PART A

Cell Biology (14 questions, 20 points).

A1. (1 point). List the following proteins in the order of decreasing evolutionary conservativeness of their primary structure:
請按照下列蛋白質一級結構在演化上的保守程度，由大至小排列。

1. Somatotropin.
   生長激素
2. Catalytic subunit of a DNA – polymerase.
   DNA 聚合酶的催化單位
3. Histone H1.
   組蛋白 H1
4. Protamines (storage proteins of cereals).
   精蛋白(穀類的儲存蛋白)

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

A2. (1 point). What is the common feature of amino acids encoded by codons XUX, where X – is any base, U – uracil?
下列何者是由密碼子 XUX 所代表的胺基酸的共同特徵，其中 X 可代表任一種
含氮鹼基，U 代表脲嘧啶

A. Hydrophobicity. 厭水性
B. Positive charge. 帶正電荷
C. Negative charge. 帶負電荷
D. Sulfur in the side chain. 側鏈中含硫
E. No common feature. 無共同特徵

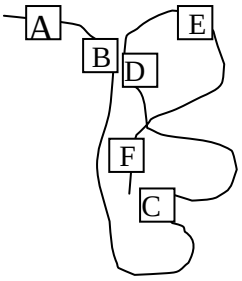
A3. (1 point). A denatured polypeptide chain containing amino acids of different chemical properties is shown on the figure.
下圖為一條變性後的多肽鏈，其中各組成胺基酸的化學特性敘述如下表

Amino acid properties:

A & E: Have negatively charged side groups. 含帶負電荷的側基	B: With many electropositive atoms. 含大量帶正電的原子
C & F: Have hydrophobic side groups. 含厭水性的側基	D: With many electronegative atoms. 含大量帶負電的原子

If renatured, the most stable configuration of the above polypeptide in the cytoplasmic environment
下列何者將會是前述多肽鏈在細胞質中復原(re-nature)後，最穩定的結構?
will be:

A.



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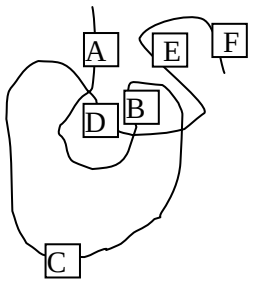

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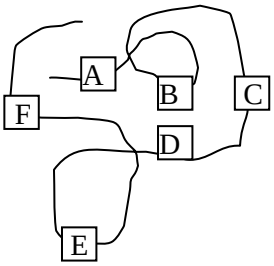
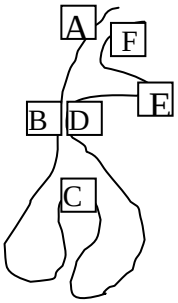


D.



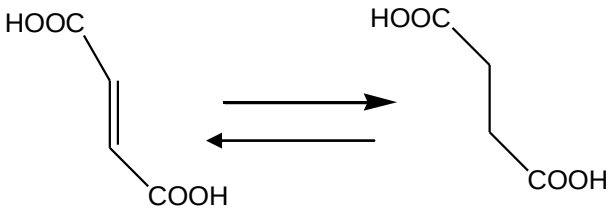
A4. (1 point). Nucleoside phosphates can be interphosphorylated enzymatically. Which of the following reactions is impossible?
核苷酸可藉由酵素進行內部磷酸化反應，下列哪些反應是不可能發生的?

A. ADP + ADP = AMP + ATP.
B. AMP + GTP = ADP + GDP.
C. ATP + GDP = ADP + GTP.
D. ATP + UMP = ADP + UDP.
E. ADP + AMP = ATP + adenosine.(腺苷)

A5. (1 point). Which nucleotides predominate in the genome of extremely thermophilic bacteria *Thermus aquaticus* in comparison to *E.coli*?
將嗜高溫菌(***Thermus aquaticus* , Taq**)與大腸桿菌(***E.coli***) 做比較，
下列哪些核苷酸在 **Taq** 的基因組中有較高的比例**?**

A. A-T.
B. C-T.
C. G-A.
D. G-C.
E. T-G.

A6. (2 points). Define from reaction written below:
請詳閱下圖所示之化學反應



A6.1. (1 point). Which class does the enzyme catalyzing the reaction of formation of succinic acid from fumaric acid belong to?
根據上圖，下列何種酵素負責自富馬酸(fumaric acid)轉換成琥珀酸的反應?

A. Isomerase.異位酶
B. Dehydrogenase.去氫酶
C. Hydrolase. 水解酶
D. Synthase. 合成酶
E. Transferase. 轉移酶

A6. 2. (1 point). Derivative of which vitamin the coenzyme of this reaction is:
下列何者是前述維生素輔酶反應的衍生物?

A. B_1 (thiamine) 維生素 B_1
B. B_2. (riboflavin) 維生素 B_2
C. B_6. (pyridoxin) 維生素 B_6
D. B_{12}. (cyancobalamine) 維生素 B_{12}
E. B_c. (folic acid) 維生素 B_c (葉酸)

A7. (1 point). It is known that cyanides (CN^-) and carbon monoxide bind specifically to the reduced and oxidized form of cytochrome a_3 (cyt a_3) (part of complex IV of electron transport chain), respectively, in mitochondria. Which of the following statements are correct:
刪除

1. Cyanides and carbon monoxide are equally toxic to mitochondria.
2. Cyanides are far more toxic for mitochondria than carbon monoxide.
3. Carbon monoxide is more toxic for animals since it is capable of binding other iron-containing substances, e.g. hemoglobin.
4. Carbon monoxide is less toxic for animals since it is capable of binding other iron-containing substances, e.g. hemoglobin.
5. Cyanides are more toxic for animals since they are only capable of binding to cytochrome a_3.

A. 1, 2, 4.
B. 2, 3, 5.
C. 1, 4, 5.
D. Only 4.
E. Only 1.

A8. (1 point). Lactobacilli lack electron transport chain. However, under special circumstances, up to 50% of ATP is synthesized by membrane-linked H^+ - ATPase. What are the circumstances to generate a proton gradient to drive ATP formation?
乳酸菌缺乏電子傳遞鏈，可是在某些特殊狀況下，有接近 **50%**的 **ATP** 是由接在膜上的 **H^+ - ATPase(ATP** 合成酶**)**所合成的，下列哪些狀況可形成用以驅動 **ATP** 合成的質子濃度梯度**?**

1. If the concentration of lactic acid is higher in the cell than it is in the medium.
   當細胞內乳酸濃度較培養液為高時
2. If the concentration of lactic acid is lower in the cell than it is in the medium.
   當細胞內乳酸濃度較培養液為低時
3. Uniport of lactic acid.
   單向運輸乳酸時
4. Symport of lactic acid with H^+.
   乳酸與 H^+運輸方向相同
5. Antiport of lactic acid with H^+.
   乳酸與 H^+運輸方向相同

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

A9. (3 points). The lactose operon of *E.coli* consists of three genes:
大腸桿菌的乳糖操縱組含有三種基因，分別是**:**

***lacZ* encodes β-galactosidase,**
lacZ 為生成**β-**半乳糖苷酶的基因
***lacY* encodes galactosidepermease which carries out lactose transport to the cell,**
lacY 為生成半乳糖苷滲透酶的基因，此酶可把乳糖傳入細胞內
***lacA* encodes tyogalactoside-transacetilase.**
lacA 為半乳糖苷乙醯基轉移酶的基因

Lac operon is under control of LacI (repressor), which is inactive in the presence of lactose (inducer). There is a wide diversity of the chemical lactose analogs, for example:
乳糖操縱組受到 **LacI (**抑制蛋白**)**的調控，**LacI** 的活性可被乳糖**(**誘導物**)**所抑制，乳糖具有多種化學似構物，例如**:**

Orthonitrophenyl-β-D-galactoside (ONPG) – is a substrate for β-galactosidase but not an inducer. The product of this reaction orthonitrophenol is toxic for a cell.
ONPG 是**β-**半乳糖苷酶的受質，但不具誘導物的功能，此項反應的產物為 **orthonitrophenol**，此對細胞有毒害。

Isopropyl-β-D-thiogalactoside (IPTG) - is an inductor but not a substrate for β-galactosidase.
IPTG 具有誘導物的功能，但不具半乳糖苷酶受質的功能。

Phenyl-β-D-galactoside (PG) - is a substrate for β-galactosidase but not an inducer. The products of its hydrolysis are nontoxic for a cell.
PG 是**β-**半乳糖苷酶的受質，但不具誘導物的功能，其水解後的產物對細胞無害。

A9.1. (1 point). Which cells will grow in the medium with PG as the only source of
當培養液中只有 PG 作為碳及能量的來源時，
carbon and energy?
下列哪些細胞可以存活?

A. *lacI* $^{-}$.
B. *lacZ* $^{-}$.
C. *lacY* $^{-}$.
D. *lacZ* $^{-}$ *lacY* $^{-}$.
E. *lacI* $^{-}$ *lacZ* $^{-}$.

A9.2. (1 point). Will these cells grow in the medium with ONPG?
前述的細胞在具有 ONPG 的培養液中能否存活?

