

Student Name: _____



BIOLOGY 2017

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

Materials supplied

- Question book of 11 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

Answer **all** questions.

Choose the response that is **correct** for the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Question 1

Nucleosomes inhibit

- A. activators.
- B. RNA polymerase.
- C. translation.
- D. assembly of transcription factors.

Question 2

All of the following can be found in a human transcription complex except

- A. activators.
- B. RNA.
- C. enhancer.
- D. silencer.

Question 3

Enhancers are

- A. proteins located adjacent to promoters.
- B. distant sites where regulatory proteins bind.
- C. expeditors of RNA polymerase capture.
- D. proteins that bind with repressors, deactivating them.

Question 4

Transcription factors appear to be unable to bind to a nucleosome because

- A. activators are inhibited by the configuration.
- B. of inhibition of RNA polymerase.
- C. nucleosomes are especially vulnerable to repressors.
- D. of histones positioned over promoters.

Question 5

In order for a gene to be transcribed, RNA polymerase must have access to the DNA helix and be able to bind to the gene's

- A. activator.
- B. regulator.
- C. promotor.
- D. operator.

Question 6

The most common form of gene expression in both bacteria and eukaryotes is

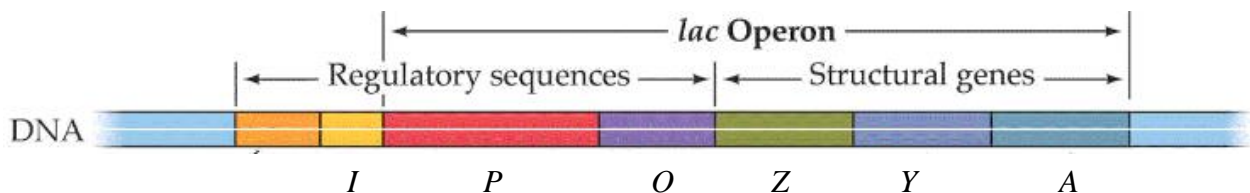
- A. translational control.
- B. transcriptional control.
- C. post-transcriptional control.
- D. post-translational control.

Question 7

What effect on transcription of the structural genes of the lac operon is observed when lactose is present in the environment?

- A. Transcription does not occur.
- B. The genes are transcribed but only for a single generation and then are shut off.
- C. Lactose represses the synthesis of the repressor.
- D. Transcription of the structural genes is induced when lactose is present.

Use the following diagram to answer Questions 8 & 9.



(*I* = *lac* repressor gene; *Z*, *Y*, *A* = *lac* operon structural genes; *P* = *lac* promoter; *O* = *lac* operator)

Question 8

Where would the *lac* repressor be bound to in an *E. coli* cell that is growing in a high glucose and high lactose environment?

- A. P.
- B. O.
- C. P and O.
- D. the repressor would not be bound.

Question 9

Which part of the DNA region shown in the diagram encodes proteins?

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

Question 10

What modification neutralises the charges on histones and loosens up the interactions between histones and DNA?

- A. phosphorylation.
- B. methylation.
- C. acetylation.
- D. polyadenylation.

SECTION B - Short-answer questions

Instructions for Section B

Answer **all** questions in the spaces provided. Write using black or blue pen.

Question 1

Cells do not express all the genes of their genome at the same time. Even when expressed, there is evidence that there are controls over how fast specific genes are transcribed and translated. The expression of genes seems to depend on the type of cell, its stage of development and conditions within and around the cell.

- a.** Identify the difference between structural genes and regulatory genes.

2 marks

- b.** Define the following terms.

- i.** repressor protein

- ii.** operator

- iii.** enhancers

iv. promotor

1 + 1 + 1 + 1 = 4 marks

c. Regulatory and structural genes differ in their arrangement in the genomes of prokaryotic and eukaryotic cells. Describe this difference.

