OCR
Oxford Cambridge and RSA

# AS Level Biology A

## H020/02 Depth in biology

## Tuesday 7 June 2016 – Afternoon

### Time allowed: 1 hour 30 minutes

**You must have:**
- the Insert (inserted)

**You may use:**
- a scientific calculator
- a ruler (cm/mm)

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

**INSTRUCTIONS**
- Use black ink. You may use an HB pencil for graphs and diagrams.
- 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, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

**INFORMATION**
- The total mark for this paper is **70**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **24** pages.

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Answer **all** the questions.

**1** **(a)** Fig. 1.1 is a diagram that represents inspiration and expiration in a human.

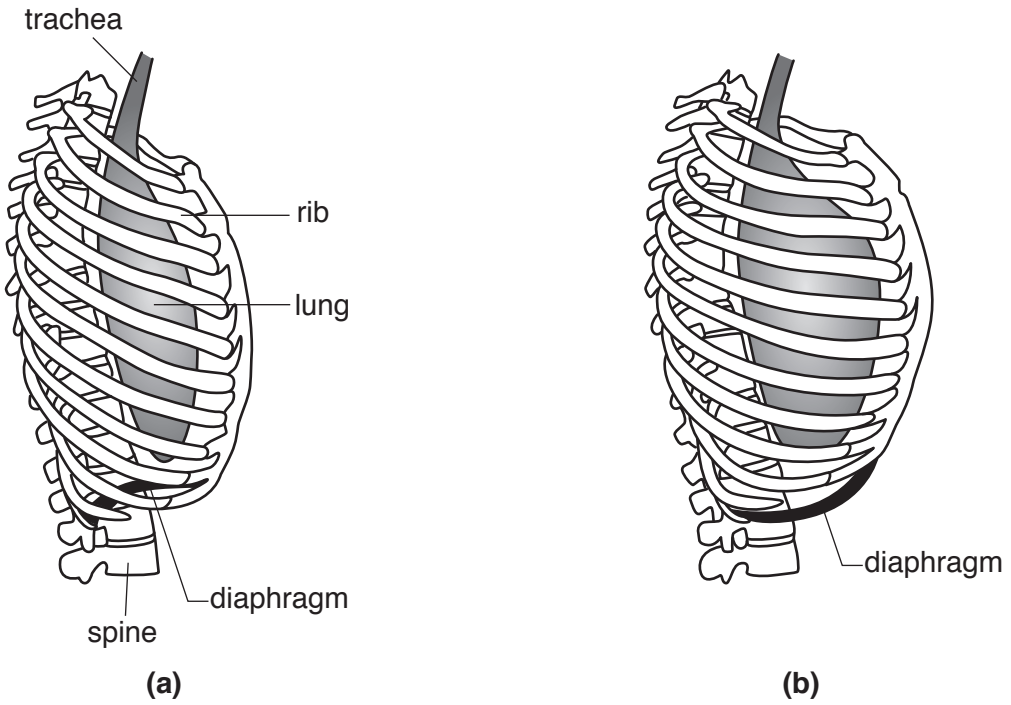



**Fig. 1.1**

**(i)** Which of the two diagrams, **(a)** or **(b)**, represents the body **immediately after** expiration?

Describe how this diagram justifies your choice.

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

**(ii)** Why can expiration be a passive process?

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

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**(iii)** Some chemicals can act as allergens. If these allergens are inhaled, they can cause breathing problems. Allergens cause the smooth muscle in the walls of the airways to contract.

Suggest the effects that this muscle contraction has on ventilation.

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

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**(b)** Fig. 1.2 represents the volume changes in the lung of a human.

