READ THE FOLLOWING INSTRUCTIONS CAREFULLY.

1. This paper consists of SIX questions in two sections. Answer ALL questions.

2. For Section A, write your answers in the spaces provided in this booklet.

3. For Section B, write your answers in the spaces provided at the end of each question in this booklet.

4. The use of silent non-programmable calculators is allowed.
SECTION A

Answer ALL questions.

Write your answers in the spaces provided in this booklet.

1. (a) Table 1 presents results of an investigation of the nutritional composition of various foods from an average American diet.

**TABLE 1: ANALYSIS OF SPECIFIC NUTRIENTS IN COMMON FOODS USING KNOWN REAGENTS**

(Note: For reagents which require a colour change to indicate the presence of a nutrient, results were recorded based on a colour index (range) of changes observed for any one reagent.)

| Food Substance | FOOD TEST REAGENT | Grease Spot on Brown Paper*
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Biuret Solution</td>
<td>Benedict’s Solution</td>
</tr>
<tr>
<td>Eggs</td>
<td>Purple</td>
<td>Blue</td>
</tr>
<tr>
<td>Milk</td>
<td>Pink</td>
<td>Pale yellow</td>
</tr>
<tr>
<td>Cheerios cereal</td>
<td>Pale blue (almost clear)</td>
<td>Brick-red</td>
</tr>
<tr>
<td>Hamburger patty</td>
<td>Purple</td>
<td>Blue</td>
</tr>
<tr>
<td>Carrot</td>
<td>Pale blue (almost clear)</td>
<td>Orange</td>
</tr>
<tr>
<td>Potato chips</td>
<td>Pink</td>
<td>Brick-red</td>
</tr>
<tr>
<td>Pepperoni pizza</td>
<td>Purple</td>
<td>Yellow</td>
</tr>
<tr>
<td>Donut</td>
<td>Pink</td>
<td>Orange</td>
</tr>
</tbody>
</table>

* Grease Spot on Brown Paper Test:

1. Using a glass rod, a sample of the food being tested is rubbed on a section of brown paper (labelled with the sample being tested). “Wet” spot appears on the paper.

2. Any excess food which may stick to the paper is removed using a paper towel.
3. The sample paper is left to dry for about 10 minutes.
4. A translucent spot indicates a positive result for the specific nutrient being tested.
5. Isopropyl alcohol serves to dissolve the nutrient in the food substance.

(i) State the nutrient being tested for, by EACH of the following tests:

- Biuret: ________________________________
- Benedict’s: ________________________________
- Lugol’s Iodine: ________________________________
- Grease spot: ________________________________ [2 marks]

(ii) Using the data presented in Table 1, determine TWO food substances which contain all four nutrients being tested for in this investigation.

____________________________________________________________________________________ [1 mark]

(iii) With reference to the qualitative results given in Table 1, suggest which foods are good sources of nutrients for cell structure and growth of the cell, and for supply of energy. Justify your answer with a brief explanation.

Cell structure and growth of the cell:

____________________________________________________________________________________

____________________________________________________________________________________

Supply of energy:

____________________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________ [4 marks]
(b) Figure 1 is a diagrammatic representation of the molecular structure of a short section of a glycogen molecule.

![Diagram of glycogen molecule]

**Figure 1. Short section of a glycogen molecule**

(i) Using a labelled arrow on Figure 1, highlight the location of EACH of the following:

a) An alpha 1,4-glycosidic linkage

b) An alpha 1,6-glycosidic linkage  [2 marks]

(ii) In the space below, sketch the general shape of one glycogen molecule.  
[Details of individual glucose residues are NOT required.]

Space for diagram  [2 marks]
(iii) Amylose (starch) and cellulose are both polymers of glucose molecules but they differ in their structure and function in plant cells. With reference to ONE structural property, briefly explain the functional differences of amylose and cellulose in plant cells.

[4 marks]

Total 15 marks

2. (a) In a cross between a plant with purple flowers and a plant with white flowers, all the F₁ plants had purple flowers. When the F₁ offspring were crossed (selfed), 705 plants had purple flowers and 224 plants had white flowers.

(i) State the expected ratio for the cross of the F₁ offspring.

[1 mark]

(ii) State an appropriate null (H₀) hypothesis and an appropriate alternative (H₁) hypothesis for a Chi-square test of the results.

H₀: __________

H₁: __________

[2 marks]
(iii) Complete Table 2 by calculating the missing values.

**TABLE 2: DATA FOR CHI-SQUARE TEST**

<table>
<thead>
<tr>
<th>Phenotype</th>
<th>Observed (O)</th>
<th>Expected (E)</th>
<th>O - E</th>
<th>(O - E)²/E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purple flowers</td>
<td>705</td>
<td>696</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White flowers</td>
<td>224</td>
<td>233</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\[
\chi^2 = \sum \left[ \frac{(O - E)^2}{E} \right]
\]

[4 marks]

(iv) Determine the number of degrees of freedom. Show your calculation.

