



Please write clearly in block capitals.

Centre number

Candidate number

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

A-level BIOLOGY

Paper 3

Monday 15 June 2020

Morning

Time allowed: 2 hours

Materials

For this paper you must have:

- a ruler with millimetre measurements
- a scientific calculator.

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in **Section A**.
- Answer **one** question from **Section B**.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

| For Examiner's Use | |
|--------------------|------|
| Question | Mark |
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| TOTAL | |

Information

- The marks for the questions are shown in brackets.
- The maximum mark for this paper is 78.



Section A

Answer **all** questions in this section.

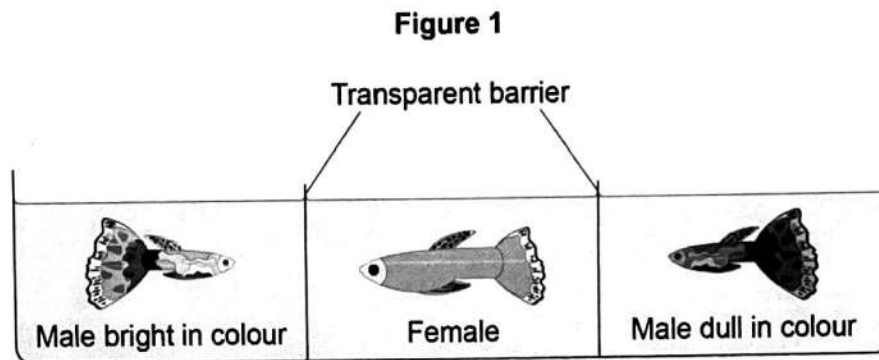
You are advised to spend no more than 1 hour and 15 minutes on this section.

0 1

Guppies are small fish. Female guppies are dull in colour. Male guppies can be bright or dull in colour.

Scientists investigated the effect of female brain size on choosing a mate. They used laboratory-bred female guppies with large brains and with small brains.

They set up a fish tank as shown in **Figure 1**.



They observed each female for 10 minutes and recorded which male they were attracted towards. They repeated this with 45 large-brained females and 45 small-brained females.

0 1 . 1

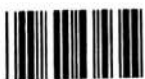
Suggest **three** possible limitations of this investigation.

[3 marks]

1 Courtship behaviours may need more than visual through the barrier

2 10 minutes may be too short for all females to make a choice.

3 Laboratory raised females may act / behave differently to wild guppies.



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Guppies with large brains are better at identifying predators.

The scientists found that **only** female guppies with large brains were attracted to male guppies bright in colour.

- 0 1 . 2 Suggest and explain the advantage of this behaviour to the population of guppies.

[3 marks]

Females with larger brain will choose males with brighter colour. So their offspring will have a brighter colour. This gives them an advantage as brighter offspring will attract even more large brain females. The population will have larger brains over time. The population may be able to use their brains for large brain to get better at other functions, like avoiding predators.

- 0 1 . 3 Describe how the behaviour of female guppies could result in sympatric speciation.

[3 marks]

2 populations could get isolated by reproduction. So no geographical barrier is between the two populations. They live in the same place but don't breed with each other as don't recognise each other as a suitable mate. Over time the frequency of alleles change in the 2 populations, so much so that they can't reproduce ~~any more~~ to produce fertile offspring, even if they tried.

Turn over ►



0 2

In northern India, there is a conflict of interests between farmers of livestock (eg cows) and people trying to conserve ibex (a type of wild goat).

When livestock are given extra food, their populations can grow too large and compete with ibex.

0 2 . 1

Name the type of competition between livestock and ibex.

[1 mark]

Interspecific (between species)

Livestock will outcompete ibex if they:

- are in the same habitat
- eat a similar diet.

Scientists investigated this conflict of interests.

Table 1 summarises some of the scientists' findings.

Table 1

| Type of livestock | Difference between livestock food and ibex food* | Difference between livestock habitat and ibex habitat* |
|-------------------|--|--|
| Cow | 1.0 | 1.5 |
| Horse | 0.5 | 0.0 |
| Yak | 0.0 | 2.0 |

* A score of 0.0 indicates that the food or habitat is the same.



0 2 . 2

There must be a balance between the need for conservation of the ibex and the need for farmers to keep livestock.

Using **all** the information, suggest and explain **three** actions that the farmers could take to achieve this balance.

[3 marks]

1 Keep cows as they have the least similar food and habitat to the ibex.

2 Don't provide extra food to livestock, so their population can't grow so big they cause too much competition.

3 They could ^{not} keep just horses, as their habitat matches perfectly the ibex, ~~but horses want~~ and horses eat very similar food to the ibex.