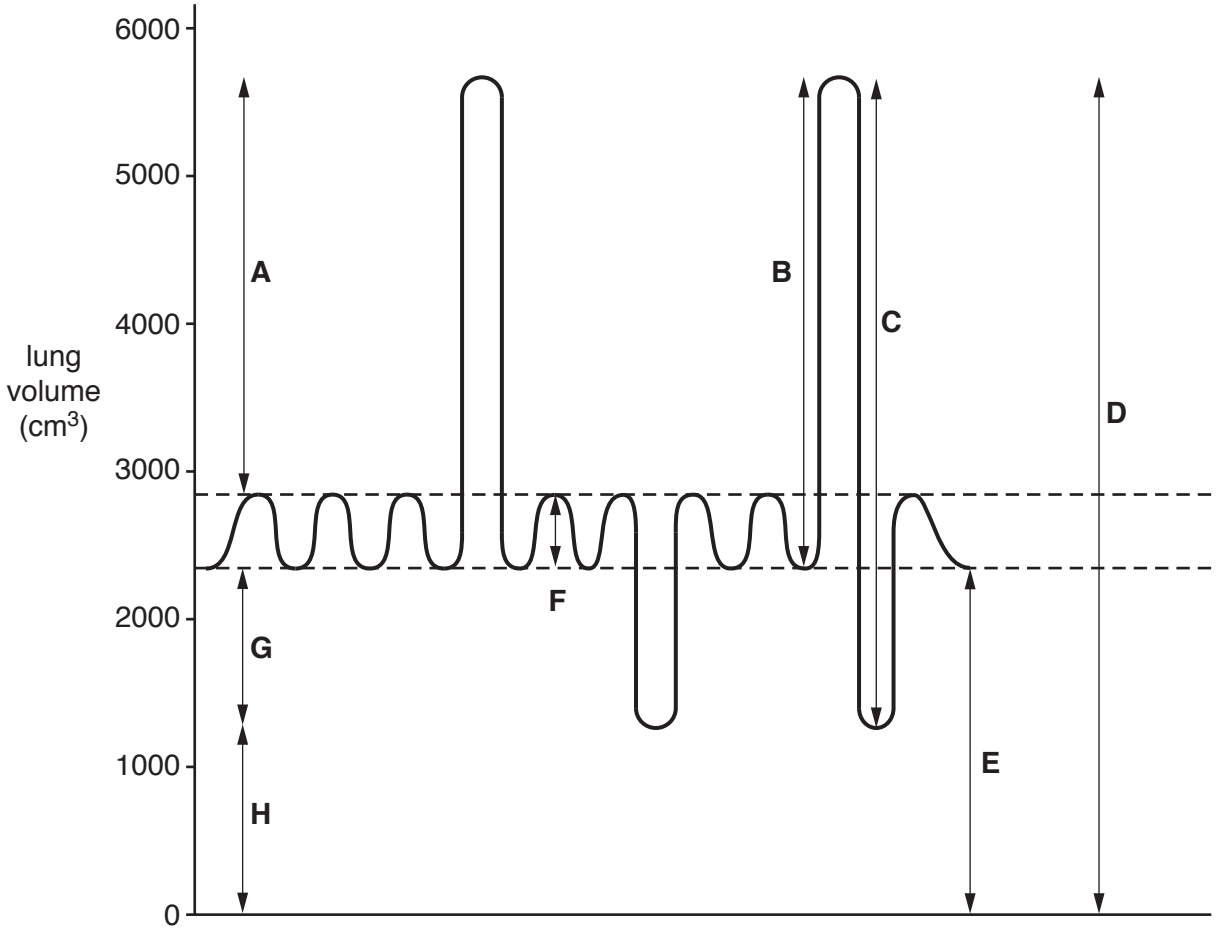



**Fig. 1.2**

**(i)** Select the letter, **A** to **H**, that corresponds to each of the following lung volumes.

The first one has been done for you.

| Lung volume | Letter |
|---|---|
| Inspiratory reserve volume | *A* |
| Residual volume | |
| Total lung capacity | |
| Tidal volume | |
| Vital capacity | |

**[4]**

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**(ii)** Volume **C** can be measured using an instrument such as a spirometer.

What **breathing** instructions would be given to a person whose volume **C** was being measured?

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

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**2** **(a)** Mitosis and meiosis play an important role in the life cycles of organisms.

Fig. 2.1 and Fig. 2.2 represent an outline of the life cycles of two different organisms.

