



NATIONAL ENTRANCE EXAMINATION – August 2012

Examination Date: Wednesday 8 August 2012

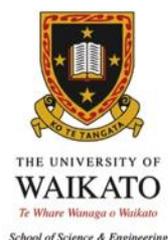
Total Time allowed: 2 hours.

This examination consists of 75 questions. Students are advised to allocate equal time to each question (1 ½ minutes per question with 7.5 minutes for checking of answers). Marks will not be deducted for incorrect answers.

Equipment: pen, pencil, eraser, ruler, and calculator.

Please immediately return the completed answer sheets (retain a copy) to:

Dr Heather Meikle
Secretary, NZIBO333
c/PNGHS
Fitzherbert Avenue
PALMERSTON NORTH 4410



PEARSON



THE UNIVERSITY OF AUCKLAND
FACULTY OF SCIENCE



MASSEY UNIVERSITY
TE KUNENGA KI PŪREHUROA

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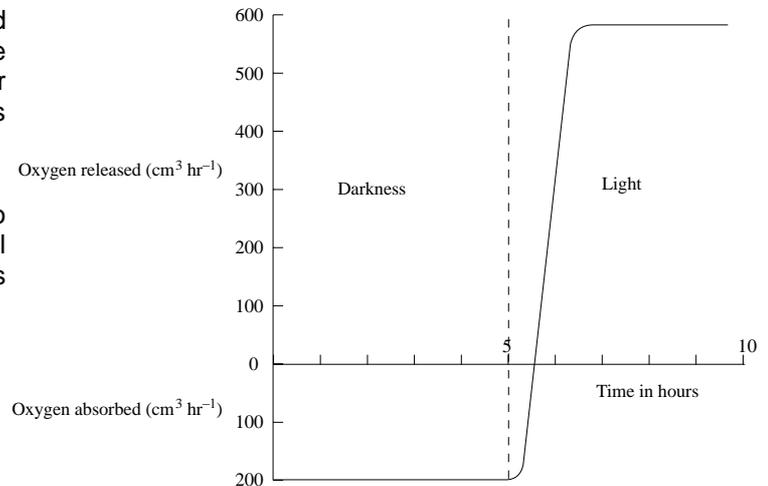
Section A

Question 1

An experiment on gas exchange in a water plant, collected data about the rate of oxygen uptake and release. The plant was in darkness for 5 hours and then illuminated for 5 hours, while the temperature was constant. The results are shown in the graph.

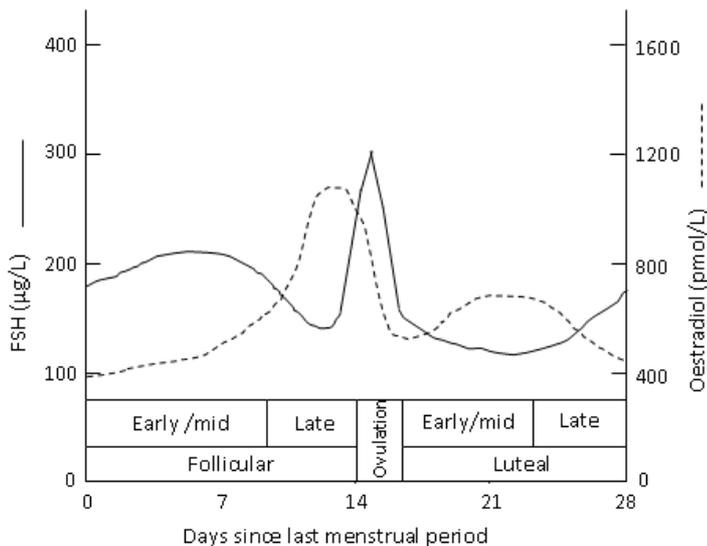
If it is assumed that changes in light intensity have no effect on the rate of respiration, the best estimate of total oxygen produced by photosynthesis in the last two hours of the experiment is:

- A. 600 cm^3
- B. 800 cm^3
- C. 1200 cm^3
- D. 1600 cm^3
- E. 1800 cm^3



Question 2

This is a graph of the menstrual cycle showing the hormones FSH and oestradiol. The labels at the bottom refer to the phase of the cycle.



Which of the following sections of the graph shows a region during early/mid luteal phase?

- A.
- B.
- C.
- D.
- E.

Question 3

A suspension of microscopic green algae was divided into two equal samples. Each was given the same total amount of light energy. Sample I was exposed to continuous light. Sample II was exposed to light flashes of 10^{-5} seconds duration followed by dark periods. Photosynthesis took place in both samples, but more occurred in Sample II. From *this evidence* we may conclude that

- A. More photosynthesis occurs in the dark than in the light.
- B. Some part of the photosynthetic process can occur in darkness.
- C. Photosynthesis requires darkness as well as light.
- D. Photosynthesis is a very rapid process.
- E. Photosynthesis involves enzymes as well as light.

Question 4

The following table shows various inhalational anaesthetic agents with comparison between pungency, potency, onset and blood-gas solubility. Potency is measured by minimal alveolar concentration (MAC), which is the concentration of vapour required to produce immobility on surgical stimulus in 50% of patients. A high MAC indicates a low potency. Onset is the time it takes for the effects of a drug to be observed after administration.

Anaesthetic Agent	Pungency	Potency (MAC)	Onset	Blood-gas Solubility
Nitrous oxide	Non-pungent	101%	Rapid	Low
Halothane	Non-pungent	0.86%	Slow	Intermediate
Isoflurane	Pungent	1.1%	Medium	Intermediate
Sevoflurane	Non-pungent	1.7%	Rapid	Low
Desflurane	Pungent	6.0%	Rapid	Low

Which of the following statements is true?

- A. Nitrous oxide has a high potency and rapid onset.
- B. Sevoflurane and Desflurane are both pungent agents with rapid onsets.
- C. Halothane has a high potency and low blood-gas solubility.
- D. Halothane and Isoflurane are both highly potent with intermediate blood-gas solubility.
- E. Desflurane has a very low potency and rapid onset.

Question 5

The following question relates to organisms from the planet Orti.

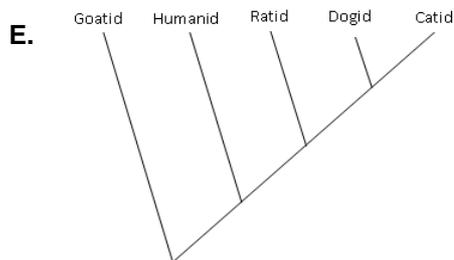
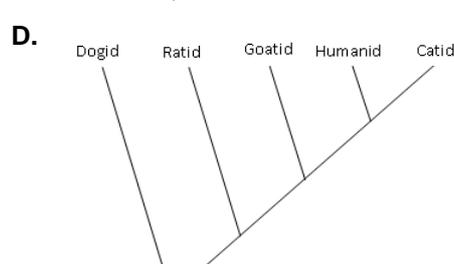
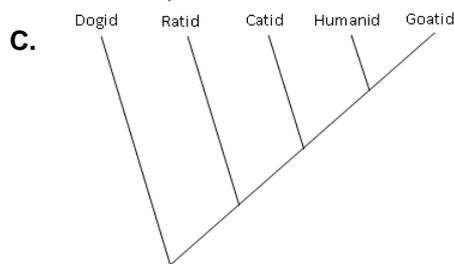
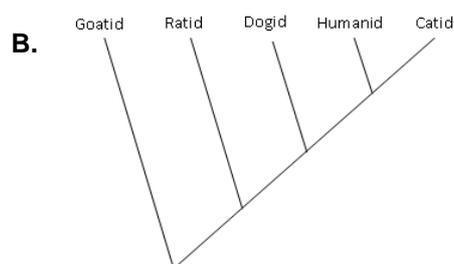
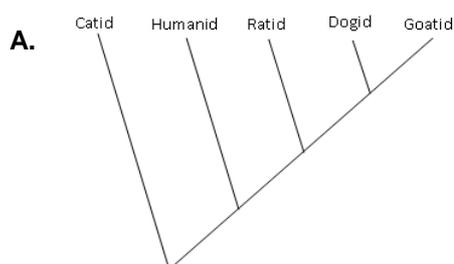
Dogids, ratids, catids and humanids have red spots.

Catids and humanids both have blue skin.

Ratids and goatids have yellow ears.

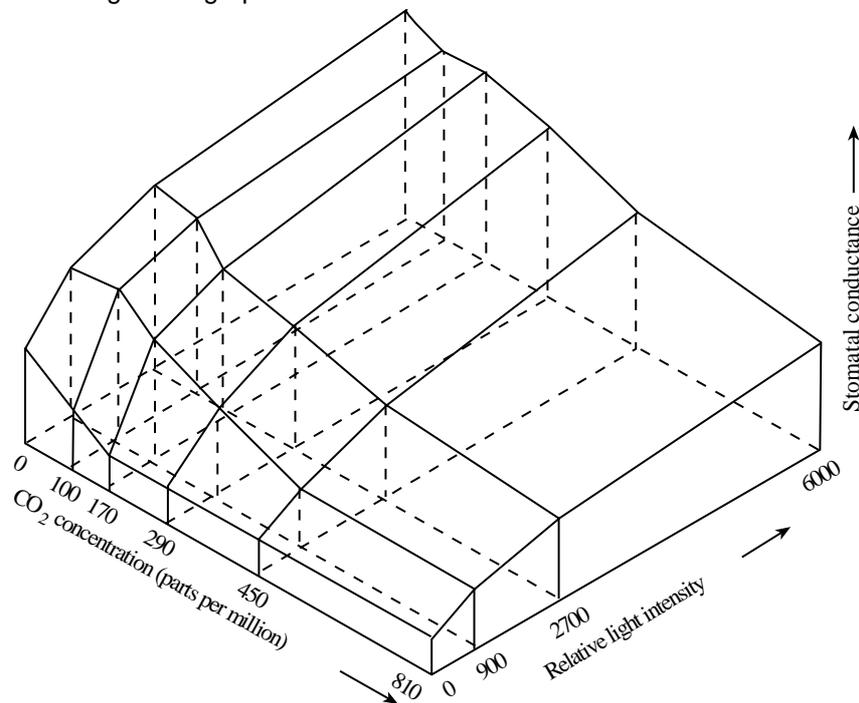
Humanids, dogids and catids have green ears.

Which of the following groups represents a possible evolution of the above characteristics, provided that each characteristic only evolved once?



Question 6

Measurements of the rate of diffusion through stomata ('stomatal conductance') were made under various CO₂ concentrations, and the following stereograph was drawn.



Which one of the following is a valid deduction from the stereograph?

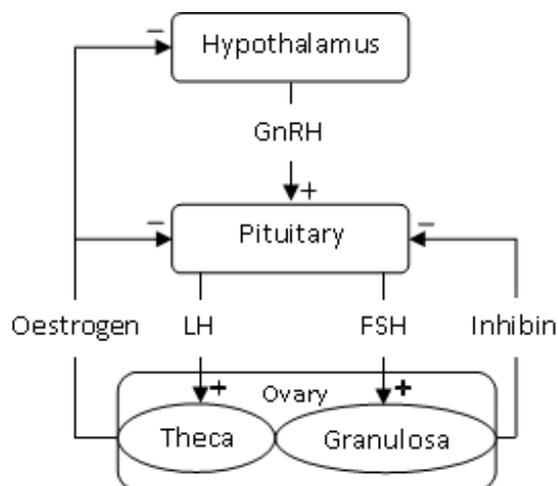
- A. Stomatal conductance is maximal when conditions for photosynthesis are optimal.
- B. Increasing light intensity increases stomatal conductance at all CO₂ levels shown.
- C. Stomatal conductance is unaffected by an increase in CO₂ concentration from 170 to 810 p.p.m.
- D. Changes in CO₂ concentration have a greater influence on stomatal conductance than changes in light intensity.
- E. Changes in light intensity have a greater influence on stomatal conductance than changes in CO₂ concentration.

Question 7

This diagram shows the female hypothalamic-pituitary-gonadal axis. Hormones are secreted from each of the organs. A "+" indicates a stimulation of secretion from the organ and a "-" indicates a decrease in secretion.

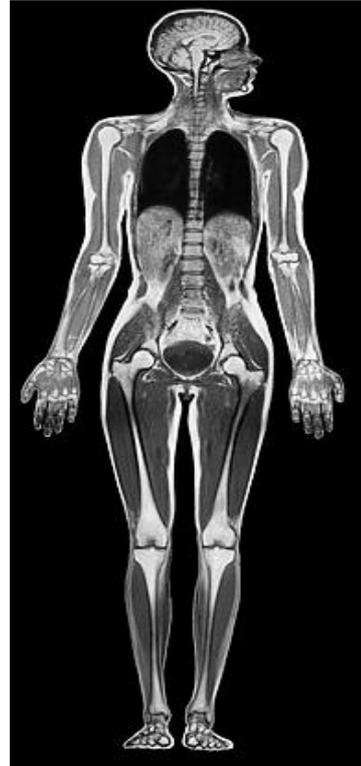
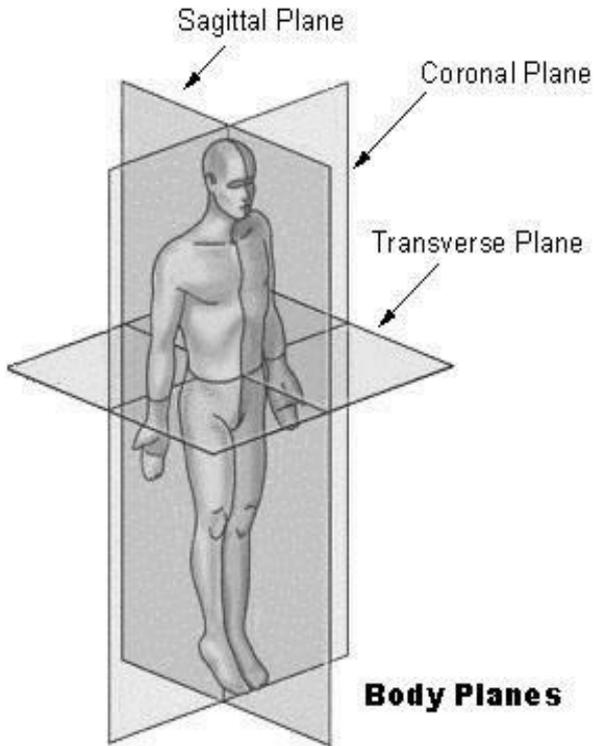
According to the diagram, a decrease in GnRH will cause:

- A. A decrease in oestrogen secretion.
- B. An increase in inhibin secretion.
- C. A decrease in GnRH secretion.
- D. An increase in FSH secretion.
- E. An increase in LH secretion



Question 8

The diagram on the left illustrates the different body planes anatomists and radiologists use when talking about structures within the human body.



