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CELL BIOLOGY

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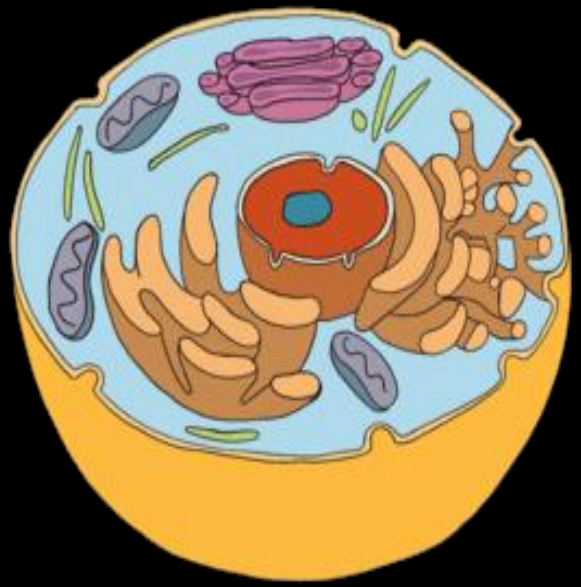
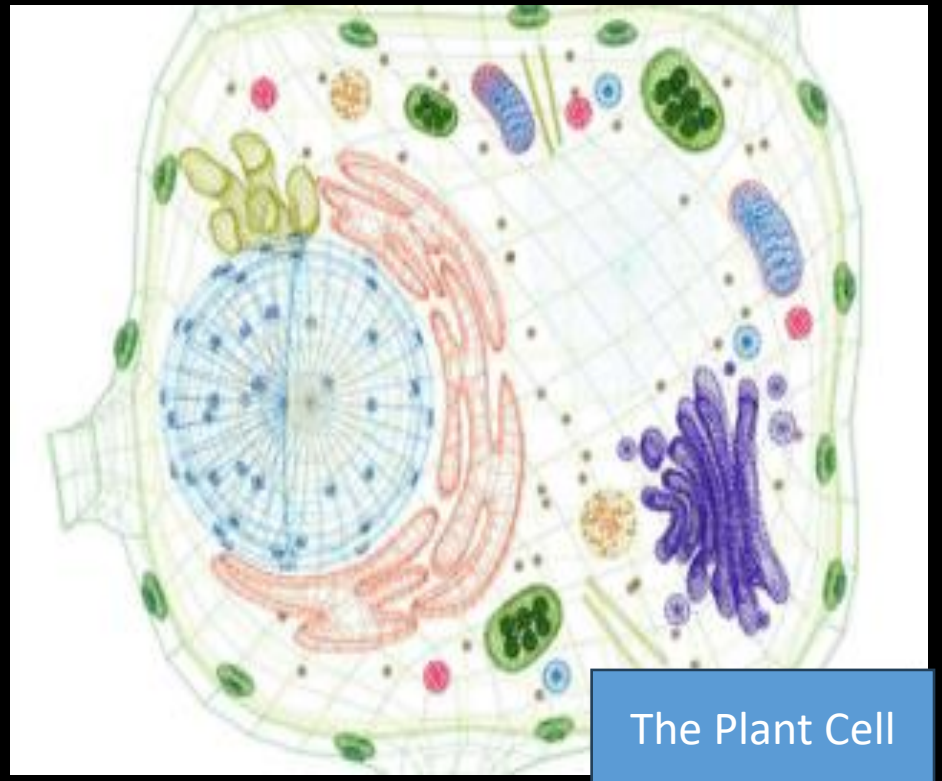
Butwal-09, Milanchowk

Cell Biology





The Plant Cell

Cell Types

Q. Prokaryotic structure is present in (IOM 2018)

a. Ulothrix
b. Nostoc
c. Spirogyra
d. Chlamydomonas

Ans: b. Nostoc

Q. Cyanobacteria (IOM 2019)

a. Have flagella or cilia
b. Are eukaryotes
c. Are photosynthetic
d. Have histone

Ans: Are photosynthetic

Q. Which of these liver cells act as phagocyte? (IOM 2015)

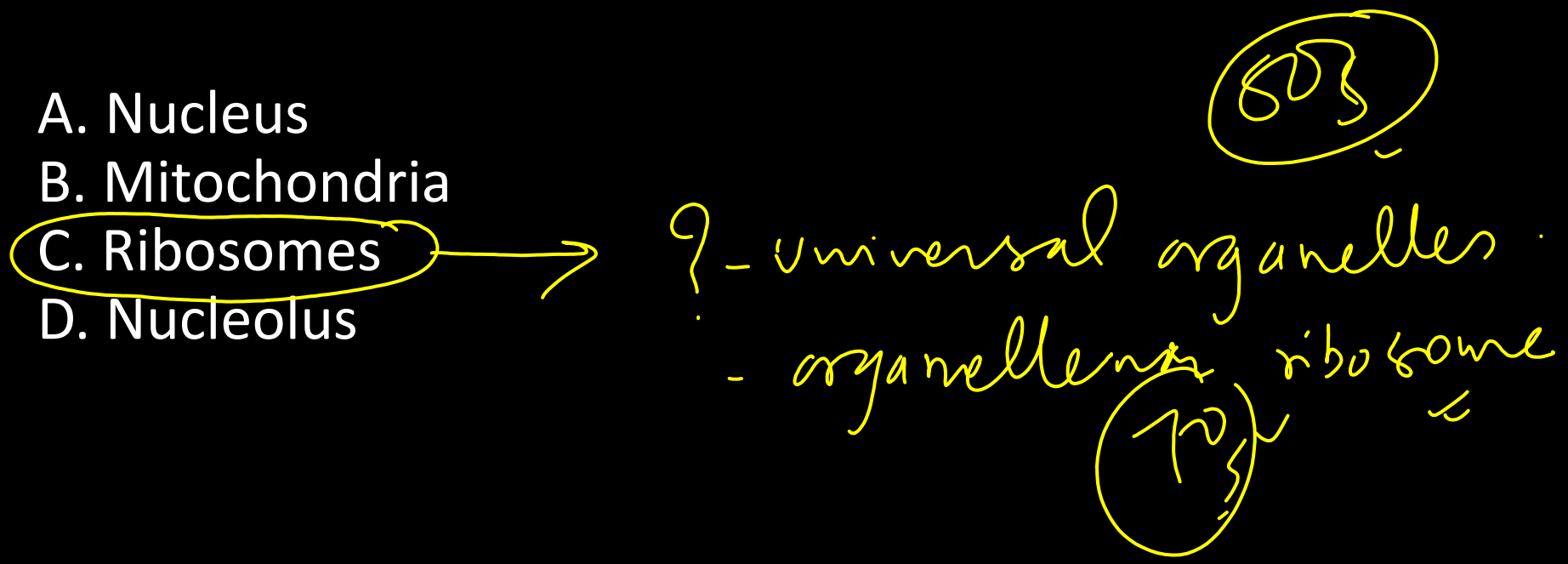
a. Kupffer cell
b. Dieter's cells
c. Hensen cell
d. Acinar cells

Ans: Kupffer cells: are specialized play a key role in phagocytosis, helping to remove bacteria, debris, and worn-out cells from the blood.

- Hensen's cells: are a layer of tall supporting cells around the outer hair cells (OHC) in the organ of Corti in the cochlea.
- Acinar cells: are located in the pancreas, and they make, store, and secrete digestive enzymes
- Deiters' cells:, also known as outer phalangeal cells or cells of Deiters found within the inner ear.

Q. Which of the following is a common cell organelle between prokaryotes and eukaryotes? (CEE 2022)

A. Nucleus
B. Mitochondria
C. Ribosomes
D. Nucleolus



C) On the basis of differentiation/**Q) Why do cell differentiate ?**

a. Undifferentiated cell eg.

- Meristem, stem cell, zygote, bone marrow.

b. Differentiated cell

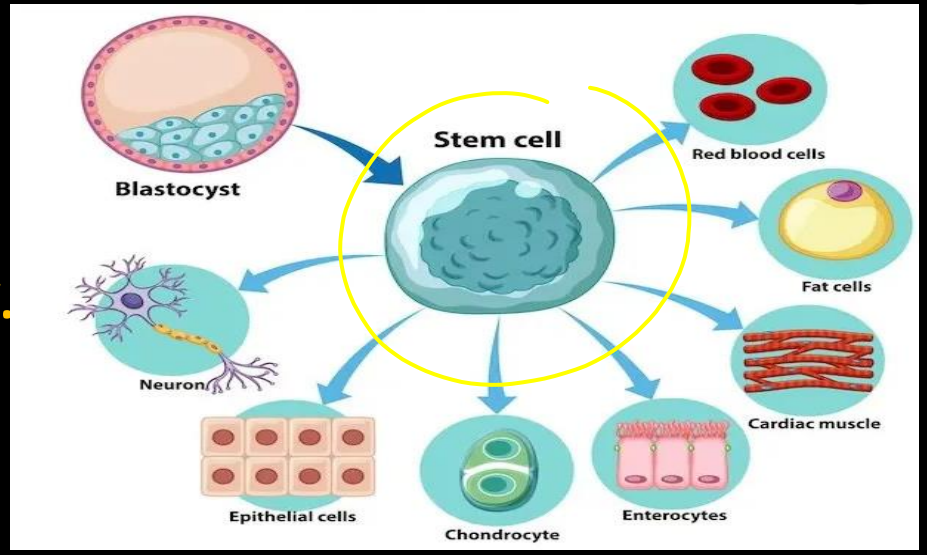
- permanent cell

c. De-differentiated cell

- Wound healing cell/regenerative cell

d. Redifferentiated cell: differentiated cell

- again loose the dividing activity.





Protoplasm = Bioplasm

- Is living biochemical substance.

- Is highly organized and most active chemical system in nature with maximum energy conversion.
- Dujardin in 1835 discovered protoplasm.

- Protoplasm coined the word
  - J.E. Purkinje

- Protoplasm is Fundamental unit of life was proposed by
  - Von Mohl

- Pritoplasm is considered as physical basis of life
  - Huxley, 1863

- Protoplasm exist in sol (inner, endoplasm) and gel (outer, ectoplasm) form. Sol– gel conversion is possible due to its colloidal nature.

- Non living substance of protoplasm is

  - deutoplasm.

- Plant cell without cell wall is

  - protoplast (Hanstein)

Chemical characteristics of protoplasm

- Consist about 36 elements
- O,C,H,N = about 93%
- Most abundant element by weight is oxygen. (62%)

- Major organic and diverse constituent is protein.
- Major inorganic constituent is water.
- PH slightly alkaline

- Specific gravity is slightly more than 1.
- Protoplasm coagulates at about 60 degree.
- Refractive index 1.4

Cytoplasm

Termed by

- Strasberger

- Consists **i.** cytoplasmic matrix **ii.** Organelles **iii.** Cell inclusions

- Cytoplasm minus organelles and inclusions =
- Hyaloplasm or cytosol.

