



Lectures of Ultrastructure of Cell

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Anatomy and Histology Department

By

Prof. Dr. Khulood Naji Rasheed

Nucleic Acids

They are large molecules that storage and expression of genetic information, classified chemically into two distinct types of nucleic acids: deoxyribonucleic acid (DNA) and ribonucleic acid (RNA). Both are in form of filamentous polymers composed of nucleotides linked together by phosphodiester bonds, where the phosphate group attached to carbon (C5) of sugar forming the first nucleotide is linked to the hydroxyl group attached to carbon (C3) of sugar that forms the next nucleotide.

Components of Nucleic Acids

They consist of condensation/polymerization of nucleotides (which are the monomer or building blocks) which in turn are composed of three structural units:

1. Pentose sugar (RNA contains ribose, DNA contains deoxyribose).
2. Phosphate group.
3. Nitrogenous bases:
 - pyrimidine, which includes uracil, cytosine and thymine compounds.
 - purine, which includes adenine and guanine compounds.

DNA is composed of two pyrimidines (cytosine and thymine) and two purines (adenine and guanine), while RNA contains (uracil) instead of (thymine) as well as adenine, guanine and cytosine.

***Nucleoside**= purine or pyrimidine + ribose or deoxyribose sugar.
(Nucleoside= nitrogenous base + sugar).

***Nucleotide**= nucleoside + phosphate.
(Nucleotide= nitrogenous base + sugar + phosphate).

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- **DNA** is a polymer of deoxyribonucleoside monophosphates covalently linked by (3-5)-phosphodiester bonds (with exception of a few viruses that contain single-stranded DNA), DNA exists as a double-stranded molecule, in which the two strands wind around each other, forming a double helix. It is found in the nucleus and with small amounts in mitochondria.
- **RNA** like DNA, is a long, unbranched macromolecule, single strand consisting of nucleotide joined by (3-5)-phosphodiester bond. It is found throughout the cell.

Types of RNA

1. **Ribosomal RNA (rRNA)**/ the main component of RNA (80-85)% it is combined with a protein in ribosome (constitutes 50% of ribosome), involved in composition of ribosomes which in turn are synthesized the proteins (it provides structural framework for ribosomes).
2. **Transfer RNA (tRNA)**/ which transfers activated amino acids to ribosomes where protein synthesis takes place, it has small molecular weight and forms about (10-20)% of total RNA in the cell. Each tRNA specialized in transferring certain amino acid.
3. **Messenger RNA (mRNA)**/ found mainly in cytoplasm “and nucleus” it has large molecular weight and small percentage of total RNA, transfers genetic code from nucleus to ribosomes where translate the genetic code into a sequence of amino acids.

Polarity

Each single-stranded nucleic acid chain has a polarity, two distinct ends: a 5' end with a free phosphate and a 3' end with a free OH-group (nucleic acids are formed when nucleotides come together through phosphodiester linkages between the 5' and 3' carbon atoms). The polarity in nucleic acids (DNA and RNA) is derived from the oxygen and nitrogen atoms in the backbone.

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Hydrogen bond

In double stranded nucleic acids, the bases of each base pair is held together by hydrogen bonds, 3 hydrogen bonds in the GC-base pair and 2 hydrogen bonds for the AT- and AU-base pair.

Hydrogen bonds importance

- Interact to stabilize and form the double helix structure.
- Hydrogen bonds between bases can be made and broken easily, allowing DNA to undergo accurate replication and repair.

* (disruption the hydrogen bonds between the paired bases using acidic or alkaline pH or heating).

Chromatin

It was first described by Fleming in 1879. Chromatin found in an interphase (non-dividing) nucleus as fine filaments (fibers) chromatin. The fibers lie crisscross to give the appearance of a diffuse network often referred to as the nuclear or chromatin reticulum, which occupies most of the nucleus. Chromatin fibers are simply extremely extended chromosomes. A chromatin fiber is normally about (100Å) in diameter and is thicker than (100Å) appears to be coiled or folded.

