SL Paper 2

a. Outline **two** possible consequences of global warming for organisms living in arctic ecosystems. [2]

b. The changes that result from global warming may lead to evolution. Define *evolution*. [2]

c. Explain how sexual reproduction promotes variation in a species. [3]

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a. Draw a labelled diagram of a prokaryotic cell. [5]

b. Bacteria are prokaryotes that sometimes act as pathogens. Describe how the body can defend itself against pathogens. [7]

c. Explain the evolution of antibiotic resistance in bacteria. [6]

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a. List **two** factors that could cause an increase in the size of an animal population. [2]

1. .....
2. .....

b. Outline how overpopulation of a species in a given environment may lead to evolution. [4]

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a. Distinguish between bryophyta and coniferophyta. [5]

b. Outline the consequences of a global temperature rise on arctic ecosystems. [6]

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a. Plants are a diverse group of eukaryotic organisms. Describe the different characteristics of the bryophyta, filicinophyta, coniferophyta and angiospermophyta. [9]

b. Plants store carbohydrate in the form of starch. Explain the reasons for starch being digested by the human digestive system. [4]

c. Compare the structure of prokaryotic and eukaryotic cells. [5]

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b. Describe how natural selection leads to evolution. [6]

c. Explain the consequences of altering a DNA base in the genome of an organism. [8]

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a. Living organisms have been placed in three domains: archaea, eubacteria and eukaryote. Distinguish archaea from eubacteria. [3]

Archaea	Eubacteria

b. List **two** types of evidence used to determine which species belong in the same clade. [2]

Mutations are the ultimate source of genetic variation and are essential to evolution.

Lice are wingless insects that belong to the phylum arthropoda.

a.i. State **one** type of environmental factor that may increase the mutation rate of a gene. [1]

a.ii. Identify **one** type of gene mutation. [1]

b. State **two** characteristics that identify lice as members of the arthropoda. [2]

1.

2.

b.ii. Some lice live in human hair and feed on blood. Shampoos that kill lice have been available for many years but some lice are now resistant to those shampoos. Two possible hypotheses are: [3]

Hypothesis A	Hypothesis B
Resistant strains of lice were present in the population. Non-resistant lice died with increased use of anti-lice shampoo and resistant lice survived to reproduce.	Exposure to anti-lice shampoo caused mutations for resistance to the shampoo and this resistance is passed on to offspring.

Discuss which hypothesis is a better explanation of the theory of evolution by natural selection.

a. Reproduction can cause populations to increase rapidly. Draw a labelled graph showing a sigmoid population growth curve. [4]

b. Explain the various possible consequences of overproduction of offspring. [6]

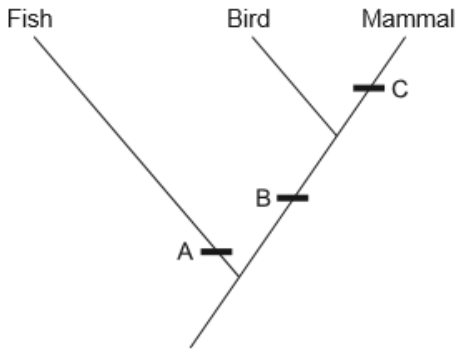
c. Outline the role of hormones in the menstrual cycle. [8]

a. Describe the movement of energy and nutrients in an ecosystem. [6]

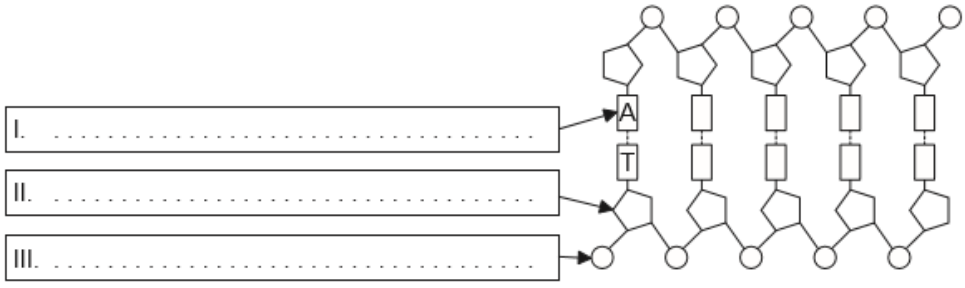
b. Explain how sexual reproduction can eventually lead to evolution in offspring. [8]

c. Using simple external recognition features, distinguish between the plant phyla bryophyta and angiospermophyta. [4]

