(b) **Kinetsosome or basal grnule or Blepheroplast or Basal body :** It is membraneless structure. Lies immediately below the plasmamembrane. Basal body exhibit **cart wheel stucture** similar to centriole. (9 triplet fibriles connected to a cetral hub in basal bosal body) .

- Arragement of microtubules is 9 (triple) +0, In basal grnul there occurs 9 microtubules on periphery and each microtubullllllle is composed of three tubules I. e. A-tubule, B-tubule and C-tubuke.
- Central part of basal granule is composed of cytosol called **" Central Hub"**
- Microtubukes connected to central hub with the help of protein fibres called **primary fibres or spokes.**
- **Secondary fibres** connect microtubles with each other.
- Each primary fiber have a thickening called X- thickening. In between X- thickenings there occurs Y- thickening. X and Y- thickening are inter connected.
- **The central tubules are connected by bridges and is** also **enclosed by a central stheath, which is connected to one of the tubules** of each peripheraldoulets are also interconnected by radial spoke. Thus hey are nine radial spokes . The peripheral doublets are also interconnected by linkers.

(C) **Rootlet Rhizoplast :** This is a conical bundle of protein fibers which arises from basal body to different directions. Rootlet have **dark bands** composed of **ATP ase.**

Types of Flagella:

(1) **Whiplash-**When the lateral hair structures absent.

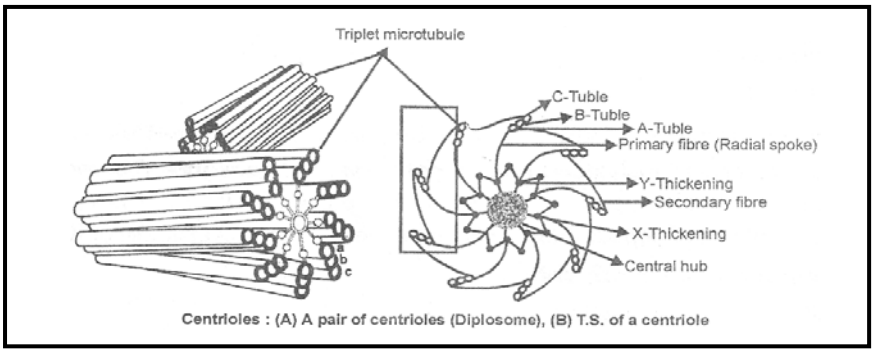
(2) **Tinsel-**When the flagella bears lateral hairs like structure (flimmers)

- Cilia and Flagella are similar in structure but some differences ay observed-

Cilia	Flagella
1. The cilia are small in size (5-10 μm)	1 Flagella are long (μm)
2. Number of cilia per cell is very large.	2 Few in number
3. Cilia beat in a coordinated manner (sweeping or pendular move)	3 Flagella beats independently (Non coordinated manner)
4. They take part in locomotion, attachment. Feeding and sensation.	4 Flagella involved only in locomotion

CENTROSOME OR CENTRIOLES

- Centrosome was discovered by **Benden. Boveri** named as Centrosome . Centrosome is abent in higher plants.
- Two centioles located just outside the nucleus and lile at right (900) to each other. Cytoplasm which srrounds centrioles called as " **Centrospher"** centrioles and centrosphere collectively called **Centrosome** or **Microcentrum** or **diplosome** . Each centriole is surrounded by peri centriolar mass, which is called as **massules or crown or satellite.**



Centrioles : (A) A pair of centrioles (Diplosome), (B) T.S. of a centriole

- Centrioles are **membrsaneless** elongated structure which exhibit **cart wheel structure** (just like body of cilia) . Basal body is also a type of centriole.

