OCR
Oxford Cambridge and RSA

# A Level Biology A
## H420/02 Biological diversity

# Practice paper – Set 1
## Time allowed: 2 hours 15 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, 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 **100**.
- 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 **28** pages.

## SECTION A

**You should spend a maximum of 20 minutes on this section.**

**Write your answer to each question in the box provided.**

Answer **all** the questions.

**1** A student investigated the effect of pH on the rate at which an enzyme breaks down a substrate.

What would be a suitable control for this investigation?

An identical tube set up with:

**A** no buffer

**B** no buffer and no enzyme

**C** no enzyme

**D** no substrate

Your answer ☐ **[1]**

**2** Which of the following, **A** to **D**, is an **incorrect** statement about enzymes?

**A** amylase and trypsin catalyse extracellular reactions

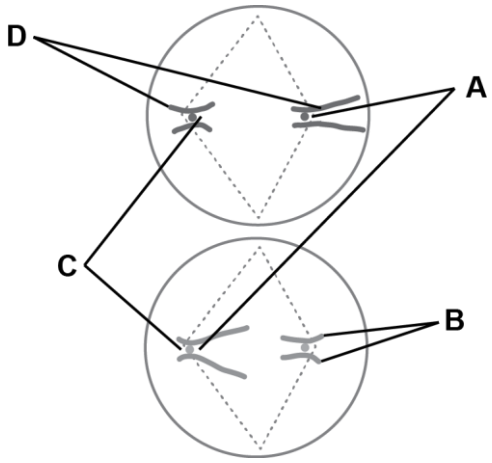
**B** catalase catalyses intracellular reactions

**C** extracellular enzymes are produced outside the cell

**D** intracellular enzymes work inside the cell

Your answer ☐ **[1]**

**3** The diagram below shows the arrangement of chromosomes in a cell during metaphase 2.




Which letter indicates a homologous pair of chromosomes?

Your answer ☐

**[1]**

**4** Which of the rows, **A** to **D**, correctly describes how genetic variation is achieved during meiosis?

| Row | Prophase 1 | Metaphase1 | Metaphase 2 | Anaphase 2 |
|---|---|---|---|---|
| **A** | crossing over of sister chromatids | independent assortment of homologous chromosomes | independent assortment of chromatids | independent segregation of chromatids |
| **B** | crossing over of non-sister chromatids | independent segregation of chromatids | independent assortment of homologous chromosomes | independent segregation of chromosomes |
| **C** | crossing over of non-sister chromatids | independent assortment of homologous chromosomes | independent assortment of chromatids | independent segregation of chromatids |
| **D** | crossing over of sister chromatids | independent assortment of chromatids | independent assortment of homologous chromosomes | independent segregation of chromosomes |

Your answer ☐

**[1]**

**5** Which of the rows, **A** to **D**, correctly describes the properties of the named proteins?

| Row | Collagen | Insulin | Elastin | Haemoglobin |
|---|---|---|---|---|
| **A** | fibrous protein which is flexible but does not stretch | globular protein with specific, fixed shape | fibrous protein which recoils after being deformed | globular protein which cannot change shape |
| **B** | fibrous protein which is flexible but does not stretch | globular protein with specific, fixed shape | fibrous protein which recoils after being deformed | globular protein which can change shape |
| **C** | fibrous protein which recoils after being deformed | globular protein with specific, fixed shape | fibrous protein which is flexible but does not stretch | globular protein which can change shape |
| **D** | fibrous protein which is flexible but does not stretch | globular protein which can change shape | fibrous protein which recoils after being deformed | globular protein with specific, fixed shape |

Your answer ☐ **[1]**

**6** Which statement, **A** to **D**, correctly describes a process that provides artificial active immunity?

**A** an injection of active antibodies for tetanus

**B** antigens for polio given in a sugar cube

**C** antibodies provided in milk from a breast-feeding mother

**D** antigens received on flu viruses via water droplets in the air

Your answer ☐ **[1]**

**7** Which statement, **A** to **D**, best describes the relationship between classification and phylogeny?

**A** classification and phylogeny are the same thing

**B** modern classification reflects phylogeny

**C** phylogeny is the science used in classification

**D** phylogeny is naming the phyla used in classification

Your answer ☐ **[1]**

**8** A student investigated the effect of different sugars on the growth of bacteria.

The student found that the bacteria grew well when provided with glucose, sucrose and fructose, but did not grow well when provided with lactose.

Which statement, **A** to **D**, provides the best explanation for these results?

