Nuclear matrix (nucleoplasm)

It is gel-like matrix in which the nuclear components are suspended where fill the space between the chromatin and nucleolus within the nucleus. It is composed mainly of proteins (some of which have enzymatic activity), metabolites and ions. Also the fibrous lamina of the nuclear envelope is a part of the nuclear matrix. The nuclear lamina is dense network of protein filaments that underlies the inner nuclear membrane.

The **nuclear matrix** composed of two parts (Figure.1):

a-Nuclear lamina

b- Internal matrix proteins (fibro-granular structure)

The nuclear matrix have structural role in the cell where is responsible for maintaining the shape of the nucleus and the organization of chromatin. Moreover, the nuclear matrix participates in several cellular processes, such as DNA replication, gene expression, cell signaling and differentiation.

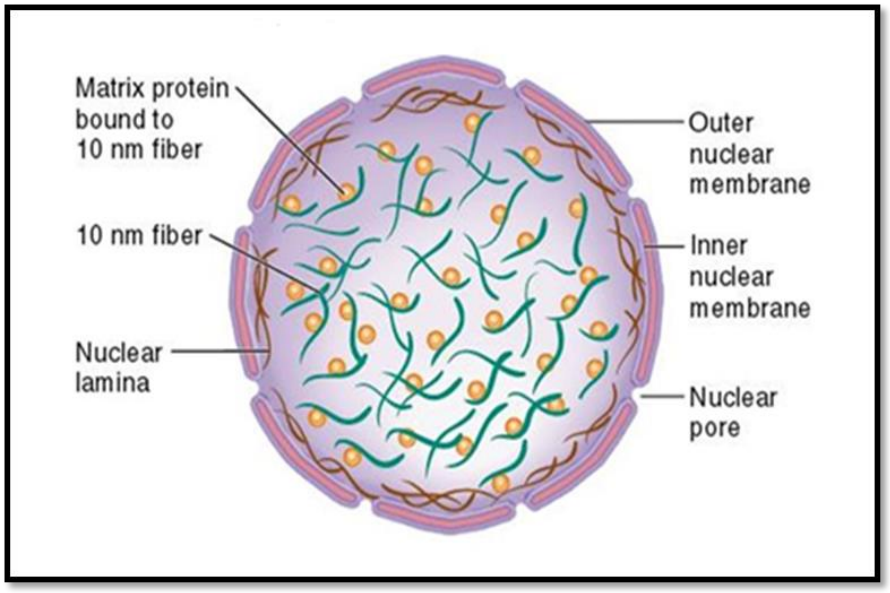

Figure (1): Structure of nuclear matrix.

The Chromatin

The nucleus contains loosely coiled fibers called **chromatin** that dispersed throughout the nucleus. It is composed of coiled strand of **nucleic acids (DNA)** bound to basic proteins called **histones** that play a role in the regulation of DNA function.

The chromatin is usually arranged in repeating units of small particles called **nucleosomes,** which consist of core of protein histone surround by double stranded of helical DNA. A **nucleosome** consists of 147 base pairs of DNA that is wrapped around a set of 8 histones called an octamer (Figure.2).

