NATIONAL ENTRANCE EXAMINATION – August 2014

Examination Date: Wednesday 20 August 2014

Total Time allowed: 2 hours.

This examination consists of 75 questions. Students are advised to allocate equal time to each question (1.5 minutes per question with 7.5 minutes for checking of answers). Marks will not be deducted for incorrect answers.

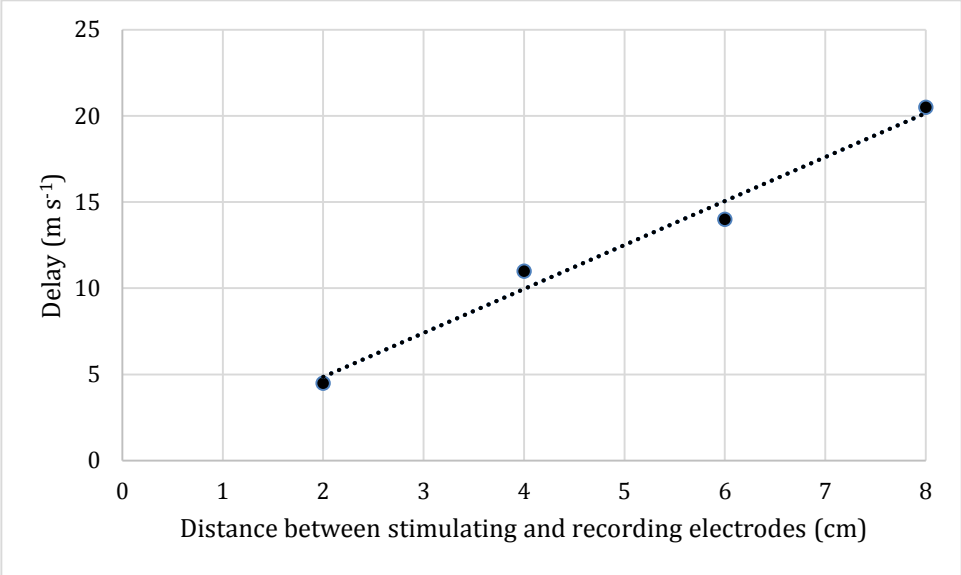
Equipment: BLACK Ballpoint pen **ONLY**, eraser, ruler, and calculator.

Please make sure your teacher **photocopies** the completed InspiroScan answer sheet and keeps a copy for his/her records. Your teacher needs to place the **original InspiroScan answer** sheets in the courier bag provided and **courier** to Massey University **immediately.**

Section A

Question 1

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.

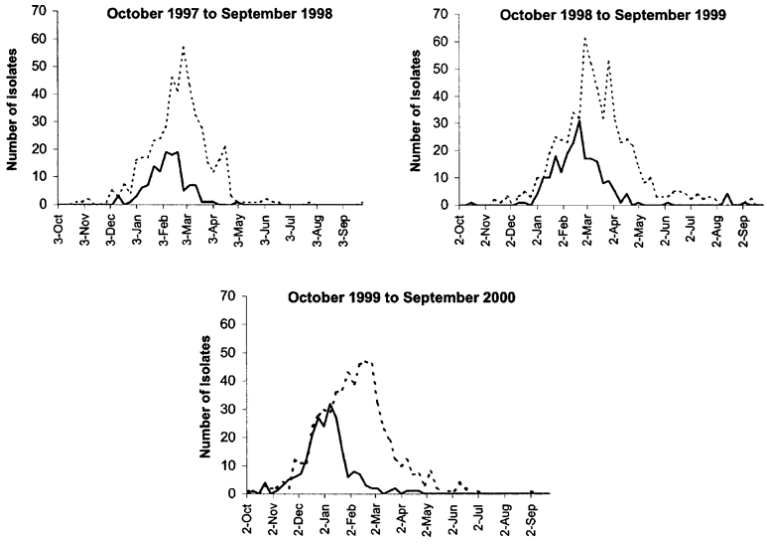


From these results the mean speed of conduction was found to be:

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 2

The graphs show the number of isolates of influenza (solid black line) and respiratory syncytial virus (dotted line), that were found in samples taken from people (mainly children) in Seattle, Washington.
http://cid.oxfordjournals.org/content/37/2/201.full



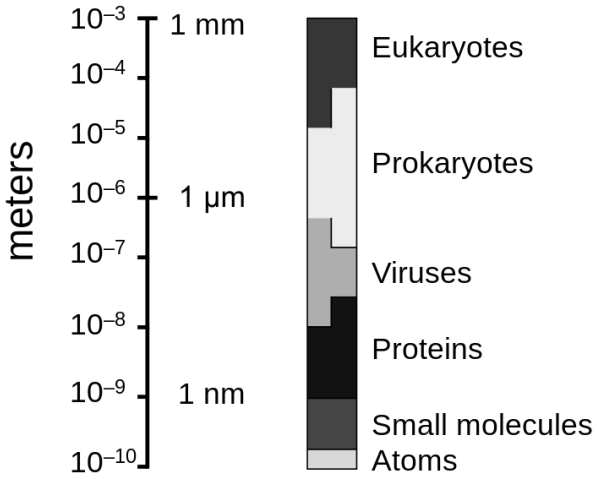
What can be concluded from these data?

A. You cannot catch the flu in summer.
B. Medical treatment works in individual patients after about two months.
C. Influenza infection always peaks in February.
D. Virus epidemics follow predictable patterns.
E. Respiratory syncytial virus kills more people than the flu each year.

Question 3

The following diagram shows the relative scale of different things. According to this diagram what is the approximate size range of typical viruses.

A. 0.1µm – 0.8mm
B. 0.1µm – 0.8µm
C. 0.00001m – 0.0008m
D. 10nm – 80nm
E. 10nm – 800nm



Question 4

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 bursts of light for 5 - 10 seconds duration, followed by dark periods. Photosynthesis took place in both samples, but more occurred in sample I. 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 5

Find the four-digit number designated by asterisks, given the following:

