GCSE (9–1) Biology B (Twenty First Century Science)
J257/03 Breadth in biology (Higher Tier)
Sample Question Paper

Date – Morning/Afternoon
Time allowed: 1 hour 45 minutes

You may use:
• a scientific or graphical calculator
• a ruler

INSTRUCTIONS
• Use black ink.
• Complete the boxes above 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, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
• Do not write in the bar codes.

INFORMATION
• The total mark for this paper is 90.
• The marks for each question are shown in brackets [ ].
• This document consists of 28 pages.
Sarah is feeling unwell so she goes to her doctor. Her doctor thinks she may have Chronic Fatigue Syndrome (CFS).

(a) CFS is difficult to diagnose. Before diagnosis doctors rule out a condition called anaemia by carrying out a blood test.

A blood test checks the number of blood cells in Sarah’s blood.

(i) What is the role of the red blood cell?

(ii) One symptom of CFS is extreme tiredness.

<table>
<thead>
<tr>
<th></th>
<th>Red blood cell (per mm$^3$)</th>
<th>White blood cell (per mm$^3$)</th>
<th>Platelets (per mm$^3$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal level</td>
<td>3 800 000</td>
<td>8 500</td>
<td>250 000</td>
</tr>
<tr>
<td>Sarah</td>
<td>2 700 000</td>
<td>9 000</td>
<td>245 000</td>
</tr>
</tbody>
</table>

Explain how the results shown in the table above could cause Sarah to feel tired.
(iii) The table below shows some information about red blood cells and the cells taken from the cheek of a human.

<table>
<thead>
<tr>
<th></th>
<th>Red blood cell</th>
<th>Cheek cell</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surface area (µm²)</td>
<td>136</td>
<td>7854</td>
</tr>
<tr>
<td>Volume (µm³)</td>
<td>90</td>
<td>65 450</td>
</tr>
<tr>
<td>Surface area: volume ratio</td>
<td></td>
<td>0.12 : 1</td>
</tr>
</tbody>
</table>

Calculate the surface area to volume ratio of the red blood cell.

Show your working.

Give your answer to two significant figures.

……………………………………… [1]

(iv) Red blood cells have a greater surface area to volume ratio than cheek cells.

Explain how this allows them to carry out their function.

……………………………………………………………………………………………………………………………………………………………………………… [1]

(v) The doctor will check to see if Sarah has an underactive thyroid gland as this could also make her feel tired.

The thyroid gland produces a hormone.

What is the role of a hormone?

……………………………………………………………………………………………………………………………………………………………………………… [1]
(b) (i) Insulin is a hormone produced by the pancreas.

The graph below shows data from two people who were given a sugary drink. Their blood sugar level was recorded every 60 minutes from when they had the drink.

![Graph showing blood sugar levels over time for two individuals](image)

There are two types of diabetes – type 1 and type 2. Person A has type 2 diabetes. Person B does not have diabetes. Describe how the graph shows this and explain why there is a difference in the blood sugar level.

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………………………………………………………………………………………………....…….

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…………………………………………………………………………………………………

(ii) The statements below are all to do with type 1 and type 2 diabetes.

Draw two lines to identify the sentences which are to do with **type 1 diabetes**.

- [ ] body no longer responds to the insulin produced
- [ ] should eat a diet high in complex carbohydrates and exercise
- [x] Type 1 diabetes
- [ ] will need to inject insulin
- [ ] pancreas stops producing insulin

[2]
2 Limpets are molluscs that are found on rocky shores.

![Limpet Image]

A student wants to sample a rocky shore to work out if the population of limpets differs on different parts of the shore.

(a) Describe a method that the student could use to determine where on the rocky shore there are more limpets.

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………………………………………………………………………………………………………………
………………………………………………………………………………………………………………
………………………………………………………………………………………………………………
………………………………………………………………………………………………………………
………………………………………………………………………………………………………………

(b) The students counted the number of limpets found on three parts of the rocky shore. The data is shown in the table below.

<table>
<thead>
<tr>
<th>Part of shore</th>
<th>Number of limpets</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test A</td>
<td>Test B</td>
</tr>
<tr>
<td>Low shore (closest to sea)</td>
<td>15</td>
<td>16</td>
</tr>
<tr>
<td>Mid shore</td>
<td>45</td>
<td>47</td>
</tr>
<tr>
<td>High shore (furthest away from sea)</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

(i) The students think one of the results is an outlier. Circle the outlier in the table above.

(ii) Calculate the mean number of limpets found on the mid shore. Show your working.
(c) This is a food web for the species that can live on a rocky shore.

Explain the impact of an increase in the number of dogwhelks on one species in this food web.

...........................................................................................................................................................................
...........................................................................................................................................................................
........................................................................................................................................................................... [2]

(d) In some areas of the UK, dogwhelk numbers are decreasing. This reduces biodiversity.

