Arihant College Of Arts, Commerce and Science,Bavdhan Pune-21

(F.Y.B.sc.)

Cell cycle in plants

Megha Pawal

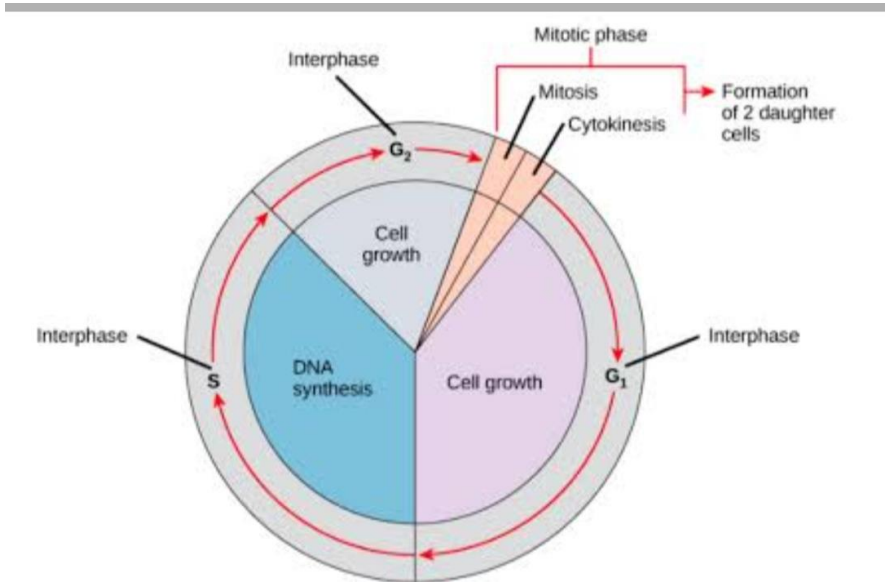
- A cell cycle is a series of events that takes place in a cell as it grows and divides. A cell spends most of its time in what is called interphase, and during this time it grows, replicates its chromosomes, and prepares for cell division. The cell then leaves interphase, undergoes mitosis, and completes its division.

*Phases/stages of cell cycle:-

- A cell cycle is a series of events that takes place in a cell as it grows and divides.
- The cell cycle is divided into two mojor

(1) Interphase or non-dividing phase

(2) The mitotic phase (karyokinesis) or dividing phase. It is also known as M-phase.



* Interphase:-

- Interphase is the longest part of the cell cycle.
- This is when the cell grows and copies its DNA before moving into mitosis. During mitosis, chromosomes will align, separate, and move into new daughter cells.
- During this period, the cell is constantly synthesizing RNA, producing protein and growing in size.
- Interphase is defined by three stages: the first gap phase (G1), the synthesis (S) phase, and the second gap (G2) phase.

*G1-Phase or post – mitotic phase:-

- G1 phase (First growth phase or Post mitotic gap phase) is the first phase within interphase, from the end of the previous M phase until the beginning of DNA synthesis, is called G1 (G indicating gap). It is also called the growth phase.

