Ministry of Higher Education

Al-Mustaqbal university collage

Intelligent of Medical Systems Department

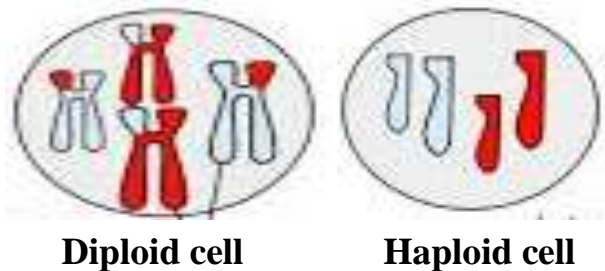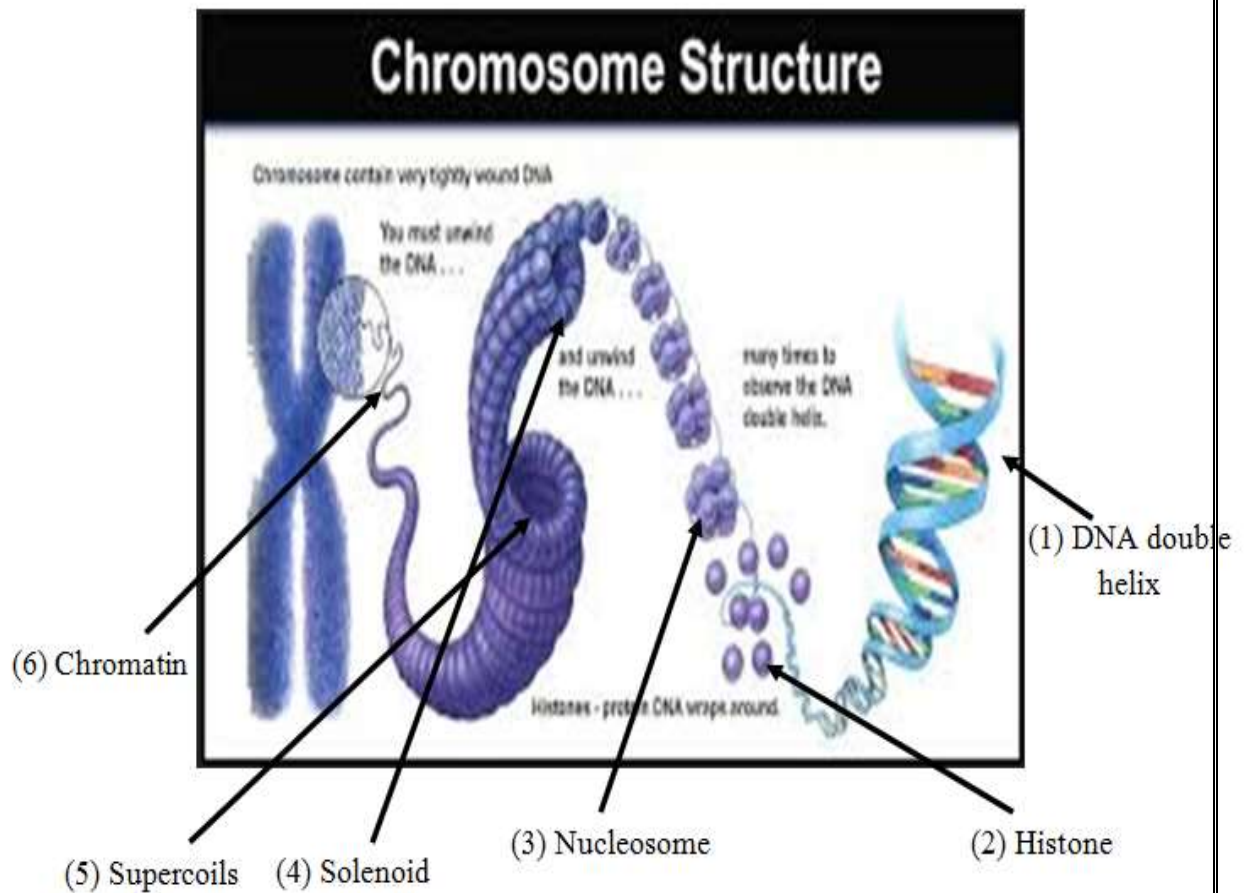# Bioinformatics

Lecture (2)

Chromosomes

Prepared by

Dr. Asma'a Hassan Mohammed

Chromosomes (Structure and Function)

DNA are a very large molecules, human DNA is over 1.5 meter in length so that how exactly dose the cell fit such a long molecules into the nucleus of the cell which is so small? The answer is that the cell uses special protein to pack the DNA into extremely dense structure called DNA.

Condensing DNA into chromosomes.

