

Genes and Genetic Diseases

Produced by: Assistant Professor Dr. Ala'a Hassan Mirza Hussain

Genes and Genetic Diseases

Gene: Is a fundamental unit of information storage.

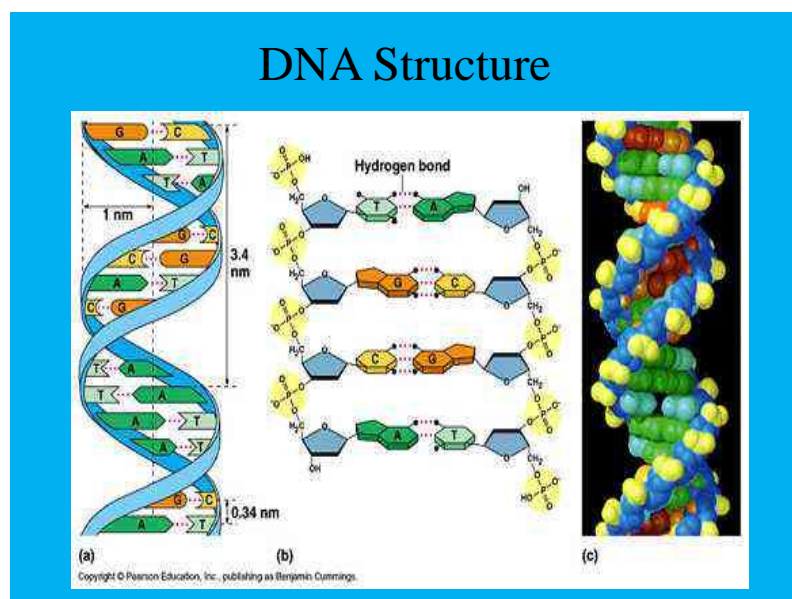
Genes determine the type of proteins and enzymes that are made by the cell. Genes control inheritance and function of all the cells in the body e.g.

- Genes control the type and quantity of hormone.
- They control the receptors that are present in the cell membrane.
- They control the enzymes synthesis needed for metabolism.

Structure of Gene

- The DNA molecule is composed of nucleotides which consist of:
- Five carbon sugar is called deoxyribose.
- Phosphate
- One of four nitrogenous bases (Adenine, Guanine, Cytosine, and Thymine).

Adenine and Guanine are originated from **purin**, while cytosine and thymine originated from **pyrimidine**.



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DNA Structure

DNA is a Double Helix - like a twisted rubber ladder made from three main components:

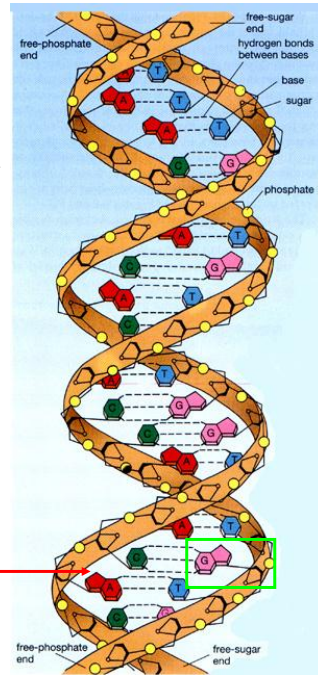
Sides of the ladder are composed of – phosphodiester bonds--a **strong bond** of alternating **sugar** and **phosphate** pieces

