Unit 2

The Variety of Living Organisms

How Science Works

Practice Exam Questions

1

Taxol is a drug used to treat cancer. Research scientists investigated the effect of injecting taxol on the growth of tumours in mice. Some of the results are shown in **Figure 3**.

Figure 3

Number of days of treatment	Mean volume of tumour / mm^3	
	Control group	Group injected with taxol in saline
1	1	1
10	7	2
20	21	11
30	43	20
40	114	48
50	372	87

(a) Suggest how the scientists should have treated the control group.

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(2 marks)

(b) Suggest and explain **two** factors which should be considered when deciding the number of mice to be used in this investigation.

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(2 marks)

(c) The scientists measured the volume of the tumours. Explain the advantage of using volume rather than length to measure the growth of tumours.

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(1 mark)

(d) The scientists concluded that taxol was effective in reducing the growth rate of the tumours over the 50 days of treatment. Use suitable calculations to support this conclusion.

(2 marks)

(e) In cells, taxol disrupts spindle activity. Use this information to explain the results in the group that has been treated with taxol.

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(3 marks)

(f) The research scientists then investigated the effect of a drug called OGF on the growth of tumours in mice. OGF and taxol were injected into different mice as separate treatments or as a combined treatment. **Figure 4** and **Figure 5** show the results from this second investigation.

Figure 4

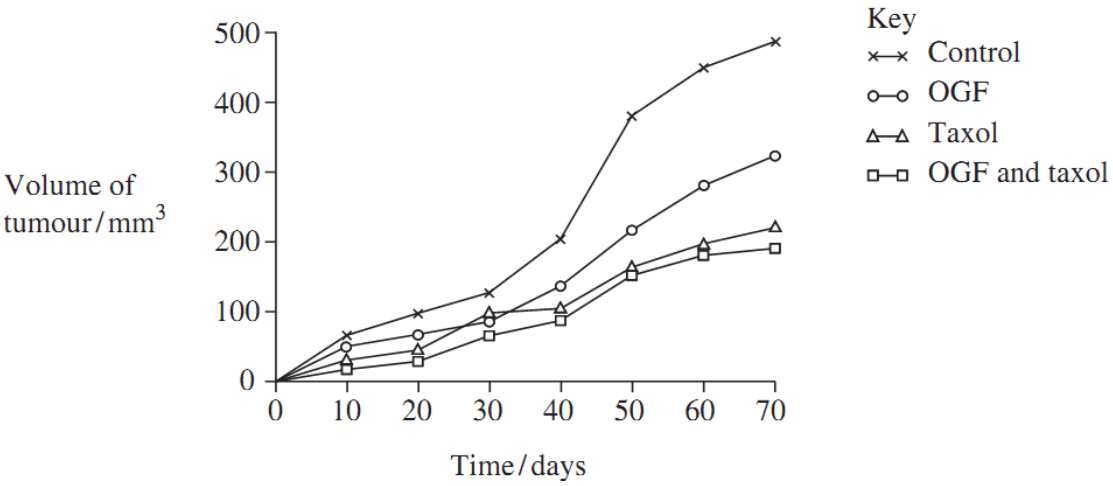

Figure 5

Treatment	**Mean volume of tumour following 70 days treatment / mm^3 (± standard deviation)**
OGF	322 (± 28.3)
Taxol	207 (± 22.5)
OGF and taxol	190 (± 25.7)
Control	488 (± 32.4)

(f) (i) What information does standard deviation give about the volume of the tumours in this investigation?

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(1 mark)

(f) (ii) Use **Figure 4** and **Figure 5** to evaluate the effectiveness of the two drugs when they are used separately and as a combined treatment.

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(4 marks)

2

The diagram shows a seahorse. A seahorse is a fish.

Scientists investigated the effect of total body length on the selection of a mate in one Australian species of seahorse. The scientists used head length as a measure of total body length.

(a) (i) Use the diagram to suggest why the scientists measured head length rather than total body length.

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(1 mark)

(ii) Suggest why the scientists were able to use head length as a measure of total body length.

