

# Cell Division

Chromosomes / Mitosis & the Cell Cycle / Stem Cells

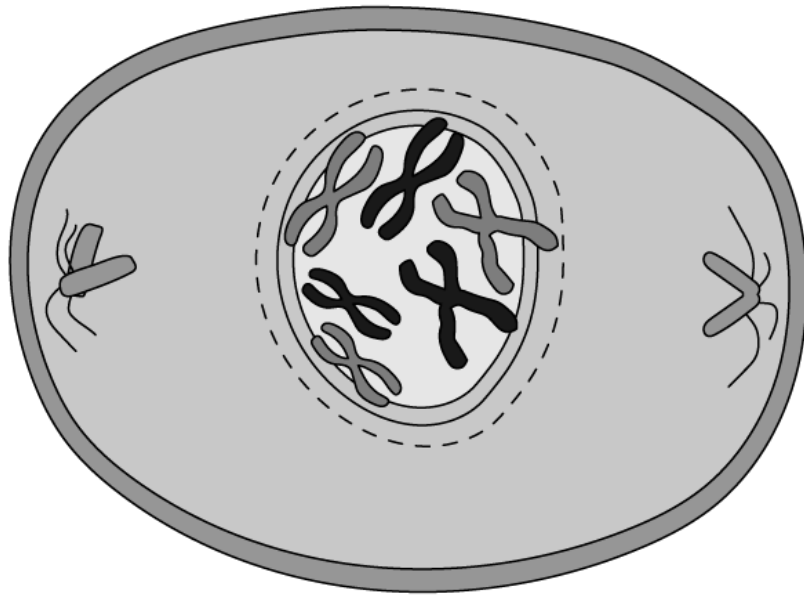
Easy (5 questions)	/39
Medium (6 questions)	/47
Hard (5 questions)	/58
<b>Total Marks</b>	<b>/144</b>

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Figure 1



Which of the following statements indicates that the cell in **Figure 1** is preparing to divide?

- A. The nucleus has visible pores
- B. The nucleus is visible and 'X' shaped
- C. The chromosomes are visible and 'X' shaped
- D. There is a haploid number of chromosomes

(1 mark)

(d) Identify the three stages of the cell cycle.

.....

.....

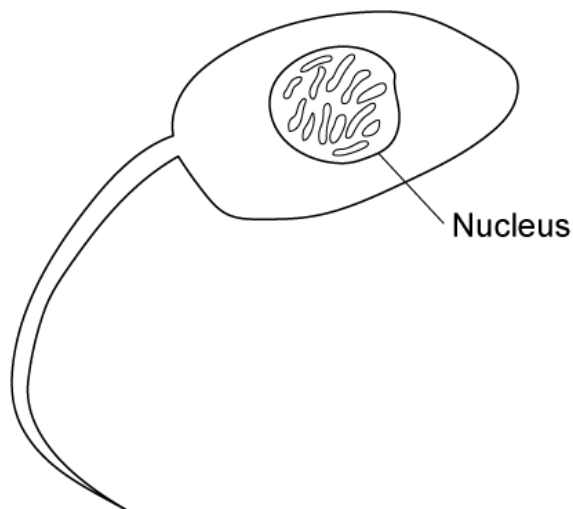
..... (3 marks)

2 (a) State why mitosis is important in multicellular organisms.

..... (1 mark)

(b) Figure 2 shows the nucleus of a male gamete from a frog.

Figure 2



What is the diploid number of chromosomes for a body cell in a frog?

..... (1 mark)

(c) Complete the table to identify which statements about mitosis are true and which are false.

Table 1

Statement	True	False
Mitosis produces genetically identical cells		
A cell divides twice in the process of mitosis		
Daughter cells from mitosis are haploid		
DNA is replicated before a cell can divide		

**(4 marks)**

- (d)** Most human cells that divide by mitosis are specialised to carry out a particular function. This is because the parent cell from which they originated was already differentiated.

Give the name that can be used to describe these parent cells and state where they might be found in the human body.

.....

