Country _____	Competitor# __ __ __

16th International Biology Olympiad

Beijing
July, 2005

THEORY EXAMINATION

Part 1

理論題 第一部分

Total time available: 2.5 hours (150 minutes) **時間 150 分鐘**

Total points available: ~80

GENERAL INSTRUCTIONS

一般指示

Please check that you have the appropriate examination papers and answer sheets.

先檢查你的試卷及答案紙是否正確

It is recommended that you manage your time in proportion to the points allotted for each question. 建議你依各題的配分來分配時間

IMPORTANT

重要

Use the answer sheets provided to record your answers.

必須以答案紙紀錄答案

Ensure your name and three digit code number is written on the top of each page of the answer sheets.

確認你三位數字的選手編號已劃記在答案紙上

Use the 2B pencil provided to fill in the mark sense icons on the answer sheet.

須以所提供的 **2B** 鉛筆在答案卡上填答

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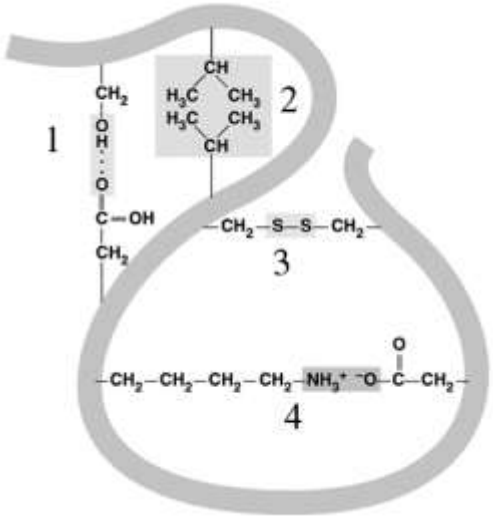
1.Various forces are important to the interactions contributing to the tertiary structure of a protein.The figure below is a diagram showing several possible interactions. Please match the numbered interactions with correct names. (1 point)

有的作用力對蛋白質的三度空間構造極為重要，下圖中的數字顯示幾種作用力。請將其正確名稱填入表中。



A. hydrogen bond 氫鍵
B. Hydrophobic interaction 厭水作用
C. Peptide bond 肽鍵
D. Disulphide bond 雙硫鍵
E. Ionic bond 離子鍵

Interactions 作用力	Answer: A-E
1	A
2	B
3	D
4	E

2. Which of the following is/are NOT correct about cytokinesis of plant cells? (1 point)
有關植物細胞的胞質分裂，下列敘述何者**錯誤**？

(1) Plant cells form cell plates 植物細胞形成細胞板
(2) Cytokinesis can start during mitosis 胞質分裂可在有絲分裂中開始
(3) Plant cells have contracting ring 植物細胞具有收縮環
(4) Membrane fusion connects cell plate and cytoplasmic membrane of mother cell.
膜的融合聯繫母細胞的細胞板及細胞膜
(5) Golgi apparatus does not participate cytokinesis of a plant cell until two daughter cells are formed.
在兩個子細胞完成前，高基氏體不參與植物細胞的胞質分裂

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

3. DNA ligase is an important enzyme that connects DNA fragments. Which of the following is/are true about DNA ligase? (1 point)

DNA 連接酶是連接 DNA 片段的重要酵素，下列有關 DNA 連接酶的敘述，何者正確？

(1) It is important to DNA replication process
它對 DNA 複製過程重要

(2) It is important in molecular cloning
它在分子轉殖過程中重要

(3) It requires DNA fragments have sticky ends
DNA 片段必須要有黏性端

(4) It could cut DNA molecules in the presence of ATP and Mg2+.
在 有 ATP 及 Mg2+的存在下，它能切割 DNA 分子

(5) It requires ATP for its function because the 3'-hydroxyl group of a DNA fragment needs to be phosphorylated before the DNA molecules could be ligated.
它需要有 ATP 以執行功能，因為 DNA 分子連接前 DNA 片段之 3'-OH 基必須磷酸化

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

Questions 4-6: Checkpoints in the cell cycle are very important in regulation of cell cycle.The following three questions are about the cells cycles and checkpoints.
細胞週期中的檢查點對調節細胞週期很重要，以下是相關的三個問題：

4. Two animal cells at different phase in cell cycle can be induced to fuse to form a single cell with two nuclei. This system provides a very useful tool for studying cell cycle. Which of the following is correct? (1 point)
處在不同細胞週期的兩個細胞核可藉融合而成為一個細胞，此系統為研究細胞週期提供了有用的工具，下列敘述何者正確？

   A. When a cell in M phase is fused with a cell in G_1 phase, the nucleus in M phase stops the process of mitosis.
   當處在 M 期與 G_1 期的兩個細胞融合時，原 M 期的細胞核停止分裂過程
   B. When a cell in M phase is fused with a cell in G2 phase, the nucleus in G2 phase starts mitosis process.
   當處在 M 期與 G_2 期的兩個細胞融合時，原 G_2 期的細胞核開始分裂過程
   C. When a cell in G2 phase is fused with a cell in G1 phase, both nuclei start mitosis process.
   當處在 G_2 期與 G_1 期的兩個細胞融合時，兩個細胞核都開始分裂過程
   D. When a cell in M phase is fused with a cell in G1 phase, the nucleus in G1 phase starts DNA synthesis.
   當處在 M 期與 G1 期的兩個細胞融合時，G1 期的細胞核開始 DNA 合成

5. Which of the following are true about checkpoints in cell cycle? (1 point)
下列有關細胞週期檢查點的敘述，何者正確？

   (1) If a cell in G_1 phase does not receive a signal at the G_1 checkpoint, the cell usually goes into G_0 phase.
   一個 G1 期的細胞在 G1 檢查點若未收到信號，通常會進入 G0 期

(2) A cell must receive a signal at G_2 checkpoint to go into mitosis.
一細胞必須在 G_2 檢查點收到信號，才會進入分裂期

(3) A cell must receive a signal at M checkpoint to go into mitosis.
一細胞必須在 M 檢查點收到信號，才會進入分裂期

(4) The protein factors that control checkpoints in cell cycle are mostly present in nuclei.
控制細胞週期檢查點的蛋白質因子多存在於核內

(5) Cell cycle in unicellular organisms does not have checkpoints.
單細胞生物的細胞週期中沒有檢查點

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

6. In cloning the first mammal, researchers used mammary cell as a donor of nucleus and fused it with a nucleus-less egg. Which of the following is correct? (1 point)
在複製第一隻哺乳動物時，科學家用了一個乳房細胞的核與另一去核的卵細胞融合，下列何者正確？

A. The mammary cell was in G_1 phase 該乳房細胞是在 G_1 期
B. The mammary cell was in G_2 phase 該乳房細胞是在 G_2 期
C. The mammary cell was in S phase 該乳房細胞是在 S 期
D. The mammary cell was in M phase 該乳房細胞是在 M 期
E. The mammary cell was in G_0 phase 該乳房細胞是在 G_0 期

7. Cyanobacteria (blue-green algae) are a group of very important bacteria that perform photosynthesis. Which of the following is/are true about cyanobacteria. (1 point)
藍綠菌(藍綠藻)是一群能行光合作用的重要細菌，下列有關藍綠菌的敘述，何者正確？

(1) They are gram-negative bacteria
是革蘭氏陰性細菌

(2) They produce oxygen in photosynthesis
其光合作用是產生氧

(3) All cyanobacteria can fix nitrogen

所有藍綠菌均能固氮

(4) Some cyanobacteria can live with fungi symbiotically
有些藍綠菌能與真菌共生

(5) The blue-green color of cyanobacteria comes solely from chlorophyll
藍綠菌的藍綠色只來自於葉綠素

A. All are correct 全都正確
B. 1, 2, 3, 4
C. 1, 2, 3
D. <u>1, 2, 4</u>
E. 1, 2

Questions 8-9 are about biotechnology of transgenic organisms or genetically modified organisms (GMO).
問題 8 ~ 9 提到有關基因改造生物(GMO)的生物科技

8. In creating "golden rice" that produces betacarotenes in rice kernels, the genes responsible for betacarotene synthesis are transformed. Which of the following is/are true? (1 point)
為了製造具帶有 b-胡蘿蔔素的黃金米，合成 b-胡蘿蔔素的基因被轉植入稻米中，下列有關此改造過程的敘述何者正確？

(1) The researcher used normal rice for transformation
科學家用一般稻米進行轉形作用

(2) The researcher used Ti plasmid for transformation
科學家使用 Ti 質體進行轉形作用

(3) The researcher used a dicot plant for transformation first followed by crossing between the dicot plant and rice plant
科學家先用雙子葉植物進行首次轉形作用，再利用其與稻米雜交

(4) Golden rice has a higher nutritional value than normal rice
黃金米較一般稻米更具營養價值

(5) Beside Agrobacterium, the researcher also used another bacterium, Escherichia coli in construction of transforming vectors.

除了土壤桿菌 Agrobacterium 外，科學家也用大腸桿菌來製造轉形作用所需的載體

A. All are correct　　全部正確
B. 1, 2, 4, 5
C. 1, 2, 3
D. 1, 2
E. 1, 3, 4, 5

9. When a DNA fragment under control of a promoter was transformed into tobacco plants with Ti plasmid, the transgenic plants showed a lower activity of CO_2 fixation. Biochemical examination found that the transgenic plant had a lower amount of Rubisco, a key enzyme for Calvin cycle. Which of the following is/are likely to be the reason(s) for the phenotype? (1 point)

(1) The DNA fragment was transformed into chloroplasts and resulted in interference with chloroplast transcription.
(2) Genetic exchange between the transformed DNA fragment and host chromosomal DNA resulted in insertion of Ti plasmid into chromosome, leading to a lower expression of Rubisco genes
(3) The transformed DNA fragment interfered normal transcription of the gene encoding large subunit of Rubisco
(4) The transformed DNA fragment interfered normal transcription of the gene encoding small subunit of Rubisco
(5) The transformed DNA fragment encoded a cytoplasmic protein that prevents Rubisco activation by bicarbonate.

