# SL Paper 2

The diploid number of chromosomes in horses (*Equus ferus*) is 64 and the diploid number in donkeys (*Equus africanus*) is 62. When a male donkey and a female horse are mated, the result is a mule which has 63 chromosomes.

a. State the haploid number for horses. [1]

b. Explain reasons that mules cannot reproduce. [2]

c. Discuss whether or not horses and donkeys should be placed in the same species. [2]

d. A mule was born at the University of Idaho in the USA with 64 chromosomes. Suggest a mechanism by which this could happen. [1]

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

a. Explain the processes by which energy enters and flows through ecosystems. [8]

b. Producers extract phosphates and nitrates from soil. Outline how these ions are used in the synthesis of organic molecules. [3]

c. Draw a labelled diagram of a pyramid of energy. [4]

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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]

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a. Define *habitat*, *population, community* and *ecosystem.* [4]

b. Outline how energy flows through an ecosystem. [6]

c. Discuss the benefits and possible harmful effects of altering species by **one** example of genetic modification. [8]

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a. Define the terms *species*, *population* and *community*. [3]

Species:

Population:

Community:

b. Explain the shape of the pyramids of energy that are constructed by ecologists to represent energy flow in an ecosystem. [3]

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a. Draw a labelled diagram showing the structure of three water molecules and how they interact. [5]

b. Aquatic and other environments are being affected by a global rise in temperature. Outline the consequences of this on arctic ecosystems [6]

c. Cell membranes separate aqueous environments in cells. Explain how the properties of phospholipids help to maintain the structure of cell membranes. [8]

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a. Describe the structure and function of starch in plants. [3]

b. Outline the production of carbohydrates in photosynthesis. [4]

c. Discuss the processes in the carbon cycle that affect concentrations of carbon dioxide and methane in the atmosphere and the consequences for climate change. [8]

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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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Plants have widespread influences, from food chains to climate change.

a. Draw a diagram of a palisade mesophyll cell labelling only the structures that would not be present in a pancreatic cell. [3]

b. Explain the process of photosynthesis. [8]

c. Describe the process of peat formation. [4]

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a. Outline the difference in absorption of red, blue and green light by chlorophyll. [4]

b. Explain how the process of photosynthesis affects carbon dioxide concentrations in the atmosphere during a typical year **and** the likely consequences on Earth of the yearly rises in carbon dioxide concentrations. [8]

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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]

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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. All organisms take in and also release carbon compounds. Draw a labelled diagram of the carbon cycle. [5]

b. Describe how the rate of photosynthesis can be measured. [6]

c. Explain the mechanism of ventilation in humans. [7]

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a. Draw a labelled diagram showing the ultrastructure of a typical prokaryote. [4]

b. Outline how **three** different environmental conditions can affect the rate of photosynthesis in plants. [6]

c. Explain how the emission of gases, both naturally and through human activity, can alter the surface temperature of the Earth. [8]

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a. Outline, with examples, the types of carbohydrate found in living organisms. [4]

b. Describe the importance of hydrolysis in digestion. [6]

c. Explain the flow of energy between trophic levels in ecosystems. [8]

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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]

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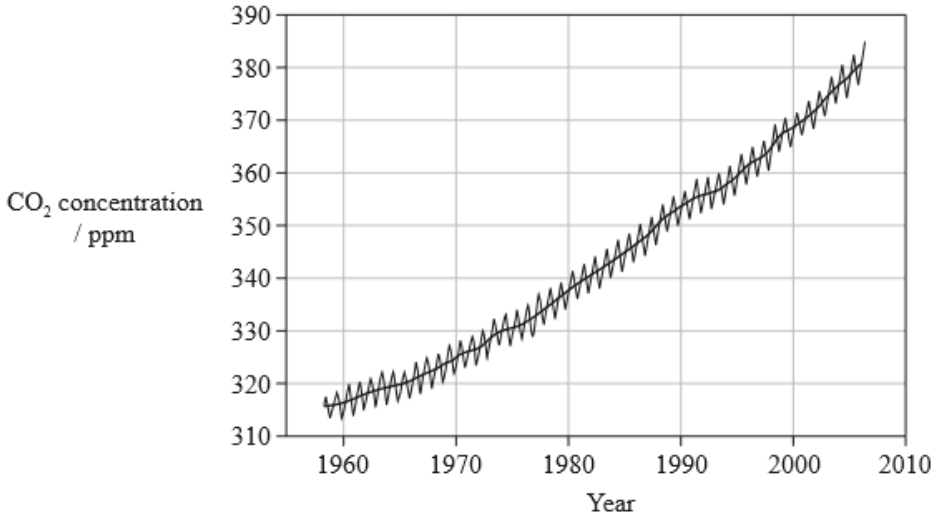
a. Below is a graph of atmospheric $CO_2$ levels measured at Mauna Loa Observatory, Hawai'i. [3]




[Source: adapted from Dr P Tans, NOAA Earth System Research Laboratory]

Explain the observed changes in atmospheric $CO_2$ concentration from 1960 to 2005.

b. Outline the precautionary principle. [2]

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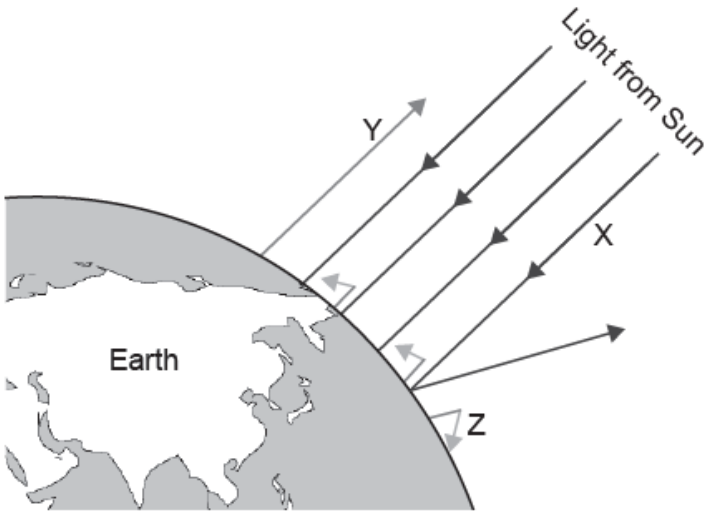
The diagram shows the greenhouse effect.




