

Multiple choice questions

1. The X-ray diffraction pattern obtained by Rosalind Franklin indicated that the structure of DNA had

- A. Complementary base pairs
- B. A helical structure
- C. A backbone
- D. Nucleosomes

2. The structure of a ribosome includes

I rRNA

II Protein

III Enzymes

A I only

B 1 and II only

C I and III only

D I, II and III

3. The role of DNA gyrase is to

- A. Rewind DNA after transcription
- B. Keep the DNA strands separate to allow base pairing
- C. Alter DNA bonding to allow helicase to unwind the DNA
- D. Form covalent bonds in the DNA backbone

4. Which of the following **do not** occur after transcription in **prokaryotes**?

I Attachment of mRNA to a ribosome

II Removal of introns

III Movement of mRNA through the nuclear membrane

A III only

B 1 and II only

C II and III only

D I, II and III

5. A quaternary structure is found in proteins because they have

- A. Many amino acids
- B. One polypeptide chain
- C. More than one polypeptide chain
- D. Enzymic properties

6. Which of the following sequences correctly describes tRNA activation?

A	ATP and a specific amino acid bind to t-RNA synthase	The specific tRNA with the correct anticodon binds to t-RNA synthase	The amino acid is attached to the tRNA and leaves the t-RNA synthase	The amino acid is activated using the ATP
B	The amino acid is activated using the ATP	ATP and a specific amino acid bind to t-RNA synthase	The specific tRNA with the correct anticodon binds to t-RNA synthase	The amino acid is attached to the tRNA and leaves the t-RNA synthase
C	The specific tRNA with the correct anticodon binds to t-RNA synthase	The amino acid is activated using the ATP	The amino acid is attached to the tRNA and leaves the t-RNA synthase	ATP and a specific amino acid bind to t-RNA synthase
D	ATP and a specific amino acid bind to t-RNA synthase	The amino acid is activated using the ATP	The specific tRNA with the correct anticodon binds to t-RNA synthase	The amino acid is attached to the tRNA and leaves the t-RNA synthase

7. The formation of mature mRNA after transcription involves:

- A. RNA polymerase
- B. Removal of exons
- C. Splicing
- D. Ribosomes

8. The role of the A site on the ribosome is for

- A. Forming a peptide bond
- B. Removal of the amino acid from the tRNA
- C. Causing the assembly of the large and small subunits of the ribosome
- D. Binding the mRNA codon to the tRNA anticodon.
- E.

9. Non- coding regions of human DNA can be

I Repetitive sequences

II Regulators of gene expression

III Transcribed into mRNA

IV Telomeres

A I only

B I, II and IV only

C I and II only

D all of them

10. Bioinformatics applications in databases containing information on DNA base sequences can be utilised to

- A. Identify homologous sequences in different species
- B. Identify infectious diseases
- C. Derive 3D protein structures
- D. Sequence a genome

Structured answer questions

1. Hershey and Chase were the first researchers to prove that nucleic acids are the genetic material, and not proteins. They used ^{35}S and ^{32}P as radioactive markers in virus cultures. Explain why they chose these markers. (3 marks)

Phosphorus is found in nucleic acids/not found in proteins;

Sulphur is found in proteins/not found in nucleic acids;

(maximum 2 marks)

^{32}P will mark Nucleic acids/make nucleic acids radioactive;

^{35}S will mark proteins/make proteins radioactive;

(maximum 2 marks)

1. Describe why the Watson and Crick model of DNA structure also suggested a method for DNA replication. (3 marks)

Complimentary base pairing (illustrated by model);

(Gave rise to the idea of) semi-conservative replication;

By complimentary pairing of bases (example A-T or G-C);

1. Draw a diagram of a polysome as it would appear under an electron micrograph. (3 marks)

Labels of Ribosomes

Labels of mRNA

(2 marks)

Several ribosomes shown attached to one mRNA strand (1 mark);

1. Distinguish between the roles of proteins produced by free ribosomes and those produced by ribosomes attached to the rough endoplasmic reticulum. (2 marks)

