OCR
Oxford Cambridge and RSA

# A Level Biology A

## H420/03 Unified biology

# Monday 18 June 2018 – Morning

## Time allowed: 1 hour 30 minutes

*6901446021*

**You may use:**
- a scientific or graphical calculator
- a ruler (cm/mm)

*H420/03*

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|---|---|---|---|---|---|---|---|---|---|
| First name | | | | | | | | | |
| Last name | | | | | | | | | |
| Centre number | | | | | | Candidate number | | | | |

**INSTRUCTIONS**
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Complete the boxes above with your name, centre number and candidate number.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

**INFORMATION**
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **20** pages.

Answer **all** the questions.

**1** The onion plant, *Allium cepa*, is grown as a food crop around the world.

**(a)** The table below contains statements about the root cells of an onion.

Place ticks (✓) in the boxes in the table to indicate whether the statements are true or false.

| Statement about onion root cells | True | False |
|---|---|---|
| contain chloroplasts | | |
| contain mitochondria | | |
| contain 70S ribosomes in the cytoplasm | | |
| have pili | | |
| have cellulose cell walls | | |

**[2]**

**(b)** Fig. 1 shows a cross section of the root of an onion plant.

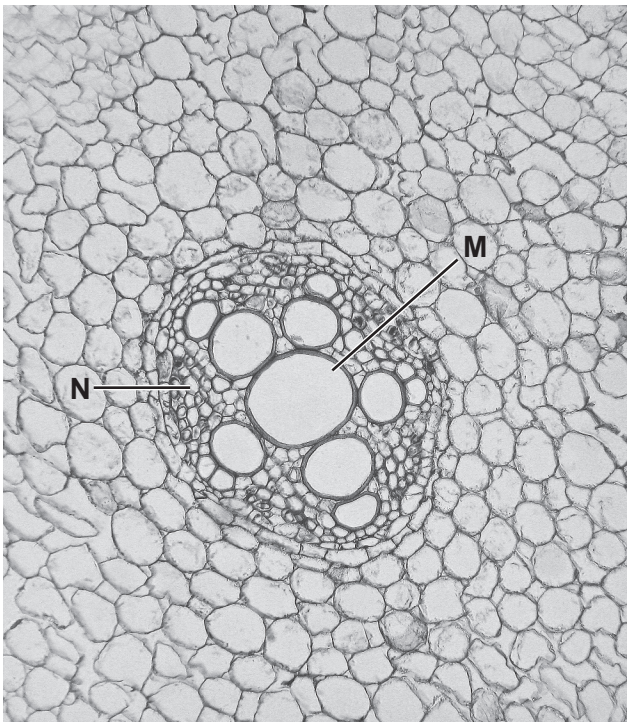


**Fig. 1**

Identify the **tissues** shown at **M** and **N**.

**M** .....

**N** .....

**[2]**

**(c)** The colour of onion bulbs is determined by two genes, **A/a** and **B/b**.

- **A** is a dominant allele and codes for the production of a red pigment.
- Onion bulbs that are homozygous for the recessive allele, **a**, produce no pigment and are white.
- **B** is a dominant allele that inhibits the expression of allele **A**.
- The recessive allele, **b**, allows the production of the red pigment.

A white onion plant was cross-pollinated with a red onion plant. All 15 offspring had the genotype **AaBb**.

**(i)** Identify the following:

The genotype of the white onion plant .....

The genotype of the red onion plant .....

The phenotype of the offspring .....

**[3]**

**(ii)** State the type of gene interaction shown by the genes **A/a** and **B/b**.

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

**(iii)** Suggest how allele **B** inhibits the expression of allele **A**.

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

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**2** ATP can be produced in various ways. Each stage of respiration contributes to the production of ATP.

**(a)** Describe the production of ATP by **substrate-level phosphorylation** in different stages of respiration with reference to the number of ATP molecules produced.

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

**(b)** Glucose and other carbohydrates are present in respiring cells. The concentrations of carbohydrate molecules vary between tissues.

