

Friday 13 June 2014 – Afternoon

A2 GCE HUMAN BIOLOGY

F224/01 Energy, Reproduction and Populations



Candidates answer on the Question Paper.

OCR supplied materials:

- Insert (inserted)

Other materials required:

- Electronic calculator
- Ruler (cm/mm)

Duration: 1 hour 15 minutes



Candidate forename		Candidate surname	
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Centre number							Candidate number			
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INSTRUCTIONS TO CANDIDATES

- The Insert will be found inside this document.
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the bar codes.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **60**.



Where you see this icon you will be awarded marks for the quality of written communication in your answer.

- You may use an electronic calculator.
- You are advised to show **all** the steps in any calculations.
- This document consists of **20** pages. Any blank pages are indicated.

Answer **all** the questions.

- 1 The human placenta can be considered unique amongst the many human organs in that, unlike other organs, it is a temporary structure.

After implantation, it is essential that the placenta develops correctly so that pregnancy is successful.

- (a) Using the placenta as an example, explain what you understand by the term *organ*.

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

- (b) Fig. 1.1, **on the insert**, shows some of the stages that follow fertilisation and the early events in the development of the embryo and the placenta. The diagrams are not drawn to scale.

The following passage describes some of these events.

Complete the passage by inserting the **most appropriate** term.

Immediately following fertilisation, the divides rapidly by

Within three to four days, a ball of cells known as the morula has been formed. The formation of the morula occurs as it travels down the

The morula develops into the blastocyst. The blastocyst implants into the of the uterus approximately seven days after fertilisation.

Some of the dividing cells in the blastocyst to form structures in the early embryo. Other cells will eventually become part of the structures that protect the developing embryo, such as the amnion and the chorion. These are known as the **extra-embryonic membranes**.

[5]

- (c) One role of the trophoblast cells shown in Fig. 1.1(b), **on the insert**, is to secrete the hormone human chorionic gonadotrophin (HCG).

State the role of HCG in pregnancy.

.....

 [1]

- (d) It is important that clinicians identify that a mother is carrying twins.

State the term that is given to the condition where twins are known to be present in the uterus.

..... [1]

- (e) Identical twins may or may not share some of the extra-embryonic membranes that develop in early pregnancy. This depends on the stage at which the embryonic cells split into two separate groups of cells.

The three possible types of identical twin are shown in Table 1.1.

Description	Name of twin type
Each twin has a separate chorion and amnion	Dichorionic-diamniotic or DiDi
Both twins share the same chorion and amnion	Monochorionic-monoamniotic or MoMo
Both twins share the same chorion but each has a separate amnion	Monochorionic-diamniotic or MoDi

Table 1.1

- (i) Using the information in Fig. 1.1 and Table 1.1, suggest which type of identical twin will form if the embryonic cells split between 5 and 6 days after fertilisation.

..... [1]

- (ii) Using the information in Table 1.1, state which of the three types of twins could also be **non-identical twins**.

..... [1]

(iii) Using the information in Fig. 1.1(f), suggest why **MoMo** twins (both twins sharing the same chorion and amnion) are at a higher risk of experiencing oxygen deprivation in the later stages of pregnancy.

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

(iv) How does a clinician identify that a mother is carrying twins?

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

[Total: 13]

5
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Question 2 begins on page 6
PLEASE DO NOT WRITE ON THIS PAGE

- (c) Some brownfield sites in large cities have become urban wildlife parks. One such example is Gillespie Park in Islington, London.

Many other brownfield sites are at increasing risk of being acquired by developers for building.

Suggest why more brownfield sites are at risk of being lost due to development **and** suggest **one** consequence of this loss to the urban ecosystem.

.....

.....

.....

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.....

..... [2]

- (d) In another part of Islington, Caledonian Park, a community orchard has been planted by a group called the London Orchard Project.

The passage below is an extract from their website.