..... **(2 marks)**

**3 (a)** Give the definition of a stem cell.

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**(2 marks)**

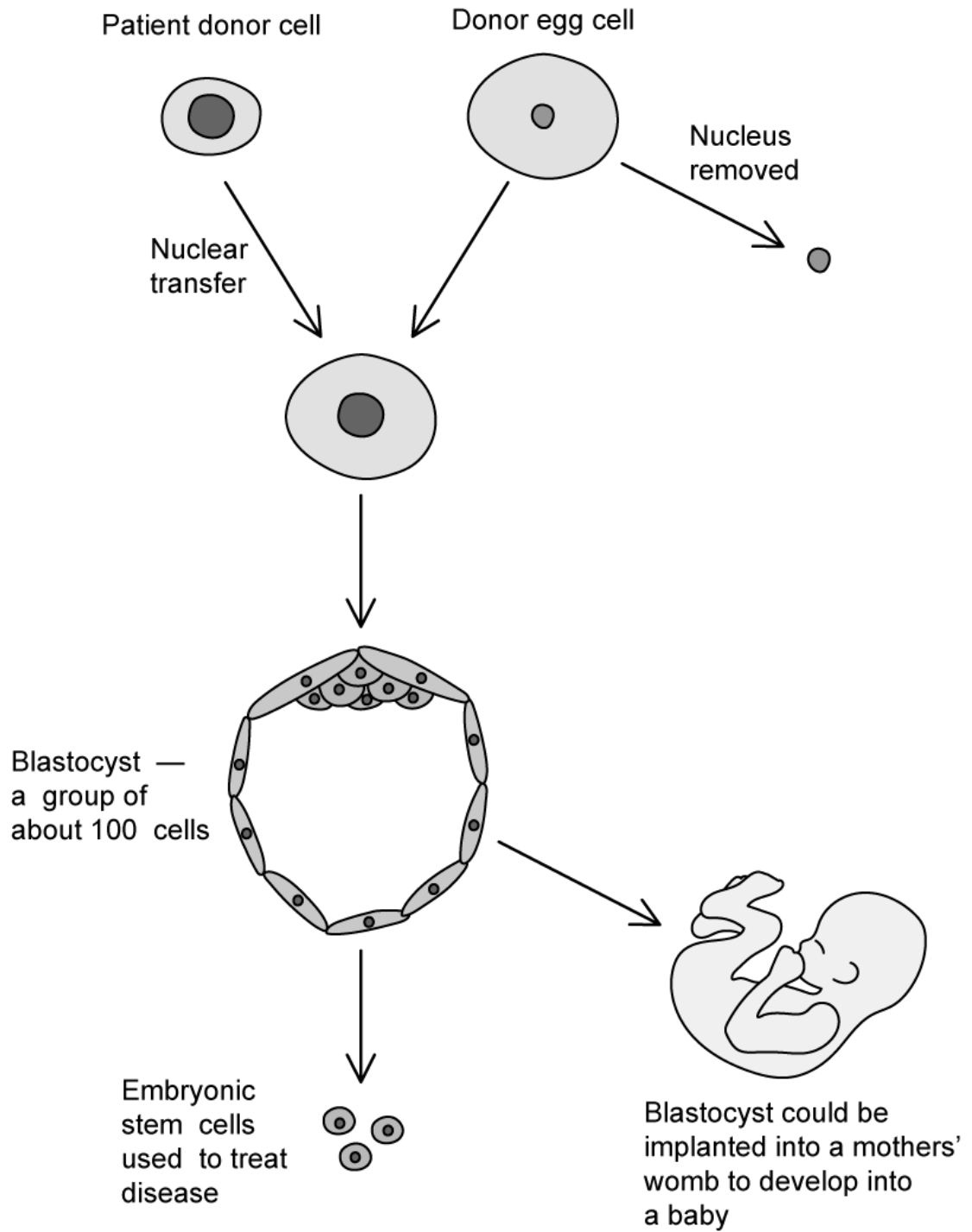
**(b)** Which of the following statements about stem cells is not true?

- A.** Meristem cells can differentiate into any type of plant cell throughout the life of the plant
- B.** Adult stem cells are partially specialised
- C.** Umbilical cord stem cells can develop into any of the different cell types in the human body
- D.** Embryonic stem cells could be used to cure type 1 diabetes

**(1 mark)**

**(c)** Identify the process shown in **Figure 3**.

Figure 3



(1 mark)

(d) Identify **two** cells from **Figure 3** which would contain a diploid number of chromosomes.

.....  
..... (2 marks)  
.....

(e) Explain why the production of stem cells as shown in **Figure 3** is opposed by many people.

.....  
..... (2 marks)  
.....

**4 (a)** Below is a list of statements regarding use of stem cells from plants.

A - Clones can be produced quickly

B - Populations of species under threat can be cultivated

C - There will be low genetic diversity in the cloned plants

D - Crops with resistance to pests can be cloned

**Table 2**

<b>Advantages</b>	<b>Disadvantages</b>

Write the letter of each statement in the correct column of **Table 2** to show whether it is an advantage or a disadvantage of stem cell use.

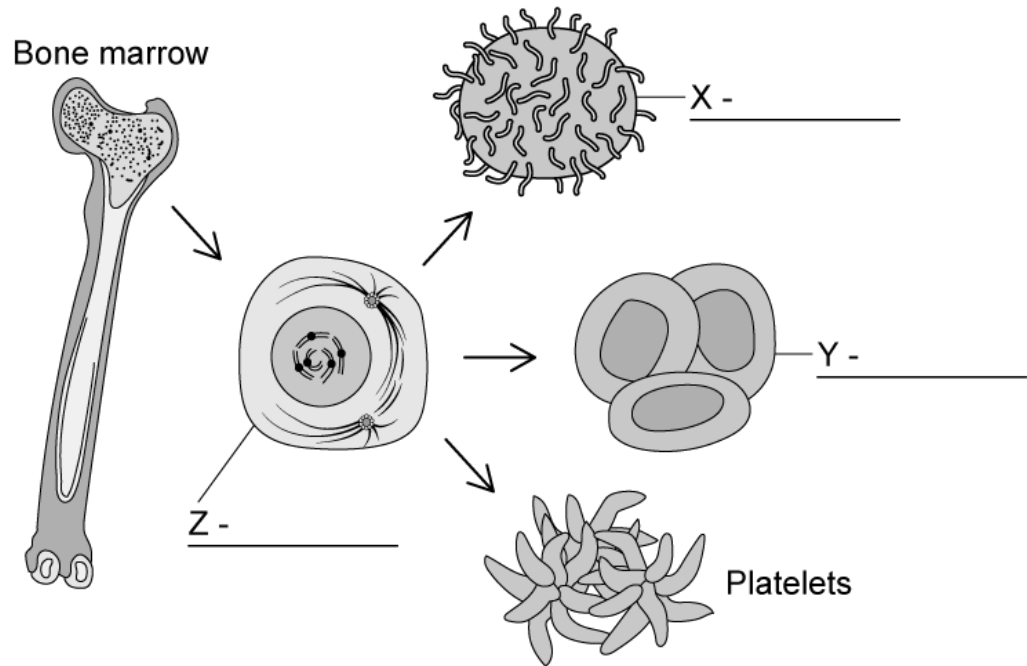
**(2 marks)**

**(b)** Name the location of the stem cells in plants.

..... **(1 mark)**

**(c)** Identify the correct labels from the words provided to complete the diagram in **Figure 4**

Figure 4



White Blood Cell	Red Blood Cell	Embryonic Stem Cell
Meristem	Egg Cell	Adult stem Cell

