THEORETICAL EXAM 2 理論試卷 第二部分

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

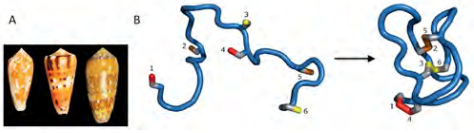
Q 1-13 Animal biology 動物生物學
Q 14-15 Biosystematics 生物系統分類
Q 16-24 Cell biology 細胞生物學
Q 25-30 Ecology 生態學
Q 31-33 Ethology 行為學
Q 36-45 Genetics & Evolution 遺傳及演化學
Q 46-50 Plant biology 植物生物學

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

Conus snails produce potent conotoxins (peptides), which are used in defense and paralysis of prey. Conotoxins affect the neuromuscular end plates. Four toxins, A-D, have the following effects:
A prevents the inactivation of Na^+ channels in the presynaptic axon
B blocks K^+ channels in the presynaptic axon
C blocks Ca^{2+} channels in the presynaptic end plate
D blocks acetylcholine receptors
芋螺可產生強效的芋螺毒素(多肽鏈)用以防禦和麻痺獵物。芋螺毒素影響神經肌肉的終板。A-D 四種毒素分別有下列影響：
A 防止突觸前軸突的Na+ 通道去活化
B 阻止突觸前軸突的K+ 通道
C 阻止突觸前終板的 Ca2+ 通道

D 阻止乙醯膽鹼的受體



A, Conus snails; B, model of an unfolded Conus toxin (left) (1-6 are cysteine side chains) and, to the right, one possible 3-D folding through disulphide binding between pairs (e.g. 2 and 5) of cystein (from Safavi-Hermami et al. 2014).
A, 芋螺；*B,* 展開的芋螺毒素模型*(左) (1-6*為半胱氨酸支鏈*)*，右方為一可能的*3-D* 折疊結構，在二半胱氨酸對之間以雙硫鍵結合 *(*例如*2*和*5)*

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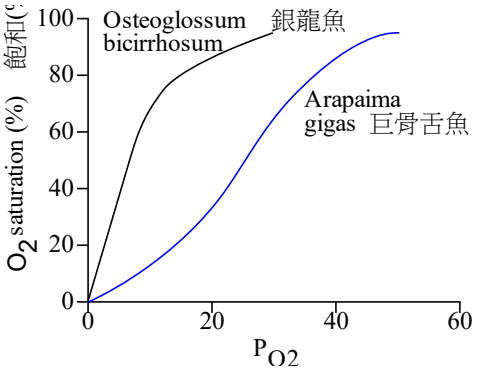
Indicate if each of the following statements is true or false.

問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
Toxin D inactivates the skeletal muscles 毒素D使骨骼肌去活化	○	○
Toxins A and B will cause muscle twitching when injected in the prey 毒素A和B注入獵物時可引起抽搐	○	○
Toxin C interferes with the exocytosis of neurotransmitters 毒素C干擾神經傳遞物質的胞吐作用	○	○
The peptide in Fig. B may be folded in various ways, but all folded molecules have the same effect, if the primary structure of the peptides remains unchanged 在圖B中的多肽鏈可以不同方式折疊，但若多肽鏈的一級結構保持不變，所有折疊分子會有相同效果	○	○

Q. 2

Fish vary in the way they take up oxygen. The precise uptake is reflected in their hemoglobin dissociation curve, and its shape is determined both by phylogeny and the habitat of the fish (Fig.).
魚會改變吸收氧氣的方式。其血紅素解離曲線可精確反映氧氣的吸收，曲線之形狀可由其種系發生及棲地所決定(圖)。



Hemoglobin dissociation curves for two species of fish Osteoglossum bicirrhosum and Arapaima gigas.
兩種魚的血紅素解離曲線：銀龍魚和巨骨舌魚

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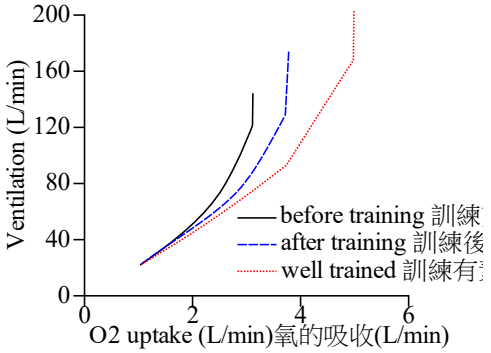
Indicate if each of the following statements is true or false.
問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
O. bicirrhosum lives in faster-running water than *A. gigas* 與巨骨舌魚比較，銀龍生活在急流的水中	○	○
O. bicirrhosum has a lower metabolic rate than *A. gigas* 與巨骨舌魚比較，銀龍具有較低的代謝率	○	○
O. bicirrhosum is an air breather (going to the surface), whereas *A. gigas* is a gill-breather 銀龍可呼吸空氣(由水面上)，而巨骨舌魚用鰓呼吸	○	○
O. bicirrhosum lives at the surface, whereas *A. gigas* is a deep water species 銀龍生活在水表面，巨骨舌魚是深水物種	○	○

Q. 3

Lung ventilation (or minute ventilation, V) at increasing workload (oxygen uptake was measured for two men. Person 1 (black) was untrained, and his V was measured before and after a few weeks of training. His body weight before and after intensive training was 70 kg and 75 kg, respectively. Person 2 (red) weighed 70 kg and was well trained. His V as a function of work was measured only once (Fig.).
測量兩男子在增加工作量(耗氧量)時的肺通氣量(或每分鐘通氣量，V)。第1人在未接受訓練前及經過數星期訓練後，可得到他訓練前後的V測量值。他在密集訓練前、後的體重分別為70公斤和75公斤。第2人體重70公斤，一直訓練有素，他的工作函數V只測了一次(圖)



Lung ventilation V (atmospheric air L/min) as a function of total maximum oxygen uptake (L/min) for person 1 before training (black) and after training (blue dashed), and for person 2 (red dotted).
肺通氣量*V(*大氣下*L/min)*為最大總攝氧量的函數*(L/min)*：第*1*人訓練前*(*黑色*)*及後*(*藍色虛線*)*，第*2*人*(*紅色點線*)*。

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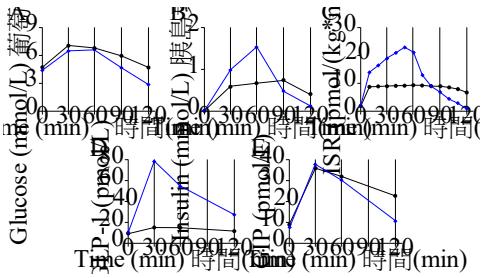
Indicate if each of the following statements is true or false.
問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 失敗
After training, person 1 has improved his VO_2max (i.e. max. oxygen uptake/L/min/kg body weight) about 30% (±5%) 訓練後，第1人最大攝氧量VO2max (即每公斤體重最大氧攝取)改善約30% (±5%)	○	○
Training by person 1 affected both start and extent of hyperventilation 第1人的訓練受到過度換氣起始和程度的影響	○	○
Further training is expected to increase person 1's anaerobic endurance significantly 進一步訓練將會大幅增加人第1的耐無氧能力	○	○
A very high V is mainly achieved by an increase in breathing frequency and not depth of breathing 非常高的肺通氣量V主要是藉著增加呼吸頻率而非呼吸深度達到	○	○

Q. 4

Morbid obesity can be treated surgically by a gastric bypass, where a part of the stomach and the proximal part of the intestine are bypassed. A group of obese individuals were enrolled in a study, in which their glucose and hormone levels were measured after an ingestion of glucose before and after gastric bypass surgery (Fig.).

病態肥胖可用胃繞道手術治療，藉以繞過胃的一部分與腸的近端部分。一組肥胖患者參加本研究，分別在胃繞道手術的前後測量了他們攝取葡萄糖後血糖和激素的高低(圖)。



Effects of a glucose ingestion at time = 0 on the level of various parameters. Black circles indicate levels before gastric bypass, and blue diamonds indicate levels 3 months after gastric bypass. A, glucose level; Fig. B–C, insulin concentration and its secretion rate (ISR); Fig. D, Glucagon-Like Peptide 1 (GLP-1, gut hormone); and Fig. E, Gastric Inhibitory Polypeptide (GIP, gut hormone) (from Jørgensen et al. 2013).
在時間 = *0*時，葡萄糖攝取對不同參數高低的影響：黑色圓圈表示在胃繞道術之前，藍色菱形表示胃繞道術*3*個月後。圖*A*、血糖水準；圖*B-C*、胰島素濃度及其分泌速率*(ISR)*；圖*D*、昇糖素似胜肽*1 (GLP-1*，腸道激素*)*；圖*E*、抑胃多肽*(GIP*，腸道激素*)*

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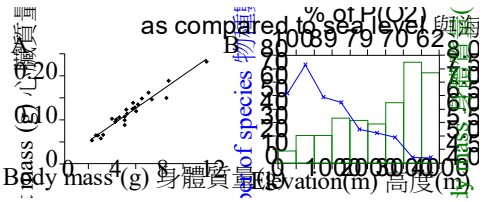
問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
Gastric bypass leads to a stronger and shorter insulin response to an increased glucose level 胃繞道手術導致對血糖的升高有更快速、更強烈、更短暫的胰島素釋放反應	○	○
From the study, GIP is expected to induce insulin secretion 從這項研究得知，GIP會誘導胰島素的分泌	○	○
Change in GLP-1-level after gastric bypass surgery may explain the faster increase in ISR 胃繞道手術後，GLP-1高低的改變可解釋ISR的快速增加	○	○
Blocking the effect of GLP-1 might be an efficient way to treat diabetes阻止GLP-1的影響可作為糖尿病治療的有效途徑	○	○

Q. 5

Partial atmospheric oxygen pressure PO2 and ambient temperature decrease with increased elevation above sea level. This affects the respiratory physiology and species richness of many animal groups, e.g.

hummingbirds (Fig.). An important physiological feature of hummingbirds is their ability to enter torpor, a state of reduced physiological activity. to save energy.
大氣氧分壓PO2及環境溫度均會因海拔高度的增加而降低，此效應會影響許多動物群的呼吸生理及物種豐度，如蜂鳥(圖)。蜂鳥有個重要的生理特點，能進入冬眠(生理活性降低的狀態)而節省能源。



A, relationship between heart mass and body mass of hummingbird species; B, average body mass (grams) per 500 m altitudinal zone (histogram, right Y-axis) and number of species of hummingbirds (x–x–line, left Y-axis) at different elevations (lower X-axis). The percentage of partial oxygen pressure compared to sea level is also given (from Altshuler & Dudley 2002).
A, 蜂鳥物種心臟及身體質量的關係; *B*，每*500*公尺海拔區*(*長條圖，右邊*Y*軸*)*蜂鳥的平均體重*(*克*)*與不同海拔*(*下方*X*軸*)*物種數目*(x-x-*線，左邊*Y*軸*)*的關係，及相對於海平面*PO2*分壓減少的百分比。

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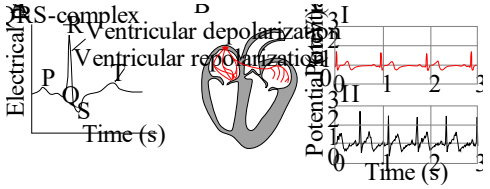
Indicate if each of the following statements is true or false.
問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
Daily decreased physiological activity is common in montane hummingbirds 每日生理活動的減少常見於山區的蜂鳥	○	○
Above 500 m, diversity of hummingbirds is negatively correlated with height above sea level 在500公尺以上，蜂鳥多樣性與海拔高度呈負相關	○	○
The heart mass is negatively correlated to the partial pressure of oxygen 心臟質量與氧分壓呈負相關品質	○	○
Hummingbird wing load (body mass/wing area) declines with altitude 隨海拔高度增加，蜂鳥翼荷載(身體質量/鳥翼面積)減少	○	○

Q. 6

An important function of an electrocardiogram (ECG) is to give information about the general health of a person. The ECG of two students was compared (Fig. C).

心電圖(ECG)的重要功能之一，是給我們一般性的健康資料。比較兩學生的心電圖(圖C)。



A, schematic representation of a standardized ECG; B, a snapshot of a heart with activitated innervations in red, pictured as if facing the student; C, electrocardiograms of two young male students (I and II) measured over 3 seconds.
A, 標準化心電圖*ECG*的示意圖； *B,* 如同面向學生的一張心臟快照圖，神經興奮的分布用紅色表示； *C,*兩位年輕男生*(I*和*II)*的心電圖，測定時間超過*3*秒。

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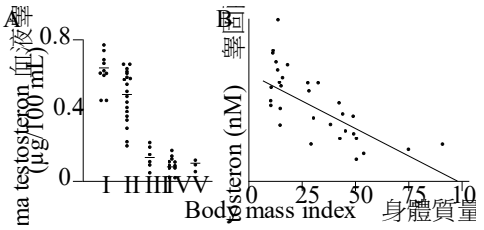
Indicate if each of the following statements is true or false.
問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
Blood flows from the right ventricle to the lungs, to the left atrium, to the left ventricle, to the body, and back to the right atrium 血液從右心室流到肺部、左心房、左心室、身體各部，回到右心房	○	○
Students I has a heart rate of 80 beats/minute 學生I的心搏率為80次/分	○	○
If the stroke volume of student 1 is 70 mL/beat, then his cardiac output will be about 4.4 L/minute 若學生I的每跳搏出量是70毫升/次，他的心輸出量約為4.4 L/分鐘	○	○
The heart in fig. B is at the R peak 圖B中的心臟在是在R峰期	○	○

Q. 7

Variation in testosterone levels has major effects on general male physiology. Concentration of testosterone was measured in blood plasma from five groups of men (Fig.).
睾固酮的濃度變化會影響男性的生理健康。今測定在五組的男人血液中睾固酮濃度(圖)



Indicate if each of the following statements is true or false.A, plasma level of testosterone in: I, Males 16-43 years old; II, Males 44-92 years; III, Males with underdeveloped pituitary glands; IV, Males with removed testes; and V, Males after treatment with injections of estrogen for some time. Each dot represents an individual, and the horizontal bars are group averages; B, plasma testosterone level in men as a function of body mass index (T = 23.94 – 0.26 BMI) (from Zumoff et al. 1990).

A、各組睾固酮濃度比較： *I, 16-43*歲男性；*II, 44-92*歲男性；*III,* 腦垂腺欠發育的男性；*IV,* 切除睾丸的男性；*V,* 接受雌激素注射治療過一段時間的男性。每個點代表一個個體，橫線為組平均值。*B*、男性血液睾固酮濃度是身體質量指數*(T = 23.94-0.26 BMI)*的函數

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

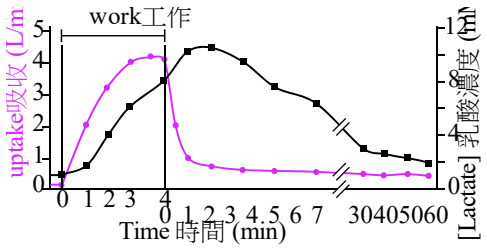
問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
Males–IV have reduced testosterone level due to negative feed-back regulation 因為負回饋調節，男性–IV的睾固酮濃度會降低	○	○
Males–IV have a high LH concentration compared to Males–I 與男性–I相比，男性–V的LH濃度較高	○	○
Estrogen injections in males lead to very low concentrations of LH 在男性注射雌激素會導致非常低的LH濃度	○	○
Even mild obesity (25<BMI < 30) might be much more important to testosterone level than higher age (> 43 years) 即使輕度肥胖(25< BMI < 30)對睾固酮濃度影響都可能比高齡(> 43歲)更重要	○	○

Q. 8

Oxygen uptake and lactate concentration in the blood were measured in a 70 kg male person before, during and after he had exercised (worked) for 4 minutes. The intensity of the exercise (work) corresponded to the consumption of 5 L oxygen/min.

在一位70公斤男性運動(工作)4分鐘之前、期間、之後，分別測定他血液中的氧攝取和乳酸濃度。運動(工作)的強度是對應在5L氧消耗/min。



Changes in oxygen uptake (purple, left Y-axis, L/min) and lactate concentration (black, right Y-axis, mM lactate in blood) before, during and after an exercise or work period of 4 min.
耗氧量(紫色、左邊Y軸，*L/min*)及乳酸濃度(黑色、右邊Y軸，*mM*血液中乳酸)在運動(工作)4分鐘前、中、後的變化。

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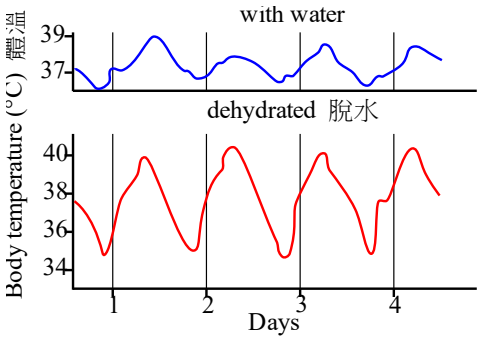
Indicate if each of the following statements is true or false.
問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
The person cannot work for 4 min at intensities equal to 5 L O_2-uptake/min, as his maximum aerobic work capacity is 4.2 L/min 他不可能在5L O_2-吸收/min強度下工作4分鐘，因他的最大有氧工作能力是4.2 L/min	○	○
The person has an aerobic capacity of 60 ml O_2/(kg min) 他的有氧代謝能力為60 ml O_2 /(kg min)	○	○
When blood lactate exceeds 11 mM, excretion begins through the kidneys, which is why its concentration declines 當血乳酸值超過11 mM/L時，腎臟開始排泄乳酸，這是濃度會下降的原因	○	○
Excess O_2-uptake after the end of work is partly due to metabolism of lactate and not to gluconeogenesis 工作結束後過多的O_2吸收，部分是因乳酸代謝而非因糖質新生作用	○	○

Q. 9

Camels are well adapted to desert life. Their hump consists mainly of fat, especially tripalmitin ($C_{51}H_{98}O_6$). A dehydrated camel's body temperature may vary from 34.5° C at night to 40.5°C during day.
駱駝非常適應沙漠生活。駝峰中主要為脂肪，特別是三棕櫚精(C51H98O6)。駱駝脫水時的體溫變化大，可能從晚上34.5°C到白天的40.5°C。



Body temperature of a dehydrated (red) camel compared to one well supplied with water (blue) (from Schmidt-Nielsen et al. 1957).
駱駝脫水時的體溫與供水充足駱駝體溫的比較

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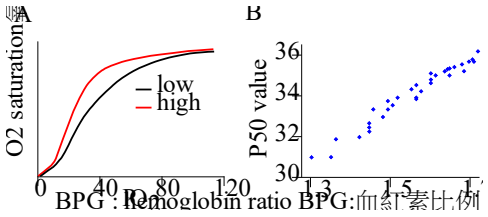
Indicate if each of the following statements is true or false.
問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
The respiration of 1 kg tripalmitin will provide the camel with more than 1 liter of water (molar mass for C = 12, H = 1, O = 16) 假設駝峰中所有的脂肪都是三棕櫚精，1公斤三棕櫚精經呼吸作用可提供超過1升的水與駱駝(摩爾質量C = 12, H = 1, O = 16)	○	○
The respiratory quotient of tripalmitin (CO_2 eliminated/O_2 consumed) is 1.4 三棕櫚精(CO_2 消除/O_2 消耗) 呼吸商是 1.4	○	○
During the day, a 500 kg dehydrated camel accumulates 2000 kcal of heat in its body (about 0.9 cal is required to increase one gram of tissue 1°C) 在白天，500公斤脫水的駱駝體內可積累2000千卡的熱量(使一公克的組織增加1°C約需0.9 cal)	○	○
To keep a constant body temperature, a camel would need 2500 ml of water to get rid of 1000 kcal (1 ml water needs 580 cal to evaporate) 為保持體溫的恒定，一駱駝需要2500 ml的水來散熱1000 kcal (使1 ml水蒸發需要580 cal)	○	○

Q. 10

Deer mice have a wide geographic range, e.g. with respect to altitude. This is partly explained by their respiratory physiology (Fig.).

從海拔高度的角度來看，鹿鼠的地理分布範圍廣泛。部分原因可歸功於其呼吸生理(圖)



A, oxygen saturation (%) of blood of deer mice from low and high altitude habitats as a function of the partial pressure of atmospheric oxygen PO_2; B, P50 is the partial PO_2 at which the blood is 50% O_2-saturated, here plotted against the BPG (2,3-bisphosphoglycerate) : hemoglobin ratio. BPG affects the oxygen affinity of hemoglobin (from Tufts et al. 2013).
A, 低及高海拔棲地之鹿鼠血液中的氧飽和度*(%)*與大氣氧分壓*PO_2*的函數圖； *B, P50*是血液中有*50% O_2*飽和時的*PO_2*，這裡將*BPG (2,3-*二磷酸甘油酸*)*對血紅素的比例作圖。*BPG*會影響血紅素對氧的親和力

Node Id: **0ce8df0b25bf93ab53199948**

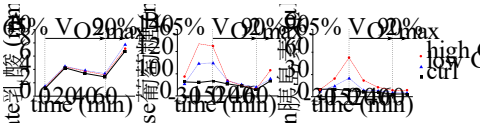
Indicate if each of the following statements is true or false.
問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
Hemoglobin in high-altitude deer mice does not release oxygen as easily as compared to that low-altitude mice 高海拔鹿鼠的血紅素釋放氧到需氧組織，會比低海拔鹿鼠的困難	○	○
High-altitude mice have lower P_{50} than low-altitude mice 高海拔鹿鼠的P50比低海拔鹿鼠的低	○	○
If BPG concentration in blood increases, the saturation curve in Fig. A will shift to the right 如果血液中的二磷酸甘油酸濃度增加，在圖A中的飽和曲線將向右移動	○	○
Assuming that adaptation to altitude is genetically determined, P_{50} values will most likely remain the same if a mouse is transferred to another altitude 假設高度的適應是由基因決定，如果將一隻鹿鼠移置到另一個高度，P50值很可能保持不變	○	○

Q. 11

The effect of consuming foods, which varied in their glycemic index (GI), on prolonged exercise were studied. GI expresses the effect of a particular type of food on a person's blood glucose level. At start of test, each person

either got 1) Control, i.e. water (black squares); 2) LGI, i.e. a low GI meal + water (blue triangles), or 3) HGI, i.e. a high GI meal + water (red circles). Afterwards, each person rested, then cycled for 1 hr at 65% of her VO_{2max}, and finally at 90% VO_{2max} until exhaustion. Blood samples were taken before and during tests to measure levels of lactate, glucose and insulin (Fig.).
針對運動時間過長者的消耗食物作用進行研究，已知其升糖指數(GI)會有差異。GI可表現出某特定食物類型對人的血糖濃度的作用。在實驗初期，受測者分別施予(1)水，作為控制組、(2)低GI的食物和水，作為LGI、或(3)高GI的食物和水，作為HGI。接著讓受測者休息，然後以其最大耗氧量(VO_{2max})的65%騎1小時的腳踏車，最後提高至90%直到耗盡體力。在實驗前以及實驗過程中，抽取受測者的血液以測量乳糖、葡萄糖及胰島素的含量。



Levels of lactate A), glucose (B) and insulin in blood (C) before (pre-exercise) and during test. Each curve represents a treatment (red circles: high GI, blue triangles: low GI, black squares: control) (from Jamurtas et al. 2011).
三圖分別為在實驗前以及實驗過程中所測血液的*(A)*乳酸、*(B)*葡萄糖、*(C)*胰島素含量變化。每個曲線代表一個處理。

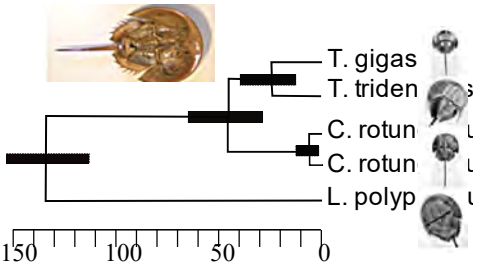
Node Id: **6dfd55e297a7ba33c5dc6d14**

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
At the time of exhaustion, O_2 uptake was sufficient for complete metabolism 體力耗盡時，氧氣的吸收足以完成代謝	○	○
The level of lactate in the blood during exercise is influenced by the diet 在運動期間，血液中的乳酸含量會受食物類型影響	○	○
Final test result at the time of exhaustion seems to be significantly affected by the kind of diet 最後在體力耗盡時所測的結果似乎會明顯受到食物類型的影響	○	○
The observed increase in blood glucose at the last phase of 90% VO_{2max} is due to an increase in fat metabolism and a reduced use of glucose 在最後的90% VO_{2max}階段，觀察到血糖上升，是由於脂肪代謝增加以及葡糖糖利用下降之故。	○	○