- All four digits of the unknown number are different.
- None of the digits is zero.
- Each "0" on the right of each four-digit number below indicates that the number has a matching digit in a non-matching position with the unknown number.
- Each "+" on the right of each four-digit number below indicates that the number has a matching digit in a matching position with the unknown number.

```
6152   +0
4182   00
5314   00
5789    +
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****
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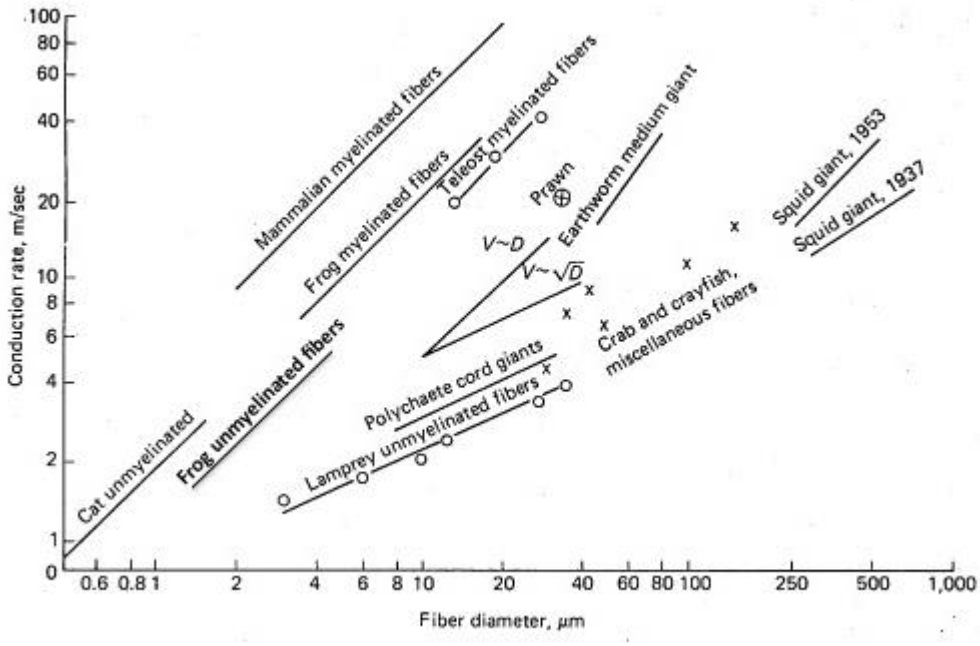
A. 6419
B. 6741
C. 5619
D. 5641
E. 5629

Question 6

The diagram below shows the velocity of nerve impulse conduction as a function of fiber diameter in a variety of animals.



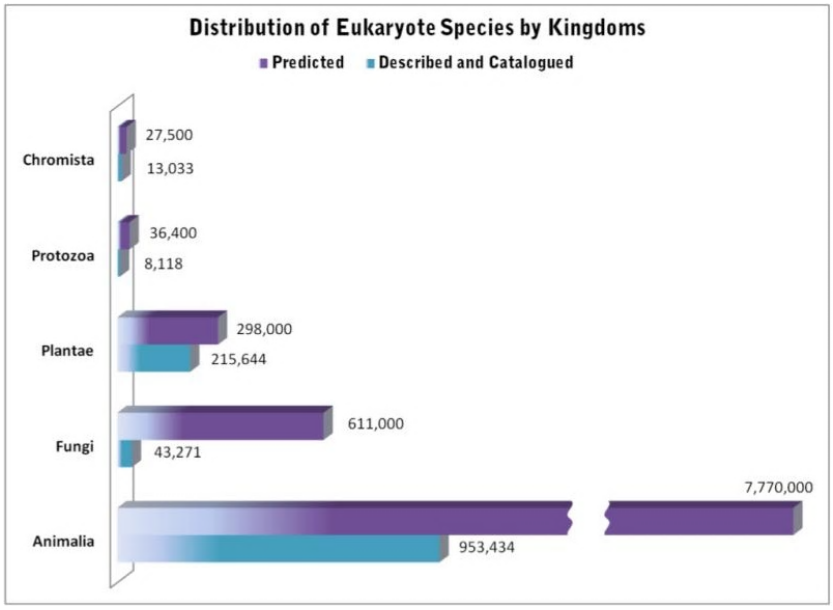
Modified from Bullock and Horridge, 1965, Structure and function of the Nervous System of Invertebrates. W. H. Freeman and Company.

Considering the information in the diagram, which of the statements below is **NOT** correct?

- **A.** Giant squid have thick nerve fibers
- **B.** Myelinated fibers conduct nerve impulses faster than unmyelinated fibers.
- **C.** The giant fibers of the earthworm are thicker than those of polychaete worms.
- **D.** Teleost myelinated fibers are thicker than frog myelinated fibers.
- **E.** The thicker mammalian myelinated fibers show the fastest conduction rate.

Question 7

Eukaryotes are organisms with their DNA organised in chromosomes, found in a distinct nucleus. Eukaryotes include algae, fungi, plants, and animals. Prokaryotes are single-celled organisms that have neither a nucleus nor other organelles. Prokaryotes include bacteria and cyanobacteria. There are approximately 8.7 million species of eukaryotes on earth – the relative size of each eukaryote group is listed below.



http://www.sciencedaily.com/releases/2011/08/110823180459.htm

From the information provided, the best conclusion is?

- **A.** Fungi are not well described as a taxonomic group.
- **B.** Animals have gone through the most evolution.
- **C.** Eukaryotes are better described than prokaryotes.
- **D.** There are not many prokaryotes on Earth.
- **E.** Simple life is dependent on photosynthesis.

Question 8

The enzyme 'lock and key' model implies that every enzyme has a substrate that it binds to at a specific site and it then catalyses a reaction. If the model below is an enzyme, which of the substrates does it fit?

A.

B.

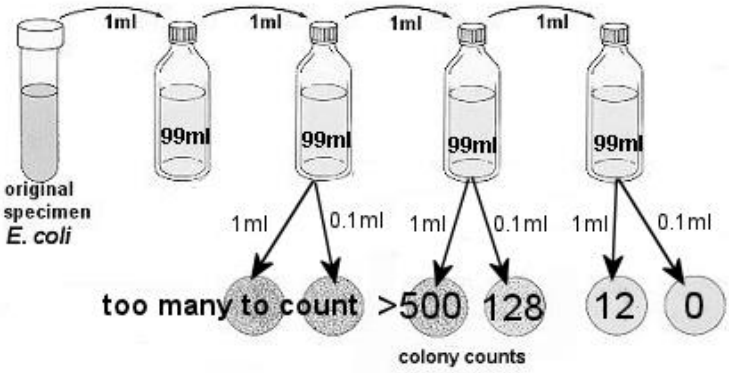
C.

D.

Question 9

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.

Bacterial counts in a stream water sample can be determined by placing a known volume of the stream water into a liquefied agar medium that is then poured into a petri dish. The agar solidifies and bacterial colonies grow within the agar. These colonies can then be accurately counted as the bacteria are equally distributed through the agar. In practice the number of bacteria is usually so great that a serial dilution must be made first so that the number of colonies can be counted. Note that the amount put on the plate is also a dilution as colonies are normally reported as per ml. Plates with 30-300 colonies are used for the calculation as plates with greater than 300 and less than 30 have a high degree of error. Air contaminants can contribute significantly to a really low count and a high count can be confounded by error in counting too many small colonies.

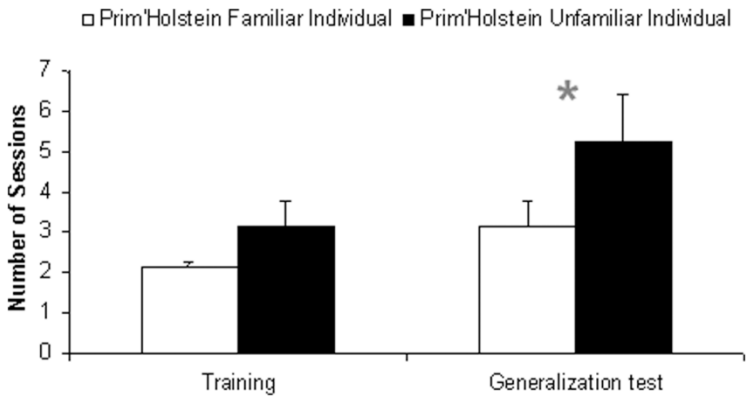


Calculate the number of bacterial cells (*E. coli*) per ml in the original water sample.

- **A.** 1.28×10^7
- **B.** 1.28×10^8
- **C.** 1.28×10^9
- **D.** 1.20×10^8
- **E.** 1.20×10^9

Question 10

Facial recognition has been show in the behaviour of many species. Cows (*Bos taurus*) of the breed Prim Holstein were studied to measure this trait. Cows were shown two pictures, one of a member of their own social group and one of an unfamiliar cow of the same breed. They were rewarded with food when they walked towards the unfamiliar cow's picture. The cows were first trained, using the same pictures of a familiar cow and an unfamiliar cow. Then, in 'generalisation' tests, experimental subjects were shown different angles of familiar cows' faces and unfamiliar cows' faces (examples are shown below). The number of sessions required for cows to reliably choose the correct picture was recorded. The * sign indicates a statistically significant difference.

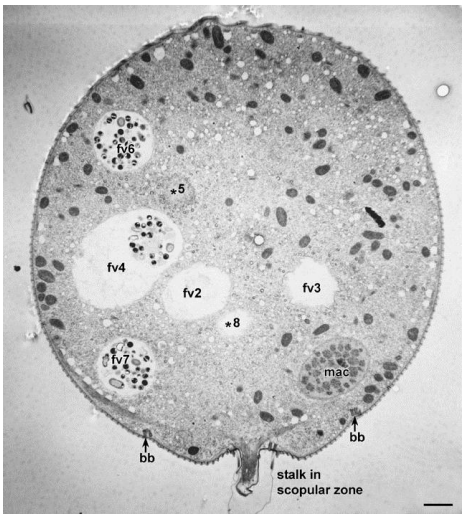


http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0004441#pone-0004441-t001

What conclusion can be drawn from the data?

- **A.** Cows only have a short term memory.
- **B.** Cows show recognition of familiar individuals.
- **C.** Cows cannot recognise familiar individuals.
- **D.** Cows are colour-blind.
- **E.** Cows will only ever walk towards food.

Question 11



http://www5.pbrc.hawaii.edu/allen/ch19/

Vorticella is a genus of protozoa found mainly in freshwater streams. On the left is a transmission electron micrograph showing food vacuoles (fv), a stalk (stalk) and a macronucleus (mac). The bar on the bottom right is 2µm.

What is the maximum diameter of the largest food vacuole shown?

- **A.** 8µm
- **B.** 18µm
- **C.** 180µm
- **D.** 0.18mm
- **E.** 0.8mm

Question 12

The two main factors taken into account when measuring biological diversity are richness and evenness. Richness is a measure of the number of different kinds of organisms present in a particular area. Evenness is a measure of the relative abundance of the different species making up the richness of an area. As species richness and evenness increase, so diversity increases. Simpson's Diversity Index (D) is a measure of diversity which takes into account both richness and evenness. Its formula is:

$$D = \frac{\sum n(n-1)}{N(N-1)}$$

Note: $\sum$ means to sum.

The value of D ranges between 0 and 1 with 0 representing infinite diversity and 1, no diversity. That is, the larger the value of D, the lower the diversity. This is neither intuitive nor logical, so to get over this problem, D is often subtracted from 1 to give Simpson's Index of Diversity 1 – D. The value of this index also ranges between 0 and 1, but now, the greater the value, the greater the sample diversity.

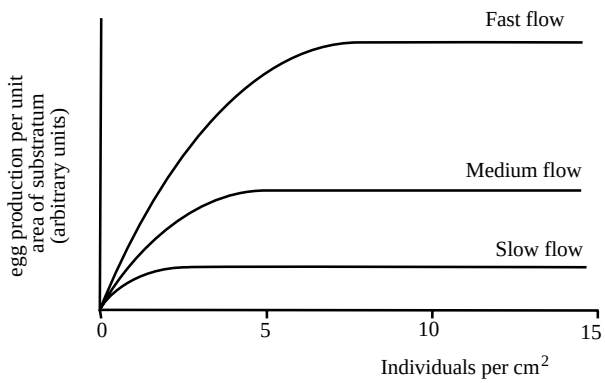
Calculate Simpson's Index of Diversity for a single transect sample of canopy trees in native bush near Rotorua.

Species	Number (n)	n(n-1)
Rimu	2	
Rewarewa	8	
Rata	1	
Tawa	1	
Tree fern	3	
Total (**N**)	**15**	**64**

A. 0.3
B. 3.0
C. 0.7
D. 7.0
E. D cannot be calculated as we do not know the transect length.

Question 13

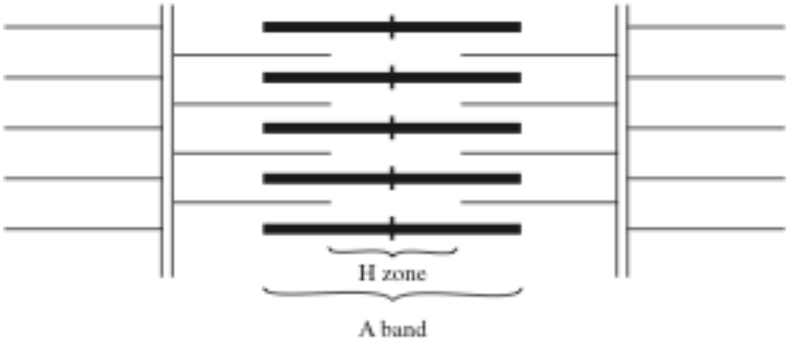
The graph show egg production at different population densities of the barnacle (*Semibalanus balanoides*) at three rates of water flow. Which of the following inferences is supported by these data?



A. The greater the population density, the more fertile the organisms become.
B. Beyond a certain population density, overcrowding reduces the rate of egg production by individuals.
C. An inverse relationship exists between the rate of water flow and egg production.
D. A linear relationship exists between population density and egg production at all population densities.
E. The effect of water flow on egg production is greater at a density of 15 individuals per cm^2 than at a density of 5 per cm^2.

Question 14

The diagram shows protein filaments in a muscle myofibril.

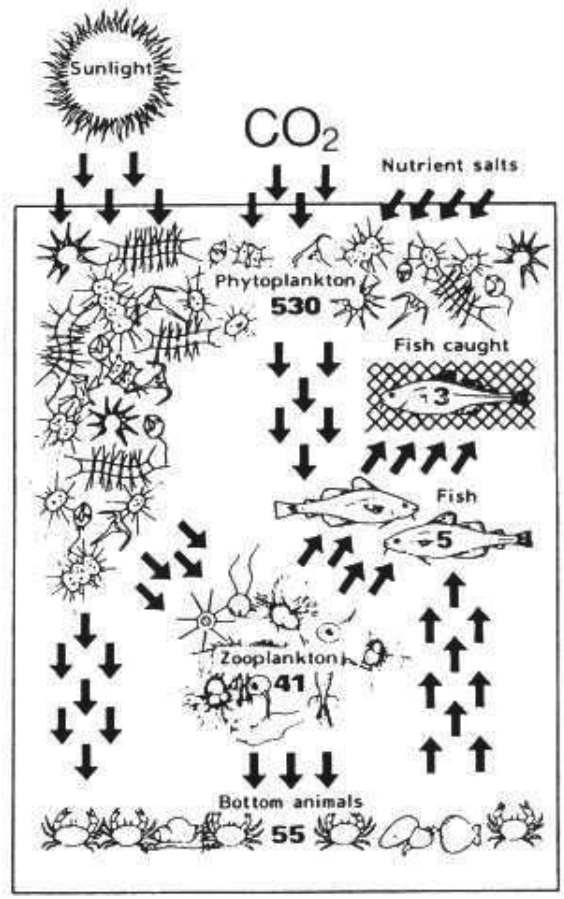


Which one of the following, A to D, correctly describes what would happen to the A band and the H zone when the muscle contracts?

	A band	H zone
A.	shorter	shorter
B.	same	same
C.	shorter	same
D.	same	longer
E.	same	shorter

Question 15

The percentage of energy transferred from one trophic level is called the ecological efficiency.



http://www.fao.org/docrep/v7180e/v7180e03.htm

The figure at left summarises the annual production (in million tonnes) in the North Sea (Moeller Christensen and Nystroem, 1977). The arrows show the direction of the energy flow.

Calculate the ecological efficiency of the true primary consumers that are feeding solely on phytoplankton.

A. 19.1%
B. 18.1%
C. 10.4%
D. 7.5%
E. 8.7%

Question 16

The genetic relatedness between various sets of relatives is shown in the table below. For relatedness to your brother, half-brother, first cousin, and so forth, simply read across the "self " row. For relatedness to your father's brother (your uncle), your father's half-brother, and so forth, read across the second row.

Generation	Brother	Half-brother	First cousin	Half-first cousin	Second cousin	Half-second cousin
Self	1/2	1/4	1/8	1/16	1/32	1/64
Father's	1/4	1/8	1/16	1/32	1/64	1/128
Grandfather's	1/8	1/16	1/32	1/64	1/128	1/256
Great-grandfather's	1/16	1/32	1/64	1/128	1/256	1/512
Great-great-grandfather's	1/32	1/64	1/128	1/256	1/512	1/1,024

Table modified from "The Altruism Equation: Seven Scientists Search for the Origins of Goodness" by Lee Alan Dugatkin (2006)