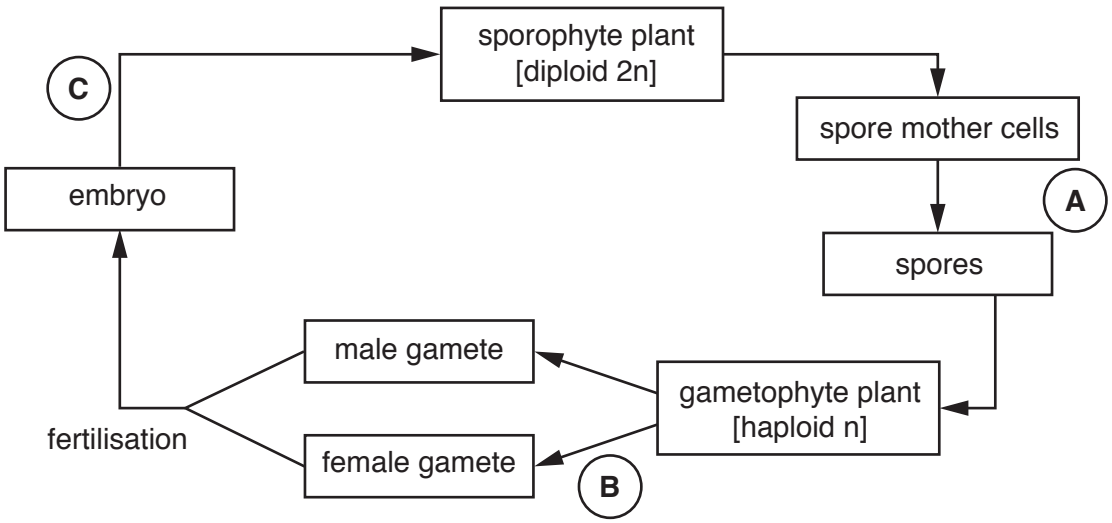



**Fig. 2.1**

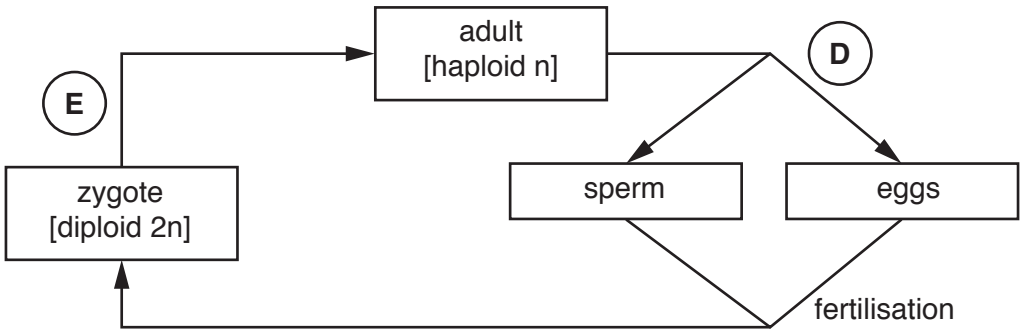



**Fig. 2.2**

Place a tick (✓) in each row of the table to indicate the type of nuclear division that occurs at each of the letters **A** to **E**.

| | **Mitosis** | **Meiosis** |
|---|---|---|
| **A** | | |
| **B** | | |
| **C** | | |

| | **Mitosis** | **Meiosis** |
|---|---|---|
| **D** | | |
| **E** | | |

**[3]**

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**(b)** Fig. 2.3 is a diagram that represents the different phases of the cell cycle.

