國中自然領域

雙語教學資源手冊 生物科英語授課用語

A Reference Handbook for Junior High School Bilingual Teachers in the Domain of Natural Sciences (Biology): Instructional Language in English

〔七年級上學期〕

國立彰化師範大學雙語教學研究中心 發行

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Life World and Scientific Methods

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■ 前言 Introduction

本章節為國中第一堂生物課，因此首先介紹何謂生物，包含了生命現象、生存要素、生物圈等等。接著介紹探究自然科學的方式，包括七大步驟的科學方法、實驗設計的實驗組和控制組與三種變因。最後進入實驗室，重心則放在顯微鏡的操作與使用，並讓學生觀察顯微鏡下的世界。在英文教學方面，老師需特別注意單字發音及其重音，例如代謝 metabolism 的重音在 ta 這個音節。

1-1 多采多姿的生命世界
Various Life World

■ 前言 Introduction

學生初次瞭解生物與非生物的定義、生物的生存要素與生存環境，以及生物如何透過各種策略適應嚴酷的環境。老師們在這一章節裡會接觸到生命現象的英文，包括生長與發育、感應與運動、代謝、繁殖(growth and development, response and motion, metabolism, reproduction)，並請注意生命現象的唸法與特性要區分出來，以便同學辨識各個生命現象的特徵。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
non-organism	非生物	organism	生物
metabolism	代謝	biosphere	生物圈
response	感應	development	發育
environment	環境	decompose	分解
vital phenomenon	生命現象	synthesis	合成
reproduction	生殖	nutrient	養分
growth	生長	bacteria	細菌

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ Organisms need ____ to _____.

例句(1)：**Organisms need** sunlight **to** get the energy.

生物需要陽光來獲得能量。

例句(2)：**Organisms need** air **to** breathe.

生物需要空氣才能呼吸。

❷ The reason why _____ can live in _____ is because____.

例句(1)：**The reason why** polar bears **can live in** the north pole **is because** they have thick fur.

北極熊能住在北極的原因是他們有厚重的皮毛。

例句(2)：**The reason why** cactus **can live in** the desert **is because** it has spines to prevent water loss.

仙人掌能生活在沙漠的原因是因為仙人掌的針狀葉能防止水份的流失。

❸ _____ can help ____.

例句(1)：The polar bears' thick furs **can help** maintain the body temperature.

北極熊的厚重的毛髮可以幫助維持體溫。

例句(2)：The cacti's needle-like leaves **can help** prevent the water loss.

仙人掌的針狀葉可以防止水分流失。

■ 問題講解 Explanation of Problems

學習目標

在學習完本單元後，學生應習得以下觀念：

After studying this section, students should be able to know that:

一、了解生物與非生物的判斷方式。

Understand the way to judge organisms and non-organisms.

二、了解生物在地球上生存需要四大生存要素，並了解生物圈的概念。

Understand that organisms need four survival elements and the concept of biosphere.

例題講解

例題一

說明：使學生能夠藉由不同環境具有不同的資源的特點，推導出限制生物生存的條件。
Students can figure out the limit to organisms surviving by observing different features of various sources in different environments.

（英文）There are few organisms in the Gobi Desert. Green plants are difficult to be found in the Mariana Trench. What factors limit the organisms to growing in these environments respectively?
(A)air, pressure (B)water, nutrient (C)air, sunshine **(D)water, sunshine**

（中文）戈壁沙漠、馬里亞納海溝都較不適合多數生物生存，請問原因分別為缺乏何種生存要素呢？
(A)空氣；壓力 (B)水；養分 (C)空氣；陽光 **(D)水；陽光**

（台東縣縣立寶桑國中七年級 106 上學期自然科第一次段考）

解題 Solution：

由於沙漠地區的降雨量少，因此答案為缺乏水分；海溝由於水深較深，因此缺乏陽光的照射。

Because of the low rainfall in desert areas, the answer is lack of moisture; ocean trenches lack sunlight due to their deep water depth.

Teacher: Which substance is the most deficient in the desert?
Student: Water.
Teacher: Yes, because the desert is very dry. Organisms need water to regulate body temperature and maintain physiological functions.
Student: Then why are there no green plants in the lower part where the sun can't reach?
Teacher: Because green plants need sunlight to do photosynthesis.

老師： 沙漠最缺乏選項中的哪一個物質？
學生： 水。
老師： 沒錯，因為沙漠非常乾旱。而生物需要水來調節體溫、維持生理機能等。
學生： 那為甚麼陽光照不到的低方就很難發現綠色植物呢？
老師： 因為綠色植物需要陽光來進行光合作用。

1-2 探究自然的科學方法
Discover Scientific Methods

■ 前言 Introduction

學生初次瞭解科學方法的 7 個步驟與實驗設計的重點，包含實驗組、對照組與三大變因。老師們在這一節裡會接觸到基本的實驗室規則、科學方法流程與做實驗相關英文，主要活動是讓學生了解科學方法與實驗設計並學習操作顯微鏡，請注意每個實驗器材的發音與科學方法流程之正確度，這樣學生在回答問題時能用英文說出該實驗器材與使用方法的句型。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
compound microscope	複式顯微鏡	hypothesis	假說
analyze the experiment result	分析實驗結果	dissecting microscope	解剖顯微鏡
control group	對照組	form a hypothesis	形成假說
draw a conclusion	提出結論	experimental group	實驗組
raise questions	提出問題	design an experiment	設計實驗
observe	觀察	refer to references	參考文獻資料
control variable	控制變因	independent variable	操作變因
scientific method	科學方法	dependent variable	應變變因

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ In scientific methods, the next step of _____ is _____.

例句：**In scientific methods, the next step of** forming a hypothesis **is** designing an experiment.
在科學方法中，提出假說的下一步驟為實驗設計。

❷ In the experiment design, the group used to __ is called the ___ group

例句：**In the experiment design, the group used to** compare the experiment results **is called the** control **group.**
在實驗設計中，用來比照實驗結果的組別稱為對照組。

❸ The variable used to/for _____ is called the _____ variable.

例句：In the experimental design, **the variable used for** comparison **is called the** independent **variable**.
在實驗設計中，用來對照的變因稱為操作變因。

■ 問題講解 Explanation of Problems

學習目標

在學習完本單元後，學生應習得以下觀念：

一、培養學生具探究實作的精神，並了解科學方法的順序與內涵。
Cultivate students with the spirit of inquiry and practice, and understand the sequence and meanings of scientific methods.

二、了解實驗設計的基本概念，並能判斷一實驗中的控制變因、操作變因與應變變因。
Understand the basic concept of experimental design, and be able to judge the control variable, independent variable and dependent variable in an experiment.

例題講解

例題一

說明：確認學生對於實驗設計的理解程度。

To confirm students' understanding of experimental design.

（英文）The following is the experimental report written by Xiaoting based on the scientific method:

- Observation: no larvae survived in the water basin with several one-yuan coins, but there were larvae in the water basin without one-yuan coins.
- Raise a question: Why can't larvae survive in a water basin with a one-yuan coin?
- Form a hypothesis: Water containing one-dollar coins might induce the death of larvae.
- Design an experiment: Prepare two sets of identical basins, I and II, and pour the same amount of pure water into them. Only put 10 one-dollar coins in Group I, and none in Group II. Both groups I and II put 30 larvae, provided sufficient same food every day, and observed the survival rate of the larvae in the two groups after one week.
- The experimental results are shown in Table (6):

Table (6)

Group	I	II
Experiment design	Water + larvae + coin	Water + larvae
Survival rate of larvae	43.3%	40.0%

According to the above, in the experimental steps designed by Xiaoting, which of the following is the operation (longitudinal) variable?

(A) Water basin

(B) Pure water

(C) loneliness

(D) One dollar coin

（中文）下列為小庭依據科學方法所寫的實驗報告：

- 初步觀察：放有數枚一元硬幣的水盆裡沒有孑孓生存，但沒有一元硬幣的水盆裡卻有孑孓生存。
- 提出問題：為什麼放有一元硬幣的水盆中孑孓無法生存？
- 提出假說：含有一元硬幣的水可能會促使孑孓死亡。
- 設計實驗步驟：準備甲、乙兩組相同的水盆，皆倒入等量的純水。僅在甲組中放入 10 枚一元硬幣，乙組則無。甲、乙兩組皆放入 30 隻孑孓，每日皆提供充足的相同食物，待一週後觀察兩組孑孓的存活率。
- 實驗結果如表(六)所示：

表(六)

組別	甲	乙
實驗設計	純水+孑孓+一元硬幣	純水+孑孓
孑孓的存活率	43.3%	40.0%

根據上述，小庭設計的實驗步驟中，下列何者為操作(縱)變因？

(A)水盆

(B)純水

(C)孑孓

(D)一元硬幣

（109 國中會考(補考)自然科第 47 題）

解題 Solution：

在實驗中分別有三個重要的變因用來釐清實驗組與對照組間的異同，其中操作變因是實驗組與對照組不同的單一因素，因此此題答案為(D)一元硬幣。

There are three important variables in the experiment to clarify the similarities and differences between the experimental group and the control group. The independent variable is a single factor that makes the experimental group and the control group different. Therefore, the answer to this question is (D) a one-dollar coin.

Teacher: In the experimental design, what are the three variables?

Student: Independent variables, control variables, and dependent variables.

Teacher: Then what is the function of the independent variable?

Student: The variables used to cause the difference between the control group and the experimental group are called independent variables.

Teacher: So what should be the reason for this operation change? It can be judged according to the difference between the experimental group and the control group.

Student: Is it a one-dollar coin?

Teacher: That's right!

老師： 在實驗設計中，三大變因分別為甚麼呢？

學生： 操作變因、控制變因、應變變因。

老師： 那麼操作變因的功能是甚麼呢？

學生： 用來造成控制組和實驗組差別的變因稱為操作變因。

老師： 那麼本次的操作變因應該為何呢？可以根據實驗組和控制組的差異來判斷。

學生： 是一元硬幣嗎？

老師： 答對了！

例題二

說明：確認學生對科學方法的步驟的觀念。

To confirm students' understanding of experimental design.

（英文）The following is the experimental report written by Xiaoting based on the scientific method:

- Observation: no larvae survived in the water basin with several one-yuan coins, but there were larvae in the water basin without one-yuan coins.
- Raise a question: Why can't larvae survive in a water basin with a one-yuan coin?
- Form a hypothesis: Water containing one-dollar coins might induce the death of larvae.
- Design an experiment: Prepare two sets of identical basins, I and II, and pour the same amount of pure water into them. Only put 10 one-dollar coins in Group I, and none in Group II. Both groups I and II put 30 larvae, provided sufficient same food every day, and observed the survival rate of the larvae in the two groups after one week.
- The experimental results are shown in Table (6):

Table (6)

Group	I	II
Experiment design	Water + larvae + coin	Water + larvae
Survival rate of larvae	43.3%	40.0%

Based on the above, whether the following experimental results about Xiaoting support his hypothesis, which is the most reasonable?

(A) Support, because the survival rate of the littermates in group A was no lower than that in group B

(B) Support, because the survival rate of the littermates in both groups A and B is less than 50%

(C) Not supported, because the survival rate of littermates in group A was not lower than that in group B

(D) Not supported, because the survival rate of the littermates in both groups A and B is less than 50%

（中文）下列為小庭依據科學方法所寫的實驗報告：

- 初步觀察：放有數枚一元硬幣的水盆裡沒有孑孓生存，但沒有一元硬幣的水盆裡卻有孑孓生存。
- 提出問題：為什麼放有一元硬幣的水盆中孑孓無法生存？
- 提出假說：含有一元硬幣的水可能會促使孑孓死亡。
- 設計實驗步驟：準備甲、乙兩組相同的水盆，皆倒入等量的純水。僅在甲組中放入 10 枚一元硬幣，乙組則無。甲、乙兩組皆放入 30 隻孑孓，每日皆提供充足的相同食物，待一週後觀察兩組孑孓的存活率。
- 實驗結果如表(六)所示：

表(六)

組別	甲	乙
實驗設計	純水+孑孓+一元硬幣	純水+孑孓
孑孓的存活率	43.3%	40.0%

根據上述，下列關於小庭的實驗結果是否支持他所提出的假說，何者最合理？

(A)支持，因為甲組孑孓的存活率沒有比乙組低

(B)支持，因為甲、乙兩組孑孓的存活率皆低於 50%

(C)不支持，因為甲組孑孓的存活率沒有比乙組低

(D)不支持，因為甲、乙兩組孑孓的存活率皆低於 50%

（109 國中會考(補考)自然科第 48 題）

解題 Solution：

題幹中「提出假說：含有一元硬幣的水可能會促使孑孓死亡。」、「實驗結果如表(六)所示：孑孓的存活率甲組 43.3% >乙組 40.0%」，可以發現甲組中放了一元硬幣，但存活率還比沒放硬幣的乙組高，因此這個假說是不被支持的。

In the stem of the question, "Hypothesis is proposed: water containing one-yuan coins may cause the death of the wiggler(mosquito larvae).", "The experimental results are shown in Table (6): the survival rate of the wiggler(mosquito larvae) is 43.3% in group I > 40.0% in group II", it can be found that group I The one-dollar coin was placed in the middle, but the survival rate was still higher than that of the group B without the coin, so this hypothesis was not supported.

Teacher: In the scientific method, what should be the next step in designing an experiment?
Student: Student: The next step in designing an experiment is analyzing the results.
Teacher: What are the two situations that the results can usually be divided into?
Student: Support or not support the hypothesis.
Teacher: That's right. After adding a one-yuan coin, the survival rate of larvae was 43.3%, which did not decrease compared with 40% in the control group. Therefore, the result does not support the hypothesis of the question stem.

老師： 在科學方法中，設計實驗的下一步應該是甚麼呢？
學生： 設計實驗的下一步為分析結果。
老師： 那結果通常可以分為哪兩種情況呢？
學生： 支持或不支持假說。
老師： 沒錯，由於加了一元硬幣後，孑孓的存活率為 43.3%，和控制組的 40%相比並沒有下降，因此結果不支持題幹的假說。

1-3 進入實驗室
Enter the Lab

■ 前言 Introduction

學生初次進入實驗室，須注意實驗器材的操作方式，特別是有火和危險藥品。

老師們在這一章節會接觸到與器材以及其使用方法的英文，主要是先介紹各個實驗器材與使用之英文，再以卡牌遊戲方式讓學生加深印象，但因為有些特定詞彙稍難，要注意單字發音正確度，以便學生學習。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
stage clips	玻片夾	arm	鏡臂
cultivate	培養	base	鏡座
petri dish	培養皿	fine focus knob	細調節輪
eyepiece	目鏡	microscope	顯微鏡
dropper	滴管	nosepiece(turret)	旋轉盤
tweezers	鑷子	slide glass	載玻片
graduated cylinder	量筒	stage	載物台
beaker	燒杯	coarse focus knob	粗調節輪
iris diaphragm	光圈	measure	測量
illuminator	光源	eye lens	目鏡

observe	觀察	objective lenses	物鏡
cover glass	蓋玻片	compound microscope	複式顯微鏡
eyepiece tube	鏡筒	dissecting microscope	解剖顯微鏡

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ Do not _____ in the_____.

例句(1)：**Do not** eat **in the** laboratory.

請勿在實驗室內進食。

例句(2)：**Do not** heat the liquid **in the** graduated cylinder.

請勿在量筒中加熱液體。

❷ We can use _____to _____.

例句(1)：**We can use** a microscope **to** observe organisms.

我們可以用顯微鏡觀察生物體。

例句(2)：**We can** use a graduated cylinder **to** measure the volume.

我們可以用量筒來測量體積。

❸ In the _____, the _____ is _____.

例句(1)：**In the** dissecting microscope, **the** direction of the image and the object **is** the same.

在解剖顯微鏡中，成像和實物的方向相同。

例句(2)：**In the** compound microscope, **the** direction of the image and the object **is** not the same.

在複式顯微鏡中，成像和實物的方向不相同。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

After studying this section, students should be able to know that:

一、學生能了解進入實驗室需注意的相關規定，並認識基本、常見的實驗器材。

Students should be able to understand what they need to pay attention to when entering the laboratory, and understand the basic and common experimental equipment.

二、了解解剖和複式顯微鏡在各方面的差異，並能夠順利使用兩種顯微鏡進行樣本觀察。

Understand the differences between dissecting and compound microscopes in various aspects, and be able to use the two microscopes to observe samples successfully.

❧ 例題講解 ☙

例題一

說明：測驗學生是否了解量筒的使用方式。

To test whether students understand how to use a graduated cylinder.

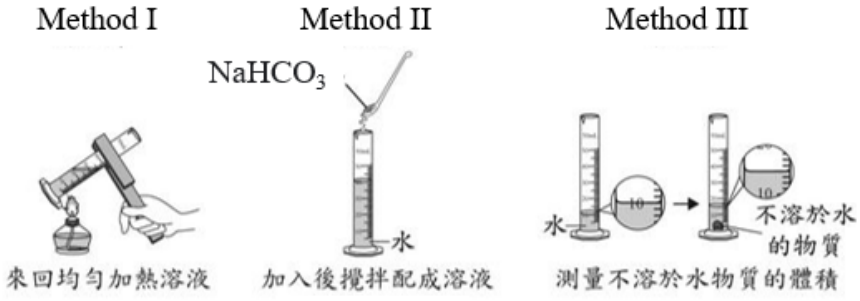


Figure 4.

（英文）Figure (4) shows three ways of using certain experimental equipment. Which of them are inappropriate? Method I: Back and forth to heat the solution. Method II: Add and stir to form a solution. Method III: Measure the volume of substances insoluble in water.

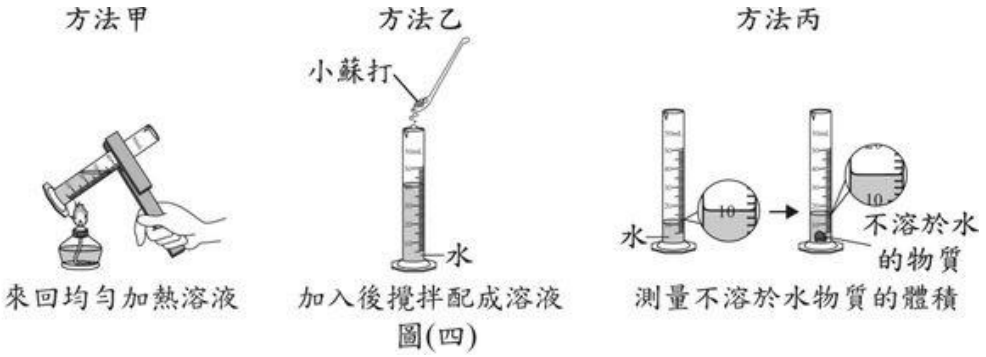
(A) Method I and Method II.

(B) Method I and Method III.

(C) Method II and Method III.

(D) None of the three methods is appropriate.

（中文）



圖(四)

圖(四)為某實驗器材的三種使用方法，哪幾種使用方法不恰當？

(A)方法甲和方法乙。

(B)方法甲和方法丙。

(C)方法乙和方法丙。

(D)三種方法都不恰當。

（106 國中會考自然科第 6 題）

解題 Solution：

量筒不能加熱和進行化學反應因此甲、乙是錯的。

A graduated cylinder cannot be heated and perform chemical reactions, so I and II are wrong.

Teacher: What mistakes did I and II make in this question?

Student: Do not heat or perform chemical reactions in a graduated cylinder.

Teacher: Yes, because it may cause the deformation of the graduated cylinder, which will affect the accuracy of the measurement. So, is III right?

Student: That's right, because the main function of a graduated cylinder is to measure volume.

Teacher: Yes, for example, after adding a stone, the value of the original liquid level rise is equal to the volume of the stone.

老師： 在這題的甲和乙分別犯了甚麼錯誤呢？

學生： 不能在量筒中加熱或是進行化學反應。

老師： 沒錯，因為可能會導致量筒變形，進而影響測量的精確度。那丙是對的嗎？

學生： 是對的，因為量筒的主要功能就是用來測量體積。

老師： 沒錯，例如加入石頭後，原本的液面上升的數值，就等於該石頭的體積。

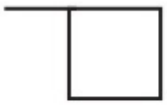
例題二

說明：測驗學生是否理解解剖和複式顯微鏡的影像的差異。

To test students' understanding of the differences between dissecting and compound microscope images.

（英文）A student observes a figure with a dissecting microscope with a magnification of 40 times, as shown in Figure (13) in the field of view. Without rotating the figure, if it is observed with a compound microscope with eyepiece 10X and objective lens 4X, which of the following is most likely to be the figure observed under the field of view of the compound microscope at this magnification?

