PART B

Cell biology (10 questions, 51 points).
細胞生物學（十題，共 51 分）

B1. (6 points). It is known that ribosomes of cytoplasm, ribosomes of endoplasmic reticulum (ER) and mitochondrial ribosomes take part in protein biosynthesis. Distribute proteins listed below on the basis of the site of their synthesis.

已知細胞質、內質網及粒線體中的核糖體均參與了蛋白質的合成，請把下述蛋白質按照其合成的部分填入表中正確的欄位內。

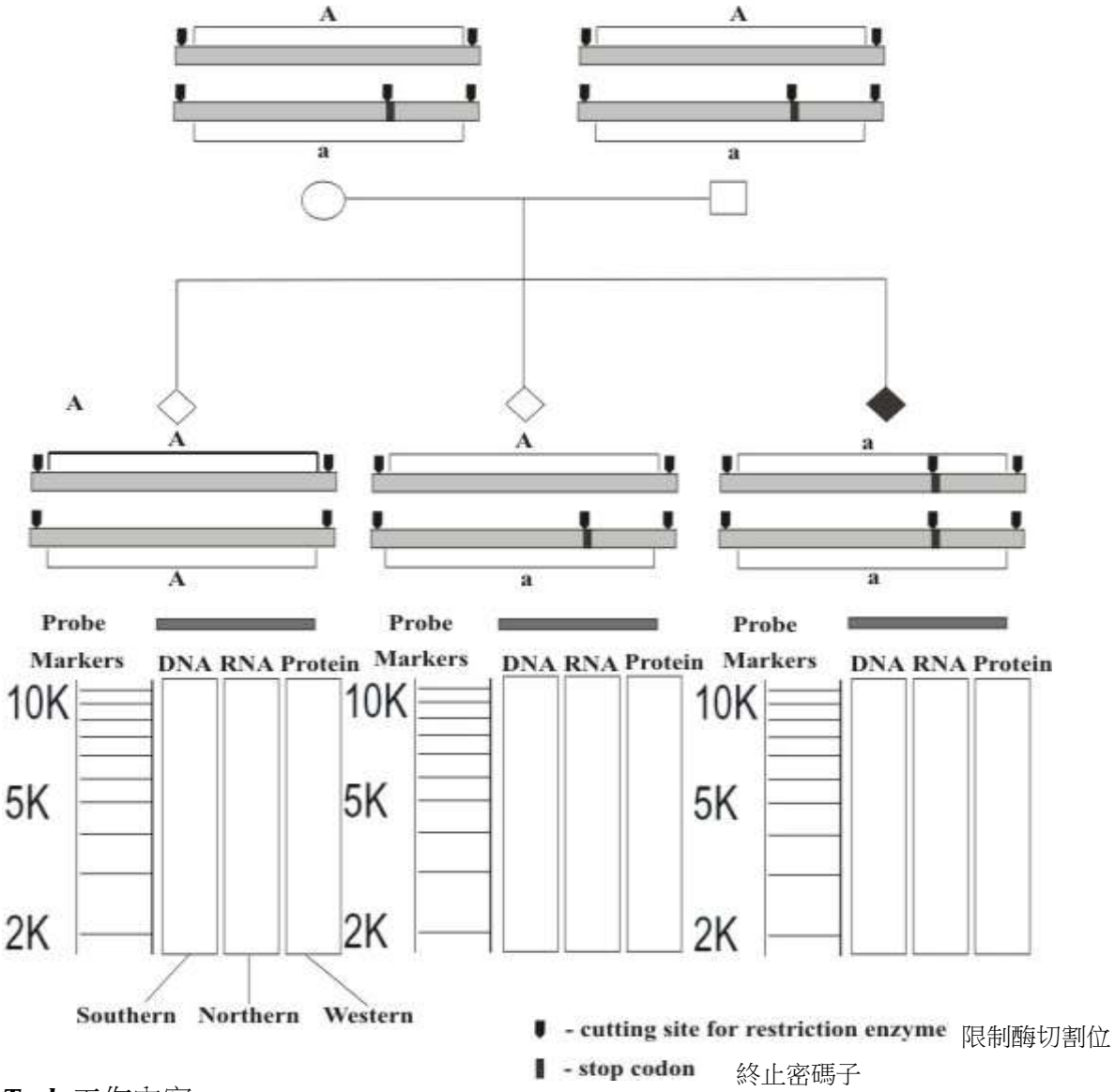
1. Elastin 彈性蛋白
2. Collagen 膠原蛋白
3. Somatotropin 生長激素
4. Actin 肌動蛋白
5. Glycogen synthase 肝腺合成酶
6. Receptors for glucagon 昇糖素的受器
7. Casein 酪蛋白
8. Phosphofructokinase 磷酸果糖激酶
9. Prothrombin 凝血酶原
10. Keratin 角蛋白
11. Lactate dehydrogenase 乳酸去氫酶
12. Tubulin 微管蛋白

Answers:

ER-bounded ribosomes 附著與內質網的核糖體	
Cytoplasmic ribosomes 細胞質中的核糖體	
Mitochondrial ribosomes 粒線體中的核糖體	

B2. (9 points). Human disease albinism is inherited in the autosomal recessive manner (see figure). The cause of this disease is mutation from wild type gene *A* to recessive allele *a*, which introduces a stop codon into the middle of the gene, resulting in a truncated polypeptide. The mutation also introduces a new target site for a restriction enzyme, which makes it possible to detect mutated genes by restriction mapping.

人類的白化症為一種隱性體染色體遺傳疾病（參閱附圖），是由於野生型基因 A 突變成隱性基因 a，使得在基因 A 中產生一個終止密碼子，造成轉譯作用過早停止，此突變也造成了一個新的限制酶切割位，因此可利用限制酶圖譜的變化來診斷此疾病。



Task:工作內容

Depict the expected results of Southern-, Northern-, Western-blot hybridization analyses of all genotypes (*aa, Aa, AA*). Results of Southern-blot hybridization should be depicted according to the length of the largest restriction fragment (11 kb) and length markers shown to the left of each Southern-blot hybridization lane. Markers have to do only with the length of DNA fragments. Results of Northern- and Western-blot hybridization should be depicted without scale, but taking into account the respective positions of different restriction fragments for different genotypes.

請劃出不同基因型（*aa, Aa, AA*）利用南方、北方及西方墨點法作分析的期待結果，南方墨點法的結果必須根據其限制片段大小。片段長度的參考標記位於各圖的左側。注意，標記(markers)的長度祇適用於計算 DNA 片段的長度，北方及西方墨點法的結果可不考慮長度，但要注意不同基因型所產生之 mRNA 及蛋白質的相對長度。

B3. (3 points). Three human-mouse hybrid cell lines have been created X, Y and Z). The table hereunder summarizes their characteristics. Each cell line has several human chromosomes carrying genes coding for particular enzymes.

三株由人類及小鼠細胞融合而成的細胞株分別命名為Ｘ、Ｙ及Ｚ。下圖為這些細胞株特徵的綜合整理。每株均具有數條人類染色體，其中包括了特定酵素的基因。

Chromosome or enzyme	**Line X** Ｘ細胞株	**Line Y** Ｙ細胞株	**Line Z** Ｚ細胞株
Chromosome 3	–	+	–
Chromosome 7	–	+	+
Chromosome 9	–	–	+
Chromosome 11	+	+	–
Chromosome 15	+	–	–
Chromosome 18	+	+	+
Chromosome 20	+	–	+
Glutathione reductase	+	+	–
Malate dehydrogenase	+	–	–
Galactokinase	–	+	+

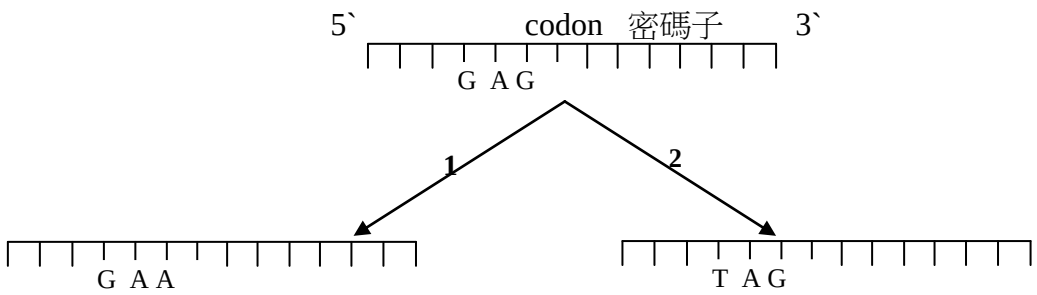
The human chromosome carrying the gene of each enzyme is:
下列基因分別位於哪條人類染色體上？

Answers:

Gene of: 基因	**Chromosome** 染色體
Glutathione reductase	
Malate dehydrogenase	
Galactokinase	

B4. (3 points). Two independent mutation events of a DNA segment lead to the following results. Mark the type of mutations observed.

某段 DNA 片段上兩件獨立的突變事件，導致了以下的結果。請標明觀察的為何種突變。



Answer:

1: ……
2: ……

A. Point mutation.
點突變
B. Transition.
轉換
C. Silent mutation.
無表型突變
D. Transversion.
易位
E. Neutral mutation.
中性突變
F. Missense mutation.
誤義突變
G. Nonsense mutation.
無意義突變

B5. (3 points). Mark the right statements by '+' and the wrong ones by '–' in the appropriate box.
請使用＋號或－號來標示下列敘述是正確（＋）或錯誤（－）

A. In any region of DNA double helix only one chain of DNA is usually used as a template for transcription.
在 DNA 的雙股中，通常只有一股 DNA 常用來當作轉錄的模板。

B. In bacteria the transcription of all classes of RNA is carried out by RNA polymerase of a single type, whereas in eukaryotic cells three types of RNA polymerase are used.
在細菌中不同種類的 RNA 均由同一種 RNA 聚合酶所合成，在真核細胞則分別由三種 RNA 聚合酶進行轉錄。

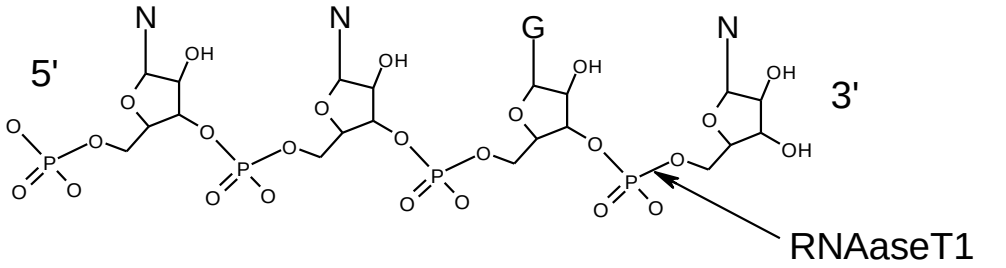
C. Formation of the peptide bond is carried out by enzyme peptidyl transferase, which binds to large subunit of ribosome after the initiation of translation.
轉譯過程中由肽基轉移酶負責合成肽鍵，此酶於轉譯作用啟動後結合在核糖體的大次單位上。

D. Since start codon for protein synthesis is AUG, methionine is only found in N termini of polypeptide chains.
由於蛋白質合成的啟動密碼子為 AUG，因此甲硫胺酸只存在於多肽鍵的 N 端。

E. Many antibiotics used in medicine today selectively inhibit protein synthesis only in prokaryotes because of structural and functional differences between ribosomes of prokaryotes and eukaryotes.
由於原核及真核生物的核糖體具有結構及功能上的差異，故目前使用的抗生素可選擇性地抑制原核生物蛋白質的合成。

F. Modified nucleotides, which are in the composition of tRNA molecule, form as a result of covalent modification of standard nucleotides after their incorporation into RNA-transcripts.
經修飾後的核苷酸，為 tRNA 分子的構成部份，它是由一般核苷酸經過共價性修飾作用加入 RNA 轉錄本後所形成。

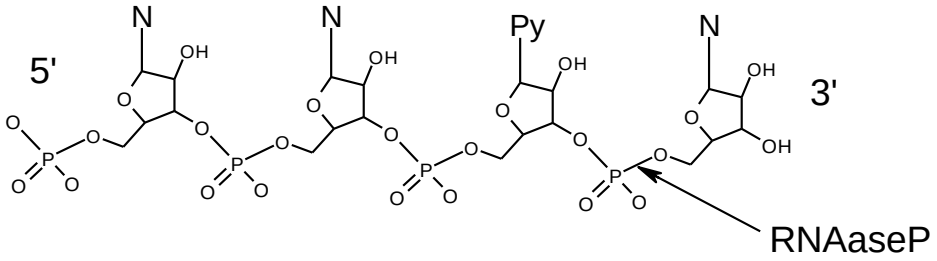
B6. (5 points). Oligoribonucleotide X was treated with phosphatase (for removal of 3′ and 5′ -
某段寡核糖核苷酸鏈X先施以磷酸酶處理（移除 3′與 5′端的磷酸基），再施
terminal phosphates), then with RNAase T1, which cleaves all phosphodiester bonds
以 **RNAase T1** 的處理，切斷 **3′**端鳥糞苷的磷酸二脂鍵（請參閱下圖）。
located in a 3′ position of guanosine in a 5′-specific manner.



