Please check the examination details below before entering your candidate information

| Candidate surname | Other names |
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Centre Number | Candidate Number

# Pearson Edexcel Level 3 GCE

**Time** 2 hours

**Paper reference** **9BN0/03**

# Biology A (Salters Nuffield)

## Advanced

## PAPER 3: General and Practical Applications in Biology

**You must have:**
Ruler, HB pencil and scientific calculator and a copy of the scientific article adapted from *Scientific American* (enclosed)

Total Marks

## Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- **Show all your working out** in calculations and **include units** where appropriate.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

## Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- You may use a scientific calculator.
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

## Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over* ▶

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Q:1/1/1/1/1/1/

P 6 7 0 9 2 R A 0 1 2 8

Pearson

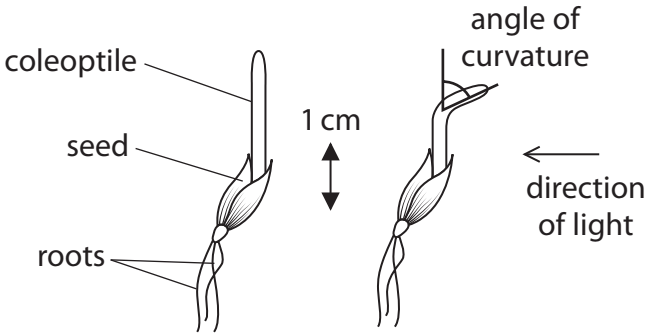
**Answer ALL questions.**

**Write your answers in the spaces provided.**

**1** When oat seeds germinate, they produce roots and a coleoptile.

(a) The effect of shading the tip of the coleoptile was investigated.

The diagram shows how the coleoptile of an oat seedling can bend towards light.



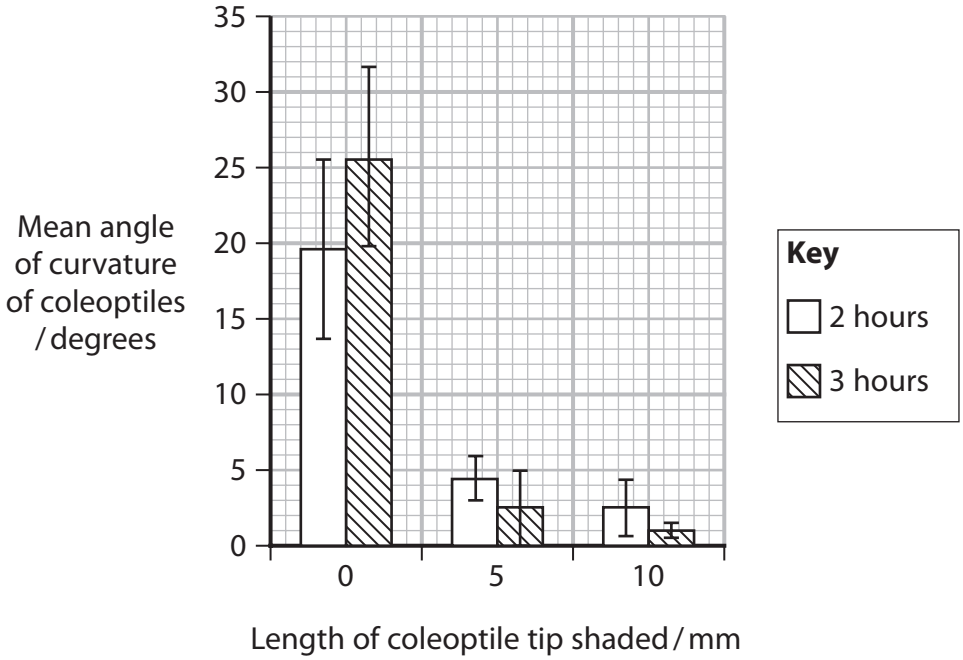

Oat seeds were germinated. When the coleoptiles were 2 cm long the seedlings were split into three groups.

- Group 1 none of the tip of the coleoptile was shaded
- Group 2 5 mm at the tip of the coleoptile was shaded
- Group 3 10 mm at the tip of the coleoptile was shaded

All the coleoptiles were then exposed to light from one side.

