Surname	StemUp Model Solution	Centre Number	Candidate Number
First name(s)			2

GCE A LEVEL

A400U30-1

S25-A400U30-1

WEDNESDAY, 18 JUNE 2025 – MORNING

BIOLOGY – A level component 3

Requirements for Life

2 hours

	For Examiner's use only		
	Question	**Maximum Mark**	**Mark Awarded**
Section A	**1.**	**10**	
	2.	**12**	
	3.	**20**	
	4.	**14**	
	5.	**15**	
	6.	**9**	
Section B	**Option**	**20**	
	Total	**100**	

A400U301
01

ADDITIONAL MATERIALS

A calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

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. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

This paper is in 2 sections, **A** and **B**.

Section **A**: 80 marks. Answer **all** questions. You are advised to spend about 1 hour 35 minutes on this section.

Section **B**: Options; 20 marks. Answer **one option only**. You are advised to spend about 25 minutes on this section.

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 **6**.

The quality of written communication will affect the awarding of marks.

© WJEC CBAC Ltd.

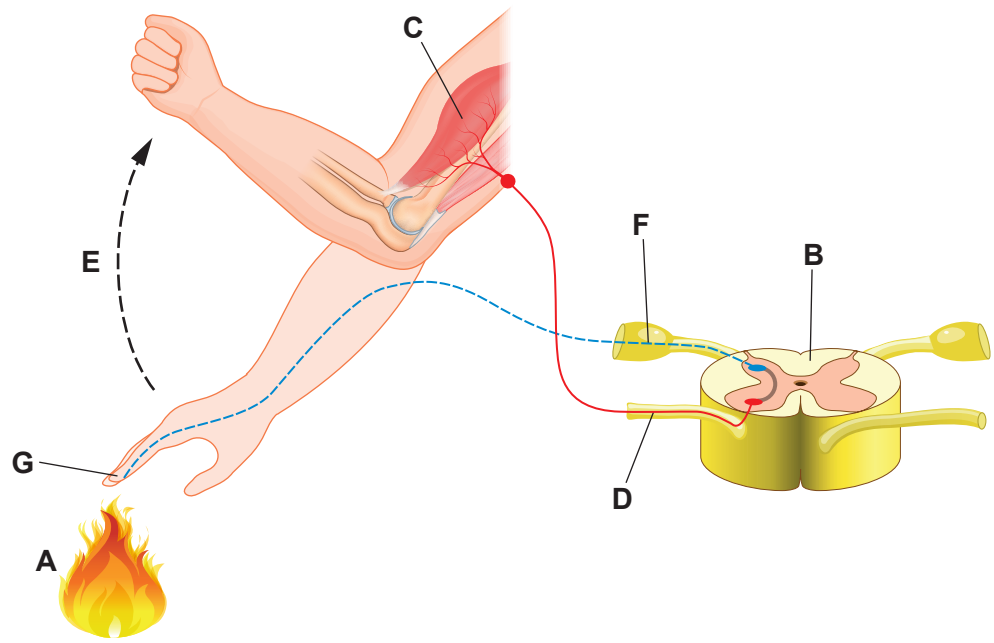
stemup.co.uk

Examiner only

Answer **all** questions.

1. The mammalian reflex arc consists of several components for sensing and responding to the environment. **Image 1.1** shows the reflex arc involved when a heat source is touched by a finger.

Image 1.1



(a) Use letters **A** to **G** from **Image 1.1** to complete the table. [2]

Component of reflex arc	Letter
Coordinator (spinal cord)	B
Effector	C
Motor neurone	D
Receptor	G
Response	E
Sensory neurone	F
Stimulus	A

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(b) Impulses are transferred along both sensory and motor neurones as a wave of action potentials.
Describe how the movement of ions generates an action potential. [3]

A stimulus causes the membrane to depolarise to the threshold value, which opens voltage-gated sodium ion channels.

Sodium ions (Na^+) rapidly diffuse (flood) into the axon through the open sodium channels.

This causes depolarisation: the inside of the axon becomes more positive than the outside, reaching about +40 mV.

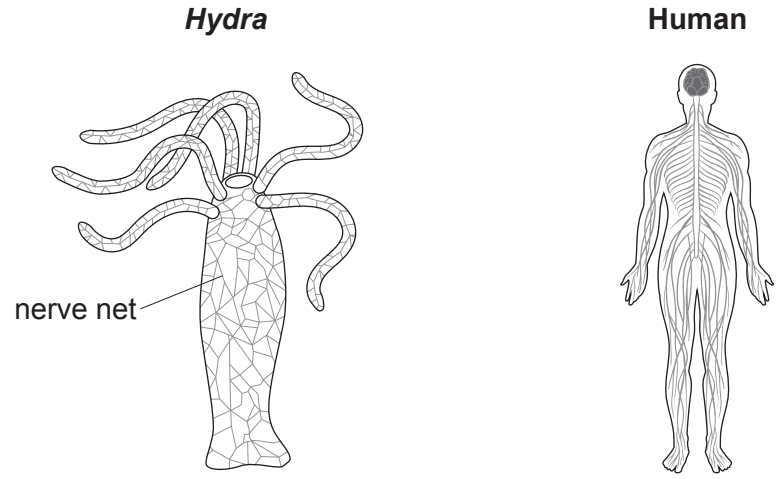
© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(c) Nerve nets are found in cnidarians (for example, *Hydra*) and are different from the nervous systems of vertebrates. **Image 1.2** shows a nerve net in *Hydra* and the nervous system of a human.

Image 1.2



(i) Use your own knowledge and the information provided in **Image 1.2** to give **three** differences between the nerve net of *Hydra* and the nervous system in a human. [3]

Hydra	Human
No brain or spinal cord, i.e. no CNS	Brain and spinal cord present (a CNS)
Unmyelinated neurones, so slow conduction	Myelinated neurones, so faster conduction
Lots of branching; impulses travel in both directions	Fewer branches; impulses travel in one direction

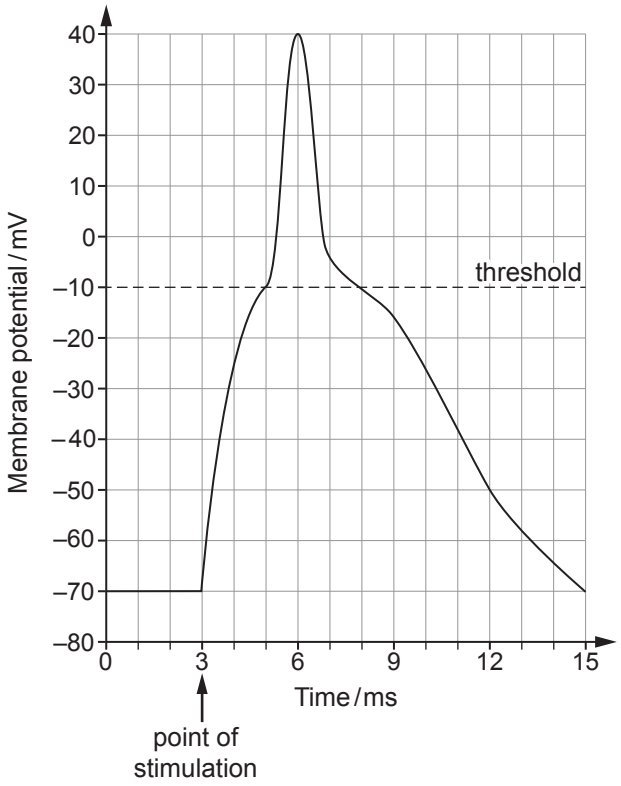
© WJEC CBAC Ltd.

