MUTATION.

Mutation is the sudden change in the amount or the structure of the DNA on the chromosome of an organism.

Mutations produces a change in the genotype of the daughter cells and may result in the change of the phenotype or in appearance of new characteristics of organism in a population, mutations which occur in gamete cells, are inherited whereas as those occurring in somatic cells can not be inherited but appear in daughter cells produced by mitosis.

GENERAL EFFECTS OF MUTATION.

- Genetic variation.
- Emergence of new characteristics.
- Retarded growth.
- Mental retardation.
- Body deformities/Abnormal development of body parts and organs.
- Sterility.
- Hybrid vigour.
- Errors in metabolism.
- Diseases.

GENERAL PROPERTIES (CHARACTERISTICS) OF MUTATION.

● It is spontaneous, occurs naturally unhibited/occurs without premeditation.
● Most mutations are disadvantageous to organism but some are advantagious.
● There occurrence is not common but when it occurs, it becomes persistent
● They occur gradually.
● Their occurrence is very sudden
● They occur randomly in nature
● Environment has less influence over them.

CAUSES OF MUTATION.

Any agent which causes mutation is called a mutagen. Mutagens alter structure of a DNA or its amount by causing some chromosomal changes. The causes of mutation include,

▪ Electromagnetic radiations such as ultra–violet light, x–rays and gamma rays.
▪ Particle radiations and fast and thermal neutrons are even more dangerous mutagens such as beta and alpha particles.

▪ A number of chemicals such as colchicine, formaldehydes, nitrous acid, sodium azide and mustard gas, cause mutations. Colchicine inhibits spindle formation and so causes polyploidy.
▪ Biological mutagens, they include human viruses like human papilloma virus, hepatitis B, C viruses.
▪ Environmnetal pollutants.

A natural mutation rate is greatly increased, in species of organisms with shorter life cycle and therefore has more frequent Meiosis. And the chance of occurrence of mutation is increased during gamete formation.

TYPES OF MUTATIONS.
Mutations are of two categories.

- Chromosome mutation.
- Gene mutation.

Chromosome mutation: Is the sudden change in the amount or arrangement of DNA on the chromosome.

Gene mutation (point mutation) Is a change in the structure of DNA at a single locus on a chromosome.

CHROMOSOME MUTATION
A change in the amount or arrangement of DNA on the chromosome can arise due to changes in the number or structure of chromosomes. These changes may involve the following aspects:

- Changes in the whole sets of chromosomes (Polyploidy)
- changes in the number of the chromosomes (Aneuploidy)
- Changes in the chromosome structure.

POLYPLOIDY (EUPLOIDY)
This is a condition where a diploid cell of an organism has an additional whole sets of chromosomes. The cell contains multiples of the haploid number of chromosomes such cells are termed as polyploids. Polyploidy can be where three sets of chromosomes are present in a cell called triploid (3n), with four whole sets of chromosomes present in a cell it is tetraploid (4n), five whole sets present, these are pentaploids (5n), etc.

It results into great increase in composition of DNA molecules in the cell, resulting into chromosome mutation.

It arises commonly in plants, sometimes fish and Amphibians. It is associated with many advantageous features, though it often results into sterility in some organisms.

CAUSES OF POLYPLOIDY/HOW POLYPLOIDY ARISES.

● Non-disjunction where all homologous pairs of chromosomes fail to be separated during anaphase I of meiosis. This occurs due to failure of spindle fibres to form during prophase I of meiosis. This can be induced by a chemical colchicines. Diploid gametes are formed, usually an ovum, and when this gamete fuses with another normal haploid one usually the sperm, a triploid (3n) is formed. Self fertilization of diploid gametes form a tetraploid (4n).

● During cell division by mitosis, chromosome duplication and DNA replication during interphase results into a tetraploid (4n) cell. These cells remain tetraploid if no nuclear and cytoplasm divisions subsequently followed. The tetraploid cell then undergoes normal mitotic division to produce tetraploid (4n) daughter cells. These tetraploid will have larger size because of increased size of their nucleus and cytoplasm.

