THEORETICAL EXAM 1 理論第一部分

OVERVIEW 綜覽

This exam lasts three hours 本部分測驗共需3小時

Q 1-13 Animal biology 動物生物學
Q 14-15 Biosystematics 生物系統分類
Q 16-24 Cell biology 細胞生物學
Q 25-30 Ecology 生態學
Q 31-33 Ethology 行為學
Q 36-45 Genetics & Evolution 遺傳及演化學
Q 46-50 Plant biology 植物生物學

Each correctly answered question gives you 1 point, i.e. all four statements are correct.
每題正確答對可得1分，亦即四項敘述都答對
If only three statements in a question are correct, you get 0.6 points
若只答對3個敘述，得0.6分
If only two statements in a question are correct you get 0.2
若只答對2個敘述，得0.2分
If only one statement in a question is correct you get 0.0
若只答對1個敘述，得0分
If no statements in a question is correct, you do not get any points.
若全答錯4個敘述，得0分

Q. 1

In mammals, a high blood pressure is needed to achieve a high blood flow (cardiac fluid flow) and to overcome any vascular resistance against the flow of blood. In order to make deductions about blood flow, Poiseuille's Law is used (Fig.).
在哺乳動物中，需要以高的血壓來達到高的血流量(心臟流體流量)及克服血管對血液流動的阻力。Poiseuille定律可以用來判斷血流量 (圖)。

$$Q = \frac{\Delta V}{\Delta t} = \frac{\Delta p \pi r^4}{8 \eta L}$$

$$\Delta p = R \Delta V$$

Poiseuille's Law: Q = fluid flow, V = volume, t = time, p = pressure, r = vessel radius, η = viscosity (constant for a given temperature and fluid type), L = vessel length, and R = flow resistance.
*Poiseuille*定律: *Q* = 血流, *V* = 容量, *t* = 時間, *p* = 壓力, *r* = 血管半徑, η = 黏度, 在溫度和流體類型一定時，為一常數, *L* = 血管長度, *R* = 流動阻力

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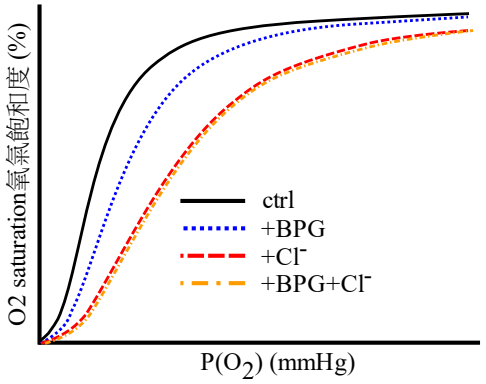
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE正確	FALSE錯誤
Assuming similar blood flow in a wide and a narrow artery of the same length, the change in mean blood pressure is greater in the former 假設在兩條相同長度動脈中的血流量相同，較寬的動脈平均血壓變化比狹窄的要大	○	○
Increased atherosclerosis leads generally to faster blood flow in the circulation 動脈粥樣硬化的增加，通常導致血流循環速度的增加	○	○
Comparing monozygotic twins, one living at sea level and the other at 3,000 m, the latter will have a higher resistance to blood flow 比較同卵雙生的雙胞胎，一個生活在海平面高度、另一個在3000公尺高地，後者的血流阻力較高	○	○
In a specific patient suffering from atherosclerosis, the radius of blood vessels on average had decreased by 1/6, which caused blood pressure to double to maintain the blood flow 在患有動脈粥樣硬化的特定病人，血管半徑平均減少1/6，則要有兩倍的血壓才能維持血液流動	○	○

Q. 2

O_2-binding or -affinity to hemoglobin is affected by specific anions, in particular 2,3 bisphosphoglycerate (BPG) and chloride (Cl^-), which are present in red blood cells and bind to the hemoglobin molecule at specific sites (Fig.).

血紅素與O_2的結合或親和力受特定陰離子的影響，特別是2,3二磷酸甘油酸(BPG)和氯離子(Cl^-)，二者存在於紅血球並與血紅素在特定位置結合(圖)。



Hemoglobin saturation curves for hemoglobin without anions (ctrl) and with BPG, chloride or both, as a function of the partial pressure of oxygen in the blood.
血紅素飽和曲線包括沒有陰離子的血紅素*(*控制組*)*，有 *BPG*、氯離子或兩者皆有的血紅素，其在血液中氧分壓的變化

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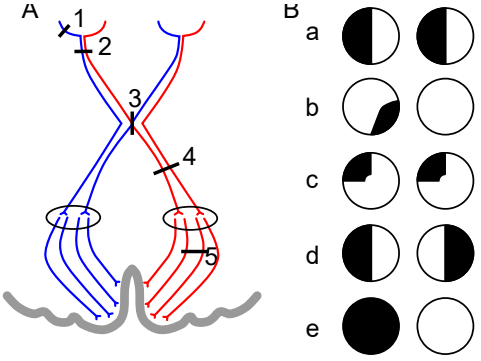
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE正確	FALSE錯誤
If peripheral tissue lacks oxygen, red blood cells produce more BPG 若周邊組織缺氧，紅血球會製造更多的BPG	○	○
At high altitudes, mutations leading to changes from polar to non-polar amino acid residues in the BPG binding site of the hemoglobin molecule will be favourable for the affinity of O_2 to hemoglobin in the lungs 在高海拔處，突變導致血紅素的BPG結合部位的胺基酸由極性變成非極性，會有利於O_2在肺部對血紅素的親和力。	○	○
It is likely that chloride and BPG bind at different sites in the hemoglobin molecule 氯和BPG與血紅素結合的位置可能不同	○	○
BPG decreases the total oxygen saturation capacity of the hemoglobin BPG會減少血紅素的總氧飽和力	○	○

Q. 3

In humans, lesions in the central visual pathways may have different consequences to the visual field (Fig.).
在人類，中央視覺路徑病變可能對視野造成不同的後果 (圖)。



A, lesions (1–5) in the central visual pathways (seen from above); B, visual field deficits (a-e, deficits shown in black, as seen by the affected person) caused by lesions in A.
A，中央視覺路徑的病變(1-5) (見上圖)；B，在A圖中的病變所引起的視野缺陷(a-e，缺陷以黑色表示，如同在受影響的人所見)

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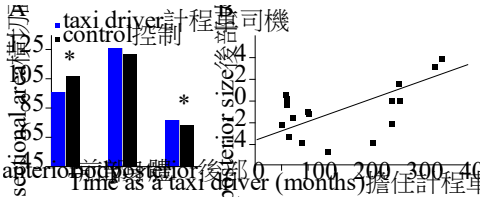
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE正確	FALSE錯誤
Lesion 2 corresponds to visual field deficit a 病變2對應視野缺陷a	○	○
Lesion 3 corresponds to visual field deficit d 病變3對應視野缺陷d	○	○
Lesion 4 corresponds to visual field deficit e 病變4對應視野缺陷e	○	○
Lesion 5 corresponds to visual field deficit c 病變5對應視野缺陷c	○	○

Q. 4

The 2014 Nobel Prize winners in medicine demonstrated that, the hippocampal (HC) region in the human brain stores spatial memory and facilitates spatial orientation. People using space extensively such as taxi drivers may depend on a well-developed HC. A study focused upon differences in HC between London taxi drivers and a control group, and its results are shown in Figs A-B.
2014年諾貝爾醫學獎得主，證實了人腦海馬(HC)區系儲存空間記憶並有利於

空間的探索，人對空間高度的使用者如計程車司機會依賴其發育良好的海馬(HC)。一項針對倫敦計程車司機及以一般人為控制組的研究，了解海馬(HC)的差異，結果顯示如圖A及B。



A, variation between taxi drivers and others in size of the entire hippocampus (HC, body) and its anterior and posterior parts separately (, significantly different); B, correlation between volume change (grey matter) of posterior part of HC and employment time as taxi driver (from Maguire et al. 2000).*
A 計程車司機及其他人海馬*(HC)*整體全區及前部和後部分開等分別的差異*(*,*有顯著差異*significantly different)*
B 海馬*(HC)*後部體積改變*(*灰質*)*與計程車司機受雇用時間的關聯

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Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE正確	FALSE錯誤
Taxi drivers have significantly larger hippocampus than the control group 計程車司機和控制組的人員相較有較大的海馬區	○	○
Spatial navigation may be located in the posterior part of hippocampus 空間領航能力可能存在海馬區的後半部	○	○
The study provides evidence that some people are predisposed genetically to become better London taxi drivers than others in the population 研究結果顯示: 在族群中，某些人在遺傳上的傾向比其他人更容易成為較佳的倫敦計程車司機	○	○
The study supports the traditional view that the hippocampus is only involved in short-term memory 此研究支持傳統的觀點海馬區只負責短期記憶	○	○

Q. 5

In a study on kidney function, several parameters were measured in three healthy persons A–C (Table).
對腎功能的研究，測定三個健康人A-C的幾個測量參數(表)

Parameter values describing kidney functions. Assume that 1 millimol O_2 has a volume of 22.4 ml (milli-litre).
描述腎功能的參數值。假設*1 millimol*的O_2分子體積為*22.4 ml (milli-litre)*。

	Person A	Person B	Person C
Glomerular filtration rate (GFR), ml/min 絲球體濾過率	135	140	135
Renal blood flow (RBF), ml/min 腎血流量 (RBF)	1190	1240	1210
Urine production, ml/min 尿液產生量	1.0	1.1	0.9
O_2 concentration in arterial blood, ml/L 動脈血中的 O_2 濃度	200	200	199
O_2 concentration in venous blood from the kidneys, ml/L 腎靜脈血液中 O_2 濃度	184	186	184
Na^+ concentration in plasma, mmol/L 血漿中的Na^+濃度	137	136	139
Na^+ concentration in urine, mmol/L 尿中的 Na^+濃度	121	120	119

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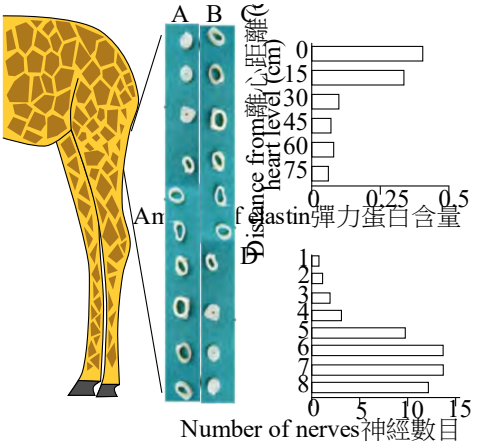
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE正確	FALSE錯誤
The amount of Na^+ filtrated in the kidneys is largest for person A 在腎臟Na^+過濾量最大的人是A	○	○
The amount of Na^+ excreted in the kidneys is largest for person B Na^+ 在腎臟排泄量最大的人為B	○	○
Renal oxygen consumption is largest for person C 腎臟的氧耗量最大的人是C	○	○
The amount of Na^+ reabsorbed per mol of O_2 used is largest for person B 消耗每mol的O_2，對Na^+再吸收量最大者為B	○	○

Q. 6

The giraffe has the highest mean arterial blood pressure of any mammal. This renders it vulnerable to leg oedema. How the animal prevents this was studied with a focus on vascular adaptations in the leg (Fig.).
在哺乳動物中，長頸鹿的平均動脈血壓最高，因而腿部容易水腫。進行動物如何防止水腫的研究重點可放在腿部血管的適應(圖)。



A-B, a series of cross-sections of leg arteries (a true and a false option); C, amount of elastin in arterial walls at increasing distance from the heart; D, number of nerves along arteries in the legs (bars 1-4: 15-30 cm from heart, bars 5-8: ≥ 30 cm from heart) (from Petersen et al. 2013, Østergaard et al. 2011).
A-B為腿動脈的系列截面圖(一真一假)；C為離心臟距離增加時，在動脈壁中彈力蛋白的量；D為沿著腿部動脈的神經數目(橫條1-4代表離心臟15-30 cm，橫條5-8代表離心臟≥ 30 cm)

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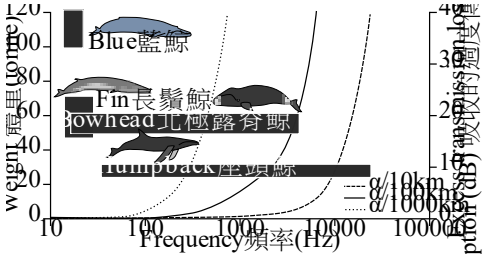
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE正確	FALSE錯誤
Since arterial pressure at entrance to skull has to be similar to other mammals (*c.* 100 mm Hg), blood pressure down at the level of the hooves becomes very low 因頭骨入口處的動脈血壓須與其他哺乳動物相似(100毫米汞柱)，在其蹄處的血壓會降到極低	○	○
The figures show how the diameter and wall thickness of arteries in the leg are expected to change; A is correct and B is wrong 腿部動脈直徑和壁厚度的變化圖中，圖中的A正確而B錯誤	○	○
Femoral arteries become more rigid distally toward the leg extremities 愈往腿部末端，股動脈會變得愈僵硬	○	○

The giraffe has a special arterial mechanism above its knees to regulate blood pressure in the leg extremities
在膝蓋以上，長頸鹿有特殊動脈機制來調節其腿部末端血壓

Q. 7

Whales rely on sound for communication in a diverse way. In a study, vocalization measurements of two distantly related whales, Humpback and Bowhead, were compared to literature data from two other species (Fig.).
鯨魚有不同方式以聲音溝通。在一項研究中，對座頭鯨與北極露脊鯨兩種親緣較遠的鯨魚做發聲測量，與文獻資料中兩個其他物種比較(圖)。



Frequency bands of vocalizations (horizontal bars) and range of body mass for 4 whale species together with the transmission loss from sound absorption in seawater at 10, 100 and 1000 km from source (from Tervo et al. 2012).
4種鯨魚(Blue藍鯨, Fin長鬚鯨, Humpback座頭鯨, Bowhead北極露脊鯨)的發聲頻率帶(水平條帶)及體重範圍，及聲音在海水中距聲源10、100和1000公里被吸收的傳輸損耗。

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Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE正確	FALSE錯誤
Larger whales are expected to produce lower frequency signals than smaller whales do 大鯨魚產生的頻率信號應比小鯨魚產生的低		
Based on vocalizations, the Blue whale is expected to have more complex social behaviour than the Humpback. 基於發聲，藍鯨的社會行應比座頭鯨更複雜。		
Humpback and Bowhead have a signalling frequency that makes it possible for them to have high inter-annual mating site-fidelity 座頭鯨與北極露脊鯨所具有的信號頻率，使牠們能準確定位每年的交配地點。		

The similar vocalization patterns of Humpback and Bowhead whales are most likely due to convergent evolution
座頭鯨與北極露脊鯨的發聲模式類似，最可能是因趨同演化的結果

Q. 8

The coldwater Goldfish have a high tolerance to anoxia. They can degrade carbohydrates to lactate and further reduce lactate to ethanol. In a study running for 12 hours with two groups of goldfish, data on these processes were gathered (Table).
冰水域的金魚對缺氧很能忍耐。牠們可分解碳水化合物為乳酸，並進一步還原乳酸為乙醇。以兩組金魚做12小時研究，並收集過程中的資料(表)。

Concentration of lactate and ethanol in fish tissue, and compared with levels in the water of the aquarium, measured in terms of fish mass (kg) (from Shoubridge & Hochachka 1980).
以魚體的質量(公斤)測量魚組織中乳酸和乙醇的濃度，並與水中含量比較。

	Fish tissue 魚組織	Fish tissue 魚組織	Water in aquarium 水族箱的水	Water in aquarium 水族箱的水
	Lactate 乳酸 mmol/kg	Ethanol 乙醇 mmol/kg	Lactate 乳酸 mmol/kg	Ethanol 乙醇 mmol/kg
Control控制組: + O_2	0.18	0.00	0.00	0.00
Treatment 實驗組: no O_2	5.81	4.58	0.00	6.63

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Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

TRUE正確 FALSE錯誤

During the study, lactate accumulation in fish tissue amounts to about half of the total ethanol produced
在此研究中，乳酸累積在魚組織的量約為所有產生之乙醇

總量的一半

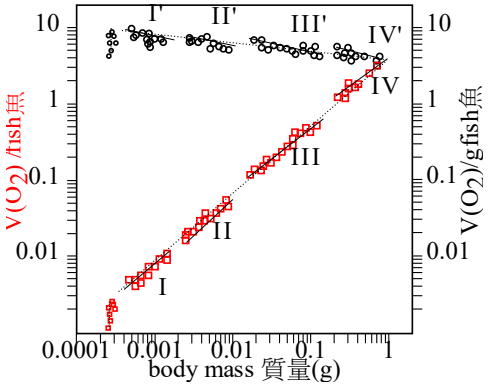
Goldfish are able to survive long periods under ice cover
金魚在冰的覆蓋下生存較長久

Goldfish have no tolerance to ethanol
金魚對乙醇不能容忍

Transformation of lactate to ethanol may be a means of avoiding acidosis
乳酸轉化為乙醇可作為避免酸中毒的一種方法

Q. 9

Size-scaling metabolism is of general importance in biology, i.e. relating metabolic processes to body mass. In a study, the metabolic rate of the fish Japanese Flounder was measured during its early life stages (Fig.).
尺度大小代謝在生物學上很重要，例如代謝過程與身體質量關係。某研究要測量日本比目魚(Japanese Flounder)在生命早期的代謝速率變化，如下圖



Ontogenetic changes in rate of respiration (VO2, squares, left Y-axis) and mass-specific rate of respiration (VO2/M, circles, right Y-axis) with increase in body mass M. Four early life stages (I-IV) from hatching were measured (from Yagi & Oikawa 2014).
測量比目魚生命早期，隨質量增加呼吸速率*(VO2,*方格,左側*Y*軸*)*及質量特定呼吸速率*(VO2/M,*圓圈,右側*Y*軸*)*的改變

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Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE正確	FALSE錯誤
Just after hatching, respiration increases without any increase in M 剛孵化後，呼吸速率增加，但身體質量沒增加		
For a given unit of body mass, the rate of respiration		

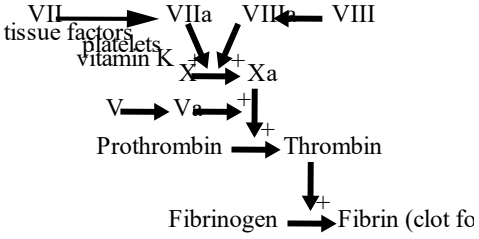
seems to increase with the age of fish
在一特定的身體質量下，呼吸速率會隨魚體的年齡增加而增加

The general equation for the lower curve in the figure is $V_{O2}=aM^b$ (*a*: scaling parameter; b: scaling exponent)
圖中下面曲線的方程式是：$Vo2=aM^b$(a為尺度參數，b為尺度指數)

In the log-log plot there is a continuous linear increase in V_{O2} over 4 orders of magnitude of body mass
在log-log繪圖中，Vo2與身體質量的4次方成線性關係

Q. 10

In a classic experiment (1935) by the Danish Nobel laureate H. Dam, chickens that were fed a lipid-depleted diet developed hemorrhage and started bleeding within a couple of weeks, because their uptake of vitamin K was inhibited. The bleeding may be stopped by adding vitamin K to the food (Fig.).
由1935丹麥諾貝爾獎得主H.Dam的典型研究指出，餵食缺乏脂質飲食的雞會發生出血現象，且於幾週後開始流血。因牠們維生素K的吸收受到抑制，假如在食物中添加維生素K，流血狀況會停止(圖)。



The blood coagulation cascade. Several of the pathways involved in coagulation are omitted for reasons of simplification. +, positive regulation; a, active form of compound.
血液凝固一連串反應，為了簡化原因許多參與血液凝固的路徑被忽略。
"+"表示正向調節，*a* 為化合物的活化態

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Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE正確	FALSE錯誤
A mutation called Factor V Leiden causes patients to produce a highly active form of factor V (Va in Fig.), therefore there is an increased risk of embolism 因子V突變會導致病人製造多量的因子V活化態(Va)，如此		

會增加栓塞的風險

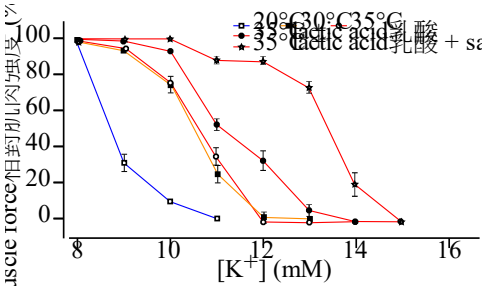
Bone-marrow insufficiency leads to increased coagulation
骨髓機能不全可使血液凝固能力增加

A lipid-rich diet may promote coagulation
富含脂質的飲食可促進血液凝固

People, suffering from a high risk of embolism, may be treated with heparin (antithrombin activator)
有高風險血栓的病人可接受肝素(抗凝血酶活化劑)的治療

Q. 11

Muscle fatigue during work results in increasing extracellular concentration of K^+. This may be modified by changes in physiological temperature and lactic acid level, and can be treated medically with the drug salbutamol. This was studied experimentally with rat muscles stimulated electrically once every 20 minutes (Fig.).
工作導致的肌肉疲勞起因於細胞外液的K+濃度增加。此種狀態可被生理溫度及乳酸濃度調節。也可利用Salbufamol此種藥物治療。老鼠肌肉以每20分鐘電刺激一次的實驗結果如下圖。



Effect of warm-up at 20°C, 30°C and 35°C before work or addition of lactic acid or a combination of lactic acid and salbutamol at 35°C on the change in muscle force (as percent of force at 4 mM [K^+]) (from Pedersen et al. 2003).
觀察作功前溫度由*20*°上升至*35°C*暖機的效用或添加乳酸，或在*35°C*時同時添加乳酸及*salbufamol*，對肌肉強度改變的影響 *(*以在*4 mM [K^+]*下的強度百分比表示*)*

Node Id: **bd5a1ffc8d924f23623f2e60**

Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE正確	FALSE錯誤
During work, contracting muscles lose K^+, leading to increased extracellular [K^+] 工作時，收縮狀態下的肌肉失去K^+，導致細胞外液K^+增加	○	○

Temperature increase, and addition of lactic acid and drug operate mainly additively
溫度上升，添加乳酸及藥物為加成性作用

The study design is incomplete
此研究是不完整的

At physiological temperature (here 35°C), lactic acid protects completely against muscle fatigue
在生理溫度(35°C)下，乳酸可完全保護肌肉免於疲勞

Q. 12

Four groups (A-D), each of 12 diabetic rats, received different diets for four weeks (Table). Researchers wanted to see if a traditional anti-diabetic plant (containing stevioside) had any effect.
四組(A-D)具有糖尿病的實驗鼠，每組12隻，接受不同的飲食4週(表)。研究者想知道傳統的抗糖尿病植物(含糖苷 成份)是否有任何影響。

Four diets (A–D) and measurements of parameters related to diet. BW, body weight. If figures are different, they are here assumed to be significantly so (from Jeppesen et al. 2006).
四組*(A-D)*飲食控制與相對的測量參數 *BW=*體重 *(*若數字不同，是假定有意義*)*

Concentration, blood pressure or body weight 濃度、血壓或體重	Group A: **Chow** = Standard carbohydrate-rich diet (標準富含碳水化合物飲食)	Group B: **Chow** + **SVS** (SVS = 0.03 stevioside 糖苷 g/(kg BW day)	Group C: 20% **Chow** + 80% **SPI** **(SPI =** Soy bean Protein Isolate 分離黃豆蛋白)	Group D: 20% **Chow** + 80% **SPI** + **SVS** (SPI **=** Soy bean Protein Isolate 分離黃豆蛋白 + SVS = 0.03 stevioside 糖苷 g/(kg BW day)
Fasting blood glucose 禁食血糖濃度 (mmol/L)	3.4	3.4	3.4	3.4

