UNDERSTANDING THE CONCEPTS

Q#1 What is cell cycle and what are its main phases?

Ans: Cell Cycle:

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

Main phases of cell cycle:

The cell cycle consists of two major phases

i. interphase

ii. mitotic phase (M phase)

The mitotic phase is a relatively short period of the cell cycle. It alternates with the much longer interphase, where the cell prepares itself for division. Interphase is the time when a cell's metabolic activity is very high, as it performs its various functions.

Phases of inter phase:

It is divided into three phases.

1. G1 (first gap), 2. S (synthesis), 3. G2 (second gap).

G1 phase:

After its production, a cell starts its cell cycle in G1 phase. During this phase, the cell increases its supply of proteins, increases the number of many of its organelles (such as mitochondria, ribosomes), and grows in size. This phase is also marked by the synthesis of various enzymes that are required in the next phase i.e. S phase for DNA replication.

Cells that have temporarily or permanently stopped dividing are said to have entered a state of quiescence called GO phase.

S phase:

In this phase the cell duplicates its chromosomes. The DNA molecule of each chromosome is copied, and new protein molecules are attached. The result is that each chromosome consists of two sister chromatids, which contain identical genes.

G2 phase:

In the G2 phase the cell prepares proteins that are essential for mitosis mainly for the production of spindle fibres. After the G2 phase of interphase, the cell enters the division phase Ie. M phase. It is characterized by mitosis, in which the cell divides into the two daughter cells.

G0 phase:

In multicellular eukaryotes, cells enter the G0 state from G1 and may remain quiescent for long periods of time, possibly indefinitely (as is often the case for neurons). Some cell types in mature organisms, such as some cells of the liver and kidney, enter the G0 phase semi-permanently and can only be induced to begin dividing again under very specific circumstances. Other cells, such as epithelial cells, do not enter G0 and continue to divide throughout an organism's life.

Q#2 The S-phase of interphase is important and a cell can never divide without it Justify?

Ans: S-phase of interphase:

Mitosis is the type of cell division in which a cell divides into two daughter cells, each with the genetic equivalent of the parent cell i.e. same number of chromosomes as were present in the parent cell. Because each resultant daughter cell should be genetically identical to the parent cell, the parent cell

must make a copy of each chromosome before mitosis. This occurs during S phase of interphase.

Q#3 How would you state the events of prophase?

Ans: Events of Prophase:

Chromatin: Normally, the genetic material in the nucleus is in a loose thread-like form called chromatin.

Chromosomes:

At the one of prophase, chromatin condenses into highly ordered structures called chromosomes. Since the genetic material has already been duplicated earlier in S phase, each chromosome is made of two sister chromatids, bound together at the centromere. Each chromosome has kinetochore at the centromere. A kinetochore is a complex protein structure that is the point where spindle fibers attach.

Centrosome:

Close to the nucleus are two centrioles collectively called a centrosome. Each centriole replicates and thus two daughter centrosomes are formed. Each daughter centrosome acts as a coordinating center for the cell's microtubules.

Mitotic Spindle:

The two centrosomes give rise to microtubules by polymerizing (joining monomers to form polymers) the tubulin proteins present in the cytoplasm. The microtubules thus formed are called spindle fibers, and the complete set of the spindle fibers is known as **mitotic spindle**. During the formation of mitotic spindle, the centrosomes migrate to opposite side of the nucleus. The nucleolus and the nuclear envelope have degraded, and spindle fibers have invaded the central space.

Aggregation of Tubulin Proteins:

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

Q.4 Make a list of the events of mitosis.

Ans: Events of Mitosis:

The process of mitosis is complex and highly regulated. The sequence of events is divided into major phases.

1. Karyokinesis:

The division of the nucleus known as karyokinesis.

2. Cytokinesis:

The division of the cytoplasm known as cytokinesis.

Events of Karyokinesis:

The division of the nucleus is further divided into four phases.

i. prophase, **ii.** metaphase, **iii.** anaphase **iv.** telophase.

Q#5 How is mitosis significant?

Ans: Significance of mitosis:

1. Maintenance of the chromosomal set:

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

2. Development and Growth:

The number of cells within an organism increases by mitosis and this is the basis of development from a single cell zygote to the multicellular body and the growth 3. Cell Replacement: Cells are constantly sloughed off, dying and being replaced by new ones in the skin and digestive tract. When damaged tissues are repaired, the new cells must be exact copies of the cells being replaced so as to retain normal function of cells. Similarly, red blood cells have short life spans of about 4 months and need to be replaced constantly by mitosis.

