Molecular Basis of Inheritance

Que 1: Differentiate between euchromatin and heterochromatin ***Marks :(3)***

Ans: In a typical nucleus, some region of chromatin are loosely packed (and stains light) and are referred to as euchromatin. The chromatin that is more densely packed and stains dark are called as Heterochromatin. Euchromatin is said to be transcriptionally active chromatin, whereas heterochromatin is inactive.

Que 2: Chromatins are lengthy molecules but then compactly arranged in Nucleus. Give a comment on this and explain the role of Histone proteins for this package ***Marks :(3)***

Ans: In eukaryotes, this organisation is much more complex. There is a set of positively charged, basic proteins called histones. A protein acquires charge depending upon the abundance of amino acids residues with charged side chains. Histones are rich in the basic amino acid residues lysines and arginine's. Both the amino acid residues carry positive charges in their side chains. Histones are organised to form a unit of eight molecules called as histone octamer. The negatively charged DNA is wrapped around the positively charged histone octamer to form a structure called nucleosome. A typical nucleosome contains 200 bp of DNA helix. Nucleosomes constitute the repeating unit of a structure in nucleus called chromatin, thread-like stained (coloured) bodies seen in nucleus. The nucleosomes in chromatin are seen as 'beads-on-string' structure when viewed under electron microscope (EM).

Que 3: The double stranded structure of DNA proposed by Watson and Crick. Make a short note on the Structure of DNA. ***Marks :(3)***

Ans: James Watson and Francis Crick, proposed a Double Helix model for the structure of DNA. One of the hallmarks of their proposition was base pairing between the two strands of polynucleotide chains. However, this proposition was also based on the observation of Erwin Chargaff that for a double stranded DNA, the ratios between Adenine and Thymine and Guanine and Cytosine are constant and equals one.

The salient features of the Double-helix structure of DNA are as follows:

(i) It is made of two polynucleotide chains, where the backbone is constituted by sugar-phosphate, and the bases project inside.

(ii) The two chains have anti-parallel polarity. It means, if one chain has the polarity 5 '....3 ', the other has 3 ' .....5 '.

(iii) The bases in two strands are paired through hydrogen bond(H-bonds) forming base pairs (bp). Adenine forms two hydrogen bonds with Thymine from opposite strand and vice-versa. Similarly, Guanine is bonded with Cytosine with three H-bonds. As a result, always a purine comes opposite to a pyrimidine. This generates approximately uniform

distance between the two strands of the helix

(iv) The two chains are coiled in a right-handed fashion. The pitch of the helix is 3.4 nm (a nanometer is one billionth of a metre, that is 10 -9 m) and there are roughly 10 bp in each turn. Consequently, the distance between a bp in a helix is approximately equal to 0.34 nm.

(v) The plane of one base pair stacks over the other in double helix. This, in addition to H-bonds, confers stability of the helical structure

Que 4: Expand the following ***Marks :(2)***

a. BAC b. YAC

Ans: a. Bacterial Artificial Chromosome

b. Yeast Artificial Chromosome

Que 5: In prokaryotes and eukaryotes structural genes are two types. Name the two types and briefly explains them. ***Marks :(2)***

Ans: The DNA sequence coding for tRNA or rRNA molecule also define a gene. However, by defining a cistron as a segment of DNA coding for a polypeptide, the structural gene in a transcription unit could be said as monoisotopic (mostly in eukaryotes) or polycistronic (mostly in bacteria or prokaryotes)

Que 6: The RNA polymerase catalysis transcription is in one direction. Give reason for it and briefly explain it ***Marks :(2)***

Ans: Since the two strands have opposite polarity and the DNA-dependent RNA polymerase also catalyse the polymerisation in only one direction, that is, 5 ' →3 ', the strand that has the polarity 3 ' →5 ' acts as a template, and is also referred to as template strand.