Q. 12

Horseshoe crabs are marine and only four extant species are known, while many have gone extinct. *Tachypleus gigas* (Tg), *T. tridentatus* (Tt) and *Carcinoscorpius rotundicauda* (Cr) are from southeast Asia, whereas *Limulus polyphemus* (Lp) lives on the east coast of N America. Tg and Cr overlap in their geographic range (from Andaman Sea (close to Thailand and Malaysia) to the South China Sea). Tt lives from Vietnam to Japan. Horseshoe crabs are "living fossils".
鱟魚為海生且現存物種僅有4種，其餘皆已滅絕。Tachypleus gigas (Tg), T. tridentatus (Tt) 和 Carcinoscorpius rotundicauda (Cr) 生長在東南亞，而則 Limulus polyphemus (Lp)生長在北美洲的東海岸。Tg和Cr兩種的地理分布有重疊(從安達曼海至南中國海)，Tt的生長範圍從越南至日本。鱟魚是"活化石"。



Phylogeny of extant horseshoe crabs. The unit of scale is a million years. Black bars indicate 95% confidence interval. The two populations of Cr are from Andaman Sea and Thailand (from Obst et al. 2012).
現存鱟魚的親緣關係圖。比例尺的刻度為一百萬年。黑色粗橫條代表*95%*的信賴區間。*Cr*的兩個族群是分別採樣自安達曼海及泰國。

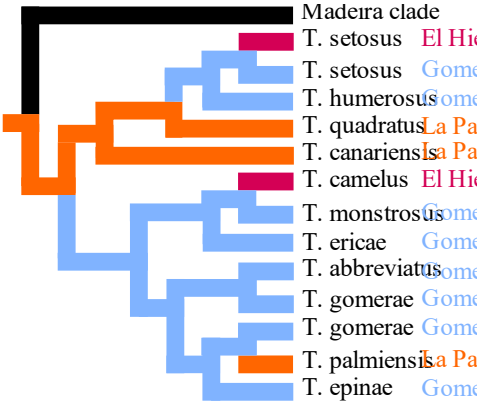
Node Id: **e91c4c7e02fb5c07ed094b4f**

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
From the Fig., we can conclude that horseshoe crabs must be a slowly evolving group 從上圖可歸納出: 鱟魚應該是演化緩慢的類群。	○	○
According to Fig., the Asian species constitute a monophyletic clade 根據上圖，亞洲種類構成一個單系群。	○	○
Speciation in horseshoe crabs seems to take between 5 and 45 million years 鱟魚的種化似乎發生在5-45百萬年期間。	○	○
The genera *Tachypleus* and *Limulus* are sister taxa Tachypleus 和Limulus兩屬為姊妹群。	○	○

Q. 13

The flightless beetle genus *Tarphius* lives in humid forests and has 29 endemic species on the Canary Islands. The species are found on the five western islands of the archipelago, but not on the two eastern islands, closest to Africa. The more northern archipelago Madeira has additional species. A species may evolve on one island and then disperse to another island (ex situ-speciation) or it may evolve within an island from another *Tarphius* species already present there (in situ-speciation).
不會飛的Tarphius屬甲蟲生長在Canary群島的潮濕森林中，且有29個特有物種。此物種出現在群島西側的5個小島，但在東側最靠近非洲的2個小島卻沒有。此外，較靠近北邊的Madeira群島也有一些物種。一個物種可在一個島嶼上演化，然後散布至其他島嶼(稱為域外種化ex situ-speciation)，或是可在島內從其他既存的Tarphius屬物種演化出新種(稱為域內種化in situ-speciation)。



Part of the cladogram of Tarphius from the Canary Islands with the Madeira clade as an outgroup (black branch). Only species from three (La Palma, Gomera and El Hierro) of the five western islands are included (from Emerson & Oromí 2005).
Canary群島內的Tarphius屬支序圖之一部分，呈現以Madeira 支系為外群(黑色分支)。只有來自5個西側群島中3個島(La Palma, Gomera and El Hierro)的物種才有呈現在圖中。

Node Id: **e15dd9846581bfbd70244974**

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

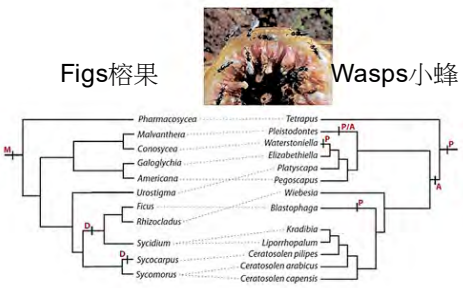
	TRUE 正確	FALSE 錯誤
The Canarian phylogeny suggests both ex situ-and in situ-speciation events Canarian系統親緣關係推測其歷經域外種化與域內的兩個種化事件。	○	○
From Madeira, *Tarphius* colonized the island of El Hierro 從Madeira 支系，Tarphius屬曾在El Hierro島上擴殖族群。	○	○

All three islands were colonized twice
所有三個島都曾被兩次擴殖過。

Gomera is likely to be the Canarian Island with the highest habitat diversity of humid forest
Gomera島可能是Canary群島中具有最大的潮濕森林棲地多樣性

Q. 14

Figs and wasps have a long coevolutionary history. Figs depend on tiny wasps for pollination, which depend on fig inflorescences, because they lay eggs in the flowers and their larvae develop in the fruits. The breeding system of fig species may either be dioecy (with male and female trees) or monoecy (with hermaphroditic trees with male and female flowers). Wasps pollinate either actively, by carrying pollen in special body pockets or passively, without any specific pollen behaviour (Fig.).
榕果及小蜂之間有長久的共同演化，榕果依賴小蜂以完成授粉，而小蜂則依賴榕果花序，因為牠們產卵在花中，幼蟲在果實中生長。榕果物種的生育系統可以是雌雄異株(具雄株及雌株)或雌雄同株(同一植株中有雄花及雌花)，小蜂可藉由攜帶花粉於身體上的特殊部位來主動協助授粉，或是沒有任何特殊授粉行為之被動協助授粉(圖)。



Phylogenies of some groups of figs (left) and wasps (right). Breeding system (M = monoecy, D = dioecy) and pollination mode of wasps (P = passive, A = active; P/A = dimorphic) are mapped onto the phylogenies. Transitions between breeding systems and between pollination modes are shown as small vertical bars on phylogenies. Dashed lines give the mutualistic relationships (from Herre et al. 2008).
某些榕果類群的親緣關係樹(左側)以及小蜂的親緣關係樹(右側)。生育系統(*M*=雌雄同株；*D*=雌雄異株)以及小蜂的授粉模式(*P*=被動型，*A*=主動型；*P/A*=兩型皆有)對應標示在親緣關係樹上，生育系統間以及授粉模式間的改變以小短線註記在分支上。虛線代表互利共生的關係。

Node Id: **87b6045bc11b77e3bb2a253c**

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

Passive pollination mode is ancestral in the evolution of fig wasps
被動協助授粉模式在榕果小蜂的演化中屬於祖先型。

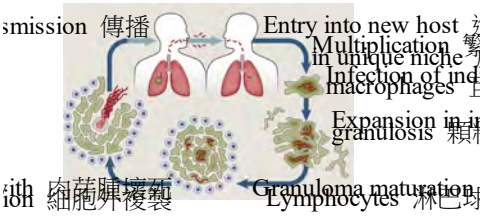
Dioecy in figs is correlated to active pollination mode in wasps
榕果的雌雄異株與小蜂的主動協助授粉模式有相關。

The coevolutionary match between figs and wasps is only seen at the level of genus and higher
榕果及小蜂之間的共同演化配對僅見於屬或更高的分類層級。

Pollination mode seems to be more labile evolutionarily than breeding system
授粉模式似乎較生育系統更容易發生不穩定的演化。

Q. 15

Tuberculosis is caused by the bacterium *Mycobacterium tuberculosis.* One third of the world's population is currently infected with *M. tuberculosis*, and about 10% of these suffer from tuberculosis (TB). TB annually kills more than 1 million people. The pathogenic life cycle of *M. tuberculosis is* shown in Fig.
肺結核是由結核桿菌所引起的。世界上有約三分之一的人曾受到感染，10%的感染者會出現肺結核 (VB) 的現象。每年約超過一百萬人死於肺結核。結核菌的致病生活史見下圖。



Pathogenic life cycle of M. tuberculosis (Mt). A granuloma is a group of tightly linked macrophages (from Cambier et al. 2014).
結核菌 *(Mt)* 的致病生活史。肉芽腫會被一群巨嗜細胞緊緊包圍。*(from Cambier et al. 2014).*

Node Id: **c1983e0b141c7ced57cb6877**

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
Transmission of tuberculosis requires physical contact 肺結核是靠接觸傳染		

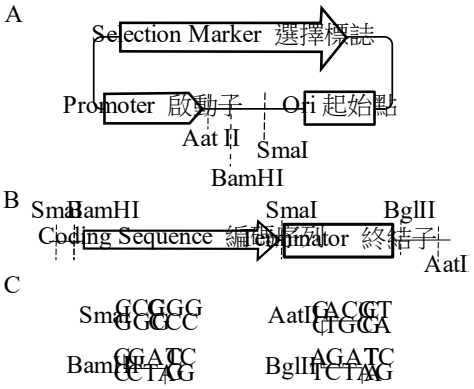
Theoretically, a person with macrophage deficiency would be expected to suffer greatly from an *Mt* attack
理論上，當患者的巨噬細胞出現缺損，結核菌的攻擊將會加劇。

The granuloma of macrophages is the host's succesful way of reducing the spread of the disease within the body
肉芽腫的形成是患者成功減緩疾病在體內散佈的原因。

A new generation of *Mt* is released when the macrophages in the granuloma die
當巨噬細胞死亡後，新一代的結核菌方能釋出。

Q. 16

A gene (coding sequence) can be expressed by cloning it into an expression plasmid using restriction enzymes and DNA-ligase. A plasmid (A), a gene of interest (B), and the recognition sequences for four restriction enzymes (C) are shown in the figure. Different cloning strategies, expressed in the statements below, could be used to insert the"Coding sequence and Terminator" of this gene into the plasmid to produce a recombinant plasmid that expresses the gene.
使用限制酶與 DNA 接合酶可以將一段要表達的基因（編碼區）插入表達質體中進行表達。下圖為一個質體與表達基因的限制酶輿圖。題目中會出現許多選殖策略，請將基因中的 "編碼序列與終結子" 的完整序列插入質體中，以產生重組質體並表達該基因。



Node Id: **cdcf0866ad1f29c064e802cd**

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
Digestion with SmaI followed by ligation can produce the		

desired recombinant plasmid.
利用 SmaI 與 接合酶可以製成所要求的重組質體。

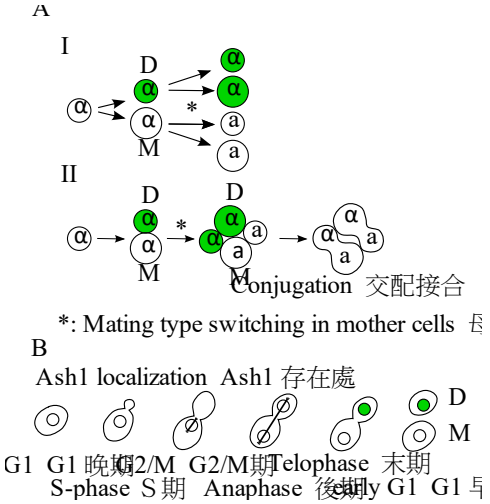
Digestion with AatII and BamHI followed by ligation can produce the desired recombinant plasmid.
利用 AatII 和BamHI切割後再使用接合酶可以製成所要求的重組質體。

Digestion with BamHI + BglII followed by ligation can produce the desired recombinant plasmid.
利用 BamHI + BglII 與 接合酶可以更有效的製成所要求的重組質體。

The 'coding sequence' needs to be in-frame with the promoter
編碼序列必須與啟動子在同一轉譯框架構。

Q. 17

Yeast (*Saccharomyces cerevisiae*) has a mating pattern with both haploid and diploid cells, mitosis and meiosis, and two kinds of mating types. Haploid cells may even switch mating type (Fig.).
酵母菌 (Saccharomyces cerevisiae) 的生活史中會出現單倍體細胞、二倍體細胞、減數分裂與有絲分裂。單倍體有兩種交配型，並可進行交配型轉換。（如下圖）



A, mating-type switching in budding yeast (M, mother cell; D, daughter cell. a and α, mating types). Fig. A I. mitosis in haploids; A II: mating and diploid formation; B, budding in haploid yeast. Both in Fig. A and B, green filling indicates the repressor factor protein Ash1p.
A：出芽酵母菌的交配型轉換（*M:* 母細胞；*D:* 子代細胞，*a* 與 α*:* 交配型）
圖 A *I.* 單倍體有絲分裂。*A II:* 交配與二倍體形成。*B:* 單倍體酵母菌出芽生殖。在圖 A 與 B 中，綠色部分為 抑制因子蛋白 *Ash1p* 表現處。

Node Id: **e58531c49e73d0adeaccf018**

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
Mating in yeast can only take place between two different kinds of haploid cells 酵母菌的交配只能發生在兩種不同交配型的單倍體細胞間。	○	○
Mating-type switching occurs only in the mother cell of each haploid generation 交配型轉換只發生在已產生單倍體子代的母細胞	○	○
Mating type shift is induced by the repressor factor Ash1p 交配型轉換受抑制因子 Ash1p 誘發。	○	○
Mating type shift of haploids and the meiosis of diploids result in maximum mixing of mating types 透過單倍體細胞的交配型轉換和二倍體的減數分裂會產生最多交配型種類的細胞。	○	○

Q. 18

Statin-drugs are used to lower blood cholesterol levels in patients that are at risk for cardiovascular diseases due to elevated blood cholesterol levels. One type of statins functions by inhibiting the *de novo* synthesis of cholesterol (or ergosterol) in eukaryotic cells via competitive binding and inhibition of the enzyme 3-hydroxy-3-methyl-glutaryl-CoA reductase (HMG). This enzyme also exists in *S. cerevisiae* and high concentrations of this group of statins can hence act as fungicides. In the current experiment aimed at identifying genes/enzymes that could make yeast resistant to statins.
他汀類藥物可以用於因血中膽固醇濃度過高引發心血管疾病的患者，用於降低血中膽固醇濃度治療之用。他汀類藥物會藉由競爭結合來抑制 3-hydroxy-3-methyl-glutaryl-CoA 還原酶 (HMG) 以抑制膽固醇（或麥角固醇）的生合成。HMG 酵素也存在酵母菌中，同時高濃度的他汀類藥物可以作為殺黴菌劑用。本實驗的目的在找出讓酵母菌抗他汀類藥物的基因／酵素。

***A**: An agar plate-based experiment, where a 5-time dilution series of two yeast cell cultures (wild type (WT) and MIcE expressing (MIcE)) have been spotted onto agar plates containing different concentrations of the statin lovastatin. The highest cell concentration is on the left of each plate; **B**: Bright field and fluorescence microscopy of yeast strains expressing red fluorescent protein (RFP) alone or RFP fused with MIcE (MIcE-RFP), respectively; **C**: The chemical structure of the compounds tested in A and D; **D**: Plate based-experiment, as described in A, testing different toxic compounds.*
A：洋菜培養皿基本實驗。分別將野生型 *(WT)* 與 表現 *MIcE* 型 *(MIcE)*酵母菌，在含有不同濃度的他汀類藥物 *(lovastin)* 之 *YPD* 培養基上，分別以連續稀釋的菌液濃度進行培養。最高的細胞濃度在左邊。B：明視野與螢光顯微鏡圖，螢光結果為單獨表現的紅色螢光蛋白 *(RFP)* 或 *MIcE* 結合紅色螢光蛋白 *(MIcE-RFP)*。C：在圖A與D中試驗的化合物結構式。D：類似於圖A的描述，但使用不同藥物處理後的結果。

Node Id: **173eb96661ad154c34745e26**

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
S. cerevisiae is naturally resistant to the effects of lovastatin up to 0.7 mM 酵母菌原本對於 lovastatin 可以忍受到 0.7mM。	○	○
MIcE encodes a protein that localizes primarily to the plasma membrane MIcE 表現出的蛋白質主要位在細胞膜上。	○	○
The MIcE offers general protection against all tested statins 在所有的酵母菌種類中，MIcE 都能提供一般的保護作用。	○	○
MIcE will likely also protect yeast from the harmful effects of compactin MIcE 也可保護酵母菌抵抗藥物 compactin 的傷害	○	○

Q. 19

The amino acid sequence MYTHELL is essential for the activity of a given enzyme. Analysis of this enzyme in three related species (A–C, see statements) reveals some diversity. The table below shows the codon usage for the different amino acids in the three organisms
有一段胺基酸序列 MYTHELL，對於活化特定酵素是必須的，在三個物種(A-C)中分析此酵素（詳見問題），發現彼此間有差異性存在。下表是這三個物種中胺基酸和密碼子的對應

TTT Phe F	TCT Ser S	TAT Tyr Y	TGT Cys C
TTC	TCC	TAC	TGC
TTA Leu L	TCA	TAA STOP	TGA STOP
TTG	TCG	TAG	TGG Trp W
CTT Leu L	CCT Pro P	CAT His H	CGT Arg R
CTC	CCC	CAC	CGC
CTA	CCA	CAA Gln Q	CGA
CTG	CCG	CAG	CGG
ATT Ile I	ACT Thr T	AAT Asn N	AGT Ser S
ATC	ACC	AAC	AGC
ATA	ACA	AAA Lys K	AGA Arg G
ATG Met M	ACG	AAG	AGG
GTT Val V	GCT Ala A	GAT Asp D	GGT Gly G
GTC	GCC	GAC	GGC
GTA	GCA	GAA Glu E	GGA
GTG	GCG	GAG	GGG

Node Id: **b81f49816c985d7df5bb9808**

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
In species A, the enzyme-encoding sequence has changed to MTTHYLL, which can be explained by two point mutations 物種 A 中，酵素序列變成 MTTHYLL，可以用出現兩個點突變解釋。	○	○
In species B, the sequence is MYYS, which is best explained by a frame shift mutation 物種 B 中，序列變成MYYS，最好的解釋為出現框架移動突變。	○	○
In species C, the sequence is in fact MYTHELL, but this can be due to 512 different nucleotide sequences 物種 C 中，序列仍然是 MYTHELL，這可以由 512 種不同的核苷酸序列來完成。	○	○
On average, a change from MYTHELL to MYTQELL is more likely than a change to MYTHEHL 由 MYTHELL 變成 MYTQELL，比變成 MYTHEHL 較為可能。	○	○

Q. 20

The adenine (A) content in DNA extracted from tissues of horse, donkey, mule and zebra has been determined. A mule is a horse x donkey hybrid. A zonkey is a zebra x donkey hybrid.
下表為來自不同動物，馬、驢、騾與斑馬，組織中 DNA 腺嘌呤的含量。其中，騾是由馬與驢交配後得到的，斑驢則是由斑馬與驢交配而來。

	Horse 馬	Donkey 驢	Mule 騾	Zebra 斑驢
Tissue 組織	Muscle (HM) 肌肉	Kidney (DK) 腎臟	Muscle (MM) 肌肉	Kidney (ZK) 腎臟
Relative genome size 相對基因體大小	3.4	4.1	3.7	4.1
Adenine (A) content (%) 腺嘌呤含量 (%)	25	20	not determined 未測定	not determined 未測定

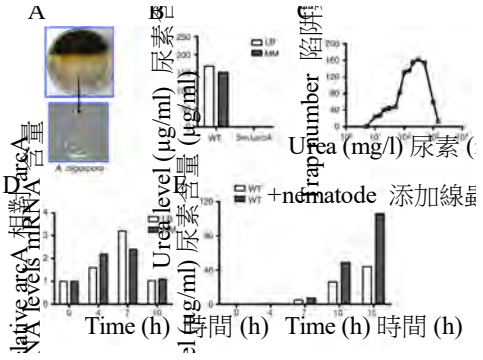
Node Id: **aaece3a24cfd3c7344eba205**

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
In the samples **DK** and **ZK**, the A content is likely to be identical DK 與 ZK 腺嘌呤的含量應該是相同的。	○	○
The A content of **MM** is likely to be approximately the weighted average of **HM** and **DK**, i.e. 23% MM 腺嘌呤的含量應該接近 HM 與 DK 的平均值，即 23%。	○	○
If the A content is 20%, then the G (guanine) content must also be 20% 假設腺嘌呤的含量為 20%，鳥糞嘌呤的含量應該也為 20%	○	○
The relative genome size of a zonkey is likely to be 4.1 斑驢的相對基因體大小應該為 4.1。	○	○

Q. 21

Bacteria are the food of many nematodes, and many bacteria have a toxic secretion defence. Nematodes are also preyed upon, e.g. by the fungus *Arthrobotrys oligospora* (*Ao*). This fungus lives in cow dung and is either saprophytic or predatory. When it encounters a nematode, it becomes predatory by producing traps to capture nematodes (Fig. A). This shift is induced by chemicals, e.g. urea produced by bacteria, e.g. *Stenotrophomonas maltophilia (Sm)* (bacterial urea production below 300 mg/L soil). The interactions between bacterium, fungus, and nematode were studied (Fig.).
細菌可以作為許多線蟲的食物，而細菌也會分泌毒素來進行防禦。而線蟲也會被捕食，例如真菌中的寡孢馬杜拉放線菌 (Ao)。這些真菌會生活在牛的糞便中進行腐生生活或是進行捕食行為。當真菌遇上線蟲時，會產生陷阱去捕捉線蟲（圖Ａ）。上述這種行為會被細菌產生的化學物質（例如：尿素）誘導產生，例如：嗜麥寡養食單胞菌 (Sm)，每公升土壤中會產生接近 300 mg 的尿素。本題要研究，細菌，真菌與線蟲間的交互作用。



A, trap-formation by Ao near cow dung on a plate; B, urea is produced from arginine and formation is catalysed by arginase, being controlled by the gene arcA; SmΔarcA is a bacterial strain without arcA (WT is wild type); LB and MM are nutrient-rich and -poor media, respectively; C, trap number as a function of urea concentration; D, arcA is expressed in bacteria, when nematodes are added; E, urea levels in bacteria with and without nematodes. (from Wang et al. 2014).
Ａ：培養皿中靠進牛糞附近放線菌 *Ao* 會產生陷阱。Ｂ：尿素會藉由精氨酸酶催化精氨酸後分解而成，這過程會藉由 *arcA* 基因所調控。*SmΔarcA* 代表的是缺少 *arcA* 基因的細菌（*WT*，野生型）。*LB* 為富養的培養基，而 *MM* 則是寡養的培養基。Ｃ：陷阱數目可以作為尿素濃度的指標。Ｄ：當線蟲加入培養基中，細菌會表現 *arcA* 基因。Ｅ：有無添加線蟲的尿素濃度。

Node Id: **e91a161501358e5cb1af4314**

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
Under normal conditions of bacterial urea production, trap production by the fungus increases 陷阱形成的增加與細菌尿素產量成正比。	○	○
Only bacteria with the specific gene *arcA* can produce	○	○

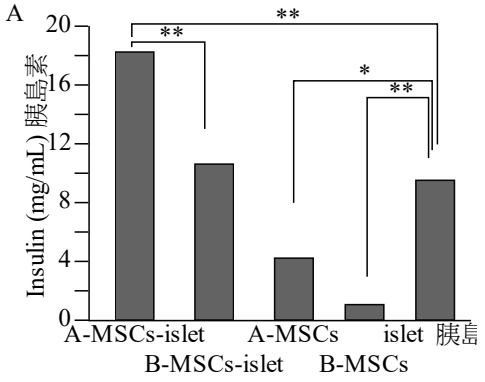
urea
細菌要具有 arcA 基因方能產生尿素。

Bacteria produce urea in both nutrient-rich and -poor conditions
不論是寡養或富養培養基，細菌都能產生尿素。

Urea production seems to be triggered by stimuli from the nematode
尿素的產生是被線蟲刺激後方能產生。

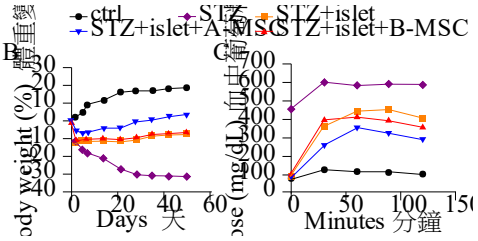
Q. 22

Differentiation of a kind of stem cells (mesenchymal stromal cells MSC) derived from adipose rat tissue (A-MSC) and bone marrow (B-MSC) was analyzed *in vitro* and *in vivo*. Diabetic rats (STZ rats) were used and MSCs were co-transplanted with pancreatic islets to confirm the *in vitro* results (Fig. A).
細胞分化現象為幹細胞（間質幹細胞 (MSC)）很重要的現象，不論是來自老鼠脂肪組織 (rAT-MSC) 或是骨髓 (rBM-MSC[RJNF1]) 中，試管內與活體內的分析都是相當重要的。糖尿病大鼠 (STZ) 常被用在共同移植 MSC 與胰島的活體內試驗研究中。（圖Ａ）



A, in vitro: insulin secretion levels after 38 days of culture of islets and stem cells
Ａ：共同培養胰島與幹細胞 *38*天後，試管中胰島素的分泌量。

The insulin-producing capacities of the islets transplanted with stem cells were compared and reduction of hyperglycemia symptoms in the rats was examined (Fig. B-C).
大鼠實驗中，胰島素的產量與高血糖減輕的症狀將作為幹細胞種類與胰島共同移植的比較結果指標。（圖Ｂ與Ｃ）



B, in vivo: body weight change after transplantation of islets into the rats. Body weight change (%) compared to the time of transplantation (day 0); C, in vivo: Glucose tolerance test was performed after injection of 2 g glucose/kg rat (from Karaoz et al. 2013).

