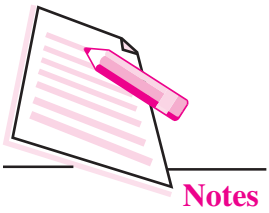


2. Which is the basic molecule in starch?

   .....

3. What is a peptide bond and where will you find it?

   .....

4. Which is the most energy rich biomolecule in living organisms?

   .....

5. What are nucleotides?

   .....

4.7 CELL DIVISION

A single cell divides many times and forms a multicelled organism. Unicellular bacteria and protozoa divide and increase in number. The injured tissues are replaced by new cells through cell division. Thus cell division is one of the most important activities in all organisms. In this lesson you will study about the two kinds of cell division and the processes involved in them.

Majority of cells in a multicellular organism grow and then can divide. However, the cells like the nerve and muscle cells of animals and guard cells of plants do not divide.

The process of cell division is almost same in all organisms. A cell passes through phases of growth after which are able to duplicate their chromosomes before they divide. These phases in the life of a cell constitute the **cell cycle.**

4.7.1 The cell cycle

You can use the term mother or parent cell for the cell that undergoes division and the daughter cells for the ones that are the result of this division. Before each daughter cell undergoes division, it must grow to the same size as its mother cell. We can distinguish two main phases in the life of a cell.

(i) Interphase - Non-dividing period (Growth phase)

(ii) Dividing phase - Also called M-phase (M for mitosis or meiosis)

(i) **Interphase - (Inter = in between)**

The interval between two successive cell divisions is termed interphase (phase at which the cell is not dividing). It is the longest period in the cell cycle (Fig.4.11). The interphase is subdivided into three main periods - G_1, S and G_2.

G_1 (Gap-1) Phase i.e. **First phase of growth** – This is the longest phase. Lot of protein and RNA are synthesised during this phase.

S or synthetic Phase - It comes next. Lot of DNA is (synthesised). A chromosome contains a single double helical strand of DNA molecule. After S-phase each chromosome becomes longitudinally double except at centromere,

and thus, it has two molecules of DNA and two chromatids. Thus each chromatid contains one molecule of DNA. The two chromatids are joined by a centromere (which does not divide at this stage) to form a single chromosome.

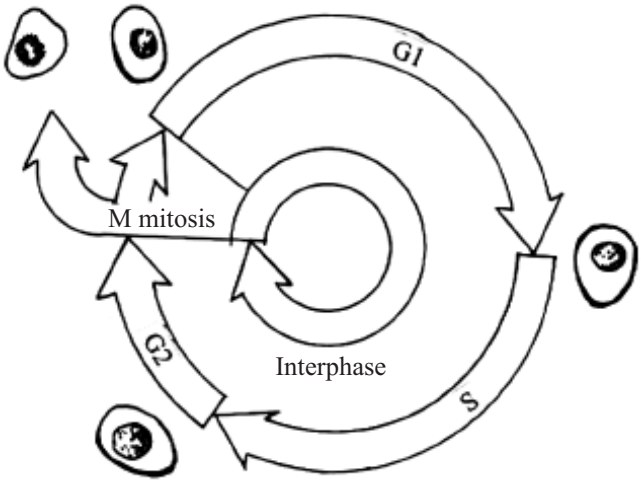


Fig. 4.11 The cell cycle consists of various stages (G_1, S, G_2 and M)

G_2 (GAP 2) phase - More protein including the histones are synthesised in this phase. Cytoplasmic organelles such as mitochondria and golgi bodies get duplicated. Centriole also divides into two centrioles contained in a single centrosome.

(ii) **M-phase or dividing phase** - Represented by the symbol M (Mitosis or meiosis) (Fig. 4.11). Mitosis occurs so that during this period the chromatids separate and form daughter chromosomes. The daughter chromosomes go to daughter nuclei and cytoplasm divides forming two identical daughter cells.

INTEXT QUESTIONS 4.8

1. Explain in one sentence
   - (i) Interphase .....
   - (ii) Synthetic-phase .....
   - (iii) Dividing-phase .....
2. What is the full form of the following in the cell cycle?
   - (i) G_1 .....
   - (ii) S .....
   - (iii) G_2 .....
   - (iv) M-Phase .....

4.7.2 Kinds of cell division

There are two kinds of cell division- mitotic cell division and meiotic cell division.

1. Mitotic : Cell division is for growth and replacement of older cells by new cells wherein the two daugher cells are identical and similar to mother cell in all respects. Mitotic cell division occurs in haploid as well as diploid cells.
2. Meiotic cell division occurs in the gonads for sexual reproduction to produce gametes. The resultant cells, egg (in female) and sperms (in male), possess half the chromosome number of that present in the parent cell. Meiotic cell division takes place only in diploid cells responsible for production of haploid spores or gametes.

1. **Mitosis (mitos = thread)** Mitosis is divided into 4 phases or stages termed as

   (i) Prophase (ii) Metaphase

   (iii) Anaphase (iv) Telophase

   These phases refer to the changes taking place in the nucleus (Fig. 4.12).

