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Examiners' report

# BIOLOGY B (ADVANCING BIOLOGY)

H422

For first teaching in 2015

## H422/02 Summer 2022 series

Version 1

# Contents

# 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. A selection of candidate answers are also provided. 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 and the mark scheme can be downloaded from OCR.

**Advance Information for Summer 2022 assessments**

To support student revision, advance information was published about the focus of exams for Summer 2022 assessments. Advance information was available for most GCSE, AS and A Level subjects, Core Maths, FSMQ, and Cambridge Nationals Information Technologies. You can find more information on our website.

# Paper 2 series overview

This paper assessed candidate skill and depth of understanding. The Scientific Literacy in Biology component has 20 marks dedicated to the Advance Notice Article. For 2022 this challenged the traditional explanation that lactate is the cause of muscle fatigue. It was clear from some of the responses that not all candidates had given this article sufficient attention in the weeks leading up to the exam.

The remainder of the paper was a mixture of short answer questions together with extended writing, particularly asking candidates to interpret, explain and evaluate experimental data.

Candidates had been well prepared in terms of most subject knowledge. Strengths were in the understanding of biochemical processes (which candidates often find challenging) and the recall of exchange anatomy and function. Haplotypes and root nodules were areas of weakness. Once again, some candidates struggled with statistics – in this case, probabilities and the *t*-test.

Individual questions no longer have the instruction to 'show your working' (this now appears on the cover rubric). Many candidates potentially lost marks that were available for intermediate working or error carried forward even if their final answer was wrong.

| **Evaluation** |
|---|
| Evaluation is a key skill that candidates did not always demonstrate. The ability to evaluate an argument, experimental method or conclusion from data and evidence is essential in biology, the sciences more generally and in many aspects of professional life. Students should be trained in analytical thinking and taking a methodical approach to evaluation. The command verb 'evaluate' will invariably mean that both sides of argument should be considered, or that conclusions may be valid, but that weaknesses or improvements should be looked for. |

| **Use of comparative data** |
|---|
| Candidates often lost marks because they referred to 'differences' or even 'significant differences' without mentioning whether this represented an increase or decrease. |

| **Candidates who did well on this paper generally did the following:** | **Candidates who did less well on this paper generally did the following:** |
|---|---|
| • Used the stem of longer answer questions to help structure their answers.<br>• Quoted data provided in support of their answers.<br>• Read the questions carefully and gave clear and comprehensive answers using only relevant information.<br>• Graded their responses, not forgetting to include basic as well as higher-level content. | • Gave generic answers rather than tailoring their answer to the specifics of the question.<br>• Elaborated unnecessarily on simple answers, thereby reducing the time available for later questions.<br>• Did not show their working in calculations so that they could be given some marks for intermediate working, even if their final answer was incorrect. |

## Question 1 (a)

**1** This question is based on the Advance Notice article **'Biochemistry of exercise-induced acidosis'**.

**(a)** The table shows several conversions that occur in carbohydrate metabolism.

Place **one** tick (✓) in the appropriate box in each row to indicate the type of reaction corresponding to each conversion. The first row has been completed for you.

| Conversion | Hydrolysis | Condensation | Oxidation | Reduction |
|---|---|---|---|---|
| ATP → ADP + $P_i$ | ✓ | | | |
| glucose → glycogen | | | | |
| maltose → glucose | | | | |
| pyruvate → lactate | | | | |
| transfer of hydrogen atoms to $NAD^+$ | | | | |

**[3]**

This question was answered well with most candidates gaining 2 or 3 marks for correctly identifying key biochemical processes.

## Question 1 (b)

**(b)** Explain why the conversion of pyruvate to acetyl CoA is described as an oxidative decarboxylation reaction.

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

Most candidates could define decarboxylation as loss or removal of carbon dioxide. Those that could not often gave answers stating that carbon or carboxyl were removed. Some candidates managed to link oxidation to dehydrogenation, although were not expected to use that term. Those that described removal of hydrogen or production of reduced NAD were given the mark. Those that did not focused on electrons so could not be given the mark.

## Question 1 (c) (i)

**(c) (i)** Use the information in the Advance Notice article to calculate the net yield of protons ($H^+$) in glycolysis when glucose is used as a respiratory substrate and when glycogen is used as a respiratory substrate.

Net yield of $H^+$ from glucose = .....

Net yield of $H^+$ from glycogen = .....

**[2]**

There was a high variability of answers to this question. Those candidates who used the advance release material well were given 2 marks. Other candidates could not be given a mark as they added all the ATPs (reactant or product) or quoted numbers (other than 2, 1) with no working.

## Question 1 (c) (ii)

**(ii)** Explain how metabolic acidosis leads to muscle fatigue during intense exercise.

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

Some candidates had obviously been well prepared and demonstrated good understanding of the Advance Notice Article and linked the decrease in pH to accumulation of $H^+$ ions (from glycolysis or hydrolysis of ATP), achieving the first mark. Some candidates simply described lactic acidosis, which could not be given the mark even if increased hydrogen ion concentration was described. Although this explanation is still taught, the Advance Notice Article provided sufficient information to show that this is no longer supported by evidence. If candidates had been presented with this information for the first time in the exam paper, they could be forgiven for failing to adjust their thinking. However, having had some time to consider this, they should all have been better prepared. The second mark (effects of the reduced pH on function) was well answered by many candidates, who linked it to denaturation of enzymes.