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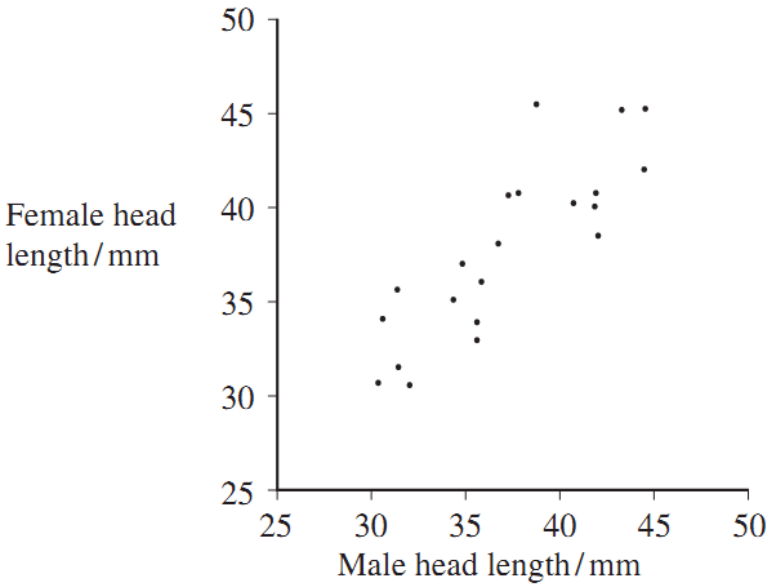
(1 mark)

The scientists measured the head lengths of the female and male of a number of pairs. The results are shown in the graph.



(b) The scientists concluded that total body length affects the selection of a mate. Explain how the results support this conclusion.

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(1 mark)

(c) A female with a head length of 50 mm selected a mate. Explain how you could use the graph to predict the total head length of the mate selected.

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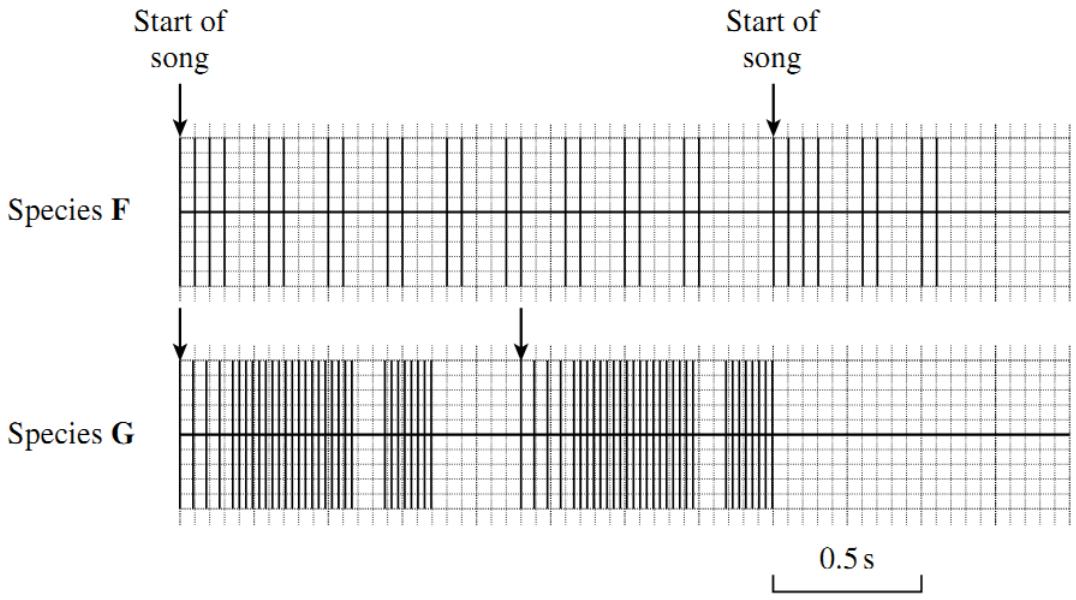
(2 marks)

3

Mole crickets are insects that live underground. At night, a male cricket produces a courtship song. A female cricket is attracted by this song and mates with the male.

Scientists investigated courtship in two species of mole cricket. They found that female mole crickets were only attracted to the song produced by a male of the same species.

The charts show recordings of typical songs of two species of mole cricket.



(a) The song of species **F** is repeated at regular intervals. The arrows on the chart show the beginning of each song.

(a) (i) Calculate the time taken for one complete song.

Answer.....seconds *(1 mark)*

(a) (ii) Calculate the rate of singing in songs per minute.

Answer.....songs per minute *(1 mark)*

4

(a) In the USA, members of the public found many frogs with deformed legs. Scientists investigated this. They collected samples of the frogs. They wanted to get reliable data. Give **one** feature of the sample, other than a large sample size, that would help to make sure that their data were reliable.

