

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

AS Level

H022/01

BIOLOGY B (ADVANCING BIOLOGY)

Foundations of biology

THURSDAY 26 MAY 2016 – Afternoon

**Time allowed: 1 hour 30 minutes
plus your additional time allowance**

MODIFIED ENLARGED

| | | | |
|-------------------|--|------------------|--|
| First name | | Last name | |
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| Centre number | | | | | | Candidate number | | | | |
|----------------------|--|--|--|--|--|-------------------------|--|--|--|--|

YOU MUST HAVE:

the Insert

YOU MAY USE:

a scientific calculator

a ruler (cm/mm)

READ INSTRUCTIONS OVERLEAF



INSTRUCTIONS

Use black ink. You may use an HB pencil for graphs and diagrams.

Complete the boxes on the first page with your name, centre number and candidate number.

Answer ALL the questions.

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.

INFORMATION

The total mark for this paper is 70.

The marks for each question are shown in brackets [].

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SECTION A

You should spend a maximum of 25 MINUTES on this section.

Answer ALL the questions.

Write your answer for each question in the box provided.

- 1 Before a cell can undergo mitosis, the cell must duplicate its entire genome.

In which stage of the cell cycle is the genome duplicated?

- A Gap 1 (G1)
- B Cytokinesis
- C Synthesis (S)
- D Gap 2 (G2)

Your answer

[1]

- 2 Tardigrades, or ‘water bears’, are a group of animals that live in extreme conditions.

In 2014, a new species of tardigrade called *Mopsechiniscus franciscae* was discovered in Antarctica. The taxonomic classification of this new species is shown below.

| DOMAIN | EUKARYOTE |
|---------|-------------------|
| Kingdom | Animalia |
| 1 | Tardigrada |
| Class | Heterotardigrada |
| 2 | Echiniscoidea |
| 3 | Echiniscidae |
| Genus | 4 |
| Species | <i>franciscae</i> |

Which of the options, A to D, completes the table opposite for the correct classification of the new tardigrade?

- A 1 Phylum
2 Family
3 Order
4 *Mopsechiniscus*

- B 1 Phylum
2 Order
3 Family
4 *Mopsechiniscus*

- C 1 Tardigrade
2 Family
3 Order
4 *Mopsechiniscus*

- D 1 Phylum
2 Order
3 Family
4 *Tardigrade*

Your answer

[1]

- 3 A person can be immunised against some diseases by injecting them with antibodies extracted from another person or from an animal.**

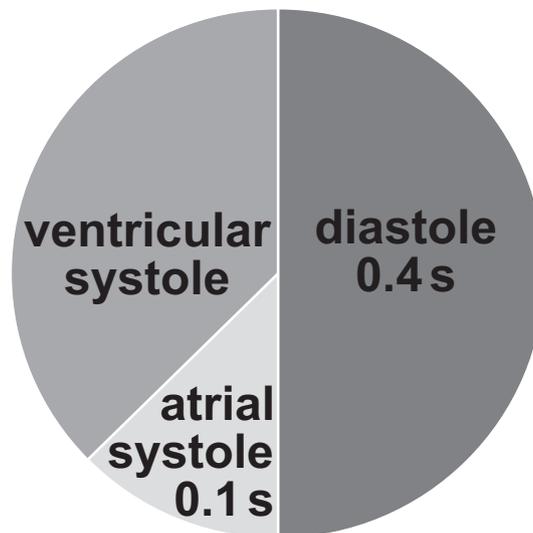
Which of the options, A to D, correctly describes this type of immunity?

- A artificial active**
- B artificial passive**
- C natural active**
- D natural passive**

Your answer **[1]**

- 4 The chart shows the main stages that occur during one cardiac cycle for an adult at rest.

Timings are shown for some of the stages.



Which of the options, A to D, shows the correctly calculated heart rate for this adult?

- A 48 beats per minute
- B 72 beats per minute
- C 75 beats per minute
- D 80 beats per minute

Your answer

[1]

- 5 An ecologist investigated the distribution of wildflowers in four fields, A to D. The data collected was used to calculate Simpson's Index of Diversity.

The results are shown below.

| | Field A | Field B | Field C | Field D |
|------------------------------|---------|---------|---------|---------|
| Simpson's Index of Diversity | 0.0163 | 0.6254 | 0.163 | 1.451 |

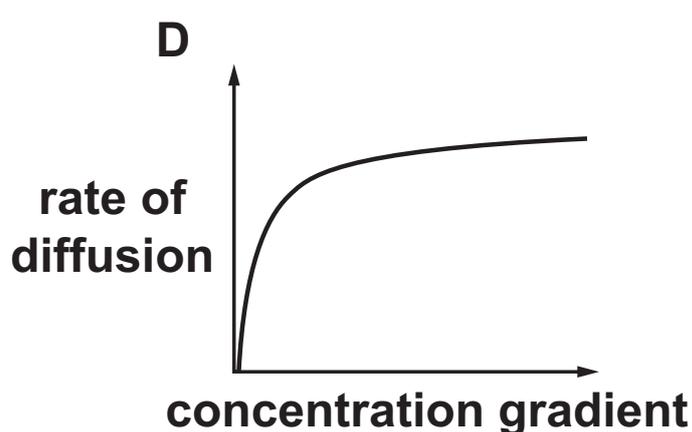
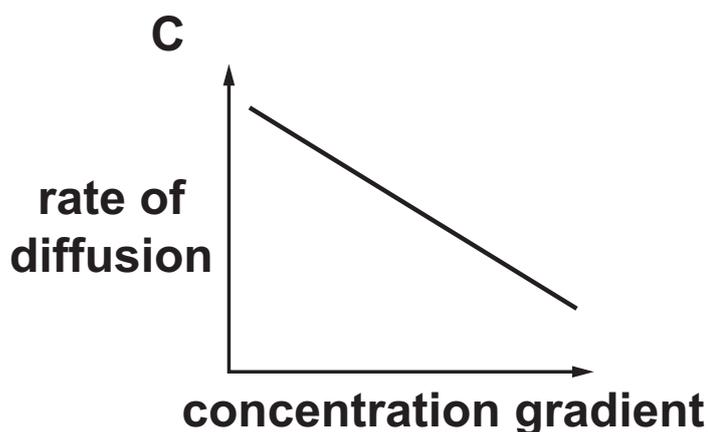
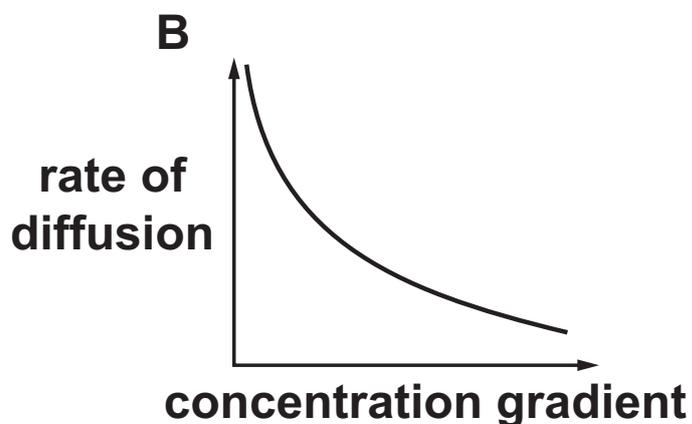
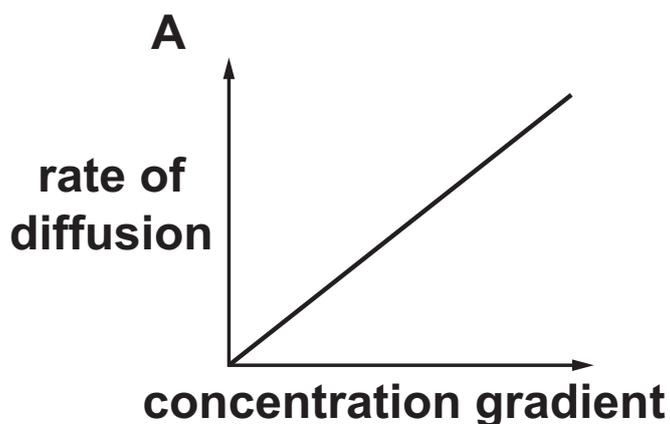
Which of the fields, A to D, is most likely to be able to withstand environmental change?

