



BIOLOGY 2020

Unit 3

Key Topic Test 3 – Gene structure and regulation

Recommended writing time*: 45 minutes

Total number of marks available: 45 marks

SOLUTIONS

SECTION A: Multiple-choice questions (1 mark each)

Question 1

Answer: B

Explanation:

Regulatory genes control the expression of other genes. In this case, operon inhibitors produced by regulatory genes control the expression.

Question 2

Answer: C

Explanation:

The section of gene that produces the repressor that controls the expression of the lac operon must be the regulatory gene

Question 3

Answer: C

Explanation:

Eukaryotic cells have introns which are spliced out or removed before gene expression.

Question 4

Answer: D

Explanation:

The promotor is the region of the lac operon where RNA polymerase attaches

Question 5

Answer: C

Explanation:

C is correct as alternative splicing refers to different combinations of exons being spliced together to produce multiple different proteins

Question 6

Answer: C

Explanation:

Prokaryotes have circular DNA however transcription happens the same way regardless of the shape of the DNA. Prokaryotes don't have introns meaning mRNA splicing does not occur and gene expression occurs faster

Question 7

Answer: D

Explanation:

A and C are incorrect as they are eukaryotic processes while B is incorrect as this occurs before transcription

Question 8

Answer: B

Explanation:

The 3 proteins assist in the transport and digestion of lactose (a milk sugar) so that it can be broken down into glucose.

Question 9

Answer: B

Explanation:

Regulatory genes produce proteins that control the expression of other genes hence the protein that attaches to the repressor must be produced by a regulatory gene

Question 10

Answer: A

Explanation:

A transcription factor is a protein expressed by a regulatory gene that attaches to an operator.

Question 11

Answer: D

Explanation:

Proteins that control the functioning of the cell such as transport or digestion are structural proteins

Question 12

Answer: B

Explanation:

The molecule that attaches to the repressor changing its shape and removing the repressor from the operator site is allolactose.

Question 13

Answer: C

Explanation:

Once the allolactose has been digested by the structural proteins, allolactose is no longer available to change the shape of the repressor allowing the repressor to reattach to the operator

Question 14

Answer: A

Explanation:

If glucose is present, there is no need for lactose to be broken down.

Question 15

Answer: C

Explanation:

Transcription factors bind to DNA to turn genes on or off. They attach to operator sites and can be found in the cytosol or nucleus.

SECTION B: Short-answer questions

Question 1

- a. Structure 1 is RNA polymerase (1) which reads and transcribes the DNA code into mRNA (1) 2 marks
- b. Structure 2 is a repressor (1) which controls the transcription of mRNA by attaching to the operator (1) 2 marks
- c. Substance 5 is allolactose (1) When present the shape of the repressor changes so that it does not fit the operator (1) 2 marks
- d. When RNA polymerase move DNA is unwound (1) and nucleotides are added to make a single stranded mRNA molecule (1) 2 marks
- e. The operator region is number 4 (1) and its function is to control the movement of the RNA polymerase to control gene expression (1) 2 marks
- f. If molecule 5 were not present the repressor would reattach to the operator (1) and RNA polymerase would not be active (1) 2 marks
- g. Parts 6, 7 and 8 are three structural proteins (1) that are all produced to transport and digest lactose (1) 2 marks

- h.** A regulatory gene controls the expression of other genes (1) while a structural gene produces proteins that control the functioning of the cell (1)

2 marks

- i.** A transcription factor binds to DNA and switches the expression of a gene on or off (1). It works by acting as a repressor or activator to produce structural proteins under the right conditions (1)

2 marks

Question 2

- a.** In prokaryotes mRNA modification does not occur as no introns are present (1), Transcription occurs in the cytosol as no nucleus is present (1) and transcription is faster (1)

3 marks

- b.** ANY 3 of - The mRNA enters a ribosome (1), tRNA brings complementary amino acids to the ribosome (1), tRNA anticodons match mRNA codons (1), amino acids are joined by a condensation reaction (1) building a polypeptide chain (1)

3 marks

- c.** One of the proteins is responsible for digesting lactose changing the lactose to glucose and galactose (1) When the allolactose that has changed the repressor is digested by the protein its shape reverts and the repressor reattaches to the operator deactivating the operon (1)

2 marks

- d.** If the regulatory gene mutation changed an amino acid or the shape of the active site of the protein (1) then the repressor may not be able to attach resulting in the lac operon always being on using resources and energy when not required (1)

2 marks

- e.** The repressor (1) and allolactose (1)

2 marks

Total 45 marks