The curvature of the coleoptiles was measured after intervals of 2 hours and 3 hours.

The results of this investigation are shown in the graph.



(i) Describe two conclusions that can be drawn from the results of this investigation.

**(2)**

(ii) The results of this investigation were analysed using the Student's t-test.

A p value of 0.05 was used to interpret the results of the t-test.

Explain what a p value of 0.05 means.

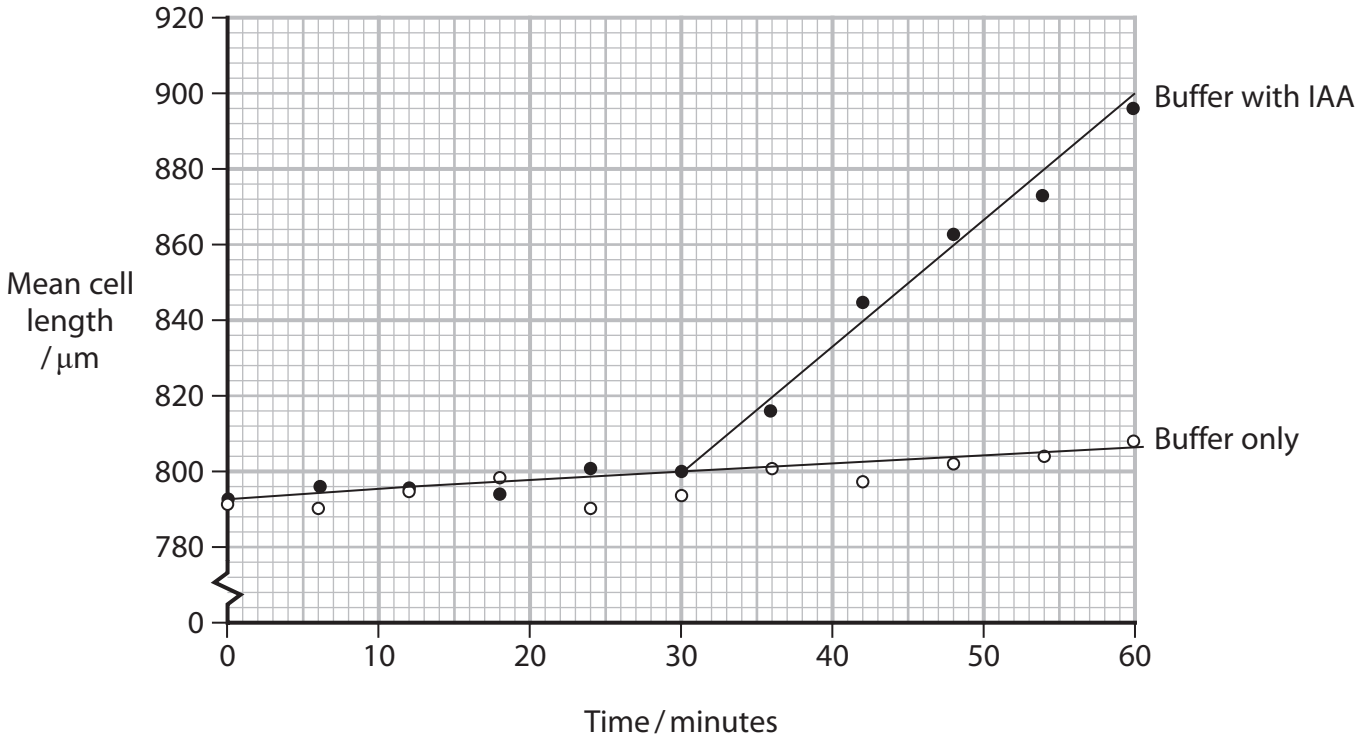
**(2)**

(b) In a second investigation, cells were taken from below the tip of the coleoptile.

These cells were soaked in buffer alone or buffer containing IAA (auxin), for a period of 60 minutes.

The lengths of the cells were measured every six minutes.

The results of this investigation are shown in the graph.



(i) Give one abiotic factor, other than pH, that would need to be controlled in this investigation.

