INSTRUCTIONS
● Answer all questions.
● Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
● Write your name, centre number and candidate number in the boxes at the top of the page.
● Write your answer to each question in the space provided.
● Do not use an erasable pen or correction fluid.
● Do not write on any bar codes.
● You may use a calculator.
● You should show all your working and use appropriate units.

INFORMATION
● The total mark for this paper is 80.
● The number of marks for each question or part question is shown in brackets [ ].
The gas exchange system is one of the organ systems of the human body.

Fig. 1.1 shows parts of the gas exchange system during breathing in and breathing out.

Fig. 1.1

(a) Complete Table 1.1 to show:

- the functions of the diaphragm and the intercostal muscles during breathing in and breathing out
- the pressure changes in the thorax.

Use these words:

contract
relax
increases
decreases.

<table>
<thead>
<tr>
<th></th>
<th>diaphragm</th>
<th>intercostal muscles</th>
<th>pressure change in the thorax</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>internal</td>
<td>external</td>
<td></td>
</tr>
<tr>
<td>breathing in</td>
<td>Contract</td>
<td>Relax</td>
<td>Relax</td>
</tr>
<tr>
<td>breathing out</td>
<td>Relax</td>
<td>Contract/relax</td>
<td>Relax</td>
</tr>
</tbody>
</table>

[4]
Fig. 1.2 shows part of the gas exchange surface of a human.

Fig. 1.2

(b) State two features of the gas exchange surface that are visible in Fig. 1.2.

1. Well supplied by blood
2. Good venation in air

(c) The cells labelled X on Fig. 1.2 form a tissue.

(i) Define the term tissue.

A tissue is made up of a group of cells that usually look similar to one another and come from the same region in a developing embryo. The group of cells that make up a tissue have physiological functions that work together in a coordinated way to support the special functions. Different kinds of tissues have different physical properties.
(ii) Cartilage is another tissue found in the gas exchange system.

State the functions of cartilage in the gas exchange system.

Cartilage forms incomplete rings around trachea. It reduces resistant to movement of air and also helps in sound production in larynx.

[Total: 2]

2 Biological washing powders contain enzymes that break down food stains.

(a) Complete Table 2.1 by naming the enzymes that break down three substances in food stains and by stating the product or products.

<table>
<thead>
<tr>
<th>substance</th>
<th>enzyme</th>
<th>product(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>starch</td>
<td>amylase</td>
<td>maltose</td>
</tr>
<tr>
<td>fat</td>
<td>lipase</td>
<td>fatty acid</td>
</tr>
<tr>
<td>protein</td>
<td>pepsin</td>
<td>amino acid</td>
</tr>
</tbody>
</table>

[Total: 3]

Some students compared how effective biological and non-biological washing powders are at removing stains at temperatures between 10 °C and 60 °C.

- Pieces of stained cloth were washed using two different washing powders.
- The degree of stain removal was measured by using a light meter to record the percentage of light reflected from the cloth.
- A light meter gave a value of 100% when the cloth was completely clean.
- Any stain left on the cloth reduced the percentage of light reflected.
The results of the students’ investigation are shown in Fig. 2.1.

![Graph showing percentage of light reflected after washing vs. temperature of washing (°C). The graph has two lines: one for non-biological washing powder and one for biological washing powder.]

**Key:**
- non-biological washing powder
- biological washing powder

**Fig. 2.1**

(b) Compare the effectiveness of the two washing powders at removing stains.

Use the information in Fig. 2.1 in your answer.

From the above graph, we observe that biological washing powder is more effective at lower temperatures i.e. between 10 and 40 degree celsius. Biological washing powder removes all stains between 30 and 40 degree celsius whereas non-biological washing powder removes stain only at 60 degree celsius. Effectiveness of washing powder is similar at higher temperatures however for biological washing powder it increases 40 to 44 degree celsius and there is no such decrease for non-biological washing powder.
(c) The students suggested that the enzymes in the biological washing powder were denatured at high temperatures.

Explain why enzyme molecules do not function when they are denatured.

The active side of enzymes molecules changes shape which prevents binding of substrate ultimately preventing the formation of enzyme-substrate complex.

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(d) Forensic scientists often try to find DNA on items of stained clothing. The DNA can be used to identify individual people.

Suggest why DNA can be used to identify individual people.

