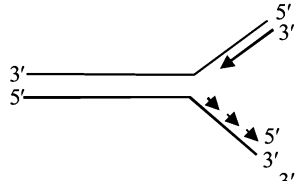
28 Molecular Basis of Inheritance

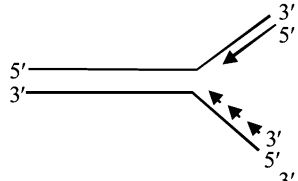
Conceptual MCQs

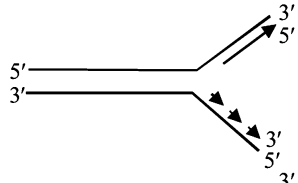
1. The primary function of DNA polymerase is to :
   (a) add nucleotides to the growing daughter strand.
   (b) seal nicks along the sugar-phosphate backbone of the daughter strand.
   (c) unwind the parent DNA double helix.
   (d) prevent reassociation of the denatured parent DNA strands.
2. The lagging daughter strand of DNA is synthesised in what appears to be the "wrong" direction. This synthesis is accomplished by :
   (a) ligating (connecting) short Okazaki fragments that are synthesised in short spurts in the "right" direction.
   (b) primase.
   (c) using multiple primers and DNA polymerase I.
   (d) Both (a) and (b)
3. Proof reading and repair occur :
   (a) at anytime during or after synthesis of DNA.
   (b) only before DNA methylation occurs.
   (c) only in the presence of DNA polymerase.
   (d) only in the presence of an excision repair mechanism.
4. Genes can be inactivated by :
   (a) inaccurate removal of introns.
   (b) transposable genetic elements.
   (c) movement of genes to heterochromatic regions of the chromosome.
   (d) All of the above
5. Which of the following mechanisms of gene regulation operates after mRNA transcription but before translation of mRNA into protein?
   (a) mRNA splicing
   (b) DNA packing
   (c) Repressors and activators
   (d) Protein degradation
6. During initiation step of translation in prokaryotes, a GTP molecule is needed in :
   (a) association of 50 S subunit of ribosome with initiation complex
   (b) formation of formyl-met-tRNA
   (c) binding of 30 S subunit of ribosome with mRNA
   (d) association of 30S-mRNA with formyl-met-tRNA
7. Each individual has a unique DNA fingerprinting as individuals differ in :
   (a) number of minisatellites on chromosome.
   (b) location of minisatellites on chromosome.
   (c) size of minisatellites on chromosome.
   (d) All of the above
8. Which of the following statements regarding the control of gene expression and phenotype is false?
   (a) The control of gene expression influences phenotype.
   (b) Since homeotic genes are always expressed, they have little effect on phenotype.
   (c) The environment influences the control of gene expression, and therefore, phenotype.
   (d) Phenotype is determined by a combination of genotype and the control of gene expression.
9. RNA primers are necessary in DNA synthesis because :
   (a) DNA polymerase can only add to an existing strand of nucleotides.
   (b) DNA polymerase can not initiate this process on its own.
   (c) Both (a) and (b)
   (d) None of the above
10. The length of DNA molecule greatly exceeds the dimensions of the nucleus in eukaryotic cells. How is this DNA accommodated?
   (a) super-coiling in nucleosomes
   (b) DNase digestion
   (c) through elimination of repititive DNA
   (d) deletion of non-essential genes
11. Haploids are more suitable for studies of mutation than the diploids. This is because :
   (a) haploids are reproductively more stable than diploids.
   (b) mutagens penetrate in haploids more effectively than diploids.
   (c) haploids are more abundant in nature than diploids.
   (d) all mutations, whether dominant or recessive are expressed in haploids.
12. The mutations that involve addition, deletion or substitution of a single base pair in a gene are referred to as :
   (a) point mutations (b) lethal mutations
   (c) silent mutations (d) retrogressive mutations.