Give two benefits of maintaining biodiversity.

1...........................................................................................................................................................................
...........................................................................................................................................................................

2...........................................................................................................................................................................
........................................................................................................................................................................... [2]
(e) Sea anemones can reproduce asexually.

Give one advantage and one disadvantage of this method of reproduction.

Advantage

Disadvantage

(f) (i) Sea anemones are mainly found in rock pools.

During the summer the water temperature in a rock pool can increase to a level which can be dangerous for a sea anemone.

Put a tick (✓) in the box that best explains why a temperature increase is a problem.

- Enzyme catalysed reactions will speed up.
- Enzyme catalysed reactions will slow down.
- Enzymes will be killed.
- Enzymes will become denatured.

(ii) When it rains, the concentration of the sea water in a rock pool decreases.

What effect will this change in concentration have on a sea anemone’s cells?

Put a tick (✓) in the box next to the correct answer.

- Some cells may burst.
- Some cells may shrink.
- There will be no change to the cells.
- Some cells will burst, others will shrink.
3 DNA is a nucleic acid. DNA is found in all living cells.

(a) Read these statements about DNA.

Put ticks (✓) in the boxes next to the two correct statements.

- DNA is made from four different nucleotides.
- Half the nucleotides have a common sugar.
- DNA is made from a copy of RNA.
- Half the nucleotides have a phosphate group.
- DNA is a polymer.

(b) RNA is another type of nucleic acid. It is involved in protein synthesis. Look at the RNA sequence.

G A C U G G A G U A C A C G C C

Use the information below and write down the sequence of amino acids that the RNA codes for. Use the abbreviation for each amino acid.

<table>
<thead>
<tr>
<th>Amino acid</th>
<th>Amino acid abbreviation</th>
<th>Nucleotide sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>glutamic acid</td>
<td>glu</td>
<td>G A G</td>
</tr>
<tr>
<td>leucine</td>
<td>leu</td>
<td>C U G</td>
</tr>
<tr>
<td>threonine</td>
<td>thr</td>
<td>A C G</td>
</tr>
<tr>
<td>tyrosine</td>
<td>tyr</td>
<td>U A C</td>
</tr>
</tbody>
</table>

…….  …….  …….  …….  …….  

[1]
(c) A mutation occurs in the RNA sequence above. The nucleotide sequence that results is:

\[ \text{G A C U G U A G U A C A C G C C} \]

Suggest what effect this could have on the production of a protein.

……………………………………………………………………………………………………………….
……………………………………………………………………………………………………………….
……………………………………………………………………………………………………………….
……………………………………………………………………………………………………………….
……………………………………………………………………………………………………………….
………………………………………………………………………………………………………………. [4]
Jack has a bacterial infection caused by *Streptococcus pneumoniae*.

A doctor takes a sample from Jack to work out which antibiotic will kill the bacteria.

The diagram below shows the effectiveness of four different antibiotics when grown on agar jelly.

The clear zone for each of the four antibiotics is shown on the diagram below. The clear zone is the area of the bacteria that has been killed by the antibiotic.

(a) (i) Using the formula $\pi r^2$ calculate the clear zone for antibiotic D.

Show your working.

$\pi = 3.14$

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Clear zone $(\text{mm}^2)$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>50.24</td>
</tr>
<tr>
<td>B</td>
<td>0.00</td>
</tr>
<tr>
<td>C</td>
<td>94.99</td>
</tr>
<tr>
<td>D</td>
<td></td>
</tr>
</tbody>
</table>
(ii) Jack’s doctor must decide which antibiotic to prescribe him.

Use the information provided at the start of this question to decide which of the following conclusions can be made.

Put a tick (✓) in the box next to the correct conclusion.

Antibiotic A works best. Jack should be given antibiotic A. □

Antibiotic B has the least effect. Jack should not be given antibiotic B. □

Antibiotic C works best. Jack should be given antibiotic C. □

All antibiotics worked equally well. Jack can be given any antibiotic. □ [1]

(iii) The control for this test could have been a disc which did not contain any antibiotic.

State a reason for using a control in this experiment.

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

(b) Aseptic techniques must be used when culturing organisms.

Give an example of an aseptic technique and explain why it is used.

........................................................................................................................................
........................................................................................................................................
........................................................................................................................................ [2]
5 (a) The human menstrual cycle is controlled by hormones.

The diagram below shows the concentration of the four hormones involved in the menstrual cycle.

Which letter, A, B, C or D, shows when ovulation occurs?

[1]

(b) Some couples are unable to conceive a child naturally. In-vitro fertilisation (IVF) is a technique that can be used to help these couples.

In IVF, a woman’s ovaries are stimulated to produce a greater number of eggs than she would during a normal monthly cycle.

Which hormone could be used to achieve this?

Put a tick (✓) in the correct box.

- Oestrogen
- Progesterone
- LH
- FSH
(c) To confirm if a female is pregnant a pregnancy test will be done. These tests use monoclonal antibodies.

