Student Code: _____

22nd INTERNATIONAL BIOLOGY OLYMPIAD

July 10-17, 2011

Taipei, Taiwan

THEORETICAL TEST: PART B

Duration: 150 minutes

Dear participants,

- Check your **Student Code** on the **Answer Sheet** before starting the test.
- The questions in Part B **may have more than one** correct answer. Fill your answers in the Answer Sheet. The **marks, numbers, or characters** to answer questions in Part B vary depending on questions. Unless mentioned otherwise, mark the correct answers with "◯" and incorrect answers with "—" for multiple choice questions on the Answer Sheet clearly, as shown below.
- 在作答前，請先檢查**答案紙**上的**學生編號**
- B部分的問題可能有**多個正確答案**，在答案紙上作答，**作答的符號，數字或代碼在 B 部分會因題目而有不同**。除非有特別提示，複選題的正確答案用"◯"作記，錯誤答案用"—"作記，**所有空格**都須清楚標示（如下例），

No.	A	B	C	D	E	F
B0.	◯	—	◯	—	—	—

- Write down your results and answers in the **Answer Sheet**. **Answers written in the Question Paper will not be evaluated.**
- Some of the questions may be marked "DELETED". DO NOT answer these questions.
- The maximal points of Part B is 120 (3 points for each question)
- **Every cell counts in** each question. Then you will get the points.
- Stop answering and put down your pencil IMMEDIATELY after the end bell rings.

- 在**答案紙**上作答，**寫在試題上的答案不計分**
- 有些標示"DELETED"的試題，**不用**回答這些問題
- B部分的總分爲 147 分（每題 3 分）
- 每題中的**所有空格都必須作答，正確才給分**
- 鈴響時須**立即**停止作答

:

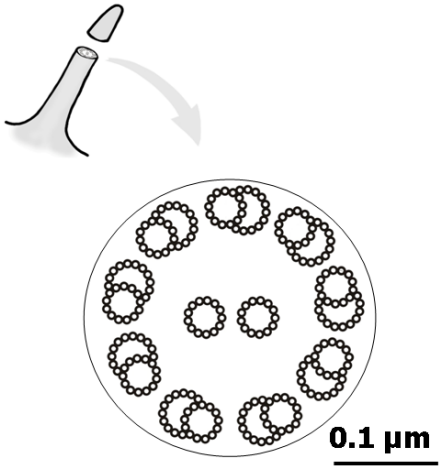
Good Luck!!

I. Cell biology

Problem set: 題組

Figure 1 depicts the cross-section of a certain cell surface structure observed by electron microscope. Answer questions B1 and B2.

題組: 下圖爲細胞表面結構橫切面的電子顯微鏡照片。回答 B1 與 B2 的問題。



B1. Which of the following possess the above structure?

下列何種生物具有上述構造

(A) *Paramecium* 草履蟲

(B) *Escherichia coli* 大腸菌

(C) Tracheid of gymnosperm 裸子植物管胞 (假導管)

(D) Human oviduct epithelial cell 人類輸卵管上皮細胞

(E) Human tracheal epithelial cell 人類氣管上皮細胞

(F) Human intestinal epithelial cell 人類腸道上皮細胞

B2. What is/are the functions and what is/are the major chemical composition of the structure?

有關該結構，請選出功能及主要化學成分正確的選項

Function options: 功能

(A) Attachment 接觸

(B) Locomotion 運動

(C) Transportation 運輸

(D) Secretion 分泌

(E) Absorption 吸收

Composition options:

(P) Cellulose 纖維素

(Q) Protein 蛋白質

(R) Mucin 黏液蛋白

(S) Lipid 脂質

(T) Nucleic acid 核酸

B3. Some pathogens produce exotoxins that can cause human diseases. One type of exotoxins consists of two polypeptides, subunits A and B. Subunit B can bind to surface receptors on the target cells and cause the transport of the subunit A or associated molecules across the plasma membrane into the cell. Once the subunit A enters the cell, it inhibits protein synthesis and destroys the cells. Which of the following statements regarding exotoxins is/are correct?

有些致病原爲分泌外毒素導致人類致病。一種外毒素由 A 與 B 兩種次單位構成。次單位 B 扮演受體並位在細胞膜表面，會導致次單位 A 進入細胞，或與之結合穿過細胞。有關外毒素的敘述，下列何者正確？

(A) Subunit A alone can cause disease.

單獨的次單位 A 能導致疾病發生

(B) Subunit B alone can bind to target cells.

單獨的次單位 B 能與細胞結合

(C) Subunit A may carry other molecules to enter and kill the target cells.

次單位 A 能與其他分子結合進入細胞，並殺死細胞

(D) Subunit B may carry other molecules and assist these molecules to enter target cells.

次單位 B 能攜帶其他分子並協助這些分子進入細胞

(E) When conjugated with an antibody against breast cancer cells, subunit A can kill breast cancer cells.

當次單位 A 與抗乳癌細胞抗體結合後，此複合物能殺死乳癌細胞

Problem set: 題組

Some leucocytes can ingest invaded pathogens by phagocytosis. Digestive enzymes that kill pathogens only function in acidic conditions. Please answer questions B4 and B5.

有些白血球能藉由吞噬作用來攝入這些入侵的病原體。這些能殺死病原體的酵素多半得在酸性的環境方具功能。請回答 B4 與 B5 的問題。

B4. Based on the information provided in the following table, complete the synthesis process of digestive enzymes during phagocytosis:

根據下表所提供的訊息，回答有關吞噬作用過程中有關的消化酵素生合成的問題。並將正確的選項填入空格中

① Replication　複製	⑤ Endoplasmic reticulum　內質網
② Translation　轉譯	⑥ Vesicle　液泡
③ Transcription　轉錄	⑦ Lysosome　溶小體
④ Mitochondrion　粒線體	⑧ Golgi apparatus　高基氏體

(1) mRNA-ribosome complex is transferred to ___a___ to continue ___b___.
mRNA – 核糖體複合物會先送到 再到

(2) Synthesized enzymes enter ___c___ and ___d___ for modification.
新合成出的酵素會先進入 進行修飾

(3) The modified enzymes are stored in ___e___.
修飾過的酵素會貯存在

B5. Tom isolated phagocytes from a blood sample. He cultured these phagocytes in a test tube for a period of time. To observe phagocytosis, *E. coli* was co-cultured with phagocytes. What will be the consequence if you neutralize acidic pH in lysosomes inhibiting proton pump by a specific inhibitor?

湯姆自血液檢體中分離出吞噬細胞，並在試管中培養這些細胞。爲了觀察吞噬現象，便把大腸菌加入培養中的吞噬細胞中。此時，你如果添加具特異性的抑制劑來中和溶小體的質子幫浦，以降低酸性的 pH 值。下列現象何者正確？

(A) Phagocytes can recognize kill *E. coli* via toll-like receptor.

吞噬細胞會辨識大腸菌，並藉由 toll- like 受體殺死大腸菌

(B) Ingestion of *E. coli* by phagocytes is inhibited.

吞噬細胞無法攝入大腸菌

(C) *E. coli* can survive in phagolysosomes for long periods of time.

大腸菌在吞噬小體中存活一段時間

(D) If phagolysosomes are formed, the digestive enzymes in them are inactive.

如果吞噬小體已經形成，內在的消化酵素並不具活性

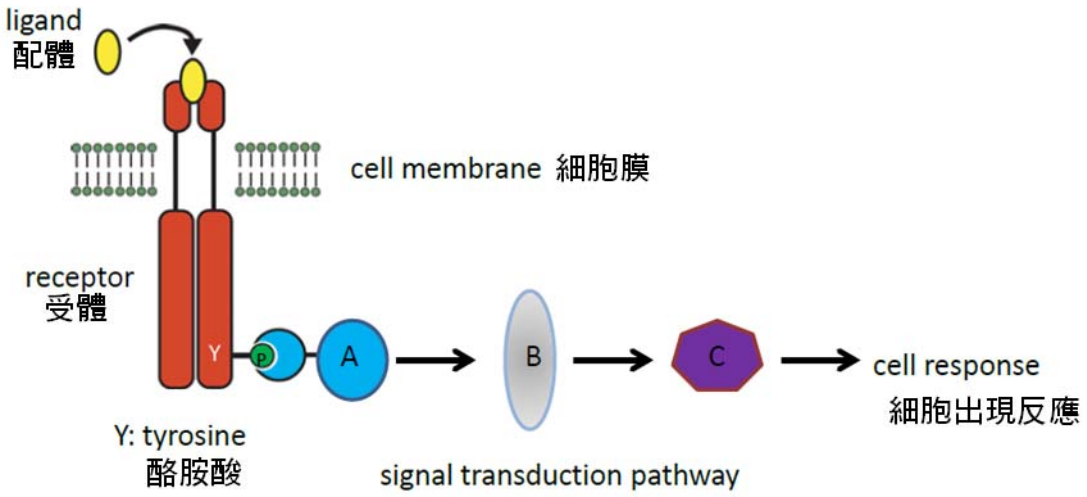
(E) Phagocytes can secrete ingested debris out of the cells.

吞噬細胞會將消化完的碎片丟出細胞外

Problem set: 題組

Jessica is dissecting a signal transduction pathway (depicted in the following figure) that leads to oncogenesis in cancer cells, in the hope that she can find inhibitors to block the signaling pathway and use them as chemotherapy drugs for cancer treatment. Please answer questions B6-B8.

潔西卡正在分析一個癌細胞致癌過程中的訊息傳遞路徑 (如下圖所示)，期望從中間找出化學藥劑來抑制此訊息傳遞路徑，藉此能治療癌症。請回答問題 B6-B8。



訊息傳遞路徑

B6. Components of signal transduction, including A, B and C, usually are activated through phosphorylation or dephosphorylation reactions. What are the mechanisms by which proteins A , B and C are phosphorylated or dephosphorylated?

訊息傳遞路徑中蛋白質 A, B, 與 C 會因爲磷酸化作用或去磷酸化作用而產生活性。試問蛋白質 A, B, 與 C 的磷酸化作用或去磷酸化作用機轉爲何？

(A) Receptors may contain enzyme domains which can catalyse phosphorylation/dephosphorylation reactions.
受體具有酵素區段 (domain) 因此能催化磷酸化作用或去磷酸化作用

(B) Enzymes that participate in phosphorylation/dephosphorylation reactions may exist in the cytoplasm.
參與磷酸化作用或去磷酸化作用的酵素存在細胞質中

(C) Proteins A, B and C may contain enzyme domains which can catalyse phosphorylation/dephosphorylation reactions.
蛋白質 A, B, 與 C 具酵素區段 (domain) 因此能催化磷酸化作用或去磷酸化作用

(D) Phosphorylation or dephosphorylation may not be mediated through enzymatic reactions.
磷酸化作用或去磷酸化作用不屬於酵素作用反應

(E) A phosphate group is transferred from the receptor to protein A.
磷酸根會自受體轉移到蛋白質 A

(F) The phosphate group can only be provided by H_3PO_4.
磷酸根系源自磷酸本身

B7. Which of the following experiment can prove that the signal transduction pathway is B→C, but not C→B?

下列實驗何者能證明訊息傳遞是由 B→C 進行，而非 C→B？

(A) Adding an A antagonist will activate B. 加入 A 的拮抗劑，B 將會被活化

(B) Adding an A agonist will activate C. 加入 A 的拮抗劑，C 將會被活化

(C) Adding a B agonist will activate C. 加入 B 的拮抗劑，C 將會被活化

(D) Adding a B antagonist will activate C. 加入 B 的拮抗劑，C 將會被活化

(E) Increasing the expression level of B will generate more of the active C molecules. 增加 B 的表達量，將會有更多具活性的 C 生成

(F) Cell response can be observed when B antagonist and active C molecules are added to the cell. 加入 B 的拮抗劑與活化的 C 分子，細胞將出現反應

B8. If this is a highly activated signal transduction pathway in cancer cells, which of the following processes may the signaling pathway be involved?

