Chromosome

Chromosomes are filamentous bodies which are typically present in the nucleus and become visible during cell division. E. Strasburger in 1875 discovered thread like structure and called ~~later as~~ Chromosomes. Chromosome (chroma = color) due to its affinity for basic dye.

Chromosomes are the carrier of the gene or unit of heredity. Chromosomes are not visible in nucleus due to its high water content. But are visible during cell division

At leptotene stage of meiotic prophase, chromosomes appear as beaded structures, bead like nodules being known as chromomeres. The DNA is thought ~~to~~ known to concentrate in the chromomere, but is believed to be present in the inter-chromomeric region also.

Most of the chromosomes in a cell are called autosomes. In addition there are one or two of sex chromosomes or heterosome which carry the gene for determination of sex.

Number, Size & Shape of Chromosome

- Normally all the individual of a species have the same number of chromosomes.
- Presence of whole set of chromosome is called euploidy It include haploids, diploids, triploids tetraploids etc.

Gamete normally contain only one set chromosome This number is called haploit)

Somatic cell contain ascually two sets of chromosom (diploid number = 2n). Triploid have to three set of chromosomes. and ~~four~~ tetraploids four sets (4n)

The condition in which ~~ea~~ chromosomes are present in multiples of n is called polyploidy. When a change in the chromosome number does not involve entire sets of chromosomes but only few chromosome, the situation is called aneuploidy.

The different types of aneuploid are monosomics (2n−1), trisomic (2n+1) nullisomic (2n−2) tetrasomic (2n+2).

Size

Chromosome is normally measured at mitotic metaphase and may be as short as 0.25μ in fungi and birds or as long as 30μ in some plant like Trillium.

As a rule most metaphase chromosome fall within a range of 3μ in fruitfly (Drosophilla), 5μ in man & 8-12μ in maize.

Shape :—

Four kind of chromosome are there depending on the position of centromere

(1) **Metacentric** :— eg (Trillium & Tradescantia) — all chromosomes are metacentric

If Centromere is in the center or middle of chromosome it called metacentric

centromere in middle

metacentric

(2) **Submetacentric**

Centromere situated distance away from the middle

~~submetr~~ centromer

away from middle

Submeta centric

(3) **Acrocentric** :— eg acrocentric chromosome present in Grasshopper

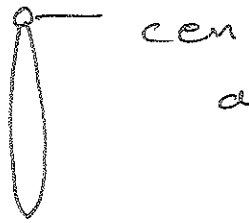
Centromere situated near end of chromosen

centromere near terminal end

acrocentric

Telocentric

When centromere is present at terminal position it is known as telocentric chromosom



Telocentric

Polycentric Chromosomes

In polycentric chromosomes centromere ~~is one~~ ~~but~~ lies in diffused condition along the length of the chromosome. In such cases the centromere is called a (diffused centromere) and the chromosom is said to be polycentric.

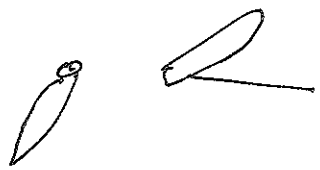
> Centromere lies in diffused condition along whole chromosom

Diacentric chromosome :—

With two centromere chromosome is known as Diacentric chromosom.

Acen

Acentric chromosome:— Sometime chromosome undergo a break into two, so that only one part has the centromere while the other is without centromere. The part lack the centromere is called acentric fragment.



