HL Paper 2

b. Describe what is meant by a food chain and a food web. [6]

c. Explain the relationship between rises in concentration of atmospheric gases and the enhanced greenhouse effect. [8]

a (i) The greenhouse effect is a naturally occurring process. [1]

State **one** greenhouse gas.

a (ii) The greenhouse effect is a naturally occurring process. [2]

Explain how radiation of different wavelengths is involved in the greenhouse effect

b (i) The enhanced greenhouse effect can cause a rise in atmospheric temperature. [2]

Outline **two** consequences of a global temperature rise on arctic ecosystems.

1.

2.

b (ii) The enhanced greenhouse effect can cause a rise in atmospheric temperature. [1]

Outline **one** effect of a temperature rise on plants.

a. Distinguish between autotrophs and heterotrophs. [2]

b. Define *saprotroph*. [1]

c (i) State an external feature that is different in: [1]

Cnidaria and Mollusca.

c (ii) State an external feature that is different in: [1]

Mollusca and Annelida.

a. Describe the relationship between the rise in the concentration of atmospheric carbon dioxide and the enhanced greenhouse effect. [5]

b. Outline the precautionary principle. [5]

c. Antibiotic resistance in bacteria is an example of evolution in response to environmental change. Using another example, explain how an environmental change can lead to evolution. [8]

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b. Most of the surface of the Earth is covered with a wide diversity of ecosystems. Outline **two** general characteristics of all ecosystems. [2]

c.i. Vascular plants can be found in a wide variety of ecosystems. [2]

Outline active transport in phloem tissue.

c.ii. Vascular plants can be found in a wide variety of ecosystems. [3]

Explain how a plant replaces the water it loses in transpiration.

---

a. Describe how plants carry out gas exchange in the leaves. [5]

b. Outline the causes and consequences of the enhanced greenhouse effect. [5]

c. Explain the role of limiting factors in photosynthesis. [8]

---

a. Outline how and where energy is stored in plants. [4]

b. Ecologists sometimes display data from an ecosystem using a diagram called a pyramid of energy. Describe what is shown in pyramids of energy. [6]

c. Explain the control of body temperature in humans. [8]

---

a. Draw a labelled diagram of a eukaryotic plant cell as seen in an electron micrograph. [4]

b. Outline how the energy flow through food chains limits their length. [3]

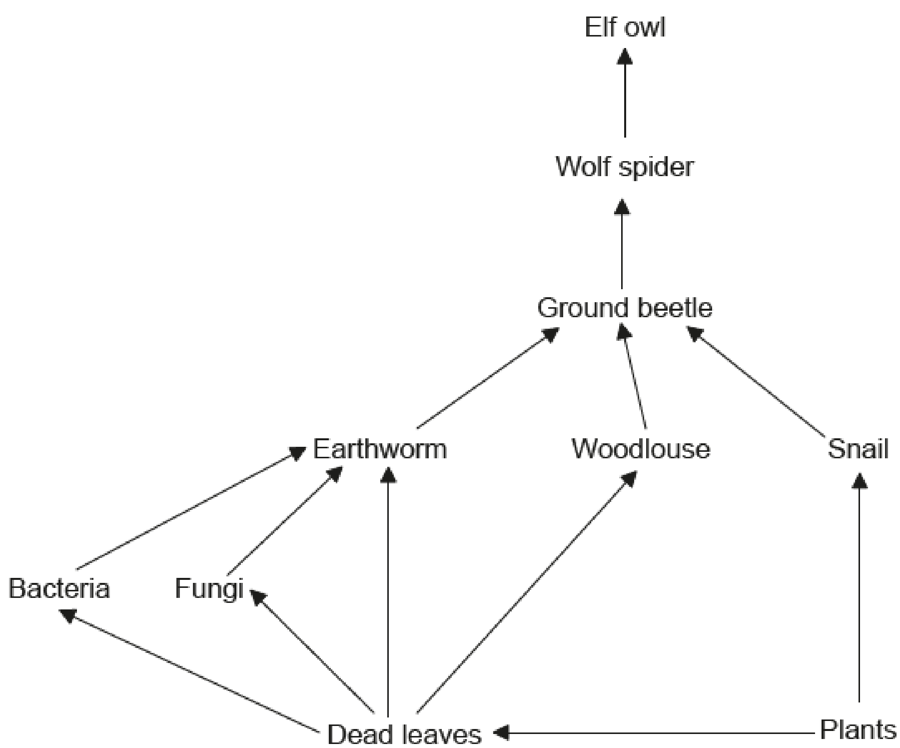
c. In hot, dry conditions plants lose water rapidly due to transpiration. Explain how the structures and processes of the plant allow this water to be replaced. [8]

In ecosystems, energy is used to convert inorganic compounds into organic matter. Energy enters ecosystems through producers.

a. Explain the processes by which light energy is converted into chemical energy. [8]

c. Describe how energy flows through and is used by organisms in ecosystems. [4]

The image shows a food web.



[Source: © International Baccalaureate Organization, 2017]

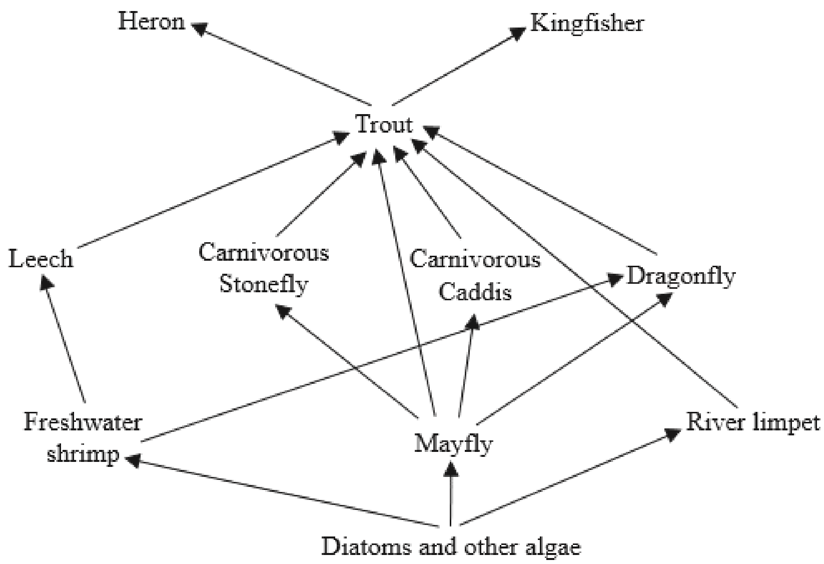
a.i. Using the food web, identify a detritivore. [1]

a.ii. Using the food web, identify a saprotroph. [1]

b. State the name of the domain to which birds, such as the Elf owl, belong. [1]

c. Outline the energy flow through this food web. [3]

The food web below shows some of the feeding relationships found between the organisms living in or near a river in England.



a (i) Identify an organism in the food web that is an autotroph. [1]

a (ii) Identify an organism in the food web that is both a secondary and tertiary consumer. [1]

b. Explain how the flow of energy in the food web differs from the movement of nutrients. [2]

c. Discuss reasons why the levels of a pyramid of energy differ in size. [2]

