

INTRODUCTION TO FORENSIC DNA FINGERPRINTING

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100 years ago
Personal identification and description



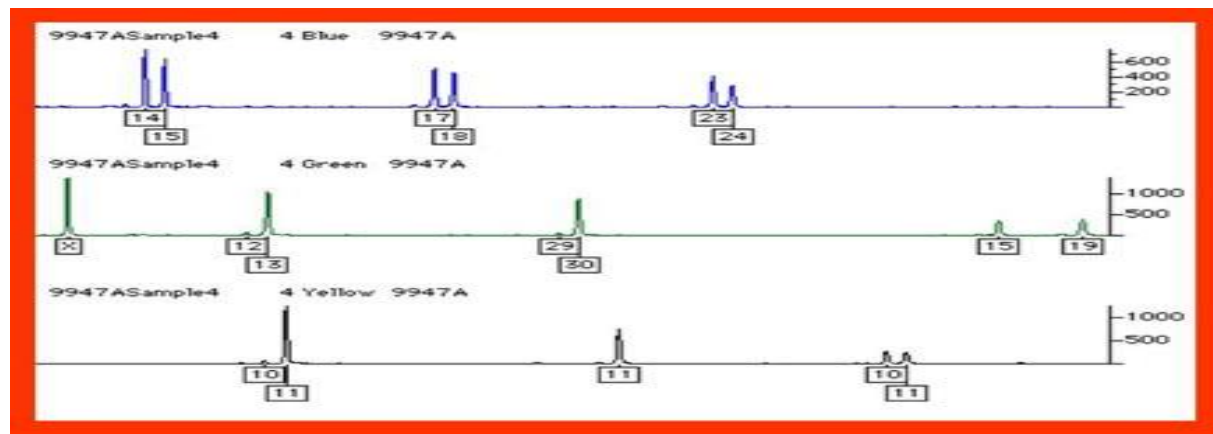
- Sir Francis Galton, a British Anthropologist, is referred to as the Father of Fingerprints.
- No two people have ever been found to have the same fingerprints- including identical twins.
- One of the basic importances of fingerprints is that it helps in establishing identity of a person with minimum time and efforts; and then enabling speedy investigation.
- The fingerprint evidence has been referred to as reliable piece of evidence.
- They are also permanent and do not undergo any change.

➤ **DNA FINGERPRINTING:-** is one of the greatest technical achievements for crime investigation since the discovery of **fingerprints**....
a century ago.

- DNA fingerprinting is a laboratory technique used to determine the probable identity of a person based on the nucleotide sequences of certain regions of human DNA that are unique to individuals.
- The technique to use the highly variable polymorphic regions of DNA to identify individuals by preparing a profile.

- DNA typing is the most important advancement in the field of Forensic Science.
- It serves as a powerful forensic tool, not only because of its high level of discrimination among individuals, but also because it can be done with many sources of biological materials.