在癌細胞中會出現高度活化的上述訊息傳遞路徑，試問此訊息傳路路經將參與下列何種細胞生化過程？

(A) Inhibiting cell division 抑制細胞分裂

(B) Inhibiting cell differentiation 抑制細胞分化

(C) Hypomethylation of some tumor suppressor genes 某些腫瘤抑制基因被低度甲基化

(D) Activating the transcription of an oncogene 致癌基因轉錄作用被活化

(E) Arresting the cell cycle at S phase 細胞週期被停滯在 S 期

(F) Inhibiting the expression of some DNA repair genes 許多 DNA 修補機制被抑制

B9. In protein synthesis, there are 64 codons, 61 codons specify the 20 amino acids and the other 3 for termination "STOP" (**Table**). The following sequence of amino acids occurred in the structure of a polypeptide found in a wild type organism: Ser-Arg-Ile-Leu-Ala-Ala-Lys-Tyr. Which of the following may generate the mutant amino acid sequence Ser-Arg-Ile-Trp-Arg-Gln-Lys-Tyr?

蛋白質合成過程中，有 64 種密碼子參與。其中 61 種會對應出 20 種特別的氨基酸，其中 3 種會形成終止密碼 (如下表)。某多胜肽的野生型胺基酸序列爲 Ser-Arg-Ile-Leu-Ala-Ala-Lys-Tyr。下列何種情況會製造出序列爲 Ser-Arg-Ile-Trp-Arg-Gln-Lys-Tyr 的突變型。

First letter of codon (5′ end)	Second letter of codon								Third letter of codon (3′ end)
	U		C		A		G		
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	U
	UUC	Phe	UCC	Ser	UAC	Tyr	UGC	Cys	C
	UUA	Leu	UCA	Ser	UAA	Stop	UGA	Stop	A
	UUG	Leu	UCG	Ser	UAG	Stop	UGG	Trp	G
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg	U
	CUC	Leu	CCC	Pro	CAC	His	CGC	Arg	C
	CUA	Leu	CCA	Pro	CAA	Gln	CGA	Arg	A
	CUG	Leu	CCG	Pro	CAG	Gln	CGG	Arg	G
A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	U
	AUC	Ile	ACC	Thr	AAC	Asn	AGC	Ser	C
	AUA	Ile	ACA	Thr	AAA	Lys	AGA	Arg	A
	AUG	Met	ACG	Thr	AAG	Lys	AGG	Arg	G
G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly	U
	GUC	Val	GCC	Ala	GAC	Asp	GGC	Gly	C
	GUA	Val	GCA	Ala	GAA	Glu	GGA	Gly	A
	GUG	Val	GCG	Ala	GAG	Glu	GGG	Gly	G

(A) 1 nucleotide mutation　單 1 個核苷酸突變
(B) 1 nucleotide insertion　插入 1 個核苷酸
(C) 1 nucleotide deletion　刪除 1 個核苷酸
(D) 2 nucleotide mutation　2 個核苷酸產生突變
(E) 2 nucleotide insertion　插入 2 個核苷酸
(F) 3 nucleotide mutation　刪除 3 個核苷酸

II. Plant anatomy and physiology

B10. At the time of pollination, the living pollen grain typically consists of only the tube cell and the generative cell. During the germination of pollen grain, a pollen tube is produced and the nucleus of generative cell divides and forms two sperms. Directed by a chemical attractant (such as GABA) produced by the synergids, the tip of pollen tube enter the ovule through the micropyle. Then in the embryo sac, double fertilization occurs by the two sperms. Which of the followings are correct as concerning the pollination and double fertilization?

授粉作用時，花粉粒中通常只有管細胞與生殖細胞兩個細胞，當花粉粒萌發時，會形成花粉管且生殖細胞再分裂爲兩個精細胞．花粉管的頂端會受到輔助細胞所產生的化學物質(如 GABA)所吸引誘導，從珠孔進入胚珠內，然後在胚囊內完成雙重受精．下列有關授粉作用與雙重受精的敘述，何者正確？

(A) Tube cell, sperm, and synergid are haploid, while generative cell and zygote are diploid.

管細胞，精細胞及輔助細胞爲單倍體細胞，但生殖細胞及合子爲二倍體細胞

(B) During the pollination, a gradient in GABA content is formed from the stigma (low) to the ovary (high).

授粉作用時，GABA 的含量梯度是從柱頭（低）至子房（高）

(C) The two sperms fertilize two eggs, but only one forming zygote.

兩個精細胞與兩個卵細胞，但只有一個成爲合子

(D) After fertilization, one zygote and one endosperm initial are formed.

受精作用後，形成一個合子與一個胚乳初始細胞

(E) Germinated pollen grain is male gametophyte, while embryo sac is female gametophyte.

花粉管爲雄配子體，而胚囊爲雌配子體

B11. Mary divided 30 pots of plant X of similar condition into 10 plants per group, with each group being treated with different types of light regime. After a month, the flowering phenotypes of each group are shown in the table below:
瑪莉將３０盆處於相似狀態的植物 X 分爲每群１０棵植物，用不同光照處理，一個月之後所得之結果如下表所示：

Treatment 處理	Light regime 光／暗時間分配	Flowering result 開花結果
(I)	12 hr / 12 hr	All 10 plants flowered １０棵植物都開花
(II)	14 hr / 10 hr	9 plants flowered, and 1 plant failed to flower ９棵植物開花，１棵植物不開花
(III)	16 hr / 8 hr	All 10 plants fail to flower １０棵植物不開花

Light 光　　Darkness 暗

According to the information above, which of the following descriptions of plant X are correct?　根據上表，下列有關植物 X 的敘述，何者正確？

(A) Plant X is a short day plant
植物X是短日照植物

(B) The critical dark-length required by plant X for flowering is less than 10 hours
植物X開花的臨界夜長爲１０小時

(C) If group III is given an “one-minute dark treatment” in the middle of the light period, after one month, most plants in this group will flower
若第III群在照光期中間施以”１分鐘黑暗處理”，在一個月之後，此群中的大部分植物將會開花

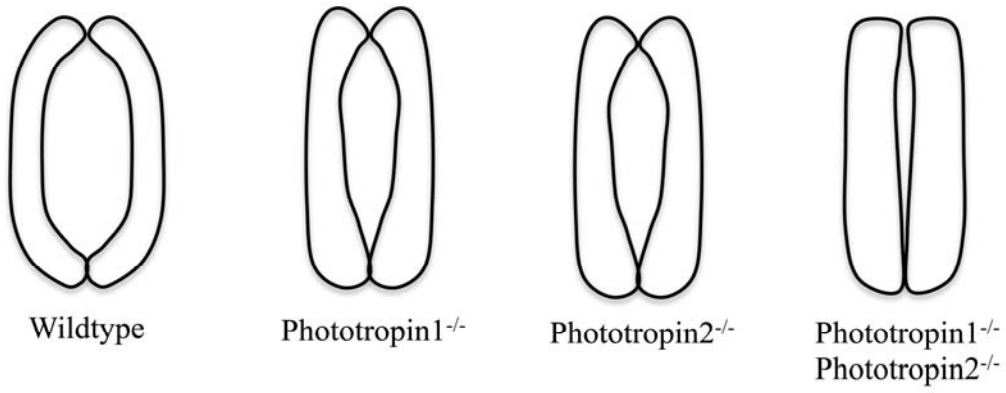
(D) If group II is given an “one-minute red light treatment” in the middle of the dark period, most plants in this group will not flower right after one month
若第II群在黑暗期中間施以”１分鐘紅光處理”，在一個月之後，此群中的大部分植物將不開花

(E) If the apical buds of group I plants are removed before giving the light regime treatment, then most plants will not produce florigen required for flowering after giving light regime treatment.
若在給予不同光照處理之前，將第I群植物的花芽移除，則大部分植物再給予不同光照處理之後，將不產生開花激素

B12 and B13 are a problem set　　B12 及 B13 爲題組

Dr. Wang carried out experiments with the model organism *Arabidopsis thatliana*, and identified the two proteins Phototropin 1 and Phototropin 2 as regulators of stomata opening. His experimental results are depicted in the following figure, illustrating the stomata of plants during the day.

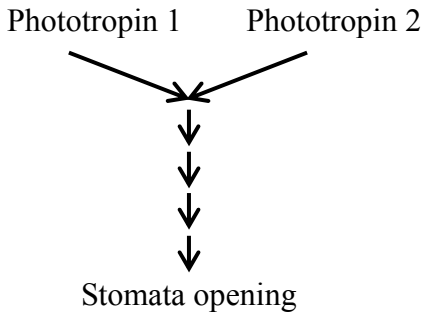
王博士在阿拉伯芥野生植株中找到兩種蛋白質 Phototropin 1 及 Phototropin 2 可調節氣孔的開閉，實驗結果顯示如下圖，代表植物在白天時氣孔的狀態



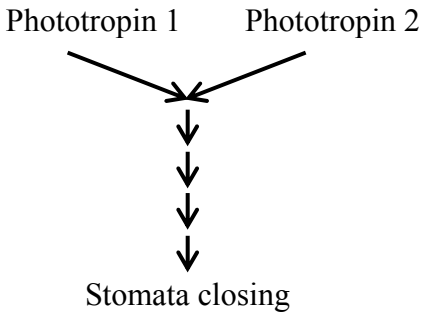
B12. Which of the following pathways potentially depicts the relationship of Phototropin 1 and Phototropin 2 on a molecular level?

下列哪些可代表 Phototropin 1 及 Phototropin 2 分子層級的作用流程？

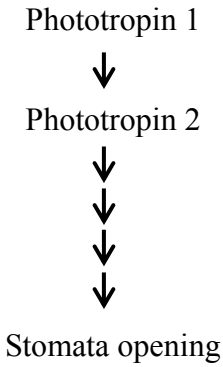
(A)



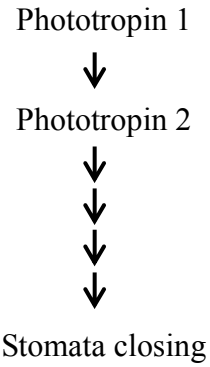
(B)



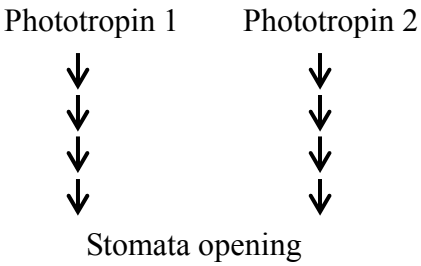
(C)



(D)



(E)



B13. Which of the following processes could be regulated and/or mediated by Phototropin 1 and Phototropin 2?

下列哪些過程可被 Phototropin 1 及 Phototropin 2 調節，或 Phototropin 1 及 Phototropin 2 爲該過程中的必經階段？

(A). K^+ ion efflux 鉀離子流出　(B). K^+ ion influx 鉀離子流入

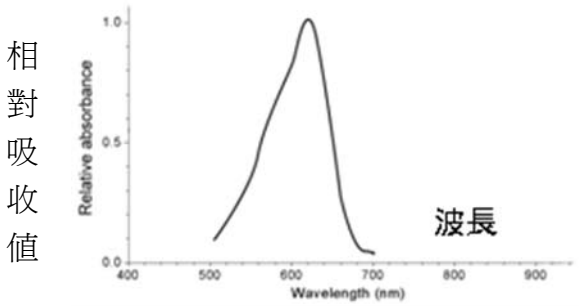
(C). Na^+ ion influx 鈉離子流入　(D). H_2O efflux　水流出

(E). H^+-ATPase activity　H^+-ATP 酵素的活性　(F). Blue light sensing　藍光感應

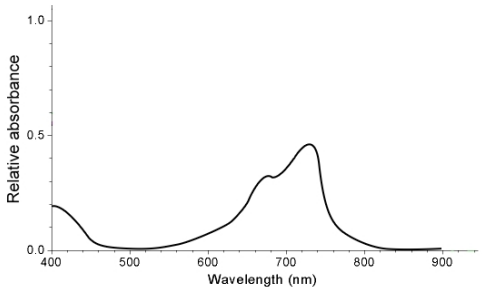
B14. Phytochromes exist in two isoforms, Pr and Pfr. In darkness, they are synthesized as Pr form, then turned into Pfr form after absorbing red light (most effective at 666 nm). When irradiated with far red light, Pfr transforms back to Pr. According to the description above, which of the following are likely to be the absorption spectra of phytochrome?