Individual people have unique DNA which contains genes made up of sequences of bases.
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[Total: 11]

3 (a) Dialysis tubing is an artificial membrane, which is similar to the lining of the intestine.

A student investigated the diffusion of glucose through dialysis tubing by using the apparatus shown in Fig. 3.1.

![Figure 3.1](image_url)
The student took samples of the water outside the dialysis tubing at 5 minute intervals and tested the samples with Benedict’s solution.

The results are shown in Table 3.1.

**Table 3.1**

<table>
<thead>
<tr>
<th>time/minutes</th>
<th>results of the Benedict’s tests on the water outside the dialysis tubing</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>blue</td>
</tr>
<tr>
<td>5</td>
<td>green</td>
</tr>
<tr>
<td>10</td>
<td>yellow</td>
</tr>
<tr>
<td>15</td>
<td>red</td>
</tr>
</tbody>
</table>

(i) Describe and explain the results shown in Table 3.1.

Appearance of blue Colour at the time 0 indicates absence of glucose on outer surface of dialysis tubing as a result of an error.

Green,yellow,red appearance indicate presence of glucose. Glucose diffuses out of the dialysis cubing as the dialysis permeable to glucose.

(ii) The student repeated the investigation with a higher concentration of glucose in the dialysis tubing.

Predict the results that the student would observe.

Benedict's solution changes colour with the concentration of glucose.
(b) Fig. 3.2 shows a drawing of a cell from the lining of the small intestine. The lumen is the space inside the intestine where food is digested.

![Diagram of a cell lining with labels A, B, C]

Fig. 3.2

State the names of the three labelled structures in Fig. 3.2 and describe the role of each structure in the intestinal cell.

A) Allow movement substances into the cell, increase the surface area for absorption for diffusion

B) Site of protein synthesis

C) Aerobic respiration

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(c) The cholera bacterium can survive in the small intestine and the large intestine. The bacterium releases a toxin that interacts with receptors on the surface of cells.

Fig. 3.3 shows the effect of the toxin. The arrows indicate the direction of movement.

Key:
- toxin
- ion X

![Diagram showing the effect of the toxin](image)

Fig. 3.3

The toxin stimulates the secretion of ion X out of the intestinal cell.

(i) State the name of ion X.

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

(ii) Describe the effects on the body of the secretion of ion X into the lumen of the intestine.

A) Diarrhea....................................................................................................................................................

B) Dehydration................................................................................................................................................

C) Loss of water by osmosis............................................................................................................................

D) Loss of other ions such as Na⁺, K⁺ etc......................................................................................................

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[Total: 15]
Johnson grass, *Sorghum halepense*, is wind-pollinated.

(a) Fig. 4.1 shows some Johnson grass flowers.

(i) State the genus of Johnson grass.

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(ii) Describe two features visible in Fig. 4.1 that show that Johnson grass flowers are adapted for wind-pollination.

1 Feathery stigma

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2 Anthers hanging outside the flowers.

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(b) Fig. 4.2 shows a section through a carpel shortly after pollination.

![Diagram of a carpel with labeled parts A, B, C, D, E.]

(i) State the names of the parts of the carpel labelled C, D and E.

C ovary
D ovule
E style

(ii) Complete the sentences:

Pollen grains are formed in anthers. During their formation the number of chromosomes in the nuclei is halved by the process of ___________. This means the male nucleus A in the pollen tube is described as a ___________ nucleus. When nucleus A ___________ with nucleus B, the chromosome number doubles to form a ___________ nucleus. The name of this process is ___________. Then the ___________ divides by the process of ___________ to form an embryo.
(c) Discuss the advantages of sexual reproduction to a wild population of flowering plants such as Johnson grass.

   Sexual reproduction gives genetic diversity and variation. It allows mutation to be expressed, develop adaptations to new conditions, allows natural selection to occur. In sexual reproduction there is cross pollination. There is diversity in the genetic makeup of the individuals produced by sexual reproduction. Since both the parents are involved, the newly formed individuals have the attributes of both.

   Variations are more successful in sexual mode than in asexual one. The species produced by sexual reproduction survive more than those produced by asexual reproduction. This is because genetic variations help them to adapt to different environments. Hence, a disease is less likely to affect all the individuals in the population.

(d) Sexual reproduction requires energy.