A. Yes.
B. No.

A9.3. (1 point). Galactose is a toxic compound for the cells which have galE^{-} mutation.
乳糖對於具有 galE^{-}突變的細胞是有毒的，
Which cells with this mutation will grow in the IPTG+PG medium (there is with
下列哪些同時具有此項突變的細胞可在的培養液中存活?
arabinose as the additional source of carbon and energy)?
(培養液中有阿拉伯糖作為額外的碳及能量來源)

A. *lacI* $^{-}$.
B. *lacZ* $^{-}$.
C. *lacA* $^{-}$.
D. *lacI* $^{-}$ *lacA* $^{-}$.

A10. (2 point). A protein synthesis assay was carried out *in vitro*. A polyribonucleotide
一項在試管中進行的蛋白質合成實驗中，利用一條含有 U 及 C 的
containing U and C in proportion 1:5 (positions of U and C are random) was used as a
核糖核苷鏈序列當作鑄模，其中 U 及 C 的比例為 1:5(被隨機分布於不同位置)，
template. Which amino acids and in what proportion will be incorporated into the
利用此鑄模轉譯所產生的多肽中，會出現哪些胺基酸?且彼此間會呈現哪種比例?
synthesized polypeptide molecules?

A. *1Phe : 5Pro : 3Leu.*

B. *1Leu : 1Pro : 1Ser : 1Phe.*

C. *1Phe : 5Ser : 5Pro : 5Leu.*

D. *1Phe : 25Pro : 5Ser : 5Leu.*

E. *5Leu : 5Pro.*

A11. (3 points). The strand of DNA molecule isolated from *E. coli* bacteria has sequence: 5′ – GTAGCCTACCCATAGG – 3′. Let's assume that an mRNA is transcribed from the corresponding double-stranded DNA, the template strand being complementary to the strand isolated.
自大腸桿菌分離出一段 DNA 分子，其序列為 5′ – GTAGCCTACCCATAGG – 3′ 假設利用與此序列互補的 DNA 分子當作鑄模，轉錄出一段 mRNA，請據此回答下列問題。

A11.1. (1 point). What is the sequence of this mRNA?
此段 mRNA 的序列為何?

A. 3′ – CAUCGGAUGGGUAUCC – 5′.
B. 5′ – GUAGCCUACCCAUAGG – 3′.
C. 5′ – GGAUACCCAUCCGAUG – 3′.
D. 5′ – CACAGAUACCCAGAUG – 3′.

A11.2. (1 point). Which peptide will be synthesized if its translation begins precisely at 5′– end of this mRNA? (Let's assume that start codon is not required). For tests 11 and 12 you can use the table of genetic code.
假如不需要啟動密碼子(start codon)，並自此 mRNA 的 5′端開始轉譯，則會產生下列哪一條的多肽?(你可使用所附的遺傳密碼表來回答第 11 及 12 題)

A. - *Gly - Tyr - Pro - Ala – Asp.*
B. - *His - Arg - Met - Gly – Ile.*
C. - *Val - Ala - Tyr – Pro.*
D. - *His - Arg - Tyr - Pro – Ala.*

A11.3. (1 point). When $tRNA^{Ala}$ separates from ribosome, which tRNA will bind next?
當 $tRNA^{Ala}$ 自核糖體上脫離後，下列何種 tRNA 會接上核糖體?

A. $tRNA^{Tyr}$.
B. $tRNA^{Pro}$.
C. $tRNA^{Val}$.
D. $tRNA^{Arg}$.
E. $tRNA^{His}$.

A12. (1 point). Transcription activity localization of which kind of RNA polymerase of eukaryote can be seen by using light microscope without any methods of coloration?
下列何種真核細胞 RNA 聚合酶的轉錄活性位置，可不透過染色，直接在光學顯微鏡下觀察到?

A. RNA-polymerase I.
B. RNA-polymerase II.
C. RNA-polymerase III.
D. Primase. 引發酶 (導引酶)
E. Impossible to determine. 無法判斷

A13. (1 point). Phalloidin, a very toxic compound isolated from the mushroom *Amanita*
自 *Amanita phalloides* 可分離出具有劇毒的蕈毒素(phalloidin)
***phalloides*, has a very high affinity for actin polymers. One can mark phalloidin by**
他對於肌動蛋白聚合物具有極高的親和力，可把它與一個螢光分子(如 fluorescein)
covalently linking it to a fluorescent molecule, like fluorescein, without affecting it's
作共價性接合，此接合反應不會影響其親和力。
affinity properties.

If a microscopic slide with methanol-fixed sperm is stained with a reagent containing
利用接上螢光分子的蕈毒素對精子染色(先用甲醇作固定)，
fluorescein-marked phalloidin (excess reagent being washed), which part of the
並沖洗掉多餘的試劑，精子的哪一部份會在螢光顯微鏡下呈色?
spermatozoids will be glowing under a fluorescence microscope?

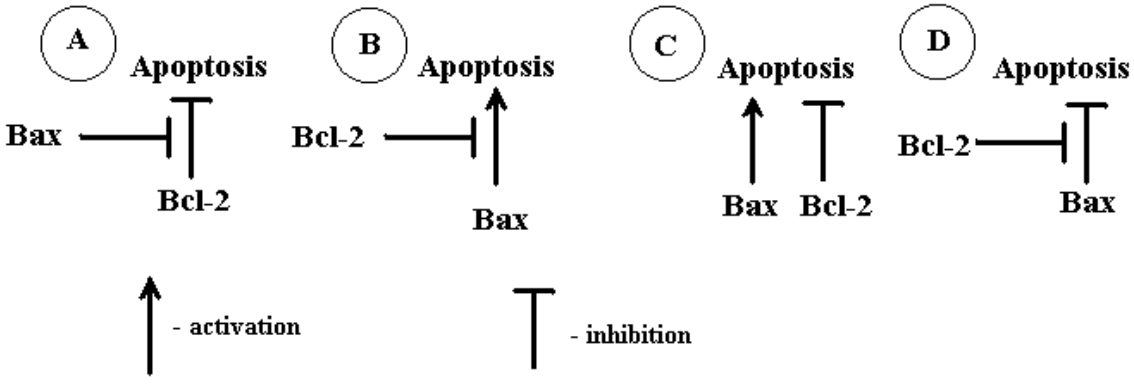
A. Acrosome. 穿孔體(頂體)
B. Flagellum. 鞭毛
C. Head. 頭部
D. Mitochondria. 粒線體
E. Whole spermatozoid. 整個精子

A14. (2 points). On the basis of the following experimental facts, decide which of the four
根據以下實驗，細胞程序性死亡(細胞凋亡)的過程中，
models (A, B, C or D) of Bax and Bcl-2 proteins' action in regulation of programmed
解釋蛋白質 Bax 及 Bcl-2 所扮演的角色之四種模式中(A, B, C or D)的敘述，何者正確?
cell death (apoptosis) is correct.

Experimental facts:
實驗結果如下:

- Mice with inactivated bcl-2 gene had high rate of apoptosis in various tissues, which
  具有不活化的 bcl-2 基因之小白鼠，在各種組織中都有高的細胞凋亡比例，
  could be corrected by the absence of Bax protein.
  此可運用除去 Bax 蛋白質的方式來治療。
- Bax gene in a single genome copy was able to promote apoptosis in the absence of
  沒有 Bcl-2 蛋白質時，Bax 基因會促進細胞凋亡。
  Bcl-2 protein.

- However, bcl-2 gene suppressed apoptosis in the absence of Bax protein.
  沒有 Bax 蛋白質時，bcl-2 基因能抑制細胞凋亡(apoptosis)。



activation: 代表"促進"　　inhibition:代表"抑制"

A. Bax protein inhibits action of Bcl-2 protein, which blocks apoptosis
依據上圖 A，Bcl-2 蛋白質會抑制細胞凋亡，而 Bax 蛋白質會抑制 Bcl-2。
(look A in the figure).

B. Bcl-2 protein is an inhibitor of Bax protein, which promotes apoptosis
依據上圖 B，Bax 會促進細胞凋亡，而 Bcl-2 蛋白質會抑制 Bax。
(look B in the figure).

C. Bcl-2 and Bax proteins act independently resulting in survival and death,
依據上圖 C，Bcl-2 及 Bax 互相獨立運作，各自造成存活或死亡
respectively (look C in the figure).

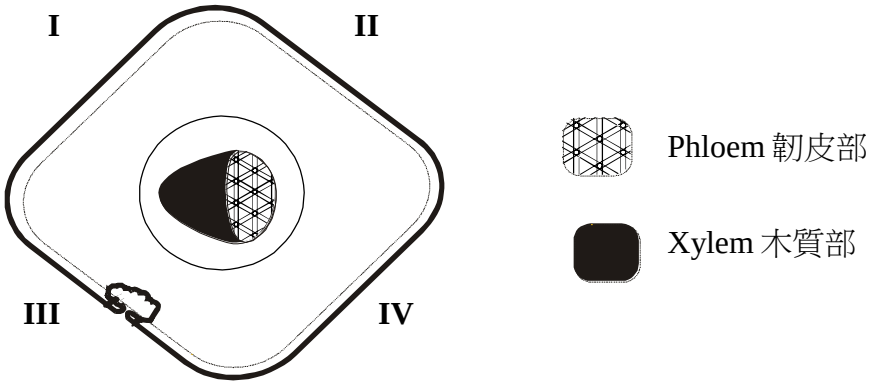
D. Bcl-2 protein blocks inhibitory action of Bax protein on apoptosis
依據上圖 D，Bax 會抑制細胞凋亡，而 Bcl-2 蛋白質會抑制 Bax。
(look D in the figure).

