12 Dec, 2019

Cell Wall

Primary Cell.

- The first form cell wall is also known as cell wall.
- It is outermost layer of cell.
- It is comparatively thin membrane.
- Some plant contain cutice and make it semi-perm.

Secondary Cell.

- The primary cell wall is followed by secondary cell wall.
- It is thick and lies near the plasma membrane or tertiary cell wall.
- It's composed of 3 concentric layer - S_1, S_2, S_3. which occur one after another.

Tertiary cell wall.

- In certain plant cell three occur another cell wall.
- It is differ form Primary and Secondary cell wall with its morphology, chemical, nature and retaining Property.

Function.

- The main function of cell to provide chemical support to plant cell.
- Dspite its strength the plant cell wall is fully permeable to water and solute.

- On the primary cell wall the dignification occur and
- Being impermeable it does mainly a function.
- Mechanical strength due to ligno cellulose composition.
- It transport water and salt since dignifiane involve loss of protoplast resulting in formation of hollow H_2O proof tube.

14 Dec, 2019

Cell Organelles.

CELL

The Cell is the basic unit of organization or structure of all living matter. It is the structural and functional unit of life and are responsible for keeping a organism alive and functioning. They are also known as Building Block of life. The study of cell is known as Cytology.

Cell was discovered by a British Scientist, Robert Hook in 1665.

The Cell Theory States that:

All Organisms are made up of one or more cells and the products of those cells. All cells carry out life activities (require energy, grow have a limited size). New cells arise only from other living cells by the process of cell division.

Prokaryotes
- PPLO
- Blue Green algae

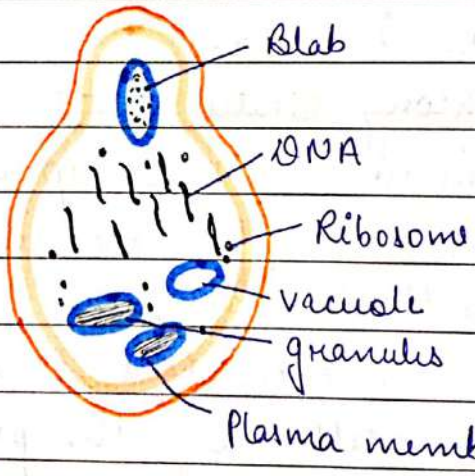
Eukaryotes.
- Plant Cell.
- Animal Cell.

1. Prokaryotes.

Pro = Primitive And Karyon = Nucleus.

- Primitive nucleus cells are the most primitive cells from the morphological point of view.
- Prokaryotic Cell is one envelope system organism.
- It consist of central nuclear component like DNA and RNA and nuclear protein surrounded by cytoplasmic substance with the whole enveloped by a Plasma membrane.

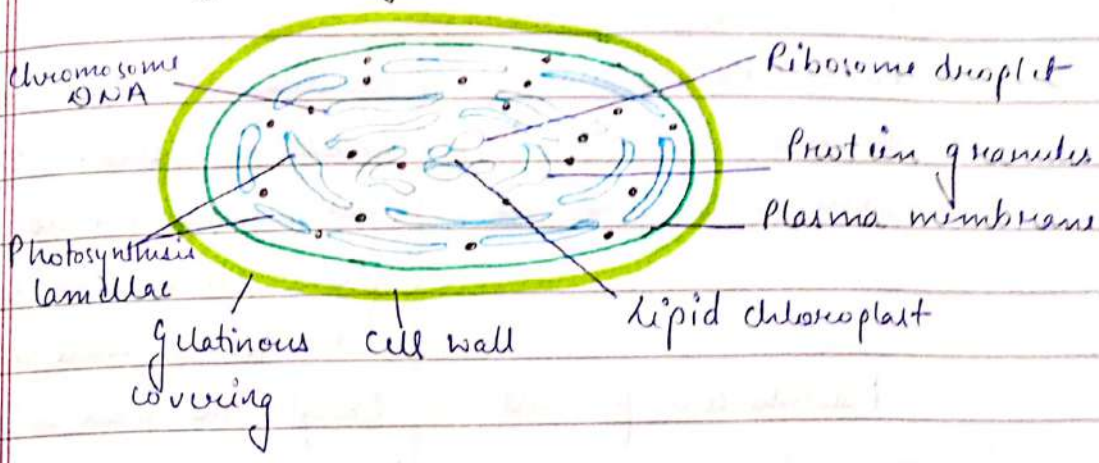
★ PPLO [Pleuro Pneumonia like Organism]



Structure of PPLO.

- The PPLO are bactria like organism which differ with later only in lacking the cell wall and mesosomes, small size and deformable P.M.
- The diameter of the smallest PPLO are 0.1-0.3 μ.
- E.g: Mycoplasma gallisaptiucm (0.25 μ).

★ Blue - Green Algae.



- Ribosome present → Protein Synthesis.
- The Blue green algae form another group of Eukaryote which include about 200 species.
- Resembling bacteria in many details. this is unicellular and grow as single separate cell.
- The cells of Blue green algae through lacks cilia and flagella but have the capacity to movement by gliding or rotatory movements.

2. Eukaryotes.

Eu = True And Karyon = Nucleus.

- They are essentially two enveloped system.
- Secondary membrane envelope, the nucleus and other internal organelles.
- Eukaryotic cells are the True cells, which occur in plants (algae to angiosperm) and the animals (Protozoa to mammalia).
- The Eukaryotic cells have different shape, size and physiology. But all the cells have typically composed of ER, Ribosomes, mitochondria, G.B.

Plant Cell	Animal Cell.
• Plant cells are larger than animal cells!	Animal cells are generally small in size.
• Cell wall is absent.	The plasma membrane of plant cell is surrounded by a rigid cell wall of cellulose
• Plastids are present.	Except the protozoan Euglena no animal cell possesses plastids
• Most mature plant cells have a large central sap vacuole.	Vacuoles in animal cells are many and small.
• Plant cell lack centrosome and centrioles.	Animal cells have centrosome and centrioles.

Plasma Membrane.

A Plasma membrane encloses every type of cell, both prokaryotic and Eukaryotic cell. The plasma membrane is also called Cytoplasmic membrane, Cell membrane or plasmalemma. The term cell membrane was coined by C. Nageli and C. Cramer in 1885 and the term plasmalemma has given by J.Q. Plowi in 1931. In plant cells, plasma membrane occurs just inner to cell wall, bounding the cytoplasm. The plasma membrane exhibits a tri-lamar (i.e, three-layered) structure with a translucent layer sandwiched between two dark layers. At molecular layer, it consists of a continuous layer of bilayer of lipid molecule (i.e phospholipids and cholesterol) with protein molecules embedded in it or adherent to its both surface. The plasma membrane of most cells vary from 100 to 250 Å. The intestinal epithelium plasma membrane have 105 Å thick. It is composed of an outer or inner dense layer of 14 Å thick and middle layer is 25 Å thick. The unphasised plasma membrane has 250 Å thick. It is fluid like.

Functions of Plasma Membrane.

The plasma membrane acts as a thin barrier which separates the intra-cellular fluid or the cytoplasm from the extra-cellular fluid in which the cell lives. In case of unicellular organisms the extra-cellular fluid may be fresh or marine water, while in multicellular organisms, the extra cellular fluid may be blood, lymph or interstitial fluid. Though the plasma membrane is a limiting barrier around the cell but it performs various important physiological functions which are as follows-:

★ **Permeability:**

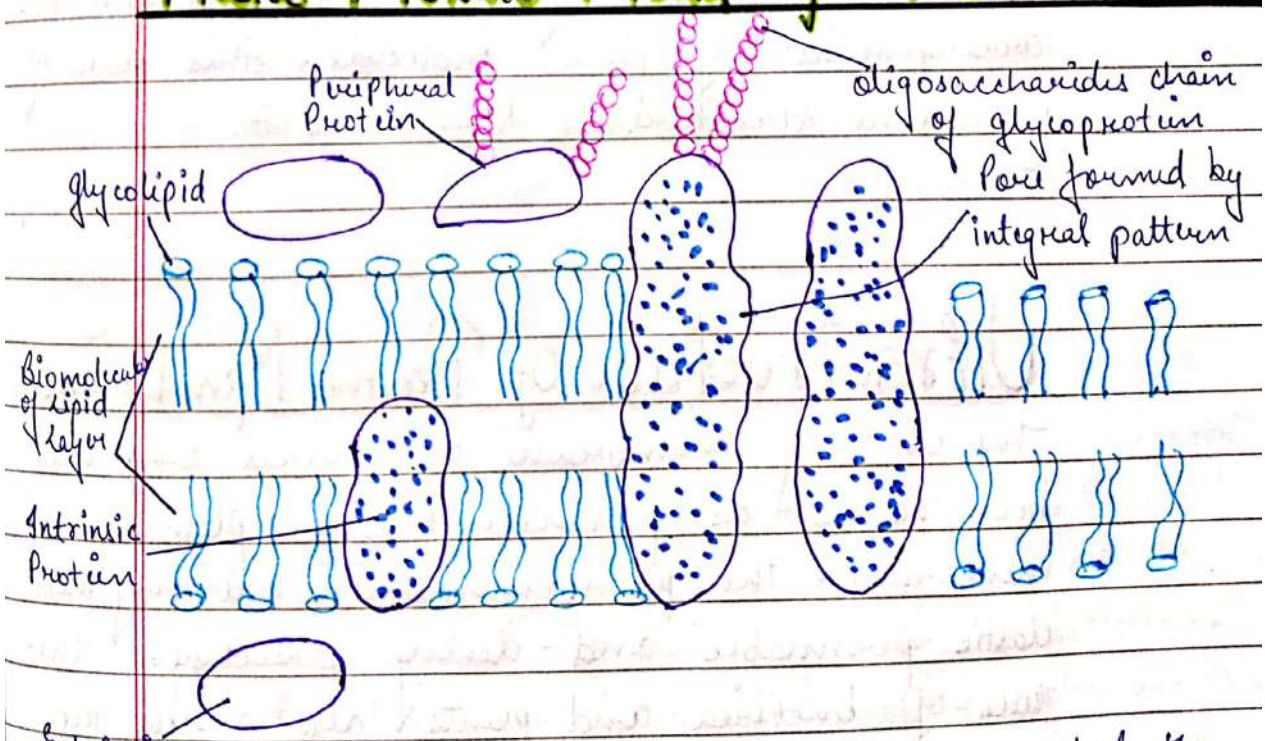
The plasma membrane is a thin, elastic membrane around the cell which usually allows the movement of small ions and molecules of various substance through it. This nature of plasma membrane is termed as permeability. According to permeability following types of plasma membrane have been recognized:-

- **Impermeable Plasma membrane:** The plasma membrane of the unfertilized eggs of certain fishes allows nothing to pass through it except the gas.
- **Semi-permeable plasma membrane:** The membranes which allow only water but no solute particles to pass through them.
- **Selective permeable plasma membrane:** The plasma

membrane and other intra-cellular membrane are very selective in nature.

- **Dialysis Plasma membrane:** The plasma membrane of certain cells have certain extraneous coats around them. The basement membranes of endothelial cells are the best example of extraneous coats. This type of plasma membrane having extraneous coats around it, acts as a dialyzer. In these membranes the water molecules and crystalloides are forced through them by the hydrostatic pressure forces.

Fluid Mosaic Model of Plasma Mem.



S.J Singer and G.L Nicolson suggested the widely accepted fluid mosaic virus model of Biological membrane. According to this model the plasma membrane contain the biomolecular

lipid, both surface of which are interrupted by protein molecule. Protein occur in form of globular molecule and they are dotted here and there is a mosaic pattern. Some proteins are attached at the polar surface of the lipid they called Extrinsic and while others are integral proteins, either partially penetrate the layer of lipid entirely through stick out on both sides called Trans-membrane Proteins. Further the peripheral protein and those parts of the integral proteins that stick on the outer surface (ectoproteins) frequently contains chains of sugar or oligosaccharides (they are glycoproteins). On account of fluidity of this model and the mosaic arrangement of protein molecule, this model of membrane structure is known as Fluid Mosaic Model.

Ultrastructure of Plasma Membrane.

The limiting membrane of animal cells has been named as plasmalemma or plasma membrane. The plasmamembrane is very thin elastic permeable and living structure. The cells of bacteria and plants also posses the plasma membrane between the cell wall and Cytoplasm.

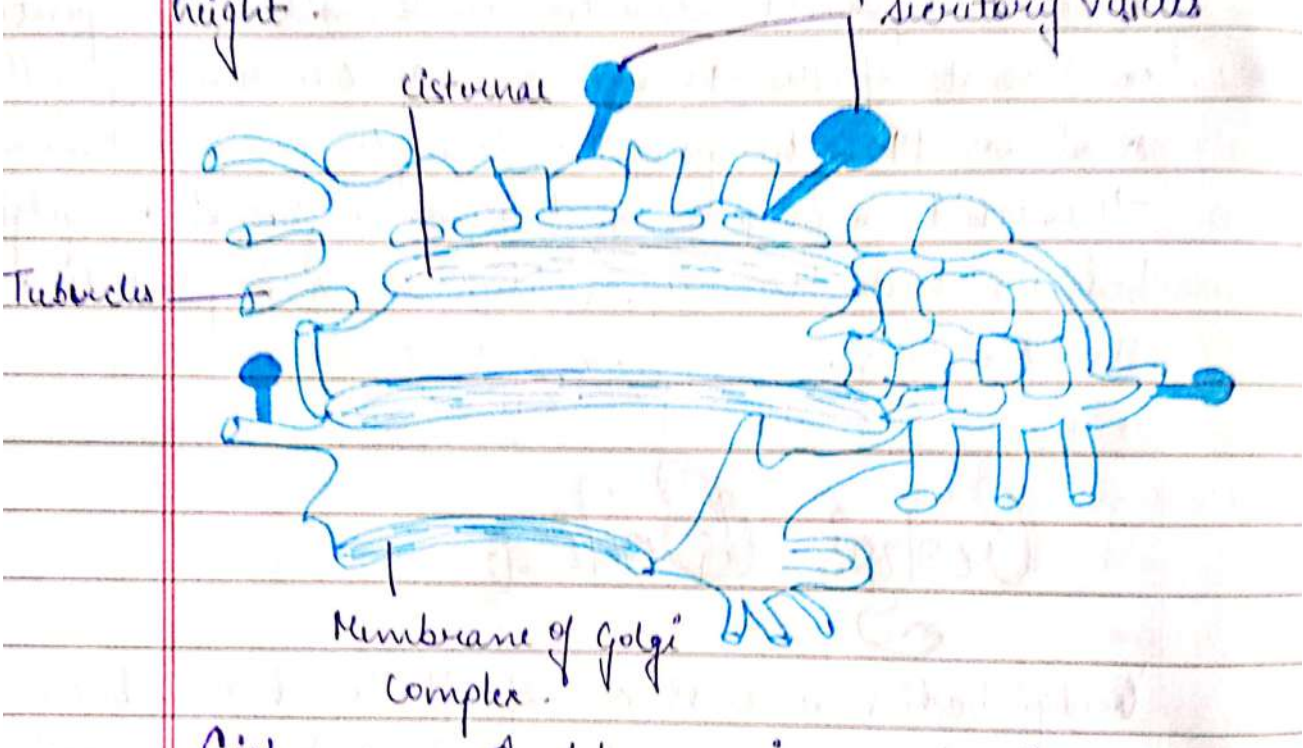
Plasma membrane is a trilamellar membrane of lipid and protein. The trilamellar nature of

plasma membrane is proposed by Danielli and Davson in 1935 and Harvey and Danielli in 1938 the hypothetical model of plasma membrane which has shown biomolecular structure of like sandwiched by two layers of protein and middle layer of lipid. The electron microscopic study have conform protein lipid protein structure. Robertson found search trilamellar composition in most of the membrane of cellular organelles and in 1955 he give the concept of unit membrane. The unit membrane has been found in golgi bodies, mitochondria, lysosomes, plastids and the Nucleus.

Golgi Bodies.

Golgi bodies are stacks of flattened membranous stacks (they look like pancakes). The Golgi Body temporily stores protein which can then leave the cell vesicles pinching off from the Golgi. It is a cup-shaped organelle which is located near the nucleus in many types of cells. Golgi apparatus consists of a set of smooth cisternae (i.e, closed fluid-filled flattened membranous sac or vesicles) which often are stacked together in parallel rows. It is surrounded by spherical membrane bound vesicles which appear to transport proteins to and form it. Golgi apparatus

consist of at least three distinct types of cisternae; cis Golgi, median Golgi, and trans Golgi. Plant cells contain many finely distributed sub-units of Golgi apparatus, called dictyosomes secreting cellulose and pectin for cell wall formation during the cell division. The golgi body of plant cells are about 1-3 μ in length and about 5 μ height.



Cisternae: A cisternae is a sac like or cavity filled with fluid contents within a cell or organisms. The no. of cisternae per golgi body may exceed upto 30 or more in lower organism.

Tubules: From the peripheral area of cisternae arise a complex, flat network of tubules 300-500 Å diameter.