As a result, oligonucleotides L, M and N were generated in equal amounts. Each of them
最後獲得三種數量相同的寡核糖核苷酸鏈分別為 L、M、N，將它們進一步施以磷酸酶
was further treated with phosphatase and subjected to alkaline hydrolysis. Results are
處理及鹼性水解，得出如下表之結果。
listed in the table below.

Oligoribonucleotide 寡核糖核苷酸鏈	Content, mole/mole of oligoribonucleotide 成份／濃度
L	UMP (1), AMP (1), CMP (1), Guanosine (1) 鳥糞苷
M	AMP (1), Cytidine (1) 胞苷
N	CMP (2) , Guanosine (1) 鳥糞苷

Then experiment was modified: oligoribonucleotide X after treatment with phosphatase was
接著改變實驗程序，寡核糖核苷酸鏈X先以磷酸酶處理，再施以 RNAaseP 處理，切斷
hydrolyzed with RNAaseP, which cleaves all phosphodiester bonds in a 3′-position of
3′端嘧啶的磷酸二脂鍵（請參閱下圖）。
pyrimidines in a 5′ - specific manner.



This hydrolysis yielded five products in approximately equimolar concentrations: uridine
反應後會得到五種濃度相似的產物，分別為單磷酸脲苷、單磷酸胞苷以及
monophosphate, cytidine monophosphate and oligonucleotides P, Q and R. After resolution of
寡核糖核苷酸鏈 P、 Q、 R，經分離各成分及鹼性水解後，得出如下表之結果。
the mixture and alkaline hydrolysis of these oligonucleotides data listed in the table below

were obtained.

Oligoribonucleotide 寡核糖核苷酸鏈	Content, mole/mole of oligoribonucleotide 成份／濃度
P	CMP (1), GMP (1)
Q	GMP (1), AMP (1), Cytidine (1)
R	AMP (1), CMP (1)

Using provided above results, deduce nucleotide sequence of oligoribonucleotide X.
請根據前述二項實驗結果定出寡核糖核苷酸鏈X的序列。
Answer: _____

B7. (5 points).The amino acid cysteine (Cys) has three ionizable groups:
半胱氨酸具有三種可離子化的功能基

- **α-amino group**
  α-胺基
- **α-carboxyl group**
  α-羧基
- **a side chain that can be negatively charged.**
  帶有負電荷的側鏈

The pK values are 8.18, 1.71 and 10.28, respectively. What is the net charge of cysteine at pH 其 pK 值分別為 8.18、1.71 及 10.28。當半胱氨酸處於 pH1、5、9 及 12 時，其淨電荷分別
1, 5, 9 and 12? Using an appropriate letter for each direction, show migration of cysteine in 為何？以及當半胱氨酸處於具有不同 pH 值的電場中之移動方向為何？
electric field at different pH values.
請使用下列三種移動方向的代號作答

A. To cathode (–)
向負極移動
B. To anode (+)
向正極移動
C. Does not migrate
不移動

Fill in the table. Which of the pH values is nearest to the pI (isoelectric point) of this amino 請把正確答案填入下表內，注意！哪一個 pH 值最接近半胱氨酸的等電位點，請在下表中
acid? Circle this pH value in the table.
圈出此 pH 值。
Answer:

pH	Net charge 淨電荷數值	Migrates toward 移動方向
1		
5		
9		
12		

B8. (8 points). Match the vitamins with their appropriate biological functions and/or consequences of deficiency of this vitamin or it's derivatives. Fill in the table for answers.
請針對下列維生素的生理功能，以及缺乏此維生素及其衍生物所引發的疾病進行配對，請把答案填入表內正確的欄位中。

Designation 代號	**Vitamin** 維生素
A.	B_1 (thiamine)
B.	B_2 (riboflavin)
C.	B_6 (pyridoxine)
D.	Folic acid 葉酸
E.	A (retinol)
F.	D (calciferol)
G.	E (tocoferol)
H.	K (menaquinone)
I.	C (ascorbic acid)
J.	B_{12} (cobalamin)
K.	PP (nicotinic acid) 菸鹼酸

Number	**Functions of vitamins or consequences of deficiency** 維生素的功能或缺乏時所導致的結果
1.	Antioxidant 抗氧化劑
2.	Regulation of calcium and phosphate metabolism 調節鈣及磷酸的代謝
3.	Group transfer to or from amino acids 自胺基酸中移功能基（移進或移出）
4.	Precursor of light absorbing group in visual pigments ents 視覺色素的前驅物
5.	Blood coagulation 凝血
6.	Scurvy 壞血症
7.	Beri beri 腳氣病
8.	Pelagra 糙皮病
9.	Anemia 貧血

10.	Subdermal hemorrhaging　皮下出血
11.	Co-enzyme of dehydrogenases 去氫酶的輔酶
12.	Rickets 佝僂症（軟骨症）

Answers:

A.	
B.	
C.	
D.	
E.	
F.	

G.	
H.	
I.	
J.	
K.	

B9. (4 points).The table below shows haploid or partial diploid *lac* operon of *E.coli.*
下表為大腸桿菌單套或部份雙套 lac 操縱組的說明。
Gene *lacI* codes for repressor.
基因 *lacI* 所表現的產物為抑制蛋白
P and O are promoter and operator, respectively.
Ｐ及Ｏ分別為啟動子（Ｐ）及操作子（Ｏ）
***LacZ* and *lacY* represent genes encoding for β-galactosidase and β-galactoside permease,**
基因 *lacZ* 及 *lacY* 所表現的產物分別為 β-半乳糖苷酶（*lacZ*）及
respectively.
β-半乳糖苷滲透酶（*lacY*）
O^c – a constitutive mutation in the operator.
O^c 為操作子的組成型突變
I^s represents a mutation in the *lacI* gene, which causes mutant repressor protein not to be
I^s 表示 *lacI* 基因的突變，突變後的抑制蛋白一但接上操作子後便無法脫離。
separated from the operator once it binds to it.

Suppose that there is no glucose in the bacterial culture medium. Put a mark 'O' if β-
假設在下列兩種條件中的培養液中沒加入葡萄糖，請分別以Ｏ及Ｘ標示是否會（Ｏ）
galactosidase is synthesized at each condition, otherwise put 'X' in the following table.
或不會（Ｘ）表現出 β-半乳糖苷酶。

Strain 菌種	Genotype 基因型	Lactose absent 沒有乳糖	Lactose present 有乳糖
1	$I^- O^c Z^+ Y^-$		
2	$I^+ O^c Z^- / I^+ O^+ Z^+$		
3	$I^- P^+ O^c Z^+ Y^+ / I^+ P^- O^+ Z^+ Y^-$		
4	$I^s P^+ O^+ Z^+ Y^- / I^- P^+ O^c Z^- Y^+$		

B10. (5 points). Match the organism in the left column with the corresponding disease in the right column.
將下面左邊的微生物與右邊的疾病相配對。

1. *Bacillus anthracis*
炭疽桿菌
2. *Borrelia burgdorferi*
博氏疏螺旋體
3. *Escherichia coli*
大腸桿菌
4. Filarial nematodes
血絲蟲
5. *Plasmodium vivax*
瘧原蟲
6. *Streptococcus pyogenes*
化膿鏈球菌
7. *Treponema pallidum*
梅毒螺旋體
8. *Trypanosoma gambiense*
睡眠病原蟲
9. *Vibrio cholerae*
霍亂弧菌
10. *Yersinia pestis*
鼠疫桿菌

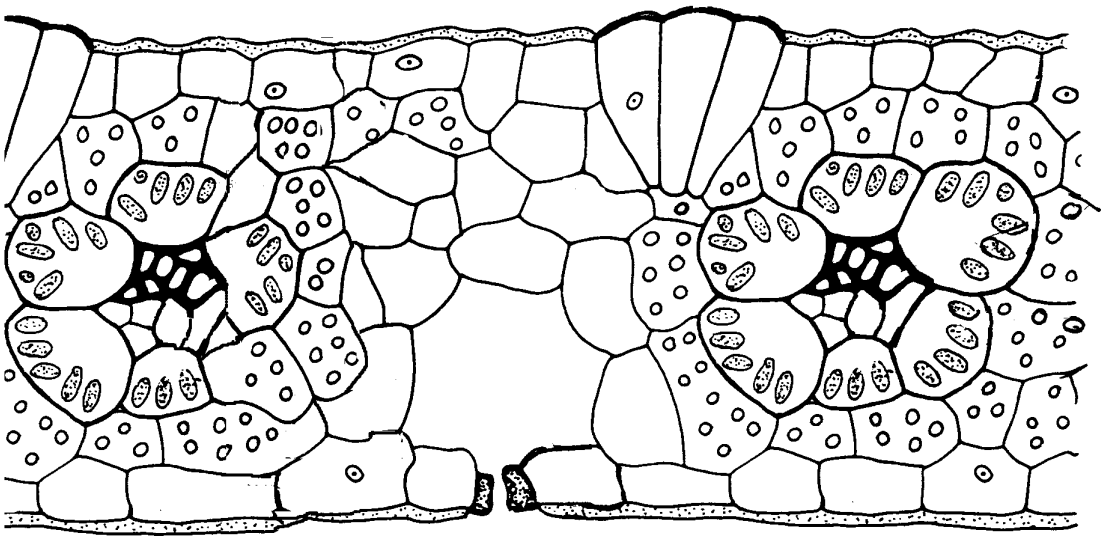
A. African sleeping sickness
非洲睡眠病
B. Anthrax
炭疽熱
C. Cholera
霍亂
D. Elephantiasis
象皮病
E. Lyme disease
萊姆疏螺旋體病
F. Malaria
瘧疾
G. Plague
鼠疫
H. Tuberculosis
肺結核
I. Strep throat
鏈球菌喉炎
J. Syphilis
梅毒
K. Urinary tract infection
尿道感染

Answers:

1	2	3	4	5	6	7	8	9	10

Plant anatomy and physiology (6 questiopns, 29 points).
植物解剖及生理(6 題、29 分)

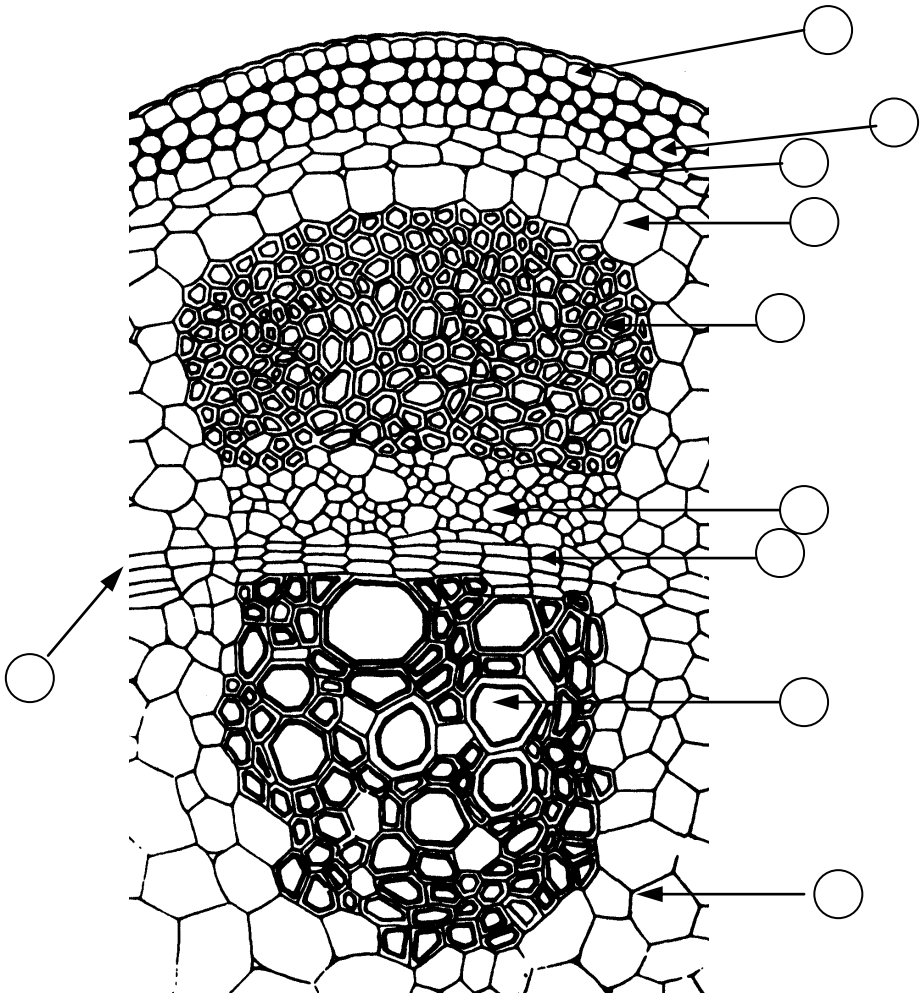
B11. (5 points). The figure shows a cross section of a plant leaf.
下圖為植物葉片橫切面