● Doubling of chromosomes of a hybrid zygote after fertilization. Hybrid zygote is formed when mating take place between two genetically unrelated species. A fertile tetraploid individual may develope which only reproduces when selfed.

● Polyploidy can also occur when whole set of chromosome double after fertilization.

Tetraploid organisms (4n) have two complete sets of homologous chromosomes and the organism is fertile. In the other hand, a triploid (3n) does not have two complete sets of chromosomes and cannot form complete homologous pairing during the gamete formation by meiosis and such organisms are sterile.

Polyploidy is much more common in plants than in animals. This is because a lot of errors occur during gamete formation by meiosis. However most plants are capable of propagating themselves vegetatively (Asexually reproducing). In animals polyploidy is also associated with sterility but in plants it is associated with hybrid vigour like increased yields, resistance to diseases and drought where as the polyploid plants can be propagated vegetatively unlike the animals.

So, Polyploidy in plants is often associated with advantageous features such as :

Increased size, hardness and resistance to diseases. This is called hybrid vigor. Most domestic plants are polyploids, producing large fruits, large storage organs, flowers and leaves, triploid tomatoes, produce more vitamin C. Polyploidy plants include most angiosperms, wheat, coffee, banana, sugar cane, apples e.t.c

There are 2 types of polyploidy

- autopolyploidy
- allopolyploidy

AUTOPOLYPLOIDY

Is the type of polyploidy where by the whole sets of chromosomes added in the cell arises from sets of chromosomes of organisms of the same species. The number of chromosomes in an autopolyploidy is always an exact multiple of its haploid number.
Autopolyploids are most likely to have arisen by spontaneous doubling of chromosomes following the failure of spindle fibres to form or to function correctly at meiosis.

An Autopolyploidy organism is fertile if they have an even number of chromosomes sets. Autopolyploid can be induced by chemical called colchicine. It inhibits spindle formation and so prevents chromosomes from separating during Anaphase I of meiosis.

Endomitosis is a type of polyploidy which occurs in animals. It involves chromosome replication without cell division e.g giant chromosome in the salivary glands of drosophila and tetraploid in the human liver.

ALLOPOLYPLOIDY

Is where the whole sets of chromosomes added in the cell arise fromsets of chromosomes from more than one different species of organisms.
The sets of chromosomes from more than one different species are then not homologous, and the plants (the polyploids) are usually sterile. But if mitosis occurs in the polyploid cells, both sets of chromosomes double and pairing of chromosomes in meiosis is possible and organisms may become fertile. The example of natural allopolyploid occurred in the origins of modern bread wheat.

Allopolyploidy does not occur in animals because there are fewer instances of cross breeding between animals of different species.

ANEUPLOIDY

Is a condition in which a diploid cell (2n) contain an extra chromosome (2n+1) or one chromosome missing (2n-1). It is a more common condition that occurs among mammals like humans.
It leads to slight increase or decrease in the composition of DNA molecules in the cell, resulting into chromosomes mutation.

CAUSE OF ANEUPLOIDY.

Aneuploidy is caused by non-disjunction where one of the homologous pairs of chromosomes fail to be separated (segregated) during anaphase I of meiosis. Gametes formed contain either one extra chromosome (n+1) or one chromosome missing (n-1).

And during fertilization, when a haploid gamete containing one extra chromosome (n +1) fuses with another normal haploid gametes (n) and it produces a diploid individual with an extra one chromosome (2n + 1), and when a haploid gamete with one chromosome missing (n-1) fuses with another normal haploid gametes (n) during fertilization, produces a diploid individual with one chromosome missing (2n - 1).

A child born with one extra chromosome in one of the homologous pairs results into the diploid cells containing three similar chromosmes a condition called Trisomy, while diploid cells with one chromosome missing resulting into only one chromosome present of a certain pair, a condition called monosomy. In children and adults Trisomy or monosomy results into complications and these include,

• Down's syndrome (Mongolism).
• Klinefelter's syndrome.
• Turner's syndrome.