'In an era of climate change and peak oil prices, planting trees, which will provide a large yield year after year for decades to come, is a logical move, helping to build food security.'

Outline how the planting of a community orchard can help to reduce the carbon footprint of communities such as those in Islington.

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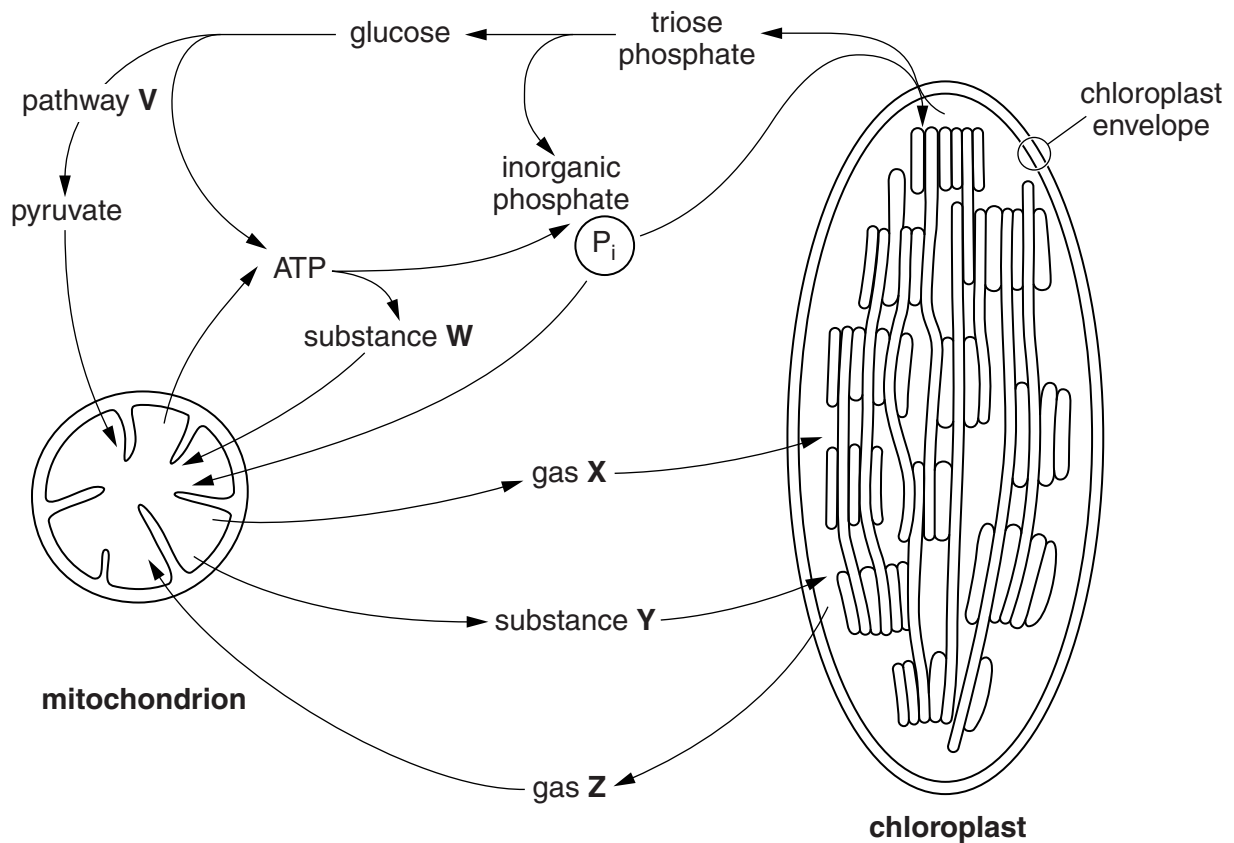
..... [2]

[Total: 9]

- 3 All living organisms respire in order to produce ATP, which is essential for a variety of biological processes.

Respiration in both plant cells and animal cells depends on the products of photosynthesis.

