

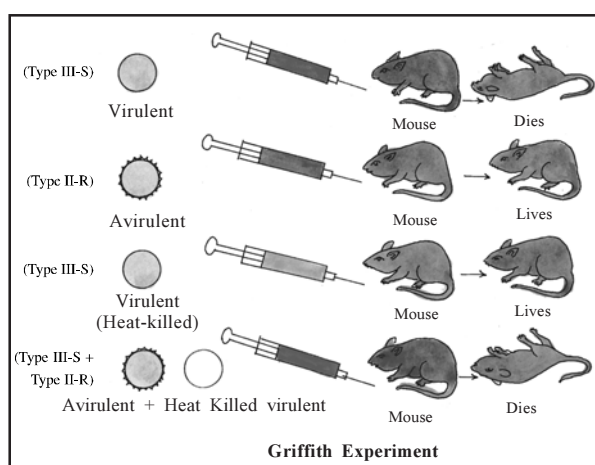
DNA is the Genetic Material :

- Recent developments in molecular biology revealed that the nucleic acids of the chromosomes are responsible for the transmission of hereditary character.
 - DNA is found to be the genetic material in almost all the living beings except plant viruses where DNA is not found and RNA act as a genetic material.
- (1) Which branch revealed that the Nucleic acid of the chromosomes are responsible for the transmission of hereditary character ?
 (A) Bio-chemistry (B) Molecular biology (C) Genetics (D) Biology
- (2) Which one of the following is responsible for the transmission of hereditary character ?
 (A) Cytoplasm (B) RNA (C) Chromosomes (D) None of above

Answers : (1-B), (2-C)

Bacterial Transformation or Griffith Effect :

- **Griffith** in 1928 carried out a series of experiments with **Pneumococcus bacteria** namely Virulent (S-III) and avirulent (R-II).
- Virulent strains have smooth polysaccharides capsules and give smooth (S) colonies.
- Avirulent strains have no capsules and give rough colonies (R).
- These two strains also differ in their antigenic properties and virulence for the disease pneumonia.
- Virulence is determined by genetic factors.
- When virulent strain were injected into mice; they killed them by causing pneumonia fever. When mice were inoculated with a virulent bacterium, there was no ill effect when mice were injected with virulent bacteria. After killing the bacteria with heat, no ill effect is produced and the mice survive.
- When mice were injected with a mixture of avirulent and heat-killed virulent bacterium, the mice were found dead due to pneumococcus infection.
- The analysis of dead mice shows that they contain virulent strain responsible for the transformation of avirulent bacteria into virulent smooth bacteria.
- Something from the heat-killed (dead) virulent bacteria transformed the live avirulent bacteria to virulent bacteria.
- As a result the avirulent bacteria are transformed into the virulent bacteria. This phenomenon is known as Griffith effect or bacterial transformation.
- In 1944, **Avery, McCarty and Macleod** supported the Griffith experiment by molecular explanations.
- They found that the DNA isolated from the heat killed smooth (S) bacterial cells, when added to rough (R) bacterial cells have changed their surface character from rough (R) to smooth (S), and also made them virulent.



- By this experiment it was shown that DNA was the genetic material responsible for inducing the smooth (S) character of the cells and their property of virulence in mice.
- Their experiment proved that bacterial transformation involves transfer of a part of DNA from the dead bacterium to the living bacterium that expresses the character of dead cells and so it is known as recombinant.

Dr. Hargovind Khorana has been successful in synthesizing one gene of yeast containing 77 nucleotides.

- American biochemists in Harvard University have synthesized a more complex gene in rabbit which contains 650 nucleotides and controls the synthesis of haemoglobin.

These synthetic activities leave no doubt that genes are molecules.

- (3) Who among the following did experiment of bacterial transformation ?
(A) Avery, McCarty, Macleod (B) Griffith (C) Hershey, chase (D) Watson, crick
- (4) The organism used in Griffith's experiment was
(A) Spirulina (B) Bacillus (C) Pneumococcus (D) Salmonella
- (5) Which two strains used by Griffith on mouse to performing experiment ?
(A) S-III, R-II (B) T-III, S-III (C) R-III, R-II (D) S-III, S-II
- (6) Pneumococcus R-II is
(A) virulent (B) Avirulent (C) contagious (D) none of above
- (7) Griffith's experiment famous with
(A) viral transformation (B) pneumococcus transduction
(C) bacterial transformation (D) bacterial recombination
- (8) How many nucleotide having the gene which synthesizing from yeast ?
(A) 77 (B) 650 (C) 87 (D) 230
- (9) What is function of a gene which synthesized from rabbit having 650 nucleotides ?
(A) Controls the synthesis of haemoglobin. (B) Controls the height of rat.
(C) Controls the synthesis of red blood cells. (D) It is responsible for growth in mouse.

Answers : (3-B), (4-C), (5-A), (6-B), (7-C), (8-A), (9-A)
--

Biochemical Evidences for DNA as a genetic material :

- (1) The amount of DNA in any given species of cell or organism is remarkably constant and can not be altered by environmental circumstances or by changes in the nutrition etc.
- (2) The amount of DNA per cell appears to be in proportion to the complexity of the cell and the amount of genetic information it contains.

- **Erwin Chargaff's rules :** Erwin Chargaff in 1949 proposed Chargaff's rules regarding the composition of bases in DNA as follows:

- Total amount of Purine nucleotides always equals the total amount of pyrimidine nucleotides.
i.e. $(A) + (G) = (T) + (C)$
- The proportion of A is equal to T and also proportion of G is equal to C, but amount of $(A) + (T)$ is not necessarily equal to $(G) + (C)$.
Therefore $(A) = (T) : (G) = (C)$ But, $\frac{A+T}{G+C}$ Varies with the organism.

- **Properties of Genetic Material (DNA) Versus RNA :**

- We have seen that by various experiment it became an established fact that it is DNA that acts as genetic material.
- However, it subsequently became clear that in some viruses; RNA is the genetic material (For example, Tobacco Mosaic Virus).
- A molecule that can act as a genetic material must fulfil the following criteria :
 - It should be able to generate its replica (Replication).
 - It should be chemically and structurally stable (see Griffith's experiment).
 - It should be able to express itself in the form of Mendalian characters.
- Both DNA and RNA are able to mutate.
- RNA can directly code for the synthesis of proteins.
DNA, however is dependent on RNA for synthesis of proteins.
- The above discussion indicates that both RNA and DNA can function as genetic material, but DNA being more stable, is preferred for storage of genetic information.
- For the transmission of genetic information; RNA is better.

(10) Chargaff's rules regarding

- | | |
|---------------------------------|------------------------------------|
| (A) Composition of bases in RNA | (B) Number of chromosomes |
| (C) Composition of bases in DNA | (D) complexity of genetic material |

(11) Who among the following proposed rules regarding the composition of bases in DNA.

- | | | | |
|------------------|--------------------|---------------------------|--------------|
| (A) Watson Crick | (B) Erwin Chargaff | (C) Dr. Hargovind Khorana | (D) Griffith |
|------------------|--------------------|---------------------------|--------------|

(12) Which one is not true ?

- | | | | |
|---------------|---------------------|---------------------|---------------|
| (A) $A/T = 1$ | (B) $A + T = G + C$ | (C) $A + G = T + C$ | (D) $G/C = 1$ |
|---------------|---------------------|---------------------|---------------|

(13) The first rule of Chargaff :

- | | | | |
|---------------------|---------------------|---------------------|-------------|
| (A) $A + G = T + C$ | (B) $A + T = G + C$ | (C) $A + C = T + C$ | (D) $A = G$ |
|---------------------|---------------------|---------------------|-------------|

(14) It varies with the organism.

- | | | | |
|---------------------|-------------|-------------------------|-----------------------|
| (A) $A + G = T + C$ | (B) $A = G$ | (C) $A = T$ and $G = C$ | (D) $\frac{A+T}{G+C}$ |
|---------------------|-------------|-------------------------|-----------------------|

(15) Who can directly code for the synthesis of proteins ?

- | | | | |
|---------|---------|----------|----------------|
| (A) DNA | (B) RNA | (C) Gene | (D) Nucleotide |
|---------|---------|----------|----------------|

(16) If the total amount of Adenine (A) and guanine (G) is 100 % then the total amount of thymine (T) and cytosine (C) will be

- | | | | |
|----------|----------|----------|-----------|
| (A) 50 % | (B) 75 % | (C) 25 % | (D) 100 % |
|----------|----------|----------|-----------|

(17) If the total number (T) is 77 then the total number of (C) will be :

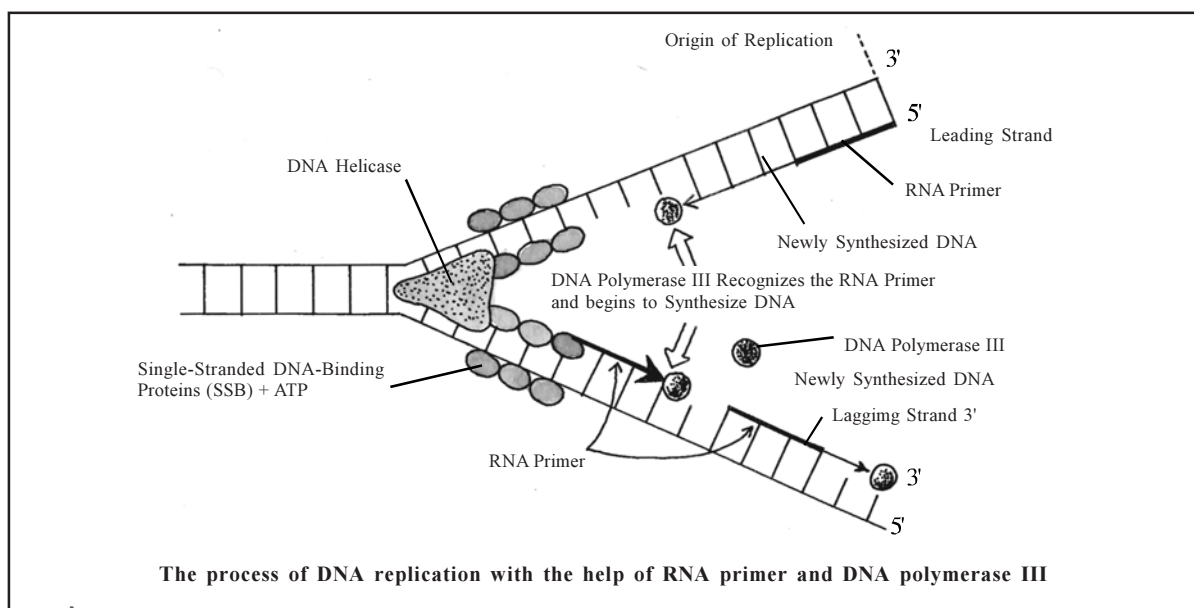
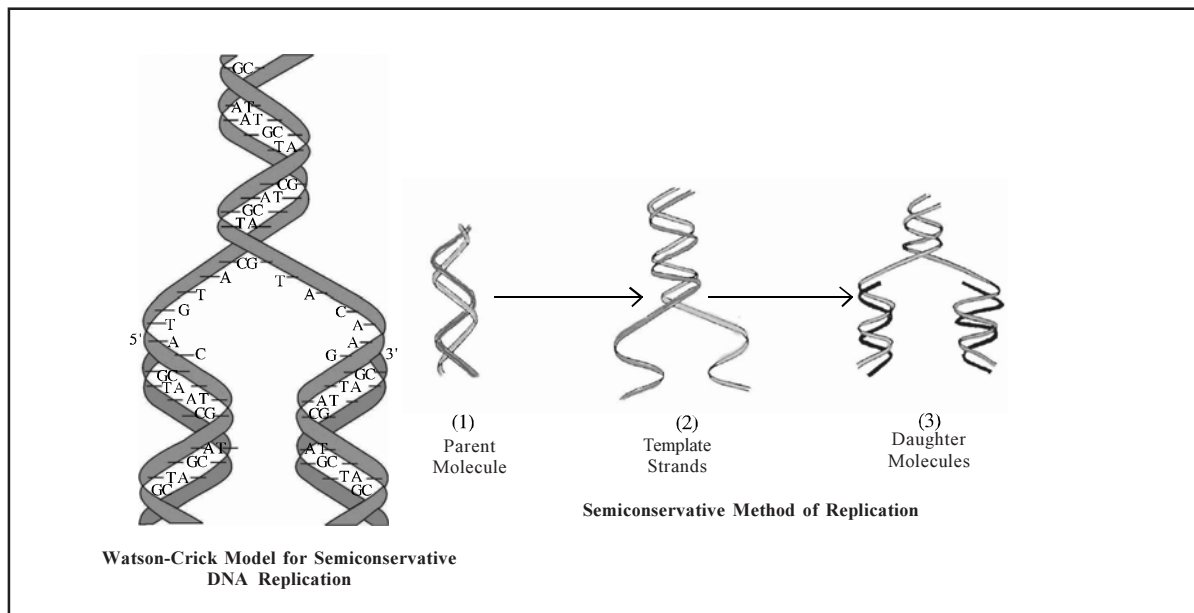
- (A) 77 (B) 100 (C) 154 (D) Can't say

Answers : (10-C), (11-B), (12-B), (13-A), (14-D), (15-B), (16-D), (17-D)

● **Replication of DNA :**

- “The synthesis of new DNA molecule from pre-existing DNA is called replication.”
- By replication, each DNA molecule produces exact copies of its own structure.
- Watson and Crick suggested that there is a self duplication of DNA molecule.
- The constituents of DNA viz; nitrogen bases, sugar molecules and phosphates are synthesized within the nucleus, these substances pair upto form the nucleotides and form new DNA molecule during replication.
- They have concluded that the two strands would separate and act as a template for the synthesis of new complementary strands.

