1. (a) To study the effect of concentration of oxygen and carbon dioxide on the breathing rate, a healthy person was asked to inhale different gas mixtures. The results are shown in the table below:

<table>
<thead>
<tr>
<th>Gas mixture</th>
<th>Concentration of gas (%)</th>
<th>Breathing rate (breaths per min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Oxygen</td>
<td>Carbon dioxide</td>
</tr>
<tr>
<td>P</td>
<td>21</td>
<td>0.03</td>
</tr>
<tr>
<td>Q</td>
<td>21</td>
<td>4.00</td>
</tr>
<tr>
<td>R</td>
<td>16</td>
<td>0.03</td>
</tr>
<tr>
<td>S</td>
<td>16</td>
<td>4.00</td>
</tr>
</tbody>
</table>

(i) With reference to the above information, state the factor that affects the breathing rate of the person. Explain how you arrive at your answer. (3 marks)

(ii) Which of the four gas mixtures has similar concentrations of oxygen and carbon dioxide as exhaled air? (1 mark)

(iii) Mouth-to-mouth ventilation is a method for rescuing a person who fails to breathe but still has heartbeat. It involves blowing exhaled air into the patient's body through the mouth as shown below:

![Mouth-to-mouth ventilation diagram]

Based on the composition of exhaled air, explain why this method can help the patient stay alive before he can breathe again. (2 marks)

(iv) Suggest why it is necessary to do the following when carrying out mouth-to-mouth ventilation:

1. Tilt the patient's head as shown in the diagram, instead of letting it lie flat. (1 mark)

2. Observe whether the patient's chest rises when blowing air into the patient. (1 mark)

(v) Which part of the brain controls the breathing rate? (1 mark)

1. (b) A student carried out a study on the effect of two different sodium chloride solutions on red blood cells. He added a drop of citrated mammalian blood to 2 cm³ of each solution in separate test tubes, A and B. After five minutes, the mixtures in both tubes appeared light red in colour. He then examined a drop of each mixture under the microscope. After repeated examinations, he found that intact red blood cells were present in tube B only and they were in two different forms as shown below:

![Wrinkled and Smooth blood cells]

The results are recorded in the table below:

<table>
<thead>
<tr>
<th>Tube</th>
<th>Concentration of solution (%)</th>
<th>Average number of different forms of intact red blood cells</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Wrinkled</td>
</tr>
<tr>
<td>A</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td>B</td>
<td>1.5</td>
<td>15</td>
</tr>
</tbody>
</table>

Note: All observations were done under the same magnification.

(i) (1) In tube B, some red blood cells became wrinkled. How would you explain this? (3 marks)

(ii) Both forms of red blood cells were observed in tube B. C reason for this. (1 mark)

(iii) How could the student be sure that the red blood cells in tube B had reached equilibrium with the surrounding solution at the time when he made the observation? (2 marks)

(iv) Account for the absence of intact red blood cells in the mixture in tube A and the light-red appearance of the mixture (4 marks)
1. (c) The photographs below show a Hong Kong newt and a lizard which can be found in Tai Mo Shan Country Park.

*Hong Kong newt*

*Lizard*

(i) The two animals above belong to different vertebrate groups. Based on the photograph, state **one** external feature of the newt that is characteristic of its group. (1 mark)

(ii) Name the vertebrate group to which the Hong Kong newt belongs. (1 mark)

(iii) Only a small number of Hong Kong newts exist today and it is listed as a protected species. Suggest **two** reasons to account for its small population. (2 marks)

(iv) The diagram below shows a simplified food web in Tai Mo Shan Country Park:

```
  snake  \
   \   \  
   \   \  
   \   \  
  lizard
```

```
  bird  \
   \   \  
   \   \  
   \   \  
  earthworm
```

```
  wild fruit tree  \
   \   \   \  
   \   \   \  
   \   \   \  
  caterpillar
```

(1) With reference to the given food web, draw a food chain that consists of five trophic levels. (1 mark)

(2) Construct a pyramid of numbers for this food chain. (2 marks)

(3) Explain the shape of this pyramid of numbers. (4 marks)
2. (a) Individuals of a certain type of plant produce either purple or white flowers. The flower colour is controlled by a pair of alleles. A gardener carried out two crosses with this type of plant and the results are shown below:

Cross 1

- Plant with purple flowers \( \times \) Plant with purple flowers
- 2 seeds were collected and sown
- both plants produced white flowers

Cross 2

- Plant with purple flowers \( \times \) Plant with white flowers
- 2 seeds were collected and sown
- both plants produced purple flowers

(i) Based on cross 1, deduce the dominant flower colour. Explain your deduction. (5 marks)
(Marks will not be awarded for genetic diagrams.)

(ii) Use symbols to show the possible genotypes of the parents in cross 2. Define the symbols you use. (3 marks)

(iii) If the purple-flower parent in cross 2 was self-pollinated (i.e. the stigma receives pollen grains from the same plant) and a large number of offspring was produced, predict the phenotypes of the offspring and their ratio. (3 marks)

2. (b) The cartoon below shows a foetus crying for help inside the mother’s body:

Help! I can't breathe.

(i) Smoking during pregnancy is hazardous to the foetus. The foetus may be affected in a number of ways, such as a reduced supply of oxygen and the entry of toxic chemicals.

(1) Suggest an explanation for the reduced oxygen supply to the foetus. (2 marks)

(2) Using a flowchart, show the route by which nicotine in cigarette smoke is transported from the mother's lungs to the foetus. Indicate only the major organs and blood vessels involved. (3 marks)

(ii) (1) An early sign of the birth process is the breaking of the amnion. What is the significance of this event in the birth process? (2 marks)

(2) Describe what happens afterwards that leads to the birth of the baby. (3 marks)
2. (c) The function of the pancreas in some people may become impaired due to the blockage of the pancreatic duct. The diagram below shows the pancreas and part of the alimentary canal:

(i) The faeces produced by such patients usually have a high fat content. Explain why.

