Thursday 25 May 2017          Afternoon          Time allowed: 1 hour 30 minutes

Materials
For this paper you must have:
• a ruler with millimetre measurements
• a scientific calculator, which you are expected to use where appropriate.

Instructions
• Use black ink or black ball-point pen.
• Fill in the boxes at the top of this page.
• Answer all questions.
• You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
• All working must be shown.
• Do all rough work in this book. Cross through any work you do not want to be marked.

Information
• The marks for questions are shown in brackets.
• The maximum mark for this paper is 75.
Figure 1 shows part of a DNA molecule.

01. **How many nucleotides are shown in Figure 1?**

[1 mark]

01. 2

01. **Name the type of bond labelled X in Figure 1.**

[1 mark]
The enzymes DNA helicase and DNA polymerase are involved in DNA replication.

Describe the function of each of these enzymes. [2 marks]

DNA helicase


DNA polymerase


Adenosine triphosphate (ATP) is a nucleotide derivative.

Contrast the structures of ATP and a nucleotide found in DNA to give two differences. [2 marks]

1


2


A student investigated the effect of three types of disinfectant on the growth of *Lactobacillus* bacteria.

During the investigation, the student:
- boiled the agar before pouring the agar plates
- transferred 0.5 cm$^3$ of a diluted liquid culture of *Lactobacillus* onto each agar plate
- left some agar plates as controls
- added to other agar plates different concentrations of the disinfectants as shown in Table 1 on page 5.

After 2 days, she counted the number of colonies of bacteria on each agar plate.

Explain the purpose of:

**[2 marks]**

boiling the agar

transferring the same volume of liquid culture onto each agar plate.
The three disinfectants used by the student were Lysol, propan-2-ol and ammonia.

Table 1 shows the student’s results.

<table>
<thead>
<tr>
<th>Concentration of disinfectant / arbitrary units</th>
<th>Number of colonies of bacteria</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lysol</td>
</tr>
<tr>
<td>0</td>
<td>300</td>
</tr>
<tr>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>15</td>
<td>0</td>
</tr>
<tr>
<td>20</td>
<td>0</td>
</tr>
</tbody>
</table>

The liquid culture the student transferred was diluted by 1 in 10 000 (10^{-4}).

Use information in this question to calculate how many bacteria were present in 1 cm^3 of undiluted liquid culture.

[2 marks]

Answer = ________________________

Question 2 continues on the next page
The student concluded that the minimum concentration of propan-2-ol needed to stop the growth of *Lactobacillus* was 15 units. This conclusion is incorrect.

Describe how you could obtain a more accurate estimate of the minimum concentration of propan-2-ol needed to stop the growth of this species of bacterium.

[2 marks]
**Figure 2** outlines the digestion and absorption of lipids.

**Tick** (✓) the box by the name of the process by which fatty acids and glycerol enter the intestinal epithelial cell.

[1 mark]

- Active transport
- Diffusion
- Endocytosis
- Osmosis
Explain the advantages of lipid droplet and micelle formation. [3 marks]

Name structure Q in Figure 2 and suggest how it is involved in the absorption of lipids. [4 marks]

Name __________________________

How it is involved __________________________

[Extra space] __________________________
Figure 3 shows the volume changes in the left ventricle of a human heart during two cardiac cycles. The numbers 1, 2, 3 and 4 represent times when heart valves open or close.

Figure 3

Use information from Figure 3 to complete Table 2. Place the number 1, 2, 3 or 4 in the appropriate box.

Table 2

<table>
<thead>
<tr>
<th></th>
<th>Valve opens</th>
<th>Valve closes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Semi-lunar valve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Atrioventricular valve</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Use Figure 3 to calculate the volume of blood pumped per minute by the left ventricle.

Answer = \_\_\_\_\_\_\_\_\_\_\_\_\_\_ cm³ min⁻¹
04.3 Explain the role of the heart in the formation of tissue fluid. [2 marks]

04.4 Lymphoedema is a swelling in the legs which may be caused by a blockage in the lymphatic system.

Suggest how a blockage in the lymphatic system could cause lymphoedema. [1 mark]
Scientists measured the mean amino acid concentration in white wines made from grapes grown organically and white wines made from grapes that were not grown organically.

Which test could the scientists have used to identify that there are amino acids in white wine? [1 mark]

All amino acids have the same general structure. Figure 4 shows the structure of the amino acid isoleucine.

Draw a box around the part of the molecule that would be the same in all amino acids. [1 mark]

Name the chemical element found in all amino acids that is not found in triglycerides. [1 mark]
The scientists used a statistical test to determine whether there was a significant difference in the amino acid concentration in the two types of white wine. They obtained a value for P of 0.04.

Name the statistical test the scientists used and give a reason for your answer.

Was the difference significant? Give a reason for your answer.

[3 marks]

Name of statistical test

Reason for choice

Explanation of test result
Figure 5 shows the life cycle of a moss plant. In this life cycle, only the stalk and spore capsule are diploid. All the cells in all the other stages of the life cycle of the moss are haploid.

