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5.1 CELL CYCLE

LONG QUESTIONS

Q.1 Write a note on cell cycle. (K.B)

(MTN 2015) (Ex. Q. No 1,2)

Ans:

CELL CYCLE

Definition:

The series of events from the time a cell is produced until it completes mitosis and produces new cells is called cell cycle.

Major Phases of Cell Cycle:

Cell cycle consists of **two major** phases:

- Interphase
- Mitotic phase (M phase)

Interphase:

(GRW 2012, 2013, LHR 2013, MTN 2014, BWP 2015)

Interphase is the time when a cell's metabolic activity is **very high**, as it performs various functions.

It is divided into **three phases**:

G1 Phase:

This is called as the **first gap**. After its production, a cell **starts its cell cycle in G1 phase**.

Events:

- Cell increases its supply of proteins.
- Cell increases the number of its organelles (mitochondria, ribosomes)
- Cell grows in size.
- Synthesis of various enzymes required in the S Phase, for the duplication of chromosomes.

S Phase:

This phase is the **synthesis phase**.

Event:

- Cell duplicates its chromosomes as a result, each **chromosome consists of two sister chromatids**.

G2 Phase:

This phase is called as the **second gap**.

Event:

- Cell prepares proteins that are essential for **mitosis**, mainly for the production of **spindle fibers**.

Inhibition of Protein Synthesis:

Inhibition of **protein synthesis during G2 phase prevents cell from undergoing mitosis**.

Duration:

Typically, the Inter phase **lasts for at least 90%** of the total time required for the **cell cycle**.

M Phase:

After the **G2 phase** of Inter phase, the cell enters the division phase, i.e. M Phase. It is characterized by **mitosis**, in which cell divides into the **two daughter** cells.

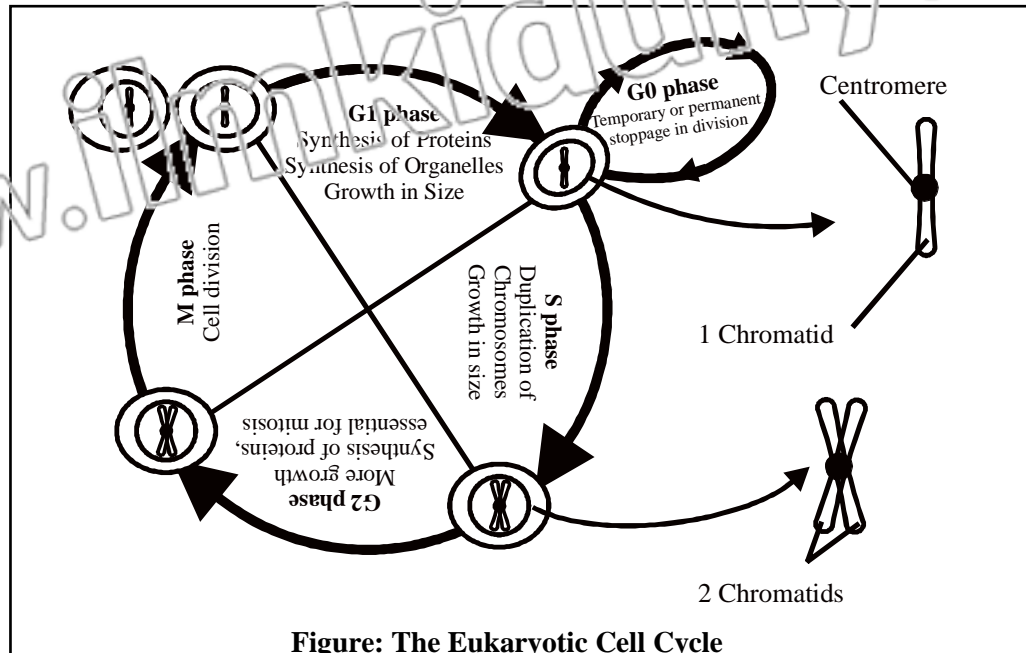


Figure: The Eukaryotic Cell Cycle

G0 Phase:

In multicellular eukaryotes, cells enter G0 phase from G1 and stop dividing.

Permanent G0 Phase:

Some cells remain in G0 phase for an indefinite period of time.

Example:

- Neurons

Semi-permanent G0 Phase:

Some cells enter G0 phase semi-permanently.

Example:

- Some cells of liver and kidney

No G0 Phase:

Many cells do not enter G0 Phase and continue to divide throughout an organism's life.

Example:

- Epithelial cells

Events of Cell Cycle:

The events of cell cycle are ordered and directional i.e. each event occurs in a sequential fashion and it is impossible to reverse the cycle.

SHORT QUESTIONS (Topic 5.1)

Q.1 Define cell cycle. (K.B) (LHR 2015, GRW 2013, BWP 2014)

Ans: Page no 168.

Q.2 What is Inter phase? What are its sub-phases? (K.B) (LHR-G1-2014)

Interphase:

Ans: "The period of cell cycle between two consecutive divisions is known as interphase".

Or

"Interphase is the time when a cell's metabolic activity is very high".

- G1 Phase
- S Phase
- G2 Phase
- Go Phase

Interphase last for about 90% of the total time required for the cell cycle.

Q.3 Can a cell cycle reverse? Cell cycle: (U.B)

Ans: The events of cell cycle are ordered and directional i.e. each event occurs in a sequential fashion and it is impossible to reverse the cycle.

Q.4 Define interphase. (K.B)

Ans: Page no 148.

Q.5 What are the changes that occur in a cell during G1 phase? (U.B) (LHR 2012, 2013)

Ans: Page no 148.

Q.6 What do you mean by S phase? (K.B) (SWL 2014, FSD 2015)

Ans: Page no 148.

Q.7 Describe G2 phase. (K.B) (MTN 2015, DGK 2015, SGD 2015)

Ans: Page no 148.

Q.8 What is G0 phase? (K.B)

Ans: Page no 149.

MULTIPLE CHOICE QUESTIONS (Topic 5.1)

1. The series of events from the time a cell is produced until it completes mitosis and produces new cells: (K.B)

- | | |
|------------------|-----------------|
| (A) Cell cycle | (B) Interphase |
| (C) Karyokinesis | (D) Cytokinesis |

2. During interphase (K.B)

- | | |
|---|--|
| (A) Cell's metabolic activity takes place | (B) Duplication of chromosomes takes place |
| (C) Cell is divided into two daughter cells | (D) Both A and B |

3. The major phases of cell cycle are: (K.B) (GRW 2013)

- | | |
|-------|-------|
| (A) 5 | (B) 4 |
| (C) 3 | (D) 2 |

4. Which phase is relatively short period of cell cycle? (K.B)

- | | |
|----------------|-------------|
| (A) Interphase | (B) Mitotic |
| (C) S-phase | (D) G phase |

5. Metabolic activity of cell is very high during: (U.B)

- | | |
|-----------------|------------------|
| (A) Interphase | (B) Mitosis |
| (C) Cytokinesis | (D) Karyokinesis |

6. **90% of the total time of the cell cycle is occupied by: (K.B)**
 (A) Mitosis (B) Interphase
 (C) Cytokinesis (D) Karyokinesis
7. **Interphase is divided into how many phases? (K.B)** (CHR 2012)
 (A) Four (B) Three
 (C) Two (D) One
8. **Which of the following is the longest phase in cell cycle? (U.B)** (BRW 2015)
 (A) Mitotic phase (B) Inter phase
 (C) G₀ phase (D) G₁ phase
9. **During G₁ phase: (K.B)**
 (A) Cell increases its supply of proteins (B) Increases its number of organelles
 (C) Duplication of chromosomes (D) Both A and B
10. **In which stage of cell cycle, the cell is preparing enzymes for chromosomes duplication? (K.B)** (SWL 2014)
 (A) S phase (B) G₁ phase
 (C) G₂ phase (D) M phase
11. **In which phase cell duplicates its chromosomes? (K.B)** (SDG 2015, GWL 2013, LHR 2012, 2016)
 (A) G₁ phase (B) S phase
 (C) G₂ phase (D) G₀ phase
12. **The phase in which cell prepare its proteins required for spindle fibers formation. (U.B)** (GRW-G2-2014)
 (A) G₁ (B) G₂
 (C) S (D) G₀
13. **The phase of interphase in which cell prepares proteins for mitosis: (U.B)** (GRW 2014)
 (A) G₁ phase (B) S phase
 (C) G₂ phase (D) G₀ phase
14. **Inhibition of protein synthesis prevents the cells from undergoing mitosis during _____ phase. (U.B)**
 (A) G₁ (B) G₂
 (C) S (D) G₀
15. **At which stage of cell cycle cell stops dividing? (U.B)** (SGD 2015)
 (A) G₀ (B) G₁
 (C) G₂ (D) S
16. **A state of quiescence in which cells are temporarily or permanently stopped dividing is termed as: (K.B)**
 (A) G₁ phase (B) G₂ phase
 (C) S phase (D) G₀ phase
17. **The cells that do not enter G₀ phase and continue to divide throughout an organism's life: (K.B)**
 (A) Neurons (B) Epithelial cells
 (C) Liver cells (D) Kidney cells
18. **Cells that remain in G₀-phase for indefinite period of time are: (K.B)**
 (A) Skeletal cells (B) Muscle cells
 (C) Neurons (D) Blood cells
19. **Cells that enter G₀ phase semi permanently are: (K.B)**
 (A) Epithelial cells (B) Liver cells
 (C) Kidney cells (D) Both b and c

20. **Characteristics associated to S phase:** (K.B)
 (A) Duplication of chromosomes (B) Growth in size
 (C) Synthesis of proteins (D) Both a and b
21. **It is impossible to reverse the cell cycle because its events are:** (C.B)
 (A) Ordered (B) Directional
 (C) Sequential (D) All of these

5.2 MITOSIS

LONG QUESTIONS

O.1 Define mitosis and describe its different phases. (K.B)

(DGK 2014)

Ans:

MITOSIS

Discovery:

In 1880s, a German biologist, Walther Flemming observed that in a dividing cell, nucleus passes through a series of changes which he called mitosis.

