⊗ In M-phase no protein synthesis occur.
⊗ chromosome first visible in prophase.

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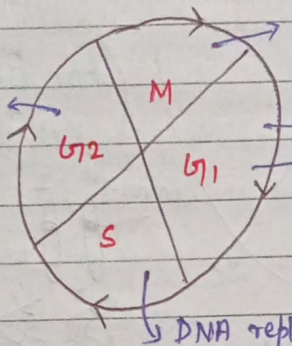
CELL CYCLE :- (2-3 Question)

→ All living cell show changes → Like Growth and Division.
→ For Eg:- A multicellular organism develop from single cell - zygote.
→ Growth is continuous process in a cell cycle. ⊙ zygote —Growth→ division → Multi-Cellular

1. # Phases of cell cycle :- → M phase (cell division)
→ Interphase.



G2 phase - Gap b/w S & M.

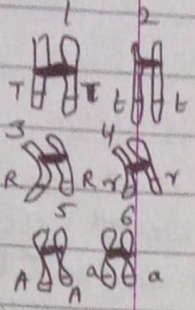
G1 phase - Gap b/w M & S
Growth → External - nutrients
→ Internal - Genes

<1> Time period in different Phases :-
(1995) → Human cell in culture (24hr) (Hela cells)
→ M-phase = 1hr = 5%
→ G1 phase = 8-12hr = 33% - 45%
→ S-phase = 6-8 hr = 25% - 33%
→ G2-phase = 3-4hr = 15%
} 95%
→ Yeast cell = 90 min
→ Most variable phase in time period - G1 phase / Both under nutrients and Genetic control.
→ S + G2 + M - only under Genetic control.

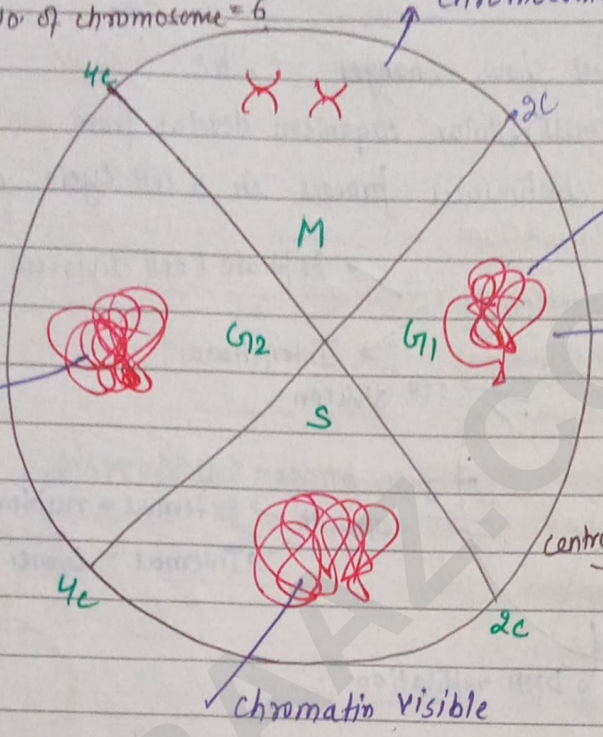
Note :- All phases of cell cycle are in strict Genetic control.

Question 1:- Give example of Division where G1 and G2 phase can be absent.
Ans. ⊙ zygote → same size as zygote {It undergoes M and S}
→ Morula.

(2) Amount of DNA and Ploidy:-



2n = 6
No. of chromosome = 6



Chromosome visible only in M-phase

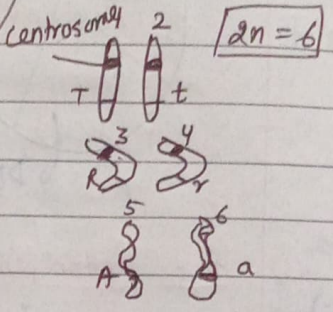
If chromatin is converted into chromosome

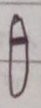
chromatin visible

chromatin

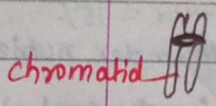
chromatin visible

(For Diploid cell amount = 2c)





G_1 phase
→ chromosome = chromatid



G_2 phase → chromose = 2 chromatid.

Question-2 Give Amount, Ploidy ; no. of chromatid in G_1 & G_2 phase of Human cell, Maize cell.

Answer- Human cell + G_1 phase = 2c

2n = 4c

Chromatid = 46

G_2 phase = 4c

2n = 46 Chromosome

Chromatid = 92

→ Maize cell + G_1 phase = 2c

2n = 20

chromatids = 2c

G_2 phase = 4c

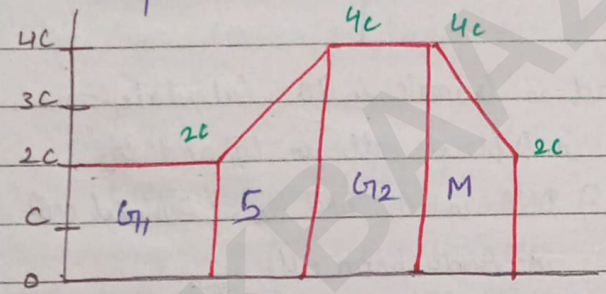
2n = 2c ~~chromatids~~ chromosomes

chromatids = 4c

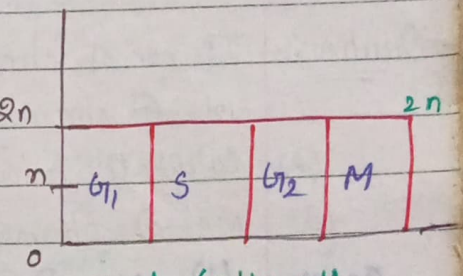
Question:- In apical meristem (dividing cells) cells present in ____ phase.

1) G_1 phase
2) G_2
3) S phase
4) M phase
5) any one of the phase.

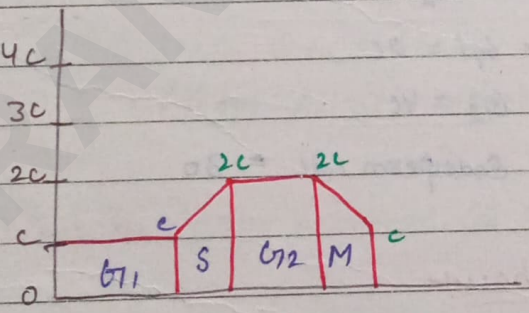
- Explanation:- Ans (5) but if 5th is not present then Answer will be G_1 phase because of more Probability of seeing chromatid.



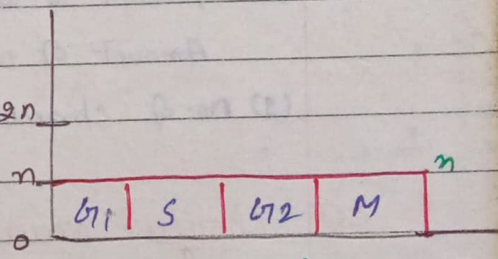
Diploid



Ploidy (Diploid)



(Haploid)



(Haploid)

- Note:- No cell is present which can divide without S-phase.
- In G_1 and G_2 phase ploidy remains constant.
  In S and M phase ploidy varies.

