THE VILLAGE
INTERNATIONAL SCHOOL
"We Nurture Dreams"

AIM HIGH, TOGETHER WE FLY

Grade 12 Biology

Chapter 6: Molecular basis of inheritance

Question bank

1) State the function of histones in DNA packaging.
   Ans. They play a role in gene regulation, They help the DNA to wind around it, The histones are positively charged proteins, which can easily bind to the negatively charged DNA.
2) What do you understand by DNA packaging?
   Ans. DNA packaging is the folding of an organism's DNA into a compact structure that can fit within the nucleus of a cell.
3) How is DNA packaged in a cell?
   Ans. The cells wrap their DNA around scaffolding proteins to form a condensed structure called chromatin. The chromatin is further folded to form different structures that eventually form chromosomes.
4) What is the importance of DNA packaging?
   Ans. DNA packaging is important because the DNA is very long. In order to fit the DNA into the nucleus, it needs to be packaged properly.
5) What role do histones play in DNA packaging?
   Ans. Histones are proteins responsible for DNA packaging. The DNA wraps around the histones. Histones are positively charged proteins and hence can easily bind to negatively charged DNA. Histones are also involved in controlling the expression of genes.
6) How do acetylation and phosphorylation affect DNA packaging?
   Ans. Acetylation and phosphorylation make the DNA more negatively charged and loosens the packaging of DNA. The enzymes that add acetyl groups to histones are called acetyltransferases.
7) What is Heterochromatin?
   Ans. Heterochromatin are a tightly packed form of DNA in the nucleus. They are so compactly organized that they are inaccessible to the protein involved in gene expression. Even the crossing over cannot take place. These are of two types – facultative heterochromatin and constitutive heterochromatin.
8) What is Euchromatin?
   Ans. These are loosely packed form of chromatin. These are active during transcription. It contains 90% of the entire human genome. Housekeeping genes are one of the forms of euchromatin.Q.3. Name any three viruses with RNA as the genetic material.
9) Name any three viruses with RNA as the genetic material.
   Ans. The viruses in which the genetic material is RNA is called the RNA virus. The three examples of the RNA virus.

   - Influenza Virus.
   - Hepatitis C Virus.
   - Human Immunodeficiency Virus.

10) What is a Virus in Biology?
    Ans. A virus is a biological entity that can only reproduce within a host. Anatomically, viruses possess nucleic acids (DNA or RNA) which are encased within a protective protein coat. These entities are able to infect all forms of life, ranging from bacteria to humans, and consequently, they bring about a multitude of diseases in their host.
11) State the basis of classification of viruses.

Ans. Typically, classification of viruses mainly depends on their phenotypic characteristics such as morphology, chemical composition, structure, and function.

12) List the types of viruses In biology.

Ans. Based on their host, viruses can be classified into three types, namely, animal viruses, plant viruses, and bacteriophages.

13) State a few examples of viral diseases.

- AIDS
- Chikungunya
- Ebola
- Influenza
- SARS
- Small Pox

14) Why are viruses neither considered living, nor non-living?

Ans. Viruses possess trademark characteristics of both living and non-living entities. For instance, they can only reproduce within a host, just like a parasite. But unlike parasites or any other living organisms, viruses can be crystallized. During this stage, they remain dormant, until they enter another host, restarting the cycle all over.

15) Give a reason for the discontinuous synthesis of DNA on one of the parental strands?

Ans. The biological process of DNA synthesis naturally occurs in 5′ to 3′ direction. In the double-stranded DNA, the strands are parallel and antiparallel to each other. During the synthesis of DNA, both the strands act as templates and only one (3′ to 5′ direction) can synthesize the parallel strand in 5'→3′ direction. The other strand 5′ to 3′ is synthesized in the opposite direction producing small stretches of DNA known as Okazaki fragments. This is the reason for the discontinuous synthesis of DNA on one of the parental strands.

16) The sequence of the coding strand of DNA in a transcription unit is mentioned below.

3′ AATGCAGCTATTAGG 5′

Write the sequence for:

a. Its complementary strand

b. Its mRNA

Ans. The complementary strand is 5′ TTACGTCGATAATCC 3′

The mRNA is 5′ AAU GCAGCUAUUAGG 3′

17) What is DNA polymorphism?

Ans. DNA's polymorphism is the variation in the DNA sequence arising due to mutation at non-coding sequences.

18) Retroviruses do not follow central dogma. Comment on this statement

Ans. Retroviruses do not follow central dogma, because, they possess RNA as genetic material instead of the DNA, which is later converted into DNA by the enzyme reverse transcriptase.

19) Sometimes, the young ones born have an extremely different set of eyes or limbs. Give a relevant explanation for the abnormality.