Which plane would the picture on the RIGHT represent?

- A. Sagittal plane.
- B. Coronal plane.
- C. Transverse plane.
- D. Oblique plane.
- E. None of the above.

Question 9

A count was made of the number of cells showing different stages of mitosis in a zone of an onion root tip. The following results were obtained.

Stage	Percentage of total number of dividing cells
prophase	85.0
metaphase	7.7
anaphase	2.9
telophase	4.4

From this it can be deduced that:

- A. Prophase takes much longer than the other stages.
- B. The division process was just starting.
- C. Telophase is the shortest phase in mitosis.
- D. The sample used for the count was too small.
- E. The area investigated was very close to the root tip.

Question 10

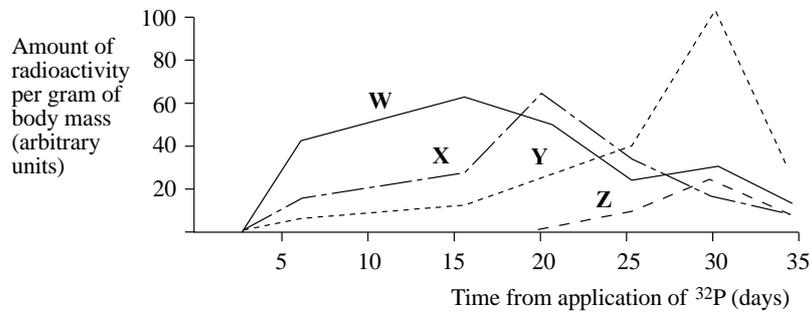
An 70 kg adult male has approximately 42 L of water in his body. Of this volume, 55% of the water is found within the cells and 45% of water is found outside the cells. For the water found outside the cells, 83.3% is found outside the blood vessels.

What is the approximate amount of water found within the blood vessels?

- A. 5.26 kg
- B. 6.43 kg
- C. 3.16 L
- D. 3.86 L
- E. 16.86 L

Question 11

Radioactive phosphate ($^{32}\text{PO}_4$) was applied to a plot of natural grassland. During the next 35 days, the radioactive content of samples from four species of arthropod was measured. The graph shows the relative amounts of radioactivity found in the four species, W, X, Y and Z.

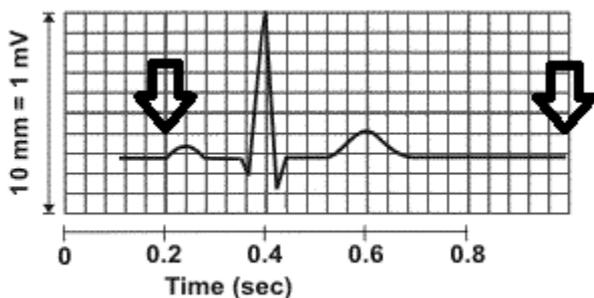


Which one of the rows A – E represents the organisms in the graph?

	W	X	Y	Z
A.	decomposer	herbivore	herbivore	carnivore
B.	herbivore	carnivore	decomposer	herbivore
C.	carnivore	herbivore	decomposer	herbivore
D.	herbivore	herbivore	decomposer	decomposer
E.	herbivore	herbivore	carnivore	decomposer

Question 12

The following diagram is what a nurse saw on a patient's ECG trace, which measures the electrical impulse passed by the heart in one heartbeat. The first arrow on the left signifies the beginning of the beat and the second arrow on the right signifies the end of the beat.



How many beats per minute did the nurse find in this patient?

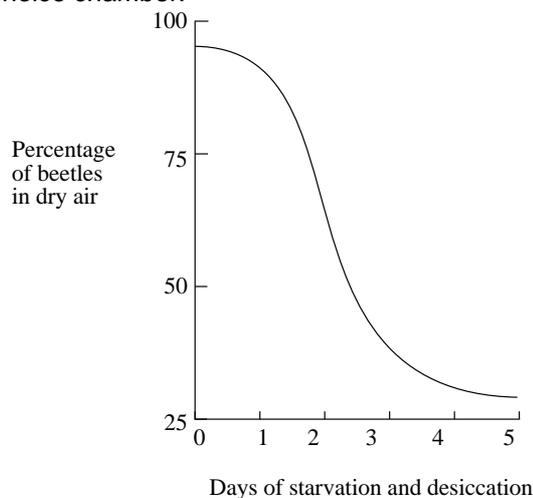
- A. 100 beats per minute.
- B. 75 beats per minute.
- C. 60 beats per minute.
- D. 54 beats per minute.
- E. 48 beats per minute.

Question 13

The graph shows the results of an experiment in which adult beetles of a species of *Tribolium* were starved and desiccated and then offered a choice of moist and dry air in a choice chamber.

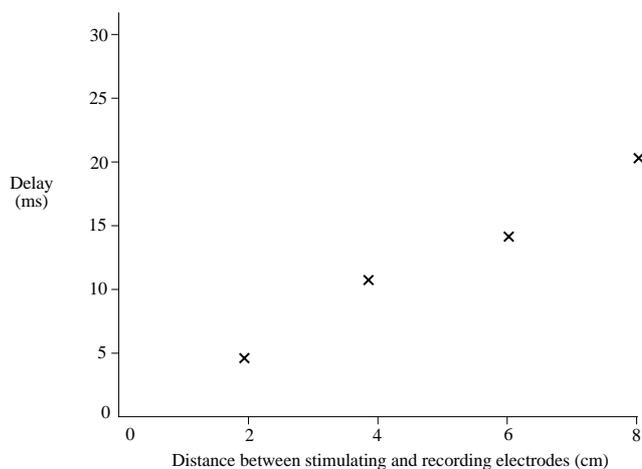
The **BEST** interpretation of these results is that

- A. The treatment reduces the beetles' response to humidity differences.
- B. The treatment reverses the beetles' normal preference for dry air.
- C. The stimulus of hunger overrides the stimulus of humidity.
- D. The stimulus of humidity overrides the stimulus of hunger.
- E. Desiccation leads to ALL beetles choosing a moist environment.



Question 14

In an experiment to measure the speed of conduction of a nerve impulse along a giant axon, the distance between the stimulating and recording electrodes was varied and the delay between stimulus and response was recorded for each distance. The results are shown in the graph below.



From these results the mean speed of conduction was found to be

- A. 2.0 cm s^{-1} .
- B. 2.5 cm s^{-1} .
- C. 0.5 m s^{-1} .
- D. 4.0 m s^{-1} .
- E. 6.0 m s^{-1} .

Question 15

The data below show how the incubation period of trout eggs in well-aerated water varies with temperature.

Temperature, °C	2	5	10	15
Incubation period (days)	205	118	4	27

The incubation period at 8 °C would be approximately

- A. 66 days
- B. 61 days
- C. 56 days
- D. 51 days
- E. 42 days

Question 16

A new medication, named "Beclopa" is currently undergoing trials to determine its effectiveness in lowering the blood pressure in patients presenting with hypertension (which is the increase in blood pressure above the normal level). The trials were done on two groups of patients (children and the elderly), where each group was divided into half (without the patient's knowing) and given either a pill containing Beclopa or a pill containing water (the control). The table below shows the percentage of patients who showed a significant decrease in blood pressure.

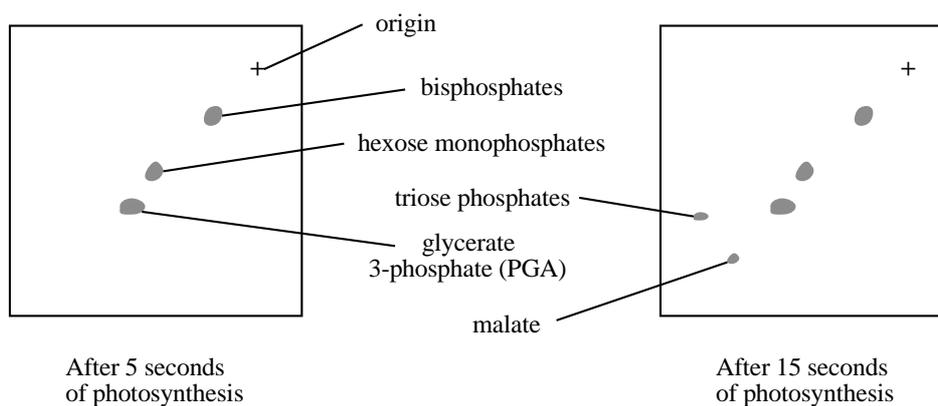
	Patients given pills with Beclopa	Patients given pills with water
Children	10%	11%
The elderly	80%	10%

Which of the following is true?

- A. Beclopa was more effective for the children than the elderly patients.
- B. Beclopa causes a decrease in blood pressure for all patients.
- C. Beclopa raises blood pressure in children.
- D. Beclopa has no effect on blood pressure in children.
- E. None of the above.

Question 17

Two cultures of algae were exposed to $^{14}\text{CO}_2$ for 5 seconds and 15 seconds respectively. They were then killed and the soluble products of photosynthesis extracted and used to produce the two chromatograms shown below.



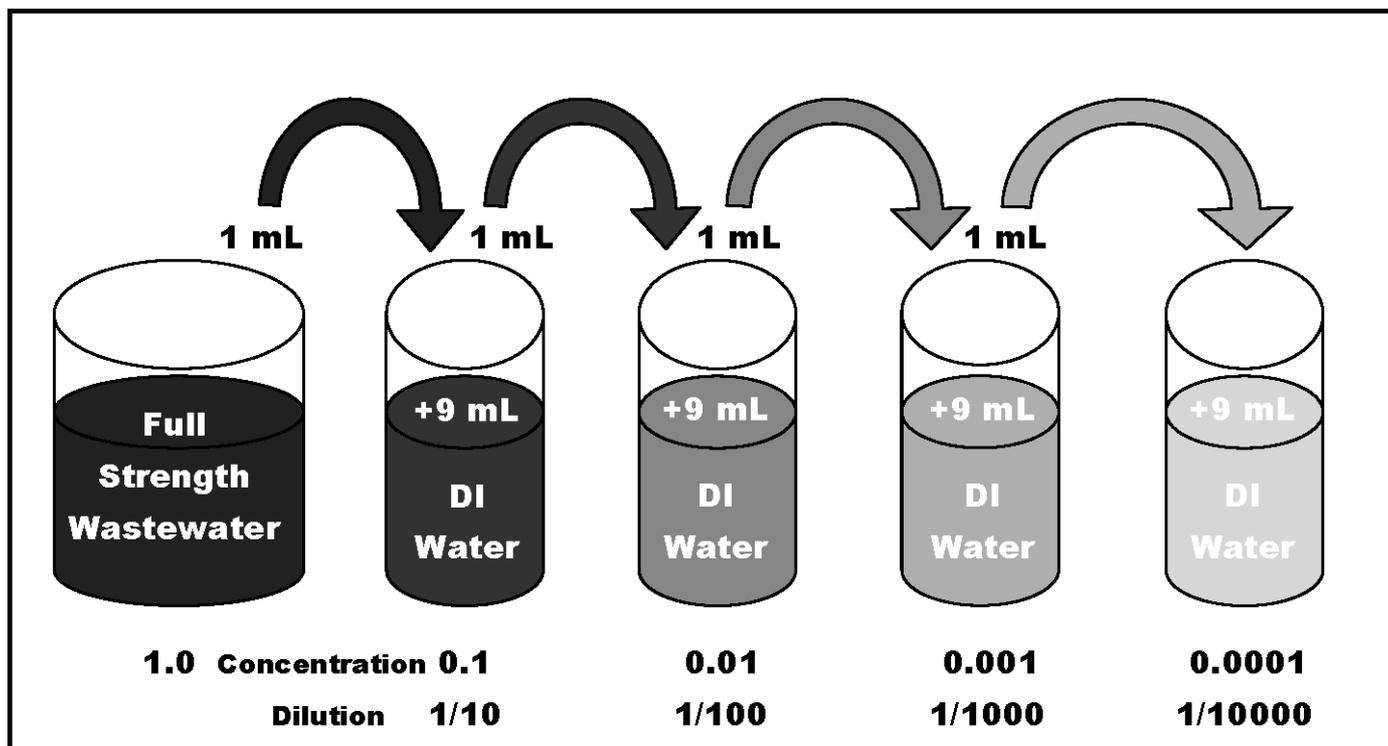
Which one of the following statements is a correct inference from the data?

- A. Glycerate 3-phosphate is the first product of CO_2 fixation.
- B. Malate is the last product of CO_2 fixation.
- C. Hexose monophosphates are unstable and break down into glycerate 3-phosphate.
- D. Glycerate 3-phosphate is converted to triose phosphate.
- E. Triose phosphates are formed after glycerate 3-phosphate.

Questions 18 & 19

Many laboratory procedures involve the use of dilutions. If a solution has a 1/10 dilution the number represents 1 part of the sample added to 9 parts of diluent. The dilution factor equals the final volume divided by the sample volume.