Question 4:- Give ploidy and Amount of DNA in following cells:-

1) Vegetative cell of pollen grain
2) Generative cell of pollen grain
3) Zygote.
4) Pollen mother cell in G_1
5) (PMC) in G_2.

Answer:

S.No.	Ploidy	Amount of DNA
1) Vegetative cell	n	2C
2) Generative cell	n	2c
3) Zygote	2n	2C
4) PMC in G_1	2n	2c
5) PMC in G_2	2n	4C

Question 5:- If no. of chromatid in Gamete is 10. Calculate:-

(1) No. of chromosome in Diploid cell in G_1 and G_2.
(2) Calculate Amount of DNA in G_1 and G_2 (Diploid cell).
(3) No. of chromosome in Endosperm cell.

Answer: (1) No. of chromose in $G_1 = 10$

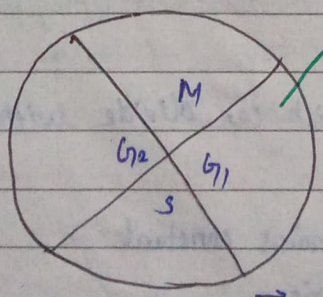
No. of chromosome in $G_2 = 20$

(2) Amount of DNA in $G_1 = 2C$

Amount of DNA in $G_2 = 4C$

(3) No. of chromosome in Endosperm cell = 30

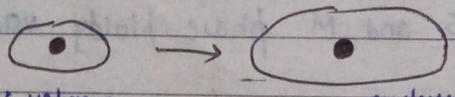
(3) **Changes occur in Phase:-**



1. G_1 Phase

→ Growth occur → Enzyme Require (Proteins)

- transcription & translation

→ 

Nucleus volume
Cytoplasmic vol.

Nucleus → Ratio decrease
Cytoplasm

(x) Centriole absent in plants.

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$\frac{n}{c}$ = Ratio bet

→ In G_1 phase cell have three option.

(1) Cell differentiation / Become permanent cell.

(2) Cell Enter into S-phase.

Before entry into s-phase cell check whether

(a) Size is sufficient or not.

(b) Nutrient available or not.

(c) DNA Damage or not.

- Notes- DNA Damage Repair occurs in G_1 phase.

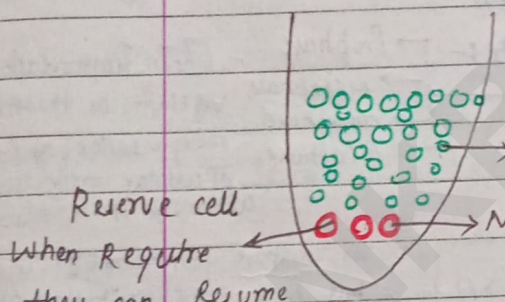
(3) Cell Enter into G_0 phase → Exit G_1 phase

↓

Enter into G_0 phase (senescent phase).

- Growth not occuring
- Cells in living (enzyme active)
- Act as Reserve cell.

(x) In G_0 phase histone synthesis not occur

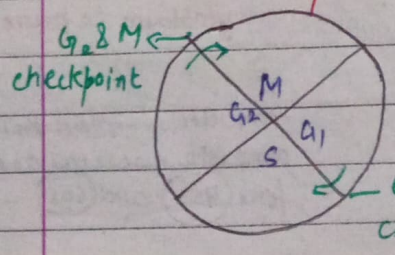


(Root Apical meristem)

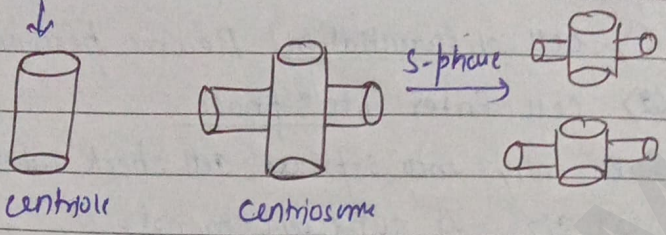
- Neurons are permanent in G_1 phase.

2. S-phase - Synthesis phase (DNA Replication).
- Euchromatin Replicate First than Heterochromatin

- Once DNA Replication start (in nucleus), Cell Enter into S-phase.
  - Histone double in S-phase
  - centrioles double in S-phase.



Tubulin (G2 phase)
↓
Microtubule → Spindle fibre
↓



(3) G2-phase:- (Preparation for M-phase occur).
→ like - tubulin synthesis (For spindle fibre).
→ Organelle double (Mitochondria, chroplast)

(4) M-phase:- (Mitosis)
→ M-phase can occur in both Haploid and diploid cells (all cells should be present in G2-phase).
→ M-phase is divided into two events :-
1) Karyokinesis:- Nuclear Division
2) Cytokinesis:- Cytoplasmic Division

→ Prophase
→ Metaphase
→ Anaphase
→ Telophase.

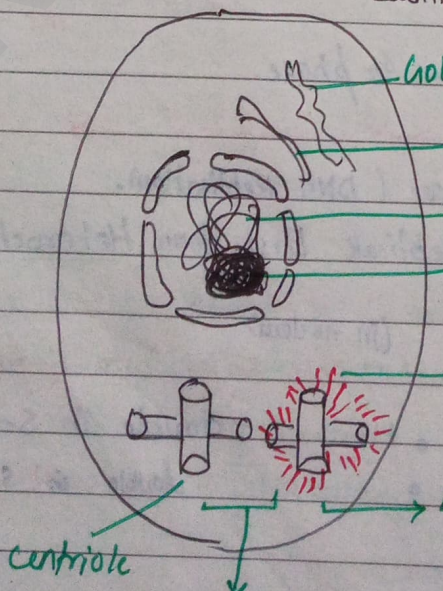
(*) In fragmentation vegetative as there reorganisation (as fo of cellular organelles although it is also

(*) In zoospore formation (It is but here reorganisation o organelle takes place.

Acc. to time wise :- P > T > M > A

M-phase is most dramatic phase → Most of the component show Reorganisation

(a) PROPHASE :- Two Nuclei are generally Identical. ← Nucleus divide, organelle distribute, cytoplasm divide



→ DNA doubled in S-phase (still - intertwined)
→ First DNA get untangled then condensed.

→ 40S and 60S combine in cytoplasm in presence of Mg^{2+}.

→ Nucleolus - rRNA Protein come into nucleolus and form (40S) and (60S)

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First event of Prophase – Initiation of condensation of chromatin
→ Centrosome / Aster move to opposite pole (spindle fibre Arise).
→ ER / Golgi body – disintegrate (Mitochondria not disintegrate).
→ Nucleolus disappear.
→ chromosome with two chromatid visible in compound microscope.