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

10. Which of the following is/are true about endosymbiosis? (1 point)
下列有關內共生的敘述，何者正確？

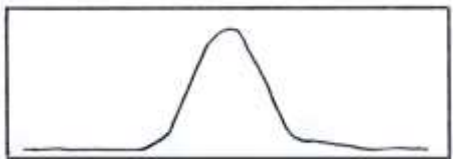
(1) Both plastid and lysozome are products of endosymbiosis
質體與溶體均為內共生的產物

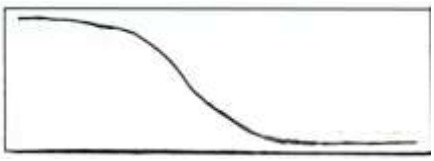
(2) A eukaryotic cells could engulf another eukaryotic cells to establish symbiotic relationship
真核細胞能吞噬其他的真核細胞以建立共生的關係
(3) Cyanobacteria are ancestors of plastids and mitochondria
藍綠菌為質體與粒線體祖先
(4) Cyanobacteria lost their chlorophyll b gene in endosymbiosis.
內共生使藍綠菌失去其葉綠素 b 的基因
(5) Flagella of some eukaryotic cells are derived from cyanobacteria
有些真核細胞的鞭毛是來自藍綠菌

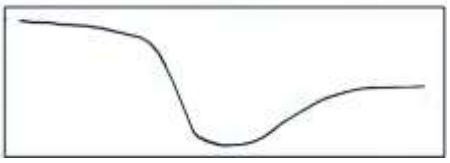
A. 1, 3, 5
B. 1, 2
C. 2, 4
D. 2
E. 4

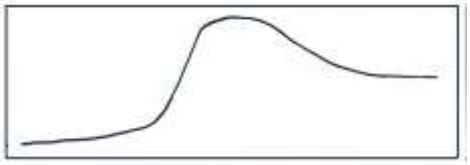
11. Which of the following graphs correctly displays the relationship of blood flow velocity in humans as the blood flows from the aorta → arteries → arterioles → capillaries → venules → veins → venae cavae: (1 point)

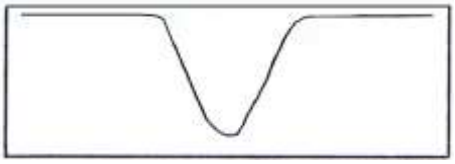
血液流動方向為動脈弓→大動脈→小動脈→微血管→小靜脈→大靜脈→靜脈腔，那個圖能正確表示出在人類不同心血管構造中血液流動速率的變化？

A 

D 

B 

E 

C 

12. Lowering the level of a hedge with a hedge trimmer stimulates the hedge to become bushy because: (1 point)
修剪樹籬，降低其高度可使樹籬更加枝繁葉茂，這是因爲：

A. It stimulates the production of ethylene gas. 加速乙烯的產生

B. Removing the apical meristems makes more auxin, which stimulates lateral branch buds to grow.
去除其頂端分生組織會產生更多生長素，而加速側枝生長

C. Removing the apical meristems makes less ethylene, which stimulates lateral branches to grow
去除頂端分生組織使乙烯變少，而加速側枝生長

D. <u>Removing the apical meristems results in less auxin, which then allows lateral branches to grow.</u>
<u>去除頂端分生組織導致生長素減少，使側枝生長</u>

E. Removing the lateral buds results in apical dominance under the influence of cytokinins
去除側芽會影響細胞分裂素而導致頂端優勢

13. Which of the following is/are true about telomeres? (1 point)
下列有關端粒的敘述，何者正確？

(1) Telomeres are present in all DNA in eukaryotic cells
端粒存在於所有真核生物細胞的 DNA 中
(2) Telomeres are present in bacterial plasmids
端粒存在於細菌的質體中
(3) Telomeres are required for replication fork formation
複製叉的形成需要端粒
(4) Telomeres are specific sequences present in eukaryotic chromomes
端粒為特定的序列出現於真核生物的染色體中
(5) Telomeres are required for maintaining chromosomal length
染色體長度的維持需要端粒

A. 1, 3, 5,

B. 3, 4, 5

C. <u>4, 5</u>

D. 2
E. 3

14. For terrestrial and most aquatic environments, neither animal nor plant life could exist without the metabolic "services" provided by: (1 point)
在陸生及大多數水生的環境中，缺少何者的代謝「服務」，動植物無法存活？

A. Chemoheterotrophs 化學異營菌
B. extremophile archaeans 嗜極端古菌類
C. Fungi 真菌
D. *Homo sapiens* 人
E. Fertilizer 肥料

15. The inner ear of humans, and most other mammals, is sensitive to body position and balance. What organ(s) is/are responsible for this? (1 point)
人類及其他哺乳類動物的內耳可感受身體姿勢及平衡的變化，下列何者負責此項功能？

A. Cochlea 耳蝸
B. cochlea and basilar membrane 耳蝸與基底膜
C. semicircular canals 半規管
D. semicircular canals and cochlea 半規管與耳蝸
E. semicircular canals, utricle, and saccule 半規管、橢圓囊與球囊

16. Flukes are often parasites in or on another animals. They could cause diseases in human beings. Blood fluke (*Schistosoma mansoni*) is a parasitic trematode that infects men. Which of the followings is NOT true about its life cycles. (1 point)
吸蟲常為其他動物的寄生蟲，也常引起人類疾病，血吸蟲 (*Schistosoma mansoni*) 是感染人類的吸蟲之一，下列其有關其生活史的敘述何者**錯誤**？

A. There are two types of larvae in the fluke
牠有兩類型的幼蟲
B. It reproduce asexually in the human host
在人體內行無性繁殖
C. The larvae need water to swim
其幼蟲需要水游泳
D. Its infection of human being is through skin

是經穿透皮膚感染人類

E. An intermediate host is often required for completion of their life cycle.
要完成其生活史需要中間宿主

.

17. In animal behavior a sign stimulus could trigger a fixed action pattern (FAP). Which of the following is Not an example of sign stimulus-FAP? (1 point)
特定刺激可引發動物產生一種固定動作模式(FAP)，下列何種不是由特定刺激所引發的 FAP？

A. Some moths fold their wings and drop to the ground when they detect an ultrasonic signal from bats.
某些飛蛾偵測到蝙蝠所發出的超音波訊號後，會收起雙翅墜落地面

B. A wasp finds its nest according to the surrounding objects.
胡蜂可根據環境中的物件找到蜂巢的位置

C. A newly hatched bird cheeping loudly in begging for food when its parent returns to nest.
當親鳥返回鳥巢時，新生的幼鳥會大聲鳴叫以求取食物。

D. Breeding mayflies lay eggs when they detect water.
繁殖中的蜉蝣會在偵測到水源後產卵

18. Some crows feed on mollusks. The crows grasp the prey and fly upwards to certain height before they drop the preys onto a rock to break the shells. If the shell was not broken by the first drop, the crows will pick it up and drop it again until it is broken. In one experiment, researchers found the following relationship between the heights of drop and the number of dropping times to break the shells. (1 point)

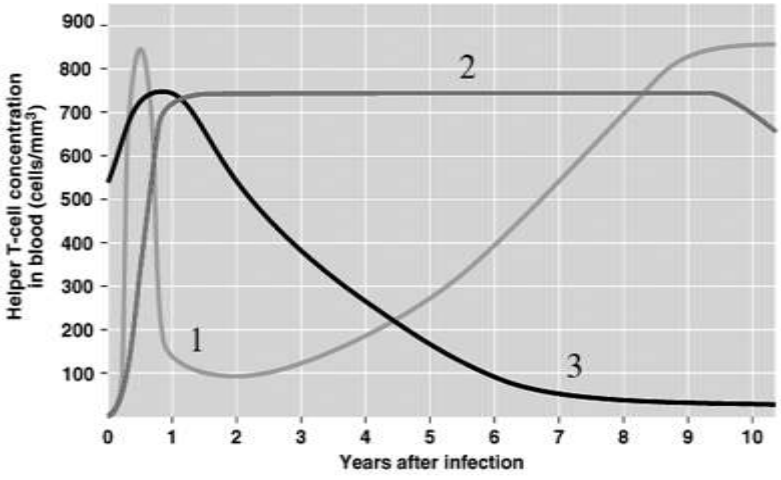
許多烏鴉以軟體動物當作食物，烏鴉抓起獵物並飛至一定高度後，將之投擲在石頭上以打碎甲殼，假如首次投擲未能打碎螺殼，烏鴉會重新抓起獵物飛至更高處重新投擲，週而復始，直到打碎甲殼為止。某一實驗中研究員發現投擲高度及投擲次數的關係如下表：（1 分）

Height of drop (m) 投擲高度	Number of drops required to break shell 打碎甲殼所需投擲次數
1	67
2	46
3	18
4	6
5	5
6	4
12	3

According to optimal foraging theory, which of the following is the most likely height that the crows would fly to drop the shells?
根據最佳搜尋理論，下列何者最可能是烏鴉選擇的投擲高度？

A. 6.5 m
B. 4.5 m
C. 2.5 m
D. 3.5 m
E. 12.5 m

19. The figure below shows cytological and biochemical changes of a human infected by HIV. There are three curves in the figure labeled as 1 through 3. Which of the followings is correct? (1 point)
下圖是人類感染愛滋病毒後，在血液中的細胞與分子的變化情形。圖中有三條曲線，分別標記為 1、2 及 3 。試問下列敘述何者正確？（1 分）