(i) Describe how monoclonal antibodies are produced.

(ii) Antibodies are proteins.

The statements below describe protein synthesis.

A  The mRNA travels to a ribosome in the cytoplasm.
B  A copy of the gene is made from messenger RNA.
C  The ribosome joins the amino acids together in the correct order.
D  The gene that codes for the protein is found in the DNA.

Put the statements in the correct order.

A   B   C   D  [1]
6 Look at the diagram of the heart.

(a) (i) Which letter on the diagram, A, B, C or D, shows how the backflow of blood is prevented?

Place a tick (✓) in the correct box.

A
B
C
D

[1]

(ii) The blood vessels in the circulatory system are adapted to their function.

The table below highlights the features of the three different blood vessels.

Use the table to identify the type of blood vessel, X, Y and Z.

<table>
<thead>
<tr>
<th>Vessel</th>
<th>Smooth inner lining</th>
<th>Valves</th>
<th>Muscular tissue</th>
<th>Elastic tissue</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Y</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Z</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

Blood vessel X .................................................................

Blood vessel Y .................................................................

Blood vessel Z .................................................................

[3]
(b) A scientist collected some data about the percentage of fat in people’s diet and the number of deaths from heart disease in various countries around the world.

The data was plotted in the graph below.

(i) What can you conclude about the percentage of fat in the diet and the likelihood of dying from heart disease?

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

(ii) What two lifestyle changes might you suggest to a person from the USA in order to decrease their chance of dying from heart disease?

1.................................................................................................................................................

2................................................................................................................................................. [2]
(c) Some diseases are inherited.

Haemophilia is an example of an inherited disease. It is caused by a **recessive allele**. The gene for haemophilia is located on the sex chromosomes.

Due to the location of the gene for haemophilia, females inherit two copies of the gene, but males only inherit one. For a male, this is shown on the diagram below.

![Diagram showing gene location on sex chromosomes]

Males **cannot** be carriers for the disease. They either have the disease or they do not.

(i) Complete the Punnet square to determine the probability of a female carrier with the genotype $X^hX^h$ and a healthy male with the genotype $X^H Y$ having a son with haemophilia.

<table>
<thead>
<tr>
<th></th>
<th>$X^H$</th>
<th>$X^h$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X^H$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$X^h$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$Y$</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Probability…………………………… [2]

(ii) Which of the following genotypes would a female with haemophilia have?

Put a tick (✓) in the correct box.

- $X^H X^H$
- $X^H X^h$
- $X^h X^h$
- $X^h X^h$
- $X^H X$

[1]
Nat has an eye disease that causes the fibres that hold her cornea in place to weaken.
Her cornea has become damaged causing its shape to change.
What is the role of the cornea and how will damage to the shape affect Nat’s sight?

Scientists are now using stem cells to repair damage to corneas.
What is a stem cell?

Stem cells can be obtained from embryos.
Why are some people against using embryos as a source of stem cells?
(b) New body cells are created as part of the cell cycle. This is represented in the diagram below.

The whole cell cycle, in this example, takes 141 minutes.

Calculate the length of time spent in mitosis.

Give your answer to 2 decimal places.

time spent in mitosis ............................... minutes [2]
A student investigates the effect of temperature on the rate of water uptake by a plant.

(a) She places a plant shoot in a room at 35°C and sets the equipment up as shown below.

(i) The student measured the distance moved by the air bubble over a period of 30 minutes.

The diagrams below show her results.

Calculate the rate of water uptake.

Show your working.

Give your answer to 2 significant figures.

rate of water uptake = .................. cm³/min  [2]
How could the student use this apparatus to investigate the rate of water uptake in windy conditions?

Other apparatus is available, too.

The volume of water taken up may not be an accurate measurement of the water lost in transpiration.

Stomata are small holes found mostly on the underside of leaves. They can open and close. The opening and closing of the stomata is controlled by guard cells.

Potassium ions from neighbouring cells enter the guard cells. This causes the stomata to open.

Explain how this mechanism works.
9 (a) In 1991 a type of genetically modified tomato was being developed.

This tomato contained a gene from the arctic flounder fish.

Arctic flounder fish live in very cold conditions.

How would the tomato with the arctic flounder fish gene be of benefit to modern agriculture?

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

(b) Genetic modification has many wider applications.

Children who lack human growth hormone can now have a genetically engineered version injected so that they grow as normally as possible.

The bacterium *Escherichia coli* is used as part of the genetic engineering process.

Use this information to describe how human growth hormone is made.

.................................................................................................................................................... [3]
10 (a) Whooping cough is a non-communicable bacterial infection.

The diagram below shows the blood of a person infected with whooping cough.

Label the two structures in the diagram.

(i) ..................................................  

(ii) ..................................................  

[2]

(iii) We can vaccinate against whooping cough.