DNA – Deoxyribo Nucleic Acid



AmpFISTR Profiler Plus STR Data Collected on an ABI PRISM 310 Genetic Analyzer

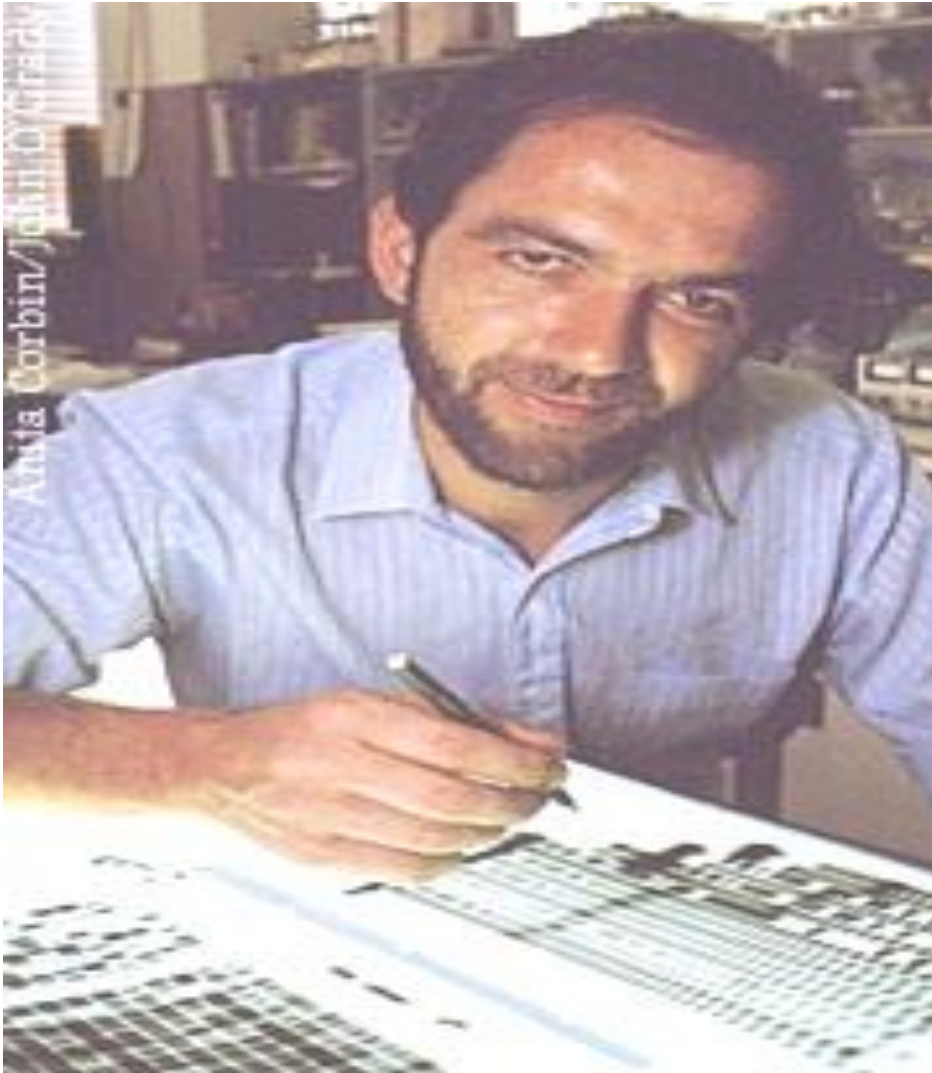
DEFINITION :

- DNA- *Deoxyribonucleic acid* - is the polymer of nucleotides present in the nucleus of the cell. It is a double stranded molecule that carries genetic information in living organisms.

DNA FINGER PRINTING – INTRODUCTION:

- DNA finger printing is a genetic technique i.e. decoding of genetic information.
- Each individual has an entirely unique genetic ‘signature’ / the DNA “fingerprint”
- DNA fingerprint is the certainty of identification.
- DNA finger printing – is also called DNA typing/DNA profiling.
- DNA typing / profiling was first described in 1985 by an English geneticist ‘ **Sir Alec Jeffreys**’.

