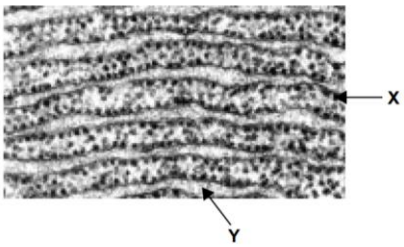
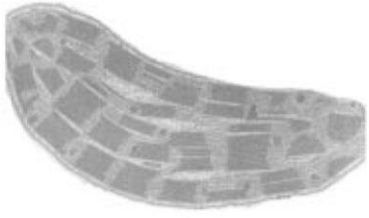
UNIT 4 BIOLOGY MATER CLASSES 2020
REVISION QUESTIONS – UNIT 3 – AOS 1 – PART 1

UNIT 3 AOS 1.1 – PLASMA MEMBRANES

KEY KNOWLEDGE REQUIRED

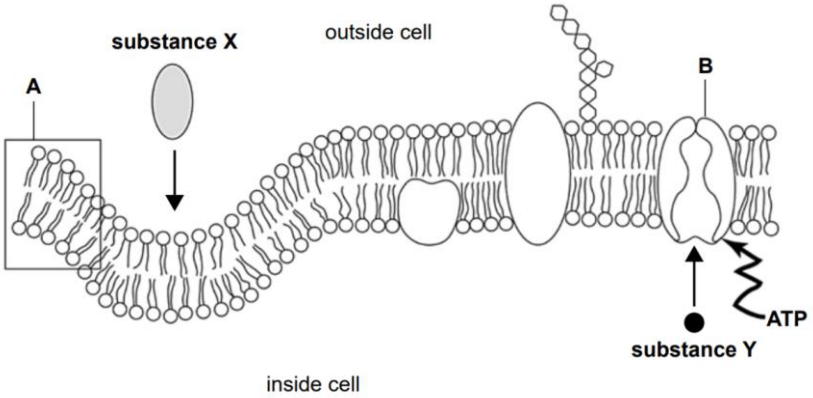
- The fluid mosaic model of the structure of the plasma membrane and the movement of hydrophilic and hydrophobic substances across it based on their size and polarity
- The role of different organelles including ribosomes, endoplasmic reticulum, Golgi apparatus and associated vesicles in the export of a protein product from the cell through exocytosis
- Cellular engulfment of material by endocytosis.

QUESTION 1 – VCAA 2002
The following table contains images of a number of structures seen in cells. Name each of the structures and outline the function of each.

Structure		Name and function
	i.	
	ii.	Structure X
	iii.	Structure Y
	iv.	
	v.	

5 marks

QUESTION 2 – VCAA 2008
The diagram below shows a cross section of part of the plasma membrane of a typical mammalian cell. The substances labelled X and Y are about to be transported across the membrane in the directions shown by the arrows ( ).



a. Structure A

Chemical composition: _____

Explain how the chemical composition of structure A facilitates its role.

_____

_____

b. Structure B

Chemical composition: _____

Explain how the chemical composition of structure B facilitates its role.

_____

_____

Use the following information to answer Questions 3 and 4.

Protein M, made by a particular cell type, is released for use by other cells.

QUESTION 3 – VCAA 2013
The site of synthesis of protein M is the

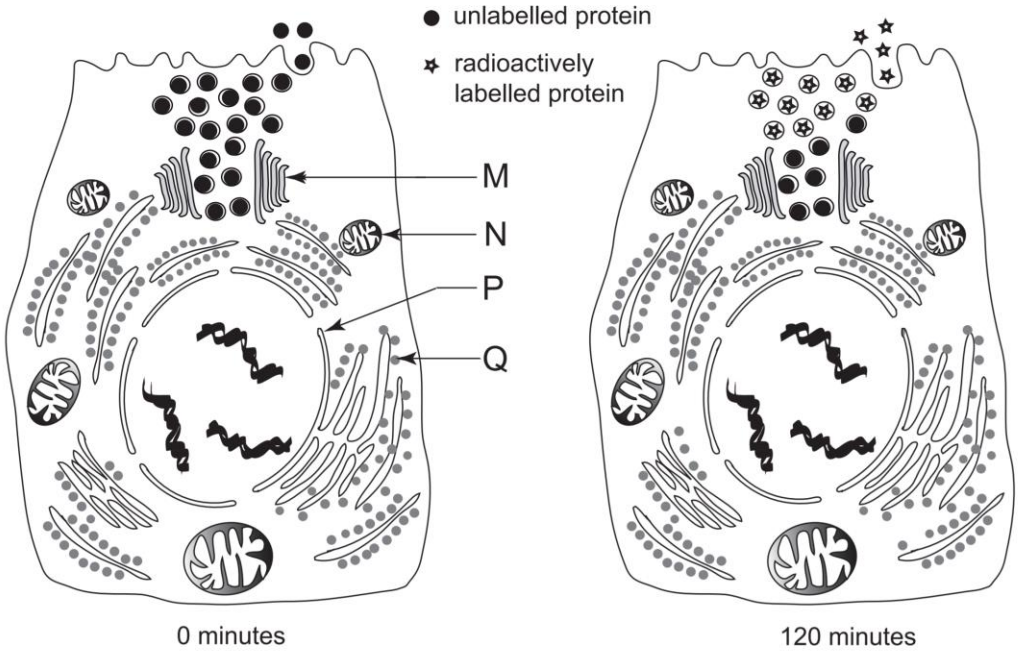
A. vesicles.
B. rough endoplasmic reticulum.
C. plasma membrane.
D. smooth endoplasmic reticulum.

QUESTION 4 – VCAA 2013
The export of protein M by these cells would involve

A. centrioles.
B. lysosomes.
C. the Golgi apparatus.
D. chromosomes.

QUESTION 5 – VCAA 2010

Human pancreatic cells produce proteases that act on the contents of the small intestine. An experiment was performed to track the pathway of protease synthesis and release. This involved feeding pancreatic cells for a brief period with amino acids that had been radioactively labelled. These amino acids can be tracked over time. Images were taken immediately (0 minutes) after feeding the cells, then 3, 20 and 120 minutes later. The results at 0 and 120 minutes are shown below.



