Practical Exam "Animal Systematics, 動物系統分類學實作測驗
Anatomy & Physiology 解剖學與生理學

Student Code:

IBO 2018
Tehran, Iran

29th International Biology Olympiad
July 15-22, 2018

Practical Exam 實作測驗

Animal Systematics, 動物系統分類學
Anatomy & Physiology 解剖學與生理學

Total Points: 總分 **100**
Duration: 時間 **90 minutes**

Animal systematics, anatomy and physiology lab
動物系統分類學、解剖學以及生理學實驗

General information

Total points : 100
Task A : 36 points
Task B : 34 points
Task C : 30 points

總分：100分
單元A：36分
單元B：34分
單元C：30分

Exam time : 90 minutes
考試時間：90分鐘

Please check your student code in the box on the title page
檢查你在封面的框框裡的編號是否正確

Use **answer sheet**, which is provided separately to answer all questions.
The answers written in the question paper **will not be evaluated**.
將答案填寫在答案卷裡，若將答案寫在題目卷裡不給分

In order to use the flags (the signs on your desk) just put them in the **flag stand** located on the left wall of your desk.
若需要使用旗子(放在桌上)，將旗子放在桌子左側牆壁的旗子架上。

Please ensure that all the materials and equipments are available to you. If anything is missing, put your yellow flag in the flag stand no later that **15 minutes** after beginning of exam. (Any complaints after 15 minutes will not be accepted)
確認所有的物品和儀器都有拿到。如果發現缺少那些東西，在考試開始的15分鐘內，將黃色旗子放到旗子架上(超過15分鐘後再反映將不予受理)

In case of emergencies put your yellow flag in the flag stand.
萬一發生任何緊急事情，將黃色旗子放到旗子架上。

No additional materials will be provided in any case of material loss during experiments.
實驗過程中若將物品遺失，將不再補發。

We suggest you to read the entire protocol before starting the experiments which helps you with time management.
建議在開始實驗之前先讀完整個實驗程序。

Stop answering and put down your pen **immediately** at the end of exam. Put the entire protocol with the answer sheet in the envelope. Our assistants will collect the envelopes.
考試時間到時馬上停止作答並將筆放下。將整份題目卷以及答案卷放在信封裡，助手會收走信封

Good luck

Write each indicated number in the cell next to it with your own handwriting.
將數字照樣手寫在下面的表中右側(協助閱卷者分辨手寫的1和7)

1	
7	

THIS LAB CONSISTS OF THREE PARTS:
這個實驗包含三個部分：

A- SYSTEMATICS AND TAXONOMY OF ACARI (25 minutes) (34 points)
A. 蜱蜱類動物(Acari)的系統分類學與分類 (時間25分鐘) (分數34分)

B- ANATOMY OF LEECH Hirudo orientalis (20 minutes) (36 points)
B. 岳蛭(*Hirudo orientalis*)的解剖學 (時間20分鐘) (分數36分)

C- Physiological changes during exercise (45 minutes) (30 points)
C. 運動中的生理變化 (時間45分鐘) (分數30分)

Materials and Equipment

Experiment A.

A Box containing FOUR Acari specimens on microscopic slides marked by A,B,C,D.
-四片螨蜱類動物(Acari)的玻片，上面分別標註A、B、C、D

A compound microscope.
-一個複式顯微鏡

Experiment B:

-Mask (1 piece)
-一個口罩

-Set of gloves (2 pairs in each of sizes).
-手套 (每種大小尺寸各有兩對)

-Tissue papers (1 box)
-一盒擦手紙

-Fine dissection scissors (1 pairs)
-兩把解剖剪刀

-Forceps (1 Piece)
-一把鑷子

-Plastic petri dish (1 piece)
-一個塑膠培養皿

-Leech in tube wrapped in wet tissue (1 specimen).
-一隻岳蛭(被濕紙巾包覆，放置在管子裡)

-Magnifier glass equipped with LED light (1 piece).
-一個附有LED燈的放大鏡

-Color-headed pins (6 piece).
-六個有顏色的針

-Pins (1 small box)
-一小盒針

-Foam dissection board marked with student code (1 piece)
-一個泡棉解剖盤(上面有標註學生的編號)

-Cotton wool tampon(5 pieces)
-五個棉條

-NaCl drops (2 container)
- 兩瓶氯化鈉(NaCl)滴液

Experiment C:

Microtubes A-B-C-D (1 each)
A-B-C-D 小管子(各一個)

Empty microtubes (12 pieces)
12個沒有裝東西的小管子

Micropipettes and tips (0.5-10, 10-100, 100-1000 microliter)
微量吸取器和塑膠尖管(尖管尺寸：0.5-10, 10-100, 100-1000 微升(microliter))

Falcone containing NaOH
裝有氫氧化鈉的50毫升離心管

Microtube I (containing phenolphthalein)
裝有酚酞的小管子 (上面標示 I)

EXPERIMENT A
實驗A

SYSTEMATICS AND TAXONOMY OF ACARI
蟎蜱類動物(Acari)的的系統分類學與分類

Acari (or Acarina) is a taxon of arachnids that contains mites and ticks. In most modern treatments, the Acari is considered a subclass of Arachnida and is composed of two superorders: **Acariformes** (or Actinotrichida), **Parasitiformes** (or Anactinotrichida). Acari are arachnids and, as such, evolved from a segmented body with the segments organised into two tagmata: a **gnathosoma** (including chelicerae and palps) and an **idiosoma**(remaining body). Internal transport and exchange of oxygen and carbon dioxide in some acarine taxa usually are mediated by a branched tracheal system that opens externally through spiracular ports or **stigmata**. Stigmata are placed on different parts of body in different orders of Acari and in some orders they are associated with peritremes (See Figs. 1 & 10).