**(1)**

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(ii) Calculate the difference in the rates of change in cell length from 30 to 60 minutes, in the presence of IAA and in the absence of IAA.

**(2)**

Answer .....

(c) Explain how the evidence from these investigations indicates that plant hormones are involved in the phototropic response of oat coleoptiles.

**(3)**

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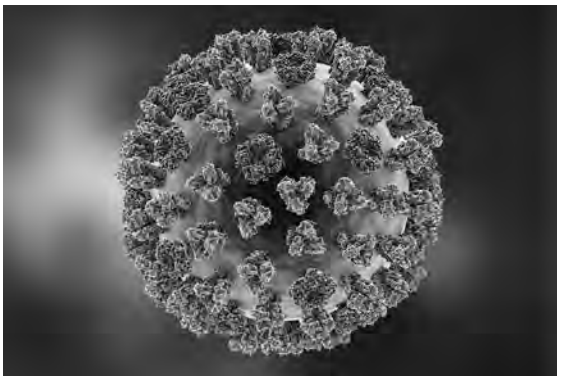
**(Total for Question 1 = 10 marks)**

**2** The diagram shows an RNA virus that causes influenza.



(Source: © Kateryna Kon/Shutterstock)

(a) Influenza cannot be treated with antibiotics.

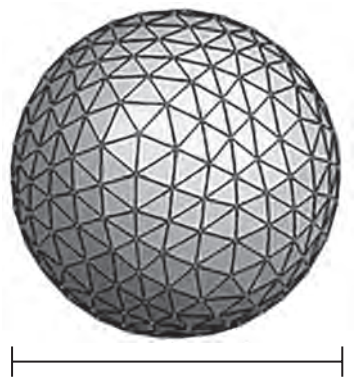
Explain why antibiotics cannot be used to treat influenza.

**(2)**

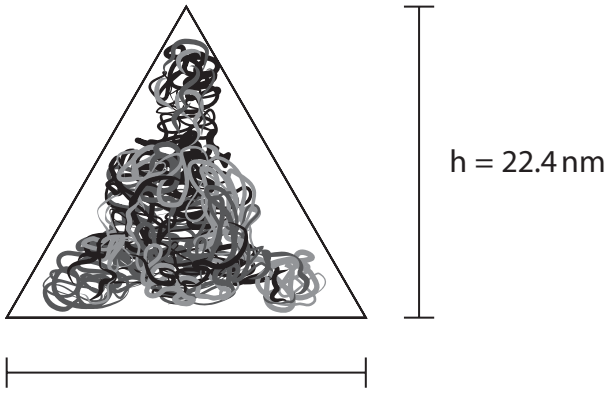
(b) The surface of this virus capsid is covered with 'spike' proteins.

The diameter of the capsid of this virus is 240 nm.

Diagram of the surface of the virus showing each spike protein as a triangle




The diagram shows the area occupied by one spike protein




Calculate the maximum number of spike proteins that can be packed on the surface of one virus particle.

The formula for calculating the surface area of a sphere is $4\pi r^2$

The formula for calculating the area of a triangle is $\frac{h \times b}{2}$

**(3)**

Answer .....

(c) Changes in the RNA of influenza produce new strains of the virus with an altered spike protein.