B：活體中實驗，移植胰島到大鼠後的體重變化。體重變化量 *(%)* 與 移植時間（第 *0* 天起）關係圖。C：活體中實驗，注射葡萄糖溶液（ *2g* 葡萄糖／公斤‧大鼠）到大鼠體內後的葡萄糖耐受實驗結果。*(from Karaoz et al. 2013)*

Node Id: **c3d9cc6da1356c8c4a23e24e**

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
There is no added advantage in cultivating pancreatic islets together with stem cells in order to obtain a high insulin production *in vitro* 於試管內進行共同培養幹細胞與胰島來獲得高胰島素產量的實驗，是沒有意義的。	○	○
Transplanting stem cells and islets may potentially reduce the blood glucose level in a glucose tolerance test, but not to the level observed in control rats 在葡萄糖耐受實驗中，移植幹細胞與胰島可能會降低血糖，但是在對照組中則沒有變化。	○	○
Transplantation of stem cells from adipose tissue together with islets seems to be the most efficient way to help people, who suffer from diabetes 移植脂肪組織來源的幹細胞與胰島，對於糖尿病患者的幫助會有較大的效益。	○	○
The conclusion from all experiments is that there are no observed effects of islets + bone marrow stem cells together as compared to islets alone 所有的實驗結果顯示，共同移植胰島＋骨髓來源幹細胞 與單獨胰島移植的結果沒有明顯差異。	○	○

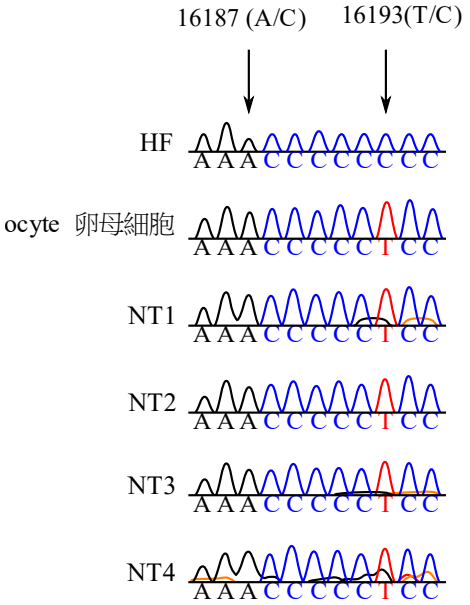
Q. 23

Researchers succeeded in reprogramming human somatic cells into

embryonic stem cells (ESC) by a somatic cell nucleus transfer (SCNT) into oocytes from which the nucleus had been removed. After the transfer, the origin of the nuclear and mitochondrial (mt) DNA were analysed (Fig.).
科學家將體細胞細胞核 (SCNT) 移植到卵母細胞（保留其基因體）後，成功地將人類體細胞重新編程進入胚胎幹細胞 (ESC)。轉殖後，原有的細胞核與粒線體 (mt) DNA 進行下列分析研究（下圖）

Nuclear DNA genotyping from three nucleus transfer (NT)-ESC lines (NT1-3) determined by microsatellite analysis; D2S1333 and D4S413 are locus names and numbers in columns are names of specific alleles.
利用微衛星分析進行細胞核的基因分型實驗。共計有三個核移植 *(NT)-ESC* 系列（*ESC-NT1* 等）。*D2S1333* 與 *D4S413* 為位點名稱，欄中數目為特別的對偶基因序列長度。

Origin 起源	**D2S1333 locus**	**D4S413 locus**
Somatic donor cell 體細胞	293/301	123/123
Oocyte 卵母細胞	297/305	133/153
NT1	293/301	123/123
NT2	293/301	123/123
NT3	293/301	123/123



mtDNA sequences of the NT-ESC lines (HF = human foetus); 16187 and 16193 are two nucleotide positions used as markers after SCNT (from Tachibana et al. 2013).
NT-ESC 系列（*HDF-f*=人類胎兒）的 粒線體 *DNA* 序列。*16187* 與 *16193* 為兩個核苷位置用來作為體細胞細胞核 *(SCNT)* 的標記。 *(from Tachibana et al. 2013)*

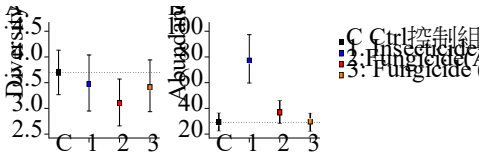
Node Id: **d8cd949b2458cab2db48b609**

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 nuclear DNA composition of the ESCs is a combination of nuclear DNA from the somatic donor cell and nuclear DNA from the oocyte donor ESC 細胞核 DNA 的組成來自體細胞細胞捐贈者和與卵母細胞捐贈者的組合。	○	○
The mtDNA of the ESC lines originates from the oocyte ESC 的粒線體 DNA 源自於 卵母細胞。	○	○
After nuclear transfer the oocyte becomes a haploid 在細胞核移植後，卵母細胞會變為單套體。	○	○
It is most likely, that different oocyte donors were used 最有可能的是，使用了不同捐贈者的卵母細胞。	○	○

Q. 24

Tropical forest plant communities are very diverse. The Janzen–Connell hypothesis argues that insect herbivores and pathogens are positive drivers of this diversity. This was tested in a rainforest by excluding herbivores and pathogens through pesticide application and observing if this affected plant diversity and abundance (Fig.)
熱帶森林群落非常多樣，根據Janzen–Connell 的假說，他們認為草食性昆蟲及病原是造成森林多樣的正向推手。針對此假說利用一處雨林進行實驗，利用殺蟲劑將草食性昆蟲及病原去除，而後觀察其是否對植物相對豐度與多樣性有影響(圖)



Effects of an insecticide and two fungicides upon: seedling diversity (A) and mean seedling abundance (B) of the forest community. Error bars represent 95% confidence intervals of the mean of all study sites with a given treatment (from Bagchi et al. 2014).
一種殺蟲及兩種除真菌劑的效果：
森林群落幼苗多樣性*(A)*及平均幼苗豐富度*(B)*
所有研究地區每組處理誤差值的直線圖，顯示平均值*95%*信賴區間*(from Bagchi et al, 2014)*

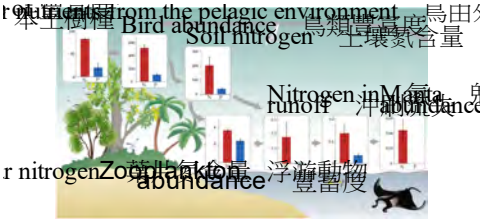
Node Id: **61d8d3d0e68527e955cbb35a**

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
All treatments had a statistically significant effect upon seedling diversity 各組處理皆有呈現對幼苗多樣性有統計上顯著的影響	○	○
In the study area, most insects were predators 在研究地區大多數的昆蟲是掠食者	○	○
Ridomil is stronger in its effects on fungi than Amistar Ridomil 對真菌的效果大於Amistar	○	○
The hypothesis is supported in the present study by the combined effect of insects and fungi 由目前研究所得綜合昆蟲及真菌的結果，支持所提出的假說	○	○

Q. 25

The fragility of an ecological food chain is examined on an atoll, where native forest was replaced by coconut palms (Fig.). This created a problem for seabirds which could not nest in palms.
選擇一處環礁研究生態食物鏈的脆弱性。此處天然林已被椰子林所取代(圖)，對於島上的海鳥造成影響，因為他們不能在椰子樹上築巢。



Changes in the ecological chain, when native forest (N) is replaced by palms (P). Each bar graph compares processes in N and P (from McCauley et al. 2012).
當本土森林*(N)*被椰子林*(P)*取代後，造成生態鏈的改變。
每一長條圖為*(N)*及*(P)*過程的比較*(from McCauley et al. 2012).*

Node Id: **527dacd2f236c9b2c4c9a707**

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
Bird presence benefits manta rays 鳥的存在對於鬼蝠魟有利	○	○

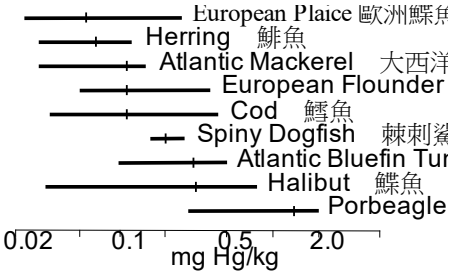
Palm growing might harm corals in the atoll
椰子樹生長或許會對環礁的珊瑚造成危害

If forest was cleared and land instead used for intensive modern farming with fertilizers, manta rays might disappear from the coast
如果森林被砍光，土地被移做現代農場使用大量肥料，則鬼蝠魟將會自海岸中消失

The food chain includes only top-down effects, and no bottom-up effects
食物鏈所形成的影響只有由上而下，而無由下而上的效應

Q. 26

The World Health Organisation (WHO) recommends a Maximum acceptable Daily Intake (MDI) of 0.1 microgram Hg (Mercury) per kg consumer body mass. Consequently, Hg levels in Danish fish for human consumption are under permanent control. Mercury level in nine species was measured (Fig.).
世界衛生組織(WHO)建議人體可忍受的汞(Hg)每天可攝入最多量(MDI)為每公斤體積中含0.1微克，是以管理單位對丹麥漁獲市場中的汞含量長期持續的監控。
下圖為9種魚體內的汞含量



Hg level in milligram/kg fish; horizontal bars span the 95% confidence interval (small vertical bars are averages).
*H*汞的含量毫克/公斤 魚：水平的長條圖為*95%*信賴區間*(*小的垂直長條為平均值所在*)*

Node Id: **81b60931f30dee16fdf8bbcb**
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

Mackerel is placed higher in the marine food chain than Halibut
鯖魚較鰈魚在海洋食物鏈的地位高

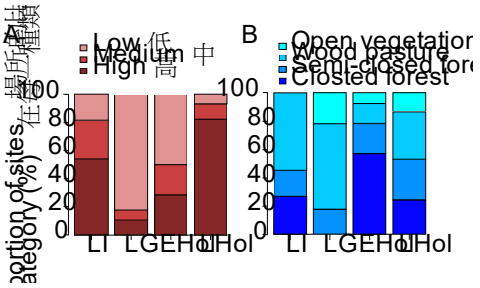
Hg-level generally increases with body weight
一般而言汞含量隨體重而增加

Mean Hg concentration in Tuna allows a 75 kg person to consume a maximum 1 kg Tuna per ca. 10 days
鮪魚體內的平均汞含量允許一個體重75公斤的人，最多可在10日內消費1公斤鮪魚

Tuna has a wider diet than Halibut
鮪魚較鰈魚有更廣的食性

Q. 27

Large herbivores have a high impact upon ecosystems, but most have become extinct during the last 100 kY (1ky=1000 years). This mass extinction also affected their associated dung beetle fauna. Subfossil findings in Northern Europe show that this beetle fauna was richer and belonged to more open woodland before the mass extinction than afterwards, when dung beetles became fewer and most lived in closed forest. Modern humans and agriculture arrived to Northern Europe 50 kY and 10 kY ago, respectively.
大型草食獸對生態系會造成很大的影響，但絕大多數的種類在過去十萬年皆已滅絕，此種大滅絕也影響相關之糞甲蟲的動物相，在北歐化石層中發現在大滅絕前甲蟲相較豐富，且生活在較開濶的樹林地，而大滅絕後糞甲蟲減少且大多數住在密閉的森林中。現代人類及農作分別在5萬到1萬年前進入北歐。



Proportions of excavation sites classified according to their fossil dung beetle density (A), and vegetation type (B); the latter being identified by its characteristic beetle fauna. LI, last interglacial period (132–111 kY ago); LG, last glacial period (50–15 kY ago); EHol, early Holocene (10–5 kY ago); and LHol, late Holocene (2 kY- ago to present) (from Sandom et al. 2014).
發掘處的分類型所占的比例，根據圖*A*，糞甲蟲化石的密度*(*圖*A)*及植被型態*(*圖*B)*：後者可由其處特有的甲蟲相來辨識
LI, 最後的間冰期*(13*萬*2*千到*11*萬*1*千年前*)*
LG 最後冰河期*(5*萬到*1*萬*5*千前*)*

EHol 全新世早期*(1*萬到*5*千年前*)*
及*LHol*全新世晚期*(2*千年前至今*)*

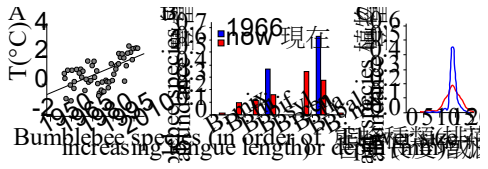
Node Id: **feee73c04c2d73b7dc408518**

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 decline of the large herbivore fauna during LG might partly be explained by climate change 造成最後冰河期(LG)大型草食獸動物相的減少，部份可能的原因是氣候變遷	○	○
The decline of the large herbivore fauna during LG might partly be explained by human arrival 造成最後冰河期(LG)大型草食獸動物相的減少，部份可能的原因是人類入侵	○	○
The small increase in dung beetle density during the warmer EHol is due to a return of large native herbivores after the LG 在較溫暖的全新世早期(EHol)，糞甲蟲密度小量增加是由於在最後冰河期(LG) 以後大型本土草食獸回流所致	○	○
The strong increase in dung beetle density during LHol is due to agriculture 在全新世晚期(LHol)糞甲蟲密度大量增加是由於農作的緣故	○	○

Q. 28

High-altitude Rocky Mountains (U.S.A.) bumblebee communities were studied 40 years ago and again today, and a set of changes was noted, and these were related to climate change (Fig.).
美國高海拔洛磯山脈熊蜂群聚在40年研究過，目前又對其進行研究，發現許多與氣候變遷有關的改變(圖)。



A, change in summer temperature in the Rocky Mountains; B, change in tongue length in a mountain bumblebee community (grey bars 1966; white bars today); and C, change in diversity of flowering plant species with different depth, i.e. access to bees, between 1966 (blue) and today (red) (from Miller-Struttmann et al. 2015).

A. 夏天洛磯山脈溫度的改變
B. 一處山區熊蜂群聚舌頭長度的改變*(*藍長條*1966*：紅色長條現在*)*
C. 在*1966(*藍*)*及現在*(*紅*)*花朵具有不同深度*(*讓蜂接近*)*之植物多樣性的改變

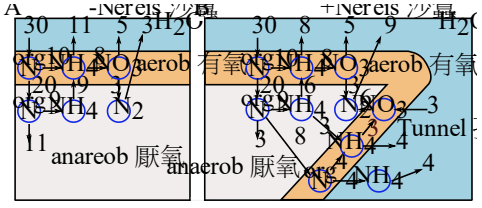
Node Id: **de420322b07b8c6ab09c29b8**

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 present-day bumblebee community is less diverse than in 1966 現今熊蜂群聚不如'1966年多樣	○	○
Higher temperature favours nectar-plant specialist bumblebees 高溫有利於採花密專業性高的熊蜂	○	○
Low-altitude bumblebee species have not been able to invade the higher altitudinal zones during the 40 study years 低海拔熊蜂在過去40年間無法入侵高海拔地區	○	○
Average depth of flowers has decreased during the 40 study years, favoring shorter-tongued bumblebees 花朵平均深度在過去40年間減少，有利於短舌熊蜂	○	○

Q. 29

The polychaete *Nereis virens* lives in the bottom sediment of shallow coastal waters. It digs tunnels in the sediment and pumps water through these tunnels. The decomposition turnover of nitrogen (N) compounds has been investigated in the sediment at two sites: one without *Nereis* (Fig. A) and one with 600 *Nereis* per m^2 (Fig. B).
多毛類的沙蠶生活在淺水海岸沉積底層(灘地)，他在沉積層挖孔道並抽水由孔道排出。在沉積層內選擇兩處進行含氮化合物分解及轉化的研究，一處無沙蠶(圖A)另一處有沙蠶(圖B，每平方米600隻)



Sediment N-processes without (A) and with (B) Nereis. Numbers at arrows give the annual N turnover in g N per m2.
沉積層氮的作用沒有沙蠶參與*(A)* 及有沙蠶參與*(B)*
箭頭的數字顯示全年氮*(N)*的轉換*(*每平方公尺中含氮的克數*)*

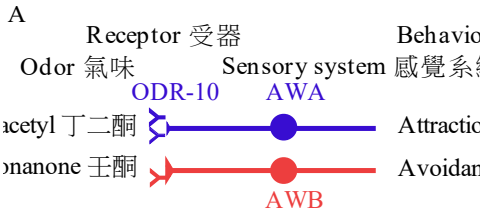
Node Id: **90943f6bc0d75a52e62da66e**

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
Less organic N is deposited in the bottom sediment in B compared to A 與A比，B有較少有機氮(N)存留在沉積層底層中	○	○
Denitrification rate is increased threefold in the presence of *Nereis* 去氮速率在有沙蠶存在時增加了3倍	○	○
In the tunnels made by *Nereis*, 5 g N per m^2 per year are deposited in the sediment 沙蠶所營造之孔道，每年會有每平方公尺5克氮回歸到沉積層中	○	○
Concentrations of nutrients, which may lead to algal bloom, are lowered in the presence of *Nereis* 營養鹽濃度可能會造成藻華，但在沙蠶存在情況下機會變小	○	○

Q. 30

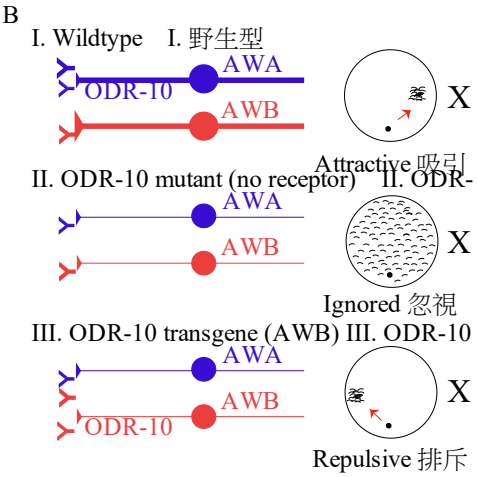
The worm *C. elegans* shows sophisticated behaviour in response to odour. It has 11 pairs of chemosensory neurons. Odours are detected by G protein-coupled receptors (GPCR) on the outside of these neurons. The receptor protein ODR-10 on the neuron AWA initiates the movement of *C. elegans* towards the odour diacetyl (its location shown as X in figure B). The neuron AWB, however, initiates movement away from the toxin nonanone (A).
秀麗線蟲(*C. elegans*)對於氣味反應有非常複雜的行為，牠有11對化學感應神經元，氣味是由這些神經元外的G蛋白結合的受器(GPCR)所偵測，在AWA神經元的感受蛋白ODR-10是最先發出訊息使秀麗線蟲朝丁二酮的氣味方向移動(他的位置是在圖B中的X處)，AWB神經元則最先發出訊息讓身體遠離壬酮毒素



A, diacetyl elicits an attraction (+) of the worm via AWA, nonanone elicits a repulsion (–);

丁二酮藉由蟲體*AWA*神經元，產生了吸引*(+)*　壬酮引起了逃避*(-)*

The behaviour of mutant and transgenic worms was compared to the one of wild-type worms (B).
基因突變及基因轉植個體與正常野生個體(B)的行為進行比較



Mutant animals don't express ODR-10. Transgenic animals only express ODR-10 receptors on AWB. The receptor still reacts to the presence of diacetyl, but its reaction is avoidance (–). I, WT = wild type; II, mutant without receptor; III, transgenic animal.
變種個體為不能表現*ODR-10*的功能，基因轉植的個體只能在*AWB*神經元表現出*ODR-10*功能。此受器仍舊對存在的丁二酮會反應但卻產生逃避反應*(-)*
I. WT=野生型；*II.* 不具受器的突變個體；*III*基因轉植個體

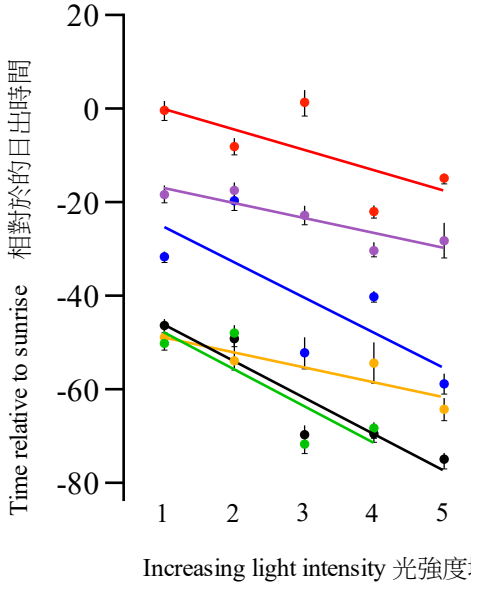
Node Id: **08b4368f388b5e712a428c67**

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
ODR-10 on AWA is required for attraction towards diacetyl 個體被丁二酮吸引前往時，AWA 神經元上的ODR-10蛋白質的功能是必需的	○	○
ODR-10 can mediate both attraction and repulsion ODR-10 對蟲產生忌避和吸引行為時皆有扮演居中傳遞的角色	○	○
Each olfactory neuron has receptors for many odour chemicals 每一個嗅覺神經元有受器可以感覺許多化學物所產生的氣味	○	○
All olfactory neurons are functionally similar even if their receptors are different 所有的嗅覺神經元縱使他們受器有所不同，但神經元功能上皆相似	○	○

Q. 31

Researchers investigated if street-lighting (artificial night lighting) affected dawn and dusk singing in six common songbirds. They used 5 sets of plots of increasing light intensities (Fig.).
研究人員調查路燈(夜間人工光源)對六種常見鳴禽晨昏鳴唱行為的影響。他們規劃了五套光度漸增的設施(圖)。



Average start of dawn singing relative to sunrise '0' (mean ± standard error) against increasing light intensity (from 1 to 5) at sites with street-lighting (from Silva et al. 2014).
清晨鳴唱與日出時間*("0")*相較*(*平均值*±*標準差*)*，不同的街景由弱到強的光度*(1-5*不同程度的光度*)*鳥平均開始鳴唱的時間

Node Id: **19d8558e53acdcb1cdcd7d52**

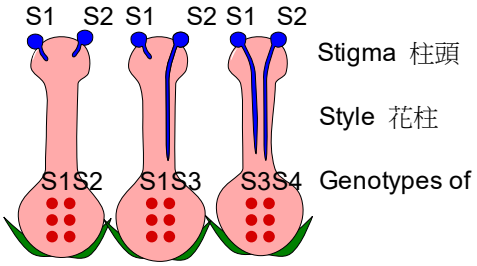
Indicate if each of the following statements is true or false.
問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
Generally, street-lighting seems to have the strongest effect on the earliest birds 一般而言，路燈對於早鳥似具有最強的效應	○	○
Streetlight increases interspecific competition among birds for time of singing 路燈增加了鳥類為了唱歌的時間所產生的種間競爭	○	○
The morning pattern may be reversed at dusk 早上的唱歌型式可能會在傍晚呈現相反的結果	○	○

Rain at dawn may delay the initiation of singing
清晨下雨可能會延遲鳴唱開始時間

Q. 32

In diploid clover species (*Trifolium*), fertilization is determined by (gametophytic) self-incompatibility alleles (*S*-alleles). Pollen with a given allele, e.g. *S*1, cannot germinate on the stigma of another plant, if this plant has the same allele (e.g. if the mother has the genotype *S*1 *S2* or *S*1 *S*3), and therefore no fertilization takes place (Fig.). In species with *S*-systems, one often finds many alleles: *S*1 … etc. in a population.
在二倍體的苜蓿類植物，受精作用受到配子體自交不和合性等位基因(S等位基因)的控制。花粉攜帶一個S 等位基因(例如S1)， 如果此花粉附著的柱頭也具有相同的S等位基因(例如基因型為S1S2 或S1S3的植物)，則此花粉不會萌發，因此也不會有受精作用發生(如圖)。這種具S 系統的植物通常有很多不同的S 等位基因存在於族群中



Self-(in)compatibility reactions in three pistils; pollen and pollen tubes are coloured blue. S1 to S4 are S-alleles, and S1S2 etc. are genotypes of mother plants.
三個雌蕊上自交(不)和合反應的例子，花粉和花粉管是藍色的，*S1~S4*是不同的*S*等位基因，*S1S2*，*S1S3*，*S3S4*等是母本植物的基因型

Node Id: **57d4bc04ed01b8d9b57f426f**

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 genotypes in the *S* gene are in Hardy-Weinberg equilibrium 族群中S基因的基因型處於哈-溫平衡		
In a population with three S alleles and equal frequencies of all possible genotypes, 1/3 of all crosses will be incompatible 族群中有3種不同的S等位基因，且各基因型頻率相同，則所有的交配中，有1/3是不和合的		
The smallest possible number of *S* alleles in a viable		

population is four
在一個可以維持繁衍的族群中，所需的不同S等位基因數目最少是4種

In another incompatibility system with only two alleles (*S1* and *S2*, and *S1* being dominant over *S2*), 1/3 of all crossing types are compatible
在另一個自交不和合系統中只有2種不同的等位基因(S1和S2，且S1對S2為顯性)，則1/3的所有交配組合是和合的

