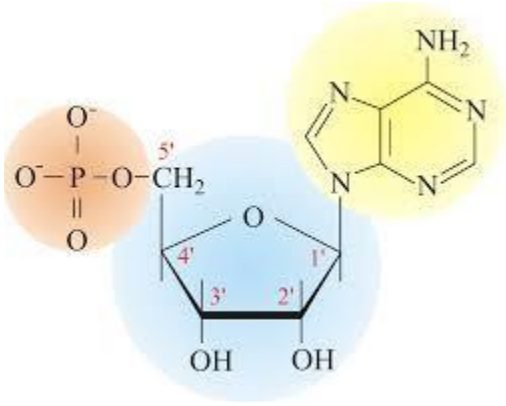
Lecture Two: 1-The chemistry of life
2- Structure and function of cell

Nucleic Acids

Nucleic acids, which are polymers of **nucleotides,** store information, include instructions for life, and conduct chemical reactions. The general structure of a nucleotide is shown in Figure (1).

Figure 1: The general structure of a nucleotide



Two types of nucleic acids are important in the storage and processing of the genetic information. **DNA** (deoxyribonucleic acid) is the type of nucleic acid that not only stores information about how to copy, or replicate, itself but also specifies the order in which amino acids are to be joined to make a protein.

Nucleotide Structure

Each nucleotide is a molecular complex of three types of subunit molecules **phosphate** (phosphoric acid), a **pentose** (5-carbon) sugar, and a **nitrogen-containing base**. The nucleotides in DNA contain the sugar deoxyribose, and the nucleotides in RNA contain the sugar ribose; this difference accounts for their respective names, also, there are four different types of bases in DNA:

adenine (A), thymine (T), guanine (G), and cytosine (C).

In RNA, the base uracil (U) replaces the base thymine.

DNA (deoxyribonucleic acid)

DNA is double-stranded, with the two strands twisted about each other in the form of a double helix (Figure 2). In DNA the two strands are held together by hydrogen bonds between the bases. When coiled, DNA resembles a spiral staircase.

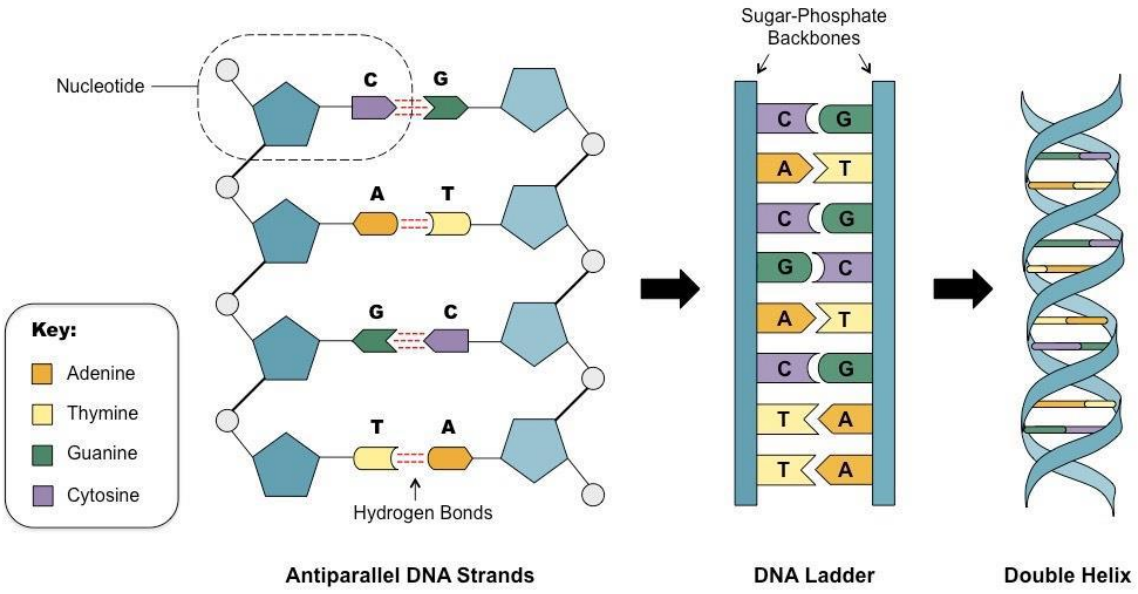


Figure 2: DNA structure

Thymine (T) always pairs with adenine (A), and guanine (G) always pairs with cytosine (C). Complementary bases have shapes that fit together. Complementary base pairing allows DNA to replicate in a way that ensures that the sequence of bases will remain the same. This is important because it is the sequence of bases that determines the sequence of amino acids in a protein. RNA is single-stranded. When RNA forms, complementary base pairing with one DNA strand passes the correct sequence of bases to RNA. RNA is the nucleic acid directly involved in protein synthesis.

RNA (ribonucleic acid) is a diverse type of nucleic acid that has multiple uses, RNA main types contains:

1-Messenger RNA (mRNA) is a temporary copy of a gene in the DNA that specifies what the amino acid sequence will be during the process of protein synthesis.