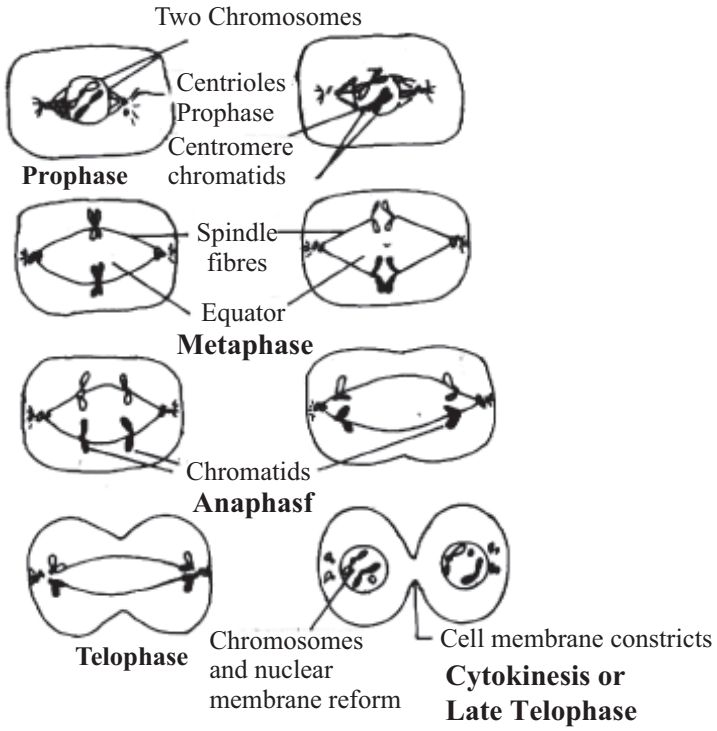


Fig. 4.12 Stages of Mitosis in an animal cell presuming there is just one pair of chromosome in the dividing cell

The nucleus divides first and then the whole cell divides. Division of one nucleus to produce two daughter nuclei a is called (**karyokinesis**). Division of cytoplasm to give two daughter cells is called **cytokinesis**.

Prophase : It shows three subphases :

(i) **Early prophase**

(a) Centriole divides and each of the two centrioles start moving towards opposite poles of the nucleus of the dividing cell.

(b) Chromosomes appear as long threads, and start coiling.

(c) Nucleus enlarges and becomes less distinct (Fig. 4.13a)

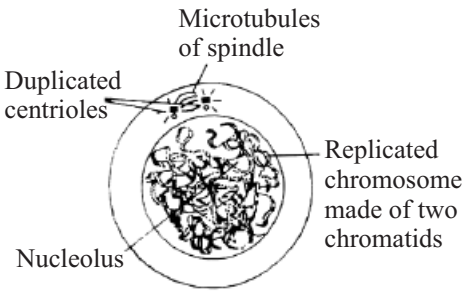


Fig. 4.13a Prophase

(ii) **Middle prophase**

(a) Chromosome condensation is complete and they become short and thick

(b) Each chromosome is made up of two chromatids held together at their centromeres.

(c) Each chromatid contains newly replicated daughter DNA molecule.

(iii) **Late Prophase**

(a) Centrioles reach the opposite poles of the dividing cell.

(b) Some spindle fibres extend from pole to the equator of the dividing cell.

(c) Nuclear membrane disappears

(d) Nucleolus is not visible.

Metaphase

(a) chromosomes are brought towards the equator of the cell, with the help of spindle fibres.

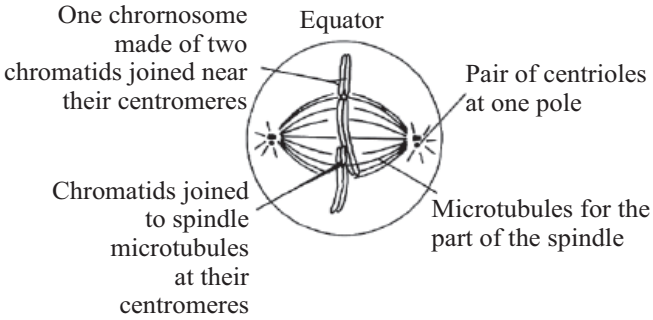


Fig. 4.13b Metaphase

(b) Each chromosome becomes attached to the two spindle fibres by centromere. Whereas each centromere is joined to the opposite poles.

(c) The sister chromatids are not yet separated. (Fig. 4.13b) because the centromere has not divided

Anaphase

(a) Centromeres of all the chromosomes divide and then each chromatid becomes a chromosome.

(b) Spindle fibres contract and pull the centromeres to the opposite poles.

(c) As the chromosomes are pulled by spindle fibres to opposite poles by their centromeres, they acquire various shapes such as V, J or I depending upon the position of centromere.