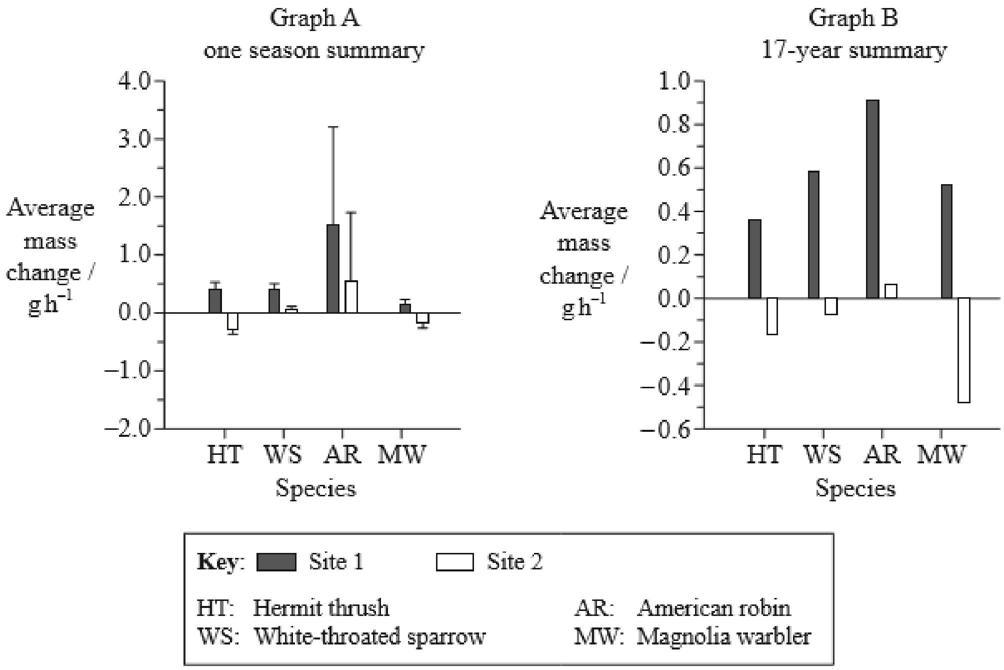
Migrating birds must refuel along the way in order to continue flying. A field study was conducted among four different species of migrating birds known to stop at high quality and low quality food sites. Two techniques were used to assess food quality in the stopover sites. Birds were captured and weighed at the two sites. Blood samples were taken from the birds to determine nutrient levels in their blood. The two techniques were compared for their effectiveness.

The table below shows data collected from the two sites during one season.

Species	Site 1		Site 2	
	N (number captured)	Mean bird mass / g	*N* (number captured)	Mean bird mass / g
Hermit thrush	46	29.8	28	28.3
White-throated sparrow	47	27.9	48	27.2
American robin	8	78.3	10	77.6
Magnolia warbler	30	8.4	10	8.2

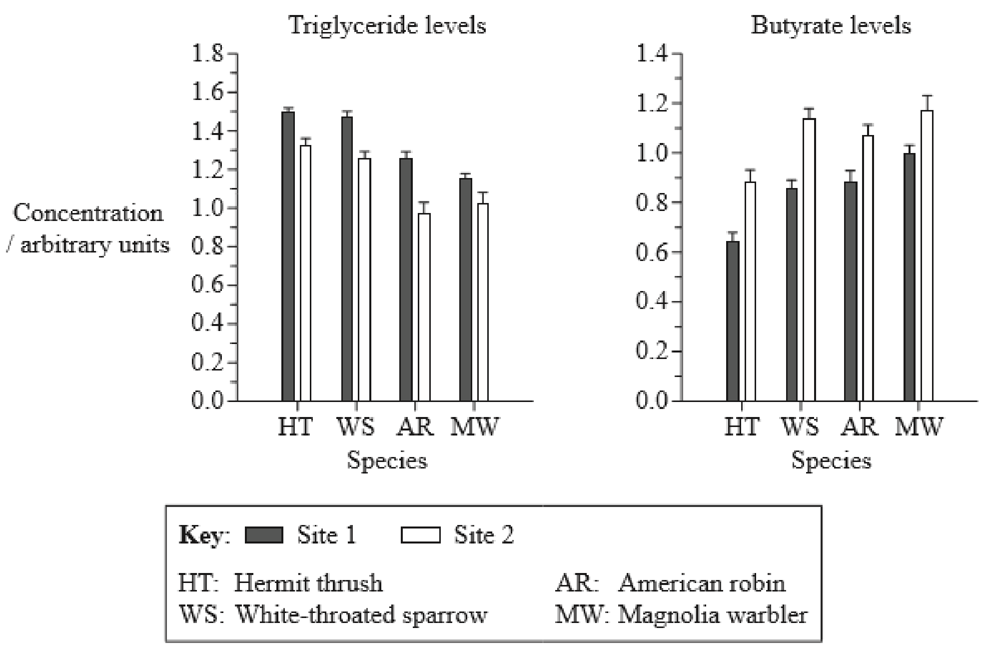
[Source: adapted from C Guglielmo, *et al.*, (2005), *Physiological and Biochemical Zoology*, **78**(1), pages 116–125]

A method was used to determine the average mass change in grams per hour (gh^{-1}) during the study. Graph A represents a summary of data collected during one season whereas Graph B represents a summary of data collected over 17 years.



[Source: adapted from C Guglielmo, *et al.*, (2005), *Physiological and Biochemical Zoology*, **78**(1), pages 116–125]

Among birds, high triglyceride concentration in blood plasma indicates fat deposition whereas high butyrate concentration in blood plasma indicates fat utilization and fasting. The following data summarizes triglyceride levels and butyrate levels measured for the same groups of birds.



[Source: adapted from C Guglielmo, *et al.*, (2005), *Physiological and Biochemical Zoology*, **78**(1), pages 116–125]

a. Considering all the birds sampled, identify which species was sampled the most and which was sampled the least. [1]

Most:

Least:

b. Using the data from the table, calculate the percentage difference in mean bird mass for the hermit thrushes refueling at Site 1 compared to those refueling at Site 2. [1]

c. Compare the 17-year summary data for the hermit thrush and the magnolia warbler. [2]

d. Evaluate the one season data for the hermit thrush and the American robin with regard to average mass change per hour at Site 1. [2]

e. Describe, using the triglyceride levels graph, the results at Site 1 and Site 2 for all of the birds. [2]

f. Explain the differences in the triglyceride level and butyrate level for the hermit thrush at Site 1 and Site 2. [2]