2-Transfer RNA (tRNA) is also necessary in synthesizing proteins and helps translate the sequence of nucleic acids in a gene into the correct sequence of amino acid during protein synthesis.

3-Ribosomal RNA (rRNA) is the RNA component of the ribosome, it works as an enzyme to form the peptide bonds between amino acids in a polypeptide.

ATP (adenosine triphosphate) is a nucleotide that stores large amounts of energy needed for synthetic reactions and for various other energy-requiring processes in cells.

Differences in the Structures of DNA and RNA

Though both DNA and RNA are polymers of nucleotides, there are some small differences in the types of subunits each contains and in their final structure. These differences give DNA and RNA their unique functions in the body.

Table 1: Comparison between DNA and RNA Structure

	DNA	RNA
Sugar	Deoxyribose Ribose	Ribose
Bases	Adenine, guanine, thymine, cytosine	Adenine, guanine, uracil, cytosine
Strands	Double-stranded with base pairing	Single-stranded
Helix	Yes	No

Structure and function of cell

The cell

All organisms, including humans, are composed of cells. From the single-celled bacteria to plants and complex animals such as human, the cell is the fundamental unit of life. Despite their importance, most cells are small and can be seen only under a microscope. The small size of cells means that they are measured using the smaller units of the metric system, such as the micrometer (µm). Most human cells are about 100 µm in diameter, about the width of a human hair. The internal contents of a cell are even smaller and, in most cases, may only be viewed using microscopes. Because of this small size, the cell theory, one of the fundamental principles of modern biology, was not formulated until after the invention of the microscope in the seventeenth century.

The Cell Theory

A cell is the basic unit of life. According to the cell theory, nothing smaller than a cell is considered to be alive. All living organisms are made up of cells. While many organisms, such as the bacteria, are single-celled, other organisms, including humans and plants, are multicellular. In multicellular organisms, cells are often organized as tissues, such as nervous tissue and connective tissue.

The prokaryotes and eukaryotes

Biologists classify cells into two broad categories the prokaryotes and eukaryotes. The primary difference between a prokaryotic cell and a eukaryotic cell is the presence or absence of a **nucleus, a membrane-bound structure that houses the DNA**. Prokaryotic cells lack a nucleus, whereas eukaryotic cells (Fig. 1) possess a nucleus.

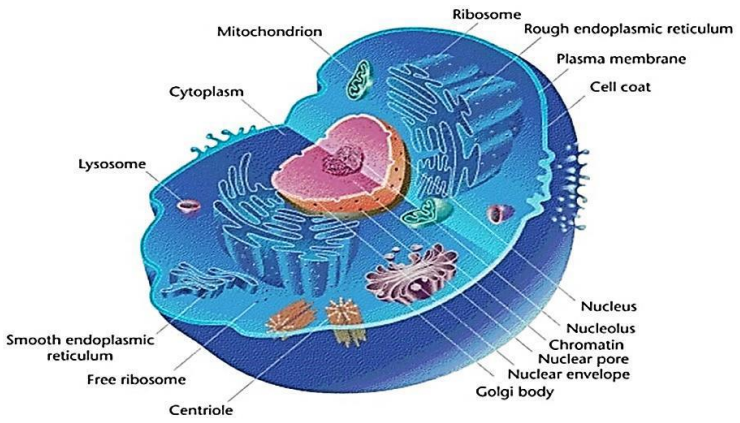


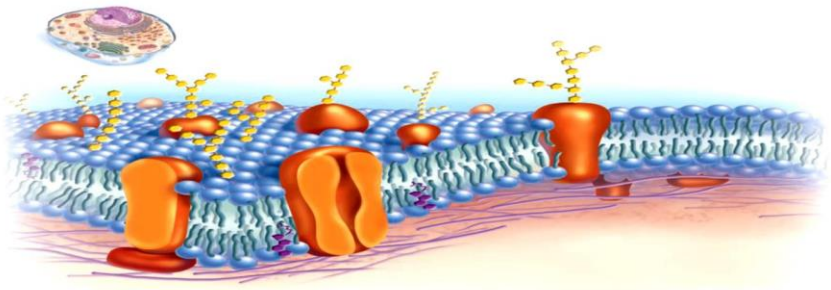
Figure (1): Eukaryotic cell

The prokaryotic group includes two groups of bacteria, the eubacteria and the archaebacteria. Within the eukaryotic group are the animals, plants, and fungi, as well as some single-celled organisms called protists. Despite their differences, both types of cells have a **plasma membrane**, a membrane that regulates what enters and exits a cell.

Cell structure:

Plasma membrane

The plasma membrane is a phospholipid bilayer made of two layers of phospholipids. Proteins scattered throughout the plasma membrane play important roles in allowing substances to enter the cell. All cells are surrounded by an outer plasma membrane (Fig. 2). The plasma membrane marks the boundary between the outside and the inside of the cell. The function of the plasma membrane is necessary to the life of the cell.



