OCR
Oxford Cambridge and RSA

Friday 13 June 2025 – Morning

A Level Biology B (Advancing Biology)

H422/02 Scientific literacy in biology

Time allowed: 2 hours 15 minutes

You must have:
- a clean copy of the Advance Notice Article (inside this document)

You can use:
- a scientific or graphical calculator
- a ruler (cm/mm)

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Use the Advance Notice Article to answer Question 1.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

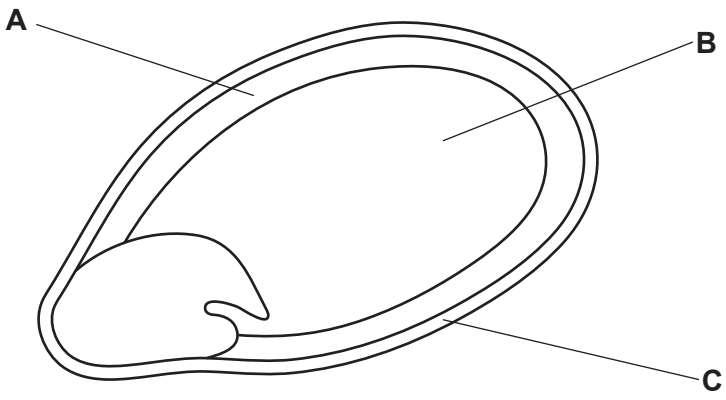
INFORMATION
- The total mark for this paper is **100**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **28** pages.

ADVICE
- Read each question carefully before you start your answer.

1 This question is based on the Advance Notice Article **'Dormancy in cereals: not too much, not too little'**.

The article describes dormancy in cereal seeds, such as barley.

The diagram shows a drawing of a cross section through a barley seed.



(a)

(i) State the name of the structure labelled **A** in the diagram and state its function.

Name ..... aleurone .....

Function ..... secretes enzymes .....

.....

.....

.....

[2]

(ii) Outline how the structure labelled **B** is formed and state its function.

Formation ..... fusion of pollen nucleus with two .....

..... polar nuclei .....

Function ..... Storage of carbohydrate .....

.....

.....

[2]

(iii) The article describes how the hormones ABA and GA regulate seed dormancy.

Suggest how removal of the structure labelled **C** can reduce seed dormancy.

- more water can enter embryo
- more oxygen can enter embryo
- more oxygen increase GA production
- so greater inhibition of ABA

[2]

(b)

(i) Outline an experimental plan to investigate the effect of temperature on the germination of barley seeds.

You do **not** need to include a risk assessment or details of apparatus in your answer.

⇒ Dependent variable:
Number of days
⇒ Independent variable:
Suitable range of temperature (10 to 30°C)
⇒ Variables kept constant
- Same age of seeds
- Light intensity
- 15cm³ of water provided each day.

⇒ • minimum 20 seeds per temperature
- incubate seed

[4]

(ii) State **two** environmental factors, other than temperature and oxygen concentration, that affect germination in barley seeds.

1 Soil pH

2 Availability of water

[2]

(iii) Seed dormancy is usually the result of seeds being exposed to a period of cold.

State the name of another process in plants that requires exposure to a period of cold.

vernalisation.

[1]

(c) Dormancy in cereal seeds is important in agriculture.

(i) Explain **one** advantage for farmers of dormancy in cereal seeds.

Avoids germination in unfavourable conditions so seed waste reduced

[2]

(ii) Flooding of fields can lead to barley seeds failing to germinate, whereas rice seeds do germinate in flooded fields. Farmers often sow rice seeds in flooded fields.

Use the information in the article to explain why rice seeds do germinate in flooded fields but barley seeds do not.

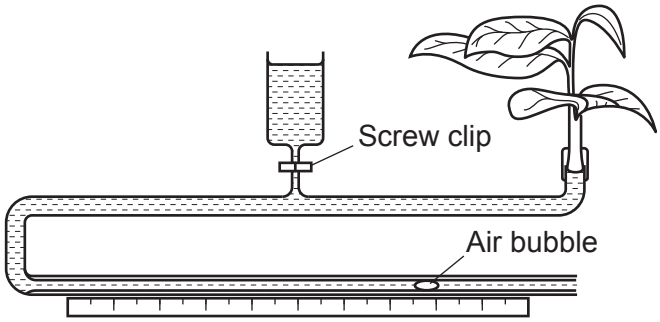
- flooding causes lack of oxygen in soil
- rice has subfamily 3 enzymes that will be activated in low oxygen conditions.
- More starch-digesting enzyme
- Amylose will be broken down.