A serial dilution is any dilution in which the concentration decreases by the same quantity in each successive step. Serial dilutions are multiplicative. Multiple dilution series use different dilution factors at each step. An example of a serial dilution of wastewater with a dilution factor of 10 is given in the diagram below (DI, dilutant).



Question 18

In a haematology laboratory, a blood glucose of 800 mg/dL was obtained. (Note: dL is a SI unit of volume, the deciliter. 1dL = 100mL). According to the manufacturer the highest glucose result that can be measured accurately on this particular instrument is 500 mg/dL. The sample must therefore be diluted. The serum was diluted by taking 5mL of serum and adding to 95mL of blood diluting fluid and retested. The result obtained was 35 mg/dL. What was the blood glucose level of this patient?

- A. 800 mg/dL
- B. 700 mg/dL
- C. 665 mg/dL
- D. 400 mg/dL
- E. 350 mg/dL

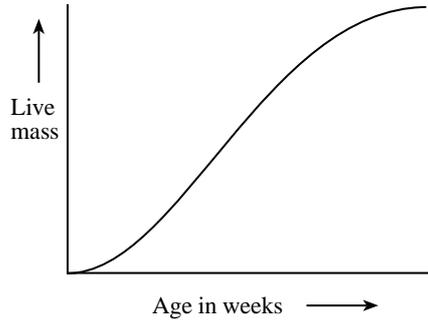
Question 19

A multiple dilution series was performed on a sample from a dairy farm's effluent pond. The sample was diluted initially by placing 25 mL of effluent into 75 mL of water. This solution was serially diluted by; 1/2, 1/5, and 1/10. The final sample had 80 faecal coliform cells per mL. How many faecal coliform cells were in the original sample from the effluent pond?

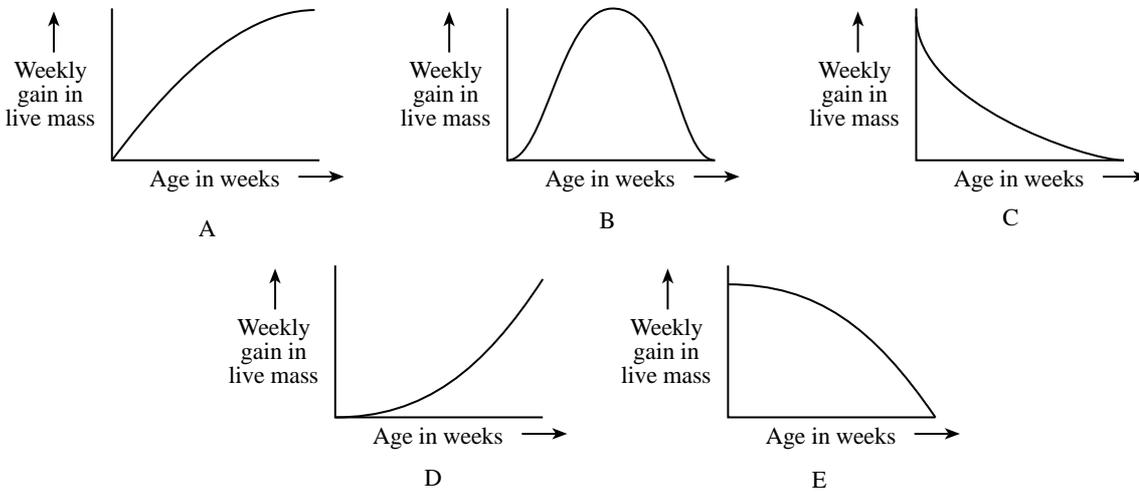
- A. 800,000 cells per mL
- B. 234,000 cells per mL
- C. 80,000 cells per mL
- D. 32,000 cells per mL
- E. 3,200 cells per mL

Question 20

The graph shows how the live mass of a sheep changes as it develops.

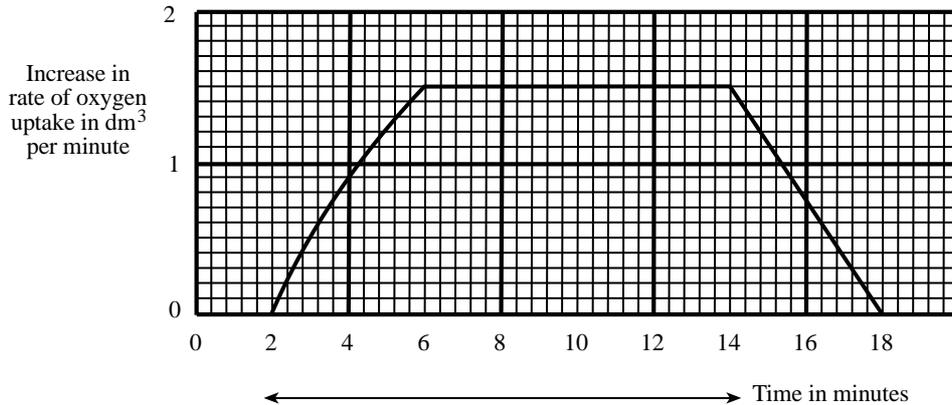


Which one of the following graphs (A – E) correctly shows the rate of change of live mass of the sheep over the same period?



Question 21

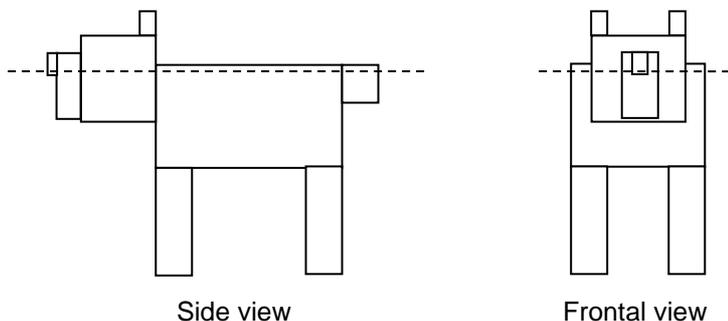
The graph shows the effect of exercise on the rate of oxygen uptake.



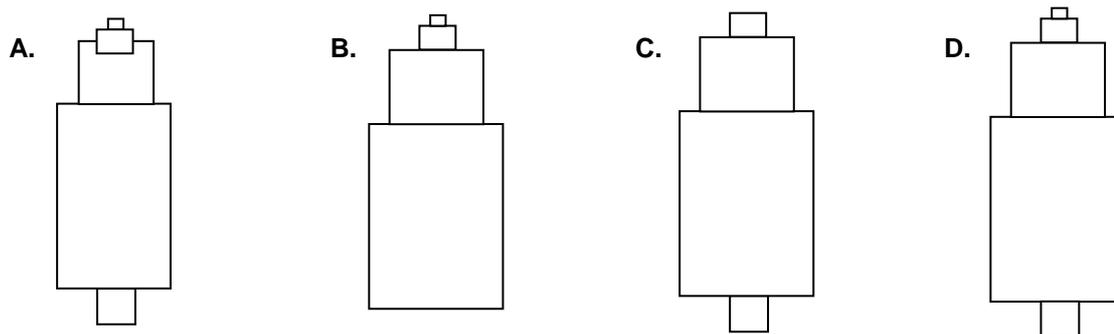
The total additional volume of oxygen used due to the exercise is approximately

- A. 12 dm³
- B. 15 dm³
- C. 18 dm³
- D. 20 dm³
- E. 24 dm³

Question 22

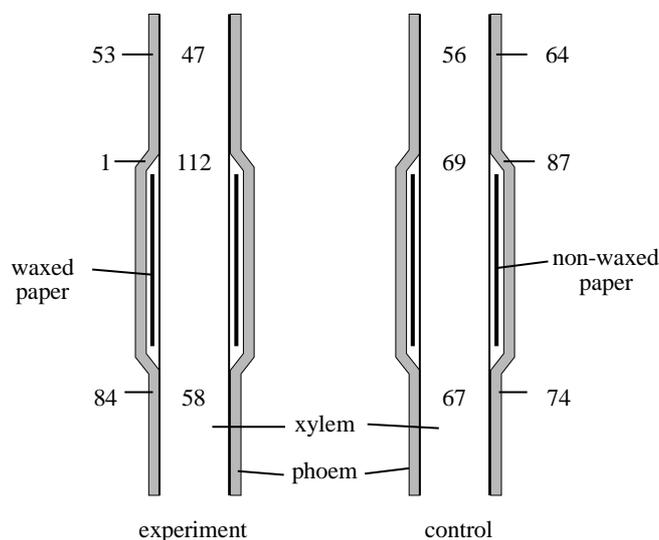


Which of the following shows a cross section through the dashed line?



Question 23

The phloem and xylem of an experimental shoot were carefully separated along part of their lengths, and a cylinder of waxed paper was placed between them. A control shoot was prepared using non-waxed paper. The base of each shoot was then placed in a solution containing a radioactive isotope of potassium. After five hours the radioactivity of different shoot regions was determined. The figures in the diagram give the location and concentration of radioactive potassium in parts per million.



The best interpretation of these results is that the transport of potassium ions:

- A. Is upward through the phloem.
- B. Is prevented by the insertion of paper cylinders around the xylem.
- C. Occurs longitudinally through both the xylem and the phloem.
- D. Occurs longitudinally through the phloem only.
- E. Occurs laterally from the xylem to the phloem.

Question 24

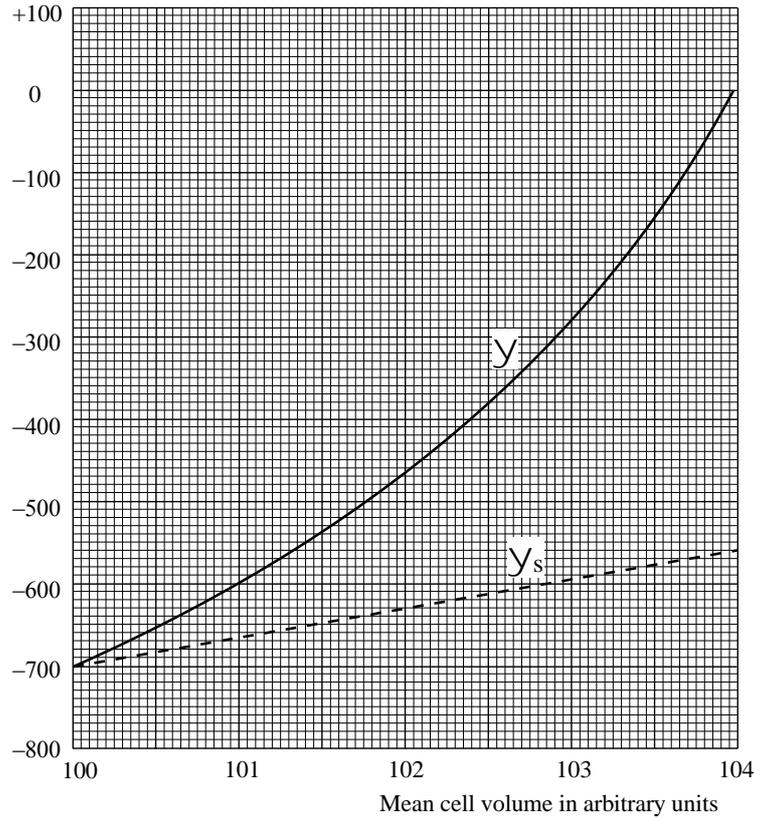
The graph shows the relationship between the volume, water potential (Ψ) and solute potential (Ψ_s) of plant cells immersed in a series of sucrose solutions of decreasing concentration. The cells were allowed to reach equilibrium with the bathing solutions, so that water was being neither lost nor gained, before the measurements were made.

Pressure potential Ψ_p is mechanical pressure. It increases as water enters a cell because the water present inside the cell exerts an outward pressure that is opposed by the structural rigidity of the cell wall. By creating this pressure, the plant can maintain turgor.

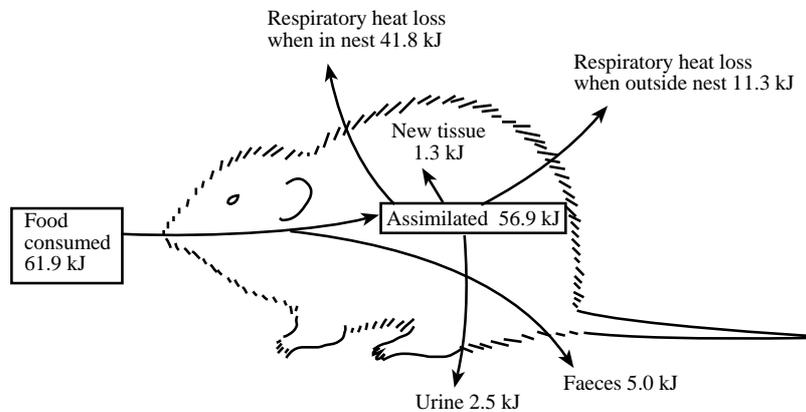
Water potential (Ψ) = pressure potential (Ψ_p) + solute potential (Ψ_s)

When the volume of the cell is 103 units, the pressure potential of the cell (Ψ_p) is

- A. - 320 kPa
- B. + 320 kPa
- C. - 590 kPa
- D. - 880 kPa
- E. + 880 kPa



Question 25



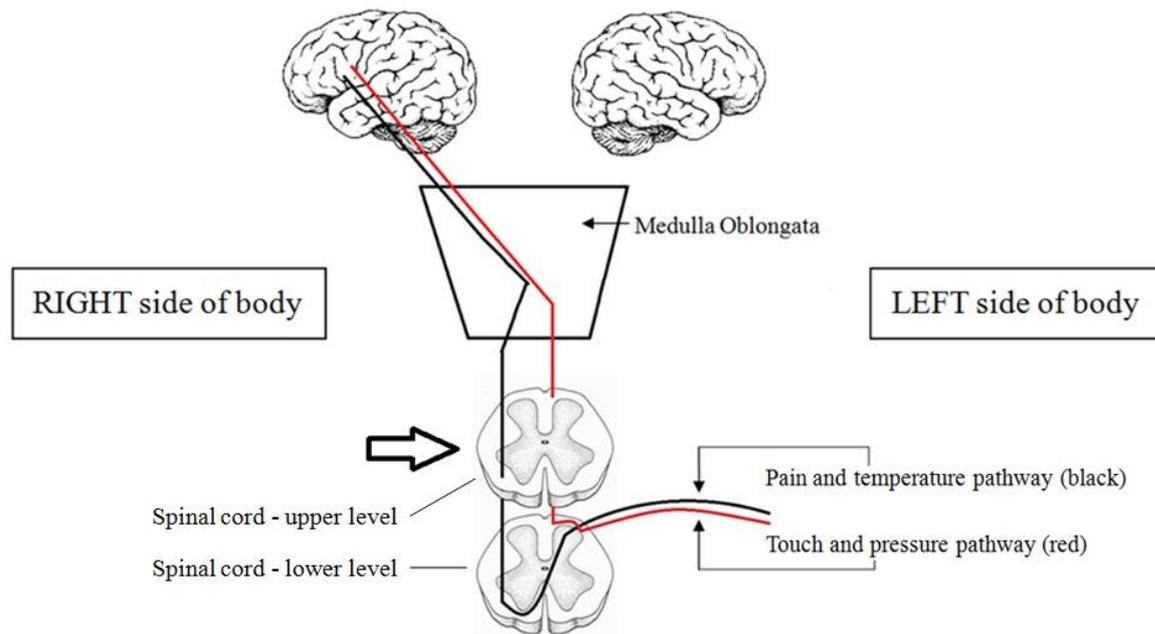
The diagram shows the daily energy budget of a small rodent weighing 23 g living in captivity during the summer.