Plasma glucose 血漿血糖濃度 (mmol/L) after 240 min	991	757	819	439
Plasma insulin 血漿胰島素 (ng/mL) after 30 min	11	19	9	24
Plasma insulin 血漿胰島素 (ng/mL) after 240 min	316	375	218	249
Plasma glucagon血漿升糖素 (pg/ml) after 240 min	21918	17024	26200	17529
Total cholesterol總膽固醇 (mmol/L)	2.5	2.3	2.1	1.8
Systolic blood pressure at start開始實驗的收縮壓 (mm Hg)	175	171	165	170
Systolic blood pressure after 4 weeks 4週後收縮壓 (mm Hg)	178	148	173	155
BW 體重(g)	226	221	222	204

Node Id: **b7b2e04a81586b3bbd4336d1**

Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

TRUE正確 FALSE錯誤

A pure chow diet is not recommended for diabetic rats as it increases cholesterol level and blood pressure
純chow食物不建議用在糖尿病鼠，因會增加膽固醇含量及血壓

SVS and SPI seem to have a synergetic effect
SVS與SPI有協同增加效用

Stevioside is harmful to diabetics
糖苷對糖尿病患者有害

When fasting, blood glucose results show that there is no statistical difference between the four groups of rats
禁食時，血糖結果顯示4組實驗鼠間沒有統計性的差異

Q. 13

Strategies for regulating body temperature include controlling the movement of blood between the body core and surface and by countercurrent heat exchangers (Fig.).
體溫調節的策略，包括控制身體核心與體表之間的血液流動及熱逆流交換(圖)

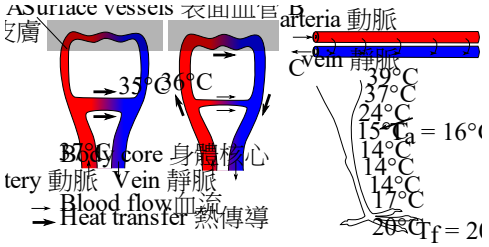


Figure. A, Regulation of heat conductance at body surface; B, thermal countercurrent system; C, body temperature in a bird limb. T_a = ambient temperature. T_f = floor temperature. (from Willmer et al. 2005).
圖*A*身體表面熱傳導的調節，圖*B*熱逆流系統，圖*C*在鳥四肢的體溫；T_a = 氣溫；T_f = 地表溫

Node Id: **27d0487e0e6363e6c4a7d9a6**

Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE正確	FALSE錯誤
In Fig. A, the shunt vessel to the left is exposed to a lower exterior temperature than the one to the right 圖A中，分流至左邊的血管較往右邊的血管所暴露的外在溫度較低		
In Fig. B, a countercurrent system often seen in animals		

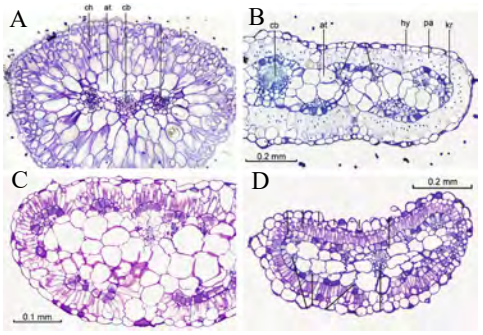
from warm habitats is shown
圖B中的逆流系統多見於溫暖棲地的動物

The animal in Fig. C lives in a warm habitat
圖C的動物生活在溫暖的棲地

In Fig. C, the venous blood at the arrow has a temperature between 14-15°C
圖C中的箭頭處，靜脈血的溫度約在14-15°C之間

Q. 14

Among plant families, grasses and Chenopodiaceae contain many species using the C4 photosynthesis pathway, and many C4 species have evolved independently from C3 ancestors within these families. The figures show cross-sections of C3 and C4 leaf types from different species.
在植物的各科中，禾草及藜科(Chenopodiaceae)具有許多利用C4光合作用途徑的植物，而且許多C4植物是分別從該科內的C3植物祖先所演化而來。下圖顯現不同物種的C3和C4型的葉橫切面。



Cross section of leaves from: A, C3 species; B, C4 species; C–D, C3 or C4 species. ch = chlorenchyma; at = aqueous tissue; cb = central vascular bundle; hy = hypodermis; pa = palisade cells or mesophyll cells; kr = Kranz cells or bundle-sheath cells (from Freitag & Kadereit 2014).
各種葉橫切面，*A*圖為*C3*植物；*B*圖為*C4*植物；*C-D*圖為*C3*或*C4*植物。*ch*=綠色組織；*at*=水生組織；*cb*=中央維管束；*hy*=下皮層；*pa*=柵狀細胞或葉肉細胞；*kr*=*Kranz*細胞或束鞘細胞。

Node Id: **f290bf6730e991eb3a18d355**

Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤。

	TRUE 正確	FALSE 錯誤
Evolution of C4 species is favoured in a climate of increasing drought, salinity and heat, but with no change in CO_2 level 在乾旱、鹽度及溫度漸增，但CO_2量沒有改變的環境中，有		

利於C4植物的演化。

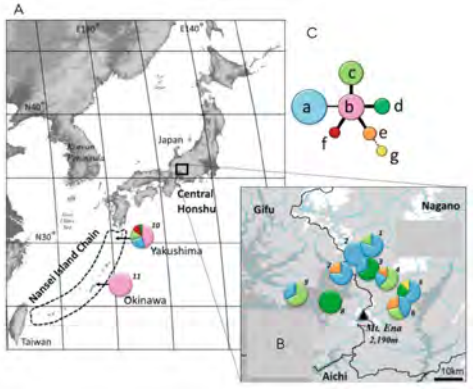
Leaf in Fig. C is from a C3 plant
圖C是來自C3植物

Leaf in Fig. D is from a C3 plant
圖D是來自C3植物

During a period of global CO_2 increase, without a concomitant increase in temperature, the global distribution of C4 plants is likely to expand
在全球CO_2增加的期間，在沒有伴隨溫度上升的情況下，C4植物在全球的分布將會擴大

Q. 15

Genetic variation in three chloroplast DNA (cpDNA) regions was studied in populations of a rare orchid *Vexillabium yakushimense* . Material from nine populations on Honshu and two populations on the Japanese Nansei Islands (Yakushima and Okinawa) were sampled (Fig.).
利用稀有蘭花(Vexillabium yakushimense)的葉綠體DNA(cpDNA)中的三段來進行族群遺傳研究，材料是來自日本本州(Honshu)的9個族群以及琉球群島中的2個族群 (如圖)。



A–B, geographic distribution of 7 cpDNA haplotypes of V. yakushimense. Pies are populations, and each colour indicates a haplotype. The size of each coloured slice shows proportion of each haplotype in the population; C, parsimony network: circles a to g are seven different haplotypes in the 11 populations. Circle size indicates frequency of each haplotype. Linked haplotypes differ by only 1-2 mutations (from Saeki et al. 2014).
*A-B*圖分別此蘭花的*7*個*cpDNA*單倍型的地理分布。圓圈代表不同族群，且每個顏色代表一個單倍型，每個扇形面積大小表示該單倍型在族群中所佔的比例。*C*圖為簡約網絡，圓圈*a-g*為*11*個族群中的*7*種不同單倍型，圓圈大小代表每種單倍型的所占比例，兩相鄰的單倍體間僅有*1-2*個突變差異。

Node Id: **55db9eb5a734cbb03c366ae3**

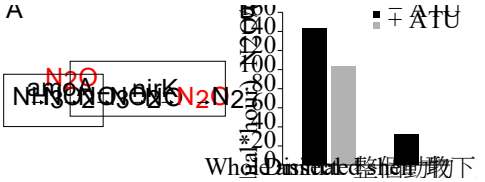
Indicate if each of the following statements is true or false.

指出下列各敘述是正確或錯誤。

	TRUE 正確	FALSE 錯誤
The origin of the orchid in Japan might be mainland Honshu because of the high genetic diversity observed here 這種在日本的蘭花可能是起源自本州(Honshu)主要陸塊，因為該地的遺傳歧異度高。	○	○
It is likely that a founder effect can been seen in Okinawa 在琉球(Okinawa)本島的族群，可觀察到創始者效應	○	○
CpDNA is better than nuclear DNA in revealing maternal origins of individuals 以葉綠體DNA來分析個體的母系起源，比利用細胞核DNA的效果佳。	○	○
The study suggests that mountains and river basins are more effective barriers to gene flow than the sea separating islands 就基因流而言，本研究顯示山區與河谷的地理隔離比海洋區隔島嶼來得有效。	○	○

Q. 16

Nitrous oxide (N_2O) is a greenhouse gas, produced by bacteria through either nitrification or denitrification (Fig. A). Many aquatic invertebrates (e.g. zebra mussel) emit N_2O, due to the activity of bacteria in their gut and the biofilm covering their shell (Fig. B, Table).
一氧化二氮 (N_2O) 為一種溫室氣體，能藉由細菌的硝化作用與脫氮作用生成（圖 A ）。許多水生的無脊椎動物（如斑馬貽貝），腸道中與殼上生物膜的細菌也會產生 N_2O（圖 B 與表）。



A, pathways for N2O production in bacteria, with key genes amoA (encoding ammonia monooxygenase AMO, nitrification) and nirK (encoding nitrite reductase NIR, denitrification); B, N2O emission from living zebra mussels and shells dissected from living animals, incubated with (+ATU) or without (-ATU) allylthiourea, which is a specific inhibitor of nitrification (from Svenningsen et al. 2012).
A：細菌產生 *N_2O* 的代謝路徑，主要參與的基因有 *amoA*（氨單氧生成酶, *AMO*，硝化作用）與 *nirK*（亞硝酸還原酶, *NIR*，脫氮作用）。 B：在有無添加烯丙基硫脲（ *+ATU or -ATU*，一種脫氮作用的抑制劑）的條件下，量測整個斑馬貽貝與其單獨外殼的 *N_2O* 產生量。*(from Svenningsen et al. 2012*

Expression sites of key genes for N_2O production in zebra mussels. amoA produces the enzyme AMO, which catalyses nitrification; nirK produces the enzyme NIR, which reduces nitrite.
斑馬貽貝產生 N_2O 主要基因的表現位置。*amoA* 表現 *AMO* 酵素（催化硝化作用），*nirK* 表現 *NIR*（還原亞硝酸鹽）

Material 材料	Expression of 表現出	Expression of 表現出
	amoA (cDNA copies/mg)	*nirK* (cDNA copies/mg)
Gut 腸道	–	205-1585
Shell biofilm 殼上生物膜	200-2000	–

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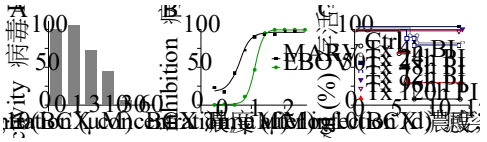
Indicate if each of the following statements is true or false.

請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
Most N_2O in zebra mussel is produced by bacteria inside the animal (e.g. in gut) 斑馬貽貝主要產生 N_2O 的細菌存在動物體內（例如：腸道中）。	○	○
The N_2O production from mussel shells is mostly due to nitrification in their biofilm 斑馬貽貝主要產生 N_2O 是肇因於生物膜上的硝化作用。	○	○
Nitrification and denitrification are equally important for N_2O emission from mussels 斑馬貽貝 N_2O 的生成，硝化作用與脫氮作用同等重要。	○	○
Increasing nitrate (NO_3^-) concentrations in lakes (e.g. from agricultural run-off) will increase N_2O emissions from freshwater invertebrates 湖中硝酸鹽 (NO_3^-) 濃度增加（例如：農業行為）會增加淡水無脊椎生物 N_2O 的生成。	○	○

Q. 17

Filoviruses, e.g. Ebola (EBOV) and Marburg (MAR), cause haemorrhagic fever. Case fatality rates are >90%, and among the highest reported for any human pathogen. Vaccine or therapeutic products are not available. Recently, however, researchers tested an adenosine analogue, BCX, which seemed to improve survival of filovirus-infected humans (Fig.).
絲狀病毒科，如伊波拉病毒 (EBOV) 與 馬爾堡病毒 (MAR)，會導致受感染者有出血熱的臨床徵兆。與目前已知的人類病源相比，是具有最高的死亡率，大於 90%。目前疫苗與有效的治療方法仍然闕如。許多研究者嘗試採用 BCX（腺苷類似物），來增加受到絲狀病毒科感染患者的存活率（如圖）。



A, effect of BCX on viral RNA polymerase activity; B, inhibition of EBOV and MAR growth in infected stem cells treated with BCX; C, survival of infected mice after BCX treatments (Tx) administered up to 14 days, beginning either before infection (BI) or post-infection (PI) at varying delays (from Warren et al. 2014).
A：*BCX* 對病毒 *RNA* 聚合酶的影響。B：*BCX* 處理受到 *EBOV* 與 *MAR* 感染的幹細胞，對*EBOV* 與 *MAR*生長的抑制程度。C：小鼠受到感染後，在不同時間，感染前 *(BI)* 或感染後 *(PI)*，以 *BCX* 進行治療 *(Tx)* 的存活率。

Node Id: **86cce4e5b5c1b005755887a6**

Indicate if each of the following statements is true or false.
問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
As an adenosine analogue, BCX affects viral gene transcription 由於 BCX 是一種腺苷類似物，所以會影響病毒的轉錄作用。	○	○
BCX is applicable exclusively against ebola BCX 可以對抗伊波拉病毒。	○	○
BCX can successfully (>50% survival) be administered up to 10 days after Ebola infection BCX 可以對抗伊波拉病毒。	○	○
The half-maximal inhibition of BCX is achieved at a concentration of about 10 µM BCX 的 50% 最大抑制濃度約為 10 µM	○	○

Q. 18

Botanists may identify plants to family using diagrams, showing the

different floral parts (Fig. A). According to the ABC gene model, development of a flower is based on expression of the A-, class-B- and C-genes. In dicots, sepals develop if gene-A is expressed alone, petals develop if both gene-A and gene-class-B are expressed, stamens develop if both gene-class-B and gene-C are expressed, and an ovary develops if only gene-C is expressed.
植物學家在鑑定植物屬於哪一科時，經常會使用圖形進行分類，特別是花的各部形態（圖 A ）。根據 ABC 基因模式，花的發育會根據 A 基因，B 群基因 與 C 基因的表現來決定。雙子葉植物中，當 A 基因單獨表現時，萼片會發育。A 基因與 B 群基因共同表現時，花瓣會發育。B 群基因與 C 基因共同表現時，雄蕊會發育。C 基因單獨表現時，子房會發育。

A, diagram of a monocot flower; B, tulip flower (a monocot), parts of the flower are removed in photo to the right; C, the ABC gene model of monocot flower development (I, ovary; II, stamens; III, petals; IV, sepals; the latter two are similar in most monocots). Gene-class-B consists of 3 genes B1–B3 (from Johansen et al. 2006).
A ：單子葉植物花的構造圖； B ：鬱金香（單子葉植物）的花，右圖為移除部分的花部。 C ：單子葉植物花的發育過程的 *ABC* 基因模式（*I*：子房，*II*：雄蕊，*III*：花瓣，*IV*：萼片，後兩者在單子葉植物中最常見）。*B* 群基因分別有三個基因，*B1-B3*。*(from Johansen et al. 2006)*

Node Id: **377db3b87f7563b302b84e53**

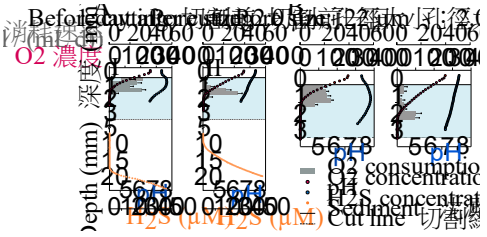
Indicate if each of the following statements is true or false.

請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
Tulips do not have any sepals 鬱金香屬植物缺乏萼片	○	○
Gene-C has different expression in monocots and dicots C 基因在單子葉植物與雙子葉植物表現各有不同	○	○
Selective supression of gene C-expression in region II leads to development of unisexual flower 選擇性抑制基因 C 的表現在區域 II，會導致單性花的發育	○	○
Complete development of stamens in the tulip requires the expression of gene-B1+gene-B3+gene-C 鬱金香屬植物雄蕊的發育需要 B1, B3 與 C 基因的共同表現。	○	○

Q. 19

In the sea, O_2 diffuses from the free water down into the top oxic layer in the sediment and here becomes reduced to water. Anoxic layers are beneath this layer, and here bacteria-mediated processes take place. One process is the oxidation of H_2S to SO_4^{2-}, which is tightly coupled to the O_2-reduction in the oxic layer above. This coupling between oxic and anoxic processes can only be explained by “electric currents” transporting electrons from H_2S oxidation to O_2 reduction. In experiments, attempts were made to identify the electron conductor (Fig.).
在海洋中，氧氣會從流動層向下擴散到達沈積層表面的好氧層，會因為水流的減緩而逐漸降低。缺氧層在好氧層之下，此處卻是細菌媒介處理最旺盛的區域。在好氧層的表面，H_2S 氧化成 SO_4^{2-} 與 氧氣還原作用緊緊相扣。在好氧層與缺氧層的交接處，有因為 H_2S 氧化成 SO_4^{2-} 而出現電子傳遞發生，進而造成電流。本實驗想偵測此處的電子傳導現象（見下圖）。



In an experimental set-up, upper oxic (< 3 mm, blue area) and lower anoxic sediment layer (> 3 mm) were: A, physically cut apart by a thin “knife” (before: left diagram, and after: right diagram); B, the two layers were separated by filters with pores of two sizes (lower horizontal line) (from Pfeffer et al. 2012). O_2 concentration (red curve), O_2 consumption rate (O2 c.r., grey-coloured histogram), pH (blue), H_2S (orange line) and sediment surface (upper grey line at value 0) are shown (after Pfeffer et al. 2012)

實驗裝置中，上層好氧區（*<3 mm* 處，藍色區域）以及下層缺氧沈澱層（*>3mm* 處）。A：以薄刃進行物理切割，（切割前：左圖，切割後：右圖）。B：利用不同孔徑大小進行兩層的分離實驗（下方的水平線）*(from Pfeffer et al. 2012)*。*O_2* 濃度（紅色曲線），*O_2* 消耗速率（灰色柱狀圖），*pH* 值（藍色），*H_2S*（橘色），沈降表面（數值為 *0* 的上方深灰線）*(after Pfeffer et al. 2012)*

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Indicate if each of the following statements is true or false.

請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
The pH peak in the oxic layer is due to production of water from oxygen 因為氧氣轉化產生水，故造成好氧層中 pH 達到高峰。	○	○
Physically interrupting the sediment by the “knife” did not affect O_2 reduction	○	○

薄刃造成的沈降物理性干擾，不會影響氧氣的還原。

The filters demonstrated that any specific solutes were not transporting the electrons

利用不同過濾器實驗證明，任何特定的溶質不會進行電子傳送

Electrons for the O_2-reduction most likely came from donors in the oxic layer
氧氣還原過程中電子來自於好氧層

Q. 20

In an experiment, two bacterial strains, I and II, were allowed to conjugate. Strain I contained genes allowing it to grow on media lacking arginine and uracil, and with galactose as its sole carbon source, and even in the presence of the antibiotic Kanamycin (+KM). Strain II could not grow on these media. After a certain incubation time, Strain II was grown on selective media until 100 isolated colonies were obtained. The success of conjugation was assessed (Tab.).
兩株細菌（I 與 II）被選入進行接合生殖的實驗中，細菌I 可以生長於缺乏 精氨酸 (-Arginine)、尿嘧啶 (-Uracil)、添加半乳糖為單一醣類來源，且添加卡納黴素 (+KM) 的培養基中。細菌II 則無法生長於上述條件培養基中。經過一段的混合培養後，在條件培養基中篩選出 100 單獨菌落。因此得知接合生殖成功的發生了。（下表）

Table. Success of growth of Strain II in (%) after conjugation.
表：經過接合生殖後的細菌*II* 培養於不同培養基下的結果

Incubation time of conjugation (min) 接合生殖培養時間	5 min	10 min	15 min	20 min	25 min	30 min
Complete medium 完全培養基	100	100	100	100	100	100
Without arginine 缺乏精氨酸	0	4	100	100	100	100
Without uracil 缺乏尿嘧啶	5	98	100	100	100	100
With galactose 添加半乳糖	0	0	0	0	2	100

With KM 添加卡納黴素	4	6	2	6	99	100

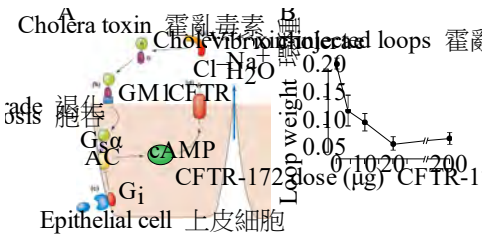
Node Id: **9e5dbb6d42e8f48253650f7b**

Indicate if each of the following statements is true or false.
請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
The gene marker 'KM resistance' is transferred before the gene required for uracil synthesis 抗卡納黴素基因要比尿嘧啶合成的基因提早發生轉移。	○	○
The data suggest that a full bacterial genome can be transferred via conjugation in less than 15 minutes 資料顯示，在 15 分鐘內細菌的基因組可以藉由接合生殖完全轉移至另一個細菌。	○	○
The data suggest that a small fraction of recipient colonies can be expected to grow on +KM medium even in the absence of conjugation 資料顯示有一小部分的接受者的菌落，即使不進行接合生殖，也可以生長在有添加卡納黴素的培養基中。	○	○
More than 20% of all colonies incubated for 15 minutes are expected to grow on a medium lacking both arginine and uracil 超過 20% 的菌落經過 15 分鐘的培養後，可以長在缺乏精氨酸與尿嘧啶的培養基中。	○	○

Q. 21

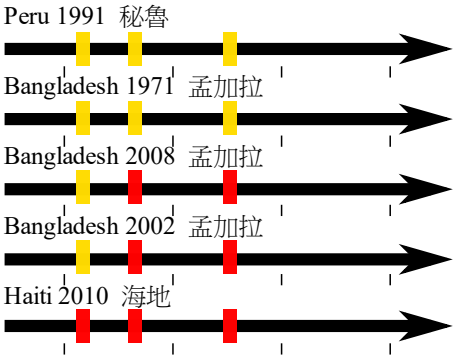
Cholera is caused by a toxin secreted by the bacterium *Vibrio cholerae* (Fig. A). One symptom is severe diarrhea, which leads to dehydration and perhaps death. Scientists tested a new CFTR-inhibitor, CFTR-172 (Fig. B) as a potential treatment for cholera.
霍亂係由霍亂弧菌分泌毒素所引起（圖 A ）。臨床的症狀為嚴重腹瀉。最後導致嚴重脫水甚至會死亡。科學家測試一種霍亂的治療藥物，CFTR-172（CFTR 抑制劑）（圖 B ）。



A, action of cholera toxin on an intestinal epithelial cell. In the figure, A and B are cholera toxin subunits; GM1 (GM1 ganglioside receptor); Gsα (G protein); AC (adenylate cyclase); Gi (G protein); cAMP (cyclic AMP); and CFTR (cystic fibrosis transmembrane conductance regulator Cl^- channel); B, dose-dependent reaction of cholera toxin-induced fluid secretion into closed loops of mouse ileum as a function of applied 'CFTR-172' dose (the small molecule 'CFTR-172' was injected into the body cavity).
A：霍亂毒素在腸道上皮細胞的作用機制。圖中 *A* 與 *B* 分別為霍亂毒素的次單位。*GM1*（*GM1* 神經糖苷受體），*Gsα*（*G* 蛋白），*AC*（腺苷酸環化酶），*Gi*（*G* 蛋白），*cAMP (cyclic AMP)* 與 *CFTR*（囊性纖維化跨膜電導調節氯離子通道）。B： *CFTR-172* 在小鼠迴腸受到霍亂毒素作用產生液體分泌與其劑量相關的實驗結果。（*CFTR-172* 直接注射進入腹腔）

After the 2010-earthquake in Haiti, a cholera outbreak led to discussions about the origin of the epidemic (Fig. C). Two theories were proposed: Either the infection originated from similar cases in Peru, or UN-soldiers from near Bangladesh carried it to the island, when they came to help after the earthquake.
2010年，海地發生大地震，接著引發霍亂的爆發。也引起了感染症起源問題的討論（圖 C ）。有兩個理論被提出，一是來自中南美洲的本土性感染，另一為從亞洲來協助地震救災的聯合國士兵。

C



C, five variants of the cholera enterotoxin subunit B open reading frame. "Yellow" loci differ from "red" loci. Labels tell where each variant has caused cholera (from Thiagarajah & Verkman 2005, Chen-Shan et al. 2011).
圖 C ：五種不同的霍亂毒素次單元*B* 的開放閱讀框架。黃色與紅色的基因位點不同。文字部分為霍亂發生的地點與時間。*(from Thiagarajah & Verkman 2005, Chen-Shan et al.*

Node Id: **8d2f878a4dec37356bac3149**

Indicate if each of the following statements is true or false.

