

OXFORD

New Senior Secondary

Mastering

新高中 **Biology**

基礎生物學

Third Edition  
第三版

牛津生物科

# DSE 試題分析 網上講座 2021

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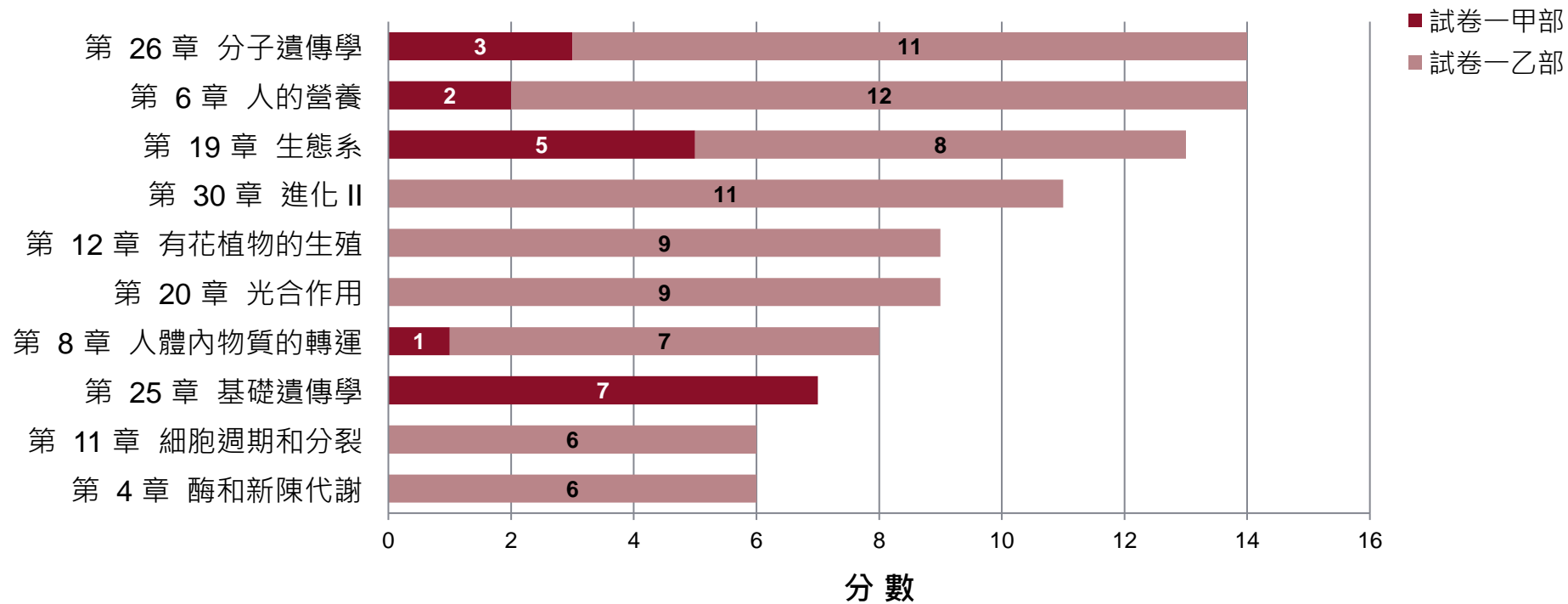
# 主要環節

- DSE 2021 統計分析
- DSE 2021 題目剖析

# DSE 2021 統計分析

## 熱門考核章次

### 佔分最多的 10 個章次



# DSE 2021 統計分析

## 佔分最少的章次

- 第 2 章 生命的基本單位
- 第 7 章 人體的氣體交換
- 第 22 章 非傳染病
- 第 23 章 傳染病和疾病的預防
- 第 29 章 進化 I

# DSE 2021 統計分析

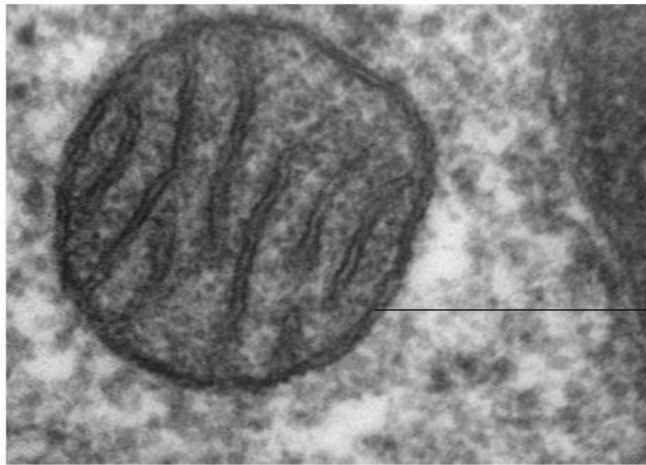
## 技巧及能力評估

	試卷一甲部	試卷一乙部
<b>a 與科學探究或 SBA 有關的技巧</b>		
<b>i 細心觀察</b>	—	Q1a, 2, 3b
<b>ii 設計實驗</b>		
• 設定問題		Q10b
• 分辨變量		
• 設計公平測試		
• 設置對照	Q9	
• 確保結果可靠和結論有效	Q31	Q8biii, 9c, 10ai–ii
<b>iii 預測結果</b>	Q10	Q7bi
<b>iv 分析數據或圖表</b>	Q13, 14, 15, 16, 28, 29, 30, 33, 34	Q3a, 4c, 6c, 7bii, 8, 9a–b, 10aiii
<b>v 分析顯微照片或電子顯微照片</b>	Q5, 6	Q5c
<b>vi 作出結論</b>	—	Q4b, 9a
<b>b 對科學本質 (NOS) 的理解</b>	Q17	—
<b>c 把知識應用到陌生情境</b>	Q12, 18, 26, 27, 34	Q4, 6cii, 7, 9, 10
<b>d 溝通能力</b>	—	Q4b, 6a, 6cii, 7a, 7bii, 9a, 10ai, 11

# DSE 2021 題目剖析

## 卷一甲部 第 5 題

During aerobic respiration, which substance enters the mitochondrion by passing through structure D?



D

- A glucose
- B pyruvate
- C acetyl-CoA
- D triose phosphate

### 試題趨勢

- 常考：呼吸作用與光合作用不同階段發生的位置
- 例子：DSE 12 1B Q9d、  
DSE 15 1A Q4

# DSE 2021 題目剖析

## 卷一甲部 第 7 題

Which of the following statements about the absorption of amino acids in the small intestine are correct?

- (1) Amino acids enter the lacteals.
- (2) The process is facilitated by membrane proteins.
- (3) Amino acids can move down or against the concentration gradient.

