Review

***Molecular Biology** is the field of biology that studies the composition, structure and interactions of cellular molecules – such as nucleic acids and proteins – that carry out the biological processes essential for the cell's functions and maintenance.

***Nucleic acid** is an important class of macromolecules found in all cells and viruses. The functions of nucleic acids have to do with the **storage and expression of genetic information.**

*There are two types of nucleic acids, deoxyribonucleic acid (DNA) and ribonucleic acid (RNA).

* Nucleic acids are the polymers of nucleotides(built up by the monomeric units called **nucleotides** - polynucleotides).

*Nucleotide essentially consists of **base**, **sugar** and **phosphate**. The term nucleoside refers to **base + sugar**. Thus, nucleotide is **nucleoside + phosphate.**

*The nitrogenous bases found in nucleotides are aromatic heterocyclic compounds. The bases are of two types **purines** **(**Adenine and Guanine) and **pyrimidine's(**Thymine , Cytosine and Uracil) **.**

- ADENINE pairs with THYMINE (A::T) with two hydrogen bonds
- GUANINE pairs with CYTOSINE (G::C) with three hydrogen bondsThe Structure of DNA

• DNA is composed of four nucleotides, each containing: adenine, cytosine, thymine, or guanine.

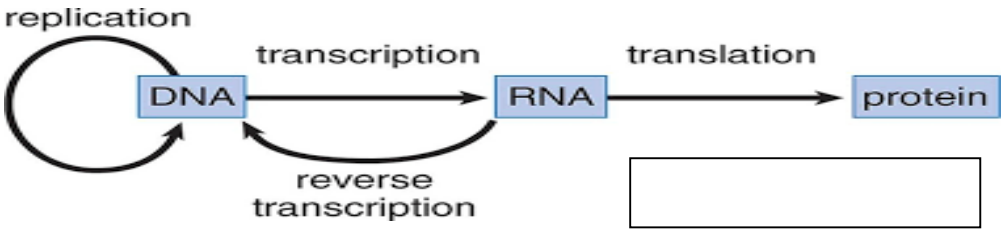
• The amounts of A = T, G = C, and purines = pyrimidine [Chargaff's Rule].

• DNA is a double-stranded helix with antiparallel strands [Watson and Crick].

• Nucleotides in each strand are linked by 5'-3' phosphodiester bonds.

• Bases on opposite strands are linked by hydrogen bonding: A with T, and G with C.

*The interrelationship of these three classes of biomolecules (DNA, RNA and proteins) constitutes the central dogma of molecular biology or more commonly the central dogma of life.



DNA Replication

• DNA replication, the basis for biological inheritance, is a fundamental process occurring in all living organisms to copy their DNA.

• In the process of "replication" each strand of the original double-stranded DNA molecule serves as template for the reproduction of the complementary strand.

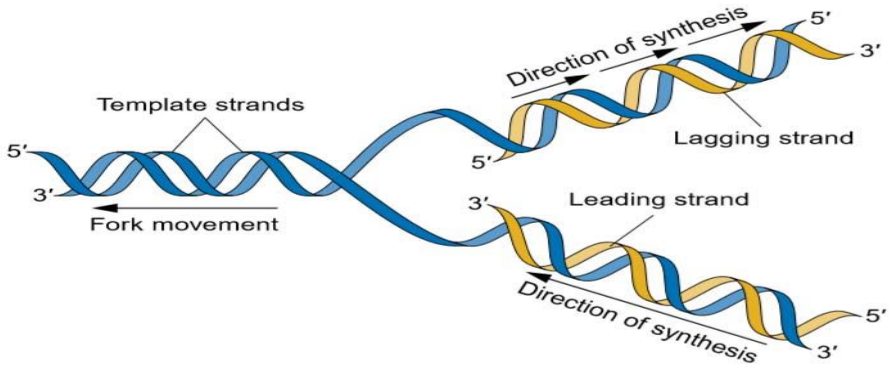
• Two identical DNA molecules have been produced from a single double-stranded DNA molecule.

• In a cell, DNA replication begins at specific locations in the genome, called "origins".

* A eukaryotic chromosome may have hundreds or even thousands of replication origins

• Unwinding of DNA at the origin, and synthesis of new strands, forms a replication fork.

• In addition to DNA polymerase, the enzyme that synthesizes the new DNA by adding nucleotides matched to the template strand, a number of other proteins are associated with the fork and assist in the initiation and continuation of DNA synthesis.