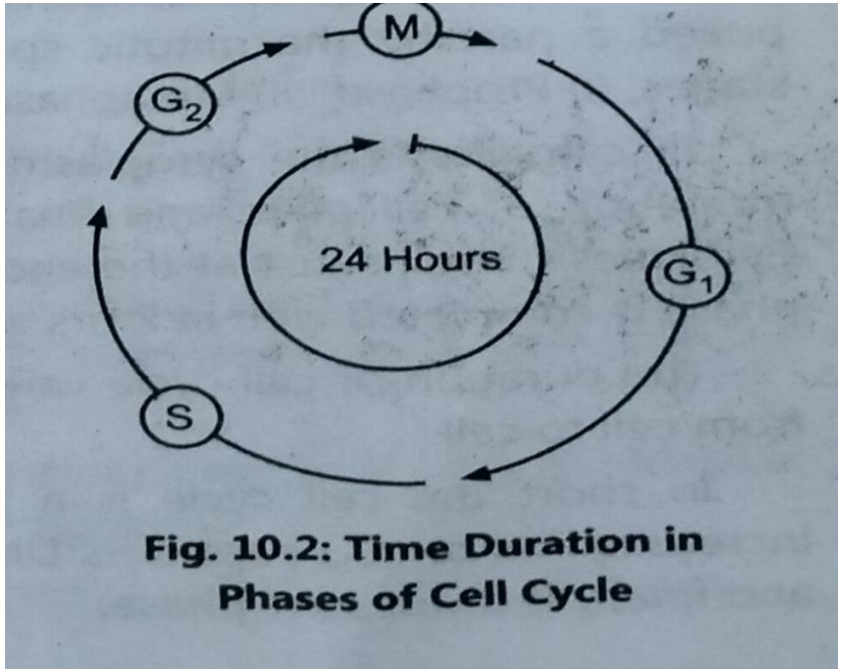


Fig. 10.2: Time Duration in Phases of Cell Cycle

*G2- Phase:-

It is the second gap phase. During this phase cell grows more and more, makes (synthesize) proteins and organelles and begins to re-organize its contents for the preparation of mitosis, G_2 phase ends when mitosis begins. During this stage r-RNA, m-RNA and nuclear RNA are synthesized. Its the intermediate step between the completion of DNA synthesis and the beginning of DNA segregation. It is the post DNA synthesis period, during which the cell makes preparations for the initiation of mitosis. G_2 is the shorter phase casting for only 3-4 hrs in most of cells.

*S-phase:-

It is the phase of complete synthesis of DNA in its nucleus. In this phase, there is also duplication of centrosome, which helps the separation of DNA during M-phase. Usually cells take 5-6 hrs to complete S-phase. It is very essential phase of cell cycle. Once DNA replication is completed, the cell has twice the number of chromosomes and become ready to enter the G_2 phase.

The G_1, S and G_2 phases together constitute the interphase.

*M-phase:-

- During the mitotic (M) phase the cell divides its copied DNA and cytoplasm to make two new cells. M-phase involves two distinct divisions related processes: (i) Mitosis, (ii) Cytokinesis. In mitosis the Nuclear DNA of the cell condenses into visible chromosomes and is pulled a part by the mitotic spindlier. Mitosis takes place in four stages, () Prophase, (ii) Metaphase, (iii) Anaphase and (iv) Telophase.
-
- In cytokinesis the cytoplasm of a cell divides into two by the formation of cell plate and finally giving two new daughter cells. Cytokinesis begins just at the end of mitosis. In most of the cells M phase is completed with in 2 hrs.
-
- The duration of cell cycle varies from organism to organism and
-
- from cell to cell.
-
- In short the cell cycle is a four stages process in which cell increases in size (G_1) copies its DNA (S.phase) prepare to divide (G_2) and finally it divides (M-phase).

*Importance of cell cycle in plants:-

(1) It plays a crucial role in a living organism’s life cycle

(2) In case of multicellular organism it helps in growth and repair by producing large number of identical cell.

(3) Almost all plants and animals depend on the cell cycle for their growth and development

(4) The cell cycle is the main process of regeneration and repair in plants and animals

(5) It helps in equal distribution and making the constant number of chromosomes in all the cell of bodies of plant’s and animals.

* Divisional stages of mitosis:-

Mitosis or somatic cell division is the multiplication of somatic cells or body cells of plants into daughter cells of equal size both containing the same number of chromosomes as the parent cell. The term mitosis Greek word refers to thread like appearance of chromosomes in the early cell division. During mitosis the nucleus gets completely reorganized.The cell enters in mitosis it starts with Interphase mitotic cell division takes place through series of consecutive phase such as

(1)Prophase

(2)Prometaphase

(3)Metaphase

(4)Anaphase

(5)Telophase

(6)Cytokinesis

In mitosis series of changes take place in nucleus and cytoplasm The changes in nucleus are known as Karyokinesis while the changes ncytoplasm are known as cytokinesis.

(1)Prophase:

It is issued into (0 Early prophase (Mide prophase () Late prophase prometaphase) it is the largest stage of mitosis and may lasts for several hours.

(a)Early phase:

The cell starts to break down some structures and build others. Setting the phase for division of chromosomes. The chromosomes start to condense (making them easier to pull apart later on). The mitosis spindle begins to form. The nucleolus disappears. This is the sign that the nucleus is getting ready to breakdown.