stemup.co.uk

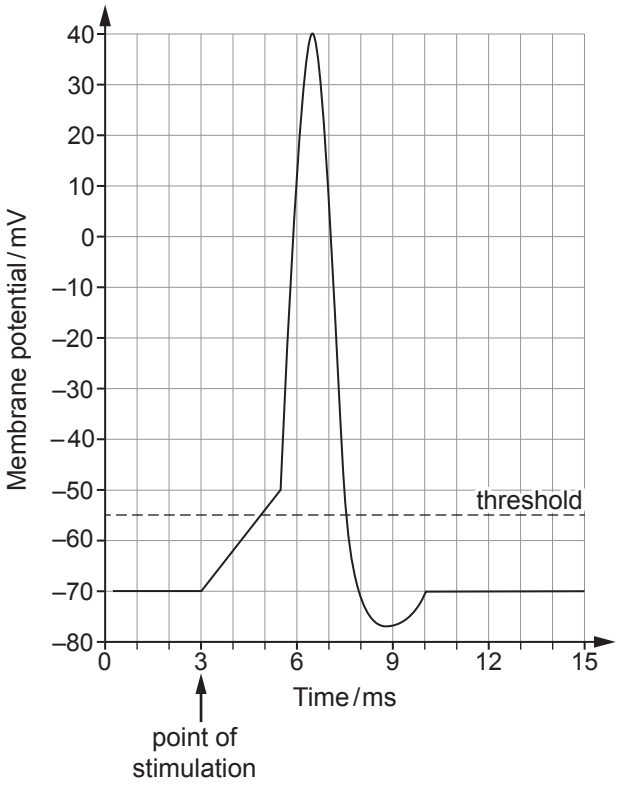
Examiner only

Both *Hydra* and humans generate action potentials in their neurones.
Graphs 1.3A and 1.3B show a trace from each organism.

Graph 1.3A – *Hydra*



Graph 1.3B – Human



(ii) Describe **two** ways in which the *Hydra* trace differs from that of the human. [2]

I. *The threshold in Hydra is higher (less negative), about −10 mV compared with −55 mV in the human.*

II. *Hydra takes longer to repolarise and return to resting potential, and it shows no hyperpolarisation (no refractory period).*

10

A400U301
05

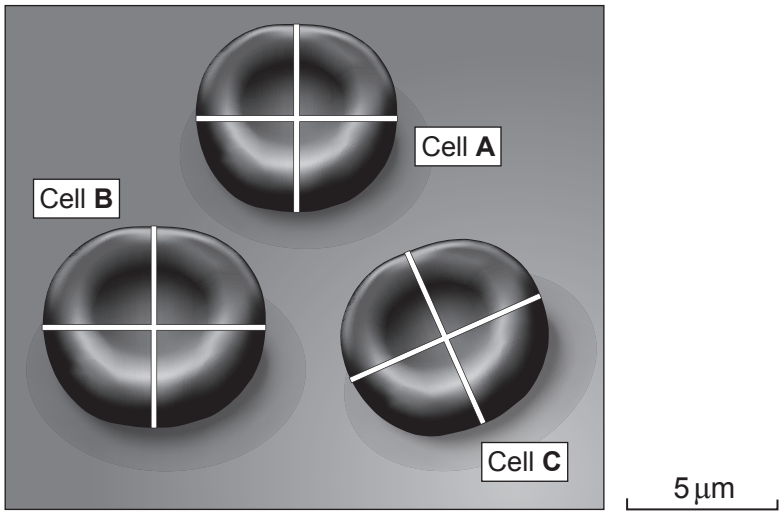
© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

2. (a) **Image 2.1** shows three human erythrocytes.

Image 2.1



(i) Human erythrocytes are biconcave in shape.
Explain how this increases the efficiency of gas exchange by these cells. [1]

It gives a large surface area to volume ratio and a short diffusion distance for oxygen.

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

Two diameters of cells **A**, **B** and **C** have been marked on **Image 2.1**. The length of the diameters for the cells were measured from the image and are shown in **Table 2.2**.

Table 2.2

Cell	Diameter 1 / mm	Diameter 2 / mm
A	28	23
B	30	28
C	27	25

(ii) I. Use all the data in **Table 2.2** to calculate the mean diameter of the human erythrocytes in **Image 2.1**. [1]

Mean diameter of human erythrocytes in **Image 2.1** = 27 mm

(28 + 23 + 30 + 28 + 27 + 25) ÷ 6 = 161 ÷ 6 = 26.8

II. **Use the scale bar** in **Image 2.1** and your answer to (ii)I. to calculate the mean **actual** diameter of a human erythrocyte. **Give your answer in µm.** [2]

scale bar = 20 mm represents 5 µm

actual = 27 ÷ 20 × 5 = 6.75 µm

Mean **actual** diameter of a human erythrocyte = 6.8 µm

III. Use **Image 2.1** to suggest **one** reason why the erythrocytes have different measured diameters in **Table 2.2**. [1]

The cells are not all lying flat, so they are viewed at different angles (not perfectly circular).

A400U301 07

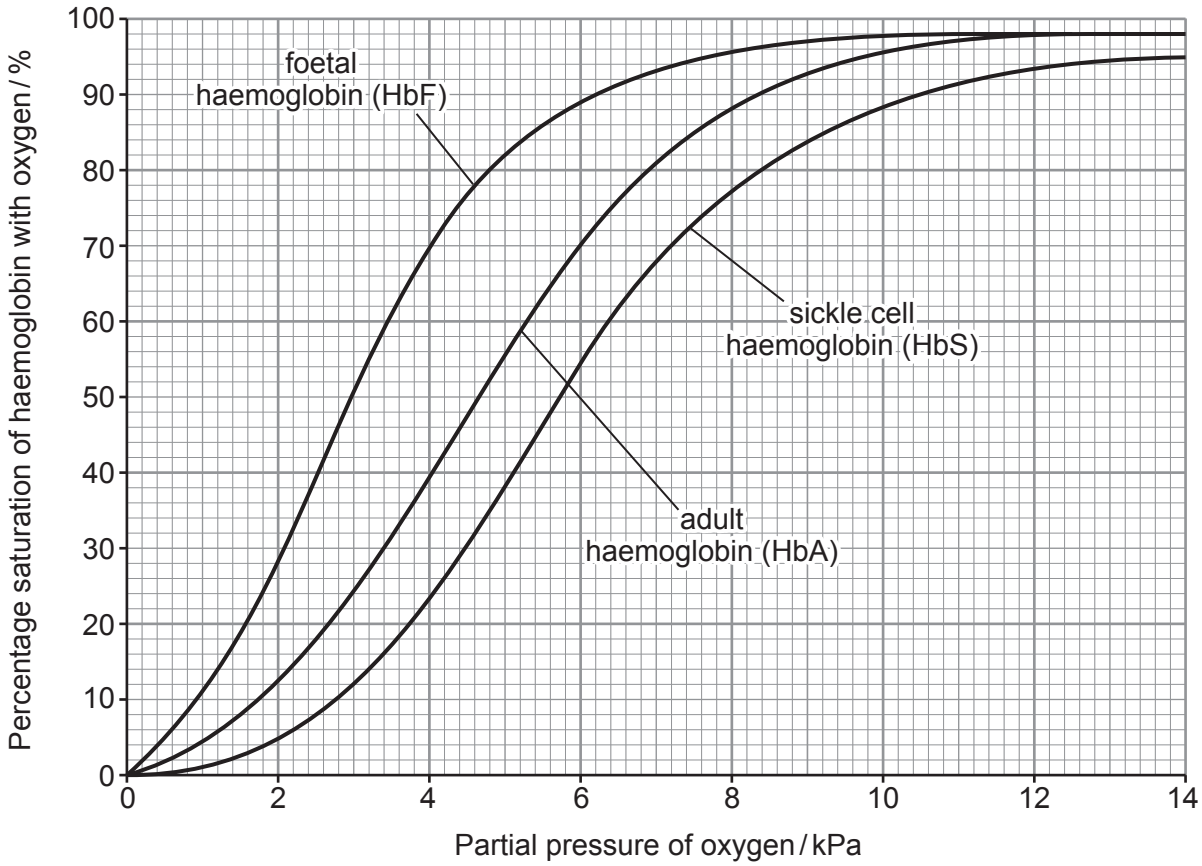
© WJEC CBAC Ltd.

Examiner only

(b) In the uterus, a developing foetus gains oxygen from maternal blood via the placenta. The foetal erythrocytes contain foetal haemoglobin (HbF) rather than adult haemoglobin (HbA).
People with sickle cell anaemia have a gene mutation resulting in the production of sickle cell haemoglobin (HbS).