- Cytoplasmic inheritance, maternal inheritance is due to
- plasma gene.

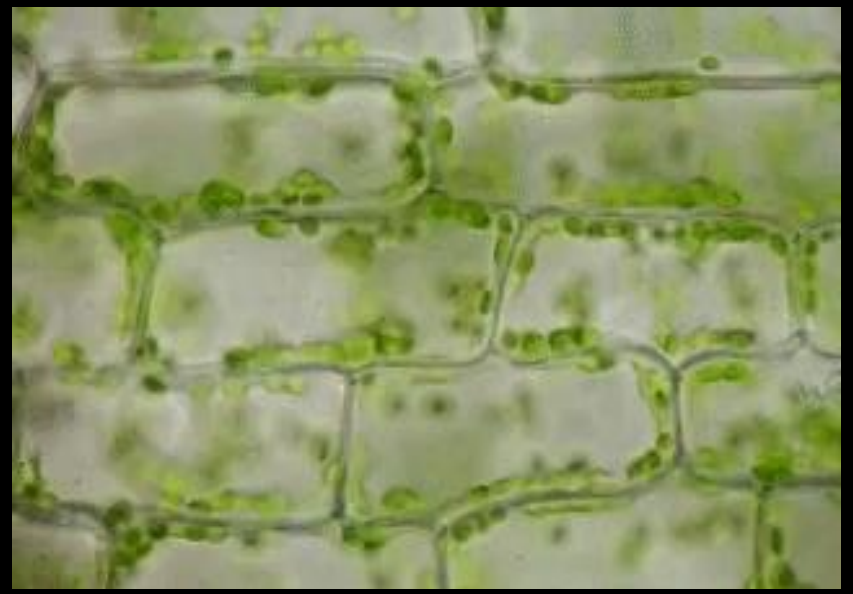
- Cytoblast:
- developmental area in nucleus.

Cyclosis

- Perpetual flow of cytoplasm generally in large cells.

- Sometime called cytoplasmic or protoplasmic streaming.

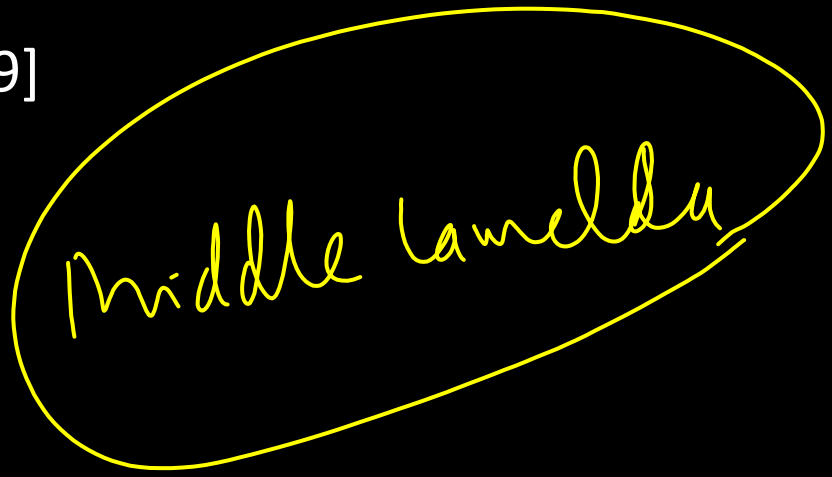
- Occurs in plant and animal both.



CELL WALL

Q. The ripen fruit is soft due to: [2019]

a. Degeneration Cell Wall
b. Partial solubility of pectate
c. Cellulose
d. None of the above



Ans: Partial solubility of pectate

Q. Oxysomes in present (IOM 2016)/2019

a. In inner membrane of mitochondria
b. Outer membrane of mitochondria
c. Thylakoid
d. Grana

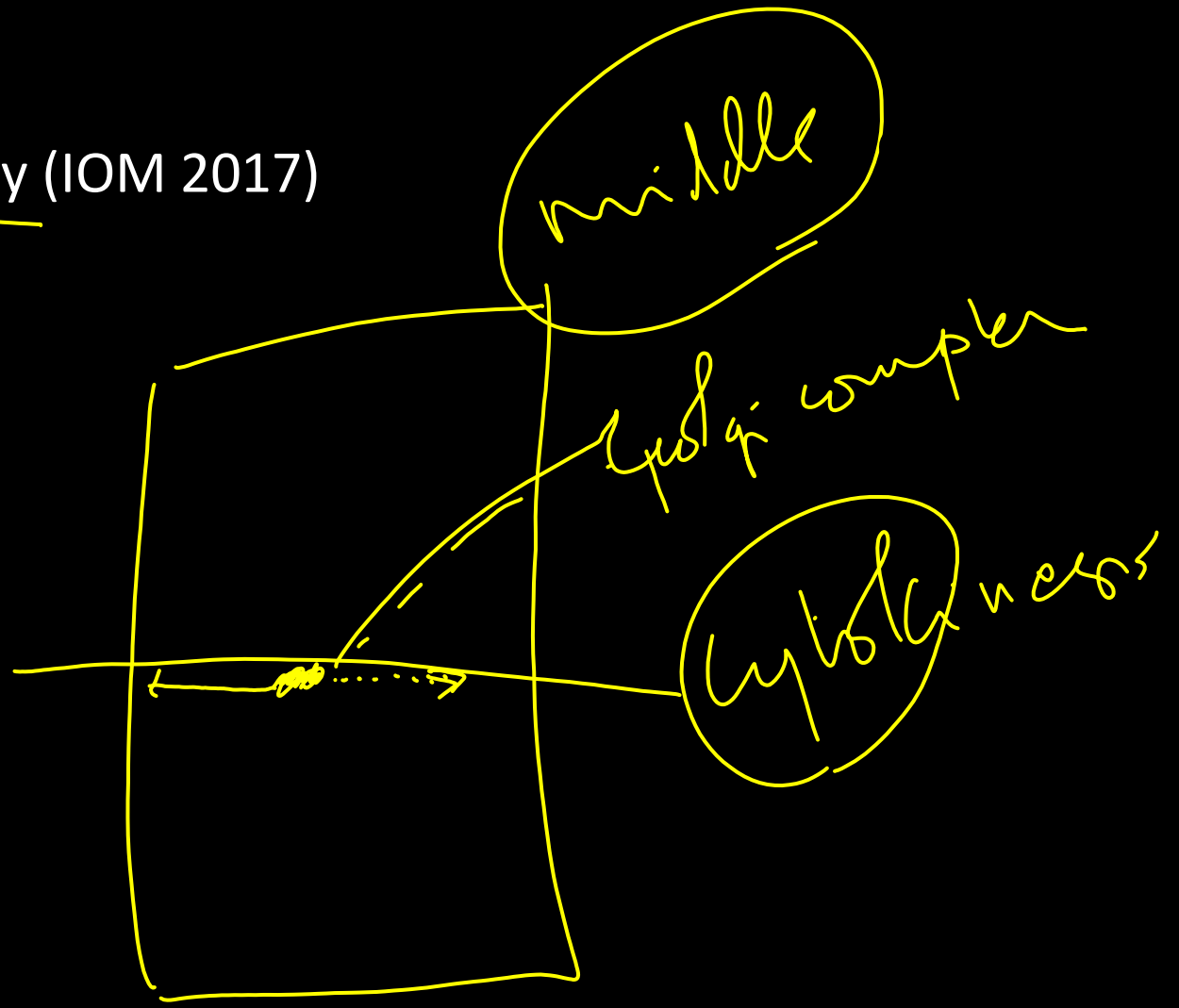


Ans: In inner membrane of mitochondria

Q. Cell plate formation is initiated by (IOM 2017)

a. Golgi bodies
b. Plastid
c. ER
d. Centriole

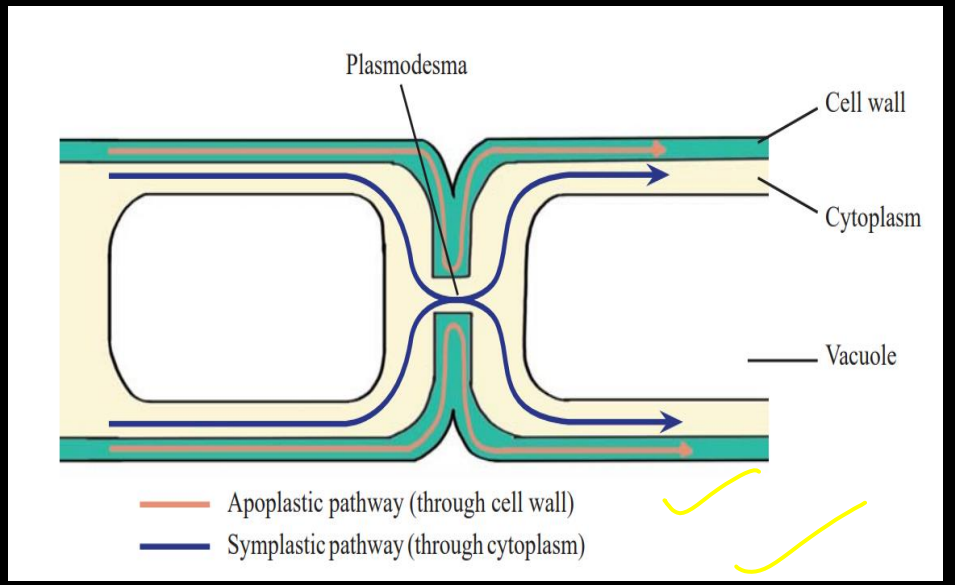
Ans: Golgi bodies



Q. Symplast pathway occurs through

a. Cell wall
b. Casparian stripes
c. Endodermis
d. Plasmodesmata

a. Plasmodesmata



Q. Polymer of sugar and proteins present in plasma membrane

a. Cellulose
b. Glycocalyx
c. Cytoskeleton
d. Cytoplasm

Ans: Glycocalyx

- ❖ Biological membrane/sub cellular membrane/plasma lemma/plasma membrane/ cytomembrane.
- ➢ The term cell membrane is used by
- ❑ Nageli and Cramer (1885).