## Exemplar 1

When Pyruvate is reduced to lactate + $H^+$, an accumulation of $H^+$ ions cause a decrease in PH, this means that causes the accumulation of lactic acid in muscles, the acidic conditions causing muscle fatigue. [2]

This candidate simply repeats the traditional explanation of lactic acidosis that the Advance Notice Article sets out to disprove. They have not considered the fact, outlined in the article, that lactate buffers $H^+$ ions released in glycolysis and hydrolysis of ATP. So, this response scored 0.

## Question 1 (d) (i)

**(d)** The Advance Notice article describes how muscle fatigue may be caused by $P_i$ produced from ATP hydrolysis.

**(i)** Describe the role of ATP in muscle contraction.

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

Many candidates could achieve 2 marks on this question, namely for ATP binding to the myosin head and hydrolysis of ATP releasing energy. It was encouraging that very few said that ATP 'produced energy'. The remaining marking points were achieved by fewer candidates. Incorrect answers suggested misconceptions in sliding filament theory are common, e.g. cross bridge being formed by ATP binding, myosin head changing shape due to ATP binding to myosin. Some candidates wasted time by giving an overly-detailed account of the sliding filament theory.

## Question 1 (d) (ii)

**(ii)** Explain how formation of calcium phosphate would cause muscle fatigue.

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

Few candidates could link calcium ions to troponin, tropomyosin and formation of cross bridges. Those that could achieved 2 marks. Those that could not generally described ATP, the power stroke and contraction instead and so were not given the marks. Other candidates tried to find other explanations. The only alternative that received credit, for 1 mark, was that formation of calcium phosphate would reduce the amount of phosphate available to produce ATP.

## Question 1 (e)*

**(e)*** Muscles produce sufficient ATP by aerobic respiration during normal exercise.

Under these conditions, protons ($H^+$) generated in glycolysis are used by the mitochondria in oxidative phosphorylation.

Describe how protons generated in glycolysis are used to produce ATP in mitochondria **and** explain why these protons do not accumulate in mitochondria.

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

This was answered well by most candidates, who could achieve Level 2 with a simple discussion of chemiosmosis and oxygen as the final electron/hydrogen ion acceptor. Fewer candidates achieved a description of oxidation of reduced NAD to release hydrogen ions and electrons or of redox and the electron transport chain in the inner mitochondrial membrane. Many candidates could not be supported in the communication mark as they had incorrectly mentioned the link reaction / Krebs cycle / FAD (the stem of the question specified glycolysis).

**Assessment for learning**

A good Level 3 response does not need to be long. In fact, concise responses often achieve higher levels.

Students should be encouraged to ask themselves: am I answering the question, or just giving a standard response?

## Question 2 (a)

**2 (a)** The table lists structural features of DNA and transfer RNA (tRNA).

Put a tick (✓) in each box where that structural feature is present. The first row has been completed for you.

| Feature | DNA | tRNA |
|---|---|---|
| Contains phosphodiester bonds | ✓ | ✓ |
| Contains deoxyribose | | |
| Contains purines | | |
| Always contains paired **and** unpaired bases | | |

**[2]**

The majority of candidates demonstrated a confident understanding of DNA structure, achieving 2 marks. The most common mark lost was for purine presence in DNA and tRNA, where a few candidates did not secure the mark.

## Question 2 (b)

**(b)** Complete the sentences using the most appropriate terms.

The first stage of protein synthesis is called ....., in which the enzyme DNA helicase unwinds the DNA so that RNA polymerase is able to bind. RNA nucleotides are activated by addition of phosphate groups from ..... . Activated RNA nucleotides align next to complementary bases on the template strands and then RNA polymerase forms ..... bonds between the nucleotides to form a strand of mRNA. The mRNA moves to the cytoplasm where it attaches to a ribosome. The first amino acid-tRNA complex with the correct complementary three base ..... then binds to the mRNA.

**[4]**

Most candidates knew protein synthesis and could apply the correct terminology to the first two gaps. Some candidates incorrectly answered 'hydrogen' for the bond and 'codon' for the three bases.

**Misconception**

? Many candidates do not appreciate that RNA polymerase catalyses formation of the phosphodiester bonds to join the nucleotides that have hydrogen bonded to the template strand. It is actually nucleoside triphosphates that bind to the template strand, although this level of understanding is not required at A level. Nevertheless, students should appreciate that the activation of the nucleotides ultimately comes from ATP.

## Question 3 (a) (i)

**3** **(a)** Variable number tandem repeats (VNTRs) are patterns of repeated nucleotides in DNA sequences.

Variation in the length of VNTRs can be used to compare DNA samples from different people.

**(i)** Describe a procedure you could use to compare the lengths of the VNTRs in two samples of DNA.

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

Many candidates omitted the fact that restriction endonucleases produce DNA fragments, perhaps because they were focused on the VNTRs. Gel electrophoresis was described well as 'separating' fragments or by a description of how the bands separated, e.g. longer DNA fragments travel a shorter distance. The concept of comparing the banding patterns was often demonstrated in candidate answers, but sometimes not in sufficient detail to be given a mark. Candidates often did not give sufficient detail of how the bands are visualised to be given a mark. For example, use of UV or fluorescence on its own was not enough. Candidates needed this together with a dye, stain or fluorescent label. Also, simply mentioning use of a probe was not sufficient for a mark; candidates had to say that the probe was labelled in some way.

