

Exam Prep DBQs [116 marks]

A study was conducted to look at the short-term effects of a change in diet on the risk of disease in young adults. The table shows data on the habitual diet of the participants as well as the study diet followed for two weeks.

	Mean daily intake \pm standard deviation	
	Habitual diet	Study diet
Energy / kJ	10 143 \pm 949	9992 \pm 479
Fat / g	100 \pm 6	99 \pm 5
Saturated fat / % total fat	37 \pm 2	60 \pm 1
Unsaturated fat / % total fat	63 \pm 2	40 \pm 1
Monounsaturated fat / % total fat	46 \pm 1	32 \pm 1
Polyunsaturated fat / % total fat	17 \pm 1	8 \pm 1
Carbohydrate / g	248 \pm 23	232 \pm 16
Protein / g	119 \pm 12	120 \pm 9

[Source: Horowitz, J.F., Ortega, J.F., Hinko, A., Li, M., Nelson, R.K. and Mora-Rodriguez, R., 2018. Changes in markers for cardio-metabolic disease risk after only 1-2 weeks of a high saturated fat diet in overweight adults. *PLoS ONE*, 13(6), e0198372.]

1a. Comment on the total energy content of the two diets.

[1 mark]

Markscheme

- a. energy is not changed (between the two diets);
- b. study diet slightly lower in energy than habitual diet (but means/SD overlap);
- c. spread of values show more variation for habitual diet / higher SD in habitual;

1b. Distinguish between the two diets.

[2 marks]

Markscheme

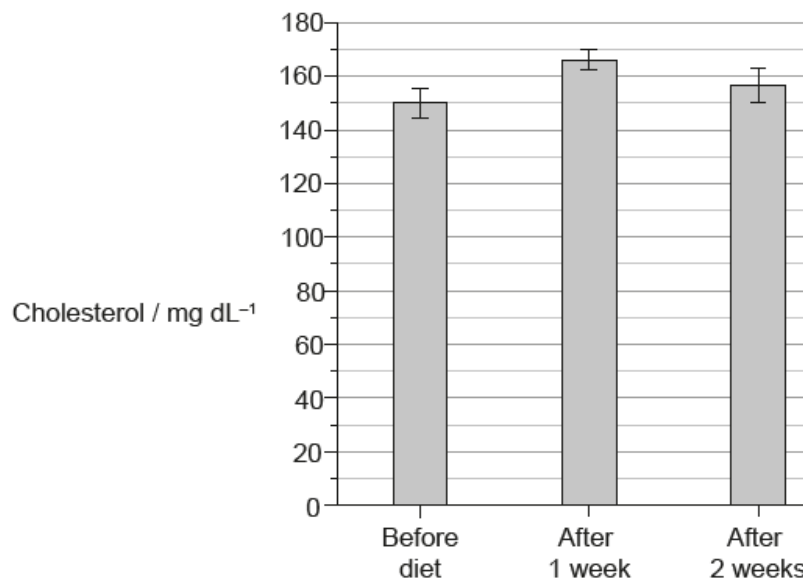
- a. they differ in percent of saturated and unsaturated fats (but not total fat);
- b. percent of saturated fats is higher in study diet / lower in habitual diet;
- c. (mono/poly) unsaturated fats decreased in study diet compared to habitual diet/more in habitual diet

OR

- polyunsaturated fats in study diet only half of what they were in habitual diet;
- d. (slightly) less carbohydrate in study;

Allow numerical points if they are a valid comparison using distinguishing terms.

Total blood plasma cholesterol levels were measured before the study began and once a week after starting the study diet. Mean results are shown in the bar chart, including the standard deviation.



[Source: Horowitz, J.F., Ortega, J.F., Hinko, A., Li, M., Nelson, R.K. and Mora-Rodriguez, R., 2018. Changes in markers for cardio-metabolic disease risk after only 1-2 weeks of a high saturated fat diet in overweight adults. *PLoS ONE*, 13(6), e0198372.]

- 1c. Calculate, showing your working, the percentage change in mean cholesterol level after **one week** on the study diet.

[2 marks]

.....%

Markscheme

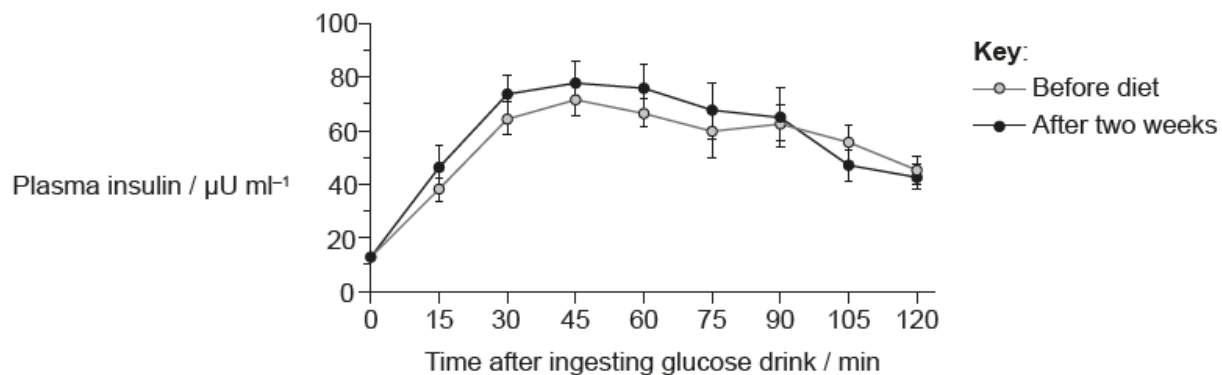
$$((165-150) \div 150) \times 100;$$

$$(\Rightarrow) 10 (\%);$$

Allow up to 167 = 11.3 %

1 mark for correct working if above 167.

Control of blood glucose concentration was investigated using an oral glucose tolerance test. For this test, the person was given a concentrated glucose drink (at time zero) and then blood samples were taken every 15 minutes to determine the plasma insulin level. This test was done before the study diet and after two weeks on the study diet. Mean results are shown in the graph, including the standard deviation.



[Source: Horowitz, J.F., Ortega, J.F., Hinko, A., Li, M., Nelson, R.K. and Mora-Rodriguez, R., 2018. Changes in markers for cardio-metabolic disease risk after only 1-2 weeks of a high saturated fat diet in overweight adults. *PLoS ONE*, 13(6), e0198372.]

- 1d. Compare the data for plasma insulin levels before and after the study diet. [2 marks]

Markscheme

- both show same pattern of rise, level and then decrease / show same trend;
- both show same/similar levels of insulin (at all times) due to overlapping error bars;
- both rise for 30/45 minutes;

Do not give credit for contrasts.

1e. State which cells secrete insulin.

[1 mark]

Markscheme

β cells of pancreas/islets (of Langerhans);

1f. Outline the reason for plasma insulin levels changing in the first 30 minutes of the test.

[1 mark]

Markscheme

as blood glucose rises, insulin rises/increases to reduce the level/*OWTTE*;
Blood glucose must be mentioned as well as a rise in insulin.

1g. The hypothesis made before the study was that saturated fats in the diet affected the risk of coronary artery blockage and diabetes. Using all the data in question 1, evaluate whether this hypothesis is supported by the study.

Markscheme

Hypothesis is partially supported

- a. Increased saturated fats in study diet resulted in increase in cholesterol levels;
- b. cholesterol level is risk for blockage of coronary arteries;

Hypothesis is not supported

- c. high insulin levels are sign of (Type II) diabetes;
- d. insulin levels were the same in both diets so no increased risk;
- e. study only 2 weeks long;

The photomicrograph below shows the protozoan *Paramecium caudatum*.



[Source: Deuterostome, CC BY-SA 3.0
<https://creativecommons.org/licenses/by-sa/3.0>, via Wikimedia Commons.]

2a. State the genus of this organism.

[1 mark]

Markscheme

Paramecium

2b. State the domain in which it is classified.

[1 mark]

Markscheme

eukaryotes

2c. Outline the method of nutrition carried out by *P. caudatum*.

[1 mark]

Markscheme

heterotroph/consumer as it feeds on bacteria/algae/yeast/smaller single celled organisms

OR

heterotroph/consumer as it does not have chloroplasts

Heterotrophic must be qualified.

2d. Outline **one** aspect of how *P. caudatum* carries out homeostasis.

[2 marks]

Markscheme

- a. lives in fresh water so water enters cell (by osmosis);
- b. contractile vacuoles collect and expel water;
- c. homeostasis is keeping internal conditions within limit/constant / involves osmoregulation/regulating water content/potential;

2e. Apart from the ribosomes, explain the evidence for the endosymbiotic theory of the origin of eukaryotic cells.

[3 marks]

Markscheme

- a. mitochondria/chloroplasts show features in common with prokaryotes/similar size;
- b. multiply by binary fission/in same manner;
- c. have naked loop of DNA/circular DNA/own DNA;
- d. surrounded by a double membrane;

3a. Outline how the amphipathic properties of phospholipids play a role in membrane structure.

