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B.Sc. BOTANY

THIRD YEAR

PAPER - VI : CYTOLOGY, GENETICS, PLANT BREEDING AND EVOLUTION

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PAPER – VI : CYTOLOGY, GENETICS, PLANT BREEDING AND EVOLUTION

Unit Structure : Unit – I

- Plant cell – Ultra structure, function and organization.
- Cell wall – structure, function and chemistry, Pits (Simple and bordered).
- Plasmodermata
- Plasmamembrane – Ultra structure, chemistry and function.
- Cytoplasm : Physical and chemical nature.
- Endoplasmic reticulum – types, occurrence, structure and function.
- Golgi complex – occurrence, distribution, structure and function.
- Lysosomes in plant cells – structure, chemical nature and function.
- Mitochondria – structure, chemical composition & function

Unit Structure: Unit – II

- Plastid - classification structure and function of chloroplast.
- Ribosomes – 70s and 80s types, structure, chemical composition and function. Peroxisomes – structure and function.
- Nucleus – structure, chemical composition and function.

Unit Structure: Unit – III

- Chromosomes – structure, number and function
- Euchromatin and heterochromatin polytene Giant Chromosomes,
- Salivary gland chromosome and Lampbrush chromosome.
- Nucleic acids – chemistry and types, nucleotides. Nucleosides.
- DNA – Molecular structure, replication.
- RNA – structure, types,

- Cell division – Types, cell division cycle, mitosis and meiosis, chemicals inducing mitosis and meiosis
- cytokinesis, Significance of mitosis, meiosis and animal. (Note : Structure includes ultra structure)

Unit Structure: Unit – IV

- Structure and development of anther
- Structure of mature pollen - male gametophyte.
- Structure and development of ovule.
- Female gametophytes : Monosporic (Polygonum_, Bisporic (Allium) Tetrasporic (Peperomia),
- Fertilization, Elementary account of post fertilization changes.

Unit Structure: Unit – V

- Endosperm types (Nuclear, Cellular, Helobial, Ruminate endosperm, Endosperm Haustoria Functions of endosperm.
- Development of embryo in Monocot and Dicot
- Apomixis Polyembryong,
- Embryo culture.

PLANT CELL – ULTRA STRUCTURE – FUNCTION AND ORGANIZATION

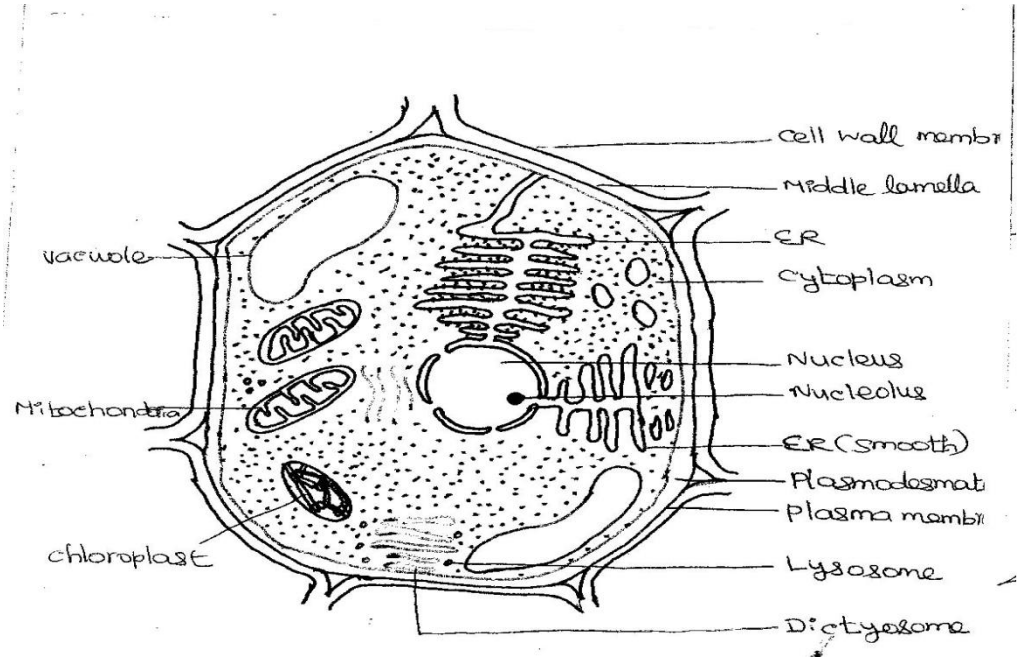
Definition

1. Each and every organism is made up of cells.
2. They are the building blocks and fundamental unit of the structure and function at an organism.
3. It is delimited by a plasmo membrane and capable of self Reproduction.
4. It is first discovered by Robert Hooke in 1665.
5. There are two types of cells, namely
   (i) Prokaryotic cells
   (ii) Eukaryotic cells

(i) Prokaryotic Cells

1. These cells do not contain definite nucleus.
2. Chromatin bodies scattered in the cytoplasm.
3. Such type of Nucleus is called nucleoid Ex.Bacteria, blue green algae.

Eukaryotic Cell – Ultra Structure



A plant cell contains the following component

(i) Cell wall

(ii) Plasma membrane

(iii) Cytoplasm

(iv) Nucleus and other

(v) Cell organelles

1. Cell wall

1. it is the firm layer found exterior to plasma membrance.
2. It consists of three layers.
   - (i) Primary Wall
   - (ii) Middle Lamella
   - (iii) Tertioary wall
3. It provides mechanical support and definite shape to the cell.

2). Plasma membrane

It is a thin double layered permeable membrane present inside the cell wall.

3). Cytoplasm

It is a colloidal, colourless, amorphology fluid which is surrounded by plasma membrane.

4). Nucleus

It is the controlling centre of the cell. It consists of Nuclear membrane and nucleoplasm and net work of chromatin.

5). Cell organelles

The following cell organelles are present in the cytoskeleton.

1). Endoplasmic Reticulum

It contains a Net work of membrane bound tubules, vesicles, and othervise called cytoskeleton.

2. Mitochondria

Mitochondria are rod shaped structures, known as the site of energy transfer in the living cells for this reason it is called “The Power House of the Cell” present in cytoplasm.

3). Plastids

They are green (or) colourless structure called chloroplasts help in the photosynthesis.

4). Golgi complex

These are the fibers seen in k;the form of net work present in the cytoplasm.

5). Lysosomes

These are small rounded bodies enclosed with hydrolytic enzymes otherwise suicidal bags.

6). Peroxisomes

These are small vesicles enclosed with enzymes.

7). Centrosome

It is otherwise called cell centre consists of two granular bodies like centriol and centrosphore.

Besides these organelles the cytoplasm includes non-living substances called ergastion substances.

Substances crystals granules of pigments secretory granules and vacuoles.

1.Function

Cells are the "building blocks" of each and every organism.

2. Nucleus

controls all the activities of the cell.

3. Plastides

involved in the formation and storage at carbohydrates.

4. Mitochondria are the power house of the cell and supply all energy needed for the maintenance of Life.

5. Endoplasmic Reticulum involved in protein synthesis.

6. Ribosomes are the sites of protein synthesis

7. Lysosomes contains enzymes which are lytic in nature

8. Centrosomes takes part in the organization and function of spindle apparatus.

9. DNA is the genetic material involved in the heredity.

10. So each and every cell controls all the activities of an organism.

CELL WALL STRUCTURE

1. Cell wall is the outer covering of plant cell, absent in animal cell.
2. It is made up of four layers. They are

(i) Middle lamella : is the intercellular matrix located between the adjacent cells.

(ii) Primary wall : is the true cell wall, which develop in the still growing cells.

(iii) Secondary cell wall : It is thick and rigid found in mature (or) non-growing cells.

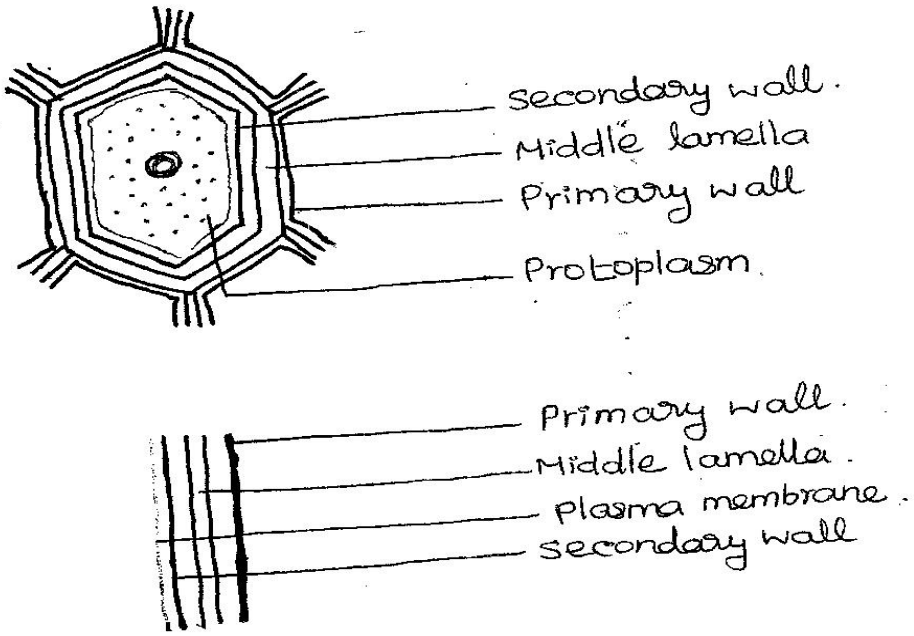
(iv) Tertiary wall : Present beneath the secondary wall.

Chemistry

1. The cell wall is mainly made up of cellulose.
2. The other substances present in the cell wall are hemicellulose, pectin, lignin, fatty acids minerals.

When the cell wall is examined under electron microscope. There are two components

(i) Matrix, (2) fibrils.



(i) Matrix

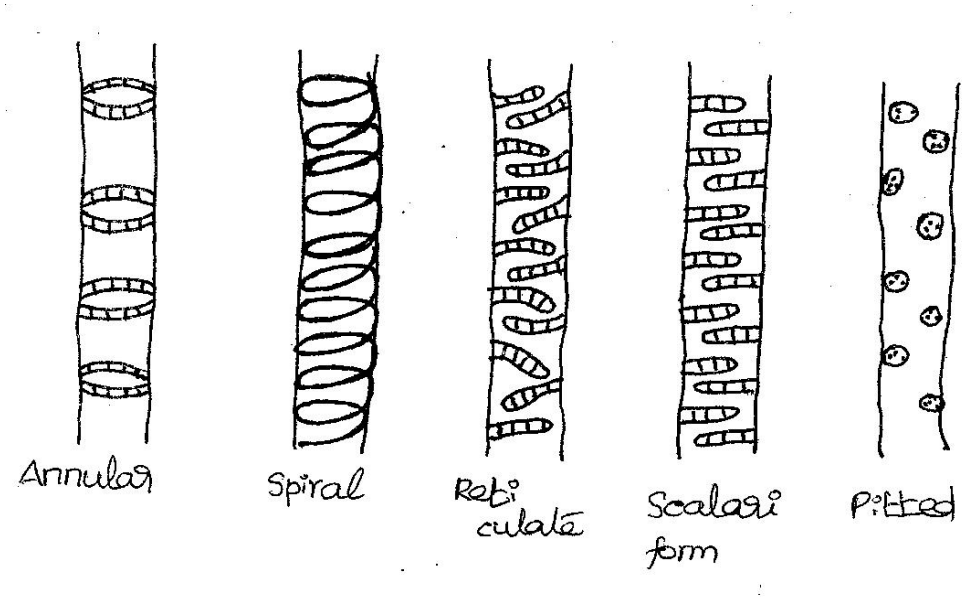
It is the ground substance: in which the fibrils are embedded. It is made up of non-cellulosic materials such as pectin lignin, fatty acids and minerals.

(ii) Fibrils

made up of cellulose.

Thickenings in cell wall

1. When the cells mature lignin deposits on the cell wall.
2. Hence the cell wall becomes thickened.
3. Thickenings does not occur uniformly.
4. It occurs in the following patterns.



(i) Annular thickenings

Thickenings occur in the form of rings.

(ii) Spiral thickenings

Thickenings occur in the form of spiral bands.

(iii) Scalariform thickenings

occur in the form of a ladder.

(iv) Reticulate thickenings

Occurs in the form of a net work.

(v) Pitted thickenings

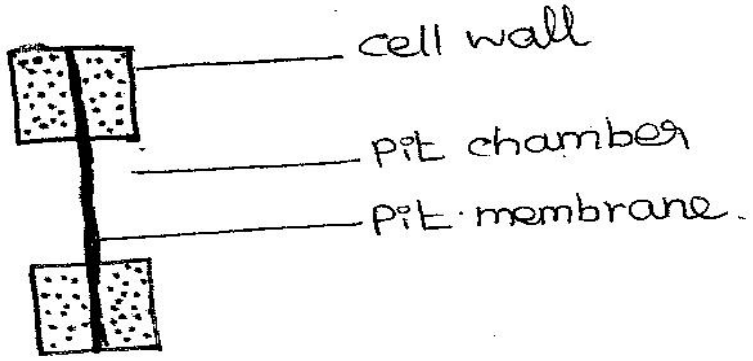
In this type, the cell wall is more (or) less uniformly thickened, leaving here and there unthickened areas called pits.

Pits

1. Pits are depressions, present in the cell wall due to thickenings.
2. They are always in pairs present against each other on the opposite sides of the wall.
3. They are called pit pairs.
4. A pit has a pit cavity (or) pit chamber which opens into the lumen through pit aperture.
5. The two pit chambers are separated by a membrane called pit membrane.
6. There are two types of pits.
7. Namely simple pits and bordered pits.

8. A pit pair may be formed of two simple pits (or) two bordered pits.

Simple Pits

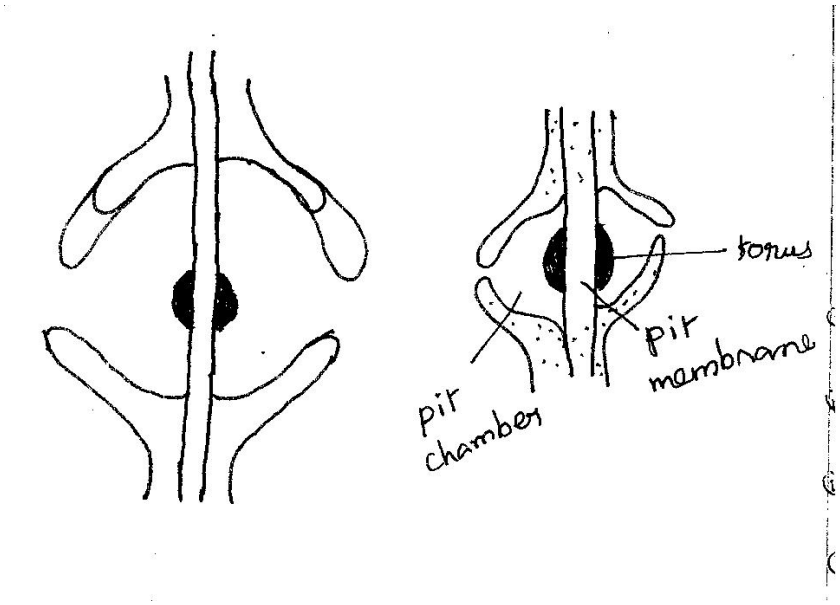


(i) In simple pits the pit chamber remains of the same diameter and the pit membrane also simple and uniform in structure.

(ii) The simple pit may be circular, oval, polygonal irregular.

(iii) It is found in flowering plants.

Bordered Pits



(i) In bordered pits the pit chamber is funnel shaped and becomes narrow towards the lumen of the cell.

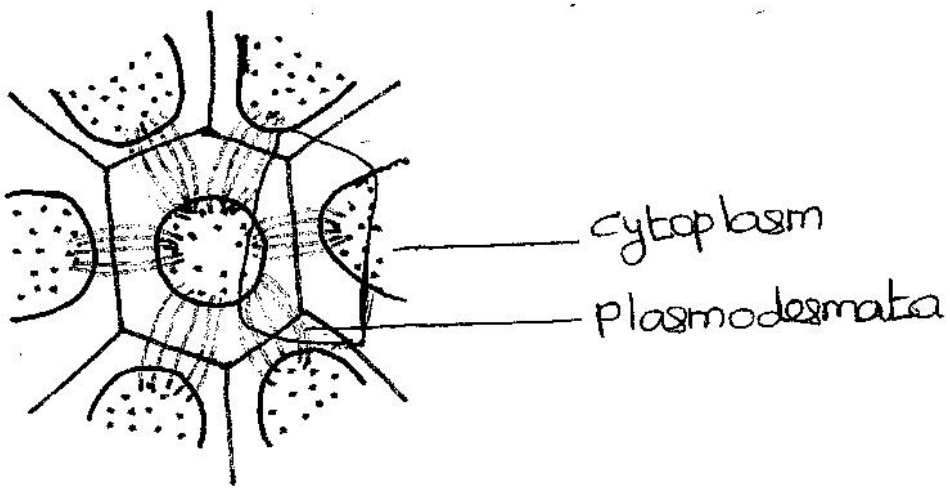
(ii) The secondary wall arched over the pit chamber it is called pit border.

(iii) So, they are called bordered pits.

(iv) The pit membrane is thickened in the central part. This thickenings is called torus.

(v) It is found in angiosperms & conifers.

Plasmodesmata



(i) The protoplasm of the cell is connected with the adjacent cells by delicate threads of the cytoplasm.

(ii) These threads are called Plasmodesmata.

(iii) It passes through the pore (or) pit in the cell wall.

(iv) They maintain the continuity of the cytoplasm

(v) They conduct stimuli and transport materials between cells.

(vi) They also function as channels for transporting viruses, bacteria, etc.,

Functions of the cell wall

(i) It gives the cells a definite shape.

(ii) It gives mechanical support and rigidity to the cell.

(iii) In root cells, it helps to absorb water from the soil by imbibition

(iv) It protects the protoplasm.

Plasma membrane

Introduction

1. it is thin elastic semipermeable living membrane serves as a bourdary for the cytoplasm.
2. The term plasma membrane was coined byk Nageli in 1885.
3. It is otherwise called cell membrane (or) Plasma lemma which is present inner to the cell wall.

4. It is 75A^{o} in thick.
5. the membrane is formed of proteins and lipids.
6. These molecules are arranged in a definite pattern.
7. The following models are proposed to explain the structure of plasma membrane.

(i) Trilaminar model

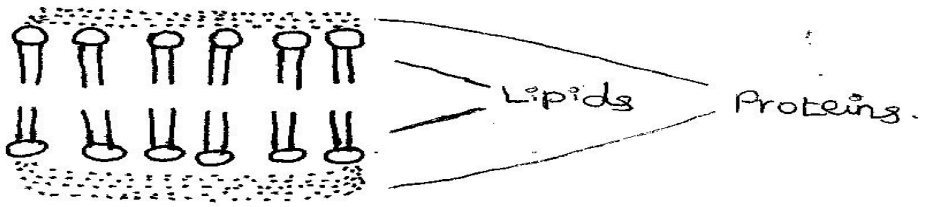
(ii) Bimolecular model

(iii) Lattice model

(iv) Fluid mosaic model

(v) Micellar model

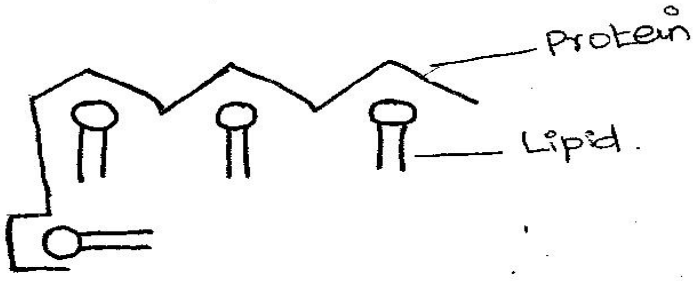
(i) Trilaminar model



(i) This was proposed by Robert son.

(ii) According to this, the membrane is formed of outer Protein Layer, a middle lipid layer and an inner Protein layer.

Bimolecular model



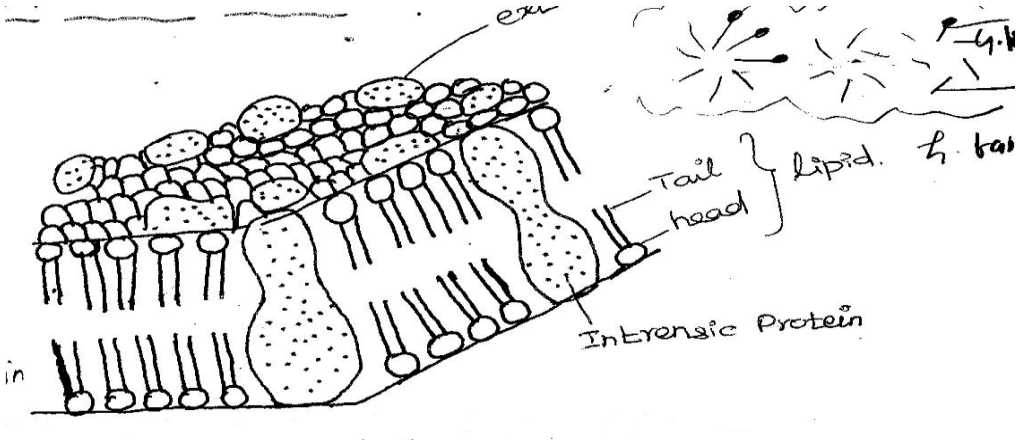
(i) This was proposed by Danielli and Davson in 1934.

(ii) According to this the membrane is made up of two layers.

(iii) The lipid molecules coated with protein.

(iv) The lipid molecules has a hydrophobic tail and hydrophilic head.

III. Fluid mosaic model



(i) This model was proposed by singe and Nicolson in 1972.

(ii) According to this model, the plasma membrane consists of two layers of Lipids and the protein molecules are embedded among the lipid molecules.

(iii) Ecto lipid molecule has a hydrophobic tail and hydrophilic head.

(iv) The heads face outwards and the tails of the two layers face each other.

(v) The proteins are globular and are of two types.

(i) Peripheral (or) extrinsic proteins.

(ii) Integral (or) intrinsic proteins.

(vi) The peripheral proteins are arranged on the surface of the lipid molecules.

(vii) The integral proteins are deeply embedded, in the lipid molecules.

Chemical composition

1. Lipids are the main component of the plasma membrane, especially phospholipids and triglycerides.
2. Proteins : structural proteins, carrier proteins and enzymes are seen.
3. Carbohydrates : form a cell coat around the membrane.
4. Nucleic acids also found in the membrane.
5. Salts generally present in the membrane.
6. Water also seen in the membrane.

Functions

1. Plasma membrane gives a definite shape and mechanic support to the cell.
2. It protects the cell contents.

3. Used in the exchange of materials by selective permeability.
4. Biogenesis of cell organelles : certain cell organelles like ER, develop from the plasma membrane.
5. Used in absorption.
6. Play a key role in the active and passive transport of materials.

Cytoplasm

Introduction

1. The mass of protoplasm present outside the nucleus is called cytoplasm.
2. It is a colourless, homogenous, translucent amorphous and colloidal fluid.
3. It composed of the matrix and the organelles.
4. After the removal of all the organelles, the fluid is known as matrix.

Physical Nature of Matrix

There are many theory about the physical nature of matrix are as follows.

1. Reticular Theory

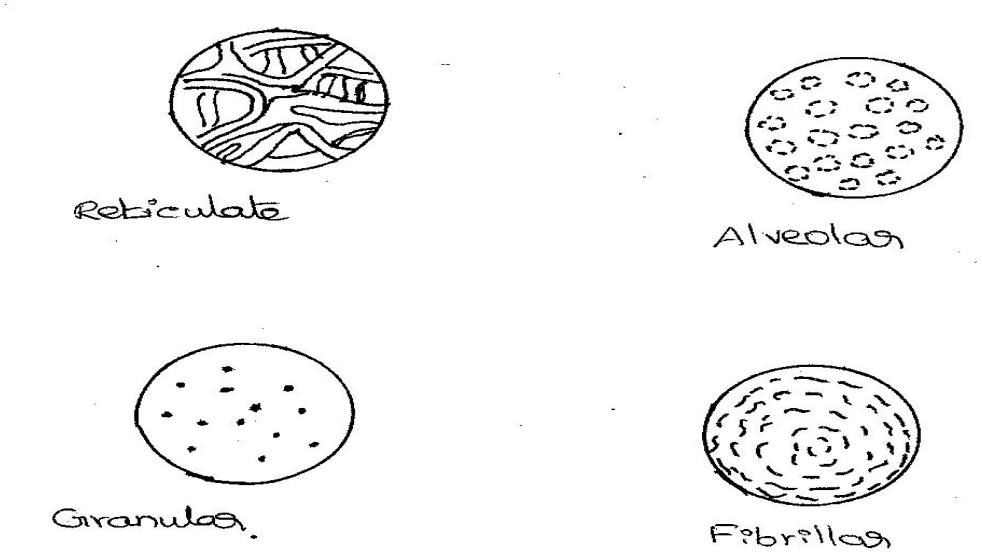
This suggests that the matrix is composed of reticulum of fiberes (or) particles in the ground substances.

2. Alveolar theory

According to this theory, the matrix consists of many suspended droplets of minute bubbles.

3. Granular theory

According to this, the matrix contains many granules of smaller and larger size arrange differently. These granules are known as bioplasts.



4. Fibrillar theory

This theory states that, the matrix is fibrillar in nature.

5. Colloidal theory

Suggests that the matrix is partly a true solution, partly a colloidal system.

Chemical nature of the matrix

1. The cytoplasmic matrix contains 36 elements.

2. The 36 elements occur in different percentage and do various important biological and chemical activities for the cell.

3. They are grouped as follows.

(i) Major elements

These elements occur more like oxygen, carbon, hydrogen and nitrogen.

(ii) Trace elements

These elements occur in low percentage like calcium, phosphorus, chlorine, sulphur, potassium, Sodium, Magnesium, Fe etc.,

(iii) Ultra structure elements

The rest of 23 element such as cu, co, mn, zn, mo, B, Si etc.,

Endoplasmic Reticulum – types, occurrence

Structure and function

Occurrence

1. Endoplasmic Reticulum is a complex, finally divided vacuolar system, extending from the nucleus, to the margins of the cell.

2. It is a net work of double membrane structure otherwise called cytoskeletion.

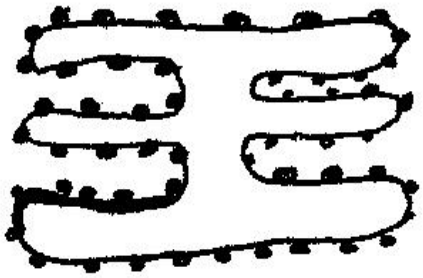
3. It was introduced by Porter.

Types

Endoplasmic reticulum is classified into two types.

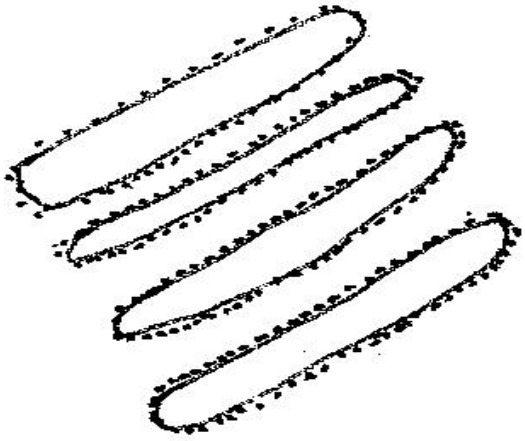
1. Granular (or) rough endoplasmic reticulum.
2. Agranular (or) smooth endoplasmic reticulum.

I. Granular (or) rough endoplasmic reticulum.



1. In some endoplasmic reticulum (E.R) spherical granular structures called ribosomes, are attached on the surface.
2. This type of E.R is called granular E.R
3. This is found in active cells.

II. Agranular (or) Smooth E.R



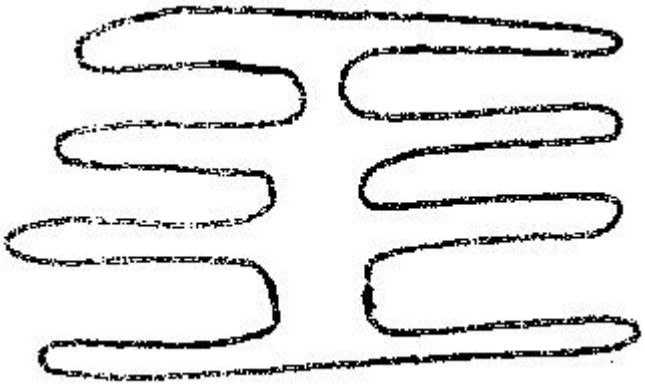
1. Ribosomes are not attached with the membranes.
2. This type of E.R is called smooth E.R.
3. They are found in inactive cells.

Structure

Endoplasmic reticulum consists of three components.

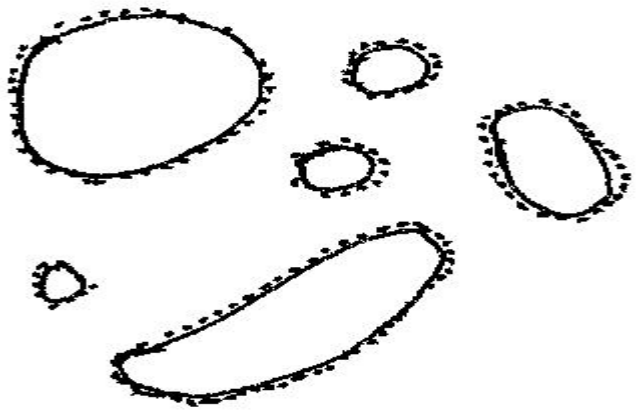
They are cisternae, vesicles, and tubules.

I. Cisternal.



1. These are long, flattened, unbranched, same like structures.
2. They are arranged in parallel bundles.
3. Their diameter is 40 – 50 mμ
4. They have ribosomes on their surface.
5. They are found in secretory cells.

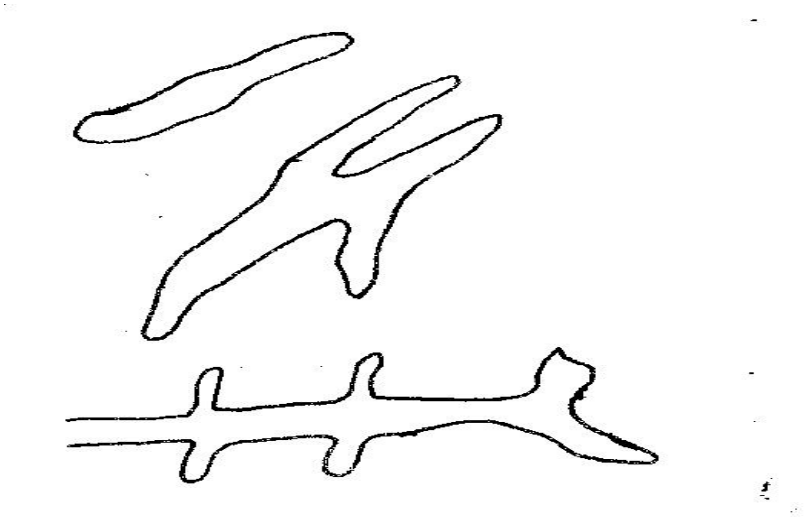
II Vesicles :



1. These are rounded (or) ovoidal structures having the diameter of 25-500 mμ.

2. They are found in Pancreatic cells.

III. Tubules



1. These are smooth walled and highly branched tubular spaces.
2. They are the diameter of 501-00 mμ
3. They occur in non-secretoy arise from the cisternae.

Functions

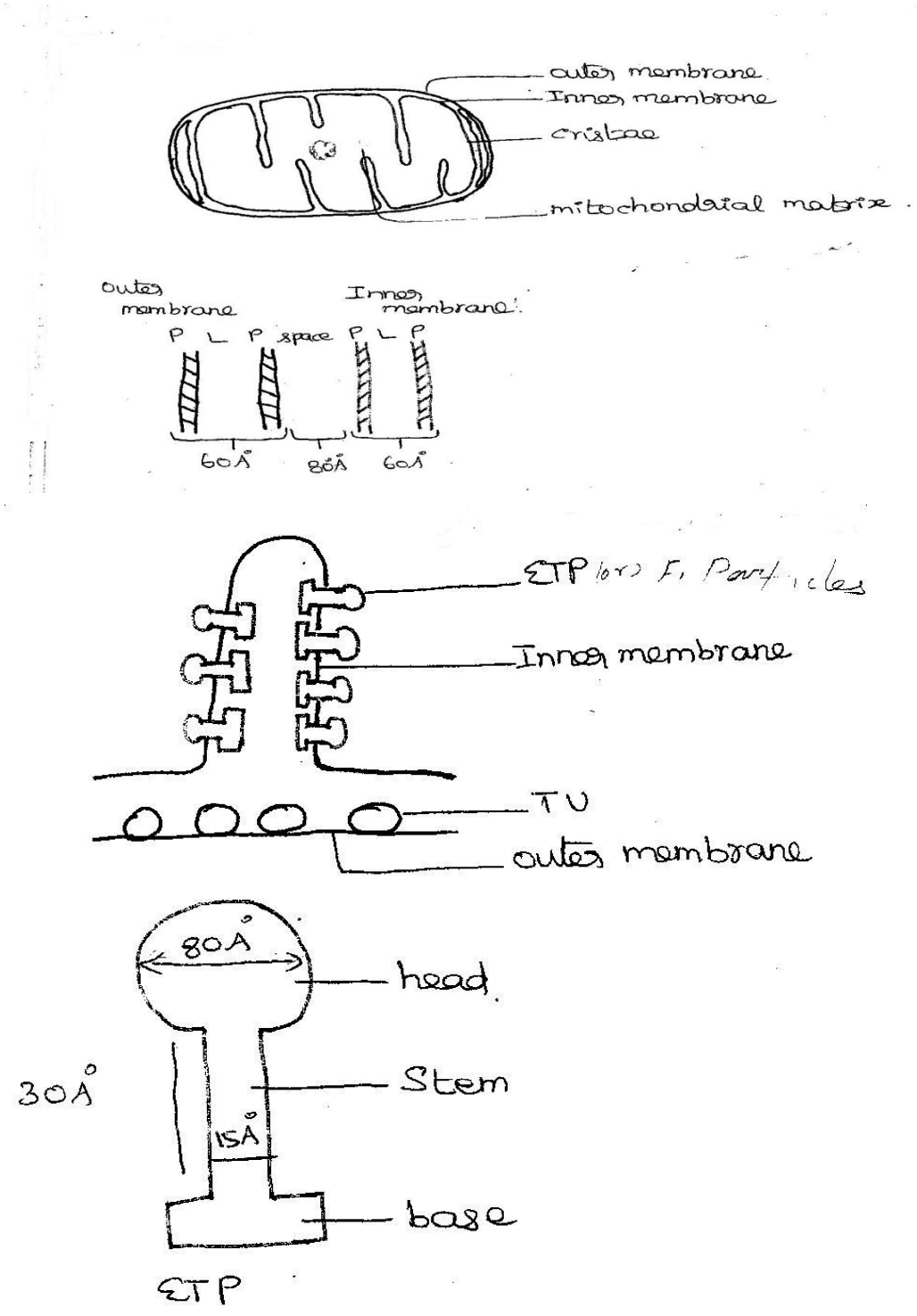
1. It gives mechanical support to the cell.
2. It involved in the import, export and intracellule circulation of various substances.
3. It play a key role for protein synthesis by providing space for the attachment of ribosomes.
4. Microbodies are formed from the E.R. E.R is the major site for the synthesis of cholesterol and steroid hormones.
5. Detoxification occurs in the E.R.

