18th INTERNATIONAL BIOLOGY OLYMPIAD
JULY 15 - 22, 2007

THEORY EXAMINATION # 1 理論試題一

Total marks : 95.5 marks 總分：95.5 分

Time allowed: 2.5 hours 總時間：150 分鐘

WRITE YOUR 4-DIGIT STUDENT NUMBER IN THE BOX BELOW 請將 4 碼學生代碼寫於下列欄位中

STUDENT CODE 學生代碼	

GENERAL INSTRUCTIONS 指引

Check that you have the correct examination paper and an answer sheet.
檢查你的題目卷與答案卷是否完整
WHEN YOU HAVE FINISHED THE EXAM, PLACE YOUR ANSWER SHEET INSIDE

YOUR QUESTION PAPER AND HAND BOTH TO THE INVIGILATOR BEFORE

LEAVING THE EXAM ROOM.

當你完成考試後，將答案卷置於試卷內，離開教室前將二者均交給監試人員
REMEMBER TO WRITE YOUR 4-DIGIT STUDENT CODE ON THE FRONT PAGE OF THE QUESTION PAPER.
記得務將 4 碼學生代碼寫於題目卷的首頁
Read each question carefully before attempting it.
仔細閱讀後再作答

IMPORTANT

- Use the answer sheet provided to record your answers.

- **Ensure that your name and student code is PRINTED in the top margin of the front page of the answer sheet.** The invigilators will enter this information in the correct places on the reverse side of the answer sheet.

請注意你的名字及學生代碼是否**正寫**（或**已列印**）在答案卷的首頁上邊。閱卷者將會將此資料填入答案卷的反頁。

- Use only the HB pencil provided to mark the answer sheet. **Completely fill in the circle.**

只能以大會提供的 HB 鉛筆作答。**將圈選之答案塗黑，如下所示：**

	A	B	C	D	E
This is the correct way:	o	•	o	o	o

- **DO NOT USE AN X OR ANY OTHER SYMBOL TO MARK YOUR ANSWER.**

·請勿用 X 號或其他任何符號劃記

- If you want to change your answer, use the eraser to remove your incorrect response and fill in the new circle you require.

若要修改答案，請用橡皮將原有答案擦去，再圈選你要的答案

- There is only one correct answer to each question.

每一題只有一個答案

- Questions 1 - 30 are worth one mark each The mark value for questions 31 – 60 varies according to the length and difficulty of the question. Marks will not be deducted for incorrect answers.

1-30 題，每題 1 分；31-60 題，每題依題目的長度和難度有不同的配分，答錯不倒扣。

INSTRUCTIONS REGARDING RECORDING YOUR ANSWERS

劃記注意

QUESTIONS 1 - 31. RECORD YOUR ANSWERS ON THE ANSWER SHEET.

1-31 題請將答案劃記於電腦卡上

QUESTIONS 32 – 60. RECORD YOUR ANSWERS IN THE EXAM QUESTION BOOKLET.

32-60 題請劃記於題目卷上

ANSWERS TO QUESTIONS 1 TO 30 ARE TO BE RECORDED ON THE ANSWER SHEET.
1 至 30 題必須寫在答案卷上

Question 1. Which of the following statements is FALSE?

"For almost every antigen you may encounter……."

A. a subset of B-cells already exists in your body specific to it.

B. a subset of T-helper cells already exists in your body that expresses a T-cell receptor specific to it

C. a subset of phagocytes already exists in your body that attacks only that antigen.

D. a subset of antigen-specific antibodies already exists, but are not yet produced in large numbers.

E. a subset of antigen-specific memory cells can be produced upon exposure to that antigen.

1. 下列敘述何者**錯誤**？
「幾乎對你所遇到的每個抗原……。」

A. 你體內已有一群對它有專一性的 B 細胞存在
B. 你體內已有一群它有專一性 T 細胞受器的 T 輔助細胞存在
C. 你體內已有一群只能攻擊它的吞噬細胞存在
D. 你體內已有一群抗原專一性的抗體存在，但尚未大量產生
E. 在遭遇時，你能產生一群抗原專一性的記憶細胞

Question 2. A blood smear of a human showing higher than normal numbers of eosinophils. Which of the following may be occurring in his body?

A. chronic nematode infection

B. anaphylactic shock

C. reduced white blood cells (leucopenia)

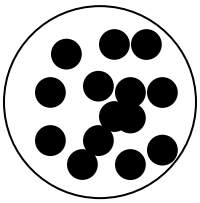
D. initial response to invading bacteria

E. hemostasis

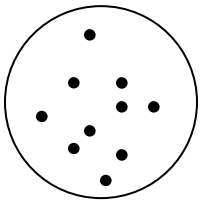
2. 某人血液抹片顯示嗜酸性球數目比正常為多，下列何者可能發生於他身上？

A. 慢性線蟲感染
B. 過敏休克
C. 白血球減少
D. 對入侵細菌的初始反應
E. 止血作用

Question 3. The ABO blood type of humans can be determined by a coagulation reaction with anti-A and anti-B antibodies.
人類的 ABO 血型可藉是否被抗 A 及抗 B 抗體凝集來決定。

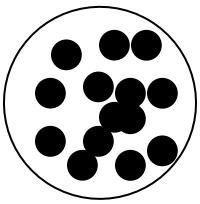
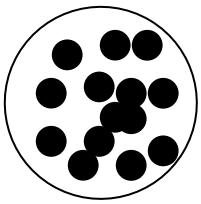
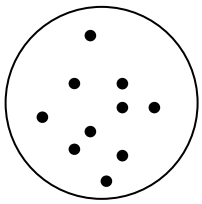
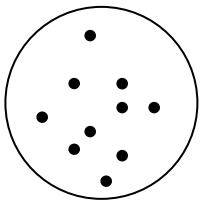


Positive coagulation
陽性凝集反應



Negative Coagulation
陰性凝集反應

Coagulation tests of person's blood produced the results shown below:
某人血液經過凝集試驗後產生以下的結果：

With anti-A and anti-B antibodies	With anti-A antibodies	With anti-B antibodies	None
			

Which of the following statements can be deduced from the above?

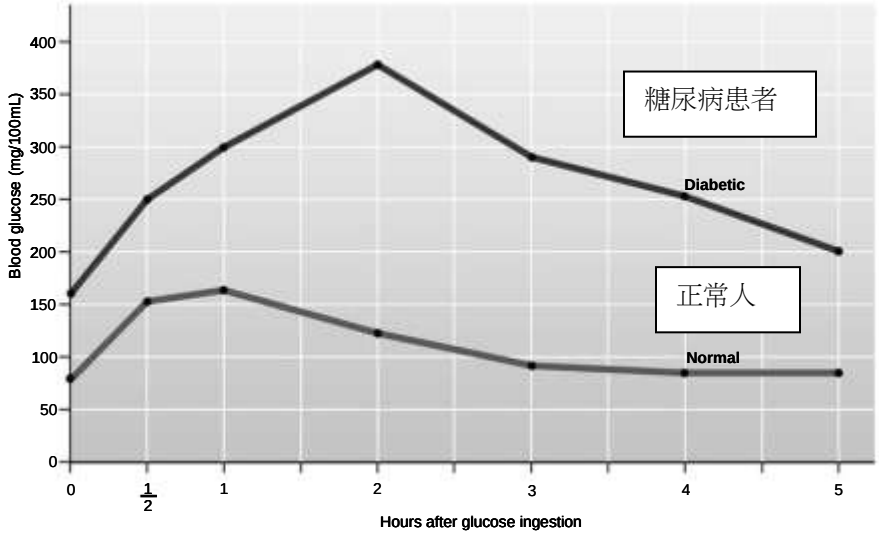
A. This person's blood contains anti-B antibodies.
B. This person's parents had to be type-A and type-O.
C. This person can receive neither type-A nor type-B blood.
D. Type-B antigens are present on the surface of this person's red blood cells.
E. This person's blood can be donated to both type-B and type-O individuals.

由此結果可做下列何種推論?

A. 此人血液含有抗 B 抗體
B. 此人父母的血型為 A 型及 O 型
C. 此人不能接受 A 型或 B 型血液的輸血
D. 此人紅血球的表面有 B 抗原
E. 此人的血液不能輸給 B 型及 O 型的人

Question 4. The graph below shows the result of blood glucose test from a diabetes patient.
下圖顯示一個糖尿病人血糖的變化情況

血糖濃度



時間(小時)

When tested 3 hours after having a carbohydrate rich meal, the blood glucose level of this patient was 3 times higher than that of a normal individual. However, there was no difference in the level of insulin in the blood between the two individuals.
當以高醣類飲食測試患者，在三小時後患者血液中葡萄糖濃度高於正常人三倍。但血液中胰島素的含量並無明顯差異。

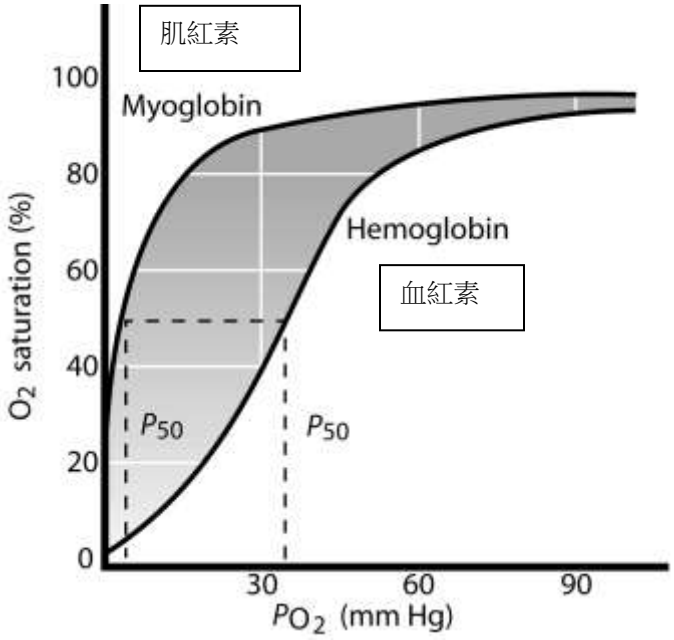
Which of the following could be the reason for diabetic symptoms in this patient?

A. Degradation of pancreatic beta-islets cells.
B. Degradation of pancreatic alpha-islets cells.
C. Abnormal proliferation of pancreatic beta-islet cells.
D. Reduced sensitivity of insulin-receptor mediated signal transduction.
E. Increased sensitivity of insulin-receptor mediated signal transduction.

下列何者可能是此病人糖尿病症狀的原因？

A. α 胰島細胞的減少
B. β 胰島細胞的減少
C. 胰臟 β 胰島細胞的異常增生
D. 對胰島素受器媒介的信息傳遞感受性降低
E. 對胰島素受器媒介的信息傳遞感受性增加

Question 5. The following graph shows the dissociation curves for hemoglobin and myoglobin.
下圖顯示血紅素及肌紅素的解離曲線



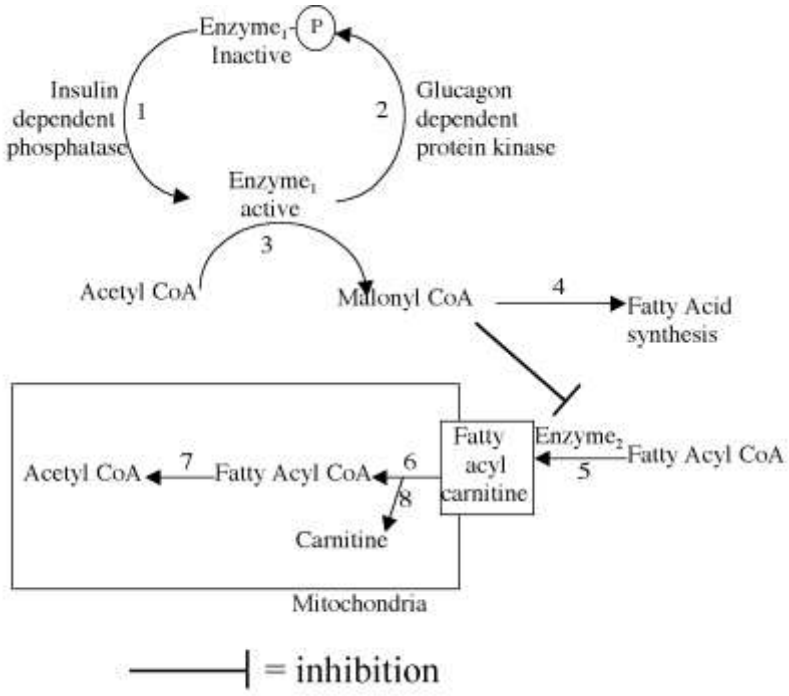
Based on the data presented in the graph, which of the following statements is true?