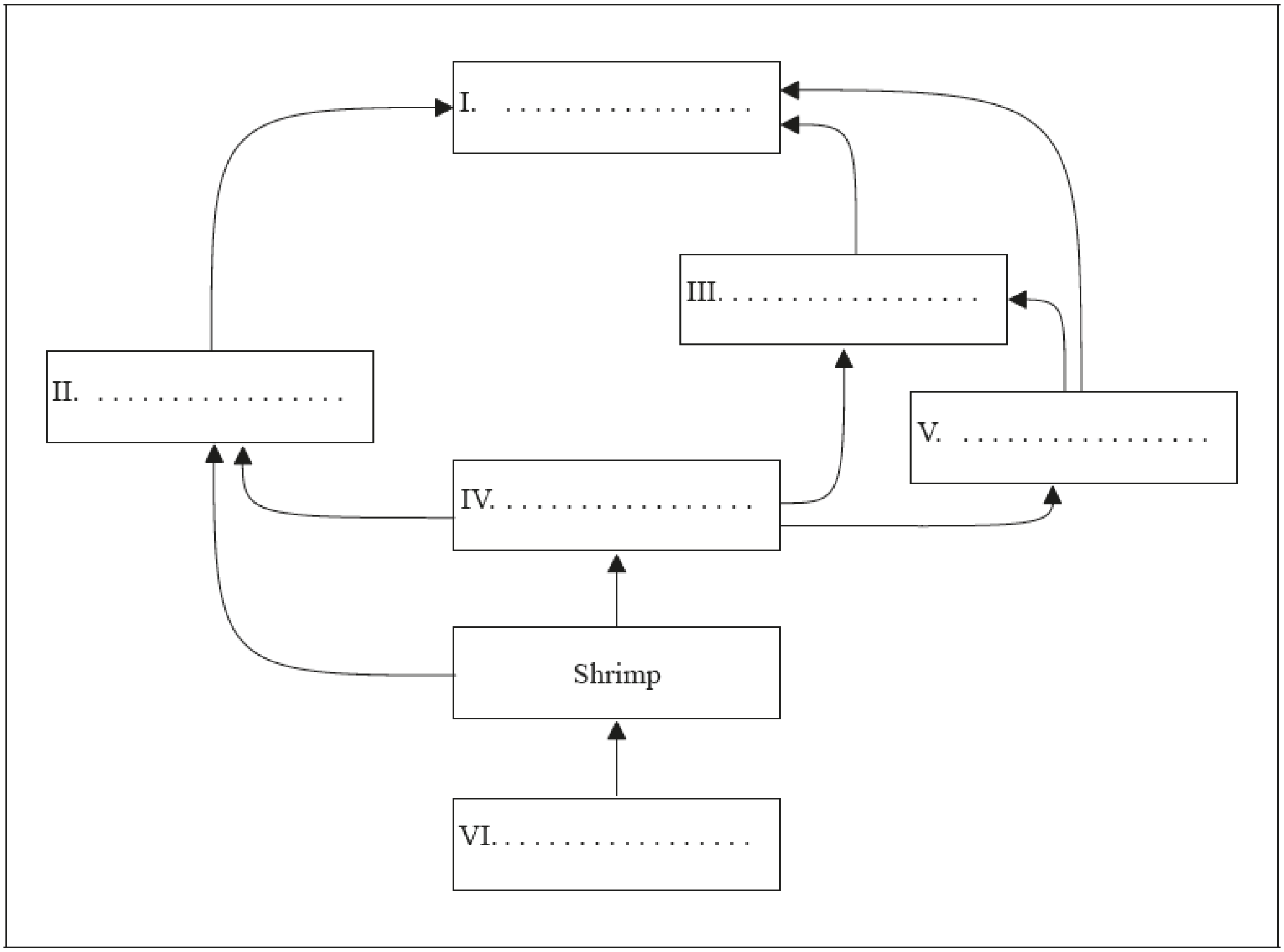
g. Scientists have hypothesized that the food quality is better at Site 1 than at Site 2. Evaluate this hypothesis using the data provided. [2]

h. Suggest **one** advantage and **one** disadvantage for blood sampling rather than weighing birds to assess food quality at stopover sites. [1]

The table provides some information about organisms found in an Arctic environment.

Organism	Prey/food	Predators
Arctic cod	Shrimp	Arctic fox, Narwhal, Seal
Arctic fox	Arctic cod, Seal	Polar bear
Narwhal	Arctic cod, Shrimp	Polar bear
Phytoplankton	None	Shrimp
Polar bear	Arctic fox, Narwhal, Seal	None
Seal	Arctic cod	Arctic fox, Polar bear
Shrimp	Phytoplankton	Arctic cod, Narwhal

a. (i) Label the diagram to complete the food web for the organisms in the table above. [3]

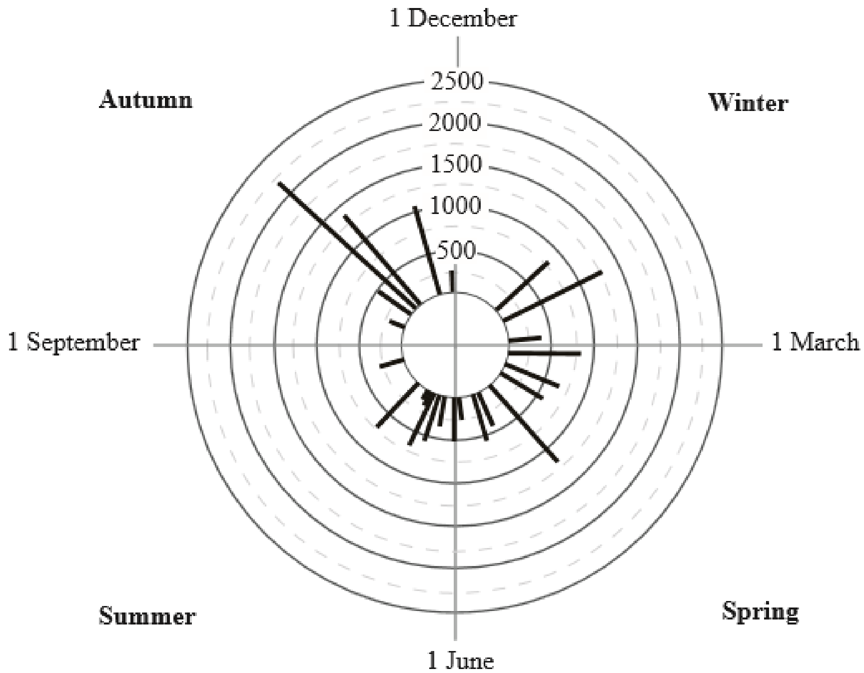


(ii) Deduce the trophic level of Artic cod.

b. Distinguish between the movement of energy and nutrients in an ecosystem. [2]

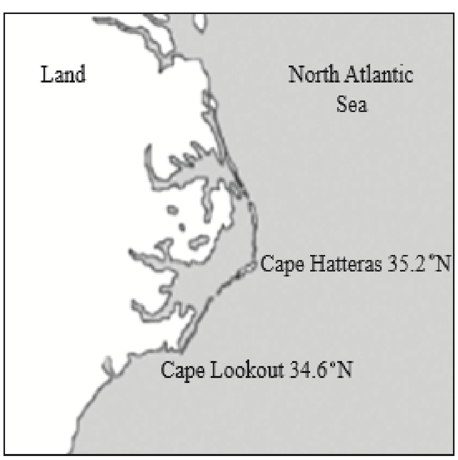
Bottlenose dolphins (*Tursiops truncatus*) inhabit almost all tropical and temperate oceans between 45°N and 45°S. Over a two-year period, aerial surveys were carried out to investigate the seasonal distribution of these animals along the mid-Atlantic and eastern coastal waters of the USA. Sightings were recorded using a global positioning system (GPS) while flying in a regular pattern within approximately 65 km of the shore. A total of 12 760 dolphins were sighted over the two-year period and the data are summarized in the chart below.

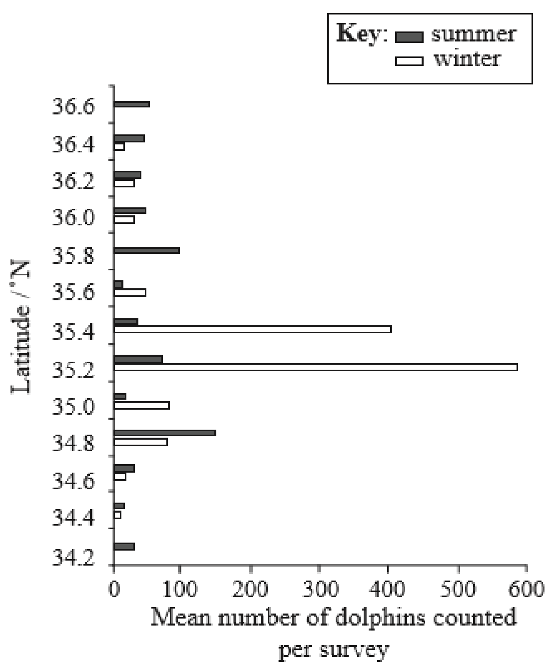
Each bar corresponds to a single survey and the length of the bar corresponds to the total number of bottlenose dolphins counted in that survey. The circles with numbers indicate numbers of dolphins.