**Misconception**

The most common misconceptions were that the restriction enzymes were placed in the gel, and that the loading dye allows you to see the DNA. In fact, the loading dye simply allows you to see where you have put your sample. To be able to visualise the bands a DNA stain such as ethidium bromide is used, or probes with fluorescent or radioactive labels are added. Note that ethidium bromide is not safe for use in centres, but other, safer stains are available.

## Question 3 (a) (ii)

**(ii)** Explain why forensic analysis uses VNTRs from different chromosomes or from loci that are far apart on the same chromosome.

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

Many candidates did not respond to the idea of linkage due to genes being close on the same chromosome. They therefore did not extend their answers to a description of the reduction of variability of VNTR combinations caused by this. The most common incorrect answers linked to electrophoresis and variability in banding patterns.

**Synoptic assessment**

Candidates often fail to make connections between different areas of the specification. Teachers should encourage students to think about the links between different areas of biology.

## Question 3 (a) (iii)

**(iii)** More recent forensic methods use shorter tandem repeats, typically 3 – 5 bases long. These are called short tandem repeats (STRs).

STRs of different lengths at one locus represent alleles.

A sample of DNA from a crime scene was analysed at five different STR loci. **Table 3.1** lists the five alleles present in the crime scene DNA and the percentage of the population that shares each allele.

| Allele | Percentage of population sharing the allele (%) |
|---|---|
| 1 | 13.5 |
| 2 | 7.8 |
| 3 | 12.3 |
| 4 | 6.6 |
| 5 | 5.1 |

**Table 3.1**

A suspect's DNA matched all five alleles from the crime scene DNA.

Calculate the probability that the match was due to chance.

Give your answer in standard form and to **2** significant figures.

Probability = 1 in ..... **[2]**

Some candidates understood that probabilities needed to be multiplied so could be given at least 1 mark on this question. The conversion from percentage to decimal was more rarely seen. A few candidates could not be supported in the second mark as they did not give answers to 2 significant figures and/or in standard form.

### OCR support

The OCR Mathematic Skills Handbook covers the use of standard form and significant figures.

AS and A Level Biology A Biology B (Advancing Biology) Mathematical Skills Handbook (ocr.org.uk)

There are more resources available at Maths for biology: arithmetic and numerical computation - OCR

## Question 3 (b) (i)

**(b)** Hypothyroidism (underactive thyroid gland) has several causes.

Study of family histories suggests that one cause is genetic.

Mutations in the thyroglobulin (*Tg*) gene are thought to cause hypothyroidism. An increasing number of patients with *Tg* mutations have been identified in Japan.

One study analysed *Tg* mutations using haplotype analysis.

**(i)** State the meaning of the term **haplotype**.

.....

.....

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

Most candidates could define haplotype. Those that could not be supported in the mark mentioned pairs of genes, 'both parents', chromosomes, and genotype.

## Question 3 (b) (ii)

**(ii)** In this study, DNA from patients with hypothyroidism was sequenced.

52 patients from 41 families had mutations in the *Tg* gene. **Table 3.2** shows the results of haplotype analysis for three of these mutations.

Patients with the R and T mutations were found only in specific locations.

The R mutation was found only in a single village surrounded by steep mountains and the sea.

Patients with the S mutation were found all over Japan.

| Mutation | Number of patients | Number of families | Number of patients with same haplotype |
|---|---|---|---|
| R | 8 | 5 | 8 |
| S | 12 | 11 | 9 |
| T | 7 | 5 | 7 |

**Table 3.2**

The researchers made these conclusions:

- The R, S and T mutations are three of many causes of hypothyroidism.
- The R and T mutations were caused by a founder effect.
- S is an old mutation that keeps reoccurring independently.

Explain how the researchers reached these conclusions.

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

Candidates who used the structure given in the question could often be given 4 marks for describing R and T in a 'specific location' where sufferers all had the 'same haplotype' and then describing S 'all over Japan' where sufferers 'didn't all have the same haplotype'. Some candidates were given a mark for calculating that 25 people had the disease but didn't have the mutations described so other genes/the environment must be causing this disease. Some candidates did not understand the concept of haplotype, achieving 2 marks for a comparison of locations of R/T and S with no discussion of haplotype.

## Exemplar 2

- The conclusion of R and T being caused by the founder effect was reached due to the fact that all patients had the same haplotype ~~as~~ despite coming from different families (this is supported by the fact R and T mutations were only found in specific locations)
- The first conclusion was reached as ~~this~~ not all 52 patients had the R, S or T mutations, ~~suggesting~~ implying there are many more causes
- The S mutation was found all over Japan and patients had different haplotypes [4]

This candidate has taken a logical and systematic approach, using the structure in the stem of the question to create an explanation that scored 4 marks without any unnecessary padding.

## Question 4 (a) (i)

**4 (a) Fig. 4.1** and **Fig. 4.2** on the **Insert** are photomicrographs of sections of human lung.

**(i)** Identify the tissues labelled **A** and **B** in **Fig. 4.1**.

**A** .....

**B** .....

**[2]**

Many candidates could recognise A as ciliated epithelial tissue and named it as this. Those that called it 'epithelial cells' were not supported in the mark as they had been asked for a tissue. This might seem harsh, but illustrates the importance of precise use of terms in biology. The majority of candidates did not recognise B as cartilage. Common incorrect responses referred to capillaries, smooth muscle and epithelium.

## Question 4 (a) (ii)

**(ii)** Identify the structure labelled **C** in **Fig. 4.2** and describe **one** visible way it is adapted for gas exchange.

Identity of **C** .....

Adaptation .....

.....

**[2]**

Most candidates achieved 2 marks on this question; correctly identifying C as alveolus and the adaptation as large surface area or short diffusion distance.