2 marks

d. Explain the role of the following in eukaryotic gene regulation and whether they promote or repress transcription.

i. Methylation

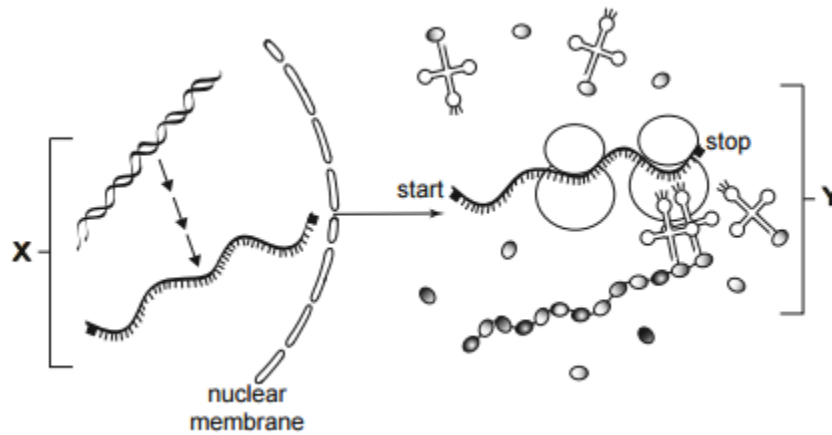
ii. Acetylation

2 + 2 = 4 marks

Total 12 marks

Question 2

The diagram below illustrates the steps that are involved if transcription occurs.



- a. The process shown by X is called transcription, however in the above diagram is simplified. An intermediate product called pre-mRNA is produced.

Outline the steps involved in process X using the terms promoter region, stop and start instructions and exons and introns.

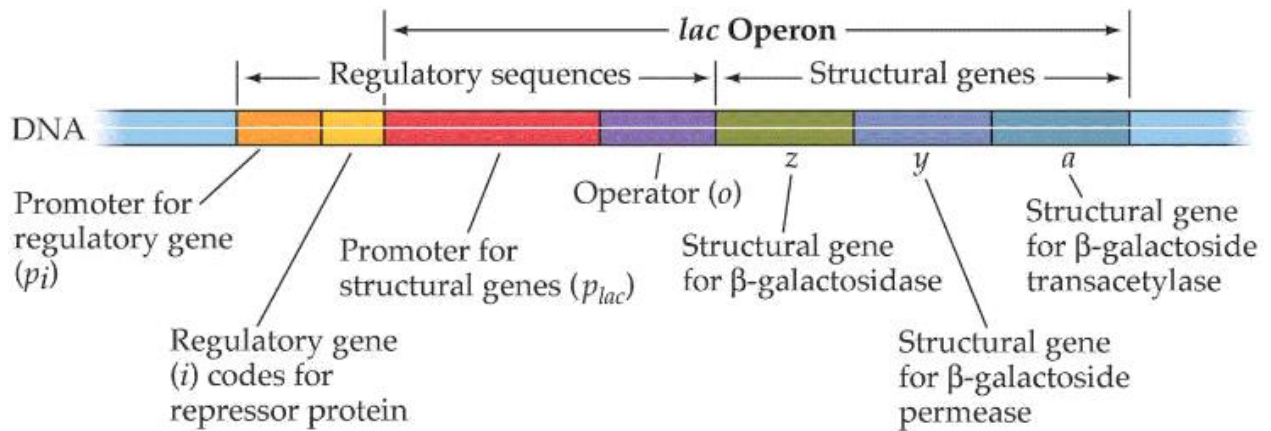
4 marks

b. What advantage would being able to switch genes on and off confer to a cell?

2 marks
Total 6 marks

Question 3

The following diagram shows the *lac* operon which controls how the genes responsible for the production of enzymes that break down lactose are regulated.



a. Describe the events that lead to the prevention of the production of the enzymes that break down lactose in *E. coli*.

4 marks

b. Describe the events that lead to the production of the enzymes that break down lactose.

4 marks
Total 8 marks

Question 4

In bacteria the regulation of the expression of genes which are involved in the production of the amino acid tryptophan occurs. The diagram below shows the relevant parts of the DNA involved in this regulation. It is an example of repressible negative regulation of gene expression.



a. The letters R, P, O represent different sections of the DNA that are involved in the regulation of the production of tryptophan.

i. What does R represent? What part does it play in the regulation of tryptophan production?

ii. What does P represent? What part does it play in the regulation of tryptophan metabolism?

iii. What does O represent? What part does it play in the regulation of tryptophan metabolism?

2 + 2 + 2 = 6 marks

b. When tryptophan is present it binds to a repressor protein which then prevents tryptophan being produced. Which enzyme is prevented from acting when the repressor protein/tryptophan complex blocks transcription?

1 mark

c. Another example of gene regulation in bacteria is the production of enzymes that break down lactose when lactose is present. The *lac* operon is described as an inducible operon, whereas the *trp* operon is described as a repressible operon. Explain why this is so in terms of the presence of lactose and tryptophan and whether transcription occurs in the presence of these molecules.

2 marks
Total 9 marks

END OF KEY TOPIC TEST