A student conducted tests on three tissues, **A**, **B** and **C**. Table 2 shows the results of these tests.

| Tissue | Colour after Benedict's test | Colour after treatment with HC*l* and Benedict's test | Colour after iodine test |
|---|---|---|---|
| **A** | red | red | yellow |
| **B** | yellow | red | black |
| **C** | orange | orange | black |

**Table 2**

Two of the tissues were known to be phloem tissue and liver tissue.

Use the evidence in Table 2 to identify which tissue, **A**, **B** or **C**, is phloem and which tissue is liver. Explain your answer.

Tissue ..... must be phloem because .....

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Tissue ..... must be liver because .....

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**[3]**

**(c)** Cells can use fatty acids instead of carbohydrates as respiratory substrates. A process called beta oxidation is used to break down fatty acids to acetyl CoA for use in respiration.

Fig. 2 shows a simplified example of beta oxidation.

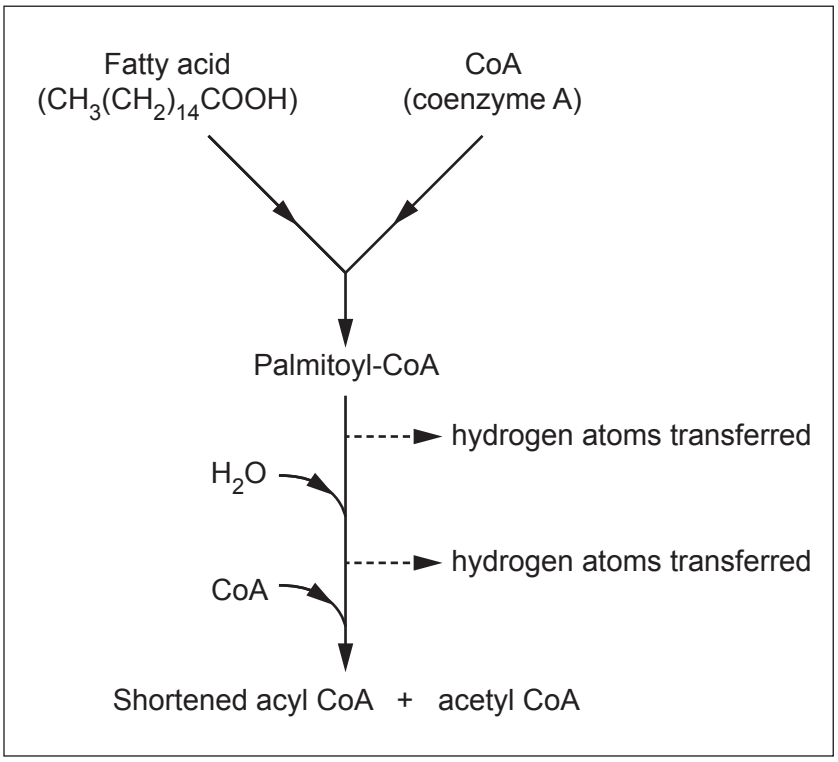


**Fig. 2**

**(i)** Using the information in Fig. 2, calculate the percentage of carbon atoms in the fatty acid that are able to enter the Krebs cycle.

Answer = ..... % **[1]**

**(ii)** The percentage of carbon atoms that a reaction makes available for use in the Krebs cycle can be described as the efficiency of the reaction.

Calculate the efficiency of the **link reaction**. Using your answer to part **(i)**, state whether the link reaction is **more**, **less** or **equally** efficient when compared to the reactions described in Fig. 2.

Show your working.

Answer = .....%

Link reaction is ..... efficient
**[1]**

**(iii)** Fig. 2 shows the role of coenzyme A in beta oxidation.

Suggest a role for coenzymes **other than coenzyme A** in beta oxidation.

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

**3** Temperature and light intensity are two factors that affect the rate of photosynthesis.

A student investigated how temperature and light intensity affected the rate of photosynthesis in the aquatic plant *Elodea canadensis*. The rate of photosynthesis was measured by counting the number of bubbles produced by the plant per minute.