What is your genetic relatedness to your great half-uncle?

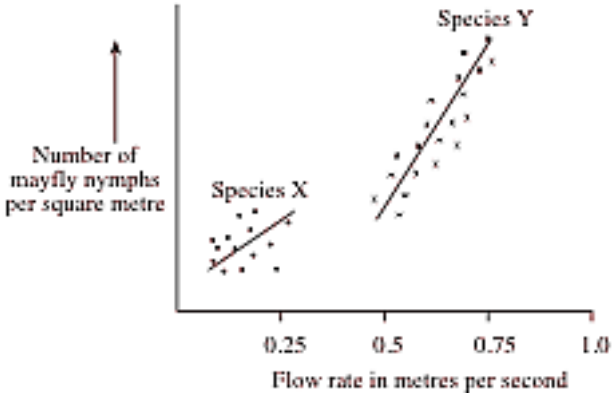
- **A.** 1/2
- **B.** 1/4
- **C.** 1/8
- **D.** 1/16
- **E.** 1/32

Question 17

The scatter graphs show the relation between the number of mayfly nymphs of two species, X and Y, and the flow rate of the water in which they live. The correlation coefficients for species X is 0.34 and for species Y is 0.87.

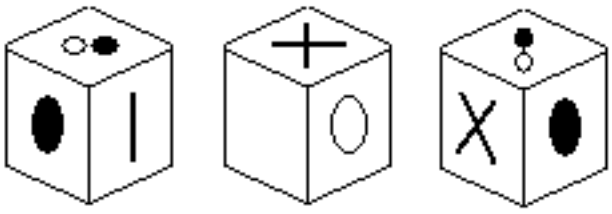
The correlation coefficient for species X is lower than that for species Y because

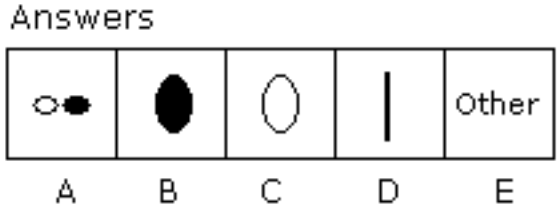
- **A.** The scattering of the points is greater.
- **B.** The mean flow rate is less.
- **C.** There are fewer points in its scatter graph.
- **D.** The slope of the line is less.
- **E.** The number of mayfly nymphs per square metre is less.



Question 18

Three views of the same cube are shown below. Which symbol is opposite the X?





http://www.psychometric-success.com/aptitude-tests/spatial-ability-tests-cubes.htm

Question 19

An investigator developed a scoring system that enabled her to predict an individual's body mass index (BMI) based on information about what they ate and how much. Information is collected from a small sample of subjects in order to compute their "diet score," and the weight and height of each subject is measured in order to compute their BMI. The graph on the left shows the relationship between the new "diet score" and BMI, and it suggests that the "diet score" is not a very good predictor of BMI, (i.e. there is little if any association between the two). She then identified the age and gender of the subjects and these data are presented in the graph on the right.

http://sphweb.bumc.bu.edu/otlt/MPH-Modules/BS/BS704-EP713_MultivariableMethods/BS704-EP713_MultivariableMethods_print.html

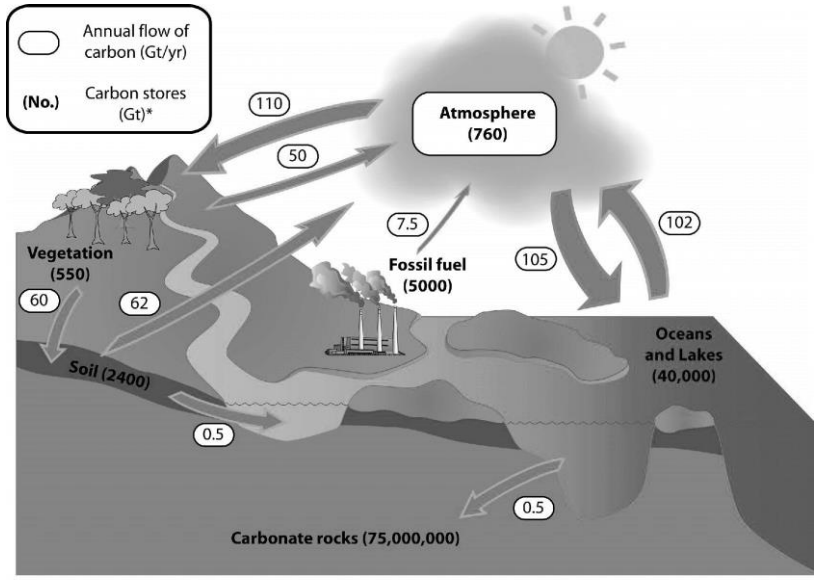
Considering these data what is the best conclusion about the relationship between “diet score” and BMI?

- **A.** There is no clear association between the two variables.
- **B.** Age is confounding the association between diet score and BMI.
- **C.** Gender is confounding the association between diet score and BMI.
- **D.** Both age and gender have an effect on BMI.
- **E.** Diet, age, and gender each have an independent effect on BMI.

Question 20

The global carbon cycle is represented in the diagram at right. Human activities that affect the distribution of carbon include the burning of fossil fuels and cultivation practices such as land clearance. The greatest annual flow of carbon is by:

- **A.** Dissolving of atmospheric carbon dioxide in water bodies.
- **B.** Erosion of calcium carbonate in soils and rocks by water.
- **C.** Release of carbon dioxide during respiration.
- **D.** Fixation of atmospheric carbon dioxide by plants.
- **E.** Release of carbon dioxide from volcanoes.

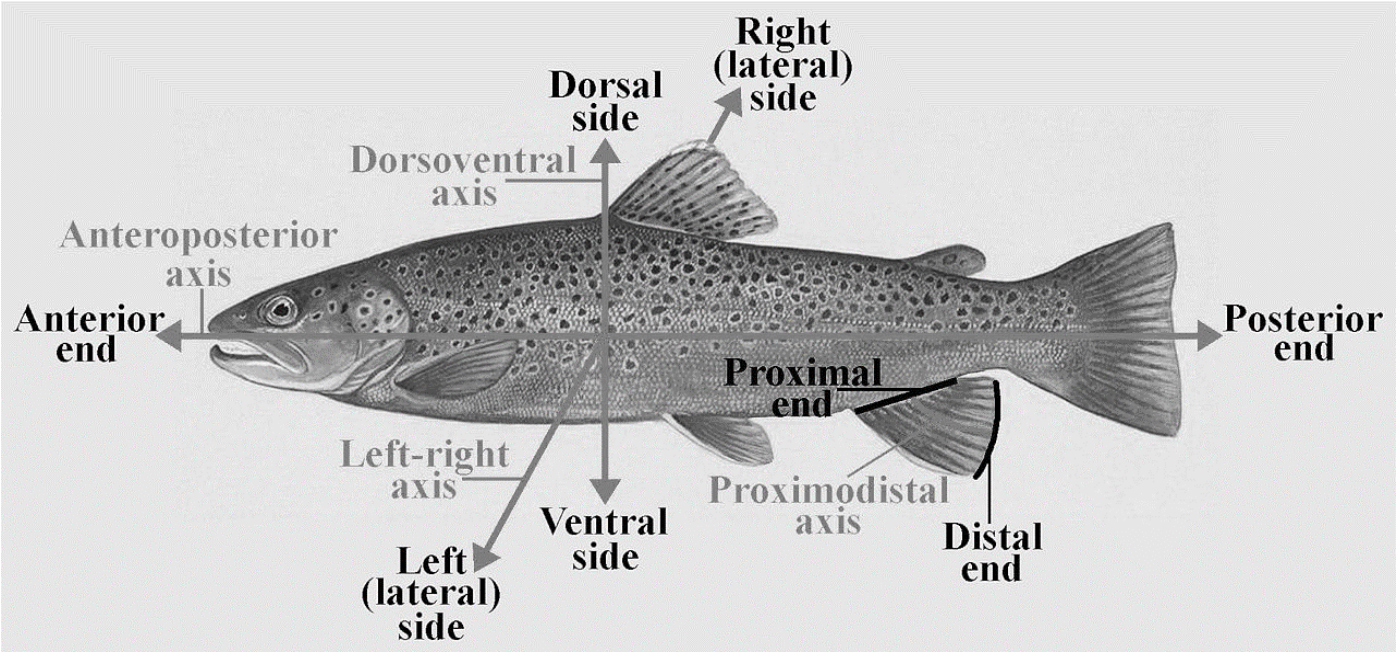


* 1 Gt = 1 Gigatonne = 1 billion metric tonnes

http://www.qld.gov.au/environment/land/soil/soil-properties/carbon/#!lightbox-uid-0

Question 21

The diagram below shows the anatomical planes and directions of a fish.



http://en.wikipedia.org/wiki/Anatomical_terms_of_location#mediaviewer/File:Anatomical_Directions_and_Axes.JPG

Fully describe the anatomical position of the gonad relative to the gut in a fish.

- **A.** The gonad is a paired organ and each gonad lies dorsal to the gut.
- **B.** The gonad is a paired organ and each gonad lies dorsal to the gut just lateral to the midline.
- **C.** The gonad lies dorsal to the gut and extends laterally.
- **D.** The gonad is a paired organ and each gonad lies lateral to the gut.
- **E.** The paired gonad is lateral to the gut.

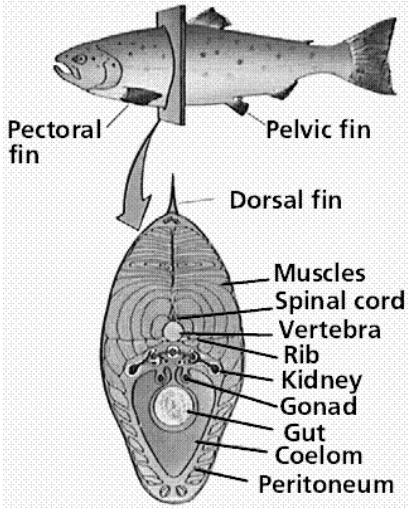
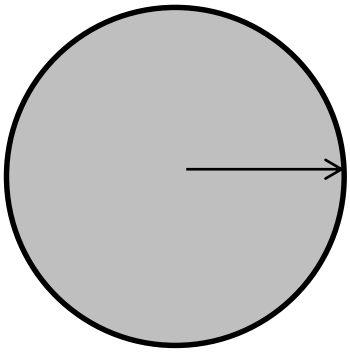


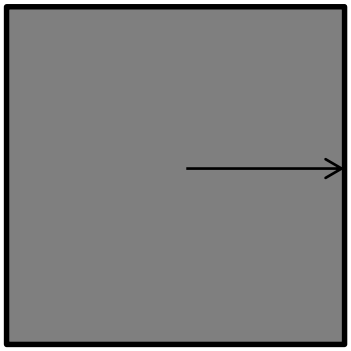
Image from Purves et al., Life: The Science of Biology, 4th Edition

Question 22

"Square trees" are being investigated to make forestry more sustainable. The underlying concept involves modifying the genome of trees so that the trunks grow in a 3D 'cuboid' shape instead of a cylinder. If the arrows on the cross sections of the trees shown are the same size, and the trunks are the same height, what is the percentage wood gained in tree on the right when compared with tree on the left? (Cuboid volume = base x height x width), (Cylinder volume = πr^2 x height).

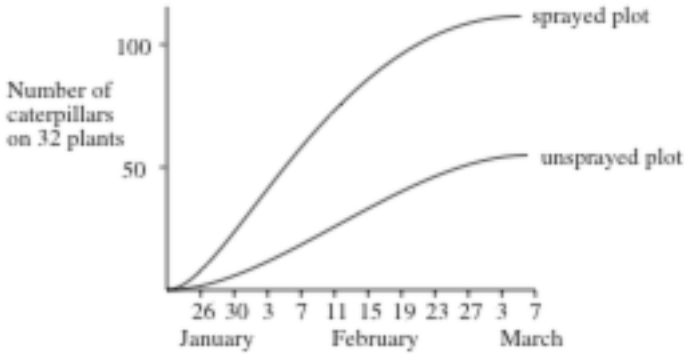
- **A.** 21%
- **B.** 10%
- **C.** 34%
- **D.** 5%
- **E.** 31.4%





Question 23

Two similar plots of cabbage plants were used in an investigation to determine the effectiveness of an insecticide. One plot was sprayed with the insecticide on 26th December. The second plot was left unsprayed as a control. The graph shows the number of caterpillars that were found on the plots during the following January, February and March.



Which one of the following statements is the best explanation of these data?

A. The caterpillars on the cabbage sprayed with insecticide were resistant to the insecticide.
B. In the sprayed plot the insecticide killed many of the natural predators of the caterpillars.
C. The effect of the insecticide had worn off by the time the caterpillars had hatched from their eggs.
D. The insecticide was applied too late in the life cycle and had the effect of delaying pupation.
E. The insecticide had no effect on the caterpillars.

Question 24

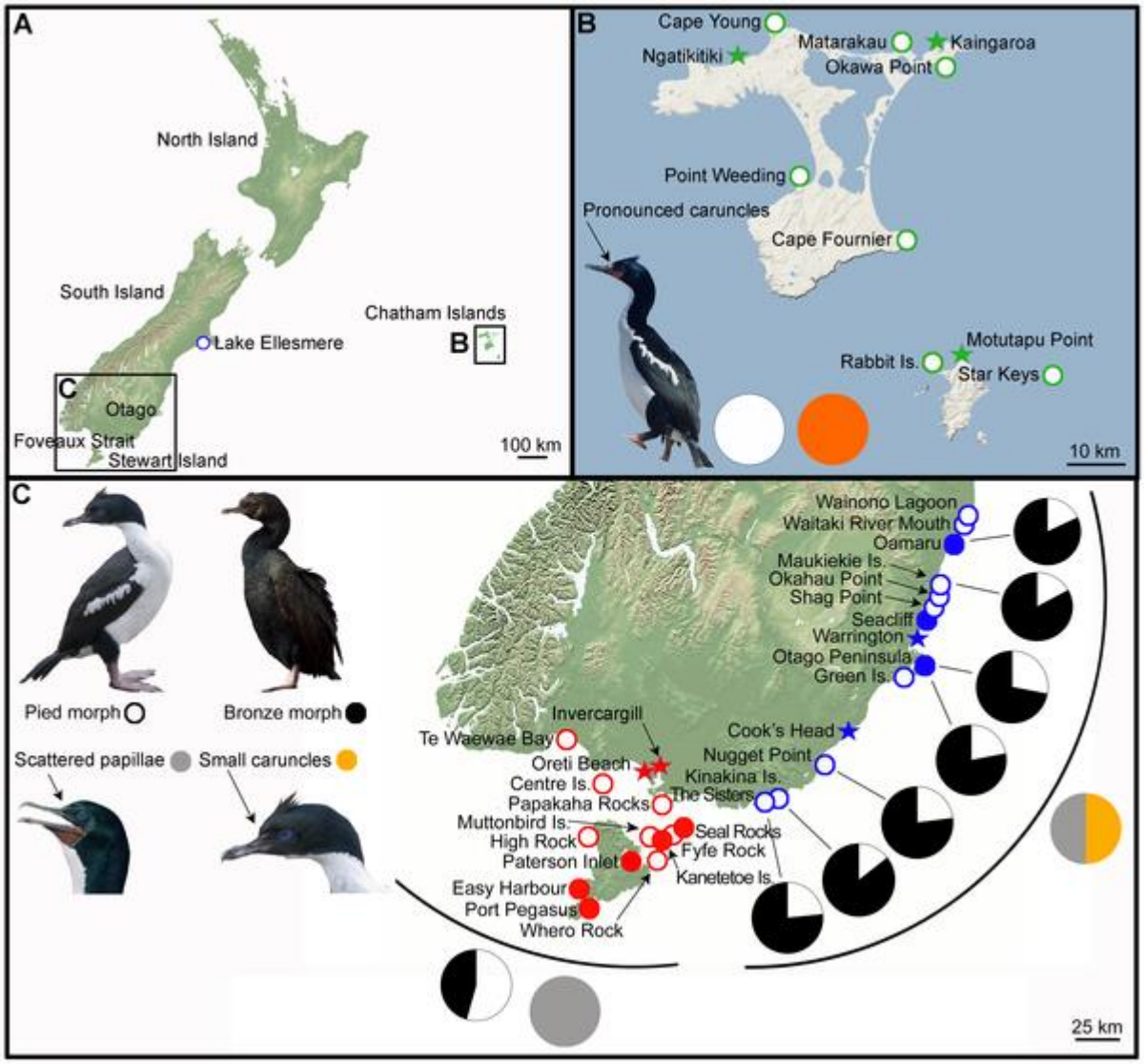
The graph below shows how the oxygen uptake of an estuarine crustacean changes with the salinity of the water.

From this information the most acceptable conclusion is that:

A. Oxygen diffuses faster in more concentrated salt solutions.
B. Oxygen diffuses faster in more dilute salt solutions.
C. Respiration rate is greater in more concentrated salt solutions.
D. Removal of excess water from the body is an energy-requiring process.
E. Uptake of water by the body is an energy-requiring process.

Question 25

Data for the distribution and morphology of the Chatham Island (*Leucocarbo onslowi*) and Stewart Island (*L. chalconotus*) shags are shown in the figure below.



Rawlence NJ, Till CE, Scofield RP, Tennyson AJD, Collins CJ, et al. (2014) Strong Phylogeographic Structure in a Sedentary Seabird, the Stewart Island Shag (*Leucocarbo chalconotus*). PLoS ONE 9(3): e90769. doi:10.1371/journal.pone.0090769

The pie charts in Section C indicate the proportion of the different morphological forms at each locality. White sectors indicate the proportion of pied morph expected and black the bronze morph. Grey sectors indicate the proportion of shags with scattered papillae and orange, small caruncles in breeding plumage.

What features would you expect to see in a shag population in Foveaux Strait?

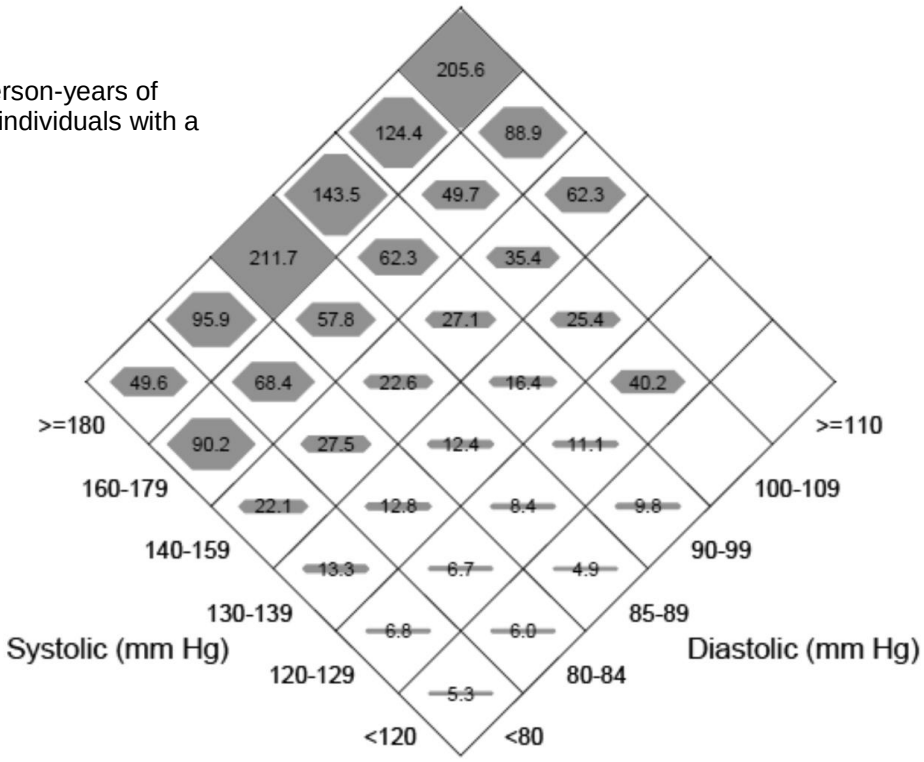
- **A.** 20% pied morphs and 80% dark-bronze morphs.
- **B.** 30% pied morphs and 80% dark-bronze morphs AND 50%:50% small bright orange caruncles: dark to dull orange scattered papillae in breeding plumage.
- **C.** 50% pied and dark-bronze morphs AND 50%:50% small bright orange caruncles: dark to dull orange scattered papillae in breeding plumage.
- **D.** 60% pied morphs and 40% dark-bronze morphs AND all with small bright orange caruncles.
- **E.** 60% pied morphs and 40% dark-bronze morphs all with dark to dull orange scattered papillae in breeding plumage.

Question 26

A new diamond graph method has been developed that can represent 3 variables equally on a 2-D graph. The diamond graph is essentially a 3-D bar graph viewed from above rather than from the side. Instead of using rising parallel bars, the diamond graph uses expanding polygons within a diamond-shaped grid to represent values. This diamond graph depicts the age-adjusted incidence rates of end-stage renal disease due to any cause per 100,000 person-years according to six categories of both systolic and diastolic blood pressure (Klag, Whelton, Randall, et al. 1996).

What is the incidence per 100,000 person-years of end-stage renal disease expected in individuals with a blood pressure of 170/100 (mm Hg)

- **A.** 143.5
- **B.** 124.4
- **C.** 62.3
- **D.** 49.7
- **E.** None of the above.



(Li, Buechner, Tarwater, and Muñoz, 2003)

Question 27

In 1976, minced beef was tested in Cork City, Ireland, for the level of bacterial contamination using processes called the total aerobic plate count (APC) and the coliform count. In some areas, meat is classed as unsafe to eat if it contains more than 10 million per gram total viable count (APC method) or 50 per gram of coliform count (total coliform method). Results from 5 different markets were sampled on two different days and the results (count/g) are shown below.

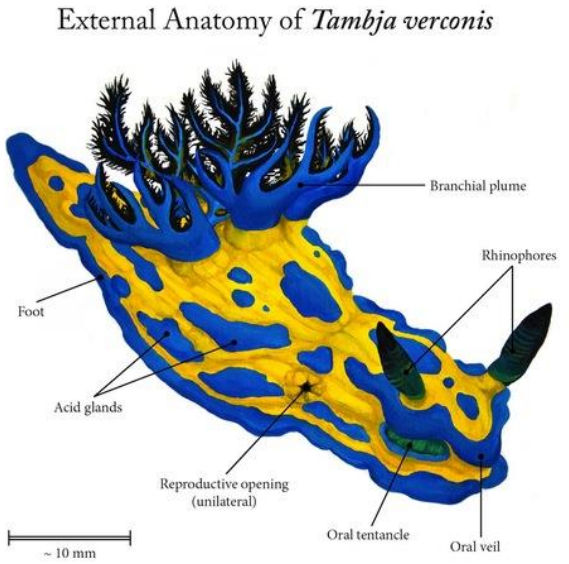
Market	Sample 1		Sample 2	
	APC	Total Coliform	APC	Total Coliform
A	2.4×10^7	3×10^5	4.1×10^7	2.9×10^5
B	3.5×10^5	8×10^4	3.0×10^6	3.0×10^6
C	3.7×10^8	4.8×10^5	1.0×10^8	4.0×10^5
D	3.2×10^6	4.2×10^5	1.9×10^7	1.3×10^5
E	2.0×10^7	5.3×10^5	2.1×10^7	2.2×10^5