- A** (1) and (2) only      **B** (1) and (3) only  
**C** (2) and (3) only      **D** (1), (2) and (3)

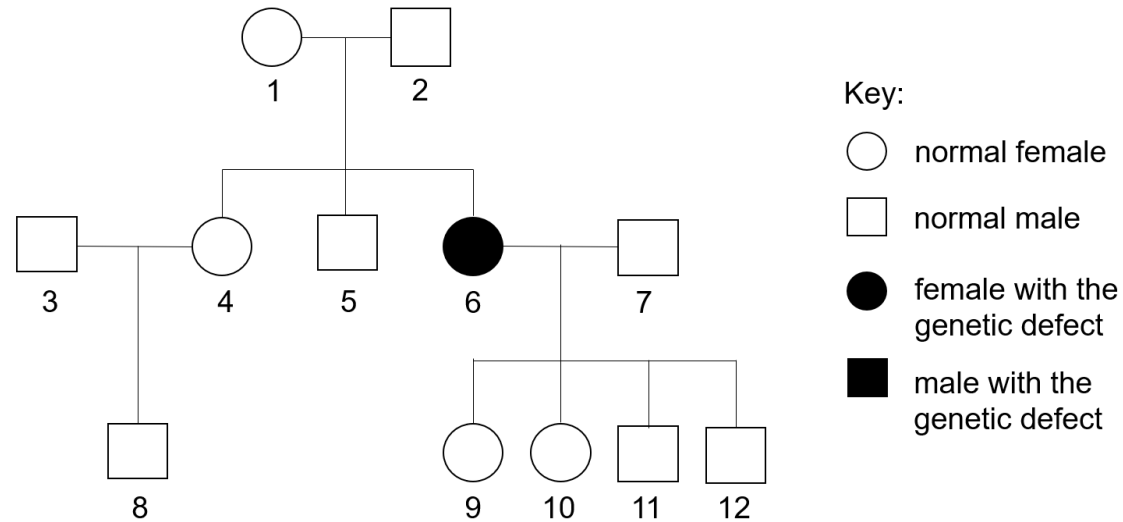
### 試題趨勢

- 類似題目於 DSE 多次出現
- 例子：DSE 13 1A Q26 、  
DSE 15 1A Q10



# DSE 2021 題目剖析

## 卷一甲部 第 13 題



Individual 6 suffers from the genetic defect because she inherited a defective allele located on

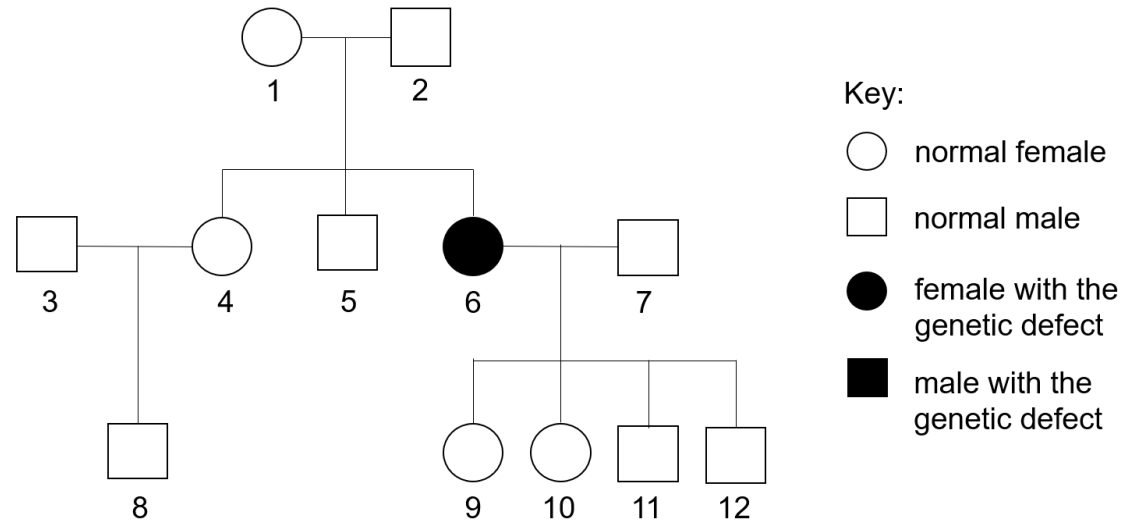
- A an autosome from both individuals 1 and 2.
- B the Y chromosome from individual 2.
- C an X chromosome from individual 1.
- D an X chromosome from both individuals 1 and 2.

### 解題技巧 ★

- 先解決是否 sex-linked
- 再想是 dominant 還是 recessive

# DSE 2021 題目剖析

## 卷一甲部 第 14 題

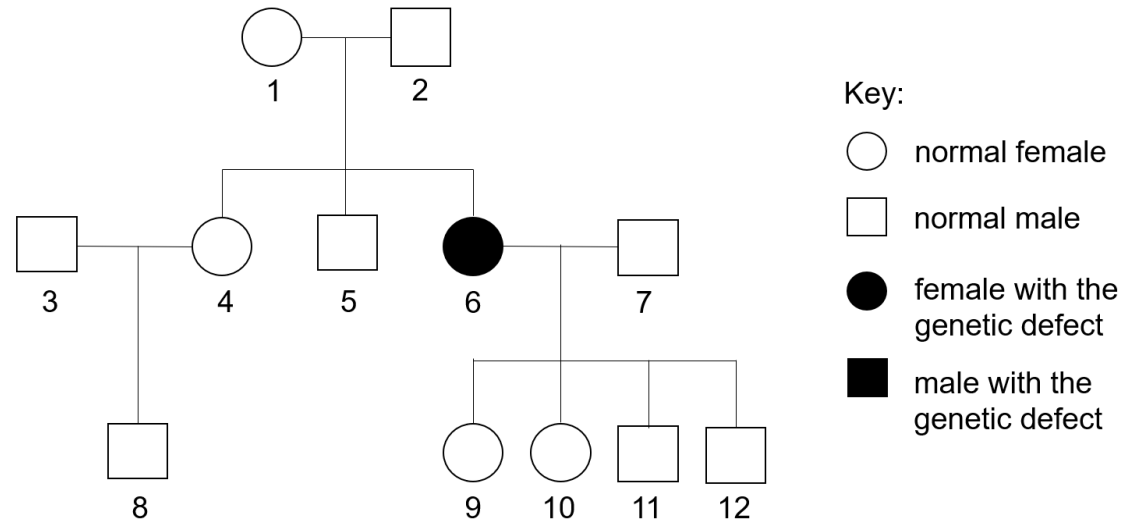


Individuals 9–12 are normal because each inherited

- A** a normal allele from individual 7.
- B** a normal allele from both individuals 6 and 7.
- C** a defective allele from individual 7.
- D** a defective allele from individual 6.

