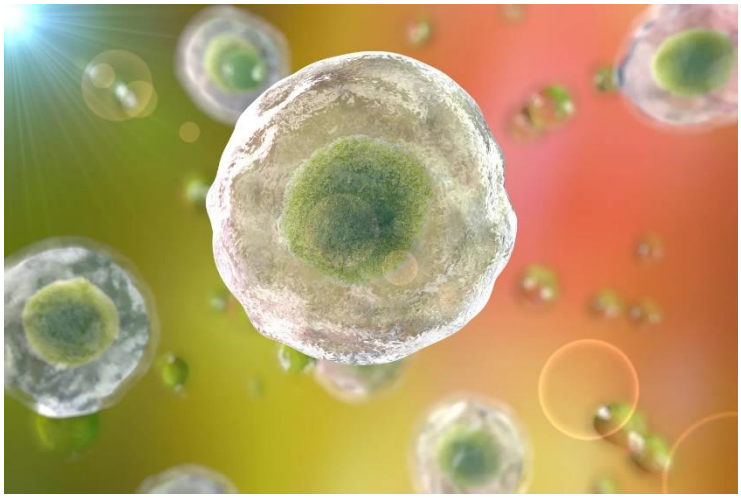
The Cell Nucleus

The cell nucleus is a membrane-bound structure that contains a cell's hereditary information and controls its growth and reproduction. It is the command center of a eukaryotic cell and is usually the most notable cell organelle in both size and function.



Function

The key function of the nucleus is to **control cell growth and multiplication**. This involves regulating gene expression, initiating cellular reproduction, and storing genetic material necessary for all these tasks. For a nucleus to carry out important reproductive roles and other cell activities, it needs proteins and ribosomes.

Protein and Ribosome Synthesis

The nucleus regulates the synthesis of proteins in the cytoplasm using messenger RNA (mRNA). Messenger RNA is a transcribed DNA segment that serves as a template for protein production. It is produced in the nucleus and travels to the cytoplasm through the nuclear pores of the nuclear envelope, which you'll read about below. Once in the cytoplasm, ribosomes and another RNA molecule called transfer RNA work together to translate mRNA to produce proteins.

Physical Characteristics

The shape of a nucleus varies from cell to cell but is often depicted as spherical. To understand more about the role of the nucleus, read about the structure and function of each of its parts.

Nuclear Envelope and Nuclear Pores

The cell nucleus is bound by a double membrane called the nuclear envelope. This membrane separates the contents of the nucleus from the cytoplasm, the gel-like substance containing all other organelles. The nuclear envelope consists of phospholipids that form a lipid bilayer much like that of the cell membrane. This lipid bilayer has nuclear pores that allow substances to enter and exit the nucleus, or transfer from the cytoplasm to the nucleoplasm.

The nuclear envelope helps to maintain the shape of the nucleus. It is connected to the endoplasmic reticulum (ER) in such a way that the internal chamber of the nuclear envelope is continuous with the lumen, or inside, of the ER. This also allows the transfer of materials as well.

Chromatin

The nucleus houses chromosomes containing DNA. DNA holds heredity information and instructions for cell growth, development, and reproduction. When a cell is "resting", or not dividing, its chromosomes are organized into long entangled structures called chromatin.

Nucleoplasm

Nucleoplasm is the gelatinous substance within the nuclear envelope. Also called karyoplasm, this semi-aqueous material is like cytoplasm in that it is composed mainly of water with dissolved salts, enzymes, and organic molecules suspended within. The nucleolus and chromosomes are surrounded by nucleoplasm, which cushions and protects nuclear contents.

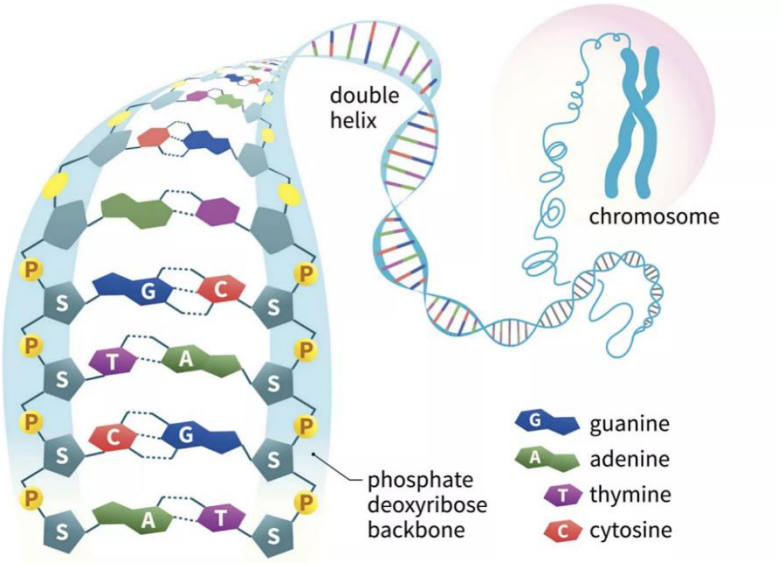
Like the nuclear envelope, the nucleoplasm supports the nucleus to hold its shape. It also provides a medium by which materials, such as enzymes and nucleotides (DNA and RNA subunits), can be transported throughout the nucleus to its various parts.