- ➢ The term Plasmalemma is used by
- ❑ Plowe (Janet Plowe)

- ➢ Concept of unit membrane is given by
- ❑ Robertson

- ➢ lipid model of cell membrane is given by
- ➢ Overton

- ➢ Greater membrane model concept is given by
- ➢ Leininger

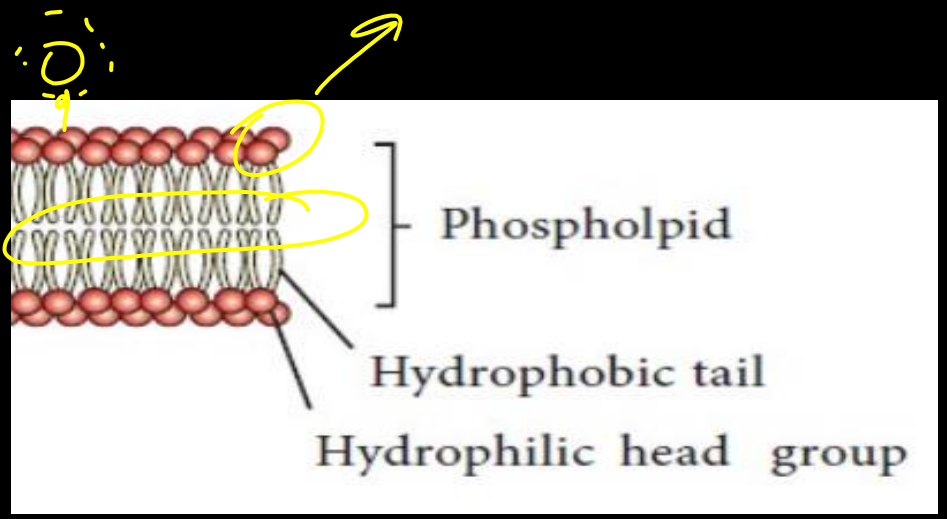
- Membrane is tri-laminar/tripartite, about 75Å, having pores (7-10 Å).

- It is characterized by quasi fluid, dynamic, can be repaired.

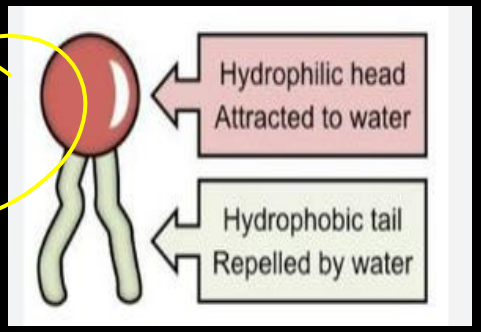
- Davson and Danielli (1935) proposed the
- first lamellar or sandwich model.

- **Fluid Mosaic Model**
- The most accepted membrane model is proposed by
- Singer and Nicholson (1972)

- **Lipid** (20-40%)
  - Phosphobilayer

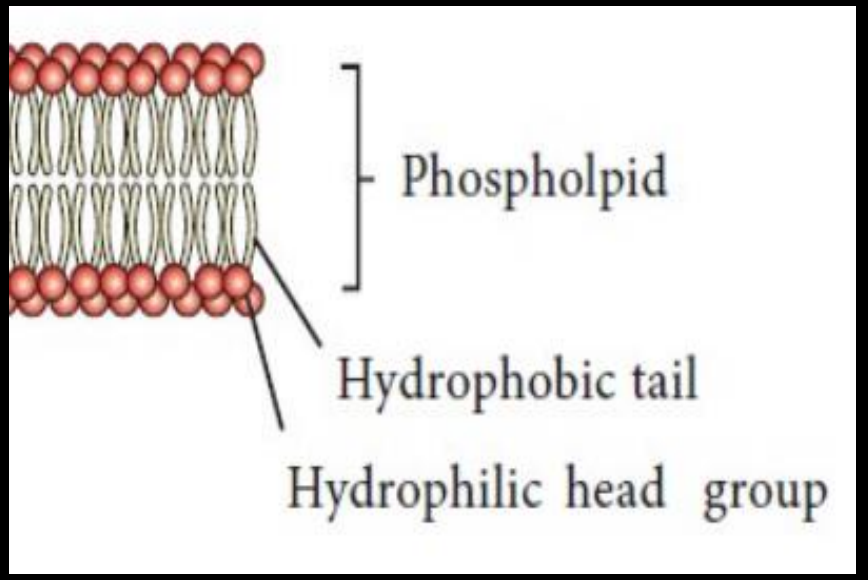


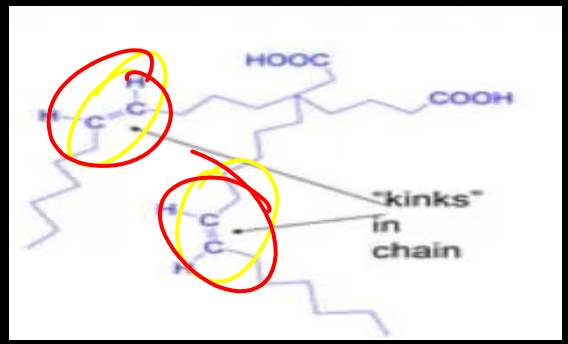
  - Usually composed of amphiphilic phospholipids



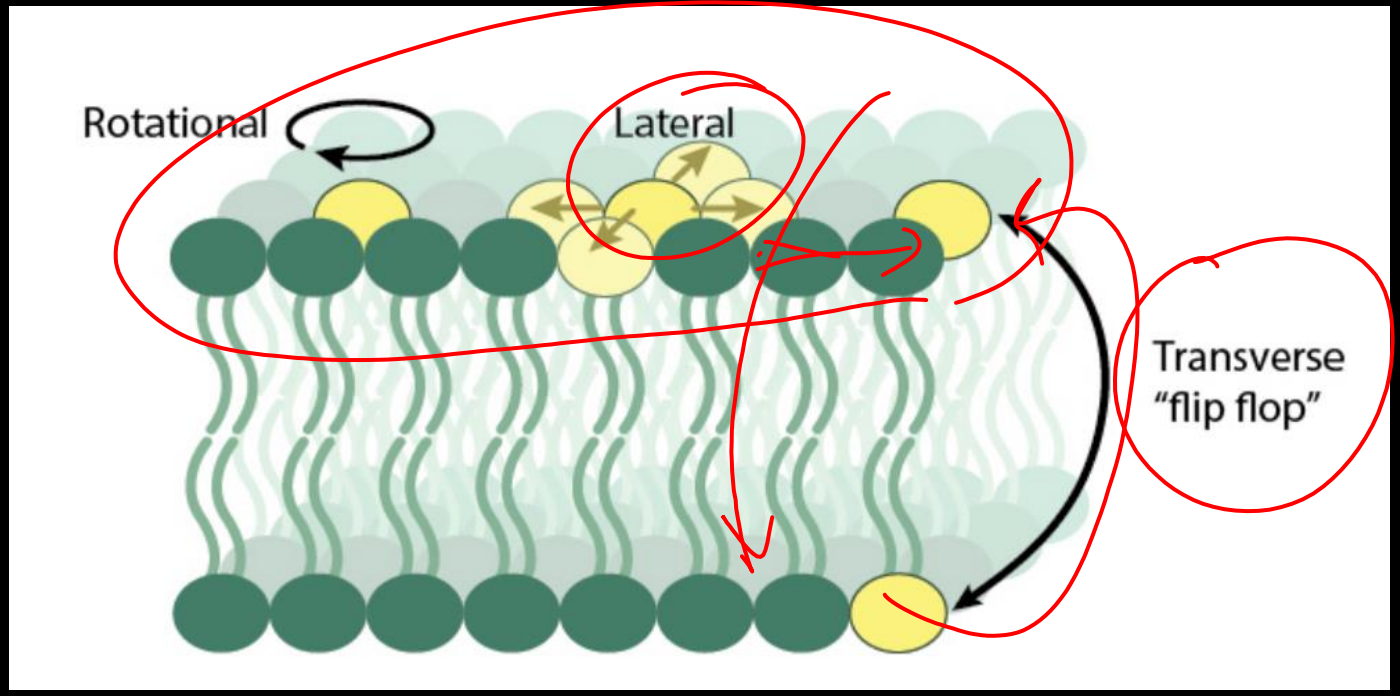
  - that have a hydrophilic phosphate head and a hydrophobic tail

- Unsaturated fats or oils are usually of plant origin and contain unsaturated fatty acids.
- Lipids have kinks.
- The double bond causes a bend or a “kink” that prevents the fatty acids from packing tightly, keeping them liquid at room temperature.





- Transition movement – within same layer.
- Flip – flap movement – trans-bilayer.



Q. RNA is stored in

a. Nucleus
b. Nucleolus
c. Golgi bodies
d. ER

Ans: Nucleolus

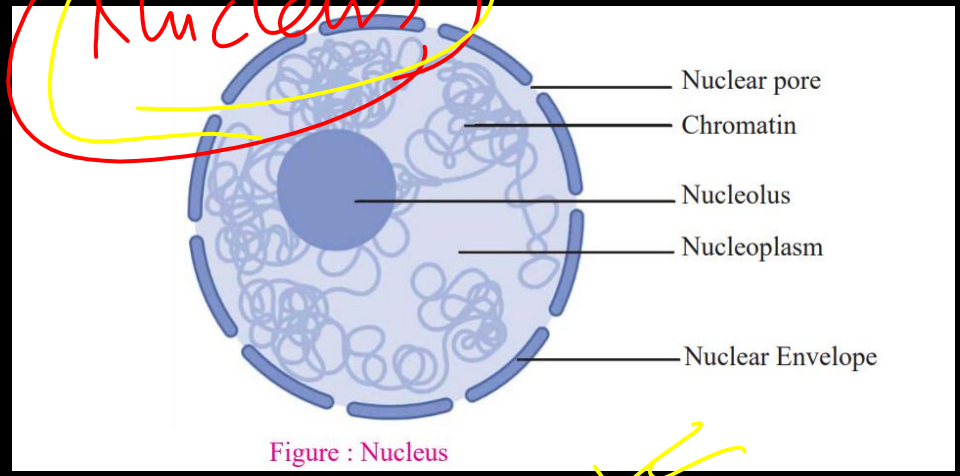


Figure : Nucleus

- Nucleus is the largest component of the cell.
- Interphase nucleus is in non-dividing or metabolic phase.
- Coenocytic condition ?
  - Multinucleated
- In **animal peripheral nucleus** is found in muscle cell, nerve cell.
- Nuclear dimorphism is seen in ciliated protozoans. Plasmodium, some foraminifera.

Q. Which of the following cell organelle is incorrectly matched with its function ? (CEE 2080)

a. Chloroplast - Photosynthesis
b. Golgi bodies - Protein synthesis
c. Mitochondria - Oxidative Phosphorylation
d. Lysosome - Suicidal bags

Golgi bodies - Protein synthesis

C value

Q. In a cell in G_1 phase, the DNA content is found to be 1.2×10^{-12}gm. Then, the DNA content in the cell at G_2 phase will be: (CEE 2022)

a. 1.2×10^{-12}gm
b. 2.4×10^{-12}gm
c. 1.2×10^{-6}gm
d. 2.4×10^{-6}gm

Ans: d. 2.4×10^{-6}gm

During the G_2 phase, the DNA content in a cell doubles compared to the G_1 phase because DNA replication occurs during the S phase (which is between G1 and G2 phases).