[1 mark]

(v) Using the Chi-square values in Table 3, comment on the validity of the null hypothesis stated on page 5.

[2 marks]

**TABLE 3: CHI-SQUARE (\(\chi^2\)) VALUES**

<table>
<thead>
<tr>
<th>Degrees of Freedom</th>
<th>Number of Classes</th>
<th>Chi-square Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>0.46 1.64 2.71 3.84 6.64 10.83</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>1.39 3.22 4.61 5.99 9.21 13.82</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>2.37 4.64 6.25 7.82 11.34 16.27</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>3.36 5.99 7.78 9.49 13.28 18.47</td>
</tr>
</tbody>
</table>

Probability that chance alone could produce this deviation

\[
\begin{array}{cccccc}
0.50 & 0.20 & 0.10 & 0.05 & 0.01 & 0.001 \\
(50\%) & (20\%) & (10\%) & (5\%) & (1\%) & (0.1\%)
\end{array}
\]
(b) Figure 2 represents the elongation stage of translation in protein synthesis.

![Diagram of elongation stage of translation]

**Figure 2. Elongation stage of translation in protein synthesis**


(i) What is the term used to describe EACH group of three bases on the mRNA and tRNA?

(ii) Using the mRNA strand below, identify the corresponding triplet bases on the tRNA molecules. Write your answer in the boxes provided. Hint: Begin at the 5' end.

mRNA 5' UGG UUU GGC UCA 3'

(iii) Outline the nucleotide sequence on the DNA strand which serves as the template for the mRNA strand in (b) (ii).

[2 marks]

Total 15 marks
3. (a) Table 4 is an incomplete table comparing the process of spermatogenesis with that of oogenesis.

**TABLE 4: COMPARISON OF THE PROCESS OF SPERMATOGENESIS AND OOGENESIS**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Spermatogenesis</th>
<th>Oogenesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of meiotic daughter cells which develop into mature gametes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duration of the process (mitotic division of stem cells and differentiated spermatogonia/oogonia) in the life span of the individual</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(i) Complete Table 4 with respect to the features listed for spermatogenesis and oogenesis in humans. [3 marks]

(ii) Outline the roles of follicle-stimulating hormone (FSH) and luteinizing hormone (LH) in the regulation of spermatogenesis.

**FSH:**

**LH:**

[3 marks]
(b) Figure 3 is a representation of a photomicrograph of a stained section through a human ovary showing developing ova.

Figure 3. Representation of a photomicrograph of a section through an ovary

In the box below, make a plan drawing of the ovary to include the stage of the developing ovum just prior to release from the ovary.

[6 marks]
Figure 4 is a diagram of a section through a carpel of an angiosperm plant showing the process of double fertilization.

![Diagram of a section through a carpel of an angiosperm plant showing the process of double fertilization.]

Figure 4. Section through the carpel of an angiosperm plant

Comment on the fate of the structure labelled X and the structure labelled Y, which includes the ovule walls and the embryo sac and its contents.

X: ________________________________________________________________________________________
________________________________________________________________________________________

Y: ________________________________________________________________________________________
________________________________________________________________________________________

[3 marks]

Total 15 marks
SECTION B

Answer ALL questions.

Write your answers in the spaces provided at the end of each question.

4. (a) Define the term ‘diffusion’, and distinguish between active transport and facilitated diffusion in cells. [4 marks]

(b) (i) With the aid of a simplified labelled diagram, describe the fluid mosaic model of membrane structure. [6 marks]

(ii) With reference to the fluid mosaic model, discuss how polar molecules and ions are transported. [5 marks]

Total 15 marks

Write the answer to Question 4 here.
Write the answer to Question 4 here.
Space for diagram.
5. (a) *Mycobacterium tuberculosis,* the bacterium that causes tuberculosis, has been virtually eliminated by the widespread use of two effective antibiotics. Due to the development of antibiotic-resistant strains of the bacterium, the disease has re-emerged as a major public health problem.

(i) Applying Darwin’s theory of evolution by natural selection, discuss how resistance to antibiotics could have evolved in bacteria. Include in your discussion a concise explanation of natural selection. [6 marks]

(ii) Briefly comment on why mutation is regarded as a driving force of evolution. [2 marks]

(b) Define the term ‘speciation’, and using examples, explain how geographical isolation may lead to speciation. [7 marks]

Total 15 marks

Write the answer to Question 5 here.
Write the answer to Question 5 here.
6. (a) (i) Give a concise description of the key stages in the fertilization of a human secondary oocyte by a spermatozoon. Begin your account with the acrosome reaction. [5 marks]

(ii) Briefly comment on the significance of the process of fertilization. [2 marks]

(b) (i) Describe TWO major functions of the placenta. [4 marks]

(ii) Discuss TWO ways in which maternal behaviour can affect foetal development. [4 marks]

Total 15 marks

Write the answer to Question 6 here.

________________________________________________________________________

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________________________________________________________________________

GO ON TO THE NEXT PAGE
Write the answer to Question 6 here.
Write the answer to Question 6 here.

END OF TEST

IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK ON THIS TEST.