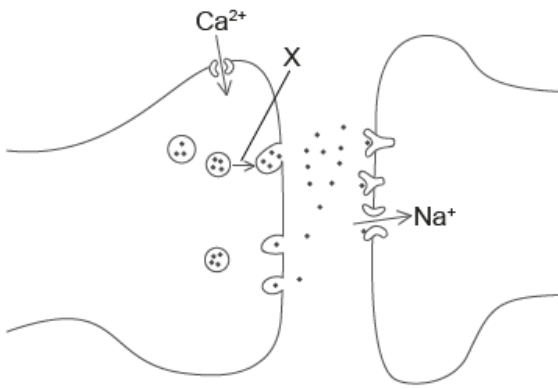
[2 marks]

Markscheme

- a. part hydrophobic/not attracted to water/non-polar **AND** part hydrophilic/attracted to water/polar; *Both needed.*
- b. bilayer formed (formed naturally by phospholipids in water);
- c. hydrophilic heads/parts face outwards **AND** hydrophobic tails/parts face inwards;

Do not allow water loving/hating in mpa or mpc.

The diagram shows part of two neurons.



[Source: © International Baccalaureate Organization 2020.]

3b. State the name of the structure shown.

[1 mark]

Markscheme

synapse/synaptic

3c. X indicates the movement of a structure in the neuron. Explain what events trigger this movement and what happens next.

[3 marks]

Markscheme

- depolarization of pre-synaptic membrane / action potential/nerve impulse arrives;
- uptake of calcium / calcium ions diffuse in / calcium channels open;
- structures containing neurotransmitter/vesicles move to/fuse with membrane;
- neurotransmitter/acetylcholine released by exocytosis into cleft/binds to postsynaptic membrane/receptors;

A short base sequence of mRNA and a table of the genetic code are shown below.

Sequence of mRNA

AUGAGCCGAAGGUAGCUG

Table of the genetic code

		2nd letter					
		U	C	A	G		
1st letter	U	Phe	Ser	Tyr	Cys	U	3rd letter
		Phe	Ser	Tyr	Cys	C	
		Leu	Ser	STOP	STOP	A	
		Leu	Ser	STOP	Trp	G	
	C	Leu	Pro	His	Arg	U	
		Leu	Pro	His	Arg	C	
		Leu	Pro	Gln	Arg	A	
		Leu	Pro	Gln	Arg	G	
	A	Ile	Thr	Asn	Ser	U	
		Ile	Thr	Asn	Ser	C	
		Ile	Thr	Lys	Arg	A	
		Met/START	Thr	Lys	Arg	G	
	G	Val	Ala	Asp	Gly	U	
		Val	Ala	Asp	Gly	C	
		Val	Ala	Glu	Gly	A	
		Val	Ala	Glu	Gly	G	

4a. Outline the function of codons.

[1 mark]

Markscheme

«three bases on mRNA» coding for one amino acid «in a polypeptide» ✓

4b. Determine the sequence of amino acids that could be translated from the

[1 mark]

sequence of mRNA.

Markscheme

met-ser-arg-arg

OR

start-ser-arg-arg

OR

met-ser-arg-arg-stop

OR

start-ser-arg-arg-stop ✓

Do not accept peptides containing an amino acid/leu for the last codon.

- 4c. Determine the DNA base sequence transcribed to form this sequence of mRNA. [1 mark]

Markscheme

TAC TCG GCT TCC ATC GAC ✓

- 4d. Suggest a hypothesis that accounts for the slightly different meaning of some codons in a very limited number of organisms. [1 mark]

Markscheme

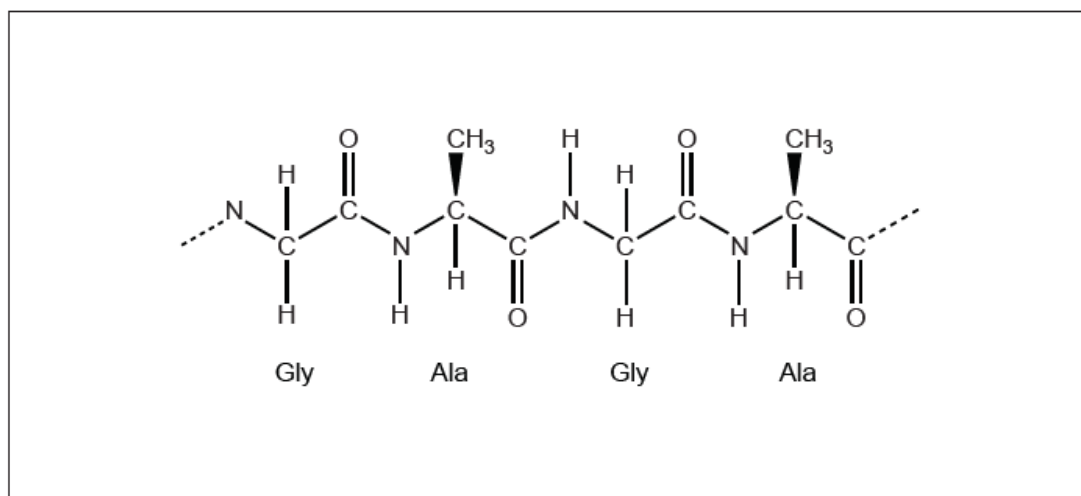
they occurred after the common origin of life *OWTTE*

OR

the genetic code is not «in fact» universal ✓

Look for alternatives.

The diagram shows a section of a polypeptide.

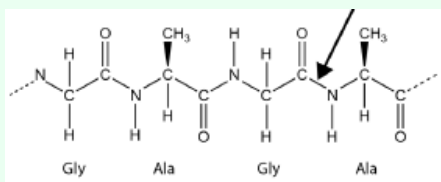


4e. Annotate the diagram to show a peptide bond between two amino acids. [1 mark]

Markscheme

any annotation between a C=O and the next NH ✓

e.g.



4f. State the type of reaction that removes water while linking amino acids together to form polypeptides. [1 mark]

Markscheme

condensation ✓

Do not accept anabolism alone.

4g. Outline the function of Rubisco and of spider silk in relation to their three-dimensional conformation.

[2 marks]

	Function	Conformation
Rubisco		
Spider silk		

Markscheme

	c	d
	Function	Conformation
Rubisco	enzyme/catalyst / carbon fixation / <i>OWTTE</i>	globular ✓
Spider silk	absorb stretch/structural / <i>OWTTE</i>	fibrous/longitudinal /linear/«mainly»β-pleated ✓

Award **[1]** per correct row or correct column.

Ebola virus disease (EVD) is the disease in humans and other primates that is caused by the Ebola virus. Fruit bats are the reservoir for the virus and are able to spread the disease without being affected. Humans can become infected by contact with fruit bats or with people infected by the virus, their body fluids or equipment used to treat them.

The table shows data for four African countries that were affected by the 2014–2015 Ebola outbreak.

Country	Total population / millions	Population density / inhabitants km ⁻²	Number of Ebola cases	Number of deaths	Death rate (as a percentage of Ebola cases) / %
Liberia	4.5	40	10672	4808	45.1
Sierra Leone	6.3	79	13250	3949	29.8
Guinea	12.3	53	3783	2512	66.4
Mali	16.3	14	8	6	75.0

[Source: adapted with permission, from Ebola Situation Report, figure 1, <http://apps.who.int/ebola/current-situation/ebolasituation-report-2-march-2016>, March 2016, and from Successful treatment of advanced Ebola virus infection with T-705 (favipiravir) in a small animal model, Oestereich, L. *et al*, 2014, under CC BY 3.0]

5a. Identify the country with the largest number of Ebola cases.

[1 mark]

Markscheme

Sierra Leone ✓

5b. Identify the country with the largest number of deaths.

[1 mark]

Markscheme

Liberia ✓

5c. Analysis of the data suggests that the number of deaths from EVD is not related to the total population size. State **one** piece of evidence from the data that would support this analysis. [1 mark]

Markscheme

country with biggest population/Mali has lowest number of deaths

OR

country with smallest population/Liberia has biggest number of deaths ✓

OWTTE

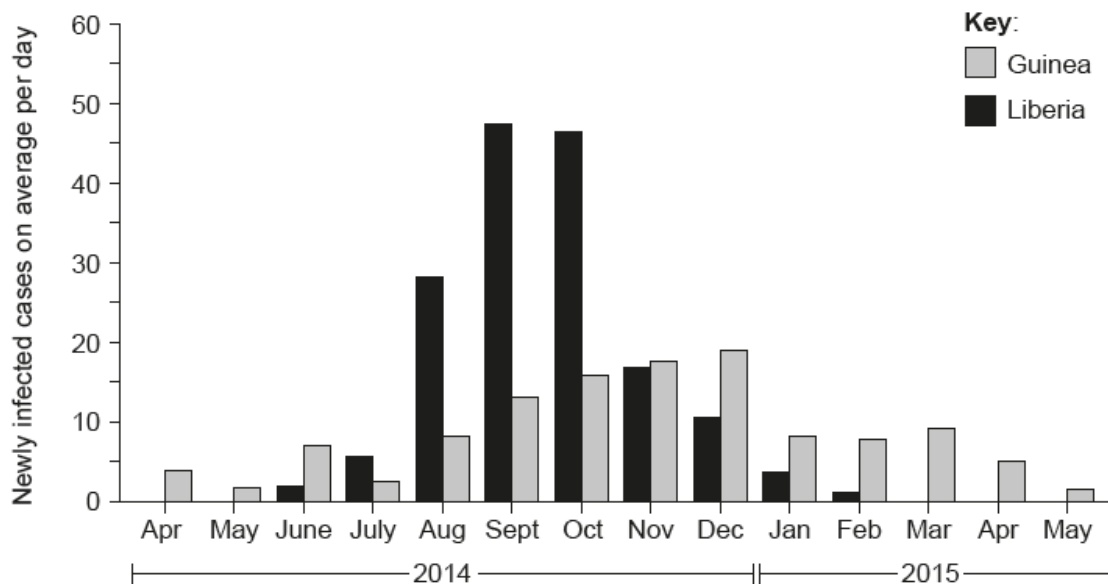
- 5d. Based on the mode of transmission of the Ebola virus, suggest a possible [1 mark] reason for the relationship between population density and the number of Ebola cases in these four countries.