**X**, **Y** and **Z** represent checkpoints in the control of the cell cycle.

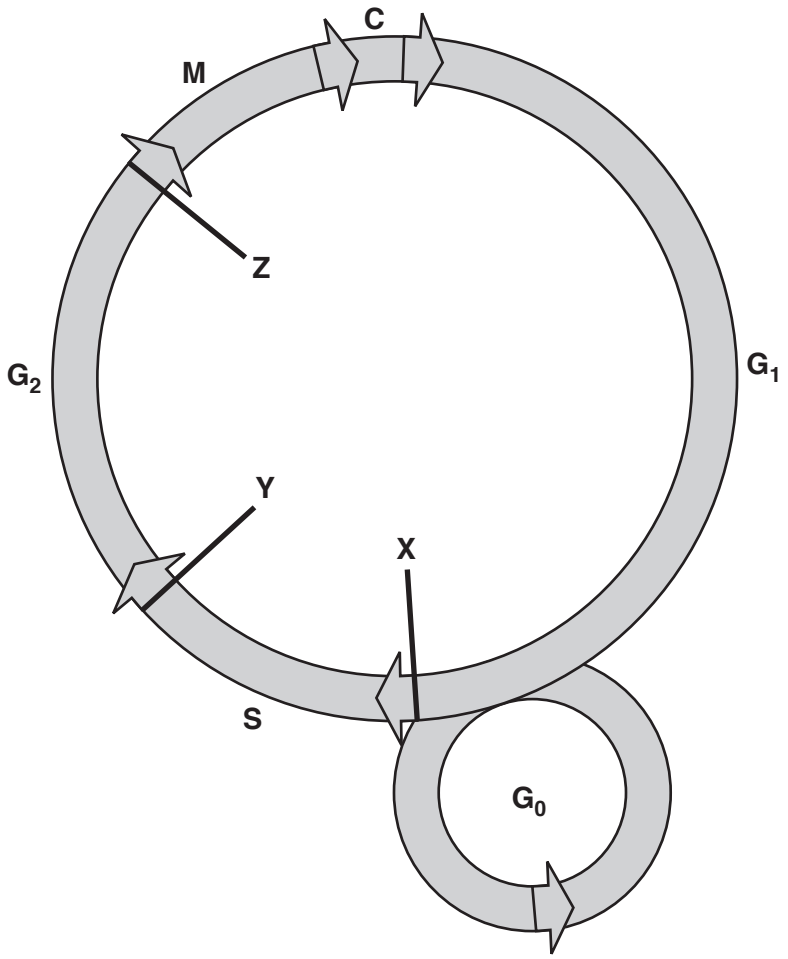



**Fig. 2.3**

**(i)** State all the letters in Fig. 2.3 that represent the **phases** of interphase.

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

**(ii)** Suggest what is being checked at checkpoint **Y** on Fig. 2.3.

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

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**(c)** Table 2.1 indicates the relative time spent in different phases of the cell cycle for three different types of cell, **P**, **Q** and **R**.

| Cell type | Relative time spent in a phase | | | |
|---|---|---|---|---|
| | $G_1/G_0$ | S | $G_2$ | M/C |
| **P** | 18 | 50 | 13 | 19 |
| **Q** | 18 | 25 | 11 | 16 |
| **R** | 100 | 0 | 0 | 0 |

**Table 2.1**

**(i)** Which of the cells **P**, **Q** or **R** takes the shortest time to divide?

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

**(ii)** Suggest why cell **P** spends twice as much time in phase **S** than cell **Q**.

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

**(iii)** What can be deduced about the behaviour of cell **R**?
Give reasons for your answer.

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

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**(d)** An experiment was carried out where a student observed cells in different tissues under the microscope.

- The cells were undergoing mitosis.
- 200 cells were observed for each tissue.
- The number of cells in each stage of mitosis was recorded.

The results are shown in Table 2.2.

| Tissue type | Number of cells in stage of mitosis | | | | Total |
|---|---|---|---|---|---|
| | Prophase | Metaphase | Anaphase | Telophase | |
| **V** | 65 | 55 | 7 | 73 | 200 |
| **W** | 85 | 59 | 6 | 50 | 200 |

**Table 2.2**

The student had expected that the results observed for tissue type **W** would not be significantly different from those for tissue type **V**.

**(i)** Identify the pieces of evidence in Table 2.2 that caused the student to suspect that the results for tissue type **W** might be **significantly** different from those for tissue type **V**.