**A** lactose was too large to be absorbed

**B** the bacteria could respire only monosaccharides

**C** the bacteria did not possess the enzyme to digest lactose

**D** the bacteria were inhibited by lactose

Your answer ☐ **[1]**

**9** The table shows the growth of a population of microorganisms.

| Time (h) | Estimated population size (cells per $mm^3$) |
|---|---|
| 0 | $1.0 \times 10^3$ |
| 4 | $4.0 \times 10^3$ |
| 8 | $9.0 \times 10^3$ |
| 12 | $1.8 \times 10^4$ |
| 16 | $3.1 \times 10^4$ |
| 20 | $5.8 \times 10^4$ |
| 24 | $1.4 \times 10^5$ |

During which time period is the maximum (absolute) growth rate?

**A** 0 – 4 hours

**B** 8 – 12 hours

**C** 16 – 20 hours

**D** 20 – 24 hours

Your answer ☐ **[1]**

**10** The table shows the genetic code in a short length of DNA, the corresponding codons on mRNA, and the anticodons on the corresponding tRNA.

| Row | Original DNA | mRNA | tRNA |
|---|---|---|---|
| **A** | CCG TTA GCA | GGC AAT CGU | CCG TTA GCA |
| **B** | CAT AAT ACG | GUA UUA UGC | CAU AAU ACG |
| **C** | ATA CGC ATC | AUA CGC UAG | UAU GCG AUC |
| **D** | ACG GTA AAA | ACG GAU UUU | ACG GTA AAA |

Which of the rows, **A** to **D** shows the correct codons and anticodons?

Your answer ☐

**[1]**

**11** The bacterium *E. coli* produces lactase only when the sugar lactose is available. The mechanism to control production of lactase is called the *lac* operon.

Statements 1 - 3 describe the role of molecules in the way the *lac* operon controls lactase production.

1 – lactose binds to the repressor protein
2 – the repressor protein binds to lactase
3 – lactase leaves the cell

Which of the options, **A** to **D**, identifies the correct statements?

**A** 1, 2 & 3

**B** Only 1 & 2

**C** Only 2 & 3

**D** Only 1

Your answer ☐

**[1]**

**12** A pure-breeding long-wing red-eyed fly and a pure-breeding short-wing white-eyed fly were crossed. All the F1 offspring were long-wing and red-eyed. When members of the F1 generation were crossed the F2 generation included 27 flies with long wings and white eyes.

Which of the options, **A** to **D**, shows the observed results that most closely match the expected results for the number of long-wing red-eyed flies and short-wing red-eyed flies?

**A** 92 long-wing red-eye and 31 short-wing red-eye

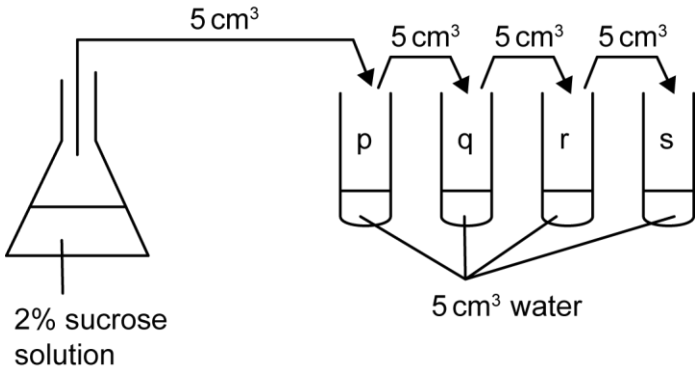
**B** 27 long-wing red-eye and 29 short-wing red-eye

**C** 86 long-wing red-eye and 11 short-wing red-eye

**D** 27 long-wing red-eye and 88 short-wing red-eye

Your answer ☐ **[1]**

**13** The diagram shows a serial dilution.




Which of the options, **A** to **D**, shows the correct concentrations of sucrose in tubes p – s?