http://www.jstor.org/stable/i25555828

Which market(s) sells minced beef that always meets the safety guidelines given?

- **A.** Market A.
- **B.** Markets B.
- **C.** Markets B and D.
- **D.** None of the markets, due to coliform count.
- **E.** None of the markets, due to coliform count and/or APC count.

Question 28



http://scientificillustration.tumblr.com/post/42376170639/wadeangeli art-this-dorid-nudibranch-sea-slug

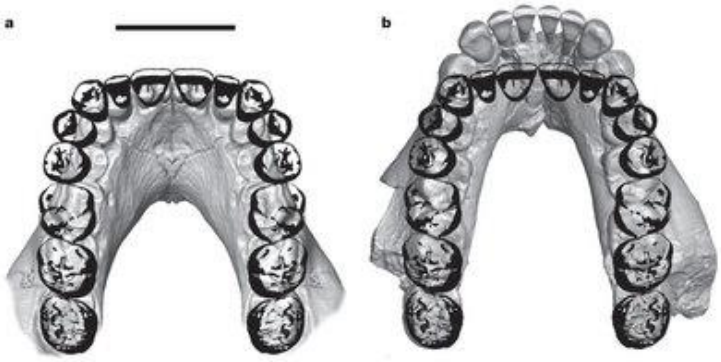
At left is a diagram of the beautiful nudibranch (sea slug), *Tambja verconis*. This sea slug is found in north-eastern waters of New Zealand. What is the approximate maximum length of this sea slug in cm?

- **A.** 20 mm
- **B.** 2 cm
- **C.** 4.8 mm
- **D.** 48 mm
- **E.** 4.8 cm

Question 29

Dental arcades are a feature that is used to differentiate between *Homo sapiens* and their recent ancestors. Dental arcades of recently discovered *Homo* species have been compared with data on previously discovered species. The reconstructed upper arcade of KNM-ER 62000 (outlined in black; discovered 2012) is occluded with (a) the reconstructed lower arcades of KNM-ER 60000 (shown in grey; also discovered 2012) and (b) KNM-ER 1802 (shown in grey; discovered 1973). What is a logical conclusion that can be made from these data?

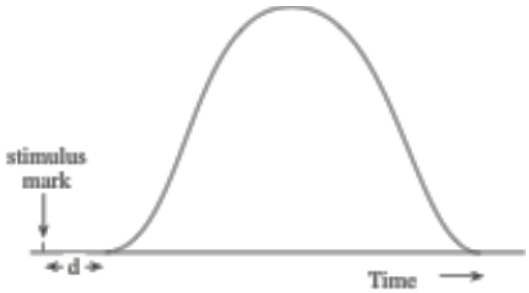
- **A.** Early *Homo* species were scavengers.
- **B.** There was morphological variation in early *Homo* species.
- **C.** Modern *Homo* sapiens have taken large evolutionary leaps from early *Homo* species.
- **D.** Early *Homo* species had an 'overbite' in their jaws.
- **E.** Fossils that are discovered at the same time, are the same shape.



http://www.nature.com/nature/journal/v488/n7410/full/nature11322.html

Question 30

The gastrocnemius (calf) muscle of a frog and the sciatic nerve supplying it can be kept alive in a special salt solution (Ringer's solution) and stimulated to contract by a single electric shock delivered to the nerve supplying the muscle. The response is called a twitch, and can be recorded by attaching the tendon of the muscle to a lever attached to a pen that makes a mark on a revolving drum (called a kymograph). The recording below is of a single twitch after stimulation of the nerve supplying the muscle.

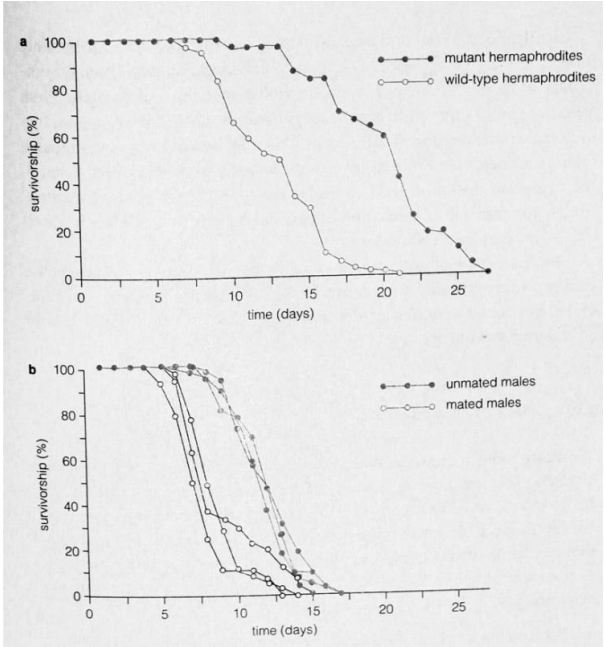


The distance (d) is **NOT** affected by the

- **A.** Velocity of the nerve impulse.
- **B.** Temperature of the Ringer's solution.
- **C.** Strength of the stimulus.
- **D.** Speed of rotation of the kymograph drum.

Question 31

Biology is often focused on survival and/or reproduction of individuals. Normal 'wild-type' male nematode worms were compared with two different mutant male strains – one group which did not produce sperm (top graph) and one group which did not mate (bottom graph). Their survivorship curves are below.



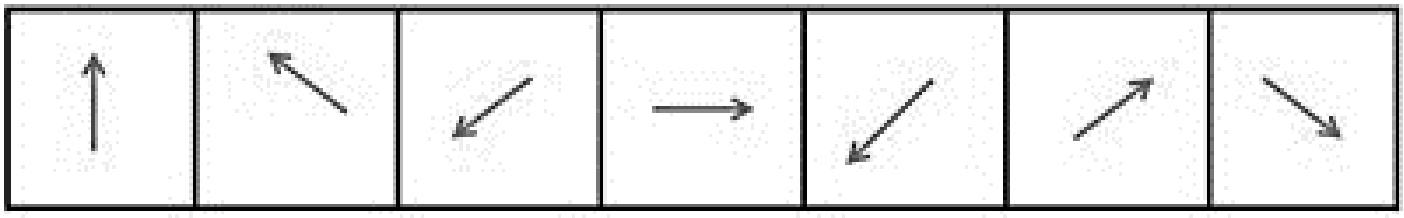
Adapted from Krohne , 1998 General Ecology

What is the best conclusion that can be made from these data?

- **A.** There is a cost to mating **and** sperm production that shortens a nematode's life.
- **B.** There is a cost to mating **or** sperm production that shortens a nematode's life.
- **C.** The cost of mating is offset by having many offspring
- **D.** Nematode females probably eat the males after mating.

Question 32

Which diagram below does not fit the logical series?



A. **B.** **C.** **D.** **E.**

Question 33

The table below summarises the complications by age for measles cases in the United States from 1987-2000.

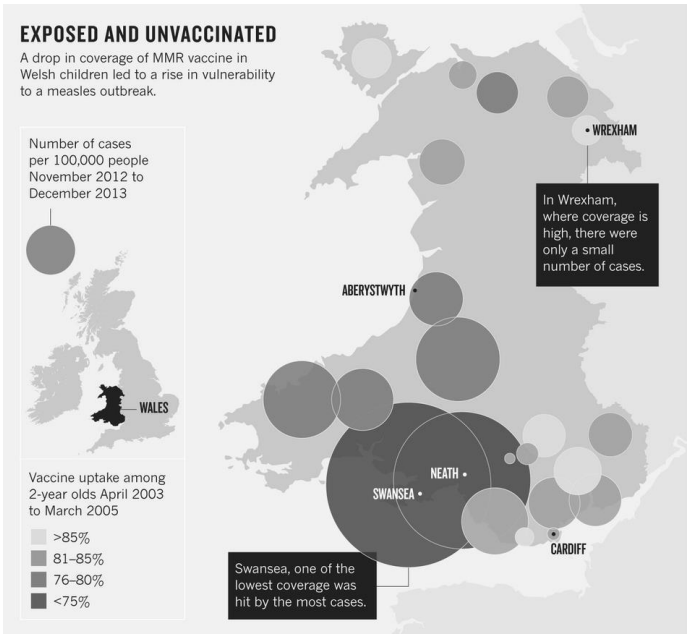
Complication	Overall (67,032 cases with age information)	No. (%) of persons with complication, by age group				
		<5 years (*n* = 28,730)	5–9 years (*n* = 6492)	10–19 years (*n* = 18,580)	20–29 years (*n* = 9161)	>30 years (*n* = 4069)
Any	19,480 (29.1)	11,883 (41.4)	1173 (18.1)	2369 (12.8)	2656 (29.0)	1399 (34.4)
Death	177 (0.3)	97 (0.3)	9 (0.1)	18 (0.1)	26 (0.3)	27 (0.7)
Diarrhea	5482 (8.2)	3294 (11.5)	408 (6.3)	627 (3.4)	767 (8.4)	386 (9.5)
Encephalitis	97 (0.1)	43 (0.2)	9 (0.1)	13 (0.1)	21 (0.2)	11 (0.3)
Hospitalization	12,876 (19.2)	7470 (26.0)	612 (9.4)	1612 (8.7)	2075 (22.7)	1107 (27.2)
Otitis media	4879 (7.3)	4009 (14.0)	305 (4.7)	338 (1.8)	157 (1.7)	70 (1.7)
Pneumonia	3959 (5.9)	2480 (8.6)	183 (2.8)	363 (2.0)	554 (6.1)	379 (9.3)

Source: Centers for Disease Control and Prevention.
http://jid.oxfordjournals.org/content/189/Supplement_1/S4/F3.expansion.html

Based on the data, which statement is correct?

- **A.** Measles is relatively more deadly in young people compared with older people
- **B.** Catching measles will give you pneumonia
- **C.** Most of the measles cases with complications reported were young people, below 19 years of age
- **D.** Hospitalization is rare with measles
- **E.** Encephalitis is a deadly complication of measles

Question 34



http://www.nature.com/nature/journal/v507/n7490_supp/fig_tab/507S17a_G1.html

What is the best conclusion(s) that can be made from the diagram at left of measles cases and immunisation rates in Wales?

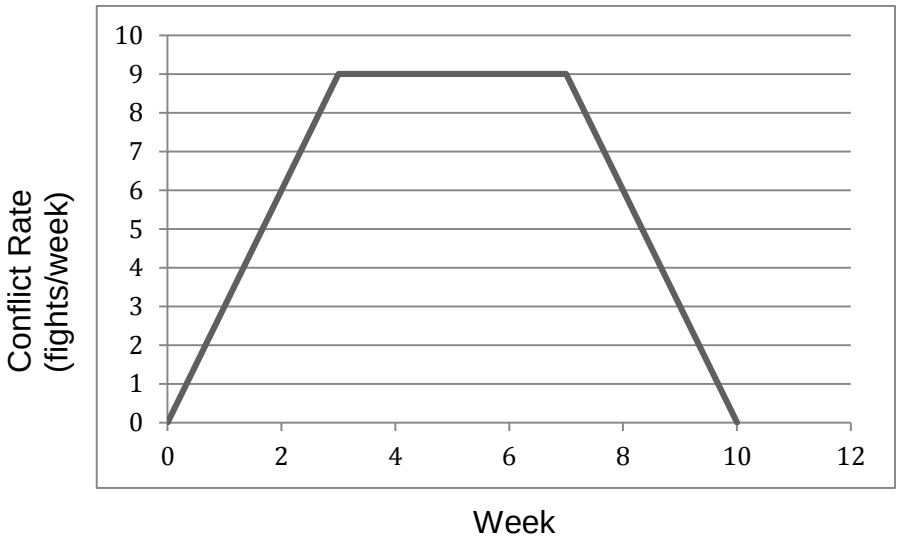
- **A.** A vaccination programme does not always stop outbreaks of disease.
- **B.** Higher infection rates are linked with lower vaccination rates.
- **C.** Outbreaks can occur in geographical clusters.
- **D.** Only B and C are valid conclusions.
- **E.** A, B and C are valid conclusions.

Question 35

The graph at right shows the conflict rate of primates, measured throughout the day and night over 10 weeks of a study period.

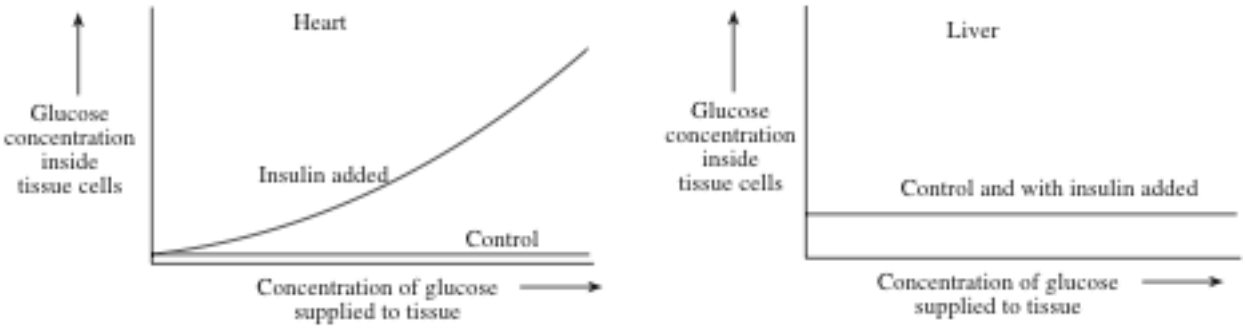
How many fights occurred in total?

- **A.** 9
- **B.** 59
- **C.** 12
- **D.** 63
- **E.** 14



Question 36

The graphs show the effect of insulin on the glucose concentrations inside the cells of liver and of heart muscle when these two tissues were supplied with increasing concentrations of glucose.

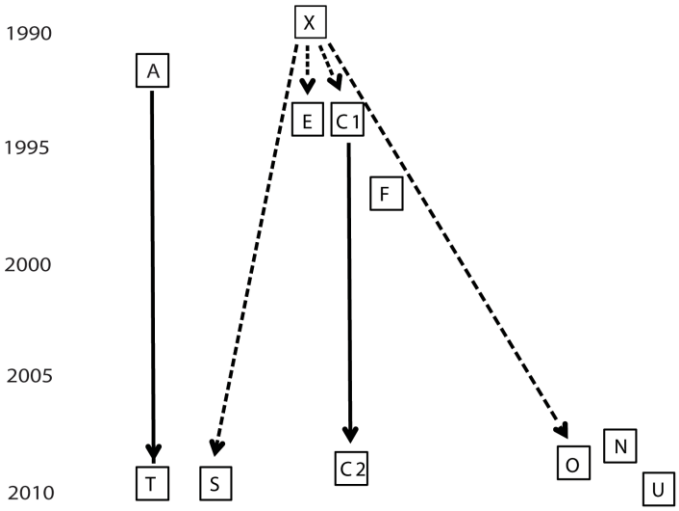


The *best* interpretation of these data is that:

- **A.** Liver cells are impermeable to glucose.
- **B.** Insulin increases the entry of glucose into heart and liver cells.
- **C.** Insulin increases the entry of glucose into the heart tissue but not into liver cells.
- **D.** Insulin is metabolised rapidly by liver cells.
- **E.** Insulin is metabolised rapidly by heart cells.

Question 37

Tuberculosis (TB) kills more than two million people annually and is a disease studied by scientists around the world.



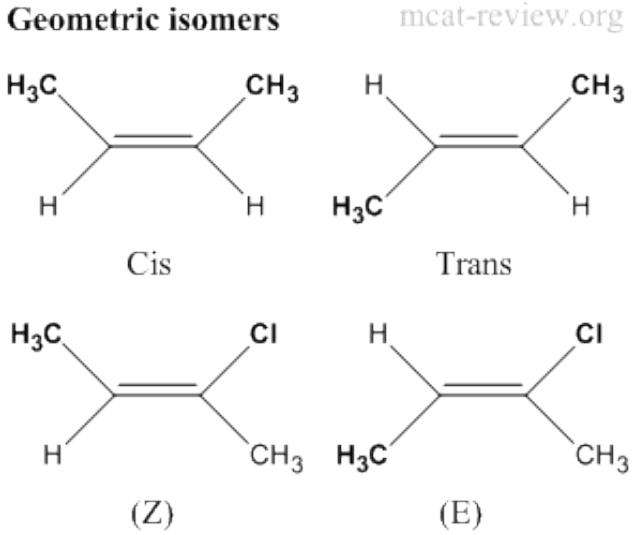
http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0091024

The diagram on the left shows the chronology of a TB outbreak in New Zealand. “Each square represent a subject at the time of the TB diagnosis. Broken lines represent known close direct contact with the initial index case ‘‘X’’ during X’s period of infectiousness. Solid lines show assumed connections between a case of presumed reactivation (C1 to C2) and a case of potential child-parent transmission (A to T)”.
What is the best conclusion to be made from these data?

- **A.** Tuberculosis is widespread in New Zealand.
- **B.** Tuberculosis can stay dormant in a human before symptoms are shown.
- **C.** Tuberculosis outbreaks occur in geographical patterns.
- **D.** Patient X and Patient A are responsible for all of the tuberculosis infections in this study.
- **E.** None of these conclusions are valid.

Question 38

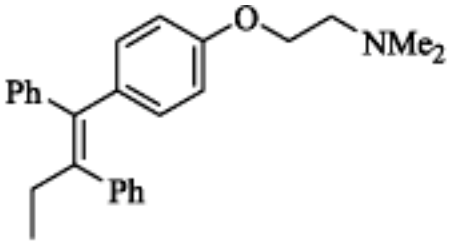
Geometric isomers are molecules which have the same molecular formula with the same connectivity between atoms but which have a different orientation across a double bond. The diagram below shows the different types of geometric isomers.



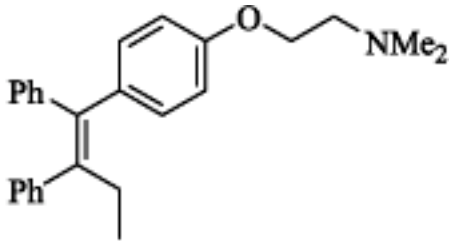
When both sides of the double bond contains the same 2 groups, then cis and trans is used. Cis = same side, Trans = opposite sides.

When different groups are attached to either side, Z and E is used. Z is when the higher priority groups (ranked according to the Cahn-Ingold-Prelog rules) are orientated on the same side across the double bond. Zusammen is the German word for together. E is when the higher priority groups are orientated on different sides across the double bond. Entgegen is the German word for opposed.

The isomerization of a molecule may have significant effects on its biological function. Tamoxifen is an antiestrogenic drug used to treat and prevent a form of breast cancer without the negative side effects of traditional chemotherapy. It exists as (Z)-Tamoxifen and its structure is shown below (1). It also exists less commonly as another isomer (2) that has estrogenic activity and therefore promotes the growth of breast cancer.



(*Z*)-Tamoxifen (**1**)
Antiestrogenic activity



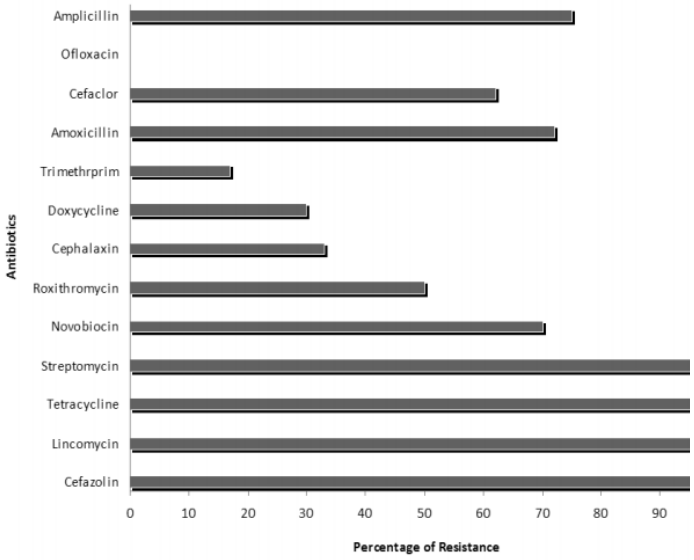
(**2**)
Estrogenic activity

Isomer 2 is best described as:

- **A.** Cis-Tamoxifen
- **B.** Trans-Tamoxifen
- **C.** E-Tamoxifen
- **D.** Cis(Z)-Tamoxifen
- **E.** None of the above

Question 39