Q. 33

In a single locus with three alleles A, B and C, the population allele frequency of A is 0.25 and the frequency of AC individuals is 0.20. We assume random mating in the population.
一特定基因在族群中有A、B、C 三種不同等位基因，等位基因A的頻率是0.25；基因型AC的個體頻率是0.20，假設此族群中是逢機交配

Node Id: **0b12bd43bb4e6d30f35cbf54**

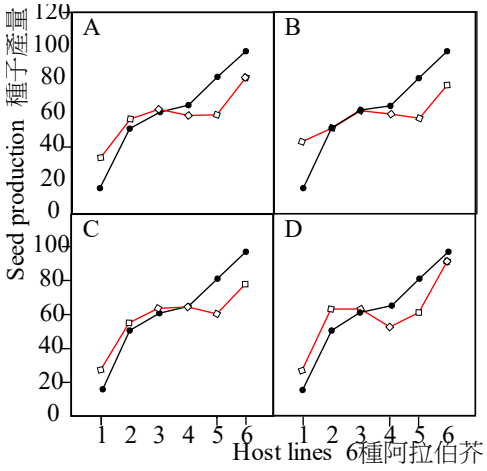
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
The frequency of the AA genotype will be 0.1875 AA基因型的頻率是0.1875		
The frequency of the AB genotype will be 0.175 AB基因型的頻率是0.175		
If B is dominant to A and C, then the frequency of the B phenotype will be the frequency of the B allele 若B等位基因對A 和C 為顯性，則B表現型的頻率和B等位基因頻率相同		
In a single locus with 5 alleles, we get 16 possible genotypes 若一個基因有5種不同等位基因，則會有16 種不同的基因型		

Q. 34

The oomycete *Hyaloperonospora arabidopsidis* (*Ha*) grows on the plant

Arabidopsis thaliana (*At*). Six genotypes of *At* (Pyr, Tsu, Sue, Fin, Tch and Gb) were grown with or without Ha in four experiments (Fig.*A–D*). In each experiment, the *Ha* sample differed: one came from a laboratory sample kept for years (*B*), one was collected in the field in Germany (*C*), another in France (*D*). Finally, one experiment (A) used a mix of the three others.
卵菌門的Hyaloperonospora arabidopsidis (Ha)生長在阿拉伯芥 Arabidopsis thalina (At)上。在一個研究中，對6個不同基因型的阿拉伯芥(Pyr, Tsu, Sue, Fin, Tch和Gb)進行卵菌處理實驗(見圖A~D)，共使用4種菌種組成：B是實驗室菌種；C是德國野生菌種；D是法國野生菌種；A是以上3種菌種的混合。每一實驗都有無菌處理的對照組。



Seed production (mg seeds/plant; Y-axis) of six At genotypes (Pyr, Tsu, Sue, Fin, Tch, Gb; X-axis) in four experiments (a)–(d). At genotypes are ranked according to increasing seed production in the absence of the oomycetes (filled symbols, black); At grown with Ha (open symbols, red) (from Salvaudon et al. 2008).
對*6*個不同基因型的阿拉伯芥*(Pyr, Tsu, Sue, Fin, Tch*和*Gb* ，*X*軸*)*進行 *4*組菌種處理實驗*(A~D)*：檢測各組處理對種子產量的效應*(Y*軸*)*。*6*個阿拉伯芥基因型依無菌處理時的種子產量遞增排列。
黑色實心標記：無菌對照組
紅色空心標記：添加菌種處理

Node Id: **107156606f9a960a5ebdd453**

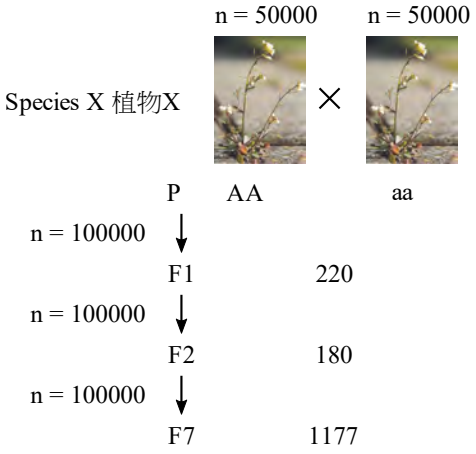
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
In experiment B, *Ha* is commensal with all *At* genotypes 實驗B中，卵菌和阿拉伯芥是共生關係	○	○
In experiment C, *Ha* is a parasite on all *At* genotypes 實驗C中，卵菌和寄生於所有阿拉伯芥	○	○
For all three fungal strains, the negative impact of Ha is strongest on the most productive genotypes 三個菌種最強的負面效應都發生於種子產量高的阿拉伯芥基因型	○	○
The outcome of interactions between Ha and At on the	○	○

plant
depends on the latter's genotype
卵菌和阿拉伯芥的交互作用之結果由阿拉伯芥的基因型決定

Q. 35

Two pure breeding lines of Species X were crossed (Fig.). For each generation, 100 000 plants were allowed to breed. For the generations F1, F2 and F7, a specified number of plants were genotyped for the alleles *A* and *a*. The experimenter assumes no selection, no self fertilization and random mating after the first generation.
以二個不同的植物X純系進行雜交實驗(如圖)，每一世代都使用100000株植物繁殖下一世代。在F1、 F2、F7世代，選取特定數目的植株，檢定其有關A等位基因和a等位基因的基因型。本實驗假設沒有篩選，沒有自交，在第一世代後逢機交配。



Breeding of pure lines in Species X; n is number of sampled plants. The central column gives number of individuals genotyped in each generation (only generations P, F1, F2 and F7 are shown).
二個不同的植物*X*純系進行雜交實驗：*n*是實驗植株數目，中間的數字是檢定基因型的植株數目*(F1、 F2、F7*世代*)*

Node Id: **1343f25eb5d39833eb07ad00**

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 parental generation (P) shows Hardy-Weinberg proportions 在親本世代(P)個體數為哈-溫平衡比例	○	○
Expected number of *Aa* genotyped individuals in F1 is 110 在F1世代被檢定基因型的植株中，Aa的預期個體數是110	○	○

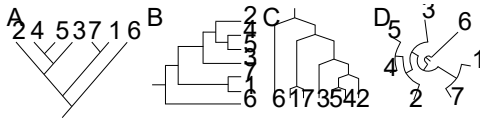
Expected number of *aa* genotyped individuals in F2 is 90

在F2世代被檢定基因型的植株中，aa的預期個體數是90

In F7, 271 plants were genotyped as *AA*. This is less than expected 在F7世代被檢定基因型的植株中有271 個是AA，這比預期數目要少

Q. 36

The phylogeny of seven species is presented in four different ways (Fig.).
七個物種的親緣關係以4種不同方式呈現(如圖A~D)



Four phylogenies of seven species (1-7).
七個物種*(1~7)*的*4*種親緣關係

Node Id: **42e3093b023498125dcfb96f**

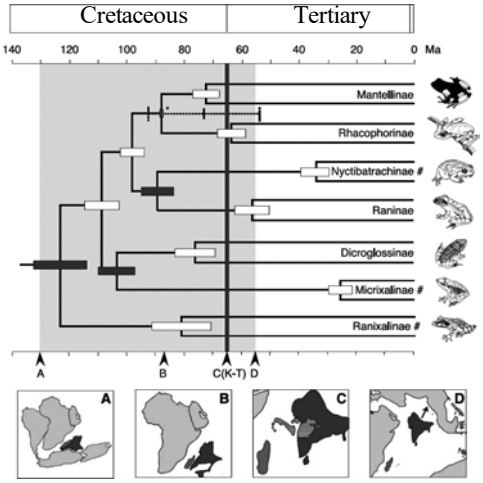
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
All four trees reflect the same phylogeny 所有親緣樹反映相同的親緣關係		
In all phylogenies, species 6 is expected to have more mutations than species 2 在所有親緣關係中，物種6應該會比物種2具有更多突變		
In phylogeny A, species 1, 6, and 7 constitute a monophyletic group 在親緣關係A中，物種1、6和7組成一個單系群		
In phylogeny C, species 7 is more closely related to species 3 than to 5 在親緣關係C中，物種7與3的關係，比7與5的關係為近		

Q. 37

The phylogeny of frogs has a very dynamic geographical history (Fig.).

蛙類的親緣關係具有很強的地理歷史特性(如圖)



Phylogeny of frog groups (branch lengths proportional to absolute time). Error bars on internal nodes are confidence intervals on the node dates; below and above the phylogeny is a geological time scale, and below the lower time scale is a cartoon for the period between the isolation of the Madagascar-India continental block from Africa (A) (130 mill. years ago, Ma) to the collision of India with Eurasia (D) (56 Ma) (shaded area in phylogeny, A–D in cartoon refer to A–D in lower time scale; K–T = Cretaceous–Tertiary boundary) (from Bossuyt & Milinkovitch 2001).

蛙類的親緣關係：分枝線的長度正比例於時間，在分歧節點的誤差條代表分歧發生時間的信賴區間。親緣關係的上、下方是地理時間尺表。最下方是描述陸塊變動時期的卡通圖*(A~D)*，並對應在下方地理時間尺表的時間點：從*(A)*馬達加斯加-印度大陸和非洲分離 *(130*百萬年前 *Ma)*，一直到*(D)*印度和歐亞大陸相接 *(56*百萬年前 *Ma)*，*A-D*這段時間是親緣關係圖中的灰底部分。

K-T = 白堊紀*Cretaceousc*和第三紀*Tertiary* 的分界

Node Id: **683271f64bf0eb833354fd76**

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
No individual living before 60 million years ago is an ancestor of Raninae Raninae的先祖物種在60 Ma前不存在	○	○
Raninae and Dicroglossinae shared a common ancestor about 75 million years ago Raninae和Dicroglossinae在75 Ma 左右有共同祖先	○	○
Divergence of Raninae and Nyctibatrachinae most likely occurred after the 85 million year old separation of India and Madagascar Raninae和Nyctibatrachinae的分歧，非常可能發生在印度和馬達加斯加分離(85 Ma)之後	○	○
The last common ancestor of Micrixalinae and Dicroglossinae lived before India and Madagascar became separated (85 million years ago)	○	○

Micrixalinae和Dicroglossinae的最後共祖生活在印度和馬達加斯加分離(85 Ma)之前

Q. 38

The marine transition area between the Bothnian Bay (the northernmost part of the Baltic Sea between Sweden and Finland) and the Eastern Atlantic ocean is characterized by a steep cline in salinity (Fig. B) and it is inhabited by a number of fish species. Studies show genetic differences, measured as F_{ST} (Fig.) between two populations, one being the Bothian Bay population, which is considered the reference population. $F_{ST} = 0$ means complete random mating across populations, $F_{ST} = 1$ means no mating between populations.
介於Bothnian 灣(位於瑞典和芬蘭間的最北波羅的海)和東大西洋間轉換水域的特性是鹽度的急遽改變(圖)，這裡也是一些魚種的棲地。在一個探討鹽度改變對魚種影響的研究中，用族群間的F_{ST}特性為遺傳變異指標，並以在Bothnian灣的族群，作為參考族群，發現遺傳變異確實存在。F_{ST}=0代表族群間完全逢機交配；FST=$_1$代表族群間完全沒有交配。

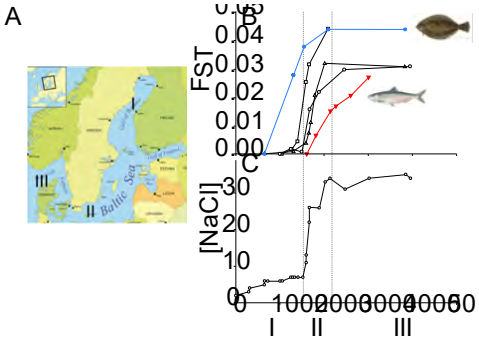


Figure. A, Bothnian Bay (I), Southern Baltic Sea (II), and North Sea (III); B, changes in genetic variation among populations (F_{ST}) of five fish species (blue filled circles = flounder (inset); red filled inverted triangles = herring (inset); open squares, triangles, and circles= three other fish species); C, change in salinity [NaCl] from the Bothnian Bay (I) towards the North Sea (III) (from Limborg et al. 2009).
A：*I*是*Bothnian*灣，*II*是南波羅的海，*III*是北海
B：*5*個魚種族群間遺傳變異*(FST)*在不同海域的改變，藍色實心圓-比目魚；紅色實心倒三角-鯡魚；空心方塊、空心三角、空心圓-其它三種魚
C：從*(I)Bothnian* 灣到*(III)*北海鹽度的改變

Node Id: **dd371d5f122686e34ef2dfd8**

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
Salinity might be important in shaping the genetic structure of marine fish		

鹽度可能對海水魚種遺傳結構的形成很重要

Baltic Sea fish are adapted to local environmental conditions
波羅的海的魚對地區環境有適應現象

The random mating of Herring is less affected by salinity than is that of the other four species
鯡魚的逢機交配比其它4種魚較不受鹽度影響

Flounder is less sensitive to changes in salinity than the other four species
比目魚比其它4種魚較不受鹽度改變影響

Q. 39

Base sequences of two genomic regions (1 and 2) from blue whale (*Balaenoptera musculus*), sheep (*Ovis aries*) and hippopotamus (*Hippotamus amphibius*) were aligned and compared (Fig.).
附圖是對藍鯨、羊、河馬基因組內的二段鹼基序列的比對

Region 1 第一段序列

```
                                10        20        30        40        50        60
                        ....|....|....|....|....|....|....|....|....|....|....|....|
Balaenoptera musculus   ATGTTCATAAACCGCTGACTATTCTCAACCAACCACAAAGACATCGGCACCCTATATTTA
Ovis aries              .....C.........T.....T.....---.........T.....T.....T..CC.T
Hippopotamus amphibius  ..............................--------.....T..A.....C..

                                70        80        90        100       110       120
                        ....|....|....|....|....|....|....|....|....|....|....|....|
Balaenoptera musculus   ATGGGTCAGCCTGGCACACTAATCGGAGATGACCAAGTCTACAACGTATTAGTAACAGCC
Ovis aries              .....C..A..C..A..T...C.........---...---.........A.T.....C..A
Hippopotamus amphibius  ........A.............T.A.............A.T.........G.T..C......
```

Region 2 第一段序列

```
                                10        20        30        40        50        60
                        ....|....|....|....|....|....|....|....|....|....|....|....|
Balaenoptera musculus   CTATTTGGTGC-TGAGCAGGAATAGTAGGCACTGGCCTAAGCTTATTAATCCGCGCTGAA
Ovis aries              .---.......C..-..T..T..C.C...A..-C.T.....C..C....T.....C...
Hippopotamus amphibius  ...........C.....T..C....C.............G.-.C..C.....-...-C...

                                70        80        90        100       110       120
                        ....|....|....|....|....|....|....|....|....|....|....|....|
Balaenoptera musculus   TTTGCCTTCGTGATAATCTTCTTCATAGTTATACCTATTATAATCGGCGGATTCGGAAAT
Ovis aries              .....A..T..AC....T.....T.AT..A..G..A.GGG....T..T...GC...C..C
Hippopotamus amphibius  .....A..T..AC....T.....T.AT.........A.GGG.G..T.....GGC.....C
```

Base sequences.'–' is a base deletion, and '.' means the base is the same as in the sequence above.
鹼基序列比對："-"是單一鹼基缺失；而"."是指和其上序列的鹼基相同

Node Id: **b3c5668ccb46677c963cab8a**

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
Region 1 is most likely a protein coding sequence 第一段序列很可能是一段蛋白質編碼序列		
Region 2 is most likely a protein coding sequence 第二段序列很可能是一段蛋白質編碼序列		
In region 1, the blue whale sequence is longer than the other two, which suggests that sheep and hippopotamus are closer related than either are to the blue whale		

在第一段序列的比較，藍鯨的序列比羊和河馬的序列長，這代表羊和河馬間的親緣關係比羊和藍鯨，或河馬和藍鯨間的親緣關係要接近

Regions 1 and 2 show the same phylogenetic relationship among the three species
對三物種親緣關係的分析，使用第一段序列和使用第二段序列的結果都相同

Q. 40

The fast growing model bacterium *E. coli* (generation time = 20 min) has a single 4.6 million base pair large chromosome that can be replicated in 42 minutes from a single origin of replication.
模式生物大腸桿菌E.coli生長快速(20分鐘分裂一次)，它有單一條染色體含4.6百萬個鹼基對，從單一個DNA複製起點，在42分鐘內完成染色體複製。

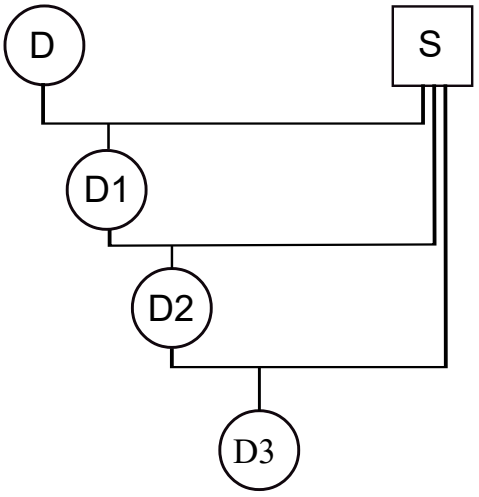
Node Id: **88f83a84e22180108473519e**

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 *E. coli, D*NA polymerase synthesizes about 900 bp/second including proof reading activity. E.coli中DNA聚合酶的作用速度約為900 bp/秒，包括錯誤鹼基修正		
An *E. coli* cell always contains two copies of its genome just prior to cell division when growing at highest possible growth rate 在最高生長速度時，一個E.coli細胞在分裂前，只含有二個染色體		
During replication, the enzyme primase forms a short RNA sequence, which is extended by DNA polymerase. This is why the genome just after replication contains multiple short stretches of RNA DNA複製時，引子酶會先合成一小段RNA，DNA聚合酶再由此RNA開始合成DNA，因此DNA完成複製後含有許多短片段RNA		
E. coli DNA polymerase III synthesizes DNA with an error rate of 1 wrong nucleotide per 1000 bases, that is why the genome after replication contains about 4600 mutations E.coli的DNA聚合酶III合成DNA時的錯誤率為1/1000，因此完成複製後會有4600個突變		

Q. 41

A plant crop is susceptible to leaf rust. In a screening of old varieties from a gene bank, a resistance allele *B* was discovered. In an intensive backcrossing program, this allele was introgressed to the crop (Fig.). Resistance was tested in each generation.
有一種農作物容易感染葉銹病，育種家從保存的的古老品種中篩選出一個抗病等位基因B。透過密集的回交育種(如圖)，這個等位基因已經被引入到栽培種作物，在每一回交世代都有檢測抗病性



Intensive breeding program. D is donor of a dominant resistance allele B, and b is the allele in the standard crop plant being susceptible to rust. S is the variety into which gene B is introduced
密集的回交育種：*D*是顯性抗病等位基因*B*的提供品種，*b*是原栽培種中對葉銹病敏感的等位基因，*S*是接受等位基因*B*的原栽培種

Node Id: **2ea7a15cad82b1ac3e9f72e4**

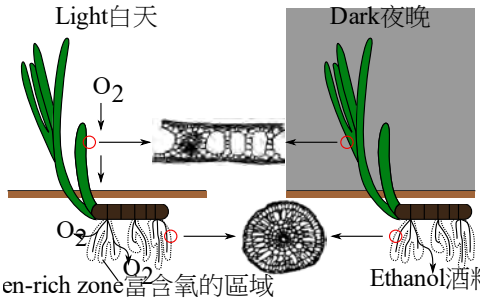
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤

	TRUE 正確	FALSE 錯誤
93.75% of the alleles, not linked to allele B, in D3 come from S D3內不和B等位基因連鎖的基因中有93.75%來自S	○	○
At least 10 backcrossings are needed to get the percentage of D genes below 1% 至少需要10次回交才能將D基因組所佔的比例減到1%以下	○	○
More crosses are needed to introgress a recessive resistance allele than a dominant one 若要引入隱性等位基因，則須做比引入顯性等位基因更多次的雜交	○	○

Introgression cannot be done with quantitative traits
等位基因引入不適用於數量性狀

Q. 42

Eelgrass (*Zostera marina)* is a submerged marine plant. During the daytime, O_2 is transported via the aerenchyma of the green parts and rhizomes out into the roots, and an oxygen-rich zone develops in the surrounding anoxic sediment. At nighttime it is a different story: now ethanol diffuses out of the roots and into the sediment (Fig.).
鰻草(Zostera marina)是一種沉水的海草。在白天，O_2從綠色部分及根莖的通氣組織傳到根部，在周圍無氧的沉積物環境中形成一個富含氧的區域。在晚上則不同，酒精會從根擴散出來，送到沉積物環境中，如圖所示。



Eelgrass at day and night, and cross-sections of leaf and root.
白天與夜晚時的鰻草，以及葉片與根的橫切面

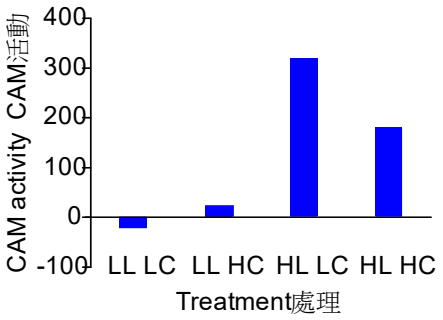
Node Id: **24a6329f0f60143c9dfd41ca**

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
For respiratory reasons, Zostera roots are expected to have a thin epidermis 由於根需要呼吸，故鰻草根的表皮薄。	○	○
Both at day and night, O_2 readily diffuse into the roots 不論在白天或夜晚， O_2都會擴散至根。	○	○
Root uptake of nutrients is independent of time of day 根吸收營養的情形不受一天的時段區分影響	○	○
At nighttime, the concentration of Na^+ is expected to decrease in root cells 在夜晚，根細胞中的Na^+濃度會降低	○	○

Q. 43

Crassula helmsii is a succesfull aquatic plant with CAM photosynthesis. In a cross-factorial study, including 2 light levels: LL and HL; and 2 CO_2 levels: LC and HC, the CAM activity of *C. helmsii* was measured (Fig.).
景天科植物(Crassula helmsii)是一種利用CAM光合作用途徑的成功水生植物。以下研究探討不同環境因子的交互影響，包括測量在2種光強度(LL和HL)以及2種CO_2含量(LC和HC)下的CAM活動。



CAM activity measured as dry matter production in plants. LL and HL = low and high light, resp. LC and HC = low and high CO_2, resp. (from Klavsen & Maberley 2010).
以測量植物的乾重生產量作為*CAM*活動，*LL*和*HL*分別代表低光照和強光照；*LC*和*HC*分別代表低和高CO_2含量。

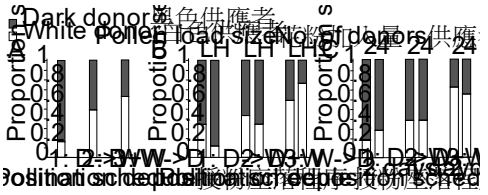
Node Id: **7d296ef53c05d76296b686ed**

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
CAM seems to be an adaptation to survive in waters rich in carbon 在富含碳的水中，CAM似乎對物種存活更有利。	○	○
The circadian stomatal opening rhythm of CAM plants enables them to take up CO_2 at nighttime CAM植物的氣孔打開之節律性使他們能在晚上吸收CO_2。	○	○
CAM increases nighttime photorespiration CAM增加夜晚的光呼吸作用。	○	○
At LL, there is less dry matter production, because CAM plants also require light for photosynthesis 在低光照下，沒有乾重生產量，是因為CAM植物也需要光來行光合作用。	○	○

Q. 44

Plants compete as pollen donors for siring offspring, i.e. becoming fathers. The stigma becomes an arena, where pollen donors/fathers “fight” for fertilization (paternity), and where the females ”choose” fathers of their seeds. This was studied in the plant Purple Chinese Houses (*Collinsia heterophylla*) (Fig.).
植物會彼此競爭成為花粉供應者以產生後代(也就是當父親)。柱頭因此成為花粉供應者/父親為父權(paternity)而”戰”的競爭地，而雌性則可選擇其所生成的種子的父親。下圖為利用Purple Chinese Houses (Collisina heterophylla)的研究結果。



Proportion of seeds sired by either a dark (D) or a white pollen donor (W): A, pollen deposited on stigma in succession (1: D → W, i.e. first D and then W, or 3: W → D) or simultaneously as a mixture (2: D + W); B, size of deposited pollen load (D and W added simultaneously): L and H = low and high pollen load, respectively; and C, two or four donors (i.e. first 2D and then 1–2 days later 2W or vice versa) (from Lankinen & Madjidian 2011).
來自黑色花粉*(D)*或白色花粉*(W)*所產生的種子比例*:*圖*A*為花粉落在柱頭上的次序*(1: D→W*代表先*D*再*W*；或是*3: W→D)* 或是同時混合兩種花粉*(2: D+W)*。圖*B*為加入的花粉量多寡*(D*和*W*同時加入*)*，*L*和*H*分別代表少量和大量的花粉。圖*C*為*2*個或*4*個花粉供應者*(*亦即先*2D*，*1-2*天之後再*2W*，反之亦然*)*。