After the completion of replication, each DNA molecule would have one parental and one newly synthesized strand, this method was termed as semi conservative DNA replication.



● **Mechanism of DNA Replication :**

- In the process of DNA replication, the hydrogen bonds between two polynucleotides chains are sequentially broken with the help of proper enzymes.
- The two chains move away from each other. New complementary chains are synthesized along these two separated chains.
- In the end, in the molecules of DNA, one chain is of parental DNA and the other chain is a new one.
- The process begins from a specific site. Then it progresses towards both directions. The enzymes responsible for this are gyrase and helicase.
- The two separated poly nucleotide chains appear like a fork. This is called replication fork. As the process of replication progresses in two directions, it is considered bidirectional.
- As each separated polynucleotide chain provides information for synthesis of the new chain, it is called template chain. The sequence of nucleotides or the template chain determines the sequence of the new chain. The synthesis of new chain is carried out by enzyme. DNA polymerase-III. Synthesis of new chain always begins from 5¹ end and progresses towards 3¹ end.

First of all RNA – polymerase forms a short RNA chain, complementary to the template DNA as its initial region. This is called primer. Only after the primer is formed DNA, polymerase III become active.

-
- Based on the direction of the replication, one chain is synthesized continuously in 5¹-3¹ direction. Such a chain is called leading chain.
 - The new chain synthesized on the other template is synthesized discontinuously and in the 3¹-5¹ direction. Such a chain is called lagging chain.
 - On this template, short pieces of DNA along with RNA- primer are joined. Such fragments are called OKAZAKI fragments.
 - At the end of DNA replication the enzyme ligase joins pieces of nucleotides with phospho-diester bonds.
 - Thus, two new molecules are formed which are exact replicates of parent-DNA molecule.
-

(18) Choose the correct statement about the direction of DNA strand.

- (A) 3¹ → 5¹ (B) 2¹ → 5¹ (C) 5¹ → 3¹ (D) 5¹ → 5¹ and 3¹ → 3¹

(19) It stimulate DNA replication.

- (A) DNA polymarese (B) DNA Ligase (C) Transcriptase (D) A and B both

(20) The direction and type of DNA replication is

- (A) Bidirectional and conservative (B) Unidirectional and conservative
(C) Bidirectional and semi-conservative (D) Unidirectional and Semi-conservative

(21) Choose correct option for formation of okazaki

- (A) Replication (B) Transcription (C) Translation (D) Transduction

(22) When DNA replication will start

- (A) While leading strand produce okazaki fragments.
(B) While hydrogen bonds between two polynucleotides chains are sequentially broken with the help of proper enzymes.
(C) While phospho di ester bonds between sequentially two nucleotides are broken.
(D) While bonds between pentose sugar and Nitrogen base are broken.

- ((23) Enzyme that breaks the bond between DNA helix is known as
 (A) Helicase (B) Gyrase (C) Ligase (D) DNA polymerase
- (24) Enzyme that does not allow unwind DNA helix is known as
 (A) Helicase (B) Gyrase (C) RNA polymerase (D) DNA polymerase
- (25) What is primer ?
 (A) long strand of DNA (B) short strand of DNA (C) long chain of RNA (D) short RNA chain
- (26) Ligase joins of nucleotides with
 (A) glycosidic bond (B) ester bond (C) peptide bond (D) phospho-di-ester bond

Answers : (18-C), (19-D), (20-C), (21-A), (22-B), (23-A), (24-B), (25-D), (26-D)

Transcription :

- “ The process where DNA gives its information to m-RNA is called transcription.”
- Which involves the formation of an RNA strand on the DNA template.

Transcription occurs in three steps.

● **First step :**

- The enzyme transcription becomes attached at the initial region of the DNA (gene) which is to be transcribed.
- As a result the two polynucleotide chains in that region move away from one another.

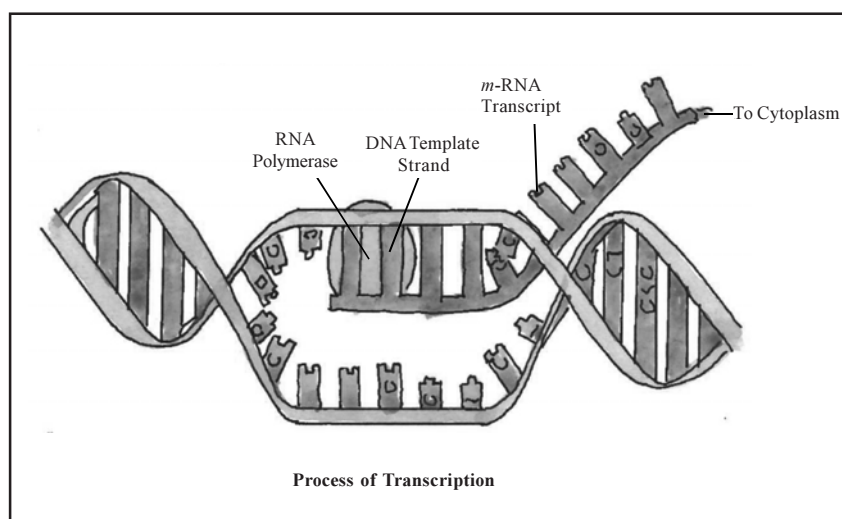
● **Second step :**

- One of these two separated chains acts as a template chain. This chain provides information for synthesis of m-RNA.
- Based on the sequence of nucleotides on the template chain, enzyme transcriptase arranges complementary RNA – nucleotide. Units one after the other and phospho-di-ester bonds are formed between them. Thus m-RNA chain is synthesized.

● **Third step / Last phase :**

- The third and Last phase are of completion. A specific protein attaches with m-RNA and separates it from template - DNA and transcriptase enzyme.

Sometimes m-RNA gets separated by itself. Then the m-RNA is translocated to cytoplasm where it associates with ribosomes.



- (27) Which enzyme responsible for transcription ?
 (A) DNA polymerase (B) RNA polymerase (C) Transcriptase (D) All of above
- (28) Which RNA synthesized by transcription?
 (A) m-RNA (B) r-RNA (C) t-RNA (D) All of above
- (29) Enzyme which constrict phospho-di-ester bond in the process of transcription is
 (A) DNA polymerase – III (B) DNA Ligase (C) DNA helicase (D) None of above
- (30) At the end of transcription m-RNA is translocated to
 (A) Nucleus (B) Cytoplasm (C) Mitochondria (D) One cell to another cell
- (31) m-RNA is translocated to cytoplasm where it associates with ...
 (A) Chloroplast (B) Mitochondria (C) Ribosomes (D) Golgibody

Answers : (27-C), (28-A), (29-D), (30-B), (31-C)

Genetic code :

- Each gene is represented in a small sector of a DNA molecule and may have its unique sequence of nucleotides in that length of DNA.
- The information present in the DNA is transcribed and carried by the m-DNA to the cytoplasm for protein synthesis. This information is designed as genetic codes.
- Thus genetic code is defined as the sequence of nitrogen bases (nucleotides) in m-RNA molecule which contains the information for the synthesis of protein molecules.
- The main problem of genetic code was to determine the exact number of nucleotides in a codon which codes for one amino acid.

Since there are only four nitrogenous bases in m-RNA for 20 amino acids, combination of only one or two nitrogenous bases can not provide sufficient codons of 20 amino acids.

- **Singlet code :**

Singlet code	A	A	A	C	G	U	Doublet code
	C		AA	AC	AG	AU	
	G		CA	CC	CG	CU	
	U		GA	GC	GG	GU	
		U	UA	UC	UG	UU	

- A singlet code consisting of only one nucleotide provides just four codons A,C,G and U. These are insufficient to code 20 amino acids.
- **Doublet code :**
- Combination of two nitrogenous bases (doublet code) provides $4 \times 4 = 16$ codons which are still insufficient for 20 amino acids.
- **Triplet code :**
- Gamov (1954) pointed out the possibility of three letter code, i.e. each codon consists of three nitrogen bases.

- Note: Nirenberg and Matthaei with Khorana (1961) experimentally proved that a single amino acid is determined by a sequence of three nitrogen bases. Khorana has got nobel prize on genetic code. This will give $4 \times 4 \times 4 = 64$ codon words of codons, which are more than enough to code twenty amino acids.

Main properties of genetic code are :

- Genetic code is universal type of code which determines the same amino acid in all organisms including virus, bacteria, plants and animals.
- Genetic code is specific. Any one codon specifies the position of one kind of amino acid only.
- The codon is triplet. 61 codons code for amino acid and 3 codon do not code any amino acid. A single amino acid may be specified by many codons: such codons are called degenerate codons .
- The synthesis of a poly peptide chain is initiated by a codon called initiation codon.
- **UAA, UGA and UAG** codons are termination codons. They indicate termination at synthesis of protein. These codons do not code for any amino acid, hence these are called non-sense codons.
- AUG has dual functions. It is the codons for methionine and it also acts as initiator codon.
- The sequence of genetic codes and sequence of amino acids in protein molecule shows linear parallelism.

Triplet code						
	U	C	A	G		
First Letter	U	UCU } UCC } UCA } UCG } Ser	UAU } Tyr UAC } UAA } Non sense (STOP) UAG } Non sense (STOP)	UGU } Cys UGC } UGA } Non sense (STOP) UGG } Try	U C A G	
	C	CUU } CUC } CUA } CUG } Leu	CCU } CCC } CCA } CCG } Pro	CAU } His CAC } CAA } Gln CAG }	CGU } CGC } CGA } CCG } Arg	U C A G
	A	AUU } AUC } AUA } AUG Met (START)	ACU } ACC } ACA } ACG } Thr	AAU } Asn AAC } AAA } Lys AAG }	AGU } Ser AGC } AGA } Arg AGG }	U C A G
	G	GUU } GUC } GUA } GUG } Val	GCU } GCC } GCA } GCG } Ala	GAU } Asp GAC } GAA } Glu GAG }	GGU } GGC } GGA } GGG } Gly	U C A G
Third Letter						

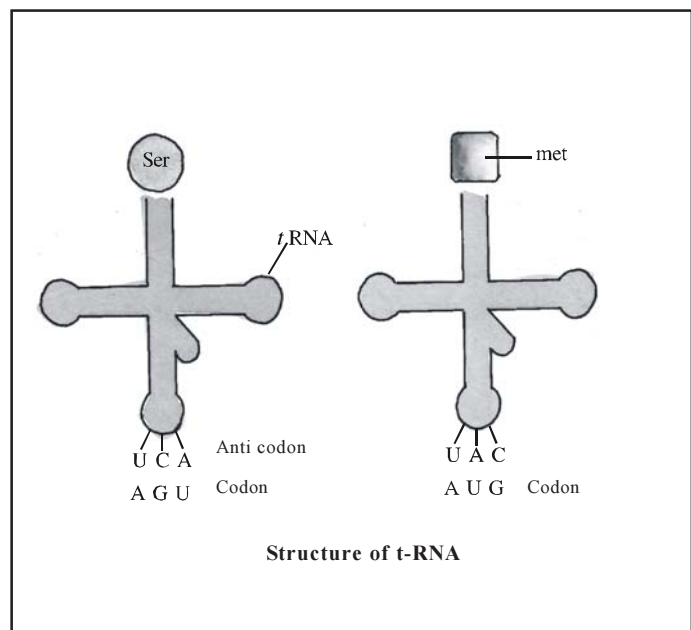
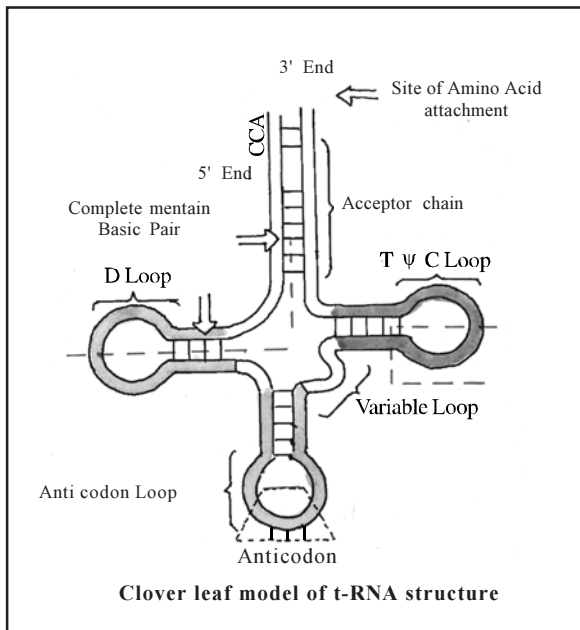
Triplet codons of m-RNA for Amino acids Represented in Tabular form