光敏素有兩種型式（Pr 及 Pfr），在黑暗中它合成 Pr 型，然後在吸收紅光(666 nm)後轉變爲 Pfr 型．當照射遠紅光，Pfr 型轉變爲 Pr 型．據此，下列哪些可能爲光敏素的吸收光譜？

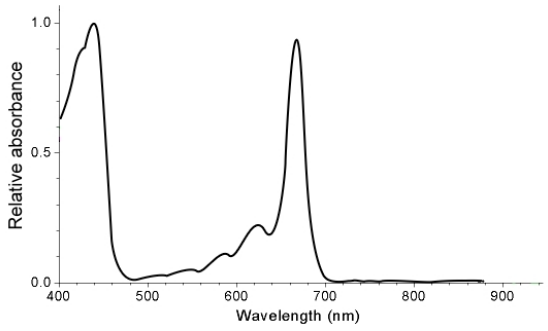
(A)



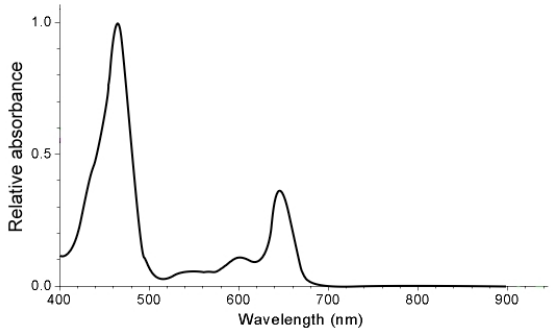
(B)



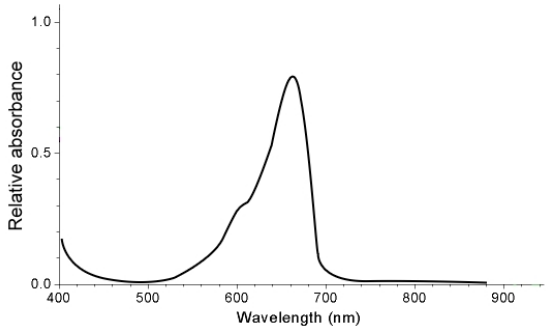
(C)



(D)



(E)



B15. The *AGAMOUS* (*AG*) gene is involved in flower development. Plant mutants without a functional *AG* would produce flowers with only receptacle, sepals and petals. A scientist generated a transgenic plant harboring a green fluorescence protein (GFP) gene driven by the *AG* promoter in a wild type background that produces normal flowers. In which of the following flower parts, you are likely to observe strong GFP fluorescent signals?

AGAMOUS (*AG*)基因與花的發育有關，不具有功能性 *AG* 的突變株產生只具有花托、花萼及花瓣的花。某科學家研發出一種由 *AG* 啓動子表現出具有綠色螢光蛋白(GFP)基因的轉殖植物，並且可開出正常的花。下列哪些花的構造可能可以觀察到強烈的螢光訊號？

(A) Receptacle 花托

(B) Sepal 花萼

(C) Petal 花瓣

(D) Stamen 雄蕊

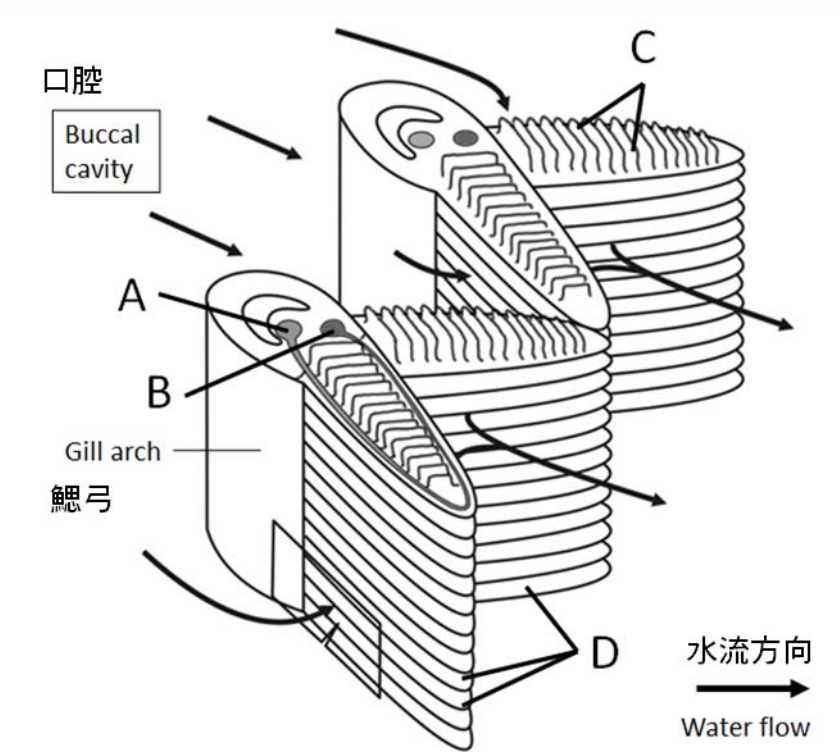
(E) Carpel 心皮

III. Animal anatomy and physiology

B16 to B18 are a problem set

B16. In the following figure, the structure of fish gills and the direction of water flow in the ventilation are illustrated. Answer the questions.

下圖爲魚鰓構造及氣體交換時的水流方向，回答問題。



Which of the following statements are correct? 下列敘述，何者正確？

(A) Vessel A carries oxygenated blood A 血管攜帶充氧血;

(B) Vessel B carries deoxygenated blood B 血管攜帶缺氧血

(C) Vessel A is an arteriole A 血管是小動脈

(D) Vessel B is a venule B 血管是小靜脈

(E) Vessel A and B are portal vessels A 及 B 血管是門脈血管

B17. During evolution, the gas exchange in gills has become more effective by

在演化過程中，鰓中的氣體交換如何能更爲有效

(A) A decrease in the thickness of the structure C 降低構造 C 的厚度

(B) A decrease in the number of cell layers in structure C 降低構造 C 的細胞層數

(C) An increase in the metabolic rate of the structure C 增加構造 C 的代謝率

(D) An increase in the cell volume of the structure C 增加構造 C 的細胞容積

(E) An increase in the surface area of the structure C 增加構造 C 的表面積

B18. Scientists found a kind of epithelial cell (X cell) in the structure of D with which fish can maintain body fluid osmolarity. Consequently, X cells are supposed to

科學家發現構造 D 中有一種上皮細胞(X 細胞)能讓魚類維持體液的滲透壓，因此 X 細胞可能：

(A) Absorb salt actively in freshwater fish 在淡水魚主動吸收鹽類

(B) Excrete salt actively in seawater fish 在海水魚主動排泄鹽類

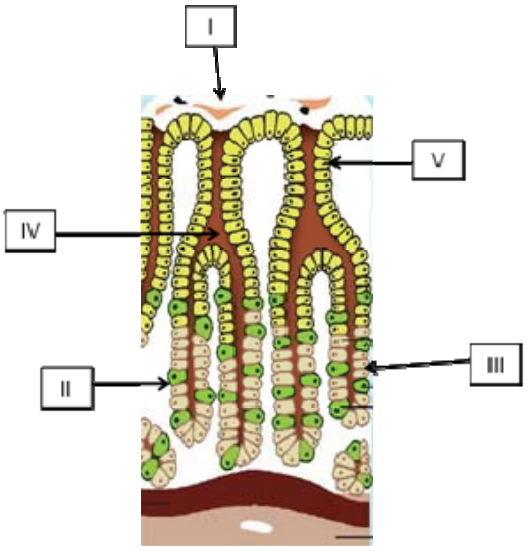
(C) Excrete water actively in freshwater fish 在淡水魚主動排除水分

(D) Absorb water actively in seawater fish 在海水魚主動吸收水分

(E) be rich in mitochondria 含有很多的粒線體

B19. The following image represents a gastric fold from the interior surface of the stomach. The different structures are indicated by roman numerals:

下面是胃部內表的胃褶層示意圖，以羅馬數字顯示五處不同構造



The list below describes the function for each structure.

以下爲各構造功能的描述

a. Secretes hydrochloric acid

分泌鹽酸

b. Secretes mucus which lubricates and protects the cells that cover the stomach.

分泌黏液潤滑並保護胃壁的細胞

c. Contains a series of ridges or deep pits which lead to the glands

含有許多的隆起及引到腺體的深孔

d. Secretes pepsinogen

分泌胃蛋白酶原

e. Contains three different types of cells that secrete the components of gastric juice.

包括三種分泌胃液成分的不同類型細胞

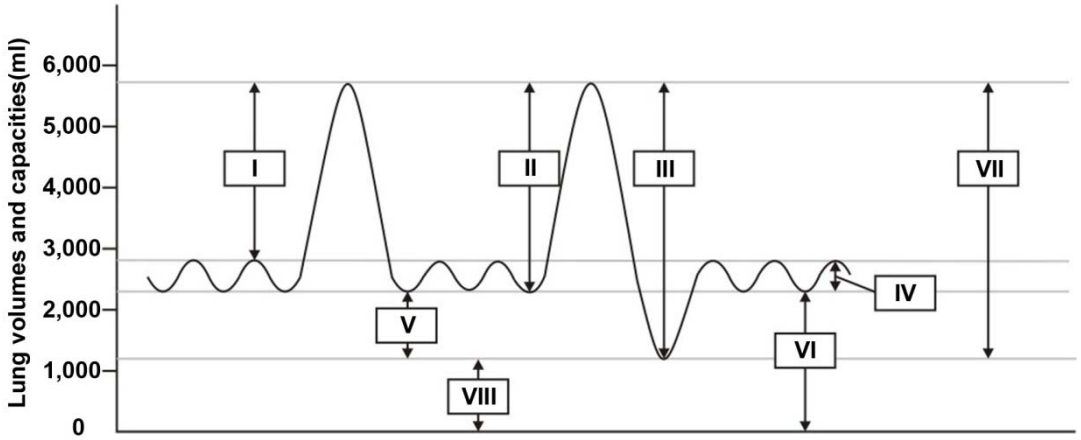
Please indicate the correct set of answers relating structure with corresponding function.

請將與功能相對應的構造填入表中

Function code 功能代碼	Structure code (I ~ V) 構造代碼
a.	Do not answer here 【寫在答案紙上】
b.	
c.	
d.	
e.	

B20. The graph below depicts the different pulmonary volumes and capacities:

下圖描述不同肺活量及容量



Below are two columns, correlate the contents in the 2 columns with the graph above:

將下面左右兩欄中的內容與上圖關聯

1. Tidal volume (TV)　潮氣容積
2. Residual volume (RV)　肺餘容積
3. Vital capacity (VC)　肺活量
4. Inspiratory capacity (IC)　吸氣量
5. Expiratory reserve volume (ERV)　呼氣儲備容積
6. Total lung capacity (TLC)　肺總量
7. Inspiratory reserve volume (IRV)　吸氣儲備容積
8. Functional residual capacity (FRC)　功能性肺餘容積

a. The maximum volume of air inhaled in a forced inspiration. It comprises tidal volume and inspiratory reserve.　用力吸氣的最大容量係由潮氣容積與吸氣量所構成
b. The maximum amount of air inhaled over the resting level of spontaneous inspiration.　平靜時自然呼吸時吸入的最大量
c. The volume of air remaining in lung after a strong forced expiration.　肺臟用力排氣後所剩下的容積
d. The volume of air present in lung after a maximum inspiration.　肺臟全力吸氣後的容積
e. Total amount of air flowing between inspiration and expiration at maximal rate. It includes tidal volume, inspiratory reserve volume and spontaneous expiration rate.　最快速吸氣與呼氣間的氣體總量，包括潮氣容積、吸氣儲備容積及自然呼出率
f. Amount of air in excess of tidal expiration that can be exhaled with maximum effort.　超過正常潮氣容積排氣量的體積，必須用力才能吐出的氣體量
g. The volume of air present in the lungs, at the end of passive expiration. It is the sum of residual volume and expiratory reserve volume　呼氣後肺臟留下來的體積，爲肺餘容積與呼氣儲備容積的總合
h. The lung volume representing the normal volume of air displaced between normal inspiration and expiration with or without extra effort applied.　肺臟的體積反映在有或無特別出力的正常呼吸的換氣量

	I	II	III	IV	V	VI	VII	VIII
Letter								
Number								

B21. Which of the following statements about thermo-adaption in animals are correct?

下列有關動物對溫度適應的敘述，何者正確？

(A) Blue-fin tuna is able to raise their core temperature. Therefore, it is an endothermic animal.

