Biology 2.2

Internally assessed
3 credits

Analyse the biological validity of information presented to the public

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Achievement Standard 91154 (Biology 2.2) involves the *analysis* of the *biological validity* of the information presented to the public on a named *socio-scientific issue.*

AS 91154 (Biology 2.2) lends itself to an individual investigation outside the class for students who want to extend themselves and/or improve their ability to process and analyse information, and present a scientific report. It also allows students to increase their number of Level 2 credits. Discuss this with your teacher if you want to take advantage of this opportunity.

A **socio-scientific issue** is one that is science-based and provokes controversy/conflict within society. The issues tend to be complex with conflicting points of view; there are no easy answers. Examples of current socio-scientific issues in New Zealand include:

- use of 1080 poison in pest control
- use of fracking in oil exploration/extraction
- pollution of waterways by farming practices
- use of waterways for irrigation and/or hydro-electric power
- overfishing of coastal waters
- mining of conservation lands
- fluoridation of town water supplies
- global warming
- deep-sea drilling for oil off the coast of New Zealand.

Biological validity refers to how *scientifically accurate* the information is and whether it is *unbiased* in conveying ideas/concepts/facts. You need to *analyse* the information presented on the issue you investigate for how scientifically accurate (or inaccurate) it is and whether it is biased or unbiased. Typically, opinions/data/ideas presented by individuals or interest groups will be *biased towards their point of view and so prevent or cloud the ability to draw a logical conclusion based on scientific evidence/data*.

The emphasis of AS 91154 (Biology 2.2) is not on researching and collecting information but on *processing* and *analysing* information. Your teacher may provide you with a selection of information from different sources; you may add to these from your own research as necessary. Sources include:

- scientific reports
- interviews – TV / radio / newspapers / journals
- documentary films / DVDs
- public lectures
- advertisements
- reports or articles in newspapers / magazines / journals / internet
- social networks – blogs / Facebook / YouTube / Twitter.

For environmental issues, the following websites may be useful:

www.teara.govt.nz

www.doc.govt.nz

www.forestandbird.org.nz

www.nzfsa.govt.nz

www.conservation.govt.nz

www.biodiversity.govt.nz

www.landcareresearch.co.nz

The New Zealand Government has a Parliamentary Commissioner for the Environment; the current [2015] commissioner is Jan Wright. She has issued reports on various environmental issues including 1080 and Fracking – these may be accessed on www.pce.parliament.nz. The reports should be essential reading for all relevant socio-scientific issues. The magazine *New Scientist* (available in many school libraries) is an excellent publication with easily accessible up-to-date reporting on current scientific research and issues.

Topic selection and processing

Select a topic that is of interest to you, one you may already have an interest in or knowledge of, or one that may be of relevance to current or future studies and career pathways, e.g. medicine / ecology / environment / conservation. Consider how large or broad the topic may be – typically, the more specific or defined an issue, the easier it is to process and analyse. Do an initial search to see how available and accessible information is and whether a wide range of sources is available. Make sure information is *up-to-date and relevant* and lends itself to in-depth analysis. Compile a list of questions that need to be answered from the resource material.

- Is the biological information accurate or inaccurate, biased or unbiased?
- Who produced/published the information?
- Who is the target audience for the information?
- What are the overall impacts/consequences of this information on the public?

Keep all relevant (be selective) information/articles in a portfolio (e.g. clear pockets, ring binder). Ensure the sources of all information are accurately recorded so they are traceable (i.e. another person could find them) – e.g. author, year, title, publisher, URL and date accessed. It is from the information in your portfolio that you will write your formal report for assessment.

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Analysing and evaluating information

Step 1

Begin by doing sufficient background reading so that you understand the *relevant biological features* of the issue and can explain it in your own words.

Step 2

Use your understanding to analyse the biology presented in the material for its accuracy and bias. Link your analysis to the purpose of the information:

- Who published it?
- Why was it published?
- Who is the target audience?

Analysis needs to be *in your own words*.

Step 3

Explain, with reasons:

- in what way the biological features are accurate, inaccurate, or contain bias
- the possible impact on the public, or the possible consequences, of inaccuracies or bias
- how the vested interests of individuals or organisations are conveyed in the information.