問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
The water loss of patients with cholera is due to osmosis 患者因為滲透作用而導致脫水。	○	○

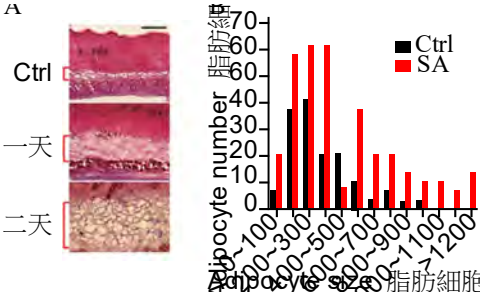
The cholera toxin binds to transmembrane ion channels thereby starting a cascade reaction
霍亂毒素結合於穿膜離子通道上後，會啟動瀑布效應。

Based on Figure B, one might treat cholera-induced diarrhea with CFTR inhibitor, CFTR 172
根據圖 B 的結果，CTFR-172（CTFR 抑制劑）可以作為因霍亂引起腹瀉的治療藥物

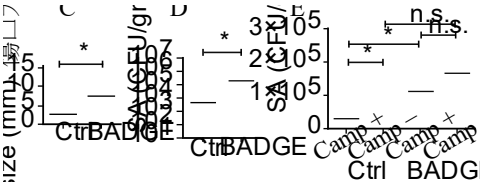
The results in Fig. C support that the cholera outbreak could be caused by infection from the UN soldiers
根據圖 C 的結果，霍亂的爆發是來自於聯合國士兵。

Q. 22

Staphylococcus aureus (*SA*) causes skin infection in humans and is a common cause of death. Immediate protection or intervention by local epithelial cells restrict spread of infection. These cells produce antimicrobial peptides (amp), e.g. cathelicidin (Camp). A newly discovered host response to such infections is changes in subcutaneous adipose (fat) tissue (fig A-B). The antibacterial role of this was studied by using BADGE, an ether that inhibits adipogenesis (fig C-E)
金黃色葡萄球菌 (SA) 會造成人類皮膚感染，甚至引發死亡。及時保護或局部表皮細胞的防護，會減緩感染的傳播。細胞會分泌抗微生物肽 (amp)，例如：抗菌肽 (Camp)。最新的發現，宿主受到感染後，會改變下表皮脂肪組織。（圖 A-B）BADGE（抗脂肪細胞增生藥物）的抗菌機制如圖 C-E。



A, mouse skin infected with SA and compared to control (ctrl) (red brackets: subcutaneous fat layer); B, change in number and size of adipocytes 3 days after SA infection.
A：小鼠皮膚受到金黃色葡萄球菌的感染，*Ctrl* 對照組，紅色括號表示下表皮脂肪層。B：感染後第三天，脂肪細胞體積與數目的變化圖。



C-D, effects of BADGE on wound size and SA CFU (the ether BADGE inhibits adipogenesis, CFU=Colony-Forming Units); E, effects of + and – Camp (, significant differences; n.s., no difference (from Zhang et al. 2015).*
C-D：*BADGE* 對傷口大小與金黃色葡萄球菌 *CFU* 的影響（*BADGE* 會抑制脂肪新生，*CFU* 菌落形成單位）。E：*+/– Camp* 與 *+/–* 脂肪新生 對 *SA* 影響（**有顯著性差異，ns* 無顯著性差異）*(from Zhang et al. 2015)*

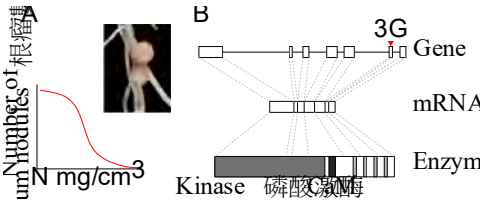
Node Id: **9af78effafde266b21a0143c**

Indicate if each of the following statements is true or false.
問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
An *SA* infection induces the average subcutaneous fat cell to increase in size 金黃色葡萄球菌感染會刺激下表皮脂肪細胞體積變大。	○	○
Number of adipocytes is important against spread of infection 脂肪細胞數目與抑制感染的散播有重要關係。	○	○
Badge destroys the effect of Camp BADGE 會破壞 Camp 的作用。	○	○
Results in Fig. C-D and in Fig. E support each other well 圖 C-D 與 圖 E 的結果可以互相支持。	○	○

Q. 23

The effect of the nodule bacterium *Rhizobium* on the growth of the legume *Lotus japonicus* has often been studied, e.g. in relation to the enzyme/gene system of the interaction (Fig.).
根瘤菌Rhizobium對豆科植物Lotus japonicus生長的影響常被探討，例如，有關酵素和基因系統之間的交互作用



A, Rhizobium nodule and the relationship between the number of Rhizobium

nodules and the nitrogen (N) content of soil.
A：根瘤照片；根瘤數目和土壤中氮含量之間的關係圖
B, the enzyme CaMK with its mRNA and associated gene. The kinase domain (large dark grey) regulates other enzymes. The black band is the CaM domain, and the four narrow grey bands are EF-hand domains. Boxes in the gene are exons.
B： *CaMK*酵素基因、*mRNA*、和*CaMK*酵素間的對應；*CaMK*的磷酸激酶功能區(寬深灰區域)會調控其它酵素，黑色部分是*CaM*功能區，4個窄淺灰區帶是*EF-hand*功能區，基因上的白色區塊是外顯子。

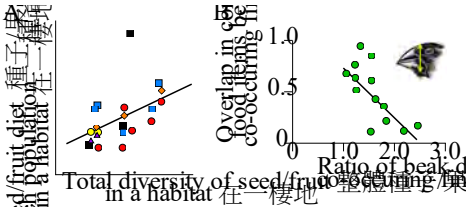
Node Id: **29f84f4da95098285b072db1**

Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE	FALSE
Nodulation mainly occurs in nitrogen-poor soil 根瘤主要發生於缺氮土壤	○	○
Rhizobium stimulates growth of *Lotus* by enlarging the surface of its root system; and consequently uptake of NO_3^- increases 根瘤菌Rhizobium誘發豆科植物Lotus增加其根系表面積，因此增加硝酸根的吸收	○	○
Mutation 3G in Fig. B inhibits the transcription of CaMK 圖B中的3G突變抑制CaMK的轉錄	○	○
Each exon encodes a specific protein domain 每一個外顯子都代表一個特定的蛋白質功能區	○	○

Q. 24

The Galápagos Islands are well known for the adaptive radiation of 14 species of finch. The drivers of this radiation are either competition for food in the community of finch species (Hypothesis 1), diversity of available food, i.e. seeds and fruits (Hypothesis 2), or both. Choice of diet is determined by size and structure of the beak. These hypotheses were tested using the six ground finches, which have very different beaks (Fig.).
加拉巴戈群島以14種雀鳥的幅射適應而聞名，造成此種幅射適應的推手有可能是種間食物的競爭(假說1)，可利用食物如種子及果實的多樣性(假說2)，或是此兩假說的組合，食性的選擇主要取決於鳥喙的大小及構造。
用六種嘴形大小不同的地面覓食的雀鳥種來進行測試這些假說(圖)



A, relationship between seed/fruit diversity within a habitat and breadth of seed/fruit diet of a finch population in the same habitat. Each dot is a finch population in a habitat, and different shapes and colours of dots indicate different finch species; B, relationship between ratio of beak depth of co-occurring pairs of finch species and overlap in consumed food items between a pair of species, i.e. each dot is a species pair. Yellow arrow on inserted finch head indicates beak depth (from Abbott et al. 1977).
A 種子/果實在一棲地與在一棲地某種雀鳥種子/果實食性廣度的關係，每一點代表一種雀鳥族群在一棲地。不同形狀及顏色的點代表不同種的雀鳥。
B. 共域雀鳥對嘴深度的比例與此對鳥種取食重疊的關係，插入雀鳥頭上的黃箭頭表示嘴深度*(from Abbott et al. 1977).*

Node Id: **fc99cac8c3cb7010953f4424**

Indicate if each of the following statements is true or false.
指出下列敘述何者正確或錯誤

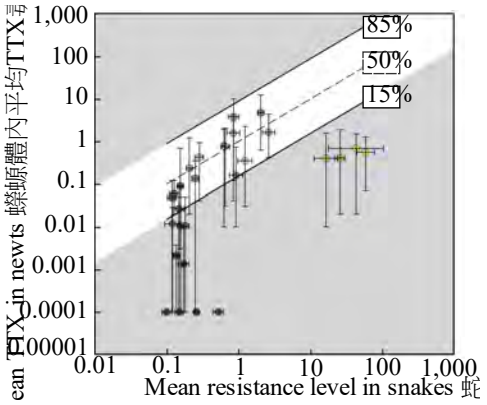
	TRUE 正確	FALSE 錯誤
According to Fig. A, Hypothesis 2 is more likely than Hypothesis 1 根據圖A，假說2較假說1更有可能成立	○	○
According to Fig. B, Hypothesis 1 is more likely than Hypothesis 2 根據圖B，假說1較假說2更有可能成立	○	○
Different finch species respond to the same extent to an increase in seed and fruit diversity 不同的雀鳥種類對於種子及果實多樣性的增加，其產生相同程度的反應	○	○
Figures . A–B show that interspecific competition is low when food is more diverse 圖A和B顯示在食物較多樣化時，種間競爭低	○	○

Q. 25

Rough-skinned Newts (a salamander) produce the toxin TTX, which is lethal to other vertebrates. Individual newts vary in their level of TTX. Garter Snakes eat almost any prey, including newts, and individual snakes vary in their resistance to TTX. The higher the TTX level in a newt population is, the greater the resistance of co-occurring snakes, which, however, still may reject newts, which are too poisonous (Fig.).

粗皮蠑螈產生毒素TTX，可使其他脊椎動物致命，蠑螈個體的毒性強度不一，

束帶蛇幾乎捕食任何獵物包括蠑螈在內，而不同蛇個體間抗TTX毒能力不同。蠑螈體內TTX毒性越高者，其共域環境中束帶蛇的抗毒性越高。但太毒的蠑螈個體，可能對蛇不具吸引力。



Relationship between levels of resistance of snakes and toxicity of newts. Each dot represents a site with interacting snake and newt populations. In the white zone, snakes consume newts, but with a cost to their mobility. Dots in grey-coloured zones are toxicity/resistance mismatches. Bars give variation in levels among individuals within a population. The 50% dashed line reflects the TTX dose that would reduce snake performance 50%; 15% and 85% lines delimit the range of functionally relevant TTX doses for snakes across all sampled sites (from Hanifin et al. 2008).

蛇的抗毒程度與蠑螈毒性的關係

每一點代表一處蛇與蠑螈交互影響族群。圖中白色區域，蛇取食蠑螈但會造成對蛇活動的影響，棕色點所構成的區域為毒性強度/抗毒能力兩者間不相稱*(Mismatches)*，在此區域一般情況下蛇不吃蠑螈。長線圖顯示在一族群中個體間的變異性。*50%*的虛線顯示蠑螈*TTX*毒劑量會影響束帶蛇*50%*的表現能力，*15%*及*85%*的線界定了蠑螈*TTX*的劑量，功能化的範圍在所有取樣的地點*(from Hanifin et al. 2008).*

Node Id: **edd298eb4dacd926695bb525**

Indicate if each of the following statements is true or false.

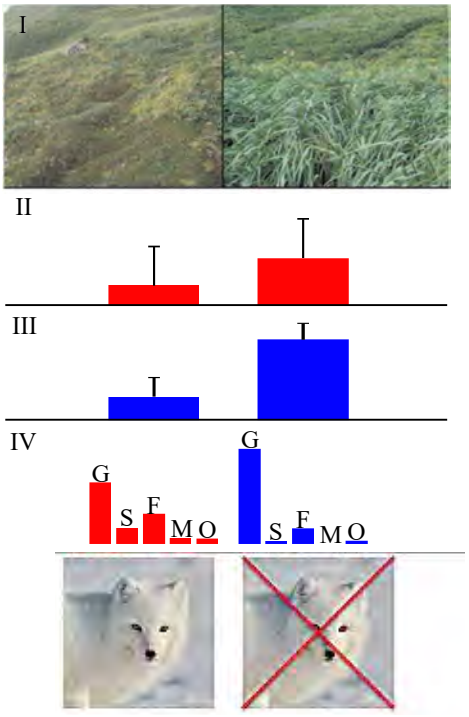
指出下列何者敘述正確或錯誤

	TRUE 正確	FALSE 錯誤
Coevolution/reciprocal selection between newt and snake mainly takes place in the white zone 在蠑螈與蛇的共同演化/互相選擇主要發生在白色區域	○	○
The figure agrees with the "life-dinner principle", i.e. survival is under stronger selection than demand for food in a prey-predator interaction 圖與生命-餐點原理(life-dinner principle)一致，即在獵物與天敵交互作用中，存活較食物需求有較強的天擇壓力	○	○
Per individual, resistance seems to be less costly than toxin production 就每一個體而言，抗毒所付出的代價似乎較生產毒物所付出的代價小	○	○

It is likely that the snake populations in the two 'green' and two 'yellow' sites at the extreme right of the figure have won the arms race.
在圖最右側有兩處"綠"及兩處"黃"的地點，蛇的族群在此很有可能在兩物種軍備競賽中獲勝

Q. 26

The Aleutians Islands west of Alaska are rich in sea birds. The Arctic Fox was not originally present here, but was introduced as a fur game-animal and is now present on many islands. The fox decimates sea bird populations severely. Indirect effects of foxes on island vegetation were compared on islands with and without foxes (Fig.).
在阿拉斯加西邊的阿留申群島海鳥豐富。北極狐原先並不存在，但基於皮毛獸的獵捕而被引入，現今存在許多島上，狐狸將海鳥族群嚴重傷害。狐狸對島上植被所產生的接間影響，可由比較有無狐狸出現的島嶼來了解(圖)。



Mean values (± standard error) for parameters sampled on fox-infested islands (red, left-hand bars) and fox-free islands (blue, right-hand bars). I, view of the plant community on an island; II, logarithm10 of density of breeding sea birds; III, total soil Phosphor; and IV, relative abundance of grasses (G), shrubs (S), non-grass herbs (F, forbs), mosses (M), and others (O) (from Croll et al. 2005).
在有狐狸入侵(紅色,左側柱狀圖)及無狐狸入侵(藍色,右側柱狀圖)島嶼其取樣測量參數的平均值(±標準差)。
I.一個島上植物群落的景觀，II.海鳥繁殖密度(對數log_{10})，III. 土壤總磷量，IV. 草(G),灌叢(S),非草草本(闊葉草本F),苔類(M),及其他(O)的相對豐度(from Croll et al. 2005)

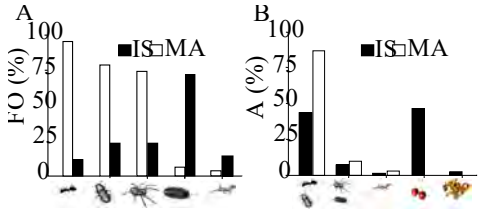
Node Id: **fbf7d564c1bb3281acf4fb93**

Indicate if each of the following statements is true or false.
指出下列敘述何者正確或錯誤

	TRUE 正確	FALSE 錯誤
The study is based on the assumption that sea bird-derived nutrients are distributed all over an island 這個研究主要是根據一個假設即島上海鳥產生的營養鹽分佈在全島上	○	○
The presence of foxes on an island changes the vegetation from grassland to tundra- shrubland 島上有狐狸存在使島上的植被從草地轉變為凍原灌叢地帶	○	○
Diversity and number of major plant groups are reduced in islands with fox populations 在有狐狸存在的島嶼主要植群的數量及多樣性減少	○	○
The ecological changes on islands with fox introduction represent exclusively top–down processes 狐狸引入造成島上生態的改變，代表完全由上而下的控制作用	○	○

Q. 27

The bird Red-billed Chough has a wide diet. It lives on the oceanic Spanish island La Palma (*IS*) and on mainland Spain (*MA*). The bird's diet on *IS* and *MA* was compared (Fig.). As a food source, invertebrates are rich in protein and lipid, whereas fleshy fruit is rich in carbohydrates. *IS*-nestlings have more poorly developed feather barbs than *MA*-nestlings.
紅嘴山鴉具有廣泛的食性，牠生活在西班牙海上的Palma島(IS)及西班牙本土(MA)，比較兩地鳥的食性(圖)。做為食物來源的無脊椎動物其富含蛋白質及脂肪，而新鮮水果則富含碳水化合物，島上小鳥羽毛橫斑的發育較大陸的小鳥更差。



A, frequency of occurrence in habitat (FO%, i.e. percentage of samples with a given food item) of animal groups (from left: Ants, Other insects, Spiders, Other arthropods (i.e. myriapods, woodlice), and Lizards); B, chough nestling diet (A%: relative abundance of food item in diet, i.e. all white bars and all black bars each add up to 100%) (from left: Insects, Other arthropods, Other animals, Fleshy fruit, and Seeds) (from Blanco et al. 2014).
*A*動物在棲地中出現的頻度 *(FO%*,即多少百分比樣本數中出現某一食物項目，左

起：螞蟻、其他昆蟲、蜘蛛、其他節肢類(即多足類, 木蝨類)及蜥蜴)
*B*山鴉的幼鳥食性(*A%*:食物在食譜中出現的相對頻度，即所有的白長條及所有的黑長條圖各自加總為*100%*)(左起：昆蟲、其他節肢類、其他動物、新鮮水果、種子) *(from Blanco et al. 2014).*

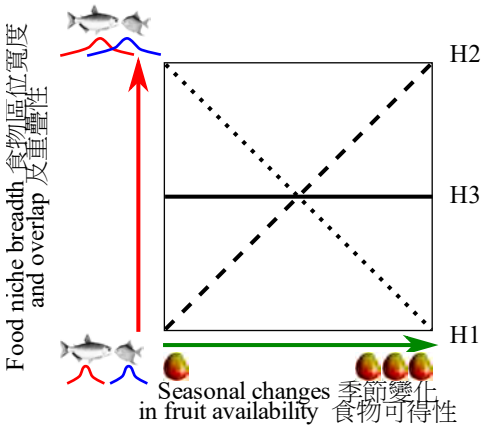
Node Id: **86e5ded216c99784f3358ccb**

Indicate if each of the following statements is true or false.
指出下列敘述何者正確或錯誤

	TRUE 正確	FALSE 錯誤
Generally, food of animal origin is more scarce on *IS* than on *MA* 一般而言，動物性食物的來源在島嶼較大陸貧乏	○	○
Mainland nestlings have a wider food niche than island populations 大陸的幼鳥比島嶼的幼鳥有更廣的食譜	○	○
In general, insects are the favorite food of nestlings 一般而言，昆蟲是幼鳥所喜好的食物	○	○
Island nestlings are expected to have a faster growth rate and shorter generation time than mainland nestlings 預期島上幼鳥較大陸幼鳥有較快的生長速率及較短之成長時間	○	○

Q. 28

Within a single year, the Amazon floodplain forests have a high-water (HW) and a low-water (LW) season with a high and low fruit production, respectively. Fruit consumption is widespread among Amazonean fishes, and the relationships between fish diet and fruit production have been explained by three hypotheses H1-H3 (Fig.). Two species of fish (*Brycon falcatus* and *Myloplus asterias*) were studied in detail.
在一年間亞馬遜泛濫平原之森林會呈現高水(HW)及低水位(LW)的季節，其相對之水果實產量亦隨之有高低之分。亞馬遜的魚吃果實的情形普遍存在，三個假說H1-H3(圖)顯示魚的食性和果實產量的關係。
對兩種魚(Brycon falcatus and Myloplus asterias)的食性進行深入研究。



Three hypotheses (H1-H3) explain how food niche breadth and overlap among fish species (Y) respond to seasonal changes in fruit availability (X) (from Correa & Winemiller 2014).
三個假說*(H1-H3)*解釋魚種*(Y)*食物區位寬度與季節改變時果實可得性*(X)*的對應 *(from Correa & Winemiller 2014).*

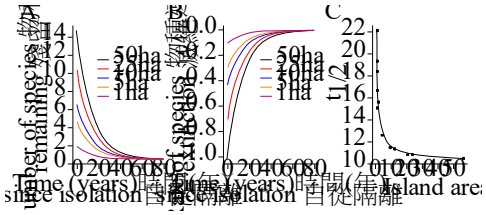
Node Id: **fcbeaf3257edf2a32a456038**

Indicate if each of the following statements is true or false.
指出下列敘述何者正確或錯誤

	TRUE 正確	FALSE 錯誤
Fact: Diet overlap among fish increased from 28% to 95% from low-resource to high-resource season: This relationship is best explained by H1 事實：在魚種間食性重疊從低資源季的28%到高資源季的95%；上述可以用假說1(H1)來解釋	○	○
Fact: *B. falcatus* was, at first, observed not to change its food niche, when food became more plentiful, but then at higher food availability it became increasingly selective: This relationship is best explained by a combination of H1 and H3 事實：當環境的食物變多時，魚(B. falcatus) 的食物區位並未改變，但當食物可得性變高時，牠變得挑剔：此一關係較符合假說1(H1)及假說3(H3)的組合	○	○
Fact: Some fish had a constant food niche throughout the year, irrespectively of fruit availability: This is best explained by H1 事實：有些魚具有全年不變的覓食區位，與食物的可得性無關：此現象較符合假說1 (H1)	○	○
Fact: During HW, *M. asterias* had a fruit-dominated diet, but switched to leaves instead of fruit in the LW season: This is best explained by H2 事實：在高水位季節，魚(M. asterias)具有果實為主的食性，但在低水位季節牠改變食果的習性為食葉：此現象較符合假說2(H2)	○	○

Q. 29

In 1986-1987 in Thailand, a water reservoir was established by flooding a forest area. In the reservoir, former hilltops now became new islands and on 16 of these, the small mammal fauna was monitored until 2013, i.e. 27 years after establishment (Fig.). The focus of the study was extinction of the hilltop fauna due to isolation.
在1986-1987泰國把一片森林淹沒，建立了一座水庫，原有的山頂現在變成新的島嶼共有16個，在水庫建立了27年後，也就是2013年對此進行了小型哺乳動物相的監測(圖)。此研究的目的在了解山頂的動物相受到孤立後物種的滅絕速率。



A, number of species remaining on different-sized islands (1–50 ha) T years after reservoir establishment (graph part after T = 27 years is expected future change); B, rate of species extinction on different-sized islands as a function of T; C, time to extinction of half of the fauna (T1/2) on different-sized islands (from Gibson et al. 2013).
A, 在水庫建立*T*年後*(*圖在*T=27*年後的變化即為未來的變化*)*留在不同大小的島嶼*(1-50*公頃*)*的殘留物種數
B, 物種在不同面積的島嶼消失速率與*T*的函數
C, 不同面積的島嶼動物相減半量*(T1/2)*所需的時間
(from Gibson et al. 2013).

