4. MOLECULAR BASIS OF INHERITANCE

Single Page Simple Synopsis

The **molecular basis of inheritance** is the mechanism by which genetic information is stored, replicated, passed and expressed in living organisms. This process is governed primarily by Deoxyribonucleic acid (DNA), which acts as the blueprint for life and dictates the structure and function of every cell.

FOUR CORE CONCEPTS:

1. **DNA:** DNA is a double-helix polymer consisting of two anti-parallel polynucleotide strands. Each nucleotide is composed of three parts:

   (i) Deoxyribose sugar (ii) Phosphate group

   (iii) Nitrogenous base: Adenine (A), Thymine (T), Guanine (G), or Cytosine (C).

   The two strands are connected by weak hydrogen bonds between complementary bases.

   - **DNA Replication:**

     Replication is semi-conservative, meaning each new DNA molecule consists of one original parental strand and one newly synthesized strand. Enzymes like DNA polymerase work to unzip the double helix and add complementary nucleotides to each exposed strand.

2. **RNA (Ribonucleic Acid):** Functions as a messenger, adapter, and structural molecule in the cell, and serves as the genetic material in some viruses.

3. **The Central Dogma**

   Coined by Francis Crick, the Central Dogma describes the unidirectional flow of genetic information in a cell: $\text{DNA} \xrightarrow{\text{Transcription}} \text{RNA} \xrightarrow{\text{Transcription}} \text{Proteins}$

   - **Transcription:** The process in the cell nucleus where a specific segment of DNA (a gene) is copied into messenger RNA (mRNA).
   - **Translation:** The process of decoding the mRNA sequence to build proteins, which is facilitated by ribosomes and tRNA.

4. **The Genetic Code:**

   The information in mRNA is read in sets of three nucleotides, known as codons.

   Each codon dictates a specific amino acid. The genetic code is universal (almost all organisms use the same codons for the same amino acids), non-overlapping, and degenerate

FRUIT POINTS

1. **DNA (deoxyribonucleic acid)** was confirmed to be the genetic material for most organisms after a century of investigation.
2. The specific **sequence of bases in DNA** is what determines the genetic information of an organism.
3. The **Human Genome Project (HGP)** was launched in 1990 to identify the complete DNA sequence of the human genome.
4. The human genome is estimated to contain approximately **3 billion (3×10^9) base pairs**.
5. HGP was closely linked to the development of a new area in biology called **Bioinformatics**.
6. One primary goal was identifying all of the approximately **20,000-25,000 genes** in human DNA.
7. The HGP was a **13-year project** coordinated by the U.S. and completed in 2003.
8. **Expressed Sequence Tags (ESTs)** was a methodology that focused on identifying all genes expressed as RNA.
9. **Sequence Annotation** involved sequencing the entire genome (coding and non-coding) and assigning functions later.
10. Vectors used included **Bacterial Artificial Chromosomes (BAC)** and **Yeast Artificial Chromosomes (YAC)**.
11. **Computer-based programs** were essential for aligning the massive number of sequenced fragments.
12. **Chromosome 1** was the last to be sequenced, with its completion occurring in May 2006.
13. Genetic and physical maps were created using information on **restriction endonuclease site polymorphism**.
14. **Microsatellites**, which are repetitive DNA sequences, were also used for mapping the genome.
15. The **average human gene** contains 3000 bases, though sizes vary significantly.
16. **Dystrophin** is identified as the largest known human gene, spanning 2.4 million bases.
17. **Less than 2 per cent** of the human genome actually codes for proteins.
18. **Chromosome 1** has the most genes (2968), while the **Y chromosome** has the fewest (231).
19. **Single Nucleotide Polymorphisms (SNPs)** occur at 1.4 million locations in the human genome.

20. **DNA fingerprinting** is a rapid method developed to compare DNA sequences between individuals.
21. Fingerprinting focuses on identifying differences in specific regions called **repetitive DNA**.
22. **Density gradient centrifugation** is used to separate repetitive DNA from bulk genomic DNA.
23. DNA fingerprinting is a powerful tool for **forensic identification** and paternity testing.
24. **DNA polymorphism** refers to variation at the genetic level resulting from mutations.
25. **Alec Jeffreys** developed the technique using **Variable Number of Tandem Repeats (VNTR)** as a probe.
26. A human female with Turner's syndrome has **45 chromosomes with XO**. **[NEET-2014]**
27. The term 'linkage' was coined by **T.H.Morgan** **[NEET-2015]**
28. A pleiotropic gene **controls multiple traits in an individual**. **[NEET-2015]**
29. Multiple alleles are present **at the same locus of the chromosome**. **[NEET-2015]**
30. Alleles are **different molecular forms of a gene**. **[NEET-2015]**
31. A **disease** caused by an autosomal primary non-disjunction is **Down's syndrome**.**[NEET-2017]**
32. **ESTs (Expressed Sequence Tags)** refers to **genes expressed as RNA.** **[NEET-2019]**
33. **Variations** caused by **mutation** as proposed by Hugo de Vries are **random and directionless** **[NEET-2019]**
34. **The genetic disorder** in which an individual has an overall masculine development gynaecomastia and is sterlie is **Klinefelter's syndrome.** **[NEET-2019]**
35. Experimental verification of the chromosomal theory of inheritance was done by **Morgan**. **[NEET-2020]**
36. The **XO -type** of sex determination can be found in grasshoppers. **[NEET-2022]**
37. Broad palm with single palm crease is visible in a person suffering from Down's syndrome. **[NEET-2023]**