## Question 4 (a) (iii)

**(iii)** Identify the tissue labelled **D** in **Fig. 4.2** and describe its function.

Identity of **D** .....

Function .....

.....

**[2]**

Many candidates correctly identified smooth muscle and the function as constriction of the bronchiole, although this was more often described as reduction in the size of the lumen, which was given the mark. However, some used the term contraction and could not be given the mark.

**Misconception**

Candidates often describe contraction of bronchioles or arterioles. Students should be reminded that muscles contract, which might then lead to constriction, but the airway or blood vessel does not contract.

## Question 4 (b)

**(b)** A section of lung tissue was prepared from a patient with emphysema.

Describe and explain how this would appear different to the lung tissue in **Fig. 4.2**.

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.....

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

This question was not answered fully by most candidates. Often the alveoli were not referred to or candidates wrote that alveoli had 'burst' with no link to walls or the role of elastin/elastase. Many realised that alveoli would be bigger, however a number could not be given this mark as they linked the observation to an incorrect structure due to a lack of clarity, e.g. larger bronchioles. Some candidates gave a highly detailed and accurate description of the role of elastase secreted by macrophages, but wasted time for a single mark.

## Question 4 (c)*

**(c)*** Asthma is a chronic condition, but an asthma attack involves severe acute symptoms.

Discuss the causes of asthma and how treatments target both the long-term condition and the acute symptoms.

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

This level of response question was answered well by candidates, many of whom had been well prepared by teachers and demonstrated comprehensive knowledge of asthma. Level 2 was often given for a discussion of the causes of asthma and one treatment. Level 3 was regularly given for causes and the two treatments (long term/short term). The communication mark was sometimes not given due to confusion between beta-agonists and corticosteroids. Candidate who did less well did not understand the importance of inflammation, either as a cause of asthma or as the target for corticosteroids.

## Exemplar 3

Asthma is caused by inflammation in the bronchi and bronchioles, which restricts airflow through them. This causes symptoms such as wheezing, coughing and shortness of breath. Asthma is thought to be partially genetic, but also environmental factors such as allergens and pollutants, which cause the inflammation. Corticosteroids are used in the long-term treatment and are used to reduce inflammation of bronchi and bronchioles. Beta-agonists are used to manage short-term symptoms. They can be used before exercise or during acute asthma attacks and they widen the lumen of the bronchi and bronchioles.

This is a good Level 3 response that covers succinctly the causes and treatments of asthma.

## Question 5 (a) (i)

**5** **(a)** Ultrasound is used to screen for Down's syndrome in pregnancy. This is carried out between 11 and 14 weeks' gestational age.

If this screening indicates a high risk of Down's syndrome, fetal cells can be sampled for chromosome analysis.

**(i)** Give the name of **one** fetal sampling technique **and** state the exact source of cells used.

Name of technique .....

Source of cells .....

**[2]**

Most candidates answered this question correctly, achieving 2 marks. Benefit of the doubt was given for the many phonetic spellings of chorionic that were given. Amniotic sac rather than amniotic fluid was not supported as the source of cells for amniocentesis.

## Question 5 (a) (ii)

**(ii)** Give the name of the technique used in the chromosome analysis of the fetal cells.

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

Most candidates answered this question correctly. A common incorrect answer was 'karyotype' which is the image, not the technique. This was another situation where careful reading of the question was essential.

## Question 5 (a) (iii)

**(iii)** Down's syndrome is described as trisomy 21.

Suggest what is meant by trisomy 21.

.....

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

Trisomy was defined well by most candidates. A few candidates were not supported for answers that did not correctly convey '3 copies of chromosome 21', instead describing '3 copies on chromosome' which is a location rather than a duplicate chromosome.

## Question 5 (b) (i)

**(b)** The gestational age of the fetus can be determined using one of two measurements:

- crown-rump length (CRL)
- head circumference (HC).

An accurate determination of gestational age is needed to ensure an accurate estimate of the risk of Down's syndrome.

**(i)** Suggest why biparietal diameter (the width of the fetus's head at its widest point) has been replaced by head circumference as a measure of gestational age.

.....

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

The correct answer was not often seen for this question; the concept of different shaped heads affecting measurements was rarely seen. Most answers focused instead on ease or accuracy of measurement.

## Question 5 (b) (ii)

**(ii)** Current practice states that ultrasound screening for Down's syndrome risk should be used up to a gestational age of 14 weeks 1 day. From a gestational age of 14 weeks 2 days, screening should be done using a maternal blood sample.

A fetus was found to have a CRL of 61 mm.

The gestational age (in days) can be calculated using the formula:

Gestational age = $8.052 \times (\text{CRL} \times 1.037)^{0.5} + 23.73$

Calculate the gestational age of the fetus in weeks and days, to the nearest day.

Gestational age = ..... weeks ..... days **[2]**

As the equation was given, most candidates confidently calculated the number of weeks obviously comfortable with the use of the $x^n$ button on their calculators. The most common error was leaving the remainder days as a proportion of a week rather than calculating this in days.

## Question 5 (b) (iii)

**(iii)** Using your answer to part **(ii)**, state whether the screening for Down's syndrome risk of this fetus should be done by ultrasound or through a maternal blood sample.

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

Candidates were highly successful in this question, quoting ultrasound as the technique of choice.