Markscheme

greater density means more frequent contact with infected people/animals ✓

Need both greater density and frequency of contact

The graphs show the progress of the EVD epidemic in Guinea and Liberia for the period April 2014 to May 2015.



[Source: Ebola Situation Report 2 March 2016 and data from *International Journal of Infectious Diseases*, 38, Ligui Wang *et al*, Epidemiological features and trends of Ebola virus disease in West Africa, 52-53., Copyright 2015, with permission from Elsevier]

- 5e. Based on the data, compare and contrast the progress of the epidemic in [3 marks] Liberia and Guinea.

Markscheme

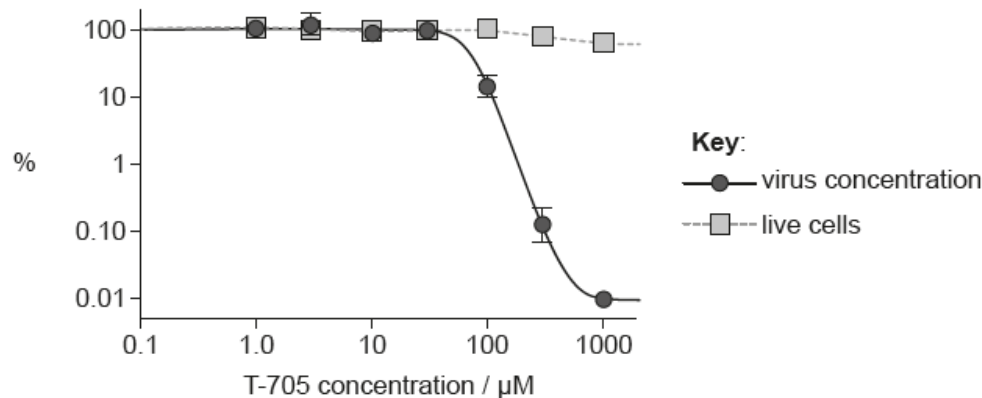
- a. overall pattern similar in both/both show a rise and a fall in the infections ✓
- b. both countries show an increase during 2014
OR
neither country shows an increase in 2015 ✓
- c. both show a sudden drop at one point
OR
sudden drop earlier «Oct-Nov 14» in Liberia than in Guinea «Dec 14, Jan 15» ✓
- d. Guinea fluctuates whereas Liberia rises to a peak and then decreases/no fluctuations ✓
- e. epidemic starts earlier «in April 14» in Guinea than in Liberia «in June 14» ✓
- f. epidemic peaks earlier «Sept 14» in Liberia than in Guinea «Dec 14» ✓
- g. epidemic lasts longer in Guinea than it does in Liberia
OR
last case recorded in Liberia Feb 15 while cases continue «at least» until May 15 in Guinea ✓
- h. numbers of cases in Guinea generally lower than in Liberia
OR
number of cases higher in Liberia than in Guinea ✓

- 5f. Suggest **two** possible reasons for the drop in the daily numbers of newly [2 marks] infected cases after October 2014 in Liberia.

Markscheme

- a. improved medical care/support/supplies/equipment/training of staff/hygiene/distribution of vaccine ✓
 - b. improved understanding of how to avoid infection «amongst public»/greater awareness in society/better education ✓
 - c. rise in number of deaths means fewer infectious individuals ✓
 - d. impact of disease control measures/control policies/quarantine/isolation ✓
 - e. drop in the number of fruit bats ✓
 - f. maybe seasonal changes/weather changes ✓
 - g. people may have left the area ✓
 - h. international aid arrives ✓
- OWTTE*

An antiviral drug, T-705, was tested in order to establish whether it has potential to treat EVD. The graph shows the data from an in vitro trial of T-705 on cells that had been infected with Ebola virus five days previously. Virus concentration and live cells are shown as percentage of the control.



[Source: Oestereich, Lisa & Rieger, Toni & Neumann, Melanie & Bernreuther, Christian & Lehmann, Maria & Krasemann, Susanne & Wurr, Stephanie & Emmerich, Petra & de Lamballerie, Xavier & Ölschläger, Stephan & Günther, Stephan. (2014). Evaluation of Antiviral Efficacy of Ribavirin, Arbidol, and T-705 (Favipiravir) in a Mouse Model for Crimean-Congo Hemorrhagic Fever. *PLoS neglected tropical diseases*. **8**. e2804. 10.1371/journal.pntd.0002804.]

- 5g. Based on these data, outline the evidence that T-705 has potential to be [2 marks] used as a treatment for EVD.

Markscheme

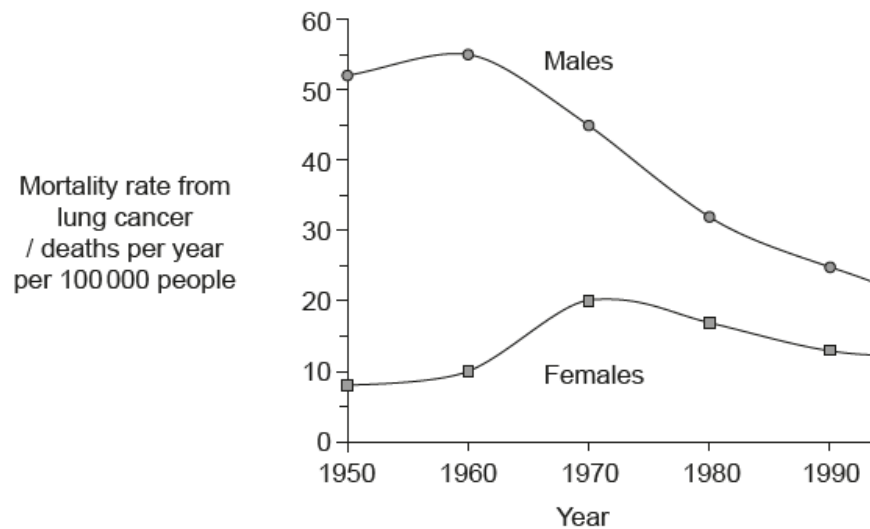
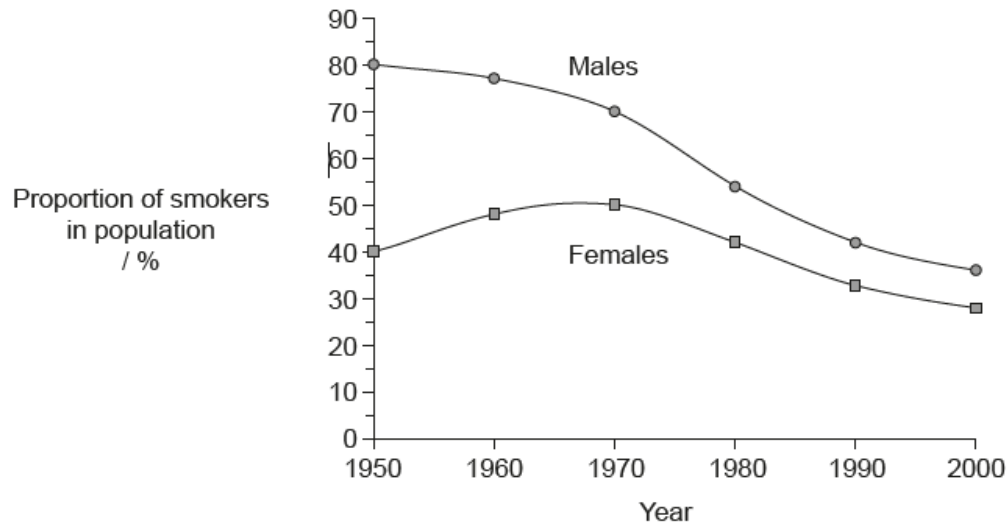
- a. cells not killed/few cells killed «even at high concentrations» ✓
- b. «T-705» effective/viruses reduced/viruses killed at 100 μM
OR
 «T-705» very effective/viruses much reduced/nearly all viruses killed at 1000 μM ✓
- c. virus concentration decreases as T-705 concentration increases ✓
- d. drug has «high» potential for treatment «at high enough concentration» ✓

- 5h. District administrators combatting the 2014 Ebola epidemic in West Africa [1 mark] were assisted by international organizations such as the World Health Organization, who provided data on the progress of the epidemic. Suggest **one** other way in which international organizations can assist with combatting an epidemic of Ebola.