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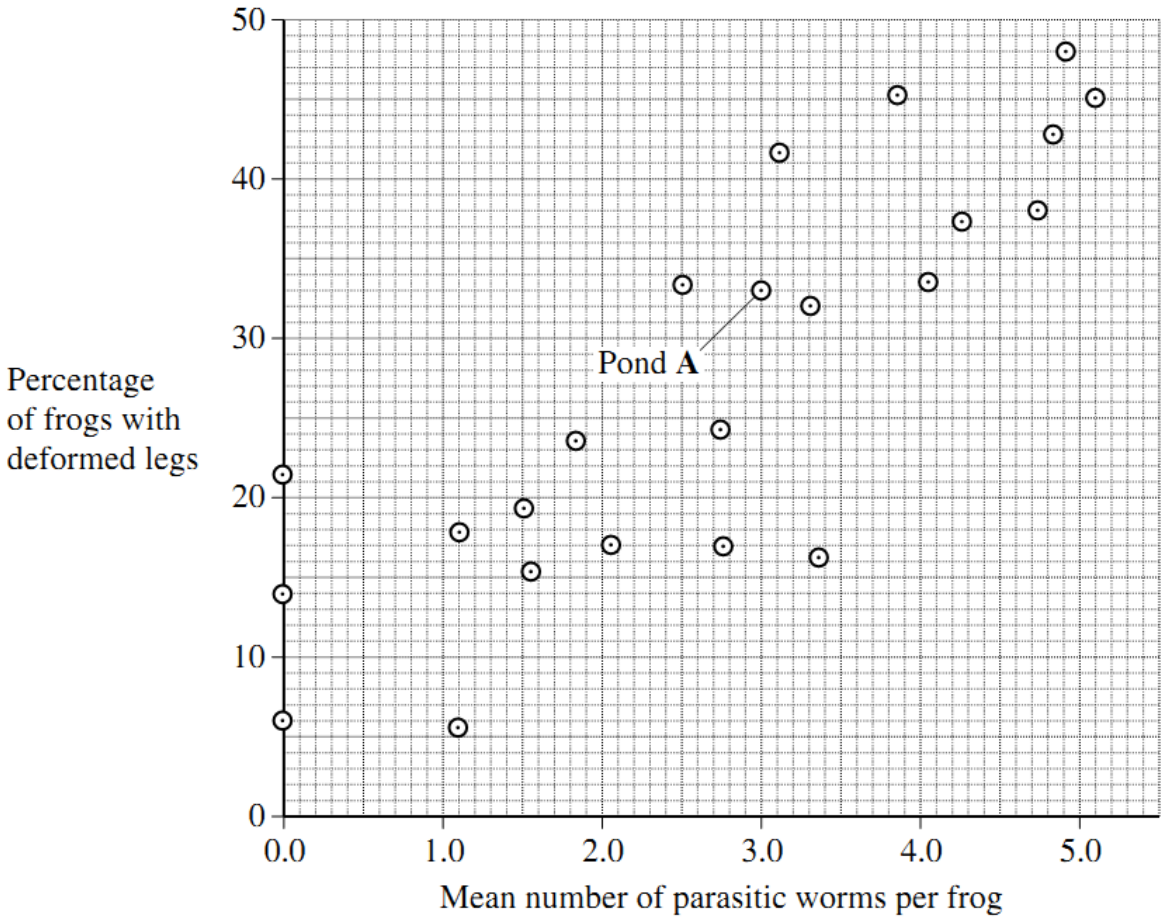
(1 mark)

The team of scientists then investigated frogs in ponds. The team measured many different factors and then analysed their results. The graph shows the relationship between the percentage of frogs with deformed legs and the mean number of parasitic worms found in the frogs.



(b) The scientists collected a sample of three frogs from pond **A**. What was the total number of parastic worms found in these three frogs?

(1 mark)

(c) One scientist suggested that the parasites caused the deformed legs found in frogs. Does the graph support this suggestion? Explain your answer.

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(4 marks)

(d) The scientists wrote a paper. In their discussion they wrote that they found very few ponds that were free from human influence. The few that they did find were only in mountainous areas.

The scientists could not draw any reliable conclusions about whether human influence contributed to the frogs' deformed legs. Explain why each of the following meant that they could not draw reliable conclusions.

(d) (i) There were very few ponds free from human influence.

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(1 mark)

(d) (ii) The ponds free from human influence were found only in mountainous areas.

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(2 marks)

In a second investigation, another research team investigated deformed legs in frogs in a different way.