- (32) The secret of the blue print of genetic information lies in the arrangement of
 (A) definite linear sequence of nitrogen bases of a RNA
 (B) definite linear sequence of nitrogen bases of a DNA
 (C) on the quality of nitrogen bases
 (D) number of purine and pyrimidine bases
- (33) What is genetic code ?
 (A) The information present in the m-RNA is transcribed and carried by the DNA to the cytoplasm for protein synthesis.
 (B) The sequence of nitrogen base in t-RNA for synthesis of protein.
 (C) The sequence of nitrogen base in r-RNA molecule which contains information for Ribosomes.
 (D) The sequence of nitrogen bases in m-RNA molecule which contains the information for the synthesis of protein molecule.
- (34) Whose experiments cracked the DNA and discovered unequivocally that a genetic code is a "triplet ?"
 (A) Griffith (B) Watson, crick (C) Nirenberg, Matthaai and Khorana (D) Tschermak
- (35) Any one codon specifies the position of one kind of amino-acid only is
 (A) specific (B) universal (C) degenerate (D) non- sense
- (36) In triplet codons how many codons specify for amino acids ?
 (A) 4 (B) 61 (C) 64 (D) 3
- (37) How many non-sense codon in triplet codon ?
 (A) 20 (B) 61 (C) 3 (D) 1
- (38) What is degenerate codons ?
 (A) One code which determine the same amino acid in all organisms.
 (B) Any one codon specifies the position of one kind of amino acid only.
 (C) A single amino acid may be specified by many codons.
 (D) Codons do not code for any amino-acid.
- (39) Which of the following in codon code for methionine ?
 (A) AUG (B) UAG (C) CCC (D) AGU
- (40) Which codons causing chain termination of protein synthesis ?
 (A) AUG, UAG, UGA (B) UAA, UGA, UAG (C) UAA, GAU, GUC (D) AUG, UAA, UCA
- (41) It is a site for termination codon.
 (A) At 3' Initial region of m-RNA (B) At 5' Initial region of m-RNA
 (C) At 3' end of m-RNA (D) At 5' end of m-RNA
- (42) Which one of the following codons code for serine ?
 (A) UCU, UCC, UCA, UCG (B) UUU, UUC, UUA, UUG
 (C) CUU, CUC, CUA, CUG (D) CCU, CCC, CCA, CCG
- (43) Which one of the following codons code for lysine ?
 (A) AAA, AAG (B) AGU, AGC (C) GGU, GGC (D) UUA, UUG
- (44) How many codons are code for serine amino acid ?
 (A) 4 (B) 2 (C) 8 (D) 6

Answers : (32-B), (33-D) (34-C), (35-A), (36-B), (37-C), (38-C), (39-A), (40-B), (41-C), (42 A), (43-A), (44-D)

Transfer – RNA (t-RNA) :

- Amino acid molecules of various kinds located in the cytoplasm are transported by t-RNA
- Each t-RNA specific for the each amino acid molecule.
- There are 61 kinds of t-RNA present in cytoplasm for transportation of 20 amino acids.
- t-RNA molecules are smallest, containing 75 to 95 nucleotides.
- t-RNA has an anticodon loop that has bases complementary to the code, and it also has an amino acid acceptor by which it binds to amino acid.



(45) The Function of t-RNA is

- (A) It provides information for synthesis of protein.
- (B) Amino acid molecules of various kinds located in cytoplasm are transported.
- (C) Amino acid transported from cytoplasm to nucleus.
- (D) It act as template strand in the process of m-RNA synthesis

(46) How many effective nucleotides present in t-RNA ?

- (A) 25 to 30 (B) 80 to 90 (C) 75 to 95 (D) More than 95

(47) How many types of t-RNA present in cytoplasm ?

- (A) 61 (B) 20 (C) 64 (D) 16

(48) A specific nucleotide sequence which attached to 3¹ end of t-RNA is

- (A) AAC (B) CCA (C) AUG (D) UUA

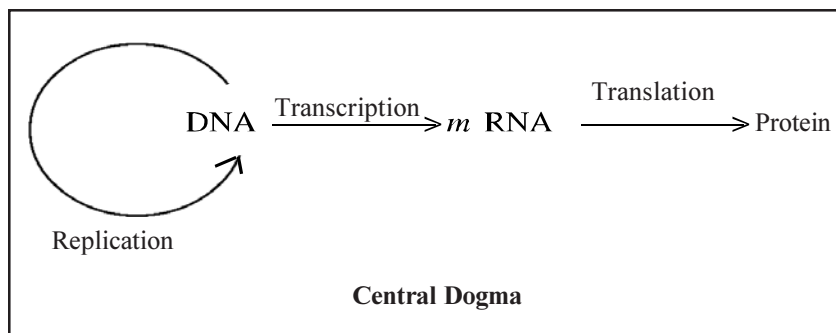
(49) The site for amino acid attachment on t-RNA is

- (A) Anticodon region (B) on TQC 100P (C) On D LOOP (D) At 3¹ - OH end

Answers : (45-B), (46-C), (47-A), (48-B), (49-D)

* **Central – Dogma :**

- With the help of m-RNA and RNA protein synthesis takes place. This unidirectional flow of information was first described by F.H.C crick in 1958 as the central dogma of molecular biology.
- The expression of the genetic material (DNA) which occurs generally through the production of protein synthesis involves two consecutive steps: (1) Transcription and (2) Translation.
- It states that the genetic information flows from DNA → m-RNA → protein replication.



- In some viruses the flow of information is in reverse direction.
- It was brought to light by H.M Temin and D. Baltimore. According to them, many tumour viruses contain RNA as a genetic material and replicate by first synthesizing a complementary DNA. This process is called reverse transcription.
- It is done with the help of RNA - dependant DNA polymerase called reverse transcriptase. It is observed in HIV.

(50) The unidirectional flow of genetic information from DNA - m-RNA - protein replication is known as
 (A) Transcription (B) Replication (C) Central dogma (D) Translation

(51) Reverse transcription means
 (A) Formation of m- RNA from DNA (B) Formation of DNA from RNA
 (C) Formation of DNA from DNA (D) Formation of t-RNA from m-RNA

(52) Which enzyme responsible for reverse transcription ?
 (A) Reverse polymerase (B) Reverse transcriptase (C) Reverse ligase (D) Reverse polymerase – III

(53) The expression of the genetic material which occurs generally through
 (A) production of carbohydrates (B) production of protein
 (C) accumulation of genetic material (D) production of lipids

(54) The phase of gene expression is
 (A) Transcription (B) Translation (C) Transduction (D) A and B both

(55) Reverse transcription observed in
 (A) TMV (B) Tumor viruses (C) HIV (D) All of above

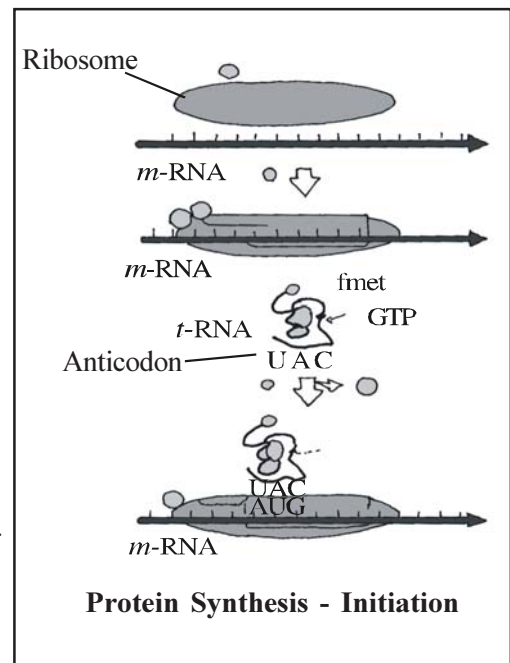
Answers : (50-C), (51-B), (52-B), (53-B), (54-D), (55-D)

Translation / Biosynthesis of Proteins :

- Translation is process in which the genetic message carried by messenger RNA from the DNA is converted into the form of a polypeptide chain having a specific sequence of amino acids.
- Translation occurs in three steps : Initiation, elongation and termination.
- Three other key components which take part in these three steps. They are (i) ribosomes (ii) t-RNA and (iii) amino acids.

(i) Initiation :

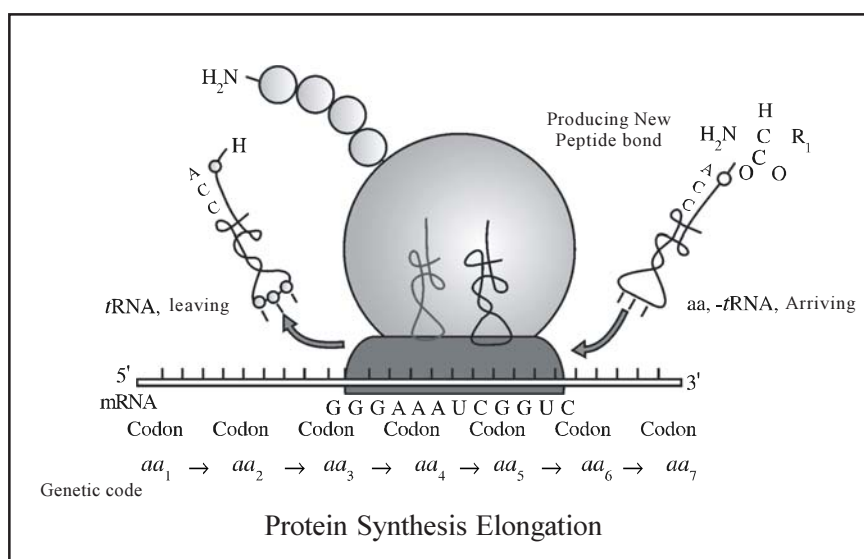
- Synthesis is always initiated with amino acid methionine.
- Amino acid molecules of various kinds located in the cytoplasm are transported by t-RNA molecules.
- A t-RNA synthesis enzyme, specific for the amino – acid molecule is essential in this.
- The amino acyl t-RNA with its specific amino acid now moves towards m-RNA.
- In eukaryotic cell methionine is arranged on m-RNA at its proper location. To decide this, a sequence of three nucleotides occurs on the t-RNA which is complementary to the genetic codon on m-RNA molecule. This unit of three nucleotides on t-RNA is called anticodon.
- The genetic code for methionine on m-RNA is AUG. Hence, anticodon on t-RNA is UAC.



- Formyl –methionine acyl t-RNA with its amino acid gets attached here. Thus, synthesis of protein is initiated.

(ii) Elongation :

- Now, other t-RNA molecules carrying their specific amino acid molecules and possessing anti codon specific to the genetic codes on m-RNA become sequentially arranged.

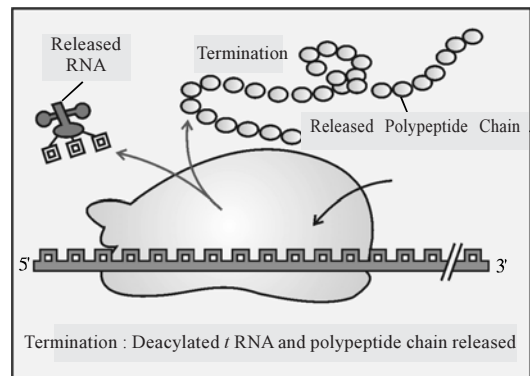


- Proteins known as elongation factors and GTP as energy source are helpful in this. Methionine at the first position is joined to the second position amino acid by a peptide bond.
- Now the t-RNA carrying formyl – methionine is released. Thus a dipeptide is formed.
- Now, ribosome moves along m-RNA in 3¹ direction by distance of one codon. As a result, t-RNA which is responsible for methionine transfer is released from the surface of the ribosome.
- The t-RNA caring dipeptide now occupies the vacant region.
- Thus one by one, t-RNA molecules carrying their amino acid get arranged, and the peptide chain elongates. This phase is elongation phase.

(iii) Termination :

- The genetic code located at 3¹ end of m-RNA does not indicate the position or any amino acid. Such codon is called nonsense codon or termination codon.
- The function of such codons is to release the synthesized polypeptide chain from ribosomes.
- From the first amino acid of the released polypeptide chain, formylmethionine, the formyl group is removed.

Sometimes, even methionine is removed. Then, the polypeptide gets ready to perform its function.



Protein Synthesis Termination

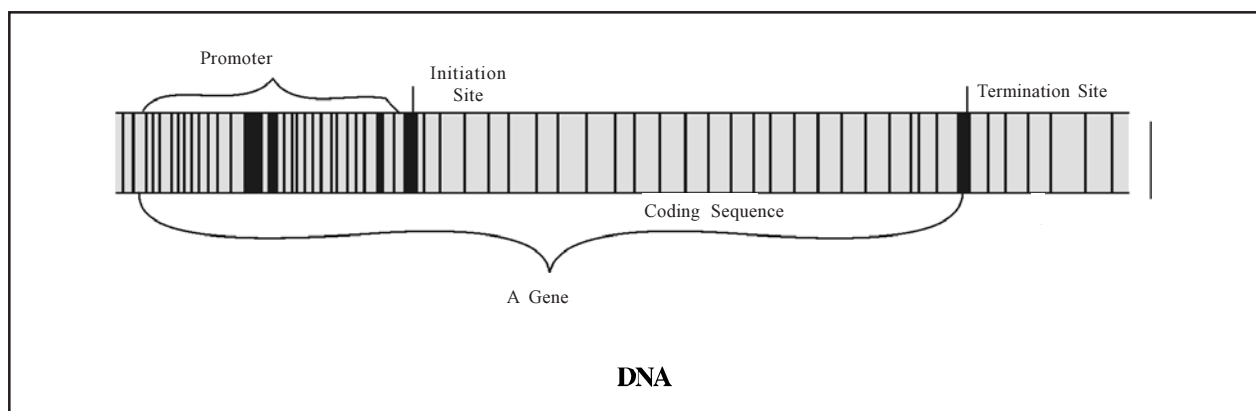
- (56) Which RNA contains information for synthesis of protein ?
 (A) m-RNA (B) r-RNA (C) t-RNA (D) All of above
- (57) A unit of three successive nucleotides indicates the position of particular in the constitution of protein.
 (A) Monomer of carbohydrates (B) Fatty acids
 (C) Nucleotides (D) Amino acids
- (58) The Sequence of nitrogen bases in a particular region of DNA molecule was found to be CAG, CCC, GAT. What would be the sequence of nitrogen bases in the m-RNA ?
 (A) CAG, CCC, CAU (B) GUC, GGG, CUA (C) GUC, CCC, GAT (D) GAC, TAG, CTA
- (59) Main components for translation process are
 (A) ribosome, t-RNA, amino acids (B) ribosome, m-RNA, DNA
 (C) DNA, m-RNA, t-RNA (D) ribosome, cytoplasm, t-RNA, r-RNA
- (60) Which one of the following amino acid is always initiate the synthesis of translation ?
 (A) Serine (B) Valine (C) Methionine (D) Tryptophan
- (61) Which enzyme essential for transportation of amino acids ?
 (A) m-RNA synthetase (B) DNA polymerase - III (C) Transcriptase (D) t-RNA synthetase
- (62) The code of nitrogen bases in a particular region of m-RNA is AUG, then the anticodon will be on t-RNA is
 (A) AUC (B) TAC (C) UAC (D) TAG
- (63) Out of the following which having region of anticodon ?
 (A) m-RNA (B) DNA (C) r-RNA (D) t-RNA

- (64) Which source are helpful in process of elongation ?
 (A) GTP as energy source, t-RNA synthetase. (B) GTP as energy source, elongation factors.
 (C) ATP as energy source, elongation factors. (D) ATP as energy source, t-RNA synthetase.
- (65) The ribosome moves along m-RNA in $3'$ direction by distance of
 (A) Two codons (B) Three codons (C) Four codons (D) One codon
- (66) The position of non-sense codon is
 (A) On $3'$ end of t-RNA (B) On $3'$ end of m-RNA
 (C) On $5'$ end of t-RNA (D) On $5'$ end of m-RNA
- (67) What is the function of non-sense codon ?
 (A) It translocate m-RNA to cytoplasm from DNA.
 (B) Release the synthesized polypeptide chain from ribosomes.
 (C) It carrying specific amino acid molecule on m-RNA .
 (D) It release polypeptide chain from methionine.