[Source: © International Baccalaureate Organization 2017]

a. State the type of wavelength of the radiation labelled X and Y. [2]

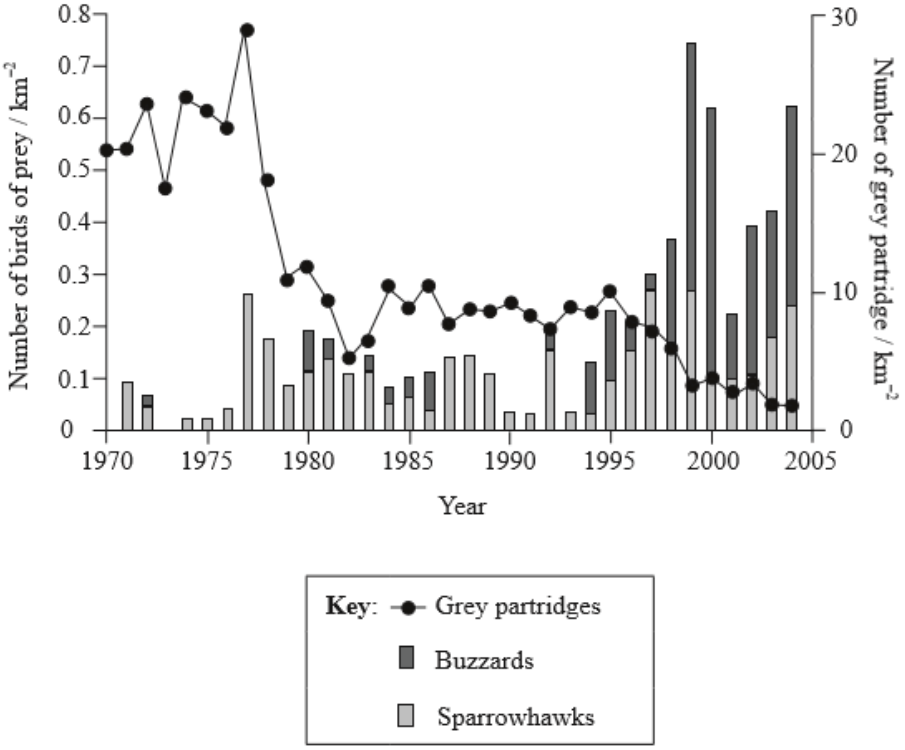
X:

Y:

b. Outline reasons for the change occurring at Z. [2]

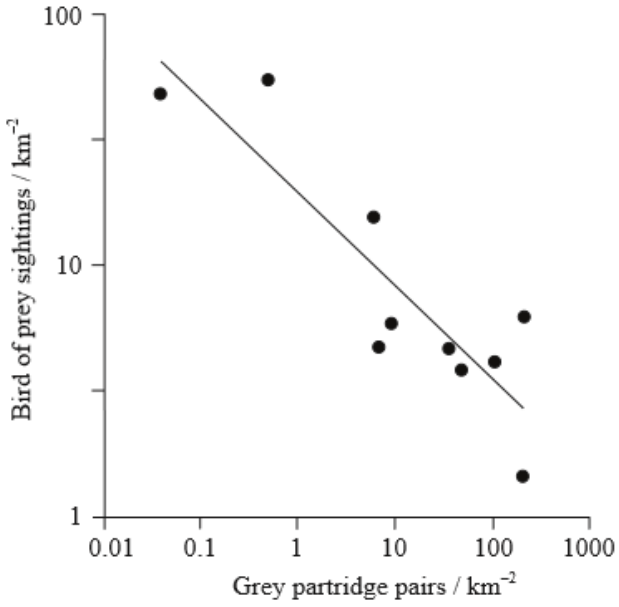
c. The short-tailed albatross (*Phoebastria albatrus*) nests and breeds on remote low-lying coral islands in the Pacific Ocean. Predict how global warming may threaten the survival of such an ocean bird. [1]

The grey partridge (*Perdix perdix*) is a species of bird that is found on farmland. Sparrowhawks (*Accipiter nisus*) and buzzards (*Buteo buteo*) are birds of prey that kill and feed on birds, including grey partridge. The number of grey partridges in a region of southern England was monitored from 1970 to 2004. The numbers of sparrowhawks and buzzards, seen from sampling positions during regular observation periods, were counted. The results are shown in the graph below.




[Source: M Watson, *et al.*, (2007), *Journal of Applied Ecology*, **44**, pages 972–982]

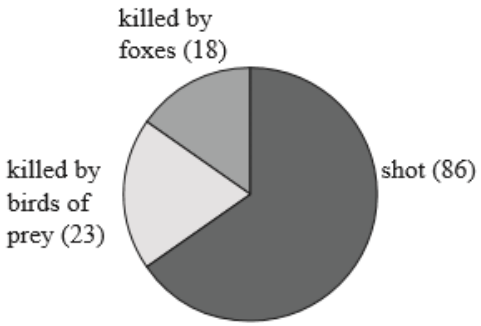
The density of grey partridge (number per square kilometre) varied considerably in different areas within the study region. The graph below shows the correlation between the density of grey partridges and the density of birds of prey.




[Source: adapted from M Watson, *et al.*, (2007), *Journal of Applied Ecology*, **44**, pages 972–982]

The highest density of birds of prey was found in areas used for recreational shooting. In these areas, other species of partridge were bred and released. Food and shelter were provided for the released birds. These measures tended to increase the number of both released and wild birds.

The causes of death of grey partridge were investigated in one of the areas that was used for recreational shooting. The pie chart below shows the causes of death.




a. Outline the trends, over the period of time shown in the graph, in the number of grey partridges, buzzards and sparrowhawks. [3]

Grey partridges: .....

Buzzards: .....

Sparrowhawks: .....

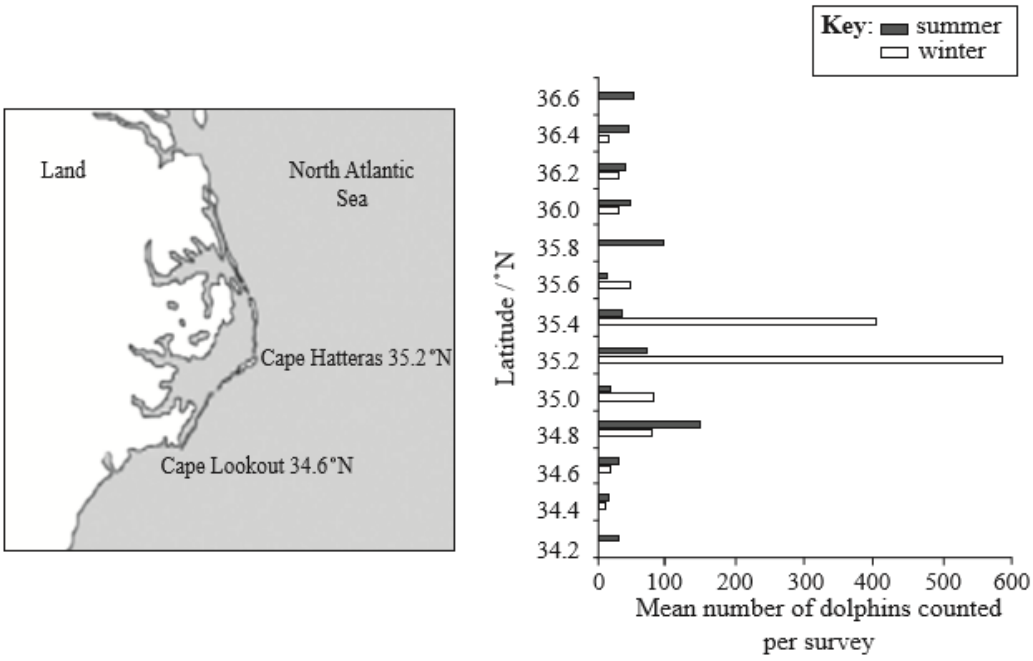
b (i) Identify the correlation between the density of grey partridges and birds of prey. [1]

b (ii) Suggest a hypothesis to account for this correlation. [2]

c (i) Calculate the percentage of deaths due to birds of prey. [1]

c (ii) Using the data provided, discuss the causes of the correlation between the density of grey partridges and the density of birds of prey. [3]

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 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.]

