GENETIC ENGINEERING

Genetic engineering, also called genetic modification or genetic manipulation, is the direct manipulation of an organism's genes using biotechnology.• It is a set of technologies used to change the genetic makeup of cells, including the transfer of genes within and across species boundaries to produce improved or novel organisms.

RECOMBINANT DNA TECHNOLOGY

The technology used for producing artificial DNA through the combination of different genetic materials (DNA) from different sources is referred to as Recombinant DNA Technology Recombinant DNA technology is popularly known as genetic engineering.The recombinant DNA technology emerged with the discovery of restriction enzymes **TOOLS OF RECOMBINANT DNA TECHNOLOGY**

The enzymes which include the restriction enzymes help to cut, the polymerases- help to synthesize and the ligases- help to bind. 1. Enzymes 2. Vectors 3. Host cells

Grouping of human chromosomes- Patau's scheme

The London system (Patau's system) of classification recognizes seven groups of human chromosomes, considering their morphological features. They are groups from A to G. In these groups, chromosomes are arranged in the order of decreasing length. Thus, A-group has the longest chromosomes, and G-group has the shortest ones. A-group includes the first three pairs of autosomes, B-group includes the 4th and 5th pairs, C-group includes 6th-12th pair of autosomes and the X-chromosome(s), D-group includes the 13th-15th pair of autosomes, E-group includes 16th-18th pair, F-group includes 19th & 20th pairs, and G-group includes 21st & 22nd pairs of autosomes, and the Y-chromosome in male. Groups A, E & F are metacentric chromosomes, B & C are sub-metacentric, and D & G are acrocentric. Autosomes 13, 14, 15, 21 and 22 (D & C groups) have secondary constriction and satellite. So, they are 'sat' chromosomes.

Karyotype : all the somatic cells of human beings have the same number and types of chromosomes the some total of the chromosomal characteristics of a cell or an individual

NORMAL HUMAN KARYOTYPEX

 Karyotype : chromosomal characteristics of a cell It signifies the number , size , kind ,shape , structure and other morphological features of chromosomes Karyogram/ideogram : schematic representation of karyotype with the arrangement of chromosomes in numerical order Somatic number / diploid number: chromosome number of somatic cell Gametic / haploid number : chromosome number of gamete cell Somatic human cell : 46 chromosomes Autosomes and allosomes(sex chromosomes) Normal karyotype of human female : 44 A + XX Normal karyotype of human male : 44 A + XX

GENETIC CONTROL OF SEX

SEX DETERMINATION

Sex determination is the mechanism by which sex is established is termed as sex determination.There are various mechanisms operating in determining the sex of different organisms.Four major kinds of sex determining mechanisms are,

1. Chromosomal sex determining system
2. Genic balance system
3. Hormonal system
4. Environmental sex determination

Sex differentiation is the process of the development of the differences between males & females from an undifferentiated zygote.Appearance of sertoli cells in males & granulosa cells in females can be thought as the starting point for testicular or ovarian differentiation in many species.Sex chromosomes

GENIC BALANCE THEORY

 It was formulated by Calvin Bridges based on his studies on Drosophila. It is the concept that both autosomes & sex chromosomes have an equal share in sx Autosomes carry the genes for maleness , X chromosomes carry the genes for femaleness & Y chromosomes have no role in sex determination. A specific ratio between the amounts of male determining genes & female determining genes & a precise balance between their interactions determine the sex of the individual.There are two kinds of chromosomes in organisms, namely 'Autosomes: Autosomes carry genes with vegetative charactersSex chrormosome: carry the genes which control sexual characteristics

Autosomal anomalies: Down's syndrome, Edward's syndrome, Patau's syndrome,cri-du-chat syndrome.Sex chromosomal anomalies: Klinefelter's syndrome, Turner's syndrome.

1) Down's Syndrome :-

• also called Mongolism •autosomal anomaly•extra chromosome added to 21st pair of autosome - trisomy 21 syndrome •45 chromosome instead of 44 • total no. of chromosome 47 instead of 46

2)Edward's Syndrome :

•Trisomy 18 syndrome, •A condition that causes severe developmental delays due to an extra chromosome 18.

•Abnormalities

3)Patau's syndrome

•case of trisomy 13 •congentical abnormalities of fore brain, congenital heart lesions, mental and development retardation..

4) Cri-du-chat syndrome

•Very rare case of deletion mutation •caused by loss of a portion of the shorter arm of 4th or 5th chromosome •severe physical and mental retardation •congenital heart disease,small head, widely spaced eyes, broad face,saddle nose • affected child is very meek and weak

Turner syndrome

Also called: gonadal dysgenesis. A chromosomal disorder in which a female is born with only one X chromosome.Turner syndrome results from a missing or incomplete sex chromosome, the absence of one X chromosome.Symptoms :- short stature, delayed puberty, infertility, heart defects and certain learning disabilities.