藍鰭鮪可調升其核心溫度，因此是一種內溫型動物

(B) Icefish spend all their life in the freezing ice-laden water and maintain a very stable body temperature. Therefore, icefish are homeothermic animals.

冰魚終生生活於充滿冰塊的冰水中其體溫極爲穩定，因此冰魚是一種恆溫動物

(C) Shivering can help mammals to generate heat, and it is regulated by hypothalamus in mammals. 發抖能幫助哺乳動物產熱，可由下視丘來控制

(D) Brown adipose tissues help mammals to generate heat by supplying energy to skeletal muscles. 棕色脂肪組織能供應能量給骨骼肌以幫助哺乳動物產熱

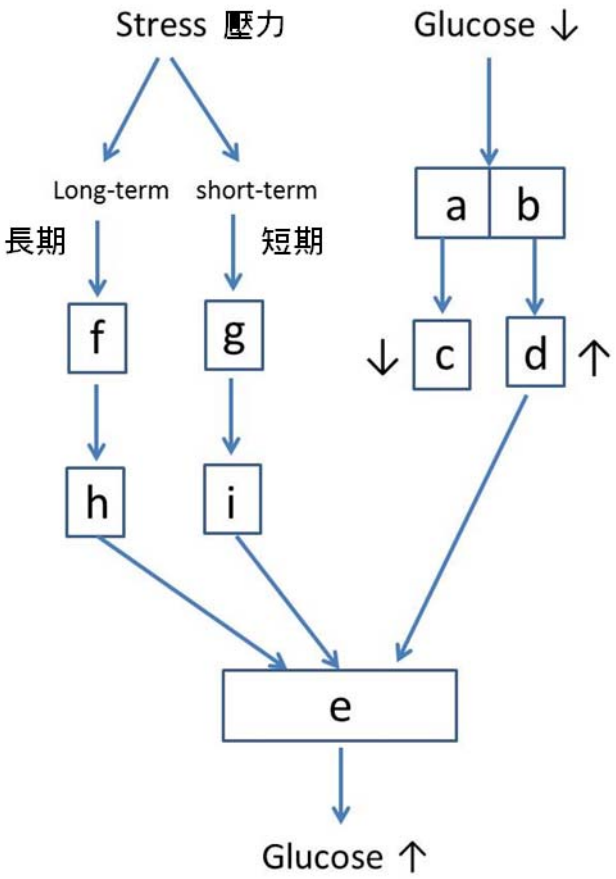
(E) Brown adipose cells are rich in mitochondria for heat generation.

棕色脂肪細胞富含粒線體可產生熱

B22. Maintenance of the blood glucose level is important for normal physiological function. It is modulated by both neural and endocrine systems. The diagram below shows two different situations resulting from physiological stress or low blood glucose level. Complete the table in the answer sheet by using appropriate letters shown below.

維持血糖濃度對正常生理功能極爲重要，由神經及內分泌系統調控，下圖顯示在生理壓力下或血糖過低時所產生的兩種不同結果。用下圖中的適當字母代碼來完成在答案卷上的表格。

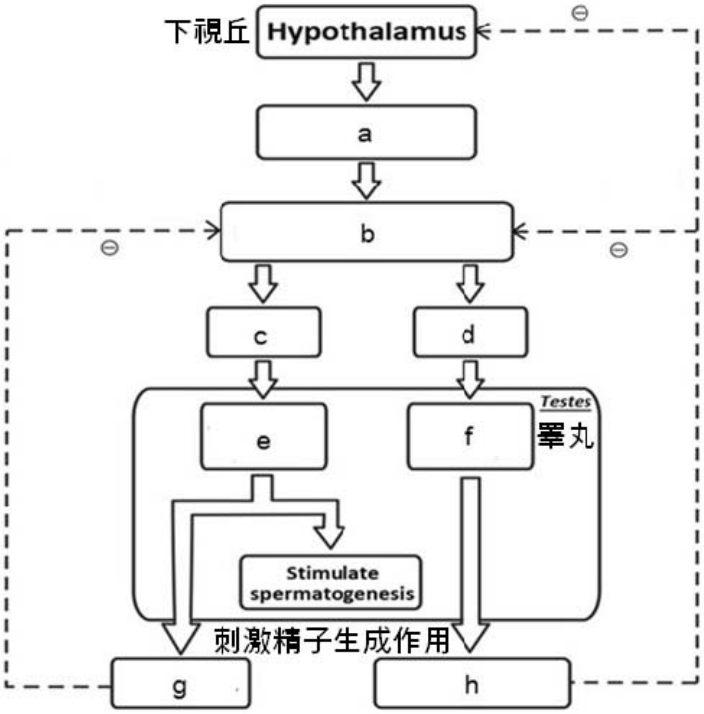
Structure/hormone 構造/激素	Answer
α cells of the pancreatic islets 胰島的α細胞	Do not answer here 【寫在答案紙上】
Insulin 胰島素	
Liver 肝臟	
Adrenal medulla 腎上腺髓質	
Cortisol 腎上腺皮質素	


Stress 壓力
Glucose ↓
Long-term
short-term
長期
短期
a
b
f
g
↓
c
d
↑
h
i
e
Glucose ↑

B23 and B24 are a problem set

B23. Normal spermatogenesis and androgen secretion are delicately regulated by hormones in males. The occurrence of infertility in the male could be resulted from the disturbance of hormonal regulation. The following figure partly illustrates the cross interactions among hypothalamus, pituitary gland, and male gonads. The symbols "(-)" indicate negative feedback inhibitions. Insert appropriate symbols (a to h) in the table of the answer sheet.

正常的精子形成過程及雄性激素的分泌受到男性的激素所調控。雄性不孕症的發生可能是因激素的調控受到干擾。下圖爲下視丘、腦垂腺與雄性性腺之間交互作用的簡圖。符號 (-) 代表負回饋的抑制。請用下圖中(a ～ h)符號所代表意義填在答案卷表格的適當格子中。



Structure/hormone 構造/激素	Answer
Sertoli cells　精子支持細胞	Do not answer here 【寫在答案紙上】
Anterior pituitary　腦垂腺前葉	
Gonadotropin releasing hormone 促性腺素釋放激素	
FSH 濾泡刺激素	
Inhibin 回饋抑制促性腺激素	

B24. The application of available and suitable hormonal therapy to the male patients with gonad failure is very important. Consider how the following case may be improved by a hormonal treatment.

以合用並適量的激素來治療性腺缺損的男性病人非常重要。思考激素治療對下列病人狀況的改善。

Patient A suffered from testicular cancer and had both testes removed. With reference to the figure in **B23**, select the most appropriate letter applicable to patient A.

病人 A 爲一睪丸癌患者，兩個睪丸均已切除，參考第 B23 題圖中的英文字母，選擇對病人 A 最有用的激素治療，在答案卷的各格中填入「O」或「--」。

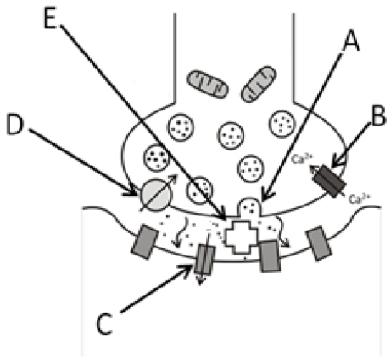
O: Supplement 有效用　　-- : No supplement 無效用

a	c	d	e	f	h

B25 and B26 are a problem set　B25-B26 爲題組

B25. A to E in the diagram below represents the five major steps of synaptic transmission.

下圖中，A 到 E 分別爲突觸間傳遞的 5 個主要步驟



A. Release of neurotransmitter.
釋放神經傳遞物質

B. Activation of presynaptic calcium channel.
活化突觸前鈣離子通道

C. Activation of postsynaptic sodium channel.
活化突觸後鈉離子通道

D. Re-uptake of neurotransmitter
回收神經傳遞物質.

E. Degradation of neurotransmitter.
降解神經傳遞物質

Scientists study drug effects on synaptic transmission by using electrophysiological recording. Briefly the postsynaptic current will be recorded and used to determine the possible mechanism which may account for the drug effects. Figure 1 is the typical tract of postsynaptic current before drug administration. Match the figure number (I, II, III, IV or V), given at the end with the correct drug effects below. Figures may be used once, more than once or not at all.

科學家利用電生理記錄法來研究藥物對突觸間傳遞的影響。簡單言之，突觸後的電流會被記錄下來並用以決定藥物影響的可能機制。圖 1 爲對照組，即未受藥物影響的突觸後電位結果。用下面的圖型編號 (I, II, III, IV or V) 填入答案卷之表中，以顯示其對應的正確藥物效果。每個圖型編號可能用一次、多次或不用。

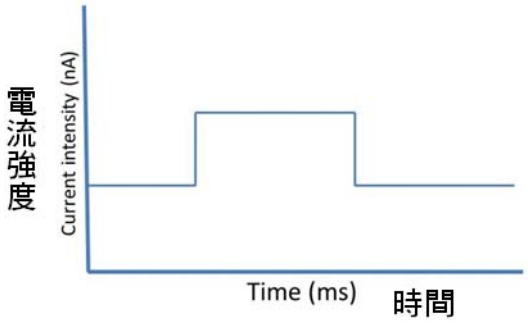
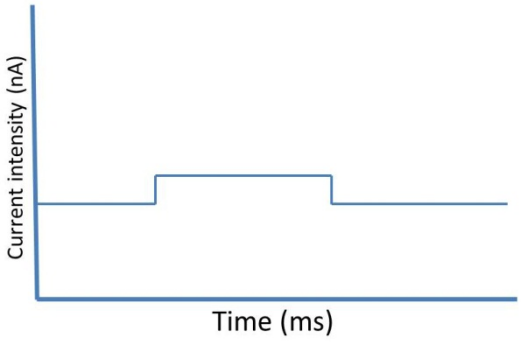


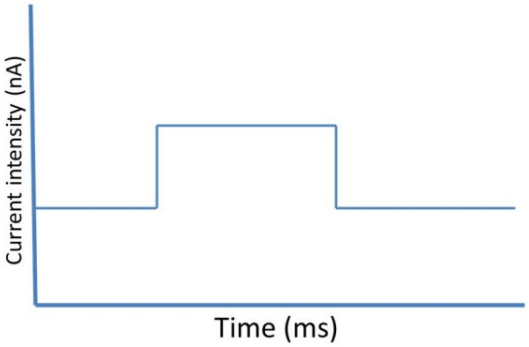
Figure-1

Mechanism 藥物效果	Figure number 對應圖型編號
Blocking of step A 阻斷步驟 A	Do not answer here 【寫在答案紙上】
Enhancement of step B 加速步驟 B	
Blocking of step C 阻斷步驟 C	
Enhancement of step D 加速步驟 D	
Blocking of step E 阻斷步驟 E	

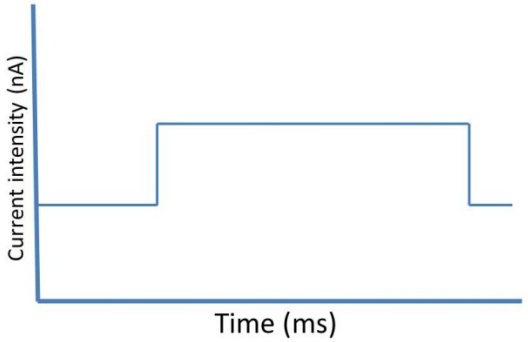
(I)


Current intensity (nA)
Time (ms)

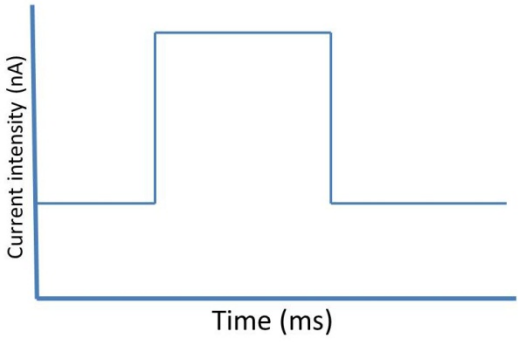
(II)


Current intensity (nA)
Time (ms)