<u>Plant anatomy and physiology</u> (10 questions, 12 points).
植物解剖及生理 (10 題, 12 分)

A15. (1 point). If vascular system of the plant tendril is represented by the only one closed collateral bundle, metamorphosis of which organ is the tendril?
若植物的捲鬚中之維管束系統僅有單一個並列維管束，則捲鬚是何種器官的變態?

A. Shoot. 地上莖部
B. Leaf. 葉
C. Stem. 莖
D. Root. 根
E. Impossible to determine. 無法辨別

A16. (1 point). The scheme of a transverse microscopic section of a spruce needle leaf is presented. By which number is the upper surface of the leaf marked?
下圖所示為一松樅的針葉之橫切面，哪個羅馬數字所代表的區域是葉子的上表面?



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

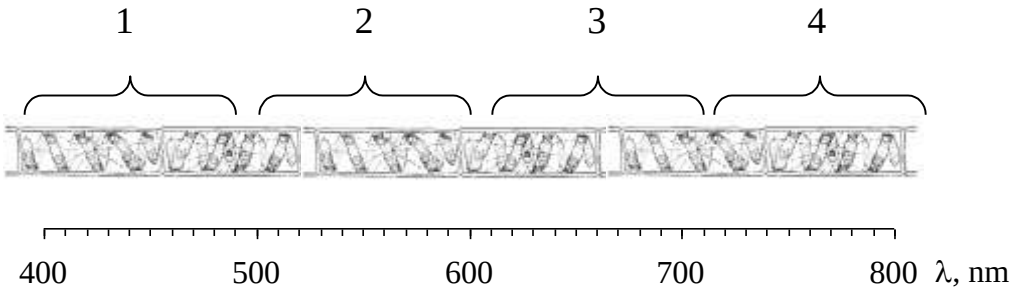
A17. (1 point). Endosperm of conifers develops from:
松柏類種子內的「胚乳」(營養組織)之發育來源是
A. The central nucleus in the result of double fertilization.
極核經由雙重授精之結果
B. The ovule after fertilization.
胚珠受精後的結果
C. The megaspore before fertilization.
大孢子受精前的衍生細胞
D. The megaspore after fertilization.
大孢子受精後的衍生細胞
E. The megasporangium cells before fertilization.
受精前的大孢子囊細胞

A18. (1 point). Which compounds are the main substrates for growth of xylophilous fungi 刪除!!
(accomplishing decomposition of wood), which elicit white (1) and brown (2) rot?

	1.	2.
A.	Cellulose.	Suberin.
B.	Cellulose.	Lignin.
C.	Lignin.	Cellulose.
D.	Suberin.	Cellulose.
E.	Pectin	Hemicellulose.

A19. (1 point). Compare pH of cytosol (1), chloroplast stroma (2) and inside thylakoid (3) of
比較植物細胞的細胞質(1)、葉綠體基質(2)及葉綠餅內部(3)在照光下之
plant cells under the light:
酸鹼值高低
A. 1>2>3.
B. 1>3>2.
C. 2>1>3.
D. 2>3>1.
E. 3>1>2.

A20. (1 point). Spirogyra trichomes were placed in the media, in which strict aerobic bacteria
培養基中有水綿絲狀體，再放入已經在無氧狀態下培養一段時間之
were incubated without access of oxygen for some time. Then part of the spirogyra
全好氧性的細菌， 然後在水綿絲狀體上
filament was lightened with a thin beam, which passed through the prism for obtaining
照射通過三稜鏡之不同波長的光(如下圖)
a spectrum (see figure below).



In which part of the filament will the greatest concentration of bacteria be observed?
在水綿絲狀體上，哪些段有最多細菌聚集?

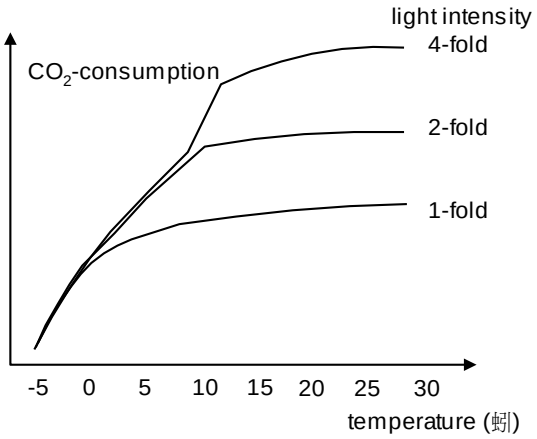
A. 1,3.
B. 1,4.
C. 2,3.
D. 2,4.
E. 3,4.

A21. (2 points). The plants of corn wild type was compared with the mutant corn variety 野生型玉米與突變型(其 Rubisco"雙磷酸核酮糖 化酶"不能進行氧化反應)相比較，whose Rubisco is not able to catalyze an oxygenation reaction. Which of the following statements is correct regarding the photosynthetic capacity under same temperature 下列關於二者在相同溫度下之光合作用能力之比較以及其原因的敘述，何者正確? condition between this mutant corn and the wild type whose Rubisco function is normal and why would it be correct ?

	Photosynthetic capacity of the mutant 突變型的光合作用能力	**Reason** 原因
A.	It would show much lower capacity compared to the wild type. 其能力較野生型低	Rubisco in the bundle sheath cell loses its oxygen fixation capacity. 維管束鞘細胞中的Rubisco失去固定氧氣的能力
B.	It would show much lower capacity compared to the wild type. 其能力較野生型低	Rubisco in the bundle sheath cell loses its carbon dioxide fixation capacity. 維管束鞘細胞中的Rubisco失去固定二氧化碳的能力
C.	It would show much higher capacity compared to the wild type. 其能力較野生型高	Since mesophyll cells photorespire, photosynthetic capacity of the mutant would not be affected by this mutation. 由於葉肉細胞可進行光呼吸，故突變型之光合作用能力不受到影響
D.	It would show the same capacity as the wild type. 其能力與野生型相同	Since mesophyll cells photorespire, photosynthetic capacity of the mutant would not be affected by this mutation. 由於葉肉細胞可進行光呼吸，故突變型之光合作用能力不受到影響
E.	It would show the same capacity as the wild type. 其能力與野生型相同	Since CO_2 concentration in the bundle sheath cells is high enough, both wild type and mutant corn do not photorespire. 由於維管束鞘細胞內的二氧化碳濃度夠高，野生型及突變型不進行光呼吸

A22. (2 points). Photosynthesis in plants is dependant on temperature (T) and light intensity 植物的光合作用與溫度(T)及光強度(L)有關。(L). The following graphs show the results of measurements of CO_2 consumption with 以下的圖代表相同物種的三株植物在不同光強度(light intensity)下，three plants of the same species under different light intensities. Which of the factors are 二氧化碳消耗量(CO_2 consumption)之曲線。

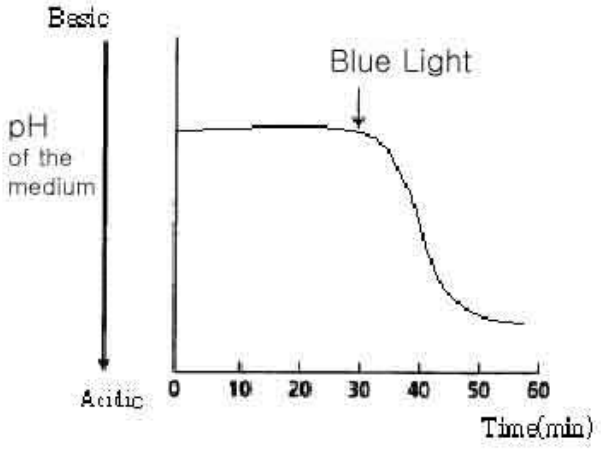
limiting in the temperature regions from –5 ℃ to 0℃ and from +20 ℃ to + 30℃?
下列何者是兩個溫度範圍(–5 ℃ ~ 0℃、+20 ℃ ~+ 30℃)受到限制的因素?



	Temperature region from –5 to 0℃ 溫度範圍(–5 ℃ ~ 0℃)	**Temperature region from +20 to +30℃ 溫度範圍(+20 ℃ ~+ 30℃)**
A.	T and L limiting factor. 溫度及光強度皆是限制因素	T and L not limiting factor. 溫度及光強度皆不是限制因素
B.	T limiting, L not limiting. 溫度是限制因素，光強度不是	T not limiting, L limiting. 光強度是限制因素，溫度不是
C.	T limiting, L not limiting. 溫度是限制因素，光強度不是	T limiting, L not limiting. 溫度是限制因素，光強度不是
D.	T not limiting, L limiting. 光強度是限制因素，溫度不是	T limiting, L not limiting. 溫度是限制因素，光強度不是
E.	None of the above combinations is correct 以上皆非	

A23. (1 point). Following is a result of the experiment which uses guard cell protoplasts of
以下是利用 *Vicia faba* 植物之保衛細胞內的原生質體進行實驗的結果
***Vicia faba*. Protoplasts were incubated in the suspension medium with corresponding**
此原生質體置於懸浮液中，在適當滲透壓下培養
osmotic pressure. After 30 min under saturating fluence rate of red light they were
在充足紅光照射 30 分後，
irradiated with blue light for 30 sec. While the experiment the pH of the medium were
再暴露於藍光 30 秒， 記錄培養基中的酸鹼值隨時間之變化。
the protoplast was cultured was monitored.

圖中縱軸上方為鹼性、下方為酸性



What would be the most plausible conclusion based on the above result?
根據上圖結果，下列何者為較適當的結論?