Ans. This abnormality is caused by many factors, including alcohol abuse by the mother during her pregnancy, medicine side effects or reactions caused to the womb, environmental factors, such as maternal exposure to the chemicals, radiations, virus, and it can also be due to the genes and non-coordination in the regulation of expression in the set of genes associated with the development of organs.

20) Explain about the dual polymerase present in E.coli.

Ans. The DNA polymerase present in E.coli is a DNA dependent polymerase. This DNA polymerase helps in the:

- Replication process.
- Performs the 5′ to 3′ polymerase activity as well as 3′ to 5′ exonuclease activity.

- The DNA polymerase III also has the ability to proofread the wrong nucleotides and substitutes it with the correct one.

21) What are the functions of the :

    a. Methylated guanosine cap

    b. Poly-A tail

Ans. Methylated guanosine cap plays a primary role in the attachment of the mRNA to the smaller sub-units of the ribosome during translation initiation.
The Poly-A tail functions by increasing the length of the mRNA and also provides longevity to the mRNA.

22) Mention any two functions of AUG codon.
Ans.. The AUG codon is also called the start codon. The two important functions of AUG codon include:
- It codes for methionine.
- It acts as an initiation codon for protein synthesis.

23) What is the function of amino acyl t-RNA synthase?
Ans. Amino acyl t-RNA synthase plays a major role in the biosynthesis of proteins by attaching an appropriate amino acid on to the tRNA molecules.

24) Enumerate the post-transcriptional modifications in a eukaryotic mRNA.
Ans. Transcription is the process of conversion of DNA to mRNA. The post-transcriptional modifications include:
- Capping at 5'-end
- Poly-A tail at 3'-end
- mRNA splicing

The 5′ cap protects the RNA from ribonuclease. The poly-A tail protects the mRNA from enzymatic degradation. The introns are spliced during mRNA splicing and the exons are joined together to form a continuous sequence that codes for a functional protein.

25) What is the process of transcription?
Ans. Transcription is the process in which a DNA sequence is transcribed into an RNA molecule with the help of enzyme RNA polymerase. One of the DNA strands acts as a template to make a complementary RNA strand.

26) Where the transcription start and terminate?
Ans. The transcription starts at the 5′-end of the DNA sequence.

27) Are enhancers necessary for transcription?
Ans. Enhancers are regions in eukaryotic cells that help to increase the transcription. These are not necessarily close to the genes they enhance.

28) What is the end product of transcription?
Ans. An RNA transcript is obtained as an end product of transcription. It can form any type of RNA such as rRNA, mRNA, non-coding RNA and tRNA. The prokaryotes form a polycistronic mRNA whereas eukaryotes form a monocistronic mRNA.

29) What are the promoter sequences?
Ans. Promoter sequences are the gene sequences where the DNA transcription begins. These are located upstream at the 5′ end of the DNA sequence.

30) Explain the process of translation.
Ans. The translation is the process of protein synthesis in which the mRNA is used to synthesize proteins. The mRNA sequence is decoded to specify the amino acid of a polypeptide. The process of translation is carried out in the following steps:
- Initiation.
- Elongation.
- Termination.

31) How does protein synthesis occurs in prokaryotes?
Ans. In prokaryotes, which lack a nucleus, the processes of both transcription and translation occur in the cytoplasm. The protein biosynthesis begins by the association of a 30s ribosomal subunit and an mRNA at the AUG codon site. Also the post-transcriptional modifications are not required here and the mature mRNA molecule is immediately produced by transcription.

32) How does protein synthesis occurs in eukaryotes?
Ans. In eukaryotes, the pre-mRNA undergoes post-transcriptional modifications in the nucleus to produce a mature mRNA molecule. The translation occurs in the cytoplasm of the cell, where the ribosomes are located either free-floating or attached to the endoplasmic reticulum. Here, the initiation of protein synthesis is the process that results in bringing together an 80S ribosome with an mRNA and initiator methionyl-transfer RNA.

33) Explain the process of DNA fingerprinting.
Ans. DNA fingerprinting is a technique that is used to analyze the genetic makeup of living beings. It is widely used for DNA analysis in forensic tests and paternity tests to identify the biological parents of the child, and also to identify the criminal during forensic investigations.

34) What is an operon? Explain an inducible operon.
Ans. An operon is the functional unit of DNA that contains a cluster of genes controlled by a single promoter. It consists of the following components:

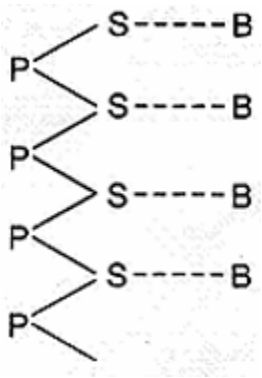
- The DNA fragment that transcribes the mRNA.
- Regulator gene that codes for a repressor protein.
- Inducer that prevents the repressor from binding to the operator.
- A promoter where the RNA polymerase binds and initiates the transcription.
- An operator that is a DNA sequence adjacent to the promoter where the repressor protein binds.