# DSE 2021 題目剖析

## 卷一甲部 第 15 題



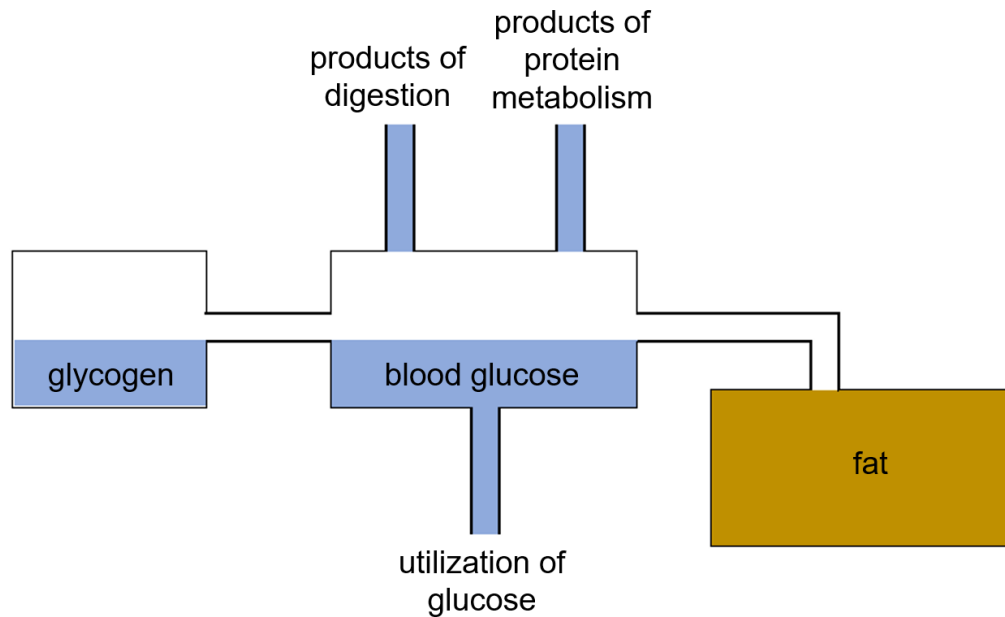
The possible genotype(s) of individual 8 is/are

- A** heterozygous only.      **B** homozygous dominant only.
- C** homozygous recessive only.      **D** heterozygous and homozygous dominant.

# DSE 2021 題目剖析

## 卷一甲部 第 26 題

A model showing the regulation of blood glucose in humans:



Which of the following additional remarks about the model is **incorrect**?

- A Muscles store excess glucose in the form of glycogen.
- B Glucose is converted by insulin into glycogen.
- C The products of digestion are in the form of simple sugars.
- D The products of protein metabolism are formed in the liver.

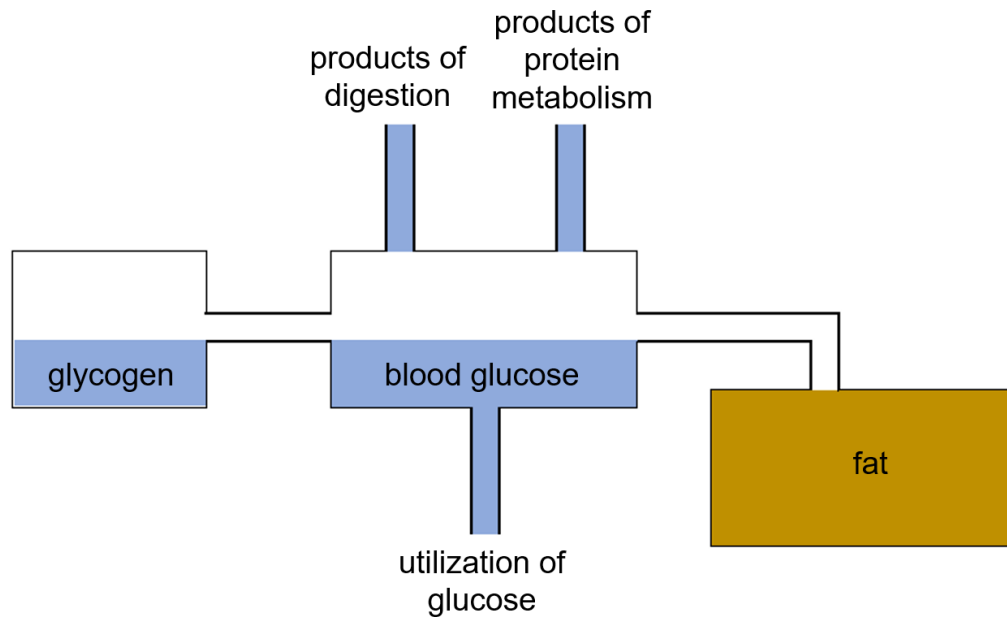
**學生常犯錯誤 ×**

- 胰島素的作用

# DSE 2021 題目剖析

## 卷一甲部 第 27 題

A model showing the regulation of blood glucose in humans:

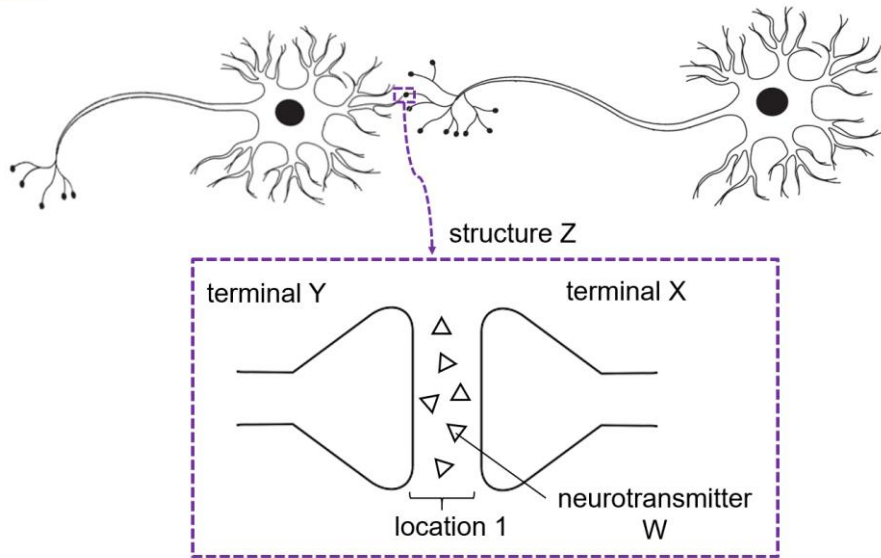


If the blood glucose level is higher than normal, which of the following changes will **not** occur?

- A More glucose will be used.
- B More fat will be converted into glycogen.
- C More glucose will be converted into fat.
- D More glucose will be converted into glycogen.