DOWN'S SYNDROME (MONGOLISM), TRISOMY 21.

This is the condition where a child is born with the diploid cells containing one extra chromosome on 21st pair of chromosomes. One extra chromosome in the 21st pair of the homologous chromosmes is trisomy 21, in humans the individual will posses 47 chromosomes (2n+1).

The cause of this condition is the non-disjunction that occurs at the 21st pair of chromosomes during gamete formation by meiosis. The down's syndrome in children has certain characteristic features, which include:

- protruding tongue.
- Flattened face.
- Short neck.
- Small ears.
- Small hands and feet.
- A single line across the palm of the hand.
- Heart defects.
- Coarse, straight hair.
- Tiny white spots on the iris of the eyes.
- Severe mental retardation.
- Congenital hearing abnormalities.
- Low IQ.
- Poor muscle tone.
- A Short life expectancy.
- Intestinal problems and leukaemia are common.

They have risks to certain diseases, such as,

- Heart defects.
- Leukemia (cancer of the blood).
- Ear and respiratory infections.
- Hypothyroidism.
- Intestinal problems.
- Reduced resistance to infections.

Non – disjunction that occurs in other pairs of chromosomes, normally result in foetus aborting or the child dying soon after birth.

KLINEFELTER'S SYNDROME (TRISOMY 23)

This is a condition where a child is born with one or more extra sex chromosome. There will be an extra sex chromosome in the 23rd pair (trisomy 23.

The extra chromosome arises due to non-disjunction on the 23rd pair of chromosomes during meiosis called sex chromosomes. This can occur during spermatogenesis or oogenesis. Upon fertilisation, zygotes or individuals with the following genotypes can arise,

• XXX.

-These are females.

- Slightly taller than the ordinary woman.
- Behavioural abnormalities and learning difficulties occur.
- Promiscuity is evident.

• XXY and XXXY.

- These are males.
- Are sterile.
- They show some female secondary sexual characteristics.
- Mentally retarded.
- Little breasts may develop.
- Little facial hair/lack beards.
- Higher than normal secretion of FSH.

• XYY.

- These are males.
- Are fertile males.
- May have a high propensity for violence.
- Relative taller than average.

TURNER'S SYNDROME (MONOSOMY 23)

This is a condition where a child is born with diploid cells having one sex chromosome missing, the sex chromosomes are X and Y chromosomes. The individuals are 2n-1 such individuals do not survive birth but when born they are mainly females.

It occurs due to non-disjunction of the homologous pair of sex chromosomes in the 23rd pair.This can occur during spermatogenesis or oogenesis. Upon fertilisation, zygotes or individuals with the following genotypes can arise,

• YO.

- Zygote do not develop because many genes are missing.

- X0.
- are phenotypically females,
- Have wide or web like necks.
- Finger nails and toe nails are narrow and turn upwards.
- sexually immature,
- physically very short,
- Their nipples are closer together.
- Small uterus.
- Sterile.
- The hair line at the back of the head is lower than normal.
- Retarded growth.
- Puffy hands and fingers at birth.
- Arms that turn outwards at elbows.

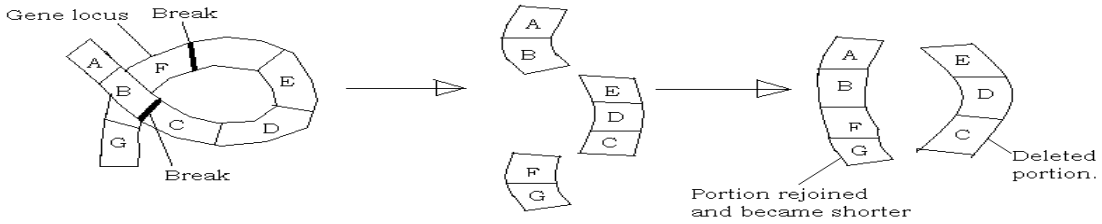
CHANGES IN CHROMOSOME STRUCTURE

Several mistakes may occur during the crossing over in prophase I of meiosis. This lead to chromosome mutations, the changes in the chromosome structure occurs by anyone of the following ways.