A. The high affinity of myoglobin for O_2 at low partial pressures of O_2 prevents hemoglobin from unloading O_2 to muscle.
B. Myoglobin binds to O_2 with greater affinity than hemoglobin and unloads O_2 after hemoglobin unloading.
C. Myoglobin helps hemoglobin bind as much O_2 as possible from lungs.
D. Hemoglobin binds to O_2 tightly thus preventing O_2 from being made available to skeletal muscle.
E. The high affinity of hemoglobin for O_2 at low partial pressures of O_2 prevents myoglobin from unloading O_2 to muscle.

根據此圖所提供的數據，下列敘述何者正確？

A. 在低氧分壓時，肌紅素對氧的親合力高能防止血紅素將氧卸給肌肉
B. 肌紅素對氧的親合力比血紅素高，卸氧是在血紅素卸氧之後
C. 肌紅素幫助血紅素由肺盡可能多結合氧
D. 血紅素與氧結合緊密，因此避免氧送給骨骼肌使用
E. 在低氧分壓時，血紅素對氧的親合力高能防止肌紅素將氧卸給肌肉

Question 6 - 8. **This figure indicates some of the pathways involved in the metabolism of food.**
6-8 題：下圖顯示食物代謝過程中的某些途徑



Question 6. When a person consumes a diet rich in carbohydrate, the reactions up-regulated will be:
若一個人吃了富含碳水化合物的大餐，哪些反應會升高？

A. 5, 6, 7
B. 2, 8
C. 5, 8
D. 1, 3, 4
E. 2, 5. 6

~~Question 7. When a person performs heavy exercise, the reactions that will be down-regulated will be:~~
~~A. 5, 6, 7, 8~~
~~B. 1, 3, 4~~
~~C. 4, 5, 6, 7~~
~~D. 1, 2, 4~~
~~E. 7, 3, 4~~ 刪除

Question 8. If a person suffers from carnitine deficiency, the reactions that will be down-regulated are:

若一個人有**肉毒鹼**缺乏症，哪些反應會降低？

A. 6, 8
B. 1, 3, 4
C. 4, 5, 6, 7
D. 2, 5, 6
E. 5, 6, 7, 8

Question 9. A yeast extract contains all the enzymes required for alcohol production. The extract is incubated under anaerobic conditions in 1 liter of medium containing: 200 mM glucose, 20 mM ADP, 40 mM ATP, 2 mM NADH, 2 mM NAD+ and 20 mM Pi (inorganic phosphates). Ethanol production can be summarized by the following equation:

酵母菌的萃取物內含有所有能製成酒精的酵素，當此萃取物培養在無氧條件下，當 1 L 培養基內含 200 mM glucose, 20 mM ADP, 40 mM ATP, 2 mM NADH, 2 mM NAD^+ and 20 mM Pi (無機磷類)，酒精會依照下列方程式被生成，

$$C_6H_{12}O_6 \longrightarrow 2\ C_2H_5OH + 2\ CO_2 + 2ATP$$

What is the maximum amount of ethanol that can be produced under these conditions?
請問在此條件下，酒精的最高生產量為何？

A. 2 mM
B. 20 mM
C. 40 mM
D. 200 mM
E. 400 mM

~~Question 10. Thyroid hormone release is due to the action of thyroid-stimulating hormone (TSH)~~

本題刪除

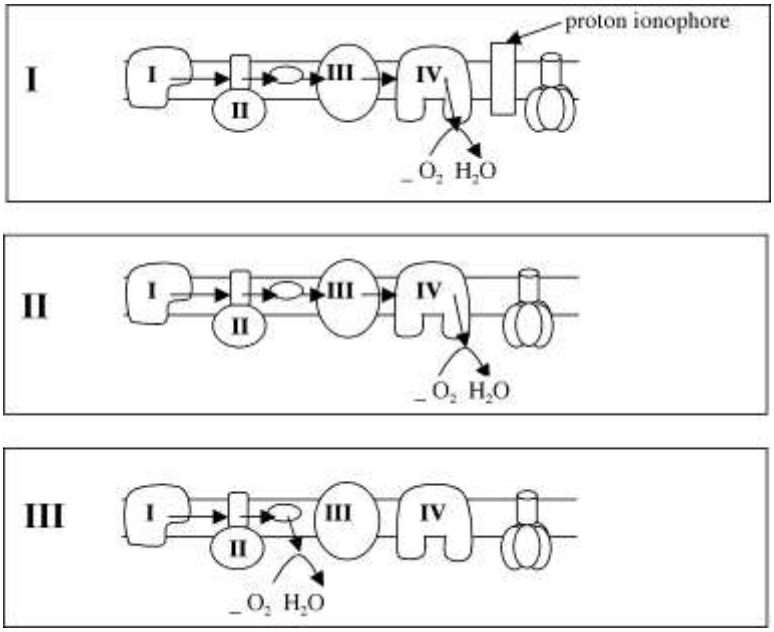
~~Question 11. Typical intracellular concentrations of the Na^+, K^+ and Ca^{2+} ions are 15 mM, 120 mM~~

本題刪除

Question 12. Thermogenesis is a process where heat is generated. The energy present in the reducing equivalents such as NADH + H^+ or FADH2 in mitochondria is normally used to pump protons across the inner mitochondrial membrane to the inter membranous space. This proton gradient is the motive force for ATP production. Examine the figures below and consider whether ATP synthesis or thermogenesis predominates when answering the following question.

升溫作用意味著產熱，能量來源是來自於粒線體內會消耗等量的 NADH + H^+ 或 FADH2。此時粒線體內的質子會穿過粒線體內膜到達粒線體內外膜間，這樣所造成的質子梯度會迫使 ATP 生成。檢視下圖，並回答與 ATP 生成或升溫作用的相關問題

The molecules represented by I, II, III and IV represent mitochondrial electron carriers.
I, II, III 與 IV 分別為粒線體電子攜帶者

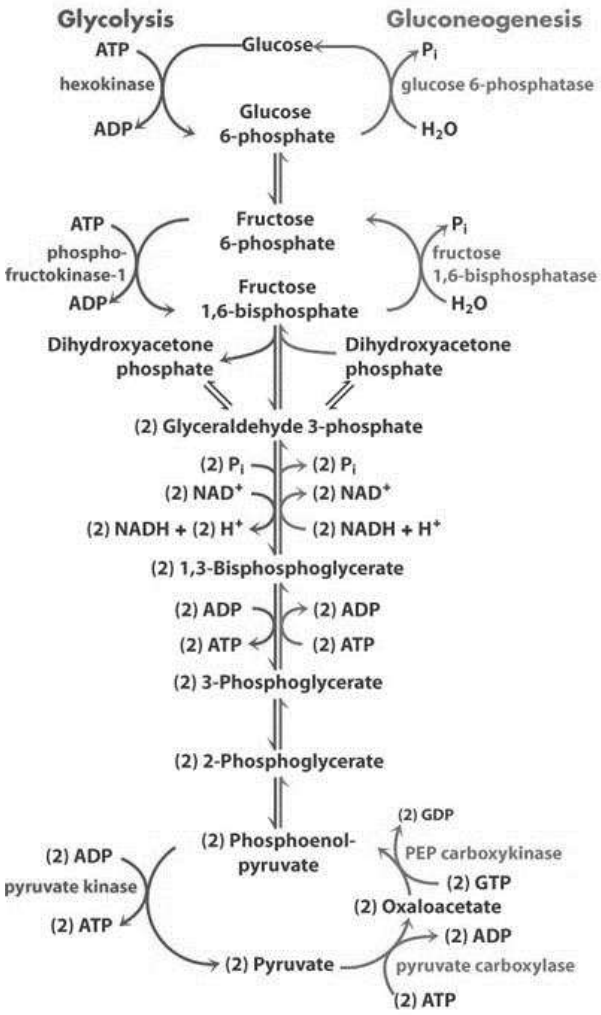


In which of the three situations shown in the figure above does thermogenesis predominate over ATP synthesis ?
上述三個圖形何者與 ATP 生成所造成的升溫作用相關

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

Question 13. The figure below outlines the glycolytic pathway. There are several regulatory steps in glycolysis. A major regulatory step in glycolysis is the conversion of fructose 6-phosphate to fructose 1,6-biphosphate by phosphofructose kinase. This enzyme is allosterically inhibited by ATP and allosterically activated by AMP. Thus, cellular ATP:AMP ratios are important in the regulation of phosphofructose kinase. In addition, low pH inhibits phosphofructose kinase activity.

下圖為糖解作用的簡圖。有相當多的步驟在調控糖解作用。最重要的調控步驟在 phosphofructose kinase（以下簡稱「該酵素」），該酵素會讓 fructose 6-phosphate 轉化成 fructose 1,6-biphosphate。該酵素會被 ATP 變構性的抑制，但會被 AMP 變構性的活化。因此細胞內 ATP 與 AMP 的比例對調節該酵素便顯得相當重要。此外，低 pH 值會抑制該酵素活性。



What effect will poisoning of mitochondrial function by the mitochondrial uncoupler dinitrophenol (DNP) have on glycolysis?

A. It will increase the rate of glycolysis if there is a means of oxidizing NADH.
B. It will result in the immediate death of the cell.
C. It will increase the rate of glycolysis if there is a means of further increasing the reduction of NAD^+.
D. It will inhibit the conversion of phosphoenol pyruvate to pyruvic acid.
E. It will promote the formation of 1,3 biphosphoglycerate from 3-phosphoglycerate.

有關粒線體解偶聯劑 DNP （二硝基苯酚）如何在糖解作用過程中對粒線體產生毒害的敘述，何者正確？

A. NADH 氧化時，糖解作用效率會增加
B. 會造成細胞立即死亡
C. NAD^+ 還原增加時，糖解作用效率會增加
D. 會抑制 phosphoenol pyruvate 轉化成為 pyruvic acid
E. 會促進 1,3 biphosphoglycerate 變成 3-phosphoglycerate.

Question 14. Lions (*Panthera leo*) live in stable social groups called prides which usually have three or more adult females, their dependent offspring and one or two dominant adult males. The old and weak male(s) in a pride may be driven away by other strong males or by a new coalition of males.

On the basis of this information, determine which combination of the following statements is correct.

I. Females born into a pride leave before they reproductive maturity.
II. Males born into a pride remain there for life.
III. Females born into a pride remain there for life.
IV. New dominant male try to kill only newly born females.
V. Males born into a pride leave before they reach reproductive activity.
VI. New dominant male try to kill only newly born males.
VII. Adult females in a lion pride are never related to each other.
VIII. New dominant male try to kill as many young cubs as possible.
IX. Adult females in a lion pride are often related each other.

獅子以獅群的型式形成穩定的社群，一般包括 1～2 隻優勢的雄性，3 隻或 3 隻以上的雌性及牠們的子代。當獅群的雄性變老或變弱時，則常被其他強壯的雄性或新的雄性聯合所取代。

根據上文，下列敘述何者 正確？

I.雌性個體在到達性成熟前即離開其所出生之獅群
II.雄性一生皆留在其所出生的獅群內
III.雌性一生皆留在其所出生的獅群內
IV.新進之優勢雄獅（入侵獲勝之優勢雄獅）只會殺死獅群中新生之幼雌獅。
V.雄性在到達性成熟前即離開其所出生的獅群
VI.新獲勝之優勢雄獅只會殺死獅群中新生之幼雄獅
VII.獅群中之雌性個體間皆無親緣關係
VIII.新獲勝之優勝雄獅將儘可能殺死幼獅
IX.獅群中之雌性個體間常有親緣關係

A. I, IV, VI, VII
B. III, V, VIII, IX
C. III, IV, V, IX
D. II, V, VI, VIII
E. I, II, VII, VIII

~~Question 15. The correct statement pertaining to the following Rank-Abundance Curve is:~~

此題刪除

Question 16. Stromatolites, layered mounds created by cyanobacteria, have been found in shallow waters. They resemble small rocks but are organic in origin. Fossilised stromatolites are thought to be important because they are suggestive of:
在淺水中由藍綠菌所造成的多層土塊稱為「層疊石」，它們外觀似小岩石，但卻來自有機質。層疊石非常重要，因為它們與下列何者相關？

A. the origin of earth. 地球的起源
B. the origin of autotrophy. 地球光合自營的起源
C. ~~rusting of oceans~~.oxidation of iron in oceans 海洋的鐵氧化
D. the appearance of the ozone layer in the atmosphere.
在大氣層中產生了臭氧層
E. the origin of life. 生命的起源

Questions 17 – 18. **A student studied the influence of temperature and light intensity upon CO_2 flux of plants in a greenhouse. During the experiment cellular respiration is not influenced by light intensity and cellular respiration of glucose is completely aerobic. At each temperature CO_2 uptake was measured during light exposure and loss of CO_2 was measured during the dark period. The light intensity was constant during the light period and was not a limiting factor for photosynthesis.**
The data collected are presented in the following table.