**A** p = 0.2% q = 0.02% r = 0.002% s = 0.0002%

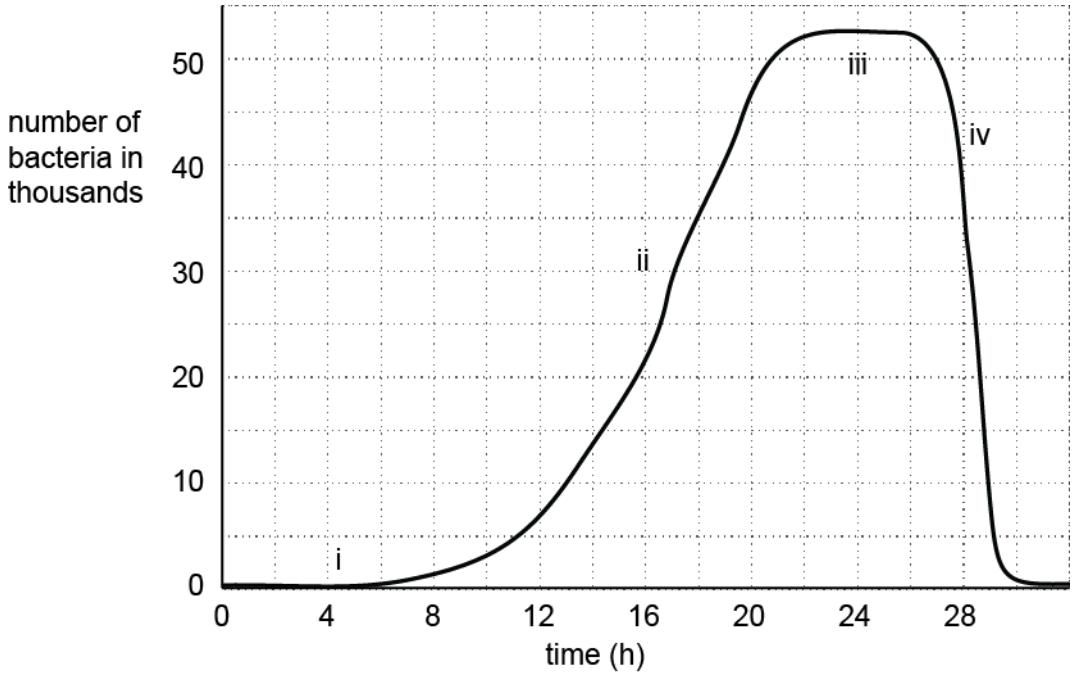
**B** p = 1% q = 0.5% r = 0.2% s = 0.1%

**C** p = 1% q = 0.5% r = 0.25% s = 0.125%

**D** p = 0.2% q = 0.1% r = 0.05% s = 0.025%

Your answer ☐ **[1]**

**14** The graph shows the growth of a population of bacteria in a closed culture.



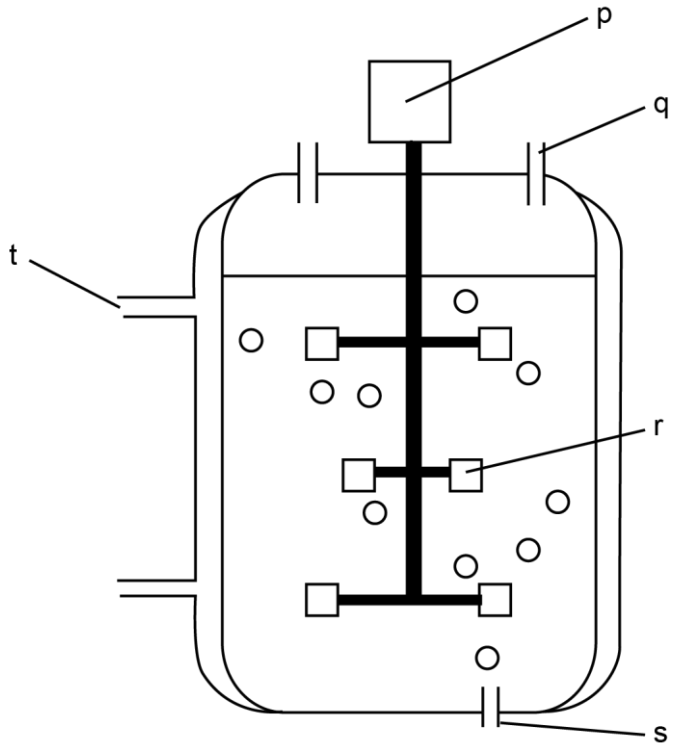

Which of the rows, **A** to **D**, correctly identifies the stages in the growth curve where primary and secondary metabolites are produced?

| Row | No metabolites | Mainly primary metabolites | Mainly secondary metabolites |
|---|---|---|---|
| **A** | i | ii | iii & iv |
| **B** | - | i & ii | iii & iv |
| **C** | i & iv | ii | iii |
| **D** | iv | i & iii | ii |

Your answer ☐

**[1]**

**15** The diagram shows a simple fermenter.




Which row, **A** to **D**, correctly identifies the labelled components?

| Row | p | q | r | s | t |
|---|---|---|---|---|---|
| **A** | motor | air inlet | stirring paddle | gas outlet | water outlet |
| **B** | stirring paddle | gas outlet | nutrient block | air inlet | water inlet |
| **C** | motor | gas outlet | stirring paddle | air inlet | water outlet |
| **D** | stirring paddle | gas outlet | nutrient block | gas outlet | water inlet |

Your answer ☐

**[1]**

## SECTION B

Answer **all** the questions.