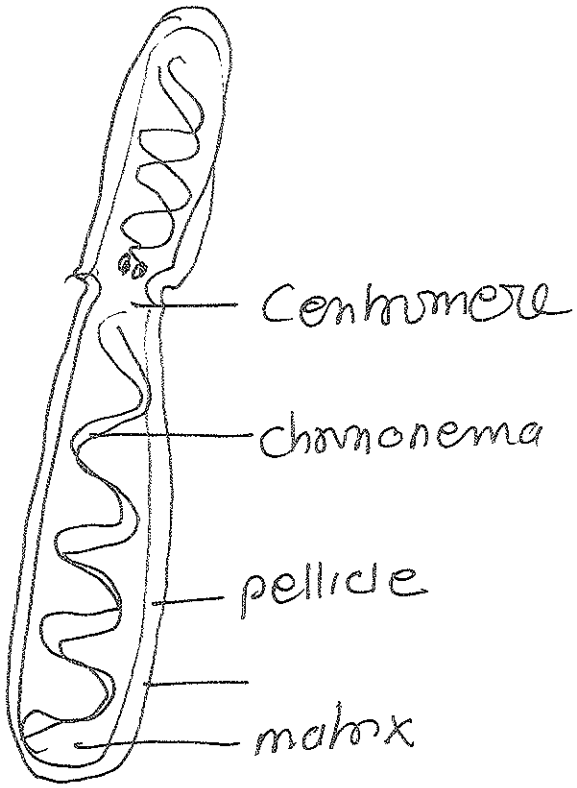
(acentric chromosm without centromere)

Morphology of Chromosome

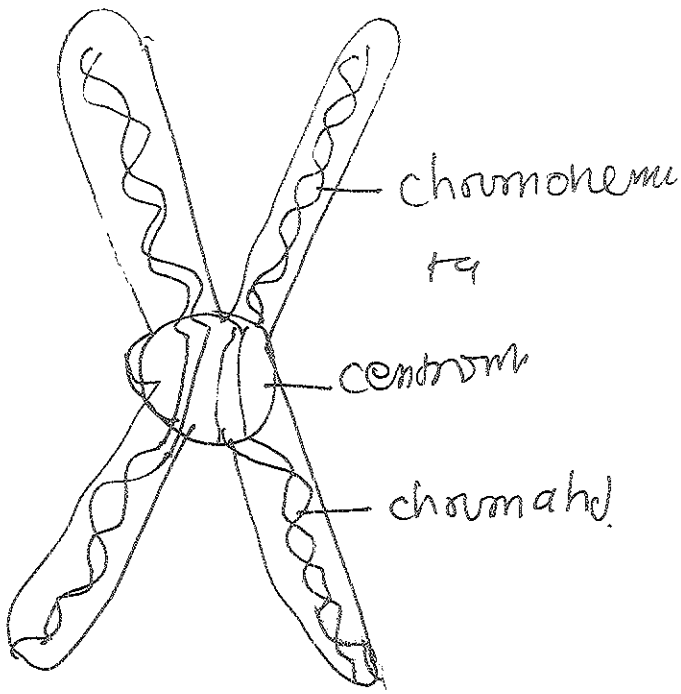
Chromosomes consists of chromatids and centromere Beside centromere there is secondary constriction is present. These secondary constriction ~~can also~~ if present in distal region of arm would pinch off a small a small fragment called trabant or satellite Satellite remain attached with the help of chromatin. Chromosomes having satellite are marker chromosome & are called SAT chromosome. The terminal position of chromatid are telomeres & end is known as telomere end.

Detail study of chromosome reveals coiled filament- filled throughout length of chromosom These filament- is known as chromonema Chromonemate are embedded in matrix of chromosomere

Matrix is enclosed in sheath called pellicle Both matrix & pellicle are non genetic material & appear only at metaphase when nucleolus disappears.



Structure of chromosome.



Metaphasic chromosome.

Nucleosome

The chromosomes of eukaryotes are made up of nucleoprotein material called chromatin

Nucleoprotein consist of = nucleic acid which

⇓

is DNA and protein (Histone).

Chromatin look like "strings of beads" ~~during~~ and is made up of repeating unit- these units (beads) have been called nucleosome.

X { The nucleosomes concept- represent- the latest chromosome.

Nucleosome consists of core of Histone around which is wrapped DNA

There are five classes of Histone protein

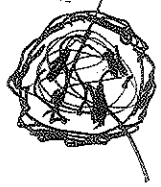
H_1, H_2A H_2B, H_3 & H_4. H_1 is distinct from rest of histone protein

Chemical Composition of Chromosome.

Euchromatin	Heterochromatin
1. Lightly stained chromatin	1. Darkly stained chromatin
2 Euchromatin loosely Packed	2 Hetero chromatin is more densely packed.
3 Transcriptionally active	3. Transcriptionally inactive
4 Replication takes Place at early S phase	4. Replication takes place at late S phase.

