

## CHAPTER 6

# MOLECULAR BASIS OF INHERITANCE

### MULTIPLE-CHOICE QUESTIONS

1. In a DNA strand the nucleotides are linked together by:
  - a. glycosidic bonds
  - b. phosphodiester bonds
  - c. peptide bonds
  - d. hydrogen bonds
2. A nucleoside differs from a nucleotide. It lacks the:
  - a. base
  - b. sugar
  - c. phosphate group
  - d. hydroxyl group
3. Both deoxyribose and ribose belong to a class of sugars called:
  - a. trioses
  - b. hexoses
  - c. pentoses
  - d. polysaccharides
4. The fact that a purine base always pairs through hydrogen bonds with a pyrimidine base in the DNA double helix leads to:
  - a. the antiparallel nature
  - b. the semiconservative nature
  - c. uniform width throughout DNA
  - d. uniform length in all DNA
5. The net electric charge on DNA and histones is:
  - a. both positive
  - b. both negative
  - c. negative and positive, respectively
  - d. zero

6. The promoter site and the terminator site for transcription are located at:
  - a. 3' (downstream) end and 5' (upstream) end, respectively of the transcription unit
  - b. 5' (upstream) end and 3' (downstream) end, respectively of the transcription unit
  - c. the 5' (upstream) end
  - d. the 3' (downstream) end
7. Which of the following statements is the most appropriate for sickle cell anaemia?
  - a. It cannot be treated with iron supplements
  - b. It is a molecular disease
  - c. It confers resistance to acquiring malaria
  - d. All of the above
8. Which of the following is true with respect to AUG?
  - a. It codes for methionine only
  - b. It is an initiation codon
  - c. It codes for methionine in both prokaryotes and eukaryotes
  - d. All of the above
9. The first genetic material could be:
  - a. protein
  - b. carbohydrates
  - c. DNA
  - d. RNA
10. With regard to mature mRNA in eukaryotes:
  - a. exons and introns do not appear in the mature RNA
  - b. exons appear but introns do not appear in the mature RNA
  - c. introns appear but exons do not appear in the mature RNA
  - d. both exons and introns appear in the mature RNA
11. The human chromosome with the highest and least number of genes in them are respectively:
  - a. Chromosome 21 and Y
  - b. Chromosome 1 and X
  - c. Chromosome 1 and Y
  - d. Chromosome X and Y

12. Who amongst the following scientists had no contribution in the development of the double helix model for the structure of DNA?
- Rosalind Franklin
  - Maurice Wilkins
  - Erwin Chargaff
  - Meselson and Stahl
13. DNA is a polymer of nucleotides which are linked to each other by 3'-5' phosphodiester bond. To prevent polymerisation of nucleotides, which of the following modifications would you choose?
- Replace purine with pyrimidines
  - Remove/Replace 3' OH group in deoxy ribose
  - Remove/Replace 2' OH group with some other group in deoxy ribose
  - Both 'b' and 'c'
14. Discontinuous synthesis of DNA occurs in one strand, because:
- DNA molecule being synthesised is very long
  - DNA dependent DNA polymerase catalyses polymerisation only in one direction (5' → 3')
  - it is a more efficient process
  - DNA ligase joins the short stretches of DNA
15. Which of the following steps in transcription is catalysed by RNA polymerase?
- Initiation
  - Elongation
  - Termination
  - All of the above
16. Control of gene expression in prokaryotes take place at the level of:
- DNA-replication
  - Transcription
  - Translation
  - None of the above
17. Which of the following statements is correct about the role of regulatory proteins in transcription in prokaryotes?
- They only increase expression
  - They only decrease expression
  - They interact with RNA polymerase but do not affect the expression
  - They can act both as activators and as repressors

18. Which was the last human chromosome to be completely sequenced:
- Chromosome 1
  - Chromosome 11
  - Chromosome 21
  - Chromosome X
19. Which of the following are the functions of RNA?
- It is a carrier of genetic information from DNA to ribosomes synthesising polypeptides.
  - It carries amino acids to ribosomes.
  - It is a constituent component of ribosomes.
  - All of the above.
20. While analysing the DNA of an organism a total number of 5386 nucleotides were found out of which the proportion of different bases were: Adenine = 29%, Guanine = 17%, Cytosine = 32%, Thymine = 17%. Considering the Chargaff's rule it can be concluded that:
- it is a double stranded circular DNA
  - It is single stranded DNA
  - It is a double stranded linear DNA
  - No conclusion can be drawn
21. In some viruses, DNA is synthesised by using RNA as template. Such a DNA is called:
- A-DNA
  - B-DNA
  - cDNA
  - rDNA
22. If Meselson and Stahl's experiment is continued for four generations in bacteria, the ratio of  $N^{15}/N^{15}$ :  $N^{15}/N^{14}$ :  $N^{14}/N^{14}$  containing DNA in the fourth generation would be:
- 1:1:0
  - 1:4:0
  - 0:1:3
  - 0:1:7
23. If the sequence of nitrogen bases of the coding strand of DNA in a transcription unit is:
- 5' - A T G A A T G - 3',
- the sequence of bases in its RNA transcript would be;
- 5' - A U G A A U G - 3'