Vesicles: The vesicles are small droplets like sacs which remain attached to tubule at the periphery of cisternae. They are classified into Smooth and Coated Vesicles.

Golgi and Vacuoles: The golgi and vacuole are large, rounded and sac like structure occuring at the distal end of cisternae.

Golgi apparatus performs the following important functions:

- The packaging of secretory materials (e.g, enzymes, mucin, lactoprotein of milk, melanin pigment etc); that are to be discharged from the cell.
- The processing of protiens i.e, glycosylation, phosphorylation, sulphonation and selective proteolysis
- The synthesis of certain polysaccharides and glycolipids.
- The sorting of protiens destined for various locations (e.g. lysosomes, peroxisomes, etc) in the cell.
- The proliferation of membranous element for the plasma membrane.
- Formation of the acrosome of the spermatozoa.

Ribosomes.

The ribosome are small, dense, rounded and granular particle of the ribonucleo protein. They occur either freely in the matrix of chloroplast and cytoplast or remain attached with a membrane of Endoplasmic reticulum and nucleus. They occur in most prokaryotic and Eukaryotic cell and are known to be sites of protein synthesis where amino acids are assemble in specified sequence to produce polypeptide chain.

Types of Ribosomes.

According to the size and sedimentation coefficient (s), 2 types of ribosomes are recognized!!

- 70S ribosome.
- 80S ribosome.

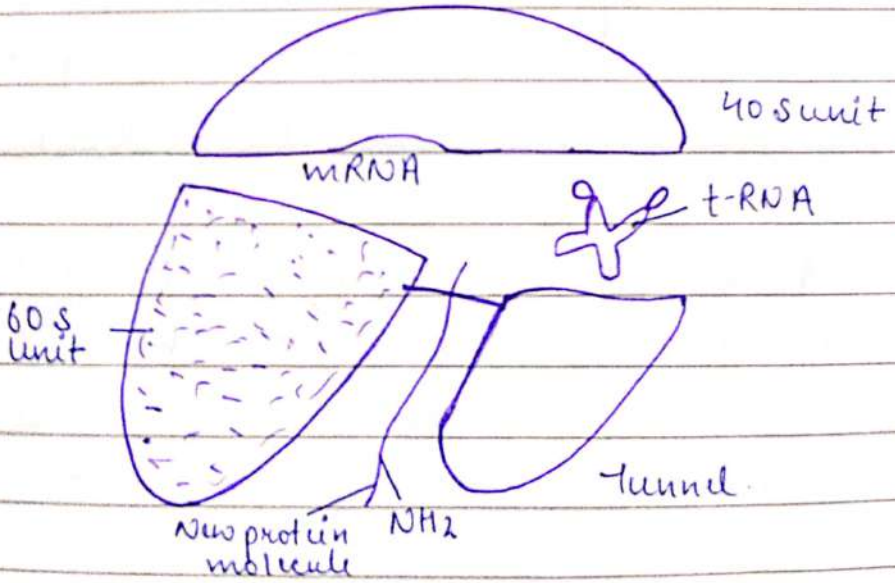
70S ribosome: The 70S ribosomes are comparitively smaller in size and have sedimentation coefficient (70S) and a molecular weight 2.7×10^{-6} Dalton (Unit of m.w).

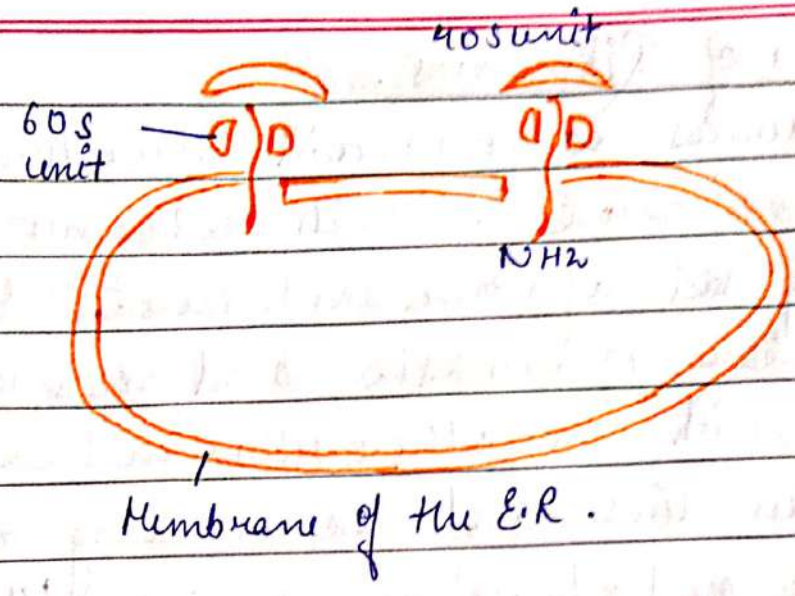
80S ribosome: The 80S ribosome have the sedimentation coefficient (80S) and the m.w 40×10^{6} Dalton. The 80S ribosome occurs in Eukaryotic cell of the plants and animals.

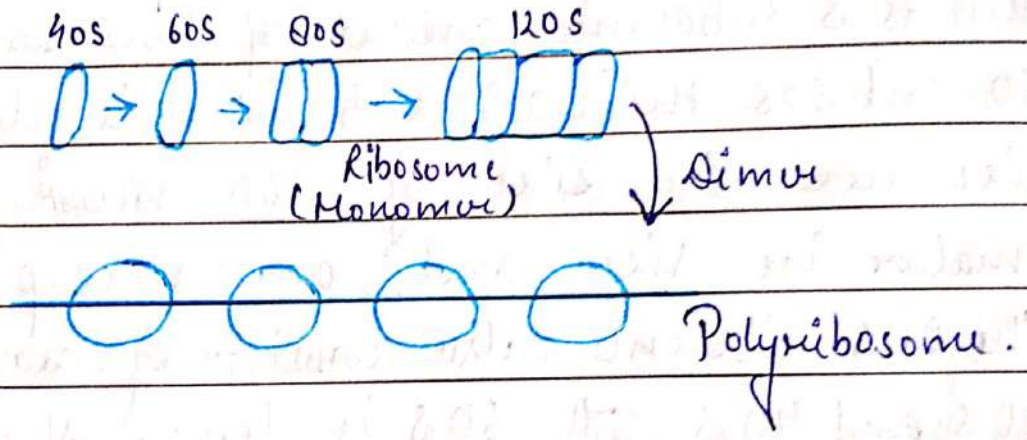
The sedimentation coefficient is expressed in the Svedberg Unit, (E.g. S unit).

Structure of Ribosomes.

The ribosomes are spheroid structure of 150 to 250 Å in diameter. Each ribosome hydrated and composed of two sub units. Each ribosomal unit is larger in size and has a dome-like structure with the other ribosomal sub-unit is smaller in size and occur ring above the larger sub-unit and forming a cap-like structure. The 70 S ribosomes consist of two subunit like 50 and 30S the 50S sub unit is larger in size and the size of 160-180 Å and 30S is smaller in size and occurs cap-like structure. The 80S ribosome also consist of two subunit like 60S and 40S. The 60S is dome-shaped and larger in size and the 40S is smaller in size and above the 60S subunit and forming a cap-like structure. Both the sub units are separated by a narrower cleft.







Function.

The ribosomes are the fundamental organelles of the cytoplasm which provide necessary space and protein factor (Enzyme) for the process of Protein Synthesis.

Endoplasmic Reticulum.

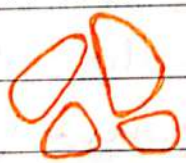
Endoplasmic Reticulum is the cytoplasmic matrix is transverse by a complex network of interconnecting membrane bound vacuoles or cavity. These are concentrated in Endoplasmic portion of the Cytoplasm. Therefore they are known as ER. They are varies from cell to cell. The egg and Embryonic cells lacks in E.R. The pancreatic cell and other endocrine glands are found most granular E.R.

Morphologically the ER is mainly Composed of Cisternae, vesicles or vacuoles and tubules.

Cisternae: The Cisternae are long, flattened, sac like, unbranched tubules having the diameter of 40-50 nm.

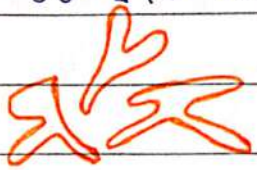
Cisternae.

Vesicles: The vesicles are oval, membrane bound vacuoles structure having the diameter of 25-500 nm.



Vesicles.

Tubules: The tubules are branched structures forming the reticular system along the cisternae and vesicles. They are usually have the diameter in all 50-190 nm and occur almost in all the cells



Tubules.

Ultrastructure.

The cavities of cisternae, vesicles and tubules of the ER are bounded by a thin membrane of 50-60 Å thick. The membrane of ER is trilaminar composed of outer and inner layer of protein molecules sandwiching two thin and transparent layers of phospholipids. The cavity of the ER is well-developed and act as a passage for the secretory products.

Types of Endoplasmic reticulum.

1. **Agranular Or Smooth ER** = This type of ER has smooth walls because the ribosomes are not attached with its membranes. The smooth type ER occurs mostly in those cells which have no active participation in protein synthesis. The muscles cells are also rich in SER.

2. **Granular Or Rough ER** = This type of ER possesses rough walls because the ribosomes remain attached with its membranes. Ribosomes play a vital role in the process of protein synthesis. They take Basiophilic stain due to its RNA content of ribosomes.

Functions of Endoplasmic reticulum.

- It is mainly responsible for the transportation of protein and other carbohydrates to another organelle, which includes lysosomes, Golgi apparatus, plasma membrane etc.
- They provide the increased surface area for cellular reactions.
- They help in the formation of nuclear membrane during cell division.
- They play a vital role in the formation of the skeletal framework.
- They play a vital role in the synthesis of proteins, lipids, glycogen and other steroids like cholesterol, progesterone etc.

Lysosomes.

"Lyso" means "digative".
"Some" means "body".

The lysosomes are tiny membrane bound vesicular structures of the cytoplasm which perform intra Cellular digestion of the cell.

Lysosomes were first of all reported by "de Duve" in 1955

Usually, the lysosomes occur in most animal cell and few plant cells which are secretory in function such as the pancreatic cells; leucocytes, liver cells, spleen cells, kidney cells (contain

large no. of lysosomes). The lysosomes often remain distributed in the cytoplasm. They are generally spherical in shape but certain meristematic cells of plants roots contain irregular shaped lysosomes. The size of the lysosomes usually ranges from 0.2 to 0.8 μm but may be exceptionally large in the mammalian kidney cells like 5 μm. The lysosomes have been found to contain molecules of about 24 enzymes.

Types of Lysosomes.

1. **Primary lysosomes** = (Storage granules), The primary lysosomes or free lysosomes are small sac-like bodies having many enzymes. These are either secreted by the granular ER or by the cisternae of the golgi complex.

2. **Secondary lysosomes** = (digestive vacuole or heterophagosome), When the cells feed on foreign or exogenous or extracellular substance by the process of phagocytosis or pinocytosis, then the P.M forms the membrane bound vesicles known as pinosomes or phagosomes around the substance. The pinosomes or phagosomes ultimately fuse with the pre-existing 1° lysosomes and form the 2° lysosomes.

3. Residual Bodies = These are formed if the digestion is incomplete. In some cells, as the Amoeba and other protozoa, these residual bodies are eliminated by defecation. Hence lysosomes having undigested material or debris are called residual bodies. These bodies are formed due to lacks of certain enzymes in lysosomes.

4. Autophagic Vacuole = (Autophagosome or Cytolysosomes). The autophagic vacuoles are formed when the cell feeds in its intracellular organelles such as the Mitochondria, ER, by the process of autophagy. In such case the 1° lysosomes are conc". around the intracellular organelles and digest them ultimately. The autophagic vacuoles are formed in special pathological and physiological condition.

Function of lysosomes.

The function of lysosomes is to remove waste as well as destroying a cell after it has died, called autolysis. A lysosome is an organelle containing digestive enzymes which it uses to function as the digestion and waste removal for cells, food particles, bacteria etc. lysosomes are responsible for a number of different functions including recycling old cells, digesting materials that are both inside and outside of the cell, and releasing enzymes. The general function of lysosomes is degrade or break down macromolecules.

Plastids.

Plastids are a group of phylogenetically and physiologically related organelles found in all type's of plants and algae. In their roles, the different types of plastids contribute to plant metabolism thus promoting plant growth and development. One of the main characteristics of these organelles is the fact that they have a double membrane. In the cells, plastids are primarily involved in the manufacture and storage of food.

The term "plastid" is derived from the Greek word "plastikos" (= formed or moulded) and was used by A.F.W. Schimper in 1885. Schimper, the classified plastids into following types —:

1. Leucoplasts. (Leuco = white and plast = living), the leucoplasts are the colourless plastid which are found in embryonic and germ cell. They are also found in meristematic cells and in those regions of the plant which are not receiving light.

2. Chromoplasts. (Chromo = Colour and plast = living), the chromoplasts are the coloured plastids containing carotenoids and other pigment. Chromoplasts of blue-green algae or cyanobacteria contain various pigment such as chlorophyll a and carotenoids.

3. **Chloroplasts.** (Chloro = green and plast = living), the chloroplast is most widely occuring chromoplast of the plants. It occurs mostly in the green algae and higher plants. The chlorophyll plasts contains the pigment chlorophyll a and chlorophyll b and DNA and RNA.

According to Schimper, different kinds of plastids can transform into one another, as shown in following fig.

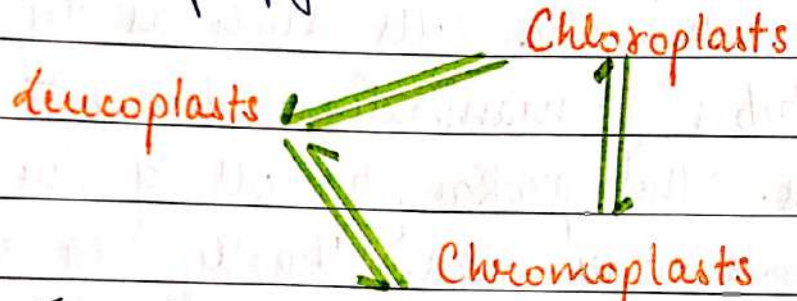


Fig. Interconversion of three kinds of plastids.

Function of Plastids.

They provide colour to fruit and flowers. They helps in storage of protein, starch and oil. They trap solar energy to manufacture food through the process of photosynthesis.

Nucleus.

This is the most significant component of the cell which controls various metabolic activity of the cell and contain the genetic material the DNA. The Robert Brown in 1831 discovered the Nucleus.

The nucleus is found in all the Eukaryotic cells of the plants and animals. However certain eukaryotic cells such as the mature sieve tubes of mammalian leucocyte contain no nucleus. The prokaryotic cell of the bacteria do not have true nucleus. Usually the nucleus remains located in the centre but its position may change from time to time according to the metabolic state of cell.

Shape = The shape are almost irregular like spheroid, cuboid, polyhedral, cylindrical and fusy form.

Size

Shape = The size of the nucleus are varied in different cells Hertwig has given the formula for the deduction of the size.

$$Np = \frac{Vn}{Vc - Vn}$$

Where, NP is the nucleoprotein index, Vn is the volume of the nucleus and Vc is the Volume of the cell.

Ultrastructure.

- Nuclear membrane
- Chromosome and Nucleoplasm.
- Nucleolus.

Nuclear Membrane.

Nucleus is bounded by lipoprotein membrane, known as Nuclear membrane. It forms a kind of envelope around the nucleus and is known as nuclear envelope. They having many pore like octagonal apperture.

Nucleoplasm And Chromosomes.

The space between the nuclear membrane and nucleolus filled by watery substance known as nucleoplasm or Karyalymph. The chromosomes appear only during cell division otherwise they occur in the form of chromatin threads. These threads having DNA, remains wrapped in RNA and nucleoprotein.

Nucleolus.

The nucleoplasm contain a darkly stained spherical body known as the nucleolus. Chemically nucleolus is composed of large amount of ribosomal protein and RNA. Ribosomal protein used in synthesis of ribosomes.

Function of Nucleus.

It controls the hereditary characteristics of an organisms. It main cellular metabolism through controlling synthesis of particular enzymes. It is responsible for photosynthesis, cell division and growth. It helps in exchange of DNA and RNA b/w the nucleus and the rest of the cell. Nucleolus produces ribosomes and are known as protein factories. It also regulates the integrity of gene and gene expression.

Peroxisomes.

These are tiny circular membrane-bound organelles containing a crystal core of enzymes (such as urate, D-amino oxidase and catalase, e.g. liver cells and kidney cells). These enzymes are required by peroxisomes in detoxification activity, i.e., in the metabolism or production and decomposition of hydrogen peroxide or H_2O_2 molecules which are produced during neutralization of certain superoxides - the end products of mitochondrial or cytosolic reactions. Peroxisomes are also related with β-oxidation of fatty acids and thermogenesis like the mitochondria and also in degradation of the amino acids. In green leaves of plants, peroxisomes carry out of the process of photorespiration.

Function of Peroxisomes.