Mitochondria

Introduction

1. Mitochondria are thread like cytoplasmic organelles.
2. They contain many enzymes and coenzymes which are responsible forl; energy metabolism.
3. Hence they are called Power house of the plants.
4. They were first observed by Flemming and Kolliker in 1882.
5. The term Mitochondria was introduced by Benda in 1898.
6. The shape of the Mitochondria may be rod-shaped, club shaped, filamentous (or) granular.
7. The size may be 3 to 10μ

Structure



1. The mitochondria are covered by two membranes called outer membrane and inner membrane.
2. The membranes are 60A^{o} in thickness.

3. The two membranes are separated by a space of 80Ao to 100Ao.
4. This space is called outer chamber, filled with a fluid.
5. The central space of the mitochondria is called inner chamber, which is filled with matrix.
6. The inner membrane gives at certain finger like project known as cristae.
7. It contains small particles called elementary particles F, particles (or) oxysomes (or) Electron Transport Particle.
8. One (or) more double stranded, circular DNA present in the matrix.

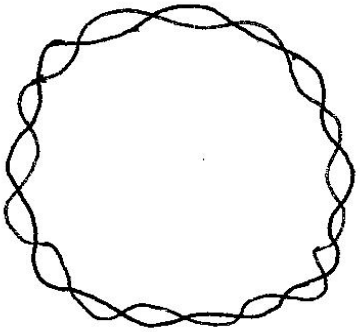
Chemistry

1. The mitochendria contain 65 to 75% Protein 25 – 305 Lipids.

   0.5% RNA. and small amount of DNA.

The chemical analysis of mitochondria shows the presence of proteins, lipids, enzymes, coenzymes, vitamins etc. Recently the presence of DNA, RNA and Ribosomes are also recorded.

Mitochondrial DNA



The mitochondria contains one or two molecules of DNA according to the size. The M. RNA is circular in shape, with in length of 5 M. It has 15000 base pairs. Due to the presence of DNA mitochondria are capable of self-reproduction and protein synthesis.

Mitochondrial Ribosomes

Ribosomes are also present in the mitochondria, but they are smaller in size than the cytoplasmic ribosomes.

Functions

1. Mitochondria generates heat by thermosis.
2. Mitochondrial DNA synthesize proteins.
3. Conversion of cholesterol to steroid hormones are lyzed by mitochondrial enzymes.

4. The first step of urea cycle occurs in mitochondri.
5. Calcium accumulation takes place in mitochondria.
6. Mitochondria are the energy plants of the cell to synthesis energy.
7. Mitochondria are the respiratory centres of the cell.

Golgi Complex

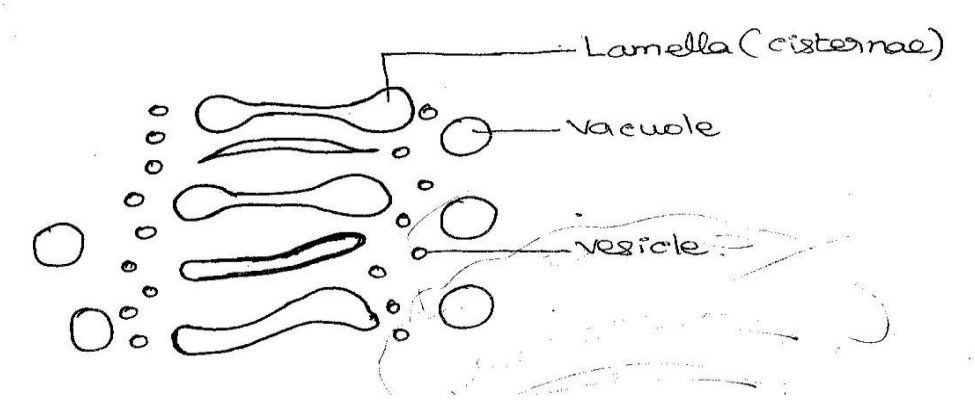
Introduction

1. 'Golgi complex is a smooth membranous system present in the cytoplasm.
2. It was discovered by Camillo Golgi.
3. It is otherwise called diotyesomes.
4. The size and shape of the Golgi complex is varies with cells.

Structrue

It consists of components.

1. Cisternae, 2. Vacuoles, 3. Vesicles.



I. Cisternae

1. The cisternae are elongated flattened sacs filled with fluids.
2. They are arranged in parallel bundles, one above the other.

II. Vacuoles

1. These are large, rounded sacs found the edges of cisternae.
2. These are formed by the expansion of cisternae.

III. Vesicles

1. These are small droplet structures.
2. These are closely associated with the peripheral of the cisternae.

Functions

1. The acrosome of sperm is developed from Golgi complex.
2. It is involved in cell wall formation.

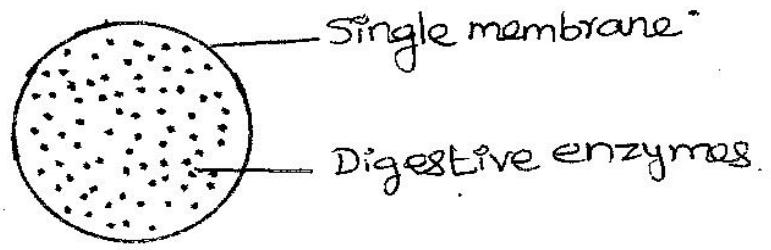
3. The golgi complex involved in the plasma membranes formation.
4. It also involved in the formation of Primary lysosomes.
5. Secretion is done by the Golgi complex.
6. It has the ability to concentrate the secretory products.
7. Glycosylation occurs in golgi complex.

Lysosomes

Introduction

1. Lysosomes are defined as ‘tiny bags’. Filled with digestive enzymes present in the cytoplasm.
2. They are concerned with intracellular digestion.
3. Lysosomes are lytic bodies, capable of lysis.
4. Hence they are called ‘ Suicidal bags’ discovered by de duve.

Structure



1. Lysosomes are usually spherical in shape.
2. The size of the lysosomes ranges from 0.2 to 0.8μ
3. They are filled with hydrolytic enzymes and acid phosphates.
4. They are bounded by single layered membrane.
5. Lysosomes shows polymorphism.

Chemistry

1. Lysosomes contains variety of enzymes.
2. All enzymes are hydrolytic.
3. These enzymes present in the lysosomes are nucleus, phosphatases, sulphatases, Lipases, Protease and Glycosidases

Functions

1.Heterophagy

Heterophagy is the lysosom digestion of extra cellular materials.

2.Autophagy

Autophagy is the lysosomal digestion of intracellular food materials.

3. Autolysis

Autalysis is the digestion of own cells by the lysosomes.

4. During fertilization, the lysosomal lenzymes, dissolve the egg membrane and make a way for the entry of sperm into the eggs.

5. It involved in the chromosomal breakage.

Plastids

Introduction

1. Plastids are large, green coloured cytoplasmic organelles.
2. They synthesize and store carbotydrate present only in plant cells.
3. Plastids were discovered by sctimper in 1885.

Classification

The plastids are divided into two main types.

1. Chromoplasts, 2. Leucoplasts.

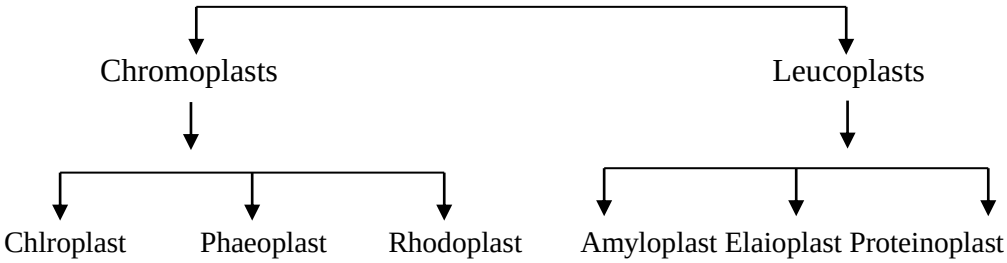
I.Chromoplasts

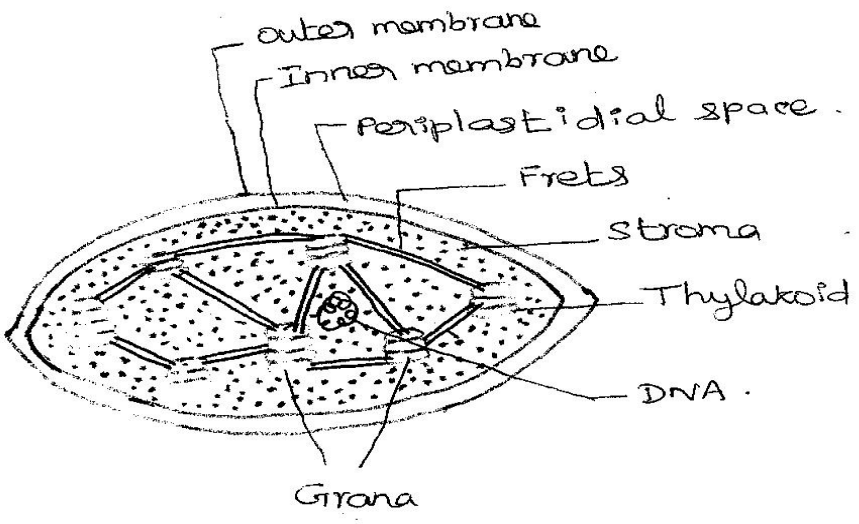
1. They are coloured plastids contains various pigments.
2. They synthesize food materials by photosynthesis.
3. The chromoplasts are further divided into chloroplast phaeoplasts and Rhodoplasts.

II.Leucoplasts

1. These are colourles plastids.
2. They store food materials
3. They are subdivided into Amyloplast, Elaioplasts, and proteinoplast.

Plastids





1. A chloroplast is bounded by two unit membranes called, an outer membrane and an inner membrane.
2. The membranes are separated by a spaces called periplastidial spaces.
3. The space is filled with a fluid.
4. The membranes are of 40 -69A^{o} thickness.
5. Inner to the membranes there is a colloidal substance called matrix (or) stroma.
6. It contains circulasr, double stranded DNA, TOS ribosomes, many enzymes and starch grains.
7. In the matrix, there are many closed flattened sacs called thylakoids.
8. 10 to 100 thylakoids are arranged one above the other in the form of a stack of discs.
9. This structure is called granum.
10. There are many granum, which are interconnected by frets (or) stromal lamellae.
11. The thylakoids contain minute particles called quantasomes.
12. The quantasomes absorbs light for photosynthesis.

Chemistry

The chloroplast contains proteins, lipids, carbohydrates, DNA, RNA, carotenoids, chlorophyll and minerals.

Function

1. Chloroplast synthesizes, certain amount of proteins.
2. Chloroplasts store starch during day time.

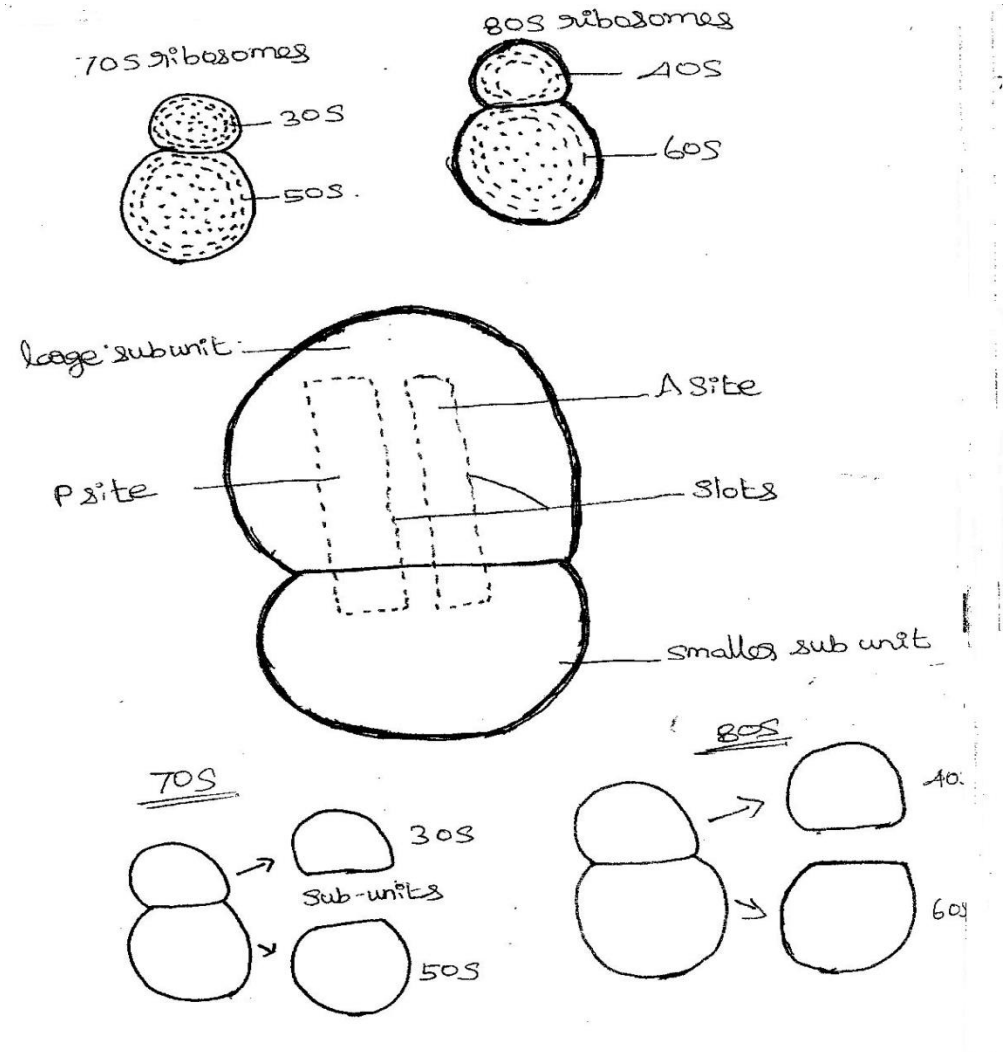
3. It utilize CO_2 and release O_2 by photosynthesis. The released O_2 is used by all animals and plants for respiration.
4. Cytoplasmic inheritance occur through plastid DNA.
5. Photasynthesis is a vital biological process done by plastids.

RIBOSOMES

Introduction

1. Ribosomes care ribo-nucleo proteins four in the cytoplasm.
2. They are located on the membranes of E.R (or) scattered in the cytoplasm.
3. They are also described as protein factories.
4. Ribosomes were first observed by palade in 1955.

Structure



1. Ribosomes are spherical shape.
2. Each ribosomes has two-sub-units, namely a large-sub unit and a small subunit.
3. The sub-units occur separately in the cytoplas,
4. They join together only at the time of protein synthesis.
5. Generally 5 (or) more ribosomes line up and join an mRNA chain. Such a chain of ribosomes is called polyribosome (or) polysome.
6. The large sub-unit has two sites namely P site and A site.
7. According to the size and sedimentation co-efficient of 2 types of ribosome.
   (i) 70s ribosomes.
   (ii) 80s ribosomes.

70s ribosomes

1. The 70s ribosomes is found in prokaryotic cells.
2. It is similar in size and has a sedimentation co-efficient of 70s.
3. 70s types made up of a large 50s and a small 30s.

80s ribosomes

1. This type found in Eukaryotes.
2. It is larger in size and has a sedimentation co-efficient of 80s.
3. It is made up of 60ss larger unit and 40s smaller unit.

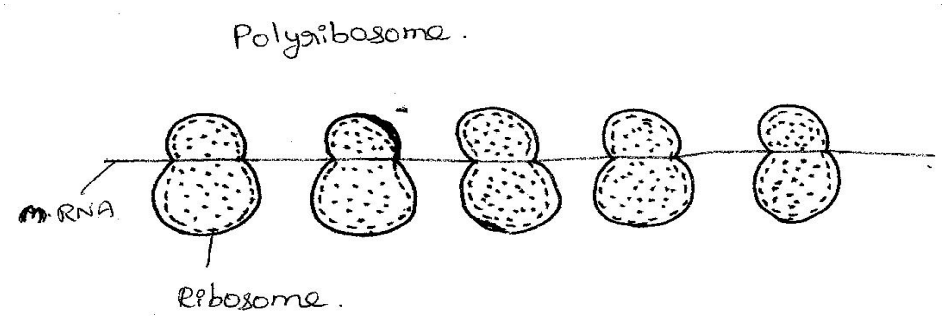
Chemical Composition

The ribosomes contains RNA, Proteins, enzymes and metal ions.

Function

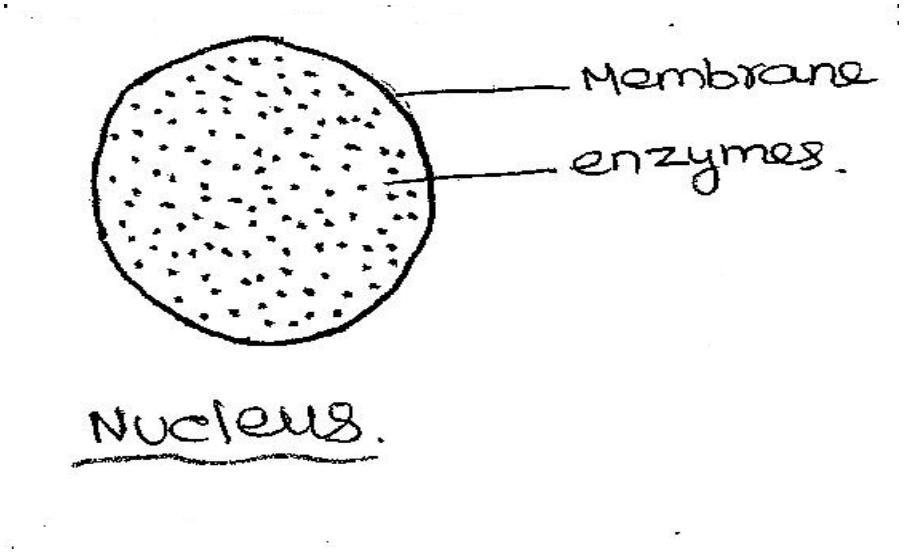
1. Ribosomes play a key role in the synthesis of proteins.
2. Newly synthesized polypeptide chains are protected from proteases.

Polyribasome



PEROXISOMES

1. Peroxisomes are small granular cell organisms helles called Microbodies.
2. They containing the enzymes, peroxidases.
3. They are found in protozoa, yeast, higher plants, liver land kidney.
4. They are formed from ER.
5. They are filled with electron dense substance and bounded by a single membrane.
6. Peroxisomes produce oxidative enxymes, called Peroxidases.
7. These enzyme produce hydrogen peroxide (H_2O_2) which is toxic to the cell.
8. Peroxisomes prodece another enzymes called catalase which destroys H_2O_2 and protects the cell.
9. They shows a relastionship with steroid synthesis and generation of NAD and NADH.
10. They oxidize a variety of substaces.
11. The most important function is its participation in photo.



Nucleus

Introduction

1. Nucleus is defined as any structure surrounded by cytoplasm from which chromosomes arise during cell division.
2. It is an important part of the cell, which controls all the cellular activities.
3. So it is otherwise called controlling centre.

4. It was discovered by Robert Brown in 1831.
5. The study, of nucleus is called Karyology.
6. It is poorly developed in prokaryotes, well developed in Eukaryotes and absent in RBC & lens cell.

Structure

1. It is double layered semiper meable membrane which is separated the nucleus from the cytoplasm.
2. The two membranes are separated by perinuclear space.
3. The membranes contains pores.

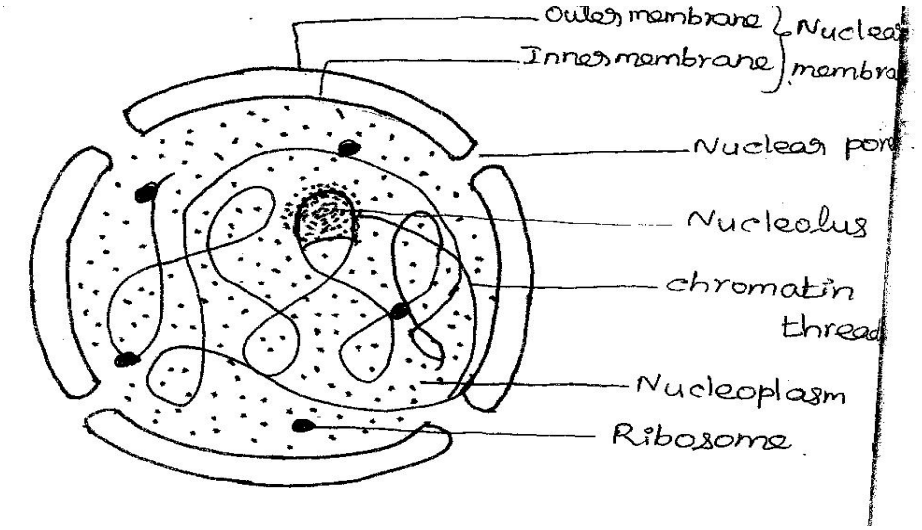
3. Nuclear Sap

The nucleus is filled with a homogenous transpasrent, substance known as nuclear sap (or) Karyo lymp.

4. Chromatin threads

These are lightly stained thread like structures embedded in the nucleoplasm called the chromonemata.

The chromonemata are in the form of network called chromatin reticulum.



5. Nucleolus

These are rounded structures present in the nucleoplasm.

6. Chromocentres

In certain cells, such as salivary gland cells of Drosophila, one (or) more areas of nucleus stain very dark such areas are called chromocentres.

Chemistry

1. Nucleus mainly consists of nucleoproteins.
2. Enzymes, inorganic salts and lipds also present.
3. Nucleic acids are two types.
   (i) Deoxy ribo nucleic acids.
   (ii) Ribo nucleic acids.
4. Lipids are phosphor lipids.

Functions

1. Nucleus control all the activities of the cell.
2. It plays a significant role in heredity.
3. It controls cell differentiation during embryonic development.
4. The synthesis of RNA takes place in the nucleus.
5. The nuclear membrane play a key role in the exchange of material between cytoplasm and nucleus.
6. It contains the message for protein synthesis.

Chromosomes

Intrduction

1. chromosomes are thread like, self reproducing structures, present inside the nucleus.
2. They absorbs colour, so they are easily stained with dyes.
3. They are the vehicles of heredity.
4. Chromosomes were first observed by Hofmeister in 184.
5. They were first named as chromosomes by waldeyer in 1888.

Number

1. The number of chromosomes varies from species to species.
2. But the number remains constant in the same species
   Ex. The lowest no.of chromosomes is in Ascaris - (2)
   The maximum no.of chromosomes is sin kprotozoa – (1700)
3. The chromosomes are arranged in pairs.
4. A pair of similar chromosomes is called homologyous chromosomes.
5. The somatic cells contain two sets of chromosomes called diploid (2n).
6. The ganetic cells contain one set of chromosomes represents (n) haploid.

7. Some cells contain more than two sets of chromosomes called polyploidy (2n, 4n, 5n, etc.,)

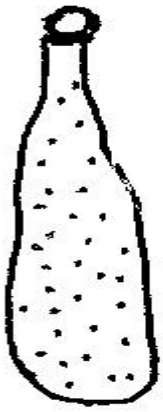
Size

1. The size of the chromosomes ranges from 0.1μ to 30μ.
2. The diameter varies from 0.2μ to 2μ.
3. The plants have large chromosomes than animals.

Shape

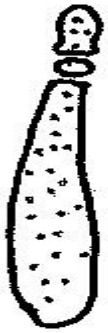
1. The shape of the chromosome is determined by the position of its centromere.
2. On the basis, there are four types.

1. Telocentric



1. The centromere is located at the end of the chromosome.
2. They are rare present in protozoa.

2. Acrocentric

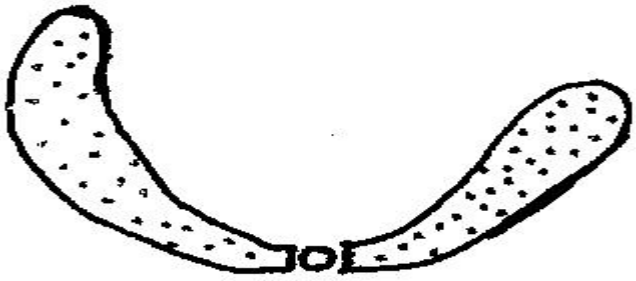


1. These are rod-like chromosomes.
2. They have a very small arm and a very large arm.

3. Sub-meta centirc

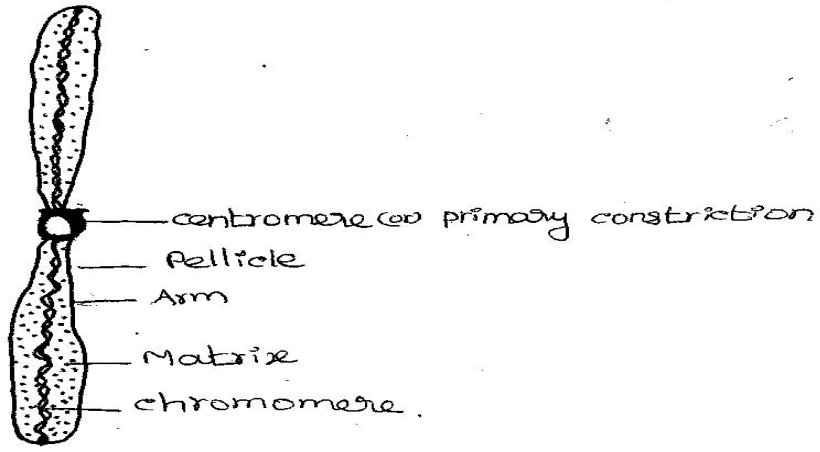
These chromosomes are ‘L’ shaped, having unequal arms.

4.Meta centric



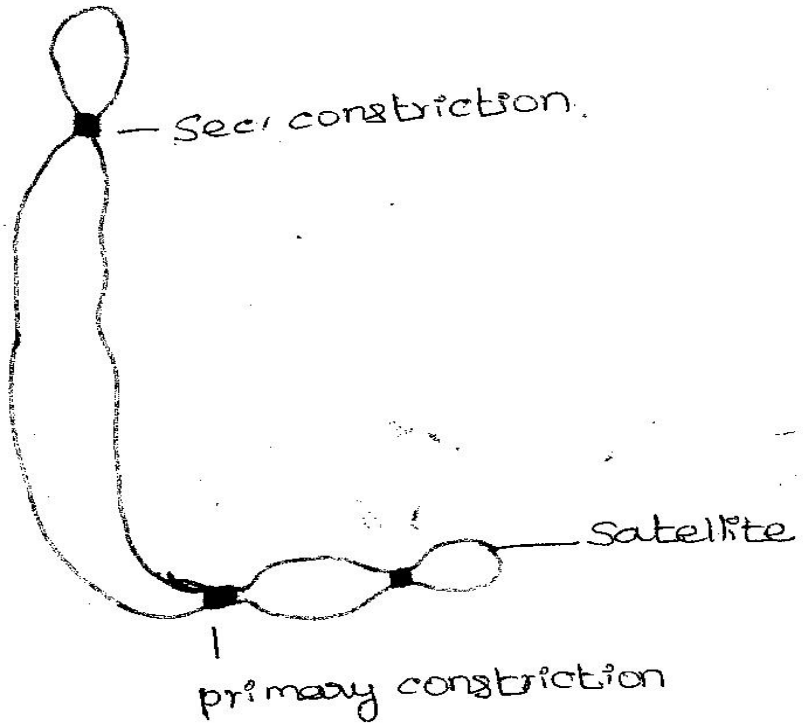
These are ‘V’ shaped having equal arms.

Morphology (Primary structure)



1. A somatic chromosome has an elongated cylindrical, structure with two arms.
2. The outer most covering of the chromosome is called Pellicle.
3. The pellicle encloses a mass of homogenous non-genetic material called the matrix.
4. The chromosome contains two identical spirally coiled filaments called chromonemata.

5. The chromonemata has alternating thick and thin regions.
6. The thick regions are called chromoneres the this regions are called inter chromomeres.
7. There is a lighter staining narrow region in the chromosome is called centromer.
8. It is in the form of constriction.
9. so, it is called primary constriction.



10. Occasionally, Chromosomes contain additional constrictions other than the pri constriction.
11. These are called secondary constriction.
12. The small piece of chromosome located beyond the secondary constriction is called satellite.
13. Chromosomes with satellite are called satellite chromosomes (or) SAT chromosomes.
14. The tips of the chromososmes are called telomeres.
15. These telomeres present the joining the ends of the adjacent chromosomes.

Euchromatin and Heterochromatin

Heterochromosome

1. Heterochromatin is the darkly stained condensed regions of chromosomes.
2. It is associated with tight folding and coiling of the chromosome fibre.
3. Heterochromatin is late replicating.
4. It is metabolically inert.

Euchromastin

1. The lightly stained non-condensed regions of the chromosomes are called euchromatin.
2. The non-condensed chromosome is called euchromosome.
3. The non-condensed chromatin is called euchromatin.
4. These are metabolically active.

Chemistry

1. The chromosomes are formed of nucleic acids and proteins.
2. 90% are deoxy ribonucleo proteins.
3. 55% are basic proteins called histone.

Special types of chromosomes

These chromosomes shows different structure, size, shape and function than the normal chromosomes.

There are two types.

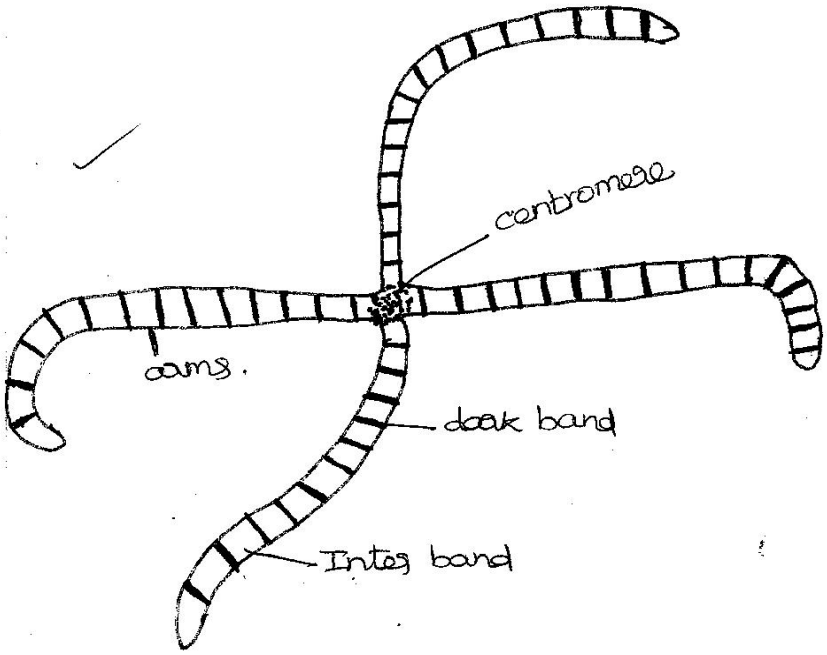
1. Giant chromosomes.
2. supernumerary chromosomes.

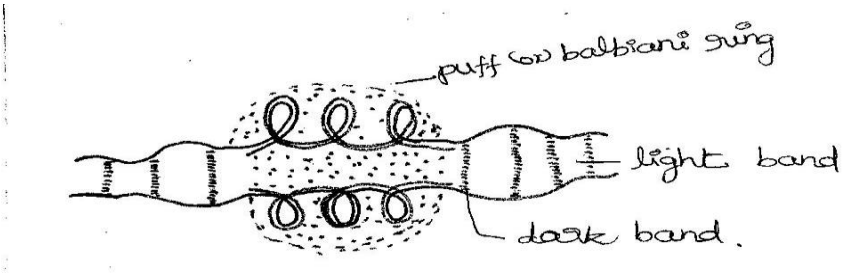
Giant chromosomes are larger in size. It is of two types.

1. Polythene chromosomes

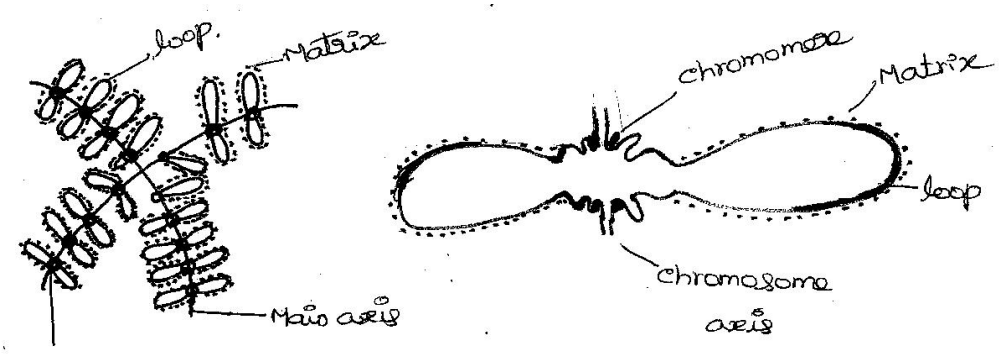
1. It is a giant chromosome. It is larger in ;size.
2. It is found in the salivary gland cells. So it is called salivary gland chromosomes.

3. It was discovered by Balbiani.
4. The larger size of the chromosome is due to the presence of may chromonemata. So it is called polytene chromosomes.
5. They were formed by endomitosis.
6. It contains many alternative dark and light bands.
7. The dark bands of polytene chromosomes become enlarged at certain regions to form swellings called puffs (or) Balbiani rings.
8. The formation of puff is called puffing.
9. The puffing is due to the uncoil and loop formation of chromonemata.





II. Lampbrush chromosome



1. It was discovered by Ruckert.
2. It is found in the Oocytes of insects, sharks and birds.
3. It appears like a brush, hence it is called Lampbrush chromosome.
4. It consists of a main axis and many lateral loops.
5. The main axis is formed of 4 chromatids.
6. It contains a series of thickening called chromomere.
7. From each chromomere a pair of lateral loops one on each side.
8. Each loop ha an axial fibres, it is the continuation of main axis.
9. The loop is surrounded by matrix.

Function of chromosomes

1. They control the heredity.
2. The chromosomes control the metabolism of an organism.
3. The heterochromatin helps in the formation of nucleous.
4. It controls the different characteristics of an organim.
5. Changes in the chromosomes leads to the formation of new species.

Nucleic acids

Introduction

1. Nucleic acid is a macromolecule with acid property.
2. It was isolated from the nucleus, so it is called as nucleic acid.
3. It is made up of C, H, O, N and P.
4. The nucleic acids were first isolated by Miescher but they named as Nucleic acid by Altmann.
5. Nucleic acids are found in all organisms.
6. They are found in the nucleus as well as in the cytoplasm.
7. It is a long chain polymer, composed of nucleotides.

