QUESTION BANK PART II BIOLOGY

Chapter No. 20

Chromosome and DNA

Short questions:

1. What is semi-conservative replication of DNA? **(LB-2015)**

Ans: Semi-Conservative Replication:

In semi-conservative replication of DNA, two strands of the parental DNA duplex separate out, each acting as a model, along which appropriate complementary nucleotides are assembled, thus form two daughter duplexes with the same sequences. This form of DNA replication is called **semi-conservative**, because while the sequence of original duplex is conserved after one round of replication, the duplex itself is not. Instead, each strand of parental duplex becomes part of the daughter duplexes.

2. What is sickle cell anemia? **(LB-2016)**

Ans: Sickle cell anemia:

In sickle cell anemia a point mutation replaces a single **thymine** with **adenine** at position **6** from N terminal end in **hemoglobin beta chain**. It leads to the change of amino acid **glutamic acid** into **valine**. This consequently alters the tertiary structure of hemoglobin molecule reducing its ability to carry oxygen. Moreover, in this disease the red blood cells are shaped like sickles or crescent moons. These sickle cells also become rigid and sticky which can slow or block the blood flow.

3. What is transformation? **(OR)** Define transformation. In which bacterium it was discovered? **(LB-2011, 2016, 2021)**

Ans: Transformation:

It is the transfer of genetic material from one cell to another and can alter the genetic makeup of the recipient cell. The genetic material **'DNA'** which is responsible for transformation is called Transforming Principle.

Bacterium:

It was discovered in ***Streptococcus pneumoniae*** bacterium.

4. What is translation? **(LB-2014, 2015)**

Ans: Translation:

Translation is the process by which cell makes proteins using genetic information from messenger RNA (mRNA). It occurs when information contained in mRNA is used to direct the synthesis of polypeptide chain by ribosomes. This process is called **translation**, because the nucleotide sequence of the mRNA is translated into an amino acid sequence of polypeptide. It takes place in the **cytoplasm** of the cell.

5. What are mutagens? Give one example. **(LB-2018)**

Ans: Mutagens:

Mutagens are substances or agents that cause alteration in the DNA sequence. This alteration in DNA sequence is known as mutation.

Examples:

Some common examples of mutagens are:

1. **Radiation (UV rays)**
2. **Chemicals (Nitrous acid)**

6. What are the contributions of P.A. Levene for determining the structure of DNA? **(LB-2017)**

Ans: Contributions of P.A Levene:

In 1920, he determined the basic structure of nucleic acids. P.A. Levene found that DNA contains three basic components:

1. Phosphate group
2. Five carbon sugar (Deoxyribose)
3. Nitrogenous bases (A, G, C, T)

He further concluded that DNA and RNA molecules are made up of repeating units of **Nucleotides.**

7. What is phenylketonuria? **(OR)** What is alkaptonuria? **(OR)** Differentiate between alkaptonuria and phenylketonuria.

Ans:

Phenylketonuria	Alkaptonuria
It is hereditary disease in which phenylalanine is not degraded because of defective enzyme **phenylalanine hydroxylase**. Consequently, phenylalanine accumulates in the cells leading to **mental retardation**, as the brain fails to develop in infancy. This disorder is due to a point mutation.	In alkaptonuria, the patients produce urine that contain homogentisic acid. This substance oxidizes rapidly when exposed to air, turning the urine **black**. In normal individuals, homogentisic acid is broken down into simpler substances. But patients suffering from alkaptonuria lacked the enzyme necessary to catalyze this breakdown.

8. What is central dogma? **(LB-2018)**

Ans: Central Dogma:

The mechanism of reading and expressing genes is referred to as central dogma. It consists of the two main steps.

1. **Transcription:** It is the process in which mRNA is synthesized from DNA.
2. **Translation:** It is the process in which protein is synthesized by ribosomes using genetic information contained in mRNA.

9. What is genetic code? **(OR)** What are non-sense codons? **(OR)** Enlist non-sense codons and their function. **(OR)** Differentiate between genetic code and stop codon.

Ans:

	Codon or Genetic code	Non-Sense Codon
Define	**Genetic code** is a combination of three adjacent nucleotides in DNA or mRNA that code for a particular amino acid.	Out of 64 codons, three codons **UAA**, **UAG**, and **UGA** do not code for any amino acid. So, these codons are called **non-sense codons**.