- Centriole mainly consist of 9 triplet fibers of tubulin. (9+0 arragement)
- Centrioles are self duplicatingunits, which contains DNA, RNA and protein synthesis machinary.
- Centrioles DNA discocered by **Randall and Disprey.** Centriolar DNA is probably ds circular and naked. Replication of centrile occur in **s-phase.**

Function: - In animal cells centrioles play important role in initiation of cell division by arranging spindle fibres between two poles of cell. The location of centrioles during cell division decides the plane of division. The plane of division is always at right angle to the long axis of spindle. Thus centrioles is also lermed as **" cellcenters**"

RIBOSOMES (ENGINE OF CELL)

- **Claude (1947)** first observed them and called Microsome . Palade (1955) coined the term **Ribosome.**
- In plants Robinson and Brown (1953) first observed them in bean roots.
- Except memmalian RBC all living cells have ribosomes . (Both prokaryotes & Eukaryotes)
- Ribosomes are **smallest cell organelles** (150x250A0) Ribosomes are **organelle without membranes.**
- Ribosomes are also called as **" Organelle with in an organelle" & " protein factory pf cell"**

Types of Ribosomes:

(1) **Eukaryotic ribosomes : -** 80 s-Occur in cytoplasm of eukaryotic cells.

(2) **Prokaryotic ribosomes: -**70 s – Occur in cytoplasm of prokaryotes, and also in mitochondria, and Chloroplast of eukaryotes, (55 S ribosome present in mitochodria of mammals)

- Each ribosome composed of two subunits I, e . larfer and smaller subunits, Larger subunit is dome shaped and smaller unit is ovold. **Smaller subunit** has a platform, a cleft, a head and a base. The **larger subunit** has a protuberance, a ridge and a stalk. Larger subunit also contains a tunnel which opens in cavity of E. R.

80s=60s+40s
70s=50s+30s

- Magensium ion is essential for the binding the ribosome sub unis. Mg+2 form ionic with phosphate groups of r-RNA of two subunits. Mimimum 0. 001 M Mg+2 concentration is required for structural formation of ribosomes . If Mg+2 concentration increased 10 times then ribosome dimer are formed.

80s+80s=120s (Dimer)
70s+70s=100s (Dimer)

Chemical Composition of Ribosomes:

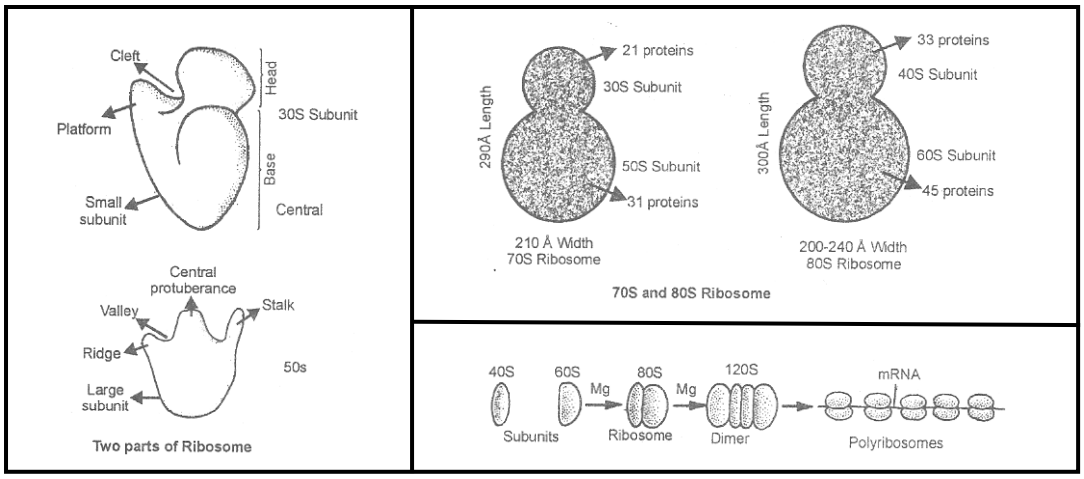
70s - 60% r-RNA+ 40% proteins
80s - 40% r-RNA +60%prteins
60s - r-RNA 28s , 5, 8s 5s
40s - r-RNA 18s
50s - r-RNA 23s , 5s
30s - r-RNA 16s