8. Each nucleotide consists of a nucleoside and a phosphate group.
9. Each nucleoside consists of a pentose sugar and nitrogenous base.
10. The sugar is of two types.
    (i) Ribose sugar – Present in RNA
    (ii) Deoxy ribo sugar – seen in DNA.

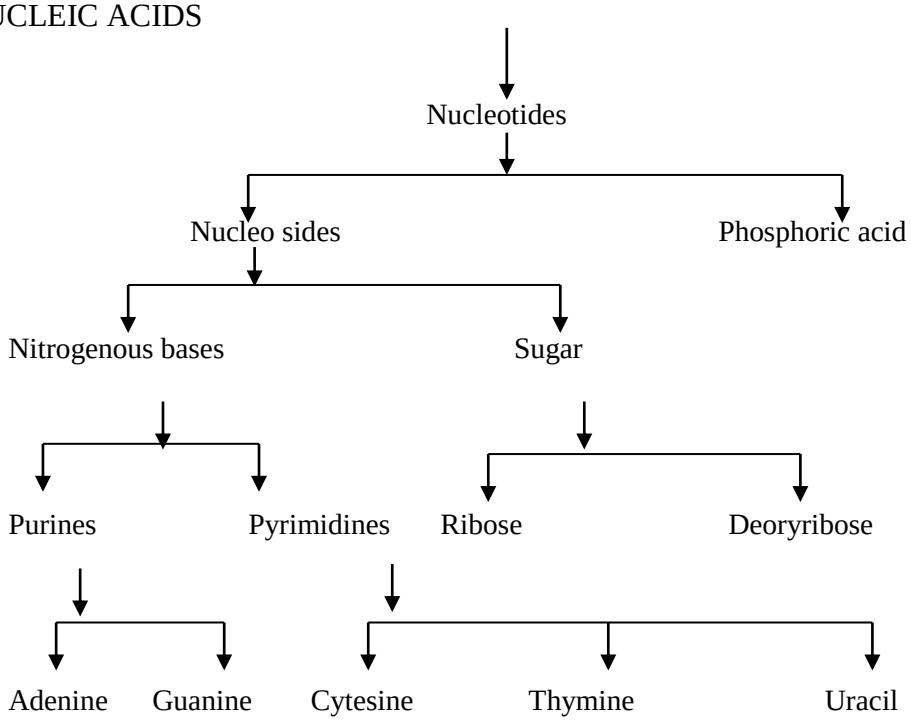
Nitrogenous base

1. It is of two types. (i) Purine (ii) Pyrimidin
2. There are two main purines namely adenine and guanine.
3. Pyrimidines are three types.

(i) cytosine, (ii) thymine, (iii) uracil.

4. cytosine and thymine are present in DNA.
5. cytoine and uracil are present in RNA.

NUCLEIC ACIDS



Polynucleotide

A number of nucleotide unit link with one another to form a polynucleotide chain (or) nucleic acid. Nucleic acids are classified into two groups.

(i) Deoxy ribo nucleic acid (DNA)

(ii) Ribo nucleic acid (RNA).

UNIT - III

GENETICS

MENDELISM

Genetics is a branch of biology which deals with heredity and variation among, organisms. Genetics originated in 1900 with the rediscovery of Gregor Jokann Mendal. The contribution of Mendel to genetics is called mendelim. Medel is called Father of Genetics. Mendel has done many hybridization exsperiments in pea plants (Pisum ativum).

Reasons for mendel's success

Mendel has selected pea plants for his experiments. He has done hybridization experiments with pea plants. The secret of Mendel's success is selection of pea plants. Following are the reason for Mendel'ssuccess.

1. Pea – plants are normally self-pollinated.
2. Cross-pollination is easy to carry out.
3. Artificial hybridization is almost successful.
4. Hybrids of pea plants are fertile.
5. Pea plant has a number distince contrasting characters.
6. Genes for the 7 pairs of characters are present on seven of homologous chromosomes.
7. Pea plants has many pure breeding varieties.
8. Pea-plants are annuals with short growth period and shot life cycle.
9. Pea plants can be cultivated easily.
10. At a time Mendel studies one character.
11. Statistical records of the results is useful for analysis.

Character selected by Mendel

Mendel observed a number of contrasting character in Pea-plants. He has selected only seven character's. Each of these seven characters has two alternatives. This is given below

No	Characters	Dominant	Recessive
1.	Height of the plant	Tall	Dwarf
2.	Position of the flower	Axill ary	Terminal
3.	Colour of the pod	Green	Yellow
4.	Shape of the pod	Inflated	Constricted

5.	Shape of the seed	Round	Wrinkled
6.	Seed coat colour	Coloured	White
7.	Cotyledon colour	Yellow	Green

Monohybrid cross

A cross between two parents differing in a pair of related characters, is called monohybrid cross. Height of the plant is the character selected Mendel took a pure breeding tall plant (ca 180 cm) and a pure breeding dwarf plant (ca 45 cm) as parents. He crossed these two artificially and obtained off spring called F_1plants were allowed to self fertile and F_2 generation was raised F_2 generation showed 3 tall and one dwarf plants.

Mendel called F1 tall plants as monohybrids. The character expressed in F_1 generation is known as dominant (Tall) and the character not expressed a recessive (dwarf). Mendel said that characters are controlled by some thing called factors . Factors are now called genes.

Tall parent has two dominant genes (TT) and Dworf parent has two recessive genes.

Parents – hight of the plant.

P = Tall x Dwarf

TT tt

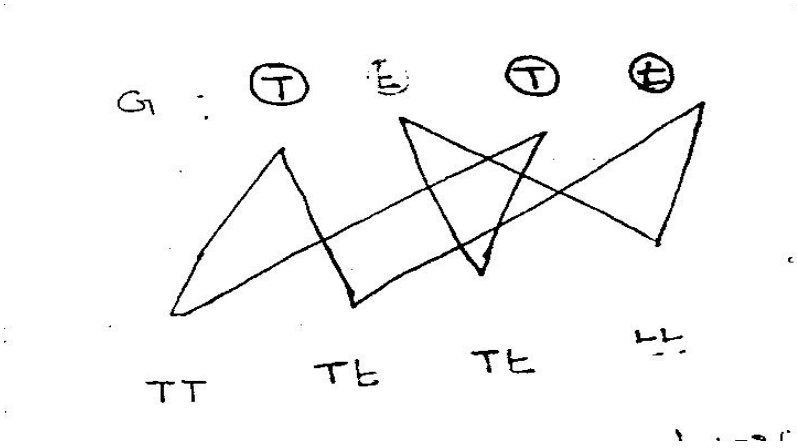
G = x

T t

F1 - Tt (Monohybrid)

Tall

Tt Tt (F1 selfied)

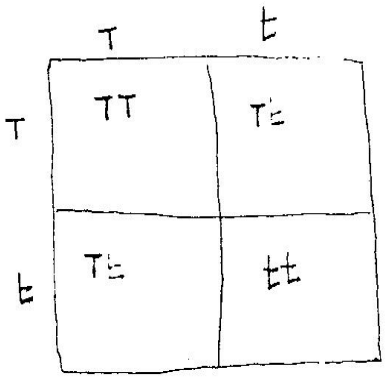


Tall Tall Tall dwarf

Homozygous Heterozygous Homozygous

Tall Tall dwarf

Checker Boo 1 :



Phenotype ratio : 3 Tall : 1 dwarf.

Genotype ratio: Tt Tt tt

1 : 2 : 1

Homozygous Hetero Homozygous

Tall zygous tall dwarf

Alleles

Members of a gene pair that control the contrasting expression of a single character are called alleles.

External appearance of plants in F_2 generation is called phenotype ration. This show 3 : 1 (tall & dwarf) ratio. Gene constricution of plants is called genotype ratio which is s 1 : 2 : 1.

Plants having a pair of similar factors are called homozygous and those with different factors are called heterozygous.

F_1 plants are always called heterozygous. Dominant character is expressed with in homozygous and heterozygous condition. Recessive character is expressed only in homozygous condition.

Law of segregation

Based on monohybrid cross Mendel proposed his first law – the law of segregation.

This law states that the two alleles in a monohybrid remain together without mixing and separate or segregate at the time of gamete formation Gametes carry only one allele or gametes are pure. This is also called low of purity of gametes. Meiosis occurs during gamete formation. This helps in segregation.

Back Cross

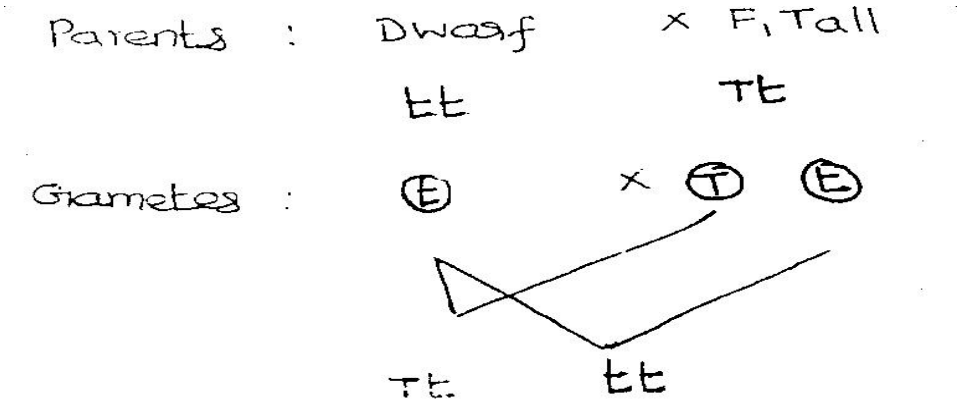
Cross of F_1 hybrid with any one of 1ts parents is called back cross. It is two types.

Dominant back cross

Cross of F_1 hybrid with dominant parent is called dominant back cross. This will give 100% dominant character.

Recessive back cross

Cross of F_1 hybrid with recessive parent is called recessive back cross or test cross.



Tall	dwarf
50%	50%

Ratio : 1 : 1

Test cross give tall and dwarf plants in 1 : 1 rastio.

F1 hybrid (Tt) gives 2 types of gasmetes (T) & (t) in 50 : 50 ratio. Dwarf parents given only one type of gametes (t). This gives 50% Tt (Tall) and 50% tt (dwarf) or 1 : 1 ratio.

Test cross helps to known whether are individual showing a dominant character is homozygous or heterozygous.

It is also used to test whether segregation of alleles takes place or not.

Dihybrid cross

It can be defined as a " cross between two parents differing in two pairs of contrasting characters". Mendel has selected two pure breeding pea plants one with round seeds and yellow cotyledons and the other with wrinkled seeds and green cotyledons. Seed shape and cotyledon colour are the two characters taken in this experiment. Round yellow parent hod "RRYY" genes and wrinkled green parent had rryy. A cross between these two parents produced

round yellow off spring in the F1 generation. When F_1 plants were selfed. The F_2 generation produced 4 phenotypes in the ratio of 9 : 3 : 3 : 1. Here round yellow and wrinkled green are parental types. Round green and wrinkled yellow are new type of progeny. This show that the inheritance of each pair of factors was independent of the other pair.

Parents : Round yellow x Wrinkled green

RRYY rryy

Gametes : RY ry

RrYy (Round yellow)

Dihybrid

RrYy x RrYy

Gametes : Ry Ry ry ry x

Ry Ry

(Selfing)

Ry Ry ry ry

ry ry

RRYY Round Yellow	RRYy Round Yellow	RrYy Round Yellow	RrYy Round Yellow
RRYy Round Yellow	Rryy Round Green	RrYy Round Yellow	Rryy Round green
RRYy Round Yellow	Rryy Round Yellow	RrYy Round Yellow	Rryy Round Yellow
RrYY Round Yellow	RryY Round Yellow	RrYY Round Yellow	RrYy Round Yellow
RrYy Round Yellow	Rryy Round green	RrYy Round Yellow	Rryy Round green

F2 Phenotype	9	:	3	:	3	:	1
	Round Yellow		Round green		Wrinkled yellow		Wrinkled green

Round yellow (RRyy) and wrinkled green (rryy) parent produce YR and yr types of gametes. The resulting F_1 progeny was round yellow with RrYy genotype was round yellow with types of gametes like RY, Ry, rY, ry, in equal number. This is due to segregation. F_1 plants produce 4 types of male gametes and 4 types of female gametes. The union of these gametes and the types of progeny are given in the checker board. 16 combination are possible as shown is the checker board by random union of male & female gametes. This gives 9 round yellow, 3 round green, 3 Wrinkled yellow and 1 wrinkled green.

Parent : Round yellow type is dominant.

Wrinkle green type is recesive.

F_1 plant is heterozygous and dihybrid.

Law of independent Assortment

Based on dihybrid cross Mendel proposed his recond law called the law of independent assortment.

This law states that "The inheritance of genes of each pair" in a dihybrid during gamete formation is independent of the other.

Round yellow parent has the genes Y, and R, wrinkled green parent has the green y and r. F_1 progeny produces 4 type of gametes. Like RY, Ry rY, ry.

This gives 4 types of plants in the F_2. This is due to independent assortment of genes.

Dihybrid Test Cross

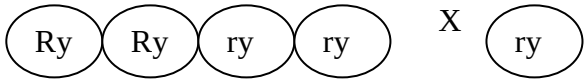
F1 dihybrid is crossed to recessive parent.

1. F1 dihybrid produce 4 types of gametes. (RY, Ry, rY,ry)
2. Wrinkled green parent (rryy) produce only one type of gametes (ry).
3. Gamete union produce 4 types of plants. (round yellow, round green, wrinkled yellow and wrinkled green) in 1 : 1 : 1 :1 ratio.
4. The observed ratio is similar to expected ratio.
5. Dihybrid test cross is usedss to verify the law of independent assortment.

Parents: F1 x Wrinkled green

Round yellow

RrYy rryy



Ry Ry rY ry

RrYy Round yellow	Rryy Round green	rYry wrinkled yellow	rryy wrinkled green

ratio 1 : 1 : 1 : 1

Interaction of genes or Factor interaction

After the rediscovery of Mendel is work, many similar experiments were carried out. The results confirmed, the law of segregation and independent assortment. However in some case 3 : 1 and 9 : 3 : 3 : 1 ratios were not obtained. Monohybrid cross showed 1 : 2 : 1& 2:1 ratio. Dihybrid cross showed 9 : 7, 9 :3 : 4, 12 : 3 : 1 etc. This is due to different effects of the different gene pair on a single character. Here more than one pair of genes were controlling a single character. This is known as gene interaction or factor interaction . this is different from mendels idea that a single , pair & genes control a character.

Allelic gene interaction

This is due to interaction between two alleles of a single gene.

Ex.

Incomplete dominance

Lethal genes

Polygenic inheritance

Incomplete dominance

Correns observed their in 4 'O' clock plant (mirabilis jalapa). According to Mendel F_1 plant resembled only one (dominant) of the parent.

This was due to complete dominance of one allele over the other correns noticed, absence of dominance in 4 'O' clock plant.

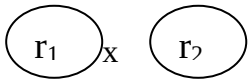
In mirabilis jalapa, a cross is made between pure breeding red folwerd and white flowered poaents. The F_1 progeny had an intermediated colour pink. When the F_1 hybrids were selfed, the F_2 had red, pink & white flowered plant in 1 : 2 : 1 ratio. This is explained below.

Parent

Red x White

r_1r_1 r_2r_2

Gametes



F_1 r_1r_2 – pink - hybrid

F_1 x F_1 Selfing

r_1r_2 x r_1r_2

	r_1	r_2
r_1	r_1r_1 Red	r_1r_1
r_2	r_1r_2 Pink	r_2r_2 white

F_1 plant is pink flowered. It did not resemble any of the parents. Neither colour is completely dominant over the other symbol r_1 for red and r_2 for white is assigned. Red parent has r_1r_1 genotype and white r_2r_2 F_1 hybrids have r_1r_2 genotype. F_1 produces 2 types of gametes (r_1 & r_2). In the F_2 ¼ progeny has r_1r_1 genotype (red), 2/4 with r_1r_2 genotype (pink) and ¼ with r_2r_2 genotype (white). Pink colour is heterozygous plants is due to incomplete dominance. Since F_1 pink is an intermediate expression of both the parents. This is also called blending inheritance. Here the expression alone is mixed and not the alleles.

Lethal genes (2 : 1) ratio :

Genes which cause the death of the organism carrying it are called lethal genes. These genes caused death in homozygous condition. Recessive that genes are expressed only in the homozygous condition.

Cue not was first to describe lethal genes in mice. In mice yellow coat colour dominant over black.

It is known that all yellow mice are heterozygous (Yy).

A cross between two yellow mice always produced 2 yellow (heterogenous and one black (2 : 1) expected ratio is 1 : 2 : 1 (pure yellow, heterozygous yellow and black).

Homozyyous yellow mice die in the embryo due to lethal genes. The dominant gene Y in lethal. This gives 2 : 1 Unusual ratio.

Parents Yellow x Yellow

Yy x Yy

Gametes (Y) (y) x (Y) (y)

Y y

YY Yellow dies	Yy Yellow
Yy Yellow	yy black

Phenotype ratio - Yellow : Black

2 : 1

Polygenetic inheritance : (or) multiple genes (or) cumulative genes (or) Additive genes (or) Quantitative characters (15 : ratio).

Multiple genes or polygenes are defined as a "group of genes located at different loci and involved in the expression of one character".

According to Mendel leach character is controlled by a pair of genes located at the same locus.

But some characters are controlled by many genes which are called multiple genes (or) polygenes.

Inheritance of multiple genes is called multiple gene inheritance.

Each gene has a small effect on the expression of the character. The effect of gene is small and similar. The net effect of the character depends on the total number of genes involved. Hence these genes are also called cumulative genes. The effect adds up with each increase in number of genes.

The character controlled by polygenes are not sharphy marked from one individual to other. They are continuous with many intermediates. This shows continuous variation between two extremes. Hence this is also called quantitative characters.

Mendels principles are not suitable to polygenes.

Ex: Kernal colour in wheat.

Skin colour in man.

Kernal colour in wheat was studied by Nilson-Ehle. When deep red and white seed varieties are closed. The F1 seeds were intermediate red (intermediate between the parents).

F1 plants when selfed F2 plants showed Red and White seed in 15 : 1 ratio.

A continuous gradation from white to red was observed as follows.

1/16	-	White
4/16	-	Pale red
6/16	-	Intermediate red
4/16	-	Dark red
1/16	-	Deep red

Here two pairs of genes are involved in the inheritance of colour. All the four have a cumulative effect. Genes R_1 and R_2 are needed for red colour.

Deep red parent was $R_1R_1R2R_2$ and white was $r_1r_1r_2r_2$.

Genes r_1 and r_2 are called non contributing genes.

Deep red has 4 dominant genes

Darked has 3 " "

Intermediate red has 2 " "

Pale red has 1 " "

White has only recessive genes

Parent : Deep red White

$R_1R_1R_2R_2$ x $r_1r_1r_2r_2$

Gametes : R_1R_2 x r_1r_2

$R_1 r_1 R_2 r_2$

F_1 Intermediate red

F_1 x F_1 Selfing

Gametes : R_1R_2 $R_1 r_2$ r_1R_2 r_1r_2

Gametes : R_1R_2 $R_1 r_2$ r_1R_2 r_1r_2

Intermediate red has 2 " "

Pale red has 1 " "

R_1R_2 R_1r_2 r_1R_2

r_1r_2

R_1R_2	$R_1R_1R_2R_2$ Deep Red	$R_1R_1R_2r_2$ dark red	$R_1r_1R_2R_2$ dark red	$R_1r_1R_2r_2$ J red
R_1r_2	$R_1R_1R_2r_2$ Dark Red	$R_1R_1r_2r_2$ I Red	$R_1r_1R_2r_2$ I Red	$R_1r_1r_2r_2$ Pale Red
r_1R_2	$R_1r_1R_2R_2$ Dark Red	$R_1r_1R_2r_2$ I Red	$r_1r_1R_2r_2$ I Red	$r_1r_1R_2r_2$ Pale Red
r_1r_2	$R_1r_1R_2r_2$ I Red	$R_1r_1r_2r_2$ Pale Red	$r_1r_1R_2r_2$ Pale Red	$r_1r_1r_2r_2$ while

Phenotype ratio : 1: 4 : 6 : 4 : 1

Genotype ratio : 15 : 1

NON-ALLELIC GENE INTERACTION

Complementary genes [9 : 7]

This can be defined " as " two pairs of non-allelic dominant genes which interact to produce one phenotype, but neither of them produce the phenotype when present alone.

Complementary genes is a very common type of gene interaction.

This was discovered in sweet pea (Lathyrus odoratus) by Bateson and punnett.

It has two pure breeding white flowered varieties. When these two were crossed F1 plants produced purple flowers, on selfing, these F2 plants produced purple and white flowered plants in 9 : 7 ratio in the F2.

This is modification of 9 : 3 : 3 : 1 ratio. Out of 16 F2 plasnts 9/16 were purple 7/16 white flowered. This shows that two pairs of genes must have been involved.

One dominant gene p controls the production of colourless pigment precursor, called chromogen. Its allele p being recessive does not produce chromogen. Other dominant gene c produces an enzyme. Chromogen and enzyme reaction produces a purple pigment called anthocyanin (cp).

Gene p $\rightarrow$ chromogen pigment precursor.

Gene c$\rightarrow$ enzyme.

P+c = chromogen + enzyme → anthocyanin (purple colour)

Purple colour is produced when the dominant. Genes p and c are present. Otherwise the floweres will be white. Thus the genes, c and p are complete mentasry. Each gene controls a step essentials for the production of purple pigment anthocyanin on the absence of any one of them does not produce purple colour.

Parent : White flower x White flower

CcPP CCpp

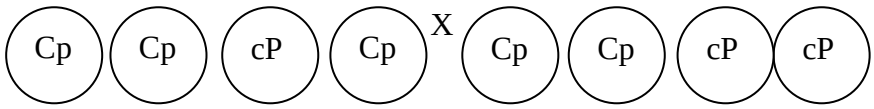
Gametes : cP Cp

Purple (CcPp)

Selfing

CcPp x CcPp

Gametes



CP Cp cP

cp

CP	CCPP Purple	CCPp purple	CcPP Purple	CcPp Purple
Cp	CCPp Purple	CCpp White	CcPp Purple	CcPP White
cP	CcPP Purple	CcPp Purple	ccPP white	CcPP White
cp	CcPp Purple	CcPP White	CcPp White	ccpp white

Purple - 9

White - 7

Phenotype ratio : Purple : White

9 : 7

One white flowered parent has ccpp genotype. This has the gene for chromogne. The other white flowered parent CCpp genotype. This has the gene for enzyme. F1 plant has CcPp genotype.

Genes C and P interact to produce purple flowers. F1 plant will produce four kinds of gametes CP, Cp, cP, cp&cp. Unioun of these gametes produce F2 plants as shows in the punnett's square.

In the F2 9/16 produce purple flowers, which have dominat genes c and p.7/16 produce white floweres. Which have only C or P or the recessive alleles.

This is modified dihybrid ratio as show below.

Dihybrid ratio : 9 : 3 : 3 : 1

Complementory gene : 9 7

Supplementary genes : 9 : 3 : 4

This is a gene interaction which has two pairs of dominant non allelic genes of which one is supplementary. It has no expression by itself but it changes the expression of the other.

Sorghum glume colour is given as an example. A cross between dark purple (ppqq) and brown (ppQq) parents produced red coloured (ppQq) progeny in the F1. This is due to interaction of p and Q. When the F1 are selfed, Three types of progeny are produced in the F2 in the ratio of 9 Red : 3 Dark purple : 4 brown. In the F2 9/16 plants have both P & Q and are there fore red 3/16 have atleast one p but no Q and are therefore purple 4/16 have the allele P is homozygous (PP) condition and hence brown.

Purple colour (P) is dominant over brown (P) Gene Q has no expression by itself. When p and Q come together purple, colour is changed o red when p and Q come together there is no modifying effect Gene q has no phenotype effect of the its own. Thus the gene q is supplementary to gene. P which change purple to red.

9 : 3 : 4 ratio is a modification of 9 : 3 : 3 : 1 ratio

Mendal's dihybrid ratio 9 : 3 : 3 : 1

Supplementary genes 9 3 4

Parents : Purple x Brown

PPqq x ppQQ

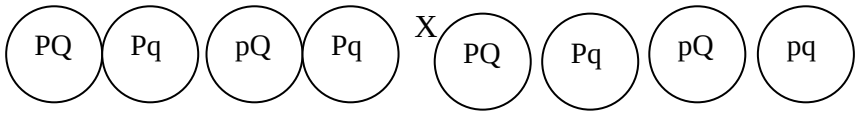
Ganetes (Pq) ↓ (pQ)

F1 PpQq Red

F1 x F1 selfing.

PpQq X PpQq

Gametes :



PQ Pq pQ

pq

PQ	PPQQ Red	PPQq Red	PpQQ Red	PqQq Red
Pq	PPQq Red	PPqq Purple	PpQq Red	PPqq Purple
PQ	PpQQ Red	PPQq Red	ppQQ Brown	ppQq Brown
Pq	PpQq Red	Ppqq Purple	PPQq Brown	ppqq Brown

Phenotype ratio : 9 : 3 : 4

Red Purple Brown

Epistasis (12 : 3 : 1)

This is an interaction between two pairs of non – allelic dominant genes affecting the same character of an individual. They interact in such a way that one marks the expression of the other. The gene that marks is called epistatic and the effect is called epistasis. The gene that is suppressed is called hypostatio epistasis is different from dominance.

Epistasis was observed by sinnolt in summer squash (cucurbita pepo). This has 3 types of fruits like white, yellow and green. White colour is produced by a dominant gene W, Yellow colour by another dominant gene Y and green colour by a recessive gene yy. The presence of w marks the effect of the genes y and y producing white fruit. Therefore yellow and green colour is produced when the epistaticl gene w is absent.

When a true breeding white variety (wwyy) is crossed to green variety (wwyy). The F1 (WwYy) plants have white flowers, selfing of F_1 plants gives

12 : 3 : 1 ratio of white, yellow and green fruits in the F_2. This is shown in the checker board. 12/16 carry atleast one esiptatic gene W and are white.

3/16 carry atleast one Y gene but not W and hence yellow.

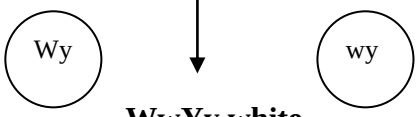
1/16 carry neither W nor Y and green.

Thus in this case W is the epistatic gene and Y or y are hypostatic genes.

Parents : White fruit x green fruit

Wwyy wwyy

Gametes :



WwYy white

F 1 x F1 selfing

WwYyx WwYy

WY Wy wY

wy

WY	WWYY White	WWYy White	WwYY White	WwYy White
Wy	WWYy White	WWyy White	WwYy Whilte	Wwyy White
wY	WwYY White	WwYy White	wwYY Yellow	WWYy Yellow
wy	WwYy White	Wwyy White	wwYy yellow	wwyy green

F_2 phenotype ration 12 : 3 : 1

White Yello green

Mendelis dihybrid ration : 9 : 3 : 3 : 1

Epistasis ratio : 12 : 3 : 1

LINKAGE

Linkage is defined as the " Tendancy of 2 or more genes present in the same chromosome to inherit together (in the parental combination) for many generation".

Mendel said that each chromosome has a single gene. But many organisms have more that two or more genes in a single chromosome. Such genes are called linked genes. Linked genes do not show independent assortment.

History

Mendel did not say anything about linkage.

1. Sutton said that each chromosome contain many genes. All the genes present in a chromosome inherit together to next generations. There is no experimental proof for this.

2. Linkage there was proposed by D.H. Morgan. He explainer that coupling and repulsion are two aspects of a single phenomenon called linkage. Morghan found 8 chromosomes in Drosophila. Hundreds of genes are located in these 8 chromosomes. There fore each chromososme must contain many genes. Such genes are called linked genes and responsible for linkage.

Coupling and repulsion

Bateson and punnet (1906) have explained two events called coupling and repulsion. In sweet pea they made a cross between two varieties as given below.

Parent	:	Blue flower		Red flower
		Long pollen	X	round pollen
		BBLL		bbll
		(dominant)		(recessive)

Gametes : BL BL

F_1 BbLl (blue long)

Test cross :

Blue long x red round

BbLl

Gamete : BL Bl bL bl X bl

Progeny : Blue long : Blue round : Red long : red round

Ratio 7 : 1 : 1 : 7

Observed ratio : 7 : 1 : 1 : 7

Expected ratio : 1 : 1 : 1 : 1

This shows that dominant alleles (so also recessive alleles) if present in the same plant tend to remain together.

This produces more parental combinations. This is called coupling.

Another cross between 2 varieties gave a different ratio which is given below.

Parent : Blue round x Red round

BBll bbLL

F_1 ↓

BbLl

Test cross : Blue long x red round

BbLl x bbll

Progeny : Blue lone : Blue round : Red long : Red round

Observed ratio : 1 : 7 : 7 : 1

Expected ratio : 1 : 1 : 1 : 1

This shows that genes present in different parent, tend to remain separate. This was called repulsion.

Linkage groups

All the linked genes present in a chromosomes form a linkage group. The number of linkage group in an organism is equal to haploid number chromosome.

Drosophila - n = 4 - linkage group – 4

Maize - n = 10 = linkage group – 10

Pea plant – n = 7 – linkage group – 7

Man – n = 23 – linkage group – 23

Linear arrangement of genes, linked genes seen in a chromosome are arranged in a linear manner.

Linkage Value or Strength of linkage

This depends upon the distance between the linked genes in the chromosome (closely arranged) genes have more linkage value Distantly arranged genes have low linkage value. High percentage of parental types in the F_2 indicate higher linkage value.

Types of linkage

There are two types like 1. complete linkage 2. incomplete linkage.

Complete linkage

Only 2 parental types are produced for many generations. There is no any recombination types. Here the linked genes are closely arranged. This is very rare. This is found in male Drosophila.

Incomplete linkage

This produces 2 parental types is more percentage and 2 recombination types is less percentage. Here the linked genes are not closely arranged. Linked genes separate and produced recombination's during reproduction. This is very common in Drosophila and maize.

Linkage in maize

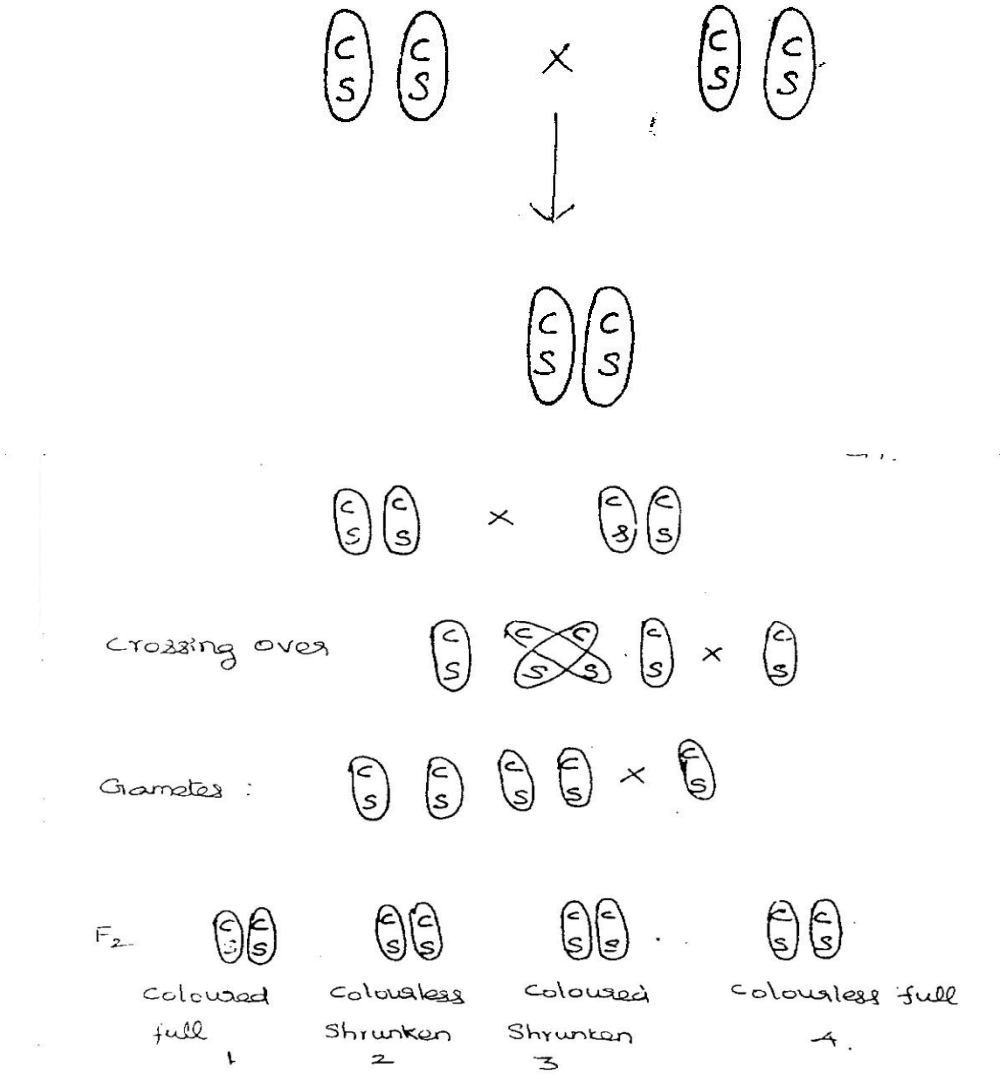
Linkage in maize has been described by Hutchinson. A cross between coloured seed and full endosperm with colourless shrunken seeds were made. It was already known that the gene for colour (c) was dominant over. Colourless (c) and the full endosperm gene (s) wass dominant over shrunken (s). The parents were cs/cs and cs/cs. Here the genes cs and cs are linked and carried on the same chromosome. All the F_1 were coloured full seed with the genotype cs/cs. A test cross between F_1 and recessive parent produced the following progeny.

Coloured full	(cs / cs)	=	4032
Coloured shrunken	(cs / cs)	=	149
Colorueless full	(cs / cs)	=	152
Colourless shrunken	(cs / cs)	=	4035
			8368

Here coloured full are colourless shrunken are the parental types with maximum frequency 96.4%. The other two types are recombinations with low frequency 3.6%.

Here the genes cs and cs did not show independent assortmet. The observed ratio is different from expected ratio. The genes c and s and c and s are linked. They do not show segregation. Hence coloured full (cs) and colourless shrunken (cs) appear in maximum frequency. Recombination of linked genes ls due to crossing lover. The fore this is called incomplete linkage.

Parents : Coloured full X Colourless Shrunken



1 & 2 - Parent types 96.4 %

3 & 4 - Recombination 3.6%

Significance of linkage

1. linkage bring parental characters with out variation.

2. Many qualitative characters (leaf shape & stem colour) are linked to quantitative characters (fruit size). This is used to identify some marker genes.

Crossing Over

Appearance of new combination of characters in the organisms during inheritance is due to crossing over. Morgan defined crossing over " as the exchange of chromation segments between non-sister chromatids of homologous chromosomes resulting in recombination of genes".