Definition:

“The type of cell division in which a cell divides into **two daughter** cells, each with the same number of **chromosomes** as were present in the parent cell is called mitosis.”

Occurrence:

- Mitosis occurs only in eukaryotic cells.
- In multicellular organisms, the somatic cells undergo mitosis.

Phases of Mitosis

(SWL 2014)

The process of mitosis is **complex and highly regulated**. There are **two major phases**.

- Karyokinesis
- Cytokinesis

Karyokinesis:

“The division of nucleus is called karyokinesis.”

The division of nucleus is further divided into four phases.

- Prophase
- Metaphase
- Anaphase
- Telophase

i. Prophase:

(LHR 2013, 2015, MTN 2015)

The events that occur in prophase are:

Condensation of Chromatin:

The **genetic material** in the nucleus is in a **loose thread-like** form called chromatin. At the onset of **prophase**, chromatin condenses into highly ordered structures called chromosomes.

Formation of Complete Chromosome:

The **genetic material** has already been duplicated earlier in **S phase**, each chromosome is made up of **two sister chromatids**, bound together at a centromere. **Each chromosome** has a kinetochore at centromere.

Kinetochore:

Kinetochore is a **complex protein** structure that is the point where **spindle fibers attach**.

Migration of Centrosomes:

There are **two centrioles**, (collectively called a **centriole**), close to the nucleus. Each centriole **duplicates** and thus **two daughter centrosomes** are formed. **Both centrosomes** migrate to the opposite poles of the cell.

Formation of Mitotic Spindle:

Centrosomes give rise to microtubules by joining **tubulin proteins** present in cytoplasm. The microtubules thus formed are called spindle fibres. Complete set of **spindle fibers** is known as the **mitotic spindle**.

Nuclear Changes:

By this time, **nucleolus and the nuclear envelope** have degraded and the **spindle fibers** have invaded the **central space**.

Prophase in Plant Cells:

In highly vacuolated plant cells, nucleus has to migrate to the center of the cell before prophase. The cells of plants lack centrioles. So, spindle fibers are formed by the aggregation of tubulin proteins on the surface of nuclear envelope during prophase.

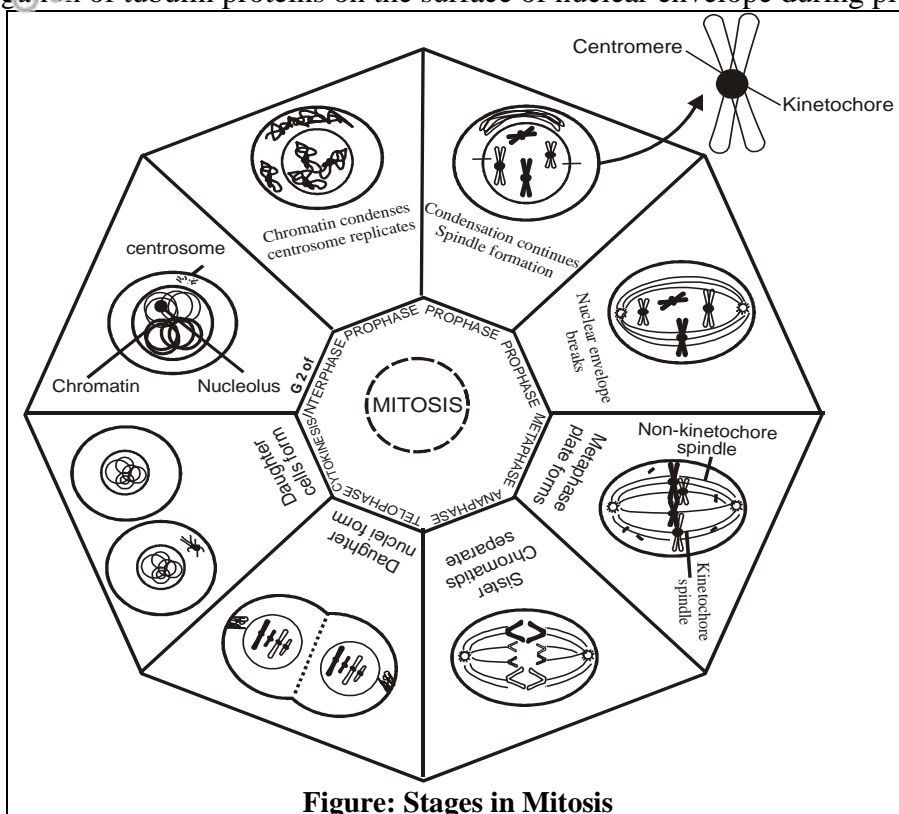


Figure: Stages in Mitosis

ii. Metaphase:

(LHR 2015)

The events that occur in metaphase are:

Attachment of Kinetochore Fibres:

When spindle fibers have grown to a sufficient length, some spindle fibres known as kinetochore fibres attach with the kinetochores of chromosomes. Two kinetochore fibres from opposite poles attach with each chromosome.

Formation of Metaphase Plate:

Chromosomes arrange themselves along the equator of the cell forming a metaphase plate.

Attachment of Non-kinetochore fibres:

A number of other fibres (non-kinetochore) from the opposite centrosomes attach with each other.

iii. Anaphase:

(LHR 2015)

The events that occur in anaphase are:

Contraction of Kinetochore Fibres:

When a kinetochore spindle fibre connects with the kinetochore of chromosome, it starts to pull toward the originating centrosomes.

Separation of Sister Chromatids:

The pulling force divides the chromosome's sister chromatids and they separate. These sister chromatids are now sister-chromosomes, and they are pulled apart toward the respective centrosomes.

Elongation of Non-kinetochore Fibres:

The other spindle fibres (non-kinetochore) also elongate. At the end of anaphase, cell has succeeded in separating identical copies of chromosomes into two groups at the opposite poles.

iv. Telophase:

Telophase is the reversal of prophase.

Appearance of Nuclear Envelope:

A new nuclear envelope forms around each set of separated chromosomes.

Decondensation of chromosomes:

Both sets of chromosomes, now surrounded by new nuclear envelopes, unfold back into chromatin. Nuclear division is completed.

Cytokinesis:**Definition:**

“The division of cytoplasm is called cytokinesis.”

Cytokinesis in Animal Cells:

- In animal cells, cytokinesis occurs by a process known as cleavage.
- A cleavage furrow develops where the metaphase plate used to be.
- The furrow deepens and eventually pinches the parent cell into two daughter cells.

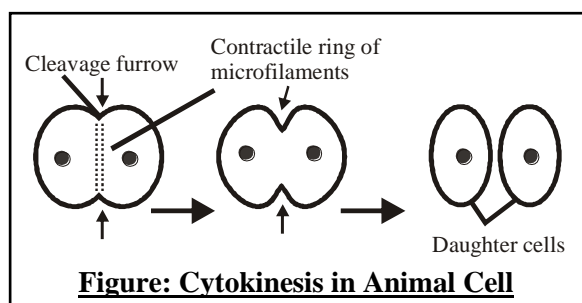
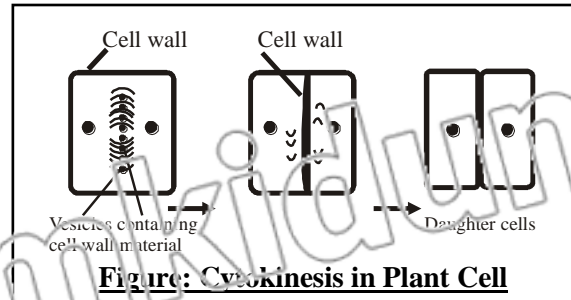


Figure: Cytokinesis in Animal Cell

Cytokinesis in Plant Cells:

- In plant cells, vesicles derived from Golgi apparatus move to the middle of the cell.
- These vesicles fuse to form a membrane-bounded disc which is called cell plate or phragmoplast.
- This plate grows outward and more vesicles fuse with it.
- Finally, the membranes of cell plate fuse with plasma membrane, and its contents join the parental cell wall.
- The result is two daughter cells, each bounded by its own plasma membrane and cell wall.



