

**DNA, RNA, Protein Synthesis Practice Questions for Journals (Class Set)**

1. Draw a diagram showing the molecular structure of a section of the DNA molecule. (Total 5 marks)

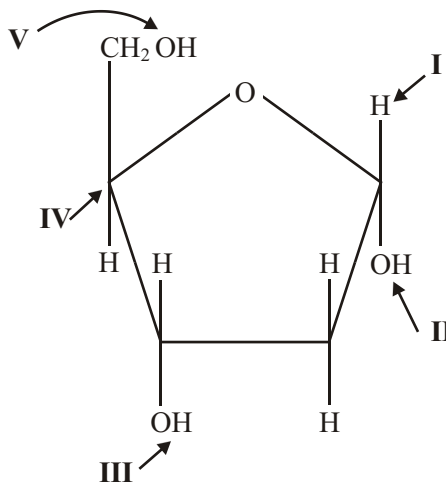
2. The structure of the DNA double helix was described by Watson and Crick in 1953. Explain the structure of the DNA double helix, including its subunits and the way in which they are bonded together. (Total 8 marks)

3. Distinguish between the structure of DNA and RNA.

DNA	RNA

(Total 3 marks)

4. To which parts of the deoxyribose molecule do phosphates bind in DNA?



- A. I and V
- B. III and IV
- C. II and III
- D. III and V

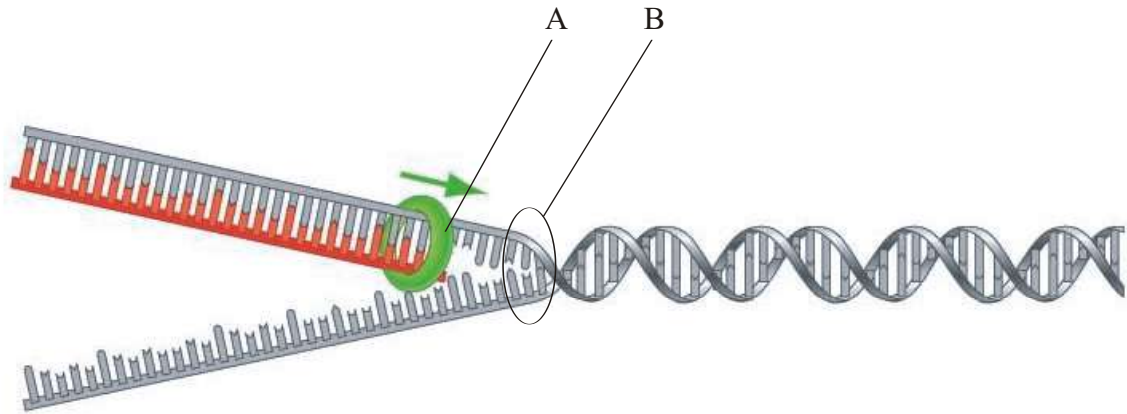
(1)

5. What is a difference between the sense and antisense strands of DNA?

- A. Nucleotides are linked to the sense strand by hydrogen bonding during transcription, but not to the antisense strand.
- B. The sense strand has the same base sequence as tRNA, but the antisense strand does not.
- C. Nucleotides are linked to the antisense strand by hydrogen bonding during transcription, but not to the sense strand.
- D. The antisense strand has the same base sequence as mRNA but the sense strand does not.

(Total 1 mark)

6. Living organisms use DNA as their genetic material. Explain how DNA is replicated within the cells of living organisms. (Total 8 marks)
7. State a role for each of **four** different named enzymes in DNA replication. (Total 6 marks)
8. The following diagram represents replication in DNA.



[Freeman, Scott, Biological Science, 1st, © 2002. Electronically reproduced by permission of Pearson Education, Inc., Upper Saddle River, New Jersey]

- (a) State the name and describe the function for the enzymes labelled A and B on the diagram.
    - (i) A: Name: .....  
Function: .....
    - (ii) B: Name: .....  
Function: .....

(2)
  - (b) Identify the cellular location of DNA replication in eukaryotic cells. (1)
  - (c) State at which period during the cell cycle DNA replication occurs. (1)
  - (d) Explain the significance of complementary base pairing during DNA replication. (2)
- (Total 6 marks)
9. Describe the consequence of a base substitution mutation with regards to sickle cell anaemia. (Total 7 marks)
  10. (a) Determine the strand of mRNA that is transcribed from the DNA strand below.
 