Usually crossing over occurs in the germ cells. Meiosis takes place during gametes formation. This has more genetic significance. This is called meiotic or germinal crossing – over.

Rarely crossing over occurs in the somatic cells, where mitosis takes place. This is called somatic or mitotic crossing over. This has x no genetic significance . ex: Drosophila

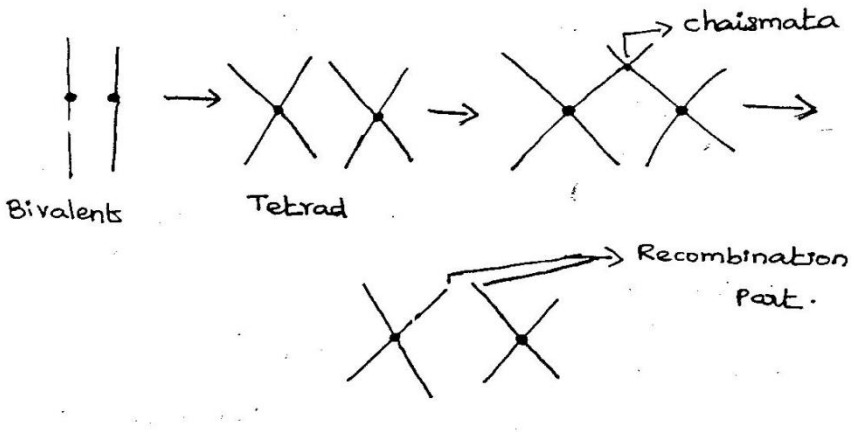
In the test cross the % of recombinant (new) types indicate the presence and strength of crossing over.

Mechanism of crossing over

Crossing over takes place during prophase I of meiosis pairing of homologous chromosome takes place and it is called synopsis.

The paired homologous chromosomes are called bivalents. Each chromosome splits longitudinally to form 4 chromatids from the homologous (2) chromosomes. This is called tetrad stage.

The adjacent non-sister chromatids meet at some points called chaismata. Crossing over takes place in the chaismta crossing over takes place in the chaisma region. Now the two non-sister chromatid breaks, exchange segments and rejoin resulting in crossing over. This is arsisted by two enzymes like endonuclease and ligase. Number of chaismata depends upon the chromosome length. Longer than the chromosomes repel each other and get separated. This is called terminalisation. Finally adjacent two chromatids show recombination of genes.



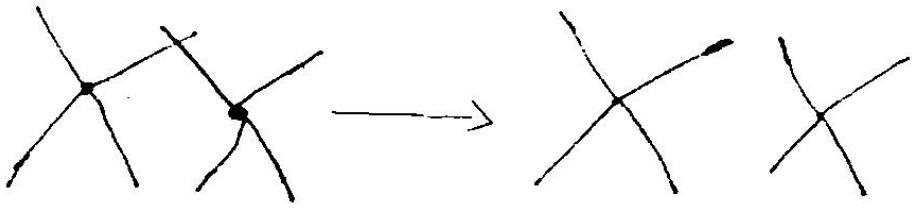
In the test cross presence of recombinant (new) types indicate the presence of crossing over.

Theories of crossing over

These are many theories about crossing over.

Chiasma type theory

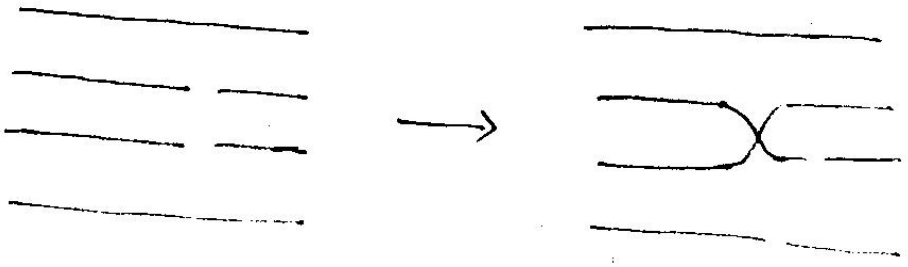
This was proposed by Janens 1909. During cross over the non-sister chromatids overlap and make a point of contact, which is called chiasma.



In the chiasma, the chromatids break, segments exchange and rejoin. The other two chromatids remain indact.

Breakge first theory

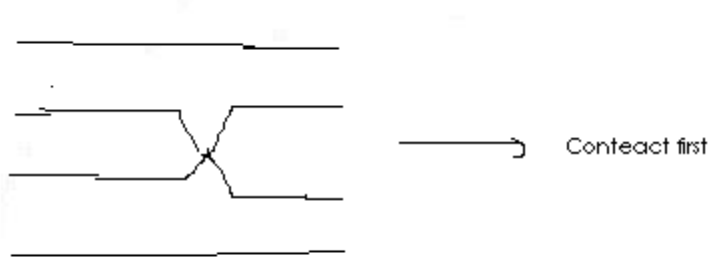
This was proposed by muller. Non-sister chromatids first break before crossing over. The broken segments rejoin to form new combination. There is no chiasma formation.



Break **exchange**

Contact first theory

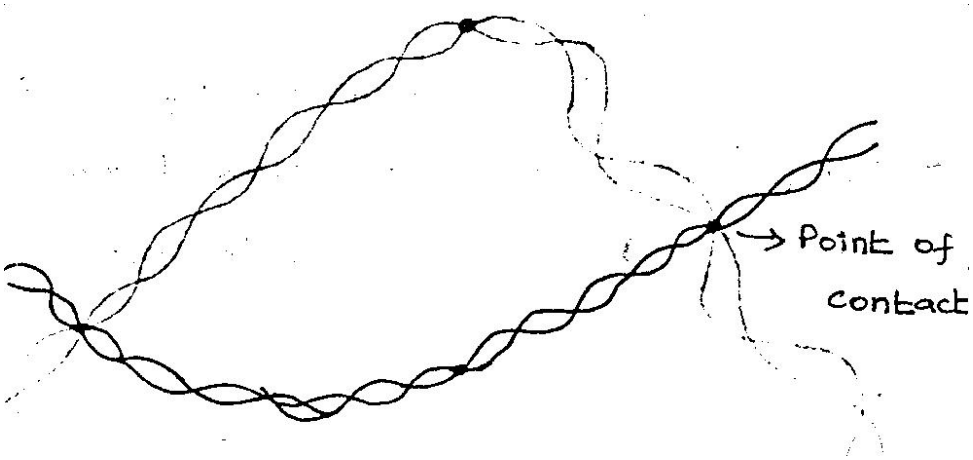
This was proposed by serebrovsky. Non-sister chromatids first contact and cross each other. Then breakage takes place in the point of contact.



Exchange of segments and reunion takes place to last.

Strain or torsion theory

This was proposed by Darlington. Bivalent homologous chromosomes coil around each other. The chromosome duplicate and the two sister chromatids in each chromosome are also coiled. During separation of chromosomes, the coils go in the opposite direction.



Repulsion causes formation which gives precursure on strain on the weak points of non-sister chromatids. Non-sister chromatids break at the point of contact and then cross over takes place.

Types of cross over

Based on the number of chiasmata there are three types of crossing over.

Single crossing over

Here only one chiasma is formed crossing over takes place at one point only. This is called single crossing over.

Double crossing over

Here two chiasmata are formed crossing over takes place at two points. This is called double crossing over. This has two subs-types.

(I) Reciprocal chiasmata

Here only two-non sister. Chromatids are involved in both the chiasmata the other two chromatids show on cross over.

(II) Complementatry chiasmata

Here all the four chromatids are involved in the formation of chiasmata.

First chiasma occurs in two strands and the second chiasma in the other two strands.

Multiple crossing overs

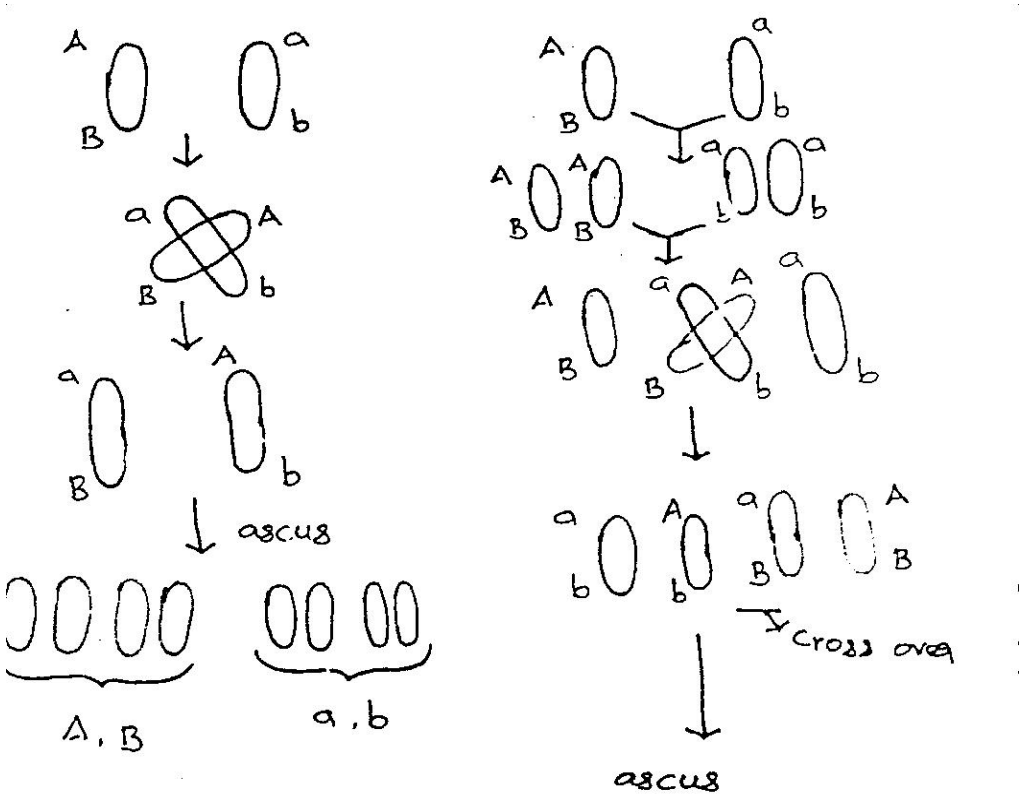
Here more than two chiasmata are formed in the same chromosome pair. This occurs in longer chromosome very rarely.

Cytological proof of crossing over

Tetrad analysis

This method is used to know whether crossing over takes place in bivalent (two strand) stage or tetrad (four strand) stage. Neurospora ascus is used for this study Neurospora ascus has eight haploid ascospores which are produced from a single diploid cell. If all cell the 8 ascospores in an ascus show crossing over, one can easily say that crossing over had taken place in the two strand stage. If the ascospores is an ascus shows 4 cross over types and 4 parental types, one can easily say that crossing over had taken place in the four strand stage.

Crossing over at bivalent. Cross over at tetravalent.



Cytological proof of crossing over

Cytological proof of crossing over was made by stern in Drosophila. Stern found a female Drosophila is while the two x-chromosomes are different from each other. They are also different from other sets of chromosomes. One

x-chromosomes has a piecep of y-chromosome attached. The other x-chromosome is broken into two unequal segments and is shorter than the other x-chromosome. These two x-chromosomes are genetically different.

Broken x-chromosome has a recessive gene (c) for carnation eye colour and a dominant gene 'B' for bar eye colour. The x-chromosome has it dominant allele (c) for red eye colour and a recessive allele (b) for round eye.

A female with red bar eye is crossed with a male having carnation round eyes. In the F_2 only female progeny is selected.

Only two types of female progeny are found when there is no crossing over.

(a) carnation bar

(b) Red round

B – Bar eye C – red

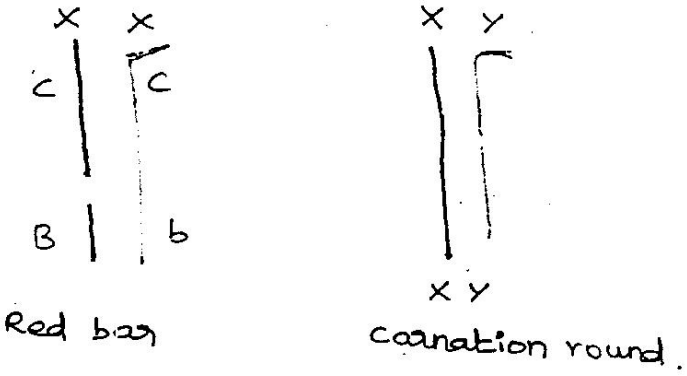
B – round eye c – carnation

Two more types of female are produced if crossing over is present.

(a) Red bar

(b) Carnation round.

Parents: Female x male



F_2 – y no cross over females

Carnation bar :cB

Red round : Cb

y cross is present females - Red bar carnation round

From this stern has proved the presence of crossing over.

Significance of crossing Over

Crossing over is found in all groups of organisms. If has the following significance

1. Crossing over helps to known the linear arrangement of genes in the chromosomes.

2. The percentage of crossing over is very useful to construct the chromosome maps.

3. It produces new combination of genes.

4. It causes genetic variations in the organisms. This is the raw material for evolution.

5. Crossing over can break the linkage groups by which good genes can be separated from bar genes.

SEX LINKAGE

Sex linkage is the association of hereditary characters with sex chromosomes. Genes responsible for sex-linkage are called sex linked genes.

The characters whose genes are present on the sex chromosome are called sex linked characters.

Sex makes no difference in mendelism. Hence Mendel laws are not applicable to the sex linked genes.

Important characters

Sex linked genes are present on the sex chromosomes (X or Y or both xy).

Most of the sex linked genes are present on the 'X' chromosome and very few in the 'Y' chromosome.

Sex linked characters are usually recessive.

(i) They follow cris – cross inheritance.

(ii) Sex linkage was discovered by Morgan (1910) in Drosophila.

Types of sex-linked genes

Sex-linked genes of three types.

X – linked genes

They are seen on the 'X' chromosome only. Their alleles are absent, in 'Y' chromosomes. X linked genes are common sex – linked genes. The characters controlled by their genes are called 'X' linked characters. A recessive allele present in the X-chromosome has no dominant allele. Ex: colour blindness in man. Eye colour in Drosophila, Haemophilia. They show cirs cross inheritance.

Y – linked genes

They are sex linked genes present on Y chromosomes. They have no alleles in the X – chromosome. They are seen in the males only. They are

called “holandric genes”. They are transmitted from father to son. Ex. Hypertrichosis in man (Hairs in the pinna).

X –Y linked genes

They are present on both X and Y chromosomes. Ex. Total colour blindness in man.

Transmission of sex linked gens

X-chromosome from a female parent goes to both daughter and son.

X-chromosome from a male parent goes to daughter only.

(i) Daughter receives one ‘X’ chromosome from the father and the other from the mother.

(ii) Sons receive X chromosome from the mother and Y chromosome from the father.

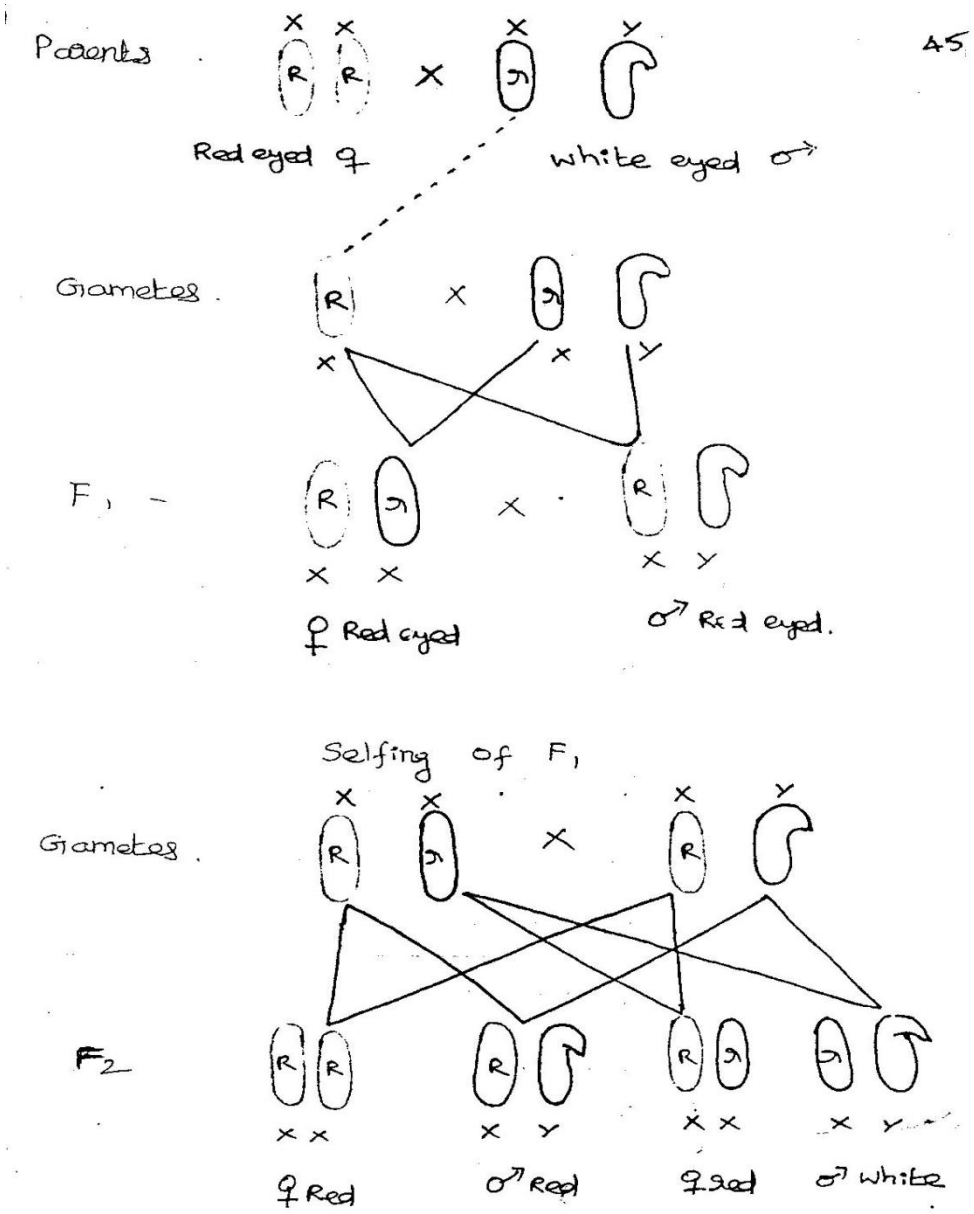
Sex linkage in Drosophila

This has been described by Morgan in 1910. Eye colour in Drosophila is X-linked character. Y chromosome has no genes for eye colour.

Red eye colour is dominant (R)

White eye colour is recessive (r)

A cross is made between red eyed female and white eyed male parents. F_1 generation was all red eyed. (and). F_1 male and female were inbred. In the F_2 red and white eyed off springs appeared in 3: 1 ratio. All females were red eyed. 50% of white eyed, 3:1 ratio suggests that the gene for red eye is



Red and white 3 : 1 Ratio

♀ All red eyed.

50% red eyed and 50% white

dominant over the gene for white eye colour.

Here red eyed female transmits the gene for red eye colour (R) to all F_1 off springs through her x chromosomes. White eyed male transmits his white eye colour gene to his daughter through 'X' chromosome. So all F_1 offsprings were red eyed. Females were heterozygous (er) and male with 'R' only.

Here transmission of white eye colour gene and xchromosome from the male parent are similar. Hence Morgan concluded that the gene for eye colour is x-linked. It is transmitted from the father to his grandsons through the daughters. It is not through his sons. This is called cris-cross or zig-zig inheritance.

Sex linkage in man

About 50 X –linked genes have been discovered. The most common are

(a) colour blindness

(b) Haemophilia

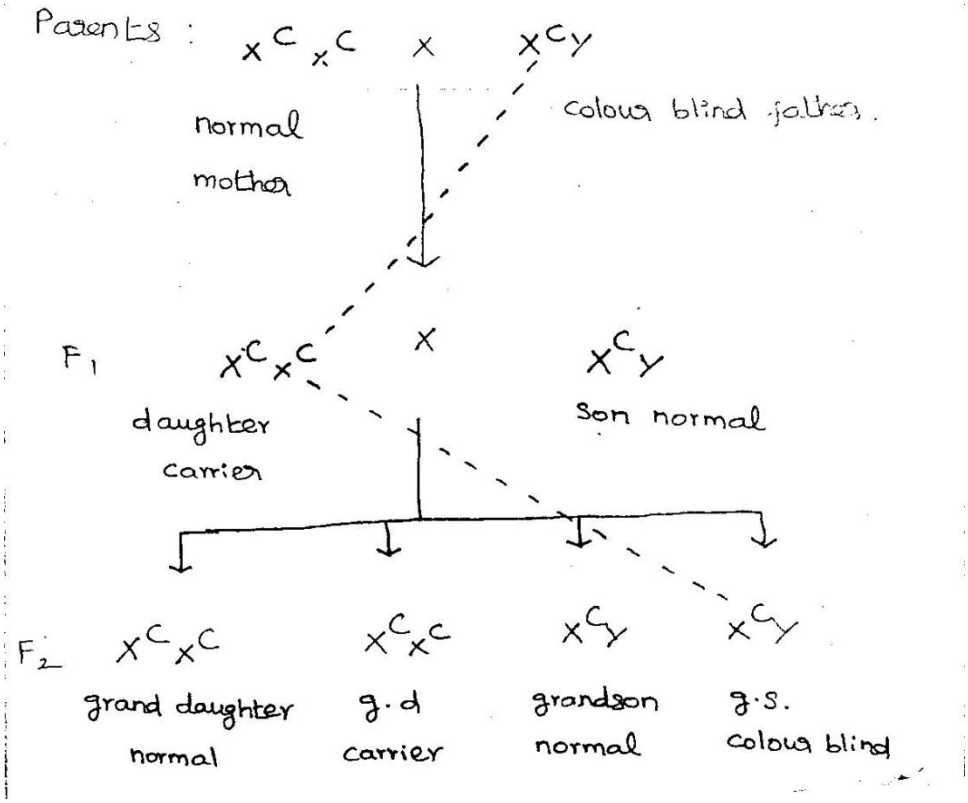
Colour blindness in man

This is a conmmon genetic disease. Colour blind persons are unable to distinguish red colour and green colour. This is a sex linked character discovered by Wilson in 1911.

Colour blindness is recessive to normal vision.

It is caused by a recessive gene C normal vision is controlled by a dominant gene 'C'.

These genes are present in the 'X' chromosomes.



When a normal woman (cc) marries a colour blind man (cy) all the F_1 off springs are normal. Daughter receive gene for colour blindness (c) from the

father. But they receive a domimant gene (c) from their mother. They are normal but carriers because they carry the gene for colour blindness. Sons are normal since they recessive the X chromosome from the normal mother. Their y chromosome has no alleles.

Colour blindness is common in man but rare in woman.

When F1 daughter's (carrier) are married to normal men, colour blind grandsons receive their x chromosome from the carrier mother.

In this cross the gene for colour blindness from the father is transmitted to the carrier daughter carrier daughter transmit these gene to colour blind grandsons. This gene is located on the x chromosome of male parent. This follows cris-cross inheritance.

Haemophilia [Bleeder's disease]

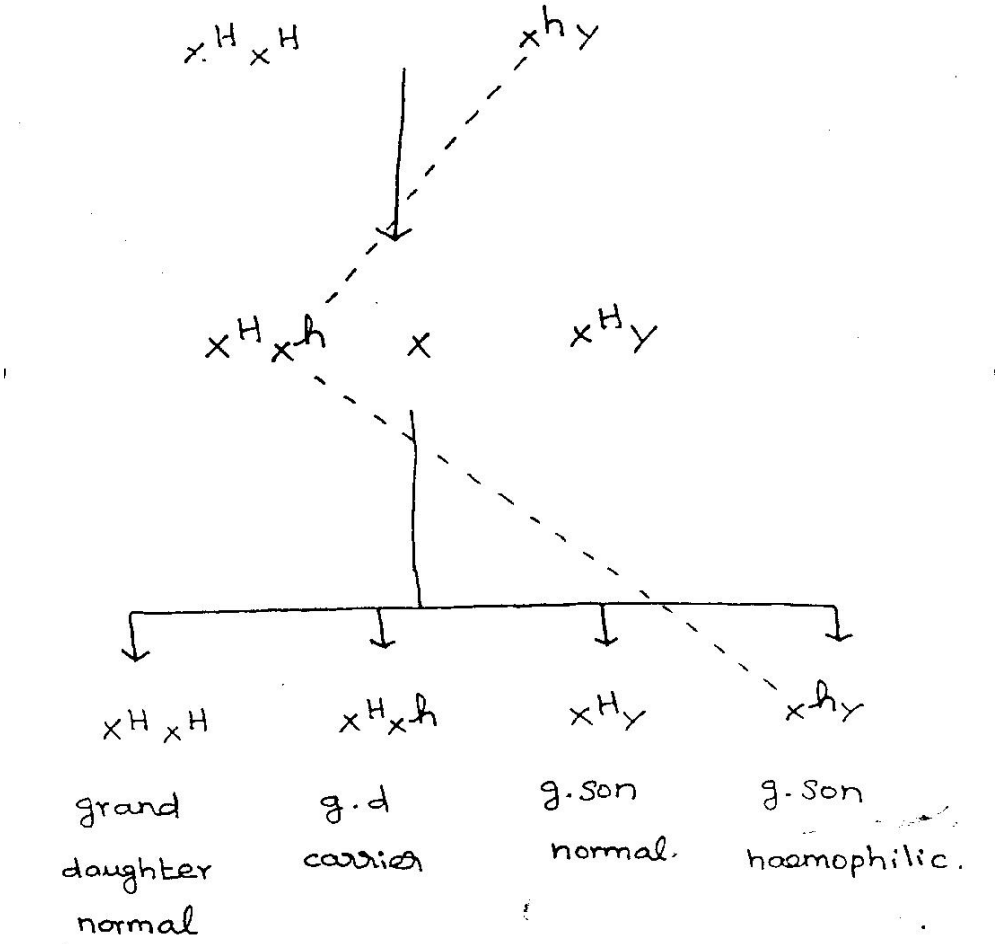
This is a sex linked disease discovered by John cotto (1803).

This is found in queen Victoria family and hence known as " Royal disease". This disease is characterized by delayed blood clotting.

This is a sex linked recessive character. This gene is located on x-chromosome. Normal person has dominant gene 'H'. haemophilic person has a recessive gene 'H'. This inheritance follows crises-cross inheritances. This is transmitted from father to grandson though his daughter.

This is common in men but rare in woman.

Parents: Noraml mother x Haemophilic father



SEX DETERMINATION

Sex determination is a process by which an organism develops the properties of one or the other sex. The factors which are responsible for determining the sex of an organism are more important.

Sex of organisms is determined in 3 different stages of its life. (Before fertilization, during fertilization, after fertilization).

Theories about sex determination

Two theories are proposed about sex determination.

(a) chromosome theory

(b) Balance theory

Chromosome theory of sex determination

This theory has been proposed by Correns (1906). Sex of an organism is divided at the chromosome level. They have two types of chromosomes.

Autosomes

Have the genes for somatic characters. Not connected with sex.

Allosomes or sex chromosomes

Have the genes that decide the sex of an organism. Female has 2n+xx and male has 2n+ xy condition.

X – Chromosome

Large sized and rod-like. Have more amount of DNA and more number of genes. Has more genetic information.

Y – Chromosome

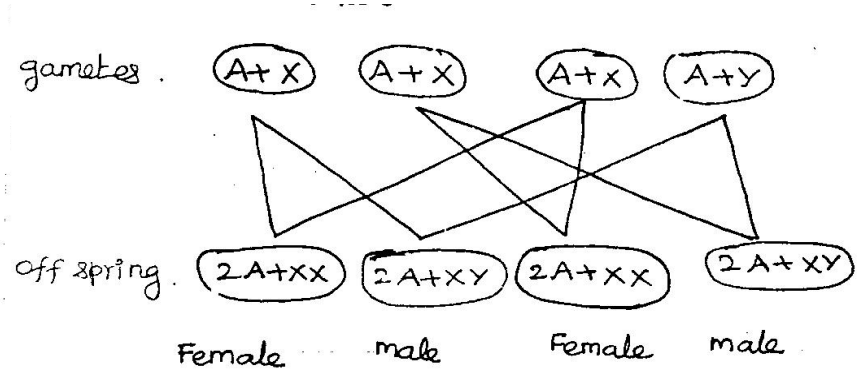
Smaller in size and curved. Has less amount of DNA and less number of genes, genetically inactive.

Chromosomal mechanism of sex-determination has 2 types like xx – yy type and xx – xo type.

XX – YY TYPE

Here female has two x chromosomes (xx) and male has xy chromosomes. Female produces only one type of gametes. This is called homogametic male produces tow types of gametes. This called heterogametic.

Fusion of a female gamete (A+X) with a male gamete having x chromosome (A+X) will produce a female offspring (2A+Xx). A female gamete if fuses with gamete having y chromosomes, the off spring will be a made (2A+XY).



This is a common type.

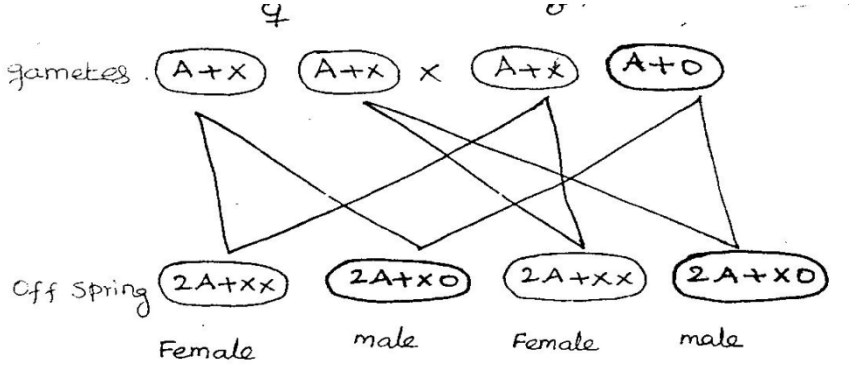
Ex. Drossophila, man, melondrium, and coccinia.

xx-male and xy female is present in fishes and birds.

XX – XO TYPE

Hence the female has two x - chromosomes (xx) and it is homogametic. Male has only one x chromosome and it is ineterogametic (xo) presence of a single x – chromosome determines the male sex.

Parents: (2A + Xx) X (2A + XO)



Balance theory of sex – determination

Genetic balance theory: ex; Drosophila

This theory was proposed by Bridges (1922). According to this theory "The ratio between the x chromosomes and autosome sets determines the sex". The number of x chromosomes and autosome sets in an organism are more important.

Even organism has both male and female stimulating genes x chromosomes carry the genes for femaleness and autosomes carry genes for maleness y chromosome has no sex influencing genes. The ratio between the number of x chromosomes and sets of autosomes.

This ratio is 1.0 in female.

This ratio is 0.5 in male.

This ratio is 0.67 in intersex.

This ratio is 0.33 in super male.

This ratio is 1.5 in super female.

Table

NO.	Sex	x-chromosome number	y-chromosome number	Ratio X/A
1.	Female normal	2	2	2/2=1
2.	Male normal	1	2	½=0.5
3.	Inter sex	2	3	2/3=0.67

4.	Super male	1	3	1/3=0.33
5.	Super female	3	2	3/2=1.5

This proves that autosomes also play some role in sex determination.

Role of 'Y' chromosome in Droophila

Y chromosome does not carry any sex determiner. It is not involved in sex determination but it influence fertility.

XY is fertile male in Drosophila.

XO is sterile male in Drosophila.

This proves that presence of y chromosome gives fertility.

Sex determination in plants

Monoecious plants

Cocus nucifera & *Ricinus communis* sex determination here is only a matter of gene difference and not a cytological difference.

Dioecious plants

Here chromosomal difference is present between males and females. Many types of sex determination are present.

XX – XY Type

XX-female-homogametic and xy male heterogametic.

Female – 2n+xx – gametes n+x and n+x

Male – 2n+xy – gametes n+x and n+y.

Ex: Melandrium, album, coccinia, indica, Hydrilla & cannabi sativa.

XX – XO Type

Female xx and male xo type. Female homogametic – gametes one type.

Male – heterogametic – gametes two type.

Ex; Dioscorea

XX –XY Type

Female xy and male xx.

Female heterogametic – gametes 2 types.

Male homogametic – gametes one type.

Ex; Fragasria.

Sex determination in melandrium Album

Warmke (1946) has sex determination in melandrium. It is determined by a balance between the genes present in the x and y chromosome and autosomes. Male plants are xy and females xx. Sex in 2n, 3n, and 4n plants

having different doses of x and y chromosomes are studied. Male plants have one or more y chromosomes. Female plant has no y chromosomes.

Y chromosome is longer than the x-chromosome. It has 4 distinct regions.

X chromosome is smaller and has 2 regions.

Only a small part of x & y chromosomes are homologous.

3 regions of y chromosomes are non homologous with sex influencing and sex determining genes.

Region I	–	suppress femaleness.
Region II	–	promote maleness.
Region III	–	promote male fertility.
Region IV	–	homologous with X chromosome.
		This regions pair in meiosis.
Region V	-	the X chromosome promote femaleness.

Region I

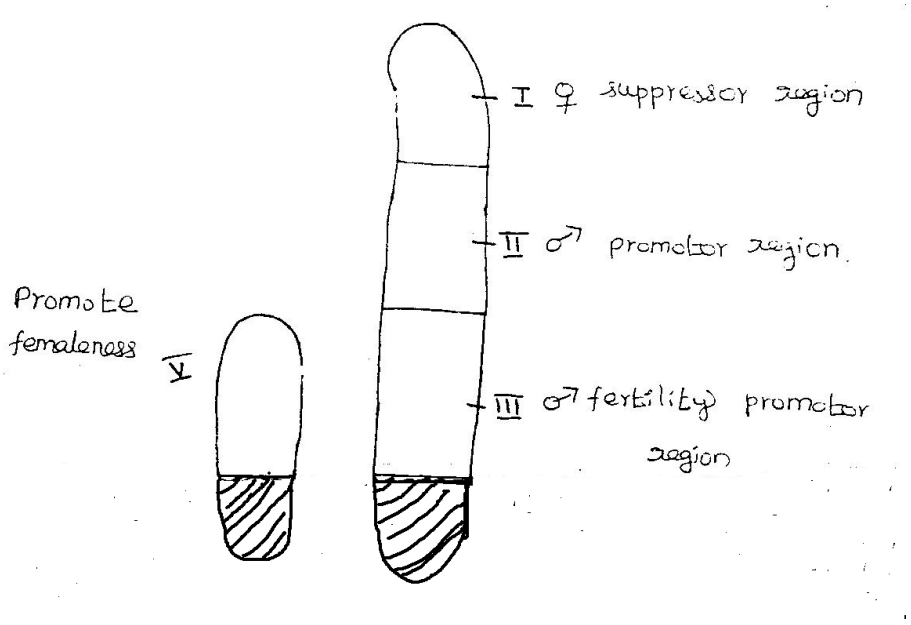
Suppress femaleness and hence male plants are produced. In its absence plants are produced.

Region II

Promote makness. In its absence female plants are produced.