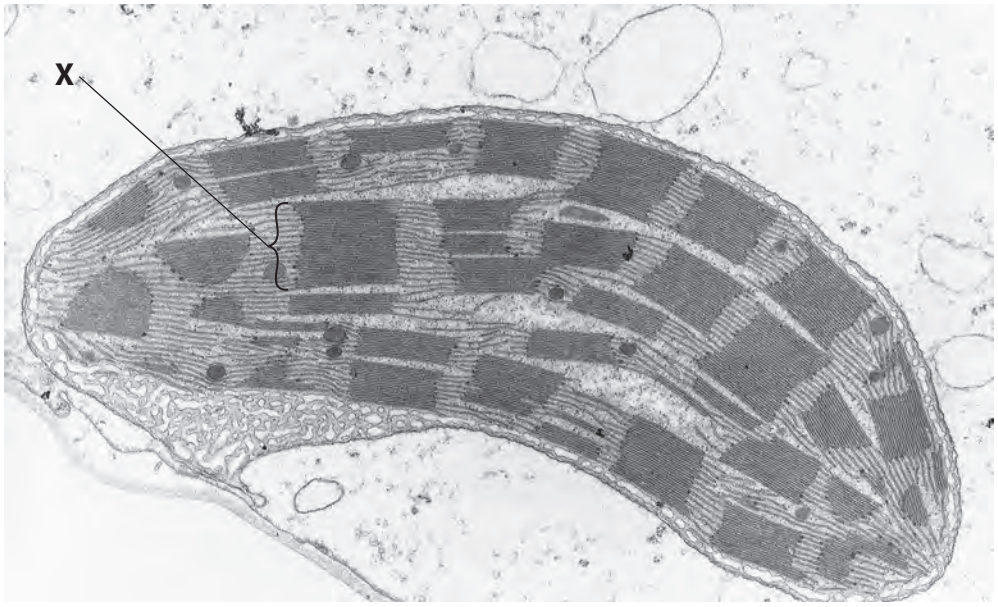
Devise a procedure to determine the similarity of the strains of influenza in saliva samples collected from different people.

**(4)**

**(Total for Question 2 = 9 marks)**

**3** Eukaryotic cells contain membrane-bound organelles.

(a) The photograph, obtained using an electron microscope, shows an organelle.




(Source: © Science History Images/Alamy Stock Photo)

(i) Label a part of this organelle where carbon fixation occurs.

**(1)**

(ii) Give the name of the component labelled X.

**(1)**

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(iii) Describe how the structure of a membrane in the part labelled X is related to its function.

**(3)**

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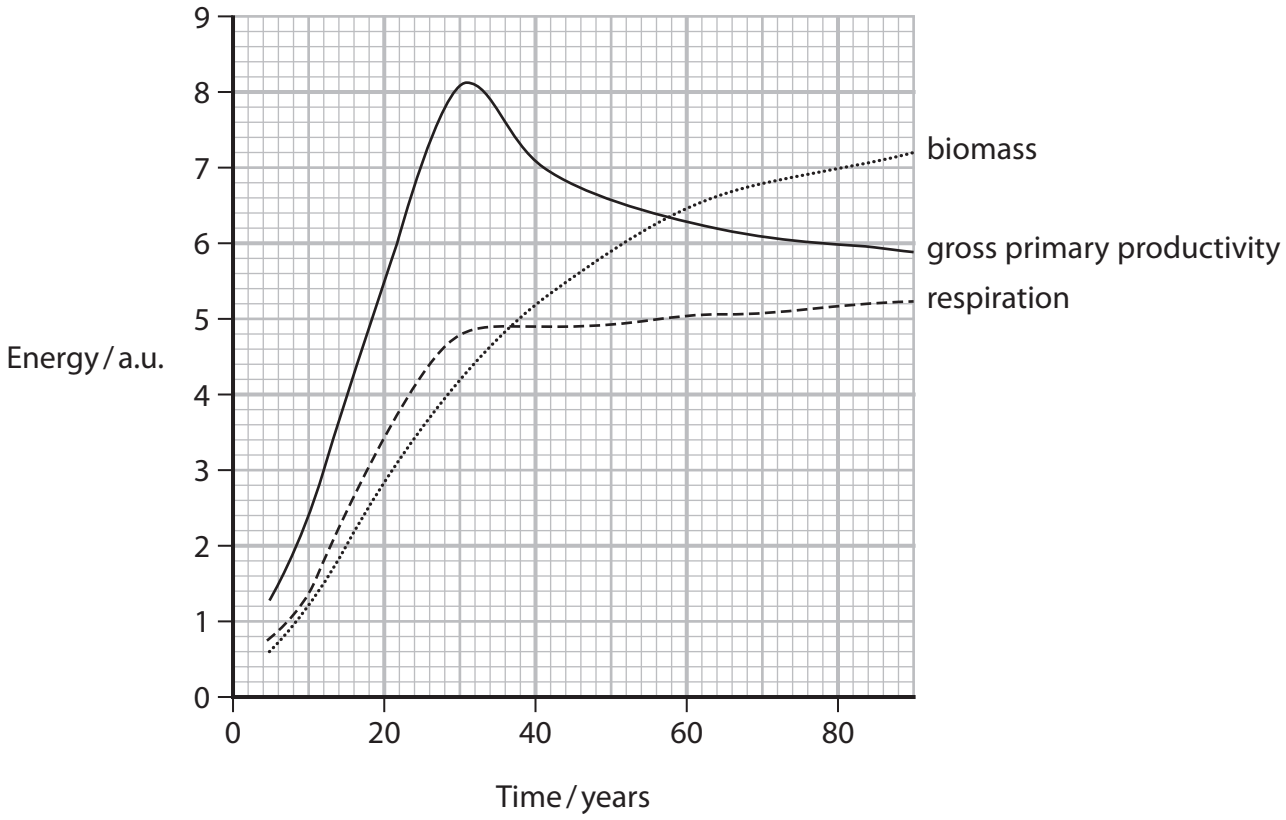
(iv) Describe how GP is produced by carbon fixation in this organelle.