(b)Late phase:

R is also known as prometaphase. The mitotic spindle begins to capture and organise the chromosomes The chromosomes ich condensing to they are very compact. The envelop breaks down releasing the chromosomes The mind grows more and some of the microtubules starts to capture chromosomes .

Mobiles can bind the chromosomes at kinetochore Centromers are the regions of DNA where the sister chromatids are Mostly tightly connected.

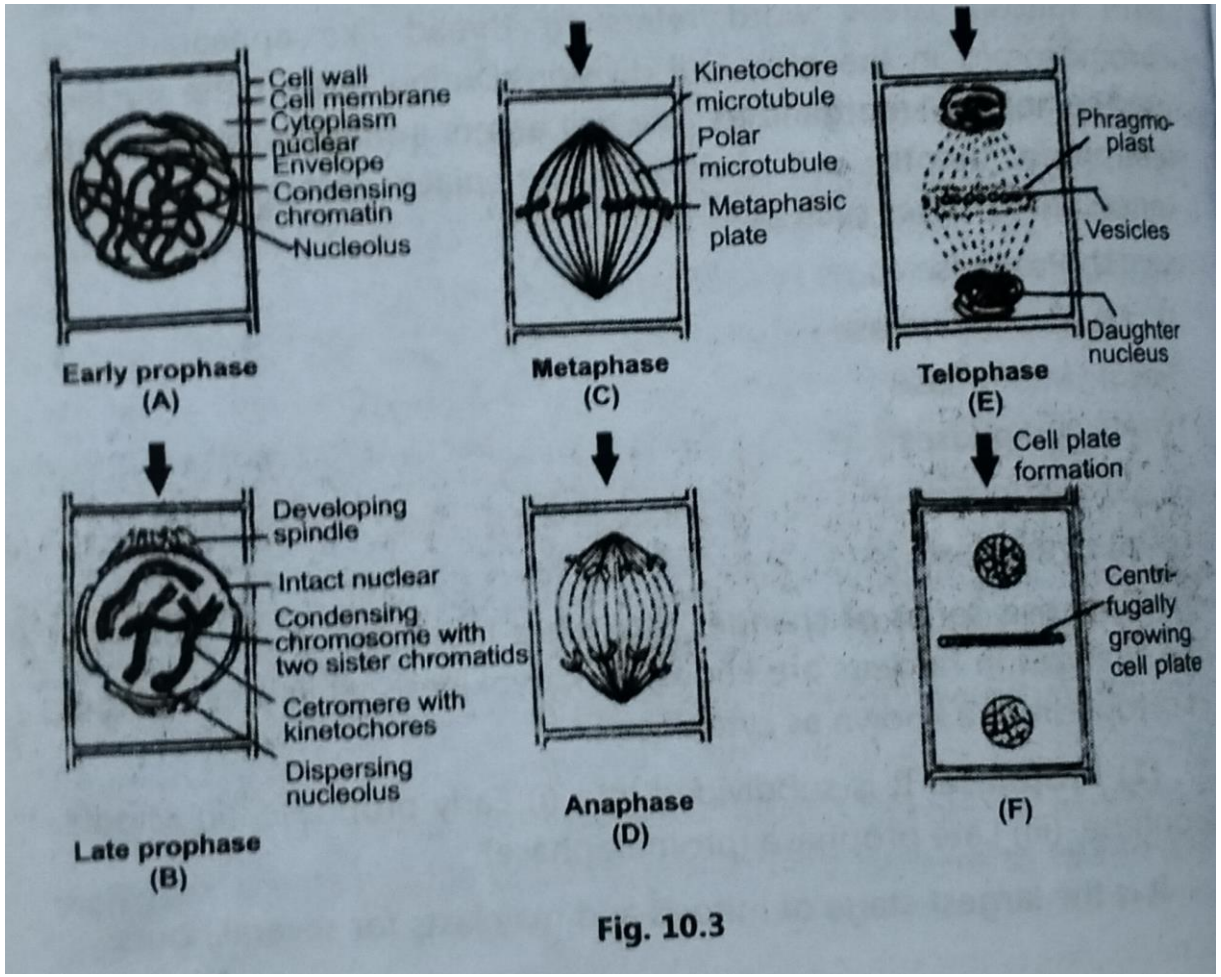

Cell wall
Cell membrane
Cytoplasm
nuclear
Envelope
Condensing
chromatin
Nucleolus
Early prophase
(A)
Kinetochore
microtubule
Polar
microtubule
Metaphasic
plate
Metaphase
(C)
Phragmo-
plast
Vesicles
Daughter
nucleus
Telophase
(E)
Developing
spindle
Intact nuclear
Condensing
chromosome with
two sister chromatids
Cetromere with
kinetochores
Dispersing
nucleolus
Late prophase
(B)
Anaphase
(D)
Cell plate
formation
Centri-
fugally
growing
cell plate
(F)

Fig. 10.3

*Metaphase:-

The spindle has captured all the chromosomes and lined the up at the middle of the cell Ready to divide. All the chromosomes align at the Metaphase plate.

Two kinetochore of each chromosomes are attached to microtubules from opposites spindle poles.

Before proceeding to Anaphase the cell check to make sure that all the chromosomes are the Metaphase plate with their kinetochore correctly attached to microtubules.

This is called as Spindle.

*Anaphase:

In Anaphase the sister chromatids separate From each other and are pulled towards opposite poles of the cell .All this is done by motor protein.

The Anaphase is further subdivision into Early Anaphase, middle Anaphase and late Anaphase depending on the movement of chromosomes towards the two opposite poles .

*Telophase:

It is also subdivided into Early Telophase and late Telophase. The cell division is nearly completed and it starts to re-establish it's normal structure as Cytokinesis take place.

The mitotic spindle is broken down into its building blocks .Two new nuclei are Fromed one for each set of chromosomes.nuclear membranes and nucleoli reappear . The chromosomes begin to decondense and return to their'stringy' form.

. Thus, Telophase is the reverse of prophase. The Spindle fibre disappear.

*Cytokinesis:

The division of the cytoplasm to from two new Daughter cells. The cell plate is formed during Cytokinesis at the middle of cell, separating the two daughters cells.

*Significance of mitosis:

mitosis is very important for plants and animals because it is responsible for their growth and development.

As well as it is helping in repair and damage recover of organism. It also plays important role in regeneration of plant part. Through mitosis Equally constant number of chromosomes in each cell is maintained.

It take place in somatic cells body cells of plants and animals.