4

Turn over for the next question

Turn over ►



0 3

In Europe, viruses have infected a large number of frogs of different species. The viruses are closely related and all belong to the Ranavirus group.

Previously, the viruses infected only one species of frog.

0 3 . 1

Suggest and explain how the viruses became able to infect other species of frog.

[2 marks]

Mutation in the viral RNA or DNA to code for different viral attachment proteins. New proteins can attach to the surface of cells for other frogs now.

0 3 . 2

Name **two** techniques the scientists may have used when analysing viral DNA to determine that the viruses were closely related.

[1 mark]

1 genome sequencing

2 genetic fingerprinting.

0 3 . 3

Determining the genome of the viruses could allow scientists to develop a vaccine.

Explain how.

[2 marks]

Could identify proteins that are part of the genome and getting expressed. One of these proteins is the antigen that could be produced and used in a vaccine.



0 3 . 4

Describe how the B lymphocytes of a frog would respond to vaccination against Ranavirus.

You can assume that the B lymphocytes of a frog respond in the same way as B lymphocytes of a human.

Do **not** include details of the cellular response in your answer.

[3 marks]

The vaccine contains the antigen found on the surface of the virus. B cells bind to this antigen with their complementary receptor. This stimulates them to clone themselves through mitosis. Also cause B cells to make plasma cells and these start to produce antibodies. Some of the B cells become memory cells for future infections.

8

Turn over for the next question

Turn over ►



0 4

Table 2 shows information about two types of medicine.

Table 2

| Name of medicine | Mass of medicine in one tablet / mg | Maximum dose of medicine an adult is allowed | Mass of sodium in one tablet / g |
|------------------|-------------------------------------|--|----------------------------------|
| Aspirin | 300 0.3g | 0.6 g every 4 hours 3.6 | 0.15 |
| Paracetamol | 500 0.5g | 1.0 g every 6 hours | 0.43 |

0 4 . 1

A journalist studied the data in Table 2. She made the following suggestion.

'If an adult takes the maximum number of tablets allowed for **either** of the medicines, then the person would have more than the RDA of sodium.'

The RDA (recommended daily allowance) of sodium for an adult human is 2.4 g per day.

Is the journalist's statement true for **both** of the medicines in Table 2?

Use suitable calculations to support your answer.

Show your working.

[2 marks]

$$0.6 \times 6 = 3.6$$

$$1 \times 4 = 4$$

$$\frac{3.6}{0.3} = 12$$

$$\frac{4}{0.5} = 8$$

$$12 \times 0.15 = 1.8g$$

$$8 \times 0.43 = 3.44g$$

Aspirin

Paracetamol

Aspirin doesn't exceed RDA, but Paracetamol does.



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Doctors investigated the link between high sodium concentrations in medicines and hypertension (high blood pressure).

They analysed medical records of patients. 1 292 337 of these patients had taken medicines containing high sodium concentrations. Each of these patients was paired with a patient from a control group.

0 4 . 2 Give **two** factors that should have been the same for each pair of patients and **one** factor that should have been different. [2 marks]

Same factor 1 other medications

Same factor 2 ethnicity

Different factor no sodium in the medicine

0 4 . 3 Doctors found:

- 4.73% of the patients who had taken medicines containing high sodium concentrations suffered from hypertension
- there were 7.18 times fewer control patients with hypertension.

Calculate how many of the control patients had hypertension.

Show your working.

$$\begin{aligned}
 1292337 \times 0.0473 & \\
 = 61127.5401 & \\
 \Rightarrow 61127 &
 \end{aligned}$$

[2 marks]

$$\frac{61127}{7.18} = \underline{\underline{8513}}$$

Answer 8513 patients

Question 4 continues on the next page

Turn over ►



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0 4 . 4

A high concentration of sodium in the blood can affect blood volume and cause hypertension.

Use your knowledge of water potential to suggest how high sodium concentrations in the medicines taken could affect blood volume.

[3 marks]

Sodium ions in the blood lower its water potential. This causes water to move in by osmosis from the cells and tissue fluid. This increases the volume of blood plasma in the same space - causing increase in the pressure.

9



- 0 5 . 1** In the UK in 2016, there were 525 048 deaths. Cancer caused 30.4% of all deaths. Throat cancer caused 5% of all deaths from cancer.

Calculate the mean number of people who died of throat cancer per month in 2016.