(3 marks)

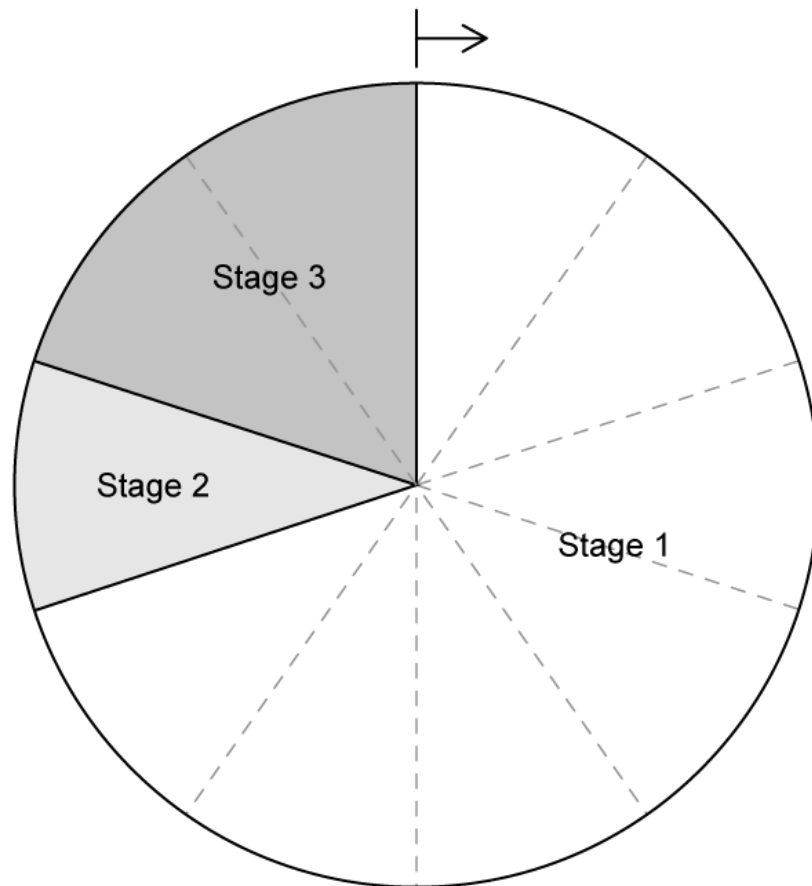
(d) Which statement correctly explains the label given to cell Z in **Figure 4** from part (c)?

- A. Cell Z produces antibodies
- B. Cell Z is found in a 5 day old embryo
- C. Cell Z is a haploid cell
- D. Cell Z is partially differentiated in the bone marrow

(1 mark)

5 (a) Figure 5 shows the cycle of a cell which lasts 10 hours in total.

Figure 5



How long does **stage 2** last?

..... (1 mark)

(b) **Stage 1** in **Figure 5** represents mitosis in the cell.

The statements in **Table 3** describe the process of mitosis.

Table 3

Statement	Number order (1 - 4)
Two genetically identical daughter cells are produced	
Chromosomes are pulled to either end of the cell	
Cytoplasm splits	
Cell growth and DNA replication occurs	

Complete the table to place the statements in the correct order (1 = first, 4 = last).