Step 4

Rank, with reasons, the aspects of the information in order of their significance in terms of the overall context.

Step 5

Evaluate the *overall impact* of the information on the public, based on the balance of accurate to inaccurate information and any bias.

Case study on fracking

At the time of writing, **fracking** remains an issue both in New Zealand and globally and continues to receive media coverage after 5 years of ongoing controversy. *Fracking* refers to horizontal hydraulic fracturing. In the process, a mixture of water, sand and chemicals is injected at extreme pressure underground in areas where petroleum (crude oil) and natural gas occur. Fracking cracks open rocks boosting the flow of oil and gas and facilitating their extraction. It is widely used by mining companies in many countries, including the United States, New Zealand and Australia. Recent research has raised concerns about the practice because sand and chemicals can enter aquifers (underground natural water reservoirs) and therefore contaminate drinking-water supplies of local communities. In addition, an increase in the frequency of earthquakes has been recorded in areas where fracking is carried out. Consequently, fracking is, and remains, a contentious environmental and health issue.

Discuss with your teacher to determine whether fracking is an issue that you could investigate for AS 91154 (Biology 2.2).

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Resources

It is usually a good idea to do some internet research to learn about the science behind the issue. Wikipedia is usually a good place to start – en.wikipedia.org/wiki/Hydraulic_fracking.

The first large-scale awareness of the issue resulted from the documentary film *Gasland* (www.gaslandthemovie.com) directed by Josh Fox and first released at the Sundance Film Festival 24 January 2010. A synopsis and critical analysis are available at en.wikipedia.org/wiki/Gasland; the film may be bought or accessed online.

In 2011, the issue was raised in New Zealand by investigative journalist Tracey Barnett in the *New Zealand Herald* (www.nzherald.co.nz) 'What the Frack is This Government Thinking?' (5 August 2011); responded to by an industrial representative Bernie Napp 'Fraction too much friction about fracking' (8 August 2011), with response by Barnett 'Oil industry's fracking spin exploits ignorance of citizens' (2 September 2011). Since then, the issue has had frequent reports in the *New Zealand Herald*; the most recent being by Peter Huck 'Fracking blamed for health problems' (7 June 2014) and 'Cracks showing in industry built on shaky ground' (22 March 2014).

The Parliamentary Commissioner for the environment, Jan Wright, released an interim report on fracking (27 November 2012) followed by another report 'Drilling for oil and gas in New Zealand: Environmental oversight and regulation' (released in June 2014). Both reports can be accessed on www.pce.parliament.nz

Interviews on RNZ national (www.radionz.co.nz) have occurred too since 2011. To access, go to the RNZ website, follow the link to National and put 'fracking' in as the search word.

Kathryn Ryan ('Nine to Noon') has conducted several interviews, including one with Josh Fox, Bernie Napp and Russel Norman on 16 August 2011. Others have been conducted with the Parliamentary Commission Jan Wright in relation to her reports on fracking – 29 March 2012 and 28 November 2012.

The *New Zealand Listener* (www.listener.co.nz) published two editorials on fracking 'Follow the Drill' (15 February 2013) and 'Drilling Down' (14 June 2014) – a comment on Jan Wright's 2014 report.

New Scientist has published at least four reports on fracking – 'Drilling into the unknown' (Peter Aldhouse, 28 January 2012), 'Frack away UK' (14 September 2013), 'Beyond fracking – the dash for gas goes extreme' (Fred Pearce, 15 February 2014), 'Should the UK frack for gas?' (Catherine Brahic, 14 February 2014).

A fracking operation in progress

Process and analyse selected information

Process and analyse selected information using the guidelines given (i.e. *Topic selection and processing* (page 24) and *Analysing and evaluating information* (page 25)). Use this to write a report in your own words that analyses the biological validity of the information presented to the public on the use of fracking by oil companies. Hand your report to your teacher for assessment.

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Biology 2.3

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Demonstrate understanding of adaptation of plants or animals to their way of life

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Animal option

Taxonomic and functional groups

All animals are classified into **taxonomic groups** depending on the features they have in common and/or how related they are. The main taxonomic groups are:

➡ Increasing number of features animals have in common
➡ Decreasing number of different types of animal

Phylum ➡ Class ➡ Order ➡ Family ➡ Genus ➡ species

For example, humans are classified as:

Chordates ➡ Mammals ➡ Primates ➡ Hominids ➡ *Homo* ➡ *sapiens*

Each species has a scientific name of 'genus plus species' written in *italics* or underlined, e.g. *Homo sapiens* or Homo sapiens.