Q. Histone protein is found in DNA is (CEE 2023)

A. Basic
B. Acidic
C. Amphoteric
D. Neutral

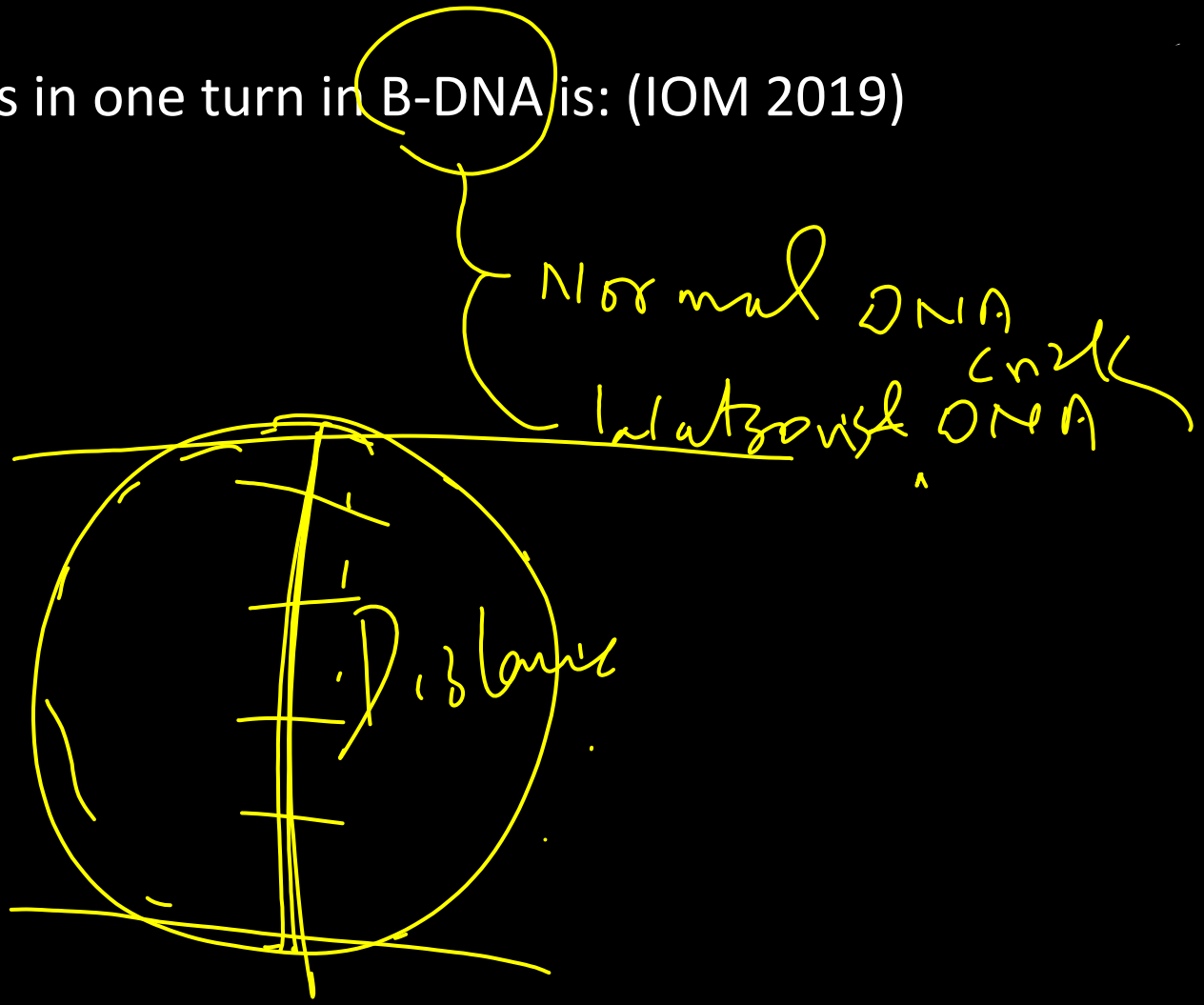
A. Basic

- **Amphoteric** refers to a substance that can act as both an acid and a base. This means it has the ability to donate protons (H^+) in a reaction (acting as an acid) or accept protons in a reaction (acting as a base), depending on the circumstances.

Q. The total number of base pairs in one turn in B-DNA is: (IOM 2019)

a. 11
b. 12
c. 10
d. 9

Ans. 10



Bonding - Biomolecule

Q. Which linkage is present between the glucose units (CEE 2022)



A. Peptide bond
B. Ester linkage
C. Glycosidic bond
D. phosphodiester bond

C. Glycosidic bond

Q. In a double stranded DNA, the Adenine content is 30%. The Cytosine content would be: (CEE 2023)

A. 30%
B. 20%
C. 25%
D. 40%

B. 20%

- Given that the Adenine content is 30%, the Thymine content will also be 30% because A pairs with T.
- Since the total percentage of all bases must equal 100%, the remaining 40%.
- Similarly Cytosine equals to Guanine i.e. cytosine % = 20%.

Q. All carbohydrates are: (CEE 2023)

A. Pentose and Hexose
B. Ribose and Deoxyribose
C. Aldose and ketose
D. Triose and tetrose

Ans: Aldose and ketose

Q. Ribosomes are synthesized in (CEE 2022)

a. Nucleus
b. Nucleolus
c. Cytoplasm
d. Mitochondria

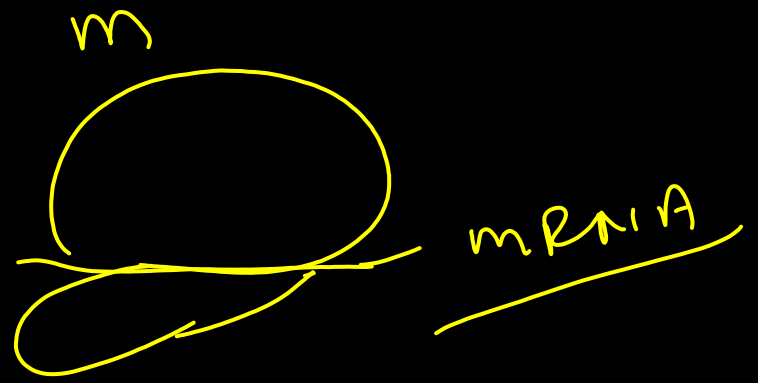


Ans: Nucleolus

Q. mRNA is attached with

a. Ribosome
b. Mitochondria
c. Golgi bodies
d. Centrioles

Ans: Ribosome



Q. Which of the following is polymorphic cell organelle (BPKIHS 2009)

a. Mitochondria
b. Golgi bodies
c. Lysosome
d. Endoplasmic reticulum

a. Lysosome

Cell Inclusions

Q. Needle shaped crystal of Colocasia are called (CEE 2022)

a. Sphaeroraphides
b. Raphides
c. Cytolith
d. Silicate

Ans: Raphides

Q. Vegetable chameleon is (IOM 2017)

a. Cytochrome

b. Anthocyanin

c. Chlorophyl

d. Pyrenoid

Ans: Anthocyanins are pigments found in many plants that can change color depending on the pH level. They are responsible for the red, purple, and blue colors in many fruits and vegetables.

Biomolecules

Cane sugar on hydrolysis yields: (IOM2014)

a. Glucose + Fructose
b. Glucose + Galactose
c. Glucose + Maltose
d. Glucose + Sucrose

Ans: Glucose + Fructose

Q. A short length of DNA molecule contains 120 adenine and 120 cytosine bases. The total number of nucleotides in this DNA fragment is: (IOM 1998)

a. 240
b. 120
c. 60
d. 480

Ans: 480

Q. Which is the following is not a carbohydrate ?

a. Inulin
b. Dextrin
c. Starch
d. Amines

Ans: Amines

- Inulin is a starchy substance found in a wide variety of fruits, vegetables, It is a type of prebiotic

- Insulin is protein.

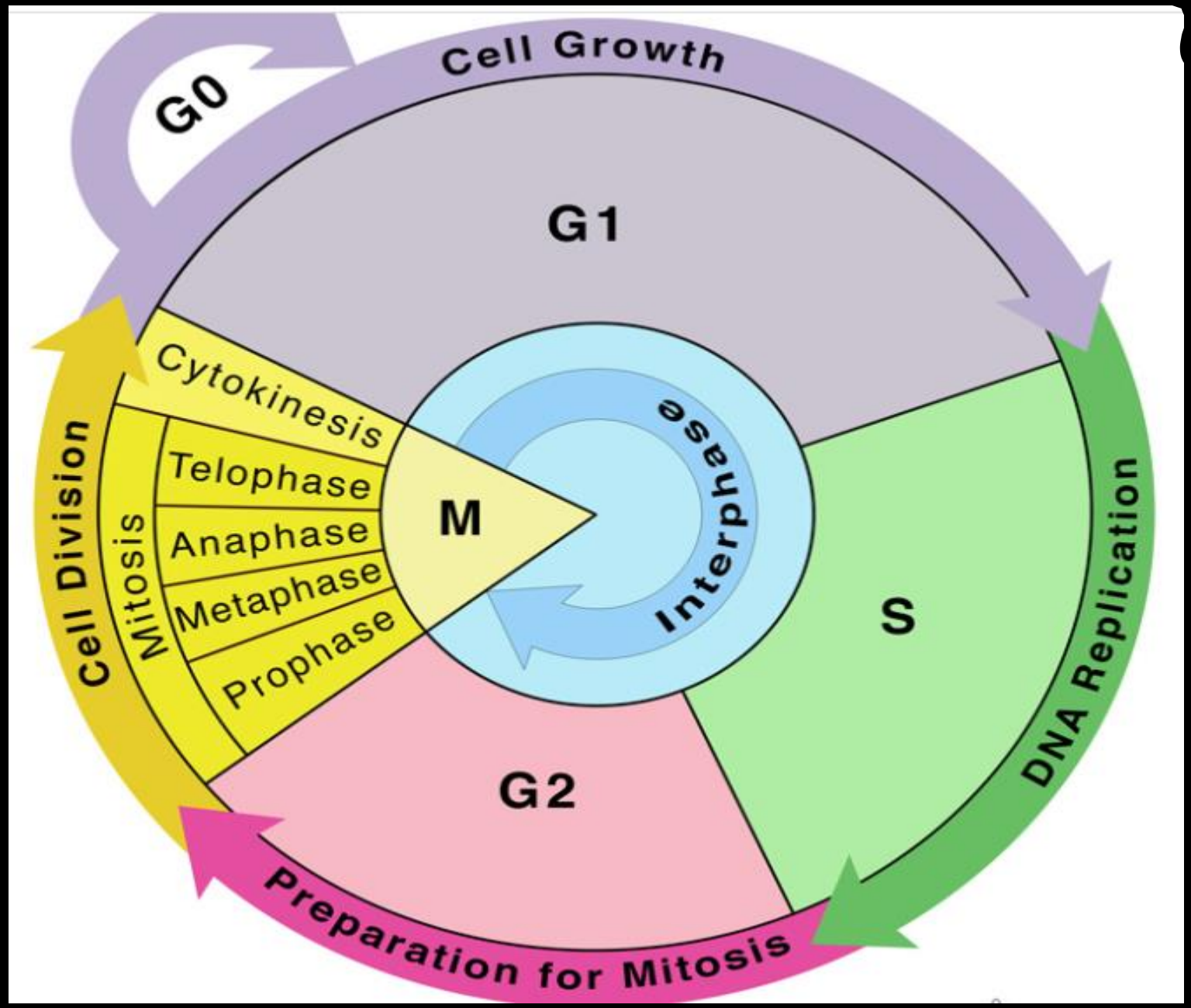
Q. The simplest amino acid is (MOE 2016)