DNA FINGERPRINTING



- *Sir Alec J. Jeffreys—
the Father of DNA
Fingerprinting.*

Dr. Lalji Singh

**“FATHER OF DNA FINGERPRINTING
TECHNIQUE IN INDIA”**



**Director, Center for Cellular and
Molecular Biology, Hyderabad**

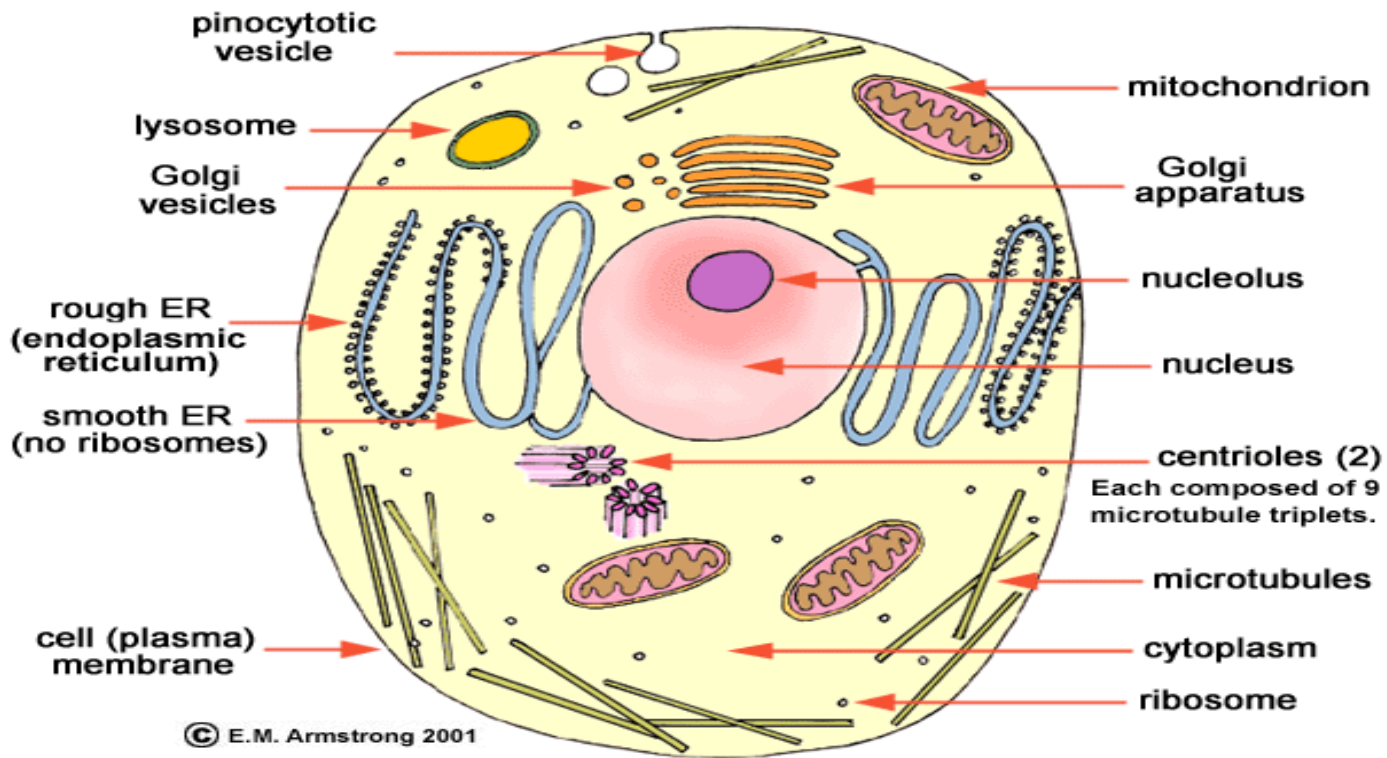


- When DNA profiling is done with appropriate care the results are highly reproducible and conclusive enough to prove the guilt or innocence of the suspect beyond reasonable doubt.

CELL – THE BASIS OF LIFE:

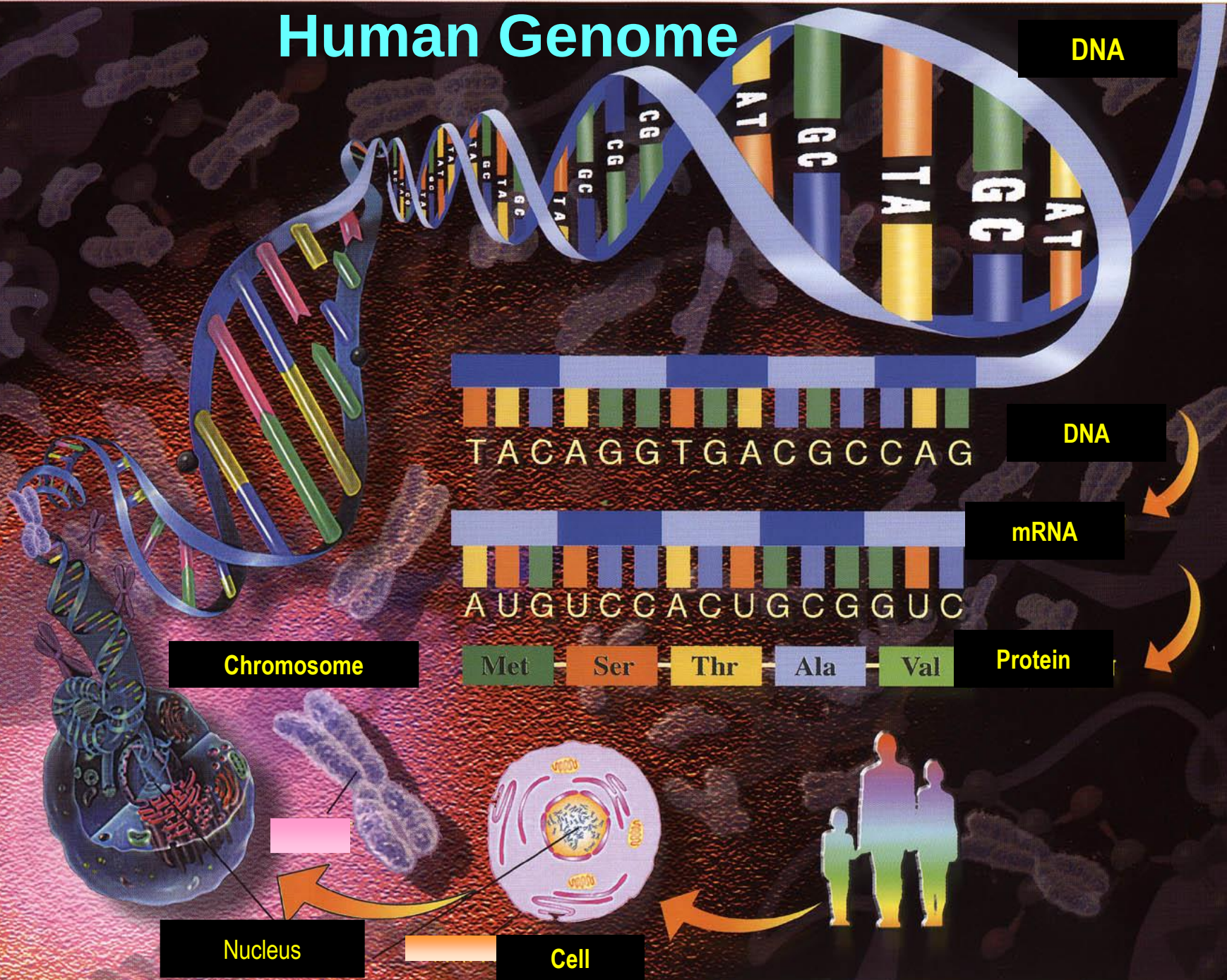
- The basic unit of life is the cell which is a miniature factory producing the raw materials, energy and waste removal capabilities necessary to sustain life. Inside each cell in the human body, within the nucleus, there are strands of genetic material called chromosomes.
- Along the chromosomes, like beads on a thread, genes are arranged.
- The gene is the fundamental unit of heredity. It instructs the body cells to make proteins that determine every character and function of the body.
- Each gene is actually composed of DNA.
- DNA is the structural and functional chemical unit of chromosomes.

