General Knowledge on Cell Cycle & Cell Division

A complete ***General knowledge on Cell Cycle and Cell Division*** for you competitive examinations such as UPSC, IAS, Banking SBI PO, Railway Group-D, SSC, CGL and others.

[Contents: Cell Cycle, Types of Cell Division ⇒ Mitosis (Karyokinesis & Cytokinesis) Meiosis]

The most significant manifestation of life is reproduction which may be at organismic, cellular or molecular level. Cell division is the method that enables life to perpetuate, generation after generation. This is equally true in case of the simplest organisms like Amoeba and highly complex ones as humans, animals or plants. Cell division produces new cells from pre-existing ones in order to help in growth, replacement, repair and reproduction in all living organisms.

During cell division a cell divides into two daughter cells (mitosis) or four daughter cells (meiosis). These are exactly similar to each other as well as resemble the parent cell. These characters are transmitted from parent cell to the daughter cells in the form of **genes** which are located on **chromosomes**. The Chromosomes are called the hereditary materials. These chromosomes are present in the nucleus of the cell. The chromosomes are able to carry character because of the fact that they duplicate before the beginning of cell division. The chromosomes contain DNA.

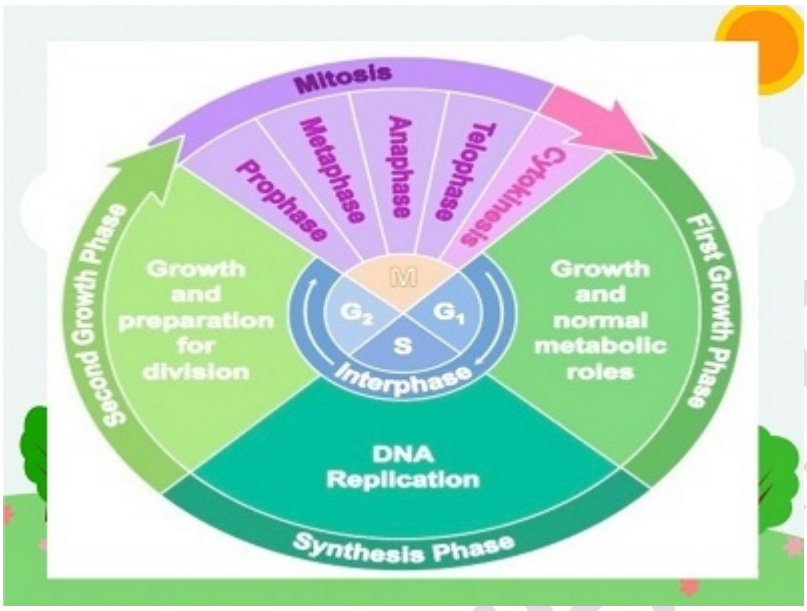
Cell Cycle :

Every Cell capable of divisions passes through recurring events called the **cell cycle**. The sequence of events including duplication of DNA, synthesis of other cell constituents, growth and division, that a cell undergoes from the time of its formation upto its division into daughter

cells is called **cell cycle**. Duration of cell cycle i.e. duration between two successive cell division is called **generation time**.

A cell cycle consists of the following two phases i.e.

1. Interphase (Non-dividing phase)
2. Mitotic phase (Dividing phase)



Cell Cycle[/caption]

 # Interphase :

It is the non-dividing, preparatory phase during which a cell prepares for the next cell division and grows to the same size as their mother cell. The chromatin reticulum, also called chromatin network, duplicates (makes its copy), due to the duplication of DNA contents. It is further divided into three sub-stages i.e.,

1. G_1-phase
2. S-phase
3. G_2-phase.

⇒ **G_1-phase :** G_1 phase is known as the First Growth Phase or Post-mitotic phase. G_1 is the longest phase of interphase. In this phase the cell in metabolically active. The RNA and proteins are synthesized and volume of cytoplasm increases hence cell grown in size. The cell carries out normal functions and gets prepared for the next phase. There in no change in the DNA contents of the cell during this phase.