Markscheme

raise awareness/provide information for local population/supply health workers/equipment/ train local staff/share expertise/provide financial support/provide vaccine/travel ban alert to affected country ✓

Trends in tobacco smoking and mortality due to lung cancer were measured in male and female smokers aged 35 to 59 living in the United Kingdom from 1950 to 2000. The first graph represents the proportion of smokers in the population. The second graph represents the mortality rate (deaths per year per 100 000 people) from lung cancer.



[Source: Figure 1 (adapted) from R Petro, *et al.*, (2000), *British Medical Journal*, **321**, number 7257, pages 323–329, <https://www.bmj.com/content/321/7257/323>. Reproduced with permission from the BMJ Publishing Group.]

6a. Calculate the change in the percentage of the male population that smoked from 1950 to 2000. [1 mark]

..... %

Markscheme

«—» 44 «%» ✓

Allow answers in the range of 43 «%» to 45 «%»

- 6b. Compare and contrast the trends in smoking behaviour between males [2 marks]
and females between 1950 and 2000.

Markscheme

Similarity:

a. both show an overall decrease

OR

both decrease after 1970 ✓

Difference:

b. proportion of male smokers is always higher than female

OR

men decrease more

OR

women first increase «till 1970» and then decrease whereas men decrease throughout

OR

males highest value in 1950 and females in 1970 ✓

*There should be **one** similarity and **one** difference*

- 6c. Evaluate the evidence provided by the data in the graphs for smoking as [3 marks]
a cause of lung cancer.

Markscheme

a. more smoking leads to more deaths

OR

there is a correlation between smoking and deaths from lung cancer ✓

b. «nevertheless» male mortality peaks in 1960 when declining numbers of smoking ✓

c. cancer takes time to develop causing delay between changes in smoking and cancer ✓

d. correlation does not prove causation ✓

e. the data shows deaths from lung cancer, not incidence ✓

The incidence of lung cancer in 75-year-old males was studied comparing current smokers, former smokers and non-smokers.

	Smoking status in males aged 75 years	Sample size	Incidence of lung cancer	Percentage incidence / %
	Current smokers	981	379	38.6
Former smokers	< 10 years since stopping smoking	485	146	30.1
	10–19 years since stopping smoking	398	92	23.1
	20–29 years since stopping smoking	252	31	12.3
	≥ 30 years since stopping smoking	256	16	6.3
	Lifelong non-smokers	403	3	0.7

[Source: adapted from R Peto, *et al.*, (2000), *British Medical Journal*, **321**, number 7257, pages 323–329]

6d. Describe the relationship between the incidence of lung cancer and stopping smoking.

[2 marks]

Markscheme

- a. highest incidence with continual smoking ✓
- b. negative correlation/incidence decreases with length of time not smoking ✓
- c. decrease «in incidence» occurs at less than 10 years since stopping smoking ✓
- d. after 30 years incidence is not much more than non-smokers ✓

6e. Explain evidence from the data in the table that could be used to persuade a smoker to give up smoking.

[2 marks]

Markscheme

- a. incidence of lung cancer decreases the earlier the smoker gives up smoking ✓
- b. continuing smoking increases incidence of lung cancer ✓
- c. after 30 years of not smoking the risk of lung cancer is low/similar to non-smokers ✓

Accept vice versa

6f. Among 75-year-old lifelong non-smokers the percentage incidence of lung cancer was 0.01 %. Suggest **one** possible cause of lung cancer in non-smokers. [1 mark]

Markscheme

passive smoking/second hand smoke/exposure to radon/asbestos/pollution/smog/genetic predisposition ✓

6g. State **two** respiratory diseases, other than lung cancer, caused by smoking.

[2 marks]

- | | |
|----|-------|
| 1. | |
| 2. | |

Markscheme

- a. emphysema ✓
- b. bronchitis ✓
- c. COPD ✓
- d. asthma ✓
- e. pneumonia ✓

Only mark first two

Boreal forests stretch across Canada, Russia and Scandinavia. This northern ecosystem accounts for 29 % of the world's forest areas. The long, cold winters favour tall evergreen trees with either needles or scale-like leaves. These trees are wind-pollinated and their seeds are not enclosed in a fruit. The photograph shows a typical boreal forest in winter.



[Source: TTphoto /Shutterstock]

7a. Identify the dominant plant phylum in the boreal forest.

[1 mark]

Markscheme

coniferophyta/conifer/coniferous/gymnosperms/pinophyta ✓

7b. In some areas there are gaps in the boreal forest where trees fail to grow and peat tends to accumulate. Suggest reasons for this.

[2 marks]

Markscheme

a. waterlogged soil/poor drainage

OR

acidic soil

OR

anaerobic conditions/soil ✓

b. organic matter is not «fully» decomposed «leading to peat formation»

OR

decomposers/saprotrophs less active/fewer in cold «temperatures» ✓

- 7c. An increase in global temperatures poses a critical threat to boreal forests. Explain the consequences of climate change to this northern ecosystem. [2 marks]

Markscheme

a. higher temperatures so more transpiration/droughts/dehydration/water shortage ✓

b. more forest fires ✓

c. more/new pests/diseases because of the changed conditions ✓

d. competition from trees/plants «that colonize/spread to boreal forests» ✓

e. trees/«named» organisms «of boreal forests» not adapted to warmer conditions

OR

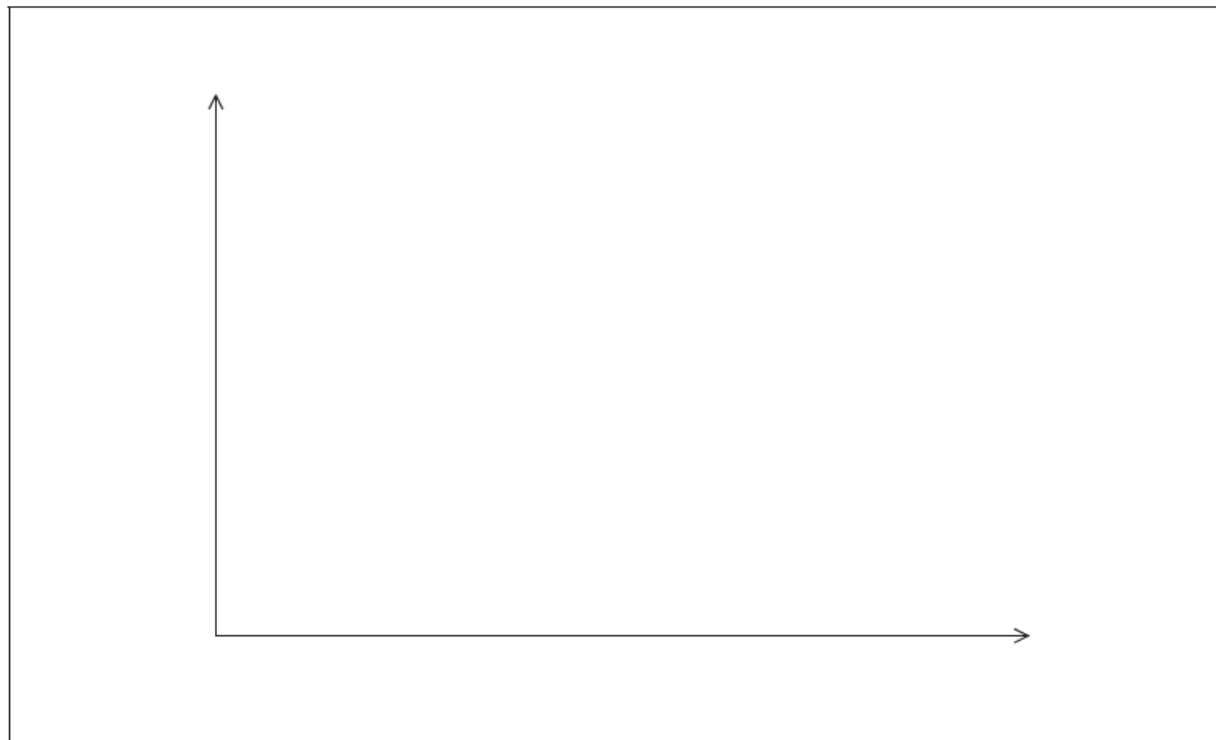
trees/«named» organisms migrate/extend range due to the warmer conditions ✓

f. trees die so there is loss of habitat for animals ✓

g. faster decomposition/nutrient cycling «so conditions in the ecosystem change» ✓

h. standing water/floods due to more snow/permafrost melting ✓

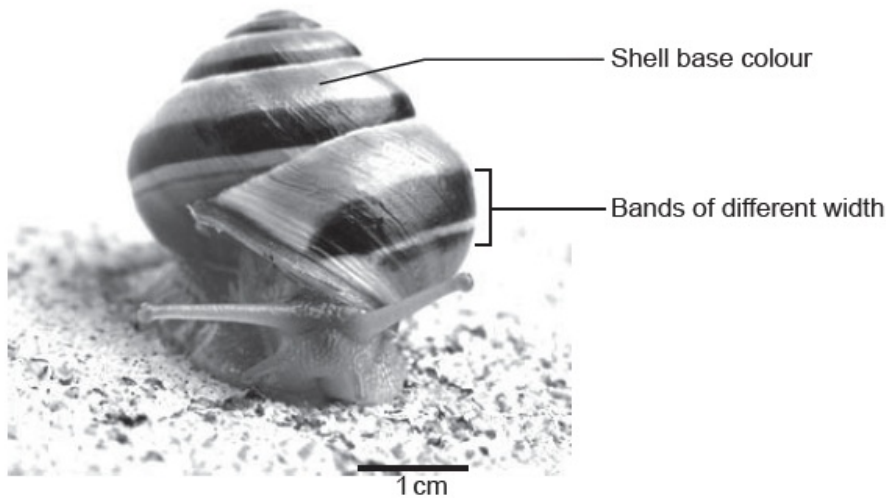
- 7d. The boreal forests are situated close to the north pole and even in summer the intensity of sunlight is lower than at the equator. Sketch a graph showing the effect of light on the rate of photosynthesis, labelling the axes. [2 marks]