There are 2 types of vaccine. Type 1 uses whole bacterial cells, type 2 uses parts of bacterial cells.

Some people are concerned about using the whole bacterial cell vaccine.

Suggest why.  

.........................................................................................................................................................  

.........................................................................................................................................................  

[1]
(b) New medicines, including vaccinations, have to be tested before they are made widely available.

Preclinical and clinical tests are used to assess the safety and effectiveness of new medicines.

For each test, complete the table by putting a tick (✓), in one box next to the test to indicate if it assesses safety, effectiveness or both.

For each test, one example has been done for you.

<table>
<thead>
<tr>
<th>Preclinical tests</th>
<th>Safety</th>
<th>Effectiveness</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultured human cells</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Whole animals</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Clinical tests</th>
<th>Safety</th>
<th>Effectiveness</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy volunteers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Humans with the disease</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
James Watson and Francis Crick are famous for identifying the structure of DNA. They wrote a scientific paper about it in 1953. Before this, scientists had clues about the parts of the DNA molecule.

One of these clues was to do with the relative amounts of the bases – A, T, C and G. Chemical analysis of DNA from a wide variety of cells showed that the total number of A bases and G bases equalled the total number of T bases and C bases.

What conclusion could early scientists have made from this analysis?

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……………………………………………………………………………………………………………………………………………….…………………..
………………………………………………………………………………………………………………………………………………..……………

(b) DNA structure is important in the production of proteins. DNA analysis allows scientists to group organisms based on similarities in their DNA.

Complete the sentences below.

A …………………………….. of bases is required to code for an amino acid.

The properties of the protein made depend on the …………………………….. of the amino acids.

Grouping organisms according to similarities in their DNA or physical characteristics is called

……………………………..
(c) Knowledge of genetics and DNA analysis has allowed scientists to group organisms based on similarities in their DNA.

It also enables them to draw conclusions about the evolutionary relationships between organisms.

It is possible to draw an evolutionary tree as seen below to highlight these relationships.

Are hippos more closely related to whales or to pigs?

Justify your answer using evidence from the evolutionary tree in your answer.

[2]
(a) Sunil considers different ways to display data about the organisms found in a woodland ecosystem.

One option is a pyramid of numbers for the simple food chain:

Oak tree  →  Yellow-necked caterpillar  →  Blackbird

```
  Blackbird
  Yellow-necked caterpillar
  Oak tree
```

Draw a pyramid of biomass for this food chain in the space below.

(b) Biomass in an ecosystem can be measured in g/m$^2$.

The following are possible values for a different food chain in the same woodland ecosystem.

```
  Grass 50g/m$^2$
  →  Slug 4g/m$^2$
  →  Thrush
```

(i) Calculate the percentage of the biomass from the grass that is passed on to the thrush.

Show your working. Give your answer to 2 decimal places.
(c) Decomposers are also an important part of ecosystems.

The graph below shows the activity of decomposers in a woodland ecosystem during a year, from January to December.

![Graph showing microbial activity over a year]

(i) Describe the pattern of microbial activity shown in the graph above.

.................................................................................................................................................. [2]

(ii) Explain the pattern you have described in (c)(ii).

.................................................................................................................................................. [2]

END OF QUESTION PAPER
…day June 20XX – Morning/Afternoon
GCSE (9–1) Biology B (Twenty First Century Science)
J257/03 Breadth in biology (Higher Tier)

SAMPLE MARK SCHEME

MAXIMUM MARK  90

Duration: 1 hour 45 minutes

This document consists of 20 pages
PREPARATION FOR MARKING

SCORIS

1. Make sure that you have accessed and completed the relevant training packages for on-screen marking: scoris assessor Online Training; OCR Essential Guide to Marking.

2. Make sure that you have read and understood the mark scheme and the question paper for this unit. These are posted on the RM Cambridge Assessment Support Portal http://www.rm.com/support/ca

3. Log-in to scoris and mark the required number of practice responses (“scripts”) and the required number of standardisation responses.

YOU MUST MARK 10 PRACTICE AND 10 STANDARDISATION RESPONSES BEFORE YOU CAN BE APPROVED TO MARK LIVE SCRIPTS.

MARKING

1. Mark strictly to the mark scheme.

2. Marks awarded must relate directly to the marking criteria.

3. The schedule of dates is very important. It is essential that you meet the scoris 50% and 100% (traditional 50% Batch 1 and 100% Batch 2) deadlines. If you experience problems, you must contact your Team Leader (Supervisor) without delay.

4. If you are in any doubt about applying the mark scheme, consult your Team Leader by telephone, email or via the scoris messaging system.
5. Work crossed out:
   a. where a candidate crosses out an answer and provides an alternative response, the crossed out response is not marked and gains no marks
   b. if a candidate crosses out an answer to a whole question and makes no second attempt, and if the inclusion of the answer does not cause a rubric infringement, the assessor should attempt to mark the crossed out answer and award marks appropriately.