Graph 2.3 shows the oxygen dissociation curves for HbF, HbA and HbS

Graph 2.3



(i) Use data from **Graph 2.3** to explain the advantage to a foetus of having HbF rather than HbA. [3]

At 4 kPa, HbF is 70% saturated but HbA is only 40% saturated.

So HbF has a higher affinity for oxygen, with a higher saturation at lower partial pressures.

The foetus lives in a low oxygen environment in the uterus, and HbF can still load oxygen there: oxygen diffuses from the mother's blood (HbA) to the foetal blood.

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(ii) Use **Graph 2.3** to explain how the positions of the curves for HbA and HbS affect oxygen saturation. [2]

The HbS curve is to the right of HbA, so HbS has a lower affinity for oxygen.

At any given ppO_2, HbS has less oxygen saturation, e.g. at 4 kPa HbA is 40% saturated but HbS only 24%.

(iii) Use all the information provided to explain the effect of HbS on a person with sickle cell anaemia. [2]

Less oxygen is delivered to the tissues and muscles for aerobic respiration, so less ATP is produced.

The person is tired (fatigued, lethargic) and less able to exercise.

A400U301 09

12

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

3. Sucrose and other carbohydrates, such as raffinose, are transported from mesophyll cells in leaves to other parts of a plant through the phloem.

(a) Sucrose is a disaccharide. Raffinose is a trisaccharide made up of galactose, glucose and fructose. Both sucrose and raffinose contain glycosidic bonds.

Raffinose is a non-reducing sugar.
Describe how you would show that raffinose is a **non-reducing sugar** and not a reducing sugar. [4]

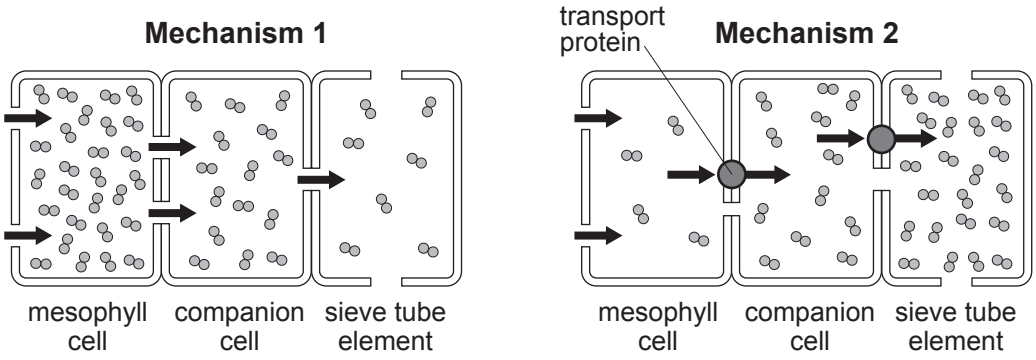
Heat raffinose with Benedict's reagent: it stays blue (negative), so no reducing sugar.

Heat a fresh sample with dilute HCl to hydrolyse the glycosidic bonds, then neutralise with sodium hydrogencarbonate.

Repeat the Benedict's test and heat: a red (orange) precipitate forms, so it is a non-reducing sugar.

(b) Carbohydrates move from leaf mesophyll cells into the sieve tube elements of plants via companion cells. There are several possible mechanisms involved. **Image 3.1** shows two of these mechanisms.

Image 3.1



(i) Identify how sucrose is transported **from mesophyll to companion cells** in each mechanism shown in **Image 3.1**. Explain the reason for your answer. [4]

Mechanism	Mode of transport	Explanation
1	Diffusion	from a high to low concentration, down a concentration gradient
2	Active transport	from a low to high concentration, against a concentration gradient

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(ii) A third mechanism involves sucrose being hydrolysed into its monosaccharides and used to synthesise raffinose in the companion cell.

Suggest how this increases the rate of movement of sucrose from mesophyll into the companion cells. [2]

Sucrose is converted to raffinose, so there is a lower concentration of sucrose in the companion cell.

This maintains a steeper concentration (diffusion) gradient from mesophyll to companion cell.

(c) The mass flow hypothesis of movement of sugars in the phloem suggests there is a pressure gradient from source to sink.
Explain how high pressure is generated in the phloem near the source cells. [4]

Sugars (sucrose) are loaded into the sieve tube elements, reducing their water potential (more negative).

Water moves into the sieve tube elements from the xylem by osmosis, down a water potential gradient.

This water entering increases the hydrostatic pressure in the phloem near the source.

© WJEC CBAC Ltd.

(d) The transport of sucrose in the phloem was investigated using radioactive carbon dioxide and ringing of the stem.

- All leaves were removed apart from one midway down the stem.
- Radioactive carbon dioxide $^{14}CO_2$ was added to a chamber surrounding the leaf.
- The level of ^{14}C was then measured at the top of the stem, in the leaf and in the root.
- The experiment was then repeated on three more plants but with the stem being ringed to remove the phloem in a combination of locations. **Image 3.2** shows the setup up of the apparatus.

Image 3.2

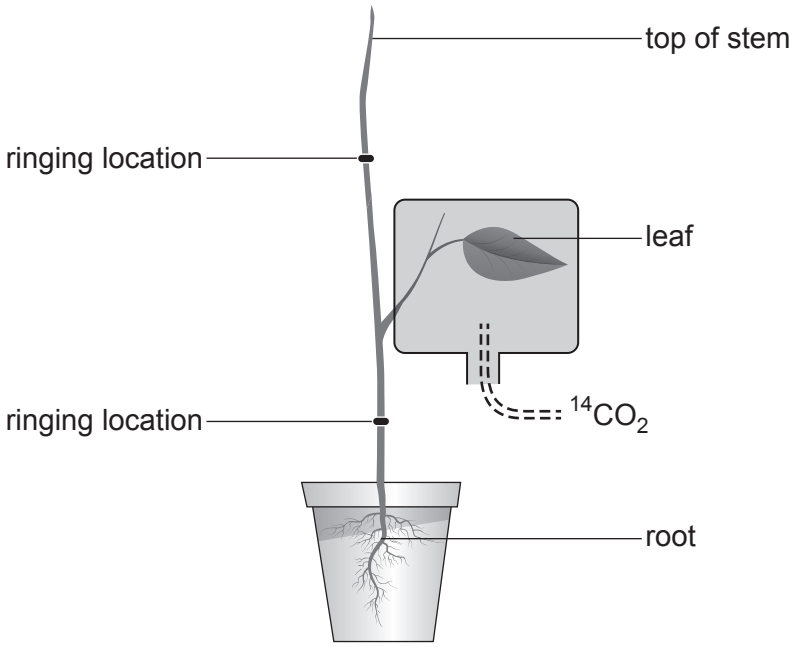


Table 3.3 shows the results of the investigation.

Table 3.3

Plant	Ringing location in relation to leaf	Level of ^{14}C / au		
		Leaf	Top of stem	Root
A	none	2.5	3.3	0.9
B	above	2.3	0.0	1.7
C	below	2.1	4.1	0.0
D	above and below	2.1	0.0	0.0

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(i) Suggest and explain the purpose of plant **A**. [2]

Plant A acts as a control (experiment).

It shows where the radioactivity (^{14}C) went when there was no ringing, for comparison.

(ii) Use the information from **Image 3.2** and **Table 3.3** to make **two** conclusions about the transport of sucrose in plants. Justify each conclusion. [4]

Conclusion 1

Phloem transports sucrose: in plants B, C and D no ^{14}C moved past the ring where the phloem had been removed (0.0 au).

Conclusion 2

Sucrose can move both upwards and downwards (source to sink): plant A has ^{14}C in both the top of the stem (3.3) and the root (0.9).

A400U301
13

20

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

4. Parasites are organisms which obtain nourishment at the expense of the host. Parasites of humans include *Taenia solium* (pork tapeworm) and *Pediculus capitus* (headlouse). These are shown in **Image 4.1**.

Image 4.1

Taenia



Pediculus



(a) *Taenia* is an endoparasite and *Pediculus* is an ectoparasite. Define each of these terms. [1]

Endoparasite: lives within (inside) its host. Ectoparasite: lives on the outside (surface) of its host.