- Deletion.
- Inversion.
- Translocation.
- Duplication.

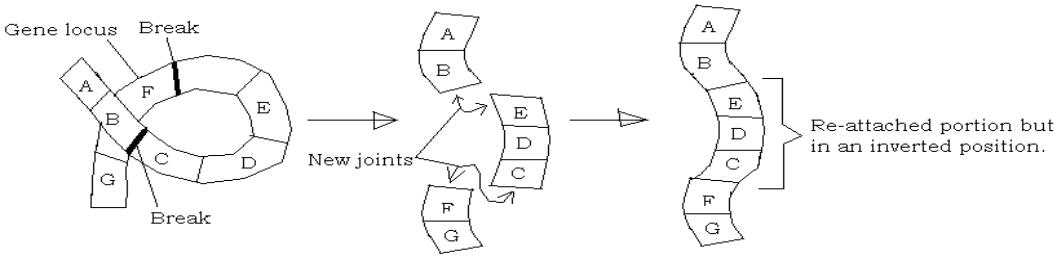
Deletion.

A portion of the chromosome is broken and lost, resulting into shortening of chromosome and loss of genes. This condition is often lethal.



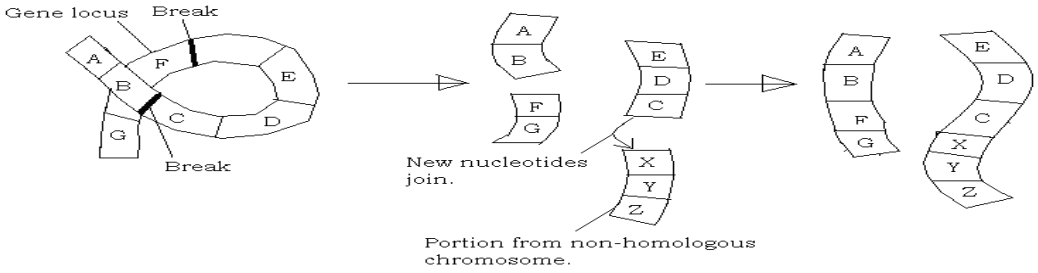
Inversion.

A portion of a chromosome becomes deleted, but becomes re-attached on the same chromosome in an inverted position. The sequence of genes (nucleotide base sequence) is reversed, the genotypes remain the same but the phenotypes may be altered.



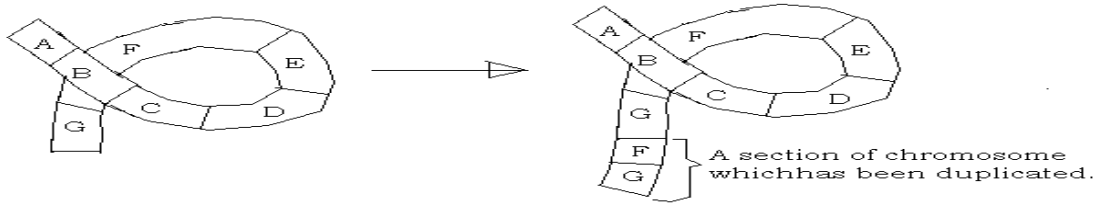
Translocation.

A portion of chromosome becomes deleted and rejoins at a different point on the same chromosome or with a different chromosome.



Duplication

A portion of chromosome is doubled, resulting in repetition of a gene sequence a different genetic constitution from the rest results, this is called a genetic mosaic.



GENE MUTATION.

Is the sudden change in the structure of DNA which occurs at a single locus on a chromosome. It is also called point mutation. The change in the structure of the DNA involves change in the nucleotide base sequence of the DNA, this can take place during DNA Replication.

The structure of a DNA molecule can change resulting into gene mutation in one or more of the following ways,

♦ **Duplication.**

An extra portion of nucleotide base sequence may be added in the nucleotide chain of the DNA. A portion of a nucleotide chain of a DNA may become repeated .