HETEROCHROMATIN & EUCHROMATIN

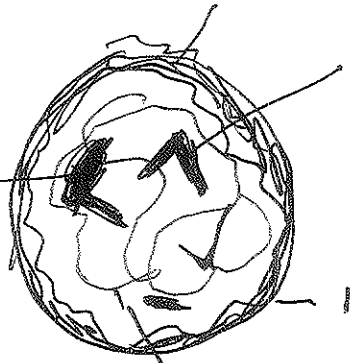
Lightly Packed euchromatin (light region)



Eukaryotes :—

Heterochromatin.

~~They are~~ chromatin = DNA + Histone



(Tightly packed) ← Heterochromatin (Dark region)

Constitutive Heterochromatin

Facultative Heterochromatin (Functioning They are silence)

Functional

involved in Transcription

eg (Centromere Telomere

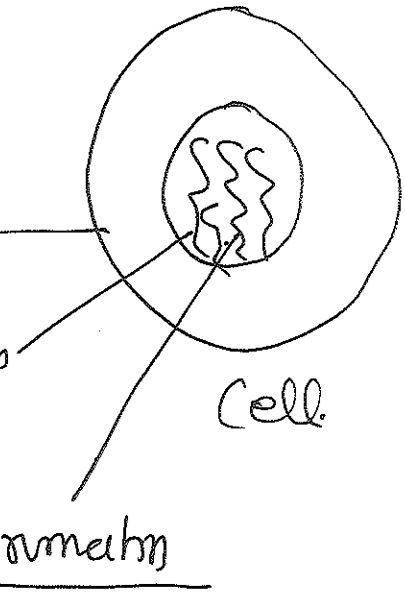
eg Silenced by Histone deacetylation

Nucleus under Electron Microscope

Heterochromatin	Euchromatin
Darkly	Lightly stained

- Chromatin is Thread like structure inside nucleus.

- Chromatin is present in Feulgen stain stained in pink



- Chromatin is made up of DNA + Histone

- Chromatin is in condensed form known as Chromosome

Chromatin = DNA + ~~Nucle~~ Histone

DNA wrapped around Histone protein

~~Nucleosomes are DNA~~

- Chromosomes are found inside nucleus.
- DNA is present inside chromosome in coiled form called chromatin
- Chromatin is made up of DNA and basic protein known as histone.
- (In prokaryotes only DNA is present Histone protein remain absent)

DNA is wrapped around protein known as Histone and locked by H_1 histone protein

Histone protein is basic protein consisting of

~~H_1 H_2A H_2B H_3 H_4~~

H_1 H_2A H_2B H_3 H_4

presents in octamer.

(4 subunit X 2)

11

octamer

- IMP During cell division condensed form of Chromatin is called chromosome

Endoplasmic Recticulum

All eukaryotic cells have an endoplasmic recticulum (ER) except red blood cells of mammals. The endoplasmic recticum is an extensive system of a network of membrane endosed branching tubules and flattened sacs (cisternae) that extends from the nuclear membrane throughout the cytoplasm. ER is the largest organelle of most eukaryotic cells

The endoplasmic recticulum (ER) is a network of flat and vesicular structure which extends throughout the cytoplasm in plants and animals cells. These sacs and tubules are all interconnected by a single continous membrane so that the organelle has only a large highly convoluted and complexly arranged lumen (internal space). It takes up approximately 12·1. of the total volume of a cell. ER is connected to one side with double membrane ~~and~~ nuclear envelop.

Discovery

Garnier (1897) first discovered the Endoplasmic Recticulum and named it ergastoplasm but its ultrastructure was given by Porter, Claude and Fullam in (1945)

K. R. Porter (1953) coined the ~~the~~ term endoplasm

Origin :—

The most accepted view regarding origin of ER is that RER arises as an invagination of outer membrane of nucleus while smooth endoplasmic reticulum are formed from RER by loss of ribosomes.

Intercisternal space of ER is continuous with perinuclear space

Isolation of Rough Endoplasmic Reticulum

When cell are disrupted, ER fragments into small vesicles called <u>microsomes</u>. These microsomes are derived from RER & lined ribosomes

Structure :—

The endoplasmic reticulum is a part of Endomembranous system and is membrane bound organelle. The membrane of endoplasmic reticulum is 50–60°A thick.