**16** A gene mutation is a change in the sequence of nucleotides within a gene.

**(a)** **(i)** Explain how it is possible for a mutation to have no effect on the protein produced from that gene.

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**(ii)** Explain how a mutation could alter the protein so that it no longer performs its correct function in the cell.

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**(b)** Gene transcription is controlled by transcription factors. Fig. 16.1 shows how a transcription factor can control transcription.

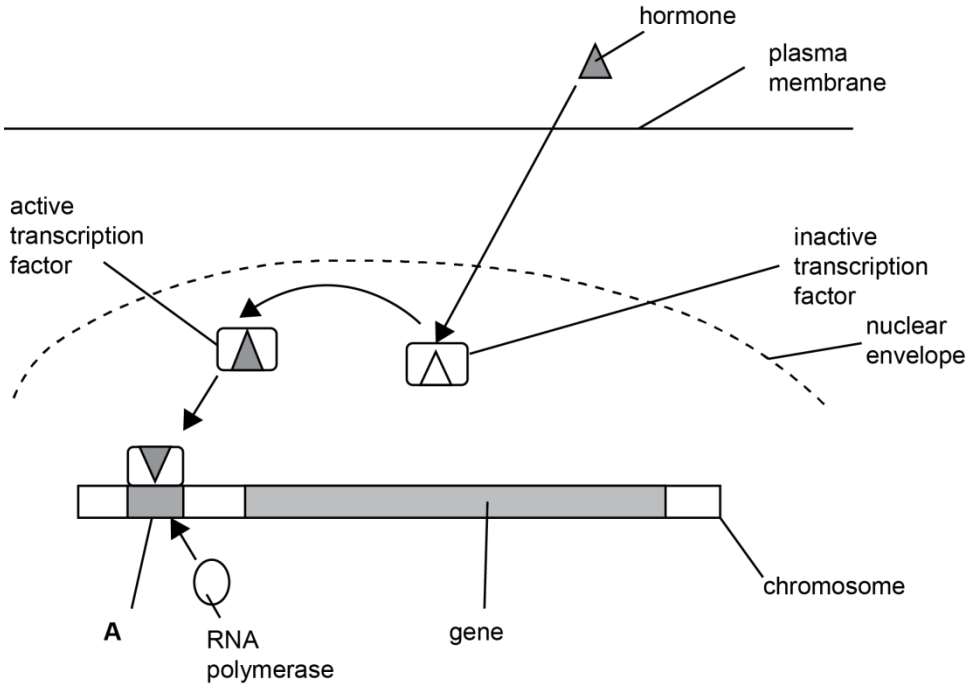


**Fig. 16.1**

**(i)** Name site **A**.

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

**(ii)** Using the information in Fig. 16.1, describe how transcription can be controlled in eukaryotes.

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.....**[3]**

**(c)** Hox genes code for transcription factors and control the development of the body plan. Fig. 16.2 shows a congenital deformity caused by failure of the control mechanism.

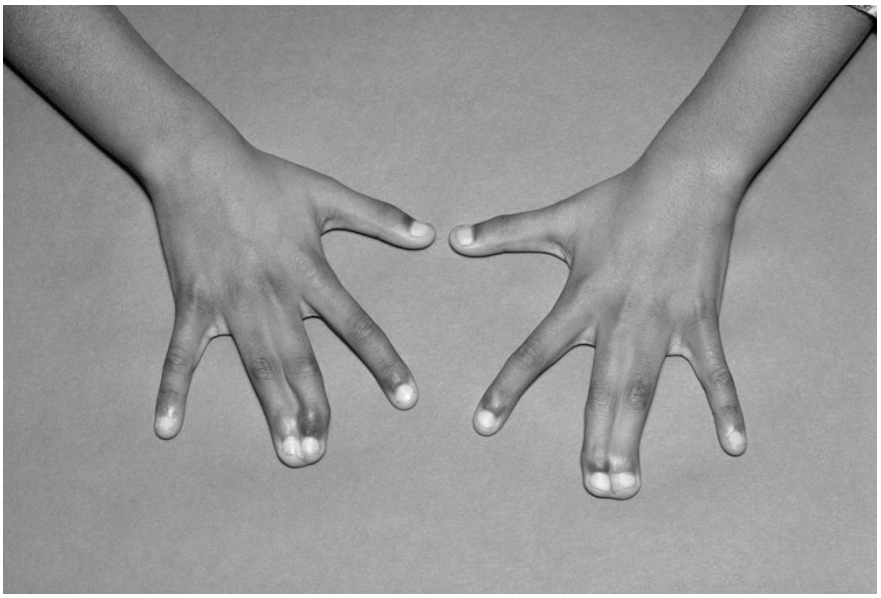

**Fig. 16.2**

Explain how failure of the control mechanism during development could lead to such a deformity.