Each “rung” of the ladder is made up of two complementary **bases**

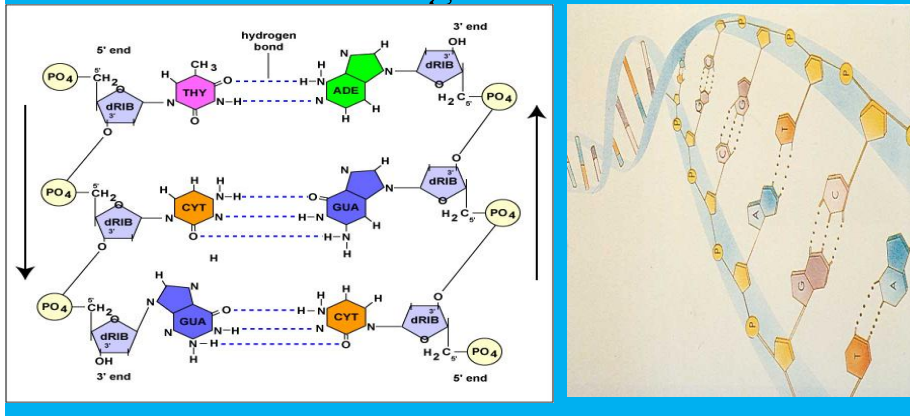
A bound to T

C bound to G

DNA is put together in chunks called **NUCLEOTIDES**



The sequence of bases (A,T,C,andG) that is the genetic code.



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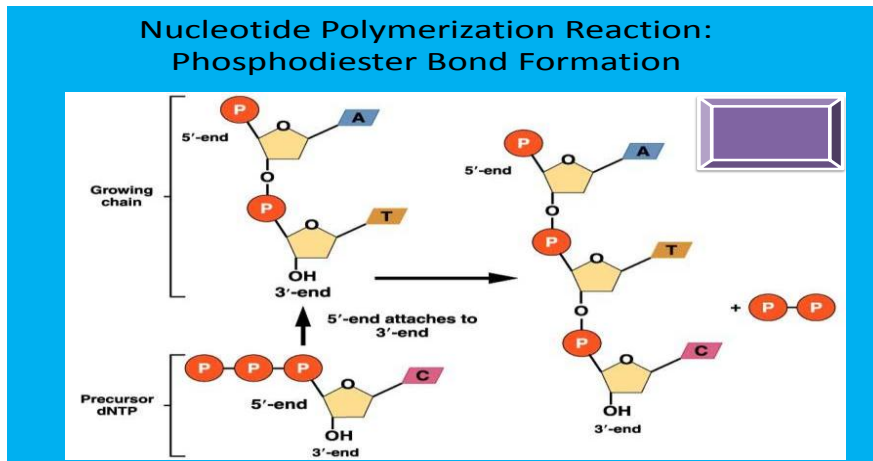
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A Nucleotide

Consists of three parts:

- Phosphate group (PO_4^{3-}) →
- Deoxyribose (sugar) →
- a nitrogen-containing base →

(see, no oxygen at 2'...)



The gene is the code of one protein

DNA molecule (Gene 1, Gene 2, Gene 3)

DNA strand (template): 3' A C C A A A C C G A G T 5'

TRANSCRIPTION → **mRNA**: 5' U G G U U U G G C U C A 3'

TRANSLATION → **Protein**: Trp - Phe - Gly - Ser

Amino acid

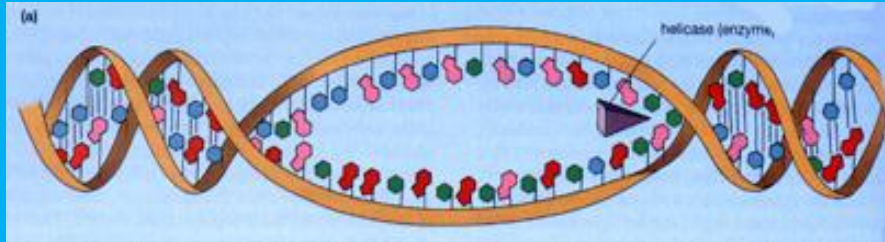
The code for a single amino acid consists of three bases in the DNA molecule.