4. Regeneration:

Some organisms can regenerate parts of the body, and production of new cells is achieved by mitosis. For example, sea star regenerates its lost arm through mitosis.

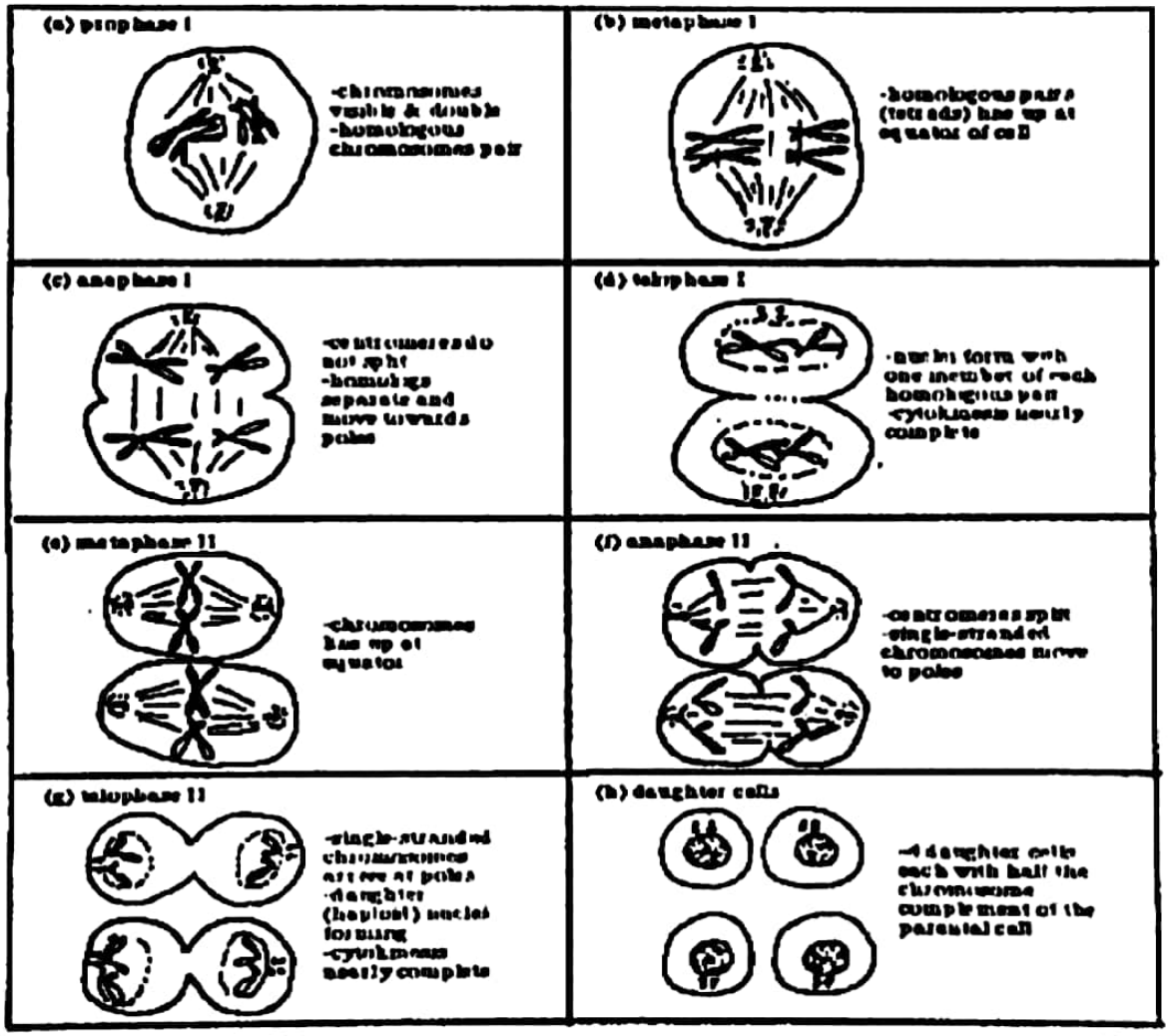
5. Asexual reproduction:

Some organisms produce genetically similar offspring Mitosis is a means for asexual reproduction. For example, hydra reproduces asexually by budding. During this process mitosis forms a mass of cells called bud on the surface of hydra. The mitosis continues in the cells of the bud and it grows into a new individual. The same happens during asexual reproduction (vegetative propagation) in plants.

Q#6 Describe the events that occur during the phases of meiosis?

Ans: Meiosis: Phases of Meiosis:

The preparatory steps of meiosis are identical to the interphase of the mitotic cell cycle. Interphase is divided into the same three phases i.e. G1, S phase, and G2. Interphase is following by meiosis I and meiosis II.



