Surname	Centre Number	Candidate Number
Other Names		0

GCSE

C400UA0-1

S19-C400UA0-1

BIOLOGY – Component 1
Concepts in Biology

HIGHER TIER

TUESDAY, 14 MAY 2019 – AFTERNOON

2 hours 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**14**	
2.	**16**	
3.	**6**	
4.	**13**	
5.	**14**	
6.	**13**	
7.	**13**	
8.	**10**	
9.	**6**	
10.	**15**	
Total	**120**	

C400UA01
01

ADDITIONAL MATERIALS

In addition to this examination paper, you will require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

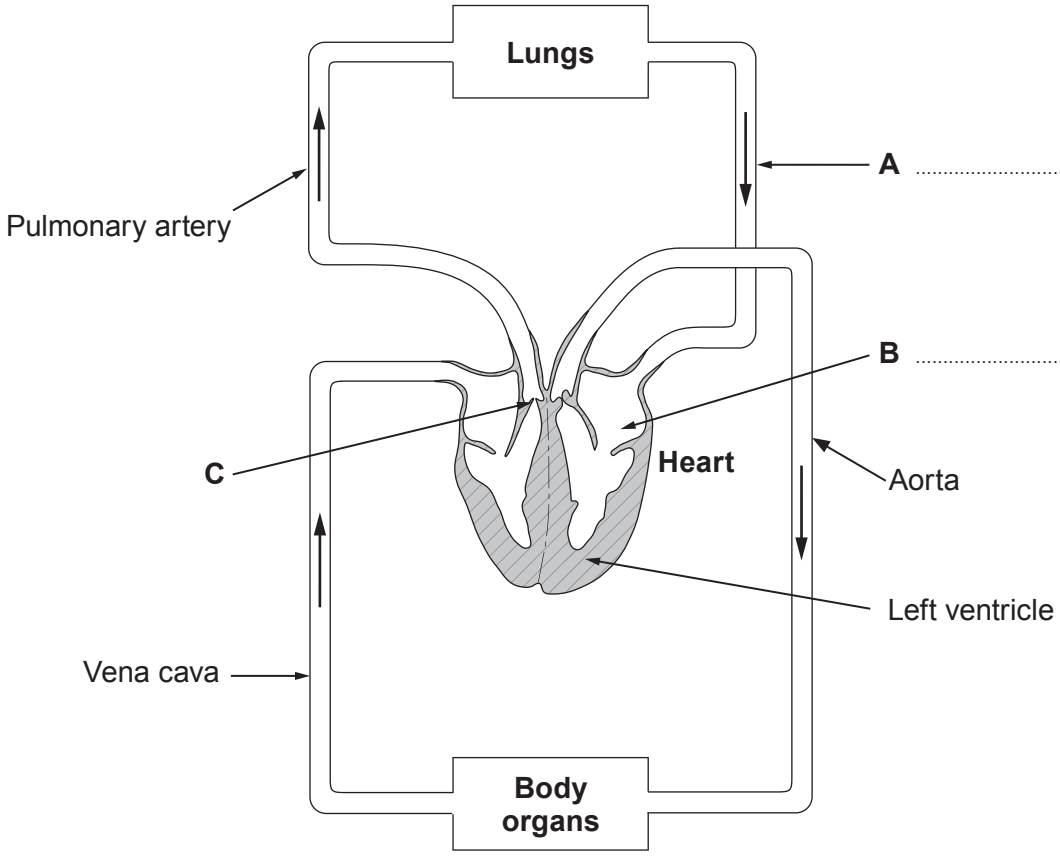
The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in question **9**.

Examiner only

Answer **all** *questions.*

1. The diagram below shows the circulatory system of the human body.



(a) (i) On the diagram, label structures **A** and **B**. [1]

(ii) State the name of valve **C** and describe its function. [2]

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Examiner only

(b) (i) Use the diagram to explain why the circulatory system of the human body is described as a *double circulation*. [1]

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(ii) During an investigation, the blood pressures were measured in some of the blood vessels shown on the diagram. The results are given in the table.

	Pressure of blood (kPa)		
Blood vessels	Maximum	Minimum	Mean
Aorta	18.0	11.0	14.5
Pulmonary artery	12.0	8.0	10.0
Vena cava	1.0	0.2	.....

Use this information and the diagram to answer the following questions.

I. **Complete the table** by calculating the mean pressure for the vena cava. Write your answer in the table. [1]

II. State the cause of the difference in pressure shown in the table between the aorta and the pulmonary artery. [1]

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III. From the table, describe the evidence that a double circulation system is necessary to maintain an effective supply of blood to the lungs. [2]

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Examiner only

(c) The table lists the percentages of blood supplied to parts of the body.

Organ	Percentage of blood supplied
Brain	16
Bone	4
Kidneys	25
Liver	10
Skin	5
All other organs of the body	40

Using the information in the table above, calculate the volume of blood supplied to **the liver** in **five minutes** when