⇒ **S-Phase :** S- phase is known as synthesis phase. Synthesis of DNA takes place and the chromosomes get duplicated (makes its copy).

⇒ **G_2-phase :** G_2-phase is known as second Growth Phase or Pre-mitotic phase. This is a shorter growth phase in which syntheses of DNA stops. However, formation of RNA and proteins, necessary for cell division, continues. It prepares the cell to undergo mitotic phase (the next cell division) and thus the cell cycle goes on.

 # Mitotic Phase :

It is the dividing phase of the cell. During this phase the nucleus as well as the cytoplasm undergoing four important stage. These are *Prophase*, *Metaphase*, *Anaphase* and *Telophase*. After Telophase the new cells formed again carry on with the cell cycle and this process goes on and on.

The cell cycle cannot go on endless. At some places it stops permanently like in brain and nerve cells, one formed in the embryo do not divide further. Once dead, they are not replaced. At some places it stops temporarily, like the liver cells which divide only once every one to two years to replace damaged cells. At other places it divides till it is needed, kile epithelial lining of the alimentary canal last only for five days and that sin epidermis cells about fifteen days.

Do you know?

- Mammalian skin surface skin cells are continuously lost and replaced by the underlying cells.
- A cell inside the cheek divides about once in 24 hours.
- The nerve cells in the brain, cells of eye lens and most muscle cells last a lifetime but once dead are never replaces.
- Red blood cells last for 120 days and are replaced.
- In plants, cells of meristems (growing points) divide very rapidly and produces new leaves, buds and flowers.
- Uncontrolled cell cycles may lead to tumours that may or may not be cancerous.

Types of Cell Division

The cell division is of two types :

1. Mitosis
2. Meiosis

Mitosis :

It is a type of cell division during which a cell divides into two daughter cells, each containing similar and same the number of chromosomes as present in the parent cell.

Since the number of chromosomes in this type of division, remains the some, hence it is also called **equational cell division**. This type of cell division takes place in somatic or body cells during growth, development and repair of an organism, hence, also known as **somatic cell division**. Mitosis was first of all described by **Flemming** in animal cells and named it as "**Mitosis**" in *1882*.

As we know, the cell prepared itself for mitosis during interphase. The following three important events take place during interphase.

- The cell grows to the same size as their mother cell.
- RNA and proteins synthesized and volume of cytoplasm increases.
- DNA synthesis takes place and chromosomes get duplicated.

During interphase, chromosomes exhibit a minimum degree of condensation or coiling but cannot be distinguished individually. There is an increase in volume of interphase nucleus as well as nucleolus. The cell is quite active metabolically. Since DNA synthesis occurs, therefore, no alternative is left for the cell except to divide by entering the mitotic phase. The process of mitosis is studied in two parts i.e.,

1. Karyokinesis
2. Cytokinesis

 # Karyokinesis (Division of Nucleus) :

All the changes in nucleus that occur during cell division are collectively termed as Karyokinesis.

During Karyokinesis many events take place in a particular sequence. All these events are studied in the following four stages :

1. Prophase
2. Metaphase
3. Anaphase
4. Telophase

 # Prophase

⇒ (i) It begins with the shortening and thickening of chromosomes. These chromosomes are clearly visible inside the nucleus. Each

chromosome splits longitudinally to form two **chromatids**. They are joined at one point called **centromere or kinetochore**.

⇒ (ii) The centriole in the centrosome of animal cell divides into two. The centrosphere (structure which surrounds the centrioles disappear from the centrosome, setting the centrioles free.

⇒ (iii) Centrioles develop very fine eyelash like threads called **astral rays**. Centrioles along with astral rays are called **asters**.

⇒ (iv) The two asters start moving towards the opposite poles. By the end of prophase they reach at the opposite poles.

⇒ (v) Between the two asters develop very fine proteinaceous thread like structures called **spindle fibres**. Asters along with spindle fibres is called **spindle or mitotic apparatus**. Such a spindle is called amphiastral spindle. In plants, the spindle is without asters and is called **anastral spindle**.

⇒ (vi) The chromosomes get attached with the spindle fibres from the centromeres.