♦ **Insertion (addition)**

A portion of a nucleotide base sequence becomes inserted in the nucleotide chain of the DNA.

♦ **Deletion**

A portion of a nucleotide base sequence in the DNA nucleotide chain may be broken and lost.

♦ **Inversion**

A nucleotide base sequence in the DNA becomes separated from the chain. It rejoins in its original position only inverted. The nucleotide sequence of this portion is then reversed.

♦ **Substitution**

One nucleotide base in the nucleotide chain of the DNA may be replaced (substituted) by another nucleotide carrying a different nitrogenous base.

THE EFFECTS / CONSEQUENCES OF GENE MUTATIONS.

When these errors occur, the new DNA is not an exact copy of the original. Such changes in the structure of the DNA is called gene mutation.

When a gene mutates, the changes in the sequence of the base in the DNA causes a complementary changes in the sequence in codons of messenger RNA. The altered codon when translated will cause the following errors,

- Synthesis of a polypeptide chain with one or more amino acids missing (Non-sense translation).

▪ Synthesis of polypeptide chain where in the amino acid sequence, one aminoacid is substituted or replaced with a nother different one or some amino acids simply added to the polypeptide chain (Mis-sense Translation).

▪ The polypeptide chains formed with such errors are usually defective and can results into the following,

- Formation of abnormal protein molecules which are defective and can not efficiently perform their functions.
- Non-production of certain particular essential protein molecules required for normal physiological functions.
- Production of certain protein molecules which may attain toxic properties.
- Inborn error of metabolism leading into in-ability to synthesise specific enzymes or sythesise enzymes which can not catalyse certain essential metabolic reactions.

Non-production of certain proteins, or production of proteins which are non-functional or defective or attain toxic properties and the inborn errors of metabolism leads to genetic diseases.

GENETIC DISEASES.

There are a number of genetic disorders arising from the consequences of gene mutations causing production of abnormal proteins, non-production of certain important protein molecules, or in-ability to synthesize specific enzymes or synthesis of enzymes that do not catalyse any essential metabolic reactions and such genetic diseases include,

- Haemophilia.
- Red-green colour blindness.
- Duchene muscular dystrophy.
- Sickle cell anaemia.
- Cystic fibrosis.
- Huntington's chorea.
- Phenylketonuria.
- Alkaptonuria.
- Galactosaemia.
- Albinism.

HAEMOPHILIA.

Is caused by mutation of the genes in a DNA that provide instructions for production of clotting factor VIII or IX proteins called antihaemophiliac globulin, this gene mutation leads to none production of these clotting factor VIII or IX proteins or prevent them from working normally. This causes a bleeding disorder that slows or prevents the process of blood clotting. It often results into excessive bleeding both internally and externally in times of injuries which may cause death.

The gene for factor VIII is carried on the X chromosome. So, Haemophilia is a sex linked (X linked) character caused by the mutant recessive allele, the normal allele is the dominant.

Haemophilia is more common among males than the females in a population.

RED-GREEN COLOUR BLINDNESS.

Is caused by genetic mutation of genes responsible for production of proteins leading to Red pigment , green pigment and blue pigment proteins in the retina of the eyes, leading to production of defective red cones and green cones in the retina of the eye which can not properly work causing red-green colour blindness.

Red-green colour blindness is controlled by sex linked mutant recessive alleles.The dominant allele controls the normal condition. The person cannot distinguish between red and green shades of colours. This condition is more common in males than females in a population.

DUCHENE MUSCULAR DYSTROPHY (DMD).

Is caused by mutation of Duchene muscular dystrophy gene that codes for production of the proteins dystrophins which keep muscles intact and strong. This gene mutation prevents production of the protein dystrophins in muscles. Muscles without the protein dystrophins are more sensitive to damage, resulting in progressive loss of muscle tissues and function.

It is a severe progressive muscle wasting disease that leads to difficulty in movement and eventually cardiac and respiratory failures occur resulting into death.