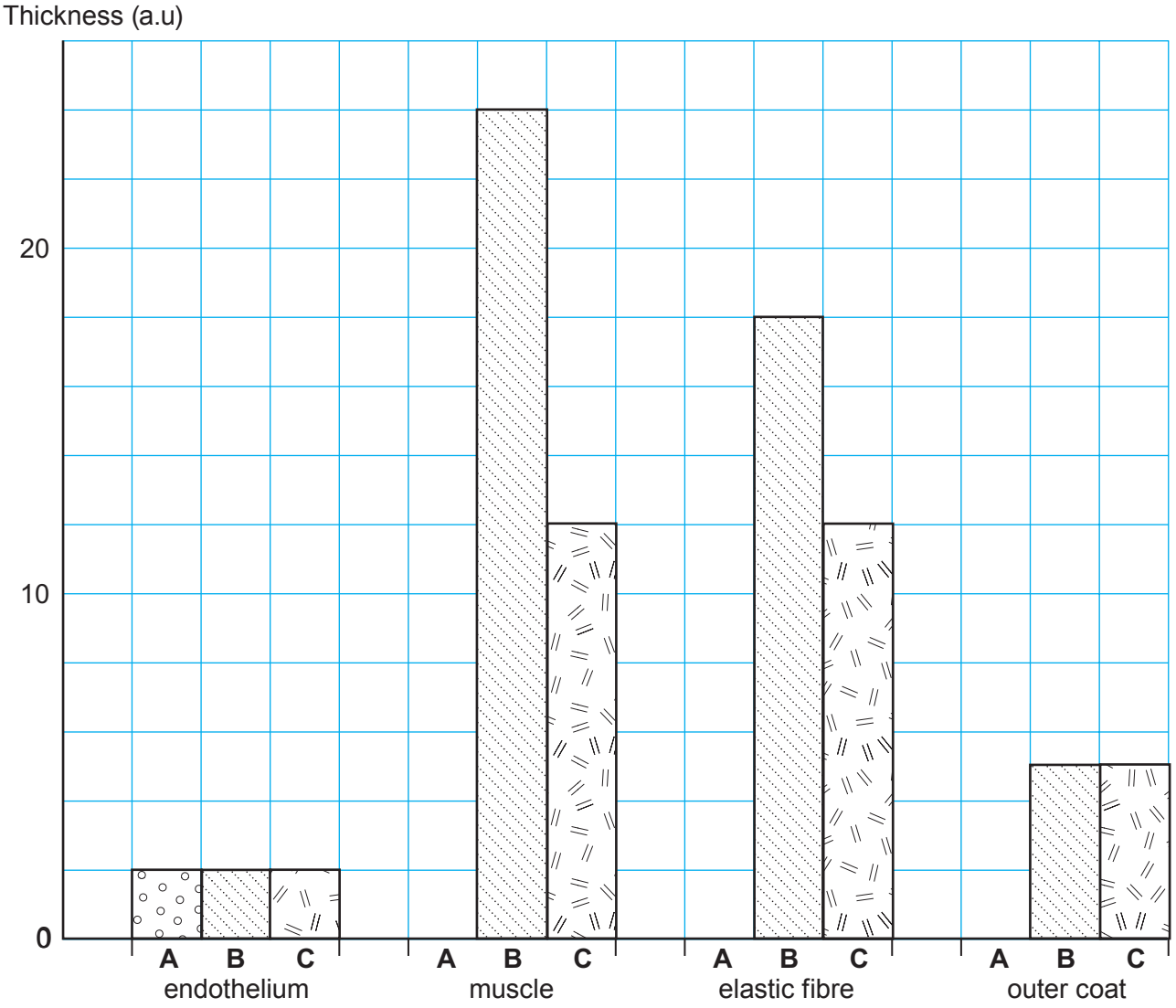
- volume of blood leaving the heart at each beat = 70 cm^3
- heart rate (number of beats per minute) = 72

Give your answer in **dm^3 to two decimal places**. [3]

Volume = ... dm^3

Examiner only

(d) The bar chart below compares the relative thickness of different tissues in the walls of three blood vessels **A**, **B** and **C** from the liver.



Identify which blood vessel **A**, **B** or **C** is a capillary. State the process which occurs when waste products from cells enter capillaries and describe how the capillary is well adapted for this process. [3]

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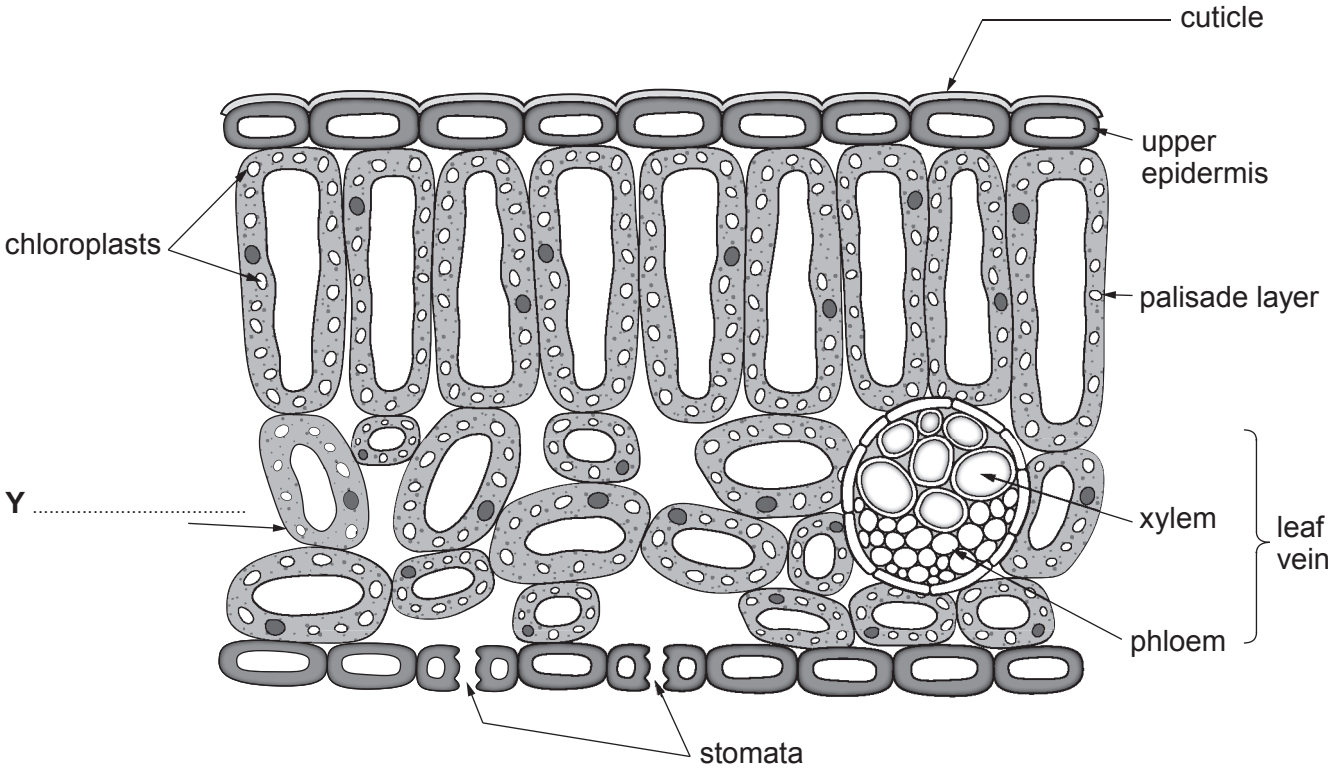
2. The diagram shows a section through the leaf of a plant.