[4]

(d) Some plant species have adaptations that allow them to grow in very dry conditions.

A student uses a potometer to calculate the rate of transpiration of different species of plant.

The potometer used by the student is shown in the diagram.



The movement of the air bubble was measured using a ruler with a mm scale.

(i) In an initial experiment, the student obtains these results for one species of plant:

Position of bubble at start = 2 mm
Position of bubble after 10 minutes = 117 mm
Distance moved by the bubble = 115 mm

Calculate the percentage error in the results.

total Uncertainity = 2 x 0.5 (mm) = ±1 (mm)

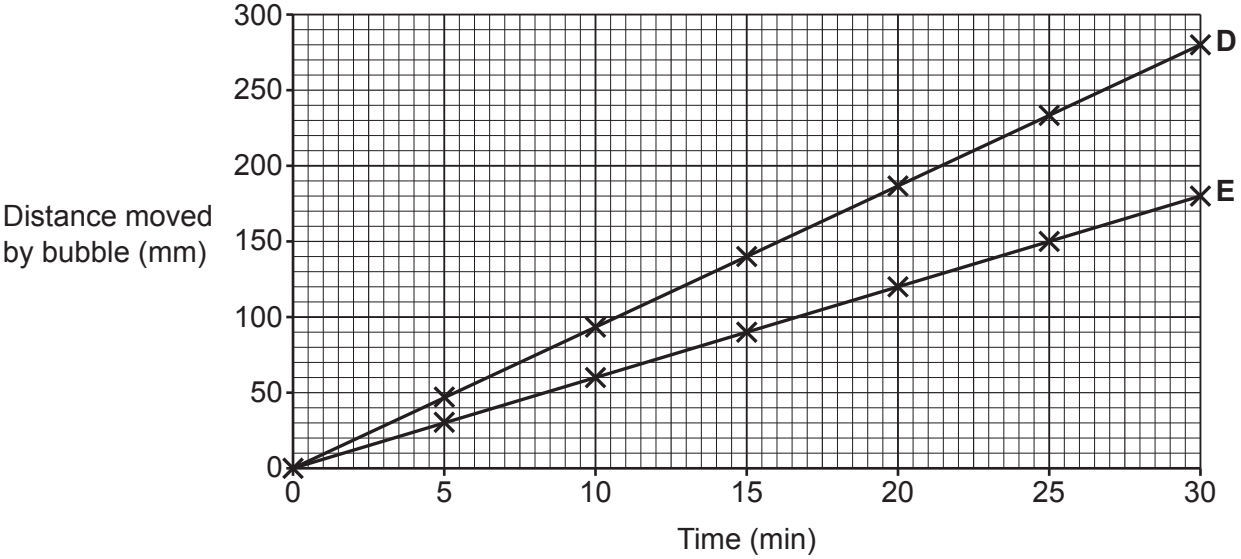
%age error = $\frac{1}{115}$ x 100 = 0.87

Percentage error = 0.87 ..... % **[2]**

(ii) The student then calculates the rate of transpiration in two other species of plant, **D** and **E**.

The student takes readings every 5 minutes using the potometer.

The results are shown in the graph.



Calculate the rate of movement of the air bubble in $mm\,min^{-1}$ for species **E**.

rate = $\frac{180}{30}$ = 6 mm min^{-1}

Rate = ... 6 ..... $mm\,min^{-1}$ **[1]**

(iii) The student calculates the rate of movement of the air bubble in species **D** as $9.33\,mm\,min^{-1}$.

The internal diameter of the potometer tube is 1.5 mm.

Calculate the rate of transpiration for species **D** in $mm^3\,min^{-1}$.

Use the formula: volume of a cylinder = $\pi r^2 l$

rate = $\pi \times 0.75^2 \times 9.33$

rate = 16 mm^3 min^{-1}

Rate = ... 16 ..... $mm^3\,min^{-1}$ **[2]**

2

(a)

(i)* Blood clotting is an essential process that protects against excessive bleeding when a blood vessel is damaged.

Describe the mechanism of blood clotting **and** suggest why a small amount of initial damage can lead to a relatively large and rapid response.