At the 3 and 20 minute intervals the radioactive amino acids were observed to be at organelles.

a. Name and describe the functions of organelles M and N. (2 + 2 = 4 marks)

i. Organelle M _____

Function: _____

_____

ii. Organelle N: _____

Function: _____

_____

b. Which of the letters, M, N, P and Q, indicates an organelle where the radioactive amino acids would be expected to be detected after three minutes? (1 mark)

_____

A hormone (hormone Y) travels from its site of production to a cell (cell X) elsewhere in the body.

c. Explain how the characteristics of hormone Y will influence the way in which it initiates signal transduction with cell X. (2 marks)

_____

_____

_____

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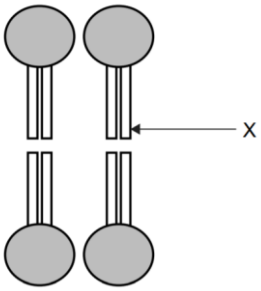
QUESTION 6 – VCAA 2015
The diagram below represents the arrangement of a type of molecule found in the plasma membrane of a cell.



The structure labelled X in the molecule is

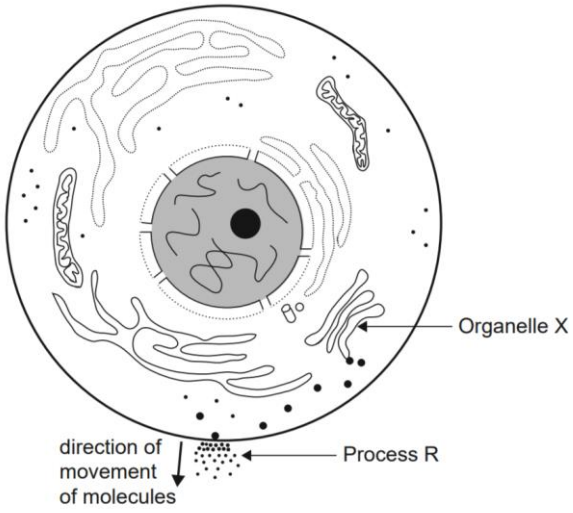
A. a protein.
B. a fatty acid.
C. a disaccharide.
D. an amino group

QUESTION 7 – VCAA 2015
All specialised cells that secrete protein molecules

A. have a rigid cell wall.
B. contain numerous lysosomes.
C. contain functional chloroplasts.
D. have an extensive Golgi apparatus.

Use the following information to answer Questions 8 and 9.

Consider the following cell diagram.



Source: www.cronodon.com

QUESTION 8 – VCAA 2014
Process R is an example of

A. exocytosis.
B. phagocytosis.
C. pinocytosis.
D. endocytosis.

QUESTION 9 – VCAA 2014
Organelle X

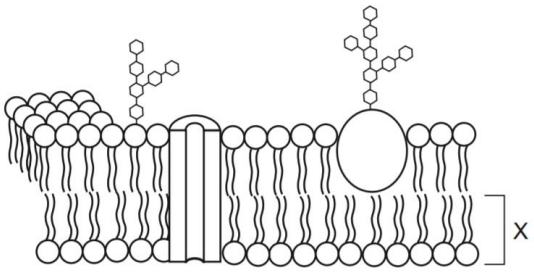
A. is the site of cellular respiration.
B. packages protein molecules for export from the cell.
C. absorbs sunlight and produces carbohydrates.
D. produces ribosomal RNA.

QUESTION 10 – VCAA 2016
In animal cells, tight junctions are multi-protein complexes that mediate cell-to-cell adhesion and regulate transport through the extracellular matrix. Proteins that form these complexes are made within the cell.

One pathway for the production of protein for these junctions is

A. nucleus – ribosome – Golgi apparatus – vesicle – endoplasmic reticulum.
B. nucleus – ribosome – endoplasmic reticulum – vesicle – Golgi apparatus.
C. nucleus – vesicle – endoplasmic reticulum – Golgi apparatus – ribosome.
D. nucleus – vesicle – Golgi apparatus – ribosome – endoplasmic reticulum.

QUESTION 11 – VCAA 2014
The diagram below shows the structure of a plasma membrane.



Source: www.cronodon.com

Structure X represents a molecule of

A. phospholipid.
B. glycoprotein.
C. carbohydrate.
D. cholesterol.

QUESTION 12 – VCAA 2014
When glycogenolysis occurs in a cell, the concentration of glucose in the cytosol increases. Glucose passes through the plasma membrane by facilitated diffusion.

a. Explain how the facilitated diffusion of glucose occurs. (2 marks)

_____

_____

_____

_____

_____

Muscle cells in the heart contract and relax more rapidly during exercise and require a constant supply of energy.

b. Which organelle would you expect to see in large numbers in heart muscle cells to supply this energy? Explain your response. (2 marks)

_____

_____

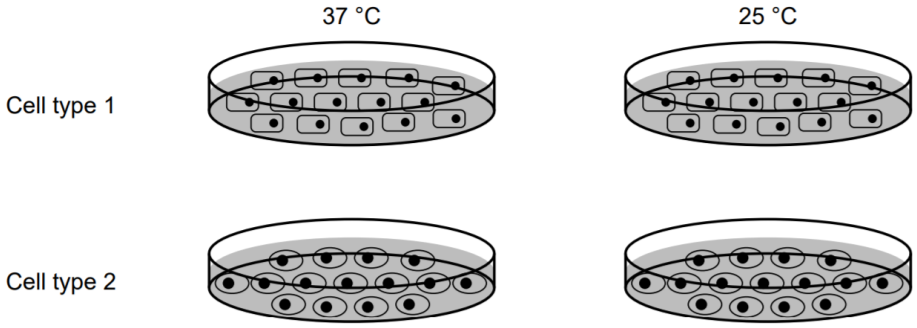
_____

_____

_____

QUESTION 13 – VCAA 2015

In an investigation into the uptake of a protein by cells, scientists immersed two cell types in solutions of this protein. The investigation was carried out at two different temperatures and the percentage of the protein taken up by the two cell types was recorded over 10 minutes.



The data was presented in a table, as shown below.

	Cell type 1 Percentage of protein taken up by cell		Cell type 2 Percentage of protein taken up by cell	
Time (mins)	**At 25 °C**	**At 37 °C**	**At 25 °C**	**At 37 °C**
0	0	0	0	0
2	2	5	5	10
4	4	10	10	20
6	6	12	12	24
8	8	16	16	32
10	8	16	18	36

Which one of the following conclusions is supported by the data?

A. The rate of uptake of this protein at 25 °C is not affected by cell type.

B. The percentage of this protein taken up by Cell type 1 is not affected by temperature.

C. The rate of uptake of this protein by Cell type 2 is faster at 37 °C than at 25 °C.

D. If the experiment continued for another 10 minutes, the percentage of this protein taken up by Cell type 1 would increase.