(a) **On the diagram label** cell **Y**. [1]

(b) An Australian plant, the leafy Hakea *(Hakea sp)* produces two types of leaves. Plants produce one type of leaf in areas of bright sunlight, where the light intensity is high (type **P**) and another type in shaded areas where the light intensity is low (type **Q**).

leaf type **P**

Bright sunlight, high light intensity

leaf type **Q**

Shade, low light intensity

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The table below shows the results from an investigation of Hakea leaves.

Features	Leaf type **P**, (bright sunlight high light intensity)	Leaf type **Q**, (shade low light intensity)
Number of leaves per stem	5	15
Surface area of each leaf (mm^2)	150	292
Total leaf surface area per stem (mm^2)	750	.....
Mean number of chloroplasts in palisade cells	80	110
Cuticle thickness	24	14
Mean number of stomata in lower epidermis (per mm^2)	89	207

(i) Complete the table by calculating the total leaf surface area of a stem with type **Q** leaves. **Write your answer in the table.** [1]

Space for working.

(ii) From the table

I. Explain how type **P** leaves are better adapted to limit transpiration in bright sunlight than type **Q** leaves. [2]

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II. Explain how type **Q** leaves are better adapted for photosynthesis in shaded areas than type **P** leaves. [3]

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(c) Phloem and xylem are found in the leaf vein. Phloem transports sugars. Give **one** way in which phloem is different from xylem. [1]

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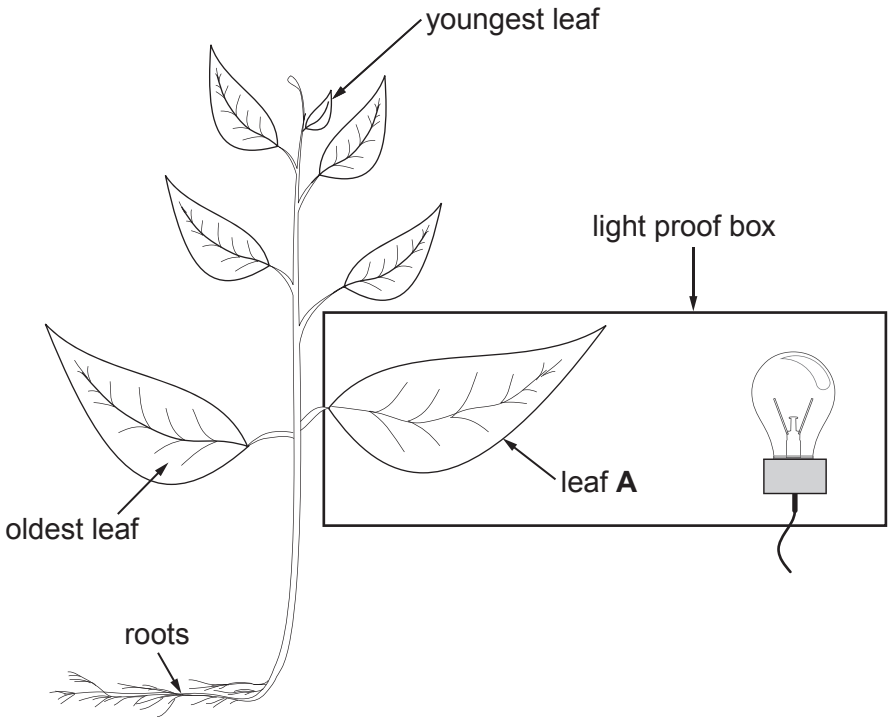
(d) A scientist investigated the transport of sugars in one *Petunia* plant. The whole plant was kept in darkness for 24 hours before the investigation.

After 24 hours leaf **A** was exposed to light, as shown in the diagram, whilst the rest of the plant remained in darkness.



By using radioactive substances, the scientist was able to track the movement of the sugars made in leaf A, as they were transported to other parts of the plant. She noted the presence or absence of sugars in different parts of the plant over one hour.

The results of the investigation are shown in the table below.