Function	Each genetic code or codon, codes for a specific amino acid.	**Non-sense codons** are usually present at the end of the gene and stop the further assembly of polypeptide chain. Hence, they are also called **stop codons**.

10. Where are codon and anticodon situated? **(LB-2012, 2014, 2018)**

Ans:

	Codon	**Anticodon**
Define	A **codon** is a sequence of three nucleotide in DNA or mRNA that either codes for a particular amino acid or tells the cellular machinery to start or stop using the successive codes. A group of codons starts with the initiation codon.	While **Anticodons** are sequences of nucleotides that are complementary to codons. They are found in tRNAs and allow the tRNAs to bring the correct amino acids to bind to the exposed codon on mRNA during protein synthesis.
Situated	DNA or mRNA	tRNA

11. What is heterochromatin? **(OR)** What is euchromatin? **(OR)** Differentiate between heterochromatin and euchromatin. **(LB-2016, 2018, 2021, 2022)**

Ans:

Heterochromatin	**Euchromatin**
Highly condensed portions of the chromatin are called **heterochromatin**. Some of these portions remain permanently condensed, so that their DNA is never expressed.	The portions of the chromatin present in an open configuration and its genes can be expressed is called **Euchromatin**. It condenses during cell-division.

12. What is mutation? **(OR)** What do you mean by mutations? **(OR)** Define mutation and differentiate between chromosomal aberration and point mutation. **(LB-2010, 2013, 2017)**

Ans:

Mutations:

It is defined as a permanent change in the DNA of cell. It includes changes in nucleotide sequences, alteration of gene position, gene loss or duplication and insertion of a foreign sequence. These changes in the DNA occur either due to mistake in replication or damage to the genetic message causing mutation.

Mutations are of two types.

- Chromosomal aberrations.
- Point mutations.

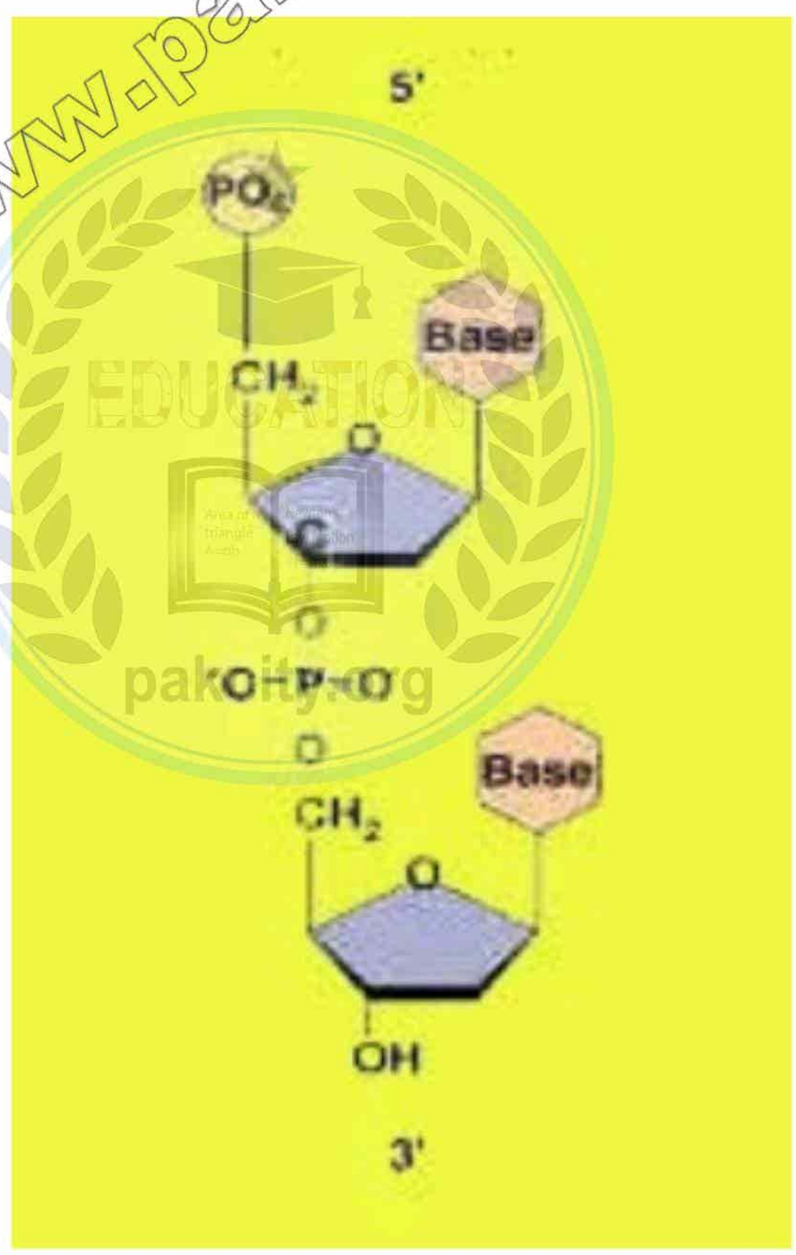
	Chromosomal aberrations	Point Mutations
Definition	These are mega changes in DNA. These may involve presence of an extra chromosome or loss of chromosome from the diploid number of chromosomes or changes like deletions, insertions, or inversions etc. in the parts of chromosomes. Such chromosomal aberrations lead to syndromes.	These are mutational changes which affect the message itself producing alterations in the sequence of DNA nucleotide. If alterations involve only one or a few base pairs in the coding sequence, they are called **point mutations.**
Examples	Down's syndrome, Turner's Syndrome etc.	Sickle cell anemia, phenylketonuria etc.