Klinefelter's syndrome:-

 Trisomy : 47 (44 A + XXY)

•A genetic condition in which a male is born with an extra copy of the X chromosome

Symptoms :

 small testicles Enlarged breasts Decreased facial and pubic hair Small penis

GENE EXPRESSION

 Process by which the instructions in DNA or gene are converted into a functional product like protein Nucleotide language – amino acid language

GENETIC CODE

 Nucleotide sequence of DNA and mRNA that specifies the amino acid sequence of proteins Provides biological information for protein synthesis Composed of series of codons : set of 3 nucleotide and codes for specific amino acid Codons are triplet

GYNANDROMORPHISM

•extreme form of sex mosaicism •in it one part of body is phenotypically male and other female •partly M&partly F individuals called gynandormorphs Gynanders •They differ from hermaphrodites in that they are sterile individuals; hermaphrodites are fertile and functionally bisexual individuals, capable of producing male and fe male sex cells.

1. AUTOSOMAL RECESSIVE DISORDERS

PHENYL KETONURIA (PKU)

 Inborn metabolic disorder due to an autosomal recessive mutation. Caused by the non-production of the liver enzyme phenylalanine hydroxylase thatconverts phenyl alanine to tyrosine. Accumulation of excessive amounts of phenylalanine. The accumulation of phenyl pyruvic acid in cerebro-spinal fluid damages brain cells. Severe mental retardation and idiocy or imbecility (IQ below 25). Some of such unfortunate children will never be able to talk or walk. Reduced hair, poor skin pigmentation, irritability, tremors, convulsions,

SICKLE CELL ANAEMIA

Sickle-cell anaemia, or sicklemia, is a hereditary disease. Severe form of haemolyti canaemia. Fatal before puberty : girls Common among the Negro populations of Africa and America and also among the people of Mediterranean countries. In Kerala, it is found among the tribals of Wayanad District.

Characterized by ; Abnormal haemoglobin and sickle-shaped RBCs. It partially or almost completely replaces the normal haemoglobin (HbA).

Symptoms

 Enlarged spleen, Rheumatic complaints, Mental disorders, Hypoxia heart failure Renal failure

2. X- LINKED SEX CHROMOSOMAL DISORDERS

HAEMOPHILIA

—Bleeder's disease‖ or —royal disease", is sex linked disease. Prolonged bleeding or oozing following an injury, surgery or having a tooth pulled. Serious complication can result from bleeding in to the joints, muscles, brain or other internal organs. Failure of the blood to clot easily Occurs mostly males and very rarely among females. A male who is hemizygous for that gene, will be a haemophilic. A female becomes haemophilic only when she is homozygous for the mutant allele. Heterozygous female serve only as carriers of haemophilicDiagnostic method : Blood test

Treatment : Replacing missing blood clotting factor and Gene therapy is possible

HUMAN COLOR BLINDNESS

 Daltonism Inability to clearly distinguish different colors Diagnosis: Ishihara test charts X-linked recessive trait Results from the absence of appropriate color genes in the X-chromosome Associated with males ; females : carrier Hereditary defect exclusively restricted to cone cells. Common : red-green color blindness.

3. Y-CHROMOSOME INFERTILITY

 Affects the production of sperm and causes male infertility

Characterized by : Spermatogenesis : disrupts the ability to produce healthy sperm cells Azoospermia : blocks the ability to even produce sperm cells Provides instructions for making proteins involved in the sperm cell production and development

4. POLYGENIC TRAITS

CLEFT PALATE/LIP

 Polygenic trait Congenital developmental defects (teratogenic defects). Cleft-lip may occur without cleft-palate. Rarely cleft-palate occurs without cleft-lip. Cleft-lip and cleft-palate are considered to be sex-controlled traits. Cleft-lip is more common among males than among females Cleft palate is more common among female Can be corrected by surgery

DIABETES MELLITUS

 Excessive accumulation of blood sugar and subsequent excretion through urine Involves disorders in carbohydrate metabolism and abnormalities in lipid and protein metabolism due to deficiency of insulin

 Hyperglycemia : sugar accumulation

 Glucose excreted through urine : glycosuria Reasons for abnormal increase in blood sugar : Insufficient cellular intake and glucose oxidation

PRE-NATAL DIAGNOSIS OF GENETIC ABNORMALITIES

 Early detection of genetic abnormalities before birth Involves analysis of karyotypic , biochemical , physiological and morphological features of the foetus to detect chromosomal abnormalities and anomalies , metabolic disorders and morphological malformations

1. AMNIOCENTESIS

Widely used , more than 30% of disorders can be detected Possible at any stage of pregnancy

2. CHORIONIC VILLUS SAMPLING (CVS)

 Carried during 8th to 12th weeks of pregnancy Involves the biopsy of chorionic villus tissue to detect the chromosomal anomalies , genetic defects ,biochemical disorders and metabolic err

3. ALPHA FOETOPROTEIN (AFP) ESTIMATION

 Blood test done between 15th and 18th weeks of pregnancy AFP is a protein of foetal origin found in amniotic fluid High level : abnormalities

4. ULTRASONOGRAPHY

 Applied in the detection of internal organs and tumours and observation of foetus Makes use of high frequency sound waves to create an image of the structures Ultrasonogram uses intermittent sound waves.

GENETIC COUNSELLING

 Part of medical genetics Provides information to a person about the probabilities and potential dangers of some congenmital disorders and birth defects Primary purpose is to secure voluntarary restriction on child-bearing by high-risk couples , groups or populations with inherited genetic disorders Educates parents about the genetic cause and heritable nature of some diseases.