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.....**[3]**

**(d)** Describe how gene expression can be regulated after transcription.

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.....**[3]**

**17** In order to sequence the whole genome of an organism it may be necessary to sequence billions of nucleotides. The human genome is approximately 3.2 billion nucleotides long.

**(a)** Sequencing DNA requires a series of steps.

Place the following steps in the correct sequence. The first and last ones have been done for you.

**A** place sections in order by matching overlapping regions

**B** cut DNA into sections of varying length

**C** sequence short sections of DNA

**D** amplify the DNA (create many copies)

**E** extract samples of DNA from cells

**E** …….. …….. …….. **A** **[2]**

The development of high-throughput sequencing techniques has enabled whole genomes to be sequenced more rapidly. Table 17.1 compares a number of DNA sequencing techniques.

| **Technique** | **Rate of sequencing (Mb day$^{-1}$)** | **Maximum length of nucleotide chain sequenced** | **Typical number of errors per 100 000 nucleotides** |
|---|---|---|---|
| **Sanger (chain termination technique)** | 6 | 1000 | 5 |
| **Roche pyrosequencing** | 750 | 500 | 50 |
| **SOLiD** | 5000 | 50 | 500 |
| **Helicos** | 5000 | 32 | 1000 |

**Table 17.1**

**(b)** The protein coded for in a gene is 200 amino acids in length. How many errors could be expected in the exons of the sequenced gene when using the least accurate sequencing technique shown in Table 17.1.

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

**(c)** Roche pyrosequencing relies on building a chain of nucleotides against a template. It involves the following steps:

- Nucleotides are washed over the template in a specific order.
- When the correct nucleotide is present it joins the new chain.
- The addition of a nucleotide to the chain releases energy.
- The energy is used to activate a protein called luciferin.
- Light released by luciferin is detected.
- If two identical nucleotides are added together then the intensity of the light emitted is doubled.

Fig. 17.1 shows a readout from a pyrosequencing machine.

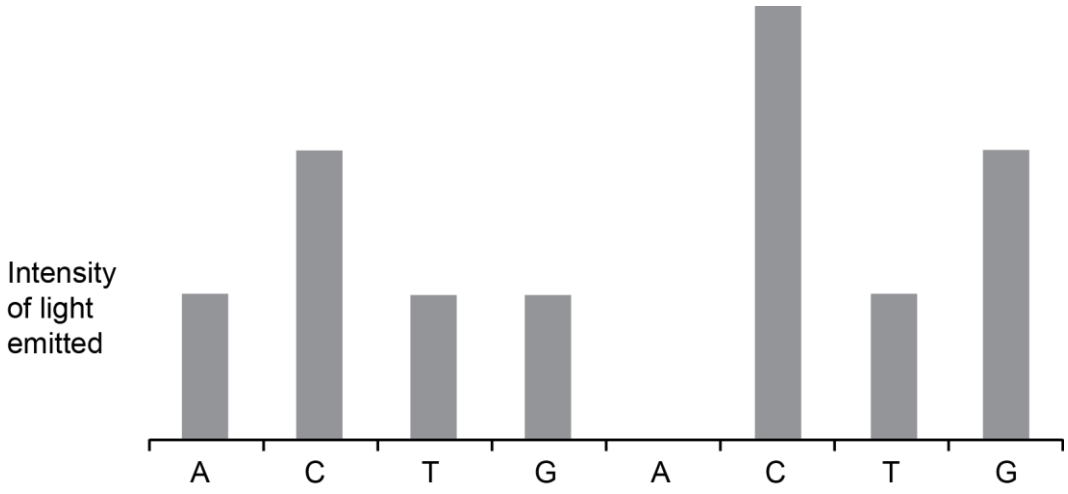


**Fig. 17.1**

Read off the sequence of bases in the length of DNA.

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**(d) (i)** A portion of a gene was sequenced from two members of the same family suspected of having a genetic disease.

The sequences are shown below:

A C G G T A T T G C T A C T T G A A T T A C G T
A C G G T A T T G A G C C T T G A A T T A C G T

What proportion of the sequence is different?