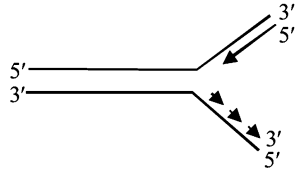
13. During translation, activated amino acids get linked to tRNA. This process is commonly called as
(a) charging of tRNA
(b) discharging of tRNA
(c) aminoacylation of tRNA
(d) both (a) and (c)

14. Which of the following figures correctly represents the replication fork formed during DNA replication?

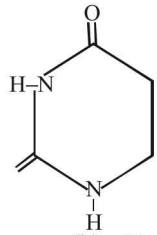
(a) 

(b) 

(c) 

(d) 

15. Identify this structure.



(a) Adenylic acid (b) Uracil
(c) Cholesterol (d) Adenosine

16. The eukaryotic genome differs from the prokaryotic genome because :
(a) large segment of repetitive sequences are present in prokaryotes.
(b) genes in the former case are organised into operons.
(c) DNA is comlexed with histones in prokaryotes.
(d) DNA is circular and single stranded in prokaryotes.

17. In processing of eukaryotic hnRNA, during protein synthesis tailing involves _____ of RNA
(a) Addition of adenylate residues at 3′ end
(b) Addition of methyl guanosine triphosphate at 3′ end
(c) Addition of methyl guanosine triphosphate at 5′ end
(d) Removal of introns

18. During protein denaturation which of the following is disrupted ?
(a) 2D structure (b) 3D structure
(c) Peptide bond (d) AA sequence

19. Which antibiotic inhibits interaction between tRNA and mRNA during bacterial protein synthesis ?
(a) Streptomycin (b) Tetracycline
(c) Erythromycin (d) Neomycin

Application Based MCQs

20. A sample of DNA from an unknown organism is analysed and found to contain histone proteins, more than 2 billion base pairs, and large segments of noncoding DNA. From this information, one can conclude that the organism is :
(a) a bacterium
(b) an animal
(c) a plant
(d) some kind of eukaryotic organisms

21. Consider Griffith's experiments on transformation in *Streptococcus pneumoniae*. Now imagine that you are extending these experiments by injecting a mixture of heat-killed strain R bacteria and live strain S bacteria into a mouse. The result will be that the mouse will _____, and you will find live strain _____ bacteria in its blood.
(a) die; R (b) live; R
(c) die; S (d) live; S

22. A short sequence of bases on one strand of DNA is AGTCTACCGATAGT. If this sequence serves as a template for the formation of a new strand of DNA, what will be the corresponding base sequence in the new strand?
(a) AGTCTACCGATAGT
(b) TCAGATGGCTATCA
(c) TGATAGCCATCTGA
(d) GACATCGATTCGAT

23. Thirty percent of the bases in a sample of DNA extracted from eukaryotic cells is adenine. What percentage of cytosine is present in this DNA?
(a) 10% (b) 20%
(c) 30% (d) 40%

24. The length of DNA has 45,000 base pairs. How many complete turns will the DNA molecule take?
(a) 45,000 (b) 450
(c) 4,500 (d) 45

25. When a molecule of DNA replicates without error, each of the resulting molecules contains :
(a) the same amount of A as T.
(b) the same amount of G as C.
(c) one new strand and one old strand.
(d) All of the above

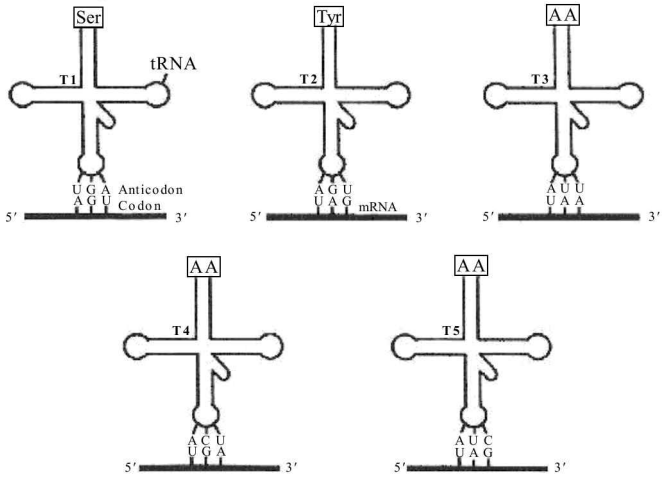
26. In order for the information contained in a gene to be used to produce a functioning protein, the :
(a) DNA must be replicated.
(b) information must be transcribed into mRNA and then translated into amino acids.
(c) tRNA must be transcribed into rRNA and then translated into amino acids.
(d) ribosome must be converted from rRNA into mRNA.