A. Curve 1 represents viral numbers
曲線 1 表示病毒數量
Curve 2 represents concentration of antibodies against HIV
曲線 2 表示抗 HIV 病毒的抗體濃度
Curve 3 represents ~~humoral and~~ T-cell mediated immunity
曲線 3 表示 T 細胞誘發的免疫力

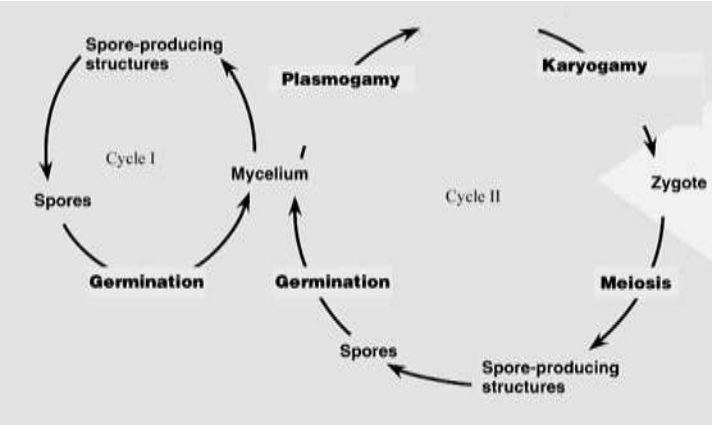
B. Curve 1 represents ~~humoral and~~ T-cell-mediated immunity
曲線 1 表示 T 細胞誘發的免疫力
Curve 2 represents concentration of antibodies against HIV
曲線 2 表示抗 HIV 病毒的抗體濃度
Curve 3 represents viral numbers
曲線 3 表示病毒數量

C. Curve 1 represents ~~humoral and~~ T-cell-mediated immunity
曲線 1 表示 T 細胞誘發的免疫力
Curve 2 represents viral numbers
曲線 2 表示病毒數量
Curve 3 represents concentration of antibodies against HIV
曲線 3 表示抗 HIV 病毒的抗體濃度

D. Curve 1 represents concentration of antibodies against HIV
曲線 1 表示抗 HIV 病毒的抗體濃度
Curve 2 represents ~~humoral and~~ T-cell-mediated immunity
曲線 2 表示 T 細胞誘發性的免疫力
Curve 3 represents viral numbers
曲線 3 表示病毒數量

E. Curve 1 represents viral numbers
曲線 1 表示病毒數量
Curve 2 represents ~~humoral and~~ T-cell-mediated immunity
曲線 2 表示 T 細胞誘發的免疫力
Curve 3 represents concentration of antibodies against HIV
曲線 3 表示抗 HIV 病毒的抗體濃度

20. The figure below shows a generalized life cycle of fungi. Which of the followings is/are true? (1 point) 下圖爲一般性真菌生命周期的示意圖。下述哪一（哪些）是正確的？（1 分）（mycelium 菌絲、 plasmogamy 胞質融合、karyogamy 核融合、zygote 合子、meiosis 減數分裂、spore 孢子、germination 萌芽）



(1) Spores are generally haploid　孢子通常是單倍數
(2) Cycle I is sexual life cycle and cycle II is asexual life cycle
周期 I 是有性周期，周期 II 是無性周期
(3) Diploid fungi are formed after plasmogamy
胞質融合可形成二倍體真菌
(4) There are two types of mycelia that mate even thought they may look alike.
它們的菌絲有兩個不同的交配型，儘管這些菌絲看起來很相像

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

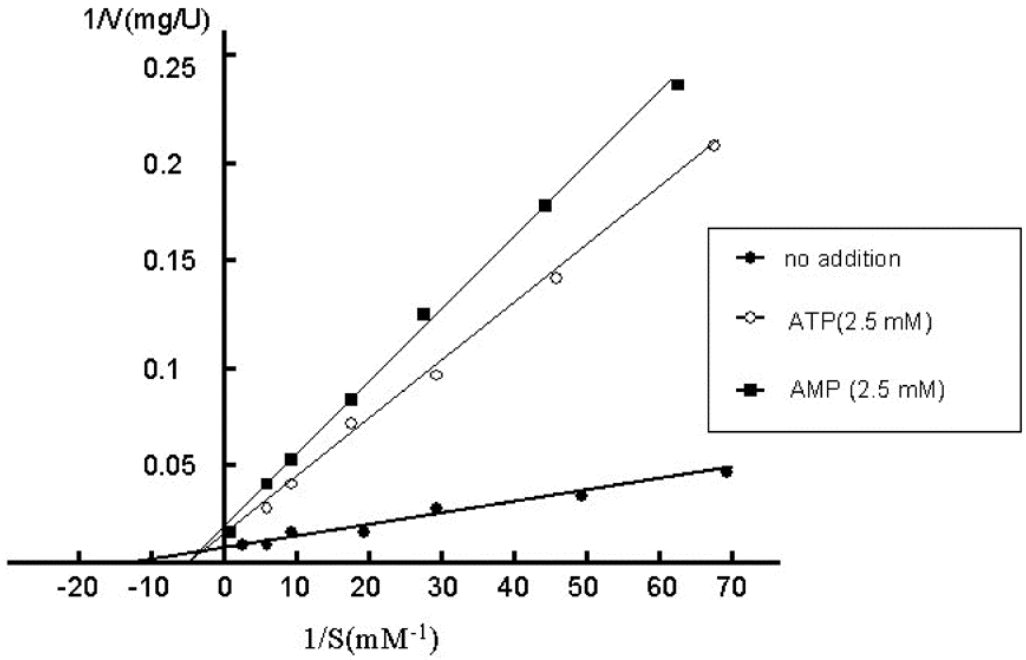
Questions 21-24. The hyperthermophilic archeon, *Pyrococcus furiosus*, has an unusual phosphofructokinase. It catalyzes the following reaction:
熱敏感的古菌類常具有果糖磷酸激酶，其催化反應如下：

Fructose-6-phosphate + ADP --> Fructose-1,6-bisphosphate + AMP

It was found that the addition of glucose, pyruvate, phosphoenolpyruvate, citrate and fructose-2,6-bisphosphate did not show any effect on the reaction rate. The effects of

ATP and AMP addition were shown as Lineweaver-Burk plots:

若添加葡萄糖、丙酮酸、PEP、檸檬酸及果糖-2,6-雙磷酸等物質並未影響此化學反應速率，添加 ATP 與 AMP 的 Lineweaver-Burk 圖形如下：



Answer the following questions:　回答下列問題

21. Which of the following statements is TRUE ? (1 point)下列敘述何者正確？

A. The reaction is ATP-dependent.　　此為 ATP-依存反應

B. The reaction is ADP-dependent.　　此為 ADP -依存反應

C. The reaction is AMP-dependent　　此為 AMP -依存反應

D. Neither of the above answers is true.　以上皆非

22. What is the effect of ATP or AMP on the reaction rate? (1 point)此反應中 ATP 或 AMP 有何作用？（1 分）

A. Only allosteric Stimulation　　只有異位刺激作用

B. Only allosteric inhibition　　只有異位抑制作用

C. Only competitive inhibition　　只有競爭性抑制作用

D. Only uncompetitive inhibition　只有非競爭性抑制作用

E. Mixed inhibition　　混合性抑制作用

23. Does this phosphofructokinase play an important role in the regulation of glycolysis in *Pyrococcus furiosus*? (1 point)
此古菌類的果糖磷酸激酶在糖解作用中是否扮演重要角色？（1 分）

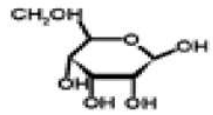
A. Yes
B. No
C. The conclusion cannot be drawn. 無結論

24. *Pyrococcus furiosus* phosphofructokinase was purified and gave a single band at 52 kDa on SDS-polyacrylamide gel electrophoresis. Its native molecular mass determined by gel filtration chromatography was approximately 190 kDa. The protein is: (1 point)
純化此古菌類的果糖磷酸激酶，經 SDS 電泳法後得到 52 kDa 的單一條帶，再利用膠體過濾色層分析法得到的原始分子約為 190 kDa，此蛋白質為：

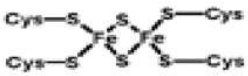
A. monomer 單體
B. dimer 雙體
C. trimer 三體
D. tetramer 四體
E. hexamer 六體

25. Match the following names or descriptions to the right biochemical compounds listed. (2 points)
將圖上分子結構與表上的名稱配合（2 分）

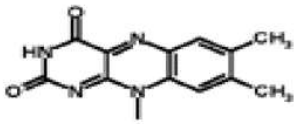
A



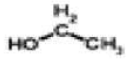
B



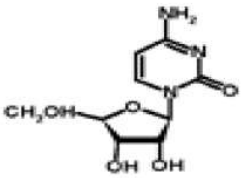
C



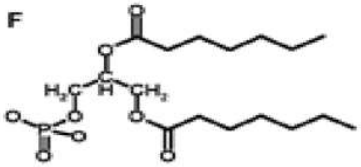
D



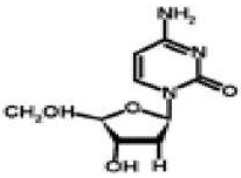
E



F



G



1. Nucleoside found in DNA 在 DNA 的核苷
2. Phospholipid 磷脂質
3. A yeast fermentation product 酵母菌發酵產物
4. Monosaccharide 單糖
5. Iron-sulfur center 鐵-硫中心