Indicate which of the following statements concerning this plant are true (+) and which are false (–).
判斷下列敘述真偽，請在答案紙上以「+」代表真、「－」代表偽。

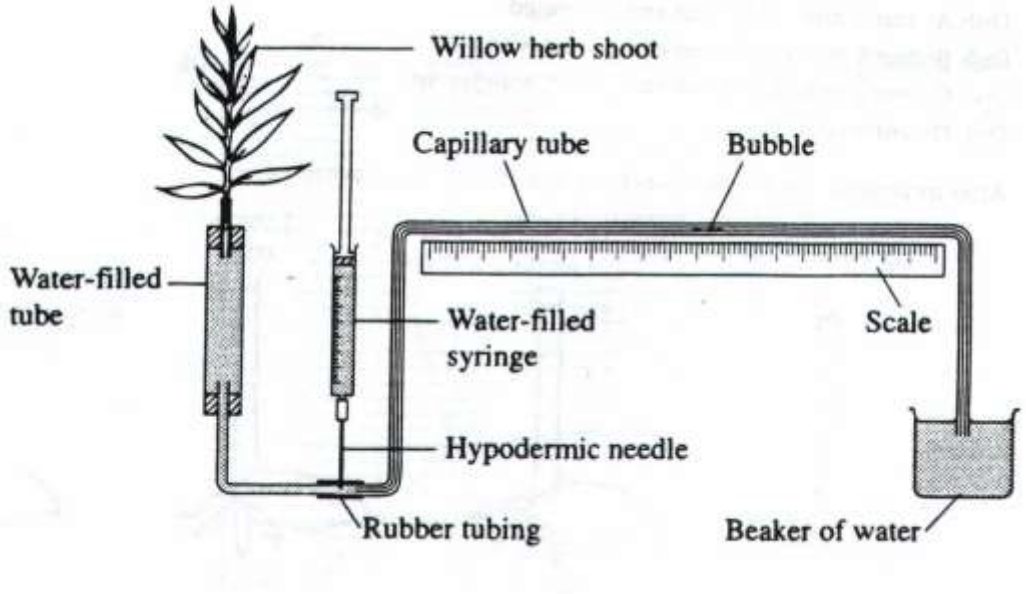
1.	Hydrophytic habitat. 此為水生植物	
2.	C_4 -photosynthetic pathway. 光合作用屬於 C4 型	
3.	Anatomy “kranz”. 具環形維管束鞘	
4.	Mesophyll with isolateral organization. 葉肉具上下相等之柵狀組織	
5.	Xerophytic habitat and plants of tropics and subtopics. 旱生植物且生長於熱帶、亞熱帶	刪除
6.	C_3 photosynthetic pathway. 光合作用屬於 C3 型	
7.	Pennate venation. 網狀脈	
8.	Asteraceae(*Compositae*) Family. 菊科	
9.	Poaceae (*Gramineae)* Family. 禾本科	
10.	Parallel venation. 平行脈	

B12. (5 points). Label the plant structures in the following picture!
在答案紙上所指的圓圈中，標示下圖的植物構造之數字代號 (如右表所示)



1. **Phloem.** 韌皮部
2. **Xylem.** 木質部
3. **Endodermis.** 內皮層
4. **Fascicular cambium.** 維管束形成層
5. **Epidermis.** 表皮
6. **Parenchyma.** 薄壁組織
7. **Cortex parenchyma.** 皮層薄壁組織
8. **Sclerenchyme.** 厚壁組織
9. **Interfascicular cambium.** 維管束束間形成層
10. **Collenchyme.** 厚角組織

B13. (5 points). The potometer can be used to measure transpiration in a cut shoot such as rose-bay willow plant, by measuring water uptake.
下圖裝置(potometer)可用以測量一段樹枝(例如柳樹) 的吸水情形來代表蒸散作用。



Indicate which of the following statements are true (+) and which are false (–).
判斷下列敘述真偽，請在答案紙上以「+」代表真、「－」代表偽。

A. The potometer is usually assembled under water
此裝置通常在水中組裝完成

B. The water-filled syringe is used to suck water out of the apparatus when air bubbles appear.裝水的針筒是當管中有多餘氣泡產生時，用來將水吸掉

C. The willow shoot must be sealed with vaseline immediately after it is cut from the plant. 柳樹條在自植物切下時，應立即以凡士林將切口封住

D. The hypodermic needle is used to introduce the air bubble into the potometer.
皮下針是用來將氣泡送入裝置中

E. Enclosing the shoot in a black plastic bag will reduce the transpiration.
將莖部以黑塑膠袋蓋住可降低蒸散作用

F. The rate of transpiration will be high in still, humid air.
在靜止無風及潮濕的空氣中，蒸散作用的速率高

G. The rate of transpiration will be highest in warm, dry moving air.
在高溫及乾燥的空氣中，蒸散作用的速率最高

H. The rate of water uptake and the rate of transpiration are not always equal.
此植物吸收水分的速率與蒸散作用的速率並不常相同

I. Low cohesive properties between the water molecules create problems for potometer experiments.
水分子間的內聚力低，會造成此裝置出問題

J. Results from potometer experiments can never be quantitative.
此裝置的結果絕不能數量化 ☐

B14. (2,5 points). For a short-day-light plant, please predict which treatments, as listed below, would inhibit (+) flowering. All the treatments were conducted at night. Mark true statements with "+", false statements - with "–".
對一棵短日照植物而言，預測下列哪一種處理可以抑制開花(+)? 所有的處理是在晚上進行。
判斷下列敘述真偽，請在答案紙上以「+」代表可抑制、「－」代表不可抑制。

A. Exposure in red light and far-red light, consecutively.
依序照射紅光、遠紅光 ☐

B. Exposure in red light, far-red light, and red light, consecutively.
依序照射紅光、遠紅光、紅光 ☐

C. Exposure in red light, far-red light, and white light, consecutively.
依序照射紅光、遠紅光、白光 ☐

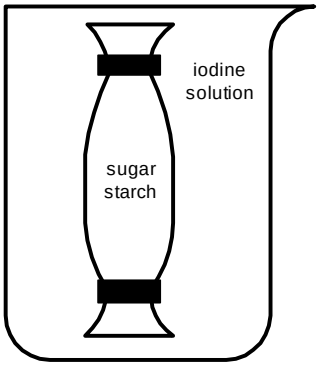
D. Exposure in white light and far-red light, consecutively.
依序照射白光、遠紅光 ☐

E. Exposure in red light, far-red light, white light, red light, and white light, consecutively. 依序照射紅光、遠紅光、白光、紅光、白光 ☐

B15. (6,5 points). Diffusion and osmosis are important for the passive transport of molecules in the cell.
擴散及滲透作用在細胞中的被動運輸具重要性。據此回答以下問題

<u>01.</u> (2,0 points). The figure shows an experiment with a dialysis membrane filled with sugar and starch (colorless) hanging in a beaker with diluted iodine solution (orange – brown). Which color would you expect after several hours of dialysis (mark with "+").
下圖顯示實驗中一個裝有糖及澱粉溶液(無色)的透析膜，置於一個裝有稀釋碘溶液(橘-棕色)之燒杯中，在數小時的透析之後，預測將有何顏色變化?
請在答案紙上之適當空格中標示"+"

	Solution in the beaker. 燒杯內的溶液	Solution in the dialysis tube. 透析管內的溶液
Colorless 無色		
Orange-brown 橘-棕色		
Pink-red 粉紅-紅色		
Greenish-yellow 黃綠色		
Blue-black 藍黑色		



<u>02</u>. (2.5 points). In a similar experiment dialysis membranes are filled with solutions 在另一相似的實驗中，使用上圖相同的裝置及透析膜，但透析管內溶液與燒杯中
with different concentrations of molecules and left in beakers with solutions with 溶液有不同的溶液濃度組合(如下表所示)，
different molecule concentrations. They have all the same mass at the beginning of 實驗進行之初，所有透析內溶液的重量都相同，
the experiment. The size of the molecules is bigger than the pore size of the 分子大小皆比透析膜的孔洞還大。
membrane. Please mark with "+" the experimental settings, where the beaker 在燒杯溶液(與透析膜內溶液相比較)為低張溶液的空格中標示"+"，
contains a hypotonic solution compared to the dialysis tube, and mark with "–" the 其他標示"–"
different settings.

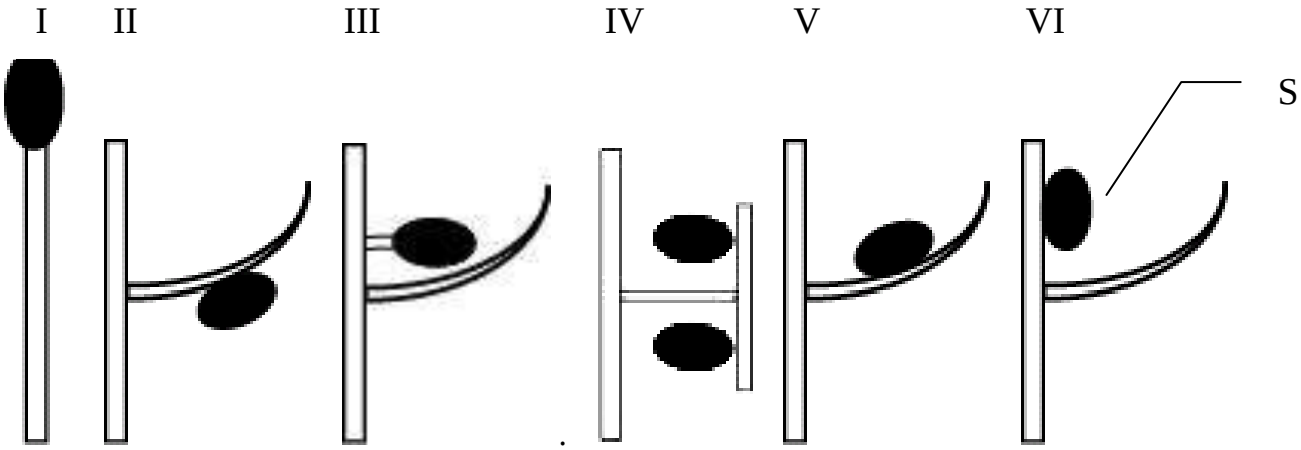
Experiment 實驗	A	B	C	D	E
Concentration in the dialysis tube (M). 透析管內濃度 (M)	0,1	0,8	0,4	0,2	0,4
Concentration in the beaker (M). 燒杯內溶液濃度 (M).	0,8	0,1	0,2	0,4	0,4
Hypotonic solution. 低張溶液					

<u>03.</u> (2 points). The tubes are weighed after several hours of dialysis. Their mass is
在數小時的透析後，將整個透析管拿去秤重，
compared to that before the dialysis. Write the letters of the experiments in the
並與透析前的重量相比較，依據其管內重量大小，
order of tube mass increase, beginning with the tube having the lowest mass.
由小到大依序，在答案紙上寫出其實驗英文字母

Order of the tubes with regard to their mass:
透析管內之重量由小到大的次序

Answers: _____

B16. (5 points). Which position of sporangia is characteristic of present day representatives of
下列各植物門的現存植物之代表種中，其典型的孢子囊位置(如下圖所示)，
the higher plants phyla listed below?
選擇適當羅馬數字代號填入答案紙中

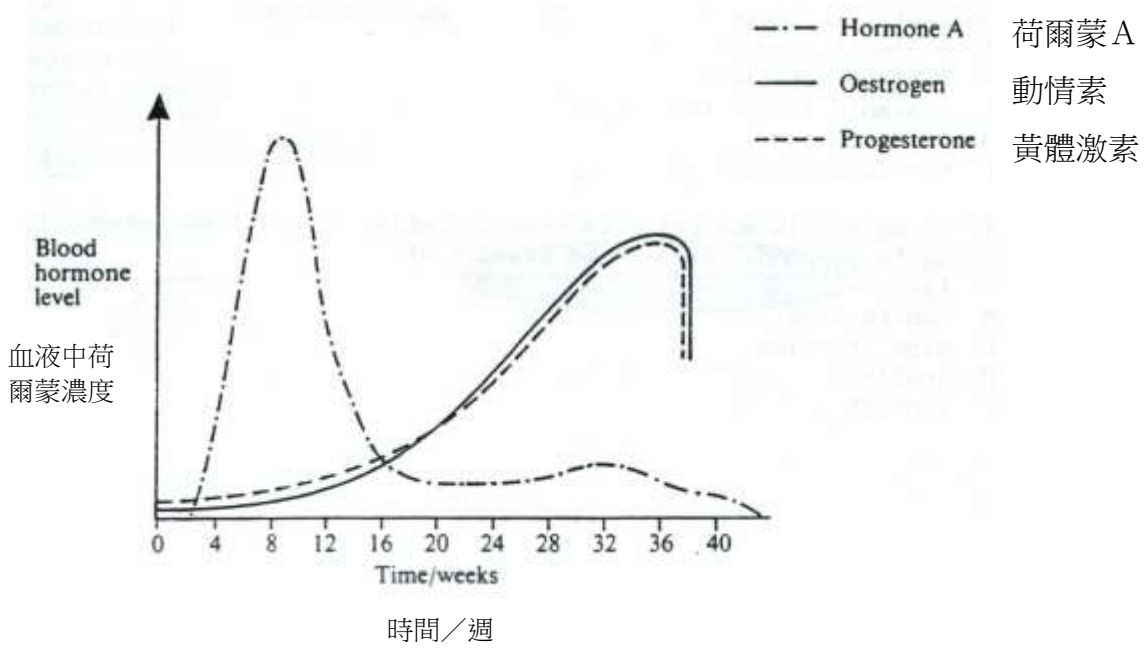


S- sporangium S 代表孢子囊

Phylum	**Plant number 植物羅馬數字代號**
Bryophyta 苔蘚門	
Lycopodiophyta 石松門	
Equisetophyta 木賊門	
Pterophyta 真蕨門 *(Polypodiophyta)*	