6. Always check the pages (and additional objects if present) at the end of the response in case any answers have been continued there. If the candidate has continued an answer there then add a tick to confirm that the work has been seen.

7. There is a NR (No Response) option. Award NR (No Response)
   - if there is nothing written at all in the answer space
   - OR if there is a comment which does not in any way relate to the question (e.g., ‘can’t do’, ‘don’t know’)
   - OR if there is a mark (e.g., a dash, a question mark) which isn’t an attempt at the question.
   Note: Award 0 marks – for an attempt that earns no credit (including copying out the question).

8. The scoris comments box is used by your Team Leader to explain the marking of the practice responses. Please refer to these comments when checking your practice responses. **Do not use the comments box for any other reason.**
   If you have any questions or comments for your Team Leader, use the phone, the scoris messaging system, or email.

9. Assistant Examiners will send a brief report on the performance of candidates to their Team Leader (Supervisor) via email by the end of the marking period. The report should contain notes on particular strengths displayed as well as common errors or weaknesses. Constructive criticism of the question paper/mark scheme is also appreciated.
10. Annotations

<table>
<thead>
<tr>
<th>Annotation</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>DO NOT ALLOW</td>
<td>Answers which are not worthy of credit</td>
</tr>
<tr>
<td>IGNORE</td>
<td>Statements which are irrelevant</td>
</tr>
<tr>
<td>ALLOW</td>
<td>Answers that can be accepted</td>
</tr>
<tr>
<td>()</td>
<td>Words which are not essential to gain credit</td>
</tr>
<tr>
<td>___</td>
<td>Underlined words must be present in answer to score a mark</td>
</tr>
<tr>
<td>ECF</td>
<td>Error carried forward</td>
</tr>
<tr>
<td>AW</td>
<td>Alternative wording</td>
</tr>
<tr>
<td>ORA</td>
<td>Or reverse argument</td>
</tr>
</tbody>
</table>
11. Subject-specific Marking Instructions

INTRODUCTION

Your first task as an Examiner is to become thoroughly familiar with the material on which the examination depends. This material includes:

- the specification, especially the assessment objectives
- the question paper
- the mark scheme.

You should ensure that you have copies of these materials.

You should ensure also that you are familiar with the administrative procedures related to the marking process. These are set out in the OCR booklet Instructions for Examiners. If you are examining for the first time, please read carefully Appendix 5 Introduction to Script Marking: Notes for New Examiners.

Please ask for help or guidance whenever you need it. Your first point of contact is your Team Leader.
The breakdown of Assessment Objectives for GCSE (9-1) in Biology B:

<table>
<thead>
<tr>
<th>Assessment Objective</th>
<th>AO1</th>
<th>AO1.1</th>
<th>AO1.2</th>
<th>AO2</th>
<th>AO2.1</th>
<th>AO2.2</th>
<th>AO3</th>
<th>AO3.1</th>
<th>AO3.1a</th>
<th>AO3.1b</th>
<th>AO3.2</th>
<th>AO3.2a</th>
<th>AO3.2b</th>
<th>AO3.3</th>
<th>AO3.3a</th>
<th>AO3.3b</th>
</tr>
</thead>
<tbody>
<tr>
<td>AO1</td>
<td>Demonstrate knowledge and understanding of scientific ideas and scientific techniques and procedures.</td>
<td>Demonstrate knowledge and understanding of scientific ideas.</td>
<td>Demonstrate knowledge and understanding of scientific techniques and procedures.</td>
<td>Apply knowledge and understanding of scientific ideas and scientific enquiry, techniques and procedures.</td>
<td>Apply knowledge and understanding of scientific ideas.</td>
<td>Apply knowledge and understanding of scientific enquiry, techniques and procedures.</td>
<td>Analyse information and ideas to interpret and evaluate, make judgements and draw conclusions and develop and improve experimental procedures.</td>
<td>Analyse information and ideas to interpret and evaluate.</td>
<td>Analyse information and ideas to interpret.</td>
<td>Analyse information and ideas to evaluate.</td>
<td>Analyse information and ideas to make judgements and draw conclusions.</td>
<td>Analyse information and ideas to make judgements.</td>
<td>Analyse information and ideas to draw conclusions.</td>
<td>Analyse information and ideas to develop and improve experimental procedures.</td>
<td>Analyse information and ideas to develop experimental procedures.</td>
<td>Analyse information and ideas to improve experimental procedures.</td>
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<tr>
<td>1 (a) (i)</td>
<td>Transports oxygen ✓</td>
<td>1</td>
<td>1.1</td>
<td>ALLOW carries oxygen / carries carbon dioxide / transports carbon dioxide</td>
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<tr>
<td>(ii)</td>
<td>Any three from 1. Sarah has fewer red blood cells than normal ✓ 2. Less oxygen transported ✓ 3. So less ATP produced ✓ 4. As less respiration ✓</td>
<td>3</td>
<td>2.1</td>
<td>MP3 DO NOT ALLOW less energy produced</td>
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<td>(iii)</td>
<td>$\frac{136}{90} = 1.5 : 1$ ✓</td>
<td>1</td>
<td>2.2</td>
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<tr>
<td>(iv)</td>
<td>Increases rate of diffusion of oxygen into cell ✓</td>
<td>1</td>
<td>1.1</td>
<td></td>
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<tr>
<td>(v)</td>
<td>A (chemical) messenger ✓</td>
<td>1</td>
<td>1.1</td>
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<tr>
<td>(b) (i)</td>
<td>Any one from Descriptions 1. Person B sugar level falls faster / person A sugar level falls more slowly ✓ 2. Person B sugar level falls back to starting level after just over 2 hours / Person A sugar level remains high ✓ Any one from Reasons why 3. Person A does not respond to the hormone / insulin produced to convert sugar to glycogen ✓ 4. Person B produces a hormone / insulin in response to the rise in blood sugar and this causes cells to convert the sugar to glycogen so the level falls ✓</td>
<td>2</td>
<td>3.1a</td>
<td>Max 1 for description and max 1 for the reason why</td>
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2.1 MPs 3 and 4 DO NOT ALLOW a reference to hormone response or lack of response without reference to the role of insulin.
<table>
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<tbody>
<tr>
<td>(ii)</td>
<td>Type 1 diabetes</td>
<td>2</td>
<td>1.1</td>
<td>If more than 2 lines are drawn, delete one mark for each incorrect line</td>
</tr>
</tbody>
</table>

