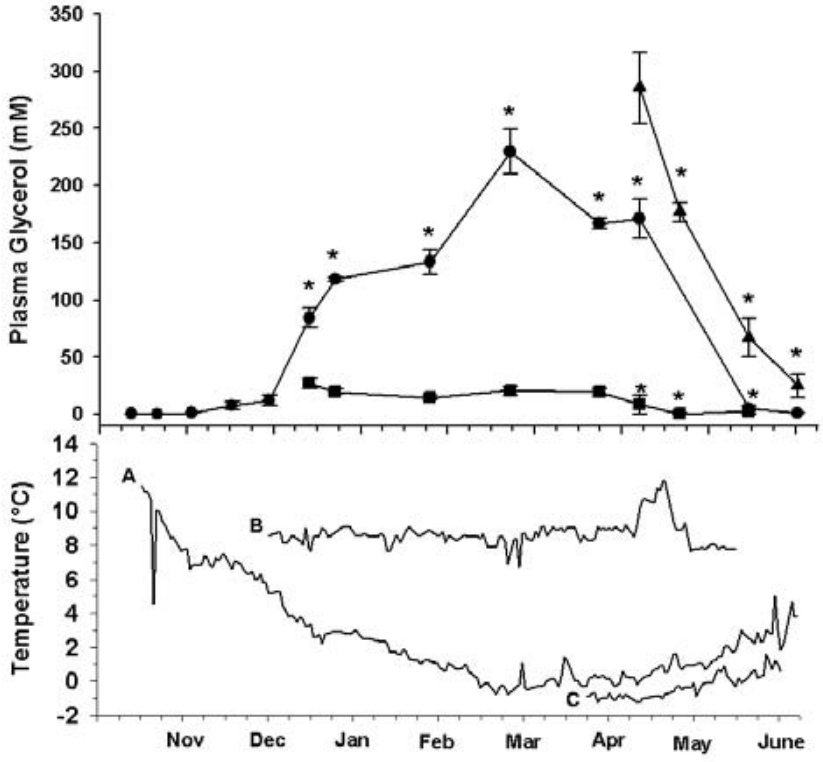
Levels of hormones involved in stress responses can be abnormal in a large number of clinical states
在許多種臨床狀況下壓力激素的分泌量會異常

Indicate if each of the following statements is true or false.
指出下列敘述正確或錯誤

	CRH	**ACTH**	**Cortisol** 皮質醇	**Cause**
A.	High	High	High	Long term stress 長期壓力下
B.	High	High	Low	Chronic adrenal insufficiency (Addisons' disease) 慢性腎上腺皮質素缺乏(愛迪生症)
C.	Low	Low	High	Adrenal hyperfunction (Cushings' adrenal disease) 腎上腺亢進(庫欣氏症)
D.	Normal	Normal	High	During long-term treatment with cortisol 長期使用皮質醇治療過程中

23. As an adaptation to extremely low temperatures in fast flowing water, Rainbow smelt (*Osmerus mordax*) produces glycerol in its blood plasma, liver, muscle and other tissues that avoids freezing at sub-zero temperatures. Maintenance of glycerol levels requires active feeding on insect larvae and active glycerol-3-phosphate dehydrogenase (GPDH).
為了適應在淡水急流中的極低溫度，虹鱒(*Osmerus mordax*)的血漿、肝臟、肌肉和其他組織中會產生甘油，以避免被冰凍，虹鱒需經常食用昆蟲的幼蟲及具有活化的甘油三磷酸去氫酶(GPDH)才能使血漿中的甘油維持定量

Glycerol can be synthesized from dihydroxyacetone phosphate (DHAP) formed either from the amino acid alanine or from glucose in an incomplete glycolysis. The figure below shows the correlation between plasma glycerol content and temperatures.
甘油可由 dihydroxyacetone phosphate (DHAP)所合成，DHAP 來自胺基酸(alanine)或葡萄糖的不完全糖解，下圖顯示血漿中甘油濃度與溫度的相關性



Seasonal pattern of plasma glycerol concentrations (mM) (●: in natural temperature;■: in artificially increased temperature;▲: in artificially decreased temperature) and temperature profile (A=natural, B= increased, C= decreased) for smelt held in a long-term acclimation study from October 2000 to June 2001. Symbols represent mean ± SEM (n=5), * indicates significance from initial sampling point within a treatment.
血漿中甘油濃度(mM)的季節性變化圖 (●：在自然溫度下； ■：在人工增加的溫度下； ▲：在人工降低的溫度下)和從 2000 年 10 月到 2001 年 6 月長期虹鱒研究的溫度變化(A=自然， B= 增加, C= 降低)圖。所有的符號代表以平均數加減 SEM (n=5)，*代表一處理中從抽樣起有顯著差異

Effect of glycerol on freezing point of water used in engine coolers.
(Molecular weight of glycerol is 102 g/mol.)
引擎冷凍機中甘油在冰點時的作用(甘油的分子量為 102 g/mol.)

Concentration of glycerol 甘油的濃度(%)	**Freezing point of water/glycerol solution 水/甘油 溶液的結冰點(^{o}C)**
0.0	**0.0**
5.0	**- 0.6**
10.0	**- 1.6**
11.5	**- 2.0**

Indicate if each of the following statements is true or false.
指出下列敘述正確或錯誤

A. Fast mobilization of glycerol is primarily dependent on protein in food and protein deposits in muscle tissue rather than dietary glucose and mobilization of glycogen stores in the body.
甘油的快速應用主要來自食物中及肌肉組織儲存的蛋白質，而非將儲存於身體中的甘糖分解

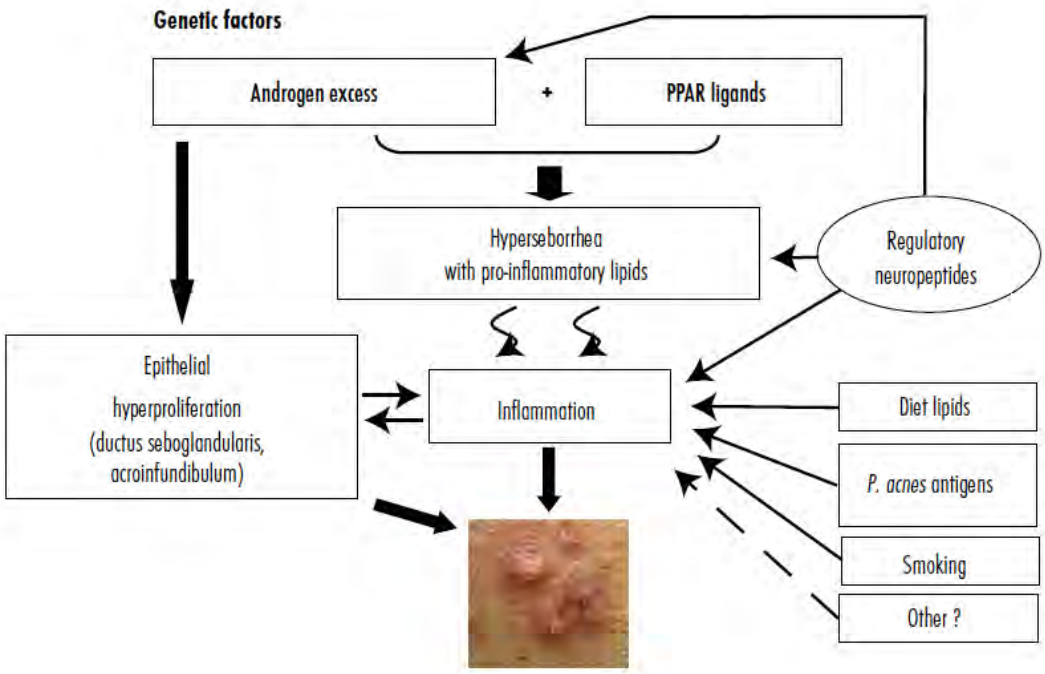
B. Since glycerol is poisonous (LD_{50} dose in guinea-pig is 7.5g/kg body weight), it is not advisable to eat rainbow smelt caught wintertime from water of subfreezing temperatures .
因為甘油具毒性(LD_{50} 在天竺鼠為 7.5g/kg 體重)，建議不要吃在冬天河水結冰時所釣的虹鱒

C. The level of plasma glycerol alone is sufficient for surviving the temperatures the fish is exposed to in experiment C.
血漿中的甘油濃度就足以保護魚活過實驗 C 中的溫度

D. When the rainbow smelt fish was kept at increased temperature B (20°C), the plasma glycerol level, will probably not permit the fish to survive if instantly moved to temperatures prevailing during winter time.
當虹鱒養在實驗 B 升高的溫度(20°C)，若將魚直接移入冬天時的溫度，血漿中甘油的濃度可能不會保護魚存活

24. Acne can be formed by several factors, such as genetic factors, androgen, nutrition, bad habit (smoking), or infection of the hair follicle by the strickly anerobic propionibacteria as shown in this figure below.

許多因素可以導致粉刺，例如遺傳因素、雄性激素、營養、壞習慣（抽煙）或毛囊被厭氧性的丙酸桿菌所感染，如下圖所示。



Indicate if each of the following statements is true or false.

指出下列敘述正確或錯誤

A. Acne may be aggravated in males with an extra Y-chromosome (XYY males).
粉刺在具有 XYY 染色體的男生身上會更嚴重

B. Some peroxides are efficient to reduce acne when applying to the skin.
皮膚上塗過氧化氫(雙氧水)可以有效減少粉刺

C. Inhibition of prostaglandins secretion will aggravate acne.
抑制攝護腺素的分泌會讓粉刺更惡化

D. The substrates used by bacteria in acne formation are actually compounds essential for epidermis lubrication.
粉刺形成過程中，被細菌所使用到的物質是對潤滑表皮的重要化合物

25. A 15-year-old boy was diagnosed as a case of Duchenne muscular dystrophy (DMD) and presented with progressive proximal weakness of the lower limbs starting at 4 years old followed by involvement of the upper limbs. In DMD, there is a mutation in dystrophin gene leading to the absence of the corresponding protein. Dystrophin is a molecular 'shock absorber' in the sarcolemma and has a major structural role in muscle as it links the internal cytoskeleton to the extracellular matrix.
一個被診斷出患有裘馨氏肌肉委縮症(DMD)的 15 歲男孩，他的下肢會有進行性的萎縮，他從 4 歲起，上肢也會有萎縮情形，裘馨氏肌肉委縮症患者的肌肉萎縮蛋白基因發生突變，導致缺乏相對應的蛋白質，肌肉萎縮蛋白是存在於肌節中可吸收震動的分子，扮演將細胞骨架連接於細胞外基質的角色。

