Molecular Biology

- Molecular Biology is a branch of biological science that aims to understand and explain the biological processes in terms of molecular interaction.
- Molecular biology is primarily focused on nucleic acids like DNA and RNA, their structure, composition, expression, and interactions among themselves.
- Molecular biology is slowly becoming an important area of research with the discovery that nucleic acids and other biomolecules play a vital role in the normal functioning of the body.
- Molecular biology developed as a separate discipline from other branches like biochemistry, genetics, and biophysics.
- Over the years, many techniques have been developed in molecular biology; however, researchers tend to use methods and techniques native to genetics.
- Common techniques used in molecular biology include X-ray diffraction and electron microscopy for the determination of the three-dimensional structure of nucleic acids.
- The discipline focuses on the molecular mechanism of genetic processes so that genes can be used for genetic engineering to isolate, modify, and sequence genes.
- Initial studies in molecular biology were involved in the determination of three-dimensional structures of proteins in order to understand their structure and mechanism of action and expression.
- Initial studies in molecular biology were based on the rapid growth and readily manipulable genetics of simple bacteria, such as *E. coli*, and their viruses.
- More recently, not only the fundamental principles but also many of the experimental approaches first developed in prokaryotes have been successfully applied to eukaryotic cells.
- Current advances in recombinant DNA technology have made even the determination of the complete sequence of the human genome a feasible project.
- Complete genome sequencing of various living beings, including humans, has been done with modern approaches like DNA sequencing techniques and PCR.
- Studies of molecular biology have also been applied in clinical research and medical therapies, both of which are covered under gene therapy.
- Molecular biology also plays a vital role in studies related to regulations of various parts of a cell, which can then be used to target new drugs and diagnose diseases efficiently.

Central Dogma- Replication, Transcription, Translation

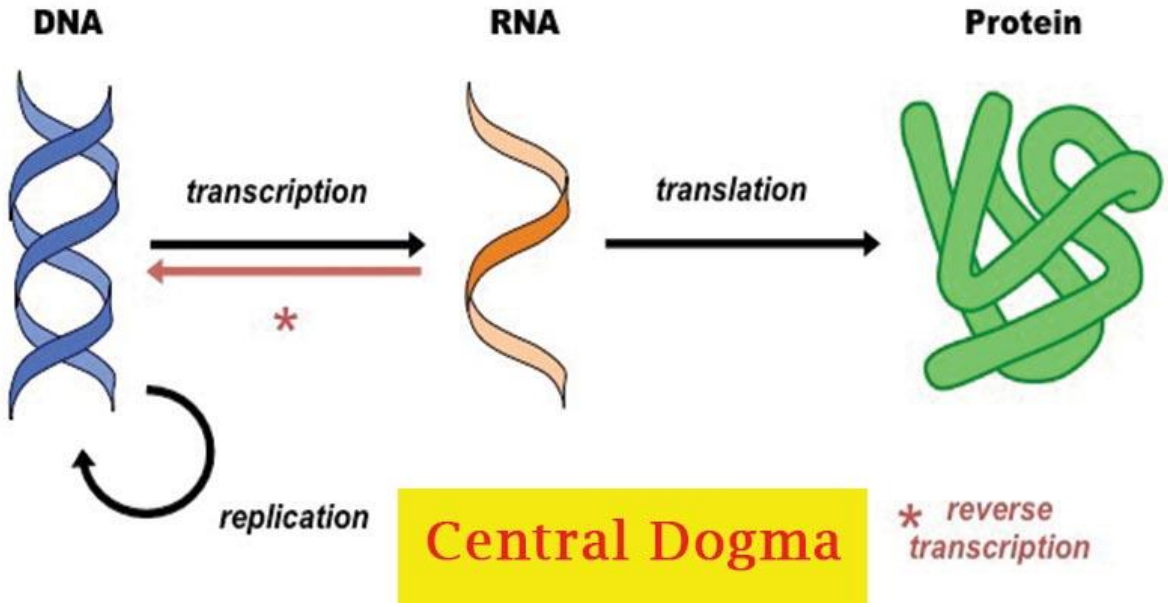
- **DNA** contains the complete genetic information that defines the structure and function of an organism.
- Proteins are formed using the **genetic code** of the DNA.
- Conversion of DNA encoded information to **RNA** is essential to form **proteins**.
- Thus, within most cells, the genetic information flows from – DNA to RNA to protein.
- The flow of information is followed through three different processes which are responsible for the inheritance of genetic information and for its conversion from one form to another:

- **Replication:** a double stranded nucleic acid is duplicated to give identical copies. This process perpetuates the genetic information.

- **Transcription:** a DNA segment that constitutes a gene is read and transcribed into a single stranded sequence of RNA. The RNA moves from the nucleus into the cytoplasm.

3. **Translation:** the RNA sequence is translated into a sequence of amino acids as the protein is formed. During translation, the ribosome reads three bases (a codon) at a time from the RNA and translates them into one **amino acid**.

- This flow of information is unidirectional and irreversible.



- In the bigger picture, the central dogma of molecular biology is an explanation of the flow of genetic information within a biological system.
- It was first stated by Francis Crick in 1958, as
- "Once 'information' has passed into protein it cannot get out again. In more detail, the transfer of information from nucleic acid to nucleic acid or from nucleic acid to protein may be possible, but transfer from protein to protein, or from protein to nucleic acid is impossible."

The Dogmas

- The dogma is a framework for understanding the transfer of sequence information between information-carrying biopolymers, DNA and RNA (both nucleic acids), and protein.

- There is 3×3=9 conceivable direct transfers of information that can occur between these.
- The dogma classes these into 3 groups of 3:

A. Three general transfers

- It describes the normal flow of biological information: DNA can be copied to DNA (DNA replication), DNA information can be copied into mRNA (transcription), and proteins can be synthesized using the information in mRNA as a template (translation).
- It is believed to occur normally in most cells.

B. Three special transfers

- The special transfers describe: RNA being copied from RNA (RNA replication), DNA being synthesised using an RNA template (reverse transcription), and proteins being synthesised directly from a DNA template without the use of mRNA.
- Temin (1970) reported the existence of an enzyme "RNA dependent DNA polymerase" (inverse transcriptase) which could synthesize DNA from a single stranded RNA template.
- Baltimore (1970) also reported the activity of this enzyme in certain RNA tumour viruses.
- This exciting finding in molecular biology gave rise to the concept of **central dogma reverse**" or teminism, suggesting that the sequence of information flow is not necessarily from DNA to RNA to protein but can also take place from RNA to DNA.
- It is known to occur, but only under specific conditions in case of some viruses or in a laboratory.

C. Three unknown transfers

- The unknown transfers describe: a protein being copied from a protein, synthesis of RNA using the primary structure of a protein as a template, and DNA synthesis using the primary structure of a protein as a template
- These are not thought to naturally occur.

Significance of the Central Dogma of Molecular Biology

- Thus, the central dogma provides the basic framework for how genetic information flows from a DNA sequence to a protein product inside cells and thus give an insight to the important processes going on inside the cells.