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Examiners' report

GATEWAY SCIENCE BIOLOGY A

J247
For first teaching in 2016

J247/03 Summer 2019 series

Version 1

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Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the question paper can be downloaded from OCR.

Paper 3 series overview

This summer is the second opportunity for candidates to sit the new J247 Gateway Biology specification. J247/03 is the first higher tier paper in the Biology suite. J247/03 assesses content from specification topics B1-B3 and B7. Therefore, to perform well on this paper candidates need to have a sound knowledge of the theory covered in topics B1-B3 and be able to apply the skills and understanding that they have developed in the practical activities covered in topic B7. This paper is not synoptic and so does not contain any material covered by topics B4-6. There are a number of questions that involve the assessment of key mathematical requirements from Appendix 5e of the specification.

Candidates who did well on this paper generally did the following:	***Candidates who did less well on this paper generally did the following:***
• Correctly performed calculations involving standard form Q11, Q20(c), Q21 • Extracted information from a table or graph and performed calculations with the data Q16(c)(i), Q17(c)(ii) • Constructed a clear and accurate line of best fit and used it to take readings Q18(c)(i) & (ii) • Displayed a good understanding of the roles of hormones in the menstrual cycle and could apply this knowledge to the use of hormones in contraception Q19 • Appreciated the role of DNA, mRNA and tRNA in protein synthesis Q22(a)	• Found it difficult to convert nanometres to metres Q21(b) • Confused the process of diffusion with osmosis Q18(a) • Failed to understand the role of ADH on the kidney and urine production Q18(b), Q13 • Confused the cause and effect on the body of type 1 diabetes with type 2 diabetes Q19(d) • Tried to explain changes in blood supply to muscles during exercise without making any comparative statements Q16(c)(ii)

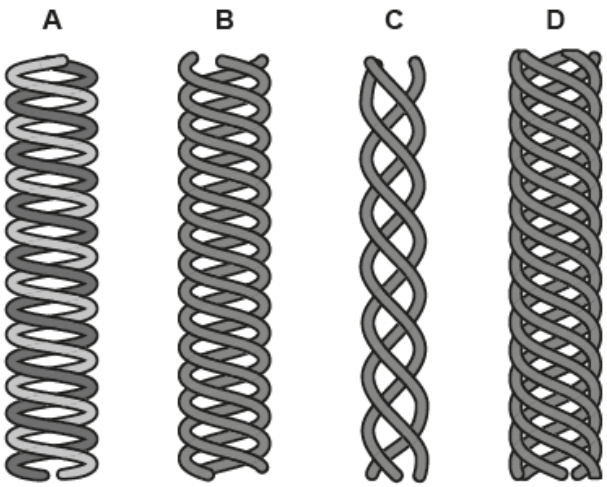
There was no evidence that any time constraints had led to a candidate underperforming.

Section A overview

Questions 1,2 & 4 proved to be very accessible questions with many correct answers. Questions 7, 13 and 15 were good discriminators, with mainly higher ability candidates answering correctly. Question 12 was the most challenging question in this section, as many candidates did not understand the concept of 'orders of magnitude'.

Question 3

3 Which structure most closely resembles DNA?

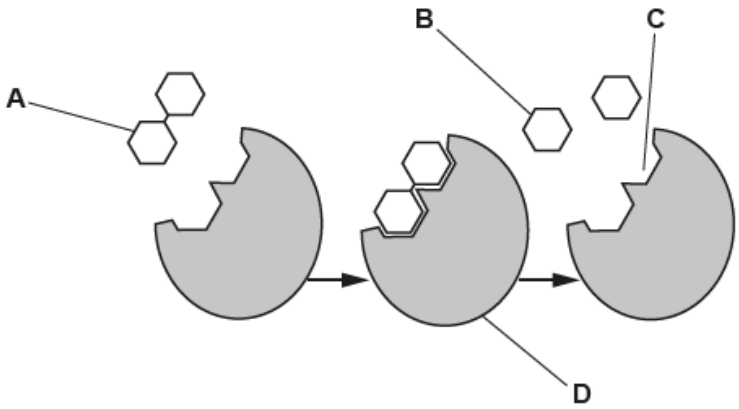


Your answer ☐ **[1]**

A very accessible question with the majority of candidates realising that DNA has a double helical structure.

Question 4

4 Look at the model of enzyme activity.



Which label represents the active site of an enzyme?

Your answer ☐ **[1]**

Another very accessible question which was answered correctly by most candidates.

Question 5

5 Which biological molecule is **not** a polymer?

A Amylase

B DNA

C Nucleotide

D Starch

Your answer ☐ **[1]**

This question proved to be challenging with a number of candidates choosing distractor A as the answer.

Question 7

7 The eye switches from focusing on a distant television to focusing on a close up newspaper.

Which change happens to the suspensory ligaments and to the lens during this switch?

	Suspensory ligaments	Lens
A	slack to tight	thicker
B	slack to tight	thinner
C	tight to slack	thicker
D	tight to slack	thinner

Your answer ☐ **[1]**

This proved to be a difficult question with no real pattern to the choices for incorrect answers.