⇒ Steps in the Clotting process

- Damaging to blood vessels exposes collagen
- Leads to activation of platelets
- Clumping of platelets and release of thermboplastin
- Involvement of calcium ions
- Involvement of clotting factors
- Release of thermboplastin by Leucocytes.
- conversion of prothrombin → Thrombin.
- conversion of fibrinogen → fibrin
- Soluble to insoluble
- Role of fibrin fiber in trapping erythocytes

⇒ Explanation for Change in response

- cascade amplifies the response
- Activation of enzymes amplifies the response **[6]**

Extra answer space if required.

- Activation of enzymes increases the rate of response
- platelets attract more platelets

(ii) Styptic pencils can be used to stop bleeding from minor cuts, such as cuts from shaving.

A styptic pencil is a stick of hydrated salt, which acts as a vasoconstrictor and also stimulates clumping of blood proteins.

Suggest how a styptic pencil stops bleeding at the site of a cut.

- Narrowing of blood vessel reduces blood flow
- clumping of protein will mimic action of fibrin

[2]

(b) The intracellular enzyme lactate dehydrogenase (LDH) can be used to diagnose tissue damage caused by injury or disease.

(i) Explain how analysis of LDH in a blood sample can be used to assess the severity of tissue damage.

- LDH is released by damaged cells
- concentration of LDH in the blood will depend on severity of the injury
- can identify location of damaged cells.

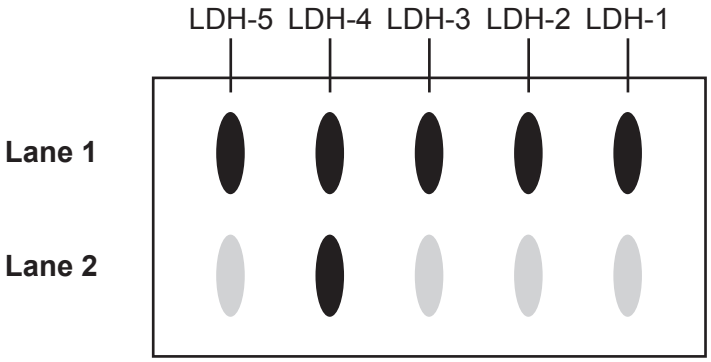
[2]

(ii) Screening for tissue damage uses gel electrophoresis to separate different forms of LDH.

The table shows the five different forms of LDH and their main locations in tissues.

Enzyme form	Main locations
LDH-1	Heart muscle and erythrocytes
LDH-2	White blood cells
LDH-3	Lung
LDH-4	Kidney, placenta and pancreas
LDH-5	Liver and skeletal muscle

The diagram shows the results of an analysis of a blood sample from a **male** patient.



Lane 1 is a mixture of pure samples of the five forms of LDH. Lane 2 is the patient sample.

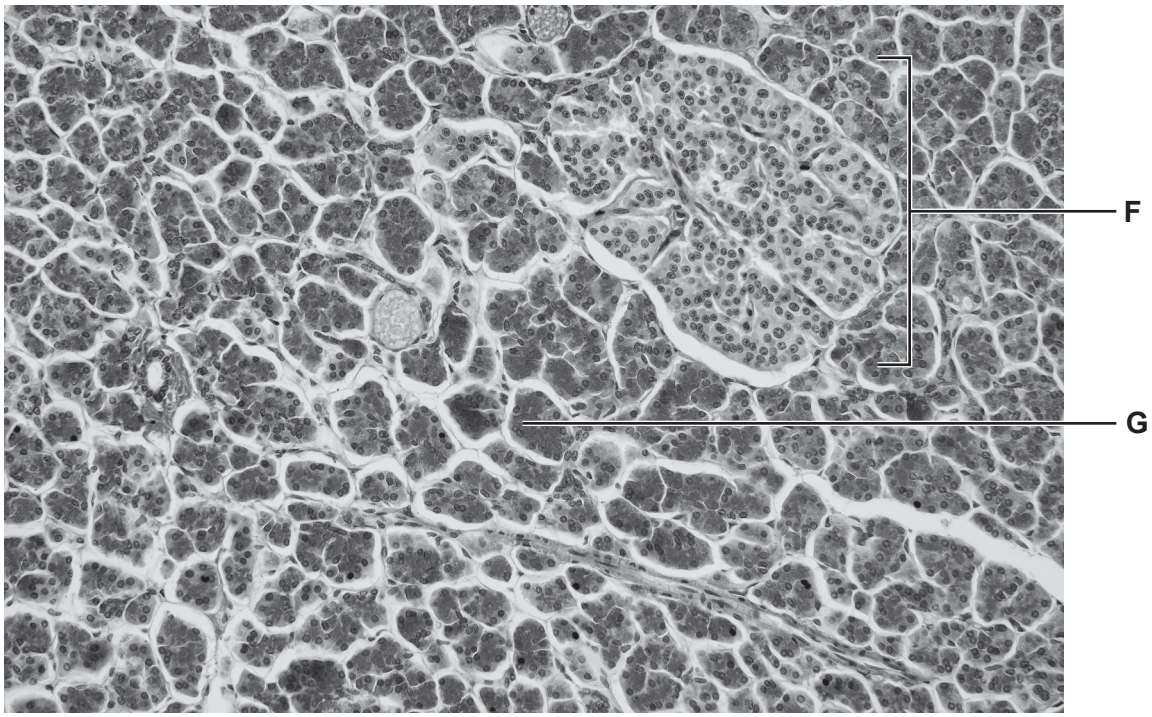
Explain why it is **not** possible to be certain about the site of tissue damage in this patient.