- They chose six ponds, all of which contained parasitic worms. Three of the ponds were close to fields and received agricultural run-off from these fields. The other three ponds did not receive agricultural run-off.
- They built two cages in each of the six ponds. One cage in each pond allowed parasitic worms to enter and one cage did not.
- They put frogs that were not infected with parasitic worms into all twelve cages.

The table shows the results of this second investigation.

	Percentage of frogs with deformed limbs					
	Ponds with agricultural run-off			Ponds with no agricultural run-off		
Pond number	1	2	3	4	5	6
Cage with mean mesh diameter of 500 µm	22	27	24	3	4	7
Cage with mean mesh diameter of 75 µm	0	0	0	0	0	0

(e) One of the boxes in the table has been shaded. Describe the information given in the shaded box.

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(2 marks)

(f) What conclusions can you draw from the data in the table about the factors causing deformed leg in frogs? Explain your answer.

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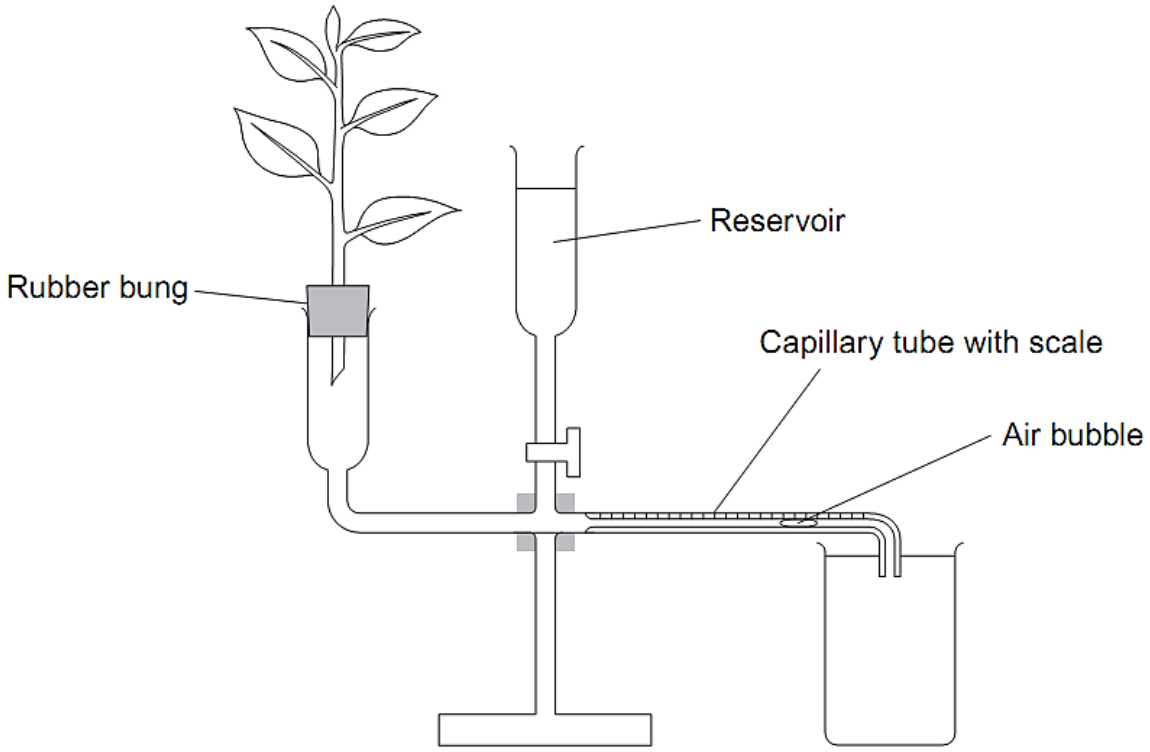
(4 marks)

5

A student investigated the rate of transpiration from a leafy shoot. She used a potometer to measure the rate of water uptake by the shoot. The diagram shows the potometer used by the student.



(a) Give **one** environmental factor that the student should have kept constant during this investigation.

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(1 mark)

(b) The student cut the shoot and put it into the potometer under water. Explain why.

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(1 mark)

(c) The student wanted to calculate the rate of water uptake by the shoot in cm^3 per minute. What measurements did she need to make?

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(2 marks)

(d) The student assumed that water uptake was equivalent to the rate of transpiration. Give **two** reasons why this might **not** be a valid assumption.

1. .....

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(2 marks)

(e) The student measured the rate of water uptake three times.

(e) (i) Suggest how the reservoir allows repeat measurements to be made.