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

b. Compare the distribution of dolphins in summer and winter. [2]

c. Suggest **one** reason for the differences in distribution. [1]

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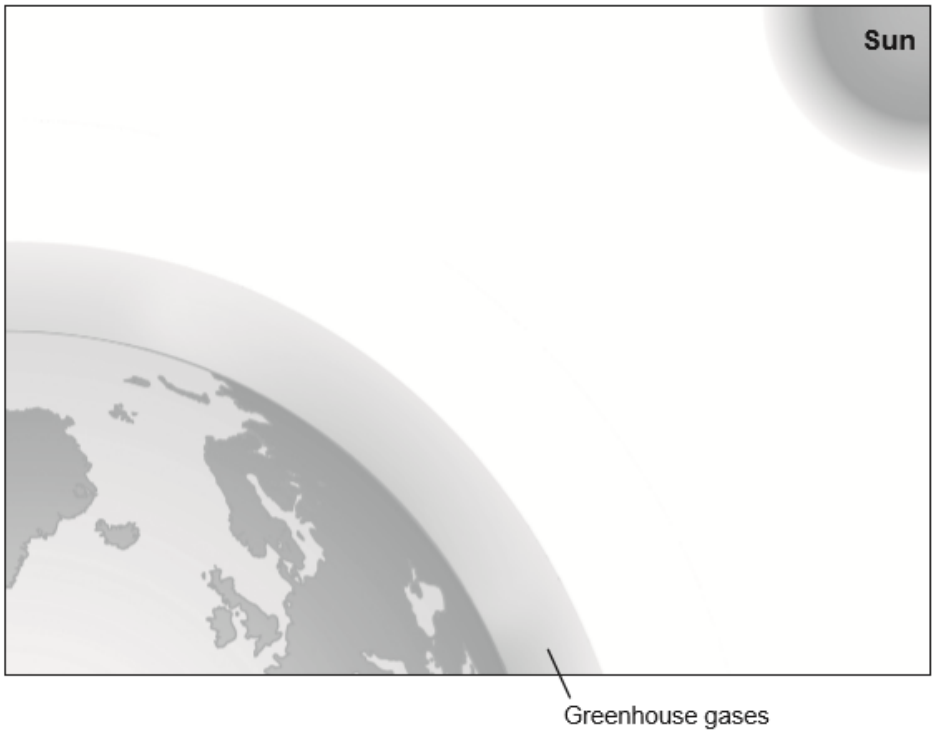
a. (i) Distinguish between the thermal properties of water and methane. [4]

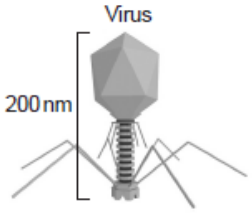
(ii) Explain the reasons for the unique thermal properties of water.

b. Using the diagram, explain the interaction of short and long wave radiation with greenhouse gases in the atmosphere. [3]

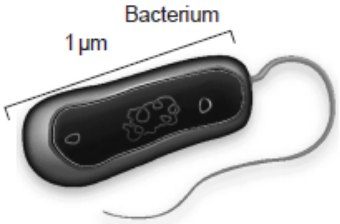



[Source: © International Baccalaureate Organization 2016]

The diagrams show a virus and a bacterium.




[Source: adapted from http://cronodon.com]




[Source: adapted from www.microbiologyonline.org.uk]

a. Calculate the magnification of the bacterium. [1]

b. State the method that bacteria use to divide. [1]

c. Outline the effectiveness of antibiotics against viruses and bacteria. [1]

d(i). Saprotrophic organisms, such as *Mucor* species, are abundant in soils. [1]

Define *saprotrophic organisms*.

d(ii). State **one** role of saprotrophic organisms in the ecosystem. [1]

a. Pictured below are Louis Pasteur's original drawings of swan-necked flasks. [3]

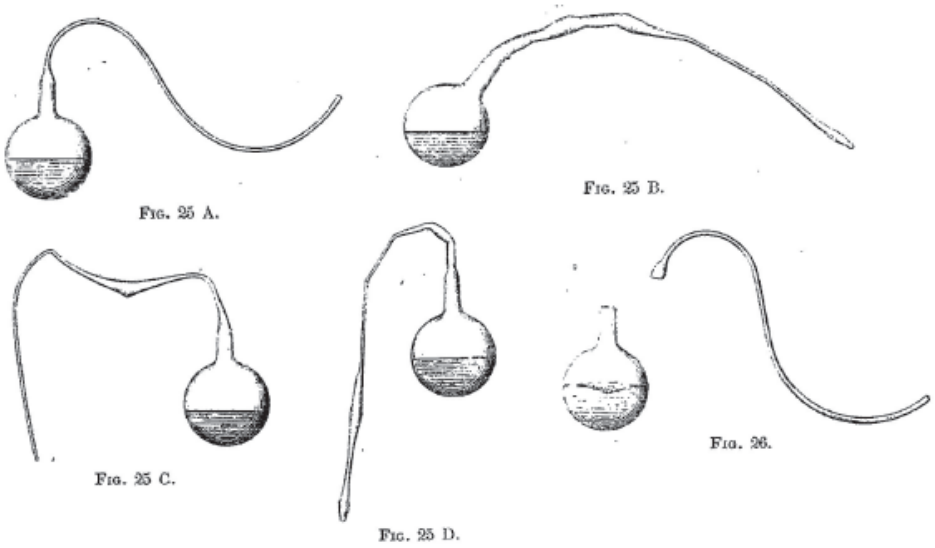


Fig. 25 A.

Fig. 25 B.

Fig. 25 C.

Fig. 25 D.

Fig. 26.

[Source: L Pasteur and L Pasteur Vallery-Radot, (1922), *Œuvres de Pasteur, Vol II Fermentations et générations dites spontanées*, pages 260–261]

Describe how Pasteur's experiments provided convincing evidence to falsify the concept of spontaneous generation.

b.i. State the function of life in *Paramecium* that is carried out by: [1]

cilia.

b.ii. State the function of life in *Paramecium* that is carried out by: [1]

the contractile vacuole.

c. Discuss the advantages and disadvantages of the use of adult stem cells. [3]

d. Explain the role of decomposers in an ecosystem. [2]

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Male Lepidoptera (butterflies and moths) commonly drink from pools of water or from moist soil. This behaviour, called puddling, was investigated in an undisturbed area where male tiger swallowtails, *Papilio glaucus*, had been seen puddling.

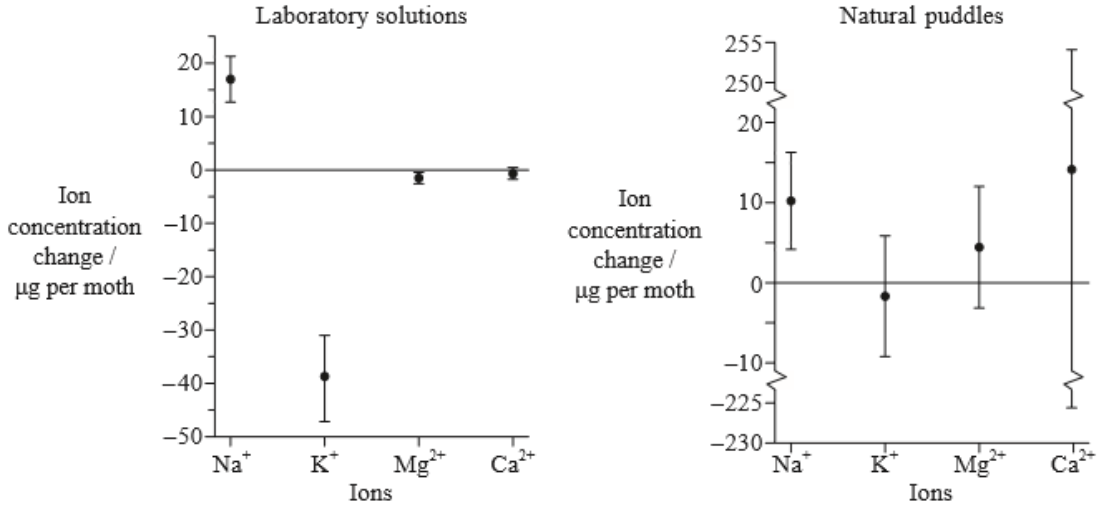
Four successive sets of experiments were performed under similar conditions of temperature and humidity. In each set, equal samples of sand were spread out evenly on trays and then treated differently. Except for one dry sample (in the first set), all others were saturated with a different liquid. Results of the observations are given in the table below.