ER is connected to nuclear pore through outer membrane of nucleus.

ER is:

ER is composed of three types of elements.

(1) Cisternae

These are narrow, flattened and unbranched structures generally present near the nucleus These lie parallel to each other and may be interconnected. They occur in the cells having active synthetic roles.

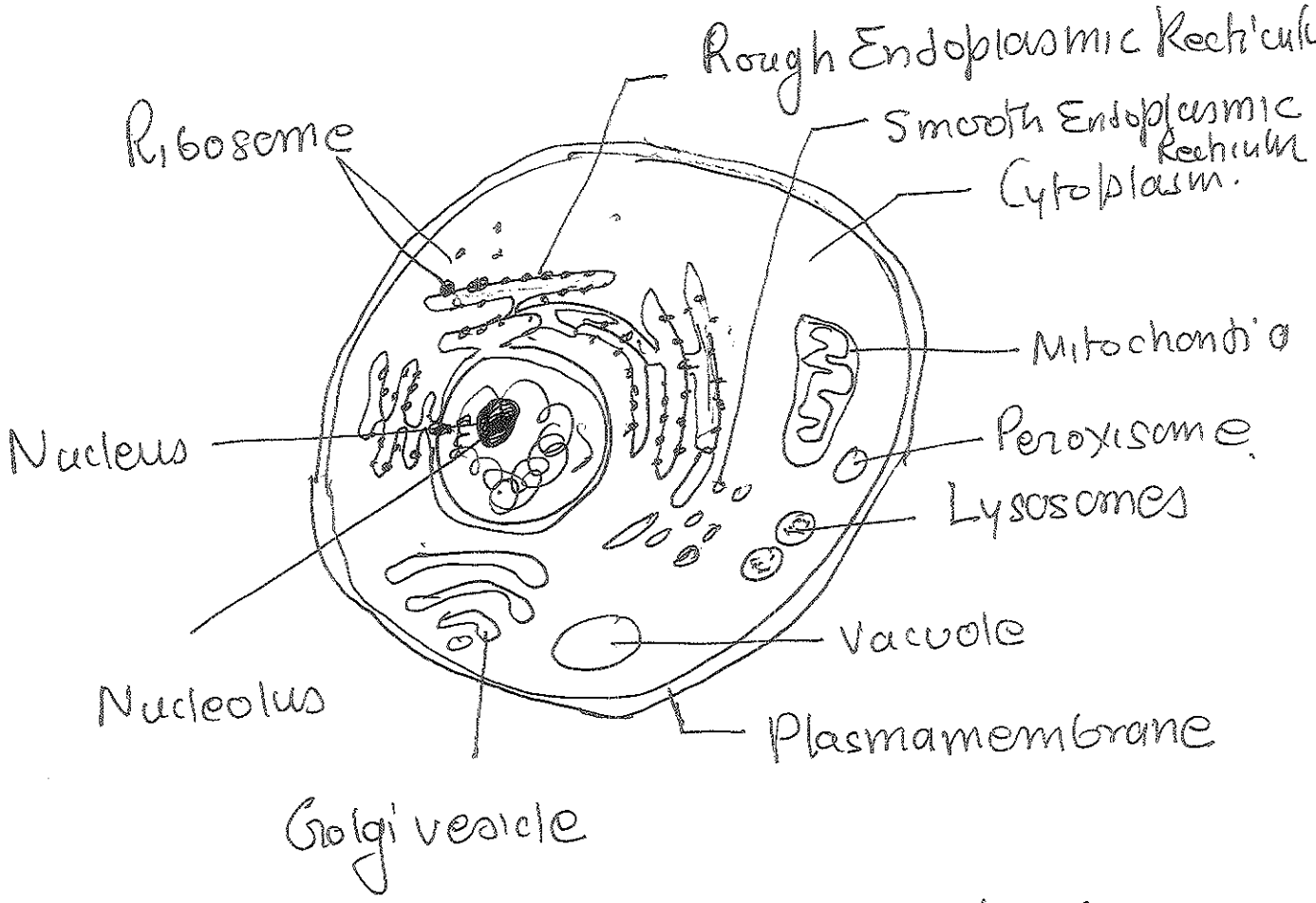
(2) Tubules :—

Tubules are wider, tubular and irregularly branched elements mainly presents near the cell membrane. Each is about 50-100 μm diameter.