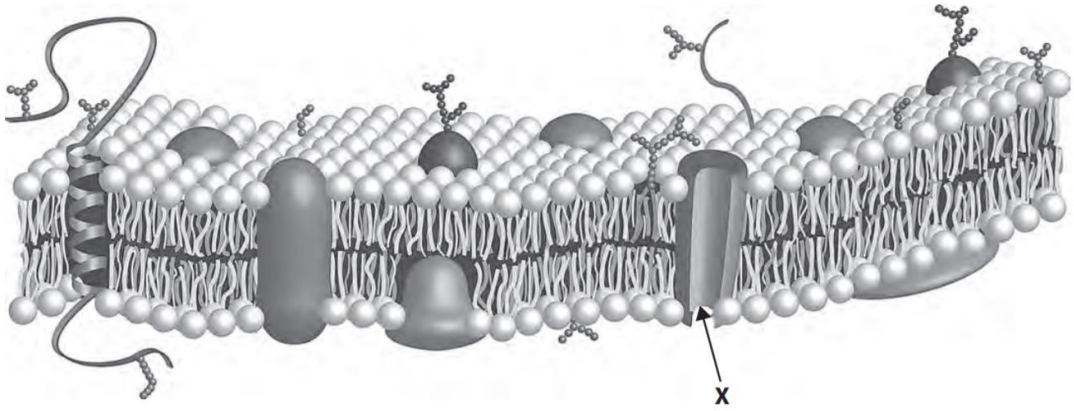
QUESTION 14 – VCAA 2015
A student was investigating four cell types from different organisms. She recorded the results of her microscopic examination of the cells in the table below.

	Cell W	Cell X	Cell Y	Cell Z
Mitochondria	few	many	absent	few
Chloroplasts	present	absent	absent	present
Nucleus	present	present	absent	present

Which one of the following is the correct conclusion that can be drawn from this data?

A. Cell W could be a muscle cell from an insect.
B. Cell Y could be a living leaf cell from a corn plant.
C. Cell X could be a heart-muscle cell from a mammal.
D. Cell Z could be an underground root cell from a pea plant.

QUESTION 15 – VCAA 2016
Consider the following diagram of a plasma membrane.

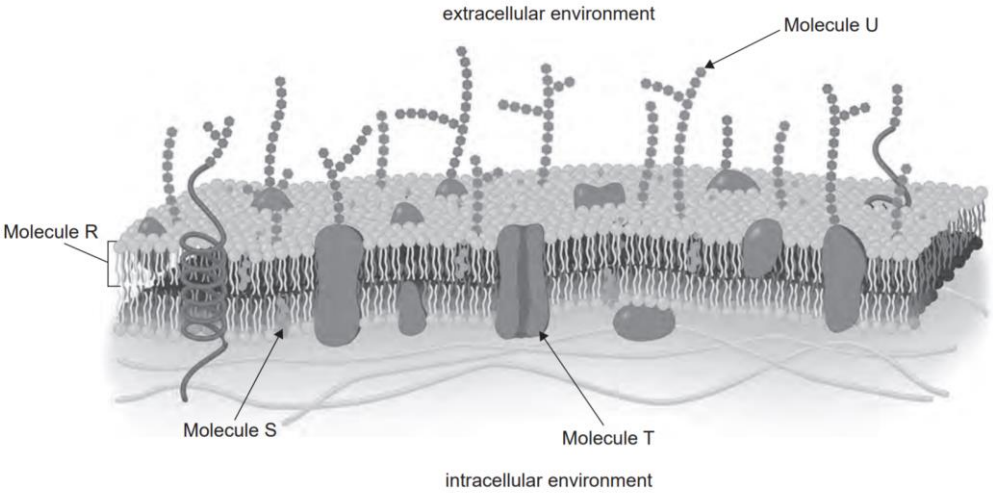


Source: magnetix/Shutterstock.com

The structure labelled 'X' is a

A. protein channel.
B. cholesterol molecule.
C. glycoprotein molecule.
D. phospholipid molecule.

QUESTION 16 – VCAA 2017
Consider the diagram of a plasma membrane below.



Source: Jamilia Marini/Shutterstock.com

a. **i.** There is a higher concentration of a small hydrophobic molecule in the extracellular environment than in the intracellular environment.

Draw one arrow on the diagram above to show the pathway taken by the small hydrophobic molecule across the plasma membrane. (1 mark)

ii. Justify the pathway you have drawn. (2 marks)

_____

_____

_____

_____

b. **i.** One of the molecules – Molecule R, Molecule S, Molecule T or Molecule U – contains many amino acids. (1 mark)

Circle the molecule below that contains many amino acids.

Molecule R Molecule S Molecule T Molecule U

ii. Name the organelle within a cell where the molecule circled in part b.i. is synthesised. (1 mark)

_____

iii. Describe the chemical reaction that takes place to join together the amino acids of this molecule. (3 marks)

_____

_____

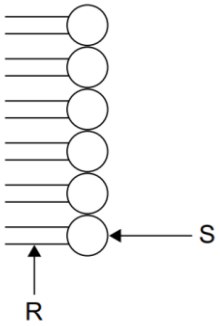
_____

_____

_____

_____

QUESTION 17 – VCAA NHT 2017
Six molecules that form part of the plasma membrane of an animal cell are shown below.



Which one of the following statements is true?

A. The R portions of the molecules are on the outer surface of the cell.

B. The S portions of the molecules represent the hydrophilic phosphate heads.

C. Both the S and R portions of the molecules remain fixed in position within the membrane.

D. The S and R portions of the molecules together allow for the easy transport of glucose.

QUESTION 18 – VCAA NHT 2018
Molecules can move across a plasma membrane in various ways.

Which of the following molecules are most likely to cross a plasma membrane by passing between the phospholipid molecules within the membrane?

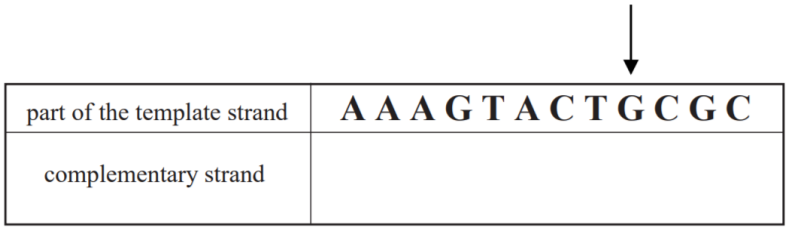
A. carbon dioxide molecules
B. molecules of an enzyme
C. hydrophilic molecules
D. molecules of mRNA

UNIT 3 AOS 1.2 – NUCLEIC ACIDS AND PROTEINS

KEY KNOWLEDGE REQUIRED

- Nucleic acids as information molecules that encode instructions for the synthesis of proteins in cells.
- Protein functional diversity and the nature of the proteome.
- The functional importance of the four hierarchal levels of protein structure.
- The synthesis of a polypeptide chain from amino acid monomers by condensation polymerization.
- The structure of DNA and the three forms of RNA including similarities and differences in their subunits, and their synthesis by condensation polymerization.
- The genetic code as a degenerate triplet code and the steps in gene expression including transcription, RNA processing in eukaryotic cells and translation.