⇒ (vii) The nuclear membrane and nucleolus start disappearing in the middle in prophase and totally disappear by the end.

 # Metaphase

⇒ The chromosomes begin to start peculiar movements. They arrange themselves between the poles, on the equator of the spindle.

⇒ The chromosomes so arranges for a plate like structure called equatorial plate or metaphase plate.

 # Anaphase

⇒ Each centromere splits into two daughter centromeres each retain one of the two chromatids,The structure so formed are now know as sister chromatids or daughter chromosomes.

⇒ Sister chromatids of each pair is formed, start moving towards the opposite poles. This movement perhaps brought about by the contraction of spinndle fibres.

⇒ By the end of anaphase, out of each pair of sister chromatids, one reaches at one pole and the second at the other pole of the spindle.

 # Telophase.

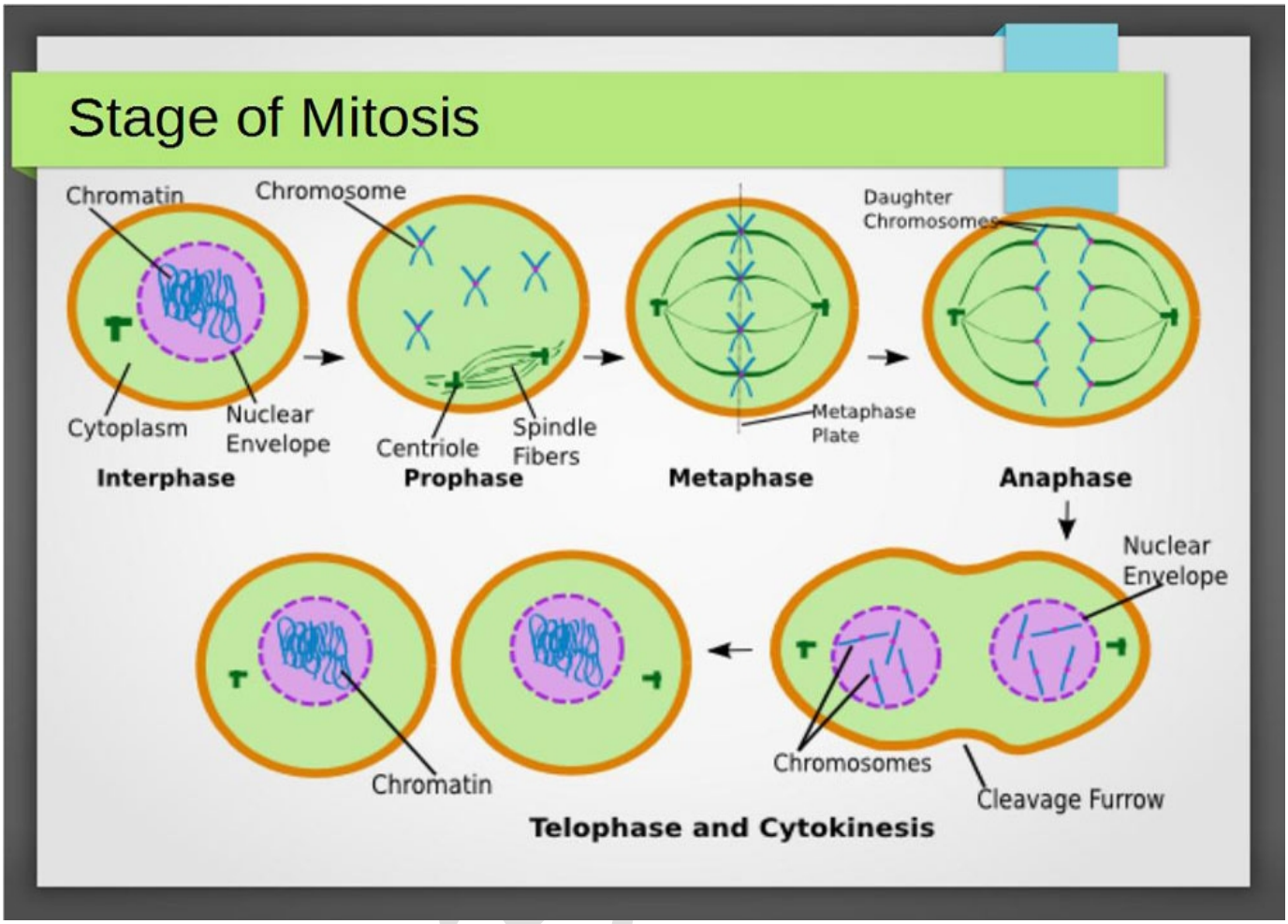
⇒ Each sister chromatid which reaches at the opposite poles starets uncoiling thinning and elongating. They form a network like structure called chromatin reticulum.