蟎蜱類動物(Acari)(或為Acarina)包括蟎(mites)和硬蜱(ticks，或稱壁蝨)這兩類屬於蛛形綱的動物(arachnids)。現行的分類系統將蟎蜱類動物歸類在蛛形綱(Arachnida)下面的一個亞綱。蟎蜱類動物包括**真蟎類**(Acariformes, or Actinotrichida)和**寄生蟎類**(Parasitiformes, or Anactinotrichida)這兩個超目(superorder)。蟎蜱類動物為蛛形綱動物，因此具有體節，身體由兩個體節(tagmata)組成：其中一個體節為頭顎部(gnathosoma)，這部分包括螯肢(chelicerae)和鬚肢(palp)；另一個體節為**腹部**(idiosoma)，包括頭顎部以外的其他部位。在一些蟎蜱類動物，體內物質運輸以及氧氣和二氧化碳的氣體交換，通常是透過氣管系統來完成，氣管系統在身體表面有一個開口，這個開口稱作**氣門/氣孔**(stigmata)。不同的蟎蜱目(order)，氣門出現的部位不一樣，有些目的氣門旁邊有另一個稱作氣門溝(peritreme)的構造(圖1和圖10)。

This examination is composed of 2 tasks
這個測驗包括兩部分

You have four specimens of Acari (slides A-B-C-D).
你會拿到四個蟎蜱類動物的玻片標本(玻片A、B、C、D)

TASK A.1: Based on shape of chelicerae and palps, please suggest the life mode of each specimen with "✔"in table A.1 of **the answer sheet.**
TASK A.1: 根據螯肢(chelicerae)和鬚肢(palp)的形狀，推論各標本動物可能的生活型態，在答案卷中的A.1表格打勾 "✔"

Soil-dwelling predator: Chelicera chelate and narrow (Figure 2). Palp simple, and five-segmented and sometimes with apotele (a thick seta on palpal tarsus with 2–3 distal branches) (Figure 7).
住在土壤裡的捕食者：具有瘦窄且有螯狀的螯肢(圖2)；鬚肢簡單，分做五節，有時候具有apotele這個構造(apotele是位於鬚肢最末端的跗節上面，有2-3個末端分枝的粗毛構造)(圖7)

Free-living predator: chelicera blade-like (Figure 4). A large claw placed on palpal tibia distally and palpal tarsus placed on tibia laterally (thumb-claw process, Figure 8).
游離生活捕食者：螯肢刀鋒狀(圖4)；鬚肢的跗節在脛節的側邊，且脛節末端有一個大螯(鬚肢突起像拇指-大爪對偶狀，如圖8)

Parasite: Chelicera without fixed digit and pointed (Figure 5), palp five-segmented.
寄生蟲：具有尖的螯肢，且螯肢沒有固定的指節數目(圖5)；鬚肢五節

Saprophagous mite: Chelicera chelate and thick (Figure 3), palp two-segmented.
行腐食生活蟎類：具有寬厚且有螯狀的螯肢(圖3)；鬚肢兩節

Phytophagous mite: Chelicera whip-like (stylet) (Figure 6), palp four-segmented.
植食性蟎類：螯肢鞭狀(稱作stylet)(圖6)；鬚肢四節

Specimen letter

Life mode 生活型態	A	B	C	D
Soil-dwelling predator 住在土壤裡的捕食者				
Free-living predator 游離生活捕食者				
Parasite 寄生蟲				
Saprophagous mite 行腐食生活蟎類				
Phytophagous mite 植食性蟎類				

TASK A.2: Identification of Acari using a dichotomous key.
TASK A.2: 使用一個二叉式檢索表來鑑定蟎蜱類動物(Acari)

Use the dichotomous key below to identify the taxon to which each Acari belongs. Indicate your selections in the **answer sheet** by filling in the **most** appropriate boxes for each Acari. Both the figure and the table illustrate the same data.

使用下面提供的二叉式檢索表，來判定各個玻片標本屬於哪個蟎蜱類動物(Acari)類群。將檢索步驟逐步填寫在答案卷裡。圖和表呈現的是相同的資訊。

1a. With 1–4 pairs of dorsolateral or ventrolateral stigmata posterior to coxae II (Figs. 1A, B, C, D) ..... Superorder **Parasitiformes** 2

1b. Without visible stigmata posterior to coxae II..... .....Superorder **Acariformes** 5

2a. Body with 4 pairs of dorsolateral stigmata posterior to level of coxae III (Figure 1A)..... Order **Opilioacarida**..... Family **Opilioacaridae**

2b. Body with 1 pair of ventrolateral stigmata in region lateral to coxae II-IV or posterior to coxa IV (Figure1 B, C, D) 3

3a. Stigmata without peritremes (Figure 1D) ...Order **Ixodida** 6

3b. Stigmata usually with peritremes (Figure 1B, C) 4

4a. Stigmata present between coxae II-III ..... Order **Holothyrida** 7

4b. Stigma present between coxae III-IV..... Order **Mesostigmata** 8

5a. Tracheal system with 1 pair of stigmata opening between bases of chelicerae associated with peritremes dorsally on the cheliceral bases (Figure 1E) ..... Order **Trombidiformes** 9

5b. Tracheal system without stigmata, and peritremes never present between cheliceral bases ..... Order **Sarcoptiformes** 10

6a. Paired spiracular plates situated dorsolaterally between coxae III-IV ..... Family **Argasidae**

6b. Paired spiracular plates situated dorsolaterally posterior to coxa IV (Figure 1D)..... Family **Ixodidae**

7a. Corniculus (Figure 7) simple ..... Family **Allothyridae**

7b. Corniculus toothed ..... Family **Holothyridae**

8a. Peritremes directly extended to level of anterior edge of coxae I ..... Family **Laelapidae**

8b. Peritremes short, looped medially or apically ..... Family **Varroidae**

9a. With 1 pair of stigmata opening between bases of chelicerae, palpal tarsus placed on tibia distally. ..... Family **Anystidae**

9b. With 1 pair of stigmata associated with peritremes dorsally on the cheliceral bases, palp with thumb-claw process (Figure 8) ..... Family **Trombidiidae**

10a. Palps two-segmented, leg tarsi with one claw ..... Family **Acaridae**

10b. Palps five-segmented, leg tarsi (plural of tarsus) with three claw ..... Family **Pheroliodidae**