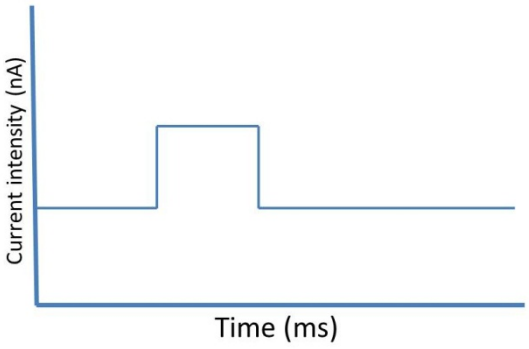
(III)


Current intensity (nA)
Time (ms)

(IV)


Current intensity (nA)
Time (ms)

(V)


Current intensity (nA)
Time (ms)

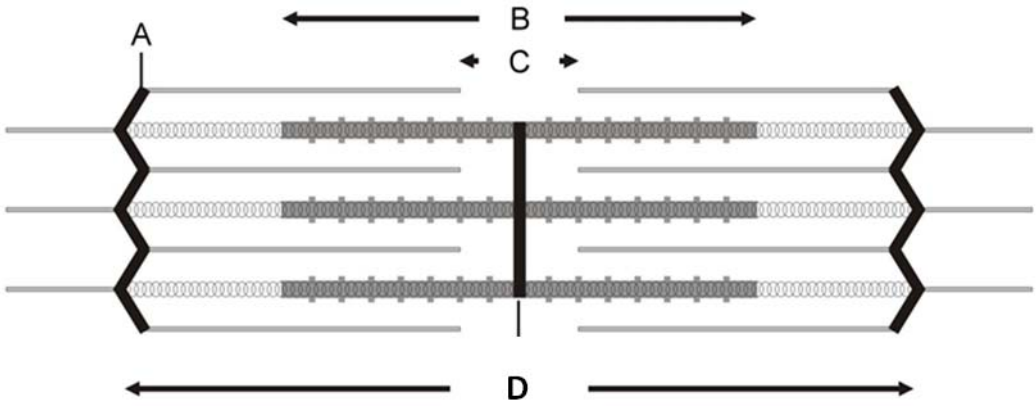
B26. Epilepsy is a common neurological condition. Patients suffer convulsions which result from hyperactivity of certain cerebral areas. Symptoms can be reduced by using antiepileptic drugs. If the receptor activated in the above figure was a chloride channel instead of a sodium channel, which of the following mechanism(s) may form the basis for an antiepileptic drug?

癲癇是一種常見的神經性疾病，病人會苦於特定腦區神經的過度活化而產生抽蓄，這種症狀能靠服用抗癲癇藥物來得到舒緩。如果上圖中活化的受器由鈉離子通道改爲氯離子通道，下列何種藥物效果能反映出抗癲癇藥的藥物基礎？在答案卷的各格中填入「O」或「ー」。

Mechanism 藥物效果	Answer 答案
Blocking of step A 阻斷步驟 A	Do not answer here 【寫在答案紙上】
Enhancement of step B 促進步驟 B	
Blocking of step C 阻斷步驟 C	
Enhancement of step D 促進步驟 D	
Blocking of step E 阻斷步驟 E	

B27. The following diagram indicates the basic structure of a sarcomere.

下圖爲肌小節的基本構造圖



Mark if the statement correct or incorrect. The statements are about a muscle fiber undergoing an isotonic contraction compared to its relaxed state.

與在放鬆狀態下相比，以下是關於肌纖維在等張收縮時的五個敘述，請在答案卷的表格中填入「O」或「--」，分別代表各敘述的正確或錯誤。

Statement		Answer
a. D bands remain the same distance apart	D 帶會維持原固定的距離	Do not answer here 【寫在答案紙上】
b. A move closer to the ends of the B	A 的移動會靠近 B 的末端	
c. C become shorter	C 會變短	
d. B become wider	B 會變寬	
e. D bands move closer to the end of the B D 帶的移動會靠近 B 的末端		

IV. Ethology

B28. There are two types of bird hatchlings: precocial and altricial. In general, precocial birds are covered with feathers when they hatch, and can find their own food with the help from their mothers. In contrast, altricial hatchlings require feeding and caring for from the parents. Based on this, which of the following statements are correct?

鳥類的雛鳥有兩型：早熟型與晚熟型。一般來說早熟型的小鳥一孵化就有羽毛且可以在親鳥的協助下自行覓食。但晚熟型的小鳥則由親鳥哺育。根據這個基礎知識以下何敘述是正確的？

(A) Precocial hatchlings usually take longer to hatch than altricial hatchlings.

早熟型雛鳥需要長一點的時間才能孵化

(B) Altricial hatchlings usually develop imprinting earlier than precocial hatchlings.

晚熟型雛鳥較早發展出印痕行爲

(C) Parents invest more in precocial hatchlings than in altricial hatchlings during nestling period.

親鳥對早熟型雛鳥的能量投資較多

(D) For a group of young birds that hatch at the same time, altricial hatchlings tend to develop the ability to move earlier than precocial hatchlings.

假設這些雛鳥在同一時間孵化，晚熟型雛鳥比早熟型雛鳥早發展出移動能力

(E) Parents of precocial and altricial hatchlings have the same level of investment in reproduction during the breeding season.

在繁殖季中親鳥對早熟型與晚熟型雛鳥的能量投資沒有顯著差異

B29. An entomologist found that a species of cockroach use the dramatic change of light intensity at dusk (given as 18:00) to reset its biological clock. He also found out that the circadian (daily) rhythm is 25 hrs. If a student cages a cockroach of this species into a dark box at 18:00, at what time will the cockroach become active after 12 days? Fill in the time (using the 24 hr system, example: 6:00 pm = 18:00) in the given space in the Answer Sheet.

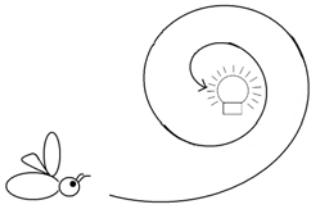
昆蟲學家發現一種蟑螂使用傍晚(也就是 18:00)時環境光度的差異來重設其生物時鐘，且其每天的生物時律爲 25 小時。因此如果有一個學生於 18:00 時把一隻蟑螂關在一個暗箱中，那麼 12 天後這隻蟑螂會在何時再度呈現活動狀態？請把時間填在答案紙的適當空格中並使用 24 小時制。

B30. A biologist discovered that a species of moth is capable of flying in a straight line at night because it keeps a constant angle (80°) between its body's longitudinal axis and the direction of moon light using photoreceptors as a tool. If the moth encounters a bright light in a dark night, what kind of flight path one will expect to see in relation to the light source?

生物學家發現一種蛾會對著光源直直地飛去，原因是牠使用其光受器讓體軸與月光保持一個穩定的 80°角。如果蛾在沒月亮的夜間遇到亮光，請問你預期蛾類向光源的飛行路徑應該是什麼樣子？

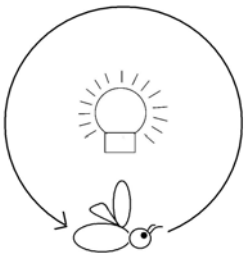
(A)

(D)

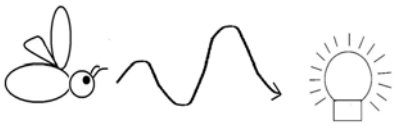


(B)

(E)



(C)



B31. A researcher monitored 10 pairs (A to J) of adult birds during the breeding season. For each of the pairs, he recorded body lengths of the male and female, and their nesting date as shown in the table below. 研究者在繁殖季監測編號爲 A-J 的 10 對成鳥，並記錄雌雄兩性的體長與築巢日期(如下表所示)。

	A	B	C	D	E	F	G	H	I	J
Female body length (cm) 雌性體長	26.4	27.8	25.1	25.0	27.0	28.1	25.5	25.9	28.3	27.4
Male body length (cm) 雄性體長	28.3	28.4	28.9	29.0	27.9	30.2	29.6	27.4	29.7	30.5
Nesting date 築巢時間	5/6	5/3	5/4	4/28	5/1	4/27	4/29	5/2	5/1	4/26

Based on this data, the mean body length is 26.65 cm for the adult females, and 28.99 cm for the adult males. In comparison with the mean body length of 26.10 cm in adult females and 27.60 cm in adult males in the total (breeders + non-breeders) population (N=30) of the study area, which of the following statements are correct?

根據表 1，受監測的雌性成體平均體長爲 26.65cm，而雄性成體爲 28.99cm。然而在該地區的所有個體(N=30，包含繁殖與非繁殖個體)中，雌性成體平均體長爲 26.10cm，而雄性成體爲 27.60cm。請問以下敘述何者爲真？

(A) All males in this species are larger than females.

這個物種的所有雄性個體必然大於雌性

(B) Females tend to pair with males that are larger than themselves.

雌性傾向與體型比自己大的雄性婚配

(C) Male body lengths do not affect female mate choices.

雄性體長不影響雌性婚配選擇

(D) Nesting dates are linked to male body lengths.

築巢時間與雄性體長有關聯

(E) The chances of breeding in this species are most likely affected by the body size.

此物種的繁殖機會很有可能被體型所影響

V. Genetics and Evolution

B32. The black, brown and white coat colors of mice are determined by the interaction of genes *B* and *C*, which are on different autosomes. *B* and *b* alleles control the synthesis of black and brown pigments, respectively. Only in the presence of the dominant *C* allele, black and brown pigments are deposited in the fur. In a crossing between *BbCc* and *bbCc*, which of the following statements are correct?

老鼠皮毛的黑、棕和白三種顏色是由 B 和 C 二個位於不同體染色體上的基因所控制，B 基因有顯性 B 和隱性 b 二種等位基因，分別負責黑色和棕色色素的合成，而老鼠唯有具顯性 C 等位基因時才能將黑色或棕色色素表現於皮毛上。將 *BbCc* 和 *bbCc* 的老鼠交配時，下列哪項敘述是正確的？

(A) The coat colors of parental mice are black and brown respectively.

二隻親代老鼠的皮毛顏色分別是黑色和棕色

(B) The ratio of black and brown offspring is 1:1.

子代中黑色和棕色老鼠的比例是 1:1

(C) 3/4 of the offspring are black.

3/4 的子代是黑色的

(D)1/4 of the offspring are brown.

1/4 的子代是棕色的

(E) 1/4 of the offspring are white.

1/4 的子代是白色的

(F) Alleles *C* and *B/b* are co-dominant.

等位基因 C 和 B/b 是共顯性

B33. Fur of guinea pigs can have different colors (black or white). Hairs can be with different textures (rough or smooth). Alleles *Q* and *q* are coding for color, alleles *R* and *r* for type of hair. There is no linkage between the two genes. A number of guinea pigs with exactly the same genotype (parental group) are allowed to mate and result in a large number of F1 offspring. Most of these have a black rough fur. A small number has white smooth fur. About the same number of offspring is white and rough, or black and smooth.

天竺鼠的皮毛是黑色或白色，毛的質地是粗糙或光滑。等位基因 Q 和 q 控制毛皮顏色，等位基因 R 和 r 控制毛的質地，此二基因無聯鎖關係。由數隻相同基因型的天竺鼠繁殖出一大群 F1 子代。在這群子代中，大部分都具黑色粗糙皮毛，少數具白色光滑，或白色粗糙，或黑色光滑皮毛，這三種少數外表型的個體數目大致相同。

B33.1. Using the given letters, indicate the genotype of the guinea pigs in the parental group: _____.

用上述代表各等位基因的字母，寫出親代的基因型：_____

B33.2. If 1024 F1 offspring were born, what is the expected number of the black and smooth? _____.

如果生出 1024 個 F1 子代，理論是會有多少隻是黑色光滑？ _____

B33.3. Guinea pigs often have a spotted pattern. According to a simplified model spotted pattern is determined by one gene with two alleles: G and g. If G is present the guinea pig is spotted. Students investigated the population guinea pigs in a territory and found out that 84 % were spotted. Presuming this population is in (Hardy-Weinberg) equilibrium, calculate the frequency of G. Give your answer in one decimal place.

天竺鼠皮毛常出現斑點，簡言之，斑點的出現與否是由一基因的二種等位基因 G 和 g 決定。具等位基因 G 者有斑點。學生們發現在一特定區域的天竺鼠族群中，84 % 的個體有斑點。假設此一族群處於哈-溫平衡狀態，請計算族群中等位基因 G 的頻率，請寫出你的答案至小數點後一位。 _____

B33.4. In one day all unspotted guinea pigs were removed. What will be the frequency of unspotted guinea pigs appearing in the next generation? Give your answer as a percentage without decimals.