- At the time of protein synthesis , several ribosomes become attached to **m-RNA** with the help of smaller subunits. This structure is called **polyribosome or polysomee or Ergosome.** Ribosomes move along the m-DNA like beads on a string , during protein synthesis . Larger subunit contains **peptidyl trasferase enzyme** which helps in the formation of peptide during protein synthesis. This I an example of Ribozyme . (Noller 1992)

Two sites are found on larger sub units:

(i) A-site → Acceptor site for t-RNA
(ii) P- site → site for growing polypeptide chain

☞ S=Svedberg unit or Sedimentation rate



After synthesis on ribosomes , protein are transported in cytoplasm and organelles
The proper folding and transport of proteins is assisted by specific proteins called **Chaperons.**

MICRO-BODIES

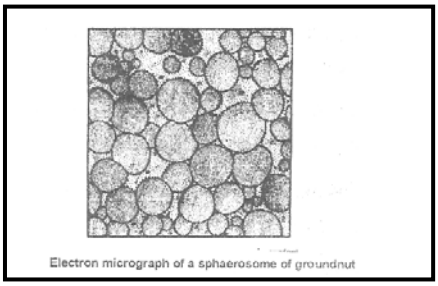
☞ The cells of **protozoa , fungi , plants, liver and kidney cells** contain certain membrane bounded spherical bodies of 0. 3 to1. 5$^{\mu}$ diameter , filled with enzymes are called as " Micro-Bodies"

On the basis of functions micro bodies are of following types-

(1) **Sphaerosomes: -**

☞ Hanstein (1880) first observed them in ground nut and called **microsomes. Perner** (1953) named them sphaerosomes. Sphaerosomes. occur only in plant cells. They are major site of lipid storage and synthesis in plants.

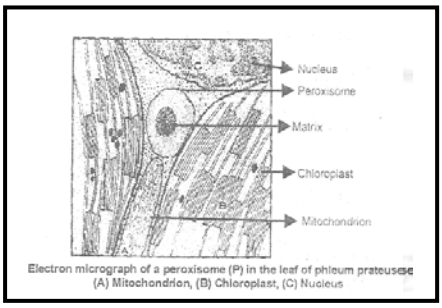
☞ Sphaerosomes. Also have lysosome like activity so they also termed as **plant lysosomes.**


Electron micrograph of a sphaerosome of groundnut

(2) Peroxisomes or Uricosomes: -

Discovered by Rhodin and **Tolbert.** Urate oxidase, Amino acid oxidase, Hydroxy acid Oxidase, Preoxidase, Catalase enzymes occrs in it .

☞ In animal cells **peroxisomes** concerned with peroxide (H2 O2) metaboism. Urate oxidase, Amine acid oxidase, and peroxidase . peroxidase induces the oxidation of amino acids to producing H2 O2. **Catalase** degrade the H2 O2 in to water and oxygen.



Electron micrograph of a peroxisome (P) in the leaf of phleum prateusese
(A) Mitochondrion, (B) Chloroplast, (C) Nucleus

☞ In plants, **peroxisomes** occurs in cells of green tissues and concerned with **photorespiration** (glycolate pathway) .

☞ Peroxisomes may involved in -$^{\beta}$ **oxidation** of fatty acids.

(3) **Glyoxisomes: -**Discovered by , **Beever** in oil containing seeds, yeast cells, **guard cells** etc.

☞ Glyoxysomes occus only in plants especially in **fatty seeds b (castor seed) , guard cells of stomata and bunripe fruits.** Glyoxylate cycle is linked with the TCA cycle and used for production of acids in fruit.

☞ Glyoxysomes are considered as a **highly specialised peroxisomes.** Glyoxylic acid cycle takeds place in glyoxysomes . The cycle convert fats into carbohydrats.

(4) Transosome : - Special microbodies in ovary cells of birds (concern with yolk formation) . These covered by three unit membranes.