# Question 5 (c)

**(c)** Fetal growth restriction (FGR) is a complication of pregnancy that results in a low birth weight. It affects up to 10% of all pregnancies and can lead to still-birth, poor growth in infancy and an increased risk of cardiovascular disease in later life. At present, there are no treatments for FGR.

FGR is diagnosed when fetal head circumference (HC) remains at or below the 5th percentile throughout gestation.

**Table 5.1** shows HC data for three fetuses at 14, 22 and 30 weeks' gestational age.

| Gestational age (weeks) | HC (mm) | | |
|---|---|---|---|
| | Fetus A | Fetus B | Fetus C |
| 14 | 71 | 75 | 92 |
| 22 | 185 | 172 | 195 |
| 30 | 272 | 252 | 293 |

**Table 5.1**

**Fig. 5.1** is a fetal growth chart. The three lines represent the 5th, 50th and 95th percentiles.

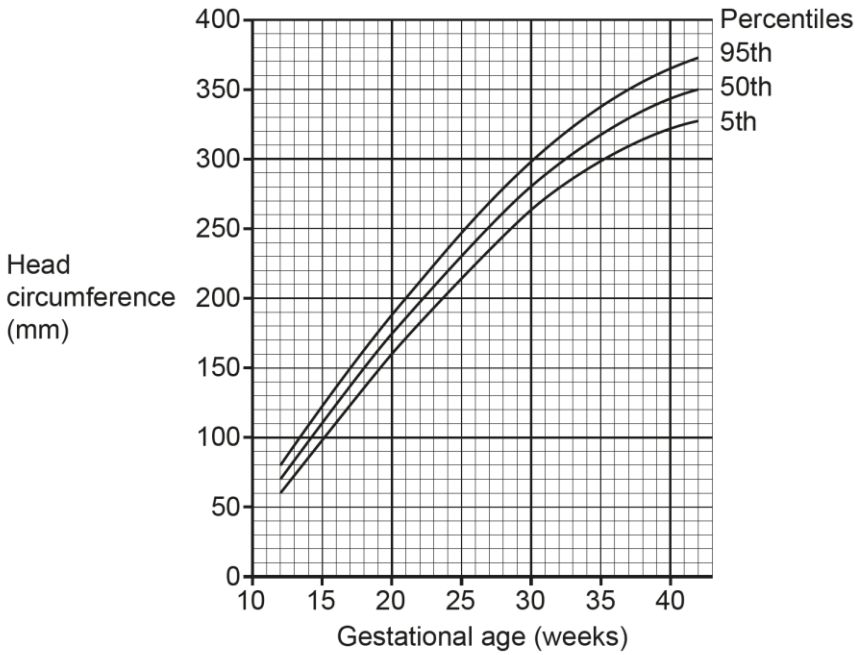


**Fig. 5.1**

Use the data in **Table 5.1** and the fetal growth chart in **Fig. 5.1** to explain which, if any, of the fetuses would be diagnosed with FGR.

Fetus(es) .....

Reason .....

.....

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

Most candidates correctly mapped the foetuses to the graph so were able to identify B as being under/on the fifth percentile throughout gestation. Some candidates dropped a mark because they did not make clear that this was throughout gestation. A was incorrectly identified, often when no working was evident.

## Question 5 (d) (i)

**(d)** FGR is associated with reduced levels of growth factors such as IGF-1 in both mother and fetus.

However, giving injections of IGF-1 to the mother has not been successful in treating FGR.

Gene therapy is now being investigated as a possible treatment for FGR.

Researchers tested gene therapy treatment on rabbits. The third fetus in a rabbit litter (the runt) has naturally reduced growth.

The researchers studied four groups of fetuses, as shown in **Table 5.2**. Each group consisted of five or six fetuses.

| Group | Fetus type | Placenta injected with |
|---|---|---|
| **A** | normal | saline solution |
| **B** | runt | saline solution |
| **C** | runt | Ad-LacZ |
| **D** | runt | Ad-IGF-1 |

**Table 5.2**

Ad-LacZ used an adenovirus vector to deliver a gene that has no effect on the placenta.

Ad-IGF-1 used an adenovirus vector to deliver the *IGF-1* gene directly into the placenta.

**(i)** Suggest how the Ad-IGF-1 could safely deliver the *IGF-1* gene into cells in the placenta.

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

Candidate knowledge of viral vectors for gene therapy was insecure. The majority did not identify that the gene had to be inserted into the virus to create Ad-IGF-1. Many incorrectly mentioned adding the IGF gene to the already modified adenovirus (Ad-IGF-1). Others gave an answer based on the use of bacterial plasmids. Safety was often incorrectly interpreted to mean methods to keep the foetus safe during injection of the virus. Few understood that viruses could be modified so they cannot replicate in the host so could not be given the second marking point.

## Question 5 (d) (ii)

**(ii)** Explain the purpose of Group **A** and Group **C** in the study.

Group **A** .....

.....

Group **C** .....

.....

**[2]**

Most candidates identified group A as a control group for comparison against normal growth. Many realised that group C had the adenovirus like the test group D so could identify if changes were due to the viral vector or the gene.

## Question 5 (d) (iii)

**(iii)** The fetuses were allowed to grow and were weighed immediately after birth.

The results are shown in **Fig. 5.2**.

