BIOLOGY WEEK NINE – TEN

TOPIC: **Chromosomes (Location, Structure, Roles in Genetics), Probability and Application of Genetics**

PROCEDURE:

Step I: Location and structure of chromosomes

Chromatin granules (thread-like structures) found in the nucleus of eukaryotic cells are the precursors or raw materials of chromosomes.

Chromosomes occur in pairs known as homologous chromosomes. Each chromosome is made up of two threads called chromatids joined at a point called the centromere. Each human somatic cell has 46 chromosomes. These are present in 23 pairs of homologous chromosomes. The number of chromosomes in each somatic cell of an organism is called the diploid number (2n). Each chromosome is made up of protein units in a strand of deoxyribonucleic acid, DNA (in the double helix). Along its length are genes arranged which are actually DNA segments. The DNA is a very large molecule made up of repeating units called nucleotides. Each nucleotide is made up of deoxyribose (a sugar molecule), phosphate and an organic nitrogenous base which may be adenine, guanine, thymine or cytosine. Guanine always pairs with cytosine and adenine with thymine. The two helical chains are referred to as complementary strands of DNA since one is the exact opposite of the other.

Sex chromosomes and autosomes

There are forty-four autosomes which are similar in shape and size in both male and female. The last pair is called sex chromosome which is of genotype XX in female and XY in male. An exception to this is in birds, moths and butterfly where the female has genotype XY and the male XX. Also, in certain grasshoppers, the Y chromosome is absent so that the male has the genotype XO. Just before cell division, the protein bundles come together and the DNA strands coil tightly around them, causing the chains to shorten and become visible under the light microscope.

This process is called condensation. Each DNA molecule is made up of thousands of genes. The DNA molecules coil around the 23 pairs of chromosomes. In the human body, cells are about 50,000 genes. Each DNA molecule can
make an exact copy of itself in a process called replication. This forms the basis for the transmission of hereditary materials from parents to the offspring.

Step II: Role of chromosome in the transmission of hereditary characters

Genes are the expression of hereditary characters in organisms and are located on the chromosomes of body cells. Therefore chromosomes are responsible for the transmission of characters from parents to offspring. Chromosomes are arranged in pairs known as homologous chromosomes (exactly alike in shape and size and carry genes responsible for the transmission of the same characteristics). The genes relating to the same character e. g. tallness and shortness occupy identical loci on the homologous pair. The genes on homologous pair of chromosomes determine whether the individual will be homozygous or heterozygous for certain characters

Step III: Process of transmission of hereditary characters by chromosomes

1. The chromosomes pass the genes into the gamete during meiosis.
2. Homologous chromosome separates into two daughter cells during the first stage of meiosis.
3. The two chromatids of each chromosome separate during the second stage of meiosis. Each gamete,

therefore, has one set of chromosomes hence one copy of genes.

4. During fertilization, the gametes fuse together to form a zygote. The zygote receives two genes for the same character (one from one chromosome in the egg and the other from one chromosome in the sperm).
5. When the two genes are the same, the offspring is homozygous but when they are different, the offspring is a heterozygous (hybrid).

Step IV: Sex-linked traits

Sex-linked traits are characteristics whose genes are carried on the X chromosome of the sex chromosomes instead of autosomes. Such genes are inherited along with such X chromosomes. They are all controlled by a recessive gene. Examples of Sex-linked traits are colour blindness, haemophilia, baldness, sickle cell anaemia and albinism.

1. **Colour blindness:** A colour blind person cannot distinguish near colours. It is an abnormality of the gene that controls the production of cone cells (light receptors) in the retina of the eye.
2. **Haemophilia:** This is a disorder in which bleeding takes an abnormally long time to stop or fails to stop because blood clotting will not occur. In haemophiliac (the victim) small injuries can result to bleeding to death e.g. Queen Victoria's lineage (gene for haemophilia arose as a mutation in Queen Victoria or one of her parents) in British Royal Family.
3. **Baldness:** The recessive gene controlling this trait causes the hair on the upper part of the head to pull out prematurely. It is more common in male human beings.
4. **Albinism:** This is the condition in which the skin of an animal is non – pigmented because of lack of the pigment called melanin.
5. **Sickle cell anaemia:** The recessive gene controlling this abnormality causes some of the red blood cells to be sickle-shaped. The haemoglobin of the affected red blood cells is abnormally shaped thereby making it inefficient in transporting oxygen. In a condition of low oxygen concentration, the haemoglobin breaks down causing the cells to be sickle-shaped. This then leads to the blockage of the cavities of the small blood vessels in the body thus hindering the free flow of blood. The body part affected receives lower blood, oxygen and nutrients. Therefore, the victim goes into crisis at such periods characterized by pains in the bones and joints.

Step IV: Applications of the principle of hereditary

In agriculture, genetics is relevant and has led to the following:

1. Cross-fertilization &self-fertilization procedures
2. Development of early maturing varieties of organisms.
3. Development of disease-resistant varieties of organisms.
4. Production of crops and animals that can adapt to climatic conditions.
5. Improvement of quality and quantity of product

In medicine, genetics helps in the following:

1. Determination of paternity of a child.
2. Blood transfusion
3. Diagnosis of diseases
4. Sex determination
5. Marriage counselling to avoid cases of a genetic disorder.
6. Knowing and choosing the sex of a baby.
7. Development of test tubes babies.

SUMMARY: The nervous systems co-ordinate various biological activities in the body of multicellular animals, the basic structural unit of the nervous system is the nerve cell called a **neurons**. It consists of a dense, cell body and protoplasmic processes called **nerve** fibers.

HOME WORK

- What is a chromosome?
- Differentiate between chromosomes and autosomes
- Describe the structure of a chromosome
- What is the role of chromosome in the transmission of hereditary characters?
- State five application of genetics in medicine and agriculture