Markscheme

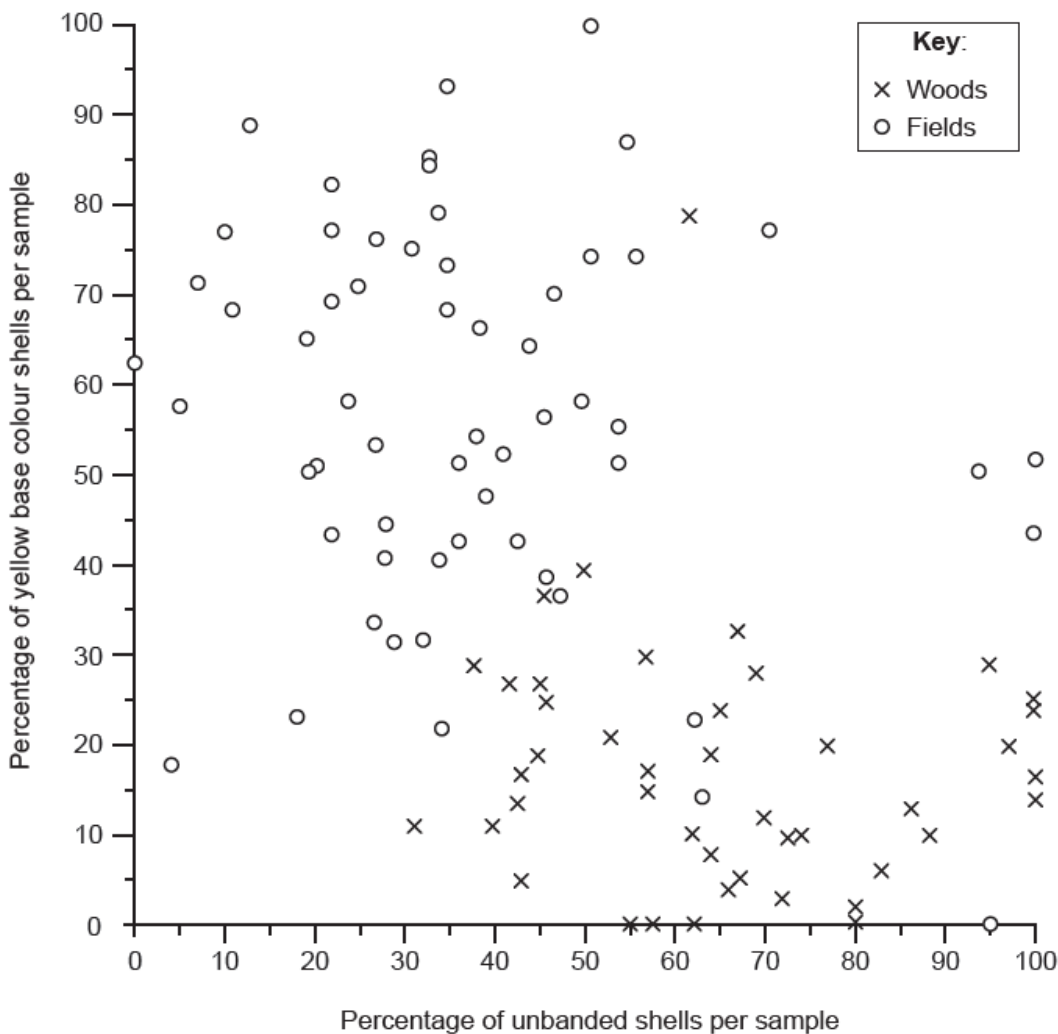
- a. x-axis labelled as light intensity/amount of light **AND** y-axis labelled as rate of photosynthesis/rate of oxygen release/rate of carbon dioxide uptake ✓
- b. curve starting at/slightly to the right of the x-axis origin and rising rapidly and then more slowly and plateauing but never dropping ✓

The land snail *Cepaea nemoralis* is very common in North America and in Europe. The base colour of its shell varies between brown, pink and yellow, and also in its intensity. Some shells are unbanded, but most show one to five bands of different width on top of the shell base colour.



[Source: © International Baccalaureate Organization 2018]

In the early 1950s, scientists studied the proportion of colours and banding of *C. nemoralis* in woods and fields near Oxford, UK, which differed in the type of plants and background colour. Each data point on the graph represents the percentage of yellow base colour shells and unbanded shells in a sample from either one type of wood or field, although other snail colours were present.



[Source: Adapted from Cain, A J and Sheppard, PM (1954), Natural Selection in *Cepaea*, *Genetics* 39 no. 1, p. 99.]

Determine the maximum percentage of yellow base colour shells found in woods.

8a.

[1 mark]

Markscheme

78 (%)

Accept answers ranging between 77 and 80 %.

- 8b. Suggest **either one** possible advantage **or one** disadvantage of having a banded shell, stating whether it is an advantage or disadvantage. [1 mark]

Markscheme

advantage: camouflage

OR

disadvantage: visibility

- 8c. Using the data in the graph, distinguish between the distribution of *C. nemoralis* shells in woods and fields. [2 marks]