- LDH-4 is associated with Kidney and Pancrease
- cannot distinguish between these organs.

[2]

3

(a) This is a photomicrograph of a section of mouse pancreas.



Identify the structures labelled **F** and **G**.

F islets of Langerthans

G Exocrine

[2]

(b) Glycosylated haemoglobin (HbA1c) is used to monitor how well a patient's diabetes is controlled.

HbA1c was traditionally measured as a percentage, but it is now measured in mmol mol^{-1}, which is the amount of glucose (in mmol) per mole of haemoglobin.

A patient was told that their HbA1c was 42 mmol mol^{-1}.

They found a table of HbA1c values used in diagnosis.

HbA1c (%)	Status
<5.7	normal
5.7–6.4	prediabetes (high probability of developing Type 2 diabetes)
>6.4	diabetes

(i) The equation can be used to convert values in % to mmol mol^{-1}.

HbA1c (mmol mol^{-1}) = (HbA1c (%) – 2.14) × 10.929

Calculate the patient's HbA1c concentration in %.

Give your answer to **2** significant figures.

$$\text{HbA1c \%} = \frac{\text{Hb A1(c) (mmol mol}^{-1})}{10.929} + 2.14$$

$$\frac{42}{10.929} + 2.14 = 5.98 = 6$$

HbA1c concentration = ... 6.0 ..... % **[2]**

(ii) Use your answer to part **(i)** to determine the status of the patient, based on the values in the table.

..... high probability of developing type 2 diabetes. ..... **[1]**

(c)* Semaglutide is a new form of anti-diabetes medication that is prescribed as a once-weekly injection for treatment of Type 2 diabetes.

Clinical trials have shown that semaglutide causes a significant reduction in HbA1c and body mass compared with existing treatments, such as daily insulin injections and other anti-diabetic drug treatments.

Other clinical trials have shown that semaglutide causes a significant reduction in kidney damage but a significant increase in retina damage compared with placebos.

Evaluate the potential advantages and disadvantages of semaglutide for treatment of Type 2 diabetes.

⇒ Potential advantages of semaglutide

- controls diabetes better than some existing treatment.
- Reduce risk associated with type 2 diabetes.
- Enable patient to be more active
- Reduces impact of density.
- May reduce cost for NHS
- Reduce risk of kidney failure

⇒ Potential disadvantages of semaglutide

- Expensive
- Loss of vision
- possible nutrient deficiency.
- too much weight Loss.
- pain.
- Negative impact on Lifestyle e.g **[6]**

Extra answer space if required.

Loss of earning due to loss of vision.

4 Solar farms use solar panels to generate electricity from sunlight. In the UK, solar farms range in size from 0.3 to 1 km^2 and are usually located on agricultural land.

Some people are concerned about the environmental impact of solar farms, particularly when agricultural land is converted into a solar farm.

(a) A study in the USA examined the biodiversity of a solar farm over a period of five years.

Construction of the solar farm was completed in 2017.

Scientists monitored the biodiversity of the plant species in the solar farm each year from 2018 to 2022 and used Simpson's Index of Diversity (*D*) to compare biodiversity over the study period.