# DSE 2021 題目剖析

## 卷一乙部 第 2 題



- a** What is structure Z? (1m)
- b i** Which terminal releases W? (1m)
- ii** How could W at location 1 cause the transmission of nerve impulses at Z? (2m)
- c** State the importance of the process mentioned in part **b** to the transmission of nerve impulses. (1m)

**a** Synapse

**b i** X

Multipolar: motor / inter-  
Unipolar: sensory  
Bipolar: sensory (rare)

**ii** W diffuses  
and binds with  
receptor protein

**c** Unidirectional

*Oxford Book 2*  
*Ch16 p.6 Fig 16.7*

<https://eresources.oupchina.com.hk/biology/oxford-dse-biology/>

# DSE 2021 題目剖析

## 卷一乙部 第 4 題

Two common energy reserves in insect species A: trehalose (a disaccharide) and glycogen

**Aim of experiment:** To study the use of energy reserves in insect species A during flying.

Treatment	Flight time (s)	Mean (s)
Injected with physiological saline	138	165.6
	150	
	162	
	168	
	210	
Injected with Inhibitor of trehalose-digesting enzyme	42	85.2
	78	
	90	
	102	
	114	
Injected with inhibitor of glycogen-digesting enzyme	132	163.2
	156	
	162	
	174	
	192	

# DSE 2021 題目剖析

## 卷一乙部 第 4 題

- b** Referring to the aim of the experiment, what conclusions can be drawn? Give explanations. (4m)
- c** Suggest **one** possible cause of the individual differences in flight time in each group. (1m)

Treatment	Flight time (s)	Mean (s)
Injected with physiological saline	138	165.6
	150	
	162	
	168	
	210	
Injected with Inhibitor of trehalose-digesting enzyme	42	85.2
	78	
	90	
	102	
	114	
Injected with inhibitor of glycogen-digesting enzyme	132	163.2
	156	
	162	
	174	
	192	

### 解題技巧 ★

#### b 部分

- 簡單數據分析得出結論
- 清晰認知哪一組是對照

#### c 部分

- 重點: individual difference



# DSE 2021 題目剖析

## 卷一乙部 第 6 題

Antigen Y can be found on the surface of pathogen X.  
It can be synthesized and manufactured as a vaccine against pathogen X using recombinant DNA technology.

- a Explain how receiving vaccines containing antigen Y can help us develop immunity against pathogen X. (4m)
- b Suggest **one** way of producing vaccines without using recombinant DNA technology. (1m)

a Recognise the antigen → primary response  
Memory cells  
Same antigen on pathogen X  
Secondary response (a large amount of antibodies will be produced in a short period of time to kill the pathogens before they can multiply and cause disease)

b *Oxford Book 3 Ch24 p.16*

### 學生常犯錯誤 ✕

- Antigen vs Pathogen vs Antibody vs Antibiotic

<https://eresources.oupchina.com.hk/biology/oxford-dse-biology/>

# DSE 2021 題目剖析

## 卷一乙部 第 6 題

c i The **coding strand** of the gene encoding for antigen Y:

ATG GCC ATA AAT TGC TGT...

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

Write down the corresponding amino acid sequence.

(2m)

### 學生常犯錯誤 ✘

- Coding strand vs Template strand
- Triplet code vs Codon (mRNA) vs Anticodon (tRNA)

<https://eresources.oupchina.com.hk/biology/oxford-dse-biology/>

# DSE 2021 題目剖析

## 卷一乙部 第 6 題

c ii Different mutations occurred in the gene:

Strain	Base sequence
Original strain	ATG GCC ATA AAT TGC TGT...
Variant P	ATG GCC ATA AAT TGC <u>TGC</u> ...
Variant Q	ATG GCC ATA AAT <u>TGA</u> TGT...
Variant R	ATG <u>GCT</u> ATA <u>AAC</u> TGC TGT...

- Variant Q
- Stop codon → shorter aa sequence
- Shorter aa sequence → different protein shape → different antigen

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

- Degenerate code
- Features of genetic code!

Which of the three variants would most likely render the vaccine ineffective? Explain. (4m)

# DSE 2021 題目剖析

## 卷一乙部 第7題

a Environmental stress can speed up flowering in flowering plants. Explain why this can improve the survival chance of flowering plants. (3m)

b **Observation:** Bees make holes in leaves.

**Hypothesis:** Bees speed up flowering by imposing mechanical stress onto the plants.

**Experiment:**

Plant group	Bee damage	Mechanical damage	No damage
Treatment	Bees made holes in leaves	Similar holes cut with forceps	Intact leaves

i What will the predicted results be if the hypothesis is correct? (1m)



(© Hannier Pulido, ETH Zurich)

- a - Sexual reproduction → genetic variation
- May create features → better adapt to environmental stress
- b i Mechanical damage → speed up flowering

# DSE 2021 題目剖析

## 卷一乙部 第 7 題

**b ii** Discuss whether the results below support the hypothesis. (4m)

Plant group	Bee damage	Mechanical damage	No damage
Average time needed for flowering	38 days	56 days	70 days

**c** If bees establish new colonies in areas where pollen is in short supply, they make more holes on the leaves. Suggest an advantage of this behaviour to the bees. (1m)

**c** To get more nectar from plants so that the new colony can develop with sufficient supply of nutrients

**b ii**

- Mechanical damage: time needed for flowering decreases (14 days less) vs no damage
- Bee damage: time needed for flowering decreases (32 days less) vs no damage
- But bee damage caused a much faster flowering (18 days less) vs mechanical damage
- Bee damage is **not** just a mechanical stress. **Other factors** may be involved

# DSE 2021 題目剖析

## 卷一乙部 第 8 題

Some data about the leaves collected from two regions of a tree:

Tree region	Average blade area (cm <sup>2</sup> )	Average blade thickness (μm)	Average thickness of palisade mesophyll (μm)
Upper	62	177	45
Lower	72	152	33

- a By **comparing the average blade area** between the two types of leaves, state **one** adaptation of the leaves from the lower region in terms of its surface area. (2m)

- Leaves in lower region have a larger blade area
- To receive sunlight which has not been absorbed by the leaves in upper region

# DSE 2021 題目剖析

## 卷一乙部 第 8 題

Some data about the leaves collected from two regions of a tree:

Tree region	Average blade area (cm <sup>2</sup> )	Average blade thickness (μm)	Average thickness of palisade mesophyll (μm)
Upper	62	177	45
Lower	72	152	33

- b i** Compare the **average thickness** of palisade mesophyll between the two types of leaves. (1m)
- ii** What structural difference would possibly cause the difference in part **i**? (1m)
- iii** What would you do to validate your answer in part **ii**? (2m)