Question 12

12 A human cell has 10 000 mitochondria and a yeast cell has 10.

By how many orders of magnitude are there more mitochondria in a human cell than in a yeast cell?

A 2

B 3

C 10

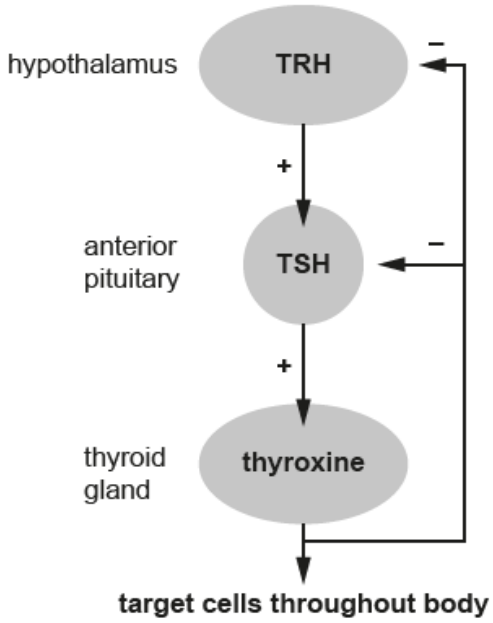
D 1000

Your answer ☐ **[1]**

The majority of candidates did not understand the concept of orders of magnitude and choose distractor D as their answer.

Question 15

15 Thyroxine is a hormone controlled by negative feedback.



There is an **increase** in the metabolic rate of the body until the cells of the body have the required amount of energy.

Once the cells of the body have the required amount of energy what will happen to the levels of the three hormones in the blood?

A all three will increase

B all three will decrease

C TRH and TSH will increase and thyroxine will decrease

D TRH and TSH will decrease and thyroxine will increase

Your answer ☐ **[1]**

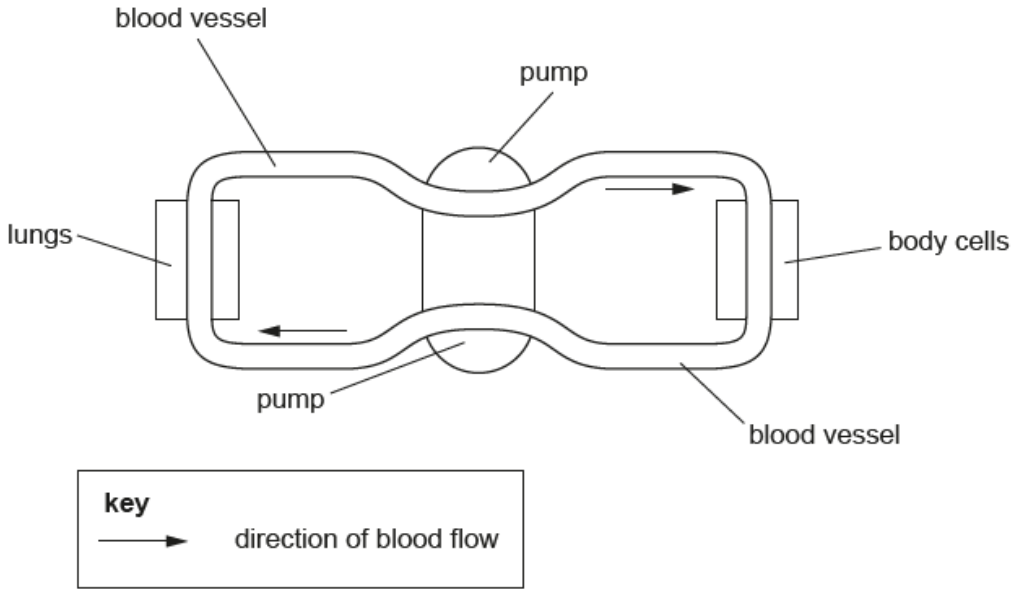
Many candidates chose distractors C or D as their answers.

Section B overview

Many candidates scored well on the mathematical questions in this section, demonstrating an ability to calculate using standard form. There were also a high number of level 3 answers to the level of response question, Q12(b). One of the questions that proved to be most challenging was Q18(a). Due to the use of dialysis tubing, many candidates tried to answer in terms of osmosis rather than diffusion.

Question 16 (a)

16 Look at the diagram. It represents the human circulatory system.



(a) Describe how the diagram shows that humans have a double circulatory system.

.....