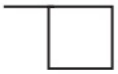
（中文）某生使用放大倍率為 40 倍的解剖顯微鏡觀察某一圖形，視野下如圖(十三)所示。在不轉動圖形的情況下，若改以目鏡 10X、物鏡 4X 的複式顯微鏡觀察，下列何者最可能是在該倍率的複式顯微鏡視野下觀察到的圖形？

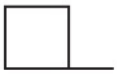


圖(十三)

(A) 

(B) 

(C) 

(D) 

（109 國中會考自然科第 18 題）

解題 Solution：

由於複式顯微鏡中的目鏡 10X、物鏡 4X 等同於解剖顯微鏡放大 40 倍率，因此物體大小應該不變，答案可能為(C)、(D)；(A)、(B)的大小縮小了因此是錯的。(C)、(D)的差別在於，複式顯微鏡的影像是上下左右皆相反，因此原本在右下的正方形應該跑至左上，如(D)選項所示。

Since the eye lens 10X and the objective lens 4X in the compound microscope are equivalent to 40 times magnification of the dissecting microscope, the size of the object should remain unchanged, the answer may be (C), (D); (A), (B) The size is reduced, so it is wrong. The difference between (C) and (D) is that the image of the compound microscope is reversed from top to bottom and left and right, so the square originally in the lower right should go to the upper left, as shown in option (D).

Teacher: In the dissecting microscope, what is the relationship between the direction of the image and the object?
Student: In the dissecting microscope, the direction of the image and the object is the same.
Teacher: Yes, what about the compound microscope?
Student: In the compound microscope, the direction of the image and the object is not the same.
Teacher: Great, so what's the difference?
Student: Upside down, left and right.
Teacher: Great! Since the magnification of the two microscopes is 40 times, which one should be chosen for the answer?
Student: It should be D, because the two are the same size, and they are upside down and left and right.
Teacher: That's right!

老師： 請問解剖顯微鏡中，影像和實物的方向應該為何種關係？
學生： 在解剖顯微鏡中，成像和實物的方向相同。
老師： 沒錯，那複式顯微鏡呢？
學生： 在複式顯微鏡中，成像和實物的方向不同。
老師： 很好，那麼是怎麼樣的不同呢？
學生： 上下顛倒、左右相反。
老師： 很棒！由於兩個顯微鏡的放大倍率皆為 40 倍，請問答案應該選哪一個呢？
學生： 應該是 D，因為兩者大小一樣，並呈現上下顛倒、左右相反。
老師： 沒錯，答對了！

★主題二 生物體的組成★
The Composition of the Organism

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■ 前言 Introduction

地球上，雖然各種生物的形態與生活方式大不相同，但科學家發現，生物其實都是由「細胞」所組成，也是本章節的主角。本章節介紹生物體的基本單位是細胞，接續講解細胞的構造、物質進出細胞的方式，最後說明生物體的組成層次。在這章節中，有許多關於生物體構造的英文專有名詞與相關句型，老師在這邊要特別注意單字發音與句型的時態。

2-1 生物體的基本單位
The Basic Unit of Living Organisms

■ 前言 Introduction

學生先前已了解生物體是由細胞所組成，具有由細胞、器官到個體等不同層次的構造，到了七年級階段，則深入討論細胞的功能與型態等特徵。在功能部分以光合作用和呼吸作用為例。此外，學生也能以顯微鏡觀察動植物細胞，例如：口腔皮膜細胞、葉的下表皮細胞或香蕉果肉細胞等。觀察後能描繪出細胞的形態，辨認細胞核、細胞質和細胞膜等構造。老師們在這章節裡會接觸到細胞構造之相關英文單字，包括細胞質、表皮細胞、胞器、氣孔等字詞，並且注意細胞構造英文的唸法與單複數型態的不同，例如氣孔複數為 stomata。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
cell	細胞	stoma, stomata (pl.)	氣孔
cytoplasm	細胞質	nerve cell	神經細胞
epidermal cell	表皮細胞	epithelial cell	表皮細胞
muscle cell	肌肉細胞	basic unit	基本單位
guard cell	保衛細胞		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ The shape of ____ cells is ___.

例句：**The shape of** leaf epidermal **cells is** flat.

葉片表皮細胞的形狀是扁平的。

❷ The function of ____ cells is to ___.

例句：**The function of** epidermal **cells is to** protect.

表皮細胞的功能為保護。

❸ _____have _____to help_____.

例句(1)：Nerve cells **have** long-thin protrusions **to help** pass messages.

神經細胞具有細長的突起，可以幫助傳遞訊息。

例句(2)：Muscle cells **have** long-tubes **to help** exercise.

肌肉細胞有長管，可以幫助運動。

■ 問題講解 Explanation of Problems

學習目標

在學習完本單元後，學生應習得以下觀念：

After studying this section, students should be able to know that:

一、了解細胞的外形與功能。

Understand the appearance and function of cells.

例題講解

例題一

說明：確認學生是否認識課本介紹的細胞並了解這些細胞的特性。

To confirm whether students recognize the cells introduced in the textbook and understand the characteristics of these cells.

（英文）Which of the following is wrong about the pairing of cells with appearance and function?

(A) Muscle cells, long tubular shape, can assist movement.
(B) Nerve cells, radial shape can transmit signal.
(C) Guard cells, semilunar shape, can form stomata to allow gas to enter and exit the leaves.
(D) Leaf epidermal cells, which have a cone-like shape and protect the leaves.

（中文）下列關於細胞與外型和功能的配對，何者<u>錯誤</u>？

(A)肌肉細胞，長管狀外型，能協助運動。
(B)神經細胞具許多細長突起，能夠進行訊息傳遞。
(C)保衛細胞，半月狀的外形，可以形成氣孔讓氣體進出葉片。
(D)葉片表皮細胞，具有類似圓錐體的形狀，可以保護葉子。

解題 Solution：

葉片表皮細胞是扁平的，而非題幹敘述的立體形狀。

The leaf epidermal cells are flat, rather than the three-dimensional shape described in the option.

Teacher: What should be the function of leaf epidermal cells?
Student: The function of leaf epidermal cells is protection.
Teacher: What about the shape of epidermal cells?
Student: Flat, but what are the benefits of the flat shape, teacher?
Teacher: That's a good question, because the flat shape allows the epidermal cells to be arranged more closely.

老師：葉片表皮細胞的功能應該為何？
學生：葉片表皮細胞的功能是保護。
老師：那表皮細胞的形狀呢？
學生：扁平，不過請問老師扁平的外型有甚麼好處呢？
老師：問得很好，因為扁平的形狀較能夠讓表皮細胞緊密排列。

2-2 細胞的構造
Cell Structure

■ 前言 Introduction

學生初次瞭解細胞內部的構造，內容包含細胞的各個胞器與其功能和特性，也有動物和植物細胞間的差異，例如植物細胞特有的中央大液胞或細胞壁，另外也需避免學生產生一些迷思概念，例如不是每個植物細胞都含有葉綠體等等。老師在這章節需注意有較多專有名詞，因此需協助學生了解各名詞的定義以及其發音正確性。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
nucleus	細胞核	cell wall	細胞壁
vacuole	液胞	nuclear envelope	核膜
mitochondria	粒線體	cellulose	纖維素
cell membrane	細胞膜	glucose	葡萄糖
chloroplast	葉綠體		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ The function(s) of _____ are/is _____.

例句(1)：**The functions of** the nucleus **are** containing genetic material and controlling cell metabolism.

細胞核的功能是含有遺傳物質及控制細胞的代謝作用。

例句(2)：**The function of** cell membrane **is** controlling substances going in and out of a cell.

細胞膜的功能是控制物質進出細胞。

❷ _____ have/has_____, while _____ don't/doesn't.

例句(1)：Plant cells **have** cell walls**, while** animal cells **don't**.

植物細胞有細胞壁，但動物細胞沒有。

例句(2)：Plant cells **have** chloroplast**, while** animal cells **don't**.

植物細胞有葉綠體，但動物細胞沒有。

❸ The site of _____ is the _____.

例句(1)：**The site of** photosynthesis **is the** chloroplast.

光合作用的地點為葉綠體。

例句(2)：**The site of** DNA storage **is** the nucleus.

保存 DNA 的地點為細胞核。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

一、了解細胞的構造與胞器。

Understand the structure and organelles of cells.

二、了解各種胞器的功能與特性。

Understand the functions and characteristics of organelles.

三、能分辨動植物細胞在外型和胞器上的差異。

Be able to distinguish the differences in appearance and organelles of animal and plant cells.

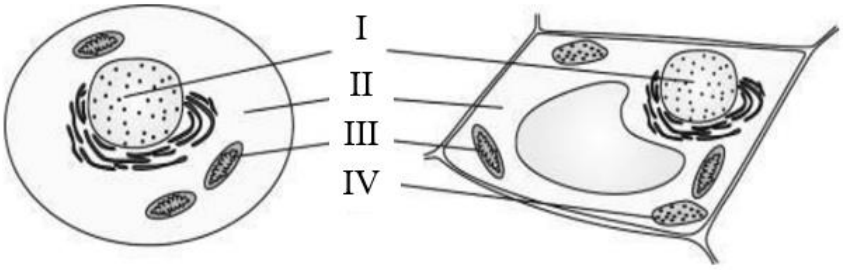
❧ 例題講解 ☙

例題一

說明：測驗學生是否清楚動植物細胞間的差異與特性。

To test whether students are aware of the differences and characteristics between animal and plant cells.

（英文）Figure (3) is a schematic diagram of animal cells and plant cells. Regarding the functions of the structures in the cells in this figure, which of the following is correct?



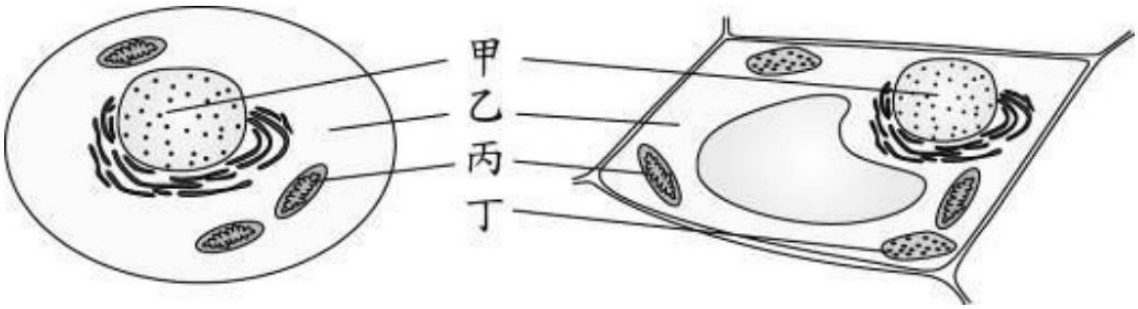
(A) I contains substances that can control genetic traits.

(B) II mainly controls the entry and exit of substances inside and outside the cell.

(C) III can carry out photosynthesis to produce nutrients.

(D) IV can decompose glucose to produce light energy.

（中文）圖(三)是動物細胞和植物細胞的示意圖，關於此圖中細胞內各構造的功能，下列何者正確？



(A)甲含有能控制遺傳性狀的物質。

(B)乙主要是控制細胞內外物質的進出。

(C)丙能進行光合作用產生養分。

(D)丁能分解葡萄糖產生光能　。

（98 年國中基測自然科第 9 題）

解題 Solution：

乙是細胞質，是代謝作用的主要場所；丙是粒線體，是細胞的能量工廠；丁是葉綠體，能透過光能合成葡萄糖。因此只有(A)是對的。

II is the cytoplasm, which is the main site of metabolism; III is the mitochondria, which is the energy factory of the cell; IV is the chloroplast, which can synthesize glucose through light energy. Therefore only (A) is correct.

Teacher: Excuse me, students, among the two cells in the picture, which one is an animal cell; which one is a plant cell?

Student: On the left are animal cells, and on the right are plant cells.

Teacher: That's right, that's right! How do you tell the difference?

Student: Because the cells on the right have more cell walls and chloroplasts! So why is the teacher answering A instead of D this time?

Teacher: Great, students know that IV is a chloroplast, which can perform photosynthesis, but photosynthesis is to synthesize glucose through the energy of light!

Student: That's right! We get it!

老師： 請問各位同學，圖片的兩個細胞中，哪一個是動物細胞；哪一個是植物細胞呢？

學生： 左邊是動物細胞，右邊是植物細胞。

老師： 沒錯，答對囉！你們是怎麼分辨的呢？

學生：因為右邊的細胞多了細胞壁和葉綠體！那請問老師為甚麼本次的答案是 A 而不是 D 呢？

老師：很棒喔，同學們知道丁是葉綠體，能行光合作用，不過光合作用是透過光的能量合成葡萄糖才對喔！

學生：原來如此！我們懂了！

例題二

說明：測驗學生是否了解粒線體的外形與功能。

To test whether students understand the appearance and function of mitochondria.

（英文）Figure (11) is a schematic diagram of the structure of plant mesophyll cells. I, II, III, and IV respectively represent different structures in the cell. Which of the following is mainly responsible for generating energy for the cell to use?

(A) I (B) II **(C) III** (D) IV

（中文）圖(十一)為植物葉肉細胞的構造示意圖，甲、乙、丙、丁分別代表細胞內不同的構造，則下列何者主要負責產生能量供細胞使用？

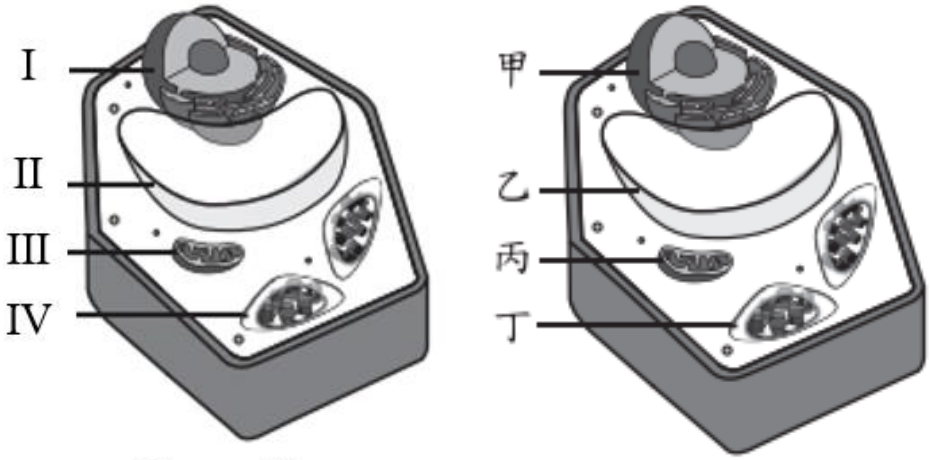


Figure 11.　圖(十一)

(A)甲　(B)乙　**(C)丙**　(D)丁

（107 國中會考自然科第 19 題）

解題 Solution：

甲為細胞核、乙為液胞、丁為葉綠體。

I is nuclei, II is vacuole, IV is chloroplast.

Student: May I ask the teacher how to tell if III is mitochondria and IV is chloroplast?

Teacher: Good question! Inside the mitochondria, there are more obvious folds; in the chloroplasts, there are many round cakes stacked in it.

Teacher: Do you know what functions they have respectively?

Student: The function of chloroplast is to carry out photosynthesis, and the function of mitochondria is to produce energy.

Teacher: That's right! Therefore, the answer to this question is to choose III, mitochondria.

學生： 請問老師要怎麼分辨丙是粒線體、丁是葉綠體呢？

老師： 問得很好！粒線體內部會有較明顯的皺褶的構造；葉綠體則有許多圓餅堆疊其中。

老師： 那你們知道他們分別具有什麼樣的功能嗎？

學生： 葉綠體的功能為進行光合作用、粒線體的功能是產生能量。

老師： 沒錯！因此這題的答案就是選丙，粒線體。

2-3 物質進出細胞的方式
The Way Matters Get in and Out of the Cell

■ 前言 Introduction

學生初次了解物質進入細胞的方式，包括擴散作用、水的滲透作用。擴散作用需注意是否需要消耗能量；而滲透作用的主角是水分子而非其他物質。另外也須注意動植物細胞在不同濃度的溶液中，細胞膨脹或萎縮的變化。老師們在這章節裡會接觸到擴散作用以及滲透作用的英文單字，並請留意其發音正確性。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
diffusion	擴散作用	water molecule	水分子
osmosis	滲透作用	red blood cell	紅血球
amino acid	胺基酸	swell	膨脹
mineral	礦物質	shrink	萎縮
concentration	濃度	saline solution	生理食鹽水

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ If we put _____, ____ will _____.

例句(1)：**If we put** animal cells into a high concentration solution, the cells **will** shrink.
如果把動物細胞放入高濃度溶液，細胞會萎縮。

例句(2)：**If we put** animal cells into low concentration solution, the cells **will** break.
如果把動物細胞放入低濃度溶液，細胞會破裂。

❷ ____ need ____ to _____.

例句(1)：Amino acids **need** channel proteins **to** pass through cells.
胺基酸需要透過通道蛋白進出細胞。

例句(2)：Minerals **need** channel proteins **to** pass through cells.
礦物質需要透過通道蛋白進出細胞。

■ 問題講解 Explanation of Problems

學習目標

在學習完本單元後，學生應習得以下觀念：

After studying this section, students should be able to know that:

一、判斷不同物質進出細胞的方式。
Determine the way different substances enter and leave the cell.

二、判斷動植物細胞在遇到不同濃度的溶液下，可能會產生的反應，如萎縮或膨脹。
Determine the reaction that animal and plant cells may produce when encountering solutions of different concentrations, such as shrinking or swelling.

例題講解

例題一

說明：測驗學生是否了解不同物質需要經由不同方法來進出細胞。
To test whether students understand that different substances need different ways to get in and out of cells.

（英文）Which of the following statements about substances entering and leaving cells is correct?

(A) Glucose can freely flow in and out of cells.

(B) Water can enter and leave cells by diffusion.

(C) Oxygen is broken down before it can enter the cell.

(D) Carbon dioxide can enter and exit the cell membrane through special proteins on the cell membrane.

（中文）下列有關物質進出細胞的敘述，何者正確？

(A) 葡萄糖可自由進出細胞。

(B) 水可藉擴散作用進出細胞。

(C) 氧氣經分解後才可進入細胞。

(D) 二氧化碳要藉細胞膜上特殊的蛋白質才能進出細胞膜。

（92 年第一次國中基測自然科第 40 題）

解題 Solution：

水和氣體皆可以直接通過細胞；葡萄糖則須經由特出的通道蛋白才能進出。

Both water and gas can pass directly through cells; glucose must pass through special channel proteins to get in and out.

Teacher: Do you know which options in the question are gases?
Student: Oxygen and carbon dioxide.
Teacher: Do you know what types of substances can directly enter and exit cells?
Student: Water and gas.
Teacher: That's right! How does glucose get in and out of cells?
Student: Glucose needs to move in and out of cells through channel proteins.
Teacher: That's right! So the answer to this question is option B.

老師： 你們知道題目哪些選項是氣體嗎？

學生： 氧氣與二氧化碳。

老師： 你們知道甚麼類型的物質才能夠直接進出細胞嗎？

學生： 水和氣體。

老師： 答對了！那葡萄糖要怎麼樣才能夠進出細胞呢？

學生： 葡萄糖需要透過通道蛋白進出細胞。

老師： 沒錯！因此這題的答案就是選 B。

例題二

說明：確認學生能夠分辨植物和動物細胞在低濃度溶液中的變化。

Confirm that students can distinguish between plant and animal cells in a hypotonic solution.

（英文）If human white blood cells and plant guard cells are placed in two glasses of distilled water for a period of time, which cell will not rupture and why, which of the following is the most reasonable?

(A) White blood cells, because they have mitochondria.

(B) White blood cells, because they have cell membranes.

(C) Guard cells, because they have vacuoles.

(D) Guard cells, because they have cell walls.

（中文）若將人體的白血球及植物的保衛細胞分別置於兩杯蒸餾水中一段時間，關於哪一種細胞不會破裂及其原因，下列何者最合理？

(A)白血球，因具粒線體。

(B)白血球，因具細胞膜。

(C)保衛細胞，因具液胞。

(D)保衛細胞，因具細胞壁。

（108 國中會考自然科第 4 題）

解題 Solution：

植物細胞有細胞壁維持細胞形狀，所以在低濃度溶液的環境中不會脹破。

Plant cells have cell walls to maintain cell shape, so they will not burst in the environment of hypotonic solution.

