

Student Name: \_\_\_\_\_



# **BIOLOGY 2020**

## **Unit 3**

### **Key Topic Test 3 – Gene structure and regulation**

Recommended writing time\*: 45 minutes

Total number of marks available: 45 marks

## **QUESTION BOOK**

\* The recommended writing time is a guide to the time students should take to complete this test. Teachers may wish to alter this time and can do so at their own discretion.

**Conditions and restrictions**

- Students are permitted to bring into the room for this test: pens, pencils, highlighters, erasers, sharpeners and rulers.
- Students are NOT permitted to bring into the room for this test: blank sheets of paper and/or white out liquid/tape.
- No calculator is allowed in this test

**Materials supplied**

- Question and answer book of 9 pages.

**Instructions**

- Print your name in the space provided on the top of the front page.
- All written responses must be in English.

**Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the room for this test.**

**SECTION A – Multiple-choice questions**

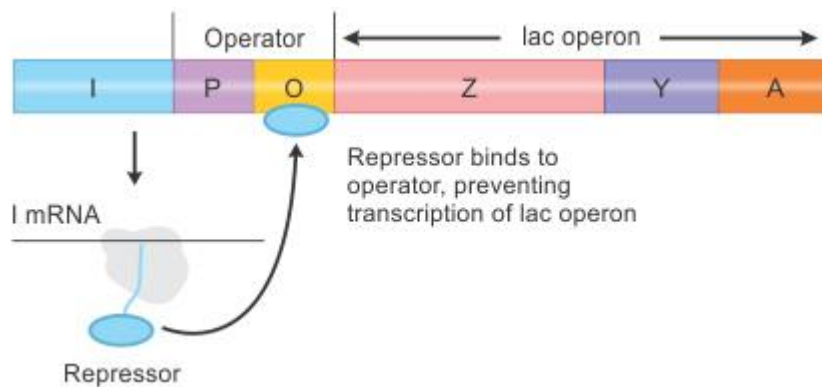
**Instructions for Section A**

Select the response that is **correct** for the question. A correct answer scores 1; an incorrect answer scores 0. Marks are not deducted for incorrect answers. If more than 1 answer is completed for any question, no mark will be given.

**Question 1**

When comparing regulatory genes to structural genes

- A. regulatory genes produce enzymes
- B. regulatory genes produce operon inhibitors
- C. structural genes produce allolactose
- D. regulatory genes produce structural proteins



**Question 2**

Regulatory genes in the above diagram would be indicated by

- A. P
- B. O
- C. I
- D. Z, Y, A

**Question 3**

If this operon was in a eukaryotic cell, there would be sections of DNA within genes Z, Y and A. These sections would normally be removed to make mRNA. The sections are removed because

- A. they are exons and are not required to make a protein
- B. they are already expressed so are not required
- C. they are introns and are spliced out
- D. they are introns which are expressed in pre mRNA

**Question 4**

A promotor region of a gene is where

- A. the repressor attaches to stop RNA polymerase from expressing the gene
- B. the DNA polymerase attaches to build mRNA
- C. the expression of the regulatory gene is initiated
- D. RNA polymerase binds

**Question 5**

In eukaryotes, pre-mRNA becomes mRNA before it leaves the nucleus. This occurs through the removal of sections of RNA that are not required to code for a protein. It is possible for one gene to produce multiple proteins in a process called

- A. alternate slicing
- B. anticodon matching
- C. alternative splicing
- D. degenerate DNA coding

**Question 6**

A difference between prokaryotic and eukaryotic gene expression is

- A. prokaryotes have circular chromosomes meaning that gene expression can only happen on the outside of the chromosome
- B. prokaryotes don't have membrane bound organelles, so gene expression happens slowly
- C. prokaryotes have no introns, so gene expression is faster
- D. eukaryotes have fewer genes, so gene expression is less complicated

**Question 7**

In prokaryotes, once transcription occurs the next stage is

- A. RNA splicing
- B. the repressor unbinds from the operator releasing the RNA polymerase
- C. adding a methyl cap and poly A tail
- D. translation

**Question 8**

The proteins that are produced by the lac operon

- A. are enzymes that digest the milk proteins
- B. assist bacteria to obtain glucose
- C. control lactose intolerance in humans
- D. are regulatory proteins

**Question 9**

The lac operon in *E. Coli* is controlled by a regulatory gene. This gene is a regulatory gene because

- A. it is attached to the promotor
- B. it produces a protein which attaches to the operator
- C. it regulates the expression of the operator exon
- D. it produces a transcription factor which transcribes the proteins

**Question 10**

Structural genes are switched off and on in the lac operon in response to

- A. a transcription factor expressed by regulatory genes
- B. not having enough milk protein to produce the repressor
- C. digestion of the lactose attached to the operator
- D. changing the shape of the repressor attached to the promotor

**Question 11**

Three proteins are produced by the lac operon. These proteins allow for the digestion and transport of the sugars in the milk. Each protein that is produced

- A. is coded for by the regulatory protein
- B. is synthesised by RNA polymerase
- C. digests lactose to produce glucose
- D. is a structural protein

**Question 12**

The repressor acts to control the production of the three lac operon proteins. The repressor does this by