QUESTION 1 – VCAA 2002
Figure 10 represents a piece of DNA from a gene. The template strand for a section of the gene is shown.



part of the template strand	A A A G T A C T G C G C
complementary strand	

Figure 10

a. In the space provided in Figure 10 write in the complementary bases for the other strand of DNA. (1 mark)

b. What does the A represent in this DNA sequence? (1 mark)

_____

c. The first step in the process of gene expression is transcription. What is produced during transcription? (1 mark)

_____

d. The compound produced during transcription attaches to an organelle in the cell.

i. What is the name of this organelle? (1 mark)

_____

ii. What is the name of the step in gene expression which follows transcription and occurs at this organelle? (1 mark)

_____

iii. What is produced during this process mentioned in part ii.? (1 mark)

_____

In the section of the gene sequence shown in Figure 10 a base substitution mutation occurred. The 9th base from the left, Guanine, was replaced by Thymine (at arrow). The genetic code is provided below (Figure 11).

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

Figure 11

e. What effect will this mutation have on the sequence of amino acids in the polypeptide? (1 mark)

_____

_____

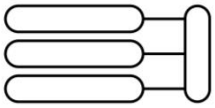
Use the following information to answer Questions 2–4.

Consider the diagrams below showing structural sub-units of four types of biomolecules. The sub-units are named in the order shown in each diagram.

W

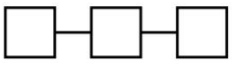
2 fatty acids, 1 glycerol, 1 phosphate

X



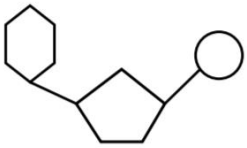
3 fatty acids, 1 glycerol

Y



amino acid, amino acid, amino acid

Z



1 nitrogen base, 1 sugar, 1 phosphate

QUESTION 2 – VCAA 2013
The class of biomolecules called lipids includes

A. W only.
B. W and X only.
C. W, X and Y only.
D. W, X, Y and Z.

QUESTION 3 – VCAA 2013
In an animal cell, a typical function of biomolecule Z is to

A. encode genetic information.
B. transport materials into the cell.
C. provide long-term energy storage.
D. help stabilise the plasma membrane.

QUESTION 4 – VCAA 2013
When biomolecule X is being formed from its respective sub-units

A. peptide bonds are formed.
B. there is a net energy output.
C. a molecule of water is added.
D. a condensation reaction occurs.

Use the following information to answer Questions 5 and 6.

Protein M, made by a particular cell type, is released for use by other cells.

QUESTION 5 – VCAA 2013
The site of synthesis of protein M is the

A. vesicles.
B. ribosomes.
C. plasma membrane.
D. smooth endoplasmic reticulum.

QUESTION 6 – VCAA 2013
The export of protein M by these cells would involve

A. centrioles.
B. lysosomes.
C. the Golgi apparatus.
D. chromosomes.

QUESTION 7 – VCAA 2003
In DNA, the number of

A. phosphate groups equals the number of nitrogen bases.
B. adenine nucleotides equals the number of cytosine nucleotides.
C. phosphate groups equals twice the number of sugar molecules.
D. guanine nucleotides equals the number of uracil nucleotides.

QUESTION 8 – VCAA 2014
The part of a molecule referred to as an anticodon can be found in

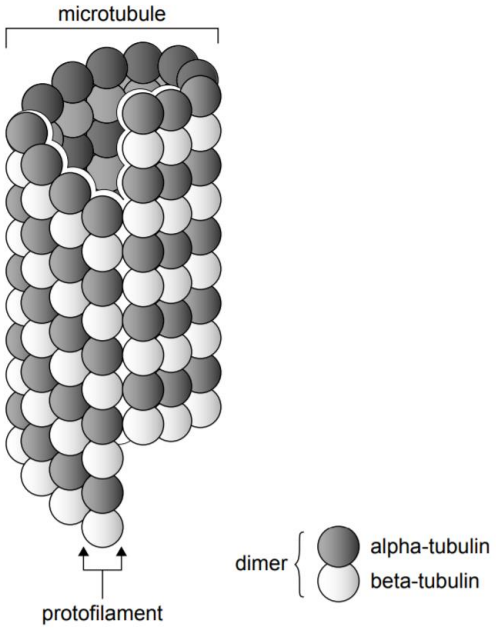
A. DNA.
B. transfer RNA.
C. ribosomal RNA.
D. messenger RNA.

QUESTION 9 – VCAA 2015
All specialised cells that secrete protein molecules

A. have a rigid cell wall.
B. contain numerous lysosomes.
C. contain functional chloroplasts.
D. have an extensive Golgi apparatus.

QUESTION 10 – VCAA 2013

Microtubules are hollow structures composed of a protein, tubulin, which has two forms: alpha-tubulin and beta-tubulin. A tubulin dimer is formed when one alpha-tubulin molecule and one beta-tubulin molecule join. Tubulin dimers polymerise into long chains to form protofilaments. A microtubule can be formed when 13 protofilaments align side by side, as represented in the diagram below.



a. With respect to the structure of a protofi lament, explain what is meant by the term 'polymerise'. (1 mark)

_____

_____

_____

b. Consider an alpha-tubulin molecule. Explain the difference between its primary structure and secondary structure. (2 marks)

_____

_____

_____

_____

_____

_____

c. Describe what is meant by tertiary and quaternary protein structures. (2 marks)

_____

_____

_____

_____

_____

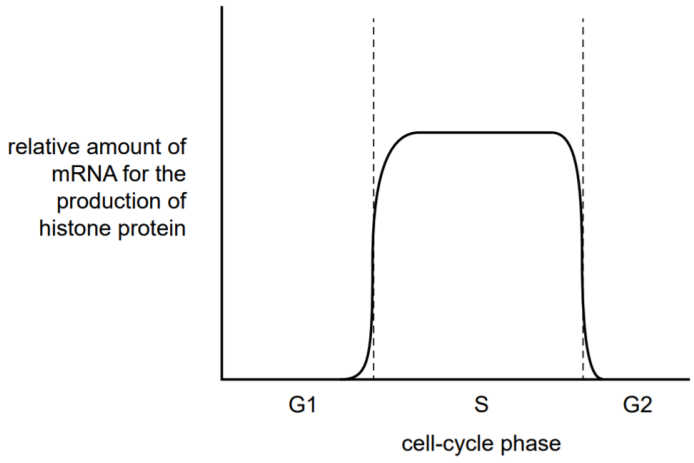
_____

QUESTION 11 – VCAA 2015
An experiment was conducted to investigate enzyme activity. A small quantity of amylase solution was added to a solution of starch dissolved in water at 35 °C. It was observed that maltose was produced.