- body no longer responds to the insulin produced
- should eat a diet high in complex carbohydrates and exercise
- will need to inject insulin
- pancreas stops producing insulin
<table>
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<tbody>
<tr>
<td>2 (a)</td>
<td>Any three from Use a line transect AND quadrat Running from the sea up the shore To take many samples Repeat at different parts of the shore</td>
<td>3</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>(b) (i)</td>
<td>8 ✓</td>
<td>1</td>
<td>3.1a</td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td>FIRST CHECK THE ANSWER ON THE ANSWER LINE IF answer = 47 award 2 marks (45 + 47 + 49) / 3 ✓ 47 ✓</td>
<td>2</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>limpets will decrease in numbers ✓ as more are eaten ✓ OR crabs will increase ✓ as more food ✓</td>
<td>2</td>
<td>3.1a 2.1</td>
<td>ALLOW any correct species with correct explanation</td>
</tr>
<tr>
<td>(d)</td>
<td>Any two from idea of interdependence ✓ example of interdependence e.g. food / shelter / reproduction ✓ maintaining genetic diversity ✓ may be required in the future for medicines ✓ maintains the stability of the food web ✓</td>
<td>2</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>(e)</td>
<td>Advantage: (can be) fast / no need to find a mate ✓ Disadvantage: lack of genetic diversity / are all genetically identical ✓</td>
<td>2</td>
<td>1.1</td>
<td>MP2 ALLOW are clones DO NOT ALLOW are all identical</td>
</tr>
<tr>
<td>(f) (i)</td>
<td>✓ Enzymes will become denatured</td>
<td>1</td>
<td>2.1</td>
<td>If more than one box is ticked, do not award the mark even if the correct box is also ticked</td>
</tr>
<tr>
<td>(ii)</td>
<td>✓ Some cells may burst</td>
<td>1</td>
<td>2.1</td>
<td>If more than one box is ticked, do not award the mark even if the correct box is also ticked</td>
</tr>
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| 3 (a)    | ✓ DNA is made from four different nucleotides  
                       ✓ DNA is a polymer                                             | 2     | 1.1        | If more than two boxes are ticked, do not award the mark even if the correct box is also ticked |
|          |                                                                        |       |            |                                               |
| (b)      | Correct sequence of amino acids – leu, glu, tyr, thr ✓               | 1     | 2.1        | ALLOW leucine, glutamine, tyrosine, threonine                                               |
|          |                                                                        |       |            |                                               |
| (c)      | **Any four from**  
                       Mutation is a substitution ✓  
                       Result could be no change / new triplet might still code for same amino acid ✓  
                       Result might be that the new triplet code for a different amino acid ✓  
                       This might cause the protein not to function correctly / not to form ✓  
                       Might affect a characteristic / the phenotype ✓ | 4     | 2.1        |                                               |
<table>
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<tr>
<td>4 (a) (i)</td>
<td>FIRST CHECK THE ANSWER ON THE ANSWER LINE IF answer = 177.63 award 2 marks</td>
<td>2</td>
<td>1.2</td>
<td></td>
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<tr>
<td></td>
<td>$\pi (7.5 \times 7.5) \checkmark$</td>
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<tr>
<td></td>
<td>$177.63 \text{ mm}^2 \checkmark$</td>
<td></td>
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<tr>
<td>(ii)</td>
<td>✓ Antibiotic B has the least effect. Jack should not be given antibiotic B</td>
<td>1</td>
<td>3.2b</td>
<td></td>
</tr>
<tr>
<td>(iii)</td>
<td>Any one from</td>
<td>1</td>
<td>3.3a</td>
<td></td>
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<tr>
<td></td>
<td>Used as a comparison ✓</td>
<td></td>
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<tr>
<td></td>
<td>To show that it is the antibiotic that has the effect ✓</td>
<td></td>
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<tr>
<td>(b)</td>
<td>Technique Working under flame ✓</td>
<td>2</td>
<td>1.2</td>
<td>ALLOW any correct technique</td>
</tr>
<tr>
<td></td>
<td>Use of alcohol / flame ✓</td>
<td></td>
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<td></td>
<td>For explanation Prevents other bacteria colonising agar plate ✓</td>
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<td></td>
<td>Kills other microorganisms ✓</td>
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<td></td>
<td>DO NOT ALLOW two techniques for 2 marks</td>
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<tr>
<td>5 (a)</td>
<td>C ✓</td>
<td>1</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>✓ FSH</td>
<td>1</td>
<td>1.1</td>
<td></td>
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<tr>
<td>(c) (i)</td>
<td>Antigen is injected into the animal ✓ &lt;br&gt;The antibody producing cells are taken from the animal ✓ &lt;br&gt;The cells producing the correct antibody are then selected and cultured ✓</td>
<td>3</td>
<td>1.1</td>
<td>All three stages needed for three marks</td>
</tr>
<tr>
<td>(ii)</td>
<td>D B A C</td>
<td>1</td>
<td>1.1</td>
<td></td>
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<tr>
<td>6 (a) (i)</td>
<td>✓ C</td>
<td>1</td>
<td>1.1</td>
<td></td>
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</table>
| (ii) | Blood vessel X – vein ✓  
Blood vessel Y – artery ✓  
Blood vessel Z – capillary ✓ | 3 | 1.1 | |
| (b) (i) | As the percentage of fat in the diet increases, the greater the risk of dying from heart disease ✓ | 1 | 3.2b | |
| (ii) | **Any two from**  
Reduce amount of fat in diet ✓  
Reduce stress ✓  
Stop smoking ✓  
Take (regular) exercise ✓ | 2 | 3.1b | ALLOW reduce cholesterol/salt |
| (c) (i) | Correct Punnet square ✓  