**Numbers of visits (V) and time in minutes (T) spent puddling by male *Papilio glaucus* adults on sand treated in different ways.**

| Experiments | Visits and times on sand plus substance: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | V | T | V | T | V | T | V | T | V | T |
| 1 | *Dry sand alone* | | *Distilled $H_2O$* | | *Casein hydrolyzate* | | *5% Sucrose* | | *NaCl (0.17 M)* | |
| | 26 | 0 | 47 | 0.5 | 27 | 205.5 | 60 | 0.5 | 74 | 320.5 |
| 2 | *KCl (0.1 M)* | | *$MgCl_2$ (0.1 M)* | | *$CaCl_2$ (0.1 M)* | | *$Na_3PO_4$ (0.1 M)* | | *NaCl (0.1 M)* | |
| | 33 | 0 | 36 | 0 | 48 | 1.5 | 43 | 79.5 | 65 | 362.0 |
| 3 | *$NH_4Cl$ (0.1 M)* | | *$KNO_3$ (0.1 M)* | | *$K_3PO_4$ (0.1 M)* | | *$Na_3PO_4$ (0.1 M)* | | *$NaNO_3$ (0.1 M)* | |
| | 9 | 0 | 6 | 0 | 6 | 0 | 3 | 0.5 | 86 | 279.5 |
| 4 | *Distilled $H_2O$* | | *NaCl ($10^{-5}$ M)* | | *NaCl ($10^{-4}$ M)* | | *NaCl ($10^{-3}$ M)* | | *NaCl ($10^{-2}$ M)* | |
| | 2 | 0 | 7 | 1.5 | 16 | 27.5 | 32 | 172.5 | 22 | 195.5 |

[Source: adapted from K Arms, *et al.*, (1974), *Science*, **185**, pages 372–374]

Study of the male moth *Gluphisia septentrionis* revealed that their puddling behaviour can last for hours. Though drinking results in the uptake of hundreds of gut-loads of fluid, this fluid becomes rapidly expelled from the digestive system through frequent anal ejections. In this experiment, the ion concentration change was calculated by subtracting ions ejected from ions taken in. The following data was collected from males drinking laboratory solutions and from natural puddles.




[Source: adapted from S R Smedley and T Eisner, (1995), *Science*, **270**, pages 1816–1818]

a. Identify the dissolved element always present in the three samples with most puddling time. [1]

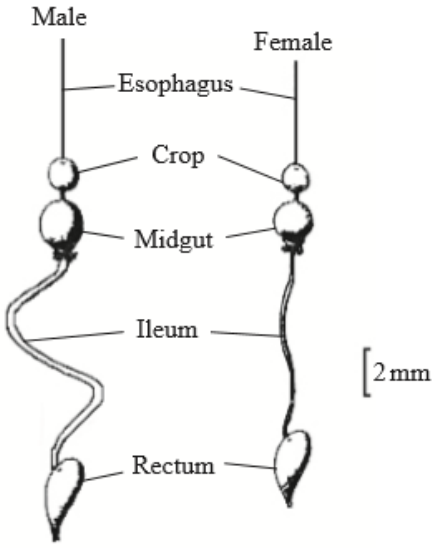
b. Discuss the relationship between sampling visits (V) and puddling time (T) in experiments 1, 2 and 3. [2]

c. Analyse the results for experiment 4. [2]

d (i) Identify which ion the moths are retaining in their body from the laboratory solutions. [1]

d (ii) Compare the gain and loss of ions in the male moths which have drunk from laboratory solutions with the changes in those that have drunk from natural puddles. [3]

e. The diagram below shows the digestive system anatomy of the male and female moth. [2]




[Source: adapted from S R Smedley and T Eisner, (1995), *Science*, **270**, pages 1816–1818]

Using the diagram above, evaluate the hypothesis that male moths are better adapted than female moths to benefit from puddling behaviour.

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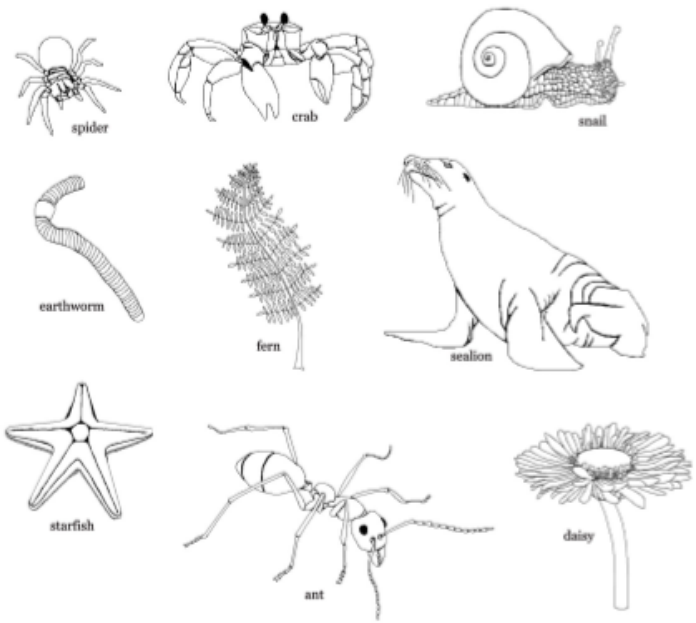
The diagrams below show different organisms (not drawn to scale).



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]

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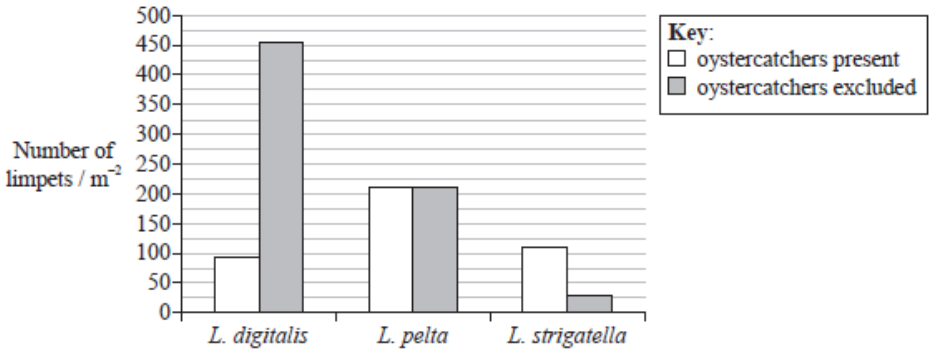
Limpets are small animals that feed on the green algae which grow on rocks on seashores. Oystercatchers (*Haematopus bachmani*) are birds that feed on limpets.

