Write your name here

Surname	Other names

Centre Number | Candidate Number

Edexcel GCE

Biology

Advanced Subsidiary

Unit 3B: Practical Biology and Research Skills

Tuesday 7 May 2013 – Morning
Time: 1 hour 30 minutes

Paper Reference
6BI07/01

You must have:
Ruler, Calculator, HB pencil

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 40.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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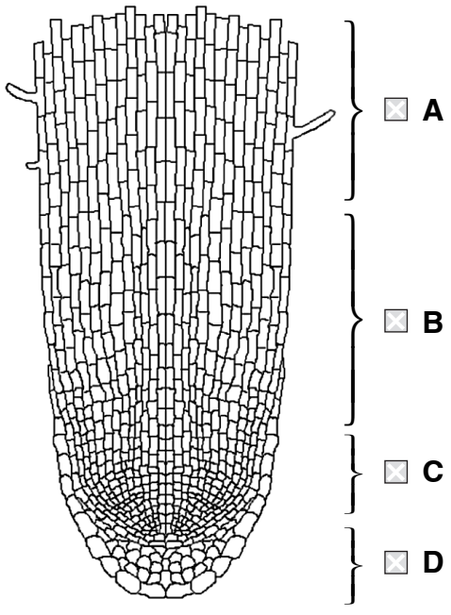
Answer ALL questions.

1 In a class practical, a student had studied cell division (mitosis) in onion roots.

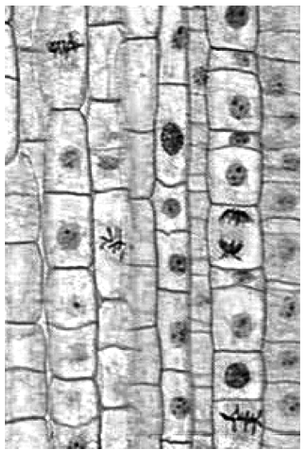
(a) The student was shown the diagram below of a longitudinal section of a root tip.

Place a cross ☒ in the box next to the letter showing the zone where mitosis takes place.

(1)



(b) Her teacher gave her the photograph below and asked her to identify cells undergoing mitosis.



(i) Draw lines to all the cells that are undergoing mitosis and label them **M**.

(2)

(ii) Draw a line to a cell which is in anaphase and label it **A**.

(1)

(iii) Give **one** reason why you chose this cell.

(1)

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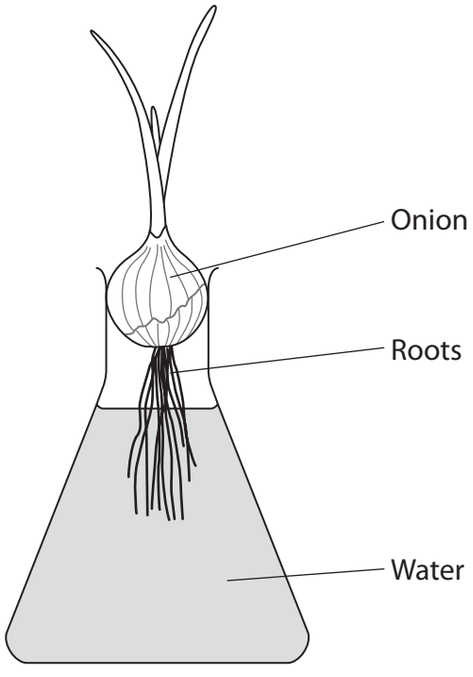
(c) She decided to investigate how many cells were undergoing cell division in different areas of a root.
She grew some onion roots in a conical flask containing water, as shown in the diagram below.



(i) In class, she had prepared a root tip squash.
To see the chromosomes in the cells, she had to stain them and observe them using a microscope.

Name a suitable stain for observing chromosomes.

(1)

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(ii) She counted the number of cells undergoing mitosis and the total number of cells in the field of view and calculated the mitotic index.

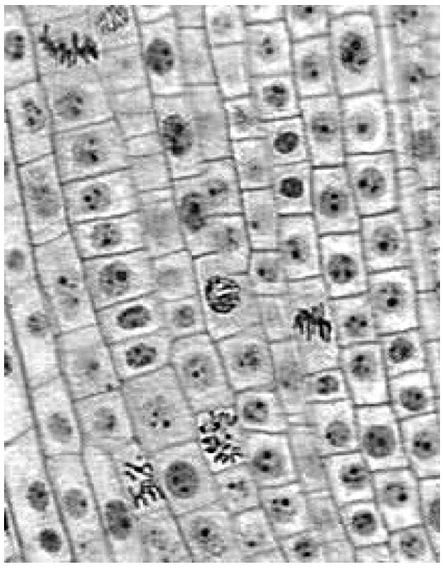
The formula is shown below.

$$\text{Mitotic index} = \frac{\text{Number of cell undergoing mitosis}}{\text{Total number of cells viewed}} \times 100\%$$

Calculate the mitotic index for the root cells shown in the photograph below. There is a total of 84 cells.