某生在溫室針對溫度及光度對植物 CO_2 交換的影響進行研究。在實驗期間，細胞呼吸不受光強度的影響，細胞呼吸利用葡萄糖行有氧呼吸。在不同的溫度下，植物在光照期間對 CO_2 之吸收及其在無光照之黑暗期 CO_2 之減少皆被紀錄。在光照期間光的強度維持一定，故對光合作用而言並非其限制因素。
下表為所收集的資料

Temp (℃) 溫度	CO_2 uptake in light* CO_2 在光照下之吸收量	Loss of CO_2 in dark* CO_2 在無光下之流失量
5	0.5	0.2
10	0.7	0.5
15	1.2	0.9
20	1.9	1.5
25	2.3	2.6
30	2.0	3.9
35	1.5	3.3

* units: mg per gram dried weight per hour （mg 毫克/乾重克/每小時）

Question 17. At which temperatures does the plant release O_2 when exposed to light?
在有光時，植物在何種溫度下釋放 O_2？

A. only in the range 5 – 20 ℃ 只在 5 – 20 ℃ 的溫度範圍內

B. only in the range 20 – 25 ℃ 只在 20 – 25 ℃ 的溫度範圍內

C. only at temperatures over 20 ℃ 只在溫度超過 20 ℃ 時

D. only at temperatures over 25 ℃ 只在溫度超過 25 ℃ 時

E. at all temperatures 在所有的實驗溫度

Question 18. The optimum temperature for photosynthesis and the optimum temperature of respiration is somewhere in the range of 5 - 35 ℃. Which of the following statements is correct?

光合及呼吸作用最佳的溫度範圍在 5 - 35 ℃ 之間，下列敘述何者正確？

A. optimum temp for photosynthesis < optimum temp for dissimilation

B. optimum temp for photosynthesis = optimum temp for dissimilation

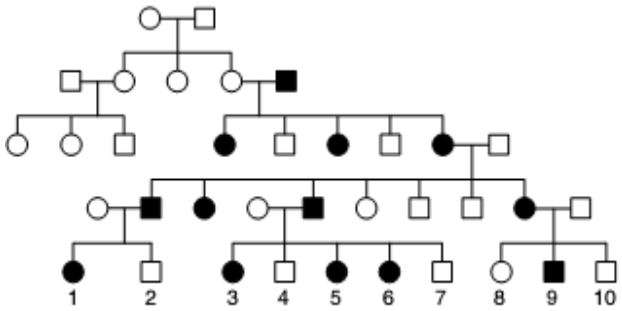
C. optimum temp for photosynthesis > optimum temp for dissimilation

A.光合作用的最佳溫度＜異化作用的最佳溫度。
B.光合作用的最佳溫度＝異化作用的最佳溫度。
C.光合作用的最佳溫度＞異化作用的最佳溫度。

~~Question 19. A woman with Turner syndrome is found to be haemophilic (X – linked recessive~~

此題刪除

Questions 20 – 21. **A rare human disease afflicted a family as show in the accompanying pedigree.** 在下方譜系圖中所示為一困擾某家族的稀有疾病。回答 20-21 題。



Question 20. What is the most likely mode of inheritance of this disease?

A, Mode of inheritance is autosomal recessive.

B. Mode of inheritance is autosomal dominant.

C. Mode of inheritance is X-linked recessive.

D. Mode of inheritance is X-linked dominant

E. Mode of inheritance could not be deduced.

此一遺傳性疾病最可能的型式(mode)為何？
A. 此一型式為體染色體之隱性基因所致。
B. 此一型式為體染色體之顯性基因所致。
C. 此一型式為 X 染色體上的隱性基因所致。
D. 此一型式為 X 染色體上的顯性基因所致。
E. 此一型式之遺傳無法推測。

Question 21. What is the probability that the first child of the marriage between cousins, 1 x 4, is a boy with the disease?

在 1 與 4 二者通婚後其生下第一個小孩是男孩且具有此疾病的機率為何？

A. 1/2

B. 1/4

C. 1/8

D. 1/16

E. 0

Questions 22 - 23. The wild-type flower color of harebell plants (genus *Campanula*) is blue. Using radiation, three mutants with white petals were produced, white 1, white 2 and white 3. They all look the same, so it was not known whether they were genetically identical. The mutant strains are available as homozygous pure-breeding lines.

The mutant strains were crossed with the wild-type blue genotype and with each other to produce the following results:

桔梗屬植物 (genus *Campanula*) 的野生型花色為藍色。當用放射線照射後，有三個突變株產生白色花瓣，分別註記為 white 1，white 2 與 white 3。外型上無法區分這些植株，因此無法知道他們是否具有相同的遺傳背景。突變株只在它是同基因型純的純品系時顯現。當這些突變株與野生型藍色植株交配後結果如下表：

Parental cross **親代交配**	**F1 phenotype** **F1 外表型**	**F2 segregation ratio** **F2 分離率**
White 1 x blue	all blue	3/4 blue : 1/4 white
White 2 x blue	all blue	3/4 blue : 1/4 white
White 3 x blue	all blue	3/4 blue : 1/4 white
White 1 x white 2	all white	資料不存在
White 1 x white 3	all blue	資料不存在
White 2 x white 3	all blue	資料不存在

Question 22. Using these results, determine which statement is the correct conclusion for this study.

A. The mutant genes in white 1 and 3 are allelic and are different to the mutant gene in white2.
B. The mutant genes in white 2 and 3 are allelic and are different to the mutant gene in white 1.
C. The mutant genes in white 1 and 2 are allelic and are different to the mutant gene inwhite 3.
D. The mutant genes in white 1, 2 and 3 are all allelic.

利用上述結果，選出 正確 的敘述：

A. 在 white1 及 white3 的突變基因為對偶基因，不同於 white2 的突變基因
B. 在 white2 及 white3 的突變基因為對偶基因，不同於 white1 的突變基因
C. 在 white1 及 white2 的突變基因為對偶基因，不同於 white3 的突變基因
D. 在 white1、white2 及 white3 的突變基因均為對偶基因

Question 23. The type of gene action operating among the crosses between the mutants in this study is

A. complete dominance.
B. dominant epistasis.
C. recessive (complementary) epistasis.
D. duplicate gene interaction.
~~E. complementary gene action.~~

在突變種間交配後，請選出正確的基因作用

A. 完全顯性
B. 上位顯性遺傳
C. 上位隱性遺傳
D. 雙基因交互作用
~~E. 互補基因作用~~

Question 24 - 25. Hemoglobin in the erythrocytes of adults is composed of a combination of two α-globin molecules and two β-globin molecules. Sickle-cell anemia is caused by the substitution of a single amino acid in the β-globin subunit.
In 1957, Vernon M. Ingram and his colleagues investigated the amino acid sequences of normal and sickle-cell anemia hemoglobins in several short peptide chains obtained by trypsin digestion. A difference in the "fourth peptide" between both types of β-globin was found and further hydrolytic digestion of the "fourth peptides" revealed six hydrolyzed products.

成人紅血球中的血紅素係由兩個 α- 球蛋白與兩個 β- 球蛋白分子構成。鐮型細胞貧血症的原因是在 β- 球蛋白分子中有一個胺基酸被置換。1957 年 Vernon M. Ingram 與其同僚利用胰蛋白酶消化法對正常血紅素與鐮型細胞貧血症血紅素進行胺基酸定序。定序結果發現正常血紅素與鐮型細胞貧血症血紅素的 β- 球蛋白分子存在著『第四胜肽』差異。將『第四胜肽』進行進一步的水解，最後得到 6 個水解產物。（胺基酸的縮寫如後：V=valine, H= histidine, L= leucine, T= threonine, P= proline, E= glutamic acid and K= lysine）

● the "fourth peptide" products of normal β-globin were (amino acid residues are abbreviated by the following letters: V=valine, H= histidine, L= leucine, T= threonine, P= proline, E= glutamic acid and K= lysine):

正常血紅素的『第四胜肽』的 6 個水解產物為：

V—H
V—H—L
V—H—L—T
T—P—E
T—P—E—E—K
E—K

- the “fourth peptide” products of β-globin of sickle cell anemia were

鐮型細胞貧血症血紅素的『第四胜肽』的 6 個水解產物為：

V—H
V—H—L
V—H—L—T
T—P—V
T—P—V—E—K
E—K

Question 24. From these results, how many amino acids is the “fourth peptide” composed of and what was the substituted position of amino acid residue counting from the N-terminus?
From the following, choose the one statement which is most appropriate. Assume that this fourth peptide contains only one molecule of T (threonine).

A. It was composed of 8 amino acids and the 6th amino acid was substituted.
B. It was composed of 8 amino acids and the 3rd amino acid was substituted.
C. It was composed of 7 amino acids and the 6th amino acid was substituted.
D. It was composed of 7 amino acids and the 3rd amino acid was substituted.
E. It was composed of 9 amino acids and the 6th amino acid was substituted.

由以上的結果，請問『第四胜肽』由多少胺基酸所組成，自 N- 端算起，第幾個胺基酸在鐮型細胞貧血症是被取代的：【注意：只有一個 T (threonine) 存在『第四胜肽』中】

A. 由 8 個胺基酸構成，第 6 個胺基酸位被取代
B. 由 8 個胺基酸構成，第 3 個胺基酸位被取代
C. 由 7 個胺基酸構成，第 6 個胺基酸位被取代
D. 由 7 個胺基酸構成，第 3 個胺基酸位被取代
E. 由 9 個胺基酸構成，第 6 個胺基酸位被取代

Question 25. Below is a DNA sequence coding a part of the amino acid sequence in the "fourth peptide" of normal β-globin. In sickle cell anemia, it is known that a mutation occurs in the region enclosed by [ ].

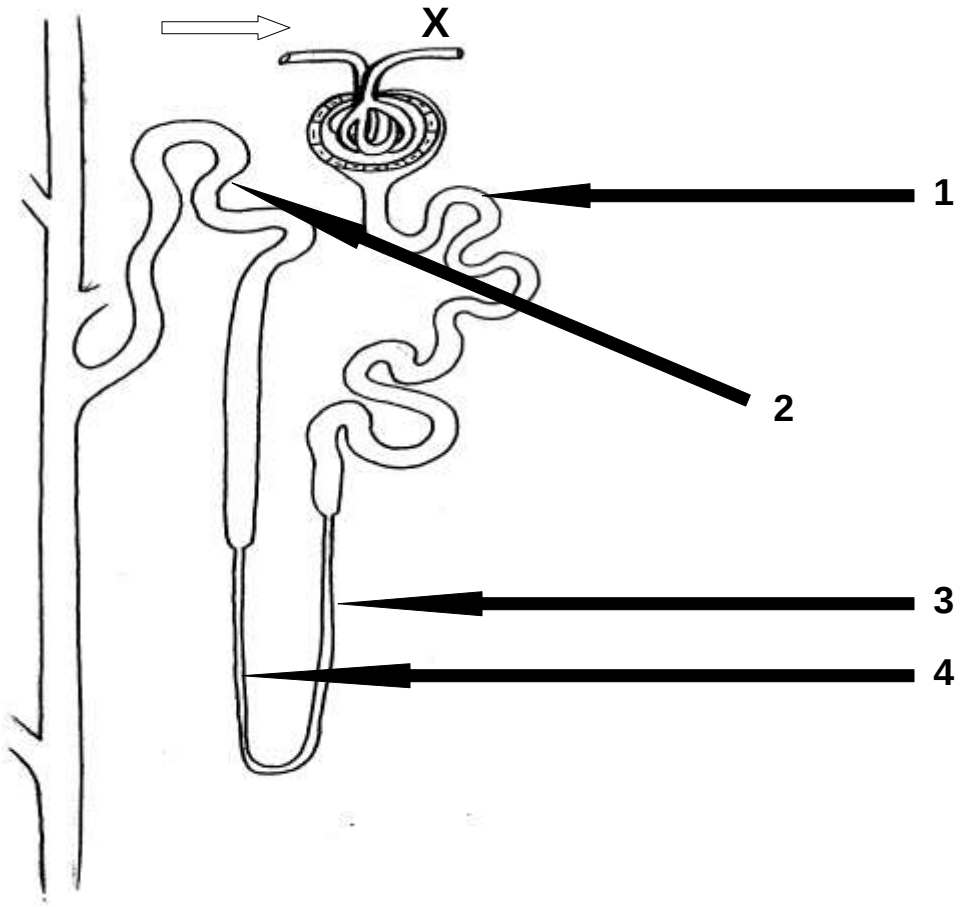
From the following, choose one that is an appropriate DNA sequence of the mutation.

