# Unit 4 Biology

## Revision Booklet 10

### Topics

**DNA**

**Organisation of genetic material**

**Gene function: genes in action**

**Protein Synthesis**

**DNA Replication**

Name: .....

## SECTION B – Short answer questions

**Instructions for Section B**

Answer this section in pen.

Answer **all** questions in the spaces provided.

**Question 1**

In Australia, Alzheimer's disease is the most common form of dementia. Alzheimer's disease is associated with the development of a toxic protein in the brain known as amyloid beta-protein. The amyloid beta-protein builds up to form plaques in the brain. This causes symptoms such as memory loss.

The synthesis of amyloid beta-protein occurs in two stages.

**a.** Name the two stages of protein synthesis.

_____

_____

1 mark

**b.** Describe the main steps of the **first stage** of synthesis of amyloid beta-protein.

_____

_____

_____

_____

_____

_____

_____

_____

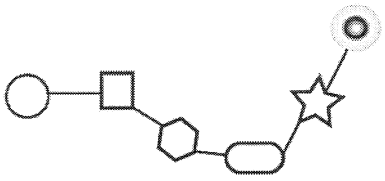
_____

_____

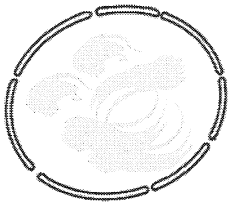
3 marks

**c.** Consider the diagrams of the following six structures.

M



J



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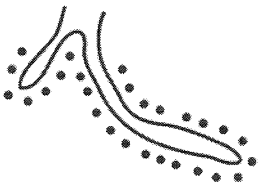

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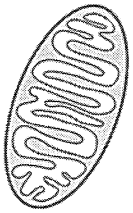

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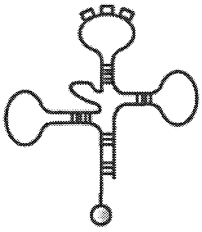


S


not to scale

Choose three of the structures shown above that are involved in the **second stage** of protein synthesis. Explain the role of each in producing amyloid beta-protein.

| **Letter representing structure chosen** | **Role of structure in second stage of amyloid beta-protein synthesis** |
|---|---|
| | |
| | |
| | |

3 marks

**Question 4**

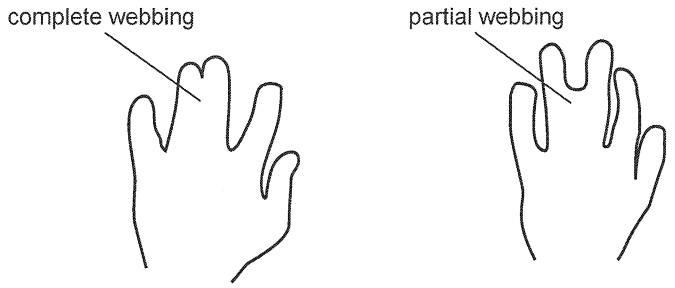
**a.** Draw a labelled diagram to outline the process of DNA replication.

4 marks

**b.** Briefly describe how the process of binary fission varies from that of mitosis.

2 marks

The following diagram shows a hand from two individuals who have each been born with syndactyly.




Syndactyly is a condition in which two or more fingers or toes do not separate during fetal development. An individual may have either complete or partial webbing.

Apoptosis plays a role in the presence or absence of webbing between fingers and toes.

**c.** Define apoptosis and outline the role it plays with respect to the prevention of syndactyly.

2 marks

Syndactyly is inherited as an autosomal dominant trait.

Ruby and her father have syndactyly. Ruby's mother has normal fingers and toes. Ruby marries Jonah, who has normal fingers and toes.

**d.** What is the chance that a child of Ruby and Jonah will have syndactyly? Assign symbols to represent the alleles of syndactyly. Show all working.

2 marks

## SECTION B – Short answer questions

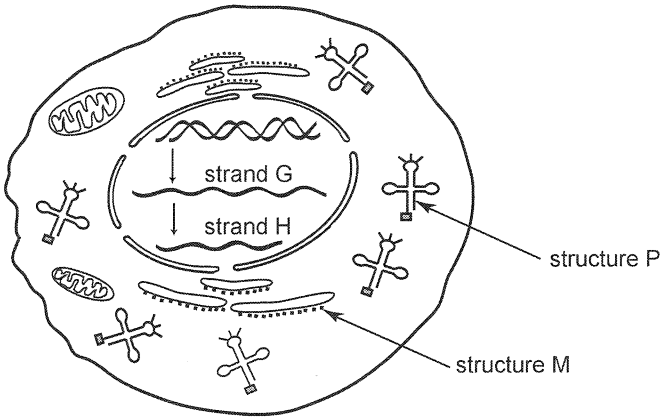
**Instructions for Section B**

Answer this section in pen.