Indicate if each of the following statements is true or false.
指出下列敘述正確或錯誤

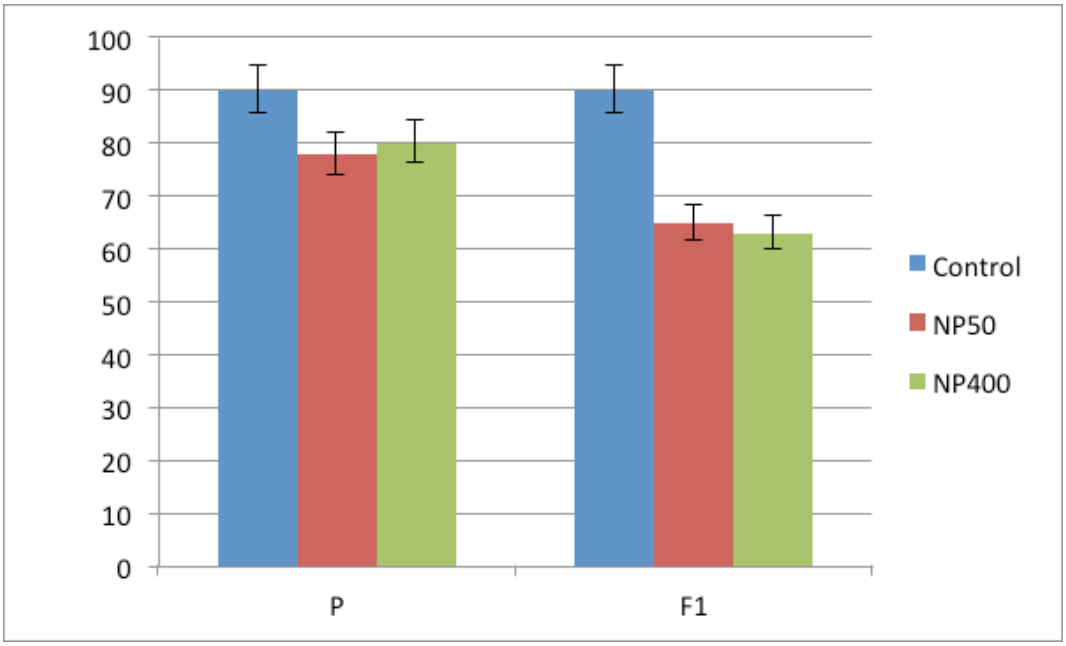
A. Increased levels of creatine kinase and other muscle-specific proteins in the blood plasm are used to diagnose the DMD.
肌酸激酶及其他肌肉專一性的蛋白質在血漿中量的增加可用來診斷裘馨氏肌肉委縮症

B. ATP cannot bind to myosin heads in the muscle of DMD.
裘馨氏肌肉委縮症患者的肌肉中 ATP 無法與肌凝蛋白分子結合

C. Motor neurons can initiate contraction in muscle fiber of DMD.
裘馨氏肌肉委縮症患者的運動神經元無法引起肌纖維收縮

D. The maximal contractile force of skeletal muscles is significantly reduced in DMD.
裘馨氏肌肉委縮症患者骨骼肌的最強收縮力會明顯降低

26. Para-Nonylphenol (4-nonylphenol / NP) isused in the preparation of lubricating oil additives, plasticizers and surface active agents. It has also been found in polyvinylchloride (PVC) used in the food processing and packaging industries. In an experiment to observe the effect of para-Nonylphenol on parental and 1st generation male mice, adult mice (P-generation) were treated with NP for four weeks. For the F1 generation, the treatment was administered during pregnancy, lactation and pubertal period up to adulthood. The results show that it wasshownthatpara-Nonylphenol was able to influence membrane integrity of spermacrosome (see figure below) and that the litter of F1 and F2 generations are therefore smaller.
Para-Nonylphenol (4-nonylphenol / NP)常用於潤滑油添加物、塑形劑及界面活性劑的製備，也常出現於食物處理和包裝的塑化劑（PVC）中，以雄性小鼠觀察 para- Nonylphenol 在親代(P)與第一子代(F1)的效應，親代成鼠以 NP 處理四週，F1 子代則在懷孕期、授乳期及青春期處理直到成鼠，結果顯示 para- Nonylphenol 會影響精子頂體細胞膜的完整性，F1 與 F1 子代的數目也會減少（見下圖）。



Percentage of spermatozoa with labeled acrosome as sign of their integrity sperm membrane of control mice, mice treated with para-nonylphenol 50mg/g body weight (NP50) and 500mg/g body weight (NP500), measured in parental (P) and 1stgeneration (F1)
在對照組與實驗組的 P 與 F1 兩代老鼠中、精蟲頂體細胞膜被標記(表明其完整性)的細胞數目百分比。實驗組是用以 para-nonylphenol 50 mg/g 體重 (NP50) 和 500 mg/g 體重(NP50) 處理的老鼠。

Indicate if each of the following statements is true or false.

指出下列敘述正確或錯誤

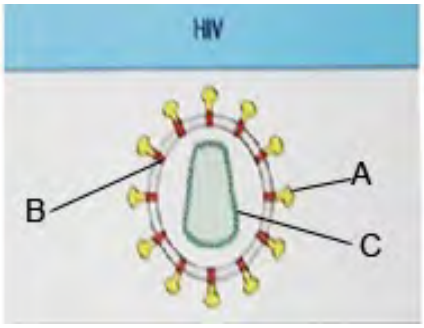
A. The effect of NP has begun since meiosis occurred in spermatogenesis.
NP 的作用開始於以減數分裂產生精子時

B. If a defective sperm fertilizes an egg, it will develop abnormally.
假使一個受損的精子與卵受精，受精卵的發育會異常

C. Defects in sperm are more severe in F1 generation due to longer NP exposure.
因為長期暴露於 NP 中，F1 子代精蟲的受損情形會更嚴重

D. If NP has the same effect on humans as on mice, it will potentially impair male fertility.
如果 NP 在人類與老鼠的作用相同，可能危害到其生育力

27. The HIV-1 lifecycle is a complex multistage process involving interactions between HIV-1 proteins and host macromolecules. The early phase of the lifecycle consists of infection of host cell and integration of viral genome, and the late phase of the lifecycle consists of regulated expression of the viral gene products followed by production of viral particles. The HIV proteome consist of 20 different molecules, only subset of them is targeted by the immune system. Immunogenic molecules are shown in the picture.
HIV-1 生活史有多個階段的複雜過程，包括 HIV-1 蛋白質與宿主巨分子間的作用，生活史的早期包括感染宿主細胞，將病毒基因插入宿主細胞中，晚期包括病毒基因表現產生蛋白質，形成病毒顆粒，HIV 的蛋白體包括 20 種不同的分子，其中只有少數是宿主免疫系統的攻擊目標，下圖顯示會造成免疫力的分子。



Indicate if each of the following statements is true or false.

指出下列敘述正確或錯誤

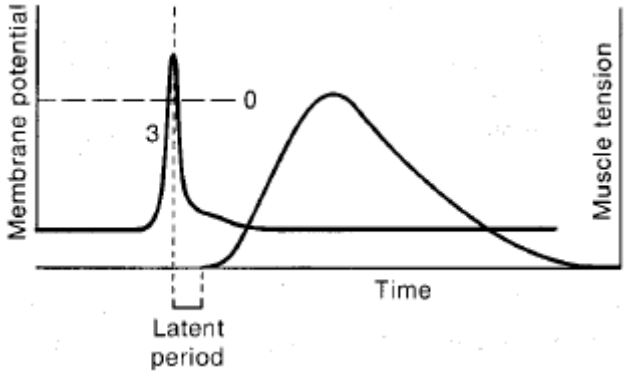
A. A-specific antibodies could efficiently interfere with infectivity of the particular viral strain.
對 A 蛋白有專一性的抗體會有效干擾病毒的感染力

B. The gene for protein A is undergoing rapid evolution (much more quickly than happens for C) resulting in escape variants to which preformed antibodies do not bind.
A 蛋白的基因會進行快速演化（較 C 蛋白基因更快），結果使突變種能逃脫被抗體結合

C. Peptide fragments derived from protein C could activate cytotoxic response of CD8 positive T-lymphocytes.
來自 C 蛋白的多肽片段能活化具有 CD8 的 T 淋巴球之毒殺作用

D. Due to lack (or highly diminished number) of helper T-cells, the humoral response is crippled and unable to clear the HIV infection.
由於缺乏（或其數量太少）輔助性 T 細胞，體液反應受損無法清除 HIV 的感染

28. The following figure shows a relationship between membrane potential and muscle tension. The latent period is gap between action potential and muscle contraction.
下圖顯示靜止膜電位和肌肉收縮的關係，不反應期是介於動作電位與肌肉收縮間的空檔



Indicate if each of the following statements is true or false.

指出下列敘述正確或錯誤

A. Both ascending and descending parts of the membrane potential curve reflect ion gradient-driven processes.
膜電位曲線中上升與下降的部分皆由離子梯度所主導

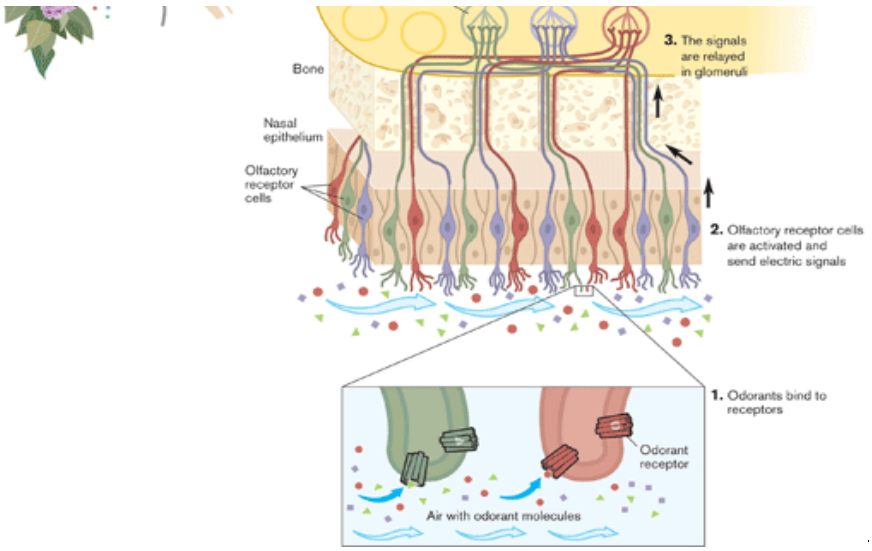
B. Both ascending and descending parts of the tension curve reflect ATP- dependent processes.
肌肉收縮曲線中上升與下降的部分反應出ATP依賴性的過程

C. The peak of the tension curve reflects minimum number of actin-myosin cross-bridges formed.
肌肉收縮曲線中的波峰代表肌動蛋白與肌凝蛋白間所形成之橫橋的最小數目

D. A decrease in temperature will decrease the duration of the latent period
溫度下降會縮短不反應期的時間

29. Axel and Buck (The Nobel Prize in Physiology or Medicine 2004) discovered and characterized a large gene family, containing more than 1,000 different genes (about three per cent of the