Show your working.

$$\begin{aligned} 525\,048 &\times 0.304 \\ &= 159\,614.59 \\ &\Rightarrow 159\,615 \end{aligned}$$

[2 marks]

$$\begin{aligned} 159\,615 &\times 0.05 \\ &= 7\,981 \frac{1}{2} \end{aligned}$$

$$\frac{7\,981}{12} = 665 \text{ /month}$$

Answer 665 people per month

Increased methylation of the promoter region of a tumour suppressor gene causes one type of human throat cancer.

In this type of throat cancer, cancer cells are able to pass on the increased methylation to daughter cells. The methylation is caused by an enzyme called DNMT.

Scientists have found that a chemical in green tea, called EGCG, is a competitive inhibitor of DNMT. EGCG enables daughter cells to produce messenger RNA (mRNA) from the tumour suppressor gene.

- 0 5 . 2** Suggest how EGCG allows the production of mRNA in daughter cells.

[3 marks]

EGCG binds to the active site of DNMT. This 'inactivates' DNMT, as it can no longer methylate tumour suppressor gene. Transcription factor can bind to gene and it can be expressed, as RNA polymerase can also bind to gene and transcribe it.

Question 5 continues on the next page

Turn over ►



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The scientists investigated the effect of different amounts of EGCG on the growth rate of the throat cancer cells grown *in vitro*. Their results are shown in **Figure 2**.

Figure 2

This figure has been removed due to third-party copyright restrictions.

0 5 . 3

A reporter who reviewed all of this work concluded that drinking green tea could be a cure for cancer.

Suggest **three** reasons why his conclusion might **not** be valid.

[3 marks]

1 _____

2 _____

3 _____

8



06.1 Describe the advantage of the Bohr effect during intense exercise.

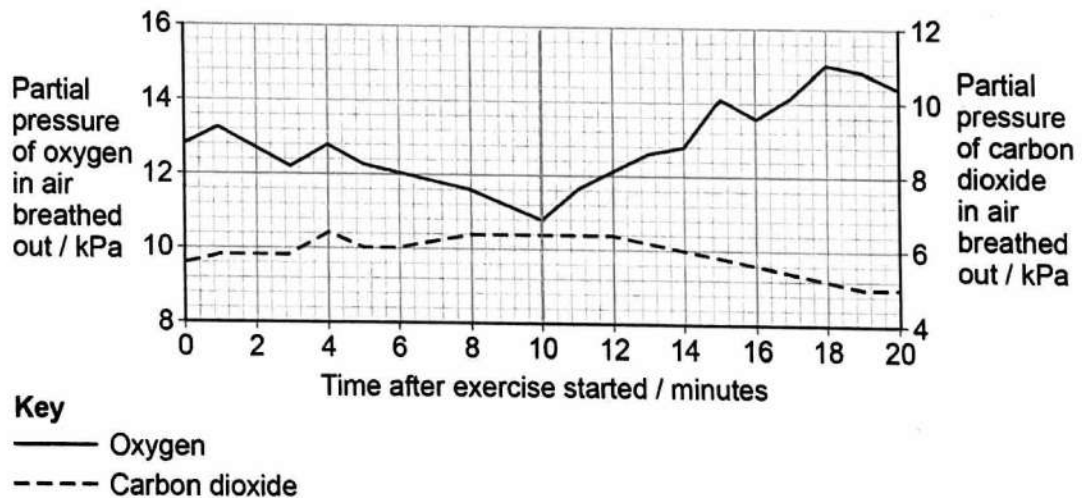
[2 marks]

As CO_2 concentration increases in the blood, so does the blood pH decrease. As pH decreases oxygen dissociation from haemoglobin increases. So more oxygen is released for cells to respire aerobically.

A cyclist completed a fitness test on an exercise bike. The intensity of the exercise was increased every 10 seconds. The test finished when he was unable to cycle any further. The partial pressure of oxygen (pO_2) and of carbon dioxide (pCO_2) in air breathed out was measured.

Figure 3 shows the results of the cyclist's fitness test.

Figure 3



Ventilatory threshold (VT) is a measure of the point when anaerobic respiration increases because aerobic respiration alone can no longer maintain muscle contraction.



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0 6 . 2

VT can be identified as the **first** point when there is an increase in pO_2 breathed out, without an equivalent increase in pCO_2 breathed out.

Use **Figure 3** to determine the **time** after the exercise started when the cyclist reached VT.

10

Calculate the **ratio** of pO_2 to pCO_2 in breathed-out air at this time.

