General Certificate of Education
Advanced Subsidiary Examination
June 2010

Human Biology HBI3X/TN

Unit 3X AS Externally Marked Practical Assignment

Teachers' Notes Confidential

A copy should be given immediately to the teacher(s) responsible for GCE Human Biology

Open on receipt

Teachers' Notes

CONFIDENTIAL

These notes must be read in conjunction with *Instructions for the Administration of the Externally Marked Practical Assignment* published on the AQA website.

Investigating the cell cycle and the time spent in different stages of mitosis

Candidates will be required to investigate how long different stages of the cell cycle, including mitosis, take to complete. Given that production of slides to show stages of mitosis is not always successful, in Task 1, candidates will use a simple method to appreciate the procedure but without the need to identify specific stages. Where this is required in Task 2, however, prepared slides will be used. Plant tissues will be used in both tasks as they provide a reliable source of cells in different stages of mitosis. The candidate's sheet for Task 1 indicates that an onion will be the source for the root tips, but centres can use other suitable material if preferred.

Materials

Task 1

In addition to access to general laboratory equipment, each candidate needs

- a prepared test tube containing 5 cm^3 hydrochloric acid (1 mol dm^{-3}) pre-heated to constant temperature in a water bath at 60 °C. (Candidates will need a tube of pre-heated acid and access to the water bath. The water bath – either a suitable heated beaker or a thermostatic water bath – can be shared.)
- 5 cm^3 toluidine blue stain
- dropping pipette
- 2 onion roots complete with root tips in water (or other suitable plant material, e.g., hyacinth, garlic, broad bean)
- test tube
- test-tube rack
- distilled water
- scalpel (or method of cutting root tip such as safety razor)
- white tile
- forceps
- 2 microscope slides
- 2 cover slips
- optical microscope capable of approximately x400 magnification
- timer
- other apparatus as required

Task 2

In addition to access to general laboratory equipment, each candidate needs

- an optical microscope capable of approximately x400 magnification
- a prepared microscope slide of a longitudinal section of onion root tip
- key to identify interphase and the stages of mitosis.

These preparations will need to be trialled before use.

Managing the investigation

Task 1

Candidates should be provided with two plant roots, complete with root tip. The roots should be removed from the plant source just before the investigation begins. They should be placed in a container of distilled water, such as a Petri dish, to keep them moist. One onion bulb could be the source of root tips for several candidates. An onion is suggested as the plant source but the centre can substitute a suitable alternative if preferred. Candidates are to be given two roots so that they have a spare available if necessary.

One way to obtain root growth from an onion is to insert four toothpicks into it, at perpendicular angles. These allow the onion to be suspended in an appropriately sized beaker which is full of water. About a third of the onion should be submerged. Roots normally grow within a few days. It sometimes helps to remove a thin slice of old tissue to allow root growth from newly exposed onion tissue.

Candidates are required to follow a simple staining procedure and mount their specimen on a microscopic slide. To save time, they should be provided with a test tube containing acid that has reached the required temperature. Thus, one thermostatic water bath could be set up in advance containing sufficient tubes of acid for all candidates within the class.

Using an optical microscope that can magnify up to x400 – oil immersion is not required – candidates will count both the total number of cells they can see in the visual field and the total number of cells that show signs of mitosis. At this stage, candidates do not need to differentiate one stage from another. Cells should be visible but, if a candidate fails to see chromosomes within the cells, it will not affect the outcome of Task 1.

Where a centre has limited access to microscopes, the same microscope can be used by different candidates. There should be no communication between candidates and the centre will need to control the time allowed for each candidate to use the microscope. Alternatively, centres might wish to investigate a microscope loan service.

Task 2

All candidates should be provided with prepared microscope slides of longitudinal sections through the root tips of a plant such as onion. In Task 2, the different stages of mitosis must be recognised and it is important that the centre checks that the prepared slides available make it possible to identify at least a few cells in all (or most) of the different stages. A key is provided to help candidates with recognition of the different stages. A candidate should obtain results from one slide but it would be appropriate to have spare prepared slides available. Only one set of data is required. Different studies report different time lengths for completion of the cell cycle. Candidates will be given a specific value to use for calculations.