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(1 mark)

(e) (ii) Suggest why she made repeat measurements.

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(1 mark)

6

Scientists tested a new group of drugs for their effectiveness against four species of bacteria. The scientists used MICs to compare the effectiveness of four drugs. The results are shown in the table.

Drug	Minimum inhibitory concentration / $\mu g\,cm^{-3}$			
	Escherichia coli	*Staphylococcus aureus*	*Enterococcus faecalis*	*Pseudomonas aeruginosa*
P	0.39	0.049	0.049	3.13
Q	1.54	0.049	0.195	3.13
R	0.39	0.049	0.195	1.56
S	1.56	0.098	0.390	12.50

(a)

Which of the four drugs is

(i) most effective against *Enterococcus faecalis*?

☐

(1 mark)

(ii) least effective against all the species of bacteria used?

☐

(1 mark)

(b)

The effectiveness of these drugs was tested in double-blind trials using human volunteers. In a double-blind trial neither the volunteers nor the scientists know which treatment a particular volunteer is receiving.

(i) Suggest **two** ways in which a double-blind trial improves reliability.

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2 .....

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(2 marks)

(ii) Suggest **two** factors the scientists should have considered when selecting adult volunteers for this trial.

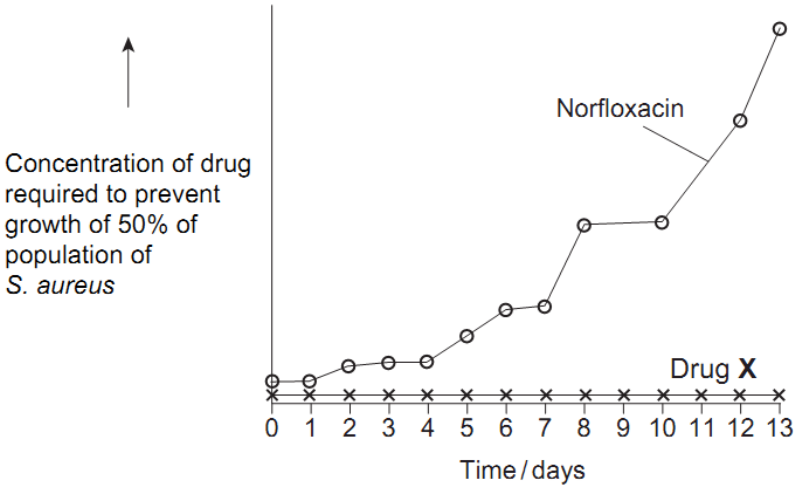
1 .....

2 .....

(2 marks)

(c)

Scientists investigated resistance of the bacterium, *S. aureus* to the antibiotic Norfloxacin. They grew the bacteria in a medium containing a low concentration of Norfloxacin. The concentration of Norfloxacin that they added killed some of the bacteria. It did not kill all of them. Every 24 hours, they removed a sample of the bacteria from the culture. They tested the sample to find the concentration of Norfloxacin that prevented the growth of 50 % of the bacteria in the sample.
The scientists then used the same method to investigate the resistance of *S. aureus* to a new drug, drug **X**. The results of both investigations are shown in the graph.



(i) Describe the results obtained with Norfloxacin.

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(1 mark)

(ii) Use your knowledge of resistance to explain the results obtained with Norfloxacin and drug **X**.

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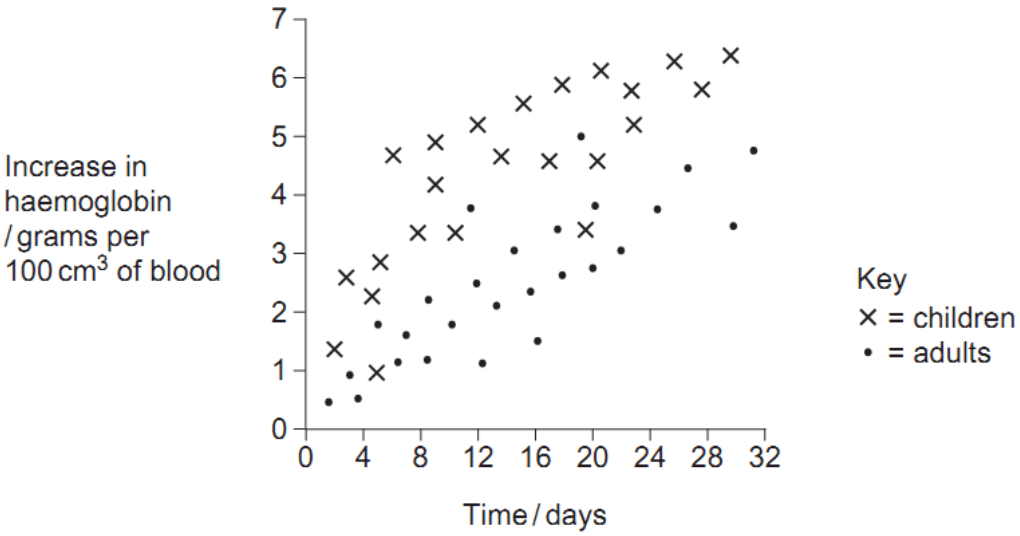
(4 marks)

