Molecular biology

- DNA is the genetic material –
- DNA replication is semiconvervative – Matthew Meselson and Franklin Stahl.

Properties of Genetic Material

1. It should be capable of storing genetic information.
2. It should be capable of replicating with high efficiency in successive generations.
3. It should form the basis for the transmission of hereditary characters that it controls.
4. It should be involved in gene action, which results in the ultimate expression of the characteristics within the organism.
5. It should be able to undergo a mutation that creates variation among organisms.
6. It must show a very wide diversity in form.

Classification

- RNA viruses can be further classified according to the sense or polarity of their RNA into:

1. positive-sense RNA viruses
2. negative-sense RNA viruses
3. ambisense RNA viruses

EVIDENCE IN FAVOUR OF RNA AS GENETIC MATERIAL

- The first evidence that RNA also has the capacity to carry genetic information came from experiments conducted with tobacco mosaic virus (TMV).
- This virus does not contain any DNA, and is composed of RNA (6%) surrounded by a hollow cylinder of protein subunits.

Experiments with tobacco mosaic virus (TMV)

- A Gierer and G Schramm (1956) showed that tobacco plants could be infected by inoculation with the RNA alone.
- When inoculated tobacco plants with Purified RNA isolated from TMV - Lesions appeared on leaves of healthy plant.

Retroviruses

- Retroviruses are a family of RNA-containing viruses that replicate through a DNA intermediate.
- An important member of the retrovirus family is the *Human immunodeficiency virus* (HIV).
- The retrovirus replication process is accomplished through the use of reverse transcriptase, an enzyme discovered in 1970 by Temin and Mizutani.

Chromosome

- A chromosome is a long DNA molecule with part or all of the genetic material of an organism.
- Most eukaryotic chromosomes include packaging proteins called histones which, aided by chaperone proteins, bind to and condense the DNA molecule to maintain its integrity.
- These chromosomes display a complex three-dimensional structure, which plays a significant role in transcriptional regulation.

Order of DNA packaging

There are various order of packaging:

1. First order of packaging – Nucleosome
2. Second order of packaging – Solenoid fibre
3. Third order of packaging – Scaffold loop Chromatids

Heterochromatin and Euchromatin

- The compaction level of interphase chromosomes is not uniform. This results in:

1. **Euchromatin**
   a. Less condensed regions of chromosomes
   b. Transcriptionally active
   c. Regions where 30 nm fiber forms radial loop domains

2. **Heterochromatin**
   a. Tightly compacted regions of chromosomes
   b. Transcriptionally inactive (in general)
   c. Radial loop domains compacted even further

Transcription

- Transcription is a cellular process in which ribonucleic acid (RNA) is synthesized from DNA as a template.
- Importance – the genetic information can be transferred from DNA to RNA.

GENETIC CODE

- The three nucleotide (triplet) base sequences in mRNA that act as code words for amino acids in protein constitute the genetic code or simply codons.
- Four bases produce 64 different combinations (4^3) of three base codons.
- Sixty one codons code for the 20 amino acids found in protein.
- The three codons UAA, UAG and UGA do not code for amino acids.
- They act as stop signals in protein synthesis.
- These three codons are collectively known as termination codons or non-sense codons.
- The codons UAG, UAA and UGA are often referred to, respectively, as amber, ochre and opal codons.
- The codons AUG - and, sometimes, GUG - are the chain initiating codons.

PROTEIN BIOSYNTHESIS

1. Requirement of the components
2. Activation of amino acids
3. Protein synthesis proper
4. Chaperones and protein folding
5. Post-translational modifications

MITOCHONDRIAL GENOME

- This genome consists of a circular chromosome, 16.5 kb in size that is located inside the mitochondrial organelle, not in the nucleus.
- Most cells contain at least 1000 mtDNA molecules distributed among hundreds of individual mitochondria.
- Not all the RNA and protein synthesized in a cell are encoded in the DNA of the nucleus.
- mtDNA contains 37 genes, and encodes 2 types of rRNA and 22 tRNAs.
- Genes encode 13 proteins that are subunits of enzymes of oxidative phosphorylation.
- The remaining 74 polypeptides of the oxidative phosphorylation complex are encoded by the nuclear genome.
- Contains only exons, no introns.
- High mutation rate especially in D-loop.
- No crossing over.

Chloroplast DNA

- Chloroplast DNA is called as ct DNA, cP DNA or plastome.
- Genome size is 120 – 170 kb.
- Inside the chloroplast, all CpDNA molecules are combined and exist as a large ring.
- Though cpDNA occurs as a single chromosome, it exists as multiple copies.
- Each chloroplast with several nucleoid regions containing 8 – 10 rings of DNA molecules.
- Number of DNA copies in mature chloroplast is 15 – 20.
- Chloroplast genome includes 100 genes, 46-90 protein coding genes that code for 4 rRNA, 21 ribosomal proteins, 4 RNA polymerase subunits and over 30 tRNA genes.
- They are generally AT rich and lack introns.

RNA silencing

- RNA silencing or RNA interference refers to a family of gene silencing effects by which gene expression is negatively regulated by non-coding RNAs such as **microRNAs**.