⇒ Around each chromatin reticulum at the two poles, reappears nuclear membrane giving rise to two daughter nuclei.

⇒ Nucleoli reappear in each daughter nucleus.

⇒ Spindle fibres, astral rays disappear.

⇒ The centrioles duplicate. They surrounded by centrosphere again producing centrosome near each daughter nucleus.



Mitosis Cell Division Stages[/caption]

 # Cytokinesis.

Division of the cytoplasm in known as **cytokinesis**. In plant cells, cytokinesis takes place by the formation of **cell plate**. Whereas, in animal cells it is by the appearance of furrow in the cytoplasm.

⇒ In plant cells, vesicles from Golgi bodies appear at the equator of the spindle. It forms a cell plate. It divides the cytoplasm into two equal halves, one around each daughter nucleus. Then primary cell wall in laid on either side of the cell plate.

⇒ In animal cells, a constriction (Furrow) appears parallel to the equator of spindle, in the cell membrane. It deepens towards the centre of the

cell, finally dividing the cytoplasm in two halves. One half of the cytoplasm is around one daughter nucleus and the other around the second daughter nucleus. It completes the formation of two daughter cells. They contain exactly similar and the same number of chromosomes as present in the parent cell.

 # Identification of Mitosis :

Prophase :

⇒ Each chromosome with two two chromatids

⇒ Disappearance of nuclear membrane.

⇒ Disappearance of nucleolus

⇒ Formation of the spindle

Metaphase :

⇒ Chromosomes arranged at equator as equatorial plate.

Anaphase :

⇒ Splitting of each chromosome into two daughter chromosomes

⇒ Movement of daughter chromosomes towards opposite pole.

Telophase

⇒ Uncoiling of chromosomes,

⇒ Disappearance of spindle

Reappearance of nucleolus and nuclear membrane.

 # Meiosis :

The term meiosis was coined by **Farm** and **Moore** in 1904. It is a special type of cell division that take place in the reproductive organs in

humans to produce **sperms** and **ova**. In flowering plants, it takes place in the **anthers** and the **ovary** to produce **pollen grains** and ovules respectively.

Meiosis is a type of cell division in which cell undergoes two successive division producing four daughter cells each containing half the number of chromosomes as compared to the parent cell. It is also called reductional cell division.

Do you know ?