Show your working.

$$pO_2 - 10.8 \text{ kPa}$$

$$pCO_2 - 6.4 \text{ kPa}$$

[2 marks]

$$6.4 \left(\begin{array}{l} 10.8 : 6.4 \text{ kPa} \\ 1.6875 : 1 \end{array} \right) \div 6.4$$

Time when the cyclist reached VT = 10 min

Ratio of pO_2 to pCO_2 at VT = 1.69 :1

0 6 . 3

An increase in the intensity of exercise produces an increase in the volume of carbon dioxide produced.

However, **Figure 3** shows that the pCO_2 in air breathed out did **not** show a large increase during the exercise.

Suggest **one** physiological change that would cause this result. Explain how the physiological change would allow for the removal of the increase in the volume of carbon dioxide produced.

[2 marks]

Physiological change Increased tidal volume

Explanation Same pCO_2 per breath, but different volume per breath.

Question 6 continues on the next page

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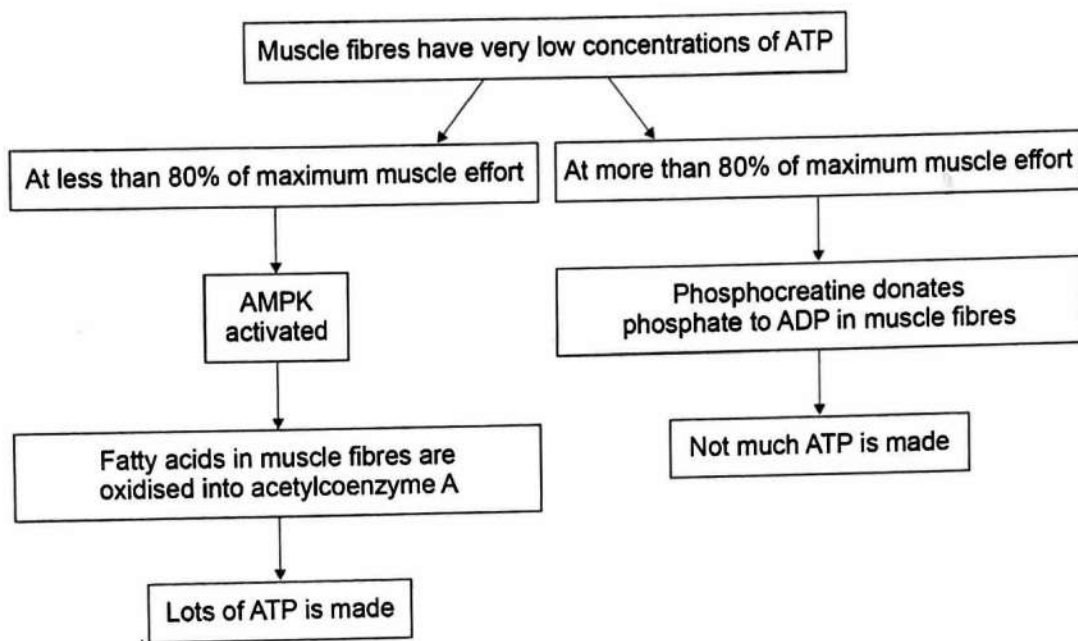


When muscle fibres have very low concentrations of ATP, they may get ATP in the following ways.

- AMPK (an enzyme) oxidises fatty acids.
- Phosphocreatine donates phosphate to ADP in anaerobic conditions.

Figure 4 shows how these chemicals work.

Figure 4



0 6 . 4 At more than 80% of maximum muscle effort, ATP can only be made for a limited time.

Use Figure 4 to suggest **one** reason why.

Tick (✓) the correct box.

[1 mark]

ATP cannot move into muscle fibres at a fast-enough rate.

Muscle fibres have a limited amount of phosphocreatine.

Muscle fibres produce too much lactate.

Muscle fibres quickly run out of ADP.



06.5

GW1516 is a performance-enhancing drug. GW1516 activates AMPK and develops slow muscle fibres at rest.

Use **Figure 4** to justify why professional athletes are **not** allowed to take GW1516.

Do **not** include details of chemiosmotic theory in your answer.

[4 marks]

If GW1516 is used it activates more AMPK so more ~~and~~ acetylcoenzyme A are made. These enter the Krebs cycle. These coenzymes are then reduced in the Krebs cycle. If there are more then there will be more reduced coenzymes. This means more ATP can be produced.

With GW1516 athletes could build slow muscle without exercise. This new slow muscle would ~~increase~~ help them delay the point when anaerobic respiration starts.

Question 6 continues on the next page

Turn over ►



EPO is another performance-enhancing drug. It can increase the haematocrit (the percentage of red blood cells in blood).