Markscheme

a. more yellow in fields (than in woods) / vice versa

b. more unbanded in woods (than in fields) / vice versa

c. more overlap within banding than within yellow colour

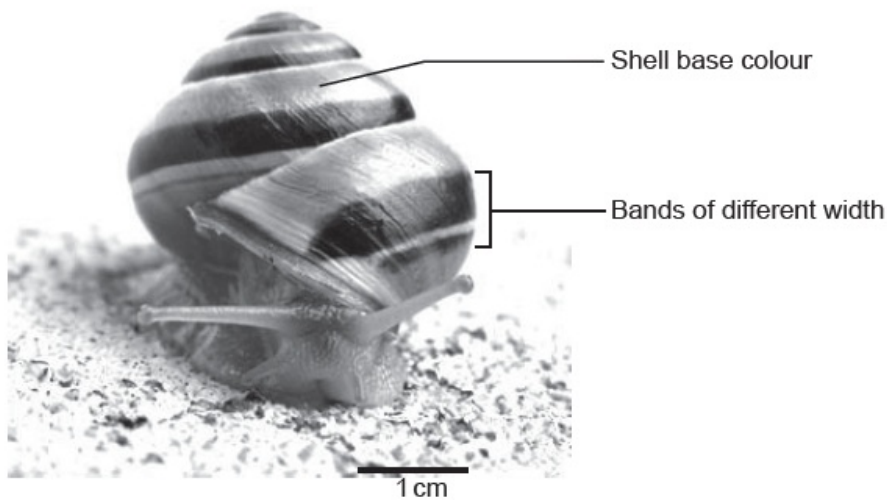
OR

yellow colour range greater than banding range

d. very little overlap between fields and woods / some outliers

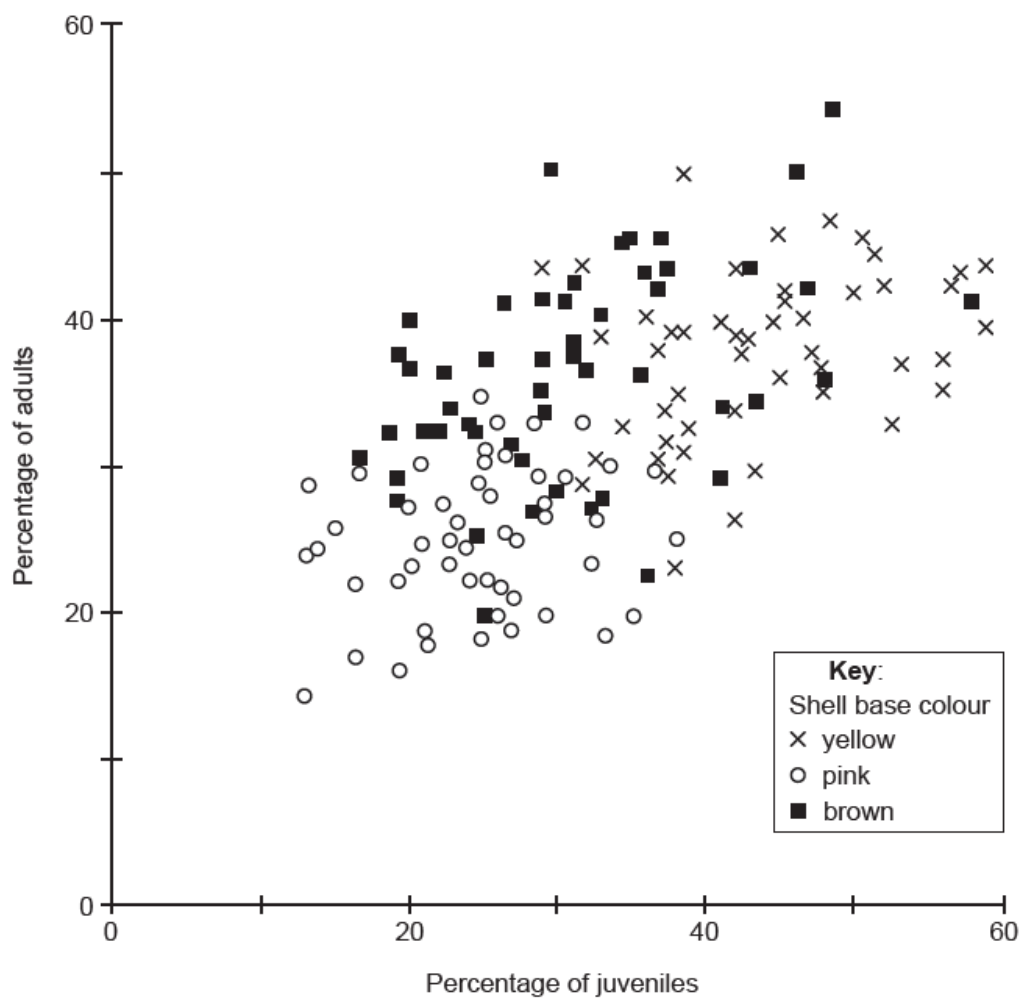
Do not accept answers with only numerical data.

The land snail *Cepaea nemoralis* is very common in North America and in Europe. The base colour of its shell varies between brown, pink and yellow, and also in its intensity. Some shells are unbanded, but most show one to five bands of different width on top of the shell base colour.



[Source: © International Baccalaureate Organization 2018]

The population of *C. nemoralis* has been studied for many years in open fields in a similar area. In the graph, each data point represents the percentage of adults of a given base colour plotted against the percentage of juveniles of the same base colour collected each year.



[Source: Adapted from Cain, A J, *et al.*, Population size and morph frequency in a long-term study of *Cepaea nemoralis* (1990), *Proceedings of the Royal Society B*, 240, page 239, DOI: 10.1098/rspb.1990.0036, <http://rspb.royalsocietypublishing.org/content/240/1298/231>; permission conveyed through Copyright Clearance Center, Inc.]

- 8d. Deduce from the data in the graph which shell base colours are on average most frequent and least frequent among adult snails. [2 marks]

Most frequent:

Least frequent:

Markscheme

- a. brown most frequent
- b. pink least frequent

- 8e. Discuss whether there is evidence in the data that colour plays a role in the survival of the snails. [3 marks]

Markscheme

Evidence that colour plays a role:

- a. few yellow adults (relative to juveniles) means that yellow juveniles do not survive into adulthood
- b. frequent brown adults (relative to juveniles) means brown juveniles survive well into adulthood

Evidence that colour does not play a role:

- c. similar numbers of adult and juvenile pink individuals means pink colour does not play a role
- d. all three colours show wide variation/considerable overlap therefore evidence is not strong

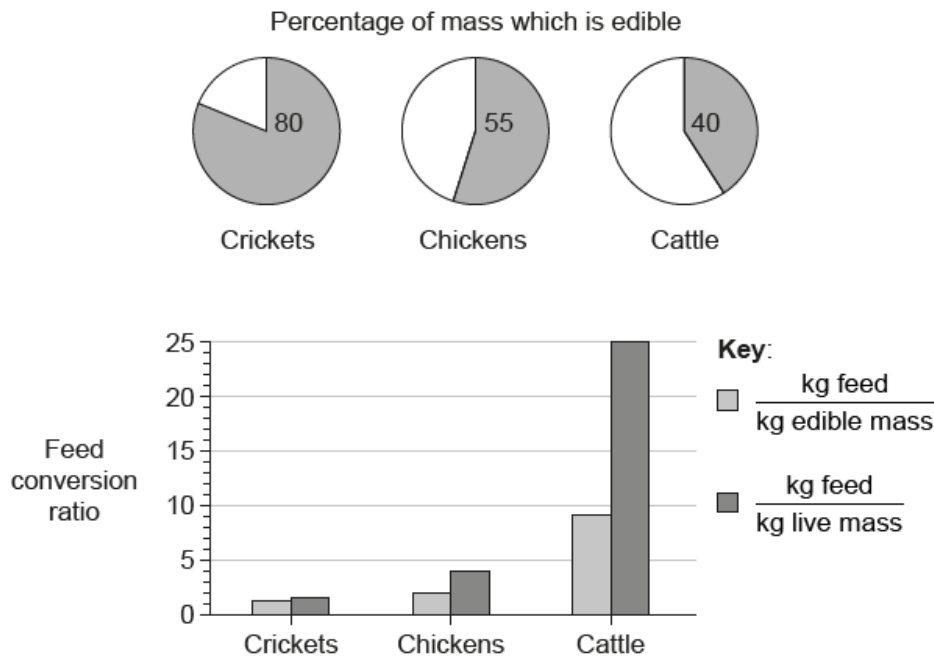
- 8f. Using the theory of natural selection, explain the differences shown in the graph between the three colours of snail. [3 marks]

Markscheme

- natural selection requires that snails become adults/live to reproduce their variations/undergo differential predation **OWTTE**
- higher adult frequency of brown shows selection
- but results for pink do not show selection
- more brown juveniles survive into adulthood showing that brown is selected for/*vice versa* against yellow
- not enough alone to support theory of natural selection but may be added evidence to similar observations in other organisms **OWTTE**

Edible insects have been a part of traditional human diets in many countries. For example, crickets are insects commonly eaten in Asia and Africa. Many studies have looked at the prospects of raising insects on a commercial scale for direct human consumption as food or indirectly by feeding insects to farm animals.

One factor to consider is which organisms are most efficient at converting the feed they eat into animal protein that can be consumed. A study compared the percentage of mass that was edible in two common farm animals and in crickets.



[Source: Food and Agriculture Organization of the United Nations. 2013. van Huis, *et al.*, *Forestry Paper* 171, page 60. <http://www.fao.org/docrep/018/i3253e/i3253e00.htm>. Reproduced with permission.]

9a. Identify which organism has the highest percentage of edible mass.

[1 mark]

Markscheme

cricket

- 9b. Calculate how much more feed is required by cattle than chickens to produce 1 kg of live mass. [1 mark]

Markscheme

$25 - 4 = 21\text{kg}$ «more required for cattle»

Must state unit kg.

- 9c. Identify which organism requires the least feed to produce 1 kg of edible mass. [1 mark]

Markscheme

cricket

The yellow mealworm (*Tenebrio molitor*) is native to temperate regions of the world and has been studied as a possible means of producing food in countries with that type of climate. The amino acid content of yellow mealworms and cattle was analysed. The table shows the results for seven amino acids that are required in the human diet.

Amino acid	Yellow mealworms / g kg ⁻¹ dry matter	Cattle / g kg ⁻¹ dry matter
Isoleucine	25	16
Leucine	52	42
Lysine	27	45
Methionine	6	16
Phenylalanine	17	24
Threonine	20	25
Valine	29	20

[Source: Food and Agriculture Organization of the United Nations. 2013. van Huis, *et al.*, *Forestry Paper* 171, page 60. <http://www.fao.org/docrep/018/i3253e/i3253e00.htm>. Reproduced with permission.]