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

**(ii)** To identify an allele that causes a genetic disease it must be sequenced accurately so that differences from the healthy allele are clear.

Using the information in **Table 17.1** decide which technique is best to use when sequencing a human gene that causes a genetic disease.

Explain your choice.

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

**(iii)** Suggest how the interdisciplinary field of *bioinformatics* may be useful in determining whether a newly-sequenced allele causes a genetic disease.

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

**(e)** DNA profiling uses techniques to separate lengths of DNA to produce a profile that is unique to each individual.

Explain why only selected sections of non-coding DNA are used when profiling a human.

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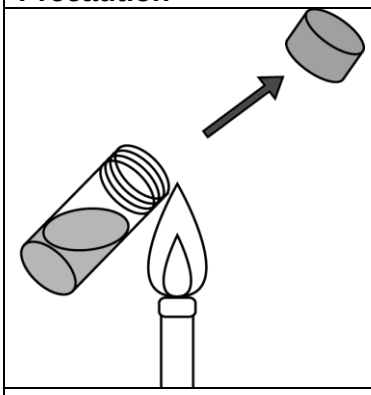
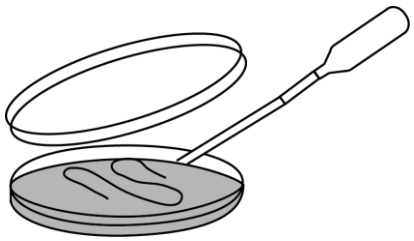
.....**[3]**

**18** A student was asked to measure the population density of bacteria in a broth. The student was supplied with a broth culture of the bacterium *Bacillus subtilis*. The teacher suggested that the student should measure the population by transferring a sample of the broth to an agar plate then incubating the plate for 24 hours. The bacterial colonies could then be counted.

**(a)** The student took certain precautions to avoid contaminating the cultures.

Explain how each precaution shown in the table below helped to avoid contamination.

Write your answers in the spaces provided on the table.

| Precaution | Explanation |
|---|---|
|  | |
|  | |

**[2]**

**(b)** After incubation for 24 hours, the student studied the agar plate. The plate was completely covered by a film of bacteria and it was not possible to count colonies.

Describe a modification to the procedure that would enable the student to estimate the population size.

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

**(c)*** Once the student had mastered the procedure to estimate population size, they decided to investigate the effect of temperature change on the rate of population growth.

The student used the following procedure:

- A broth culture was incubated at 20°C.
- Every four hours a pipette was used to transfer a sample of the culture to agar growth medium in a petri dish.
- The sample was spread over the surface of the agar by tilting and swirling the dish.
- The petri dish was incubated at 30°C for 24 hours.
- After 24 hours the petri dish was labelled and stored in a refrigerator until all results were complete.
- The procedure was repeated with broth cultures incubated at 10°C, 30°C and 40°C.
- Once all the agar plates had been collected the student removed them from the refrigerator and estimated population size by counting the visible colonies.
- Finally the student converted the data into a growth rate.

Describe and explain modifications that the student should make to improve the investigation and ensure the data collected are valid. (You may assume that full aseptic technique was used.)

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**(d)** Microorganisms such as the single-cell fungus *Fusarium* can be cultured to grow food for the human population. In order to scale up cultures of microorganisms scientists use large fermenters. A study was carried out to determine which of two species of *Fusarium* would be better for production of fungal protein.

Fig. 18.1 shows the results of the study.