Answer **all** questions in the spaces provided.

**Question 1**

Consider the following diagram of a cell. The parts of the diagram are not drawn to scale.




**a.** In which structure would RNA polymerase be found?

1 mark

**b.** Describe the function of RNA polymerase.

2 marks

**c.** Strand H is shorter than strand G. Describe the process that results in this shortening, using appropriate names for both strands.

2 marks

**d.** Name strand H and structures P and M. Explain how each contributes to protein synthesis.

Strand H _____

_____

_____

Structure P _____

_____

_____

Structure M _____

_____

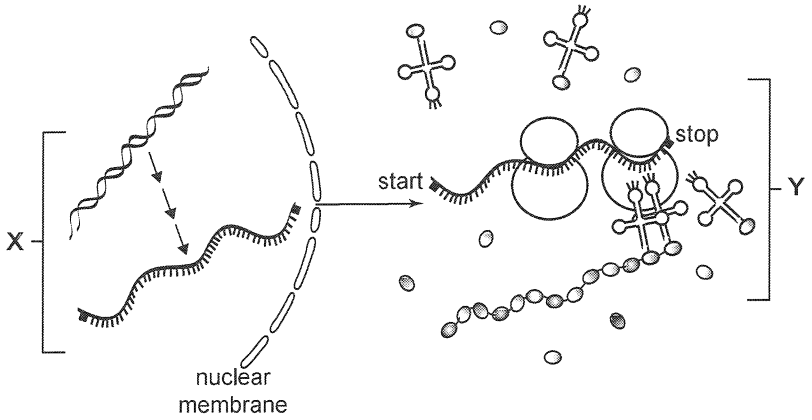
_____

3 marks

Total 8 marks

**Question 2**

The following diagram outlines processes that occur in living cells.




**a.** **i.** Name the process represented at **X**.

_____

**ii.** Describe the sequence of events that occur during the process at **X**.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

1 + 3 = 4 marks

**b.** **i.** Name the process represented at **Y**.

_____

**ii.** Describe the sequence of events that occur during the process at **Y**.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

1 + 3 = 4 marks

Total 8 marks

Translation occurs within the cytosol of a cell.

1 **d.** Outline the steps that normally occur in translation. Use specific terms and names of the molecules involved. Name the final product of the process.

3 marks

Total 6 marks

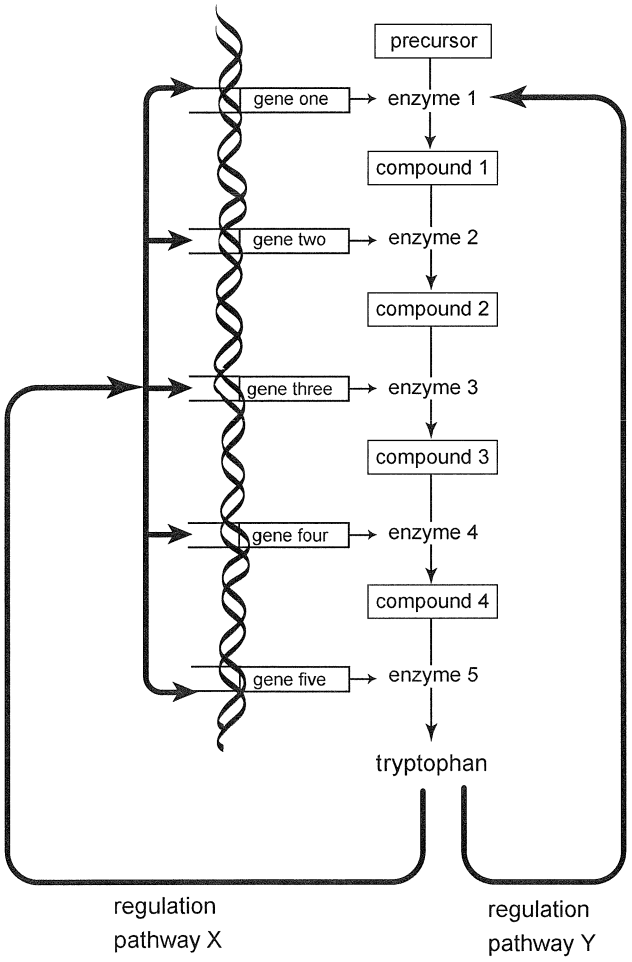
**Question 3**

**a.** Explain what is meant by gene regulation.

1 mark

Bacteria require amino acids to produce proteins. For example, bacteria in a human intestine may absorb amino acids from digested food, but at times there may be a deficiency of a particular amino acid. If this is the case, the bacteria will produce the necessary amino acid themselves.