Answer [A-G]
1. G
2. F
3. D
4. A
5. B

~~26. Antibiotics are antimicrobial substances produced by some organisms to prevent growth of other organisms. Match the following antibiotics as inhibitors to their cellular targets: (1 point)~~

~~A. Cell wall synthesis 細胞~~
~~B. Plasma membrane formation~~
~~C. DNA replication~~
~~D. RNA transcription~~
~~E. Protein translation~~

	~~Answer (A-E)~~
~~1. Polymyxins~~	
~~2. Tetracycline~~	
~~3. Rifampin~~	
~~4. Penicillin~~	
~~5. Mitomycin~~	

~~27. Glucose labeled with ^{14}C at C-1 is incubated with the glycolytic enzymes and necessary cofactors. What is the distribution of ^{14}C in the pyruvate that is formed? (1 point)~~

~~A. The label is in the methyl carbon atom of pyruvate.~~
~~B. The label is in the carboxyl carbon atom of pyruvate.~~
~~C. The label is in both the methyl and carboxyl carbon atoms of pyruvate.~~
~~D. The label is in the middle carbonyl carbon atom of pyruvate.~~

28. A common component of NADP, NAD, ~~FMN~~, FAD, and coenzyme A is: (1 point)
NADP, NAD, FAD, FMN 及 coenzyme A 的共同成分為：（1 分）
A. A purine ring 嘌啉環
B. A three ring structure 三環構造
C. An ADP 腺嘌呤核苷雙磷酸
D. A Deoxyribose 去氧核糖
E. A triphosphate group 三磷基團

29. Which of the following statements is/are correct? (1 point)
下列哪一（哪些）敘述正確？
(1) The citric acid cycle does not exist as such in plants and bacteria, because its functions are performed by the glyoxylate cycle.
檸檬酸循環不存在於植物、細菌，原因是它們使用乙醛酸循環
(2) The citric acid cycle oxidizes the acetyl CoA derived from fatty acid degradation.

檸檬酸循環是將源自脂肪酸降解產物乙醯輔酶 A 氧化之

(3) The citric acid cycle produces most of the CO_2 in anaerobic organisms.
厭氧生物的檸檬酸循環之產物大部分為 CO_2

(4) The citric acid cycle provides succinyl CoA for the synthesis of carbohydrates.
檸檬酸循環提供碳水化合物合成過程所需之琥珀酸輔酶 A

(5) The citric acid cycle provides carbon skeletons for amino acid synthesis.
檸檬酸循環提供胺基酸合成過程所需之碳骨架

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

30. Key enzymatic differences between liver, kidney, muscle and brain account for their differences in the utilization of metabolic fuels. Which of the following does NOT represent such a biochemical difference? (1 point)
肝、腎、肌肉與腦所使用代謝燃料不同，其關鍵酵素亦不同，下列生化作用無法呈現此差異性？（1 分）

A. The liver contains glucose 6-phosphatase, whereas muscle and the brain do not. Hence muscle and the brain, in contrast with the liver, do not release glucose into the blood.肝含葡萄糖-6-磷酸酵素，肌肉與腦沒有，因此肌肉與腦不會釋出葡萄糖至血液。
B. The liver has little of the transferase needed to activate acetoacetate to acetoacetyl CoA. Consequently, acetoacetate and 3-hydroxybutyrate are exported by the liver and be used by heart muscle, skeletal muscle and the brain.肝很少具促進酮醋酸鹽至酮醋酸輔酶 A 所需的轉移酵素，因此酮醋酸鹽與 3-hydroxybutyrate 由肝運轉至心肌、骨骼肌與腦利用。
C. Under conditions of prolonged starvation, the fatty acids stored in the adipose tissues will be converted into ketone bodies there before being transported to the brain and muscle for complete oxidation. 持續饑餓下，存放在脂肪組織的脂肪酸在轉運至腦與肌肉完全氧化前會先轉至酮體。
D. Lactate dehydrogenase does not appear to exist in the heart muscle. As a result, the heart depends on aerobic oxidation to obtain the energy for its continuous pumping.乳酸去氫酶不存在於心肌中，因此心臟需依賴有氧呼吸作用以取得

能量來維持心跳。

31. An organelle in eukaryotic cell is spherical or ovoid with a diameter of 0.1 to 1.5 μm and consists of a single membrane. It participates in a variety of metabolic processes, including H_2O_2-based respiration and lipid metabolism. This organelle is most likely? (1 point)
真核細胞某胞器呈現球狀或卵形，直徑 0.1 to 1.5 μm，具單層膜，參與多種代謝反應包括 H_2O_2-呼吸與脂質代謝。此胞器應該是下列何者？（1 分）

A. Mitochondrion 粒線體
B. Peroxisome 過氧化體
C. Endoplasmic reticulum 內質網
D. Lysosome 溶體
E. Endosome 內質體

32. （刪除）A red alga has two major kinds of photosynthetic pigments: phycobilisomes （phycobilins） that absorb green light and chlorophylls that absorb red and blue light. A student performed an experiment and obtained measurement data as shown in table. Note, all light is used with identical light intensity. ~~at 100 mol.m^{-2}.s^{-1}~~

紅藻含有兩種光合色素：藻青素可吸收綠光，葉綠素可吸收紅與藍光。某生獲得下列實驗結果，實驗中各處理的光強度均相同。

Light quality 光處理	Photosynthetic oxygen evolution rate 光合成作用的氧生成速率
Blue light only 只有藍光	28
Green light only 只有綠光	65
Red light only 只有紅光	47
Blue and green 藍光與綠光	150
Blue and red 藍光與紅光	73
Green and red 綠光與紅光	146

Which of the following is/are NOT correct? (2 points)

下列哪一（哪些）錯誤？（2 分）

(1) Blue light absorbed was less efficient for photosynthetic electron transfer because the blue light is mostly absorbed by chlorophyll b.
吸收藍光對光合作用的電子傳遞效率較低，因藍光主要由葉綠素 b 所

吸收。

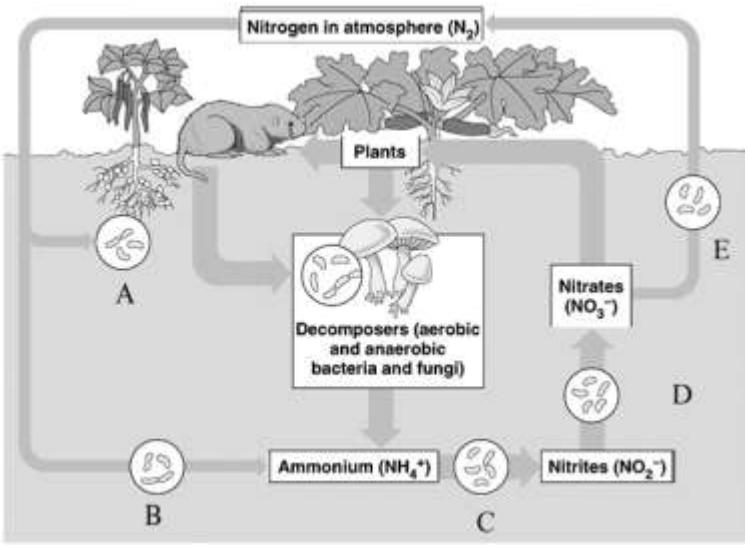
(2) Red light is more efficiently absorbed by chlorophyll than blue light.
葉綠素吸收紅光的效率比藍光高。

(3) ~~Emerson enhancement effect is observed in this experiment.~~ An enhancement effect, caused by the simultaneous excitation of the two photosystems, is observed in this experiment.
兩光線同時激發所產生的光反應增強效應，可在此實驗中觀察到。

(4) It is predicted that more overlapping is present in long wavelength region and than the short wavelength region between phycobilisome absorption spectrum and chlorophyll absorption spectrum.
可預估介於藻青素與葉綠素吸收光譜在長波區域的重疊大於短波區域。

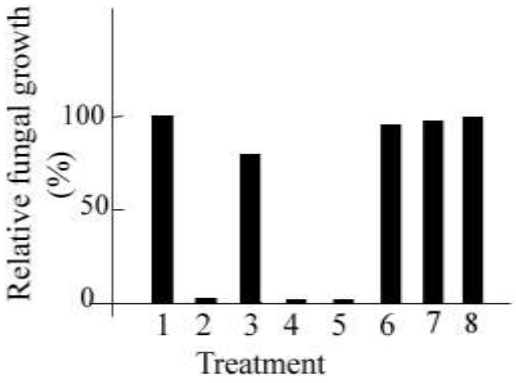
A. 1, 2, 4
B. 1, 3, 4
C. 3, 4
D. 1, 2
E. 1

33. The figure below shows the nitrogen cycle on earth. Finish the table below according to the information provided. (1 point)
將下列氮循環圖依其所提供訊息填寫下表（1 分）



Bacteria:細菌：	Answer: A through E. **Note, there could be more than one answer** 可填寫 A 至 E 的代號至此答案區，但需注意可能不只一個答案
(1) Able to form nodule with plants 可與植物形成根瘤	A
(2) Able to denitrify 去硝化(脫氮)作用	E
(3) Able to nitrify 硝化作用	CD
(4) Able to use ammonium as energy source 可利用銨鹽作為能量來源	CorD
(5) Able to fix nitrogen from air 能固定空氣中的氮	AB

34. A researcher found that seeds from a plant could inhibit growth of some fungi. He isolated some substances from the seeds and performed analyses. The figure below is the result. He also ran a regular SDS-gel electrophoresis that separated molecular standard proteins from 14 kDa to 100 kDa.
某科學家發現一種植物的種子會抑制一些真菌的生長。他由種子中分離出一些物質並進行分析。下圖為他的實驗結果。