[Source: adapted from Leigh G. Torres, William A. McLellan, Erin Meagher and D. Ann Pabst (2005) 'Seasonal distribution and relative abundance of bottlenosedolphins, *Tursiops truncatus*, along the US mid-Atlantic Coast.' *Journal of Cetacean Research and Management*, 7 (2), pp. 153–161.]

As part of the same study, coastal aerial surveys were carried out over the same time period by flying parallel to the coast approximately 500 m offshore. The diagram below shows a map of the section of coast surveyed. The bar graph shows the seasonal data for summer and winter at the corresponding latitudes (°N). A total of 5431 bottlenose dolphins were sighted during these surveys.





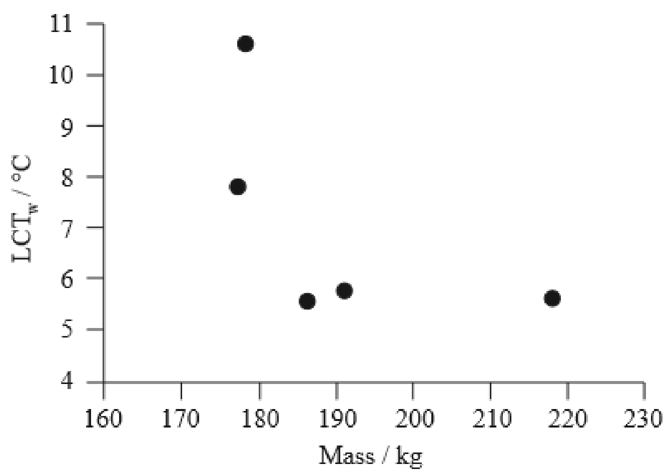
[Source: adapted from Leigh G. Torres, William A. McLellan, Erin Meagher and D. Ann Pabst (2005) 'Seasonal distribution and relative abundance of bottlenosedolphins, *Tursiops truncatus*, along the US mid-Atlantic Coast.' *Journal of Cetacean Research and Management*, 7 (2), pp. 153–161.]

In a different study, researchers investigated the role of water temperature as a possible factor in the distribution of bottlenose dolphins. The rate of metabolism (measured as the rate of oxygen uptake per unit mass) of five captive adults was measured under a range of water temperatures. The rate of metabolism was found to increase significantly when the water temperature fell below a certain value known as the lowest critical water temperature (LCT_w). Below this temperature the body uses more energy to combat the cooling effect of the surrounding water. The data for these animals are summarized below.

Animal	Sex	Age / years	Mass / kg	LCT_w / °C
1	male	27	177.3	7.8
2	male	24	191.4	5.7
3	male	26	219.7	5.6
4	male	14	187.0	5.5
5	female	33	178.2	10.6

Adapted with permission from L.C. Yeates and D.S. Houser (2008) 'Thermal tolerance in bottlenose dolphins (*Tursiops truncatus*).' *Journal of Experimental Biology*, 211, pp. 3249–3257, Table 1. doi:10.1242/jeb.020610: The Journal of Experimental Biology: jeb.biologists.org

The graph below summarizes the relationship between LCT_w and body mass.



[Adapted with permission from L.C. Yeates and D.S. Houser (2008) 'Thermal tolerance in bottlenose dolphins (*Tursiops truncatus*).' *Journal of Experimental Biology*, 211, pp. 3249–3257, Figure 4. doi:10.1242/jeb.020610: The Journal of Experimental Biology: jeb.biologists.org.]

a. State the largest number of dolphins counted in a single survey. [1]

b. Calculate the mean number of dolphins counted per survey for the winter season. [1]

c. Compare the data for the dolphin populations in winter and summer. [2]

d (i) Compare the distribution of dolphins in summer and winter. [2]

d (ii) Suggest **one** reason for the differences in distribution. [1]

e. Outline the relationship between body mass and LCT_w for male dolphins. [2]

f. Suggest **one** reason for the high LCT_w measured for the female dolphin. [2]

g. Evaluate the hypothesis that water temperature determines the range and distribution of bottlenose dolphins in the wild. [2]

h. Explain how an increase in water temperature due to global warming could affect the distribution of bottlenose dolphins along the eastern coast of the USA. [2]

The Chinese soft-shelled turtle, *Pelodiscus sinensis*, lives in salt water marshes. The turtle can live under water and out of water.

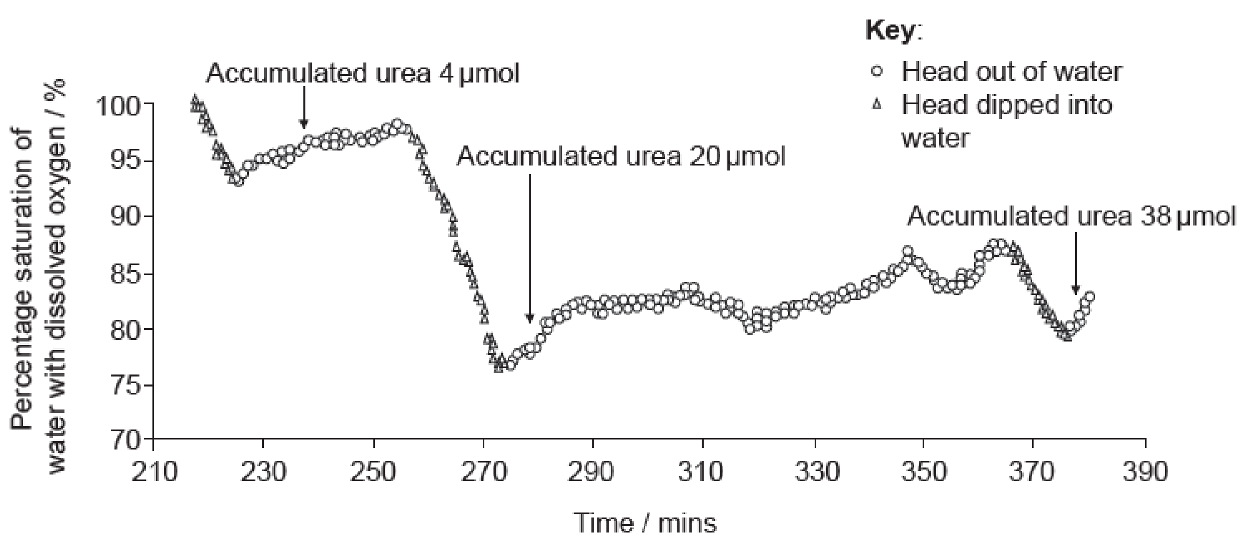
These turtles have fully developed lungs and kidneys, however, many microvilli have been discovered in the mouth of *P. sinensis*. A study was undertaken to test the hypothesis that oxygen uptake and urea excretion can simultaneously occur in the mouth.

Initial experiments involved collecting nitrogen excretion data from *P. sinensis*. The turtle urinates both in water and out of water. When in water it allows waste products to be washed out of its mouth. When out of water it regularly dips its head into shallow water to wash its mouth. The table shows the mean rates of ammonia and urea excretion from the mouth and kidney over six days.