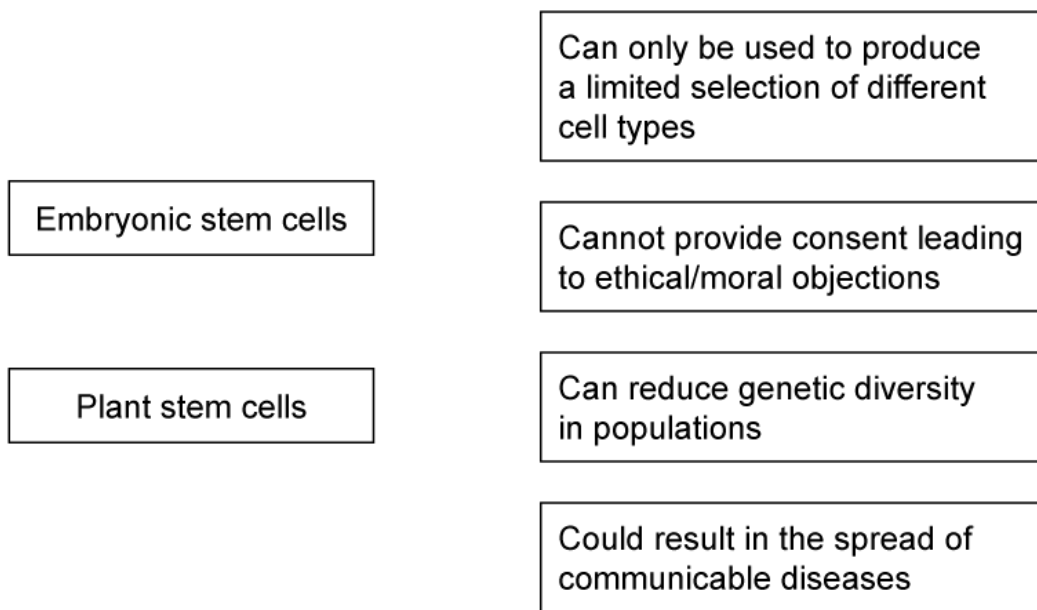
**(2 marks)**

**(c)** Describe **one** use of plant stem cells.

..... **(1 mark)**

**(d)** Draw a line to link each stem cell type in **Figure 6** with the associated issue that they might involve.

Figure 6

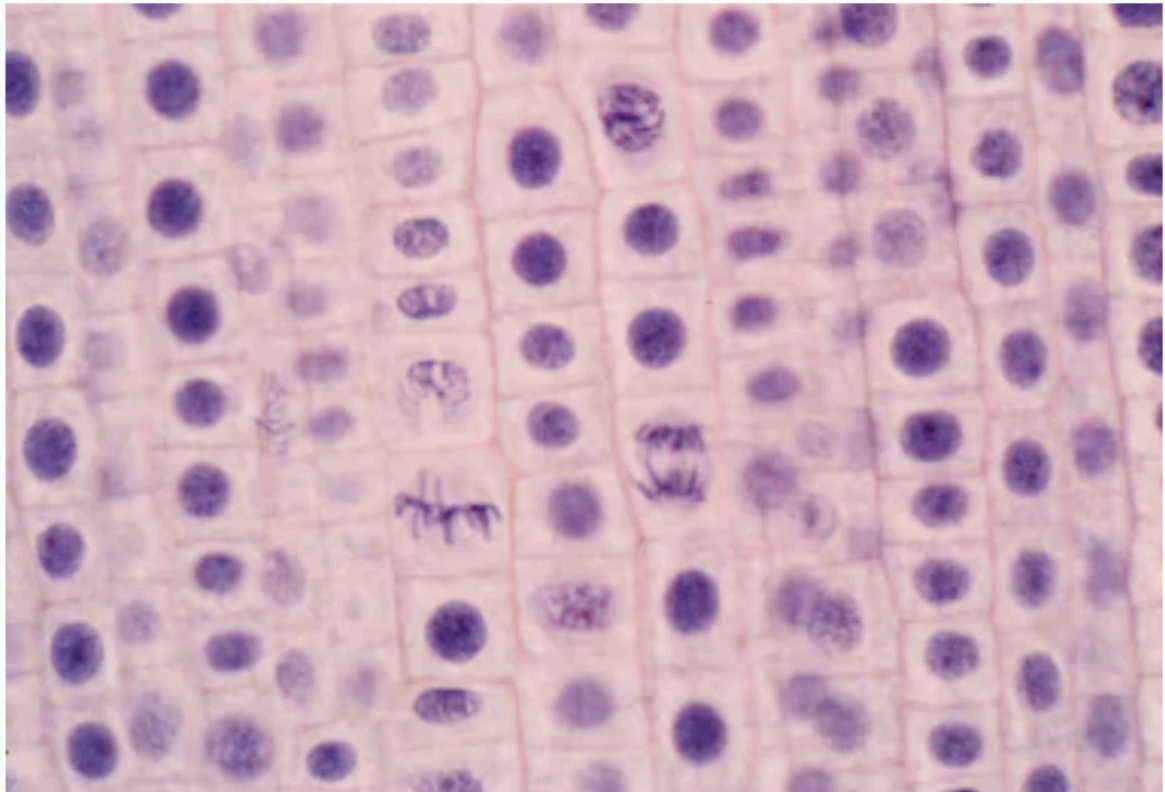


(2 marks)

# Medium Questions

1 (a) Figure 1 below is a photomicrograph of cells in the root of an onion.

Figure 1



On the image above, label a cell that is actively dividing with the letter X.

(1 mark)

(b) Name the type of cell division that occurs in the meristem of plants for growth.

..... (1 mark)

(c) Before a cell divides, what must happen to its genetic material?

..... (1 mark)

(d) A group of students decided to investigate the cell cycle.

They prepared a microscope slide of a root tip from an onion.

They then viewed the slide under a light microscope to count the number of cells in each part of the cell cycle in one field of view.

The table below shows their results.

**Parts of the cell cycle**

	Growth phase	Stage 1	Stage 2	Stage 3	Stage 4	Total
Number of cells	36	15	9	6	2	68

Different parts of the cell cycle take different lengths of time.

State which part of the cell cycle is the slowest. Give a reason for your answer.

.....

.....

.....

**(2 marks)**

**(e)** It takes 18 hours for one complete cell cycle in a typical onion root tip cell.

Calculate the length of time **stage 3** lasts in a typical onion root tip cell.

Give your answer in minutes to 2 significant figures.

.....

.....

.....

**(3 marks)**

**2 (a)** Read the information below about stem cells:

It may be possible to treat some human diseases, such as Parkinson's and diabetes, with stem cells in the future.

Human early embryos produced *in vitro* are a source of stem cells.

The use of embryonic stem cells to treat human disease is new and patient trials have already begun.

Another source of stem cells is adult bone marrow.

The operation for collecting these cells is simple but it can be painful. It is already possible to use adult stem cells to treat certain blood diseases.

There is also hope that adult stem cells from bone marrow can also be used to treat other diseases such as heart disease; such trials have already begun.

Explain how an embryonic stem cell differs from an adult stem cell.

.....

.....

..... **(3 marks)**

**(b)** Evaluate the use of embryonic and adult stem cells to treat human diseases.

Your answer should contain a conclusion.

.....

.....

.....

.....

..... **(5 marks)**

**3 (a)** How many pairs of chromosomes are there in a body cell of a human?

..... (1 mark)

**(b)** For any organism to grow, it must be capable of making new cells.

Describe what must happen in a cell before it can divide.