The diagram below is a regulation system in a bacterial cell involving the production of the amino acid tryptophan. Note that there are two pathways (X and Y). Tryptophan is the regulatory compound in these two pathways and acts as a repressor in both.




**b.** Describe the immediate outcome when tryptophan activates pathway X.

1 mark

**c.** Describe the immediate outcome when tryptophan activates pathway Y.

1 mark

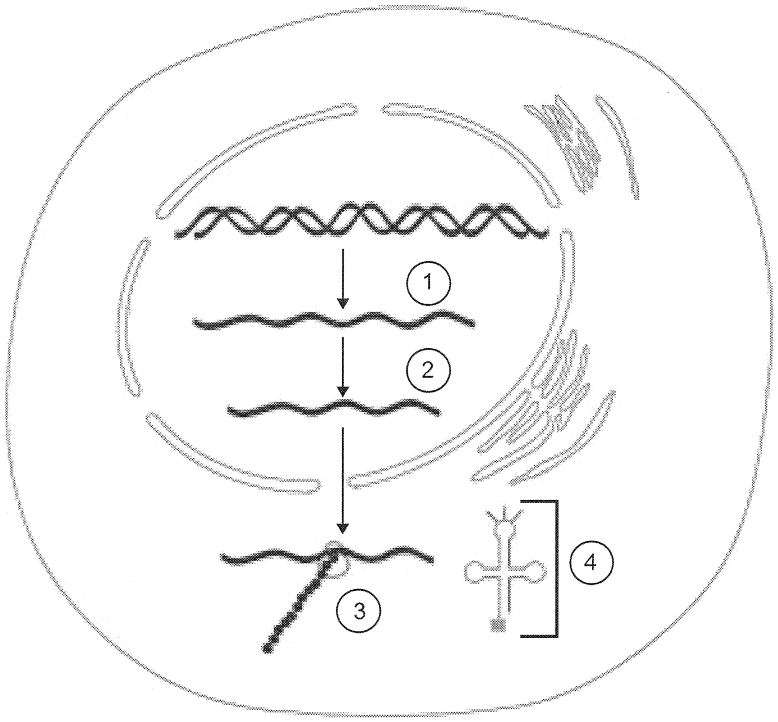
**d.** Suggest how the action of tryptophan as a repressor in this system could be of selective advantage to a bacterial cell in the digestive tract.

2 marks

Total 5 marks

**Question 2**

The following diagram outlines events associated with the production of a polypeptide chain in a eukaryotic cell.




**a.** What is the name of the process at step 1?

_____

1 mark

**b.** **i.** Name the product of step 1.

_____

**ii.** Outline what occurs at step 2.

_____

_____

_____

_____

1 + 1 = 2 marks

**c.** Name the event that occurs at structure 3.

_____

1 mark

**d.** **i.** Name the structure at 4.

_____

**ii.** Outline the function of the structure you named in **d.i.**

_____

_____

_____

_____

1 + 1 = 2 marks

Total 6 marks

**Question 7**

Organisms can regulate the expression of their genes in a number of ways.

**a.** Suggest why an organism regulates the expression of its genes.

_____

_____

_____

1 mark

One example in bacteria is the regulation of the expression of a gene which produces an enzyme (enzyme X) involved in the metabolism of the amino acid tryptophan. Enzyme X is only produced when tryptophan is in high concentration. This gene regulation involves several genes. Two of the genes include a gene for the production of enzyme X and an operator gene. If a protein, called a repressor protein, binds to the operator gene, transcription of the gene for enzyme X is stopped. If no repressor protein is bound to the operator, transcription of the gene for enzyme X occurs. A summary of this regulation is shown in Figure 1.