The tasks will need to be trialled before use.

Task 1

One week before Task 1 of the EMPA, teachers may give their candidates the following information.

You will investigate the cell cycle and mitosis.

There should be no further discussion of this topic.

In this investigation, teachers must not give candidates the following information

- how to set up the microscope
- how to recognise whether a cell is in a stage of mitosis.

It is acceptable in Task 1 to remind candidates to keep their roots moist at all times.

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use
Total Task 1

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Human Biology HBI3X/PM1

Unit 3X AS Externally Marked Practical Assignment

Task Sheet 1

To be completed before Task Sheet 2.

For submission by 15 May 2010

For this paper you must have:
- a ruler with millimetre measurements
- a calculator.

Investigating the cell cycle and the time spent in different stages of mitosis

Introduction

In this investigation, you will estimate the number of cells undergoing mitosis in the root tip of an onion.

Task 1

The root tip of a plant is a region where many cells are dividing by mitosis. You are going to stain cells from an onion root tip with toluidine blue. If a cell is dividing by mitosis, you will see chromosomes. If a cell is not dividing, you will see a nucleus but you will not see chromosomes. You only need to obtain one set of results from one slide that you prepare.

Materials

You are provided with

- test tube containing pre-heated hydrochloric acid
- toluidine blue stain
- thermometer
- dropping pipette
- 2 root tips in water
- test tube
- test-tube rack
- distilled water
- scalpel
- white tile
- forceps
- access to water bath at 60 °C
- microscope slides
- cover slips
- microscope
- timer

You may ask your teacher for any other apparatus you require.

Outline method

Read these instructions carefully before you start your investigation.

It is important that the root tips are not allowed to dry out by being exposed to air between steps in the method.

1. You are provided with a test tube containing hydrochloric acid that has been heated in a water bath at 60 °C. Remove the first 3 mm from the tip of each root.
2. Add the root tips to the pre-heated acid and leave at 60 °C for 4 minutes.
3. Use the forceps to hold one root tip by its cut end and rinse the root tip in a tube of water.
4. Transfer the root tip by its cut end onto a microscope slide.
5. Place a second microscope slide on top of the root tip, at right angles to the first slide, and squash the root tip between the two slides.
6. Separate the two slides and add 1 drop of toluidine blue to the squashed root tip on one of the slides. Immediately cover the squashed tissue with a cover slip.
7. Use the microscope at its highest magnification (such as x400) to examine the slide for signs of mitosis.
8. Select an appropriate field of view and count:
    - the total number of cells visible
    - the number of cells showing mitosis (where chromosomes can be seen).
9. Record your results in the table below.

You will need to decide for yourself

- whether or not a cell shows signs of mitosis.

Recording your results

Record your results in the table.

Total number of cells visible	Total number of cells showing mitosis

Questions on Task 1

Answer **all** questions in the spaces provided.

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1 Suggest **one** reason why you

1 (a) held the root tip by its cut end (step 3).

1 (b) added toluidine blue stain to the squashed root tip (step 6).

1 (c) placed the root tips in hydrochloric acid (step 2).

1 (d) heated the root tips at 60 °C (step 2).

2 You squashed the root tip between two microscope slides.

2 (a) Explain why you squashed the root tip.

2 (b) Squashing between two microscope slides can provide more than one set of results. Explain how.

3 Another student carried out the same investigation as you did. She counted the cells in one field of view and recorded the number of cells showing mitosis. She calculated the mitotic index from these figures. The mitotic index is the percentage of cells undergoing mitosis. The table shows her results.

Total number of cells visible	Total number of cells showing mitosis	Mitotic index
368	59	

3 (a) Use the student's results to calculate the mitotic index for the root tip. Enter this value in the table.

3 (b) A different student used the same procedure with a pea plant he had grown himself. He counted 227 cells in one field of view and recorded that 2 of the cells were undergoing mitosis. He calculated the mitotic index but did not think that the figure he calculated was reliable.