(d) Half the number of chromosomes move towards one pole and the other half to the opposite pole.

(e) Cytokinesis begins as the cleavage furrow starts from the periphery towards the centre in animal cells, and in plants, cell plate appears in the centre that grows centrifugally towards periphery.

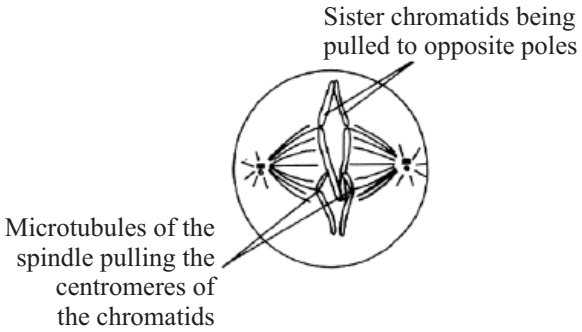


Fig. 4.13c Anaphase

Telophase

(a) Chromosomes uncoil to form a chromatin network as in the parent nucleus.

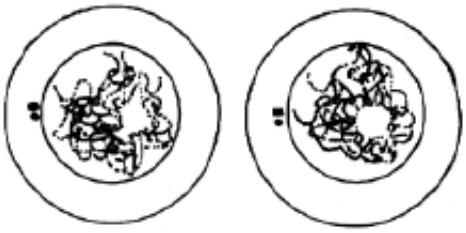


Fig. 4.13d Telophase

(b) New nuclear membrane is formed around each daughter nucleus

(c) Nucleolus reappears again in each newly formed daughter nucleus.

Cytokinesis

It is the process of the division of cytoplasm of a dividing cell into two. It is initiated in the beginning of telophase and is completed by the end of telophase. The mechanism of cytokinesis is different in plant and animal cells. In an animal cell, invagination of plasma membrane proceeds from the periphery of the cell towards the interior. In plant cell phragmoplast (cell plate) begins to form in the centre of cell and then expands towards the periphery (Fig. 4.13e).

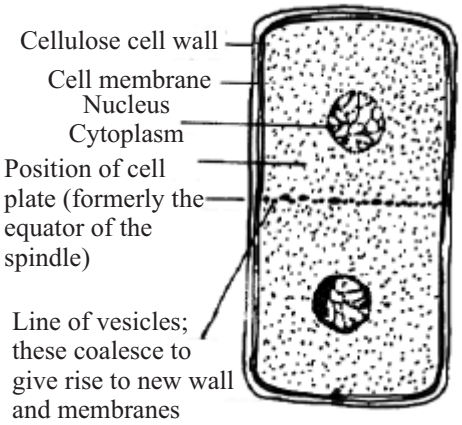


Fig. 4.13e Cytokinesis

Siginificance of Mitosis

It is an equational division, and the two newly formed daughter cells are identical in all respects. They receive the same number and kind of chromosomes as were in the mother cells.

- It is the only mode of reproduction in unicellular organisms.
- It is the process by which growth takes place in multicellular animals and plants by constantly adding more and more cells.
- It also plays a role in repair during growth, for example in wound healing, regeneration of damaged parts (as in the tail of lizard), and replacement of cells lost during normal wear and tear (as the surface cells of the skin or the red blood cells).

Mitotic Cell Division (Limited or unlimited)

Growth by mitosis occurs in a limited or controlled manner to the extent it is required in the body. But at times due to some special cases the number of cells may increase abnormally which may cause **Cancer**.

In plant tissue culture, a cell from a plant can be grown in a nutrient medium, where it divides repeatedly by mitosis to give an undifferentiated cell mass called **callus** capable of differentiating into a plant in the presence of nutrients and specific growth hormones. In animals, stem cell culture is also based on the ability of a cell to divide and give rise to cells of specific type.

INTEXT QUESTIONS 4.9

1. Name the stage of cell cycle during which chromatin material is duplicated.

   .....

2. Is the number of chromosomes reduced in the daughter cells during mitosis? yes/no?

   .....

3. Name the stage in nuclear division described by each of the following sentences:

   (i) disappearance of the nuclear membrane

   .....

   (ii) The nuclear membrane and nucleolus reappear

   .....

   (iii) The centromere divides and the chromatids move to opposite poles due to the shortening of spindle fibres

   .....

   (iv) The chromosomes arrange themselves at the equatorial plane of the spindle with the spindle fibres attached to the centromeres.

   .....

---

2. Meiotic Cell Division (GK meioun = make smaller, sis = action)

This division is also known as '**reduction division**'. But why this name? This is because, in this kind of cell division the normal **chromosome number of the mother cell is reduced to half in daughter cells.** The normal chromosome number in human being is 46 (23 pairs), but as a result of meiosis in ovary and testes this number is halved to 23 in daughter cells (called sperms or the egg).

Where does it occur? It occurs in reproductive cells, e.g. in the testes of male and in the ovaries of female animals; and in plants, in the pollen mother cell of the anthers (male organs) and in the megaspore mother cells of the ovary (female organ) of the flowers.