7

Haemoglobin contains iron. One type of anaemia is caused by a lack of iron. This type of anaemia can be treated by taking tablets containing iron. A number of patients were given a daily dose of 120 mg of iron. **Figure 8** shows the effect of this treatment on the increase in the concentration of haemoglobin in their red blood cells.

Figure 8



(a) (i) Give **one** difference in the response of adults and children to this treatment.

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(1 mark)

(a) (ii) You could use the graph to predict the effect of this treatment on the increase in haemoglobin content of an adult after 40 days. Explain how.

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(2 marks)

(b) (i) Pernicious anaemia is another type of anaemia. One method of identifying pernicious anaemia is to measure the diameter of the red blood cells in a sample of blood that has been diluted with an isotonic salt solution. Explain why an isotonic salt solution is used to dilute the blood sample.

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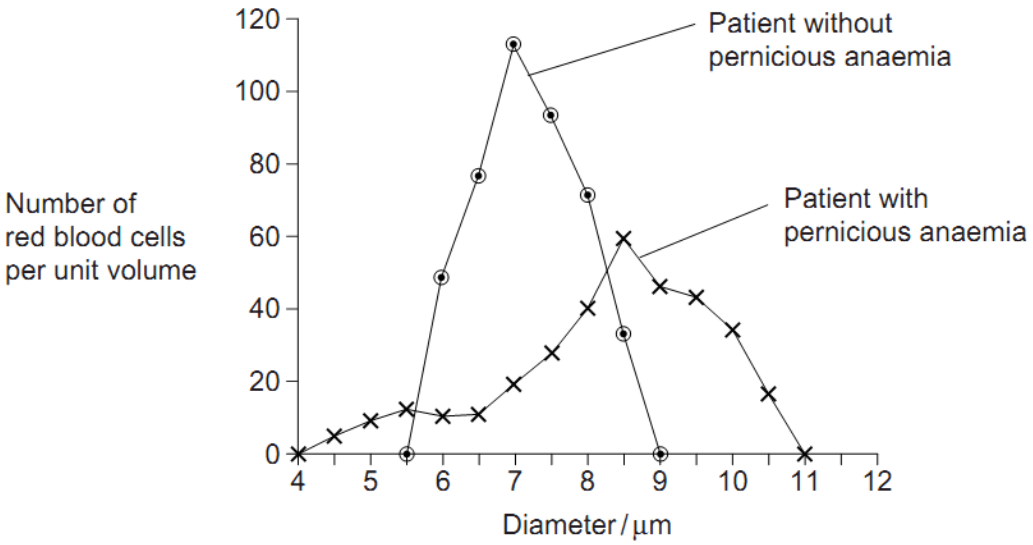
(3 marks)

(b) (ii) A technician compared the red blood cells in two blood samples of equal volume. One sample was from a patient with pernicious anaemia, the other was from a patient who did not have pernicious anaemia. **Figure 9** shows some of the results she obtained.

Figure 9



Describe **two** differences between the blood samples.

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(2 marks)

8

Erythropoietin (EPO) is a substance produced in the body. It increases the production of red blood cells. Synthetic EPO is made artificially. It is used to treat patients who have a form of anaemia in which there is a reduced number of red blood cells. Scientists investigated the effect of synthetic EPO on volunteers with this form of anaemia.

- The scientists injected synthetic EPO in a salt solution into patients in the experimental groups. They also set up control groups.
- They gave the different experimental groups different doses of synthetic EPO and different lengths of treatment.
- At the beginning and end of the treatment, the scientists measured each patient's haemoglobin concentration. From these measurements, they calculated the mean increase in haemoglobin concentration.

Some of the results are shown in the table.

