

25. Heredity

- Features passed down from one generation to the other is **Heredity** or **Inheritance**. Genes control heredity.
- Differences in features of individuals of the same species is **variation**.
- An Austrian monk, **Gregor Johann Mendel** experimented with peas to find out how the various features get inherited. He postulated laws of inheritance.

Build Your Understanding

• Heredity and Variation

When your eyes are like those of your mother and your brother's eyes like those of your father, it is due to **heredity**. The noticeable difference in the colour of eyes is termed **variation**.

• Mendel's Laws

Mendel explained heredity and variation through laws called Mendel's laws of inheritance.

1st Law: Law of segregation of characters

Every feature is controlled by a pair of genes (factors) which segregate during gamete formation and go to different cells (gametes, sperm or egg)

2nd Law: Law of Dominance

A gene of a pair which may express even in the presence of the other – is called **dominant**. The other gene termed **recessive** expresses only when two recessive genes are present, one each received from either parent.

The different forms of a gene are termed **alleles**.

Dominant alleles are shown by capital letter and recessive by small letter e.g. Bb; B = Brown eyes, b = blue eyes

What will be the eye colour of a person whose genetic composition is indicated as bb?

Chromosomes and Genes

- **Sutton** (1902) saw thread like structures in the dividing cells of grasshopper's testis. These were the chromosomes. Soon it was evident that **genes** are present on chromosomes.

- **chromosomes** seen only in dividing cells. Jumbled up as **chromatin network** in the nucleus of non-dividing cells
- Number of chromosomes fixed in a species, present in **homologous pairs** (both chromosomes of a pair bearing same genes, but not necessarily same alleles). Hence, the fixed member is termed **diploid** and designated as $2n$ ($n = \text{haploid}$). In humans $2n = 46$. Of these 44 are termed autosomes and X and Y as sex chromosomes. Male has a long X and a short Y chromosome and female has two X chromosomes.
- A chromosome is made of one molecule of DNA or Deoxyribonucleic acid and proteins.
- Segments of this DNA molecule are **genes**.
- Bacteria have only one circular chromosome.

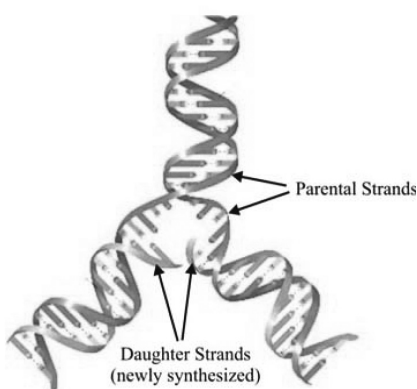
DNA – Deoxyribonucleic Acid

- Is a polynucleotide made of many units of deoxyribonucleotides.
- Each deoxyribonucleotide has
 - A nitrogenous base
 - A deoxyribose sugar
 - A phosphate
- The nitrogenous bases are Adenine (A), Guanine (G), Thymine (T), Cytosine (C).
- A DNA molecule is made of two strands of DNA helically coiled around each other.

DNA Replication

- For genes to be inherited, DNA needs copies of itself. This is called DNA **replication**. The steps are aided by enzymes, DNA unwinds into its two strands.
- New daughter strands are formed such that their base pairing is correct with the two parental DNA strands.
- So upon DNA replication, two identical molecules of DNA are formed. These are termed **chromatids** and remain joined by a **centromere**.

DNA Replication



- Parent DNA @ DNA unzips
- Two new daughter strands helically coil against the two unzipped parental strands.
- So two identical daughter DNA molecules formed giving rise to two chromatids.
- A chromosome after replication

Blood Groups

Every human belongs to one of the four blood groups A, B, AB, O controlled by genes I^A , I^B , or i and Rh^+ or Rh^-