DMD is controlled by sex linked mutant recessive alleles, dominant alleles determine normal condition involving production of protein dystrophin in muscles. It affects infant children mainly boys. This disease can result into death of the sufferer at an early age (before the age of 20 years is reached).

THE SICKLE CELL ANAEMIA.

Is caused by base substitution gene mutation of a gene that determines production of normal haemoglobins in red blood cells. This gene mutation leads to production of abnormal haemoglobins called haemoglobins S in red blood cells resulting into red blood cells attaining sickle shaped structures causing conditions of sickle cell anaemia. Sickle cell anaemia is associated with the following conditions, symptoms, consequences ,

- Anaemia, low Red blood cells count.
- Oxygen deficiency.
- Poor blood circulation.
- Enlargement of the spleen.

ANAEMIA AND OXYGEN DEFICIENCY.

Anaemia and tendency of the red blood cells to change shape from Biconcave to sickle shape. Anaemia arises because the sickle shaped red blood cells are constantly destroyed in the spleen. The efficiency of the red blood cells to transport oxygen is reduced, oxygen deficiency occurs in the body. Deficiency of oxygen results into,

- Infections and frequent illness.
- Body weakness and fatique.
- Poor physical development.
- Dilation of the heart causing heart failure.

POOR BLOOD CIRCULATION.

Poor blood circulation. This is because the sickle shaped red blood cells get jammed in the blood capillaries and small arteries. This will cause the following effects.

- Heart damage resulting into heart failures.
- Damage of the lungs causing pneumonia.
- Muscle and joint damage causing rheumatism and pain.
- Gut damage causing abdominal pain.
- Kidney damage causing kidney failure.
- Liver damage.

ENLARGEMENT OF THE SPLEEN.

Enlargement of the spleen. This is because sickle celled red blood cells collect in the spleen for destruction so increase in the activities of the spleen leads to its enlargement.

NOTE :

Sickle cell anaemia affects mainly the African, Americans, the people of Mediterranean countries and northern Africa.

CAUSES OF SICKLE CELL ANAEMIA (HOW SICKLE CELL ANAEMIA ARISE)

Sickle cell anaemia is caused by base substitution gene mutation. It occurs on one of the triplet nucleotide bases i.e Cytocine, thymine, cytocine in a DNA located on the 11^{th} pair of chromosomes that carry genetic information for the production of beta polypeptide chain, determining formation of haemoglobin molecule.

During this base substitution gene mutation, the nucleotide base, Adenine replaces thymine in the DNA nucleotide triplet code i.e cytocine, thymine, cytocine (CTC), forming a wrong DNA triplet nucleotide base sequence i.e Cytocine, Adenine, Cytocine (CAC).

During transcription, messenger RNA copies complementary DNA nucleotide base sequence which will include the codon Guanine, Uracil, Guanine (GUG) as a result of the base substitution, instead of the Guanine, Adenine, Guanine (GAG). This causes a mistake to occur on the 6^{th} aminoacid in the beta polypeptide which is 146 amino acids long, where the amino acid valine replaces the aminoacid glutamic acid.

The presence of valine instead of glutamic acid in the beta polypeptide leads to production of abnormal haemoglobin called haemoglobin S. This is because the messenger RNA codon GAG codes for aminoacid glutamic acid while GUG codes for amino acid valine.

Glutamic acid carries a negative charge and is polar where as valine is non-polar and hydrophobic. So, abnormal haemoglobin S is much less soluble than normal haemoglobin and it begins to crystallize when the oxygen concentration falls as it does in the capillaries

of body tissues, resulting into the red blood cells normally biconcave disc shaped to assume the shape of a crescent or become sickle shaped, this reduces their surface area for absorption of oxygen and there fore, With their abnormal haemoglobins, the sickle shaped red blood cells are far less efficient at carrying oxygen in blood.

OCCURRENCE AND DISTRIBUTION OF THE SICKLE CELL ANAEMIA IN A POPULATION.

Is a genetic disorder or disease caused by the base substitution gene mutation occurring in DNA.