某一天，所有沒有斑點的天竺鼠被移除，在原區域剩餘族群所產生的下一代中，沒有斑點的個體所佔的頻率爲何？請以百分率寫出你的答案，不含小數位。

B34. It is believed that "land plants" are evolved from charophytes. Which of the following statements support this hypothesis?

一般人認爲陸生植物是由輪藻演化而來，下列何敘述支持這個假說？

(A) Both have alternation of generation in life cycles

二者都有世代交替的生活史

(B) Both contain chlorophyll a and chlorophyll b

二者都有葉綠素 a 和葉綠素 b

(C) Both have peroxisomes that contain photorespiration-related enzymes

二者的過氧化體都含有與光呼吸作用相關的酵素

(D) Both can form phragmoplasts during cytokinesis

二者在細胞質分裂的時候都會形成成膜體

(E) Both contain cellulose cell walls

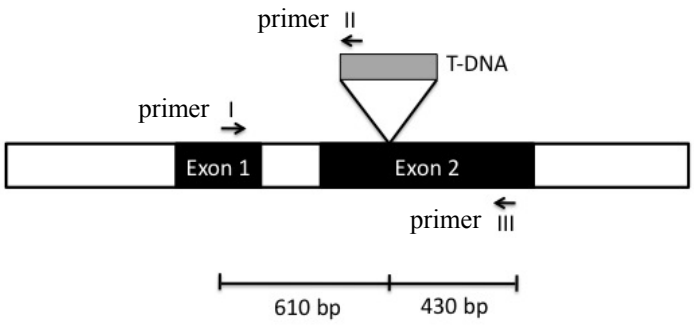
二者的細胞壁都由纖維素組成

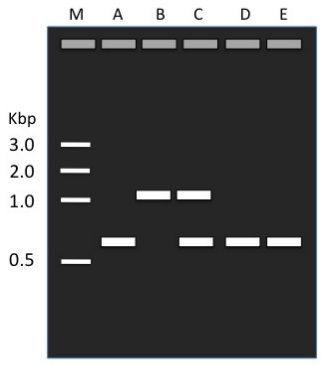
Questions B35a-B35c are a <u>problem set</u>

問題 B35a-B35c 是 <u>題組</u>

Dr. Chen was investigating the function of gene *X* in rice by using a mutant with a T-DNA inserted in the exon 2 illustrated below. The size of the T-DNA is approximately 5 kilo base pairs (kbp). She used PCR and gel electrophoresis analyses for genotyping of five individual plants (A, B, C, D, E) with mixture of primers I, II, and III as indicated in the diagram. The gel figure shows the PCR result. The DNA molecular size markers are shown in lane M. Lane A-E are the PCR products from leaf samples of the plant A-E, respectively. It is known that the polymerase being used is unable to effectively amplify DNA fragments above 5 kbp.

陳博士研究水稻中 *X* 基因的功能，她用具 T-DNA 插入在第二外顯子(exon 2)的突變體(如下圖所示)做材料。T-DNA 的長度大約是 5 kbp。她以 PCR 和電泳技術分析五個植株 (A, B, C, D, E)，同時使用引子 I, II, 和 III 進行反應。PCR 的結果如下圖右電泳膠所示，Lane M 是 DNA 長度標尺，Lane A-E 分別是植株 A-E 葉片樣品的 PCR 產物。已知此實驗中所使用的聚合酶無法合成長度超過 5 kbp 的 DNA 片段。





Based on the above information, answer questions B35a-B35b :

根據以上資訊回答問題 B35a-B35b :

B35a. Which pair of primers (I+II, I+III, or II+III) amplified the DNA band in lane B? Write down the correct pair of primers in the answer sheet.

Lane B 的 DNA 片段是由哪一組引子合成(I+II, I+III, or II+III)？

在答案紙上寫下正確的一對引子

B35b. Which plant(s) (A, B, C, D, or E) is/are homozygous mutant(s)? Write down the correct letter(s) in the answer sheet.

哪些植株(A, B, C, D, or E)是同型合子突變體

在答案紙上寫下正確的字母代號

B35c. Which plant(s) (A, B, C, D, or E) is/are the F1 offspring of homozygous mutant crossed with the wild type? Write down the correct letter(s) in the answer sheet.

哪些植株(A, B, C, D, or E)是同型合子突變體與正常植株的雜交後代

在答案紙上寫下正確的字母代號

B36. Doctor Lin isolated a rice mutant with a late flowering time phenotype. The mutant allele responsible for this phenotype was identified by map-based cloning technique and named LFT^m. When Doctor Lin sequenced the whole LFT^m gene, including the promoter region, she could not find any difference in the nucleotide sequence as compared to the wild-type allele. Which of the following phenomena are likely to be responsible for this observation?
林博士篩選到一個晚開花的水稻突變體，並且利用遺傳輿圖定位技術找到造成此突變外表型的突變等位基因 LFT^m。當林博士將此等位基因完全定序(包括啓動子區域)，並將之與正常等位基因比對後，她沒有發現任何核苷酸序列的差異。下列哪些現象有可能是造成此結果的原因？

(A) The mRNA level of *LFT* in the mutant is the same as that in the wild-type at the same developmental stage
在相同的發育時期，*LFT* mRNA 的量在正常型和突變植株中是一樣的

(B) The LFT protein found in the wild type plants cannot be detected or is lower in the mutant
正常型植株中找到的 LFT 蛋白質，在突變植株中無法偵測到或含量較少

(C) The DNA methylation patterns on *LFT* are altered in the mutant
LFT 基因上 DNA 甲基化的模式在突變植株中有改變

(D) The levels of histone proteins are dramatically altered in the mutant
組織蛋白(histone proteins)的量在突變植株中有巨大改變

(E) Introducing the cloned *LFT* into the wild-type plant generates a *LFT* overexpression transgenic plant with late flowering phenotype
將此 *LFT* 基因轉殖入正常型植株後所產生過量表現 *LFT* 基因的轉殖植物會有晚開花現象

VI. Ecology

B37. The population size of a dragonfly in a pond was estimated to be 50,000 during a survey. Their sex ratio is 1:1. Each female lays approximately 400 eggs. A second survey of the next generation revealed that the population size is still 50,000 and the sex ratio is still 1:1. What is the average survival rate (surviving to adult stage) of the eggs?

某個調查估計某池塘的蜻蜓族群規模有 50,000 隻，其性比爲 1:1，每隻雌蟲大約可產 400 顆卵。然後在針對下一個世代的第二次調查顯示：其族群規模仍然是 50,000 隻，性比仍然是 1:1，請問在這種情況下由卵成功發育到成蟲階段的平均存活率爲何？

(A) 0.2%

(B) 0.25%

(C) 0.5%

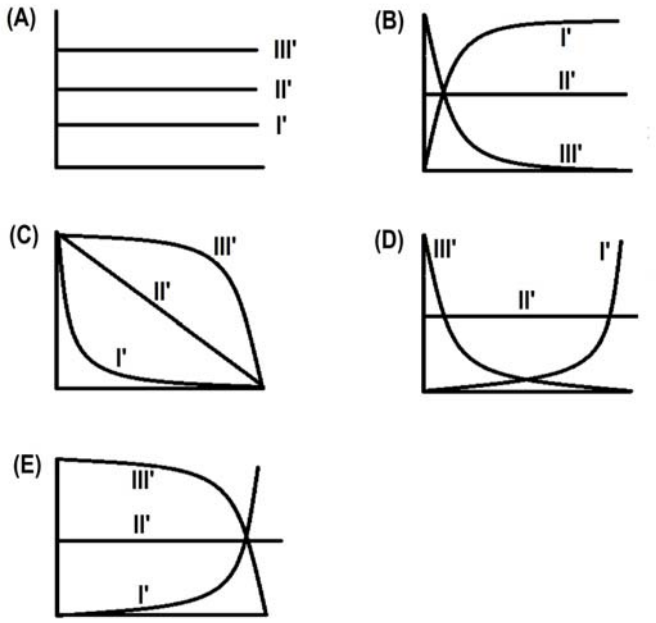
(D) 1%

(E) 5%

B38. Biologists found that the threshold temperature for development of a mosquito species is 15℃. They also found that the product of (1) the number of days it takes to complete development, and (2) the difference between the temperature during development and threshold temperature, is a constant. That is, the result of multiplying (1) and (2) is a constant. It is known that this mosquito requires 15 days to complete development at 30℃. Given that May was unusually warm in India this year with an average temperature of 40℃, how many days should it take this mosquito to complete development this May in India?

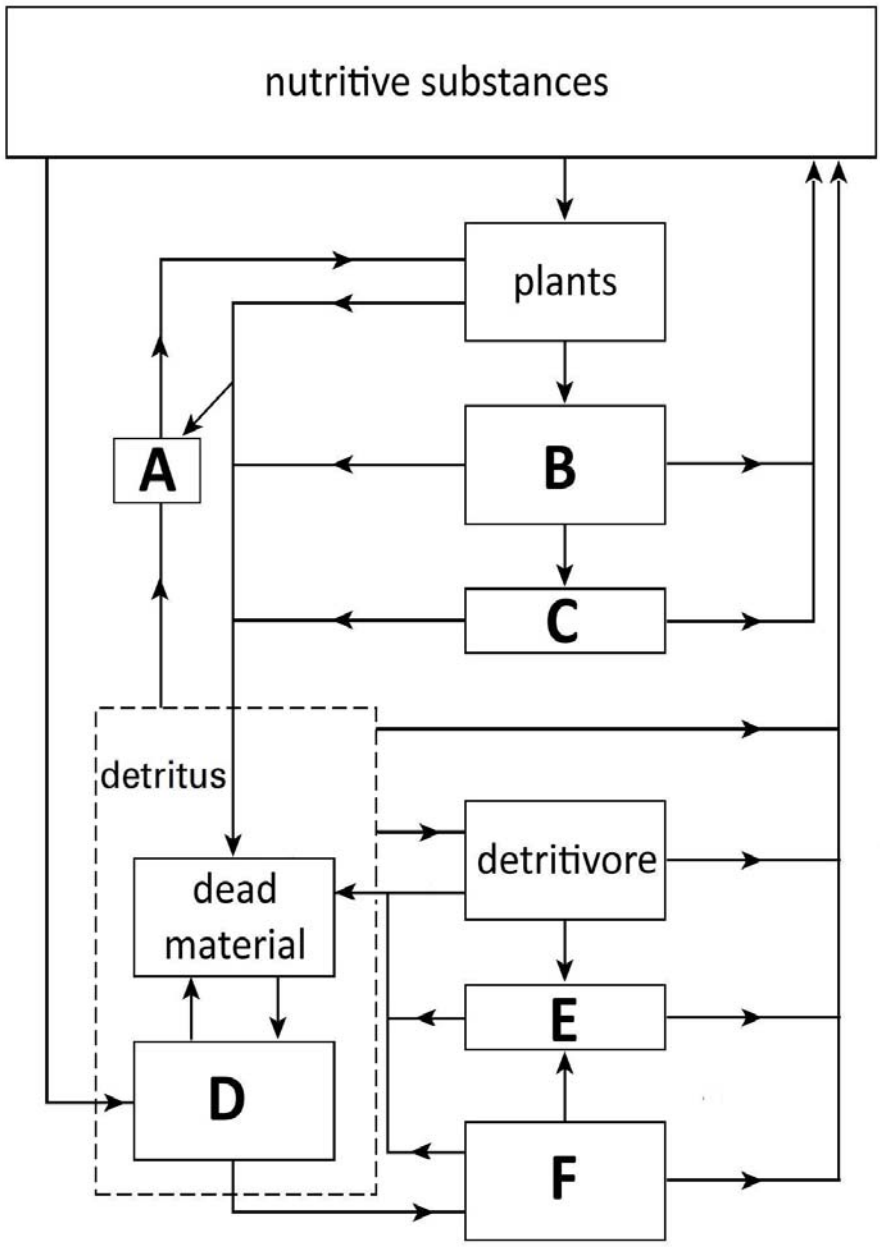
生物學家發現某種蚊子的發育臨界溫度爲 15℃。他們也發現(1)完成發育的天數，以及(2)發育期間的溫度與臨界溫度的差異是恆定的。這也就是說， (1) 與 (2) 的乘積爲一常數。現在已知這種蚊子在 30℃時需 15 天方可完成發育，若牠們出現在印度五月均溫高達 40℃的環境中會需要幾天才能完成發育？

B39. Assuming human, a typical bird, and typical fish species have Type I, II, and III survival curves (the vertical axis is survival rate, and horizontal axis is time) respectively, which of the following figures most accurately describes mortality curves (obtained by replacing survival rate with mortality rate) for these three groups of organisms (Type I', II' and III')?
假設人類、一種典型鳥類與一種典型魚類分別具有 Type I、II 與 III 的生存曲線(縱軸爲存活率，橫軸爲時間)，下列那些圖最能精確描述這三群生物的死亡曲線(也就是以死亡率置換爲存活率)



B40. The figure below shows a nutrient cycle, and the six groups of organisms (A to F) involved in this cycle.