27. What would happen if in a gene encoding a polypeptide of 50 amino acids, 25th codon (UAU) is mutated to UAA?
(a) A polypeptide of 25 amino acids will be formed.
(b) A polypeptide of 24 amino acids will be formed.
(c) Two polypeptides of 24 and 25 amino acids will be formed.
(d) A polypeptide of 49 amino acids will be formed.

28. Which step of translation does not consume a high energy phosphate bond ?
(a) Translocation
(b) Amino acid activation
(c) Peptidyl-transferase reaction
(d) Aminoacyl tRNA binding to active ribosomal site

29. In humans, the hormone testosterone enters cells and binds to specific proteins, which in turn bind to specific sites on the cell's DNA. These proteins probably act to :
(a) help RNA polymerase transcribe certain genes.
(b) alter the pattern of DNA splicing.
(c) stimulate protein synthesis.
(d) unwind the DNA so that its genes can be transcribed.

30. Study the following tRNA molecules related with their anti codon pairing with respective codons. Which types of tRNA is impossible?



(a) T1 and T2 (b) Tl, T2 and T3
(c) Tl and T4 (d) T3, T4 and T5

31. If the gene encoding the *lac* repressor is mutated so that it can no longer bind the operator, will transcription of that operon occur?
(a) Yes, but only when lactose is present.
(b) No, because RNA polymerase is need to transcribe the genes.
(c) Yes, because the operator will not be bound by repressor and RNA polymerase can transcribe the *lac* operon.
(d) No, because cAMP levels are low when the repressor is nonfunctional.

32. A functional piece of mRNA has 66 codons. What is the maximum number of amino acids that could be present in the protein coded for by this mRNA?
(a) 22 (b) 64
(c) 65 (d) 66

33. Chromatin structure must be altered in order for gene expression to occur because :
(a) condensed chromatin is replicated but not transcribed.
(b) condensed chromatin makes most DNA sequence inaccessible to the transcription complex.
(c) decondensed chromatin has more nucleosomes per DNA molecule.
(d) heterochromatin is actively transcribed and euchromatin is not transcribed.

34. Prior to mutation, a sequence of DNA reads GAGCCTATGCCAGTA. After the mutation, the sequence reads GAGCGTACGCCATTA. Which of the following best explains the change in DNA that has occurred?
(a) There was a single base deletion.
(b) There was a single base substitution.
(c) There were multiple base deletions.
(d) There were multiple base substitutions.

35. *E.coli* cells with a mutated *z* gene of the *lac* operon cannot grow in medium containing only lactose as the source of energy because:
(a) the *lac* operon is constitutively active in these cells.
(b) they cannot synthesise functional beta-galactosidase.
(c) in the presence of glucose, *E.coli* cells do not utilise lactose.
(d) they cannot transport lactose from the medium into the cell.

36. Wild type *Escherichia coli* growing on medium having glucose, is transferred to lactose containing medium. Which one of the following change will occur?
(a) The bacterium stops dividing.
(b) *Lac* operon is off.
(c) *Lac* operon is suppressed.
(d) *Lac* operon is induced.

37. Termination of protein synthesis needs :
(i) AUG codon and sigma factor
(ii) GUG and Rho factor
(iii) Stop signal/Non-sense codon
(iv) Release/termination factor
Which of the following are correct?
(a) (i), (iii) (b) (i), (ii), (iii), (iv)
(c) (iii), (iv) (d) (i), (ii), (iii)

38. Go through the following facts :
I. AAG always codes for lysine. It cannot code for any other amino acid.
II. Serine amino acid can be coded by UCU/UCC/UCA or UCG
III. UUU codes for phenylalanine in bacteria as well as human beings
IV. UUU, GGG, CCC, AAA, AAC code for five amino acids.

Now point out the nature of genetic code after reading the above statements.