Why does it occur? In meiosis the chromosome number is reduced to half so that when doubled at fertilisation (zygote formation) during the reproduction it once again becomes ristored to the deploid state.

- The number of chromosomes remains constant in a species generation after generation.
- Cells divide mitotically in the organisms that reproduce vegetatively/ asexually. Thus, there is no change in the number of chromosomes, but sexually reproducing organisms form gametes such as sperms in males and ova in females. The male and female gametes fuse to form the zygote which develops into a new individual. .
- If these gametes were, produced by mitosis, the offspring developing from zygote then would have double the number of chromosomes in the next generation.
- Every living organism has a definite number of chromosomes in its body cells. e.g. onion cell-16; potato-48; horse-64; man-46. Therefore to keep the chromosome number constant the reproductive cells of the parents (ovaries and testis in animals, and pollen mother cells in anthers and megaspore mother cells in the ovules inside the ovary in plants) divide through meiosis.

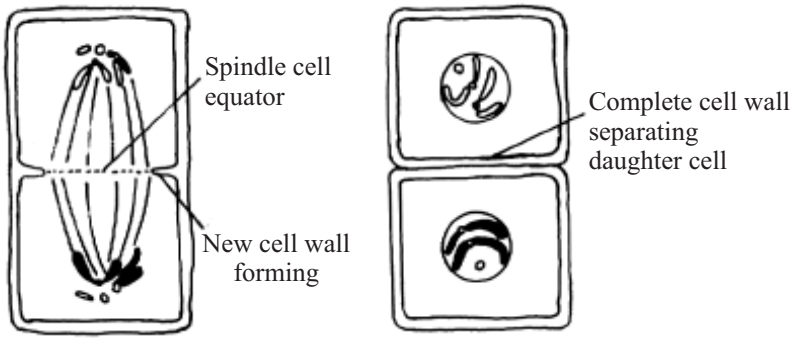
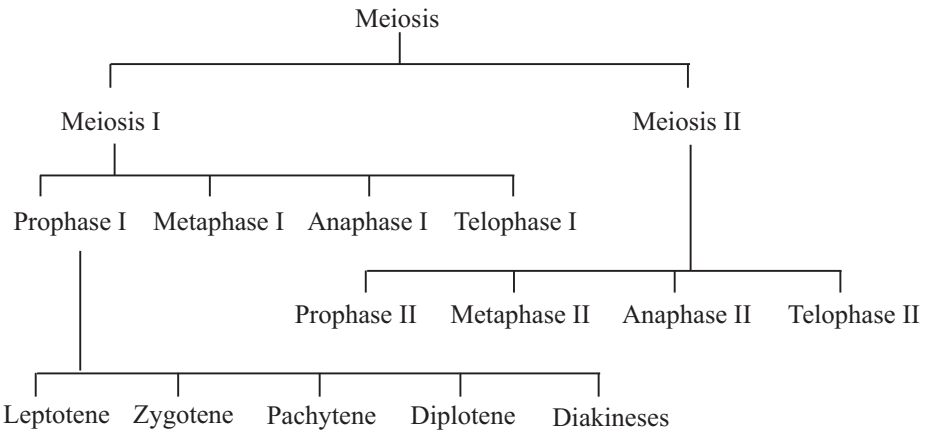


Fig. 4.14 : Cell wall formation after mitosis in a plant cell

How does meiosis occur?

Meiosis is characterized by two successive divisions of the nucleus (meiosis I and II) and cytoplasm, whereas the chromosomes divide only once. The phases of meiotic division are given in the flow-chart drawn here.

– **The interphase** which precedes the onset of meiosis is similar to the interphase which precedes mitosis. At S-phase, the DNA molecule of each chromosome duplicates to give rise to two DNA molecules and hence two chromatids are found in one chromosome attached to a single centromere.



– Meiosis-I and meiosis-II are continuous and have been divided into sub-stages only only for convenience to study the process of nuclear division.

Meiosis-I

Like mitosis, meiosis-I also consists of four stages; prophase-I, metaphase-I, anaphase-I and telophase-I.

Prophase-I

The prophase-I of meiosis-I is much longer as compared to the prophase of mitosis.

- It is further sub-divided into the following five sub-stages :

(i) **Leptotene** (GK 'leptos' - thin; 'tene - thread) (Fig. 4.15a)

- The chromosomes become distinct and appear as long and thin threads bearing fine beads due to condensation (coiling of DNA) at specific points called chromomeres.
- Each chromosome consists of two chromatids held together by a centromere but these are not easily visible.
- Nuclear membrane and nucleolus are distinct.