Animal Anatomy & Physiology (6 questions, 26 points).
動物解剖及生理學(六題，共 26 分)

B17. (5 points). The graph indicates the blood levels of three hormones produced in a pregnant woman.
下圖為一婦女於懷孕期內，血液中三種荷爾蒙的濃度變化



01. (2 points). Using + (true) and – (false), indicate whether each of the following is true or false.
請使用＋或－號，來標示下列敘述是正確（＋）或錯誤（－）

A. Hormone A is produced by the ovary
荷爾蒙A是由卵巢所製造

B. Hormone A is human chorionic gonadotrophin.
荷爾蒙A是人類絨毛膜性促素荷爾蒙（HCG）

C. Hormone A is prolactin.
荷爾蒙A為泌乳激素

D. Hormone A is made by the chorion.
荷爾蒙A是由絨毛膜所製造

02. (1 point). Which hormone keeps the smooth muscle of the uterus relaxed during pregnancy? (mark with '+').
下列何種激素使子宮平滑肌於懷孕期間維持放鬆狀態？請用＋號標示正確的答案

A. Progesterone.
助孕酮（黃體激素）

B. Prolactin.
泌乳激素

C. Oxytocin.
催產素

D. FSH.
濾泡刺激素（促濾泡激素）

E. LH.
黃體生長素

<u>03.</u> (1.5 points). Two other hormones, not shown on the graph, are also produced during pregnancy. These are prostaglandins and oxytocin. Indicate whether the following statements are true (+) or false (–).

除上圖所示的激素外，還有二種於懷孕期被製造的激素，分別為前列腺素及催產素，請使用＋號或－號來標示下列敘述是正確（＋）或錯誤（－）

A. These two hormones are produced by the ovaries.
這兩種激素均由卵巢所製造

B. These two hormones are esponsible for milk formation.
這兩種激素均負責乳汁的製造

C. These two hormones are responsible for contractions of the uterine wall.
這兩種激素均負責子宮壁的收縮

D. These two hormones are made by the endometrium and pituitary gland, respectively.
這兩種激素分別由子宮內膜（前列腺素）及腦下腺（催產素）所製造

刪除

B18. (3 point). Name the germ layers of metazoan embryo of which the following systems or organs developed:

請利用符號（1、2、3）分別標明下列器官是源自何種胚層：

A. Brain.大腦

B. Hair.頭髮

C. Autonomic ganglia.自主神經的神經結

D. Lungs.肺

E. Cardiac muscle.心肌

F. Cartilage.軟骨

1. **Ectoderm.** 外胚層
2. **Endoderm.** 內胚層
3. **Mesoderm.** 中胚層

B19. (3 points). Match the protein (1 to 6) and its function (A to F):

請把下列的蛋白質及功能作配對

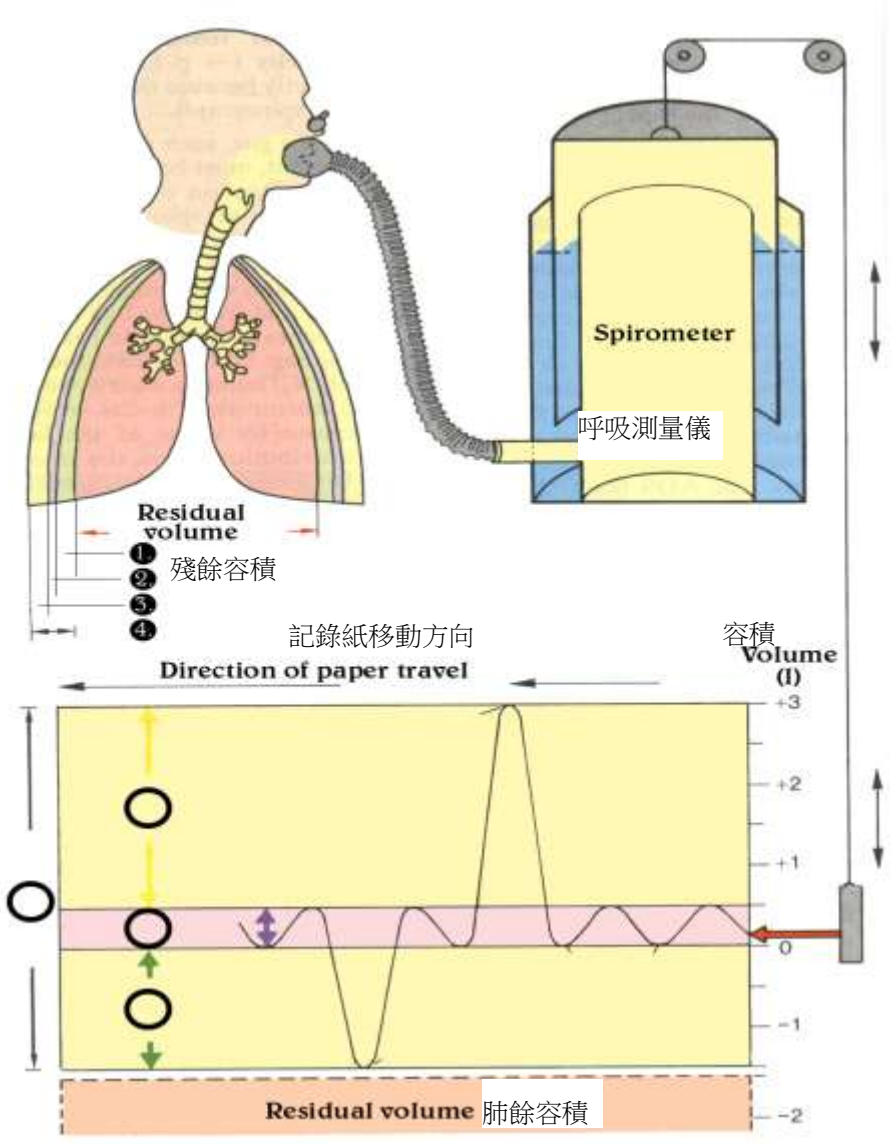
1. Myoglobin. 肌紅素	A. Blood clotting. 凝血作用
2. Prothrombin. 凝血酶原	B. Regulation of water excretion. 調控水份的排泄
3. Ferritin. 運鐵蛋白	C. Light-sensitive pigment of rod cells. 為桿細胞中對光敏感的色素分子
4. Vasopressin. 抗利尿激素	D. Oxygen-storage in skeletal muscles. 骨骼肌中負責氧氣的貯存
5. Collagen. 膠原蛋白	E. Iron storage in spleen, liver and bone marrow. 在脾、肝及骨髓中負責鐵的貯存
6. Rhodopsin. 視紫紅質	F. Major fibrous protein of connective tissue. 為結締組織中主要的纖維蛋白

Answers:

1	2	3	4	5	6

B20. (4 points). Sign the curve by filling in the circles using appropriate numbers from the upper figure. In the table, for every number put a correct letter corresponding to a term given below.

在下圖表中的四個圈圈內，分別填入數目字以標示肺容積的相對變化，再把代表不同肺容積名稱的英文代號填入表中正確的欄位內



Respiratory volumes 呼吸容積	
Number in the picture and curve 圖中曲線的代號	**Term letter 英文代號**
1.	
2.	
3.	
4.	

A. Expiratory reserve volume.
呼氣貯備容積

B. Tidal volume.
潮氣容積

C. Inspiratory reserve volume.
吸氣貯備容積

D. Vital capacity.
肺活量

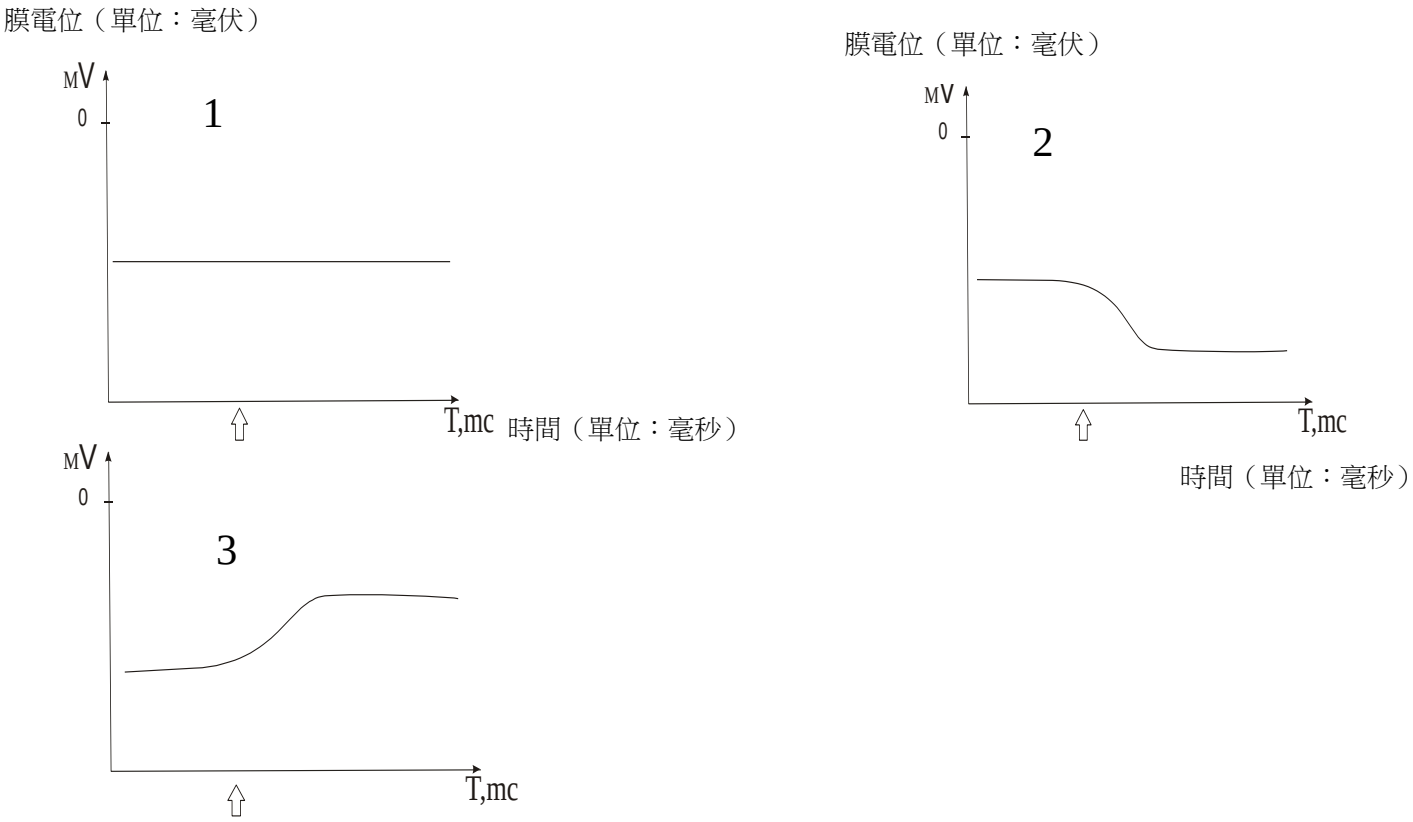
B21. (7 points). How can resting potential of a cell change after addition of the biologically active compounds listed below (compound addition is marked by an arrow ⇧)?

加入不同藥物後，對細胞靜止膜電位的影響，⇧代表加入藥品的時間點。

01. (5 points). Please determine which graph reflects the addition of which compound.

請把圖表代號填入表中正確的欄位內

Fill the results in the table.



Nistatin (Na^+- ionophore*): Na^+的離子載體	_____
Tetrodotoxin (inhibitor of Na^+-channels): Na^+通道抑制劑	_____
Valinomycin (K^+- ionophore): K^+的離子載體	_____

<u>02.</u> (2 points). How is the change of transmembrane potential, shown in the graphs 2 and 3, called?