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Replication Site Bubble

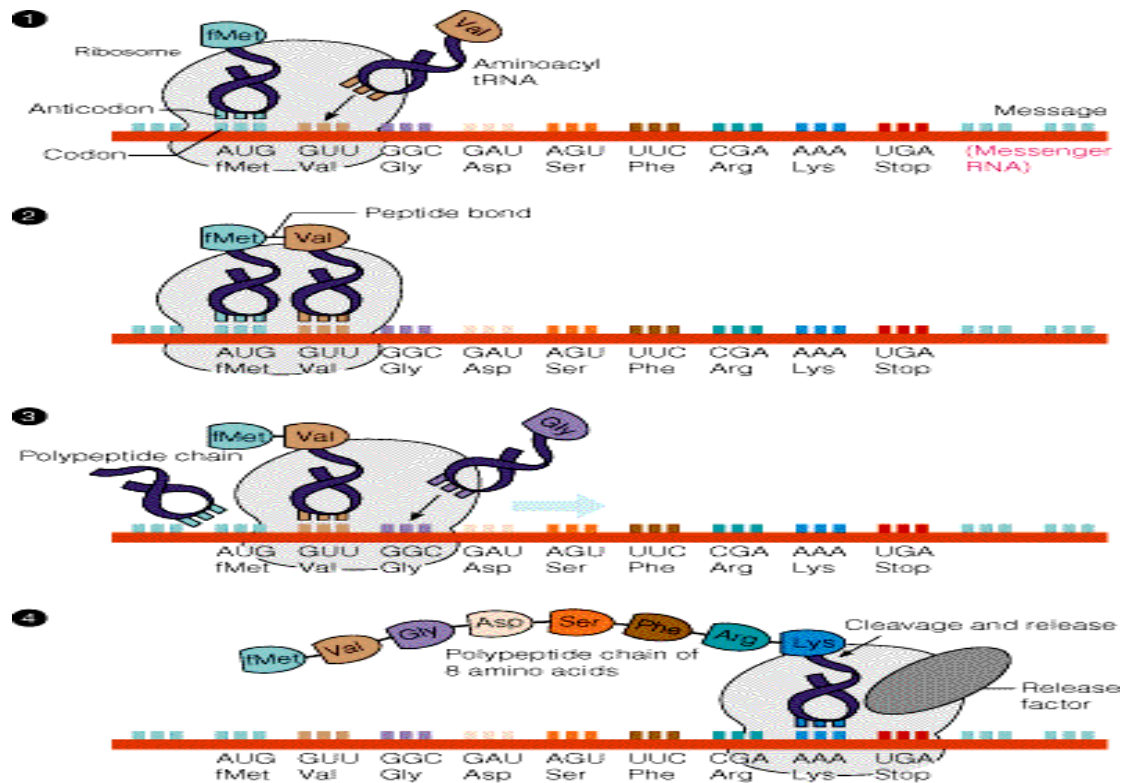
A **DNA Helicase**, an enzyme, **separates** the H-bonds and **unwinds** a small portion of the double helix



Protein synthesis. The m-RNA is formed as a copy of a portion of a portion of the DNA in the nucleus of a cell. In the cytoplasm, the mRNA becomes attached to the ribosomes

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Gene expression

The expression of a gene means that the product of the gene is apparent. e.g. brown eyes or blue eyes.

Mutation:

- Means development of abnormal gene which results from substitution of one base pair for another, loss or addition of one or more base pair.

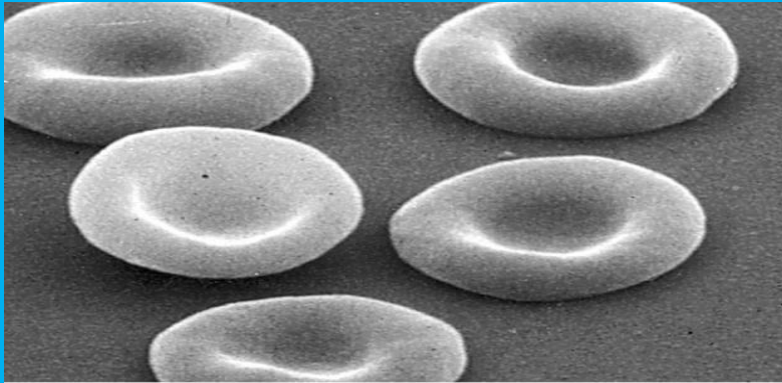
Sickle Cell Anemia

In This disease there is defect in the **β chain** of hemoglobin molecule. Sickle hemoglobin (**HbS**) is transmitted by **recessive inheritance**.