The student's results are shown in Table 3.

| Light intensity | Temperature (°C) | Number of bubbles produced / minute |
|---|---|---|
| 8 | 25.0 | 10 |
| 32 | 25.0 | 31 |
| 127 | 25.0 | 102 |
| 510 | 25.0 | 108 |
| 8 | 40.5 | 25 |
| 32 | 40.5 | 28 |
| 127 | 40.5 | 118 |
| 510 | 40.5 | 133 |
| 8 | 70.0 | 2 |
| 32 | 70.0 | 4 |
| 127 | 70.0 | 12 |
| 510 | 70.0 | 16 |

**Table 3**

**(a) (i)** Identify the anomalous result in Table 3 and explain how this result could be confirmed as an anomaly.

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

**(ii)*** Describe how the student could improve their experimental method **and** the presentation of their data.

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

**(b)** Photosynthesis occurs in two stages: the light-dependent stage and the light-independent stage. The light-independent stage is affected by temperature more than the light-dependent stage.

Explain why temperature has a greater effect on the rate of the light-independent stage.

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

**(c)** Scientists are able to clone desirable plants that show a high rate of photosynthesis. The following passage describes how plants are cloned.

Complete the passage using the most appropriate words or phrases.

Cells are removed from the meristem tissue in axial buds or ..... tips. The tissue sample that is removed is called the ..... . Ethanol can be used to ..... the plant tissue. Hormones are used to stimulate mitosis, which produces a mass of cells called a ..... .

**[4]**

**4** Agammaglobulinemia and Vici syndrome are both genetic diseases.

**(a)** Agammaglobulinemia results in a lack of mature B lymphocytes in a person's blood.

**(i)** Suggest and explain one symptom of agammaglobulinemia.

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

**(ii)** Fig. 4 shows the inheritance pattern of agammaglobulinemia in a family.

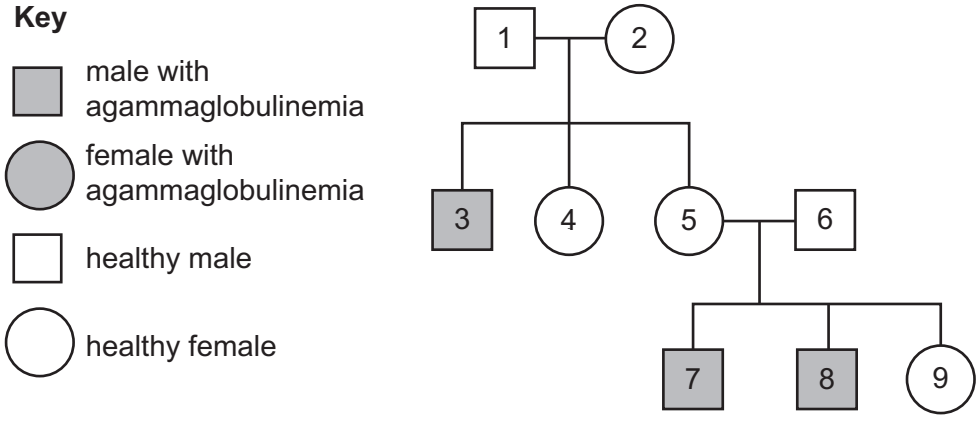


**Fig. 4**

What conclusions can you draw about the location and nature of the allele responsible for causing agammaglobulinemia? Explain your conclusions.

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

**(b)** Vici syndrome is a genetic disease that shows a recessive inheritance pattern. The allele responsible for Vici syndrome is found on chromosome 18.

**(i)** Two carriers of Vici syndrome have six children.

Calculate how many of the six children you would expect to:
- have Vici syndrome
- be carriers of Vici syndrome.

Vici syndrome .....

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

**(ii)** A daughter of these parents and a male carrier of Vici syndrome have a child.

Calculate the probability of the child having Vici syndrome.

Answer = ..... **[1]**

**(c)** DNA profiling can be used to analyse the risk of inheriting conditions such as agammaglobulinemia and Vici syndrome.

**(i)** To produce a DNA profile, DNA first needs to be purified.

Explain why a protease enzyme is added to the mixture during the DNA purification process.