本題作廢



Indicate if each of the following statements is true or false.
指出下列敘述正確或錯誤

A. Olfactory receptors belongs to a family of seven times membrane spanning molecules associated with trimeric G-proteins.
嗅覺受體屬於橫跨細胞膜口外七次的G-蛋白（trimeric G-proteins）家族

B. Each glomerulus in the olfactory bulb receives synaptic inputs from the primary olfactory receptor neurons of one type expressing particular odorant receptor scattered among about the thousand different types of olfactory receptor neurons localized in the olfactory epithelium.
嗅球中的嗅小球可接受來自初級嗅覺受體神經元突觸的訊息，該神經元是一種會接受特殊氣味的受體，分布於嗅覺上皮中上千種不同類型的嗅覺神經元間

C. Olfactory receptor neurons are able to regenerate and are replaced in about every two months.
每約兩個月嗅覺受體神經元可新生並被取代

D. Odorant receptors are localized on cilia of olfactory receptor cells and are analogous to the cilia.
氣味受體是位於嗅覺受體細胞的纖毛上，並與纖毛是屬於同功器官

30. The effects of high altitude on humans are considerable. After the human body reaches around 2,100 m (7,000 feet) above sea level, the saturation of oxyhemoglobin begins to plummet. However, the human body has both short-term and long-term adaptations to altitude that allow it to partially compensate for the lack of oxygen.
人體對海拔高度會產生反應，高度到達約 2,100 公尺(7,000 英尺)時，氧合血紅素的飽和度會急遽下降，但人體對高度會有短期和長期的適應以補償氧的缺乏。

Indicate if each of the following statements is true or false.

指出下列敘述正確或錯誤

A. Unacclimatized people experiencing high altitudes sense lack of oxygen by the carotid bodies, which cause hyperventilation followed by the respiratory alkalosis. This inhibits the respiratory center from enhancing the respiratory rate as much as would be required.
無法適應高海拔的人會缺氧，頸動脈化學受體會引起過度換氣而造成呼吸性鹼中毒，因此抑制呼吸中樞提高所需呼吸速率的調控

B. During full acclimatization, there is a decrease in the plasma volume and increase of the hematocrit number.
完全適應的過程中，血漿體積會降低而血球容積比值會增加

C. At high altitude an unacclimatized person´s heart rate increases, stroke volume is slightly decreased and non-essential bodily functions are suppressed. This result in a decline in digestion efficiency.
在高海拔，無法適應的人其心跳速率會增加、心輸出量會略為下降、非必要的身體功能會被抑制，結果會造成消化效率的降低

D. In the skeletal muscle tissue full acclimatization leads to lower density of capillaries and decreased myoglobin content.
完全適應者的骨骼肌組織中微血管密度和肌蛋白含量皆會降低

GENETICS AND EVOLUTION 遺傳與演化

31. Three corn phenotypes plant-color booster, liguleless and silkless are all controlled by a single gene located on the same chromosome. In all cases, the wild type allele is dominant. A cross between a plant with wild type characters and a plant showing all three recessive phenotypes resulted in the following progeny:
玉米控制深色，無葉舌和無玉米鬚三種突變表現型的各基因位於同一染色體上，而此三個基因的野生型等位基因皆為顯性。一個三種性狀皆為正常表現型的玉米與一個同時帶有此三種突變表現型的玉米雜交，得到下列各種子代：

type	silk	color	ligule	number of progeny
1	wild type	wild type	wild type	7
2	wild type	wild type	liguleless	179
3	wild type	booster	wild type	41
4	silkless	wild type	wild type	352
5	wild type	booster	liguleless	398
6	silkless	wild type	liguleless	49
7	silkless	booster	wild type	158
8	silkless	booster	liguleless	10
				Total=1194

Indicate if each of the following statements is true or false.
推定下列各敘述是正確 true 或錯誤 false

A. The wild type parent plant carried a chromosome with only dominant alleles.
在此野生型親本的一條染色體上，此三個基因中只有一個為顯性等位基因

B. Recombination frequency between the loci encoding plant-color booster and liguleless was 37.18 %.
深色基因和無葉舌基因間的總重組互換率為 37.18 %

C. The locus controlling silkless is located between the loci controlling the other phenotypes.
控制無玉米鬚的基因位於其他二個基因之間

D. The progeny of a back-cross between an all wild type progeny and the wild type parent will result in a similar distribution of phenotypes to that found on the table.
子代中三種性狀皆為正常表現型的玉米與原來正常型的親本雜交時，會得到與之前相似的子代表現型分布

32. Earlier research suggested that the red flower pigment of plant species was the result of a chemical pathway including multiple steps and that all intermediate pigments were white. Three pure-bred lines with white flowers (White 1, 2 and 3) of this species were crossed with each other and the following ratio of colors were obtained among the progeny:
過去研究指出植物紅花色素是經過許多化學轉換過程而得，過程中的中間產物都是白色。三個不同的白花純品系 (White 1, 2 和 3) 相互雜交後得到的子代的顏色分布如下表

No of Cross	Cross	F1	F2 (F1 x F1)
1	White 1 x White 2	All Red	9 Red : 7 White
2	White 2 x White 3	All Red	9 Red : 7 White
3	White 1 x White 3	All Red	9 Red : 7 White

Indicate if each of the following statements is true or false.

推定下列各敘述是正確 true 或錯誤 false

A. These results suggest that flower color is controlled by two genes.
雜交結果顯示花色是由 2 個基因控制

B. F1 plants were all heterozygous for all genes controlling flower color.
這些花色控制基因在各組 F1 個體中都是異型合子

C. A cross between an F1 individual of cross 1 and a pure White 3 individual will result in only white individuals.
雜交組合 1 所得的 F1 個體和 White 3 純品系雜交後，其子代都是開白花

D. One fourth of all offspring between a cross of F1 individuals from crosses 1 and 3 are expected to be white.
雜交組合 1 所得的 F1 個體和雜交組合 3 所得的 F1 個體雜交後，其子代有 1/4 開白花

33. Each of five mutant strains of *Escherichia coli* (1 – 5) has a mutation affecting the *lac* operon. Mutant 1 has a mutation in the *lac*Y gene and the others have one each of the following mutations:

- A nonsense mutation in *lac*Z; a nonfunctional β-galactosidase is produced.
- A *lac*O^C mutation; the repressor cannot bind to the operator.
- A promoter mutation; RNA polymerase cannot bind to the promoter.
- A super-repressor mutation; lactose cannot bind and inactivate the repressor

The *lac* operon from each mutant was inserted on a plasmid into a wildtype and the mutant *E. coli* strains and their ability to grow on lactose-containing medium was assayed. + indicates the ability to grow and – indicated that no growth was observed. Growth requires both functional LacZ and LacY.

5 個大腸桿菌 *E. coli* 的突變株(Mutant 1~5)皆影響乳糖操縱組(*lac* operon)，Mutant 1 的突變發生在 *lac*Y 基因，其他的突變株的性質分別為下列其中之一：

- 一個 *lac*Z 的無意義突變(nonsense mutation)；表現無功用的 β-galactosidase
- 一個 *lac*O^C 的突變；抑制蛋白無法附著於操作子(operator)
- 一個啟動子(promoter)突變；RNA 聚合酶無法附著於啟動子
- 一個超級抑制蛋白突變(super-repressor mutation)；乳糖無法與抑制蛋白結合，因而不能將之去活化

將上述突變株的突變 *lac* operon 放在質體上，轉殖入正常型和各突變株內，檢測他們在乳糖培養基上的生長(如下表)，”+”表示可生長；”-“則為無生長。在乳糖培養基生長需要有功能的 LacZ and LacY 蛋白。

		Host cell					
		1	**2**	**3**	**4**	**5**	**Wildtype**
Inserted *lac* operon	**1**	-	+	+	-	-	+
	2		+	+	+	+	+
	3			-	-	-	+
	4				-	-	-
	5					-	+

Indicate if each of the following statements is true or false based on the type of mutation in mutant 2 - 5

根據各突變株性質，推定下列各敘述是正確 true 或錯誤 false

A. Mutant 2 has a LacO^{C} mutation.

Mutant 2 帶有一個 *lac*O^{C} 的突變

B. Mutant 3 has a promoter mutation.

Mutant 3 帶有一個啟動子(promoter)突變

C. Mutant 4 has a super-repressor mutation.

Mutant 4 帶有一個超級抑制蛋白突變

D. Mutant 5 has a LacZ nonsense mutation

Mutant 5 帶有一個 *lac*Z 的無意義突變

34. Two highly inbred strains of a plant (P1 x P2) were crossed to get F1 plants, which were then selfed, all in the same location. The mean and variance of stem height were evaluated in every generation. Stem height is controlled by many genes modulated by environmental factors.

將二個高度自交的植物品系雜交(P1 x P2)得到 F1 子代，F1 再自交，所有試驗於相同地點進行，量測各代莖高之平均和變異值如下表。莖高由許多基因共同控制，且受環境因子影響。

Generation 世代	**Stem Height (Mean)** 莖高之平均	**Stem Height (Variance)** 莖高之變異
P1	60.5 cm	4.3 cm
P2	85 cm	4.2 cm
F1 (P1 x P2)	**Data lost** 資料遺失	5.1 cm
F2 (F1 x F1)	**Data lost** 資料遺失	25.4 cm

Indicate if each of the following statements is true or false.