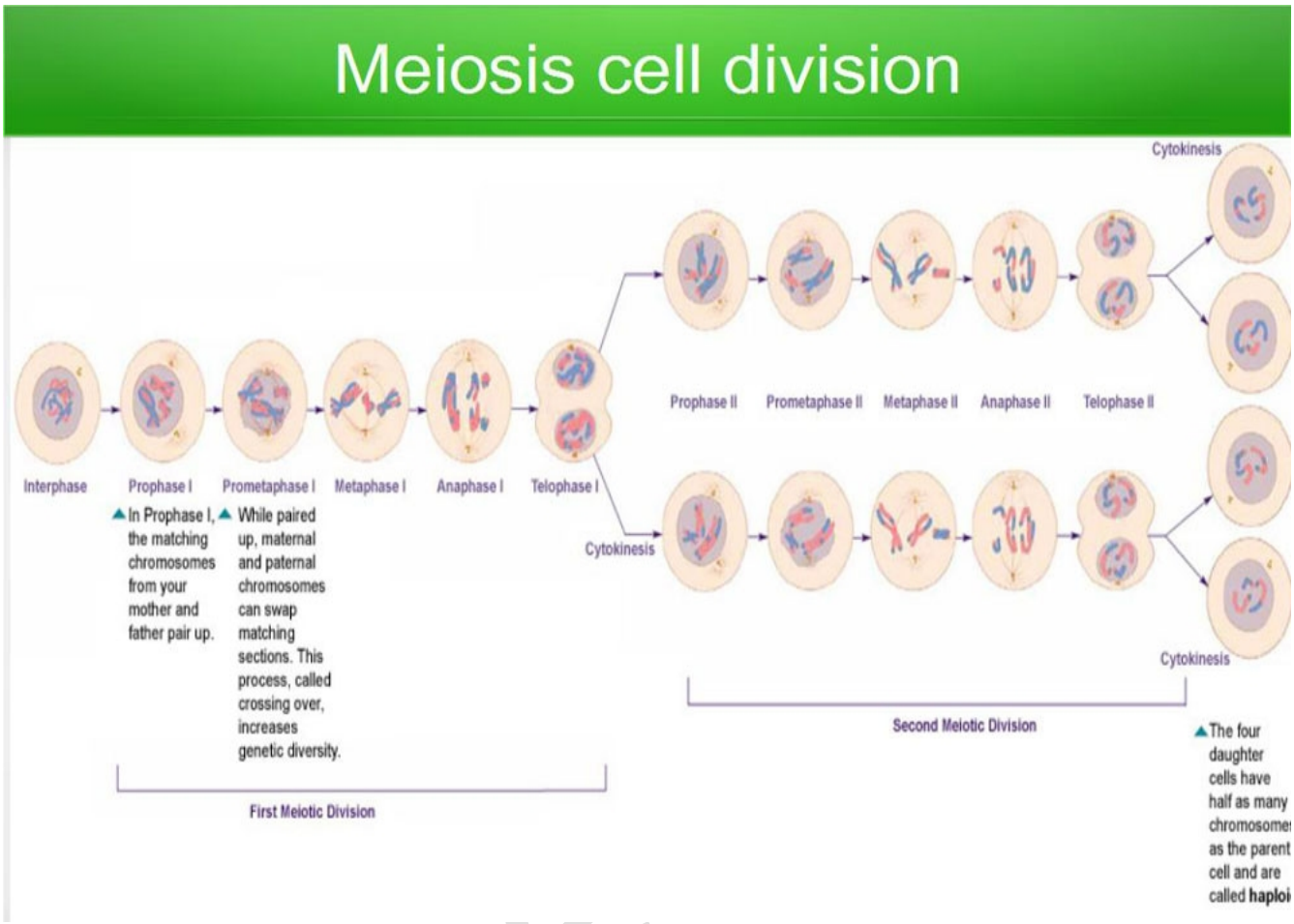
Meiosis always takes place in diploid cells. A diploid cell is one in the nucleus of which the chromosomes are present in the form of pairs i.e., each type of chromosomes are two in number, one is maternal and other is paternal.

There are two types of meiosis. They are -

1. Meiosis-I or Reductional division
2. Meiosis-II or Equational division.

Meiosis-I or Reductional division : During meiosis-I or First meiotic division, a diploid cell (2n) divides into two haploid (n) daughter cells. It is called **reductional division** because the number of chromosomes is reduced to half in the daughter cells. This division always takes place in those cells in which the chromosome are present in the form of pairs of **homologous chromosomes**.

Homologous chromosome : The chromosomes which are exactly similar in shape and size and bear same genes at same loci are called homologous chromosomes. In each pair of this chromosome one is shared by the male parent (paternal chromosome) and the other is shared by the female parent (maternal chromosome).



Meiosis cell division[/caption]

Meiosis_II or Equational division : Meiosis-II division is much similar to mitosis. It is known as **equational division**, because it maintains the number of chromosomes received by the daughter cells at the end of meiosis-I. hence, in the end of meiosis **four haploid cells** are produced from **one diploid cell** in which each daughter cell has **half the number of chromosomes** as compared to plant cell.

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