Region III

Promote male fertility. In its absence sterile males are produced.



Reion IV

Promote femaleness in the absence of region I on chromosome.

In general the effect of Y chromosome is powerful that of X chromosome. Autosomes also carry female determine factor. Male determine genes are present on Y – chromosome.

Single gene control of sex

Maize is a monoecious plant with male inflorescence (tarsel) and female inflorescence (silk) on the same plant. Sex determination is controlled by a single gene.

ts- tassal seed gene – suppress male flowers and promote female flowers.

Flowers and promote female flowers.

sk – silkness seed gene – suppress female flowers and promote male flowers.

sk /sk palnt is a male.

ts / ts plant is a female.

These lwo genes are located in two- non – homologous chromosome.

POLYPLOIDY

Polyploidy are the individuals in which the numbers of chromosomal sets are more than two. This condition is called polyploidy.

Polyploids may occur in nature or may be artificially induced. Natural polyploidy are called Spontaneous. Ex. Cynodon doctylon , oenothera – lamarckiana.

Colochicine

Induced polyploidy is possible by the use of chemicals, by temperate shock or by causing mechanical injuries. Chemicals like colchicines and acetonapthalene etc.

It I one of the common chemical used for induction of polyploidy. It interferes with spindle formation colchicines is an alkaloid extracted from the corm of colchicum autumnat.

The success of colchicines treatment depends on the following conditions.

1. Direct contact of growing tissue with the chemical.
2. Effective concentration.
3. Effective stage of development.

Treatment

Seed treatment – seeds are socked in the aqueous solution.

1. Infection – colchicines injected into the cortex of seedlings.
2. Axillaries bud treatment.
3. Shoot apex treatment.

Origin of polyploidy

It may be the following methods.

(i) Failure of cytokinesis.

(ii) Abnormal meiosis.

(iii) One egg is fertilized by more than one male gamete.

Cytology

Polyploidy have more than two sets of homologous chromosomes. This leads to the formation of multivalent. Polyploidy with odd number of ploidy are sterile, because they lack homologous pairing. Polyploids with even number of ploidy are fertile.

Types of Polyploids

Polyploids are of two types.

(i) Autopolyploids.

(ii) Allopolyploids.

Autopolyploids

Autopolyploids are organisms with the same basic set of chromosomes multiploid.

(i) If the genome of a diploid is AA, its autotriploids will have AAA and autotertraploids with AAAA genome.

(ii) Autoployploids may be of 2 types like
  (i) Natural
  (ii) Induced

(iii) Natural autopolyploids are common in deop grass (cynodon dactylon). It shows peculiar meiosis.

(iv) Autotriploids are usually sterile, no seed set and show only vegetative propagation.

(v) Induced autopolyploids are possible by the treatment of colchicines.

(vi) Autotriploids are induced in watermelon, sugar beet, tomato, grapes and banana.

(vii) Autotertraploids are induced in Rye (secale) corn, Apple etc.

(viii) Aqueous solution of colchicines in 0.01 to 0.50 is effective.

Treatment methods

(a) seed treatment

(b) Seedlings are injected.

(c) Axillaries bud treatment

(d) Shoot apex treatment.

Cytology

Autopolyploids have multivalent during meiosis instead of bivalent.

(i) Autotriploids have 3 sets of chromosomes, do not show normal meiosis, gametes are unbalance and hence sterile.

(ii) Autotetraploids have 4 sets of chromosomes show normal meiosis, gametes are viable and fertile.

Uses

Auotriploids in water melon, tomato and grapes helps to give large sized less fruits.

(i) Autotertroploids in apple and grapes give large sized fruits.

(ii) Autotetraploid tarley and corn are considered as good varieties.

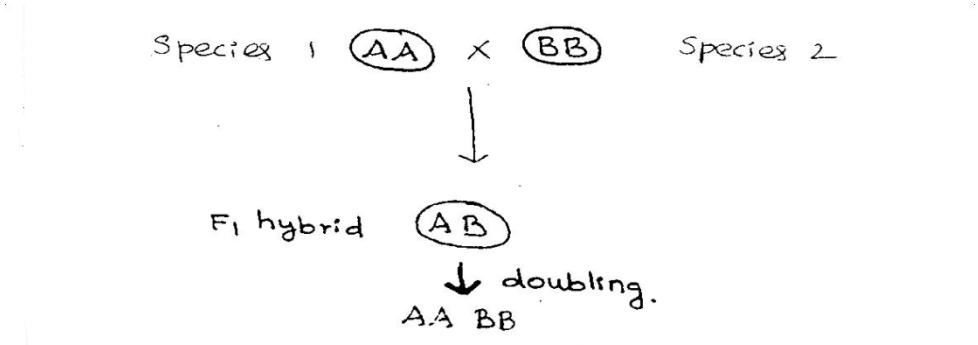
(iii) Autotetroploids in many ornamental plants give superior varieties in lily, marigold, snapdragon etc.

Allopolyploids

They are those individuals which arise by the multiplication of chromosome sets of a hybrid between two different species.

This is also possible by doubling of chromosomes of a hybrid. This will bring 2 different sets of chromosomes.

Examples



Allopolyploids are also called amphidiploids.

Examples

Raphanobrassica is a classical example of allopolyploidy. Karpechenk (1927) a Russian geneticist, synthesized a new species, by inter genic cross, Raphanobrassica. The cross is between Radish (Raphanus – sativus 2n = 18) and cabbage (Brassica oleracea 2n = 18). The F_1 hybrid was sterile. This was due to lack of chromosomes pairing. They can be made fertile by chromosome doubling. Fertile Raphanobrassica (2n = 36) had 18 chromosomes of radish type and 18 of cabbage type.

This new species was expected like radish and shoot like cabbage. However it was uneconomical.

Raphanus sativas x Brassica oleracea

2n = 18 2n = 18

↓

F1 hybrid Sterile

2n = 18

↓ Doubling chromosome

Raphano – brassica

2n = 36

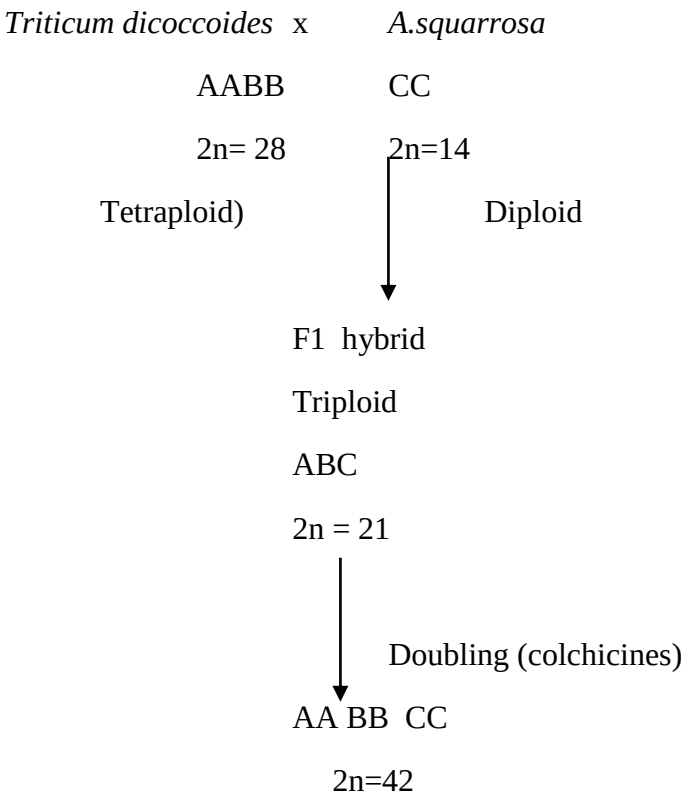
Allotebaploid

Evolution of Wheat

Wheat is another example of allopolyploid. It is a hexaploid (2n = 42) and is derived from 3 diploid species.

1. *Triticum agelopoides* (2n = 14) AA (genome)
2. *Aegilops speltoides* (2n = 14) BB
3. *Aegilops squrrosa* (2n = 14) CC

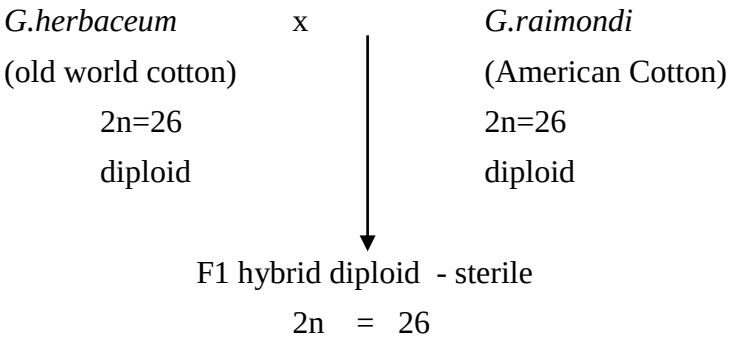
The wheat (hexaploid) is designated as AA BB CC. This is confirmed by the following experiment.

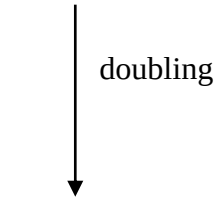


This synthesized hexaploid wheat was crossed with naturally occurring hexaploid wheat. The F_1 hybrid was fertile, showing normal pairing of chromosomes. This suggested that the hexaploid wheat must have originated in the part due to natural hybridization.

Cotton

Gossypium hirsutum, the upland cotton (2n = 52) must have come by doubling the chromosomes number of the hybrid of the cross between *G. herbaceum* (Asiatic cotton) (2n = 26) and *G. raimondic* (American cotton) 2n = 26.





G.hirsotum

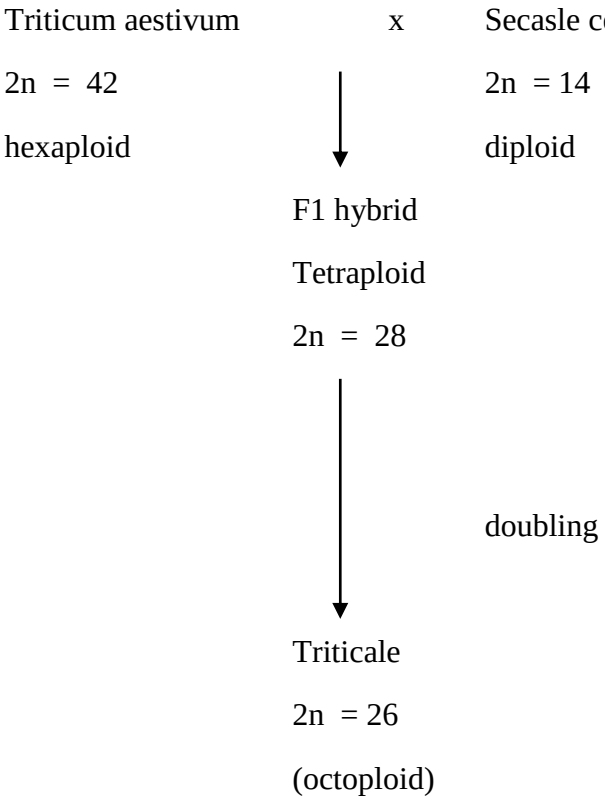
2n = 52 (Tebaplid)

New world cotton

Triticale

It is a new crop synthesized in a cross by Sweden plant breeders. The F_1 hybrid of a cross between wheat (Tritiary) and rye (Secale) is a tetraploid. Doubling resulted in an octaploid, called Triticale.

Recently hexaploid Triticale has been synthesized by using Tetrasploid wheat.



Importance of polyploidy or significance

Polyploidy play an important role in plant breeding and evolution.

Polyploidy in plant breeding

Polyploidy produces larger sized organisms.

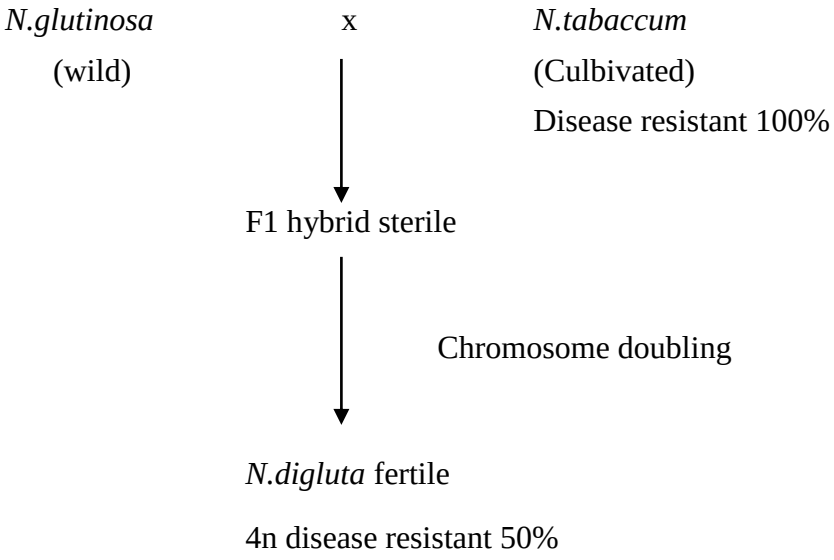
(i) Sometimes polyploidy are smaller sized than the diploids but their leaves and flowers are larger sized. This is much used in horticulture.

(ii) Fertility level in polyploidy is very low. This is much used to obtain sesedless fruits. Ex. Grape, tomato etc.

(iii) Ploypoid varieties are more vigorous and better than diploid varieties. ex. Coffee, Apple, Ground nut, potato etc.

(iv) Polyploidy is used as a medium for gene transfer from one species to another. This is the most important use of allopolyploidy.

Ex. Nicotiana.



N.digluta when back-crossed with the cultivated parent, a virus resistant cultivation variety was obtained.

(i) Allopolyploidy is useful for getting fertile hybrids in interspecific and intergenic crosses which usually give sterile progeny.

Polyploidy in evolution

This is very much useful in evolution. This is one of the sources of varieties which is basis for evolution.

Ex. Raphanobrassica, Triticale etc.

Polyploidy brings in adaptability to the changing environment in the organisms. Such plants have better survival capacity than the diploid parents.

MUTATION

Mutation can be defined as "sudden heritable phenotypic changes in the organisms". Hugo Divvies was the first to use the term mutation while studying oenothera. Mutation is common in plants and animals. Only large mutations are visible where as small mutations are not visible. Most mutations are recessive and harmful. Rare fly mutations are beneficial.

Mutations are occurring in three stages in the life of organisms.

(a) **Before gametogenesis** : This effect all the gametes. All the individuals derived from these gametes are affected. This is heritable.

(b) **Mutation in a gamete or a zygote**: This effect a single individual which carries the mutation. This is heritable.

(c) **Somatic mutation**: This effect only a part of an organism. This is not heritable and has no genetically significance.

(d) **Mutagens or Mutagenetic agents**: Mutation can be induced artificially by using some substance which are called mutagenetic agents.

Ratio active substances

These are commonly used to induce mutations. This has two types like.

1. Ionizing radiations.
2. Non – ionizing radiations.

Ionizing radiation

X rays, lgamma rays, $\propto$ and β rays and electrons are common ionizing radiation Muller used x rays to induce mutations in drasophila.

These are highly powerful and penetrable agents. They cause many charges in the organisms and produce mutations.

They break thee sugar – phosphate backbone of DNA. They are allele to cause Mutations even in seeds.

Non – Ionizing radiations

UV rays and Infra red rays are non-ionizing radiations. They are effective in 260 nm wave length.

They are less powerful and less penetrating and not effective.

The can effect only the local parts.

Useful in unicellular structures like Bacteria, pollen grains etc.

Chemical mutagens

Many non- toxic chemicals are used as mutagens. These effect the DNS id many ways.

Some mutagens affect DNA directly by determination.

Ex: Nitrous acid, Nitrogen mustraid, Diethyl sulphate etc.

Some mutagens affect the sugar-phosphate structure of DNA.

Some mutagens cause additions or deletion (Acridine dyes).

Temperature

Change in temperature causes mutations. Temperature increase causes increased rate of mutation and vice versa.

PH

Low pH causes mutations.

Rate of mutation

It is very low land ranges from 1 x 10.5 to 1 x 10.6

Classification of mutation

Mutation is classified into many types based on many character.

1. Based on origin

Based on origin mutation is of two types like spontaneous mutation and Induced mutations.

i. Spontaneous mutation (or) natural

Sudden natural mutations are called as spontaneous mutations.

ii. Induced or Artificial Mutation

Artificially induced by exposing the organisms to mutagene.

2. Based on cell types

(i).Somatic mutation

It occurs in body cell and give some phenotypic changes. It is not haritable No genetic significance.

ii.Germinal mutation

It occurs in reproductive cells like gametes. They are heritable. Has genetic significance.

3. Based on chromosome in which it occurs:

(i). Autosomal mutation

Here mutation occurs at body cell chromosomes.

(ii).Allosomal mutations

Here mutation occurs at sex – chromosome. They are heritable.

4. Based on direction:

(i).Forward mutation

A $\rightarrow$ B $\rightarrow$ C

Mutation occurs in wild type, and they become abnormal. This type is very common. It helps in variation and evolution.

(ii).Backward mutation

While the some mutant changes back into the wild type is called backward mutation. It is very rare.

A $\rightarrow$ B $\rightarrow$ A

5. Based on allelic condition

(i).Dominant mutation

When the wild type mutated into dominant are it is called as dominant mutations. It is very rare.

(ii).Recessive mutations

When the wild type becomes recessive it is called as recessive mutations. This is visible only in double recessive condition. This a common type.

6. Based on the effect:

It has two types; they are called Lethal, Beneficial

(i).Lethal mutation

It is a type of mutation which causes the death of the organism. It can be a dominant lethal (or) recessive lethal. Dominant lethality is a visible at both homozygous (AA) and heterozygous (AC) condition. But the recessive lethality is only visible in homozygous (aa) condition.

7. Based on its size

(i).Macro mutation:

Here mutation causes large phenotypic changes.

(ii).Micro mutations:

Here mutation causes a small effect on the organism. Which is some times unnoticed?

8. Biochemical mutation

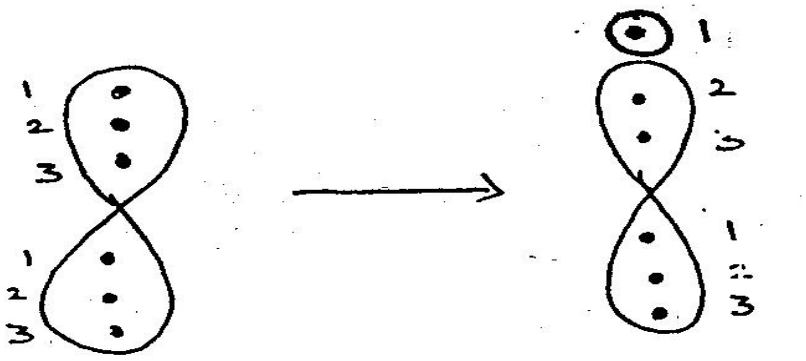
Mutation cause changes in metabolism in the organism.

9. Gene mutation

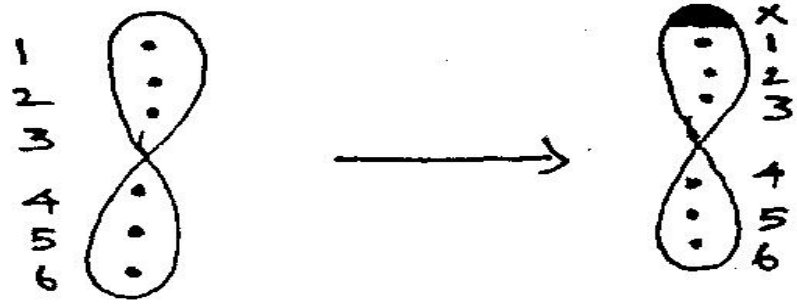
Gene mutation is changing in the structure of a gene. It is very common and it brings many changes in phenotypic characters.

10. Chromosomal mutation

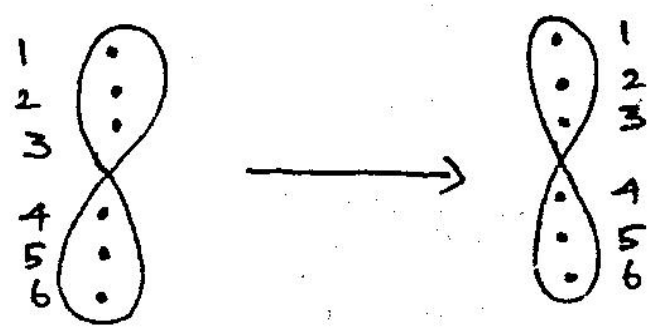
Here mutation is occurring in chromosome. It is otherwise called as chromosomal aberration.



Here a portion of chromosome is detached, so the structure of chromosome is changed and it is called as deletion mutation.



Here a new portion is added and it is called as addition mutation.



Here the position of genes in chromosomes is changed.

Detection of sex Linked Lethal Mutation

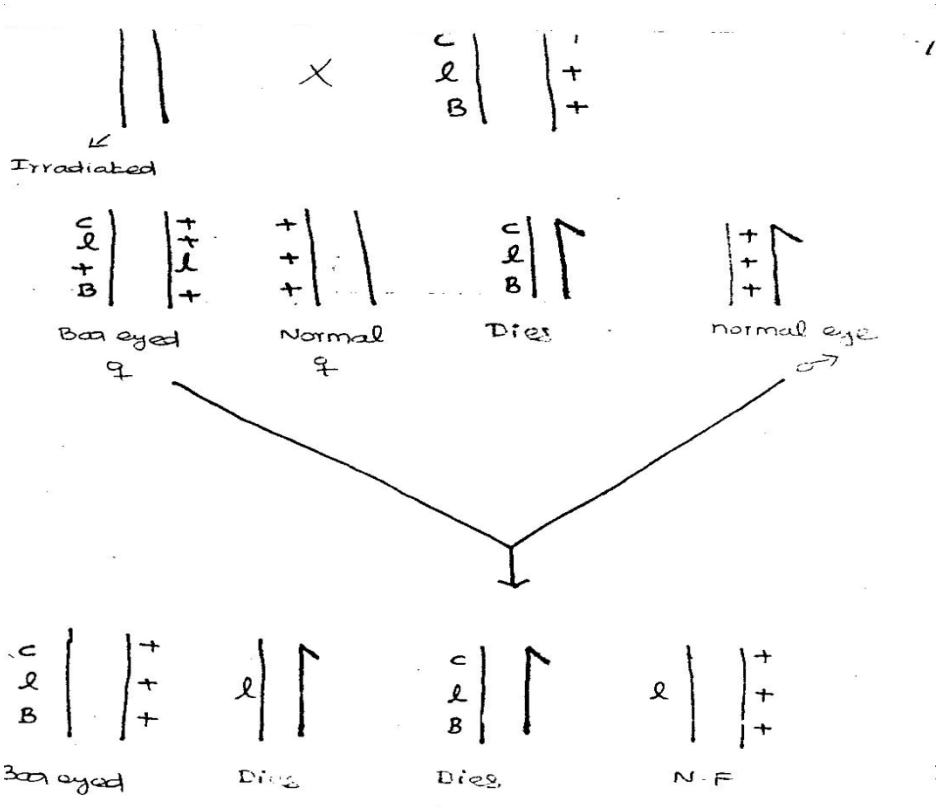
H.J. Muller devised an easy method for detection lethal mutation in the sex chromosomes of Drosophila. This is called clb method.

In clb method muller used a special type of female fly. This fly had one normal 'X' chromosome and one abnormal x-chromosome. The abnormal x-chromosome had an inversion mutation C. Because of this inversion crossing over between the two x chromosomes could not occur. Hence the c was called crossover suppressor. The abnormal chromosome contained a recessive mutational lethal gene l and a dominant gene B for bar eye. The B gene was used as an indicator gene.

Muller irradiated male files were muted with clB females. In the F_1 four types of flies were expected.

1. Bar eyed female

This flies received clB chromosome from female parent and an irradiated X-chromosome from male parent. The effect of Lethal gene in clB chromosome is suppressed by the wild dominant gene (allel) in the irradiated X-chromosome.



If irradiation had caused any lethal mutations, in another locus in theX-chromosome of the lethality could be overcome by the presence of wild dominant gene in the clB X chromosome. So these bar eyed females were considered as carriers of the induced lethal mutation. These flies were kept for further crosses.

2. Normal females

They received one normal x from clB and an irradiated x . These flies survived because of the wild dominant gene of the normal x.

3. Bar eyed male

These flies did not appear because the Y chromosome had no gene to overcome the lethaling of the lethal gene to overcome the lethaling of the lethal gene present in the clB.

4. Normal male

They received a normal x from clB female and an irradiated Y. Since there were no lethal genes these flies survived. These flies were kept for further crosses.

The Bar eyed females and normal males of the F1 were crossed. In the F_2 normal females and bar eyed females alone were produced. Bar eyed s and normal s were expected to appear. But these flies did not appear in F_2.

The clB male failed to appear because of the effect of the lethal gene in clB gene to counteract. The lethal gene. So the lethal gene could express itself in hemizygous.

Condition

The normal male received the Y chromosome from the parent and irradiated carrier x chromosome from the clB of F_1.

When this fly did not survive, it could be understood that the irradiation of the male parent. Should have induced a new lethal gene in a new lows of the x chromosome.

F_2 generation female and male flies ratio clearly indicated the presence or absence of induced mutation in the irradiated male parent.

If the ratio is 2 : 1 : There is no induced mutation.

If the ratio is 2 : 0 : There is induced mutation.

Importance of mutations or Practical uses of mutations

Induced beneficial mutations are used in the plant breeding and crop improvements. This helps to get new varieties of crops. Many scientists helped in this time for green revolution in India.

Wheat

X – ray M.S. Swaminathan 1967 Sharpati Sonora – India, non – lodging, gain amber colour with high protein.

Rice

Reimei –Jagannatha; Mutant variety – High yielding, short life, more protein & tolerance to low temperature.

Jute

Atompat 38 – high yielding.

Barley

Luther Boaley – USA 1967 – high yielding.

Castor

Aruna – India – Early masturity

Penicillium

Mutant type of penicillium – yields more penicillin.

Ornamental and fruits plant

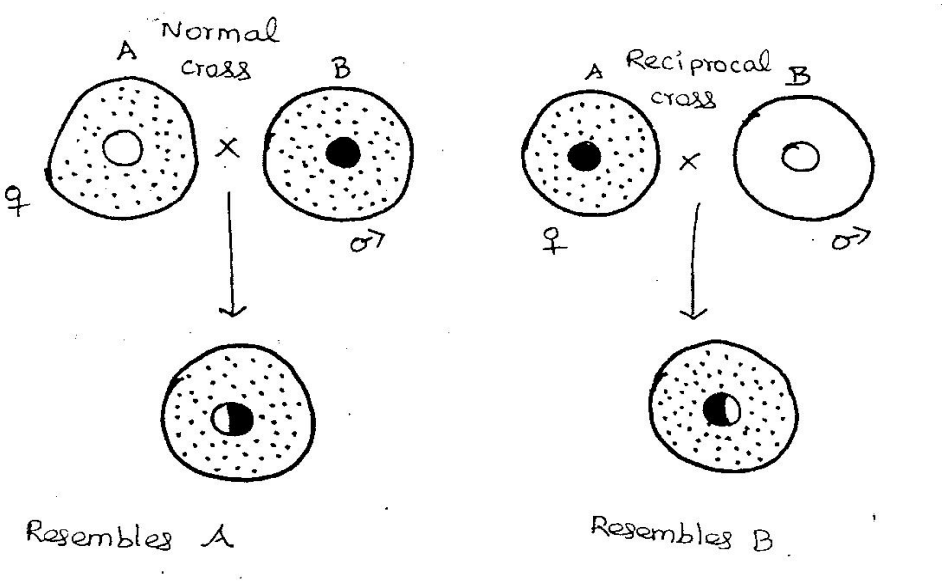
Somatic mutation in many ornamental and fruit plants used to get new varieties.

Mutation is the raw materials for evolution. In brings about variation in the organisms. Additions of such mutations create new varieties and species. Thus mutation plays an important role in evolution.

CYTOPLASMIC INHERITANCE (or) Extra chromosomal inheritance (or) Extra nuclear inheritance (or) Uni-parental inheritance

Transmission of characters controlled by plasmogenes is called cytoplasmic inheritance (or) extra nuclear inheritance. Normally characters are controlled by nuclear genes. Here genes are contributed equally from male and female parents to the off springs.

Cytoplasmic inheritance is due to the influence of DNA present in the mitochondria and chloroplasts. These are called Exta nuclear or cytoplasmsic genes. These are transformed mainly from the female parent to the off springs. Cytoplasm of the zygote is responsible for this. This is otherwise known as maternal inheritance.



These are transmitted by means of cytoplasm only. These are also show mutation. The result of reciprocal crosses is not the same.

Plastid inheritance in Mirabilis

This has been described by correns (1909). Mirabilis jalapa has 3 types of branches like green, variegated and colourless. Green branches contain only chloroplasts.

(1) Variegated branches have white patches. It has chloroplasts and levcoplasts.

(2) Colourless branches have colourless plastids called leucoplasts.

(3) Correns carried out 3 types of experiments explained plastid inheritance.

(4) Seeds collected from green branches produce only.

(5) Seeds from variegated branches produce three types of plants like green, white, and variegated.

(6) When green branch flowers are pollinated with pollen from white branch, all the progeny are green.

(7) When white branch flowers are pollinated with pollen from green branch, all the progenies are white.

(8) When flowers from variegated branch are pollinated with pollen from any type (green, white or variegated.

These experiments show that the phenotype of the offspring is determined by the female parents which give pollen is not inherited. The offspring receive cytoplasm with plastids only through the egg (female parent).

1. Parent : branchx branch

(Green) **green, white or** variegated

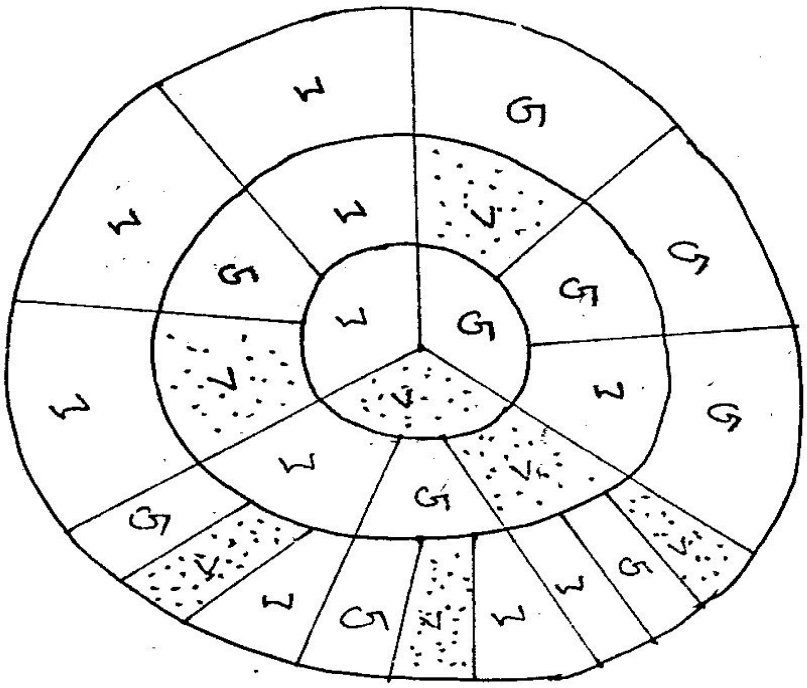
Green progeny only

2 branch x branch (green, white or variegated)

White progeny only

3 branch x branch (green, white or variegated)

green, white or variegated progeny



Central circle

parent – branch which produce flowers and seeds.

parent – branch which donate pollen.

Outer circle

Types of progeny.

When variegated branches are used as female, the gametes carry green plastids, white plastids or both. Hence 3 types of 3 progeny are produced.

Egg contain large amount of cytoplasm with plastids like vegetative cells. Therefore the plastid colour is due to Maternal inheritance. Pollen has very little cytoplasm and no plastids. This is an example of cytoplasm inheritance.

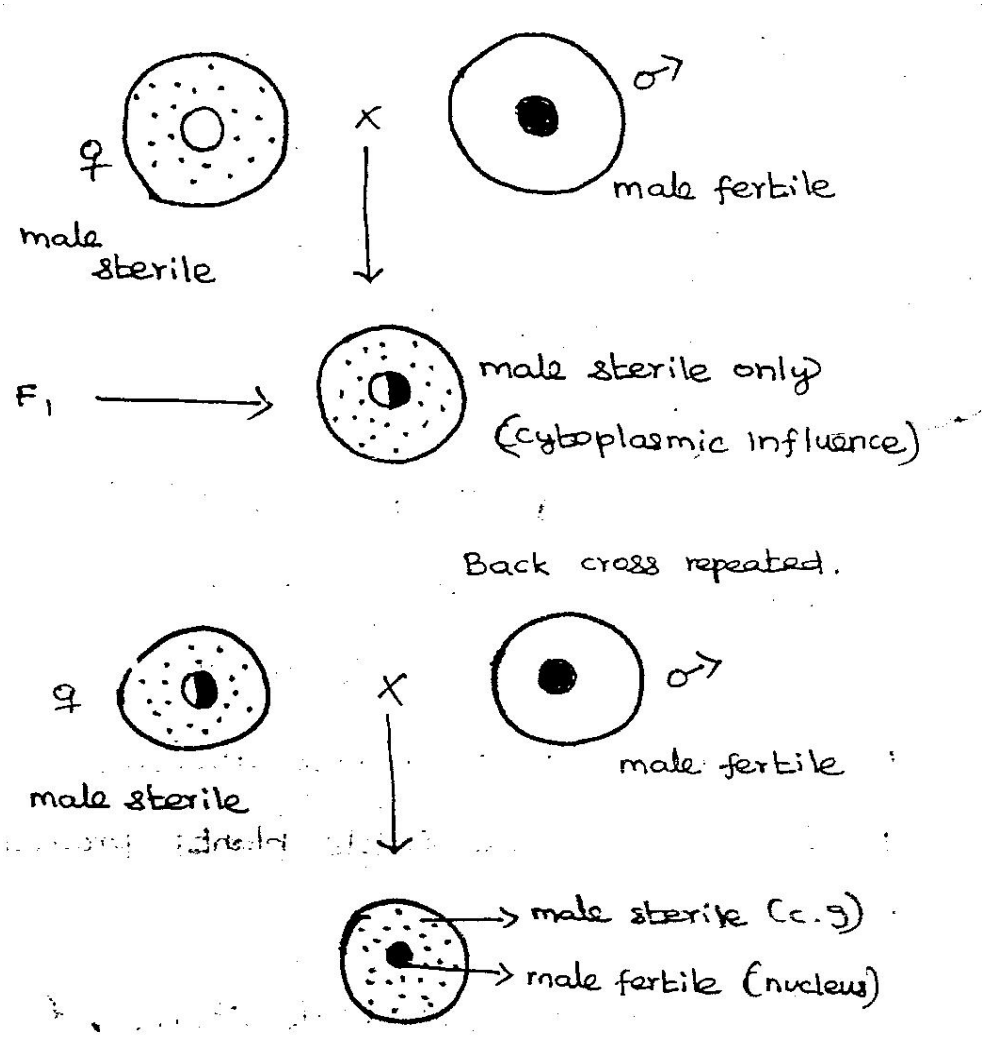
This type of inheritance is found in rice, beans etc.