A. Blue light may help guard cells to take up protons outside into the cell.
藍光可幫助保衛細胞自細胞外獲得質子，進入細胞中
B. Blue light may enhance guard cells to pump protons out of the cell.
藍光可促進保衛細胞將質子送出細胞
C. Blue light may be a very effective light for the respiration of the guard cells.
藍光在保衛細胞之呼吸作用是非常有效的光
D. Blue light may activate all of the protoplasts give away their energy.
藍光可激發所有的原生質體釋出其能量
E. Not only blue light but also other light with different wavelengths may help guard cells to transfer protons.
藍光以及其他波長的光皆有助於保衛細胞轉移質子

A24. (1 point). If an oats coleoptile deprived of epidermis is placed into physiological solution with pH = 5,0, relatively fast lengthening occurs. The action of which hormone does this experiment imitate?
若將一個去除表皮的燕麥芽鞘置於 pH = 5 的生理溶液中培養，它將伸長得較快，此實驗是因為何者荷爾蒙的作用?

A. Auxin.
生長素
B. Gibberellin acid.
吉貝素
C. Cytokines.
細胞分裂素
D. Ethylene.
乙烯
E. Abscisin.
離素 (ABA)

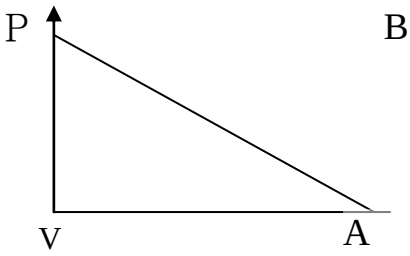
<u>Animal Anatomy & Physiology</u> (9 questions, 11 points).
動物解剖及生理學（九題，共 11 分）

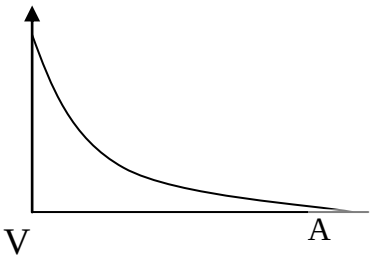
A25. (1 point). In what animals the volume of the lungs is relatively constant during all the steps of ventilation ?
下列哪一類動物在換氣過程的各不同階段中，其肺容量的變化十分輕微?

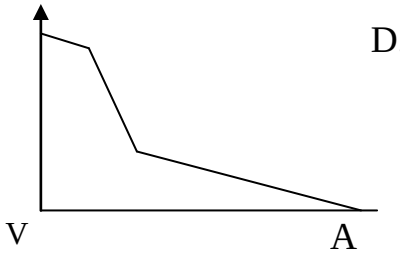
A. In insects.昆蟲
B. In birds.鳥類
C. In mammals.哺乳類
D. In reptiles.爬蟲類

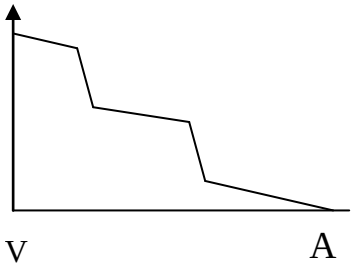
A26. (1 point). How does the pressure change during the blood passage via the blood circulatory system from the ventricle to atrium in fishes?
下列哪一個圖表能夠顯示魚類循環系統中血液由心室流向心房時的壓力變化？

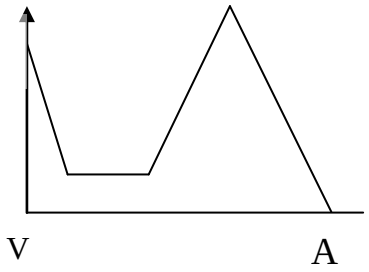
A - Atrium.心房
V - Ventricle.心室
P - Pressure.壓力

A.


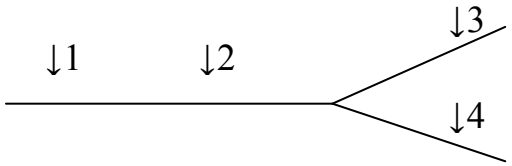
B.


C.


D.


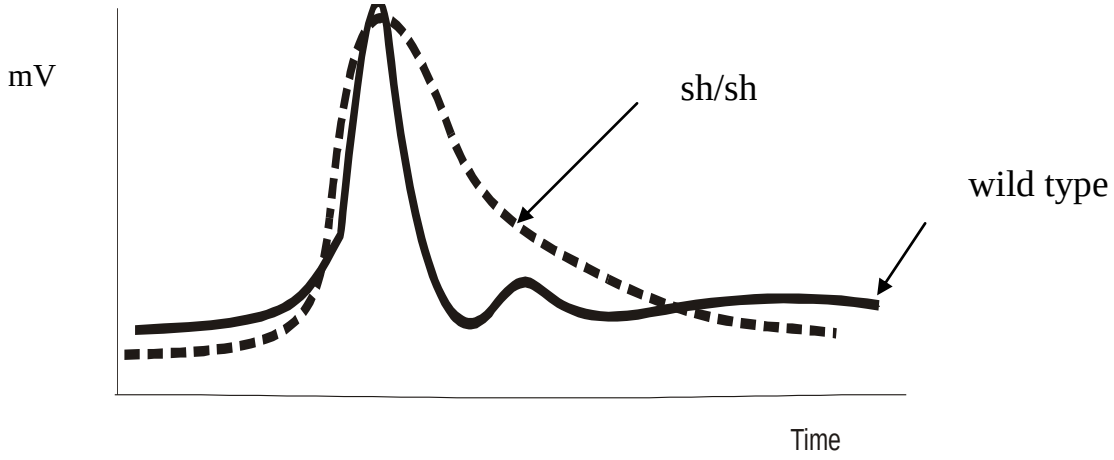
E.


A27. (1 point). A branched axon is stimulated at the site '1' (see figure below). The excitement 下圖描述的是一個軸突的分支，自位置**'1'**給予一電流刺激，其傳導方向先
transferred from site '1' to '2' and then to '3' and '4'. The excitement is measured in 向**'2'**，然後再到**'3'**及**'4'**。在這些位置測量此刺激，下列這些位置所測得的
these sites. Which comparison of the impulse frequencies (I) measured at these sites is 神經衝動頻率**(I)**大小的比較何者為真？
correct?



A. I(1) > I(2) > I(3), I(3) = I(4), I(3) + I(4) = I(2).
B. I(1) > I(2) > I(3), I(3) = I(4), I(3) x I(4) = I(2).
C. I(1) < I(2) < I(3), I(3) = I(4).
D. I(1) = I(2) > I(3), I(3) = I(4), I(3) + I(4) = I(2).
E. I(1) = I(2) = I(3) = I(4).

A28. (1 point). *Drosophila* flies homozygous for the *shake* mutation are extremely sensitive to 果蠅在***振動***的同型合子突變對乙醚非常敏感，會引起該個體痙攣。
diethyl ether which causes convulsions in homozygous individuals. Convulsions are 此痙攣是因為神經衝動的傳導不正常所引起（見下圖），在***振動***突變的個體中，下列
caused by abnormalities in nerve impulse conduction. (see graph below). Function of 何者無法發揮正常功能？
which structures is impaired in the *shake* mutations?



A. Na^+ -chanals.鈉離子通道

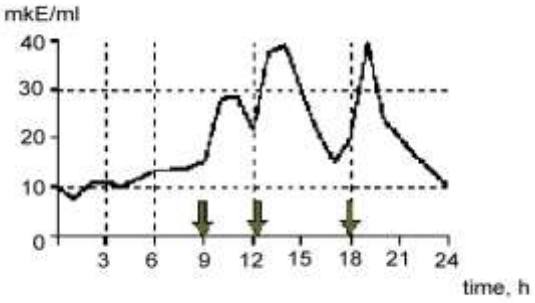
B. K^+ -chanals.鉀離子通道

C. Ca^{2+} -chanals.鈣離子通道

D. K^+/Na^+ -ATPase. . K^+/Na^+ -ATP 酶

E. H^+ -pump.氫離子泵

A29. (1 point). Daily changes in the concentration of which hormone are represented on
下圖可代表何種荷爾蒙在一天中的濃度變化？
the following graph?



Arrows indicate the time of food consumption.
箭頭代表進食的時間

A. Thyroxin.甲狀腺素

B. Glucagon.昇糖素

C. Insulin.胰島素

D. Cortisol.葡萄糖皮質素

E. Parathormone.副甲狀腺素

A30. (1 point). Thyreoiditis is an autoimmune disease, which is caused by hyperfunction of
甲狀腺炎是一種自體免疫疾病，是由甲狀腺亢進所引起。
thyroid gland. TSH (thyroid stimulation hormone) concentration is below normal in the
病人血液中的 **TSH**（促甲狀腺素）濃度比正常人低，當抗體結合在荷爾蒙上時會抑
blood in this disease. Antibody binding to hormone may block or activate them.
制或激活此荷爾蒙，此疾病的原因是由於自體免疫抗體結合在下列那一個位置上？
The cause of this disease is the binding of autoimmune antibodies to:

A. Thyroxin receptors.
甲狀腺素的受器
B. Thyroxin.
甲狀腺素
C. TSH receptors.
TSH 的受器
D.TSH.

E. Thyreoliberin receptors.
促甲狀腺素釋放素的受器

A31. (3 points). There are two recessive mutations ob^- and db^- in mice. These mutations cause
老鼠有 **ob^-** 及 **db^-** 兩種隱性突變，此二突變可導致相同的外表型：肥胖、
the same phenotype: obesity, adipose tissue hypertrophy and predisposition to obesity
脂肪組織肥厚以及出現與肥胖相關疾病的因子（高血壓、生理性糖尿病…等），

related diseases (hypertension, physiological diabetes insipidus and so on). The
此二突變無聯鎖現象，
mutations are not linked. Three experiments of parabiosis (surgically joining blood
有三種以手術方式連結二不同基因型老鼠的血液循環系統使神經活動暫停的實驗，
circulation systems of two mice with different genotypes) were carried out to define roles
可用來界定這二基因產物在體重調控上所扮演的角色。
of the products of these genes in weight regulation.