The table shows the results for 2018 and 2022.

Plant species	**Mean number of each species**	
	2018	**2022**
Black-eyed Susan	15	45
Clover	18	50
Blue vervain	3	40
Common yarrow	2	28
Ironweed	0	35
Canadian milkvetch	0	30
Totals	38	228
D =	0.61	0.83

(i) Use the data in the table to calculate *D* for 2022.

Use the formula: $D = 1 - \left(\Sigma\left(\frac{n}{N}\right)^2\right)$

$D = 1 - 0.1739$

$= 0.83$

Plant species	$(n/N)^2$
Black-eyed susan	0.0390
Clover	0.0481
Blue vervain	0.0308
Common yarrow	0.0151
Ironweed	0.0236
Canadian milkvetch	0.0173
Total	0.1739

D = 0.83 **[3]**

(ii) The scientists concluded that the biodiversity had increased from 2018 to 2022.

Explain whether your value for *D* supports this conclusion.

Supported because D has increased.

[1]

(iii) Suggest what additional information would be needed to increase the confidence in this conclusion.

- use identification key to ensure species are recognized correctly
- t-test (unpaired) to compare significance.
- Obtain data for other species
- ensure data collected at same time of the year.

[2]

(b) In the same study, the scientists compared the biodiversity of insect species in the solar farm and in two parts of an adjacent field that was growing soybean crops throughout the study period.

Their results are shown in the table.

Study area	Insect biodiversity
Solar farm	high
Soybean field (adjacent to solar farm)	medium
Soybean field (middle of field)	low

Explain the results shown in the table.

plant biodiversity in soyabean field is Lower than solar farm so fewer habitats

[2]

(c) A student stated:

'The main challenge for agriculture in the future is that climate change will have a worse effect on crop plants than it will on weed species.'

Suggest and explain whether the student's statement is likely to be correct.

⇒ correct because
- weed species may have greater genetic diversity
- weed species more likely to adapt climate change
- Drought may have less effect on weed species.

⇒ Incorrect because crop plants might grow with higher temperature and likely to genetically modified.

[3]

5

(a) The hormones that control gametogenesis have different roles in males and females.

(i) State the role of luteinising hormone (LH) in males and in females.

Males triggers release of testosterone

Females Cause release of secondary oocyte from mature follicle.

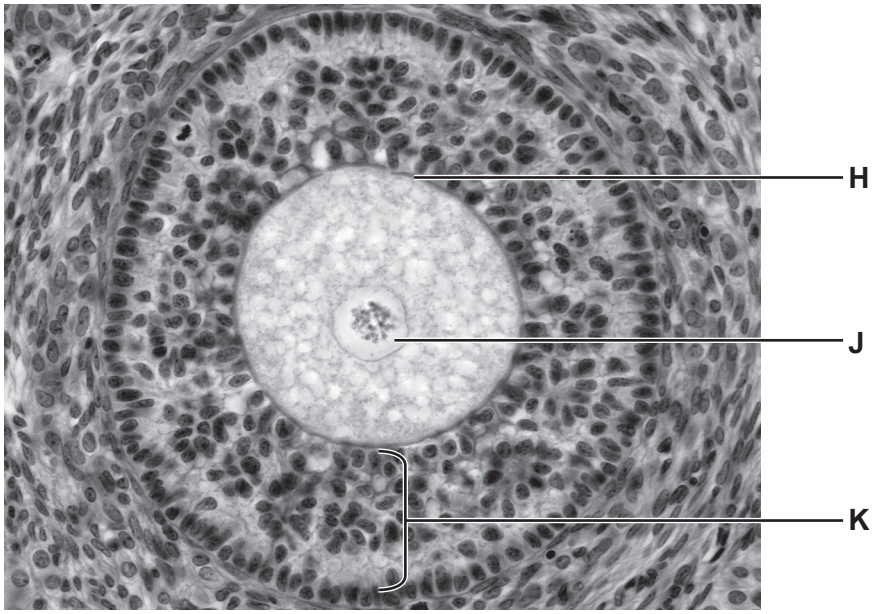
[2]

(ii) Explain why follicle stimulating hormone (FSH) is often used to treat infertility in women.

Stimulates oestrogen production
Stimulates maturation of follicles.

[2]

(b) The light microscope image shows a section through part of a human ovary.



(i) Identify the structures labelled **H**, **J** and **K**.