Que 7: In DNA replication is bidirectional way of new strand synthesis. Fill the followings

a. 5' .....3' is ..... strand

b. 3' .....5' is ..... strand ***Marks :(2)***

Ans: a. leading strand

b. lagging strand

Que 8: Number of base pairs that can be held by the Nucleosome is

(300bp, 50bp, 200bp, 100bp) ***Marks :(1)***

Ans: 200bp

Que 9: Name the scientist proposed the transforming principle ***Marks :(1)***

Ans: Frederick Griffith

Que 10: Pick out the odd one ***Marks :(1)***

(UAA, UAG, AUG, UGA)

Ans: AUG

Que 11: In RNA instead off Thymine ..... Nucleotide seen

(Adenine, Guanine, Thymine, Uracil) ***Marks :(1)***

Ans: uracil

Que 12: The process off protein synthesis in cell is named as

(Transcription, Translation, Transformation, Replication) ***Marks :(1)***

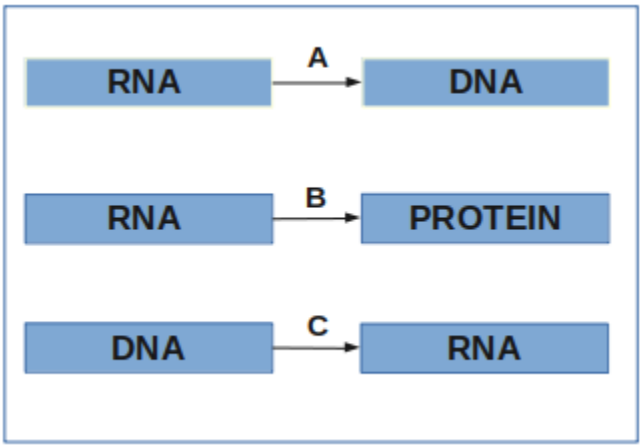
Ans: Translation

Que 13: List the salient features of genetic code. ***Marks :(3)***

Ans: The salient features of genetic code are as follows:

(i) The codon is triplet. 61 codons code for amino acids and 3 codons do not code for any amino acids, hence they function as stop codons.
(ii) One codon codes for only one amino acid, hence, it is unambiguous and specific.
(iii) Some amino acids are coded by more than one codon, hence the code is degenerate.
(iv) The codon is read in mRNA in a contiguous fashion. There are no punctuations.
(v) The code is nearly universal: for example, from bacteria to human UUU would code for Phenylalanine (phe).
(vi) AUG has dual functions. It codes for Methionine (met), and it also act as initiator codon.

Que 14:



Choose the correct answer from the brackets

(Transcription, transcription, reverse transcription) ***Marks :(3)***

Ans: A. Reverse transcription

B. Translation

Transcription

Que 15: Give full form of the following abbreviations ***Marks :(3)***

1.BAC

2.HGP

3.YAC

4.ESTs.

5.SNPs.

6.VNTR

Ans: *1.BAC -bacterial artificial chromosomes*

2.HGP-Human Genome Project

3.YAC - yeast artificial chromosomes

4.ESTs. - Expressed Sequence Tags

5.SNPs. - Single nucleotide polymorphism

6.VNTR - Variable Number of Tandem Repeats

Que 16: List out any six salient features of HGP ***Marks :(3)***

Ans: i) The human genome contains 3164.7 million nucleotide bases.
(ii) The average gene consists of 3000 bases, but sizes vary greatly, with the largest known human gene being dystrophin at 2.4 million bases.
(iii) Almost all (99.9 per cent) nucleotide bases are exactly the same in all people.
(iv) The functions are unknown for over 50 per cent of discovered genes.
(v) Less than 2 per cent of the genome codes for proteins.
(vi) Repeated sequences make up very large portion of the human genome.
(vii) Repetitive sequences are stretches of DNA sequences that are repeated many times, sometimes hundred to thousand times.
(viii) Chromosome 1 has most genes (2968), and the Y has the fewest (231).

Que 17: List out the application of HGP ***Marks :(2)***

Ans: 1.HGP enabling a radically new approach to biological research.

2.Reserchers can study all the genes in a genome, like tumor in which all the genes and proteins work together in interconnected networks to understand the chemistry of life.