Bacterial contamination of meat was studied in Karachi, Pakistan in 2010. Of the 342 bacterial pathogens isolated from meat samples, 120 (35%) were identified as *Escherichia coli* and 51 (15%) of these *E. coli* isolates were characterized as serotype 0157;H7, which is known to cause hemorrhagic colitis. Other potentially pathogenic isolates were *Listeria* species 14 (4%), *Klebsiella* 27 (8%), *Enterobacter* species 51 (15%), and *Staphylococcus aureus* 24 (7%). Antibiotic susceptibility was tested on the total microbial population and the results are shown below.



Ali, et al. 2010. Microbial contamination of raw meat and its environment in retail shops in Karachi, Pakistan. J Infect Dev Ctries; 4(6):382-388.

What is the probability that a pathogenic bacterium chosen at random would be **E col 0157;H7** that is resistant to **Novobiocin**?

A. 0%
B. 10.50%
C. 12.60%
D. 70.15%
E. 24.5%

Question 40

The diagram shows the sequence of bases in a strand of DNA that codes for a polypeptide composed of ten amino acids. An additional base sequence coding for the start signal is on the left also codes for methionine.

T A C G G T C A A T C T G G T T C T G G T T C T T C T G A G C A A

When the polypeptide for which this gene codes was hydrolysed, it yielded the amino acids shown in the table.

Amino acid	Number of amino acid residues per polypeptide
w	1
x	2
y	3
z	4

The correct sequence of amino acids in the polypeptide is:

A. x y z x z y z z w y
B. y z x y z z y z w x
C. z x y z y z y y w z
D. y x z y z y z z x w
E. y x z y z y z z w x

Section B

KĀKĀRIKI – CONSERVATION OF NEW ZEALANDS PARAKEETS

There are five main species of kākāriki: yellow-crowned parakeet, orange-fronted parakeet, red-crowned parakeet, Forbes' parakeet and Antipodes Island parakeet. All are bright green in colour but with distinguishing coloured areas on the head. The yellow-crowned parakeet is rare but is found throughout forested areas of the North, South and Stewart Islands as well as the sub-Antarctic Auckland Islands. The orange-fronted parakeet is critically endangered with around 300 birds found in just three alpine beech forest valleys in Canterbury. The red-crowned parakeet was widespread throughout the mainland last century but today is very rare on the mainland and only common on islands free of mammalian predators. Forbes' parakeet is restricted to the Chatham Island and also critically endangered. The Antipodes Island parakeet is restricted to the Antipodes Islands.

Deforestation, disease, introduced predators, and shooting by farmers have all contributed to the present restricted distribution of these species. An important conservation tool for the restoration of endangered birds is the translocation of species to habitats that have been restored and introduced predators eradicated.

Question 41

Luis Ortiz-Catedral at the Ecology and Conservation Lab, Institute of Natural & Mathematical Sciences, Massey University, has been studying kākāriki on Raoul Island, a remote volcanic island approximately 995 km north of New Zealand. There had not been a confirmed record of resident parakeets on Raoul Island since 1836 following the introduction of goats, cats and rats. Goats were removed from the island in 1986. Then, in the world's largest multi-species eradication project to date, the New Zealand Department of Conservation (DOC) successfully removed domestic cats, and Norway and Pacific rats (kiore) from Raoul Island using aerial drops of poisoned bait for rats between 2002 and 2004, and follow-up ground-based control for cats.

Prior to the removal of these invasive species on Raoul, the last strongholds for Kermadec red-crowned parakeets were the Herald Islets (ca. 50 breeding pairs) and Macauley (ca. 10,000 breeding pairs) 2-4 km east and 108 km south respectively off the coast of Raoul Island. Since 2000 (i.e. two years prior to initiation of the predator removal programme), staff from DOC have carried out bird surveys roughly once a year on Raoul to assess the effect of the removal of predators. No parakeets were detected prior to eradication of cats and rats. After the cat and rat eradication there were infrequent sightings of one to three parakeets. In 2008 during the parakeet survey, 100 parakeets were caught during a 13-day mist-netting period. Of these, 59 were female and 41 were male, of which 56 were adults and 44 sub-adults hatched in 2008. One full pre-mating display followed by copulation was also observed and two nests were located in fallen logs of Kermadec pohutukawa.

Considering the data given above what conclusion can be drawn about the presence of red-crowned parakeets on Raoul Island?

- **A.** Red-crowned parakeets are now frequent visitors to Raoul Island from their breeding sites on the Herald Islets.
- **B.** Red-crowned parakeets have successfully recolonised Raoul Island after eradication of invasive predators.
- **C.** Red-crowned parakeets have been successfully translocated to Raoul Island.
- **D.** Eradication of invasive predators on Raoul Island has allowed remnant populations of red-crowned parakeets to increase.
- **E.** Red-crowned parakeets are now common on Raoul Island after eradication of invasive species.

Questions 42 - 47

Understanding the foraging ecology of a species is crucial when conservation management involves translocation of the species. Work by Kearvell et al. (2002) had described the foods consumed by orange-fronted parakeets in the South Island and noted that for most of the year the species fed almost exclusively on *Nothofagus* spp (beech trees) and that invertebrates made up nearly 70% of the food items consumed in spring.

Luis' research group recorded data on the diet of translocated orange-fronted parakeets on Maud Island, in the Marlborough Sounds, South Island. They recorded the foraging of the parakeets on each research visit to Maud Island from March 2007 to January 2009, visiting approximately every two months (17 visits in total).

132 feeding bouts were recorded with a total of 124 observations (81%) consisting of dietary items and 29 (19%) of non-dietary items such as bark, sticks and grit. Orange-fronted parakeets were observed to consume fruits 94 times, leaves 19 times, flowers six times and invertebrates five times.

The table below gives the plant species and food types ingested by translocated orange-fronted parakeets on Maud Island.

Species	Type	Proportion of diet (feeding bouts in brackets)
Sycamore (*Acer pseudoplatanus**)	Fruits	3.36 (4)
Titoki (*Alectryon excelsus*)	Fruits	1.68 (2)
Makomako (*Aristotelia serrata*)	Fruits, leaves	13.44 (16)
Putaputaweta (*Carpodeus serratus*)	Fruits, leaves	5.88 (7)
Karamu (*Coprosma robusta*)	Fruits	8.40 (10)
Tree lucerne (*Cytisus palmensis**)	Flowers, leaves	5.04 (6)
Akeake (*Dodonea viscosa*)	Leaves	0.84 (1)
Kohekohe (*Dysoxilum spectabile*)	Flowers	0.84 (1)
Koromiko (*Hebe stricta*)	Flowers	1.68 (2)
Manuka (*Leptospermum scoparium*)	Fruits	7.56 (9)
Mahoe (*Melycitus ramiflorus*)	Fruits, leaves, flowers	43.70 (52)
Whauwhaupaku (*Pseudopanax arboreus*)	Fruits	5.04 (6)
Pine (*Pinus radiata**)	Leaves	1.68 (2)
Karo (*Pittosporum* sp.)	Fruits	0.84 (1)

*Introduced species.

Question 42

The most important food type for orange-fronted parakeets in the South Island in spring was?

- **A.** Leaves.
- **B.** Flowers.
- **C.** Fruit.
- **D.** Beech trees.
- **E.** Invertebrates

Question 43

The percentage of plant material consumed by orange-fronted parakeets on Maud Island was?

- **A.** 96%
- **B.** 90%
- **C.** 76%
- **D.** 71%
- **E.** 15%

Question 44

The most important food type for orange-fronted parakeets on Maud Island was?

- **A.** Leaves.
- **B.** Flowers.
- **C.** Fruit.
- **D.** Invertebrates.
- **E.** None of the above.

Question 45

The native plant species consumed most frequently by the orange-fronted parakeet on Maud Island was?

- **A.** Sycamore
- **B.** Makomako
- **C.** Tree lucerne
- **D.** Manuka
- **E.** Mahoe

Question 46

The introduced plant species consumed most frequently by the orange-fronted parakeet on Maud Island was?

- **A.** Sycamore
- **B.** Makomako
- **C.** Tree lucerne
- **D.** Manuka
- **E.** Mahoe

Question 47

Considering all the data above, the best conclusion about the diet of the orange-fronted parakeet is?

- **A.** They have very specific dietary preferences.
- **B.** They rely primarily on fruit for energy.
- **C.** Invertebrates are an important food source in spring.
- **D.** They exhibit dietary flexibility.
- **E.** They feed on the most abundant plant species in an area.

THE RENA OIL SPILL – BIOLOGY WHEN DISASTER STRIKES

The grounding of the CV *Rena* on October 5, 2011 was New Zealand's worst maritime environmental disaster when the container ship spilled approximately 350 tonnes of heavy fuel oil into the ocean. The container ship ran aground on Otaiti (Astrolabe Reef) just off Mōtītī Island in the Bay of Plenty, releasing oil into a relatively pristine marine environment. Te Mauri Moana, a group of scientists led by the University of Waikato as part of the Government's $4.2 million Rena Long-term Environmental Recovery Plan, undertook one of the most comprehensive, multi-disciplinary studies ever done following a marine pollution event. Their findings are summarised in the report; "Rena Environmental Recovery Monitoring Programme 2011-2013."