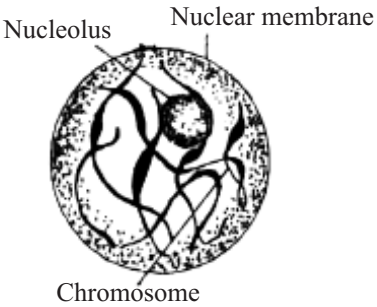


Fig. 4.15a Leptotene

(ii) **Zygotene** (GK. 'Zygos'-pairing) (Fig. 4.15b)

- Chromosomes continue coiling and become shorter and thicker
- Similar or homologous chromosomes start pairing from one end. This pairing is known as **synapsis.**
- Each pair of homologous chromosomes is called a **bivalent**.
- Nuclear membrane and nucleolus are distinct.

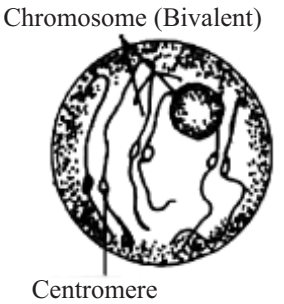


Fig. 4.15b Zygotene

(iii) **Pachytene** (GK. 'pachus' - thick) : (Fig. 4.15c)

- The chromosomes become shorter and thicker due to further coiling.
- Each paired unit called a 'bivalent' shows four chromatids hence bivalents are also known as **tetravalents**.

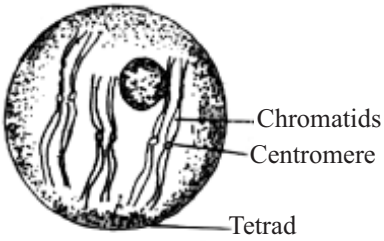


Fig. 4.15c Pachytene

- Crossing-over occurs at the end of pachytene i.e. break and exchange of parts (genes) occurs between non-sister chromatids (chromatids of a homologous pair)

  The point of interchange and rejoining appears X-shaped and is known as chiasma (plural-chiasmata) or the point of **crossing over**.

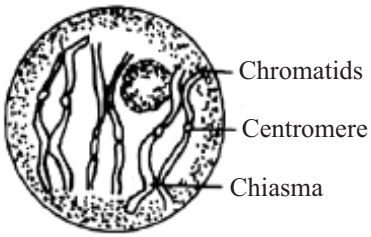


Fig. 4.15d Diplotene

(iv) **Diplotene** ('Diplous'-double) (Fig. 4.15d)

- Chromosomes continue coiling further and become shorter.
- The centromeres of homologous chromosomes start repelling each other
- The two non-sister chromatids of a homologous pair of chromosomes remain, attached at one or two points, the **chiasmata**.
- Nucleolus and nuclear membrane become indistinct.
- It is at the chiasmata that exchange of segments of nonsister chromatids (genes) between homologous chromosomes has taken place. The process of gene exchange is known as **genetic recombination**.

(v) **Diakinesis** (GK dia = through, in different directions, kinesis = motion; Fig. 4.15e)

- The bivalents become the shortest and thickest due to maximum coiling.
- The centromeres and non-homologous parts of homologous chromosomes of a bivalent move apart due to repulsion from each other.

- Consequently, the bivalents acquire various configurations such as O, X or 8, depending upon the number of chiasmata per bivalent.
- Nuclear membrane and nucleolus disappear.
- Spindle formation is completed.

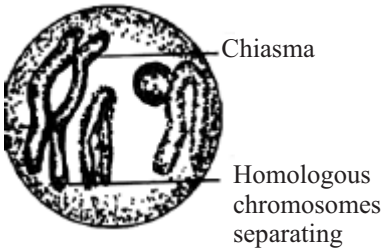


Fig. 4.15e Diakinesis

(vi) **Metaphase-I** (Fig. 4.15f)

- The bivalents arrange themselves at the equatororial plate.
- The homologous chromosomes arrange in such a way that all maternal or all paternal chromosomes do not get attached to same pole. In other words, some maternal and some paternal chromosomes are joined to each pole.
- The spindle fibres are attached at the centromere of the chromosomes.

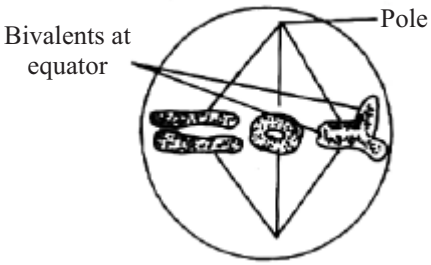


Fig. 4.15f Metaphase

- One centromere of a bivalent is joined to one pole and second centromere is joined to the opposite pole by the separate spindle fibres.

(vii) **Anaphase-I** (Fig. 4.15g)

- The spindle fibres shorten.
- The centromeres of homologous chromosomes are pulled along by the spindle fibres towards the opposite poles (no division of centromere)
- Thus, half of the number chromosomes (each with two chromatids) of the parent cell go to one pole and the remaining half to the opposite pole.