(b) Explain why *Taenia* does not have a digestive system but *Pediculus* does have a digestive system. [4]

Taenia lives in the host's gut, where food has already been digested (predigested) by the host's enzymes.

So it absorbs the soluble nutrients directly across its cuticle (body surface): no digestive system is needed.

Pediculus bites the scalp and sucks blood from the host.

It needs a digestive system to digest (break down) the blood proteins, such as haemoglobin and plasma proteins.

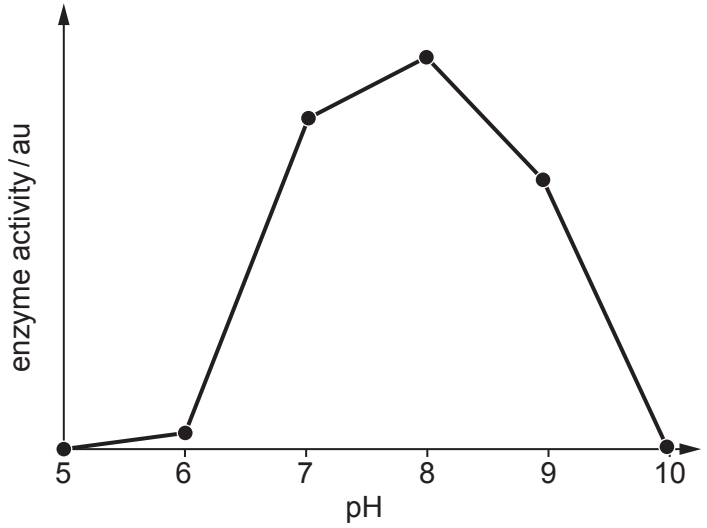
© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(c) Trypsin is an enzyme which digests proteins in the small intestine of humans. **Graph 4.2** shows how trypsin is affected by pH.

Graph 4.2



(i) Describe the evidence in **Graph 4.2** that suggests that trypsin is released into the duodenum. [1]

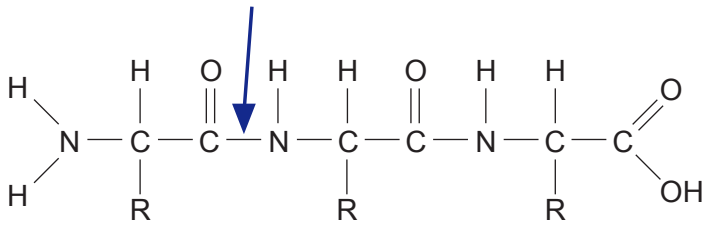
The optimum pH of trypsin (about pH 8, range 7 to 9) is similar to the pH of the duodenum.

(ii) Trypsin is released in an inactive form called trypsinogen.
Name the molecule that activates trypsinogen. [1]

enterokinase (enteropeptidase)

Image 4.3 shows a polypeptide containing three amino acids.

Image 4.3



(iii) Trypsin hydrolyses peptide bonds within polypeptides.
Draw an arrow on Image 4.3 to identify **one** peptide bond. [1]

A400U301
15

© WJEC CBAC Ltd.

Examiner only

(d) *Taenia* is able to change the pH of its environment.

An investigation was carried out to determine the effect of *Taenia* on the pH of its environment.

- Different saline (salt) solutions were prepared, each with a different initial pH (between 5.5 and 10.0).
- One *Taenia* was added to each solution.
- Each solution was incubated for two hours at 37 °C.
- The pH of the solutions was measured after incubation.

(i) Suggest why the *Taenia* were placed in saline solution rather than distilled water. [1]

Saline is isotonic to Taenia cells, so there is no net osmosis of water in and the cells do not lyse.

(ii) The results of the experiment showed that the pH of **all** the saline solutions at the end of the two-hour period was pH 5.0.
With reference to **Graph 4.2**, explain why it is of benefit to *Taenia* to reduce the pH of its environment. [3]

pH 5.0 is away from the optimum pH of trypsin (pH 8); Graph 4.2 shows no trypsin activity at pH 5.

At pH 5 trypsin is inactive (denatured), with no activity.

So trypsin cannot digest (break down) the proteins of the Taenia body wall, and it is not digested by the host.

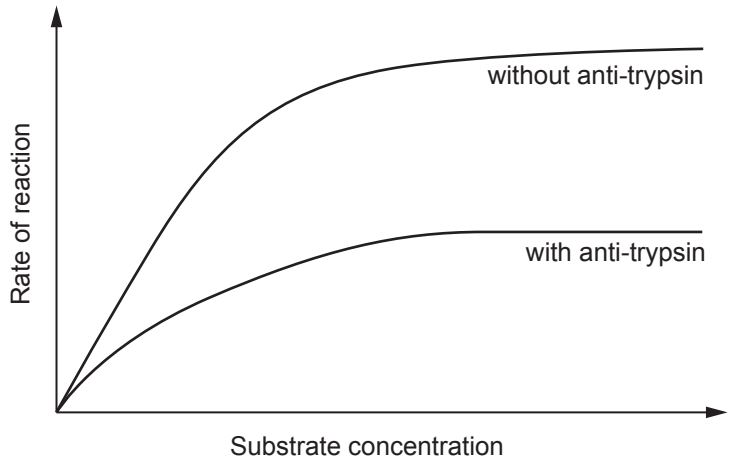
© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

Taenia also secretes a molecule called anti-trypsin which acts as an inhibitor of trypsin. **Graph 4.4** shows the rates of reaction of trypsin with and without the anti-trypsin.

Graph 4.4



(iii) Use **Graph 4.4** to identify which type of inhibition is shown by antitrypsin. Explain your answer. [2]

Non-competitive inhibition.

The maximum rate is not reached: at any substrate concentration the rate is always lower with anti-trypsin, so it is not overcome by increasing substrate concentration.

14

A400U301
17

© WJEC CBAC Ltd.

stemup.co.uk

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

5. Bony fish have a specialised gas exchange surface. Smaller organisms, like the flatworm, do not need specialised surfaces for gas exchange.

(a) Explain why larger organisms require specialised gas exchange surfaces. [2]

Larger organisms have a low surface area to volume ratio.

Diffusion over the body surface is too slow (insufficient) to meet their metabolic oxygen demand.

(b) Nitrogenous waste, in the form of ammonia, is released by the gills of bony fish directly into the water. Other organisms release different forms of nitrogenous waste.

(i) State the main form of nitrogenous waste excreted by: [1]

Mammals *urea*

Birds *uric acid*

Mammals have kidneys which can change the concentration of their urine. Urine concentration is measured in mOsm dm^{-3} and represents the number of particles dissolved in a dm^3 of solvent. **Table 5.1** shows the water availability and the urine concentration of a range of organisms.

Table 5.1

Organism	Water availability	Urine concentration / mOsm dm^{-3}
domestic cat	medium	3100
kangaroo rat	low	5500
beaver	high	520
human	medium	1400
camel	low	2800

(ii) I. Use the information in **Table 5.1** to describe the relationship between the availability of water and the concentration of urine produced by different mammals. [1]

The lower the water availability, the higher the urine concentration.

II. Explain the advantage of this relationship to the kangaroo rat. [1]

More water is conserved (reabsorbed), so less water is lost in urine.