上述圖 2 及圖 3 中膜電位變化的正確名稱分別為？

A. Hyperpolarisation.
過極化
B. Depolarisation.
去極化

C. Repolarisation.
再極化
D. Action potential.
動作電位
E. Overshoot.
越射電位

Answers:

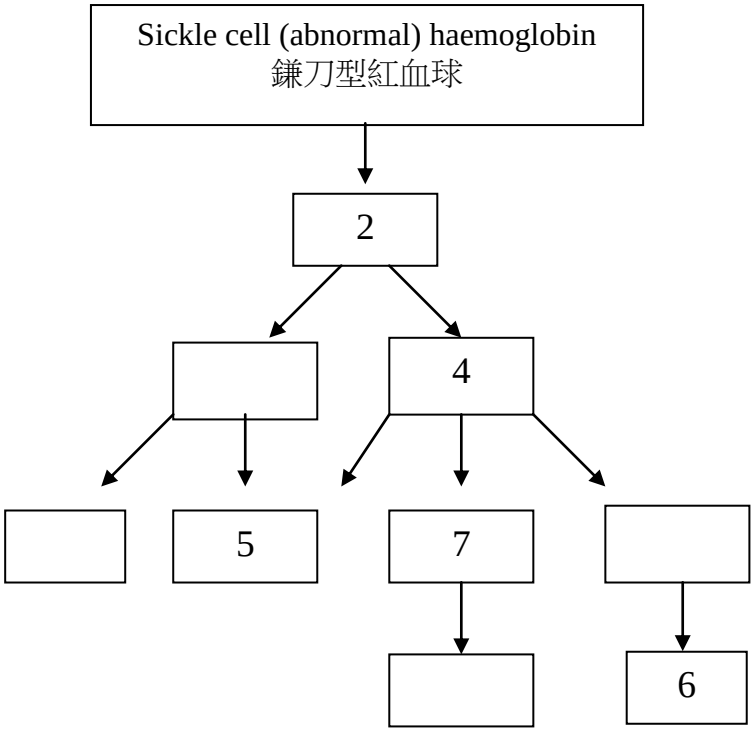
2 – _____

3 – _____

B22. (4 points). A mutation in the hemoglobin gene (*HbS*) causes sickle cell disease that
一種血紅素基因的突變(*HbS*)會產生鐮刀型貧血，它會引發一系列的症狀，
produces a cascade of symptoms, such as:
其中包括：

1. Anemia.
貧血
2. Sickle shaped red blood cells.
鐮刀型紅血球細胞
3. Breakdown of red blood cells.
紅血球細胞破裂
4. Clumping of cells and clogging of small blood vessels.
紅血球聚集成團，導致小血管阻塞
5. Heart failure.
心衰竭
6. Kidney failure.
腎衰竭
7. Brain damage.
腦部損傷
8. Damage to other organ.
其他器官的損傷
9. Paralysis.
癱瘓

In the following diagram, the symptom in the box on top of the arrow causes the symptom in
在後頁的流程圖中，先出現的症狀標示在較上方的位置，請按照症狀出現的次序，於
the box below the arrow. Fill the empty boxes with the number of the appropriate symptoms.
空格中填入正確的代號。


Sickle cell (abnormal) haemoglobin
鎌刀型紅血球
2
4
5
7
6

Ethology (1 questions, 8 points).
動物行為學(一題，共 8 分，第 23 題已刪除，不須做答)

B23. (3 points). Guppies are often called 'millionaire fishes' because of their progeny. (刪除)

In 1966, Professor C.M. Breder, then director of the New York aquarium, decided to perform an experiment, in order to learn more about fish reproduction. He put pair of Guppies (one adult male and one adult female) into a small aquarium, with 27.5 liters of water capacity supplied with enough food and oxygen to maintain up to 300 fish. During the 6 following months and with an interval of 4 weeks between each breeding (these fishes are ovoviviparous), the female produced 102, 87, 94, 51 and 89 offspring, it means a total of 443 guppies. A later recount showed that only 9 were alive: 6 females and 3 males. The rest had been eaten by their own mothers.

In another aquarium with the same size and conditions, the researcher placed 8 adult males, 8 adult females and 8 young fishes, a total of 24 guppies. Females got abundant progeny, too. Data of proliferation during the course of the following 6 months from the introduction of the original group of 24 guppies in the aquarium, are shown in the following tables.

FEMALE 1						
		Week 4	Week 8	Week 12	Week 16	Week 20
Number of offspring after each hatching	Males	29	24	31	30	33
	Females	58	48	64	58	68
	Total	87	72	95	88	101
Number of offspring counted some hours after hatching	Males	0	0	0	0	0
	Females	0	0	0	0	0
	Total	0	0	0	0	0
Observation: The just hatched guppies were devoured by their own mother						

FEMALE 2						
		Week 4	Week 8	Week 12	Week 16	Week 20
Number of offspring after each hatching	Males	32	26	33	28	29
	Females	65	50	66	56	58
	Total	97	76	99	84	87
Number of offspring counted some hours after hatching	Males	0	0	0	0	0
	Females	0	0	0	0	0
	Total	0	0	0	0	0
Observation: The just hatched guppies were devoured by their own mother						

FEMALE 3						
		Week 4	Week 8	Week 12	Week 16	Week 20
Number of offspring after each hatching	Males	32	29	25	34	28
	Females	64	56	51	69	55
	Total	96	85	76	103	83
Number of offspring counted some hours after hatching	Males	0	0	0	0	0
	Females	0	0	0	0	0
	Total	0	0	0	0	0
Observation: The just hatched guppies were devoured by their own mother						

FEMALE 4						
		Week 4	Week 8	Week 12	Week 16	Week 20
Number of offspring after each hatching	Males	28	25	35	30	29
	Females	57	49	69	61	60
	Total	85	74	104	91	89
Number of offspring counted some hours after hatching	Males	0	0	0	0	0
	Females	0	0	0	0	0
	Total	0	0	0	0	0
Observation: The just hatched guppies were devoured by their own mother						

FEMALE 5						
		Week 4	Week 8	Week 12	Week 16	Week 20
Number of offspring after each hatching	Males	33	30	30	23	30
	Females	67	59	64	47	60
	Total	100	89	94	70	90
Number of offspring counted some hours after hatching	Males	0	0	0	0	0
	Females	0	0	0	0	0
	Total	0	0	0	0	0
Observation: The just hatched guppies were devoured by their own mother						

FEMALE 6						
		Week 4	Week 8	Week 12	Week 16	Week 20
Number of offspring after each hatching	Males	30	29	26	35	25
	Females	62	57	53	70	52
	Total	92	86	79	105	77
Number of offspring counted some hours after hatching	Males	0	0	0	0	0
	Females	0	0	0	0	0
	Total	0	0	0	0	0
Observation: The just hatched guppies were devoured by their own mother						

FEMALE 7						
		Week 4	Week 8	Week 12	Week 16	Week 20
Number of offspring after each hatching	Males	29	24	33	28	29
	Females	60	50	71	57	62
	Total	89	74	104	85	91
Number of offspring counted some hours after hatching	Males	0	0	0	0	0
	Females	0	0	0	0	0
	Total	0	0	0	0	0
Observation: The just hatched guppies were devoured by their own mother						

FEMALE 8						
		Week 4	Week 8	Week 12	Week 16	Week 20
Number of offspring after each hatching	Males	26	32	33	28	28
	Females	52	65	64	58	57
	Total	78	97	97	86	85
Number of offspring counted some hours after hatching	Males	0	0	0	0	0
	Females	0	0	0	0	0
	Total	0	0	0	0	0
Observation: The just hatched guppies were devoured by their own mother						

ORIGINAL NUMBER OF FISH			
	ADULTS		YOUNGS
	Males	Females	
Initial number of guppies in the aquarium	8	8	8
N° of guppies recounted one year later	3	6	0
Observations: The young of the original establishment were devoured by the adults. Some adults of the original establishment died by unknown causes.			

Which of the following statements arise from the analysis of the previous data? Mark with 'X' correct statements.

I. Guppies eat their own offspring ('infanticide' behaviour). ☐

II. Guppies show 'indiscriminate' cannibalism, eating all individuals belonging to its species. ☐

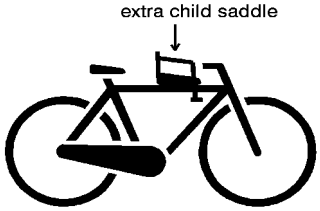
III. Guppies show 'selective' cannibalism, eating the individuals belonging to its species which are shorter than threshold level. ☐

IV. Guppies show 'selective' cannibalism eating only foreign progeny. ☐

以上刪除**(B23 不須做答)**

B24. (8 points). Two young men (Hans and Henri), behaviour researchers of more or less the same age and appearance, are going to do some investigation about sexual preferences of human females. For this purpose they select six nice outdoor cafés popular with young women and hire two identical bikes of which one is provided with an extra child saddle (see picture).

兩位(Hans and Henri)年輕的行為學家，年紀與外貌相仿，想要研究人類女性的性嗜好，為此他們選擇了六個廣為年輕女性所喜愛的戶外咖啡座，並租用兩輛自行車，其中一輛加裝了小孩的坐椅（如圖）。



Hans and Henri expect that a man having a bike with a child's saddle is more attractive for young women. This is checked on a sunny afternoon in July. Hans and Henri make a tour along the six outdoor cafés, indicated A to F. At every café they halt for 15 minutes. While standing in front of the café with their bikes and simulating as if they are having a talk together, in the meantime they both try individually to realise as many eye contacts as possible with the females sitting outside. This is recorded and after each café Hans and Henri change bikes. The results of this experiment are shown in the table.

Hans 及 Henri 假設一男人的自行車若加裝了小孩的坐椅會對年輕的女性更具吸引力，故在某個晴朗的七月下午測試他們的假設，他們在A到F的六個露天咖啡座做調查，每站他們停留十五分鐘，他們站在咖啡座前假裝在談天，同時分別計算坐在外頭的女性與他們的眼神互相注視的次數，將此記錄下來，然後前往下一個咖啡座並彼此交換自行車。實驗結果如下表所示。

	Number of hits (eye contacts) at café A to F 由 A 至 F 咖啡座眼神對視的次數						
	A	B	C	D	E	F	Total 總數
Hans	**12**	10	**14**	7	**17**	12	72
Henri	9	**17**	10	**10**	12	**20**	78
Total 總數	21	27	24	17	29	32	150

Remark: underlined are the hits obtained by man (Hans or Henri)+bike with child saddle.
註：加底線的數字代表自行車加裝小孩座椅的人被注視的次數

Hans and Henri expect that the man with a bike supplied with an extra
Hans 及 Henri 預期有加裝小孩座椅的男人會比未加裝座椅者對女性更具吸引力，
child saddle will be more attractive for females than the man with the bike without a
支持此一想法的可能理論是根據女性較會表現出對與物種存活相關的物件加以
child saddle. Possible arguments supporting this idea are based on the hypothesis
注意的行為之假設。
that female organisms often show behaviour focusing on objects related to survival

of species.

01. (1 point). Which of the following statements is a correct Null Hypothesis for
下列哪一敘述是 Hans 和 Henri 實驗中的虛無假設？
the experiment of Hans and Henri?

1. Hans and Henri do have the same attractiveness for females.
   Hans 和 Henri 對女性有相等的吸引力。
2. The attractiveness of a man + bike with child's saddle is the same as man + bike without child's saddle.
   自行車加裝小孩坐椅的男人與未加裝者有相等的吸引力。
3. The six café's do not differ in the character of the visiting females.
   此六個咖啡座的女性在個性上沒有什麼不同。
4. Having eye contact of a male with a female is not an indicator for attraction.
   男性和女性眼睛相注視並不是吸引力的指標。
5. The attractiveness of a man+bike with child's saddle is larger than that of a man+bike without
   自行車加裝小孩坐椅的男人吸引力會比未加裝者大。
   child's saddle.

02. (1 point). Hans and Henri do some calculations with their results.
Hans 和 Henri 對其結果的計算

	Number of hits per café 每一咖啡座眼神對視的次數	
	Mean (average) **平均值**	**Standard deviation** **標準差**
Hans	**12**	**3.4**
Henri	**13**	**4.5**
Hans+Henri	**25**	**5.5**
Situation A: 情況 A **Man + bike with child's saddle** 自行車加裝小孩座椅的男人	**15**	**3.7**
Situation B: 情況 B **Man + bike without child's saddle** 自行車未加裝小孩座椅的男人	**10**	**1.9**

You have to check the significance of the differences between situation A and B using
你必須用 t-test 檢測情況 A 及情況 B 是否具有顯著差異，請使用下面的表格。
the t-test. The following table should be used.

