MOLECULAR STRUCTURE OF THE CELL

CHEMICAL STRUCTURE OF THE CELL

The substances found in the structure of the cells are divided into two groups according to their types and functions:

Inorganic substances

a) Water
b) Electrolytes

Organic substances:

a) Carbohydrates
b) Lipids
c) Proteins
d) Nucleic acids

Nucleic acids

These are the biggest and the most important organic molecules that are found in the cell. They are grouped as DNA and RNA and consist of C, H, O, N, P.

They are first discovered in the 19th century by Swedish biochemist Friedrich Miescher in the nucleus. After this discovery they are demonstrated to be present in other parts of the cell as well, however they are called «nucleic acids» since they were first detected in the nucleus. DNA (deoxyribonucleic acid) and RNA (ribonucleic acid) are named according to the sugar molecules that are found in their structures. Nucleic acids consists of units called **nucleotides**. Each of these nucleotides form due to the combination of 3 different types of molecules: the base containing **N**, **sugar molecule (pentose) and phosphoric acid**.

If we examine these 3 components one by one:

i) Base: Divided into 2 as **purine** and **pyrimidine** bases.

- Purine bases: Has a basic skeleton of a dual ring system consisting of carbon and nitrogen atoms. The first ring is identical to the pyrimidine skeleton, a N and a C atom added to this ring forms the purine compound.

- Pyrimidine bases: These bases has the fundamental skeleton consisting of four C and 2 N atoms within a ring system.

Pyrimidine bases are **Cytosine**, **Thymine** and **Uracil**. Among them, cytosine is found in the structure of DNA and RNA both; uracil is only found in the structure of RNA and thymine is only found in the structure of DNA.

ii) <u>Sugars</u>: These are pentoses having 5 C atoms: **Ribose** ($C_5H_{10}O_5$) and **deoxyribose** ($C_5H_{10}O_4$). Ribose is only found in RNA and deoxyribose is only found in DNA.

iii) <u>Phosphoric acid (H_3PO_4)</u>: Found in DNA and RNA.

If we summarize the structure of RNA and DNA:

	RNA	DNA
Sugar:	Ribose	Deoxyribose
Base:	Adenine, Guanine, Cytosine, Uracil	Adenine, Guanine, Cytosine, Thymine
Phosphoric acid:	Present	Present
Structure:	Single strand, shorter than DNA	Double strand, long
Where found:	Generally in ribosomes	Generally in the nucleus
Function:	Protein synthesis	Administration, replication

Structure of DNA and its replication:

DNA nucleotides bind to each other with weak hydrogen bonds and form long chains of DNA; always a purine base comes opposite to a pyrimidine base. According to this, adenine always comes opposite to thymine and guanine opposite to cytosine within a DNA molececue.

Due to the width of the DNA spiral is 20 A°. Only a purine and a pyrimidine base can be placed opposite to each other within this distance. If two purine bases come across, then more space would be required and with two pyrimidine bases, there would be space left.

One of the most important functions of DNA within a cell is replicating itself during cell division and distribute itself in both of the cells equally. By this way, all of the genetic achievements that the parent cell obtained with evolution are passed to the daughter cell. Replication starts at various points in the eukaryote chromosome and two strands of the DNA separate from each other.

These branches serve as a template until this separation is complete. Nucleotids that are found in the nucleolus (synthesized previously and then stored) are arranged in an order opposite the template branches with the help of DNA polimerase III enzyme and hydrogen bonds are forme d between them. As a result two identical daughter strands are formed from DNA.

Helicase unwinds the double helix, allowing a DNA polymerase to bind with each strand of the molecule. As the DNA polymerase moves along the strand, it adds bases to the new strand, using the original strand as the template. These bases are added according to what is called the Watson-Crick base-pairing rule. If there is an A on the original strand, a T would be added to the new strand, a C on the original strand, G on the new strand, T pairs with A, G with C, etc. These pieces of DNA are synthesized in stretches of roughly 100.000 nucleotides, then joined together by ligase.

Eukaryotic chromosomes are linear and are very long, containing millions, and millions, and millions of bases. If replication started at one end of the chromosome and moved to the other end, it would probably take days and days. Some cells, such as the cells that produce red blood cells, are actively dividing, undergoing successive rounds of mitosis. For the DNA to be replicated within the time allowed, replication occurs all along the chromosome simultaneously, forming little "bubbles" as the helicase unwinds the molecule at all of these sites. Then, the replicated portions are joined together by ligase. In addition, DNA polymerase can only add nucleotides in one direction (3' to 5') but the two DNA strands run in opposite directions from each other. As a result, one strand (**leading strand**) can be copied continuously behind the helicase but the other strand (**lagging strand**) must be copied in short segments which are also joined together by ligase.

DNA replication is called "**semiconservative replication**" because after replication the molecule is composed of one new strand and one original strand. Replication occurs during S phase of Interphase in the cell cycle. A replicated chromosome goes from having a single strand of DNA to having two strands (sister chromatids). The sister chromatids are produced by DNA replication, and each chromatid is composed of one original strand and one new strand.

Since the numbers and ratios of bases found in the DNA of each living being is different from each other, living beings have different type of proteins. In addition to replicating itself, DNA also manages protein synthesis along with other cellular activities.