Normal TGAGG[ACTCC]TCTTCAGA

下方為正常血紅素的『第四胜肽』的部分 DNA 序列，鐮型細胞貧血症血紅素的發生突變的區域用長方形（[ ]）標記出來。請問下列何者為最適當的鐮型細胞貧血症血紅素的部分 DNA 序列：

A. TGAGG[ACCC]TCTTCAGA
B. TGAGG[ACTACC]TCTTCAGA
C. TGAGG[ACACC]TCTTCAGA
D. TGAGG[ACC]TCTTCAGA
E. TGAGG[AACTCC]TCTTCAGA

Question 26 - 28. **The diagram below represents a nephron from an adult human.**
下圖代表一個成人的腎元



Question 26. At which of the numbered points would the filtrate be hypertonic to the blood?
26. 在哪些位置中的濾液對血液是高張的？

A. 1 and 3 only
B. 1, 2 and 3
C. 2 and 3 only
D. 4 only
E. 3 and 4

Question 27. At which of the numbered points sodium is active reabsorbed from the filtrate?
27. 在哪些位置中的鈉可由濾液中再吸收？

A. 1 only
B. 1 and 2 only
C. 1, 2 and 3
D. 1, 2 and 4
E. 4 only

Question 28. The open arrow shows the direction of blood flow into the Glomerulus. What happens if the diameter of the blood vessel is constricted at point **X**?

A. More sodium will appear in the urine
B. Water reabsorption will be decreased
C. The rate of ultrafiltration will be increased
D. The rate of urine production will be reduced
E. Glucose will be appear in the urine

28. 空心箭頭顯示血流進入腎小球的方向，若血管的直徑在 **X** 點縮小，會發生何種結果？

A. 尿液中會出現更多的鈉
B. 水的再吸收會降低
C. 超過濾作用的速率會增加
D. 尿液產生的速率會降低
E. 尿液中會出現葡萄糖

Question 29. A and B are two 70 Kg individuals with same body water volume. Both of them had a snack that had a high salt content, and B also drank a glass of an alcoholic drink . Based on this information, which one of following statements is true?

A. A will have a lower circulating level of antiduretic hormone (ADH) than B

B. B will have a lower circulating level of antiduretic hormone (ADH) than A

C. Both of them will have the same level of circulating ADH

D A will have less body water than B

E. B will produce less urine than A

29. 70 Kg 的 A 及 B 兩人身體所含水分的體積相同，兩人均吃了含高鹽的零嘴，B 另外又喝了一杯酒精飲料。根據這些資料，下列敘述何者正確？

A. A 血液中抗利尿素(ADH) 的量比 B 少
B. B 血液中抗利尿素(ADH) 的量比 A 少
C. 兩人的血液中將會有同量的 ADH
D. A 身體的水分將會比 B 少
E. B 產生的尿液將會比 A 少

Question 30. Which of the following RNA sequences would hybridize most effectively with the DNA sequence 5’ - ATA CTT ACT CAT TTT – 3’?

30. 下列 RNA 序列中，何者與ＤＮＡ序列 5’ - ATA CTT ACT CAT TTT – 3’的雜合最有效？

A. 5’ – AAA AAC GUC CCC UAA – 3’
B. 5’ – ATA CTT ACT CAT TTT – 3’
C. 5’ – UAU GAA UGA GUA AAA – 3’
D. 5’ – AAA AUG AGU AAG UAU – 3’
E. 5’ – AAA ATG AGT AAG TAT – 3’

Question 31. What does a small deviation indicate about data obtained from an experiment?

A. The data is not reliable.

B. More data needs to be collected.

C. More of the values are above the mean than below the mean

D. Data is grouped closely around the mean.

E More of the group values are below the mean than above the mean.

31. 若一個實驗所得數據的偏差很小，代表什麼意思？

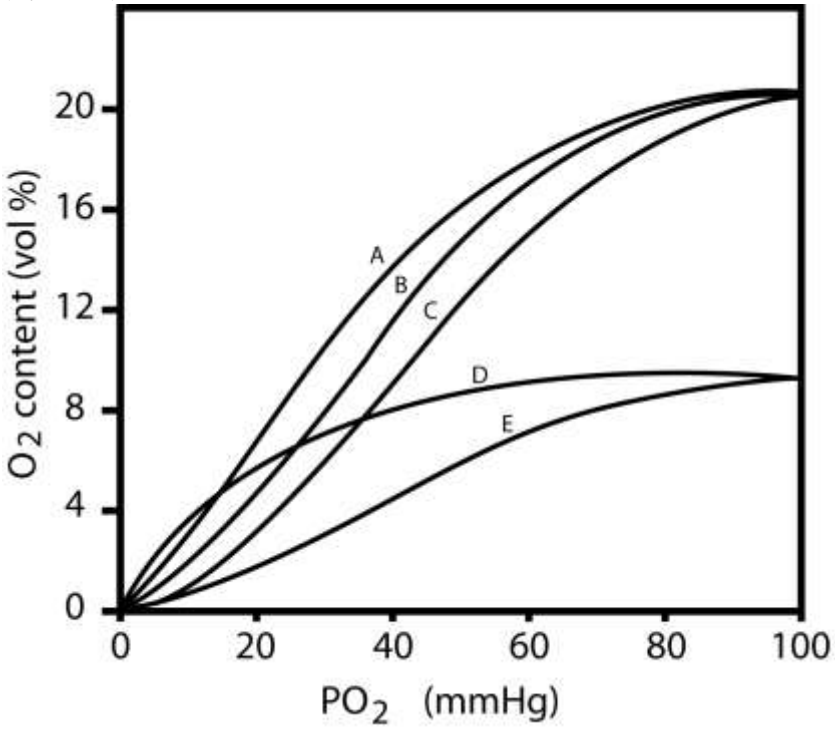
A. 數據不可靠
B. 需要收集更多的數據
C. 高於均值的值比低於均值的多
D. 數據多落在均值的附近
E. 低於均值的值比高於均值的值多

IMPORTANT 重要注意事項

ANSWERS TO QUESTIONS 32 TO 60 ARE TO BE WRITTEN IN THIS EXAM BOOKLET.
本卷試題 **32** 至 **60** 之作答須將答案書寫於本試卷內

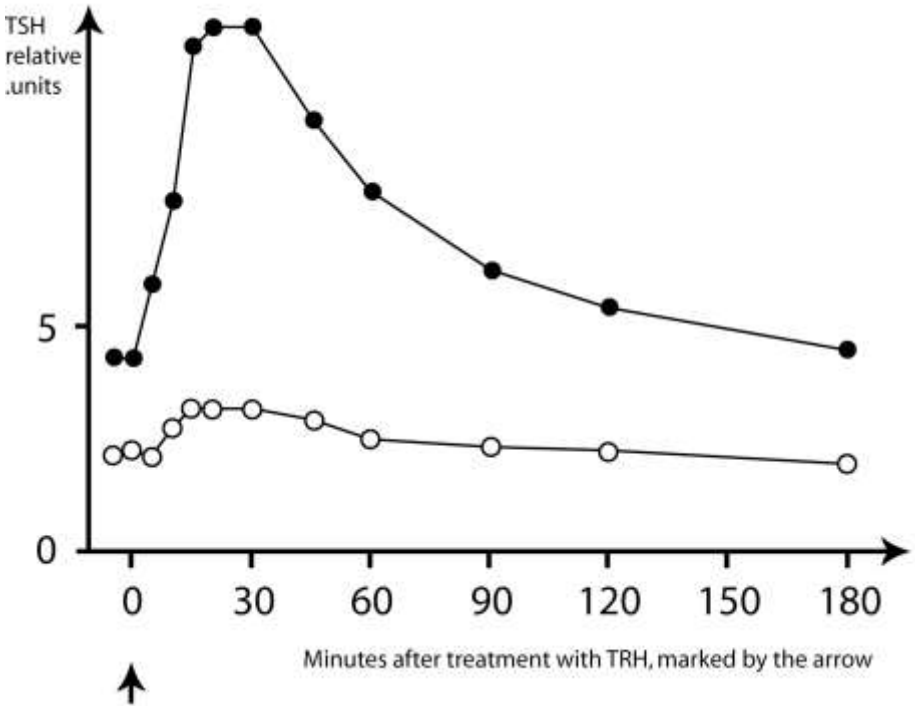
STARTING AT THE NEXT PAGE, WRITE YOUR STUDENT CODE AT THE TOP OF EVERY PAGE IN THIS EXAM BOOKLET
由下頁開始，請將你的學生代碼寫在此卷每頁上方

Question 32. For blood under each of the conditions described below, select the letter of the oxy-hemoglobin dissociation curve with which it is most likely to be associated. (3 marks)
血在下列所描述的各種不同情況下，選擇圖中與之對應之不同有氧血紅素釋放曲線，將其所代表之字母填入。



1. Normal adult arterial blood 正常人動脈血
2. ~~Blood stored for 2 weeks~~
3. Anaemic blood 貧血者的血
4 .Foetal blood 胚胎血
5. ~~Blood exposed to CO 暴露於 CO 的血~~
6. Blood from a person with hypothermia 失溫者的血
7. Blood with Pa_{CO2} above normal 血中 CO2 分壓高於正常人的血
8. Blood with an increased pH pH 值增加的血

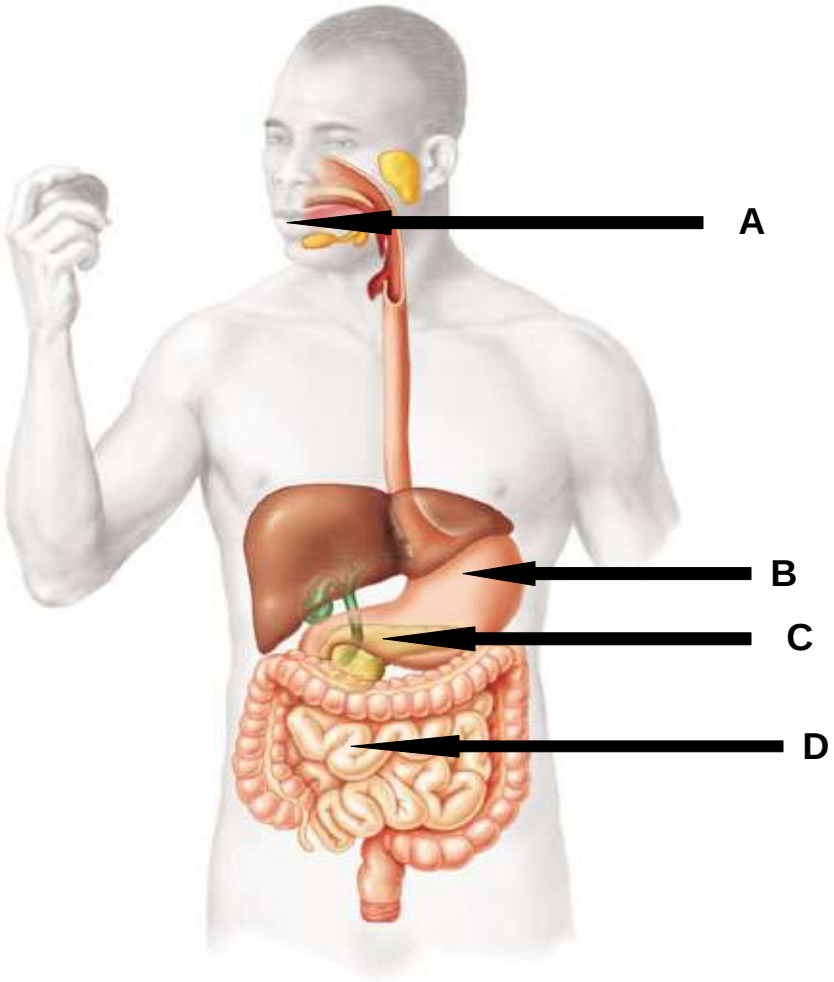
Question 33. The following graph shows the concentration of thyroid-stimulating hormone (TSH) in human blood during the 3 hours following an injection of TSH-releasing hormone (TRH) in two groups of people (A and B). One group was treated with thyroxine daily for a week prior to the experiment. (2 marks)
下圖為二組人類（A 及 B）血中促甲狀腺素(TSH)在注射甲狀腺釋放激素(TRH)後 3 小時的濃度變化。一組在注射前曾經為期一週，每天施打甲狀腺。（2 分）