Teacher: Do you know the difference between animal and plant cells?
Student: Plant cells have cell walls, but animal cells do not.
Teacher: That's right! The cell wall is composed of cellulose, which helps maintain the shape of the cell. Will plant cells burst when placed in distilled water?
Student: No, because plant cells have cell walls.
Teacher: Then we put animal cells in distilled water, what should happen?
Student: Cells can swell and even burst.

老師： 你們知道動植物細胞的差別是什麼嗎？
學生： 植物細胞有細胞壁，而動物細胞沒有。
老師： 沒錯喔！細胞壁的成分是纖維素，可以協助維持細胞的形狀。那將植物細胞放入蒸餾水中會破裂嗎？
學生： 不會，因為植物細胞有細胞壁。
老師： 那我們將動物細胞放置蒸餾水中，應該會有甚麼變化呢？
學生： 細胞會膨脹甚至破裂。

2-4 生物體的組成層次
Compositional Hierarchy of Organisms

■ 前言 Introduction

學生初次了解生物體的組成層次，包含單細胞生物與多細胞生物，單細胞生物的特色在於僅需一個細胞就能生存；多細胞生物則有不同細胞間分工合作的現象。另外動物體的組成層次為：細胞、組織、器官、器官系統、個體以及植物體的組成層次與動物大致相同，但缺乏器官系統。老師在這章節需注意動物體與植物體之間的組成層次差異以及其英文發音正確性。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
unicellular organism	單細胞生物	reproductive organs	生殖器官
multicellular organism	多細胞生物	root	根
tissue	組織	stem	莖
organs	器官	leaf	葉
organ system	器官系統	flower	花
individual	個體	fruit	果實
nutritive organ	營養器官	seed	種子

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ is/are made up of_____.

例句：Tissues **are made up of** a group of cells with similar structures and functions.

組織是由一群構造與功能相似的細胞組成。

❷ _____ belongs to _____.

例句(1)：Meat **belongs to** tissues.

肉屬於組織。

例句(2)：Leaf **belongs to** organs.

葉子屬於器官。

例句(3)：Crab **belongs to** individuals.

螃蟹屬於個體。

■ 問題講解 Explanation of Problems

ଓ 學習目標 ଓ

在學習完本單元後，學生應習得以下觀念：

After studying this section, students should be able to know that:

一、了解生物可分為單細胞生物和多細胞生物。

Understand that organisms can be divided into unicellular organisms and multicellular organisms.

二、了解各個生物的組成層次。

Understand the composition level of each creature.

例題講解

例題一

說明：測驗學生對生物組成層次的了解程度。
To test students' understanding of biological composition levels.

（英文）Which of the following biological structures has the lowest level of composition?
(A) Lymph nodes
(B) White blood cells
(C) Ribs
(D) Blood vessels

（中文）下列哪一個生物構造的組成層次最低？
(A) 淋巴結
(B) 白血球
(C) 肋骨
(D) 血管

（96 年國中第二次基測自然科第 11 題）

解題 Solution：

組成層次最低的是細胞層次，因此選(B)白血球；其餘選項皆為組織層次。
The lowest composition level is the cell level, so choose (B) white blood cells; the rest of the options are the tissue level.

Student: May I ask what level of biological composition A, C, and D are and how to judge them?
Teacher: They are all organs. The way to judge is that all three are composed of a group of organizations with similar functions.
Teacher: Which level is the lowest level of biological composition?
Student: Cell.
Teacher: That's right! White blood cells belong to the cell level, so this question chooses (B) white blood cells.

學生： 問 A、C、D 選項是哪種生物組成的層次以及要怎麼判斷呢？

老師： 都是器官。判斷的方式為三者皆由一群功能接近的組織組成。

老師： 那生物組成層次最低的是哪個層次呢？

學生： 細胞。

老師： 沒錯！白血球屬於細胞層次，因此這題選(B)白血球。

★主題三 生物體內的營養★
Nutrition in Vivo

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■ 前言 Introduction

本章建立於健體領域國小中高年段的養分概念。營養可分類為：水果、蔬菜、全穀雜糧、豆魚蛋肉、乳品、油脂與堅果種子，而本章第一節「食物中的營養素」，則包含醣類、蛋白質、脂質、維生素、礦物質、水，讓同學可以將生活中的食物含有何種營養素及其功用更加了解，同時釐清產生能量及不可產生能量的營養素的概念。第二章第一節時，學生學習到「生物是由更小的單位－細胞組成，而細胞則是由更小的分子，如醣類、蛋白質、脂質構成」的概念，可以完整學生對於微觀世界的理解。第二節介紹酵素，如何將攝入的食物，由大分子營養素轉換成小分子營養素，講解細胞利用酵素合成物質或分解物質，進行身體中的能量利用或是儲存。第三部分講述植物如何經由光合作用製造養分。最後則是講述人體如何透過消化系統獲得養分，包含消化道的構造以及物理作用、消化腺分泌的消化液以及消化液的作用，了解食物在體消化系統內的變化。多以日常中的例子引導學生思考，知識就藏在生活中。

3-1 食物中的養分與能量
Nutrition and Energy in Food

■ 前言 Introduction

這章節建立在國小中高年段健康領域的營養概念，課程進一步細說了這些食物中主要的營養素。透過簡單的介紹，我們讓學生更深入了解日常飲食中的營養素及其功能。同時，我們釐清了能量產生與不可產生的營養素概念，有助於學生在未來挑選食物時更有方向性。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
different/ difference	不同的、不同處	contain	含有
non-caloric	不可產能的	cellulose	纖維素
protein	蛋白質	fat	脂肪
starch	澱粉	fatty acid	脂肪酸
carbohydrate	碳水化合物	produce	製造
energy	能量	category/ kind	種類
glycogen	肝醣	importance	重要性
function	功能	nutrition	營養素
calorie	卡路里	malnutrition	營養不均

gram	克	vitamin	維生素
mineral	礦物質		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ can produce energy, but _____ can't produce energy.

例句(1)：Carbohydrates **can produce energy, but** water **can't produce energy.**

碳水化合物可產生能量，但水不能產生能量。

例句(2)：Proteins **can produce energy**, but vitamins **can't produce energy.**

蛋白質可產生能量，但維生素不能產生能量。

❷ The function(s) of _____ in human bodies is/ are _____.

例句(1)：**The function of** carbohydrates i**n human bodies is** restoring energy.

醣類在人體中的功能是儲存能量。

例句(2)：**The function of** minerals **in human bodies is** regulating physiological functions.

礦物質在人體中的功能是調節生理機能。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

After studying this section, students should be able to know that:

一、了解養分對人體的重要性(養分的基本功能)。

Understand the importance of nutrients toward human body (the basic function of nutrition).

二、分辨能產能以及不能產能的營養素以及所產之熱量。

Distinguish caloric nutrition and non-caloric nutrition, and the energy they can produce.

❧ 例題講解 ☙

例題一

說明：學生不被題目中提到的寒冷天氣所誤導認為不能吃冰，而思考題目背後想傳達的問題－「食物中含有哪些營養素」以及「哪些營養素可以產生能量」。

Through this seemingly intuitive question, students are able to think about the meanings behind the question— the functions of different nutrition, and whether the nutrition can produce energy.

（英文）The little match girl lit the last match to make a wish when she was cold and starving. There was hot water and chocolate ice cream appeared in front of her to choose. Which one should she choose to maintain a longer life? Why?

(A) Hot water, because the higher temperature helps to maintain body temperature.

(B) Hot water, because water contains more calories.

(C) Chocolate ice cream, because it tastes better than hot water.

(D) Chocolate ice cream, because it contains more caloric nutrition.

（中文）賣火柴的小女孩在又冷又餓的情況下點燃最後一根火柴許願，眼前出現熱騰騰的開水和巧克力冰淇淋兩樣食物讓她做選擇，請問她應該選擇哪一樣食物才能維持較久的生命？為什麼？

(A) 熱騰騰的開水，因為溫度較高可以維持體溫。

(B) 熱騰騰的開水，因為水含有較多的熱量。

(C) 巧克力冰淇淋，因為和開水比起來比較美味 。

(D) 巧克力冰淇淋，因為含有較多能夠產生能量的營養素。

（生物複習講義_REV_CH3）

解題 Solution：

先將題目中的重點釐清，是「食物能維持較久的生命」或是「又冷又餓」，理解題目的重點為前者後，老師將「開水」與「冰淇淋」以提問的方式，引導同學們回答何者的營養素能夠產能，為身體帶來能量，答案為「冰淇淋」。

Clarify the main point of the question first. Which is “food to maintain a longer life” or “cold and hungry”? After understanding the main point above, the teacher keeps asking questions about hot water and ice cream to guide students to answer the nutrition in which food can produce energy to the body. Therefore, the answer is “ice cream”.

Teacher: What do you think is the main point this question wants to ask?
Student: The food helps people to maintain a longer life.
Teacher: That’s right! What is the nutrition in hot water and ice cream?
Student: Hot water is just water. Ice cream contains fats and carbohydrates.
Teacher: Could you tell me which nutrition can produce energy?
Student: The fats and carbohydrates in ice cream.
Teacher: Let’s go back to the original question, the little match girl was under a cold and starving situation, which should she choose to help her produce more energy?
Student: Ice cream, because fats and carbohydrates can produce energy.

老師： 大家覺得這個題目想問的重點是什麼？
學生： 哪樣食物能維持較久的生命。
老師： 沒錯！那麼「開水」與「冰淇淋」裡面有什麼樣的營養素呢？
學生： 開水就是水，冰淇淋裡面則有脂質、醣類，若是為乳製品的冰淇淋，則還會含有蛋白質。
老師： 那可以請你們告訴我哪一種營養素可以產能嗎？

學生： 冰淇淋中的脂質與醣類。

老師： 再回到原先的問題，賣火柴的小女孩在又冷又餓的情況下，應該選擇哪一樣食物才能幫助她產生更多的熱量呢？

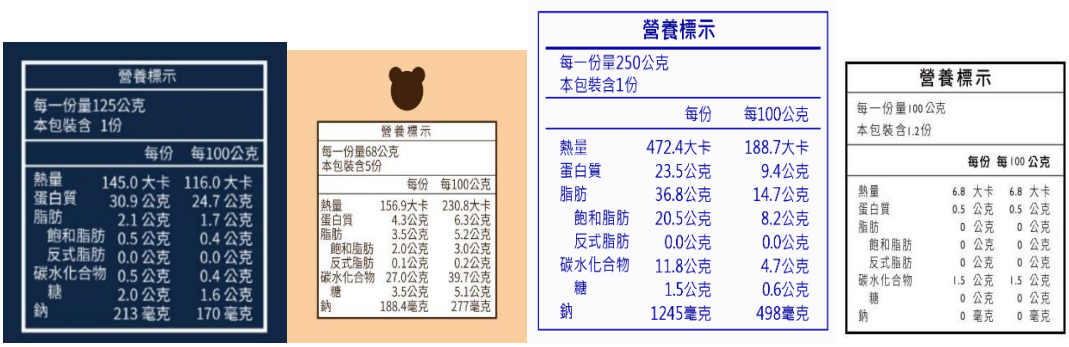
學生： 冰淇淋，因為脂質和醣類可以產能。

例題二

說明：此題不僅能夠讓學生學會判讀生活中食物的營養成分，同時也讓學生知道如何在不同的需求下做出更好的飲食規劃。

This question can not only make students learn how to interpret the nutritional contents of food in daily life, but also makes them understand how to create a better diet plan under different needs.

（英文）Research reports indicated that high blood pressure, cardiovascular diseases (arteriosclerosis, coronary artery disease, stroke) are all related to excessive salt intake. Table salt is mainly composed of sodium chloride, and the recommended amount of sodium for Chinese people is around 2,400 mg. The tables below show the nutrition labels of the food she eats in one day (a packet of chicken breast, two packets of oatmeal, a serve of curry rice, and a bottle of green tea). How much sodium does she consume in one day?



(A) 1834.3 mg (B) 1408.3 mg (C) 2400 mg (D) 2053mg

（中文）食鹽主要是由氯化鈉組成，醫學研究所（IOM）建議健康的成年人每天攝取 1,500 毫克，不要超過 2,300 毫克。若攝取不足會有低血鈉的風險，症狀包括噁心、嘔吐、頭痛、嗜睡、昏迷；攝取過多則會造成腎臟的負擔，易致心血管及高血壓的疾病。下表是小美一天進食的食物營養標示，分別是雞胸肉一包、燕麥兩份、咖哩一份、綠茶一瓶，請問她今天攝取的鈉含量是否超標？

(A)鈉攝取過多　(B)鈉攝取未超標　(C)鈉攝取過低　(D)無法計算

（研編者自行出題）

解題 Solution：

先將每樣商品的每份鈉含量與攝取份數相乘，再將上述相加做總和，在依題目中的資訊判斷「小美攝取的鈉含量」是否超標。

Multiply the sodium content per serving of each product by the number of intake servings, and add them together to make the total.

Teacher: Does anyone know how to calculate the amount of sodium intake?

Student: Multiply each serving of the amount of sodium in each product by the intake serving, then add them together.

Teacher: Does anyone know why there is always an option of “per 100 grams” on nutrition labels?

Student: This is to make it easier for consumers to compare products.

Teacher: Then how much sodium did Xiaomei consume today?

Student: A bag of chicken breast contains 213 mg of sodium, two bags of oat contains 188.4 mg of sodium times two portions, a portion of curry contains 1245 mg of sodium, and a bottle of green tea contains 0 mg of sodium. So the total amount of sodium is 1834.8 mg.

Teacher: Is it too low or high compared to the recommended intake?

Student: The recommended intake of sodium is 1500-2300 mg. The intake of Xiaomei is 1834.8 mg, so it is a moderate intake.

老師： 同學們知道該如何計算攝取的鈉含量嗎？

學生： 將每個商品的每份鈉含量乘上攝取的份數相加。

老師： 同學們知道為什麼營養標示上要有每 100 公克的選項嗎？

學生： 這是為了讓消費者能更方便進行產品比較。

老師： 那小美今天攝入了多少的鈉呢？

學生： 雞胸肉一包鈉含量 213 毫克、燕麥兩包鈉含量 188.4 毫克×2 份、咖哩一份鈉含量 1245 毫克、綠茶一瓶鈉含量 0 毫克，相加共 1834.8。

老師： 對照建議鈉攝取量是否過低或過高？

學生： 鈉攝取建議量為 1500-2300 毫克，小美今日攝取量為 1834.8，故為適當攝取量。

3-2 酵素
Enzyme

■ 前言 Introduction

人體進行代謝作用以維持身體的運作，代謝作用包括分解作用以及合成作用，攝食進入身體的大分子物質沒有辦法被吸收，如澱粉、蛋白質，而透過酵素的分解作用，能夠將大分子轉換成小分子以利細胞使用，如：腦、神經系統以及紅血球細胞所需要的能量主要由葡萄糖的代謝來提供；而身體中的小分子則需要轉換成大分子，以利儲存。以進食後的血糖變化舉例，消化系統將澱粉大分子分解成葡萄糖小分子，並加以吸收，以提供身體能量，此時血液中會有大量的葡萄糖；胰島素的分泌可以促進肝臟細胞和肌肉細胞將葡萄糖合成為肝糖，能將血液中過多的葡萄糖轉換成儲存性的肝醣，將能量儲存，如果胰島素分泌不足，無法降低血液中的葡萄糖含量，長時間下來可能導致糖尿病的發生。生活中有許多酵素的應用，如鳳梨蛋白酵素可以用於軟化肉質、酵素洗衣粉，更有許多瘦身商品主打攝入酵素可以幫助消化，老師可以在此堂課程之後留一些時間和同學一起探討這些酵素是否真的如廣告所說有著神奇的功效，可以培養學生對生活中不同資訊的判斷能力。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
decomposition	分解作用	break down	拆解
metabolism	代謝作用	reusability	重複使用性
anabolism	合成作用	substrate	受質

activity	活性	combine	組合
environment	環境	pH value	酸鹼度(pH 值)
absorb	吸收	factor	因素
enzyme	酵素	influence	影響
specificity	專一性	temperature	溫度

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ The features of _____ are _____ and _____.

例句(1)：**The features of** enzymes **are** specificity **and** reusability.
酵素的特性有專一性和重複使用性。

例句(2)：**The features of** metabolism **are** decomposition **and** anabolism.
代謝作用的特性有分解作用和合成作用。

❷ _____ can transform _____ into _____.

例句(1)：Decomposition **can transform** big molecules **into** small molecules.
分解作用可將大分子轉換成小分子。

例句(2)：Anabolism **can transform** small molecules **into** big molecules.
合成作用可將小分子轉換成大分子。

❸ The factors affecting _____ are _____ and _____.

例句(1)：**The factors affecting** enzyme activity **are** temperature **and** pH value.
影響酵素活性的因素是溫度和酸鹼值。

例句(2)：**The factors affecting** protein denaturation **are** physical **and** chemical factors.
影響蛋白質變性的原因有物理和化學性因素。

■ 問題講解 Explanation of Problems

學習目標

在學習完本單元後，學生應習得以下觀念：

一、了解何為代謝作用與其運作機制。

Understand what metabolism is and its operating mechanism.

二、了解酵素特性。

Understand the features of enzymes.

例題講解

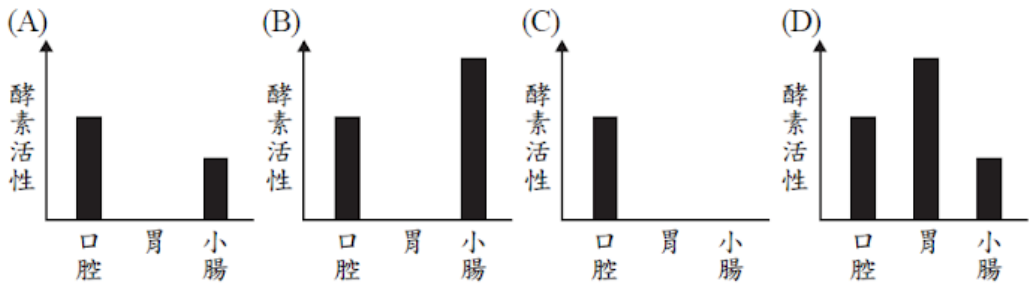
例題一

說明：此題運用日常生活中會遇到的情境，請學生判讀圖表，以檢視其是否能理解酵素的特性。

This question uses a situation that students will encounter in daily life. Teachers can ask students to read the charts in order to examine whether they understand the features of enzymes.

（英文）A certain enzyme is known to react best in an environment of 37 °C and pH value of 8, and it will be completely destroyed in the environment of pH value of less than 5. If someone eats this enzyme, which activity chart of the enzyme in the oral cavity, stomach, and small intestine will be the most reasonable?

（中文）已知某種酵素最適合在 37°C 及 pH=8 偏鹼性的環境中作用，且在 pH<5 的環境下會被完全破壞。若某人吃下此種酵素，則此酵素在口腔、胃及小腸中的活性大小，下列何者最合理？



（110 年國中會考 42）

解題 Solution：

學生除了需要知道消化道的順序外，還要了解各消化道中酵素作用的環境。學生要先知道酵素被完全破壞後就不再具有活性，再將圖表和已知的知識做連結。

Students have to know not only the order of the digestive tract but also the environment that enzymes' function in each digestive tract. Students have to know in advance that enzymes will lose activity after being completely destroyed, then make a connection between the charts and the knowledge they know.

Teacher: Does anyone know the order (provided by the topic) of food passing through the digestive tracts and the environment of each digestive tract?

Student: It is neutral in the oral cavity. → There is strong acid in stomach. → It is alkaline in the small intestine.

Teacher: That's right. What will happen if this enzyme goes into the stomach?

Student: It will be destroyed by the strong acid in the stomach and lose its activity.

Teacher: You got the correct answer. And what will happen if it goes to the small intestine?

Student: It will be destroyed by the strong acid in the small intestine and lose its activity.

Teacher: Yes. As we can see the charts in the options, we should understand what are the things that the figure represents, and usually the chart would be interpreted from the vertical and horizontal axes. We should identify the information that the chart represents, which means to interpret the project and unit of the vertical and horizontal axes. What are the vertical and horizontal axes represented for?

Student: The vertical axis is the enzyme activity, and the horizontal axis is the order of the digestive tract.

Teacher: Then how should it look like in the chart?

Student: It should show activity in the oral cavity. When it enters the stomach, the enzyme has been completely destroyed, loses its activity and no longer shows up, so it does not show activity in the small intestine as well.