All animals carry out the life processes of: nutrition, internal transport, gas exchange, excretion, support and movement, sensitivity and co-ordination and reproduction; large, multicellular animals have evolved complex body systems to successfully carry out these processes. Members of a taxonomic group have *similarities* in the structure and function of their systems, but have *differences* related to the animals' particular ways of life. For example, the digestive system in mammals is a hollow tube extending from the mouth to the anus that has enlarged parts (e.g. stomach) to carry out digestive processes; however, the presence / size / extent of development / length of the particular parts are dependent on each particular mammal's diet. The presence (and location) of digestive enzymes also vary depending on diet.

Animals may also be grouped into certain **functional groups**, depending on their way of life. For example, for nutrition, mammals may be placed into the functional groups of:

- omnivores – e.g. humans, bears, rats, pigs
- carnivores – e.g. all members of the cat and dog families
- herbivores – foregut (e.g. ruminants such as cows and deer), or hindgut (e.g. rats and rabbits)
- filter feeders – e.g. baleen whales such as humpback and blue whales.

Body systems *do not work in isolation* but connect with, and depend on, other systems to function successfully and efficiently. For example, the digestive system provides the nutrients needed for the functioning of the cells of all other systems. However, the transport system gets these nutrients to cells; the gas exchange system provides the oxygen needed for cellular respiration which releases energy needed to fuel all chemical reactions of cells of all systems (e.g. muscular contraction of heart to pump blood, manufacture of digestive enzymes by pancreas); the excretory system removes toxic wastes from metabolism (e.g. CO_2 from respiration, excess amino acids (as urine) from protein digestion).

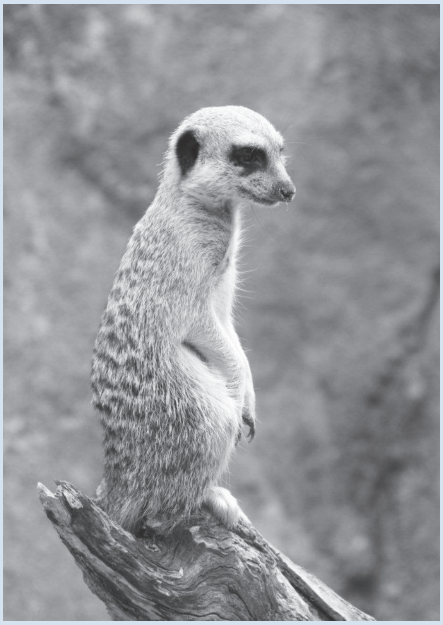
Students may select which life process(es) and which taxonomic or functional groups they will investigate. To meet the requirements of AS 91155 (Biology 2.3):

- *Either*: one life process may be investigated over *three* taxonomic or functional groups with *comparisons* being made of how the animals are adapted to their way of life in relation to the life process – limitations and advantages involved in each feature within each organism need to be considered.
- *Or*: *two related* life processes may be investigated in *one* taxonomic or functional group; how the animals are adapted to their way of life for *both* processes needs to be investigated as well as how the two processes are *connected* (and so work together) to ensure the successful functioning of both systems – limitations and advantages involved in each feature within each organism need to be considered.
- Adaptations include structural, behavioural, physiological features of an organism. An *adaptation* provides an advantage for the organism/species in its specific habitat and ecological niche.

This chapter will investigate:

- the life process of nutrition, in the taxonomic group of mammals *and* include nutrition in the *functional* groups of omnivores, carnivores, herbivores (both foregut and hindgut) within the mammals
- the life process of gas exchange in the taxonomic groups of insects, fish, mammals
- the life process of internal transport in mammals.

Connections between the life systems of nutrition, transport and gas exchange are included for mammals.



Meerkat

Mammals are distinguished by the presence of body hair and the young are born alive and suckled on milk. Mammals, along with birds, are homeotherms (*warm-blooded*) – i.e. they can maintain a stable core body temperature. This requires a large input of heat energy (released in respiration) – a significant amount of the calories consumed in the diet is needed to maintain body temperature.