Peroxisomes derive their name from their use of molecular oxygen for metabolic process. These organelles are largely associated with lipid metabolism and the processing of reactive oxygen species. Within lipid metabolism, peroxisomes mostly deal with β-oxidation of fatty acids, the mobilization of lipid stores in such, cholesterol biosynthesis and steroid hormone synthesis.

Mitochondria.

Mitochondria are thread granule or filamentous or granular cytoplasmic organelles of aerobic cells of higher animals and plants and also of certain microganisms. Mitochondria has lipoprotein framework.

They are bounded by double membrane envlop which provide good tensile strength. Trilamellar in nature.

Functions of Mitochondria.

Mitochondria perform most imp. function such as oxidation, dehydration, oxidative phosphorylative, respiratory chain of the cell.

Stored chemical energy is disposed of very quickly at the time of need in various function such as respiratory cycle, protein and cell division and bioluminisins etc.

11 Dec, 2019

Chromosome.

Chard Nageli (1842) Observed rod like chromosomes in the nuclei of plant cell.
E. Strasburger (1875) first described that chromosomes are rod shaped thread like structure which appear during cell division.

Chromo = Colour and Some - body i.e, colourful body. This name is given by Waldane in 1888 due to their affinity for basic dies. These chromosomes are invisible in the nucleus but can be seen during metaphase (mitosis, meiosis).
Chromosomes compared thin chromatin thread called chromatin fibre. The fibre become thick and smaller during prophase due to folding and coiling of fibres. At diplotene phase of mitotic prophase chromosomes appears beaded structure known as Chromosomes.
Chromosomes are most visible in dipterian giant salivary gland as dark staining band. Chromosomes form gene bearing portion of the Chromosome.
Chromiotemmata are embedded in the achromatin substance known as matrix. Matrix is enclosed in sheath or pellicle. Both matrix and sheath are non-genetic material and appear only at metaphase stage.

Chromosome number.

The no. of chromosome is constant for a particular species. The no. of chromosomome such as sperms and ova is known as gametic reduce or haploid set of chromosome. The haploid set of chromosome is known as genome. Somatic cell contain 2 haploid sets or genome known as diploid (ploids refers 2 chromosome sets) di or haploid or monoploids refers the degree of ploidy. The organisms with the lowest no. of chromosome is the nematods, saccaris, myelocephalus 2 chromosome in somatic cells: $2n=2$ In plant $2n=4$, in haplopappus gracilic (compositae) its $2n=1200$ in ptridophytes.

n = gametic chromosomal no.

x = genomic chromosomal no.

Morphology.

Size = The size of chromosome is normally measured at mitotic metaphase and may be as short as 25 micron in fungi and birds or as long as 30 cm in some plants as trillium. The monocotyledon plant contain the large sized chromosome than the dicotyledons plants. Normally plant has large sized chromosome in comparison to animals.

Shape = The shape of chromosome is changeable from phase to phase in the cell division and cell growth. In the resting phase chromosome occur in the form of thin coiled, elastic and contractile, thread like stainable structure. In metaphase and a anaphase, the chromosome becom thick and filamentous. Each chromosome contain a clear zone known as Centromere or kinetochore, along the length. The centromere divides the chromosome into 2 parts. Each part called chromosome arm. The position of centromere varies from chromosome to chromosome. It provides different shape to the chromosome.

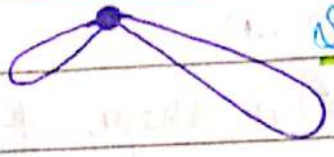
Telocentric.

The rod like chromosome which have the centromere on the proximal end are known as telocentric chromosome.

Acrocentric.

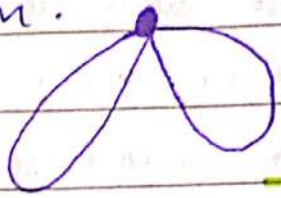
The acrocentric chromosome are also rod like in shape but these have the centromere at one end and thus giving a very short arm and an exceptionally long arm like it shape.

Acrocentric



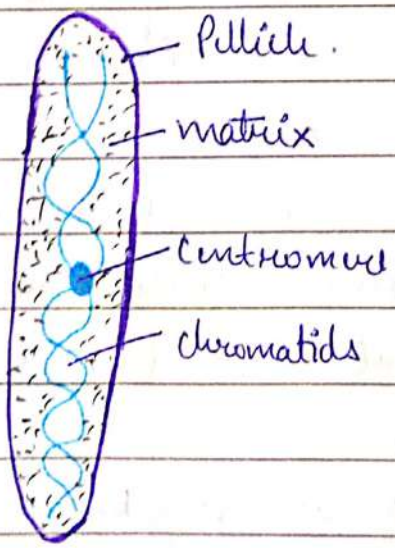
Submetacentric.

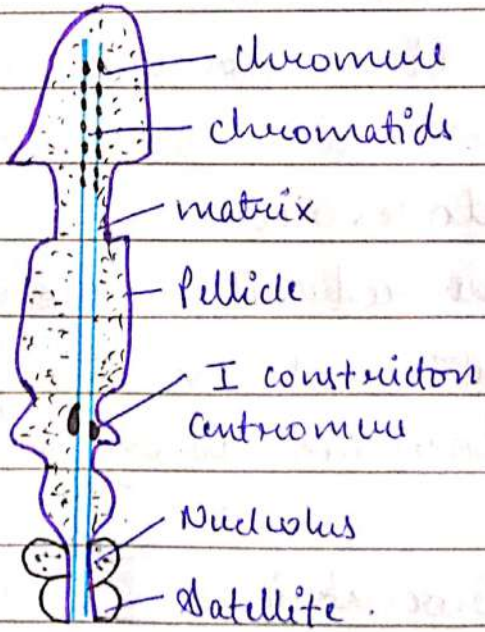
The submetacentric chromosome are "J" or "L", shape The centromere occur near the centre at median portion of the chromosome. They forming 2 unequal arm.



Metacentric

The metacentric chromosome are "V" shaped and these chromosomes the centromere occurs in the centre and forming 2 equal arm.





17 Dec, 2019

Structure.

Chromatid.

At mitotic metaphase each chromosome consist of 2 symmetrical called chromatids. Both chromatids are attached each other only by centromere and become separated at a beginning of anaphase, when sister chromatin migrate to opposite pole. Each chromatids contain single DNA molecule.

Chromonema (Chromonemata).

- During prophase chromosomal material become visible as very thick filament called chromonemata.
- A chromonema present a chromatin in the early stage of condensation.
- Chromonema is imbedded in matrix and enclose in a sheath or pellicle.

Chromomeres.

The chromomeres are beaded str. that are visible along interphase and specially clear in polytene chromosome. They are believed to correspond to the unit of genetic function in chromosome. (The unit of hereditary considered as genes).

Centromere And Kinetochore (Primary constriction).

The region where 2 sister chromatid of a chromo. appear to be joint and held together during

mitosis phase is known as centromere and also known as P.C. Centromere are found to contain specific DNA special protein bound to them forming a disc shaped structure called kinetochore.

Normally the chromosome possess a single centromere known as Monocentric.

But in some chromosome there are 2 centromere called dicentric or many centromere called polycentric.

Telomere.

Each chromosome has a polarity and therefore it prevents other chromosomal segment to differ with it. The chromosomal ends are known as Telomere. If a chromosome breaks the broken end can fuse with each other due to lack of Telomere.

Secondary Constriction.

Beside the primary cons. or centromere the arm of one or more constriction called secondary cons. S.C may be short or long it is often associated with nucleolus during interphase and may take part in the re-organization of nucleolus during Telophase stage of cell division. for this region S.C is also called Nucleolus organizing region (NOR).

Satellite.

The chromosome region between the S.C and nearest telomere is known as Satellite and chromosome called Satellite chromosome or SAT chromosome. It is rounded elongated or knob like appendages. The shape and size of satellite remains constant.

Karyotype And Idiogram.

The term Karyotype usually refers to the general morphology of a set of chromosome at somatic metaphase of an individual. A diagrammatic representation of a Karyotype (or morphological character of chromosome) of a species is called Idiogram. Generally in an Idiogram the chromosome of a haploid set are ordered in a series of decreasing size. Sometimes an idiogram is prepared for the diploid set of chromosome.

Material of a Chromosome.

Depending on their staining properties the following 2 types of chromatids may be distinguish in the interphase nucleus.

Euchromatid.

Portion of chromosome or non-condensed segment that stain lightly are termed as Euchromatin. Bulk of chromatin is made up of Euchromatin.

Heterochromatin.

In the dark staining region the chromatin

remain in the condensed stage is called Heterochromatin. Heterochromatin characterized by high content of repetitive DNA sequences. Heterochromatin remain condensed during interphase and early prophase and form the so called chromocenter.

Types of Heterochromatin:

Heterochromatin has been further classify into two types - Constitutive and facultative heterochromatin.

Constitutive Heterochromatin.

C.H contains short repetitive sequences of DNA (satellite DNA) this DNA is called satellite DNA because a upon ultracentrifugation it separates from the main component of DNA.

In C.H DNA is permanently in active and remains in the condense state throughout the cell cycle, and occurs around the centromere

Facultative Heterochromatin.

Such type of heterochromatin is not permanently maintained in the condence state, instant it undergo and during these time is transcriptionally active.

Facultative heterochromatin is essentially euchromatin that has undergon hetero (conversion into heterochromatin).

C.H remains permanently in the heterochromatic that is. does not convert into the euchromatin

stage. Ex: Centromeric region.

Chemical Composition.

Chromatin contain DNA, RNA and protein. The protein is of 2 types - histone and Non-histone. Ratio of DNA with histone protein is 1:1 and Non histone protein with DNA 0.6:1 and RNA DNA ratio is 0.1:1 in that of liver.

DNA.

DNA is the most imp. chemical component of chromatin. Since it plays the central role of controling hereditary and 10^{-12} picogram is present.

Histone Protein.

Histones are very basic protein because they are enriched in the amino acid are arginine and lysine to a level of about 24 mole present. There are 5 types of histone in the Eukaryotic chromosome namely H1, H2a, H2b, H3 and H4. Histone H1 is the least rigidly concerned histone protein. It contains 210-220 amino acid and may be represented by a variety of forms even within a single tissue. H1 is a absent in yeast. H1 histone protein is present only once per 200 base pairs of DNA (In contact to rest of the 4 types of histone each of which is present twice) and is rather loosely associated with DNA.

Non-Histone Protein.

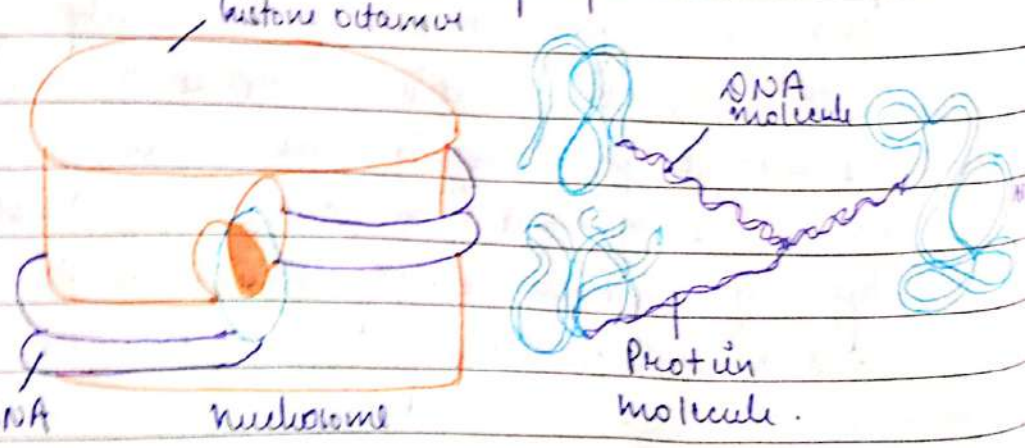
In contrast to the histone protein non-histone protein display more diversity, in various organism 12-20 non-histone protein present.

Ultrastructure.

There are many theories are proposed for the structure of Chromosomes.

Folded fibre Model And Nucleosome Concept.

Folded fibre model proposed by F.J Dupraw in 1965. According to it the bulk of the chromosome is visualist to be composed of a tightly folded fibre which as a rather homogeneous diameter of 200-300 Å. This folded fibre is supposed to contain DNA stem helix of (30Å) diameter, in a supercoil condition. Another model is most significant called Nucleosome model proposed by R.D Kornberg in 1974. Thus while in the folded fibre model is proposed that the stem were bound on the outside of the DNA coil the nucleosome model has proposed the contrast.



Each nucleosome is a disc shaped particle containing 2 copies of each 4 nucleosome histone i.e. H_{2a}, H_{2b}, H_3, H_4. This histone octamer forms a protein core. And the a polar region of H_{2a} and H_{2b} around which the double stranded DNA helix found $1\frac{3}{4}$ time containing 146 pairs.

18 Dec, 2019

Solenoid Model.

This model is proposed by Daphano during mitosis or miosis when the chromosomes become shorter and thicker at prophase stage due to solenoid coiling of nucleosome containing fibre, the following types of chromosomal structure can be observed during cell cycle-

10 nm fibre. Nucleosomes are 10nm filament in which packing of DNA is about 5-7 fold.

30nm fibre. The 30nm fibre consist of closely packed nucleosome it probably arises from the folding of the nucleosome chain into a solenoid str. having about 6 nucleosome per turn. Histone H_1 molecule are found responsible for packing of nucleosome into 30nm fibre.

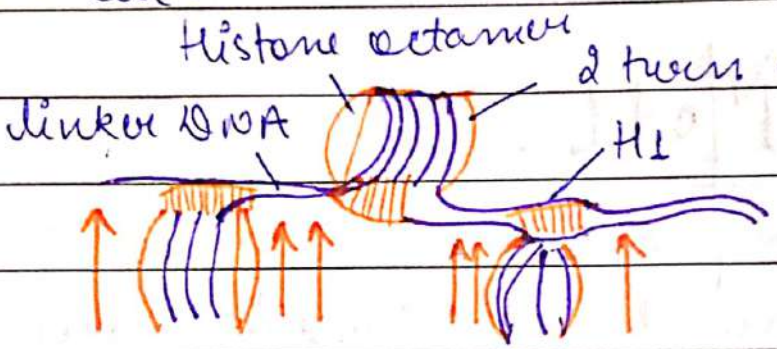
Radial loop of 30 nm fibre. Two types of chromosomes i.e. lampbrush and polytene seems to contain a series of looped domain, loops of chromatin that extends at an angle from the main chromosome axis.

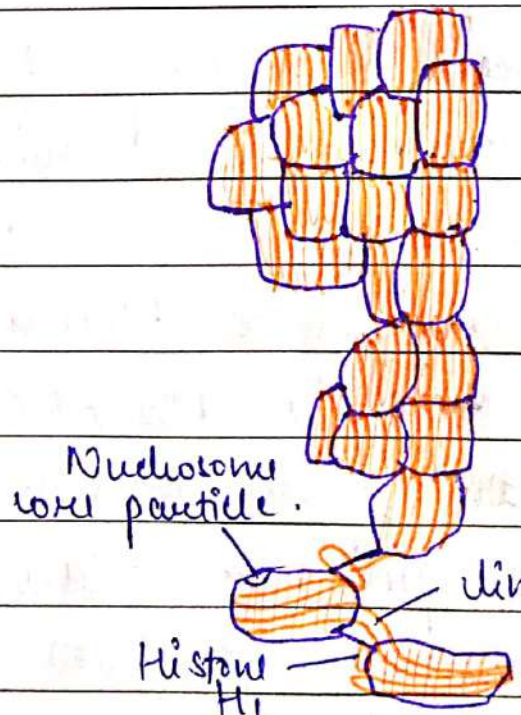
The nucleosome beads can be remove from long

DNA string dilation with enzyme that digrad DNA.

Function.

The function of chromosome is to carry the genetic information from one cell to another. DNA is the real genetic material of the cell.





Unit - 2. **Salivary gland Chromosome / Polytene Chromosome / Giant Chromosome.**

In Salivary gland cell of species Ex; Drosophila, Chironomus ; giant chromosome was chromosome observed by For the first time in 1881. These chromosomes

are very long upto 200 times or more the six corresponding chromosomes at meiosis in nuclei of ordinary mitotic cells. Hence they are known as giant chromosomes.

Their significance was realize only after the extensive study of painter during 1930's another characteristic of these giant chromosomes is that they are somatically paired consiquently the no. of these giant chromosome in the salivary gland cell always appear to be half that in the somatic cells.

In Drosophila melanogaster salivary gland giant chromosome radiate as 5 long and one short arm form a deeply staining and more or less amorphous str. called chromocenter. One long strand correspond to the X chromosome and the remaining 4 long strand are the arms of 2nd or 3rd chromosome. Short arm from the chromocentre represent 4th chromosome. The centromer of all these chromosome fuse to form the chromocenter. In the male flies the Y chromosome is also found fuse within the chromocenter and is therefore not seen separate strand.