老師： 同學們知道食物經過消化道（題目中提供）的順序以及各消化道的環境如何嗎？

學生： 口腔偏中性→胃有強酸→小腸偏鹼性。

老師： 沒錯，那麼口腔中的酵素進到胃中會發生甚麼事呢？

學生： 被胃中的強酸破壞失去活性。

老師： 答對了，那麼此種酵素進到小腸會發生甚麼事呢？

學生：　在小腸中被破壞且失去活性。

老師：　是的，那我們看到選項中的圖表，首先我們需要先理解這個圖表要表達什麼事情，通常會從縱軸與橫軸開始判讀，我們需先將圖表想告訴我們的事情釐清，也就是先判讀橫軸與縱軸的項目與單位。那麼此題的縱軸和橫軸分別為何呢？

學生：　縱軸為酵素活性、橫軸為消化道的順序。

老師：　那麼圖表應該如何顯示呢？

學生：　在口腔中應顯示活性，進到胃中，酵素已被完全破壞，失去活性，不再顯示，故在小腸中也不顯示活性，故圖表的呈現應為口腔中有黑色的長條形，而胃及口腔則無。

例題二

說明：學生須知道人體常見的大分子與小分子轉換為何，並且訓練同學判讀圖表的能力。Students should know the transformation of the common big and small molecules in human bodies, and the question also trains the ability of students to interpret charts.

（英文）Mix the enzyme A and starch solution in a test tube, and measure the starch concentration in the test tube regularly. As shown in the figure, it is known that the starch concentration in the test tube will change with time. Which of the following statements about A is correct?

(A) A is mainly composed of glucose.

(B) After A reacts with starch, A will be broken down into amino acids.

(C) If lowering the activity of A, the synthesis rate of starch will be faster.

(D) If raising the activity of A, the decomposition rate of starch will be faster.

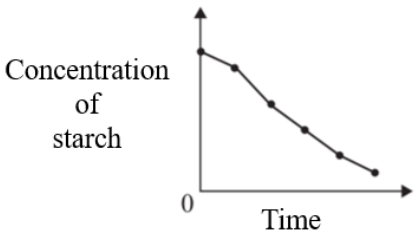


Figure (10)

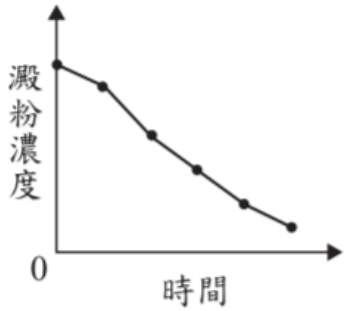
（中文）將酵素甲和澱粉溶液在試管中混合均勻，並定時測量試管內的澱粉濃度。如圖所示，已知試管內澱粉濃度會隨著時間而改變，下列關於甲的敘述，何者正確？

(A)甲主要由葡萄糖組成。

(B)甲與澱粉反應後，會被分解成胺基酸。

(C)若降低甲的活性，會使澱粉的合成速率變快。

(D)若提高甲的活性，會使澱粉的分解速率變快。



圖(十)

（會考 107 自然考科題目）

解題 Solution：

學生能夠在判讀圖表後，釐清每一個選項。

Students can clarify each option after interpreting the chart.

Teacher: What do the horizontal and vertical axes in the chart represent?

Student: The horizontal axis is starch concentration, and the vertical axis is time.

Teacher: Then what does the line chart represent?

Student: It means the concentration changes of the starch with the increase of time.

Teacher: What does it mean if the trend of the line chart goes up? What does the gradually decreasing trend imply?

Student: It means that the concentration of starch is rising as the time goes if the trend of the line chart goes up. The trend of the line chart gradually going down represents that the concentration of starch is decreasing as the time goes.

Teacher: If enzyme A and starch solution are mixed evenly in a test tube, what can we know that the starch concentration changes from this picture?

Student: Under the reaction of enzyme A, the concentration of starch decreases with time.

Teacher: That's right. What is the effect of enzyme A on starch? (correspond to options B, C)

Student: It is decomposition. If we raise the activity of enzyme A (amylase), the speed of starch decomposition will be faster.

Teacher: What are the components of enzymes and starch?

Student: Enzymes are composed of protein, while starches are composed of glucose to be some large molecules.

Teacher: Is the description of option A correct?

Student: No, A is an enzyme. It is mainly composed of proteins.

Teacher: Is the description of option B correct?

Student: No. After A reacts with starch, the starch will be broken down into small molecules of carbohydrates.

老師： 請問圖表內的橫軸與縱軸分別代表什麼呢？

學生： 橫軸是澱粉濃度，縱軸是時間。

老師： 那麼這張圖想告訴我們什麼呢？

學生： 是隨著時間增加，澱粉的濃度變化。

老師： 若此圖表的趨勢向上代表著什麼意思呢？向下的趨勢又暗示了什麼事情呢？

學生： 若數據趨勢逐漸往上則代表隨著時間過去澱粉濃度漸高，數據趨勢逐漸往下則代表隨著時間過去澱粉濃度逐漸減少。

老師： 若將酵素甲和澱粉溶液在試管中均勻混和，藉由這張圖，我們可以知道澱粉濃度有怎麼樣的變化呢？

學生： 在酵素甲的作用下，澱粉濃度隨著時間越來越低。

老師： 沒錯，那麼酵素甲對於澱粉的作用為何? (對應到選項 B,C)

學生： 是分解作用，若提高甲（澱粉酶）的活性，會使澱粉的分解速率變快。

老師： 酵素和澱粉分別是由什麼組成的呢？

學生： 酵素是由蛋白質組成的，澱粉則是由葡萄糖組成的大分子

老師： 那麼 A 選項的敘述是否正確？

學生： 否，甲為酵素，其主要由蛋白質組成。

老師： 那麼 B 選項的敘述是否正確？

學生： 否，甲與澱粉反應後，澱粉會被分解成較小分子的醣類。

3-3 植物如何製造養分
How Do Plants Make Nutrients

■ 前言 Introduction

光合作用對人類生活有著非常大的影響，光合作用在葉綠體中進行，以水、二氧化碳為原料，葉綠素吸收太陽能，將水分解成氧氣到大氣中並且轉化能量。光合作用的反應物中，水由根部吸收，經維管束的運輸至葉肉組織；二氧化碳則由成對保衛細胞間的氣孔進入。光合作用的產物包括氧氣和葡萄糖，氧氣會經由氣孔排放至大氣，而能量可以用於將二氧化碳轉換成葡萄糖和水分，葡萄糖可以被植物直接利用或是儲存成澱粉。光合作用不僅可以從介紹植物的內部構造開始講解，如表皮上散布著成對的保衛細胞，兩個保衛細胞中間的縫隙則稱為氣孔，是氣體進出植物體的主要通道，也可以以植物會產出氧氣供給生物生存、將溫室氣體二氧化碳消耗，減緩全球暖化，以環保的議題帶領學生認識植物在製造養分時，對整個世界帶來的益處，培養同學具有環保的意識。講述植物進行光合作用製造養分與氧氣，並在不涉及光反應、固碳反應等過程前提下進行教學。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
protect	保護	air space	氣室
guard cell	保衛細胞	palisade tissue	柵狀組織
prevent	防止	turn into	轉換
structure	構造	save	儲存
photosynthesis	光合作用	lower/upper epidermis	上下表皮

control	控制	blade	葉片
spongy tissue	海綿組織	vein	葉脈
cuticle	角質層	chloroplast	葉綠體
gas	氣體	mesophyll	葉肉
stoma/ stomata (pl.)	氣孔	ingredient	原料

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ consist of different structures. They are _____, _____…, and _____.

例句(1)：Leaves **consist of different structures. They are** lower/upper epidermis, mesophyll cells, and veins.

葉片由不同的構造組成。它們是上下表皮、葉肉和葉脈。

例句(2)：Stems **consist of different structures. They are** epidermis, cortical layers, and vascular bundles.

莖由不同的構造組成。它們是表皮、皮層和維管束。

❷ Through _____, _____ turn into _____.

例句(1)：**Through** sunlight and chlorophyll, carbon dioxide and water **turn into** glucose, oxygen, and water.

藉由陽光與葉綠素，二氧化碳和水轉換成葡萄糖、氧氣與水。

例句(2)：**Through** amylase, starch **turns into** maltose and glucose.

藉由唾液澱粉酶，澱粉轉換成麥芽糖和葡萄糖。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

After studying this section, students should be able to know that:

一、認識葉片的構造以及其功能。

Understand the structures of leaves and their functions.

二、了解光合作用的過程與重要性。

Understand the process and importance of photosynthesis.

❧ 例題講解 ☙

例題一

說明：使學生釐清光合作用的反應。

Make students clarify the reaction of photosynthesis.

（英文）Xiaofan wants to know the reaction speed of photosynthesis when each plant stays in different living environments. Which one of the data can help him make the prediction?

(A) The amount of oxygen produced per unit time.

(B) The amount of chlorophyll consumed per unit time.

(C) The amount of glucose consumed per unit time.

(D) The amount of carbon dioxide produced per unit time.

（中文）小帆想知道某一植株在不同環境條件下，葉片行光合作用時速率的快慢，應依據下列哪一資料進行推測最為合理？

(A) 單位時間內產生氧氣的量。

(B) 單位時間內消耗葉綠素的量。

(C) 單位時間內消耗葡萄糖的量。

(D) 單位時間內產生二氧化碳的量。

（108 國中會考自然科第 5 題）

解題 Solution：

先理解何謂速率快的定義，再思考光合作用的反應。

Understand the definition of fast speed, then think about the reaction of photosynthesis.

Teacher: How can we define speed?

Student: It can be defined by the same amount of reactant that can produce more product in the same amount of time.

Teacher: That's right! How about the reactant and the product of photosynthesis?

Student: Chloroplast uses carbon dioxide and water as the reactants, and it will absorb the energy from the sun to transform carbon dioxide and water into oxygen and glucose.

老師： 應該要如何定義速率的快慢呢？

學生： 在一樣的時間內，用固定量的反應物產生出較多的產物。

老師： 沒錯！那麼光合作用的反應物和產物為何呢？

學生： 葉綠體接收太陽光的能量吸收二氧化碳以及水作為反應物，轉換為氧氣與葡萄糖。

例題二

說明：學生能透過光合作用以及呼吸作用的反應式以及其作用反應場所判斷細胞中是否有特定的胞器。

Students can identify whether there are specific organelles in cells through the chemical equations of photosynthesis or respiration and the reaction field.

（英文）The table below is a comparison of whether there are two specific biological reactions in A cell or B cell. To predict whether there are specific structures in A cell or B cell, which of the following descriptions is the most reasonable?

	glucose + oxygen → water + carbon dioxide	**water + carbon dioxide → glucose + oxygen + water**
A cell	**yes**	**no**
B cell	**no**	**yes**

(A) Only the A cell contains mitochondria.

(B) Only the A cell contains chloroplast.

(C) Only the B cell contains mitochondria.

(D) Only the B cell contains chloroplast.

（中文）下表為甲細胞和乙細胞內有無兩種特定生理作用的比較。根據此表推測甲、乙細胞內特定構造的有無，下列敘述何者最合理？

	葡萄糖+氧氣→水+二氧化碳	水+二氧化碳→葡萄糖+氧氣+水
甲細胞	有	無
乙細胞	有	有

(A)僅甲細胞含有粒線體。

(B)僅甲細胞含有葉綠體。

(C)僅乙細胞含有粒線體。

(D)僅乙細胞含有葉綠體。

（106 年國中第二次基測 18）

解題 Solution：

學生能先想出反應式代表的作用為何，並結合第二章介紹之細胞構造與胞器的基本功能，回憶起不同作用反應場所位於何種胞器，去判斷出細胞中是否具有特定胞器。

Students can come up with the effects of chemical equations first, and combine the structures of cells and the basic functions of organelles in chapter 2 to recall the different reaction fields in which organelles, then to determine whether there are specific organelles in the cells.

Teacher: Can you know what are the effects of the left and right reactions according to the chemical equation in the table?

Student: The left one is respiration, and the right one is photosynthesis.

Teacher: Great. Then where do these two effects react?

Student: The reaction field of respiration is in mitochondria, and the reaction field of photosynthesis is in chloroplast.

Teacher: Very good! Now I want to ask you guys, “can photosynthesis react in human bodies?”

Student: No, because we don’t have chloroplast in our bodies.

Teacher: Then the A cell and B cell in the question can perform which kind of effect separately?

Student: A cell can perform respiration, but it cannot perform photosynthesis. B cell can perform respiration and photosynthesis.

Teacher: What are the organelles in A cell and B cell separately?

Student: According to the clues in the question we can know there is only mitochondria in A cell, while there are mitochondria and chloroplast in B cell, so selection (D) is the answer.

老師： 依據表中的反應式可以知道左右兩種反應分別為何種作用嗎？

學生： 左邊的反應是呼吸作用、右邊的反應是光合作用。

老師： 很棒，那這兩種作用分別在何處進行反應呢？

學生： 呼吸作用的反應場所在粒線體、光合作用的反應場所則在葉綠體。

老師： 很棒喔！那老師想問大家：在人體中可以進行光合作用嗎？

學生： 不行，因為我們身上沒有葉綠體。

老師： 那題目中的甲細胞和乙細胞分別可以進行何種作用呢？

學生： 甲細胞可以進行呼吸作用，但不能進行光合作用；乙細胞可以進行呼吸作用以及光合作用。

老師： 那甲、乙細胞中分別有何種胞器呢？

學生： 依題目的題是可以知道甲細胞只有粒線體，乙細胞則有粒線體與葉綠體，故選擇選項(D)。

3-4 人體如何獲得養分
How Do Human Bodies Get Nutrients

■ 前言 Introduction

由前面的章節介紹營養素，以及大小分子的轉換。此章則是介紹人體中的消化系統，經由攝食、消化、吸收獲得所需的養分。其中內容包含介紹消化道的構造，並帶領學生了解其所發揮的物理作用（例如：磨碎、攪拌）、認識消化腺及其所分泌的消化液，了解消化液的作用。最後則可以不同的食物如何被消化進行講解，先分析該食材含有的營養素，在一一經過不同的消化器官會發生怎麼樣的消化作用，使學生了解食物在人體消化系統內的變化。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
egestion	排泄	alimentary canal	消化管
exhaust	排出	digestion	消化系統
defecation	排遺	digestive gland	消化腺
secrete	分泌	digestive fluid	消化液
large intestine	大腸	small intestine	小腸
salivary gland	唾腺	intestinal gland	腸腺
pass	通過	esophagus	食道
liver	肝臟	hold	容納

anal	肛門	pancreas	胰臟
oral	口腔	pharynx	咽
muscle	肌肉	stomach	胃
enter	進入	gastric gland	胃腺
organ	器官		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ includes _____, _____…, and _____.

例句(1)：Digestive tract **includes** the oral cavity, pharynx, esophagus, stomach, small intestine, large intestine**, and** anus.

消化管包含口腔、咽、食道、胃、小腸、大腸、肛門。

例句(2)：Digestive gland **includes** salivary gland, gastric gland, liver, pancreas**, and** intestinal gland.

消化腺包括唾腺、胃腺、肝臟、胰臟和腸腺。

❷ _____ comes from _____.

例句(1)：Saliva **comes from** the salivary glands.

唾液來自唾腺。

例句(2)：Gall **comes from** the liver.

膽汁來自肝臟。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

After studying this section, students should be able to know that:

一、了解人體的消化管與消化腺的運作機制。

Understand the digestive tract of the human body and the operating mechanism of digestive glands.

❧ 例題講解 ☙

例題一

說明：測驗學生是否知道消化腺分泌的消化液作用於何處。

Test whether students know where the digestive fluid produced by digestive glands works.

（英文）Gastric juice and pancreatic juice of the human body both contain digestive enzymes. Regarding the places where these two digestive juices mainly act in the body, which of the following pairs is correct?

(A) gastric juice: stomach, pancreatic juice: pancreas

(B) gastric juice: stomach, pancreatic juice: small intestine

(C) gastric juice: small intestine, pancreatic juice: small intestine

(D) gastric juice: small intestine, pancreatic juice: pancreas

（中文）人體的胃液及胰液中皆具有消化酵素，關於此兩種消化液在體內主要作用的場所，下列配對何者正確？

(A)胃液：胃，胰液：胰臟

(B)胃液：胃，胰液：小腸

(C)胃液：小腸，胰液：小腸

(D)胃液：小腸，胰液：胰臟

（109 年國中會考(補考)第 24 題）

解題 Solution：

胃液由胃分泌並在胃中作用，胰液則藉由導管注入小腸，作用的場所在小腸。

The gastric juice is secreted by the stomach and acts in the stomach, while the pancreatic juice is injected into the small intestine through a catheter, and the place of action is in the small intestine.

Teacher: Where does gastric juice act?
Student: It acts in the stomach.
Teacher: Where does pancreatic juice act?
Student: It is injected into the small intestine through a catheter, and the place of action is in the small intestine.

老師： 胃液在何處作用呢？
學生： 胃中。
老師： 胰液在何處作用呢？
學生： 由導管注入小腸，作用的場所在小腸。

例題二

說明：測驗學生是否有辦法判讀圖片之消化器官與其功能。

Test whether students can interpret the digestive organs and their functions in the picture.

（英文）Figure (15) is a schematic diagram of part of the digestive organs of the human body. If there is a blockage in the I part of Lao Wang's body, which of the following is most likely to happen with regard to his digestion and nutrient absorption functions?

(A) Pancreatic juice cannot be discharged into the small intestine.

(B) Gastric juice cannot break down proteins.

(C) The function of digesting lipids decreases.

(D) The function of digesting glucose decreases.

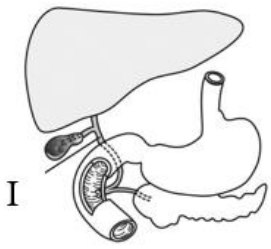


Figure (10)

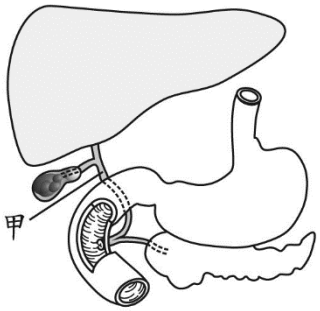
（中文）圖(十五)為人體部分消化器官的示意圖，若老王體內的甲處發生阻塞，則下列關於他的消化及養分吸收功能，何者最可能發生？

(A)胰液無法排至小腸內。

(B)胃液無法分解蛋白質。

(C)消化脂質的功能下降。

(D)吸收葡萄糖的功能下降。



圖(十五)

（106 年國中會考第 27 題）

解題 Solution：

本題圖中的「甲」處為導管，若甲處(導管)發生阻塞，膽汁無法到達小腸，消化脂質的功能則會下降。

The "I" part in the picture of this question is the biliary tract. If the I part (biliary tract) is blocked, the bile cannot reach the small intestine, and the function of digesting lipids will decrease.

Teacher: What kind of digestive fluid transporting channel is I? What is its function?

Student: I is the biliary tract that transports the gallbladder, and its function is to emulsify lipids.

老師： 甲為運輸何種消化液的管道？其功能為何？

學生： 甲是運輸膽汁的導管，其功能為乳化脂質。

★主題四 生物體的運輸作用★
The Transportation in Organism

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■ 前言 Introduction

無論是植物或是動物，得到養分之後都須將其運送到各個部位，以供各組織能將能量吸收以維持組織正常運作，同時，組織運作產生的廢物也需要排出。本章接續第三章「生物體的營養素」，第四章介紹植物與人體的運輸構造、機制，以及循環。生物體中的運輸維持著生物體中的循環，學生若能了解其中的原理，則可以進一步思考生活中發生的事情背後的奧妙，如為何有些植物的外皮被松鼠啃食就無法存活，有些植物已經失去了整個樹幹中心卻仍可生存；為何注射在手臂上的疫苗可以造成全身的痠痛，疫苗引起的發燒又是為什麼發生？

4-1 植物的運輸構造
The Transport Structures of Plants

■ 前言 Introduction

本章節主軸為介紹植物體根、莖、葉、花、果實內的維管束，具有運輸功能。由植物體的運輸構造開始介紹，包括維管束組成、功能，如負責運輸水分及養分的木質部與負責運送養分的韌皮部。學生同時需要比較單／雙子葉中的不同，如莖的橫切面中的散生／環生排列方式，與形成層的有無。同時介紹木本植物的構造，以及如何依其年輪判斷植物的生長狀態和生長環境。章節活動會進行觀察植物葉片、莖、花、果實內的維管束，了解維管束貫穿植物體，能運輸水分和養分。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
xylem	木質部	cambium layer	形成層
monocot (monocotyledon)	單子葉	dicot (dicotyledon)	雙子葉
big/ small volume	體積大/小	phloem	韌皮部
tree ring	年輪	leaf/ leaves	葉
structure	構造	dark-/light- colored	顏色深/淺
root(s)	根	nutrition	養分
mineral	礦物質	vascular bundle	維管束
stem(s)	莖	transport/ transportation	運輸

absorb	吸收		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ We guess _____ are ____ because they have _____ (and) ____.