Chromatin fibers typically appear approximately (250Å) in diameter. During cell division, the chromatin fibers by condensing and tight coiling form short, thick, and rod-like bodies known as chromosomes. There are two types of chromatin (Fig. 1) according to their features:

Prof. Dr. Khulood Naji Rasheed

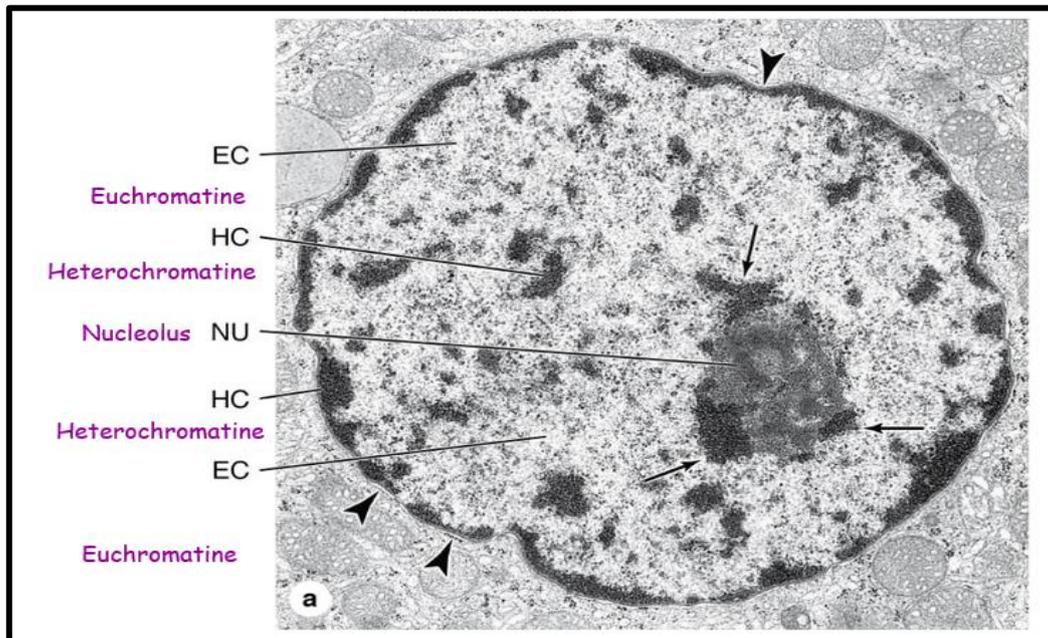


Fig. 1: Types of Chromatin.

1. Heterochromatin consists of condensed chromosome segments and produces dense aggregations, which are mostly located near the nuclear envelope, it can be also irregularly distributed throughout the nucleus, it's a transcriptional inactive chromatin.

2. Euchromatin has soft, foamy, or almost fibrillar structure. It consists of de-condensed segments of chromosomes, its transcriptional active and is present in the cells with high protein synthetic activity.

Summary of chromatin structure

- Chromatin is the combination of DNA and its associated proteins.
- Chromatin with DNA that is active in transcription stains lightly and is called euchromatin; inactive chromatin stains more darkly and is called heterochromatin.
- DNA molecule initially wraps around complexes of basic proteins called histones to form nucleosomes (a structural unit of a eukaryotic chromosome, consisting of a length of DNA coiled around a core of histones) producing a structure resembling beads on a string.
- Additional levels of chromatin fiber condensation are less well understood and involve nonhistone proteins.

Comparison between Heterochromatin and Euchromatin

Heterochromatin vs Euchromatin		
	More Information Online WWW.DIFFERENCEBETWEEN.COM	
	Heterochromatin	Euchromatin
DEFINITION	Heterochromatin is the highly packed form of chromatin in the nucleus	Euchromatin is the loosely packed form of chromatin in the nucleus
ACTIVE VS INACTIVE	Generally inactive	Generally active
DNA CONTENT	Contains more DNA	Contains less DNA
OCCURRENCE IN THE GENOME	Less abundant	Around 90% of the total human genome is euchromatin
ORGANISMS	Only present in eukaryotes	Present in both prokaryotes and eukaryotes
TYPES	There are two types	Present in only one form
STAIN	Easily and highly stained	Stains lightly
LOCATION	Found at the periphery of the nucleus	Present in the inner body of the nucleus