Last event :- Disintegration of Nuclear membrane (stored in ER in form of vesicles).
(Late Prophase) or Pro-metaphase.

Aster → ~~An Aster (Plant) → one aster~~
Aster → amphiaster (Animal) → two aster

- ER shape
  - → Vesicle
  - → cisternae
  - → tubular

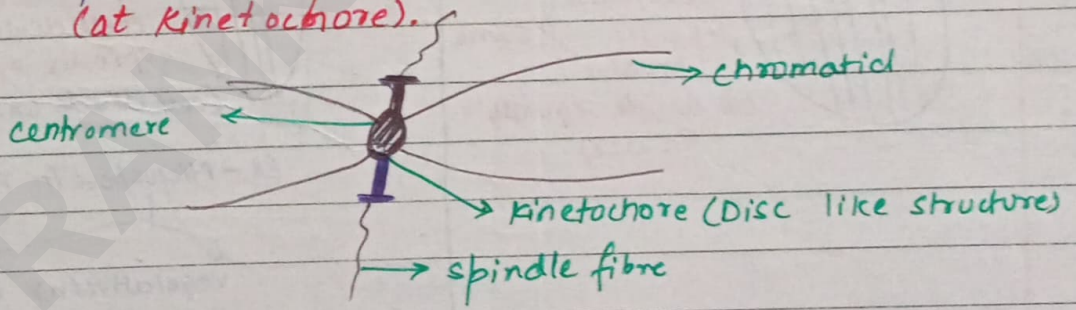
→ DNA as a structure, & Gene as a function.

→ chromose are in nucleus.
→ In microscope → Spindle fibres & Chromosome start visible.

NOTE:- Although chromosome appear in Prophase with two chromatids, but, it is not fully condensed.

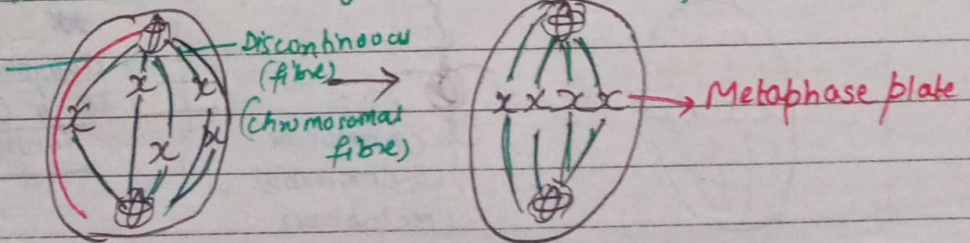
It is called no // simply divide) observed also asexual), cellular

(B) METAPHASE – → chromosome are in cytoplasm
→ spindle fibre get attach on chromosome on centromere (at Kinetochore).



1 chromosome = 2 chromosomal fibre.

→ Human cell = 46 chromosome = 92 chromosomal fibres.
chromosome are bring into centre = Congression.



→ Disintegration of nuclear membrane marks the Entry of cell into metaphase.

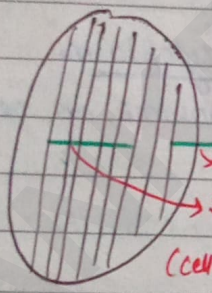
✓ **Metaphasic plate:-** Plane of alligments of arms is known as Metaphasic plate.

- Microscope → Condense chromosome → at equator.

Spindle fibre
↓ Continuous | ↓ Discontinuous

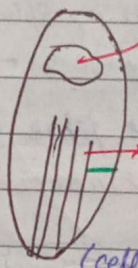
- chromosome is most condensed - Metaphase
So it is Best phase to study chromosome - nuclear (Karyotype) M
- morphological nk
- size. m
s

Symmetric spindle.



(cell divide equally in size)

Asymmetic spindle.

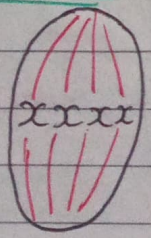


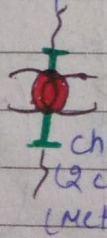
(cell divide at spindle equator)
(cell divide unequally in size)

Ex - Microspore in Plants
↓ Vegetative (n) | ↓ Generative (n)

Note:- In spindle fibres, sulphur rich protein are present
↓
Met → cystyne.
↓ Methionine → cystine

(c) **ANAPHASE:-** → In anaphase all chromose split at centromere.





→ ** daughter chromosome or It is chromosome of future cells. →

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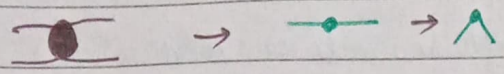
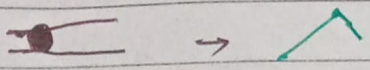
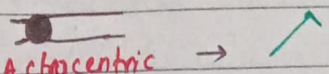
Shapes:-



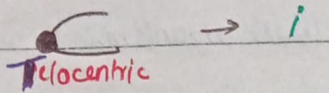
Metacentric → Inverted V-shape



Sub-metacentric → Inverted L-shape



Acrocentric → Inverted J-shape



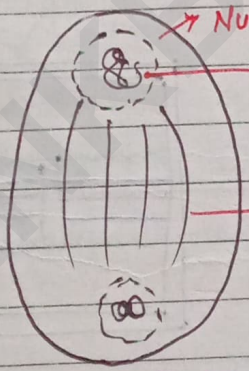
Telocentric → Inverted I-shape.

Note:- In Anaphase chromosome no. get double.

(D) TELOPHASE:-

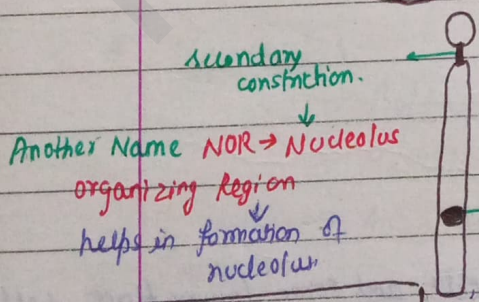
→ chromosome now at opposite pole - start to decondense (chromose lost its identity & convert into chromatin).

→ Two nuclei is present at both pole.



→ Nuclear membrane Reappear (Nucleolus, ER, Golgi body) → they form again on the Basis of Requirement of cells

→ Spindle Fibre start to disappear



→ satellite

Secondary constriction.
↓
Another Name NOR → Nucleolus organizing Region
↓
helps in formation of nucleolus

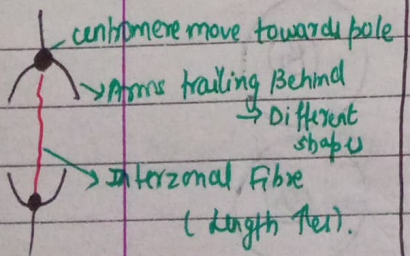
→ centromere (Primary constriction)

(It is different from satellite DNA used in DNA fingerprinting).