- A field A
- B field B
- C field C
- D field D

Your answer

[1]

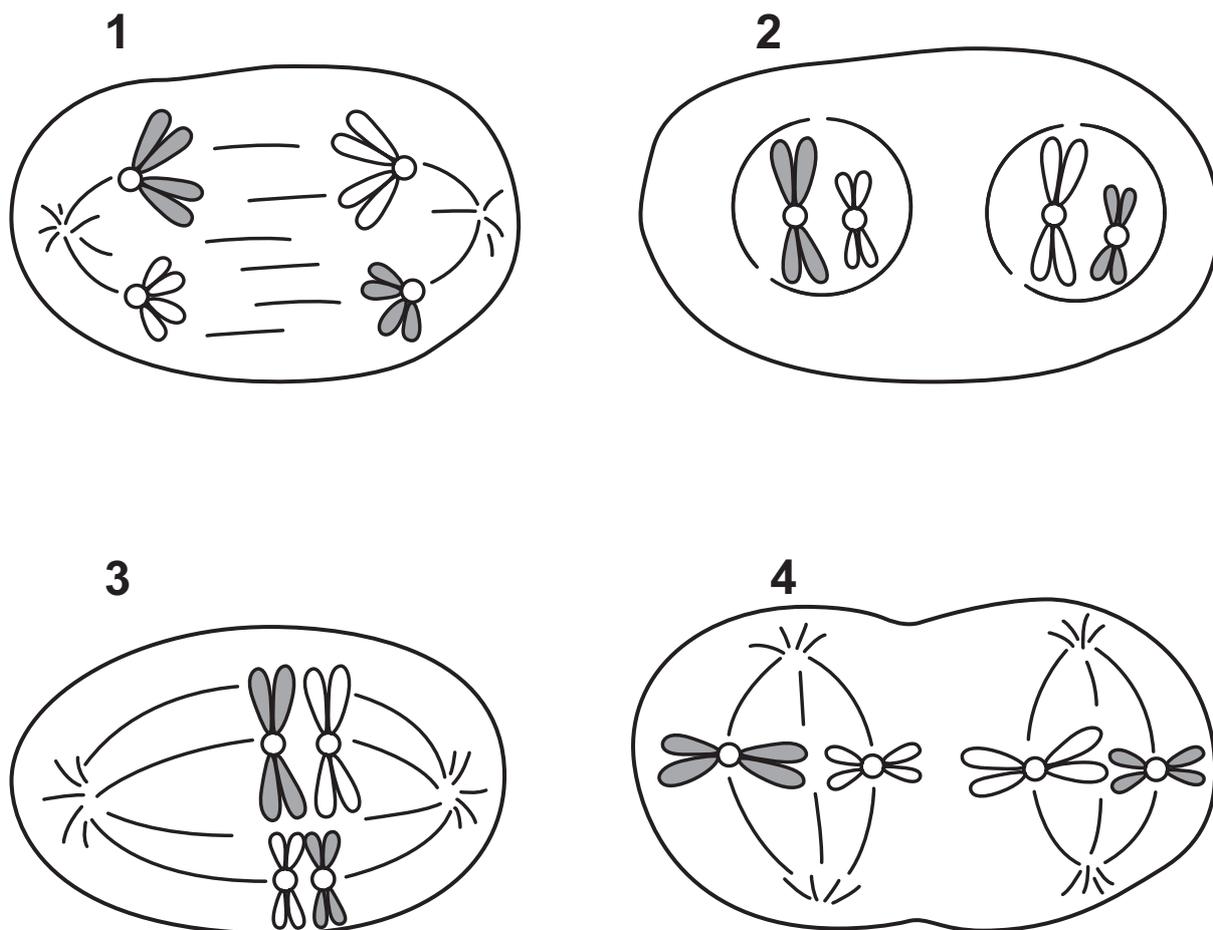
6 Oxygen molecules enter cells by passive diffusion through the plasma (cell surface) membrane. The rate of diffusion of oxygen is affected by its concentration gradient across the membrane.



Which of the graphs, A to D, shows how the rate of diffusion of oxygen changes as its concentration gradient increases?

Your answer [1]

7 The diagram shows four different stages in meiosis.



Which of the options, A to D, shows the correct sequence in which these four stages would occur?

A 3, 1, 4, 2

B 3, 2, 4, 1

C 3, 1, 2, 4

D 4, 1, 2, 3

Your answer

[1]

- 8 Lactose is formed by a reaction between glucose and galactose, both of which have the chemical formula $C_6H_{12}O_6$.

Which of the options, A to D, is the correct chemical formula for lactose?



Your answer

[1]

- 9 A group of students were investigating the effect of exercise on pulmonary ventilation.

The table below shows some of the results recorded for one of the students in the group.

| | |
|-------------------------------------|----------------------|
| Tidal volume | 0.45 dm ³ |
| Vital capacity | 3.45 dm ³ |
| Mean breathing rate at rest | 14 min ⁻¹ |
| Mean breathing rate during exercise | 18 min ⁻¹ |

Which of the options, A to D, shows the total volume of air that moved in and out of this student's lungs in a five minute period BEFORE the start of exercise?

- A 31.50 dm³
- B 36.00 dm³
- C 40.50 dm³
- D 241.50 dm³

Your answer [1]

10 A student wrote the following statement:

'Water is polar because the oxygen side of the molecule is slightly positive in charge.'