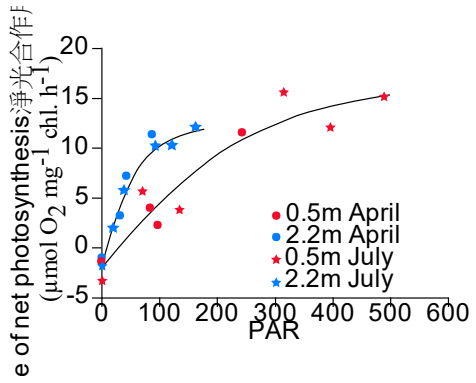
Node Id: **d8e81b656584cca9b5bde84b**

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
There is a first-donor advantage 在此有第一花粉供應者優先的優勢	○	○
No competitive effect of high pollen load is observed 大量花粉加入並沒有競爭上的優勢效果	○	○
Increase in number of fathers increases competition 若增加父親數目，則競爭也會增加	○	○
If lots of pollen from the first donor is deposited, pollen added 2 days later from a second donor does not sire seeds 如果第一花粉供應者加入的花粉量多，則2天後再加入的第二花粉供應者並不會結出種子。	○	○

Q. 45

The relationship between light intensity and net photosynthesis rate (NPR) was measured in the submerged plant *Crassula helmsii* in a lake. The plant has CAM photosynthesis. Measurements of the photosynthetic rate (µmol O_2 mg-1 chlorophyll h^{-1}) were made on plants growing in shallow water (6.5 mg chlorophyll/g dry weight) and deep water (10.3 mg chlorophyll/g dry weight) in April and July (Fig.).
測量景天科植物(Crassula helmsii)的光照強度與淨光合作用速率(NPR)，以探討兩因子間的關係。此植物是一種生長在湖中的沉水性植物，其利用CAM光合作用途徑。測量光合作用速率 (µmol O_2 mg-1 chlorophyll h^{-1}) 在四月和七月期間生長在淺水的植物樣本(其每克乾重中含有6.5 mg 葉綠素)，以及在深水的植株(其每克乾重中含有10.3 mg 葉綠素)，結果如下圖。



Light response curves in April and in July for C. helmsii, growing in shallow (0.5 m) and deep (2.2. m) water. PAR photosynthetically active radiation (from Klavsen & Maberly 2009).
測量生長在淺水*(0.5*公尺*)*及深水*(2.2*公尺*)*區的植株樣本，在四月和七月期間對光的反應曲線。*PAR*代表光合作用活化之光強度。

Node Id: **6792958f72dfbd24b17c15ba**

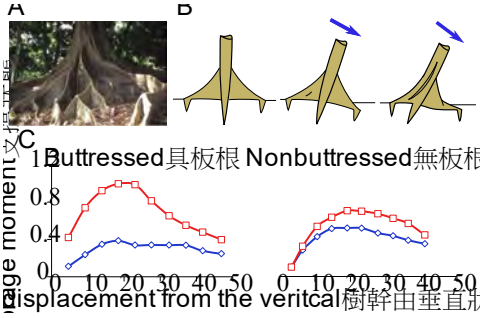
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤。

	TRUE 正確	FALSE 錯誤
Shallow-water plants have higher NPR at 100 PAR than deep-water plants 在100 PAR時，淺水區的植物比深水區有較高的NPR。	○	○
Deep-water plants have higher NPR in July than in April 深水區植物在七月時的NPR較四月時高	○	○
In the experiment, NPR is light limited 本實驗中，NPR受光限制。	○	○
Deep-water plants have a higher NPR because of their higher chlorophyll content	○	○

深水區植物有較高的NPR是因為其有較多的葉綠素含量。

Q. 46

Some trees have large triangular, superficial lateral roots called buttresses (Fig. A). Their functions are widely discussed, but poorly understood. They are more common on trees with an asymmetrical crown; they may prevent windfall (Fig. B); presence of buttresses may also depend on soil type and inclination, and wood density. Their stabilizing importance was tested experimentally (Fig. C).
有些樹木具有大型三角形、露出地面上的支根稱為板根(圖A)。其功能雖受廣泛討論，但仍鮮少被了解。板根通常出現在具有不對稱樹冠層的樹木，可避免被風吹倒(圖B)；板根的出現也可能與土壤種類、樹木在斜坡生長以及樹木密度有關。在此測試板根的穩固重要性(圖C)。



A, tree with buttress roots; B, a tree with buttresses and vertical tap root pulled over by wind (blue arrow is direction of wind); C, an experimental study of change in anchorage moment for buttressed (left) and non-buttressed trees (right) as a function of the tree's displacement from vertical (inclination in degrees): red squares are for trees with an intact root system, and blue diamonds for trees, in which all lateral roots (including buttresses, but excluding vertical tap root)) have been cut off (from Crook et al., 1991).
圖*A*為具板根樹木；圖*B*為具板根樹木但其垂直軸根被風吹而拔起*(*藍色箭頭代表風吹的方向*)*；圖*C*為實驗測試板根樹木*(*左側*)*和無板根樹木*(*右側*)*的支撐狀態*(anchorage moment)*之變化，作為樹木從垂直轉為傾斜程度*(*以斜角度數表示*)*的功能觀測。紅色方形者為具有完好根系的樹木，藍色菱形者為去除所有支根*(*包括板根*)*但保留垂直軸根的樹木。

Node Id: **af14e09255d0045294f5568e**

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
Buttresses of a tree help to increase the resistance of the tree to wind 樹木的板根有助於增加樹木對風吹的抵抗力。	○	○
The tap root is relatively more important to anchorage in buttressed than in non-buttressed trees	○	○

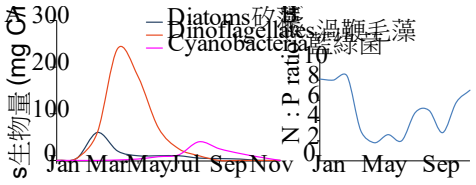
相較於無板根樹木，有板根樹木的軸根對支撐力而言，較為重要。

The smallest vessels and lowest vessel frequency are found in the parts of the tree, such as buttress roots, subjected to greatest mechanical stress
在樹木中，導管口徑最小且導管出現率最低的部位 (例如板根)，受到最大機械壓力的影響。

Understorey trees growing below the canopy layer in a rainforest rarely have buttresses
在雨林下層，生長在樹冠層下方的樹木鮮少有板根。

Q. 47

Countries around the Baltic Sea have agreed to reduce the outlet of nutrients in drainage water, especially N. In a study, growth of diatoms, N-fixing cyanobacteria and dinoflagellates was monitored together with the seawater N: P ratio to estimate the effects of outlet reduction. Optimum N: P ratio for growth in the three groups is approximately 7.
波羅的海周圍的國家同意減低其輸出之地下汙水所含營養鹽的量，特別是氮素。在研究中，矽藻、可固氮的藍綠菌和渦鞭毛藻三群生物在不同氮磷比的海水下生長情形，以評估汙水輸出減量的效果。 此三群生物的最適生長的氮磷比約為7。



Annual variation in biomass of the three study groups (A) and seawater N: P-ratio (B) (from FF 1998).
圖A為三個生物群的生物量之年變化，圖B為海水的氮磷比年變化。

Node Id: **98b0ae0182f4fbccebc41c3c**

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 limiting factor for diatoms during the winter (January–March) is N 矽藻在冬天(一月至三月)的限制因子為氮素。		
The limiting factor for phytoplankton during the summer (June-Aug.) is P 浮游生物在夏天(六月至八月)的限制因子為磷。		

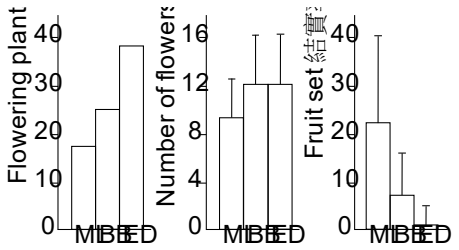
Less N from drainage water will, in particular, reduce growth of cyanobacteria
地下水中的氮鹽愈少，特別會降低藍綠菌的生長。

Autotrophic dinoflagellates begin to increase dramatically in number in early spring (March), because of their mobility

自營性的渦鞭毛藻數量在早春(三月)時會急遽上升，是因為其移動能力。

Q. 48

Some plants deceive their pollinators by emitting odours, mimicking rotten flesh or dung. Such plants are pollinated by carrion and dung flies. This phenomenon is common among orchids, e.g. *Bulbophyllum variegatum*, three populations (ML, BB and ED) of which were studied at three different locations on the island of Réunion (Fig.).
有些植物藉由釋出味道、模擬腐肉或糞便，來欺騙它的傳粉者。這些植物是由食肉及糞便的蠅類傳粉。此現象常見於例如豆蘭屬(Bulbophyllum variegatum)的蘭花，在 Réunion島的三個不同樣區進行研究，結果如下圖所示。



Reproductive data from populations ML, BB and ED (from Humeau et al. 2011).
蘭花的三個族群*(ML、BB及ED)*的生殖數據

Node Id: **44c4b04d83ae3565bbb82078**
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
Number of fruits produced per plant is higher in BB than in ML and ED 三個族群中，植株平均產生果實的數目(包括開花及未開花的植株)在BB族群最高。		
Compared to ML and BB, fruit set in ED may have severe pollinator limitation 相較於ML和BB兩族群，ED族群的結實量嚴重受到傳粉者的		

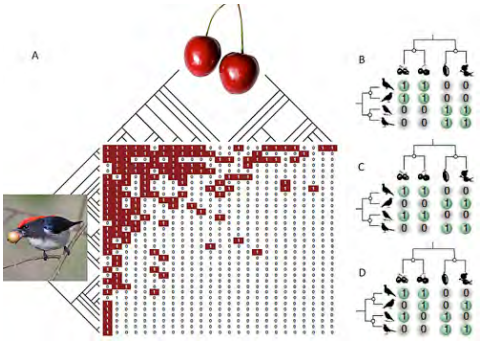
限制。

Compared to ED and BB, ML may be a neighbour to cattle pastures
相較於ED和BB兩族群，ML族群可能鄰近牛隻畜牧場。

Compared to ED and BB, ML may be a relatively young population
相較於ED和BB兩族群，ML族群可能是相對較為年輕

Q. 49

Plants interact with animals, and within a habitat, entire plant and animal communities form complex interaction networks. One important class of plant–animal networks is between fruit-eating birds and plants with fleshy fruit (Fig.). Observed interactions are partly determined by plant traits, but many other factors may be in play, e.g. the phylogenetic history of species communities.
植物與動物會有交互作用。在某一棲地中，整個植物與動物群集形成複雜的交互作用網絡。在這些植物-動物網絡中，重要一類是食果鳥類與具多肉果實的植物(圖)。針對一種鳥在吃一特定植物果實的交互作用，其交互作用的觀察可一部分由植物特徵決定，但尚有許多其他因子與其交互作用有關聯，例如物種群集的系統發生歷史。



A, interaction matrix between fruit-eating bird species (rows) and fleshy-fruited plant species (columns). Each '1' is an observed interaction, and each '0' is no interaction. The phylogenies of the communities of birds and plants are included; B–D, small artificial networks showing various interaction pattern (from Jordano 2010).
圖*A*為食果鳥類*(*列*)*與具多肉果實的植物*(*欄*)*的交互作用矩陣，每個*"1"*代表觀察到的交互作用，*"0"*則代表沒有交互作用。鳥類及植物的親緣關係樹分別置於矩陣的兩側。圖*B-D*為小型的人為交互作用網絡，顯示不同交互作用模式。

Node Id: **4d49abef2915934f5e05333d**

Indicate if any 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 bird community has many food generalists, but only few specialists
鳥類群集有許多廣食性者，但僅有少數幾個專一食性者

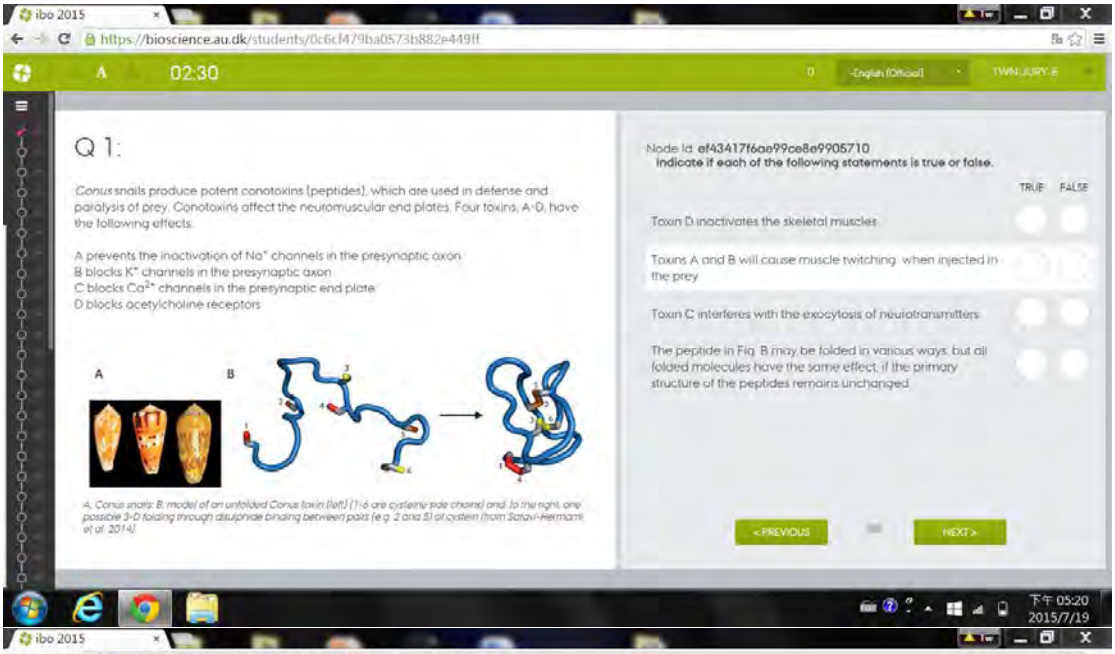
The plant community has many fruit consumer specialists, but only few generalists
植物群集含有許多特殊取食果實之消費者，但僅有少數幾個廣食性者

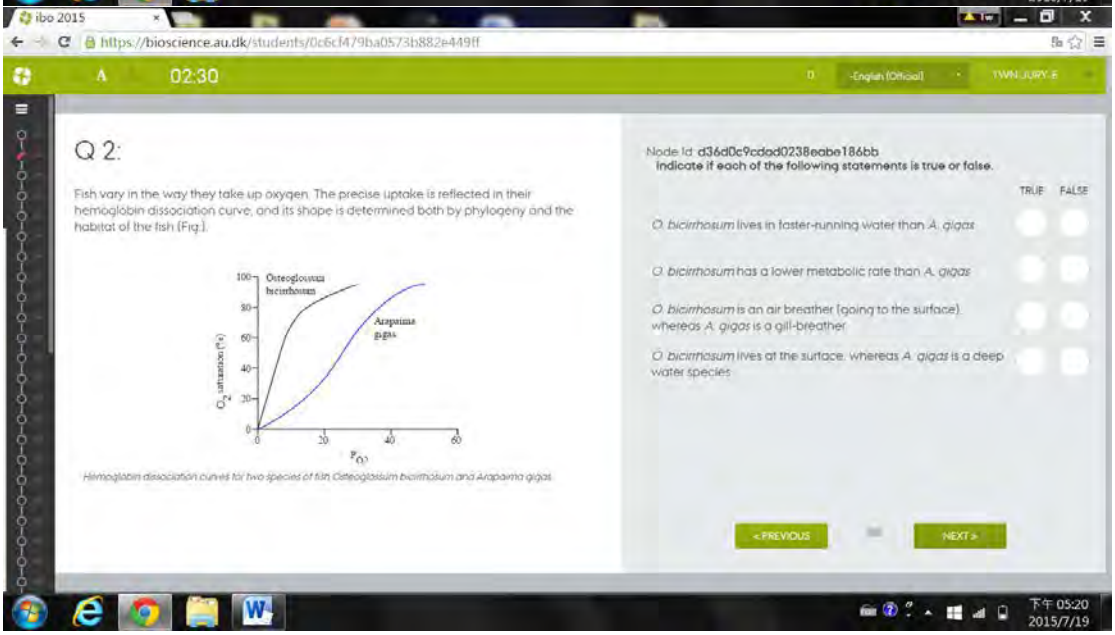
Phylogenetic relatedness is an important driver of interactions in network B
演化親緣關係之遠近是影響網絡B中互作用的重要因子。

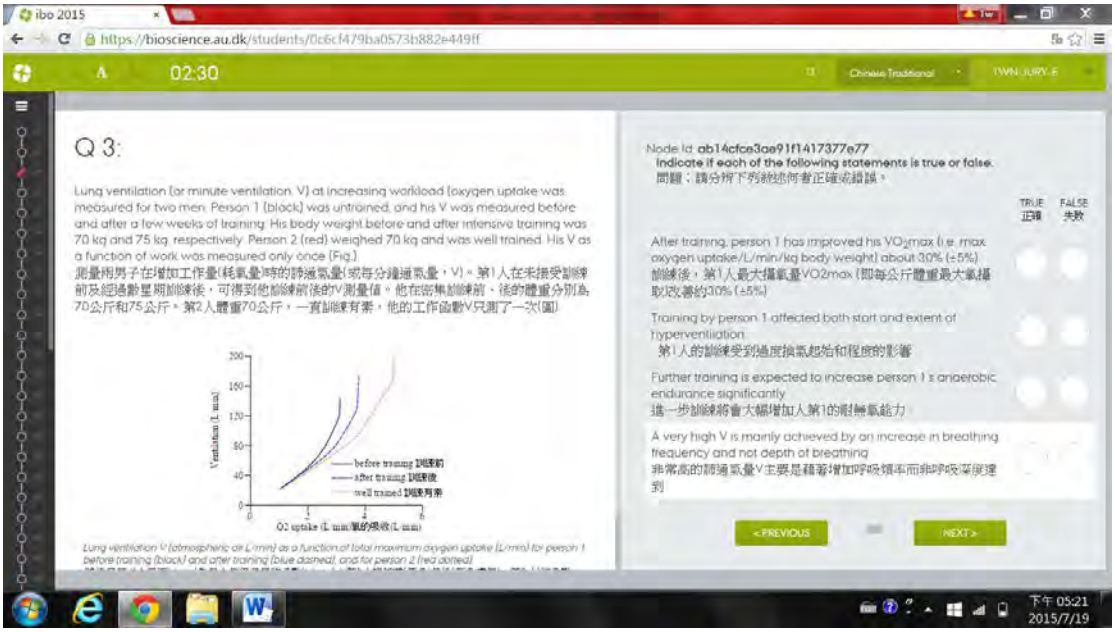
Closely related birds reduce food overlap more in network C than in network D
相較於網絡D，網絡C中親緣相近的鳥類較會降低其攝取食物的重疊性。

END 結束

IBO 2015 理論 2 圖







ibo 2015

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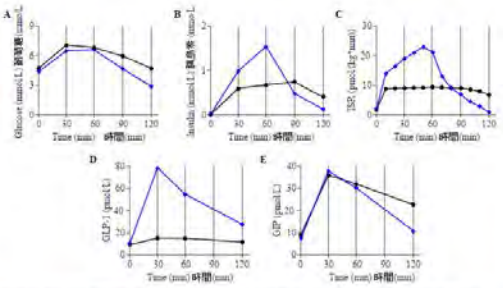
A 02:30 Chinese Traditional TWIN_JURY_F

Morbid obesity can be treated surgically by a gastric bypass, where a part of the stomach and the proximal part of the intestine are bypassed. A group of obese individuals were enrolled in a study, in which their glucose and hormone levels were measured after an ingestion of glucose before and after gastric bypass surgery (Fig.).
病態肥胖可用胃繞道手術治療，藉以繞過胃的一部分與腸的近端部分。一組肥胖患者參加本研究，分別在胃繞道手術的前後測量了他們攝取葡萄糖後血糖和激素的高低(圖)。



Effects of a glucose ingestion at time = 0 on the level of various parameters. Black circles indicate levels before gastric bypass, and blue diamonds indicate levels 3 months after gastric bypass. A, glucose level. Fig

Node Id: 28a81c3225a8ba1eaf9b315c
問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
Gastric bypass leads to a stronger and shorter insulin response to an increased glucose level 胃繞道手術導致對血糖的升高有更快速，更強烈，更短暫的胰島素釋放反應		
From the study, GIP is expected to induce insulin secretion 從該項研究得知，GIP會誘導胰島素的分泌		
Change in GLP-1-level after gastric bypass surgery may explain the faster increase in ISR 胃繞道手術後，GLP-1高低的改變可解釋ISR的快速增加		
Blocking the effect of GLP-1 might be an efficient way to treat diabetes 阻止GLP-1的影響可作為糖尿病治療的有效途徑		

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下午 05:21
2015/7/19

ibo 2015

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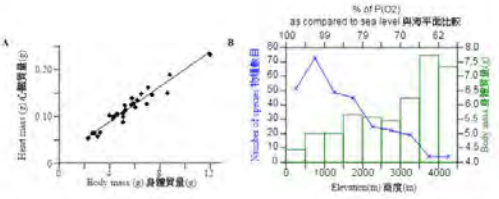
A 02:30 Chinese Traditional TWIN_JURY_F

Partial atmospheric oxygen pressure PO2 and ambient temperature decrease with increased elevation above sea level. This affects the respiratory physiology and species richness of many animal groups, e.g. hummingbirds (Fig.). An important physiological feature of hummingbirds is their ability to enter torpor, a state of reduced physiological activity, to save energy.
大氣氧分壓PO2及環境溫度均會因海拔高度的增加而降低，此效應會影響許多動物群的呼吸生理及物種豐度，如蜂鳥(圖)。蜂鳥有個重要的生理特點，能進入冬眠(生理活性降低的狀態)而節省能源。



A, relationship between heart mass and body mass of hummingbird species. B, average body mass (grams) per 500 m altitudinal zone (histogram, right Y-axis) and number of species of hummingbirds (x-x-line, left Y-axis) at different elevations (lower X-axis). The percentage of partial oxygen pressure compared to sea level is also given (from Altshuler & Dudley 2002).
A. 蜂鳥物種心臟及身體質量的關係 B. 每500公尺海拔區(長條圖，右邊Y軸)蜂鳥的平均體重(克)與不同海拔(下方X軸)物種數目(x-x線，左邊Y軸)的關係。及相對於海平面PO2分壓高方的百分比。

Node Id: a8f83b90abe197c6969f75c5
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
Daily decreased physiological activity is common in montane hummingbirds 每日生理活動的減少常見於山區的蜂鳥		
Above 500 m, diversity of hummingbirds is negatively correlated with height above sea level 在500公尺以上，蜂鳥多樣性與海拔高度呈負相關		
The heart mass is negatively correlated to the partial pressure of oxygen 心臟質量與氧分壓呈負相關品質		
Hummingbird wing load (body mass/wing area) declines with altitude 隨海拔高度增加，蜂鳥翼荷載(身體質量/鳥翼面積)減少		

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2015/7/19

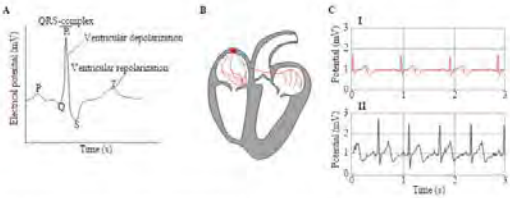
ibo 2015

https://bioscience.au.dk/students/0c6cf479ba0573b882e449ff

A 02:30 Chinese Traditional TWIN_JURY_F

Q 6:

An important function of an electrocardiogram (ECG) is to give information about the general health of a person. The ECG of two students was compared (Fig. C).
心電圖(ECG)的重要功能之一，是給我們一般性的健康資料。比較兩學生的心電圖(圖C)。



A, schematic representation of a standardized ECG. B, a snapshot of a heart with activated innervations in red pictured as if facing the student. C, electrocardiograms of two young male students (I and II) measured over 3 seconds.
A. 標準化心電圖ECG的示意圖；B. 如面向學生的一張心臟快照圖，神經興奮的分布用紅色表示；C.兩位年輕男生(標示的心電圖，測定時間超過3秒。

Node Id: 726eed8010bd83991e915ee4
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
Blood flows from the right ventricle to the lungs, to the left atrium, to the left ventricle, to the body, and back to the right atrium 血液從右心室流到肺部、左心房、左心室、身體各部，回到右心房		
Students I has a heart rate of 80 beats/minute 學生I的心搏率為80次/分		
If the stroke volume of student 1 is 70 mL/beat, then his cardiac output will be about 4.4 L/minute 若學生I的每跳搏出量是70毫升/次，他的心輸出量約為4.4 L/分鐘		
The heart in fig. B is at the R peak 圖B中的心臟在是在R峰期		