Mammals evolved to live a completely terrestrial life, though marine mammals (e.g. dolphins, whales, manatees, dugongs) have subsequently adapted to living a completely aquatic life (however, unlike fish, they still need to breathe atmospheric oxygen for respiration).

Mammals are comparatively large, active, intelligent animals with complex body systems and high energy demands. They are adapted to finding, consuming and processing large amounts of food. They are the top carnivores in many ecological communities. The mammal circulatory system is a completely double, closed system with a four-chambered heart, ensuring efficient transport of oxygen, nutrients, and other substances (e.g. hormones) from site of origin to site of need – e.g. oxygen from alveoli of the lungs to the cells of the muscles. All mammals have two lungs in the chest (thoracic) cavity for gas exchange (O_2 and CO_2) with the atmosphere. A sheet of muscle, the diaphragm, traverses the thoracic cavity under the lungs and works together with the rib cage to ventilate the lungs.

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Carnivore and herbivore comparison

Answers p. 134

Carnivores and herbivores display many adaptations to their way of life. The photos show a typical (predatory) carnivore (lion) and a herbivore (springbok).

Profile each of these two animals to describe, with reasons, how they are adapted to their way of life. Consider the following features.

- Senses – how acute?
- Location of eyes (lion in front, springbok at sides).
- Solitary or live in groups?
- Colour.
- Legs – length, size and shape.
- Movement and speed.
- Tail.
- Hunting behaviour (lion), predator-avoidance behaviour (springbok).
- How helpless are the young after birth?
- Special features – e.g. mane in lion, 'pronking' (Google it!) in springbok.

Use your own paper. Discuss your ideas with your classmates then write a comparison of the adaptations of each animal – show this to your teacher for feedback.

Nutrition in mammals

Food is essential for providing fuel for respiration, synthesis of essential compounds needed for cell functioning, reproduction of cells for growth, repair of cells in tissue damage, maintaining a stable internal environment (*homeostasis*). Most of our food is made up of large organic compounds – **carbohydrates** (including starches and sugars), **lipids** (includes fats and oils), **proteins**. Essential in smaller amounts are certain **mineral ions** (e.g. Ca, Fe, Se, Co), and **vitamins** (e.g. vitamins C and D). *Water* is needed in large amounts.

Herbivores gain their nutrients by eating plant material, *carnivores* by eating other animals (meat), *omnivores* by eating both plants and animals.

Pigs are omnivores.

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Nutrition

Answers p. 134

1. Find out, then say why, the body needs each of the following:

a. carbohydrates ______

b. lipids ______

c. proteins ______

d. calcium, Ca ______

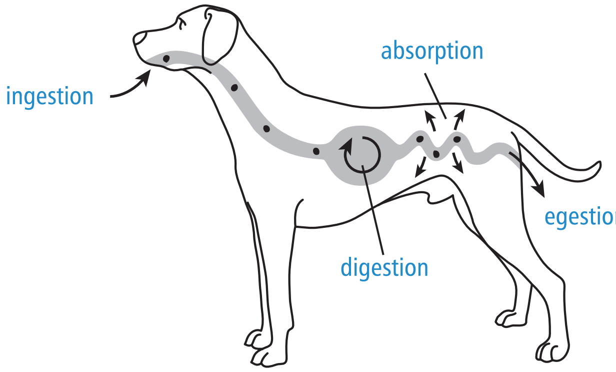
e. iron, Fe ______

f. vitamin C ______

g. vitamin D ______

h. water ______

2. The *processing* of food to provide the body with nutrition requires the following four processes.



Define each of the four processes:

a. ingestion ______

b. digestion ______

c. absorption ______

d. egestion ______

Ingestion

Ingestion is assisted by specialised teeth – **incisors**, **canines**, **molars** (and premolars). The presence, size and shape of each of these tooth types are an adaptation to the mammal's diet.

Molar tooth of a cow; the molars are very large and heavily ridged to chew grasses – the tooth measures 60 mm from top of the ridges to bottom of the root.

Many schools have a collection of skulls and/or teeth. If available, examine these in conjunction with this section of work.