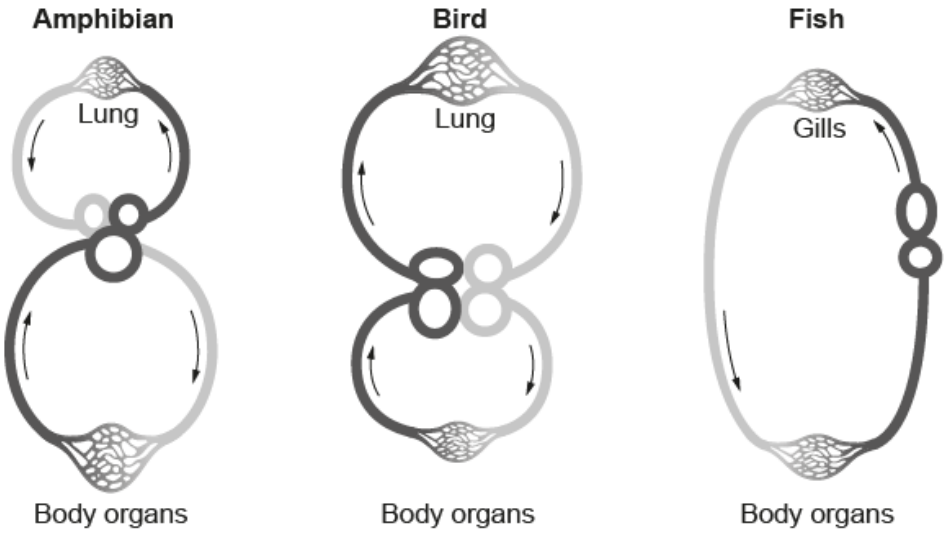
.....

..... **[2]**

There were many concise and correct answers, stating that the blood flows through the heart twice on each circuit. Some candidates tried to describe the flow of blood, but their answers did not differentiate between a single or a double system.

Question 16 (b)

(b) Look at the diagrams of the circulation systems in an amphibian, bird and fish.



Which of these has a circulatory system most similar to humans?

Tick (✓) **one** box.

Amphibian ☐

Bird ☐

Fish ☐

Explain your choice.

.....

.....

.....

.....

.....

..... **[3]**

The majority of candidates chose the correct organism and stated that the fish had a double circulatory system and had a four-chambered heart. A description of the double system was accepted.

Question 16 (c) (i)

(c) Scientists investigate how exercise affects blood flow to different organs in the body.

This is their method.

- Ask a healthy person to sit in a room at 20 °C
- Measure the blood flow to different organs in the person's body
- Repeat this with the person exercising at a constant speed on a treadmill in the same room.

The table shows the scientists' results.

Organ	Rate of blood flow (ml per minute)	
	Sitting	Doing exercise
Brain	750	750
Heart muscle	250	1000
Muscles	1200	22000
Skin	500	600
Other organs	3100	650
Total	**5800**	**25000**

(i) By how many times has the **total** blood flow increased by doing exercise?

Give your answer to the **nearest whole number**.

Number of times the total blood flow has increased = ... **[2]**

The majority of candidates extracted the correct numbers from the table, completed the calculation and gave their answer to the nearest whole number.

Question 16 (c) (ii)

(ii) The table shows that blood flow to other organs has decreased by nearly 5 times when a person is **doing exercise**.

The blood flow to the muscles has increased by more than eighteen times.

Explain these changes to blood flow rate.

.....

.....

.....

..... **[2]**

The main error here made by candidates was that they did not give a comparative answer. Exemplar 1 clearly states that **more** oxygen is required for **more** respiration and so scores both marks. Only one comparative statement was required but a number of candidates did not give any, simply stating that muscles need more blood because they need oxygen.

Exemplar 1

The blood flow to the muscles increases because they are contracting more and hence require more glucose and oxygen for more respiration, the increased blood flow provides the muscle cells with significant amounts of glucose and oxygen. **[2]**

Question 17 (a)

17 Yeast cells can respire anaerobically.

(a) Complete the word equation for **anaerobic** respiration in yeast.

glucose ⟶ ..... + ... **[1]**

This question was well answered by the majority of candidates.

Question 17 (b)

(b) Write down **two** ways in which anaerobic respiration in yeast cells is different from anaerobic respiration in human muscle cells.

1 .....

.....

2 .....

..... **[2]**

Although most candidates identified differences in the products formed, there were a number of incorrect references to the energy released by the two processes. One of these is seen in exemplar 2, which only scored one mark.

Exemplar 2

1 Anaerobic respiration in humans produces lactic acid.

2 Yeast cells produce more energy anaerobically than human muscle cells do. **[2]**

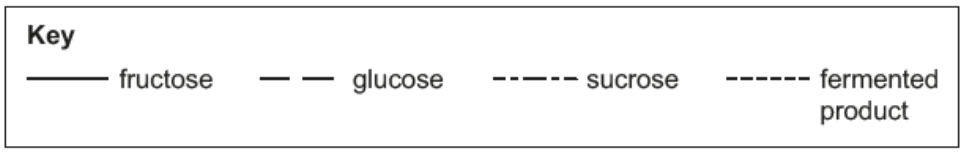
Question 17 (c)

(c) Date fruits contain three different sugars, fructose, glucose and sucrose.