SAT- chromosome

- all chromosome not have satellite only few have

Eg. 13, 14, 15, 21, 22 - In Human



→ centromere move towards pole
→ Arms trailing Behind → Different shape
→ Interzonal Fibre (length ↑).

CYTOKINESIS:- After nuclear division, cytoplasm divide to form two Daughter cells.

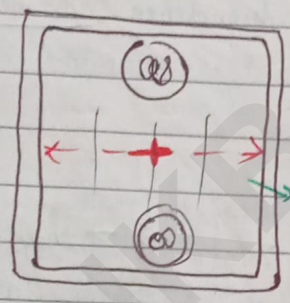
- If cytokinesis not occur → Multinucleate or syncytium (Liquid Endosperm of coconut water).

TYPE OF CYTOKINESIS:-

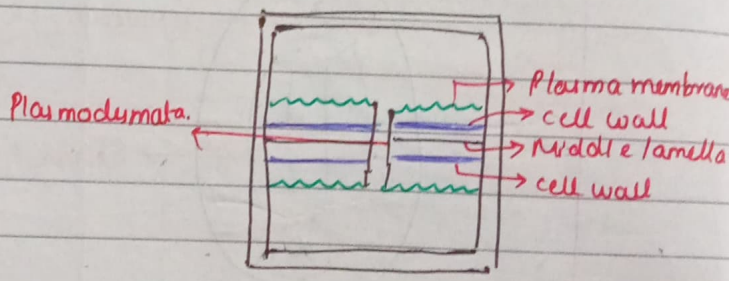
→ Cell plate method – Plants.

→ Cleavage method – Animals & some lower organism.

Cell plate method:- Daughter cell form, link with plasmodesmata connection
- In plant cells, some spindle spindle fibres remain. It is known as phragmoplast.



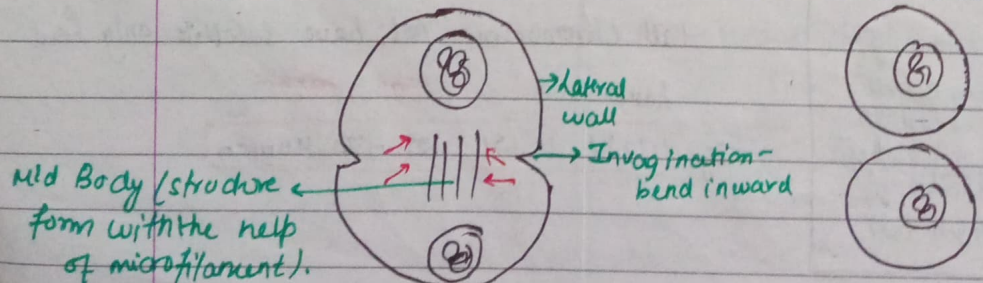
- Golgi body deposit calcium pectate = cell plate = middle lamella (Inner to outer).



- Sequence:-

Phragmoplast
⇓
Cell plate
⇓
Cell wall
⇓
Plasma membrane.

Cleavage Method:- → Present in Animal cell and some lower plant cells.



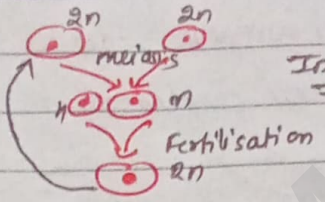
[MEIOSIS:I

→ Meiosis evolve in sexually reproducing organism.

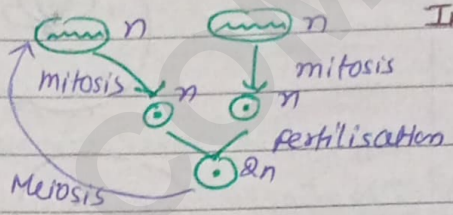
→ In order to increase variation meiosis evolve from mitosis which reduction of chromose no. occur.

→ In diploid organism meiosis reduce no of chromosome, and Fertilisation restores no.

→ In Haploid organism, fertilisation increase no. and this no. is restored by meiosis.



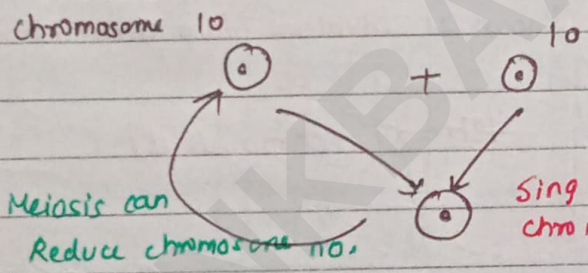
In Diploid organism



In Haploid organism

→ In mitosis source of variation is - S-phase. (DNA copying Mechanism show error).

→ For more variations → we need to combine variation of two cells



→ All cells undergoing meiosis should have Amt. of DNA - 4C in G_2 phase (Already double Amt. of DNA ~~4C in G_2 phase~~. In S-phase)

~~EAT~~

Meiosis - I :-

→ Prophase - I

→ Metaphase - I

→ Anaphase - I

→ Telophase - I

→ Interkinesis (Gap b/w Meiosis I & II) (DNA Replication not occur).

Meiosis II :- Prophase - II

Metaphase - II

Anaphase - II

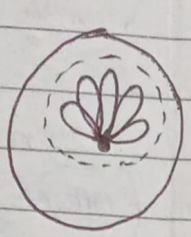
Telophase - II

Prophase-I:- → Within prophase → 5 stages (on the basis of chromosome behaviour).

(a) Leptotene:-

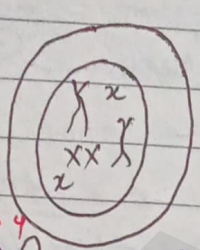
- Chromatin start to condense or get compact
- This condensation occurs throughout leptotene

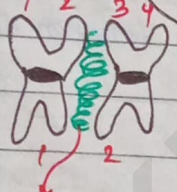
~~Animal cell~~:-



chromatin appear to be appearing from single point
- Bouquet stage.

(b) Zygotene:-





synaptonemal complex (Protein - which keep chromosome together).

Synapsis:- Process of pairing of chromosome
- Paired chromosome in zygotene is known as Homologus Pair.

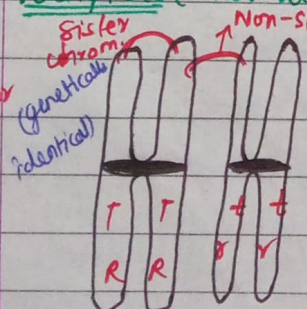
→ Result of synapsis → paired chromosome known as Bivalent (two chromosomes) or tetrad [4 chromatid]

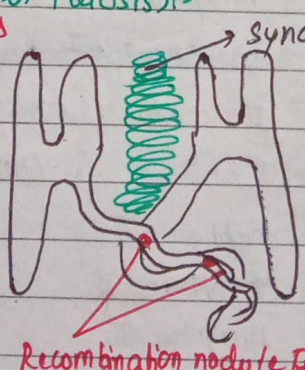
No. of Bivalent = No. of tetrad = No. of chromosomes in haploid cell

NOTE:- • Leptotene and zygotene can be visualised / seen in light / compound microscope but for synaptonemal complex, electron microscope required.
• Zygotene and leptotene are shorter than Pachytene.