State three uses of energy in organisms other than in reproduction.

1. Protein synthesis
2. Transport in phloem
3. Cell division

[Total: 21]
Ciliates are classified in the kingdom Protoctist. Bacteria are classified in the kingdom Prokaryote.

(a) State **two structural** features that distinguish the cells of a protoctist from a prokaryote.

1. **Presence of nuclear membrane**

2. **Cell walls if present have different composition**

(b) Fig. 5.1 shows five species of ciliate that are found in sewage treatment works.

Fig. 5.1
Fig. 5.2 is a dichotomous key to identify the ciliates shown in Fig. 5.1.

![Dichotomous Key Diagram]

Complete the key in Fig. 5.2 by writing suitable statements:

- for box 2 to distinguish species B and E
- for box 4 to distinguish species A and C.

Text for box 2: **Organism has two rings of cilia**

Text for box 4: **Organism has a covering of cilia**
(c) Didinium is a predatory ciliate. A video recording was made of one Didinium feeding on a Paramecium. Fig. 5.3 shows a sequence of still photographs taken from the video.

![Fig. 5.3](image)

Fig. 5.3

Complete the table by putting a tick (✓) by each characteristic of life that can be seen in the still photographs from the video in Fig. 5.3.

<table>
<thead>
<tr>
<th>Characteristic of Life</th>
<th>Example from Fig. 5.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>excretion</td>
<td>✓</td>
</tr>
<tr>
<td>nutrition</td>
<td>✓</td>
</tr>
<tr>
<td>growth</td>
<td>✓</td>
</tr>
<tr>
<td>reproduction</td>
<td>✓</td>
</tr>
<tr>
<td>movement</td>
<td>✓</td>
</tr>
<tr>
<td>respiration</td>
<td>✓</td>
</tr>
</tbody>
</table>

(d) Fig. 5.4 is a food web for some of the microorganisms in a sewage treatment works.

![Fig. 5.4](image)

Fig. 5.4

(i) Construct one food chain with three trophic levels that use energy derived from the breakdown of sewage. Do not draw the organisms.

Bacteria ➔ Paramecium ➔ Didinium
(ii) The water that passed out of the sewage works was often cloudy with suspended matter. Scientists discovered that ciliates reduce the cloudiness of water during sewage treatment.

Suggest how the ciliates reduce the cloudiness of the water using the information in Fig. 5.4.

Ciliates eat many bacteria. They may also eat dead and decomposing material.

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(iii) Explain how sewage treatment reduces the spread of disease.

A) By removal of harmful bacteria and pathogens of sewage.

  e.g. Cholera bacteria or water borne disease or parasites

B) Stopping the spread of pathogens via water

C) Use of chlorination

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

(iv) Nitrifying bacteria are found in sewage works.

Explain the importance of nitrifying bacteria in the nitrogen cycle.

Nitrifying bacteria perform nitrogen cycle. They are involved in conversion of ammonium ions to nitrate ions which are further converted to nitrite ions. The nitrate ions are biologically available to plants for absorption. Plants absorb it and use it to make proteins.

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[Total: 14]
Colour blindness is a characteristic that is inherited. Colour blindness is more common in males than in females.

Fig. 6.1 is a pedigree diagram showing the inheritance of colour blindness in a family.

(a) Define the term inheritance.

Transmission of genetic information from generation to generation is called as inheritance.

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

(b) (i) Using the symbols \(B\) and \(b\), state the genotypes of individual 5 and individual 8 in the pedigree diagram.

5 \(\text{XY}\) .................................................................

8 \(\text{XY}\) ................................................................. [3]
(ii) Individual 3 is a carrier of colour blindness because she has one copy of the allele for colour blindness but has normal colour vision.

Describe the evidence from Fig. 6.1 that shows that individual 3 is a carrier.

- Colour blindness is a sex-linked characteristic. She is heterozygous for the gene (Bb). She
- has normal allele for normal colour vision but has passed on the relative allele to her sons.
- She has two X chromosomes which have the gene to colour vision; father passes on his Y chromosome.

(iii) There was no history of colour blindness in the parents and grandparents of individuals 1 and 2.

Suggest how colour blindness first occurred in the family in Fig. 6.1.

- Occurrence of colour blindness in family could be due to mutation or due to appearance of recessive allele.