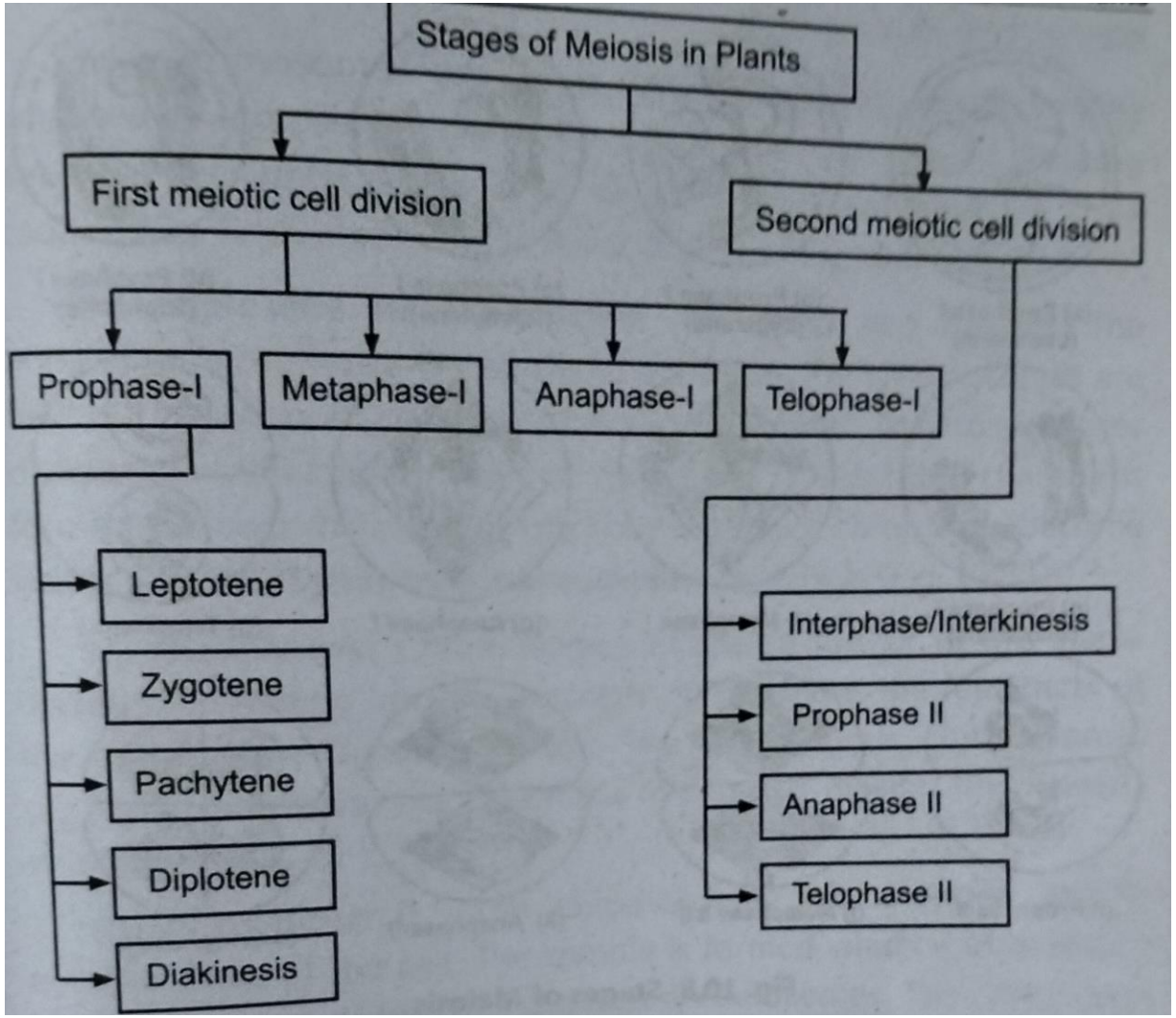
*Meiotic type of cell division:-

Meiosis:

This type of all division take place only in reproductive cells. It is pivotal in plants and animals for reducing the chromosomes number of diploid organisation (2n) to half (n) .

Genetic resortment take place during meiosis. Meiotic recombination and chromosomes segration take place through meiotic type of cell division. Meosis is a specialized cell division that generates four haploid daughter cells from a diploid parents cell, in which single round of DNA, replication and two consecutive round of nuclear division take place. It’s a reduction cell division.

- Following are the different stages of mitosis in plants:
- (1) First Meiotic Cell Division:
- (A) Prophase I: It consists of following stages(1) Leptotene(in) Zygotene(iii) Pachytene(iv) Diplotene(V) Diakinesis
- (B) Metaphase I including prometaphase
- (C) Anaphase-1
- (D) Telophase-1Second mitotic cell division:
- (0) Interphase.or interkinesis(II)(ii) Prophase II(i) Anaphase II(iv) Telophase IIAll the stages are summarised in the chart


Stages of Meiosis in Plants
First meiotic cell division
Second meiotic cell division
Prophase-I
Metaphase-I
Anaphase-I
Telophase-I
Leptotene
Zygotene
Pachytene
Diplotene
Diakinesis
Interphase/Interkinesis
Prophase II
Anaphase II
Telophase II

At the end of second meictic cell division four daughter cells are formed

At the end of first meiotic cell division two daughter cells are formed.

Its reduction division. Diploid mother cell forms two

haploid daughter cells.

Its equitional division

. The two daughter cells just under go divisions like mitosis and produce four haploid cells.