The image shows part of a cladogram.



a. Label the parts of two paired nucleotides in the polynucleotide of DNA. [3]



b. Using the cladogram, identify **one** diagnostic feature that characterizes the given groups of vertebrates at A, B and C. [3]

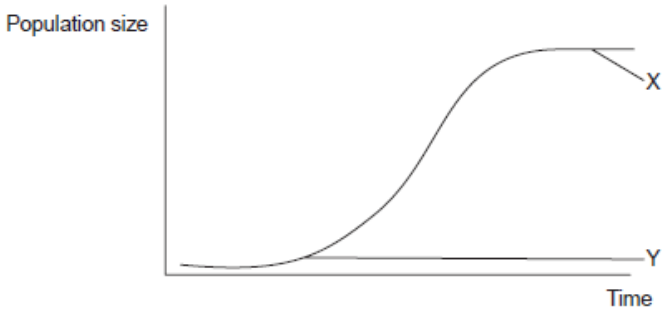
A: .....
B: .....
C: .....

c. State the name of the domain to which these organisms belong. [1]

b. Outline the process of gas exchange necessary for aerobic respiration in a unicellular eukaryotic organism. [3]

c. Explain how the process of evolution occurs. [8]

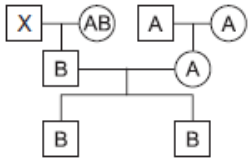
The graph shows a sigmoid population growth curve.



The table summarizes the genome size of several organisms.

Organism type	Organism	Genome size / base pairs
Bacterium	*Helicobacter pylori*	1667867
Fruit fly	*Drosophila melanogaster*	130000000
Rice	*Oryza sativa*	420000000
Human	*Homo sapiens*	3200000000

The figure shows a pedigree chart for the blood groups of three generations.



a. Identify the phases labelled X and Y. [1]

X:

Y:

b. Outline how fossil records can provide evidence for evolution. [2]

c(i). Distinguish between the terms genotype and phenotype. [1]