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Indicate if each of the following statements is true or false.
指出下列敘述何者正確或錯誤

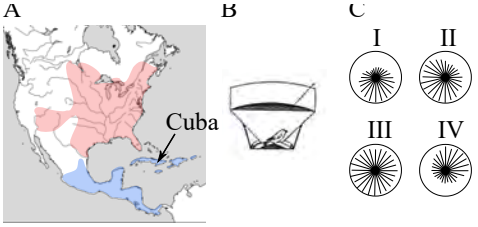
	TRUE 正確	FALSE 錯誤
Smaller islands (1–10 ha) lose more species per year than larger islands (25-50 ha) 小島(1-10公頃)比大島(25-50公頃)每年物種的損失要多	○	○
At reservoir establishment, a linear relationship existed between species number and island area 在水庫建立時，物種數與島嶼面積呈線性關係	○	○
The study supports the hypothesis that in the long run, a single large protected island will support biodiversity better than several small ones 此研究支持，就長遠觀點來說，單一大型的保護地比幾個小	○	○

型的保護地對生物多樣性保存的效果要佳的假說

In all islands, which are larger than 10 ha, the mean time to extinction of half of all species, is comparable
在所有的島嶼中面積大於10公頃之島嶼其半數物種滅絕的平均時間是較相近的

Q. 30

Stephen Emlen experimentally studied seasonal migration of an American bird, the Indigo bunting. He used a funnel-shaped test cage (Fig. B), at the bottom of which he placed an ink pad. Each time a bunting tried to fly out of the cage, the location of its footprint was marked by ink on a piece of paper, so its orientation pattern easily could be recorded (Fig. C). The bird migrates at night, using stars as cues.
Stephen Emlen對美國季節性遷移的候鳥靛鴉進行研究，他使用一個漏斗型的試驗鳥籠(圖B)在鳥籠的底部放置墨水墊，每當靛鴉想要飛離鳥籠時，他的腳印就會留在鳥籠內週遭的紙張上，因此他的方位選擇的模式可以很容易被記綠下來，此種鳥夜間遷移，用星象當線索。



A, distributional range of the bird (pink area = summer range; blue area = winter area); B, Emlen's experimental cage; and C, four examples of footprint pattern; each radius is a take-off attempt by the bird (from Emlen 1967).
A, 鳥的分佈區*(*粉色區域為夏天範圍，藍色區為冬天範圍*)*
*B, Emlen's*的實驗研究鳥籠
C, 鳥腳印留下型態的四種範例，每一個半徑軌跡是鳥打算起飛所留
(from Emlen 1967).

Node Id: **6d08b509dab5b9d7169beedd**
Indicate if each of the following statements is true or false.
指出下列敘述何者正確或錯誤

	TRUE 正確	FALSE 錯誤
The bird breeds in Central America and the Caribbean (blue area, Fig. A)　此種鳥在中美洲及加勒比海繁殖(藍區圖A)		
Fig. C-I is made by a north-eastern USA bird ready for autumn migration to the western part of Central America		

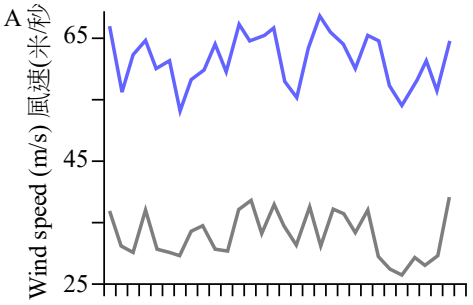
圖C-I是在美國東北部此種鳥的個體，在秋季打算遷移至中美洲西部時所留下的腳印

Fig. C-II is made by a western USA bird ready for autumn migration to Cuba
圖. C-II是在美國西部此種鳥的個體在秋天打算遷移至古巴時所留下的腳印

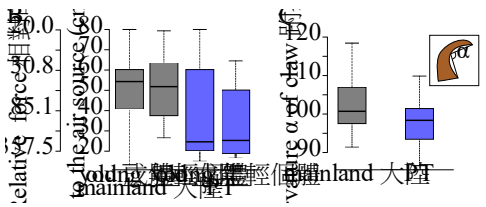
Fig. C-III: The footprint of a young bird, suggesting that migration patterns are genetically determined
圖. C-III為幼鳥的腳印，由此推測遷移的型態是由遺傳所決定的。

Q. 31

About 100 individuals of the butterfly *Melitaea cinxia* lives on a tiny island PT in the Gulf of Finland. Researchers studied how the butterflies on PT coped with the very windy conditions on the island. In the lab, they exposed butterflies from mainland and PT to a wind source (hair dryer) (Fig. B) and they also studied the morphology of the claws of the butterfly (Fig. C).
在芬蘭灣小島PT上，約有100隻Melitaea cinxia的蝴蝶生存其間，研究人員擬了解蝴蝶如何適應此小島的強競風勢，在實驗室他們將島上及大陸的蝴蝶置放於風源中(吹風機Hair dryer)(圖B)同時也研究蝴蝶跗爪上的形態(圖C)



A, wind speed in June on PT (blue) and mainland (gray)
A是PT島(藍色)及大陸(灰色)六月時的風速



B, distance (cm) to wind source, when a butterfly loses its grip on a surface; old and young butterflies from mainland (grey boxes) and PT (blue boxes) are compared (mainland vs. PT, p = 0.003); C, The angle of curvature α of tarsal claw on mainland (grey box) and PT (blue box) (mainland vs. PT, p = 0.001). The

inset indicates the tarsal claw, with its angle of curvature and how it is measured. (from Duplouy & Hanski 2014).
B, 一隻蝴蝶無法抓住表面時其與風源的距離*(*公分*)*；大陸*(*灰色方塊*)*與*PT*島*(*藍色方塊*)*成年與年輕蝴蝶的比較*(*大陸*VS. PT, p=0.003)*
C, 跗爪彎曲的角度α，在大陸*(*灰色方塊*)*與*PT*島*(*藍色方塊*)*蝴蝶跗爪彎曲的角度α*(*大陸*VS. PT*島*, p=0.001).*插圖顯示蝴蝶跗爪彎曲角度的測量及其測量方式*(from Duplouy & Hanski 2014).*

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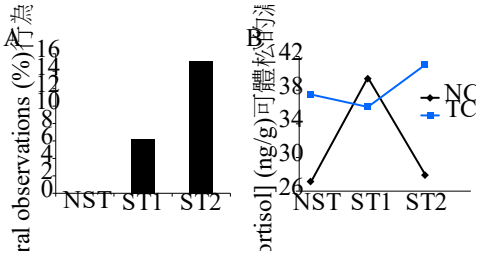
Indicate if each of the following statements is true or false.
指出下列敘述何者正確或錯誤

	TRUE 正確	FALSE 錯誤
Island insects in general are more often flightless than are mainland insects 一般而言，島上昆蟲不具飛行能力者的比例較大陸昆蟲高	○	○
If more curved tarsal claws are a disadvantage in escaping predators, then PT probably has very few insect-eating birds as compared to mainland localities 假設跗爪彎曲角度越彎對其逃避天敵越不利，則PT島與大陸相較，具有較少食蟲性的鳥	○	○
In general, butterflies do not evolve flightlessness because of their mode of foraging 蝴蝶因為他們覓食的模式不會演化成失去飛行能力	○	○
With age, island butterflies learn to hide from the wind 隨著年齡增加，島上蝴蝶學習如何躲避強風	○	○

Q. 32

In farms, a study of mink looked at how reduced welfare, e.g. postponed feeding, led to abnormal behaviours, such as stereotypic pacing and tail-chewing. Indicators of abnormal behaviours could also be elevated levels of the hormone cortisol and increased fearfulness. Based on their behavioural response to stress, minks were classified into three groups, NST = no stereotypic pacing, ST1 = low level of pacing and ST2 = high level of pacing. The differences between these groups of minks in their stress responses to postponed feeding are shown in figures A and B.
一項在飼養場中進行貂在福利減少時對其行為的影響，如延遲餵食對動物產生不正常的行為，包括重覆踱步的老套(制式)行為及自咬尾巴的現象。異常行為的指標可以由動物身上可體松(cortisol)的升高及恐懼的增加顯現，貂的行為可以被歸為：無老套行為(NST)；低度老套行為(ST1)及高度老套行為(ST2)三類。



A, frequency of stereotypic pacing, caused by postponed feeding; B, mean cortisol concentration in the two stereotypic groups (ST1 and ST2) and in the control (NST), and in absence (NC) or presence of tail-chewing (TC) (from Svendsen et al. 2013).
A, 受延遲餵食所產生老套踱步行為的頻度
B, 兩組老套群組*(ST1*及*ST2)*及控制群組*(NST)*及不具有自咬尾巴*(NC)*或具有自咬尾巴*(TC)*群組，其平均可體松激素的濃度
(from Svendsen et al.2013).

Node Id: **552ba21c77247860d76d8cb6**

Indicate if each of the following statements is true or false.
指出下列敘述何者正確或錯誤

	TRUE正確	FALSE錯誤
Animal welfare studies always require behavioural observations 動物福利的研究皆是需要進行行為的觀察	○	○
Stereotypic pacing is affected by postponed feeding 老套行為(制式)受到延遲餵食的影響	○	○
Tail-chewing and stereotypic pacing are closely correlated 自咬尾巴及老套行為是緊密相關的	○	○
Very high behavioural stress levels seem to suppress cortisol production 極高的緊迫程度似抑制可體松的產生	○	○

Q. 33

In order to make safe blood transfusions, we have to know the blood types of both patient and donor. Mixing incompatible blood types is dangerous and may be lethal. In this problem we consider only the ABO blood group system and transfusions that do not include plasma.
為求輸血的安全，我們需要知道病人和捐血者的ABO血型，混合不相容的血型是危險的，甚至會致死。本題中只考慮ABO血型系統，輸血不包括血漿

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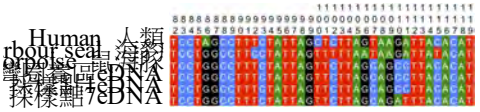
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
Blood transfusion with A-blood causes an incompatibility reaction in an O-recipient 將A型的血輸給O型受血者會造成不相容反應	○	○
A traffic accident victim needed blood fast, and without knowing the blood group type of the victim the doctor prescribed blood of type O, and the patient showed signs of incompatibility 一個車禍傷患急需輸血，在不知其血型的情形下，醫生給予O型血，此病人會有不相容症狀	○	○
Persons with type AB can receive blood from all ABO types AB型的人可以接受所有ABO血型的血	○	○
Persons with type B can receive blood of type AB B型的人可以接受AB型的血	○	○

Q. 34

Use of environmental DNA (eDNA) is a new tool in tracking of marine organisms. In a study, a base sequence from the mitochondria of the cetacean Harbour Porpoise was analysed. Samples were taken both from a harbour pen and outside from natural sites (fig.).
環境中收集的DNA(eDNA)是海洋生物學的研究新工具。在一研究中，以鼠海豚(Harbour Porpoise)的一段粒線體DNA作為分析標的，收集港灣內和外海不同地點的eDNA進行分析比對(如圖)



Base sequences (base no. 82 to 119) from human, seal, porpoise, and 3 samples of eDNA (Fjord Baelt, Site 1 and Site 7) (from Foote et al. 2012).
人類，海豹，鼠海豚和*3*個*eDNA*樣品*(Fjord Baelt* 圈養區、採樣點*1*和採樣點*7)*的鹼基序列*(82~119)*比對

In addition, echolocation clicks were used for acoustic monitoring (table).
此外，也使用高頻回聲定位來做聲波確認鼠海豚(如表)

Detection of harbour porpoise DNA and sounds at 11 sites, including a control DNA from skin;

values in right column are numbers of positive PCRs out of a sample of 3.
*11*個採樣地點的鼠海豚*DNA*和聲波檢測結果，並以其表皮細胞*DNA*作為對照組，最右欄位的數字代表*3*個樣品中有陽性*PCR*反應的數目

Location 取樣位置	**Acoustic detection** **% Porpoise positive days** 有偵測到鼠海豚聲波的天數比例%	**Genetic detection** **Positive PCRs** 陽性PCR數
Positive control (DNA extracted from skin) 陽性PCR反應對照組(表皮細胞DNA)		3/3
Fjord & Bælt pen Fjord Baelt 圈養區		3/3
< 10 m from F&B pen 距圈養區10 m內		1/3
> 10 m from F&B pen 距圈養區10 m外		0/3
Site 1 外海採樣點 1	94	1/3
Site 2 外海採樣點 2	42	0/3
Site 3 外海採樣點 3	63	0/3
Site 4 外海採樣點 4	6	0/3
Site 5 外海採樣點 5	0	0/3
Site 6 外海採樣點 6	0	0/3
Site 7 外海採樣點 7	0	2/3
Site 8 外海採樣點 8	79	0/3

Node Id: **c7a00eefbc62bf6f0638cfb3**

Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
In this study eDNA may be an effective tool to detect marine animals far away from their habitat 在此研究中，eDNA可作為一種偵測遠離棲地之海洋生物的有效工具	○	○
Most likely, the eDNA from site 7 was from an animal more closely related to the porpoise than to harbour seal 在採樣點7的eDNA樣品來源動物與鼠海豚的親緣關係較近，與海豹較遠	○	○
Based on the short sequence in the Fig., the two marine animals, seal and porpoise, are more closely related to each other than seal and human are to each other 根據圖中的短序列，鼠海豚與海豹間的親緣性比人和海豹間的親緣性為高	○	○
eDNA seems to be a poorer detection method than acoustic monitoring 作為偵測方法而言，eDNA的檢測效果不如聲波檢測	○	○

Q. 35

In a criminal case about rape, which was brought to court, four men (1–4; Table), the victim (Mother) and the resulting child (Daughter) (1-4, Table) were blood-type scored for ABO (alleles I^A and I^B are co-dominant, *i* recessive), Rhesus (allele Rh^+ dominant to Rh^-), MN (alleles *M* and *N* are co-dominant), and the X-linked $Xg^{(a)}$ (allele $Xg^{(a+)}$ dominant to $Xg^{(a-)}$). Results are shown in the Table.
在一個強暴案的調查中，4個嫌疑犯、被害者(母親)及因強暴所生之女孩的血型分析包括：ABO(I^A和I^B為等顯性，i為隱性)；Rhesus(Rh+對Rh-為顯性)；MN(M和N為等顯性)；X-聯鎖基因$Xg^{(a)}$ ($Xg^{(a+)}$對$Xg^{(a-)}$為顯性)，分析結果如表所示

Results of blood-type testing. .Man 1–4 are potential fathers.
血型分析結果，男性*1~4*為可能的父親

Individual 相關人	ABO phenotype	Rh phenotype	MN phenotype	$Xg^{(a)}$ phenotype

Mother 母親	AB	Rh–	MN	$Xg^{(a+)}$
Daughter 女孩	A	Rh+	MN	$Xg^{(a-)}$
Man 1 男性**1**	AB	Rh+	M	$Xg^{(a+)}$
Man 2 男性**2**	A	Rh–	N	$Xg^{(a-)}$
Man 3 男性**3**	B	Rh+	N	$Xg^{(a-)}$
Man 4 男性**4**	O	Rh–	MN	$Xg^{(a-)}$

Node Id: **23015c3ab37e355c6e7fa99f**

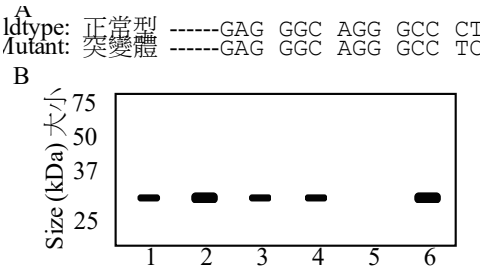
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
Both Man 2 and Man 3 can be the father 男性2和3都可能是父親	○	○
The father could be identified unambiguously with less than four blood type systems 利用少於4種的血型分析系統，就可以清楚確定誰是父親	○	○
Using the *ABO* system alone, the daughter's genotype had to be I^Ai 依照ABO分析，女孩的基因型一定是I^Ai	○	○
If the daughter bears a boy with a man, whose genotype is $Xg^{(a+)}$, then her son must be $Xg^{(a+)}$, because the allele $Xg^{(a+)}$ is dominant 如果這女孩生了一個男孩，男孩的父親是Xg^{a+}，則這個男孩一定也是$Xg^{(a+)}$，因為$Xg^{(a+)}$是顯性	○	○

Q. 36

Ficolins are important immune system proteins, e.g. ficolin-3. Consequently, patients with ficolin-3 deficiency may suffer from several complications. This deficiency is caused by a mutation in the ficolin exon (A).

Samples of ficolin-3 in the blood from five family members were analyzed, using electrophoresis (B).
Ficolins 是重要的免疫系統蛋白，例如，ficolin-3。病人缺少ficolin-3可能會有各種病徵，這種ficolin-3缺乏是因為在ficolin 外顯子(圖A)上的一個突變。對一個家庭中5位成員的血液進行ficolin-3電泳分析(如圖B)



Western blots of serum ficolin-3 from a family without any sick members except for the patient (5): The patient's sisters (1 and 2), mother (3), and father (4), compared to a control with ficolin-3 added (6). (from Munthe-Fog et al. 2014).
一家庭的5成員中只有一位缺少*ficolin-3*病人，對他們的血清進行西方轉染分析：各樣品個體編號：*1).* 病人的姐姐、*2).* 病人的妹妹、*3).* 病人的媽媽、*4).* 病人的爸爸、*5).* 病人自己、*6).* 外加*ficolin-3*作為對照

Node Id: **ae83599e89bdcdff4c0848e6**

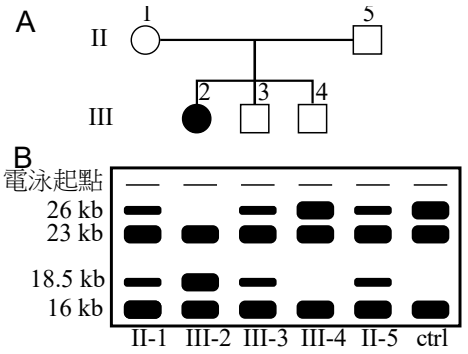
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
The mutation is a frame-shift mutation 此突變是一個轉譯框位移突變	○	○
If a child lacks ficolin-3 protein, at least one of her/his parents should have the same phenotype 如果一個小孩缺少ficolin-3，則至少他/她的雙親之一具有和小孩相同的的表現型	○	○
All three possible genotypes of the ficolin-3 gene can be determined using Western blots 三種可能的ficolin-3基因型都可以用西方轉染分析去判定	○	○
Sister (1) might be heterozygous 病人的姐姐(1)可能是異型合子	○	○

Q. 37

DNA from five members of a family, in which dwarf growth occurs (Fig. A), was examined using restriction enzymes, DNA probes, and gel electrophoresis (Fig. B). Dwarf growth occurs due to deficiency of growth hormone.

侏儒是因缺乏生長賀爾蒙所致，對一個侏儒和其4個正常家人(如圖A)的DNA進行限制酶片段分析，DNA電泳結果如圖B所示



A, pedigree with a dwarf member (2); B, gel electrophoresis plate with size of fragments to the left. DNA from a control person (ctrl) without this type of mutation was also examined (from Phillips et al. 1981).
A：侏儒個體*(2)*的族譜圖
B：限制酶片段電泳分析，尺標註記於左側，數字相對族譜個體，一個正常人的*DNA*作為對照*(ctrl)*

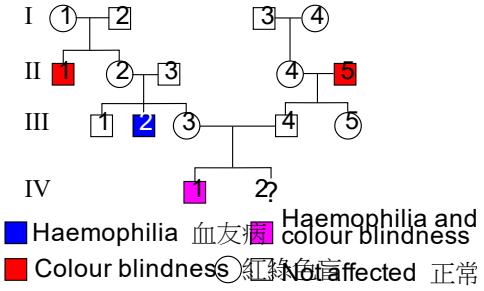
Node Id: **90c44ca25fc389babdad194a**

Indicate if each of the following statements is true or false
指出下列各敘述是正確或錯誤.

	TRUE 正確	FALSE 錯誤
The gene for growth hormone is situated within the 26 kb DNA sequence 生長賀爾蒙基因位於這段26 kb DNA片段中	○	○
The mutation is due to a deletion of the size of 26 kb 突變是因一個26 kb的DNA缺失	○	○
III-4will most probably not have children that lack growth hormone 個體III-4大概不會有缺少生長賀爾蒙的小孩	○	○
The risk that a fourth child of II-1 and II-5 will be a dwarf is 50% 個體II-1和個體II-5的第4個小孩是侏儒的機率是50%	○	○

Q. 38

Two human genetic disorders, haemophilia and red-green colour blindness, are both located on chromosome X. The pedigree in the Fig. shows a family with both disorders.
人類遺傳疾病血友病和紅綠色盲的基因都位於X染色體上，圖中所示是一個發生這二種遺傳疾病的家庭之族譜



Pedigree of a family suffering from both haemophilia and red-green colour blindness. Blue symbols = haemophilic individuals; red symbols = colour blind individuals; purple symbol (IV-1) = haemophilic+colour blind individuals; white symbols = unaffected individuals. It is assumed that no new mutations related to the two disorders occur in the family.
一個受到血友病和紅綠色盲二種遺傳疾病影響的家庭之族譜，藍色= 血友病個體； 紅色= 色盲個體；紫色 = 血友病+色盲個體*(IV-1)*；白色 = 正常個體。假設在這家庭中沒有與這*2*種疾病相關的新突變發生

Node Id: **15e51d9c678ec4e818038808**

Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
Person II-2 is a carrier of both disorders 個體 II-2是這二種遺傳疾病的帶原者	○	○
At least two individuals in the pedigree carry recombinations due to genetic crossover 在這族譜中，至少2個個體帶有因染色體互換而生的基因重組	○	○
If IV-2 (unborn) has Klinefelter's syndrome (XXY) and also has colour blindness, then a non-disjunction must have taken place in the first meiotic division of the mother's egg cell 如果一個尚未出生的個體IV-?為克氏症患者(XXY)，假設他也有色盲，則其克氏症原因是在其母親產生卵的第一次減數分裂時發生染色體不分離	○	○
III-5 marries a man from a population in which the frequency of the allele for colour blindness is 1%. The probability that their firstborn child is a colourblind daughter is 0.25% III-5的先生來自於一個色盲等位基因頻率為1%的族群，則他們的第一個小孩是色盲女孩的機率為0.25%	○	○

Q. 39

Egg producers prefer hens to roosters, and they select these by using sex-specific traits. Roosters have the sex chromosomes ZZ and hens have ZW (W is a dwarf chromosome perhaps without coding information). In a parental crossing (P) between a black-coloured rooster and a barred (coloured stripes) hen all male chickens became barred and all female chickens black. Breeders knew beforehand that only one gene was involved in the trait.
蛋農偏好母雞甚於公雞，他們利用性聯性狀及早進行小雞篩選。公雞帶有ZZ染色體，母雞則帶ZW染色體(W是短小染色體，可能不攜帶基因)。在選擇親代(P)交配時，以黑色的公雞和條文母雞交配，則子代所有公小雞都是條紋，而所有母小雞都是黑色的。雞的育種者知道只有一個基因控制這項性狀

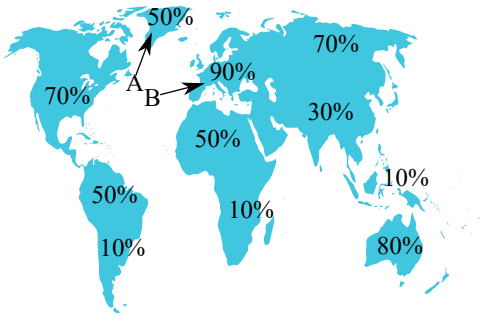
Node Id: **066e5631e72a740deb09dce9**

Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
Black plumage dominates over barred 黑色羽毛對條紋是顯性	○	○
All barred chickens in F2 can be regarded as hens and used for egg production 在F2中所有的條紋雞會是母雞，可飼養作為蛋雞	○	○
Half of the male chickens in F2 are heterozygous 一半的F2公雞是異結合型	○	○
All male chickens in F2 are black 所有的F2公雞是黑色	○	○

Q. 40

The proportion of lactose-tolerance in adults varies globally (Fig.). Lactose tolerance is a 1-locus dominant trait (dominant allele *K* and recessive allele *k*).
在全球不同地區對乳糖耐受的成人比例差異很大(如圖)，乳糖耐受性由單一基因控制，K 是顯性等位基因，k是隱性等位基因



Lactose tolerance (%) among adults around the world. A points to Greenland, B to Europe.
全球不同地區對乳糖耐受成人比例，*A*是格陵蘭，*B*是歐洲

Node Id: **a5dd65988210263a0adedb8f**

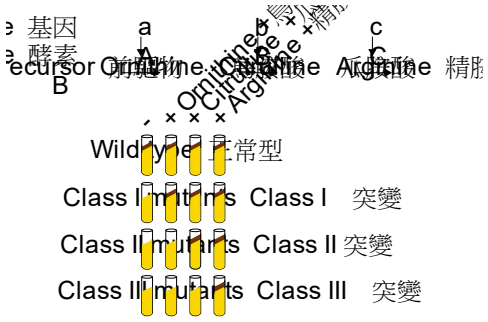
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
Assuming that the European (B) population is in Hardy-Weinberg equilibrium, the frequency of *K* in the next generation will be 0.968 假設歐洲族群(圖中B)已達哈-溫平衡，則等位基因K在下一代中的等位基因頻率為0.968	○	○
Differences in the frequencies of the *K* allele between populations prove that selection has been acting on this trait 不同族群中K等位基因頻率的不同證明是否具乳糖耐受性受到篩選	○	○
In Greenland (圖中A) where the percentage of lactose tolerance is 50%, the frequencies of the alleles *k* and *K* are equal 在格陵蘭乳糖耐受性比例是50%，所以k 和K的等位基因頻率相等	○	○
Lactose tolerance is assumed to be the ancestral trait among adult humans 乳糖耐受性被認為是遠古人類遺傳的性狀	○	○

Q. 41

In mold/mould, synthesis of the amino acid arginine requires prior conversion of a precursor to ornithine, which is then converted to citrulline, which further is converted to arginine. Each of these three steps is catalyzed by a separate enzyme, coded for by a separate gene (Fig.).