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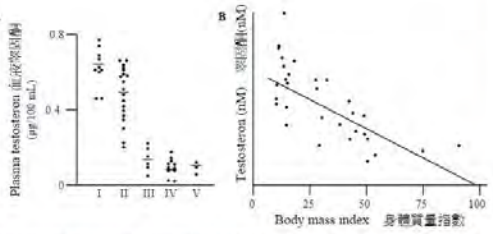
A 02:30 Chinese Traditional TWN_JURY_E

Q 7:

Variation in testosterone levels has major effects on general male physiology. Concentration of testosterone was measured in blood plasma from five groups of men (Fig.).
睾固酮的濃度變化會影響男性的生理健康。今測定在五組的男人血液中睾固酮濃度(圖)



Indicate if each of the following statements is true or false A: plasma level of testosterone in I. Males 16-43 years old. II. Males 44-92 years. III. Males with underdeveloped pituitary glands. IV. Males with removed testes

Node Id: 886c017d4ab143e49729d010
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
Males-IV have reduced testosterone level due to negative feed-back regulation 因為負回饋調節，男性-IV的睾固酮濃度會降低		
Males-IV have a high LH concentration compared to Males-I 與男性-I相比，男性-V的LH濃度較高		
Estrogen injections in males lead to very low concentrations of LH 在男性注射雌激素會導致非常低的LH濃度		
Even mild obesity (25<BMI < 30) might be much more important to testosterone level than higher age (> 43 years) 即使輕度肥胖(25< BMI < 30)對睾固酮濃度影響都可能比高齡(> 43歲)更重要		

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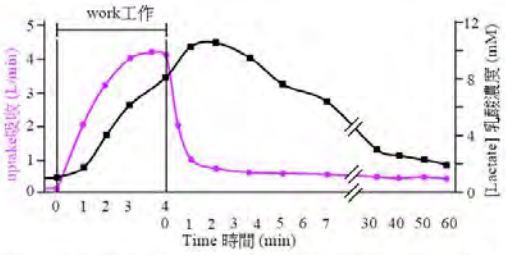
https://bioscience.au.dk/students/0c6cf479ba0573b882e449ff

A 02:30 Chinese Traditional TWN_JURY_E

Oxygen uptake and lactate concentration in the blood were measured in a 70 kg male person before, during and after he had exercised (worked) for 4 minutes. The intensity of the exercise (work) corresponded to the consumption of 5 L oxygen/min.
在一位70公斤男性運動(工作)4分鐘之前、期間、之後，分別測定他血液中的氧攝取和乳酸濃度。運動(工作)的強度是對應在5L氧消耗/min。



Changes in oxygen uptake (purple, left Y-axis, L/min) and lactate concentration (black, right Y-axis, mM lactate in blood) before, during and after an exercise or work period of 4 min.
有氧量(紫色，左縱Y軸，L/min)及乳酸濃度(黑色，右縱Y軸，mM血液中乳酸)在運動(工作)4分鐘前、中、後的變化。

Node Id: e0d7faa0595a12a96eac5b67
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 person cannot work for 4 min at intensities equal to 5 L O_2-uptake/min, as his maximum aerobic work capacity is 4.2 L/min 他不可能在5L O_2-吸收/min強度下工作4分鐘，因他的最大有氧工作能力是4.2 L/min		
The person has an aerobic capacity of 60 ml O_2/(kg min) 他的有氧代謝能力為60 ml O_2 /(kg min)		
When blood lactate exceeds 11 mM, excretion begins through the kidneys, which is why its concentration declines 當血乳酸值超過11 mM/L時，腎臟開始排泄乳酸，這是濃度會下降的原因		
Excess O_2-uptake after the end of work is partly due to metabolism of lactate and not to gluconeogenesis 工作結束後過多的O_2吸收，部分是因乳酸代謝而非因糖質新生作用		

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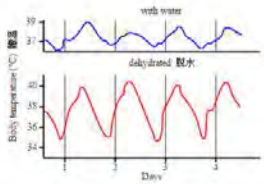
ibo 2015

https://bioscience.au.dk/students/0c6cf479ba0573b882e449ff

A 02:30 Chinese Traditional TWN_JURY_E

Q 9:

Camels are well adapted to desert life. Their hump consists mainly of fat, especially tripalmitin ($C_{51}H_{98}O_6$). A dehydrated camel's body temperature may vary from 34.5° C at night to 40.5°C during day.
駱駝非常適應沙漠生活。駝峰中主要為脂肪，特別是三棕櫚精($C_{51}H_{98}O_6$)。駱駝脫水時的體溫變化大，可能從晚上34.5°C到白天的40.5°C。



Body temperature of a dehydrated (red) camel compared to one well supplied with water (blue) (from Schmidt-Nielsen et al. 1957)
脫駝脫水時的體溫與給水充足駱駝體溫的比較

Node Id: 5bb62e61399d43821f9bf8f5
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 respiration of 1 kg tripalmitin will provide the camel with more than 1 liter of water (molar mass for C = 12, H = 1, O = 16) 假設駝峰中所有的脂肪都是三棕櫚精，1公斤三棕櫚精經呼吸作用可提供超過1升的水與駱駝(摩爾質量C = 12, H = 1, O = 16)		
The respiratory quotient of tripalmitin (CO_2 eliminated/O_2 consumed) is 1.4 三棕櫚精(CO_2 消除/O_2 消耗) 呼吸商是 1.4		
During the day, a 500 kg dehydrated camel accumulates 2000 kcal of heat in its body (about 0.9 cal is required to increase one gram of tissue 1°C) 在白天，500公斤脫水的駱駝體內可積累2000千卡的熱量(使一公克的組織增加1°C約需0.9 cal)		
To keep a constant body temperature, a camel would need		

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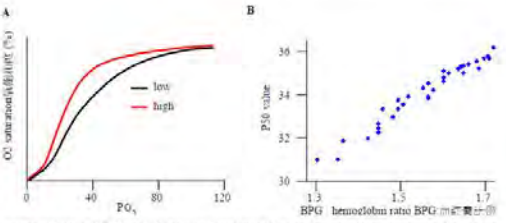
Deer mice have a wide geographic range, e.g. with respect to altitude. This is partly explained by their respiratory physiology (Fig.1).
從海拔高度的角度來看，鹿鼠的地理分布範圍廣泛。部分原因可歸功於其呼吸生理(圖)



A, oxygen saturation (%) of blood of deer mice from low and high altitude habitats as a function of the partial pressure of atmospheric oxygen PO_2. B, P50 is the partial PO_2 at which the blood is 50% O_2-saturated, here plotted against the BPG (2,3-bisphosphoglycerate) : hemoglobin ratio. BPG affects the oxygen affinity of hemoglobin (from Tufts et al. 2013).
A. 低及高海拔棲地之鹿鼠血液中的氧飽和度(%)與大氣壓分壓PO_2的函數關係；B. P50是血液中有50% O_2飽和時的PO_2，這裡將BPG (2,3-二磷酸甘油酸):血紅素的比例作圖。BPG會影響血紅素對氧的親和力)

Node Id: 0ce8df0b25bf93ab53199948
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
Hemoglobin in high-altitude deer mice does not release oxygen as easily as compared to that low-altitude mice. 高海拔鹿鼠的血紅素釋放氧到體組織，會比低海拔鹿鼠的困難	○	○
High-altitude mice have lower P_{50} than low-altitude mice. 高海拔鹿鼠的P50比低海拔鹿鼠的低	○	○
If BPG concentration in blood increases, the saturation curve in Fig. A will shift to the right. 如果血液中的二磷酸甘油酸濃度增加，在圖A中的飽和曲線將向右移動	○	○
Assuming that adaptation to altitude is genetically determined, P_{50} values will most likely remain the same if a mouse is transferred to another altitude. 假設高度的適應是由基因決定，如果將一隻鹿鼠移置到另一個高度，P50值很可能保持不變	○	○

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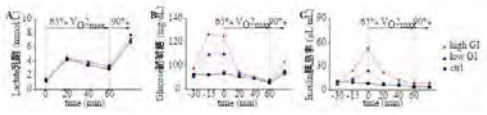
The effect of consuming foods, which varied in their glycemic index (GI), on prolonged exercise were studied. GI expresses the effect of a particular type of food on a person's blood glucose level. At start of test, each person either got 1) Control, i.e. water (black squares), 2) LGI, i.e. a low GI meal + water (blue triangles), or 3) HGI, i.e. a high GI meal + water (red circles). Afterwards, each person rested, then cycled for 1 hr at 65% of her VO_{2max}, and finally at 90% VO_{2max} until exhaustion. Blood samples were taken before and during tests to measure levels of lactate, glucose and insulin (Fig.).
針對運動時間過長者的消耗食物作用進行研究，已知其升糖指數(GI)會有差異。GI可表現出某特定食物類型對人的血糖濃度的作用。在實驗初期，受測者分別被予(1)水，作為控制組、(2)低GI的食物和水，作為LGI，或(3)高GI的食物和水，作為HGI。接著讓受測者休息，然後以其最大耗氧量(VO_{2max})的65%騎1小時的腳踏車，最後提高至90%直到耗盡體力。在實驗前以及實驗過程中，抽取受測者的血液以測量乳糖、葡萄糖及胰島素的含量。



Levels of lactate a), glucose (B) and insulin in blood (C) before (pre-exercise) and during test. Each curve represents a treatment (red circles: high GI, blue triangles: low GI, black squares: control) (from Jamurtas et al. 2011)
三個分別為在實驗前以及實驗過程中所測血液的(A)乳酸、(B)葡萄糖、(C)胰島素含量變化。每個曲線代表一個處理。

Node Id: 6dfd55e297a7ba33c5dc6d14
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
At the time of exhaustion, O_2 uptake was sufficient for complete metabolism. 體力耗盡時，氧氣的吸收足以完成代謝	○	○
The level of lactate in the blood during exercise is influenced by the diet. 在運動期間，血液中的乳酸含量會受食物類型影響	○	○
Final test result at the time of exhaustion seems to be significantly affected by the kind of diet. 最後在體力耗盡時所測的結果似乎會明顯受到食物類型的影響	○	○
The observed increase in blood glucose at the last phase at 90% VO_{2max} is due to an increase in fat metabolism and a reduced use of glucose. 在最後的90% VO_{2max}階段，觀察到血糖上升，是由於脂肪代謝增加以及葡萄糖利用下降之故。	○	○

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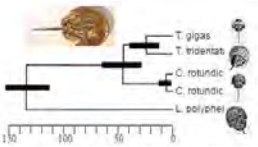
Horseshoe crabs are marine and only four extant species are known, while many have gone extinct. *Tachypleus gigas* (Tg), *T. tridentatus* (Tt) and *Carcinoscorpius rotundicauda* (Cr) are from southeast Asia, whereas *Limulus polyphemus* (Lp) lives on the east coast of N America. Tg and Cr overlap in their geographic range (from Andaman Sea (close to Thailand and Malaysia) to the South China Sea). Tt lives from Vietnam to Japan. Horseshoe crabs are "living fossils".
鱟魚為海生且現存物種僅有4種，其餘皆已滅絕。Tachypleus gigas (Tg), T. tridentatus (Tt)和Carcinoscorpius rotundicauda (Cr)生長在東南亞，而Limulus polyphemus (Lp)生長在北美洲的東海岸。Tg和Cr兩種的地理分布有重疊(從安達曼海至南中國海)，Tt的生長範圍從越南至日本。鱟魚是"活化石"。



Phylogeny of extant horseshoe crabs. The unit of scale is a million years. Black bars indicate 95% confidence interval. The two populations of Cr are from Andaman Sea and Thailand (from Obst et al. 2012).
現存鱟的親緣關係圖，比例尺的刻度為一百萬年，黑色粗條線代表95%的信賴區間，Cr的兩個族群分別採自安達曼海及泰國。

Node Id: e91c4c7e02fb5c07ed094b4f
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
From the Fig., we can conclude that horseshoe crabs must be a slowly evolving group. 從上圖可歸納出: 鱟魚應該是演化緩慢的類群。	○	○
According to Fig., the Asian species constitute a monophyletic clade. 根據上圖，亞洲種類構成一個單系群。	○	○
Speciation in horseshoe crabs seems to take between 5 and 45 million years. 鱟魚的種化似乎發生在5-45百萬年期間。	○	○
The genera *Tachypleus* and *Limulus* are sister taxa. Tachypleus 和Limulus兩屬鱟為姊妹群。	○	○

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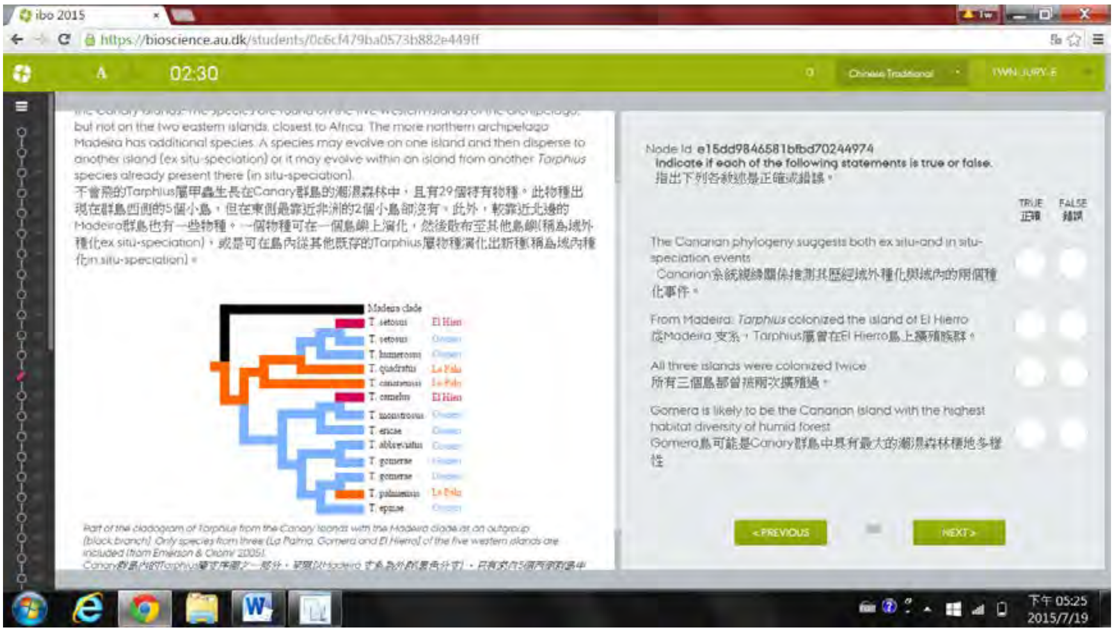
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but not on the two eastern islands, closest to Africa. The more northern archipelago Madeira has additional species. A species may evolve on one island and then disperse to another island (ex situ-speciation) or it may evolve within an island from another Tarphius species already present there (in situ-speciation).
不會飛的Tarphius屬甲蟲生長在Canary群島的潮濕森林中，且有29個特有物種。此物種出現在群島西側的5個小島，但在東側最靠近非洲的2個小島卻沒有。此外，較靠近北邊的Madeira群島也有一些物種。一個物種可在一個島嶼上演化，然後散布至其他島嶼(稱為域外種化ex situ-speciation)，或是可在島內從其他既存的Tarphius屬物種演化出新種(稱為域內種化in situ-speciation)。
Madeira clade
T. setosus
El Hierro
Node Id: e15dd9846581bfbd70244974
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 Canarian phylogeny suggests both ex situ-and in situ-speciation events
Canarian系統親緣關係推測其歷經域外種化與域內的兩個種化事件。
From Madeira: Tarphius colonized the island of El Hierro
從Madeira 支系，Tarphius屬曾在El Hierro島上擴殖族群。
All three islands were colonized twice
所有三個島都曾被兩次擴殖過。
Gomera is likely to be the Canarian island with the highest habitat diversity of humid forest
Gomera島可能是Canary群島中具有最大的潮濕森林棲地多樣性
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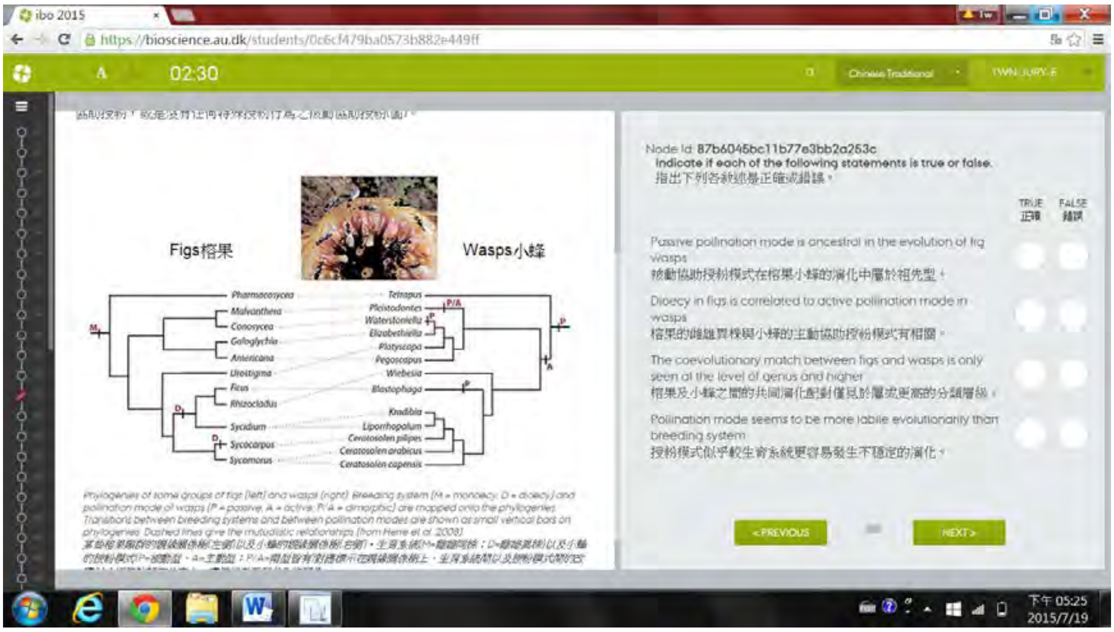
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Figs榕果
Wasps小蜂
Node Id: 87b6045bc11b77e3bb2a253c
Indicate if each of the following statements is true or false.
指出下列各敘述是正確或錯誤。
TRUE 正確
FALSE 錯誤
Passive pollination mode is ancestral in the evolution of fig wasps
被動協助授粉模式在榕果小蜂的演化中屬於祖先型。
Dioecy in figs is correlated to active pollination mode in wasps
榕果的雌雄異株與小蜂的主動協助授粉模式有相關。
The coevolutionary match between figs and wasps is only seen at the level of genus and higher
榕果及小蜂之間的共同演化配對僅見於屬或更高的分類層級。
Pollination mode seems to be more labile evolutionarily than breeding system
授粉模式似乎較生育系統更容易發生不穩定的演化。
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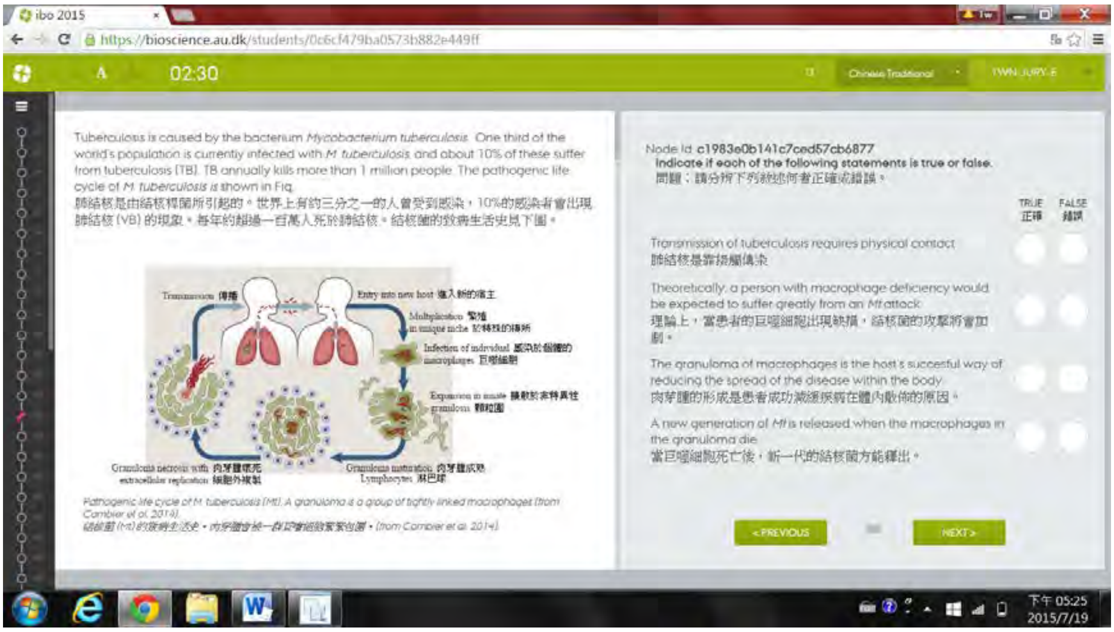
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Tuberculosis is caused by the bacterium Mycobacterium tuberculosis. One third of the world's population is currently infected with M. tuberculosis and about 10% of these suffer from tuberculosis (TB). TB annually kills more than 1 million people. The pathogenic life cycle of M. tuberculosis is shown in Fig.
肺結核是由結核桿菌所引起的。世界上有約三分之一的人曾受到感染，10%的感染者會出現肺結核 (VB) 的現象。每年約超過一百萬人死於肺結核。結核菌的致病生活史見下圖。
Transmission 傳播
Entry into new host 進入新的宿主
Multiplication 繁殖
Lymphocytes 淋巴球
Pathogenic life cycle of M. tuberculosis (Mt). A granuloma is a group of tightly linked macrophages (from Cambier et al. 2014).
Node Id: c1983e0b141c7ced57cb6877
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
Transmission of tuberculosis requires physical contact
肺結核是靠接觸傳染
Theoretically, a person with macrophage deficiency would be expected to suffer greatly from an Mt attack
理論上，當患者的巨噬細胞出現缺損，結核菌的攻擊將會加劇。
The granuloma of macrophages is the host's succesful way of reducing the spread of the disease within the body
肉芽腫的形成是患者成功減緩疾病在體內散佈的原因。
A new generation of Mt is released when the macrophages in the granuloma die
當巨噬細胞死亡後，新一代的結核菌方能釋出。
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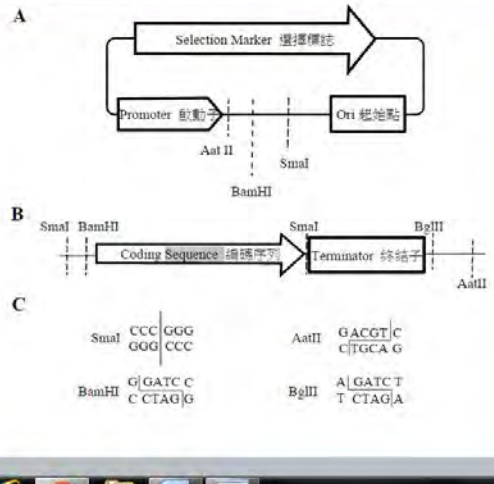

Node Id: cdcf0866ad1f29c064e802cd
Indicate if each of the following statements is true or false.
問題：請分辨下列敘述何者正確或錯誤。

	TRUE 正確	FALSE 錯誤
Digestion with SmaI followed by ligation can produce the desired recombinant plasmid. 利用 SmaI 與 接合酶可以製成所要求的重組質體。		
Digestion with AatII and BamHI followed by ligation can produce the desired recombinant plasmid. 利用 AatII 和BamHI切割後再使用接合酶可以製成所要求的重組質體。		
Digestion with BamHI + BglII followed by ligation can ptoduce the desired recombinant plasmid. 利用 BamHI + BglII 與 接合酶可以更有效的製成所要求的重組質體。		
The 'coding sequence' needs to be in-frame with the promoter. 編碼序列必須與啟動子在同一轉譯框架構。		

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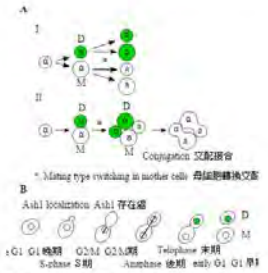
mating type (Fig.).
酵母菌 (Saccharomyces cerevisiae) 的生活史中會出現單倍體細胞，二倍體細胞，減數分裂與有絲分裂。單倍體有兩種交配型，並可進行交配型轉換。（如下圖）



A, mating-type switching in budding yeast (H, mother cell; D, daughter cell; a and α, mating types). Fig. A. I, mitosis in haploids. A. II, mating and diploid formation. B, budding in haploid yeast. Both in Fig. A and B, green filling indicates the repressor factor protein Ash1p.
A, 芽殖酵母菌的交配型轉換（H: 母細胞；D: 子代細胞，a 與α: 交配型）。圖 A I 單倍體有絲分裂，A II 交配與二倍體形成。B. 芽殖酵母菌的單倍體芽殖。在圖 A 與 B 中，綠色部分為 抑制因子蛋白 Ash1p 表現處。

Node Id: e58531c49e73d0adeaccf018
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
Mating in yeast can only take place between two different kinds of haploid cells. 酵母菌的交配只能發生在兩種不同交配型的單倍體細胞間。		
Mating-type switching occurs only in the mother cell of each haploid generation. 交配型轉換只發生在已產生單倍體子代的母細胞。		
Mating type shift is induced by the repressor factor Ash1p. 交配型轉換受抑制因子 Ash1p 誘發。		
Mating type shift of haploids and the meiosis of diploids result in maximum mixing of mating types. 透過單倍體細胞的交配型轉換和二倍體的減數分裂會產生最多交配型種類的細胞。		

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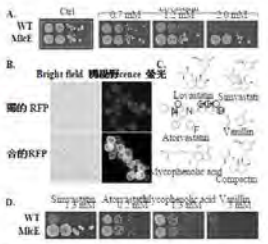
genes/enzymes that could make yeast resistant to statins.
他汀類藥物可以用於因血中膽固醇濃度過高引發心血管疾病的患者，用於降低血中膽固醇濃度治療之用。他汀類藥物會藉由競爭結合來抑制 3-hydroxy-3-methyl-glutaryl-CoA 還原酶 (HMG) 以抑制膽固醇（或麥角固醇）的生合成。HMG 酵素也存在酵母菌中，同時劇毒的他汀類藥物可以作為殺菌劑使用。本實驗的目的在找出讓酵母菌抗他汀類藥物的基因／酵素。



A. An agar plate-based experiment, where a 5-time dilution series of two yeast cell cultures (wild type (WT) and MicE expressing (MicE)) have been spotted onto agar plates containing different concentrations of the statin lovastatin. The highest cell concentration is on the left of each plate. B. Bright field and fluorescence microscopy of yeast strains expressing red fluorescent protein (RFP) alone or RFP fused with MicE (MicE-RFP), respectively. C. The chemical structure of the compounds tested in A and D. D. Plate based experiment, as described in A, testing different toxic compounds.