1a	With 1–4 pairs of dorsolateral or ventrolateral stigmata posterior to coxae II (Figs. 1A, B, C, D) 在第二對足的基節後方有1-4對的背側方或腹側方氣門（氣孔） (圖. 1A, B, C, D)	Superorder **Parasitiformes** 寄蟎總目	2
1b	Without visible stigmata posterior to coxae II 在第二對足的基節後方沒有可見的氣門	Superorder **Acariformes** 蟎形總目	5
2a	Body with 4 pairs of dorsolateral stigmata posterior to level of coxae III (Figure 1A) 於第三對足基節的水平位置後方有四對位於背側方的氣孔 (圖 1A)	Order **Opilioacarida**- Family **Opilioacaridae** 節腹蟎目/ 傑腹蟎科	-
2b	Body with 1 pair of ventrolateral stigmata in region lateral to coxae II-IV or posterior to coxa IV (Figure1 B, C, D) 在第二到第四足基節的側方有一對位於腹側方的氣門，或那對氣門會位於第四足基節的前方 (圖1 B, C, D)	-	3
3a	Stigmata without peritremes (Figure 1D) 氣門沒有氣門溝 (圖1D)	Order **Ixodida** 真蟎目	6
3b	Stigmata usually with peritremes (Figure 1B, C) 氣門通常具有氣門溝 (圖 1B, C)	-	4
4a	Stigmata present between coxae II-III 氣門會出現在第二與第三足的基節之間	Order **Holothyrida** 巨蟎目	7
4b	Stigma present between coxae III-IV 氣門出現在第三與第四足的基節之間	Order **Mesostigmata** 革蟎目	8
5a	Tracheal system with 1 pair of stigmata opening between bases of chelicerae associated with peritremes dorsally on the cheliceral bases (Figure 1E) 氣管系統具有一對氣門，其開口位於螯肢基部之間，該處還有一條氣門溝(圖 1E)	Order **Trombidiformes** 恙蟎目	9
5b	Tracheal system without stigmata, and peritremes never present between cheliceral bases 氣管系統沒有氣門開口，氣門帶也不會出現在螯肢的基部之間	Order **Sarcoptiformes** 疥蟎目	10
6a	Paired spiracular plates situated dorsolaterally between coxae III-IV 在第三與第四足的基節之間具有一對長在背側方的氣門片	Family **Argasidae** 軟蜱科	-
6b	Paired spiracular plates situated dorsolaterally posterior to coxa IV (Figure 1D) 成對的氣門片出現在第四足基節後方的背側面 (圖 1D)	Family **Ixodidae** 硬蜱科	-
7a	Corniculus (Figure 7) simple 顎肢末端突起形狀(圖 7)簡單	Family **Allothyridae** 異蟎科	-
7b	Corniculus toothed 顎肢末端邊緣有齒狀突起	Family **Holothyridae** 巨蟎科	-
8a	Peritremes directly extended to level of anterior edge of coxae I 氣門溝直接延伸到第一足基節前緣的基準線	Family **Laelapidae** 厲蟎科	-
8b	Peritremes short, looped medially or apically 氣門溝很短，在中段或是末端會捲捲的	Family **Varroidae** 瓦蟎科	-

9a	With 1 pair of stigmata opening between bases of chelicerae, palpal tarsus placed on tibia distally 在螯肢的基部有一對氣門開口，鬚肢的跗節位於脛節的離體端	Family **Anystidae** 大赤螨科	-
9b	With 1 pair of stigmata associated with peritremes dorsally on the cheliceral bases, palp with thumb-claw process (Figure 8) 在螯肢基部有一對氣門，基部的背側有一條氣門溝；鬚肢具有拇指-大爪對偶狀的突起(圖 8)	Family **Trombidiidae** 絨螨科	-
10a	Palps two-segmented, leg tarsi with one claw 鬚肢有兩節，足的跗節有一個爪	Family **Acaridae** 粉螨科	-
10b	Palps five-segmented, leg tarsi (plural of tarsus) with three claw 鬚肢有五節，足的跗節有三個爪	Family **Pheroliodidae** 負殼甲螨科	-

No image info

Show serially your identification pathway **in table A.2 of the answer sheet**. For example, a pathway to the family Holothyridae is as follow:

將檢索步驟逐步填寫在答案卷的表A.2裡；例如Holothyridae科的檢索步驟如下所示

Step Specimen	1	2	3	4	5	6
Family Holothyridae	1a	2b	3b	4a	7b	-
Slide “A”						
Slide “B”						
Slide “C”						
Slide “D”						

EXPERIMENT B:

ANATOMY OF LEECH *Hirudo orientalis*
岳蛭(***Hirudo orientalis***)解剖學

Introduction:

The Persian leech *Hirudo orientalis* Utevsky and Trontelj, 2005 is a clittellate annelid and belongs to family Hirudinidae. This was described from the Caspian region. It has been used for leech therapy (Hirudotherapy) from the time of Zoroastrian in the Persian traditional medicine. Avicenna, the great Persian philosopher and physician, used the leeches for treatment of different diseases. The cure was aided by injection of active compound of its saliva, while sucking blood, into the host bloodstream. Due to wide use of Hirudotherapy in the recent years the wild populations get close to extinction and therefore, School of Biology, University of Tehran has been working on this species life cycle for a decade, firstly to stop the pressure of leech caught from the natural ponds for conservation purposes and secondly to supply clean cultivated ones for leech therapy. The specimen on the table is a cultured one at indoor aquaculture facility at University of Tehran and was fed on pathogen free horse or camel blood.

前言
岳蛭(*Hirudo orientalis* Utevsky and Trontelj, 2005)屬於蛭科，是具有環帶(clittellate)的環節動物。產於里海，在波斯被當作醫蛭用。由於廣泛捕捉使用在醫療上，近年來野生岳蛭趨近滅絕，因此德黑蘭大學致力於保育野外岳蛭族群，以及提供人工繁殖的岳蛭供醫療使用。桌上的岳蛭是由德黑蘭大學提供的人工繁殖個體。

Task B.1 Identify the external structures of *Hirudo orientalis*.
Task B.1 辨識岳蛭(*Hirudo orientalis)*外部構造

Task B.2 Dissect and identify the internal structures of *Hirudo orientalis*.
Task B.2 解剖及辨識岳蛭(*Hirudo orientalis)*內部構造

Task B.1. Identify the external structure of *Hirudo orientalis*.
Task B.1. 辨識岳蛭(*Hirudo orientalis)*外部構造

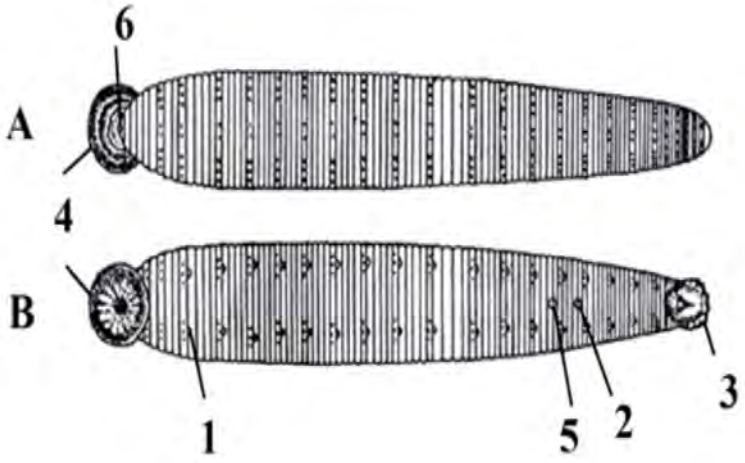
Use a hand magnifier glass to observe the anal pore, oral and rear suckers, nephridiopores, male and female genital pores in the provided specimen of *Hirudo orientalis*. Then, answer the following questions in the **ANSWER SHEET.**
使用放大鏡觀察岳蛭肛孔，口部和身體後端吸盤，腎孔，雄性和雌性生殖孔。在答案卷上回答下列問題。