Treatment 1: no addition of the substance. 處理 1：未加分離物

Treatment 2: addition of the substance. 處理 2：加入分離物

Treatment 3: addition of substance that was treated with -mercaptoethanol (BME)
處理 3:加入經還原劑 BEM 處理後的分離物

Treatment 4: same as treatment 3 except that BME was removed before addition of the substance to the fungal culture.
處理 4: 將處理 3 移除 BME 後的分離物加至真菌培養基中

Treatment 5: the substance was treated at 80℃ for 20 min before the addition to the fungal culture.
處理 5:分離物經 80℃ 處理 20 分鐘後，加至真菌培養基中

Treatment 6: the substance was treated at 80℃ for 20 min in the presence of BME before the addition to the fungal culture.
處理 6:處理 3 的分離物經 80℃ 處理 20 分鐘後，加至真菌培養基中

Treatment 7: the substance was treated with trypsin.
處理 7：分離物經胰蛋白酶處理

Treatment 8: only trypsin was added to the fungal culture.
處理 8：在真菌培養基中，僅加入胰蛋白酶

He found no protein could be detected in this molecular mass range with coomassie stain even though the substance(s) showed Coomassie binding in solution. The substance(s) is colorless, but had a strong absorption in UV region. Which of the following is/are correct? (2 point)

此外，他也進行 SDS 蛋白質膠體電泳，此電泳可以分離分子量 14 kDa 到 100 kDa 大小的標準蛋白質。膠體經蛋白質染劑 Coomassie blue 染色後，並未測到蛋白質，但在 UV 區有強的吸光現象。下列敘述何者正確。

(1) The substance(s) contains protein
分離物中含有蛋白質
(2) The substance(s) has disulfide bond that is important to the function
此分離物含有雙硫鍵對其功能非常重要
(3) The substance(s) is stained poorly with Coomassie blue
此分離物無法被蛋白質染劑 Coomassie blue 染色
(4) The substance(s) is a protein with molecular mass smaller than 14 kDa.
此分離物的分子量小於 14 kDa
(5) The substance(s) is not resistant to trypsin treatment.
此分離物會受到胰蛋白酶的影響

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

35. Calculate the pI value of aspartic acid. Its pK_1 is 2.09, pK_2 is 3.86, pK_3 is 9.82. (1 point)
請計算天門冬胺酸的 pI 值，其 pK_1 是 2.09, pK_2 是 3.86, pK_3 是 9.82。
A. 5.26
B. 2.98
C. 5.96
D. 6.84

Question 36-40. ~~To complete a life cycle, e.g. from zygote to gametes, plants need to constantly incorporate environmental information to ensure all the organs required for the life cycle to be properly initiated from growth tip. Flowering is a process with the most sophisticated morphological changes, in which, specific environmental signals are often required.~~

36. When we refer to a plant as a “short-day plant”, it exactly means: (1 point)

「短日照植物」的真正意思是：（1 分）

A. The plant flowers in winter　植物在冬天開花
B. The plant flowers when day is shorter than 12 hours
植物在白天短於 12 小時情況下會開花
C. The plant flowers only in the equator area　植物只有在赤道地區會開花
D. The plant flowers when night is longer than its own critical night length
當夜晚時數長於某閥值時會開花
E. A and D　　在 A 與 D 均是

37. Which of the following is the photoreceptor that responses to day-length? (1 point)
下列何者是會對日照長短反應的「光受體」？

A. Chlorophyll 葉綠素
B. Carotenoids 類胡蘿蔔素
C. Cytochrome 細胞色素
D. Phytochrome 植物色原
E. Retinal 視網膜

38. Which of the following statements is correct? (1 point)　下列敘述何者正確？

A. A flower is a reproductive organ　花是一繁殖器官
B. A flower lacking any of sepal, petal, stamen or carpel is an imperfect flower
缺花顎、花瓣、雄蕊或雌蕊其中之一部分的花，即稱之為不完全花
C. Most grasses have imperfect flowers　大部分草本植物為不完全花
D. Floral parts in all angiosperm are arranged as four whorls
所有被子植物的花均排列成四輪。
E. Floral parts are sequentially initiated at the floral meristem
花是源自花的形成層。

39. One the means to prevent self-fertilization in plants is self-incompatibility. Which of the following statements is/are true about self-incompatibility? (1 point)
植物防止自花授精方法之一為自花不合和，下列關於自花不合和的敘述哪一（哪些）是正確的？（1 分）

(1) The plants that show self-incompatibility have a unique stigma structure.
植物以單一柱頭構造來呈現自花不合和。
(2) The flowers of the plants that show self-incompatibility only produce pollens when stigmas fail to develop.

柱頭不發育來呈現自花不合和。

(3) Self-incompatibility is analogous to animal immune response in that both have the ability to distinguish the cells of “self” from those of “nonself”.
自花不合和類似動物的免疫反應，能區別「自己」或「不是自己」的細胞。

(4) A pollen from one plant will only develop pollen tube on its own stigma if a pollen from another plant is present on the stigma.
一植物的花粉粒只能在其他植物的花粉粒共同存在於自己的柱頭時，才能發育成花粉管。

(5) A pollen from one plant will develop pollen tube on its own stigma, but will not be able to fertilize the egg.
一植物的花粉粒可以在自己的柱頭上發育成花粉管，但無法與卵授精。

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

40. Where do you find the cells undergo meiosis in plants? (1 point)
植物的減數分裂在哪種細胞進行？（1 分）
A. From shoot apical meristem 由莖頂分生組織
B. From pollens 由花粉粒
C. From embryo sacs 由胚囊
D. From corolla 由花冠
E. From ovule 由胚珠

41. Which of the following structures of plants consists of haploid cells? (1 point)
下列植物構造具單套染色體細胞？（1 分）
A. Sporophytes 孢子體
B. Sporocytes 孢母細胞
C. Sporangia 孢子囊
D. Tapetum
E. Gametophytes 配子體

Questions 42-45. Algae play very important roles in ecosystems. They are also diverse in pigmentation. 藻類在生態系統中扮演重要角色，它們的色素具多樣化。

42. Red algae differ from green algae and brown algae in that： (1 point)
紅藻之異於綠藻與褐藻是在：（1 分）

A .Red algae produce agar. 紅藻產生洋菜膠
B. Red algae do not produce chlorophyll a. 紅藻無葉綠素 a
C. Red algae do not have sexual reproduction. 紅藻不具有性生殖
D, No unicellular red alga has been found. 單細胞的紅藻未被發現
E. Red algae do not produce flagelatted cells in their life cycle.
紅藻生活史中不產生鞭毛細胞。

43. Dinoflagellates are a group of algae. Their pigments are similar to brown algae. Therefore, the pigments of a typical dinoflagellate are similar to: (1 point)
雙鞭藻是藻類的一群，其所含色素類似褐藻，因此典型雙鞭藻的色素相似於下列何種藻類之色素：（1 分）

A. Pigments of Chlamydomonas 單胞藻
B. Pigments of Volvox 團藻
C. Pigments of a diatom 矽藻
D. Pigments of a red alga 紅藻
E. Pigments of blue-green algae 藍綠菌

44. According to their pigmentation, which algal group would be most likely to perform photosynthesis in deepest water? (1 point)
基於所含色素，哪一類群的光合作用利於深海環境？（1 分）

A. Red algae 紅藻
B. Green Algae 綠藻
C. Brown algae 褐藻
D. Golden algae 黃金藻

45. （刪除）Seaweeds are large marine algae and they play very important role in marine ecosystems. Which of the following is/are NOT true about seaweeds? (1 point)
海草是大型海生藻類，對海洋生態系深具重要性，下列敘述何者**錯誤**？

(1) Most seaweeds are brown algae. 大部分的海草是褐藻
(2) Diatoms can sometimes be large enough to be included as seaweeds.
矽藻有時可大到足以被包涵在海草中。
(3) Seaweeds have complicated structures such as leaves.
海草具如葉片等複雜構造。
(4) Seaweeds live in deep water 海草生長於深水中
(5) They use holdfast to absorb nutrients 它們利用固著器吸收養分

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

46. Apoptosis was first described in nematodes and later was found to be present in many organisms. Which of the following is NOT true about apoptosis? (1 point)
細胞凋亡最早是在線蟲中觀察到的。其後，此現像也在許多生物中被發現。以下有關細胞凋亡的敘述，何者**錯誤**?