例句(1)：**We guess** green onions **are** monocots **because they have** fibrous roots **and** parallel veins.

因為青蔥有鬚根和平行脈，所以我們猜測它是單子葉植物。

例句(2)：**We guess** sunflowers **are** dicot **because they have** taproots **and** net veins.

因為向日葵有軸根和網狀脈，所以我們猜測它是雙子葉植物。

❷ The biggest difference between ____ and _____ is _____.

例句：**The biggest difference between** monocotyledonous **and** dicotyledonous vascular bundles **is** the presence of the cambium layer.

單子葉和雙子葉植物維管束最大的不同就是形成層的有無。

■ 問題講解 Explanation of Problems

學習目標

在學習完本單元後，學生應習得以下觀念：

After studying this section, students should be able to know that:

一、辨識（草本/木本生）植物體內的維管束運輸構造與其功能。

Identify the transport system and functions of vascular bundles in herb or woody plants.

二、了解植物體內運輸構造的功能及方向。

Understand the functions and directions of the transport system in the plants.

例題講解

例題一

說明：學生須能夠辨識木本植物的運輸構造位置與功能。

Students should be able to identify the position and function of the transport system of woody plants.

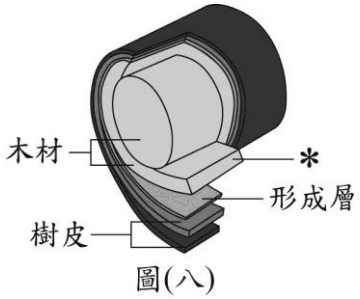
（英文）The stem of a dicotyledonous woody plant has structures such as bark and wood, as shown in Figure (8). Which of the following is the main function marked with * in the figure?

(A) Transporting nutrients.

(B) Transporting water.

(C) Cell division.

(D) Photosynthesis.



圖(八)

（中文）某雙子葉木本植物的莖具有樹皮及木材等構造，如圖(八)所示。下列何者為圖中標示＊處的主要功能？

(A)運輸養分。

(B)運輸水分。

(C)細胞分裂。

(D)光合作用。

（106 國中會考自然科第 12 題）

解題 Solution：

閱讀圖片中提供的訊息，先判斷各運輸構造位在何處，再思考該運輸構造之功能。

Solution: Read the information provided in the picture, first determine where each transport structure is located, and then think about the function of the transport structure.

Teacher: What are the structures of the transport system in woody plants?

Student: Starting from the outside, the order of the transport system of woody plants are phloem, cambium layer, and xylem.

Teacher: How about the positions of the transport system?

Student: The outside of phloem is tree bark, which is in the outermost layer of the trunk. Besides, the wood accumulating from the cambium layer and gradually moving to the inside are all xylem, which is in the center.

Teacher: That's right. Then what is the * mark for? What is its function?

Student: Xylem. It can transport water.

Teacher: And I also want to know the difference between the part with * mark and wood.

Student: The cambium layer will undergo cell divisions inward to form xylem. The cells being closer to the cambium layer are younger, which is the part to transport water efficiently. In addition, the xylem cells being farther to the cambium layer are those losing the functions of transporting water, and they can only be used as wood.

老師： 木本植物的運輸構造有哪些？

學生： 木本植物的運輸構造由外向內為韌皮部、形成層、木質部。

老師： 那這些運輸構造的位置又在哪呢？

學生： 韌皮部向外的部分是樹皮，在樹幹的最外圈；而由形成層向內逐漸累積的木材則皆為木質部，位在中心。

老師： 沒錯，那麼＊字號的部分是什麼呢？其功能為何？

學生： 木質部，運輸水分。

老師： 那老師想知道＊字號的部分以及木材的部分的差異是什麼呢？

學生： 形成層會向內進行細胞分裂形成木質部，越靠近形成層的部位（＊字號的部份）細胞越年輕，為運輸水分功能發達的部位，而距離形成層較遠的木質部細胞則為失去運輸水分功能的細胞，僅可以做為木材使用。

例題二

說明：測驗學生是否能了解運輸構造的功能，同時須能夠判斷植物為單子葉或是雙子葉植物，並推測該植物的莖橫切面構造。

Test whether students can understand the functions of transport structures, and should be able to judge whether a plant is a monocot or a dicot, and to infer the cross-section structure of the plant stem.

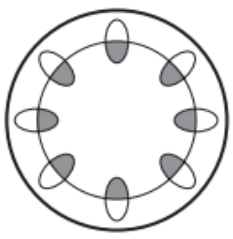
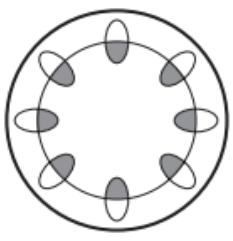
（英文）Ah Xiang put the white rose in a vase, added water containing blue pigment in the vase, and placed it in the sun.

After a period of time, it was found that the petals of the rose turned light blue, as shown in Figure (20), and Ah Xiang inferred that it was caused by the vascular bundle of the rose transporting the blue pigment from the base of the stem to the flower.

According to this article, if the gray part of the diagram represents the xylem and the white part represents the phloem, then the classification of roses and the arrangement of the vascular bundles in the tender stem can be inferred. Which of the following pairs is the most reasonable?

圖(二十)

（中文）阿湘將白玫瑰放入花瓶中，並在花瓶加入含有藍色色素的水，置於陽光下。一段時間後發現玫瑰的花瓣變成淡藍色，如圖(二十)所示，阿湘推論是由於玫瑰的維管束將藍色色素由莖的基部運送至花所造成。根據本文，若以示意圖的灰色部位代表木質部、白色部位代表韌皮部，則推論玫瑰的分類及其嫩莖內維管束之排列，下列配對何者最合理？

(A)雙子葉植物 dicotyledonous plants	(B)單子葉植物 monocotyledonous plants	(C)雙子葉植物 dicotyledonous plants	(D)單子葉植物 monocotyledonous plants
			

（110 國中教育會考(補考)第 50 題）

解題 Solution：

學生需依圖判斷其為單／雙子葉植物，辨識出運輸構造之位置與其功能。

Students are required to judge whether it is a monocotyledonous or dicotyledonous plant based on the picture, and identify the location and function of the transport structure.

Teacher: Is the white rose in the picture a monocot or a dicot? Why?

Student: Dicotyledonous plants, which can be judged by the reticulate veins of their leaves.

Teacher: Great! So what should the cross-section structure of the dicotyledon look like?

Student: Dicotyledons have a cambium structure, and the vascular bundles in the cross-section of the stem are arranged in a ring.

Teacher: Then, do you know what the arrangements of structure are inside? Why is the structure darker inside?

Student: The structure from outside to inside is phloem > cambium > xylem. Water is transported by the xylem, and the transport of dyed water makes the xylem in a darker color.

老師： 圖中的白玫瑰為單子葉植物還是雙子葉植物呢？為什麼？

學生： 雙子葉植物，可依其葉子為網狀脈進行判斷。

老師： 很棒！那麼雙子葉的橫切面構造應該長成甚麼樣子呢？

學生： 雙子葉具有形成層的構造，且莖的橫切面維管束呈環狀排列。

老師： 那麼大家知不知道裡面的構造排列為何呢？為什麼裡面的構造顏色較深呢？

學生： 由外而內的構造為韌皮部＞形成層＞木質部。水是由木質部運送，運輸經過染色的水使木質部呈較深的顏色。

4-2 植物體內物質的運輸
Transportation of Substances in Plants

■ 前言 Introduction

簡單的描述植物所需的物質來源，如葉片行光合作用由韌皮部向上供應至新芽生長所需，向下則運輸至莖與根供其利用；根與根毛吸收的水與礦物質，向上供應至莖、葉片利用。再進一步介紹背後的原理，如蒸散作用，以及整個植物體的的搭配，如保衛細胞的開閉。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
guard cell(s)	保衛細胞	stem apex	莖頂
capillarity	毛細作用	stoma	氣孔
direction	方向	transpiration	蒸散作用
one-way/ two-way	單向/雙向	go up/ down	上升/下降
extra	多餘的	water vapor	水蒸氣
root hair(s)	根毛	in need	有需求的
open/ close	開放/關閉		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ When NP1 is _____, NP2 will _____.
(NP 意指 noun phrase, 中文意思為名詞片語)

例句：**When** the guard cell **is** full of water, the stomata **will** open.
當保衛細胞充滿水分時，氣孔會打開。

❷ If NP1 _____, NP2 will _____.

例句：**If** the guard cell lacks water**,** the stomata **will** be closed.
如果保衛細胞缺乏水分，氣孔則會關閉。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

一、了解植物構造如何運輸養分及水分。
Understand how the plant structures transport nutrients and water.

二、了解植物內物質運輸的方向。
Understand the direction of substances transport in plants.

例題講解

例題一

說明：學生須比較韌皮部與木質部的運輸方向與運輸物質的不同。

Students are required to compare the direction and substances of transport between phloem and xylem.

（英文）Figure (20) is a schematic diagram of the flow of substances in vascular plants. I is the pipeline for transporting substances in the vascular bundle, and II is the main transport substance in this pipeline. The arrows indicate the possible directions of flow of substance II in the pipeline at different time points. Which of the following statements about I and II is the most reasonable?

(A) I is in xylem, II is sugar.

(B) I is in the phloem, II is sugar.

(C) I is in the xylem, II is a mineral.

(D) I is in the phloem, II is a mineral.

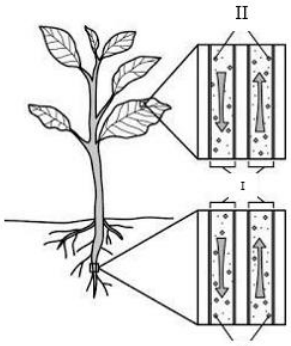


Figure (10)

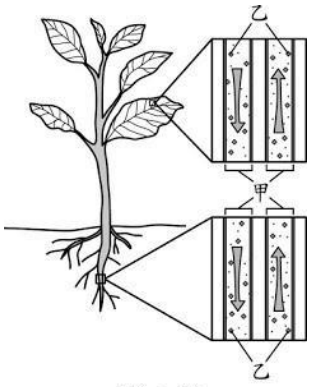
（中文） 圖(二十)為維管束植物體內物質流向的示意圖，甲為維管束內運輸物質的管道，乙為此種管道內主要的運送物質，箭頭表示乙物質在不同時間點於管道內可能的流動方向。下列有關甲和乙的敘述，何者最合理？

(A)甲位在木質部，乙為醣類。

(B)甲位在韌皮部，乙為醣類。

(C)甲位在木質部，乙為礦物質。

(D)甲位在韌皮部，乙為礦物質。



圖(二十)

（108 年國中會考第 41 題）

解題 Solution：

閱讀圖片中提供的訊息，先判斷物質運輸的方向，再進一步推測其為何種運輸構造。

Read the information provided in the picture, determine the direction of material transportation at first, then infer what kind of transportation structure it is.

Teacher: What are the substances that xylem and phloem transport separately?

Student: Xylem transports water and minerals, and phloem transports nutrition.

Teacher: What about the transport directions of xylem and phloem? Are they one-way or two-way?

Student: The transport direction of xylem is one-way. It transports water and minerals from the bottom to the top, which refers to transport from the root (bottom) to the upper body of the plants (stems and leaves). Phloem transports nutrition in both directions. The nutrients are generated by the leaves through photosynthesis. They are transported up to the new buds and down to the stems and the roots.

Teacher: What is the transport direction of substance “II” in the question?

Student: The direction is both up and down.

Teacher: That’s right! So what is the substance “II” in the question?

Student: The nutrients that should be transported in both directions, carbohydrates.

Teacher: Correct, then what is the transport system of substance “II”?

Student: Phloem is in charge of the transportation of nutrients, so option B is the correct answer.

老師： 請問木質部與韌皮部分別運輸何種物質呢？

學生： 木質部運輸水分及礦物質、韌皮部則運輸養分。

老師： 那麼木質部與韌皮部的運輸方向分別為單向或雙向呢？

學生： 木質部為由下至上單向運輸水分及礦物質，由根部（下）運往上部的植物體（莖、葉）、韌皮部則為雙向運輸養分，由葉部進行光合作用產生養分，向上運往新芽，向下運往莖以及根部。

老師： 題目中的物質「乙」運輸方向為何？

學生： 有向上也有向下。

老師： 沒錯！那麼題目中的物質「乙」為何？

學生： 需要雙向運輸的養分：醣類。

老師： 正確，那麼的運輸物質「乙」的運輸構造為何？

學生： 韌皮部負責養分的運送，因此選項(B)是正確答案。

例題二

說明：同學能夠辨識出植物維管束的構造及功能，同時辨別蒸散作用時，葉綠體的狀態。
Students can identify the structures and functions of the vascular bundle. Besides, they can also identify the condition of chloroplast during transpiration.

（英文）Figure (3) is a schematic diagram of material transportation in plants, and Figure (4) is a schematic diagram of the state of leaf stomata. When plants undergo vigorous evapotranspiration during the day, with regard to the direction of water transport in the body (I or II) and the state of leaf stomata (III or IV), which of the following combinations is correct?

(A)I, III
(B) I, IV
(C)II, III
(D) II, IV

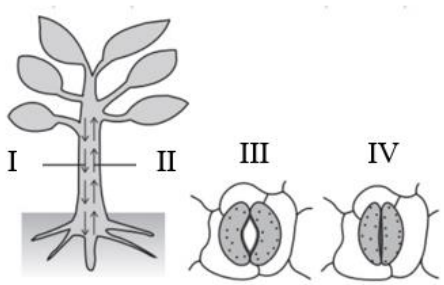
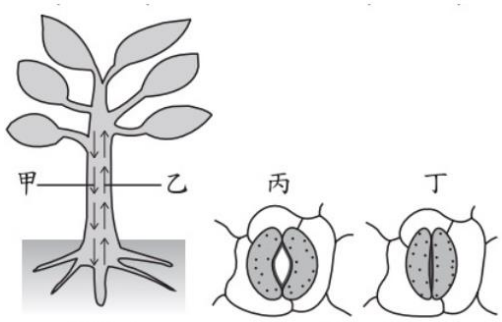


Figure (3)　Figure (4)

（中文）圖(三)為植物體內物質運輸示意圖，圖(四)為葉片氣孔狀態示意圖。白天植物進行旺盛的蒸散作用時，有關體內水分運輸方向(甲或乙)及葉片氣孔狀態(丙或丁)，下列組合何者正確？

(A)甲，丙　　(B)甲，丁
(C)乙，丙　　(D)乙，丁



圖(三)　圖(四)

（109 年國中會考第 5 題）

解題 Solution：

先辨別水分運輸方向，再由「旺盛的蒸散作用時」葉片氣孔狀態去進行判斷。

Identify the direction of water transportation first, then judge by the state of stoma during intensive transpiration.

Teacher: What is the direction of water transportation?
Student: It goes from the root (bottom) to the leaf (top).
Teacher: What is the open/closure condition of stoma during intensive transpiration?
Student: Stoma are open and moderated by the bloating guard cells.

老師： 水分的運輸方向為何？
學生： 由根部（下）往葉子（上）方向。
老師： 旺盛的蒸散作用時葉片的氣孔開閉狀況是如何呢？
學生： 氣孔是開啟的，由保衛細胞的膨大進行調控。

4-3 人體血液循環的組成
The Composition of The Human Cardiovascular System

■ 前言 Introduction

介紹動物體（以人體為例）的循環系統能將體內的物質運輸至各細胞處，並進行物質交換。由循環的起點——心臟開始介紹，包含心臟的位置、構造以及心臟如何用收縮與舒張影響循環，可實際經由心跳、心音與脈搏的探測，以了解循環系統的運作情形。接著會介紹運輸通道——血管，進行不同血管間的特性與比較，最後介紹負責交換體內養分、廢物等物質的重要因子—血液，其組成並進行不同血球的特性、功能的描述，傳達循環系統能運送與交換細胞所需的物質和排出細胞產生的廢物的觀念。介紹完血液循環系統，會將淋巴系統的異同及關聯進行比較。以生活中實際的例子：預防注射為例，認識淋巴系統能產生抗體，預防下一次的感染，不涉及各種免疫細胞的名稱、功能及機制。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
leukocyte	白血球	platelet	血小板
valve	瓣膜	blood pressure	血壓
pulse	脈搏	blood	血液
artery	動脈	blood backflow	血液倒流
flexibility	彈性	heartbeat	心搏
flow into/ out of	流入/流出	atrium	心房

vascular wall	管壁	ventricle	心室
regular	規律的	heart	心臟
thick/ thin	厚/薄	cardiac sound	心音
erythrocyte	紅血球	contract/relax	收縮/舒張
vein	靜脈	between	在...之間
carry	攜帶	left/ right	左/右
vessel	血管	capillary	微血管
plasma	血漿		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ NP1 is _____er/ more _____ than NP2, and NP2 is _____er/ more _____ than NP3, so _____ is NP1, NP2, and NP3 in order.

例句(1)：The pipe walls of arteries **are thicker than** veins, **and** the pipe walls of veins **are thicker than** capillaries**, so** the thickness of pipe walls in the vascular **is** artery, vein, and capillary **in order**.

動脈管壁比靜脈厚，而靜脈管壁又比微血管厚，所以血管管壁厚薄度依序為動脈、靜脈、微血管。

例句(2)：The flexibility of pipe walls in arteries **is better than** in vein, and the flexibility of pipe walls in vein **is better than** in capillary**, so** quality of the flexibility in pipe walls is artery, vein, and capillary **in order.**

動脈管壁彈性優於靜脈，而靜脈管壁彈性又優於微血管，所以血管管壁彈性優劣依序為動脈、靜脈、微血管。

❷ _____ contain(s) NP1, NP2, and NP3. NP1 help(s) _____, NP2 help(s) _____, and NP3 help(s)_____.

例句(1)：Blood **contains** erythrocyte, leukocyte**, and** platelet. Erythrocyte **helps** the body to transport oxygen, leukocyte **helps** the body to swallow bacteria and produce antibodies**, and** platelet **helps** the injured part of the body to clot.

血液中包含紅血球、白血球及血小板。紅血球幫助人體輸送氧氣、白血球幫助人體吞噬細菌及產生抗體，而血小板幫助受傷的身體部位凝血。

例句(2)：The types of blood vessels **contain** arteries, veins, and capillaries. Arteries **help** the body to transport blood away from the heart**,** Veins **help** the body to transport blood into the heart**, and** capillaries **help** the body to transport blood from arteries to veins.

血管種類包含動脈、靜脈及微血管。動脈幫助人體將血液帶離心臟、靜脈幫助人體將血液帶回心臟，而微血管幫助人體將血液由動脈輸往靜脈。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

After studying this section, students should be able to know that:

一、各種血球在血液中所佔的數量，透過題目中所提供的資訊，判斷出不同代號對應到的血球。

The numbers that different blood cells account for in the blood, and use the information provided in the questions to determine the blood cells corresponding to different codes.

二、心臟的構造與血液循環走向。

The structure of the heart and the direction of blood circulation.

❧ 例題講解 ☙

例題一

說明：由生活情境閱讀題考驗學生判讀表格的能力，以及對於不同血球功能的了解。

Students' ability to interpret tables and their understanding of different blood cell functions are tested by reading life-situation questions.

（英文）A patient was infected with bacteria and caused pneumonia. After examination, it was confirmed to be streptococcus pneumoniae infection. A, B, and C represent the three types of blood cells in the human body. Table (7) is the test results of this patient compared with the statistical data on the number of blood cells in normal adults. The results show that the number of certain blood cells that fight pathogenic bacteria in this patient is abnormally increased.

It is known that red blood cells are the most abundant blood cells in the blood. According to the inferences of A, B and C, which of the following is correct?