Q.2 Describe significance of mitosis. (Knowledge Based)

(Ex Q. No 5)

(LHR 2016, DGK 2014, 2015, RWP 2014, SGD 2015, RWP 2015)

Ans:

SIGNIFICANCE OF MITOSIS

The importance of mitosis is the maintenance of chromosomal set, i.e. each daughter cell receives chromosomes that are alike in composition and equal in number to the chromosomes of parent cell.

Following are the occasions in the lives of organisms where mitosis happens.

Development and Growth:

The number of cells within an organism increase by mitosis. This is the basis of the development of a multicellular body from a single cell, i.e. zygote, and also the basis of growth of multicellular body.

Cell Replacement:

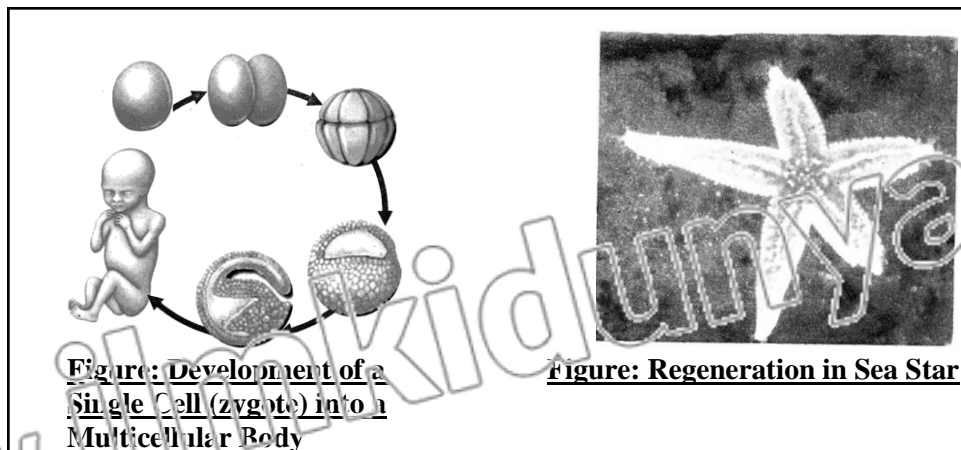
In some body parts, cells are constantly sloughed off and replaced by new ones. New cells are formed by mitosis and are exact copies of the cells being replaced.

Examples:

- Cells of skin and digestive tract

Red Blood Cells:

Red blood cells have a short life span (about 4 months). New red blood cells are formed by mitosis



Regeneration:

Some organisms can regenerate parts of their bodies. The production of new cells is achieved by mitosis.

Example:

- Sea star regenerates its lost arm through mitosis

Asexual Reproduction:

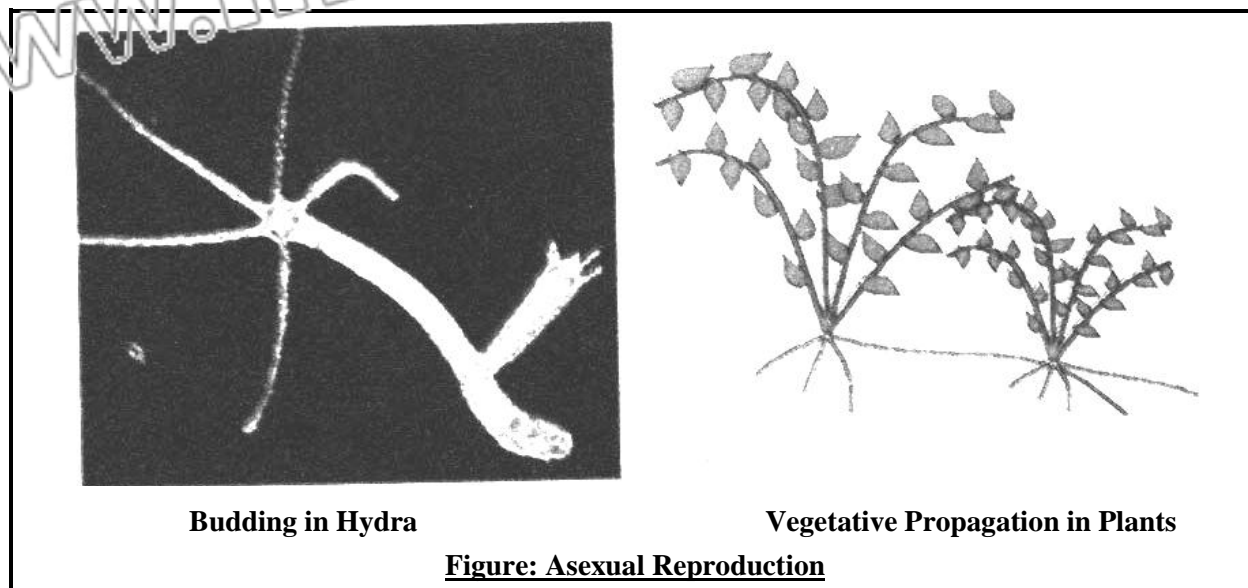
Some organisms produce genetically similar offsprings through asexual reproduction. Mitosis is a means of asexual reproduction.

Example:

- Hydra reproduces asexually by budding. The cells at the surface of hydra undergo mitosis and form a mass called bud. Mitosis continues in the cells of bud and it grows into a new individual.

Vegetative Propagation:

The same division happens during asexual reproduction, i.e. vegetative propagation in plants.



Q.3 Describe errors in mitosis. (*Knowledge Based*)

(SGD 2014)

Ans:

ERRORS IN MITOSIS**Cancer:**

Errors in the control of mitosis may cause cancer.

Tumor Development:

All cells have genes that control the timing and number of mitosis. Sometimes mutations occur in such genes and cells continue to divide. It results in growth of abnormal cells called tumors.

Types of Tumors:

There are following types of tumors:

- Benign Tumors
- Malignant Tumors

i. Benign Tumors:

As long as tumors remain in their original locations, they are called benign tumors.

ii. Malignant Tumors:

If tumors start to invade other tissues, they are called malignant or cancerous tumors, and their cells are called cancer cells.

Metastasis:

Malignant tumors can send cancer cells to other body parts where new tumors may form. This phenomenon is called metastasis (spreading of disease).

SHORT QUESTIONS (Topic 5.2)

Q.1 What is mitosis? (K.B) (LHR, GRW2013, BWP 2014, SWL 2015, RWP 2014)

Ans: Page no 152

Q.2 What is the difference between somatic and germ line cells? (K.B)
(LHR, GRW 2014, LHR 2015, SWL 2015)

Ans:

DIFFERENTIATION

The difference between somatic and germ line cells is as follows:

Somatic Cells	Germ Line Cells
Cell Type	
Somatic cells are those which form the body of organisms.	Germ line cells are those which give rise to gametes.
Cell Division	
Somatic cells undergo mitosis.	Germ line cells undergo meiosis.

Q.3 When was mitosis discovered. Who was the first to report the process of mitosis? (U.B)

Ans: **Discoverer of mitosis:**

In 1880's a German biologist **Walther Flemming** observed that in dividing cell, nucleus passes through a series of changes which he called mitosis.

Q.4 What is difference between mitosis and binary fission? (K.B)

Ans:

Mitosis	Binary Fission
Spindle	
Nuclear envelope disappear when spindle formed	Spindle is found inside the nucleus.
Cell structure	
Mitosis occurs exclusively in eukaryotes	Prokaryotes undergo binary fission e.g bacteria

Q.5 What is karyokinesis? What are its sub-divisions? (K.B) (GRW-C2-2016)

Ans:

Q.6 Write the main features of prophase of mitosis. (K.B)

Ans: **Prophase of mitosis:**

Following are the characteristics of prophase of mitosis

1. Chromatin condenses into highly ordered structure called chromosomes.
2. Centrosome consisting of two centrioles divide into two and migrate toward the opposite poles.
3. Nuclear membrane degraded and spindle fiber invaded the central space.

Q.7 Why prokaryotes do not undergo proper mitosis? (U.B)

Ans: Page no 156.

Q.8 What is binary fission? (K.B) (DGK 2015)

Ans: Page no 156.

Q.9 Name the phases of mitosis in order. (K.B) (MTN 2015, BWP 2015)

Ans: Page no 152.

Q.10 What is kinetochore? (K.B)

Ans: Page no 152.

Q.11 What do you know about mitotic spindle? Mitotic spindle: (K.B)

Ans: The complete set of spindle fibers is known as mitotic spindle. It is formed by polymerizing microtubules. Microtubules are assembled by centrosomes. They are made up of tubulin proteins.

Q.12 What are spindle fibres? (K.B)

Ans: Page no 153.

Q.13 Enlist the important changes that occur in prophase of mitosis. (K.B)

Ans: Page no 152.

Q.14 What is metaphase plate? Metaphase plate: (K.B)

Ans: "Arrangement of chromosomes on spindle fibers at the equator of the cell is called metaphase plate." Kinetochore as well as non-kinetochore forms the metaphase plate.

Q.15 What is telophase of mitosis? (K.B)

Ans: Page no 153.