A. It was discovered by cell lineage analysis of nematodes
此現象是經由線蟲細胞遺傳族系分析而被發現的
B. It is a critical process in animal development.
在動物發生中，此現象是一個決定性過程
C. It is controlled by single gene
此現象是由單一基因控制的
D. It is found in insects
此現象可以在昆蟲發現
E. Proteases and nucleases participate in apoptosis.
蛋白酶和核酸酶參與細胞凋亡

47. After synthesis, proteins are translocated either by nonvesicular transport or by vesicular transport. Answer A for vesicular or B for Non-vesicular to indicate how the protein indicate is transported. (0.2x9, 1.8 points)
蛋白質合成後可經由非囊泡或囊泡型式進行運送。回答下表所列的各種蛋白質在細胞內的運送方式，A：為囊泡型；B：為非囊泡型。(0.2x9, 1.8 分)

Proteins:	Answer A or B
1. cytoskeletal proteins 細胞骨架蛋白	B
2. Mitchondrial proteins 粒線體蛋白	B
3. Lysosomal proteins 溶小體蛋白	A
4. Nuclear proteins 核蛋白	B
5. Cytosolic enzymes 細胞質酵素	B
6. integral plasma membrane proteins 穿膜蛋白	A
7. secreted proteins 分泌性蛋白	A
8. Chloroplast proteins 葉綠體蛋白	B
9. Peroxisomal protein 過氧小體蛋白	B

48. An action potential in neurons is characterized by all the following except that (1 point)
下列何項**不是**神經元動作電位的特性？

A. It is initiated by opening of voltage-gated potassium channels
它是經由電壓匣門型鉀離子通道開啟的
B. It is regarded as a regenerative response
它是一種重覆發生的反應
C. It is regarded as a all-or-none response
它是一種全或無的反應
D. It does not degrade in magnitude with space or time
它的空間或時間性的大小沒有降低
E. It is characteristic of transmembrane potential changes that occur in most axons.
它的膜電位改變發生在軸突上

49. The resting potential in most neurons is primarily due to the permeability of (1 point)
大部分神經元的靜止膜電位主要起因於何種離子的通透性？

A.Calcium 鈣

B. Chloride 氯
C. Sodium 鈉
D. Potassium 鉀
E. Magnesium 鎂

50. Which of the following cell cycle phases is usually the shortest in duration? (1 point)
細胞週期中，那一個時期最短？
A. G_1
B. G_0
C. G_2
D. S
E. M

51. Which of the following is/are often used for protein purification? (1 point)
下列何者常用於蛋白質純化？
(1) Gel filtration chromatography 膠體過濾層析管柱
(2) Ion exchange chromatography 離子交換層析管柱
(3) Salt precipitation 塩析沈澱
(4) SDS-electrophoresis SDS 電泳法
(5) Substrate affinity chromatography 受質親和力層析管柱

A. all of the above 以上皆是
B. 1, 2, 3, 4,
C. 1, 2, 4, 5
D. 1, 2, 3, 5
E. 2, 3, 4, 5

52. Which of the following is/are important in ATP synthesis? (1 point)
在 ATP 合成中，下列何者是重要的？
(1) P700
(2) P680
(3) P450

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

E. 1, 2, 3

53. Which of the following statements about mRNA is correct? (1 point)
下列有關 mRNA 的敍述，何者正確？

(1) All mRNA has a cap at its 5’ end
所有的 mRNA 在 5’端都具有 cap

(2) All mRNA has a poly A tail at its 3’ end
所有的 mRNA 在 3’端都具有一段 poly A tail

(3) Its synthesis is performed by RNA polymerase
它是經由 RNA 聚合酶催化合成的

(4) The stability of mRNA regulates abundance of its coding protein.
mRNA 的穩定性可以調節它轉錄出的蛋白質產量

(5) The codons on mRNA pair with anti-codons of tRNA through A-T, G-C hydrogen bonds
mRNA 上的密碼子與 tRNA 上的反密碼子之間的配對是經由 A-T 和 G-C 的氫鍵

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

54. Which of the following about tRNA is/are correct? (1 point)
下列有關 tRNA 的敍述，何者正確？

(1) There are stem-loop structures
它們具有一苜蓿葉狀的構造

(2) It consumes ATP in synthesis of aminoacyl tRNA
在合成胺醯 tRNA 時，需消耗 ATP

(3) tRNA is synthesized by RNA polymerase III
tRNA 是由 RNA 聚合酶 III 催化合成的

(4) tRNA is synthesized as a precursor and was processed before it is functional.
tRNA 合成之初為一前驅物，需經過處理後才具有功能

(5) Although theoretical number of tRNA molecules is 61, the actually number of tRNA molecules in most of the cell is smaller, partially because some anticodons can recognize more than one codon.
雖然理論上有 61 種 tRNA，但實際上在大部分的細胞中，tRNA 的種類少於 61，原因是有些反密碼子能辨認一個以上的密碼子

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

55. Which of the following is/are NOT true about Freeze-fracture method in electron microscopy? (1 point)
下列有關電子顯微鏡之冷凍斷裂法的敘述，何者**錯誤**？

(1) Low temperature is used to weaken hydrogen bonding.
以低溫減弱氫鍵
(2) It is often used to observe structures within membrane.
此方法通常用在觀察膜內的構造
(3) Particles observed on fractured faces are often liposomes
在斷裂面看到的顆粒通常是脂肪小體
(4) Both eukaryotic and prokaryotic cells can be observed with this method
真核和原核細胞都可以利用此方法進行觀察
(5) This method actually observes a replica of specimen.
實際上，此方法看到的是樣本的複製品

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

Questions 56-57. Yeast is one of the ideal organisms for the study of cellular, developmental and genetic processes. It can grow either on fermentable or non-fermentable carbon sources. With this property, people can isolate and analyze different

yeast mutants associated with certain functions of subcellular organelles.
在細胞發生和基因的研究上，酵母菌是非常適當的生物體之一。由於它可以利用碳源進行醱酵或非醱酵性的生長，因此人類可以進行不同變株的分離，並分析它們胞器之特定功能。

56. When the yeast mutant cannot grow on oleate (long-chain fatty acid), the mutant has defect in which organelle? (1 point)
當酵母菌無法在油酸脂（長鏈脂肪酸）中生長時，表示此突變株缺少下列何種胞器？

A. Mitochondria 粒線體
B. Lysosome 溶體
C. Peroxisome 過氧化小體
D. Nucleus 細胞核
E. Endoplasmic reticulum 內質網

57. When a yeast mutant cannot grow on glycerol, the mutant has defect in which organelle? (1 point)
當酵母菌無法在甘油中生長時，表示此突變株缺少下列何種胞器？

A. Mitochondria 粒線體
B. Lysosome 溶體
C. Peroxisome 過氧化小體
D. Nucleus 細胞核
E. Endoplasmic reticulum 內質網

58. Which of the following is NOT a factor influencing membrane fluidity? (1 point)
下列何者不會影響細胞膜的流動性？

A. Number of double bonds in lipids 脂質中雙鍵的數目
B. Temperature 溫度
C. Flip-flop move of lipids 脂質的翻轉
D. Cholesterol 膽固醇

Questions 59-61 are about food digestion in mammalian digestive system.
題目 59~61 與哺乳類動物消化系統的消化作用有關

59. Which of the following is NOT involved directly in protein digestion? (1 point)
下列何者<u>不會</u>直接影響蛋白質的消化？

A. Trypsin 胰蛋白酶
B. Dipeptidase 雙肽酶
C. Aminopeptidase 胺基肽酶
D. Carboxypeptidase 羧肽酶
E. <u>Enteropeptidase 腸肽酶</u>

60. Which of the following enzymes is NOT functionally present in small intestine? (1 point) 下列何種酵素在小腸中<u>不具有</u>功能？

A. Nucleases 核酸酶
B. Lipase 脂酶
C. Chymotrypsin 胰蛋白酶
D. Pancreatic amylases 胰澱粉酶
E. <u>Pepsin 胃蛋白酶</u>

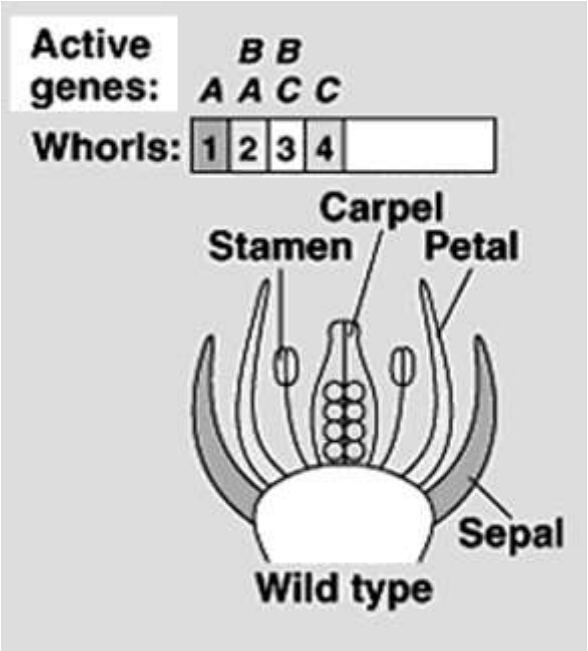
61. Many hormones are involved in food digestion and absorption. Please match the functions with appropriate hormones. (1 point)
多種激素與食物的消化和吸收有關，請針對其功能進行配對。

A. Regulation of blood sugar 血糖的調節
B. Stimulation of bicarbonate release 刺激碳酸氫離子的釋放
C. Stimulation of gallbladder to contract and release bile 刺激膽囊收縮釋放膽汁
D. Stimulation of secretion of gastric juice.刺激胃酸釋放

Hormones 激素	Fill your answer 填入英文代號
1. Cholecystokinin 膽囊收縮素	<u>C</u>
2. Gastrin 胃泌素	<u>D</u>
3. Secretin 胰泌素	<u>B</u>
4. Insulin 胰島素	<u>A</u>

Questions 62-63. Flowering is one of the most sophisticated processes in plants. By analysis of flowering mutants and through other studies, researchers proposed an ABC model (hypothesis) to explain gene regulation of flower structures. Three classes of genes are involved: class A, class B and class C.

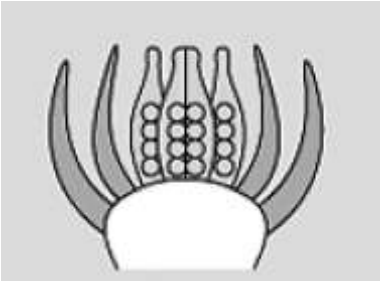
開花是植物中最錯綜複雜的過程之一。經由開花突變體基因的分析，及其他的研究，科學家們提出了一個 ABC 模型（假設），以解釋基因對花結構的調節。三類基因參與其中：A 類，B 類和 C 類。



In this model, sepal is produced where gene A is active, petal is produced where genes A and B are active; Stamen is produced where genes B and C are active and Carpel is produced where gene C is active. When gene A is missing, gene C takes its place and when gene C is missing, gene A takes gene C's place.