	Time after start of investigation (min)						
	5	*10*	*20*	*30*	*40*	*50*	*60*
leaf **A**	✓	✓	✓	✓	✓	✓	✓
oldest leaf	**x**	**x**	✓	✓	✓	✓	✓
youngest leaf	**x**	✓	✓	✓	✓	✓	✓
root	**x**	**x**	**x**	**x**	**x**	✓	✓

Key ✓ = sugar present **x** = sugar absent

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(i) The scientist's hypothesis stated that

I. Sugar would be transported both upwards and downwards in the phloem of a plant.

II. It would be transported at different speeds.

From the table, evaluate the extent to which the results support the hypothesis. [3]

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(ii) I. State how the scientist could check the repeatability of her results. [1]

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II. State **one** *other* way in which the investigation could be improved to increase confidence in the results. [1]

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(iii) I. At the end of the experiment the scientist found that sugars had been converted to starch in the root.

Describe how a test for starch would be carried out, stating the name of the chemical solution used and the colour change seen in a positive result. [2]

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II. State why it was necessary to place the plant in darkness for 24 hours before using it in this investigation. [1]

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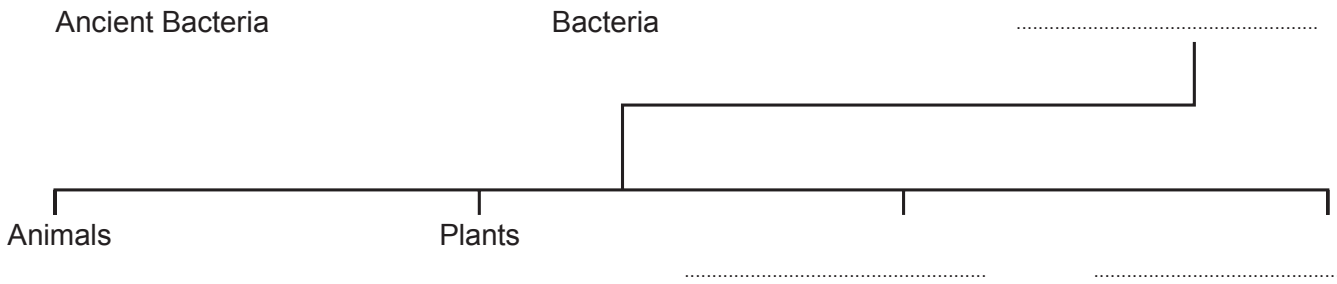
Examiner only

3. *(a)* Complete the classification chart below by inserting the names of:

(i) the missing domain, [1]

(ii) the missing kingdoms. [1]



The photograph below shows two different species of the European medicinal leech, *Hirudo medicinalis* and *Hirudo verbana*.

Hirudo medicinalis

Hirudo verbana

The European medicinal leech was first classified by Carl Linnaeus in 1758 as one species, which he called *H. medicinalis*. In 2007, using the evidence from new scientific techniques, scientists reclassified the European medicinal leeches as two closely related, but distinct species.

(b) (i) Explain why in 1758 Linnaeus classified the leeches as belonging to the same species and state what new evidence the scientists would have used to reclassify the leeches in 2007. [2]

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Examiner only

(ii) Suggest how and why the reclassification of the European medicinal leech will affect the validity of over 300 research papers published on *H. medicinalis* before 2007. [2]

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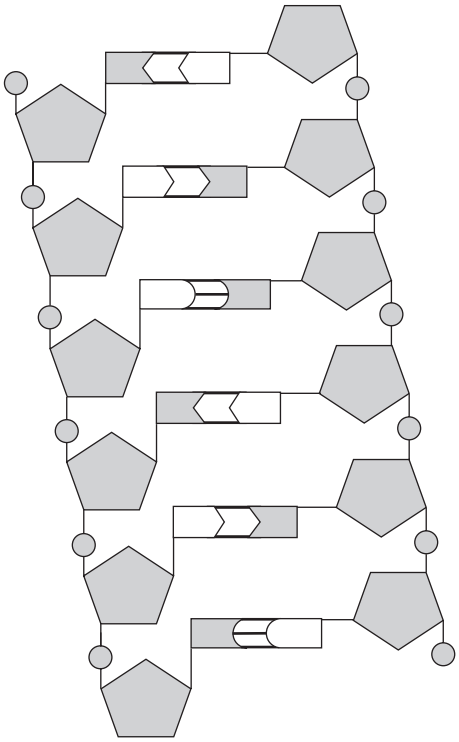
4. The diagram below represents part of a length of DNA.



(a) (i) On the diagram, label the following:

I. sugar molecule [1]

II. phosphate molecule [1]

(ii) State the name used to describe the shape of DNA. [1]

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(b) Erwin Chargaff recognised that there were four types of bases found in DNA.

Chargaff concluded that adenine paired with thymine, and cytosine paired with guanine because he observed that the proportions were approximately equal.

(i) Adenine comprises 30.9% of the bases in human DNA.
Using Chargaff's conclusions calculate the percentage of guanine in human DNA. [3]

Percentage of guanine = ...

Examiner only

(ii) The table below shows results from his experimental work.

	Percentage of base present			
Organism	Adenine	Guanine	Cytosine	Thymine
Wheat	27.3	22.7	22.8	27.1
Broad bean	29.7	20.6	20.1	29.6
Salmon	29.7	20.8	20.4	29.1
Cow	28.6	22.2	22.0	27.2

Suggest why the percentage values for adenine and thymine in the table are not exactly equal. [1]

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The table below shows the amino acids coded for by DNA.