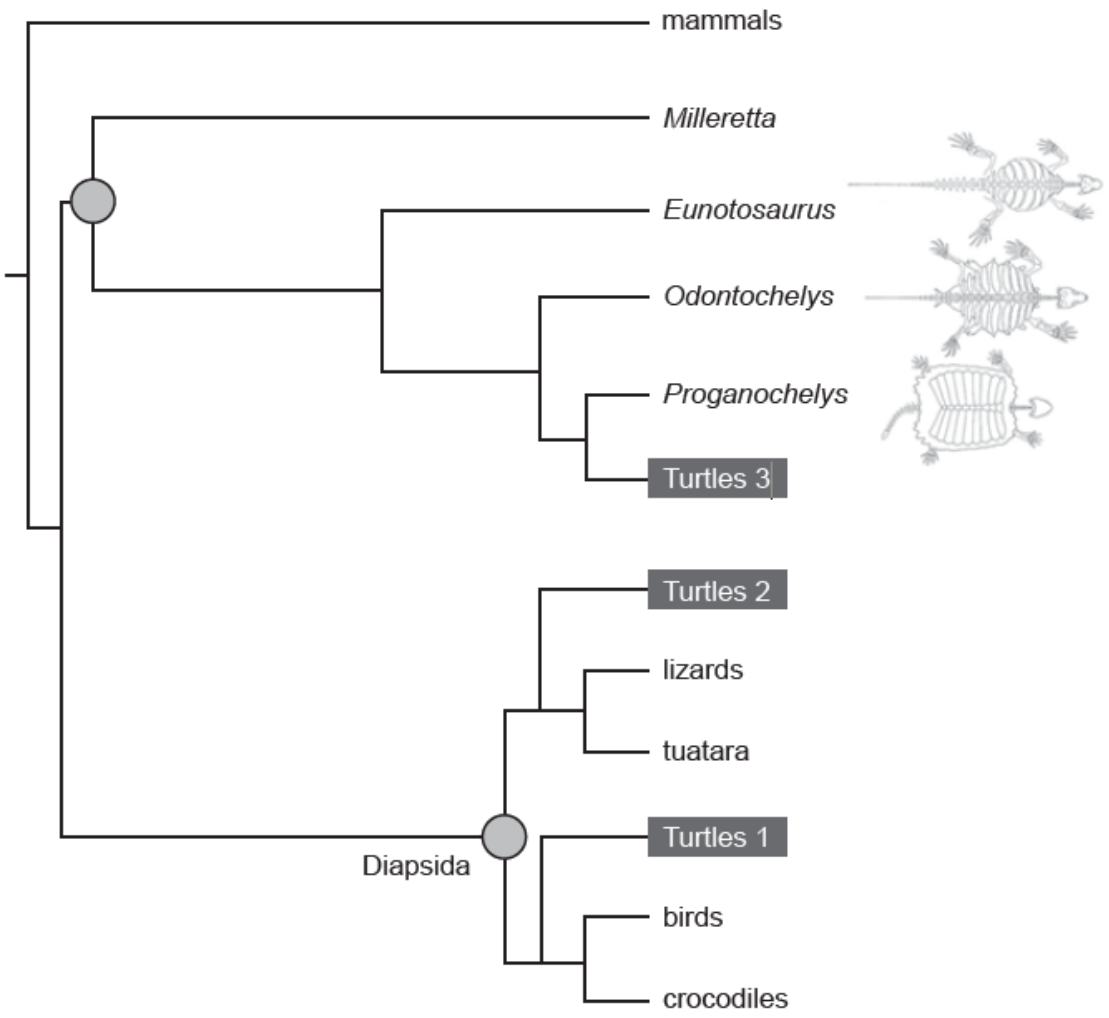
c(ii). Outline a structural difference between the chromosomes of *Helicobacter pylori* and *Homo sapiens*. [1]

c(iii). Deduce the percentage of adenine in *Oryza sativa* if the proportion of guanine in that organism is 30 %. [1]

d(i). Deduce the possible phenotypes of individual X. [1]

d(ii). Describe ABO blood groups as an example of codominance. [1]

The following cladogram shows three possible evolutionary routes for the turtle (Turtles 1, Turtles 2 and Turtles 3). The taxa in italics are extinct.



[Source: Tyler R. *et al*., Transitional fossils and the origin of turtles, *Biology Letters* 6, Dec 23, 2010, pages 830–833, by permission of the Royal Society.]

a.i. State the organism most closely related to the lizards. [1]

a.ii. Based on the taxa shown, deduce a difficulty in gathering data to study turtle ancestry. [1]

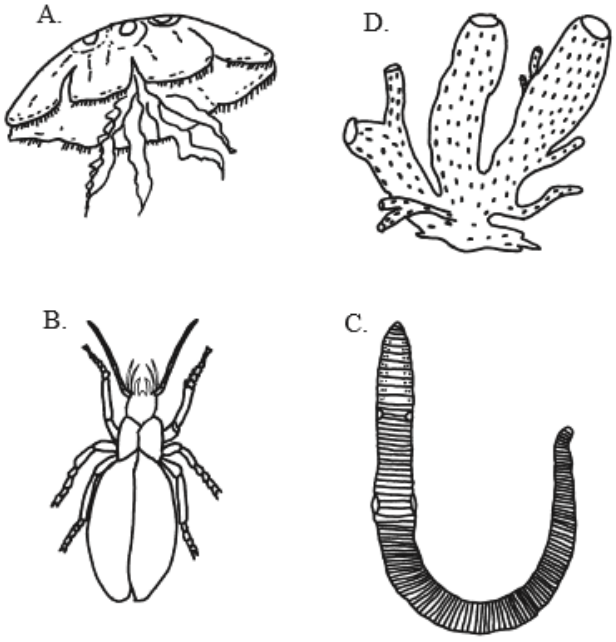
b.i. Molecular evidence is often used to construct a cladogram. Describe **one** type of molecular-based evidence to identify members of a clade. [2]

b.ii. Suggest **one** type of additional evidence that could provide strong support for Turtles 3 as the evolutionary route for turtles rather than Turtles 1 or Turtles 2. [1]

c. Taxonomists aim to place species into genera, families and higher taxa according to their evolutionary origins. This is known as natural classification. [2]