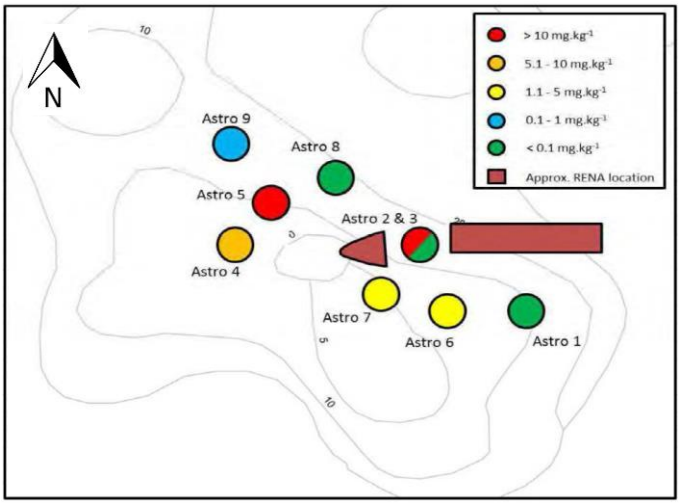
By international standards the oil spill was relatively minor but it occurred in an otherwise uncontaminated coastline in an area renowned for its beauty and highly valued for tourism, recreation and fisheries. Iwi, government, commercial stakeholders and the public were rightly concerned there would be long-lasting negative impacts on beaches, reefs and fisheries. Te Mauri Moana reports on fifteen monitoring and research programmes focused on the range of ecosystems and habitats within the Bay of Plenty.

Questions 48 - 52

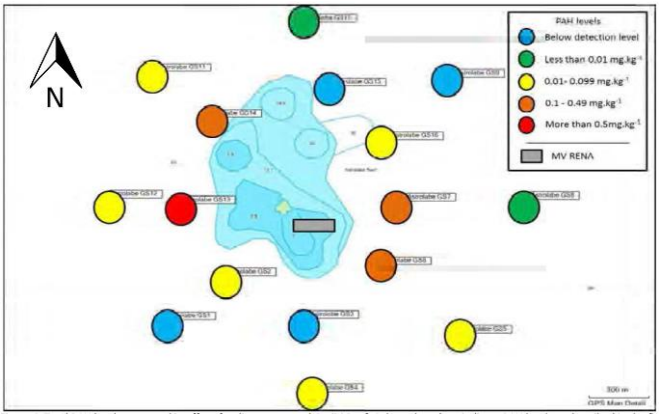
Chemical contamination of the sediments and fauna of Otaiti Reef and Mōtītī Island and the surrounding soft sediments was examined to determine if the discharge of fuel oil (and later release of container debris) from the *Rena* resulted in significant chemical contamination of the marine environment and marine organisms. Amongst other contaminants the presence of polycyclic aromatic hydrocarbons (PAHs) from fuel oil was examined in sediments and from selected organisms.

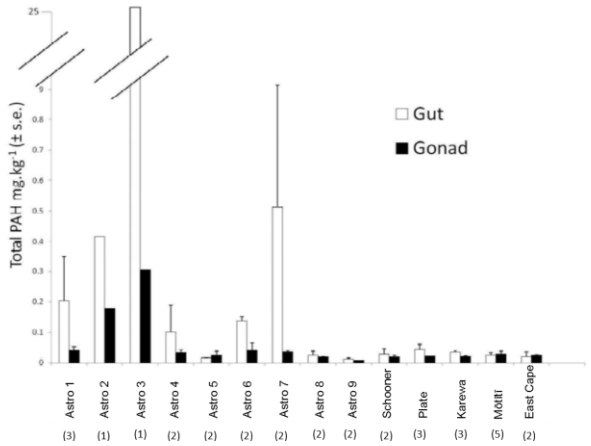
The maps below shows the PAH levels in sediments collected from **A.** on Otaiti Reef and **B.** off-reef.

A.



B.





The graph at left shows the PAH levels in sea urchins collected from Otaiti Reef and nearby islands. The numbers in brackets indicate the number of samples collected at each site. All sea urchins on Otaiti reef showed elevated PAH levels in the gonad with an average level of 0.057 mg kg^{-1}. Gut levels averaged 1.58 mg kg^{-1} but at Astro 2 and 3 were orders of magnitude higher than at other sites on Otaiti Reef. PAH levels in the gonad and gut from urchins from Mōtītī Island averaged 0.026 mg kg^{-1} and 0.03 mg kg^{-1} respectively and were similar to levels found elsewhere, including East Cape.

Question 48

Off-reef sediment levels of PAH are greatest?

- **A.** North of the *Rena*.
- **B.** East of the *Rena*.
- **C.** South of the *Rena*.
- **D.** West of the *Rena*.
- **E.** East and West of the *Rena*.

Question 49

The shallowest on-reef sampling site was?

- **A.** Astro 2/3
- **B.** Astro 4
- **C.** Astro 5
- **D.** Astro 6
- **E.** Astro 7

Question 50

On-reef sediment levels of PAH are greatest at?

- **A.** Astro 2/3
- **B.** Astro 4
- **C.** Astro 5
- **D.** Astro 6
- **E.** Astro 7

Question 51

The levels of PAH in sea urchin guts from the most contaminated Otaiti reef site are how much higher than those from Mōtītī Island?

- **A.** 61 times higher.
- **B.** 53 times higher.
- **C.** 2 times higher.
- **D.** 3 times higher.
- **E.** 4 times higher.

Question 52

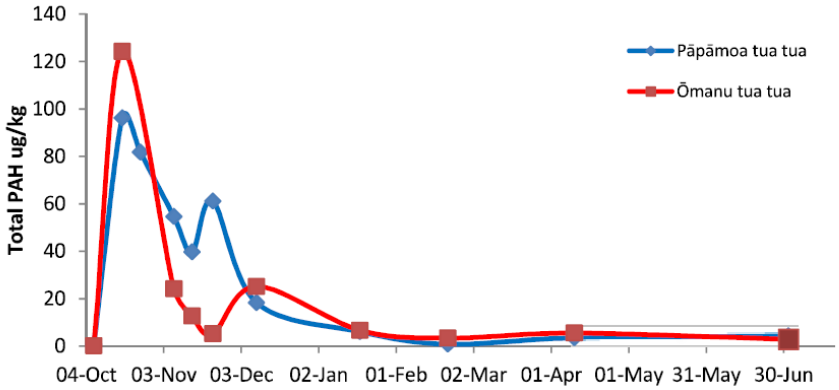
Considering these data what is the main, substantiated, conclusion that can be drawn about the effect of fuel oil contamination on the sediments and fauna of Otaiti Reef and Mōtītī Island from the grounding of the Rena?

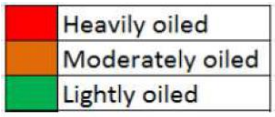
- **A.** On reef sediment PAH levels generally match PAH levels in sea urchins because sea urchins ingest sand as they graze.
- **B.** Significant contamination of sediments and accumulation within the food chain has occurred.
- **C.** Contamination of sediments and sea urchins on and around Otaiti, particularly in the close vicinity of the ship's hull, has occurred.
- **D.** Otaiti Reef and Mōtītī Island show contamination of sediments and sea urchins.
- **E.** Widespread contamination of sediments and some marine organisms has occurred.

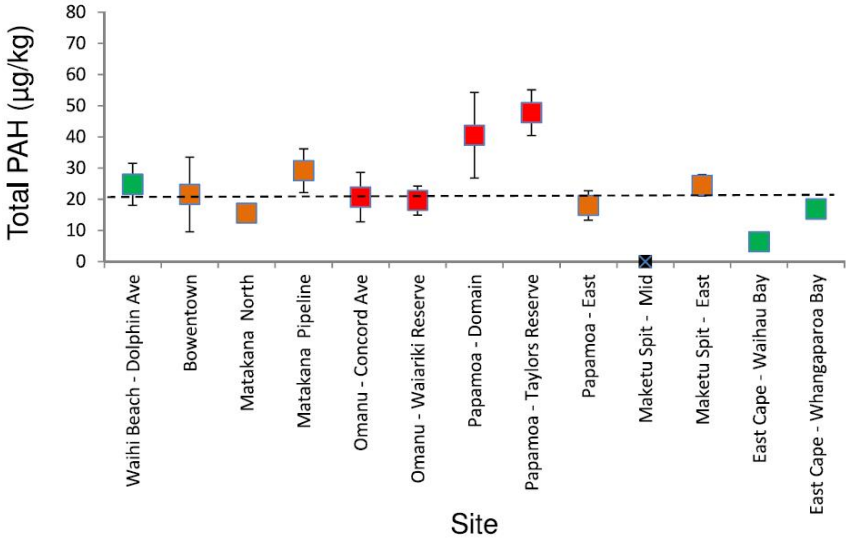
Questions 53 – 55

There were approximately 1733 tonnes of oil onboard the *Rena* when she ran aground. Approximately 350 tonnes were not recovered from the wreck and most of this washed ashore on Matakana Island and the coastline from Mt Maunganui to Maketu between 9 and 11 October 2011. Surveys examining the effects of the oil and debris washed onto the surf beaches focused on the northern tuatua (*Paphies subtriangulata*), as this is one of the most common species found burrowing in the sand on the open coast surf beaches that were most heavily fouled by oil from the *Rena,* and they are an important kai moana species.

The figure at right shows the level of total PAH in the tissue of tuatua from Papamoa and Omanu beaches from October 5 2011 to 30 June 2012. Before impact total PAH levels (background) were about 0.7µg/kg at Papamoa beach and 0.2 µg/kg at Ōmanu Beach. These values were produced on a wet weight basis.







The graph at left shows the total PAH levels in tuatua in winter 2012 from beaches from Waihi – East Cape. They are colour-coded to represent the degree of oiling. No winter PAH data was available for Maketū Spit - Mid (shore level). Results obtained from Waihi and Ōhope beaches are considered background levels and an average between these levels (20.6 µg/kg) is plotted as a dashed line. These values were produced on a dry weight basis.

Question 53

Considering the levels of total PAH over time, which statement is **NOT** correct.

- **A.** Total PAH levels in the tissue of tuatua from both Papamoa and Ōmanu beaches peaked on the 18th October.
- **B.** Total PAH levels in the tissue of tuatua returned to about pre-impact levels by 30 June 2012.
- **C.** Total PAH levels in the tissue of tuatua declined rapidly following the initial impact.
- **D.** Total PAH levels in the tissue of tuatua from Ōmanu beach showed a minor elevation in early December 2011.
- **E.** Minor elevations in the total PAH levels in the tissue of tuatua from Papamoa and Ōmanu beaches occurred on different dates.

Question 54

Total PAH levels in tuatua in winter 2012 were elevated above background levels at:

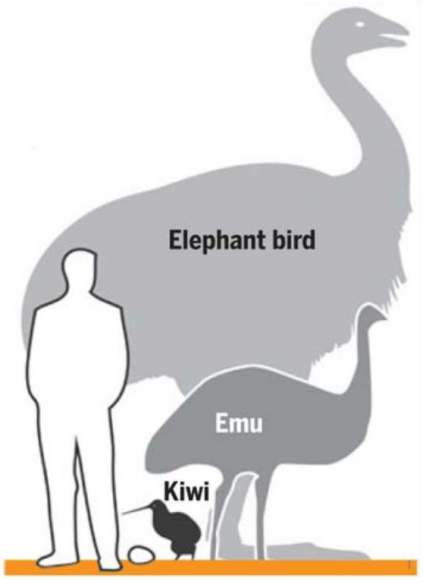
- **A.** Matakana Pipeline only.
- **B.** Papamoa Domain and Papamoa Taylors reserve only.
- **C.** Matakana Pipeline, Papamoa Domain and Papamoa Taylors reserve only.
- **D.** Matakana Pipeline, Papamoa Domain, Papamoa Taylors reserve and Maketu Spit only.
- **E.** Papamoa Domain, Papamoa Taylors reserve and Maketu Spit only.

Question 55

From these results it can be concluded:

- **A.** Total PAH levels in tuatua are strongly related to the degree of oil fouling.
- **B.** Tuatua at beaches that were fouled by oil from the Rena show significant ongoing contamination with PAH.
- **C.** Total PAH levels in tuatua from Ōmanu Beach can be directly compared and show an increase of 103-fold.
- **D.** Tuatua communities on Bay of Plenty open surf beaches do not appear to be catastrophically affected by the *Rena* oil spill in the long term.
- **E.** None of the above is a valid conclusion.

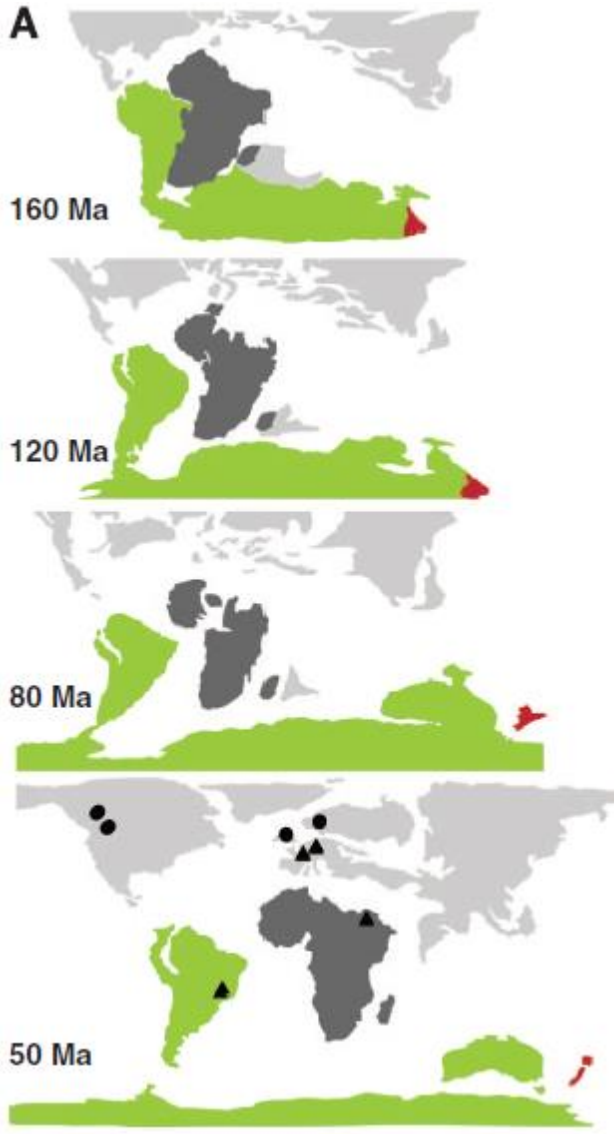
BIRDS OF A FEATHER – EVOLUTIONARY RELATIONSHIPS AMONGST THE RATITES



Our national bird, the kiwi, is a ratite, a group of flightless birds that includes the emu and cassowary in Australia and New Guinea, the ostrich in Africa, and the rhea in South America. There are also two recently extinct groups that include the largest birds ever known: our own moa and the elephant birds from Madagascar who reached heights of up to 3m. Ratites and tinamous (found in South America and weak fliers) belong to an ancestral group of birds called "palaeognaths" and are the sister group (closest relatives) to all other living birds, the "neognaths".

The evolutionary relationships within the ratites have been the subject of considerable research as these birds are believed to have originated through vicariant speciation driven by the continental breakup of the supercontinent Gondwana. Vicariant speciation is the process by which new species are formed from the separation of the original population into two or more populations by a geographic barrier. Researchers at the Australian Centre for Ancient DNA, and the Allan Wilson Centre for Molecular Ecology in New Zealand have recently published a study in Science which examines ancient DNA and clarifies ratite evolution.

The maps at right show the position of continents during the Late Cretaceous and Tertiary. Continental landmasses are coloured according to the order in which they broke away from the remaining Gondwanan landmass: Africa and Madagascar (dark gray) split 100 to 130 Million years ago (Ma), followed by New Zealand (red; 60 to 80 Ma), then finally Australia, Antarctica, and South America (green; 30 to 50 Ma).
Source: Mitchell *et al.* Science 344, 898 (2014).



Question 56

Which relationship amongst the palaeognaths might be expected if they are the result of vicariant speciation only?

- **A.** Ostrich and elephant birds are sister groups.
- **B.** The moa and emu are sister groups.
- **C.** Tinamous are most closely related to the cassowary.
- **D.** Rhea and cassowary are sister groups.