	Excretion of nitrogen by the mouth / µmol day^{-1} g^{-1} turtle		Excretion of nitrogen by the kidney / µmol day^{-1} g^{-1} turtle	
	Turtle submerged in water	Turtle out of water	Turtle submerged in water	Turtle out of water
Ammonia	0.29	0.30	0.63	0.54
Urea	0.90	1.56	0.07	0.73

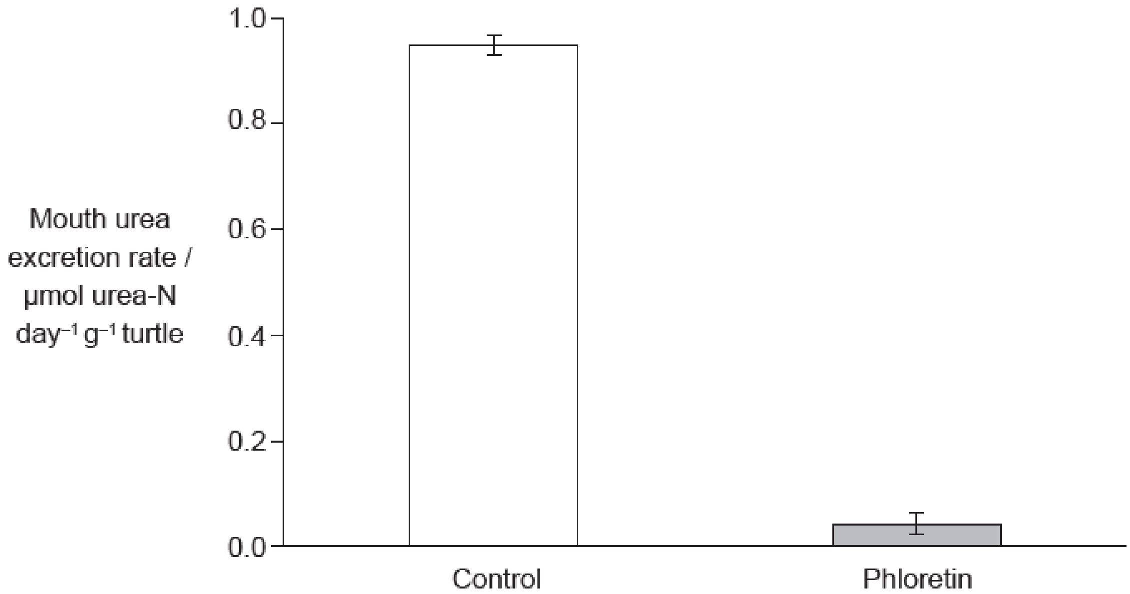
[Source: Reproduced with permission, Y. Ip *et al*. (2012) *The Journal of Experimental Biology*, 215, pages 3723—3733. jeb.biologists.org. doi: 10.1242/jeb.068916]

It was noted that during long periods out of water, turtles rhythmically moved their mouths to take in water from a shallow source and then discharge it. Changes in the dissolved oxygen and the quantity of accumulated urea in the rinse water discharged by the turtles were monitored over time as shown in this graph.



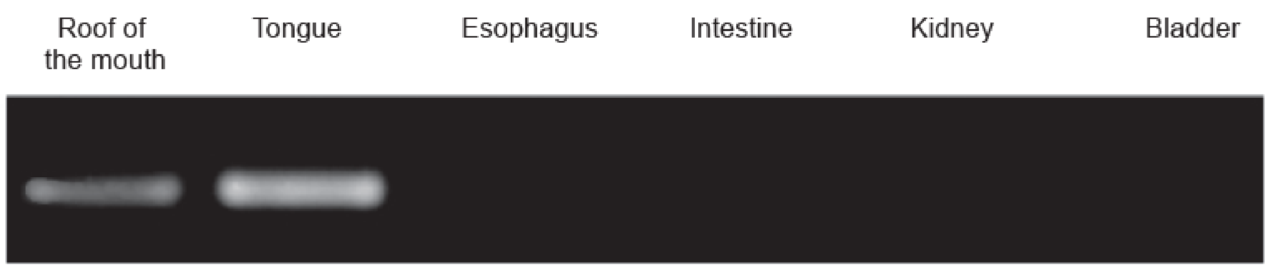
[Source: adapted with permission from Y. Ip *et al*. (2012) *The Journal of Experimental Biology*, 215, pages 3723–3733.]

In order to test whether a urea transporter was present in the mouth tissues of the turtles, phloretin (a known inhibitor of membrane proteins that transport urea) was added to the water in which a further set of turtles submerged their heads. The results of that treatment are shown.



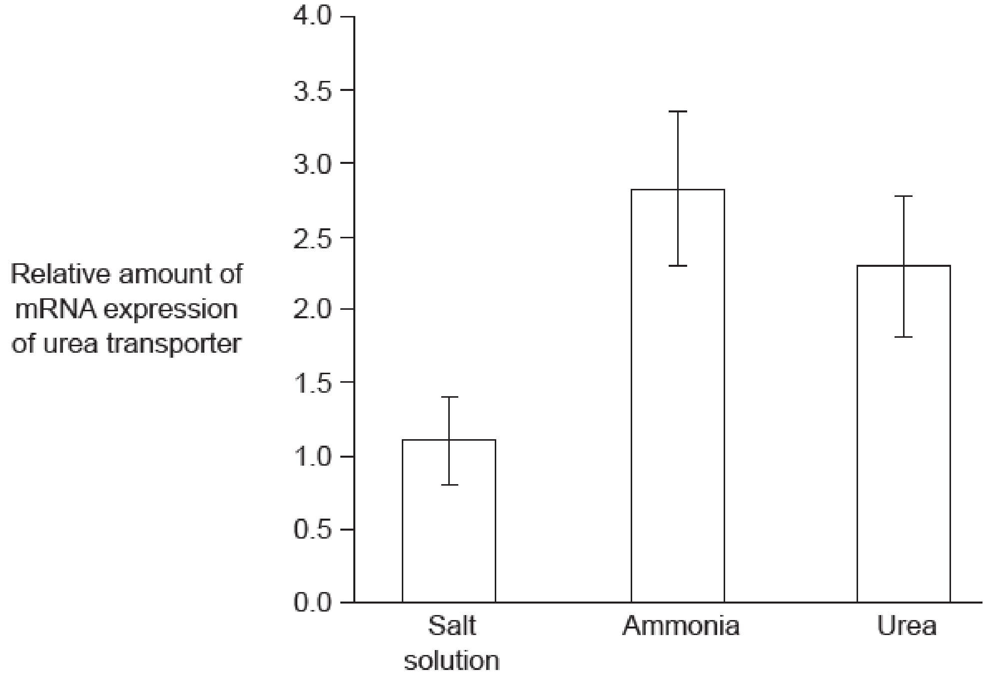
[Source: Reproduced with permission from Y. Ip *et al*. (2012) *The Journal of Experimental Biology*, 215, pages 3723–3733. jeb.biologists.org.]

Further research was conducted to determine where mRNA expression of a urea transporter gene might be occurring in *P. sinensis*. Gel electrophoresis was used to analyse different tissue samples for mRNA activity.



[Source: Reproduced with permission from Y. Ip *et al*. (2012) *The Journal of Experimental Biology*, 215, pages 3723–3733. jeb.biologists.org.]