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

**(ii)** The student decided to analyse the data using a statistical test.

A friend suggested using Student's *t*-test.

Why is Student's *t*-test **not** suitable for dealing with this data?

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

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**(e)** The chi-squared ($\chi^2$) test can be used to analyse the data.

**(i)** Complete the rows for metaphase and telophase in the table below and calculate the $\chi^2$ value for the data.

The $\chi^2$ value is calculated using the following formula:

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

| Cells | Observed (O) | Expected (E) | (O–E) | $(O–E)^2$ | $\frac{(O - E)^2}{E}$ |
|---|---|---|---|---|---|
| **In prophase** | 85 | 65 | 20 | 400 | 6.154 |
| **In metaphase** | | | | | |
| **In anaphase** | 6 | 7 | -1 | 1 | 0.143 |
| **In telophase** | | | | | |
| **Total** | 200 | 200 | | | |

$\chi^2$ = ..... **[3]**

**(ii)** The value of chi-squared ($\chi^2$) can be used to conclude whether the results for cells in tissue type **W** differ significantly from those for tissue type **V**.

The number of **degrees of freedom** determines which row of the $\chi^2$ probability table is used.

The number of degrees of freedom is defined as:

**the number of categories – 1**

What will be the number of degrees of freedom used in this analysis?

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

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**(iii)** The student had expected that the results observed for tissue type **W** would not be significantly different from those for tissue type **V**.

Use your calculated value for $\chi^2$ and the information from the $\chi^2$ probability table below to conclude whether or not the results observed for tissue type **W** are significantly different from those for tissue type **V**.

| Degrees of freedom | Probability (p) | | | | |
|---|---|---|---|---|---|
| | **0.99** | **0.95** | **0.05** | **0.01** | **0.001** |
| **1** | 0.00 | 0.00 | 3.84 | 6.64 | 10.83 |
| **2** | 0.02 | 0.10 | 5.99 | 9.21 | 13.82 |
| **3** | 0.11 | 0.35 | 7.82 | 11.35 | 16.27 |
| **4** | 0.30 | 0.71 | 9.49 | 13.28 | 18.47 |
| **5** | 0.55 | 1.15 | 11.07 | 15.09 | 20.52 |
| **6** | 0.84 | 1.64 | 12.59 | 16.81 | 22.46 |
| **7** | 1.24 | 2.17 | 14.07 | 18.48 | 24.32 |

Conclusion .....

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

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**3** **(a)** Polymers are important molecules that have structural and functional roles in organisms.

Chitin is a polymer that is found in insects, where it forms a major part of the structure of the exoskeleton.

- Chitin is a macromolecule that is similar to a polysaccharide.
- Chitin is composed of molecules of N-acetylglucosamine, the structure of which is shown in Fig. 3.1 below.
- The monomers of N-acetylglucosamine join by 1–4 glycosidic bonds to form the chitin molecule.

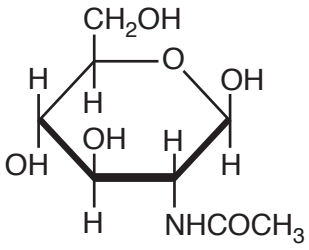



**Fig. 3.1**

**(i)** How does the composition of N-acetylglucosamine differ from the composition of a monosaccharide sugar?

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

**(ii)** Which monosaccharide sugar does N-acetylglucosamine most closely resemble?

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

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**(iii)** Using your knowledge of the formation of structural polysaccharides, describe the formation of the chitin molecule from its monomer and predict its structure.

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**(b)** Fig. 3.2 is a photomicrograph of the trachea of a honeybee, *Apis mellifera*.

The trachea of this honeybee is infected with honeybee tracheal mites, *Acarapis woodi*. Some of these mites are labelled **M** on Fig. 3.2.

The trachea and tracheoles of insects have circular bands of chitin. One of these bands is labelled **C** on Fig. 3.2.