在這個模型中，萼片的形成是 A 類基因活化的結果，花瓣在的形成是 A 和 B 類基因都活化的結果，雄蕊的形成是 B 和 C 類基因活化的結果，心皮的形成是 C 類基因活化的結果。當 A 基因缺失，C 基因佔據 A 基因的位置，當 C 基因缺失，A 基因佔據 C 基因的位置。

62. According to the ABC model, which of the following mutants will produce a phenotype shown below? (1 point)
根據 ABC 模型，下列突變體如何形成？（1 分）



A. A mutant lacking gene A 缺失 A 基因的突變體
B. A mutant lacking gene B 缺失 B 基因的突變體
C. A mutant lacking gene C 缺失 C 基因的突變體
D. A mutant lacking genes A and B 缺失 A 基因和 B 基因的突變體
E. A mutant lacking genes B and C 缺失 B 基因和 C 基因的突變體

63. It has been demonstrated that Genes A, B and C encode transcription factors. Which of the following is NOT a property of transcription factors? (1 point)
人們已經證實，A 基因，B 基因和 C 基因解碼為轉錄因子。下面哪個選項不是轉錄因子的特性？（1 分）

A. DNA-binding 結合 DNA
B. Interaction with other proteins 與其他蛋白相互作用
C. Degradation by protease 由蛋白酶降解
D. RNA binding 結合 RNA
E. Participation of other gene regulation. 參與其他基因的調解作用

64. PCR (polymerase chain reactions) is one of the most powerful methods in molecular biology. Which of the following is/are NOT true about PCR? (1 point)
聚合酶連鎖反應是分子生物學十分有效的工具，下列哪些有關 PCR 的敘述是錯誤的？

(1) Primers are needed in PCR
PCR 需要引子的參與
(2) A DNA polymerase that can tolerate high temperature is needed in PCR
需要一種可耐 PCR 高溫的 DNA 聚合酶

(3) ATP is needed in PCR
PCR 需要 ATP 的參與
(4) A DNA template is needed in PCR
PCR 過程中需要 DNA 模板

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

65. Nitrogenous wastes of animals are released to their environments in different forms. Which of the following statements is/are true about animal nitrogenous wastes? (1 point)
動物可排出不同形式的含氮廢物，下列何者正確？
(1) Urea is excreted by many marine fishes.
許多海洋魚類可排出尿素
(2) Ammonia is so toxic that it is rarely excreted as nitrogenous waste by any animals
因氨具有毒性，故動物甚少將之當作含氮廢物排出
(3) The animals in dry environments could excrete uric acid
在乾旱環境中的動物可排出尿酸
(4) The form of nitrogenous waste is often an adaptation to animal habitats.
含氮廢物的形式常是動物對棲息地的適應行為

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

66. Among the nitrogenous wastes, urea, uric acid and ammonia have the toxicity in following order: (1 point)
請依序排出含氮廢物的毒性大小？
A. Ammonia > uric acid > urea　氨 〉尿酸 〉尿素
B. Urea > ammonia > uric acid　尿素 〉氨 〉尿酸
C. Uric acid > urea > ammonia　尿酸 〉尿素 〉氨

D. Ammonia > urea > uric acid 氨〉尿素 〉尿酸

E. ~~Urea > ammonia > uric acid~~

F. ~~Uric acid > urea > ammonia~~

Question 67-69. Equilibrium dialysis is a method often used to determine dissociation constant K_D for a ligand-binding protein. In this method, a protein at a know concentration is put into several dialysis tubes and each dialysis tube containing the protein is dialyzed against solutions containing the ligand at various ligand concentrations. Because the protein can not move cross the dialysis tube membrane while the ligand can, the ligand is "trapped" by the protein inside the dialysis tube and it creates a higher concentration of the ligand in dialysis tube than that outside the dialysis tube. The dissociation constant of the ligand can thus be determined according to the following formula:

平衡透析法常用於判別配體結合蛋白(ligand-binding protein)的解離常數(K_D)，本方法是將已知濃度的蛋白質置放於含有不同濃度配體的透析管中，蛋白質與配體一旦結合便無法通過透析膜，所以透析管內的蛋白質濃度將會高於管外透析液的濃度，可藉由下列公式推算解離常數

$$K_D = \frac{[M][L]}{[ML]}$$

Where [M] is the concentration of free protein (no bound ligand) in dialysis tube, [L] is the concentration of the ligand and [ML] is the concentration of the protein with bound ligand. Therefore, K_D is the ligand concentration when [M] equals [ML]. $[M_T] = [M] + [ML]$. Where $[M_T]$ is the total concentration of the protein

[L] 代表配體的濃度

[M]代表未於配體結合的蛋白質濃度

[ML] 代表與配體結合的蛋白質濃度

$[M_T]$ 代表蛋白質的總濃度 ($[M_T] = [M] + [ML]$)

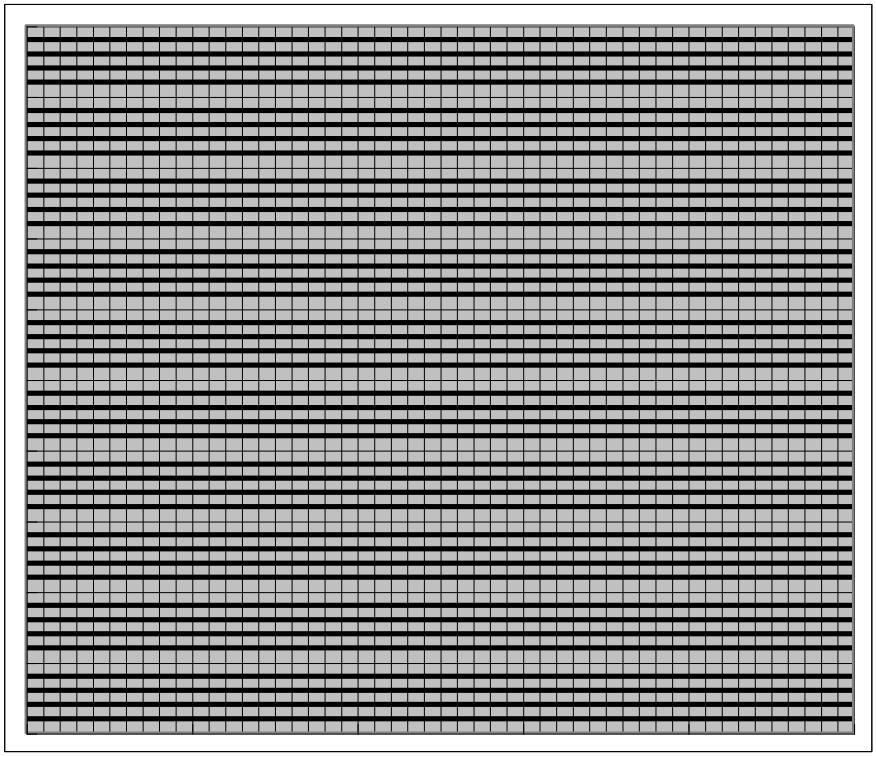
K_D 為當[M]= [ML]時的配體濃度

The table below shows the measurement result of a calcium-binding protein. The protein has a molecular mass of 20 kDa and the concentration of the protein in equilibrium dialysis is 1 $mg.ml^{-1}$.

下表為某一鈣離子結合蛋白的測量結果，該蛋白質的分子量為 20 kDa，使用的蛋白質濃度為 1 $mg.ml^{-1}$ (1 mg/.ml)

Calcium concentration in dialysis solution (M) 管外透析液中的鈣離子濃度	Calcium concentration in dialysis tube (M) 透析管內的鈣離子濃度	$[M]/[M_T]$
20	30	
50	68	
100	129	
200	237	
400	442	
600	647	
1000	1050	
1500	1548	
2000	2049	

Please calculate the values of at each concentration and plot the data (Calcium concentration in solution vs $[M]/[M_T]$) with the plotting paper shown below.
請算出各濃度下的 $[M]/[M_T]$ 比值，並將結果繪入下方的繪圖紙中



67. How many calcium ions does one protein molecule bind? (1 point)
一個蛋白質分子可結合多少個鈣離子？

A. 1
B. 2
C. 3
D. 4
E. It can not be determined 無法判定

68. What is the K_D of the protein? (3 point) 該蛋白質的 K_D 為何？

A. 30 M
B. 78 M
C. 95 M
D. 104 M
E. 200 M

69. There are two calcium-binding proteins, protein X and protein Y. If protein X has a K_D of 250 nM and protein Y has a K_D of 400 nM, which of the following is/are NOT correct? (2 point)

X、Y 為兩種鈣離子結合蛋白，其 K_D 分別為 250 nM 和 400 nM，下列敘述何者<u>錯誤</u>？

(1) Protein X binds calcium more tightly than protein Y.
X 蛋白與鈣離子的結合力較 Y 蛋白強

(2) Half of protein Y will have bound calcium at the concentration of 400 nM.
當鈣離子濃度為 400 nM 時，有半數的 Y 蛋白會與鈣離子結合

(3) It is more difficult to release the bound calcium from protein Y.
與 Y 蛋白結合的鈣離子較難釋出

(4) When protein X and protein Y are mixed at equal molar concentration, more protein X will have bound calcium than protein Y at a calcium concentration of 250 nM.
當相同濃度的 X 蛋白與 Y 蛋白混合後，在鈣離子濃度為 250 nM 時，較多的蛋白 X 會與鈣離子結合

(5) When protein X and protein Y are mixed at equal molar concentration, equal amount of protein X and protein Y will have bound calcium at a calcium concentration of 400 nM.
當相同濃度的 X 蛋白與 Y 蛋白混合後，於鈣離子濃度為 400 nM 時，相同數量的蛋白 X 及蛋白 Y 會與鈣離子結合