.....  
..... (2 marks)

**(c)** Describe how a cell divides by mitosis.

.....  
.....  
..... (3 marks)

**(d)** Why is cell specialisation (differentiation) an important process in the development and growth of a fertilised egg into a healthy baby?

.....  
..... (2 marks)

**4 (a)** After a baby is born, it is possible to use the umbilical cord as a source of stem cells.

What are stem cells?

.....  
..... **(2 marks)**

**(b)** In Vitro Fertilisation can be used to produce embryos for research purposes. Stem cells can be extracted from a 3-day-old embryo made in this way.

Suggest why it may be considered more ethically acceptable to take stem cells from an umbilical cord rather than an embryo.

..... **(1 mark)**

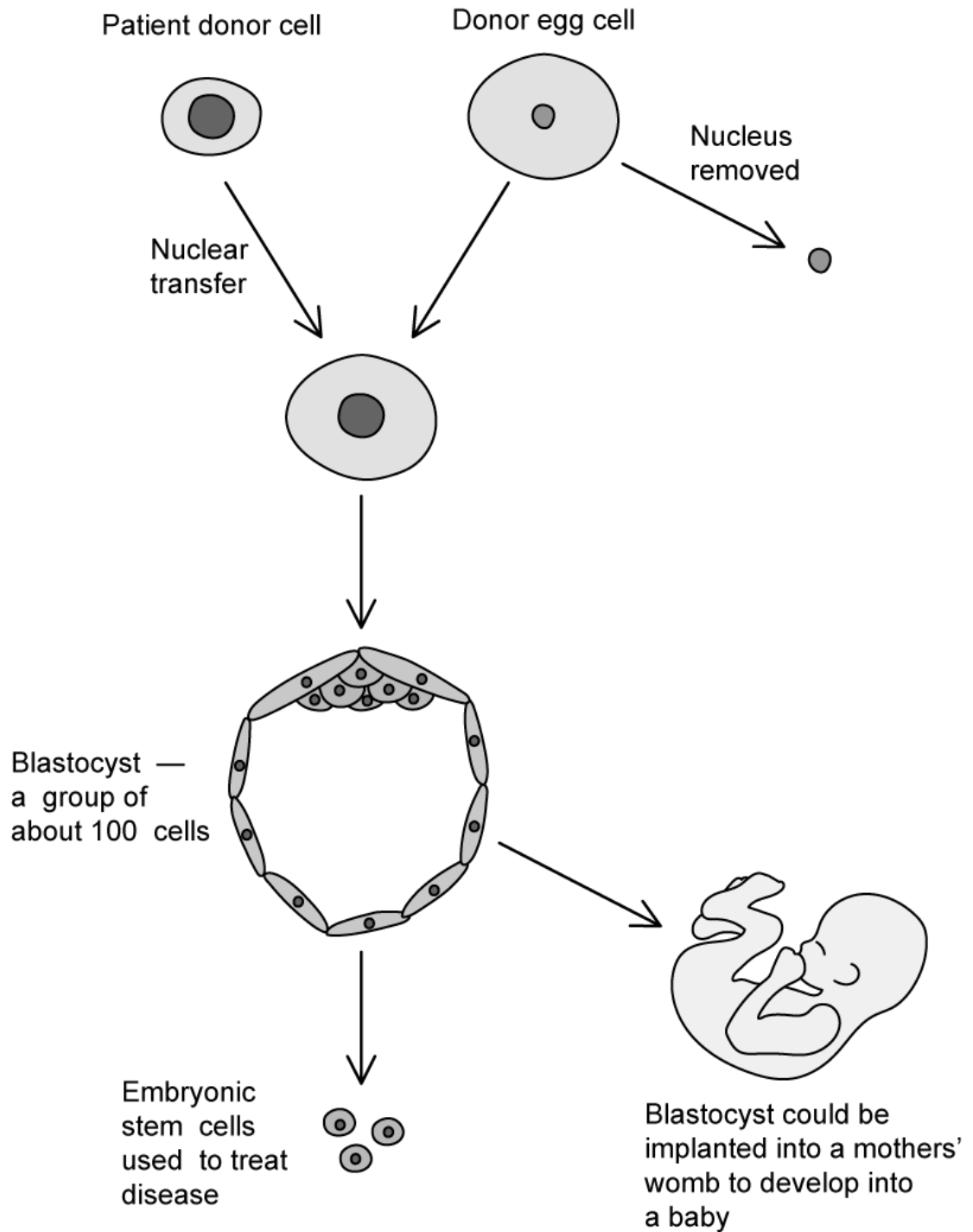
**(c)** Stem cells taken from an umbilical cord can be frozen and stored. They could be used later in that child's life to treat a condition.

Suggest a reason why it would be better to use a child's own umbilical cord stem cells instead of stem cells donated from another person.

..... **(1 mark)**

**(d)** **Figure 2** below outlines the process of therapeutic cloning.

Figure 2



This technique could be used to produce cells to treat conditions such as paralysis or diabetes, or to produce a baby.

Scientists may be allowed to use therapeutic cloning to treat disease but not to produce a baby.

Using information from the diagram and your own knowledge, suggest an explanation for this.

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**(4 marks)**

5 (a) The nucleus of a typical onion cell contains **16** chromosomes.

What is a chromosome?