Give **two** reasons why his calculation was unreliable.

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use
Total Task 2

General Certificate of Education
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June 2010

Human Biology HBI3X/PM2

Unit 3X AS Externally Marked Practical Assignment

Task Sheet 2

To be completed before the EMPA Written Test.

For submission by 15 May 2010

For this paper you must have:
- a ruler with millimetre measurements
- a calculator.

Investigating the cell cycle and the time spent in different stages of mitosis

Introduction

In eukaryotic organisms, such as humans and plants, cells divide by mitosis. Between the visible events of mitosis, a cell is in interphase. Interphase is the stage in the cell cycle when a cell is not dividing.

The stages of mitosis take different times to complete. You can estimate how long each stage takes by using a microscope to count the number of cells in each stage. The larger the number of cells you see at each stage, the longer the stage must take to complete.

In Task 2, you will use prepared slides of plant root tips. For this investigation, you may assume that one complete cell cycle takes 720 minutes.

Task 2

Materials

You are provided with

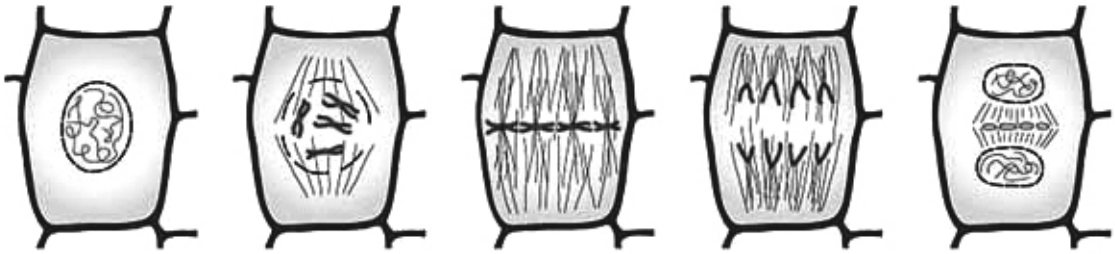
- a microscope
- a prepared slide of a longitudinal section through a root tip
- photographs and diagrams to allow you to identify the stages of the cell cycle **(Figure 1)**

You may ask your teacher for any other apparatus you require.

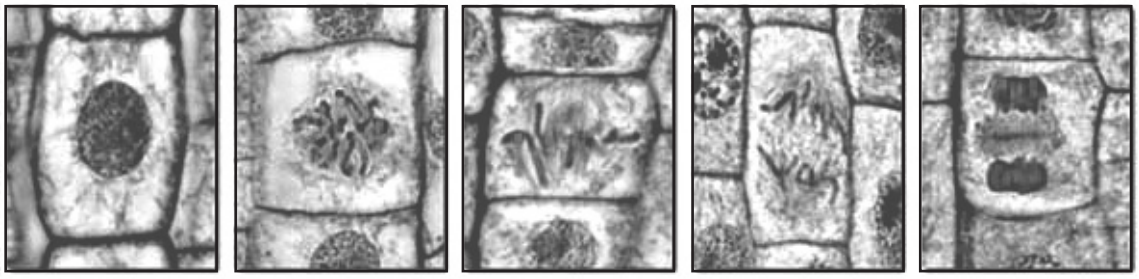
Figure 1

The stages in the cell cycle in cells from a root tip

Diagrams



Photographs



interphase prophase metaphase anaphase telophase

Method

Read these instructions carefully before you start your investigation.

1. Place the slide of the root tip on the stage of your microscope.
2. Count and record the number of cells in interphase and in each stage of mitosis.

You will need to decide for yourself

- how to locate the region of dividing cells
- the stage of mitosis or cell cycle that a cell is showing
- how many cells to count.