Table (7):

Types of blood cells	A	B	C
The numbers of blood cells in normal adults (10000 pieces/ mm3)	0.4~1.0	20~45	380~600
The test results of the patients (10000 pieces/ mm3)	2.9	38	575

(A) A: platelets, B: white blood cells, C: red blood cells

(B) A: platelets, B: red blood cells, C: white blood cells

(C) A: white blood cells, B: red blood cells, C: platelets

(D) A: white blood cells, B: platelets, C: red blood cells

（中文）某病患被細菌感染而引發肺炎，經檢查後證實為肺炎鏈球菌感染，以甲、乙、丙代表人體內的三種血球，表(七)為此病患檢驗結果及正常成年人血球數量統計資料的比較，結果顯示此病患體內對抗病原菌的某種血球數量有異常增加的現象。

表(七)

血球種類	甲	乙	丙
正常成年人的血球數量（萬個/立方毫米）	0.4～1.0	20～45	380～600
病患檢驗結果（萬個/立方毫米）	2.9	38	575

已知紅血球為血液中數量最多的血球，根據本文，關於甲、乙、丙的推論，下列何者正確？

(A)甲：血小板，乙：白血球，丙：紅血球

(B)甲：血小板，乙：紅血球，丙：白血球

(C)甲：白血球，乙：紅血球，丙：血小板

(D)甲：白血球，乙：血小板，丙：紅血球

（109 年國中會考第 51 題）

解題 Solution：

由題目給的關鍵句進行初步的判斷，再依據給予的情境，思考其餘選項的正確性。

Make a preliminary judgment based on the key sentences given by the question, and then consider the correctness of the remaining options according to the given situation.

Teacher: Which kind of blood cells are the most in the blood?

Student: Red blood cells.

Teacher: Then which one is the red blood cell in A, B, C blood cells?

Student: Judging from the clues provided in the question, C should be the red blood cell.

Teacher: Great! So what kind of blood cells are A and B?

Student: The number of A blood cells in normal adults is 0.4-1.0 (10,000/cubic millimeter), but it is 29 (10,000/cubic millimeter) in the patient test results, which is beyond the standard. On the other hand, the test results for B blood cells are in the normal value of the average adult blood cell count. According to the description of the question, "the number of certain blood cells in the patient's body that fights pathogenic bacteria is abnormally increased", so it is speculated that A is a white blood cell that can engulf pathogens to protect human health, and B is a platelet, so the answer is option (D).

老師： 哪一種血球在血液中的數量最多呢？

學生： 紅血球。

老師： 那麼甲、乙、丙三種血球何者為紅血球呢？

學生： 依題目提供的線索判斷，丙應為紅血球。

老師： 很棒！那麼甲和乙又分別為何種血球呢？

學生： 甲血球在正常成年人的血球數量為 0.4~1.0(萬個/立方毫米)，而在病患檢驗結果中卻有 2.9(萬個/立方毫米)，為超標。而乙血球的病患檢驗結果在一般成年人的血球數量正常值中。根據題幹敘述，「病患體內對抗病原菌的某種血球數量有異常增加的現象」，故推測甲為可以吞噬病原體，以保護人體健康的白血球，乙則是血小板，因此答案為選項(D)。

例題二

說明：考驗學生判讀表格的能力，以及對於不同血球功能的了解。

Examine students' ability of interpreting the table and their understanding about the functions of different blood cells.

（英文）The attached table is part of the blood report after Ah Hong took the health examination. In addition to the measured values of the three types of blood cells in Ah Hong's body, the table also lists the normal values. According to this table, which of the following physiological functions of Ah Hong is most likely to have problems?

Test Items	Ah Hong's Measurement (pcs/ mm3)	Normal Value (pcs/ mm3)
white blood cells	3000	4500-11000
red blood cells	5.2 millions	4.5-6.2 millions
platelets	300 thousands	150-400 thousands

(A) Transporting nutrients

(B) Transporting oxygen

(C) Helping blood clot

(D) Resisting bacterial invasion

（中文）附表為阿宏健康檢查後血液報告的部分內容，表中除了列出阿宏體內三種血球數目的測量值外，也列出正常值。根據此表推測，阿宏的下列何種生理功能最可能出現問題？

檢驗項目	阿宏的測量值(個/mm^3)	正常值(個/mm^3)
白血球	3000	4500－11000
紅血球	520 萬	450 萬－620 萬
血小板	30 萬	15 萬－40 萬

(A)運輸養分　(B)運輸氧氣　(C)幫助血液凝固　**(D)抵抗細菌入侵**

（100 年第二次國中基測第 5 題）

解題 Solution：

先判斷圖表中阿宏的受測值中何項血球數值為異常，並思考出對應異常項目之血球功能為何。

First, identify which blood cell value in Ah Hong's measured values in the table is abnormal, and think about the function of the blood cell corresponding to the abnormal items.

Teacher: According to the normal value corresponding to Ah Hong's data in the table, which value is abnormal?

Student: Ah Hong's numerical data of white blood cells is abnormal. There are only 3000(unit/mm2), which is lower than the normal value of 4500-11000(units/mm2).

Teacher: In the case of a lower value of white blood cells, what kind of problem will Ah Hong encounter?

Student: The function of white blood cells is something about the immune system such as swallowing pathogens. In the circumstance of a lower value of white blood cells, Ah Hong may not be able to resist bacterial invasion, so the answer should be option (D).

老師： 依據圖表中提供的正常值對應到阿宏的數據，哪一項數值異常？

學生： 阿宏的白血球數值異常，僅有 3000(個/mm2)，低於正常值 4500~11000(個/mm2)。

老師： 在白血球低於正常值的情況下，阿宏可能會遇到什麼樣的問題呢？

學生： 白血球的功能為吞噬病原體等與免疫相關的功能，白血球低於正常值的情況下，阿宏可能會無法抵抗細菌入侵，因此應選擇選項(D)。

4-4 人體循環系統
The Circulatory System of the Human Body

■ 前言 Introduction

將 4-3 所學之運輸分子（如血管、血球）統整，以實際應用的心血管循環、淋巴循環做進一步地介紹免疫系統。皮膚是人體的第一道防禦系統，能阻止外來物，如細菌的侵入；而體內則有淋巴系統，可以做進一步的免疫作用。建立在淋巴循環之上，介紹人體的免疫系統，從第一道防線到第三道防線，一一介紹人體如何抵抗病菌的攻擊。可以讓學生知道人類在防禦疾病所做的研究，並連結淋巴系統單元，了解疫苗的原理，及預防注射的重要性，不涉及疫苗類型、抗體產生的機制。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
protect	保護	memory	記憶性
pathogen	病原體	enter/ leave	進入/離開
skin	皮膚	deoxygenated blood	缺氧血
inflammatory response	發炎反應	eliminate	消滅
pulmonary circulation	肺循環	cardiovascular system	心血管系統
line of defense	防線	inject... with	注射/施打
defense mechanism	防禦作用	specificity	專一性
systemic circulation	體循環	oxygenated blood	充氧血
swallow	吞嚥	injury	傷口

lymph	淋巴	invade	入侵
lymph vessel	淋巴管	block	阻擋
lymph node	淋巴結	tissue fluid	組織液
lymph system	淋巴系統	vaccine	疫苗
lymph circulation	淋巴循環		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ NP1 starts from _____(place 1), transporting _____ to _____(place 2), and then goes to _____(place 3).

例句：The systemic circulation **starts from** the left ventricle, **transporting** blood **to** the aorta, **and then goes to** the whole body.

體循環從左心室開始，將血液輸送到主動脈，然後流向全身。

❷ If _____, NP1 is/are responsible for _____, NP2 is/are responsible for _____, and NP3 is responsible for _____.

例句(1)：**If** pathogens invade the human body, the skin and mucosa **are responsible for** the pathogens on the surface of the human body, the inflammatory response **is responsible for** the pathogens in the human body, and the specific defense **is responsible fo**r the rest of the pathogens.

如果病原體入侵人體，體表上的病原體由皮膚與黏膜負責；體內的病原體由發炎反應負責，剩下的病原體由專一性防禦負責。

例句(2)：**If** the human body is processing blood circulation, systemic circulation **is responsible for** the circulation between the body and the heart, and pulmonary circulation **is responsible for** the circulation between the lungs and the heart.

如果人體正在進行血液循環，體循環負責全身和心臟間的循環；肺循環則負責肺臟和心臟間的循環。

■ 問題講解 Explanation of Problems

學習目標

在學習完本單元後，學生應習得以下觀念：

After studying this section, students should be able to know that:

一、釐清人體的血液循環順序與走向。

Clarify the order and direction of blood circulation in the human body.

二、區分淋巴、組織液與血液之差別。

Distinguish the differences between lymph, tissue fluid, and blood.

例題講解

例題一

說明：以生活中的情境題目，考驗同學是否了解人體血液循環。

With the situational questions in life, students will be tested whether they understand the blood circulation of the human body.

（英文）Figure (27) is a schematic diagram of the site where the drug is injected into the human body. There are several statements about the drug being injected into the vein of the human body from site I or site II, and first enters the heart chamber through the blood circulation. Which of the following statements is the most reasonable?

(A) Drugs from site I and site II enter the right atrium first.

(B) Drugs from site I and site II enter the left atrium first.

(C) The drug from site I enters the right atrium first, and the drug from site II enters the left atrium first.

(D) The drug from site I enters the left atrium first, and the drug from site II enters the right atrium first.

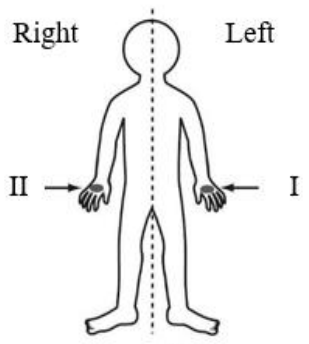


Figure (27)

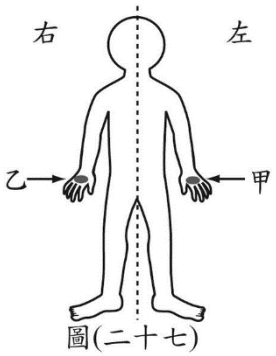
（中文）圖(二十七)為人體注射藥劑的部位示意圖，關於藥劑從甲部位或乙部位注入人體的靜脈後，經由血液循環最先進入心臟腔室的敘述，下列何者最合理？

(A)甲、乙部位的藥劑皆先進入右心房。

(B)甲、乙部位的藥劑皆先進入左心房。

(C)甲部位的藥劑先進入右心房，乙部位的藥劑先進入左心房。

(D)甲部位的藥劑先進入左心房，乙部位的藥劑先進入右心房。



圖(二十七)

（107 年國中會考第 37 題）

解題 Solution：

找到關鍵句「藥劑從甲部位或乙部位注入人體的靜脈」，再釐清人體的體循環是如何運作。

Find the key phrase “medicine is injected into the veins of the human body from part A or part B”, and then clarify how the circulation of the human body works.

Teacher: Where is the drug injected into the human body?

Student: Veins.

Teacher: That's right! So how does the circulation of the human body work?

Student: When the human body is in systemic circulation, blood starts from the left ventricle and is transported to the whole body through the aorta, arterioles and capillaries. The blood in the microvessels of each tissue flows into the small veins, gradually collects into the large veins, and then returns to the right atrium. Therefore, regardless of whether the drug is injected from site A or site B, it will be collected into the great vein and enter the right atrium, so option (A) is the correct answer.

老師： 藥劑是從哪裡注入人體的呢？

學生： 靜脈。

老師： 沒錯！那麼人體的體循環是如何運作的呢？

學生： 人體進行體循環時，血液由左心室出發，經由主動脈、小動脈與微血管運送到全身。各組織的微血管中的血液流入小靜脈，慢慢匯集至大靜脈後回到右心房。故無論藥劑是從甲部位或是乙部位注入，皆會匯集至大靜脈進入右心房，因此選項(A)為正確答案。

例題二

說明：考驗同學是否熟悉血液流經各血管的順序。

Examine whether students are familiar with the order in which blood flows through each blood vessel.

（英文）The attached figure is a partial schematic diagram of human blood circulation and lymphatic circulation. I, II and III are the names of different pipes. In the figure, ⟶ represents the flow direction of the liquid, and ⇢ represents the exudation of substances from the microvessels. Judging from this picture, which statement is the most reasonable for the presence or absence of red blood cells in I, II, and III?

(A) Only I and II have.

(B) Only I and III have.

(C) Both I, II, and III have.

(D) None of I, II, and III have.

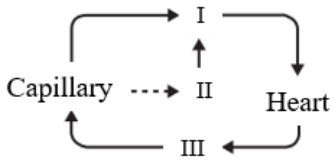
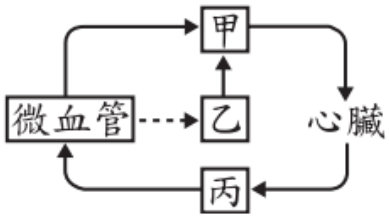


Figure (17)

（中文）附圖為人體血液循環和淋巴循環的部分示意圖，甲、乙和丙為不同的管道名稱，圖中⟶代表液體的流動方向，⇢代表物質由微血管滲出。根據此圖判斷，甲、乙和丙內有無紅血球的敘述，何者最合理？



圖(十七)

(A)僅甲、乙有 **(B)僅甲、丙有** (C)甲、乙、丙皆有 (D)甲、乙、丙皆沒有

（105 年國中會考第 32 題）

解題 Solution：

可依血液流經各血管的順序推論出各代號所代表的血管，再依血球特性得到答案。

The blood vessels represented by each code can be deduced according to the order of blood flow through each blood vessel, and then the answer can be obtained according to the characteristics of blood cells.

Teacher: The description of the question is about which of the three vessels will have red blood cells in them. And I want to ask you, what kind of circulation would the red blood cells appear in?

Student: Blood is composed of plasma and blood cells. Lymphs in the lymph circulation is plasma leaking out in the capillaries and into the tissue, then flowing back to the lymph vessel. Therefore, red blood cells are in blood circulation but not lymph circulation.

Teacher: Correct! Let's begin with the order of blood circulation to clarify the vessels represented by each code. What is the vessel that starts from the heart, flows through III, and goes to the capillaries? How do you identify?

Student: Because blood flows from the heart into arteries, then passes through capillaries, so we can know III is the artery.

Teacher: That's right. Then following the order of the flow, what is II? How do you identify?

Student: Because of the order of flow passing through capillaries, some of the plasma will leak from the capillary into the tissue cells to form tissue fluid, and the tissue fluid will leak into the lymph vessel, so the dashed arrows from capillaries to vessel II indicate there is fluid leaking out from capillaries to vessel B, then we can judge II is the lymph vessel.

Teacher: Yes. And the last one, what is vessel I? How do you identify?

Student: Vessel I is the vein because lymphs flow in the lymph vessels and enter veins at the end, becoming a part of the blood circulation again. They gather with the blood in the vessels and flow into the veins, then return to the heart at the end, so the process also represents the blood in the capillaries flow from veins and return to the heart at last.

Teacher: Concluding the above interpretation, which of the vessels I, II, and III contain red blood cells?

Student: Vessel I is the vein, vessel II is the lymph vessel, and vessel III is the artery. Only in the lymph vessels cannot see the red blood cells, so we should choose option (B).

老師： 題目敘述為三種管道中，哪一些管道中會有紅血球？那麼老師想要先詢問同學，紅血球會出現在什麼循環中？

學生： 血液是由血漿以及血球組成，淋巴循環的淋巴則是血漿在微血管滲出至組織間，再流到淋巴管中，所以血液循環中有紅血球，而淋巴循環則無。

老師： 正確！那我們先以血液循環的順序來釐清各代號所代表的管道。請問從心臟出發流經丙再通往微血管的血管管道為何？你是怎麼判斷的？

學生： 因為血液會由心臟流入動脈，再經過微血管，故可以判斷丙為動脈。

老師： 沒錯。那依照流經的順序，請問乙為何？你是怎麼判斷的？

學生： 因為流經順序有經過微血管，部分血漿會由微血管滲出至組織細胞間，形成組織液，而組織液會滲入淋巴管中，所以從微血管到管道乙中的虛線箭頭表示微血管中滲出液體至乙管道，故可以判斷乙為淋巴管。

老師： 是的，最後請問甲管道為何？你是怎麼判斷的？

學生： 甲管道為靜脈，因為淋巴在淋巴管中流動，最後會匯入靜脈，重新成為血液循環的一部分，也就是乙到甲之間的箭頭。而微血管經過甲再回到心臟的過程也就代表著微血管中的血液經由靜脈最後回到心臟。

老師： 綜合上述判斷，甲、乙、丙管道中哪些有紅血球的存在？

學生： 甲為靜脈、乙為淋巴管、丙為動脈，僅有淋巴管中沒有紅血球，因此要選擇選項(B)。

★主題五 生物體的協調作用★
The Coordination of the Organism

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■ 前言 Introduction

本章節包含了神經與內分泌系統，神經系統對學生來說是比較容易搞混的部分，尤其在如何分辨意識與反射行為中的神經傳導途徑，而內分泌系統則有較多記憶的部分，教師在教學時應注意避免讓學生過於死記，而是從器官與該內分泌腺的功能上出發，較容易讓學生理解。在英文方面，由於這章節提到較多不同的神經與激素，老師需注意每個英文單字的拼法與發音。此外，為了引導學生講出人體生理機能的路徑，這部分的教學句型稍長，老師需幫助學生不會的單字以及發音。

5-1 刺激、反應、神經系統
Stimulus, Response, Nerve System

■ 前言 Introduction

此節主要提到受器與動器的概念，因此教師應注意學生是否能將課本有提到的幾種刺激，連結到正確的受器與動器上。另外有感覺疲勞的介紹，在這裡可以用一些簡易的圖片或是不同溫度的水來讓學生實際感受。老師們在這章節主要會介紹到受器與動器的單字，這兩這單字的字尾相似，老師需特別注意。以及介紹了神經系統的基本單位，神經細胞。人體的神經系統分為中樞神經和周圍神經，中樞神經包含的是腦與脊髓，而腦又分可分為大腦、小腦與腦幹，彼此各有不同的功能，其中需特別留意腦幹是生命中樞；周圍神經指的是 12 對腦神經與 31 對脊神經，中樞神經可整合訊息並發出命令；周圍神經的主要功能是傳遞訊息。神經傳導途徑為受器→感覺神經元→中樞神經→運動神經元→動器，進而產生反應，這邊應該特別注意反射與意識行為的差別在於，中樞神經是否有大腦的介入，若有大腦介入則為意識行為。英文方面，老師需要留意神經傳導路徑的相關單字，例如：大腦、脊神經、腦神經、運動神經元等等，並且要熟悉用英文描述路徑的過程。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
receptor	受器	peripheral nerve	周圍神經
effector	動器	brain	腦
stimulus	刺激	cerebrum	大腦
response	反應	cerebellum	小腦
fatigue	感覺疲勞	brainstem	腦幹

afterimage	後像	spinal cord	脊隨
pupil	瞳孔	spinal nerve	脊神經
gland	腺體	cranial nerve	腦神經
muscle	肌肉	skull	顱骨
salivary gland	唾腺	vertebrae	脊椎骨
saliva	唾液	neural pathway	神經傳導路徑
nervous system	神經系統	sensory neuron	感覺神經元
nerve cell	神經細胞	motor neuron	運動神經元
nerve fibers	神經纖維	reflex action	反射作用
central nerve	中樞神經		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ People ____ is the process of ___ as the receptor and ____ as the effector.

例句(1)：**People** smelling tasty food **is the process of** nose **as the receptor and** salivary gland **as the effector.**

當人聞到美食的香味時，是由鼻子當受器；唾腺當動器。

例句(2)：**People** moving hands away from the hot water is the process of skin of the hand **as the receptor and** muscles **as the effector**.

當人的手碰到熱水時，是由手部的皮膚當受器，肌肉當動器。

❷ ___ has/have ___ receptors, and it/they can accept the stimulus of ____.

例句(1)：Eyes **have** visual receptor**s, and they can accept the stimulus of** light.
眼睛具有視覺受器，可接受光線的刺激。

例句(2)：Ears **have** auditory **receptors, and they can accept the stimulus of** sound.
耳朵有聽覺受器，可以接受聲音的刺激。

❸ ____ is located _____. And it is in charge of ____ of our body.

例句：Cerebellum **is located** behind the brain. **And it is in charge** of coordinating the muscles **of our body.**
小腦位於大腦的後下方，負責協調全身肌肉。

❹ ____ contains ____, _____, and _____.

例句：Brain **contains** cerebrum**,** cerebellum**, and** brainstem.
腦是由大腦、小腦以及腦幹所組成。

❺ The ___ neuro passes the signal to _____.

例句：**The** sensory **neuron passes the signal to** receptors.
感覺神經元將訊息傳遞至受器。

❻ First, when ____, the receptors receive the stimulus, and then pass the signal through____. Second, the signal goes to ____, and then passes to the ____. Last, the signal reaches _____.