Meiosis I:

In meiosis I, the homologous chromosomes in a diploid cell separate and so we haploid daughter cells are produced. It is the step-in meiosis that gene sets genetic diversity.

Steps involved in Meiosis I:

Meiosis I occur in two main steps i.e. karyokinesis and cytokinesis

Sub division of Karyokinesis of Meiosis

1: The karyokinesis of Meiosis I is subdivided into:

i. prophase I, **ii.** metaphase I, **iii.** anaphase I. **iv.** telophase I.

i. Prophase I:

Prophase I is the longest phase in meiosis. During this stage, individual chromosomes begin to condense within the nucleus. Then the homologous chromosomes line up with each other and form pairs.

Bivalent:

The combined homologous chromosomes are said to be bivalent. They may also be referred to as a tetrad, a reference to the four sister chromatids.

Chiasmata:

The two non-sister chromatids of homologous chromosomes become "zipped" together, forming complexes known as chiasmata, in a process known as synapsis.

Crossing over:

In the next stage, the non-sister chromatids of homologous chromosomes randomly exchange their segments and the phenomenon is known as crossing over. The exchange of segments results in a recombination of genetic information. After crossing over the homologous chromosomes separate from one another. However, they remain tightly bound at chiasmata, the regions where crossing over occurred.

Spindle fibres:

Chromosomes condense further, the nucleoli disappear, and the nuclear envelope disintegrates. Centrioles, which were duplicated during interphase, migrate to the two poles of the cell. They give rise to spindle fibres. The kinetochore spindle fibres attach to the kinetochores of chromosomes. While the non-kinetochore spindle fibres from both sides interact with each other. There are two kinetochores on each tetrad, one for each kinetochore spindle fiber.

ii. Metaphase I:

As kinetochore spindle fibers from both centrioles attach to their respective kinetochores, the homologous chromosomes align along an equatorial plane forming the metaphase plate.

iii. Anaphase 1:

Kinetochore spindle fibers shorten, breaking the chiasmata and pulling homologous chromosomes apart. Since each chromosome only has one kinetochore, one chromosome is pulled toward one pole, forming two diploid sets. Each chromosome still contains a pair of sister chromatids.

iv. Telophase 1:

The first meiotic division ends when the chromosomes arrive at the poles. Each pole now has half the number of chromosomes but each chromosome still consists of a pair of chromatids. The spindle network disappears, and a new nuclear envelope surrounds each haploid set. The chromosomes uncoil back into chromatin. Cytokinesis, the pinching of the cell membrane in animal cells or the formation of the cell wall in plant cells, occurs, completing the creation of two daughter cells. After meiosis both haploid daughter cells enter a period of rest known as interkinesis or interphase II. The interphase il is different from the interphase of mitosis and meiosis 1 There is no S-phase and so no DNA replication occurs during this stage

Meiosis II:

It is the second part of the meiotic process. Much of this part is similar to mitosis.it is subdivided into

i. prophase II, **ii.** metaphase II, **iii.** anaphase II, **iv.** telophase II

i. Prophase II:

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

ii. In metaphase II:

In metaphase II the chromosomes attach with the kinetochore spindle fibers 1 align at the equator of the cell. This is followed by anaphase II.

iii. In anaphase II:

In anaphase II the centromeres are cleaved and sister chromatids are pulled ....

The sister chromatids are now called sister chromosomes, and they are ....

toward opposing poles.

iv. The telophase II:

The telophase II is marked with uncoiling and disappearance of the chrom.... Nuclear envelopes reform; cleavage or cell wall formation eventually pre.... total of 4 daughter cells, each with a haploid set of chromosomes.

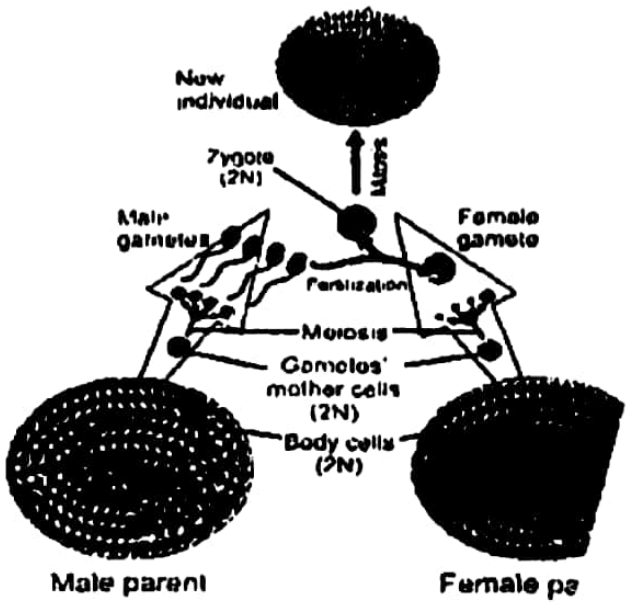
Q#7 Describe the significance of Meiosis?