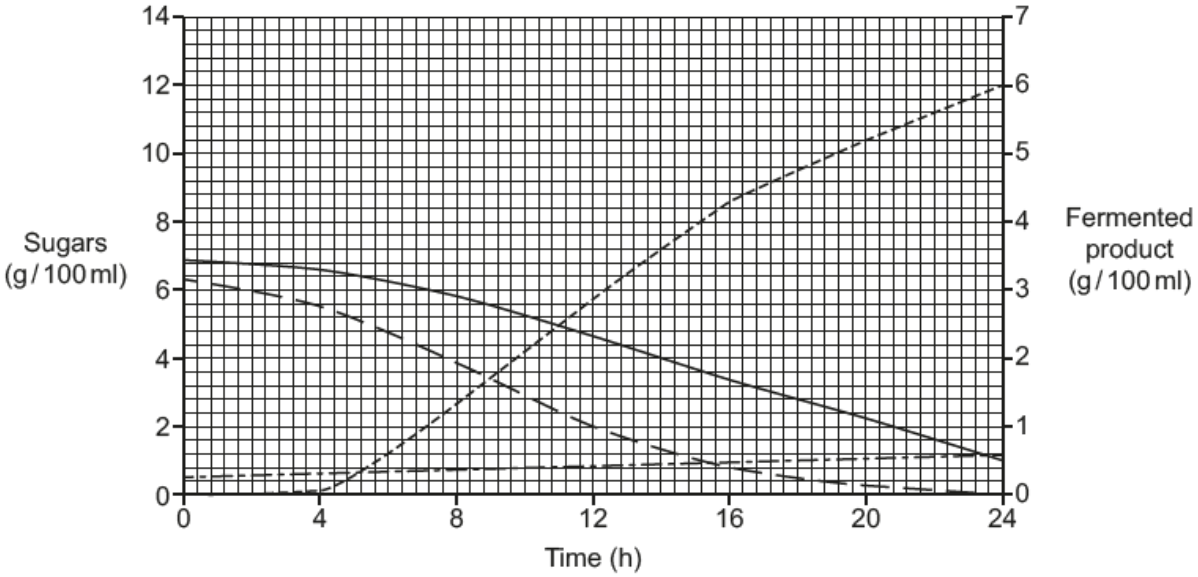
Different strains of yeast can ferment different sugars to produce a fermented product.

Scientists investigate how two different strains of yeast, **A** and **B**, ferment sugars inside date fruits.

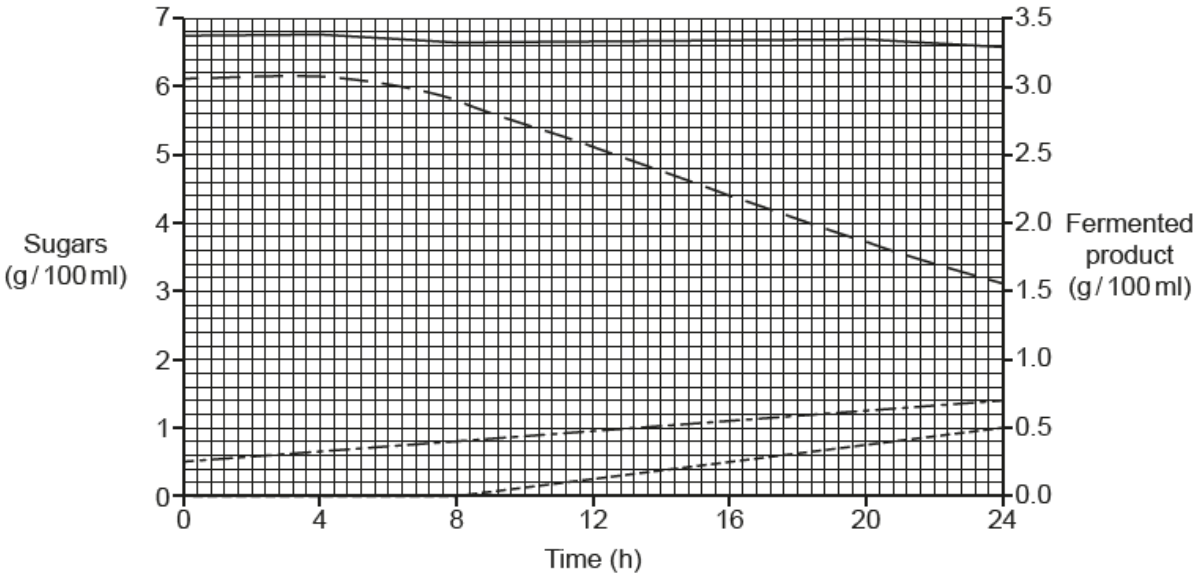
Look at their results.



Yeast A



Yeast B



Question 17 (c) (i)

(i) Which sugar is **not** fermented by either strain of yeast?

Tick (✓) **one** box.

Fructose ☐

Glucose ☐

Sucrose ☐

[1]

Most candidates correctly identified the sugar as sucrose.

Question 17 (c) (ii)

(ii) After 24 hours, how many times higher is the fermented product yield of yeast **A** compared to yeast **B**?

Number of times higher = ... **[2]**

Most candidates could extract the correct data from the graph and complete the calculation.

Question 17 (c) (iii)

(iii) Which sugar would increase fermentation the **most** if added to either yeast **A** or yeast **B**?

Tick (✓) **one** box.

Fructose ☐

Glucose ☐

Sucrose ☐

[1]

This question proved to be more challenging with both sucrose and fructose being chosen equally as incorrect answers.

Question 17 (c) (iv)

(iv) Fermented dates are used to supply both fructose and fermented product.