Q.16 What is difference in cytokinesis in animal and plant cells? (U.B)

(LHR-G1, G2-2016, GRW-G2-2014, LHR-G2-2015)

Ans:

DIFFERENTIATION

The difference between cytokinesis in animal and plant cells is as follows:

Animal Cell	Plant Cell
<ul style="list-style-type: none"> In animal cells, cytokinesis occurs by a process known as cleavage. A cleavage furrow develops where the metaphase plate used to be. The furrow deepens and eventually pinches the parent cell into two daughter cells. 	<ul style="list-style-type: none"> In plant cells, vesicles derived from Golgi apparatus move to the middle of the cell. These vesicles fuse to form a membrane bounded disc which is called cell plate or phragmoplast. Finally, the membranes of cell plate fuse with plasma membrane, and its contents join the parental cell wall.

Q.17 Define phragmoplast. (U.B)

(SGD 2014)

Ans: Page no 154.

Q.18 Why nucleus is only visible in interphase while chromosomes are only visible during cell division? (U.B)

Ans: Page no 152.

Q.19 What is importance of mitosis? (K.B)

(LHR-G1-2014, LHR-G2-2016)

Ans: Page no 155.

Q.20 Define regeneration. (K.B)

(SWL 2014, DGK 2014, MTN 2015, SGD 2014)

Ans: Page no 155.

Q.21 How does mitosis help in asexual reproduction? (U.B)

Ans: Page no 156.

Q.22 What can be the results of errors in mitosis? (A.B)

Ans: Page no 156.

Q.23 What is difference between malignant and benign tumor? (A.B)

(LHR 2014, GRW 2015, MTN 2015, SGD 2015)

Ans:

DIFFERENTIATION

The difference between malignant and benign tumor is as follows:

Malignant Tumor	Benign Tumor
<ul style="list-style-type: none"> If the cells of tumor invade other tissues, they are called malignant tumors. The cells of malignant tumor are called cancer cells. 	<ul style="list-style-type: none"> As long as tumors remain in their original location, they are called benign tumors. The cells of benign tumor are not called cancer cells.

Q.24 Define metastasis. (K.B)

(BWP 2015)

Ans: Page no 178.

MULTIPLE CHOICE QUESTIONS (Topic 5.2)

1. Mitosis was discovered in: (K.B)

- (A) 1860's (B) 1870's
(C) 1880's (D) 1890's

2. Who discovered mitosis? (K.B)

- (A) Walther Flemming (B) Oscar Hertwig
(C) T. H. Morgan (D) August Weismann

3. The cells which form the body of an organism are called:

- (A) Somatic cells (B) Epithelial
(C) Germ cell (D) all cells

4. The germ line cells give rise to

- (A) Liver (B) Gamete
(C) Germs (D) Kidney

5. Germ line cells undergo:

- (A) Mitosis (B) Meiosis
(C) Binary fission (D) Budding

6. Prokaryotic cells undergo a process similar to mitosis called: (U.B)

- (A) Binary fission (B) Multiple fission
(C) Regeneration (D) Meiosis

7. The division of cytoplasm: (K.B)

(LHR 2015, GRW 2012)

- (A) Karyokinesis (B) Cytokinesis
(C) Prophase (D) Metaphase

8. The division of nucleus is called: (K.B)

(SGD 2014)

- (A) Karyokinesis (B) Cytokinesis
(C) Prophase (D) Metaphase

9. The division of cytoplasm is called:

- (A) Cytokinesis (B) Karyokinesis
(C) Cytosol (D) Cytosis

10. Mitosis consists of phases: (K.B)

(LHR 2014)

- (A) One (B) Two
(C) Three (D) Four

11. The genetic material in nucleus is in a loose thread like form called:

- (A) Chromosomes (B) Chromatin
(C) Chromatids (D) Centromere

12. **Chromatin is condensed at the onset of:**
 (A) Metaphase (B) Prophase
 (C) Anaphase (D) Telophase
13. **A complex protein which is present in centromere is called:**
 (A) Centrosome (B) Centriole
 (C) Kinetochore (D) Chromatin
14. **A small round body near the nucleus in the cytoplasm is called:**
 (A) Centriole (B) Centrosome
 (C) Centromere (D) Both B and C
15. **During mitosis one cell divides into daughter cells: (K.B) (FSD 2014)**
 (A) 2 (B) 3
 (C) 4 (D) 5
16. **Which of the following is the longest phase of karyokinesis? (U.B)**
 (A) Prophase (B) Metaphase
 (C) Anaphase (D) Telophase
17. **Complete set of spindle fibres is known as: (K.B) (RWL 2015)**
 (A) Chromatin (B) Kinetochore
 (C) Mitotic spindle (D) Cleavage
18. **Spindle fibers are formed during: (U.B) (LHR 2013, 2015)**
 (A) Prophase (B) Metaphase
 (C) Anaphase (D) Telophase
19. **Spindle fibers are made by special protein is called:**
 (A) Keratin (B) Tubulin
 (C) Actin (D) Myosin
20. **The chromosomes arrange themselves along the equator of the cell in phase: (K.B) (MTN 2015, SWL 2015)**
 (A) Prophase (B) Metaphase
 (C) Anaphase (D) Telophase
21. **Which phase is a reversal of prophase? (U.B)**
 (A) Interphase (B) Metaphase
 (C) Anaphase (D) Telophase
22. **In animal cells, cytokinesis occurs by a process known as: (K.B)**
 (A) Regeneration (B) Cleavage
 (C) Binary fission (D) Phragmoplast
23. **New red blood cells are formed by: (U.B)**
 (A) Mitosis (B) Meiosis
 (C) Multiple fission (D) Binary fission
24. **Which animal shows regeneration? (K.B) (DGK 2015)**
 (A) Amoeba (B) Paramecium
 (C) Sea star (D) Hydra
25. **Budding takes place in: (K.B)**
 (A) Volvox (B) Euglena
 (C) Sea star (D) Hydra
25. **Asexual reproduction in hydra takes place by: (K.B) (RWL 2015)**
 (A) Mitosis (B) Budding
 (C) Cutting (D) Spore

27. Tumors are produced as a result of errors in: (A.B) (LHR 2013)
 (A) Meiosis (B) Mitosis
 (C) Binary fission (D) Multiple fission
28. Errors in the control of mitosis may cause: (A.B) (TGG 2015)
 (A) Cancer (B) Ulcer
 (C) Constipation (D) Cough
29. The tumors which remain at their production site are called: (A.B) (GRW 2015)
 (A) Benign (B) Malignant
 (C) Metastatic (D) Cancerous
30. The phenomenon of spreading cancer: (K.B)
 (A) Infection (B) Regeneration
 (C) Metastasis (D) Inflammation

5.3 MEIOSIS

LONG QUESTIONS

Q.1 Define meiosis and describe its different phases. (K.B) (Ex Q. No 6) (FSD 2014)

Ans:

MEIOSIS

Definition:

“The process by which one **diploid (2n) eukaryotic cell** divides to generate four **haploid (1n) daughter cells** is called meiosis.”

Meaning:

The word **meiosis** comes from **Greek word ‘Meioun’** meaning “to make smaller” since it results in a reduction in chromosome number.

Discovery:

Meiosis was discovered and described for the first time in **1876**, by a **German biologist Oscar Hertwig**.

Phases of Meiosis:

Interphase:

The **preparatory** steps of meiosis are identical to the interphase of mitosis. It is divided into the **same three** phases i.e. **G1, S, and G2**. Interphase is followed by **Meiosis I** and **Meiosis II**.

Meiosis I:

In meiosis I, the homologous **chromosomes** in a diploid cell separate and **two haploid daughter** cells are produced. It is the **step in meiosis that generates** genetic variations.

Steps:

Meiosis I occurs in **two main steps**:

- Karyokinesis
- Cytokinesis

Karyokinesis:

It is divided into:

- i. Prophase I
- ii. Metaphase I
- iii. Anaphase I
- iv. Telophase I

i. Prophase I

It is the **longest phase in meiosis**.

Condensation of Chromosomes:

During this stage, chromatin condenses into **chromosomes**.

Synapsis:

The **homologous chromosomes** line up with each other and form pairs by a **process called synapsis**.

Bivalent:

Each pair of homologous chromosomes is called bivalent.

Tetrad:

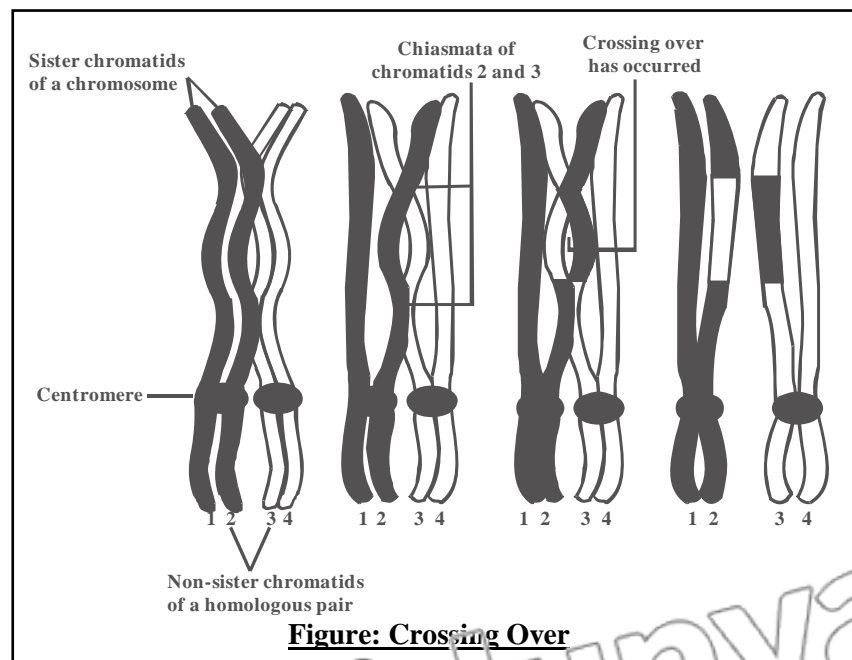
Each bivalent has four chromatids, so it is also called as tetrad.