The information in the diagram suggests that:

- A. Less than 1% of the food eaten is used for new growth.
- B. In captivity the vole spends most of its time in its nest.
- C. The rate of heat loss is lower when the vole is active.
- D. The vole's metabolism is adapted to warm weather conditions.
- E. The vole converts food into flesh more efficiently when in its nest.

Questions 26 & 27

The following diagram represents the pathways conveying the sensory information in the human body to the sensory part of the brain.



In brief, the pathway conveying touch and pressure (shown in grey) passes from the left side of the body to the spinal cord and ascends to the medulla oblongata, where it crosses over to the other side and reaches the sensory regions of the right brain. For the pain and temperature pathway (shown in black), the sensory information passes from the left side of the body to the right side of the spinal cord before ascending up into the medulla and finally onto the right part of the brain. The same process occurs for pain and temperature, and touch and pressure pathways from the right side of the body.

Question 26

From this information, what would happen if the right side of the spinal cord were cut (i.e. damaged) at the level indicated by the arrow?

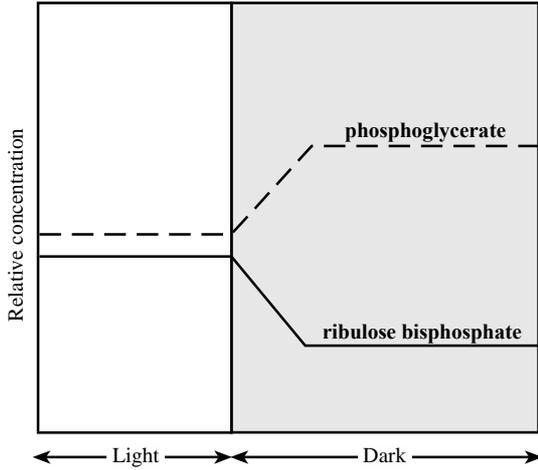
- There would be a loss in touch and pressure on the right side of the body and a loss in pain and temperature sensation on the left side of the body below that level.
- There would be a loss in touch and pressure sensation on the left side of the body below that level only.
- There would be a loss in touch and pressure on the left side of the body and a loss in pain and temperature sensation on the right side of the body below that level.
- There would be a loss in touch and pressure on the left side of the body and a loss in pain and temperature sensation on the left side of the body.
- There would be a loss of all sensation below that level, both touch and pressure and pain and temperature.

Question 27

Following from the previous question, what would happen if the medulla oblongata was completely damaged?

- There would be no loss of sensations.
- There would be no sensations coming from the left side of the body only.
- There would be no sensations coming from the right side of the body only.
- There would be a complete loss of sensation.
- None of the options is correct.

Question 28



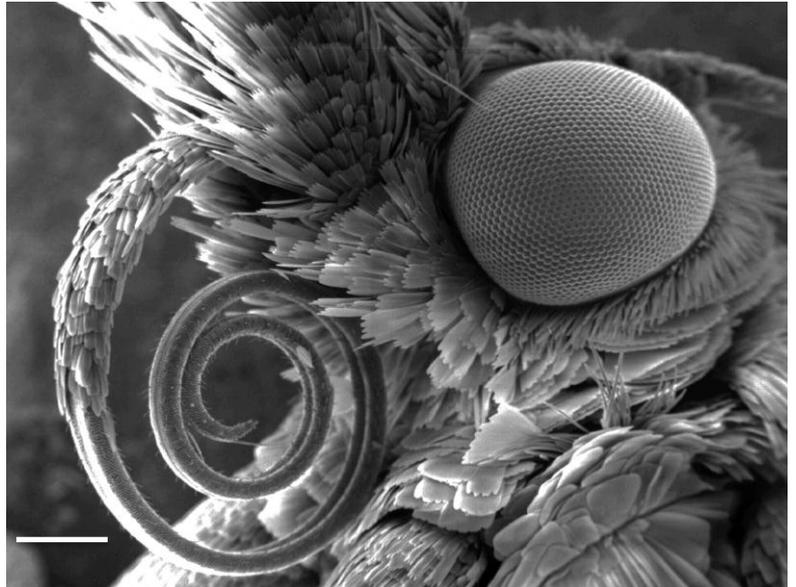
Which one of the following features of the graph does **NOT** provide support for the hypothesis that ribulose biphosphate is converted to phosphoglycerate? The concentration of the compounds

- A. Have similar concentrations at the start of the experiment.
- B. Respond immediately to the changed conditions.
- C. Achieve a new steady concentration at the same time.
- D. Have the same rate of response, one negative and the other positive.

The graph above shows the effects of a change from light to dark conditions on the relative concentrations of phosphoglycerate and ribulose biphosphate in a plant.

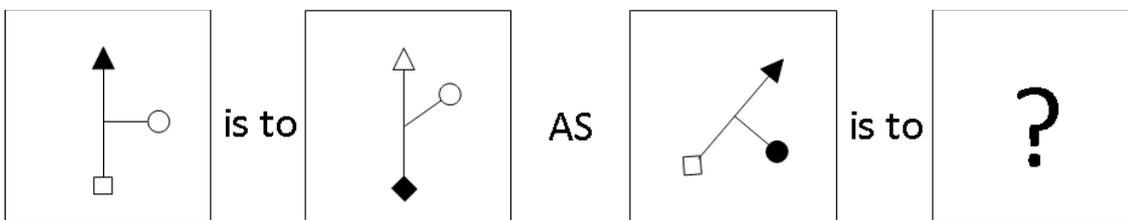
Question 29

The SEM photomicrograph of a moth at right shows the compound eye in great detail. What is the best estimate of the maximum horizontal width of this eye, given that the scale bar represents 200 μm ?



- A. 550 μm
- B. 600 μm
- C. 650 μm
- D. 700 μm
- E. 750 μm

Question 30

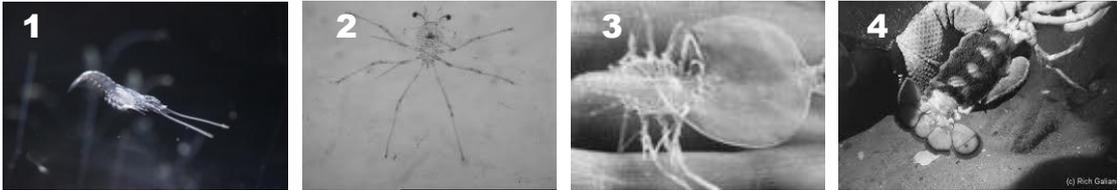


- A.
- B.
- C.
- D.
- E.

Question 31

The New Zealand crayfish, *Jasus edwardsii*, has a complex life cycle. The female attaches the fertilized eggs to her abdomen. The eggs hatch as a small spidery creature called a naupliosoma larva and are released by the female. The naupliosoma swims to the surface and moults, transforming into a leaf-like larva, known as a phyllosoma. In this form, the crayfish larva spends an extended period floating in ocean currents that carry it far from shore. At the end of this time, the final moult transforms the larva into a miniature transparent version of the adult called a puerulus larva. The puerulus swims back to the coast and settles, becoming a small coloured adult.

Place the photos of the crayfish life stages below into the correct order.



Photos are from <http://www.teara.govt.nz/en/crabs-crayfish-and-other-crustaceans/media> and www.wilderness.org.au

- A. 1, 2, 3, 4
- B. 1, 3, 2, 4
- C. 2, 3, 1, 4
- D. 4, 3, 2, 1
- E. 4, 2, 3, 1

Question 32

Imagine there is giant jellyfish. The jellyfish weighs 10 kg, and is 99% water by weight. The jellyfish washes up on the beach and the water evaporates from the jellyfish until it reaches 98% water by weight. How much does the jellyfish now weigh?

- A. 9.9 kg
- B. 9.8 kg
- C. 9 kg
- D. 8 kg
- E. 5 kg

Question 33

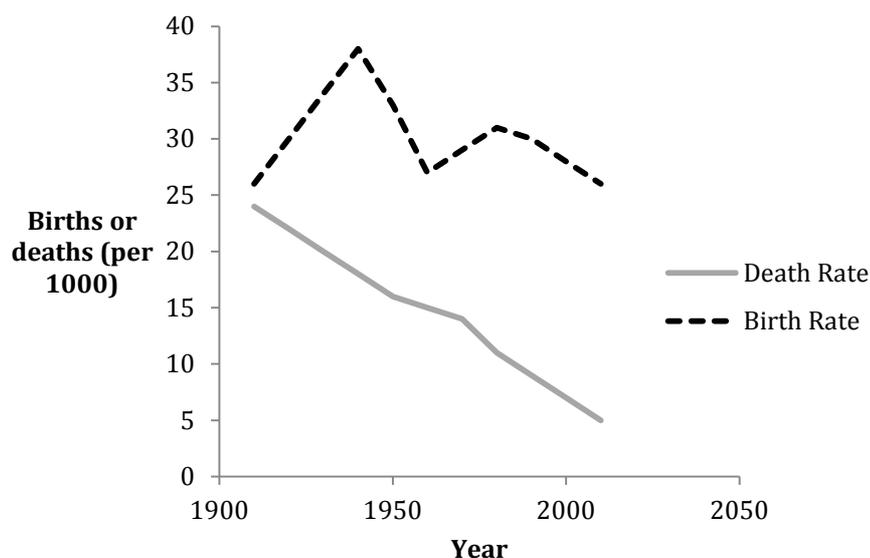
Spines and thorns on plants look similar, and both provide protection from herbivores. However, not all plants with spines or thorns have descended from a recent common ancestor. Spines are modified leaves, and thorns are modified stems.

Which of the following statements best describes how this information provides evidence for evolution by natural selection?

- A. It shows that different organisms sometimes look alike.
- B. It shows that herbivores are the strongest selection force on organisms.
- C. It shows that a variety of structures can be effective in protecting an organism from herbivores.
- D. It shows that environmental pressures can cause unrelated species to change in similar ways.
- E. It shows that spines and thorns provide the best protection from herbivores.

Question 34

The graph shows the birth rate and death rate for a population over a 100-year period.

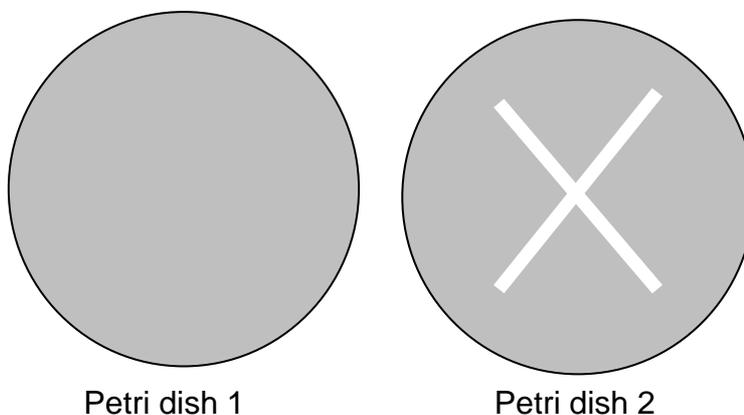


Assuming equal emigration and immigration, from 1900 to 2000, the population has

- A. Increased
- B. Decreased
- C. Stayed the same
- D. Increased until 1930, then decreased
- E. Fluctuated over the years

Question 35

A student filled two Petri dishes with a clear cornstarch gel, then marked the letter "X" invisibly onto the gel in Petri dish 1 with a damp cotton swab. He then placed saliva from his mouth onto a second cotton swab and used that swab to mark the letter "X" invisibly onto the gel in Petri dish 2.



Fifteen minutes later, the student rinsed both Petri dishes with a dilute solution of iodine to indicate the presence of starch. The entire surface of Petri dish 1 turned blue-black, indicating starch. Most of the surface of Petri dish 2 was blue-black, except that the letter "X" was clear, as shown above.

The most probable explanation of the clear "X" is that?

- A. The starch in the gel was absorbed by the damp cotton swab.
- B. The iodine reacted with a chemical in the saliva and broke down.
- C. A chemical in the saliva broke down the starch in the gel.
- D. The saliva prevented the iodine from contacting the starch in the gel.
- E. The cotton swab removed the iodine from the areas it touched.

Question 36

The pea weevil is a type of insect. The table below shows the average time it takes for pea weevil eggs to hatch at different temperatures.