Two weeks after the parabiosis the weight of each mouse was determined (see table).
在手術兩週後測量老鼠的體重（見下表）

	ob^-/ob^- + wt^+		db^-/db^- + wt^+		ob^-/ob^- + db^-/db^-	
Weight 體重	**Loss of weight 減輕**	**Without changes 不變**	**Without changes 不變**	**Loss of weight 減輕**	**Loss of weight 減輕**	**Without changes 不變**

A31.1. (1 point). Define the product of the *ob* gene:
下列何者是 ***ob*** 基因的產物？

A. Peptide hormone favouring to obesity.
偏向產生肥胖的多肽類荷爾蒙
B. Peptide hormone favouring to loss of weight.
偏向使體重減輕的多肽類荷爾蒙
C. Hormone receptor favouring to obesity.
偏向產生肥胖的荷爾蒙受器
D. Hormone receptor favouring to loss of weight.
偏向體重減輕的荷爾蒙受器
E. Nonpeptyde hormone favouring to obesity.
偏向肥胖的非多肽類荷爾蒙

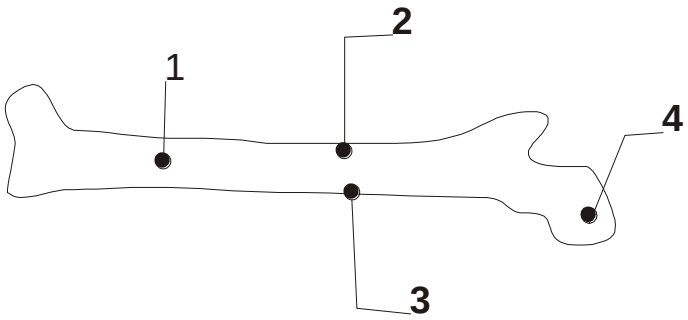
A31.2. (1 point). Define the product the *db* gene:
下列何者是 ***db*** 基因的產物？

A. Peptide hormone favouring to obesity.
偏向產生肥胖的多肽類荷爾蒙
B. Peptide hormone favouring to loss of weight.
偏向使體重減輕的多肽類荷爾蒙
C. Hormone receptor favouring to obesity.
偏向產生肥胖的荷爾蒙受器
D. Hormone receptor favouring to loss of weight.
偏向體重減輕的荷爾蒙受器
E. Nonpeptyde hormone favouring to obesity.
偏向肥胖的非多肽類荷爾蒙

A31.3. (1 point). What segregation by phenotype will be seen in F_2 after interbreeding of
將帶有 *ob*$^-$ / *ob*$^-$ 及 *db*$^-$ / *db*$^-$ 基因型的個體交配後，其 F_2 的外表型會出
individuals with the genotypes *ob*$^-$ / *ob*$^-$ and *db*$^-$ / *db*$^-$?
現下列何種比率？

A. 9:3:3:1.
B. 9 :7.
C. 15:1.
D. 1:2:1.
E. 3:1.

A32. (1 point). If four golden rods are implanted into a tibia-bone of a newborn rat (as it is
將四個小金棒植入新生鼠的脛骨中（如下圖），下列何者間的距離會隨
shown on a figure), distances between which rods will be altered with growth?
著老鼠的生長而改變？



A. 1 and 2.
B. 2 and 3.
C. 3 and 4.
D. 3 and 1.

A33. (1 point). Quick movement of the individuals of genus *Dryocopus* (wood-pecker) on tree
trunks is enabled thanks to the fact that:

A. All its leg fingers are directed forward.

B. Two its leg fingers are directed forward and two leg fingers are directed to the back.

C. Three its leg finger are directed forward and one leg finger is directed to the back .

D. One its leg finger is directed forward and three leg fingers are directed to the back.

A34. (1 point). The major difference between humoral immunity and cellular mediated immunity
抗體免疫體液性免疫及細胞性免疫的主要差別為何？
is that:

A. Humoral immunity is non-specific, whereas cellular mediated immunity is specific for particular antigen
. 體液性免疫無專一性，而細胞性免疫對特定抗原有專一性。
B. Only humoral immunity is a function of lymphocytes
只有體液性免疫有淋巴球的參與。

C. Humoral immunity cannot function independently; it is always activated by cellular mediated immunity.
體液性免疫不能獨立作用，均需經細胞性免疫所活化。

D. Humoral immunity acts against free-floating antigens, whereas cellular mediated immunity works against pathogens that have entered body cells.
體液性免疫用來對抗自由流動的抗原，而細胞性免疫用來對抗進入細胞的病原體。

E. Only humoral immunity displays immunological memory.
只有體液性免疫能表現免疫的記憶性。

Ethology (2 questions, 2 points).
動物行為學（二題，共 2 分）

A35. (1 point). In what case so called conditioning (Pavlovian) will be optimal:
下列何種情況用來稱呼條件反應（巴夫洛夫式）最為適當？

A. If unconditional stimulus is delivered before conditional stimulus and unconditional stimulus is stronger than conditional stimulus.
若非條件性刺激給在條件性刺激之前，非條件性刺激較條件性刺激為強。

B. If unconditional stimulus is delivered before conditional stimulus and unconditional stimulus weaker than conditional stimulus.
若非條件性刺激給在條件性刺激之前，非條件性刺激較條件性刺激為弱。

C. If conditional stimulus is delivered before unconditional stimulus and conditional stimulus is stronger than unconditional stimulus.
若條件性刺激給在非條件性刺激之前，條件性刺激較非條件性刺激為強。

D. If conditional stimulus is delivered before unconditional stimulus and conditional stimulus weaker than unconditional stimulus.
若條件性刺激給在非條件性刺激之前，條件性刺激較非條件性刺激為弱。

A36. (1 point). The cuckoo (*Cuculus canorus*) and its hosts is a well studied system of coevolution as a long never ending process. A cuckoo population is parasitising, i.e. laying its eggs in the nest of small passerines (*Passeriformes*). The cuckoo and its hosts have adopted different behaviours that result from the coevolution between them.
杜鵑（學名為 *Cuculus canorus*）和其托卵對象的共同演化系統已被持續地廣為研究。杜鵑族群的托卵行為就如下蛋於小燕雀（***Passeriformes***）的巢中，杜鵑及其托卵對象彼此適應的各種行為是二者間共同演化的結果。

Which of the following statements (A – E) are true?
下列敘述何者正確，請用Ａ－Ｅ表示？

1. The hosts are laying their eggs in the afternoon.
   其托卵對象在下午生蛋
2. The cuckoo eat ant eggs.
   杜鵑吃掉螞蟻蛋
3. The host is aggressive towards a cuckoo.
   其托卵對象會攻擊杜鵑
4. The cockoo´s eggs are not mimetic to the host´s eggs.
   杜鵑的蛋不會擬似其托卵對象的蛋
5. The cuckoo is aggressive towards a host.
   杜鵑會攻擊其托卵對象
6. The cuckoo tries to avoid being seen in the host nest.
   杜鵑會嘗試躲在其托卵對象的巢中不被發現

A. 3 and 6.
B. 4 and 6.
C. 2 and 3.
D. 1 and 5.
E. 4 and 2.

Genetics (8 questions, 9 points).
遺傳學（八題，共 9 分）

A37. (1 point). In birds, for instance chickens, sex is determined by a combination of sex chromosomes Z and W. At an early age it is difficult to determine their sex. However, it is commercially very important to distinguish males and females at this age. Using genetic marker, it is possible to conduct such crosses that sex will be determined by phenotypic expression of a marker gene. In what chromosome must the marker gene (I) be located and which crossing allows to separate the males from females (II)? Find the right combination.