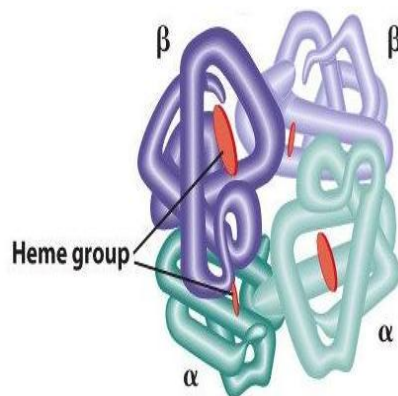
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Scanning electron micrograph of normal human erythrocytes. Note their biconcave shape. x3300



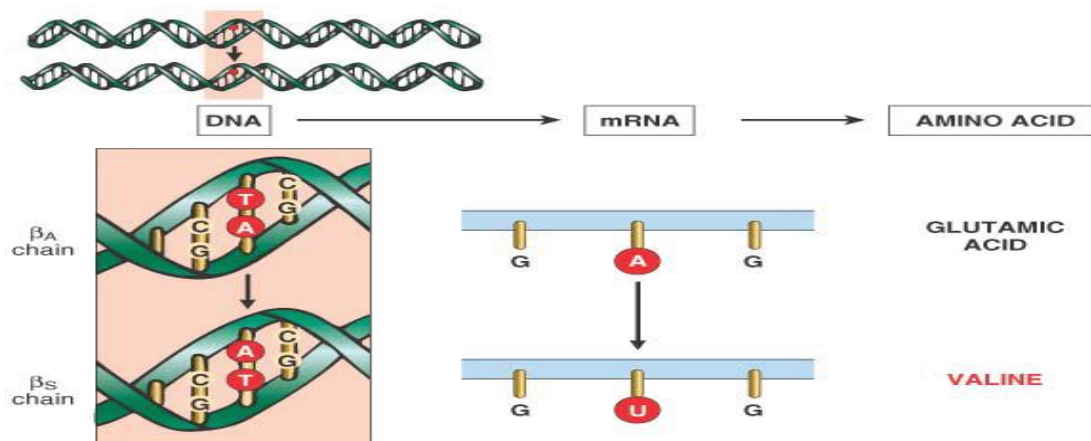
Normal hemoglobin (HbA) contains 4 polypeptide chains (2 α and 2 β chains)



Each α chain contains 141 amino acids, and each β chain contains 146 amino acid.

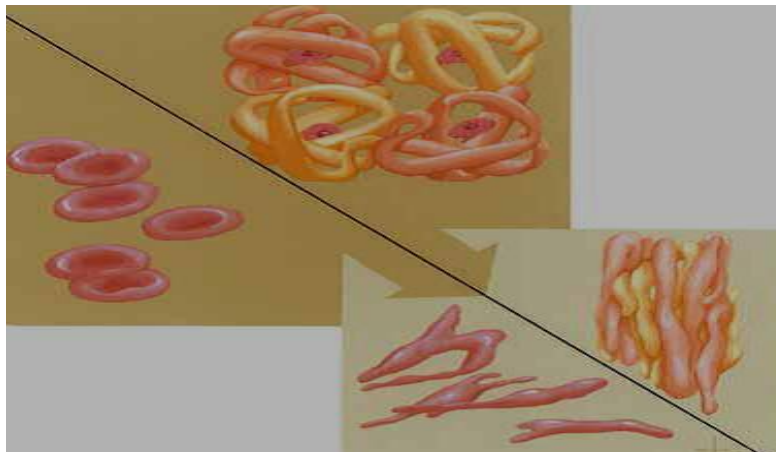
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POINT MUTATION