A400U301 19

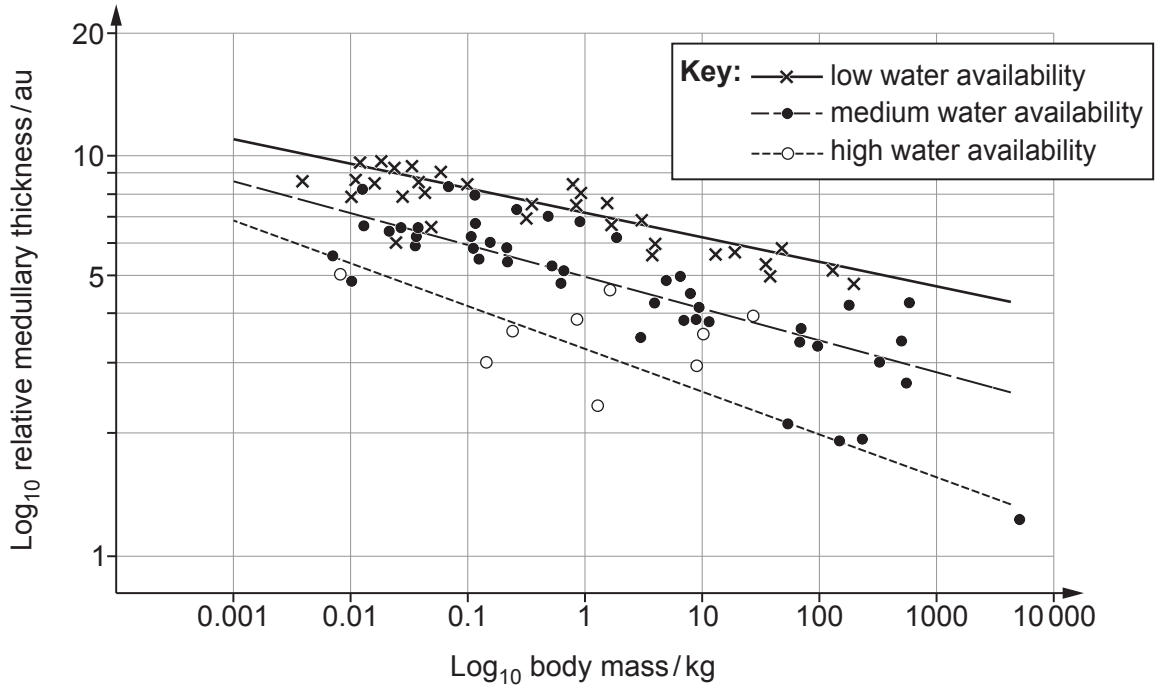
© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

The medulla of the kidney contains the loop of Henle and the collecting ducts. **Graph 5.2** shows the relative medullary thickness in a range of organisms from habitat types with different levels of water availability.

Graph 5.2



(iii) Explain why **Graph 5.2** uses a log scale for body mass. [1]

There is a large range of values (0.001 to 10 000 kg), which a log scale fits on one axis.

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(iv) Use **Graph 5.2** and your own knowledge to suggest how mammals living in habitats with a low water availability produce more concentrated urine. No details of ADH are required. [4]

Mammals from low water habitats have a thicker medulla, which contains longer loops of Henle (and collecting ducts).

More ions (Na^+ and Cl^-) are pumped out of the ascending limb into the tissue fluid of the medulla.

So the medulla has a more negative water potential.

More water is reabsorbed by osmosis out of the descending limb and the collecting duct, giving more concentrated urine.

© WJEC CBAC Ltd.

Examiner only

(c) (i) Toxic particles from plasma can be removed from the body in urine. Renal clearance is a measure of the volume of plasma that can be cleared of a particle by the kidneys per unit time.

Renal clearance can be calculated using the following equation:

$$CL_x = \frac{U_x \times V}{P_x}$$

Where

CL_x = renal clearance of particle **X**
U_x = urine concentration of particle **X**
P_x = plasma concentration of particle **X**
V = urine flow rate

Use the equation and the values below to calculate the renal clearance for particle **X** for a human. **Give your answer to the nearest whole number.** [3]

$U_x = 3.3\,\text{mg}\,\text{cm}^{-3}$
$P_x = 0.24\,\text{mg}\,\text{cm}^{-3}$
$V = 7\,\text{cm}^3\,\text{min}^{-1}$

$CL_x = (3.3 \times 7) \div 0.24$
$= 23.1 \div 0.24 = 96.25$

$CL_x =$ 96 $\text{cm}^3\,\text{min}^{-1}$

(ii) If a human was dehydrated their urine flow rate would decrease.
Suggest how this would affect renal clearance of particle X and the consequences of this to the person. [2]

Renal clearance of X would decrease.

So X builds up in the plasma and could reach toxic levels, harming the person.

15

© WJEC CBAC Ltd.

stemup.co.uk

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

6. Mollusca is a phylum of invertebrate animals that have evolved different types of vascular systems. **Images 6.1** and **6.2** show the generalised circulatory systems of an aquatic snail and a squid (also aquatic). The circulatory system of aquatic snails includes a haemocoel. This is the main body cavity containing circulatory fluid which surrounds the internal organs.

Image 6.1: circulatory system of an aquatic snail

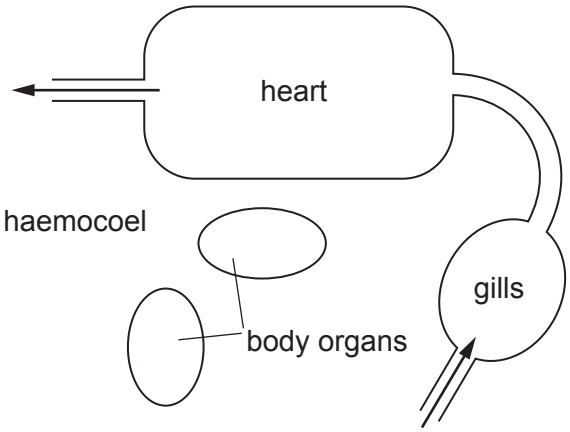
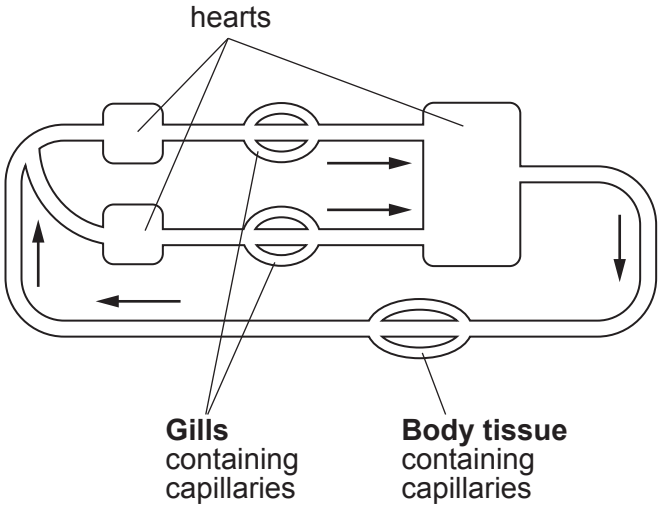




Image 6.2: circulatory system of a squid





Snails are slow-moving animals which feed mainly by grazing on algae and plants.

Squid are fast-moving predatory animals feeding on a wide variety of marine animals.

Describe the key features of the open circulatory system found in aquatic snails (**Image 6.1**) and the closed circulatory system found in squid (**Image 6.2**).
Explain how the circulatory systems of these organisms reflect their lifestyles. [9 QER]

The snail has an open circulatory system. It has a single heart, which pumps circulatory fluid (haemolymph) out at low pressure. The blood is not contained

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

in vessels for most of its circuit; it leaves the vessel and flows into the haemocoel, the main body cavity.

In the haemocoel the haemolymph bathes the body organs and is in direct contact with the cells and tissues, so substances exchange directly. Flow is slow and is not controlled or directed to particular organs, and blood returns to the heart slowly via the gills.

The squid has a closed circulatory system. All the blood is contained within blood vessels and does not come into direct contact with the cells; exchange happens across capillaries in the gills and in the body tissue.

It has more than one heart (three): two hearts pump blood through the gill capillaries and a main heart pumps oxygenated blood to the body. This means blood pressure is high and maintained after the gills, so blood flows quickly, and flow can be controlled and directed to the tissues that need it.

These systems reflect their lifestyles. The squid is a fast-moving predator: it must hunt and catch prey and move away from its own predators. This requires rapid muscle contraction, so it has a high demand for oxygen and a high rate of respiration (metabolism). The high pressure, fast, directed flow of a closed system delivers oxygen and glucose quickly and removes CO_2, supplying enough ATP.

The snail is a slow-moving herbivore that grazes on algae and plants, so it does not need to hunt. Its muscles contract slowly and it has a low demand for oxygen and a low rate of respiration (metabolism). The slow, low pressure flow of an open system is therefore sufficient to meet its needs.