推定下列各敘述是正確 true 或錯誤 false

A. The mean stem height was approximately similar among F1 and F2 individuals.
F1 和 F2 的平均莖高大致相近

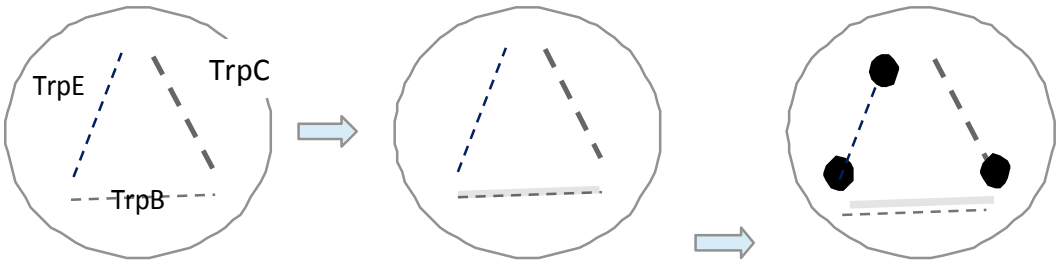
B. The variance in stem height among F1 individuals is determined by both genetic and environmental factors.
F1 個體間的莖高變異值包括遺傳因子變異和環境因子變異

C. In F2, environmental factors have a greater effect on stem height variation than do genetic factors.
F2 個體間的變異中，環境因子變異大於遺傳因子變異

D. F1 individuals are heterozygous for all genes contributing to stem height.
在 F1 個體中所有影響莖高的基因皆為異型合子

35. Three mutant bacterial strains, TrpB-, TrpC- and TrpE-, each defective in one of the steps in the tryptophan biosynthesis pathway were streaked in a triangle on a petridish, as shown below. The very small concentration of tryptophan in the medium allowed them to grow and form pale streaks until it was depleted. Some regions of the streaks, however, continued to grow slowly and became thicker. The tryptophan pathway involves the successive conversion of chorismate to anthranilate, indole and finally, tryptophan:

三個細菌突變株，TrpB-, TrpC- 和 TrpE- 各自影響色胺酸(tryptophan)合成過程中的一個步驟。將此三突變菌株畫在含低量色胺酸的培養基上(如下圖所示)，在此培養基上，各菌種中可行有限生長後停止，但在一些特定位置，會有持續緩慢生長而讓菌落變大。
色胺酸(tryptophan)合成過程是由 chorismate 先轉成 anthranilate，再轉成 indole ，最後才生成 tryptophan



Indicate if each of the following statements is true or false.
推定下列各敘述是正確 true 或錯誤 false

A. These results suggest that intermediates of the biosynthetic pathway are actively secreted out of the cells.
這些實驗結果顯示合成過程的中間產物會被主動分泌出細胞

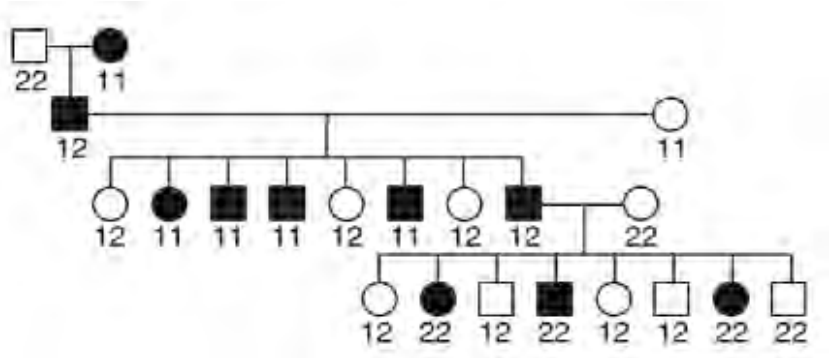
B. $TrpC^-$ has a mutation in the enzyme that catalyzes the conversion of indole to tryptophan.
$TrpC^-$突變株的突變發生在負責催化將 indole 轉為 tryptophan 的基因

C. $TrpE^-$ has the capability to synthesize tryptophan if the medium contains anthranilate or indole.
如果培養基中含有 anthranilate 或 indole，$TrpE^-$突變株可以合成 tryptophan

D. Indole will continue to accumulate in the medium where $TrpB^-$ cells are in the vicinity of $TrpC^-$ cells.
在 $TrpB^-$和 $TrpC^-$相鄰處會有 indole 累積

36. The pedigree below shows the inheritance of a rare genetic disease (inherited by autosomal dominant allele) in a family. Locus for this disease is unknown. A genetic consultant is curious whether the inheritance of this disease is linked with a certain genetic marker (microsatellite) located on chromosome 5 in humans. This microsatellite has two main allele variants: allele 1 and allele 2. The pedigree shows the inheritance of the disease (dark means the person has the disease) and the microsatellite marker associated with it in each person (1 or 2)

下圖的族譜是關於一罕見遺傳疾病的發生情形，此疾病是由一體染色體顯性等位基因引起，此基因所在位置不明。一遺傳學家想知道此基因是否與位於第五條染色體上的特定遺傳標籤(microsatellite)連鎖，此遺傳標籤有二種等位基因：等位基因 1(allele 1)和等位基因 2 (allele 2)，族譜中標示罹病者(黑色實心)和每個人所帶的遺傳標籤(microsatellite)



Indicate if each of the following statements is true or false.

推定下列各敘述是正確 true 或錯誤 false

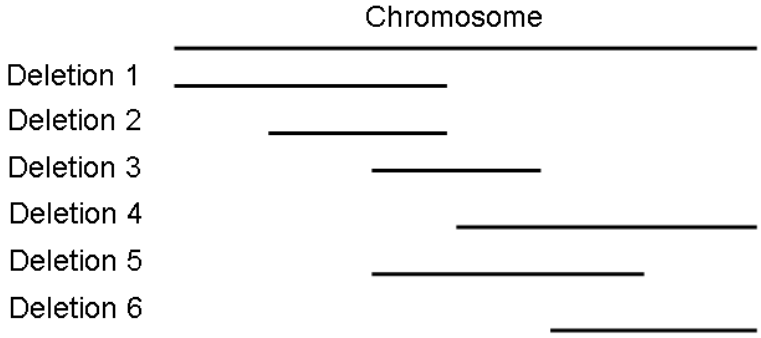
A. It is possible that the gene for the disease is also located on chromosome no 5
此致病基因有可能位於第 5 條染色體上

B. If a person has the disease, he/she would always have microsatellite allele 1 variant
罹病者一定帶有遺傳標籤(microsatellite)的等位基因 1

C. In the 4th generation, only one child obtained a recombinant chromosome from his/her father
在第四代中只有 1 個小孩從其父親處得到一個新重組的染色體

D. From the 3rd and 4th generation, it could be concluded that the recombination frequency between the gene of the disease and the microsatellite was 3/16
由第三和第四代的個體推算致病基因和遺傳標籤(microsatellite)的重組互換率為 3/16

37. The locations of six deletions have been mapped to the *Drosophila* chromosome as shown in the following diagram.
在果蠅特定染色體上有 6 個染色體缺失突變區域如下圖中實線所示



Recessive mutations *a, b, c, d, e* and *f* are known to be located in the same regions as the deletions, but the order of the mutations on the chromosome is not known. When flies homozygous for the recessive mutations are crossed with flies homozygous for the deletions, the following results are obtained, where the letter "m" represents a mutant phenotype and a plus sign (+) represents the wild type.

隱性點突變 *a, b, c, d, e* 和 *f* 都位於此染色體，但他們的順序不明。將帶有單一點突變同型合子的果蠅分別與帶有不同染色體缺失突變同型合子的果蠅交配，所得子代結果如下表所示，其中 "m" 代表突變表現型； (+) 代表正常野生型

	Mutations					
Deletion	***a***	***b***	***c***	***d***	***e***	***f***
1	m	+	+	m	+	m
2	+	+	+	m	+	m
3	+	m	+	m	+	+
4	+	m	m	+	m	+
5	+	m	m	m	+	+
6	+	+	m	+	m	+

Indicate if each of the following statements is true or false.

推定下列各敘述是正確 true 或錯誤 false

A. Mutation *d* is located in the overlapping area between deletion 4 and deletion 6.
突變 *d* 位於缺失 4 和缺失 6 重疊區域

B. Location of the deletion where mutation *b* is located can be deduced using information of overlapping area between deletions 3, 4 and 5.
由缺失 3, 4 和 5 可以推出突變 *b* 所在區域

C. Among the six mutations, mutation *d* is located in the shortest deletion
在各點突變中，突變 *d* 的可能定位區域最短

D. The relative order of the six mutations on the chromosome is *a, f, d, b, c, e*.
這些點突變的相對順序為 *a, f, d, b, c, e*

38. Suppose that the horse's color is determined by one gene which has two alleles *B* and *b*. *B* allele is dominant over *b* and expresses brown color, while *b* allele is recessive and codes for black color. There were two populations of horses in two separate locations. In population 1, the allele frequency of *B* was 0.5, while in population 2 it was 0.2. The size of population 1 was five times larger than population 2. Initially, both populations were in Hardy Weinberg Equilibrium. Then, the two populations joined into one unified population..
假設馬的毛色由單一基因控制，此基因有二個等位基因，B 和 b，B 對 b 是顯性，B 是棕色，b 是黑色。有二個分開的馬族群，族群 1 中，B 等位基因頻率是 0.5，族群 2 中，B 等位基因頻率是 0.2，族群 1 的個體數量是族群 2 的 5 倍。二個族群原本都處於哈-溫平衡狀態，然後，這二個族群混合為單一族群。

Indicate if each of the following statements is true or false.

推定下列各敘述是正確 true 或錯誤 false

A. The above phenomenon is an example of genetic drift

上述事件是遺傳漂變的例子

B. After the populations joined, the allele *B* frequency is higher than frequency allele *b*.

二族群混合後，B 等位基因頻率會大於 b 等位基因頻率

C. Two generation after the population joined, 12.6 % of all offsprings between two brown horses are expected to be black.

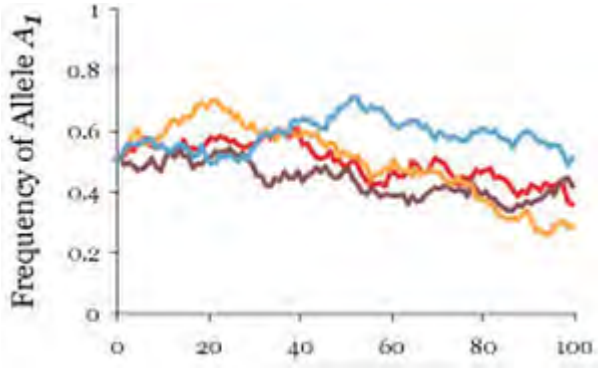
在族群混合後二個世代，二匹棕馬交配後生下黑馬的機率是 12.6 %

D. Among 1000 offspring born in the first generation after the populations joined, 698 are expected to be brown horses.

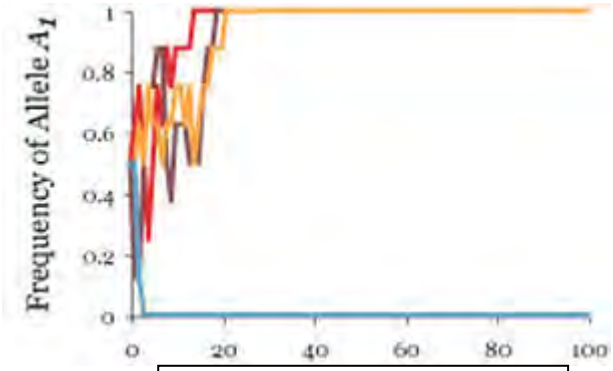
在混合族群後第一代誕生的 1000 匹新生小馬中，有 698 匹是棕色的

39. Figures (A, B, and C) illustrate the results of a series of computer simulations of changes in allele frequencies in a group of populations due to chance alone (*genetic drift*). The simulations were done in different population sizes. X axis indicates the number of generation, Y axis indicates allele frequency and different colors indicate the repetition of simulations.