Expression of the urea transporter gene by cells in the turtle's mouth was assessed by measuring mRNA activity. Turtles were kept out of water for 24 hours and then injected with either a salt solution that matched the salt concentration of the turtle, dissolved ammonia or urea, followed by another 24 hours out of water.



a. Deduce whether the excretion of ammonia or urea changes more when a turtle emerges from water. [2]

b. Compare and contrast the changes in urea excretion in the mouth with the changes in urea excretion in the kidney when a turtle emerges from the water. [3]

c.i. Describe the trends shown by the graph for dissolved oxygen in water discharged from the mouth. [1]

c.ii. Suggest reasons for these trends in dissolved oxygen. [2]

d. Deduce with a reason whether a urea transporter is present in the mouth of *P. sinensis*. [2]

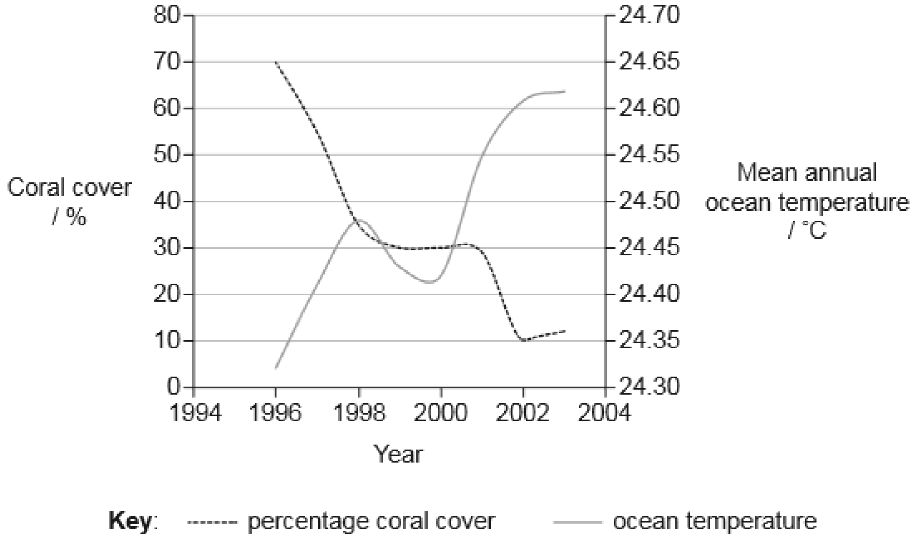
e. Outline the additional evidence provided by the gel electrophoresis results shown above. [2]

f.i. Identify which of these turtle groups represent the control, giving a reason for your answer. [1]

f.ii. Suggest a reason for the greater expression of the gene for the urea transporter after an injection with dissolved ammonia than an injection of urea. [2]

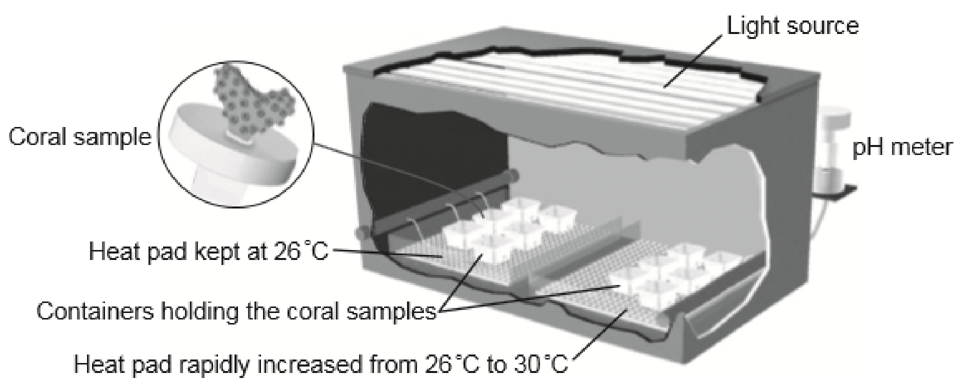
g. The salt marshes where these turtles live periodically dry up to small pools. Discuss the problems that this will cause for nitrogen excretion in the turtles and how their behaviour might overcome the problems. [3]

Coral reefs are among the most spectacular ecosystems on Earth. They support a rich diversity of life and provide economic benefits to the people who use them. In Papua New Guinea in the Pacific Ocean north of Australia the following data were collected. Coral cover is the percentage of the reef surface covered by live hard coral.

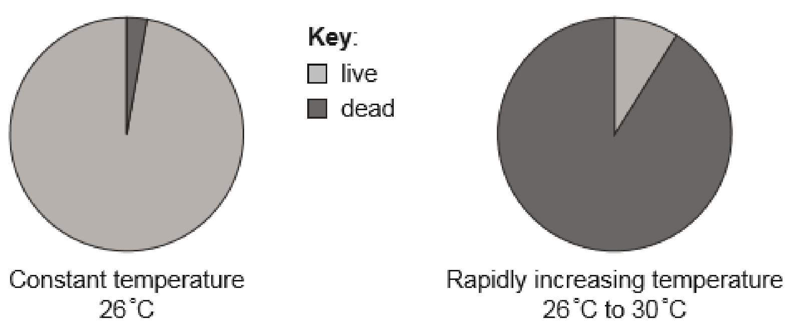


[Source: adapted from Jones et al. (2004), The Encyclopedia of Earth, Patterns of Coral Loss]

In order to test the effect of temperature, live samples of a species of coral, *Pocillopora damicornis*, were placed in an experimental chamber at a constant pH, water depth and low light. All the coral samples were started at 26°C and half of them were rapidly increased to 30°C.

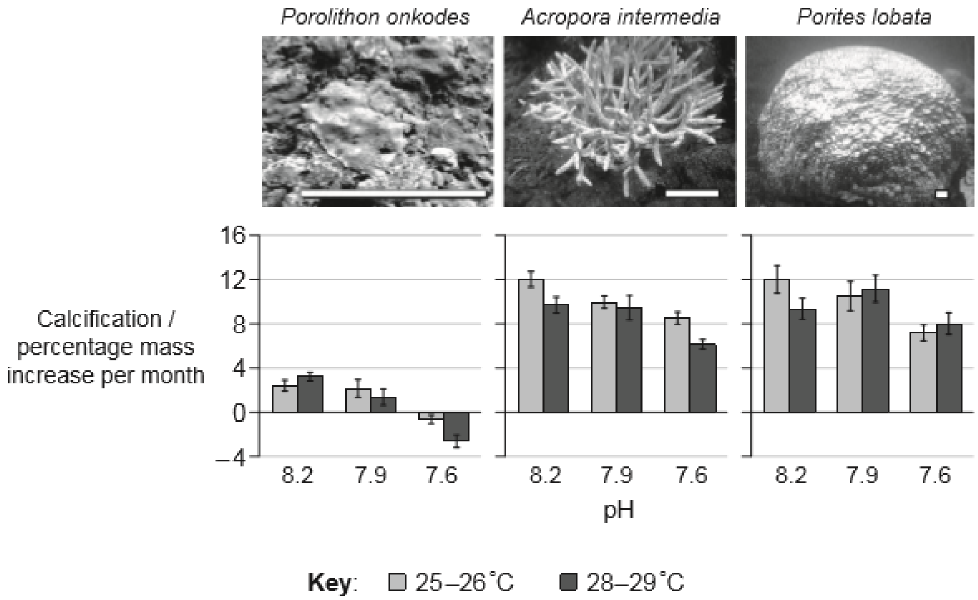


The pie charts show the percentage of live and dead tissues at the end of the experiment.