Which of the following options, A to D, explains why this statement is NOT correct?

- A Water must be non-polar because it can dissolve non-polar molecules like carbon dioxide.**
- B Water must be non-polar because it can pass through the fatty acid tails of phospholipids.**
- C The oxygen side of the molecule is slightly negative in charge, not positive.**
- D Water is not polar, it is charged.**

Your answer

[1]

11 Phosphatidylserine is a type of phospholipid found in some cell membranes. Phosphatidylserine has a role in the process of apoptosis.

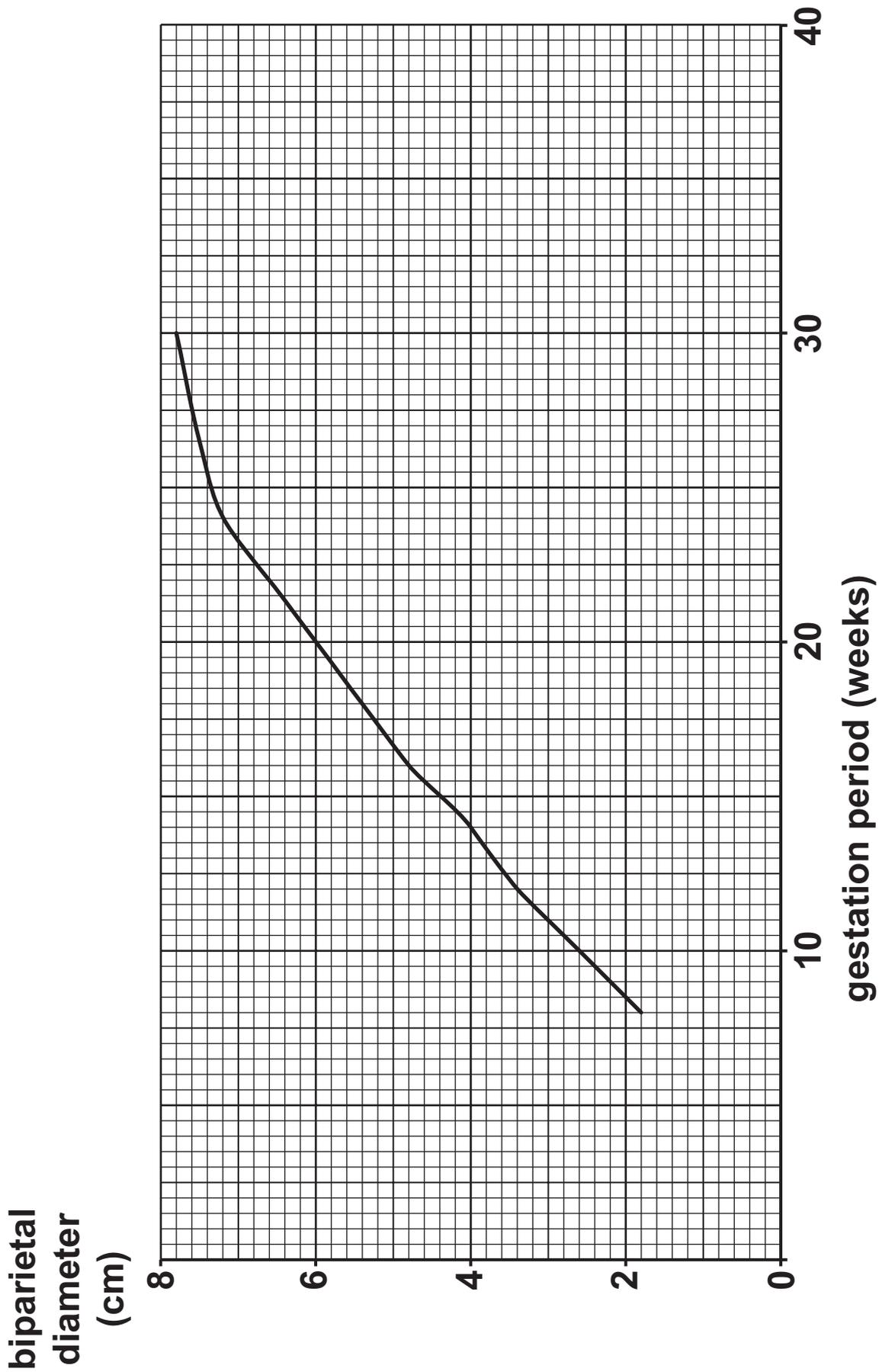
Which of the options, A to D, describes the role of phosphatidylserine in the apoptosis of a damaged cell?

- A Binds to receptors on the plasma (cell surface) membrane of the damaged cell to allow formation of blebs.**
- B Binds to receptors on the plasma (cell surface) membranes of macrophages to allow phagocytosis of apoptotic vesicles.**
- C Binds to receptors on the plasma (cell surface) membranes of macrophages to allow formation of apoptotic vesicles.**
- D Binds to receptors on the nuclear envelope of the damaged cell to allow breakdown of the nucleus.**

Your answer **[1]**

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12 The chart shows biparietal diameter measurements for a fetus during its development.



Which of the options, A to D, shows the correct percentage increase in biparietal diameter between 12 and 22 weeks of gestation?

A 48%

B 113%

C 94%

D 51%

Your answer

[1]

13 Below are some statements about how water is transported from soil to the xylem of plants.

The statements are NOT in the correct order.

- 1. Mineral ions are actively transported into the xylem vessel.**
- 2. The cohesive properties of water create a tension which draws water along the cell walls of the root cortex cells.**
- 3. Water enters the root hair cell by osmosis, creating a higher water potential than that of the adjacent root cortex cell.**
- 4. Water enters the xylem by osmosis.**
- 5. Water is forced into the cytoplasm of the endodermal cells by the presence of the Casparian strip.**
- 6. Water moves from the cytoplasm of one root cortex cell to the next cell down the water potential gradient until it reaches the endodermis.**

Which of the options, A to D, correctly explains how water enters a xylem vessel via the symplast pathway?