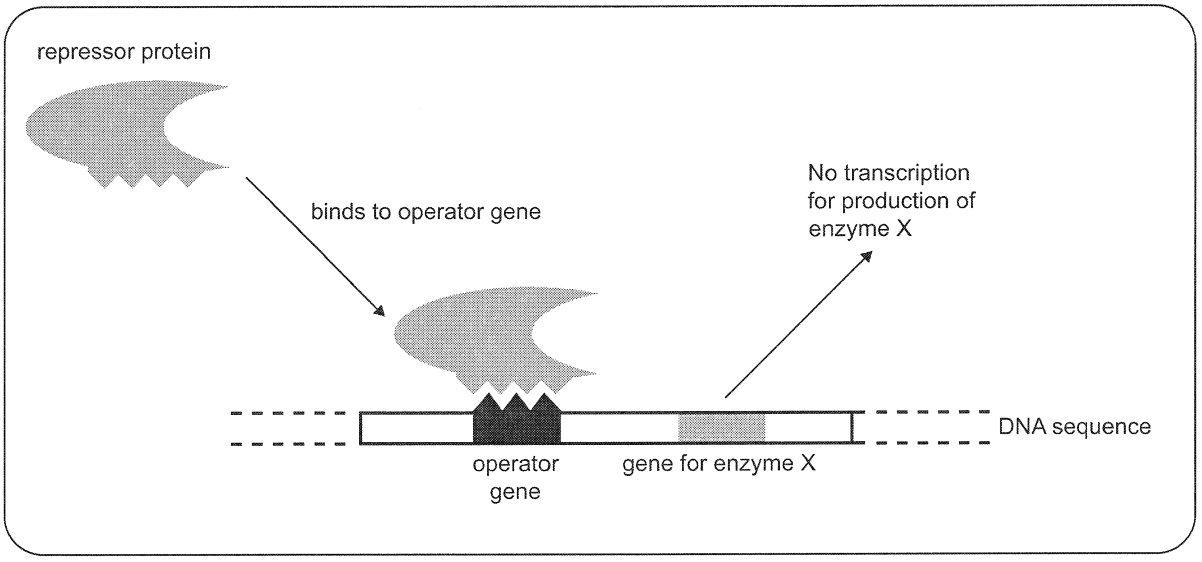



**Figure 1**

**b.** The gene coding for enzyme X is not transcribed when the repressor protein binds to the operator gene. What enzyme is prevented from functioning during this binding?

_____

1 mark

When tryptophan binds to the repressor protein, the repressor protein can no longer bind to the operator gene. (See Figure 2.)