The lac operon of E.coli is an inducible operon.

35) Explain the process of DNA replication.
Ans. DNA replication is a biological process of producing two identical strands of DNA from the original strand. The original strand is known as the parent strand and the new strands are known as the daughter strands. This is achieved by a number of enzymes such as DNA polymerase, helicase, primase, topoisomerase, and ligase.

36) What is the distance between two base pairs in DNA?
Ans. The diameter of the B-DNA is ~20 Angstroms, and the distance between base pairs is ~3.4 Angstroms. The base pairing of opposite strands is stereochemically selective, Adenine always pairing with Thymine, and Guanine with Cytosine.

37) Refer to the following diagram and answer the given question



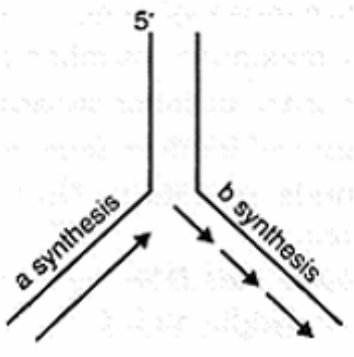
What type of bond is represented by the dotted lines?

Ans. Hydrogen

38) Khorana and his colleagues synthesized an RNA molecule with repeating sequence of AG nitrogenous bases (AG AG AG AG AG AG). It produced a tetrapeptide with alternating sequence of valine and tyrosine. It proves that codon for valine and tyrosine are?
Ans. Codon for valine – AGA

Codon for tyrosine – GAG

39) Name the types of synthesis 'a' and 'b' occurring in the replicating fork of DNA as shown below:



Ans. 'a' – synthesis of leading / continuous strand.
'b' – synthesis of lagging / discontinuous strand.

40) What is teminism?

Ans. Reverse transcription is known as teminism, which was first reported by Temin and Baltimore. RNA of some viruses (Retroviruses) first synthesizes DNA through reverse transcription. The DNA then transfers information to RNA, which takes part in translation of coded information to form polypeptide.

41) Mention two functions of the codon AUG.

Ans. (i) It codes for methionine amino acid.
(ii) It acts as initiator codon for protein synthesis

42) Differentiate between the process of transcription in prokaryotes and eukaryotes.

Ans.

Transcription in Prokaryotes	Transcription in Eukaryotes
(i) Products of transcription become effective in situ.	(i) Products of transcription come out of the nucleus for functioning in cytoplasm.
(ii) There is only one RNA-polymerase.	(ii) Three RNA polymerases take part in it.
(iii) mRNA is polycistronic.	(iii) mRNA is monocistronic.
(iv) Splicing is not required.	(iv) Splicing is required for removing introns.

43) A Couple quarrelled with the hospital authority on suspicion that their child had been exchanged after birth. The couple based their argument on the fact that their child is O blood group whereas they are A and B blood groups respectively. The doctor smiled and explained.

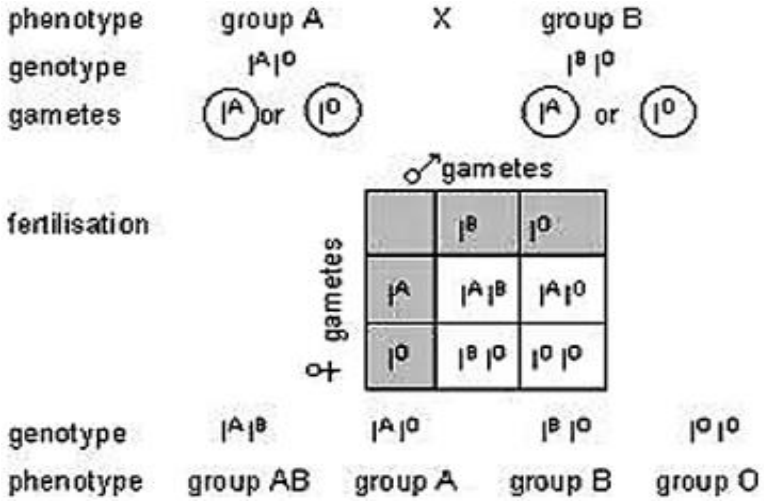
a. What values of the doctor is reflected here?
b. How can the child be O blood group as explained by the doctor?
c. Which test method can be considered authentic to identify the biological parents of the child?
d. Name the other blood group(s) which the child could have inherited.