A 3, 6, 2, 4

B 3, 5, 1, 4

C 3, 6, 1, 4

D 3, 6, 5, 4

Your answer

[1]

14 The pressure of blood flowing through the heart changes during the cardiac cycle.

The table shows some values for the pressures in the chambers of the right side of the heart and the pulmonary artery.

| | Pressure in right atrium (mm Hg) | Pressure in right ventricle (mm Hg) | Pressure in pulmonary artery (mm Hg) |
|----------|---|--|---|
| A | 2 | 25 | 25 |
| B | 8 | 5 | 25 |
| C | 2 | 25 | 5 |
| D | 8 | 5 | 5 |

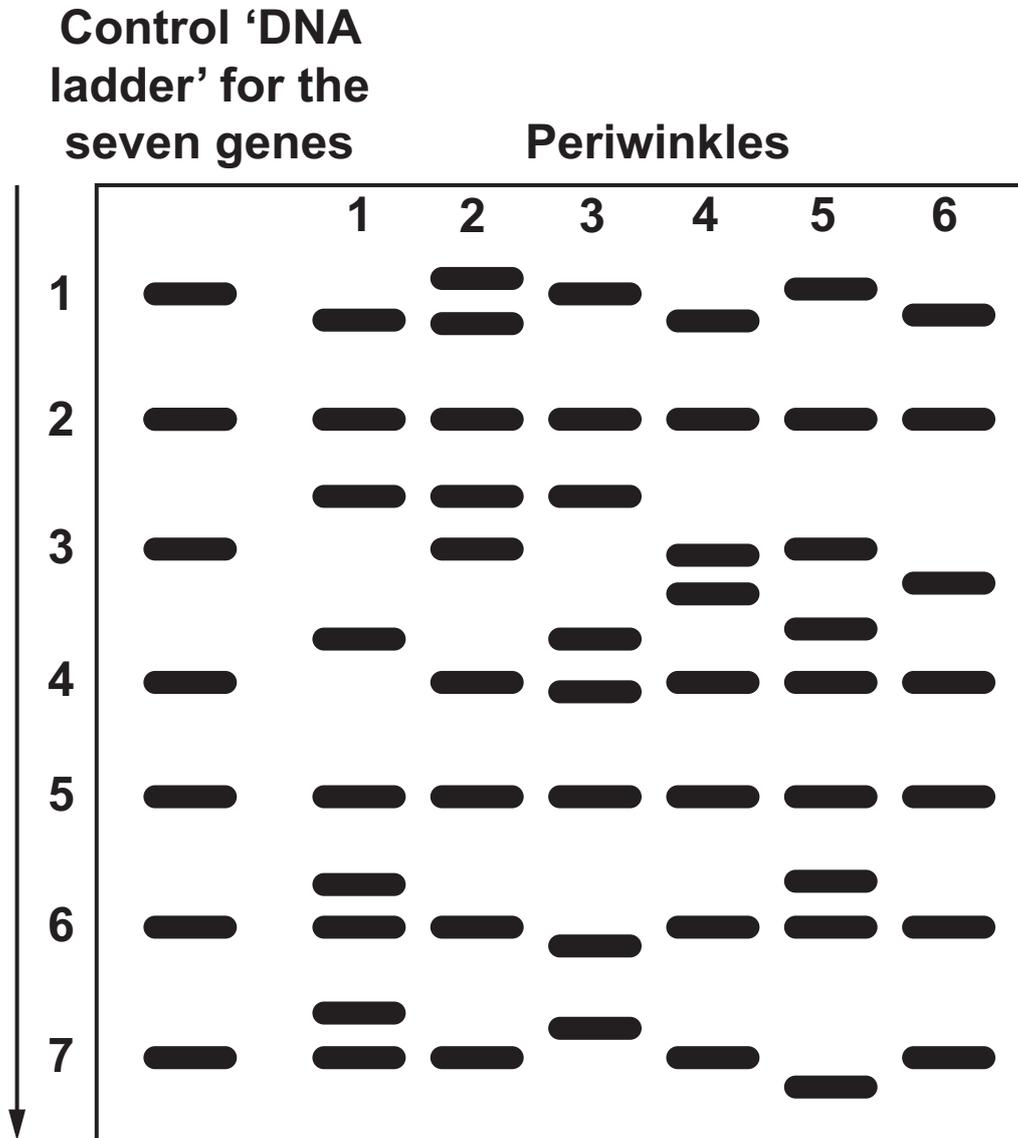
Which of the rows, A to D, is correct if the atrioventricular valve is open and the semilunar valve is closed?

Your answer [1]

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15 Researchers were studying genetic diversity in the common periwinkle, *Littorina littorea*. Seven genes from six periwinkles were analysed using gel electrophoresis.

The results are shown below.



Some of the periwinkle genes were polymorphic and the researchers calculated the proportion of polymorphic genes shown above using the following equation:

$$\text{Proportion of polymorphic genes} = \frac{\text{number of polymorphic genes}}{\text{total number of genes}}$$

Which of the options, A to D, shows the correctly calculated proportion of polymorphic genes expressed as a percentage?

A 28.6%

B 36.7%

C 71.4%

D 140.0%

Your answer [1]

16 B-lymphocytes produce antibodies. The following organelles are involved in the synthesis and secretion of antibodies:

- 1. Golgi apparatus**
- 2. ribosome**
- 3. endoplasmic reticulum**
- 4. nucleus**

Which of the options, A to D, shows the correct sequence of organelles involved in the synthesis and secretion of antibodies?

A 2, 3, 1, 4

B 4, 2, 3, 1

C 4, 3, 2, 1

D 4, 2, 1, 3

Your answer

[1]

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17 A patient was admitted to hospital complaining of chest pains.

An ECG (electrocardiogram) was taken on arrival.

A copy of the patient's ECG trace is shown opposite.

Which of the conditions, A to D, would result in the ECG trace shown opposite?

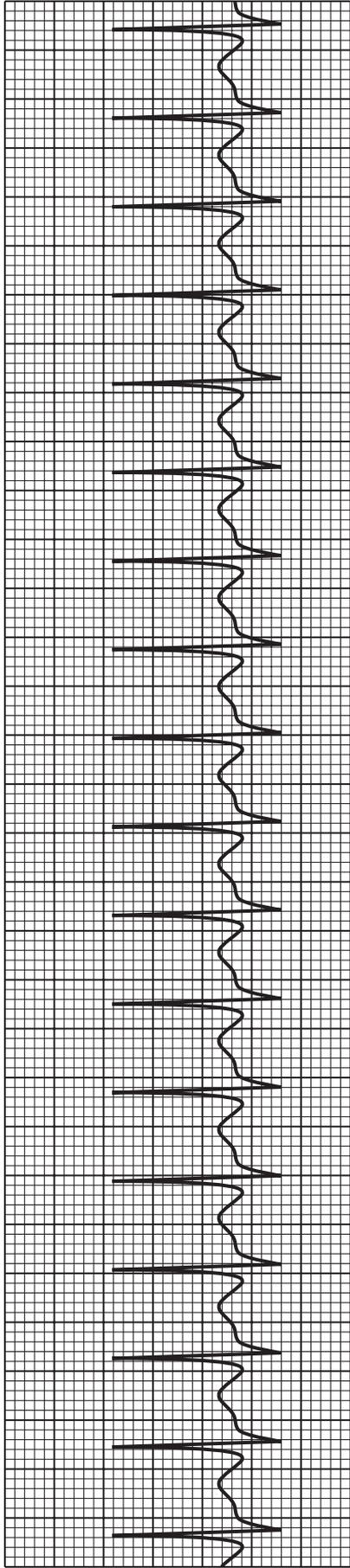
A bradycardia

B atrial fibrillation

C ventricular fibrillation

D tachycardia

Your answer **[1]**



1 second

18 The table below compares the structures of mRNA and DNA.

| | STRANDS | BASES | SUGAR |
|-------------|----------------|--------------|--------------------|
| DNA | 2 | ATCG | deoxyribose |
| mRNA | | | |

Which of the options, A to D, correctly completes the table for the structure of mRNA?