a. Glycine
b. Tryptophan
c. Alanine
d. Proline

Ans: Glycine

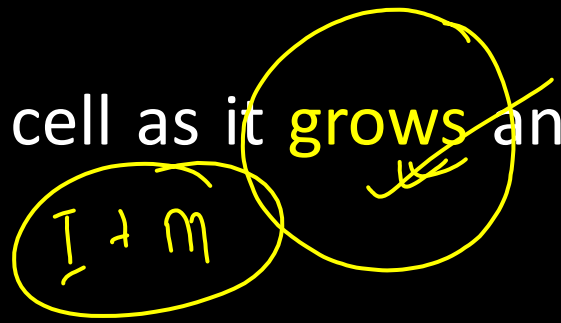
❑ The most complex amino acid is tryptophan

Cell cycle


G0
Cell Growth
G1
Cytokinesis
Telophase
Anaphase
Metaphase
Prophase
Mitosis
Cell Division
M
Interphase
S
DNA Replication
G2
Preparation for Mitosis

Cell cycle and cell division

- is a series of events that takes place in a cell as it grows and divides.



- Cell cycle time is different in different types of cell.
- Cell cycle time is also called generation time.
- It is total time to divide parent cell to daughter cell or total time period between two cell divisions.

- The eukaryotic cell cycle has interphase (G1 phase, S phase, G2 phase and M phase (mitosis and cytokinesis).

- In prokaryotes…….?

- Cells that have temporarily or reversibly stopped dividing process are said to be in quiescence state or G0 phase.

Interphase (I phase): It is the period between two successive mitotic divisions.

- It is the longest phase of cell cycle.
- It is also called resting and invisible phase because nucleus does not change in this phase.

the chromosomes still exist in the form of loosely packed chromatin fibers.

G1 phase (Gap one phase)

- In this phase proteins (except histone and spindle protein) are synthesized but the histone protein synthesis starts here.
- Maximum growth takes place in G1 so that the cell size increases and nuclease is in largest in size.
- Most of the transcription occurs in G1 phase.
- Decision of cell division occurs here.

S phase (synthetic phase)

- DNA replication occurs in S phase.
- Histone proteins are also synthesized here.
- Two chromatids are formed but replicated chromosomes are not visible. So, it is also called invisible phase.
- Centrioles are also divided here.
- After S phase cell division is compulsory.

Gap 2 phase (G2 phase)

- Major cell organelles like mitochondria, plastids and centrioles are duplicated.
- The amount of DNA doubles (4C) than the parental DNA (2C).
- Proteins for microtubules or spindle fibres are synthesized eg. tubulin proteins.

Mitotic phase (M phase/D phase)

- After G2 phase, cell enters to cell division phase. It is the final stage of cell cycle.

- The term Mitosis was given and observed first by W. Flemming in animal cell (1879). In plant cell it is first observed by Strasburger.

1. Karyokinesis
2. Cytokinesis

Q. Replication of DNA occurs during

(a) G_1 phase
(b) S phase
(c) G_2 phase
(d) M phase

Q. Cells in G_0 phase

(a) terminate the cell cycle
(b) exit the cell cycle
(c) enter the cell cycle
(d) suspend the cell cycle.

Ans: exit the cell cycle

Q. During cell cycle, two molecules of DNA are present in chromosome during

(a) G_1 phase
(b) beginning of S phase
(c) G_2 phase
(d) end of M phase

Q. Which of the following is associated with cell division?

a. centriole

b. mitochondria

c. ribosome

d. chloroplast

Q. At what stage of the cell cycle are histone proteins synthesized eukaryotic cell?

(a) During G2 stage of prophase
(b) During S-phase
(c) During entire prophase
(d) During telophase

Cell division

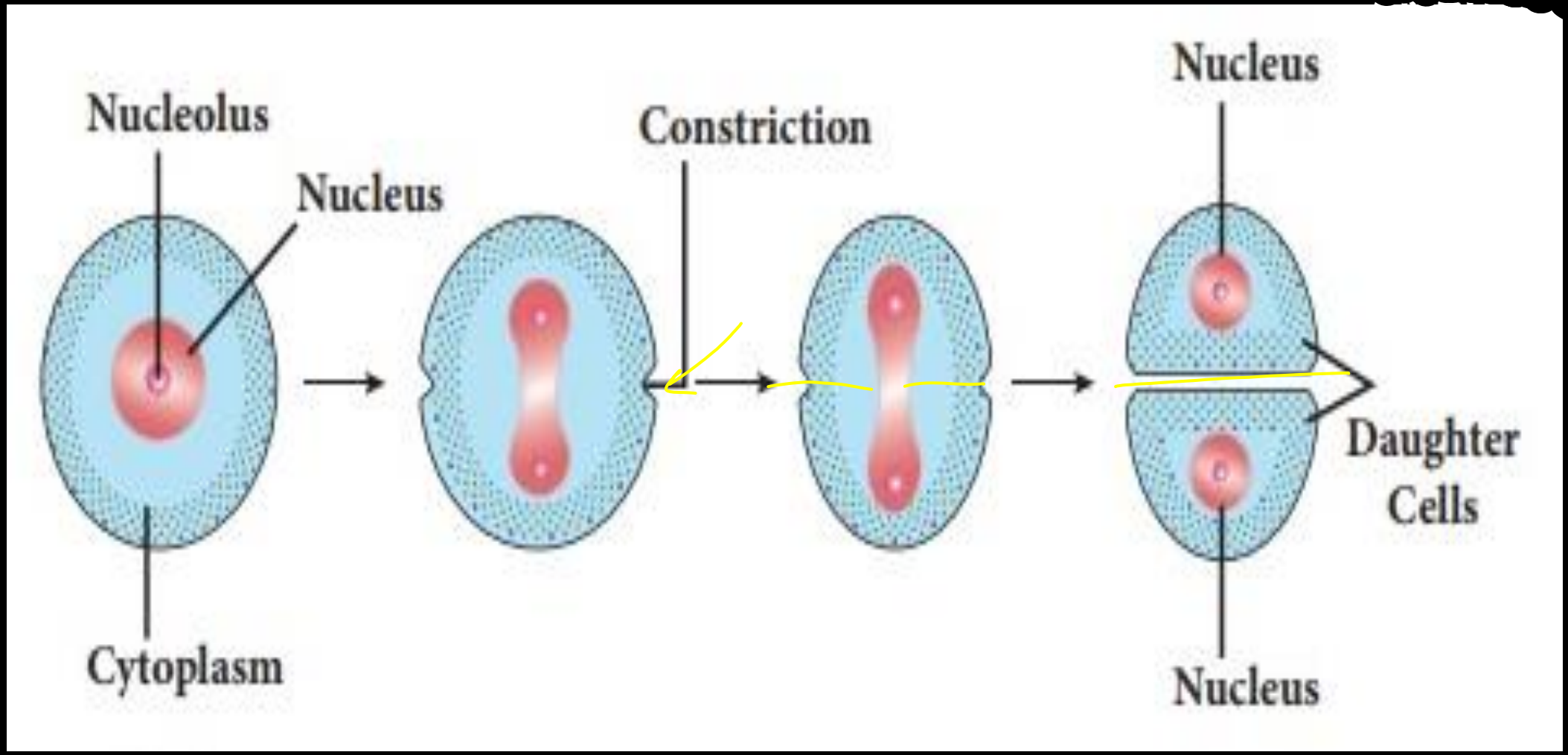
Direct cell division

- Amitosis:
- Amitosis was first observed by Robert Remak and the term amitosis was first coined by W. Flemming.

Primitive organism like protozoans, bacteria, cyanobacteria and yeast are divided through this process.

Chromosomes and spindle fibres are not formed.

Nuclear membrane does not disappear,


Nucleolus
Nucleus
Cytoplasm
Constriction
Nucleus
Daughter
Cells
Nucleus

Significance of amitosis

- It gives large number of cell in short time period.
- It is the most common method of reproduction in primitive organism.
- It occurs in diseased cells, metabolic nucleus (Paramecium) etc.

Q. Colchicine interferes with cell division because of

(a) splitting of chromosomes
(b) non-paring of chromosomes
(c) double replication of chromosomes
(d) non formation of spindle

- Colchicine is extracted from the corm of *Colchicum autumnale, Autumn Crocus.*
- It arrest in metaphase.