**Limpet**

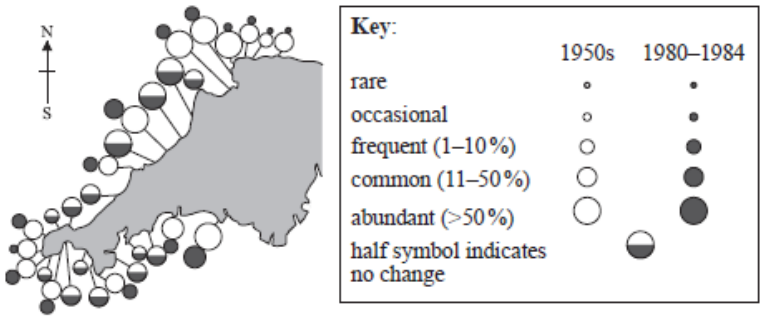
**Oystercatcher**

In a study on the north-west coast of the USA, where three limpet species are common (*Lottia digitalis*, *Lottia pelta* and *Lottia strigatella*), the limpets were protected from the oystercatchers by large wire cages. After two years the number of limpets in this area was compared with the number of limpets in an area without cages, where oystercatchers were present.




[Source: J T Wootton, (1992), *Ecology*, **73**, pages 981–991]

There is evidence to show that both air and water temperatures have increased over a period of time. An investigation was undertaken to determine the effect this change in climate had on the populations of another species of limpet, *Patella depressa*, around south-west England. The population of the limpet was recorded in many locations and around 30 years later, this study was repeated. The chart below compares the population in each of the locations.




[Source: M A Kendall, *et al.*, (2004), IBIS, **146**, pages 40–47]

a. State the effect that the exclusion of the oystercatchers had on the total number of limpets per $m^2$. [1]

c. Suggest reasons for the difference in numbers of *L. strigatella* between the areas where oystercatchers were present and where oystercatchers were excluded. [3]

d. On the map above label **one** location, [2]

(i) with the letter X, where the limpet population was abundant in the 1950s and occasional in the 1980s (1980–1984).

(ii) with the letter Y, where the limpet population was abundant in both the 1950s and in the 1980s (1980–1984).

e. Outline, using the data, the overall trend in the limpet population from the 1950s to the 1980s (1980–1984). [2]

f. Suggest **two** reasons for the change in limpet population between the 1950s and the 1980s (1980–1984). [2]

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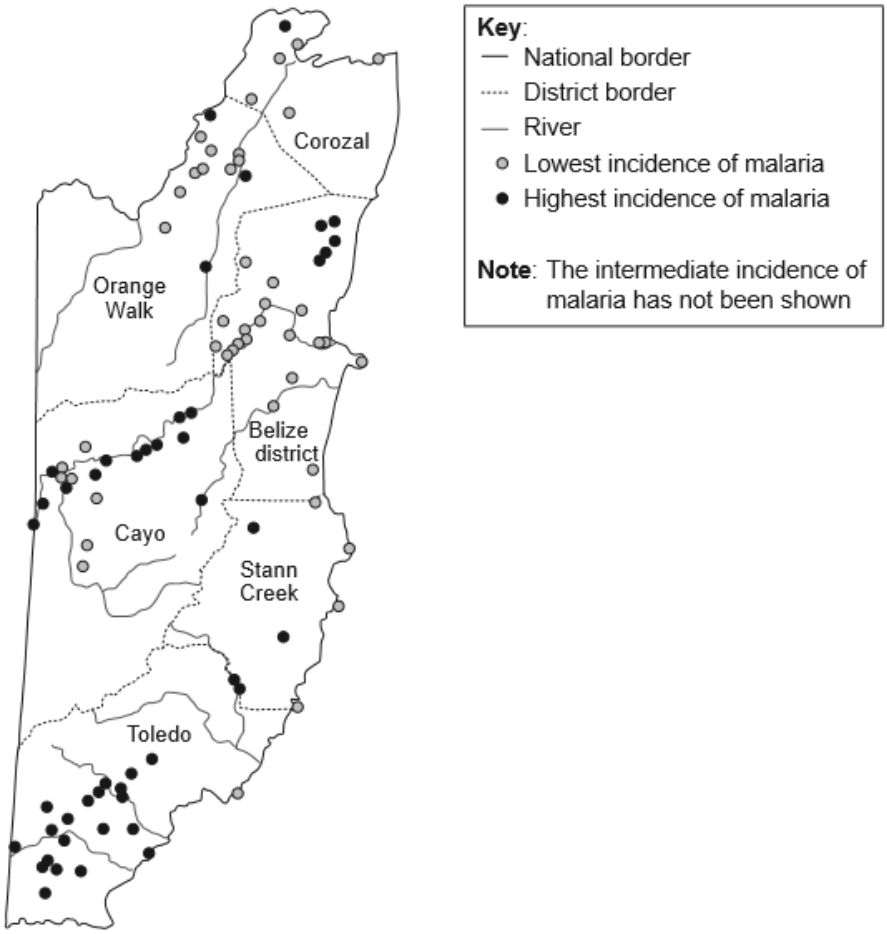
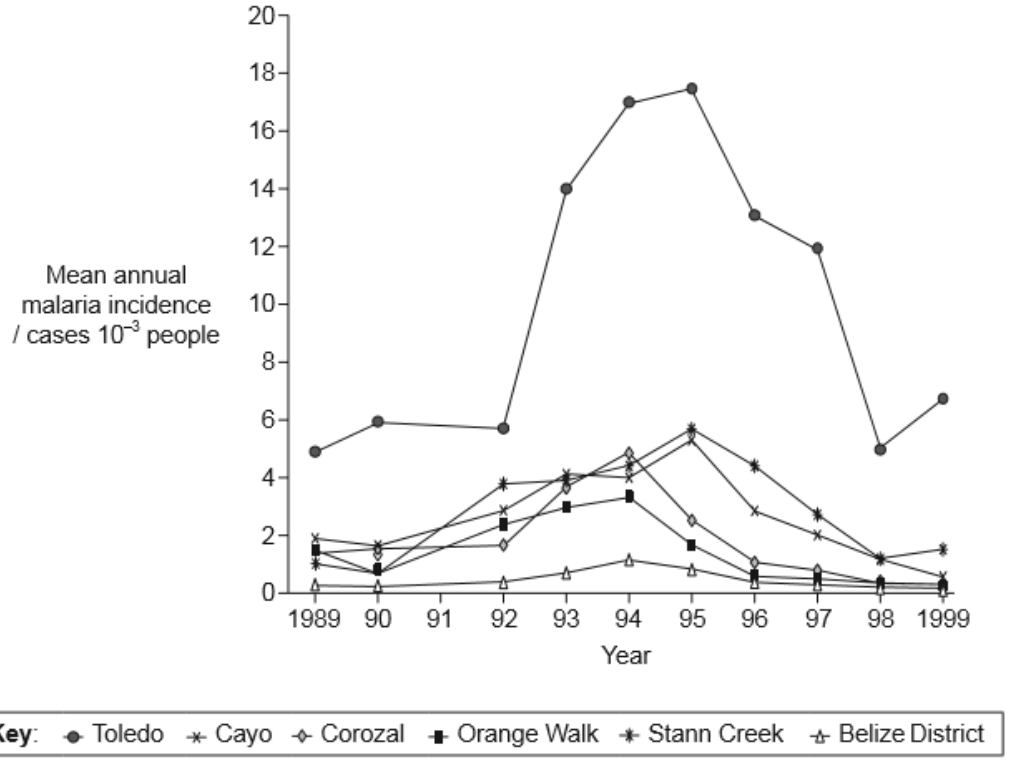
Malaria is a mosquito-borne disease caused by a unicellular organism, *Plasmodium*. *Plasmodium* is a parasite that spends part of its life in a mosquito and part in a human. The mosquito transmits the *Plasmodium* to a human when it feeds on human blood. Mosquitoes hatch in water and are flying insects as adults. In the country of Belize, where malaria is a serious problem, studies have been made to determine what environmental factors affect the incidence of the disease. 156 villages were studied over a ten-year period.