Ans: Significance of Meiosis:

i. Reproduction and inheritance:

The significance of meiosis for reproduction and inheritance was descry.... by German biologist August Weismann, who noted that meiosis was.... transform one diploid cell into four haploid cells if the number of chror.... to be maintained

ii. Essential for sexual reproduction:



Meiosis is essential for sexual reproduction and therefore .... including single-celled organisms that reproduce sexually.... archaea or prokaryotes, which reproduce asexually by bi....

ii. Diploid gamete:

Humans, for example, are diploid creatures. The diploid gamete-mother cells undergo meiosis to produce haploid gametes, which are spermatozoa in males and ova in females. These gametes then fertilize, producing a diploid zygote. The zygote undergoes repeated mitosis and develops into the new organism.

iv. Haploid gametes:

Many fungi and many protozoa are haploid. Such organisms produce haploid gametes through mitosis. When two gametes fuse, they form diploid zygote, which undergoes meiosis immediately, creating four haploid cells. These cells undergo mitosis to create the haploid organism

5. Alternation of generations:

Plan's life cycle shows alternation of generations. The cells of the diploid sporophyte generation undergo meiosis to produce haploid spores, which grow into haploid gametophyte generations. The haploid gametophyte generation

produces haploid gametes through mitosis. The gametes combine to produce the diploid zygote. The zygote undergoes repeated mitosis to become the diploid sporophyte.

6. Genetic Variation:

Because the chromosomes of each parent undergo genetic recombination during meiosis, each gamete, and thus each zygote, will have a unique genetic makeup. In other words, meiosis and sexual reproduction produce genetic variation. Thus, meiosis allows a species to bring variations to handle the changes in the environment.

Q#8 Contrast mitosis and meiosis, emphasizing the events that lead to different outcomes?

Ans: Contrast between mitosis and meiosis:

Mitosis	**Meiosis**
1. Mitosis takes place in somatic cells.	**1.** Meiosis takes place in gonads.
2. Mitosis results in two daughter cells.	**2.** Meiosis results in four daughter cells.
3. No crossing over takes place.	**3.** Crossing over between homologous chromosomes takes place.
4. Number of chromosomes remain as main same as in parent cell.	**4.** Number of chromosomes to half compared to the parent cell.
5. Daughter cells remain diploid.	**5.** Daughter cells become from the diploid parent cell.

Q#9 Describe necrosis and apoptosis?

Necrosis:

….sis is the name given to accidental death of cells and living tissue. Necrosis is ….quential than apoptosis.

….s of necrosis:

…. Are many causes of necrosis including injury, infection, cancer, infraction, …. And inflammation. Necrosis is accompanied by the release of special ….s from the lysosomes. The lysosomal enzymes break cellular components …. Also be released outside the cell to break other surrounding cells. Cells …. Necrosis may also release harmful chemicals that damage other cells.

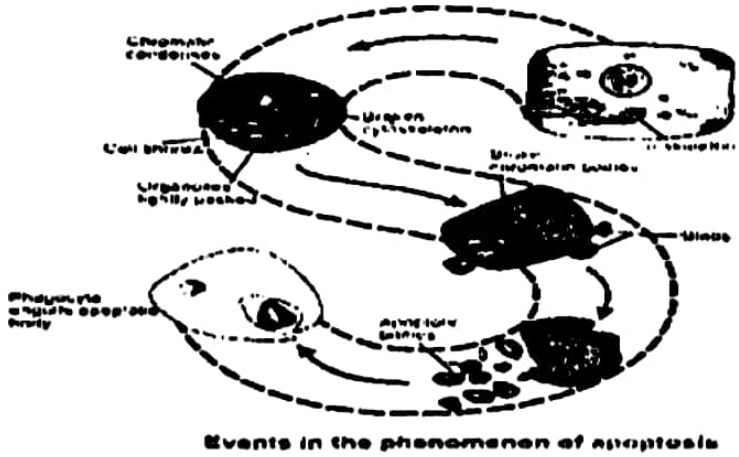
Distinctive patterns of necrosis:

There are many distinctive patterns of necrosis e.g.

i. Necrosis may occur when a cell is given hypoxic (with less oxygen) environments.

ii. Necrosis may be usually associated with cellular destruction and pus formation (e.g. pneumonia).

iii. Necrosis may be due to blockage of the venous drainage of an organ or tissue.