A – T – C – C – A – G – G – T – C – A – A – G

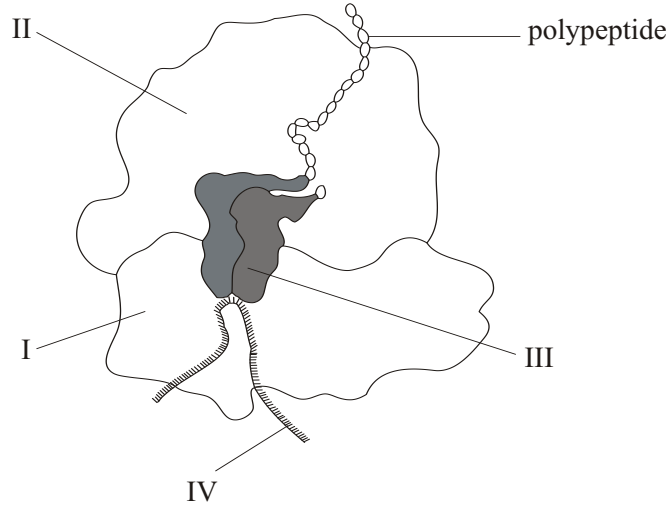
(1)
  - (b) List **three** of the other molecules, apart from mRNA, required for transcription. (3)
- (Total 4 marks)
11. Explain the process of translation. (Total 9 marks)
  12. Compare DNA transcription with translation. (Total 4 marks)

13. The process of translation involves the use of transfer RNA (tRNA) and amino acids. Outline the structure of tRNA.

(Total 5 marks)

14. (a) State **two** differences between the structure of DNA and RNA. (2)

The diagram below shows the structure of a ribosome during protein synthesis.



(b) State the names of the structures labelled above.

- I. ....
- II. ....
- III. ....
- IV. ....

(2)

(c) State the name of a structure shown on the diagram that has an anticodon.(1)

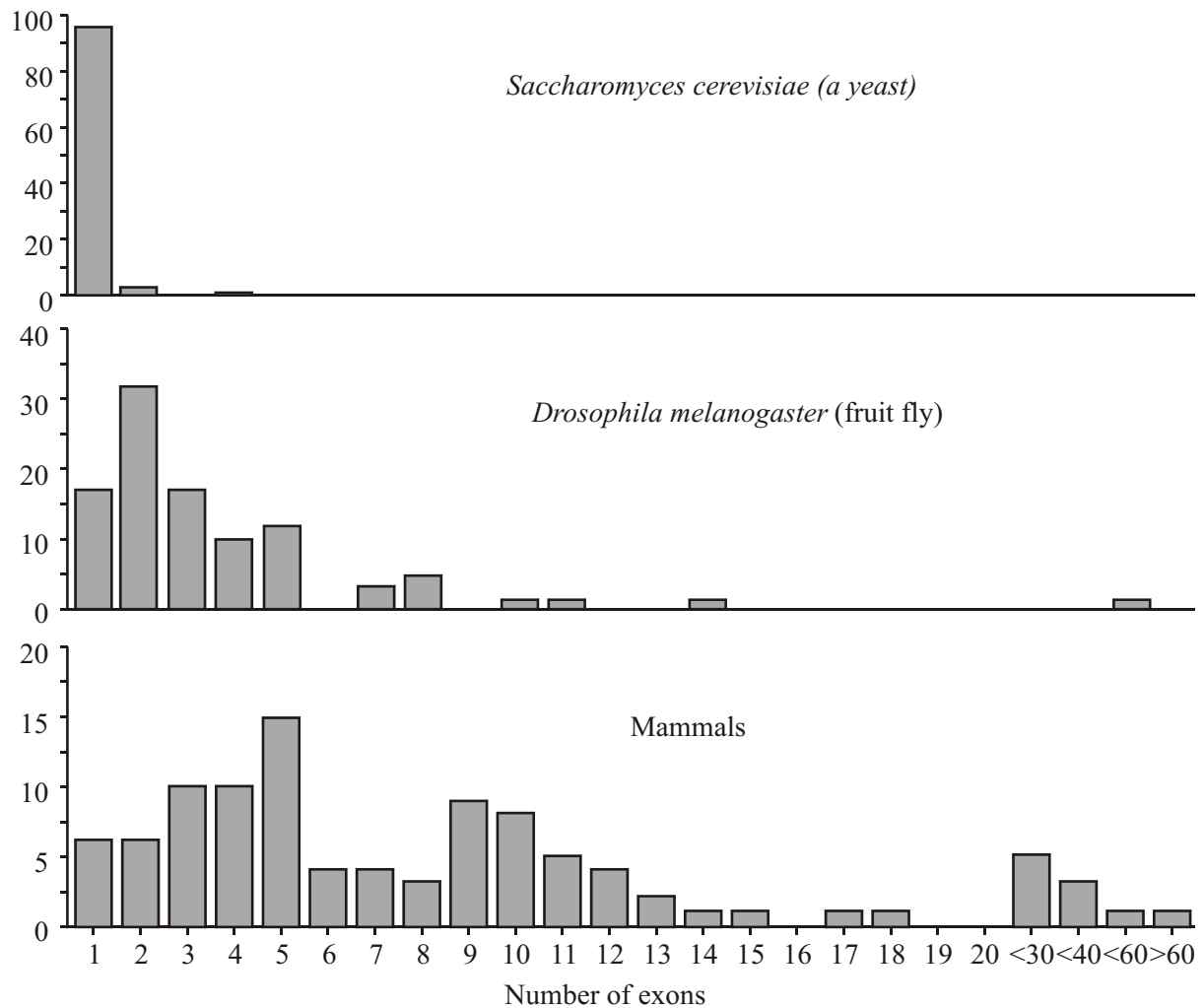
(d) Explain why the process used during protein synthesis in cells is called *translation*.(2)