Ans. The doctor was assertive, patient and pragmatic.
It is possible if the parents are heterozygotes, i.e. Ai x Bi. If the child receives i from both the parents, it becomes ii, and expresses the O blood group. See the chart below:

Parent A blood type	Parent B blood type	possible Child Blood type
A	A	A, O
A	B	A, AB, B, O

Parent A blood type	Parent B blood type	possible Child Blood type
A	AB	A, AB, B
AB	AB	A, AB, B
B	B	B, O
B	AB	A, AB, B
O	O	O
O	A	A, O
O	AB	A, B
Rh+	Rh-	RH+, Rh-
Rh-	Rh-	Rh-
Rh+	Rh+	Rh+, RH-

DNA fingerprinting
A or B or AB



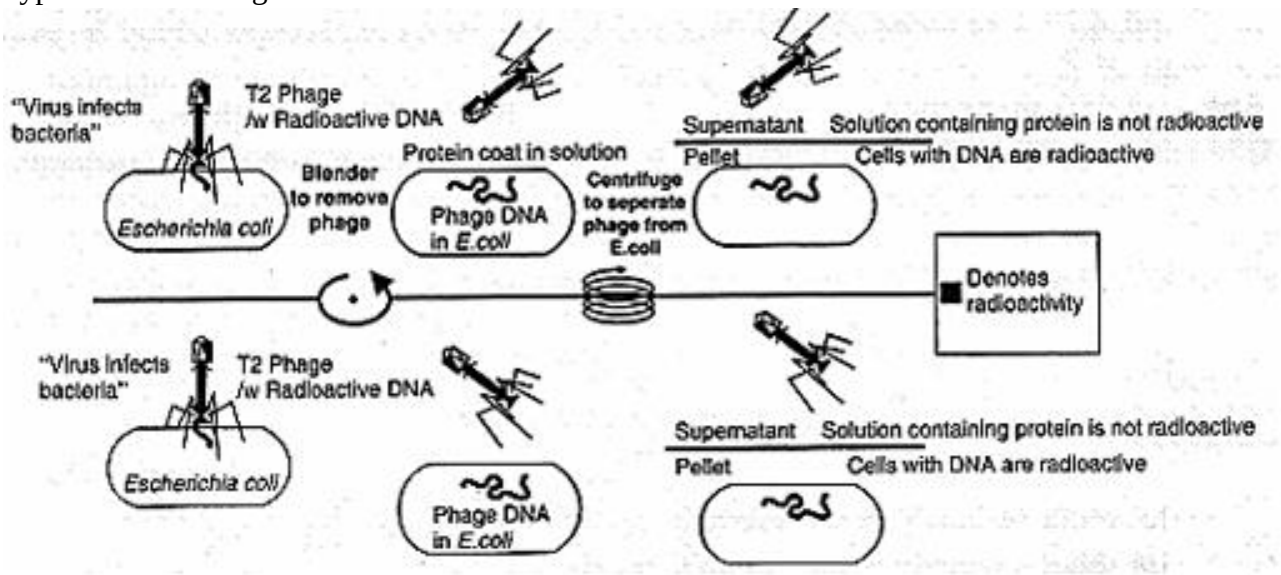
44) Differentiate between leading strand and lagging strand.
Ans.

Leading strand	Lagging strand
1. It is a replicated strand of DNA which grows continuously without any gap.	1. The lagging strand is a replicated strand of DNA which is formed in short segments called discontinuous.
2. It does not require DNA ligase for its growth	2. DNA ligase is required for joining okazaki fragments.

3. The direction of growth of a leading strand is 5′ →→ 3′	3. The direction of the lagging strand is 3′ →→ 5′
4. Only a single RNA primer is required	4. Starting of each okazaki fragment requires a new RNA.
5. Its template opens in 3′ →→ 5′ direction	5. Its template opens in 5′ →→ 3′ direction
6. Formation of leading strand begins immediately at the beginning of replication.	6. Formation of lagging strand begins a bit later than that of leading strand.

45) How did Hershey and Chase prove that DNA is the hereditary material? Explain their experiment with suitable diagrams.

Ans. Hershey – Chase Experiment (1952) Hershey and Chase conducted their experiments on the T2 phase, a virus. The phase consists only of a protein shell containing its genetic material. In a first experiment, they labelled the DNA of phages with radioactive phosphorus – 32 (the element phosphorus is present in DNA but not present in any of the 20 amino acids from which proteins are made). They allowed the phages to infect E.coli, then removed the protein shells from the infected cells with a blender and separated the cells and viral coats by using a centrifuge. They found that the radioactive tracer was visible only in the pellet of bacterial cells and not in the supernatant containing the protein shells. In a second experiment, they labelled the phages with radioactive Sulfur-35 After separation, the radioactive tracer then was found in the protein shells, but not in the infected bacteria, supporting the hypothesis that the genetic material which infects the bacteria is DNA.



46) How many base pairs would a DNA segment of length 1.36 nm have?