Node Id: 173eb96661ad154c34745e26
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
S. cerevisiae is naturally resistant to the effects of lovastatin up to 0.7 mM. 酵母菌原本對於 lovastatin 可以忍受到 0.7mM。		
MicE encodes a protein that localizes primarily to the plasma membrane. MicE 表現出的蛋白質主要位在細胞膜上。		
The MicE offers general protection against all tested statins. 在所有的酵母菌種類中，MicE 都能提供一般的保護作用。		
MicE will likely also protect yeast from the harmful effects of compactin. MicE 也可保護酵母菌抵抗藥物 compactin 的傷害。		

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Q 19:

The amino acid sequence MYTHELL is essential for the activity of a given enzyme. Analysis of this enzyme in three related species (A-C, see statements) reveals some diversity. The table below shows the codon usage for the different amino acids in the three organisms.
有一段胺基酸序列 MYTHELL，對於活化特定酵素是必須的，在三個物種(A-C)中分析此酵素（詳見問題），發現彼此間有差異性存在。下表是這三個物種中胺基酸和密碼子的對應

TTT Phe F	TCT Ser S	TAT Tyr Y	TGT Cys C
TTC	TCC	TAC	TGC
TTA Leu L	TCA	TAA STOP	TGA STOP
TTG	TCG	TAG	TGG Trp W
CTT Leu L	CCT Pro P	CAT His H	CGT Arg R
CTC	CCC	CAC	CGC
CTA	CCA	CAA Gln Q	CGA
CTG	CCG	CAG	CGG
ATT Ile I	ACT Thr T	AAT Asn N	AGT Ser S
ATC	ACC	AAC	AGC
ATA	ACA	AAA Lys K	AGA Arg G
ATG Met M	ACG	AAG	AGG
GTT Val V	GCT Ala A	GAT Asp D	GGT Gly G
GTC	GCC	GAC	GGC
GTA	GCA	GAA Glu E	GGA
GTG	GCG	GAG	GGG

Node Id: b81f49816c985d7df5bb9808
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
In species A, the enzyme-encoding sequence has changed to MTTHYLL, which can be explained by two point mutations 物種A中，酵素序列變成 MTTHYLL，可以用出現兩個點突變解釋。		
In species B, the sequence is MYYS, which is best explained by a frame shift mutation 物種B中，序列變成MYYS，最好的解釋為出現框架移動突變。		
In species C, the sequence is in fact MYTHELL, but this can be due to 512 different nucleotide sequences 物種C中，序列仍然是 MYTHELL，這可以由 512 種不同的核苷酸序列來完成。		
On average, a change from MYTHELL to MYTOELL is more likely than a change to MYTHEHL		

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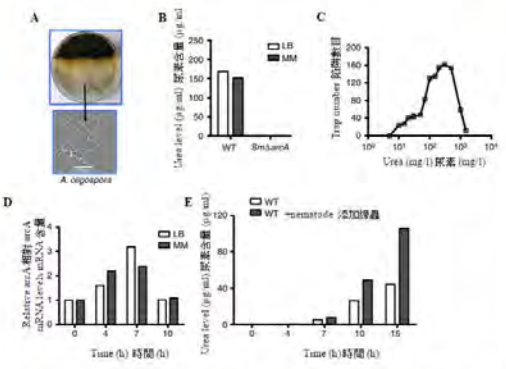
A 02:30 Chinese Traditional TWIN_JURY_E

接近 300 mg 的尿素。本題要研究，細菌、真菌與線蟲間的交互作用。



A, trap formation by Ao near cow dung on a plate. B, urea is produced from arginine and formation is catalysed by arginase, being controlled by the gene arcA. ΔmAureA is a bacterial strain without arcA (WT is wild type). LB and MM are nutrient-rich and -poor media, respectively. C, trap number as a function of urea

Node Id: e91a161501358e5cb1af4314
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
Under normal conditions of bacterial urea production, trap production by the fungus increases 陷阱形成的增加與細菌尿素產量成正比。		
Only bacteria with the specific gene arcA can produce urea 細菌要具有 arcA 基因方能產生尿素。		
Bacteria produce urea in both nutrient-rich and -poor conditions 不論是富養或貧培養基，細菌都能產生尿素。		
Urea production seems to be triggered by stimuli from the nematode 尿素的產生是被線蟲刺激後方能產生。		

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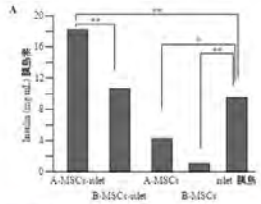
A 02:30 Chinese Traditional TWIN_JURY_E

Q 22:

Differentiation of a kind of stem cells (mesenchymal stromal cells MSC) derived from adipose rat tissue (A-MSC) and bone marrow (B-MSC) was analyzed *in vitro* and *in vivo*. Diabetic rats (STZ rats) were used and MSCs were co-transplanted with pancreatic islets to confirm the *in vitro* results (Fig. A).
細胞分化現象為幹細胞（間質幹細胞 (MSC)）很重要的現象。不論是來自老鼠脂肪組織 (rAT-MSC) 或是骨髓 (rBM-MSC[RJNF1]) 中，試管內與活體內的分析都是相當重要的。糖尿病大鼠 (STZ) 常被用在共同移植 MSC 與胰島的活體內試驗研究中。（圖A）



A, in vitro insulin secretion levels after 38 days of culture of islets and stem cells
A：共同培養胰島與幹細胞 38天後，試管中胰島素的分泌量。

Node Id: c3d9cc6da1356c8c4a23e24e
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
There is no added advantage in cultivating pancreatic islets together with stem cells in order to obtain a high insulin production *in vitro* 於試管內進行共同培養幹細胞與胰島來獲得高胰島素產量的實驗，是沒有意義的。		
Transplanting stem cells and islets may potentially reduce the blood glucose level in a glucose tolerance test, but not to the level observed in control rats 在葡萄糖耐受實驗中，移植幹細胞與胰島可能會降低血糖，但是在對照組中則沒有變化。		
Transplantation of stem cells from adipose tissue together with islets seems to be the most efficient way to help people, who suffer from diabetes 移植脂肪組織來源的幹細胞與胰島，對於糖尿病患者的幫助會有較大的效益。		

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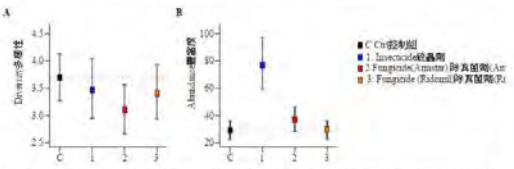
A 02:30 Chinese Traditional TWN_JURY_E

Q 24:

Tropical forest plant communities are very diverse. The Janzen-Connell hypothesis argues that insect herbivores and pathogens are positive drivers of this diversity. This was tested in a rainforest by excluding herbivores and pathogens through pesticide application and observing if this affected plant diversity and abundance (Fig.)
熱帶森林群落非常多樣，根據Janzen-Connell 的假說，他們認為草食性昆蟲及病原是造成森林多樣的正向推手。針對此假說利用一處雨林進行實驗，利用殺蟲劑將草食性昆蟲及病原去除，而後觀察其是否對植物相對豐度與多樣性有影響(圖)



Effects of an insecticide and two fungicides upon seedling diversity (A) and mean seedling abundance (B) of the forest community. Error bars represent 95% confidence intervals of the mean of all study sites with a given treatment (from Bagchi et al. 2014)
一種殺蟲劑與兩種殺真菌劑的效果：
森林群落的苗木多樣性(A)及平均的苗木豐富度(B)

Node Id: 61d8d3d0e68527e955cbb35a
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
All treatments had a statistically significant effect upon seedling diversity 各組處理皆有呈現對幼苗多樣性有統計上顯著的影響		
In the study area, most insects were predators 在研究地區大多數的昆蟲是掠食者		
Ridomil is stronger in its effects on fungi than Amistar Ridomil 對真菌的效果大於 Amistar		
The hypothesis is supported in the present study by the combined effect of insects and fungi 由目前研究所得綜合昆蟲及真菌的結果，支持所提出的假說		

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A 02:30 Chinese Traditional TWN_JURY_E

Q 25:

The fragility of an ecological food chain is examined on an atoll, where native forest was replaced by coconut palms (Fig.). This created a problem for seabirds which could not nest in palms.
選擇一處環礁研究生態食物鏈的脆弱性。此處天然林已被椰子林所取代(圖)，對於島上的海鳥造成影響，因為他們不能在椰子樹上築巢。

Changes in the ecological chain, when native forest (N) is replaced by palms (P). Each bar graph compares processes in N and P (from McCauley et al. 2012)

Node Id: 527dacd2f236c9b2c4c9a707
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
Bird presence benefits manta rays 鳥的存在對於鬼蝠魟有利		
Palm growing might harm corals in the atoll 椰子樹生長或許會對環礁的珊瑚造成危害		
If forest was cleared and land instead used for intensive modern farming with fertilizers, manta rays might disappear from the coast 如果森林被砍光，土地被移做現代農場使用大量肥料，則鬼蝠魟將會自海岸中消失		
The food chain includes only top-down effects, and no bottom-up effects 食物鏈所形成的影響只有由上而下，而無由下而上的效應		

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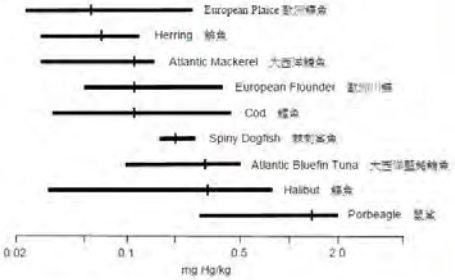
A 02:30 Chinese Traditional TWN_JURY_E

世界衛生組織(WHO)建議人體可忍受的汞(Hg)每天可攝入最多量(TDI)為每公斤體積中含0.1微克，是以管理單位對母嬰漁獲市場中的汞含量長期持續的監控。
下圖為9種魚體內的汞含量



Hg level in mg/gm/kg fish, horizontal bars span the 95% confidence interval (small vertical bars are averages)
汞的含量單位(公斤/魚，水平的長條圖為95%信賴區間(小的垂直長條為平均值所在)

Node Id: 81b60931f30dee16fdf8bbcb
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
Mackerel is placed higher in the marine food chain than Halibut 鯖魚較鰈魚在海洋食物鏈的地位高		
Hg-level generally increases with body weight 一般而言汞含量隨體重而增加		
Mean Hg concentration in Tuna allows a 75 kg person to consume a maximum 1 kg Tuna per ca. 10 days. 鮪魚體內的平均汞含量允許一個體重75公斤的人，最多可在10日內消費1公斤鮪魚		
Tuna has a wider diet than Halibut 鮪魚較鰈魚有更廣的食性		

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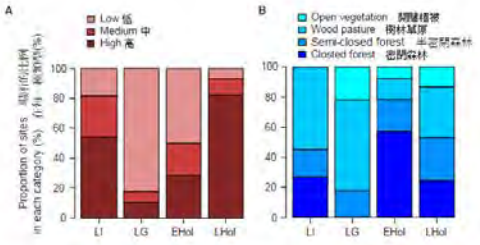
A 02:30 Chinese Traditional TWIN_JURY_E

when dung beetles became fewer and most lived in closed forest. Modern humans and agriculture arrived to Northern Europe 50 kY and 10 kY ago, respectively.
大型草食獸對生態系會造成很大的影響，但絕大多數的種類在過去十萬年皆已滅絕，此種大滅絕也影響相關之糞甲蟲的動物相，在北歐化石層中發現在大滅絕前甲蟲相較豐富，且生活在較開闊的樹林地，而大滅絕後糞甲蟲減少且大多數住在密閉的森林中。現代人類及農作分別在5萬到1萬年前進入北歐。



Proportions of excavation sites classified according to their fossil dung beetle density (A) and vegetation type

Node Id: feee73c04c2d73b7dc408518
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 decline of the large herbivore fauna during LG might partly be explained by climate change 造成最後冰河期(LG)大型草食獸動物相的減少，部份可能的原因是氣候變遷		
The decline of the large herbivore fauna during LG might partly be explained by human arrival 造成最後冰河期(LG)大型草食獸動物相的減少，部份可能的原因是人類入侵		
The small increase in dung beetle density during the warmer EHol is due to a return of large native herbivores after the LG 在較溫暖的全新世早期(EHol)，糞甲蟲密度小量增加是由於在最後冰河期(LG)以後大型本土草食獸回流所致		
The strong increase in dung beetle density during LHol is due to agriculture 在全新世晚期(LHol)糞甲蟲密度大量增加是由於農作的緣故		

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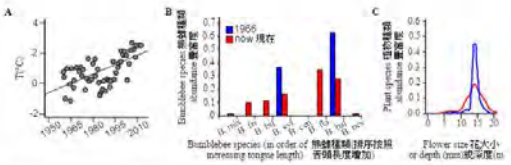
A 02:30 Chinese Traditional TWIN_JURY_E

Q 28:

High-altitude Rocky Mountains (U.S.A.) bumblebee communities were studied 40 years ago and again today, and a set of changes was noted, and these were related to climate change (Fig.).
美國高海拔洛磯山脈熊蜂群聚在40年研究過，目前又對其進行研究，發現許多與氣候變遷有關的改變(圖)。



A, change in summer temperature in the Rocky Mountains. B, change in tongue length in a mountain bumblebee community (grey bars 1966, white bars today); and C, change in diversity of flowering plant species with different depth, i.e. access to bees, between 1966 (blue) and today (red) (from Hiller-Strutmann et al. 2015).
A. 夏天洛磯山脈溫度的改變
B. 一處山區熊蜂群落舌頭長度的改變(藍長條1966；紅色長條現在)

Node Id: de420322b07b8c6ab09c29b8
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 present-day bumblebee community is less diverse than in 1966 現今熊蜂群聚不如1966年多樣		
Higher temperature favours nectar-plant specialist bumblebees 高溫有利於採花密專業性高的熊蜂		
Low-altitude bumblebee species have not been able to invade the higher altitudinal zones during the 40 study years 低海拔熊蜂在過去40年間無法入侵高海拔地區		
Average depth of flowers has decreased during the 40 study years, favoring shorter-tongued bumblebees 花朵平均深度在過去40年間減少，有利於短舌熊蜂		

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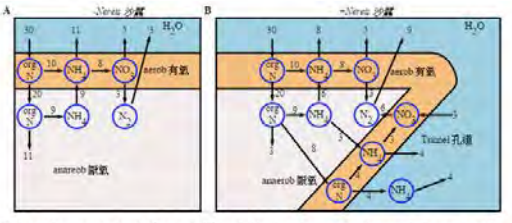
Q 29:

The polychaete *Nereis virens* lives in the bottom sediment of shallow coastal waters. It digs tunnels in the sediment and pumps water through these tunnels. The decomposition turnover of nitrogen (N) compounds has been investigated in the sediment at two sites: one without *Nereis* (Fig. A) and one with 600 *Nereis* per m^2 (Fig. B).
多毛類的沙蠶生活在淺水海岸沉積底層(灘地)，他在沉積層挖孔道並抽水由孔道排出。在沉積層內選擇兩處進行含氮化合物分解及轉化的研究，一處無沙蠶(圖A)另一處有沙蠶(圖B，每平方米600隻)



Sediment N-processes without (A) and with (B) Nereis. Numbers at arrows give the annual N turnover in g N

Node Id: 90943f6bc0d75a52e62da66e
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
Less organic N is deposited in the bottom sediment in B compared to A 與A比，B有較少有機氮(N)存留在沉積層底層中		
Denitrification rate is increased threefold in the presence of *Nereis* 去氮速率在有沙蠶存在時增加了3倍		
In the tunnels made by *Nereis* 5 g N per m^2 per year are deposited in the sediment 沙蠶所營造之孔道，每年會有每平方公尺5克氮回歸到沉積層中		
Concentrations of nutrients, which may lead to algal bloom, are lowered in the presence of *Nereis* 營養鹽濃度可能會造成藻華，但在沙蠶存在情況下機會變小		

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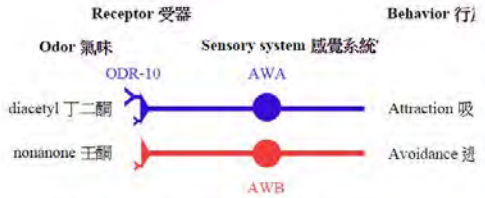
the outside of these neurons. The receptor protein ODR-10 on the neuron AWA initiates the movement of *C. elegans* towards the odour diacetyl (its location shown as X in figure B). The neuron AWB, however, initiates movement away from the toxin nonanone (A).
秀麗線蟲(*C. elegans*)對於氣味反應有非常視嫵的行為，牠有11對化學感應神經元，氣味是由這些神經元外的G蛋白結合的受器(GPCR)所偵測，在AWA神經元的感受蛋白ODR-10是最先發出訊息使秀麗線蟲朝了二酮的氣味方向移動(牠的位置是在圖B中的X處)，AWB神經元則最先發出訊息讓身體遠離壬酮毒素

A



A, diacetyl elicits an attraction (+) of the worm via AWA, nonanone elicit a repulsion (–)
丁二酮經由嗅覺AWA神經元，產生了吸引(+)，壬酮引起了逃避(–)

The behaviour of mutant and transgenic worms was compared to the one of wild-type

Node Id: 08b4368f388b5e712a428c67
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
ODR-10 on AWA is required for attraction towards diacetyl 個體被丁二酮吸引前往時，AWA 神經元上的ODR-10蛋白質的功能是必需的		
ODR-10 can mediate both attraction and repulsion ODR-10 對蠕產生忌避和吸引行為時皆有扮演關中傳遞的角色		
Each olfactory neuron has receptors for many odour chemicals 每一個嗅覺神經元有受器可以感覺許多化學物所產生的氣味		
All olfactory neurons are functionally similar even if their receptors are different 所有的嗅覺神經元縱使他們受器有所不同，但神經元功能上皆相似		

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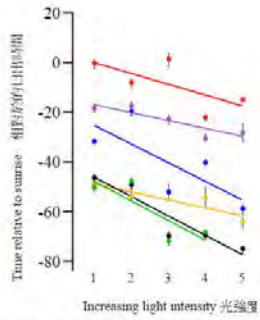
A 02:30 Chinese Traditional TWIN_JURY_F

(Fig.).
研究人員調查路燈(夜間人工光源)對六種常見鳴禽晨昏鳴唱行為的影響。他們規劃了五套光度漸增的設施(圖)。



Average start of dawn singing relative to sunrise (0) (mean ± standard error) against increasing light intensity (from 1 to 5) at sites with street-lighting (from Silva et al. 2014).
路燈地區晨曦日出時間(0)相對平均值(標準差)，不同的強度由較弱的光度(1)至不同程度的光度(最平均的強

Node Id: 19d8558e53acdcb1cdcd7d52
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
Generally, street-lighting seems to have the strongest effect on the earliest birds 一般而言，路燈對於早鳥似乎有最顯的效應		
Streetlight increases interspecific competition among birds for time of singing 路燈增加了鳥類為了唱歌的時間所產生的種間競爭		
The morning pattern may be reversed at dusk 早上的唱歌型式可能會在傍晚呈現相反的結果		
Rain at dawn may delay the initiation of singing 清晨下雨可能會延遲鳴唱開始時間		

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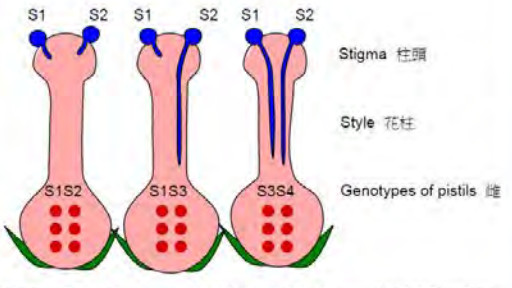
A 02:30 Chinese Traditional TWIN_JURY_F

systems, one often finds many alleles: S1 ... etc. in a population.
在二倍體的首禮類植物，受精作用受到配子體自交不和合性等位基因(S等位基因)的控制。花粉攜帶一個S 等位基因(例如S1)，如果此花粉附著的柱頭也具有相同的S等位基因(例如基因型為S1S2 或S1S3的植物)，則此花粉不會萌發，因此也不會有受精作用發生(如圖)。這種具S 系統的植物通常有很多不同的S 等位基因存在於族群中



Self-(in)compatibility reactions in three pistils: pollen and pollen tubes are coloured blue. S1 to S4 are S-alleles and S1S2 etc. are genotypes of mother plants.
三個雌蕊上自(不)和合反應的例子，花粉和花粉管是藍色的，S1-S4是不同的S等位基因，S1S2，S1S3，S3S4

Node Id: 57d4bc04ed01b8d9b57f426f
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 genotypes in the *S* gene are in Hardy-Weinberg equilibrium 族群中S基因的基因型處於哈-溫平衡		
In a population with three *S* alleles and equal frequencies of all possible genotypes, 1/3 of all crosses will be incompatible 族群中有3種不同的S等位基因，且各基因型頻率相同，則所有的交配中，有1/3是不和合的		
The smallest possible number of *S* alleles in a viable population is four 在一個可以維持繁衍的族群中，所需的不同S等位基因數目最少是4種		
In another incompatibility system with only two alleles (*S1* and *S2* and *S1* being dominant over *S2*) 1/3 of all crossing types are compatible		

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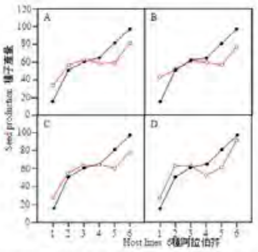
A 02:30 Chinese Traditional TWN-JURY-5

Germany (C), another in France (D). Finally, one experiment (A) used a mix of the three others.
卵菌門的Hyaloperonospora arabidopsidis (Ha)生長在阿拉伯芥 Arabidopsis thaliana (At)上。在一個研究中，對6個不同基因型的阿拉伯芥(Pyr, Tsu, Sue, Fin, Tch和Gb)進行卵菌感染實驗(見圖A–D)，共使用4種菌種組成：B是實驗室菌種；C是德國野生菌種；D是法國野生菌種；A是以上3種菌種的混合。每一實驗都有無菌處理的對照組。



Seed production (mg seeds/plant, Y-axis) of six At genotypes (Pyr, Tsu, Sue, Fin, Tch, Gb; X-axis) in four experiments (a)–(d). At genotypes are ranked according to increasing seed production in the absence of the oomycetes (filled symbols, black). At grown with Ha (open symbols, red) (from Salvaudon et al. 2008).
對6個不同基因型的阿拉伯芥(Pyr, Tsu, Sue, Fin, Tch和Gb，X軸)進行4組卵菌感染實驗(A–D)，檢測各組處理對種子產量的效應(Y軸)。6個阿拉伯芥基因型依無卵菌處理時的種子產量遞增排列。