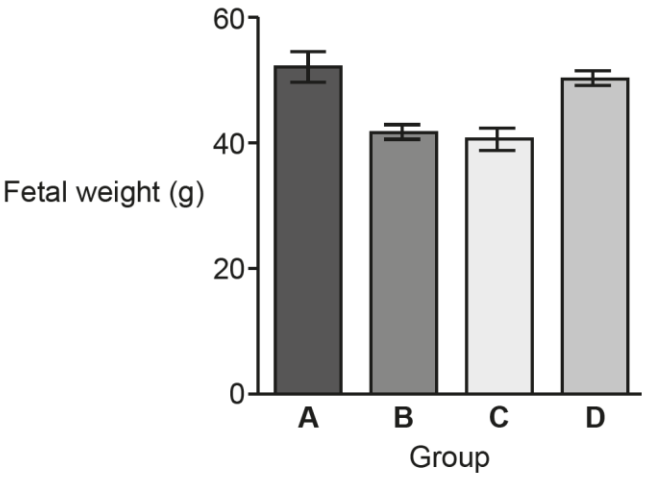


**Fig. 5.2**

Statistical analysis showed significant differences ($p < 0.01$) between these groups:

- groups **A** and **B**
- groups **B** and **D**
- groups **C** and **D**.

The researchers concluded that Ad-IGF-1 gene therapy represents a suitable treatment strategy for FGR in humans.

Evaluate their conclusion.

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.....

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

A wide variety of responses were seen. No mark was given for answers that described 'significant difference' with no reference to the data. Candidates sometimes achieved 2 marks for comparing the data between A/D and B or C/D. Occasionally a candidate would conclude that Ad-IGF-1 had restored normal growth. More rarely evaluative points were written, identifying that there are differences between rabbits and humans, that the effect in humans will not be known and that sample sizes are low. Candidates sometimes omitted mention of sample size here, only to mention it in Question 6 (b) (vi) where the sample sizes were not particularly low.

## Question 6 (a) (i)

**6** **Fig. 6.1** on the **Insert** shows a light micrograph of a transverse section through the root of a leguminous plant.

**(a)** **(i)** Identify the tissues labelled **E** and **F** on **Fig. 6.1**.

**E** .....

**F** .....

**[2]**

Most candidates could identify the vascular tissue in the plant. Some were able to correctly define E as xylem and F as phloem. Often the reverse of this answer was seen, achieving no marks.

## Question 6 (a) (ii)

**(ii)** Suggest the function of the region marked **G** on **Fig. 6.1**.

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

This question was answered poorly in most scripts. Candidates often did not recognise G as a vascular link between the root nodule and the root cortex. The few answers that gained marks mentioned 'phloem', 'sucrose to nodule' and 'nitrate from nodule'. The most common misconception was that this was a root hair cell, resulting in detailed answers (none of which could be supported) of water movement by osmosis, symplast, apoplast and vacuolar pathways and the casparian strip. Careful reading of the question would have shown candidates that this was a legume, so they should be thinking about root nodules.

## Question 6 (b)

**(b)** *Vigna mungo* (black gram) is an important leguminous food crop in South Asia. The seeds are high in protein and are used to make dal, a staple of Indian food.

Formation of root nodules does not always lead to efficient nitrogen fixation. Some species of nitrogen-fixing bacteria will only induce nitrogen-fixing nodules on certain legumes.

Farmers sometimes inoculate seeds with nitrogen-fixing bacteria to try to improve yields.

An experiment investigated the effectiveness of this practice.

- A pure culture of a species of nitrogen-fixing bacteria was mixed with a charcoal carrier.
- The mixture was used to inoculate *V. mungo* seeds.
- 24 pots containing unfertilised soil were prepared.
- Half the pots were planted with 20 inoculated seeds each and half were planted with 20 untreated seeds (control group).
- The pots were moved to a greenhouse.
- After 45 days, 2 pots from each group were taken and measurements made of the plants.

The results are shown in **Table 6.1**.

Each set of measurements used 12 plants and the data are shown as mean ± 2 standard deviations.

| | Height of plant (cm) | Fresh weight (g) | Number of roots | Number of root nodules |
|---|---|---|---|---|
| **Inoculated seeds** | 45 ± 1.27 | 55 ± 1.03 | 25 ± 0.52 | 14 ± 0.46 |
| **Untreated seeds** | 23 ± 0.68 | 29 ± 0.82 | 12 ± 0.45 | 6 ± 0.26 |

**Table 6.1**

**(i)** State **one** variable that should be controlled during the 45 days to allow a valid comparison between the two groups of seeds.

.....

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

Most candidates correctly identified a control variable for terrestrial plant growth. Incorrect answers often mentioned control of carbon dioxide.

## Question 6 (b) (ii)

**(ii)** Explain why the seeds were grown in unfertilised soil.

.....

.....

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

Most candidates could not link root nodule development to the nutrient content of soil, so did not achieve this mark.

## Question 6 (b) (iii)

**(iii)** Suggest, with a reason, another control group that the researchers should have used.

.....

.....

.....

.....

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

Few candidates identified that charcoal (as a source of carbon) could affect growth of plants. The few correct answers managed to achieve 2 marks for 'charcoal with untreated seeds' and 'to see if charcoal has an effect on growth'.

## Question 6 (b) (iv)

**(iv)** The researchers used a paired *t*-test to analyse their results.

Suggest whether this was an appropriate test to use.

.....

.....

.....

.....

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

The *t*-test was understood by some candidates, correctly identifying that while the means of 2 sets of data were compared, there were 2 separate groups, so the unpaired *t*-test was the right statistic to use. Several candidates answered briefly 'yes this is the correct test' suggesting they did not have sufficient knowledge to discuss it.

## Question 6 (b) (v)

**(v)** State the number of degrees of freedom used for this paired *t*-test.

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

Most candidates could not calculate the degrees of freedom as 12 plants – 1 = 11.