Normal & abnormal Hb (HbA & HbS)

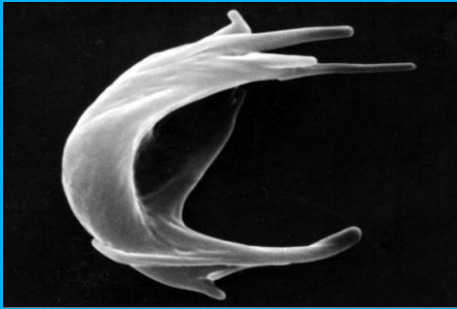


The sixth amino acid of each chain in HbS is incorrect; Valine instead of the glutamic acid found in HbA.

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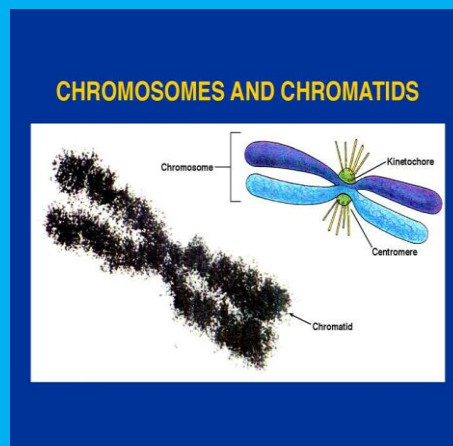
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Scanning electron micrograph of a distorted erythrocyte from a person who is homozygous for the HbS gene (sickle cell disease). x6500.



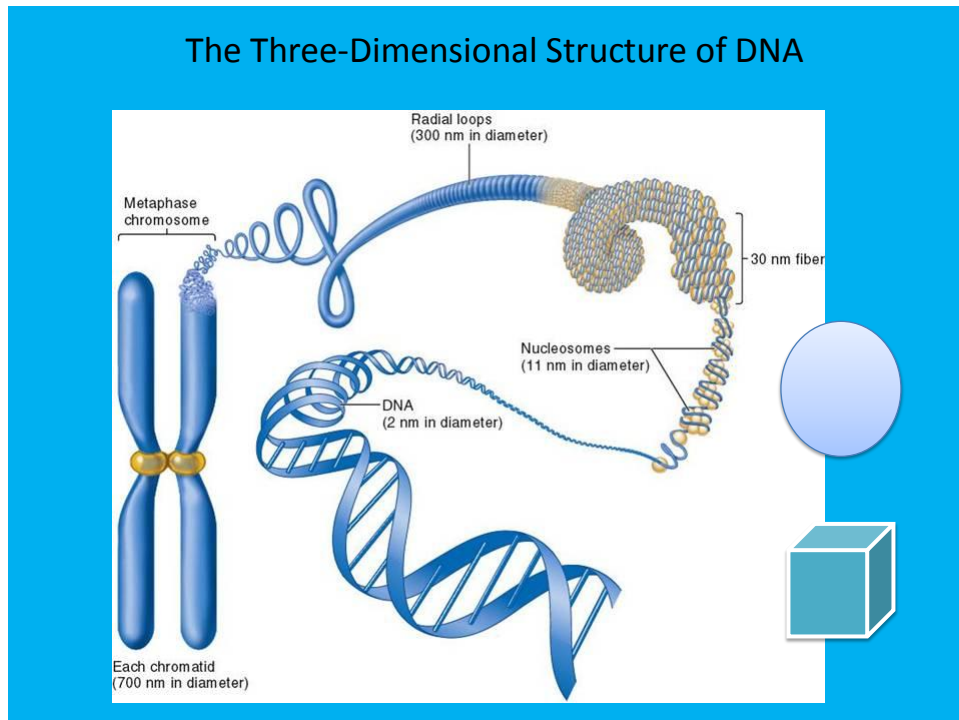
HbS has a great tendency to crystallize when O₂ levels are low. When HbS crystallizes the red blood cells are deformed into crescent and other irregular shapes. These cells clog and rupture capillaries, causing internal bleeding and severe pain.