H Zona pellucida

J haploid nucleus of oocyte

K corona radiata

[3]

(ii) Outline the formation of secondary oocytes from oogonia.

- process start before birth
- oogonia grow to produce primary oocytes
- meiosis starts and pause in prophase I
- meiosis restarts to form secondary oocytes
- Diploid (oogonia) to haploid (secondary oocyte) **[2]**

(c) The most common cause of Down's syndrome is trisomy 21, which results in three copies of chromosome 21 being present in the cells of an affected individual.

(i) Describe how trisomy 21 occurs.

Non disjunction
Non seperation of homologous chromosomes in meiosis.
after meiosis gamete has two copies of Chromosome 21 **[2]**

(ii) Describe **one other** way in which Down's syndrome can be caused.

translocation. **[1]**

(d) The risk of having a child with Down's syndrome increases with the mother's age.

(i) Suggest and explain a reason for this.

- Increased risk of Chromosomal abnormality
- mutation accumulate with age of oocytes
- Long time spent in prophase I results in more errors **[2]**

(ii) Describe **two** ways in which an older couple can reduce the risk of having a child with Down's syndrome.

1 genetic counselling to indicate risk factor due to family history
2 Parental screening to diagnose Down's Syndrome in embryo. **[2]**

(iii) Identify **one** ethical issue associated with either of your answers to part **(ii)**.

- genetical counselling can cause anxiety **[1]**

6

(a) In 1952, Erwin Chargaff published a paper showing the composition of DNA bases in many species.

The paper formed the basis of what are now known as Chargaff's rules.

The table shows some of the data from Chargaff's original paper.

Source of DNA	Percentage of base within DNA (%)			
	Adenine (A)	Guanine (G)	Cytosine (C)	Thymine (T)
Human	29.3	20.7	20.0	30.0
Maize	26.8	22.8	23.2	27.2
E. coli bacteria	24.7	26.0	25.7	23.6
PhiX174	24.0	23.3	21.5	31.2

(i) Use data from the table for human, maize and *E. coli* DNA to explain the basis of Chargaff's rules.

% of G = C and % of A = T

This is same in all species because of complementary base pairing.

in human A = 29.3 % and T = 30.0 %

in human A ÷ T = 0.977 .

[3]

(ii) PhiX174 is a virus that has single-stranded DNA and does not obey Chargaff's rules.

Suggest an explanation for PhiX174 not obeying Chargaff's rules.

no complementary base pairing

[1]

(b) A group of students extract DNA from peas.

This is the method they use:

1. Blend 100 cm^3 peas with 2 g table salt and 100 cm^3 cold water.
2. Strain through a mesh and collect the liquid portion (the homogenate) in a beaker.
3. Allow to settle for 10 minutes.
4. Transfer to several test tubes.
5. Slowly pour ethanol into each tube to form a layer on top of the homogenate.
6. Use a glass rod to collect the DNA that clumps where the layers meet.

Suggest modifications to the procedure that would:

- reduce damage to the DNA by enzymes
- increase the release of DNA from cells after step 2
- remove histones from DNA after step 4.

Reduce damage to DNA by enzymes .....

work at Low temperature

.....

Increase release of DNA from cells .....

use detergent

.....

Remove histones from DNA .....

add a protease

.....