Answers : (56-A), (57-D), (58-B), (59-A), (60-C), (61-D), (62-C), (63-D), (64-B), (65-D), (66-B), (67-B)

*** Gene :**

- It is actually a “Factor” as per Mendelian theory. It is a segment of DNA present in the chromosome.
- Thus gene is the hereditary unit. It controls characters. It transmits characters from parents to offspring.
- The gene consists of four main regions namely promoter, initiation site, coding sequence and termination site.
- **Promoter :** The promoter is at one end of the gene. The RNA polymerase is attached to this region during RNA synthesis.



- **Initiation site :** Initiation site is located next to promoter. The m-RNA synthesis begins from this site.
- **Coding sequence :** The coding sequence is the middle segment of the gene. All these nucleotides are copied into the m-RNA.
- **Termination site :** The termination is at the other end of the gene, where m-RNA synthesis is stopped.

- (68) It controls characters
 (A) gene (B) chromosomes (C) RNA (D) DNA
- (69) How many regions consisted by gene ?
 (A) 1 (B) 4 (C) 3 (D) 5
- (70) Which enzyme attached to the region of promoter ?
 (A) DNA polymerase (B) DNA Ligase (C) RNA polymerase (D) t-RNA synthetase
- (71) The m-RNA synthesis begins from
 (A) promoter (B) termination site (C) initiation site (D) coding sequence
- (72) Name the region where all nucleotides are copied into the m-RNA.
 (A) Coding sequence (B) Promoter site (C) Operator site (D) Termination site

Answers : (68-A), (69-B), (70-C), (71-C), (72-A)

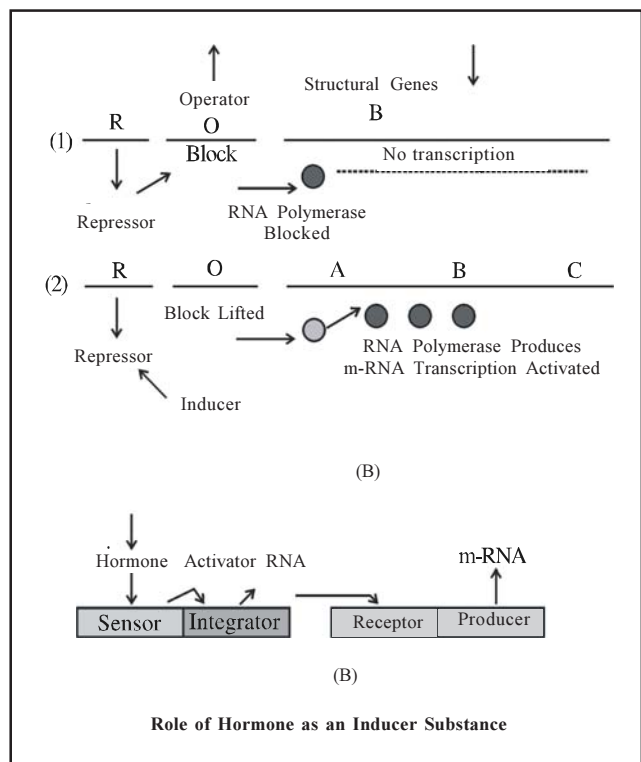
Regulation of Gene Expression :

- Different genes in an organism are meant for the synthesis of different proteins. All these proteins are not needed at the same time.
- The mechanism involved in this process is difficult to work out particularly in higher organisms. While in bacteria (prokaryotic cells) detailed information has been obtained regarding regulation of gene expression. Mechanisms in prokaryotes and eukaryotes differ due to their different levels of complexity of organisms.
- French scientists Jacob and Monod discovered a mechanism in E-coli bacteria and won the Noble Prize for the same.
- They found that for an expression of a gene there may be a few other genes are involved.
- The gene whose product is required may be expressed; such a gene is called a structural gene.
- The repressor gene can produce a product which will block operator gene so that the RNA

polymerase will not form m-RNA. That means it prevents transcription of one or many structural genes.

- If an inducer which could be a substrate; precursor or a hormone when provided will bind the repressor proteins and thus open up operator gene.
- Now RNA polymerase gets bound to promoter site and starts transcription process to produce m-RNA.
- **Jacob and Monod** proposed that metabolic path ways are regulated as a unit.
- They studied the change in the nature of enzymes of E-coli; when provided with different kinds of sugars.
- They found that when sugar lactose is added to the cultures of E.coli, it induces three enzymes necessary to break down the lactose into galactose. These newly synthesized enzymes are:

- (i) β -galactosidase (ii) permease and (iii) transacetylase.



- According to them, the synthesis of these three enzymes are controlled by a long DNA segment known as operon which is divisible into an operator site (o) and three structural genes; z, y and a.
- The action of structural genes is regulated by operator site with the help of a repressor protein produced by the action of gene 'i' known as the regulator gene.
- The genes are expressed or not expressed depends on whether the operator switch is on or off.
- When the switch is on, the three genes are transcribed by RNA polymerase into a single stretch of m-RNA covering all the three genes.
- The switching on or off of the operator switch is achieved with the help of a protein known as repressor.
- When this protein ties together to the operator (O) and blocks, it the switch is turned off and the three genes (z, y and a) are not expressed.
- Thus an operon consists of :

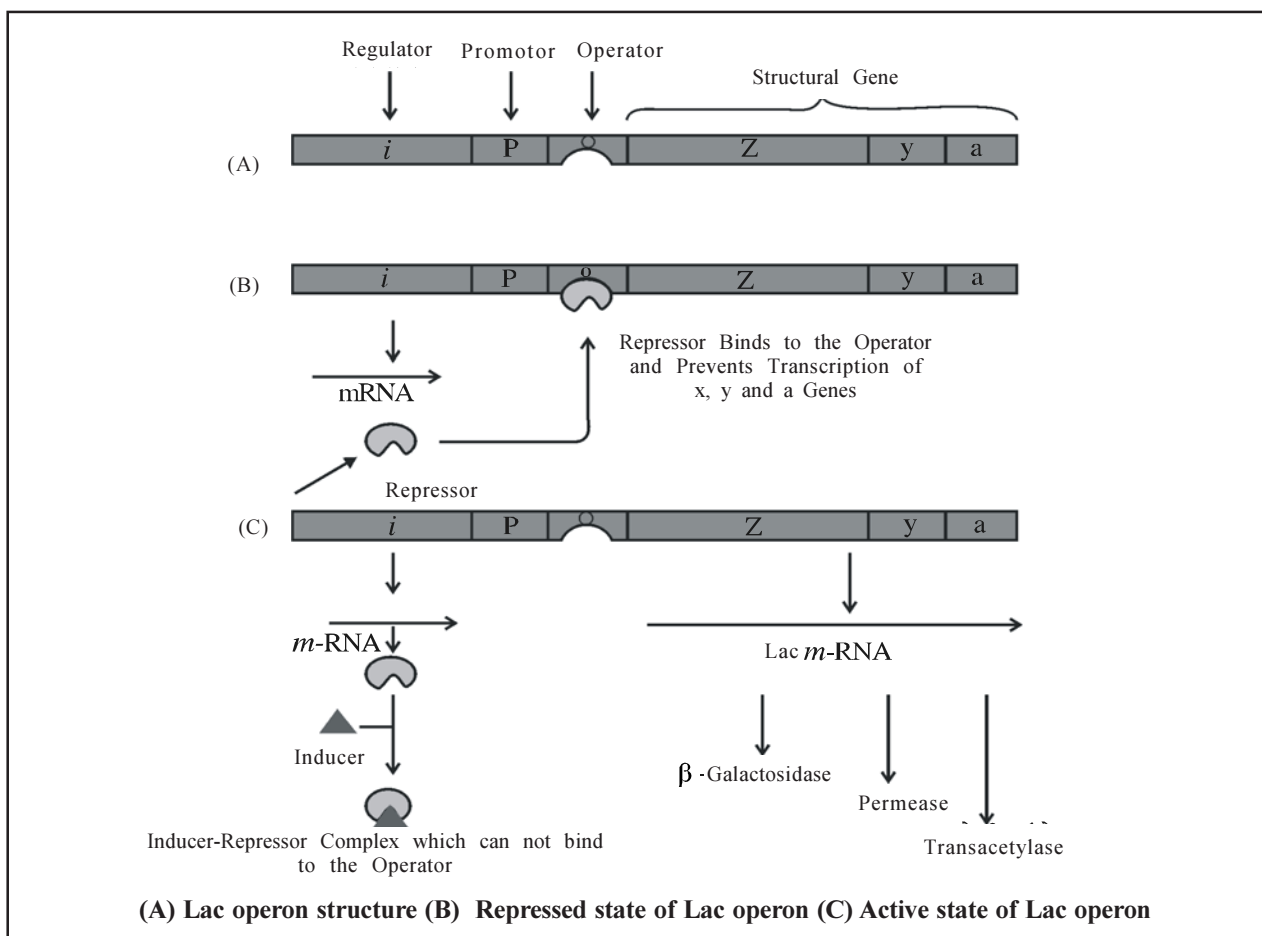
Operon = Regulator gene + promoter gene + Operator gene + Structural gene

- The genes composing operon are :

- (1) **Structural gene** : They are segment of DNA which carry codes for the synthesis of proteins.
- (2) **Control genes** : These control the activity of structural genes either by induction or suppression.

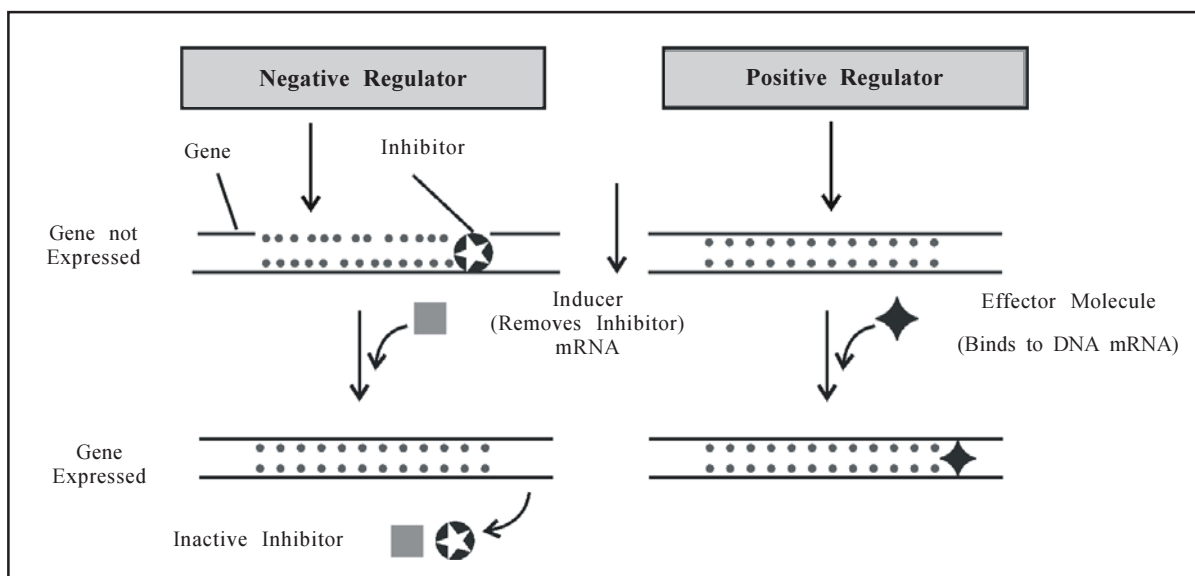
These genes are as follow :

- (i) **Regulator gene** : The regulator gene produces some specific enzyme which RNA polymerase binds. It initially acts as a repressor substance.