A 1 AUCG deoxyribose

B 2 ATCG ribose

C 1 AUCG ribose

D 1 ATCG ribose

Your answer

[1]

19 *Chlamydomonas* is a small, fresh-water protocist commonly found in ponds.

A group of students collected a sample of pond water and counted the number of *Chlamydomonas* using a haemocytometer. The students noted the following:

The counting chamber of the haemocytometer had an area of 0.04 mm^2 and a depth below the cover slip of 0.1 mm .

The mean number of *Chlamydomonas* counted using this counting chamber = 2.

Which of the options, A to D, is the correctly calculated number of *Chlamydomonas* in 1 cm^3 of this pond water sample?

A 5×10^5

B 500

C 5×10^4

D 50

Your answer [1]

20 Klinefelter's syndrome can be diagnosed by looking at the arrangement of chromosomes in a karyotype.

Which of the options, A to D, shows the sex chromosomes present in the karyotype of someone with Klinefelter's syndrome?

A X only

B XYY

C XXX

D XXY

Your answer **[1]**

SECTION B

Answer ALL the questions.

- 21 A group of students were investigating the effect of varying sodium chloride concentration on a suspension of mammalian erythrocytes (red blood cells) by observing haemolysis.

When haemolysis occurs, the contents of the erythrocytes are released and the suspension will become clear.

Fig. 21, IN THE INSERT, shows the appearance of the suspensions at the end of the investigation.

- (a) Using Fig. 21, EXPLAIN the results for the suspension in test tube B.

[2]

- (b) The students waited for 15 minutes after adding the erythrocyte suspensions to the sodium chloride solutions before recording their observations.

Explain why.

[1]

- (c) The students repeated the experiment using a colorimeter to measure the absorbance of each erythrocyte suspension after 15 minutes.

Table 21.1 below shows the data obtained.

Table 21.1

| Concentration of sodium chloride (mol dm ⁻³) | Absorbance (a.u.) |
|---|----------------------|
| 0.00 | 0.00 |
| 0.05 | 0.01 |
| 0.10 | 0.08 |
| 0.15 | 0.70 |
| 0.20 | 0.73 |
| 0.25 | 0.75 |
| 0.30 | 0.75 |

- (d) The students decided to repeat the experiment using the colorimeter once more, but this time they used glucose instead of sodium chloride.

Table 21.2 shows the results obtained for glucose.

Table 21.2

| Concentration of glucose (mol dm ⁻³) | Absorbance (a.u.) |
|---|----------------------|
| 0.00 | 0.00 |
| 0.05 | 0.03 |
| 0.10 | 0.10 |
| 0.15 | 0.18 |
| 0.20 | 0.19 |
| 0.25 | |
| 0.30 | 0.78 |

- (i) Compare the results for concentrations of glucose AND sodium chloride between 0.05 and 0.20 mol dm⁻³.

[2]

- (ii) The students forgot to take the measurement for absorbance at 0.25 mol dm^{-3} glucose concentration.

Suggest how the missing data could affect the conclusions made about haemolysis in this investigation.

[1]

22 Fig. 22 opposite shows a phylogenetic tree for the evolution of flowering plants.

(a) (i) At which point on the phylogenetic tree, R, S or T, would xylem and phloem tissue have appeared?

_____ [1]

(ii) Primitive plants lived in water. As plants evolved they adapted to life on land.

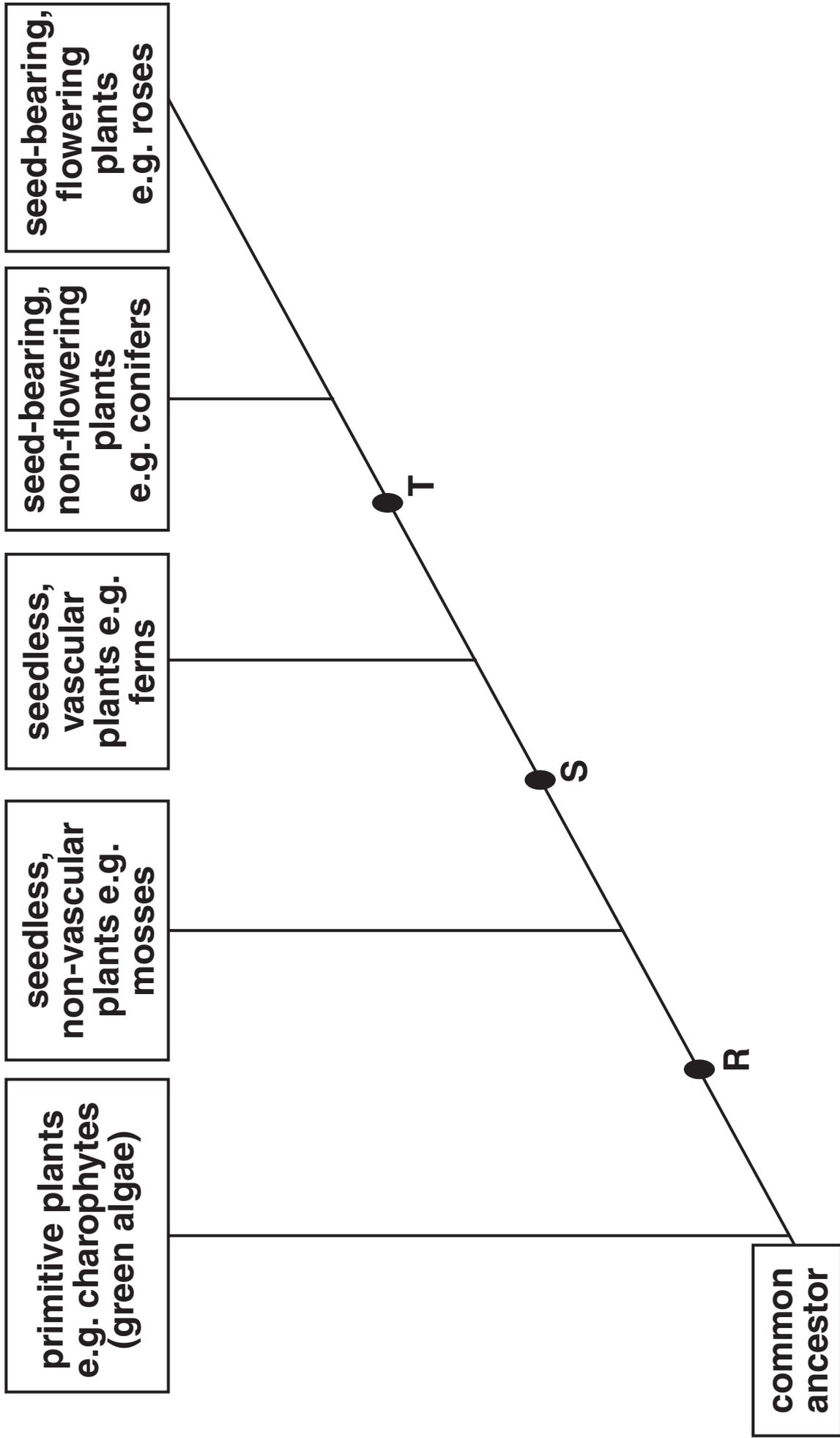
Suggest ONE adaptation that would have enabled primitive plants, such as charophytes, to evolve to living on land.