Chromosome



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Chromosome

- There are nuclear component which are capable of maintaining their morphological and physiological properties through successive cell division.

Types of Cell division

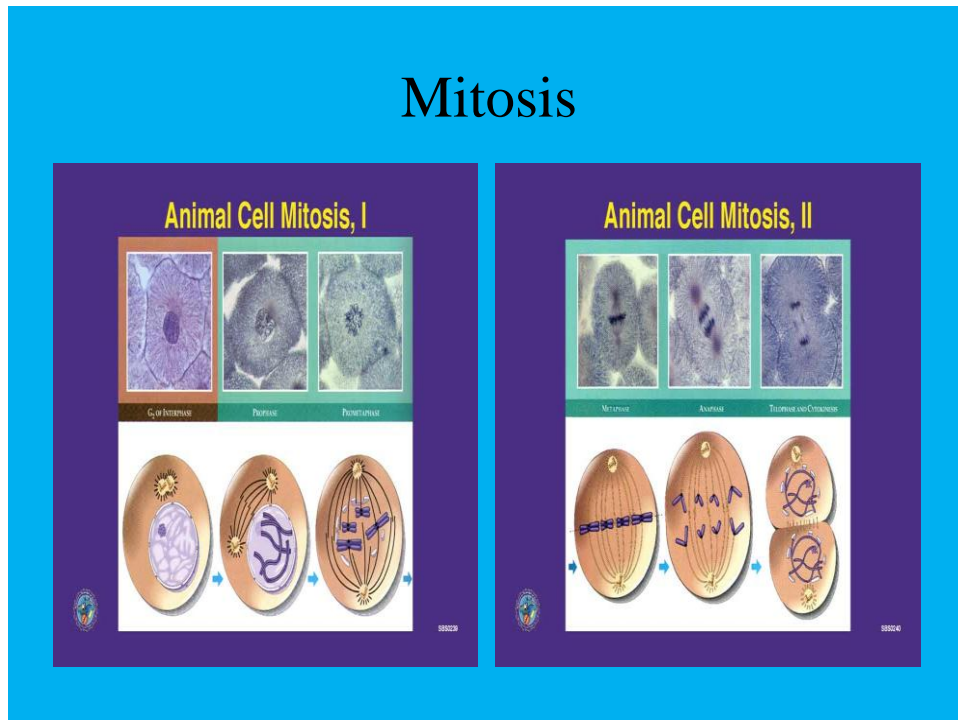
Mitosis:

- The process by which the nucleus divide to produce two identical daughter nuclei.
- During mitosis each chromosome divides into two so that the number of chromosomes in each daughter nucleus is the same as the parent cell.

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Mitosis



Meiosis: The process by which the chromosome number is halved during gametogenesis.

- Somatic cells of man contains a set of “46” chromosomes, i.e (23) pairs.