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Ingestion

Answers p. 134

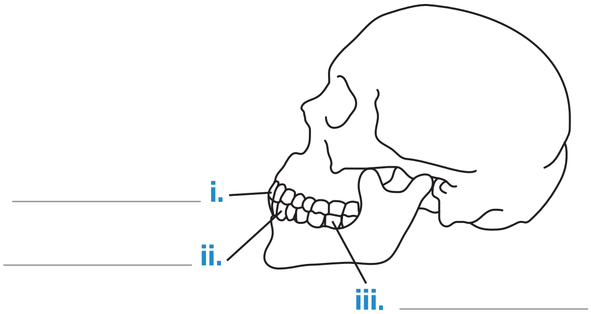
1. Find out and give the function of each of the three types of tooth:

a. incisors ______________________

b. canines ______________________

c. molars/premolars ______________________

2. The skull is that of a human, an omnivore.



a. Label the diagram to give the names of the types of tooth.

b. Explain how the presence, shape and size of the teeth are an adaptation to the diet of humans.

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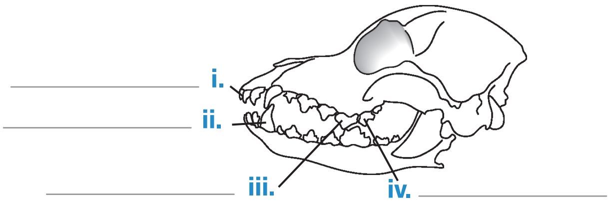
3. The skull in the photo is that of a wolf, while the skull diagram is that of its close relative, the dog.



a. Label the diagram to give the names of the types of tooth.

b. Explain how the presence, shape and size of the teeth are an adaptation to the diet of dogs/wolves.

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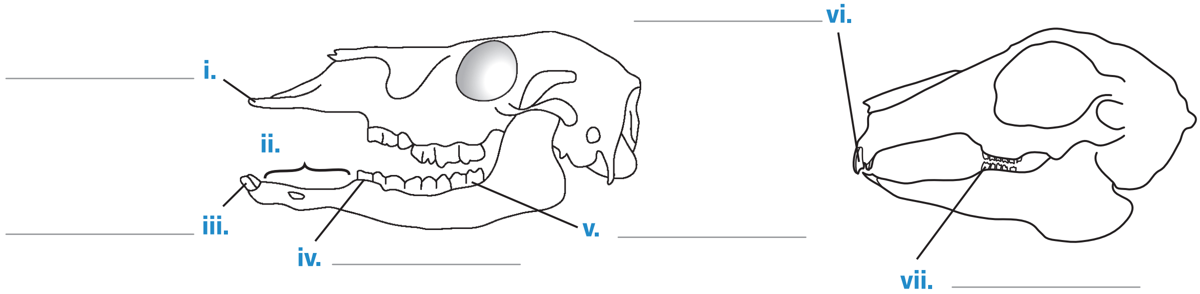
4. The skulls drawn are of a cow (a foregut herbivore) and a rabbit (a hindgut herbivore).

a. Label both diagrams to give the diastema and bony pad (cow only) and the names of the types of tooth.



Herbivore teeth (cow (left) and rabbit (right))

b. Explain how the presence, shape and size of the teeth of the cow are an adaptation to its herbivorous diet.

c. Give the main difference(s) in the teeth between cows and rabbits, and suggest reason(s) for these differences.

5.

Premolar and molar teeth in a deer

Teeth are an adaptation to cutting off pieces of food then breaking it up into smaller pieces. Give the purpose of breaking food into smaller pieces.

6. Give the role of the tongue in ingestion.

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Answers

Achievement Standard 91153 (Biology 2.1)

Experimental concepts (page 2)

1. **a.** dependent variable **b.** reliability
c. conclusion **d.** discussion
e. hypothesis **f.** independent variable
g. validity **h.** analysis
i. results **j.** processing
k. controlled variables **l.** method

2. **a.** Materials and equipment used in the method must be stated using specified quantities – e.g. 10 mL (not just 'a small amount of water'), 30 °C (not just 'warm water'), a 500 mL beaker (not just 'a medium-sized beaker') – so that the method is accurate enough for another person to carry it out and get the same or similar results (without having to ask for clarification).

b. Step-by-step instructions mean:

- each instruction is clear
- the steps can be arranged in a logical order
- the chances that another person can accurately and easily replicate the investigation (and get similar results) are increased.