在黴菌中，精胺酸(arginine)的產生是先由前驅物轉換為鳥胺酸(ornithine)，再轉為瓜胺酸(citrulline)，由此再轉變成精胺酸，此3個步驟分別由3個不同的酵素催化，3種酵素各由不同的基因負責表現(如圖A)



A, biosynthetic pathway for arginine in mold; B, experimental set-up to confirm pathway; dark brown stripe denotes mold growth. The wild type grows on minimal medium, while the mutants only grow with addition of specific nutrients.
A：精胺酸*(arginine)*的合成路徑圖
B：確認合成路徑的實驗組合，深棕色條帶代表黴菌生長，正常菌種生長於最少培養基，但各種營養突變體則須另加特定養分才能生長

Node Id: **c09a7c7a160e848cb7d5e47c**

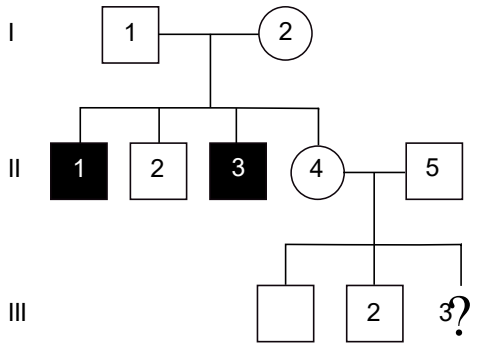
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
Class III mutants may have mutations in more than one gene involved in the pathway Class III 突變體可能有超過一個以上的合成路徑基因發生突變	○	○
Class I mutants lack activity of all three enzymes Class I 突變體缺少所有3種酵素活性	○	○
Mutants, lacking both enzyme A and C, will grow if ornithine and citrulline are both added 同時外加鳥胺酸(ornithine)和瓜胺酸(citrulline)可使缺少酵素A和酵素C的突變體生長	○	○
Assuming that an inhibitor to enzyme B is added to the wild type, gene B will be inactivated 若加入酵素B的抑制劑，會使正常型菌種的B基因不表現	○	○

Q. 42

This pedigree shows the occurrence of a rare disease phenotype (shown in

black) with full penetrance. The genetic disorder is caused by a recessive autosomal allele *d*.
圖中的族譜顯示一個罕見遺傳疾病的發生情形(黑色個體)，此遺傳疾病是由一個體染色體隱性等位基因d引起，致病基因型的發生率是100%



Pedigree of family with an autosomal recessive disease.
一個體染色體隱性遺傳疾病的族譜

Node Id: **ef508e5e4a6666895c9d9cdd**

Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

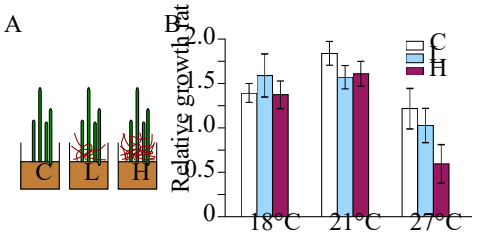
	TRUE 正確	FALSE 錯誤
The probability that II-4 carries the disease allele is 0.50 II-4個體是此致病等位基因攜帶者的機率是0.50	○	○
II-2 and II-4 have the same probability of carrying the disease allele II-2和II-4是此致病等位基因攜帶者的機率相同	○	○
If assume that II-5 does not carry allele d, the probability that III-3 carries this allele is 0.30 or higher 假設II-5不帶等位基因d，則III-3帶有此致病等位基因的機率≧0.30	○	○
If we assume, that II-5 is heterozygous and III-3 has the disease, then the probability that II-4 is a carrier is 0.5 假設II-5是異結合型，且III-3是疾病患者，則II-4是此致病等位基因攜帶者的機率為0.5	○	○

Q. 43

Eelgrass*(Zostera marina)* is a key species in Danish coastal waters, which during summer rarely get warmer than 18°C. In an experiment, the growth rate of eelgrass was measured at three temperatures and under the

influence of the invasive red alga *Gracilaria vemiculophylla* (Fig.). A hypothesis is that global warming and the presence of *Gracilaria* negatively affect eelgrass.

鰻草(*Zostera marina*)是丹麥海岸水域的關鍵海草物種，附近海域在夏天的溫度很少高於18°C。在三種溫度以及入侵的紅藻物種Gracilaria vemiculophylla的影響下，測量鰻草的生長速率(圖)，此研究的假說是全球暖化以及紅藻的存在對鰻草生長有負面影響。



A, three buckets with eelgrass were exposed to increasing amounts of Gracilaria. C = no Gracilaria; L = Low Gracilaria content; H = High, Gracilaria content per bucket; Fig. B, relative growth rate of eelgrass at three temperatures and together with increasing amounts of Gracilaria (white bar = C; light blue bar = L, purple bar = H in Fig. A) (from Höffle et a. 2011). ***If error bars do not overlap, the differences are statistically significant.***
*A*圖為三桶鰻草，桶內的紅藻量漸增，*C*=沒有紅藻；*L*=紅藻量少；*H*=紅藻量多。*B*圖為三種溫度以及不同程度的紅藻入侵下的鰻草生長相對速率 *(*白色條帶*=C*；淡藍色*=L*；紫色*=H)* 若直條上的標準偏差區間*(error bar)*沒有重疊，則屬統計上有顯著差異。

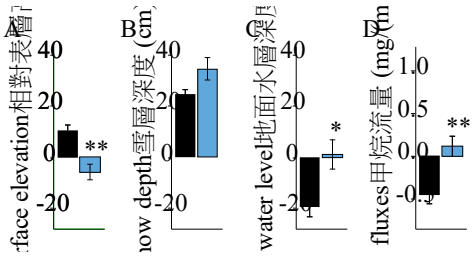
Node Id: **48e14a2ec4367680b53bcd35**

Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤。

	TRUE 正確	FALSE 錯誤
Irrespective of temperature, *Gracilaria* inhibits the growth rate of eelgrass 紅藻抑制鰻草的生長速率，與溫度無關聯	○	○
In general, temperature affects the growth rate of eelgrass 一般而言，溫度會影響鰻草的生長速率	○	○
There is a combined effect of *Gracilaria* and temperature on the growth of eelgras 溫度與紅藻對鰻草的生長速率有混合影響	○	○
In Danish waters without *Gracilaria*, eelgrass growth is temperature limited 在沒有此種紅藻的丹麥海域中，鰻草的生長速率受溫度限制	○	○

Q. 44

Arctic tundras are warming faster than the global average. This influences their soil carbon reservoirs. The permafrost layer in the tundra is covered by an active layer, which has an annual thaw/refreeze dynamic. The influence of tundra vegetation as a driver of this dynamics was studied in Siberia from 2006 to 2012. Four parameters were measured in plots, where the woody vegetation was removed (blue bars in the figure), and in undisturbed control plots (black bars).
北極凍原的暖化情況較全球平均要快，此情況會影響凍原土壤中的碳源。凍原中的永凍土層(permafrost layer)上覆蓋著一活躍土層(active layer)，其每年會有冰溶/再結凍的週期動態變化。凍原植被的影響可視為此動態的驅動力，並被用來進行在西伯利亞從2006-2012年的研究。下圖中，在樣區中測量4個變數，且有些樣區為移除木本植被(圖中的藍色條帶)以及不受干擾的操控環境(黑色條帶)。



*A, Surface elevation relative to ground surface level (0); B, spring snow depth; C, summer ground water level compared to soil surface level; D, August CH4 emission (+ value, emission). *, significant differences (from Nauta et al. 2014).*
*A*圖為表層相對於地表*(*當作*0)*的高度；*B*圖為春天的雪層深度；*C*圖為夏天地面水層相較於土表層的深度；*D*圖為八月時甲烷釋放量*(*正值代表釋放*)*；***代表有顯著差異。

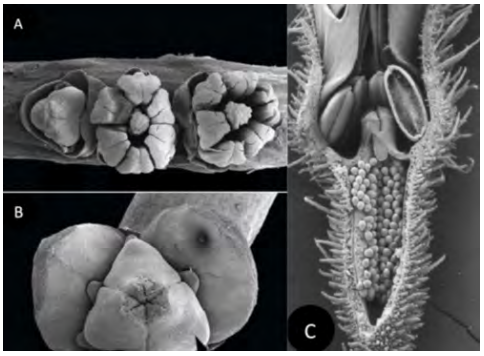
Node Id: **e71d889d2035da3e553b0199**

Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤。

	TRUE 正確	FALSE 錯誤
Soil subsides when its woody vegetation is removed 若移除木本植被，則土壤會下陷	○	○
Undisturbed tundra woody vegetation functions as a source of global methane emission 未受干擾的凍原木本植被是全球甲烷釋放的來源	○	○
Removal of woody vegetation initiates a cycle, leading to more dominance of water-tolerant plants 移除木本植被會引發一個循環，導致耐水的植物較具優勢	○	○
After removal of woody vegetation, the chain of events will be: Fig. B --> Fig. C --> Fig. A --> Fig. D 移除木本植被之後，引發的連鎖事件會是圖 B --> 圖 C --> 圖 A --> 圖D	○	○

Q. 45

The structure of flowers has many morphological characters important to reproductive success, e.g. sexual dimorphism (dioecy, monoecy). Such characters show phylogenetical conservatism, and thus may be used in evolutionary analysis.
花的構造有多種利於生殖的重要形態特性，例如單性花(雌雄異株、雌雄同株)。這樣的特性顯現出親緣保守性(phylogenetical conservatism)，因此可用以進行演化分析。



A-B, flowers of a palm; C, longitudinal section of a flower of species saxifrage (from Soltis et al. 2003, Castaño et al. 2014).
圖*A-B*為棕櫚樹的花；圖*C*為虎耳草屬植物的花之縱剖面觀。

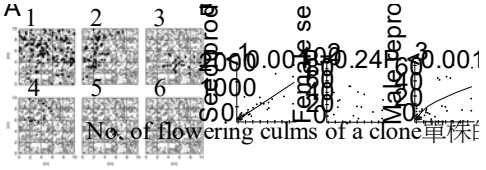
Node Id: **54b3090c2dcbaa39f15e460f**

Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤。

	TRUE 正確	FALSE 錯誤
The palm in Fig. A is monoecious (i.e. hermaphroditic plants with unisexual flowers) 圖A的棕櫚樹為雌雄同株(即在同一植株上有兩種單性花)	○	○
The palm in Fig. A originates from an ancestor, which most likely had hermaphroditic flowers 圖A的棕櫚樹的祖先很有可能有雌雄同株的花	○	○
The palm and the saxifrage are both most likely dicots 棕櫚樹與虎耳草屬植物兩者可能皆為雙子葉植物	○	○
If structures through evolution become more specialized, one would expect the saxifrage to be phylogenetically older than the palm 若構造經由演化會更具專一性，則虎耳草屬植物在演化親緣上比棕櫚樹較古老	○	○

Q. 46

Many plants reproduce both sexually and vegetatively (clonally). A hypothesis says: As both reproductive modes require energy, a negative trade-off is expected to exist between the two reproductive modes. This was studied in a population of Japanese bamboo (*Sasa veitchii*) (Figs A-B).
許多植物可進行有性及無性生殖。假說指出: 由於兩種生殖型式皆需要能量，兩生殖型式間有一種負向的權衡(trade-off)。研究日本竹(Sasa veitchii)族群來驗證此假說，結果如圖A-B所示。



A, six plots (10 x 10 m) each presenting the spatial distribution of a bamboo clone; black dots show the positions of all flowering culms of the clone, whereas all the grey dots show the positions of all flowering culms of all the other clones in the plot; B, relationships between no. of flowering culms of a clone and its sexual success (measured in three ways). A regression line is present, if the relationship is significant (from Matsuo et al. 2014).
圖*A*顯示*6*個*10 x 10 m*樣區，每個樣區代表單一竹子植株的空間分布；黑點則是此單一植株有開花的枝叢，而所有灰點則是在樣區內來自其他植株的開花枝叢。圖*B*為單一植株的開花枝叢數量與其生殖成功的關係*(*以三種方式來測量*)*。圖中若其關係為顯著者，則會顯示其迴歸線。

Node Id: **a5a55a3a5454eb3bc3a9507f**

Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤。

	TRUE 正確	FALSE 錯誤
More "investment" in clonal growth negatively affects male reproductive success of an individual bamboo 在無性生長上"投資"愈多，將會對單一竹子植株的雄性生殖成功有負面的影響。	○	○
More "investment" in clonal growth negatively affects female reproductive success of an individual bamboo 在無性生長上"投資"愈多，將會對單一竹子植株的雌性生殖成功有負面的影響。	○	○
Larger bamboo clones have more self-pollination 較大範圍的竹子單株有較多的自體授粉	○	○
The gain in female fitness per produced flowering culm diminishes with increasing clone size 每個開花枝叢的雌性適應性(fittness)會隨單株範圍大小漸增而漸減	○	○

Q. 47

The carnivorous plant sundew, *Drosera capensis,* has tentacles with mucilage on their leaf surface. In an experiment, plants were each fed 50 fruit flies per day for ten weeks (Table). The weight of each fruit fly was measured before and after digestion, showing an average dry weight loss of 60%. Estimates of different parameters are given in table. Enzyme activity in mucilage was estimated 24 h after either being fed with fruit flies or exposed to mechanical irritation (the addition of polystyrene balls, which were the size of fruit flies).
食蟲植物茅氈苔(Drosera capensis)的葉子表面具有可分泌黏液的觸毛，下表中呈現實驗結果。在10週的實驗期間，每棵植物每天餵給50隻果蠅(如下表)，每隻果蠅再被植物消化的前後皆秤重，顯示出平均乾重減少了60%。下表中顯示不同變數的估計值；在餵給果蠅或是給予機械性刺激 (以同大小的塑膠球取代果蠅)後的24小時，測量黏液的酵素活性。

Activities of AP and PD, PA and nutrient levels in leaf tissue.
磷酸酶*(AP)*、磷酸二酯酶*(PD)*及葉組織中的蛋白水解活性與葉組織營養含量

	Enzyme activity in mucilage 黏液的酵素活性	Enzyme activity in mucilage 黏液的酵素活性	Enzyme activity in mucilage 黏液的酵素活性	Ratio of nutrients in leaf tissue 葉組織營養含量比
	Acid phosphatase 磷酸酶(AP), millimol/(mg protein蛋白質 x hour)	Phospho-diesterase 磷酸二酯酶(PD), micromol/(mg protein 蛋白質 x hour)	Total proteolytic activity 蛋白水解活性(PA), unit/mg protein蛋白質	N:P
Mechanical irritation 機械性刺激	65.4	4.07	297	
Control = unfed plants	24.7	2.04	363	47.6

對照組=未餵食的植株				
Fruit fly--fed plants 餵給果蠅的植株	297	11.6	2000	30.1

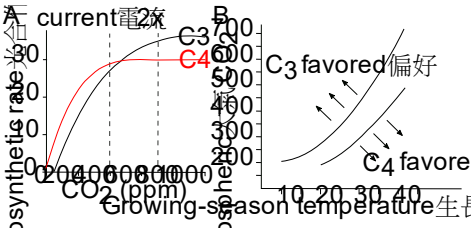
Node Id: **9304df5aeeea4c618a187888**

Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤。

	TRUE 正確	FALSE 錯誤
Results indicate that growth of *D. capensis* plants is normally limited by N 結果顯示: 茅氈苔的生長通常受到氮限制	○	○
Mechanical irritation increases enzyme activity, but proteolytic activity requires the presence of insects 機械性刺激可增加酵素活性，但是蛋白水解活性則需要有昆蟲的存在	○	○
No chitinase activity was observed in the mucilage, which might explain the fact that the weight of the fruit flies was only reduced by 60% 黏液中未觀察到幾丁質酶的活性，此現象可解釋果蠅的重量僅減少60%	○	○
N was a more efficiently absorbed nutrient from fruit flies than K 植物從果蠅吸收到的營養中，氮的吸收效率高於鉀	○	○

Q. 48

Plants have different photosynthetic systems. Most plants have the C3 system, but others, especially grasses, have a C4 system. The two systems show different photosynthetic rate, when CO_2 and ambient temperature vary (Fig.).
許多植物可進行有性及無性生殖。假說指出: 由於兩種生殖型式皆需要能量，兩生殖型式間有一種負向的權衡(trade-off)。研究日本竹(Sasa veitchii)族群來驗證此假說，結果如圖A-B所示。



Photosynthetic rate (A) and expected dominance (B) of C3 and C4 plants as a function of ambient CO_2 level and temperature (from Ehleringer et al. 1997).
在不同CO_2及氣溫下，*C3*與*C4*植物的光合作用速率*(A*圖*)*及預期優勢*(B*圖*)*

Node Id: **925f21fffc0005ae2835c4c1**

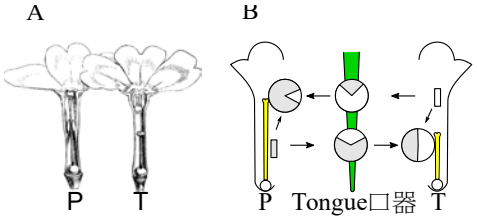
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤。

	TRUE 正確	FALSE 錯誤
The proportion of C4-plant species increases towards the poles C4植物的物種比例向極地漸增	○	○
At current atmospheric CO_2 levels, CO_2 is limiting the growth of both C3- and C4-plants 在目前的大氣中CO_2量之下， C3與C4植物的生長受CO_2含量限制	○	○
The predicted CO_2-increase can be more advantageous to C4- than C3-plants 與C3植物相較，預測CO_2量增加的現象對C4植物較具適應優勢	○	○
In dry and warm regions during the last glacial period, C4-plants were probably more widespread 在前一個冰河時期中，生長在乾燥溫暖區域的C4植物可能分布更廣	○	○

Q. 49

Primrose has heterostyly, i.e. two flower forms on different individuals: P-plants with long style and short stamens inside the corollar tube, and T-plants with short style and stamens higher in the corolla (Fig. A). Darwin crossed T x P primroses (Table), and found that heterostyly increases outcrossing and thus fruit set. A bee inserts its tongue in a P-flower and gets pollen on the tip of its tongue, and then places the pollen on the stigma of a T-plant and *vice versa* for T-pollen to P-stigma (Fig. B). Heterostyly is controlled by one gene (T is *Ss* and P is *ss*; *SS* is non-viable, *S* is dominant to *s*).

纓草植物具有異形花柱的現象，亦即不同個體有兩種花型: P型者的花冠筒中具有長的花柱及雄蕊；T型者則在花冠筒開口處具有短的花柱及雄蕊(如圖A所示)。達爾文將這兩型的纓草雜交(T x P；結果如表所示)，結果發現異形花柱可增加異交的機率，且增加果實產量。一隻蜜蜂將其口器伸入P型花中，並由口器先端取得花粉，然後將花粉落在T型花的柱頭上，而同樣地，T型花的花粉落到P型花的柱頭上(如圖B所示)。異形花柱是由單一基因所控制(T型花的基因型為Ss，而P型花為ss，SS則無異形花柱的現象，S對s為顯性)。



A, flower forms P (left) and T (right) of primrose; B, flowers P and T, with a bee's tongue (green) in between; arrows show amount of pollen transferred along different routes from the anther, to tongue and to the stigma (white and grey slices are T- and P-pollen, respectively).
圖*A*左側為*P*型花、右側為*T*型花；圖*B*顯示蜜蜂口器*(*綠色*)*以及口器在*P*、*T*型花中，箭頭代表花粉自花藥經由不同途徑傳遞出去的量*(%)*，包括傳至口器、柱頭。口器及花上的圓形圖中白色及灰色區域分別代表*T*、*P*型花的花粉。

Fruit set (Number of fruits) after 100 T x T and P x P crossings and 100 T x P and P x T crossings.
經過分別為*100*次的*T x T*與*P x P*，以及*T x P*與*P x T*的雜交試驗，所測量的果實產量*("*好*"*果實的數目*)*

	Number of fertilized flowers 受孕花的數量	**Number of fruits** 果實數量
T x T and P x P	100	63
T x P and P x T	100	75

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Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤。

	TRUE 正確	FALSE 錯誤
Frequencies of T and P in a primrose population stay the same, if mating is random with respect to form, and all crossings give the same fruit set 若T及P型兩型的交配為隨機，則此兩型在纓草族群的頻率維持相同，且所有雜交的產果量相同	○	○
Incomplete sterility within the same flower form is seen in the population as a deviation from a 1: 1 T: P ratio 在族群內，同一種花型內的不完全不孕性，其T:P比率會偏離1:1	○	○

The two routes of pollen transfer (T --> P or P --> T) are equally efficient in terms of the pollen transferred
兩種花粉傳遞途徑(T --> P 或 P --> T)的花粉傳遞效率一樣

Pollen deposition from tongue to stigma is more difficult than pollen harvesting from anther to tongue
花粉由口器落至柱頭的過程比花粉從花藥被口器採集的過程較為困難

END結束

IBO 2015 理論 1 圖

ibo 2015

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02:30

Q 1:

In mammals, a high blood pressure is needed to achieve a high blood flow (cardiac fluid flow) and to overcome any vascular resistance against the flow of blood. In order to make deductions about blood flow, Poiseuille's Law is used (Fig.).

$$Q = \frac{\Delta V}{\Delta t} = \frac{\Delta p \pi r^4}{8 \eta L}$$

$$\Delta p = R \Delta V$$

Poiseuille's Law: Q = fluid flow, V = volume, t = time, p = pressure, r = vessel radius, η = viscosity, (constant for a given temperature and fluid type), L = vessel length, and R = flow resistance.

Node Id: 338c0fcc31bbddb715316d3a
Indicate if each of the following statements is true or false.

	TRUE	FALSE
Assuming similar blood flow in a wide and a narrow artery of the same length, the change in mean blood pressure is greater in the former.		
Increased atherosclerosis leads generally to faster blood flow in the circulation.		
Comparing monozygotic twins, one living at sea level and the other at 3,000 m, the latter will have a higher resistance to blood flow.		
In a specific patient suffering from atherosclerosis, the radius of blood vessels on average had decreased by 1/6, which caused blood pressure to double to maintain the blood flow.		