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<tr>
<th></th>
<th>X&lt;sup&gt;H&lt;/sup&gt;</th>
<th>X&lt;sup&gt;h&lt;/sup&gt;</th>
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<td>X&lt;sup&gt;H&lt;/sup&gt;</td>
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<td>X&lt;sup&gt;h&lt;/sup&gt;X&lt;sup&gt;h&lt;/sup&gt;</td>
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<tr>
<td>Y</td>
<td>X&lt;sup&gt;H&lt;/sup&gt;Y</td>
<td>X&lt;sup&gt;h&lt;/sup&gt;Y</td>
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</table>

Probability 25% / ¼ / 1 in 4 ✓ | 2 | 1.2 | |
<p>| (ii) | X&lt;sup&gt;H&lt;/sup&gt;X&lt;sup&gt;h&lt;/sup&gt; ✓ | 1 | 2.1 | |</p>
<table>
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<tr>
<td>7 (a) (i)</td>
<td>Cornea – responsible for bending the light ✓ Light rays will no longer meet on the retina so sight will be poor ✓</td>
<td>2</td>
<td>1.1 2.1</td>
<td>ALLOW reference to blindness</td>
</tr>
<tr>
<td>(ii)</td>
<td>An unspecialised cell which can become any cell type ✓</td>
<td>1</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>(iii)</td>
<td>Any one from Embryos killed in the process ✓ Embryos could be a life ✓</td>
<td>1</td>
<td>2.1</td>
<td></td>
</tr>
<tr>
<td>(b)</td>
<td>FIRST CHECK THE ANSWER ON THE ANSWER LINE IF Answer = 27.42 award 2 marks (\frac{141}{360} \times 70 ✓) 27.42 (minutes) ✓</td>
<td>2</td>
<td>2.2</td>
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<tr>
<td>8 (a) (i)</td>
<td><strong>FIRST CHECK THE ANSWER ON THE ANSWER LINE IF answer = 0.23 award 2 marks</strong></td>
<td>2</td>
<td>1.2</td>
<td><strong>ALLOW</strong> 1 mark for 7 / 30</td>
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<td></td>
<td>7 / 30 ✓ 0.23 ✓</td>
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<td>(ii)</td>
<td>Measure the rate of water uptake with a fan running on the shoot ✓</td>
<td>1</td>
<td>3.3a</td>
<td><strong>DO NOT ALLOW</strong> 'place plant/apparatus outside'</td>
</tr>
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</table>
| (iii)    | **Any two from**  
1. Water may be lost from parts of the equipment that are not sealed ✓  
2. Some water is used for photosynthesis ✓  
3. If the plant is wilting, the plant will use water to restore turgidity ✓ | 2     | 1.2        | **DO NOT ALLOW** incorrect use of water e.g. respiration                                                                                                                                           |
|          |                                                                                                                                                                                                                                   |       | 1.1        |                                                                                                                                                                                                        |
| (b)      | **Any two from**  
Potassium ions (reduce the water potential) increase the concentration in the guard cells ✓  
So water moves into the cell ✓  
By osmosis ✓  
Guard cells become turgid ✓ | 2     | 1.1        |                                                                                                                                                                                                        |
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<tr>
<td>9 (a)</td>
<td>Able to grow in colder conditions / less likely to be damaged by cold conditions ✓</td>
<td>1</td>
<td>2.1</td>