Number of volunteers	Length of treatment / weeks	Dose of synthetic EPO / units per kilogram per week	Mean increase in haemoglobin concentration / arbitrary units
58	8	85	19.0
18	8	170	26.0
40	12	150	12.5
82	12	450	34.2
46	24	120	23.0
53	24	240	31.0

(a) Explain why treatment with synthetic EPO affects the haemoglobin concentration in these volunteers.

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(2 marks)

(b) Suggest how the control groups should have been treated in this investigation.

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(2 marks)

(c) The scientists measured the dose of synthetic EPO per kilogram per week. Explain why they measured the dose per unit mass and per unit time.

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(2 marks)

(d) Explain how the information that the scientists collected might be useful in treating patients with anaemia.

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(2 marks)

(e) Some athletes have used synthetic EPO as a performance enhancer. Explain how synthetic EPO may improve performance in long-distance events.

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(4 marks)

(f) Athletes may be tested to see if the concentration of EPO in their blood is above normal. Suggest how scientists determine the normal concentration of EPO in blood.

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(2 marks)

(g) Synthetic EPO can increase blood pressure. Suggest why.

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(1 mark)

Unit 2 HSW Answers & Markscheme

Question 1

(a)	Given only saline; Otherwise treated exactly the same way;	2	
(b)	Ethical consideration, e.g., leads to death/suffering of mice; Large number to improve reliability / reduce sampling error; Number of mice related to cost/space available/animal husbandry;	2 max	
(c)	Vary in shape / do not grow uniformly;	1	**Q** Allow descriptions of variation in shape.
(d)	7.44 and 1.74;; 7.42 and 1.72;; (Ratio) 4.28 : 1;; (Ratio) 4.31 : 1;; (Percentage decrease) 76.6%;; (Percentage decrease) 76.8%;;	2 max	Any of the answers shown gain two marks. An answer of 23.4% or 23.2% Percentage decrease gains one mark. Correct method of calculating rate/ratio/percentage increase with an incorrect answer gains one mark.
(e)	Reference to Mitosis; As chromosomes cannot attach (to spindle)/ chromatids cannot separate (on spindle); Cell division/cell cycle slows down;	3	**Q** Do not penalise confusion between chromosomes and chromatids in second marking point **Q** Mitosis slows down = 2 marks **Q** Mitosis stopped = 1mark **Q** Mitosis must be spelt correctly
(f)(i)	(Degree of) spread/variation from the mean;	1	
(f)(ii)	Both chemicals (on their own) slow down growth/are effective; Taxol is more effective than OGF; Combined treatment (seems) most effective; SD overlap for OGF with taxol and taxol (on its own) so not conclusive/could be chance/both treatments could be equally effective;	4	**Q** Ignore all references to significance

Question 2

(a) (i)	Less stress caused to seahorse / quicker/more accurate method / body is curved / head is linear;	1	**Q** Do not accept "easier" unless qualified.
(ii)	Head length proportional to body length/or described;	1	
(b)	Positive correlation between head/body lengths of male and female/ female and male with similar head/body lengths pair together;	1	
(c)	Use line of best fit; And extrapolate/extend line as required;	 2	

Question 3

(a)	(i)	2;	1	Allow 1.75
(a)	(ii)	30 / 60 ÷ answer to part (i) if incorrect;	1	Allow 34(.315)

Question 4

(a)		Randomly collected/collected from many ponds/same species/same time of year;	1	Accept other answers providing they might reasonably impact on data
(b)		9;	1	
(c)		Curve/line of best fit; Shows upward slope/positive correlation/description of positive correlation; Correlation does not necessarily mean causation; Some other factor might be involved; Some ponds had no worms but had frogs with deformed legs;	4 max	Q No mark awarded for "yes" or "no"
(d)	(i)	Sample too small to establish a pattern/to be representative/ to identify anomalies;	1	
(d)	(ii)	Must compare like with like/must be a fair test; Some factors differ in mountains/named factor differs in mountains;	2	Note that fair test is acceptable if used in context defined in How Science Works glossary
(e)		27% of the frogs had deformed legs in pond 2; Agricultural run-off and cage mesh diameter of 500 µm;	2	
(f)		Worms cause deformed legs; Deformed legs in 500 µm mesh cages /deformed legs when worms in cage; Run off (on its own) does not cause deformed legs; No deformed legs with run off and 75 µm mesh/no worms; When run off present makes effect of worms worse; Quantitative statement e.g. increased by factor of 7 to 8 times;	4 max	

Question 5

(a)		Light (intensity) / temperature / air movement / humidity;	1	
(b)		Prevent air entering / continuous water column;	1	Allow answer in context of shoot, xylem or potometer.
(c)		Distance and time; Radius/diameter/area (of capillary tube);	1 1	Reject 'amount bubble moves'
(d)		(used to provide) turgidity/support/description of; (used in) photosynthesis / (produced in) respiration; Apparatus not sealed/'leaks';	1 1 1	2 max
(e)	(i)	Returns bubble (to start);	1	
(e)	(ii)	Increases reliability (of results) / anomalous result can be identified;	1	***Q*** Ignore references to validity/precision/accuracy etc.