To help you process your data, the time required for each stage of the cell cycle can be calculated using the formula:

$$\text{Number of minutes to complete a stage} = \frac{\text{number of cells in stage}}{\text{total number of cells counted}} \times 720$$

Presenting data

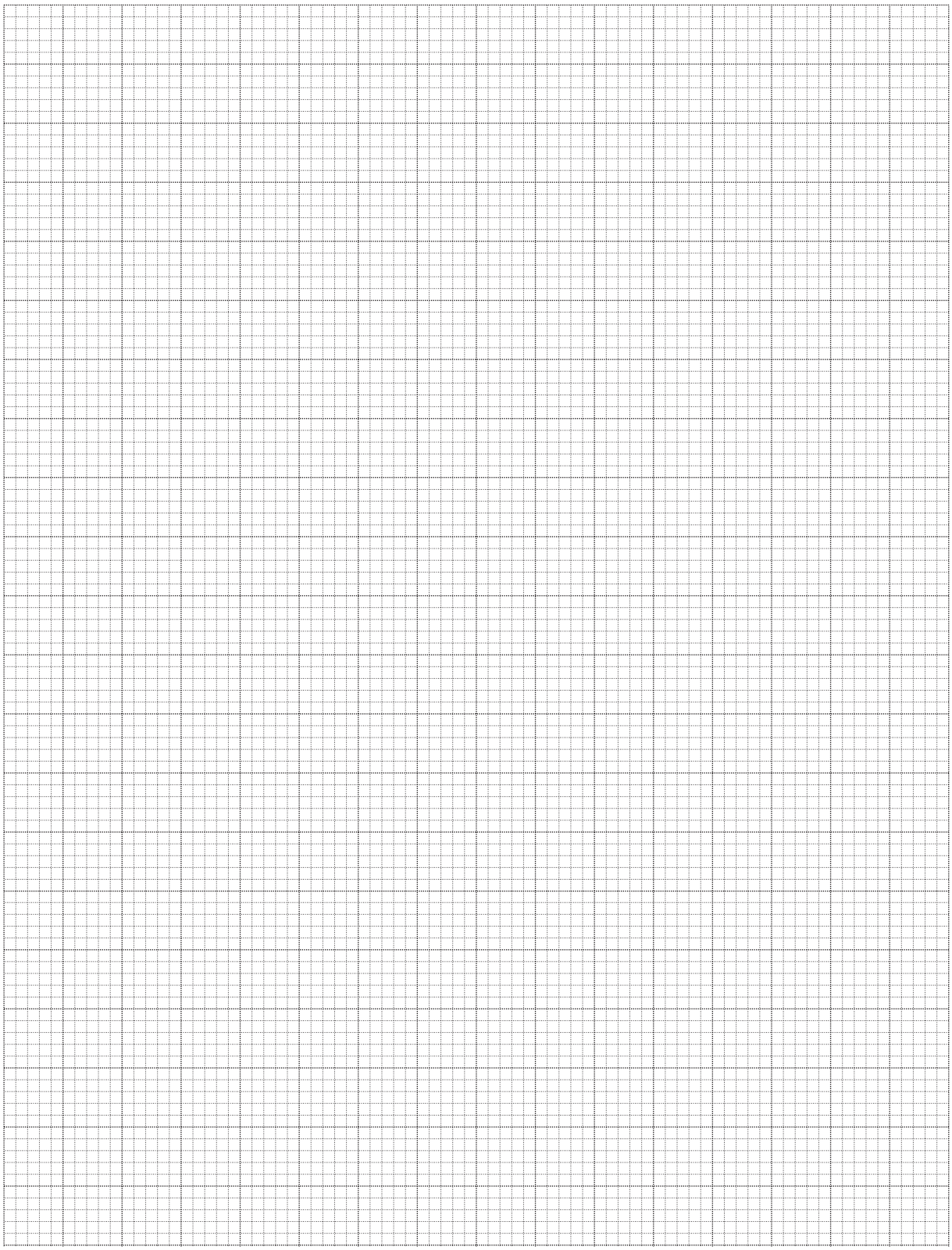
4 Record the results of your investigation in an appropriate table in the space below.