**(2)**

(b) The graph shows the changes in biomass, gross primary productivity and the energy used in respiration during succession from grassland to mature forest.




(i) Add shading to the graph to show the area that represents net primary productivity.

**(1)**

(ii) Describe what is meant by the term succession.

**(2)**

(iii) Deduce the effect of succession on the level of carbon dioxide in the atmosphere.

**(3)**

**(Total for Question 3 = 13 marks)**

**4** The photograph shows a plant called lantana (*Lantana camara*).

(Source: © Peter Vrabel/Alamy Stock Photo)

The leaves of lantana contain chemicals known to have antimicrobial properties.

The antimicrobial activity of lantana leaf extracts prepared using three different solvents, A, B and C, was compared.

Fresh lantana leaves were dried and powdered. The dried leaf material was mixed with the solvent and then the extract was purified and dried.

The mass of extract obtained from 5 g of powdered leaf, using each solvent, was measured.

| Solvent used | Mean mass of extract ± SD / μg |
|---|---|
| A | 501.3 ± 3.5 |
| B | 721.3 ± 1.5 |
| C | 245.6 ± 4.0 |

(a) The mass of dried and powdered lantana leaves is 10.5% of the mass of fresh leaves.

Calculate the mass of fresh leaves needed to produce 1 mg of extract using solvent A.

Give your answer to three significant figures.

**(2)**

..... g

(b) The antimicrobial properties of the extracts produced using these solvents are shown in the table.

| Solvent used to prepare extract | Dry mass of extract / μg | Bacteria tested | |
|---|---|---|---|
| | | *Klebsiella pneumoniae* (Gram negative) | *Micrococcus luteus* (Gram positive) |
| | | Mean diameter of the zone of inhibition / mm | |
| A | 5.0 | 8.3 | 7.1 |
| | 10.0 | 10.5 | 7.0 |
| B | 5.0 | 14.5 | 12.2 |
| | 10.0 | 18.1 | 18.0 |

(i) Deduce the effect of using different solvents on the effectiveness of the extracts against these two bacteria.

**(2)**

(ii) Devise a method that could be used to collect the data in the table.

**(4)**

**(Total for Question 4 = 8 marks)**

**5** Habituation is a learning response observed in many types of animal.

(a) Explain the importance of the habituation response in an animal.

**(2)**

(b) The 'light-off jump' assay can be used to study habituation in fruit flies.