..... (1 mark)

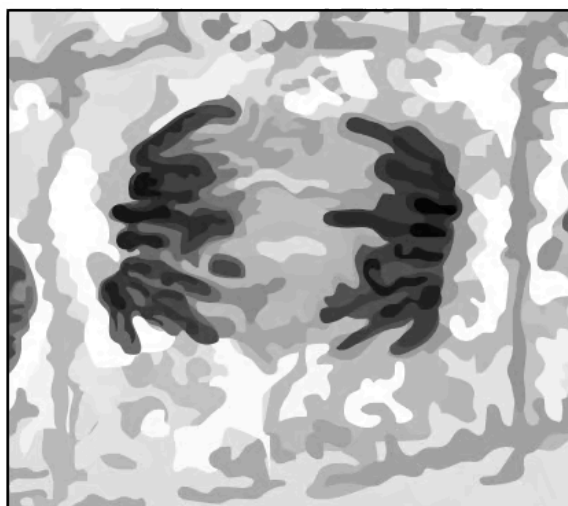
(b) An onion cell divides by mitosis.

How many chromosomes will each of its daughter cells contain?

..... (1 mark)

(c) **Figure 3** shows a photograph of an onion cell at one point during the cell cycle.

**Figure 3**



Describe what is happening to the cell in **Figure 3**.

.....  
..... (2 marks)

(d) Suggest the events that would occur after those observed in the cell in **Figure 3**.

.....  
..... (2 marks)

(e) Onion plants contain meristem tissue.

Compare the meristem tissue found in an onion plant with bone marrow tissue found in humans.

.....  
..... (2 marks)

(f) Many plants are at risk of extinction as a result of human activity.

Stem cells from the meristem can be used to clone rare plant species.

Describe the advantages of cloning plants in this way.

.....  
..... (2 marks)

(g) Suggest one **other** useful application of cloning plants.

..... (1 mark)

(h) Suggest one disadvantage of producing clones of plants from meristems.

..... (1 mark)

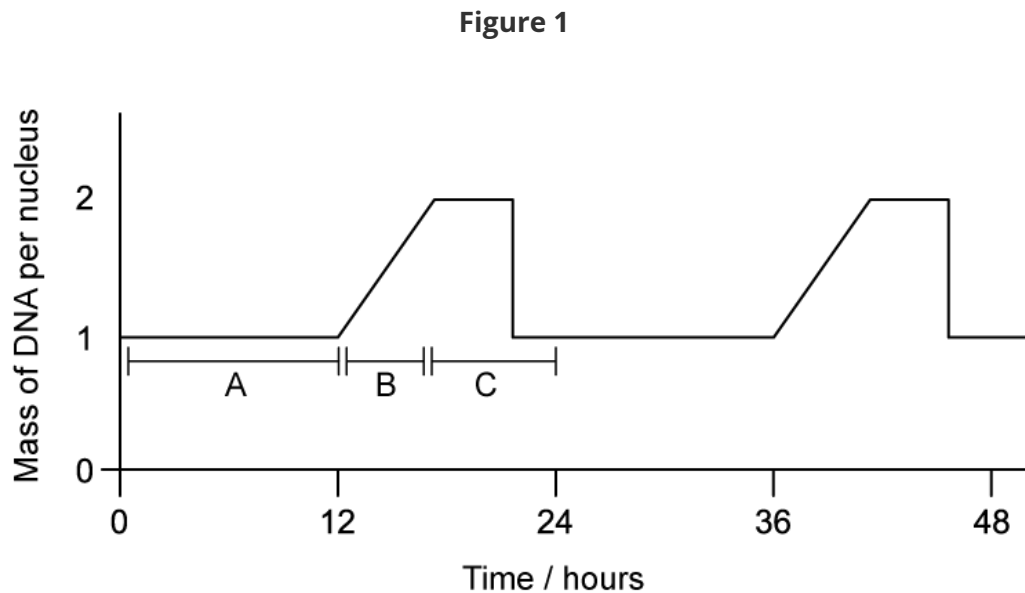
6 Embryonic stem cells have the potential to be used to treat many human diseases.

Suggest how embryonic stem cells could be used to treat a person who has been paralysed.

.....  
.....  
..... (3 marks)

# Hard Questions

1 (a) **Figure 1** shows the quantity of DNA found in the nucleus of a human cell throughout the cell cycle.



Identify what is happening during stage B on **Figure 1**. Explain your answer.

.....

..... (2 marks)

(b) **Figure 1** shows two complete cell cycles. 50% of the cell cycle is spent in stage A and 30% is spent moving through stage C.

Calculate how long the cells spend in stage B of the cell cycle.

.....

.....

..... (3 marks)

(c) How many chromatids would be found in the nucleus of this human cell during stage B?

..... (1 mark)

(d) Describe the stages of the cell cycle.

.....

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..... (6 marks)

- 2 (a)** When a cell divides by mitosis, it produces identical daughter cells, however, when a zygote divides by mitosis, it develops into an embryo and then a fetus.

Explain how the process of mitosis can produce a whole organism from a single cell.

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.....

..... **(3 marks)**

- (b)** Compare and contrast the processes of mitosis and meiosis.