Chiasmata Formation:

The **two non-sister** chromatids of homologous chromosomes join each other at certain **points along their length**. These points of attachment are called chiasmata.

Crossing Over:

The **non-sister** chromatids of **homologous chromosomes exchange their segments**. This phenomenon is known as crossing over.

**Significance of Crossing Over:**

The **exchange** of segments results in the **recombination of genetic information**. After crossing over each pair of **homologous chromosomes** remains as a bivalent.

Nuclear Changes:

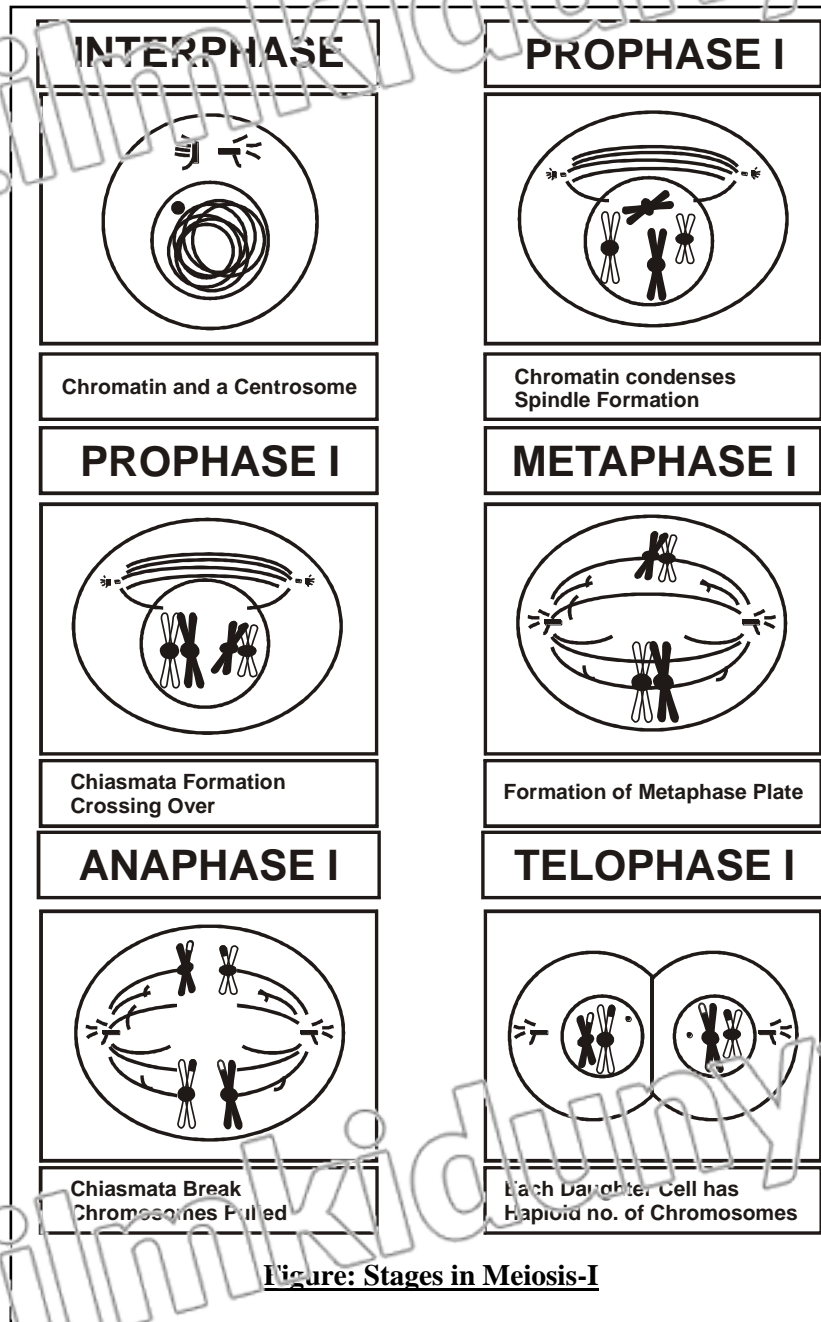
Chromosomes condense further, the **nucleoli disappear**, and the **nuclear envelope disintegrates**.

Spindle Fibres Formation:

Centrioles, which were **duplicated** during interphase, migrate to the **two poles** and give rise to **spindle fibres**.

Attachment of Kinetochore Fibres:

The kinetochore spindle fibres attach with the kinetochore of chromosomes. While the non-kinetochore spindle fibres from both sides interact with each other. **Two kinetochore spindle fibres (from the opposite poles) attach to a pair of chromosomes.** In **mitosis, two** kinetochore spindle fibres attach with **one chromosome**



ii. Metaphase I:**Formation of Metaphase Plate:**

The pairs of homologous chromosomes align along the equatorial plane forming the metaphase plate.

iii. Anaphase I:**Separation of Diploid Chromosome:**

Kinetochores and spindle fibres shorten. It results in pulling apart the chromosomes of each pair. Since one chromosome is pulled toward one pole, two haploid sets are formed. Each chromosome still contains a pair of sister chromatids.

iv. Telophase I:

Chromosomes arrive at the poles. Each pole now has half the number of chromosomes, but each chromosome still consists of two chromatids. Spindle network disappears and nuclear envelope is formed around each set. Chromosomes uncoil back into chromatin.

Cytokinesis:

Cytokinesis, (the pinching of cell membrane in animal cells or the formation of cell wall in plant cells) occurs and the creation of two haploid daughter cells is completed.

Interkinesis or Interphase II:

After meiosis I, both haploid daughter cells enter a period of rest, known as interkinesis or interphase II.

Difference from Interphase of Mitosis:

The interphase II is different from interphase of mitosis and meiosis I. There is no S Phase and so there is no duplication of chromosomes during this stage.

It is the second part of meiosis, and is similar to mitosis.

MEIOSIS II**Phases of Meiosis II:**

It is divided into:

- Prophase II
- Metaphase II
- Anaphase II
- Telophase II

Prophase II:

It takes much less time compared to Prophase I. In this prophase, nucleoli and nuclear envelope disappear and chromatin condenses. Centrioles move to the polar regions and make spindle fibres.

Metaphase II:

Chromosomes attach with kinetochores and spindle fibres and align at the equator of the cell.

Anaphase II:

Centromeres are cleaved and sister chromatids are pulled apart. The sister chromatids are now called 'sister chromosomes' and they are pulled towards opposing poles.

Telophase II:

It is marked with uncoiling of chromosomes into chromatin. Nuclear envelopes reform.

Cytokinesis:

Cleavage or cell wall formation eventually produces a total of 4 daughter cells, each with a haploid set of chromosomes.

Q.2 Describe significance of meiosis. (Application Based) (Ex Q. No 7)

(LHR 2014, GRW 2014, SWL 2014, 2015, BWP 2015, SGD 2014)

Ans:

SIGNIFICANCE OF MEIOSIS

Role of August Weismann:

The significance of meiosis for reproduction and inheritance was described in 1890 by a German biologist August Weismann. He pointed out that:

“Meiosis was necessary not only to maintain the number of chromosomes in the next generation, but also to produce variations in the next generation.”

Maintenance of Chromosome Number:

Meiosis is essential for sexual reproduction.

In Humans:

In humans, diploid gamete mother cells or germ line cells undergo meiosis to produce haploid gametes. Male and female gametes unite to form a diploid zygote, which undergoes repeated mitosis and develops into a new human.

In Fungi and Protozoans:

Many haploid fungi and protozoans produce haploid gametes through mitosis.

In Plants:

Plants' life cycle shows alternation of generations.

- The cells of diploid sporophyte generation undergo meiosis to produce haploid spores.
- The spores grow into haploid gametophyte generation.
- Gametophyte generation produces haploid gametes through mitosis.
- The gametes combine to produce diploid zygote. Zygote undergoes repeated mitosis to become a diploid sporophyte.

Production of Variations in Next Generations:

The chromosome pairs of each parent undergo crossing over during meiosis. So daughter cells, i.e. gametes, have genetic variations. When gametes fuse to form a zygote, its genetic makeup is different from both the parents. Thus, meiosis allows a species to bring variations in the next generations.

Adaptation:

Beneficial variations help organisms to adapt better to the changes in the environment.