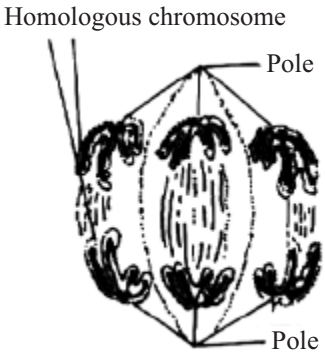


Fig. 4.15g Anaphase

- Each set of chromosomes that moves to one pole consists of a mixture of paternal and maternal chromosome parts (new gene combination). This is the basic reason for mixing of maternal and paternal genes in the products of meiosis.

(viii)**Telophase-I** (Fig. 4.15h)

- The separated chromosomes uncoil in the newly formed daughter nuclei.
- The daughter nuclei have half the number of centromeres as compared to that in the parent nucleus. But, since each centromere has two chromatids, amount of DNA at the two poles at telophase-I is same i.e. 2n (diploid as in the parent nucleus wherein the chromosomes had duplicated at S-phase, thus amount of DNA in the dividing cell upto anaphase I was 4n)
- The daughter cells now have half the amount of DNA as compared to that at Anaphase-I, that is 2n.
- The nucleous reappears and nuclear membrane forms
- The daughter nuclei enter into the second meiotic division.,

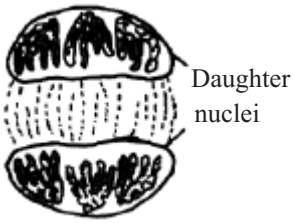


Fig. 4.15h Telophase

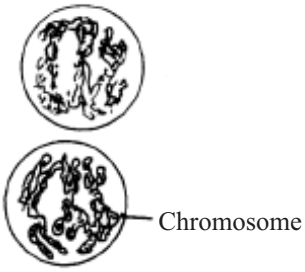


Fig. 4.15i Prophase II

Second Meiotic Division has the same four stages;

(i) Prophase II (ii) Metaphase II

(iii) Anaphase II (iv) Telophase II

(i) **Prophase II** (Fig. 4.15i)

- The chromosomes shorten and chromatids become distinct. The two chromatids of each chromosome are attached to the single centromere.
- Formation of spindle starts.
- Nucleolus and nuclear membrane begin to disappear.

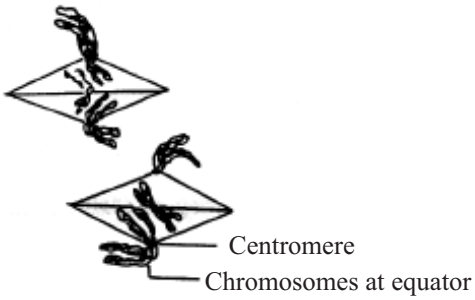


Fig. 4.15j Metaphase II

(ii) **Metaphase II** (Fig. 4.15j)

- The chromosomes arrange themselves along the equator.
- Formation of spindle apparatus is completed.
- The centromere of each chromosome is attached by two spindle fibres to the opposite poles.

(iii) **Anaphase II** (Fig. 4.15k)

- The centromere in each chromosome divides so that each chromatid has its own centromere and each chromatid is now a complete chromosome.

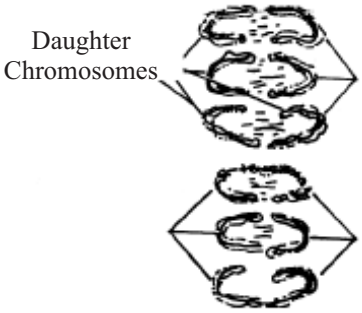


Fig. 4.15k Anaphase II

Fig. 4.15l Telophase II

- The chromatids get their respective centromere and become daughter chromosomes and begin to move towards the opposite poles due to contraction of spindle fibres.

(iv) **Telophase II** (Fig. 4.15l)

- On reaching the poles, the chromosomes organize themselves into haploid daughter nuclei.
- The nucleolus and the nuclear membrane reappear.
- Each of the four daughter nuclei has half the number of chromosomes (n) as well as half the amount of DNA as compared to the parent nucleus (2n).

Cytokinesis

- This may occur in two successive stages, once after meiosis I and then after meiosis II, or in some instances it occurs only after meiosis II.
- Thus after meiotic cell division four haploid cells are formed.

Significance of Meiosis

(i) It helps to maintain constant number of chromosomes in different generations of a species undergoing sexual reproduction.

(ii) Meiosis occurs during gamete formation (gametogenesis) and reduces the number of chromosomes from diploid (2n) to haploid (n) in the gametes. These haploid gametes fuse to form diploid zygote during fertilization. The diploid zygote develops into a normal diploid individual.

(iii) Meiosis establishes new combination of characters due to (i) mixing of paternal and maternal chromosomes and (ii) crossing over during prophase I. As a result the progeny inherits the traits of both the mother and the father in new gene combinations.