Explain why it would be best to use yeast **B** to ferment dates to supply both fructose and fermented product.

.....

.....

.....

..... **[2]**

The examiners were looking for an understanding that yeast B does not use up as much fructose but still produces some fermented product. A number of candidates stated that fructose is actually produced by yeast B and others claimed that it also produces high concentrations of fermented product. Exemplar 3 makes both of these errors and so does not score.

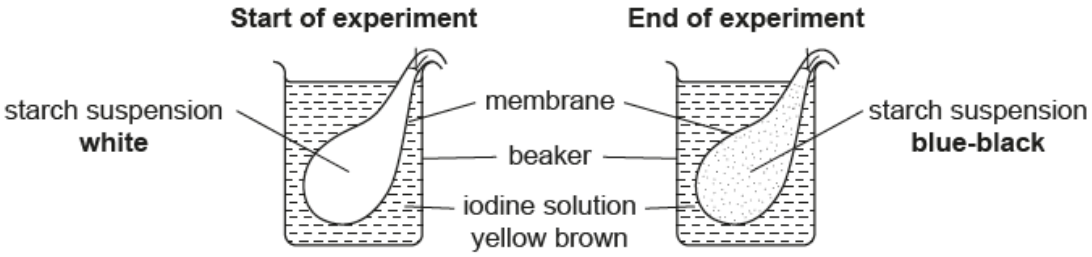
Exemplar 3

Yeast B produced 3·25 g/100ml of fructose in 24 hours which was more than yeast A did at only 0·4 g/100ml. Yeast B also produced 0·5 g/100ml of fermented product which is still high. **[2]**

Question 18 (a)

18 (a) An experiment is set up to investigate how substances move into and out of cells.

Look at the results.



Explain the results of this experiment.
Use ideas about molecules in your answer.

.....

.....

.....

.....

..... **[3]**

Many of the candidates understood that the iodine molecules must have entered the bag. However, some of them put this down to osmosis rather than diffusion and therefore lost this mark. Few candidates commented on the fact that starch molecules could not leave the bag and did not explain this in terms of the size of the molecules.

Question 18 (b)

***(b)** Sodium ions help regulate the balance of water between the blood and body cells.

In some people the level of sodium ions in the blood can become very low. This can alter the balance of water between the blood and body cells. Doctors can prescribe drugs for patients who have this condition.

Explain how low sodium ion levels in the blood will affect the cells of the body and suggest why drugs that block the action of ADH can treat this condition.

.....

.....

.....

.....

.....

..... **[6]**

A number of candidates did not commit themselves as to whether the body cells would lose or take up water and explained both possibilities. Incorrect references to turgidity were also seen. There was also confusion regarding the role of ADH, with a number of candidates stating that it makes the body pass out more water. Exemplar 4 shows a clear, correct Level 3 answer.

Exemplar 4

Low sodium ion levels can cause a ~~patients~~ persons cells to be ~~dehydrated~~ overhydrated which puts them at risk of bursting. this is because the water potential of the blood will be higher than that of the cells. Through osmosis, water moves into those cells and if too much enters the cells could burst. ADH is the anti-diuretic hormone and it prevents water from being lost through urine by causing the kidneys to reabsorb it into the blood. Drugs blocking this action would cause more ~~blood~~ water to be lost during urination as not as much would be reabsorbed. This would lower the water potential of the blood and reduce the amount of water entering cells, reducing the chance of cells undergoing lysis and bursting. **[6]**

Question 18 (c) (i)

(c) Plant cells are also affected by osmotic conditions.

Look at the graph. It shows the percentage change in mass of potato chips in different concentrations of sucrose.

(i) Draw a curve of best-fit on the graph. **[1]**

The ability of candidates to draw a best fit curve seems to be improving and less double lines or sketched lines were seen.

Question 18 (c) (ii)

(ii) Use the graph to estimate the concentration of sucrose that has the same water potential as the potato cells.

Concentration = ... mol/dm^3 **[1]**

Some candidates had difficulties with the scale, but most could read off the intercept.

Question 18 (d)

(d) Osmotic conditions can increase the size of plant tissue but stem cells are responsible for growth of new cells.

What name is given to plant tissue that contains stem cells?

..... **[1]**

Although some of the spellings varied, a number of candidates correctly identified meristems.

Question 19 (b)

(b) Explain how hormones can be used by women for contraception.

.....

.....

.....

.....

.....

.....