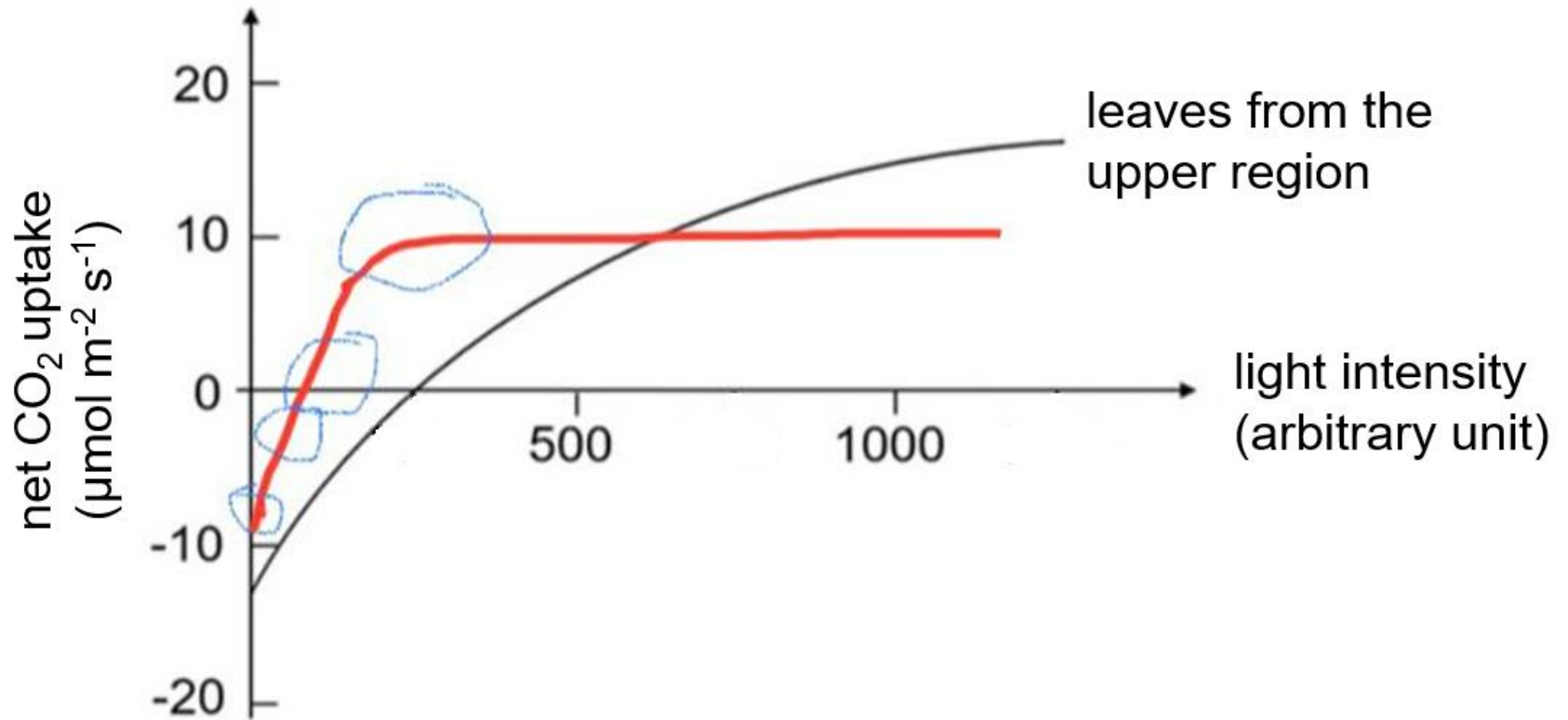
*Oxford Book 3  
Ch20 p.47  
Reading to learn*



- b i** PM is thicker in upper region
- ii** The leaves of upper region: 2 to 3 more layers of PM cells
- iii** - Make a cross section of the leaves in upper region
- Examine the cross section under the light microscope to see if there are more layers of PM cells

# DSE 2021 題目剖析

## 卷一乙部 第 8 題

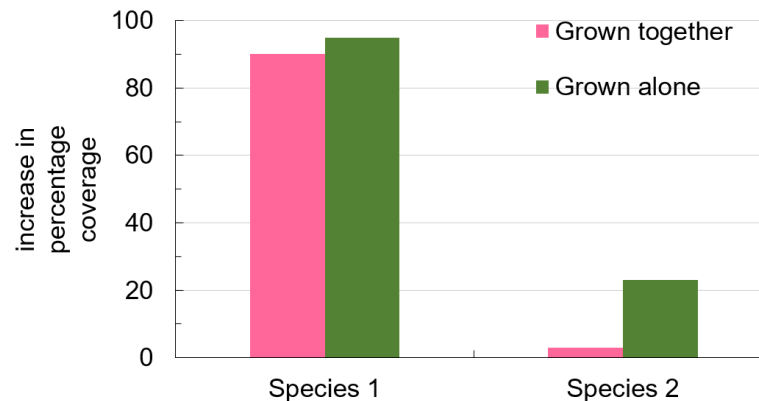
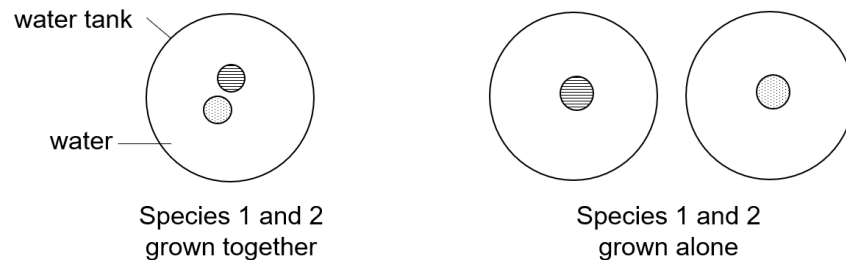




# DSE 2021 題目剖析

## 卷一乙部 第 9 題

**Aim of experiment:** To study the interaction between two species of free-floating plants.



a What conclusions can you draw regarding the interaction between species 1 and 2? Explain. (4m)

### Conclusion I:

- Sp1 and sp2 compete
- They grow slower when together than they grow separately

### Conclusion II:

- Sp1 is a stronger competitor
- The decrease in sp1 is much smaller when both species grow together

# DSE 2021 題目剖析

## 卷一乙部 第 9 題

Species 1



(© Barbarossa – Wikimedia Commons)

Species 2



(© Ingrid Taylor from San Francisco Bay Area USA)

- b** Referring to the above photographs, explain for the **difference** in the percentage coverage of 1 and 2 when the two species are grown together. (2m)
- c** Give reasons to explain for the feasibility of each of the methods below in this experiment. (2m)
- Fresh mass – Feasible
  - Number of leaves – Not feasible

- b** - The % coverage of sp1 is much higher than that of sp2 when grown together
- The SA of leaves of sp1 is larger, which can maximize the absorption of sunlight for *photosynthesis*, allowing sp1 to outcompete sp2
- c** - Growth of leaves is proportional to the change in fresh mass
- The two species have different leaf sizes

# DSE 2021 題目剖析

## 卷一乙部 第 11 題

- The source of variations within a population
- How variations enable the population to adapt to environmental changes and diverse environmental conditions over time

### **Source of genetic variation:** *Oxford Book 4 Ch25 p.37*

- Independent assortment of homologous chromosomes in meiosis
- Random fertilization
- Crossing over during prophase I of meiosis
- Mutation

### **Adapt to a changing environment:**

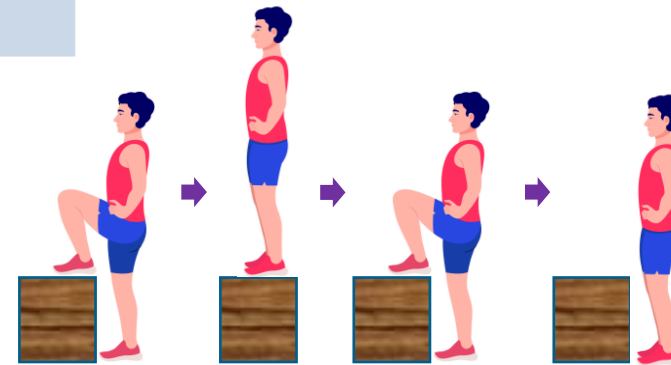
- Genetic variation generates a diverse adaptative features
- Those which are better adapted to the specific environment have a higher chance to survive and reproduce → pass the favourable gene to offspring
- Those which are not well-adapted die
- Proportion of individuals having that favourable gene will increase

# DSE 2021 題目剖析

## 卷二 第 1a 題

Billy and Alice did step-ups at different intensities. Their heart rates and lactate concentrations in blood before and after exercise were measured.