Temperature (°C)	Average Hatching Time (days)
11	38
14	20
16	16
18	10
22	10
24	7
25	5
27	5
28	7

Based on the data, which of the following climatic conditions would promote the highest population growth rate in pea weevils?

- A. Cold springs with temperatures from 11°C to 16°C
- B. Moderate summers with temperatures from 25°C to 27°C
- C. Heat waves in which the temperature is sustained well above 28°C
- D. Overnight frosts after which the temperature warms from 0°C to 11°C
- E. Cold winters with the temperatures below 11°C

Question 37

Partial amino acid sequences for a particular protein in three animal species are shown below. Each letter in the sequence stands for an amino acid. For example, Q stands for glutamine, and L stands for leucine.

Which of the following statements best explains how these sequence data are used as evidence to determine evolutionary relationships?

- A. All species translate the amino acid sequences of their proteins in a similar way.
- B. The species that are most closely related have the most similar amino acid sequences.
- C. Individual organisms acquire changes in their amino acid sequences over their lifetimes.
- D. The organisms that evolved at the same time in geologic history have identical amino acid sequences.

Species	Amino Acid Sequence
Green junglefowl (bird)	QHEPHERKRM
Nile crocodile (reptile)	SHDPAQQKRL
Domestic chicken (bird)	QHEPHKRKRM

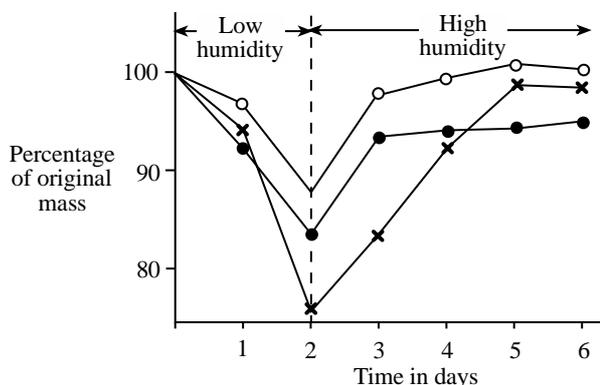
Question 38

Mary's father has five daughters: 1. Nana, 2. Nemu, 3. Nino, 4. Nomi. What is the name of the fifth daughter?

- A. Nune
- B. Nume
- C. Nunu
- D. Numu
- E. Mary

Question 39

The graph shows changes in mass of three individual sheep ticks when they were removed and kept for two days at low humidity and then four days at high humidity.



The best deduction from these data is that

- A. At high humidity ticks absorb water from the atmosphere.
- B. At day 6 the ticks have recovered their body water.
- C. The loss of mass during the first two days is due to starvation.
- D. Individual ticks contain different amounts of water.
- E. Individual ticks lose water at the same rate when held in low humidity conditions.

Question 40

Measurements were made on the growth of young spruce trees in a pure stand and in a mixture with pine trees. The density of trees in both stands was the same. The effect of providing the plants with a calcium and nitrogen source (basic slag) was also investigated at the same time. The results of these investigations on twelve-year old trees are shown in the table.

	Mean height of spruce trees in centimeters in:	
	Pure stand of spruce	Mixed stand of spruce and pine
Not treated	60	100
Basic slag applied after planting	95	130

Using only these data, which is the **BEST** interpretation?

- A. Spruce and pine are in competition with each other.
- B. The growth of pine is decreased by the presence of spruce.
- C. Calcium ions stimulate the growth of spruce more in mixed stands.
- D. The growth of spruce is increased by the presence of pine
- E. Pine trees grow faster with the addition of basic slag.

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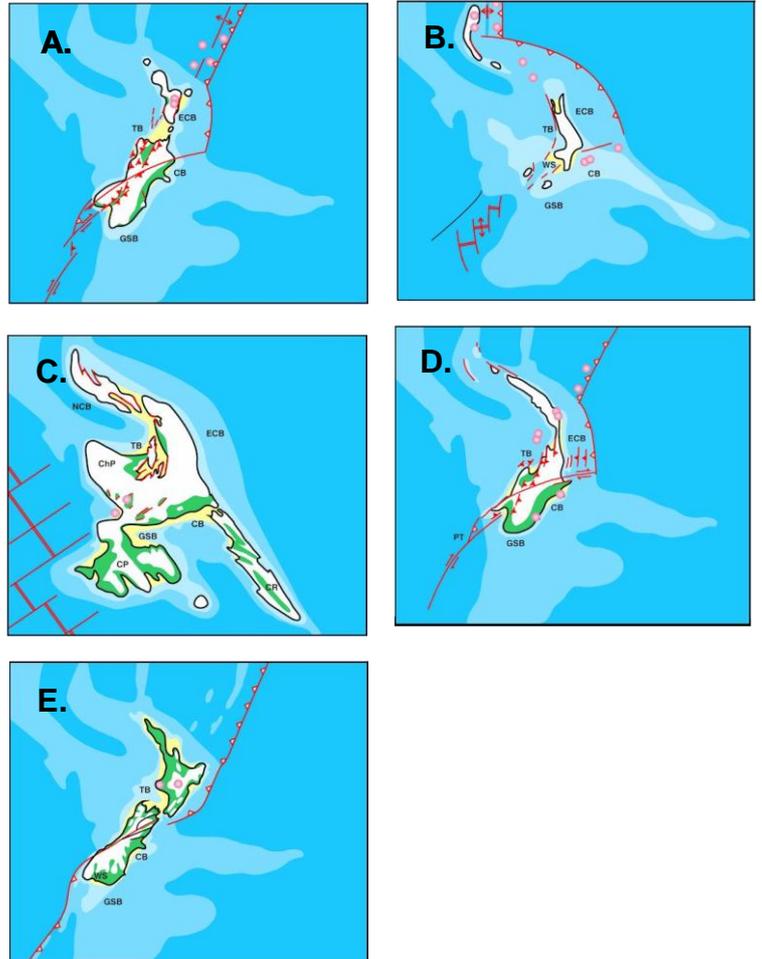
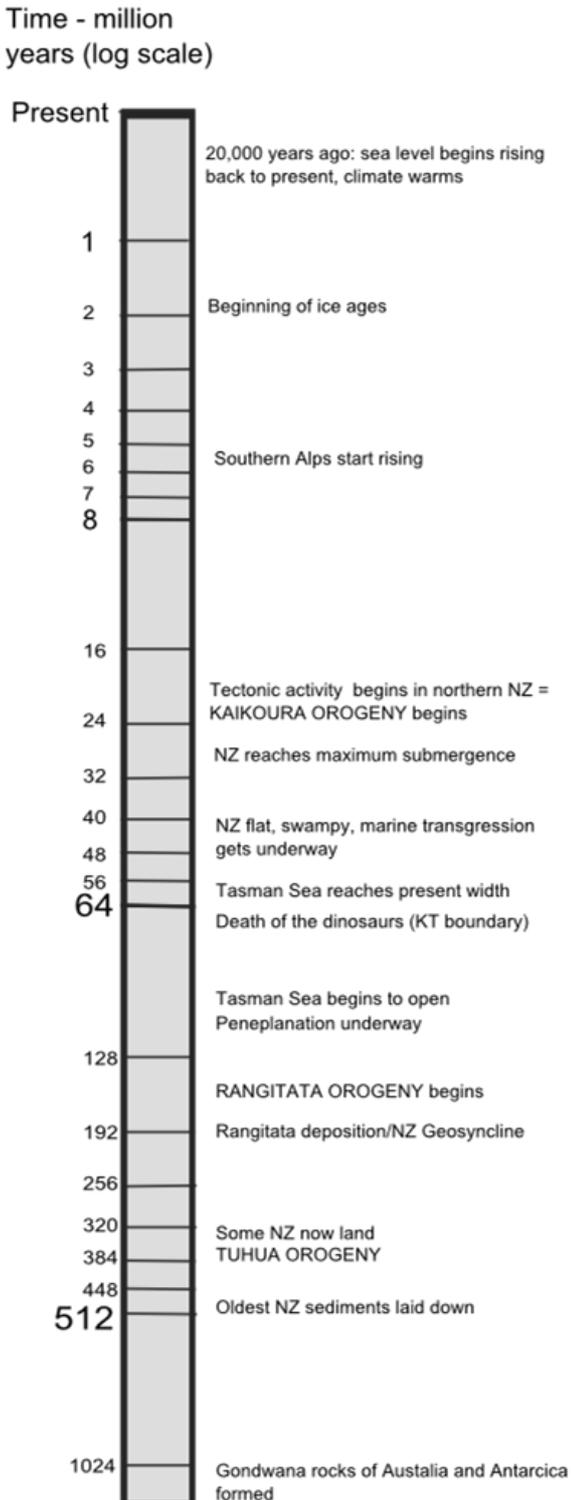
Section B

ZEALANDIA

New Zealand is the terrestrial part of a submerged continent called Zealandia, formed over a period of 500 million years. It was once part of the Gondwana supercontinent, and split off 80-60 million years ago when the Tasman Sea formed. New Zealand's complex geological history is mirrored in the complex patterns of evolution seen in New Zealand's flora and fauna.

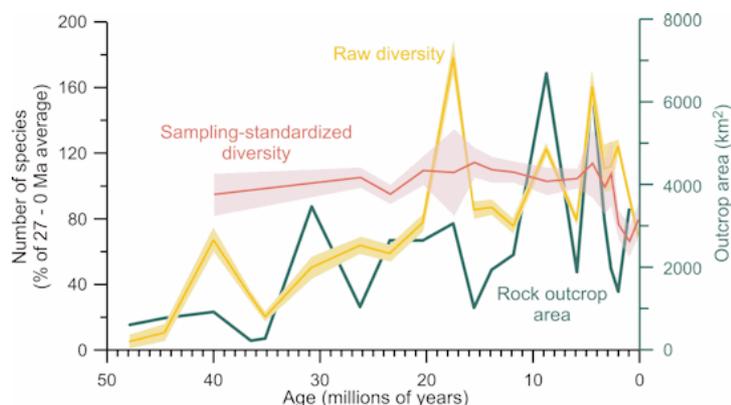
Question 41

Using the information from the geological timeline at left, place the paleo-geographical maps (A-E) of New Zealand below into the correct order.



- A. BC ADE
- B. BACDE
- C. CBDAE
- D. CABDE
- E. CDBAE

GNS scientist, James Crampton, and his research team have been using NZ's extensive, though imperfect, fossil record of molluscs (clams and snails) together with molecular data of living species to study evolution and the patterns of marine biodiversity change over the past 50 million years in the New Zealand region.



Question 42

This graph demonstrates that

- A. Diversity has increased over the last 50 million years.
- B. Diversity has remained more-or-less constant throughout the last 50 million years.
- C. Diversity has fluctuated significantly over the last 50 million years.
- D. Diversity has fluctuated widely but with an underlying increase over the last 50 million years.
- E. Diversity remained relatively constant for much of the last 50 million years but declined over the past few million.

The graph shows the diversity of New Zealand molluscs over the past 50 million years in relation to rock outcrop area.

The research team sequenced the genome of 11 species of New Zealand snails and compared this molecular information with detailed mathematical description of the shape of the shell and outline of the shell opening. The relationships between these species are shown in the cladograms below. A cladogram uses branching lines that end at groups of organisms. At the point of branching, a common ancestor is believed to have existed. Clades or groupings of organisms, are characterized by synapomorphies, characters present in the last common ancestor.

Question 43

Which species is inferred to be most closely related to *Alcithoe benthicola*?

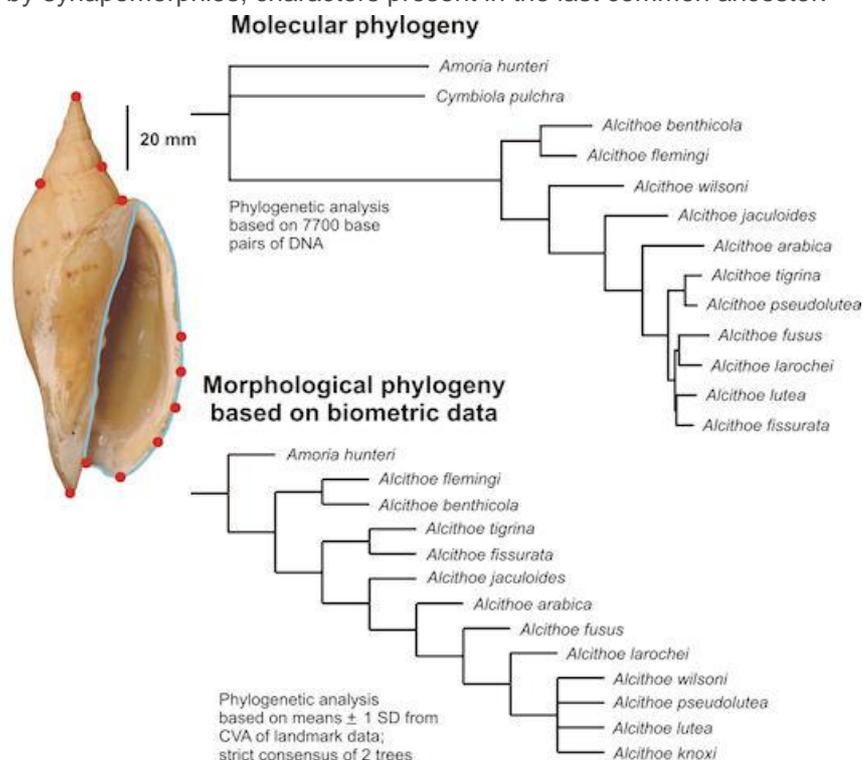
- A. *Alcithoe flemingi*
- B. *Alcithoe tigrina*
- C. *Alcithoe wilsoni*
- D. *Amoria hunteri*
- E. *Alcithoe fissurata*

Question 44

The results indicate significant congruence (agreement) between molecular and structural inferences.