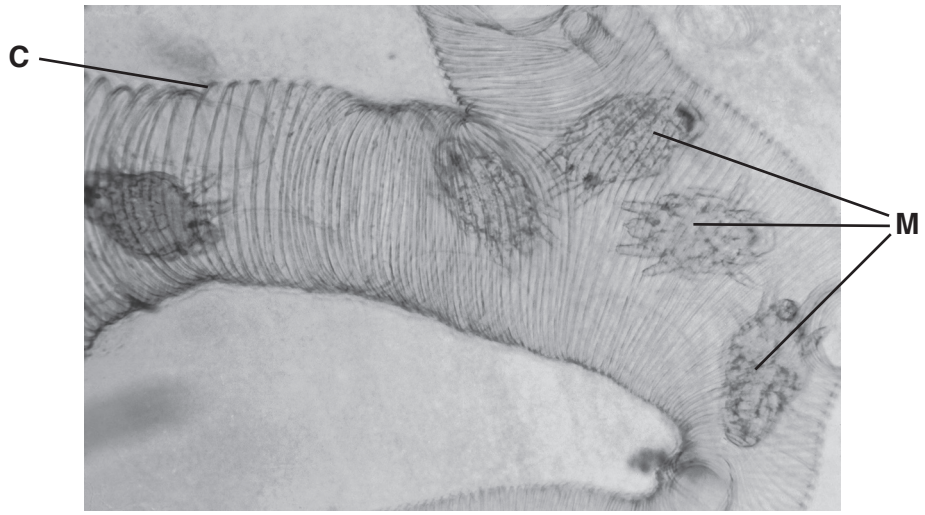



**Fig. 3.2**

**(i)** What is the function of the circular bands of chitin labelled **C**?

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

**(ii)** The mites use their mouthparts to bite through the walls of the trachea. They then feed off the haemolymph, the blood-like liquid that bathes the cells and organs of the honeybee.

Suggest **one** other way in which the presence of the mites might affect the honeybee.

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

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**4** **(a)** Fungi produce enzymes to digest complex food substances. Amylase is an enzyme that catalyses the conversion of starch to maltose.

- A sample of the fungus *Amanita citrina* was placed on agar in a petri dish.
- The agar contained starch.
- The dish was incubated until the thread-like hyphae had grown a few centimetres.
- Iodine solution was then poured onto the surface of the agar.

A diagram representing the results is shown in Fig. 4.

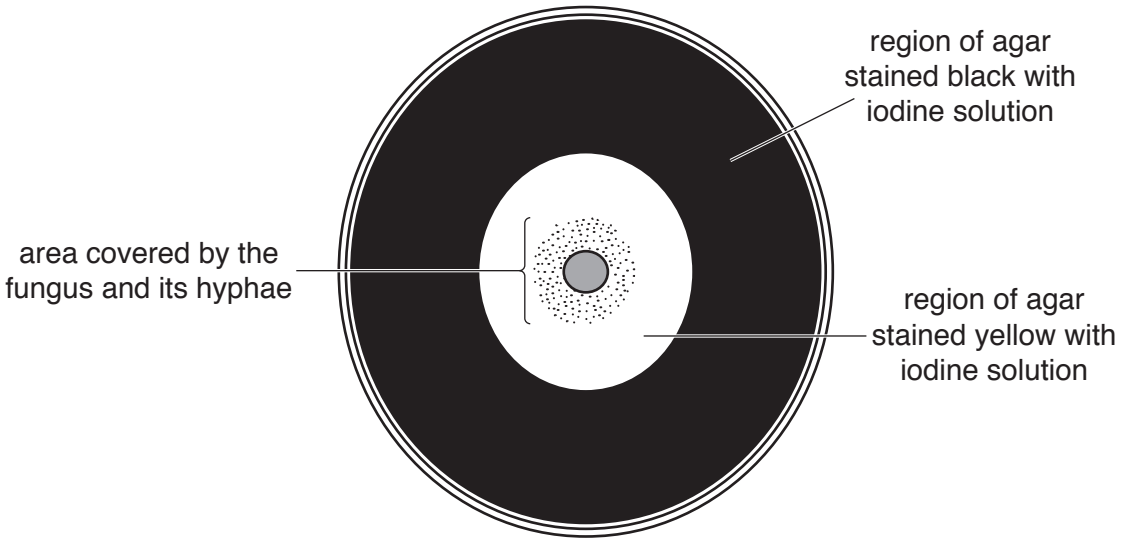



**Fig. 4**

**(i)** To which genus does this fungus belong?

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

**(ii)** The region of yellow staining shown in Fig. 4 includes part of the agar where the fungus had not yet grown.

What does this pattern indicate about the action of the fungal enzymes?