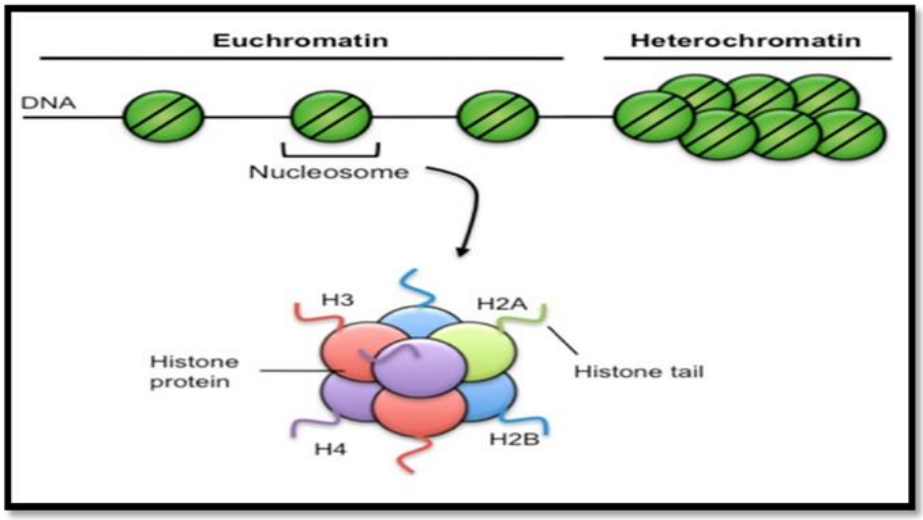

Figure (2): Structure of nucleosome

These nucleosomes are further folded around an axis to form **chromatin fiber**, which then more condenses to form **chromosomes** (Figure.3). Chromatin structure plays an important role in a number of cell processes that occur in the cell including DNA replication, transcription, DNA repair, and cell division.

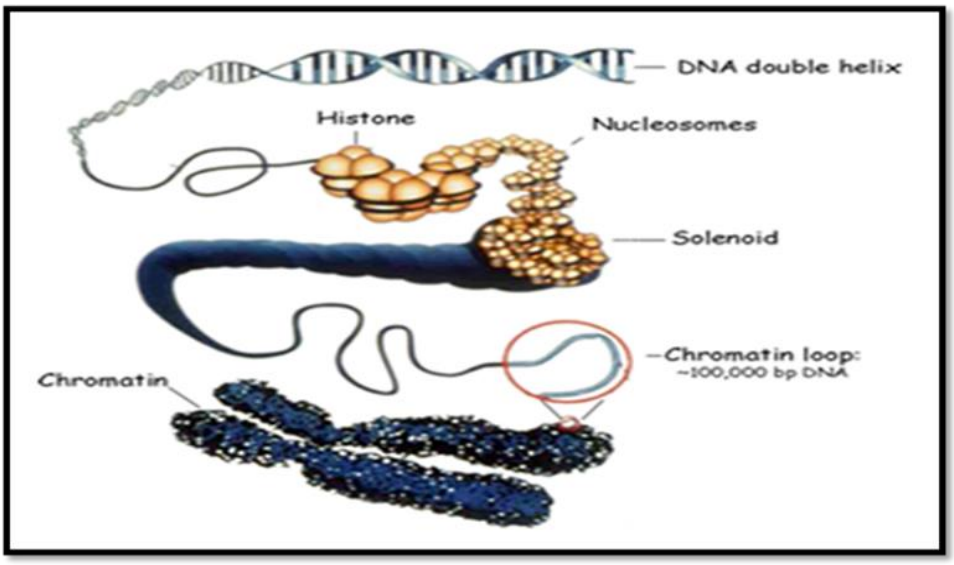

Figure (3): Structure of chromatin

There are two types of chromatin can be distinguished under electron microscope (Figure.4):

1- Euchromatin **(dispersed less-coiled chromatin)**

It is visible under electron microscope as electron-lucent area, light staining. It appears as loose network of fine fibrils, less coiled portion of chromosomes visible as finely dispersed granular material. The euchromatin is metabolically active, which play an important role in transmission of genetic information and in protein synthesis.

2- Heterochromatin **(condensed or coiled chromatin)**

It is appear under electron microscope as electron-dense area, darkly staining, composed of coarse granules. The chromatin fold upon itself to form a highly condensed structure called heterochromatin. The heterochromatin is metabolically inert, it could be involved in cytoskeletal function.

The distribution of this condensed chromatin includes three locations:

1-Marginal chromatin: It is forming a thin peripheral layer which lines the inner nuclear envelope.

2-Karyosome: It forms patches scatter in the nucleoplasm.