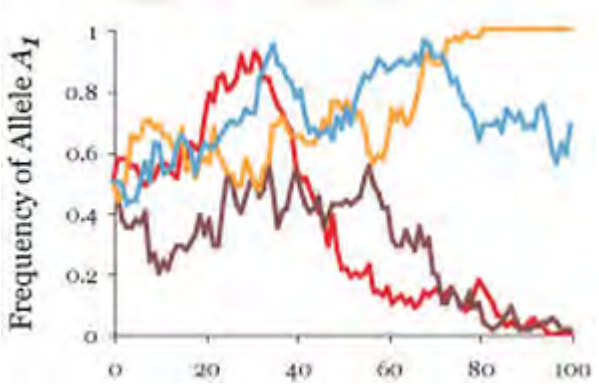
圖 A，B 和 C 為一系列電腦模擬在不同族群中，遺傳漂變(genetic drift)對等位基因頻率的效應，這些模擬是以不同大小的族群(I，II 和 III)分別進行。圖中 X 軸表示世代數，Y 軸是基因頻率，不同顏色代表重複模擬。



Simulation on Population I



Simulation on Population II



Simulation on Population III

Indicate if each of the following statements is true or false.

推定下列各敘述是正確 true 或錯誤 false

A. Among the three simulations, Simulation III was done on the smallest population size while Simulation I was done on the largest population size.

在這些模擬族群中，模擬 III 是以最小的族群進行，模擬 I 是在最大的族群進行

B. Time of fixation of an allele at 50% is shorter in Population I than in Population III.

新等位基因被固定 (fixation) 所需的時間，在族群 I 會比在族群 III 要短

C. Probability that new mutation will be lost in a population will be higher in Population III than in Population I.

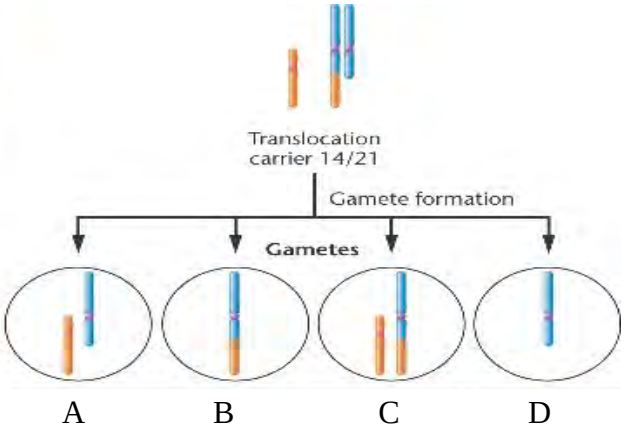
族群中新突變遺失的機率，在族群 III 中要比在族群 I 中要高

D. Results, such as those obtained for Population II can also be obtained when a weakly deleterious allele is simulated.

當以一個略微有害的等位基因進行模擬時，會得到與族群 II 一樣的結果，

40. **Robertsonian translocation** is a rare form of chromosomal rearrangement that can potentially involve the five acrocentric chromosome pairs, namely 13, 14, 15, 21 and 22, in humans. Other translocations occur too but are inviable. During a Robertsonian translocation, the participating chromosomes break at their centromeres and the long arms fuse to form a single chromosome with a single centromere. The short arms also join to form a reciprocal product, which typically contains nonessential genes and is lost within a few cell divisions. The figure below shows the four possible gametes produced by a carrier of a Robertsonian translocation.

Robertsonian 易位(translocation)是一種罕見的染色體構造突變，可在那些中節近端粒的染色體(acrocrntric chromosome)上觀察到(人類：13, 14, 15, 21,和 22)，其他染色體也會發生，但無法存活。發生 Robertsonian 易位時，染色體在中節處斷裂，二條染色體長臂相互結合成具單一中節的染色體，而短臂也相互結合，但通常其上不攜帶重要基因，常在幾次細胞分裂後丟掉。下圖中說明攜帶 Robertsonian 易位染色體者可能產生的四種配子。



Indicate if each of the following statements is true or false.
推定下列各敘述是正確 true 或錯誤 false

A. The fusion of gamete B with a normal gamete results in a translocation carrier with a normal phenotype but 45 chromosomes.
配子 B 和一正常配子結合後會生下一個易位染色體攜帶者，正常表現型，但只有 45 條染色體

B. The fusion of gamete C with a normal gamete results in trisomy 21. (Down Syndrome).
配子 C 和一正常配子結合後會生下一個帶有三個第 21 條染色體片段的三染色體(trisomy)患者(唐氏症)

C. The fusion of gamete D with a normal gamete results in a lethal monosomy.
配子 D 和一正常配子結合後會變成致死的單染色體(monosomy)

D. Among the offspring of two translocation carriers, one-fourth is expected to have 44 chromosomes.
二個攜帶 Robertsonian 易位染色體者生下的子代中，1/4 會只有 44 條染色體

ECOLOGY 生態學

41. The table below is a static life table for an unspecified invertebrate species with a life span of around five months. Certain values in the table are missing, and are denoted by the letters A to J.
下表是某種無脊椎動物的靜態生命表，壽命為五個月，表中有部份資料缺失(以英文字母 A 到 J 表示)。

Age class ***(x)*** 年齡層	**Number alive** ***(n_x)*** 存活個體數	**Number dying** ***(d_x)*** 死亡個體數	**Proportion surviving ** ***(l_x)*** 存活比例	**Mortality rate** ***(q_x)*** 死亡率
0-1	2000	**C**	1.000	0.944
1-2	112	**D**	0.056	**G**
2-3	74	27	0.037	**H**
3-4	**A**	43	**E**	**I**
4-5	**B**	3	**F**	**J**

Indicate if each of the following statements is true or false.
指出下列敘述是正確或錯誤

A. The values for A and B are respectively 47 and 4.
A 與 B 值分別為 47 及 4

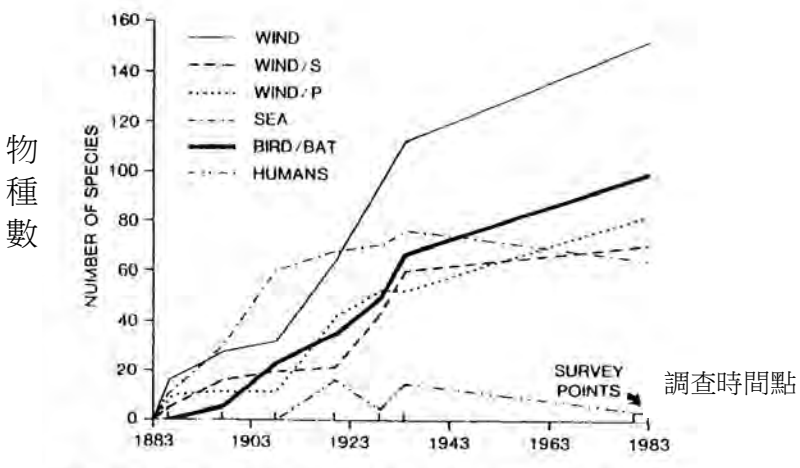
B. The values for G and H are respectively 0.019 and 0.014.
G 與 H 值分別為 0.019 及 0.014

C. The above life table is based on cohort data.
上述生命表是根據同齡層的資料而得

D. The organism recorded in the life table is most likely a K-strategist with a Type-I survival curve.
在生命表中所紀錄的個體，最有可能是屬於具 Type-I 存活曲線的 K 策略者(K-strategist)

42. Studies spanning a period of more than 100 years have recorded the changes in vegetation on islands around the volcanic area of Krakatau, Indonesia. The following graph shows the number of plant species recorded, since after the volcanic eruption of 1883 up to 1983. The graph differentiates species according to their mode of dispersal, i.e., by wind (S=Spermatophytes, P=Pteridophytes), sea, bird/bat, or humans.

印尼 Krakatau 火山附近地區的植被變化已有超過 100 年的資料，下圖顯示 1883 年爆發後到 1993 年的植物物種數。此圖根據不同物種的散佈方式區分，即藉由風力(S=Spermatophytes 種子植物, P=Pteridophytes 蕨類)、海洋、鳥/蝙蝠或人類。



Indicate if each of the following statements is true or false.

指出下列敘述是正確或錯誤

A. Dispersal through mutualistic relationships was most important in determining plant establishment on the Krakatau islands.

藉由互利共生關係的散佈方式，是決定 Krakatau 島上植物最重要的因子

B. In 1943, most plants would likely have small-sized seeds.

在 1943 年，大多數植物可能具有小型的種子

C. Leaching of nutrients is likely to be higher in 1963 than 1923.

1963 年的營養鹽流失可能較 1923 年高

D. Plant community change as illustrated above is an example of primary succession.

上述顯示的植物群集改變是初級演替的例子

43. Vascular plants and macroalgae produce a variety of secondary metabolites that can function as defenses against herbivory. These defense chemicals can either be present and produced at effective levels continuously (constitutive defense) or increase in production when induced by herbivory or artificial clipping (inducible defense). In many vascular plants, response to herbivory may also result in increased resistance to further grazing. An experimental study examined the importance of phlorotannins (polyphenolics) in the chemical defense mechanism of the brown seaweed (macroalgae) *Ascophyllum nodosum*, which is grazed upon by two species of mesoherbivores, i.e., the gastropod *Litorina obtusata* and the isopod *Idotea granulosa*. Part of the study results is presented in the figures below:

維管束植物與大型藻類產生多樣的次級代謝物，可用來防禦草食性動物的啃食。此類防禦化學物質一則可持續以有效劑量存在 (本質防禦)，或者可藉由草食性動物啃食或人工剪取所造成的刺激來增加產量(誘發防禦)。許多維管束植物因應草食性動物的啃食壓力，也有助於抵抗更多的啃食。某研究探討大型褐藻(*Ascophyllum nodosum*)所產生的化學物質 phlorotannins (polyphenolics)對防禦兩種中型草食動物-螺(*Litorina obtusata*)及等足類(*Idotea granulosa*)的重要性，其部分結果顯示於下。