## Question 6 (b) (vi)

**(vi)** The researchers concluded that farmers should use inoculated *V. mungo* seeds to maximise their yields.

Evaluate this conclusion.

.....

.....

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.....

.....

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

Candidates who quoted the data often achieved 2 marks (2 features and 1 data quote for improvement). Some candidates referred simply to 'improved' growth or just mentioned a single measured variable, neither of which was considered worth of the mark. Evaluative points were rarely observed, generally limited to discussions of how expensive it would be to inoculate seeds (how expensive inoculated seed would be).

### Assessment for learning

Wet mass versus dry mass.

No candidates commented on the fact that the researchers measured the fresh weight (wet mass), which can be influenced by water uptake. Students should understand the importance of using dry mass in such situations, including the study of efficiency of biomass transfer in ecosystems which was the subject of part (c).

## Question 6 (c) (i)

**(c)** Beef cattle can be fed on grass or cereal grains, such as maize.

It is common in some countries to raise beef cattle in two stages:

- the first 14 months the cattle are fed on grass
- the last 6 months they are fed on cereal grains.

**Table 6.2** shows the average mass of a group of cattle at the end of each stage and the average mass of feed consumed during that stage.

| Stage | Age at end of stage (months) | Average mass at end of stage (kg) | Average mass of feed consumed (kg) |
|---|---|---|---|
| **Fed on grass** | 14 | 320 | 9600 |
| **Fed on grain** | 20 | 560 | 3120 |

**Table 6.2**

**(i)** Calculate the efficiency of biomass transfer in the period when the cattle are fed on grass and in the period when they are fed on grain.

Give your answer to **2** significant figures.

Fed on grass = ..... %

Fed on grain = ..... %

**[2]**

Percentage efficiency when fed on grass was often correct, achieving 1 mark. However, the percentage efficiency when fed on grain was rarely correct as candidates did not calculate the change in average mass during the stage cattle were fed on grain, instead just using the average mass at the end of the grain stage from the table. A few answers couldn't be supported for a mark as they were not given to 2 significant figures.

## Question 6 (c) (ii)

**(ii)** A student concluded that it would be more sustainable to raise beef cattle entirely on grass.

Evaluate this conclusion.

.....

.....

.....

.....

.....

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

Linking to efficiency was strong in this question, awarding most candidates 1 mark. The other 2 marks were often not supported as candidates did not understand the differences in sustainability between grain production and grass production, instead choosing to discuss mass changes from the table.

### Assessment for learning

Sustainability is highly topical and there are now many advocates of plant-based diets.

This makes for a useful topic for class discussion. As with so many things in biology, the situation is neither simple nor clear-cut. Students should be encouraged to examine all sides of the arguments and apply sound biological knowledge and understanding to the issues.

## Question 6 (d)

**(d)** Alfalfa is a leguminous plant used as a food crop for livestock such as beef cattle.

Alfalfa grows in areas with a shortage of water.

Scientists investigated the drought resistance of two different varieties of alfalfa: Algonquin and Longdong.

**Fig. 6.2** shows photomicrographs of the upper and lower epidermis of leaves taken from the two varieties.

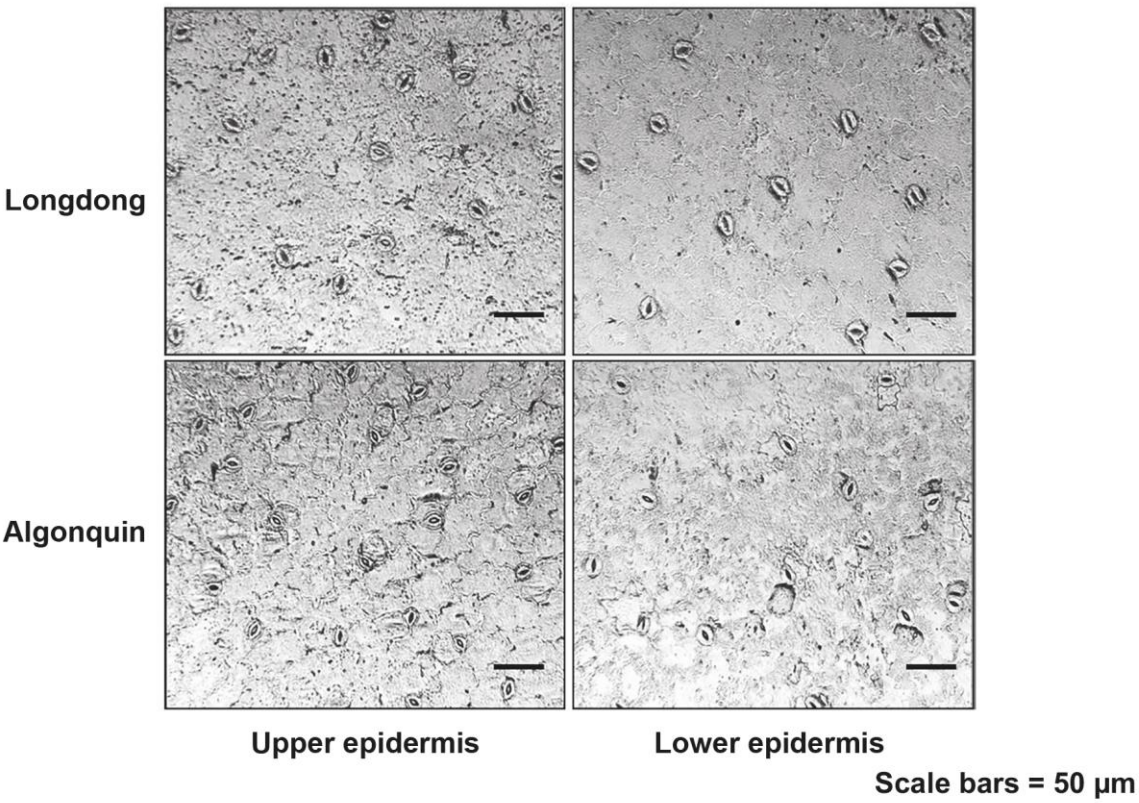



**Fig. 6.2**

Estimate the density of stomata on the lower epidermis of the two varieties.