(c) Pachytene (First variation form in Meiosis):-

Assume in 5th pair





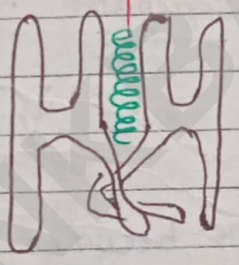
Recombination Nodule Form
↓
Genetic Material / DNA / Arm

★ Exchange from non-sister chromatid of Homologous pair (Recombinase).

→ Genetic material exchange b/w two non-sister non-Homologus chromosomes
Within cell → Translocation.
out of cell → Transposition / Transposons / Mobile elements.

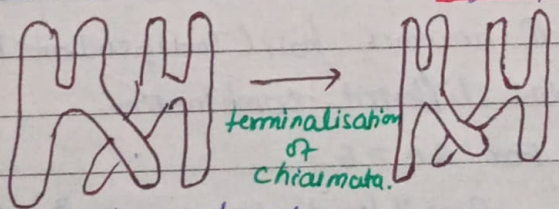
→ crossing over:- Exchange B/w homologous pair
If K of one gene go into another without complete exchanging
- Duplication & Delction.

(d) Diplotene:- longest phase of meiosis in vertebrates.
(arrest in human female) for some years.
oocyte → oocyte prese arrest in Diplotene for months and years.



→ Initiation of dissolution of (Digestion). synaptonemal complex.
→ chromosome pair start to move apart.
→ Now chromosome found attach only at chiasmata. → cross like structure

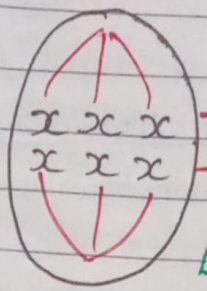
(e) Diakinesis:- In some organism i Diplotene ii shorter than Diakinesis will be the longest phase.



→ chromosome is Fully condensed.
→ Centrosome move to opposite pole, spindle Arise.
→ Endoplasmic Reticulum, Nucleous, & Nuclear membrane disappear.

Diakinesis is transition to metaphase.

METAPHASE I:- 1 pair of chromac = 2 chromosomal fibres



→ Double Metaphasic plate.

Human - 1 metaphasic plate = 23 chromosome

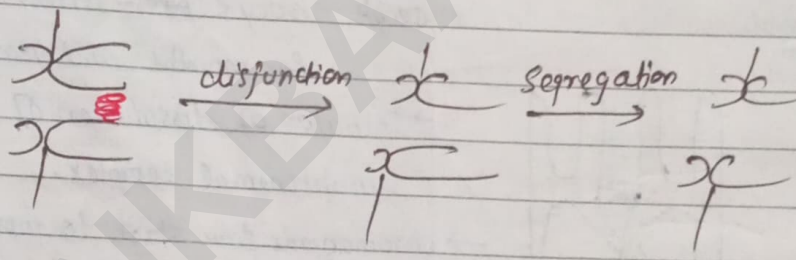
ANAPHASE - I:-

→ chromose pair → Disjunction → Segregation.

→ Complete chromosome (two sister chromatid) move to opp. pole

→ If non-disjunction occurs chromosome pair not segregate -no. of chromosome unequal.

Human (46) → 24
→ 22.



→ In anaphase I, chromosome no. becomes half due to segregation of chromose pair.

→ Each cell form after meiosis I have no. of chromosome half and amount 2C.

→ Since Segregration of one chromosome pair not depend on segregation of another pair (Independent Assortment), variation occur due to different combination.

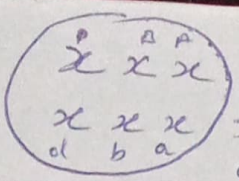
For eg. → For $2n = 6$

Possible combination $= 2^3 = 8$

→ If non-disjunction occur then chromosome of one-pair move together, then unequal no. of chromosome from after meiosis - I. This will lead to aneuploidy (Trisomy & Monosomy).

Independent Assortment = assortment of B is independent of A.

Anaphase I :- D b A
1 pair = n
Combination = 2^n
d B a



D B A
d b A

Date
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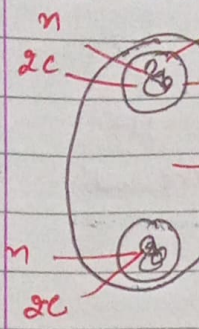
Brother # Sister / to be same probability

$\frac{F}{2^{23}} \times \frac{M}{2^{23}} = \frac{1}{2^{46}}$

TELOPHASE-I



- chromosome decondense
- Nuclear membrane reappear
- ER, Golgi body & Nuclear Reappear

Interkinesis :-

- → Gap b/w Meiosis I & Meiosis II.
- → Centriole Double. (X)
- → DNA Replication not occur.
- → DNA not come in fully decondense state.

⇒ We can skip directly from Anaphase I to Metaphase II i.e. we can skip Telophase I and Prophase II.

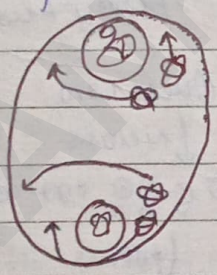
(*) Interkinesis has more condensed dna than G_2.

Meiosis II :- It like mitosis (chromosome no. not change).

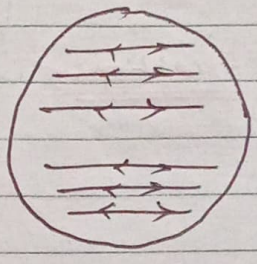
(*) (Crossing over)

Meiosis II - occur in haploid, and cells are non-Identical
Mitosis - can occur in haploid & diploid cell.

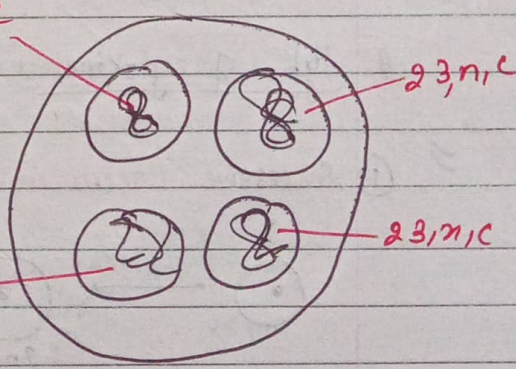
↳ Prophase II :- → chromatin condense
→ spindle assembly occur.



↳ Anaphase II :-

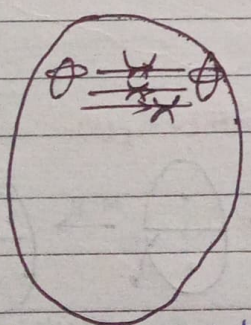


↳ Telophase II.