Second Letter

First Letter	T	C	A	G	*Third Letter*
T	TTT, TTC **phe** TTA, TTG **leu**	TCT, TCC, TCA, TCG **ser**	TAT, TAC **tyr** TAA stop TAG stop	TGT, TGC **cys** TGA stop TGG **trp**	T C A G
C	CTT, CTC, CTA, CTG **leu**	CCT, CCC, CCA, CCG **pro**	CAT, CAC **his** CAA, CAG **gln**	CGT, CGC, CGA, CGG **arg**	T C A G
A	ATT, ATC, ATA **ile** ATG **met**	ACT, ACC, ACA, ACG **thr**	AAT, AAC **asn** AAA, AAG **lys**	AGT, AGC **ser** AGA, AGG **arg**	T C A G
G	GTT, GTC, GTA, GTG **val**	GCT, GCC, GCA, GCG **ala**	GAT, GAC **asp** GAA, GAG **glu**	GGT, GGC, GGA, GGG **gly**	T C A G

Examiner only

The DNA base sequences below show part of two alleles found at the same position on a pair of chromosomes and the order of amino acids for which they code.

Allele 1

A A G T G G A C G C T C

Lys | Trp | ..... | .....

Allele 2

A A G T G G A A G C T C

Lys | Trp | ..... | .....

(c) (i) Use your knowledge of protein synthesis and the information provided to **complete the diagram above** by inserting the missing amino acids. [2]

(ii) Explain how the two alleles shown will give rise to slightly different physical characteristics. [3]

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(iii) Describe a possible function of non-coding DNA. [1]

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5. Plants growing on windowsills generally tend to grow towards the window.

(a) State the response shown by the shoots in the photograph above and explain the mechanism that causes the response. [4]

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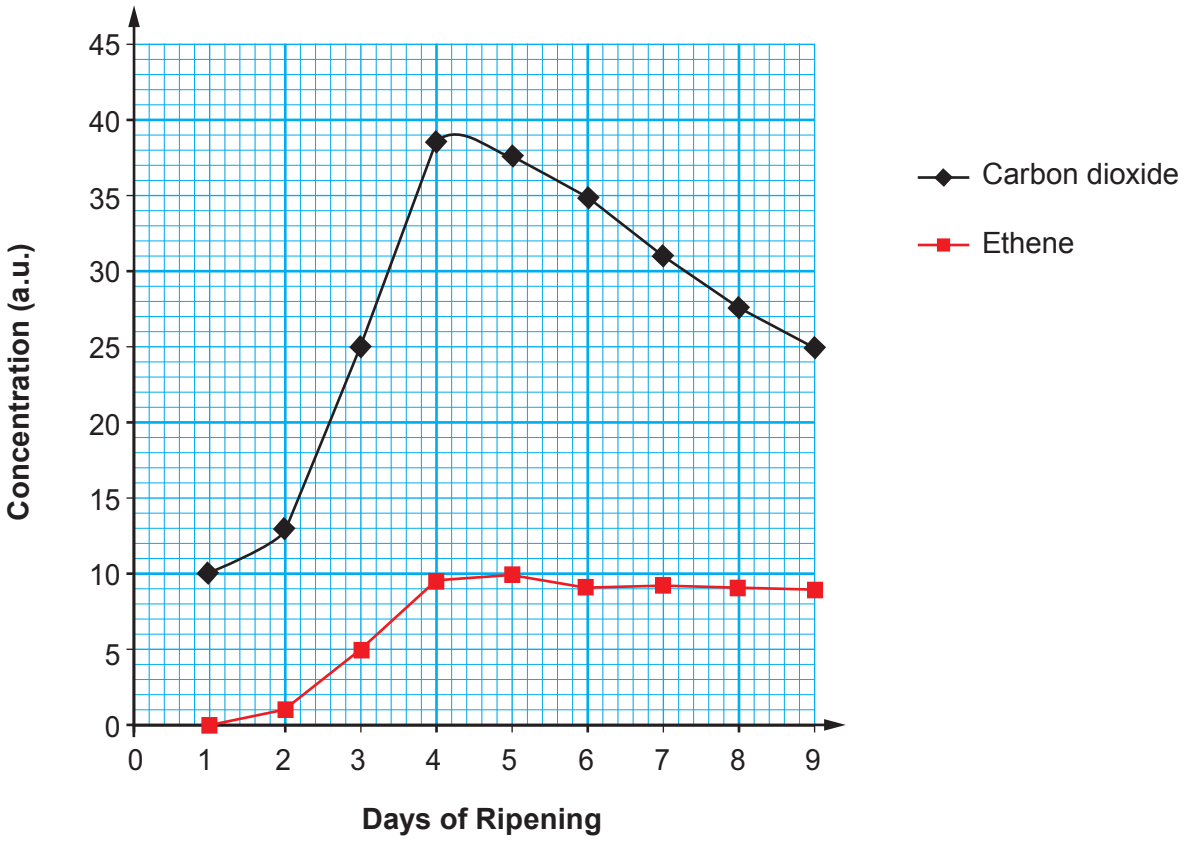
When a fruit ripens, it undergoes changes in skin colour, internal flesh softening, aroma development and sweetening. The processes responsible for these changes require energy from respiration.

The graph below shows emissions of ethene and carbon dioxide from a ripening tomato.



(b) (i) State the word equation for aerobic respiration. [2]

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(ii) It has been shown that the concentration of ethene can affect the concentration of carbon dioxide produced by ripening fruit. Using the graph describe the relationship between ethene emissions from a ripening tomato and the carbon dioxide it produces. [2]

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Examiner only

(iii) State the function of ethene and suggest an explanation for its effect on fruit. [4]

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(iv) Suggest why carbon dioxide production declines between day 4 and day 9. [1]

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(c) State the commercial application for ethene. [1]

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Examiner only

6. *(a)* State the difference between the terms **population** and **community**. [2]