在鳥類中（例如：雞），性別是由性染色體Z和W的組合來決定。在過去很難鑑別牠們的性別，但是在現今，就商業上而言，能區分牠們的性別是十分重要的。使用基因標示（genetic marker），我們可以用「標示基因」（marker gene）的表現性狀來鑑定性別。請問(I)此一標示基因應位於哪一條染色體上？(II)哪種雜交類型可區辨雌雄？

	Marker gene localization (I) 標示基因的位置(I)	**Crossing type (II)** 雜交類型(II)
A.	In Z chromosome. Z 染色體上	Female with recessive phenotype is crossed with a male homozygous for domitant allele. 隱性 X 顯性同型合子
B.	In W chromosome. W染色體上	Female with recessive phenotype is crossed with a male homozygous for domitant allele. 隱性♀ X 顯性同型合子♂
C.	In Z chromosome. Z 染色體上	Female with domitant phenotype is crossed with a male homozygous for recessive allele. 顯性♀ X 隱性同型合子♂
D.	In an autosome. 體染色體上	Female with recessive phenotype is crossed with a male heterozygous. 隱子♀ X 異型合子♂
E.	In Y chromosome. Y 染色體上	Female with domitant phenotype is crossed with a male heterozygous. 顯性♀ X 異型合子♂

A38. (1 point). a*bcde* genes are closely linked on the *E. coli* chromosome. Short deletions within this region led to the loss of some genes. For example:

a*bcde* 基因聯鎖在大腸桿菌（***E. coli***）染色體上，而且非常靠近。這個區域的缺失將導致部分基因的喪失，例如：

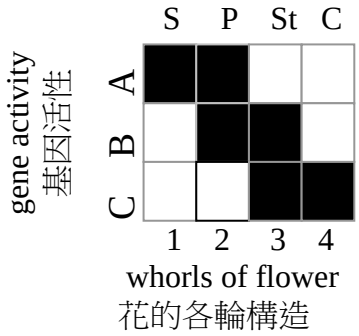
deletion 1 – *bde* genes
缺失 1－*bde* 基因
deletion 2 – *ac* genes
缺失 2－*ac* 基因
deletion 3 – *abd* genes

缺失 3－*abd* 基因

What is the gene order on the genetic map of the *E. coli* chromosome?
請問這些基因在染色體上的排列順序為何？

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

A39. (2 points). According to the model proposed for floral organization, each whorl is determined by unique combination of three genes, namely, A, B and C.
根據花朵的構造模式，每一輪構造都是由 A、B、C 三個基因的特殊組合來決定。
It has been shown that genes A and C mutually repress each other. Expression pattern of these genes in the wild type flowers is shown below.
Ａ與Ｃ基因會互相抑制。野生型花朵的基因表現類型如下圖所示：



S: sepal formation 萼片形成
P: petal formation 花瓣形成
St: stamen formation 雄蕊形成
C: carpel formation 心皮形成

A39.1. (1 point). The morphology of flower that lacks the functional gene A will be:
缺乏「有作用Ａ基因」的花，其形態應為如何？

A. **－ － St C**
1 2 3 4

B. **C St St C**
1 2 3 4

C. **C P P C**
1 2 3 4

D. **－ P St C**
1 2 3 4

A39.2. (1 point). The whorls of a flower that lacks the functional gene C will be:
缺乏「有作用 C 基因」的花，其形態應為如何？

A. | C | P | St | P |
   | 1 | 2 | 3 | 4 |

B. | – | – | – | C |
   | 1 | 2 | 3 | 4 |

C. | S | P | P | S |
   | 1 | 2 | 3 | 4 |

D. | S | P | St | – |
   | 1 | 2 | 3 | 4 |

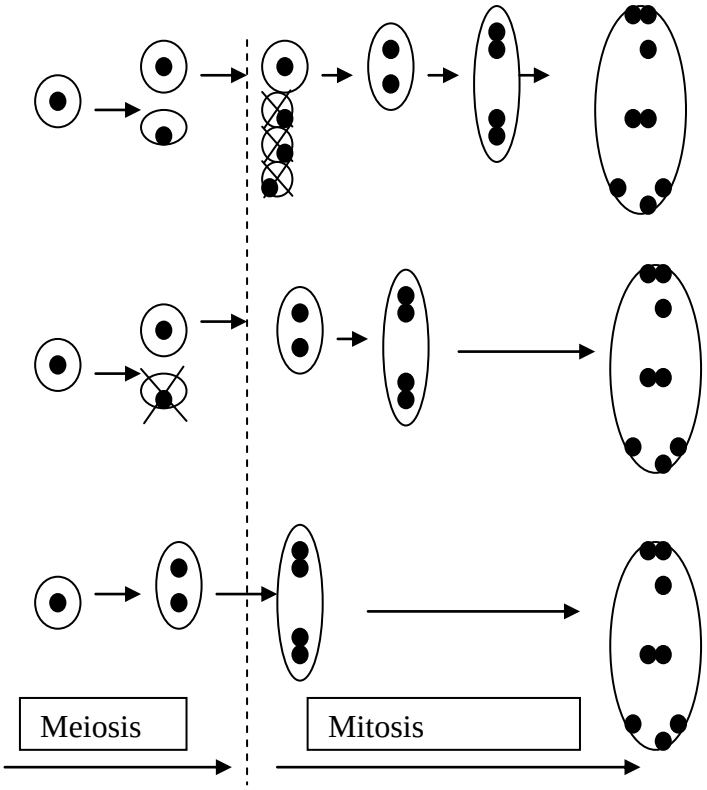
A40. (2 points). Colour of the plant endosperm is determined by a single gene located in the (刪除)
centromere region. Expression of this gene takes place only in the cells of endosperm.

Experiment 1. Inbred plant line with coloured endosperm (CE) was pollinated by the pollen of inbred plant line with colourless endosperm (CLE). F_1 seeds were with coloured endosperm.

Experiment 2. After pollination of F1 plants with pollen of CLE line all F2 seeds were with coloured endosperm as well.

Experiment 3. After pollination of F2 plants with pollen of CLE line 50% of plant gave seeds were with coloured and 50% with colourless endosperm.

A40.1. (1 points). According to the results of three experiments, determine which (刪除)
type of embryo sack is typical for this plant species?



A. Monosporical.

B. Bisporical.

C. Tetrasporical.

A40.2. (1 point). What ratio of seeds with coloured and colourless endosperm would be (刪除)
observed in experiment 2, if the gene of colouration of endosperm were located in >50 cM distance from centromere?

A. 3:1.
B. 1:3.
C. 7:1.
D. All with coloured endosperm.

E. All with colourless endosperm.

A41. (1 point). In humans PKU (phenylketonuria) is a disease caused by an enzyme
人類苯酮尿症（PKU）是因下述反應中，催化步驟 A 的酵素異常
inefficiency at step A in the following simplified reaction sequence, and AKU
所致，而黑尿症（AKU）則是由於催化步驟 B 的酵素異常所造成：
(alkaptonuria) is due to an enzyme inefficiency in one of the steps summarized as step B here:

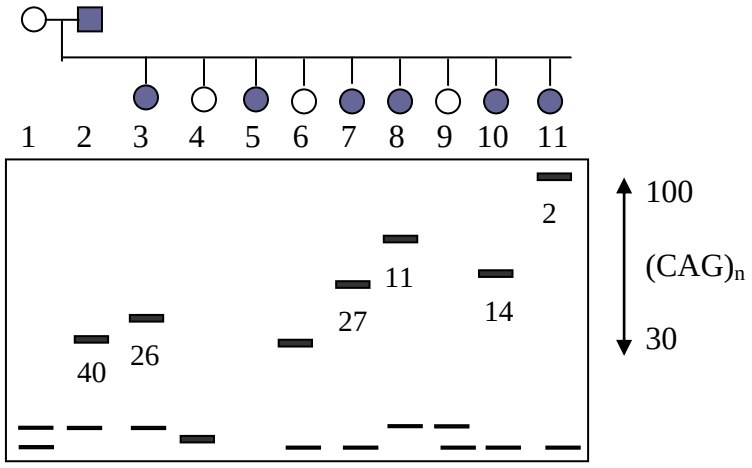
Phenylalanine $\xrightarrow{A}$ tyrosine $\xrightarrow{B}$ $\longrightarrow$ $\longrightarrow$ $CO_2 + H_2O$
苯丙胺酸　　酪胺酸

A person with PKU marries a person with AKU. What are the expected phenotypes for
一位苯酮尿症（PKU）患者與黑尿症（AKU）患者結婚，他們小孩的表現型將是如何？
their children? Note: both diseases (PKU and AKU) are not sex linked. Both parents are not
注意：這兩種疾病都不是性聯遺傳，雙親都不是異型合子。
heterozygous.

A. All will be ill.
全都有病
B. All children will be normal
全都正常
C. A half of their children will have PKU, but another half will be normal.
一半患有苯酮尿症，另一半正常
D. A half of their children will have AKU, but another half will be normal.
一半患有黑尿症，另一半正常

A42. (1 point). The figure shows the results of electrophoresis of PCR-amplified DNA
下圖為一家庭成員的 DNA 經 PCR(聚合酶連鎖反應)放大並跑電泳後
fragments obtained from members of a single family: mother (1), father (2) and 9
的結果。該家庭有母親(1)、父親(2)以及 9 個小孩，父親與其中的 6 個小孩
children. Father and 6 children (3, 5, 7, 8, 10, 11) in this family have symptoms of
(3、5、7、8、10 及 11)有享丁頓舞蹈症的症狀。 父親在 40 歲後首次出現症狀，
Huntington disease (HD). Father first showed symptoms of the disease after he was 40
小孩出現症狀的年齡標示在下圖相對應的 DNA 片段下方。請問第 4、第 6 及第 9 號
years, the onset age of the disease in children is shown in the figure near
小孩也有病的可能性是如何？
corresponding DNA fragments. What is the probability of 4th, 6th and 9th child in

this family falling ill with the disease?



A. Child 4 and child 9 are healthy and will never develop the Huntington disease,
第 4 號和第 9 號小孩是健康的，而且不會有舞蹈症，但是第 6 號小孩
whereas child 6 has high probability of developing the disease.
有很高的可能性會發病。
B. Short PCR fragments correspond to appearance of HD at an early age.
PCR 片段愈短，發病年齡愈早。
C. Child 4, child 6 and child 9 have all chances to develop HD at an older age.