Task B 1.1:
Indicate If each of the following statements is true or false with a "✓" in the answer sheet.
Task B 1.1:
用打勾方式 "✓"回答下面各個問題的敍述是正確或錯誤

Q.1 The clitellum is easily seen antero-dorsally on the provided specimen.
問題1-可以很容易在岳蛭外部看到環帶(clitellum)

Q.2 The crawling of this species requires the use of three types of muscles, namely longitudinal, circular and diagonal.
問題2-岳蛭爬行時會需要用到縱向(longitudinal)、環狀(circular)、以及對角線方向(diagonal)三種肌肉

Task B.1.2
According to the following figure match the correct number with its relevant characters in the following table **in your answer sheet.**
Task B.1.2
根據下面的圖，在答案卷上填入各個標識數字對應的構造名稱



Characters	Oral sucker 口部吸盤	Rear sucker 身體後側吸盤	Anal pore 肛孔	Male genital pore 雄性生殖孔	Female genital pore 雌性生殖孔	Nephridiopore 腎孔
Number						

Task B.2.2 (18 points)

Dissection and identification of the internal structure of *Hirudo orientalis*.
岳蛭的解剖與內部結構的鑑識

Put on the gloves, take your alcohol treated leech wrapped in wet tissue from the provided tube using the forceps and place it inside the petri dish. For your convenience its gut blood is mostly ejected thorough a small horizontal cut into the body wall and gut, at the center of the body, after narcotization. But, there is always some blood in the gut. First, take the blue dissecting board (~15×20 cm), place the leech head forward (toward student code) and dorsal up. Fix the leech by inserting the provided ordinary pin obliquely into the anterior and posterior sucker on the foam dissecting board. Then, locate the anus and lift the dorsal cuticle using the forceps, about 2 cm away from the anus, anteriorly. Insert the tip of the scissors into the cuticle and make a small cut. The cut should be deep enough to reach the gut dorsally with the scissors. Continue to cut the dorsal cuticle and dorsal gut wall together toward the oral sucker. Clean the residual gut blood using cotton wool tampon and NaCl drops and throw away the unclean paper tissue to the small rubbish bin on your desk. Take the skin apart and pin it down using the ordinary pin, inserted obliquely. The reproductive, nervous, urinary systems are located ventrally under the gut wall and are easily visible by the naked eye or a magnifying glass.

戴上手套，以鑷子拿出岳蛭擺在培養皿上。在麻醉之後，如果在水平面對體壁與腸道切一刀，腸血就會給它噴出來。但是腸道內還會有一些血。首先，拿著那塊藍色的解剖盤，把岳蛭的頭部朝向你的編號，背部朝上。使用所提供的針固定頭部與尾部的吸盤。然後找到肛門，用鑷子把背方的表皮挑起來，挑到往前且離肛門約2cm距離。把剪刀的尖端插入表皮然後剪一個小口。這個小口一定要能深及腸道的背方。繼續用剪刀剪背方的表皮和腸道背方壁直到前吸盤。使用棉花還有食鹽水來清理腸道內的血液，然後把髒東西連同面紙通通丟到小垃圾桶去。現在把表皮打開，然後使用給你的針斜斜美美地固定。岳蛭的生殖、神經、泌尿系統都在腸道的腹方，非常清晰可見。

Note that this species is a hermaphrodite and at any particular time, each individual can act as a potential male or female.
岳蛭為雌雄同體，所以可以同時當作雄性或雌性。

When dissection is finished, **mark the following organs using the provided colored pins.**

當解剖完成後，將下列器官用有顏色的針標示出來。

Organ	Pin color
Salivary gland 唾液腺	Pink
Vagina 陰道	Black
Testis 睪丸	Yellow
Prostate 前列腺	Green
Epididymis 附睪	White
Segmental ganglion (2 cm below the genital organs) 體節內的神經節 (位於生殖器官以下2公分的位置)	Blue

In accordance with the internal and external features of the dissected specimen, indicate if each of the following statements is true or false with a "✓" in the **answer sheet**.
根據岳蛭內部和外部構造，用打勾方式 "✓"回答下面各個問題的敍述是正確或錯誤

Q.1 Gas exchange is cuticular.
問題1. 透過表皮進行氣體交換

Q. 2 Potentially, each individual can mate with several potential females.
問題2. 每隻個體有機會時，能和好幾隻雌性交配

Q. 3 Fertilization is internal.
問題3. 體內受精

Q. 4 Individuals are capable of self-fertilization.
問題4. 能自體受精

Q. 5 The coelom is highly enlarged to support large amounts of blood storage in the gut.
問題5. 體腔極度膨大，用來儲存大量的血液於腸道中

Q. 6 The gut wall bears lateral pouches to increase the intestinal surface.
問題6. 腸道壁兩側有囊袋，用來增加小腸的表面積。

Q. 7 This species bears a proboscis.
問題7. 岳蛭口部具有突出的長條形構造

Q. 8 Analysis of the external rings and internal anatomy of the species shows 50 or more segments.
問題8. 檢視岳蛭外部的環和內部構造，可以發現有50個以上的體節。

When the marking is finished, put your RED flag in flag stand and a laboratory assistant will take a photo of your dissection. He/she also will take your dissection board away. After this stage take your gloves out and put it in the rubbish bin.
完成標示後，將你的紅色旗子放在旗座上，助手會接著拍照並將解剖板子帶走。完成後，帶走手套並丟棄在垃圾桶裡。

EXPERIMENT C

Physiological changes of exercise.
運動後之生理變化

In this part, we aim to evaluate physiological changes of exercise. To do so, we will go through the following steps:
本部分將試圖評估運動後之各項生理變化，為達此目的，我們將依循下列步驟進行

Measuring QT interval in electrocardiogram (ECG), during exercise.
Indicating significant changes in ECG with statistical analysis.
Measuring post-exercise pH.
測量運動時心電圖上的QT間距，
利用統計方法並指出是否具顯著差異。
測量運動後之pH值

In this part, you will measure QT intervals in the following ECGs. We have provided four ECGs that belongs to the beginning, 1st, 2nd and 3rd minute of exercise. Based on the guide provided and using the grid, meauasure the QT interval of each ECG. (Note that in the ECGs, the smallest square equals to 0.04 seconds)
請量測下列心電圖中的QT間距，本題中分別有運動剛開始，開始後第一分鐘，開始後第二分鐘及開始後第三分鐘的心電圖。請利用所提供之資料及心電圖上之格線，計算每一個心電圖上的QT間距。(請務必注意，心電圖上的最小方格為0.04秒)