(a) I-Specificity/non-ambiguity of code; II-Universality of code; III-Degeneracy of code; IV-Triplet and non-overlapping code
(b) I-Specificity/non-ambiguity of code; II-Degeneracy of code; III-Universality of code; IV-Triplet and non-overlapping code
(c) I-Specificity/non-ambiguity of code; II-Degeneracy of code; III-Universality of code; IV-Triplet and overlapping code
(d) I-Specificity/non-ambiguity of code; II-Universality of code; III-Degeneracy of code; IV-Triplet and overlapping code

Direction: Read the sentence of neucleotides in the given segment of mRNA and the respective amino acid sequence in the polypeptide chain to answer the Q. nos. 39 and 40.

mRNA **AUG UUU AUG CCU GUU UCU UAA** →

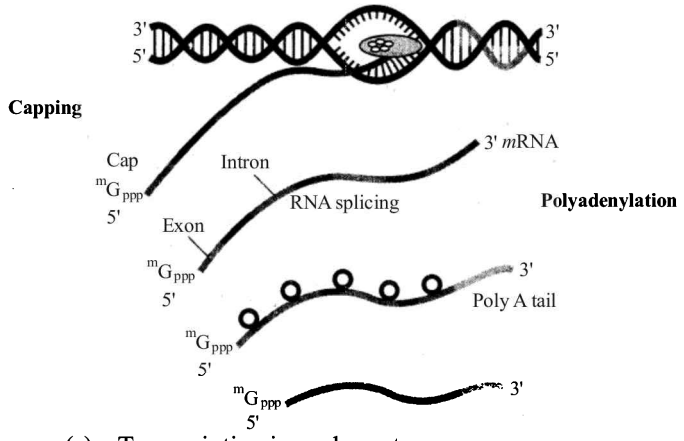
Polypeptide Met—Phe—Met—Pro—Val—Ser

39. Nucleotide sequence of the DNA strand from which this mRNA was transcribed is :
(a) TAC AAA TAC GGA CAA AGA ATT
(b) AUG UUU AUG CCU GUU UCU UAA
(c) UAC AAA UAC GGA CAA AGA AUU
(d) ATG TTT ATG CCT GTT TCT TAA.

40. Which codons respectively code for proline and valine amino acids in the given polypeptide chain, respectively?
(a) CCU and GUU (b) GUU and UCU
(c) UCU and UAA (d) GUU and CCU

41. In one polynucleotide strand of a DNA molecule the ratio of A + T/G + C is 0.3. What is the A + G/T + C ratio of the entire DNA molecule?
(a) 0.3 (b) 0.6
(c) 1.2 (d) 1

42. Refer the given diagram. What does it represent?



(a) Transcription in prokaryotes
(b) Transcription in eukaryotes
(c) Translation in prokaryotes
(d) Translation in eukaryotes

43. What would be the base sequence of RNA transcript obtained from the given DNA segment?

5′ – G C A T T C G G C T A G T A A C – 3′ Coding strand of DNA
3′ – C G T A A G C C G A T C A T T G – 5′ Non-Coding strand of DNA
(a) 5′ – G C A U U C G G C U A G U A A C – 3′
(b) 5′ – C G U A A G C C G A U C A U U G – 3′
(c) 5′ – G C A T T C G G C T A G T A A C – 3′
(d) 5′ – C G T A A G C C G A T C A T T G – 5′

44. **(A):** Eukaryotic mRNA requires post-transcription processing for formation of functional mRNA.
(B): Eukaryotic transcripts possess extra non-functional segments called introns.
(a) Both (A) and (B) are true.
(b) (A) is true but (B) is false.
(c) Both (A) and (B) are false.
(d) (A) is false but (B) is true.

45. Consider the following statements.
A. The four nucleotide bases are not necessarily present in DNA in exact equal proportions.
B. The total amount of purines are equal to the total amount of pyrimidines.
C. DNA ligase enzyme act to hydrolyse or breakdown a polyucleotide chain into its component nucleotides.
D. Nuclease enzymes are capable of restoring an intact DNA duplex.
Of the above statements :
(a) B is correct but A, C and D are wrong.
(b) C and D are correct but A and B are wrong.
(c) A and B are correct but C and D are wrong.
(d) B, C and D are correct but A is wrong.

46. Which one of the following pairs is correctly matched?
(a) Ribosomal RNA – carries aminoacids to the site of protein synthesis
(b) Transcription – process by which protein is synthesised
(c) Translation – process by which *m*RNA carries the information from nucleus to the ribosome
(d) Anticodon – site of *t*RNA molecule that contains complementary bases on *m*RNA

47. A naturally occurring coding strand composed of alternating C and U residues would result in the formation of:
(a) A polypeptide containing alternating Leu and Ser residues.
(b) A polypeptide containing either Leu or Ser residues.
(c) A polypeptide containing only Leu residues.
(d) A polypeptide containing only Ser residues.