Explain the usefulness of natural classification in biodiversity research.

a. Parts of a dichotomous key to organisms A, B, C and D are shown. Design missing parts of the key using features visible in the following diagrams. [2]



1.

Body with tentacles .....A

Body without tentacles ..... go to 2

2.

.....B

.....go to 3

3

.....C

.....D

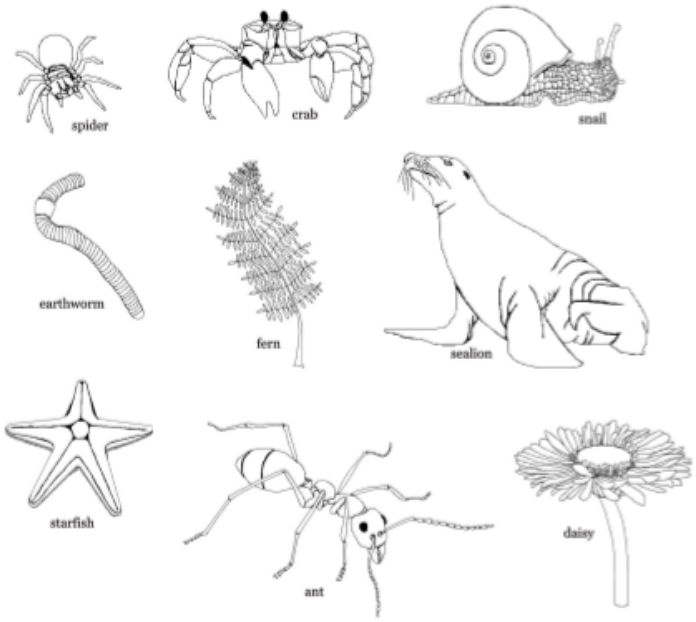
b. All of these organisms belong to the animal kingdom. State **two** structural differences between animal cells and plant cells [2]

a. Draw a labelled diagram of a section of DNA showing four nucleotides. [5]

b. Outline a technique used for gene transfer. [5]

c. Explain how evolution may happen in response to an environmental change. [8]

The diagrams below show different organisms (not drawn to scale).



a. State **all** the organisms shown above that belong to the following phyla. [3]

Filicinophyta:
Arthropoda:
Mollusca:

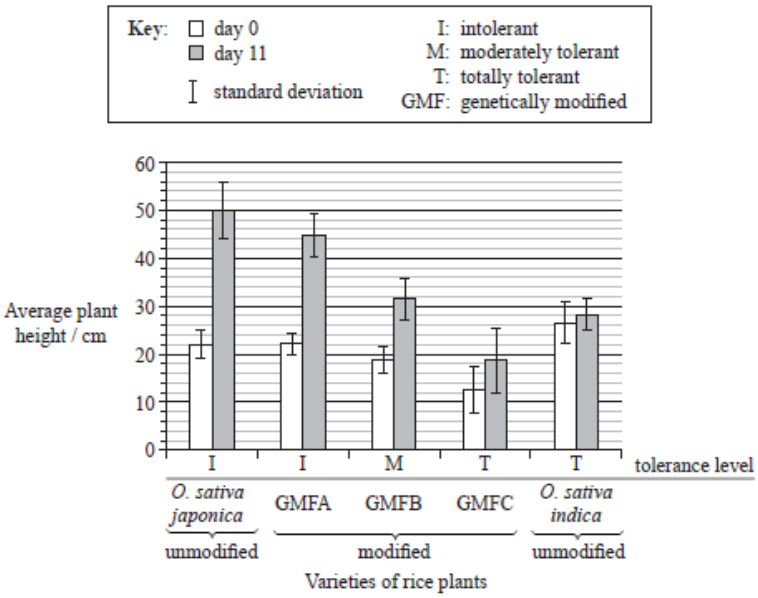
b (i) Construct a possible food chain using **three** of the organisms shown opposite, stating the trophic level to which they belong. [2]

b (ii) State the initial energy source of the food chain constructed in (b)(i). [1]