Cytoplasmic Male sterility in maize

Cytoplasmic male sterility in maize was described by Rhoades. In maize there are two types. Like male sterile and male fertile. Male sterile plants produce abortive (sterile) pollen and the male fertile plants produce normal pollen (viable).

A cross between male sterile, female parent and male fertile female parent, the progeny is always male sterile. This is because the cytoplasm is mainly derived from the female parent.

Repeated back cross between male sterile and male fertile plant is made to replace the entire male sterile. Chromosomes by the male fertile parent. Even then male sterile progeny only produced. This shows that male sterility is controlled by cytoplasmic genes and not by nuclear genes.



Male sterility in plants

Male sterility is failure to produce viable pollen. This is controlled by nuclear genes in majority of plants. But in maize, wheat, onion, beet root etc. Male sterility is controlled by cytoplasmic genes and not by nuclear genes. Therefore at least 3 different mechanisms are present to control male sterility.

(a) Genetic or nuclear male sterility

This is controlled by a single nuclear gene. This gene is recessive to fertility.

(i) F_1 progeny would be fertile.

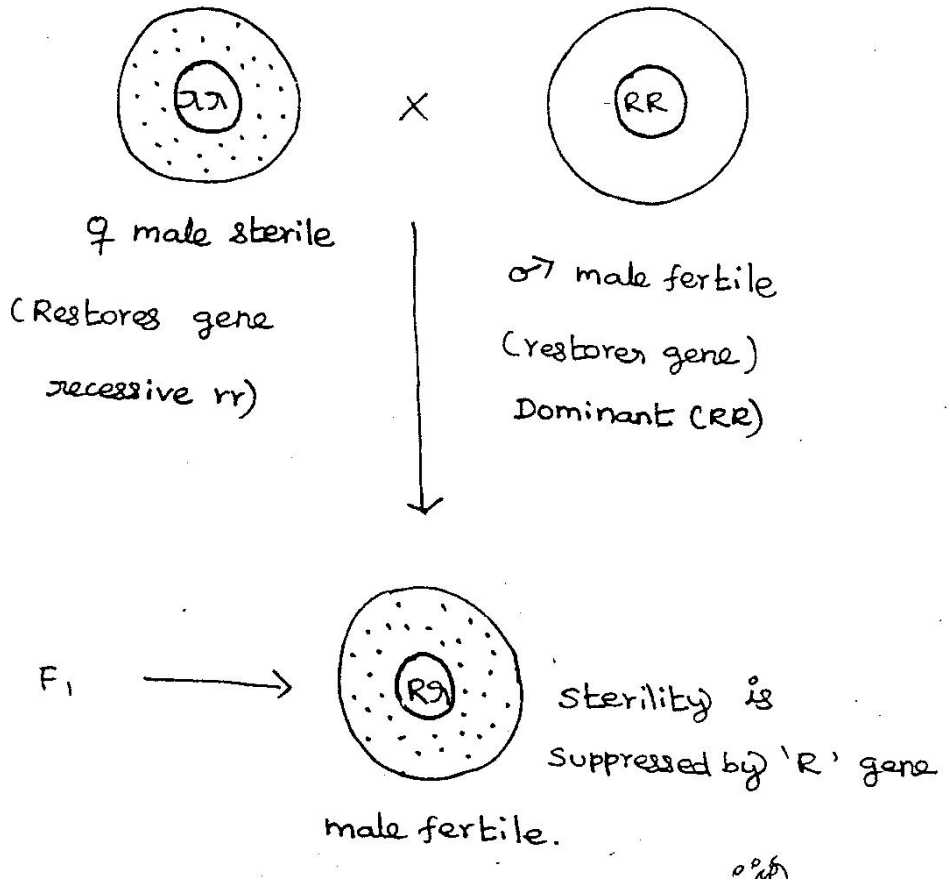
(ii) F_2 progeny would produce fertile and sterile individuals in 3 : 1 ratio.

(b) Cytoplasmic and nuclear male sterility

In maize a gene calle "restore gene" is present in the nucleus. This gene is a dominant condition (RR). Suppresses the effect of cytoplasmic male sterility. This shows that the expression of male sterility in maize depends upon the interaction between nuclear and cytoplasmic genes.

c) Cytoplasmic male sterility:

Maize refer male sterility in maize



Significance of male sterility

Male sterility has great significance in plant breeding.

1. It is very difficult to make a normal plant into a female. (emusculation) during hybridization.

2. Male steriles are used to get hybrids at low cost

3. This is used in raising hybrids easily.

Genetic code

Genetic code is defined as the sequence of nitrogen bases in MRNA molecules which contains the; information for the synthesis of protein molecules.

Genetic information is carried by the DNA and so it is called genetic material.

A protein is made up of many amino acids linked by peptide bonds (Poly peptide chain)

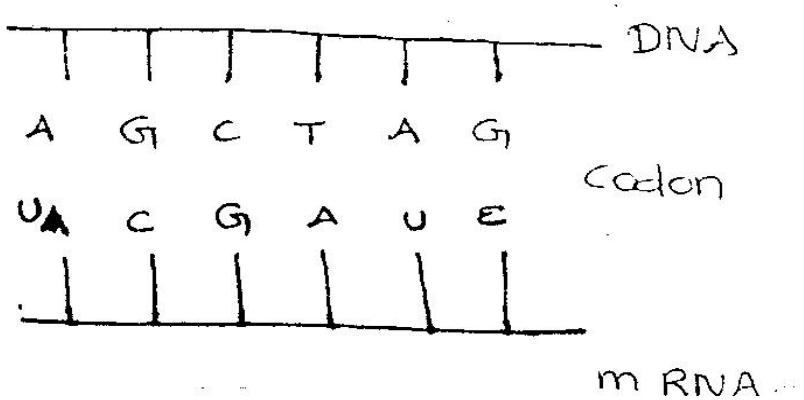
The sequence of amino acids in a protein is determined by the sequence of nitrogen bases in a DNA molecule.

The genetic information present in the DNA is passed on to MRNA.

MRNA carries the information to lthe cytoplasm for protein synthesis.

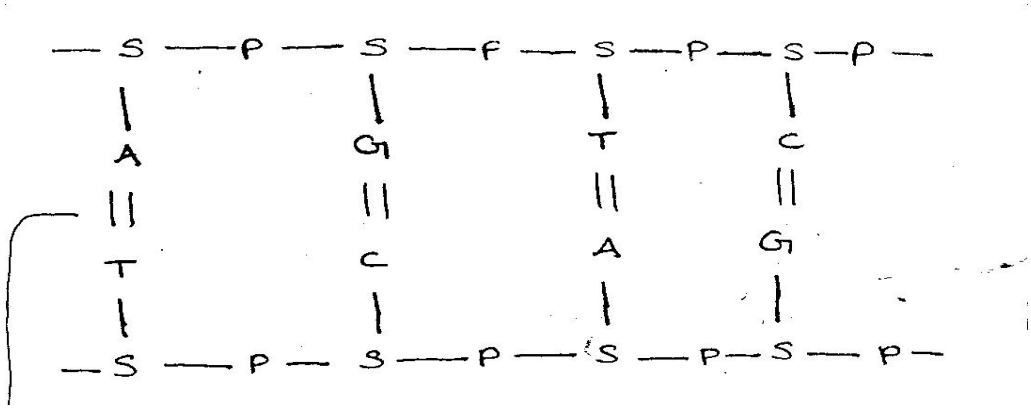
	Transcription		Translation	
DNA	⟶	MRNA	⟶	Protein
	Nucleus		cytoplasm	

The sequence of nitrogen bases in MRNA which codes for a single amino acid is known as codon. It is always complementary to DNA nitrogen bases.



In the DNA genetic information is connected with the nitrogen bases only. (not with sugar & phosphate)

The sequence of nitrogen bases in DNA molecule is similar to that of the sequence of amino acids in a protein this is known as colinearity.



nitrogen bases carry the genetic information.

This suggests that the specific arrangement of the four nitrogen bases (Adenine, thymine, Guanine & cytocine) in a DNA chain determines the sequence of amino-acids in a protein molecule.

Anticodon

t – RNA 3 nitrogen bases complement to mRNA nitrogen bases.

Genetic code dictionary

How the four nitrogen bases give information for 20 amino acids (or) How 4 letter language is translated into twenty letter languages.

(a) Singlet code

This is a simplest code. A code is written by single letter. One nitrogen base codes for one-amino-acid. This is not possible because only four nitrogen bases can not be coded for 20 amino – acids.

(b) Doublet code

A code has 4 nitrogen bases. This is not possible, because if can specifly only 16 amino – acids.

(c) Triplet code

A code has 3 letters for one amino acids. Every 3 nucleotides in mRNA refer one amino acid. So it is called a triple code. This is possible because it is called a triplet code. This is possible because it is enough for 64 amino acids.

Amino acid		code
Alanine	-	GUC
Glycine	-	GGG
Leucine	-	UUA
Phenylalalnine	-	UUU

(d) poly – u – analysis

Nirenberg and mathaei discovered condons for 4 amino acid. They have used only one type of nucleotide in protein synthesis. They have discovered 4 codons for 4 amino acids.

UUU	-	Phenylalanine.
AAA	-	lysine.
GGG	-	Glycine.
CCC	-	Proline.

(e) co-polymer method

This method helped to know codons for few more amino – acids.

(f) Khorana

He has produced a new polypeptide from synthetic mRNA. This gave full information about genetic code.

Initiation codon

This is the first codon present in the synthesis of a polypeptide. This includes the first three nitrogen bases in has usually AUG & it codes for the amino acid methionine.

Termination codon or non – sence codon

This is the last codon sean in the synthesis of a polypeptiede. This includes the last three nitrogen bases in mRNA. It may be UAA, UAG etc. This does not mean any amino acid so it is called non –sence codon.

Propertiess of genetic code

Genetic code has the following properties or characters.

(a) code is triplet

A code has always 3 successive nitrogen bases. It always refers to one amino acid. Ex. GGG – glycine

(b) code is universal

One code decides the same amino acid in all organisms like bacterias, plant & animals.

(c) linear arrangement

codons in mRNA & the amino acids in polypeptide chains have a linear arrangement.

(d) commerence

There is no comma between two adjacent codons. A codon is followed immediately by the next codon without any gap.

(e) Non – overlasppin

Recently studies show that codons are non-over lapping.

(f) Degeneracy

A single amino acid is specified by many codons. This is called degeneracy such codons. This is called degeneracy such codons are called degenerate codons.

(g) Non - ambiguous

A codon has only one meaning. Always it codes for only one amino acid.

Wobbely base or wobble hypothesis

This was proposed by crick (1966). Third base of a codon has no specifically.

(i) A t-RNA can pair with more than one codon.

(ii) This gives economy in the number of t-RNA molecules.

(iii) Mutation seen to play very important role in the study of genetic code.

GENES – STRUCTURE & CONCEPT

(or)

GENES – Fine Structure

Gene is the basic unit of heredity.

(i) Its presence was first proposed by Mendel.

(ii) Mendel called it as factor.

(iii) Johanson (1909) coined the word gene.

(iv) It occupies a definite locus in the chromosome.

(v) It is responsible for the expression of a specific character.

(vi) It is transmitted from one generation to the other.

Definition

A gene can be defined as a segment of DNA with many nucleotides which contains information for the synthesis of one protein.

Size

A gene consists of about 1500 nucleotides with a molecular weight of 10.6.

Modern concept

Recent studies reveals that DNA is the genetic material.

Genes are made up of a segment of DNA.

Modern concept of gene shows that it has units which are as follows:

Cistron

It is a modern term for gene.

(i) This term was coined by Benzer.

(ii) Cistron is a segment of DNA specifying a single polypeptide chain (protein).

(iii) It has hundreds of nucleotides.

(iv) Cistron is the nearest equivalent to the gene.

(v) A gene is a DNA segment with hundreds of nucleotides.

(vi) This code for one enzymic protein.

(vii) This is one gene one enzyme hypothesis.

(viii) Cistron in a functional unit of gene.

(ix) Change in a cistron casuses mutation.

(x) Two alleles of a gene are two slightly changed forms of a cistern.

(xi) Thus it is clear that's " a gene is a functionally complete unit of DNA molecule, which can synthesis, a specific protein.

Kecon

This term was coined by Benzer.

(i) It is a small segment of DNA capable or recombination.

(ii) A citron contains many recons in it.

(iii) It has less number of nucleotides.

Muton

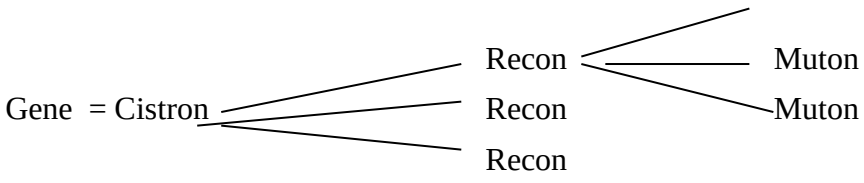
It is the smallest unit of DNA capable of mutation.

(i) This term was coined by Benzer.

(ii) A recon contains many mutons in it.

(iii) Thus it is clear that a gene can be divided into smaller units. This can be shows as follows.

Muton



(hundreds & nucleotides) (Less number of nucleotides) (Recombination) (Single nucleotide) mutation.

Gene Expression

It is the mechanism by which a gene expresses a character (phenotype).

It can be given as follows.

Gene (DNA) Nucleus Transcription MRNA Cytoplasm Translation Protoplasm

A gene (DNA) contains the code for a protein in the form of nucleotide bases. It transfers its code to mRNA. It is called transcription.

The code present in the mRNA is translated into protein with the help of tRNA & rRNA.

Gene Concept

Gene concept was proposed by Morgan.

(i) It is based on the information about character, genes, chromosomes, linkage & crossing over.

(ii) Each character of an organism is controlled by a pair of genes.

(iii) Each gene pair segregates during gamete formation by meiosis.

(iv) Genes assort out independently of each other during gamete formation.

(v) Cross – over occurs between genes of homologous chromosomes.

(vi) Some genes show linkage by which they are inherited together.

(vii) A chromosome has many genes in a lineos.

Order like beads

Genes show mutation.

Function of genes

Genes have many functions to do.

Expression of character

The main function of a gene is to control characters. Each gene produces an enzyme which in turn regulates a metabolic reaction.

Protein synthesis

Genes contain information for the synthesis of proteins as genetic code. The genetic code determines the type of proteins to be synthesized.

Inheritance

Genes are responsible for the transmission of characters from parents to offspring.

Regulation of gene action

An organism contains large number of genes. Gene action is regulated correctly. At any one time only a few genes are active and all other genes remain inactive.

Operon Concept (or) Gene Action

Gene Regulation: Gene Expression

This refers to the mechanism by which a gene regulates characters.

This observed in protein or enzyme synthesis.

Jacob & monad (1961) proposed operon model to explain this in bacteria.

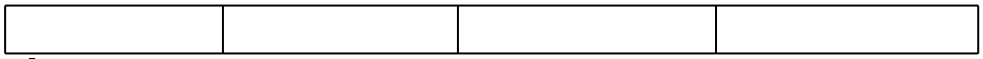
(i) Operon concept says that each reaction is controlled by a set of genes.

(ii) All these genes are involved in the synthesis of lactose are called lac operon.

(iii) An operon has the following gnes.

1. regulator gene – R
2. promoter gene – P
3. operator gene – O
4. structural gene – S

Regulator gene Promotor gene operator gene structural gene



Regulator gene

Produces a susbstance called repressor. Repressor susppress the activity of structural genes. Repressor attach with operator gene for suppression activity.

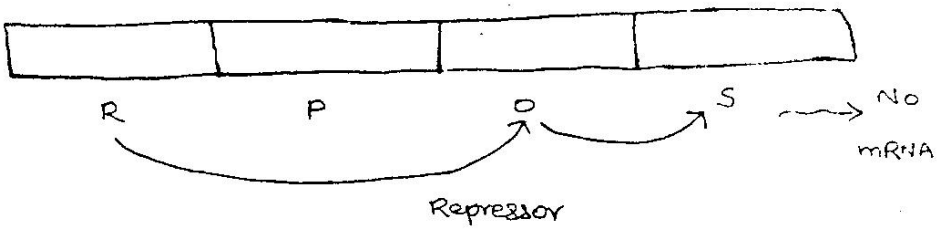
Promotor gene

Promotes the synthesis of mRNA.

Operator gene

Directly controls the structural gene. It is close to the structural gene. It is close to the structural gene. It binds with repressor during action.

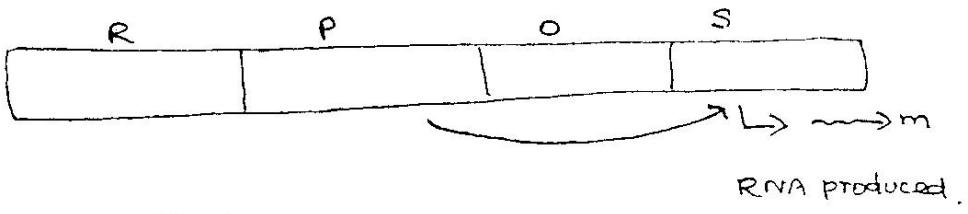
Operon repressed or switched off:



When operon is switched no mRNA is produced. Now repressor is produced which bind with operator.

Operon switched on

When operon is switched on an induce substance is produced mRNA is produced. This regulation is called a negative control.



Hardy Weinberg Law (or) Population genetics

(i) The study of inheritance of phenotypic character in a given population is called population genetics.

(ii) This is based on a principle proposed by Hardy Weinberg 1908.

(iii) This is connected with the frequencies of genes in a population.

(iv) The inbreeding groups with in a particular area are called merddian population or genetic population.

(v) The total sum of genes in a population is called gene pool.

(vi) The proportion of a gene to its allele in a population is called gene frequence.

(vii) The frequency of la character in a population is related to the frequency of the gene controlling it.

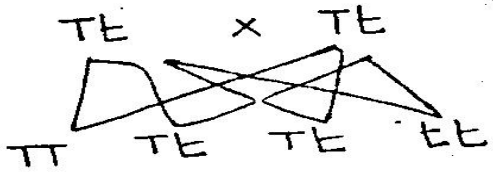
(viii) So the frequency of a gene in a gene pool can be calculated from the observed frequency.

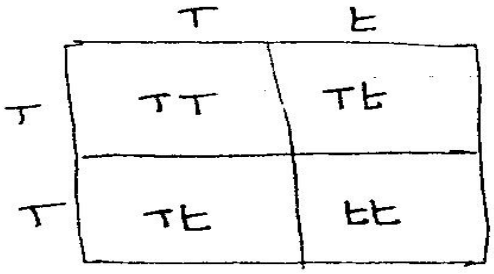
(ix) Hardy Weinberg law shows that the relative frequency of a gene (allele) bend to remain constant in a mendalian population for many generation.

(x) There is an equilibrium between the frequencies of genes in a population.

(xi) There is explained by a mathematical analysis.

(xii) Mendalian monohybrid ratio 1 : 2 : 1 gives there genetype.





This is explained by binomial expansion

(A+B)2 = A2 +2AB + B2 (or)

(T +t)2 = T2 + 2Tt + t2

⇨ If p is represents T

q is represents t

(p+q)2 = p2 + 2pq + q2 = 1

/ p + q = 1

p = 1 – q

q = 1 – p

If the frequency of one gene is known then the frequency of other gene can be calculated.

Recessive gene frequency can be calculated easily. From this the other gene frequency is calculated.

Thus Hardy Weinberg law is an easy method to know the gene frequency in a population.

Chromosome map (or) Linkage map

Cross-over map (or) genetic map

Chromosome map is a line, on which the genes are marked by points.

(i) This is a graphic representation of the genes in a chromosome.

(ii) Chromosome map was first made by sturterant Bridges and others.

(iii) This is related to the amount of cross-over.

(iv) The percentage of cross over is directly proportional to the distance of the genes in the chromosome.

(v) The greater the distance between the genes will show higher the percentage of cross over between them.

(vi) The percentage of cross – over determined test crosses.

(vii) In gene mapping a unit of distance is used and it is called map unit or morgan unit

(viii) One map unit will be equal to one percentage of cross-over.

(ix) Chromosome map is known in many plants and animal like maize, Drasophila etc.

(x) In Drosophila a three point cross using 3 pairs of genes gave & types of progenies (G cn L).

(xi) The data showed the following % of cross over and map units.

% of cross over between G & cn is 95.

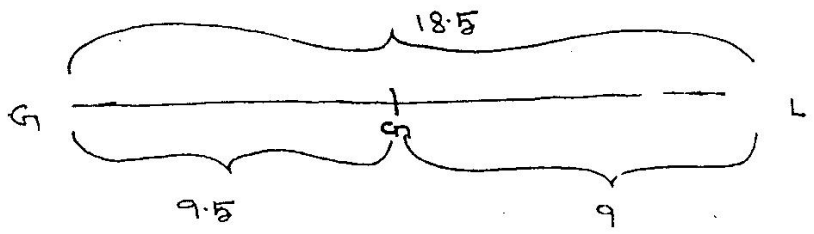
% of cross over between cn & L is 9.

Distance between the genes are equal to the % of cross over.

Distance between G & cn is 9.5 map units.

Distance between cn & L is a 9 map units.

This is drawn as follows:



Thus chromosome maps give the order in which the genes occur & the distance between the genes.

Multiple Alleles

This can be defined as a series of 3 or more genes which occupy the same locus and control the same character in the homologous chromosome. This is formed by the mutation of normal genes.

(i) Mendel said that a character is controlled by a single pair of genes.

(ii) Two alternative forms of a gene is called allele.

(iii) Different alternative forms of a single gene produce multiple alleles.

Multiple alleles are present in the same locus of a chromosome.

(i) There is no crossing over with in one multiple allele series.

(ii) They may have dominant or intermediate phenotypic effect.

(iii) Cross between two multiple alleles always produce a mutant type and not the wild type. Ex: Coat colour in Rabbit.

In rabbit coat colour is controlled by multiple alleles. Coat colour is of 4 types in rabbits like.

1. Agouti.
2. Chinchilla.
3. Himalayan.
4. Albino.

Agouti is wild type, and it is brownish gray in colour. This is controlled by a dominant gene C. This dominant gene shows three mutant alleles like Cch, Ch, c.

They show different coat colour like chinchilla, Himalayan, & Albino.

Possible phenotypes and genetypes due to multiple alleles.

1. Agouti (wild)
2. Chinchilla (Mutant)
3. Himalayan(mutant)
4. Albino(mutant)

Chinchilla has silver gray coat colour. This is recessive to agouti but dominant to Himalayan and albino.

(i) Himalayan has coloured ears, nose and tips of limps on their rest of the body is white. This is recessive to agouti and chinchilla but dominant to albino. Albino is white colour recessive to the other three types.

A cross between agouti and albino showed agouti in the F_1, F_2 progeny showed agouti and albino in 3 : 1.

P Agouti x Albino

↓

Agouti

↓

F_2 Agout albino

3 : 1

A cross between agouti and Himalayan showed the same result. Another cross between Himalayan and albino showed all F1 himalayan F2 showed Himalayan and albino in 3 : 1 ratio. All these shows that 4 types of coat colour are allelic to each other.

Self Sterility in Tobaco: (Nicotiana)

This has been described by east 1925. Self sterity is a condition in which the pollen of a flower is sterile on the stigma of the same flower.

(i) This controlled by a series of multiple alleles of a single gene namely S^1, S^2, S^3, S^4 etc.

(ii) A pollen carrying certain allele (S1) fail to grow in the stigma of a plant that carries the same allele. Thus if a plant S^1, S^2 is pollinated by the same type of pollen (S^1, S^2) the pollen fail to germinate.

(iii) A cross between S1, S2 female with S2, S3 male showed off springs of S1, S3 and S2, S3 and not S1, S2.

(iv) Another cross between S1, S2 and S1, S3 progeny. This shows that the presence of an allele in the mothers tissue prevents the growth of the pollen which carry the same allele.

Tobacco showed 15 alleles.

Oenothera showed 37 alleles.

Blood group in man

In man red blood cell, show an important and interesting multiple allele series. This has been described by Landsteiner. There are two types of antigens like A, B antigen, antibody reaction in the blood showed 4 types like A & B & AB & O.

Blood group	Antigen	Antibody
A	A	B
B	B	A
AB	A & B	-
O	-	a & b

Group – A

Persons have the antigen A, but no antibody, that agglutinates ‘A’ cells. They have antibodies that agglutinates “B”.

Group – B

Persons have the antigen B, but no antibody that agglutinates B cells. They have antibodies that agglutinates A cells.

Group – AB

Persons have the antigen A & B but no antibodies.

Group – O

Persons have neither antigens but have both types of antibodies.

These blood group are controlled by a gene I with as series of 3 alleles.

Allele I^A is responsible for antigen A.

Allele I^B is responsible for antigen B.

I^AI^B are dominants to i, Allele is fuils to specify any antigen.

Here wild allele is recessive and it is i A and B are Mutant alleles and dominant to wild allele.

Blood groups and gene types

Group	-	Geno type
A	-	I^AI^A, I^A i
B	-	I^BI^B, I^B i
AB	-	I^AI^B
O	-	ii

Presence of these alleles in man has some practical application in blood transfusion. Cases of disputed percentage and description of human population.

A group present can received blood from A and O persons only.

B group persons can receive blood from B and O persons only.

AB group persons can receive blood from A and B and AB and O persons.

O group persons can receive blood from O persons only,

O group is called universal donor.

A – Part questions

1. Multiple alleles?
2. Pseudo alleles?
3. Chromosome theory of inheritance?
4. Laws of Mendal
5. Dihybrid cross?
6. Types of polyploidy?

7. *Pisum sativum* – contrasting characters?
8. Sex – linkage – explain with an example.
9. What is meant by genetic ratio, explain any one ratio.
10. Explain linkage with suitable examples?
11. Coupling & repulsion?
12. Characters controlled nuclear or cytoplasmic genes?
13. Bio chemical mutants?
14. Law of independent assortment?
15. Advantage – Pea plants?
16. Quantitative and qualitative characters?
17. Incomplete dominance?
18. Aneuploidy?
19. Two chemical mutagens and mode of action?
20. Modern concept of genes?
21. DNA – replication?
22. Hybridity?
23. Chemosynthesis?
24. Polygenic inheritance?
25. Degenerative code?
26. tRNA?
27. Gamma radiation?
28. Gene (or) point mutation?
29. Base analog?
30. Blood groups in man?
31. Cross over significance?
32. Protein synthesis?
33. Lethal genes?
34. Role of tRNA in the genetic expression?
35. Translocation?
36. Amphidiploid?
37. Transduction?
38. 9 : 3 : 4 ratio?
39. Sex factor in bacteria?
40. Chromosome map?

41. Transcription?
42. Non allelic gene interaction?
43. Wobble hypothesis?
44. Translation?
45. Back cross – Technique?
46. Tasutomerism and mutastion?
47. Non sense codon?
48. Genetic code?
49. Mutation?
50. Population?
51. Chromosome theory of inheritance?
52. operon concept?
53. Male sterility in man?
54. Genetic drift?

1. Multiple alleles

Multiple allele can be defined as a series of many genes which control the same character.

(i) These genes occur in the same locus of homologous chromosome.

(ii) Multiple alleles are produced by mutation of a normal gene.

(iii) Skin colour in Rabbit, Blood groups in man are best examples for multiple alleles.

(iv) In Rabbit the normal dominant gene coloured is used wild.

(v) Mutated genes produced 1. Himalayan 2. albino etc.

(vi) Blood groups in man is controlled by a gene. I with a series of three alleles.

(vii) Mendelian allele has only alternate from a gene.

2. Pseudo alleles

Closely linked genes which behave like alleles of a same gene are called pseudoalleles.

(i) These genes inherit together with minimum chance of crossing over.

(ii) Ex.. Eye colour in Drosophila.

(iii) Eye colour in drosophila changes from red to white with many intermediate colours.

(iv) All these from an allelic series present in the 'X' chromosome.

(v) These genes are actually non-allelic but behave as alleles.

3. Chromosome theory of inheritance

This theory was proposed by sutten to explain mendelian inheritance in clear terms.

(i) According to this characters are controlled and inherited by chromosome.

(ii) They are passed on from one generation to another generation through gametes.

(iii) Division of chromosomes arrangement of homologous chromosomes suggests chromosome theory.

(iv) Characters are inherited through the chromosomes from generation to generation.

(v) Sex termination is also connected with sex chromosomes.

(vi) These are two types of sex chromosomes called " X +Y".

(vii) Cytological proof of chromosome theory is seen in crossing over.

Law of Mendel

Mendel who is the "Father of genetics" proposed these laws.

(i) These laws based on certain principles.

Law of dominance

One factor in a pair of characters may mark or prevent the expression of the other.

Law of segregation

During gamete formation the genes of a particular character separate and enter into different gametes.

Law of independent assortment

The genes for each pair of characters separate independently from those of either character during gamete formation.

In these three laws

Law of dominance

Law of segregation

Monohybrid cross 3 : 1.

Law of independent assortment 9 : 3 : 3: 1 based on Dihybid experiment.

4. Dihybrid cross

A cross between two plants which differ in two pair of characters is called dihybrid cross.

(i) This was done by Mendel in "Pea plants".

(ii) The parents were

Dominant: a) round seeds, yellow cotyledons RRYY.

Recessive: b) wrinkled seeds green cotyledons rryy.

(iii) All F_1 were round yellow RrYy.

(iv) In F2 if shows 9 : 3 : 3 : 3 : 1 ratio.

Round yellow	-	9
Round green	-	3
Wrinkled yellow	-	3
Wrinkled green	-	1.

This is used to explain law of dominance and law of independent assortment.

5. *Pisum Sativum* – Contrasting characters

Mendel has done his experiments in pea plants.

(i) He found this plant suitable because it had distinct dominant and recessive character.

Dominance	Recessive
1. Round seed	Wrinkled seed.
2. Yellow seed	green cotyledon.
3. Grey seed coat	white seed coat.
4. Inflated fruit	Constricted fruit.
5. green fruit	yellow fruit.
6. Axillary flower	Terminal flowers.
7. tall plant	Dwarf plant.

6. Types of polyploidy

Polyploidy is a condition in which an organism has many sets of chromosomes.

(i) It may be triploid , tetrasploid, pentaploid, hexa ploid …. So on.

(ii) Polyploids occur in nature are can be induced.

(iii) They are two types of like 1. Autopolyploidy. 2. Allopolyploidy.

(iv) In autopolyploidy the same basic sets of chromosomes are multiple (AAAA).

(v) In allopolyploids there is multiplication of chromosome sects of two types (AABB).

(vi) Hybrids are usually allopolyploids.

(vii) Allopolyploids are very important in plant breading by which many new varieties are produced.

7. Sex linkage

Sex linkage is the association of hereditary characters with sex chromosomes.

(i) These genes present in the sex chromosomes are called sex linked genes.

(ii) These characters are called sex linked characters.

(iii) This inheritance is called sex linked inheritance.

(iv) Sex linked characters is seen in drosophila and man.

(v) In man colour blindness is x linked character.

(vi) There is seen in x chromosomes. This is recessive to normal vision.

(vii) Sex linked characters show criss-cross inheritance.

8. What is meant by genetic ratio

The genotypic expression of characters if the F_2 genes ratio is called genetic ratio.

(i) This is observed in hybridization experiments.

(ii) This ratio indicate the inheritance of character through genes.

(iii) In monohybrid cross it is 1 : 2 : 1 ratio.

1 = TT – pure tall (homozygous)

2 = Tt – heterozygous.

1 = tt – heterozygous recessive (pure dwarf)

(iv) This ratio help us the hoxozygous or heterozygous condition of F_2 individuals.

9. Explain Linkage

The tendency of 2 or more genes to remain together in a chromosome and inherited for the next generation is called linkage.

(i) Theory of linkage was proposed by T.H. Morghan (1911).

(ii) These genes are called linked genes.

(iii) Linked genes do not separate in the inheritance.

(iv) Linkage is found in drosophila, maize etc.

(v) In drosophila the genes for grey body and long wings are linked.

(vi) It is of two types like complete and incomplete linkage.

(vii) Linked genes don't follow mendelian inheritance.

10. coupling & Repulsion

Coupling and Repulsion are two events of linkage.

(i) Coupling is the tendency of two dominant or recessive characters of the same parent to remain together.

(ii) Repulsion is a condition where two genes from different parent remain separate from each other.

(iii) Coupling and Repulsion was described by Bateson and Punnett.

(iv) In coupling characters of the same parent enter the same gamete, where as in repulsion the characters enter different genetes.

11. How do you assess wheather a character is controlled by nuclear genes or cytoplasmic genes?

Or

Meternal inheritance of a uniparental inheritance:

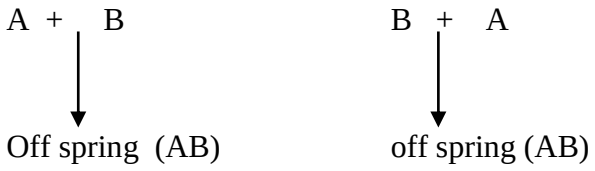
(i) Characters in individual are determined by genes.

(ii) Usually they are controlled by nuclear genes.

(iii) Sometimes cytoplasmic genes also control characters.

(iv) In the inheritance nuclear genes change is equally for male and female parents to the offspring's.

(v) The reciprocal crosses of the parents will give the same result.



(vi) Cytoplasmic genes contributions of different parent are unequal.

(vii) Here characters are mainly transferred from female parent to off spring.

(viii) The offspring usually resemble female parent this is also called maternal inheritance.

12. What are biochemical mutants?

They are found in Neurospora fufngus.

(i) This was discovered by "Beedle and Tatum".

(ii) Mutant which has lost the ability to synthesize one more compound are called bio-chemical mutants.

(iii) They cannot grow in a minimal medium.

(iv) They are also called " Auxotrophs ".

(v) Wild type which grows in a minimal medium is called "phototrophs".

(vi) Biochemical mutants are obtained by irradiations.

13. Why Mendel has selected pea plants for his genetic studies

In has short period growth and short life cycle.

(i) Flowers are normally self-fertilized.

(ii) They have clear cut contrasting characters.

(iii) Hybrids of garden pea plants are perfectly fertile.

(iv) Cross pollination was not difficult.

(v) Artificial fertilization almost successful.

(vi) Many pure breeding varieties are available for experiment.

(vii) Very easy to cultivate.

(viii) These are the reasons for Mendel selecting pea plants.

14. QUALITATIVE & QUANTITATIVE CHARACTERS:

QUALITATIVE	QUANTITATIVE
1. It deals with inheritance of character of of Kind namely structure color etc.	It deals with inheritance of traits degree of height and weight.
2. Discreate phenotyphic classes occur. occur.	A spectrum of phenotyphic classes
3. Show discontinuous variation.	Continuous variation.
4. Controlled by a single gene.	Controlled by polygenes.
5. Not affected by environment	Affected by environment.
6. Connected with one pair and their progeny.	connected with population.
7. Analysis is made by counts or ratios.	Analysis us made by statistical methods.
8. Menddial inheritance of characters. colour in man.	Kernel colour in wheat skin

15. INCOMPLETE DOMINANCE.

In some cases crossing don't give menddial ratio.