Ans. Distance between two base pairs = 0.34 nm or 0.34×10–6 nm Number of base pairs in 1.36 nm DNA segment

$$= \frac{1}{0.34 \times 10^{-6}} \times 1.36$$

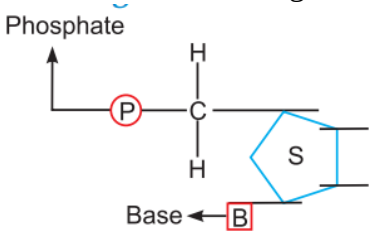
$$= \mathbf{4 \times 10^{6}\ bp}$$

47) In an experiment, DNA is treated with a compound which tends to place itself amongst the stacks of nitrogenous base pairs. As a result of which the distance between two consecutive base increases, from 0.34 nm to 0.44 nm. Calculate the length of DNA double helix (which has 2 × 109 bp) in the presence of saturating amount of this compound.
Ans. 2 × 109 × 0.44 nm.

48) Calculate the length of the DNA of bacteriophage lambda that has 48502 base pairs.
Ans. Distance between two consecutive base pairs = 0.34 × 10–9 m
The length of DNA in bacteriophage lambda = 48502 × 0.34 × 10–9 m = 16.49 × 10–6 m

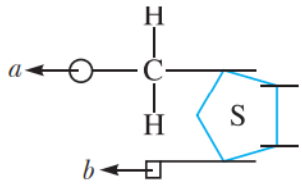
49) Why are proteins either positively or negatively charged?
Ans. If the proteins are rich in basic amino acids, they are positively charged, and if the proteins are rich in acidic amino acids, they are negatively charged.

50) Mention the carbon positions to which the nitrogenous base and the phosphate molecule are respectively linked in the nucleotide given below:



Ans. Nitrogenous base is linked to first carbon.
Phosphate is linked to fifth carbon.

51) What are ‘a’ and ‘b’ in the nucleotide with purine represented below?



Ans. ‘a’ is phosphate group and ‘b’ is purine (adenine/guanine).

52) Name the negatively charged and positively charged components of a nucleosome.
Ans. In a nucleosome, the negatively charged component is DNA and positively charged component is histone octamer.

53) In a nucleus, the number of RNA nucleoside triphosphates is 10 times more than the number of DNA nucleoside triphosphates, still only DNA nucleotides are added during the DNA replication, and not the RNA nucleotides. Why?
Ans. DNA polymerase is highly specific to recognise only deoxyribonucleoside triphosphates. Therefore it cannot hold RNA nucleotides.

54) Name the transcriptionally active region of chromatin in a nucleus.
Ans. Euchromatin or exon.

55) Mention the two additional processing which hnRNA needs to undergo after splicing so as to become functional.
Ans. Capping and tailing.

56) When and at what end does the ‘tailing’ of hnRNA take place?
Ans. ‘Tailing’ of hnRNA takes place during conversion of hnRNA into functional mRNA after transcription. It takes place at the 3′-end.

57) At which ends do ‘capping’ and ‘tailing’ of hnRNA occur, respectively?
Ans. Capping occurs at 5′-end and tailing occurs at 3′-end.

58) What is cistron?
Ans. A cistron is a segment of DNA coding for a polypeptide.

59) How does a degenerate code differ from an unambiguous one?

Ans. Degenerate code means that one amino acid can be coded by more than one codon. Unambiguous code means that one codon codes for only one amino acid.

60) Mention two functions of the codon AUG.
Ans. Two functions of the codon AUG are:
(i) It acts as a start codon during protein synthesis.
(ii) It codes for the amino acid methionine.

61) Write the function of RNA polymerase II.
Ans. RNA polymerase II transcribes precursor of mRNA or hnRNA.

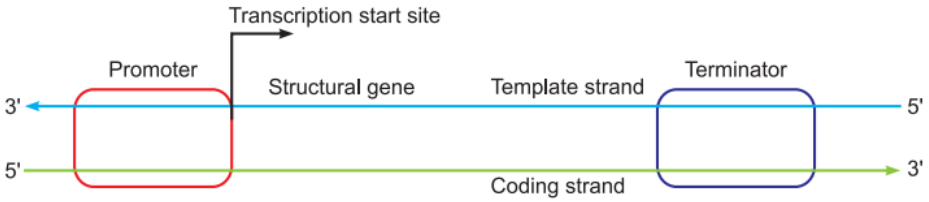
62) Give an example of a codon having dual function.
Ans. AUG acts as an initiation codon and also codes for methionine.

63) Mention how does DNA polymorphism arise in a population.
Ans. DNA polymorphism in a population arise due to presence of inheritable mutations at high frequency.

64) Suggest a technique to a researcher who needs to separate fragments of DNA.
Ans. Gel electrophoresis is used to separate DNA fragments.

65) Draw a labelled schematic structure of a transcription unit. Explain the function of each component in the unit in the process of transcription.

(i) Promoter: It is the binding site for RNA polymerase for initiation of transcription.
(ii) Structural gene: It codes for enzyme or protein for structural functions.
(iii) Terminator: It is the region where transcription ends.