These are without ribosomes and are actively involved in glycogen ~~meta~~ metabolism, lipid & steroid synthesis.

(3) Vesicles :—

These are spheral or oval bodies scattered in the cytoplasm whose diameter ranges from 25- 500 nm. These are also studded with ribosomes and are present mainly in cells that are involved in protein synthesis



Cell : Structure of ER

Types Of Endoplasmic Recticulum.

(a) Smooth Endoplasmic Recticulum (without ribosomes)

(b) Rough Endoplasmic Recticulum. (with ribosomes)

Smooth Endoplasmic Recticulum:—

- SER consists of a long network of a folded tube like structure.
- It is more abundant in mammalian liver cell and gonad cell.
- SER is formed form RER coherit loses ribosomes.

Rough Endoplasmic Recticulum.

- RER bears ribosomes on its surface.

Function of SER:—

(1) Manufacturing:— SER is involved in lipid synthesis. It is due to distribution of synthatases on the surface of ER. It synthesize steroid hormones.

(2) SER play a role in steroid metabolism. Many enzymes present in membrane of SER have a key role in the synthesis of cholesterol, the precursor of steroid hormones & bile acids

- Release, uptake and storage of calcium ion

  SER attaches receptor to calcium binding proteins of cell membrane and relaxation

- Lipid Metabolism:—

  Synthesis of fatty acid, glycereuds and steroids such as cholesterol takes place in SER and special cell organelles sphaerosomes

- In liver SER is abundant in hepatocyte & is involved in the production of lipoprotein

- Processing of Toxins

- SER is helpful in detoxification of certain drugs like phenobarbitol, many carcinogens and 3, 4 benzypyrene SER uses enzymes for break down the toxic compounds.

- Detoxification is carried out by a system of oxygen transferring enzymes (oxygenases) including the cytochrome P-450 family

- These enzyme, due to their lack of substrate specificity being able to oxidize thousands of different hydrophobic compounds and convert them into more hydrophilic more readily excreted derivatives.

Muscle Contraction

SER helps in sequestering of calcium ions within the cytoplasm of cells.

The regulated release of Ca^{++} from the SER of skeletal and cardiac muscle cells (Known as the sarcoplasmic reticulum in muscle cells) triggers contraction

Function of Rough Endoplasmic Reticulum

(1) Protein Synthesis :—
RER provides surface to ribosomes and provided two dimensional arrangement and increase the rate of protein synthesis

(2) Transportation

Rough Endoplasmic is involved in collection

and transportation of synthesized proteins and forms transport vesicles which carry the material like proteins to the cisternae of Golgi bodies for their condensation into secretory vesicles.

Glycosylation :—

Carbohydrates are added to the nascent polypeptide by the enzyme ~~oligosaccharo~~ oligosaccharyltransferase

~~Disulphide formation~~

— Packaging & Folding of Protein :—

Misfolded protein are not destroyed in the ER but instead are transported into cytosol by a process of dislocation.

— It remain unclear whether misfolded proteins are dislocated back into cytosol through the translocons that brought them into the ER or by way of a separate dislocation channel of uncertain identity.

Golgi Complex

A membraneous complex of vesicles, vacuoles and flattened sacs in the cytoplasm of most cell involved in intracellular secretion and transport- Golgi complex sometime also called as the Golgi Body or Golgi Apparatus