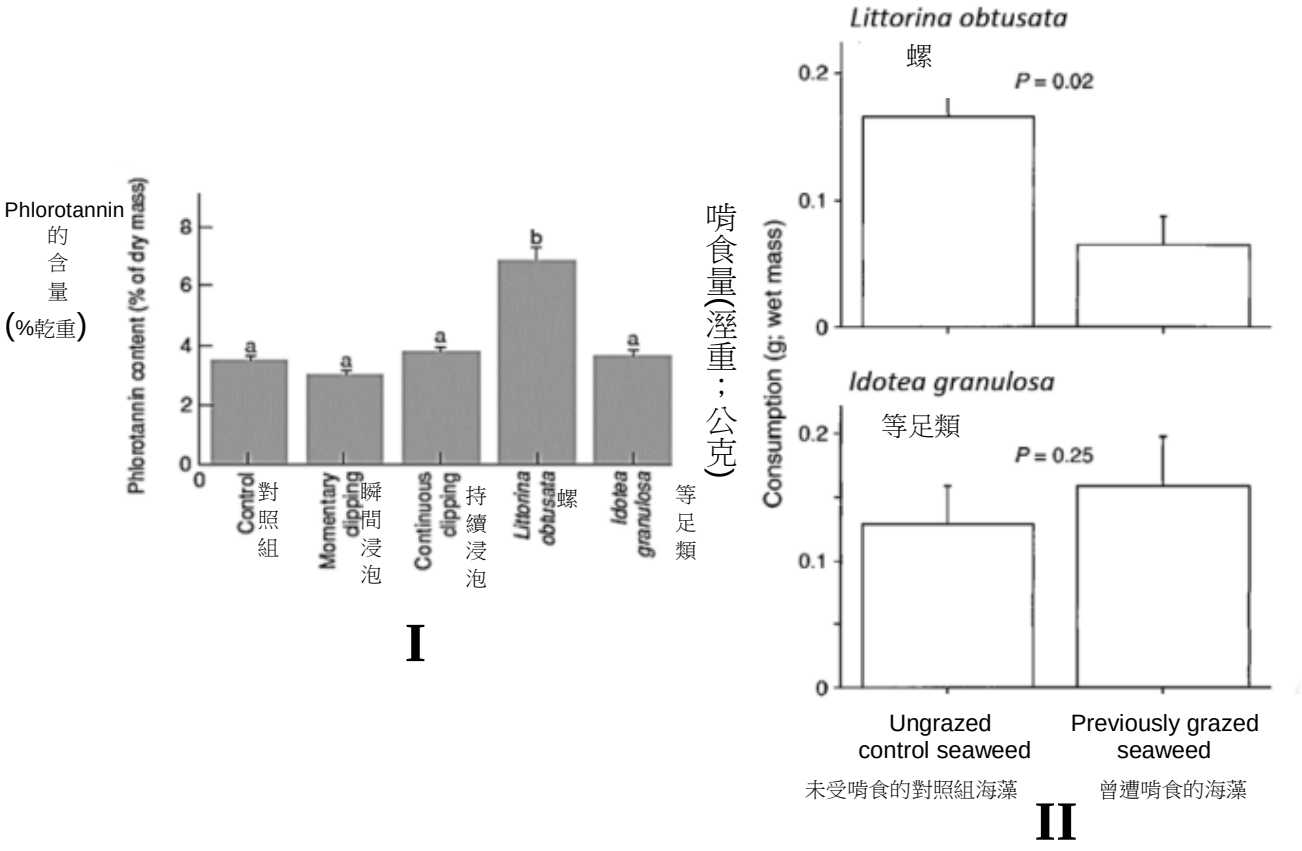


Figure: (I) Phlorotannin content of *A. nodosum* seaweed after exposure to grazing by mesoherbivores and simulated herbivory (clipping with a hole punch). Control treatment received no physical damage (no clipping or herbivory). (II) The amount of *A. nodosum* shoots consumed by mesoherbivores in two-choice feeding preference experiments. Mesoherbivores were offered a choice between seaweed shoots that had been grazed by individuals of the same herbivore species or shoots from control seaweed.

圖：(I) *A. nodosum* 海藻在被中型草食性動物啃食及模擬被啃食(在海藻上打洞)下所產生的 Phlorotannin 量，對照組則不受任何外來的傷害(即無打洞或被啃食)。

(II) 利用 *A. nodosum* 海藻進行實驗，測試兩種中型草食性動物對兩種不同處理的海藻之偏好，一為未受啃食的對照組海藻，另一為曾遭啃食的海藻。

Indicate if each of the following statements is true or false.

指出下列敘述是正確或錯誤

A. There is a high degree of specificity in the elicitation of chemical responses by *A. nodosum* to physical damage.
*A. nodosum*海藻在遭受外力傷害時，會引起高度專一的化學反應

B. Production of phlorotannins by *A. nodosum* is strictly an inducible defense.
*A. nodosum*海藻產生phlorotannins的反應屬於誘發防禦

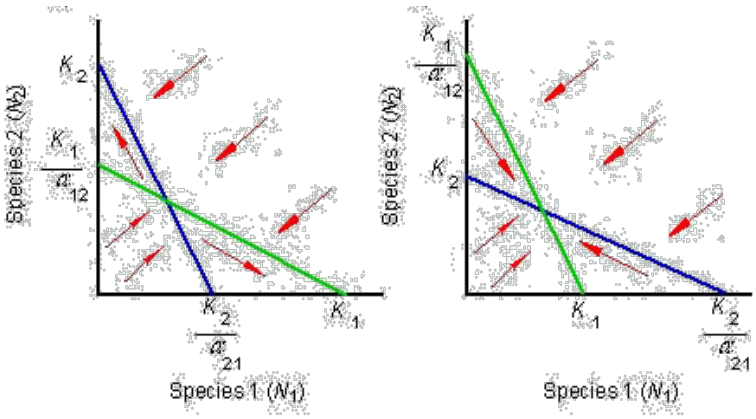
C. *A. nodosum* that had been grazed by *I. granulosa* were less susceptible to further grazing, compared to ungrazed ones, as a result of induced resistance.
相較於未被啃食的*A. nodosum*海藻，曾遭*I. granulosa*等足類啃食的海藻，其未來被啃食的機會較低，這是由於誘發防禦的結果

D. The different feeding modes of the two predators are likely to be responsible for the differential chemical response of the algae.
這兩種不同的草食動物所呈現的不同啃食模式，很可能造成海藻產生不同化學反應

44. Given below are Lotka-Volterra equations which model the competition between populations of Species 1 and Species 2. In the equations, *N*=number of individuals, *K*=carrying capacity, *r*=intrinsic rate of increase, and δ=competition coefficient.
下面是 Lotka-Volterra 的公式，其模擬兩物種間(Species 1 and Species 2)族群的競爭。在這些公式中 *N*=個體數， *K*=承載量， *r*=族群內在增加率及 δ=競爭係數。

$$\frac{dN_1}{dt} = r_1 N_1 \frac{(K_1 - N_1 - \partial_{12} N_2)}{K_1}$$

$$\frac{dN_2}{dt} = r_2 N_2 \frac{(K_2 - N_2 - \partial_{21} N_1)}{K_2}$$



The figure shows two possible positions of the isoclines, i.e., lines which indicate zero population growth for the two populations on a graph that relates N_1 (green) to N_2 (blue). Arrows indicate direction of population change. The location of the isoclines depends on the parameter values, which for species 1 and species 2 are found to be: K_1=80, K_2=100, δ_{21}=0.80, and δ_{12}=0.67. Based on the graphs, the outcome of the competition between the species can be predicted.

上圖顯示兩種等值線(isocline)可能的位置，即當兩個族群為零成長時，在圖上以線來呈現兩族群可能的位置，其中 N_1 以綠色、 N_2 以藍色表示。箭頭表示族群改變的方向。此二等值線的位置取決於物種 1(species1)及物種 2(species 2) 的變量值，現已知 K_1=80, K_2=100, δ_{21}=0.80, 及 δ_{12}=0.67。根據此二圖可以預測兩物種間競爭的結果。

Indicate if each of the following statements is true or false.

指出下列敘述是正確或錯誤

A. This model assumes that carrying capacity is constant.
此模式假設承載量是固定的。

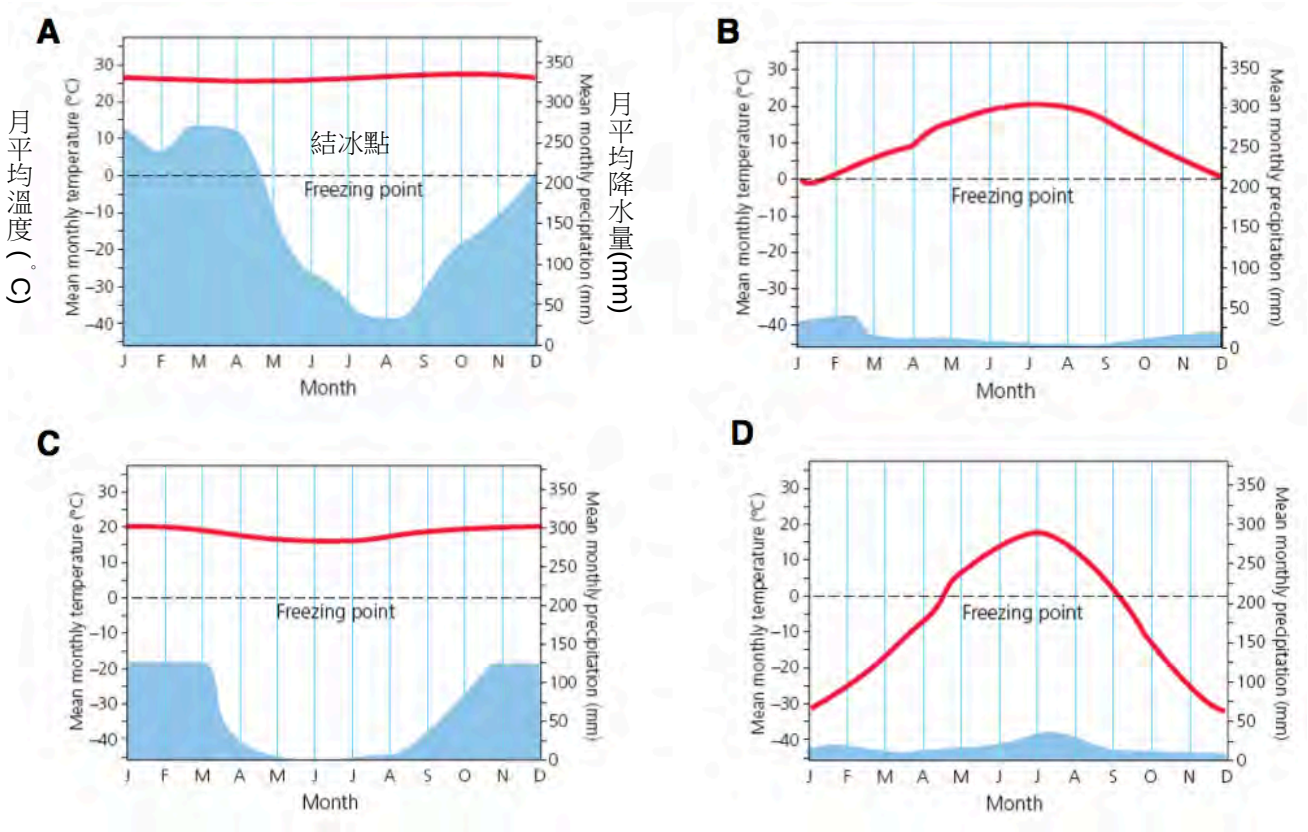
B. The outcome of this competition is co-existence of Species 1 and Species 2.
此競爭模式的結果是兩個物種 (Species 1 and Species 2) 族群共存。

C. The two species will co-exist if intraspecific competition is stronger than interspecific competition.
倘若種內競爭大於種間競爭，則此兩物種會共存。

D. The competitive exclusion principle states that all competition will eventually result in the exclusion of one of the competing species.
競爭不容原則(competitive exclusion principle)為所有競爭最終會將其競爭對手排除。

45. Terrestrial biomes are distinguished primarily by their predominant plants and are associated with particular climates. Climate diagrams are used as a tool to explore the relationship between the distribution of terrestrial vegetation and climatic factors, particularly seasonal variation in temperature and precipitation. Pictured below are climate diagrams for four biomes (A, B, C and D). The bold, red curve denotes mean monthly temperature, while the filled blue area denotes mean monthly precipitation.