Fair-test investigations – Method (page 3)

1. In a fair test, only one variable is altered (the independent variable) and all other variables that may affect the results are kept constant ('controlled'). Thus the dependent variable is measured with respect to *only* the independent variable, therefore any relationship between the dependent variable and independent variable will show up (as a pattern or trend). If the investigation is a fair test, then the method will be valid (i.e. will measure what it is designed to measure).

2. For an investigation to be a fair test, all variables that may affect the result must be kept constant – e.g. temperature, volume of solution, size of sample, etc. so that only the effect of the independent variable is seen on the dependent variable.

3. The independent variable *must have an appropriate range of values* to increase the chances of revealing a pattern or trend that may exist between the independent variable and the dependent variable. The range must be appropriate in that the range must reflect conditions the organism may experience in its natural environment (e.g. air temperatures, body temperatures, humidity levels, light intensity) and/or the range covers all possibilities (e.g. from 0 to 100%, 0 to 14 for pH).

4. If the investigation is not reliable, then the results are meaningless – another person *must* be able to carry out the investigation and get similar results. Having multiple samples increases the chances of revealing any pattern or trend that exists between the dependent variable and independent variable.

5. **a.** The investigation as given would not be accurate enough to allow a valid conclusion to be made or for the investigation to be repeated by another person.

- The Vaseline will trap any mosquito that lands on it by chance and cannot be taken as an indicator of temperature attraction.
- The heater and ice pack will give temperature differences, but there has been no attempt to measure the temperature in the aquarium or to relate it to the temperature of any mammal host.
- The ice pack will melt and spread water along the floor, which will not only affect the temperature gradient but will also provide a safety hazard with the heater.
- The size/dimensions of the aquarium have not been given, so the set-up cannot be duplicated.
- The time allowed for one trial (one hour) is much too long to be realistic – mosquitoes find their host very quickly.
- The control does not relate to the investigation. If temperature difference is being tested, then the control would be an aquarium with uniform temperature throughout to see if the mosquitoes were attracted to any particular end/area – if they were found to prefer one area *per se*, this would mean the results were biased from the very start.
- To better test the hypothesis, the body temperature of the host needs to be known and this generated (by a heater) in the centre of a suitable container. As the distance from the heater increases, it will represent the temperature gradient from the host. If the mosquitoes fly towards the heater consistently, then they are probably being attracted by temperature.

b. Method: This would need trialling and changing as required.

- Set up a large transparent plastic container 1 m × 1 m.

  Include a large, clear, labelled diagram of the final set-up used.

- In the middle of the container, place a suitable heat source set at the temperature of the host (e.g. 37 °C for humans).

  The heat source would need to be tested, e.g. heating coil/beaker of hot water/low-wattage bulb.

- Cover the heat source (safely) with cloth/fur so that it more resembles the host's surface and will act to control other variables such as light/steam/humidity.

  It is essential to control all other variables so that only the temperature changes.

- Measure the temperature of the heat source and maintain it at the set temperature throughout the trials.
  Must state how this is done.
  Measure the temperature gradient from the heat source to the walls of the container.
  The temperature gradient is the independent variable.
- Release 10 mosquitoes into the container at a time and after 1 minute record how many have landed on the heat source.

  The number of mosquitoes landing on the heat source is the dependent variable.

- Repeat 10 times with different mosquitoes each time.
  Increases the chances of reliable results.

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Tabulating and processing data (page 5)

The following answers are given to the correct number of significant figures (the numerical/calculator answer is given in the screened right-hand side column).

An answer can only be given to the accuracy of the least accurate piece of data used to calculate the answer. In this case, each piece of trial data was required to 2 significant figures (and to one decimal point) so the answer can only be given to 2 significant figures (and to one decimal point).

Temperature (°C)	Average	Numerical calculation
5	0.4	0.4
10	1.0	1.0333
15	1.4	1.3666
20	2.0	2.0
25	2.9	2.8666
30	4.1	4.1
35	6.1	6.0666

Graphing and analysing (page 8)

1. A line of best fit best reveals the relationship between the points on a graph. A line of best fit best takes into account if the data are linearly related (straight line) or geometrically related (a curved line). A line of best fit also accounts for scattered data and outliers – both outliers that are data that result from incorrect measurement (these outliers need to be ignored) and outliers that are data that result from the dependent variable having a wider range than expected.