..... **[4]**

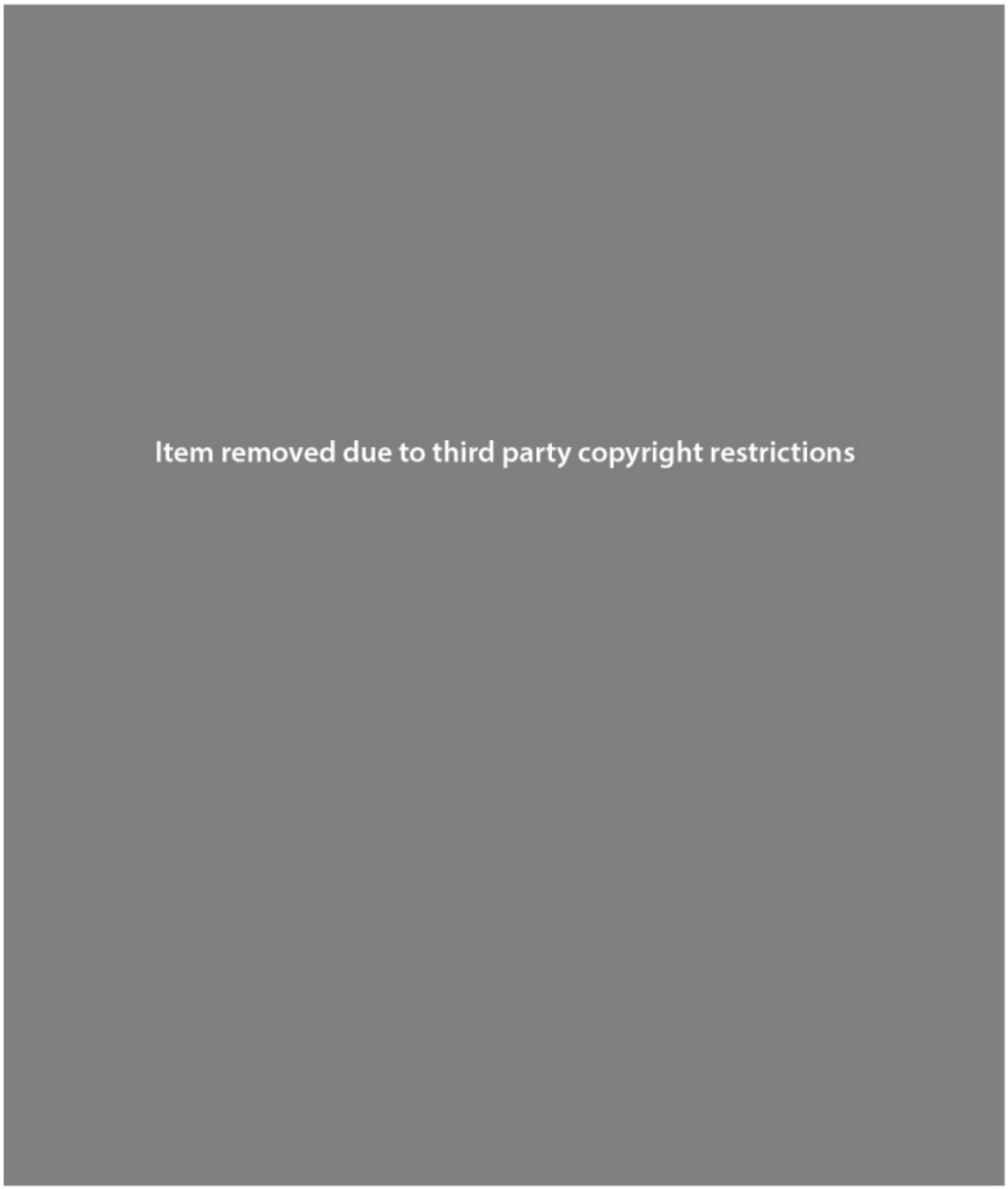
A small number of candidates confused fertility treatment with contraception and so referred to the use of FSH or LH. However, the majority could correctly explain why oestrogen and/or progesterone were used.

Question 19 (d)

(d) A glucose tolerance test can help identify diabetes.

The graphs show a glucose tolerance test in three people, **A**, **B** and **C**.

One person is healthy, and two people have different types of diabetes.



Question 19 (d) (i)

(i) Which person has **type 2** diabetes?

Person ..... **[1]**

A significant number of candidates thought that candidate A had type 2 diabetes. Others confused type 1 with type 2 and so chose option B.

Question 19 (d) (ii)

(ii) Explain the reasons for your choice in part **(d)(i)**.

.....

.....

.....

..... **[2]**

Confusion between type 1 and type 2 diabetes was seen in a number of the candidates' responses. Some however explained type 2 diabetes clearly and concisely and so scored both marks. This is shown in exemplar 5.

Exemplar 5

Insulin is being produced due to the high levels of glucose however because the person is resistant to insulin glucose levels don't rapidly decrease when Insulin peaks **[2]**

Question 19 (e)

(e) Scientists are using human embryonic stem cells to grow cells to treat type 1 diabetes.

Explain why scientists use embryonic rather than adult stem cells.

.....

.....

.....

..... **[2]**

The majority of candidates correctly explained the totipotent nature of embryonic stem cells but few candidates went on to explain the consequences of this in replacing pancreatic cells. Exemplar 6 shows an example of a common answer that only scores the first marking point.

Exemplar 6

embryonic stem cells can specialise to become any type of cell whereas adult stem cells can only specialise to become a cell from their own tissue. **[2]**

Question 19 (f)

(f) Plant development is also controlled by hormones.

Describe **one** effect of gibberellins and **one** effect of ethene on plant development.

gibberellins .....

.....

ethene .....