The time required for each stage of the cell cycle can be calculated using the formula:

$$\text{Number of minutes to complete a stage} = \frac{\text{number of cells in stage}}{\text{total number of cells counted}} \times 720$$

Use the space below to do any calculations.

5 Use the graph paper to plot an appropriate graph of your processed data.



END OF TASK 2

Centre Number						Candidate Number				
Surname										
Other Names										
Candidate Signature										

For Examiner's Use Total EMPA mark	
Examiner's Initials	
Section	Mark
Task 1	
Task 2	
Section A	
Section B	
TOTAL EMPA MARK	

General Certificate of Education
Advanced Subsidiary Examination
June 2010

Human Biology HBI3X

Unit 3X AS Externally Marked Practical Assignment

Written Test

For submission by 15 May 2010

For this paper you must have:
- Task Sheet 2, your results and your graph
- a ruler with millimetre measurements
- a calculator.

Time allowed
- 1 hour 15 minutes

Instructions
- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 30.
- You will be marked on your ability to:
  – use good English
  – organise information clearly
  – use scientific terminology accurately.

Section A

These questions relate to your investigation of the cell cycle and the different stages of mitosis.

Use your Task Sheet 2, your results, processed data and your graph to answer the questions.

Answer **all** questions in the spaces provided.

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6 In Task 1, human tissue was not used.
Give **two** reasons why human tissue was not used.

7 In Task 2, the prepared slide that you used was a longitudinal section of a root tip.
What is meant by a *longitudinal* section?

8 (a) Which stage of mitosis, prophase, metaphase, anaphase or telophase, did you find takes the longest time to complete?
Suggest how the events that occur during this stage result in it taking the longest time to complete.

8 (b) The nuclei of many cells in interphase appear to be unevenly stained.
Explain why they appear to be unevenly stained.

9 How did you decide how many cells to count?

10 In Task 2, you assumed that one complete cell cycle takes 720 minutes.
A scientist studying onion root tips found that the time taken for mitosis was about 80 minutes.
She recognised that the proportion of 80 minutes that a stage of mitosis took to complete could be found from the percentage of cells that were in that stage of mitosis.
She used this to calculate the time in minutes for each stage of mitosis.

10 (a) Use the scientist's method to complete the table.

Stage of mitosis	Number of cells in stage of mitosis	Percentage of cells in stage of mitosis	Time to complete stage of mitosis / minutes
Prophase	108		
Metaphase	16		
Anaphase	8		
Telophase	28		

10 (b) Describe the similarities and differences between the times you obtained for each stage of mitosis in your investigation with the results you have calculated in this table.

10 (c) Was the method you used to find the time taken to complete each stage of mitosis more reliable than the one that the scientist used?
Explain your answer.

Resource Sheet

Introduction

During growth, mitosis occurs rapidly and new cells are produced. Mitosis is a controlled process but sometimes abnormal cells develop that divide out of control. Uncontrolled mitosis results in the formation of a mass of cells called a tumour. If the cells in the tumour are malignant, the tumour is a cancer.

Resource A

A scientist studied the mean times required for healthy stomach cells and stomach cancer cells to complete stages of the cell cycle.

The results are shown in **Table 1**.

Table 1

Stage of cell cycle	Mean time for stomach cells to complete stage of cell cycle / minutes	
	Healthy cells	Cancer cells
Interphase	527	378
Prophase	58	44
Metaphase	9	8
Anaphase	4	3
Telophase	11	9

Resource B

Vinblastine is a drug that kills cancer cells as they divide. It is particularly effective during metaphase. Like other drugs used against cancer, it is not just specific to cancer cells. It kills healthy cells as well.

Scientists studied the effects of low and high doses of vinblastine on a type of malignant tumour. They measured how much the drug affected tumour growth and blood flow through the tumour compared with an untreated tumour.

Some of the results are shown in **Table 2**.