Anatomy of the animal cell



**EVERY HUMAN BODY CONTAINS CRORES OF CELLS
EVERY CELL CONTAINS NUCLUES
EACH NUCLUES CONTAINS DNA.**

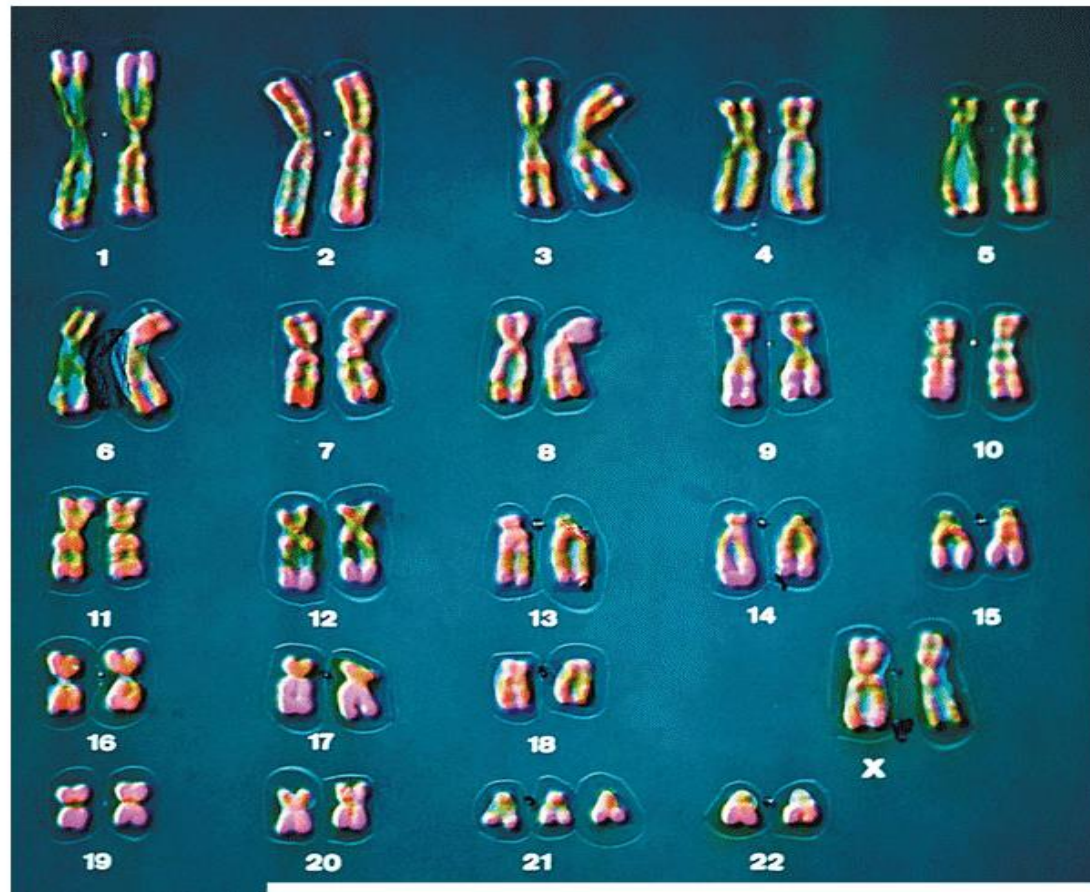
Human Genome



CHROMOSOMES – INHERITANCE:

- Every species has a characteristic set of chromosomes in each cell called the karyotype.
- The human karyotype consists of 46 chromosomes or 23 pairs of chromosomes.
- Out of these, 44 chromosomes form homologous pairs (one from each parent); and in addition, females have **two** X chromosomes (XX) and males have **one** X and **one** Y chromosome (XY).
- Most human identity testing is performed using markers on the autosomal (somatic) chromosomes and gender determination is done with markers on the sex chromosomes.