- b. 5' - U A C U U A C - 3'
  - c. 5' - C A U U C A U - 3'
  - d. 5' - G U A A G U A - 3'
24. The RNA polymerase holoenzyme transcribes:
- a. the promoter, structural gene and the terminator region
  - b. the promoter and the terminator region
  - c. the structural gene and the terminator region
  - d. the structural gene only.
25. If the base sequence of a codon in mRNA is 5'-AUG-3', the sequence of tRNA pairing with it must be:
- a. 5' - UAC - 3'
  - b. 5' - CAU - 3'
  - c. 5' - AUG - 3'
  - d. 5' - GUA - 3'
26. The amino acid attaches to the tRNA at its:
- a. 5' - end
  - b. 3' - end
  - c. Anti codon site
  - d. DHU loop
27. To initiate translation, the mRNA first binds to:
- a. The smaller ribosomal sub-unit,
  - b. The larger ribosomal sub-unit
  - c. The whole ribosome
  - d. No such specificity exists.
28. In *E.coli*, the lac operon gets switched on when:
- a. lactose is present and it binds to the repressor
  - b. repressor binds to operator
  - c. RNA polymerase binds to the operator
  - d. lactose is present and it binds to RNA polymerase

### VERY SHORT ANSWER TYPE QUESTIONS

1. What is the function of histones in DNA packaging?
2. Distinguish between heterochromatin and euchromatin. Which of the two is transcriptionally active?

3. The enzyme DNA polymerase in *E.coli* is a DNA dependent polymerase and also has the ability to proof-read the DNA strand being synthesised. Explain. Discuss the dual polymerase.
4. What is the cause of discontinuous synthesis of DNA on one of the parental strands of DNA? What happens to these short stretches of synthesised DNA?
5. Given below is the sequence of coding strand of DNA in a transcription unit  
3' A A T G C A G C T A T T A G G - 5'  
write the sequence of
  - a) its complementary strand
  - b) the mRNA
6. What is DNA polymorphism? Why is it important to study it?
7. Based on your understanding of genetic code, explain the formation of any abnormal hemoglobin molecule. What are the known consequences of such a change?
8. Sometimes cattle or even human beings give birth to their young ones that are having extremely different sets of organs like limbs/position of eye(s) etc. Comment.
9. In a nucleus, the number of ribonucleoside triphosphates is 10 times the number of deoxy x10 ribonucleoside triphosphates, but only deoxy ribonucleotides are added during the DNA replication. Suggest a mechanism.
10. Name a few enzymes involved in DNA replication other than DNA polymerase and ligase. Name the key functions for each of them.
11. Name any three viruses which have RNA as the genetic material.

### SHORT ANSWER TYPE QUESTIONS

1. Define transformation in Griffith's experiment. Discuss how it helps in the identification of DNA as the genetic material.
2. Who revealed biochemical nature of the transforming principle? How was it done?
3. Discuss the significance of heavy isotope of nitrogen in the Meselson and Stahl's experiment.