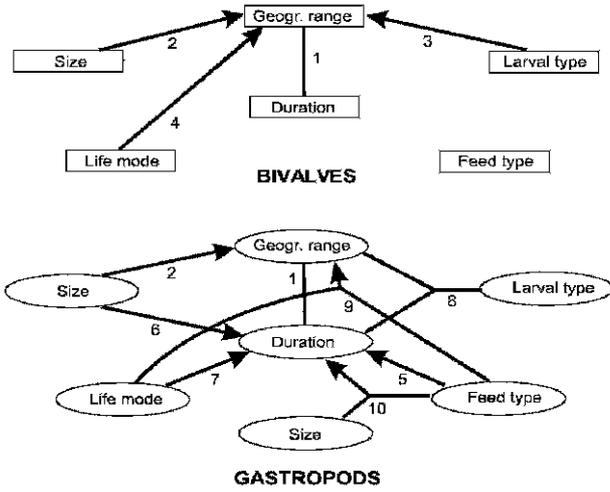
Which species is incongruent when these two phylogenies are compared?

- A. *Alcithoe benthicola*
- B. *Alcithoe wilsoni*
- C. *Alcithoe arabica*
- D. *Amoria fusus*
- E. *Amoria hunteri*



Question 45

There is consensus that factors such as geographic range influence species survivorship (species duration) in the fossil record with species with large geographical ranges surviving for longer periods. There is less agreement about the influence of factors such as body size and larval type. Crampton *et al.* 2010 looked at a variety of biotic influences on species duration. The relationships between duration, geographic range and these other traits are illustrated below for both bivalves (clams) and gastropods (snails).



- Key to interactions**
- 1 Widespread = long
 - 2 Large = widespread
 - 3 Planktotr. = widespread
 - 4 Epifaunal = widespread
 - 5 Carnivorous = long
 - 6 Large = long
 - 7 Infaunal = long
 - 8 Planktotr.+widespr. = long
 - 9 Infaunal+carniv. = widespr.
 - 10 Large+carniv = long

From these relationships it can be inferred that in gastropods:

- A. There is a direct relationship between a planktotrophic larval phase and a large geographical range.
- B. Larval type influences species survivorship but not geographical range.
- C. A planktotrophic larval phase has no influence on geographical range.
- D. A planktotrophic larval phase is associated with large range size and long duration in a three-way interaction.
- E. Larval type has no influence on species survivorship.

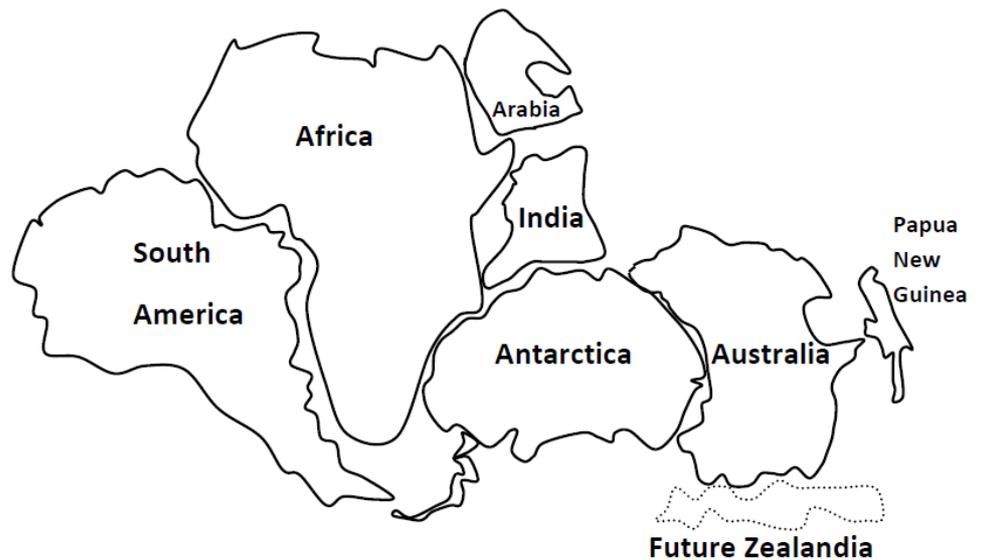
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RATITE EVOLUTION

Ratites are named for their flat “raft-like” sternum that lacks a keel and thus cannot provide sufficient anchorage for flight muscles to effectively generate the power required to fly. Cassowary (Australia and Papua New Guinea), Emu (Australia), Rhea (South America), Ostrich (Africa), Kiwi (New Zealand), and extinct Moa (New Zealand) are all examples of ground dwelling, flightless ratites. Given their large, flightless nature, biologists have proposed that they have all descended from a common ancestor present in ancient Gondwana before it broke apart. The exact timing and evolutionary origin of the Moa and Kiwi in New Zealand have been greatly debated in the scientific literature.

Geological History of Gondwana

- 180 mya Africa breaks free from Antarctica and India
- 130 mya South America breaks free of Africa
- 80 mya Zealandia breaks free
- 60 mya New Zealand separates from Australia
- 40 mya Australia separates from Antarctica
- 30 mya South America breaks from West Antarctica (Antarctica freezes over)



Flying Cousins

Ratites are one of only two groups of birds belonging to the “old jaw” *Paleognaths* originating in Gondwana, the other comprises the 47 living Tinamou species of Central and South America. Tinamou species are generally ground dwelling, though they do have wings that allow for limited flight.

It is generally accepted that loss of flight in birds is due to the development of successful foraging behaviours and diminished predation on eggs and nests.

Fossil Evidence

Examination of the oldest known Moa fossils, dating from 19 million years ago, determined they had thickened leg bones and no wing structures at all. At least two species of flightless Moa were present in New Zealand at this time.

The oldest Tinamou fossils in South America are 10 million years old.

The oldest Kiwi fossil dates back 1 million years. Though diminished in size, kiwis have wings and flight feathers. Kiwis are the only known bird to have nostrils at the end of their beaks and the only ratite with two functioning ovaries.

Question 46

Scientists have proposed that Moa and Kiwi share an immediate common ancestor. Which of the following statements would **BEST** support this hypothesis?

- A. They are both found in New Zealand.
- B. They are both flightless birds.
- C. Kiwi and Moa are not found outside of New Zealand.
- D. Without help, Kiwi are likely to go extinct.
- E. Oldest Kiwi fossils are much younger than the oldest Moa fossils.

Question 47

According to the estimated break up of Gondwanaland the **BEST** hypothesis is that?

- A. Ostrich and Cassowary are the most distantly related ratites.
- B. Tinamou and Cassowary are the most distantly related ratites.
- C. Kiwi evolved from Moa.
- D. Tinamou and Moa are the most closely related ratites.
- E. Moa evolved from Ostriches.

Question 48

Proportional to their body size, Kiwi have the largest egg of all the ratites. Which of the following inferences about Kiwi is **LEAST** likely to be true?

- A. Kiwi have evolved from a much larger species.
- B. Having two ovaries allows them to produce larger eggs.
- C. Kiwi have been flightless for a very long time.
- D. Larger eggs allow for better survival of Kiwi chicks.
- E. Larger eggs evolved after flightlessness.

Question 49

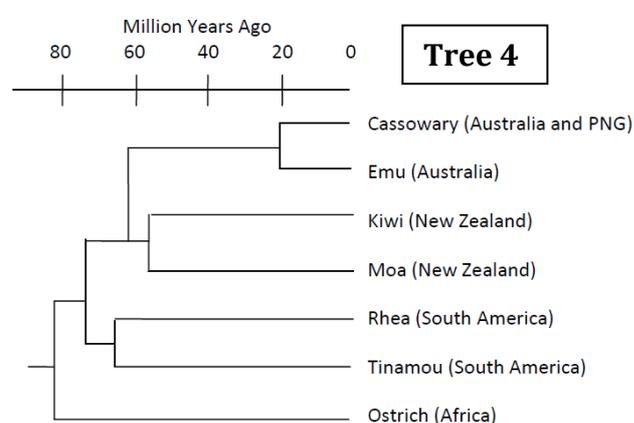
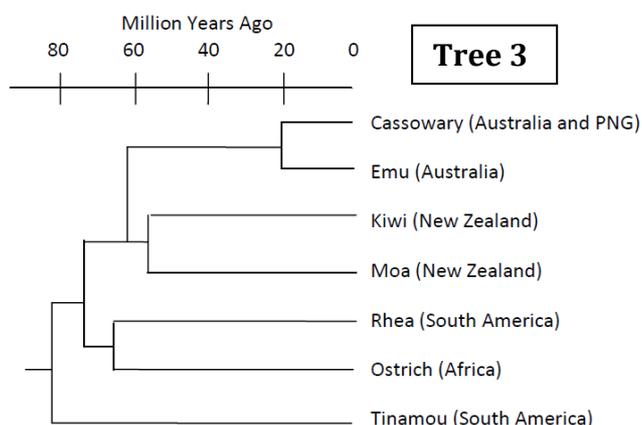
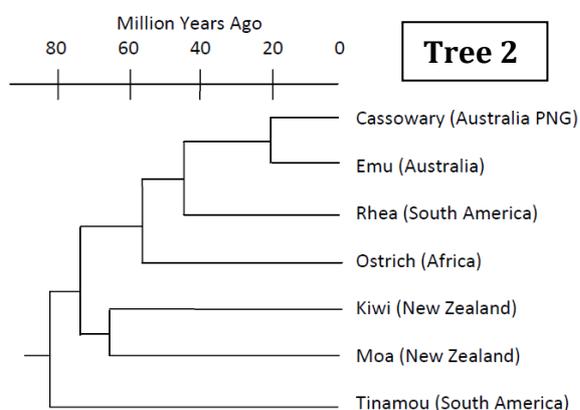
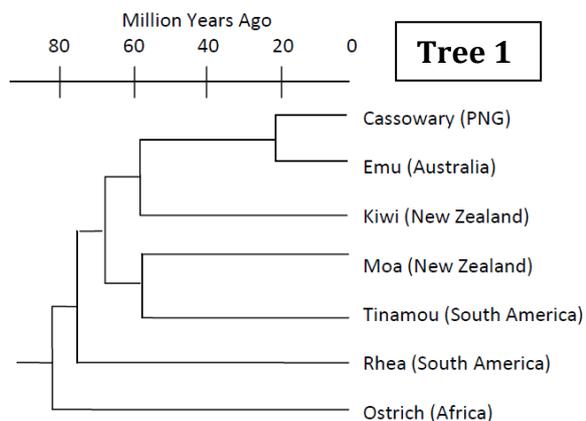
Tinamou are the only group of Paleognath birds that have the ability to fly. Which of the following is **LEAST** likely to account for their flying ability?

- A. A common ancestor became isolated from other Paleognaths prior to them becoming flightless.
- B. The rich biodiversity of South America provided a selective advantage for flying.
- C. Possessing wings provide benefits for Tinamou that are unrelated to flying.
- D. Possessing wings allows Tinamou to escape from ground dwelling predators.
- E. Tinamou evolved from a flightless bird that regained the ability to fly.

Continued on next page

Questions 50 - 53

Geological analysis suggests the initial separation of New Zealand from Gondwana took place approximately 80 million years ago. However, it is hypothesised that full separation was not complete until 60 million years ago. Some scientists propose that a common ancestor of the Moa and the Kiwi (a proto-Moa) floated away from Gondwana during this time. Others propose that Moa and Kiwi arrived in New Zealand at two different times. Four possible phylogenetic trees, describing different possible evolutionary relationships within the ratites, are shown below. Use these trees to answer the following questions.



Question 50

Which tree is most consistent with present day locations of Paleognath species?

- A. Tree 1
- B. Tree 2
- C. Tree 3
- D. Tree 4

Question 52

Which tree would support the hypothesis of a proto-Moa ancestor flying to New Zealand?

- A. Tree 1
- B. Tree 2
- C. Tree 3
- D. Tree 4

Question 51

Which tree incorporates mitochondrial DNA evidence showing that the Cassowary shared a common ancestor with Kiwi 60 mya and with Moa 70 mya.

- A. Tree 1
- B. Tree 2
- C. Tree 3
- D. Tree 4

Question 53

Which of the following provides the **BEST** evidence for two distinct migrations?

- A. Moa fossils are much older than Kiwi fossils.
- B. DNA analysis estimates that Moa and Kiwi each evolved into flightless species approximately 60 mya.
- C. Mitochondrial evidence suggests that Kiwi and Moa split from a common ancestor 80 mya.
- D. Moa have no wings, Kiwi still possess flight feathers.

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DEAR ENEMIES & NASTY NEIGHBORS

“Dear Enemy, I curse you, and hope that something slightly unpleasant happens to you, like an onion falling on your head.”