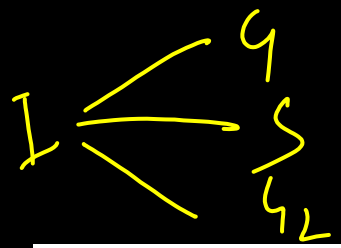
Mitosis (mitos= thread or fibrils)

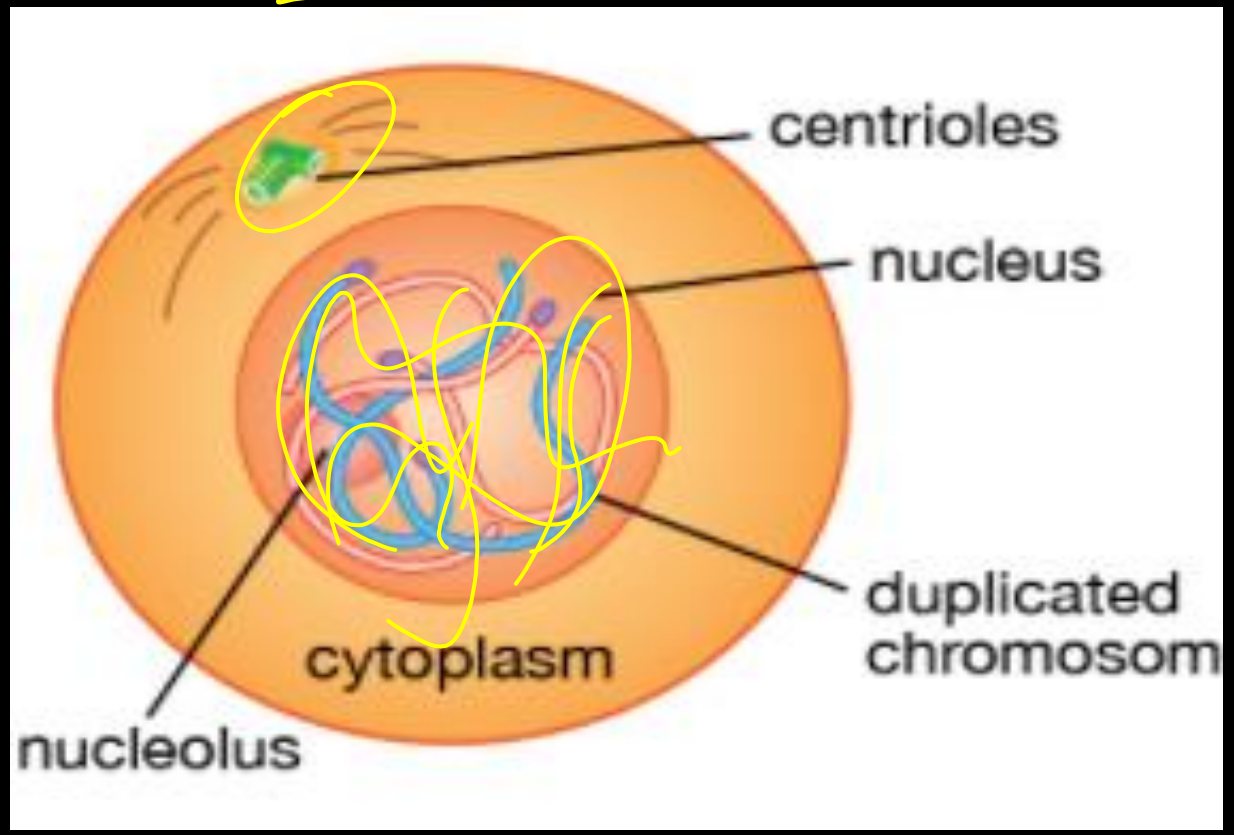
- It is for the growth and multiplication of cells.
- The term mitosis was coined by Walther Flemming in 1882.
- Occurs……
- What do I prefer you in bread fast?
- I Prefer Milk And Tasty Cupcakes.

Q. Colchicine is a cell poison which arrests cell division at _____ can induce_____.

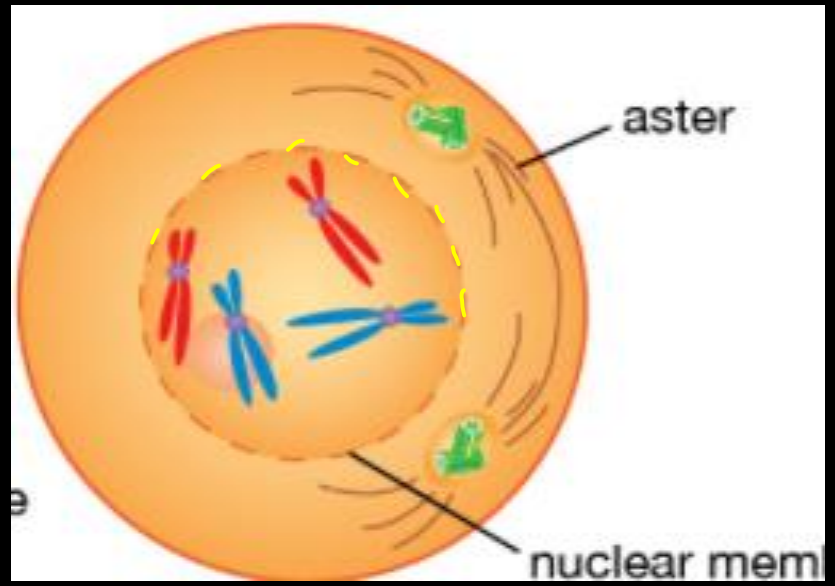
a. Metaphase and parthenocarpy
b. Anaphase and parthenocarpy
c. Metaphase and polyploidy
d. Metaphase and polyploidy

Interphase


G1
S
G2


centrioles
nucleus
duplicated chromosom
cytoplasm
nucleolus

1.Prophase

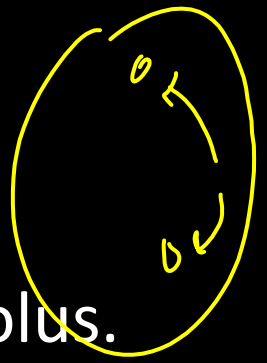


- Condensation
- Nuclear membrane
- Nucleolus } disappear

- Prophase occupies over half of mitosis.
- It is the most active phase of mitotic division.

- Condensation of chromatin fibers is the characteristic prophase.

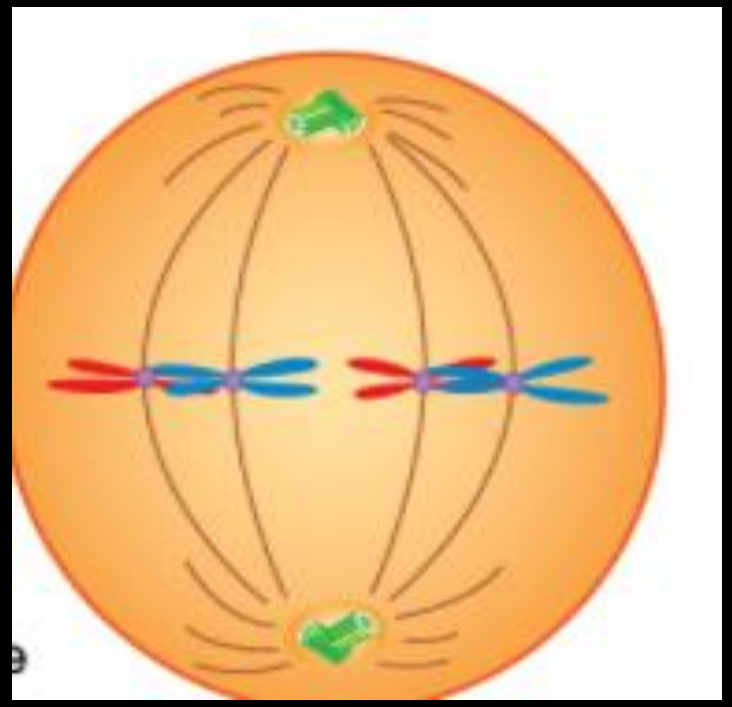
- Each replicated chromosome can now be seen to consist of two identical chromatids (or sister chromatids) held together by a structure known as the centromere.



- disappearance of nuclear membrane and nucleolus.

- In animal cell, centrosome migrate to opposite ends of the cell.

Metaphase



Metaphase starts with the disappearance of nuclear membrane and nucleolus.

The chromosomes, led by their centromeres, migrate to the equatorial plane of cell.

- The chromosomes, led by their centromeres, migrate to equatorial plane of cell.

- Congression.

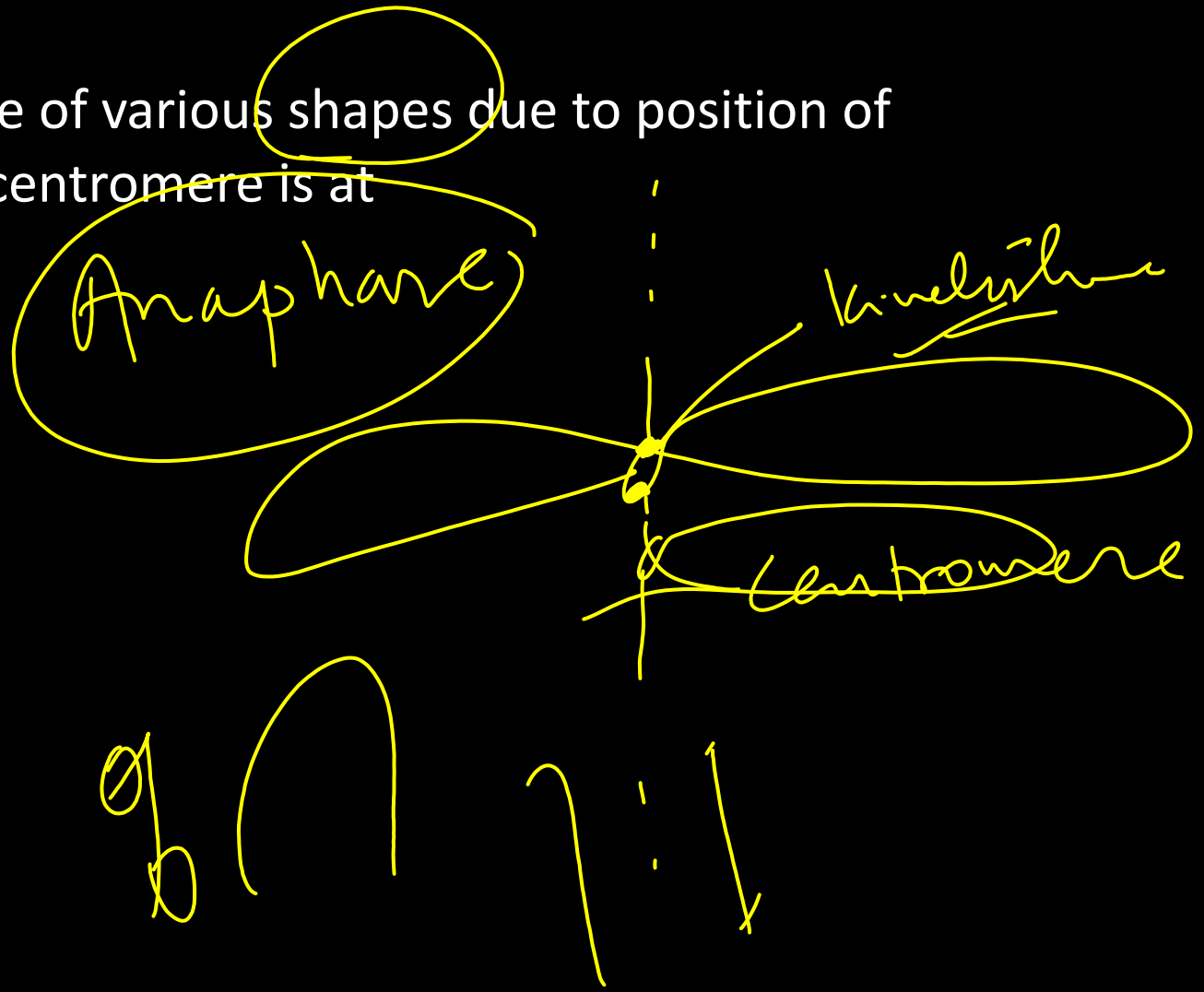
- The spindle fibers bind to with the centromere of each chromosome called a kinetochore.