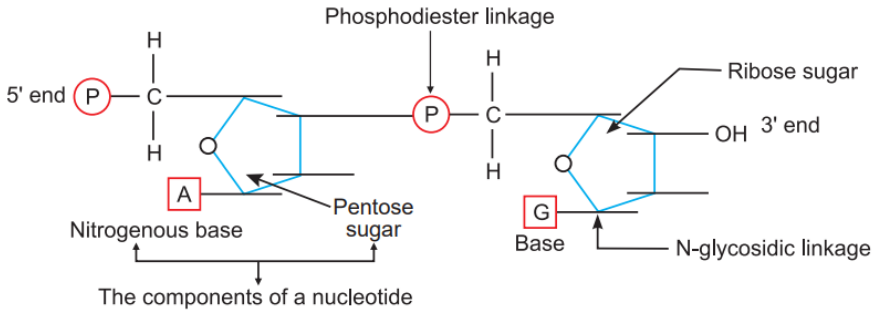


66) Mention one difference to distinguish an exon from an intron.
Ans. Exon is the coded or expressed sequence of nucleotides in mRNA. Intron is the intervening sequence of nucleotides not appearing in processed mRNA.

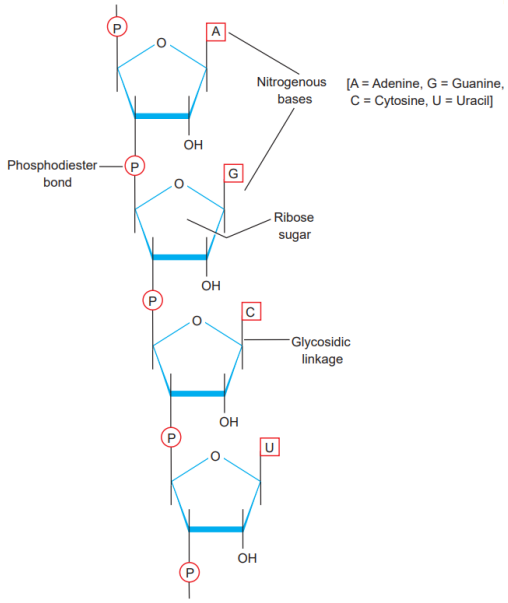
67) There is only one possible sequence of amino acids when deduced from a given nucleotide. But multiple nucleotide sequences can be deduced from a single amino acid sequence. Explain this phenomena.
Ans. Some amino acids are coded by more than one codon (known as degeneracy of codon), hence on deducing a nucleotide sequence from an amino acid sequence, multiple nucleotide sequences will be obtained.
For example, isoleucine has three codons AUU, AUC and AUA. Hence a dipeptide Met–Ile can have any of the following nucleotide sequences:

(i) AUG–AUU
(ii) AUG–AUC
(iii) AUG–AUA

68) Draw a schematic representation of dinucleotide. Label the following:
(i) The components of a nucleotide
(ii) 5′ end
(iii) N-glycosidic linkage
(iv) Phosphodiester linkage.
Ans. Nucleotide = Ribose sugar + Base + phosphate group.



69) Describe the structure of a RNA polynucleotide chain having four different types of nucleotides.



70) A DNA segment has a total of 1500 nucleotides, out of which 410 are Guanine containing nucleotides. How many pyrimidine bases this DNA segment possesses?

According to Chargaff's rule

$$\frac{A}{G} = \frac{T}{G} = 1$$

G = C, G = 410, hence C = 410

$$G + C = 410 + 410$$
$$= 820$$

So, $A + T = 1500 - 820$
$$= 680$$

A = T, so $T = \frac{680}{2} = 340$

So, Pyrimidines = C + T
$$= 410 + 340$$
$$= \mathbf{750}$$

71) List the criteria a molecule that can act as genetic material must fulfil. Which one of the criteria are best fulfilled by DNA or by RNA thus making one of them a better genetic material than the other? Explain.
Ans. A molecule that can act as a genetic material must fulfil the following criteria:

(i) It should be able to generate its replica (Replication).
(ii) It should chemically and structurally be stable.
(iii) It should provide the scope for slow changes (mutation) that are required for evolution.
(iv) It should be able to express itself in the form of 'Mendelian Characters'.
In DNA the two strands being complementary if separated by heating come together, when appropriate conditions are provided. Further, 2'-OH group present at every nucleotide in RNA is also now known to be catalytic, hence reactive. Therefore DNA chemically is less reactive

and structurally more stable when compared to RNA. Therefore, among the two nucleic acids, the DNA is a better genetic material. The presence of thymine at the place of uracil also confers additional stability to DNA.

Both DNA and RNA are able to mutate. In fact, RNA being unstable, mutate at a faster rate. RNA can directly code for the synthesis of proteins, hence can easily express the characters. DNA, however, is dependent on RNA for synthesis of proteins. The protein synthesising machinery has evolved around RNA.