Exercise intensity (step-ups per 10 s)	Heart rate (beat min <sup>-1</sup> )		Blood lactate conc. (mmol L <sup>-1</sup> )	
	Billy	Alice	Billy	Alice
0	80	58	0.4	0.4
2	91	64	0.8	0.6
6	132	94	2.4	0.8
10	178	130	5.8	1.2



# DSE 2021 題目剖析

## 卷二 第 1a 題

Billy and Alice did step-ups at different intensities. Their heart rates and lactate concentrations in blood before and after exercise were measured.

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0	80	58	0.4	0.4
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10	178	130	5.8	1.2

- i What general effects does the increase in exercise intensity have on the heart rate and blood lactate concentration? (1m)
- ii Account for the change in blood lactate concentration during exercise. (3m)

- i Both HR & blood lactate conc. increase
- ii - Rate of anaerobic respiration increases  
- Provide extra energy for muscular activity  
- More lactate is produced

# DSE 2021 題目剖析

## 卷二 第 1a 題

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0	80	58	0.4	0.4
2	91	64	0.8	0.6
6	132	94	2.4	0.8
10	178	130	5.8	1.2

iii How does the nervous system lead to the change in heart rate during exercise? (4m)

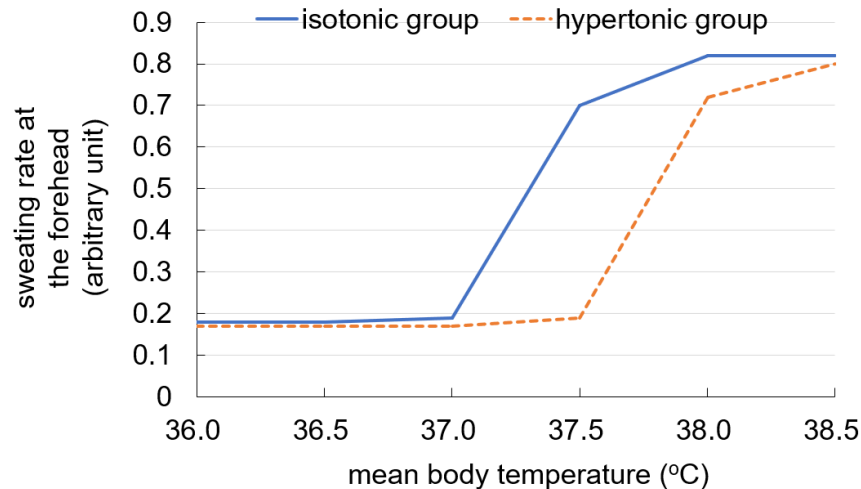
iv Based on the data given, give **two** pieces of evidence to support the idea that Alice is a trained athlete. (2m)

- iii - CO<sub>2</sub> production increases → pH decreases
  - Detected by the chemoreceptors in aortic and carotid bodies → cardiovascular centre in medulla oblongata
  - Sympathetic nerve: more active
  - SA node is stimulated; faster contraction of cardiac muscles
- iv - Lower heart rate at rest & during exercise
  - Lower lactate conc. at higher exercise intensities

# DSE 2021 題目剖析

## 卷二 第 1b 題

Two groups of participants immersed their bodies in a hot bath for 30 minutes.



- i What are the receptor and effector involved in the thermoregulatory response of the participants? (2m)
- ii The thermoregulatory response of the isotonic group is an example of negative feedback. With reference to the graph, explain the reasoning behind. (4m)

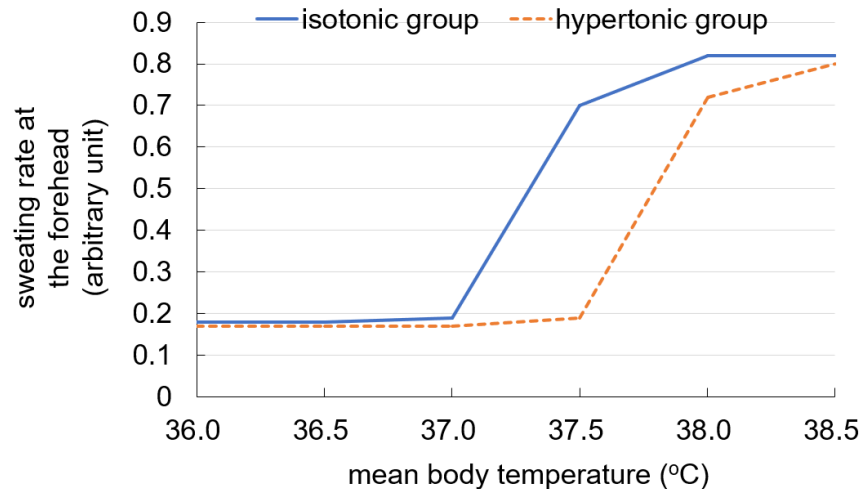
i Receptor: thermoreceptors in hypothalamus or skin  
Effector: sweat glands

- ii - Hot water bath increases body and blood temp.  
- Detected by thermoreceptor in hypothalamus  
- Sweat production increases  
- Evaporation of more sweat increases heat loss and lowers the body temp.  
- -ve feedback: a change in level of parameter → response opposite of the change

# DSE 2021 題目剖析

## 卷二 第 1b 題

Two groups of participants immersed their bodies in a hot bath for 30 minutes.



- iii** What effect does the hypertonic condition of blood have on the negative feedback mechanism of thermoregulation? (2m)
- iv** Explain how the effect described in part **iii** can help the hypertonic group regulate water balance. (2m)

- iii-** -ve effect on the -ve feedback mechanism
- Lower sweating rate
  - Response of -ve feedback is deterred as the response is set off by 0.5 °C higher than isotonic group
- iv-** Hypertonic blood condition = lower water potential in blood
- Decreased sweating conserves more water in blood to help restore normal water potential



# DSE 2021 題目剖析

## 卷二 第 2a 題

Herbicides and insecticides are used in conventional farms, but not in organic farms.