(1) Prophase I: Consists of five sequential cell divisions

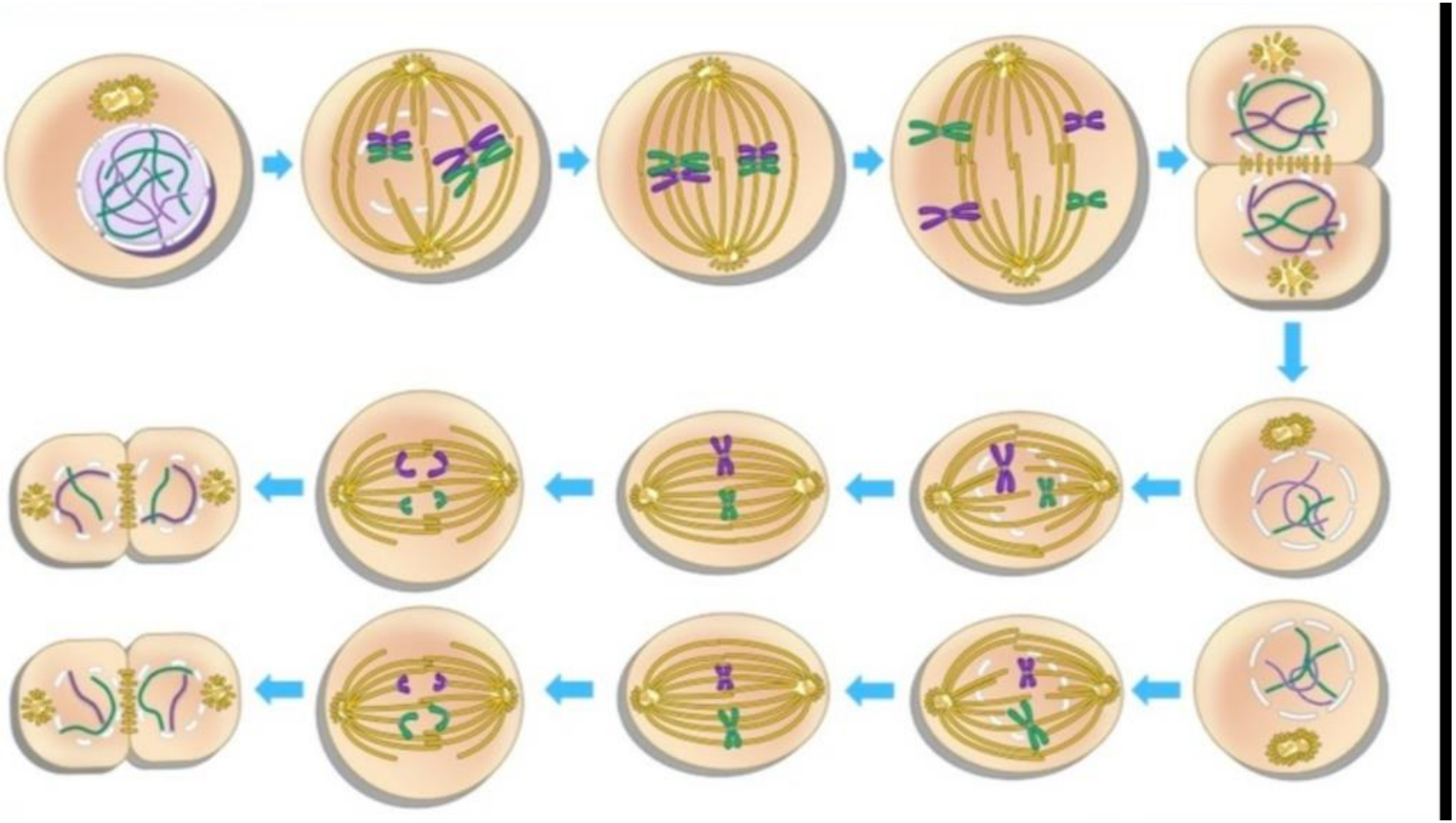
(0) Leptotene. (ii) Zygotene. (iii) Pachytene, (iv) Diplotene. (1) Leptotene: It is the first stage of prophase 1 (meaning thin

(V) Diakinesis.

Threads). Individual chromosomes begin to condense into long.

Strands within the nucleus. Nucleus increases in size. The synthesis of

RNA and protein increases.



(ii) Zygotene:

This is also known as zygonema. The name zygotene to this stage indicate that the chromosomes form paired thread like structure. The chromosomes become shorter and thicker The pairing or synapsis of homologous chromase take place. The homologus chromosomes undergo length wise pairing in which one chromosomes is from paternal and the next is from maternal side.