Events in the phenomenon of apoptosis

Apoptosis and necrosis:

Apoptosis and necrosis are two phenomena of cell death.

Apoptosis:

Apoptosis is one of the main types of programmed cell death, and involves a series of biochemical events. This process is controlled by extracellular signals (e.g. hormones) or intracellular signals (e.g. food deprivation, viral infection).

Series of events in apoptosis:

Following is the series of events in apoptosis.

1. Cell shrinks and becomes rounded due to the breakdown of the cytoskeleton by enzymes.

2. The cytoplasm appears dense, and the organelles appear tightly packed

3. Chromatin undergoes condensation into compact patches against the nuclear envelope

4. The nuclear envelope breaks and the DNA is fragmented. Thus, the nucleus breaks into several discrete chromatin bodies.

5. The cell membrane shows irregular buds known as blebs, through which the cellular components are discharged.

6. The blebs break off from the cell and are now called apoptotic bodies, which are then phagocytosed by other cells.

Significance of apoptosis:

1. Apoptosis can occur when a cell is damaged, infected with a virus, or undergoing stress conditions such as starvation. DNA damage from ionizing radiation or toxic chemicals can also induce apoptosis. The decision for apoptosis can come from the cell itself or from the surrounding tissue.
2. Apoptosis removes the damaged cell, preventing it from getting further nutrients from the organism, or to prevent the spread of viral infection.

3. Apoptosis generally gives advantages during an organism's life cycle. For example, the differentiation of fingers and toes in a developing human embryo requires cells between the fingers to initiate apoptosis so that the digits can separate.
4. In the adult organism, the number of cells is kept relatively constant through cell death and division. Cells must be replaced when they become diseased or malfunctioning.

SHORT QUESTIONS

Q.1 A never cell does not divide after its formation. In which phase of cell cycle it is?

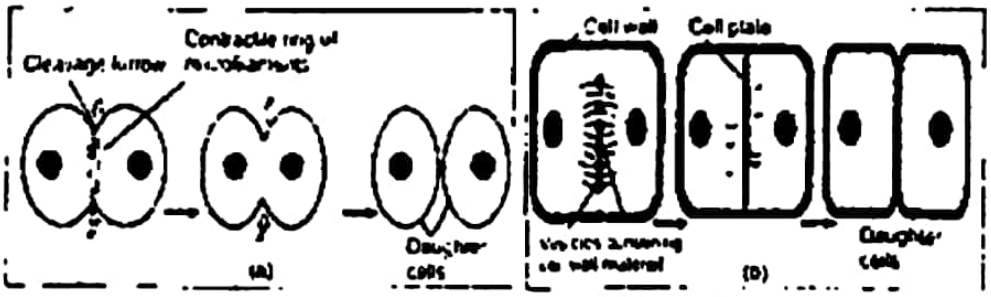
Ans: Cell that have temporarily or permanently stopped dividing are said to have entered a state of quiescence, called G0 phase.

Q.2 How is cytokinesis different in plant cells as compared to animal cell?

Ans: Cytokinesis in Animal Cells:

Cytokinesis is the division of the cytoplasm. In **animal cells**, cytokinesis occurs by a process known as cleavage. A **cleavage furrow** develops where the metaphase plate used to be. At the site of the furrow, the cytoplasm has a ring of microfilaments (a part of the cytoskeleton). The ring contracts deepening the furrow and eventually pinching the parent cell into two.

Cytokinesis in Plant Cells:



Cytokinesis: (a) in animal cell, (b) in plant cell

Cytokinesis in plant cells occurs differently. Vesicles derived from the Golgi apparatus move to the middle of the cell and fuse to form a membrane-bounded disc called the cell plate or **phragmoplast**. The plate grows outward and more vesicle fuse with it. Finally, the membranes of the cell plate fuse with the 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.3 What type of cell division occurs when our wounds are healed?

Ans: Mitosis occurs when our wounds are healed. The number of cells within an organism increases by mitosis and this is the basis of development from a single cell zygote to the multicellular body and the growth.

When damaged tissues (wounds) are repaired (healed), the new cells must be exact copies of the cells being replaced so as to retain normal function of cells.

Q.4 Plants do not make their gametes by meiosis. How is that?

Ans: Plants do not make their gametes by meiosis Due to sporangiophores. A sporangiophore is a group of cells that act together to form sporangia.