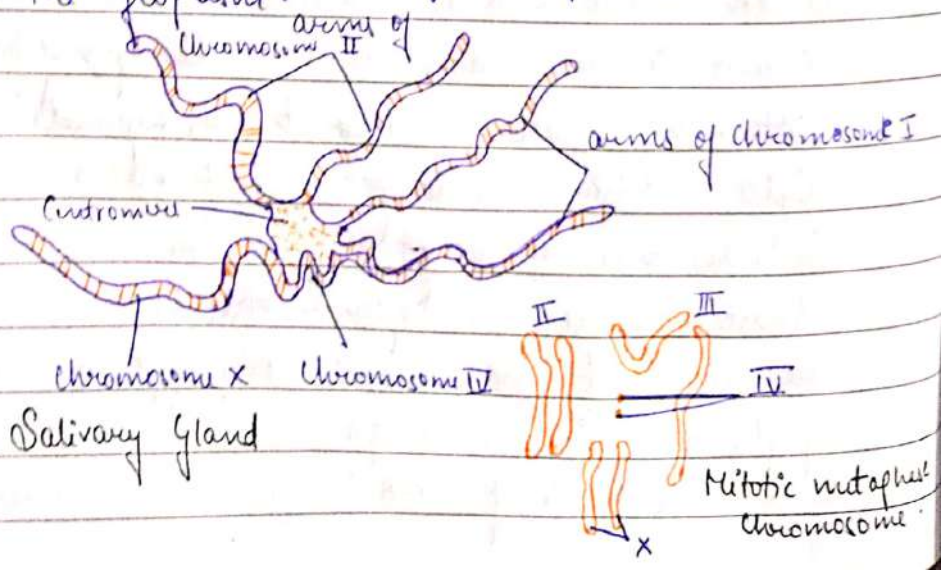
Giant chromosomes are made up of several dark staining region called bands separated by relatively light or non staining inter band region. These bands have greatly helped in the maping of chromosome in cytogenetics studies. The band occasionly form reversible puffs known as chromo. puffs or balbiani rings.

About 95% of DNA is polytene chromosome is in

bands and rest 15% is in inter bands.
The giant chromosomes represent a bundle of fibrils which arises by repeated cycle of Endo-Reduplication of a single chromatid. Endo-Reduplication means chromatin replicate without cell division as a result of which the no. of chromonemata keep on increasing this is why these chromosomes are also popular known as polytene chromosomes and the no. of chromonemata may reach upto 2000 in extreme case.

Function.

Some hormones Ex. Ecdysone induce puffs in specific bands during specific period of dev. These chromosomes are also found in malpighian tubule, fat body etc. The process of puffing involve several process such as accumulation of HB protein, accumulation of RNA polymerase B and enzyme involved in the transcription of mRNA molecule and release of newly synthesized mRNA in the cytoplasm.



27 Dec, 2019

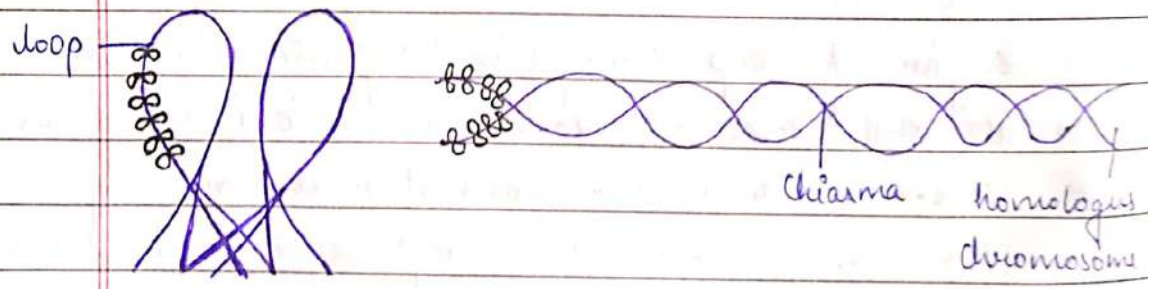
Lampbrush Chromosome.

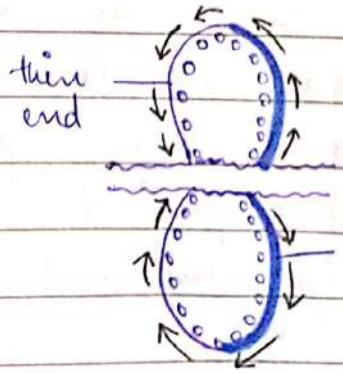
The lampbrush chromosome were first observed in oocyte some invertebrates and all vertebrates specially amphibian and all mammals. They have also been reported in human and rodent oocyte. The name lampbrush chromosome is due to the chromosome look like the brushes which were used for cleaning glasswares. Lampbrush chromo. are most distinctly observable during prolong diplotene stage of oocyte they are extremely long in some case about 800 to 1000 micron in length, they contain numerous paired loops emerging from the chromosomes of homologous pair in general 1-9 pairs of loop emerge from a single chromosomes. The size of loop varies with an average of 9.5 micron in interchromomeric fibre. These pairs of loops in these chromosome distribute over its length from each chromosome a pair of loop emerges in opposite direction vertical to the main chromosomal axis (Sometimes 2 or more). Main chromosomal axis consist of 2 sister chromosome while the loop represent individual chromatids. Since lampbrush chromosome consist of 2 homologous contact with each other at several point called Chiasma. These loops exhibits a thin axis from which fibre projects covered with a loop matrix consisting of RNA and protein. 1 end of each loop is markedly thinner than the other. There is extensive RNA synthesis at thin end of loop while

There is little or no RNA synthesis at the thick end. The DNA at thick end of a loop is progressively with drawn and assembled in chromomeres. The DNA axis of loop moves progressively from thin end toward thick end.

Function.

- Clearly loop represent the site of gene action (transcription).
- The function of lampbrush chromosome is to produce large no and quantities of protein and RNA's stored in egg.
- It has been observed that if activity of these genes stopped by actinomycin D (actinomycin D able to stop synthesis of RNA on DNA template).
- The loop will collapse suggesting that the loop mainly consists of RNA.





B- Chromosome.

Many species of plants and animals contain in addition to normal constant compliment of A chromosome a variable no. of minute and usually heterochromatin chromosome. These are called super numerary or extrachromosome or accessory or B chromosome. B chromosome are distinguished from the other smaller chromosome of normal compliment in their staining properties. In some cases however the distinction on basis of staining reaction. In trdescantia and trilium. Ex- Super numeries appear to be largely euchromatids and in maize they contain both type of chromatin. B chromosome dt cover by Willson (1935) in Hamptonian in maize 1927-28. The occurance of B- chromosome is found in more than. B chromosome are recognised on the basis of characters.

Morphology.

They are usually much smaller in size than the smallest A chromosome. In morphology most of the accessory chromosome are acrocentric and polycentric and some are metacentric. They have their occur unique pattern of heterochromatin nutrition:

Genetic effectiveness.

They are invert but may rarely organise nucleoli and carry functional genetic material.

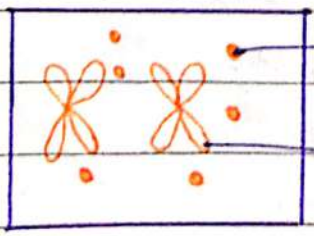
Numerical Variation.

The no. of B chromosome may vary in different cell tissue, individual and population.

Meiotic Behaviour.

The B-chromosome will not combine with A chromosome. They show degree of early separation from each other at late prophase I and metaphase I. They are known to effect the overall region of all the plant as well as pollen fertility vegetative region is usually reduced by high no. of accessory chromosome. The origin of B-chromosome is not yet known yet it is presume that they pair heterochromatin - This means that super numerary chromosome might have originate from small fragment caused by several rearrangement and might had eventually become as large as other chromosome by repeated duplication. 2 Type of B-Chromosome -

- Which are mitotically stable and all the cell of organism has the same no. of B- chromosome.
- Which are mitotically unstable given rise to different cell of B- chromosome and some individual.



Cell Division.

All the living creatures are made up of cell some are unicellular while other are multicellular the growth and development of individual depend exclusively on growth and multiplication of cell. During multiplication both nucleus and cytoplasm take part in cell division. Division of cytoplasm is cytokinesis and nuclear division is Karyokinesis. Somatic cell forming body part and sex cells form reproduce organ. Somatic cell are divide by mitotic division while meiosis take place in a germ cell or sex cells.

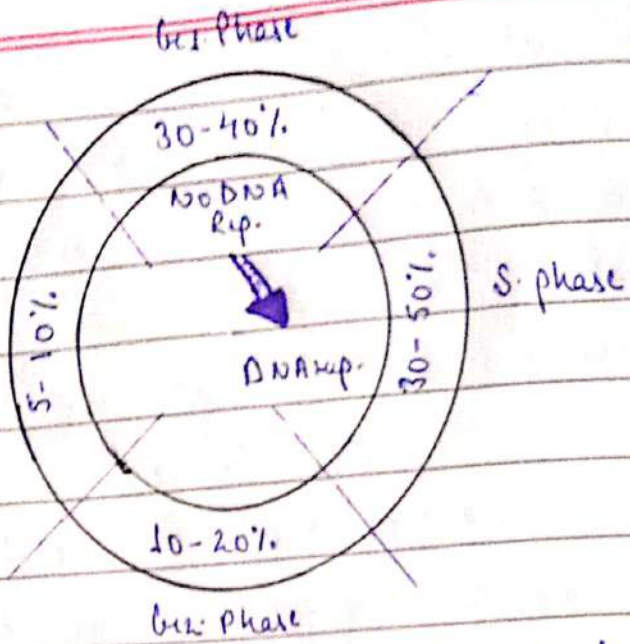
Types of Cell Division.

1. **Direct or Amitosis division:** In this process the cytoplasm of cell divide directly by each constriction and form nearly 2 equal cell Amitotic division is in the cell where nucleus chromosome is absent. Ex. Bacterial cell.

2. **Indirect:** This type of division complete in 2 different phases Karyokinesis and cytokinesis. Indirect cell division is of 2 types.

- **Mitotic division** - It does not done reduction in chromosome number.
- **Meiotic division** - This reduces chromosome no. in 2 halfs.

In both unicellular and multicellular eukaryotes the cell reproduction is cyclic reproduction of growth nuclear and cytoplasmic division called cell cycle.



In Somatic Cell the Cell cycle contain 4 phase-

(1) G1 or Gap 1 Phase.
(2) Synthesis or S Phase.
(3) G2 or Gap 2 Phase.
(4) M or mitotis.

Infact cell division a continuus process in which cell divide gradually from one stage to another the boundary between any 2 stages no. at all clearly defin

Interphase (Cell Cycle).

It occur after telophase stage of the previous mitotic division and before the onset of prophase stage of next one. Interphase often not regarding a stage of cell division since early cytologist occur to it as resting stage. But it is not a resting stage during interphase chromosome are fully stained and uncoil. Chromosome replication protein and RNA synthesis taken place during this stage.

1. **G_1-Phase:** During G_1 phase chromatin fibre become cylinder less coiled and fully extend and more active for transcription. Protein synthesis during G_1 phase synthesis of r-RNA, t-RNA and m-RNA the enzyme and substrate necessary for DNA synthesis during S-phase are also synthesid.

2. **S-Phase:** During S-phase of interphase replication of DNA occur. Since DNA replication is dependent on protein synthesis for the overall replication of chromosomes At the end of S-phase each chromosomes is composed of 2 morphologically and genetically identical sister chromatin. RNA and protein synthesis are very low during S-phase.

3. **G_2-Phase:** It is a period between the end of S-phase and the beginning of prophase of the next division during G_2 Phase synthesis RNA and protein continue which is required for cell growth.

4. **M-Phase:** Mitos-thread describe by Fleming in 1879 this word is used by him in 1882 mitosis occur in somatic cells in this division the 2 chromatids of each chromosomes separate and move to the opposite pole of a cell as a result the two daughter nuclei present and increase in cell no. They are identical to parent nucleus entire nuclear material has been divided into 2 equal and similar halfs i.e, Mitosis is also known as equitorial division Mitosis divide into 4 phase-

(a) Prophase
(b) Metaphase
(c) Anaphase
(d) Telophase

09 Jan, 2020

Prophase.

- Pro = before and Phase = appears.
- In biginning chromosome, appear as long of chromosome of thin wool.
- Chromosome becomes shorter and thicker due to increase condensation.
- In the mid prophase each chromosomes split longitudinally to produce chromatids except centromere.
- Nucleolus decrease gradually and disappears towards the late prophase.
- NM breaks down and at the same time spindle fibres comes in picture (Distribution of component of ER).

Metaphase.

Appearance of spindle fibre. All the split chromosomes arranged themselves in a plain at a equator at a equitorial plate.

Anaphase.

Chromosomes split at centromere. Sister chromatid move towards opposite pole of spindle and attain characteristics shape. The movment of sister chromatids towards opposite pole is achieved by enlargement and arrangement.

Probably due to hydration and contraction of chromosomal fibre. Since the fibre shorter without becoming thicker the process probably involve from the removal of water molecule from fibre. During movt. towards the pole the centromere moves 1st along a spindle axis carrying it with the chromatids. Thus chromatids thus assume either J or V shape called hetrobranchial or isobranchial chromosomes respectively.

Telophase:

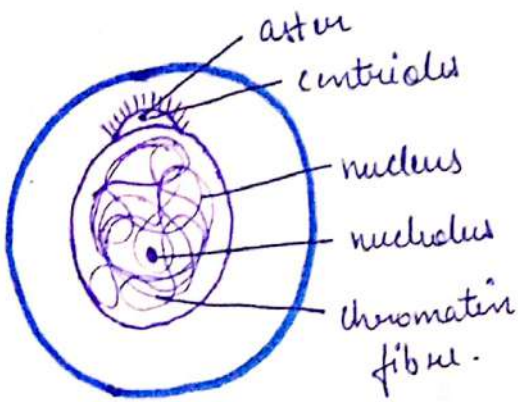
- The spindle gradually fader away become liquify and dispersed into cytoplasm.
- The NM develop and nucleolus makes it appearance. Chromosome uncoiled so that they become very long and thin.
- Chromosome reach the opposite pole and surrounded by NM.

Cytokinesis.

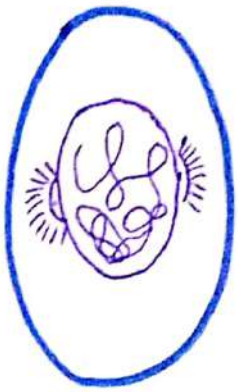
In the cell of higher plant cytokinesis occur a cytoplasm and NM between 2 daughter nuclei. A cell wall is the process of formation is called cell plate.

Significance of Mitosis.

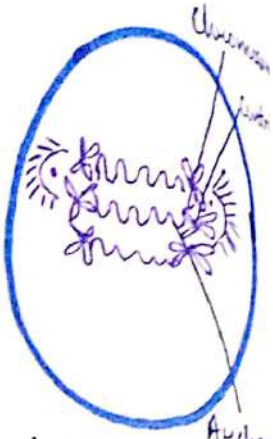
The chief function of mitosis are growth of organism of regeneration of damaged tissue. Other various function of mitosis are as follows -



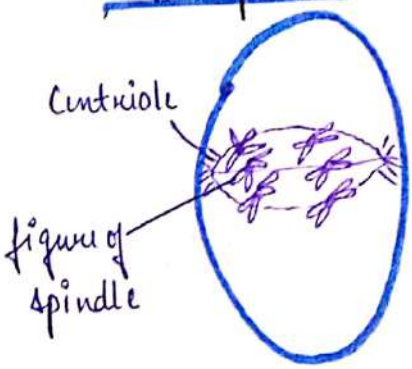
Interphase.



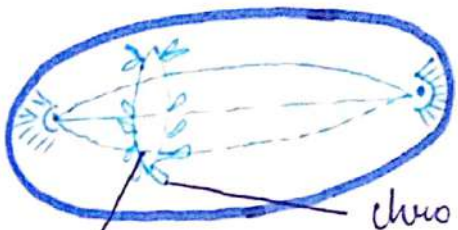
Early Prophase

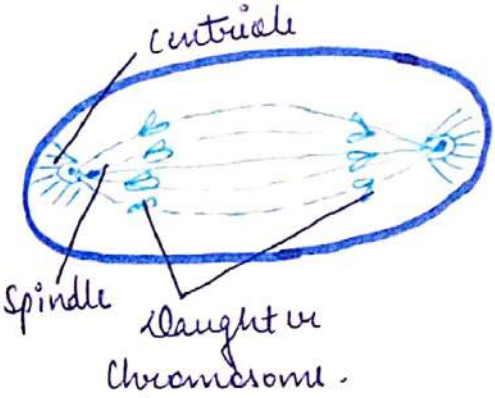


Late Prophase

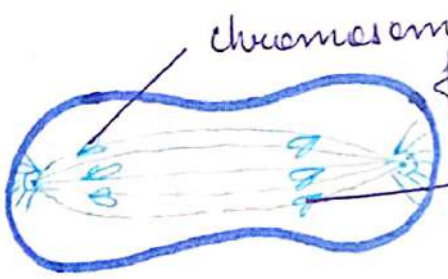


Prometaphase.