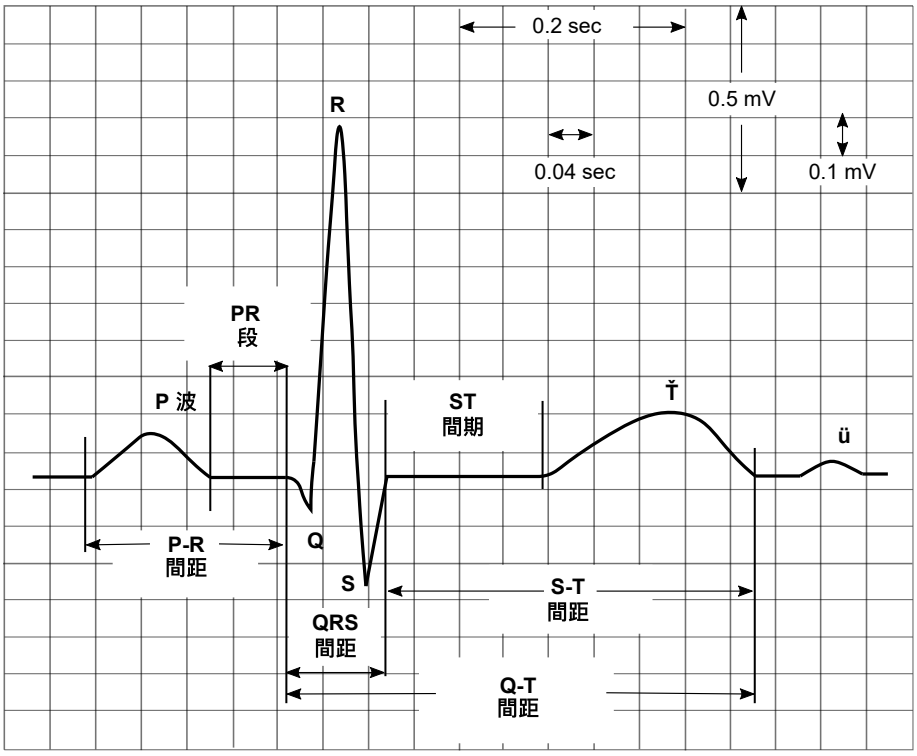


圖1.心電圖指南。請注意，QT間隔是從Q波開始到下一個T波結束的確切時間。

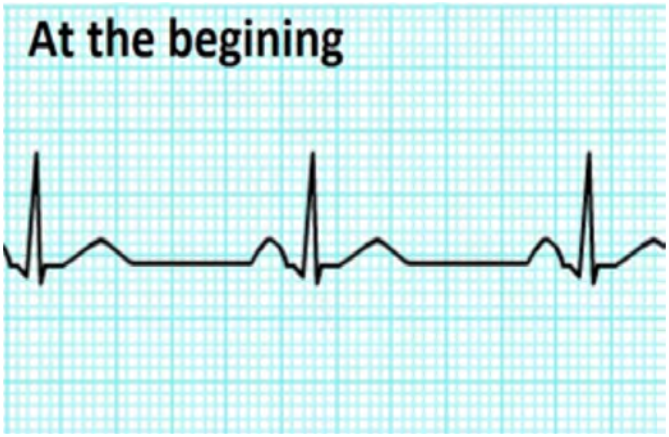


Figure 2. *A part of ECG at the beginning of exercise.*

*圖**2.**開始運動時的心電圖。*

Figure 3. *A part of ECG in the 1st minute of exercise.*
圖3.運動開始後第一分鐘之心電圖

Figure 4. *A part of ECG in the 2nd minute of exercise.*

圖4,運動開始後第二分鐘之心電圖。

Figure 5. *A part of ECG in the 3rd minute of exercise*

圖5.運動開始後第三分鐘之心電圖。

Task 3.1. Write your answers in seconds in the **Answer sheet (rounded to two decimal places)**.(0.5 point each)
Task 3.1. 在答案卷寫下你的答案(以秒為單位)並記錄至小數點後兩位(每個0.5分)

	QT間距 **QT interval**
運動剛開始 **At the beginning**	
運動開始後第一分鐘 **1st minute**	
運動開始後第二分鐘 **2nd minute**	
運動開始後第三分鐘 **3rd minute**	

3.2. Statistical analysis of QT intervals

We have measured QT intervals in three different subjects during exercise. In **3.2.A.,** you will perform analysis of variance (ANOVA) to test for significant changes of QT interval during exercise in healthy individuals. In **3.2.B.,** the same analysis were performed on healthy individuals during pacing stress testing, instead of measuring QT interval during exercise. Finally, you will interpret your results and make the conclusion.

3.2 QT間距的統計分析
我們將量測三位不同受試者在運動中的QT間距。在3.2.A.中，請利用統計分析中常用之變異數分析(ANOVA)來分析不同健康個體在一般運動時之QT間距是否具顯著差異。在3.2.B.中，同樣以ANOVA分析步態壓力(pacing stress testing) 測試中QT間距之變化。最後，請寫出預期結果並做出結論。

3.2.A. Conducting ANOVA on QT intervals data.
3.2.A.利用變異數分析(ANOVA)方法來分析QT間距。

3.2.A.1. In the following table, we have measured QT intervals (in milliseconds) of three different subjects.
3.2.A.1. 下表顯示三位不同受試者之QT間距(單位為毫秒 millisecond)

	Subject 1 QT interval 第一位受試者之QT間距	Subject 2 QT interval 第二位受試者之QT間距	Subject 3 QT interval 第三位受試者之QT間距	Mean 平均
1st minute 第一分鐘	360	340	347	349
3rd minute 第三分鐘	320	312	325	319
10th minute 第十分鐘	310	298	307	305
20th minute 第20分鐘	298	280	295	291
平均 **Mean**	322	307.5	318.5	總平均值（M_T）= 316

Task 3.2.A.2. Calculate the "total sum of squares" (**SS_T or SS_{total}**), using the following formula. **Write in Table 3.2.A of the answer sheet (rounded to one decimal place).**
Task 3.2.A.2. 使用以下公式計算"總平方和"（ **SS_T或 SS_{total}**）。 寫在答案卷的 表**3.2.A** 中 ，並記錄至小數點後一位。

$$SS_T = \sum (X - M_T)^2$$

X: individual value for each subject for each time-point, **MT** : total mean.
X：每個受試者在每個時間點的數值， **M_T** ：總平均值

Task 3.2.A.3 Calculate the "between group sum of squares" (**$SS_{between}$ or SS_B**), using the following formula. **Write in the Table 3.2.A of the answer sheet (rounded to one decimal place).**
Task 3.2.A.3 利用下面的公式計算"組間平方和"（ **$SS_{組間}$ 或SS_B** ）並 寫在 答案紙 的 表**3.2.A**中，記錄至小數點後一位 。

$$SS_B = n \sum (M_G - M_T)^2$$

M_G: mean for each group compared, **M_T**: total mean., **n**: the number of observations in each group.
M_G ：每組的平均值， **M_T** ：總平均值。**n**為每一組中之觀察個體數