Fig. 3.1 shows some of the exchanges that take place in plant cells during bright sunlight.



Key

P_i = inorganic phosphate

Fig. 3.1

(a) In which tissue in a plant leaf would a cell containing the organelles shown in Fig. 3.1 be found?

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

(b) Using Fig. 3.1, **name** the following:

(i) gas **X**
gas **Z** [1]

(ii) substance **Y** [1]

(iii) substance **W** [1]

(c) Two groups of enzymes, **carboxylases** and **decarboxylases**, are essential to the exchanges that happen within the plant cell.

On Fig. 3.1, **write the letter C** exactly where a carboxylase is located in the cell and **write the letter D** exactly where a decarboxylase is located.

The answers to this question should be written on Fig. 3.1. [2]

(d) Identify **one** substance **in addition** to those shown in Fig. 3.1 that is produced in pathway **V**, and which will enter the mitochondrion.

..... [1]

(e) ATP is often referred to as '*the universal energy currency*'.

State **one** advantage of using ATP to provide energy for biological processes.

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

[Total: 8]

- 4 The contraction and relaxation of human muscles relies on interactions between different proteins within muscle cells.

In skeletal muscles, the proteins are arranged in bundles known as **myofibrils**.

Fig. 4.1 shows simplified diagrams of some of the proteins present in muscle myofibrils.

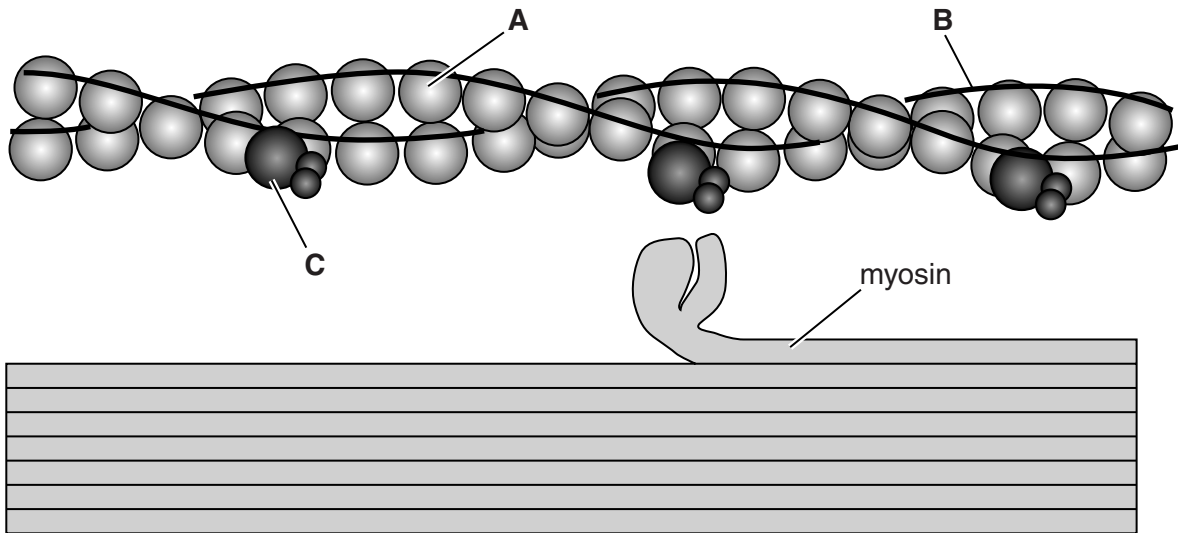


Fig. 4.1

- (a) Using the letters **A**, **B** or **C**, identify the following proteins on Fig. 4.1.

tropomyosin

troponin

[2]

(ii) Suggest why **DMD** cannot be detected by amniocentesis or chorionic villus sampling.

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

(d) The role of dystrophin is to protect the membranes such as the sarcoplasmic reticulum from damage during muscle contraction.