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

9

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

SECTION B: OPTIONAL TOPICS

Option A: **Immunology and Disease** ☑

Option B: **Human Musculoskeletal Anatomy** ☐

Option C: **Neurobiology and Behaviour** ☐

Answer the question on **one topic only**.

Place a tick **(✓)** in **one** of the boxes above, to show which topic you are answering.

You are advised to spend about 25 minutes on this section.

© WJEC CBAC Ltd.

stemup.co.uk

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

Option A: Immunology and Disease

7. Scarlet fever is an infectious disease of young children. The characteristic symptoms are sore throat, fever, and a red rash. The disease is caused by the bacterium *Streptococcus pyogenes* which produces a toxin that causes the symptoms. Diagnosis of scarlet fever may be confirmed by a test that detects antigens of *S. pyogenes*.

(a) Define the following terms: [2]

Infectious disease;

A disease that can be passed (transmitted) from one individual to another.

Toxin;

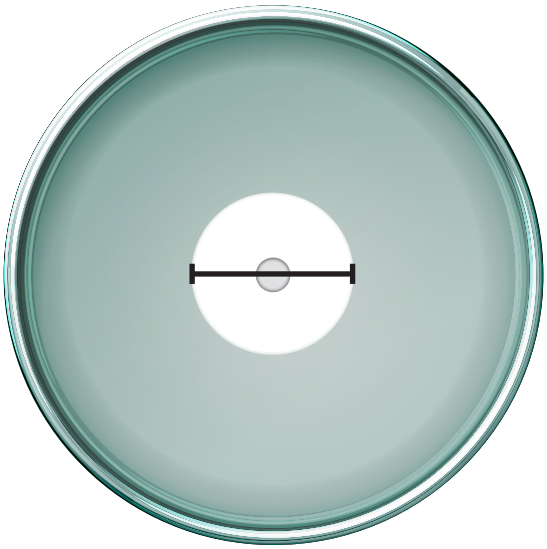
A chemical produced by a pathogen (microorganism) which causes damage (harm) to its host.

Antigen.

Any substance (e.g. a protein on a cell surface) which stimulates an immune response, the production of antibodies.

(b) **Image 7.1** shows the results of an experiment into the effect of an antibiotic on *S. pyogenes*. This involved placing a disc soaked in the antibiotic on an agar plate spread with a culture of *S. pyogenes*. The antibiotic diffuses through the agar and a clear zone is produced around the disc where bacterial growth has been inhibited.

Image 7.1



Magnification = × 0.6

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(i) Use the line on **Image 7.1** to calculate the actual diameter of the clear zone. [2]

line = 21 mm; actual = 21 ÷ 0.6 = 35 mm

Actual diameter = 35 mm

The experiment was then carried out for a range of antibiotics. The mean results are shown in **Table 7.2**.

Table 7.2

Antibiotic	Mean diameter of clear zone / mm	Standard deviation / ±
Penicillin G	30.4	2.7
Amoxycillin	27.8	2.9
Tetracycline	9.5	2.4
Control	0.0	0.0

(ii) It was concluded that Penicillin G was the most effective antibiotic against *S. pyogenes*.
Use the data in **Table 7.2** to evaluate this conclusion. [2]

Penicillin G does give the largest mean clear zone (30.4 mm), so it supports the conclusion.

However, the standard deviations of penicillin G (30.4 ± 2.7) and amoxycillin (27.8 ± 2.9) overlap, so the difference may not be significant and the conclusion is not fully valid.

(iii) In this investigation, identical agar plates and discs were used for all antibiotics and the concentration of each of the antibiotics was kept the same.
State **two** other variables which would need to be controlled during the investigation. [2]

Incubation temperature.

Incubation time (and the volume or density of bacterial culture spread).

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(c) Tetracycline is a broad-spectrum antibiotic. Some strains of *S. pyogenes* have become resistant to this antibiotic.

(i) Explain why tetracycline is effective against a wide range of bacterial species. [1]

It affects protein synthesis: it inhibits translation by blocking the binding site on the bacterial ribosome, which all bacteria have.

(ii) *S. pyogenes* is a Gram positive bacterium. Resistant strains of *S. pyogenes* survive due to one of two different mechanisms:

- A transmembrane protein which pumps tetracycline out of the cell as fast as it enters.
- A protein that protects the ribosome from the effects of tetracycline.

Use the information given to explain why *S. pyogenes* which are resistant to tetracycline can still be killed by penicillin. [3]

The transmembrane pump and the ribosome-protecting protein are specific to tetracycline: they will not remove penicillin or protect the cell wall.

S. pyogenes is Gram positive, with a thick peptidoglycan cell wall, so it is affected by penicillin.

Penicillin inhibits cross-linkage formation in the cell wall, so the wall is weakened and the bacteria die by osmotic lysis.

(iii) Scientists have concluded that resistance of *S. pyogenes* to tetracycline has become a problem due to the extensive use of this antibiotic.

Explain how the extensive use of this antibiotic might lead to an increased number of resistant strains of *S. pyogenes*. [3]

Mutations give some bacteria a resistance allele.

Overuse of tetracycline kills susceptible bacteria; those with the allele survive (selective advantage).

They reproduce, passing the allele to the next generation (or by plasmid transfer).

So the resistance allele frequency increases in the population.

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(d) Following infection by *S. pyogenes*, the patient develops immunity to the bacterium. This immunity can last for several years.

(i) Describe how infection can lead to the development of a primary immune response against *S. pyogenes*. [3]

Macrophages engulf S. pyogenes and present its antigens; the T helper cell with a complementary receptor is activated (clonal selection). T helper cells secrete cytokines, which activate B cells with complementary receptors (antibodies). These B cells divide by mitosis (clonal expansion) and differentiate into plasma cells, which produce antibodies against S. pyogenes and its toxin. Memory cells remain in the blood for years.

(ii) Scarlet fever caused by *S. pyogenes* is very uncommon in children under 6 months old who are breastfed.

State the type of immunity present in these children and suggest how this occurs. [2]

Natural passive immunity. Antibodies are passed from the mother in breast milk (and crossed the placenta before birth).

20

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

Option B: Human Musculoskeletal Anatomy

8. (a) The axial skeleton includes the vertebral column and rib cage.

(i) State **one** function of the axial skeleton. [1]

.....

Image 8.1 shows an X-ray of part of the axial skeleton of a patient with a postural deformity.

Image 8.1



(ii) Name the type of deformity shown in **Image 8.1** and identify the region of the spine which is most affected in this patient. [2]

.....

.....

(iii) In addition to surgery, identify **one** type of treatment which might be used to correct the deformity shown in **Image 8.1**. [1]

.....

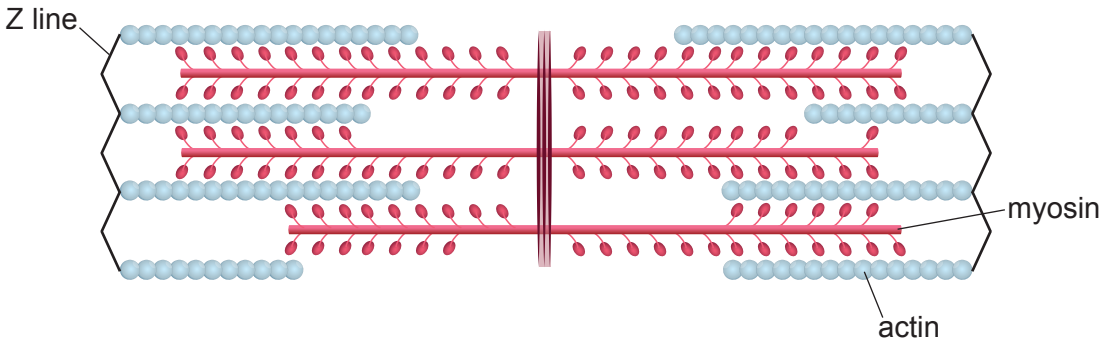
© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(b) Muscle wasting involves both the breakdown of muscle tissue and increased muscle fatigue. This can occur as part of the aging process, prolonged inactivity or disease. **Image 8.2** shows the appearance of a sarcomere in a person with wasted muscles.