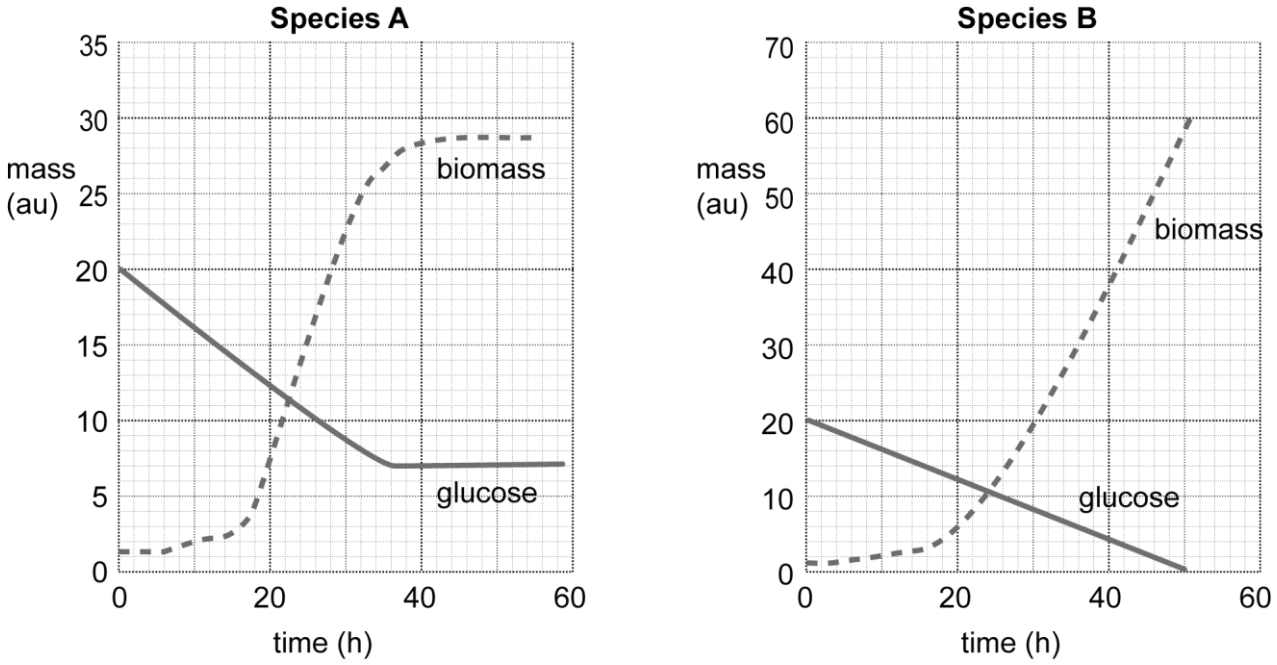


**Fig. 18.1**

**(i)** Calculate the percentage of glucose used by species **A**.

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

**(ii)** Using the information in Fig. 18.1 suggest which species would be better for use in production of fungal protein for human consumption.

Explain your choice.

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

**(e)** Table 18.1 compares burgers made from fungal protein with burgers made from beef.

| Protein source | Total fat (%) | Saturated fat (%) | Cholesterol (%) | Essential amino acids (%) | Energy (kJ $100g^{-1}$) |
|---|---|---|---|---|---|
| **Fungus** | 4.8 | 0.5 | 0.000 | 4.98 | 611 |
| **Beef** | 24.7 | 10.7 | 0.076 | 7.92 | 1218 |

**Table 18.1**

Some people think that we should produce fungal protein rather than beef for human consumption. Use Table 18.1 and your own knowledge to discuss this claim.

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.....**[4]**

**19 (a)*** A student cut their hand during a field trip. The bleeding stopped within a few minutes and formed a scab over the cut. However, over the next three days they noted that the area around the cut became swollen, red and tender. They also noted a small swelling and discomfort in their armpit.

Describe the non-specific defences against pathogens that would explain **all** these observations.

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**(b)** Fig. 19.1 shows a neutrophil responding to a pathogenic bacterium.

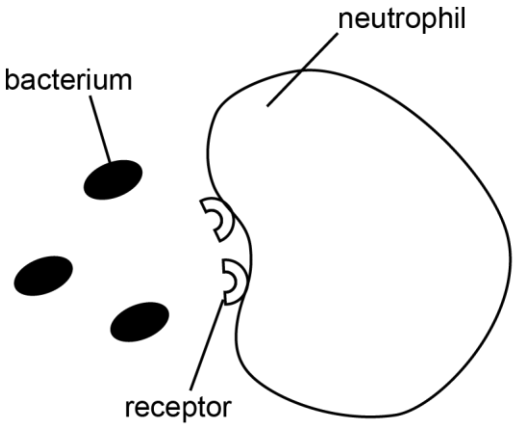


**Fig. 19.1a**

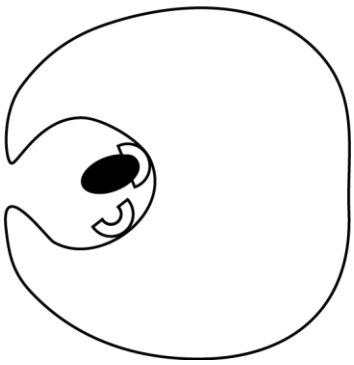

**Fig. 19.1b**

**(i)** What is the role of an opsonin during this process?

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

**(ii)** Other than having specific receptors, describe **one** way in which the structure of the neutrophil is specialised.

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

**(c)** When their bark is damaged, trees in the genus *Boswellia* release the aromatic resin frankincense which soon hardens to cover the wound.