Q.3 Describe errors in meiosis. (Application Based) (Ex Q. No 7)

Ans:

ERRORS IN MEIOSIS

Disjunction:

During anaphase I, chromosomes separate and go to opposite poles, while during anaphase II, sister chromosomes separate. This is called disjunction.

Non-disjunction:

Sometimes the separation of chromosomes or is not normal and it is called as non-disjunction.



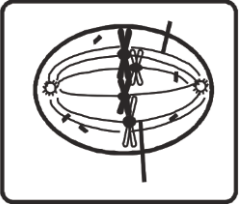
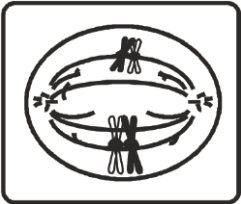
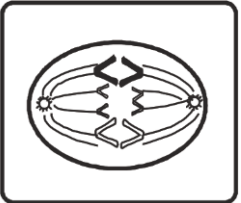



Consequences of Non-disjunction:

Non-disjunction results in the production of gametes which have either more or less than the normal number of chromosomes. If such an abnormal gamete fuses with a normal gamete, it results in an abnormal number of chromosomes in the next generation, for example 45 or 47 chromosomes in humans.

Q.4 Give a comparison between mitosis and meiosis. (K.B) (BWP 2014, DGK 2015, SGD 2015)

Ans: COMPARISON BETWEEN MITOSIS AND MEIOSIS

A comparison between mitosis and meiosis is as follows:

Mitosis	Meiosis
 <p style="text-align: center;">PROPHASE</p> <ul style="list-style-type: none"> • Homologous chromosomes do not form pairs. There is no crossing over. 	 <p style="text-align: center;">PROPHASE I</p> <ul style="list-style-type: none"> • In prophase I, there is pairing of chromosomes and crossing over between homologous chromosomes.
 <p style="text-align: center;">METAPHASE</p> <ul style="list-style-type: none"> • Single chromosomes align to form metaphase plate. 	 <p style="text-align: center;">METAPHASE I</p> <ul style="list-style-type: none"> • Homologous pairs align to form metaphase plate.
 <p style="text-align: center;">ANAPHASE</p> <ul style="list-style-type: none"> • Chromosomes break and individual chromatids are pulled towards poles. 	 <p style="text-align: center;">ANAPHASE I</p> <ul style="list-style-type: none"> • Individual chromosomes are pulled towards poles.
 <p style="text-align: center;">DAUGHTER CELLS</p> <ul style="list-style-type: none"> • Daughter nuclei contain diploid number of chromosomes. • Each chromosome has single chromatid. 	 <p style="text-align: center;">DAUGHTER CELLS</p> <ul style="list-style-type: none"> • Daughter nuclei contain haploid number of chromosomes. • Each chromosome has two chromatids.

SHORT QUESTIONS (Topic 5.3)

Q.1 Who had discovered meiosis? (K.B)

Ans: Oscar Hertwig:

Meiosis was discovered by German biologist Oscar Hertwig in 1876.

Q.2 Define meiosis. (K.B)

(LHR 2013)

Ans: Page no 161.

Q.3 What is the difference between diploid and haploid cells? (K.B) (GRW 2012, SGD 2014)

Ans: DIFFERENTIATION BETWEEN DIPLOID AND HAPLOID CELLS

Diploid Cells	Haploid Cells
Definition	
The cells in which chromosomes are in pairs (homologous pairs) are called diploid cells.	The cells with half the number of chromosomes i.e. chromosomes are not in the form of pairs are called haploid cells.
Example	
• Somatic cells	• Gametes

Q.4 Define synapsis. (K.B)

(FSD 2014)

Ans: Page no 162.

Q.5 What is chiasmata? Chiasmata: (K.B)

Ans:

Q.6 Differentiate between bivalent and tetrads. (K.B)

Ans:

Bivalent	Tetrads
Homologous chromosomes line up with each other and form pairs called bivalent.	Each bivalent has four chromatids so it may be called tetrads.

Q.7 What is the difference between meiosis I and meiosis II? (K.B)

Ans: DIFFERENTIATION

The difference between meiosis i and meiosis ii is as follows

Meiosis i	Meiosis ii
Separation	
In Meiosis I, the homologous chromosomes in a diploid cell separate and so two haploid daughter cells are produced.	In meiosis II, two haploid cells separate and so four haploid daughter cells are produced. It is the second part of meiosis and is similar to mitosis.
Genetic Variation	
It is the step in meiosis that generates genetic variations.	It is the step in meiosis where no genetic variation takes place.
Time	
Prophase I takes more time.	Prophase II takes less time.

Q.8 Describe process of crossing over in meiosis? (K.B)

(LHR 2013, SWL 2014, MTN 2014, DGK 2015, BWP 2015, SGD 2015, RWP 2015)

Ans: Page no 162.

Q.9 What is the contribution of Thomas Hunt Morgan? (A.B)

Ans: Page no 162.

Q.10 What is interkinesis? (U.B)

Ans: Page no 164.

Q.11 What is the importance of meiosis according to August Weismann? (K.B)



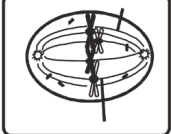

Ans: Page no 165.

Q.12 What kind of error can occur during meiosis? (A.B) (CRW 2014, FSD 2014)

Ans: Page no 165.

Q.13 State any two major differences between mitosis and meiosis. (K.B)

Ans:

MITOSIS	MEIOSIS
 <p>PROPHASE</p> <ul style="list-style-type: none"> Homologous chromosomes do not form pairs. There is no crossing over. 	 <p>PROPHASE I</p> <ul style="list-style-type: none"> In prophase I, there is pairing of chromosomes and crossing over between homologous chromosomes.
 <p>METAPHASE</p> <ul style="list-style-type: none"> Single chromosomes align to form metaphase plate. 	 <p>METAPHASE I</p> <ul style="list-style-type: none"> Homologous pairs align to form metaphase plate.

MULTIPLE CHOICE QUESTIONS (Topic 5.3)

- The word meiosis comes from which language? (K.B)
 - Latin
 - Italian
 - Greek
 - French
- Who discovered meiosis? (K.B)
 - Walter Flemming
 - Oscar Hertwig
 - August Weismann
 - T. H. Morgan
- Meiosis takes place in: (K.B)
 - Eukaryotic cells
 - Prokaryotic cells
 - Haploid cells
 - Cyanobacteria
- Those cell which give rise to gametes are called: (U.B) (LHR 2014)
 - Somatic cells
 - Spindle Fibers
 - Germ line cells
 - Neurons
- Meiosis was discovered in: (K.B)
 - 1875
 - 1876
 - 1877
 - 1878
- In meiosis, one diploid cell divides into how many haploid cells? (K.B)
 - 2
 - 4
 - 6
 - 8
- Diploid means the cells in which chromosomes are in: (K.B)
 - Pairs
 - Recombination state
 - Crossing over
 - All of these

8. **The longest phase in meiosis is: (U.B)** (SGD 2014, BWL 2014)
(A) Prophase I (B) Metaphase I
(C) Anaphase I (D) Telophase I
9. **In which phase chromosomes form a metaphase plate? (K.B)**
(A) Prophase (B) Metaphase
(C) Anaphase (D) Telophase
10. **Genetic variations take place during: (K.B)**
(A) Prophase I (B) Prophase II
(C) Anaphase I (D) Telophase II
11. **In which phase of meiosis1 the pairs of homologous chromosomes align along equatorial plane forming the metaphase plate? (U.B)**
(A) Prophase I (B) Metaphase I
(C) Anaphase I (D) Telophase I
12. **The process in which homologous chromosomes line up with each other and form pairs: (K.B)**
(A) Tetrad (B) Crossing over
(C) Chiasmata (D) Synapsis
13. **Who discovered crossing over? (K.B)**
(A) Walter Flemming (B) Oscar Hertwig
(C) August Weismann (D) T. H. Morgan
14. **The phase in which crossing over occurs: (K.B)** (FSD 2015)
(A) Anaphase (B) Metaphase
(C) Prophase II (D) Prophase I
15. **The two non-sister chromatids of homologous chromosomes join each other at: (U.B)**
(A) Centromere (B) Kinetochore
(C) Chiasmata (D) Sister chromatids
16. **After crossing over, each pair of homologous chromosomes remain as: (U.B)**
(A) Tetrad (B) bivalent
(C) Condensed (D) All of these
17. **Thomas Hunt Morgan observed crossing over in *Drosophila melanogaster* in: (K.B)** (MTN 2015)
(A) 1905 (B) 1907
(C) 1909 (D) 1911
18. **August Weismann described the significance of meiosis in: (U.B)**
(A) 1890 (B) 1891
(C) 1892 (D) 1893
19. **Many haploid fungi and protozoans produce haploid gametes through: (U.B)**
(A) Mitosis (B) Meiosis
(C) Regeneration (D) Budding
20. **The diploid sporophyte generation produces haploid spores through: (U.B)**
(A) Mitosis (B) Meiosis
(C) Budding (D) Fragmentation
21. **Gametophyte generation produces haploid gametes through: (U.B)**
(A) Mitosis (B) Meiosis
(C) Grafting (D) Fragmentation

22. The abnormal separation of homologous chromosomes during anaphase I of meiosis I: (A.B)
 (A) Disjunction (B) Non-disjunction
 (C) Synapsis (D) Crossing over
23. The abnormal number of chromosomes in humans: (K.E)
 (A) 45 or 43 (E) 47 or 45
 (C) 46 (D) 23 Homologous pairs

54 APOPTOSIS AND NECROSIS

LONG QUESTIONS

Q.1 Write a note on apoptosis. (A.B)

(GRW 2012, 2013, LHR 2014, 2016, SWL 2014, RWP 2015) (Ex Q. No 9)

Ans:

APOPTOSIS

Definition:

“The **type of cell death** which is **well-programmed** and **regulated** is called apoptosis.”

