CLASS 12 BIOLOGY
MOLECULAR BASIS OF INHERITANCE

CBSE / NCERT-Oriented Study Material

1. DNA — The Genetic Material

- DNA = Deoxyribonucleic Acid. It stores hereditary information in most organisms.
- DNA has two polynucleotide chains forming a double helix. The strands are antiparallel: one runs 5′→3′ and the other 3′→5′.
- Purines: Adenine (A), Guanine (G). Pyrimidines: Cytosine (C), Thymine (T).
- A pairs with T by 2 hydrogen bonds; G pairs with C by 3 hydrogen bonds.
- Watson and Crick proposed the double-helix model in 1953.

2. Nucleotide and Nucleoside

- Nucleoside = sugar + nitrogenous base.
- Nucleotide = sugar + nitrogenous base + phosphate.

3. Chargaff's Rule

- In double-stranded DNA: A = T and G = C. Therefore A + G = T + C, so purines = pyrimidines.
- Example: If A = 30%, T = 30%, G = 20% and C = 20%.

4. DNA Packaging

- In prokaryotes, DNA forms a nucleoid. In eukaryotes, DNA is associated with histone proteins.
- DNA wrapped around a histone octamer forms a nucleosome, the basic unit of chromatin.

5. Griffith's Transformation Experiment

- Griffith used Streptococcus pneumoniae. S strain is smooth and virulent; R strain is rough and non-virulent.
- Live R + heat-killed S produced live S bacteria. He proposed a transforming principle.

6. Avery, MacLeod and McCarty

- They showed that DNA was the transforming principle. Protease and RNase did not stop transformation, but DNase did.

7. Hershey and Chase Experiment

- They used bacteriophage T2 and E. coli. DNA was labelled with 32P and protein with 35S.
- 32P entered bacterial cells while 35S largely remained outside. Conclusion: DNA is the genetic material.

8. RNA as Genetic Material

- In some viruses, RNA is the genetic material. DNA is generally more stable because of its double-stranded structure, deoxyribose and thymine.

9. DNA Replication

- DNA replication is semiconservative: each daughter DNA molecule contains one parental strand and one newly synthesized strand.
- DNA polymerase synthesizes DNA in the 5′→3′ direction.

10. Meselson–Stahl Experiment

- 15N was used as heavy nitrogen and 14N as light nitrogen. After transfer from 15N to 14N medium, the first generation showed hybrid DNA and the second generation showed hybrid plus light DNA.
- Conclusion: DNA replication is semiconservative.

11. Enzymes in DNA Replication

- Helicase: unwinds DNA. Primase: makes RNA primer. DNA polymerase: adds nucleotides. DNA ligase: joins fragments. Topoisomerase: relieves tension during unwinding.
- Leading strand is synthesized continuously. Lagging strand is synthesized discontinuously as Okazaki fragments, which are joined by ligase.

12. Central Dogma

- DNA → RNA → Protein.
- Replication: DNA → DNA. Transcription: DNA → RNA. Translation: RNA → protein.

13. Transcription

- Transcription is synthesis of RNA using DNA as a template.
- Major RNAs: mRNA carries the message; tRNA brings amino acids; rRNA forms a major part of ribosomes.
- Transcription unit: promoter → structural gene → terminator. RNA polymerase binds the promoter.

14. Eukaryotic RNA Processing

- hnRNA undergoes capping, tailing and splicing.
- Capping: modified guanine at 5′ end. Tailing: poly-A tail at 3′ end. Splicing: introns are removed and exons are joined.
- Memory: CTS = Capping, Tailing, Splicing.

15. Genetic Code

- The genetic code is triplet, degenerate, unambiguous, nearly universal and non-overlapping.
- Start codon: AUG (methionine). Stop codons: UAA, UAG and UGA.

16. Translation

- Translation forms a polypeptide from mRNA. Main stages: initiation, elongation and termination.
- Ribosomes are the site of protein synthesis. tRNA acts as an adapter between codon and amino acid.

17. Lac Operon

- Jacob and Monod explained gene regulation in bacteria using the lac operon.
- Components: regulatory gene (i), promoter (P), operator (O), and structural genes z, y and a.
- Without lactose: repressor binds the operator and structural genes remain OFF.

- With lactose/allolactose: the inducer inactivates the repressor, allowing transcription of structural genes.
- z: β-galactosidase; y: permease; a: transacetylase.

18. Human Genome Project

- Started in 1990 and completed in 2003.
- Objectives included identifying human genes, determining DNA sequence, storing information in databases, developing analysis tools and understanding genetic variation.
- Human genome contains approximately 3.2 billion nucleotide bases.

19. DNA Fingerprinting

- Developed by Sir Alec Jeffreys. It is based on variation in repetitive DNA sequences such as VNTRs (Variable Number Tandem Repeats).
- Applications: forensic identification, biological relationship testing and identification of individuals.

20. High-Yield Facts

- DNA structure — Watson & Crick (1953)
- Transformation — Griffith
- Transforming principle — Avery, MacLeod & McCarty
- DNA genetic material — Hershey & Chase
- Semiconservative replication — Meselson & Stahl
- Central dogma — Francis Crick
- Lac operon — Jacob & Monod
- DNA fingerprinting — Alec Jeffreys
- Okazaki fragments — lagging strand
- DNA ligase — joins DNA fragments

21. Exam-Focused Questions

- 1. Explain the Hershey and Chase experiment.
- 2. Explain the Meselson-Stahl experiment.
- 3. Describe the Watson-Crick model of DNA.
- 4. Explain DNA replication and distinguish leading and lagging strands.
- 5. Explain transcription and RNA processing in eukaryotes.
- 6. Describe the properties of genetic code.
- 7. Explain translation.
- 8. Explain the lac operon with a labelled diagram.
- 9. Describe the major objectives and findings of the Human Genome Project.
- 10. Explain the principle and applications of DNA fingerprinting.

22. One-Minute Revision

- Replication = Copy DNA
- Transcription = Make RNA
- Translation = Make Protein
- A = T (2 H-bonds); G ≡ C (3 H-bonds)
- Leading = continuous; Lagging = discontinuous
- mRNA = message; tRNA = amino acid carrier; rRNA = ribosome component
- Start = AUG; Stop = UAA, UAG, UGA.

Submitted by
Seeniamol M V
Pgt Biology
PM Shri KV Mysuru