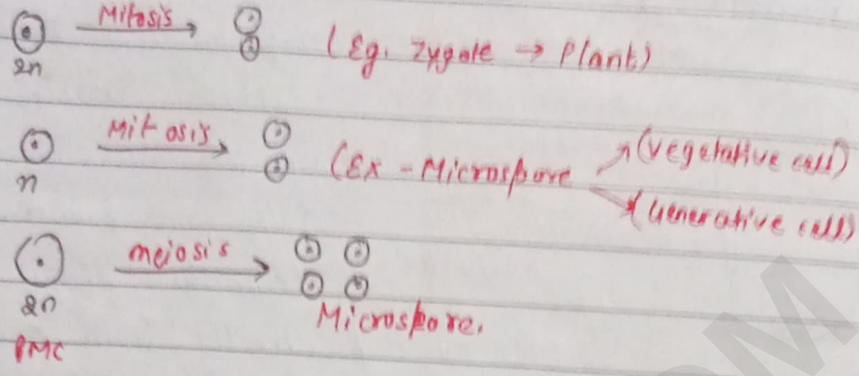
All are non-identical

↳ Metaphase II :-

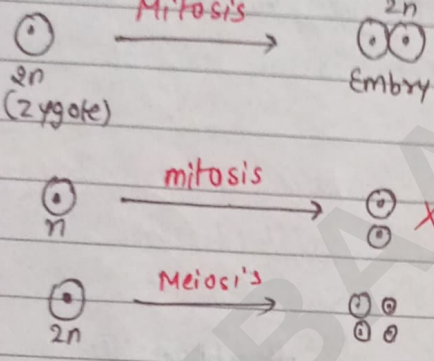


→ Single metaphasic plate
→ Each chromosomal ~~fibre~~ have 2 chromosomal fibre.

→ Plant cell:-



↳ Animal :-



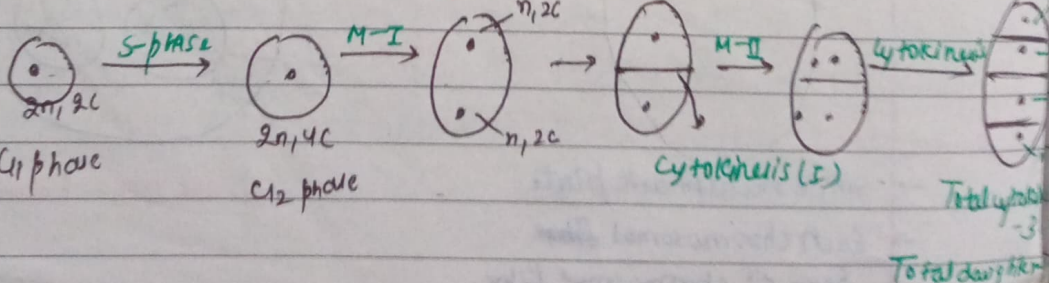
In Animals - Mitosis occurs only in Diploid cell
- haploid cells always produced by Meiosis

Exceptions :- Social insect (colony) → Ants, Termite, Honey bees

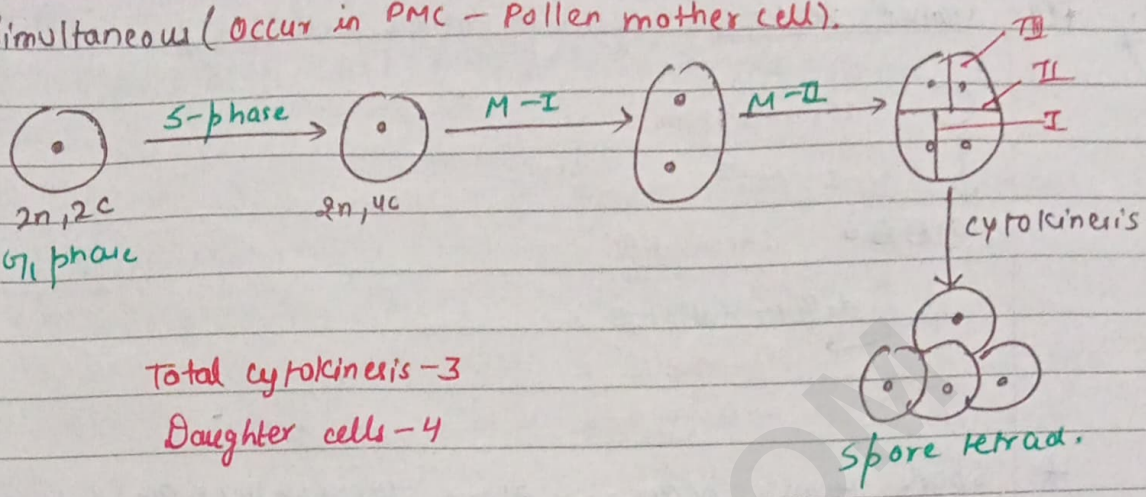
Queen (2n)
↓ Meiosis
n n n n egg cell
↓ Mitosis
(n) drone.

Type of cytokinesis:-

① Successive (occur in MMC - Megaspore mother cell).



(2) Simultaneous (occur in PMC – Pollen mother cell).