		Conventional farm		Organic farm	
		Within the farm	Around the farm	Within the farm	Around the farm
Species richness	Plants other than crops	3	7	18	28
	Pollinators	0	1	6	10
Abundance	Pest A	160	310	49	51
	Predators of A	3	9	11	24

- i Discuss the effectiveness of using **herbicides** by referring to the data provided. **Describe how** using herbicides can result in an increase in crop yield. (3m)

- Data
- Effective
- Relationship (reduce competition)

# DSE 2021 題目剖析

## 卷二 第 2a 題

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Abundance	Pest A	160	310	49	51
	Predators of A	3	9	11	24

ii Discuss the effectiveness of chemical pest control and biological pest control by referring to the pest population. Support your answer with evidence. (4m)

- Data
- Ineffective
- Relationship  
(kill predator of A → less predation)

# DSE 2021 題目剖析

## 卷二 第 2a 題

Herbicides and insecticides are used in conventional farms, but not in organic farms.

		Conventional farm		Organic farm	
		Within the farm	Around the farm	Within the farm	Around the farm
Species richness	Plants other than crops	3	7	18	28
	Pollinators	0	1	6	10
Abundance	Pest A	160	310	49	51
	Predators of A	3	9	11	24

iii In terms of **species richness**, explain how organic farming is favourable to the **sustainable** development of the **communities** around the farm. (3m)

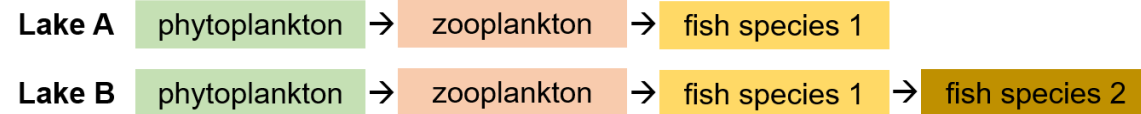
- Species diversity
- Pollinator no. → plant reproduction (sustainability)
- Producer → primary consumer (community)

# DSE 2021 題目剖析

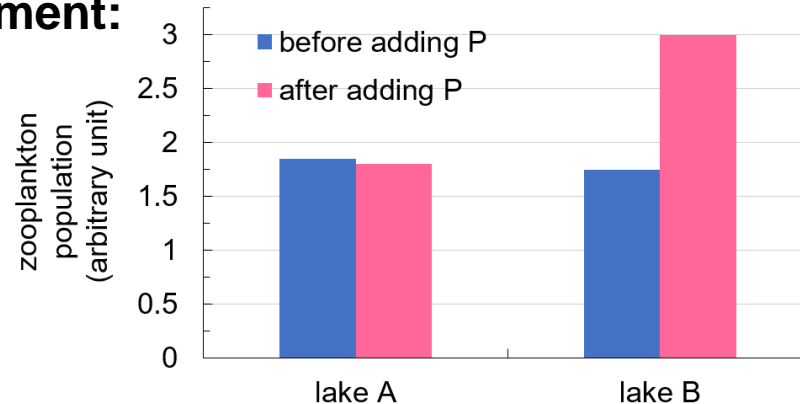
## 卷二 第 2b 題

**Observation:** Lakes A and B have similar environmental conditions, but algal bloom occurs less frequently in B.

**Hypothesis:** The number of trophic levels in food chains causes the difference in the rate of occurrence of algal bloom in the two lakes.

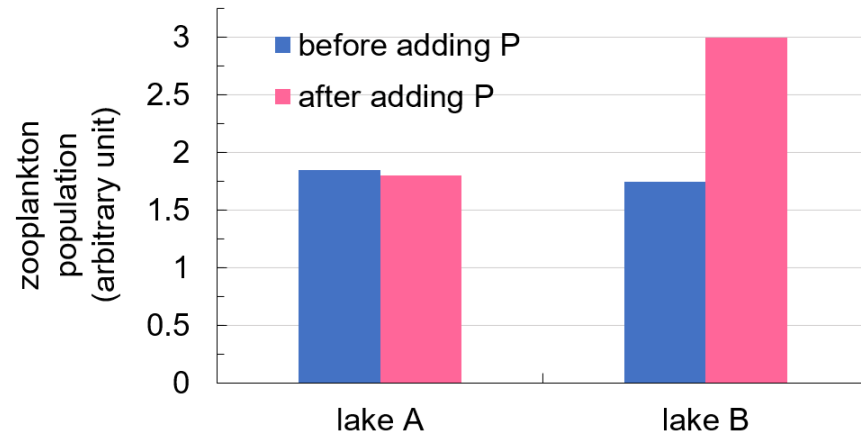
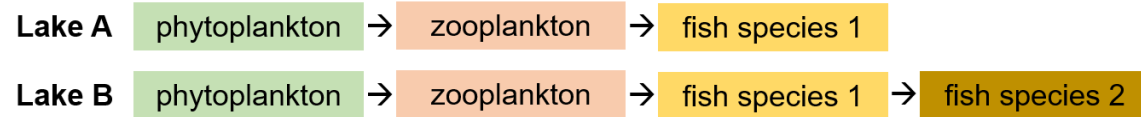


### Experiment:



# DSE 2021 題目剖析

## 卷二 第 2b 題

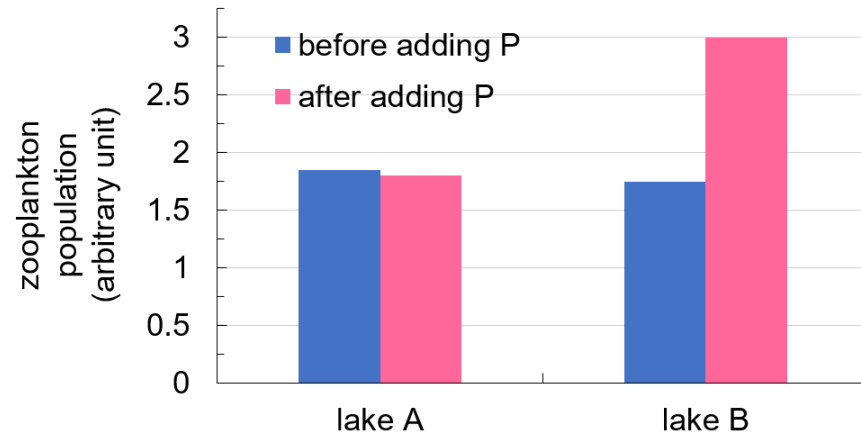
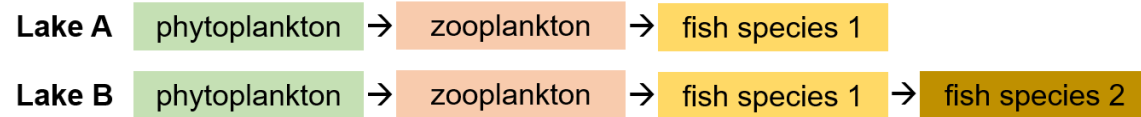


- i Deduce, with reasons, how the addition of phosphate affects the phytoplankton population. (2m)
- ii Based on the bar chart, suggest an explanation for the lower rate of occurrence of algal bloom in lake B. (3m)

- i - Phyto. increases  
- Phosphate: inorganic nutrient essential for the growth of phyto.
- ii - After adding phosphate, population of zoo. in A remains relatively unchanged  
- Zoo. in B increases significantly  
- Food chain  
Phyto. vs Zoo.