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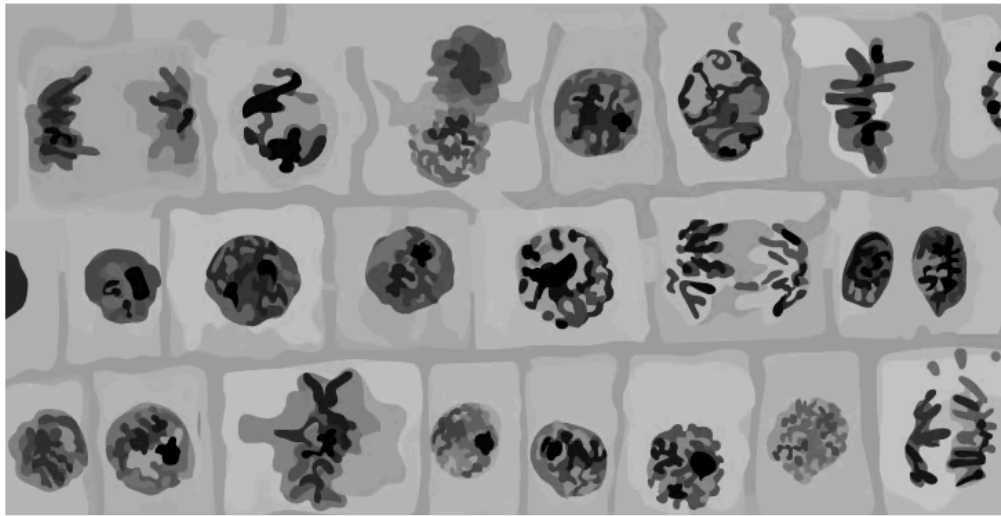
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..... **(6 marks)**

- (c)** Initially, before a cell can divide, it needs to prepare for division by replicating DNA within the nucleus. During this time, there are no visible chromosomes.

**Figure 2** shows a cell sample taken from plant tissue. The cell cycle in this plant tissue takes 20 hours.

Figure 2



Calculate how long cells remain in the preparation stage before cell division occurs.

.....

.....

..... (3 marks)

**3 (a)** Multiple sclerosis (MS) is a condition which affects the central nervous system caused by the immune system mistakenly attacking the brain and nerves. MS can lead to symptoms which flare up periodically, such as fatigue, vision problems, muscle spasms, mobility problems, difficulty in thinking, learning or planning, amongst others.

There are several different treatments for MS; two are considered here.

1. Stem cell treatments: Healthy cells found in the patients bone marrow can be used to rebuild the immune system. Must be used in combination with chemotherapy to remove the harmful immune cells.
2. Disease modifying therapies (DMT): Medicines that can reduce the number of relapses a patient suffers and reduce the symptoms of MS. An example of a DMT is a drug called Lemtrada.

**Table 1** gives some extra information about these two treatments for MS.

**Table 1**

Treatment type	Side effects	Cost	Success rate
<b>Stem Cells</b>	Risk of developing infections, cancer or fertility issues  Chemotherapy may lead to fatigue and appetite loss, hair loss  1 in 330 people may die	\$550 000 per treatment	94% success rate (condition stabilised) over 4 years  Can provide a cure for MS
<b>Disease modifying therapies (e.g. Lemtrada)</b>	Headaches, rashes, nausea, under or overactive thyroid, changes in blood pressure or kidney problems	\$340 000 for 5 years of treatment	82% success rate (condition stabilised) over 4 years.  Does not provide a cure.

Evaluate the use of stem cells and disease modifying therapies to treat multiple sclerosis.



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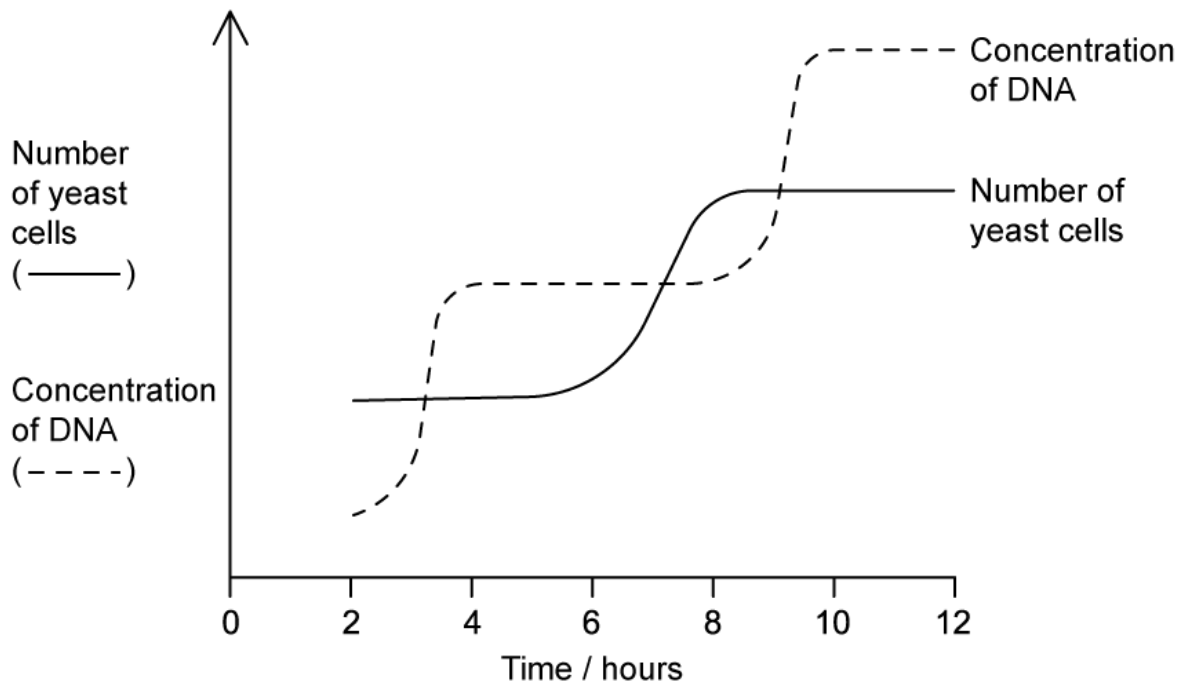
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**(4 marks)**

4 (a) Some scientists studied mitosis in yeast cells. **Figure 3** shows the concentration of DNA and the number of yeast cells over a 12 hour period.