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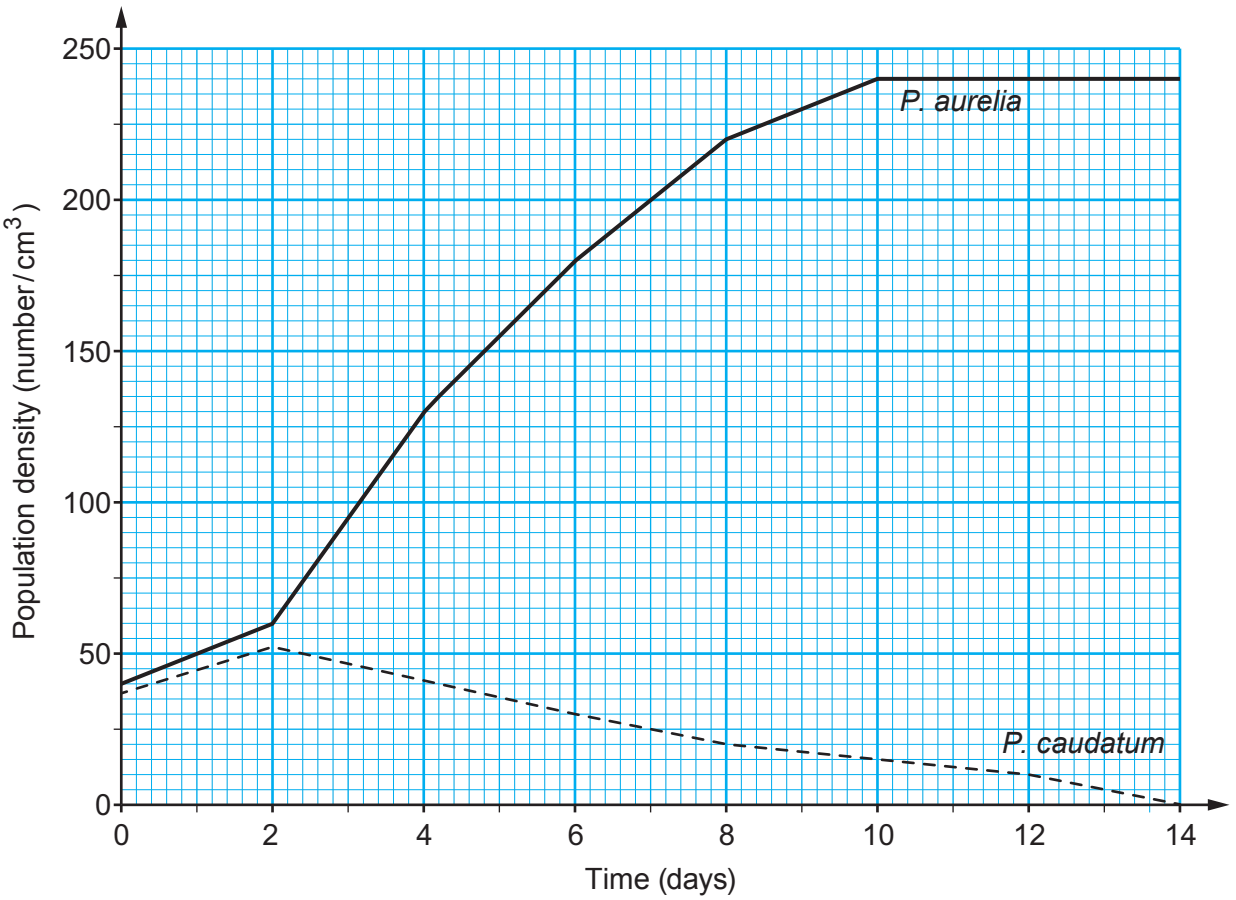
(b) *Paramecium aurelia* and *Paramecium caudatum* are two species of single-celled organisms normally found swimming freely in ponds.

Students tested the hypothesis that *'two species cannot co-exist when they compete for the same resources'*.

They cultured *P. aurelia* and *P. caudatum* together in a liquid medium containing bacteria on which both species fed.

They measured the population densities every two days and the results are shown in graph 1.

Graph 1



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(i) Calculate the mean rate of increase in the population density of *P. aurelia* between days two and ten. Include a unit for your answer. [3]

Increase in population density = ...

Units .....

(ii) State **two** biotic factors and **one** abiotic factor which might affect the population density of *Paramecium* in the liquid medium. [3]

Biotic factors

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Abiotic factor

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(iii) Explain the change in population density for both species as shown in graph 1. [3]

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Examiner only

(iv) State whether the results shown in graph 1 support the students' hypothesis. Explain your answer. [1]

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(v) State how confident the students can be with the validity of their conclusion. Explain your answer. [1]