This stage is known as ‘bivalent’ stage. Each chromosome consists of four chromatids and hence known as ‘tetrad’ The pairing of chromosomes is very specific forming a special structure called as Synaptonemal complese. It is the structural basis for pairing and synopsis of meiotic chromosomes.

(iii) Pachytene:

It is also called as pachynema meaning thick threads. The homologus chromosomes now are very much closely associated than in the zygotene. This process is known as synapses

The chromosomes are in bivalent or tetrad condition. The synapsed chromosomes generally undergo the process of crossing over in pachytene stage. The chromosomes continuously show condensing. Each chromatid is the unit of crossing over

(v) Diplotene or Diplonema:

Meaning two threads The homologus chromosomes begin to separate. The chromosomes are held at one or more points known as chaismata The crossing over or recombination takes place at chaismata. At least one chaisma is formed for each bivalent.

In this stage the four chromatids become visible and the Synaptonemal complex disappear.

(v) Diakinensis:

Chromosomes condense further in this stage dakinesis meaning moving through. In diakinesis the four parts of the tetrads are actually visible. The homologous chromosomes separate further and the chiasmata terminalise making them clearly visible.

(II)Metaphase I :

The chromosomes are arranged at the equator plate of the cell. The spindle is formed which is attached to the centromenes of two homologous chromosomes. The centromers of each bivalent le on opposite sides of equatorial plate. The bivalent consisting of two centromenes are being pulled towards the poles of opposite side.

(III) Anaphase I:

Two homologous chromosomes of each bivalent separate and start moving towards the opposite poles of the cell. The short chromosomes separate rapidly but long chromosomes take time for the separation. In each homoglous chromosome one chromatid is unchanged while the other has undergone mixing of maternal and paternal section.

(IV) Telophase I:

It begins when the chromosomes reach to their respective poles. The chromosomes for some time remain in condensed state. Later they under go depolarization and become elongated. Nuclear membrane is formed around each set of chrosomes. By the formation of cell plate between two groups of chromosomes two daughter cells are formed due to cytokinesis

