



BIOLOGY 2017

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: D

Explanation:

Nucleosomes inhibit assembly of transcription factors.

Question 2

Answer: B

Explanation:

Activators, enhancers and silencers are all found in a human transcription complex

Question 3

Answer: B

Explanation:

Enhancers are distant sites where regulatory proteins bind

Question 4

Answer: D

Explanation:

Transcription factors are unable to bind to a nucleosome because of histones positioned over promoters.

Question 5

Answer: C

Explanation:

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

Question 6

Answer: B

Explanation:

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

Question 7

Answer: D

Explanation:

Transcription of the structural genes is induced when lactose is present

Question 8

Answer: B

Explanation:

The lac repressor would be bound to the operator (O) region in E.coli that is growing in high glucose and high lactose as the bacteria would metabolise the glucose in preference to the lactose.

Question 9

Answer: C

Explanation:

I codes for the repressor protein and Z, Y and A code for the structural genes for lactose metabolism

Question 10

Answer: C

Explanation:

Acetylation neutralises the charges on histones and loosens up the interactions between histones and DNA.

SECTION B: Short-answer questions

Question 1

- a. Structural genes code for any protein product that is not a regulatory product (1 mark) whereas a regulatory gene is a gene involved in controlling the expression of one or more other genes (1 mark)

2 marks

b.

- i. A protein that binds to DNA or RNA and inhibits the expression of one or more genes
- ii. Short region of DNA that the repressor binds to
- iii. short region of DNA that when bound by activators increase the likelihood of transcription of a particular gene
- iv. region of DNA that initiates transcription of a particular gene

1 + 1 + 1 + 1 = 4 marks

- c. Prokaryotic cells have regulatory and structural genes all organised into an operon (1 mark), eukaryotes do not (1 mark)

2 marks

d.

- i. methyl groups are added to DNA (1 mark) which represses gene transcription (1 mark)
- ii. removes positive charge on histones which allows transcription factors to bind to DNA (1 mark) and promotes transcription (1 mark)

2 + 2 = 4 marks

Total 12 marks

Question 2

- a. Transcription factors bind to the promotor region of a gene and initiate transcription (1 mark) RNA polymerase binds at the start instruction and converts DNA into mRNA until a stop instruction is reached (1 mark) the pre-mRNA is spliced and introns are removed and exons are joined together resulting in mRNA (1 mark) this product then leaves the nucleus (1 mark)

4 marks

- b. All genes being switched on all of the time requires lots of energy (1 mark). Only switching genes on when they are required conserves energy (1 mark)

2 marks

Total 6 marks

Question 3

- a. In the absence of lactose (1 mark) the repressor protein is able to bind to the operator for the structural gene (1 mark). RNA polymerase is therefore unable to bind to the promotor region (1 mark) and therefore transcription of the enzymes that breakdown lactose cannot occur (1 mark)

4 marks

- b. If lactose is present (1 mark) it binds to the repressor protein (1 mark) The repressor protein is then unable to bind to the operator region for the structural genes (1 mark). RNA polymerase is therefore able to bind to the promotor region for the structural genes and transcription of the enzymes that breakdown lactose occurs (1 mark)

4 marks

Total 8 marks

Question 4

a.

- i. repressor gene (1 mark). It inhibits tryptophan production (1 mark)
- ii. promotor gene (1 mark). RNA polymerase binds o this so tryptophan production can occur (1 mark)
- iii. operator gene (1 mark) is where the repressor binds, if the repressor is bound to it then RNA polymerase is prevented from binding to the promotor region (1 mark)

2 + 2 + 2 = 6 marks

b. RNA polymerase

1 mark

- c. If lactose is present production of structural genes is promoted (1 mark) whereas if tryptophan is present, production of structural genes is inhibited (1 mark)

2 marks

Total 9 marks