The sarcoplasmic reticulum stores calcium ions in the relaxed muscle cells.

An early sign of **DMD** in muscles is a delay in muscle relaxation following a contraction.

Suggest why muscle cells fail to relax following a contraction if dystrophin is not functioning correctly or is absent.

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

[Total: 13]

- 5 The energy necessary for carrying out any form of activity comes from the breakdown of the carbohydrates and fats, which are consumed in the diet.

A balanced diet contains enough of these substances, along with protein and the essential minerals and vitamins, to meet the needs of an individual.

- (a) Carbohydrates and fats can both be respiratory substrates.

Define the term *respiratory substrate*.

.....

.....

..... [1]

- (b) The type of respiratory substrate being utilised by organisms can be deduced from calculating the RQ value.

Table 5.1 shows RQ values obtained for different combinations of carbohydrates and fats.

RQ value	Percentage contribution of respiratory substrate	
	Carbohydrate (%)	Fat (%)
0.70	0.0	100.0
0.75	14.7	85.3
0.80	31.7	68.3
0.85	48.8	51.2
0.90	65.9	34.1
0.95	82.9	17.1
.....	0.0

Table 5.1

Complete Table 5.1 by inserting the correct figures into the final row. One has already been inserted for you.

The answers to this question should be written in Table 5.1.

[2]

Question 5(c) begins on page 14

- (c) RQ values can be determined from measurements made on humans using sophisticated electronic equipment.

Historically, several pieces of apparatus were required to determine RQ values experimentally. The steps required and some of the apparatus used are as follows:

- exhaled air is collected in a gas-proof bag
- exhaled and inhaled air is analysed using a gas analyser
- breathing rate and volume are measured.

From calculating the RQ value, the relative percentage of carbohydrate and fat being used as respiratory substrates by a person can be deduced.

- (i) What apparatus could be used for measuring both breathing rate and volume?

..... [1]

- (ii) Suggest **two** variables that should be taken into account during an investigation into the effect of **exercise intensity** on RQ values in 18-year-old males.

1

2

[2]

- (iii) Suggest a **biological** reason why the results will only provide an **estimate** of the percentage contribution of fat and carbohydrate as respiratory substrates.

.....

.....

..... [1]

- (d) Fats can only be used as a respiratory substrate if conditions within the muscles remain aerobic **and** if some carbohydrate is available.

This is often summarised by fitness trainers in the saying:

'Fats burn in a carbohydrate flame'.

- (i) Suggest why fats can only be broken down in aerobic respiration.

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

- (ii) Name the carbohydrate compound stored in muscle cells and briefly describe one method used by athletes to increase this store.

carbohydrate compound

method

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

[Total: 12]

6 Storage of sperm by cryopreservation is not limited to human sperm samples.

The maintenance of the dairy cow population in the United Kingdom also relies on being able to store semen from bulls. These bulls have been bred to father offspring with a high milk yield. Their semen is used to inseminate cows that have also been bred to produce a high milk yield.

(a) Sperm cells may become damaged during cryopreservation or during the thawing process.

Most of the damage that occurs is due to the disruption of the cell surface membranes or intracellular membranes, such as the nuclear envelope.

In addition to the nuclear envelope, identify two further **intracellular** membranes that may be damaged during the cryopreservation or thawing of sperm cells.

1

2

[2]

(b) Following cryopreservation and thawing, it is important to be able to assess the viability of the sperm before the sample is used.

Since many samples have to be assessed, techniques have been developed that can be automated.

A technique that can be used is flow cytometry.

- Sperm cells are labelled with two different fluorescent molecules.
- A molecule that fluoresces **green**, labels only **undamaged, viable** sperm.
- A molecule that fluoresces **red**, labels only sperm with **membrane damage**.
- Samples containing approximately 10 000 sperm cells are analysed in a flow cytometer.
- The flow cytometer counts the numbers of green and red cells.