- (ii) **Promoter gene** : The promoter gene (p) is the DNA segment at which the transcription of the structure genes takes place. It controls the rate of m-RNA synthesis.
- (iii) **Operator gene** : The operator gene (O) is the segment of DNA which exercises a control over transcription.

Negative and Positive Control :



- The regulator gene exercises a negative control on the functioning of lac operon, because the enzyme produced by the regulator gene switches off the activity of operon gene. It is not allowed to function the protein is not required.
- Certain substances exercise a positive control. These substances when added to the medium initiate the regulator gene to produce the stimulant which stimulates the production of enzyme by the operator gene.

(73) Who discovered a lac-operon ?

- (A) Jacob and Monad (B) Watson and Crick (C) Gamov and Khorana (D) Avery and Mccarty

(74) Name the gene which can produce a product which will block operator.

- (A) Promoter gene (B) Structural gene (C) Repressor gene (D) Control gene

(75) The Repressor protein is a product of

- (A) promoter gene (B) repressor gene (C) operator gene (D) structural gene

(76) The sugar which used by Jacob and Monad for explanation of regulation of gene expression is ...

- (A) glucose (B) lactose (C) surcose (D) A and B both

(77) Which Bacteria has been used regarding regulation of gene expression ?

- (A) Streptococcus (B) Bacillus (C) E-coli (D) Salmonella

(78) Which enzyme necessary to break down the lactose into galactose ?

- (A) β -glycosidase (B) Permease (C) Transacetylase (D) All of above

(79) The segment of DNA which exercises a control of an enzyme which responsible for digestion of lactose is ...

- (A) Operator gene (B) Promoter gene (C) Structural gene (D) Regulator gene

(80) It is responsible for switching on the lac-operon in bacteria is

- (A) lactose (B) numbers of bacteria (C) structural gene (D) RNA polymerase

- (81) Operon Contains :
- (A) Structural gene + promoter gene + operator gene
 (B) Regulator gene + operator gene
 (C) Regulator gene + promoter gene + operator gene
 (D) Regulator gene + promoter gene + operator gene + structural gene
- (82) It controls the rate of m-RNA synthesis.
 (A) Operator gene (B) Regulator gene (C) Promoter gene (D) Structural gene
- (83) It exercises a control over transcription.
 (A) Operator gene (B) Promoter gene (C) Termination gene (D) Regulator gene
- (84) In lac – operon if mutation occurs in the y gene of the ‘Structural gene’ then
 (A) Permease will not be synthesized. (B) β - Galactosidase will not be synthesized.
 (C) Transacetylase will not be synthesized (D) Lactose digestion will be rapid.

Answers : (73-A), (74-C), (75-B), (76-D), (77-C), (78-D), (79-A), (80-A), (81-D), (82-C), (83-A), (84-A)

Human Genome Project (HGP) :

- The Human Genome project (HGP) is an international scientific research project.
 - The primary goal of the project is of determining the sequence chemical base pairs which make up DNA, and identifying and mapping the approximately 20,000 – 25,000 genes of the human genome.
 - In 1990, the project was initiated by the joint efforts of the of U.S. Department of energy and the National Institute of Health. A working draft of the genome was announced in 2000. In February 2001, the analysis of the working draft was published.
- * Following set of goals was there :**
- To prepare a “genetic map” of all genes in human beings in full detail.
 - The information of nucleotide sequence of each gene and its mode of expression should be determined and stored.
 - To store information in data bases and improve the project tools for data analysis and transfer related technologies to the private sector.
 - To understand social, ethical and legal complications related in the project and find out proper solution for them.
 - In April 2003 the HGP sequencing was completed.
 - The human genome contains 3 billion chemical nucleotide bases (A, C, T and G). The average gene consists of 3000 bases.
 - The total number of genes is estimated at around 35,000 – lower than previous estimated of 80,000 to 1,40,000.
 - The deciphering of nucleotide sequence and its store is referred to as “data base”. It is a molecular data base.
 - While the objective of HGP is to understand the genetic makeup of the species, the project has also focused on several other non human organisms such as E-coli, the fruit fly and the laboratory mouse.
 - Scientists have found the following information :

Organism	Genomesize	Estimated genes
Human (Homo sapiens sapiens)	>3 billion	30,000
Laboratory mouse (M. musculus)	2.6 billion	30,000
Fruit fly (D. melanogaster)	137 million	13,000
Bacteria (E. coli)	4.6 million	3200
HIV	9700	9

Future Challenges of HGP :

- Gene number, exact locations and functions
- Gene regulation - DNA sequence organization - Coordination of gene expression.
- To understand disease susceptibility prediction based on gene sequence variation.

Application of HGP :

- (1) **Molecular Medicine** : It improves diagnosis of disease and is also used in gene therapy. Improve understanding of several diseases like Alzheimers, Parkinsons diseases etc.
- (2) **Microbial Genomics** : It rapidly detects and treats pathogens in clinical practice; develops new energy sources and monitors environment to detect pollutants.
- (3) **Risk Assessment** : It is used to evaluate the health risks faced by individuals who may be exposed to radiation and to cancer – causing chemicals and toxins.
- (4) **DNA Identification (Forensics)** : It is used to identify potential suspects whose DNA may match the evidence left at crime scenes, to establish paternity and other family relationships.
- (5) **Agriculture, livestock breeding** : It is used to develop biopesticides in corporate edible vaccines incorporated into food products.
- (6) **ELSI** : The project's goal included not only identifying all the genes in the human genome, but also addressing the ethical, legal and social issues (ELSI).

Thus HGP will provide a healthy and disease free life.

Salient features of Human Genome : The human genome contains 3 billion nucleotide bases.

- The average gene consists of **3000** bases.
- The total number of genes is estimated at **30,000**. Almost all (**99.9 %**) nucleotide bases are **exactly the same** in all people.
- The functions are unknown for over **50 %** of the discovered genes.
- Less than **2 %** of the genome codes for proteins.
- Repeated sequences make up a very large portion of the human genome.
- **Chromosome 1** has most genes (**2968**) and **Y** has the fewest (**231**).
- It is expected that we will soon have Snapshots of more than 1200 genes that responsible for common cardiovascular ailments, endocrine diseases like **diabetes**, neurological disorders like **Alzheimer's** diseases, **cancer** etc.

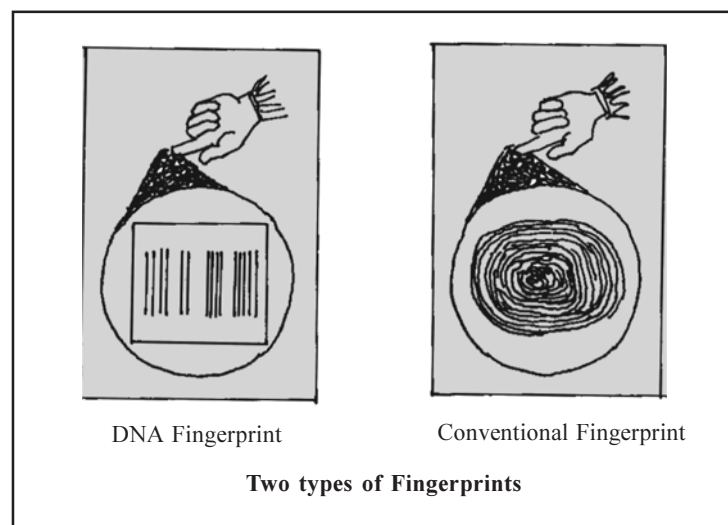
- The human genome sequencing not only holds promise for a healthier living, It also holds the prospects of a vast database of knowledge about designer drugs, genetically modified diets and finally our genetic identity.

-
- (85) It is not for HGP goal.
 (A) To prepare a genetic map.
 (B) The deciphering of nucleotide sequence and store is referred to data base.
 (C) To understand ELSI.
 (D) To understand genetic mutation
- (86) When HGP sequencing was completed ?
 (A) April - 2001 (B) July - 2003 (C) April - 2000 (D) April - 2003
- (87) Human Genome size is
 (A) >3 billion (B) >5 billion (C) > 10 billion (D) >1 billion
- (88) The deciphering of nucleotide sequence and its store is referred to as
 (A) genome (B) data size (C) data base (D) genetic map
- (89) Genome size of M. musculus D. melanogaster and E-coli are as
 (A) 2.6 billion, 137 million, 4.36 million (B) 3 billion, 2.6 million, 137 million
 (C) 4.6 billion, 137 million, 4.6 million (D) 9700 billion, 137 million, 2.6 million
- (90) How many genes present in HIV ?
 (A) 4000 (B) 9 (C) 1300 (D) 30
- (91) What is a use of Microbial genomics?
 (A) Improve understanding of diseases.
 (B) Develop new energy sources.
 (C) To evaluate the health risks faced by individuals who may be exposed to radiation.
 (D) To establish paternity and other family relationships.
- (92) It improves diagnosis of disease and is also used in gene therapy.
 (A) Forensics (B) Microbial genomics (C) Molecular medicine (D) Risk assessment
- (93) It is a function of Forensics
 (A) To establish paternity
 (B) To establish family relationships
 (C) To identify potential suspects whose DNA may match the evidence left at crime scenes
 (D) All of above
- (94) How many genome are codes for proteins ?
 (A) 10% (B) 2% (C) 99% (D) 50%
- (95) In Human most genes present on chromosome number is
 (A) first chromosome (B) fifth chromosome (C) X chromosome (D) Y chromosome
- (96) In Human fewest genes present on chromosome is
 (A) X (B) Y (C) First (D) Both X and Y
- (97) How many gene present on Y chromosome ?
 (A) 231 (B) 2968 (C) 3000 (D) 900

Answers : (85-D), (86-D), (87-A), (88-C), (89-A), (90-B), (91-B), (92-C), (93-D), (94-B), (95-A), (96-B), (97- A)
--

DNA fingerprinting:

- Like the fingerprinting that came into use by detectives and police labs during the 1930s, due to its specification, each person has a unique DNA fingerprint.
- Unlike a conventional fingerprint that occurs only on the fingertips, a DNA fingerprint is the same for every cell, tissue and organ of a person.
- DNA fingerprint can not be altered by any known treatment but fingerprint can be changed by surgery.
- Consequently, DNA fingerprint is rapidly becoming the primary method for identifying and distinguishing individual human beings.
- An additional benefit of DNA fingerprint technology is the diagnosis of inherited disorders in adults, children and unborn babies.
- Even bloodstained clothing from **Abraham Lincoln** has been analyzed for evidence of a genetic disorder called **Marfan's syndrome**.



- There are **23 pairs** of human chromosomes, with >3 billion genome size.
- You know that not all segments of DNA code for proteins; some DNA segments have a regulatory function, while others are **intervening sequences (introns)**, and still others are repeated DNA sequence.
- For DNA fingerprinting short repetitive nucleotide sequence which is specific for a person is important. These nucleotide sequence is known as **variable number tandem repeats (VNTR)**.
- It was initially developed by Alec Jeffreys. He used a satellite DNA as probe that shows a very high degree of polymorphism.

Making DNA Fingerprints :

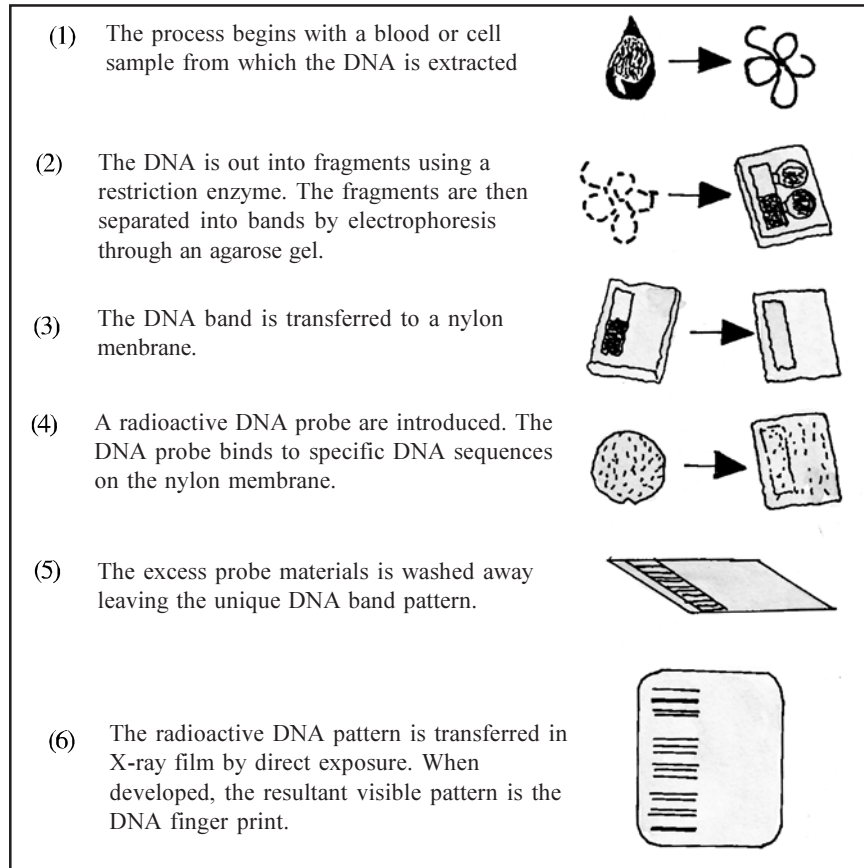
- As every cell contains DNA, extremely small amount of blood, semen, hair bulb or any other cell from the body of a person are sufficient to detect the individual.
- Thus it is a laboratory procedure that requires the following steps :

Application of DNA Fingerprints: DNA fingerprints are useful in several areas of society.