箭頭為注射 TRH 的時間

STATEMENT	True (1) or False (2)
a. Thyroxine treatment stimulated TSH release in Group A 注射甲狀腺刺激 A 組個體釋放出 TSH	
b. Group A has been treated with thyroxine daily before treatment with TRH A 組人在注射 TRH 之前，每天都接受甲狀腺注射	
c. Group B has been treated with thyroxine daily before treatment with TRH B 組人在注射 TRH 之前，每天都接受甲狀腺注射	
d. Thyroxine treatment inhibited TSH release in Group B 甲狀腺注射抑制 B 組個體釋放 TSH	

Question 34. Digestion of food is facilitated by enzymes and hormones secreted at various regions of the gastro-intestinal tract. Select the organs (identified by different letters) from the diagram below that secretes the following enzymes and hormones: (4 marks)
食物消化之促進受在不同消化道上分泌之酵素及激素的影響。選擇下圖中器官（以不同字母表示）其所分泌之酵素與激素為何？（4 分）



I. Amylase 澱粉酶

II. Lipase 脂

III. Chymotry

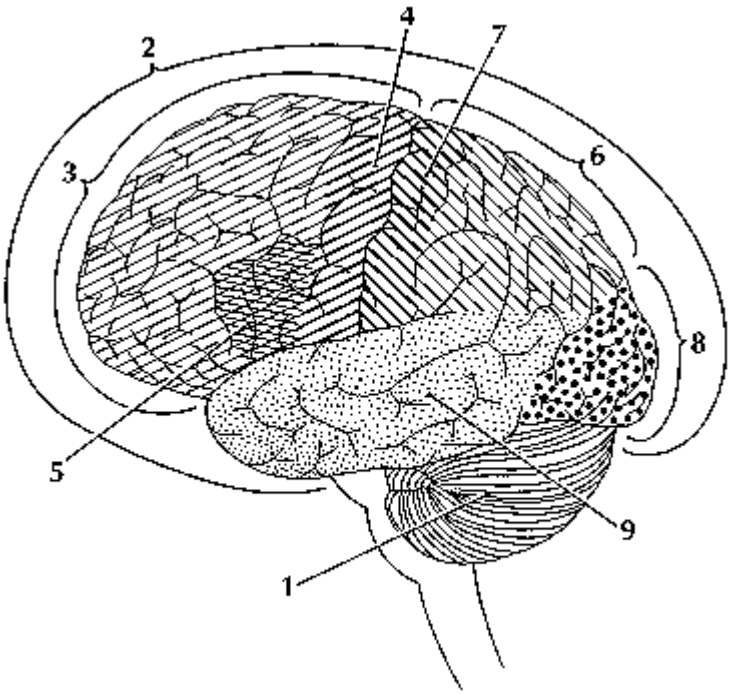
IV. Insulin 胰

V. Cholecyst

VI. Aminopep

VII. Gastrin 胃

VIII. Carboxyp



Questions 35 - 37 brain trauma. Use the figure below to to refer to the region of the brain

一位 21 歲的學生 腦各部分區域。

Question 35. The patient experiences lack of co-ordination and problems in balance. What part of the brain is most likely damaged? (0.5 mark)
病患行動缺乏協調，無法平衡，此係其腦中何處受傷所致？（0.5 分）
ANSWER:

~~Question 36. The patient slurs her speech and is unable to clearly read even simple passages from a book. What part of the brain is most likely damaged? (0.5 mark)~~
~~病患講話含糊不清，並無法清楚讀出書中最簡單的字句，此係其腦中何處受傷所致？（0.5 分）~~
~~ANSWER:~~

Question 37. The patient experiences double vision and images are blurry. What part of the brain is most likely damaged? (0.5 mark)
病患視覺重疊及影像模糊，此係其腦中何處受傷所致？（0.5 分）
ANSWER:

Question 38. To study hierarchial reaction in crickets (*Gryllus campestris*) five crickets, A, B, C, D and E, were marked with colours and placed two by two in an experimental field. Observations were made on their aggressive behaviour and the results are shown below :
某生研究蟋蟀之位階行為，以 5 隻個體上色標的 A、B、C、D、E 蟋蟀進行實驗。觀察其兩兩相鬥的行為，結果如下：

Partner 對手	Won fights 勝場數	Lost fights 負場數
B	6	0
C	2	9
D	7	0
E	2	6

Table 1 : Fight results for cricket A
A 蟋蟀和對手打鬥的結果

Partner 對手	Won fights	Lost fights
A	0	6
C	0	5
D	5	1
E	0	7

Table 2 : Fight results for cricket B
B 蟋蟀和對手打鬥的結果

Partner	Won fights	Lost fights
A	9	2
B	5	0
D	6	0
E	9	3

Table 3 : Fight results for cricket C
C 蟋蟀和對手打鬥的結果

Partner	Won fights	Lost fights
A	0	7
B	1	5
C	0	6
E	0	5

Table 4 : Fight results for cricket D
D 蟋蟀和對手打鬥的結果

Partner	Won fights	Lost fights
A	6	2
B	7	0
C	3	9
D	5	0

Table 5 : Fight results for cricket E
E 蟋蟀和對手打鬥的結果

Indicate if the following statements are correct by writing the appropriate answer code in the answer column of the following table. (3 marks)

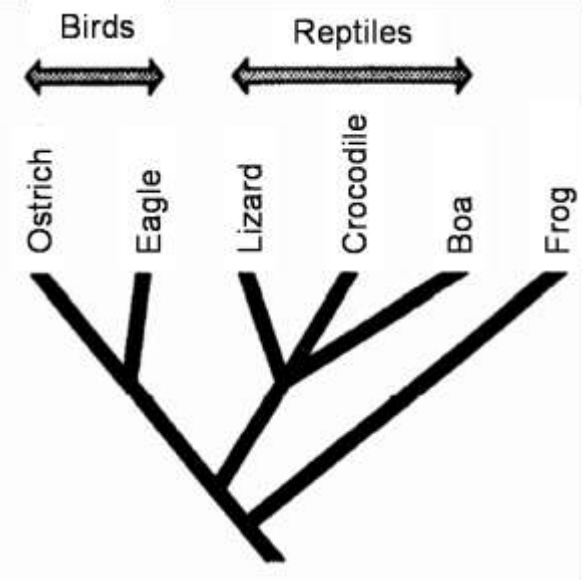
判定下表中各敘述正確與否。用 1 表示正確，2 表示錯誤，填入下表。（3 分）

Answer code : **1** = CORRECT **2** = INCORRECT

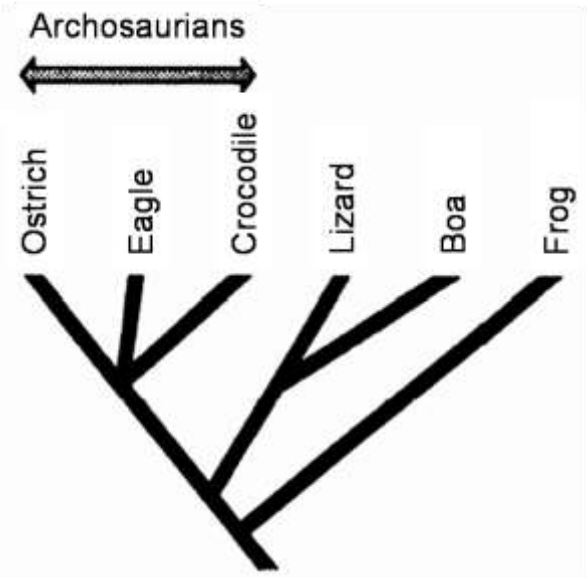
Statement	Answer
a. Cricket D is last in the hierarchical order. 蟋蟀 D 在位序中排名最後	
b. Cricket E is first in the hierarchical order. 蟋蟀 E 在位序中排名第一	
c. The hierarchy is linear: with the following order: C → E→ A → B → D 蟋蟀的位序呈線性，其順序為：C → E→ A → B → D	
d. Some crickets won fights against crickets that were higher in the hierarchical order. 某些蟋蟀與位序較高的個體打鬥時亦有勝場	

Question 39. According to the usual classification, Birds are classified as Vertebrates with feathers and Reptiles as epidermal scale Vertebrates. A different phylogenetic classification has been proposed and includes birds and crocodiles in the Archosaurian group.
Below are the two types of classification:
根據一般的分類，鳥被歸為有羽毛的脊椎動物，爬蟲類被歸為表皮有鱗片的脊椎動物。另一不同的系統演化樹將鳥及鱷歸入古蜥亞綱。下圖為 2 種分類的方式

usual classification 一般分類



phylogenetic classification 支序分類



Comparison of selected anatomical characteristics of these vertebrates

下列各脊椎動物部分解剖特徵的比較

	Epidermal scales **表皮衍生的鱗片**	**Preorbital fenestra** **前眼眶窗**	**Gizzard** **砂囊**	**Feathers** **羽毛**
Eagle **鷹**	covering feet 覆蓋在腳上	present 有	present 有	present
Ostrich **鴕鳥**	covering feet 覆蓋在腳上	present 有	present 有	present
Crocodile **鱷**	covering all the body 覆蓋全身	present 有	present 有	none
Boa **蟒蛇**	covering all the body 覆蓋全身	none 無	none 無	none
Lizard **蜥蜴**	covering all the body 覆蓋全身	none 無	none 無	none
Frog **蛙**	none 無	none 無	none 無	none

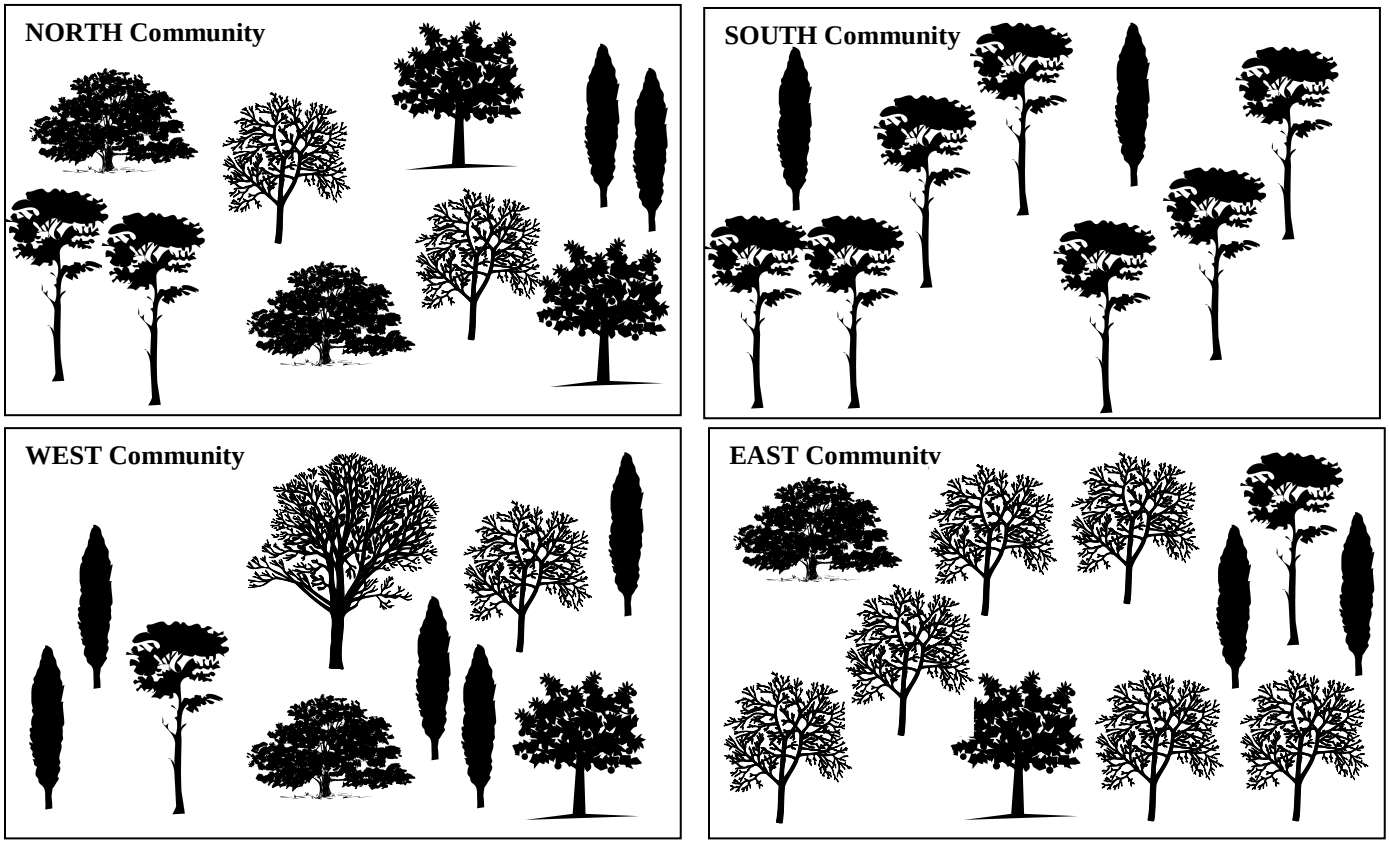
Indicate if the following statements are correct by writing the appropriate answer code in the answer column of the table. (3 marks)