48. Gene regulation governing lactose operon of *E.*coli that involves the *lac* I gene product is :
(a) Negative and inducible because repressor protein prevents transcription.
(b) Negative and repressible because repressor protein prevents transcription.
(c) Feedback inhibition because excess of β-galactosidase can switch off transcription.
(d) Positive and inducible because it can be induced by lactose.

Skill Based MCQs

49. A murder has occurred, and you are asked to help to solve it. The police bring you a sample from the crime scene of what they believe is the killer's DNA and ask you for a chemical analysis. Your study of this sample reveals the presence of adenine, thymine, ribose, and uracil, leading you to conclude that the sample is :
(a) pure DNA.
(b) pure RNA.
(c) probably a mixture of DNA and RNA.
(d) probably a mixture of rRNA and mRNA.

50. Which one is/are correct?
1. DNA cannot produce its copies without DNA polymerase.
2. DNA cannot produce mRNA.
3. RNA can produce complementary DNA / cDNA
4. DNA helps in protein synthesis
(a) 1, 3 and 4 (b) All of these
(c) 2, 3 and 4 (d) 1, 2 and 3

51. The differences between mRNA and tRNA are that :
(i) mRNA has more elaborated 3 dimensional structure due to extensive base-pairing.
(ii) tRNA has more elaborated 3 dimensional structure due to extensive base-pairing.
(iii) tRNA is usually smaller than mRNA.
(iv) mRNA bears anticodon but tRNA has codons.
(a) (i) and (ii) (b) (ii) and (iii)
(c) (i), (ii) and (iii) (d) (i), (ii), (iii) and (iv)

52. A small segment of DNA contains the base sequence CGT. If an mRNA transcript is made that includes this DNA sequence, what will be the anticodon on the tRNA that will bind to the corresponding mRNA codon for this DNA triplet?
(a) CGT (b) GCA
(c) CGU (d) GCT

53. A triplet base sequence in DNA reads ATT. What will be the corresponding mRNA codon, tRNA anticodon, and amino acid called by this DNA?
(a) TAA; UTT; methionine
(b) TAA; AUU; no amino acid (= stop codon)
(c) UAA; AUU; no amino acid (= stop codon)
(d) CGG; GCC; alanine

54. In the genetic code dictionary, how many codons are used to code for all the 20 essential amino acids ?
(a) 60 (b) 20
(c) 64 (d) 61

55. What would happen if a mutation occurred in the DNA such that the second codon of a polypeptide, UGC, was changed to a UAG?
(a) Nothing. The ribosome would skip that codon and translation would continue.
(b) Translation would continue, but the reading frame of the ribosome would be shifted.
(c) Translation would stop at the second codon and no functional protein would be made.
(d) Translation would continue, but the second amino acid in the protein would be different.

56. Match the column-I with column-II and select the correct answer using the codes given below.

	Column-I		Column-II
A.	Termination	1.	Aminoacyl tRNA synthetase
B.	Translation	2.	Okazaki fragments
C.	Transcription	3.	GTP dependent release factor
D.	DNA replication	4.	Rho factor

(a) A → (2); B → (1); C → (3); D → (4)
(b) A → (3); B → (1); C → (4); D → (2)
(c) A → (4); B → (3); C → (1); D → (2)
(d) A → (2); B → (3); C → (1); D → (4)

57. Given below are the steps of protein synthesis. Arrange them in correct sequence and select the correct option.
(i) Codon-anticodon reaction between mRNA and aminoacyl tRNA complex.
(ii) Attachment of mRNA and smaller sub-unit of ribosome.
(iii) Charging or aminoacylation of tRNA.
(iv) Attachment of larger sub-unit of ribosome to the mRNA-$tRNA_{Met}$ complex.
(v) Linking of adjacent amino acids.
(vi) Formation of polypeptide chain.
(a) (ii)→ (i)→ (iii) → (v) → (iv) → (vi)
(b) (v) → (ii) → (i) → (iii) → (iv) → (vi)
(c) (iii)→ (ii) → (iv) → (i) → (v) → (vi)
(d) (iii) → (ii) →(i) → (iv) →(v) → (vi)