Que 18: Complete the table ***Marks :(2)***

Enzyme	**Function**
DNA Ligase	**----------**
----------	**Transcription**
Restriction endonuclease	**Digestion of DNA**
DNA Polymerase	**----------**
----------	**Unwinding of DNA strand**

Ans:

Enzyme	Function
DNA Ligase	Joining DNA Fragmnts
RNA Polymerase	Transcription
Restriction endonuclease	Digestion of DNA
DNA Polymerase	Replication of DNA
Helicase	Unwinding of DNA strands

Que 19: Write the applications of DNA fingerprinting. ***Marks :(2)***

Ans: DNA Fingerprinting is a technique to find out variations in individuals of a population at DNA level.

It has immense applications in the field of forensic science, genetic biodiversity and evolutionary biology.

Que 20: Various steps of DNA fingerprinting is given below arrange them in proper order.

(i) isolation of DNA,

(ii) separation of DNA fragments by electrophoresis,

(iii) detection of hybridised DNA fragments by autoradiography.

(iv) digestion of DNA by restriction endonucleases,

(v) hybridisation using labelled VNTR probe,

(vi) transferring (blotting) of separated DNA fragments to synthetic ***Marks :(3)***

Ans: (i) isolation of DNA,

(ii) digestion of DNA by restriction endonucleases,

(iii) separation of DNA fragments by electrophoresis,

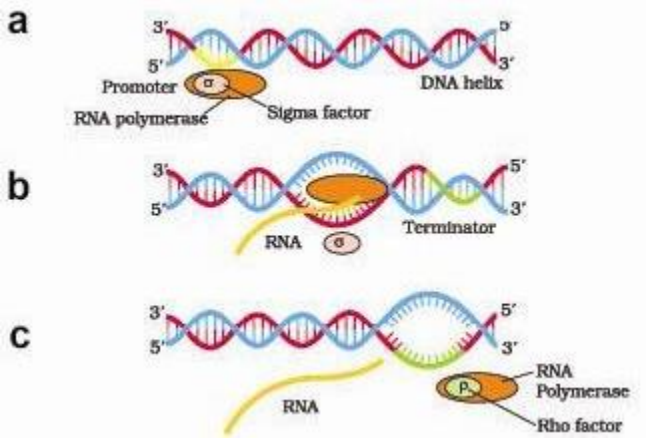
(iv) transferring (blotting) of separated DNA fragments to synthetic

membranes, such as nitrocellulose or nylon,

(v) hybridisation using labelled VNTR probe, and

(vi) detection of hybridised DNA fragments by autoradiography.

Que 21: ***Observe the diagram and give the answers Marks :(3)***



(a) Name the process.

(b) a, b and c are the steps of this process, identify them.

Ans: a) Process of Transcription in Bacteria.

b) a) Initiation

b) Elongation

c) Termination

Que 22: Mention the main three linkages present in a nucleotide of DNA? ***Marks :(3)***

Ans: Nitrogen base is linked with OH of the sugar through N-glycosidic linkage to form nucleotide

A phosphate group is linked to OH of 5^{th} carbon of a nucleotide through phospho-ester linkage

Two nucleotides are linked through $3^{'}$-$5^{'}$ phosphor diester linkage to form dinucleotide.

The nitrogen base are linked with hydrogen bond. Adenine forms two hydrogen with thymine and guanine forms three hydrogen bond with cytosine

Que 23: Describe the termination process of transcription in bacteria. ***Marks :(2)***

Ans: Termination of transcription starts when the termination region is recognised. It is a particular sequence of nucleotide where the translation stops.

In bacteria, as soon as the polymerase enzyme encounters the terminator region, the nascent RNA so formed falls off. The polymerase enzyme associates transiently with termination factor (ρ) to terminate the transcription.