Image 8.2



(i) Use your own knowledge of the sliding filament theory to describe the damage seen to the sarcomere in **Image 8.2**. Explain how this can lead to muscle weakness. [3]

.....

.....

.....

.....

.....

.....

(ii) Enzymes in lysosomes of muscle cells can lead to the breakdown of mitochondria in a process called autophagy.

Suggest how autophagy might affect muscle contraction. [2]

.....

.....

.....

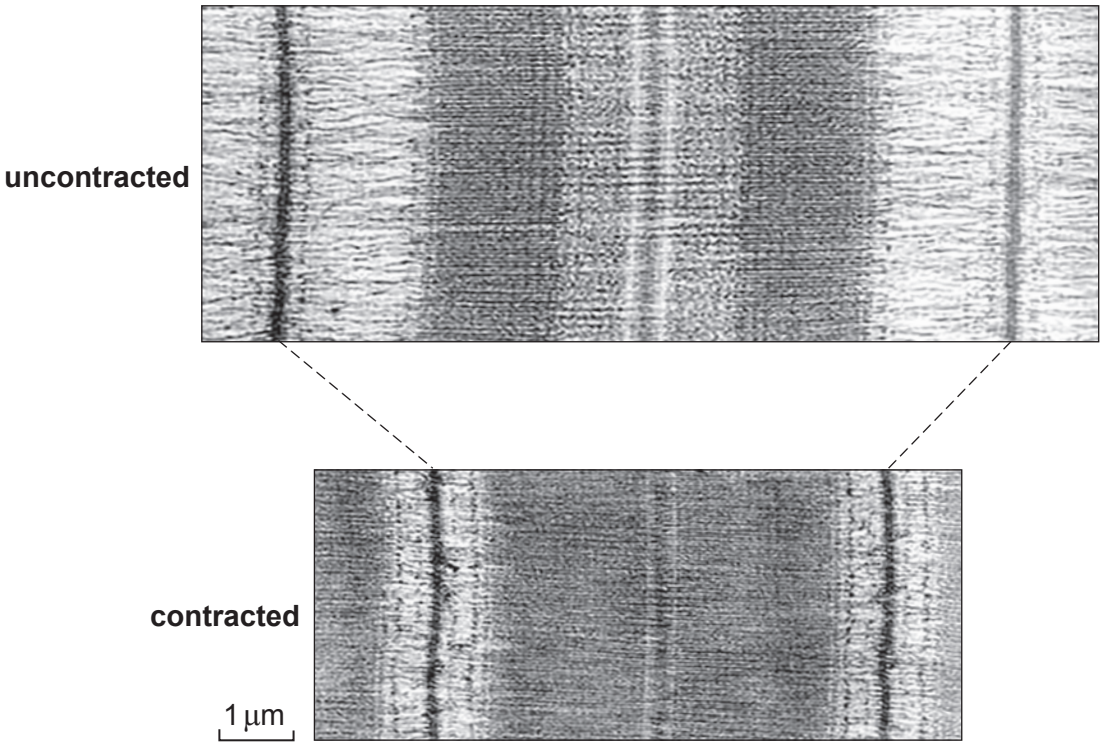
.....

© WJEC CBAC Ltd.

Examiner only

Image 8.3 shows the changes that occur in a sarcomere when skeletal muscle contracts, as seen through an electron microscope.

Image 8.3



(iii) Use the scale bar to determine the actual length of the **contracted** sarcomere in **Image 8.3**. [2]

Actual length = ... µm

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(c) **Table 8.4** shows data on the percentage of slow twitch (ST) and fast twitch (FT) muscle fibres from groups of athletes and non-athletes. It also shows the ratio of slow twitch to fast twitch muscles in each group of athletes.

Table 8.4

Group	Proportion of slow twitch and fast twitch muscle fibres		
	Slow Twitch / %	Fast Twitch / %	Ratio ST : FT
marathon runners	82	18	4.6 : 1
swimmers	75	25	3.0 : 1
non-athlete	45	55	0.8 : 1
sprinters	37	63	0.6 : 1

(i) The ratio of ST : FT muscle fibres in marathon runners was 4.6 : 1.
Explain the advantage of this ratio to marathon runners. [1]

.....

.....

(ii) The samples analysed were all obtained from the same muscle in all individuals in the study.

Explain why it is important to obtain the samples from the same muscle in each individual. [2]

.....

.....

.....

.....

(iii) State **two** factors that should have been controlled within each group to improve confidence in the conclusions. [2]

.....

.....

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(d) **Image 8.5** shows an X-ray of a patient who was suffering from osteoarthritis of the knee.

Image 8.5

FRONT VIEW



(i) Describe the evidence from **Image 8.5** that this patient had osteoarthritis. [1]

.....

.....

(ii) The patient above was advised that they would be a suitable candidate for knee replacement surgery.
State **three disadvantages** of this treatment. [3]

I. .....

.....

II. .....

.....

III. .....

.....

20

© WJEC CBAC Ltd.

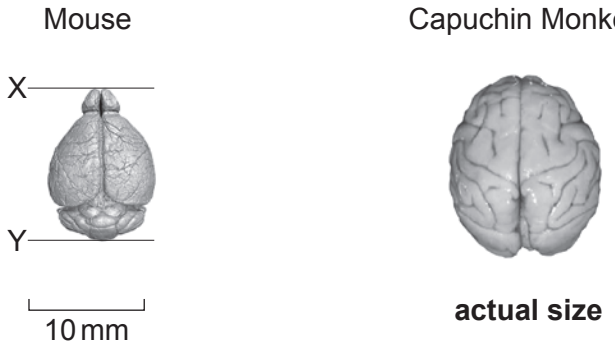
stemup.co.uk

Examiner only

Option C: Neurobiology and Behaviour

9. (a) **Image 9.1** shows the brains of a mouse and a capuchin monkey.

Image 9.1



(i) The mouse brain in **Image 9.1** has been magnified to allow comparison with the monkey brain.
Use the scale bar to calculate the actual length of the mouse brain. **Give your answer to the nearest mm.** [2]

Actual length = ... mm

(ii) The monkey has a larger brain than the mouse and is considered to be a more intelligent animal.
Use **Image 9.1** to identify **one** other difference between the two brains that might account for this. [1]

.....

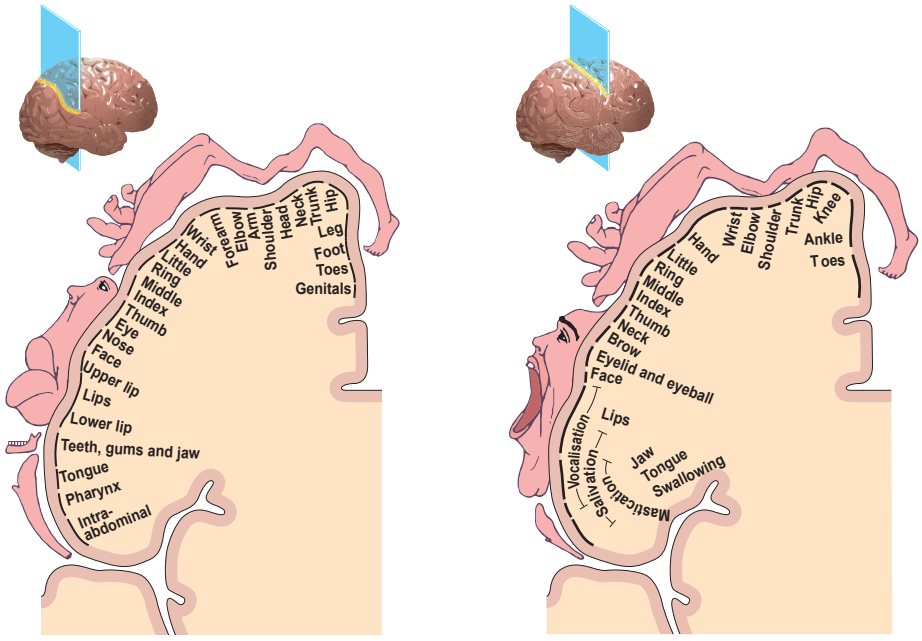
.....