- They are used by professionals in human health and justice system. It can be used to help identify

individuals, who may have carried out crimes such as rape, settling paternity disputes, deterring relationships in inherited diseases and **monitoring** bone marrow transplants.

- It is used to diagnose inherited disorders like **cystic fibrosis, haemophilia, Huntington's diseases, Alzheimer's sickle cell anemia thalassemia** and many others.



- (98) Bloodstained clothing from Abraham Lincoln has been analyzed for evidence of a genetic disorder called
 (A) Alzheimer's (B) Marfan's syndrome (C) Huntington's disease (D) Haemophilia.
- (99) Which of the following is correct about DNA segment ?
 (A) Code for proteins (B) Intervening sequences (C) VNTR (D) All of above
- (100) In DNA fingerprinting separation of DNA Fragments by
 (A) Gas – chromatography (B) TLC (C) Electrophoresis (D) PCR
- (101) It is known as DNA scissors.
 (A) REN (B) Ligase (C) DNA polymerase (D) RNA polymerase
- (102) What is the use of radioactive DNA probe ?
 (A) The DNA probe binds to specific DNA sequence on the nylon membrane.
 (B) Separation of DNA fragments.
 (C) It makes x-ray film.
 (D) Extraction of DNA fragments.

- (103) When radioactive DNA pattern becomes visible ?
- (A) While bombarding with DNA probes.
- (B) While radioactive DNA pattern is transferred to x-ray film by direct exposure.
- (C) While washing DNA fragments.
- (D) While DNA fragments are separated by electrophoresis.

Answers : 98 (B), 99 (D), 100 (C), 101 (A), 102 (A), 103 (B)

● **A - Assertion, R - Reason type questions**

Choose the correct option from the following for given questions.

(A) A and R both are correct, while R is correct explanation of A.

(B) A and R both are correct but R is not correct explanation of A.

(C) A is correct, but R is wrong.

(D) A is wrong but R is correct.

- (104) Assertion A : Polytene chromosomes are consisting of thousands of DNA strands.
Reason R : Specialized cells undergo repeated rounds of DNA replication without cell division to increase cell volume forming giant polytene chromosome.
- (A) (B) (C) (D)
- (105) Assertion A : The termination codon is present on the end of m-RNA.
Reason R : End of translation process occurs with or without termination codon.
- (A) (B) (C) (D)
- (106) Assertion A : Semi conservative DNA replication proposed by Avery and Mccarty.
Reason R : At the end of DNA replication the enzyme ligase joins pieces of nucleotides with phosphodiester bond.
- (A) (B) (C) (D)
- (107) Assertion A : $(A) + (G) = (T) + (C)$
Reason R : $(A) = (T) : (G) = (C)$
- (A) (B) (C) (D)
- (108) Assertion A : The synthesis of new chain in DNA replication is carried out by enzyme RNA polymerase.
Reason R : RNA polymerase forms a short RNA chain complementary to the template DNA as its initial region, this is called a primer.
- (A) (B) (C) (D)
- (109) Assertion A : Genetic code is defined as the sequence of nitrogen bases in m-RNA molecule.
Reason R : Genetic code contains the information for the synthesis of protein molecules.
- (A) (B) (C) (D)
- (110) Assertion A : Genetic code is specific.
Reason R : Any one codon specifies the position of one kind of amino acid only.
- (A) (B) (C) (D)
- (111) Assertion A : Transcription observed in HIV.
Reason R : Tumour viruses follow reverse transcription.
- (A) (B) (C) (D)

- (112) Assertion A : The RNA polymerase is attached to promoter region.
Reason R : The operator gene is the segment of DNA which produces repressor substances.
(A) (B) (C) (D)
- (113) Assertion A : DNA is cut into section by using restriction endonucleases.
Reason R : Separation of DNA fragments by electrophoresis.
(A) (B) (C) (D)

Answers : (104-A), (105-B), (106-D), (107-B), (108-D), (109-A), (110-A), (111-D), (112-C), (113-B)

• **True – False type MCQs :**

- (114) **Choose correct option : True for (T) and False for (F)**
 (1) (A) + (G) = 500 then (T) + (C) = 500
 (2) (A) = 600 then (G) = 600
 (3) (A) = 300 then (T) = 300, (G) = 200 then (C) = 200
 (A) TFT (B) TTF (C) FFT (D) TTT
- (115) **Choose correct option : True for (T) and False for (F)**
 (1) DNA - DNA = Replication
 (2) DNA - m-RNA = Transcription
 (3) DNA - Protein = Translation
 (A) TTF (B) TTT (C) FTT (D) FFT
- (116) **Choose correct option : True for (T) and False for (F)**
 (1) Helicase : Breaks down hydrogen bonds between two polynucleotide chain.
 (2) DNA – polymerase – III : The synthesis of new chain is carried out by enzyme DNA polymerase -III.
 (3) RNA polymerase : It removes RNA primers from lagging strand.
 (A) FTT (B) TTF (C) TTT (D) FFT
- (117) **Choose correct option : True for (T) and False for (F)**
 (1) In transcription process two separated chains of DNA act as template chain.
 (2) In transcription the hydrogen bonds between two polynucleotides chains are sequentially broken by gyrase and helicase.
 (3) m-RNA is translocated to nucleus where it associates with DNA.
 (A) FFF (B) TTF (C) TFT (D) FFT
- (118) **Choose correct option : True for (T) and False for (F)**
 (1) AUG = Methionine
 (2) CCC = proline
 (3) UAA = Leucine
 (A) FFF (B) TFF (C) TTF (D) TFT
- (119) **Choose correct option : True for (T) and False for (F)**
 (1) AUG = START
 (2) AGA = STOP
 (3) UAA = STOP
 (A) TTF (B) TFT (C) FTF (D) TTT

(120) **Choose correct option : True for (T) and False for (F)**

- (1) In t-RNA 3' end is a site for the attachment of activated amino acid.
(2) In t-RNA definite sequence of three nitrogenous bases, which constitute the anti codon.
(3) In t-RNA the region of D LOOP responsible for releasing amino acids.
(A) TFF (B) FFT (C) TTF (D) TFT

(121) **Choose correct option : True for (T) and False for (F)**

- (1) Genetic information flows from DNA → *m*-RNA → protein.
(2) Unidirectional flow of information was first described by F.H.C. Crick.
(3) Tumour viruses contain RNA as a genetic material. It follows transcription.
(A) TTT (B) FFT (C) TTF (D) TFT

(122) **Choose correct option : True for (T) and False for (F)**

- (1) Genome size in Human is > 3 billion.
(2) Genome size in *Drosophila* is 137 million.
(3) Genome size in *E. coli* is 4.6 million.
(A) TTF (B) FFT (C) FTF (D) TTT

(123) **Choose correct option : True for (T) and False for (F)**

- (1) **Structural gene** : They are segments of DNA which carry codes for the synthesis of protein.
(2) **Promoter gene** : RNA polymerase is attached to this region during DNA synthesis.
(3) **Operator gene** : The segment of DNA which exercises a control over transcription.
(A) FTF (B) TFT (C) TTF (D) FFT

(124) **Choose correct option : True for (T) and False for (F)**

- (1) DNA is cut into sections by using restriction ligase.
(2) DNA band pattern is transferred to a nylon membrane or nitro cellulose.
(3) A radioactive DNA Probe is introduced. The DNA Probe binds a specific DNA sequence on the nylon membrane.
(A) FTT (B) FTF (C) TFT (D) FFT

Column Type MCQs :

(125) **Match the enzyme in column - I with its function in column - II and select correct option:**

Column - 1	Column - 2	
(I) β -galactosidase	(p) Joining of DNA fragments	(A) (I- r) (II-q) (III-p) (IV-s)
		(B) (I-r) (II-s) (III-p) (IV-q)
(II) Permease	(q) Peptide bond formation	(C) (I-s) (II-r) (III-p) (IV-q)
(III) Ligase	(r) Hydrolysis of lactose	(D) (I-q) (II-r) (III-p) (IV-s)
(IV) Ribozyme	(s) Increase permeability to β - galactosidase	

(126) **Match column - I with column - II and select the correct option:**

Column - 1	Column - 2	
(I) AUG	(p) Phenyl alanine	(A) (I- p) (II-q) (III-r) (IV-s)
(II) UAA	(q) Methionine	(B) (I-q) (II-s) (III-r) (IV-p)
(III) UUU	(r) Tryptophan	(C) (I-s) (II-q) (III-r) (IV-p)
(IV) UGG	(s) Termination	(D) (I-q) (II-s) (III-p) (IV-r)

(127) Match column - I with column - II and select the correct option:

Column - 1

Column - 2

- | | | |
|--------------------------|---|----------------------------------|
| (I) t-RNA | (p) Amino acid attachment | (A) (I- s) (II-r) (III-p) (IV-q) |
| (II) m- RNA | (q) It brings genetic information into cytoplasm | (B) (I-q) (II-p) (III-r) (IV-s) |
| (III) r-RNA | (r) Nucleolus organization region | (C) (I-s) (II-q) (III-r) (IV-p) |
| (IV) Peptidyl transfrase | (s) Transport aminoacids from cytoplasm towards ribosomes | (D) (I-p) (II-r) (III-q) (IV-s) |

(128) Match column - I with column - II and select the correct option:

Column - 1

Column - 2

- | | | |
|---------------------------|---|----------------------------------|
| (I) Griffith | (p) Lac- operon | (A) (I- s) (II-q) (III-r) (IV-p) |
| (II) Erwin Chargaff | (q) Rules regarding the composition of bases in DNA | (B) (I-s) (II-q) (III-p) (IV-r) |
| (III) Temin and Baltimore | (r) Reverse Transcription | (C) (I-p) (II-q) (III-r) (IV-s) |
| (IV) Jacob and Monad | (s) Bacterial Transformation | (D) (I-q) (II-r) (III-s) (IV-p) |

(129) Match column - I with column - II and select the correct option:

Column - 1

Column - 2

- | | | |
|--------------------------|---|---------------------------|
| (I) Molecular Medicine | (p) Improve understanding of diseases like Alzheimers, Parkinsons etc | (A) (I- r) (II-q) (III-p) |
| (II) Forensics Science | (q) To establish family relationships | (B) (I-r) (II-p) (III-q) |
| (III) Microbial Genomics | (r) develop new energy sources and monitor environment to detect pollutants | (C) (I-p) (II-q) (III-r) |
| | | (D) (I-q) (II-r) (III-p) |

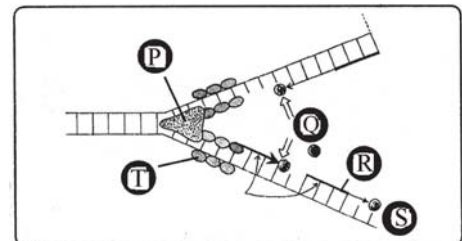
Answers : (114-A), (115-A), (116-B), (117-A), (118-C), (119-B), (120-C), (121-C), (122-D), (123-B), (124-A), (125-B), (126-D), (127-C), (128-A), (129-C)

Figure based MCQs :

Note : Use given figure for question number 130 to 133.

(130) what is Name and Function of 'P' indicated region in given diagram?

- (A) Helicase : It Starts Synthesis of new strand.
 (B) Helicase : It breaks down H_2 bond between two strands.
 (C) RNA polymerase : It forms primer.
 (D) DNA polymerase - III : It start synthesis of new DNA strand.



(131) Which Process illustrated in given diagram?

- (A) RNA replication (B) Translation (C) DNA replication (D) Transcription

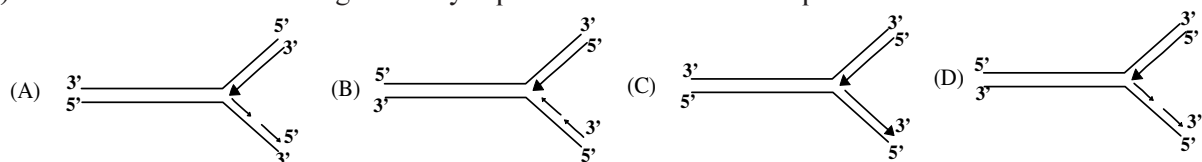
(132) What is indicated by 'T' in given diagram?

- (A) DNA helicase (B) RNA polymerase (C) DNA polymerase - III (D) SSB protein

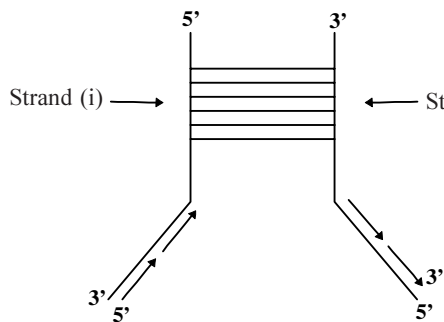
(133) Give the name of cell- division phase where given process occurred :

- (A) G_1 - phase (B) S-phase (C) G_2 - phase (D) M- phase

(134) which one of the following correctly represents the manner of replication of DNA ?