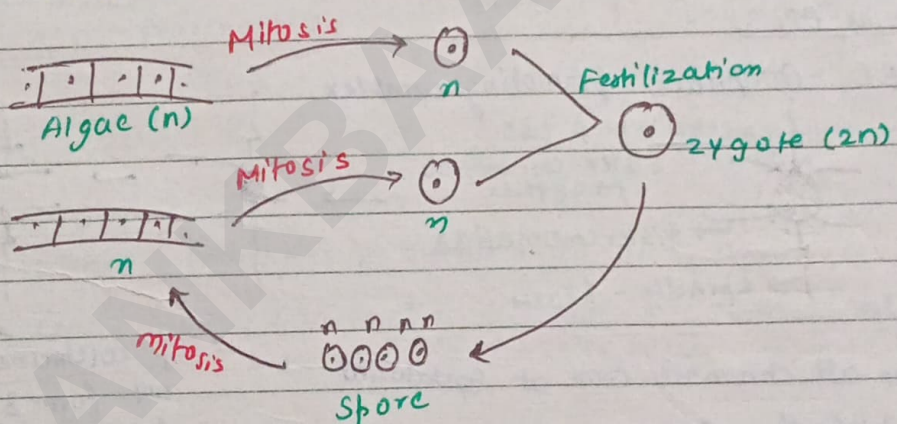


Total cytokinesis – 3
Daughter cells – 4

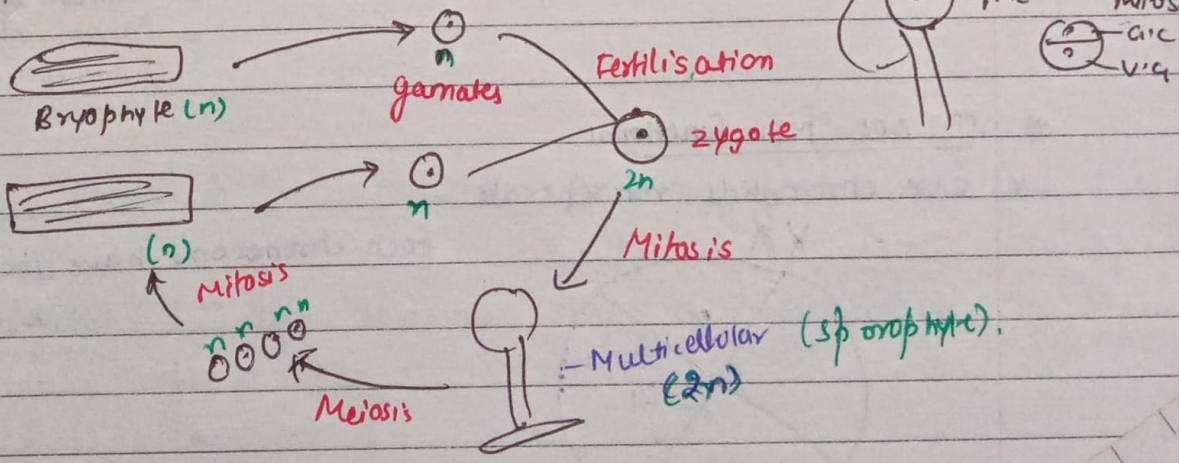
Type of meiosis – three types.

(1) Zygotic meiosis (occur in haploid organism). (In Algae and Fungi).

↳ meiosis occur in zygote



(2) Sporic meiosis – Meiosis occur to form spore.



(III) Gametic meiosis:- Occur in Animal cell

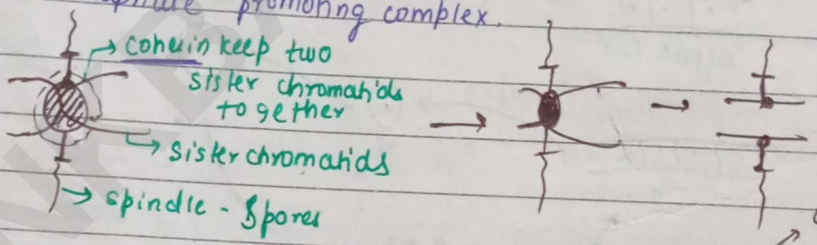
Spermatogonia
↓ M-I, M-II
Spermatids
↳ differentiation
Sperms

* Sporic Meiosis occur in - Algae, Bryophytes, Pteridophytes, Gymnosperms, Angiosperm
* Sporic meiosis of Algae is known as Zygotic meiosis.

Polyteny and Polyploidy:-

Role of APC :-

APC - Anaphase promoting complex.



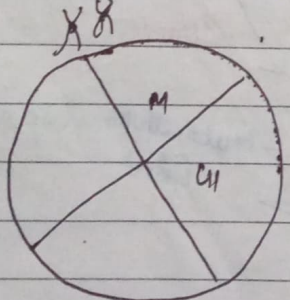
- When all chromose come at Equatorial plate than APC get Active
→ APC Digest cohesin

- If colchicine Apply, spindle not form & APC normally function
- Sister chromatid get separated But remain in same cell = Polyploidy (No. of chromosome get double).

obtained from plant colchicu (Lily fami

If APC Non-functional:-

→ Sister chromatids not seperate.



Each chromosome have double chromatid = Polyteny.

[PLANT KINGDOM] (2-3 Questions)

Examples :- (1) Green Algae :- → Chlamydomonas → Chlorella → Volvox → Spirogyra → Ulothrix → Cladophora → chara → Ulvorina

(2) Brown Algae → → Fucus → Laminaria → Dictyota → Sargassum → Kelp → Ectocarpus

(3) Red Algae :- → Polysiphonia → Porphyra → Gracilaria → Gelidium

Bryophytes :-

1. Liverworts - Marchantia, Riccia
2) Mosses → Funaria, Sphagnum, Polytrichum.

Pteridophytes :-

→ Ferns - (Pteris, Dryopteris, Adiantum, Azolla, Ophioglossum).
→ Lycopodium, Selaginella, Equisetum (Horse tail), Psilotum, Salvinia.

(coconut) → form → Obtained colchine (Alkaloid)

Gymnosperm :- → Cycas → Pinus, cedrus] → conifers → Sequoia → Ginkgo

Basic features in Plant kingdom.

(1) Embryophytal :- → Zygote undergo mitosis to form Embryo (zygotic mitosis)

→ Bryophyte
→ Pteridophyte
→ Gymno Sperm
→ Angiosperm

Algae is not Embryophyte → zygotic meiosis

Que:- Which of the following not show zygotic mitosis?
(1) Lycopodium (2) Ginkgo (3) Marchantia (4) Ulothrix.

(2) Cryptogamae & Phanerogamae

hidden sex organs	sex organs visible
Ex - Algae	- Gymnosperm
- Bryophyte	- Angiosperm
- Pteridophyte	

(3.) Haploid & Diploid plants

Algae	Pteridophyte	Vascular bundle present also known as tracheophyta.
Bryophyte	Gymnosperm	
	Angiosperm	

Que:- Few examples are given
G.Algae B.Algae Pter. (BRYO) P.T. (Gym) (Pter)
Chlorella, Sargasum, Sphagnum, salvinia, Cycas, Selaginella,
R Algae (Ang) (Ang)
Gelidium, Hibiscus, Wheat

How many are.
(a) Haploid → 4
(b) Cryptogamae → 6
(c) Diploid Cryptogamae → 2
(d) Haploid tracheophyte. → 0
(e) show zygotic mitosis → 6

(4) Life cycle-

Haplontic — Algae } — Haploid / organism

Haplodiplontic [Bryophyte, pteridophyte
Diplontic — [Gymnosperm, Angiosperm. } — Diploid.

• Note:- Diplontic and Haplodiplontic show zygotic mitosis

Exception in Algae { → Some Algae is Haplontic → Kelp, Ectocarpus, Polysiphonia. (V. diplontic)
→ Diplontic — Fucus.

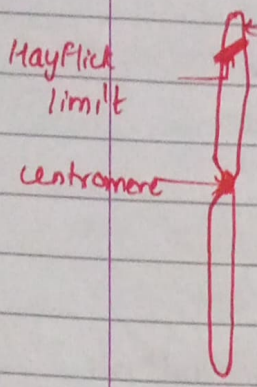
Que. Few examples are Given

- Kelp (Algae), Ulothrix (Algae), Spirogyra (Algae), Laminaria (Algae), Funaria (Bry.), Azolla (Pt), Gingko (Gym), Solanum (Ang), Pteris (Pter), Marchantia (Pter), Fucus (B. Algae)

(a) Haplontic — 3
(b) Diplontic — 3
(c) Haplodiplontic phanerogames — 0
(d) ~~Haplontic~~ Haplodiplontic — 5
(e) Show zygotic mitosis — 8 (Kelp, Funaria, Azolla, Gingko, Solanum, Pteris, Marchantia, Fucus)

Spermatophyta - Gymno & Angio (Seed bearing)

(1) TELOMERASE ENZYME :-



Telomere (non-sticky) with each division, Some Amt. of telomerase is lost

↓ After 60 - 70 division Hayflick limit achieve

Cell stop dividing.