MICROTUBULES

- De Robertis and Franchi (1953) discovered microtubules.
- Microtubules are composed of contractile protein , **Tubulin.**
- In plants microtubules. often associated with cell wall. Probably these transport cell wall material from Golgi body to outside of cell. During cell division these microtubules form **spindle fibers.**

MICROFILAENTS

Microfilaments are long rods 40-50 A^0 in thickness and distributed throughout the cytoplasm. They are composed of contractile protein, **Actin** which concern with **muscle contraction , and cyclosis,** Microtubules and microfilament provides cytokeleton- base of cell.

NUCLEUS

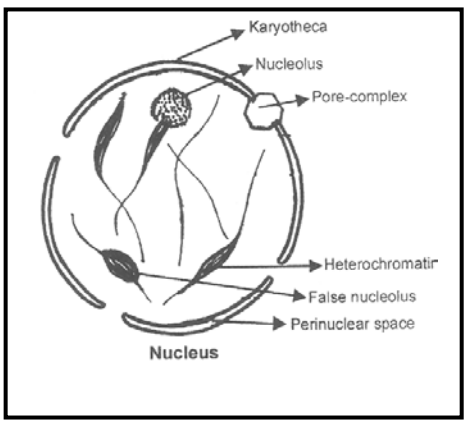
INTRODUCTION

- First of all **Leeuwenhoek** observed , nucleus in RBC s , o f fish
- Detail studied in orchid root cells and named by **Robert Brown** in 1831. Credit of discovery goes to Robent Brown.
- " Nucleus is double membrane bound dense Protoplasmic body , which controls all cellular metabolism and encloses the genetic information of cell"
- Nucleus is consider as controller of director of cell . Importance of nucleus in control of heredity , growth and nucleus is microtules **very important and largest** component of cell.
- If the nucleus of a cell is, experientally removed, then unicellular organism will die after some time, Thus nucleus is very important and largest component of cell.
- **srasburgar stated that : -**Nucleus arises from division of pre-existing nucleus only . The study of nucleus is known as **Karyology .**
- enerally eukaryotic cell contain at least one nucleus but nucleus is absents immature phloem **sieve tube** elements and **mature RBCs** of mammals . (exceptionally nucleus is present in RBCs of **camel & lama**)
- Dikaryotic (Phycomecium) and muktikaryotic cells are also known. Multinucleated cells may be following type:
  - **(a) Coenocytic cells: -** This type of cells, are formed by free nuclear divisions. Example: - Phycomycetesfungi, Endosperm, rhizopus, vaucheria, etc.
  - **(b) Syncytim: -** Syncytion condition is formed by the fusion of cells. Example: -Epidermis of nematods, striped muscles

STRUCTURE OF NUCLEUS:

(i) Nuclear membrane or nuclear envelope or karyotheca.
(ii) Nucleoplasm / Karyoplasm/Karolymph.
(iii) Chromatin met
(iv) Nucleolus/ little nucleus/Ribosome factory

(i) Nuclear membrane: -Nucleus is surrounded by two unit membranes, thus nucleus is double membranous component of cell. Space (150 to 300Å) between two membranes is known as **perinuclear space.** Outer membrane, of nucleus also may found on it.



- ☞ Nuclear membrane is perforated by minute **nuclear pores** of size, 300 to 1000Å diameter. Each nuclear pore is guarded by a octagonal discoid structure of **nucleoplasmin protein** this structure is called as **annulus or Bleb.** (Annulus +Pore =Nuclear pore complex.)
- ☞ The inner side of inner nuclear membrane is lined by **nuclear lamina.** This structure is formed by filaments of **lamin protein.**
- ☞ **Pore complex** provides the main channel, between nucleoplm and cyoplam, while **nucleoplasmin** regulates nucleocytoplasmic traffic.

(ii) Nucleoplasm or Karyolymph (Term by strasburger 1882)

Nucleoplasm or Nuclear sap is a ground substance of nucleus which is a complex colloidal formed of a number of chemicals like nucleotides, nucleotides, ATPs, proteis & enzymes of RNA & DNA polymerases, endonucleases, minerals, (Ca^{++}, Mg^{++}) etc.