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下午 04:51
2015/7/19

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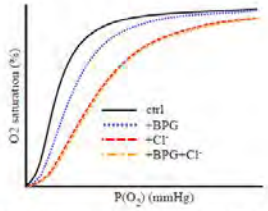
02:30

Q 2:

O_2-binding or -affinity to hemoglobin is affected by specific anions, in particular 2,3 bisphosphoglycerate (BPG) and chloride (Cl^-), which are present in red blood cells and bind to the hemoglobin molecule at specific sites (Fig.).



Hemoglobin saturation curves for hemoglobin without anions (ctrl) and with BPG, chloride or both, as a function of the partial pressure of oxygen in the blood.

Node Id: f032f7774164bc961d4279fa
Indicate if each of the following statements is true or false.

	TRUE	FALSE
If peripheral tissue lacks oxygen, red blood cells produce more BPG.		
At high altitudes, mutations leading to changes from polar to non-polar amino acid residues in the BPG binding site of the hemoglobin molecule will be favourable for the affinity of O_2 to hemoglobin in the lungs.		
It is likely that chloride and BPG bind at different sites in the hemoglobin molecule.		
BPG decreases the total oxygen saturation capacity of the hemoglobin.		

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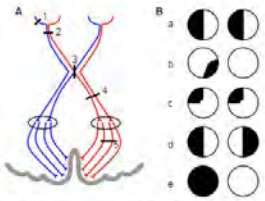
02:30

Q 3:

In humans, lesions in the central visual pathways may have different consequences to the visual field (Fig.).



A, lesions (1-5) in the central visual pathways (seen from above). B, visual field deficits (a-e, deficits shown in black, as seen by the affected person) caused by lesions in A.

Node Id: 323628807ee56f8ebbbf05a1
Indicate if each of the following statements is true or false.

	TRUE	FALSE
Lesion 2 corresponds to visual field deficit a.		
Lesion 3 corresponds to visual field deficit d.		
Lesion 4 corresponds to visual field deficit e.		
Lesion 5 corresponds to visual field deficit c.		

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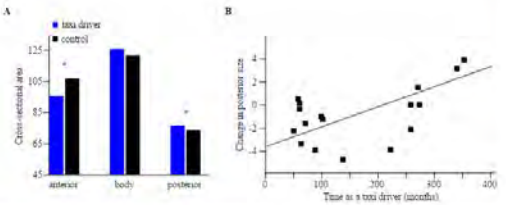
A 02:30 English (Official) TWN_JURY_6

Q 4:

The 2014 Nobel Prize winners in medicine demonstrated that the hippocampal (HC) region in the human brain stores spatial memory and facilitates spatial orientation. People using space extensively such as taxi drivers may depend on a well-developed HC. A study focused upon differences in HC between London taxi drivers and a control group, and its results are shown in Figs A-B.



A, variation between taxi drivers and others in size of the entire hippocampus (HC, body) and its anterior and posterior parts separately (, significantly different). B, correlation between volume change (grey matter) of posterior part of HC and employment time as taxi driver (from Maguire et al, 2000).*

Node Id: 481fd09f13a36ef52c92d601

Indicate if each of the following statements is true or false.

	TRUE	FALSE
Taxi drivers have significantly larger hippocampus than the control group		
Spatial navigation may be located in the posterior part of hippocampus		
The study provides evidence that some people are predisposed genetically to become better London taxi drivers than others in the population		
The study supports the traditional view that the hippocampus is only involved in short-term memory		

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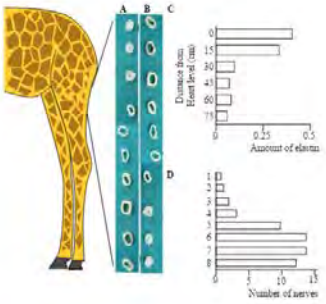
A 02:30 BE TWN_JURY_6

Q 6:

Node Id: 7a94b6b60025ebb901237c66



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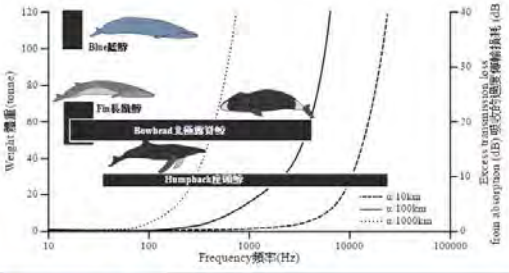
A 02:30 Chinese Traditional TWN_JURY_6

Q 7:

Whales rely on sound for communication in a diverse way. In a study, vocalization measurements of two distantly related whales, Humpback and Bowhead, were compared to literature data from two other species (Fig.).

鯨魚有不同方式以聲音溝通。在一項研究中，對座頭鯨與北極露背鯨兩種親緣較遠的鯨魚做發聲測量，與文獻資料中兩個其他物種比較(圖)。



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Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE正確	FALSE錯誤
Larger whales are expected to produce lower frequency signals than smaller whales do 大鯨魚產生的頻率信號應比小鯨魚產生的低		
Based on vocalizations, the Blue whale is expected to have more complex social behaviour than the Humpback. 基於發聲，藍鯨的社會行為比座頭鯨更複雜。		
Humpback and Bowhead have a signalling frequency that makes it possible for them to have high inter-annual mating site-fidelity 座頭鯨與北極露背鯨所具有的信號頻率，使牠們能準確定位每年的交配地點。		
The similar vocalization patterns of Humpback and Bowhead whales are most likely due to convergent evolution 座頭鯨與北極露背鯨的發聲模式類似，最可能是因趨同演化		

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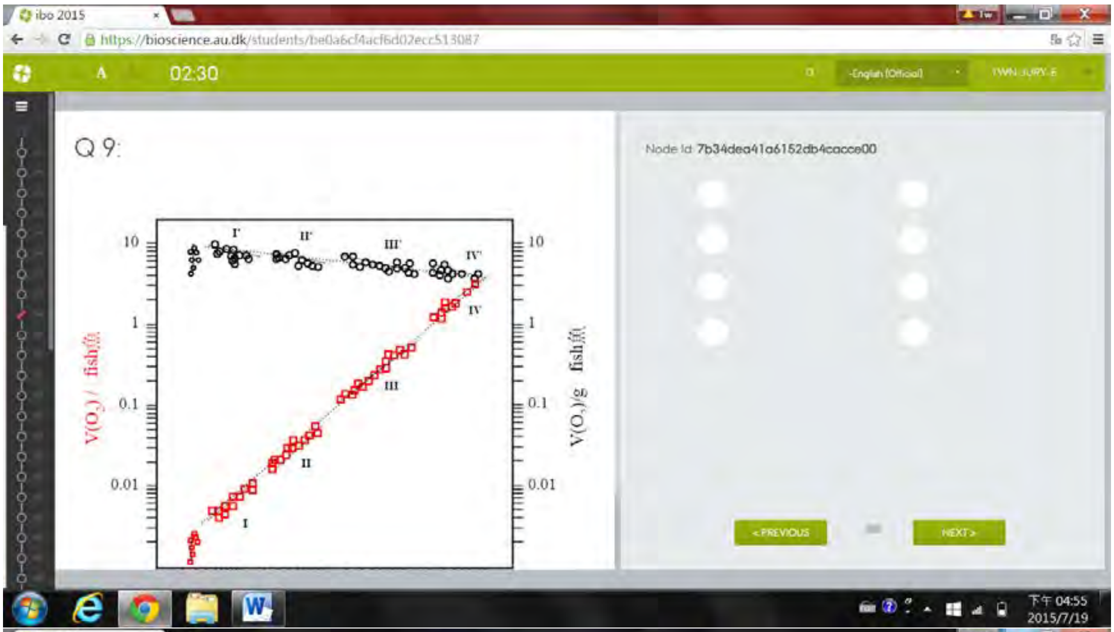
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02:30
English (Official)
Q 9:
Node Id 7b34dea41a6152db4cacce00
V(O₂) / fish
V(O₂)/g fish
10
1
0.1
0.01
I'
II'
III'
IV'
I
II
III
IV
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NEXT >
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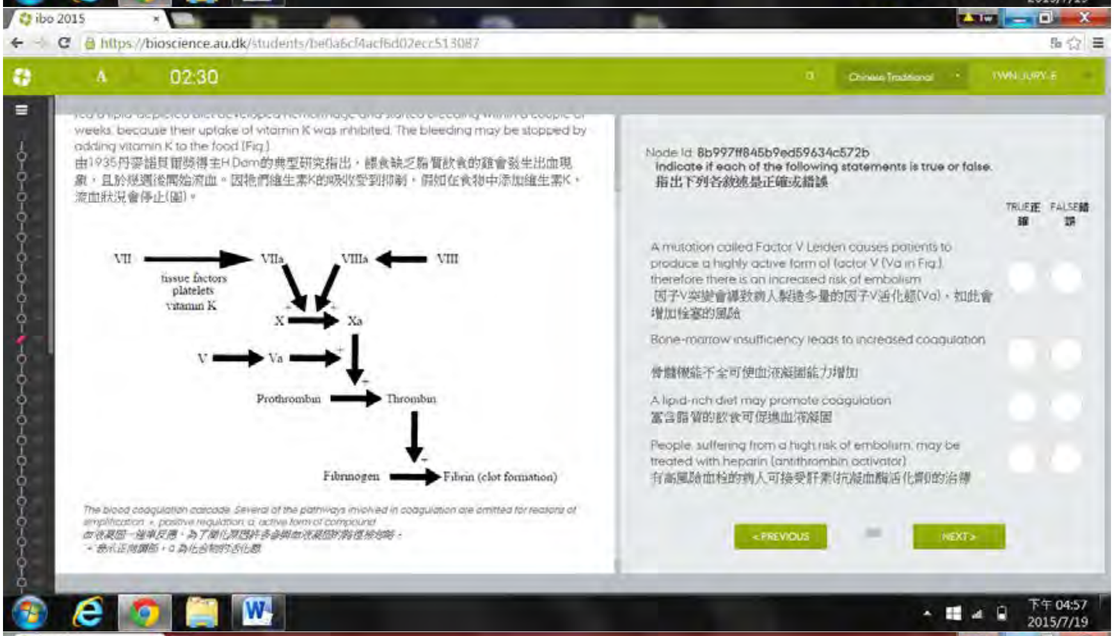
2015/7/19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02:30
Chinese Traditional
weeks, because their uptake of vitamin K was inhibited. The bleeding may be stopped by adding vitamin K to the food (Fig.)
由1935丹麥諾貝爾獎得主H.Dam的典型研究指出，餵食缺乏脂質飲食的雞會發生出血現象，且於幾週後開始流血。因牠們維生素K的吸收受到抑制，假如在食物中添加維生素K，流血狀況會停止(圖)。
VII
VIIa
VIIIa
VIII
tissue factors
platelets
vitamin K
X
Xa
V
Va
Prothrombin
Thrombin
Fibrinogen
Fibrin (clot formation)
The blood coagulation cascade. Several of the pathways involved in coagulation are omitted for reasons of simplification. +, positive regulation; a, active form of compound
Node Id 8b997ff845b9ed59634c572b
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤
TRUE正確
FALSE錯誤
A mutation called Factor V Leiden causes patients to produce a highly active form of factor V (Va in Fig.) therefore there is an increased risk of embolism
因子V突變會導致病人製造多量的因子V活化態(Va)，如此會增加栓塞的風險
Bone-marrow insufficiency leads to increased coagulation
骨髓機能不全可使血液凝固能力增加
A lipid-rich diet may promote coagulation
富含脂質的飲食可促進血液凝固
People suffering from a high risk of embolism may be treated with heparin (antithrombin activator)
有高風險血栓的病人可接受肝素(抗凝血酶活化劑)的治療
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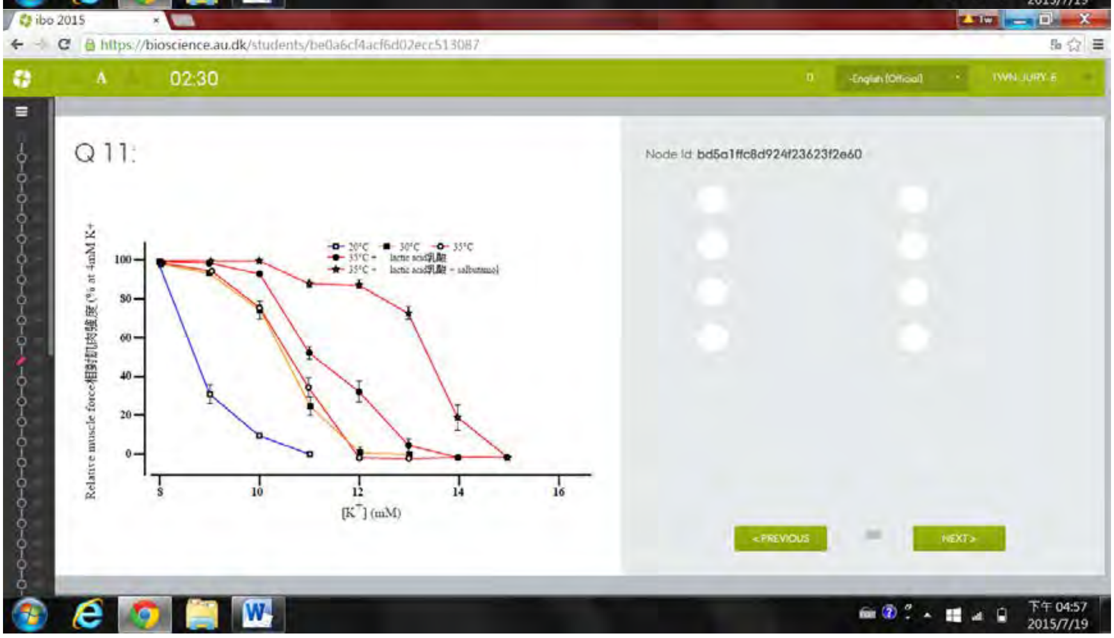
2015/7/19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02:30
English (Official)
Q 11:
Node Id bd5a1ffc8d924f23623f2e60
Relative muscle force相對肌肉強度 (% at 4mM K+)
[K+] (mM)
20°C
30°C
35°C
35°C + lactic acid乳酸
35°C + lactic acid乳酸 + salbutamol
100
80
60
40
20
0
8
10
12
14
16
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2015/7/19

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A 02:30 Chinese Traditional TWN_JURY_6

Q 13:

Strategies for regulating body temperature include controlling the movement of blood between the body core and surface and by countercurrent heat exchangers (Fig.).
體溫調節的策略，包括控制身體核心與體表之間的血液流動及熱逆流交換(圖)

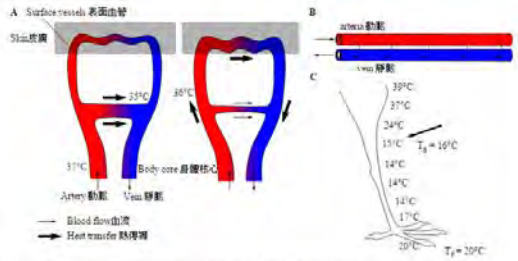

Figure. A. Regulation of heat conductance at body surface. B. thermal countercurrent system. C. body temperature in a bird limb. T_a = ambient temperature, T_f = floor temperature. (from Wittmer et al. 2005).
圖A.身體表面熱傳導的調節，圖B.熱逆流系統，圖C.在鳥腿的體溫；T_a = 氣溫；T_f = 地表溫

Node Id: 27d0487e0e6363e6c4a7d9a6
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
In Fig. A, the shunt vessel to the left is exposed to a lower exterior temperature than the one to the right. 圖A中，分流至左邊的血管較往右邊的血管所暴露的外在溫度較低		
In Fig. B, a countercurrent system often seen in animals from warm habitats is shown. 圖B中的逆流系統多見於溫暖棲地的動物		
The animal in Fig. C lives in a warm habitat. 圖C的動物生活在溫暖的棲地		
In Fig. C, the venous blood at the arrow has a temperature between 14-15°C. 圖C中的箭頭處，靜脈血的溫度約在14-15°C之間		

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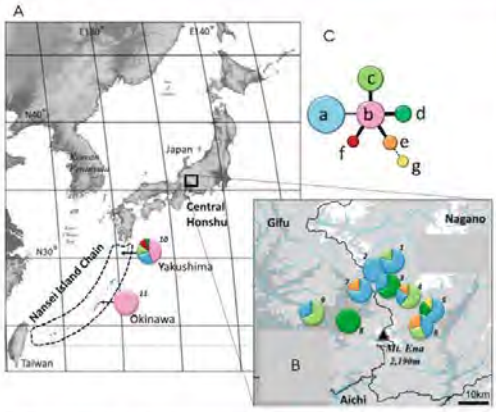
A 02:30 Chinese Traditional TWN_JURY_6



A–B, geographic distribution of 7 cpDNA haplotypes of Y. yakushimense. Pies are populations, and each colour indicates a haplotype. The size of each coloured slice shows proportion of each haplotype in the

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Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤。

	TRUE 正確	FALSE 錯誤
The origin of the orchid in Japan might be mainland Honshu because of the high genetic diversity observed here. 這種在日本的蘭花可能是起源自本州(Honshu)主要陸塊，因為該地的遺傳歧異度高。		
It is likely that a founder effect can been seen in Okinawa. 在琉球(Okinawa)本島的族群，可觀察到創始者效應		
CpDNA is better than nuclear DNA in revealing maternal origins of individuals. 以葉綠體DNA來分析個體的母系起源，比利用細胞核DNA的效果佳。		
The study suggests that mountains and river basins are more effective barriers to gene flow than the sea separating islands. 就基因流而言，本研究顯示山區與河谷的地理隔離比海洋區隔島嶼更具有效。		

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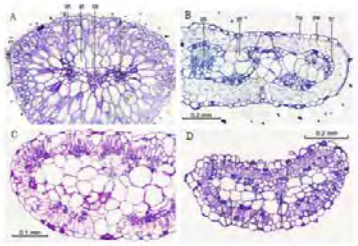
A 02:30 -English (Official) TWN_JURY_6

Q 14:



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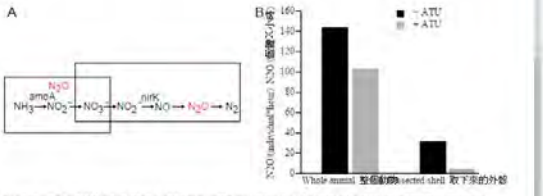
A 02:30 Chinese Traditional TWN_JURY_E

Q 16:

Nitrous oxide (N_2O) is a greenhouse gas, produced by bacteria through either nitrification or denitrification (Fig. A). Many aquatic invertebrates (e.g. zebra mussel) emit N_2O, due to the activity of bacteria in their gut and the biofilm covering their shell (Fig. B, Table).
一氧化二氮 (N_2O) 為一種溫室氣體，能藉由細菌的硝化作用與脫氮作用生成（圖 A）。許多水生的無脊椎動物（如斑馬貽貝），腸道中與殼上生物膜的細菌也會產生 N_2O（圖 B 與表）。



A, pathways for N2O production in bacteria, with key genes amoA (encoding ammonia monooxygenase AMO, nitrification) and nirK (encoding nitrite reductase NIR, denitrification). B, N2O emission from living zebra mussels and shells dissected from living animals, incubated with (+ATU) or without (-ATU) allylthiourea, which is a specific inhibitor of nitrification (from Svenningsen et al. 2012).
A：細菌產生 N2O 的代謝路徑，主要參與的基因有 amoA（氨單氧化酶，AMO，硝化作用）與 nirK（亞硝酸

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Indicate if each of the following statements is true or false.
請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
Most N_2O in zebra mussel is produced by bacteria inside the animal (e.g. in gut) 斑馬貽貝主要產生 N_2O 的細菌存在動物體內（例如：腸道中）。		
The N_2O production from mussel shells is mostly due to nitrification in their biofilm 斑馬貽貝主要產生 N_2O 是歸因於生物膜上的硝化作用。		
Nitrification and denitrification are equally important for N_2O emission from mussels 斑馬貽貝 N_2O 的生成，硝化作用與脫氮作用同等重要。		
Increasing nitrate (NO_3^-) concentrations in lakes (e.g. from agricultural run-off) will increase N_2O emissions from freshwater invertebrates 湖中硝酸鹽 (NO_3^-) 濃度增加（例如：農業行為）會增加洗水		

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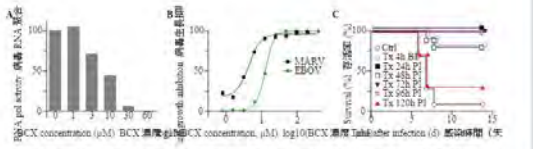
A 02:30 Chinese Traditional TWN_JURY_E

Q 17:

Filoviruses, e.g. Ebola (EBOV) and Marburg (MAR), cause haemorrhagic fever. Case fatality rates are >90%, and among the highest reported for any human pathogen. Vaccine or therapeutic products are not available. Recently, however, researchers tested an adenosine analogue, BCX, which seemed to improve survival of filovirus-infected humans (Fig.).
絲狀病毒科，如伊波拉病毒 (EBOV) 與馬爾堡病毒 (MAR)，會導致受感染者有出血熱的臨床徵兆。與目前已知的人類病源相比，是具有最高的死亡率，大於 90%。目前疫苗與有效的治療方法仍然闕如。許多研究者嘗試採用 BCX（腺苷類似物），來增加受到絲狀病毒科感染患者的存活率（如圖）。



A, effect of BCX on viral RNA polymerase activity; B, inhibition of EBOV and MAR growth in infected stem cells treated with BCX; C, survival of infected mice after BCX treatments (Tx) administered up to 14 days, beginning either before infection (PI) or post-infection (PI) at varying delays (from Warren et al. 2014).
A：BCX 對病毒 RNA 聚合酶的影響；B：BCX 處理受到 EBOV 與 MAR 感染的幹細胞；C：EBOV 與 MAR 老鼠的

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Indicate if each of the following statements is true or false.
問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
As an adenosine analogue, BCX affects viral gene transcription 由於 BCX 是一種腺苷類似物，所以會影響病毒的轉錄作用。		
BCX is applicable exclusively against ebola BCX 可以對抗伊波拉病毒。		
BCX can successfully (>50% survival) be administered up to 10 days after Ebola infection BCX 可以對抗伊波拉病毒。		
The half-maximal inhibition of BCX is achieved at a concentration of about 10 μM BCX 的 50% 最大抑制濃度約為 10 μM		

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A 02:30 Chinese Traditional TWN_JURY_E

Q 18:

Botanists may identify plants to family using diagrams, showing the different floral parts (Fig. A). According to the ABC gene model, development of a flower is based on expression of the A-, class-B- and C-genes. In dicots, sepals develop if gene-A is expressed alone, petals develop if both gene-A and gene-class-B are expressed, stamens develop if both gene-class-B and gene-C are expressed, and an ovary develops if only gene-C is expressed.
植物學家在鑑定植物屬於哪一科時，經常會使用圖形做分類，特別是花的各部形態（圖 A）。根據 ABC 基因模式，花的發育會根據 A 基因、B 群基因與 C 基因的表現來決定。雙子葉植物中，當 A 基因單獨表現時，萼片會發育。A 基因與 B 群基因共同表現時，花瓣會發育。B 群基因與 C 基因共同表現時，雄蕊會發育。C 基因單獨表現時，子房會發育。

A, diagram of a monocot flower; B, tulip flower (a monocot), parts of the flower are removed in photo to the right; C, the ABC gene model of monocot flower development (I, whorl; II, stamens; III, petals; IV, sepals; the latter two are similar in most monocots). Gene-class-B consists of 3 genes B1-B3 (from Johansen et al. 2006).
A：單子葉植物花的構造圖；B：鬱金香（單子葉植物）的花，右圖為移除部份的花瓣；C：單子葉植物花的

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Indicate if each of the following statements is true or false.
請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
Tulips do not have any sepals 鬱金香屬植物缺乏萼片		
Gene-C has different expression in monocots and dicots C 基因在單子葉植物與雙子葉植物表現各有不同		
Selective supression of gene C-expression in region II leads to development of unisexual flower 選擇性抑制基因 C 的表現在區域 II，會導致單性花的發育		
Complete development of stamens in the tulip requires the expression of gene-B1+gene-B3+gene-C 鬱金香屬植物雄蕊的發育需要 B1, B3 與 C 基因的共同表現。		

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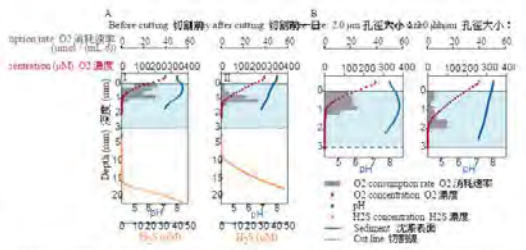
A 02:30 Chinese Traditional TWN_JURY_E

electron conductor (Fig.).
在海洋中，氧氣會從溶動層向下擴散到達沈積層表面的好氧層，會因為水流的減緩而逐漸降低。缺氧層在好氧層之下，此處即是細菌媒介處理最旺盛的區域。在好氧層的表面，H_2S 氧化成 SO_4^{2-} 與 氧氣還原作用緊緊相扣。在好氧層與缺氧層的交接處，有因為 H_2S 氧化成 SO_4^{2-} 而出現電子傳遞發生，進而造成電流。本實驗想偵測此處的電子傳導現象（見下圖）。



In an experimental set-up, upper oxic (< 3 mm) (blue area) and lower anoxic sediment layer (> 3 mm) were A physically cut apart by a thin 'knife' (before: left diagram; and after: right diagram). B the two layers were separated by filters with pores of two sizes (lower horizontal line) (from Pfeifle et al. 2012). O_2 concentration (red curve), O_2 consumption rate (O2 c.r., grey-coloured histogram), pH (blue), H_2S (orange line) and sediment surface (upper grey line at value 0) are shown (after Pfeifle et al. 2012).