第 4、第 6 以及第 9 號小孩都有可能在較大年齡時發病

D. There is no correlation between the age of children with disease symptoms and the rate of migration of PCR-amplified fragments.
發病年齡與 PCR 電泳結果沒有相關性

E. Huntington disease is an infectious disease therefore most children of the family must be ill.
享丁頓舞蹈是傳染病，所以大部分小孩都會染病

A43. (1 point). The long corona of tobacco is inherited as a recessive monogenic characteristic. If in a natural population 49% of plants have long corona, what is the probability that the result of test crossing plants with shot corona from this population in F_1 it will be uniformity of progeny?

菸草的長花冠筒是單基因隱性遺傳，如果在自然族群內 49%的植物有長花冠筒，則以此族群的短花冠植物進行試交後，子代性狀都相同的機率是多少？

A. 82,4 %.
B. 51 %.
C. 30 %.
D. 17,7 %.
E. 42 %.

A44. (1 point). In a genetically balanced population alleles T and t are featuring. 51 % of the individuals show the dominant phenotype. Suddenly the living conditions are changing causing death of all recessive individuals before they reach maturity. After this, conditions return to normality. What will be the frequency of allel t after one generation?

探討一遺傳平衡族群內的對偶基因 T 與 t ，51%的個體是顯性。突然，環境改變了，使所有隱性個體在成熟前都死亡，然後，環境如恢復正常。則一代之後 t 的基因頻率將是多少？

A. 0.41
B. 0.3
C. Impossible to determine.無法判斷
D. 0.7
E. 0.58

A45. (1 point). On land the process of evolution proceeds faster than in the sea, because:

陸地上演化的速度比海裡快是因為

A. Life started in the sea.
生命源自海底

B. Selection pressure is higher in the sea so surviving is more difficult.
海裡的天擇壓力較大，因此生存較為困難

C. More fossils are found in depositions of the sea.
海裡沈積物內化石較多

D. Living conditions in the sea are more stable.
海裡的生活環境較穩定

A46. (1 point). The phenomenon of reduction in organism complexity during the process of (删除)
evolution is called:

A. Biological regress.

B. General degeneration.

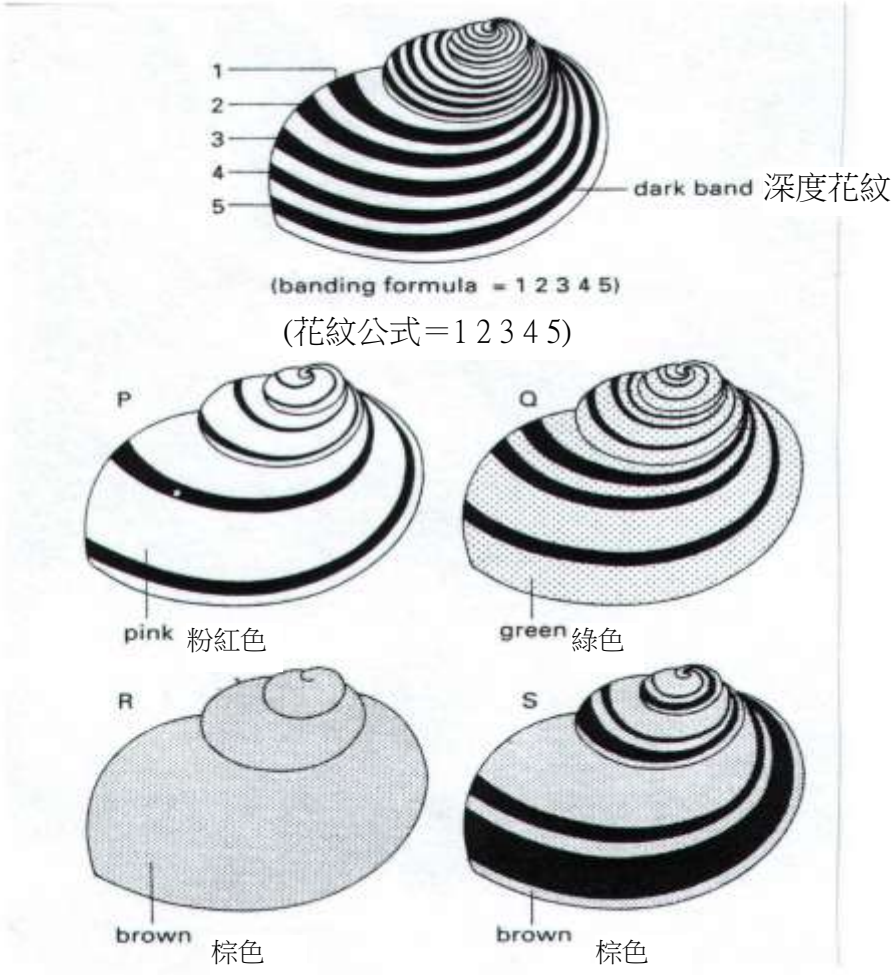
C. Idioadaptation.

D. Aromorphosis.

E. Disjunction.

<u>Ecology</u> (8 questions, 10 points).
生態學（八題，共 10 分)

A47. (3 points). The shell of the land snail shows variation in both colour and banding
蝸牛殼在顏色及花紋上都有差別，可建構一公式來加以敘述，
pattern. In order to construct a 5-figure banding formula, bands are numbered
以具有 5 條花紋的殼而言，其花紋數目由最上面開始算起，
from the top of the largest whorl, as shown in the diagram. '0' is used to represent
若缺少某一條特定花紋
the absence of a band and square brackets indicate the fusion of two bands.
就用**'0'**來表示，如果二條花紋合成一條就將此二數字括弧起來。



<u>A47.1.</u> (1 point). Using the appropriate letter, indicate the banding formula of shell S.
上圖中殼 S 的花紋公式為

A. 030[45].
B. 03045.
C. 02045.
D. 003[45].

<u>A47.2.</u> (1 point). Thrushes (which have good colour vision) smash the shells of land
畫眉鳥會覓食蝸牛，假如草原中的蝸牛 P、Q、R、S 為等量，鳥會最
snails against stones (anvils) in order to feed on the soft inner body. If snail types
容易吃到哪一種蝸牛？

P, Q, R and S began in equal numbers in a habitat of grassland, which would be the most popular among birds?

A. P.
B. Q.
C. R.
D. S.

A47.3. (1 point). A survey of broken shells collected from thrush anvils amongst dead beech leaves in a woodland area was carried out. Predict which of the following sets of results was obtained. Marked the correct option.

在森林中的枯葉上收集破碎的殼，請問哪一個答案是最可能的結果？

	Broken shells of each type (%) 不同蝸牛之破碎殼(%)			
	P	Q	R	S
A.	13	33	1	5
B.	11	1	34	6
C.	5	1	14	32
D.	6	21	20	5

A48. (1 point). Which of the following statements, referring to the process of ecological succession, are correct?

下列有關於生態演替(消長)的敘述何者是正確的？

1. Nutrient availability generally increases.
   養分的供應會逐漸增加
2. Species diversity decreases as the process proceeds.
   物種歧異度(多樣性)逐漸減少
3. A new group of plant species achieves dominance over time and ousts the previous species.
   新的一群植物會取代前一批植物，而成為優勢種
4. The height and biomass of the vegetation usually increases as the process proceeds.
   植被的高度和生物量會逐漸增加
5. Each group of species modifies the habitat making it more favourable for other species.
   每一群物種會改變環境，讓棲息地更適合其他的物種

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

A49. (1 point). Which matching of factors influencing the growth of a population is correct?
下列影響族群生長之二因子，哪一個答案的組合是正確的？

	Factors depending on the population's density. **與族群密度有關的因子**	**Factors independent on the population's density.** **與族群密度無關的因子**
A.	Development of territories, cannibalism. 領域和同類相食現象	Wind, parasites, light. 風、寄生、光
B.	Migration, amount of food. 遷移、食物量	Temperature, crowding factor. 溫度、擁擠因子
C.	Development of territories, temperature. 領域、溫度	Humidity, wind, light. 濕度、風、光
D.	Crowding factor, light. 擁擠因子、光	Wind, quality of the soil. 風、土壤品質
E.	Parasites, predators. 寄生、捕食	Quality of the soil, humidity. 土壤品質、濕度

A50. (1 point). A typical feature of the climax stage of an ecological succession is:
生態演替的極相（巔峰）群集的典型特性為

A. The ecosystem is very stabile
生態系非常穩定
B. The increasing of the biomass is at its highest.
生物量的增加速率會最快
C. The number of plant and animal species is continually increasing rapidly.
動植物種類的數目持續快速增加
D. The net production of the ecosystem has remarkable but regular differences from year to year.
年和年之間，生態系的淨生產量會有顯著而規則性的差別

A51. (1 point). In ecological pyramids normally every higher trophic level is smaller. Possible exceptions leading to inverted pyramids are:
在生態塔中，通常高階者較少。導致生態塔上下顛倒的可能例外為

I. A pyramid of numbers with one big producer.
具有一個巨大生產者的個體數塔
II. A pyramid of mass when producers have a very short lifecycle.
生產者的生活週期非常短的生物量塔
III. A pyramid of energy in extreme hot ecosystems.
極端炎熱的生態系之能量塔

What is correct?
何者正確？

A. Only I and II.
只有 I 和 II.
B. Only II and III.
只有 II 和 III

C. Only I and III.
只有 I 和 III.
D. I, II and III.
全部
E. None of these.
三者皆非

A52. (1 point). You and your family are stranded on a remote island with one cow and a large stock of wheat for cow feed. To obtain the highest amount of energy and survive for the longest period of time, you should:

你和家人困在一孤島上，有一頭牛及大量的小麥，如要獲取最大能量並存活最久，你必須：

A. Feed the wheat to the cow, then drink the milk.
用小麥餵牛，然後喝牛奶
B. Eat the cow, then eat the wheat.
先吃掉牛，再吃小麥
C. Feed the wheat to the cow, drink the milk, then eat the cow.
用小麥餵牛，喝牛奶，再吃掉牛
D. Drink the milk, eat the cow when milk production ceases, than eat the wheat.
先喝牛奶，至牛不再產奶時吃掉牛，最後吃小麥。

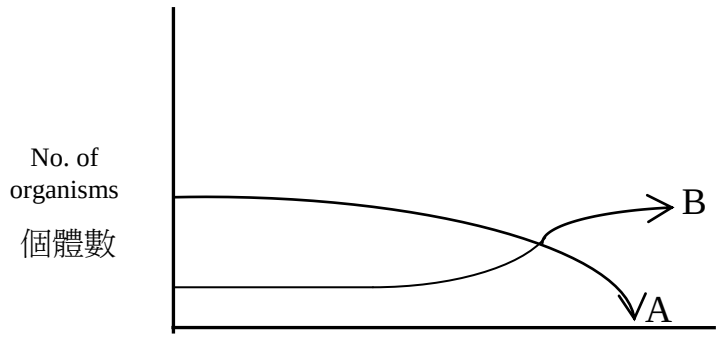
A53. (1 point). If an area has a total of energy K in the sunlight available, the net energy productivity of the fourth trophic level in the area is roughly:

假如某地區可用的日光量為K，則生態塔中第四層營養層的能量淨值大約為：

A. $10^{-3} \times K$
B. $10^{-5} \times K$
C. $10^{-7} \times K$
D. $10^{-4} \times K$
E. $10^{-6} \times K$

A54. (1 point). Assume first that the graph bellow shows the changes in two populations of herbivores in a grassy field. A possible reason for these changes is that:

下圖表示二草食動物的族群變化，造成變化的可能原因為：



A. All of the plant population in this habitat decreased.
此棲地的所有植物族群減少了
B. Population B competed more successfully for food than did population A.
族群Ｂ較族群Ａ更能成功地獲得食物
C. Population A produce more offspring than population B did.
族群Ａ較族群Ｂ產生更多的後代
D. Population A consumed the members of population B.
族群Ａ捕食族群Ｂ的成員
E. Over time, both populations will have the same average number.
長期而言，二族群會有相同的平均數字

Biosystematics (6 questions, 6 points).
生物系統分類學（六題，共 6 分）

A55. (1 point). To assign ascidia to subphylum *Urochordata seu Tunicata* it is necessary to know the features of the larval stage of ascidia. Choose them.
將海鞘歸類到尾索動物亞門，必須知道海鞘的幼體時期的特徵，請選擇正確的組合：

I. They present notochordum in the larval stage.
它們在幼體時具有脊索
II. They are highly specialised.
它們具有高度的特化
III. They present a hollow dorsal neural tube, which in the metamorphosis is reduced to a ganglion.
它們有一中空的背部神經管，在變態時會縮成神經節
IV. They present a propulsive tail, pharynx and branchial openings.
它們有一條推進用的尾巴、咽及鰓裂

A. I.
B. II.
C. I and II.
D. I, III and IV.
E. I and III.

A56. (1 point). Choose right characteristics of *Cnidaria* from those listed below:
由下列項目中選擇腔腸動物所具有的正確特徵：

A. Oceanic or freshwater, always predators.
海水或淡水棲，全為捕食者
B. Only oceanic, mainly predators.
只限海生，多為捕食者
C. Oceanic or freshwater, filter feeding.
海水或淡水棲，為濾食者
D. Only oceanic, always filter feeding.
只限海生，全為濾食者
E. Only freshwater, predators or parasites.
只限淡水棲，為捕食者或寄生

A57. (1 point). Which of the following statements can be evidence to prove the close evolutionary relationship between Phylum *Annelida* and Phylum *Mollusca*?
下列哪一項敘述可作為環節動物門和軟體動物門具有密切演化關係的証據？

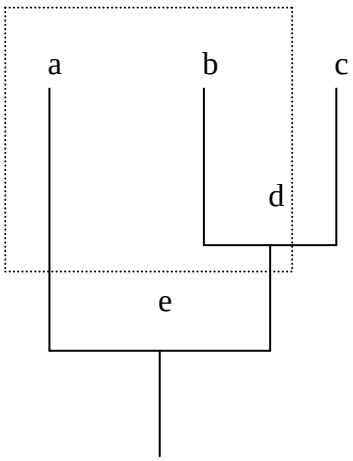
A. Both of them have bodies with bilateral symmetry.
二者的身體皆為兩側對稱
B. Their digestive systems have similar parts.
它們的消化系統有相似的部分
C. Their bodies consist of similar tagmata.
它們的身體由相似的體節組成
D. Both of them have closed circulatory system.
二者皆具有閉鎖式的循環系統
E. Many molluscs and marine annelids have a trochophore larva in their life cycle.
在許多軟體動物和海洋環節動物生活史中具有擔輪幼蟲

A58. (1 point). Zoologists place chordates and echinoderms on one major branch of the 動物學家將脊索動物和棘皮動物放在演化樹的同一主要分枝上，而將 **animal phylogenetic tree, and mollusks, annelids, and arthropods on another major** 軟體動物、環節動物及節肢動物放在另一分枝上，下列何者為他們分類的根據？ **branch. Which of the following is a basis for this separation?**

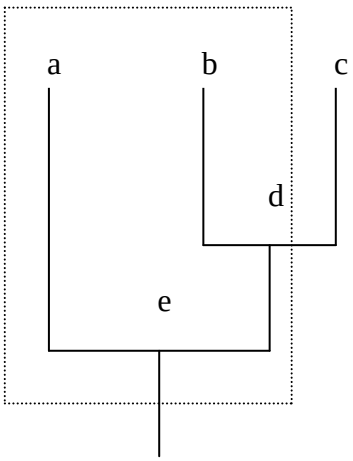
A. Whether the animals have skeletons.
是否具有骨骼
B. What type of symmetry they exhibit.
呈現的對稱型式
C. Whether the animals have a body cavity.
是否具有體腔
D. How the body cavity is formed.
體腔如何形成
E. Whether the animals are segmented.
身體是否分節

A59. (1 point). Phylogenetic connections between three extant (a, b, c) and two extinct (d, e) 三種現存（a、b、c）和兩種已滅絕（d、 e）的分類群之演化樹如下所示。 **taxonomic groups are shown below in the cladogram. What kind of their association into** 依照系統分類學的原則，在下列用小點框出的分類群中何者最為正確？ **a taxon of the highest rank (encircled with dotted line) would be in concord with principles of natural systematics?**

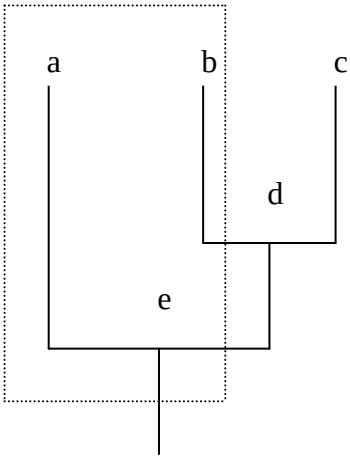
A



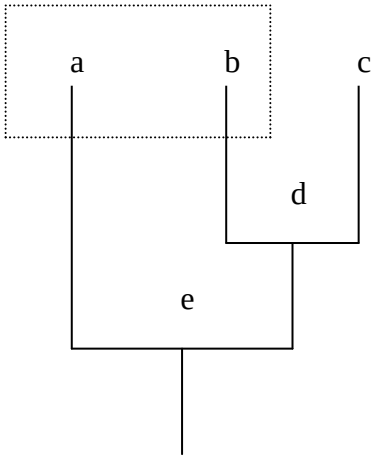
B



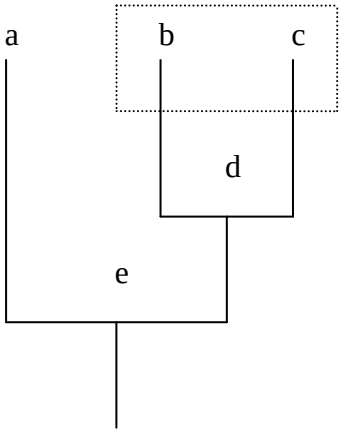
C



D



E



A60. (1 point). There are five species (K, L, M, N, and E) of a single family. They belong
在一科中有五個物種（K, L, M, N, 及 **E**）為同屬，下表顯示它們的六個特徵：
to the same genus. The table lists data on the presence of six features in these species:

Species 物種	Features 特徵					
	1	2	3	4	5	6
K	+	–	+	+	+	–
L.	–	–	–	–	+	–
M.	+	–	–	–	–	–
N.	–	+	–	–	–	–
E.	+	–	+	+	–	–

Based on the assumption that the most probable scheme of phylogenetic development
根據系統發生學，最可能的演化路徑是特徵改變的數目最少的，如果是這樣的話，哪一
is that which required the least number of evolutionary changes, indicate the species
種是物種 E 的最可能祖先？
that is the most probable ancestor of species E.

A. K

B. L

C. M

D. N