Nucleoplasm contain high concentration of Nucleotids in the form of triphosphate.

- ☞ Nucleoplasm also have enzymes for Glycolysis , thus nucleus may obtain energy by glycolysis.
- ☞ **Chromation net and nucleolus** are ambeded in nucleoplasm. Nucleoplasm provides site for proceess of transcription.

(iii) Chromation net: - (Term given by **Flemming**)

- ☞ It is an intranuclear, (stained with basic dyes) long , thread like fine fibres , whichembeded in nucleoplasm. Chromatin net is mainly formed of DNA and histone protein complexes. Chromatin fibres contaion genetic information and condensed to form constant mumber of chromosomes duing cell division.
- ☞ Chemically Chromatin consists of NDA (31%) RNA (205%) , Histone protein (36%) , and non hisone (28%) , 20 to 30% part of histone is made up arginin and lysin there are five type of Histone protein.

  (H2 A, H2 B, H3 , H4 , H1)
- ☞ Chromatin net has two type of chromatins (by Emil Heitz)

(a) Euchromatin: - This is lightly stained and diffused part of chromatin. Which is transcriptionally or **genetically or active.** Generally euchromatin lies at central part of nucleus.

(b) Heterochromatin: - This is dark stained , thick and condensed part of chromatin this part have move histone and less acidic protein . Heterochromatin is **genetically less active** chromatin and forms stop point in transcription. Heterochromatin occurs near nucleus.

(i) **Constitutive heterochromatin: -**Occurs in all cells in all stages e. g. centromeric region.

(ii) **Facultative heterochromatin: -** Occurs in some cell in some stages e. g. **barr body.**

- ☞ Barr body in female cells is a **facultative heterochromatin** structure. (By M. Barr)
- ☞ Number of Barr body in nucleus of an individual is number of X –chromosome mine one.

Difference between Euchromatin and Heterochromatin.

Euchromatin	Heterochromatin.
(i) Consist of thin, extended , light stained part of chromatin	(i) Consist of thick **coild,** condensed part of chromatin and dark stained.
(ii) Genetically more active chromatin	(ii) Less active or inert chromatin .
(iii) Lies at centre of nucleus	(iii) Lies near the nuclear membrane.
(iv) Less histone protein	(iv) More histone protein
(v) Replicate in earl s phase	(v) Replicate in late s phase
(vi) DNA → mRNA	(vi) DNA → rRNA , t RNA

- ☞ Heterochromatin takes light stain during cell division stages (M-phase) & takes dark stain during Interphase.

(iv) Nucleolus: - Discovered by **Fontana** and Term by **Bowman.**

- ☞ Nucleolus is naked or membraneless, rounded or slightly irregular structure present in nucleus ans usually attached to chromatin (on chromosomes) of specific site called **Nucleolar organiser** region/NOR,
- ☞ Number of nucleolus in a aucleus is one. Onion cell has 4, and in oocytes of amphibian has 2000 nucleoli. Nucleoli absent in sperm cell, muscle cells etc. Human cell has 5 nucleoli.
- ☞ Calcium is essential for maintenance of nucleolus. Nucleolus disappears during prophase and reappears in telophase.
- ☞ **Chemistry of nucleolus: -**

Proteins	85%
RNA	10%
DNA	5%

Electron microscope has shown nucleolus to be made of following parets:
(Ultrastructure of mucleolus) :

(i) Fibrilar region: - This is central fibrous part o f nucleolus , which is consist of mainly rDNA andproteins.
(Nucleonema)

(ii) Granular region: - This is peripheral granular part of nucleolus which is consist of rRNA and proteins.

(iii) Amorphous matrix or pars amorpha: -This is proteinaceous ground matrix, which contains both fibres and granules.