Nucleolus

Contained within the nucleus is a dense, membrane-less structure composed of RNA and proteins called the nucleolus. The nucleolus contains nucleolar organizers, the parts of chromosomes carrying the genes for ribosome synthesis. The nucleolus helps to synthesize ribosomes by transcribing and assembling ribosomal RNA subunits. These subunits join to form ribosomes during protein synthesis.

Nucleic Acids and Their Function

Nucleic acids are molecules that allow organisms to transfer genetic information from one generation to the next. These macromolecules store the genetic information that determines traits and makes protein synthesis possible. Two nucleic acid examples include **deoxyribonucleic acid** (better known as DNA) and **ribonucleic acid** (better known as RNA). These molecules are composed of long strands of nucleotides held together by covalent bonds. Nucleic acids can be found within the nucleus and cytoplasm of our cells.

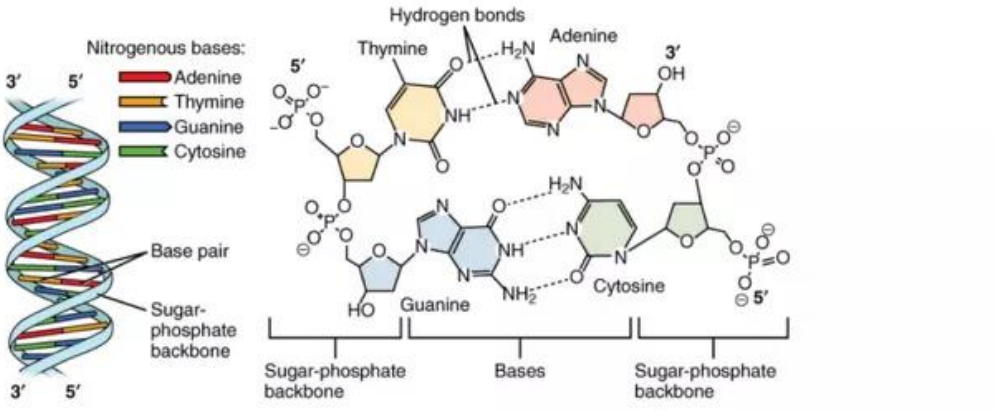


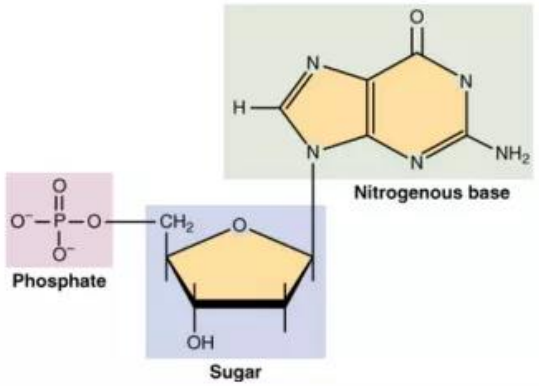
Nucleic acids are composed of nucleotide monomers linked together. Nucleotides have three parts:

1. **A Nitrogenous Base**
2. **A Five-Carbon (Pentose) Sugar**
3. **A Phosphate Group**

Nitrogenous bases include **purine molecules** (adenine and guanine) and **pyrimidine molecules** (cytosine, thymine, and uracil.) In DNA, the five-carbon sugar is **deoxyribose**, while **ribose** is the pentose sugar in RNA. Nucleotides are linked together to form polynucleotide chains.

They are joined to one another by covalent bonds between the phosphate of one and the sugar of another. These linkages are called **phosphodiester linkages**. Phosphodiester linkages form the sugar-phosphate backbone of both DNA and RNA.





1. DNA Structure

DNA is the cellular molecule that contains instructions for the performance of all cell functions. When a cell divides, its DNA is copied and passed from one cell generation to the next. DNA is organized into **chromosomes** and found within the nucleus of our cells. It contains the "programmatic instructions" for cellular activities. When organisms produce offspring, these instructions are passed down through DNA.

DNA commonly exists as a **double-stranded molecule** with a twisted double-helix shape. DNA is composed of a phosphate-deoxyribose sugar backbone and the four nitrogenous bases:

adenine (A)

guanine (G)

cytosine (C)

thymine (T)

In double-stranded DNA, adenine pairs with thymine (A-T) and guanine pairs with cytosine (G-C).

2. RNA Structure

RNA is essential for the synthesis of proteins. Information contained within the genetic code is typically passed from DNA to RNA to the resulting proteins. There are several types of RNA.

Messenger RNA (mRNA) is the RNA transcript or RNA copy of the DNA message produced during DNA transcription. Messenger RNA is translated to form proteins.

Transfer RNA (tRNA) has a three-dimensional shape and is necessary for the translation of mRNA in protein synthesis.

Ribosomal RNA (rRNA) is a component of ribosomes and is also involved in protein synthesis.

MicroRNAs (miRNAs) are small RNAs that help to regulate gene expression.

RNA most commonly exists as a single-stranded molecule composed of a phosphate-ribose sugar backbone and the nitrogenous bases **adenine, guanine, cytosine** and **uracil (U)**. When DNA is transcribed into an RNA transcript during DNA transcription, guanine pairs with cytosine **(G-C)** and adenine pairs with uracil **(A-U)**.