Chromosomal abnormality

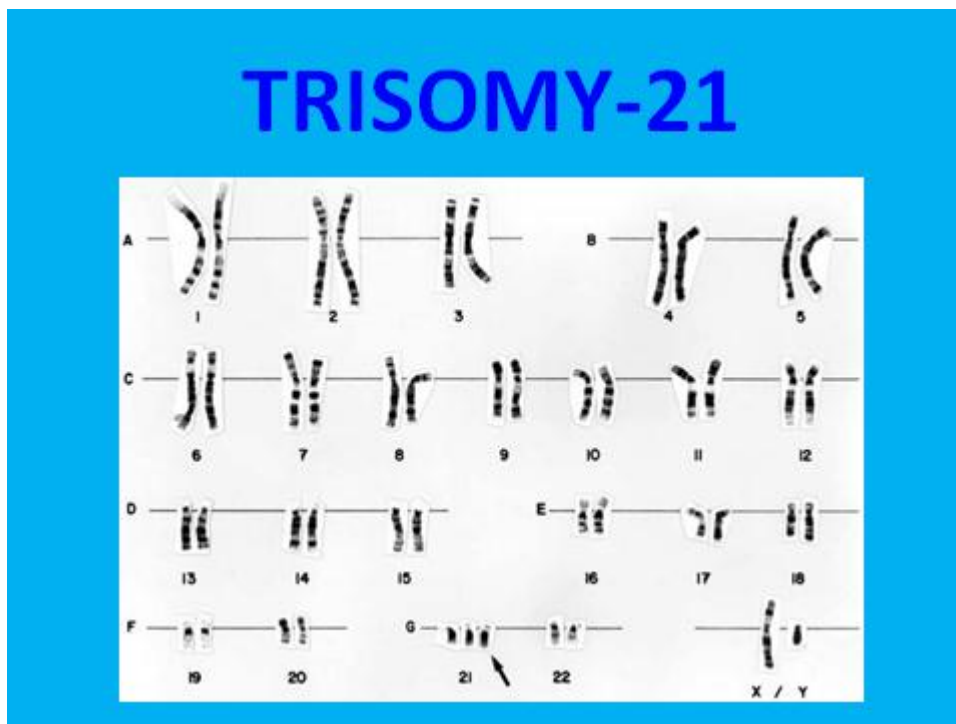
- Abnormality in the chromosome may be involved sex chromosomes or somatic chromosomes
- The abnormality may be in number (numerical abnormality occurs when on or more chromosomes are gained or lost= aneuploidy).
- Structure abnormality= Deletion a portion, Add piece derived from other or unusual shape.

Autosomal abnormality

Down's Syndrome (Mongolism)

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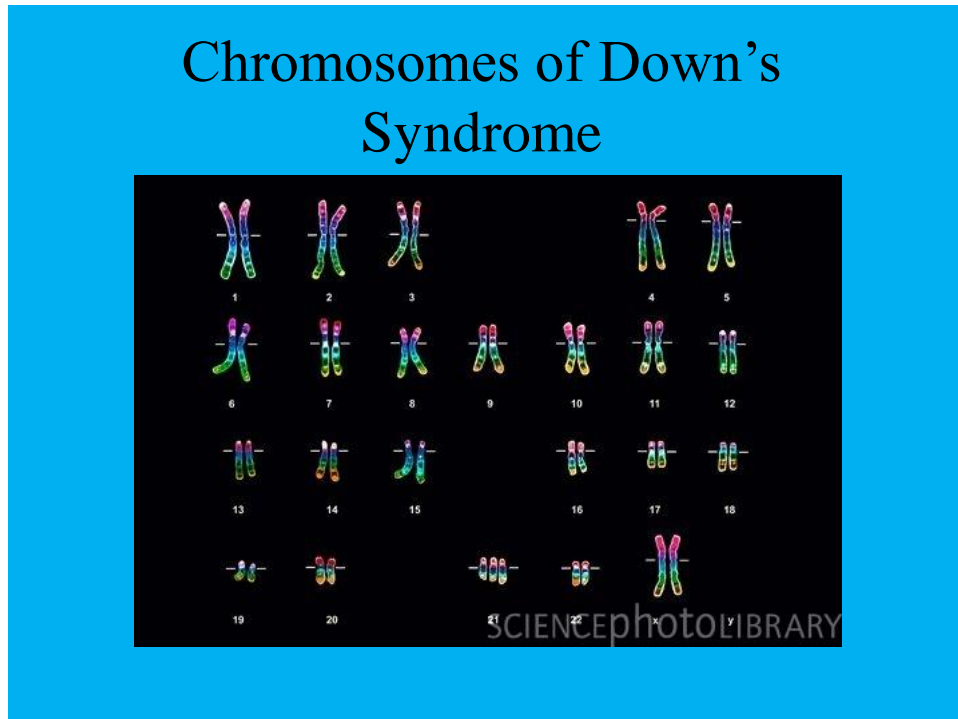
Individual with Down's syndrome display characteristic features:

1. including upward slanting of the eyes, flattened face, and an enlarged tongue.
2. Growth and mental retardation

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3. Increase risk for other significant heart defects, hearing loss, duodenal stenosis.