例句：**First, when** we catch the ruler in a quick time**, the receptors receive the stimulus, and then pass the signal through** the sensory neuron. **Second, the signal goes to** the brainstem / spinal cord **and then passes to** the motor neuron. **Last, the signal reaches** the effectors.
首先，當我們快速抓住尺時，受器接收到刺激，然後通過感覺神經元傳遞訊號。再來，訊號進入腦幹/脊髓，然後傳送到運動神經元。最後到達動器。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

After studying this section, students should be able to know that:

一、了解人體內有各式各樣的受器來接受外在的刺激。

Understand that there are various receptors in the human body to receive stimuli.

二、了解人體主要的動器為肌肉和腺體，負責執行反應。

Understand that the main effector of the human body is the muscles and glands, which are responsible for executing the reaction.

三、了解神經系統的基本概念與運動神經和感覺神經的差異。

Understand the basic concepts of the nervous system and the difference between motor and sensory nerves.

四、了解意識與反射行為的神經傳導路徑與作用特性。

Understand the neural pathway and the characteristics of consciousness and reflex action.

例題講解

例題一

說明：測驗學生是否理解神經系統的運作。

To test whether students understand the workings of the nervous system.

（英文）Xiaoxiang saw his long-lost good friend on the street, and immediately waved hello excitedly. Which of the following statements about the functioning of the nervous system in relation to the above process is correct?

(A) Immediate waving is a reflex.

(B) The receptors for this process are in the hand muscles.

(C) The sensation of excitement is produced by sensory nerves.

(D) The command to wave is transmitted by the motor nerve.

（中文）小湘在街上看到久違的好朋友，興奮地立即揮手打招呼。下列與上述過程相關的神經系統運作之敘述，何者正確？

(A)立即揮手是屬於反射作用。

(B)此過程的受器是在手部肌肉。

(C)興奮的感覺是由感覺神經產生。

(D)揮手的命令是由運動神經傳遞。

（107 年國中會考第 24 題）

解題 Solution：

在較複雜的行為中，控制中樞為大腦為主；興奮的感覺也為運動神經傳遞的。

In more complex behaviors, the control center is dominated by the brain; the feeling of excitement is also transmitted by the motor neuron.

Teacher: May I ask if the waving action has been thought through the brain, and is it a reflex?

Student: It goes through the brain, so it's not a reflex.

Teacher: Yes, and the actuator is the muscle of the hand, but what kind of nerve does the actuator receive?

Student: Motor neurons, because motor neurons pass the signal to effectors.

Teacher: That's right!

老師： 請問揮手的動作有沒有經過大腦思考，並且是不是反射呢？
學生： 有經過大腦，所以不是反射。
老師： 沒錯，而且動器是手部的肌肉，不過動器是接收哪種神經的訊號呢？
學生： 運動神經元，因為運動神經元將訊息傳遞至動器。
老師： 答對了！

例題二

說明：測驗學生是否理解神經傳導途徑與中樞和神經系統的連結。
To test whether students understand the connection of nerve conduction pathways to the central and nervous systems.

（英文）Most people will shrink their hands immediately after getting an electric shock with their fingers, or feel pain and shake their hands quickly. Figure (14) is a schematic diagram of nerve signal transmission when the human fingertips are electrocuted. In the figure, I, II, and III are the nerves through which the information is transmitted. The following descriptions about this information transmission path and the corresponding nerves are matched, which one is the most reasonable?

(A) Withdraw their hands immediately after an electric shock—I, II.

(B) Feel pain after the electric shock—II, III.

(C) After receiving stimulation from the receptor, it is transmitted to the central nervous system—II, III.

(D) The central nervous system sends a hand shake command to it effector-III, I.

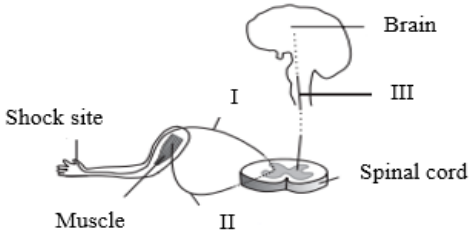


Figure (14)

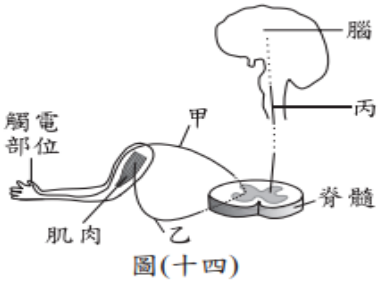
（中文）一般人手指觸電後會立刻縮手，也會感覺疼痛而趕緊甩手。圖(十四)為人體指尖觸電時神經訊息傳導的示意圖，圖中甲、乙、丙分別為訊息傳導所經過的神經，下列有關此訊息傳導路徑相關敘述與所對應的神經之配對，何者最合理？

(A)觸電後立刻縮手—甲、乙。

(B)觸電後感覺疼痛—乙、丙。

(C)受器接受刺激後傳至中樞神經—乙、丙。

(D)中樞神經發出甩手的命令後傳至動器—丙、甲。



圖(十四)

（106 年國中會考第 24 題）

解題 Solution：

甲為感覺神經元、乙為運動神經元、丙為腦幹。

B 錯在感覺疼痛不是由乙、丙控制而是大腦與甲；C 錯在刺激不是從乙傳入丙，而是由甲傳入腦；D 錯在甩手的命令不是由丙傳到甲，而是由腦傳到乙。

I is the sensory neuron, II is the motor neuron, and III is the brainstem.

B's mistake is that the feeling of pain is not controlled by II and III, but the brain and I; C's mistake is that the stimulation is not transmitted from II to III, but from I to the brain; D's mistake is that the command to shake hands is not transmitted from III to I, but from brain to II.

Teacher: What kind of action does the hand pull back immediately after being electrocuted?
Student: Reflex action.
Teacher: That's right! The III in the question is located at the bottom of the brain. What is the structure and what function does it have?
Student: III is the brain stem. The brainstem is located below the brain. And it is in charge of maintaining the body's life.
Teacher: Yes! Does the reflex action of the hand go through the brain stem?
Student: No.

老師： 請問手觸電後立即抽回是屬於哪種動作呢？
學生： 反射動作。
老師： 沒錯！那題目中的丙位於腦部下方，請問是甚麼構造，又有甚麼功能呢？
學生： 丙是腦幹。腦幹位於腦的下方，負責維持人體的生命。
老師： 是的！那手部的反射動作會經過腦幹嗎？
學生： 不會。

5-2 內分泌系統
Endocrine System

■ 前言 Introduction

此節主要提到內分泌腺體與激素，激素由血液輸送到全身，會對特定的細胞發生作用。教師應注意是否有解釋並讓同學理解各個激素的功能與存在的重要性，而非讓同學認為此節只需靠記憶來度過。在英文方面，老師務必熟悉各個激素的英文名稱，以及該激素會對身體造成什麼作用，最後，老師需充分瞭解激素作用過程的句型，並引導學生說出來。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
hormone	激素	thyroid hormone	甲狀腺素
endocrine system	內分泌系統	parathyroid hormone	副甲狀腺素
pituitary gland	腦垂腺	insulin	胰島素
thyroid gland	甲狀線	glucagon	升糖素
parathyroid gland	副甲狀腺	adrenaline / epinephrine	腎上腺素
pancreatic islets	胰島	testicle	睪丸
adrenal gland	腎上腺	androgen	雄性激素
sex gland	性腺	ovary	卵巢
growth hormone	生長激素	estrogen	雌性激素

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ gland can release _____.

例句：The pituitary **gland can release** growth hormone.

腦垂腺會釋放生長激素。

❷ The function of _____ is to _____.

例句：**The function of** growth hormone **is to** help humans grow.

生長激素的功能是幫助人體生長。

❸ The effects of the ___ of ____ are as follows. When ___ is/are ____, the ___ will ___. The receptors of ____ will receive and pass the signal to _____. Then, _____ will secrete ____ to _____.

例句：**The effects of** insulin on reducing the level **of** blood sugar **are as follows**. **When** rice **is** digested and absorbed by the intestine**, the** level of blood sugar **will** go up. **The receptor of** high blood sugar **will receive and send the signal to** the pancreas. Then, pancreas **will secrete** insulin **to** reduce the level of blood sugar.

胰島素降低血糖的作用如下。當飯被腸道消化吸收時，血糖會上升。高血糖的受器會接收信號並將其發送到胰腺。然後，胰臟會分泌胰島素來降低血糖。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

一、了解內分泌系統的作用方式是透過分泌激素，並藉由血液運輸至特定細胞產生反應。

Understand how the endocrine system works by secreting hormones and transporting them through the blood to specific cells for response.

二、了解激素的作用位置與功能。

Understand the functions of hormones and location where they work.

❧ 例題講解 ☙

例題一

說明：測驗學生是否了解人體的腺體與激素的作用位置。

To test whether students understand the role and location of the body's gland and hormones.

（英文）The pituitary gland of the human body secretes hormone X, which promotes a certain gland to secrete thyroxine. Regarding the transport mode and location of hormone X in the human body, which of the following is correct?

(A) Nervous system, pituitary gland

(B) Circulatory system, pituitary gland

(C) Nervous system, thyroid

(D) Circulatory system, thyroid

（中文）人體的腦垂腺會分泌 X 激素，促進某腺體分泌甲狀腺素。關於 X 激素在人體內的運輸方式和作用位置，下列何者正確？

(A)神經系統、腦垂腺

(B)循環系統、腦垂腺

(C)神經系統、甲狀腺

(D)循環系統、甲狀腺

（109 年國中會考(補考)第 32 題）

解題 Solution：

腦垂腺分泌的 X 激素會釋放到血液中，利用血液運送(循環系統)至作用部位。因為最終釋放出的激素為甲狀腺素，故推測作用位置為甲狀腺。

The hormone X secreted by the pituitary gland will be released into the blood and transported (circulatory system) to the site of action, and the site of action is in the thyroid.

Teacher: What glands release thyroxine?
Student: The thyroid gland can release thyroxine.
Teacher: That's right!
Student: The X hormone released by the brain is transported by the blood. Teacher, what kind of physiological system does blood belong to?
Teacher: Good question. Blood is transported by the circulatory system.

老師： 請問甚麼腺體會釋放甲狀腺素呢？
學生： 甲狀腺會釋放甲狀腺素。
老師： 沒錯！
學生： 那大腦釋放的 X 激素由血液運輸，請問老師血液是屬於何種生理系統？
老師： 問得很好，血液是由循環系統來做運輸。

5-3 行為與感應
Behavior and Sensory

■ 前言 Introduction

此節講述的是行為與感應，動物的行為表現主要受神經與內分泌控制，而行為可分成本能與學習行為，本能指的是與生俱來的行為，例如反射、求偶、覓食等。學習行為指的是後天經由學習得到的技能，例如使用工具、表演或協助搜救等。植物沒有神經系統但是可以根據周遭環境產生相對應反應，例如因激素而產生的向性與膨壓改變而產生的運動；通常向性需要較長的時間才有明顯變化，運動則是短時間就可以觀察。

在英文方面，由於向性相關的英文單字偏長，老師可以將單字以字根字首的概念傳遞給學生，幫助學生記憶單字。例如：向性是 tropism，向光性是 photo-tropism，photo 有光的意思。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
instinct behavior	本能行為	stereotropism	向觸性
learning behavior	學習行為	seismonastic movement	觸發運動
tropism	向性	nyctinastic movement	睡眠運動
geotropism	向地性	insect trapping	捕蟲運動
phototropism	向光性	taxis	趨性

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ belongs to _____.

例句(1)：Animals breathing **belongs to** instinct behavior.

動物呼吸屬於本能行為。

例句(2)：Animal's communication **belongs to** learning behavior.

動物溝通屬於學習行為。

❷ The ____ of plants will grow _____.

例句(1)：**The** roots **of plants will grow** deeply into the ground.

植物的根會往地面生長。

例句(2)：**The** stems **of plants will grow** toward light.

植物的莖會向光生長。

❸ The phenomenon that the ____ of plants will grow toward the ____ is called ____.

例句：**The phenomenon that the** stem **of plants will grow toward the** light **is called** phototropism.

植物的莖會朝光線生長的現象稱為向光性。

■ 問題講解 Explanation of Problems

學習目標

在學習完本單元後，學生應習得以下觀念：

After studying this section, students should be able to know that:

一、了解何謂本能行為與學習行為。

Understand what instinctive behavior and learning behavior is.

二、了解向性與運動需要的時間有長短上的差異。

Understanding tropism and the time required for movement.

例題講解

例題一

說明：測驗學生是否理解向性和運動在時間長短上的差異。

To test whether students understand the difference in time between tropism and movement.

（英文）The reports of four groups of students on plant induction experiments are organized as shown in Table (2). Knowing that each group has set its own theme, and then observing and recording the process of plants from receiving stimuli to producing obvious responses, inferring from the data in the table, which group of observation records is the most unreasonable?

Group	Theme	Observing record
G1	Geotropism of mung bean seedlings	After 2 days, the original horizontal roots will grow downward
G2	Phototropism of pea seedlings	The stem bends towards the light source within 1 minute
G3	Seismonastic movement of mimosa	Leaflets close within 1 minute
G4	Insect trapping of Venus flytrap	Leaves close to capture insects within 1 minute

Table (2)

(A) The first group

(B) The second group

(C) The third group

(D) The fourth group

（中文）將四組同學進行植物感應實驗的報告，整理如表(二)所示。已知每組設定了各自的主題，接著觀察並記錄植物從接受刺激到產生明顯的反應之過程，根據表中的資料推論，下列哪一組的觀察紀錄最不合理？

(A)第一組　**(B)第二組**　(C)第三組　(D)第四組

表(二)

組別	主題	觀察紀錄
第一組	綠豆苗的向地性	2天後原本水平的根往下長
第二組	豌豆苗的向光性	1分鐘內莖往光源處彎曲
第三組	含羞草的觸發運動	1分鐘內小葉閉合
第四組	捕蠅草的捕蟲運動	1分鐘內葉片閉合捕捉昆蟲

（109 年國中會考(補考)第 14 題）

解題 Solution：

B 選項「第二組觀察紀錄 1 分鐘內莖往光源處彎曲」，此為植物的向光性，須經過一段時間才能看的出來，所以一分鐘是不合理的。

Option B "The second set of observation records that the stem bends towards the light source within 1 minute". This is the phototropism of the plant, which can only be seen after a period of time, so one minute is unreasonable.

Teacher: What kind of tropism is the phenomenon that the stem bends and grows toward the light source?
Student: The phenomenon that the stem of plants grows towards light is called phototropism.
Teacher: Very good, then may I ask whether it takes a long time or a short time to observe the tropism?
Student: Long time.
Teacher: What about sports?
Student: Short time.

老師：　莖往光源處彎曲生長的現象是屬於何種向性呢？
學生：　植物的莖會朝光線生長的現象稱為向光性。
老師：　很好，那請問要觀察到向性需要長還是短的時間？
學生：　長時間。
老師：　那運動呢？
學生：　短時間。

例題二

說明：測驗學生是否了解植物的莖的向光性與負向地性。

To test whether students understand the phototropism and negative geotropism of stems of plants.

（英文）Place two identical potted plants with plants in two separate dark rooms I and II, and place the light source in different positions to illuminate the plants. After a period of time, their growth status is shown in Figure (36). If the light source is removed at this time, after a period of time, observe the growth direction of the stem. If Figure (37) is a schematic diagram for predicting the direction of stem growth, which of the following statements about stem growth at I and II is the most reasonable?

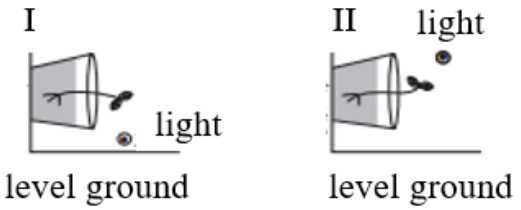


Figure (36)

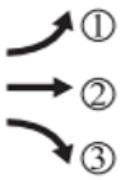


Figure (37)

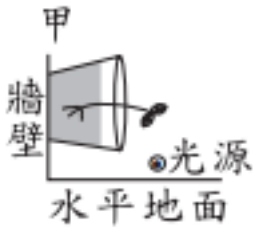
(A) Both stems grow like 1.

(B) Both stems grow like 2.

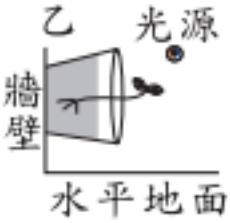
(C) The stem at I grows like 1; the stem at II grows like 3.

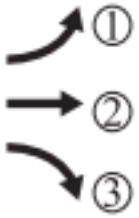
(D) The stem at I grows like 3; the stem at II grows like 1.

（中文）將種有植株的兩相同盆栽，分別放在甲、乙兩個獨立的黑暗房間內，且將光源擺放在不同位置照射植株，經一段時間後，其生長狀況如圖(三十六)所示。若此時把光源移 開，再經一段時間後，觀察莖的生長方向。若圖(三十七)為預測莖生長方向的示意圖，則下列有關甲、乙兩處的莖生長之敘述，何者最合理？



圖(三十六)





圖(三十七)

(A)兩處的莖皆如 1 生長。
(B)兩處的莖皆如 2 生長。
(C)甲處的莖如 1 生長；乙處的莖如 3 生長。
(D)甲處的莖如 3 生長；乙處的莖如 1 生長。

（107 年國中會考第 46 題）

解題 Solution：

植物的莖具有負向地性，所以在黑暗的房間內莖會往地面的反方向生長

The stems of plants have negative geotropism, so the stems will grow in the opposite direction of the ground in a dark room.

Teacher: In this question, what is the growth direction of the stem?
Student: The stem of the plant grows towards the light.
Teacher: That's right! Do the students know which tropism the stem has?
Teacher: Negative Earth.
Student: What does negative earth mean?
Teacher: Indicates that the stem of the plant will grow upward.
Student: The classmates are great! So even if we remove the light source today, the stem will still grow upwards.

老師： 在這題中，莖的生長方向是如何呢？
學生： 植物的莖會向光生長。
老師： 答對了！那同學們知不知道莖還具有哪個向性呢？
老師： 負向地性。
學生： 負向地性是什麼意思呢？
老師： 表示植物的莖會往上生長。
學生： 同學很棒喔！所以即使我們今天將光源移走，莖依舊會向上生長。

★主題六 生物體的恆定★
The Homeostasis of Organism

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■ 前言 Introduction

本章節包含了呼吸與氣體、排泄與水分、以及體溫與血糖的恆定。在 6-1 呼吸與氣體的恆定中，包含細胞利用養分進行呼吸作用來釋放能量、氣體會藉由各系統的協調，使體內所含的物質以及各種狀態能維持在一定範圍內；而在排泄與水分恆定中，學生將學到代謝廢物如何排出，而生物體都有不同的排除類型，以及人體排出尿液的過程；在體溫與血糖的恆定中，學生將學到外溫動物以及內溫動物的體溫與血糖中的變化，而影響血糖的恆定又包含升糖素、胰島素以及腎上腺素的作用。在英文方面，由於有許多器官名稱以及生物專有名詞，老師在教學時可以多留意其發音，以及觀察英文器官名中有相似的字根、字首、字尾，來幫助學生記憶。

6-1 呼吸與氣體的恆定
The Breathing and the Homeostasis of Gases

■ 前言 Introduction

此節主要提到呼吸與氣體的恆定，包括生物體的恆定性、呼吸運動和呼吸作用的關係、動物體（以人體為例）藉由呼吸系統與外界交換氣體、細胞利用養分進行呼吸作用釋放能量，供生物生存所需。此外，呼吸與恆定性有緊密關係，以人體內環境維持恆定為例，了解生物體是透過多個系統的協調作用以維持體內的恆定，例如：血糖恆定的維持。或是人在運動時，體內會對於運動時的狀態作出調整，以維持恆定性。在英文方面，呼吸系統構造的英文多而複雜，老師需記憶以外也需留意其發音，例如氣管 trachea 以及支氣管的 ch 發音為[k]。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
homeostasis	恆定性	pharynx	咽
respiration	呼吸作用	larynx	喉
glucose	葡萄糖	trachea	氣管
mitochondrion	粒線體	bronchi	支氣管
photosynthesis	光合作用	lungs	肺臟
diffusion process	擴散作用	pulmonary alveoli	肺泡
enzyme	酵素	blood capillaries	微血管

paramecium	草履蟲	nasal cavity	鼻腔
stoma / stomata(pl.)	氣孔	rib	肋骨
lenticel	皮孔	diaphragm	橫膈
epidermal cell	表皮細胞		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ The process of _____is to use _____and _____to produce _____.

例句：**The process of** respiration **is to use** glucose **and** water **to produce** energy.
呼吸作用的過程是利用葡萄糖和水製造出能量。

❷ ____ can exchange gasses through _____.