(e) Explain briefly how termination of translation occurs.(2)

(Total 9 marks)

15. It had always been assumed that eukaryotic genes were similar in organization to prokaryotic genes. However, modern techniques of molecular analysis indicated that there are additional DNA sequences that lie within the coding region of genes. Exons are the DNA sequences that code for proteins while introns are the intervening sequences that have to be removed. The graph shows the number of exons found in genes for three different groups of eukaryotes.

Percentage of genes



[Source: Benjamin Lewin, (1999) *Genes VII*, OUP, page 55]

- (a) Calculate the percentage of genes that have five or less exons in mammals. (1)
- (b) Describe the distribution of the number of exons and the percentage of genes in *D. melanogaster*. (2)
- (c)
  - (i) Compare the distributions of the number of exons found in genes of *S. cerevisiae* and mammals. (2)
  - (ii) Suggest one reason for the differences in the numbers of exons found in genes of *S. cerevisiae* and mammals. (1)

Human DNA has been analysed and details of certain genes are shown in the table below.

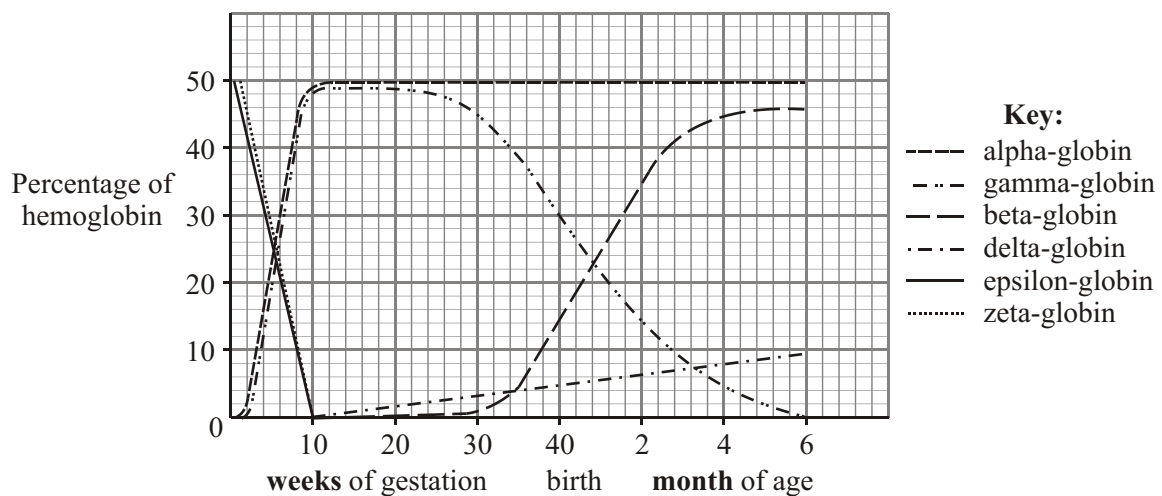
Gene	Gene size / kb*	mRNA size / kb	Number of introns
Insulin	1.7	0.4	2
Collagen	38.0	5.0	50
Albumin	25.0	2.1	14
Phenylalanine hydroxylase	90.0	2.4	12
Dystrophin	2 000.0	17.0	50

