

3. MOLECULAR BASIS OF INHERITANCE

Single Page Simple Synopsis

Molecular basis of inheritance is the mechanism by which genetic information is stored, replicated, 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. The Structure of 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 : A=T, G=C

2. 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.

3. The Central Dogma:

Genetic information flows in one primary direction from **DNA to RNA to Protein**.

Transcription: The process in the cell nucleus where a specific segment of DNA (a gene) is copied into messenger RNA (mRNA).

Translation: The process in the cytoplasm where ribosomes decode the mRNA sequence to build a specific chain of amino acids, forming a functional protein.

4. Gene Expression & 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 non-overlapping, and degenerate.

ROOT POINTS

1. **DNA (deoxyribonucleic acid)** is the genetic material for the majority of organisms.
2. DNA is a **long polymer of deoxyribonucleotides**, and its length is defined by the number of nucleotides or base pairs.
3. A **nucleotide** consists of three components: a nitrogenous base, a pentose sugar, and a phosphate group.
4. Nitrogenous bases are categorized as **Purines (Adenine, Guanine)** and **Pyrimidines (Cytosine, Thymine, Uracil)**.
5. Nucleotides link through **3'-5' phosphodiester linkages** to form a polynucleotide chain.
6. **RNA** differs from DNA by having an additional **2'-OH group** on its ribose sugar.
7. In 1953, **Watson and Crick** proposed the **Double Helix model** of DNA based on X-ray diffraction data.
8. **Chargaff's rule** states that for double-stranded DNA, the ratios of A:T and G:C are constant and equal to one.
9. The two chains of the double helix have **anti-parallel polarity** (one 5'→3', the other 3'→5').
10. **Chromatin** consists of repeating nucleosome units, appearing as '**beads-on-string**' under an electron microscope.
11. **Euchromatin** is loosely packed and transcriptionally active, while **Heterochromatin** is densely packed and inactive.
12. **Frederick Griffith (1928)** discovered the **Transforming Principle** using *Streptococcus pneumoniae*.
13. **Avery, MacLeod, and McCarty** proved that **DNA alone** was the biochemical responsible for this transformation.
14. Genetic material must fulfill four criteria: **replication, stability, mutability, and expression of characters**.
15. **DNA is chemically more stable** than RNA because it lacks the reactive 2'-OH group.
16. The **RNA World** theory suggests RNA was the first genetic material and essential life processes evolved around it.
17. **DNA ligase** joins the discontinuously synthesized fragments.
18. A **transcription unit** includes a **Promoter, a Structural gene, and a Terminator**.
19. **Exons** are coding sequences that appear in mature RNA; **introns** are non-coding and are removed during **splicing**.

20. The **Genetic Code** is a **triplet** system; 61 codons code for 20 amino acids, while 3 are stop codons.
21. The code is **degenerate** (one amino acid coded by multiple codons) and **nearly universal**.
22. **Frameshift mutations** occur when the insertion or deletion of bases changes the reading frame of the genetic code.
23. The **Lac Operon** is a regulated system in bacteria where genes for **lactose metabolism** are switched on by the inducer, lactose.
24. The movement of a gene from one linkage group to another is called **translocation**. [NEET-2015]
25. The equivalent of a structural gene is **cistron**. [NEET-2016]
26. A complex of ribosomes attached to a single strand of RNA is known as **polysome**. [2016]
27. **AUG** is the starter codon. [NEET-2016]
28. Spliceosomes are not found in cells of **bacteria**. [NEET-2017]
29. The association of histone H with a nucleosome indicates that **the DNA is condensed into a chromatin fibre**. [NEET-2017]
30. The final proof for DNA as the genetic material came from the experiments of **Hershey and Chase**. [NEET-2017]
31. The first phase of translation is **aminacylation of tRNA**. [NEET-2020]
32. Transposons can be used in **Gene silencing**. [NEET-2022]
33. DNA polymorphism forms the basis of the **both genetic mapping & DNA finger printing**. [NEET-2022]
34. The role of RNA polymerase III in the process of transcription in Eukaryotes in **Transcription of TrNA , 5 sr RNA & sn RNA** [NEET-2023]
35. The salient features of genetic code are **code is unambiguous, specific & is nearly universal**. [NEET-2023]
36. **Lactose** acts as an inducer for lacoperon. [NEET-2023]
37. **Chromosome I** is the last chromosome sequenced in Human Genome Project. [NEET-2023]
38. The lactose present in the growth medium of bacteria is transported to the cell by the action of **Permease**. [NEET-2024]
39. The **rho (ρ) factor** is important for the termination of transcription. [NEET-2025]