Answer code : **1** = CORRECT **2** = INCORRECT

判定下表中各敘述正確與否。用 1 表示正確，2 表示錯誤，填入下表。（3 分）

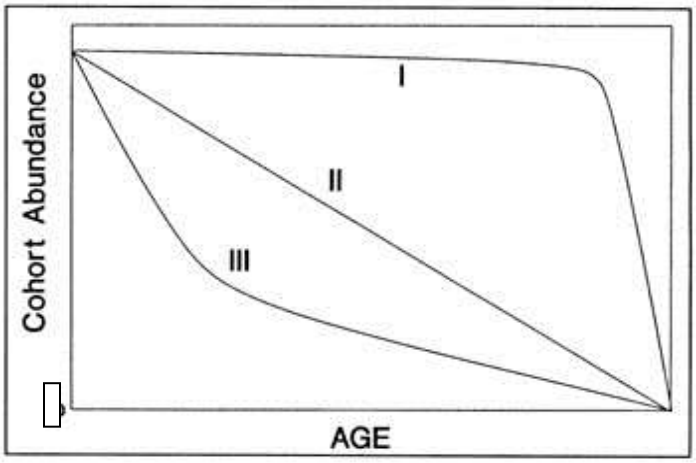
Statement	Answer
a. Birds and Reptiles both have scales. Therefore, we can assume that they share a common ancestor which is different from that of the frog. 鳥及爬蟲皆有鱗片，故吾人可假設它們有共同的祖先，其與蛙不同	
b. ~~Vertebrates~~, Eagle, ostrich and crocodile, are homologous for the preorbital fenestra feature 老鷹、鴕鳥及鱷，在前眼眶窗的特徵上係屬同源	
c. Possession of feathers is an ancestral characteristic, whereas the possession of scales is a more recent modification. 擁有羽毛為祖徵，而鱗片則為較近代的特化	
~~d. Since crocodiles are more closely related to birds than to lizards, scales are not relevant as aa to be used in this type of classification..~~	

Question 40. Four tree communities were identified at four different locations to the north, south, west and east of Ottawa, Canada. The communities are represented below, with each different tree figure symbolizing a different species. （6 marks）
四個樹木聚落位於加拿大歐大瓦的東、西、南、北向的區域，下圖為這些聚落中的不同樹型代表不同物種。（6 分）



	Community attribute 聚落屬性	**ANSWER**			
		A. North	**B. South**	**C. West**	**D. East**
a.	Highest species richness 最高物種豐富度				
b.	Lowest species richness 最低物種豐富度				
~~c.~~	~~Highest species evenness~~ ~~最高物種均勻度~~				
~~d.~~	~~Lowest species evenness~~ ~~最低物種均勻度~~				
e.	Highest species diversity 最高物種歧異度				
f.	Lowest species diversity 最低物種歧異度				
g.	Highest total abundance 最高總豐度				
h.	Lowest total abundance 最低總豐度				

Question 41. A survivorship curve depicts the age-specific mortality through survivorship. Indicate whether the following statements about the survivorship are true. The graphs shown below indicate different types of survivorship curves.
下圖為三種年齡的生存曲線型式。指出下列關於存活之敘述何者正確？



Circle whether each statement is TRUE or FALSE. (2 marks)
指出每個敘述的真偽：把答案圈選出來（2 分）

A Graph I represents organisms that provide good care of their offspring, such as humans and many other large mammals.
曲線 I 代表提供子代良好保護的生物，如人及其他大型哺乳類

TRUE FALSE

B. Graph II is typical of survivorship curves for organisms such as many fishes and marine invertebrates.
曲線 II 的代表生物為魚類及海生無脊椎動物

TRUE FALSE

C. Graph II is characteristics of the adult stages of birds after a period of high juvenile mortality.
曲線 II 代表歷經高的幼體死亡階段的成鳥時期

TRUE FALSE

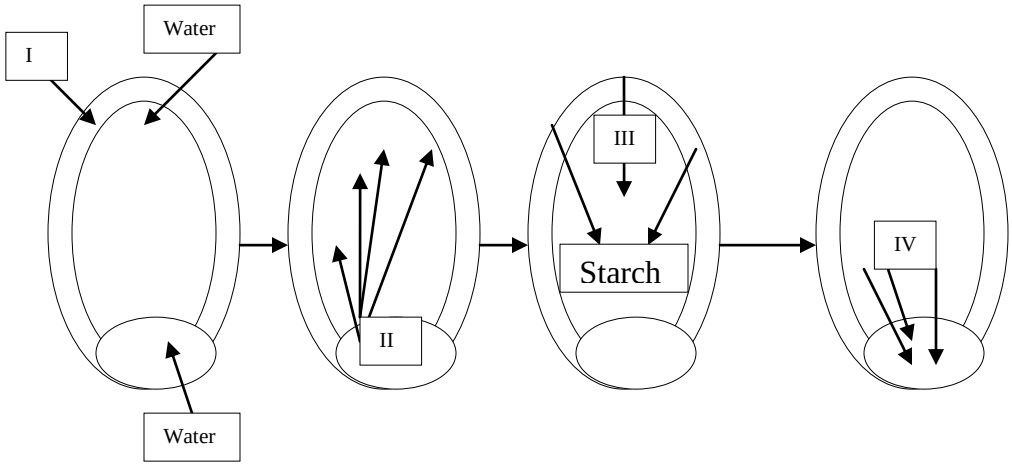
D. Birds may have a Graph III-type survivorship curve with a brief period of high mortality among the youngest individuals, followed by increasing periods of lower mortality.
鳥類可能為曲線 III，幼體階段死亡率高，成鳥時期死亡率低

TRUE FALSE

~~E. In populations where migration is common, survivorship is important factor in determining changes in population size~~
~~遷徙性的族群中，存活率是決定族群大小的重要因素~~
~~TRUE FALSE~~

~~Question 42. The following diagram represents the gymnosperm lifecycle.~~ 此題刪除

Questıon 43. The diagram below represents the stages in the mobilization of starch reserves in a barley grain. 下圖表示大麥穀粒中澱粉移動的各階段 I ~ IV



Match the appropriate term with the correct Roman numeral from the diagram above. (Note: not all terms have answers.) (3 marks)
對應上圖中的羅馬數字於下表適當名詞旁的空格中（有些名詞沒有答案；空格）（3 分）

TERM FROM DIAGRAM	**ANSWER**
Alpha-amylase 澱粉酶	
Aleurone layer糊粉層	
Auxın 植物生長素	
Gibberellic acid 吉貝素	
Sugar 糖	
Proteın 蛋白質	

Question 44. The structures in **List B** develop from the structures shown in **List A**. Match each structure in **List A** with the appropriate structures in **List B.** Enter your answers in the table below. (2.5 marks) List B 的構造是由 List A 發育而來， 把適當的構造配對並填入下表中。

List A	**List B**
a. Microspore 小孢子	1. Pollen sac 花粉囊
b. Microsporophyll 小孢子葉	2. Primary cell of Embryo sac 胚囊的起始細胞
c. Megaspore 大孢子	3. Carpel 心皮
d. Megasporangium 大孢子囊	4. Nucellus 珠心
e. Megasporophyll 大孢子葉	5. Pollen grain 花粉粒

LIST A	**LIST B**
a.	
b.	
c.	
d.	
e.	

Question 45. Plants obtain various mineral nutrients from the soil. These nutrients have different physiological roles in plants.
Match the elements/compounds from the left column with their functions in plants in the right column. Write your answers in the answer table below. (5 marks)
植物從土壤中取得多種礦物鹽類，這些礦物鹽在植物體內各有不同生理角色。
將左欄的礦物鹽與右欄的功能配對，把答案（字母）填入空格中。（5 分）

1. Calcium 鈣	A. A cation that is important in the formation of turgor in stomata 形成氣孔膨壓的重要陽離子
2. Nitrogen 氮	B. A nitrogen anionic compound that is accessible to plants in natural ecosystems 在生態系中，可被植物所吸收的含氮化合物型式
3. Nitrate 硝酸	C. Necessary for the synthesis of the side chains of cysteine and methionine 合成半胱氨酸(cysteine)及甲硫氨酸(methionine)的必需物
4. Iodine 碘	D. An element present in all amino acids, nucleotides and chlorophyll 存在於所有氨基酸、核苷酸及葉綠素的元素
5. Phosphate 磷酸	E. A metal present in the chlorophyll molecule 存在葉綠素分子的金屬離子
6. Magnesium 錳	F. Enables the crosslinking of pectates in the cell wall 使細胞壁中的果膠酸得以作連結
7. Potassium 鉀	G. A component of DNA and RNA that is not a part of purine or pyrimidine bases. 是 DNA 及 RNA 組成，但不是嘌呤或嘧啶鹽基
8. Sulfate 硫酸	H. Is the most abundant metal in the electron transport chain proteins 是電子傳遞鏈蛋白中最多的金屬元素
9. Manganese 鎂	I. Participates in the photo-oxidization of water during photosynthesis 參與在光合作用中水的光氧化反應
10. Iron 鐵	J. Is not essential for the growth of plants 在植物生長中並非必需的

Answer Table

1.	2.	3.	4.	5.	6.	7.	8.	9.	10.

Questions 46 - 48. The ways different substances can be transported through the biological membrane is shown in the Figure 1.

下圖為物質進出細胞膜的方法

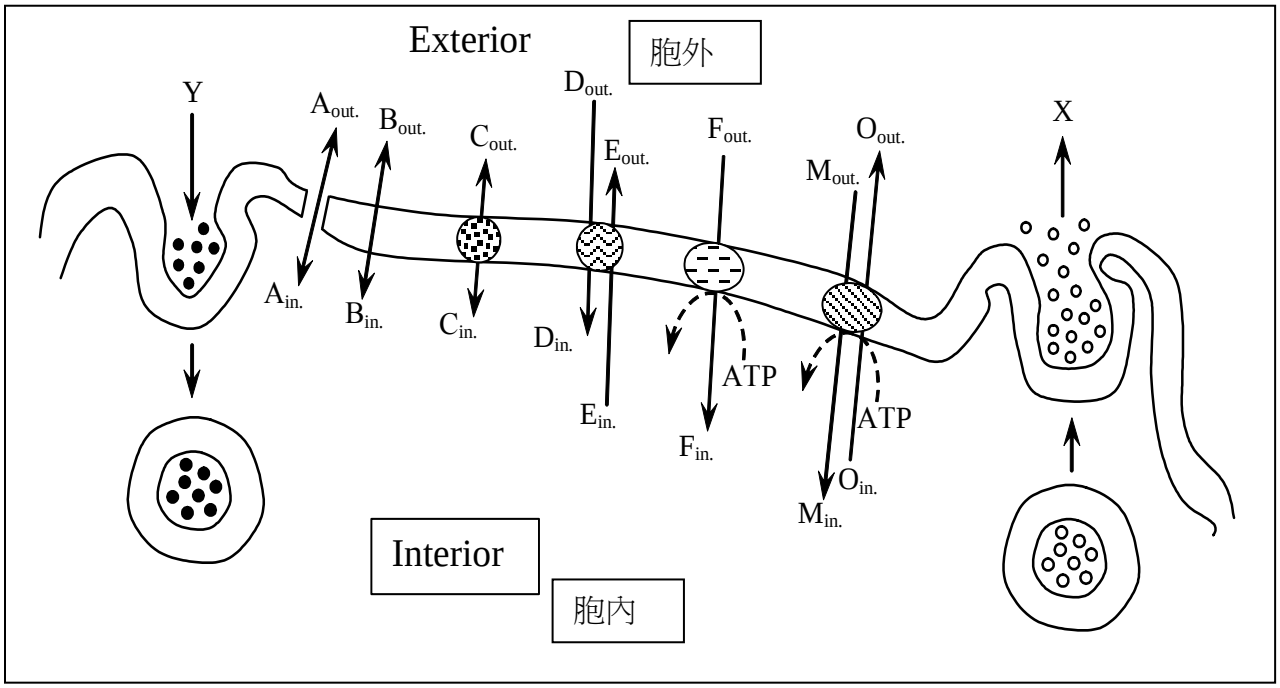


Figure 1 Transport of different substances through the biological membrane.
圖 1 為物質進出細胞膜的方法