Table 2

Vinblastine dose	Mean slowing of tumour growth / arbitrary units	Change in blood flow through the tumour
Low	1.1	effect not noticeable
High	2.1	noticeable effect

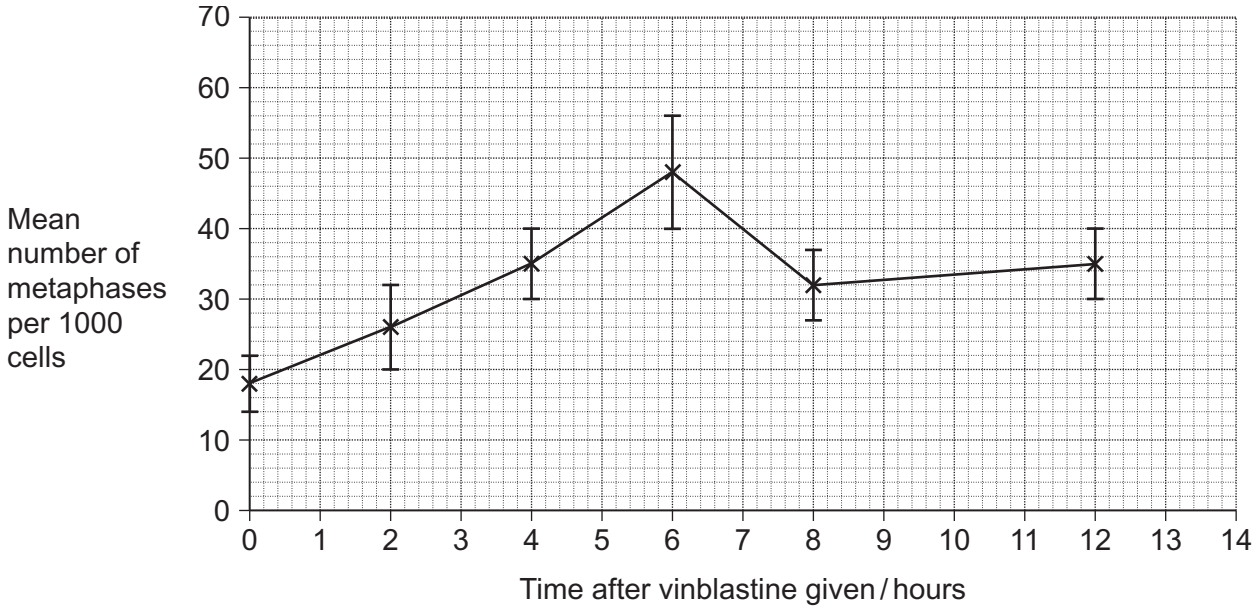
Resource C

Researchers studied the effect of vinblastine on the rate of mitosis. Patients with one form of mouth cancer were given a single dose of vinblastine. The researchers then examined samples of tissue from the cancer.

They recorded the mean number of metaphases per 1000 cells at regular intervals.

The results are shown in **Figure 1**. The bars show the standard deviations.

Figure 1



Section B

Use the information in the **Resource Sheet** to answer the questions.

Answer **all** questions in the spaces provided.

Use the information provided in **Resource A** to answer the following questions.

11 (a) Give **three** conclusions that you can draw from the data in **Table 1** about the similarities and differences in the cell cycle of these two groups of cells.

11 (b) Use the data in **Table 1** to explain the rapid growth of the cancer.

Use the information provided in **Resource B** to answer the following questions.

12 Explain how a 'noticeable effect' on blood flow through the tumours slowed their growth.

13 The scientists studied the effects of different doses of vinblastine on malignant tumours. Explain why the results of their investigation would be important to doctors who treat cancer.

Use the information provided in **Resource C** to answer the following questions.

14 (a) The rate of mitosis is given as the mean number of metaphases per 1000 cells. Explain the change in the mean number of cells in metaphase over the first six hours.

14 (b) Some doctors were shown the results of this research. They concluded that, on the basis of these results, vinblastine was not a good drug to treat this type of tumour. Evaluate this conclusion.

END OF QUESTIONS

There are no questions printed on this page

DO NOT WRITE ON THIS PAGE
ANSWER IN THE SPACES PROVIDED