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

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**(b)** Lipase is an enzyme that catalyses the breakdown of lipids.

An investigation was carried out to see the effect of temperature on the activity of a lipase.

- 5 $cm^3$ of an alkaline solution of lipid was poured into a test tube.
- The test tube was placed into a water bath maintained at 20 °C and left to equilibrate.
- A few drops of an indicator were added to the wells of a white spotting tile. The indicator is pink above pH values of 8.3 and turns colourless at pH values below 8.3.
- Once the lipid solution had equilibrated, 1 $cm^3$ of 0.5% lipase solution at the same temperature was then added to the test tube.
- For five minutes, at 30 second intervals, the solution was stirred and a few drops were removed from the test tube and placed in a well on the white spotting tile.
- The time was recorded when the solution and indicator did not remain pink.
- The procedure was repeated four more times at 20 °C and then again at a further six temperatures.

The results are shown in Table 4.1 below.

| Temperature (°C) | Time when solution did not remain pink | | | | |
|---|---|---|---|---|---|
| | Replicate 1 | Replicate 2 | Replicate 3 | Replicate 4 | Replicate 5 |
| **20** | 210 | 270 | 240 | 300 | 270 |
| **25** | 90 | 120 | 210 | 180 | 120 |
| **30** | 60 | 60 | 90 | 90 | 60 |
| **35** | 60 | 60 | 60 | 90 | 60 |
| **40** | 210 | 120 | 210 | 180 | 210 |
| **45** | 240 | 300 | 300 | – | 270 |
| **50** | – | – | – | – | – |

**Table 4.1**

**(i)** Why is pH **not** a controlled variable in this investigation?

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

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**(ii)** Identify **one** variable that has been controlled in this procedure.

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

**(iii)** Identify **one** variable, other than pH, that has **not** been controlled in this procedure.

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

**(iv)** The procedure required the solution to be stirred and then drops of solution to be placed on a white spotting tile.

Suggest why this procedure was followed rather than simply adding indicator to the test tube, stirring the solution and looking for the colour change in the test tube.

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

**(v)** What can be concluded from the results in Table 4.1 about the optimum temperature for lipase activity?

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

**(vi)** Describe **two different** ways in which the procedure could be modified to obtain a more accurate value for the optimum temperature for lipase activity.

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**[4]**

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**(c)*** There are two models for the mechanism of enzyme action. Outline how changes in temperature can affect these mechanisms of lipase action.

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**5** **(a)** Fig. 5.1, **on the insert**, shows the circulatory systems of three groups of animals.

**(i)** What type of circulatory system is shown in **all** these animals?

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

**(ii)** How does the circulatory system of a fish compare to that of a mammal?

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

**(b)*** Fig. 5.2, **on the insert**, shows the flow of blood through the heart of an amphibian such as a frog.

Use the information in Fig. 5.1 **and** Fig. 5.2 to compare the circulations of a frog and a mammal and the relative effectiveness of each type of circulation.