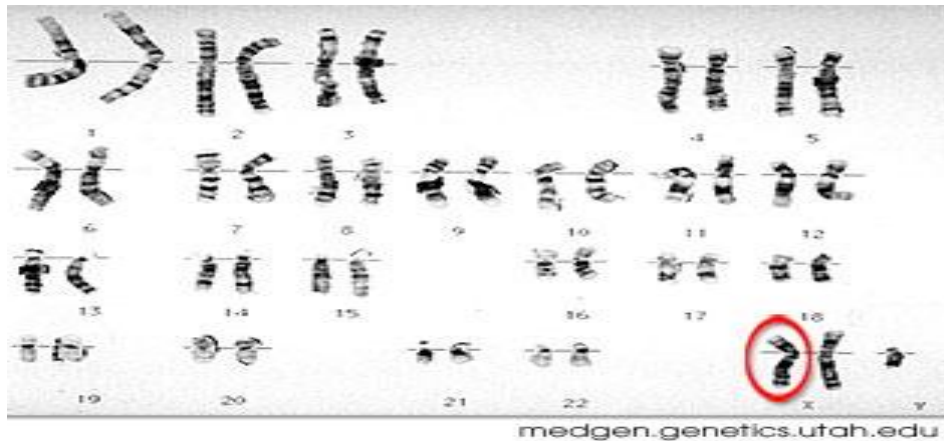


Sex Chromosome Abnormalities

- **Klinefelter's Syndrome:**
 - is the most common chromosomal disorder associated with infertility.
- Male suffering from this condition has an extra X chromosome i.e. XXY
- Patient has longer arms and leg, mild mental deficiency, high luteinizing hormone (LH) and follicle stimulating hormone (FSH), gynecomastia (enlarged breast), obesity, mild mental deficiency.

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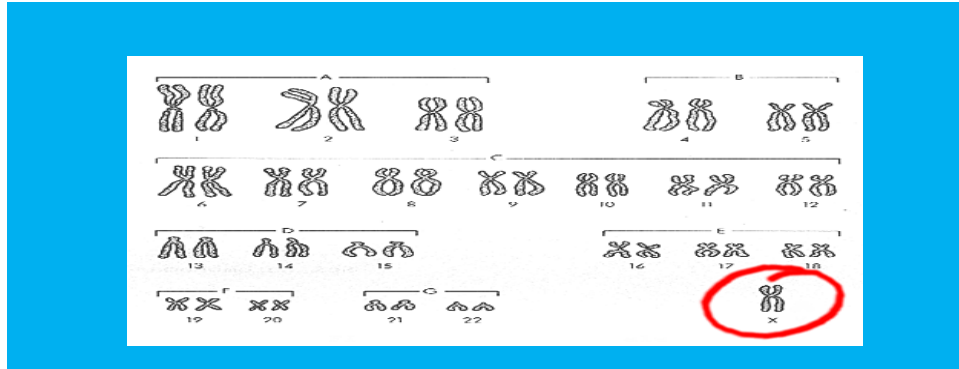
Turner Syndrome:

- Individual with one X chromosome and no Y chromosome, i.e. XO.
- Phenotype is a female but has a group of physical abnormalities including dwarfism and failure of ovarian development, so she is infertile.

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- Short in stature with a triangle-shaped face, and webbed neck.
- Often has congenital heart defect, but not mentally retarded



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