13. What is phosphodiester linkage? Draw structural formula. **(OR)** What is phosphodiester bond or linkage? **(OR)** Sketch phosphodiester linkage between two nucleotides. **(LB-2013, 2015, 2016)**

Ans: Phosphodiester Bond:

The reaction between the phosphate group of one nucleotide and the hydroxyl group of another is dehydration synthesis, eliminating a water molecule and forming a covalent bond that links the two groups. This linkage is called **phosphodiester bond** because the phosphate group is linked the two sugars by means of a pair of ester (P-O-C) bonds.

Sketch of Phosphodiester Bond:



20.11 A phosphodiester

14. Compare replication, transcription, and translation.

Ans:

	DNA Replication	Transcription	Translation
Definition	**DNA replication** is the process by which a double stranded DNA molecule is copied to produce two identical DNA molecules.	**Transcription** is the process in which an **RNA** copy of the DNA sequence encoding the gene is produced with the help of an enzyme **RNA polymerase**.	Translation is the transfer of information from mRNA to proteins. It occurs when information contained in mRNA is used to direct the synthesis of polypeptide chains by ribosomes. This process is called **translation**, because the nucleotide sequence of the mRNA is translated into an amino acid sequence of the polypeptide/protein.
Synthesize	Two molecules of DNA	mRNA	Protein

15. Define chromosomal theory of inheritance. **(LB-2010, 2014)**

Ans: Chromosomal theory of inheritance:

It was presented by **Walter Sutton** in **1902**. According to this theory, the genes are located on the chromosomes. The similar chromosomes pair with one another during meiosis. It means that one member of gene pair is located on one homologous chromosome and the other member of a gene pair is located on another homologous chromosome. The homologous chromosomes segregate during meiosis.

16. Define karyotype**. (OR)** What is karyotype? **(OR)** What do you mean by karyotype? Give its significance. **(OR)** What is karyotype? Give its application in species recognition. **(LB-2014, 2022)**

Ans: Karyotype:

The morphology of chromosomes of an organism as viewed with light microscope is called **Karyotype**.

(OR)

A particular array of chromosomes that an individual possesses is called its **Karyotype**.

Significance:

Karyotype shows **differences** among species and sometimes among the individuals of the same species.

17. Define nucleosome. **(LB-2012)**

Ans: Nucleosome:

Every 200 nucleotides, the DNA duplex is coiled around a core of eight histone proteins forming a complex known as **Nucleosome**.