- The chromosomes continue to condense. Chromosomes are shortest and thickest in metaphase.

- Chromosomal size, structure and number is best studied in metaphase.

Q. Chromosomes at anaphase are of various shapes due to position of centromere. It is J shaped when centromere is at

a. middle
b. top
c. sub terminal
d. near centre

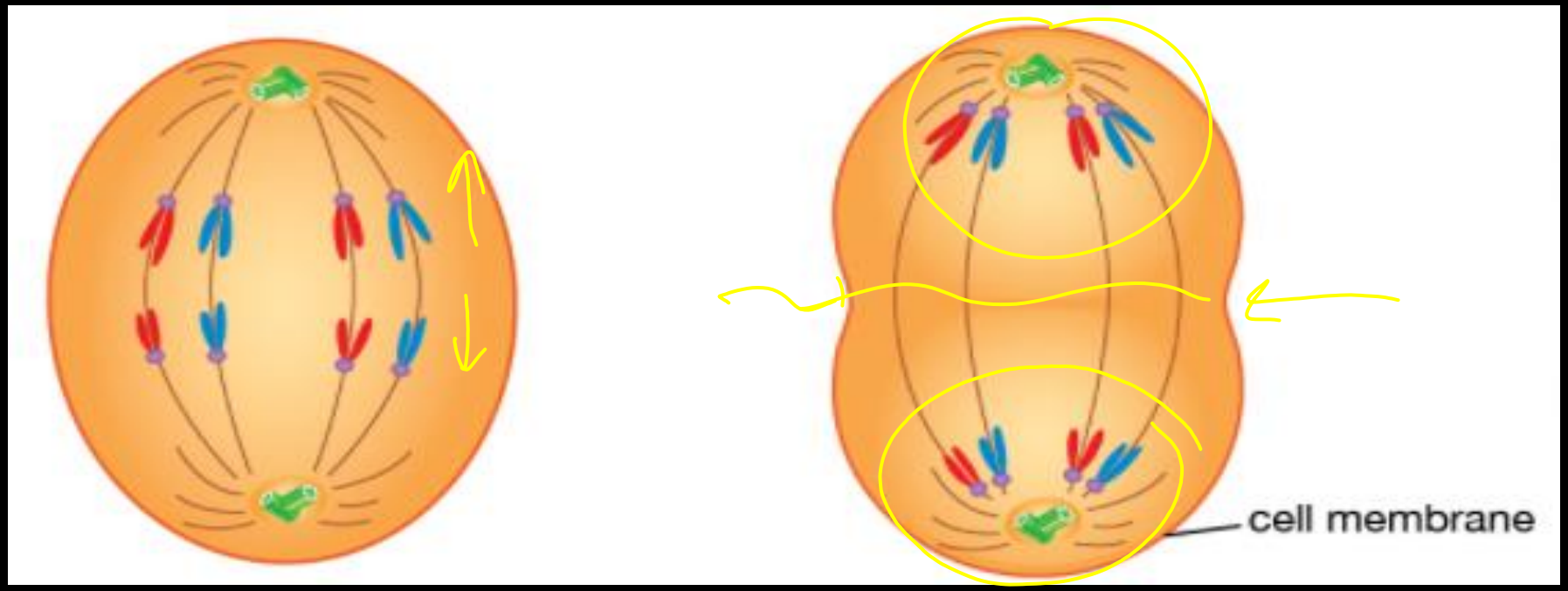


Ans: sub terminal

Q. Chromosomes are seen distinctly during

(a) anaphase
(b) telophase
(c) metaphase
(d) interphase

Anaphase

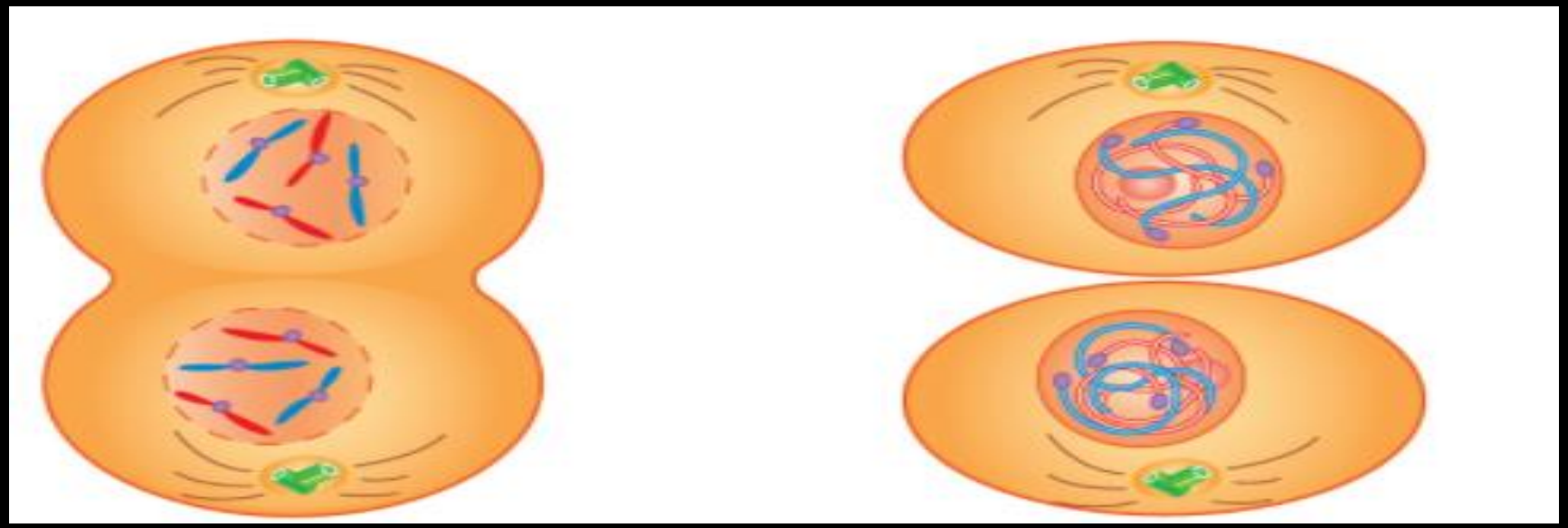


Early anaphase

Late anaphase

- Centriole splits
- spindle fibers contraction.
- Similar numbers of chromosomes are moved towards the pole so that anaphase is called equational division.
- Anaphase ends when the newly formed daughter chromosomes reach to the poles.

Telophase



Early telophase

Late telophase

- Reverse phase of prophase

Q. Mitosis can be clearly observed from

(a) cells of bud
(b) root & shoot apex
(c) cambium region
(d) flower part

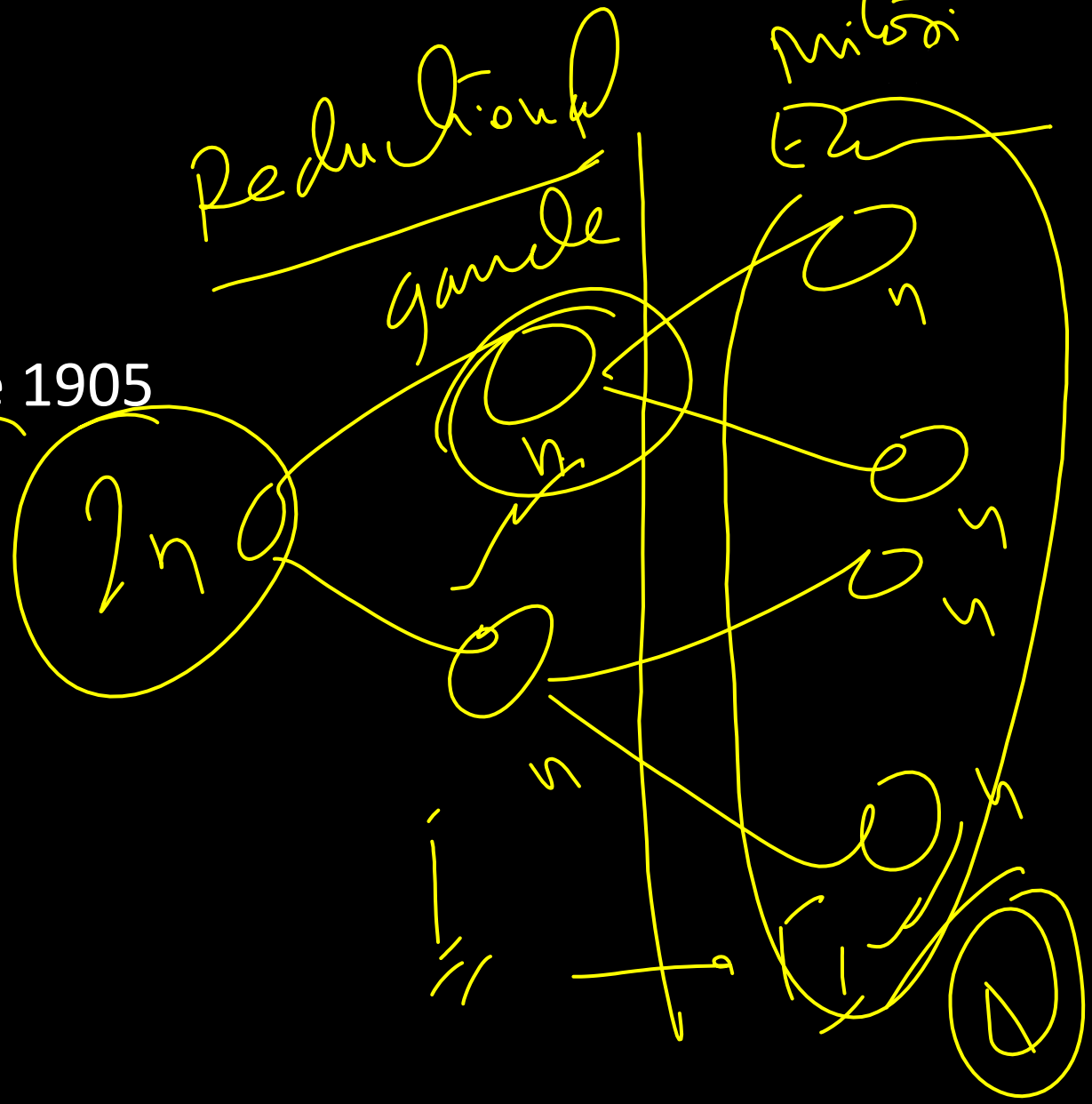
Ans: root & shoot apex

Why ? mitosis

- Growth and multiplication
- Repair, Replacement, Regeneration (R3)
- Prevents parental properties (P3)
- Asexual reproduction

Meiosis

- Studied by Van Benedin 1887
- Termed by Farmer and Moore 1905
- meiosis I
- Meiosis II



- meiosis I – reductional - heterotypic division
- Meiosis II – equational - homotypic division
- The cell in which meiosis occurs – meiocytes
- Meiosis occurs in diploid or polyploid cells but never in haploids.