Question 6

(a)	(i)	P;	1	
	(ii)	S;	1	
(b)	(i)	Prevents bias; Vested interest (of scientists); Prevents 'placebo'/positive/negative/psychological effects/'demand characteristics' (in volunteers);	1 1 1	
	(ii)	Age; Ethnicity; Lifestyle; Body mass; Health; Sex of person;	1 1 1 1 1 1	2 max Ignore references to same or different
(c)	(i)	Gradual/slight increase followed by rapid/greater increase;	1	Allow more detailed descriptions which describe similar trend of gradual increase followed by rapid increase.
	(ii)	1. No/little resistance shown to drug X; 2. Mutation present (for antibiotic resistance); 3. Gene/allele for (antibiotic) resistance; 4. Bacteria with (antibiotic) resistance survive; 5. Vertical gene transmission; 6. Frequency of gene/allele (for resistance) increases;	1 1 1 1 1 1	max 4 Reference to horizontal gene transmission = neutral Reject mark for mutation if context suggests presence of antibiotic causes bacteria to mutate. Resistance is passed on by vertical gene transmission = two marks i.e. points 3 and 5.

Question 7

(a)	(i)	Faster/greater/more effective response in children;	1	Do not accept children have more haemoglobin
(a)	(ii)	Use line of best fit; Extrapolate/extend line (and read from graph);	1 1	Allow calculation using rate of increase per day = one mark. However for both marks this must be linked to line of best fit.
(a)	(iii)	More than one polypeptide chain;	1	Allow many polypeptide chains. 'Haemoglobin has four polypeptide chains' must be in correct context to gain mark.
(b)	(i)	Has same <u>water</u> <u>potential</u>; No (net) water movement / osmosis; Cells will not swell/burst/change size;	1 1 1	Allow converse for effect of using distilled water or a concentrated solution. No osmotic lysis = two marks
(b)	(ii)	Pernicious anaemia (cells) greater range/spread/variation of diameters/widths; Some pernicious anaemia (cells) wider than 9 (μm) / some less than 5.5 (μm) / / without pernicious anaemia none more than 9 (μm) / none less than 5.5 (μm); Pernicious anaemia (cells) peak/most frequent at 8.5 (μm) / peak/most frequent at higher diameter / / without pernicious anaemia peak/most frequent at 7 (μm) /peaks at lower diameter;	1 1 1	2 max There are several alternatives for marking points 2 and 3

Question 8

(a)	More red blood cells; More haemoglobin;	2	
(b)	Given (only) salt solution; (Otherwise) treated the same way;	2	Accept: 'Placebo' in salt solution. Reference to salt solution is essential for first marking point.
(c)	Allows comparison to be made; Different masses/weights (of volunteers); Different weeks/lengths of treatment;	2 max	Accept: 'Both were different' for one mark. Neutral: Size for second marking point.
(d)	To determine (most effective) dose; To determine (most effective) length of treatment; Investigate long term effect / toxicity / side effects; To find the most cost effective treatment;	2max	Do not credit marks for descriptions of the information in the table in terms of dose and length of treatment.

(e)	More haemoglobin / more red blood cells; (More) oxygen can be absorbed/transported; (For) respiration / to respiring tissues/cells; (More) energy released/more ATP; For muscle <u>contraction</u>; Delays <u>anaerobic</u> respiration / delays build up of lactate/lactic acid;	4 max	Reject: 'Energy produced or made' but allow energy made in form of ATP'.
(f)	Large sample / wide range (of individuals tested); Random (sampling); Tested at different times/more than once; Mean/average value determined; Idea of establishing a range for the normal concentration / reference to use of standard deviation;	2 max	
(g)	Blood thicker/denser/more viscous/more 'concentrated' / heart <u>contraction</u> greater / increases volume of blood;	1	Accept: More blood cells in same volume/'space'. Neutral: 'more red blood cells' / 'more blood' on its own. Neutral: 'Heart pumps/beats more/harder'