Task 3.2.A.4 Based on the following table, fill the blank cells in the summary of ANOVA for QT intervals. **Write in the Table 3.2.A of the answer sheet. (rounded to one decimal place)**

Task 3.2.A.4根據下表，在空格中填寫利用ANOVA分析**QT**間距後之數據。將數據寫在答案卷的表**3.2.A**中 (數據紀錄須達小數點後一位)

Summary of ANOVA for QT intervals:
QT間距的ANOVA分析結果：

變異來源	平方和	自由度	方差估算(均方)	F比例值
組間變異	SS_B	K - 1	$MS_B = \frac{SS_B}{K-1}$	$\frac{MS_B}{MS_W}$
組內變異	$SS_W = SS_T - SS_B$	N - K	$MS_W = \frac{SS_W}{N-K}$	
總變異	SS_T	N - 1		

K指不同時間點的數目，N是觀察的總數。
K is the number of time-points and N is the total number of observations.

Task 3.2.A.5. Using the table below, estimate the upper threshold for the P value corresponding to the F ratio you have obtained. **Write in the answer sheet. (1 point)**
Task 3.2.A.5. 使用下表，估算與F比例值相對應的P值之閾值上限並寫在答案卷上（**1**分）

F比例值 (F ratio)	P值 (P value)
0.45	0.5
2.92	0.1
5.42	0.025
7.59	0.01
9.60	0.005
15.83	0.001

P值 (P value)	

3.2.B. In the second experiment, similar data was obtained from three subjects who underwent pacing stress testing during cardiac catheterization. In this experiment, heart rate was elevated gradually during the experiment using a cardiac catheter, instead of the elevated heart rate being observed during exercise, which was done in the previous experiment. The results are presented in the table below.
3.2.B.在第二個實驗中，將利用心導管分析步態壓力測試時三個受試者之QT間距。類似之前運動狀態的實驗，本實驗中裝有心導管之受試者其心跳會逐漸上升。結果如下表所示。

	Subject 1 QT interval 第一位受試者之 QT間距	Subject 2 QT interval 第二位受試者之 QT間距	Subject 3 QT interval 第三位受試者之 QT間距
1st minute 第一分鐘	310	315	310
3rd minute 第三分鐘	310	310	310
10th minute 第**10**分鐘	310	305	310
20th minute 第**20**分鐘	310	305	305

Then again, we have performed ANOVA and **F ratio of 2.2 was obtained.**Using the table below, estimate the upper threshold for the P value corresponding to the F ratio you have obtained. **Write in the answer sheet. (1 point)**
然後，我們再次進行ANOVA， **得到F比例值為2.2**。使用下表，估算與F比例值相對應的P值之閾值上限並寫在答案卷上（**1**分）

F比例值(F ratio)	P值 (P value)
0.45	0.5
2.92	0.1
5.42	0.025
7.59	0.01
9.60	0.005
15.83	0.001

P值 (P value)	

Task 3.2.C.1. Considering a P value less than 0.05 to be statistically significant, are the effects of exercise and pacing different? (Indicate the correct answer with "✓" in the answer sheet.) (2 points)

Task 3.2.C.1. 在統計分析中，若P值小於0.05即表示在統計分析上具顯著差異，所以步態壓力測試和運動的實驗結果是否不同?（在答題紙中打勾**"✓"**表示正確答案。）（2分）

Yes (有顯著差異)	
No (沒有顯著差異)	

Task 3.2.C.2. Based on your physiology knowledge and the results of this study, indicate if each of the following statements is true of false. (Indicate the correct answer with "✓" in the answer sheet.) (1 point each)
Task 3.2.C.2. 根據你的生理學知識和本研究的結果，指出以下每個陳述是否正確或錯誤。（在答題紙中打勾**"✓"**表示正確答案。）（每個1分）

說明 **statement**	對	錯
1. Opening and closure of the aortic valve happen in the QT interval in healthy subjects. 主動脈瓣的打開和關閉主要發生於健康受試者的QT間距。		
2. Based on the results from the first study, cardiac output would decrease between 1st and 20th minute of exercise. 基於第一項實驗的結果，運動第一分鐘到第20分鐘間的心輸出量會下降。		
Results from the second study indicate that sympathetic activation is probably the main factor behind QT interval changes. 第二項實驗的結果顯示，交感神經系統活化可能是QT間距改變的主要因素。		

Task 3.3: Measuring urine and blood plasma pH after exercise.
Task 3.3: 運動後測量尿液和血漿pH值。

A group of researchers wanted to measure urine and blood plasma pH 30 minutes after exercise, so they have collected urine and blood plasma samples from three vessels of a monkey with ventricular septum defect (VSD) 30 minutes after exercise. The defect in the ventricular septum allows blood to leak from the left ventricle to the right ventricle.
一組研究人員希望量測運動後30分鐘尿液和血漿的pH值，因此他們在運動後30分鐘收集患有心室中隔缺損（VSD）的猴子的尿液樣本及從三條不同血管中收集血液樣本。心室中隔缺損會使血液從左心室滲漏到右心室。

They used chromatography technique to eliminate the effect of proteins on titration of samples by separating proteins of **"Original samples"**.
他們使用色層分析技術分離出**"原始樣品"**中的蛋白質，以消除蛋白質對樣品滴定的影響。

In the second step, researchers wanted to remove the effect of other buffers in their sample, so they have added HCl to the collected samples based on their routine protocols.
在第二步驟中，研究人員希望移除其他緩衝液對樣品的影響，所以他們基於常用之實驗流程，添加鹽酸(HCl)在所收集之樣品中。

The "**Treated samples"** from four different sources are provided in four microtubes (A-D).
來自四個不同來源的" **處理後樣品 "**置放於四個不同的小管子(microtube)中（A到D)。

To find the source from which each of the samples were collected, you have to measure the pH of microtubes (A-D) using the following protocol:
為了釐清每個樣品的來源，你必須使用以下實驗步驟測量各樣品（A到D）的pH值：

1. Start with choosing one of your samples (A-D) and adding 100 microliters of that sample to an empty microtube.
1.首先選擇A到D其中一個樣品（A到D），然後將100 微升(100 microliter)樣品加入空的小管子中。

2. Using your micropipettes, add 10 microliters of phenolphthalein indicator (microtubes “I”) to the micrutube containing 100 microliters of the sample. (The indicator is colorless in the acidic solutions and pink in basic solutions.)
2.使用微量滴管(micropipettes)，在含有100 微升樣品的小管子中加入10微升之酚酞指示劑(標為"I"之小管子)(此指示劑在酸性溶液中無色，在鹼性溶液中呈粉紅色)。