4. Define a cistron. Giving examples differentiate between monocistronic and polyeistronic transcription unit.
5. Give any six features of the human genome.
6. During DNA replication, why is it that the entire molecule does not open in one go? Explain replication fork. What are the two functions that the monomers (d NTPs) play?
7. Retroviruses do not follow central Dogma. Comment.
8. In an experiment, DNA is treated with a compound which tends to place itself amongst the stacks of nitrogenous base pairs. As a result of this, the distance between two consecutive base increases. from 0.34nm to 0.44 nm calculate the length of DNA double helix (which has  $2 \times 10^9$  bp) in the presence of saturating amount of this compound.
9. What would happen if histones were to be mutated and made rich in acidic amino acids such as aspartic acid and glutamic acid in place of basic amino acids such as lysine and arginine?
10. Recall the experiments done by Frederick Griffith, Avery, MacLeod and McCarty, where DNA was speculated to be the genetic material. If RNA, instead of DNA was the genetic material, would the heat killed strain of Pneumococcus have transformed the R-strain into virulent strain? Explain.
11. You are repeating the Hershey-Chase experiment and are provided with two isotopes:  $^{32}\text{P}$  and  $^{15}\text{N}$  (in place of  $^{35}\text{S}$  in the original experiment). How do you expect your results to be different?
12. There is only one possible sequence of amino acids when deduced from a given nucleotides. But multiple nucleotides sequence can be deduced from a single amino acid sequence. Explain this phenomena.
13. A single base mutation in a gene may not 'always' result in loss or gain of function. Do you think the statement is correct? Defend your answer.
14. A low level of expression of lac operon occurs at all the time. Can you explain the logic behind this phenomena.
15. How has the sequencing of human genome opened new windows for treatment of various genetic disorders. Discuss amongst your classmates.
16. The total number of genes in humans is far less ( $< 25,000$ ) than the previous estimate (upto 1,40,000 gene). Comment.
17. Now, sequencing of total genomes getting is getting less expensive day by the day. Soon it may be affordable for a common man to get his genome sequenced. What in your opinion could be the advantage and disadvantage of this development?

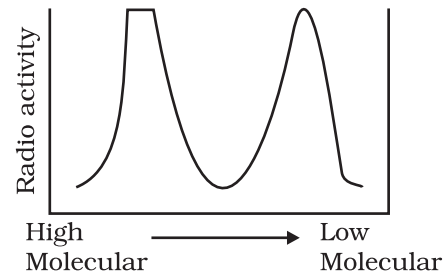
18. Would it be appropriate to use DNA probes such as VNTR in DNA finger printing of a bacteriophage?
19. During in vitro synthesis of DNA, a researcher used 2', 3' – dideoxy cytidine triphosphate as raw nucleotide in place of 2'-deoxy cytidine. What would be the consequence?
20. What background information did Watson and Crick have made available for developing a model of DNA? What was their contribution?
21. What are the functions of (i) methylated guanosine cap, (ii) poly-A “tail” in a mature mRNA?
22. Do you think that the alternate splicing of exons may enable a structural gene to code for several isoproteins from one and the same gene? If yes, how? If not, why so?
23. Comment on the utility of variability in number of tandem repeats during DNA finger printing.

### LONG ANSWER TYPE QUESTIONS

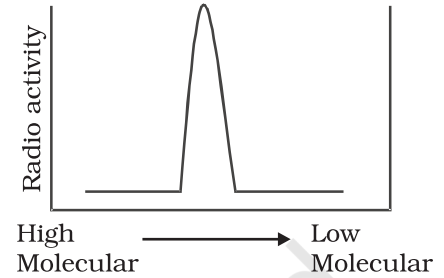
1. Give an account of Hershey and Chase experiment. What did it conclusively prove? If both DNA and proteins contained phosphorus and sulphur do you think the result would have been the same?
2. During the course of evolution why DNA was chosen over RNA as genetic material? Give reasons by first discussing the desired criteria in a molecule that can act as genetic material and in the light of biochemical differences between DNA and RNA.
3. Give an account of post transcriptional modifications of a eukaryotic mRNA.
4. Discuss the process of translation in detail.
5. Define an operon. giving an example, explain an Inducible operon.
6. ‘There is a paternity dispute for a child’. Which technique can solve the problem. Discuss the principle involved.
7. Give an account of the methods used in sequencing the human genome.
8. List the various markers that are used in DNA finger printing.
9. Replication was allowed to take place in the presence of radioactive deoxynucleotides precursors in *E.coli* that was a mutant for DNA ligase. Newly synthesised radioactive DNA was purified and strands



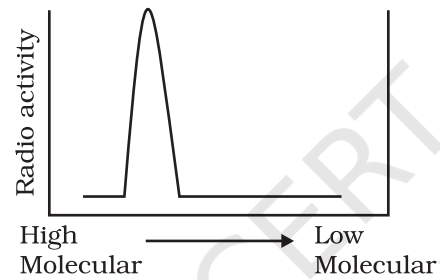
were separated by denaturation. These were centrifuged using density gradient centrifugation. Which of the following would be a correct result?



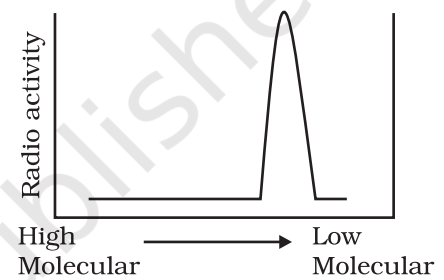
(a)



(b)



(c)



(d)