# DSE 2021 題目剖析

## 卷二 第 2b 題



iii Referring to the food chain of lake B, explain why the zooplankton population in lake B is larger than in lake A after adding phosphate. (3m)

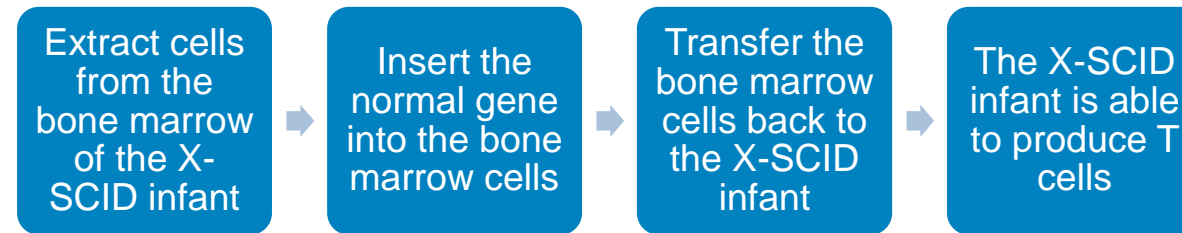
iv Describe how algal bloom causes a drop in the dissolved oxygen level by night. (2m)

- iii- Food chain
  - Phyto. vs Zoo. (effect of phosphate on phyto.)
  - Fs1 vs fs2 (feed on fs1)
  - Zoo. vs fs1 (pressure on zoo. decreases)
- iv- At night, no photosynthesis
  - Respiration only

# DSE 2021 題目剖析

## 卷二 第 4a 題

Using gene therapy to treat X-linked severe combined immunodeficiency (X-SCID):



- i Suggest **two** criteria used to choose a suitable type of cells (e.g. bone marrow cells) for the gene therapy. (2m)
- ii What method can be used to insert the normal gene into the bone marrow cells? Give **one** advantage and **one** disadvantage of this method. (3m)

### i (Properties of stem cells)

- Ability to carry out unlimited mitotic cell division
- Ability to express the target gene / differentiate into the desired cell types

### ii Viral vector

Adv: transfer the gene to target cell

Disadv: immune response against the virus OR

Microinjection

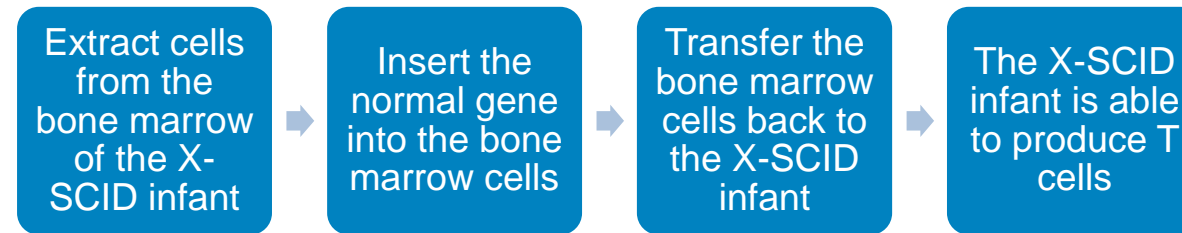
Adv: transfer the gene to target cell

Disadv: low success rate

# DSE 2021 題目剖析

## 卷二 第 4a 題

Using gene therapy to treat X-linked severe combined immunodeficiency (X-SCID):



**iii** 20 years later, the recovered X-SCID patient marries a healthy woman. Will their offspring inherit the defective gene from their father? Explain. (3m)

**iv** Generally, this type of gene therapy arouses less controversy than the production of GM animals. Discuss why. (2m)

**iii-** Only somatic cells are healed

- Son: inherit Y chromosome
- Daughter: inherit X chromosome with defective gene

**iv-** The normal gene already exists in the human gene pool

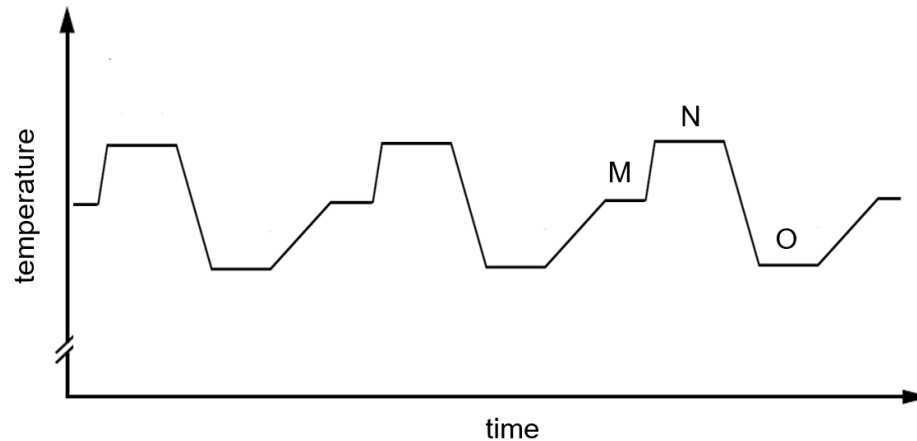
- The inserted gene will not be inherited
- GM animals: may affect ecological balance



# DSE 2021 題目剖析

## 卷二 第 4b 題

PCR is used to amplify an antibiotic resistance gene (gene X) in food products made from GMO.



- i (1) Which stage is annealing? Explain your answer by referring to the events in the PCR cycle. (3m)
- (2) Sketch a diagram to show the event that occurs during annealing. (2m)

i (1)

- Stage O
- Stage N: high temp. double helix → two single strands
- Stage O: lower temp. allows primers to bind to the single strands

i (2)

Primer x2

Single strand x2



# DSE 2021 題目剖析

## 卷二 第 4b 題

Base sequence of the primer annealing region of gene X (600 bp):

...GGATCAGCTG ACTCGCCTGG.....CACGCGGAGG AGCGTGCGCG...

direction of extension →

ii Which primer should be used? (2m)

Primer 1	GGTCCGCTCA	GTCGACTAGG
Primer 2	CCTAGTCGAC	TGAGCGGACC
Primer 3	GTGCGCCTCC	TCGCACGCGC
Primer 4	GCGCGTGCGA	GGAGGCGCAC

iii How can gel electrophoresis be used to ensure that the PCR product is gene X? (3m)

ii Primers 2 and 4

- iii- DNA: -ve charged → move towards +ve pole under an electric field
- Shorter DNA fragments move faster in the gel
  - Position of the band of DNA fragment (gene X) = Position of the band of PCR product (same position as the band of 600 bp if DNA ladder is used)

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**THANK YOU!**