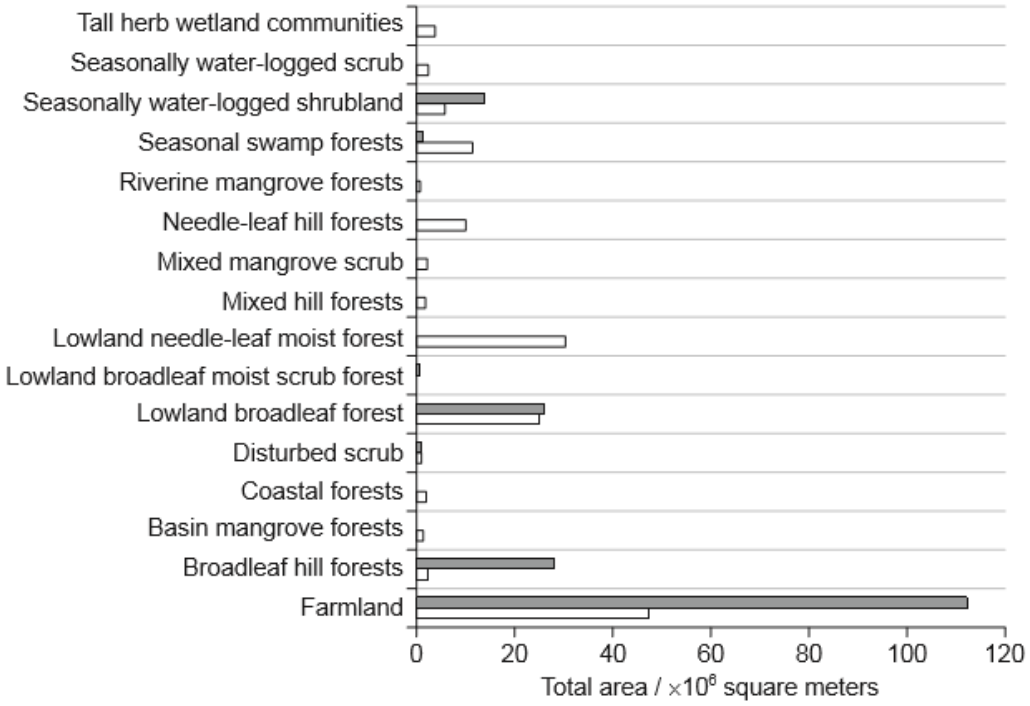

[Source: adapted from S. Hakre *et al.* (2004) *International Journal of Health Geographics*, **3** (6). Spatial correlations of mapped malaria rates with environmental factors in Belize, Central America. Shilpa Hakre, Penny Masuoka, Errol Vanzie and Donald R. Roberts © 2004 Hakre *et al*; licensee BioMed Central Ltd]

Each of the six districts of Belize was studied from 1989 to 1999. The graph shows the mean number of people in each district to be affected by malaria per year per 1000 people.




[Source: adapted from S. Hakre *et al.* (2004) *International Journal of Health Geographics*, **3** (6). Spatial correlations of mapped malaria rates with environmental factors in Belize, Central America. Shilpa Hakre, Penny Masuoka, Errol Vanzie and Donald R. Roberts © 2004 Hakre *et al*; licensee BioMed Central Ltd]

The country of Belize has many different ecosystems. These ecosystems are shown in the bar chart. The white bars indicate the total area within each ecosystem with the lowest incidence of malaria. The dark grey bars indicate the total area within each ecosystem with the highest incidence of malaria. The total area with an intermediate incidence of malaria is not shown.




[Source: adapted from S. Hakre *et al.* (2004) *International Journal of Health Geographics*, **3** (6). Spatial correlations of mapped malaria rates with environmental factors in Belize, Central America. Shilpa Hakre, Penny Masuoka, Errol Vanzie and Donald R. Roberts © 2004 Hakre *et al*; licensee BioMed Central Ltd]

a. State the district where there is the highest number of villages with the highest incidence of malaria. [1]

b. Analyse the data in the map to find whether there is an association between rivers and the incidence of malaria. [2]

c. Compare the trends in incidence of malaria for Toledo and Corozal. [3]

d (i) Suggest a reason for the decreases in the incidence of malaria from 1995 to 1999. [1]

d (ii) Suggest a reason why the incidence of malaria is so low in the Belize District. [1]

e. Besides farmland, identify which two ecosystems have the greatest total area with a high incidence of malaria. [1]

f. Predict with a reason, using the data, which district has most farmland. [1]

g. Discuss whether malaria could be reduced by replacing farmland with natural ecosystems and replacing broadleaf hill forest with mixed hill forest. [4]

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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]

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Beavers are large rodents that live in waterways throughout the northern hemisphere. Dams made by beavers change the temperature of the streams and affect the mayfly, *Baetis bicaudatus*. In the summer of 2008, beaver ponds in West Brush Creek and Cement Creek, Colorado, were studied to evaluate their impacts on mayflies. The study sites included streams flowing into (upstream) and out of (downstream) each beaver pond.


[Source: adapted from https://upload.wikimedia.org/wikipedia/commons/thumb/d/d4/Beaver_lodge.jpg/330px-Beaver_lodge.jpg]

Mayflies, including the species *B. bicaudatus*, are aquatic insects that hatch and spend their larval stages in water emerging from the water as adults. Larger females produce an increased number of better quality eggs.

The table shows the mean temperature differences (downstream – upstream) and mean dry mass for female and male mayflies.

| | Beaver pond | Relative height of dam | Mean temperature differences / °C | Mean dry mass / mg | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Female | | | Male | | |
| | | | | Up-stream | Down-stream | Difference | Up-stream | Down-stream | Difference |
| West Brush Creek | 1 | low | +0.1 | 1.97 | 1.83 | −0.14 | 1.39 | 1.37 | −0.02 |
| | 2 | high | −0.3 | 1.43 | 1.51 | +0.08 | 1.15 | 1.18 | +0.03 |
| | 3 | high | −0.2 | 1.55 | 1.67 | +0.12 | 1.19 | 1.23 | +0.04 |
| | 4 | low | +0.4 | 2.27 | 2.15 | −0.12 | 1.53 | 1.51 | −0.02 |
| Cement Creek | 5 | low | 0.0 | 2.12 | 2.07 | −0.05 | 1.39 | 1.33 | −0.06 |
| | 6 | high | −0.1 | 1.79 | 1.76 | −0.03 | 1.34 | 1.31 | −0.03 |
| | 7 | high | −0.2 | 2.10 | 2.14 | +0.04 | 1.53 | 1.49 | −0.04 |
| | 8 | low | +0.2 | 2.14 | 2.10 | −0.04 | 1.49 | 1.53 | +0.04 |
| | 9 | high | −0.3 | 2.05 | 2.09 | … **I** … | 1.57 | 1.45 | … **II** … |