陸域生態系主要是藉由該地的優勢植物種類及其對應的特殊氣候來分類。氣候圖可用來探索陸域植物分佈與氣候因子的關係，特別是季節溫度及降雨量的變異。下圖是四個生態系的氣候圖(A, B, C 及 D)，其中粗紅曲線代表每月平均溫度，而藍色區域表示每月平均降水量。



Indicate if each of the following statements is true or false.
指出下列敘述是正確或錯誤

A. Biome A is found in tropical countries such as Indonesia.
生態系 A 存在於熱帶的國家，例如印尼

B. Permafrost can be found in Biome B.
永凍層存在於生態系 B

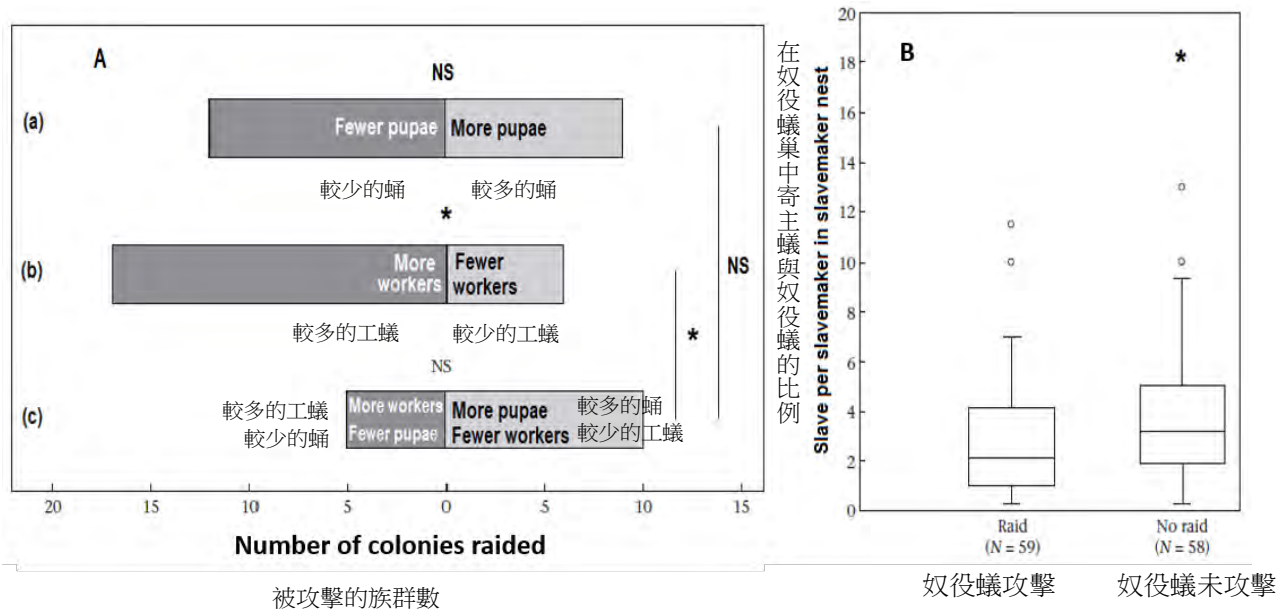
C. Biome C is characterized by the presence of large herbivorous mammals.
生態系 C 的特色是具有大型的草食哺乳動物

D. Succulent plants with reduced leaves are among the typical plants found in Biome D.
具小型葉的多肉植物是生態系D內的典型植物

ETHOLOGY

46. *Protomognathes americanus* (slave-making ants) are eusocial parasites that live in highly organized societies and exploit the brood care behavior of *Temnothorax*, a related host species. *P. americanus* attacks *Temothorax* colonies to replenish their slave workforce, but the *Temothorax* host workers defend their colonies and kill intruders. Additional new slaves are critical to the slave-makers' life cycle since they ensure the colony's survival. Prior to attack, a single scout evaluates the host colony's susceptibility. If found sutitable, the scouts recruit slave-maker workers to attack the colony. A study of preferences of the scout ant to demographic parameters (A) and the condition of the slave-making colony prior to a raid is shown in the graphs below.
Note: * indicates statistically significant data, NS not statistically significant.

Protomognathes americanus (奴役蟻)是真社會型的寄生蟻，牠們形成極為規律的社會，利用與奴役蟻親緣相近的寄主蟻(*Temnothorax*)，來照顧牠們的幼體。奴役蟻(*P. americanus*)會攻擊寄主蟻的社會來獲取牠們的奴工，但是寄主蟻會防禦巢穴並殺死入侵者。為延續奴役蟻族群的生存，牠們得隨時補充新的奴工。在出擊前，牠們會派偵測者去評估寄主蟻的強弱。假設發現情況適當，偵測者會徵召奴役蟻的工蟻進行攻擊。下圖顯示奴役蟻的偵測者在攻擊前對寄主蟻巢內年齡因子的偏好 (A)及奴役蟻巢中的狀況(B)。
註: *顯示資料在統計上有顯著差異, NS= 無統計上顯著差異



Indicate if each of the following statements is true or false.

指出下列敘述是正確或錯誤

A. Scouts prefer colonies with more workers since they indicate larger and better quality colonies.
奴役蟻的偵測者偏好寄主蟻巢內有較多的工蟻，因為他們顯示該寄主蟻的巢穴較大且品質較好。

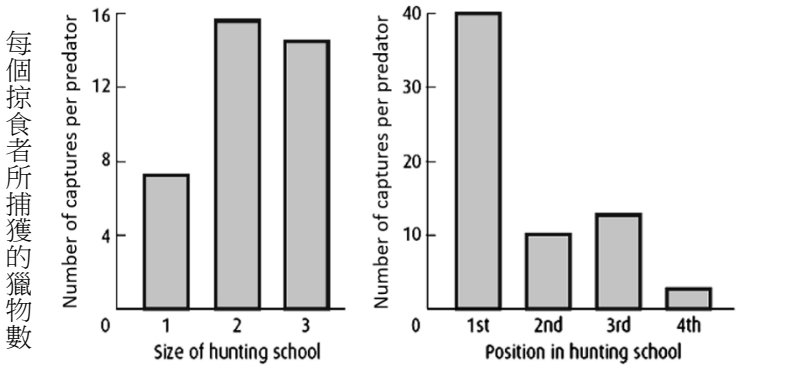
B. Host workers are caught by raiding workers since the slavemaker colony needs these workers as slaves
寄主蟻的工蟻被入侵的奴役蟻所捕捉，因為奴役蟻需要這些工蟻當作奴工。

C. Slavemaker colonies send out scouts to find new hosts on a regular basis.
奴役蟻的巢穴會定期派出偵測者來尋找新寄主。

D. The scouts join the raiding party to guide the attack throughout the raiding process
奴役蟻的偵測者會參與入侵群，在入侵過程中擔任引導攻擊的角色。

47. Some animals form temporary groups as they receive certain advantages when they are together. A study (see figure below) examined the success of hunting groups of fish that hunt prey, also found in large schools.

有些動物當他們在一起時，會因獲得好處而形成暫時性的群體。下圖為研究掠食魚群的捕獲獵物成果與其群體大小的關係，以及魚在大群體位置的關係。



掠食者的群體大小　　掠食者在群體中的位置

Indicate if each of the following statements is true or false.

指出下列敘述是正確或錯誤

A. The total number of captures increases with increasing hunting school size
總捕獲量會隨掠食者的群體增大而增加。

B. A stable dominant hierarchy is set up in large hunting schools with more than four fishes
在超過4隻魚的大掠食群體中，會形成一個穩定的優勢階級。

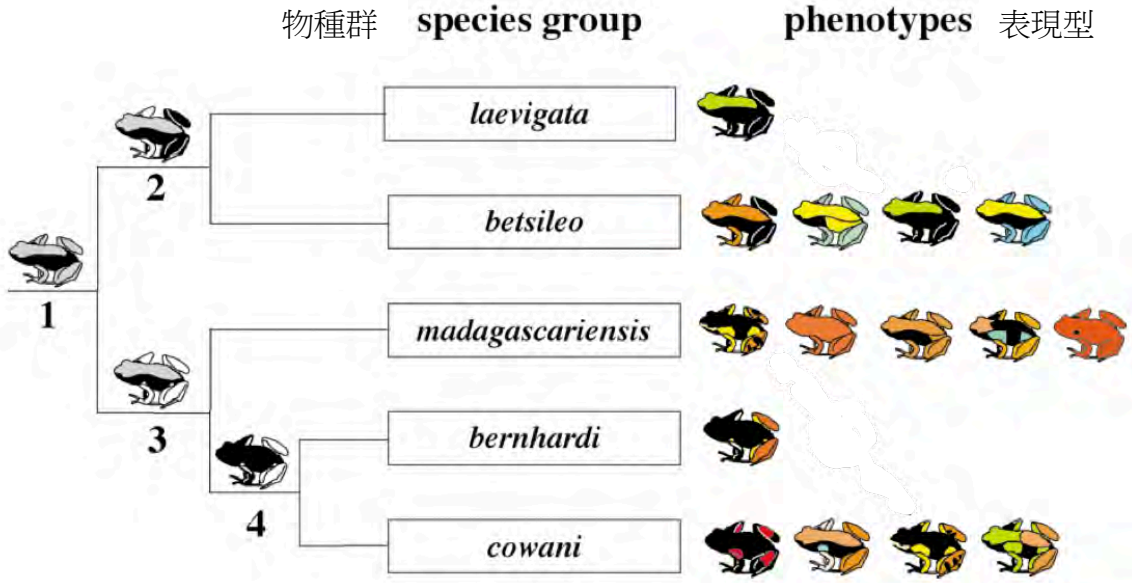
C. The individuals in the second and third positions in a hunting school should leave and hunt solitarily
在掠食者群體中擔任第2和第3位置的個體應該離開群體並單獨獵捕。

D. Bigger hunting groups increase the energy spent by individuals in hunting
在獵捕時，較大掠食群體中的個體會增加其能量消耗。

BIOSYSTEMATICS 系統分類

48. A study investigated the evolution of aposematic pattern in the Malagasy poison frogs (*Mantella*) using data from mitochondrial 16S rRNA sequences. The phylogenetic tree is shown below with the dorsal coloration phenotypes of each group.