Semen from six different bulls was stored using cryopreservation and then thawed. The thawed semen was analysed using the technique described above.

Table 6.1 on page 17 shows the results obtained.

Results:

Semen sample	Sperm fluorescing green		Sperm fluorescing red	
	Mean percentage	Standard deviation	Mean percentage	Standard deviation
1	47.6	2.5	49.3	2.6
2	56.0	1.2	37.0	1.5
3	47.3	1.5	48.7	1.7
4	50.4	1.1	45.5	1.2
5	52.8	2.7	40.9	2.9
6	47.7	2.8	49.2	2.8

Table 6.1

- (i) Using the information in Table 6.1, describe the effect of cryopreservation on the viability of the sperm in the semen samples.

.....

.....

.....

.....

..... [2]

- (ii) The standard deviation is a measure of the spread of data around the calculated mean. The investigators concluded that there was no significant difference between the numbers of red fluorescing sperm cells in semen samples 2 and 5.

Does the evidence in Table 6.1 support this conclusion?

Explain your answer.

.....

.....

..... [1]

[Total: 5]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

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

A large area of lined paper for writing. It consists of a vertical solid line on the left side, creating a margin. To the right of this line, there are numerous horizontal dotted lines spaced evenly down the page, providing a guide for handwriting.

A large area of the page is reserved for writing, featuring a vertical solid line on the left side and horizontal dotted lines extending across the page.



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INSERT

Duration: 1 hour 15 minutes



INFORMATION FOR CANDIDATES

- This Insert contains Fig. 1.1.
- This document consists of **2** pages. Any blank pages are indicated.

INSTRUCTIONS FOR EXAMS OFFICER/INVIGILATOR

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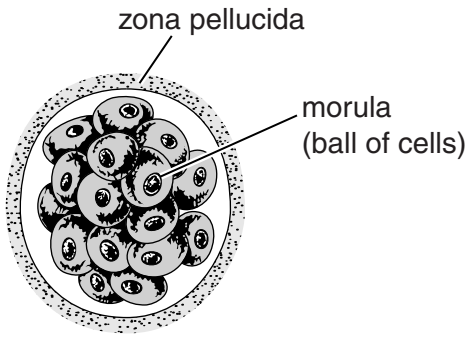
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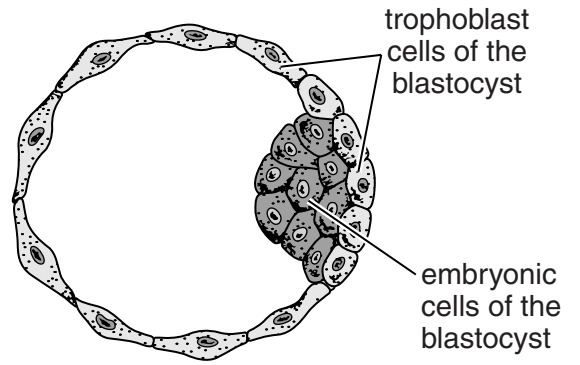
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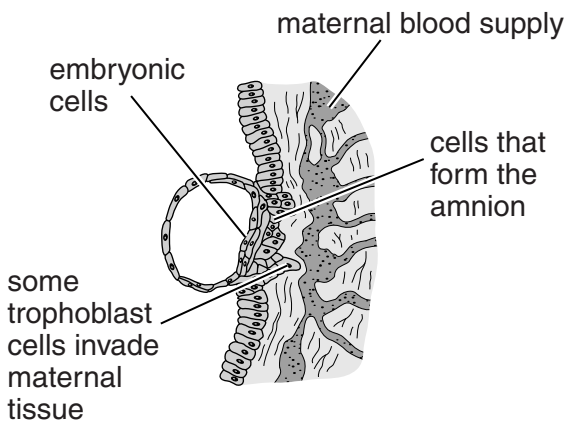
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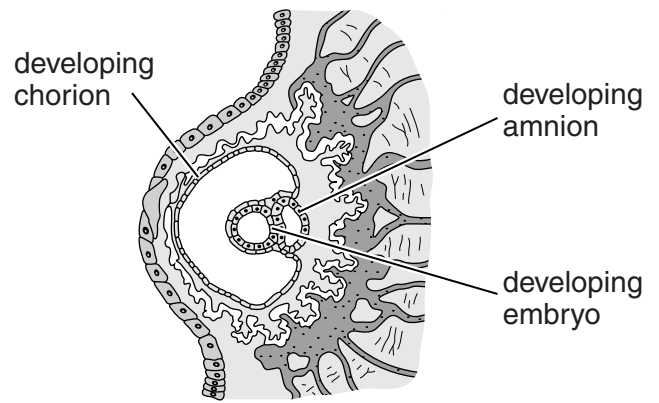
(a) 3-4 days