*Second meiotic division (meiosis II):-

- During this stage actually mitotic divisions occur in two daughter cells formed during meiosis I and giving rise to four haploid daughter cells. It consists of
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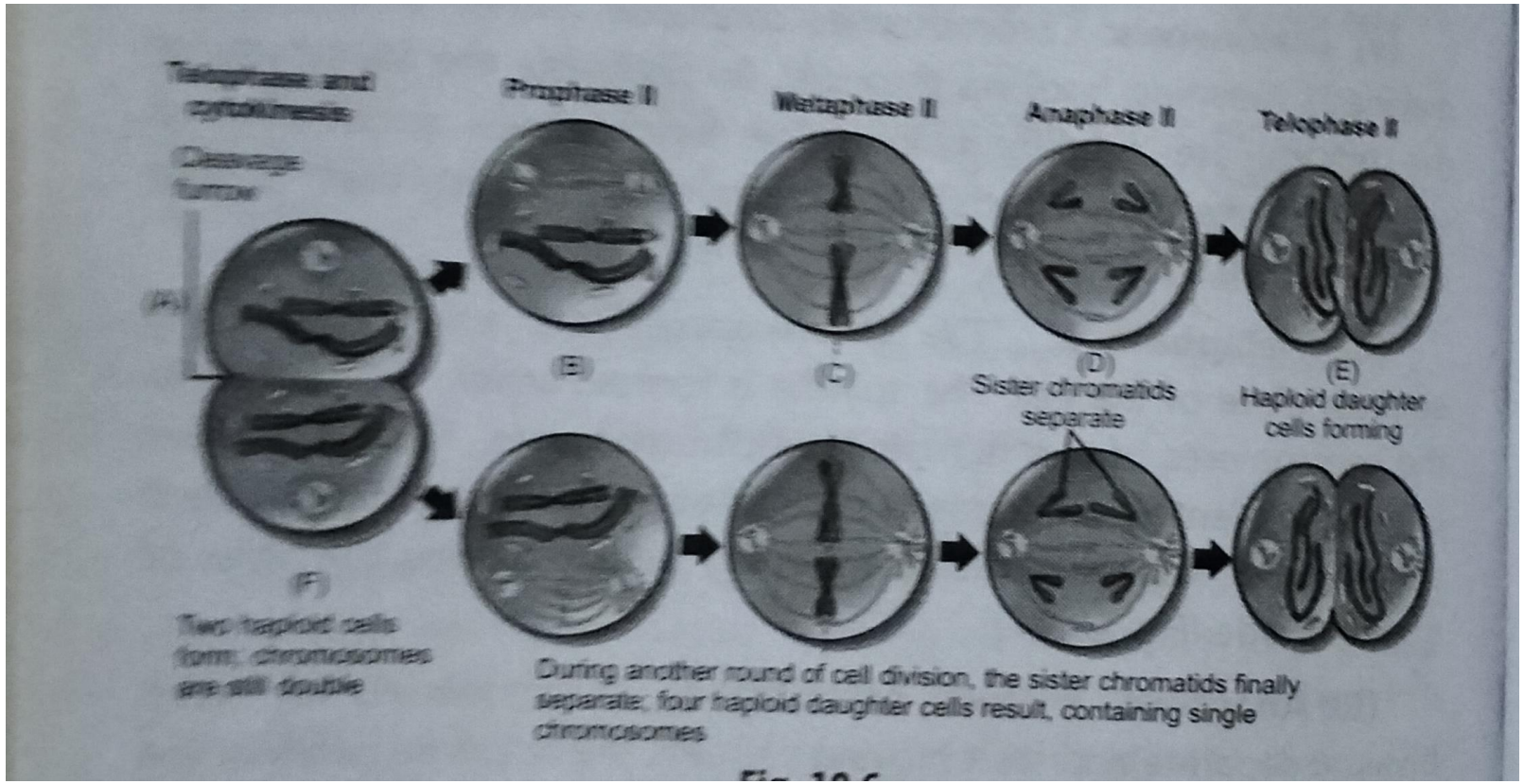
- (1) interphase II or Interkinesis
-
- (2) Prophase II
-
- (3) Metaphase II
-
- (4) Anaphase II
-
- (5) Telophase II
-
- (6) Cytokinesis


Prophase II
Metaphase II
Anaphase II
Telophase II
(B)
(C)
(D)
(E)
Sister chromatids separate
Haploid daughter cells forming
(F)
During another round of cell division, the sister chromatids finally separate; four haploid daughter cells result, containing single chromosomes

Interphase II or Interkinesis:

The two haploid daughter cells undergo typical resting stage as in mitosis. This intervening stage between telophase I and beginning of prophase II is called as Interphase II or Interkinesis in which there is no DNA duplication.

Prophase II:

This is a very short duration stage or very simple. The chromosomes undergo shortening and thickening. The sister chromatids have already been separated. The two chromatids of each chromosome remain separate except at centromere.

Spindle formation takes place in prophase II along with the disappearance of nuclear membrane.

Metaphase II:

The chromosomes become arranged on the metaphase plate. The centromere of each chromosome splits longitudinally forming two centromeres. At the end of metaphase centromeres are connected to the spindle fibres from respective poles.

Anaphase II:

It begins with the movement of chromatids to the opposite poles and they are pulled by contraction of spindle fibres The sister chromaids are now become individual chromosomes reach towards the opposite poles of the cell.

Telophase II:

Nuclear membrane is formed around each set of chromosomes the nucleolus in each nucleus. The chromosomes lengthen and become indistinct.

Cytokinesis:

Cell walls are formed between the daughter cells at

the end of Melosis I. Finally, four daughter cells with haploid number

of chromosomes are formed.

*Significance of Meiosis:

(1) During meiotic cell division the chromosome number is reduced to half and due to this the chromosome number in a species remain constant

(2) Meiosis is playing very important role in reshuffing of genetic material during crossing over. This is useful for the exchange of genetic material (genes) between the homologouschromosomess.

(3) Random separation of chromosomes and crossing over in meiosis are responsible for the variations in plant and animal species.

(4) The genetic variation is the basis raw material for evolution.

THANK YOU…..