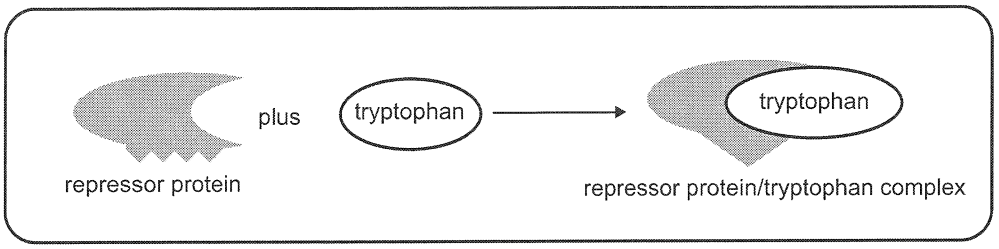



**Figure 2**

**c.** When tryptophan binds to the repressor protein what will happen to the production of enzyme X?

_____

1 mark

**d.** Based on Figure 2, suggest how tryptophan prevents repressor protein function.

_____

_____

_____

_____

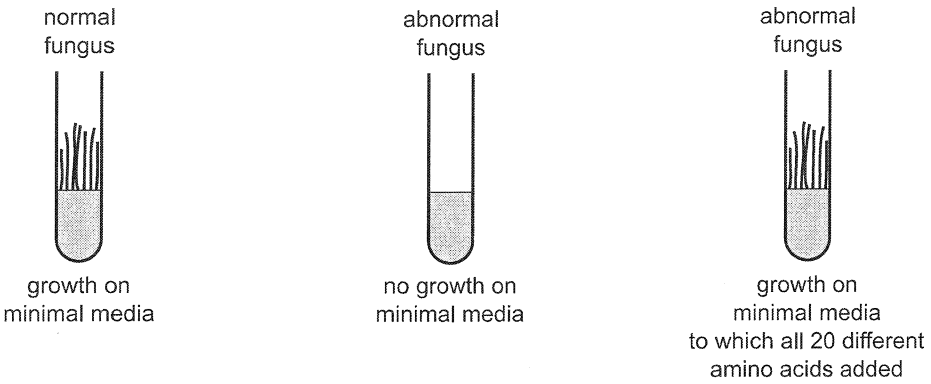
1 mark

Total 4 marks

**Question 5**

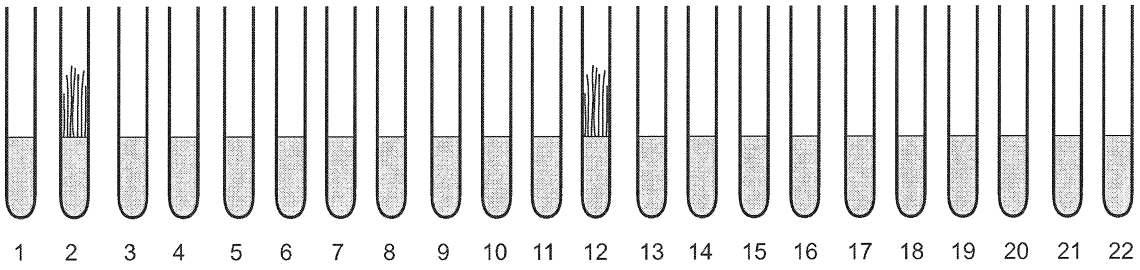
Fungi can make their own amino acids and are able to grow on a substance called minimal media.

An abnormal strain of fungus that could not grow on minimal media was discovered. The abnormal fungus was able to grow on minimal media to which all of the twenty amino acids were added. These observations can be summarised as follows.




It was assumed that the deficiency in the abnormal fungus was because of a fault in the genetic material coding for the production of one of the amino acids.

An experiment was designed to investigate which amino acid was involved. The experimental set up, involving 22 tubes, is outlined in the following diagram and the results are shown.




Tube 1 Minimal media

Tube 2 Minimal media plus all 20 different amino acids added

Tubes 3 to 22 Minimal media + one of the 20 amino acids. Each tube contained a different amino acid.

Spore of abnormal fungus was added to surface of media in each tube. All tubes were incubated under the same conditions for several days and then examined.

**a.** Why were tubes 1 and 2 included in the experiment?

_____

_____

1 mark

The diagram shows that the fungus grew in tube 12. The amino acid histidine had been added to this tube.

**b.** From the above experiment what two conclusions can be made about the ability of the abnormal fungus to produce amino acids?

_____

_____

_____

_____

2 marks

Consider the following genetic code table.

| First letter | Second letter: U | Second letter: C | Second letter: A | Second letter: G | Third letter |
|---|---|---|---|---|---|
| U | UUU phe | UCU ser | UAU tyr | UGU cys | U |
| | UUC phe | UCC ser | UAC tyr | UGC cys | C |
| | UUA leu | UCA ser | UAA stop | UGA stop | A |
| | UUG leu | UCG ser | UAG stop | UGG trp | G |
| C | CUU leu | CCU pro | CAU his | CGU arg | U |
| | CUC leu | CCC pro | CAC his | CGC arg | C |
| | CUA leu | CCA pro | CAA gln | CGA arg | A |
| | CUG leu | CCG pro | CAG gln | CGG arg | G |
| A | AUU ile | ACU thr | AAU asn | AGU ser | U |
| | AUC ile | ACC thr | AAC asn | AGC ser | C |
| | AUA ile | ACA thr | AAA lys | AGA arg | A |
| | AUG met | ACG thr | AAG lys | AGG arg | G |
| G | GUU val | GCU ala | GAU asp | GGU gly | U |
| | GUC val | GCC ala | GAC asp | GGC gly | C |
| | GUA val | GCA ala | GAA glu | GGA gly | A |
| | GUG val | GCG ala | GAG glu | GGG gly | G |

**c.** **i.** What sequences of nucleotides in DNA code for the amino acid histidine?
(Note: in the table **his** represents histidine.)

_____

**ii.** Which of the following DNA sequences could lead to the production of an uninterrupted chain of amino acids in the abnormal fungus?

sequence 1 AACGCCTCGGTGCCA
sequence 2 CAAGTAGGTACACTC
sequence 3 TAATGGACCCCCGGT

Sequence _____

**iii.** Explain why you made this selection in **c.ii**.

_____

_____

_____

1 + 1 + 1 = 3 marks

During their work in establishing the structure of DNA, Watson and Crick were interested in the proportion of nucleotides in skin cells from a particular organism. They considered the results from three different laboratories. The result of each of the laboratories was as follows.

| | Laboratory 1 | | | | Laboratory 2 | | | | Laboratory 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **nucleotides in DNA** | **A** | **T** | **C** | **G** | **A** | **T** | **C** | **G** | **A** | **T** | **C** | **G** |
| **per cent** | 29 | 19 | 21 | 31 | 30 | 29 | 20 | 21 | 29 | 32 | 19 | 20 |

**d.** Watson and Crick used the results of laboratories 2 and 3. What difference would it have made to the model they constructed of DNA had they used the results of laboratory 1 only?

_____

_____

1 mark

Total 7 marks