Discovery

(1) Golgi apparatus is named after the scientist who discovered it

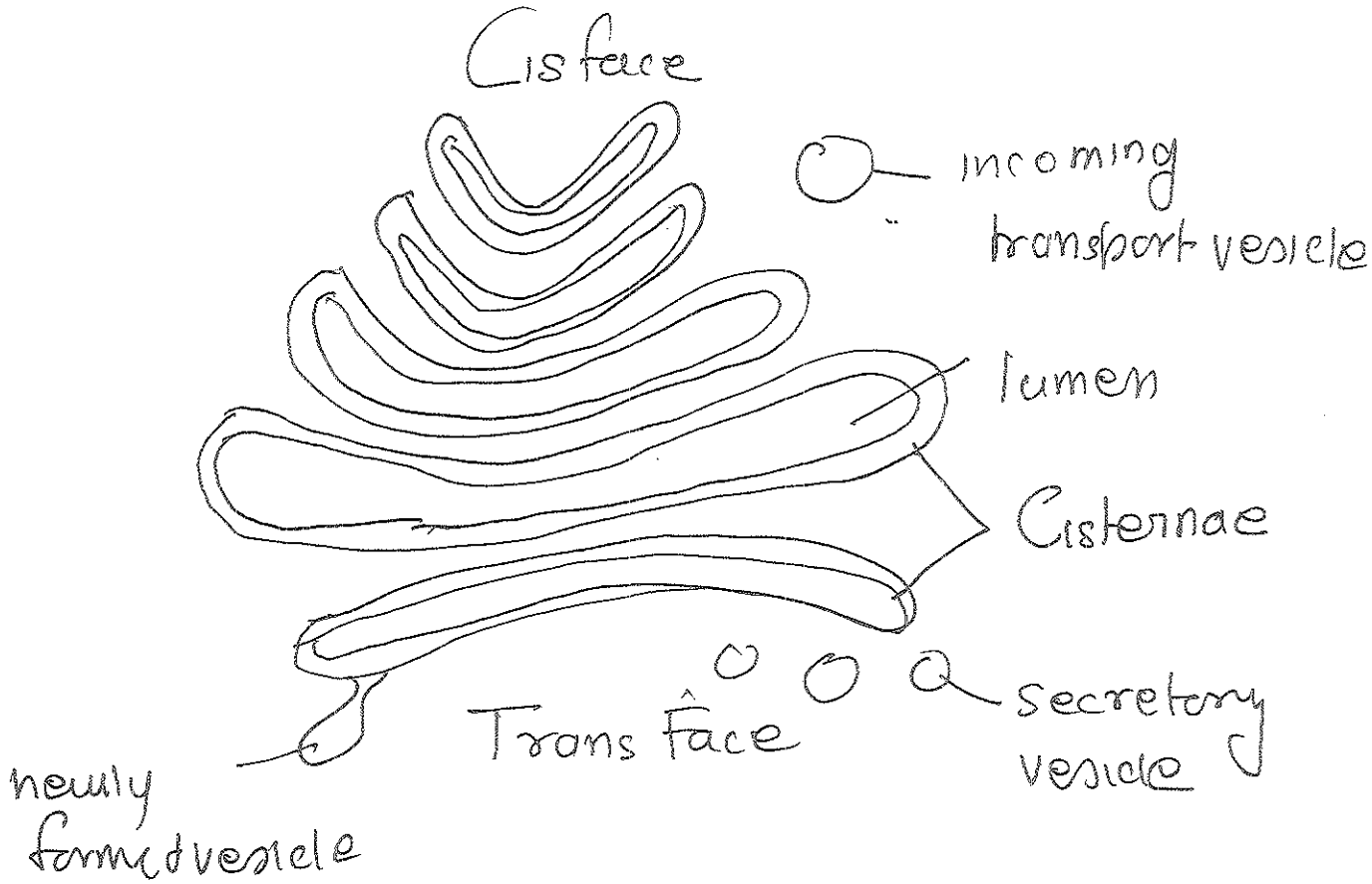
(2) Camillo Golgi was an Italian biologist- who discovered this organelle with a right microscope in 1898

Structure

1 The Golgi is composed of stacks of membrane bound structures known as Cisternae

2 A cisterna (plural cisternae) composes a flattened membrane disk that makes up the Golgi apparatus

3. The cisternae stack has two faces



Golgi Apparatus

Cis Golgi

(1) The side faces the Endoplasmic reticulum is Cis Face and is the entry face that receive small membrane vesicle from ER.

(2) Vesicles form the endoplasmic reticulum fuse with the cis Golgi network and subsequently progress through the stack to the trans Golgi network.