18. Define nucleotide and nucleoside. **(OR)** What is nucleotide? **(OR)** Differentiate between nucleotide

and nucleoside. **(LB-2017, 2021)**

Ans:

Nucleotide	Nucleoside
Nucleotide is a single/basic unit of nucleic acids. Each nucleotide is made up of **three** components: **1)** Phosphate group **2)** Five-carbon sugar **3)** Nitrogenous base Nitrogenous base is attached to carbon number **1** of pentose sugar and phosphate is attached to the carbon number **5** of the sugar.	**Nucleoside** is a compound which consists of **two** components: **1)** Five-carbon sugar **2)** Nitrogenous base

19. Define one gene/one polypeptide hypothesis? **(LB-2017)**

Ans: One-gene /one-polypeptide:

Beadle and Tatum concluded that genes produce their effects by specifying the structure of enzymes and that each gene encodes the structure of one enzyme. They called this relationship as one gene /one enzyme hypothesis. But many enzymes contain multiple protein or polypeptide subunits, each encoded by a separate gene. Thus, the hypothesis is today more commonly referred to as '**one gene/one polypeptide'.**

20. Define point mutation. **(OR)** State point mutation with examples. **(OR)** Define point mutations. Give one example. **(OR)** What is point mutation? Give an example. **(LB-2012, 2014, 2018, 2019)**

Ans: Point Mutations:

These are mutational changes which affect the message itself, producing alterations in the sequence of DNA nucleotide. If alterations involve only one or a few base pairs in the coding sequence, they are called **point mutations**.

Example:

- Sickle cell anemia
- Phenylketonuria

21. Define transcription and how it is initiated? **(OR)** What is the function of RNA polymerase in transcription? **(LB-2010, 2013)**

Ans: Transcription:

It is the process in which an RNA copy of the DNA sequence encoding the gene is produced with the help of an enzyme RNA polymerase. Transcription proceeds from 5'- 3' direction of the template or antisense strand of DNA duplex.

22. Differentiate among conservative, semi-conservative and dispersive replication of DNA.

Ans:

Conservative Replication	Semi-Conservative Replication	Dispersive Replication
In **conservative replication,** the parental DNA double helix would remain intact (unbroken) and generate DNA	In **semi-conservative replication**, the two strands of the DNA duplex separate out, each acting as a model along which	In **dispersive model**, the parental DNA would become completely dispersed and that each strand of all daughter

copies consisting of entirely new molecules.	new nucleotides are arranged, thus giving rise to two new duplexes. In this process primary structure by separation of two strands, primary structure is conserved whereas secondary structure is disrupted.	DNA molecules is a 'mixture' or "hybrid" of parental and daughter DNA.

23. Differentiate between leading and lagging strand. **(LB-2021)**

Leading Strand	Lagging Strand
During replication of DNA, the leading strand is that which elongates towards the replication fork. It is built up simply by adding nucleotides continuously to its growing 3' end.	During replication of DNA, the lagging strand is that which elongates away from the replication fork and is synthesized discontinuously as a series of short fragments called as **Okazaki fragments**. These fragments are later connected.

24. Differentiate between sense and antisense strands of DNA. **(OR)** What is the difference between template and sense strand? **(LB-2018, 2019)**

Sense Strand	Antisense/Template Strand
The strand opposite to antisense strand is called **sense strand** or **coding strand**. It is the strand of DNA that has the same sequence as the mRNA.	Antisense is the non-coding DNA strand of a gene. A cell uses antisense DNA strand as a **template for producing messenger RNA** (mRNA) that directs the synthesis of a protein. It is also known as **template strand**.

25. Enlist different shapes of chromosome. **(LB-2012)**

Ans: Shapes of Chromosomes:

Depending upon the location of the centromere between the middle and tip of chromosomes. Chromosomes acquire different shapes at the time of anaphase during cell division.

Examples:

Types of Chromosomes	Shape
Telocentric and Acrocentric	i shaped
Sub-meta centric	j shaped.
Meta-centric	v shaped.

26. Give the length of Okazaki fragment. **(OR)** What are Okazaki fragments? **(LB-2015, 2016, 2021)**

Ans: Okazaki Fragment:

Okazaki fragment is a short fragment of DNA produced by discontinuous replication of the lagging strand elongating in the 5'- 3' direction away from the replication fork. When polymerase reaches 5'

end of the lagging strand, DNA Ligase attaches the fragment to the strand.

Length of Okazaki Fragments:

Okazaki Fragments are about **100-200** nucleotides long in eukaryotes and **1000-2000** nucleotides long in prokaryotes.

27. Give the role and kinds of tRNA. **(LB-2013)**

Ans: Role of Transfer RNA (tRNA):

Transfer RNA molecules transport amino acids to the ribosomes for use in building the polypeptides and also position each amino acid at the correct place on the elongating polypeptide chain.