_____ [1]

(iii) Why do seed-bearing plants need a transport system?

_____ [1]

Fig. 22



23 Listeriosis is a disease caused by eating contaminated food products, such as unpasteurised milk.

The bacterium responsible for the disease, *Listeria monocytogenes*, releases an extracellular protein called p60 which enables the bacterium to invade host cells.

Anti-p60 antibodies have been identified that act as opsonins for the phagocytosis of *L. monocytogenes*.

(a) (i) Explain what is meant by the following terms.

opsonin

phagocytosis

[2]

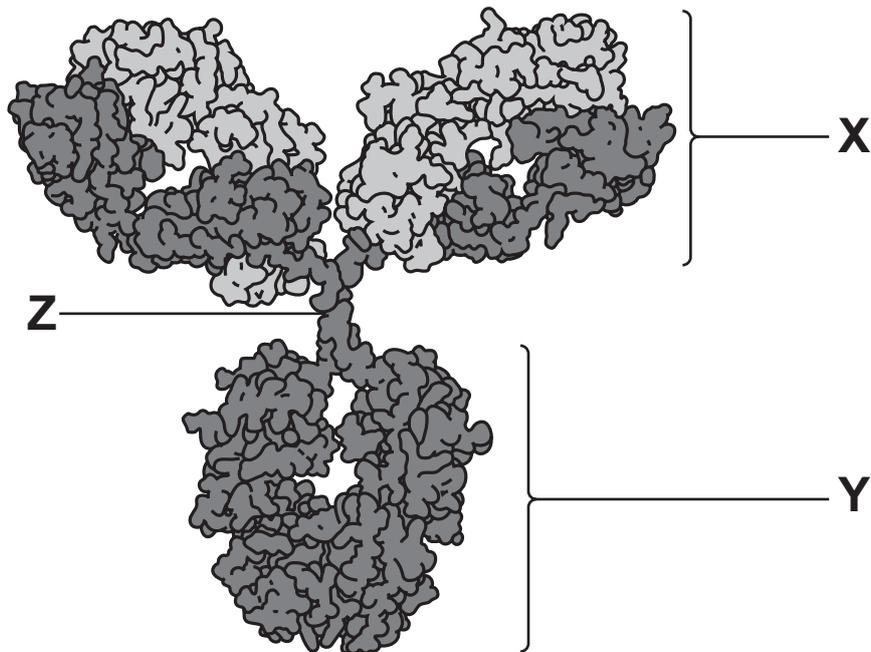
- (ii) Explain how the production and release of extracellular proteins in mammalian cells would differ from that of p60 in *L. monocytogenes*.

[2]

(b) Antibodies, such as anti-p60, have a generalised structure.

The generalised structure of an antibody is shown in Fig. 23.

Fig. 23



Name AND describe the function of the parts of the antibody labelled X, Y and Z.

X _____

Y _____

Z _____

[3]

(c) Listeriosis can be fatal. Pre-screening food products for the presence of *L. monocytogenes* or p60 would be of great benefit to public health.

The protein p60 can be detected using diagnostic methods involving antibodies.

Outline the role of antibodies in the detection of *L. monocytogenes* and p60 in food samples.

[3]

24 Chronic myeloid leukemia (CML) is a type of blood cancer.

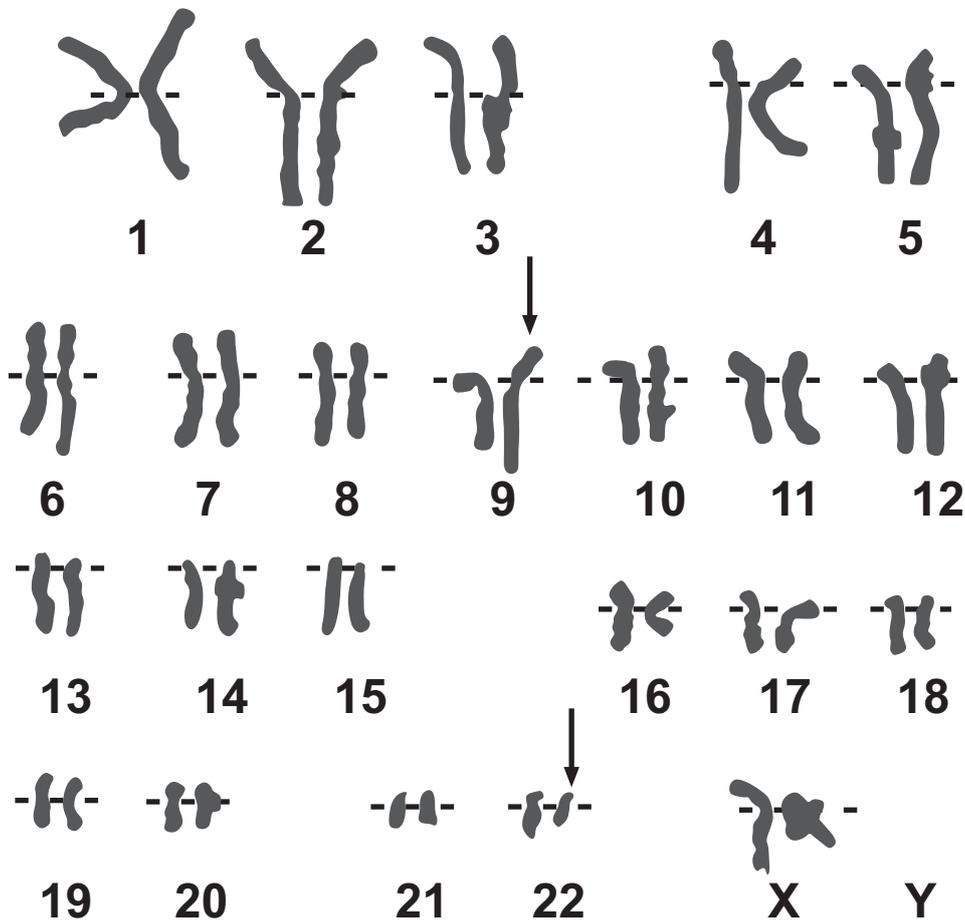
(a) What is a chronic disease?