The genes controlling sickle cell anaemia show codominance in some cases but sometimes described as recessive autosomal genes showing complete dominance. Homozygous recessive individuals possess both recessive allele(Hb^sHb^s) and suffer sickle cell anaemia and may die at an early age.

It shows codominance because heterozygous individuals possess both the dominant allele (Hb^A) and the recessive allele (Hb^s) with a genotype (Hb^AHb^s). The red blood cells of this individual contain about half of normal haemoglobin and about half of the abnormal haemoglobin S. In this case The Alleles Hb^A and Hb^s are codominant but it shows complete dominance in some other cases this is because the heterozygous individuals (Hb^AHb^S) are described as showing sickle cell traits and the individuals do not suffer from the conditions of the sickle cell anaemia.

Heterozygous individuals are only affected at unusually very low oxygen concentrations like climbing at high altitudes. So some the haemoglobin can crystallize causing some few red blood cells to attain sickle shapes.

The sickle cell condition shows some advantages. It is widely distributed in a population in and remain persistent. The frequency of the recessive alleles for abnormal haemoglobin S is high in malarial infected areas. This is because individuals carrying the recessive alleles do not suffer from malaria (are less susceptible to malarial infections) since the plasmodium parasites do not multiply in the red blood cells containing abnormal haemoglobins S, sickle celled red blood cells have reduced surface area and cannot absorb sufficient oxygen. Lack of enough oxygen in the red blood cells prevents adequate aerobic respirations to occur and many physiological processes can not take place in the plasmodium and may be destroyed inside the sickle shaped red blood cells, so its life cycle is not completed and many other red blood cells can not be infected. So, heterozygous individuals have a selective advantage over non-carriers and are more likely to survive and continue to pass the recessive alleles for abnormal haemoglobin in the next generations. The final frequency of the genes in the population is determined by

the levels of malarial infections in the population. This is an example of balanced polymorphism.

CYSTIC FIBROSIS.

Is caused by deletion of three nucleotide bases in a gene called cystic fibrosis transmembrane conductance regulator (CFCR) gene. This mutation leads to production of defective proteins in the plasma membranes called cystic fibrosis transmembrane regulators that work as chloride channels in the cells that produce mucus, sweat and digestive enzymes.

In persons suffering from cystic fibrosis, the cystic fibrosis transmembrane regulators do not function. Thus mucus lining the cell surfaces become thick and sticky. This affects mostly the lungs, pancreas and the liver where unusually thick mucus clogs lungs, liver and pancreas.

In the pancreas fibrous patches called cysts develop and in the lungs, when the thick mucus dries up, it causes blockage of air ways of the lungs, and branches of pancreatic ducts and the bile duct from liver into the gut. This leads to repeated lung infections , difficulty in breathing and digestive problems. Male and female infertility occurs, the individual may also show other symptoms which include,

- Production of very salty sweat.
- Persistent coughing at times with phlegm.
- Frequent lung infections including pneumonia or bronchitis.
- Poor growth.
- Nasal polyps. These are soft, painless, non-cancerous growths on the lining of your nasal passages or sinuses.

Note:

- Cyst is a growth or swellings containing liquids that form on the body of a person.
- Cystic fibrosis is a recessive gene mutation very common in Europe.

HUNTINGTON'S DISEASE (CHOREA).

Is a progressive brain disorder that causes uncontrolled movements, emotional problems and loss of thinking ability(cognition).

Huntington's chorea is caused by the mutation of the huntingtins gene located on chromosome 4 where nucleotide base sequence CAG on DNA is duplicated or repeated 40 to 60 times.

The mutant gene is an autosomal dominant allele, meaning that only one mutant gene of the two copies of the gene in the cell is sufficient to cause the disease.

The normal Huntingtons gene provides instructions for making a protein called huntingtins. Huntingtins is a soluble protein found in many of the body·s tissues with the highest levels in the brain and the testes. Within cells the protein huntingtins seem to be involved in, chemical signaling, transporting materials, binding to proteins and other structures and protecting the cells from self destruction.