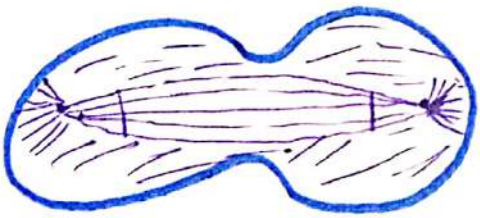




Early Anaphase



Late Anaphase.



Telophase.

2 Daughter Cells.

Diagrammatic Representation of Mitosis.

Meiosis.

Von Benedeta in 1883 in round worm observed meiosis. Meiotic division of one diploid cell give rise to 4 haploid daughter cell in 1st division reduction in chromosome without an division of chromosomes. In 2nd division separation of chromatids of chromosomes. These two division known as 1st meiotic division and 2nd meiotic division. Such division which reduces the diploid condition into haploid one is called reduction division or meiosis. The term meiosis is coined by JB farmer and JE Moray.

Premeiotic Interphase.

Chromosome replication during S phase approx. 3% of the total DNA present in the nucleus does not replicate chromosome replicate only one's while nuclei divide twice.

1st Meiotic Division.

1st Prophase.

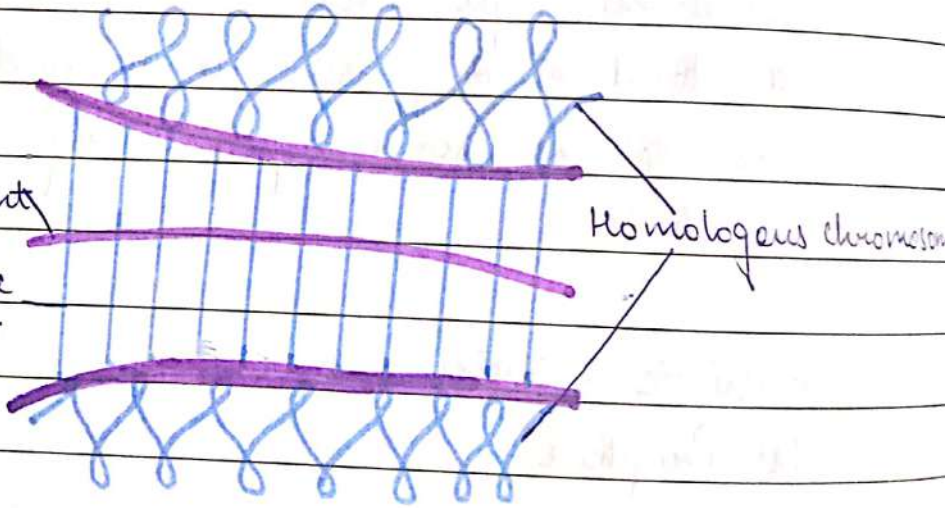
Leptotene: • Chromosome appear as long thread like str. loosely interwoven.

• Beaded structure known as chromomere present along the length of chromosome.

Zygotene: During this stage the homologus chromosome coming from different sexes of male and female began to attract each other to form pairs or bivalent the

process is called synapsis. Zygotene pairing starts from a point and proceeds over word in a zipper like fashion.

- Proterminal Pairing: Starts pairing at the end or terminal which gradually than progress towards the centromere.
- Procentric Pairing: Starts at the centromere and proceeds towards the end.
- Random or intermediate: Start at random at any point which then finally fused itogether. As synapsis takes place a complex structure becomes organized a space between paired chromosome. This structure is called Synaptonemal Complex.



Moses in 1956 discover Synaptonemal complex. According rule Chromosome pairing occur in 2 stages - 1st stage homologus move each other and stay 1000 Å away from each other. 2nd stage, a specific structure structure synaptonemal complex develop in these local region. Synaptonemal complex is bipartide structure usually found Between 2 paired homologus chromosome of each bivalent in all animal and plant nuclei

undergoing meiosis complete synaptonemal complex seen in zygonema in the region of pairing synaptonemal complex composed of protein consist of 3 distinct element rich in DNA, RNA and protein but central element contain RNA and protein lies part of DNA.
Synaptonemal complex interrupted as a protein frame work that permit the proper alignment of the homologous chromosome.

Pachytene: • Further condensation of chromosomes so that chromosome pair become shorter and thicker.

- These pair of homologous chromosome are called the bivalent (2 bivalent of 4 chromatid called tetrad).
- Crossing over between homologous chromosomes takes place this stage.
- Nucleus is distinct and quite large.

Diplotene: • Homologous chromosome start separating from one another due to such separation dual nature of bivalent become distinct and hence the
- 2 homologous of each bivalent appear to be attach with each other at one or more point these attachment are called Chiasma.

Chiasma Terminalization: Movement of chiasma towards terminal position it is due to the movement of homologous chromosome away from each other.

Diakinesis.

- The end of chiasma terminalisation marks
- Nucleolus or NM disappear towards the end of diakinesis
- Bivalent separate of due to repulsive force.
- Chromosome become shorter and thicker.
- Bivalent moves away from each other and separate towards the periphery of the cell.

Metaphase.

- Spindle appearing Bivalent become attached to spindle through centromere and appear in the form of an equitorial plate.

Anaphase.

- One chromosome from each bivalent began to migrate to one pole while the other migrate on another pole

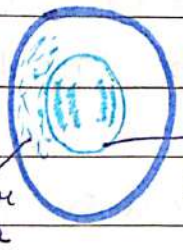
Telophase.

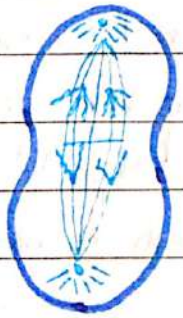
- Chromosome uncoiled partially.
- NM become organised around a group of chromosom
- Nucleolus also reappear.
- 1st telophase followed by cytokinesis given rise to a diaded.

Interphase.

- In many sp. the interphase after 1st meiotic division is absent in other sp. there it occur it is very short in duration there is no DNA synthesis during this interphase.

- When sister chromatid goes to same pole called miosis and a reduction division.
- When sister chromatid separate and goes to opposite pole called mitosis where chromosomes no. is same.
- Two daughter cell do not separate by they stay together this structure is called diad.





Diagrammatic Representation of Miosis.

Mendelian Genetics / Mendel And His Work.

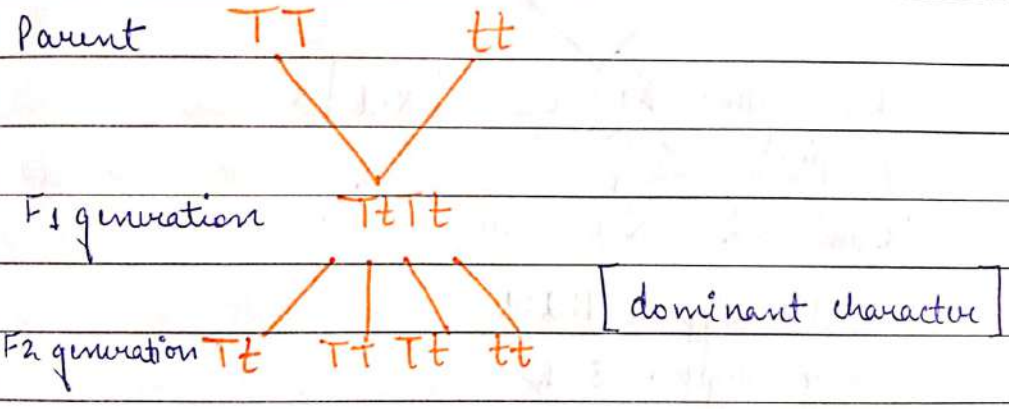
John Mendel born in July 22.1822. John Mendel attained agriculture of agriculture. He was appointed as teacher he studied mathematics and natural science in university of vianna.

Mendel found in edible pea a best material for his hybridisation exp. the pea plant has various contrasting character among different variety such as stem may be small or dwarf cotyledon may be green or yellow seed seed may be round or wrinkle. Seed coat may be round or wrinkle. coloured or colourless the unripe may be green or yellow the ripe pod may be inflated and constricted between leaf. the flower may have axil or terminal position and colour of flower may be red or white for the required cross pollination the anther have to remove from flower at a bud stage before their maturity (Emasculation).

Plants with one alternative trait were used as female and other alternative as male reciprocal process were also made. The population obtain as a result of crossing plant showing contrasting character is called F1 generation. The progeny of F1 plant were then obtain by self fertilization from F2 generation. Similarly next generation will also be obtain. On the basis of his exp. Mendel recognise phenomenon of dominance and formulated 2 laws-

- Law of Segregation
- Law of Independent Assortment.

The cross in the plant differing in single pair of contrasting character is known as monohybrid cross. For Ex- Mendel made a monohybrid cross between tall and dwarf pea plant, only tall pea plant appear in F_1 generation. But when the F_1 progeny where allowed to be self fertilized both characters appear in F_2 generation. This shows tallness dominates over dwarfness. The character which express in F_1 generation is called by Mendel as dominant character. While the character which remained unexpressed or latent had been called recessive character.



Phenotypic = 1 : 2 : 1.

Genotypic = 3 : 1.

Variation In dominance relation.

Mendel reported full dominance and recessiveness for all the gene pair or allele pair he studied. Mendel found that in heterozygous state only one of the 2 allele of a gene was able to express itself i.e, produce the character. This allele is referred to as dominant allele and recessive allele is unable to express itself in the heterozygous state all situation of dominance have been grouped into the foll. categories-

(i) Complete dominance
(ii) Incomplete dominance
(iii) Co-dominance
(iv) Over-dominance

Complete Dominance.

The phenotype produced by heterozygotes is identical with that produced by homozygotes for the consult dominant allele the dominant allele in such situation is known as complete or fully dominance.

Parent RR × rr

F1 generation (Selfing) RrRr [Red]

F2 gen: RR Rr Rr rr

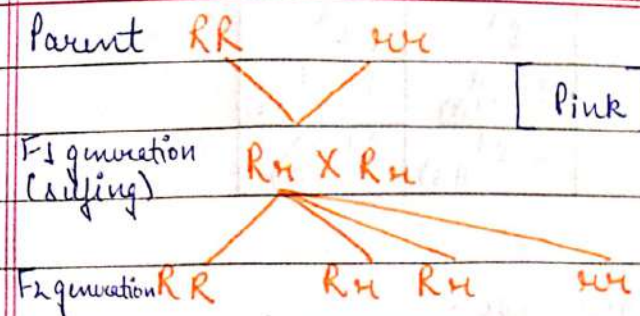
Phenotype = 1:2:1

Genotype = 3:1

In F1 generation phenotype red colour complete dominance.

Incomplete Dominance.

In many cases the intensity of phenotype produce by heterozygotes is less than that produce by homozygotes for the consult dominant allele however the phenotype of heterozygote falls between those of the homozygotes for the 2 consult allele such a situation known as incomplete or partial dominance and the dominant allele is termed as incomplete or partial dominant.



Phenotype = 1:2:1 (Pink).

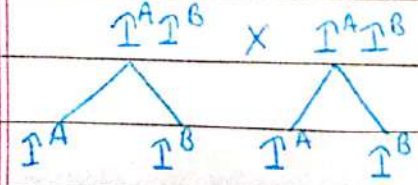
Genotype = 3:1

Co-Dominance.

When both the allele express themselves in heterozygotes. As a result heterozygote for such gene posses the phenotype produced by both the constant allele.

One of the most widely known and the earliest recorganised human blood group in a ABO blood group. These blood group arise due to the presence of an antigens on the surface of red blood cells. These antigens are produced by the gene I. One dominant allele of this gene that is I^A allele produce Antigen A which rise to blood group A. Another dominant allele of the genes, I^B produce antigen B which is responsible for blood group B. In the heterozygote I^AI^B, both the allele I^A and I^B produce their respective antigen. As a result the heterozygote have the blood group AB.

Marriage Between heterozygote I^AI^B having blood group AB produce 3 types of progeny i.e, blood group A, B, AB. The ratio is 1:2:1.



♀♂	I^A	I^B
I^A	$I^A I^A$ (A)	$I^A I^B$ (AB)
I^B	$I^A I^B$ (AB)	$I^B I^B$ (B)

1 : 2 : 1 - Phenotype.
AB AB B

Over Dominance.

In some gene intensity of character expression is greater in the heterozygotes than in the 2 consult homozygotes this situation is known as over dominance. The white eye w gene of drosophila exhibit over dominance for some of the eye pigment. Ex- Sepiapteridine, hemiblaus allele "w" produces white eye in the homozygous state w^+ white is complete dominant allele ww give rise to dull red eye colour, eye pigment Sepiapteridine, hemiblaus are in low concentration in small ww homozygotes while w^+w^+ homozygotes relatively higher concentration of this pigment. However their heterozygotes for this gene w^+w have an appreciably higher concentration of these 2 pigment than the 2 homozygotes w^+w^+ ww. In F_2 generation have 1 : 2 : 1 ratio.

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Law of Segregation.

Mendel's first law the law of segregation is also known as **Law of Purity of Gamete**. The law state that the hybrids or heterozygotes of F1 generation have 2 contrasting character or allelomorphs of dominant and recessive nature. These alleles though remain together for long time but do not contaminate or mix with each other and separate or segregate at the time of gametogenesis. So that each gamete receive only one allele of a character either dominance or recessive. Mendel crossed a homozygous red flower Rplant with a homozygous white part Rplant, the F1 heterozygotes or hybrid produce red colour flower (Pink colour flower in incomplete dominance). When F1 hybrids were allowed to be self fertilised they produce both colour red and white (red, pink and white in incomplete dominance) in F2 generation in the ratio of 3:1.

RR X rr

R_H

♀/♂	R	r
R	RR	R_H
r	R_H	rr

Law of Independant Assortment.

To study that how different characters good behave in relation to each other in their inheritance from generation to generation, for this purpose Mendel crossed 2 varities of pea plants which are differing in 2 pairs of contrasting characters because such crosses yielded dihybrid and at a time 2 pairs of contrasting characters have been considered in them. Therefore these crosses where known as dihybrid cross.

Mendel Crossed a homozygous pea plant having yellow round seeds with homozygous pea plant having green plant where F_1 hybrid were formed to have Y.R.S. When the F_1 hybrid were allow to cross among themselves they produce 4 types of seeds in the ratio of 9:3:3:1, Yellow round (9), Yellow wrinkled (3), green round (3) and green wrinkled (1).

YYRR × yyrr

$Yy R_r$ ⇒ 9:3:3:1

	YR	Y_r	yR	yr
YR	YYRR Yellow round	YYR$_r$ Yellow round	YyRR Yellow round	Yy R$_r$ Yellow round
Y_r	YY R$_r$ Yellow round	YY$_{rr}$ Yellow wrinkled	Yy R$_r$ Yellow round	Yy$_{rr}$ Yellow wrinkled
yR	yyRR Yellow round	YyRR Yellow round	Yy R$_r$ Green round	yy R$_r$ Green round
yr	Yy R$_r$ Yellow round	Yy$_{rr}$ Yellow wrinkled	yy R$_r$ Green round	yy$_{rr}$ Green wrinkled

Thus 4 types of alleles are assorted independently to produce four types of gamete that is YYRR, YR, Yr, yR and yr.
These four types of gamete (Polen or ovules) of F_1 hybrid unite at random in the process of fertilization and produce 16 types of individual in F2 generation in above table.
Thus the 16 F2 individuals have the ratio of 9 yellow round : 3 yellow wrinkled : 3 green round : 1 green wr
These result have proved the law of independent assortment and showed that, each pair of contrasting character behave independently and no permanent relation with a particular character. The allele Y was associated with allele R in parent but it does not always remain associated with it and it is also associated with the allele when the parent differ from each other in 2 or more pairs of contrasting character or factors then the inheri of one pair of factor is independent to that of the other pair of factors, this is the mendels law of independ assortment.

Back Cross And Tut Cross:

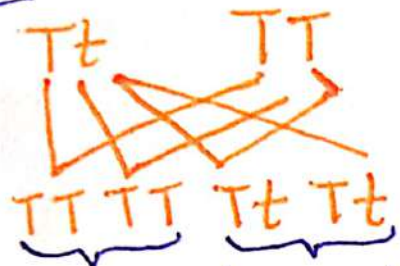
When F1 individuals are crossed with one or 2 parent from which they were derived then such cross is called Back Cross. In such Back crosses when F_1 is Back crossed to the parent with dominant character no recessive individuals are obtain in the progeny. On the other hand when it is crossed recessive parent both phenotype appear in the pogeny. While both of

Back Cross And Test Cross

TT tt

Tt (hybrid Tall).

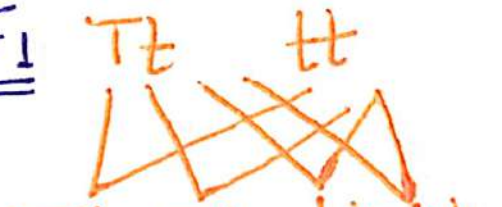
F2



(Homozygous Tall) (hybrid Tall).

[Genotype = 2:2.]

F1



Heterozygous Homozygous.

[Phenotype = 2:2]

YyRr
(Yellow round)

YR Yr yR yr

yyrr
(Green wrinkled)

yr

yr	YR	yr	YR	yr
	YyRr Yellow round	Yyrr Yellow wrinkled	yyRr Green round	yyrr Green wrinkled

[Genotype = 1:1:1:1.]