Which one of the following is the substrate in this reaction?

A. water
B. starch
C. maltose
D. amylase

QUESTION 12 – VCAA 2015
The graph below shows the relative amount of mRNA for the production of histone protein at different times throughout a cell cycle.

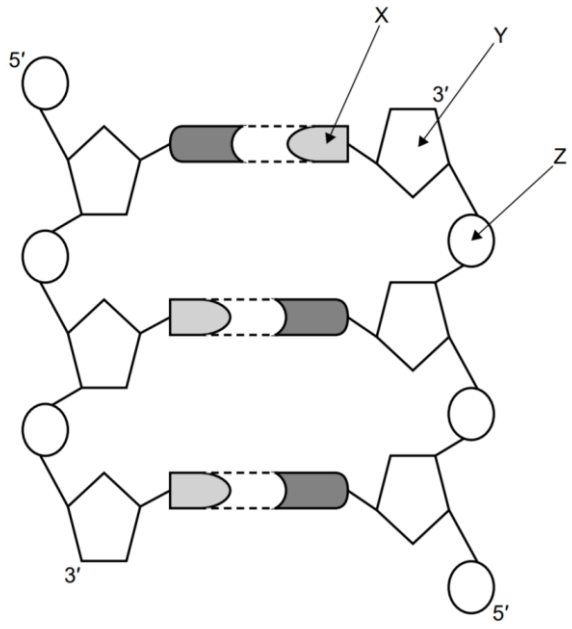


Using your knowledge of the cell cycle and the information in the graph, it is correct to state that

A. DNA replication occurs most actively in the G1 phase.
B. histone genes are highly active throughout the cell cycle.
C. histone protein synthesis occurs simultaneously with DNA synthesis.
D. histone protein is not present in the cell during the G1 and G2 phases.

Use the following information to answer Questions 13 and 14.

The diagram below represents part of a DNA molecule.



QUESTION 13 – VCAA 2015
A single DNA nucleotide is shown by sub-unit(s)

A. X alone.
B. X and Y together.
C. Y and Z together.
D. X, Y and Z together.

QUESTION 14 – VCAA 2015
A feature of DNA that can be seen in the diagram above is

A. the anti-parallel arrangement of the two strands of nucleotides.
B. the process of semi-conservative replication.
C. its ribose sugar–phosphate backbone.
D. its double-helix structure.

QUESTION 15 – VCAA 2014
Scientists studying the nucleus of the fruit fly Drosophila melanogaster observed distinct types of nucleic acid chains.

These scientists noticed that one type of nucleic acid chain was able to pass through the nuclear membrane and move to a ribosome. After the nucleic acid chain attaches to the ribosome, a polymer is produced.

a. Describe the steps occurring at the ribosome that resulted in the production of the polymer. (3 marks)

b. One particular length of nucleic acid chain passed through the nuclear membrane and coded for the production of a polymer that was 90 monomers long. How many nucleotide bases on the nucleic acid chain were involved in the coding for this polymer? Explain your response. (2 marks)

QUESTION 16 – VCAA 2015
The following is a sequence of amino acids located within a polypeptide:

– Asn – Gly – Pro – Arg – Ser –

1st position (5′ end) ↓	2nd position				3rd position (3′ end) ↓
	U	C	A	G	
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	STOP	STOP	A
	Leu	Ser	STOP	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Gln	Arg	A
	Leu	Pro	Gln	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

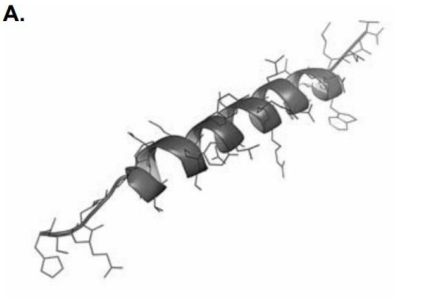
Using the table provided, the DNA template sequence that could code for this amino acid sequence is

A. TTG / CCC / GGT / GCT / TCG
B. TTG / GTT / GGT / GCT / TCG
C. TTG / CCC / GGT / GCT / TCT
D. UUG / CCC / GGU / CGU / UGC

QUESTION 17 – VCAA 2015

The diagrams below represent examples of three levels of structure with respect to the folding and assembly of a protein. The diagrams are not to scale.

A.

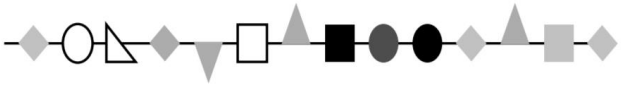


alpha-helix

B.

human interferon

C.



a polypeptide sequence

Sources: molekuul.be/Shutterstock.com (A.); petarg/Shutterstock.com (B.)

a. **i.** Complete the table below to indicate the diagram that represents the structural level of the protein given. (1 mark)

Structural level of protein	Diagram (A., B. or C.)
primary	
secondary	
tertiary	

ii. Name the molecular sub-unit of a protein. (1 mark)

_____

The particular shape achieved by the folding of a protein is of great signifi cance. Proteins sometimes fold incorrectly to form groups of joined, identical polypeptide sequences called aggregates. Sufferers of Alzheimer's disease have aggregates of various sizes in their brain tissue. Aggregates of amyloid beta protein are present in their brain tissue. These patients experience memory loss and have large areas of dead neurons in their brains.

Several hypotheses have been suggested as possible explanations for neuron death. One hypothesis is summarised below.

Hypothesis: Aggregates of amyloid beta protein could cause death of neurons.
Explanation: These aggregates have star-like shapes that pierce the plasma membrane.

b. Suggest, by referring to cellular function, how aggregates of amyloid beta proteins could result in death of neurons. (2 marks)

_____

_____

_____

_____

c. In healthy brain tissue, other proteins, called molecular chaperones, bind temporarily to a protein during its folding process to allow the correct folding and assembly of the protein. Researchers are trying rational drug design to mimic the action of molecular chaperones as a treatment for Alzheimer's disease.