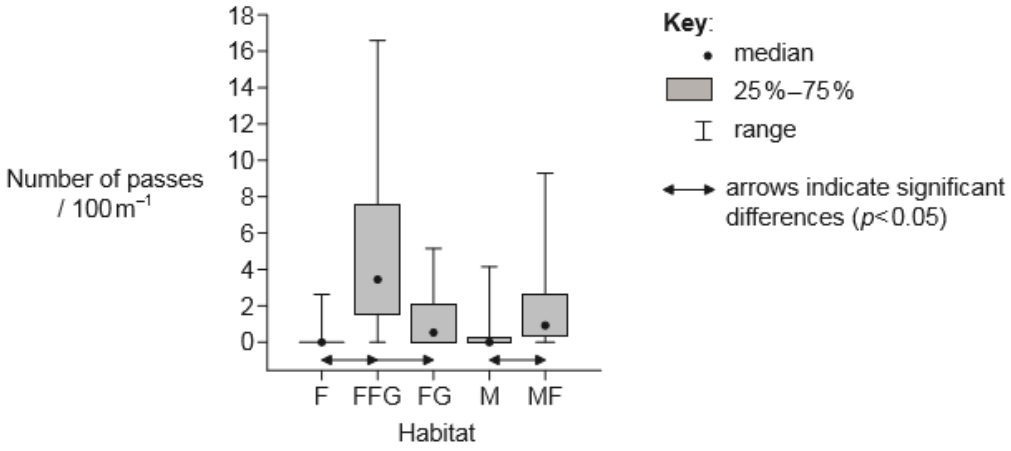
[Source: Fuller, M. R. and Peckarsky, B. L. (2011), Ecosystem engineering by beavers affects mayfly life histories. *Freshwater Biology*, 56: 969–979. doi:10.1111/j.1365-2427.2010.02548.x


The bat, *Pipistrellus nathusii*, feeds on insects including mayflies. A study was undertaken in Poland to see the effect of European beavers (*Castor fiber*) on the activity of bats. Beaver activity can affect forests that are covered by trees and meadows that are covered by grasses and have no trees.

The following habitats were studied:

- forest (F)
- flooded forest with canopy gaps created by beavers and flooding due to the presence of beaver dams (FFG)
- forest with canopy gaps created by beavers but no flooding (FG)
- meadow (M)
- meadow with flooding due to the presence of beaver dams (MF).

As bats feed they fly through the air catching insects. The number of feeding passes made by bats was counted. The graph shows differences in the bat activity between particular habitats.




[Source: adapted from Ciechanowski, M., Kubic, W., Rynkiewicz, A. et al. (2011), "Reintroduction of beavers *Castor fiber* may improve habitat quality for vespertilionid bats foraging in small river valleys". *European Journal of Wildlife Research*, Volume 57, Number 4, Page 737.]

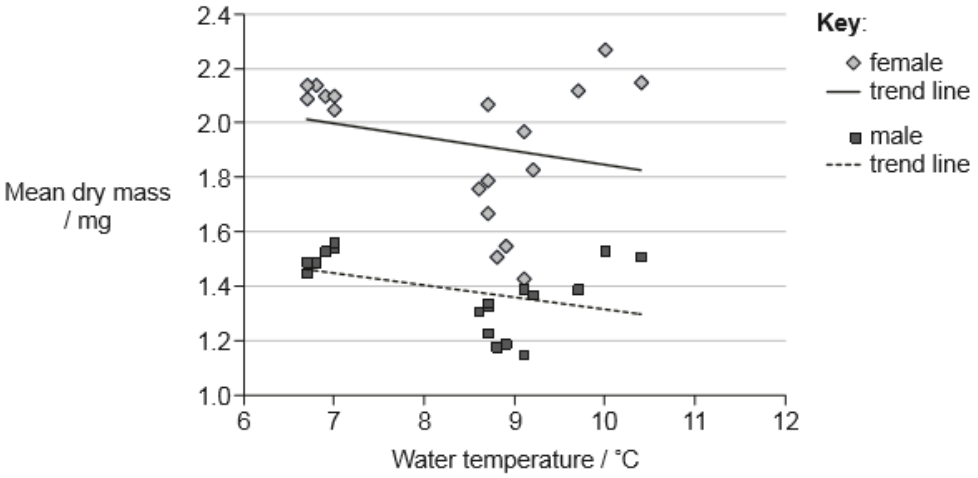
a. Calculate the difference in the mean dry mass of mayflies upstream and downstream of Cement Creek pond 9 for female and male mayflies. [1]

I. Female: ..... mg

II. Male: ..... mg

b. Describe the effect dams have on water temperature. [2]

c. The graph shows the mean dry mass of mayflies relative to the water temperature in their habitats. [2]




[Source: Fuller, M. R. and Peckarsky, B. L. (2011), Ecosystem engineering by beavers affects mayfly life histories. *Freshwater Biology*, 56: 969–979. doi:10.1111/j.1365-2427.2010.02548.x


Using the graph, discuss evidence for the hypothesis that mayflies grow to greater dry mass in cooler water.

d. Analyse the data to find the effect of flooding and tree felling by beavers on the activity of bats. [2]

e. The trout, *Oncorhynchus mykiss*, that live in West Brush Creek and Cement Creek also feed on the mayflies. Fishermen come to Colorado to catch and eat trout. Draw a diagram of part of a food web for the creeks in Colorado, including mayflies, humans, trout and bats. [2]

f. Identify an example of competition between organisms in this food web. [1]

g. The North American beaver (*Castor canadensis*) was introduced to islands adjacent to Argentina and Chile where they have become an invasive species. Discuss **one** ecological criterion (a basis for deciding) whether beavers are harmful **or** helpful to the ecosystems there. [2]

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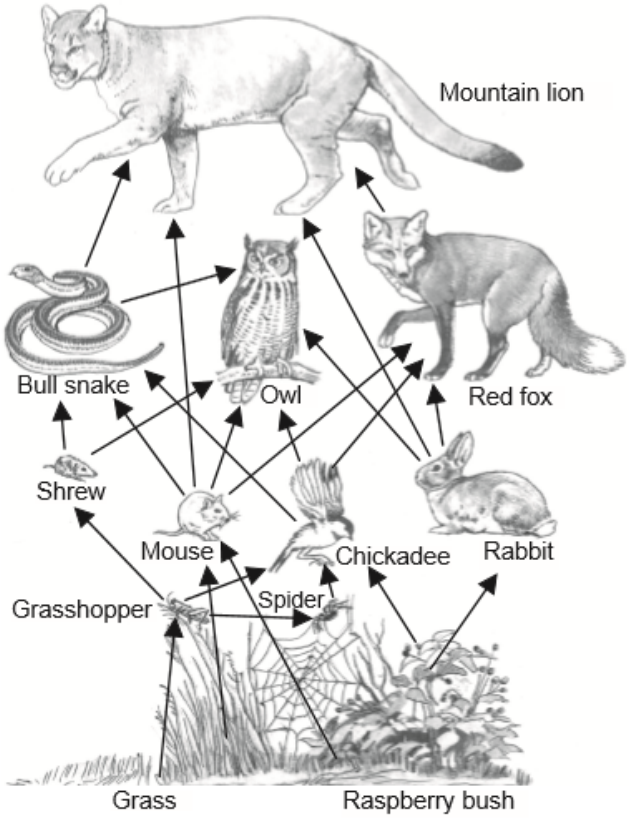