3-Nucleolar associated chromatin: It is found as a rim condensed chromatin in association with nucleolus.

The chromatin DNA is a major form of DNA in the cell that is the carrier most of genetic information, within the chromatin there are sites of RNA synthesis where synthesis of precursors of messenger, ribosomal and transfer ribonucleic acid (mRNA, rRNA , tRNA).

The amount of euchromatin and heterochromatin usually indication of the metabolic activity. The nucleoprotein of chromatin is coiled and the degree of coiling varies during cell activity. The cells with light nuclei (with few heterochromatin clumps) are more active where more DNA surface available for the transcription of genetic information. The cells with darkly nucleus (the coiling of DNA makes less surface available) therefore less active.

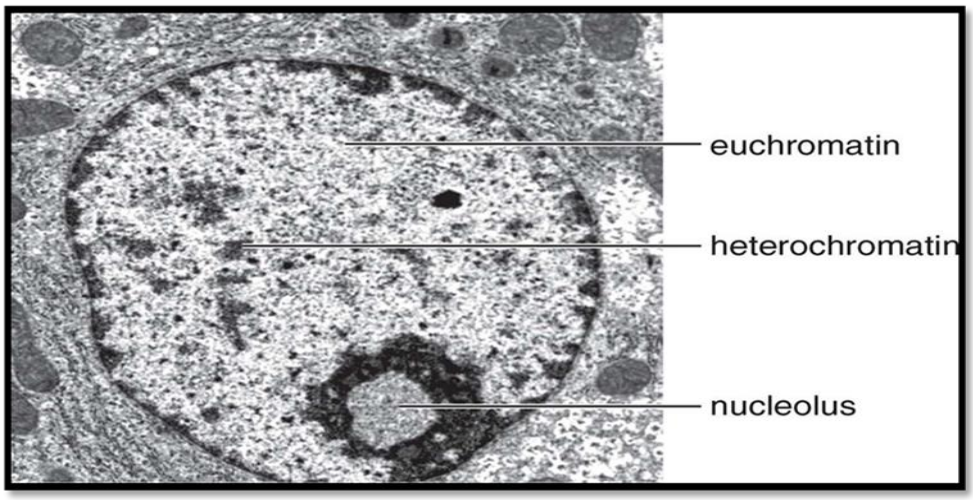

Figure (4): Types of chromatin

Sex chromatin

Human male somatic cells have (46) chromosomes arranged in (23) pairs, (22) pairs called autosomes and (1) pair is formed by X and Y or sex chromosomes.

In female , there are (22) pairs of autosomes and two X chromosomes. One of these X chromosome is extremely heterochromatin and forms a visible tightly coiled mass in the interphase nucleus. This small visible mass is called **barr body** or **sex chromatin**, it is about (1µm) in diameter, whereas the other X chromosome is uncoiled and not visible. The coiling of this chromosome explain why it is easily stained and can be observed with light microscope. Evidence suggests that the coiled X chromosome including the sex chromatin is genetically inactive.

In male, there is (22) pairs of autosomes and (1) pair of sex chromosome include X and Y chromosome as sex determinants. The X chromosome is uncoiled, therefore no sex chromatin is visible, so Barr body is not seen in normal male somatic cells.

The Barr body appears clearly in epithelial cells as a small granule attached to the nuclear envelope. It is seen well in nuclei of squamous epithelial cells that lining the internal surface of the check or buccal cavity (Figure.5). Blood smears are also used, in which the sex chromatin appears as drumstick –like appendage attached to the nuclei of the neutrophil leukocytes (Figure.6).

The study of sex chromatin has wide application in medicine, because it permits determination of genetic sex in doubtful cases, such as in patients

whose external sex organs do not permit to determine of gender as in hermaphroditism.

Sex chromatin is essential for the study of other anomalies that include:

1- **Klinefelter's syndrome** XXY chromosomes (male phenotype).

2- **Turner's syndrome** XO chromosomes (female phenotype).