- 9d. Distinguish between the amino acid contents of yellow mealworms and cattle. [1 mark]

Markscheme

- a. mealworms have more isoleucine/leucine/valine than cattle
- b. cattle have more lysine/methionine/phenylalanine/threonine
- c. the total proportion of these amino acids is «slightly» greater in cattle (188 to 176)

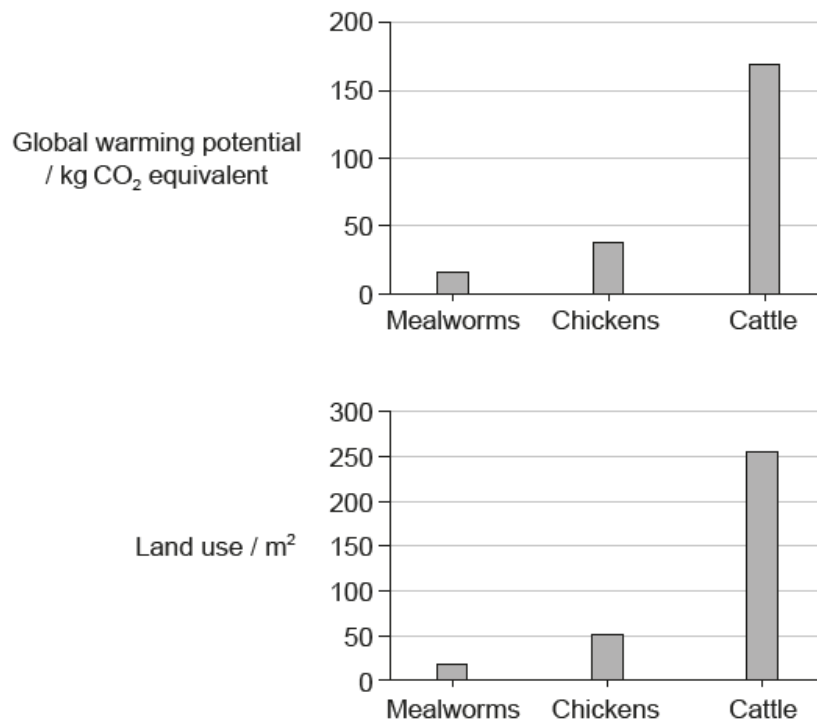
- 9e. Predict, with a reason, whether the amino acid composition of yellow mealworms **or** cattle is more suitable for a human diet. [1 mark]

Markscheme

- a. cattle as they are more closely related to humans
- b. cattle as they are more likely to have proteins with a similar amino acid composition to humans *OWTTE*.
- c. cattle as they contain a «slightly» higher proportion of «essential» amino acids required in human diet (188 to 176)

OWTTE

The environmental impact of producing protein from mealworms was compared with the impact of producing traditional protein sources. The graphs show the greenhouse gas production (global warming potential) and land use due to the production of 1 kg of protein from mealworms, chickens and cattle.



[Source: Food and Agriculture Organization of the United Nations. 2013. van Huis, *et al.*, *Forestry Paper* 171, page 60. <http://www.fao.org/docrep/018/i3253e/i3253e00.htm>. Reproduced with permission.]

- 9f. Outline the differences between the environmental impact of using mealworms and traditional farm livestock for protein production. [2 marks]

Markscheme

- a. mealworms contribute much less to global warming than other traditional farm livestock for protein production
- b. mealworms require less land use than other traditional farm livestock for protein production

Accept converse or OWTTE.

- 9g. Birds and mammals maintain constant body temperature despite considerable losses of body heat to the environment. In insects such as mealworms, body temperature is variable and is often the same as the temperature of the environment or only slightly above it. Analyse the data in the bar charts, using this information. [2 marks]

Markscheme

- a. cell respiration required to generate heat (lost to environment) to maintain body temperature
- b. birds/chickens and mammals/cattle carry out cell respiration at higher rate than insects
- c. «chickens/cattle therefore» generate more CO₂ per kg protein produced
- d. «chickens/cattle» need more food/land area to produce body mass
- e. feed conversion ratios are lower in mealworms/insects/cold blooded animals as they do not need to maintain a constant body temperature (accept converse)

- 9h. Using all the relevant data in this question, discuss the use of insects as *[3 marks]* a major food source for humans.

Markscheme

- a. insects/crickets have the highest edible percentage
- b. insects have the lowest feed conversion ratio/produce the most edible mass per kg of food they eat
- c. insects supply amino acids required in the human diet
- d. insects cause less global warming/use less land area per kg of protein produced
- e. in western countries, there is a disgust factor/cultural factors about eating insects which would need to be overcome before they could be used as a significant food source
- f. insects may supply less proportions/content of amino acids required in human diets

Chronic Obstructive Pulmonary Disease (COPD) is characterized by progressive airflow limitation. Classification of COPD as mild, moderate or severe is based on measurement of Forced Expiratory Volume (FEV), which is the maximum volume of air that can be exhaled in one second.

The table shows the numbers of individuals in each COPD class and their mean FEV for a Swedish study of 349 people.

	Normal	Mild COPD	Moderate COPD	Severe COPD
Never smoked	96	12	6	0
Ex-smokers	95	29	19	3
Regular smokers	32	18	17	2
Occasional smokers	11	8	1	0
FEV / litres	2.9 ± 0.68	2.6 ± 0.60	2.0 ± 0.46	1.3 ± 0.24

[Source: Reproduced with permission of the © ERS 2012. European Respiratory Journal Apr 2012, 39 (4) 839-845; DOI: 10.1183/09031936.00064611]

10a. State the level of COPD that has the lowest FEV.

[1 mark]

Markscheme

Severe

10b. Explain how a low FEV can be used to indicate emphysema.

[2 marks]

Markscheme

- a. low FEV indicates inability to force out air/adequate volume of air
OWTTE
- b. airflow limitation is the reason for inability to force out air/shortness of breath
- c. inability to force out air/shortness of breath indicates emphysema
- d. emphysema causes/involves breakdown of alveoli walls «so less elastin»

The idea that there are fewer alveoli to “push”

[Max 2 Marks]

The elasticity and resilience of the lungs are mainly provided by the protein elastin. Degradation of elastin produces peptides called desmosines.

Desmosines in urine or blood plasma have been proposed as biomarkers of lung degradation. The relationship between urine desmosines, plasma desmosines and COPD severity in patients was assessed.

Disease severity	Urine desmosines / nmol mmol ⁻¹ of creatinine	Plasma desmosines / nmol L ⁻¹
	Median	Median
No disease	2.5 (1.3–5.7)	0.46 (0.16–1.4)
Mild COPD	2.6 (1.5–5.0)	0.49 (0.30–1.3)
Moderate COPD	2.9 (1.7–6.0)	0.55 (0.33–1.2)
Severe COPD	2.8 (2.0–4.1)	0.64 (0.47–1.1)

[Source: Reproduced with permission of the © ERS 2012. European Respiratory Journal Apr 2012, 39 (4) 839–845; DOI: 10.1183/09031936.00064611]

- 10c. State the disease severity group that has the highest range of plasma desmosines. [1 mark]

Markscheme

No disease

- 10d. Evaluate which of the two biomarkers would be the most useful indicator of COPD severity. [2 marks]

Markscheme

- a. plasma desmosines
- b. neither is very good due to large overlaps of ranges
OWTTE
OR
the range of data for each category is less for plasma desmosines
OR
data are more reliable
- c. the level of plasma desmosines increases with disease severity
- d. easier/less invasive to take urine sample rather than a plasma sample

[Max 2 Marks]

10e. Elastin is also an important component of other tissues such as arteries [2 marks] and ligaments. Evaluate how these other sources of elastin could affect the interpretation of the biomarker as an indicator of COPD.

Markscheme

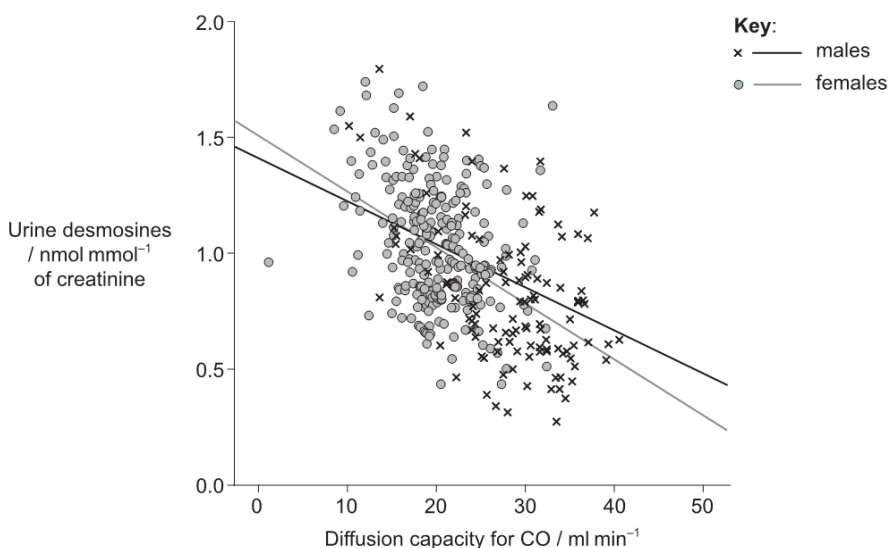
- a. degradation of elastin from other tissues may have contributed to the results
- b. there is no guarantee that the concentrations of desmosines measured came from the lungs

OR

- difficult to assess how much lung elastin constitutes the total
- c. overlapping ranges makes interpretation difficult

[Max 2 Marks]

The graph shows the relationship between the diffusion capacity of the lungs for carbon monoxide (CO) and urine desmosines.