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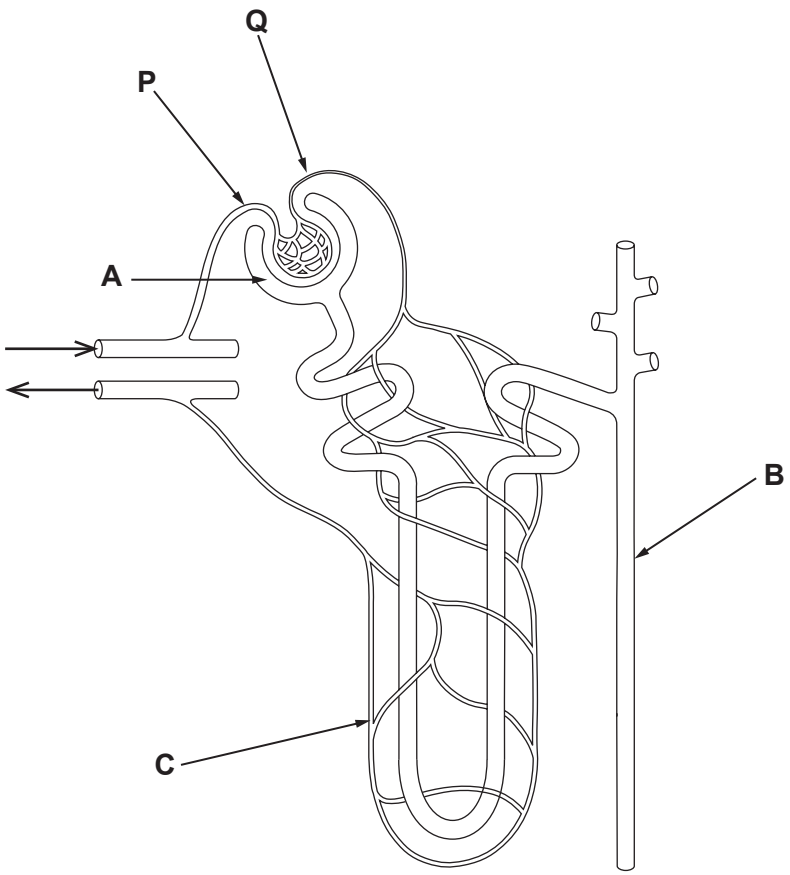
7. Autosomal Dominant Polycystic Kidney Disease (ADPKD) affects approximately 60 000 people in the UK. It accounts for one in eight people who need a kidney transplant and 1 in 10 patients on dialysis.
The disease is characterised by the development of cysts in kidney tubules. Cysts can expand in diameter causing blockage of the tubules.
Kidney function in people affected by ADPKD can be maintained at a normal level for decades whilst the cysts develop. However, at some point kidney function rapidly declines, generally when individuals are in their 60s and their kidneys begin to fail.

The diagram below shows a nephron and associated structures.



(a) (i) Give the names of the structures labelled **A**, **B** and **C**. [2]

A .....

B .....

C .....

Examiner only

(ii) Explain the significance of the arteriole labelled **Q** having a different diameter than the arteriole labelled **P** and describe what happens to the blood in the capillary knot. [3]

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(b) (i) On Thursday January 18th 2018, it was estimated that the population of the UK was 66 396 774 people.
Calculate the ratio of people in the UK affected by ADPKD compared to those not affected. Express your answer to **one significant figure**. [2]

Ratio of people affected by ADPKD : people not affected by ADPKD = ... : .....

(ii) Suggest how ADPKD may affect the function of the nephron and why individuals only develop kidney failure after many years. [2]

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ADPKD is an inherited disease caused by a mutation to the PKD1 gene.

(c) State what is meant by a gene mutation. [1]

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The allele for ADPKD can be represented by the letter **A**. Individuals who lack the **A** allele are not affected by ADPKD.

(d) An unaffected mother and an affected father decide to have children. A genetic counsellor stated that they had a 50% chance of having a child affected by ADPKD.

Give the genotype of both parents and construct a Punnett square in the space below to show how the genetic counsellor's prediction is possible. [3]

	Mother	Father
Phenotype:	Unaffected	Affected by ADPKD
Genotype:	.....	.....

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8. *(a)* State what is meant by negative feedback. [2]

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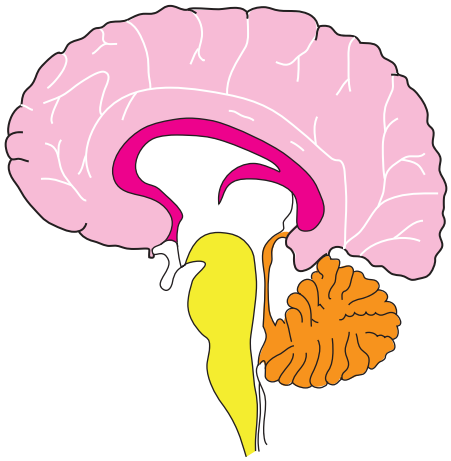
The diagram shows a section through a human brain.



(b) State the names of the parts of the human brain involved in controlling the following:

(i) balance and muscular contraction; [1]

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(ii) heartbeat and breathing; [1]

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(iii) conscious activity and memory. [1]