Node Id: 107156606f9a960a5ebdd453
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 experiment B, *Ha* is commensal with all *At* genotypes 實驗B中，卵菌和阿拉伯芥是共生關係		
In experiment C, *Ha* is a parasite on all *At* genotypes 實驗C中，卵菌和寄生於所有阿拉伯芥		
For all three fungal strains: the negative impact of Ha is strongest on the most productive genotypes 三個菌種最強的負面效應都發生於種子產量高的阿拉伯芥基因型		
The outcome of interactions between Ha and At on the plant depends on the latter's genotype 卵菌和阿拉伯芥的交互作用之結果由阿拉伯芥的基因型決定		

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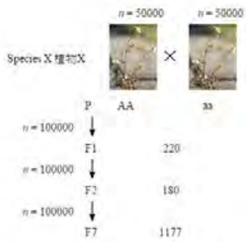
A 02:30 Chinese Traditional TWN-JURY-5

以二個不同的植物X純系進行雜交實驗(如圖)，每一世代都使用100000株植物繁殖下一世代。在F1、F2、F7世代，選取特定數目的植株，檢定其有關A等位基因和a等位基因的基因型。本實驗假設沒有篩選，沒有自交，在第一世代後逢機交配。



Breeding of pure lines in Species X: n is number of sampled plants. The central column gives number of individuals genotyped in each generation (only generations P, F1, F2 and F7 are shown).
二個不同的植物X純系進行雜交實驗，n是實驗植株數目，中間的數字是檢定基因型的植株數目(F1、F2、F7世代)

Node Id: 1343f25eb5d39833eb07ad00
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 parental generation (P) shows Hardy-Weinberg proportions 在親本世代(P)個體數為哈-溫平衡比例		
Expected number of *Aa* genotyped individuals in F1 is 110 在F1世代被檢定基因型的植株中，Aa的預期個體數是110		
Expected number of *aa* genotyped individuals in F2 is 90 在F2世代被檢定基因型的植株中，aa的預期個體數是90		
In F7, 271 plants were genotyped as *AA*. This is less than expected. 在F7世代被檢定基因型的植株中有		

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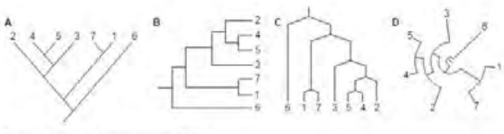
A 02:30 Chinese Traditional TWN-JURY-5

Q 36:

The phylogeny of seven species is presented in four different ways (Fig.)
七個物種的親緣關係以4種不同方式呈現(如圖A~D)



Four phylogenies of seven species (1-7)
七個物種(1~7)的4種親緣關係

Node Id: 42e3093b023498125dcfb96f
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
All four trees reflect the same phylogeny 所有親緣樹反映相同的親緣關係		
In all phylogenies, species 6 is expected to have more mutations than species 2 在所有親緣關係中，物種6應該會比物種2具有更多突變		
In phylogeny A, species 1, 6, and 7 constitute a monophyletic group 在親緣關係A中，物種1、6和7組成一個單系群		
In phylogeny C, species 7 is more closely related to species 3 than to 5 在親緣關係C中，物種7與3的關係，比7與5的關係為近		

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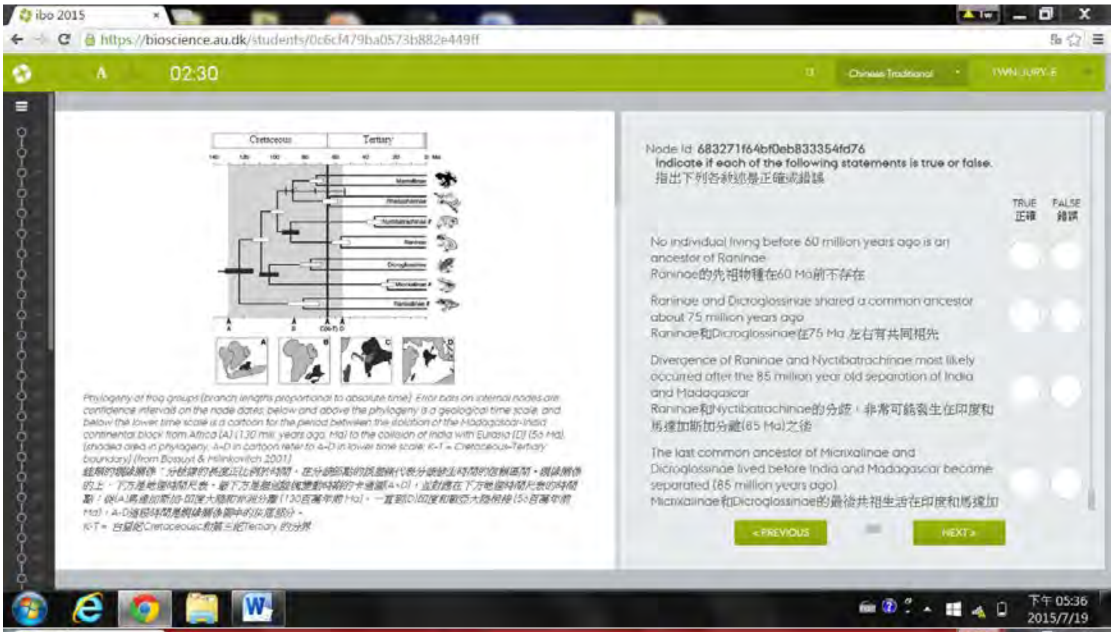
2015/7/19


ibo 2015
https://bioscience.au.dk/students/0c6cf479ba0573b882e449ff
02:30
Chinese Traditional
TWN-JURY-E
Cretaceous
Tertiary
Node Id: 683271f64bf0eb833354fd76
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
No individual living before 60 million years ago is an ancestor of Raninae
Raninae的先祖物種在60 Ma前不存在
Raninae and Dicroglossinae shared a common ancestor about 75 million years ago
Raninae和Dicroglossinae在75 Ma 左右有共同祖先
Divergence of Raninae and Nyctibatrachinae most likely occurred after the 85 million year old separation of India and Madagascar
Raninae和Nyctibatrachinae的分歧，非常可能發生在印度和馬達加斯加分離(85 Ma)之後
The last common ancestor of Micrixalinae and Dicroglossinae lived before India and Madagascar became separated (85 million years ago)
Micrixalinae和Dicroglossinae的最後共祖生活在印度和馬達加
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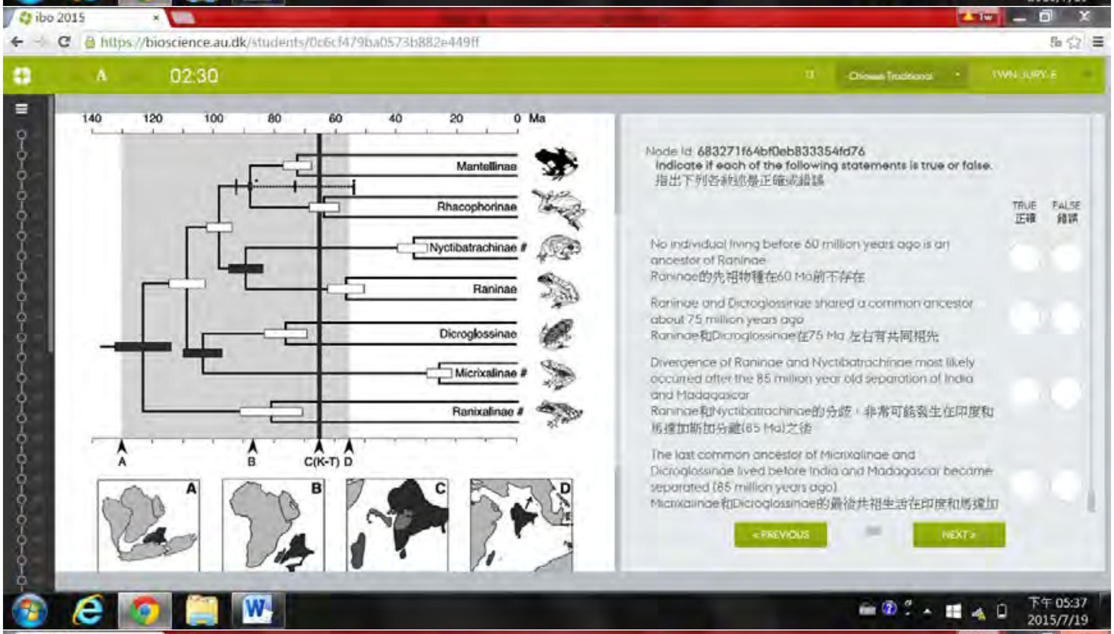
下午 05:36
2015/7/19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https://bioscience.au.dk/students/0c6cf479ba0573b882e449ff
02:30
140
120
100
80
60
40
20
0 Ma
Mantellinae
Rhacophorinae
Nyctibatrachinae #
Raninae
Dicroglossinae
Micrixalinae #
Ranixalinae #
A
B
C(K-T)
D
Node Id: 683271f64bf0eb833354fd76
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
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Raninae和Dicroglossinae在75 Ma 左右有共同祖先
Divergence of Raninae and Nyctibatrachinae most likely occurred after the 85 million year old separation of India and Madagascar
Raninae和Nyctibatrachinae的分歧，非常可能發生在印度和馬達加斯加分離(85 Ma)之後
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Micrixalinae和Dicroglossinae的最後共祖生活在印度和馬達加
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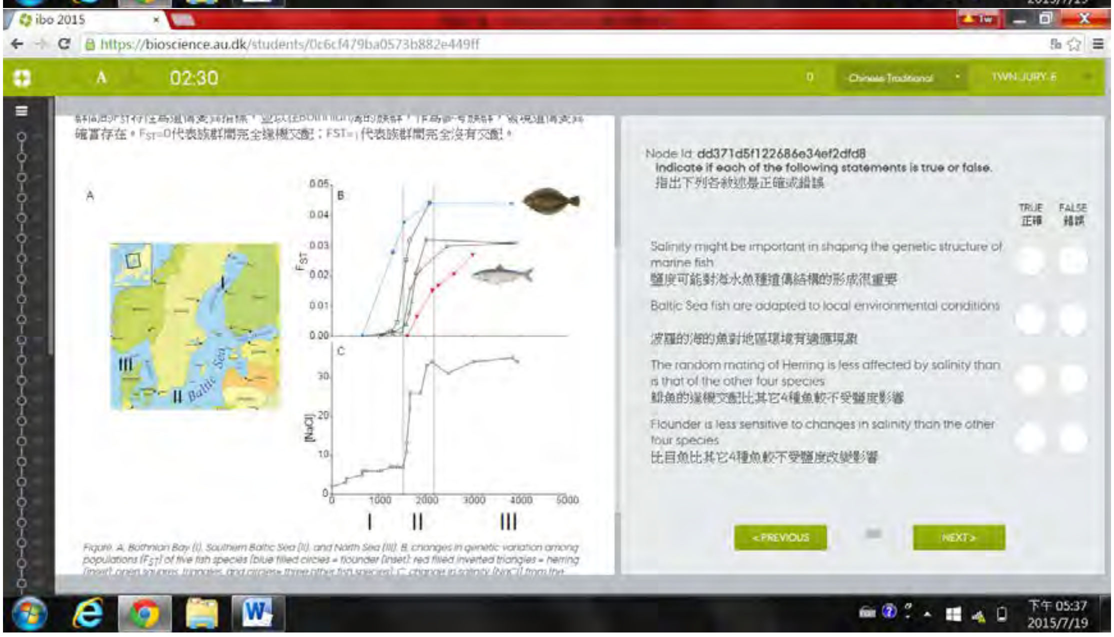
2015/7/19


ibo 2015
https://bioscience.au.dk/students/0c6cf479ba0573b882e449ff
02:30
Chinese Traditional
TWN-JURY-E
確實存在。FST=0代表族群間完全隨機交配；FST=1代表族群間完全沒有交配。
A
B
C
Baltic Sea
F_{ST}
[NaCl]
Node Id: dd371d5f122686e34ef2dfd8
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
Salinity might be important in shaping the genetic structure of marine fish
鹽度可能對海水魚種遺傳結構的形成很重要
Baltic Sea fish are adapted to local environmental conditions
波羅的海的魚對地區環境有適應現象
The random mating of Herring is less affected by salinity than is that of the other four species
鯡魚的隨機交配比其它4種魚較不受鹽度影響
Flounder is less sensitive to changes in salinity than the other four species
比目魚比其它4種魚較不受鹽度改變影響
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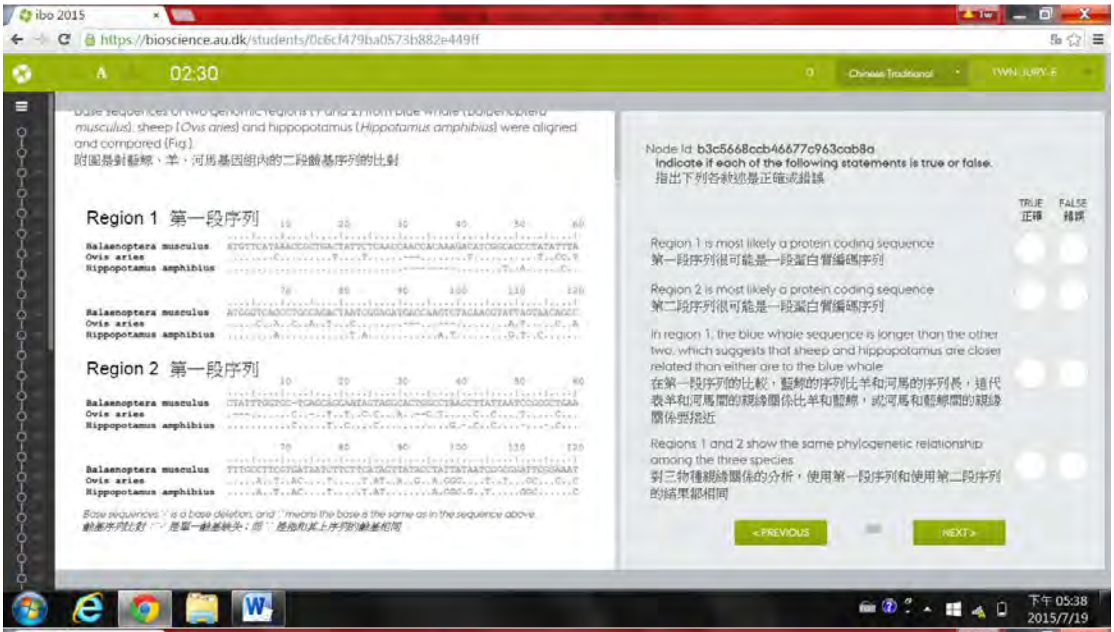


musculus), sheep (*Ovis aries*) and hippopotamus (*Hippotamus amphibius*) were aligned and compared (Fig.)

附圖爲對藍鯨、羊、河馬基因組內的二段鹼基序列的比對

Region 1 第一段序列

Balaenoptera musculus
Ovis aries
Hippopotamus amphibius

Region 2 第一段序列

Balaenoptera musculus
Ovis aries
Hippopotamus amphibius

Base sequences '-' is a base deletion, and '.' means the base is the same as in the sequence above

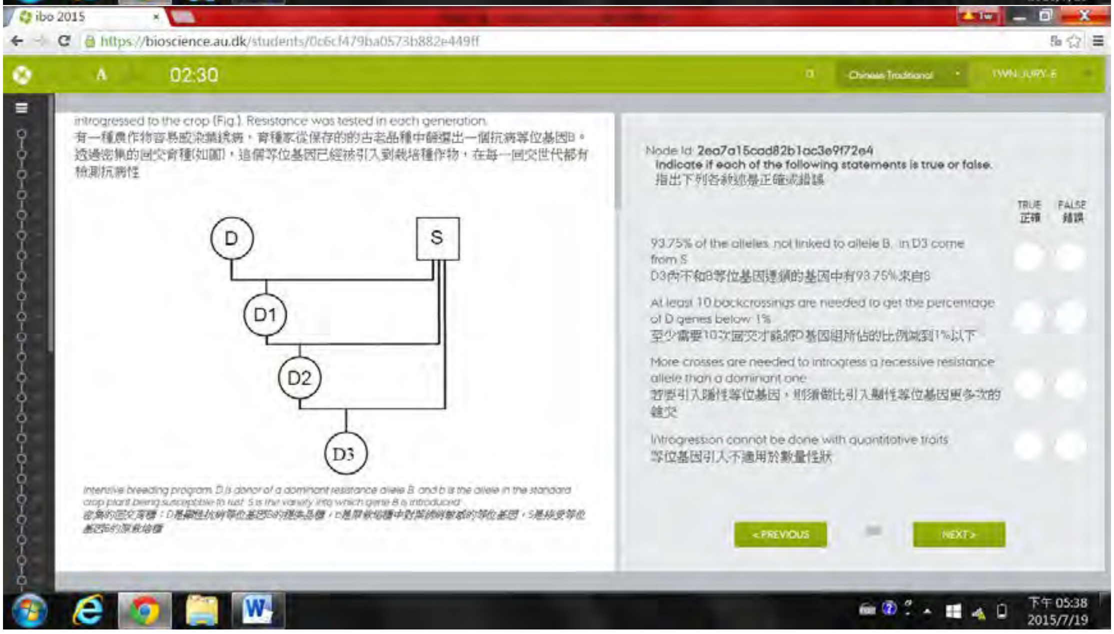
鹼基序列比對：'-'是單一鹼基缺失；而'.'是指和其上序列的鹼基相同

Node Id: **b3c5668ccb46677c963cab8a**

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
Region 1 is most likely a protein coding sequence 第一段序列很可能是一段蛋白質編碼序列		
Region 2 is most likely a protein coding sequence 第二段序列很可能是一段蛋白質編碼序列		
In region 1, the blue whale sequence is longer than the other two, which suggests that sheep and hippopotamus are closer related than either are to the blue whale 在第一段序列的比較，藍鯨的序列比羊和河馬的序列長，這代表羊和河馬間的親緣關係比羊和藍鯨，或河馬和藍鯨間的親緣關係要接近		
Regions 1 and 2 show the same phylogenetic relationship among the three species 對三物種親緣關係的分析，使用第一段序列和使用第二段序列的結果都相同		



introgressed to the crop (Fig.). Resistance was tested in each generation.

有一種農作物容易感染鏽病，育種家從保存的的古老品種中篩選出一個抗病等位基因B。透過密集的回交育種(如圖)，這個等位基因已經被引入到栽培種作物，在每一回交世代都有檢測抗病性

Intensive breeding program. D is donor of a dominant resistance allele B, and b is the allele in the standard crop plant being susceptible to rust. S is the variety into which gene B is introduced.

Node Id: **2ea7a15cad82b1ac3e9f72e4**

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
93.75% of the alleles, not linked to allele B, in D3 come from S D3內不和B等位基因連鎖的基因中有93.75%來自S		
At least 10 backcrossings are needed to get the percentage of D genes below 1% 至少需要10次回交才能將D基因組所佔的比例減到1%以下		
More crosses are needed to introgress a recessive resistance allele than a dominant one 若要引入隱性等位基因，則須做比引入顯性等位基因更多次的雜交		
Introgression cannot be done with quantitative traits 等位基因引入不適用於數量性狀		

鰻草(Zostera marina)是一種沉水的海草。在白天，O_2從綠色部分及根莖的通氣組織傳到根部，在周圍無氧的沉積物環境中形成一個富含氧的區域。在晚上則不同，酒精會從根擴散出來，送到沉積物環境中，如圖所示。

Eelgrass at day and night, and cross-sections of leaf and root.

Node Id: **24a6329f0f60143c9dfd41ca**

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
For respiratory reasons, Zostera roots are expected to have a thin epidermis 由於根需要呼吸，故鰻草根的表皮薄。		
Both at day and night, O_2 readily diffuse into the roots 不論在白天或夜晚，O_2都會擴散至根。		
Root uptake of nutrients is independent of time of day 根吸收營養的情形不受一天的時段區分影響		
At nighttime, the concentration of Na^+ is expected to decrease in root cells 在夜晚，根細胞中的Na^+濃度會降低		

ibo 2015

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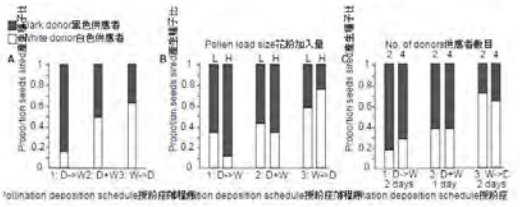
A 02:30 Chinese Traditional TWNJURY.F

Q 44:

Plants compete as pollen donors for siring offspring, i.e. becoming fathers. The stigma becomes an arena, where pollen donors/fathers "fight" for fertilization (paternity), and where the females "choose" fathers of their seeds. This was studied in the plant Purple Chinese Houses (*Collinsia heterophylla*) (Fig.)
植物會被此競爭成為花粉供應者以產生後代(也就是當父親)。柱頭因此成為花粉供應者/父親爭取父權(paternity)而"戰"的競爭地，而雌性則可選擇其所生成的種子的父親。下圖為利用Purple Chinese Houses (Collisina heterophylla)的研究結果。



Proportion of seeds sired by either a dark (D) or a white pollen donor (W) A. pollen deposited on stigma in succession (1. D→ W, i.e. first D and then W; or 3. W→ D) or simultaneously as a mixture (2. D + W). B. size of

Node Id: d8e81b656584cca9b5bde84b
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
There is a first-donor advantage 在此有第一花粉供應者優先的優勢		
No competitive effect of high pollen load is observed 大量花粉加入並沒有競爭上的優勢效果		
Increase in number of fathers increases competition 父親數目增加，則競爭也會增加		
If lots of pollen from the first donor is deposited, pollen added 2 days later from a second donor does not sire seeds 如果第一花粉供應者加入的花粉量多，則2天後再加入的第二花粉供應者並不會結出種子。		

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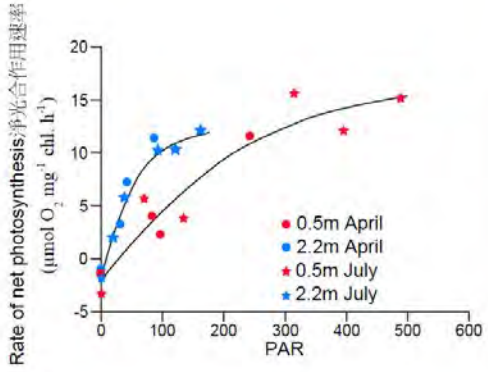
A 02:30 Chinese Traditional TWNJURY.F



Light response curves in April and in July for C. heimsii growing in shallow (0.5 m) and deep (2.2 m)

Node Id: 6792958f72dfbd24b17c15ba
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
Shallow-water plants have higher NPR at 100 PAR than deep-water plants 在100 PAR時，淺水區的植物比深水區有較高的NPR。		
Deep-water plants have higher NPR in July than in April 深水區植物在七月時的NPR較四月時高		
In the experiment, NPR is light limited 本實驗中，NPR受光限制。		
Deep-water plants have a higher NPR because of their higher chlorophyll content 深水區植物有較高的NPR是因為其有較多的葉綠素含量。		

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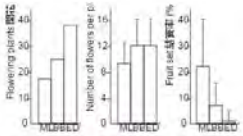
A 02:30 Chinese Traditional TWNJURY.F

Q 48:

Some plants deceive their pollinators by emitting odours, mimicking rotten flesh or dung. Such plants are pollinated by carrion and dung flies. This phenomenon is common among orchids, e.g. *Bulbophyllum variegatum*, three populations (ML, BB and ED) of which were studied at three different locations on the island of Reunion (Fig.)
有些植物藉由釋出味道，模擬腐肉或糞便，來欺騙它的傳粉者。這些植物是由食肉及糞便的蠅類傳粉。此現象常見於例如豆蘭屬(Bulbophyllum variegatum)的蘭花，在 Reunion島的三個不同地區進行研究，結果如下圖所示。



Reproductive data from populations ML, BB and ED (from Humeau et al. 2011)
蘭花的三個族群ML、BB及ED的生殖數據

Node Id: 44c4b04d83ae3565bbb82078
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
Number of fruits produced per plant is higher in BB than in ML and ED 三個族群中，植株平均產生果實的數目(包括開花及未開花的植株)在BB族群最高。		
Compared to ML and BB, fruit set in ED may have severe pollinator limitation 相較於ML和BB兩族群，ED族群的結實量最重受到傳粉者的限制。		
Compared to ED and BB, ML may be a neighbour to cattle pastures 相較於ED和BB兩族群，ML族群可能鄰近牛隻畜牧場。		
Compared to ED and BB, ML may be a relatively young population 相較於ED和BB兩族群，ML族群可能是相對較為年輕		

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A
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Chinese Traditional
A
B
C
D
Node Id: 4d49abef2915934f5e05333d
Indicate if any 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 bird community has many food generalists, but only few specialists
鳥類群集有許多廣食性者，但僅有少數幾個專一食性者
The plant community has many fruit consumer specialists, but only few generalists
植物群集含有許多特殊取食果實之消費者，但僅有少數幾個廣食性者
Phylogenetic relatedness is an important driver of interactions in network B
演化親緣關係之遠近是影響網絡B中互作用的重要因子。
Closely related birds reduce food overlap more in network C than in network D
相較於網絡D，網絡C中親緣相近的鳥類較會降低其攝取食物的重疊性。
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