72) Answer the following questions based on Meselson and Stahl's experiment:
(a) Why did the scientists use 15NH4Cl and 14NH4Cl as sources of nitrogen in the culture medium for growing E. coli?
(b) Name the molecule(s) that 15N got incorporated into.
(c) How did they distinguish between 15N labelled molecules from 14N ones?
(d) Mention the significance of taking the E. coli samples at definite time intervals for observations.
(e) Write the observations made by them from the samples taken at the end of 20 minutes and 40 minutes respectively.
(f) Write the conclusion drawn by them at the end of their experiment.

Ans. (a) 15N is the heavy isotope of nitrogen and it can be separated from 14N based on the difference in their densities.
(b) 15N was incorporated into newly synthesised DNA.
(c) The two molecules were distinguished by caesium chloride centrifugation in which these two separated into two different bands at different positions based on their densities.
(d) E. coli culture is taken at equal intervals to know the progress of the experiment as generation time of E. coli is 20 minutes.
(e) After 20 minutes the culture had an intermediate density showing a band in the middle tube and after 40 minutes, the culture had equal amounts of hybrid DNA and the light DNA showing two bands, one in the centre and one at the bottom.
(f) They concluded that DNA replicates semi-conservatively.

73) (a) What did Meselson and Stahl observe when (i) they cultured E. coli in a medium containing 15NH4Cl for a few generations and centrifuged the content? (ii) they transferred one such bacterium to the normal medium of NH4Cl and cultured for 2 generations?
(b) What did Meselson and Stahl conclude from this experiment?
(c) Which is the first genetic material? Give reasons in support of your answer.

Ans. (a) (i) Meselson and Stahl observed that in the E. coli bacterium the DNA becomes completely labelled with 15N medium after few generations. (ii) After two generations, they observed that density changed and showed equal amount of light DNA (14N) and dark hybrid DNA (15N–14N). (b) They concluded that DNA replicates semi-conservatively.
(c) RNA is the first genetic material. Reasons: (i) RNA is highly reactive and acts as a catalyst as well as a genetic material. (ii) Essential life processes such as metabolism, translation and splicing evolved around RNA. (iii) It expresses itself through proteins.

74) How do RNA, tRNA and ribosomes help in the process of translation?

Ans. mRNA provides a template with codons for specific amino acids to be linked to form a polypeptide/protein.
tRNA brings amino acid to the ribosomes reads the genetic code with the help of its anti-codons, initiator tRNA is responsible for starting polypeptide formation in the ribosomes tRNAs are specific for each amino acid. Ribosomes-(Cellular factories for proteins synthesis) its smaller sub unit binds with mRNA to initiate protein synthesis at the start codon AUG, in its larger sub unit there are two sites present which brings two amino acids close to each other helping them to form peptide bond. Ribosomes moves from codon to codon along mRNA, amino acids are added one by one to form polypeptide/protein.

75) Which methodology is used while sequencing the total DNA from a cell? Explain it in detail.

Ans. Methodologies of HGP:
For sequencing, the total DNA from cell is first isolated and broken down in relatively small sizes as fragments.
These DNA fragments are cloned in suitable host using suitable vectors. When bacteria is used as vector, they are called bacterial artificial chromosomes (BAC) and when yeast is used as vector, they are called yeast artificial chromosomes (YAC).
Frederick Sanger developed a principle according to which the fragments of DNA are sequenced by automated DNA sequences.
On the basis of overlapping regions on DNA fragments, these sequences are arranged accordingly.
For alignment of these sequences, specialised computer-based programmes were developed.
These sequences were annotated and were assigned to each chromosome. Sequence of chromosome 1 was completed only in May 2006. It was the last chromosome be sequenced).
Finally, the genetic and physical maps of the genome were constructed by collecting information about certain repetitive DNA sequences and DNA polymorphism, based on endonuclease recognition sites.

76) (i) DNA polymorphism is the basis of DNA fingerprinting technique. Explain.
(ii) Mention the causes of DNA polymorphism.

Ans. (i) Allelic sequence variation has traditionally been described as a DNA polymorphism if its frequency is greater than 0.01. Simply, if an inheritable mutation is observed in a population at high frequency, it is referred to as DNA polymorphism. DNA fingerprinting is a technique of determining nucleotide sequences of certain areas of DNA which are unique to each individual.
Although the DNA from different individuals is more alike than different, there are many regions of the human chromosomes that exhibit a great deal of diversity. Such variable sequences are termed "polymorphic" (meaning many forms)A special type of polymorphism, called VNTR (variable number of tandem repeats), is composed of repeated copies of a DNA sequence that lie adjacent to one another on the chromosome. Since polymorphism is the basis of genetic mapping of human genome, therefore it forms the basis of DNA fingerprinting too.
(ii) The probability of such variations to be observed in non-coding DNA sequences would be higher as mutations in these sequences may not have any immediate effect in an individual's reproductive ability. These mutations keep on accumulating generation after generation and form one of the basis of variability. There is a variety of different types of polymorphisms ranging from single nucleotide change to very large scale changes. For evolution and speciation, such polymorphisms play very important role. The single nucleotide polymorphisms are used in locating diseases and tracing of human history. DNA polymorphisms are due to mutations.