Date
Page

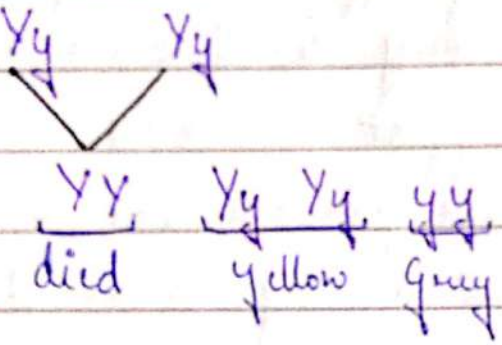
thus crosses are back crosses, only the cross with the recessive parent is known as Test Cross. It is called test cross because it is used to test whether an individual is pure (homozygous) or hybrid (heterozygous) for a monohybrid test cross ratio remain 1:1 but for a dihybrid test cross ratio is 1:1:1:1.

Lethal Gene Interaction.

There are genes which controls certain phenotypic traits and at the same type also influence the vibrati of individuals. There are still other genes which have no effect on the phenotype but influence the vibraty. This influence on viability may be in such order that the individual may way to survive. Such genes which cause the death of a individuals carrying it are known as lethal gene. Most of the lethal genes are recessive lethal, hence their lethal effect is expressed only when they are in homozygous stage and the survival of heterozygous is

In 1905 a french genetics L. Cuenot reported on the inheritance of mouse body colour. He found the Yellow coat in mouse is produce by a dominant gene Y while its recessive allele y determine the normal grey colour. Further all the mice with yellow coat colour were heterozygotes Yy and he was unable to found a mouse homozygous. A recessive lethal YY because it causes the death of homozygous YY embry

at an early stage of development.
Mating of yellow female with yellow male produce the following zygotes 2:1. YY embryos die at an early stage in the uterus itself. Thus the phenotic ratio in this mating ratio is 2:1



Semi lethal.

The genes causing lethality may differ in the level of their penetration and expressivity. Many of these genes do not cause definite lethality semi lethal or subvital. It is difficult to draw a line between categories of lethal but usually only those genes are regarded as lethal genes which cause a death of organism at early stages.

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Gene Interaction.

The phenomenon of 2 or more genes governing the development of a single character in a way that they affect the expression of each other in various way is known as Gene Interaction. When Gene affect in any way the expression of other gene, the phenomenon is called Epistasis. Gene interaction may evolve 2 or more gene.

Type of Gene Interaction.

- Typical dihybrid Ratio for a single trait or 2 gene pair affecting same character.
- Duplicate gene action.
- Complement Gene action.
- Supplementary Gene action.
- Inhibitory Gene action.
- Masking Gene action.
- Polymeric Gene action.

Type of Gene Action	Ratio	P_1	P_2	F_1	Gametes	F2	Explanation
1. Two gene	9:3:3:1	PPrr (Pea comb)	ppRR (Rose comb)	PpRr (walnut)	PR pR Pr pr PR = walnut comb - 9 pR = Rose comb - 3 Pr = Pea comb - 3 pr = single comb - 1	PR / pR / Pr / pr PR: [illegible] pR: [illegible] Pr: [illegible] pr: [illegible]	When both dominant allele present produce walnut (9:...) when single allele present produce Pea/Rose comb.
2. Duplicate gene action	15:1 non floating : floating	A_1A_2 (non floating)	a_1a_2 (Floating)	$A_1a_1A_2a_2$ (non floating)	A_1a_2 A_1a_2 A_1a_2 A_2a_2	[illegible]	Only single allele able to express only dominant them.
3. Complementary gene action	9:7 Purple : white	CCRR Purple	ccrr White	CcRr Purple	CR Cr cR cr	CR / Cr / cR / cr CR: CCRR / CCRr / CcRR / CcRr Cr: CCRr / CCrr / CcRr / Ccrr cR: CcRR / CcRr / ccRR / ccRr cr: [illegible]	Any one of the 2 dominant gene is unable to produce the phenotype when it is alone.
4. Supplementary Gene Action	9:3:4 Purple : red : white	RRPrPr Purple	rrprpr White	RrPrpr Red	RPr Rpr rPr rpr RPr - Purple Rpr - Red rPr - Purple rpr - white	RPr / Rpr / rPr / rpr [illegible]	Dominant allele R produces red & Pr not produces any colour but present red colour and pure recessive and produces white colour. If R is alone produces red colour and with Pr it produces purple colour (because Pr present red.)
5. Inhibitory Gene Action	13:3 white : Red	RRii Red	rrII White	RrIi white	RI Ri rI ri	RI / Ri / rI / ri RI: RRII / RRIi / RrII / RrIi Ri: RRIi / RRii / RrIi / Rrii rI: RrII / RrIi / rrII / rrIi ri: RrIi / Rrii / rrIi / rrii	One dominant inhibit by gene Prevent the expression of another dominant gene.
6. Masking Gene Action	12:3:1 Black : Yellow : White	BByy Black	bbYY yellow	BbYy Black	BY By bY by.	BY / By / bY / by BY: BBYY / BBYy / BbYY / BbYy By: BBYy / BByy / BbYy / Bbyy bY: BbYY / BbYy / bbYY / bbYy by: BbYy / Bbyy / bbYy / bbyy	Both the gene expresses themselves when there dominant allele present together one gene does not inhibit the expression of another gene.

7. Polymeric Gene Action.

Ratio = 9:6:1 (long awn: medium awn less).

P1 = AABB (long awn)

P2 = aabb (awnless)

F1 = AaBb (long awn).

Gametes = AB, aB, ab, bA

F2 =

	AB	aB	bA	ab
AB	AABB	AaBB	AABb	AaBb
aB	AaBB	aaBB	aABb	aaBb
bA	AABb	AaBb	AAbb	Aabb
ab	AaBb	aaBb	Aabb	aabb

Expression = Dominant allele of both the gene are present together produced the effect (long) but when Dominant gene are alone produced medium length and recessive produced awnless.

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Unit - 3.

Linkage.

The genes for different character may be either situated in the same or different chromosome. If the genes are situated in different chromosome, the character, they control, appear in next generation but if the genes are situated in the same chromosome and are closely placed to each other, they trend to be inherited together. This type of co-existence of 2 chromosome genes in the same chromosome is known as **Linkage.**

Difference Between Independent Assortment and Linkage.

Example 1: for independent assortment: Ratio 1:1:1:1.

AABB aabb

AaBb X aabb

Test Cross F1 Aabb : AaBb : aaBb : aabb

F2 1 : 1 : 1 : 1.

Example 2: for linkage: Ratio 1:1.

Linkaged gene do not assort independently but trend to stay together in same combination as they were in the parent.

AB/AB ab/ab

AB ab

F1 ABab

Test cross. AB/ab X ab/ab

	AB ab	ab
	AB/ab	ab/ab
F2	1:1	1:1

This theory was given by "Morgan" in (1911).

Coupling And Repulsion Hypothesis.

Bateson and Punett pointed out when 2 or more dominant inherited from same parent, they tended to remain together and did not assort independently so, that the recombinants were fewer than the parental type. Similar was the case with recessive allele also. Bateson and Punett called this tendency of both dominant or both recessive introduced in the cross by the same parent to remain together in consequent generation more often as coupling. Conversely it was found that the 2 dominant gene introduced in the cross by different parent. This is called repulsion.

Chromosome Theory of Linkage.

Morgan along with Castle formulated the chromosome theory as follows –

- The gene which show the phenomenon of linkage are situated in the same chromosome and these linked gene usually remain bounded by the chromosomal material, so that they cannot be separated during the process of inheritance. The distance between the linked genes determines the strength of linkage. The closely related gene show stronger linkage than the widely relative gene which show the weak linkage.

The genes are arranged in linear fashion in the chromosome.

Kinds of Linkage.

1. **Complete Linkage:** The complete linkage is a phenomenon in which parental combination of characters appear together for 2 or more generation in a continuous and regular fashion. In this type of linkage genes are closely associated and found to transmit together.

2. **Incomplete Linkage:** The linked genes do not always stay together because homologous non-sister chromatids may exchange segments of varying length with one another during meiotic prophase. This sort of exchange of chromosomal segment in between homologous chromosome is known as **Crossing over**. The linked gene which are widely located in chromosomes and have changes of separation by crossing over are called **incompletely linked genes** and the phenomenon of their inheritance is called **incomplete linkage**.

3. **Crossing Over:** The crossing over is a process that produce new combination of genes by interchange of corresponding segment between non-sister chromatids of homologous chromosome.

OR

Mutual exchange of blocks of homologous genes between a pair of homologous chromosome is called the **Crossing over**.

Crossing over involves breaking and rejoining of chromosomes in the synptonemal complex. The pairs where homologies are held together and exchange bet. chromatids are known as Chiasmata. The phenomen. of crossing over provides an exhaustible store of gen. variability in sexually reducing organism. As a result of crossing over new gene combination are produced which play an imp. role in microevolution. Cross over between linked genes allows their recombin. during meiosis is called meiotic crossing over and it involve breaking and rejoining of chromosome in synptonemal complex during zygotene and pachytene and about synptonemal complex.

When the process of crossing over occurs in the chromosome of body or somatic cells of an organism during the mitotic cell division is called Somatic or mitotic crossing over.

Theories of Crossing Over.

Break And Exchange theory.

Is the most excepted theory states that in the crossing over breaks occur in the non-sister chromatids of the tetrad and exchange of chromosomal segment occurs between non-sister chromatids.

Duplication theory.

This theory was proposed by John Belling (1928) in meiosis.

- During duplication of chromosome eventially the chromosomes are duplicated and newly formed chromo. tightly jointed the old one.
- When inter chromomers region are synthesized to join these new genes on chromomers they may switch for a newly synthesized chromomere of on homologous chromosome to adjacent chromosome of other homology. This result into the formation of recombinant or cross over a new set of chromatids.

24 Jan, 2020

Cytoplasmic Inheritance.

It is universally accepted that gene showing mudilian inheritance are located in chromosome of eukaryotic nuclei since mudilian inheritance pattern is regarded as sufficient widence for a gene to be located in chromosome such gene are termed as nuclear genes or genes.

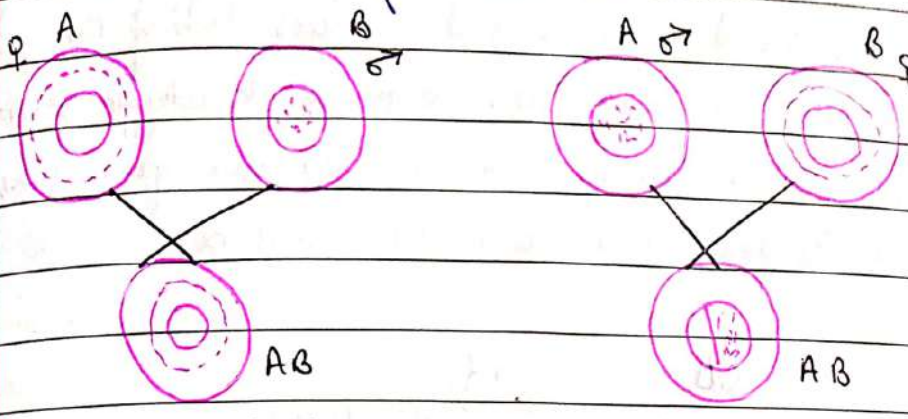
It is perhaps not suprising that some of the character may occasionally be transmitted from one generation to another through cytoplasm. The transmission of certain genetic information from parent to offspring through cytoplasm is termed as cytoplasmic inheritand or extra chromosomal or extra nuclear inheritance.

Extra chromosomal inheritance is governed by cytoplasmic factor that exhibit replication and independent transmission. Since the gene governing trait showing cytoplasmic inheritance are located outside the nucleus and in the cytoplasm. They are referred to as plasma gene, cytoplasmic genes, cytogenes, extranuclear gene or extrachromosomal gene.

Maternal effect.

The development of some characters in several organism is either governed or markedly influenced by genotype of female parent this is known as Maternal effect. Such characters are governed by nuclear genes however maternal effect are produced due to effect of genes through cytoplasm. The 2 imp. and essential organelles i.e.,

Plastids (In plants only) and mitochondria located in cytoplasm carry DNA. It controls extra chromosomal inheritance in many cases.



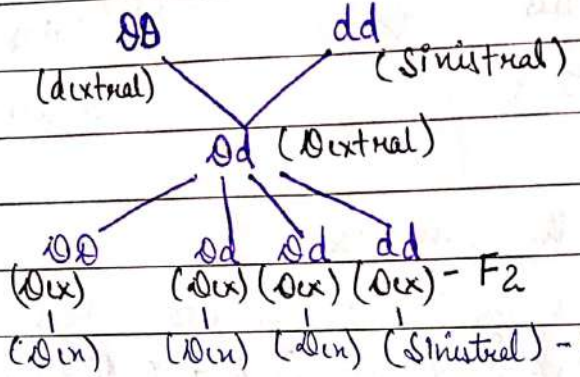
Resemble to A

Resemble to B.

Shell Coiling in Limnaea.

In some cases the maternal attack does not disappear during development but is retained throughout the adult life in this snail (limnaea) the coiling of shell is determined by a pair of genes. The coiling may be of 2 type - one being towards the left side and i.e. Sinistral and 2nd towards right i.e. dextral. The Dominant allele D produce dextral coiling while recessive allele d sinistral. If three snail are crossed coiling of the shell of offsprings will be determined by the genotype of the maternal snail irrespective to genotype of the offspring. So a self fertilized dextrally coiled heterozygote (Dd) will always produce egg that develop into dextrally coiled offspring even if the offspring poseen the recessive allele these effect however last only for one generation because in next generation sinistrally coiled offspring are produced by the homozygous (dd) mother even though themselves are dextrally coiled. The typical 3:1 ratio is exhibit in F_3 in place of F_2 the 3:1 ratio clearly

indicate that coiling of shell is governed by single nuclear gene but segregation of this nuclear gene appears to be delayed by one generation i.e. act segregation of the nuclear gene Dd is normal and occurs during the gamete formation in F_1 generation itself. But the phenotypic effect of this segregation become visible only one generation later i.e. in F_2 generation than the usual F_2.



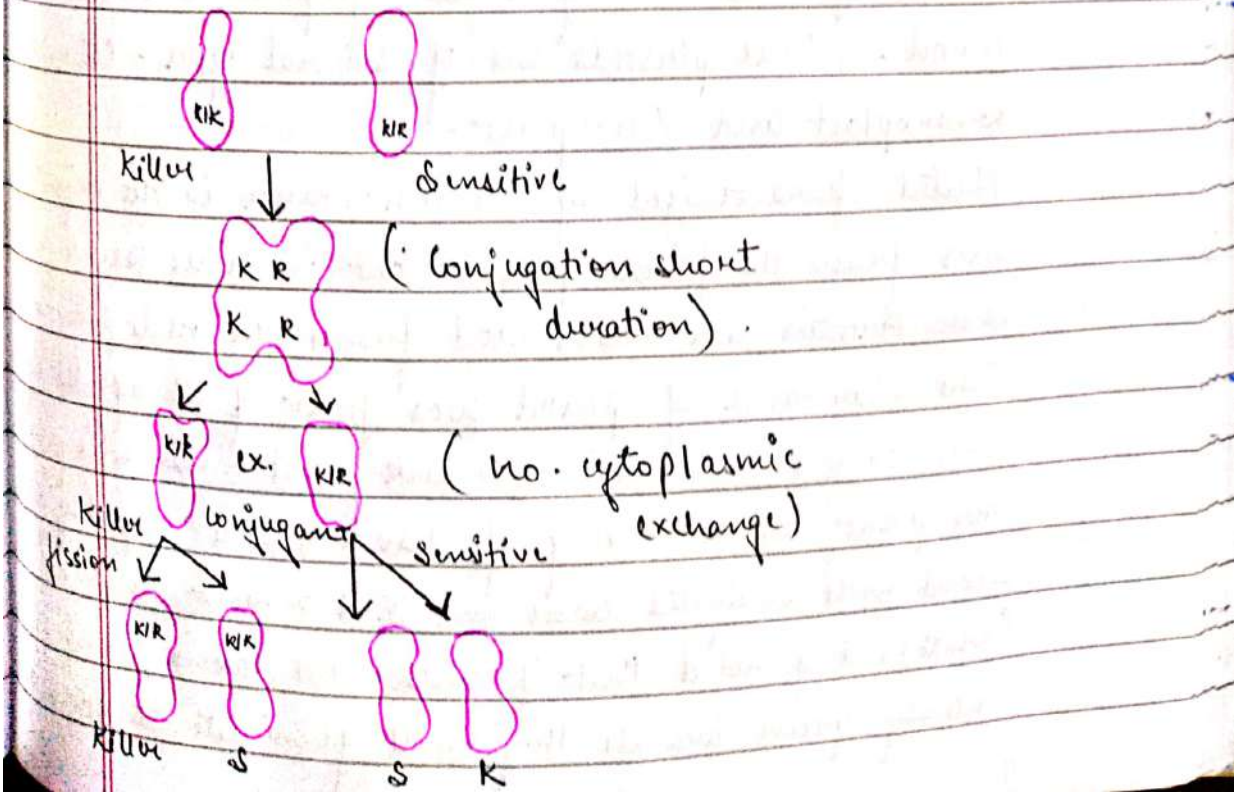
Kappa Particle Transmission in Paramecium.