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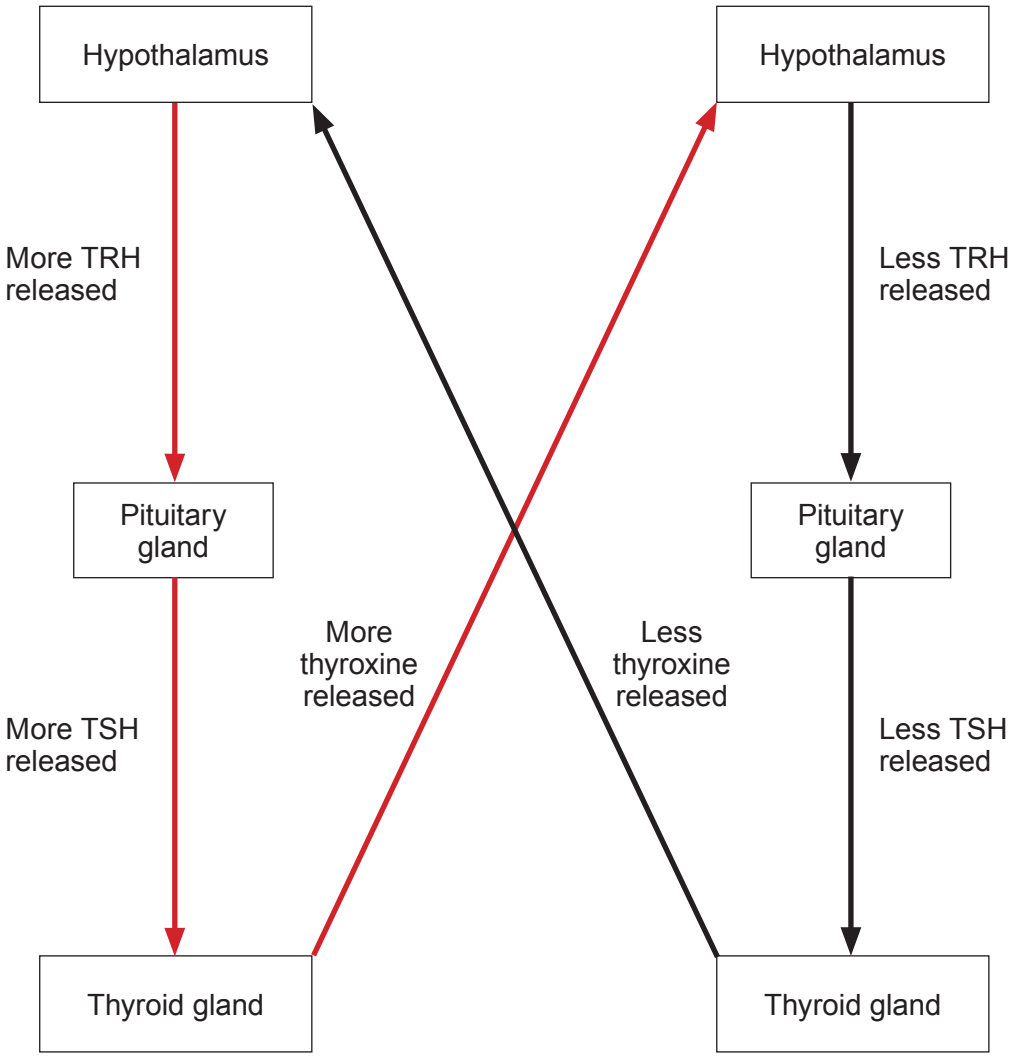
The chart below outlines a feedback mechanism which involves thyrotropin-releasing hormone (TRH), thyroid-stimulating hormone (TSH) and thyroxine.

One function of thyroxine is to stimulate an increase in body temperature in humans. Iodine consumed as part of a balanced diet is essential for the production of thyroxine molecules. Excessive release of TSH can cause goitre, a medical condition where the thyroid gland increases in size leading to a swelling of the neck.



Examiner only

(c) Using the information provided, explain how iodine deficiency can lead to goitre and suggest why individuals affected by this condition find it difficult to maintain optimum body temperature in cold conditions. [5]

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Examiner only

9. Dopamine is a chemical which allows nervous impulses to be sent to the parts of the brain that control movement and some forms of thinking. People with Parkinson's disease do not produce enough dopamine because the disease causes dopamine producing neurones in the brain to die. As these neurones die, people with Parkinson's disease develop tremors.

Three potential treatments for Parkinson's disease currently being researched are outlined below.

1. Transplants of developing neurones from human foetuses into the brains of people with Parkinson's disease.

2. Transplant of embryonic stem cells into the brains of people with Parkinson's disease.

3. Transplant of stem cells from the person's own skin cells into their brain.

Describe the major limitation in treating brain damage such as that caused by Parkinson's disease. Evaluate the advantages and disadvantages of the three methods outlined above as potential treatments. [6 QER]

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10. On January 7th 2018, daytime air temperatures in Sydney, Australia reached 47 °C, the highest recorded in the city for 79 years. By 2040, it is predicted that Sydney could experience air temperatures over 50 °C. The human body has not evolved to survive in the high temperatures that are predicted for large parts of the world. This could lead to many areas becoming uninhabitable.

(a) (i) State why it is important that human body temperature remains between 36.5 °C and 37.5 °C. [1]

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(ii) **Apart from sweating**, explain how the skin would have maintained a constant body temperature in response to the conditions in Sydney on January 7th 2018.[3]

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The temperature that the human body experiences depends on the combined effects of air temperature and relative humidity, as shown in diagram 1.

Diagram 1 – Temperature experienced by body in different air temperatures and humidity.

Air temperature (°C) \ RELATIVE HUMIDITY (%)	40	45	50	55	60	65	70	75	80	85	90	95	100
27	27	27	27	27	28	28	28	29	29	29	30	30	31
28	28	28	28	29	29	29	30	31	32	32	33	34	35
29	29	29	29	30	31	32	32	33	34	36	37	38	39
30	30	31	31	32	33	34	35	36	38	39	41	42	44
31	31	32	33	34	35	37	38	39	41	43	45	47	49
32	33	33	35	36	38	39	41	43	45	47	50	53	56
33	34	36	37	38	41	42	44	47	49	52	55	58	
34	36	38	39	41	43	46	48	51	54	57			
36	38	40	42	44	47	49	52	56					
37	41	43	45	47	51	53	57						
38	43	46	48	51	54								
39	46	48	51	54									
40	48	51	55										
41	51	54											
42	54												
43	58												

Potential hazard
Caution
Fatigue possible
Extreme Caution
Sunstroke, muscle cramps, and/or heat exhaustion possible
Danger
Sunstroke, muscle cramps, and/or heat exhaustion likely
Extreme Danger
Possible death from heat stroke

Examiner only

(b) (i) At 06:00 on the 13th of January 2018, the air temperature in Sydney was 36 °C and the relative humidity was 70%. Use diagram 1 to state the temperature the body experienced and the potential hazard arising. [2]

(ii) Explain why sweating is less effective at cooling the body in high relative humidity. [2]

(iii) Explain how the regulation of the water content of blood by the kidneys is affected by excessive sweating. [4]

(iv) Explain how water loss during excessive sweating could lead to osmotic changes in the body fluids which could be life threatening. [3]

END OF PAPER