The mutation of the huntingtons gene by nucleotide base sequence CAG repeat, causes alteration of the nature of the huntingtins protein which attain toxic properties (a toxic gain of function phenotype). This results in neuro-degeneration and break down of the neurons in the part of the brain responsible for coordination of habit and emotional memories and voluntary movements, resulting into,

- Deterioration of brain cells, resulting into loss of intellectual ability.
- Involuntary muscular movements or loss of control of voluntary muscles by motor neurones. This results into uncontrollable shaking and dance (chorea) like movements.
- Hallucinations, mood and personality changes.

Genetic counseling and gene cloning techniques can be applied to diagnose the disease and prevent frequency of its occurrences.

PHENYLKETONURIA.

Phenylketonuria (PKU) is caused by gene mutation of the gene for production of the enzyme phenylalanine hydroxylase (PAH) found on chromosome 12. It is an autosomal recessive disorder resulting from the essential amino acids phenylalanine accumulating in the blood, causing brain damage.

It Is a rare genetic disorder 0r disease where the individual can not synthesize the active form of an enzyme phenylalanine hydroxylase which catalyze conversion of excess essential amino acid phenylalanine to tyrosine in the liver or the enzyme produced is less efficient. Deficiency or absence of the enzyme causes the amino acids phenylalanine to accumulate and become in excess in the blood. The excess phenylalanine is converted to toxins. This will prevent the child·s brain from absorbing sufficient amounts of other essential amino acids from the the blood, as a result the brain and other organs and tissues such as muscles and cartilage fail to grow and develop normally, leading into the,

- Mental retardation.
- Organ damage.
- Child can not walk properly and will have awkward posture during walking.
- Females with high concentration of phenylalanine in their blood, would have the risk of the brain of their developing fotus getting damaged.
- Convulsions.

ALKAPTONURIA (THE BLACK URINE DISEASE).
Is a defect in the gene resulting into in-ability to synthesize certain enzymes needed for the proper metaboilism of aminoacids tyrosine and phenylalanine. This leads into poor breakdown of the amino acids tyrosine and phenylalanine in the body. The excess aminoacids tyrosine is converted to acids called alkapton (homogentisic acids).
The alkapton(homogentisic acids) build up in the skin and other connective tissue like the cartilage. The acids leave the body through the urine and if treatment delays, it will lead to severe deformity of joints, spines and organ dysfunction.

The urine of people with alkaptonuria turns black when exposed to light due to high concentration of the acids alkapton. When alkapton get deposited in the cartilage, it causes the tip of the nose to turn black. It can also lead to severe joint pains.

GALACTOSAEMIA.
Is caused by mutations of a gene that results into deficiency or in-ability to synthesize the enzyme needed for conversion of the sugar galactose to glucose. Accumulation of the sugar galactose in blood causes cataracts, damage of the liver or the kidney.

Children with galactosaemia are often normal when they are born but within weeks they begin to vomit much of the milk they drink and fail to undergo normal processes of growth and development. If the conditions are not dealt with quickly the child may become blind and mentally retarded.

ALBINISM.
Is an inheritable genetic disorder in which the body is unable to produce or distribute the skin pigment melanin, resulting into a person having light skin, white hair and pink eyes.

It is caused by mutation of certain genes that affect the amount of melanin your body can produce. The mutant allele is recessive and determines the condition while the dominant allele determines normal production of melanin. Melanin is a chemical in the body that determines the colour of the skin, hair and eyes. It is also involved in optical nerve development.
Due to their light-coloured skin, people with albinism have an increased risk of sun burn, skin cancer and blindness.

Common signs and symptoms of albinism include,
- Pale skin.
- White skin.
- White or Light blonde or brown or reddish hair.
- Pink or light blue or gray eyes.

- High sensitivity of the eys to light.
- Back and forth movement of the eyes.

Albinism is a genetic defect and can not be cured, except for some precaustions for a person with albinism to take, these include,
Stay out of sun, wearing sun glasses, covering up with su-protective clothing, wearing hats and applying sun screen regularly.