Rice (*Oryza sativa*) is usually intolerant to sustained submergence under water, although it grows rapidly in height for a few days before dying. This is true for one variety, *Oryza sativa japonica*. The variety *Oryza sativa indica* is much more tolerant to submergence.

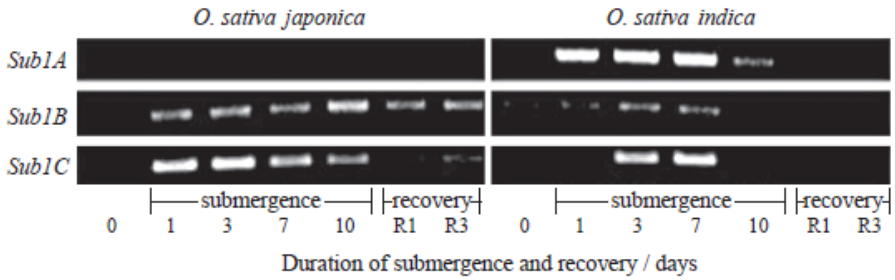
Three genetically modified forms of *O. sativa japonica*, GMFA, GMFB and GMFC, were made using different fragments of DNA taken from *O. sativa indica*.

The plants were then submerged for a period of 11 days. The heights of all the plants were measured at the beginning and at the end of the submergence period.



[Source: Adapted from "Sub1A is an ethylene-response-factor-like gene that confers submergence tolerance to rice" (2006) Kenong Xu, Xia Xu, Takeshi Fukao, Patrick Canlas, Reycel Maghirang-Rodriguez et al. Nature, 442, pp. 705—708. Adapted by permission from Macmillan Publishers Ltd (c) 2006.]

In the same experiment, the researchers hypothesized that the capacity to survive when submerged is related to the presence of three genes very close to each other on rice chromosome number 9; these genes were named *Sub1A*, *Sub1B* and *Sub1C*. The photograph below of part of a gel shows relative amounts of messenger RNA produced from these three genes by the submergence-intolerant variety, *O. sativa japonica*, and by the submergence-tolerant variety, *O. sativa indica*, at different times of a submergence period, followed by a recovery period out of water.



[Source: Adapted from "Sub1A is an ethylene-response-factor-like gene that confers submergence tolerance to rice" (2006) Kenong Xu, Xia Xu, Takeshi Fukao, Patrick Canlas, Reycel Maghirang-Rodriguez et al. Nature, 442, pp. 705—708. Adapted by permission from Macmillan Publishers Ltd (c) 2006.]

a(i). State which group of rice plants were the shortest at the beginning of the experiment. [1]

a(ii). Calculate the percentage change in height for the *O. sativa japonica* unmodified variety during the submergence period. Show your working. [2]

c. Deduce the general relationship between the growth of all the *japonica* varieties and their stated tolerance level. [1]

d. Outline the use of the binomial system of nomenclature in *Oryza sativa*. [2]

e(i). Determine which gene produced the most mRNA on the first day of the submergence period for variety *O. sativa japonica*. [1]

e(ii). Outline the difference in mRNA production for the three genes during the submergence period for variety *O. sativa indica*. [2]

e(iii). Compare the mRNA production for the three genes during the submergence period between the two varieties. [2]

f. Deduce, using all the data, which gene was used to modify GMFC. [2]

g. Evaluate, using all the data, how modified varieties of rice could be used to overcome food shortages in some countries. [2]

The diagram shows a leaf from Dryopteris arguta.