(ii) In these patients, tissues of the pancreas may get digested. How would you account for this?

(iii) Explain why the patients may produce urine containing glucose if the tissues of the pancreas are damaged by digestion.

3. (a) The diagram below shows a section of the human eye:

(i) Structure A has no blood capillaries.

(1) Why is this feature important to the formation of a clear image?

(2) From where does structure A obtain nutrients?

(ii) When a person steps out from a dark room into broad daylight, B becomes constricted.

(1) Explain the importance of this response.

(2) State the type of response illustrated by the constriction of B.

(3) The person also puts on his sunglasses. With regard to the nature of the response, state two ways in which this action is different from the constriction of B.

(iii) In recent years, dark-coloured sunglasses are in fashion, but some of these sunglasses cannot cut off ultra-violet light. Suggest why wearing such sunglasses under bright sunlight would be more damaging to the eye than not wearing any sunglasses.
3. (b) The following shows the procedure of an experiment to study the effect of pH on the activity of catalase extracted from bean seedlings:

Paper discs are put into the extract of bean seedlings.

The paper discs are then put into test tubes containing equal volumes of hydrogen peroxide solutions at different pH.

Start timing when the paper disc reaches the bottom of the tube.

Note the time (T) for the paper disc to rise to the surface of the solution.

The results of the experiment are shown below:

<table>
<thead>
<tr>
<th>pH of hydrogen peroxide solution</th>
<th>T (s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>&gt;100</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>7</td>
<td>20</td>
</tr>
<tr>
<td>9</td>
<td>20</td>
</tr>
<tr>
<td>11</td>
<td>27</td>
</tr>
</tbody>
</table>

(i) Explain why the paper discs rose to the surface of the solution in some of the tubes.

(ii) (1) Work out the rate of reaction from the value of T for each tube. Tabulate your answer.

(ii) (2) Using the data obtained in (1), plot a graph on graph paper to show the effect of pH on catalase activity.

(iii) (1) Based on your graph, estimate the optimum pH of catalase.

(iv) In order to get a more accurate estimate of the optimum pH, what further work would you carry out in this experiment?
3. (c) The photomicrograph below shows part of the transverse section of a herbaceous stem:

- cell type A
- cell type B
- cell type C
- cell type D

(i) Based on the photomicrograph, state two features that can be observed in cell type C but not in cell type B. (2 marks)

(ii) Some insects use their tube-like mouthparts to obtain a continuous supply of carbohydrate from one of the cell types shown above. Using the letters in the photomicrograph, state which cell type it is. What is the main carbohydrate that can be obtained? (2 marks)

(iii) When this stem is heavily infected by a fungus, cell type C is often blocked up by the fungal hyphae.

   (1) On a hot day, the infected stem droops and bends whereas an uninfected stem remains upright. Account for the appearance of the infected stem. (4 marks)

   (2) State the ecological relationship between the fungus and the infected plant. (1 mark)

4. (a) In the 17th century, a Dutch scientist, van Helmont, wanted to test the following hypothesis: The soil is the main source of food for plant growth. He grew a young willow plant in a known mass of soil for five years. In this period, he only supplied the plant with water. His investigation is summarized in the diagram below:

   ![Diagram of plant growth]

   - 90.90 kg dry soil + 2.25 kg plant → pot after 5 years → 90.85 kg dry soil + 76.90 kg plant

   (i) Calculate the change in mass of the dry soil and that of the plant in these five years. (1 mark)

   (ii) Based on the results obtained in (i), what conclusion can you draw with reference to the above hypothesis? Explain your answer. (3 marks)

   (iii) Explain why it is important to put a cover on the pot in this investigation. (2 marks)

   (iv) At van Helmont's time, people did not know that carbon dioxide in the air is also needed by plants for making food.

      (1) You are provided with a destarched potted plant. Draw a labelled diagram of an experimental set-up which can be used to show that carbon dioxide is necessary for the plant to make food. (3 marks)

      (2) What is the purpose of destarching the plant before the experiment? State how you would destarch the plant. (2 marks)
4. (b) The photograph below shows the transverse section of a pig’s heart, which has a structure similar to that of the human heart.

4. (c) Cholera is a human disease caused by a type of bacteria. It is transmitted through contaminated water and food. A vaccine against this disease is made up of killed cholera bacteria. To study the effectiveness of the vaccine, a mouse was first injected with the vaccine and then with live cholera bacteria 20 days later. During the study, the mouse showed no sign of cholera. The changes in the antibody level in the plasma of the mouse are shown in the graph below:

(i) Which chamber of the heart, A or B, is responsible for sending out blood to all parts of the body except the lungs? Explain your choice. (3 marks)

(ii) (1) Name valve X. (1 mark)

(2) In a type of heart disorder, valve X cannot close properly. A man suffering from this disorder may faint easily when he performs vigorous exercise. How would you explain this? (4 marks)

(iii) Vessel Y is an artery found in the heart wall. Explain why the risk of heart attack would be higher if fatty substances are deposited on the inner wall of vessel Y. (2 marks)

(i) Explain the rise in the antibody level between day 5 and day 7. (2 marks)

(ii) State two differences between the patterns of antibody production as induced by the two injections. Suggest an explanation for such differences. (5 marks)

(iii) People may be infected with cholera through eating contaminated seafood. Besides vaccination, suggest two ways to reduce the risk of cholera infection through eating seafood. (2 marks)

END OF PAPER