[1]

(b) About 95% of people with CML have an abnormality called the Philadelphia chromosome. Breaks occur in chromosomes 9 and 22 and they exchange DNA resulting in two abnormal chromosomes.

The arrows in Fig. 24.1 indicate these two abnormal chromosomes.

Fig. 24.1



- (i) Philadelphia chromosome arises in bone marrow stem cells. These stem cells are described as being multipotent.

What is the significance of multipotency to the development of disease?

[1]

- (ii) How does the appearance of the abnormal chromosomes indicated in Fig. 24.1 differ from those in a normal cell at the same stage in the cell cycle?

[1]

- (iii) Describe the technique used to produce images of chromosomes, such as those shown in Fig. 24.1.

[3]

- (c) CML can be treated using the targeted therapy drug Imatinib, also known as Glivec®.**

During clinical tests, a phase 3 trial found that almost 90% of CML patients treated with Imatinib showed no further progression of the disease.

What is meant by a phase 3 trial?

[2]

- (d) During a clinical trial, the number of abnormal white blood cells (blasts) was recorded over a period of time for two patients, F and G, who were being treated with Imatinib. Both patients had received alternative therapies before starting treatment with Imatinib.**

Fig. 24.2(a) and Fig. 24.2(b) show the results of the clinical trial.

Fig. 24.2(a)

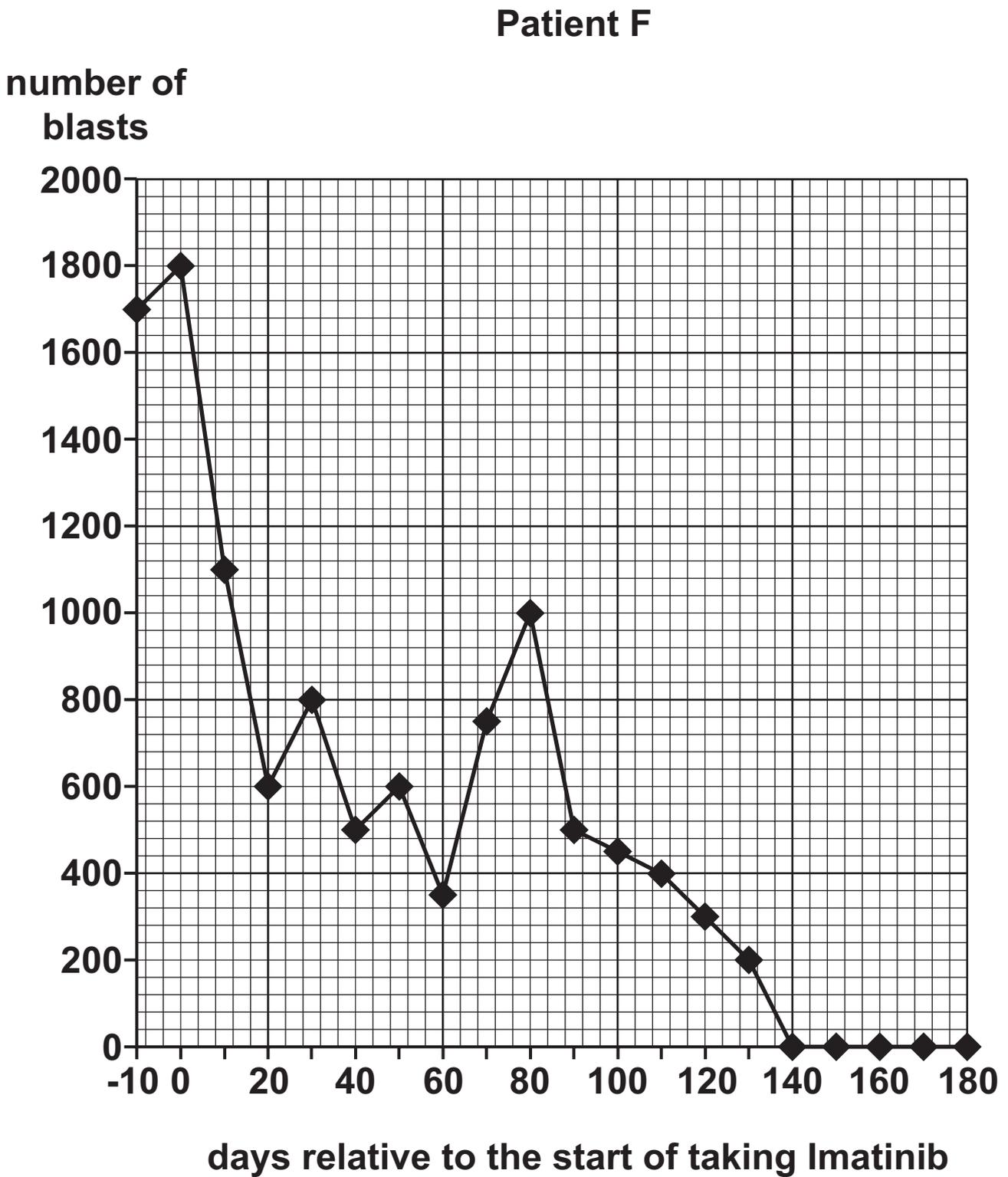
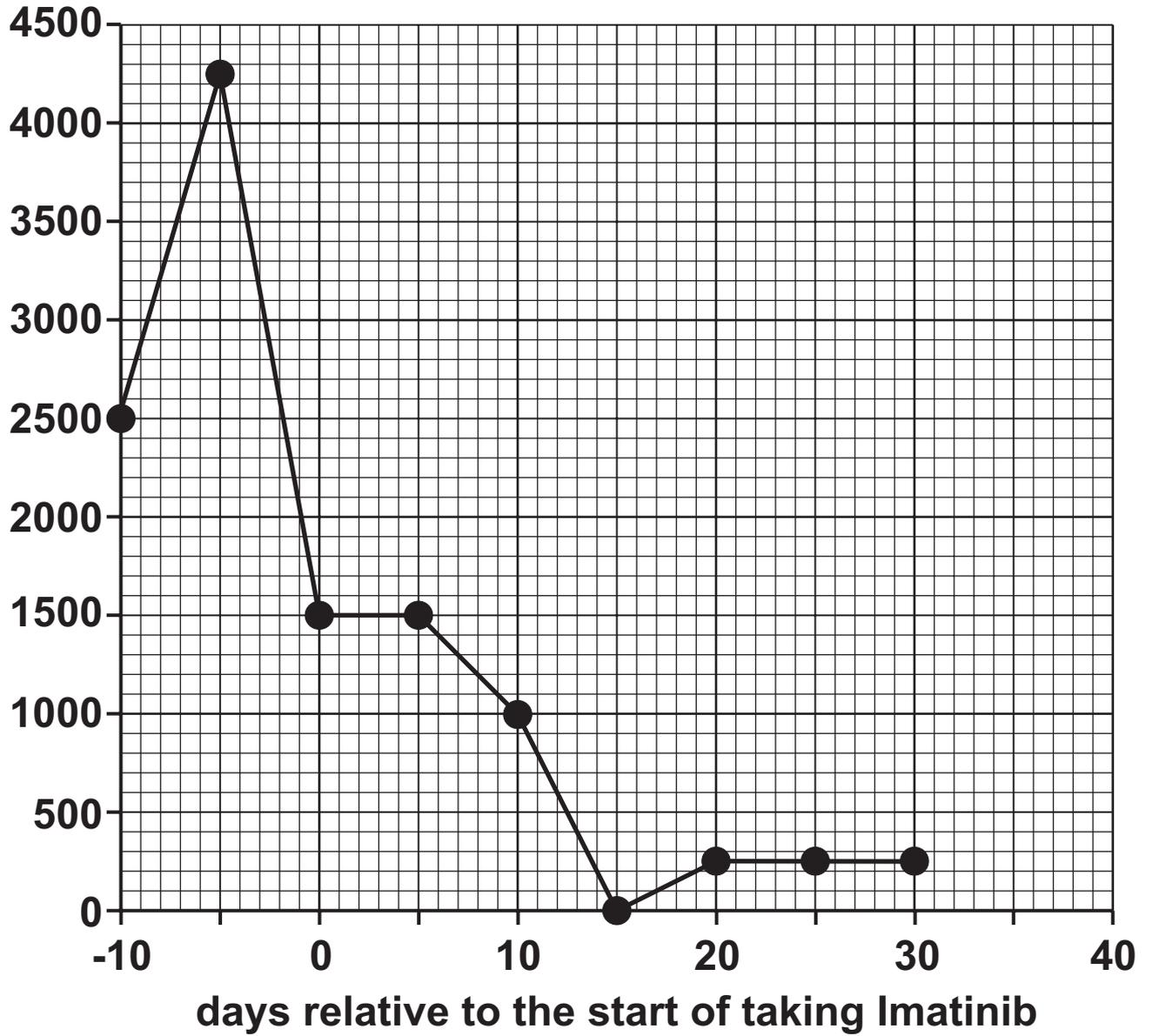