例句：Frogs **exchange gasses through** their lungs and skin.
青蛙能夠透過肺和皮膚來交換氣體。

❸ ____ is composed of _____.

例句：Respiratory system **is composed of** the nose, pharynx, larynx, trachea, bronchi, and lungs.
呼吸系統是由鼻、咽、喉、氣管、支氣管以及肺組成。

❹ When we inhale/exhale, the ribs go ____, the diaphragm goes _____, and the chest cavity becomes ____.

例句：**When we inhale, the ribs go** up**, the diaphragm goes** down**, and the chest cavity becomes** larger.
當我們吸氣時，肋骨上升，橫膈下降，胸腔變大。

■ 問題講解 Explanation of Problems

☙ 學習目標 ❧

在學習完本單元後，學生應習得以下觀念：

After studying this section, students should be able to know that:

一、了解恆定性對生物體的重要性。

Understand the importance of homeostasis for organisms.

二、了解生物需要與外界交換氣體，以維持體內氧氣含量的恆定。

Understand that organisms need to exchange gasses with the outside world to maintain the homeostasis of oxygen content in the body.

三、認識人體呼吸系統中重要的器官與功能。

Understand the important organs and functions of the human respiratory system.

❧ 例題講解 ☙

例題一

說明：測驗學生是否能夠分辨胸腔、肋骨、橫膈膜在呼氣和吸氣時，會有怎麼樣的變化。

To test whether students can distinguish how the thorax, ribs, and diaphragm change when exhaling and inhaling.

（英文）When the gas in the human respiratory system moves from the pulmonary alveoli to the bronchi and trachea, which of the following is the most reasonable for the structural changes related to the breathing movement?

(A) The lungs become larger

(B) The diaphragm rises

(C) The chest cavity becomes larger

(D) The ribs are raised

（中文）當人體呼吸系統內氣體由肺泡往支氣管、氣管移動，此時進行呼吸運動的相關構造之變化，下列何者最合理？

(A)肺漸變大

(B)橫膈上升

(C)胸腔變大

(D)肋骨上舉

（108 年國中會考第 19 題）

解題 Solution：

氣體由肺泡往支氣管、氣管移動的過程為呼氣。呼氣時，肋骨下降，橫膈上升，胸腔便會縮小，肺也會隨之縮小，此時肺內的壓力變大，導致肺內空氣排出體外。

Exhalation is the process of moving gas from the pulmonary alveoli to the bronchi and trachea. When exhaling, the ribs descend and the diaphragm rises, the chest cavity will shrink, and the lungs will also shrink. At this time, the pressure in the lungs increases, causing the air in the lungs to be expelled from the body.

Teacher: When we exhale, what happens to the inside of the chest cavity?

Student: When we inhale, the ribs go up, the diaphragm goes down, and the chest cavity becomes bigger.

Teacher: Very good, what about breathing?

Student: When we exhale, the ribs go down, the diaphragm goes up, and the chest cavity becomes smaller.

Teacher: Very good, so this question refers to exhalation, so it is correct that the diaphragm rises.

老師： 請問當我們呼氣時，胸腔內部會有什麼樣的改變呢？

學生： 當我們吸氣時，肋骨上升，橫膈下降，胸腔變大。

老師： 很好，那吸氣呢？

學生： 當我們呼氣時，肋骨下降，橫膈上升，胸腔變小。

老師： 非常棒，所以這題指的是呼氣，因此橫膈上升是正確的。

例題二

說明：測驗學生是否理解橫膈在呼吸運動中位置的變化與呼出的氣體含有些許水分。
To test whether students understand the change in the position of the diaphragm during respiration and that the exhaled air contains a little water.

（英文）Figure (21) is a schematic diagram of the position change of the diaphragm when the human body performs breathing exercise. X substance in exhaled breath can be detected using blue cobalt chloride test paper. Which of the following is true regarding the change in the position of the diaphragm during exhalation and the substances that can change the color of the test strip?

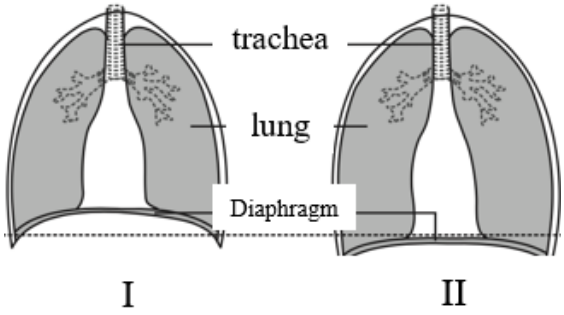
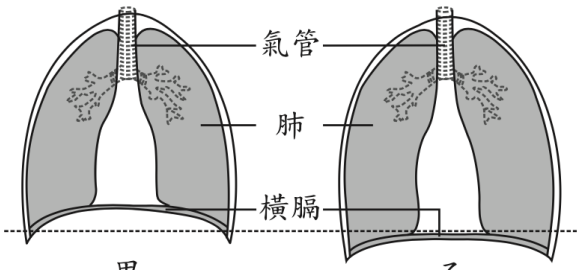


Figure (21)

(A) I→II, water
(B) I→II, carbon dioxide
(C) II→I, water
(D) II→I, carbon dioxide

（中文）圖(二十一)為人體進行呼吸運動時，橫膈位置變動的示意圖。利用藍色氯化亞鈷試紙可檢測人體呼出氣體中的某物質。有關呼氣時橫膈位置的變化及可使試紙變色的物質，下列何者正確？

(A)甲→乙，水
(B)甲→乙，二氧化碳
(C)乙→甲，水
(D)乙→甲，二氧化碳



圖(二十一)

（110 年國中會考第 38 題）

解題 Solution：

人進行呼吸運動時，橫膈會上升，於是由「乙→甲」。另外，可使藍色氯化亞鈷試紙可檢測水分子的存在。故選(C)。

When a person performs breathing movement, the diaphragm will rise, so the process is from II to I. In addition, the blue cobalt chloride test paper can be made to detect the presence of water molecules. Therefore choose (C).

Teacher: When we exhale or inhale, does the diaphragm descend?
Student: When we exhale, the ribs go down, the diaphragm goes up, and the chest cavity becomes smaller.
Teacher: Very good. What kind of substance does the blue cobalt chloride test paper turn pink?
Student: Water.
Teacher: That's right! Therefore, we can understand that the air we exhale actually contains a little water.

老師： 請問當我們呼氣或吸氣時，橫膈會下降呢？
學生： 當我們呼氣時，肋骨下降，橫膈上升，胸腔變小。
老師： 很好，那藍色氯化亞鈷試紙遇到甚麼物質的時候會變粉紅色呢？
學生： 水。
老師： 沒錯！因此大家可以了解我們呼出的氣體其實是含有一點水分的。

6-2 排泄與水分的恆定
The Excretion and the Homeostasis of Water

■ 前言 Introduction

此節的標題是排泄與水分的恆定，而排泄主要提到的是所謂的代謝廢物，水分恆定主要提到的是排尿，尿液和代謝廢物之間通常具有一定的關聯性。生物體中主要需要排除的代謝廢物通常是指含氮廢物，常見種類依照毒性強弱分別為氨、尿素與尿酸。水生生物、人體、鳥類等不同的動物有不同的排除類型，以人類為例，我們主要透過尿液的方式排除多餘的水分和尿素。英文方面，尿素與尿酸、泌尿系統等英文單字非常類似，因此教師教學時應提醒學生注意各單字間的細微差異。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
excretion	排泄作用	ureter	輸尿管
metabolic waste	代謝廢物	bladder	膀胱
toxic	毒性	urine	尿液
ammonia	氨	urethra	尿道
urea	尿素	sweat	流汗
uric acid	尿酸	exoskeleton	外骨骼
urinary system	泌尿系統	scale	鱗片
kidney	腎臟		

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ _____ is more ____ than _____.

例句(1)：Ammonia **is more** toxic **than** urea.

氨的毒性較尿素更強。

例句(2)：Urea **is more** toxic **than** uric acid.

尿素的毒性較尿酸更強。

❷ The human body loses water through _____

例句：**The human body loses water through** urination.

人體的水分經由排尿而流失。

❸ When there is ____ water in the blood, it ___ the formation of urine in the kidneys

例句：**When there is** too little **water in the blood, it** reduces **the formation of urine in the kidneys.**

當血液中的水分過少時會減少腎臟中尿液的形成。

■ 問題講解 Explanation of Problems

學習目標

在學習完本單元後，學生應習得以下觀念：

一、了解排泄作用在肝臟和腎臟中扮演的角色。

Understand the role of excretion in the liver and kidneys.

二、了解生物體內的代謝廢物需要被排除體外。

Understand that the metabolic wastes need to be excreted from the body.

例題講解

例題一

說明：測驗學生是否理解含氮廢物在肝臟轉換為尿素，尿素再經由腎臟過濾到尿液中。
To test whether students understand that nitrogenous wastes are converted into urea in the liver, which is then filtered into the urine by the kidneys.

（英文）Figure (21) is a schematic diagram of the blood circulation between the human heart, liver and kidney. The arrows represent the direction of blood flow, and I, II, III and IV represent different blood vessels. According to the direction of blood flow in this figure, compare the urea concentrations in the blood of I and II, and III and IV respectively. Which of the following is the most reasonable?

(A)I＜II，III＜IV

(B)I＜II，III＞IV

(C)I＞II，III＜IV

(D)I＞II，III＞IV.

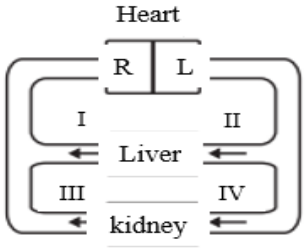


Figure (21)

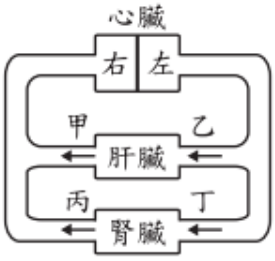
（中文）圖(二十一)為人體心臟、肝臟和腎臟之間血液循環的示意圖，箭頭代表血液流動的方向，甲、乙、丙及丁分別代表不同的血管。根據此圖的血液流動方向，分別比較甲和乙、丙和丁血液中的尿素濃度，下列何者最合理？

(A)甲＜乙，丙＜丁

(B)甲＜乙，丙＞丁

(C)甲＞乙，丙＜丁

(D)甲＞乙，丙＞丁.



圖(二十一)

（106 年國中會考第 36 題）

解題 Solution：

人體的肝臟會將血液中的氨轉換為尿素，再經血液運輸至腎臟，故尿素濃度：甲＞乙；腎臟可過濾血液，將其中的尿素過濾至尿液後排出體外，故尿素濃度：丙＜丁。

The liver of the human body converts ammonia in the blood into urea, and then transports it to the kidneys through the blood, so the urea concentration: I>II; the kidneys can filter the blood, filter the urea into urine and excrete it out of the body, so the urea concentration: III <IV.

Teacher: Which organ in the human body metabolizes ammonia into urea?

Student: Ammonia is metabolized to urea by the liver.

Teacher: Very good. Then, among the two blood vessels of I and II, which one is going to pass through the liver?

Student: II.

Teacher: The answer is correct, so I is a blood vessel that has passed through the liver. During the process of passing through the liver, the urea concentration in the blood vessel will increase, so the urea content should be I>II.

Student: Then how to judge urea?

Teacher: Everyone should think about it, what is the relationship between the kidney and urea?

Student: The kidneys filter urea into the urine.

Teacher: That's right! Therefore, everyone can understand that the concentration of urea will be the lowest after passing through the blood vessels after the kidneys. Therefore, the urea concentration is III<IV.

老師： 請問同學，人體中是哪個臟器將氨代謝成尿素的呢？

學生： 由肝臟將氨代謝成尿素。

老師： 很好，那請問甲乙兩條血管中，哪條血管是準備通過肝臟呢？

學生： 乙。

老師： 答對囉，因此甲是已經通過肝臟的血管，在通過肝臟的過程中，血管中的尿素濃度會增加，因此尿素含量應該是應該選甲＞乙。

學生： 那該如何判斷尿素呢？

老師： 那麼大家要想想看，腎臟和尿素之間有甚麼關係呢？

學生： 腎臟會將尿素過濾至尿液中。

老師： 沒錯！因此大家可以了解，通過腎臟之後的血管，尿素濃度會最低。因此尿素濃度是丙＜丁。

6-3 體溫的恆定與血糖的恆定
The Homeostasis of Body Temperature and Blood Sugar

■ 前言 Introduction

此節的內容主要提到的是體溫和血糖在生物體的恆定，體溫的恆定和生物體的生理機能運作關係密切，而動物又因為體熱的來源不同而分為外溫和內溫兩類動物。血糖的恆定和進食與生物的需求有關，人體能夠分泌胰島素來降低血糖，也能夠分泌升糖素來提升血糖，另外遇到緊急狀況時也能分泌腎上腺素升高血糖。

■ 詞彙 Vocabulary

單字	中譯	單字	中譯
body temperature	體溫	insulin	胰島素
ectotherms	外溫動物	glucagon	升糖素
endotherms	內溫動物	epinephrine	腎上腺素
glycogen	肝糖	diabetes	糖尿病

■ 教學句型與實用句子 Sentence Frames and Useful Sentences

❶ **_____ maintain body temperature by _____.**

例句：Endotherms **maintain body temperature by** the heat of metabolism.
內溫動物藉由體內代謝作用所產生的熱能來維持體溫。

❷ **When the blood sugar concentration _____, it will stimulate the secretion of _____.**

例句：**When the blood sugar concentration** rises**, it will stimulate the secretion of** insulin.
當血糖濃度升高，就會刺激胰島素的分泌。

■ 問題講解 Explanation of Problems

學習目標

在學習完本單元後，學生應習得以下觀念：
After studying this section, students should be able to know that:

一、了解人體對不同溫度的環境的生理反應。
Understand the physiological response of the human body to different temperature environments.

二、了解人體能夠透過胰島素和升糖素互相控制血糖。
Understand that the human body can antagonize blood sugar through insulin and glucagon.

例題講解

例題一

說明：測驗學生是否理解人體在冷和熱的環境下的生理反應。

To test whether students understand the physiological response of the human body to cold and hot environments.

（英文）Ahua entered two environments, I and II, respectively. In the I environment, the muscles trembled, while in the II environment, the blood vessels on the skin surface expanded and the blood volume increased. If it is only judged by the normal response to regulate the constant body temperature, which of the following comparisons of the ambient temperature of I and II and the body temperature of Ahua may be true?

(A) I ambient temperature > II ambient temperature > body temperature

(B) I ambient temperature > body temperature > II ambient temperature

(C) II ambient temperature > I ambient temperature > body temperature

(D) II ambient temperature > body temperature > I ambient temperature

（中文）阿華分別進入甲和乙兩種環境，在甲環境中肌肉出現顫抖的現象，而在乙環境中皮膚表面的血管擴張、血液量增加。若僅以調節體溫恆定的正常反應判斷，則下列有關甲、乙環境溫度及阿華體溫的比較，何者可能成立？

(A)甲環境溫度＞乙環境溫度＞體溫

(B)甲環境溫度＞體溫＞乙環境溫度

(C)乙環境溫度＞甲環境溫度＞體溫

(D)乙環境溫度＞體溫＞甲環境溫度

（110 年國中會考第 4 題）

解題 Solution：

「甲環境中肌肉出現顫抖」，表示環境溫度較低，「乙環境中皮膚表面的血管擴張、血液量增加」，表示環境溫度較高，所以乙環境溫度＞體溫＞甲環境溫度。

“Muscles tremble in environment I” means that the ambient temperature is low, and “blood vessels on the skin surface in environment II expand and blood volume increases”, indicating that the ambient temperature is high, so ambient temperature II > body temperature > ambient temperature I.

Teacher: What does “muscle tremor” in the title mean?
Student: The ambient temperature is low.
Teacher: That's right, so the muscles of the human body will vibrate to help us generate energy.
Student: Teacher, the “dilation of blood vessels on the surface of the skin” means that the ambient temperature is higher, right?
Teacher: Yes, it’s like when we are very hot in summer, our face will be red. At this time, our blood flows faster and more.
Student: That's right.

老師： 題目中「肌肉出現顫抖的現象」表示什麼意思？
學生： 學生：環境溫度較低。
老師： 老師：沒錯，所以人體的肌肉會有顫抖的現象來幫助我們產生能量。
學生： 學生：老師那「皮膚表面的血管擴張」就代表環境溫度較高對嗎？
老師： 老師：是的，就像是我們夏天的時候很熱，臉會紅紅的，這時候我們的血液流動的比較快也比較多。
學生： 學生：原來如此。

例題二

說明：測驗學生是否理解激素調控血糖濃度的機制。

To test whether students understand the mechanism by which hormones regulate blood glucose concentration.

（英文）The blood sugar concentration of the human body can be regulated by hormones. Under the action of hormone I, the blood sugar concentration can be increased. The blood sugar concentration will decrease under the action of hormone II. Which of the following sources of hormones I and II is the most plausible?

(A) Hormones I and II can only be secreted by the pancreas.

(B) Hormones I and II can only be secreted by the adrenal glands.

(C) Hormone I may be secreted by the pancreas, and hormone II may be secreted by the adrenal glands.

(D) Hormone I may be secreted by the pancreas or adrenal glands, and hormone II may be secreted by the pancreas.

（中文）人體的血糖濃度可受激素調節，在激素甲的作用下血糖濃度可提升，在激素乙的作用下血糖濃度會降低。下列有關激素甲和激素乙的來源，何者最合理？

(A)激素甲、激素乙皆只可能由胰臟分泌。

(B)激素甲、激素乙皆只可能由腎上腺分泌。

(C)激素甲可能由胰臟分泌，激素乙可能由腎上腺分泌。

(D)激素甲可能由胰臟或腎上腺分泌，激素乙可能由胰臟分泌。

（110 年國中會考(補考)第 2 題）

解題 Solution：

人體中能夠提升血糖的甲激素可能有腎上腺素和升糖素，而腎上腺素由腎臟分泌；升糖素由胰臟分泌。另外能夠降低血糖的乙激素應該是胰島素，由胰臟分泌。

The hormone I that can raise blood sugar in the human body may include epinephrine and glucagon, and epinephrine is secreted by the kidneys; glucagon is secreted by the pancreas. Another hormone II that can lower blood sugar should be insulin, which is secreted by the pancreas.

Student: May I ask which hormones in the human body can affect blood sugar?

Teacher: The question is very good, respectively glucagon, insulin and adrenaline. Among them, insulin can lower blood sugar, while glucagon and adrenaline both increase blood sugar.

Teacher: In addition, as you can tell from the names, insulin is secreted by the pancreas, and adrenaline is secreted by the kidneys.

Student: What about glucagon?

Teacher: Glucagon is secreted by the pancreas, so the pancreas is an important organ in our body for blood sugar control!

Student: That's right. Hormone I raises blood sugar, which may be glucagon or adrenaline; conversely, hormone II is insulin.

Teacher: Very good, so the answer should be (D). Hormone I may be secreted by the pancreas or adrenal gland, and hormone II may be secreted by the pancreas.

學生： 請問人體中分別有哪些激素能夠影響血糖呢？

老師： 問題很好唷，分別升糖素、胰島素和腎上腺素。其中胰島素能夠使血糖下降，而升糖素和腎上腺素都是使血糖上升。

老師： 另外你們可以從名字發現，胰島素由胰臟分泌，腎上腺素是腎臟分泌的。

學生： 那升糖素呢？

老師： 升糖素是胰臟分泌的，因此胰臟是我們身體中對於血糖控制很重要的器官喔！

學生： 原來如此，那麼激素甲提升血糖，可能是升糖素或腎上腺素；反之，激素乙是胰島素。

老師： 非常好，因此答案應該選 D，激素甲可能由胰臟或腎上腺分泌，激素乙可能由胰臟分泌。

國內外參考資源 More to Explore

HHMI Biointeractive 教學資源網站，可以根據學生教育階段(高中或大學)及主題選擇教學資源(含影片)。 https://www.biointeractive.org/	
Rediscovering Biology: Molecular to Global Perspectives 是一個進階的課程。提供給高中老師最新的生物知識，網站有影片，課程指引，師生互動網頁。 https://www.learner.org/classroom-resources/	
Khan Academy 可汗學院，有分年級的生物教學影片及問題的討論。 https://www.khanacademy.org/	
Interactive Simulations, University of Colorado Boulder 互動式電腦模擬，除了生物，還有其他自然科。 https://phet.colorado.edu/	

雙語教學資源手冊：生物科 英語授課用語

[七年級上學期]

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[7th grade 1st semester]

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