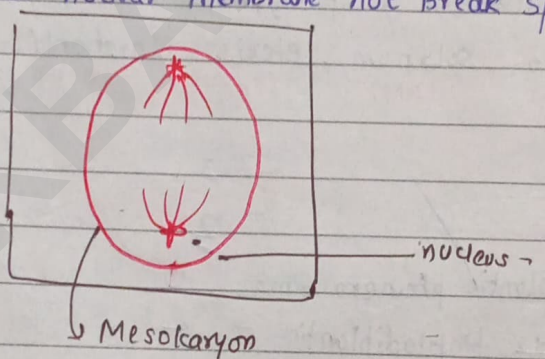
Telomerase Enzyme (Ribonucleoprotein) - It can Regenerated End

- This means If End Regenerate than Hayflick limit not Achieve cell keep on dividing.

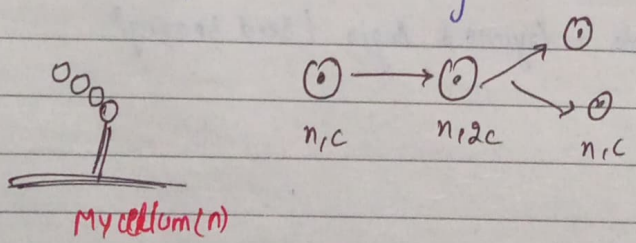
Telomerase Activity is high in cancer cells.

DINOMITOTIS / ENDOMITOSIS :-

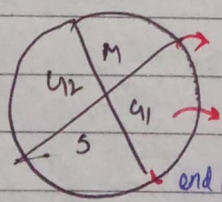
Dinomflagellates nuclear membrane not Break spindle ~~intranucell~~ intranuclear.



Asexual cycle :- haploid. (Amt. vary c & 2c).



Cyclin :-



- Cyclin are form in particular phase

↓

end (break) - Activate enzyme CDK (Cyclin Dependent Kinase).

Inactive enzyme → Add phosphate → Active enzyme.

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[ALGAE]:-

- **Habitat:-** mainly Aquatic (main habitat)
  - Fresh water
    - Stagnant
    - Flowing
  - Marine
    - Open sea
    - Brackish water (Freshwater mix with marine)
    - deep sea.

Unusual habitat - terrestial (moist soil)
- Snow
- On Animal (on sloth Bear) - Trycophysium

(largest Algae) → Brown Algae, Red Algae > Marine
- Green Algae - Mainly fresh water

Question:- Hold Fast (Attachment) is Absent in
(a) Porphyra
(b) Ectocarpus
(c) Spirogyra — Stagnant water (In Pond water).
(d) Ulothrix - Flowing water

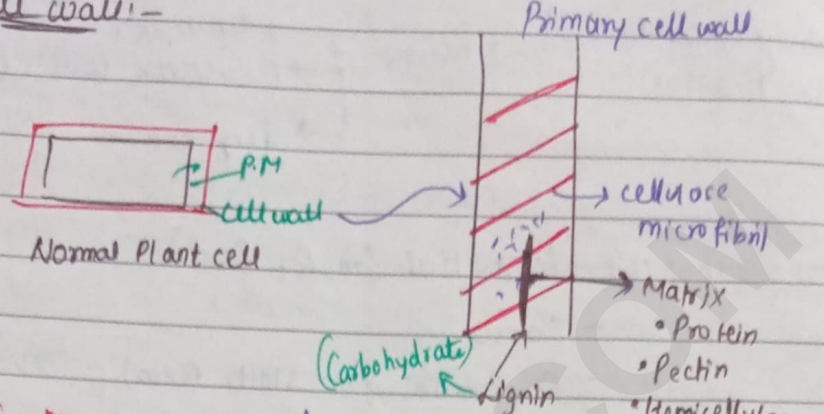
Present in flowing water

- **STRUCTURE:-**
  - Form
  - cell division.

(a) **Form:-**
- → Unicellular Algae → chlamydomonas, cholera.
- → Colonial
- → Multicellular
  - Filamentous - Unbranched
  - Filamentous Branched
  - Advance thallus (Red Algae)

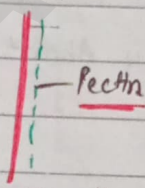
(b) Cell detail:-

(i) Cell wall:-



In Algae- Matrix have
→ Galactans (Polymer of Galatons and Mannans),
→ Mannans
→ $CaCO_3$

In Green algae:-



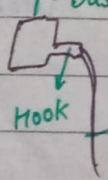
In cell wall - Cellulose Inner. (Impermeable) because Alage absorb CO_2 From water holded.

In Brown algae:- Inner cellulose
Outer Algin. (Impermeable)

In Red Algae- Inner cellulose outer caragenin. (Impearable).

(ii) Flagella:- → Present in both Prokaryotes and Eukaryotes.
→ Flagella is a feature of Single cell.

- Prokaryote Flagella:- → made up of Flagelin protein
→ three part.
→ Basal body



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- **Eukaryote Flagella:-** → Made up of tubulin protein.
  ↓ give
  Microtubule
  ↓
  9+(2) Arrange form Flagella.
  — Basal body, Filament.

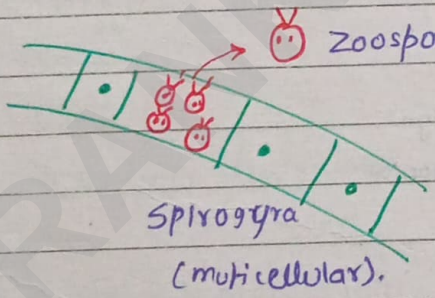
Flagella present = motile
Flagella Absent = non-motile

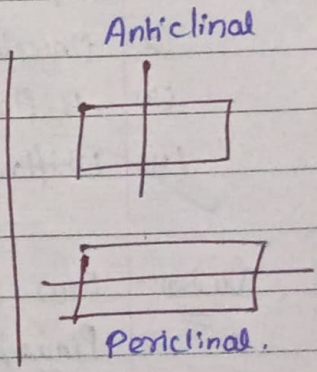
Flagella can be present in 3 locations in Eukaryotic organism:-

1. Unicellular Organism:-  – chlamydomonas – motile.

 – chlorella – non-motile.

2. Zoospore:- [Present in Algae & Few Fungi]
   (Asexual stage).





3. Flagella in gametes (sexual stage)

Group	Asexual stage	Sexual stage.
1. Green Algae (2-8 Apical), Equal	motile	motile (Except = Spirogyra)
2. Brown Algae (2, unequal, Lateral)	motile (zoospore)	motile