以下圖片顯示六種生物，及其在一個養份循環中的角色



Detritus：碎屑 detritivore：食屑生物 dead material：生物死屍

Which of the following descriptions are correct?

請問以下何者爲真？

(A) C and F are carnivores. C 與 F 是肉食生物

(B) C and E are carnivores. C 與 E 爲肉食生物

(C) A and B are herbivores. A 與 B 爲草食生物

(D) D includes bacteria and fungi. D 包含了細菌與真菌

(E) F includes bacterivores and fungivores. F 包含了食菌性與食真菌性生物

B41. When comparing closely-related bird species, mortality of breeding individuals appears to be higher for species in temperate regions than in tropical regions. Therefore, predation risks to parents themselves, their young and eggs are given different priorities for species in different regions. In an experiment where specimen of three different predators (predator A, predator B, and predator C) were placed at close distances to the nests during the day in the breeding period, which of the following responses from the parents can be expected? Note that predator A are predators of the young and eggs, predator B are nocturnal predators, and predator C are diurnal predators of adult birds.

比較近緣鳥種的生存率時發現，溫帶物種的繁殖期個體的死亡率會高於熱帶地區的物種。這也就是不同地區的掠食者對於親鳥、幼鳥與卵的捕食優先性是不一樣的。在一個實驗中，A、B 與 C 這三種掠食者的標本被擺在正值繁殖期的鳥巢近處。請問以下那些是我們預期親鳥會出現的行爲反應？請留意 A 捕食幼鳥與鳥蛋，B 爲夜行性捕食者，而 C 則在白天捕食成鳥。

(A) The predator B specimen is more strongly avoided by the parents than the predator C specimen.

比較起 C 掠食者的標本，親鳥比較會迴避 B 掠食者的標本

(B) With the predator A specimen, the parents of tropical species reduce the frequency of returning to the nests and feeding the young to a lesser degree than parents of temperate species.

若遇到 A 掠食者，熱帶鳥種比較起溫帶鳥種來說，親鳥會降低回巢育雛的頻度

(C) With the predator C specimen, the parent birds of tropical species reduce the frequency of returning to the nests and feeding the young to a lesser degree than parents of temperate species.

若遇到 C 掠食者，熱帶鳥種比較起溫帶鳥種來說，親鳥會降低回巢育雛的頻度

(D) With the predator C specimen, the parent birds of tropical species reduce the frequency of returning to the nests and feeding the young to a greater degree than parents of temperate species.

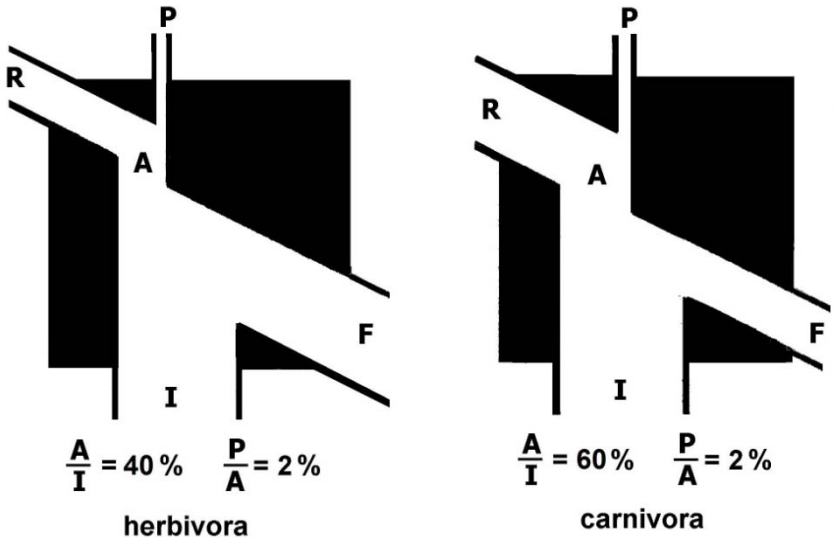
若遇到 C 掠食者，熱帶鳥種比較起溫帶鳥種來說，親鳥會增加回巢育雛的頻度

(E) The degree to which the parents reduce their frequency of returning to the nests and feeding the young when predator specimen is present is not affected by the type of predators or the latitudes in which the species occurs.

當某個掠食者標本出現在時，親鳥降低回巢育雛頻度的程度與掠食者型式以及物種分布的緯度是沒有關係的

B42. The figure below shows a scheme of the assimilation efficiency (A/I) and production efficiency (P/A) of two groups of mammals in a meadow ecosystem.

以下爲兩群生活在濕草原生態系中一種草食哺乳動物 (herbivore) 與一種肉食哺乳動物 (carnivore) 在消化上的同化效率 (A/I) 以及生產效率 (P/A) 的能量收支示意圖



A = energy intake in blood after digestion
F = loss of energy through excretion and heat
I = energy present in ingested organic compounds
P = production
R = loss of energy through respiration and heat

其中

A：吃飽後血液中增加的能量

F：經由排泄與散熱所造成的能量損失

I：攝食有機化合物所產生的能量

P：生產力

R：經由呼吸與散熱所損失的能量

Suppose I = 100 J Which of the following descriptions are correct?

假設 I 爲 100 焦耳，請問以下何敘述爲真？

(A) Digestion of plant materials costs relatively less energy than digestion of animal materials.

消化植物性食材相對於動物性食材所需耗費的能量較少

(B) Plant materials that are reabsorbed have less organic contents than animal materials that are reabsorbed.

被重覆吸收的植物性食材比較起被重覆吸收的動物性食材具有較少的有機成份

(C) R ranges between 40 and 60 J in carnivores.

在肉食動物中 R 的範圍是 40-60 焦耳

(D) R ranges between 40 and 60 J in herbivores.

在草食動物中 R 的範圍是 40-60 焦耳

(E) R is lower in amphibians than in mammals.

兩生類的 R 會比哺乳類低

B43. Some fungi form symbiotic associations with the roots of vascular plants, which are called mycorrhizae. In such associations, mycorrhizae help plants to absorb water, phosphate salt and other mineral nutrients. Depending on whether the fungus colonizes the roots extracellularly or intracellularly, mycorrhizae can be grouped into ectomycorrhizae or arbuscular mycorrhizae. Which of the following descriptions of mycorrhizae are correct?

有些真菌與維管束植物的根形成共生關係因而被稱爲菌根。菌根幫助植物吸收水、磷酸鹽以及其它的礦物質。根據真菌拓植在植物的胞外或胞內，菌根可分爲外生菌根以及叢枝內生菌根兩型。請問以下有關菌根的描述何者正確？

(A) Seedlings with mycorrhizae grow more rapidly than seedlings without mycorrhizae in phosphorus-poor soils.

在低磷鹽的土壤中有菌根的幼苗會長得比沒有菌根的幼苗快

(B) Hyphae of arbuscular mycorrhizae can penetrate the roots and cell membranes of the cortical cells to form symbiotic associations intracellularly.

叢枝內生菌根的菌絲可穿透根部的皮層細胞與細胞膜以形成胞內的共生關係

(C) Hyphae of ectomycorrhizae fungi can grow into the cortex of the roots, and form hyphal sheaths around the roots.

具外生菌根的真菌菌絲可長進根部的皮層，並在根的周圍形成菌鞘

(D) Mycorrhizae have similar functions as root hairs of plants, and as a result, plants with both kins of mycorrhizae have less-developed root hairs.

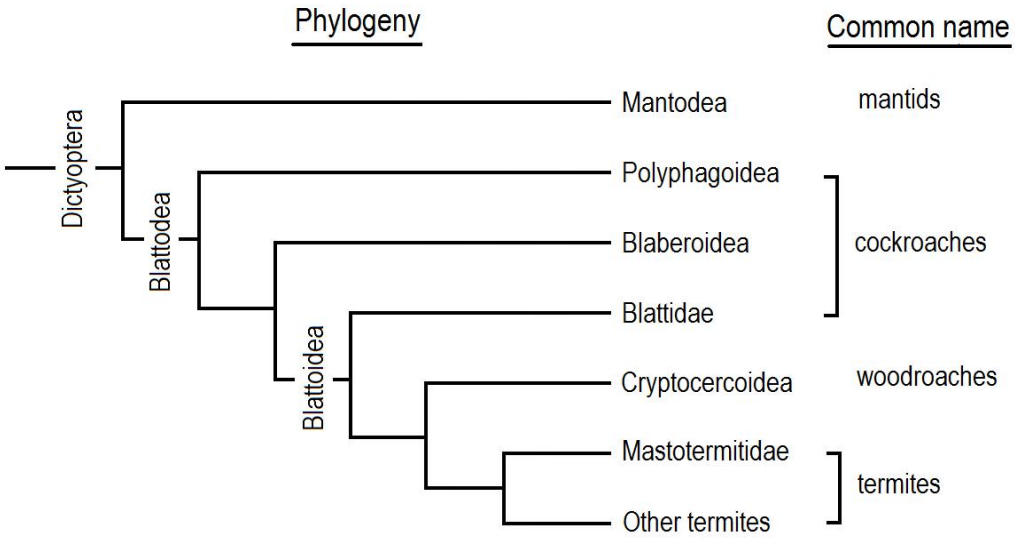
菌根的功能類似根毛，所以具菌根植物的根毛就不太發達

(E) Each mycorrhiza forms symbiotic associations with the roots of specific plants.

菌根與植物根的共生關係具有專一性

VII. Biosystematics

B44. Eggleton et al (2007) studied the phylogeny of Dictyoptera, as shown below. According to the proposed phylogeny, determine whether the following statements are true (T) or false (F).
Eggalton 等人在 2007 年研究網翅群的親緣關係。根據此假說，請問下敘是(T)敘非(F)



Mantids：螳螂　Cockroaches：蟑螂　Termites：白蟻

(A) Mantids' sister group is cockroaches. 螳螂是蟑螂的姐妹群

(B) Cockroaches form a paraphyletic group. 蟑螂是一個並系群

(C) Termites should be viewed as highly modified cockroaches
白蟻應被視爲高度特化的蟑螂

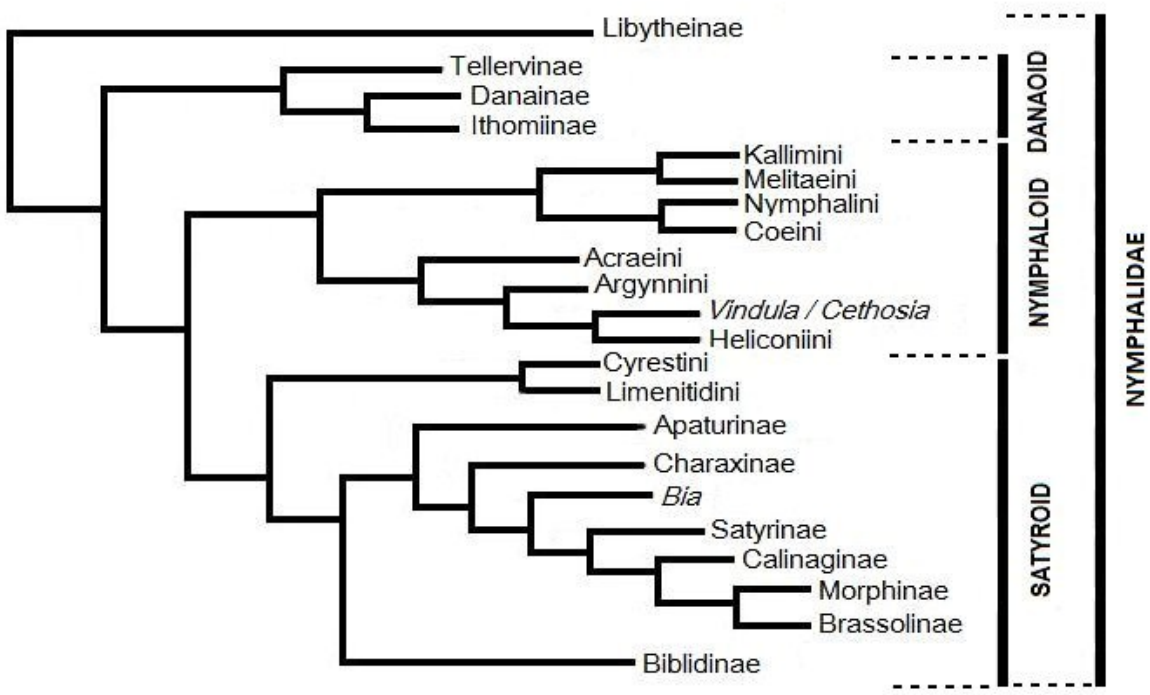
(D) Mantids should be viewed as highly modified cockroaches.
螳螂應被視爲高度特化的蟑螂

(E) Termites evolved from mantids. 白蟻演化自螳螂

B45a. Systematic positions of some butterflies such as satyrids (ringlets, etc.), nymphalids (frush foots, etc), and danaids (milkweed butterflies, etc.) were controversial. Some researchers regarded them as distinct families, while others disagreed. Recent studies supported the view to pool them into a single family Nymphalidae. Below is a phylogeny of these butterflies reconstructed by Freitas & Brown (2004), who supports this view. Answer the following questions based on this phylogeny.