[Source: Adapted from Mace G. Barron, Cheryl J. McGill, Lee A. Courtney, and Dragoslav T. Marcovich, "Experimental Bleaching of a Reef-Building Coral Using a Simplified Recirculating Laboratory Exposure System," *Journal of Marine Biology*, vol. 2010, Article ID 415167, 8 pages, 2010. doi:10.1155/2010/415167]

Acidification of the world's oceans is an increasing threat to the health of oceanic life including coral reefs. Corals perform calcification to create their calcium carbonate exteriors. An experiment was conducted on Heron Island, Southern Great Barrier Reef, Australia. For the experiment the pH was altered by dissolving carbon dioxide in the water. Three different coral species were used, with each test group at two different temperature ranges and three different pH values. The white line in each photograph represents 5 cm.



[Source: Adapted from K. R. N. Anthony, D. I. Kline, G. Diaz-Pulido, S. Dove, and O. Hoegh-Guldberg, "Ocean acidification causes bleaching and productivity loss in coral reef builders," *PNAS*, vol. 105 no. 45, 17442–17446, Copyright 2008 National Academy of Sciences, U.S.A.]

a. Calculate the difference in coral cover in 1996 and 2002. No working required. [1]

. . . . %

b. Describe the evidence that the ocean temperature has an effect on coral cover. [2]

c. Suggest causes for the changes in ocean temperature. [2]

d. Identify **one** advantage of conducting this experiment in the laboratory rather than in the ocean. [1]

e. Comment on whether the experimental data supports the observed data from the ocean. [1]

f. (i) Describe the trend in calcification when the pH is decreased at 25 –26°C. [3]

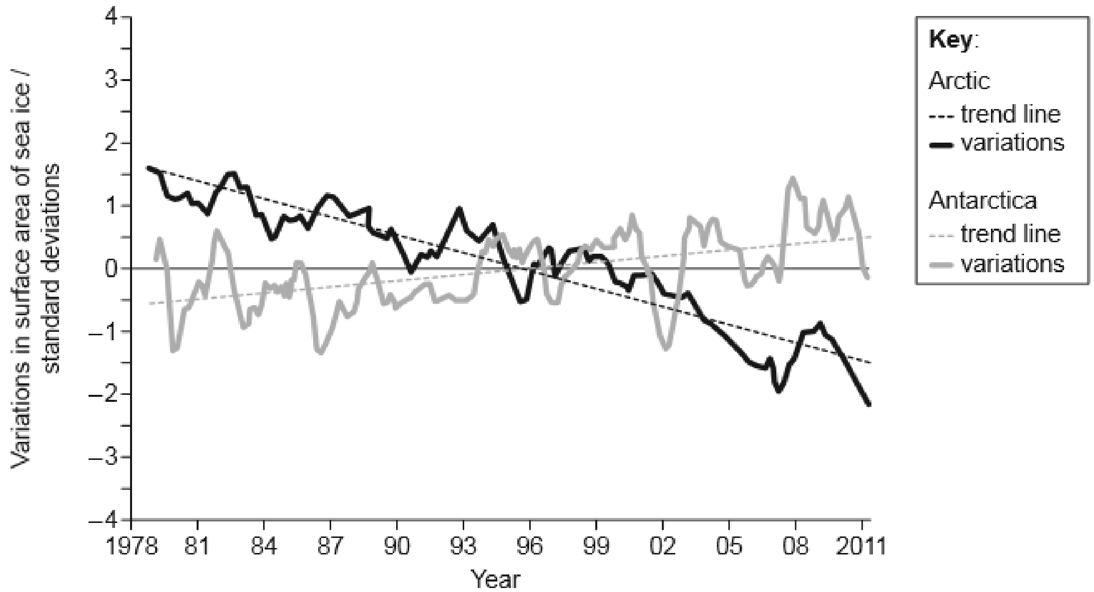
(ii) In environmental studies, a critical value is the level at which a population declines or shows signs of poor health. Suggest a critical pH for *P. onkodes*.

(iii) Using all of the data, comment on the hypothesis that ocean acidification in warming seas will have the same effect on all species of coral.

g. Suggest another marine animal that has parts made of calcium carbonate and may therefore be damaged due to ocean acidification. [1]

h. Outline causes of ocean acidification. [2]

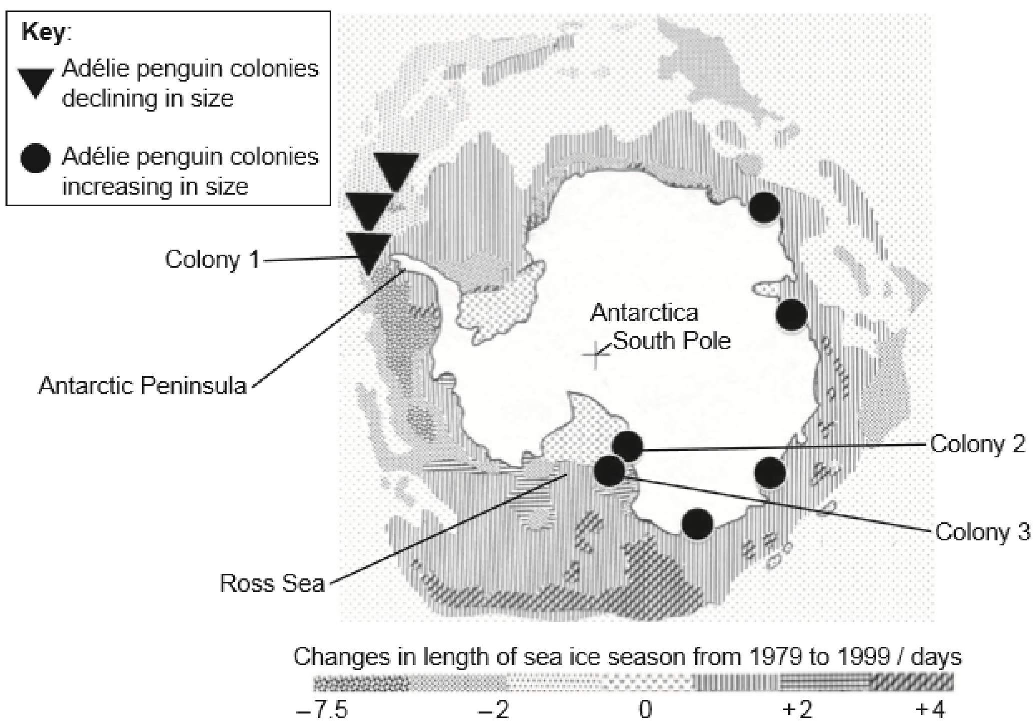
i. Discuss the need for international cooperation to solve the problems of declining coral populations. [3]



[Source: © International Baccalaureate Organization 2015]

Global warming has changed both the thickness and surface area of sea ice of the Arctic Ocean as well as the Southern Ocean that surrounds Antarctica. Sea ice is highly sensitive to changes in temperature.