Fig. 24.2(b)

Patient G

number of
blasts



- (i) Calculate the percentage reduction in blasts for patient G from the day treatment with Imatinib STARTED to the end of the trial.

Show your working. Give your answer to THREE SIGNIFICANT FIGURES.

Answer = _____ % [2]

- (ii) Suggest why different scales were used on BOTH axes for the two patients.

[1]

25 A group of AS level students were planning a pilot study before investigating the effect of exercise intensity on heart rate. They were hoping to obtain data by measuring the heart rates of ten students in the group.

The following factors for investigation were suggested by the students:

age

environmental temperature.

(a) The teacher advised the students that these factors were not suitable for their investigation.

For each factor, suggest why it is not suitable for this investigation.

age _____

environmental temperature _____

[1]

- (b) The students' pulse rates were measured using electronic monitors while sitting down (resting rate).

The students then exercised for five minutes.

A second pulse rate measurement was taken exactly four minutes into the exercise period (heart rate during exercise).

The investigation was repeated after giving all students enough time for their pulse rates to return to resting rates.

The results of their pilot study are shown in Table 25.

Table 25

| Student | Resting heart rate (bpm) | | Heart rate during exercise (bpm) | |
|---------|--------------------------|----|----------------------------------|-----|
| | 1 | 2 | 1 | 2 |
| 1 | 56 | 54 | 82 | 84 |
| 2 | 68 | 66 | 92 | 98 |
| 3 | 74 | 72 | 102 | 98 |
| 4 | 72 | 74 | 104 | 102 |
| 5 | 70 | 72 | 100 | 98 |
| 6 | 58 | 60 | 88 | 90 |
| 7 | 66 | 64 | 94 | 94 |
| 8 | 68 | 66 | 94 | 72 |
| 9 | 68 | 64 | 92 | 96 |
| 10 | 62 | 62 | 90 | 92 |

- (i) During the repeat investigation, it was noticed that STUDENT 8 had a lower than expected heart rate during exercise. This anomaly was circled in the results table.

The students agreed that the anomaly was most probably caused by human error.

Suggest ONE human error that could have resulted in this anomaly.

[1]

- (ii) The students highlighted the results of STUDENT 1 who appeared to have heart rates that were much lower than those of the other students.

Suggest ONE explanation for this lower heart rate.

[1]

(iii) The students made the following conclusion about resting heart rates:

'All resting heart rates were in the normal range within ONE standard deviation.'

Variance can be calculated using the following formula and this can then be used to calculate the standard deviation.

$$s^2 = \frac{\sum(x - \bar{x})^2}{n - 1}$$

where s^2 = variance

n = number of data values

Standard deviation can then be calculated using the following formula:

$$s = \sqrt{s^2}$$

where s = standard deviation

s^2 = variance

Complete the missing calculations in the table below and use the equations given to find the variance (s^2) and standard deviation (s) for the students' results.

| Student | Heart rate (x) | Heart rate – mean heart rate ($x - \bar{x}$) | $(x - \bar{x})^2$ |
|---------|--------------------|--|-------------------|
| 1 | 55 | -11 | 121 |
| 2 | 67 | 1 | |
| 3 | 73 | 7 | |
| 4 | 73 | 7 | |
| 5 | 71 | 5 | |
| 6 | 59 | -7 | |
| 7 | 65 | -1 | |
| 8 | 67 | 1 | |
| 9 | 66 | 0 | |
| 10 | 62 | -4 | |

Variance (s^2) =

Standard deviation (s) =

[3]

(iv) Do the results calculated in (b)(iii) support the conclusion made by the students?

Justify your answer.

[1]

26 Fig. 26, IN THE INSERT, is a light micrograph of a cross section through lung tissue.

(a) (i) Identify P labelled on Fig. 26, in the insert.

_____ [1]

(ii) The walls of the alveoli consist of squamous epithelial cells.

How does the structure of these cells differ from the epithelial cells lining bronchioles?

_____ [1]

(iii) Bronchiole walls contain smooth muscle and elastic fibres.

Describe the role of each of these tissues.

smooth muscle _____

elastic fibres _____

[2]

- (b) Cartilage tissue is found in some areas of the gas exchange system.

Name ONE area of the gas exchange system where cartilage is found AND describe its role.

_____ [1]

- (c) Respiratory syncytial virus (RSV) is a major cause of bronchiole infections in small children.

- (i) RSV contains the enzyme reverse transcriptase.

What type of nucleic acid will be found in RSV?

_____ [1]

- (ii) Currently, no vaccines have been developed for preventing RSV infection.

Suggest one BIOLOGICAL problem in developing a vaccine for RSV.

_____ [1]

END OF QUESTION PAPER

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