..... **[2]**

Many answers correctly referred to the action of gibberellins in breaking seed dormancy and the action of ethene in controlling fruit ripening. A number of marks were lost through inaccurate answers such as the 'control of plant ripening'.

Question 20 (a)

20 A scientist clones a cauliflower plant.

He uses small pieces of the cauliflower plant called explants.

This is the method the scientist uses to get the explants:

- Place the equipment in a beaker of bleach and swab the bench with 70% alcohol.
- Collect a small piece of cauliflower and place on a white tile.
- Using a scalpel cut the piece of cauliflower lengthways into small 3–5 mm pieces called explants.
- Measure the mass of the explants.

(a) What equipment should be used to measure the mass of the explants to 1 hundredth of a gram?

..... **[1]**

Many candidates did not concentrate on the accuracy needed and just stated 'a mass balance'.

Question 20 (b) (i)

(b) The scientist prepares the explants for cloning on an agar jelly plate.

He does this by placing the explants on the agar.

To grow the explants into cauliflower plants, the scientist places the agar jelly plate in a warm room near to a window.

(i) Before they form new plant structures, the explants must take in sugars from the agar jelly.

Explain why explants cannot make their own sugars.

.....

.....

..... **[2]**

There were many good answers seen here, with candidates linking the inability to photosynthesise to the absence of leaves or chlorophyll.

Question 20 (b) (ii)

(ii) The experiment could be improved by placing the agar jelly plate with explants into a heated cabinet containing light bulbs.

Describe how this cabinet could be further improved to maximise the growth and development of the explants.

.....

.....

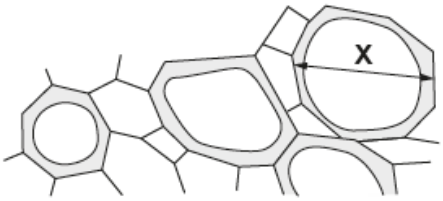
..... **[2]**

A common improvement was suggesting the provision of extra carbon dioxide, but a number of candidates concentrated on the heating or lighting rather than exploring 'further improvements'.

Question 20 (c)

(c) The scientist observes some of the tissues of the growing explants using a light microscope.

The diagram shows some of the plant cells.



The diameter of **X** has been magnified 500×.

What is the actual diameter of **X**?

Give your answer in **standard form**.

Diameter = ... mm **[2]**

Many candidates could correctly convert the answer of 0.04mm to standard form and so gained 2 marks. There were a number who simply answered 0.04 and so scored one of the available marks.

Question 20 (d)

(d) Transmission **electron** microscopes (TEM) work by passing a beam of electrons through a very thin slice of an object.

Suggest **one** advantage and **one** disadvantage of using TEM rather than a light microscope to look at cells.

advantage .....

.....

disadvantage .....

..... **[2]**

Candidates displayed a good knowledge of the advantages and disadvantages of the TEM and full marks were common here.

Question 21 (a) (i)

21 **(a)** Investigating brain function may involve the following techniques:

- External recording of the brain using EEG.
- Scanning techniques such as CAT and MRI.
- Case studies of humans with accidental damage.
- Deliberate damage in animal experimentation.

(i) Understanding of brain function has increased in recent years. However, there are still problems that scientists face that are preventing a complete understanding.

Evaluate the reasons why understanding has increased but also why problems still exist.

.....

.....

.....

.....

.....

.....

..... **[4]**

Many answers referred to improvements in technology leading to advancements. The most common problem stated was ethical issues with animal experimentation. Some candidates understood that human subjects may be reluctant to give consent but many simply stated that they were incapable of giving consent.

Question 21 (a) (ii)

(ii) When scientists complete their research they usually publish it in journals or online.

Give **two** reasons why scientists publish their results.

1 .....

.....

2 .....

.....

[2]

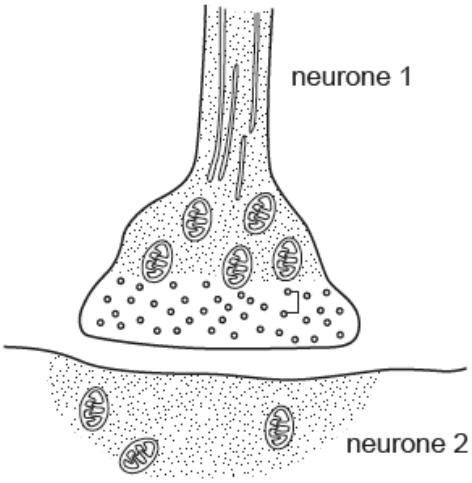
Peer review, other scientists using the results in their research and publishing to gain recognition were often given as correct reasons. There were a number of vague references to 'letting other people know', which did not gain credit.

Question 21 (b) (i)

(b) Alzheimer's disease involves damage to nerve transmission.

Symptoms include difficulties in judging distance, concentrating and making decisions.

The diagram shows a synapse between two neurones in the brain.



Acetylcholine is a neurotransmitter in the brain. It diffuses across the 32 nanometre synaptic gap.

In a brain from a person with Alzheimer's disease, the time for acetylcholine to diffuse between neurones is 6.4×10^{-7} s.