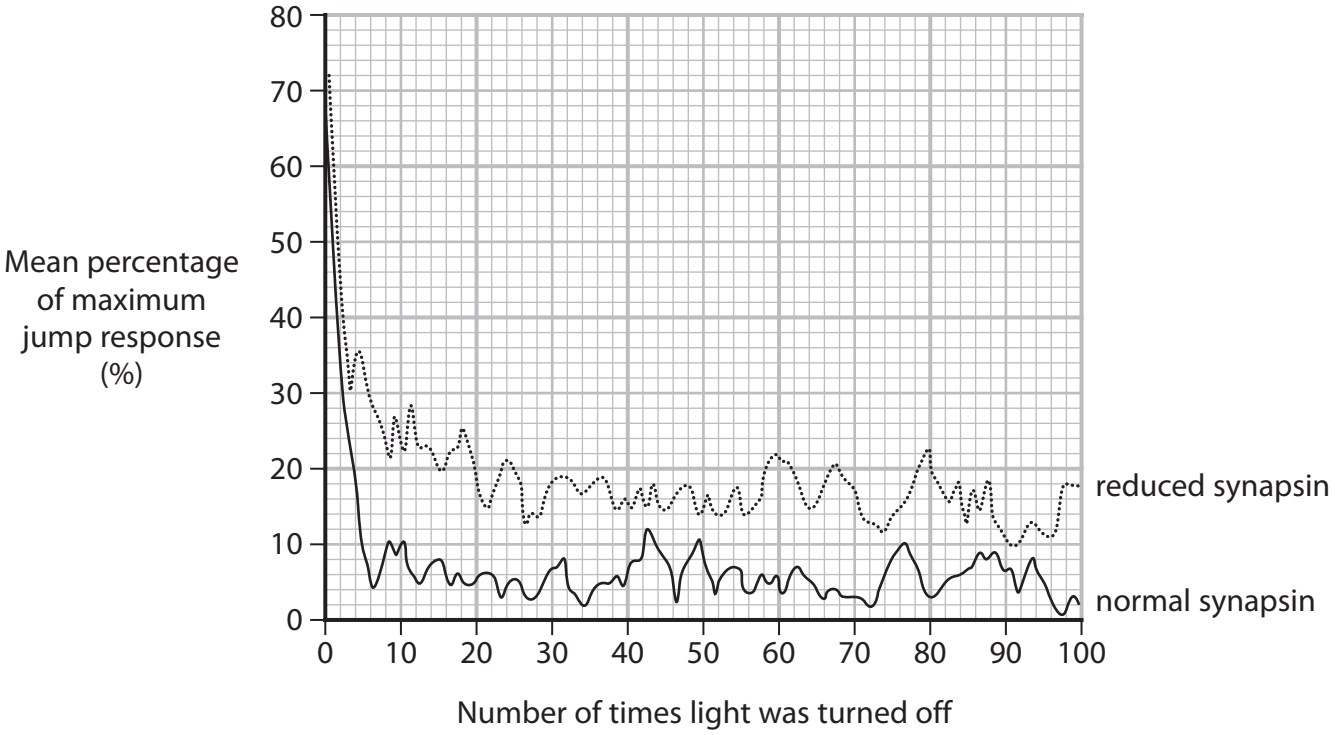
When the light is turned off the flies jump into the air and attempt to fly away.

The strength of this response can be measured by recording the noise made by the flies.

In one experiment, fruit flies with reduced expression of a protein called synapsin were compared with a control group.

Synapsin is a protein that inhibits the binding of presynaptic vesicles to the cell membrane.

The results of this experiment are shown in the graph.



(i) State two variables associated with the light-off stimulus that need to be controlled in this experiment.

**(2)**

(ii) Determine the effect of reduced synapsin on the habituation of fruit flies in this experiment.

**(3)**

(iii) Explain how reduced expression of synapsin could produce these results.

**(3)**

(c) Scientists are using fruit fly habituation to investigate the role of genes associated with human autism spectrum disorders (ASD).

Before they can do this, the scientists first identify genes linked to human ASD.

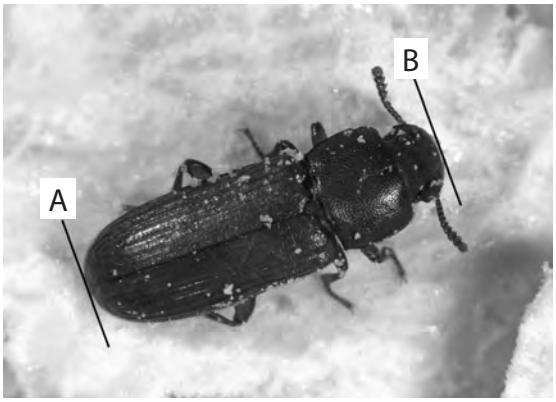
Describe how genes linked to human ASD could be identified.