- The double-helix DNA molecule winds around proteins called **histones**.
- Eight (8) of these histones group together to form a unit called the **nucleosome**.
- These nucleosome then wrap around in a helical fashion to form a coil called a **solenoid**. The coil wraps even further to form **supercoils**. These supercoils form a fiber of DNA-protein called the **chromatin**. Chromatin also contains a small amount of RNA.
- This chromatin fiber condense even further into a structure called the **chromosome**.
- In human somatic cells, there are 23 pairs of chromosomes where each chromosomes in a pair comes from each of the two parents.
- A region called the **centromere** connects the two chromosomes in a pair said to be **homologous** with respect to one another because they contain genes that code for similar traits (a hair color, eye color, ect…).
- Somatic cells are said to be **diploid** because they contain these homologous pairs on the other hand, **haploid** cells do not contain pairs of homologous chromosomes (e.x. germ cells).

Chromosome Structure

Chromosome contain very tightly wound DNA

You must unwind the DNA . . .

and unwind the DNA . . .

many times to observe the DNA double helix.

Histones - protein DNA wraps around.

(1) DNA double helix

(6) Chromatin

(5) Supercoils   (4) Solenoid

(3) Nucleosome

(2) Histone

Diploid cell   **Haploid cell**

## Transcription of DNA in Chromosomes

- The DNA in chromosomes is too packed and too densely coiled to undergo transcription. In order for RNA polymerase to transcribe DNA, the chromosome must unwrap into a lightly-packed chromatin called **euchromatin**. Euchromatin contains exposed genes that allows the polymerase to bind and begin the process.

Chromosomal Centromere

The centromere is the specialized DNA sequence of a chromosome that links a pair of sister chromatids. During mitosis, spindle fibers attach to the centromere via the **kinetochores**.

The physical role of the centromere is to act as:

1- the site of assembly of the kinetochores – a highly complex multiprotein structure that is responsible for binding microtubules and signaling to the cell cycle and cell division.

2- Separation of chromosomes into short arms (P) and long arms (q).
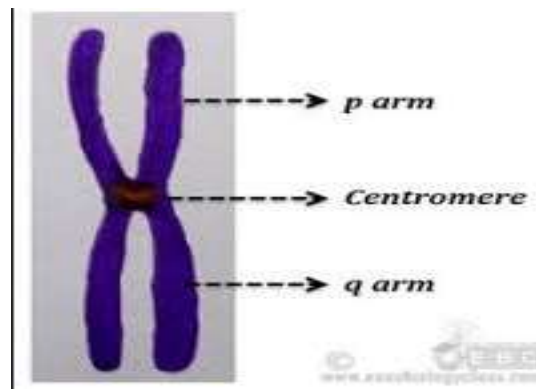
Classification of chromosomes according to centromere position

According to centromere position, there are four major types of chromosomes:

1- Metacentric Chromosomes

Metacentric chromosomes have the centromere in the center, such that both sections are of equal length. Human chromosome 1 and 3 are metacentric.
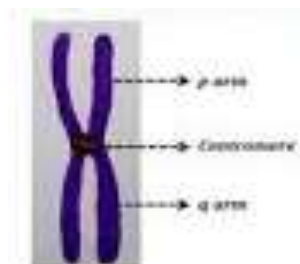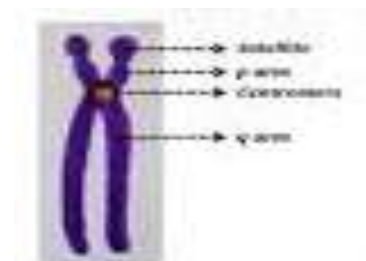
2- Submetacentric Chromosomes

Submetacentric chromosomes have the centromere slightly offset from the center leading to a slight asymmetry in the length of the two sections. Human chromosomes 4 through 12 are submetacentric.
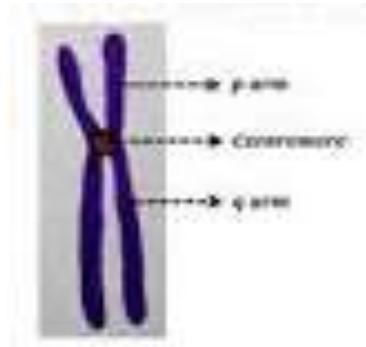

3- Acrocentric Chromosomes

Acrocentric chromosomes have a centromere which is severely offset from the center leading to one very long and one very short section. Human chromosomes 13,15, 21, and 22 are acrocentric.

4- Telocentric Chromosomes

Telocentric chromosomes have the centromere at the very end of the chromosome. Humans do not possess telocentric chromosomes but they are found in other species such as mice.
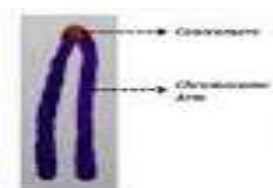
Chromosomal telomeres

A **telomere** is a region of repetitive nucleotide sequences at each end of a chromosome, which protects the end of the chromosome from deterioration or from fusion with neighboring chromosomes. The sequence of nucleotides in telomeres is AGGGTT, with the complementary DNA strand being TCCCAA.

This sequence of TTAGGG is repeated approximately 2,500 times in humans. In humans, average telomere length declines from about 11 kilobases at birth to less than 4 kilobases in old age.