Question 46. Match the name of the transport system to the letter(s) in Figure 1. (4 marks)
配合題：請將運送機制配合圖 1 中的標式（大寫英文字母）（四分）

Transport mechanism 運送機制		**Answer**
1.	Conjugated active transport 結合性主動運輸	
2.	Active transport (non-conjugated) 主動運輸 （非結合性）	
3.	Exocytosis 胞泌	
4.	Transport through membrane pores 膜孔運送	
5.	Phagocytosis/pinocytosis 胞吞 / 胞飲	
6.	Facilitated (mediated) diffusion 便捷式（要靠媒介的）擴散	
7.	~~Physical~~ Simple diffusion through membrane phospholipid bilayer 擴散通過脂雙膜~~物理性~~	
8.	~~Exchange diffusion~~ co-transport 協同運輸	

~~Question 47. Indicate which letters in Figure 1 correspond to each transport system. (4 marks)~~
~~配合題：請將運送系統配合圖 1 中的標式（大寫英文字母）（四分）~~
此題刪除

Question 48. Identify from Figure 1 the correct example for each transport type. (4 marks)
配合題：請將運送型式配合圖 1 中的標式（大寫英文字母）（4 分）

Membrane transport type 膜上運送型式		**Answer**
13.	Na^+, K^+-ATPase	
14.	Low-density lipoproteins 低密度脂蛋白	
15.	water, urea 水、尿素	
16.	Inner mitochondrial membrane H^+-ATPase 粒線體內膜的 H^+-ATPase	
17.	glucose, amino acids 葡萄糖，胺基酸	
18.	Exchange of ADP for ATP across inner mitochondrial membrane 粒線體內膜 ADP 與 ATP 的交換	
19.	Long chain fatty acids and alcohols 長鏈脂肪酸與酒精	
20.	Hormonal secretion 激素分泌	

Question 49. The total respiration (R) of a young growing plant can be described by the following expression:
新生植物的總呼吸 (R) 可以以下列公式表示

Total R = Maintenance R + Growth R
總呼吸　　支持性呼吸　　生長呼吸

Some of the processes that occur during growth of this plant are:

1. Movement of water within a cell

2. Reduction of nitrate (NO_3^-)-ions to ammonium (NH_4^+)-ions

3. Uptake of K^+ -ions through the plasma membrane of an endodermis cell

4. Uptake of CO_2 in cells of palisade parenchyma

5. Opening and closing of stomata

6. Lengthening of a polypeptide chain

7. Absorption of light by chlorophyll A

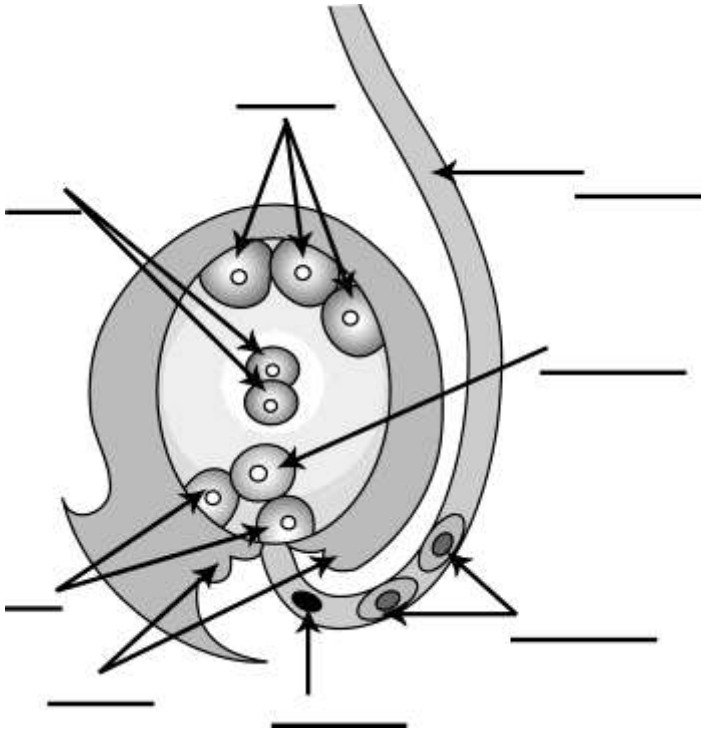
有關生長相關的描述如下
1. 細胞內水的運送
2. 將硝酸根離子 (NO3-) 還原成銨離子 (NH4+)
3. 透過內皮細胞細胞膜吸收鉀離子 (K^+)
4. 透過柵狀組織吸收二氧化碳
5. 開關氣孔
6. 多胜肽鏈的增長
7. 葉綠素 A 吸收光線

Certain of these processes require energy, some supply energy to the plant and others are not involved in energy use or supply. Indicate which processes require or supply energy by writing a + (plus sign), and which processes have no energy involvement by writing a ー (minus sign), in the correct places in the following table. (3.5 marks)

上述的過程都有些是要消耗能量的，有些則是提供植物能量的，有些則不涉及能量的使用或供給。請配合上述說明，分在下表中標記出能量的關係。需要能量參與的以“＋”（正號）表示，不需要能量參與的以“ー”（負號）表示，（3.5 分）

Process number	Energy required/supplied (+) or no energy involvement (-) 耗能 (＋) 或不耗能 (ー)
1	
2	
3	
4	
5	
6	
7	

Question 50. The following diagram shows an ovule just prior to double fertilization. Identify each of the structures indicated by an arrow and label it on the diagram with the appropriate letter code from the table below. (4 marks)
下圖為雙重受精之前的胚珠示意圖，圖中箭頭所指分別為多種構造，對應下表中的名詞，將字母填在圖旁各箭頭之橫線上。(4 分)



STRUCTURE 構造	LETTER CODE
Antipodal cell 反足細胞	A
Egg cell 卵細胞	B
pollen tube nucleus 花粉管核	C
Integument 珠被	D
Polar nuclei 極核	E
Pollen tube 花粉管	F
Sperm cell 精細胞	G
Synergid cell 助細胞	H

Questions 51-52. A family consists of three children, David, Edna & Sophie and their parents Alison and Alfred. One of the children is blood group A and is also red green colour blind . Edna is blood group B and Sophie is blood group O. Of the children only David has blue eyes. Neither parent is colour blind but only Alfred has blue eyes and is blood group B.
一個家庭中有三個小孩（David, Edna & Sophie），父母分別是 Alfred 及 Alison。有一個小孩為 A 型且為紅綠色盲；Edna 為 B 型；Sophie 為 O 型；只有 David 為藍眼；父母皆沒有色盲，但只有為 Alfred 藍眼且為 B 型。回答 51-52 題。

Questions 51. Choose a possible genotype for each family member and write the letter for that genotype against the name in the following table. (2.5 marks)
判定家中每個成員的基因型，並將對應的字母填在成員的名字旁之空格中。(2.5 分)

A = $X^C X^c$ AO Bb B = X^C Y AO bb C = $X^C X^c$ BO Bb ~~D = $X^C X^c$ AO Bb~~

E = X^C Y AO Bb F = $X^C X^c$ OO Bb G = X^C Y BO bb H = X^c Y AO bb

Family member	**Genotype**
David	
Edna	
Sophie	
Alison	
Alfred	

Question 52. In Canada, 7.0 % of the male population is colorblind. This is a sex linked recessive feature located on the X-chromosome. (1 mark)
What percentage of the female population, not being colorblind, is carrier of alleles responsible for colorblindness?
在加拿大，7.0 %的男性族群為色盲，此為聯在 X 染色體上的隱性基因。
女性族群中，沒有色盲但帶有色盲基因的百分比為多少？

Answer: .....%

Questions 53 - 55. **The *fox* operon, which has sequences A,B,C, and D, encodes enzymes 1 and 2. Mutations in sequences A, B, C, and D have the following effects, where a plus sign (+) = enzyme synthesized and a minus sign (-) = enzyme not synthesized. *Fox* is the regulator of *Fox* operon.**

53-55 ***fox*** **操縱組具有序列 A,B,C 及 D，可編碼酵素 1 及 2。在序列 A,B,C 及 D 突變會產生下列影響，其中正號(+) = 有酵素合成，負號(-) = 無酵素合成。*Fox* 為 *fox* 操縱組的調控因子。**

Mutation in sequence	***Fox* absent**		***Fox* present**	
	Enzyme 1	**Enzyme 2**	**Enzyme 1**	**Enzyme 2**
No mutation	−	−	+	+
A	−	−	−	+
B	−	−	−	−
C	−	−	+	−
D	+	+	+	+

Question 53. Is the *fox* operon inducible or repressible? Indicate your answer by writing X in the appropriate place in the table below. (1 mark)

53. ***fox* 操縱組是可誘發的或可抑制的？在下表的適當位置畫 X 。 (1 分)**

Inducible	
Repressible	

Question 54. Which sequence (A, B, C, or D) is part of the following components of the operon? Match the correct letter against the component in the table below. (2 marks)

上述序列 (A, B, C, or D) 分別為操縱組中的何種單元

Component of operon 操縱組單元	**Answer 答案**
Regulator gene 調控基因	
Promoter 促進子	
Structural gene for enzyme 1 酵素 1 的結構基因	
Structural gene for enzyme 2 酵素 2 的結構基因	

Question 55. The following is a list of mutational changes. For each of the specific mutations described, indicate which of the following terms could apply, either as a description of the mutation or as a possible cause. More than one term from the right column can apply to each statement in the left column. (6 marks)

下表為突變形成的原因。在每一種突變形成的原因都可以找到相對應的專有名詞。請配合突變形成的原因 (1 到 10) 分別填入與其對應的專有名詞 (a 到 k)。每個突變形成的原因**可能會有不只一個專有名詞與其對應**。（6 分）

Code	**Description of mutation** 突變描述		**Code**	**Term**
1.	An A-T base pair in the wild-type gene is changed to a G-C pair 野生型基因的一個 A-T 鹼基對改變成 G-C 鹼基對		**a.**	Transition 轉位
2.	An A-T base pair is changed to a T-A pair A-T 鹼基對改變成 T-A 鹼基對		**b.**	base substitution 鹼基取代
3.	The sequence AAGCTTATCG is changed to a AAGCTATCG AAGCTTATCG 改變成 AAGCTATCG		**c.**	Transversion 易位
4.	The sequence AAGCTTATCG is changed to a AAGCTTTATCG AAGCTTATCG 改變成 AAGCTTTATCG		**d.**	Inversion 插入
~~**5.**~~	~~The sequence AACGTTATCG is changed to a AATGTATCG~~ ~~AACGTTATCG 改變成 AATGTATCG~~		**e.**	Translocation 移位

6.	The sequence AACGTCACAACACATCG changed to a AACGTCACATCG AACGTCACAACACATCG 改變成 AACGTCACATCG		**f.**	Deletion 缺失
			g.	Insertion 插入
7.	The gene map in a given chromosome arm is changed from *bog-rad-fox1-fox2-try-duf* (where *fox*1 and *fox*2 are highly homologous, recently diverged genes) to *bog-rad-fox1-fox3-fox2-try-duf* (where *fox3* is a new gene with one end similar to *fox1* and the other similar to *fox2).* 染色臂的基因圖譜由 *bog-rad-fox1-fox2-try-duf*（*fox*1 及 *fox*2 為高度同源、最近才分歧的基因）改變成 *bog-rad-fox1-fox3-fox2-try-duf*（*fox*3 為新基因，且一端與 *fox1* 相似；另一端與 *fox*2 相似）		~~**h.**~~	~~deamination 脫氨作用~~
			i.	X-ray irradiation X-ray 照射
			j.	Intercalator 插入因子
8.	The gene map in a chromosome is changed from *bog-rad-fox1-fox2-try-duf* to *bog-rad-fox2-fox1-try-duf.* 染色臂的基因圖譜由 *bog-rad-fox1-fox2-try-duf* 改變成 *bog-rad-fox2-fox1-try-duf*		**k.**	unequal crossingover 不對等的互換
9.	The gene map in a given chromosome is changed from *bog-rad-fox1-met-qui-txu-sqm* to *bog-txu-qui-met-fox1-rad- sqm* 染色臂的基因圖譜由 *bog-rad-fox1-met-qui-txu-sqm* 改變成 *bog-txu-qui-met-fox1-rad- sqm*			

Write your answers in the table below.