過去有些蝴蝶類群，例如眼蝶、蛺蝶與斑蝶的親緣關係有爭議，有些研究者把牠們視爲不同的科，但有人認爲只是蛺蝶科下的各亞科。近年的研究建議把牠們都置入同一個科，也就是蛺蝶科(Nymphalidae)。以下是 Freitas & Brown 在 2004 年針對牠們所重建的親緣關係。請你根據這個親緣關係回答以下問題：

其中 Danaoid 是斑蝶群、Nymphaloid 是蛺蝶群、Satyroid 是眼蝶群、Apaturinae 是小紫蛺蝶亞科、Calinaginae 是首環蝶亞科、Brassolinae 是鷹蝶亞科。從 Libytheinae 喙蝶亞科到篦蛺蝶亞科 Biblidinae 都被 Freitas & Brown 包含在蛺蝶科中。



Determine whether the following statements are true (T) or false (F).

判斷以下敘述孰是(T)孰非(F)

(A) Danaoid butterflies may still be a distinct family according to Freitas & Brown's phylogeny if Nymphalidae is still allowed to divide into several families.

如果蛺蝶仍可以被分成好幾個科，根據 Freitas & Brown 的觀點，斑蝶群仍然可以被視爲獨立的一科

(B) Calinaginae butterflies resemble Danaoid butterflies in appearance, so they should be classified as Danaoid butterflies.

首環蝶看起來和斑蝶群很像，所以牠們應該被分到斑蝶群

(C) If we want to define the family Nymphalidae to include Apaturinae, Satyrinae and Brassolinae have to be included as well.

如果我們希望蛺蝶科的概念可以包含小紫蛺蝶亞科，那麼眼蝶亞科與鷹蝶亞科也就應該被包含在蛺蝶科

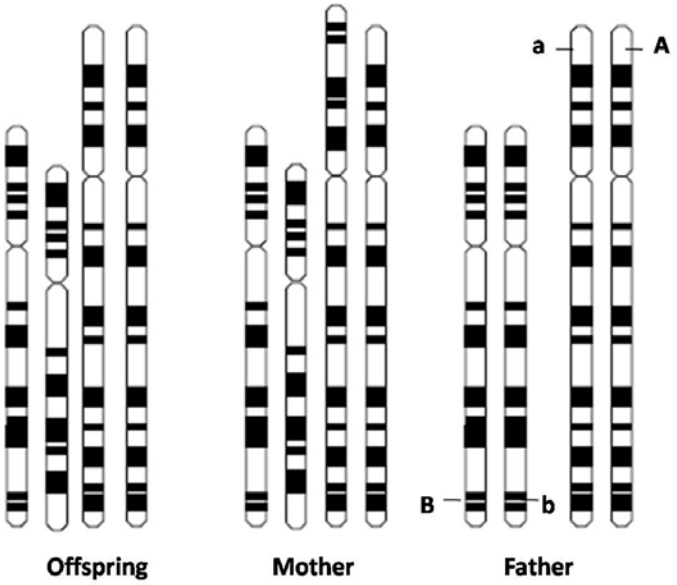
(D) Danaioid butterflies may be considered as the ancestors of Nymphaloid + Satyroid.

斑蝶群可以被視爲蛺蝶群 + 眼蝶群的祖先

VII. Genetics and Evolution (Part II)

B46. A hypothetical mammal possesses genes A and B, involved in embryonic development, on chromosomes 6 and 12 of its genome. Alleles A and B are functional whereas alleles a and b are non-functional. A breeding pair has been unable to produce viable offspring experiencing many miscarriages and still births. Karyotype analysis was performed on the breeding pair as well as an offspring that died at birth, showing that a balanced chromosome translocation within the mother's genome is responsible for this outcome. The diagram below shows chromosomes 6 and 12 for each of these individuals, the location of genes A and B are also shown on the father's chromosomes. The father is heterozygous for both gene loci, whilst the mother is homozygous. It is known that overdose or complete absence of the gene product of either gene A or B during development is lethal.

某種哺乳動物的A基因和B基因分別位於第6和第12對染色體，其功用都與胚胎發育有關。等位基因A和B是有功能的，等位基因a和b是沒有功能的。一對配偶一直流產或無法產下活的子代。對此對配偶及其產下之死胎進行核型分析，發現母親所含之一組平衡易位染色體(balanced chromosome translocation)是造成流產或死胎的原因。下圖中所示是這些個體的第6和第12對染色體組成，A基因和B基因所在的位置標示在父親的染色體。父親的A基因和B基因都是異型合子組成，而母親則都是同型合子組成。已知對於A基因或是B基因的產物，任一者無論是過量或是完全缺乏都會致死。



Assuming that no other genes in the affected regions of chromosome 6 and 12 have an effect on development, answer the following questions.

假設在此易位區域沒有其他影響發育的基因存在，請回答下列問題：

B46.1. Which of the following are possible genotype/s of the offspring shown for A and B? 上圖中的子代其基因型可能爲哪些？

(A) AAa, b

(B) AAA,Bb

(C) AAA, B

(D) a, BBb

(E) A, BBB

(F) A, BBb

B46.2. What is the probability (as a fraction) that a fertilized zygote produced by these parents will possess three functional copies of allele *B*?

由此對配偶交配所得的受精卵具有三個等位基因 B 的機率是多少？

B47. A study has determined that 13.3% of men in a given population are short-sighted for a genetic reason (single gene mutation). 55% of these men also have a short-sighted father.
研究顯示一族群中 13.3%的男人是遺傳性近視(單一基因突變造成)，而 55%的這些遺傳性近視男人其父親也是近視。

B47.1. Mark the correct mode of inheritance for the short-sightedness.
此遺傳性近視的遺傳模式爲何？

(A) autosomal dominant 體染色體顯性遺傳

(B) autosomal recessive 體染色體隱性遺傳

(C) X-chromosomal dominant X 染色體顯性遺傳

(D) X-chromosomal recessive X 染色體隱性遺傳

(E) mitochondrial 粒線體遺傳

B47.2. Based on the conditions of the Hardy-Weinberg equilibrium, what is the frequency of the allele for short-sightedness? Write your answer on the answer sheet.
依據哈-溫定律，近視等位基因在此族群中之頻率爲何？

在答案紙上寫下正確的答案

B48. In *Drosophila* an autosomal transformer allele can be observed. If present, the transformer allele brings about a male appearance if an animal has two X-chromosomes, but such animals are sterile as their testes are underdeveloped. In *Drosophila* the red and white eye color is determined by a gene on an X-chromosome.
在果蠅 Drosophila 中有可能產生一個位於體染色體上的轉型基因，當此轉型基因以同型合子組成存在時，會使具二條 X 染色體的個體表現出雄性外表型，但因睪丸發育不全而不具生育能力。此外，果蠅紅白眼色是由一個位於 X 染色體上的基因所決定。

A cross is performed between a red eyed *Drosophila* female heterozygous for both loci and a white eyed *Drosophila* male heterozygous for transformer. They produce a large number of offspring. What fraction of their offspring looks like white eyed males?
當一紅眼雌果蠅(眼色基因和轉型基因皆爲異型合子組成)與一白眼雄果蠅(轉型基因爲異型合子組成)交配，產下一大群子代。此子代中外表爲白眼雄果蠅的比例爲何？

B49. Two enzymes X and Y form a biochemical pathway that converts substance A into substance C via an intermediate substance B. In order to infer on which human chromosomes genes X_h and Y_h are located, Mr. Lin generated mouse/human hybrid cell lines. These cell lines contain all mouse chromosomes and a few human chromosomes, as shown in Table 1. Prior to the experiment, a non-sense mutation was induced at the beginning of the mouse gene Y_m. Mr. Lin used specific antibodies to test if human enzyme X_h is produced in each cell line (Table 2). In addition, Mr. Lin added substance A to the cell cultures and, after some time, used colorimetric assays to determine which of the substances A, B or C is present (Table 2). On which human chromosome is Gene Y_h located? Write down the appropriate chromosome number on the answer sheet.

酵素 X 和酵素 Y 作用於一生化反應流程，將物質 A 轉化爲中間產物物質 B 再轉化爲物質 C。爲找出人類對應酵素 X 和酵素 Y 的基因 X_h and Y_h 位於哪條染色體上，林先生製備了鼠/人雜合細胞株(cell lines)。這些細胞株含有所有的鼠染色體和少數的人染色體(如 Table 1 所示)。再進行此實驗前，鼠的 Y_m 基因已被改變爲不能產生有功能的酵素。林先生使用專一抗體偵測人的 X_h 酵素是否存在於這些細胞株中(如 Table 2 所示)。此外，林先生在這些培養細胞中加入物質 A，經過一段時間後以比色分析去決定物質 A, B, 或 C 是否存在(如 Table 2 所示)。由這些結果，請推論人的 Y_h 基因位於哪一條染色體上？

請在答案紙上寫下正確的染色體編號

Table 1

	Human Chromosomes							
Cell line	1	2	3	4	5	6	7	8
a	+	-	+	-	+	+	-	-
b	+	+	-	-	-	-	-	+
c	+	+	-	+	+	-	+	+
d	-	+	+	+	-	+	-	+

Table 2

Cell line	Production of X_h	Substance present
a	+	C
b	-	B
c	-	C
d	+	B

B50. Ernst Mayr defined biological species as “groups of actually or potentially interbreeding natural populations that are isolated from other such groups by one or more mechanisms of reproductive isolation”. For which of the following organism couplets is the observation provided sufficient to call them distinct biological species?

Ernst Mayr 對”生物物種觀”的定義是”一群在實際上或有潛力進行繁殖的天然族群，而這些族群與其它類似族群因具有一個或以上的生殖隔離機制而有所隔離”。請問根據以下對這些”兩兩生物”的觀察，那個情況可被稱爲”不同的生物種”？

(A) Two populations are fixed for competing alleles in the wild, but heterozygous individuals can be produced in laboratory setting. 兩個族群在野外狀況只產生具同型合子的後代，但在實驗室狀態下可以產生具異型合子的後代

(B) No mating can be found between Dalmatian and Chihuahua dogs as their body sizes differ dramatically. 大麥丁狗與吉娃娃狗因爲體型差異太大所以無法交配

(C) Female of two firefly species each only responds to the light signal issued by their conspecific males 兩種螢火蟲的雌蟲只對牠們同種雄蟲所發出來的光訊號有反應

(D) A male and a female moth sample caged in a box failed to mate and lay eggs 一隻雄蛾與雌蛾被關在一個盒子裏但沒有交配也沒有產卵

(E) Two individuals of stag beetles with prominent difference in mandible morphology employ the same of sex pheromones. 兩隻鍬形蟲的個體因其大顎具有明顯的形態差異，因此這暗示它們的性費洛蒙一定相同