Blackadder I, The Archbishop

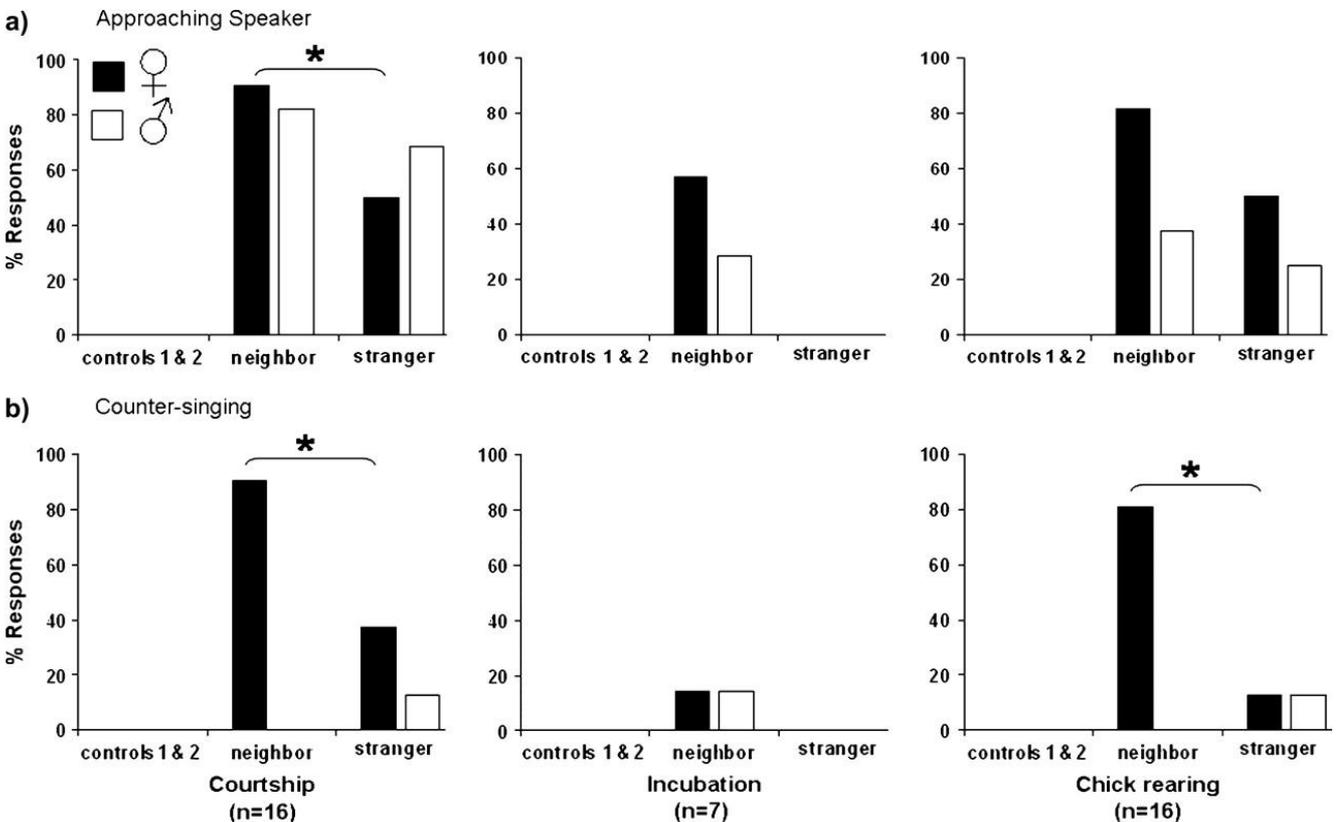
Many species show territorial behaviour (actively defending an area containing resources) allowing the species to monopolise resources such as food or mates. Territoriality is costly in terms of energy and time so some species reduce these costs by being less aggressive towards their neighbours than towards unfamiliar strangers, the so called “dear enemy” hypothesis. The converse are “nasty neighbours” in which species are more, not less aggressive towards their neighbours.



Dr Brunton’s research group, at the Institute of Natural Sciences at Massey University, has been studying the behaviour of the New Zealand bellbird, (*Anthornis melanura*) on Tiritiri Matangi Island. Both sexes sing prolifically and are known to use vocalisations to recognise individuals. Male and female bellbirds counter-sing in response to the vocalisations of their neighbours in a territorial behaviour that may lead to chasing of an individual bird intruding on a territory.



The researchers used speakers to play the song of neighbouring females or stranger females at different breeding stages. They recorded the responses of male and female bellbirds, including counter-singing and whether the birds approached the speaker. An asterisk indicates significant differences between the response to neighbours and strangers. Due to small sample sizes, the responses to the neighbours versus strangers were not tested during the incubation stage. Control 1 was silence, control 2 played back the song of a different species.



Using the information and the graphs above answer **Questions 54 – 58** on the following page.

Question 54

The average percentage of female bellbirds responding to playback of neighboring female song by counter-singing over the entire breeding season was?

- A. 90%
- B. 82%
- C. 77%
- D. 62%
- E. Unable to be determined

Question 55

During courtship, male bellbirds respond how much more frequently to the sound of a stranger female by approaching the speaker than by counter-singing?

- A. 88%
- B. 68%
- C. 56%
- D. 22%
- E. 20%

Question 56

Considering the differences in the behaviour of male and female bellbirds towards playback of female song, which of the following can be concluded from this research?

- A. Territorial male bellbirds are more likely to move towards a female intruder than their female partner.
- B. Female bellbirds were most territorial during courtship and chick rearing.
- C. Male bellbird territorial behaviours of all types are strongest during courtship.
- D. During the incubation period female bellbirds are more likely to counter-sing in response to an intruding female than are males.
- E. There were no significant differences between the territorial behavior of male and female bellbirds.

Question 57

Female bellbird counter-singing occurs at a much lower frequency during incubation. Which of the following is the **MOST** plausible explanation for this change in behaviour over the breeding season?

- A. Male bellbirds are likely to eat eggs that they discover so females remain quiet when incubating.
- B. Noise from the incubating female bellbird may attract predators to the nest resulting in a loss of eggs.
- C. Female bellbirds do not require any resources whilst incubating so they have no need to exhibit territorial behaviours.
- D. During incubation male bellbirds leave the area so females do not need to counter-sing.
- E. During chick rearing the female bellbirds need to communicate with their young so counter-singing increases.

Question 58

This research provides evidence for which of the following statements?

- A. The female bellbird responses support the “dear enemy” hypothesis.
- B. The female bellbird responses support the “nasty neighbours” hypothesis.
- C. The male bellbird responses support the “dear enemy” hypothesis.
- D. The male bellbird responses support the “nasty neighbours” hypothesis.
- E. Both male and female bellbird responses support “dear enemy” hypothesis.

AVOIDING FREEZING IN ANTARCTICA

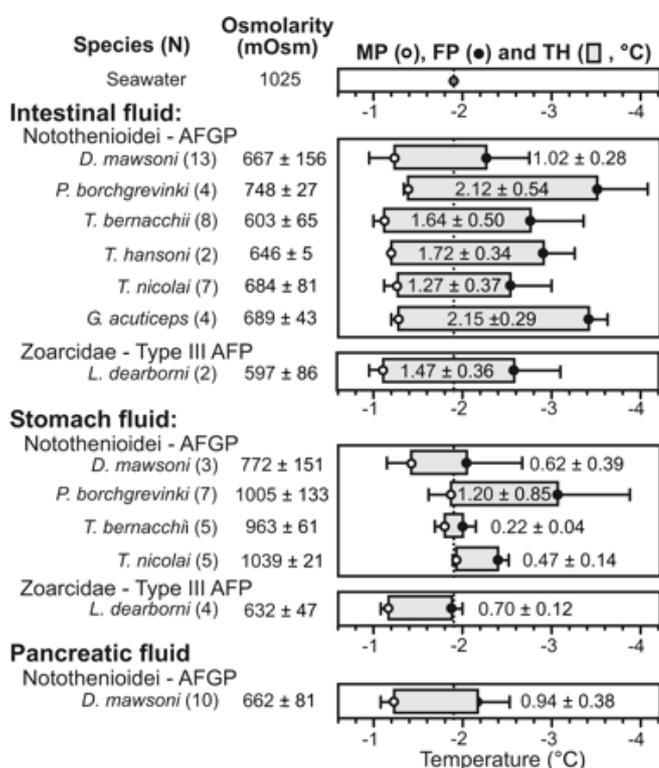
The research group of Associate Professor Clive Evans at the University of Auckland has an active Antarctic Programme investigating how fish avoid freezing in the frigid waters of the Southern Ocean surrounding Antarctica.

Seawater temperature hovers close to its freezing point of around -1.93°C throughout the year but most marine fish freeze at about -0.7°C so they cannot survive in the icy Antarctic waters. Notothenioid fishes (icefish) thrive in this freezing environment because they are able to produce antifreeze glycoproteins (AFGPs). AFGPs bind to and inhibit the growth of minute ice crystals that occasionally enter the fish, thus preventing their body fluids from freezing. This key evolutionary innovation allowed the icefish to colonize the frigid waters of the Southern Ocean some 5-15 million years ago.



Questions 59 - 61

Icefish risk freezing of the intestinal tract by swallowing ice in ingested seawater or food. This suggests that AFGPs should be present in the stomach and intestinal fluids to decrease the risk of freezing initiated by ingested ice. In the diagram below, the activity of antifreeze in these fluids is examined by measuring the difference between melting and freezing points in degrees Celsius, a measure of thermal hysteresis (TH). TH is represented by the gray box.



Cheng C C *et al.* PNAS 2006;103:10491-10496

Question 59

Examining this data, in which fluid is the TH particularly large

- Intestinal fluid only
- Stomach fluid only
- Pancreatic fluid only
- Both intestinal and stomach fluid
- All gastrointestinal fluids show equally high levels of TH

Question 60

The species of fish is written in italics on the left hand side of the diagram. Which species shows the greatest TH of the intestinal fluid?

- D. mawsoni*
- P. borchgrevinki*
- T. bernacchii*
- G. acuticeps*
- L. dearborni*

Question 61

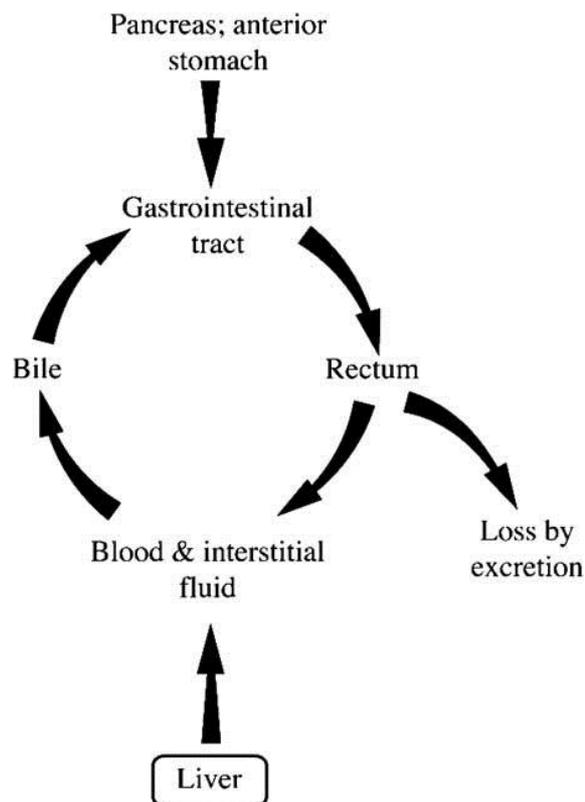
Which species has the lowest intestinal fluid freezing point (FP)?

- D. mawsoni*
- P. borchgrevinki*
- T. bernacchii*
- G. acuticeps*
- L. dearborni*

Questions 62 – 63

Interestingly, a recent paper by Evans *et al.* 2012 in Antarctic Science suggests that both Antarctic icefish and Arctic cods have evolved essentially identical AFGPs, which are synthesized and recycled in similar ways. This is an example of convergent evolution (where distantly related organisms independently evolve similar traits) in response to the identical problem of how to deal with internal ice in freezing environments.

AFGPs are synthesized in the exocrine pancreas in both groups of fish. They are then discharged into the gastrointestinal tract (gut) to inhibit the growth of ingested ice. AFGPs bound to ice are lost with the faeces or if unbound, absorbed from the gut in the rectum. AFGPs circulate in the blood and interstitial fluids where they are available to bind to ice crystals that may form. It is thought that AFGPs are phagocytosed by macrophages (engulfed by the cell) and build up in the macrophages of the spleen where they remain bound to ice crystals until a warming event occurs. AFGPs in the blood are ultimately secreted into the bile and re-enter the gut when bile is secreted for digestion. Arctic cods, unlike the Antarctic icefish, also synthesize AFGP in the liver.



Question 62

Describe one possible pathway of an AFGP molecule that encounters an ice crystal formed in the interstitial fluid of an Antarctic icefish in August (winter).

- Binds to the ice crystal in the interstitial fluid, enters the bile, is secreted into the gut, passed into the rectum and lost in the faeces.
- Binds to the ice crystal in the interstitial fluid, enters the blood and circulates to the liver, enters the bile, is secreted into the gut with the bile, passed into the rectum and lost in the faeces.
- Binds to the ice crystal in the interstitial fluid, enters the blood, is engulfed by macrophages, is stored in the spleen until a warming event occurs, is released from the ice crystal as it melts, circulates in the blood.
- Binds to an ice crystal in the blood, circulates to the liver, enters the bile, is secreted into the gut with the bile, passed into the rectum and then absorbed from the gut in the rectum to circulate in the blood.
- Binds to an ice crystal in the blood, enters the bile, is secreted into the gut with the bile, passed into the rectum where the ice melts and then absorbed from the gut in the rectum to circulate in the blood.

Question 63

Which of the following statements is **NOT** correct?

- Ice ingested with food is attached to an AFGP molecule and excreted with the faeces.
- In winter, ice bound to AFGPs accumulated in the macrophages of the spleen.
- AFGPs are recycled, conserving energy.
- AFGPs are found in interstitial fluid, blood, pancreas and gut fluids.
- Antarctic icefish synthesize AFGPs in both the exocrine pancreas and the liver.

MARINE BIODIVERSITY – THE CENSUS OF MARINE LIFE

The Census of Marine Life (2000–2010) is the largest global research programme on marine biodiversity. Its findings have recently been integrated in an article authored by Mark Costello who is based at Leigh Marine Laboratory, University of Auckland (PLoS ONE 5(8): e12110). The study found that many habitats were poorly sampled and that there are major gaps in our knowledge of marine organisms worldwide that limit our ability to understand species of economic and ecological importance.

Question 64 - 66

The table below gives the number of endemic plants, invertebrates, and vertebrates reported for specific geographic regions. Endemic species are those found only in one specific geographical area.