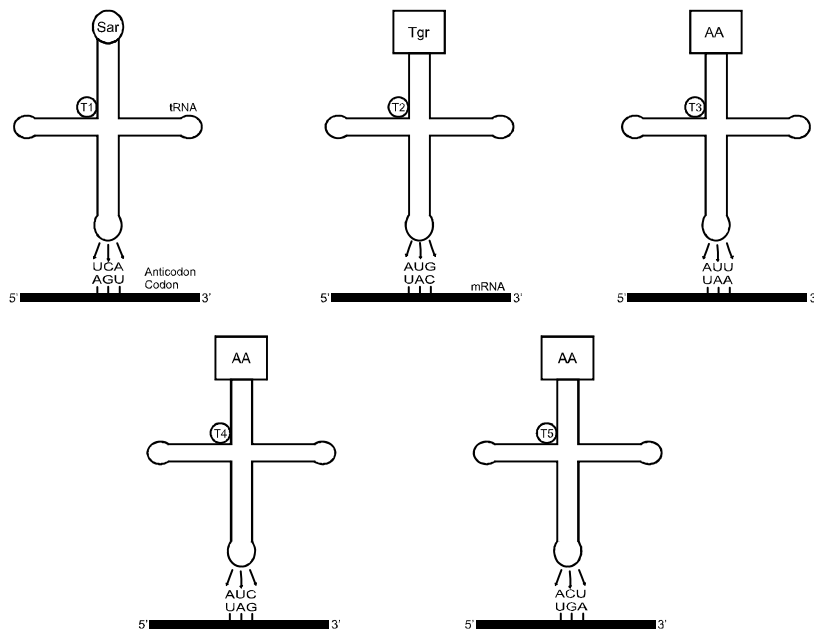


(135) Choose the correct option by using given diagram.



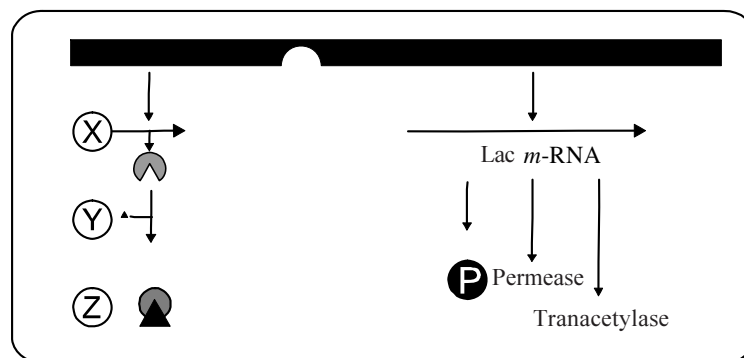
- (A) Strand (i) shows direction of DNA replication
 (B) Strand (ii) shows direction of DNA replication
 (C) Strand (i) shows direction of discontinuous replication
 (D) Strand (ii) shows direction of discontinuous replication

(136) Study the following t-RNA molecules related with their anti-codon pairing with respective codon. Which type of t-RNA is impossible ?



- (A) T₁ and T₂ (B) T₁ T₂ and T₃ (C) T₁ and T₄ (D) T₃, T₄ and T₅

Note: Use Given diagram for question number 137 to question number 140.



(137) What is indicated by 'X' in given diagram?

- (A) Protein (B) m-RNA (C) Inducer (D) t-RNA

(138) What is indicated by Y and Z in given diagram?

- (A) y - Inducer, z - Inducer-repressor complex (B) y - Repressor, z - Inducer-repressor complex
 (C) y - Protein, z - Promoter complex (D) y - Promoter, z - Operator

(139) What is function of 'Y' labelled region in given diagram?

- (A) Inducer which could be a Substrate, Precursor, when provided will bind the repressor protein and thus open up operator gene.
- (B) It prevents transcription of one or many Structural genes.
- (C) Help in formation of β -galactosidase.
- (D) It removes repressor from structural gene region and starts transcription of Z, Y, a genes.

(140) what is the function of 'P' labelled region in given diagram?

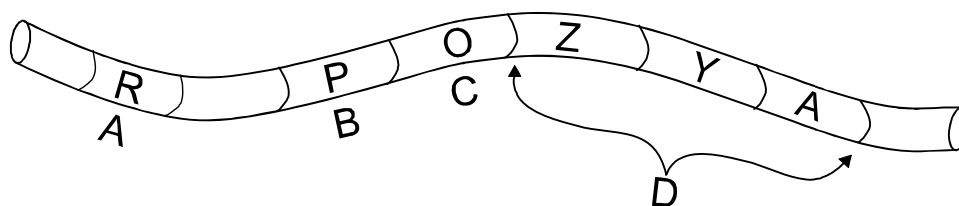
- (A) Digestion of glucose
- (B) Hydrolysis of lipids
- (C) Digestion of galactose
- (D) Hydrolysis of lactose.

(141) Strand 'X' in the figure shows a small part of a nucleic acid molecule. Which pair of the following strands are complementary to strand X.

Strand-X A T G A C	Strand :	1 A C A G T	2 T A C T G	3 A C A G U	4 U A C U G
---	------------------------	--	--	--	--

(A) 1 and 3 (B) 2 and 4 (C) 1 and 2 (D) 3 and 4

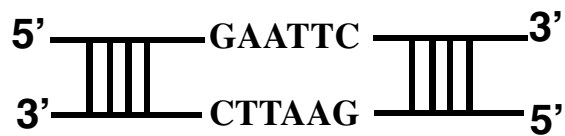
(142) The figure of the Lac-operon from E.coli is shown below. Each alphabet indicates its components may be used more than once, then which of the following option is correct in which all the alphabets are matched with their functions.



DNA Strand

- | | |
|---|--|
| (A) D - The binding site for repressor protein. | C - The binding site for RNA polymerase. |
| B - Structural gene. | A - The gene that codes for the repressor protein. |
| (B) A - The binding site for repressor protein. | D - The binding site for RNA polymerase. |
| B - Structural gene. | C - The gene that codes for the repressor protein. |
| (C) A - The binding site for repressor protein. | B - The binding site for RNA polymerase. |
| C - The structural gene. | D - The gene that codes for repressor protein. |
| (D) C - The binding site for repressor protein. | B - The binding site for RNA polymerase. |
| D - The structural gene. | A - The gene that codes for the repressor protein. |

(143) Given below is a sample of a portion of DNA strand giving the base sequence on the opposite strands. What is so special shown in it ?



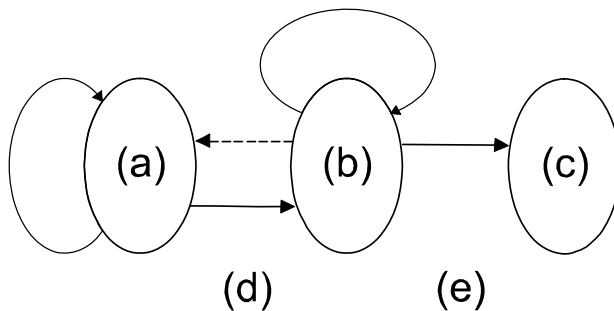
(A) Palindromic sequence of base pairs.

(B) Replication completed

(C) Deletion mutation

(D) Start codon at the 5' end

(144) The diagram represents the “central dogma” of molecular biology. Choose the correct combination of labelling.



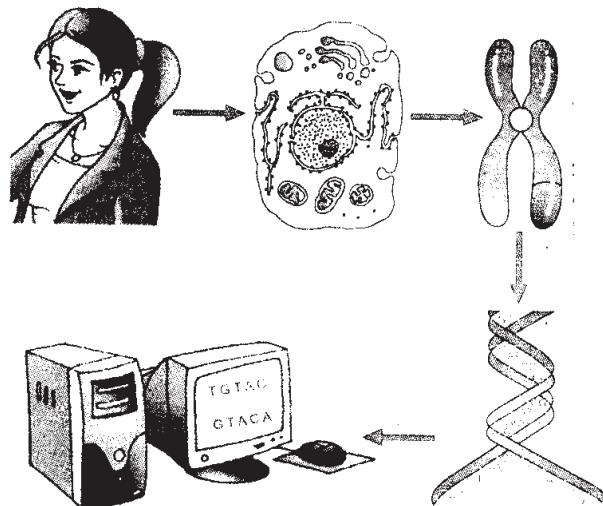
(A) a - protein, b - RNA, c - DNA, d - translation, e - transcription

(B) a - RNA, b - DNA, c - protein, d - transcription e - translation

(C) a - transcription, b - translation, c - protein, d - DNA, e - RNA

(D) a - DNA, b - RNA, c - protein, d - transcription, e - translation

(145) The given diagram illustrates:



(A) Chromosomal walking

(B) Humoral Analysis

(C) Human genome project

(D) Method of DNA finger printing

Answers : (130-B), (131-C), (132-D), (133-B), (134-D), (135-C), (136-D), (137-B), (138-A), (139-A), (140- D), (141-B), (142-D), (143-A), (144-D), (145-C)

● **MCQs for NEET :**

(146) Mode of DNA replication is

- (A) Semi conservative and bidirectional (B) Conservative and complete
(C) Semi conservative and unidirectional (D) Only conservative

(Hint) : After the completion of replication, each DNA molecule would have one parental and one newly synthesized strand; this method was termed as semi-conservative DNA replication.

- As the process of replication progresses in two directions, it is called bidirectional.

(147) If DNA strand have CTGATGC sequences then what would be the correct base sequences on mRNA

- (A) GUCTUTCG (B) GACUAUCG (C) GACTATGC (D) UACTATCU

(Hint) : The process where DNA gives its information to RNA is called transcription.

- In transcription one of these two DNA separated chains acts as a template chain. This chain provides complementary information for synthesis of m-RNA.

- RNA possesses 'U' instead of 'T'.

(148) The polypeptide synthesis in eukaryotes is initiated by

- (A) CCA (B) GCA (C) AUG (D) GUU

(Hint) : Translation is always initiated with amino acid methionine.

AUG is starting codon as well as code for methionine amino acid.

(149) It having anticodon region

- (A) m-RNA (B) s-RNA (C) t-RNA (D) r-RNA

(Hint): - t-RNA has an anticodon loop that has bases complementary to the code and it also has an amino acid acceptor by which it binds to amino acid.

(150) What is the meaning of Lac in "Lac-operon" ?

- (A) Digit of 1 Lac (B) Lactose (C) Lactase (D) Lactic acid

(Hint) : Jacob and Monod proposed that metabolic pathways are regulated as a unit. They studied the change in the nature of enzymes of E.coli when provided with different kinds of sugars. They found that when sugar lactose is added to the culture of E.coli it induces three enzymes necessary to break down the lactose into galactose.

(151) What would happen if there occurs mutation in 25th codon (ie-UAA to UAG) of a gene encoding a polypeptide chain of 50 amino acids ?

- (A) enhancer (B) promoter (C) regulator (D) receptor

(Hint) : The promoter gene is the DNA segment at which the transcription of the structure genes take place. It controls the rate of m-RNA synthesis.

(152) During translation initiation in Prokaryotes, a GTP molecules is needed in

- (A) association of 50s subunit of ribosome with initiation complex
(B) formation of formyl-met- t-RNA
(C) association of 30s subunit of ribosome with m-RNA
(D) association of 30s m-RNA with formyl-met-tRNA

(Hint) : For creating complicated complex the elongation process required energy, so GTP used as source of energy.

(153) What would happen if in a gene encoding a polypeptide of 50 amino acids, a mutation occurs in 25th codon is mutated and it change from UAA to UAG ?

- (A) A polypeptide of 24 amino acids will be formed.
(B) A polypeptide of 50 amino acids will be formed.
(C) Two polypeptide of 24 and 25 amino acids will be formed.
(D) A polypeptide of 49 amino acids will be formed.

(Hint) : The codon present on 25th position of a gene is a termination codon and due to mutation new codon is formed that also termination codon, so this newly formed codon UAG cause termination of process, hence A polypeptide of 24 amino acids will be formed.

(154) How many effective codons are there for the synthesis of twenty amino acids?

- (A) 60 (B) 20 (C) 64 (D) 61

(Hint) : According to possibility of three letter code four nitrogen bases A, U, G, C provide 64 codons. Out of this three codon do not code for any amino acids such codons are called non sense codons hence 61 codon code for 20 amino acids.

(155) 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

(Hint) : Because CUC and UCC code for respectively Leucine and Serine.

(156) Which one of the following is correct for gene map?

- (A) It shows different species distribution at different geological regions.
(B) It helps describe the spatial arrangement of genes on a chromosomes.
(C) It triggers cell-division.
(D) It gives proper information regarding genetic evolution.

(157) DNA fingerprinting method is very useful for

- (A) Molecular analysis of DNA samples (B) Forensic studies and gene map
(C) Polytene chromosome (D) Combination of different-different samples of DNA

(Hint) : For DNA fingerprinting, short repetitive nucleotide sequence which are specific for a person are important. These nucleotide sequences are known as variable number tandem repeats (VNTR).

(158) A mutation which substitutes one purine (A) base with another purine (G) base is called

- (A) transversion (B) transduction (C) transition (D) transfection

(159) Which proportion of Nitrogen bases varies with the organism:

- (A) $\frac{A + G}{T + C}$ (B) $\frac{T + C}{G + A}$ (C) $\frac{A + T}{G + C}$ (D) $\frac{A + C}{T + G}$

(Hint) : According to Erwin Chargaff: The proportion of A is equal to T and also proportion of G is equal to C, but amount of (A)+(T) is not necessarily equal to (G)+(C).

Therefore (A)=(T) : (G)=(C).

But $\frac{A + T}{G + C}$ = varies with the organism.

(160) During transcription holoenzyme RNA polymerase binds to a DNA sequence and the DNA assumes a saddle like structure at the point. What is that sequence called ?

- (A) AAAT Box (B) TATA Box (C) GGTT Box (D) LAAT Box

(Hint) : TATA box is present in eukaryotic promoter region. It has a resemblance with pribnow box of prokaryotes. TATA box was identified by Dr. Hogness and so it is also called as Hogness box. During the process of transcription the RNA polymerase binds to TATA box due to which DNA assumes a saddle like structure at this place.