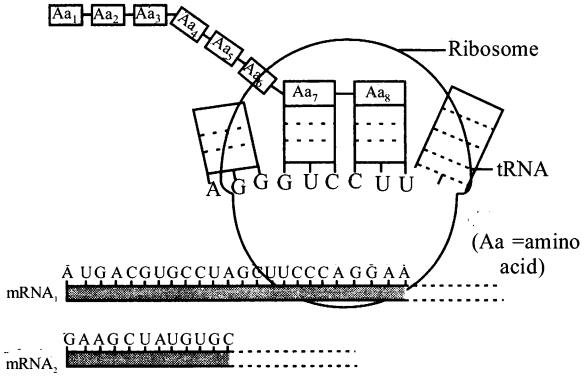
58. Which one(s) is / are correct?
1. In prokaryotes single type of RNA polymerase can transcribe mRNA, tRNA and rRNA.
2. In eukaryotes RNA polymerase I transcribes rRNA (28S, 18S and 5.8S) whereas RNA pol III is responsible for transcription of tRNA, 5S rRNA and Sn RNAs.
3. RNA pol II transcribes hnRNA in eukaryotes.
4. Ribosomal large subunit has P and A-sites.
(a) 1 and 3 (b) All of these
(c) 2, 3 and 4 (d) 1, 2 and 3

59. Match column-I with column-II.

	Column-I		Column-II
A.	5'AUG 3'	I.	Segment of DNA
B.	RNA with introns and exons	II.	Chromatin
C.	Gene	III.	hnRNA
D.	DNA with histone	IV.	Initiation codon

(a) A-I, B-II, C-III, D-IV
(b) A-IV, B-III, C-I, D-II
(c) A-IV, B-II, C-I, D-III
(d) A-II, B-IV, C-III, D-I

60. Refer to the diagram which shows the synthesis of a part of protein molecule.



Which of the following is the first part of the protein molecule that would be translated from $mRNA_2$?

(a) $Aa_4 - Aa_2 - Aa_7 - Aa_6$
(b) $Aa_6 - Aa_7 - Aa_2 - Aa_4$
(c) $Aa_3 - Aa_1, - Aa_6 - Aa_8$
(d) $Aa_8 - Aa_5 - Aa_1 - Aa_3$

61. In a 3.2 Kbp long piece of DNA, 820 adenine bases were found. What would be the number of cytosine bases ?
(a) 780 (b) 1560
(c) 740 (d) 1480

62. In a given DNA segment ATGACC AGG ACC CCA ACA, the first base gets mutated. The effect of this on coding by this DNA segment will result in:
(a) Complete change in the type as well as sequence of amino acids.
(b) Change in the first amino acid only
(c) No change in the sequence
(d) No coding takes place

ANSWER KEY																			
Conceptual MCQs																			
1	(a)	**3**	(a)	**5**	(a)	**7**	(d)	**9**	(a)	**11**	(d)	**13**	(d)	**15**	(b)	**17**	(a)	**19**	(d)
2	(d)	**4**	(d)	**6**	(d)	**8**	(b)	**10**	(a)	**12**	(a)	**14**	(d)	**16**	(d)	**18**	(b)		
Application Based MCQs																			
20	(d)	**23**	(b)	**26**	(b)	**29**	(a)	**32**	(c)	**35**	(b)	**38**	(b)	**41**	(d)	**44**	(a)	**47**	(a)
21	(c)	**24**	(c)	**27**	(b)	**30**	(d)	**33**	(b)	**36**	(d)	**39**	(a)	**42**	(b)	**45**	(c)	**48**	(a)
22	(b)	**25**	(d)	**28**	(d)	**31**	(c)	**34**	(d)	**37**	(c)	**40**	(a)	**43**	(a)	**46**	(d)		
Skill Based MCQs																			
49	(c)	**51**	(b)	**53**	(c)	**55**	(c)	**57**	(d)	**59**	(b)	**61**	(a)						
50	(a)	**52**	(c)	**54**	(d)	**56**	(c)	**58**	(b)	**60**	(d)	**62**	(b)						