CHROMOSOMES

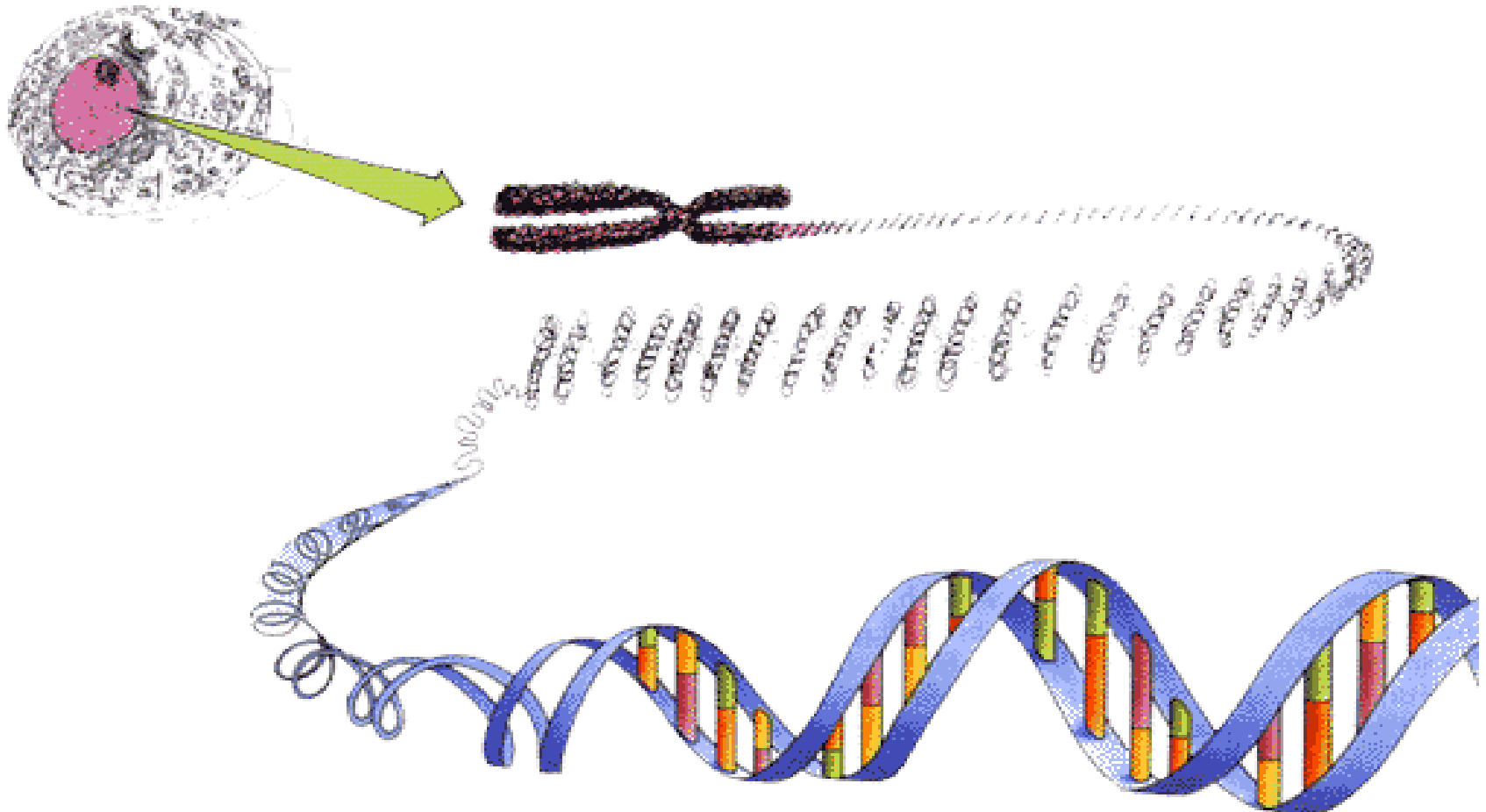


- Every human body cell contains 46 chromosomes i.e 23 pairs, except in reproductive cells i.e. the egg & sperm.
- During fertilization a sperm & an egg combine so that each contributes chromosomes to form the new cell – zygote.
- Because the genes are positioned on the chromosomes, the offspring inherits genetic material from each parent.
- The egg cell always contains XX chromosomes.
- The sperm cell contains a short one called “Y” chromosome and one “X” chromosome.
- When X- carrying sperm fertilizes with an egg; the new cell is – XX – develops into a female.
- When Y- carrying sperm fertilizes with an egg; the new cell is – XY – develops into a male.
- The father biologically determines the sex of the child.

- **Genes** that govern a given character are similarly positioned on chromosomes inherited from the mother & the father (Alleles).
- Genes instruct the body cells to make proteins – determining characteristics of a person – hair color to susceptibility to diseases.
- The inheritable traits that are controlled by DNA which directs the production of complex molecules called **proteins**.
- Proteins are actually made by linking together a combination of up to 20 known **amino acids**.
- The sequence of amino acids-determines the shape & function of a protein.

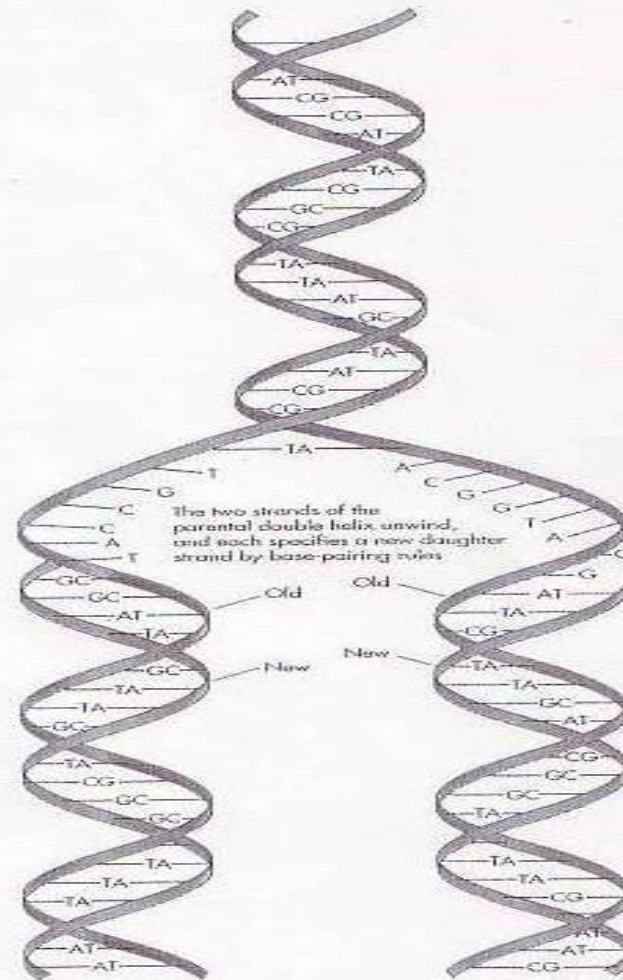
- The observable variation in human DNA is called polymorphism.
- The polymorphic segments in the DNA molecule serve as a means to identify individuals.
- On the basis of these findings, it was revealed that, except for monozygotic twins, each individual can be differentiated from another.