\*kilobase pairs

[Source: William S Klug and Michael R Cummings, (2002), *Concepts of Genetics*, 7th edition, Prentice Hall, page 314]

- (d) Calculate the average size of the introns for the albumin gene. (2)
- (e) Analyse the relationship between gene size and the number of introns. (2)
- (f) Determine the maximum number of amino acids that could be produced by translating the phenylalanine hydroxylase mRNA. (1)

Hemoglobin is a protein composed of two pairs of globin molecules. During the process of development from conception to adulthood, human hemoglobin changes in composition. Adult hemoglobin consists of two alpha- and two beta-globin molecules. Two globin genes occur on chromosome 16: alpha- and zeta-globin. Four other globin genes are found on chromosome 11: beta, delta, epsilon and gamma. The graph below illustrates the changes in expression of the globin genes over time.

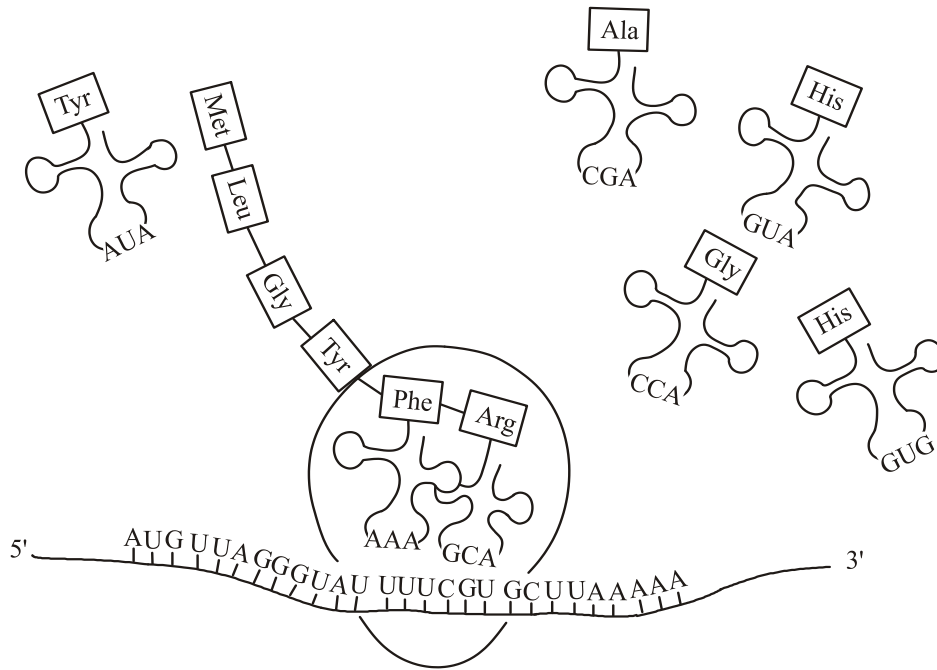


[Source: adapted from M Cummings, *Human Heredity*, 4th edition, West/Wadsworth Publishing Company]

- (g) State which globin genes are the first to be expressed after fertilization.(1)
- (h) Compare the expression of the gamma-globin gene with the beta-globin gene. (3)
- (i) Deduce the composition of the hemoglobin molecules  
at 10 weeks of gestation; .....  
2 months after birth. .... (2)

**(Total 17 marks)**

16. The information needed to make polypeptides is carried in the mRNA from the nucleus to the ribosomes of eukaryotic cells. This information is decoded during translation. The diagram below represents the process of translation.



**Key :**

Tyr = Tyrosine	Ala = Alanine
Met = Methionine	Gly = Glycine
Leu = Leucine	His = Histidine
	Phe = Phenylalanine

- Annotate the diagram to show the direction in which the ribosome moves during translation.(1)
- State the name of the next amino acid which will attach to the polypeptide.(1)
- Explain how the amino acid was attached to the tRNA.(3)
- Identify **two** locations within a eukaryotic cell where translation occurs. (1)

**(Total 6 marks)**