Show your working.

(3)



Answer = ... %

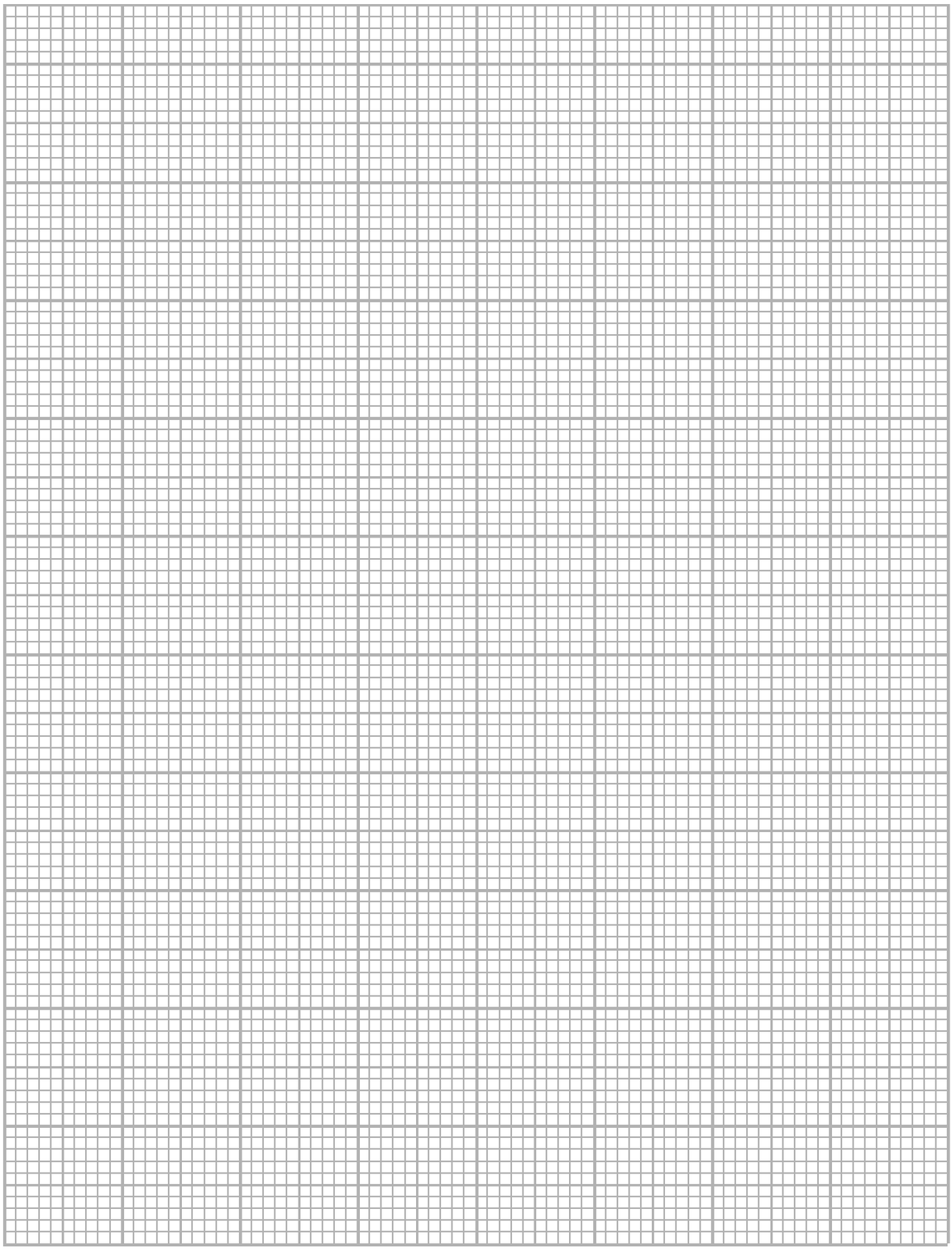
(d) The student determined the mitotic index of cells at five distances from an onion root tip. She repeated this procedure on another five root tips.

Her results are shown in the table below.