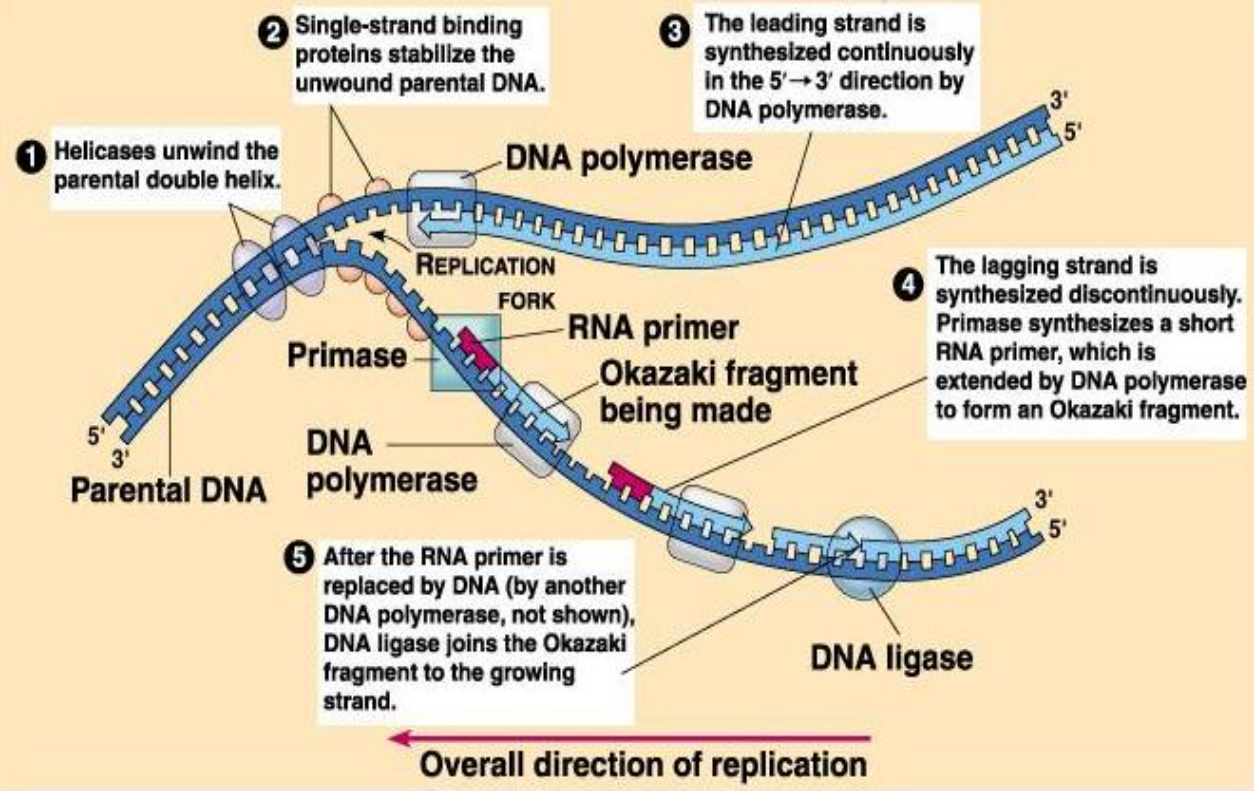
The Mechanism of DNA Replication

• DNA synthesis on the leading strand is continuous.

• The lagging strand grows the same general direction as the leading strand (in the same direction as the Replication Fork). However, DNA is made in the 5'-to-3' direction.

• Therefore, DNA synthesis on the lagging strand is discontinuous

• DNA is added as short fragments (Okasaki fragments) that are subsequently ligated together.



Enzymes in DNA replication

Many proteins assist in DNA replication

• DNA **helicases** unwind the double helix, the template strands are stabilized by other Proteins . • Single-stranded DNA binding proteins make the template available

• RNA **primase** catalyzes the synthesis of short RNA primers, to which nucleotides are added.
• DNA **polymerase III** extends the strand in the 5'-to-3' direction.

• DNA **polymerase I** degrades the RNA primer and replaces it with DNA.

• DNA **ligase** joins the DNA fragments into a continuous daughter strand.

Transcription of DNA

• Transcription, is the process of creating an equivalent RNA copy of a sequence of DNA. It is the first step leading to gene expression. During transcription, a DNA sequence is read by RNA polymerase, which produces a complementary, antiparallel RNA strand. Transcription results in an RNA complement that includes uracil (U) instead of thymine (T).

• The stages of transcription are :-

1. **Initiation**

Transcription is catalyzed by the enzyme RNA polymerase. It attaches to and moves along the DNA molecule until it recognizes a promoter sequence, which indicates the starting point of transcription. Once bound to the promotor sequence, RNA polymerase unwinds a portion of the DNA double helix, exposing the bases on each of the two DNA strands.

2. **Elongation**

The polymerase moves downstream, unwinding the DNA and elongating the RNA transcript 5'→3 ' In the wake of transcription, the DNA strands re-form a double helix.

3. Termination

Elongation will continue until the RNA polymerase encounters a stop sequence. At this point, transcription stops and the RNA polymerase releases the DNA template.