Rate of Apoptosis:

In an adult human, **50 to 70 billion cells die** by apoptosis each day.

Mechanism:

Break Down of Cytoskeleton:

During Apoptosis, **cell shrinks** and **becomes rounded** due to the **breakdown of cytoskeleton by enzymes**.

Degradation of Nucleus:

Chromatin undergoes condensation and **nuclear envelope breaks**. In this way, nucleus spreads in the form of several discrete chromatin bodies.

Blebs:

Cell membrane makes **irregular buds** called blebs.

Apoptotic Bodies:

Blebs break off from the cell and are now called apoptotic bodies.

Phagocytosis:

These **apoptotic bodies** are then **phagocytosed by other cells**.

Significance of Apoptosis:

Apoptosis is **important** in the following ways:

Cellular Damage and Stress Conditions:

Apoptosis can **occur when a cell is damaged** or **undergo stress conditions**. Apoptosis **removes the damaged cell**, preventing it from getting further nutrients.

Infection:

Apoptosis prevents the **spread of infection**.

Developmental Stages:

Apoptosis **gives advantages** during **development**. For example, during the formation of fingers, the cells between them undergo apoptosis and the digits separate.

Q.2 Write a note on necrosis. (A.B)

(LHR 2012, SWL 2015) (Ex Q. No 9)

Ans:

NECROSIS

Definition:

“The accidental death of cells and living tissues is called necrosis.”

Difference from Apoptosis:

Necrosis is less sequential than apoptosis.

Causes of Necrosis:

There are many causes of necrosis, including:

- Injury
- Infection
- Cancer
- Hypoxic environment
- Lack of proper care to a wound site
- Spider bites

Mechanism:

The mechanism of necrosis is as follows:

Release of Lysosomal Enzymes:

During necrosis, there is a release of special enzymes from lysosomes.

Lysis of Cellular Components:

Lysosomal enzymes break cellular components and may also be released outside the cell to break the surrounding cell.

Damage to Surrounding Tissues:

The cells that die by necrosis may also release harmful chemicals that damage other cells.

SHORT QUESTIONS (Topic 5.4)

Q.1 Define apoptosis and describe its advantages. (A.B)

(LHR 2015, RWP 2015)

Ans: Page no 170.

Q.2 Define blebs. What is another name of these? (K.B)

(LHR 2015)

Ans: Page no 170.

Q.3 Define necrosis and describe its causes. (A.B)

Ans: Page no 171.

MULTIPLE CHOICE QUESTIONS (Topic 5.4)

1. The programmed cell death: (A.B)

- | | |
|-----------------|----------------|
| (A) Necrosis | (B) Apoptosis |
| (C) Endocytosis | (D) Exocytosis |

2. In an adult human, the number of cells that die each day by apoptosis: (K.B)

- | | |
|---------------------|---------------------|
| (A) 30 - 50 billion | (B) 40 - 60 billion |
| (C) 50 - 70 billion | (D) 60 - 80 billion |

3. **Blebs break off from the cell and are called: (K.B)**
 (A) Apoptotic bodies (B) Lysosomes
 (C) Phagocytes (D) Food vacuoles
4. **The accidental cell death: (A.B)** (B.F.W 2015)
 (A) Phagocytosis (B) Apoptosis
 (C) Both A & B (D) Necrosis

ANSWER KEYS**MULTIPLE CHOICE QUESTIONS****5.1 CELL CYCLE**

1	A	5	A	9	D	13	C	17	B	21	D
2	D	6	B	10	B	14	D	18	C		
3	D	7	B	11	B	15	A	19	D		
4	B	8	B	12	C	16	D	20	D		

5.2 MITOSIS

1	C	6	A	11	B	16	A	21	D	26	B
2	A	7	B	12	B	17	C	22	B	27	B
3	A	8	A	13	C	18	A	23	A	28	A
4	B	9	B	14	D	19	B	24	C	29	A
5	B	10	A	15	A	20	B	25	D	30	C

5.3 MEIOSIS

1	C	6	B	11	B	16	B	21	A
2	B	7	A	12	D	17	D	22	B
3	A	8	A	13	D	18	A	23	B
4	C	9	B	14	D	19	A		
5	B	10	A	15	C	20	B		

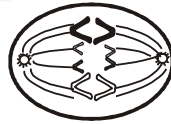
5.4 APOPTOSIS AND NECROSIS

1	B	3	A
2	C	4	D

REVIEW QUESTIONS

MULTIPLE CHOICE QUESTIONS

- In which stage of the cell cycle each chromosome is duplicated and so it consists of two chromatids? (K.B)
 - G1
 - S
 - M
 - G₂
- If you observe a cell like this one, what phase of mitosis is it? (U.B)



- Anaphase
 - Telophase
 - Metaphase
 - Prophase
- During which phase of mitosis are spindle fibers formed? (K.B)
 - G₂
 - Interphase
 - Prophase
 - Metaphase
 - In which stage of cell cycle, the cell is preparing enzymes for chromosome duplication? (K.B)
 - G1
 - G₂
 - S
 - M
 - Which of the following stage of cell division is very different for animal and plant cells? (U.B)
 - Metaphase
 - Anaphase
 - Telophase
 - Cytokinesis
 - Prior to cell division, each chromosome replicates or duplicates its genetic material. The products are connected by centromere and are called: (K.B)
 - Sister chromosomes
 - Homologous chromosomes
 - Non-sister chromatids
 - Sister chromatids
 - The process of mitosis ensures that: (U.B)
 - Each new cell is genetically different from its parent
 - Each new cell receives the proper number of chromosomes
 - Cells will divide at the appropriate time
 - Chromosomes duplicate without errors
 - Cytokinesis in a plant cell is characterized by: (K.B)
 - The equal division of homologous chromosomes
 - A pinching off of the cell membrane to divide the cell
 - The formation of a cell plate in the cytoplasm
 - The movement of chromosomes from the metaphase plate
 - Which of the following is unique to mitosis and not a part of meiosis I? (K.B)
 - Homologous chromosomes pair forming bivalents
 - Homologous chromosomes cross-over
 - Chromosome pairs are broken during anaphase
 - Chromatids separate during anaphase
 - Which event distinguishes meiosis from mitosis? (U.B)
 - Condensation of chromosomes
 - Loss of nuclear membrane
 - Formation of metaphase plate
 - Pairing of homologous chromosomes

11. In which stage of the cell cycle most cells spend their lives? (U.B)
 (a) Prophase (b) Metaphase
 (c) Interphase (d) Telophase
12. Which of the following distinguishes meiosis from mitosis? (U.B)
 (a) The chromosome number is reduced
 (b) Chromosomes undergo crossing over
 (c) The daughter cells are genetically different from the parent cell
 (d) All of the above
13. For mitosis, the chromosome of cell duplicates during interphase. When do the chromosomes duplicate for meiosis? (U.B)
 (a) Before meiosis I (b) Before meiosis II
 (c) During meiosis I (d) Do not duplicate
14. Find the correct statement: (U.B)
 (a) Homologous chromosomes form pairs during mitosis
 (b) Chromosomes do not duplicate in the interphase preceding meiosis I
 (c) Homologous chromosomes form pairs during meiosis but not mitosis
 (d) Spindles are not required during meiosis
15. What reason would you suggest for the fact that the total DNA content of each daughter cell is reduced during meiosis? (U.B)
 (a) Chromosomes do not duplicate during the interphase before meiosis I
 (b) Chromosomes do not duplicate between meiosis I and II
 (c) Half of the chromosomes from each gamete are broken
 (d) Sister chromatids separate during anaphase of meiosis I

ANSWER KEY

1	b	2	a	3	c	4	a	5	d
6	d	7	b	8	c	9	d	10	d
11	c	12	d	13	a	14	c	15	b

UNDERSTANDING THE CONCEPTS

1. What is cell-cycle and what are its main phases? (K.B)

Ans: See the LQ.1 of (Topic 5.1)

2. The S-phase of interphase is important and a cell can never divide without it. Justify. (U.B)

Ans: IMPORTANCE OF S PHASE

S Phase is called as the synthesis phase

In this phase:

Events of S Phase:

- Cell duplicates its chromosomes.
- As a result, each chromosome consists of two sister chromatids.