Which letter, A, B, C or D, in Figure 5, shows where meiosis occurs in the life cycle of the moss? Write the appropriate letter in the box provided.

[1 mark]
Explain how the chromosome number is halved during meiosis.

Figure 6 shows a cell from the moss plant.

The cell is in the second meiotic division.

What is the haploid number of chromosomes for this species of moss?
Crossing over greatly increases genetic diversity in this species of moss.

Describe the process of crossing over and explain how it increases genetic diversity.

[4 marks]
Describe how you would use cell fractionation techniques to obtain a sample of chloroplasts from leaf tissue. Do not include in your answer information about any solutions.

[3 marks]

Table 3 shows features of a mitochondrion and a chloroplast. Complete Table 3 with ticks where a feature is present.

[3 marks]

<table>
<thead>
<tr>
<th>Feature</th>
<th>Mitochondrion</th>
<th>Chloroplast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Double outer membrane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Starch grains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diffusion of oxygen into the organelle</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Give the function of a mitochondrion. [1 mark]

Scientists investigated the effect of an exercise programme on the number and size of mitochondria in skeletal muscle. They took samples of muscle from a large number of volunteers before and after the exercise programme. From each sample, they cut thin sections and used these to determine the mean number of mitochondria per μm² and the mean area of inner mitochondrial membranes.

Their results are shown in Figure 7 and Figure 8.

What do the data in Figure 7 and Figure 8 suggest about the effect of the exercise programme on mitochondria? [2 marks]
Give **three** properties of water that are important in biology. [3 marks]

1. ________________________________
2. ________________________________
3. ________________________________

A student investigated the effect of different concentrations of sucrose solution on “chips” cut from a potato. Each chip had the same dimensions.

The student:
- weighed each chip at the start
- placed each chip in a separate test tube, each containing 10 cm³ of sucrose solution at a different concentration
- left the chips in the sucrose solution for 24 hours
- dried the surface of the chips and then weighed them again.

**Table 4** shows the student’s results.

<table>
<thead>
<tr>
<th>Concentration of sucrose solution / mol dm⁻³</th>
<th>Initial mass of chip / g</th>
<th>Final mass of chip / g</th>
<th>Ratio of final mass to initial mass of chips</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>2.79</td>
<td>3.82</td>
<td></td>
</tr>
<tr>
<td>0.2</td>
<td>2.75</td>
<td>2.97</td>
<td></td>
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<tr>
<td>0.4</td>
<td>2.78</td>
<td>2.67</td>
<td></td>
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<tr>
<td>0.6</td>
<td>2.69</td>
<td>2.31</td>
<td></td>
</tr>
<tr>
<td>0.8</td>
<td>2.72</td>
<td>2.20</td>
<td></td>
</tr>
<tr>
<td>1.0</td>
<td>2.77</td>
<td>1.99</td>
<td></td>
</tr>
</tbody>
</table>
The student produced the sucrose solutions with different concentrations from a concentrated sucrose solution.

Name the method she would have used to produce these sucrose solutions.

[1 mark]

Name of method

Calculate the ratio of final mass to initial mass of potato chips and plot a suitable graph of your processed data. Express the ratios in Table 4 as a single number (for example 5.26:1 would be expressed as 5.26).

[3 marks]
08.4

Explain the result for the chip in 0.8 mol dm$^{-3}$ sucrose solution.

[2 marks]
Define each of the following terms. [2 marks]

Species

Species richness

Scientists investigated the species richness of fish caught at various depths in the Pacific Ocean close to the western coast of Chile.

**Figure 9** shows the scientists’ results. 68% of all the fish caught in this investigation came from sample A.

What is the modal value of species richness? [1 mark]
68% of all the fish caught in this investigation came from sample A. A student thought this showed that sample A had a greater index of diversity than any of the other samples.

It is not possible to draw this conclusion from the given data. Give reasons why.

[3 marks]
Azidothymidine (AZT) is a drug used to treat people infected with human immunodeficiency virus (HIV). It inhibits the enzyme that synthesises DNA from HIV RNA. This does not destroy HIV in the body but stops or slows the development of AIDS.

In the past, some people who took AZT on its own eventually developed AIDS. Some of the HIV in their bodies had become resistant to AZT. To prevent this from happening, people infected with HIV are now treated with highly active antiretroviral therapy (HAART). This involves taking AZT with other anti-HIV drugs at the same time.

AZT is taken in low doses. This is because people who took high doses over long periods of time suffered muscle wastage. It was found that high doses of AZT inhibit replication of mitochondria.

Use information from the passage and your own knowledge to answer the questions.

Suggest and explain why AZT does not destroy HIV in the body but stops or slows the development of AIDS (lines 3–4).

[4 marks]

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[Extra space] __________________________________________________________
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Suggest and explain **two** advantages of using HAART (lines 7–9).

<table>
<thead>
<tr>
<th></th>
<th>Advantage 1</th>
<th>Advantage 2</th>
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**Question 10 continues on the next page**
Suggest why high doses of AZT lead to muscle wastage (lines 10–11). [2 marks]

END OF QUESTIONS