Level of significance **顯著水準**	**Critical t-value** **臨界 t 值**
100 %	**2.02**
50 %	**2.57**
25 %	**3.37**
10 %	**4.03**
05 %	**6.86**

Calculate the standard deviation of the difference between the means of the two situations A and B
應用下列公式計算狀況 A 與狀況 B 平均值差異的標準偏差。
in using the formula:

$$s = \sqrt{\{(s_A{}^2/n_A) + (s_B{}^2/n_B)\}}$$

s =

<u>03</u>. (1 point). Calculate t, using the formule:
應用下列公式計算 t 值。

t=d/s,

t =

d – difference between compared means (situation A and situation B).
d 代表狀況 A 與狀況 B 平均值的差異。

<u>04</u>. (1 point). How sure can we be about rejecting the Null hypothesis (e.g. difference between situation A and B is significant)
我們如何決定他們的虛無假設是錯的(即狀況 A 與狀況 B 在統計上具有顯著差異)

1. Less than 75,0 %
   小於 75%
2. In between 75,0 % and 90,0 %
   介於 75%和 90%之間
3. In between 90,0 % and 95,0 %
   介於 75%和 90%之間
4. In between 95,0 % and 97,5 %
   介於 95%和 97.5%之間
5. In between 97,5 % and 99,0 %
   介於 97.5%和 99.0%之間
6. In between 99,0 % and 99,5 %
   介於 99.0%和 99.5%之間
7. Over 99,5 %
   超過 99.5%

<u>05</u>. (1 point). Hans and Henri show their results to Paula, their boss. Paula claims that Hans and Henri made a big mistake looking at the total number of hits per café since the six cafés differ too much as a spread 17 up to 32 is too much. Hans and Henri do not agree with Paula and want to prove their point of view using the χ^2 test. Determine the χ^2 using the following formule.
Hans 和 Henri 把他們的結果給老師 Paula 看，Paula 說他們犯了一個大錯，因為不同咖啡座眼神對視的總數由 17 至 32 的差異太大，Hans 和 Henri 不同意 Paula，並想用卡方分析來證實他們的觀點。使用下列公式計算χ^2值。

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

χ^2 =

<u>06</u>. (1 point). Indicate the degree of freedom (df) for this test:
標明此卡方分析的自由度。

<u>07</u>. (1 point). Determine the probability P for this χ^2 test, using the following table. Estimate the answer in %.
應用下表決定此卡方分析的 P 值，估算答案以百分比表示之。

(df) 自由度	Probability (P) of random deviation 由隨機因素所造成的機率									
	0.995	**0.975**	**0.9**	**0.5**	**0.3**	**0.25**	**0.1**	**0.05**	**0.025**	**0.01**
1	**0.00**	**0.00**	**0.02**	**0.46**	**1.07**	**1.32**	**2.71**	**3.84**	**5.02**	**6.64**
2	**0.01**	**0.05**	**0.21**	**1.39**	**2.41**	**2.77**	**4.61**	**5.99**	**7.38**	**9.214**
3	**0.07**	**0.22**	**0.58**	**2.37**	**3.67**	**4.11**	**6.25**	**7.82**	**9.35**	**11.35**
4	**0.21**	**0.48**	**1.06**	**3.36**	**4.8**	**5.39**	**7.78**	**9.49**	**11.14**	**13.28**
5	**0.41**	**0.83**	**1.61**	**4.35**	**6.6**	**6.63**	**9.24**	**11.07**	**12.83**	**15.09**
6	**0.68**	**1.24**	**2.20**	**5.35**	**7.3**	**7.84**	**10.65**	**12.59**	**14.45**	**16.81**
7	**0.99**	**1.69**	**2.83**	**6.35**	**8.383**	**9.04**	**12.02**	**14.07**	**16.0**	**18.48**

<u>08.</u> (1 point). Which of the following conclusions based upon this χ^2 test is correct? Looking to the total number of hits per café.

由每一咖啡座眼神對看的總數來看，基於此卡方分析，下列結論那一個正確？

1. The café's are different, but the differences are not significant
   咖啡座之間有差別，但其差異並不顯著。
2. The differences between the café's are significant
   咖啡座間的差別有顯著性。
3. The results are dubious or questionable, something must be wrong in the design
   結果曖昧不明或有問題，此實驗設計的某部份必定有誤。
   of this experiment
4. The café's are not different, but this is not significant
   各咖啡座之間沒有差別，但這並不代表任何意義。
5. The café's are not different and this is significant
   咖啡座間沒有差別，且此結果具有意義。

Genetics (7 questions, 26 points).
遺傳

B25. (4 points). What genetic problems can be solved, using the next objects: *Zea mays,*
對應下列生物可幫助我們回答哪些遺傳學問題? 玉米

Drosophila melanogaster, Saccharomyces cerevisiae, Caenorhabditis elegans,
果蠅 **酵母菌** **線蟲**

Escherichia coli, bacteriphage λ,
大腸桿菌 **λ噬菌體**

***priones*?**
普恩蛋白(毒蛋白顆粒)

1. Obtain gene mutations.
   獲得基因突變
2. Obtain chromosomal mutations in eukaryotes.
   獲得真核生物的染色體突變
3. Make gene maps.
   製作基因圖譜
4. Investigate meiosis.
   研究減數分裂
5. Investigate mitosis.
   研究有絲分裂
6. Investigate X-chromosome.
   研究 X-染色體
7. Obtain extranuclear mutations.
   獲得細胞核外突變
8. Use *Agrobacterium tumefaciens* Ti-plasmid for gene treansfer to the cells of given
   利用農桿菌 Ti-質體，將基因轉殖入一個特定生物的細胞內
   organisms.
9. Perform the gene transfer by transduction formation.
   利用性狀導入進行基因轉殖
10. Investigate *lac*-operon regulation.
    研究乳糖操縱組的調節
11. Determine the DNA sequences.
    鑑定 DNA 序列

Indicate the correct statements by "X" in corresponding box of answer table:
在答案紙的表內，以"X"標示正確的敘述

Object 生物	Statement number(s) 敘述編號										
	1	2	3	4	5	6	7	8	9	10	11
Zea mays 玉米											
Drosophila melanogaster 果蠅											
Saccharomyces cerevisiae 酵母菌											
Caenorhabditis elegans 線蟲							刪				
Escherichia coli 大腸桿菌											
Bacteriophage λ λ-噬菌體											
Priones 普恩蛋白											

B26. (5 points). Suppose the situation when the birth records for 4 children were occasionally
假設在醫院內有四個嬰兒的出生紀錄遺失了，
lost at a hospital. The ABO blood types of four babies are known to be A, B, AB, and O.
這四個嬰兒的ABO血型為A型、B型、AB型、及O型。
To solve the problem all of their parents were tested to blood type. (Father of third child
四對父母也分別驗了血型(但第三個嬰兒的父親沒有資料)，
wasn't found). The results are shown in the following table.
結果記錄在下表中。

<u>01.</u> (4 points). Match the babies with their parents by marking the right blood types in
將正確的嬰兒血型，標示在其父母親後的空格內。
the table .

Families 家庭		**Blood type of each parent** 父母的血型	**Blood type of a baby** 嬰兒的血型
Parents 1	Father	AB	
	Mother	O	
Parents 2	Father	A	
	Mother	O	
Parents 3	Father	Unknown 未知	
	Mother	A	
Parents 4	Father	O	
	Mother	O	

<u>02.</u> (1 points). Which blood type(s) can the unknown father have?
第三個嬰兒的父親是哪種血型?(將英文字母填入答案紙空格中)

B27. (3 points). Connect the terms widely used in population genetics in the left column with
將左欄中族群遺傳學的專有名詞與右欄的說明相配對。
the correct statement in the right column.

	Term 專有名詞
1	Inbreeding depression. 近親交配衰退
2	Gene flow.基因流

	Statement 說明
A	Fixes advantageous alleles and removes disadvantageous alleles. 保留有利的，而移除不好的對偶基因
B	Increases genetic diversity within and between sub-populations, but occurs rarely.使小族群內及各族群間的基因歧異度都增加，但不常發生

3	Selection. 選擇
4	Outbreeding depression. 與外群雜交後衰退
5	Genetic drift. 遺傳漂變
6	Mutation. 突變

C	Increases variation between sub-populations and decreases variations within sub-populations.使各個小族群間的差異增加，而使小族群內的變異減少
D	Fitness reduces due to increase in homozygosity, expression of deleterious alleles increases as a consequence of mating between closely related individuals.同型合子的比例增加，使適應性降低。近親交配使不好的基因之出現率增加
E	Reduction of fitness due to mating of genetically divergent individuals.與基因組成不同的個體交配後，造成適應力降低
F	Decreases variation between sub-populations and increases variation within sub-populations.使各個小族群間的差異減少，而使各小族群內的變異增加

Term	1	2	3	4	5	6
Answers:						

B28. (4 points). In an isolated human population of 8400 persons, the frequency of allele I^A is
在一個由 **8400** 個人所組成的隔離族群內，I^A 的基因頻率為 **30%**，
30% and allele I^B is 10%.
I^B 的基因頻率為 **10%**。

What is the number (and %) of people with each blood group?
則每種血型的人數及其所佔的百分比各是多少**?**

Group	**People number** **人數**	**(%)** **百分比**
O		
A		
B		
AB		

B29. (4 points). Suppose that the difference between 10 cm high maize and 26 cm high maize
假設玉米的穗長**(10** 公分**~26** 公分**)**是由四對基因所決定的
is due to four pairs of addictive genes. The individuals with 10 cm have the aabbccdd
多基因遺傳**(**量的遺傳**)**，表現型為 10 公分個體的基因型是 **aabbccdd**
genotype and the 26 cm - AABBCCDD.
26 公分的則是 **AABBCCDD**

<u>01</u>. (1 point). Determine the phenotype of F1 if it is known that the parental plants are
以 10 公分與 26 公分的個體當作親代進行雜交，則第一子代(F1)的表現型
10 cm and 26 cm of high.
應是如何**(**幾公分**)?**

Answer:

F1:

02. (1 point). How many phenotypes classes would be in F2?
在 F2 中有多少種表現型?

Answer:

F2:

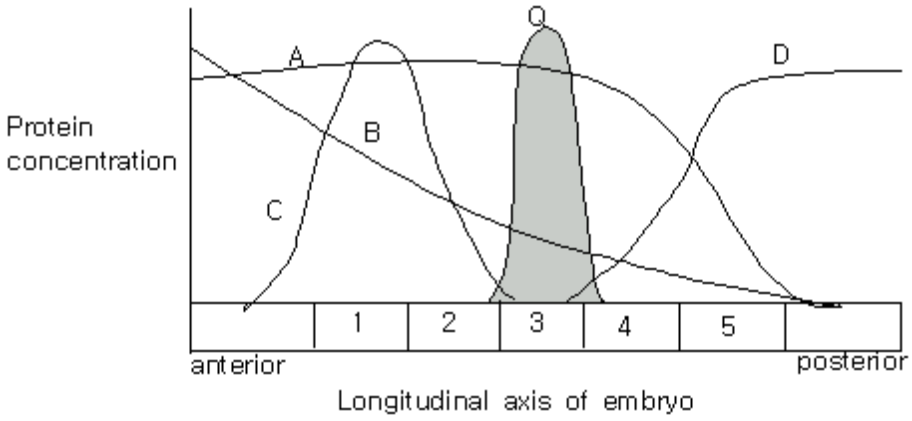
03. (1 point). Determine the phenotypes of F2 if it is known, that the parental plants are
假如親代的穗長分別為 **10 cm** 及 **26 cm**，請寫出 **F2** 的各種表現型性狀。
10 cm and 26 cm of high.

Answers:

04. (1 point). What fraction of plants in F2 will be 18 cm high ?
F2 中 18 公分穗長的植物個體所佔比例是多少?

Answer:

B30. (4 points). The following figure shows the distribution of the concentrations of five
下圖為果蠅胚胎中五種假想蛋白質的濃度分布圖，
hypothetical proteins in a *Drosophila* embryo. The anterior end is on the left and the
圖的左側有頭端(吻前)方向，圖右側為尾端(尾後)方向，
posterior end is on the right. A and B gene products activate the expression of Q gene,
基因A及B的產物會活化Q基因的表現，而基因C與D的產物則會抑制Q基因。
and C and D gene products repress the expression of Q gene.



If one of the A, B, C and D genes is mutated, where the protein Q would be found? Choose the right answer from proposed variants.
如果 A, B, C 及 D 基因中分別有一個發生突變，則蛋白質 **Q** 會在何處被發現**?**
從以下提出的選項中選擇正確的對應答案

	Expression pattern of Q gene
Mutant A	
Mutant B	
Mutant C	
Mutant D	

<Examples>選項

I. **Would be found in the anterior end on the embryo body.**
胚胎前端

II. **Would be found in the posterior end oh the embryo body.**
胚胎後端

III. **No significant change**
無顯著改變

IV. **Expression of Q gene would decrease significantly.**
Q基因的表現將顯著增加

B31. (4 points). It is known that in some dioecy plants sex can be determined genetically as in animals. Examine the results of analysis of different types of polyploids and ascertain the type (mechanism) of sex determination in the given plant species.
Choose the correct statement and fill its number into a box.