[https://commons.wikimedia.org/wiki/File:E20161208-0001%E2%80%94Dryopteris_arguta_(Reverse)%E2%80%94RPBG_(30698925004).jpg, E20161208-0001—Dryopteris arguta (Reverse)—RPBG Source: https://www.flickr.com/photos/john_d_rusk/30698925004/ (https://www.flickr.com/photos/john_d_rusk/30698925004/) Author: John Rusk from Berkeley, CA, United States of America, licensed under Creative Commons licence: https://creativecommons.org/licenses/by/4.0/legalcode]

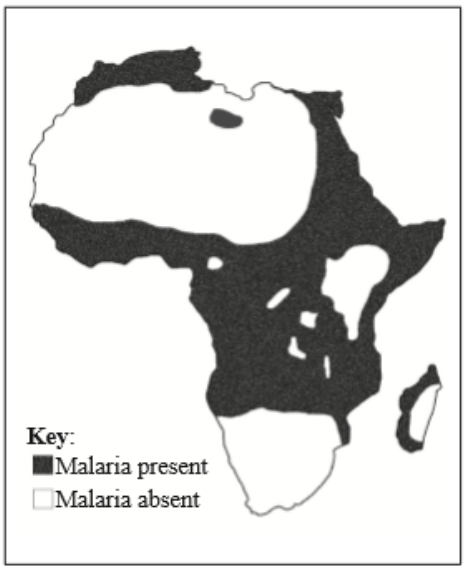
a.i. State the phylum of this plant. [1]

a.ii. State **two** characteristics of plants from the phylum you stated in (a)(i). [2]

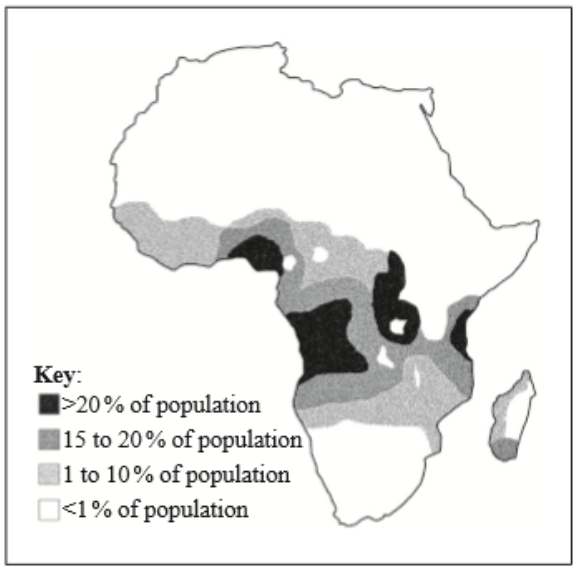
b. Outline why the number of trophic levels is limited in a food chain. [1]

Sickle-cell anemia is a disease caused by a base substitution mutation, where GAG has changed to GTG. The distribution of the sickle-cell allele is correlated with the incidence of malaria in many places, as shown by the map of Africa.

Malaria incidence



Sickle-cell allele distribution



[Source: Image courtesy of Anthony Allison; image source: Wikimedia Commons]

a. The correlation shown in the data above can be explained by natural selection. Outline how the process of natural selection can lead to evolution. [3]

b. Explain how a base substitution mutation, such as GAG to GTG, can lead to a disease like sickle-cell anemia. [2]

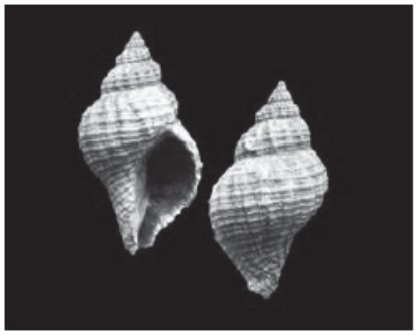
c. Using a Punnett grid, determine the possible genotypes and phenotypes of a cross between a man and a woman who are both carriers of the sickle-cell allele. Use the symbol Hb^S for the sickle-cell allele and Hb^A for the normal allele. [2]

Phenotypes:

Native oyster populations are decreasing where rivers meet the ocean along the northwest coast of North America. These oyster populations are being attacked by a gastropod.