Importance of S Phase:

- This step is characterized by DNA Replication.
- This phase is important because correct duplication is essential for cell division.
- It enables daughter cells to receive the same number of chromosomes as the parent cell. Each daughter cell will have 2n number of chromosomes, which is same as the parent cell.
- If S phase does not occur, chromosomes and thus DNA, would not duplicate, and the cell would not enter M phase as chromosomes will not consist of sister-chromatids.

3. How would you state the events of prophase of mitosis? (K.B)

Ans: See the LQ.1 of (Topic 5.2)

4. Make a list of the events of mitosis. (K.B)

Ans: See the SQ.5 of (Topic 5.2)

5. How is mitosis significant? (A.B)

Ans: See the LQ.2 of (Topic 5.2)

6. Describe the events that occur during the phases of meiosis I? (K.B)

Ans: See the LQ.1 of (Topic 5.3)

7. Describe the significance of meiosis. (A.B)

Ans: See the LQ.2 of (Topic 5.3)

8. Contrast mitosis and meiosis, emphasizing the events that lead to different outcomes. (K.B)

Ans: COMPARISON BETWEEN MITOSIS AND MEIOSIS

Feature	Mitosis	Meiosis
Definition	The type of cell division in which a cell divides into two daughter cells, each with the same number of chromosomes as were present in the parent cell.	The type of cell division in which one diploid (2n) eukaryotic cell divides to generate four haploid (1n) daughter cells, i.e. with half the number of chromosomes.
Type of cells	It occurs in somatic cells (cells that make up the body)	It occurs in germ cells (gamete producing cells)
Number of divisions	One	Two
Bivalent/tetrad formation	No	Yes

Number of daughter cells	Two	Four
Pairing of homologous chromosomes	No	Yes
Centromere Splitting	During Anaphase	During Anaphase II, and not during I
Crossing over	No	Yes
Variations	Identical genotype as parent cell	Different genotype from parent cell (variations are produced)

9. Describe necrosis and apoptosis. (A.B)

Ans: See the LQ.1 and 2 of (Topic 5.4)

SHORT QUESTIONS

1. A nerve cell does not divide after its formation. In which phase of cell-cycle is it? (U.B)

Ans: Page no 196.

2. How is cytokinesis different in plant cell as compared to an animal cell? (U.B)

Ans:

DIFFERENTIATION

Cytokinesis of plant cell is different from animal cell in the following ways:

FEATURE	PLANT CELL CYTOKINESIS	ANIMAL CELL CYTOKINESIS
Contributing component	Vesicles from Golgi apparatus	Cell membrane
Dividing structure	Phragmoplast	Cleavage Furrow
Location	At metaphase plate region	In the middle of the cell
Direction	Outward growth of cell-plate	Inward pinching of cell membrane
Involvement of cell wall	Yes	No
Summary of Process	The vesicles fuse to form a cell-plate called 'Phragmoplast' which grows outward and joins the parental cell membrane and cell wall to divide the cell.	The cleavage furrow forms where metaphase plate used to be, and deepens from both sides to pinch and divide the cell.

3. What type of cell division occurs when our wounds are healed? (A.B)

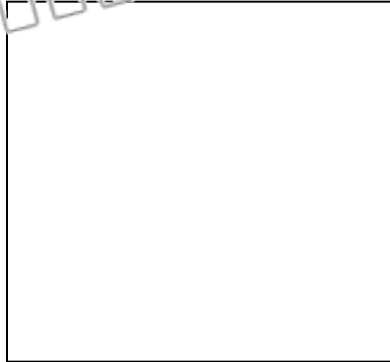
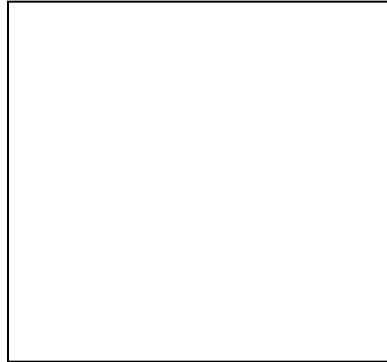
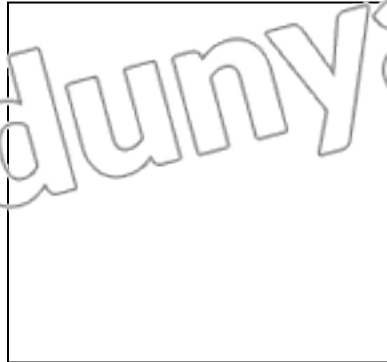
Ans: Page no 196.

4. Plants do not make their gametes by meiosis. How is that? (U.B)

Ans: Page no 197.

KIPS ASSIGNMENT**LET'S DRAW AND LABEL****(A) Phases of Mitosis****Instructions:**

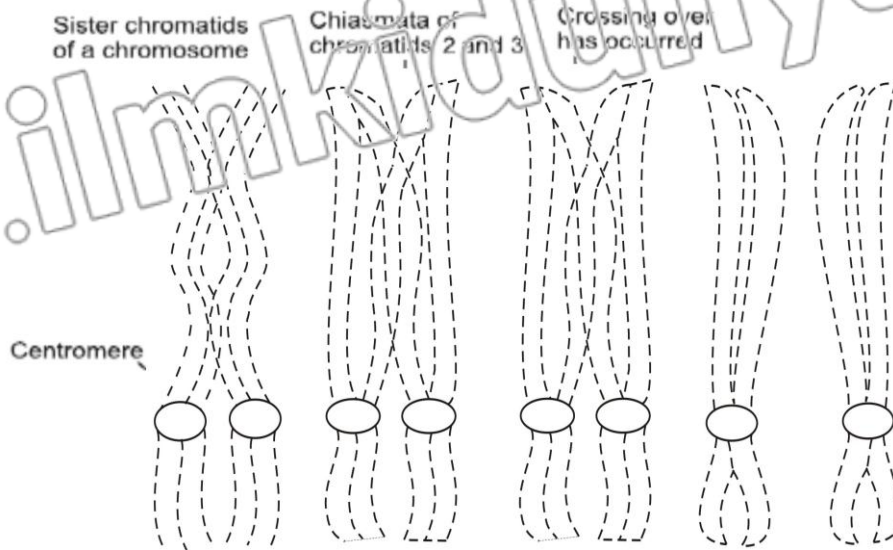
- Draw the cells showing different phases of mitosis.

Interphase**Prophase****Metaphase****Anaphase****Telophase****Cytokinesis**

(B) Crossing over during prophase (I)

Instructions:

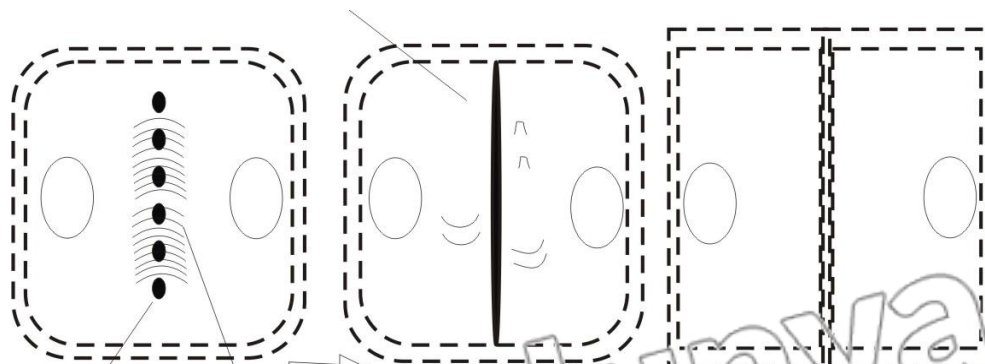
- Trace the patterns of chromosomes as given in diagram



(C) Cytokinesis in Plants

Instructions:

- Trace the patterns and marks the labels



**SELF TEST**

Time: 40 min

Marks: 25

Q.1 Four possible answers A, B, C and D to each question are given, mark the correct answer. (6×1=6)

1. The major phases of cell cycle are: (K.B)
(A) 1 (B) 2
(C) 3 (D) 4
2. Which one of the following is the premitotic phase? (U.B)
(A) G 0 (B) G 1
(C) G 2 (D) S
3. The phase of mitosis in which sister chromatids separate: (K.B)
(A) Prophase (B) Metaphase
(C) Anaphase (D) Telophase
4. Which phase is a reversal of prophase? (U.B)
(A) Interphase (B) Metaphase
(C) Anaphase (D) Telophase
5. Uncontrolled mitosis may cause: (U.B)
(A) Cancer (B) Ulcer
(C) Constipation (D) Cough
6. Which one is not the function of mitosis? (A.B)
(A) Asexual reproduction (B) Budding
(C) Gametes formation in animals (D) Regeneration

Q.2 Give short answers to following questions. (5×2=10)

- (i) Define mitosis. (K.B)
- (ii) Enlist the important changes that occur in G2 phase. (K.B)
- (iii) What is non-disjunction? (U.B)
- (iv) What is necrosis? (K.B)
- (v) Explain anaphase I of meiosis I. (I.P)

Q.3 Answer the following questions in detail. (5+4=9)

- (a) Describe the events of karyokinesis in mitosis in detail. (K.B) (5)
- (b) Write a note on apoptosis. (K.B) (4)

Note:

Parents or guardians can conduct this test in their supervision in order to check the skill of students.