1. This is obtained in "mirabilis jalapa".
2. Here the F_1 hybrid is intermediate between the parents.
3. This condition is called as complete dominance.
4. Here the parental characters are shown in a mixture in the F_1.
5. A cross between red and white gene pink coloured off springs.

Red x White

↓

Pink intermediate

(off spring)

6. In the F_2 Red and pink and white appeared in 1 : 2 : 1.
7. Correns found this in mirasbilis Jalapa.

16. Aneuploidy

Aneuploidy is variation in one or more chromosome of a set.

(i) In 2n is 16, aneuploids have 2n = 17 or 2n = 15.

(ii) Thus it can be 2n+1 or 2n-1.

(iii) 2n-1 is called monosomy.

(iv) 2n-2 is called Nallisomy.

(v) Nallisomes are abnormal individuals.

(vi) 2n+1 is called trisomy and 2n+2 is called terasomy.

(vii) Trisomics are used to Locate genes on a particular chromosome.

17. Two chemical mutagens and mode of Actions

Mutagen is a substance which induces mutation in an organism.

a. It is of many types like ionizing radiation, non-ionizing, chemical mutasgenes etc.,
b. X – rays and γ rays are mainly used as mutagents.
c. They bring mutation by breaking the sugar phosphate backbone of DNA.
d. They are used to induce mutation in buds and seeds.
e. Chemical mutagens are Nitrous acid, Nitrogen, mustard, mustard gas etc.
f. They chemicals affect the nucleic acid to bring about mutation.

18. Test for parity or hybridity

Test cross or recessive back cross is used to know to purity or hybridity of an individual.

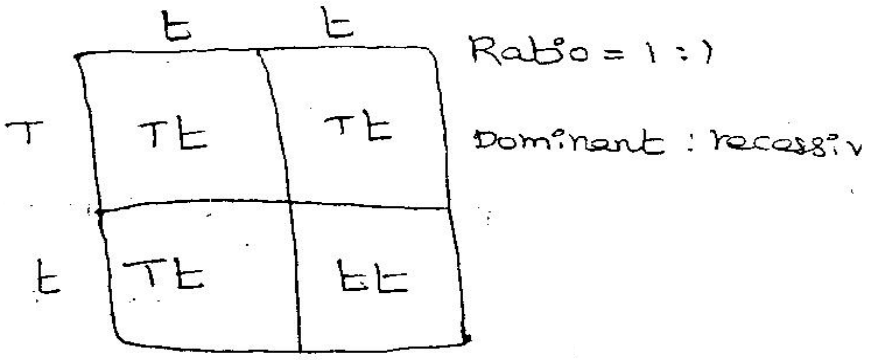
(i) Here F_1 individuals are closed back with recessive parent.

(ii) Here F_2 result will be 1:1 ratio of dominant and recessive types.

(iii) This is used to know whether the hybrid is homozygous or heterozygous.

(iv) F_1 when hybrid the ratio is 1 : 1.

(v) F_1 when homozygous the ratio is 100% dominant F_1 when hybrid.



19. Chemosynthesis

Chemosynthesis is method in which energy is obtained from inorganic substances.

(i) This is common in sulphor bactria, iron bacteria etc.

(ii) Bacteria break the substance to release energy.

(iii) Mainly they prefer organic substances.

(iv) This is used to explain origin and evolution of life of each.

20. Polygenetic inheritance

This is a condition where a single character is influenced by a number of independent genes.

(i) Each gene has a small effect.

(ii) The final effect is cumulative.

(iii) This type of inheritance is called polygenetic inheritance or blending inheritance of quantitative inheritance.

(iv) Ex: coat colour in cattle skin colour in human beings and kernel colour of wheat.

(v) A cross between pure red and white parents should dull coloured F_1 off springs.

(vi) F_2 showed red and white in 15 : 1 ratio.

(vii) Red coloured showed different shades according to the number of dominant alleles.

21. Degenerative code

Genetic information present in the DNA molecule is called genetic code.

(i) It is represented by 3 nucleotides that code for a particular amino acid.

(ii) A genetic code for one amino acid has more than one word (synonymn).

(iii) This is called degeneric code (or) the code is degenerate.

(iv) Formerly it was thought that there is only one code for one amino acid.

(v) According there are 44 useless or nonsence codons.

(vi) But later it was shown that there is no any non-sense codon.

(vii) This proves that the code is degenerate.

22. Transfer RNA or t-RNA

tRNA is a nucleic acid which transport amino acids to the lift of protein synthesis.

(i) It is single standards and smaller than mRNA.

(ii) It is folded to form a colour leaf like structures.

(iii) It has two terminal ends and four loops.

(iv) One loop has a sequence of 3 nitrogen bases called anticodon.

(v) It is attached to the ribosome through one loop.

(vi) Each tRNA transport. Only one amino acid.

(vii) It is more stable.

23. Gamma radiation

Gamma radiation is a mutagene used to induce mutation.

(i) Muller (1927) and stadler used x – ray and γ - rays to induce mutation.

(ii) They are ionizing radiation which can induce mutation in seeds.

(iii) Used of gamma rays break the DNA structure and bring about mutation.

(iv) Produce many new varieties use of gumma rays.

23. Gene mutation or Point mutation

Mutation by a change in a gene is called gene mutation.

(i) It is also called point mutation, because it affects only a point in the chromosome.

(ii) This is very important in the evolution.

(iii) This is caused by the chemical changes of DNA molecule.

(iv) Gene mutation occurs at random.

(v) It is of many types like substitution.

25. Blood groups in man

A blood group in man is due to an important and interesting multiple alleles.

(i) Multiple alleles are a group of alternative forms of a gene.

(ii) Landsteiner found the human blood groups. According to the antigen present in the RBC.

(iii) They are four blood groups as A, B, AB and O.

(iv) They are controlled by a gene I with a series of 3 alleles like I^A I^B and i.

(v) i is recessive.

(vi) Blood group A has I^A.

Blood group B has I^B.

Blood group AB has I^AI^B.

Blood group O has "i".

(vii) It has some practical application in blood transfusion.

26. Crossing over significance

Crossing over is a process of exchange of chromatid segment between non-sister chromatids of a homologous chromosomal pair.

(i) This produces a new combination of genes.

(ii) It is useful to find out the linear arrangement of gene in the chromosome.

(iii) The frequency of crossing over is useful to constract chromosome map.

(iv) It brings about new combination of genes.

(v) It is used to separate linked genes.

(vi) This process genetic variation which is the raw material for evolution.

27. Protein synthesis

Formation of protein in a cell medium is called protein synthesis.

(i) Protein synthesis is controlled by DNA molecule.

(ii) The information of protein synthesis is present in the DNA in the form of genetic code.

(iii) By transcription the information from the DNA is passed on to mRNA.

(iv) By translation, mRNA sends the information to tRNA and finally proteins are prepared.

(v) rRNA and tRNA assit in the formation of polypeptide chain.

(vi) Ribosome is the auturd life of protein synthesis.

28. Lethal genes

Genes which causes the death of the individual carrying it are called lethal genes.

(i) It is of 2 types like dominant and recessive lethal genes.

(ii) Recessive lethal is expressed only in the homozygous condition.

(iii) Lethal genes are found in mice coat colour variegated leaf in shape – dragon, Albinism in corn etc.

(iv) In mice lethal genes showed 2 : 1 ratio.

(v) It can albino plants fail to produce chlorophyll and die.

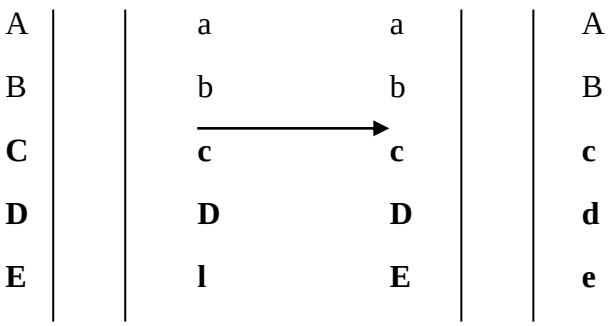
29. Translocation

It is a process of exchange of chromosome segments between 2 chromosomes.

(i) This is an important type in the chromosome mutation.

(ii) This exchange between chromosome produce new combination and new varieties.

(iii) This plays an important role in the evolution.



30. Amphidiploid

Amphidiploids are individuals which are produced by multiplication of chromosome of a hybrid between 2 different species.

(i) They are also called alloplyploids.

(ii) They are produced by intergeneric crosses.

(iii) Wheat, Gossypium, hirsutum and Triticate are best examples of allopolyploids.

(iv) Raphano brassica is a hybrid between Raphanus and Brassica.

(v) Wheat is a hexaploid produced from three diploid species.

(vi) Allopolyploid produce hybrid and new species.

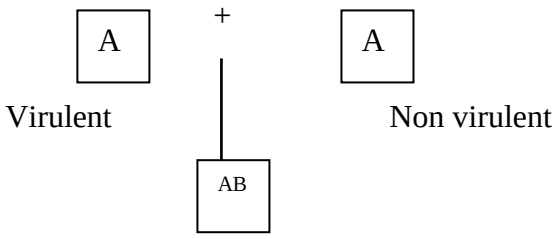
31. Transduction

This is a process of transfer of genetic material from one bacteria to another bacteria through a virus agency.

a. This was discovered by zinder and Laddernberg.

b. Here a non-virulent bacteria becomes virulent by taking a bit of host as DNA.

c. This DNA is transferred to another host by the infection of this new virus.



Virulent

32. 9 : 3 : 4 ratio

This is the ratio used to explain supplementary genes.

(i) In the interaction of two gene. One gene produces its effect independently where as the other gene can produce its effect in the presence of the first gene.

(ii) Coat colour of mice and grain colour in maize are the examples of supplementar genes.

(iii) A cross between block, dominant and Albino recessive parents produced agouti individuals.

(iv) In the F_2 Agouti black and albino appeared in 9 : 3 : 4 ratio.

(v) Here black colour is due to gene "C" and the other gene has no effect.

(vi) The second gene only in the presence of the first gene shows its effect.

33. Sex factor in Bacteria

Sexual reproduction in Bacteria takes place by conjugation.

(i) It is found in E.coli bacteria.

(ii) In the conjugation the donor is + strain and the recipient is – strain.

(iii) Donor has a transnissable factor called F_+ Factor.

(iv) The recipient has no F- factor.

(v) F_+ factor is small piece of DNA molecule.

(vi) In the conjugation the + factor enter into the recipient and it is converted into donor F+.

(vii) By this F recipient becomes F_+.

34. Mapping of gene (or) chromosome map

It is a diagrammatic graphic representation of distance between linked genes of a chromosome.

(i) This map is studied with the help of crossing over and so called cross over map.

(ii) This was discovered b T.H. Morghan in drosophila.

(iii) Chromosome map is used to find out the exact location arrangement and combination of genes in a chromosome.

(iv) This is used to find out the distance between two genes.

(v) This is useful to predict the result of dihybrid and trihybrid cross.

35. Transcription

Transcription is the first step in the protein synthesis.

(i) This is transfer of genetic information from DNA to mRNA.

(ii) This is assisted by an enzyme called RNA polymerase.

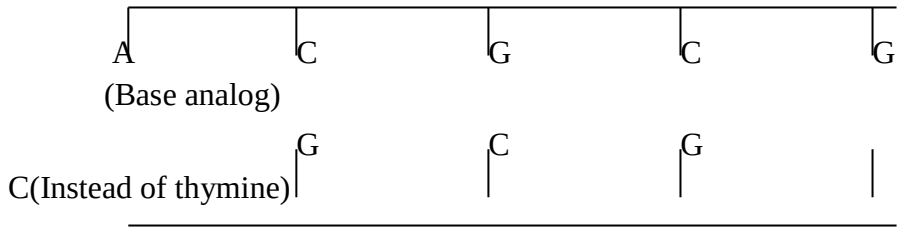
(iii) Now the DNA uncoil and each strand functions temperate.

(iv) New mRNA is produced.

(v) They are constructed according to the DNA base.

(vi) The newly formed mRNA diffuses into the cytoplasm.

(vii) Thus by transcription mRNA carries the information from the nucleus (DNA).



36. Base analog

This is seen in gene mutation.

(i) Gene mutation is the changes that occur in the chemical and structural composition of a gene.

(ii) In the substitution gene mutation one nucleotide is replaced by another nucleotide.

(iii) Certain chemicals have similar molecular structure to the DNA bases. They are called base analog.

(iv) B – bromo uraicl is a chemical similar to the thymine.

(v) This is the first base analog inserted into the DNA.

(vi) This chemical functions with in the chromosome just like thmine.

(vii) Presence of base analog in the DNA produces unusual m-RNA which leads to mutation.

37. Non allelic gene interaction

Different genes located on the same or different chromosomes interact with one another for the expression of single character.

(i) Bateson and punnett found this in fouls comb pattern.

(ii) It is also called factor hypothesis.

(iii) In four, 2 gene pairs affect the single character comb type.

(iv) The four types of comb are pea, rose, walnut and single.

(v) Complementor factors, supplementary factors, epistasis and duplicator genes are here (eggs) examples of non allelic gene interaction.

(vi) 9 : 3 : 3 : 1 ratio is changed 12 : 3 :1 or 9 : 3 : 4 or 15 : 1.

38. Wobble hypothesis

This is proposed b crick 1965 to explain the specificity of a codon.

(i) According to this in the triplet genetic code the first two bases are important and the 3rd is not very important.

(ii) By this one t-RNA can recognize more than one code for the same amino acid.

(iii) If "V" is present in the first position of anticodon it can pair with either A or G. This is called Wobble.

(iv) This allows economy of the number of tRNA molecules.

39. Translation

This is the second step of protein synthesis.

(i) Here the information from mRNA is translated into the sequence of amino acids of a polypeptide chain.

(ii) This takes place in the cytoplasm.

(iii) This is initiated by the initiation codon of m – RNA.

(iv) This forms a complex called Ribosome, m –RNA amino acid t-RNA help in the construction of polypeptide chain.

(v) Finally a protein or polypeptide chain is produced.

40. Back cross technique (Test cross)

It is the cross of F_1 hybrid with anyone of its parents.

(i) It is of 2 types like dominant back cross and recessive back cross.

(ii) In the dominant back cross F_2 shows 100% dominant.

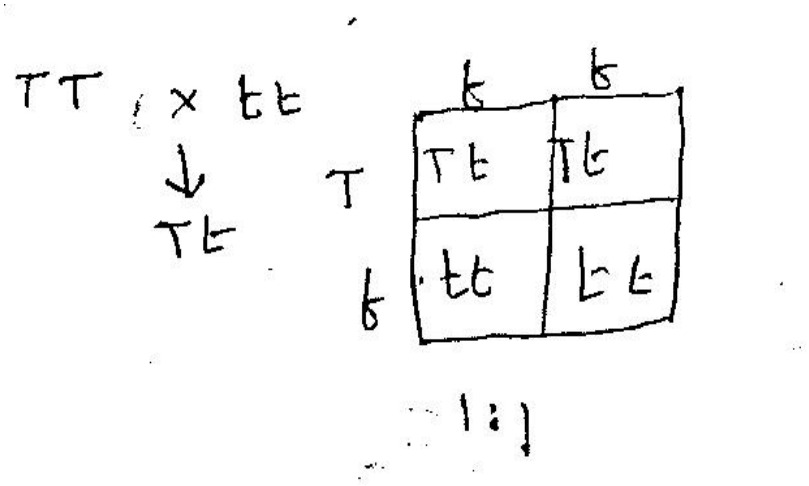
(iii) Test cross or recessive back cross is used to know the purity of an undivided.

(iv) Here F_1 individuals are crossed back with recessive parent.

(v) Here the F_2 result will be 1 : 1 ratio of dominant and recessives types.

(vi) This is used to know whether the hybrid is homozygous or heterozygous.

(vii) F_1 when hybrid the ratio is 1 : 1.



41. Transutomerism and mutastion

Mutation is sudden heritable changes in an organism.

(i) Gene mutation is the mutation that occurs in a gene.

(ii) In the substitution mutation, Tautomerisation.

(iii) Tautomersation is rearrangement of histrogen bases due to electron shifting.

(iv) By this the changed nitrogen bases combine with other nitrogen bases.

(v) This situation is called copy error.

(vi) This leads to change of character causing.

42. Non-sense codon

Codons which do not code for any amino acid is called non-sense codon.

(i) Genetic code is represented by 3 latter codes or triplet code each representing one amino acid.

(ii) In the genetic code dictionary there are 3 codons called termination codons.

(iii) They are UAA, UAG and UGA.

(iv) They do not code for any amino acid.

(v) Thus termination codons are called nonsense codons.

(vi) Their main function is termination of protein synthesis.

43. Genetic code

Genetic code is the information that is passed on from DNA to mRNA for the synthesis of protein molecules.

(i) Each code is represented by 3 letters and so it is called triplet code.

(ii) Each code represent one amino acid.

Ex., UUU - Phenlalanine.

GUU - alanine.

CCC - Proline etc.

(iii) Each code is specific for one amino acid.

(iv) It is seen in all living organisms.

(v) Genetic code is in the linear arrangement and it has no comma between adjacent codons.

(vi) Terminal codons are nonsense codons.

(vii) mRNA → codons.

tRNA → Anticodons.

44. Mutation Deta

Mutation is sudden neritable changes in living organisms.

(i) Hugo devvries was first to use the term mutation.

(ii) Mutation can occur in the somatic cells (or) in the reproductive cells.

(iii) Mutation is reproductive cells are more important.

(iv) It is of 2 types like spontaneous and induced mutation.

(v) Gene mutation is more important which bring about new characters.

(vi) Recessive mutations are expressed in the homozygous condition.

(vii) Beneficial mutations are much use to plant breeding.

(viii) Plays an important role in evolution.

DNA

Deoxyribo Nucleic acid

Introduction

1. DNA is the molecule of heredity. It functions as the genes.
2. It is present in all the cells except in plant virus.
3. In evkaryotic cells it is in the form of a double helix.
4. But it is circular in mitochondria, bacteria and plastics.
5. DNA is made up of three chemical components life sugar, phosphoric acid and Nitrogenous bases.

Structure (Watson and crick model of DNA)

1. According to Watson and Crick DNA is in the form of a double helix.
2. It is made up of two chains, each chain is a polynucleotide chain.
3. Each polnucleotide is made up of many small units called nucleotides.
4. Each nucleotide is made up of three chemical components like a phosphoric acid a deoxy ribose sugar and a nitrogen base.
5. The nitrogen bases are two purines like adenine, guanine two primidines like thymine and cytosine.
6. The nucleotides of DNA are two purines like adenine guanine two pyrimidines like thymine and cytosine.

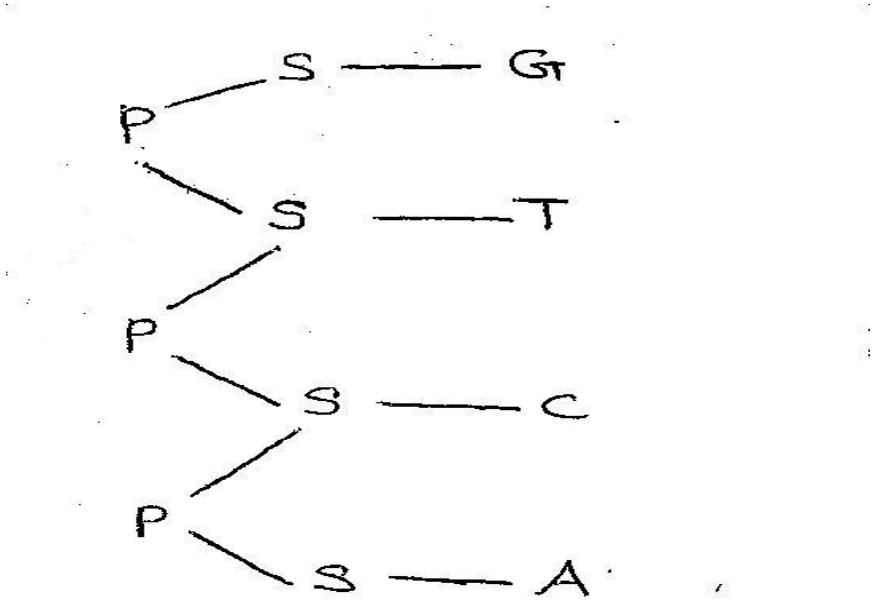
AMP - Adenosine monophosphate.

GHP - Guanosine monophosphate.

TMP - Thymidine monophosphate.

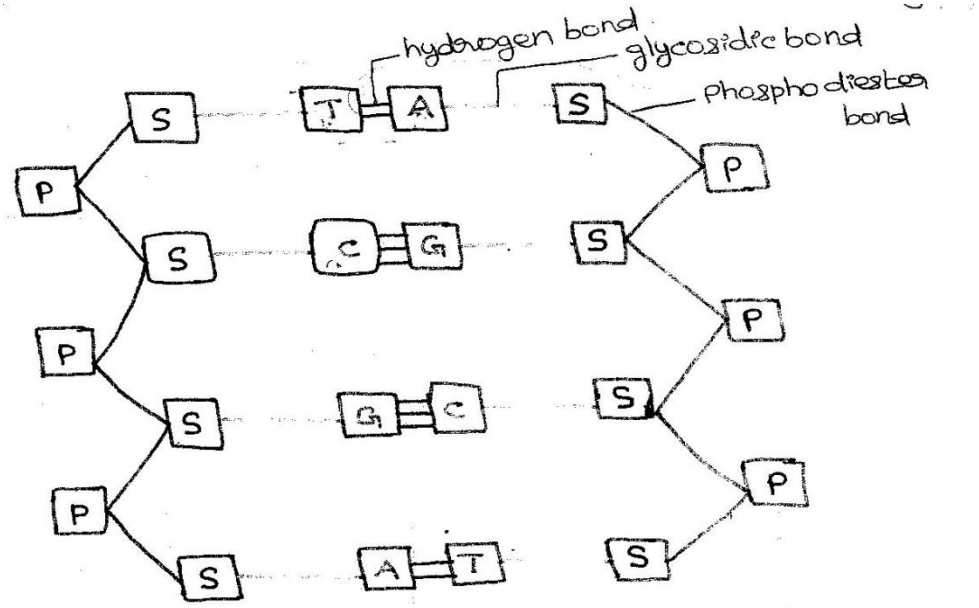
CMP - Cytidine monophosphate.

7. In each nucleotide, the sugar molecule is attached with a phosphoric acid at one side, and nitrogen base at the another side.
8. The nitrogen base is joined with sugar by glycosidic bond.
9. Two nucleotides are linked together by phophodiester bond.
10. It is formed between the sugar of one nucleotide and the phosphate component of another nucleotide.



11. Each DNA molecule has two polnucleotide chains.
12. So the nucleotides of adjacent chains are linked.
13. Adenine is always linked with thymine. (A = T).
14. Guanine is always linked with cytosine. (G = C).
15. The linking between purines and pyrimidines is made by hydrogen bones.

    A = T G = C
16. The amount of adenine is equal to the amount thymine, similarly Guanine is equal to cytosine.
17. The two chains of a DNA are Complementary.



a. At one end of the polynucleotide chain, the 3rd carbon of the sugar is free, it is called 3' prime (end).
b. At the other end of the 5th carbon of the sugar is free and this end is called 5' prime (end).
c. The two strands are antiparallel.
d. The two polnucleotide chains are coiled around each other to form a double helix.
e. The width of the helix is 20 A°.
f. The distance between the two nucleotides is 3-4 Ao.
g. The DNA has a major and minor grooves externally.

Functions

1. DNA acts as the carrier of genetic information from generation to generation.
2. DNA is a very single stable macromolecule of all organisms and it is immortal.
3. It controls all the activities of life.
4. It synthesis RNAs.
5. DNA is the genetic code which is responsible for protein synthesis.

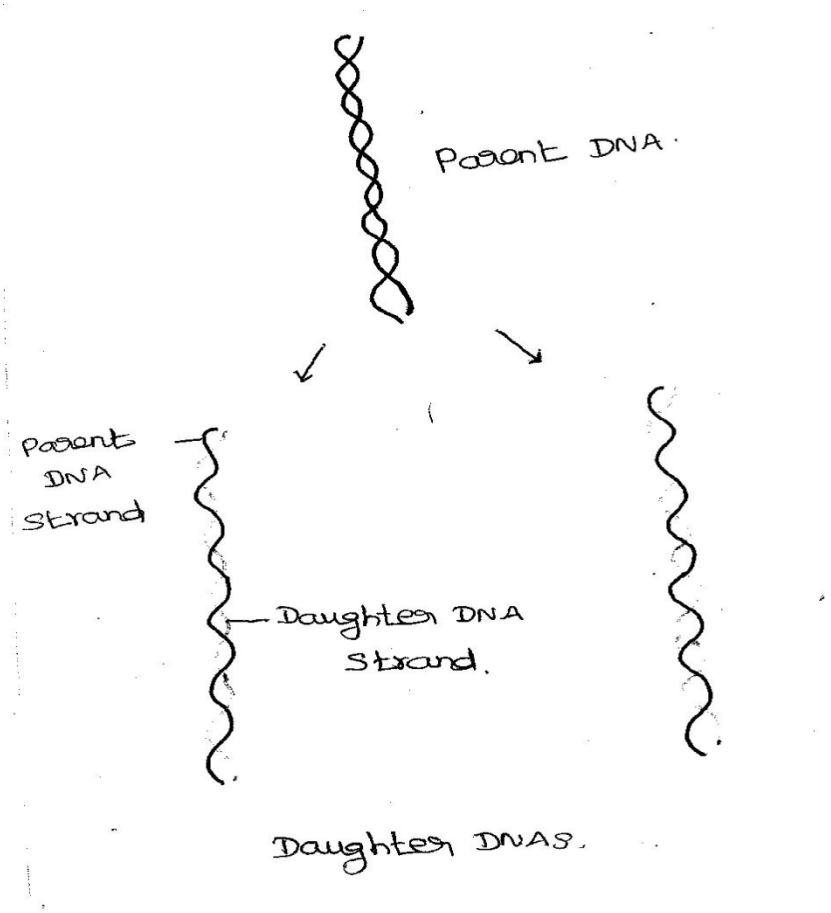
Watson & Crick DNA Double helix.

Replication of DNA

1. Replication is the duplication process by which a DNA molecule produces exact copies of its own structure.

2. It occurs inside the chromosomes during interphase.
3. The parent DNA strands function as templates for the synthesis of new DNA strands.
4. There are three types of DNA replication.
   (i). Semi conservative method.
   (ii).Conservative method.
   (iii).Dispersive method.

I. Semi-conservative method



1. This method was proposed by Watson and crick.
2. It is experimentally supported by meselson and stahl.
3. The parent DNA is produced by semi conservative process, of the two strands produced one strand is the parental and the other is newly synthesized.
4. The DNA replication requires the following components.
   (i).DNA template.
   (ii).Helicase (Unwinding enzyme).

(iii).A Primer RNA.

(iv).RNA Polymerase.

(v).DNA Polymerase.

(vi).Ligase.

5. Replication starts at a specific point called origin.
6. At the site of origin, the two strands separate by the enzyme helicase.
7. At the point, where the two strands are separated, a 'Y' shaped replication fork is formed.
8. The separated DNA strands act as templates.
9. DNA synthesis requires a primer RNA synthesized by RNA polymerase.
10. New DNA strand synthesized by DNA polymerase in 5' – 3' direction.
11. The first strand formed continuously, hence it is called leading strand.

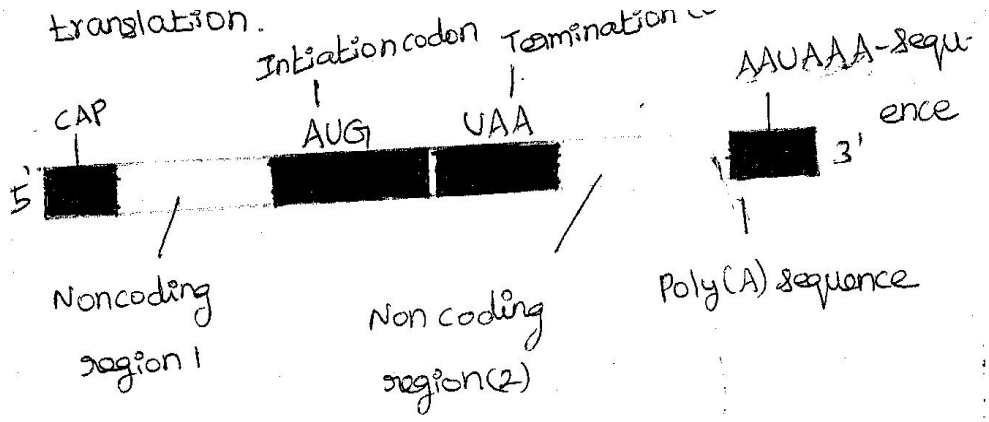
3. The new DNA double helix made up of new material.

1. According to this method, the parent DNA breaks down into small pieces.
2. Each piece synthesizes a small DNA molecule and assembled.
3. Thus the pieces of parent DNA remain scattered in the daughter DNA molecule.

I. Messenger RNA (m RNA).

1. Messenger RNA is a ribo – nuleic acid, which carries genetic information for protein synthesis, from the DNA to the cytoplasm in the form of Triplets.
2. The term mRNA was coined by Jacob and monad.
3. It is complementary with DNA.
4. It is a single stranded polynucleotide chain.
5. The genetic information carried by the mRNA is called genetic code.
6. The genetic code is the sequence of nitrogen bases in mRNA.
7. It is formed of several cod ons.
8. Each codon is a sequence of three nitrogen bases which codes for one amino acid.

9. So the code is Triplet.
10. mRNA is the longest one than other RNAs consists of 900 to 1500 nucleotides.
11. Each mRNA contains the condones for one polypeptide chain.
12. One end of the mRNA is called 5’ end the other end is called 3’ end.
13. At the 5’ end a cap is found which helps the mRNA to bind with ribosome’s.
14. The cap is followed by a non – coding region which does not code for protein.
15. It is followed by initiation cod on.
16. The initiation cod on is followed coding region contains codes for protein.
17. The coding region is followed by termination cod ons which completes the translation.
18. The termination cod on is followed by non – coding sequences.
19. At the 3’end, there is poly Aden late sequences.
20. The mRNA is synthesized from the DNA by the enzyme RNA polymerase through transcription.
21. Protein is synthesized from the mRNA by translation.



Transfer RNA (tRNA)

Introduction

1. The tRNA is a ribonucleic acid which transfers the activated amino acids to the ribosomes to synthesize proteins.
2. It is smaller in size, so during centrifugation it remains supernatant.
3. Hence it is also called soluble RNA on supernatant RNA.

4. It serves as an adopter molecule to attach amino acids so it is called adopter RNA.
5. Holley worked out the nucleotide sequence of tRNA.

Structure

1. The tRNA is in the form of single polynucleotide chain having 5' and 3' ends.
2. This polynucleotide chain is folded on it self and attain the shape of clover leaf.
3. Due to folding the 3' and 5' ends present side by side.
4. The 3' end always ends in CCA base sequence.
5. This is the site for the attachment of activated amino acids.
6. The 5' end terminates in G (or) C.
7. The tRNA has 5 arms. They are

   a). amino acid receptor arm.

   b). D arm.

   c). Anticodon arm.

   d). Variable arm

   e). T Ψ C arm.

   1. Each arm is made up of a stem and a loop.
   2. But the amino acid acceptor arm has no loop the variable arm has no stem.
   3. tRNA molecules are synthesized at particular regions of DNA by transacription.
   4. The tRNA pickes up the specific and transferred to the ribosomes.

Ribosomal RNA (rRNA)

1. These are the ribonucleic acid present in the ribosomes and hence it is called ribosomal RNA.
2. It is otherwise called insoluble RNA.
3. It is single stranded polynucleotide chain.
4. In some times the single strand is twisted to form double helix.
5. The rRNA are classified into 7 types, according to this sedimentation co efficient. They are 28S RNA, 18S RNA, 58S RNA and 55 rRNA are presenting Eukaryotes.
6. 23 rRNA, 16 rRNA and 5 rRNA are present in prokarotes.
7. It plays a major role in protein synthesis.

Cell Cycle

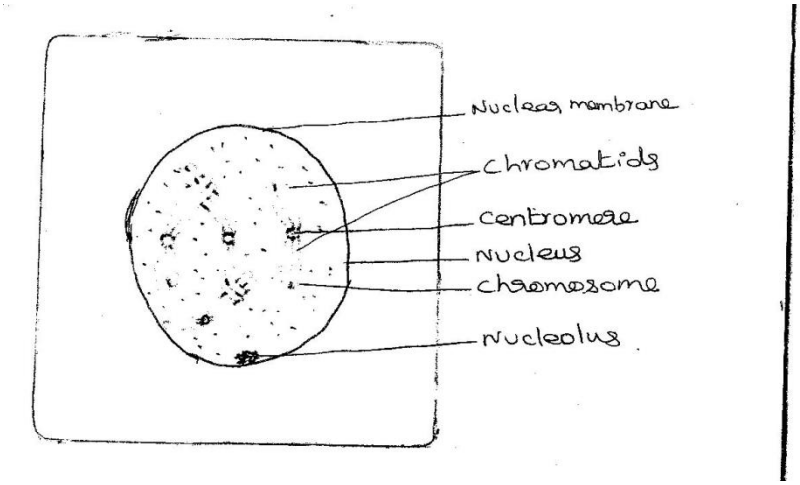
Introduction

1. The events occurring in the life of cell is called cell cycle.
2. There are two periods in the life of a cell.
3. They are
   1. inter phase. 2. mitotic phase.

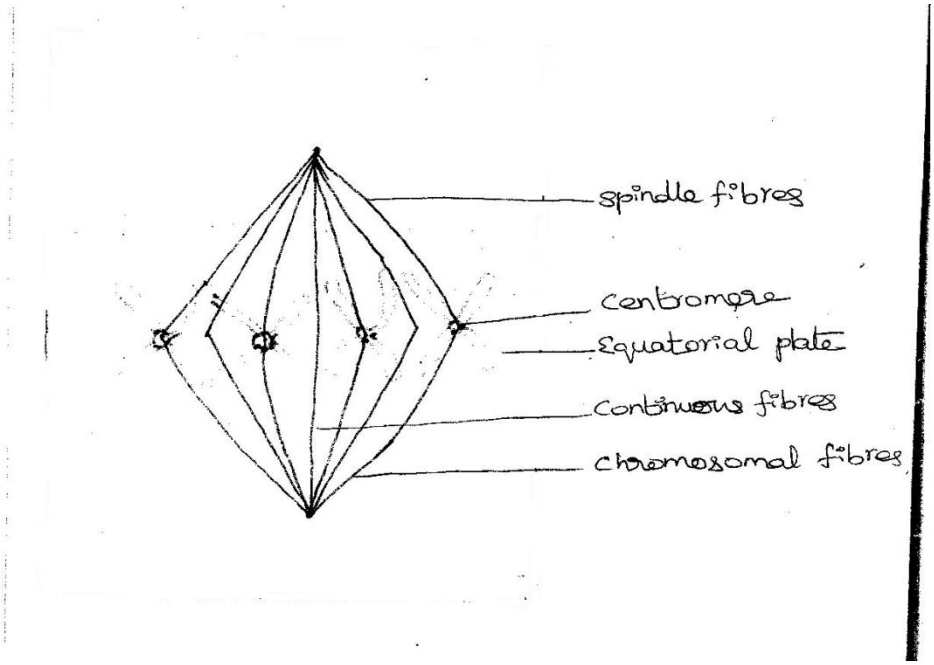
Inter phase

1. Inter phase is the stage between two divisions.
2. It is the resting – phase.
3. During inter phase, the cell grows, increases in volume and synthesizes RNA, DNA and proteins.
4. The cell undergo all the metabolic activities.
5. It has three sub stages like G1, S and G2.
6. G1 is the first growth phase which starts in the daughter cells resulting from mitosis.
7. S is the synthetic phase where DNA is synthesized.
8. G2 is the second growth phase which prepares the cell for the mitotic phase.