**(2)**

**(Total for Question 5 = 12 marks)**

**6** The red flour beetle (*Tribolium castaneum*) is a food pest found in flour.

The photograph shows a red flour beetle.




(Source: © Nigel Cattlin/Alamy Stock Photo)

magnification ×15

(a) Calculate the length of the red flour beetle between A and B.

**(1)**

..... mm

(b) The main food source for adult red flour beetles is starch.

Red flour beetles lay eggs that contain all the nutrients required for the development of the embryo.

The main food source in the eggs is glycogen.

Describe how starch can be used to make glycogen.

**(3)**

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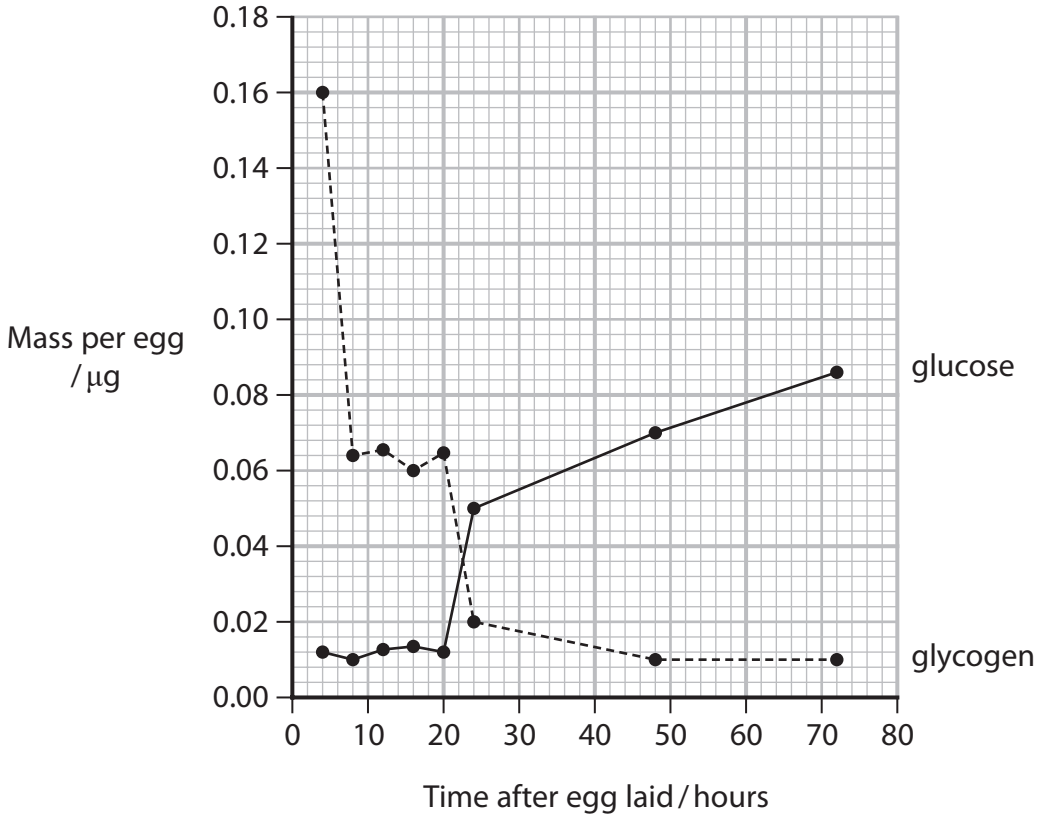
(c) The graph shows the changes in mass of glucose and glycogen in the eggs of the red flour beetle during embryo development.




(i) Calculate the percentage of glycogen used from 4 to 8 hours after the eggs were laid.

**(2)**

.....%

(ii) A student suggested that between 20 and 24 hours the cells in the developing embryo switched from anaerobic to aerobic respiration.