A. 1, 2, 5
B. 2, 4,
C. 3, 4
D. 4, 5
E. <u>3, 5</u>

70. Which of the following are amniotes? (1 point)
下列哪些為羊膜動物？

(1) Bony fishes (Osteichthyes) 硬骨魚
(2) Reptiles 爬蟲類
(3) Chondrichthyes 軟骨魚
(4) Agnatha 無頷魚類
(5) Mammalia 哺乳類
(6) Amphibia 兩生類
(7) Aves 鳥類

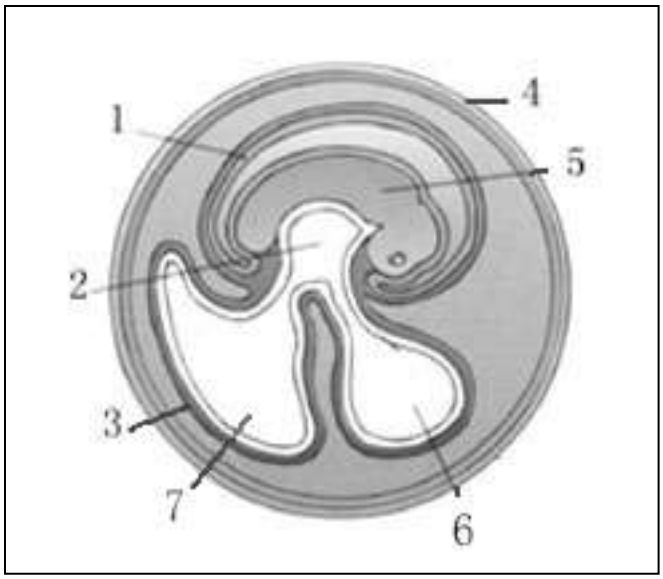
A. 1, 4, 6, 7
B. 2, 3, 5

C. 2, 5, 7
D. 2, 4, 5, 6
E. 2, 5, 6, 7
F. 4, 5, 6, 7
G. 5, 6, 7

71. The figure below shows schematic structures of an amniotic egg. Please name the structures labeled by numbers 1 through 7. (1 point)

下圖為某孵化中胚胎的示意圖，請將正確的數字與結構進行配對。

A. amnion 羊膜　B. embryo 胚胎　C. allantois 尿囊　D. chorion. 絨毛膜
E. yolk sac.卵黃囊　F. gut 原腸　G. allantois cavity 尿囊腔



1
2
3
4
5
6
7

Answer
A-G

A
F
C
D
B
E
G

72. Fill appropriate answers based on the functions of the structure shown the figure of question 71. (1 point)

請按照其功能將代表構造的數字填入答案欄中

Main Function 主要功能	Answer: A-G
(1) It protects the embryo in a fluid-filled cavity that prevents dehydration. 保護胚胎以避免脫水	A
(2) It provides nutrients for embryo 提供胚胎養分	E
(2) It functions as a disposal sac for metabolic wastes 作為儲存代謝廢物的囊狀構造	G
(4) It is rich in blood vessels and it forms sac for collecting waste 大量存在於血管中並可形成代謝廢物的囊狀構造	C

Questions73-74. Compare 4 different invertebrates 比較四種不同的無脊椎動物

(1) Spider. 蜘蛛
(2) Grasshopper 蝗蟲
(3) Millipedes 馬陸
(4) Shrimp 蝦

73. Fill in appropriate answers according to the following descriptions. (1 point)
根據下列敘述填入適當的答案

A. 1 pair of antennae, 3 pairs of legs
觸角一對；腳三對
B. 1 pair of antennae, more than 4 pairs of legs
觸角一對；腳四對以上
C. 2 pairs of antennae, 4 pairs of legs
觸角兩對；腳四對
D. 2 pairs of antennae, more than 4 pairs of legs
觸角兩對；腳四對以上

Answer: A-F	
(1)	E
(2)	A
(3)	B
(4)	D

E. No antennae, 3 pairs of legs
無觸角；腳三對

F. No antennae, more than 3 pairs of legs
無觸角；腳三對以上

~~74. Fill in appropriate answers according to organs of excretion and gas exchange. (1 point)~~

~~A. Excretion with Malpighian tubules and gas exchange with tracheal system.~~

~~B. Excretion with Malpighian tubules and coxal gland, gas exchange with tracheal system.~~

~~C. Excretion with maxillary gland and gas exchange with gill and tracheal system~~.

~~D. Excretion with Malpighian tubules and coxal gland, gas exchange with book lung~~

~~E. Excretion with Malpighian tubules and coxal gland, gas exchange with book lung and tracheal system~~

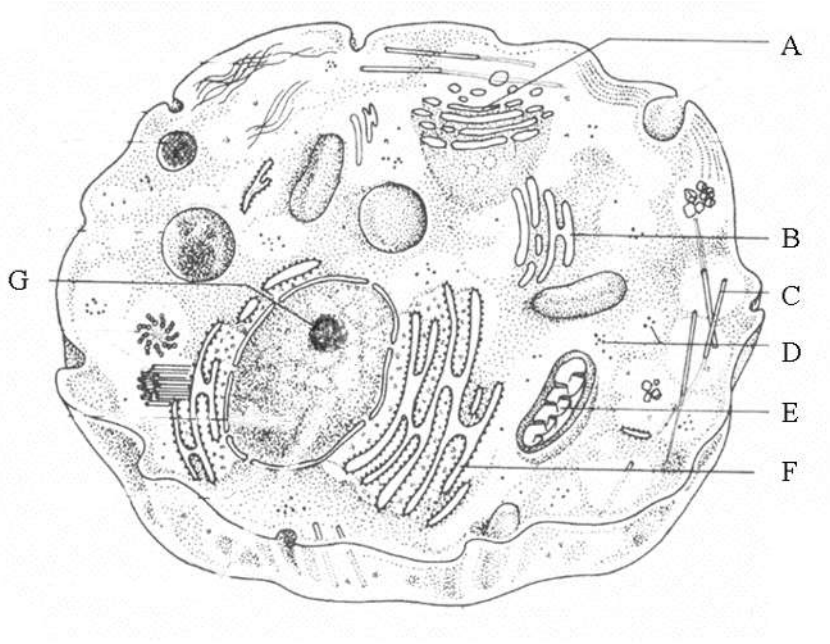
F. ~~Excretion with maxillary gland and gas exchange with gill.~~

Answer
A-F

(1)	
(2)	
(3)	
(4)	

Questions 75-84. The figure below is a diagram for ultra-structure of a cell..

下圖為一細胞的微構造示意圖



75. If you are provided with two electron microscopic pictures, one from of pancreas gland cells and the other from endothelial cells of proximal tubule of a kidney's nephron. Which of the structure shown in the figure will be more developed in pancreas gland cell? (1 point)
兩張電子顯微鏡照片分別為胰臟腺體細胞及腎元近端腎小管上皮細胞，哪一個構造在胰臟腺體細胞中較發達？

Answer: choose one from A through G. 自 A 至 G 中選出一個正確答案 F

76. As the cells grow, the surface area of each cell increases. Which structure is the location where the lipids are synthesized for plasma membrane synthesis? (1 point)
細胞表面面積會隨著生長而增加，哪一個構造負責細胞膜的合成？

Answer: choose one from A through G. 自 A 至 G 中選出一個正確答案 B

77. If you treat the cells for a short period of time with ^{3}H-Uracil followed by detecting the labeled cellular structure with autoradiography, which structure will have the highest silver grains (strongest labeling)? (1 point)

對細胞使用氚標記之脲嘧定(^{3}H-Uracil)短時間處理後，再使用自動顯影法進行觀察，哪一個構造可觀察到最強的曝光訊號？

Answer: choose one from A through G.　自 A 至 G 中選出一個正確答案 G

78. Which structure is assembled in nucleus and then transported to cytoplasm? (1 point)
哪一個構造在細胞核內組裝再送至細胞質？

Answer: choose one from A through G.　自 A 至 G 中選出一個正確答案 D

79. Erythropoietin (EPO) is hormone that stimulates production of erythrocytes. EPO is a highly glycosylated and secretive protein. Which structure would be responsible for the synthesis of EPO? (1 point)
紅血球生成素(EPO)可促進紅血球的製造，EPO 是一種高度糖基化的分泌性蛋白，哪一構造負責紅血球生成素的合成？

Answer: choose one from A through G.　自 A 至 G 中選出一個正確答案 F

80. Which structure would be the site for initial glycosylation of EPO? (1 point)
哪一個構造為紅血球生成素進行首次糖基化的場所？

Answer: choose one from A through G.　自 A 至 G 中選出一個正確答案 F

81. Which structure would be the site for final glycosylation of EPO? (1 point)
哪一個構造為紅血球生成素進行最後一次糖基化的場所？

Answer: choose one from A through G.　自 A 至 G 中選出一個正確答案　A

82. Which structure is essential for the transport of EPO inside the cell? (1 point)
哪一個構造負責紅血球生成素在細胞內的運輸？

Answer: choose one from A through G.　自 A 至 G 中選出一個正確答案 C

83. The receptor for EPO is a membrane protein. Which structure is responsible for EPO's receptor synthesis? (1 point)
紅血球生成素的受器為一種膜蛋白，哪一個構造負責 EPO 受器的合成？

Answer: choose one from A through G.　自 A 至 G 中選出一個正確答案 F

84. Which structure has ability to synthesize some proteins that are not encoded by nucleus. (1 point)
哪一個構造可合成蛋白質，但其基因序列並不存在於細胞核中？

Answer: choose one from A through G. 自 A 至 G 中選出一個正確答案 E

END of PART I