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indicate if each of the following statements is true or false.
請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
The pH peak in the oxic layer is due to production of water from oxygen 因為氧氣轉化產生水，故造成好氧層中 pH 達到高峰。		
Physically interrupting the sediment by the "knife" did not affect O_2 reduction 薄刃造成的沈降物理性干擾，不會影響氧氣的還原。		
The filters demonstrated that any specific solutes were not transporting the electrons 利用不同過濾器實驗證明，任何特定的溶質不會進行電子傳送		
Electrons for the O_2-reduction most likely came from donors		

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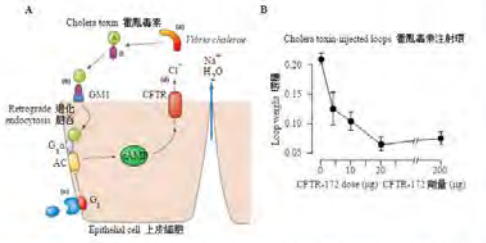
A 02:30 Chinese Traditional TWN_JURY_E

Q 21:

Cholera is caused by a toxin secreted by the bacterium *Vibrio cholerae* (Fig. A). One symptom is severe diarrhea, which leads to dehydration and perhaps death. Scientists tested a new CFTR-inhibitor, CFTR-172 (Fig. B) as a potential treatment for cholera.
霍亂係由霍亂弧菌分泌毒素所引起（圖A）。臨床的症狀為嚴重腹瀉。最後導致嚴重脫水甚至會死亡。科學家測試一種霍亂的治療藥物，CFTR-172（CFTR 抑制劑）（圖 B）。



A, action of cholera toxin on an intestinal epithelial cell. In the figure, A and B are cholera toxin subunits; GM1 (GM1 ganglioside receptor), Gαs (Gs protein), AC (adenylate cyclase), PKA (Protein kinase A), cAMP (cyclic AMP), and

Node Id: 8d2f878a4dec37356bac3149
indicate if each of the following statements is true or false.
問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
The water loss of patients with cholera is due to osmosis 患者因為滲透作用而導致脫水。		
The cholera toxin binds to transmembrane ion channels thereby starting a cascade reaction 霍亂毒素結合於穿膜離子通道上後，會啟動瀑布效應。		
Based on Figure B, one might treat cholera-induced diarrhea with CFTR inhibitor, CFTR-172 根據圖B的結果，CTFR-172（CTFR 抑制劑）可以作為因霍亂引起腹瀉的治療藥物		
The results in Fig. C support that the cholera outbreak could be caused by infection from the UN soldiers 根據圖C的結果，霍亂的爆發是來自於聯合國士兵。		

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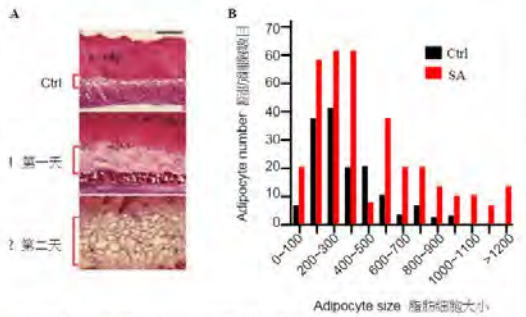
A 02:30 Chinese Traditional TWN_JURY_E

金黃色葡萄球菌 (SA) 會造成人類皮膚感染，甚至引發死亡。及時保護或局部表皮細胞的防護，會減緩感染的傳播。細胞會分泌抗微生物肽 (amp)，例如：抗菌肽 (Camp)。最新的發現，宿主受到感染後，會改變下表皮脂肪組織。（圖 A-B）BADGE（抗脂肪細胞增生藥物）的抗菌機制如圖 C-E。



A, mouse skin infected with SA and compared to control (ctrl) (red brackets: subcutaneous fat layer). B, change in number and size of adipocytes 3 days after SA infection.
A，小鼠皮膚受到金黃色葡萄球菌感染，Ctrl 對照組，紅色括號表示下表皮脂肪層。B，感染後第三天，脂

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indicate if each of the following statements is true or false.
問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
An SA infection induces the average subcutaneous fat cell to increase in size 金黃色葡萄球菌感染會刺激下表皮脂肪細胞體積變大。		
Number of adipocytes is important against spread of infection 脂肪細胞數目與抑制感染的散播有重要關係。		
Badge destroys the effect of Camp BADGE 會破壞 Camp 的作用。		
Results in Fig. C-D and in Fig. E support each other well 圖 C-D 與 圖 E 的結果可以互相支持。		

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下午 05:02
2015/7/19

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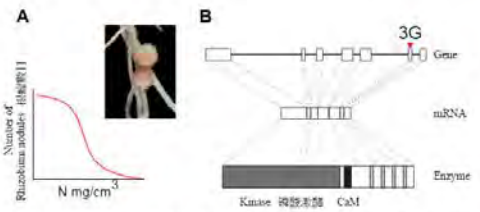
A 02:30 Chinese Traditional TWN_JURY_6

Q 23:

The effect of the nodule bacterium *Rhizobium* on the growth of the legume *Lotus japonicus* has often been studied, e.g. in relation to the enzyme/gene system of the interaction (Fig.).
根瘤菌Rhizobium對豆科植物Lotus japonicus生長的影響常被探討，例如，有關酵素和基因系統之間的交互作用



A. Rhizobium nodule and the relationship between the number of Rhizobium nodules and the nitrogen (N) content of soil.
A：根瘤照片；根瘤數目和土壤中氮含量之間的關係圖
B. the enzyme CaMK with its mRNA and associated gene. The kinase domain (large dark grey) regulates other enzymes. The black band is the CaM domain, and the four narrow grey bands are EF-hand domains. Boxes in the gene are exons.

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Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE	FALSE
Nodulation mainly occurs in nitrogen-poor soil 根瘤主要發生於缺氮土壤		
Rhizobium stimulates growth of *Lotus* by enlarging the surface of its root system, and consequently uptake of NO_3^- increases 根瘤菌Rhizobium誘發豆科植物Lotus增加其根系表面積，因此增加硝酸根的吸收		
Mutation 3G in Fig. B inhibits the transcription of CaMK 圖B中的3G突變抑制CaMK的轉錄		
Each exon encodes a specific protein domain 每一個外顯子都代表一個特定的蛋白質功能區		

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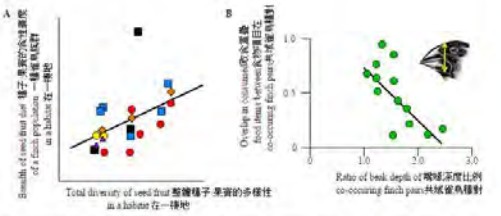
A 02:30 Chinese Traditional TWN_JURY_6

The Galápagos Islands are well known for the adaptive radiation of 14 species of finch. The drivers of this radiation are either competition for food in the community of finch species (Hypothesis 1), diversity of available food, i.e. seeds and fruits (Hypothesis 2), or both. Choice of diet is determined by size and structure of the beak. These hypotheses were tested using the six ground finches, which have very different beaks (Fig.).
加拉巴戈群島以14種雀鳥的輻射適應而聞名，造成此種輻射適應的推手有可能是種間食物的競爭(假說1)，可利用食物如種子及果實的多樣性(假說2)，或是此兩假說的組合，食性的選擇主要取決於鳥喙的大小及構造。
用六種嘴形大小不同的地面覓食的雀鳥種來進行測試這些假說(圖)



A. relationship between seed/fruit diversity within a habitat and breadth of seed/fruit diet of a finch population in the same habitat. Each dot is a finch population in a habitat, and different shapes and colours of dots indicate different finch species. B. relationship between ratio of beak depth of co-occurring pairs of finch species and overlap in consumed food items between a pair of species, i.e. each dot is a species pair. Yellow

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Indicate if each of the following statements is true or false.
指出下列敘述何者正確或錯誤

	TRUE 正確	FALSE 錯誤
According to Fig. A, Hypothesis 2 is more likely than Hypothesis 1 根據圖A，假說2較假說1更有可能成立		
According to Fig. B, Hypothesis 1 is more likely than Hypothesis 2 根據圖B，假說1較假說2更有可能成立		
Different finch species respond to the same extent to an increase in seed and fruit diversity 不同的雀鳥種類對於種子及果實多樣性的增加，其應生相同程度的反應		
Figures .A-B show that interspecific competition is low when food is more diverse 圖A和B顯示在食物較多樣化時，種間競爭低		

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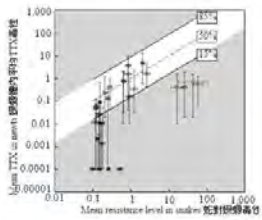
including newts, and individual snakes vary in their resistance to TTX. The higher the TTX level in a newt population is, the greater the resistance of co-occurring snakes, which, however, still may reject newts, which are too poisonous (Fig.).
組皮蜥蜴產生毒素TTX，可使其他脊椎動物致命，蜥蜴個體的毒性總度不一，
東帶蛇幾乎捕食任何獵物包括蜥蜴在內，而不同蛇個體間抗TTX毒能力不同。蜥蜴體內TTX毒性越高者，其共域環境中東帶蛇的抗毒性越高。但太毒的蜥蜴個體，可能對蛇不具吸引力。



Relationship between levels of resistance of snakes and toxicity of newts. Each dot represents a site with interacting snake and newt populations. In the white zone, snakes consume newts, but with a cost to their mobility. Dots in grey-coloured zones are toxicity-resistance mismatches. Bars give variation in levels among individuals within a population. The 50% dashed line reflects the TTX dose that would reduce snake performance 50%. 15% and 85% lines delimit the range of functionally relevant TTX doses for snakes across all sampled sites (from Hanifin et al. 2008).

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Indicate if each of the following statements is true or false.
指出下列何者敘述正確或錯誤

	TRUE 正確	FALSE 錯誤
Coevolution/reciprocal selection between newt and snake mainly takes place in the white zone 在蜥蜴與蛇的共同演化/互相選擇主要發生在白色區域		
The figure agrees with the "life-dinner principle", i.e. survival is under stronger selection than demand for food in a prey-predator interaction 圖與生命-餐點原理(life-dinner principle)一致，即在獵物與天敵交互作用中，存活較食物需求有較強的天擇壓力		
Per individual, resistance seems to be less costly than toxin production 就每一個體而言，抗毒所付出的代價似乎較生產毒物所付出的代價小		
It is likely that the snake populations in the two 'green' and two 'yellow' sites at the extreme right of the figure have won the arms race		

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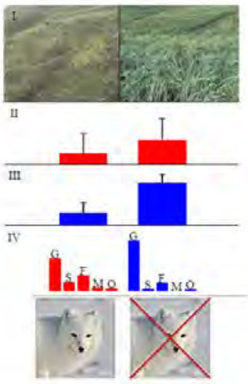

Mean values (± standard error) for parameters sampled on fox-infested islands (red, left-hand bars) and fox-free islands (blue, right-hand bars). I. view of the plant community on an island. II. logarithm10 of density of

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Indicate if each of the following statements is true or false.
指出下列敘述何者正確或錯誤

	TRUE 正確	FALSE 錯誤
The study is based on the assumption that sea bird-derived nutrients are distributed all over an island 這個研究主要是根據一個假設即島上海鳥產生的營養鹽分佈在全島上		
The presence of foxes on an island changes the vegetation from grassland to tundra- shrubland 島上有狐狸存在使島上的植被從草地轉變為凍原灌叢地帶		
Diversity and number of major plant groups are reduced in islands with fox populations 在有狐狸存在的島嶼主要植群的數量及多樣性減少		
The ecological changes on islands with fox introduction represent exclusively top-down processes 狐狸引入造成島上生態的改變，代表完全由上而下的控制作用		

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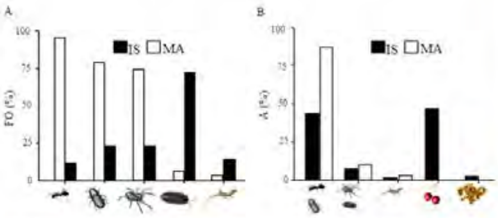
A 02:30 Chinese Traditional TWN-JURY-E

Q 27:

The bird Red-billed Chough has a wide diet. It lives on the oceanic Spanish island La Palma (*IS*) and on mainland Spain (*MA*). The bird's diet on *IS* and *MA* was compared (Fig.). As a food source, invertebrates are rich in protein and lipid, whereas fleshy fruit is rich in carbohydrates. *IS*-nestlings have more poorly developed feather barbs than *MA*-nestlings.
紅嘴山鴉具有廣泛的食性，牠生活在西班牙海上的Palma島(IS)及西班牙本土(MA)，比較兩地鳥的食性(圖)。做為食物來源的無脊椎動物其富含蛋白質及脂肪，而新鮮水果則富含碳水化合物，島上小鳥羽毛構造的發育較大陸的小鳥更差。



A. frequency of occurrence in habitat (FO%, i.e. percentage of samples with a given food item) of animal groups (from left: Ants, Other insects, Spiders, Other arthropods (i.e. myriapods, woodlice), and Lizards). B. chough nestling diet (A%, relative abundance of food item in diet, i.e. all white bars and all black bars each

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Indicate if each of the following statements is true or false.
指出下列敘述何者正確或錯誤

	TRUE 正確	FALSE 錯誤
Generally, food of animal origin is more scarce on *IS* than on *MA* 一般而言，動物性食物的來源在島嶼較大陸貧乏		
Mainland nestlings have a wider food niche than island populations 大陸的幼鳥比島嶼的幼鳥有更廣的食譜		
In general, insects are the favorite food of nestlings 一般而言，昆蟲是幼鳥所喜好的食物		
Island nestlings are expected to have a faster growth rate and shorter generation time than mainland nestlings 預期島上幼鳥較大陸幼鳥有較快的生長速率及較短之成長時間		

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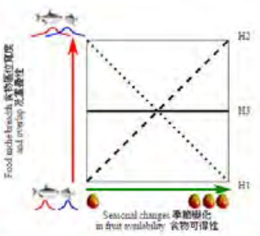
A 02:30 Chinese Traditional TWN-JURY-E

widespread among Amazonean fishes, and the relationships between fish diet and fruit production have been explained by three hypotheses H1-H3 (Fig.). Two species of fish (*Brycon falcatus* and *Myloplus asterias*) were studied in detail.
在一年間亞馬遜泛濫平原之森林會呈現高水(HW)及低水位(LW)的季節，其相對之水果實產量亦隨之有高低之分。亞馬遜的魚吃果實的情形普遍存在，三個假說H1-H3(圖)顯示魚的食性和果實產量的關係。
對兩種魚(Brycon falcatus and Myloplus asterias)的食性進行深入研究。



Three hypotheses (H1-H3) explain how food niche breadth and overlap among fish species (Y) respond to seasonal changes in fruit availability (X) (from Correa & Winemiller 2014).
三個假說(H1-H3)解釋魚種(Y)食物區位寬度與重疊如何隨季節果實可得性(X)的改變 (from Corréa & Winemiller 2014)

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Indicate if each of the following statements is true or false.
指出下列敘述何者正確或錯誤

	TRUE 正確	FALSE 錯誤
Fact: Diet overlap among fish increased from 28% to 95% from low-resource to high-resource season. This relationship is best explained by H1 事實：在魚種間食性重疊從低資源季的28%到高資源季的95%；上述可以用假說1(H1)來解釋		
Fact: *B. falcatus* was, at first, observed not to change its food niche, when food became more plentiful, but then at higher food availability it became increasingly selective. This relationship is best explained by a combination of H1 and H3 事實：當環境的食物變多時，魚(B. falcatus) 的食物區位並未改變，但當食物可得性變高時，牠變得挑剔；此一關係較符合假說1(H1)及假說3(H3)的組合		
Fact: Some fish had a constant food niche throughout the year, irrespectively of fruit availability. This is best explained by H1		

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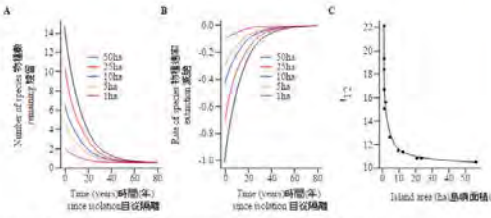
mammal fauna was monitored until 2013, i.e. 27 years after establishment (Fig.). The focus of the study was extinction of the hilltop fauna due to isolation.
在1986-1987春關掐一片森林淹沒，建立了一座水庫，原有的山頭現在變成新的島嶼共有16個，在水庫建立了27年後，也就是2013年對此進行了小型哺乳動物相的監測(圖)。此研究的目的在了解山頭的動物相受到孤立後物種的滅絕速率。



A. number of species remaining on different-sized islands (1-50 ha) T years after reservoir establishment (graph part after T = 27 years is expected future change). B. rate of species extinction on different-sized islands as a function of T. C. time to extinction of half of the fauna (T1/2) on different-sized islands (from Gibson et al. 2013).
A. 在水庫建立T年後(圖在T=27年後的變化即為未來的變化)留在不同大小的島嶼(1-50公頃)的殘留物種數
B. 物種在不同面積的島嶼消失速率與T的函數
C. 不同面積的島嶼動物相減半量(T1/2)所需的時間
(from Gibson et al. 2013)

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Indicate if each of the following statements is true or false.
指出下列敘述何者正確或錯誤

	TRUE 正確	FALSE 錯誤
Smaller islands (1-10 ha) lose more species per year than larger islands (25-50 ha) 小島(1-10公頃)比大島(25-50公頃)每年物種的損失要多		
At reservoir establishment, a linear relationship existed between species number and island area. 在水庫建立時，物種數與島嶼面積呈線性關係		
The study supports the hypothesis that in the long run, a single large protected island will support biodiversity better than several small ones. 此研究支持，就長遠觀點來說，單一大型的保護地比幾個小型的保護地對生物多樣性保存的效果較佳的假說		
In all islands, which are larger than 10 ha, the mean time to extinction of half of all species, is comparable. 在所有的島嶼中面積大於10公頃之島嶼其半數物種滅絕的平均時間是較相近的		

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下午 05:05
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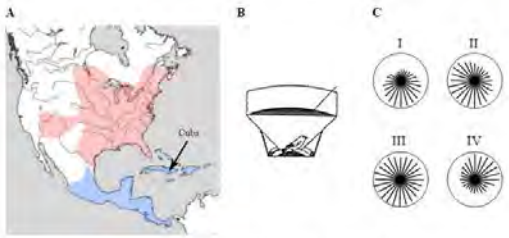
A 02:30 Chinese Traditional TWN_JURY_E

ink pad. Each time a bunting tried to fly out of the cage, the location of its footprint was marked by ink on a piece of paper, so its orientation pattern easily could be recorded (Fig. C). The bird migrates at night, using stars as cues.
Stephen Emlen對美國季節性遷移的候鳥觀鴉進行研究，他使用一個漏斗型的試驗鳥籠(圖B)在鳥籠的底部放置墨水墊，每當設鴉想要飛離鳥籠時，他的腳印就會留在鳥籠內襯墊的紙張上，因此他的方位選擇的模式可以很容易被紀錄下來，此種鳥夜間遷移，用星象當線索。



A. distributional range of the bird (pink area = summer range, blue area = winter area). B. Emlen's experimental cage, and C. four examples of footprint pattern, each radius is a take-off attempt by the bird (from Emlen 1967).
A. 鳥的分布區(粉色區域為夏天範圍，藍色區為冬天範圍)
B. Emlen 的實驗研究鳥籠
C. 鳥類印留下足跡的四種範例，每一個半徑軌跡是鳥打算起飛所留

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Indicate if each of the following statements is true or false.
指出下列敘述何者正確或錯誤

	TRUE 正確	FALSE 錯誤
The bird breeds in Central America and the Caribbean (blue area, Fig. A). 此種鳥在中美洲及加勒比海繁殖(藍區圖A)		
Fig. C-I is made by a north-eastern USA bird ready for autumn migration to the western part of Central America. 圖C-I是在美國東北部此種鳥的個體，在秋季打算遷移至中美洲西部時所留下的腳印		
Fig. C-II is made by a western USA bird ready for autumn migration to Cuba. 圖 C-II是在美國西部此種鳥的個體在秋天打算遷移至古巴時所留下的腳印		
Fig. C-III. The footprint of a young bird, suggesting that migration patterns are genetically determined. 圖 C-III為幼鳥的腳印，由此推測遷移的型態是由遺傳所決定的。		

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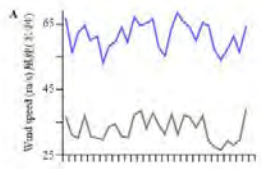
A 02:30 Chinese Traditional TWN_JURY_E

Q 31:

About 100 individuals of the butterfly *Melitaea cinxia* lives on a tiny island PT in the Gulf of Finland. Researchers studied how the butterflies on PT coped with the very windy conditions on the island. In the lab, they exposed butterflies from mainland and PT to a wind source (hair dryer) (Fig. B) and they also studied the morphology of the claws of the butterfly (Fig. C).
在芬蘭灣小島PT上，約有100隻Melitaea cinxia的蝴蝶生存其間，研究人員探了解蝴蝶如何適應此小島的強風勢，在實驗室他們將島上及大陸的蝴蝶置放於風源中(吹風機Hair dryer)(圖B)同時也研究蝴蝶附爪上的形態(圖C)



A. wind speed in June on PT (blue) and mainland (grey).
A.原PT島(藍色)及大陸(灰色)六月時的風速

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Indicate if each of the following statements is true or false.
指出下列敘述何者正確或錯誤

	TRUE 正確	FALSE 錯誤
Island insects in general are more often flightless than are mainland insects. 一般而言，島上昆蟲不具飛行能力者的比例較大陸昆蟲高		
If more curved tarsal claws are a disadvantage in escaping predators, then PT probably has very few insect-eating birds as compared to mainland localities. 假設附爪彎曲角度越彎對其逃避天敵越不利，則PT島與大陸相較，具有較少食蟲性的鳥		
In general, butterflies do not evolve flightlessness because of their mode of foraging. 蝴蝶因為他們覓食的模式不會演化成失去飛行能力		
With age, island butterflies learn to hide from the wind. 隨著年齡增加，島上蝴蝶學習如何躲避風		

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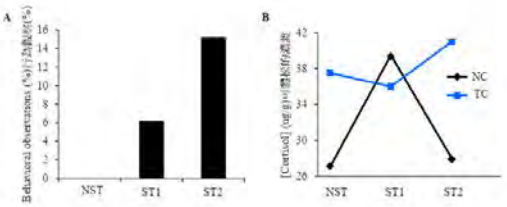
A 02:30 Chinese Traditional TWIN_JURY_E

groups. NST = no stereotypic pacing, ST1 = low level of pacing and ST2 = high level of pacing. The differences between these groups of minks in their stress responses to postponed feeding are shown in figures A and B.
一項在飼養場中進行超在福利減少時對其行為的影響，如延遲餵食對動物產生不正常的行為，包括重覆踱步的老套(制式)行為及自咬尾巴的現象。異常行為的指標可以由動物身上可體松(cortisol)的升高及恐懼的增加顯現，貂的行為可以被歸為：無老套行為(NST)；低度老套行為(ST1)及高度老套行為(ST2)三類。



A, frequency of stereotypic pacing, caused by postponed feeding. B, mean cortisol concentration in the two stereotypic groups (ST1 and ST2) and in the control (NST), and in absence (NC) or presence of tail-chewing (TC) (from Svendsen et al. 2011).