.....

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

**(ii)** DNA samples can be amplified using the polymerase chain reaction (PCR).

In theory, how many fragments of DNA might be present after 12 cycles of PCR?

Assume one DNA fragment was present at the beginning of the PCR process. Represent your answer as a $\log_{10}$ value.

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

**(iii)** Suggest why the figure you calculated in **(ii)** may not be achieved in practice.

.....

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

**(iv)** State the name of the enzyme used in PCR to synthesise new DNA strands.

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

**(v)** DNA fragments are separated to produce a DNA profile using electrophoresis.

A student wrote the following description of the electrophoresis procedure:

> We will set up an agarose gel plate and place the DNA samples in the wells at the cathode. Voltage will be passed through the gel for one minute. The gel will then be placed in purified water and we will be able to see the banding pattern of each DNA sample.

Describe **two** changes you would make to the student's procedure and explain how these changes would improve electrophoresis.

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

**5** Accurate analysis of an ecosystem's biodiversity requires a detailed classification of organisms.

The spruce pine plant is given the binomial name *Pinus glabra*.

**(a) (i)** Place a tick (✓) in the box next to the species most closely related to *Pinus glabra*.

*Diplodia pinea* ☐

*Ilex glabra* ☐

*Pinus resinosa* ☐

*Annona glabra* ☐

**[1]**

**(ii)** Explain why *Pinus glabra* and humans, *Homo sapiens,* are classified in the same domain but in different kingdoms.

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

**(b)** A scientist sampled the species of trees present in two different habitats containing *Pinus glabra*.

The results of the sampling are shown in Table 5.

| Species | Number of individuals in habitat A | Number of individuals in habitat B |
|---|---|---|
| *P. glabra* | 45 | 60 |
| *M. grandiflora* | 23 | 10 |
| *F. grandiflora* | 55 | 20 |
| *L. styraciflua* | 0 | 10 |
| *L. tulipifera* | 0 | 0 |
| *S. shumardii* | 23 | 4 |

**Table 5**

Using Simpson's Index of Diversity, the scientist calculated the biodiversity (*D*) of Habitat A as 0.71.

Use the formula given to calculate the biodiversity of Habitat B.

Show your working.

State which habitat, A or B, has the greater biodiversity.

$$D = 1 - \left( \Sigma \left( \frac{n}{N} \right)^2 \right)$$

*D* (Habitat A) = 0.71

*D* (Habitat B) = .....

Habitat with the greater biodiversity = .....

**[2]**

**(c)** Habitat B was situated beside a lake and showed evidence of ecological succession.

The scientist planned to investigate how the biodiversity changed from the edge of the lake to the other side of habitat B.

**(i)** State the collective name of the animal and plant populations that are present at the end of primary succession.

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

**(ii)** Suggest how the scientist could achieve the following during their investigation:

Sample all stages of succession in the habitat .....

.....

Minimise sampling bias .....

.....

Sample insect biodiversity .....

.....

**[3]**

**(iii)** The scientist also measured primary production in both the woodland and lake habitats.

Suggest the units the scientist should use to measure primary production in the two habitats.

Woodland .....

Lake .....

**[1]**

**6** The process of ultrafiltration in the kidney shares similarities with the formation of tissue fluid.

**(a)*** Describe the similarities and differences between ultrafiltration and the formation of tissue fluid.

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

**(b)** A person's glomerular filtration rate (GFR) provides an indication of the health of their kidneys. The GFR is a measure of the volume of blood that can be filtered by the kidneys every minute.

GFR can be estimated by monitoring the blood concentration of creatinine, which is a breakdown product of creatine phosphate in muscles.

**(i)** Suggest **two** characteristics of a patient that must be taken into account when using this GFR measurement to diagnose kidney damage.

Explain why each characteristic must be considered.

1 .....

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2 .....

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

**(ii)** If kidney damage is suspected, the patient's urine is likely to be tested for the protein albumin.

Explain why the presence of albumin in the urine indicates kidney damage.

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

**END OF QUESTION PAPER**

## ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).