利用粒線體 16S rRNA 序列研究 Malagasy 毒蛙 (*Mantella*)警戒色形態的演化。下圖是根據各個青蛙群體的背部顏色表現型所建立的親緣關係樹。



Indicate if each of the following statements is true or false.

指出下列敘述是正確或錯誤

A. The *madagascariensis* species group a sister taxon to the ancestor of the *bernhardi-cowani* groups.

此 *madagascariensis* 物種與 *bernhardi-cowani* 物種的祖先歸成姐妹群。

B. This study provides evidence for homoplastic pattern evolution in these frogs.

此研究提供這些蛙類有趨同模式(homoplastic pattern)的演化證據。

C. The aposematic patterns in these frogs may have evolved in response to nocturnal predators.

這些蛙警戒色的型態可能是針對夜行性掠食者所演化出來的。

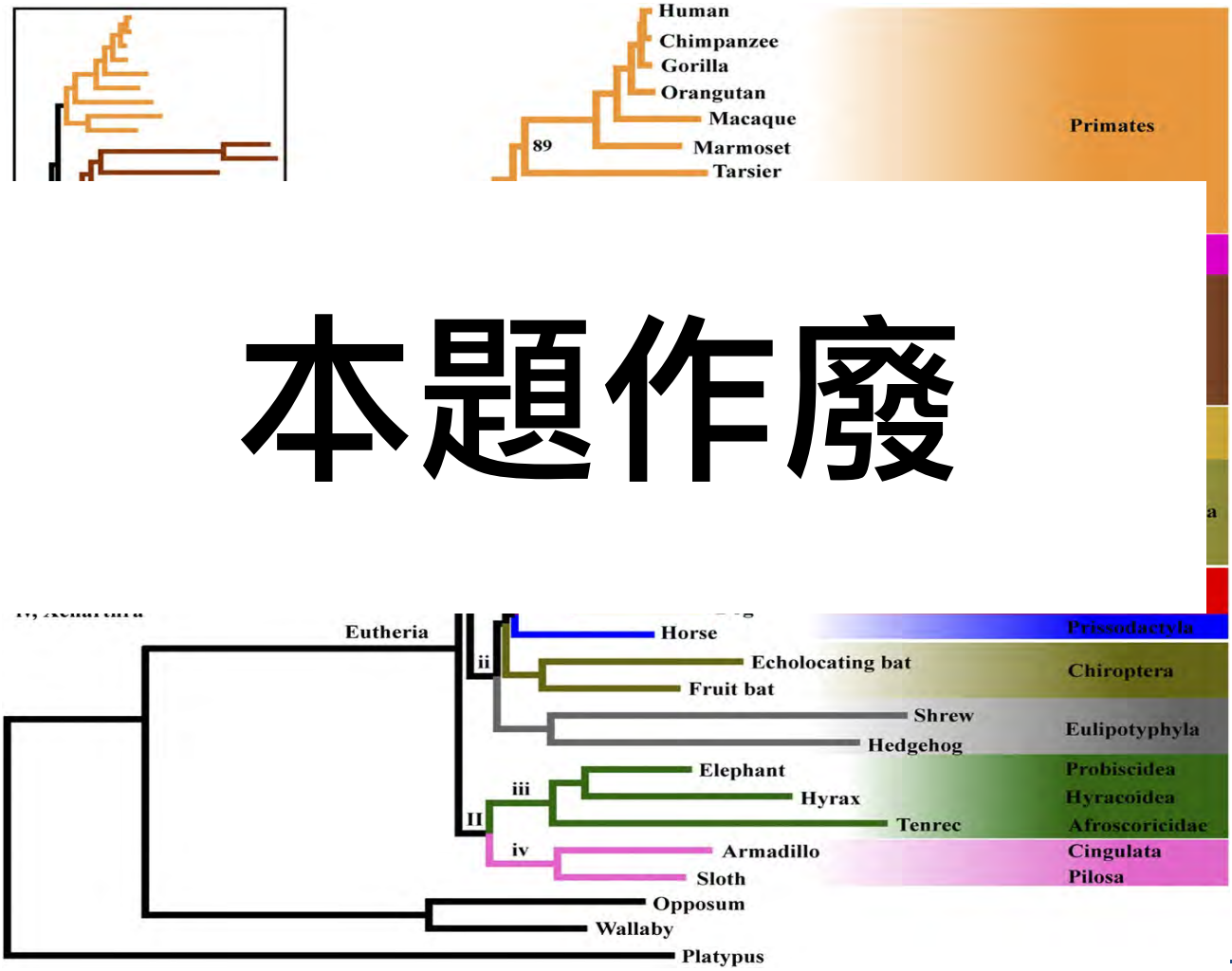
D. Mitochondrial 16S rRNA is often more suited to infer deep phylogenetic relationships than non-coding DNA of the same length.

相較於同長度的非編碼 DNA，粒線體 16S rRNA 通常較適用於推論更高階的親緣關係。

~~**49.** The phylogenetic tree for Eutheria in the Tree of Life is shown in Figure 1 and that from a more recent study (Sen Song et al. 2012) in Figure 2.~~
~~圖 1 的生命樹為真獸類的親緣關係樹，而圖 2 則是最近的研究結果(Sen Song et al. 2012)~~

本題作廢

~~Figure 1~~
~~圖 1~~



~~Figure 2 圖 2~~

~~**Indicate if each of the following statements is true or false.**~~
~~指出下列敘述是正確或錯誤~~

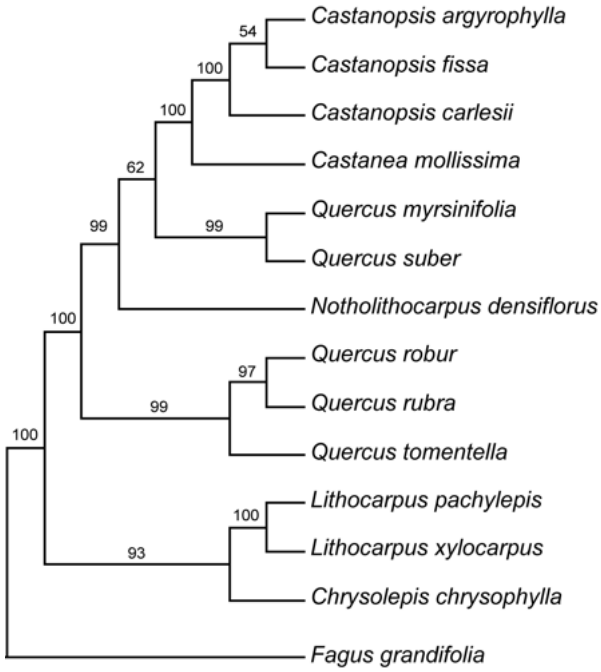
~~A. The tree depicted in Figure 2 has resolved the polyphylies present in the tree shown in Figure 1.~~
~~圖 2 所呈現的親緣關係可解決圖 1 所呈現的多源系(polyphylies)問題。~~

~~B. We now have evidence that the Carnivora emerged from a paraphyletic ungulate clade.~~
~~我們現在已有證據顯示食肉目動物是來自平源的(paraphyletic)有蹄類動物。~~

~~C. There is still no consensus on whether Primates and Scandentia are sister taxa.~~
~~對於靈長類(Primates)及樹鼩(Scandentia)是否屬姐妹群，目前尚無共識。~~

~~D. The differences between two phylogenetic trees may be due to gene tree heterogeneity.~~
~~這兩個親緣關係樹的差異可歸因於基因樹的異質性。~~

50. A phylogenetic tree of Fagaceae was generated using the CRABS CLAW gene. In this tree, *Fagus grandifolia* is the outgroup.
下圖為利用CRABS CLAW 基因所建構的殼斗科親緣關係樹，其中*Fagus grandifolia*是外群。



Numbers above each branch represents the relative credibility of clades. Attempts were made to classify the species into 3 subfamilies that best reflect the evolutionary relationship with *Corylaceae.*
在每一分支上的數字表示該群的相對可信度。研究者試圖將這些物種分為3個亞科，以使其最能呈現與*Corylaceae*的演化關係。

Indicate if each of the following statements is true or false.
指出下列敘述是正確或錯誤

A. *Quercus suber is more closely related to Castanopsis fissa than to Ouercus rubra*
相較於*Quercus suber* 與 *Ouercus rubra* ，*Quercus suber* 與*Castanopsis fissa*的親緣較近。

B. The genera of some species have to be changed.
某些物種的屬(genera)必須更改。

C. The phylogenetic relationships among *Castanopsis* species are poorly resolved.
Castanopsis 物種間的親緣關係尚未釐清。

D. *Fagus grandiflora* is the ancestral species of all other taxa in this tree.
此 *Fagus grandiflora* 物種是此關係樹的所有其他分類群之祖先種。

END OF TEST

ANSWER SHEET

No.	Answer			No.	Answer		
	Statement	**T**	**F**		**Statement**	**T**	**F**
1.	A			14.	A		
	B				B		
	C				C		
	D				D		
2.	A			15.	A		
	B				B		
	C				C		
	D				D		
3.	A			16.	A		
	B				B		
	C				C		
	D				D		
4.	A			17.	A		
	B				B		
	C				C		
	D				D		
5.	A			18.	A		
	B				B		
	C				C		
	D				D		
6.	A			19.	A		
	B				B		
	C				C		
	D				D		
7.	A			20.	A		
	B				B		
	C				C		
	D				D		
8.	A			21.	A		
	B				B		
	C				C		
	D				D		
9.	A			22.	A		
	B				B		
	C				C		
	D				D		
10.	A			23.	A		
	B				B		
	C				C		
	D				D		
11.	A			24.	A		
	B				B		
	C				C		
	D				D		
12.	A			25.	A		
	B				B		
	C				C		
	D				D		
13.	A			26.	A		
	B				B		
	C				C		
	D				D		

No.	Answer			No.	Answer		
	Statement	**T**	**F**		**Statement**	**T**	**F**
27.	A			40.	A		
	B				B		
	C				C		
	D				D		
28.	A			41.	A		
	B				B		
	C				C		
	D				D		
29.				42.	A		
					B		
					C		
					D		
30.	A			43.	A		
	B				B		
	C				C		
	D				D		
31.	A			44.	A		
	B				B		
	C				C		
	D				D		
32.	A			45.	A		
	B				B		
	C				C		
	D				D		
33.	A			46.	A		
	B				B		
	C				C		
	D				D		
34.	A			47.	A		
	B				B		
	C				C		
	D				D		
35.	A			48.	A		
	B				B		
	C				C		
	D				D		
36.	A			49.			
	B						
	C						
	D						
37.	A			50.	A		
	B				B		
	C				C		
	D				D		
38.	A						
	B						
	C						
	D						
39.	A						
	B						
	C						
	D						

T = True
F = False

Signature

(……..)