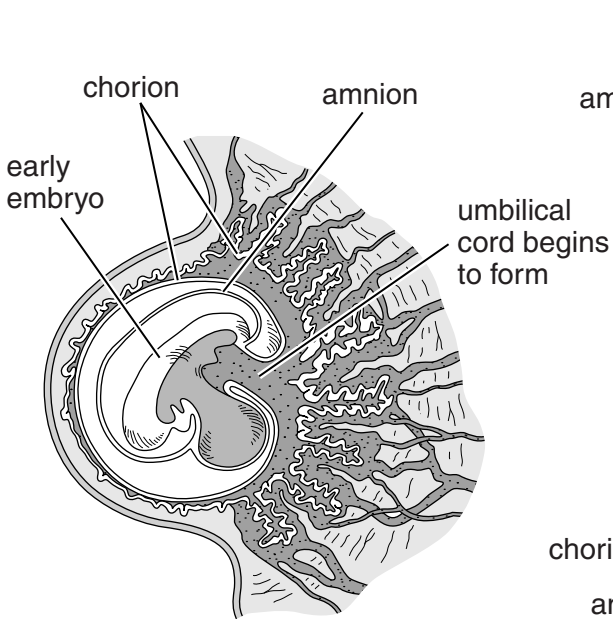
(b) 5-6 days



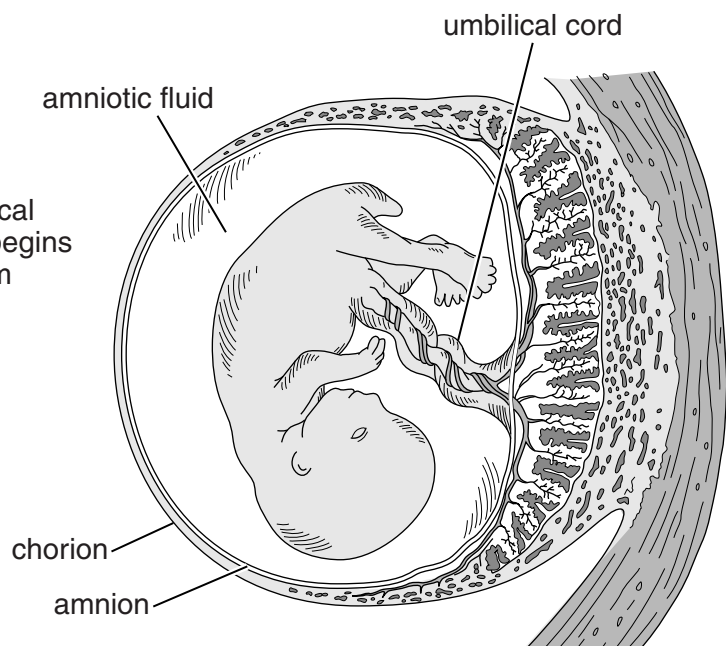
(c) 7-8 days



(d) 3 weeks



(e) 4 weeks



(f) 8 weeks

Fig. 1.1