Cell wall

A cell wall is a structural layer surrounding some types of cells, just outside the cell membrane. It can be tough, flexible, and sometimes rigid. It provides the cell with both structural support and protection, and also acts as a filtering mechanism. Cell walls are present in most prokaryotes (except mollicute bacteria), in algae, fungi and eukaryotes including plants but are absent in animals.

Cytoplasm

All types of cells contain cytoplasm, which is a semi-fluid medium that contains water and various types of molecules suspended or dissolved in the medium. The presence of proteins accounts for the semi-fluid nature of the cytoplasm. The cytoplasm of a eukaryotic cell contains organelles.

The Nucleus

The nucleus, a prominent structure in cells, stores genetic information (Fig. 3). Every cell in the body contains the same genes. Genes are segments of DNA that contain information for the production of specific proteins. Chromatin is the combination of DNA molecules and proteins that make up the chromosomes.

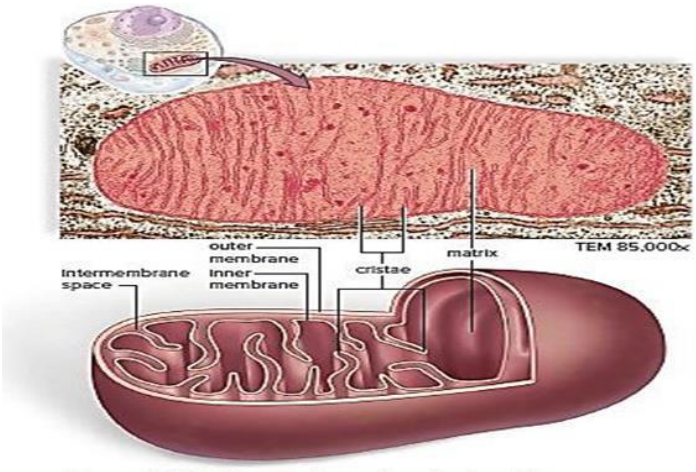
Ribosomes

Ribosomes are organelles composed of proteins and rRNA. Protein synthesis occurs at the ribosomes. Ribosomes are often attached to the endoplasmic reticulum

Mitochondria

Mitochondria (sing., mitochondrion) are often called the powerhouses of the cell. Just as a powerhouse burns fuel to produce electricity, the mitochondria convert the chemical energy of glucose products into the

chemical energy of ATP molecules. In the process, mitochondria use up oxygen and give off carbon dioxide. Therefore, the process of producing ATP is called cellular respiration.

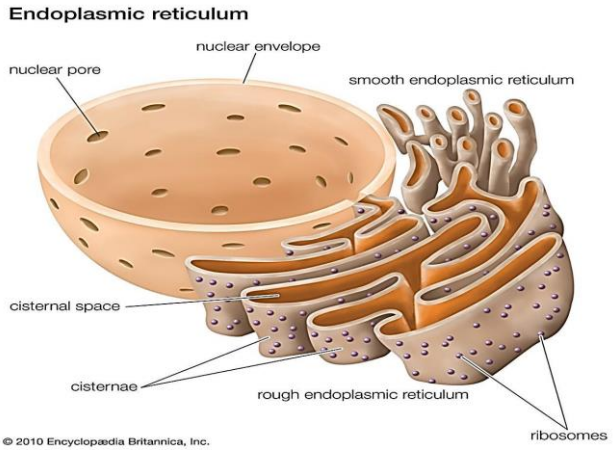


The Endoplasmic Reticulum

The endoplasmic reticulum (ER) has two portions. Rough ER and The smooth ER. general its function is to produce proteins for the rest of the cell to function.

The Golgi apparatus

The Golgi apparatus consists of a stack of slightly curved saccules, Here proteins and lipids received from the ER are modified.



Lysosomes

Lysosomes, membranous sacs produced by the Golgi apparatus, contain enzymes that can break down many kinds of biomolecules. Lysosomes are found in all cells of the body but are particularly numerous in white blood cells that engulf disease-causing microbes.

Cilia and Flagella

Cilia (sing., cilium) and flagella (sing., flagellum) are involved in movement. The ciliated cells that line our respiratory tract sweep back up the throat the debris trapped within mucus.

Centriole

Centriole is a cylindrical organelle composed mainly of a protein called **tubulin**. The position of the centriole determines the position of the nucleus and plays a crucial role in the spatial arrangement of the cell.

The Cytoskeleton

It took a high-powered electron microscope to discover that the cytoplasm of the cell is containing by several types of protein fibers, called the cytoskeleton.

Vacuole

A vacuole is a membrane-bound organelle which is present in all plant and fungal cells and some protist, animal, and bacterial cells. Vacuoles are essentially enclosed compartments which are filled with water containing inorganic and organic molecules including enzymes in solution

Vacuole Functions

1) Isolating materials that might be harmful or a threat to the cell.

2) Containing waste products.

3) Containing water in plant cells.

4) Maintaining internal hydrostatic pressure within the cell.

5) Maintaining an acidic internal pH.

6) In protists, vacuoles have the function of storing food.