- **E.** None of the above are consistent with vicariant speciation.

Question 57

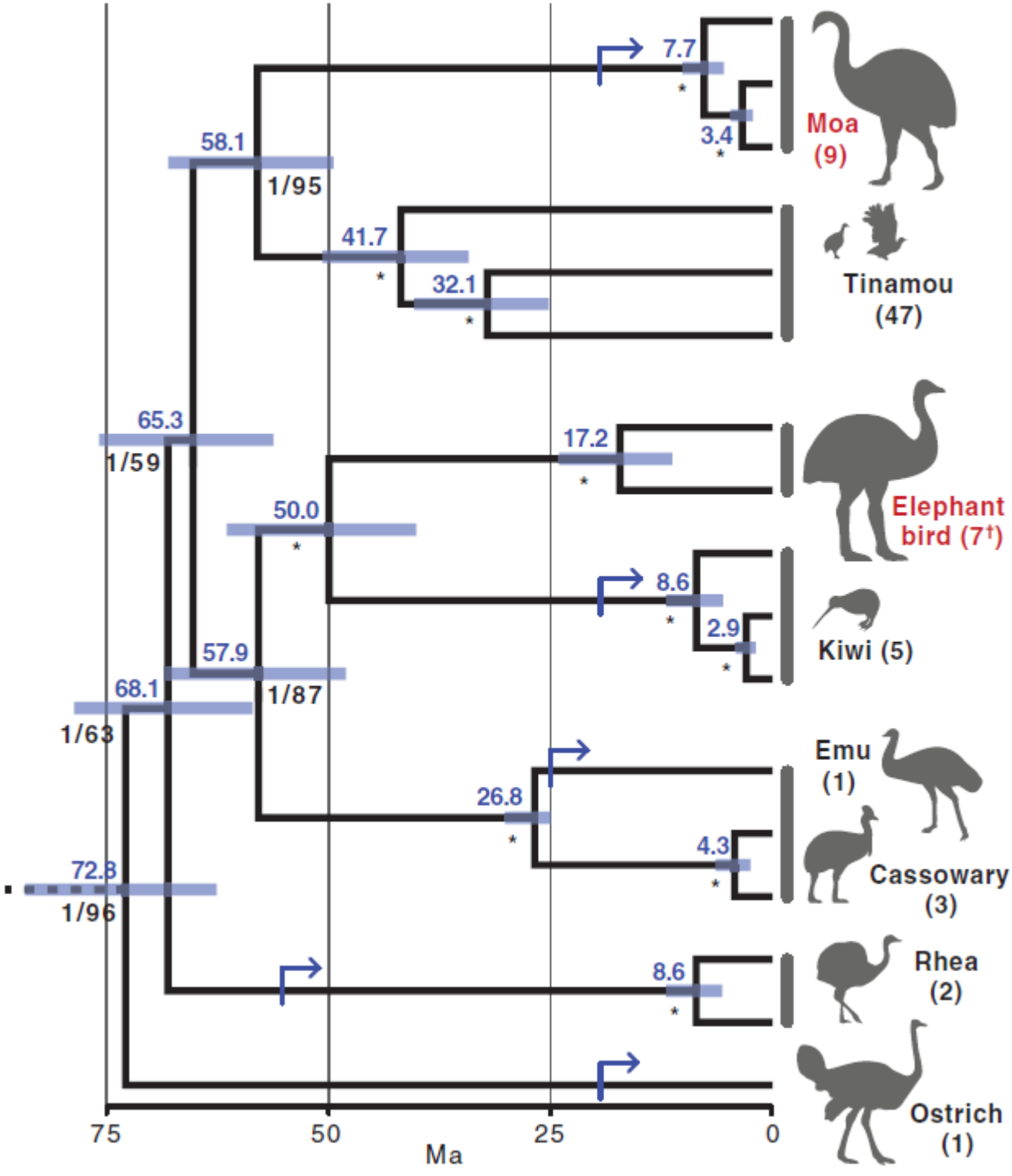
Scientists discover a "new" fossil palaeognath from Antarctica, dated at 60 Million years old. Under a vicariant speciation model you would expect this fossil to be most closely related to ratites from:

- **A.** Africa and Madagascar only.
- **B.** Australia and South America only.
- **C.** New Zealand only.
- **D.** Both A and B.
- **E.** Both A and C.

Questions 58 - 63

Evolutionary relationships or phylogeny can be represented by branching lines that end at groups of organisms on diagrams called cladograms. 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.

Mitchell *et al.* sequenced the mitochondrial genomes of two elephant birds and used these to infer relationships within the palaeognaths. These data are presented in the cladogram below. Divergence dates are given in the blue numbers above branches with the blue bars representing the 95% probability around that date. Blue arrows mark the minimum date for the evolution of flightlessness in lineages for which fossil evidence is available. The scale is given in millions of years before the present. Silhouettes indicate the relative size of representative taxa. Species diversity for each major clade is presented in parentheses, with extinct groups shown in red. The dagger symbol (†) indicates that the number of species is uncertain.



Source: Mitchell *et al.* Science 344, 898 (2014).

Question 58

At what minimum date is flightlessness thought to have arisen in the emu lineage?

- **A.** 55Ma
- **B.** 50Ma
- **C.** 25Ma
- **D.** 20Ma
- **E.** 15Ma

Question 59

Assume that once flight is lost it cannot be regained. If both the ancestor of all palaeognaths (at 72.3 Ma) and the ancestor of elephant birds and kiwi (at 50.0 Ma) could fly, what is the minimum number of times flightlessness must have arisen among the palaeognaths?

- **A.** 3
- **B.** 4
- **C.** 5
- **D.** 6
- **E.** 7

Question 60

How many species of elephant birds are known to have existed?

- **A.** Scientists are uncertain of the number
- **B.** 2
- **C.** 3
- **D.** 4
- **E.** 5

Question 61

Tinamous and the moa last shared a common ancestor?

- **A.** 68.1Ma
- **B.** 65.3Ma
- **C.** 58.1Ma
- **D.** 41.7Ma
- **E.** 7.7Ma

Question 62

This phylogeny suggests the closest relative of the kiwi is?

- **A.** Moa
- **B.** Tinamou
- **C.** Elephant bird
- **D.** Emu
- **E.** Rhea

Question 63

Considering these data what is the best conclusion/s?

- **A.** Vicariant speciation provides a poor explanation of the close relationship between elephant birds and kiwi.
- **B.** Madagascar and New Zealand have been directly connected in the geological past.
- **C.** Kiwi and elephant birds diverged after the breakup of Gondwana.
- **D.** A and B only.
- **E.** A and C only.

SAVING THE MAUI'S DOLPHINS – A STORY OF BIOLOGY, POLICY & CONSERVATION

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http://wwf.panda.org/wwf_news/?206249/NZ-govt-fails-Mauis-dolphins-on-global-stage

http://www.doc.govt.nz/conservation/native-animals/marine-mammals/dolphins/hectors-dolphin/docs-work/hectors-and-mauis-dolphin-incident-database/

Maui's dolphin (*Cephalorhynchus hectori maui*) is one of the world's rarest dolphins and is found only on the west coast of the North Island of New Zealand (Resource Pack, Figure 1). It is a sub-species of Hector's dolphin (*Cephalorhynchus hectori*). The Maui's dolphin is protected by the West Coast North Island Marine Mammal Sanctuary (WCNIMMS) which restricts seabed mining activities, acoustic seismic survey work and commercial and recreational set netting. The boundaries of this sanctuary extend alongshore from Maunganui Bluff in Northland to Oakura Beach, Taranaki, in the south and from mean high water springs to the 12 nautical mile (nm) territorial sea limit. The total area of the sanctuary is approximately 1,200,086 hectares covering 2,164 km of coastline. (Resource Pack, Figure 1).

Maui's dolphin is 'critically endangered' (IUCN Red List), with the population dropping from around 1000 individuals in 1970 to 111 in 2004 according to research by Assoc. Prof. Dr Liz Slooten and others from Otago University. Recent research by the Department of Conservation (DOC) suggests there are now even fewer Maui's dolphins remaining. Maui's dolphins are relatively short-lived (approximately 25 years), and are slow breeders. Females do not have their first calf until they are about seven or eight years old, and have a new calf only every two to four years. This means the species may be threatened by even occasional deaths caused by human activity. Fishing, particularly set netting, is the greatest known human threat to Maui's dolphins and thought to be responsible for about 75 per cent of reported deaths with a known cause. Other human threats include marine tourism, vessel traffic, mining, construction, coastal development pollution, sedimentation, oil spills, plastic bags, marine farming and climate change.

In recent weeks the need to develop effective management strategies for this species to prevent its extinction has hit the news. Liz Slooten presented the latest research to the International Whaling Commission in May this year, showing that the current protection measures are not sufficient to avoid the extinction of Maui's dolphin. WWF-New Zealand, Greenpeace, and Forest & Bird and international conservation groups including NABU and WDC in 2012 and 2013 are all campaigning to protect the Maui's dolphin and hundreds of angry protesters marched to the office of the Energy and Resources Minister Simon Bridges' office in Tauranga to protest the government allowing oil exploration within the West Coast North Island Marine Mammal Sanctuary in their annual tender process 'Block Offer 2014' (Resource Pack, Figure 3). This government decision came just two weeks after the International Whaling Committee (IWC) criticised New Zealand for not taking the necessary steps to save the Maui's dolphin. The IWC noted that a 350 km^2 set net restriction had been added to the WCNIMMS but commented that these measures fell significantly short of those required to reverse the Maui's dolphin decline as recommended by the IWC in 2012 and 2013. The IWC reiterated its extreme concern about the continued decline of such a small population "as the human-induced death of even one dolphin would increase the extinction risk for this subspecies". In 2013 it strongly recommended that the NZ government should:

> "take immediate management actions that will eliminate bycatch of Maui's dolphins. This includes full closures of any fisheries within the range of Maui's dolphins that are known to pose a risk of bycatch of small cetaceans (i.e. set net and trawl fisheries)". Ensuring full protection of Maui's dolphins in all areas throughout their habitat, together with an ample buffer zone, would minimise the risk of bycatch and maximise the chances of population increase". and "commit to specific population increase targets and timelines".

Because this recommendation was ignored by the NZ government, in 2014, the IWC recommended that the protected area should be extended south to Whanganui, offshore to 20 nautical miles and should include the harbours.

Questions 64 - 68

The resource pack contains maps of Maui's and Hector's dolphin sightings from 1970 – July 2013, Protection measures for Maui's dolphins on the West Coast North Island and the 'Block Offer 2014' for the Offshore Release Area: Taranaki Basin 14TAR-R1. It also has a table of all Maui's dolphin sightings from Pariokariwa Point to New Plymouth and New Plymouth South to Cape Terawhiti. Much of this area is included in the Block Offer 2014' Taranaki Basin 14TAR-R1 area. This table is modified from the Maui's dolphin sightings database:
http://www.doc.govt.nz/conservation/native-animals/marine-mammals/dolphins/mauis-dolphin/docs-work/mauis-dolphin-sightings/

Conservation Minister Nick Smith was questioned in parliament about the decision to open part of the sanctuary for exploration. "The block offer is nowhere near where the Maui's live," Dr Smith said. "There hasn't been a single observation of a Maui's dolphin, and the oil and gas industry hasn't been involved in a single Maui's dolphin incident in Taranaki over the past 40 years despite 23 wells being drilled" (Source: http://www.3news.co.nz/Greenpeace-get-23000-signatures-in-petition-to-sack-Bridges/tabid/423/articleID/349373/Default.aspx).

Question 64

Considering the recorded sightings of Maui's dolphins since 1970 (Resource Pack, Figure 1). What valid conclusion could Dr Smith have drawn?

- **A.** The block offer is nowhere near where the Maui's live.
- **B.** There has not been a single observation of a Maui's dolphin in the block offer area.
- **C.** The block offer covers some of the most important areas where Maui's dolphins live.
- **D.** The block offer overlaps with the southern end of the Maui's dolphin range.