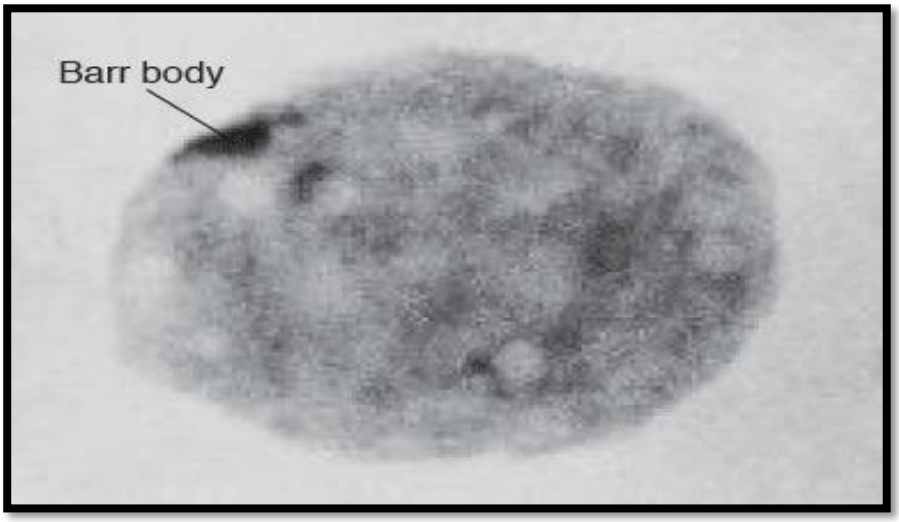

Figure (5): Barr body in epithelial cell.

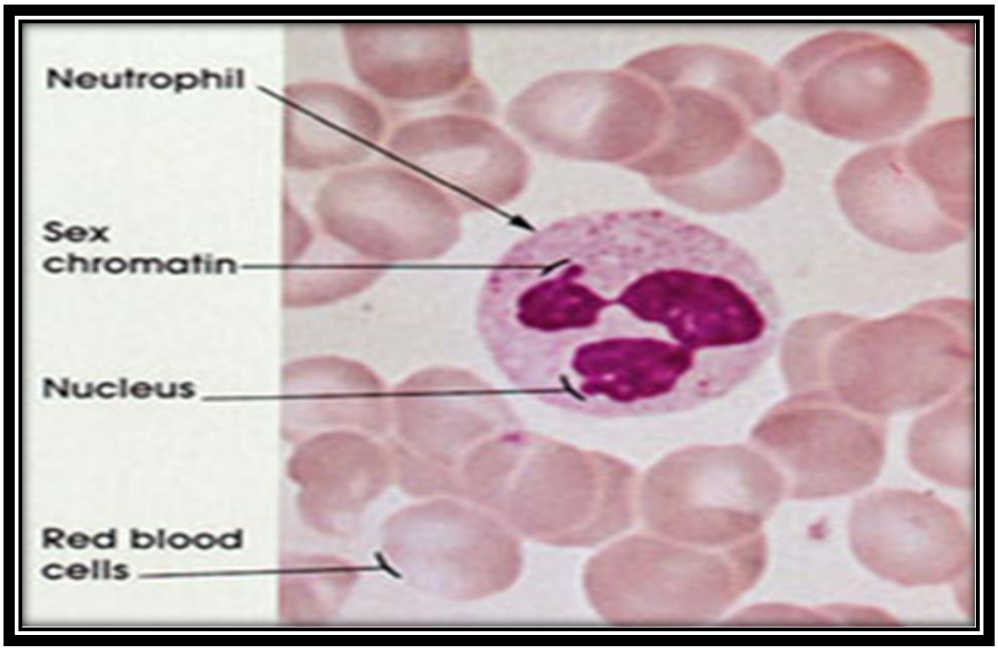

Figure (6): Drumstick –like appendage in neutrophil leukocytes .