FUNTIONS OF NUCLEOLUS:

Ribosome formation is the chief role of nucleolus, thus its called as **Ribosme factory of cell,** the proteins of ribosomes are synthesised in cytoplasm but it diffused in to nucleus and reach at nucleolus. Here r-RNA and ribosomal proteins are assembled to form ribosomes which move to cytoplasm through nuclear pores.

- ☞ At the some places heterochromatin forms thickned dense granules which are known as **Karyosomes or chromo centre or false nucleoli.**

FUNCTIONS OF NUCLES:

(i) Genetic information: -Nucleus contains genetic information in its chromatin. (store house of genetis material)

(ii) Transmission of genetic information: -Nucleus takes part in transmission of genetical information form parent cell to daughter cell or the one generation to next.

(iii) In cell-division: -Division of nucleus is pre-requisite to cell division.

(iv) Control of metabolism : -Nucleus controls metabolism of cell by sending mRNA in cytosol (Basically biomolecule DNA controls cellular activities through directing synthsis of enzyme) .

(v) Variation: -Vareiation develops due to change in genetic material o f nucleus. (Evolutionary role) .

CHROMOSOMES

GENERAL INTRODUCTION

- ☞ At the time of cell division the chromatin material get condensed to form **chromosomes,** thus **chromosome is highly condensed form of the chromatin.** Chromosomes are not visible during inerphase stage.
- ☞ First of all, chromosomes was observed by Hofmeister (1818) and Kari Nin pollen mother cells (PMC) of Tradescantia.

- Strsburger (1875) described chromosomes structure apperared in nucleus during cell division . (**Credit of discovery of chromosomes goes to strasburger**)
- Term" **chromosomes** was proposed by **Waldeyer** in 1889. (Term' **Chromatin** , was suggested by **Flemming**) .
- Generally chromosomes are rod- shaped , elongated or dot like in shape with size of 0. 5 to 32 μ (Trillium plant has longest chromosomes)
- Chromosomes can be best studied **at metaphase** stage because size of chromosomes is the shortest during metaphase due to highly chromosomes of chromatin threads by gelation , dehydration and coiling .
  (Shape of chromosome (V. L. J. I) is studied at Anaphase stage)
- Chromosomal theory of inheritance, was given by **Sutton & Boveri.**
- Generally chromosomes in plants are larger than chromosomes of animals, but number of chromosomes is high in animals as compared to plants.
- The number of chromosomes has no relation with any specific like size , complexity of organism.

Chromosomes number in some organisms:

Plants	**2n**	**n**
Mucor hemelis (Fungi)	2	1
Haplopappus gracilis (Family compositae)	4	2
& Brachycome plant	4	2
Takakia (Bryophyta)	14	7
Pisum sativum (Pea)	20	10
Maize (Zea mays)	42	21
Wheat (Triticum)	1262	631
Ophioglossum reticulatum (Pteridophyta)		
Animals		
Ascaris megalocephala (Round worm)	2	1
Drosophila melanogaster (Fruit fly)	8	4
Chimpanzee /Gorilla	48	24
Homo sapiens	46	23
Aulocantha (a protozoan)	1600	800

- 2n =number of chromosome in diploid cell . n= number of chromosome in haploid cell.
- X=Basic number in one set of earliest ancestor.
- The number of chromosomeis definite for each species. For example every normal human being has 46 chromosome in each body cell.
- Gametes of all organisms contain only one of each chromosome. The number of chromosomes in a gamete is called **" Genome"** or haploid chromosome (Human 23) " A complete set (n) of chromosomes (all genes) inherited as a unit form one parent is known as genome, , .
- First of all **T. D. Tijo** and **A. Levan** (1950) reported that 2n -46 in human cell.
- **Karyotype** $\Rightarrow$ karyotype is external morphology of chromosomes which is specific for each species of living organisms, Karyotype can be studied in metaphase of mitosis.
- Karyotype includes the number of chromosomes, relative size , position of Centro mere, length of the arms, secondary constrictions and banding batterns. **Banding technique** is used to study of the specific pattern of bands and interbands on chromosome. This includes the use of **fluorochromes** (flurescent dyes) .