DNA in the Cell:



- Nuclear DNA is a unique type of molecule.
- Its shape is called a double helix.
- Consider a very long ladder.
- This ladder has two poles connected by many rungs.
- Each rung consists of two complementary pieces that are joined together.
- Now, if the ladder is twisted many times throughout its length, it resembles a spiral staircase.
- That is the shape of the DNA molecule.

DOUBLE HELICAL STRUCTURE OF DNA



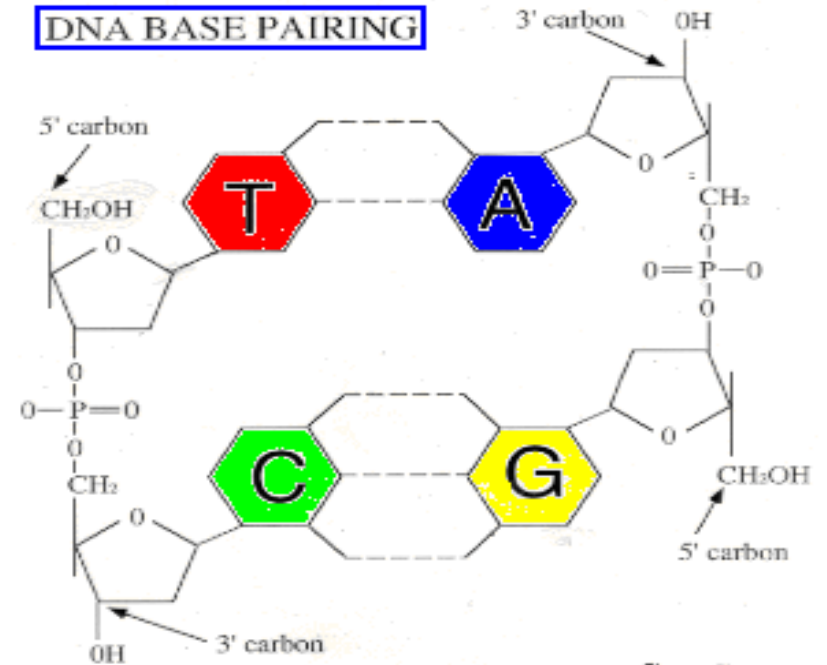
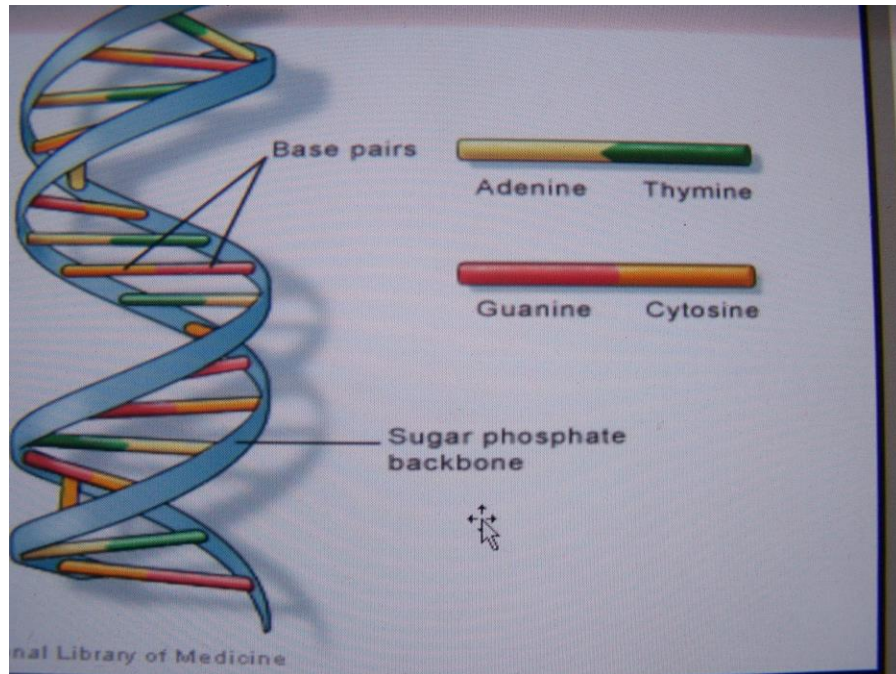
- **Watson and Crick** have described the structure of DNA molecule.
- DNA molecule is a composition of two DNA strands coiled into a double helix.