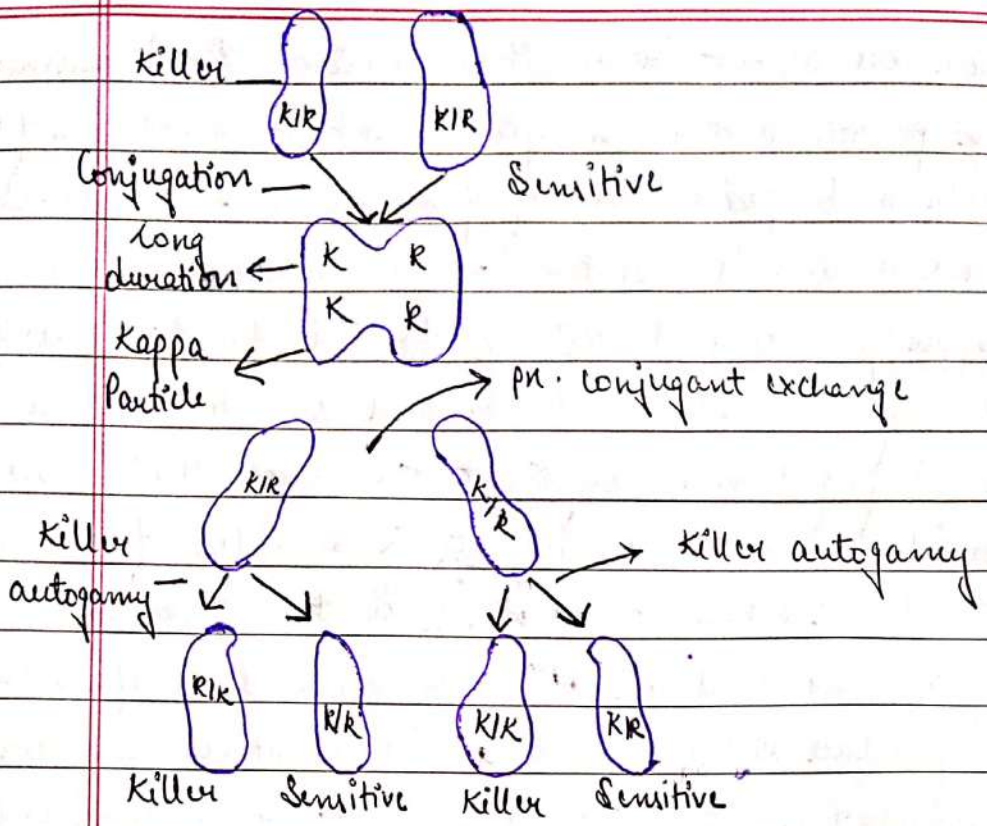
TM Sonneborn and his associate reported the transmission of certain cytoplasmic particle in Paramecium aurelia, this particle are called as Kappa particle in this species 2 strains of individual have been reported one is called as killer which secrets a toxic substance paramecium and the other strain is known as Sensitive and is killed if it comes in contact with paramecium.

The killer strain require atleast 400 Kappa particle to secrete the sufficient amount of paramecium to kill the sensitive strain in cytoplasm of killer strain these are present a Kappa particle which have symbiotic cytoplasmic bacteria having cytoplasmic DNA. The maintainance of these particle is dependent on a dominant nuclear gene "K". Kappa

particle are absent in sensitive strain. The transmission of Kappa particle is through cytoplasm but maintain. of kappa particle and production of paramecium is controlled by gene K which is dominant over other K. The transmission of Kappa particle and killing effect is treated out if there is conjugation between killer and sensitive strain.

On conjugation, conjugants exchange their nuclear material so that X conjugants K resulted from conjugants KK and KR when conjugation is for normal time then only nuclear material is exchanged and therefore the killer will produce killer daughter and sensitive daughter but if conjugation for longer period there will be exchange (Kappa particle) and cytoplasm resulting by both the X conjugant so that all daughter paramecia produced are killer because all inherit Kappa particle through mixing of cytoplasm therefore this trait is transmitted through cytoplasmic heredity the trait is only stable in killer strain.





25 Jan, 2020

Chloroplast Genetics.

Chloroplast are found only in green plant so that chloroplast genetics is a subject of study of extra nucleus inheritance only in green plant. In cytoplasm of plant cell are formed mainly small cytoplasmic bodies called Plastid. These plastids are of several types - Chloroplast, Chromoplast and Leucoplast.

Plastid characterized by the inheritance in the majority of cases from the female parent but in some cases a few characteristics are transmitted from the male parent also.

The inheritance of plastid was first of all reported by Carl Correns in 1909 in 4'o Clock plant - mirabilis jalapa. This plant has a variety of leaves One is completely green second with variegated color and IIIrd without green color (white), it is noted that if seeds were taken from an entirely green branch they will germinate to produce

plants which are completely green while a seeds from a variegated branch produce a plant which are with variegated leaves.

But if seeds from a white branch are raised to plant the young plant will die soon due to the absence of chloroplast and in compatibility for photosynthesis. Here the pollen grain taken into pollination are interfere almost nil with, humidity because the plastid are present more in ovule and almost none in pollen grain. It is clear from above experiment that color of leaves depend upon the inheritance of the plastid such a method of transmission of colour has been found in 20 genera of plant including rice, maize, barley etc.

Parent Type		Progeny.
PISTIUATE PARENT	POLLEN PARENT	PHENOTYPE.
White leaved	Green leaved	White
White	White	White
White	Variegated	White
Green leaved	Green	Green
Green	White	Green.
Green	Variegated	Green.
Variegated leave	Green.	Variegated, green, white
Variegated leave	White.	Variegated, green, white
Variegated.	Variegated	Variegated, green, white.

For these experiment 2 suprising feature came to light→...

Reciprocal crosses.

Yield different Result, For Ex- The cross between green female and white male yield green plants whereas the cross between white female and green male yield white plant (which usually soon die).

The phenotype of female plant in each cases determine the phenotype of progeny the male plant makes no contribution to phenotype of progeny. This phenomenon is refered to as Maternal inheritance.

Sex Determination.

Sex determination in most plants and animals is concerned with study of factors which are responsible for make of an individual male and female or ♀. Sexual dimorphism has also been studied in considerable details in atleast 2 organism; Drosophila melanogaster (fruit fly) and the Caenorhabditis elgans (a free living nematode).

Sex Character.

Most animal male and female individual differs from many characteristics features these characters are called Sex characters.

Primary And Secondary Sex character.

Primary sex character are related to the gonads or gametes producing organs of male and female individuals.

Secondary sexual character include all character other than gonads that show consistence difference between male and

female individual of species. Ex- pitch of voice, mammary gland.

Chromosome theory of Sex determination.

There may be 2 type of chromosome present in such individuals -:

1) **Autosomes:** Those chromosome whose no. and morphology do not differ between male or female of a species called Autosomes.

2) **Sex chromosomes:** Male and female individual ordinary differ from each other in respect of either the no. or morphology of homologies of one chromosome pair is known as Sex chromosome or Allosome.

There are 2 type of chromosomes X and Y. X chromo. is found in both male and female. Although one sex has only one while other sex has 2 sex chromosome. In contrasting Y chromosome occur only one of 2 Sex.

Ex → Male mice, Drosophilla And human female bird and reptile. Y chromosome contain mostly heterochromatin and regarded as inactive. X chromosome contain euchromatin

17 Jun 2020

Y chromosome contain mostly heterochromatin. X chrom. of genes located in both show a peculiar pattern of inheritance called Sex linkage. In a diploid individual 2n-2 autosome and 2 sex chromosomes.

Autosomes.

The chromosome which have no relation with the sex and contain the genes which determine the somatic characters of the individuals.

Mechanism of Sex Determination.

In dioecious diploid organism following a system of sex chromosomal determination of sex has been recognized

- Heterogametic Male.
- Heterogametic female.

Heterogametic Male.

In this type the female have 2x chromo. and male has only 1x chromo. Therefore during Gametogenesis produce 2 type of gametes (x and Y), 50% carry x chromosome whereas another 50% gamete lack x chromosome. Such a sex which produces 2 different type of gamete called Heterogametic sex and female produce similar type of gamete is called Homogametic sex. Heterogametic male may be of 2 types:-

XX- XO Type.

In certain plants, Ex: Ballisneria and Dioscorea etc. The female having 2x chromosome where male have only 1x.

XX - XY Type.

In man and other mammals female has 2x and male having 2 heteromorphic sex chromosome produces 2 kinds of sperms half with x chromosome and half with Y chromosome.

The sex of embryo depends on the kinds of sperms and egg fertilize by x bearing sperm produces a

female but if fertilize by Y bearing sperm produced a male.

Heterogametic Female.

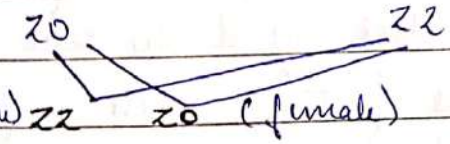
Heterogametic females may be of 2 type-

XO-XX System.

In moth and butterflies the female posses single Z chromosome and referred to as XO i.e, heterogametic producing 2 kinds of egg half with Z chromosome and half without Z chromosome. The male posses 2Z chrom. and is homogametic producing single type of sperm carries a Z chromosome. The sex of offsprings depends on the kind of egg.

♀ ♂

2A + ZO. 2A X ZZ



ZW-ZZ System.

Fishes, Reptiles and Birds; some plants like Fragaria clation contain this system true female has 1Z chromo. and 1W chromosome and male has 2 Z chromosome. The sex of offspring depends on the kind of egg (Z or without Z). The Z bearing X produce male but W bearing X produce female.

Xenic Balance Theory.

Willson 1909, Bridges 1921 and Gold Smith 1934 Given this theory. The most organism generally have inherit

potentiality for both sexes and each individual is found to be more or less intermediate between male and female. Hence may be referred to as Intersex. There seems to be exist a very delicate balance of male and female in their hereditary complement of an individual and mechanism like the XY ordinary serve to trip the balance in one direction or another. Such genic balance mechanism of determination of sex was first of all studied in Drosophilla by C.B Bridge.

In Drosophilla the presence of Y chromosome has been found essential for the fertility of male sex but that has nothing to do with the determination of male sex. The sex of an individual then depends upon the ratio of X chromosome to autosomes. If each haploid set of autosome carries factors with a male determining value equal to one then each X chromosome carries factor with a female determining the value of one and half, Tior a represent autosomes a normal male (AAXY) the male and female determiners are in the ratio of 2: 1/2 and therefore the genic balance is in the favour of maleness. A normal female AAXX has a male and female ratio of 2:3 and therefore the balance in the favour of femaleness.

3A+XXX ♀ × 2A+xy ♂

	A+x	A+y
2A+xx	3A+xxx triploid ♀	3A+xxy triploid intersex
A+x	2A+xx diploid ♀	2A+xy diploid ♂
2A+x	3A+xx triploid ♀	3A+xy Super ♂
A+xx	2A+XXX Super ♀	2A+xxy diploid ♀

Phenotype	No. of Chromo.	No. of autosome	Sex Index.
Super female.	3	2	1.5
Normal female. — tetraploid	4	4	1.0
— triploid	3	3	1.0
— diploid	2	2	1.0
— haploid	1	1	1.0
Inter Sex	2	3	0.67.
Normal male	1	2	0.50
Super male	1	3	0.33.

When the XY a ratio is 1.0 the individual will be female and if its is 0.50 it would be male. But when this balance is disturb the sex of individual deviate from normal male or normal female. Ex- when XY a ratio falls between 1 and 0.50 it would be Intersex, when it is below 0.50 it would be super male and when above 1.0 it would be super female.

21 Jan 2020

Gynandromorph:

Concept of sex determination as developed for drosophilla are very few occasional occurance of gynandromorphs.

which are individual in which part of body expres male character whereas other part expres femal character in a way gyandromorph represent one kind of mosaic or an organism made up of tissue of male and female genotype. Eg - Bilatral gyandromorph of drosophilla is male on one side and female on other it result due to loss of an X chromosome in a particular cell during development i.e when the dangered X chromosome fails to be incorporated in a daughter nucleus and is lost forever.

If this event happens during first cleavage of zygote then one of the two blastomere will have AAXX chromosome compliment and other will have AAXO the portion of body developing from AAXX will be normal female and body developing from AAXO will be male.

The cytological examination of gyandromorph suggest that Y chromosome, does not play an role in determination of Sex in drosophilla.

Chromosomal Abbrevation / Variation

The chromosome of each species has a characteristic morphology / structure and solution but sometimes due to certain accident or irregularities at a time of cell division, crossing over or fertilization some alteration in morphology and no. of chromosome take place.

Variation in chromosome morphology or structural
Variation in chromosome no. or numerical abbrevation

1. Variation in chromosome morphology.

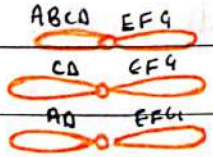
Structural changes mostly caused due to mutation or accidental, natural or induced breakage of chromosome. Induced chromosome breakage may be caused by radiation and chemicals such as lysergic acid diethylamide (LSD), the chromosomal aberration may remain confined to a single chromosome or may extend to both of member of a pair or may involve two or more pairs of chromosome. It is following 2 type-

- Intrachromosomal Aberration.
- Interchromosomal Aberration.

Intrachromosomal Aberration.

It is of following type :-

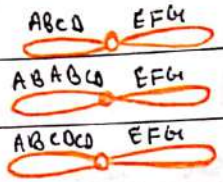
Deletion or Deficiency: When a chromosome lack in a intercalary or terminal segment the deficiency or deletion occurs. The lost chromosomal segment if lacks in a centromere lag in anaphasic movement and is lost from reorganising nuclei. A lost of any considerable portion of chromosome is usually lethal to a diploid organism because of genetic imbalance.



Terminal Intercalary.

Duplication: Duplication occur when a segment of chromosome is represented 2 or more times in a chromosome. The extrasegment may be attached to the chromosome whose loci are repeated or to a different linkage

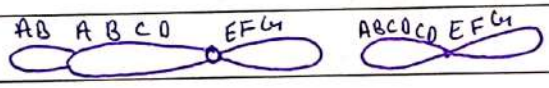
group or present as separate fragment moreover duplication is useful in volution of new genetic material and in altering the phenotype due to reallocation of chromosomal material.



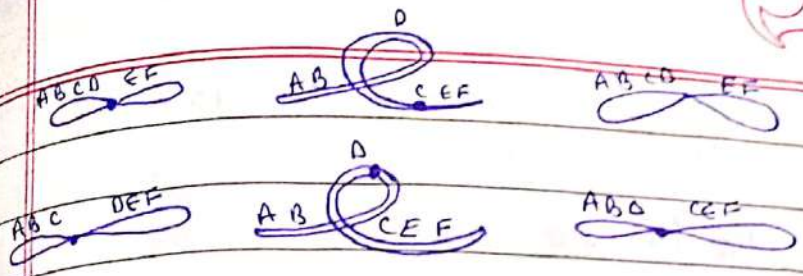
Terminal intercalary.

30 Jan, 2020

Moreover the duplication is useful in evolution of new genetic material and altering the phenotype due to reallocation of chromosome material.



Invorion: An invorion is a chromosomal abnormation in which segment is inverted at 180°. Invorion are called pericentric when the segment include centromere and paracentric if centromere is located outside the segment when a crossing over occur within the inverted segment of a paracentric invorion dicentric and acentric chromatin are form. A dicentric and acentric chromatin are form. A dicentric chromatin form a bridge that breaks when a anaphase chromosome separates toward the pole A crossing over occur within a loop of pericentric invorion the chromatin are produced within deficiency and a duplication.



Isochromosome.

An isochromosome is a chromosome in which both arms are identical. It is thought to arise when centromere divide in a wrong plane. Yielding two daughter chromosome each of with carries the information of one arm only but present twice.

Inter Chromosomal Abberation.

When break occur in non homologus chromosome and resulting fragment are interchange by both of the non-homologus chromosome. The interchromosomal occur. The interchromatid Abberation include translocation

Translocation.

Translocation include the shifting of a part of one chromosome to another non homologus chromosome If two non-homologus chromosome exchange parts which need not to be of same size the result is a reciprocal translocation. The reciprocal may be of following Types-

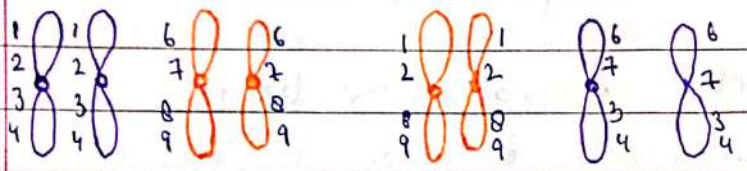
Homozygotic Translocation.