77) Explain the steps of DNA fingerprinting that will help in processing of the two blood samples A and B picked up from the crime scene.

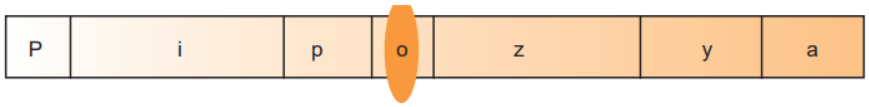
Ans. Methodology and Technique:
(i) DNA is isolated and extracted from the cell or tissue by centrifugation.
(ii) By the process of polymerase chain reaction (PCR), many copies are produced. This step is called amplification.
(iii) DNA is cut into small fragments by treating with restriction endonucleases.
(iv) DNA fragments are separated by agarose gel electrophoresis.
(v) The separated DNA fragments are visualised under ultraviolet radiation after applying suitable dye.
(vi) The DNA is transferred from electrophoresis plate to nitrocellulose or nylon membrane sheet. This is called Southern blotting.
(vii) VNTR probes are now added which bind to specific nucleotide sequences that are complementary to them. This is called hybridisation.
(viii) The hybridised DNA fragments are detected by autoradiography. They are observed as dark bands on X-ray film.
(ix) These bands being of different sizes, give a characteristic pattern for an individual DNA. It differs from individual to individual except in case of monozygotic (identical) twins.

78) (a) Absence of lactose in the culture medium affects the expression of a lac operon in E. coli. Why and how? Explain.
(b) Write any two ways in which the gene expression is regulated in eukaryotes.

Ans. (a) (i) When lactose is absent, i gene regulates and produces repressor mRNA which translate repression.
(ii) The repressor protein binds to the operator region of the operon and as a result prevents RNA polymerase to bind to the operon.
iii) The operon is switched off.
(b) Gene expression in eukaryotes is regulated at following levels:

- Transcriptional level (formation of primary transcripts)
- Processing level (regulation of splicing)
- Transport of messenger RNA from nucleus to the cytoplasm
- Translational level.

79) Observe the representation of genes involved in the lac operon given below:



(a) Identify the region where the repressor protein will attach normally.
(b) Under certain conditions repressor is unable to attach at this site. Explain.
(c) If repressor fails to attach to the said site what products will be formed by z, y and a?
(d) Analyse why this kind of regulation is called negative regulation.

Ans. (a) The repressor protein will attach to operator region, o.
(b) In presence of an inducer, lactose, repressor is unable to attach.
(c) z—β galactosidase.
y—Permease
a—Transacetylase
(d) It is called negative regulation as it involves constitutive (all the time) repressor. The operon is always in off position due to presence of repressor and is switched on only in presence of an inducer. Inducer Lactose or allolactose interacts with repressor making it inactive.

80) Where do transcription and translation occur in bacteria and eukaryotes respectively? Explain the complexities in transcription and translation in eukaryotes that are not seen in bacteria.

Ans. Transcription and translation in bacteria occur in the cytoplasm of the cell, whereas in eukaryotes, transcription occurs in the nucleus and translation occurs in the cytoplasm.
Complexities in transcription in eukaryotes
(i) The structural genes are monocistronic and split in eukaryotes.
(ii) The genes of eukaryotic organisms have coding or expressed sequences called exons that form the part of mRNA and non-coding sequences called introns, that do not form part of the mRNA and are removed during RNA splicing.
(iii) In eukaryotes, apart from the RNA polymerase found in the organelles, three types of RNA polymerases are found in the nucleus.
(iv) RNA polymerase I transcribes rRNAs (28S, 18S, and 58S).
(v) RNA polymerase II transcribes the precursor of mRNA (called as heterogeneous nuclear RNA (hnRNA).
(vi) RNA polymerase III helps in transcription of tRNA, 5S rRNA, and snRNAs (small nuclear RNAs).
(vii) The primary transcripts contain both the coding regions called exons and non-coding regions called intron in RNA and are non-functional called hnRNA.
(viii) The hnRNA undergoes two additional processes called capping and tailing.
(ix) In capping, an unusual nucleotide is added to the 5′-end of hnRNA i.e. methyl guanosine triphosphate.
(x) In tailing, about 200-300 adenylate residues are added at 3′-end in a template independent manner.
(xi) Now the hnRNA undergoes a process where the introns are removed and exons are joined to form mRNA called splicing. Translation in both eukaryotes and prokaryotes is similar.

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