Describe one structural characteristic of the molecular chaperone proteins that would need to be considered in order for this approach to provide a successful treatment. (1 mark)

_____

_____

_____

d. Enzymes are protein catalysts. Use labelled diagrams to illustrate both enzyme denaturation and enzyme inhibition. Include both the enzyme and substrate in your diagrams. (3 marks)

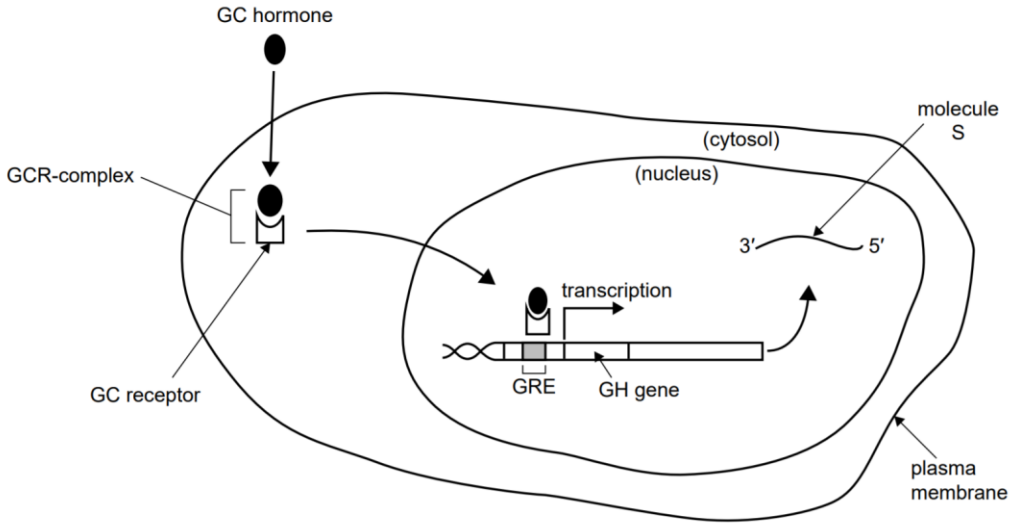
Enzyme denaturation

Enzyme inhibition

QUESTION 18 – VCAA 2015

Glucocorticoid (GC) is a hormone in rats that binds to a receptor, as shown in the diagram below. The glucocorticoid-receptor complex (GCR-complex) moves into the nucleus and attaches to the DNA, causing transcription to begin.

GC signal transduction in rat pituitary gland cells



The location where the GCR-complex attaches to the DNA is called the glucocorticoid response element (GRE). The GRE is located approximately 250 base-pairs upstream of the growth hormone (GH) gene. Following the attachment of the GCR-complex to the GRE, an enzyme catalyses the transcription of the gene.

a. Name the enzyme that catalyses transcription. (1 mark)

_____

b. Name the transcription product, molecule S, and describe the processing that molecule S undergoes before it exits the nucleus. (3 marks)

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c. In the rat pituitary gland, GC stimulates the production of the growth hormone protein. However, in the rat liver, GC stimulates the production of the enzyme tryptophan oxygenase.

Given that the genetic sequence is identical in all somatic rat cells, explain how the production of distinct proteins in different cell types could occur. (2 marks)

d. If a human gene is inserted into the DNA of rat pituitary gland cells, these genetically engineered cells can be used to produce human growth hormone. What characteristic of the genetic code enables a human protein, such as human growth hormone, to be made by rat cells? (1 mark)

QUESTION 19 – VCAA 2015
Consider the template strand of a hypothetical gene, shown below. The exons are in bold type.

3′ **TAC AAA** CCG GCC **TTT GCC AAA** CCC AAC CTA **AAT ATG AAA ATT** 5′

Note:

1. The DNA triplet TAC indicates START and codes for the amino acid methionine that remains in the polypeptide.

2. The DNA triplets ATC, ATT and ACT code for a STOP instruction.

a. **i.** How many amino acids would be present in the polypeptide expressed by this gene? (1 mark)

_____

ii. An allele for this gene codes for a polypeptide with only fi ve amino acids. This is caused by a mutation in one of the exons. This mutation is a result of one nucleotide change.

By referring to the original sequence above, identify the nucleotide change that must have occurred to bring about this shorter polypeptide. (1 mark)

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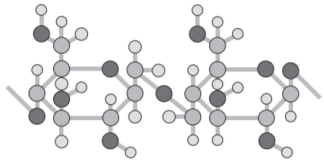
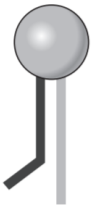
QUESTION 20 – VCAA 2016
Which one of the following statements about gene regulation is correct?

A. Regulator genes are composed of mRNA.
B. Gene regulation is expressed only during the process of meiosis.
C. Regulator genes produce factors that alter the expression of another gene.
D. Gene regulation is not affected by environmental factors external to the cell.

Use the following information to answer Questions 21 to 23.

The diagrams below represent three of the major macromolecule groups in living things.

		
Group A	Group B	Group C

QUESTION 21 – VCAA 2016
Synthesis of macromolecules from these groups involves

A. energy-generating condensation reactions requiring an input of water molecules.
B. energy-generating reactions requiring an input of carbon dioxide molecules.
C. energy-requiring condensation reactions with an output of water molecules.
D. energy-requiring reactions with an output of oxygen molecules.

QUESTION 22 – VCAA 2016
Each monomer of a macromolecule from Group B is made up of a

A. deoxyribose sugar, a phospholipid group and a nitrogen-containing base.
B. deoxyribose sugar, a phosphate group and a nitrogen-containing base.
C. ribose sugar, a phospholipid group and a nitrogen-containing base.
D. ribose sugar, a phosphate group and a glycerol backbone.

QUESTION 23 – VCAA 2016
A portion of one strand of a macromolecule from Group B has the sequence