1 metre = 10^9 nanometres

(i) Calculate the speed of diffusion in a person with Alzheimer's disease.

Use this formula: speed = distance ÷ time

Give your answer in metres per second.

Speed of diffusion = ... metres per second **[3]**

Many candidates could handle the conversion from nanometres to metres, divide by the time and give the correct answer in standard form. Credit was given for dividing by the time even if the initial conversion was incorrect. Exemplar 7 shows an example of this. It only scores one mark because the conversion is incorrect and the final calculation also contains an error.

Exemplar 7

(i) Calculate the speed of diffusion in a person with Alzheimer's disease.

Use this formula: speed = distance ÷ time

Give your answer in metres per second.

32×10^9
$= 32000000000$

$t = 6.4 \times 10^{-7}$
$d = 32000000000$
$\frac{32 \times 10^9}{6.4 \times 10^{-7}}$
$= 5 \times 10^{15}$

Speed of diffusion = 5×10^{15} metres per second **[3]**

Question 21 (b) (ii)

(ii) In the brain of a healthy person the speed of diffusion is 0.2 metres per second.

How does the result obtained in part **(i)** account for the symptoms of Alzheimer's disease?

.....

.....

.....

..... **[2]**

Most answers commented on the reduced speed of diffusion in people with Alzheimer's disease, but some did not follow this up by relating this to the symptoms.

Question 22 (a) (i)

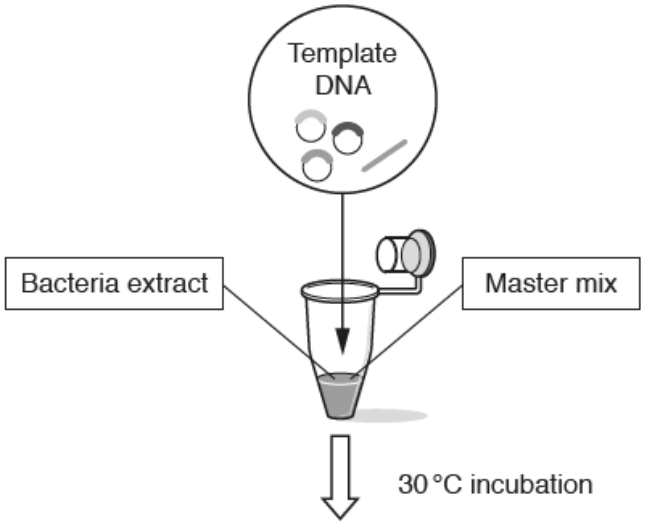
22 Scientists can make the proteins they need outside of living cells (*in vitro*).

To do this they use cell free protein synthesis kits.

The kit includes three different parts:

- A template DNA molecule
- An extract from bacteria containing mRNA and tRNA nucleotides
- A master mix containing amino acids, energy sources, enzymes and ribosomes.

To make a protein the three different parts are mixed together and incubated for 3 hours at 30 °C.



(a) (i) Describe the role of the DNA template and mRNA nucleotides in the production of the protein.

.....

.....

.....

..... **[2]**

There were some correct references to transcription, but this question was intended as a high demand question and did prove to be quite challenging. Exemplar 8 shows an answer that does gain credit for referring to the pairing of DNA bases with mRNA bases.

Exemplar 8

The DNA is unzipped to be read by the mRNA. The mRNA then reads the DNA template, matching each base with its complimentary base pairing. **[2]**

Question 22 (a) (ii)

(ii) Describe the role of the tRNA nucleotides and ribosomes in the production of the protein.

.....

.....

.....

..... **[2]**

Again, there were some correct references to translation, but many answers confused the roles of ribosomes, mRNA and tRNA. Another common error was to refer to the making of amino acids, rather than proteins.

Question 22 (b) (i)

(b) Thirty years ago, identifying a person from their DNA required a large sample of DNA.

Polymerase chain reaction (PCR) is a technique developed in 1983.

PCR allows a single copy or segments of DNA to quickly make multiple copies of a DNA sequence.

(i) Many crimes committed over 30 years ago can now be solved using PCR.

Explain why.

.....

.....

..... **[2]**

A number of candidates thought that the PCR process actually matched the DNA samples. Often the ability to copy small amounts of DNA to make enough for testing was not appreciated.

Question 22 (b) (ii)

(ii) Which part of the cell cycle takes place in PCR?

..... **[1]**

S phase or DNA replication was stated by a number of candidates but more commonly there were references to mitosis or one of the stages of mitosis.

Question 22 (c) (i)

(c) (i) DNA databases involve storing a person's individual DNA profile. The DNA profile identifies DNA sequences present in an individual.

DNA databases are used by many different organisations.

Solving crimes is one use of a DNA database.

Suggest **other** reasons why organisations might need a DNA database.

.....

.....

.....

..... **[2]**

There were many correct references to genetic conditions, making ancestral links or the identification of individuals.

Question 22 (c) (ii)

(ii) Write down **one** reason why people might **not** want to be included on a DNA database.

.....

..... **[1]**

A number of candidates seemed to think that the database actually stored physical samples of DNA that could be used for cloning. The most common creditable answers referred to protection of privacy.

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