In homozygotic Translocation normal meiosis occur and that cannot be detected cytologically. Genetically they are marked by alter linkage group and by the fact produced a

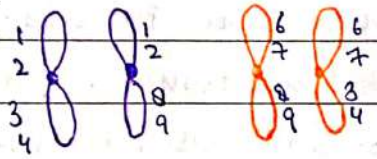
somewhat different effect in its new location.

Heterozygotic Translocation.

In Heterozygotic translocation considerable degree of meiotic irregularity occur typically crossed shape formation is seen in prophase I. The heterozygous translocation produce semi sterile organism between half or 2/3 of gamete or spore failed to receive the full compliment of gene required for normal development of Ex common in Maize.



Normal



Homozygotic.

Heterozygotic

Translocation may be of 3 types -

1. **Simple Translocation**: They involve a single break in a chr. the broken piece get attached to one end of non homologous chromosome.

2. **Shift Translocation**: In this type of translocation the broken segment of one chromosome get inserted inter intritially in a non-homologous chromosome.

3. **Reciprocal Translocation**: All ready written.

Unit-4

Variation in Chromosomal Numberic or Numerical Abberation.

Each species has a characteristics no. of chromosome in a nuclei of its gametes and somatic cell. The gametic chromosome no. constitute a basic set of chromosome called genome and is called haploid when haploid gamete of both sexes unite in process of fertilisation diploid zygote with two genome is form changes in whole chromosome is called Ploidy or heteroploidy. Heteroploidy may involve addition of single whole chromosome.

2.2020

Euploidy.

The term euploidy duigivate genome contain chromosome that are multiply of some basic no. (x) - The no. of chromosome in a basic set is called monoploid no. x those euploid whose no. of site is greater than one are diploid and polyploid.
The haploid (n) refers to strictly to the no. of chromo. in gamete 2n and 2x can be used interchangably.

Monoploid.

Monoploid plants are often weak and sterile. E.g - some algae, fungi, bryophytes, triticum, holdium, sorgum.
The monoploid organism have one set of chromosome or one genomes in the nuclei of the body cell.

Cytology of Monoploid.

During Anaphase I univalent distribution at randomly.

Ex- Haploid in maize 2n = 20 will have 10. chrome and no. of chromosome in a gamete can range fr 0-10 consequently considerably sterility will be found monoploid maize.

Tetraploid.

The organism with 4 genome in the nuclei of the somatic all are called tetraploid. The tetraploidy is arised by somatic doubling of chromosome no. the doubling is accomplished either spontaneously or it can be induced in high frequency by exposure to chemicals such as colchicine accnapthene etc.

Any organism with more than 2 genomes is called polyploid. Ex- the rose, genus rosa include species w somatic no 14, 21, 28, 35 etc. These no. are multipl of basic monoploid no. 7.

Types of Polyploidy.

Autopolyploid: The autopolyploid are those polyploid which consist of some basic set of chromosome multiply. For Eg = If a diploid sp. has 2 similar sets of chromosome or genome (AA) and autotiploid will have 3 similar genom and autotitraploid will have 4 such genome (AAAA).

Origin And Production of Autopolyploid.

Polyploid may arise naturally by following means-

- A result of interference with cytokinesis over chromosom

replication has occured.

- It may occur either in somatic tissue which give rise to tetraploid branches or during meiosis which produce reduced gametes.

- Autopolyploid have been induced in many plants and animals by artificial means which colchicine sulphanite amide, mercury amide hexachlorocyclohexane etc radio active substance radium and exray.

Colchicine.

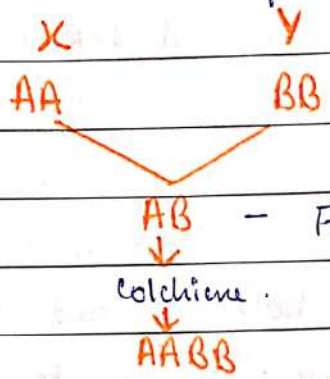
Is a drug canalcoholoid obtain from the corms of plant colchicum or Autmnale and its aqueous solution is found to be present in the formation and organi". of spindle fibre so the metaphase chromosome of affected cell called C-metaphase do not move to a metaphase plate and remain scattered cytoplasm.

Use of Polyploidy.

Since the induced polyploid the fertility label and sled root. So seedless root can be produced by using triploid. These triploid are obtain from seeds raised by cross of tetraploid and diploid plant by colchicine treatment by adopting these method the variety of triploid such as sugar beet, Comalo and grapes and tetraploid such as rye, barley, cotton, apple, grape, marigold etc.

Allopolyploid.

When the polyploid result due to doubling of chromosome no. in F1 hybrid which is derived from 2 distinctly different species than it is called allopolyploid and the resultant species is called an allopolyploid let A represents a set of chromosome (genome) in species X and B represents another genome in a species Y the F1 hybrid in these species than would have AB genome the doubling of chromosome the F1 hybrid will give rise to AABB.



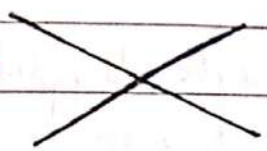
Ex: Rafinobrassica classical name of allopolyploid or amphipolyploid. A cross between reddish Rafinous species and 2n=18 and cabbage brassica odoracea 2n=18 and F1 generation got 1 diploid hybrid among these sterile F1 hybrid contain fertile plant which were found to contain 36 chromosome. These fertile alloploid are called Raffinbrassi

01 Feb, 2020

Triticale.

Triticale is the first man made cereal which has been developed in recent years and is cultivated on about 1 million hectare land throughout the globe for commercial use. Triticale is an artificial halopolyploid which has been derived from crossing of wheat (Triticum) rye (secale) depending upon whether triticum is a tetraploid

hexaploid one would get hexaploid triticale $2n = 6x = 42$ or octaploid triticale $2n = 8x =$ respectively in each case only diploid rye $2n = 4x = 14$ was used.



F_1 Hybrid sterile, triploid $2n > 21$.

Hexaploid triticale.
$2n = 42$.

Phenotypic Effect of Ploidy.

The increase in the genome size beyond the diploid level is often caused following detectable phenotypic characteristic in a polyploid organism.

Morphology effect of Polyploidy.

The polyploidy is invariably related with gigantism the polyploid plants have been found to contain large sized pollen grain, cells, larger stomata, xylem etc.

Physiological Effect of Polyploidy.

The ascorbic acid content has been reported to be higher in tetraploid cabbage and tomato than in corresponding diploid

Effect on fertility of Polyploid.

The most important effect of Polyploidy is that it reduces the fertility of polyploid plants in variable of degree.

Evolution through Polyploid.

Interspecific hybridisation combined with polyploidy offers a mechanism here by new species may arise suddenly in nature population.

Aneuploidy.

Changes that involve part of a chromosome set result in individual called aneuploids. Aneuploidy can be attributed to the loss of 1 or more chromosome (hypoploidy) or due to addition of 1 or more chromosome to the complete chromosome set called **Hyperploidy**.

Hyperploidy is mainly due to the subtraction of a single chromosome or pair of chromosome, it is of following types —

Monosomy.

When subtraction of a single chromosome is called **monosomy** $(2n-1)$ or diploid organism which are missing 1 chromosome of a single pair are monosomic with genomic formula $(2n-1)$. The n-1 gamete do not survive in plants but in animal that may cause genetic imbalance i.e. reduced fertility in organism.

Nullisomy.

An organism which has lost a pair of chromosome is

called nullisomic organism with genomic formula (2n-2). A nullisomic diploid often does not survive however a nullisomic polyploid (hexaploid wheat) may survive with reduced vigor and fertility.

Hyperploid.

It is of following type -

Trisomy.

Trisomic are those diploid organism which have an extra chromosome 2n+1 since the extra chromosome 2n+1 since the extra chromosome may belong to any one of different chromosome of haploid complement.

When the extra chromosome is identical to its homologues is called primary trisomic. If the extra chromosome should be an isochromic called 2° trisomic and 3° trisomic would mean that extrachromosome should be the product of translocation.

Double Trisomy.

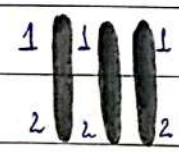
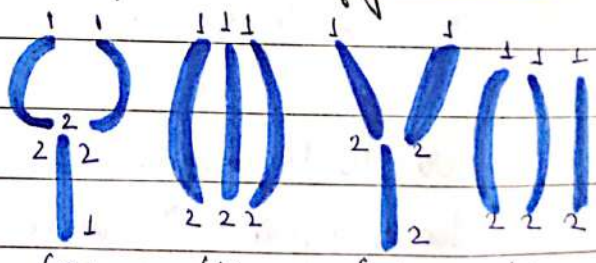
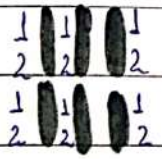
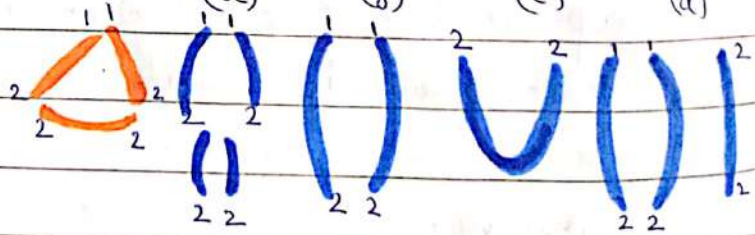
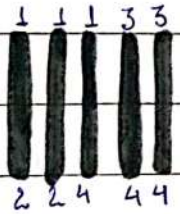
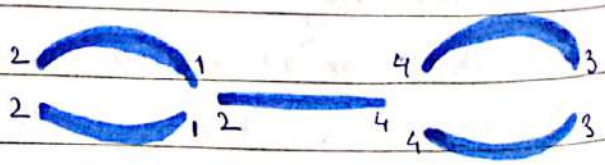
In a diploid organism when 2 different chromosome are represented in triplicate 2n+1+1 the double trisomy cause great genetic imbalance.

Tetrasomy.

The diploid organism having 2 extra chromosome are known as tetrasomic. They have genomic formula (2n+2).

Variation in chromosome no. (Ploidy).

- Euploidy
  - Monoploidy (n)
  - Diploidy (2n)
  - Polyploidy (3n, 4n, 5n)
- Aneuploidy.
  - Hypoploidy
    - Monosomy
    - Nullisomy
  - Hyperploidy
    - Trisomy (2n+1)
    - Doubly Trisomy (2n+1+1)
    - Tetrasomy (2n+2)

Type of Trisomic	Somatic Chromosome.	Metaphase I Configuration.
Primary Trisomic		 (a) (b) (c) (d)
Secondary Trisomic		
Tertiary Trisomic		

Genetic Mutation.

An this is abbrupted inheritable qualitative or quantitative change in the genetic material of an organism. In most organism genes are segment of DNA molecule. So a mutation can be regarded as a change in the DNA sequence which is reflected in the changes in a RNA or protein molecule. Mutation occur in random manner or spontaneously by the environmental effect. However they can be induced in the lab by radiation, physical factors, chemicals called mutagens.

Kinds of Mutation.

★ **Classification of mutation according to type of cycles-**

1. **Somatic mutation:** The mutation occuring in non reproductive body cell are known as somatic mutation. Somatic mutation have been related with malignant (cancerous growth).

2. **Gametic mutation:** The mutation occur in gamete cell (sperm and ovum) are called gametic mutation. The gametic mutation only form the raw material for natural selection. Such mutation are heritable and of imens genetic significance.

★ **Classification of Mutation according to size and quality-**

1. **Point Mutation:** When heritable ultration occur in very small segment of DNA molecule i.e. is a single

nucleotide or nucleotide pair then this type of mutation are called point mutation. This is of following Types —

Deletion Mutation = A point mutation which is caused due to lost or deletion of some portion (single nucleotide pair) in a triplet codon of a cistron or gene is called deletion mutation.

Addition Mutation = The point mutation which occur due to addition of 1 or more extra nucleotide to a gene or cistron are called Insertion mutation. The insertion mutation can be artificially induced by certain chemical substances called mutagens. Such as Acridine dye and proflavin. A proflavin molecule insert between two successive bases of a DNA strand thereby stretching the strand length wise. The mutation which arise from the insertion or deletion of individual nucleotide and cause the rest of the msg. downstream to the mutation to by readought of base are called frame shift mutation. They result in prod. of an incorrect and hence inactive protein due to which death of the cell may occur.

Substitution Mutation = A point mutation in which a nucleotide of a triplet is replaced by another nucleotide called substitution mutation. Such an altered code (codon) may designate diff. amino acid and may result in the production of a protein with a single amino acid substitution.

When a purine (Adine) base of a triplet codon of a cistron is substituted between another purine base

(Guanine) or a pyrimidine (thymine) is substituted by another pyrimidine base (cytosin) then such kind of substitution is called transition. The transitional substitutional occur due to tautomerisation.

Tautomerisation.

In a DNA molecule normally purine Adenine 'A' is linked to pyrimidine thymine 'T' by 2H-bond while the purine Guanine 'G' is linked to the pyrimidine cytosin 'C' by 3-H bond besides the common molecular configuration each DNA base may have some altered uncommon molecular configuration.

Such uncommon form of DNA bases are generated by single p^+ shifts and are called rare state or tautomers. The abnormal pairing due to transitional substitution may also occur due to ionisation of a base at a time of DNA replication. Ionisation involve the loss of H_2 from the no. 1 N_2 of a base.

Affect of Chemical Mutagen on Nucleotide Sequence.

Deamination.

In the process of oxidative deamination the NH_2 group of DNA base is replaced by hydroxyl group of DNA base is chemical mutagens. Thus Adenine is deaminated into hypoxanthine. Similarly deamination converts cytosin to uracil which has pairing properties similar to thymine and in such a case G:C pair would be change in A:C pair.

Hydroxyl Amine And Aydrazine.

When DNA is treated with hydroxyl amine its cytosin base is the strongest reacting base. Hydroxyl amine probably cause hydroxylation of cytosin and NH_2 group giving rise to hydroxyl cytosin which then subsequently pair with Adenine. Thus hydroxyl amine induces in DNA in ABCTC, a base pair transition.

Classification of Mutation according to Origin.

According to mode of origin follow 2 kind of mutation have been recognised.

Spontaneous Mutation.

This occur suddenly on nature and thus origin is unknown they are also called background mutation reported in many organism, such as bread, maize mould, microorganism bactria, virus, drosophilla etc.

04 Feb, 2020

Induced Mutation.

Besides naturally occuring spontaneous mutations, the mutation can be induced artificially in the living organism by exposing them its abnormal environment such as the radiation, certain Physical conditions temperature, chemical etc. The substance or agents which induce artificial mutation are called Mutagen or Mutagenic agents.

Mutagenic agents are of following kinds -

Radiation.

The radiations which are important in mutagenesis are of 2 characterise -

Ionising Radiation

X Rays, γ-Rays, Alpha and β-Rays, e⁻ and proton and other fast moving particles are used as ionising mutagens.

Non-Ionising Radiation.

Ultra violet and visible light.

Temperature as Mutagen.

The rate of all chemical reaction are influence by temperature. It is not surprising that temperature can be mutagenic it is reported that the rate of mutation is increase due to increase in temperature. Temp. probably step both thermal stability and the rate of reaction of other substances with DNA.

Chemical Mutagens.

Many chemical substances such as mustard gas and related compounds as the nitrogen and sulphur mustard, mustard oil and chloracetone have been responsible to increase the mutability of gene. Any chemical substance that affect the chemical environment of chromosome is likely to influence atleast indirectly the stability of DNA and its ability to replicate without error. A chemical mutation can cause mutation only when it enters in the nucleus of cells.

Classification of Mutation according to Direction.

Forward Mutation.

As an organism when mutation create a change from wild type to abnormal phenotype, then that type of mutation are known as F.M.

Reverse or Back Mutation.

The F.M are often corrected by error correcting mechanism. So that an abnormal phenotype changes into wild type phenotype are known as Reverse or Back mutation.

Classification of Mutation according to the Types of Chromosome.

Autosomal Mutation.

This type of mutation occurs in autosomal chromosome.

Sex chromosomal Mutation.

This type of mutation occurs in sex chromosome

Classification of mutation according to magnitude of Phenotypic Effect.

Dominant Mutation.

The mutation which have dominant phenotypic effect are called D.M.

Recessive Mutation.

Most type of mutations are recessive in natured and so they are not expressed phenotypically immediately. The phenotypic effect of mutation of a recessive gene is seen only after one or more generation when the mutant is able to recombine with another similar recessive gene.

Iso Alleles.

Some mutation alters the phenotype of an organism so slightly that they can be detected only by special technique. Mutants gene that give slightly modify phenotypes are called Isoalleles. They produce identical phenotypes in homozygous or heterozygous conditions.

06 Feb, 2020

Lethal Mutation.

According to their effect on the phenotype mutation may be classified as lethal subvital and supervital.

- Lethal mutations results in the death of the cells or

organisms which they occur.

- Sub vital mutations reduces the chances of survival of organism in which they occur.
- Super vital mutation in contrast the improvement of biological fitness under certain condition.