NRIC region	Plants	Invertebrates	Fish	Other vertebrates	Total	Number of species	% endemics
Antarctica	—	—	—	—	3,700	8,200	45
Australia	—	7987	1298	—	9,286	32,889	28
Baltic	1	0	0	0	1	5,865	2
Caribbean	—	868	704	1	1,573	12,046	13
China	142	1387	70	2	1,601	22,365	7
Japan	—	1508	364	0	1,872	32,777	6
Mediterranean	171	844	80	3	1,098	16,845	7
New Zealand	225	6014	278	43	6,560	12,780	51
South Africa	—	3269	280	—	3,549	12,715	28
Total	538	21,639	3,074	49	25,300	150,617	17

doi:10.1371/journal.pone.0012110.t004

Note: - means no specific data is available.

Question 64

Which area has the greatest proportion of endemic species?

- A. Antarctica
- B. Australia
- C. Japan
- D. New Zealand
- E. South Africa

Question 65

Which area has the greatest proportion of endemic invertebrates?

- A. Antarctica
- B. Australia
- C. Japan
- D. New Zealand
- E. South Africa

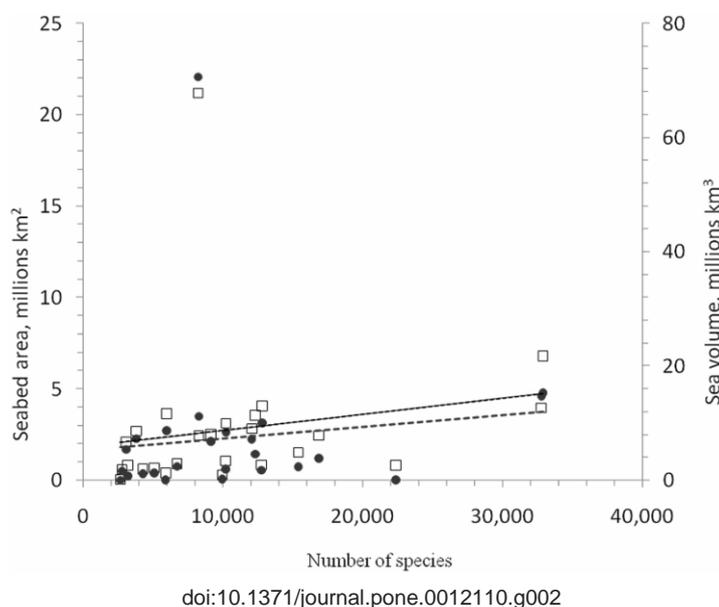
Question 66

Which of the following statements is **INCORRECT**?

- A. Antarctica has no endemic fish.
- B. Australia has the greatest number of reported marine species.
- C. The Baltic has low endemism.
- D. Japan has no endemic other vertebrates reported.
- E. South Africa has a high proportion of marine invertebrates that are endemic.

Question 67

The geographic regions with the most recorded species were Australia and Japan, each reporting over 32,000 species. However, South Korea, China, South Africa, Baltic Sea and Gulf of Mexico had the most species per unit area. The graph shows the relationship between total number of recorded species in each region to sea volume (solid dots, dashed line, millions km³), and seabed area (squares, solid line, millions of km²) with linear trend lines shown. The Southern Ocean, Antarctica, is the outlier at top left of graph.



From this information you can conclude:

- A. There are always more marine species in regions with a larger seabed area.
- B. Antarctica has an extremely low number of marine species given the sea volume and seabed area in this region.
- C. Australia and Japan had approximately the same number of species per seabed area.
- D. South Korea is represented by the square furthestmost to the right on the graph.
- E. There are always more marine species in regions with a larger sea volume.

Question 68 - 69

The Census of Marine Life also examined the global threats to marine biodiversity and these are summarized in the table below.

	Overfishing	Habitat loss	Pollution	Alien species	Temperature	Hypoxia	Acidification	Total	Median
Mediterranean	5	5	4	5	5	2	1	27	5.0
Gulf of Mexico	5	5	5	4	2	3	1	25	4.0
China	5	5	5	2	2	3	1	23	3.0
Baltic	4	3	4	3	4	3	1	22	3.0
Caribbean	4	4	4	4	2	2	2	22	4.0
USA Southeast	4	4	3	3	3	2	3	22	3.0
Brazil and Tropical West Atlantic	4	4	3	3	3	3	2	22	3.0
Humboldt Current and Patagonian Shelf	4	3	3	3	2	4	2	21	3.0
North Indian Ocean	3	4	4	3	3	2	2	21	3.0
Tropical East Pacific	3	3	3	3	3	3	2	20	3.0
South Africa	3	2	4	4	2	4	1	20	3.0
New Zealand	4	3	2	4	2	1	3	19	3.0
Atlantic Europe	4	2	4	2	4	1	2	19	2.0
USA Northeast	4	3	3	2	3	2	1	18	3.0
Japan	3	3	3	2	3	1	2	17	3.0
Canada (all)	2	4	2	2	5	0	1	16	2.0
Australia	3	3	2	3	2	0	1	14	2.0
Antarctica	2	2	2	0	1	0	2	9	2.0
Total	66	62	60	52	51	36	30		
Median	4.0	3.0	3.0	3.0	3.0	2.0	2.0		

Each threat was scored from 1 to 5 (minimum to maximum) across a comparative scale among different regions. Some regions (e.g., Australia) reported only known threats rather than predicted threats. Table is sorted by reported greatest threats and areas with greatest impacts. Median values of each threat and for each region are also reported.
doi:10.1371/journal.pone.0012110.t005

Question 68

Worldwide, the greatest threat to marine biodiversity is?

- A. Overfishing
- B. Habitat loss
- C. Pollution
- D. Alien species
- E. Temperature

Question 69

The region whose marine biodiversity is under the most threat from temperature changes such as global warming is?

- A. Mediterranean only
- B. Mediterranean and Canada
- C. Mediterranean and Baltic
- D. Canada and Baltic
- E. Canada only

NEW ZEALAND & BEYOND – MARINE PLASTIC POLLUTION, A GLOBAL ISSUE

Canterbury Museum ornithologist Paul Scofield, who does autopsies on 400 muttonbirds caught accidentally by fishing boats every year, has shown that most New Zealand seabirds have plastics in their stomachs. He has also found red Coke bottle tops, cigarette lighters, pieces of fishing buoys and other plastic material in Albatross colonies on Campbell Island, 700 km south of Bluff. He has also seen albatross chicks that have died because they had so much plastic in their stomachs there was no room for food.

Marine plastic pollution is a major threat to seabirds and of growing concern worldwide. Seabirds that feed on the surface of the ocean by dipping or scavenging, such as albatross, are at greatest risk. They can mistake pieces of plastic for their normal food of squid, crustaceans such as krill, fish eggs (typically attached to floating pumice and seeds) and fish larvae. Types of plastic ingested by albatross include single-use “user” plastic e.g. bottle caps, plastic toys, cigarette lighters, light sticks, industrial pellets known as nurdles, and fishing floats. Seabirds such as the albatrosses also eat fishing line.

Albatross feed their chicks by regurgitating food into the chick’s mouth. Plastics ingested in error by the adults are also fed to their chicks in this way. Albatross chicks regurgitate a bolus of indigestible remains just before they leave the nest to begin their ocean-going adult life. This bolus should contain the indigestible remains of fish (50%), squid (32%), crustacea (5%) and stomach oil (10%). In recent years studies have shown albatross bolus’ to contain natural indigestible materials, primarily squid beaks, and un-natural indigestible materials such as plastics. If the parents are feeding lots of plastics to the chicks the chicks grow more slowly as they become easily satiated (full feeling). Chicks can become so full of plastic that they are unable to regurgitate a bolus and die. (Information in this section is from: Oikonos, Ecosystem Knowledge. http://www.oikonos.org/projects/oceanstewardship_projects.htm and approved for educational use)



A recently dead Laysan Albatross chick with its belly full of plastic.

Photo: Claire Johnson/NOAA



Rinsing 306 pieces of plastic debris from the stomach of the albatross chick.

Photo: Claire Johnson/NOAA

Using the information provided in this paper, together with that provided **IN YOUR RESOURCE PACK**, answer the following questions.

Question 70

Squid possess hardened beaks used for gripping and ripping apart their prey. These beaks are extremely hard and indigestible. They are commonly found in the stomachs of seabirds and marine mammals that prey on the squid. Typically, these organisms regurgitate the indigestible beaks rather than allowing them to pass through the gut to be excreted with the faeces.



Count the number of “Extra large plastic fragments” in Bolus 1 and **record your answer on your answer sheet**.

Question 71

We can investigate the composition of a bolus in detail and then compare how similar different bolus' are using a Percent Similarity Index (PSI). Total PSI values of 100 indicate 100% overlap; values of >80% can be considered similar.

Bolus 3 and 4 have been analysed for you and the results recorded in the table. You are to calculate the PSI by choosing the smallest value of the percent numerical abundance (% NA) for each item and entering this value in the PSI column at right. The first PSI value for squid beaks has been done for you. The PSI values are then summed to obtain overall PSI (dark grey box at bottom right). Record your value for the overall PSI (rounded to the nearest whole number) on your answer sheet.

	Bolus #3		Bolus #4		PSI
	Count	%NA	Count	%NA	
Squid beaks	47	37.0	63	43.4	37.0
Fishing line	4	3.1	3	2.1	
Whole Plastic Items eg bottle caps	2	1.6	5	3.4	
Extra large plastic fragments (≥50 mm)	0	0	0	0	
Large plastic fragments (≥.20 mm and < 50 mm)	4	3.1	6	4.1	
Medium plastic fragments (< 20 mm and ≥10 mm)	5	3.9	8	5.5	
Small plastic fragments (<10 mm)	62	48.8	55	37.9	
Other	4	3.1	4	2.8	
TOTAL	127		145		

Note: % numerical abundance (NA) for each item in each bolus is calculated as follows: % NA = count/total*100

Question 72

Calculate the length of the piece of white plastic second from the top in Bolus 2. Record this value on your answer sheet.

Question 73

You will note when looking at the dissected bolus' that coloured plastic is more common than transparent and that much of the plastic is red or orange, rather than blue. What is the **LEAST LIKELY** inference that can be drawn from these observations?

- A. Albatross select specific colours, mistaking them for prey items such as crustaceans.
- B. Albatross are non-selective feeders and consume plastic debris in proportion to its abundance.
- C. Transparent items are harder to see and are therefore seldom consumed by albatross.
- D. Coloured plastic items are more easily seen and therefore consumed by albatross.
- E. Blue plastic items are harder to see and are therefore seldom consumed by albatross.

Question 74

About 80% of marine debris comes from sources on land and much of this debris is plastic. Charles Moore from Algalita Marine Research Foundation first published an article about marine debris in the November 2003 issue of the Journal Natural History. He showed that the dominant feature in the North Pacific Ocean is the North Pacific Gyre, a large water mass that is rotating in a clockwise direction and can trap debris originating from across the Pacific. Floating debris accumulates in the "eastern garbage patch", an area the size of Texas. There is approximately 250 g of plastic for every 100 m² of sea surface in the "eastern garbage patch".

Scientists use satellite telemetry to track the movement of albatross. IN 2004 9 albatross where fitted with satellite tags and their position recorded from July to October.

With reference to Figure 3 in your Resource Pack, which Albatross is likely to have ingested the MOST plastic debris?

- A. bfal_36634 (red)
- B. bfal_36635 (peach)
- C. bfal_36636 (blue)
- D. bfal_36639 (lime green)
- E. bfal_36641 (pink)

Question 75

Three factors influence the incidence of seabird ingestion of plastics: (1) foraging mode, (2) habitat use and (3) body size. Far-ranging species that feed opportunistically at the sea surface are most susceptible to plastic ingestion. Surface feeders have a greater rate of plastic ingestion. Diving birds also eat plastic but are not as susceptible as surface feeders. Oceanic species - which commonly range over vast areas in search of broadly distributed prey – seem more prone to plastic ingestion than coastal species – which target dense aggregations of fish and zooplankton prey. Finally, because larger seabirds consume larger prey items, large-bodied species often ingest larger plastic fragments.

Seabirds in New Zealand come from four orders:

- Sphenisciformes – penguins
- Procellariiformes – albatrosses, shearwaters and other petrels
- Pelecaniformes – shags, gannets and their kin
- Charadriiformes – terns, gulls and skuas.

Penguins live only in the southern hemisphere. Of all the birds, penguins are the most accomplished divers, with some species capable of reaching depths of 100 metres or more. Their small wings or flippers, stiff oily plumage, dense bones and thick fat deposits are all adaptations to diving. They catch fish, crustaceans (such as krill) and squid by underwater pursuit.

The order Procellariiformes has about 124 species around the world. They range in size from tiny 35-gram storm petrels to huge albatrosses weighing in at 9 kilograms, with a 3.5 metre wingspan. These birds find all their food at sea, and most species come to land only to breed. Petrels and shearwaters are adept divers – some shearwaters regularly dive to 60 metres. Storm petrels, prions and albatrosses obtain their food close to the water's surface.

Shags pursue their prey under water, using their feet to propel themselves whereas gannets sight fish while flying overhead and capture them by plunging into the water.

Most members of the order Charadriiformes are not marine species. Gulls and some terns take a large proportion of their food ashore or from freshwater habitats. However, some tern species and all skuas are largely marine, and both of these groups have New Zealand representatives. Marine terns such as the white-fronted tern (*Sterna striata*) feed by dipping – hovering above the water then dropping to catch surface-shoaling fish. Skuas are well-known predators of eggs, chicks and small birds at seabird colonies but they do in fact take a large proportion of their food at sea, often by harassing smaller seabirds and forcing them to regurgitate their food. (information from Te Ara The encyclopedia of New Zealand).

Which of the following New Zealand seabirds would be at **MOST** risk of harm from marine debris?

- A. Little Blue penguins
- B. Shearwaters
- C. Storm petrels
- D. Australasian gannet
- E. Skua

We all have an obligation to learn about our planet and to protect it from harm. NZIBO hopes you have enjoyed this exam and have learnt a little about the biological scientists working in New Zealand to understand and protect our wonderful planet. We wish you well with your biology studies this year, regardless of whether you are selected for the tutorial programme. Thank you for taking the time to sit this exam.