Kinds of Transfer RNA (tRNA):

Human cells contain about **45** different kinds of tRNA molecules.

28. How many types of DNA polymerases are found, write down their names? **(LB-2017)**

Ans: There are three main types of DNA polymerase found in cell for replication. Following are the names:

1. DNA Polymerase I
2. DNA Polymerase II
3. DNA Polymerase III

29. Write two characteristics of DNA polymerase III. **(LB-2019)**

Ans:

- DNA polymerase III is true *E. coli* replicating enzyme.
- It is 10 times larger and far more complex in structure.
- It is a dimer and catalyzes the replication of one DNA strand.
- It moves at a rapid rate and adds some **1000 nucleotides/second** to the growing strand of DNA.
- It can add nucleotides only to a chain of nucleotides that is already paired with the parent DNA strands.

30. Why cap and tail are added to eukaryotic RNA, when it leaves from nucleus to cytoplasm? **(LB-2019)**

Ans: The **'7 methyl GTP' cap** and **poly A tail** are added to eukaryotic RNA because these two save the mRNA from variety of nucleases and phosphates that can cleave (break) the mRNA.

31. Define promoter and what is its role. **(OR)** Describe promoter area in transcription. **(LB-2019, 2022)**

Ans: Promoter:

It is a particular binding site located upstream of the gene.

32. Draw structural formula of nucleotide. **(LB-2021)**

Ans:

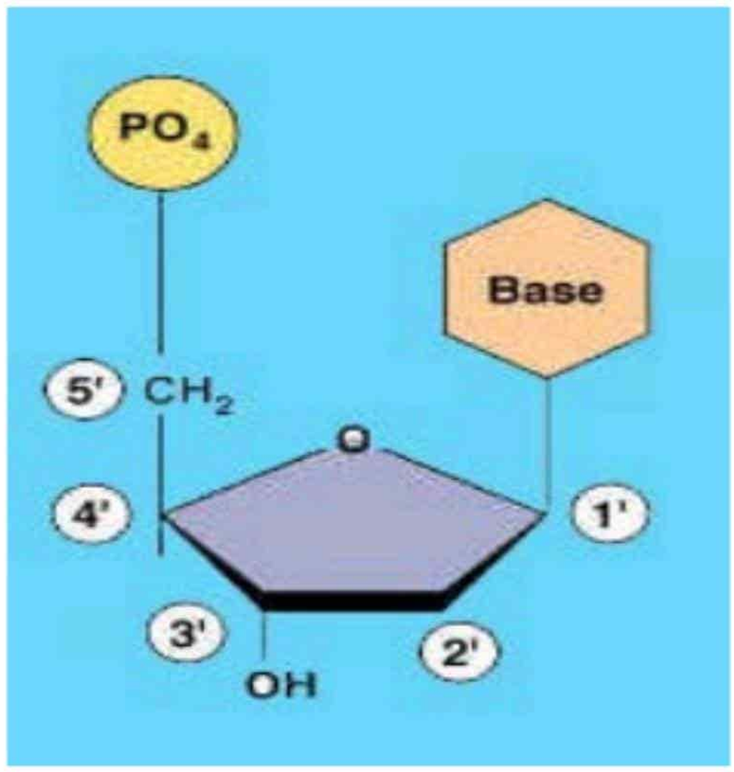


Fig 20.10 Numbering the carbon atoms in a ncleoties

33. Why does every genetic code consist of three nucleotides? **(LB-2022)**

Ans: There are **three nucleotides** in a codon because of the following reasons:

- A two-nucleotide codon would **not** yield enough combinations to code for the **20 different amino acids** that commonly occur in proteins.
- With **four** DNA nucleotides (A, C, G and T) only 42 or **16 different pairs** of nucleotides could be formed.

Therefore, nucleotides are arranged in the combinations of **three,** that yield **43 or 64 different codons,** which are more than enough to code for the 20 amino acids.

34. What do you know about the minimal medium used by Beadle and Tatum? **(LB-2022)**

Ans: Beadle and Tatum used a **minimal medium** that contained **only sugar, ammonia, salts, a few vitamins,** and **water.**

35. Give the composition of chromosomes. **(LB-2022)**

Ans: Chromosomes are composed of

- **40% DNA**
- **60% Protein**
- **A significant amount of RNA** which is associated with chromosomes. These are the sites of RNA synthesis