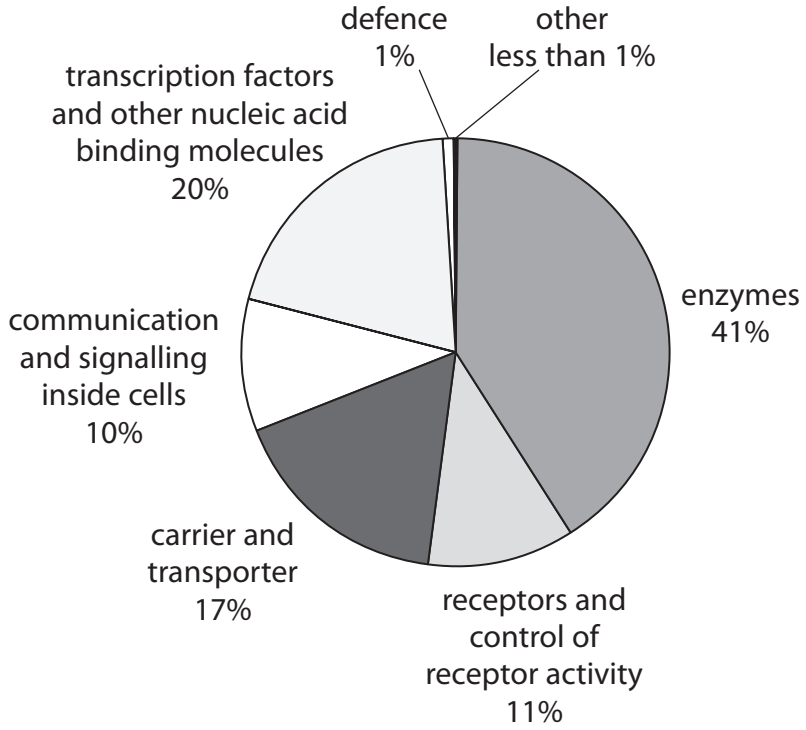
Describe how a respirometer could be used to test this suggestion.

**(3)**

**(Total for Question 6 = 9 marks)**

***7** The human genome codes for approximately 20 000 different proteins.

The pie chart shows the proportion of proteins carrying out different functions.




The 20 amino acids used to make proteins can be classified according to the properties of their side chains (R groups).

Table 1 shows the number of amino acids with these properties.

| Property of the side chain group | Number of amino acids with the property |
|---|---|
| Non-polar | 9 |
| Polar, uncharged | 6 |
| Negatively charged | 3 |
| Positively charged | 2 |

**Table 1**

Table 2 shows three amino acids, used to synthesise proteins, that have unique properties.

| Amino acid | Comment on structure |
|---|---|
| Cysteine | The side chain contains a thiol group (-S-H) that is chemically reactive. |
| Glycine | The side chain is a hydrogen atom which is much smaller than any other side chain. This allows tight coiling of polypeptide chains. |
| Proline | The side chain forms a peptide bond with the nitrogen in the amino group. This makes a polypeptide chain more rigid. |

**Table 2**

Discuss the importance of the amino acid side chain to the structure, function and location of proteins.

**(9)**

**(Total for Question 7 = 9 marks)**

**8** The scientific article you have studied is adapted from *Scientific American*.

Use the information from the scientific article and your own knowledge to answer the following questions.

(a) Explain why natural selection took place in Darwin's Galapagos finches (paragraph 3).

**(3)**

(b) Explain how inflammation and the immune response can cause damage to tissues (paragraph 4).

**(3)**

(c) Describe how tumour shrinkage could be observed (paragraph 6).

**(2)**

(d) "Why is aging, smoking or radiation exposure associated with cancer?" (paragraph 8).

Explain why "These things cause mutations".

**(3)**

(e) Explain why a cancer cell needs to 'use the resources of the tissue immediately around it' (paragraph 12).

**(2)**

(f) Explain how 'a cancer-causing mutation' could increase the rate of division in stem cells (paragraph 14).

**(3)**

(g) Describe how a cell that is 'a key player in the body's immune system' differs from a stem cell (paragraph 14).

**(4)**

(h) Describe how the effects of 'competitive release' could be demonstrated (paragraphs 18 and 19).

**(4)**

(i) Describe how evasion mechanisms can enable pathogens to become drug-resistant (paragraph 20).

**(2)**

(j) Discuss the ethical issues relating to the use of mice in experiments such as those described in the article (paragraph 25).

**(4)**

**(Total for Question 8 = 30 marks)**

**TOTAL FOR PAPER = 100 MARKS**