2. **a.** Bar graph: there is no relationship between the data categories (i.e. data categories represent different species).

b. Histogram: data for the independent variable show a range (e.g. 0–4.9, 5.0–9.9 cm) and the range is continuous (0–24.9) for the one factor (length of blue mussels).

c. Line graph:

- discrete readings of both variables (e.g. heights of 10 cm, 25 cm) have been taken
- both variables measured over a range.

3. **a.** Rate of photosynthesis – measured as % CO_2 consumed per hour.

b. **i.** Light intensity – ranges from 10 000 lux to 80 000 lux.

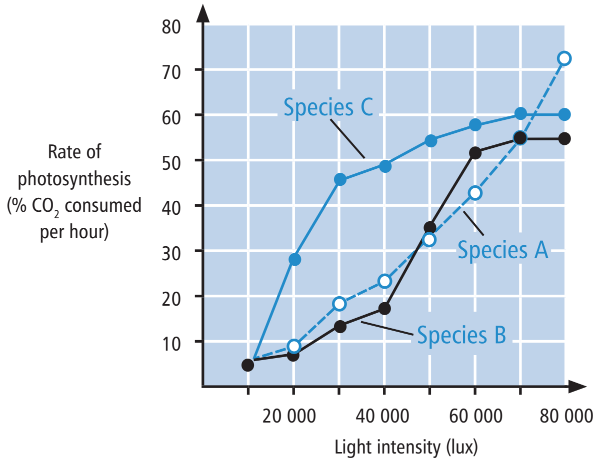
ii. Range needs extending above 80 000 lux as the rate of photosynthesis for species A is still increasing.

Rate for two other species has stabilised – at 55 for species B and 60 for species C.

c. Air temperature needs to be kept constant – changes in temperature will affect the chemical reactions of photosynthesis (increasing temperature will increase the rate up to an optimum).

d.

Photosynthetic rate for three species of plant



e. **i.** Species A: Rate of photosynthesis increases as light intensity increases from 10 000 to 80 000 lux.

Species B: Rate of photosynthesis increases slowly at low light intensities until 40 000 lux, then increases rapidly until 70 000 lux. Light intensity above 70 000 lux has no further effect on rate of photosynthesis (it has peaked).

Species C: Rate of photosynthesis high at low light intensities until 40 000 lux. Rate then slows until 70 000 lux. Increasing light intensity above 70 000 lux has no further effect on rate of photosynthesis (it has peaked).

ii. Species A is best adapted to high light intensities, as its rate of photosynthesis increases as light intensity increases, and is still increasing at 70 000 lux.

Species C is best adapted to low light intensities, as it has a high rate of photosynthesis in low light conditions.

4. **a.** Activity of enzyme pepsin measured as amount of egg white digested (in grams).

b. Independent variable = pH, with a range from 1–10. This is a suitable range as it:

- reflects the acid environment of the stomach (pH 1–4)
- reflects the pH range found within the human body (pH 1–10).

The range could have been reduced so that it went from 1 to 8 (instead of 1 to 10), as enzyme activity drops to zero above pH 8 – this should have shown up in practice runs.

c. Enzyme activity rose rapidly from just above pH 1 to peak at pH 2, dropping slightly before plateauing at pH 3–4.5, then dropping rapidly down to effectively no activity above pH 6.5.

d. Enzymes work within a specific pH range which corresponds to that of their environment. The results indicate that pepsin has peak activity within the pH range of 1–3. This would be expected as pepsin is located in the stomach which has a very acidic environment from the presence of hydrochloric acid. As the pH increases above pH 6.5, pepsin can no longer act as a catalyst (it has been denatured); its activity becomes zero.

Case Study 1 – Effect of temperature on the rate of photosynthesis (theory investigation) (page 12)

1. **a.** Dependent variable = Rate of photosynthesis, recorded as number of bubbles of oxygen produced every 3 minutes.

The rate of photosynthesis is being measured by the amount of oxygen gas produced.

b. Independent variable = water temperature, with a range from 15 to 40 °C. This is a suitable range as it reflects the natural environment of *Elodea*.

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