Node Id: 552ba21c77247860d76d8cb6
Indicate if each of the following statements is true or false.
指出下列敘述何者正確或錯誤

	TRUE 正確	FALSE 錯誤
Animal welfare studies always require behavioural observations 動物福利的研究皆是需要進行行為的觀察		
Stereotypic pacing is affected by postponed feeding 老套行為(制式)受到延遲餵食的影響		
Tail-chewing and stereotypic pacing are closely correlated 自咬尾巴及老套行為是緊密相關的		
Very high behavioural stress levels seem to suppress cortisol production 極高的緊迫程度似抑制可體松的產生		

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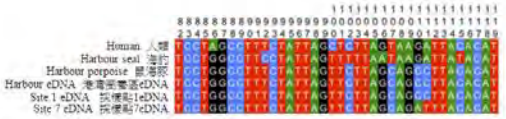
Q 34:

Use of environmental DNA (eDNA) is a new tool in tracking of marine organisms. In a study, a base sequence from the mitochondria of the cetacean Harbour Porpoise was analysed. Samples were taken both from a harbour pen and outside from natural sites (fig.).
環境中收集的DNA(eDNA)是海洋生物學的研究新工具。在一研究中，以鼠海豚(Harbour Porpoise)的一段粒線體DNA作為分析標的，收集港灣內和外海不同地點的eDNA進行分析比對如圖)



Base sequences (base no. 82 to 119) from human, seal, porpoise, and 3 samples of eDNA (Fjord Baelt, Site 1 and Site 7) (from Foote et al. 2012).
人類，海豹，鼠海豚的3個eDNA樣品(Fjord Baelt 獨有區，採樣點1和採樣點7)的鹼基序列(82-119)比對

In addition, echolocation clicks were used for acoustic monitoring (table).
此外，也使用高頻回聲定位來做聲波確認鼠海豚(如表)

Node Id: c7a00eefbc62bf6f0638cfb3
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
In this study eDNA may be an effective tool to detect marine animals far away from their habitat 在此研究中，eDNA可作為一種偵測遠離棲地之海洋生物的有效工具		
Most likely, the eDNA from site 7 was from an animal more closely related to the porpoise than to harbour seal 在採樣點7的eDNA樣品來源動物與鼠海豚的親緣關係較近，與海豹較遠		
Based on the short sequence in the Fig., the two marine animals, seal and porpoise, are more closely related to each other than seal and human are to each other 根據圖中的短序列，鼠海豚與海豹間的親緣性比人和海豹間的親緣性為高		
eDNA seems to be a poorer detection method than acoustic		

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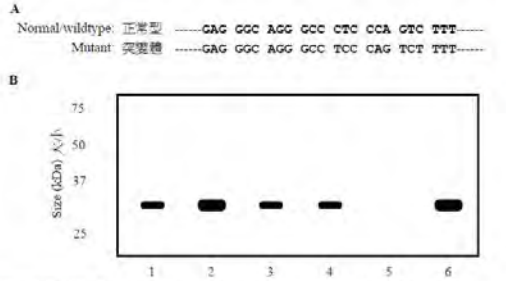
electrophoresis (B).
Ficolins 是重要的免疫系統蛋白，例如，ficolin-3。病人缺少ficolin-3可能會有各種病徵，這種ficolin-3缺乏是因為在ficolin 外顯子(圖A)上的一個突變，到一個家庭中5 位成員的血液進行ficolin-3電泳分析(如圖B)



Western blot of serum ficolin-3 from a family without any sick members except for the patient (5). The patient's sibes (1 and 2), mother (3), and father (4), compared to a control with ficolin-3 added (6). (from Munthe-Fog et al. 2014).
一家庭的成員中只有一位缺少ficolin-3病人，對他們的血液進行西方轉染分析；各樣品的體液數：1) 病人的姐姐，2) 病人的妹妹，3) 病人的媽媽，4) 病人的爸爸，5) 病人自己，6) 外部ficolin-3作為對照

Node Id: aa83599e89bdcdff4c0848e6
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
The mutation is a frame-shift mutation 此突變是一個轉譯框位移突變		
If a child lacks ficolin-3 protein, at least one of her/his parents should have the same phenotype 如果一個小孩缺少ficolin-3，則至少他/她的雙親之一具有和小孩相同的的表現型		
All three possible genotypes of the ficolin-3 gene can be determined using Western blots 三種可能的ficolin-3基因型都可以用西方轉染分析去判定		
Sister (1) might be heterozygous 病人的姐姐(1)可能是異型合子		

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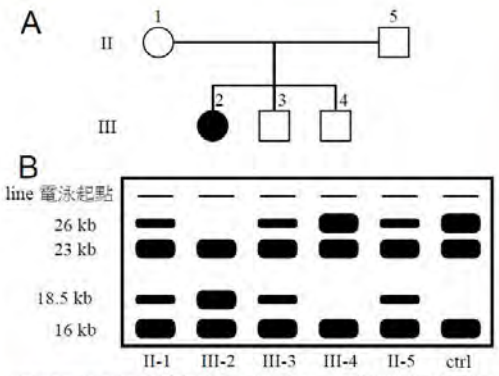
分析，DNA電泳結果如圖所示



A pedigree with a dwarf member (2). B. gel electrophoresis plate with size of fragments to the left. DNA from a control person (ctrl) without this type of mutation was also examined (from Phillips et al. 1981)

Node Id: 90c44ca25fc389babdad194a
Indicate if each of the following statements is true or false
指出下列各敘述是正確或錯誤.

	TRUE 正確	FALSE 錯誤
The gene for growth hormone is situated within the 26 kb DNA sequence 生長賀爾蒙基因位於這段26 kb DNA片段中		
The mutation is due to a deletion of the size of 26 kb 突變是因一個26 kb的DNA缺失		
III-4will most probably not have children that lack growth hormone 個體III-4大概不會有缺少生長賀爾蒙的小孩		
The risk that a fourth child of II-1 and II-5 will be a dwarf is 50% 個體II-1和個體II-5的第4個小孩是侏儒的機率是50%		

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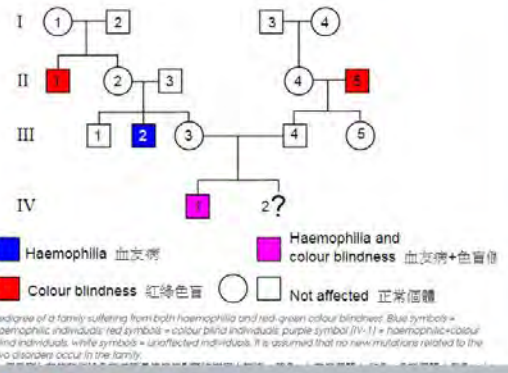
人類遺傳疾病血友病和紅綠色盲的基因都位於X染色體上，圖中所示是一個發生這二種遺傳疾病的家庭之族譜



Pedigree of a family suffering from both haemophilia and red-green colour blindness. Blue symbols = haemophilic individuals; red symbols = colour blind individuals; purple symbol (IV-1) = haemophilic+colour blind individuals; white symbols = unaffected individuals. It is assumed that no new mutations related to the two disorders occur in the family.

Node Id: 15e51d9c678ec4e818038808
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
Person II-2 is a carrier of both disorders 個體 II-2是這二種遺傳疾病的帶原者		
At least two individuals in the pedigree carry recombinations due to genetic crossover 在這族譜中，至少2個個體帶有因染色體互換而生的基因重組		
If IV-2 (unborn) has Klinefelter's syndrome (XXY) and also has colour blindness, then a non-disjunction must have taken place in the first meiotic division of the mother's egg cell 如果一個尚未出生的個體IV-2為克氏症患者(XXY)，假設他也有色盲，則其克氏症原因是在其母親產生卵的第一次減數分裂時發生染色體不分離		
III-5 marries a man from a population in which the frequency of the allele for colour blindness is 1%. The probability that their firstborn child is a colourblind daughter		

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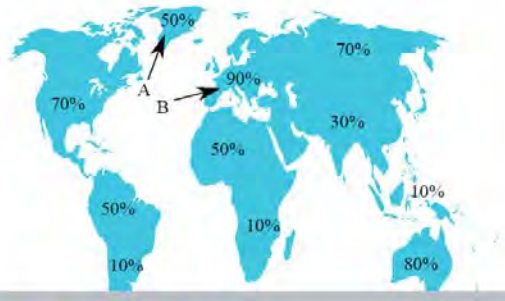
A 02:30 Chinese Traditional TWN_JURY_6

Q 40:

The proportion of lactose-tolerance in adults varies globally (Fig.). Lactose tolerance is a 1-locus dominant trait (dominant allele *K* and recessive allele *k*).
在全球不同地區對乳糖耐受的成人比例差異很大(如圖)，乳糖耐受性由單一基因控制，K 是顯性等位基因，k是隱性等位基因



Node Id: a5dd65988210263a0adedb8f
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
Assuming that the European (B) population is in Hardy-Weinberg equilibrium, the frequency of *K* in the next generation will be 0.968 假設歐洲族群(圖中B)已達哈-溫平衡，則等位基因K在下一代中的等位基因頻率為0.968		
Differences in the frequencies of the *K* allele between populations prove that selection has been acting on this trait 不同族群中K等位基因頻率的不同證明是否具乳糖耐受性受到篩選		
In Greenland (圖中A) where the percentage of lactose tolerance is 50%, the frequencies of the alleles *k* and *K* are equal 在格陵蘭乳糖耐受性比例是50%，所以k 和K的等位基因頻率相等		
Lactose tolerance is assumed to be the ancestral trait		

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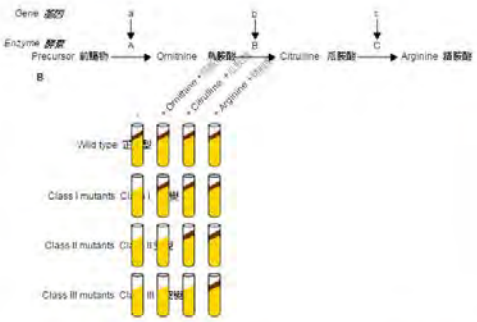
的基因負責表現(如圖A)



A, biosynthetic pathway for arginine in mold; B, experimental set-up to confirm pathway; dark brown stripe denotes mold growth. The wild type grows on minimal medium, while the mutants only grow with addition of specific nutrients.

Node Id: c09a7c7a160e848cb7d5e47c
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
Class III mutants may have mutations in more than one gene involved in the pathway Class III 突變體可能有超過一個以上的合成路徑基因發生突變		
Class I mutants lack activity of all three enzymes Class I 突變體缺少所有3種酵素活性		
Mutants lacking both enzyme A and C, will grow if ornithine and citrulline are both added. 同時外加鳥胺酸(ornithine)和瓜胺酸(citrulline)可使缺少酵素A和酵素C的突變體生長		
Assuming that an inhibitor to enzyme B is added to the wild type, gene B will be inactivated 若加入酵素B的抑制劑，會使正常型菌種的B基因不表現		

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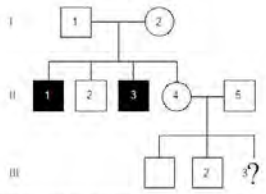
Q 42:

This pedigree shows the occurrence of a rare disease phenotype (shown in black) with full penetrance. The genetic disorder is caused by a recessive autosomal allele *d*.
圖中的族譜顯示一個罕見遺傳疾病的發生情形(黑色個體)，此遺傳疾病是由一個體染色體隱性等位基因d引起，致病基因型的發生率是100%



Pedigree of family with an autosomal recessive disease
一個體染色體隱性遺傳疾病的族譜

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Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
The probability that II-4 carries the disease allele is 0.50 II-4個體是此致病等位基因攜帶者的機率是0.50		
II-2 and II-4 have the same probability of carrying the disease allele II-2和II-4是此致病等位基因攜帶者的機率相同		
If assume that II-5 does not carry allele d, the probability that III-3 carries this allele is 0.30 or higher 假設II-5不帶等位基因d，則III-3帶有此致病等位基因的機率≧0.30		
If we assume, that II-5 is heterozygous and III-3 has the disease; then the probability that II-4 is a carrier is 0.5 假設II-5是異結合型，且III-3是疾病患者，則II-4是此致病等位基因攜帶者的機率為0.5		

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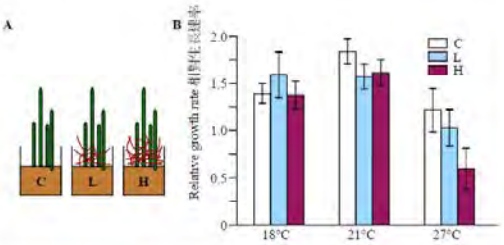
at three temperatures and under the influence of the invasive red alga *Gracilaria vermiculophylla* (Fig.). A hypothesis is that global warming and the presence of *Gracilaria* negatively affect eelgrass.

鰻草(*Zostera marina*)是丹麥海岸水域的關鍵海草物種，附近海域在夏天的溫度很少高於18°C。在三種溫度以及入侵的紅藻物種Gracilaria vermiculophylla的影響下，測量鰻草的生長速率(圖)，此研究的假說是全球暖化以及紅藻的存在對鰻草生長有負面影響。



A, three buckets with eelgrass were exposed to increasing amounts of Gracilaria: C = no Gracilaria, L = Low Gracilaria content, H = High Gracilaria content per bucket. Fig. B, relative growth rate of eelgrass at three temperatures and together with increasing amounts of Gracilaria (white bar = C, light blue bar = L, purple bar = H in Fig. A) (from Rolfe et al, 2011). If error bars do not overlap, the differences are statistically significant.

Node Id: 48e14a2ec4367680b53bcd35
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤。

	TRUE 正確	FALSE 錯誤
Irrespective of temperature, *Gracilaria* inhibits the growth rate of eelgrass 紅藻抑制鰻草的生長速率，與溫度無關聯		
In general, temperature affects the growth rate of eelgrass 一般而言，溫度會影響鰻草的生長速率		
There is a combined effect of *Gracilaria* and temperature on the growth of eelgrass 溫度與紅藻對鰻草的生長速率有混合影響		
In Danish waters without *Gracilaria*, eelgrass growth is temperature limited 在沒有此種紅藻的丹麥海域中，鰻草的生長速率受溫度限制		

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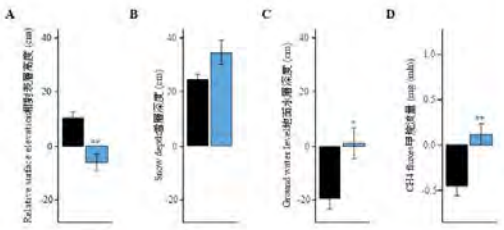
dynamics was studied in Siberia from 2008 to 2012. Four parameters were measured in plots where the woody vegetation was removed (blue bars in the figure), and in undisturbed control plots (black bars).
北極凍原的暖化情況較全球平均要快，此情況會影響凍原土壤中的碳源。凍原中的永凍土層(permafrost layer)上覆蓋著一活躍土層(active layer)，其每年會有冰溶/再結凍的週期動態變化。凍原植被的影響可視為此動態的驅動力，並被用來進行在西伯利亞從2006-2012年的研究。下圖中，在樣區中測量4個變數，且有些樣區為移除木本植被(圖中的藍色條帶)以及不受干擾的操作環境(黑色條帶)。



A. Surface elevation relative to ground surface level (0), B. spring snow depth C. summer ground water level compared to soil surface level, D. August CH4 emission (+ value, emission). * significant differences (from

Node Id: e71d889d2035da3e553b0199
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤。

	TRUE 正確	FALSE 錯誤
Soil subsides when its woody vegetation is removed 若移除木本植被，則土壤會下陷		
Undisturbed tundra woody vegetation functions as a source of global methane emission 未受干擾的凍原木本植被是全球甲烷釋放的來源		
Removal of woody vegetation initiates a cycle, leading to more dominance of water-tolerant plants 移除木本植被會引發一個循環，導致耐水的植物較具優勢		
After removal of woody vegetation, the chain of events will be: Fig. B --> Fig. C --> Fig. A --> Fig. D. 移除木本植被之後，引發的連鎖事件會是圖 B --> 圖 C --> 圖 A --> 圖 D.		

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Q 45:

The structure of flowers has many morphological characters important to reproductive success, e.g. sexual dimorphism (dioecy, monoecy). Such characters show phylogenetical conservatism, and thus may be used in evolutionary analysis.
花的構造有多種利於生殖的重要形態特性，例如單性花(雌雄異株、雌雄同株)。這樣的特性顯現出親緣保守性(phylogenetical conservatism)，因此可用以進行演化分析。

A, B. flowers of a palm, C. longitudinal section of a flower of species saxifrage (from Soltis et al. 2003, Clusella et al. 2014).
圖A-B為棕櫚樹的花；圖C為虎耳草屬植物的花之縱剖圖。

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Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤。

	TRUE 正確	FALSE 錯誤
The palm in Fig. A is monoecious (i.e. hermaphroditic plants with unisexual flowers) 圖A的棕櫚樹為雌雄同株(即在同一植株上有兩種單性花)		
The palm in Fig. A originates from an ancestor, which most likely had hermaphroditic flowers 圖A的棕櫚樹的祖先很有可能有雌雄同株的花		
The palm and the saxifrage are both most likely dicots 棕櫚樹與虎耳草屬植物兩者可能皆為雙子葉植物		
If structures through evolution become more specialized, one would expect the saxifrage to be phylogenetically older than the palm 若構造經由演化會更具專一性，則虎耳草屬植物在演化親緣上比棕櫚樹較古老		

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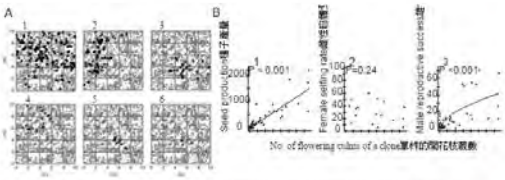
https://bioscience.au.dk/students/be0a6cf4acf6d02ecc513087

A 02:30 Chinese Traditional TWIN_JURY_E

Q 46:

Many plants reproduce both sexually and vegetatively (clonally). A hypothesis says: As both reproductive modes require energy, a negative trade-off is expected to exist between the two reproductive modes. This was studied in a population of Japanese bamboo (*Sasa veitchii*) (Figs A-B).
許多植物可進行有性及無性生殖。假說指出: 由於兩種生殖型式皆需要能量，兩生殖型式間有一種負向的權衡(trade-off)。研究日本竹(Sasa veitchii)族群來驗證此假說，結果如圖A-B所示。



A. six plots (10 x 10 m) each presenting the spatial distribution of a bamboo clone, black dots show the positions of all flowering culms of the clone, whereas all the grey dots show the positions of all flowering culms of all the other clones in the plot. B. relationships between no. of flowering culms of a clone and its sexual success (measured in three ways). A regression line is present, if the relationship is significant (from Hidaka et

Node Id: a5a55a3a5454eb3bc3a9507f
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤。

	TRUE 正確	FALSE 錯誤
More "investment" in clonal growth negatively affects male reproductive success of an individual bamboo 在無性生長上"投資"愈多，將會對單一竹子植株的雄性生殖成功有負面的影響。		
More "investment" in clonal growth negatively affects female reproductive success of an individual bamboo 在無性生長上"投資"愈多，將會對單一竹子植株的雌性生殖成功有負面的影響。		
Larger bamboo clones have more self-pollination 較大範圍的竹子單株有較多的自體授粉		
The gain in female fitness per produced flowering culm diminishes with increasing clone size 每個開花枝獲的雌性適應性(fitness)會隨單株範圍大小漸增而漸減		

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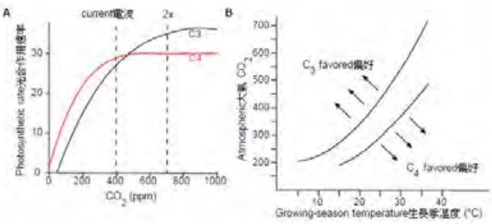
Q 48:

Plants have different photosynthetic systems. Most plants have the C3 system, but others, especially grasses, have a C4 system. The two systems show different photosynthetic rate, when CO_2 and ambient temperature vary (Fig.).

許多植物可進行有性及無性生殖。假說指出:由於兩種生殖型式皆需要能量，兩生殖型式間有一種負向的權衡(trade-off)。研究日本竹(Sasa veitchii)族群來驗證此假說，結果如圖A-B所示。



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Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤。

	TRUE 正確	FALSE 錯誤
The proportion of C4-plant species increases towards the poles C4植物的物種比例向極地漸增		
At current atmospheric CO_2 levels, CO_2 is limiting the growth of both C3- and C4-plants 在目前的大氣中CO_2量之下，C3與C4植物的生長受CO_2含量限制		
The predicted CO_2-increase can be more advantageous to C4- than C3-plants 與C3植物相較，預測CO_2量增加的現象對C4植物較具適應優勢		
In dry and warm regions during the last glacial period, C4-plants were probably more widespread 在前一個冰河時期中，生長在乾燥溫暖區域的C4植物可能分布更廣		

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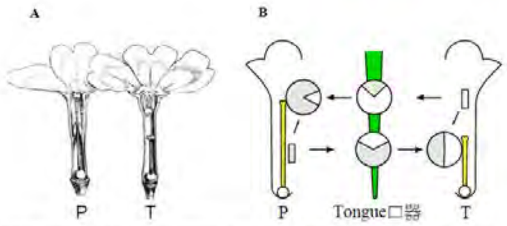
A 02:30

雄蕊；T型者則在花冠筒開口處具有短的花柱及雄蕊(如圖A所示)。達爾文將這兩型的櫻草雜交(T x P；結果如表所示)，結果發現異形花柱可增加異交的機率，且增加果實產量。一隻蜜蜂將其口器伸入P型花中，並由口器先端取得花粉，然後將花粉落在T型花的柱頭上，而同樣地，T型花的花粉落到P型花的柱頭上(如圖B所示)。異形花柱是由單一基因所控制(T型花的基因型為Ss，而P型花為ss，SS則無異形花柱的現象，S對s為顯性)。



A, flower forms P (left) and T (right) of primrose. B, flowers P and T, with a bee's tongue (green) in between; arrows show amount of pollen transferred along different routes from the anther, to tongue and to the stigma (white and grey slices are T- and P-pollen, respectively).

Node Id: 2b5787936c6edcd855dcc037

Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤。

	TRUE 正確	FALSE 錯誤
Frequencies of T and P in a primrose population stay the same, if mating is random with respect to form, and all crossings give the same fruit set 若T及P型兩型的交配為隨機，則此兩型在櫻草族群的頻率維持相同，且所有雜交的產果量相同		
Incomplete sterility within the same flower form is seen in the population as a deviation from a 1 : 1 T : P ratio 在族群內，同一種花型內的不完全不孕性，其T:P比率會偏離1:1		
The two routes of pollen transfer (T --> P or P --> T) are equally efficient in terms of the pollen transferred 兩種花粉傳遞途徑(T --> P 或 P --> T)的花粉傳遞效率一樣		
Pollen deposition from tongue to stigma is more difficult than pollen harvesting from anther to tongue 花粉由口器落至柱頭的過程比花粉從花藥被口器採集的過程		

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