Adult oyster, *Ostrea lurida*

[Source: © International Baccalaureate Organization 2017]



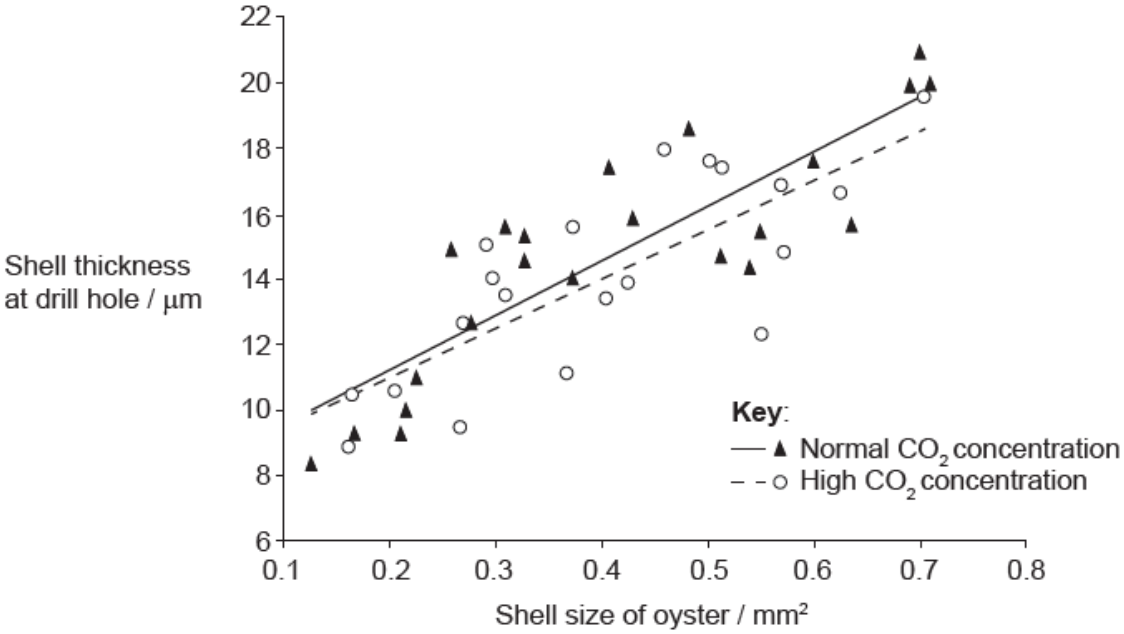
Adult gastropod shell, *Urosalpinx cinerea*

[Source: © International Baccalaureate Organization 2017]

It is known that oysters and gastropods have hard parts composed of calcium carbonate and that ocean acidification is increasing. Studies were carried out using juvenile oysters and gastropods to investigate the effects of acidification on the decrease in the population of oysters.

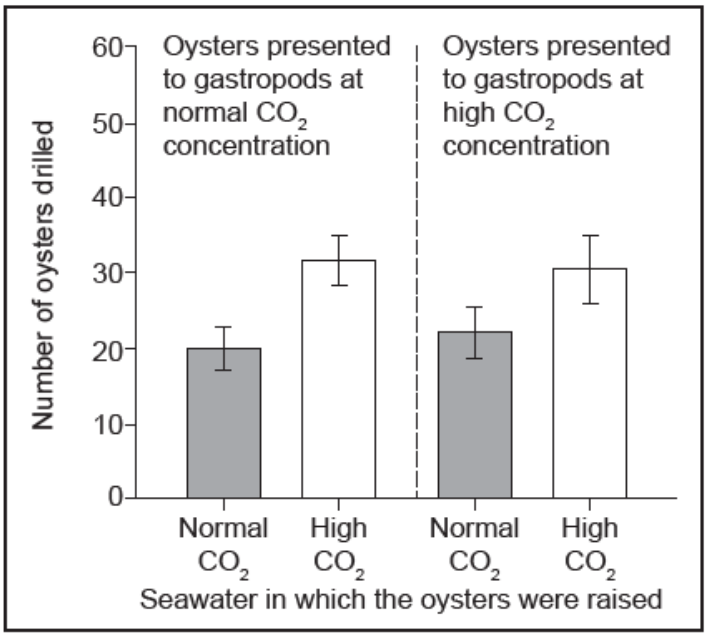
The first step was to raise oysters in two different mesocosms. One had seawater at a normal concentration of CO_2 and the other had sea water with a high concentration of CO_2. Gastropods were raised in two further mesocosms with normal and high CO_2 concentrations respectively.