3. Start the primary titration of the solution you have prepared through last two steps by adding 100 microliters of **NaOH (0.01M) solution**.
3.利用100微升之**NaOH（0.01M）溶液，滴定前述兩步驟所得溶液**。

4. Do the previous step (Adding 100 microliters of NaOH) again until the point that your indicator turns faint pink and the pink color does not disappear by pipetting. Note that you do not need to write the volumes in the answer sheet. (At pH of 7, the indicator turns faint pink and it is the end point of titration.)
4.反覆進行前述滴定步驟（添加100微升NaOH），直至指示劑變為淡粉色，及不再變色之粉紅色（在pH值為7時，指示劑變為淡粉色，這是滴定的終點。）

5. Now to do a more accurate titration of the chosen sample, throw away the microtube of the titrated solution (solution that turned faint pink in the step 4) and prepare another solution in another empty microtube for the chosen sample based on steps 1 and 2.
5.接下來對所選取樣品進行更精確的滴定，丟棄之前滴定後的小管(即在步驟4(上述步驟)中變成淡粉色的溶液），並根據步驟1和步驟2，另取一微量離心管重新製備新的溶液。

6. Add NaOH to the solution of step 5 until you have 100 microliters left to reach the end point volume you have reached at step 4.
6.將NaOH加入到步驟5的溶液中，直到剩下100微升就達到您在步驟4最後滴定所需體積。

7. Add 10 microliters of NaOH to the solution of step 6.
7.向步驟6的溶液中加入10微升NaOH。

8. Do the previous step (Adding 10 microliters of NaOH) again until the point that your indicator turns faint pink and you reach the end point. Write down the total volume of NaOH you used to reach the end point. The NaOH volume you reached in this step is more accurate than the estimated volume of step 4.
8.反覆執行上一步驟（添加10微升NaOH），直至指示劑變為淡粉紅色並達到滴定終點。這次請記錄用於達到滴定終點所需NaOH的全部體積。本步驟中所得到用以滴定之體積將遠較步驟四精確。

9. Choose another sample (A-D) and do steps 1 to 8 for that sample to find out the NaOH volume you need to reach the end point of titration.
9.選擇另一個樣品（A-D）並對該樣品重複執行步驟1到8，以找出每一樣品所需的NaOH體積。

Task 3.3.1. Based on the volume of NaOH (0.01M) solution you have used to reach the end point of titration of each sample, calculate the pH of each **“Treated sample”**.**(rounded to three decimal places).**
Task 3.3.1. 根據上述實驗中滴定完成所需NaOH（0.01M）溶液的體積，請計算每個**“處理過的樣品”**的pH值**(計算至小數點後三位)**。

樣品 (sample)	A	B	C	D
volume of NaOH added (microliters) 所加入NaOH的體積(microliters)				
pH of **“Treated sample”** **“處理過的樣品”**的 pH值				

Task 3.3.2. The protocol that researchers used to diminish the buffers of original samples, has provided a formula (find below) to calculate the pH of “Original Sample” based on the results of titration of “Treated Sample”.
Task 3.3.2. 研究人員用下列公式**(**見下文**)**來計算**pH**值以減少**“**原始樣品**”** 緩衝液的影響。

$$\text{原始樣本的pH值} = 6.37 + \log \frac{10^4 - V}{\alpha}$$

V: Volume of NaOH used to reach the end point of titration of **"Treated Sample" (microliters)**
V：用於滴定**"處理過的樣品"**（微升）所需之NaOH體積

α: It is an index corresponding to buffer content of the "Original Sample". The α index of each sample is provided in the table below.
α：對應於不同"原始樣本"的緩衝液的索引值，每個樣品的α指數提供於下表。

樣品 (Sample)	A	B	C	D
α 索引值 (α Index)	6420	902	1111	709

Considering the provided formula, the α index and the NaOH volume used to reach the end point of titration, calculate the pH of **"Original Samples"** and write them in the answer sheet. **(rounded to three decimal places).**
利用所提供的公式，a值及用於滴定的NaOH體積，計算**"原始樣品"**的pH值並將其寫在答案紙中**(請記錄至小數點後三位數)**。

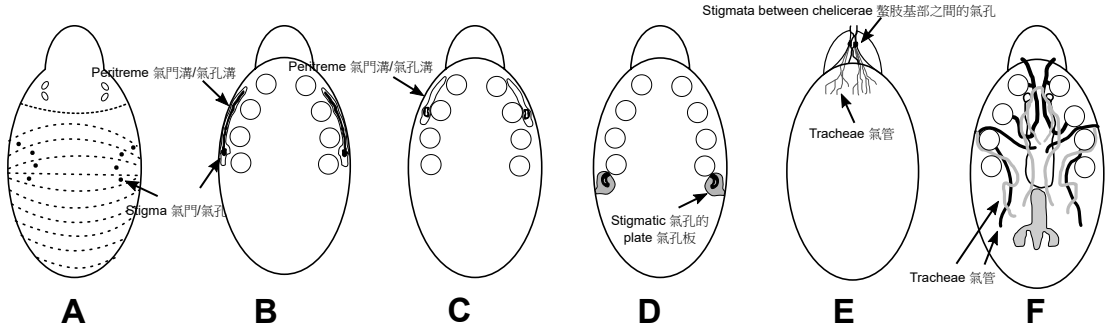
樣品 (Sample)	A	B	C	D
"原始樣品"的 pH值 pH of **"Original Sample"**				

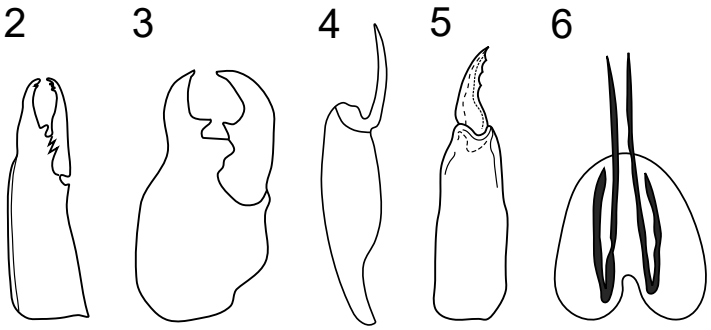
Task 3.3.3 Based on the calculated pH of the original samples, determine the source of each sample and write its name (A-D) under its source in the answer sheet.
Task 3.3.3 根據所得之原始樣品的pH值，請確定每個樣品的來源，並在答案紙寫下其樣品名稱（A到D）。