**(i)** Suggest **two** ways in which frankincense contributes to defending the tree from pathogens.

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

Frankincense is collected by cutting the bark of a tree and allowing the resin released to harden.

It can be used to relieve the pain of rheumatoid arthritis.

Frankincense works by blocking receptors for molecules called leukotrienes which cause inflammation. Leukotrienes are released by cells from the immune system.

**(ii)** What type of disease is rheumatoid arthritis?

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

**(iii)** Trees that are overused for harvesting frankincense do not live long and are becoming increasingly rare.

Explain how traditional remedies, such as the use of frankincense, provide a strong argument for conservation of biodiversity.

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

**20** Fig. 20.1, **on the Insert**, shows a transmission electron micrograph of part of a eukaryotic cell.

**(a) (i)** Identify **one** feature inside the cell that would also be seen in a prokaryotic cell.

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

**(ii)** Identify **two** features of this cell that confirm it is **not** a prokaryotic cell.

In each case state the letter and the name of the feature.

*Letter*……. *Name*……

*Letter*……. *Name*……

**[2]**

**(b)** The cell shown in **Fig. 20.1** is capable of synthesising and secreting proteins.

Using **only** the letters from **Fig. 20.1**, list the correct sequence of the organelles involved in synthesis and secretion of a protein.

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.....**[3]**

**(c)** Peroxisomes are vesicles that usually contain enzymes such as catalase.

Explain how peroxisomes can be moved around inside the cell.

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

**(d)** Catalase is an intracellular enzyme with an iron-containing haem group.

**(i)** State the term used to describe an ion that is essential for the enzyme to function.

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

**(ii)** Name another conjugated protein that contains a haem group.

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

**(e)** Fig. 20.2 shows the effect of copper ions on the activity of catalase.

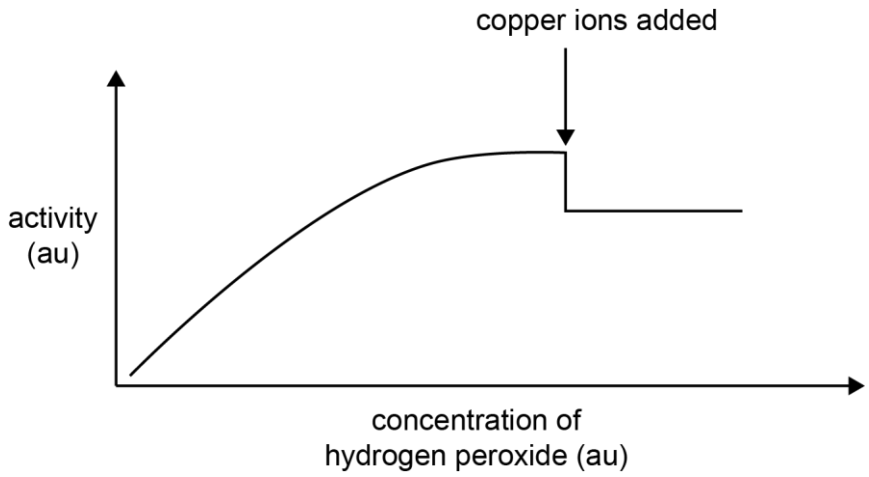


**Fig. 20.2**

What can you conclude from Fig. 20.2 about the type of inhibition shown? Explain your answer.

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

**21** Water has many important roles in living organisms.

**(a) (i)** State the name of the bond that holds water molecules together.

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

**(ii)** DNA is one of many substances which will dissolve in water. Explain why water is a good solvent.

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

**(iii)** A student studied the pack of 'plant food' supplied with some cut flowers. The list of ions included hydrogen and sodium.

Suggest what roles these may play in helping the cut flowers to last longer.

hydrogen

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sodium

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**[2]**

**(b)** A student tried to extract some DNA from a crushed banana at home. DNA dissolves in water but the student realised that they needed to add something to break open the nuclear envelope to release the DNA.

Suggest a suitable substance the student could use to release the DNA, **and** explain why it should work.

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

**22** **(a)** Bone marrow contains stem cells that can develop into erythrocytes, neutrophils and lymphocytes.

Describe the changes that must occur inside these stem cells as they differentiate to form erythrocytes.

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

**(b)** Cells from an embryo can be used for medical research and for research on the development of an organism.

Suggest **three** ways in which the use of embryonic stem cells in research has practical benefits to biological knowledge.

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.....**[3]**

**(c)** During development, cells become organised into tissues and organs.

Explain the difference between *muscle tissue* and *a muscle*.

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

**END OF QUESTION PAPER**

## ADDITIONAL ANSWER SPACE

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