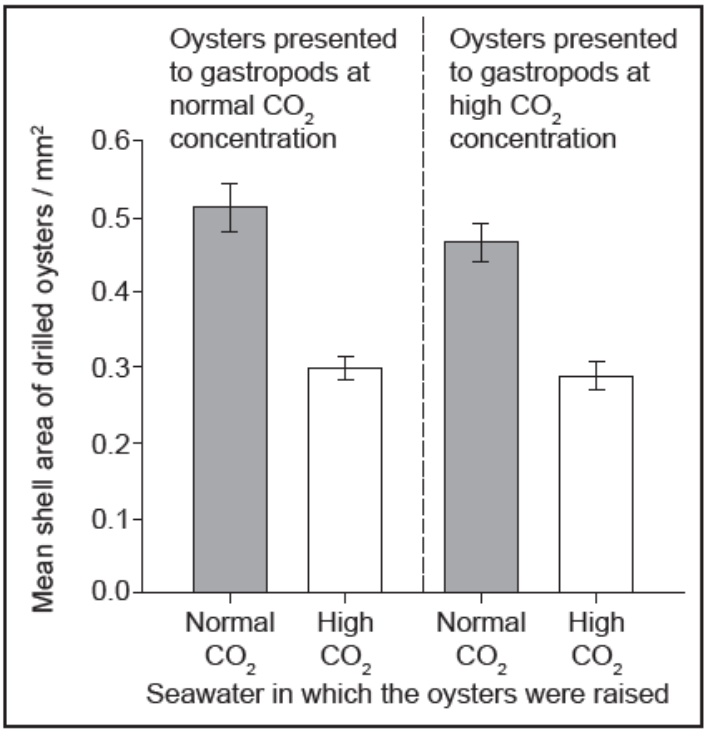
A juvenile gastropod will attack a juvenile oyster by using its tongue-like structure (radula) to drill a hole through the oyster shell. Once the hole has been drilled, the gastropod sucks out the soft flesh. Researchers investigated the shell thickness at the site of the drill hole in relation to the size of the oyster. The results are seen in this graph.



[Source: E Sanford *et al*. (2014) *Proceedings of the Royal Society B*, 281, by permission of the Royal Society.]

Equal numbers of oysters raised in seawater with a normal CO_2 concentration and in seawater with a high CO_2 concentration were then presented together to the gastropod predators in seawater with a normal CO_2 concentration. The same numbers of oysters from the two groups were also presented together to the gastropods in seawater with a high CO_2 concentration. The bar charts show how many of the oysters were drilled by the gastropods and the mean size of drilled oysters.





[Source: © International Baccalaureate Organization 2017]

a. Outline how acidified sea water could affect the shells of the oyster. [1]

b. Outline the trends shown in the data in the graph. [2]

c. Estimate how much smaller drilled oysters raised in seawater at a high CO_2 concentration were than drilled oysters raised in seawater at a normal CO_2 concentration. [1]

d.i. Deduce from the data in the bar charts which factors were and were not correlated significantly with the number of oysters drilled by the gastropods. [2]

d.ii. Suggest reasons for the differences in the numbers of oysters drilled, as shown in the bar charts. [2]

d.iii The radula in a gastropod is hard but not made of calcium carbonate. Outline how this statement is supported by the drilling success of the gastropods in seawater with normal or high CO_2 concentrations. [2]

e. Using all the data, evaluate how CO_2 concentrations affect the development of oysters and their predation by gastropods. [2]