© WJEC CBAC Ltd.

Examiner only

Homunculi are used to represent the sizes of the relevant parts of the cerebrum associated with receiving sensory information from different parts of the body and their motor control. **Image 9.2** shows sensory and motor homunculi.

Image 9.2



Sensory cortex in right cerebrum

Motor cortex in right cerebrum

(iii) I. Describe the relationship between the size of the body parts shown in **Image 9.2** and the degree of innervation of the cerebrum. [1]

.....

.....

II. Explain why the size of the fingers in both the sensory and motor homunculi are similar. [2]

.....

.....

.....

.....

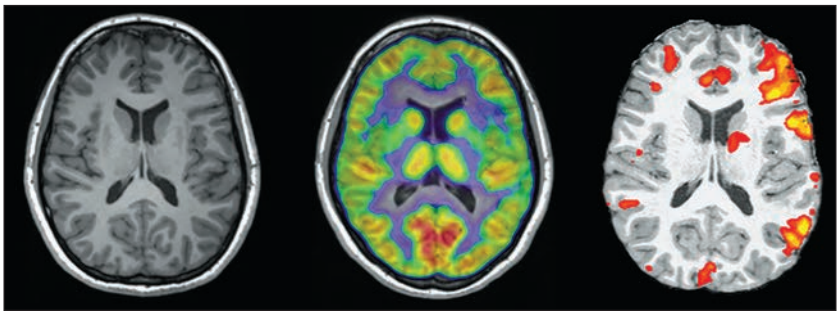
© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(b) **Image 9.3** shows three types of scan which are used to visualise the brain.

Image 9.3



CAT/CT Scan PET Scan fMRI Scan

(i) Describe **two** advantages of using scans to visualise the brain. [2]

.....

.....

.....

.....

(ii) fMRI scanning is considered the best method for monitoring brain activity.
State the full name for this scanning method. [1]

.....

(iii) The coloured areas on the fMRI scan correspond to increased flow of oxygenated blood in that region.
Explain how this can be used to monitor brain activity. [2]

.....

.....

.....

.....

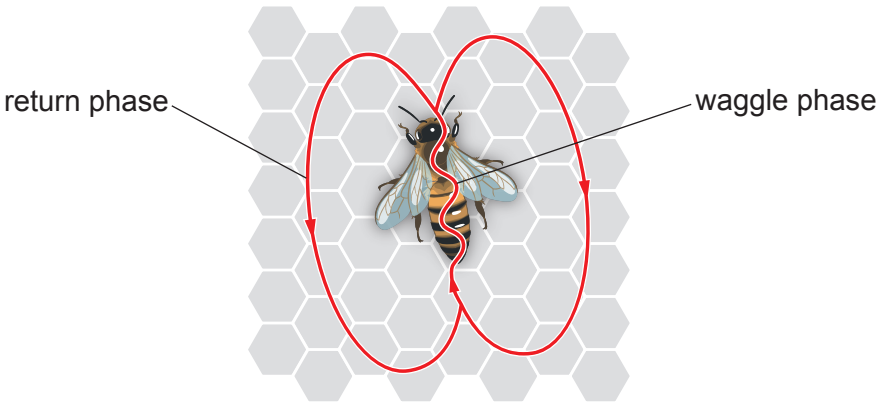
© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

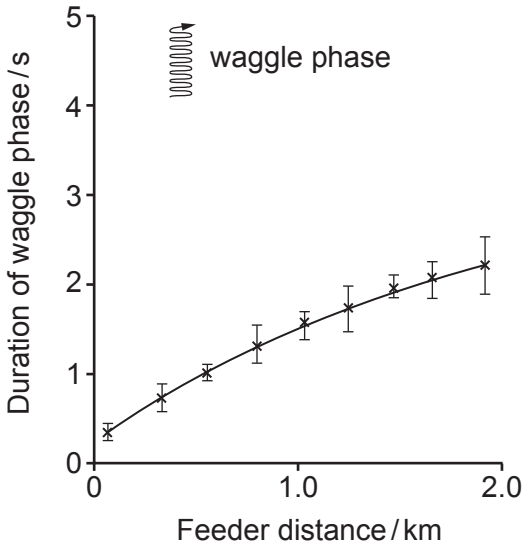
(c) Honeybees live in dense groups called colonies. The bees display a range of innate behaviour patterns which help them to communicate within the colony. On returning to their colonies, worker honeybees perform a waggle dance many times to communicate to other bees the distance and direction of a food source from the hive. The dance is made up of two phases, the waggle phase and the return phase. This is shown in **Image 9.4**.

Image 9.4

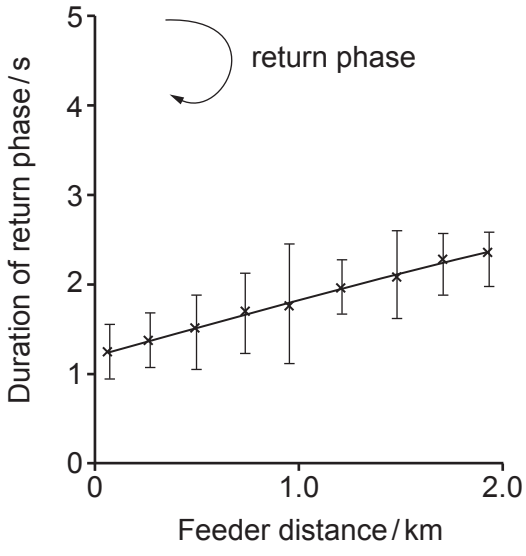


A group of researchers studied the relationship between the duration of the two phases of the waggle dance to the distance of artificial feeders from the hive. The artificial feeders contained a sugar solution and were all the same colour. The results they obtained are shown in **Graph 9.5A** and **Graph 9.5B**.

Graph 9.5A



Graph 9.5B



(i) Suggest **two** factors that could be controlled by using an artificial feeder for this experiment rather than relying on naturally occurring flowers. [2]

.....

.....

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(ii) Identify which of **Graphs 9.5A** and **B** has the more reliable data. Explain your choice. [1]

.....

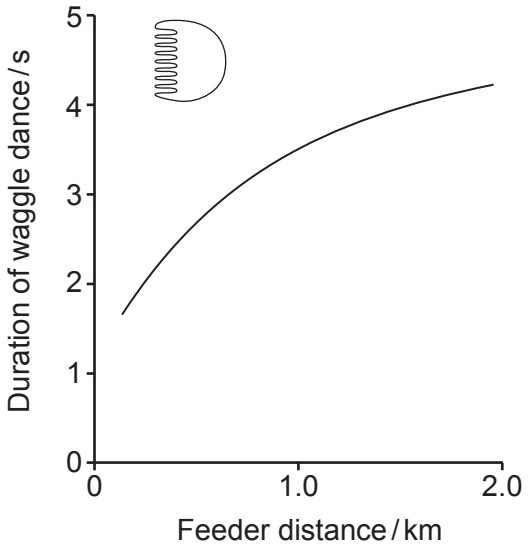
.....

.....

.....

Graph 9.6 shows data from **Graphs 9.5A** and **B** combined.

Graph 9.6



(iii) State the general relationship shown in **Graph 9.6** and suggest the benefit of this relationship to the bee colony. [3]

.....

.....

.....

.....

.....

.....

© WJEC CBAC Ltd.

stemup.co.uk

Examiner only

(iv) The bee waggle dance is an example of innate behaviour in a social insect. Primates also live in close social groups and display both innate and learned behaviour within the social group.

I. Distinguish between innate and learned behaviour. [1]

.....

.....

II. Give **one** example of each type of behaviour in primates. [2]

Innate

.....

Learned

.....

20

END OF PAPER

© WJEC CBAC Ltd.

stemup.co.uk

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

Examiner only

© WJEC CBAC Ltd.

stemup.co.uk

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

Examiner only

© WJEC CBAC Ltd.

stemup.co.uk

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

Examiner only

© WJEC CBAC Ltd.

stemup.co.uk

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

© WJEC CBAC Ltd.

stemup.co.uk