[Source: adapted from *BSCS Biology: An Ecological Approach*, Figure 1.10, page 12]

The image shows a forest food web from North America.

a. Describe what is meant by a food chain. [2]

b (i). Identify a food chain with four or more organisms from the forest food web. [1]

b (ii). Deduce the trophic level of each organism identified in your food chain from (b)(i). [1]

c. State one reason that the population of mountain lions is smaller than the populations of other animals in the food web. [1]

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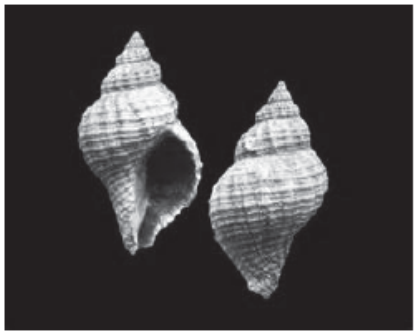
Native oyster populations are decreasing where rivers meet the ocean along the northwest coast of North America. These oyster populations are being attacked by a gastropod.

Adult oyster, *Ostrea lurida*

[Source: © International Baccalaureate Organization 2017]



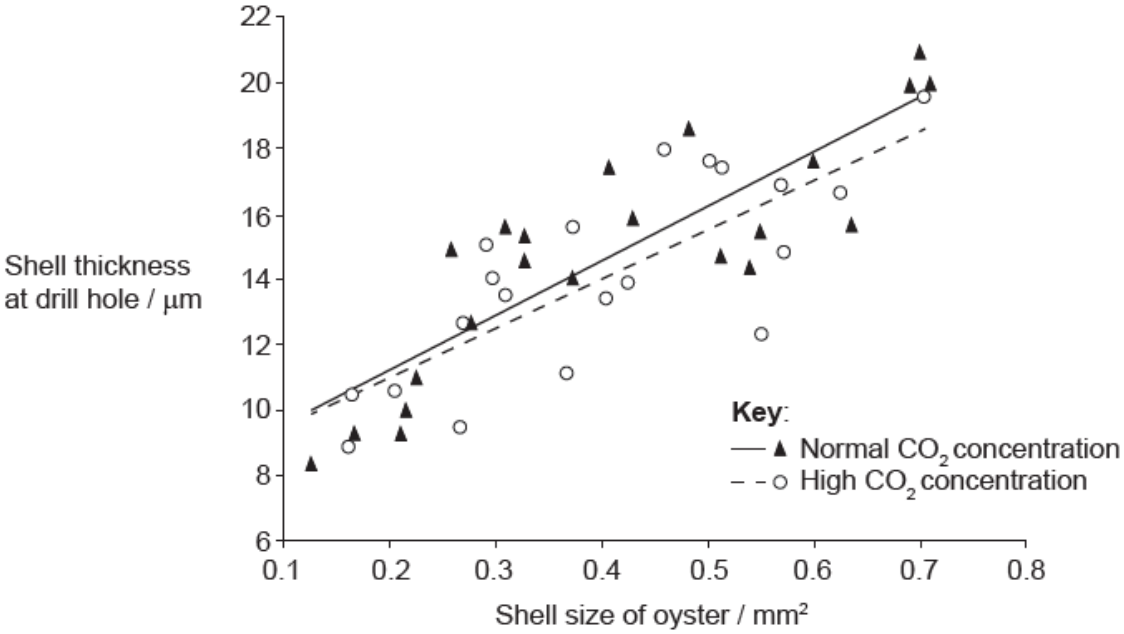
Adult gastropod shell, *Urosalpinx cinerea*

[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.

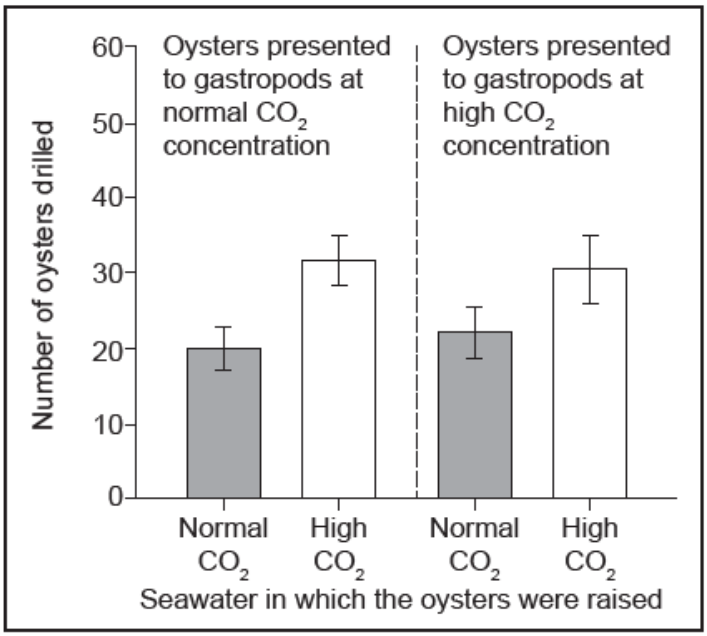
The first step was to raise oysters in two different mesocosms. One had seawater at a normal concentration of $CO_2$ and the other had sea water with a high concentration of $CO_2$. Gastropods were raised in two further mesocosms with normal and high $CO_2$ concentrations respectively.

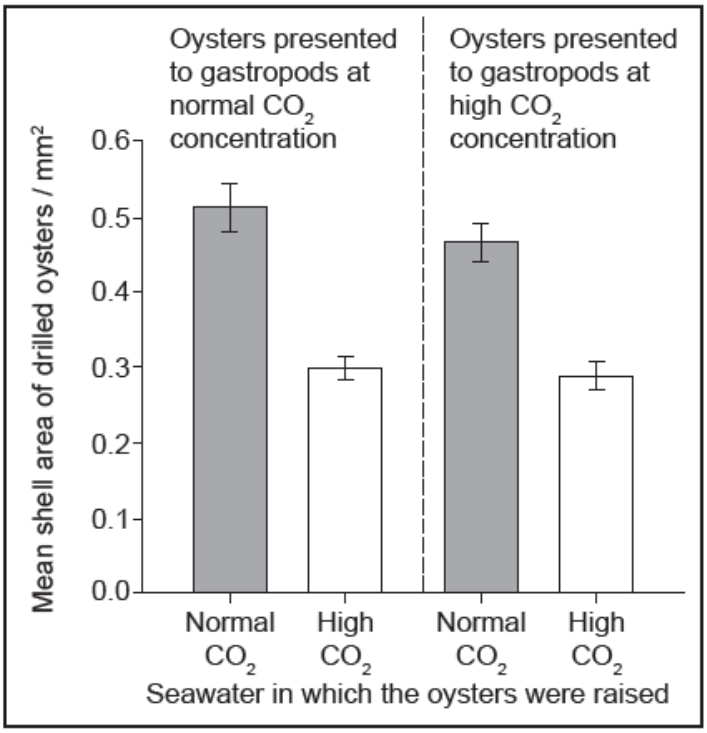
A juvenile gastropod will attack a juvenile oyster by using its tongue-like structure (radula) to drill a hole through the oyster shell. Once the hole has been drilled, the gastropod sucks out the soft flesh. Researchers investigated the shell thickness at the site of the drill hole in relation to the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