Comparison of Mitosis and Meiosis

Mitosis	Meiosis
1. Cell divides only once	There are two cell divisions. First meiotic division and the second meiotic division.
2. Takes place in somatic cells as well as in reproductive cells which may be haploid or diploid or polyploid	Takes place only in diploid germ cells.
4. Duration of prophase is short (few hours)	Prophase-I, is compartively longer. (takes many days).
5. Prophase simple.	Prophase I is complicated having five sub-stages namely leptotene, zygotene, pachytene, diplotene and diakinesis.
7. Synapsis does not occur.	Synapsis of homologous chromosomes takes place during prophase-I.
8. No exchange of segments during prophase between two nonsister chromatids of chromosomes.	Exchange of segments during crossing over between non sister chromatids of two homologous chromosomes takes place.
9. Each chromosome consists of two chromatids united by a centromere.	Each bivalent has four chromatids and two centromeres.

10. Chromosomes are duplicated at the beginning of prophase.	In prophase I, chromosomes appear single although DNA replication has taken place in interphase I.
11. In metaphase all the centromeres line up in the same plane.	In metaphase I, the centromeres are lined up in two planes which are parallel to one another.
12. The metaphasic plate is made up of duplicated chromosome.	The metaphasic plate is made up of paired chromosomes.
13. Centromere division takes place during anaphase.	No centromere divisions during Anaphase I, centromeres divide only during Anaphase II.
14. Spindle fibres disappear completely in telophase.	Spindle fibres do not disappear completely during telophase I.
15. Reappearance of nucleoli at telophase.	Nucleoli do not appear in telophase I.
16. The chromosome number does not change at the end of mitosis.	There is reduction in the chromosome number from diploid to haploid.
17. The genetic constitution of chromosomes daughter cells is absolutely identical to that of parent cells.	The genetic constitution of chromosomes in daughter cells is different as compared to the parent cells. The daughter cell chromosomes contain a mixture of maternal and paternal genes.
18. Mitosis is of shorter duration.	Meiosis is of longer duration.
19. It is the basis of growth and repair and reproduction in vegetatively or asexually reproducing organisms.	It is basis of maintaining same chromosome number in different generations of a species reproducting sexually as well as for providing genetic variation in the progeny.

What is a karyotype

Chromosomes can be seen distinctly only at metaphase. They are then photographed, cut and arranged in pairs according to size. Such an arrangement of homologous chromosomes of an individual in descending order according to size, is termed as a karyotype (see human karyotype in lesson 21).

INTEXT QUESTIONS 4.10

1. Name the sub-stage of meiosis-I in which the :

   (i) Homologous chromosomes pair

   .....

   (ii) Tetrads are formed.

   .....

   (iii) Homologous chromosomes begin to move away from each other.

   .....

Notes

2. Sites of meiosis in flowering plants, are :

   .....

3. Rearrange the following stages of meiosis I in their proper sequence :

   zygotene, pachytene, leptotene, metaphase-I diakinesis, anaphase-I, telophase-I.

   .....

4. Mention two major points in which meiosis I differs from meiosis II

   .....

WHAT YOU HAVE LEARNT

- A living cell is a self-sufficient unit of the body of a living plant or animal.
- Important cell organelles are mitochondria, Golgi complex, ER, ribosomes, peroxisomes, chloroplast, glyoxisomes, nucleus.
- With the exception of centrioles, ribosomes and nucleolus, all other organelles are membrane-bound.
- Although a cell fails to live, grow and reproduce in the absence of a nucleus, nucleus all by itself without cytoplasm is also ineffective.
- Some organelles like mitochondria and chloroplast have the capacity to duplicate themselves to some extent without the help of the nucleus i.e. they are termed semi-autonomous.
- The living cells divide by mitotic cell division to produce new cells.
- Growth in body occurs due to increase in the number of cells.
- The continuity of the chromosomal set is maintained by cell division.
- The life cycle of a cell includes interphase (G_1, S & G_2) and M-phase (mitosis or meiosis)
- Mitotic cell division occurs in somatic cells or reproductive cells that results in the formation of identical cells, both qualitatively and quantitively.
- Meiosis occurs in germ cells only i.e. testis and ovary. This is a reduction division where the chromosome number becomes half.
- The significance of mitosis is growth, and reproduction where the product of reproduction is identical.
- The Significance of meiosis is in sexual reproduction where ova and sperm both have half the number of chromosomes i.e. 23 each in human gametes (but normal number of chromosome of human is 46 or 23 pair) and on fertilization the chromosome number becomes normal.
- Meiosis also helps in mixing the paternal and maternal characters.