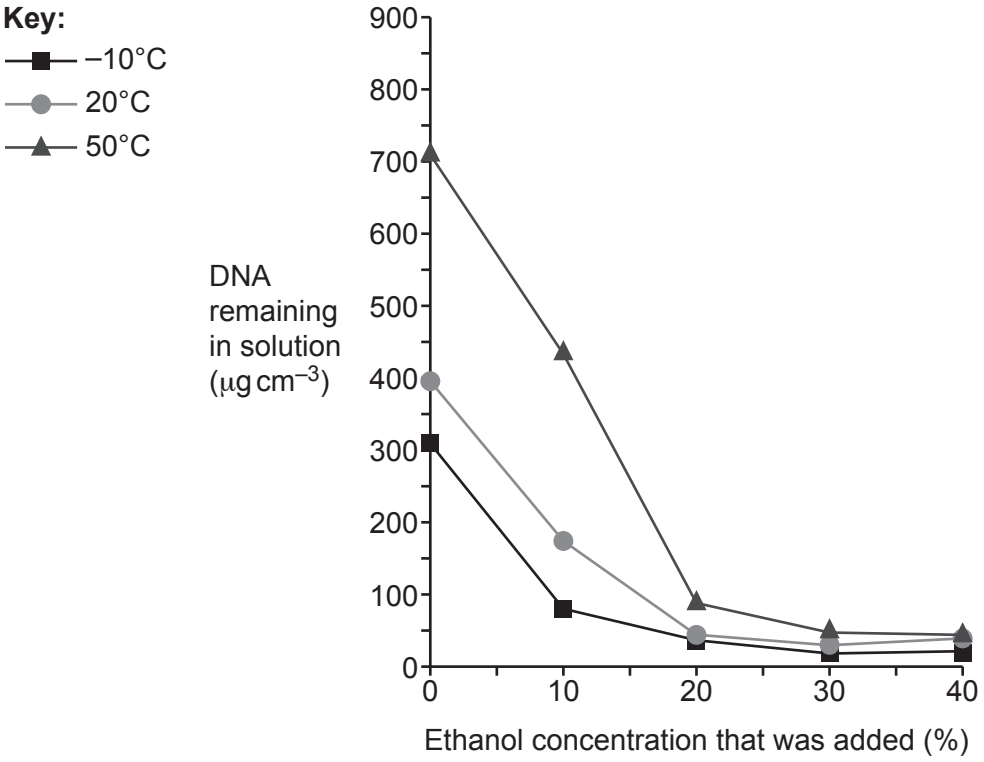
[3]

(c) One student places the ethanol in a water bath at 50 °C before using it in step 5.

The student is unable to collect any DNA.

The student carries out some research online. They find a publication that investigated the effect of temperature on the concentration of DNA remaining in solution when ethanol was added.

The results are shown in the graph.



Use the data in the graph to explain why the student was unable to collect any DNA.

DNA is more soluble at 50°C at low ethanol concentration

They were using low concentration of ethanol.

They should have used at least 20% ethanol. **[2]**

7

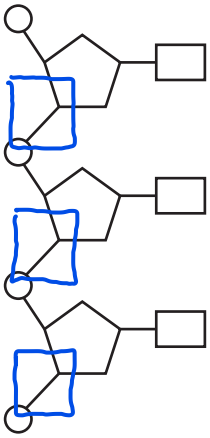
(a) The table compares the structure of DNA and RNA nucleotides.

Complete the table by writing the names of the structural features present in DNA and RNA.

Structural feature	DNA	RNA
Pentose sugar	Deoxyribose	Ribose
Purine bases	Guanine Adenine	Guanine Adenine
Pyrimidine bases	Cytosine Thymine	Cytosine Uracil

[3]

(b) A section of RNA is represented in the diagram.



Draw a circle around a phosphodiester bond.

Answer on the diagram. **[1]**

(c) Complete the following passage using the most appropriate words or phrases.

Semi-conservative replication of DNA involves the enzyme ....helicase..... ,

which breaks the .....hydrogen..... bonds between the two strands.

DNA nucleotides bind to each of the separated strands and the enzyme

DNA polymerase..... joins the nucleotides in a

....condensation..... reaction to form two new strands.

[4]

(d)

(i) Describe the role of cell cycle checkpoints in ensuring the accuracy of DNA replication.

DNA synthesis checkpoint for S
Check for damaged DNA
triggers repair mechanism
halt cell cycle.

[2]

(ii) Suggest why mutations that affect cell cycle checkpoints can increase the general rate of mutation.

Damaged DNA will bypass checkpoint
dysregulation of the cell cycle
increase in cell division.

[2]

(e) Radiotherapy causes damage to the DNA of cancer cells.

Suggest how this process can reduce the size of a tumour.

- Ionizing radiation damages cancer cells
- cell with damaged DNA undergo apoptosis
- So less cancer cells so the tumour shrinks.

[2]

(f) Umbilical cord blood can be collected from the placenta after birth.

Umbilical cord blood transplantation can be used as an alternative to bone marrow transplantation.

(i) Suggest the type of potency for the stem cells present in umbilical cord blood.

multipotent ..... **[1]**

(ii) Suggest **one** advantage of umbilical cord blood transplantation over bone marrow transplantation.

easier to obtain .....

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

END OF QUESTION PAPER

EXTRA ANSWER SPACE

If you need extra space use these lined pages. You must write the question numbers clearly in the margin.