<td>DO NOT ALLOW reference to freezing tomatoes</td>
</tr>
</tbody>
</table>
| (b) (i)  | **Any three from:**
|          | Isolate the gene for human growth hormone ✓
|          | Put the gene into a vector / plasmid ✓
|          | Use the vector to put the (human growth hormone) gene into *E.coli* bacteria ✓
<p>|          | Grow bacteria / separate the hormone ✓ | 3 | 2.1 |</p>
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<tbody>
<tr>
<td>10 (a)</td>
<td>(i) Antigen ✓</td>
<td>1</td>
<td>1.1</td>
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<tr>
<td></td>
<td>(ii) Antibody ✓</td>
<td>1</td>
<td>1.1</td>
<td></td>
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<td></td>
<td>(iii) Whole cell could cause disease ✓</td>
<td>1</td>
<td>2.1</td>
<td></td>
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<tr>
<td></td>
<td>(b) Preclinical tests</td>
<td>2</td>
<td>1.1</td>
<td>Tick in correct box for mark if more than one box is ticked in each empty row, do not award the mark even if the correct box is also ticked.</td>
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<tr>
<td></td>
<td>Cultured human cells</td>
<td>✓</td>
<td></td>
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<tr>
<td></td>
<td>Whole animals</td>
<td>✓</td>
<td></td>
<td></td>
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<td></td>
<td>Clinical tests</td>
<td>Safety Effectiveness Both</td>
<td></td>
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<tr>
<td></td>
<td>Healthy volunteers</td>
<td>✓</td>
<td></td>
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<td></td>
<td>Humans with the disease</td>
<td></td>
<td>✓</td>
<td></td>
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<td>Question</td>
<td>Answer</td>
<td>Marks</td>
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<tr>
<td>11 (a)</td>
<td>A pairs with T or A pairs with C ✓&lt;br&gt;G pairs with T or G pairs with C ✓</td>
<td>2</td>
<td>3.2b</td>
<td>DO NOT ALLOW A pairs with T or G pairs with C alone</td>
</tr>
<tr>
<td>(b)</td>
<td>Triplet ✓&lt;br&gt;Order / sequence ✓&lt;br&gt;Classification ✓</td>
<td>3</td>
<td>1.1</td>
<td></td>
</tr>
<tr>
<td>(c)</td>
<td>Whales ✓&lt;br&gt;As they are closer to them on the tree ✓</td>
<td>2</td>
<td>2.1</td>
<td></td>
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<tr>
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<tr>
<td>12 (a)</td>
<td>Would have biggest bar at bottom, then next biggest with smallest at top ✓</td>
<td>1</td>
<td>2.1</td>
<td>DO NOT ALLOW if bars are not labelled</td>
</tr>
<tr>
<td>(b) (i)</td>
<td>(4 / 600) x 100 = 0.67% ✓</td>
<td>1</td>
<td>2.2</td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td>Any one from Not all of the biomass is eaten e.g. roots ✓ Biomass is used in respiration (by other organisms) ✓ Biomass is egested (by slugs/ thrush) ✓</td>
<td>1</td>
<td>2.1</td>
<td>DO NOT ALLOW biomass egested by grass</td>
</tr>
<tr>
<td>(c) (i)</td>
<td>Any two from Activity starts to rise in spring ✓ Activity is at its peak in the summer months ✓ Activity falls in autumn ✓ Activity is low in the winter ✓</td>
<td>2</td>
<td>3.1a</td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td>Any two from (Rise in spring) as more water is available ✓ (peak in summer) as this is when it is warmer / when the temperature is higher ✓ (Fall / low in autumn / winter) as this is when it is colder / when the temperature is lower ✓ Idea of a link between more enzyme activity and more decomposer activity ✓</td>
<td>2</td>
<td>1.1</td>
<td></td>
</tr>
</tbody>
</table>