-CGATTCGGTTAA

The complementary strand would be

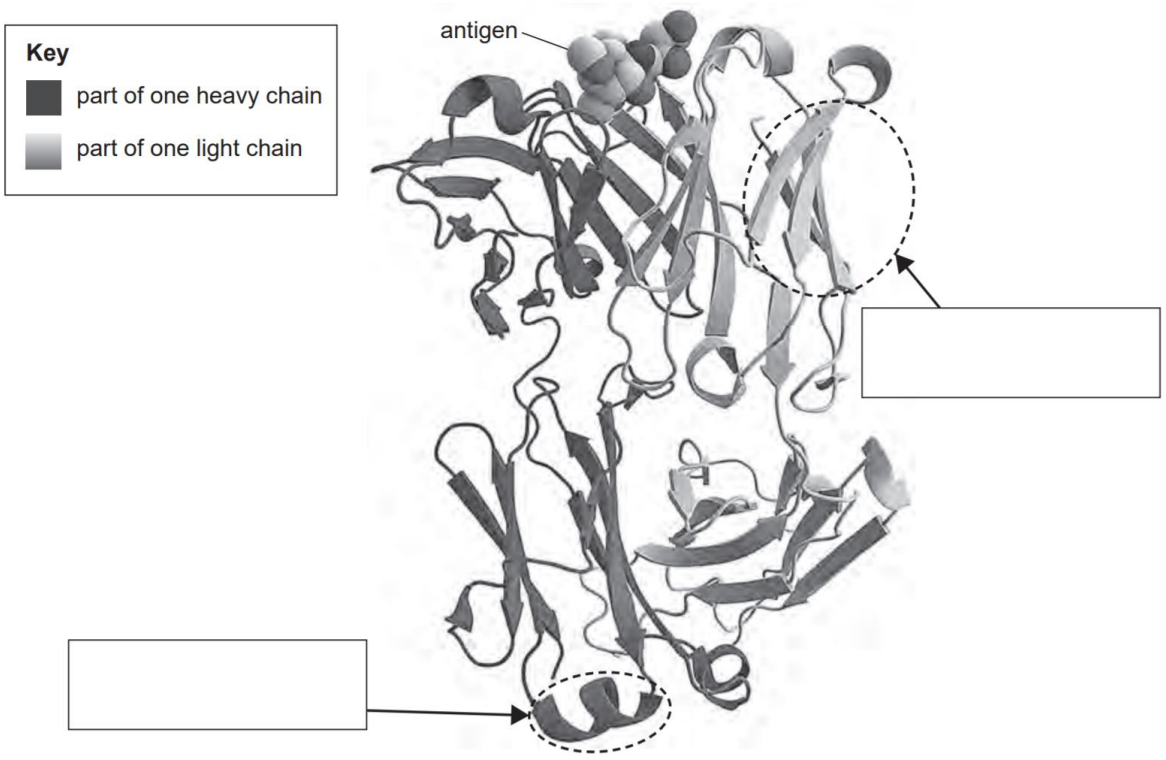
A. -CGATTCGGTTAA
B. -AATTGGCTTAGC
C. -GCTAAGCCAATT
D. -GCUAAGCCAAUU

QUESTION 24 – VCAA 2016
Immunoglobulins, or antibody molecules, have an important role in the immune system. They are made up of two heavy chains and two light chains.

a. Name the molecular monomer of these chains. (1 mark)

_____

b. Part of a mouse immunoglobulin molecule bound to an antigen is shown in the diagram below. Two arrows point to two different types of secondary structures of the immunoglobulin molecule. Give the name of each structure in the boxes provided. (2 marks)



Source: Thomas Splettstoesser (www.scistyle.com)

c. Immunoglobulin molecules also display a tertiary structure and a quaternary structure. Referring to the diagram, explain what 'quaternary' means. (2 marks)

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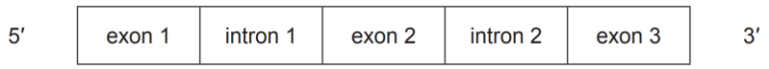
QUESTION 25 – VCAA 2016
A by-product of the acid treatment of plant materials is a group of chemical compounds called furans. It has been observed that as the concentration of furans increases, the rate of fermentation decreases. The enzyme alcohol dehydrogenase is required for the process of fermentation.

Design an experiment to test the hypothesis that one of the furans, called furfural, is an inhibitor of the enzyme alcohol dehydrogenase. Assume that the experiment will be repeated many times and that environmental factors are kept constant. (4 marks)

QUESTION 26 – VCAA NHT 2018
Alpha-globin is one of the polypeptides in a human haemoglobin molecule. The HBA1 gene codes for the production of alpha-globin.

Molecule X is produced when the HBA1 gene is transcribed.

The diagram below shows the relative positions of the two introns and the three exons in Molecule X.



a. Outline the steps that occur within the nucleus of a cell to produce Molecule X. (4 marks)

b. Alpha-globin is a polypeptide consisting of 141 amino acids. In which parts of Molecule X would the codons for these amino acids be found? (1 mark)

UNIT 3 AOS 1.3 – GENE STRUCTURE AND REGULATION

KEY KNOWLEDGE REQUIRED

- The functional distinction between structural genes and regulatory genes.
- The structure of genes in eukaryotic cells including stop and start instructions, promoter regions, exons and introns.
- Use of the lac operon as a simple prokaryotic model that illustrates the switching off and on of genes by proteins (transcriptional factors) expressed by regulatory genes.

QUESTION 1 – CHECKPOINTS SUMMARY Qs (2017) p.10

a. Name two types of functions of genes. Explain whether all genes are responsible for the production of a protein.

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b. Complete the following summary of the structure of a eukaryotic gene.

Name	**Function**
Promoter	
Start triplet	
Coding region	
Stop triplet	

c. How do prokaryotic and eukaryotic genes differ?

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d. Explain how the lac operon switches genes on and off.

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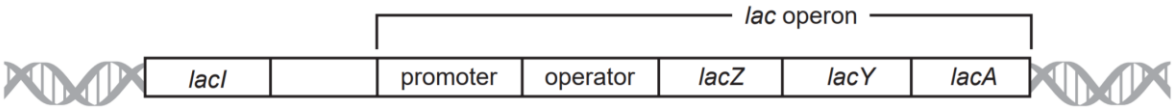
QUESTION 2 – VCAA NHT EXAM 2018
Transcription of a structural gene can be initiated by the

A. presence of DNA polymerase.
B. arrival of mRNA at a ribosome.
C. increase in concentration of amino acids in the cytosol of a cell.
D. absence of a protein that is usually attached to an operator for that structural gene.

Use the following information to answer Questions 3 and 4.

Structural genes can be switched off and turned on by transcriptional factors expressed by regulatory genes. In prokaryotes, a group of genes associated with the breakdown of lactose is grouped together in a single operon called the lac operon. The diagram below shows the position of the genes on the prokaryotic chromosome.



QUESTION 3 – VCAA EXAM 2019
Transcription of the structural genes within the lac operon will occur when

A. a repressor molecule is attached to the operator.
B. RNA polymerase is attached to the promoter.
C. lactose is absent from the prokaryotic cell.
D. transcription of the lacI gene is optimal.

QUESTION 4 – VCAA EXAM 2019
Transcription of the structural genes within the lac operon results in the production of molecules of

A. a transcription factor.
B. a repressor protein.
C. lactose.
D. mRNA.

QUESTION 5 – VCAA EXAM 2019

Ten amino acids that form part of a protein are shown below. -phe-val-asn-gln-his-leu-cys-gly-ser-his- The section of an RNA molecule found in the nucleus of the cell associated with the translation of these 10 amino acids was found to contain over 300 monomers.