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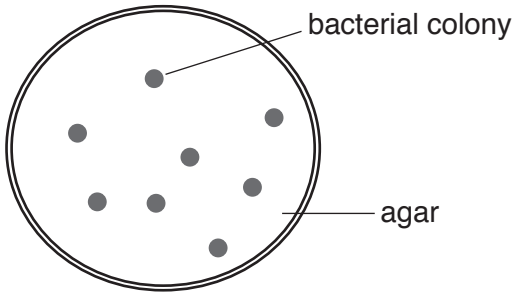
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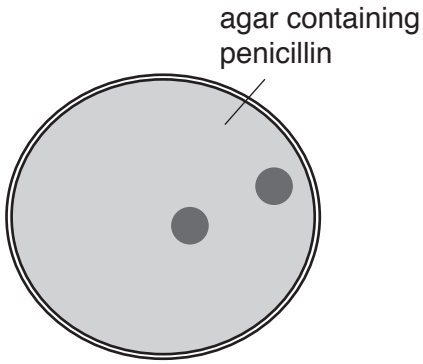
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**6** **(a)** An experiment was carried out to investigate the resistance of a species of bacterium to the antibiotic penicillin.

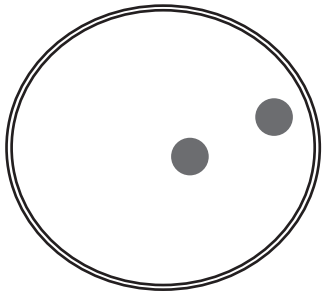
Bacteria were allowed to grow into colonies on an agar plate.

A cloth was placed onto the bacteria and then the pattern of bacterial colonies was transferred to an agar plate that contained penicillin.




Only two colonies survived and continued to grow on the agar that contained penicillin.
The bacteria in these colonies possessed a mutation that gave them resistance to the penicillin.



The original plate was flooded with a solution containing penicillin and the same two colonies continued to grow.

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**(i)** A student made the following suggestion:

> I think that the colonies on the agar containing penicillin that survived and grew did so because those bacteria evolved resistance.
> They evolved resistance as a result of being exposed to the penicillin.

Another student commented:

> But some of the bacteria in the population were already resistant, so they can't have evolved resistance because they were exposed to the penicillin.

What evidence indicates that the penicillin-resistant bacteria already existed in the population?

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

**(ii)** Name the process that increases the proportion of penicillin-resistant bacteria in the population.

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

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**(b)** One role of the Office for National Statistics (ONS) is to collate data about the causes of death in England and Wales. Deaths involving *Staphylococcus aureus* and MRSA statistics have been produced by the ONS for each year since 1993.

*S. aureus* can be mentioned on a death certificate and *S. aureus* may also be specified as being methicillin resistant (MRSA).

Table 6 shows the data for the years 1993 to 2012.

| Year | Number of death certificates mentioning *S. aureus* | | |
|---|---|---|---|
| | ***S. aureus* not specified as resistant** | ***S. aureus* specified as MRSA** | **Total** |
| 1993 | 379 | 51 | 430 |
| 1994 | 358 | 90 | 448 |
| 1995 | 409 | 198 | 607 |
| 1996 | 445 | 298 | 743 |
| 1997 | 395 | 386 | 781 |
| 1998 | 451 | 409 | 860 |
| 1999 | 484 | 480 | 964 |
| 2000 | 476 | 666 | 1036 |
| 2001 | 473 | 731 | 1204 |
| 2002 | 421 | 794 | 1215 |
| 2003 | 448 | 968 | 1516 |
| 2004 | 461 | 1138 | 1599 |
| 2005 | 450 | 1649 | 2099 |
| 2006 | 498 | 1652 | 2150 |
| 2007 | 459 | 1593 | 2052 |
| 2008 | 270 | 1230 | 1500 |
| 2009 | 472 | 781 | 1253 |
| 2010 | 475 | 485 | 960 |
| 2011 | 274 | 364 | 638 |
| 2012 | 265 | 292 | 557 |

**Table 6**

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**(i)** Calculate the percentage increase in the number of death certificates that mention MRSA from 1993 to the year when the numbers reach a peak.

Show your working and give your answer to **three significant figures**.

Answer = ..... % **[2]**

**(ii)** The proportion of death certificates that mention MRSA in 1993 is 12%.

Compare this figure with the proportion of death certificates that mention MRSA in 2012.

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

**(iii)** What can you conclude from these data about the deaths involving *S. aureus* and MRSA since 2007?

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

**END OF QUESTION PAPER**

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## ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin.

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