[Source: Reproduced with permission of the © ERS 2012. European Respiratory Journal Apr 2012, 39 (4) 839–845; DOI: 10.1183/09031936.00064611]

10f. State the relationship between diffusion capacity and urine desmosines. [1 mark]

Markscheme

inversely correlated

OR

negative correlation

OR

the higher the «urine» desmosine concentration, the lower the diffusion «rate»

10g. Other studies on pulmonary diseases have shown a wide variety of results. Apart from age, sex and severity of COPD, list **two** other factors that may explain the inconsistent results between studies. [2 marks]

Markscheme

a. «small» sample size

OR

only studied in one country

b. methods used

c. environment/pollution/workplace exposure

d. race/genetic factors

e. health status/fitness/BMI of volunteers

[Max 2 Marks]

10h. Discuss whether measurements of desmosine concentration would be useful for monitoring changes in the health of a patient. [3 marks]

Markscheme

a. positive correlation with COPD severity «as seen in the table»

OR

negative correlation with «CO» diffusion capacity «as seen in the graph»

b. not directly proportional/other factors affect it

c. «but» if other factors stay the same in a patient it could be an effective indicator of change

d. because the ranges are high, only change in an individual is useful

e. the measurements may be more useful for one gender than the other as differences seen in the graph

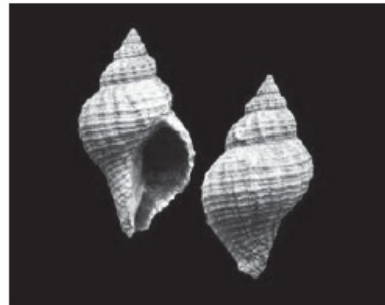
[Max 3 Marks]

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.

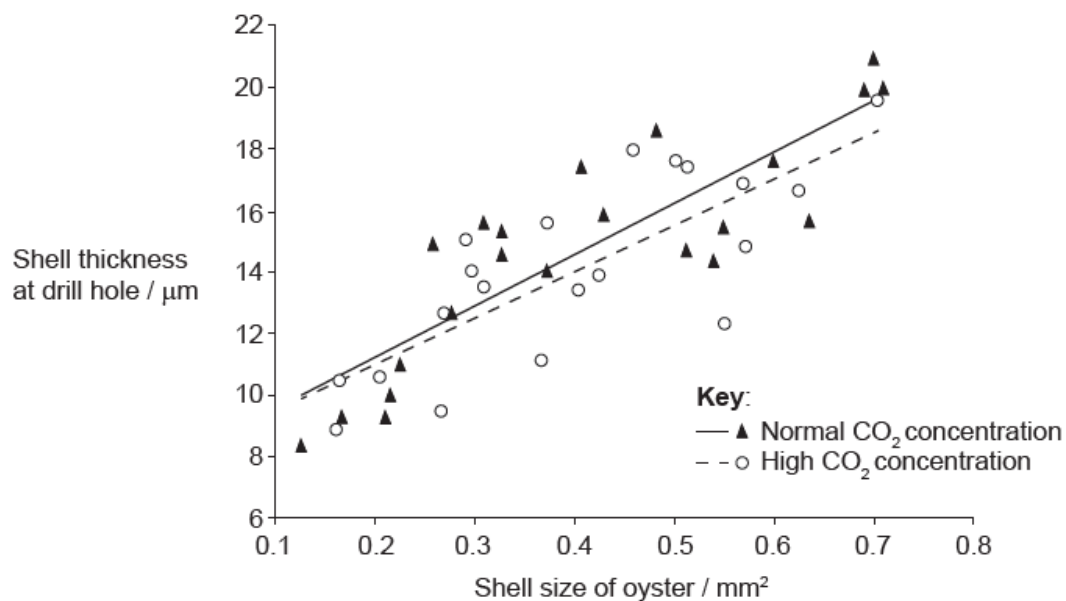
The first step was to raise oysters in two different mesocosms. One had seawater at a normal concentration of CO₂ and the other had sea water with a high concentration of CO₂. Gastropods were raised in two further mesocosms with normal and high CO₂ concentrations respectively.

11a. Outline how acidified sea water could affect the shells of the oyster. [1 mark]

Markscheme

Shells might dissolve/deteriorate / become smaller/thinner/weaker / OWTTE
OR
shell formation reduced / more difficult

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.]

11b. Outline the trends shown in the data in the graph.

[2 marks]

Markscheme

a. positive correlation between shell thickness and shell size

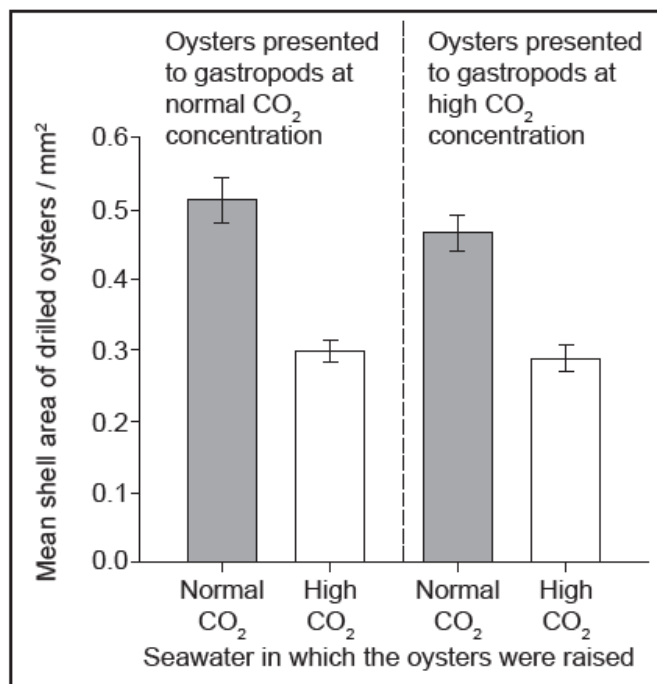
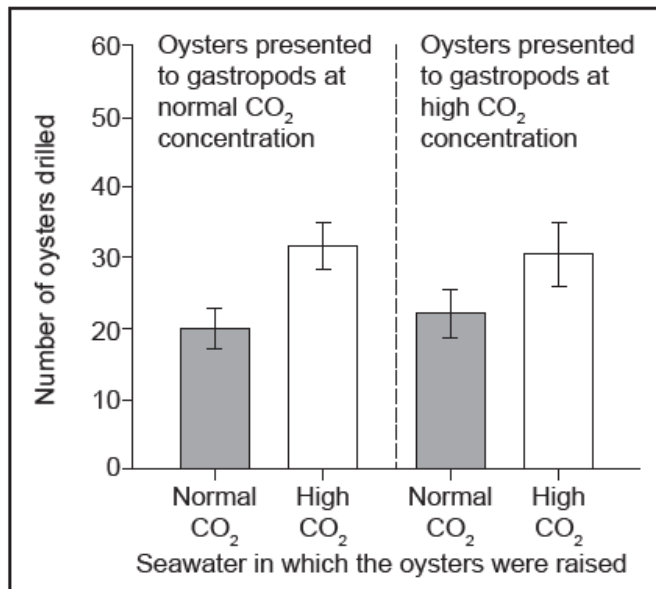
OR

as shell thickness increases, shell size «also» increases

b. (positive correlation) occurs at two different CO_2 concentrations / both high and normal concentrations

c. trend for thickness is «slightly» lower with high CO_2

Equal numbers of oysters raised in seawater with a normal CO₂ concentration and in seawater with a high CO₂ concentration were then presented together to the gastropod predators in seawater with a normal CO₂ concentration. The same numbers of oysters from the two groups were also presented together to the gastropods in seawater with a high CO₂ 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]

- 11c. Estimate how much smaller drilled oysters raised in seawater at a high CO₂ concentration were than drilled oysters raised in seawater at a normal CO₂ concentration. [1 mark]

Markscheme

«approximately» 0.2 mm²

OR

«approximately» 40 % «smaller»

unit required

- 11d. Deduce from the data in the bar charts which factors were and were not [2 marks] correlated significantly with the number of oysters drilled by the gastropods.

Markscheme

- a. significant factor: concentration of CO₂ in which oysters were raised
- b. insignificant factor: concentration of CO₂ at which oysters were presented to gastropods

- 11e. Suggest reasons for the differences in the numbers of oysters drilled, as [2 marks] shown in the bar charts.

Markscheme

- a. (because) shells are thinner/smaller when the oyster is raised in high CO₂/lower pH
- OR**
- «because» lower pH/higher acidity prevents/reduces deposition of calcium carbonate
- b. gastropods target smaller/thinner-shelled oysters more
- c. gastropods can eat/drill thin-shelled/smaller oysters at a faster rate (and move onto another)
- d. eating smaller oysters «from high CO₂ environments» means given population of gastropods require more oysters for same food intake

- 11f. The radula in a gastropod is hard but not made of calcium carbonate. [2 marks]
Outline how this statement is supported by the drilling success of the gastropods in seawater with normal or high CO₂ concentrations.

Markscheme

a. data shows that similar numbers are drilled regardless of conditions

b. since radulas are not affected by acidification

OR

radulas not made of calcium carbonate so (remain) strong/successful at drilling

11g. Using all the data, evaluate how CO₂ concentrations affect the development of oysters and their predation by gastropods.

[2 marks]

Markscheme

a. the data/trend lines indicate that a higher CO₂ concentration diminishes the shell thickness, making gastropod predation more successful

OR

the bar graphs suggest that oysters raised in a higher CO₂ concentration are smaller, making gastropod predation more successful

b. CO₂ concentrations «during feeding» do not change the occurrence of drilling/predation «by gastropods»

c. «limitation» no information about how exaggerated the CO₂ concentrations were

OR

«limitation» no information about numbers of gastropods used «in each setting»