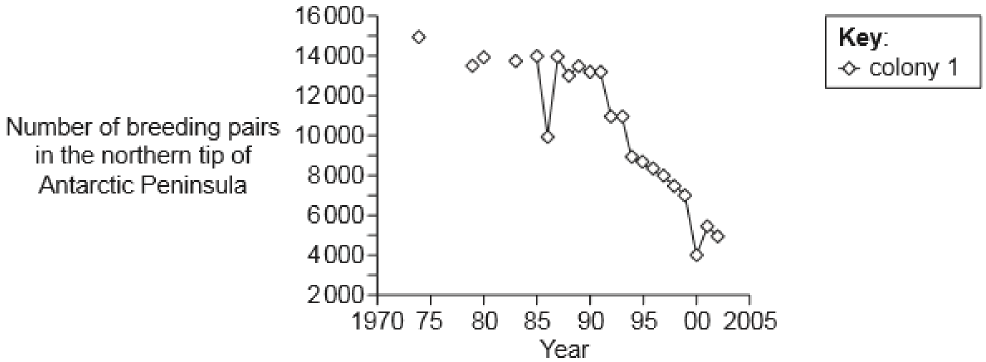
Scientists have calculated a long-term mean for the surface area of sea ice in the Arctic and in the Southern Ocean around Antarctica. This mean value is used as a reference to examine changes in ice extent. The graph shows the variations from this mean (zero line) over a period of time.

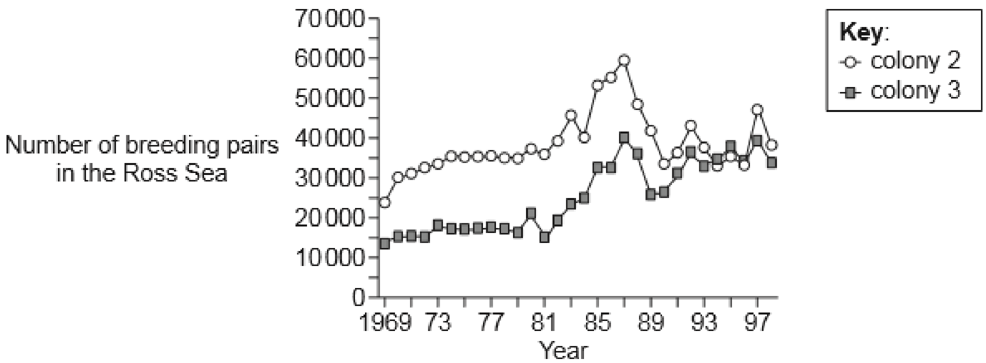


[Source: Data sourced from the penguinscience.com website]

Adélie penguins (Pygoscelis adeliae) are only found in Antarctica and need sea ice for feeding and nesting. Biologists are able to deduce how these penguins have responded to changes in their environment for the last 35 000 years, as the Antarctic conditions have preserved their bones and their nests. The image is a map of Antarctica and the surrounding Southern Ocean. It shows the trends in the length of the sea ice season (days of the year when sea ice is increasing) and the sites of nine Adélie penguin colonies.

The graphs show the changes in penguin population in three of the colonies shown on the map.





[Source: Data sourced from: www.penguinscience.com/clim_change.php]

a. State the trend in the surface area of sea ice in the Southern Ocean around Antarctica. [1]

b. Distinguish between changes in the surface area of sea ice in the Arctic and Antarctica. [2]

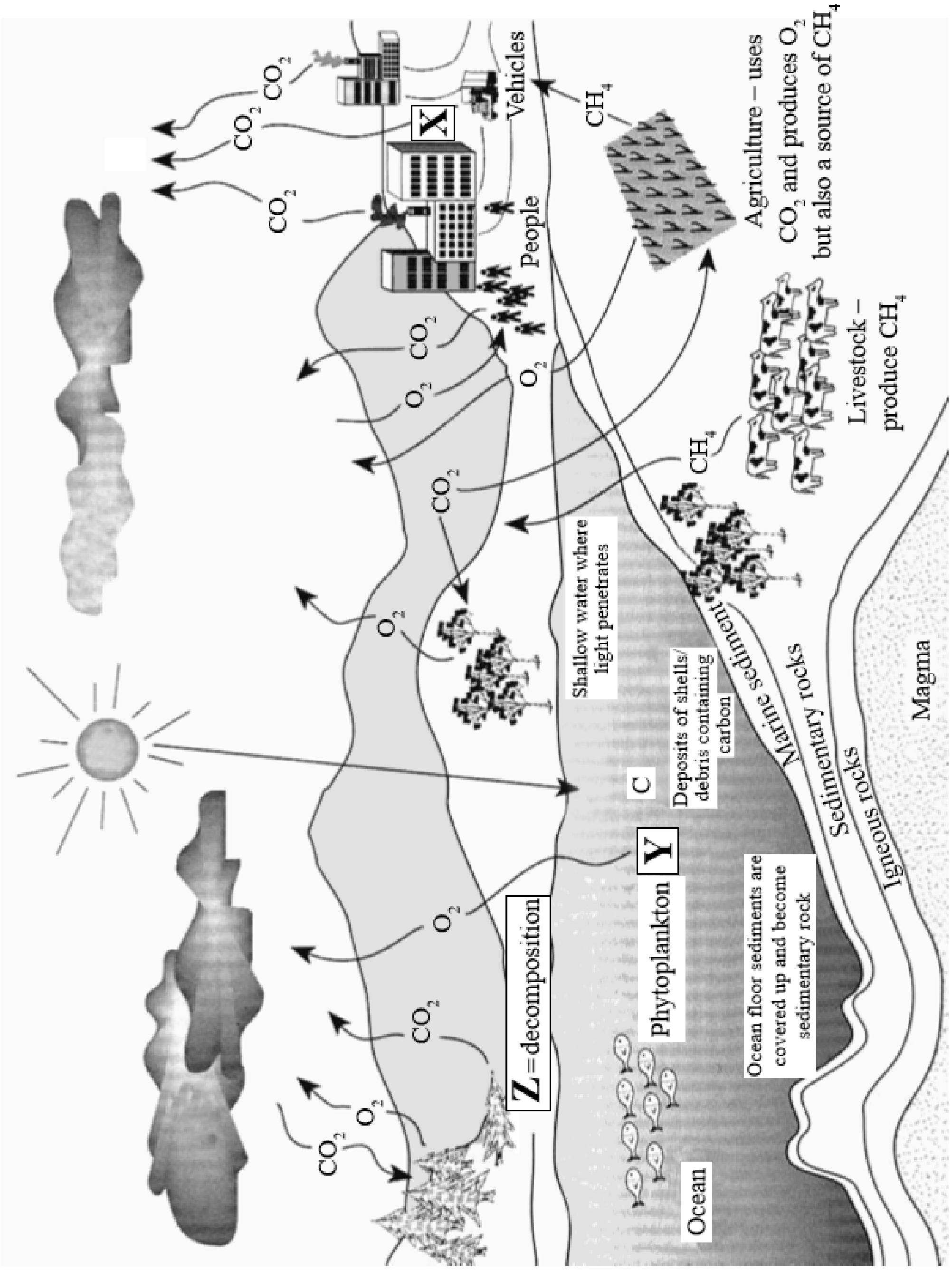
c. Discuss the data as evidence of global warming. [3]

d. Describe the trends in the length of the sea ice season around the Antarctic Peninsula and in the Ross Sea. [2]

e. Analyse the trends in colony size of the Adélie penguins in relation to the changes in the sea ice. [3]

f. Discuss the use of Adélie penguins in studying the effects of global warming. [3]

The diagram below shows the carbon cycle.



[Source: adapted from www-das.uwyo.edu/~geerts/cwx/notes/chap01/carbon_cycle.jpeg]

a. State the process occurring at X and Y. [2]

X: ....

Y: ....

b. Suggest **one** type of organism that can be involved in process Z. [1]

c. Explain the relationship between the rise in concentration of atmospheric carbon dioxide and the enhanced greenhouse effect. [3]