Explain how there can be over 300 monomers in this section of the RNA molecule but only 10 amino acids translated. (2 marks)

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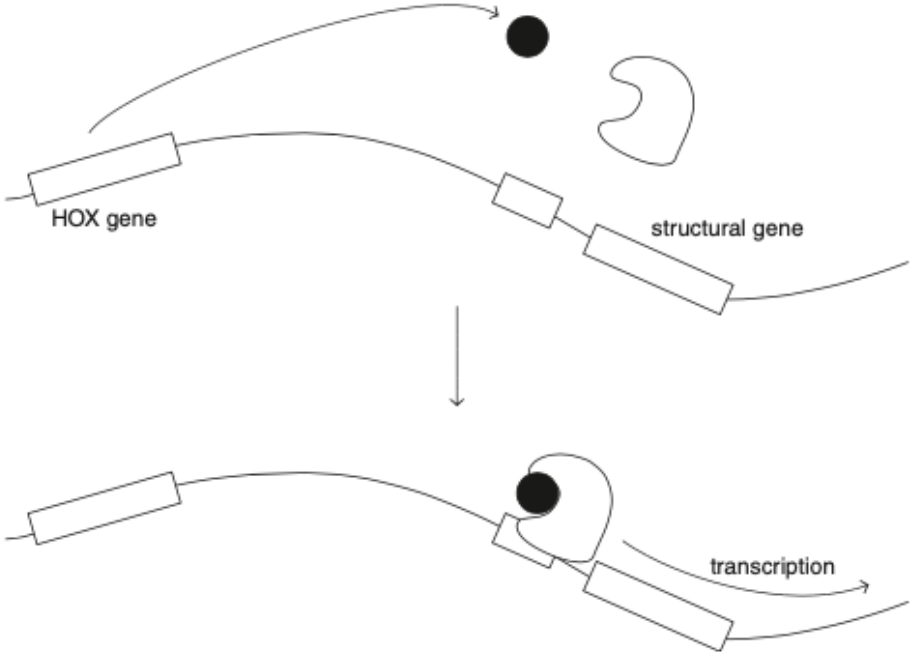
QUESTION 6 – NEAP 2019

HOX genes are important regulatory genes that control body form and are highly conserved across most species. An example of how a HOX gene may work is illustrated in the diagram below.



a. **i.** In this case, describe the function of the transcription factor. 1 mark

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_____

ii. Why would HOX genes be 'highly conserved' across species? 1 mark

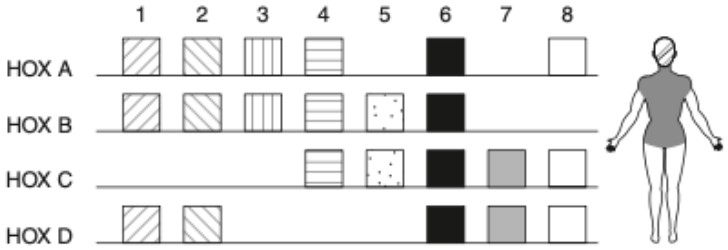
_____

_____

HOX genes have been categorised into four main types (A, B, C and D), each one controlling the expression of many structural genes in different stages of embryonic development in most animals (genes 1–8).

The diagram below illustrates the action of these HOX genes in the development of body structures (arms, head, legs, body) in a human. The shading of the human gives a guide as to which HOX genes are active in the development of that body part. Once the body plan HOX genes are activated, the structural genes 1–8 may or may not be activated. A box with any type of shading represents this. If there is no box, the gene is repressed.

An example of this action would be if, for the development of the torso, one of the HOX genes activated in\s HOX D. The structural gene HOX D will activate structural genes 1, 2, 6, 7 and 8, and repress genes 3, 4 and 5.



b. **i.** State the HOX gene(s) that are active in the development of arms and legs. 1 mark

_____

ii. State the structural gene(s) that are the most repressed when the head is developing. 1 mark

_____

c. Explain why the effect of the HOX A gene is different to the effect of the HOX B gene. 2 marks

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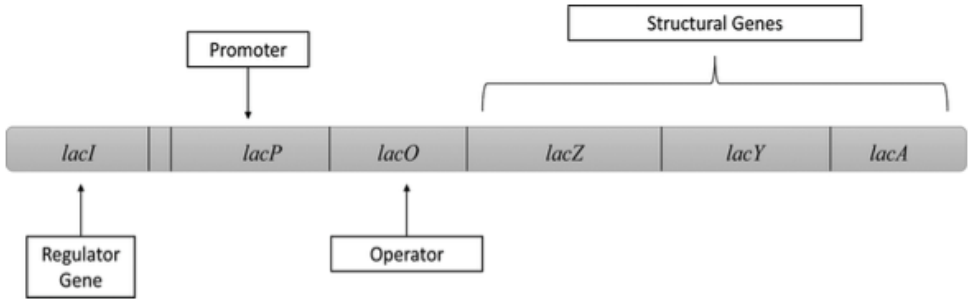
Use the following information for Questions 7 and 8.

The diagram below is of the lac operon a group of genes found on the chromosome of the bacteria Escherichia coli.



QUESTION 7 – ACED 2019

Activation of the lac operon requires

A. repressor activation due to the action of RNA polymerase.
B. RNA polymerase being activated by the presence of a repressor.
C. presence of lactase that removes a repressor from the promotor.
D. presence of lactose that removes a repressor from the operator.

QUESTION 8 – ACED 2019

In a lactose rich environment, which of the following must occur to allow the transcription of the structural genes lacZ, lacY and lacA?

A. RNA polymerase must bind to the promotor region of the gene and the repressor protein must be removed from the operator region
B. RNA polymerase must bind to the operator region of the gene and the repressor protein must be removed from the promotor region
C. DNA polymerase must bind to the promotor region of the gene and the repressor protein must be removed from the operator region
D. lacl must first synthesise RNA polymerase and the lactose in the cell must digest the repressor protein

QUESTION 9 – ACED 2019

lacl is a regulatory gene. Which of the following best contrasts a regulatory gene and a structural gene?

A. regulatory genes are transcribed into mRNA, whereas structural genes are not
B. regulatory genes carry out processes involved with cellular regulations such as enzyme reactions, whereas structural genes code for cellular structures such as microtubules
C. regulatory genes control the expression of other genes, whereas structural genes code for proteins which form part of the structure or function of an organism
D. structural genes code for proteins that have only quaternary structures, whereas regulatory genes can code for proteins with both tertiary and quaternary structures