(161) Which of following is famous as a RNA dependent DNA polymerase ?

- (A) DNA polymerase (B) RNA polymerase (C) Reverse Transcriptase (D) Transcriptase

(Hint) : According to Temin and Baltimore, many tumour viruses contain RNA as a genetic material and replicate by first synthesizing a complementary DNA. This process is called reverse transcription and it is done with the help of reverse transcriptase. It is observed in HIV.

(162) What is telomerase?

- (A) Protein (B) RNA (C) Ribonucleoprotein (D) Palindromic sequence

(Hint) : It is a ribonucleo protein that adds a species-dependent telomere repeat sequence to the 3' end of telomeres. A telomere is a region of repetitive sequence at each end of a eukaryotic chromosomes in most eukaryotes. Telomeres protect the end of the chromosome from DNA damage or from fusion with neighbouring chromosomes.

(163) One gene one enzyme hypothesis was proposed by

- (A) Hershey and chase (B) Watson and Crick (C) Beadle and Tatum (D) R. Franklin

(164) The okazaki fragments in DNA chain growth :

- (A) Polymerize in the 3' to 5' direction and forms replication fork.
(B) Prove semi-conservative nature of DNA replication.
(C) Polymerize in 5' to 3' direction and explain 3' to 5' DNA replication.
(D) Result in transcription.

(Hint) : Okazaki segment is a short fragment of DNA having RNA primer at 5' terminus during the process of DNA replication. During the synthesis of complementary DNA strands the leading strand always reads - 5' to 3'. Anti parallel complementary strand i.e lagging strand reads from 3' to 5' direction. As original strands of DNA are anti-parallel the only one new continuous strand can be formed at 3' end of leading strand. This is due to intrinsic 5' to 3' polarity of DNA polymerase. The remaining other strand of DNA grows discontinuously in opposite side.

(165) 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) DNAase digestion.
(C) Through elimination of repetitive DNA. (D) Deletion of non-essential genes.

(Hint) : The solenoid defines the packing of DNA as a 30 nm fiber of chromatin and results from the helical winding of at least five nucleosome strands.

(166) Which organelles provide platform for translation process?

- (A) Mitochondria (B) Ribosome (C) Lysosome (D) Golgi body

(167) Which one of the following statement is correct ?

- (A) GUU, GCU - Alanine (B) UAA, UAG - Terminator
(C) AUG, ACG - Methionine (START) (D) UUA, UCA - Leucine

(Hint) : GUU – valine, GCU – Alanine, UAA, UAG, and UGA – Termination codones. AUG. starting codon as well as code for methionine amino acid, UUA – Leucine while UCA code for serine.

(168) Haploids are more suitable for mutation studies than the diploids. This is because

- (A) all mutations, whether dominant or recessive are expressed in haploids
- (B) haploids are reproductively more stable than diploids
- (C) mutagen penetrate in haploids more effectively than in diploids
- (D) haploids are more abundant in nature than diploids.

(169) Removal of introns and joining the exons in a defined order in a transcription unit is called

- (A) Tailing
- (B) Transformation
- (C) Capping
- (D) Splicing

(Hint): In molecular biology splicing is the editing of the nascent pre-mRNA transcript. After splicing introns are removed and exons are joined together (ligated).

(170) Semi-conservative replication of DNA was first demonstrated in

- (A) *Streptococcus pneumoniae*
- (B) *E. coli*
- (C) *Salmonella typhimurium*
- (D) *Drosophila melanogaster*

(Hint) : Genome size in *E. coli* is 4.6 million having estimated genes are 3200. Besides *E. coli* can easily grow in culture medium and multiply very fast so it is best for making more copies of DNA, hence semi-conservative replication of DNA was first demonstrated in *E. coli*.

(171) Select the correct statements out of the four (i-iv) given below about lac operon.

- (i) Glucose or galactose may bind with the repressor and inactivate it.
- (ii) In the absence of lactose the repressor binds with the operator region.
- (iii) The Z- gene code for permease.
- (iv) This was elucidated by Francis Jacob and Monod.

- (A) i and iii
- (B) i and ii
- (C) ii and iv
- (D) i and iii

(172) Whose experiments cracked the DNA and discovered unequivocally that a genetic code is a triplet ?

- (A) Nirenberg, Matthaei and Khorana
- (B) Hershey and Chase
- (C) Beadle and Tatum
- (D) Watson and Crick

(Hint) : Nirenberg and Matthaei (1961) experimentally proved that a single amino acid is determined by a sequence of three nitrogen bases which is known as triplet code. Khorana has got Nobel Prize on genetic code.

(173) Out of following which organism is odd for central dogma?

- (A) Bean
- (B) Yeast
- (C) Sunflower
- (D) HIV

(Hint) : According to Crick genetic information flows from DNA → m-RNA → protein replication. But in some viruses the flow of information is in reverse direction, some HIV like viruses contain RNA as genetic material and replicated by first synthesizing a complementary DNA. This process is called reverse transcription.

(174) Removal of RNA polymerase- III from nucleoplasm will affect the synthesis of :

- (A) t-RNA
- (B) r-RNA
- (C) Ribosomes
- (D) m-RNA

(Hint) : RNA Polymerase-I : It is responsible for synthesis of r-RNA.

RNA Polymerase-II : It is responsible for synthesis of m-RNA.

RNA Polymerase-III : It is responsible for t-RNA synthesis, hence nucleoplasm will affect the synthesis of t-RNA.

(175) During transcription the nucleotide sequence of the DNA strand that is being coded is AACCGG, then the nucleotide sequence in m RNA would be :

- (A) GGUUCC (B) UUGCGC (C) UUGGCC (D) TTGGCC

(176) Melting of DNA at an elevated temperature (90⁰ C) is primarily due to the result of :

- (A) DNA converted into RNA (B) It breakdown in numbers of pieces
(C) Nothing will happen. (D) Breakdown of Hydrogen bonds and two chain become separated

(177)) It is a vector of genetic information

- (A) RNA (B) DNA (C) Enzyme (D) Protein

(Hint): Recent developments in molecular biology revealed that nucleic acids of the chromosomes are responsible for the transmission of hereditary character. DNA is found to be the genetic material in almost all the living beings except plant viruses and in some retro viruses.

(178) If the DNA codons are ATG ATG ATG and a cytosine (c) base is inserted at the beginning, which of the following will result

- (A) A non-sense mutation (B) CATGATGATG
(C) CATGATGATG (D) CATGATGATG

(179) Non-genetic RNA is of

- (A) Two types (B) Three types (C) Only one type (D) None of these

(Hint) : Non-genetic RNA having three Types (i) m-RNA, (ii) t-RNA and (iii) r-RNA. It helps in Translation process.

(180) It is known as a chemical scissors :

- (A) Ligase (B) Polymerase (C) Endonuclease (D) Transcriptase

(Hint) : A endonuclease is an enzyme that cuts DNA at or near specific recognition nucleotide sequences known as restriction site.

(181) which form of RNA has a structure resembling clover leaf?

- (A) m-RNA (B) t-RNA (C) r-RNA (D) hn-RNA

(182) Unit of nucleic acid is

- (A) Nucleotide (B) Nucleoside (C) Nucleic Acid (D) All of Above

(Hint) : Nucleic acid is made up of units of nucleotide. In nucleotide, purine or pyrimidine nitrogenous base joined by deoxyribose pentose sugar (D), which is further linked with phosphate (P) group to form nucleotides.

(183) The double helix model of Watson and Crick is known as

- (A) C-DNA (B) B-DNA
(C) Z-DNA (D) D-DNA

(Hint) : Five different morphological forms of DNA double helix have been described. These are A,B,C,D and Z forms. Most of these forms (except B and Z) occur in rigidly controlled experimental condition. Watson and Crick model represents commonest form Biotic-form (B-form or B- DNA) of DNA. It is a handedness of the double helix is right handed.

(184) Which of the following statements are correct ?

- (A) Introns are present in m RNA and exons are present in t RNA.
- (B) Codons are present in m RNA and anticodons are in t RNA.
- (C) Every intron is a set of three terminator codons.
- (D) Exons are present in eukaryotes while introns are present in prokaryotes.

(185) If a segment of an m-RNA molecule has the sequence 5' GUACCGAUCG 3', which of the following could have been template DNA molecule ?

- (A) 5' GCU AGC CAU G 3'
- (B) 5' GUA CCG AUC G 3'
- (C) 5' CAT GGC TAG C 3'
- (D) 5' CGA TCG GTA C 3'

(186) If percentage of cytosine is 18% then percentage of adenine will be :

- (A) 32 %
- (B) 64 %
- (C) 36 %
- (D) 23 %

(Hint): If 100% of Nitrogen bases A,T,G and C, then C having 18%. So G also has 18%

$$\therefore G = C$$

So, 100 - G - C

$$100 - 18 - 18 = 64\% \text{ Nitrogen bases}$$

$$\text{So, } \frac{64}{2} = 32\% (A = T)$$

(187) Select the correct Option :

Sr.	Direction of RNA Synthesis	Direction of reading of the template DNA Strand
(A)	5' → 3'	5' → 3'
(B)	3' → 5'	3' → 5'
(C)	5' → 3'	3' → 5'
(D)	3' → 5'	5' → 3'

(Hint) : RNA polymers catalyse polymerization only in one direction, that is 5' → 3' and the strand that has the polarity 3' → 5' act as a template.

(188) Which one of the following Nitrogen bases is not correctly matched with termination codons ?

- (A) Cytosine (c)
- (B) U
- (C) A
- (D) G

(189) Which one of the following has dual functions?

- (A) UGA
- (B) UUU
- (C) AUG
- (D) AAA

(190) Which of the following codons has no t RNA ?

- (A) UAA
- (B) UAU
- (C) UGU
- (D) UGG

(Hint): UAA is a termination codon. It does not indicate the position of any amino acid. So such a codon is to release the synthesized polypeptide chain from ribosomes.

- (191) Genes that are involved in turning on or off the transcription of a set of structural genes are called
 (A) Polymorphic genes (B) Promoter genes (C) Regulatory genes (D) Operator genes
- (192) Which one of the following codons codes for the same information as UGC ?
 (A) UGU (B) UGA (C) UAG (D) UGG

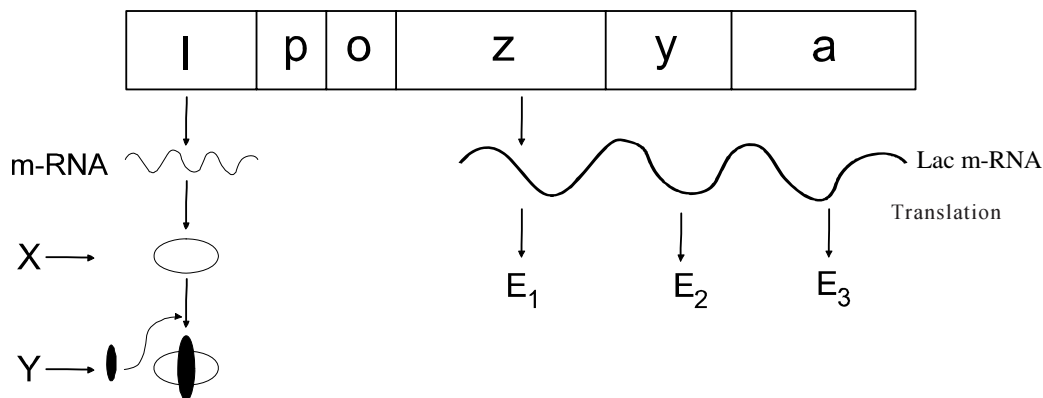
- (193) Which one of the following gene is not matched with name of cartoon characters?
 (A) TinTin (B) Popeye (C) Asterix (D) Obelix

(Hint): Popaye gene : Protein is responsible for development of stroted muscels

Asterix gene : Mutant gene is found in rabbit.

Obelix gene : It produce Nuclear binding protein.

- (194) In the given figure of the lac operon, an operon for inducible enzymes, Identify Components and enzymes.



Sr.	X	Y	E ₁	E ₂	E ₃
(a)	Repressor protein	Inducer (lactose)	Permease	Transacetylase	β-galactosidase
(b)	Repressor protein	Inducer (lactose)	β-galactosidase	Transacetylase	Permease
(c)	Inducer (lactose)	Repressor protein	β-galactosidase	Permease	Transacetylase
(d)	Repressor protein	Inducer (lactose)	β-galactosidase	Permease	Transacetylase

- (195) Which option is correct for the amino acid and the total number of their genetic code ?
 (A) Arg = 6, His = 6
 (B) Val = 6, Pro = 6
 (C) Pro = 4, Thr = 4
 (D) Thr = 4, Arg = 4
- (196) Which region of gene below become transcription but does not translate?
 (A) Exon (B) Intron (C) Cistron (D) Codon

- (197) Balbiani rings are sites of

- (A) DNA replication (B) RNA and protein synthesis
 (C) synthesis of lipids (D) synthesis of polysaccharides

Answers : (146-A), (147-B), (148-C), (149-C), (150-B), (151-B), (152-D), (153-A), (154-D), (155-A), (156- B), (157-A), (158-C), (159-C), (160-B), (161-C), (162-C), (163-C), (164-C), (165-A), (166-B), (167-B), (168-A), (169-D), (170-B), (171-C), (172-A), (173-D), (174-A), (175-C), (176-D), (177- B), (178-C), (179-B), (180-C), (181-B), (182-A), (183-B), (184-B), (185-C), (186-A), (187-C), (188-A), (189-C), (190-A), (191-D), (192-A), (193-A), (194-D), (195-C), (196-B), (197-B)