- The poles are exactly the same in all people.
- The rungs are special, however.
- Each rung is made up of two bases or nucleotides that are joined together in the middle as well as to the poles.
- So, each rung is made up of a base pair.

- DNA is a polymer.
- A polymer is a very large molecule made by linkage of a series of repeating units known as nucleotides.
- A nucleotide is composed of a sugar molecule, a phosphorous containing group and a nitrogen containing molecule called a base, which is either Adenine (A), Guanine (G), Thymine (T) or Cytosine (C).

- The only arrangement possible in the double-helix configuration was the pairing of bases - A to T and G to C, a concept that is known as “base pairing”.
- Although A-T and G-C pairs are always required, there are no restrictions on how the bases are to be sequenced on a DNA strand.

- Any base can follow another on a DNA strand.
- The average human chromosome has DNA containing 100 million base pairs.
- All the human chromosomes taken together contain about 3 billion base pairs.
- That is the diversity of DNA and hence the diversity of living organisms.



- **T-C-G-A** can be paired with the base sequence
- **A-G-C-T** in a double-helix configuration.

- DNA Finger printing is the technique to use the highly variable polymorphic regions of DNA to identify individuals by preparing their DNA profiles.
- The basic chemical structure of everyone's DNA is the same. The only difference between people (or any animal or plant) is the order of the base pairs.

- There are so many millions of base pairs in each person's DNA and every person has a different sequence.
- Using these sequences every person could be identified solely by the sequence of their base pairs.
- No two human beings have identical sequences with an exception of identical twins.

The following are various types of crimes where in the biological evidence is crucial

- Murder
- Violence
- Cases involving injury
- Accident
- Sexual assault
- Cases of identity: of the missing and the dead etc.

CRIME SCENE



Questionnaire on blood stains:

The blood stains are examined to answer one or more of the following questions.

- ▶ Whether the stain in question is of blood or not?
- ▶ If it is blood, is it of human or animal origin?
- ▶ If it is animal, what species of animal?
- ▶ If human, what is the blood group?

The questions can be answered by examining the blood stains by serological methods.



Serological examination of forensic evidence

- ▶ There are more than 20 genetically determined blood group systems known today.
- ▶ The system most intensively used in routine forensic examination is the AB0 system discovered by **Landsteiner** in 1900.
- ▶ The next best known is the Rh system, which is however, not found useful in the analysis of dried bloodstains.
- ▶ It is more often used in disputed paternity cases in which whole blood analysis is involved.

ABO blood grouping system:

- According to the ABO blood typing system there are four different kinds of blood groups: **A, B, AB & O.**

SUMMARY OF ANTIGEN, ANTIBODY COMPONENTS IN BLOOD

BLOOD GROUP	ANTIGEN IN RED CELLS	ANTIBODIES IN SERUM	APPROXIMATE % OF INDIAN POPULATION
A	A	Anti-B	22
B	B	Anti-A	33
AB	A&B	--	5
O	--	Anti-A & anti-B	40

BLOOD GROUP NOTATION:

According to above blood grouping systems, you can belong to any of the following 8 blood groups:

A Rh+

A Rh-

B Rh+

B Rh-

AB Rh+

AB Rh-

O Rh+

O Rh-

BLOOD GROUPING OF BLOOD STAINS

- ▶ In dried blood stains as the red blood cells are all broken, it is not possible to undertake direct agglutination tests for the purpose of grouping.
- ▶ However the blood group antigens in the broken cells especially the ABO antigens retain their property of combining with specific antibodies for a considerable period.
- ▶ The absorption – elution and the mixed agglutination tests are most frequently used tests to determine the blood groups of dried stains.

Other blood group systems:

- ▶ There are blood groups other than ABO system. They are Rh, MN types, DUFFY, LUTHRAN, LEWIS etc., which divide the blood group into hundreds of groups.
- ▶ Polymorphic enzymes like Gm, Gc, Haptoglobins- serum groups and red cell enzyme groups like PGM, AK, EAP, GLO1, ESD etc. and white cell antigen-HLA system etc. exist in variable forms although they have the same function to play.