有些雌雄異株的植物在遺傳上的性別決定方式與動物相同。
下表為 2 種植物的不同染色體組成(雙倍或多倍體、與性染色體之數量)以及性別對照表。請據此判斷其性別決定方式分別符合下列哪些敘述?
在下列敘述中選擇正確者，並將其號碼填入方格中。

Rumex acetosa 酸模		Silene latifolia 長葉瞿麥	
Genotype	Sex	Genotype	Sex
2A+2X	♀	2A+2X	♀
2A+X+Y	♂	2A+X+Y	♂
2A+X+2Y	♂	2A+X+2Y	♂
2A+X+3Y	♂		
2A+2X+Y	♀	2A+2X+Y	♂
2A+2X+2Y	♀		
3A+X+2Y	♂		
3A+X+3Y	♂		
3A+X+4Y	♂		
3A+2X	♀♂	3A+2X	♀
3A+2X+Y	♀♂	3A+2X+Y	♂
3A+2X+2Y	♀♂		
3A+2X+3Y	♀♂		
3A+3X	♀	3A+3X	♀
3A+3X+Y	♀	3A+3X+Y	♂
3A+3X+2Y	♀	4A+X+Y	♂
4A+2X+2Y	♂	4A+2X	♀
4A+2X+3Y	♂	4A+2X+Y	♂
4A+2X+4Y	♂	4A+2X+2Y	♂
4A+3X	♀♂	4A+3X	♀
4A+3X+Y	♀♂	4A+3X+Y	♂
4A+3X+4Y	♀♂	4A+3X+2Y	♂
4A+4X	♀	4A+4X	♀
4A+4X+Y	♀	4A+4X+Y	♀♂
4A+4X+2Y	♀	4A+4X+2Y	♂
5A+5X	♀		
6A+4X+4Y	♀♂		

A – haploid number of autosomes. A 代表體染色體的單倍體

1. Sex determination as in human.
   性別決定方式與人類相同
2. Sex determination as in *Drosophila.*
   性別決定方式與果蠅相同
3. Sex determination as in birds.
   性別決定方式與鳥類相同
4. Sex determination as in bees.
   性別決定方式與蜜蜂相同

5. In given plants X-chromosome determines maleness and Y-chromosome determines femaleness.
   X-染色體決定雄性，Y-染色體決定雌性
6. The presence of Y-chromosome is necessary and sufficient condition for the formation of male
   Y-染色體的存在為雄花形成的充分必要條件
   flowers.

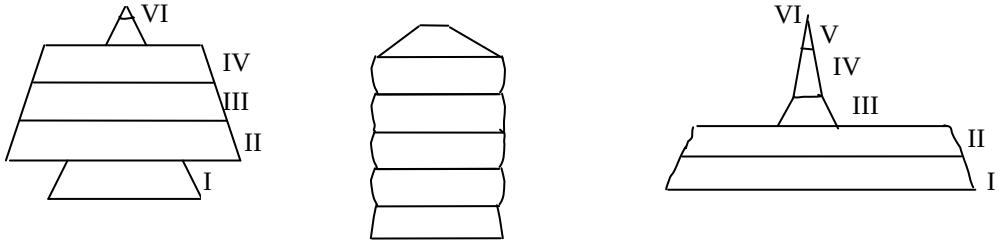
7. Y-chromosome doesn't take part in sex determination.
   Y-染色體與性別決定無關
8. X-chromosome doesn't take part in sex determination.
   X-染色體與性別決定無關

01. Rumex acetosa 酸模

02. Silene latifolia 長葉瞿麥

Ecology(5 questions, 17 points).
生態學(5 題、17 分)

B32. (3 point). Three pond ecosystems (1, 2 and 3) were used for fish production. When the
三個池塘生態系**(1, 2 及 3)**被用來探討魚的產量。
total number of fish in each pond was measured, following pyramids were obtained.
每一個池塘內的魚總數計算過後，依年齡**(**分成六級**)**
(Age of the fish is divided into six class intervals).
所建構的金字塔如下所示。



1. 2. 3.

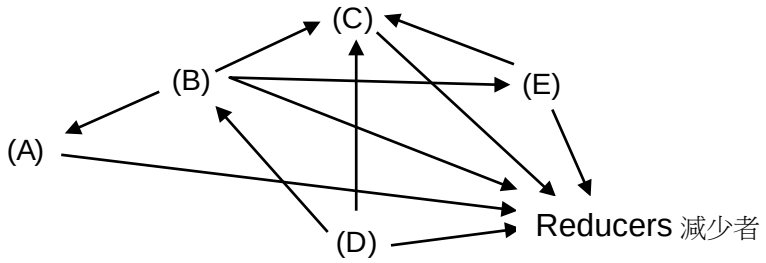
Assign these pyramids the appropriate features from below. Indicate answer in the table
下列敘述中，選擇與此些金字塔相符合的答案，填入表中。
below.

A. Pond with very intensive fish cropping.
非常密集捕魚的池塘
B. Pond with selective cropping of baby fish.
選擇性捕捉幼魚的池塘
C. Pond with limited fish cropping.
少量捕魚的池塘
D. Eutrophic pond.
優養化池塘
E. Pond cropped regularly.
定期捕魚的池塘
F. Pond with excessive turbidity and excessive phytoplankton.
過度混濁和太多量的浮游植物
G. Pond with optimal age structure.
適當年齡結構的池塘

Pond 池塘	**Statement 敘述**
1	
2	
3	

B33. (2,5 points). The following figure shows the food web of a certain ecosystem with five species (A-E). Arrow indicate the flow of energy. Match the letters to the descriptions of the species:

下圖是含有 A 至 E 五個物種的生態系之食物網。箭頭代表能量流動方向，選擇符合描述的物種字母。



Producer 生產者	
Herbivore 草食動物	
Omnivore 雜食動物	
Carnivore 肉食動物	

B34. (8,5 points). Fresh water bodies can be subdivided into still-water systems (lenitic waterbodies = ponds and lakes) and streaming water systems (lotic waterbodies = creeks and rivers). Both groups differ in the abiotic factors and in their flora and fauna.

淡水生態系可分為靜水系統(池塘和湖泊)和流動水系統(溪河)，此二系統在非生物因子和動植物相上都不相同。

<u>01.</u> (2,5 points). Indicate the correspondence by marking with '+'.

在適當的欄位標示'+'

Water system characteristic 水系特徵	Water system type 淡水系統	
	lotic 流動水	lenitic 靜水
Rapid decrease of the light density with the depth 光線強度會因深度而快速降低		
Normaly staggered water temperature 水溫通常變化很少		
Occurence of long-lasting plankton communities 具有長存的浮游生物群落		
Streamline body of the animals 動物身體為流線型		
Animals with suction cups (suckers) 具有吸器的動物		

<u>02</u>. (3 points). Rivers show a marked profile of various water quality parameters along
河流沿河上下會有不同的水質特性。(如下表敘述)
their length. Samples taken near the source of the river show different values for
將河流源頭的水和下游的水加以比較，
various parameters compared to samples from down stream parts of the river.

Mark the expected tendency of this difference using the symbols "+" for increase,
標示這些不同的趨勢，以"+"代表增加、"-"代表減少、"="代表沒變化。
"-" for decrease or "=" for no change.

From near the river's source ⟶ To lower part of the river.
河流源頭 河流下游

A. Water temperature. 水溫

B. Oxygen content. 氧氣含量

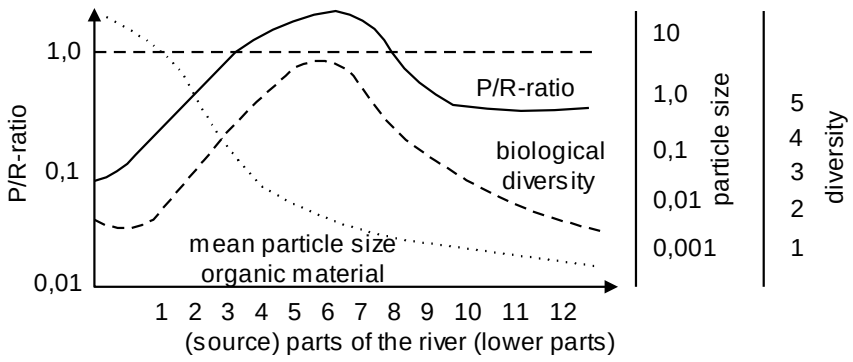
C. Turbidity. 混濁度

D. Amount of sediments. 沉澱量

E. Amount of nutrient minerals. 礦物養分的量

F. Velocity of the flow. 流速

<u>03.</u> (3 points). The graph shows values measured along a river (river continuum). The
下圖表示一河流沿河上下所測得的值，
P/R ratio represents the ratio of production to respiration in the given part of the
P/R 值代表生產量對呼吸量的比值，
river. Choose the correct parts of the river for the given below questions according
依據下圖選擇正確的河流段落。
to the graph.



Answer the three questions**.** Write the numbers of river parts in the boxes below.
回答以下三題。在方格中填入代表河流段落的數字。

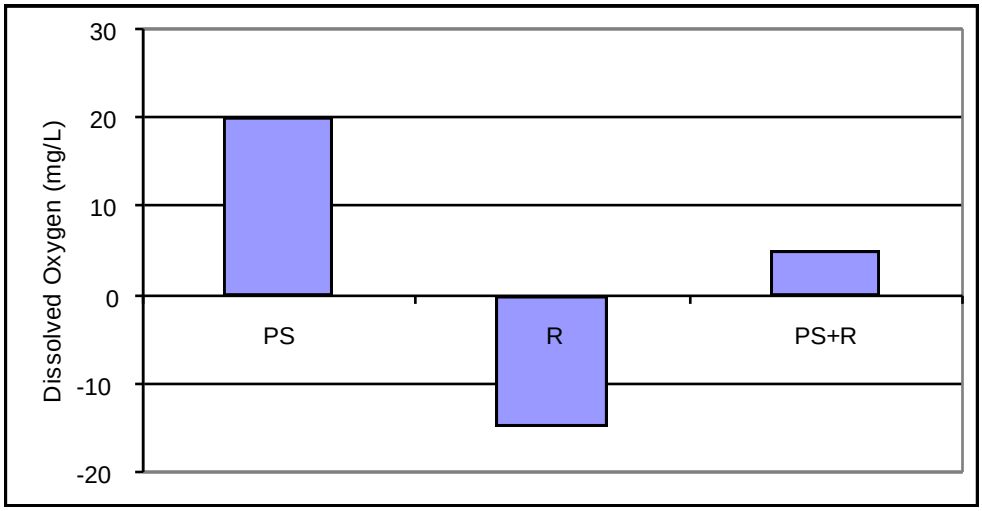
A. Which parts of river are autotrophic?
哪些段落是自營的?

B. In which parts is organic material (such as tree leaves) essential for the consumers?
在哪些段落中，有機物(例如樹葉)對消費者是必須的?

C. In which parts can predators be found?
有哪些段落可以找到捕食者?

B35. (1 point). A student wished to estimate the size of a population of an endangered water
一學生欲估計一個小池塘中的瀕危甲蟲的族群數量，
beetle species in a small pond. He captured 30 individuals, marked and then released
他首先捕捉到 **30** 個個體，作標示後將其放回池塘，
them back in the pond. After 24 hours, once again he captured 30 individuals. Of the
24 小時後，他再去捕捉，也捉了 **30** 個個體。
newly captured individuals, only 14 were marked. Assume that no individuals were
在這些新捉到的個體中，**14** 個具有原先的標示，假設實驗中沒有個體誕生、
born, died, immigrated to or emigrated from the population during the experiment.
死亡、移出或移入，
What would be the student`s estimation of the endangered water beetle population in
此池塘中這種瀕危甲蟲族群的估計個體數為多少**? (**在空格中填入數字**)**
the pond? Estimated population size of endangered water beetle in the pond is:

B36. (4 points). The graph shows the productivity of an aquatic ecosystem measured in terms
此圖表示一水生生態系中由綠色植物和光合藻類
of dissolved oxygen produced and consumed by green plants and photosynthetic algae
製造和消耗的溶氧量，
where PS = photosynthesis and R = respiration.
其中 **PS** 代表光合作用、**R** 代表呼吸作用



Study the graph and answer the following questions, writing your answers in the box.
依圖回答下列 5 題，將答案填入方格中。

01. (1 points). Which bar represents net primary productivity.
哪一個直條代表淨生產量?

02. (3 points). An algal bloom occurs until nutrient levels are exhausted. Then the algae die off and microbial decomposition begins. How will this affect the graph parameters PS and R?
如果有藻類大量出現藻葉，並消耗掉所有的養分，則藻類會死掉，且微生物開始其分解作用，試探討此對 PS 及 R 的影響。

02.1. (1 point). What will happen during the algal bloom?
藻類大量出現時，下列哪些現象會發生？

1. PS will be increased, R will be decreased.
   PS 增加，R 減少
2. PS will be decreased, R will be increased.
   PS 減少，R 增加
3. PS and R will not change.
   PS 及 R 皆不改變
4. PS + R will increase.
   PS + R 增加
5. PS + R will decrease.
   PS + R 減少
6. PS + R will remain unchanged.
   PS + R 維持不變

02.2. (1 point). What will happen after decomposition has begun?
刪除!! 勿作答!