**Figure 3**



Describe and explain the shape of the curve for the number of yeast cells between 2 and 8 hours.

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.....

**(4 marks)**

(b) One cell cycle in **Figure 3** from part (a) takes 6 hours.

Calculate the percentage of time taken by mitosis in one cell cycle.

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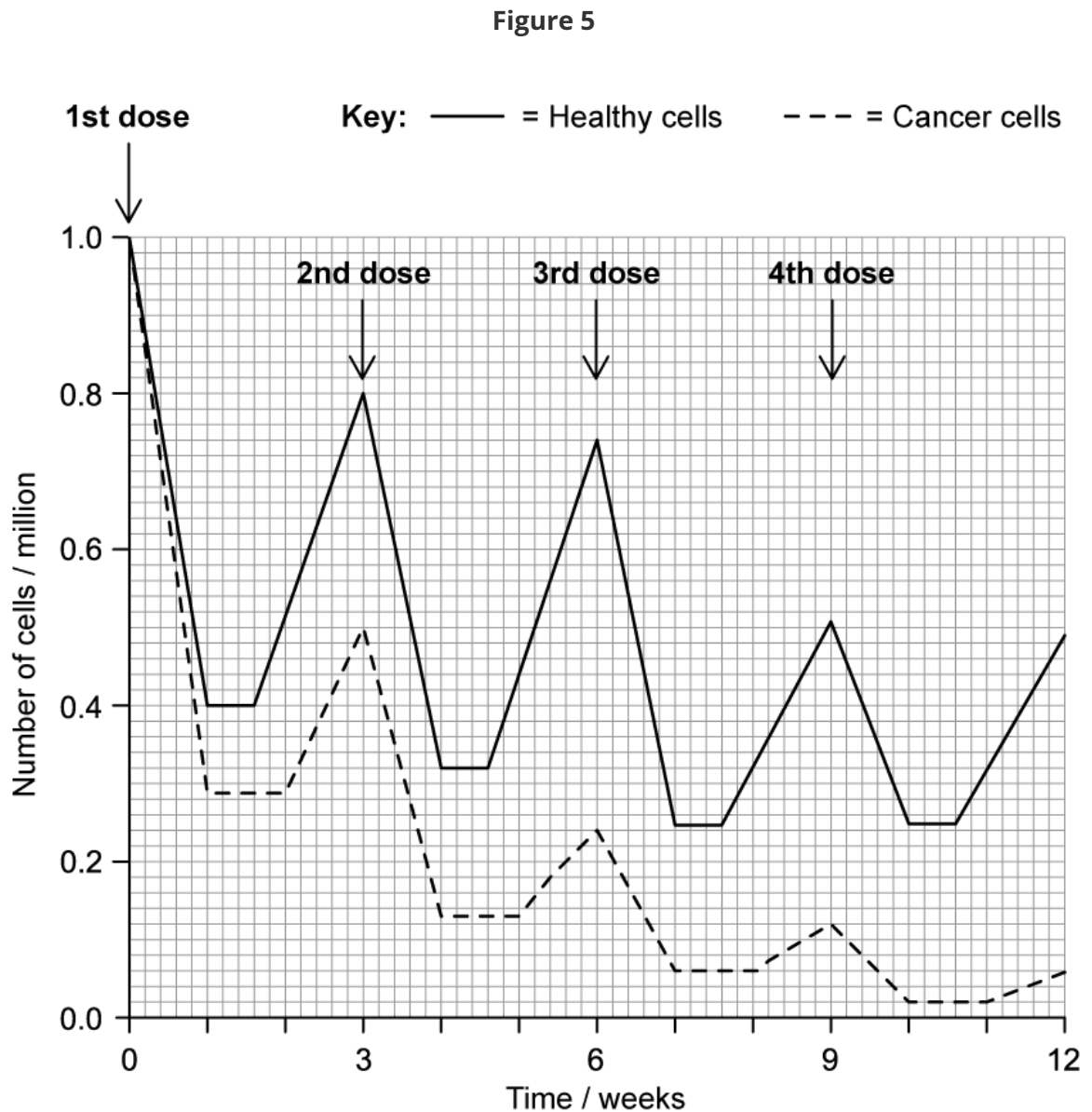
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**(2 marks)**



**5 (a)** Cancer cells originate from healthy cells where the cell cycle is not being controlled normally. This can lead to uncontrolled cell division and the formation of tumours. Drugs used to destroy cancer cells also cause damage to healthy cells, although are more effective against the cancer cells.

**Figure 5** shows the effect of a chemotherapy cancer treatment on the number of healthy and cancerous cells over a 12-week time period.



Calculate how many more cancer cells than healthy cells were destroyed after the first treatment.

Give your answer in standard form.

.....

.....  
.....  
..... (4 marks)

**(b)** With reference to the data in **Figure 5**, identify a time period in which the cancer cells were dividing by mitosis.

..... (1 mark)

**(c)** Another treatment for cancer patients is to receive a stem cell transplant from a donor. The process includes the following steps:

1. The patient is given a high dose of chemotherapy
2. Stem cells are taken from the bone marrow of a closely-related individual (with similar tissue type and genotype)
3. Stem cells are introduced into the patient
4. The patient is monitored for after-effects of the transplant

With reference to the data in **Figure 5** and the information provided here, suggest why a high dose of chemotherapy might be necessary.

.....  
..... (2 marks)

**(d)** With reference to the process described in part **(c)**, suggest an issue that might be associated with receiving a stem cell transplant which requires careful monitoring of the patient after the procedure (stage 4).

..... (1 mark)