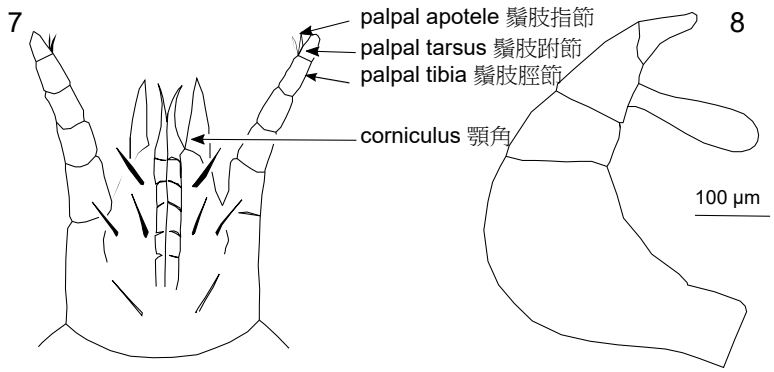
樣品來源 (Source)	Inferior vena cava 下腔靜脈	Pulmonary artery肺動脈	Pulmonary vein肺靜脈	Urine 尿液
Sample name (A-D) 樣品名稱（A到D）				

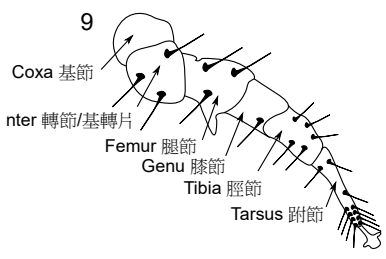
Task 3.4 Determine whether each of the following statements is true or false and check your answer in the answer sheet.(indicate your answer with "✓" in the related box)
Task 3.4 請確認以下每個陳述是正確還是錯誤，並在答案紙上打勾"✓"顯示正確答案。

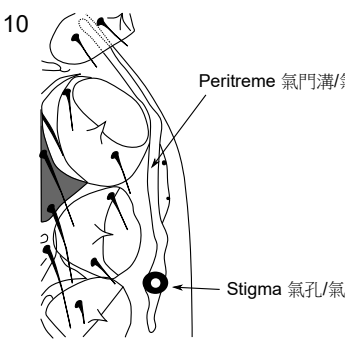
statement 說明	**對 True**	**錯 False**
1. Partial pressure of O_2 (PO_2) in right atrium is higher than that of pulmonary vein. 右心房的氧分壓（PO 2 ）高於肺靜脈的氧分壓。		
2. Partial pressure of CO_2 (PCO_2) in pulmonary artery is higher than that of pulmonary vein. 肺動脈的二氧化碳分壓(PCO2)高於肺靜脈的二氧化碳分壓。		
3. In a healthy subject with hyperventilation that has led to decreased PCO_2 in the blood, the kidney tries to increase the amount of bicarbonate ions in inferior vena cava. 健康受試者在過度換氣時會導致血液中二氧化碳分壓下降，此時腎臟會增加下腔靜脈碳酸氫根離子的數量		
4. During fasting that leads to increased amount of lactic acid in blood, the kidney tries to decrease the amount of hydrogen ions in urine. 禁食期間會導致血液中乳酸含量增加，此時腎臟將試圖減少受試者尿液中氫離子的量。		
5. In a subject with normal respiration and without hyperventilation, if the hydrogen ion pumps of the nephrons get inhibited and hydrogen ion secretion into the tubular fluid gets decreased, the amount of bicarbonate ions in pulmonary artery would be less than normal. 在呼吸正常且無過度換氣之受試者中，如果腎元的氫離子幫浦受到抑制並且分泌到腎小管中的氫離子量減少，則肺動脈中的碳酸氫根離子的量將低於正常值。		











Student Code:

ANSWER SHEET - ANIMAL SYSTEMATICS, PHYSIOLOGY AND ANATOMY答案卷 - 動物系統分類學、生理學與解剖

Table A.1: indicate the life mode of each specimen with "✓". **(3 points for each true column)**

Specimen letter 標本編號

Life mode 生活形式	A	B	C	D
Soil-dwelling predator 生活在土壤裡的捕食者				
Free-living predator 行自由生活的捕食者				
parasite 寄生性蟎				
saprophagous mite 腐食性蟎				
phytophagous mite 植食性蟎				

Table A.2: **(6 points for each true row)**

Step / Specimen	1	2	3	4	5	6
Family Holothyridae	1a	2b	3b	4a	7b	-
Slide No. A						
Slide No. B						
Slide No. C						
Slide No. D						

Experiment B:

Task B.1.1: **(1 point for each question)**

Question number	True	False
Q1		
Q2		

Task B.1.2: **(1 point for each cell) (Do not use each number more than once)**

Characters	Oral sucker 口部吸盤	Rear sucker 身體後側吸盤	Anal pore 肛孔	Male genital pore 雄性生殖孔	Female genital pore 雌性生殖孔	Nephridiopore 腎孔
Matching No.						

Task B.2.2 (1 point for each)

Question number	True	False
Q1		
Q2		
Q3		
Q4		
Q5		
Q6		
Q7		
Q8		

Task 3.1。每個答案**0.5**分

	QT interval (間距)

At the beginning 運動剛開始	
1st minute 運動開始後第一分鐘	
2nd minute 運動開始後第二分鐘	
3rd minute 運動開始後第三分鐘	

表 **3.2.A.1-4**

Source 變異來源	Sum of Squares 平方和 （每個1分）	Degrees of Freedom 自由度 （每個0.5分）	Variance Estimate (MS) 方差估算(均方) （每個0.25分）	F Ratio F比例值 （1分）
Between 組間變異度				
Within 組內變異度				=======
Total 總變異度			======	======

Task 3.2.A.5。（**1**分）

P value **P**值	

Task 3.2.B（**1**分）

P值	

Task 3.2.C.1（**2**分）

Yes(有顯著差異**)**	

No(沒有顯著差異)	

Task 3.2.C.2。（每個**1**分）

Statement 說明	True 對	False 錯
1		
2		
3		

Task 3.3.1（每個空格**0.5**分）

sample	A	B	C	D
volume of NaOH added (microliters) 所加入NaOH之體積 (microlitters)				
pH of Treated sample 處理後樣品之pH值				

Task 3.3.2（每個**0.5**分）

sample 樣品	A	B	C	D
pH of original sample 原始樣品之pH值				

Task 3.3.3（各**1**分）

Source 樣品來源	Inferior vena cava 下腔靜脈	Pulmonary artery 肺動脈	Pulmonary vein肺靜脈	Urine 尿液
Sample name 樣品名稱（A到D）				

Task 3.4（各**1**分）

statement	**True**	**False**

說明	對	錯
1		
2		
3		
4		
5		