0 6 . 6

A heart attack is caused by a lack of glucose and oxygen being delivered to cardiac muscle via the coronary arteries. The overuse of EPO can increase the risk of a heart attack.

Suggest how.

[2 marks]

EPO causes high density of red blood cells so causes blood to be thicker. This increases the risk of a blood clot in a coronary artery getting blocked.

0 6 . 7

The normal haematocrit for human males is $47(\pm 5)\%$. For professional male cyclists, the maximum haematocrit allowed is 50%.

A student suggested that professional male cyclists should be allowed to use EPO until their haematocrit is 50%.

Give two reasons why this suggestion is not valid.

[2 marks]

1 Cyclist with lower % gain larger advantage from use than ones already closer to 50%

2 There are risks associated to taking it, so not worth it.



Section B

Answer one question.

You are advised to spend no more than 45 minutes on this section.

07 Write an essay on one of the topics below.

Either

07.1 The functions of enzymes and their importance in organisms. [25 marks]

or

07.2 The causes and importance of variation and diversity in organisms. [25 marks]

Plan

| | |
|--------------------------------|--------------------------|
| DNA replication/expression | Digestion |
| → RNA polymerase / DNA poly... | → amylase - starch |
| → ligase | → endo and exo peptidase |
| → helicase | |

Enzymes

| | |
|----------------------------|------------------------------|
| Phagocytosis | Photosynthesis / respiration |
| lytic enzymes in lysosome. | Rubisco photosystem II |
| | ATP synthase, kinase enzyme |
| | enzymes in respiration |
| | o decarboxylase enzyme |
| | ↳ limits reaction |

Turn over ►



07.1

Enzymes are essential part of most life processes. As biological catalysts they fill in an important role in mediating biochemical reactions in both eukaryotic as well as prokaryotic organisms.

Their specificity is due to their particular shape in their tertiary structure. All enzymes are polypeptides, so proteins, but not all, but a lot of proteins are enzymes.

They play important roles in DNA replication as well as gene expression. DNA helicase is vital for DNA replication, as it's able to bond 'unzip' the double strand, breaking apart the hydrogen bonds between base pairs. Also DNA polymerase plays a role in genome replication, by joining up nucleotides that are free and paired up along DNA template strand. This allows the formation of 2 sets of the original DNA as identical copies of each other. This is a vital process for mitosis to be able to happen in cell, which is essential for a body to grow and repair.

Enzymes such as RNA polymerase, similarly to DNA polymerase use the template DNA strand to



form a new nucleotide chain. However, this is an mRNA strand not DNA. mRNA is used in the expression of a cell's genome into its proteins, hence the ~~production~~ synthesis of proteins. This is also a vital process relying on enzymes, as enzymes themselves are proteins and rely on protein synthesis to be made.

Some proteins produced in protein synthesis are digestive enzymes. These get secreted outside of cells and act on ingested ~~part~~ particles to break them down so the smaller monomers can then be absorbed into the bloodstream. An example of this would be amylase that breaks down starch.

Starch forms the large part of ~~a~~ the diet of humans and many other organisms. Amylase hydrolyses starch into maltose. This then gets hydrolysed further into glucose by maltase. This glucose is then necessary to be transported to cells and used in respiration to produce ATP for vital bodily processes.

The digestion of proteins and lipids also happens by enzymes proteases and lipases. ~~Proteases~~ Proteases have different types like endo- or exopeptidases. They hydrolyse polypeptide chains at different locations, allowing the more efficient breakdown

Turn over ►



of proteins. This is possible due to the specificity of proteases, due to their active site, which is specific to the shape complementary to the shape of the substrate they can break down.

Phagocytosis of pathogens is one form of the body's defense against infection. Once the pathogen is trapped in a vesicle containing it fuses with the lysosome. This contains many lytic enzymes, that are able to hydrolyse the pathogen and break it down into its components. This allows it to destroy the pathogen and hence to prevent infection.

Lastly, but not least, both vital processes of respiration and photosynthesis rely on enzymes. Rubisco has been called the 'most important enzyme'. This is due to its massive role in photosynthesis, combining RuBP with CO_2 , so involved in carbon fixation. This means we can thank photosynthesis and therefore Rubisco for the development of an oxygen rich atmosphere on our planet. Hence the ability for animal and other forms of life to evolve.

Another important enzyme is ATP synthase, involved in both photosynthesis and respiration. It's involved in the production of ATP from ADP and P_i . As ATP is a form of short term energy storage



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This enzyme is in direct control to how much energy is available to cells. Therefore, it carries a vital role in the life of both animals and plants.

Turn over ►