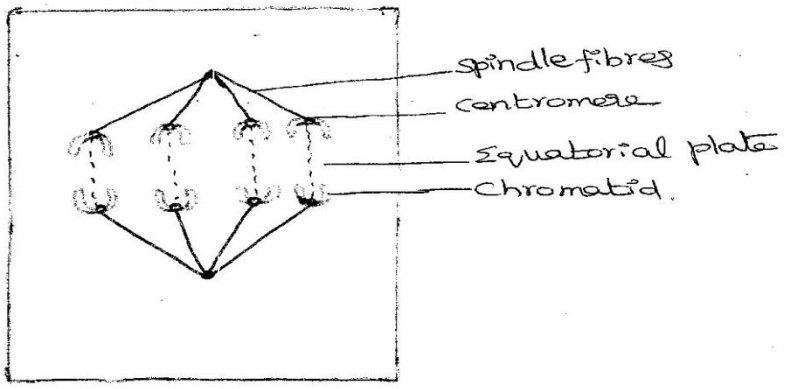
I. PROPHASE



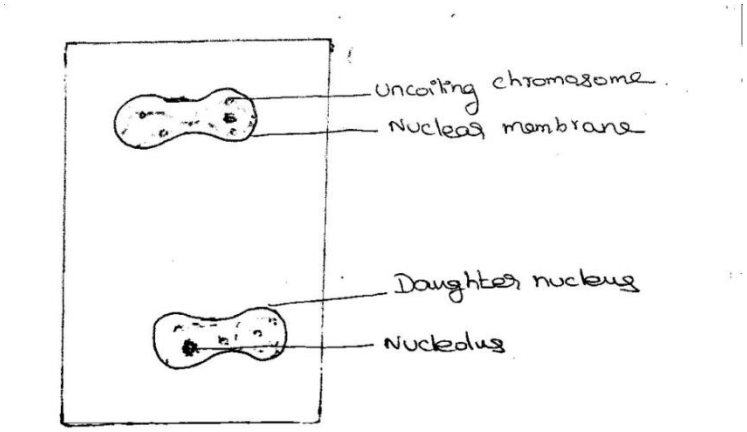
II. METAPHASE



III. ANAPHASE



IV. TELOPHASE



Significance of mitosis

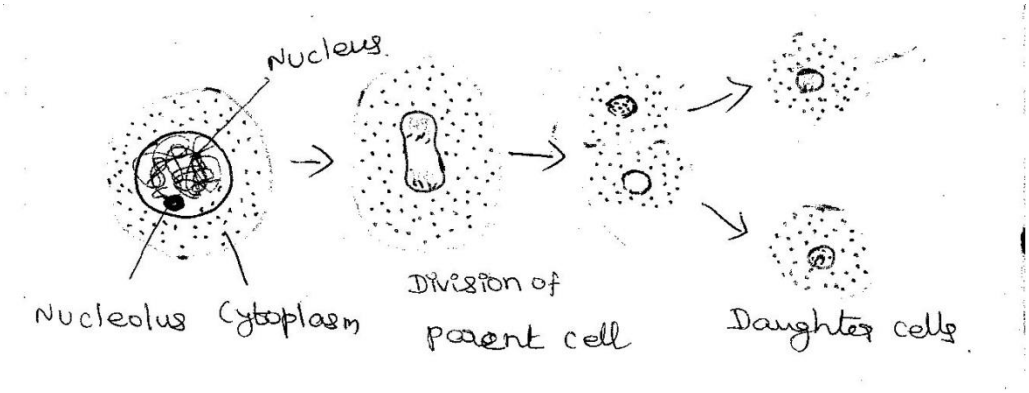
1. It helps to maintain the size of the cell.
2. It is essential for the growth and development of an organism.
3. Old and wound cells are replaced through mitosis.
4. It helps in the asexual reproduction of an organism.
5. It helps to repair the tissues.
6. Used to maintain the number of chromosome.
7. It helps in the maintenance of an equilibrium in the amount of DNA and RNA in a cell.

Cell Division

1. The Division of cells into daughter cells is called cell division.
2. The growth and development of every living organism depend on cell division.
3. There are three kinds of cell division.
    1. Amitosis (or) direct division.
    2. Mitosis (or) indirect division.
    3. Meiosis (or) reduction division.

I. Amitosis

1. It is the simplest mode of cell division and first described by Remak.
2. During amitosis, the nucleus elongates first.
3. Then a constriction appears.
4. This constriction deepens and divides the nucleus into two.
5. This is followed by the division of cytoplasm.
6. Finally two daughter cells results.



II. Mitosis

a. Mitosis is a process of cell division of a cell into two identical daughter cells having same number of chromosome and same amount of DNA as the parental cell.

b. It was first discovered by Fleming in 1879.

c. It occurs in somatic cells, hence otherwise called somatic cell division.

Mitosis consists of two events.

1. Karyokinensis. 2. Cytokinensis.

I. Karyokinensis

The division of nucleus during mitosis is known as karyokinensis.

It is divided into four stages.

1. Prophase.
2. Metaphase.
3. Anaphase.
4. Telophase.

I. Prophase

1. It is the first stage of mitosis.
2. The nuclear membrane disappears in the cytoplasm.
3. The chromosome become shortened and thickened.
4. Each chromosome is formed of two identical chromatids, connected by centromere.
5. The nucleolus starts to disappear.
6. Due to the disappearance of nuclear membrane and nucleolus, the chromosome present directly in the cytoplasm.

2. Metaphase

1. It is the second stage of mitosis.
2. The chromosomes are radically arranged at the equatorial plate.
3. Spindle fibres start and developing from the two poles of the cell.
4. Each spindle fibre is made up of 4 – 10 microtubules.
5. Some of the spindle fibres are attached with centromere, they are known as chromosomal fibres.
6. Some are extend from one pole to another they are called continuous fibres.
7. Due to the division of centromere, each chromatid has distinct centromere.

3. Anaphase

1. It is the third phase of mitosis.
2. The chromatids get separated.
3. These separated chromatids are more towards the opposite poles of the cell.
4. They become daughter chromosomes.

4. Telophase

1. It is the final stage of mitosis.
2. The spindle fibres break down and absorbed by cytoplasm.
3. The chromosomes begin to uncoil and lengthen.
4. The nucleolus begins to reappear.
5. The nuclear membrane develops around the chromosomes.
6. Thus two daughter nuclei are formed.

Cytokinesis

a. The division of cytoplasm is called ctoinensis.
b. It follows the nuclear division.
c. It is the process of segmentation and separation of cytoplasm.
d. The vesicles of golgi complex accumulates at the centre to form cell plate.
e. The cell plate become primary wall by the addition of pectin.
f. The new cell wall divides the cytoplasm into two daughter cells.

Meiosis

1. Meiosis is seen in the sex cells.
2. It produces 4 daughter cells, each having half the number of chromosomes.
3. So, it otherwise called reduction division.
4. It consists of

   (i). Meiosis I.

   (ii).Meiosis II and

   (iii).Cytokinensis.

I. Meiosis - I

1. It is also called reduction division.
2. It consists of

Prophase – I, Metaphase – I, Anaphase – I and Telephase – I

I. Prophase I.

1. It is the longest phase.
2. It consists of the following five stages.

(i). Leptotene

In this phase, the chromosomes appear as long, inter woven, thread like structures.

The nucleus increases in size and the nucleolus becomes prominent.

(ii). Zygotene

a. In this, the pairing of homologous chromosomes takes place.
b. They are held together tightly along their entire length and are called bivalents.

(iii). Pachytene

1. During Pachytene each chromosome splits longitudinally into two chromatatids.
2. But they remain attached at the centromere.
3. Now they are called tetrad.
4. At this time crossing over takes place.

(iv). Diplotene

1. In this stage, the paired homologous chromosomes start separating.
2. The separating chromosomes are attached at one (or) more points where the crossing over takes place.
3. These points are called chiasmata.
4. The chiasmata move towards the terminal ends, it is called terminalization.

(v). Diakinesis

1. The pair of chromosomes is completely free from each other.
2. The nuclear membrane and nucleolus disappear.
3. The spindle fibres start to appear.

II. Metaphase - I

a. The chromosomes get attached with the spindle fibres at centromere.

b. The bivalents are arranged in the equatorial region.

III. Anaphase – I.

1. The chromosomes of each bivalent separate and move towards the opposite poles.
2. It is due to the contraction of spindle fibres.
3. Here, the half of the chromosomes of the mother cell goes to one pole and the other half goes to opposite pole.
4. Hence, it is called reduction division.

IV. Telophase – I.

1. The chromosome sets reach opposite poles.
2. The chromosomes become slender coiled and less distinct.
3. The spindle fibres disappear.
4. Nuclear membrane and nucleolus reappear.
5. Finally two daughter nuclei with reduced number of chromosomes are formed.

Meiosis – II

After meiosis – I, the cell enters the second phase of division called the meiosis . II.

1. It is similar to mitosis.
2. So, it is also known as meiotic mitosis.
3. It consists of four phases.

I. Prophase – II.

1. The chromosomes become short and thick.
2. The nuclear membrane and nucleolus disappear.
3. The spindle apparatus is formed.

II. Metaphase – II.

a. The chromosomes get arranged on the equatorial plane.
b. The centromere of each chromosome splits, longitudinally, attached with the spindle fibres.

III – Anaphase – II.

1. Due to the contraction of the spindle fibres, the daughter chromosomes move towards the opposite poles.

IV – Telophase – II

1. The chromosomes form a cluster at the opposite poles.
2. Nuclear membrane and nucleolus reappear.
3. The spindle fibres disappears.

Cytokinesis

After, karokinesis, cytokinesis takes place. It occurs either by successive cell plate formation (or) simultaneous cell plate formation.

Significance of meiosis

1. Meiosis results in the production of haploid (n) gametes.
2. After fertilization it forms the diploid (zn) organisms. Hence it maintains the fixed number of chromosomes present in the somatic cells.
3. It helps in the formation of new combinations of characters during crossing over.
4. It results in the formation of four new cells having haploid number of chromosomes.
5. It is necessary part in the life cycle of sexually reproducing species.

A. THEORY OF INHERITANCE OF ACQUIRED CHARACTERS (LAMARCKISM)

(I) Brief biography of Lamarck

Jean Baptiste Lamarck (1744-1829), who proposed the theory of inheritance of acquired characters or also popularly known as "Lamarckism", was a French biologist. Lamarck began his career as a botanist but later became a zoologist. He was really holding a position of zoologist in Jardin des Plantes (an institute of general biology and not a botanical garden as the name might suggest). Although his name at present is associated with this theory only, but he undertook extensive studies of animals, finally classifying the animals into vertebrates and invertebrates. Although Lamarck's views on evolutionary mechanism are outmoded now, he still occupies a very important

place in the history of evolutionary though. He was the first person to conclude that evolution is a general fact covering all forms of life, and it was in order to explain this fact that he proposed his theory which unfortunately could not stand the test of time.

Among the numerous writings of Lamarck, there are three which particularly express his theory of evolution. These are recherches surle organisation des corps vivant (1802);philosophic zoologique (1809);and historie naturelle des Animaux sans vertebras(1815-1822). He surveyed the whole organic world of life and recognized the fact that a species is a dynamic entity. This was later confirmed by Charles Darwin also.

[II] Postulates of Lamarckism

Lamarcks thought that the environment will influences the morphological characters and these changes will be inherited to the next generation. Following are the four important postulates on which Lamarck's theory of the inheritance of acquired characters is based-(i) living organisms and their component parts continuously tend to increase in size,(ii)new organs will be produced due to new need and due to the movement, which the individual will start and maintain due to such a need. (iii) The development and degeneration of organs will be based on use and disuse respectively. (iv)The modifications which are produced due to, the above three principles will be inherited by the off springs and consequently such changes will accumulate in course of time.

In order to support his theory, Lamarks used examples like long neck of giraffe, limblessness in snakes, webbed feet of ducks, blindness of moles and also dimorphism of submerged and aerial leaves in aquatic plants. A large number of similar examples can be given. As a matter of fact, all changes in morphologycan be explained on the basis of desire and need and the use and disuse. To elaborateh this point, if the example of giraffe is discussed, the long neck and high shoulders can be explained as follows. These individuals perhaps were like other mammals, but were living under dry conditions, where trees are tall and leaves are away from ground the animals had to stretch their necks for getting food. When the leaves on lower branches were eaten, they had to further stretch their necks to get the food. Therefore, due to need and response, the shoulders grew higher, and neck longer such a change was inherited and was cumulative from generation to generation.

[III] Analysis of Lamarck's postulates

After having published his theory in 1802, Lamarck courageously defended it throughout his life. However, it was criticized during his lifetime

and afterwards. We may perhaps consider the four postulates of Lamarck one by one and analyse the evidences for and against these postulates.

1. The first postulate suggests a tendency for increase in size. While the evolutionary trend in certain groups may be associated with increase of size, there are a number of cases, where evolution proceeded not only without any increase in size but rather through a reduction in size. In several groups of plants such a reduction in size can be seen. Many ferns and conifers which became extinct were gigantic trees and then more highly evolved flowering plants are really much smaller in size.

2. The second postulate suggests that new needs and desire and efforts in this direction will lead to the development of the needed structures. This would mean that in case we need to fly, we will have wings in course of time or else in case we need eyes on the back, these should develop untimely. These may be very crude examples but we know that certain species would not become extinct, if changes could be brought about due to new needs in the new environmental conditions.

3. The third postulate suggests that organs will develop due to use and degenerate due to disuse. Such a postulate may be correct as for as the growth of an organ within the lifetime of an individual is concerned. For insistence, it is a common observation that if muscles are put to use these would develop. However, this postulate has a meaning in evolution only when read along with the fourth postulate and we will see that the fourth postulate could never be proved true through experimental evidence.

4. The inheritance of the characters acquired during the life time of an individual is the fourth postulate and is an essential requirement, if the modifications produced due to changes in environment have to have an evolutionary significance. All serious experiments performed to test this postulate gave negative results with the possible exception of McDougall's experiments on rats; Weismann was perhaps the first person who for the first time made a definite distinction between heritable changes and those which can not be inherited. Some details of Weismann's experiments and ideas and those of McDougall's experiments will be presented in this section.

(a) Weismann's experiment.

Weismann performed some experiments to test if characters may disappear due to disuse. This he did by experiments which hardly involve disuse, but should rather be called mutation. He had cut the tails of mice and continued such operations for more than 20 generations to see if this has any effect on tail length. As expected but contrary to what Lamarck's fourth postulate should suggests, no reduction in tail length was recorded.

Weismann on the basis of above experiment attacked the theory of inheritance of acquired characters and proposed his theory, popularly known as germplasm theory. In this theory, Weismann proposed that the body of an individual can be divided into two parts, the germplasm and the somatoplasm and that only those characters will be inherited by the progeny which are located in the germplasm. The characters in the somatoplasm will not be inherited. This is true with most of Lamarck,s acquired characters also.

(b) McDougall's experiment.

McDougall conducted learning experiments in rats and from the results obtained he tried to suggest that learning as an acquired character can be inherited. His experiment consisted of rats, dropped in a tank of water having two exit holes. One of these holes had light and would give electric shock and the other one was dark and had no lelectric shock. Not always the same hole had the light, so that the rats had to learn that they should always go out through the dark exit hole. Although it was natural to expect that rats in their lifetime would learn it, McDougall showed that offsprings learnt it much more quickly, thus suggesting that learning habit is inherited.

The objections against McDougall's experiments are many. It is suggested that genetic constitution of rats was not controlled. Moreover, in the progeny of control rats not subjected to these learning tests, the learning habit was found to change the same was as in the treatments. Therefore, it was suggested that some unanalyzed changes in the technique may be responsible for the recorded increase in the speed of learning.

Most serious objection to McDougall's experiments is that the same experiments repeated in other laboratory never gave similar results.

We may perhaps also consider some natural cases disproving the inheritance of acquired characters. A regular practice of shoe binding in Chinese to keep small size of feet as a beauty has not resulted in any decrease in the size of the feet over hundreds of generations. Similarly, a practice where Jewish boys are circumcised for thousands of year has never led to any reduction of the prepuce among Jews. Hundreds of such examples can be cited.

Neo-Lamarckism

Future followers of Lamarck tried to modify Lamarckism in order to make it acceptable. It was mainly based on the idea of adaptation and on an intimate direct and causal relationship between structure, function and environment. Prominent Neo-Lamarckians are French Giard (1846-1908) and American Cope (1840-1897). They thought that although the necessity may not be logical, but that there would be a causal relationship between structures,

function and the environment was desired by Lamarck and a tendency towards perfection which was a central thesis of Lamarckism was omitted in Neo-Lamarck's thought.

The use and disuse of Lamarck's postulates was retained in Neo-Lamarckism. The major error in Lamarckism as well as Neo-Lamarckism is that both assumed the inheritance of acquired characters. While in Lamarckism these acquired characters result from needs, according to Neo-Lamarckism these will be induced due to environment and habit. The emphasis on structure-function-environment in Neo-Lamarckism definitely suggested that forces of evolution must integrate these three aspects.

B.THEORY OF NATURAL SELECTION (DARWINISM)

[1] Brief biography of charles Darwin

The autobiography which Charles Drawin wrote for his children gives some idea of Darwin's attitude towards nature, and also of the basis on which Darwin built his Natural Selection theory. This, brief biographic sketch is based upon the autobiographic account given by Charles Darwin himself.

Charles Robert Darwin(1809-1882) was born on February 12, 1809 in England. His father Robert Waring Darwin practiced medicine at shrewsbury, England and Charles Darwin had his early education there. He had great love for dogs and would hunt birds, so that his father was rather dissatisfied with his interest in studies.

After his school education, Darwin was sent to medical school at Edinburgh in 1825. he did not find any interest in medical studies and after two years he discontinued. His father then suggested him to become a clergyman, which appealed him. Since it was necessary to have a degree for this position, Charles Darwin enrolled himself for a degree at Cambridge in 1828 and graduated in 831. Although this period was also considered a waste by Darwin, he came in contact with some eminent persons, at Edinburgh as well as at Cambridge. Most important of these persons was Dr. Henslow, a botanist at Cambridge.

It was with Dr. Henslow that Charles Darwin later had the privilege of going in a voyage of exploration on the famous H.M.S. Beagle. Since Henslow was asked to nominate a young scientist for this voyage, he nominated Darwin and Darwin's father allowed him to accept this assignment ultimately with some difficulty. The ship left on December 27, 1831 and visited man islands of the Atlantic Ocean, some coasts of South America and some islands of South Pacific, of which Galapagos Islands are the most important. Darwin took extensive notes and collected a lot of material during his visit and on returning

published a large number of books. Beagle finally returned on October 2, 1836 after five years.

In 1839, Darwin published his Journal of Researches. He also got married in 1838 and later had two daughters and five sons. From 1838 to 1841, Darwin was secretary of Geological Society, where he came in contact with a topmot geological Lyell. Due to poor health, in 1842 Darwin moved from London to Down, where he lived in seclusion and produced a large numbers of books.

Darwin's ideas on natural selection resulted from a reading of an essay, Malthus on population, in 1838. This suggested him that a struggle for existence among plants and animals would ultimately lead to natural selection of those which were the fittest. However, Darwin first wrote his theory in 1842 after having collected more data and expanded it to a manuscript of 230 pages in 1844. After completing his work on Cirripedia in 1854, Darwin devoted all his time to the writing of Origin of Species. However, in 1858 he received a short essay entitled "On the tendency of varieties to depart indefinitely from the original type" from a young English naturalist, Alfred Russel Wallace (1823-1913). Wallace sent this essay for Darwin's advice. Since Darwin thought well of Wallace's work, Darwin's work was jointly published with JWallace's paper in the "proceedings of the Linnean society" in 1859. Portions of Darwin's letter to Asa Gra (a great American botanist) written in 1857 were also published, since this letter contained Darwin's views on natural selection and the origin of species.

Darwin died on April 19, 1882, when he was 73.

[ii] Postulates of Darwinism

Darwinism is based on three important postulates, namely, (i) Multiplication of individuals of a species in a geometric proportion, (ii) existence of variations, and (iii) the operation of natural selection on the existing variability in order to select the best fitted variations. Of these postulates perhaps natural selection is the most important, so much so that certain workers consider natural selection to be the whole of Darwinism. It should however, be very clear and should be emphasized here that although natural selection forms the most important part of Darwinism or natural selection theory, but it is not the only part of this evolutionary theory. The three postulates outlined above will be briefly discussed separately.

1. Prodigality of nature

Nature is rather prodigal so far as the multiplication through reproduction is concerned. Darwin attached some importance to this feature. We know that a salmon produces 28,000,000 eggs in a season and an oyster

produces 114,000,000 eggs at a single spawning. If such an immense number has to survive and reproduce in each generation, the population of an individual species will increase in a geometric proportion, so that the food and space will soon fall short of the requirement.

Due to geometric multiplication and due to the availability of limited food and space for these individuals, the struggle for existence in inevitable. This struggle ma take different shapes including living in adverse conditions of climate and obtaining their share from limited supply of food and space for which there is strong competition. Since the requirement of the members of the same species would be similar, such a struggle would be more intense among the members of the same species, although interspecific struggle cannot be ruled out.

2. Variations

Variation is a rule of nature and is a common observation, so that we find that no two leaves of a tree or no two peas in a pod are visibly similar. With perhaps the possible exception of identical twins, no two individuals of a species can show complete identity. Even identical twins would differ if placed under two different environments. Sometimes, a whole population may show a definite pattern of variation differentiating it from other populations of the same species. These are called subspecies by taxonomists and were called "incipient species" by Darwin. Such "incipient species" will attain the status of a species in course of time and this is how origin of a new species due to variations is brought about according to Darwin.

Darwin recognized two principal kinds of variations (a) continuous variations showing the whole range of variation in a particular character, and (b) discontinuous variations which appear all of a sudden and show no gradation. These second classes of variations were sudden and show no gradation. This second class of variations were called as sports, which were later called "mutation" by de Vries. These were considered by Darwin to be of no significance for evolution. Darwin thought that it is the continuous variations only which are important for evolution, because such variations will be selected if useful and will attain perfection rather gradually. Discontinuous variations will appear suddenly and will mostly be harmful and, therefore, will not be selected again. The appearance of dinosaurs, which become extinct due to their enormous size, and similar other examples were explained by Darwin as the result of discontinuous variations or "sports". On the bases of natural selection if a character develops gradually, it will not be selected by nature. On the other hand, examples like long neck of giraffe were explained by Darwin on the basis of continuous variations operated upon by natural selection.

3. Natural selection

Natural selection is the principle element of Darwin's theory. Darwin suggested that any variation which helps the individual possessing it will tend to be preserved. The principle by which this preservation of useful variation is brought about was called natural selection by Darwin. However, spencer often used another phrase, survival of the fittest, which is considered to be more appropriate.

[iii] Theory of pangenesis

Darwin realized that for understanding of evolution, an understanding of the mechanism of heredity was essential. He although did not accept Lamarck's idea of inheritance of acquired characters but had not come across Mendel's important work on pea published long before Darwin's death. This is why Darwin in the last chapter of his book, origin of species, stated that the fundamental principles of heredity were still unknown. Therefore, in order to explain heredity on the basis of a hypothetical model, Darwin proposed his theory of pangenesis. According to this theory all organs of an individual produce pangenesis, which are minute particles carrying information about the organs. The pangenes traveling through the blood stream will ultimately reach the gametes, so that each gamete will have pangenes from each of the different organs. After zygote formation, the pangenes tend to form the same organs from which these pangenes were produced. This theory is nothing more than Lamarck's theory of inheritance of acquired characters and therefore was later discarded.

[iv] Neo-Darwinism

Neo-Darwinism is a modified form of Darwinism. However, one should be very clear ass to what we mean by Neo-Darwinism. There are workers, who believe (like Dodson did in his book Evolution: Process and Product) that the modern synthetic Theory of evolution is really Neo-Darwinism. These workers include, in the concept of Neo-Darwinism, the views and works of scientists like sewall wright, Th.Dobzhansky, G.L. stebbins and Julian Huxley. On the other of hand, there are workers like simpson, who in his book The Meaning of Evolution, warns that the modern synthetic theory should not be confused with Neo-Darwinism. He feels that the term Neo-Darwinism was long associated with the work of Weismann and his followers, whose theory of evolution was very much different than the modern synthetic theory of evolution. However, some of these workers, who are responsible to develop the modern synthetic approach for evolution, did call this synthetic theory as Neo-Darwinism. Therefore, it is desirable that the readers be familiar

with Neo-Darwinism in the broader sense of synthetic approach is universally accepted, in the weismannian approach it had to be modified.

Neo-Darwinism and Weismann.

Weismann and his followers rejected Darwin's theory except the principle element of natural selection. These Neo-Darwinians, although distinguished between germplasm and somatoplasm, they could not appreciate the role of mutations in evolution. Darwin thought that the adaptations result mainly b a single source i.e.natural selection. Neo-Darwinians, on the other hand, thought that adaptations result from multiple forces and natural selection is perhaps only one of these many forces. It was also realized by the Neo-Darwinians that the characters as such are not inherited but that there are character determiners which control only the development. The ultimate character will result due to the interaction of the determiners, activity of the organism and the environment during development.

Such a Neo-Darwinism was incomplete and partly wrong also due to the missing information which was later supplied by geneticists in the present century. Neo-Darwinism in the context of modern synthetic theory of evolution will be discussed at the end of this chapter, after a full account of "Mutation Theory" of Hugo de Vries is presented.

Aims of plant breeding

The first and foremost aim in plant breeding is to create useful variation in the crop plant. This can be achieved by the following measures.

1. Bringing wild food crops to cultivation. (Wheat, oats and many cereal crops were once wild plants which had now been domesticated).
2. Obtaining genes from desirable plants or related species (eg.as seeds from various parts of the world).
3. Introduction of plants from nearbyregions or even from other countries for improvement of the crop. (eg.cauliflower, tomato, potato andsoyabeans).
4. By employing certain plant breeding techniques, new varieties are developed. Eg. Maize, sorghum, cotton and sunflower.
5. Auto and Allopolyploid breeding.
6. By inducing mutations using physical and chemical mutagens.
7. Production of haploids by the application of plant tissue culture of anther and overy.
8. Improvement of nutritional quality by genetic engineering (eg.Fortified rice – iron rich rice and carotene rich rice).
9. Development of disease, drought and environmental stress resistant varieties.

Aspects of plant breeding

Present day crop plants are from wild species reared by careful domestication, cultivation and management. We have several wild varieties existing in nature just as in the case of salinity tolerance could be cloned in a rice variety. In such of those areas where shortage of fresh water exists, rice can be cultivated using seawater and can even be grown in extreme saline soil. Similarly, we need many more such wild plants showing increased capacity to extremes of climatic conditions and disease resistance for plant breeding programmes. In order to safeguard the biodiversity and certain important valuable crops from going into extinction, scientists are protecting these crops by establishing gene or germplasm banks by preserving their seeds.

Selection

It is one of the oldest procedures in which individual plants or group of plants are sorted out from mixed population, thus eliminating undersirable ones. Selection methods are of two types – mass selection and pure line selection.

Mass selection

In this method, plants are selected based on their desirable morphological characters (phenotype). Their seeds are composite or mixed and the progenies are grown in masses. They are not individually tested. After repeated selection for about five to six years, selected seeds are multiplied and distributed to farmers. The only disadvantage of mass selection is that it is difficult to distinguish hereditary variation from environmental variation.

Pure line selection

A pure line is a collection of plants obtained as a result of repeated self-pollination from a single homozygous individual. Hence, a variety formed by this method shows more homozygosity with respect to all genes. One disadvantage is that new genotypes are never created by this method. Genetic variability is essential for adaptations in different environmental and seasonal conditions.

Clonal selection

Crops like sugarcane, potato, tea, banana and certain species of grasses are asexually propagated and produce very poor seeds. Based on their phenotypic appearance,l the method of clonal selection is employed to select improved variety from a mixed population (clones) Selected plants are multiplied through vegetative propagation to give rise to a clone. The genotype of a clone remains unchanged for a long period of time.

Introduction

India has several varieties of crops such as maize, tobacco, tomato, potato and brinjal which were introduced from countries such as America, China and Australia. Introduced varieties sometimes do not get adjusted easily with our local environment. It takes some time for these introduced crops to settle sometimes, it is essential to select suitable and desirable variety from the introduced plants. For example, a mung *Phaseolus aureus* variety was introduced from China but was not giving good yield and produced dull coloured seeds. From amongst the introduced mung crop, a plant suddenly produced large and bright coloured seeds. This aspect may be due to sudden mutation. This variant plant was selected and further subjected to inter or intra specific crosses with our native crop. In this way, new varieties were produced and released as newly developed mung variety. Such a mung No.1 variety is now being cultivated in Punjab.

Introduction is a method in plant breeding to improve the native crops by obtaining diverse genotypes that can be used as a source material for collection of crop with desirable characters and genes obtained from many parts of the world. It involves crossing of two varieties or species or genera having desirable genes and breeding them together of the desirable traits into one progeny, which is called the hybrid, Hybrids are the products of first generation obtained by crossing genetically unrelated parents.

When two individuals of the same species are crossed, it is called inbreeding or selfing or self-pollination. This results in the increase of homozygosity. Particularly homozygous recessive alleles develop loss of vigor in plants. By careful observation of morphological features, we can remove these deleterious and harmful alleles by selection.

Protoplasmic fusion or somatic hybridization

A hybrid produced from fusion of protoplasts of two different species is called somatic hybridization. Naked protoplastis are obtained through dissolution of their cell walls by the macerating encymes such as pectinase and cellulase. Fusion of protoplasts from two different varieties can be enhanced by treatment with the chemical called polyethylene glycol (PEG) in the presence of high voltage electric current on a suitable medium. By this method somatic hybrid plants with desirable changes can be obtained. This method in plant breeding is called protoplasmic fusion. This concept had been studied by you already in the chapter four.

Heterosis

The superiority of the F_1 hybrid in performance over its parents is called heterosis or hybrid vigour. Vigour refers to increase in growth yield, resistance to diseases, pests and drought. F1 hybrids of maize show 25% increase in yield when compared to their own parent crop. Vegetative propagation is the best suited measure for maintaining hybrid vigour, since the desired characters are not lost and can persist over a period of time.

Polyploid breeding

The source for plant breeding is variations in plants. Heritable and desirable variations occur in nature by mutation, polyploidy, recombination and chromosomal aberrations. A diploid plant has two sets of chromosomes but any organism in which the number of sets of chromosome is doubled is called a polyploid.

When chromosome number is doubled by itself in the same plant, it is called autopolyploidy. For example, three sets of chromosomes i.e. a triploid condition in sugar beats, apples and pear has resulted in the increase in vigour and fruit size, large root size, large leaves, flower, more seeds and sugar content in them. Seedless tomato, apple, watermelon and organge are autopolyploids.

Polyploidy can be induced by the use of colchicines to double the chromosome number. Allotetraploids are produced by multiplication of chromosome sets that are initially derived from two different species. Eg. *Triticum x Secale gives Triticale*

The haploid individual plant will have only one set of chromosome. Through the technique of anther and ovary culture, haploid plants can be modified todiploid ones by doubling their chromosomes. Variations that are brought forth through plant tissue culture are called somoclonal variation. Eg. Disease resistant potato and rust resistant wheat. Varieties of short duration sugarcanes are produced by polyploid breeding.

Mutation breeding

Radiation induces mutation to develop new variety of crops. Now with newer and more powerful sources of raditations (UV shortwave, Z-ray,Alpha, Beta, Gamma waves) and many chemicals (mutagens) eg. Caesium, ethyl methane sulfonate, nitromethyl urea), we can increase the rates of mutation eg. Triple gene dwarf wheat with increase in yield and height. Atomita 2-rice with saline tolerance and pest resistance, groundnuts with thick shells are products of breeding methods through induced mutation.

Breeding for disease resistance

Many crop plants suffer from several diseases caused by pathogens such as bacteria, fungi, viruses, nematodes, protozoa and mycoplasma. In vegetatively propagated plants like potato, cassava, sugarcane and dahlia, viral pathogens are transmitted through their roots, tubers, bulbs and rhizomes. Disease free plants are obtained by shoot apical meristem culture technique. Plants raised through tissue culture are free from pathogens, which are widely cultivated.

Whenever, a trait that show disease resistance in a plant is observed, the best way to transfer that trait to other useful crop is by the method of backcross Repeated back crosses are attempted with the parent crop with more desirable characters and such a crop is known as recurrent parent. For example, A is a non-recurrent parent and B is a recurrent parent with desirable trait.

A x BC x BD x B E x B F x B

↓ →↓ → ↓ → ↓ → ↓

C D E F G

* desirable disease resistance with disease resistance

Genetic engineering

Genetic engineering will enable the plant or animal breeder to select the particular gene from one plant and then place the same gene into another plant for it to express its desired character. Today, genetic engineering is widely employed as a tool in modern crop improvements. Recombinant DNA technology, popularly termed ‘gene cloning’ or ‘genetic engineering’ offer unlimited opportunities for creating new combination of genes that at the moment do not exist under conditions. Genetic engineering can be defined as the formation of new combinations of heritable material by the insertion of foreign nucleic acid-molecule from other sources.

The foreign genes are generally incorporated into a host organism either through a bacterial plasmid or a virus, which acts as vectors (vehicular traffic). Genes are compared to biological software and are the programs that drive the growth development and functioning of an organism. By changing the software in a precise and controlled manner, it becomes possible to produce desired changes in the characteristics of the organisms eg. *E.coli* is made to

produce human insulin by introduction of human insulin producing gene into bacterial plasmind.

Genetic engineering is a tool used in modern crop improvement programs. Its objective is to isolate and introduce a gene or genes into a crop plant that normally does not possess them. Addition of genes or DNA (foreign genes) from one plant or a microbe to another plant is called transgenic plant. Herbicide resistance, saline resistance, altered flower colour, improved protein quality and protection against viral infection are few examples of recently formed transgenic higher plants by using this technology eg. *Nicotiana, tomato, potato, sunflower and apple.*

Improved varieties

Improvement of a crop lies in its genetic makeup and the environment in which it grows and interacts. An improved variety is one that is superior to other existing varieties in one or few characters. It may show high yield than other varieties, early maturity, and disease and pest resistance. A new improved variety is developed by continuous breeding experiments as described above under various methods. By making use of modern technologies, like biotechnology, Tissue culture and conventional breeding methods new improved crops are obtained with desirable characters that suits well to the existing environment without polluting or altering it is any way. In order to release a newly created variety it takes nearly 12 years involving extensive field trials, naming and multiplication.

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