- A. attaching to RNA polymerase to stop it transcribing the protein
- B. changing shape depending on the presence of allolactose
- C. permanently binding to the operator to stop transcription
- D. acting as an enzyme to digest the lactose when it is present changing the active site

**Question 13**

Once all the milk has been digested, the production of the lac proteins stop. This is because the

- A. *E. coli* is full and does not need any more food
- B. repressor has allolactose attached and changes shape
- C. allolactose has been digested and the repressor reattaches to the operator
- D. all the amino acids have run out so not proteins can be made

**Question 14**

If glucose is present, the lac operon does not produce the three proteins to digest lactose. This is due to

- A. the bacteria having enough glucose for ATP production
- B. lactose not containing glucose so there is no need for digestion
- C. the glucose binding to the repressor changing its shape
- D. the repressor not binding to the operator region

**Question 15**

The lac operons three proteins cannot be produced without transcription factors. Transcription factors are

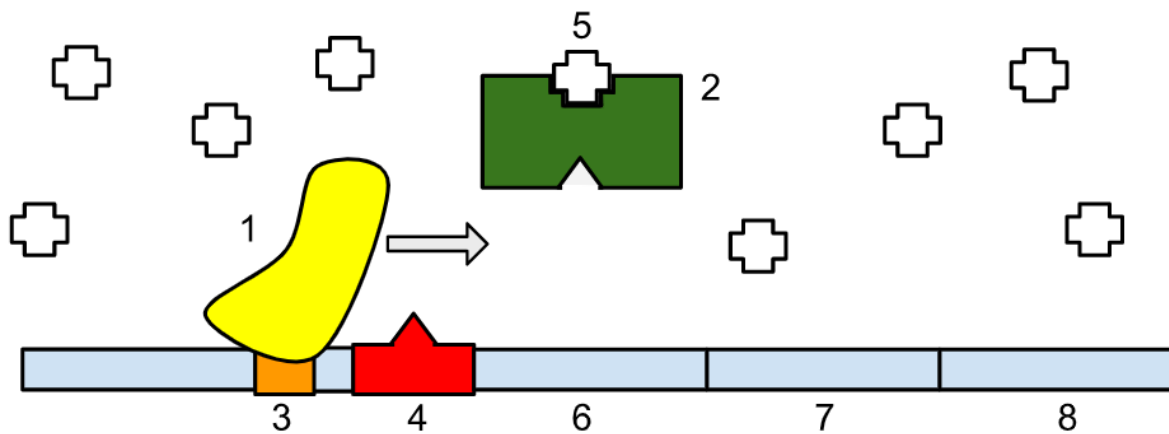
- A. found attached to promotor sites to start and stop protein production
- B. only found in the nucleus as they attach to DNA
- C. proteins that help turn specific genes on or off by binding to DNA
- D. proteins found throughout a cell that are produced by structural genes

**SECTION B - Short-answer questions**

**Instructions for Section B**  
 Answer **all** questions in the space provided. Write using a blue or black pen.

**Question 1**

The lac operon is a simple form of gene expression that has been investigated in *E. coli* a bacterium commonly found in the gut of mammals and which assists in the breakdown of milk. The parts of the lac operon have been identified and are shown in the diagram below



a. Name and explain the role of structure 1

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2 marks

b. Name and explain the role of structure 2

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2 marks

c. Structure 2 is shown interacting with a substance 5. What is substance 5 and how does its presence change structure 2?

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2 marks

**d.** Explain what occurs when structure 1 moves in the direction as shown above

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2 marks

**e.** In each operon there is an operator region that has a specific function. What number represents the operator region in the diagram above and what is its function?

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2 marks

**f.** When molecule 5 is not present what changes would you see in the diagram above?

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2 marks

**g.** Explain the role of the proteins coded for by parts labelled 6, 7 and 8

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2 marks

Molecule 5 is produced by a regulatory gene not shown on the diagram and acts as a transcription factor

**h.** What is the difference between a regulatory gene and a structural gene?

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2 marks

**i.** What is the role of a transcription factor and how does it work?

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2 marks

Total 18 marks



**Question 2**

Gene expression in a eukaryotic cell is different to a prokaryotic cell. The way transcription occurs highlights these differences.

- a. List 3 ways that transcription is different in prokaryotes and eukaryotes.

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3 marks

- b. Both eukaryotic and prokaryotic cells have very similar translation of mRNA to produce proteins. What are the three parts of translation that are the same in both?

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3 marks

- c. Three proteins are produced by the lac operon which act on lactose in milk and allow the bacteria access to glucose through the digestion and transport of lactose. How do these proteins eventually lead to the deactivation of the lac operon?

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2 marks

- d. The lac operon cannot function efficiently without the presence of a repressor which is produced by a regulatory gene. If the regulatory gene became mutated what may be an effect on the lac operon.

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2 marks

- e. The type of regulation the operon undergoes is known as negative inducible meaning that the gene is turned off by the regulatory factor unless a substrate is added. What is the regulatory factor and substrate that is involved in the lac operon?

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2 marks

Total 12 marks

**END OF KEY TOPIC TEST**