Give your answer as stomata $mm^{-2}$.

Longdong = ..... stomata $mm^{-2}$

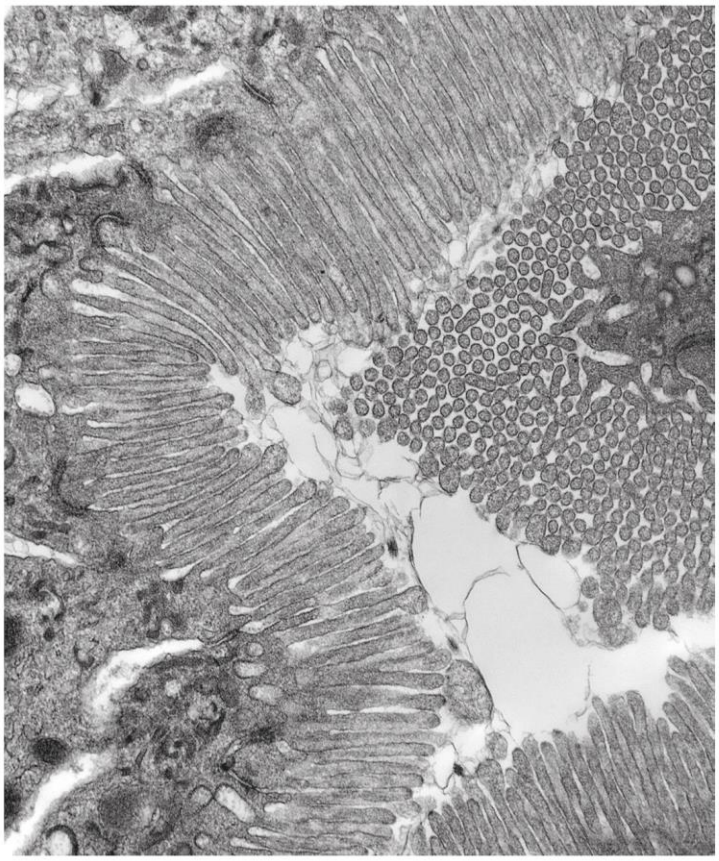
Algonquin = ..... stomata $mm^{-2}$

**[3]**

Most candidates were able to correctly count stomata in the underside of the leaves, although this was quite challenging with the Algonquin, which is why a range of values was accepted. Very few were able to calculate the area of the field of view. Calculating areas allowing for magnification is not trivial. Accurate stomatal densities were therefore rarely seen.

## Question 7 (a)

**7 (a)** The image below is a transmission electron micrograph of a section through the proximal convoluted tubule (PCT) of a human kidney.



Identify **one** structural feature in the image and state how it is adapted to the function of the PCT.

Structural feature .....

Adaptation .....

.....

.....

.....

**[2]**

Most candidates identified this as the microvilli of the PCT. Once they had correctly done this, many achieved the second mark for 'large surface area to maximise reabsorption'. Those that could not express this information well often were not given marks. For example, villi or cilia were not supported and 'large surface area for increased diffusion' was also not given a mark. Some candidates could not identify the structural feature, nevertheless they were able to achieve the second mark for correctly describing the adaptation.

**Assessment for learning**

Magnification is often given for micrographs and students should be taught to use this to help judge the scale of what they are viewing.

In this case, magnification was not given, but candidates were told that this was a transmission electron micrograph, so they should have realised that it showed microvilli and not villi.

## Question 7 (b) (i)

**(b)** Kidney failure can be treated by dialysis or transplant surgery.

**(i)** The table lists statements about two types of dialysis treatment.

Complete the table by writing 'true' or 'false' for each statement.

| Statement | True or false |
|---|---|
| Both haemodialysis and peritoneal dialysis use a partially permeable membrane. | |
| The dialysis fluid for haemodialysis contains sugars and amino acids to match the composition of the patient's blood, but peritoneal dialysis uses saline solution. | |
| Haemodialysis must be performed several times per day. | |

**[2]**

Most candidates achieved 1 to 2 marks on this question. The most common misconception was that peritoneal dialysis fluid was just saline.

## Question 7 (b) (ii)

**(ii)** A student made the following statement about transplant surgery:

Dialysis is only a treatment for kidney failure, but transplant surgery is a permanent solution.

Evaluate the student's statement.

.....

.....

.....

.....

.....

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

This was another 'evaluate' question, but candidates who answered the question fully were able to achieve 3 marks by explaining that 'dialysis is not a cure'; 'transplant is not necessarily permanent' and 'because kidneys can be rejected'. Often candidates did not give comprehensive answers, achieving only the 'transplant is not necessarily permanent' mark. Common incorrect answers were that dialysis and/or transplant was permanent.

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