將答案填入下表中

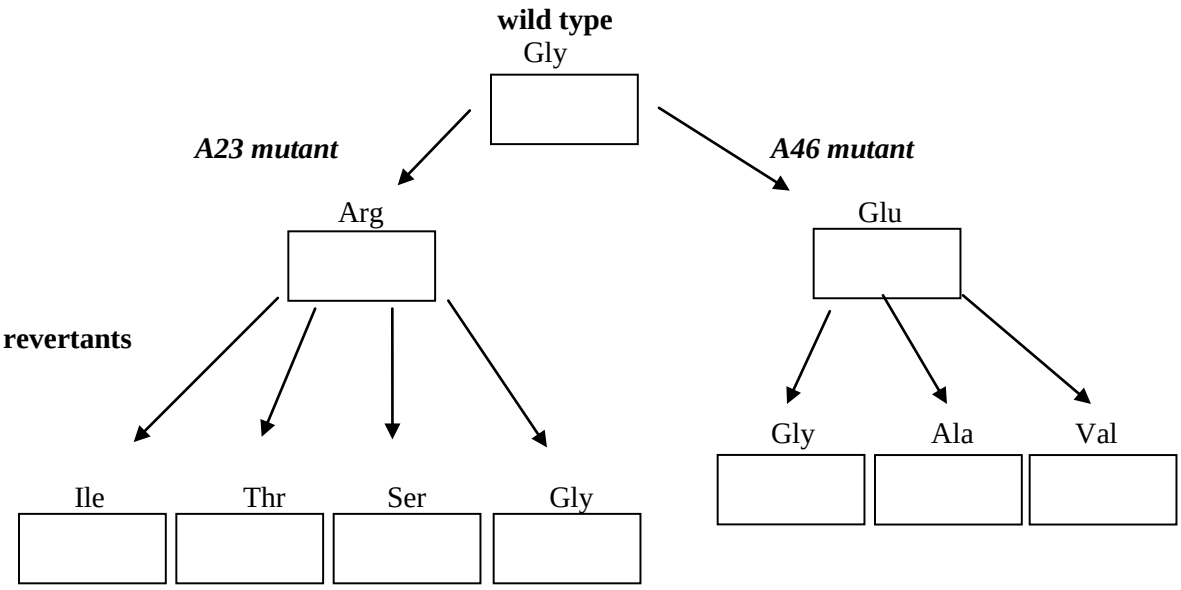
1	2	3	4	5	6	7	8	9

Question 56. The wild type tryptophan synthetase enzyme of *E. coli* contains a glycine (Gly) at position 38. Two *trp* mutants ***A23*** and ***A46*** have been isolated which have arginine (Arg) instead of glycine at position 38 (***A23***) and glutamate (Glu) at position 38 (***A46***). Both mutants were plated on minimal medium and from ***A23*** four spontaneous revertants to prototrophy (i.e. are able to grow without supplements) were obtained and from ***A46*** three spontaneous revertants to prototrophy were obtained. The tryptophan synthetase from each of seven revertants were isolated and the amino acids at position 38 were identified. A summary of these data is given below.
大腸菌野生型的色胺酸合成酶在第 38 位置是甘胺酸 (Gly)，***A23*** 與 ***A46*** 分別為兩株突變株，***A23*** 是在第 38 位置被精胺酸 (Arg) 所取代，***A46*** 則是在第 38 位置被麩胺酸 (Glu) 所取代，當這些菌株培養在基本培養基時，***A23*** 得到 4 株自然回復成原始營養型（不需添加特殊營養源便能生長），***A46*** 得到 3 株自然回復成原始營養型。這 7 株的第 38 位置的胺基酸分別被定序出來，並列在下面的表格中

mutant 突變株	revertant 回復株	amino acid at position 38 第 38 位置胺基酸
A23	1	isoleucine (Ile)
	2	threonine (Thr)
	3	serine (Ser)
	4	glycine (Gly)
A46	1	glycine (Gly)
	2	alanine (Ala)
	3	valine (Val)

Using the genetic code table provided (page 52), deduce the codons for the wild type, mutants ***A23*** and ***A46*** and for the revertants and place each designation in the box provided. (5 marks)

利用次頁的遺傳碼對照表，分別推論野生型、突變株 (A23, A46) 與回復株 (revertant) 第 38 位置的胺基酸遺傳碼，並將答案填入方格中（5 分）

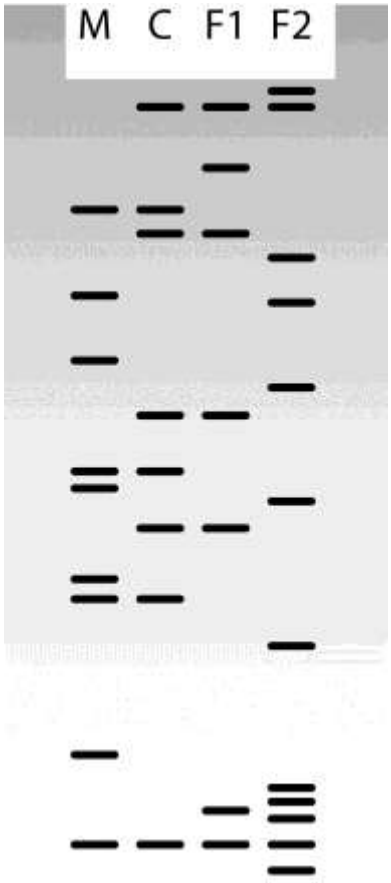


This table shows the 64 codons and the amino acid each codon codes for. The direction is 5' to 3'.

		2nd base			
		U	**C**	**A**	**G**
1st base	**U**	UUU (Phe/F)Phenylalanine	UCU (Ser/S)Serine	UAU (Tyr/Y)Tyrosine	UGU (Cys/C)Cysteine
		UUC (Phe/F)Phenylalanine	UCC (Ser/S)Serine	UAC (Tyr/Y)Tyrosine	UGC (Cys/C)Cysteine
		UUA (Leu/L)Leucine	UCA (Ser/S)Serine	UAA Ochre (*Stop*)	UGA Opal (*Stop*)
		UUG (Leu/L)Leucine	UCG (Ser/S)Serine	UAG Amber (*Stop*)	UGG (Trp/W)Tryptophan
	C	CUU (Leu/L)Leucine	CCU (Pro/P)Proline	CAU (His/H)Histidine	CGU (Arg/R)Arginine
		CUC (Leu/L)Leucine	CCC (Pro/P)Proline	CAC (His/H)Histidine	CGC (Arg/R)Arginine
		CUA (Leu/L)Leucine	CCA (Pro/P)Proline	CAA (Gln/Q)Glutamine	CGA (Arg/R)Arginine
		CUG (Leu/L)Leucine	CCG (Pro/P)Proline	CAG (Gln/Q)Glutamine	CGG (Arg/R)Arginine
	A	AUU (Ile/I)Isoleucine	ACU (Thr/T)Threonine	AAU (Asn/N)Asparagine	AGU (Ser/S)Serine
		AUC (Ile/I)Isoleucine	ACC (Thr/T)Threonine	AAC (Asn/N)Asparagine	AGC (Ser/S)Serine
		AUA (Ile/I)Isoleucine	ACA (Thr/T)Threonine	AAA (Lys/K)Lysine	AGA (Arg/R)Arginine
		AUG (Met/M)Methionine	ACG (Thr/T)Threonine	AAG (Lys/K)Lysine	AGG (Arg/R)Arginine
	G	GUU (Val/V)Valine	GCU (Ala/A)Alanine	GAU (Asp/D)Aspartic acid	GGU (Gly/G)Glycine
		GUC (Val/V)Valine	GCC (Ala/A)Alanine	GAC (Asp/D)Aspartic acid	GGC (Gly/G)Glycine
		GUA (Val/V)Valine	GCA (Ala/A)Alanine	GAA (Glu/E)Glutamic acid	GGA (Gly/G)Glycine
		GUG (Val/V)Valine	GCG (Ala/A)Alanine	GAG (Glu/E)Glutamic acid	GGG (Gly/G)Glycine

GENETIC CODE TABLE

Question 57. In a paternity suit the ABO phenotypes of the mother, the child and the two possible fathers (F1 and F2) were determined, and a DNA profile was made for each person.
Both the mother (M) and the child (C) are type A, Rh-negative. Father F1 is type B, Rh-negative and Father F2 is type O, Rh-negative. The DNA profiles are shown below.
為分析母親(M)、小孩(C)、兩個可能父親(F1 and F2)的 ABO 表型親源對應。母親(M)及小孩(C)都是 A 型、Rh-陰性；父親 F1 是 B 型、Rh-陰性；父親 F2 是 O 型、Rh-陰性，下圖為這四人的 DNA 指紋分析結果。

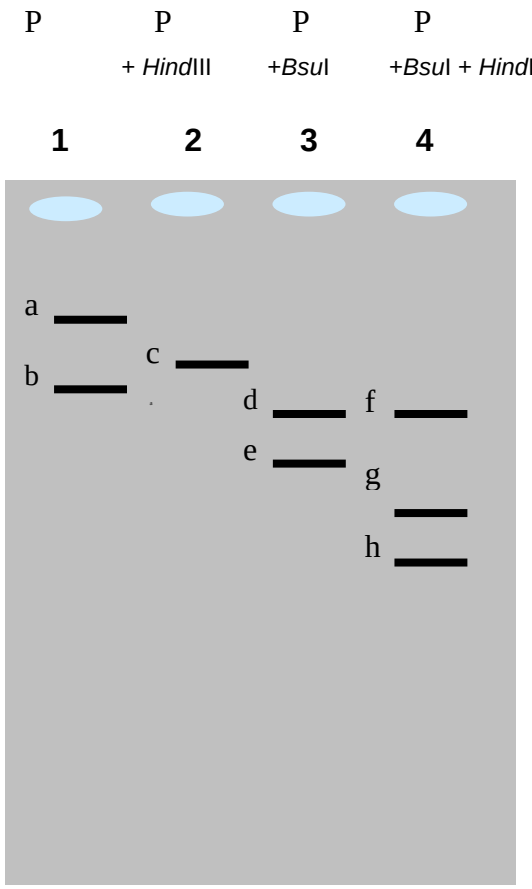


Answer the following questions. (3 marks)
回答下列問題的真偽。(3 分)

Question	Answer: True (1) or False (2)
a. The mother has the genotype Rr for the Rh factor 母親 Rh 因子的基因型為 Rr	
b. The child has the genotype I^AI^o 小孩具 I^AI^o 基因型	
c. F1 cannot be the father F1 不是小孩的父親	

~~Question 58. "DNA repair" mechanisms can be divided into 3 categories (listed below). A list of repairing processes is also given.~~
本題刪除

Question 59. The pBR322 plasmid was cut with two different restriction enzymes. The patterns of ethidium bromide staining of plasmid DNA after electrophoresis on agarose gels are shown.
將質體 pBR322 以兩種不同的限制酶去切，經洋菜膠電泳及 ethidium bromide 染色後，所得結果如下。



Reference:

P: plasmid

Answer true (T) or false (F): (2.5 marks)

1. **(.. …)** The pBR322 has only one restriction site for HindIII.
   pBR322 只有一個 HindIII 的限制切位

2. **(……)** The restriction enzyme HindIII induces plasmid supercoiling **.**
   限制酶 HindIII 可誘導質體形成超螺旋

3. **(.....)** The pBR322 has two restriction sites for BsuI.
   pBR322 只有兩個 BsuI 的限制切位

.4. **(.....)** The migration rate of a DNA molecule in an agarose gel is inversely proportional to its size. 洋菜膠上的 DNA 分子移動速率與其大小成反比

5. **(.....)** The bands in lane 4 indicate that both enzymes have the same restriction site.
   lane 4 的條帶型式顯示兩種酵素有相同的限制切位

~~Question 60. Information on the description and appearance of various chromosomal structural arrangements is given below.~~
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- THE END -