Que 24: The percentage of nucleotide A in DNA isolated from human liver is observed to be 30.7%, What is the expected percentage of a)T, b)G, c)C ***Marks :(2)***

Ans: a) T = 30.7%

b) G = 19.3%

c) C = 19.3%

Que 25: Note the relation between the first two and find the missed one.

i) Operon concept: Jacob and Monad : :Central dogma:_____

ii) Polymerase I: rRNA :: RNA Polymerase II:_____

iii) Termination codon: UAG :: Initiation codon :_____ ***Marks :(3)***

Ans: i) Francis Crick.

ii) Precursor of mRNA

iii) AUG

Que 26: Genetic information is copying from one strand of DNA to RNA by an important process ***Marks :(3)***

(a) Name the process mentioned here?

(b) Which are the steps involved in this process?

Ans: a) Transcription

b) Initiation

RNA polymerase binds to promoter and initiates transcription.

Elongation

RNA polymerase uses nucleoside triphosphates as substrate and polymerises in template depended fashion following the rule of complementarity.

Termination

Once the polymerases reaches the terminator region, the nascent

RNA falls off, so also the RNA polymerase. This results in termination of transcription.

Que 27: ***Marks :(2)***

Complete the Table

HERSHEY&CHASE ----------A---------

----------B------- **Transforming Principle**

WATSON&CRICK **----------C---------**

----------D---------- **Artificial synthesis of RNA**

Ans: A) DNA is the genetic material

B) Frederick Griffith

C) Structure of DNA

D)Har Gobind Khorana

Que 28:
During transcription, one of the DNA strand act as template strand.

a. Name the opposite strand ?

b. What will happen if two of the strands are acting as template ? ***Marks :(3)***

Ans: a) Coding strand.

b), if both strands act a template, they would code for RNA molecule with different sequences if they code for proteins, the sequence of amino acids in the proteins would be different. Hence, one segment of the DNA would be coding for two different proteins, and this would complicate the genetic information transfer machinery.

The two RNA molecules if produced simultaneously would be complementary to each other, hence would form a double stranded RNA. This would prevent RNA from being translated into protein

Que 29: DNA act as a better genetic material compared to RNA. Justify your answer. ***Marks :(3)***

Ans: 1DNA chemically is less reactive and structurally more stable when compared to RNA.

2)2 ' -OH group present at every nucleotide in RNA is a reactive group and makes RNA labile and easily degradable.

4)RNA being unstable, mutate at a faster rate.

5)The presence of thymine at the place of uracil also confers additional stability to DNA.

Que 30: A strand of DNA has the sequence

3' GGTATATCCGGG AAATTC '5

a) Give the complementary DNA sequence

b) Give the mRNA sequence that would be produced from this strand and the direction of transcription. ***Marks :(2)***

Ans: a) 5'CCATATAGGCCCTTTAAG'3

b)3'GGUAUAUCCGGGAAAUUC '5

Que 31: Define the term Nucleoid. ***Marks :(2)***

Ans: In prokaryotes, DNA (being negatively charged) is held with some proteins (that have positive charges) in a region termed as ‘nucleoid’.

Que 32: List out any four salient features of DNA. ***Marks :(3)***

Ans: (i) It is made of two polynucleotide chains.

(ii) The backbone is constituted by sugar-phosphate, and the bases project inside.
(iii) The two chains have anti-parallel polarity. It means, if one
chain has the polarity 5 ' - 3 ', the other has 3 ' -5 '

(iv) Base pairing -adenine thymine with two hydrogen bonds and Guanine Cytosine with three hydrogen bonds

(v) The pitch of the double helix is 3.4 nm and roughly 10 base pairs. The distance between a base pair in a helix is 0.34 nm

(vi) The plane of one base pair stacks over the other in double helix. This, in addition to H-bonds, confers stability of the helical structure

Que 33: Explain Erwin Chargaff's observation about base pairing in DNA. ***Marks :(3)***

Ans: In a double stranted DNA the ratios between Adenine and Thymine and Guanine and Cytosine are constant and equal.

i.e A/T = G/C = 1

Que 34: Choose the number of base pairs present in the Lambda bacteriophage and E- coli

(5386, 3.3 x 10^9, 48502, 4.6 x10^6) ***Marks :(1)***

Ans:

Lambda bacteriophage - 48502

E-Coli - 4.6 x 10^6