- **E.** The block offer covers most of the area where the Maui's dolphins live.

Question 65

Estimate the area of overlap between the West Coast North Island Marine Mammal Sanctuary and the 'Block Offer 2014' Taranaki Basin 14TAR-R1 using the information contained in Figures 2 and 3 in the resource Pack.

- **A.** 3000 km^2
- **B.** 3000 nm^2
- **C.** 1000 km^2
- **D.** 1000 nm^2
- **E.** 500 km^2

Question 66

Considering the data in Table 1 in the Resource Pack, how many Maui's dolphins have been sighted from Pariokariwa Point to New Plymouth and New Plymouth South to Cape Terawhiti

- **A.** 78
- **B.** 89
- **C.** 92
- **D.** 95
- **E.** This cannot be determined.

Question 67

What evidence suggests that Maui's dolphins do interact with the current oil and gas industry and may do so at increased levels if exploration occurs within the West Coast North Island Marine Mammal Sanctuary

- **A.** There have been four sightings of Maui's dolphins from oil platforms in Taranaki.
- **B.** Maui's dolphins have been sighted in Port Taranaki.
- **C.** Commercial fisherman have reported sightings of Maui's dolphins.
- **D.** Both A and B provide evidence.
- **E.** A, B and C provide evidence.

Question 68

Determining the distribution and population size of Maui's dolphins from sightings has a number of problems. These include:

- **A.** The sampling effort is unequal so the lack of presence of a species could relate to a real absence or simply to a lack of sampling effort.
- **B.** Low or zero sampling effort could easily miss the presence of a low-density species such as Maui's dolphin.
- **C.** Misidentification of species, or misreporting of locations, can confound such studies.
- **D.** Environmental factors such as rough seas can decrease sampling effort and result in dolphins being 'missed'.
- **E.** All of the problems above (A-D) are inherent in using sighting data to determine the distribution and population size of Maui's dolphins.

Questions 69 - 75

Conservation of the critically endangered Maui's dolphin requires a good understanding of the trends in abundance and effective population sizes so that conservation actions can be planned and evaluated. DOC (2012) reported on the genetic monitoring of the Maui's dolphin using DNA profiles to estimate the current abundance and effective population size, as well as to document movements of individuals. The study collected of 37 dart-biopsy samples in summer 2010 and a further 36 in summer 2011. DNA profiles were completed for each sample and the sex was identified. These profiles were used to identify individual Maui's dolphins and Hector's dolphin migrants, to describe individual movements, and to estimate the abundance, population trend and effective population size of Maui's dolphins for 2010–11, including comparison with data from a previous set of samples collected in 2001–07.

Based on the microsatellite genotyping, 26 individuals were identified from the 37 samples collected in 2010 (16 females, 10 males) and 27 individuals from 36 samples collected in 2011 (16 females, 11 males). Twelve individuals were sampled in both 2010 and 2011, and with the addition of one unique male washed up on a beach in 2010, this provided a minimum census of 42 individuals (25 females, 17 males) alive at some point during the two years of the survey. Of this total, two females were identified as West Coast South Island Hector's dolphin (*C. h. hectori*) migrants based on distinct mtDNA haplotypes and genotype-based population assignment procedures.

Population size can be estimated by the Lincoln-Petersen estimator:

$N = [(n_1+1)(n_2+1)/(m_2+1)] - 1$

Where N = abundance
$n1$ = number of individuals sampled in occasion 1
$n2$ = number of individuals sampled in occasion 2
$m2$ = number of individuals sampled in both occasions 1 and 2

Individual movements of Maui's dolphins and a Hector's dolphin migrant (^) that were sampled more than once during 2010–11 are given in Table 2 in the Resource Pack.

An Expert Panel of New Zealand and international scientists, convened by the New Zealand government in 2012, estimated that five Maui's dolphins were killed in fishing gear each year – one in trawl fisheries and four in gillnet fisheries. The number of gillnet mortalities per year is estimated to have decreased from four to at best two per year as a result of the 350 sq. km set net restriction extension in the WCNIMMS. The Ministry of Primary Industries (MPI) and the Department of Conservation (DOC) reviewed the Maui's dolphin portion of the Threat Management Plan (TMP) in 2013. During the TMP review process it was highlighted that non-fishing-related threats such as seismic surveying, oil and gas exploration, vessel strikes, and disease also pose a serious risk to the long-term viability of Maui's dolphins. These threats represented 4.5% of the estimated dolphin mortalities. The importance of both the fishing and non-fishing risks needs to be assessed relative to the Potential Biological Removal (PBR) level which is defined as the number of human-caused deaths the stock can withstand annually. The PBR for Maui's dolphins is one dolphin in 10 – 23 years or 0.044 – 0.1 per year.

For Maui's dolphin the impact of seismic surveying was combined within all mining and oil activities. This was estimated to contribute to the equivalent of 0.10 deaths per year (95% confidence interval 0.01-0.46), with a 61.3% likelihood of exceeding the PBR. In terms of seismic surveying, the greatest concern is noise in the marine environment. Noise leading to trauma was scored at 0.01 deaths per year (95% CI:<0.01-0.13) and a likelihood of exceeding the PBR of 8.8%, while non-trauma noise effects was scored at 0.03 deaths per year (95% CI: <0.01-0.23) and a likelihood of exceeding the PBR of 28.6%.
(http://www.fish.govt.nz/en-nz/Environmental/Hectors+Dolphins/default.htm)

The Minister of Conservation has proposed the following measures:

- Making the Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Survey Operations a mandatory standard by reference under section 28 of the Marine Mammal Protection Act.
- Developing a voluntary code of conduct with the inshore boat racing community to minimise the potential for vessel strike, and
- Ensuring that disease investigations are a priority in the Maui's dolphin Research Advisory Group.

There has been no recommendation to prevent set net and trawl fishing throughout the range of Maui's dolphins as to do so would need to extend fishing restrictions as far south as Whanganui, out to the 100 m depth contour, and include all harbours.

Question 69
Use the Lincoln-Petersen estimator to calculate the population size of the Maui's dolphin.

A. 57
B. 55
C. 61
D. 104
E. 107

Question 70
What proportion of the Maui's dolphin population sampled in 2010 and 2011 is female?

A. 45.5%
B. 41.8%
C. 59.5%
D. 54.7%
E. Unable to be determined.

Question 71
The maximum distance known to have been travelled by a Maui's dolphin within a single year is?

A. 17.88 km
B. 26.44 km
C. 46.30 km
D. 78.62 km
E. 80.43 km

Question 72
The major identified risks to Maui's dolphins are:

1. Trawl fishing
2. Set netting
3. Seismic surveying
4. Mining and oil activities
5. Noise leading to trauma
6. Non-trauma noise effects

Which of these risks are estimated to be above the PBR and could result in gradual extinction of the Maui's dolphins if the current rates are allowed to continue.

A. 1, 2, 3, 4, 5 and 6
B. 2, 3, 4, 5 and 6 only.
C. 1, 2 and 4 only.
D. 1, 2, 4 and 6 only.
E. 2, 4 and 6 only.

Question 73
The greatest risk for the survival of Maui's dolphin remains?

A. Trawl fishing
B. Set netting
C. Seismic surveying
D. Mining and oil activities
E. Noise leading to trauma

Question 74
Trawl fisheries contributes 1 death per year. This exceeds the estimate PBR by:

A. Between 10 – 22.72 times.
B. 10 times.
C. 22.72 times.
D. 0.1 times.
E. 0.04 times.

Question 75
Considering all the scientific evidence you have available about the Maui's dolphin, what would you recommend that the government does to protect this critically endangered dolphin?

A. The extension to the set netting restricted areas together with the new codes of conduct for acoustic surveying and boat racing is sufficient.
B. Ban set netting and mining and oil activities within the West Coast North Island Marine Mammal Sanctuary.
C. Ban set netting throughout the range of Maui's dolphins including south to Whanganui, out to the 100m depth contour and within all harbours.
D. Prevent all mining and oil activities within the West Coast North Island Marine Mammal Sanctuary.
E. Ban trawl fishing, set netting, and mining and oil activities throughout the range of Maui's dolphins including south to Whanganui, out to the 100m depth contour and within all harbours.

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 to understand and protect our wonderful planet here in New Zealand. 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.