Distance from root tip / mm	Mitotic index (%)							Standard deviation (SD)
	Root section number						Mean	
	1	2	3	4	5	6		
0.1	11.5	11.0	10.7	10.6	11.7	10.9	11.1	0.4
0.3	9.4	8.9	7.8	9.9	9.7	8.9	9.1	0.8
0.5	8.1	8.9	7.6	7.7	8.4	7.5	8.0	0.5
0.9	4.0	3.9	3.6	4.2	4.4	3.7	4.0	0.3
1.1	3.0	2.9	3.2	3.3	2.7	2.9	3.0	0.2

(i) Plot the distance from the root tip, mean mitotic index and standard deviations (SD) in a suitable graphical form.
Draw a straight line of best fit through the points.

(5)



(ii) Use your line of best fit to predict the distance from the tip at which there will be no mitosis. Write your prediction below.

(1)

Answer = ... mm

(iii) State the relationship between mean mitotic index and distance from the root tip.

(1)

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.....

(iv) The student was confident that there is a difference between the mean mitotic index at 0.5 mm and the one at 0.9 mm. She was not confident that there is a difference between the mean mitotic index at 0.3 mm and the one at 0.5 mm.

Using the information in the table, suggest why she thought this.

(4)

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(Total for Question 1 = 20 marks)

2 The following is an extract from a student's report on the topic of artificial blood.

Making Blood

1. Blood loss for patients during operations can be significant, resulting in an ever increasing demand for blood. Blood donation through transfusion services is likely to remain the main source to meet this demand. However, more reliable and less costly sources of blood are being sought. This is partly because of projected donation supply shortfalls and contamination of natural blood.

2. Blood is complex and performs many functions, such as the transport of oxygen, defence against disease, the promotion of clotting and the transport of food, hormones and other substances.

3. Whole blood is too complex to synthesise, so research has focused on creating substitutes for two of its important functions; oxygen transport and clotting.

4. The structure of haemoglobin was first determined in 1959 and researchers have been trying to develop products which mimic red blood cells (RBCs) to deliver oxygen to damaged body tissues ever since. Several blood substitute products have been developed over the past fifty years. Some products have reached advanced clinical trials in patients whose lives were threatened. They are as effective as natural blood for carrying oxygen. However, we are still not sure if there are any side-effects for patients.

5. Three approaches to develop blood products for oxygen transport have been used. Haemoglobin-based oxygen carriers (HBOCs*)* are solutions of modified haemoglobin from human, other animals and genetically engineered sources in plasma-like fluids.

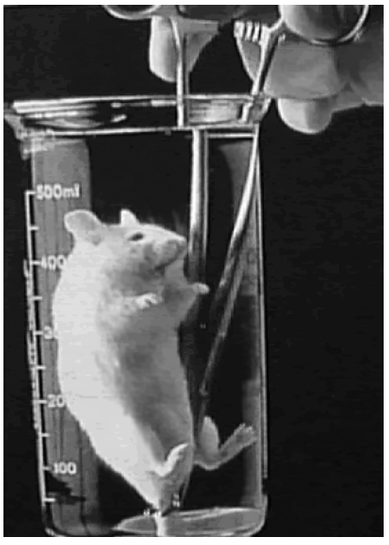
6. **Haemoglobin-based oxygen carriers (HBOCs)**

   HBOCs have benefits over natural red blood cells. They show faster and better oxygen distribution. The sterile HBOC manufacturing process virtually eliminates the risk of viral infection versus red cells in natural blood. 100% screening of donated blood for infections such as AIDS/HIV, Creutzfeld-Jacob, smallpox and SARS is not practical or even possible. HBOCs can survive over a wide range of storage temperatures, no refrigeration is required and there is a longer shelf life. There are no intact red blood cells with ABO antigens so there is no need for cross-matching of patients' blood types prior to use. They are a universal product, meaning that patients who only accept bloodless medical care can be treated. They can deliver oxygen quickly to damaged tissues because of their lower viscosity than RBCs.

7. HBOCs also have some drawbacks. They may increase the chances of deaths and heart attacks in patients with high blood pressure. They can cause an immune response with adverse side-effects. Haemoglobin does not last long outside red blood cells (3–4 days) and breaks down within the body, sometimes resulting in renal failure. RBCs typically live for up to 3 months. The manufacturing process requires very large quantities of haemoglobin. This is likely to be a constraint.

8. **Perfluorocarbons (PFCs)**

   Perfluorocarbon (PFC) based oxygen carriers are fully synthetic hydrocarbon-based compounds. PFCs are chemically inert organic fluids, but have the ability to dissolve 20 times more oxygen than plasma. The potential of PFCs was widely publicised in the 1960s when a photo appeared of a mouse submerged in a container "breathing" an oxygen-saturated PFC solution.