1. PS will be increased.

2. PS will be decreased.

3. R will be increased.

4. R will be decreased.

5. PS + R will be increase.

6. PS + R will be decrease.

7. PS + R remain unchanged.

02.3. (1 point). How would the graphs (parameters PS, R and PS+R) change if the net community productivity per dissolved oxygen levels was measured?

刪除!! 勿作答!

1. PS will be increased, R will be decreased.

2. PS will be decreased, R will be increased.

3. 3. PS and R will not change.

4. PS + R will increase.

5. PS + R will decrease.

6. PS + R will remain unchanged.

Biosystematics (4 questions, 16 points).
生物系統分類(4 題、16 分)

B37. (3 points). Below is a list of extant mammalian genera. Assign them to the continents and subcontinents where they live and in the ordo they belong to. Insert the number of the animal into the correct boxes of tables 01 and 02.
下表所列為現存哺乳類的某些屬名，將代表該動物的代碼填在表 **01** 及 **02** 中，以分別指出它們所棲息的大陸及次大陸，以及其所屬的目名表中。

GENUS 屬名	
1.	***Ursus*** **熊屬**
2.	***Cebus*** **捲尾猴屬**
3.	***Pan*** **黑猩猩屬**
4.	***Pongo*** **紅毛猩猩屬**
5.	***Elephas*** **亞洲象屬**
6.	***Macropus*** **袋鼠屬**

01. (1,8 points). Continents & subcontinents.
大陸及次大陸

Australia 澳洲	
North America 北美洲	
India 印度	
Africa 非洲	
Europe 歐洲	
Asia 亞洲	
South America 南美洲	

02. (1,2 points). Ordor 目名

Marsupialia 有袋目	
Proboscidea 長鼻目	
Carnivora 食肉目	
Primates 靈長目	

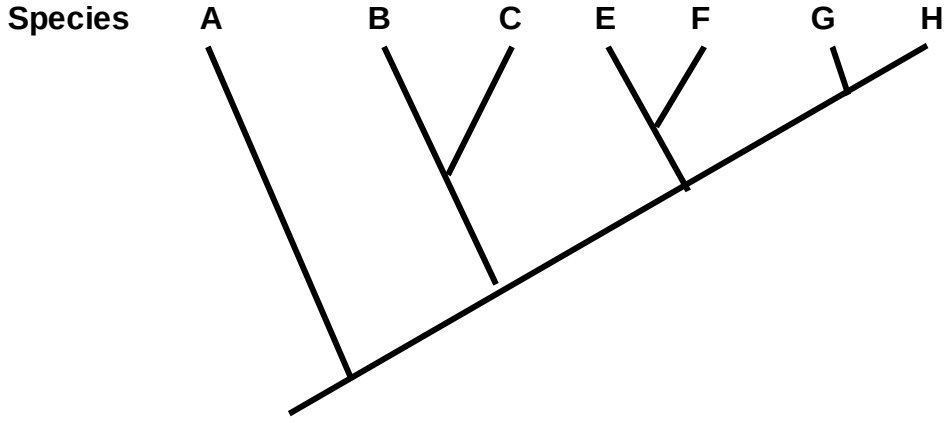
B38. (3 points). Match the terms in the left column (1 to 6) with the names of organisms in the right column (A to F).
刪除!!勿作答!　　將下面左邊的(1-6)名詞與右邊的生物(A-F)配對。

1. Polyembryony. 多胚胎	A. Primroses (*Primula*). 櫻草
2. Heterostily. 花柱不等長	B. *Helix snail.* 底圈蝸牛
3. Neoteny. 幼體性熟	C. Armadillo. 穿山甲
4. Hermaphrodity. 雌雄同體	D. Rotatoria. 輪蟲
5. Parthenogenesis. 孤雌生殖	E. Banana. 香蕉
6. Parthenocarpy. 單性結實	F. Axolotl (*Ambystoma*). 美西蠑螈

Answer:

1	2	3	4	5	6

B39. (3 points). The cladogram shows the phylogenetic relationships among seven hypothetical species.
刪除!!勿作答!　　一演化樹顯示七個假想生物種的親緣關係，回答下列問題



01. (2 points). Which of the following is a paraphyletic group (A) and which is a polyphyletic group (B)?
下列何者為側源系(A)、多源系(B)的群?

1. E + F + G.
2. E + F.
3. E + F + G + H.
4. C + E.
5. B + C.

Answer:

A. _____

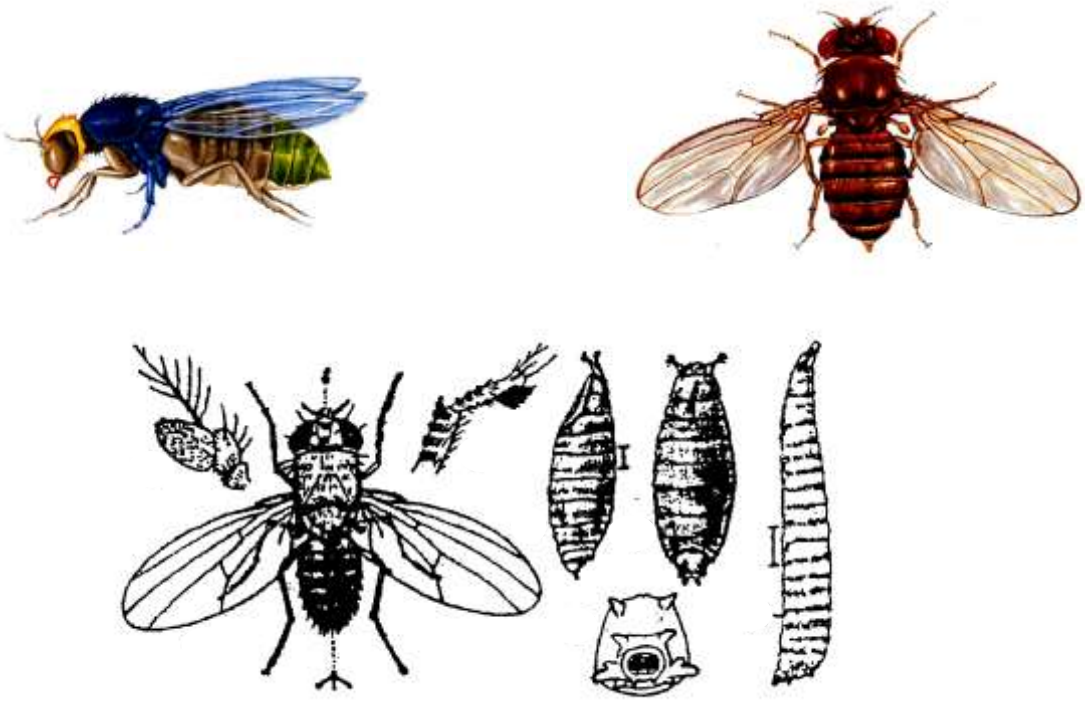
B._____

02. (1 point). Which species are most closely related?
下列何組物種親源最近?

1. G and H.
2. G and F.
3. H and F.
4. Evolutionary closeness is equal for all species.
   所有種類的演化親源遠近相同

B40. In the figure is shown a well known organism.
下圖示一種廣為人知的生物，

01. (1,2 points). Give its systematic position by choosing suitable numbers from the list below.
由下表中選擇合適的數字顯示其分類的地位。



1 – Animalia; 動物界
2 – Arthropoda;節肢動物門
3 – Echinodermata; 棘皮動物門
4 – Mollusca; 軟體動物門
5 – Fungi; 真菌界
6 – Chilopoda; 螯肢亞門
7 – Insecta; 昆蟲綱
8 – melanogaster; 黑腹種
9 – Plantae; 植物界
10 – Apis; 蜜蜂屬
11 – Gastropoda; 腹足綱
12 – Annelida; 環節動物門
13 – Protozoa; 原生動物
14 – Viviparus 胎生屬
15 – Hymenoptera 膜翅目
16 – domestica; 家蠅種
17 – Arachnida; 蛛形綱
18 – Cnidaria; 腔腸動物門
19 – Diptera; 雙翅目
20 – fabae; 似豆種
21 – Drosophila; 果蠅屬
22 – Aphis; 蚜蟲屬
23 – Leptinotarsa; 金花蟲屬
24 – Coleoptera; 鞘翅目
25 – maculipennis; 斑莖種
26 – Oligochaeta; 貧毛綱
27 – Lepidoptera; 鱗翅目
28 – Anopheles; 瘧蚊屬
29 – Locusta; 蝗蟲屬
30 – decemlineata. 十層種

Kingdom 界	
Phylum:門	
Classis: 綱	
Order: 目	
Genus: 屬	

02. (1 point). Choose the number corresponding to the type of the insect leg.
選出代表此昆蟲腳的功能的那個數字

1. Leaping. 跳躍
2. Burrowing. 掘穴
3. Swimming. 游泳
4. Gathering. 採集
5. Walking. 步行
6. Prehensile.握執

<u>03</u>. (1 point). List the leg structural elements this insect possesses in sequence (beginning
依次寫出昆蟲腳之各部分構造(由靠近身體的開始)

with closer to the body).

A. Femur. 腓節 (腿節)

B. Tibia. 脛節

C. Trochanter. 轉節

D. Coxa. 基節

E. Tartus. 跗節

04. (1 point). Give the number corresponding to the type of insect mouthpart.
寫出代表此昆蟲口器型式的數字

1.Piercing-suctorial. 刺吸型

2. Licking. 舐吮型

3. Biting. 咬嚼型

4. Suctorial. 吸吮型

05. (1 point). Select the organs of other organisms, which are homologous to the wings of the insect concerned.
在下列生物的器官中，何者屬於此昆蟲翅的同源器官?

1. Sparrow wing. 麻雀的翅

2. Crawfish gills. 蝦的鰓

3. Bat wings. 蝙蝠的翅

4. Fish dorsal fin. 魚的背鰭

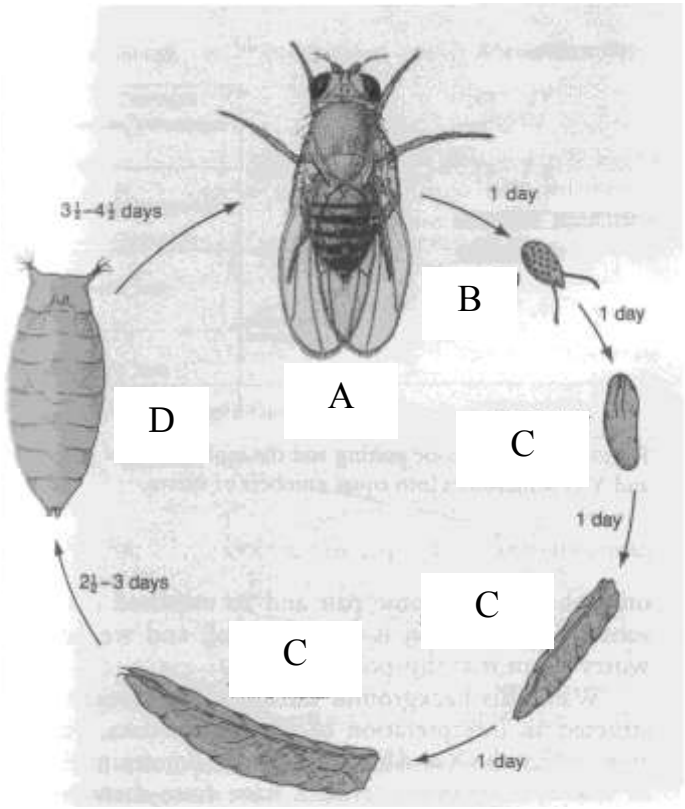
5. Fish pectorial fin. 魚的腹鰭

6. Potato beetle elytrum. 馬鈴薯甲蟲的鞘翅

7. Frog legs. 蛙的腿

06. (0,8 point). In table for answer sign the developmental stages of this insect according to the letter specifications in the figure.
使用下列代碼在答案紙的表中寫出此昆蟲的正確發育時期

1. Sporocyst. 芽胞幼蟲
2. Egg. 卵
3. Graaf vesicle. 卵囊胞
4. Larva. 幼蟲
5. Imago. 成蟲
6. Redia. 雷氏幼蟲
7. Pupa. 蛹
8. Hydatid cyst. 包囊幼蟲



Answer:

A	B	C	D

07. (1 point). What is the value of the species for the human?
此昆蟲對人類有何價值?

1. Animal and human parasite. 人及動物的寄生蟲
2. Crop pest. 穀物的害蟲
3. Object of genetic investigation. 遺傳研究之材料
4. Entomophagous. 吞食其他昆蟲
5. Vector of sleeping sickness agent. 睡眠病的病媒
6.