Meiosis I - Prophase I

- **Leptotene /Leptonema (Greek, leptos = thin, tene = nema = thread**

- Nucleus increases in its size and volume.
- Due to condensation chromosomes become short and thick. They are in bouquet shape.
- Chromosome seems beaded like structure. Each bead is called chromomere.
- Nuclear membrane and nucleolus remain intact.



❖ Zygotene/ Zygonema (Greek, Zygo = yoke/pair)

- Condensation process continue i.e chromosomes looks more prominent.
- It is characterized by the pairing of homologous chromosome synapsis.
- The synaptonemal protein complex
- Pairing usually starts from one end, i.e. zipper like fashion.
- Paring makes bivalent.

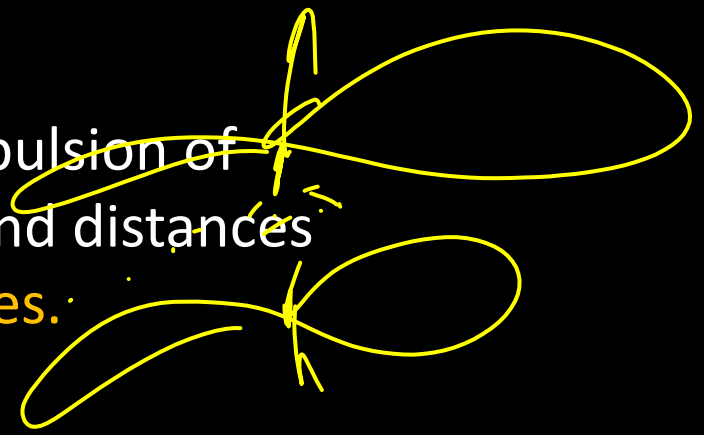
Pachytene (Greek, pakhus = thick, tene = thread)



- It is the longest sub-phase of prophase I.
- duplication of chromosome = tetrads formed
- Chiasmata formation
- Crossing over
- Nucleolus and nuclear membrane remains prominent.

Diplotene (Greek, diplos = double)

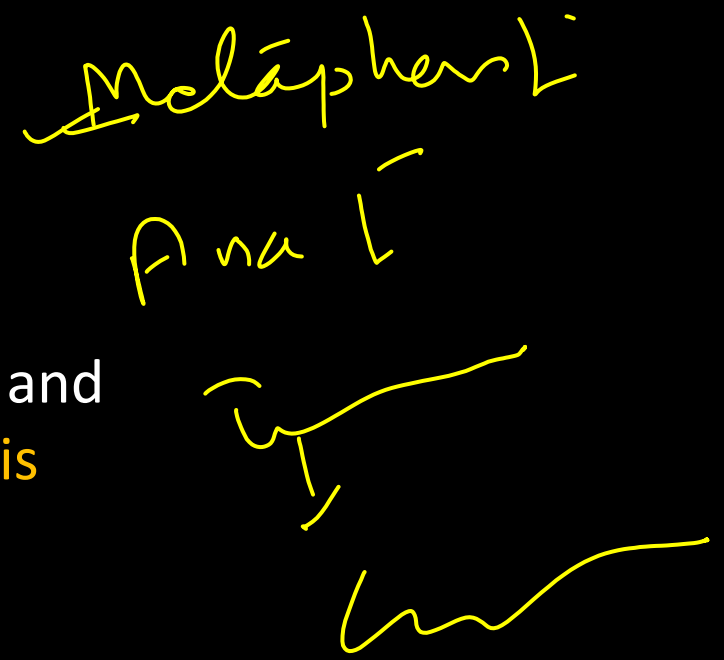
- Synaptonemal complex protein starts to disappear (not at chiasmata) so that chiasmata are clearly visible in diplotene.



- Uncoiling process helps in repulsion of homologous chromosomes and distances between centromere increases.

- Nuclear membrane is intact but nucleolus start to degenerate.

Diakinesis (Greek, dia = across, kinesis = movement)



- Terminalization phase
- The synaptonemal complex completely breaks down and the cohesive connection between homologous pairs is failed.
- Nuclear membrane and nucleolus disappear.
- At the late diakinesis spindle fibers begin to appear.

Metaphase I

- Independent assortment of chromosome occurs in metaphase I.



Anaphase I

i. by the seperation of homologous chromosomes.

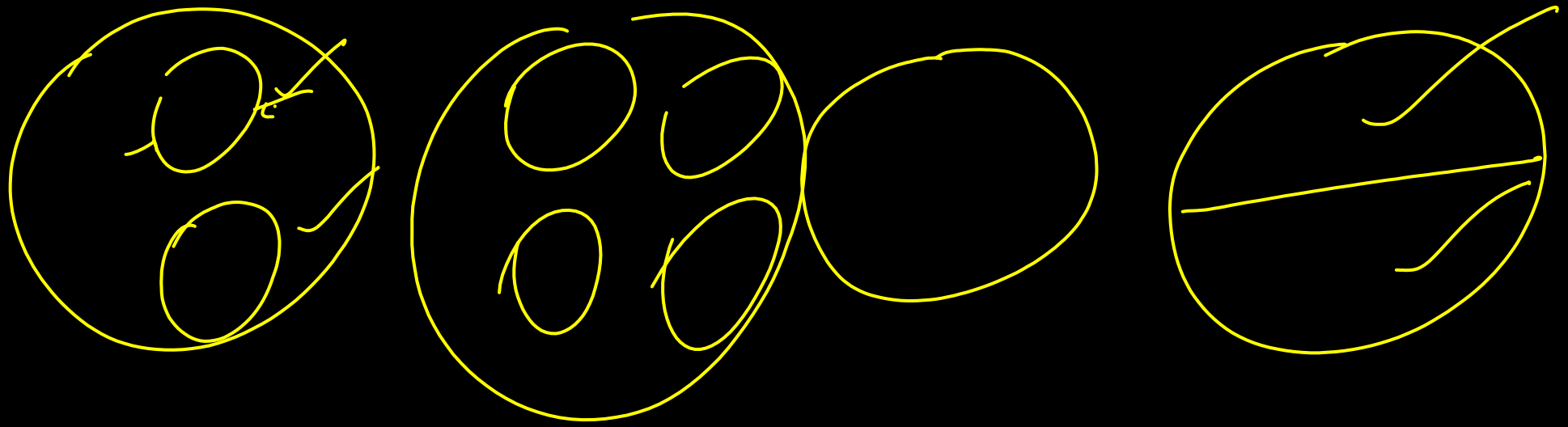
ii. cenromere does not divide - reductional phase.

Interphase II

- It is the time period between meiosis I and meiosis II.
  or in some cases absent may not present.
- DNA is not synthesized (S phase is absent).

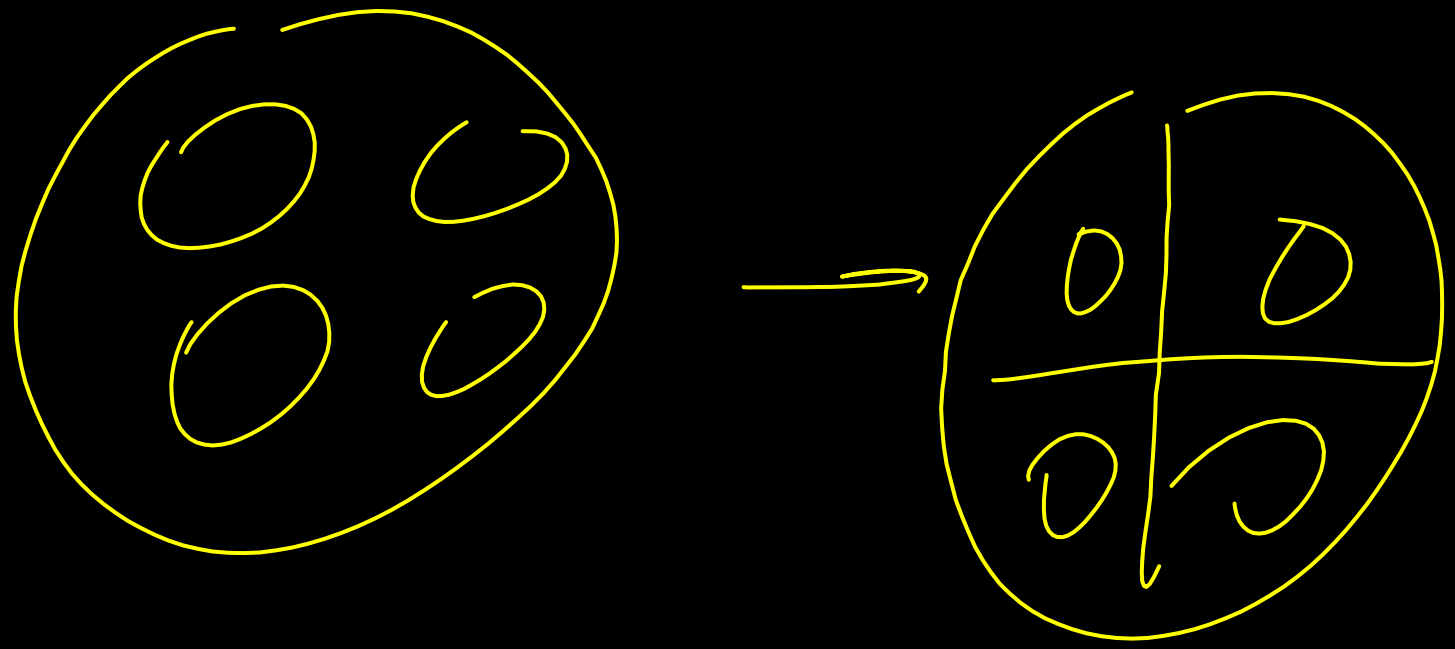
The process of meiosis II and mitosis is similar. Cytokinesis in meiosis may Successive or Simultaneous

- Successive cytokinesis: It occurs twice, i.e. one after meiosis I and another after meiosis II.



- It forms isobilateral tetrad. This type is found mostly in monocots.

- Simultaneous cytokinesis: It occurs only once after meiosis II only.



- Tetrahedral type of tetrad is formed from this process. It found mostly in dicot plants.

Q. Crossing over occurs between

A. Non- sister chromatids of non-homologous chromosomes
B. Sister chromatids of no-homologous chromosomes
C. Non-sister chromatids of homologous chromosomes
D. Sister chromatids of homologous chromosomes

Ans: Non-sister chromatids of homologous chromosomes

Q. The number of times a cell needs to divide mitotically to form 32 cells is: (CEE 2023)

A. 5
B. 6
C. 16
D. 8

A. 5

- $2^n = 32$

Thank You