Magnification $\times 0.50$

9. Some oxygen can dissolve in plasma but usually less than 1% of the total oxygen content in arterial blood. A major advantage of PFCs, such as Perflubron, is that they can increase dissolved oxygen to between two to three fold over the norm, depending on the oxygen partial pressure. A PFC called 'Oxygent' underwent clinical trials in the USA and Europe. It is universally compatible with all blood types, has a two year approximate shelf-life and can be manufactured on a large-scale, using commercially available raw materials. However, Phase III trials have shown an increased risk of stroke in treated patients compared to controls.

10. **Embryonic stem cells (ESCs)**

    A third approach taken in some recent work has been to look at the possibility of using embryonic stem cells (ESCs) to make blood. Work on ESCs almost completely ceased in 2001 in the USA due to the ban by President George Bush. However, in 2009 President Barack Obama reversed the ban, saying that sound science and moral values are not inconsistent with each other.

11. Work by Robert Lanza and his colleagues has led to the production of human RBCs from ESCs. These have been shown to be just as good at carrying oxygen as natural RBCs. They can be mass-produced very easily. The dream is to make RBCs from ESCs of blood type O negative, which can then be transfused into any patient as they do not cause an immune response.

12. While these are positive scientific developments, the powerful emotions raised by the use of ESCs and IVF embryos continue to be debated in public forums. Objections have been raised by religious communities. Scientists are accused of interfering with nature. Some groups are making legal claims of unethical behaviour in the creation or destruction of life. However, another type of stem cell which can also be coaxed into turning into other cell types does not require an embryo. These are called 'induced pluripotent stem cells' or iPSCs.

(a) (i) It was suggested that the information on the benefits and drawbacks of haemoglobin-based oxygen carriers (HBOCs) in comparison with red blood cells (RBCs) could be summarised in a table.
The student attempted this but it is unfinished.

Complete the empty boxes in the table using information from the report.

(4)

Feature	HBOCs	RBCs
Onset of oxygen carriage action		About a day
Risk of disease transmission		Attempts to minimise it by screening but never 100% successful
Duration of oxygen carriage action in body		
Viscosity		
Shelf life	Many months	A few days

(ii) Suggest **two** further features of HBOCs and RBCs, given in the extract, that could be included in this comparative table.

(2)

1 .....

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2 .....

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(b) The student needed data to illustrate some of the points he made in his report.

He found the data below for the PFC Perflubron.

Partial pressure of oxygen / kPa	**Oxygen concentration in plasma / cm^3 per 100 cm^3**	**Oxygen concentration in Perflubron / cm^3 per 100 cm^3**
0.0	0.0	0.0
13.3	0.2	0.8
26.7	0.5	1.5
40.0	0.8	2.1
53.2	1.0	3.0
79.8	1.8	4.6

(i) Draw a sketch graph to represent this data.

(3)

(ii) Suggest where in the extract this graph should be placed and describe the extent to which the graph supports the information in the extract.

(4)

(c) Identify a paragraph in the report in which the student has referred to an economic issue. State the issue referred to and suggest what additional information you could include in this paragraph.

(3)

Paragraph .....

Issue .....

Additional information .....

(d) Part of the student's reference list is shown below.

References

1. Changing age distribution of the blood donor population in the United States. In the journal *Transfusion* (Vol. 48, issue 2, pages 251–257) by Shimian Zou, Fatemeh Musavi, Edward P. Notari, Chyang T. Fang. 2007

2. Riess J. G. Understanding the Fundamentals of Perfluorocarbons and Perfluorocarbon Emulsions Relevant to In Vivo Oxygen Delivery. *Art Cells Blood Subs Immob Biotech.* 2005

3. Eric Niiler, *Nature Biotechnology* Vol. 20, 962–963 (2002)

4. New Scientist, Issue 23 August 2008. Page 10, article written by Andy Coghlan

His teacher gave him a note explaining how to do references properly.
The teacher suggested he should reorganise what he had done and find out any missing information. Here is the note:

Journal refs should have all the following information, in the order shown:

- Author(s) (family name and then initials)
- Year published (in brackets)
- Article title
- Journal title (in *italics*)
- Journal volume number followed by issue number in brackets
- Start and finish page numbers of the article in the journal

An example:

Wolanski, E., Richmond, R., McCook, L. and Sweatman, H. (2003) Mud, Marine Snow and Coral Reefs. *American Scientist* 91(1), 44–51.

(i) Choose **one** reference from the list above, which has all the required information and re-write it as the teacher suggested.

(2)

Reference number .....

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(ii) Choose another reference and list the pieces of information you would need to make it complete.

(2)

Reference number .....

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(Total for Question 2 = 20 marks)

TOTAL FOR PAPER = 40 MARKS

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