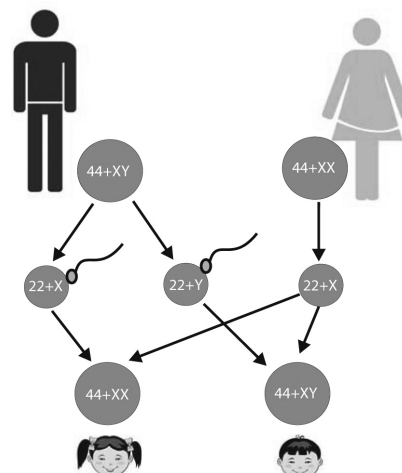
$I^A I^A$ or $I^A i$	Blood group A	Can donate blood to A or AB
$I^B I^B$ or $I^B i$	Blood group B	Can donate blood to B or AB
$I^A I^B$	Blood group AB	Universal Recipient
$I^A I^B$	Blood group O	Universal donor
Safest blood group for transfusion O Rh^-		

• Heredity and Variation

Variations caused by environment such as sun burn, powerful muscles of body builder, scars due to accident are **not hereditary**. Only genetic

variations like hair color, height, tongue rolling etc. are inherited. Intelligence, musical and sports ability are due to both effect of genes and environment.

• Sex determination in humans



Slogan: Say **No** to testing foetus for its sex.

• Hereditary disorders in human and Genetic Counselling

A change in a gene is called mutation. A mutated gene may cause hereditary diseases such as:

- **Thalassemia**, a genetic disorder when Hb is not synthesised in bone marrow and frequent blood transfusion is required
- **Haemophilia**, where a gene for clotting is absent.

Colour blindness, when the recessive gene for colour distinction present on X-chromosome interferes with distinguishing colours.

When marriages take place between relatives, there is a chance of inheritance of two recessive genes from either parents who are related. Hence, it makes sense to meet a **genetic counsellor** beforehand if there are defective genes in the family.

• Human Genome

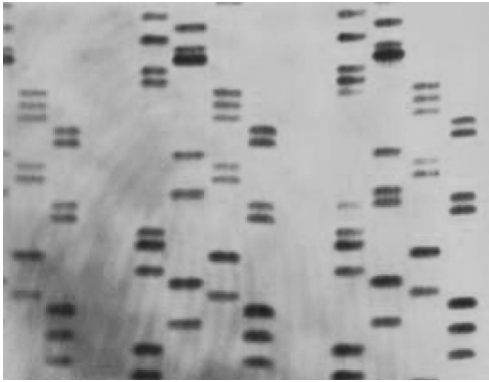
Genome means all the genes and their location on various chromosomes. Human genome has been mapped and gene therapy for curing hereditary diseases is underway.

DNA Fingerprinting: Method to identify unique DNA of an individual and genetic relationships.

- Source of DNA of the suspect such as hair, blood, skin is obtain.

- Extract DNA is extracted and increase its quantity.
- Cut and separated DNA fragments according to size are used to get '**genetic fingerprint**'.
- Compared and the suspect identified.

Use of genetic fingerprinting as criminal evidence



This shows that the suspect I was at the crime scene as the DNA fragments match up.

Genetic Engineering or Recombinant DNA Technique

- Genes may be altered for making a useful product e.g. insulin for diabetics.

★ Stretch Yourself

1. How does variation arise?
Variation arises at gamete formation or through **mutation**.
2. How is it that normal couple may have a child with a genetic disorder?
When a gene in a gamete mutates either naturally or due to exposure to radiation or other causes, it may lose its normal function. The expression of a defective gene is usually masked by the normal gene with which it pairs. But if both parents possess the defective gene, then the child may inherit both the defective genes and is likely have the disorder.

? Test Yourself

1. Why are 'heredity' and 'variation' studied together?
2. 'Law of segregation of characters' is Mendel's first and universal law of inheritance. How does the segregation take place? Explain.
3. What is the chemical nature of a chromosome and a gene and what is the difference between a chromosome and gene?
4. What is needed to be collected from the side of crime for finding the real criminal through DNA finger printing and why is just a bit of the tissue from criminal site enough?
5. What is DNA made of? Describe.
6. Which is the safest blood group for transfusion in an emergency and why?
7. Why should parents not be blamed for the sex and gender of their child?
8. What is genetic engineering?
9. Why should marriages between relatives be discouraged?
10. How does DNA make identical copies?