TERMINAL EXERCISES

1. Justify the statement that cell wall although a dead material, influences living processes inside the cell.
2. Differentiate between cell wall and cell membrane.
3. Draw Singer and Nicholson's model of cell membrane.
4. Why is cell membrane vital for the cell?
5. Draw structure of mitochondria and chloroplast as seen by electron microscope.
6. List functions of mitochondria and chloroplast.
7. Name the self–duplicating cell organelles? Why are they called so?
8. Differentiate between functions of ER, ribosomes and Golgi bodies.
9. Most organelles are membrane – bound. What is the advantage of such arrangement.
10. Differentiate between the structure and function of centriole and cilia/flagella.
11. Why are lysosomes known as "suicidal bags"?
12. What are the functions of nucleus?
13. List the cell organelles. Write in one line each, about their functions and explain the division of labour.
14. Give the points of difference between
    (i) prokaryotic and eukaryotic cell.
    (ii) plant and animal cell.
15. Why is the cell termed the structural and functional unit of living organisms?
16. Name the following :
    (i) The condition in which a cell has the normal paired chromosomes.
    (ii) The condition in which a cell contains only one member of each pair of chromosomes.
    (iii) The pairing of maternal and paternal chromosomes during meiosis.
    (v) The exchange of parts in homologous (maternal and paternal) chromosomes during prophase-I of meiosis.
    (vi) The point by which a chromosome is attached to the spindle fibre.
    (vii) The type of cell division that results in growth.
17. What are the sites of meiosis in a flowering plant and in a sexually reproducing animal?

Notes

18. List the sub-stages of prophase-I.
19. What is the significance of meiosis?
20. Draw a schematic diagram of various stages of the life-cycle of a cell.
21. Draw labelled diagrams of various stages of mitosis.
22. Tabulate the main differences between mitosis and meiosis.
23. Why is prophase of meiosis so prolonged and elaborate?
24. What is the difference between cytokinesis in animal cell and cytokinesis in plant cell?

ANSWERS TO INTEXT QUESTIONS

4.1
1. Pre-existing cells
2. Schleiden and Schwann
3. Chloroplast/plastid
4. Prokaryote - naked nucleus, no membrane bound cell organelles

   Eukaryote - distinct nucleus with a cell membrane, membrane bound cell organelles present

4.2
1. Diffusion : Movement of molecules from region of their higher concentration to region of their lower concentration.

   Osmosis : Movement of water molecules across a semipermeable membrane from region of their higher concentration to the region of their lower concentration.
2. Movement of molecules against concentration gradient that is region of lower to higher concentration by expending energy.
3. Intake of solid particles (phagocytosis)

   Intake of fluid droplets (pinocytosis)
4. (i) – d (ii) – a (iii) – e

   (iv)– b (v) – c
5. (i) Protection/shape

   (ii) Provide communication between cells through plasmodesmata

4.3
1. Membrane bound bodies in the cytoplasm
2. ATP
3. Grana
4. Thylakoids
5. Because energy as ATP is generated and stored in mitochondria
6. Mitochondria

7. (i) both are semiautonomous
   (ii) both contain DNA or both contain ribosomes
8. Chromoplasts
9. Chloroplast
10. They have their own DNA for production of more copies of themselves by self duplication but cannot lead independent life, outside the cell/ cytoplasm.

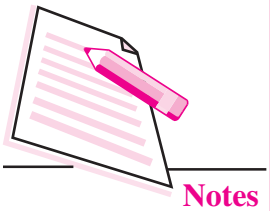
4.4
1. (a) Golgi body (b) ER, (c) amyloplasts (d) ER, (e) ribosomes
2. refer text
3. (i) internal framework, (ii) transport of cellular substances
4. cytoplasm, ER, Nucleolus; chloroplasts, mitochondria
5. ER

4.5
1. Because the lysosome can devour organelles of the same cell
2. They help in cleaning up the cell by digesting useless matter
3. Fat metabolism

4.6
1. Nucleus controls all the functions of the cell as it has the hereditary information
2. (a) Chromosomes are present as a network when not dividing, that is, at early interphase or Go-stage (Differentiation stage during development)
   (b) Bearers of hereditary information as genes on them
3. Site of RNA synthesis

4.7
1. (i) It is a universal solvent and most chemical reactions of the cell occur in aqueous medium
   (ii) It is a constituent of protoplasm
2. glucose
3. –NHCO–, between amino acids in a polypeptide, found in proteins
4. ATP
5. building blocks of nucleic acids, each containing a pentose sugar, nitrogenous base and phosphate

4.8
1. (i) Interphase - stage between two successive cell divisions;
   (ii) Synthetic phase - DNA is synthesised;
   (iii) Dividing phase - Mitosis in somatic cells or meiosis in the germ cells takes place.



Notes

2. (i) First growth phase; (ii) Synthetic phase;
   (iii) Second growth phase; (iv) Mitosis/meiotic phase.

4.9 1. S-shape of Interphase;
2. No;
3. (i) Late Prophase; (ii) Late Telophase; (iii) Anaphase; (iv) Metaphase

4.10 1. (i) zygotene (prophase I); (ii) Pachytene; (iii) Diplotene
2. Microspore/pollen mother cell in anthers and megaspore mother cell in the ovule.
3. Leptotene, zygotene, pachytene, diplotene, diakinesis, metaphase I, telophase I.
4. Reduction in chromosome number to half in Meiosis-II; exchange of genetic material in meiosis I.