Free ribosomes – make proteins used within the cell/cytoplasm;

Bound ribosomes – make proteins secreted/stored in lysosomes;

1. Variable number tandem repeats (VNTR) are short segments of repeating bases found in non-coding DNA. The number of repeats at certain places in the genomes of different individuals varies. Explain the significance of this variation in the number of repeats for DNA profiling. (4)

Number of repeats determines the length of a DNA fragment;

Fragments are replicated;

Gel electrophoresis is used to separate fragments;

Separation/run length depends upon length of fragment/example;

Creating bands on a profile (for identification);

1. Explain, using an example, how the environment can affect gene expression. (3 marks)

Environment can cause a gene to be expressed or repressed (1 mark)

Examples (maximum 2 marks)

Tyrosine/cat coat colour/temperature;

Melanin expression/UV light;

Methylation / ageing;

Epigenome inheritance/diabetes predisposition;

Other valid example;

1. Introns are removed from pre-mRNA leaving the exons to form mature mRNA. The arrangement of these exons can vary in some genes. Explain why this process of alternative splicing increases the number of polypeptide types that can be made from one DNA molecule. (3 marks)

Removal of different introns leaves a different set of exons for mRNA molecules;

Exons spliced together each produce a different mature mRNA sequence;

Produces several different polypeptide sequences (for each gene);

Many genes on the DNA molecule – several proteins for each gene.

1. There are 20 kinds of aminoacyl t-RNA synthase enzymes that activate tRNA molecules prior to translation. Explain how this illustrates enzyme specificity. (2 marks)

Enzyme specific to anticodon

Also specific to amino acid (that matches anticodon)

There are 20 types of amino acids

1. Describe how the addition of a prosthetic group to the quaternary structure of a protein can form a functional protein. (2marks)

Prosthetic group – non-protein molecule bonded to quaternary structure

Haem in haemoglobin carries oxygen

Other valid example

1. Haemoglobin is a protein with 4 subunits, 2 α polypeptides, 2 β polypeptides and a haem prosthetic group containing iron for oxygen transport.

2. Haemoglobin E is abnormal form of haemoglobin with a point mutation in the β chain. There is no difference between the DNA base sequence for normal and E-type haemoglobin but the E type has glutamic acid in place of lysine at position 26 in the β chain. The result of this substitution is a weakening of the attachment of the α and β chain causing instability in high oxygen concentrations

a) Discuss why a change in the amino acid sequence may result in weaker bonding of the protein quaternary structure. (2 marks)

Bonds between side chains of amino acids are involved in forming the quaternary structure

Different side chains may prevent bonds forming/form weaker bonds

b) Explain how identical mRNA formed at transcription for both normal and E-type haemoglobin can result in the formation of a different polypeptide chain during translation of these mRNA variants. (3 marks)

Base sequence is identical in both

Formation of mature mRNA involves removal of introns

Slight change in the introns removed/splicing can change the base sequence of mRNA

Resulting in a different base sequence in mature mRNA

Hence a variation in the polypeptide chain

Extension questions

1. Outline the functions of the following three enzymes:

1. Helicase
2. DNA polymerase I
3. DNA ligase.

(3 marks)

Helicase unwinds the DNA and breaks hydrogen bonds to unzip the two strands;

DNA polymerase I replaces the RNA primers with DNA nucleotides.

DNA ligase joins the okazaki fragments together

1. Compare and contrast the functions of DNA polymerase I and DNA polymerase III in DNA replication

2. (3 marks)

3.

Similarities

DNA polymerase I and DNA polymerase III both add DNA nucleotides to a DNA strand;

Both DNA polymerase I and DNA polymerase III require an RNA primer to be present before they can begin to add nucleotides;

Both add nucleotides in a 5' to 3' direction

Both enzymes are found in prokaryotes and are involved in DNA replication;

Differences

DNA polymerase I replaces the RNA primer, DNA polymerase III builds the okazaki fragments on the lagging strand.

On the leading strand DNA polymerase III is much more active than DNA polymerase I