UNIT – 1: BASIC BIOLOGY

CHAPTER-1

CELL CYCLE AND CELL DIVISION OF CHROMOSOME

Topic-1 Cell Cycle and Cell Division

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Revision Notes

- > All living beings are made up of one or more units called cells.
- The organisms made up of a single cell are called unicellular organisms while the organisms that consist of many cells are known as multicellular organisms.
- The study of cell is called cytology. The term cell was given by Robert Hooke for the first time when he observed cork cells under a primitive microscope assembled by him.
- Cell Theory : The credit of formulation of cell theory is given to a German Botanist M.J. Schleiden and a German Zoologist T. Schwann . Cell theory states that :
 (a) All living organisms are made up of cells.
 - (b) Cells always arise from the pre-existing living cells with the help of division.
- > Growth is a continuous process which occurs throughout the life of a cell.
- Each and every cell in an organism possesses three essential parts cell membrane, cytoplasm and nucleus.

Cell division:

> It is necessary for proper growth, development and survival of organisms.

Cell cycle:

- It is the sequence of events including growth and division, that cell undergoes from the time of its formation up to its division into daughter cells.
- Cell cycle comprises of two phases Interphase and phase of division (mitosis or meiosis i.e., M Phase.)
- G_1 , S, G_2 and M phase collectively form the cell cycle.

Interphase:

- It is a series of changes that takes place in a newly formed cell and in its nucleus before it becomes capable of dividing again. Therefore, it is also called intermitosis.
- Interphase of dividing cell has three stages G_1 , S and G_2 -phase.
- It is also known as biosynthetic phase in which cell duplicates its cell organelles & replicates its DNA.
- **G**₁ **phase** is characterised by the synthesis of RNA and non-histone proteins. Cell growth occurs and substances are produced which inhibit or stimulate the onset of next S phase.
- **S phase** follows the G₁ phase. It is characterised by the replication of DNA and the chromosomes are completely duplicated.
- G₂ phase is the period in which centrioles, mitochondria, Golgi bodies and other cytoplasmic organelles are doubled.

M or D phase:

• It is the phase when the cell enters the prophase stage of cell division.

Phase of division- Mitosis

- Mitotic (M phase) consists of karyokinesis (division of nucleus) and cytokinesis (division of cytoplasm).
- **Mitosis** results in the formation of identical cells. Daughter cells have same genetic constitution quantitatively and qualitatively as the original cell.
- Mitosis was first observed by Strasburger in plant cells and by Flemming in animal cells. In some cells like gamete mother cells or sporogenous cells mitosis is replaced by meiosis.

Karyokinesis:

- Karyokinesis: It comprises of four phases prophase, metaphase, anaphase and telophase.
- **Prophase:** It is the longest phase of division. Replicated chromosomes each with two sister chromatids condense and become visible. Nuclear membrane along with nucleolus disappear.
- **Metaphase:** The chromosomes arrange themselves at the equator of the spindle to form the equatorial plate. Each chromosome is attached to the spindle fibres by its centromere.
- Anaphase: The centromere splits and the newly-copied chromosomes (daughter chromatids) are moved to opposite poles of the cell.
- **Telophase:** It is the phase in which nuclear membrane is reformed around each group of chromatids, now called chromosomes at each pole. Two nuclei are thus formed.
- Karyokinesis is followed by cytokinesis in which cytoplasm of the cell divides in two parts.

Importance of Mitosis:

- It brings about the reproduction in unicellular organisms.
- It is necessary for growth, maintenance and repair in multicellular organisms.

Differences between Animal and Plant cell Mitosis :

Mitosis in Animal cell	Mitosis in Plant cell	
1. Asters are formed.	1. Asters are not formed.	
2. Cytokinesis occurs by furrowing of cytoplasm.	2. Cytokinesis occurs by cell plate formation.	
3. Occurs in most tissues throughout the body.	3. Occurs mainly at the growing tips and sides.	

Meiosis:

- **Meiosis** is the cell division which occurs in sex cells and results in the formation of four daughter cells. The daughter cells are quantitatively and qualitatively different from mother cells.
- The whole process consists of two successive coordinated divisions called meiosis I and meiosis II.
- During meiosis I, the number of chromosomes is reduced to half while in meiosis II, division is of simple mitotic type.
- Meiosis maintains the same chromosome number through successive generation of species as in meiosis the number of chromosomes in the sex cells are halved and when these sex cells fuse during fertilisation, original chromosome number is restored.
- It helps to produce new recombination of characters as a result of crossing over (exchange of genetic material between two homologous chromosomes).
- Major differences between Mitosis and Meiosis are:

Mitosis	Meiosis	
(a) Mitosis takes place in the somatic cells.	It occurs either in the reproductive cells or at the time of development of zygote.	
(b) It is a single division which produces two cells.	It is a double division. It gives rise to four cells.	
(c) The number of chromosomes remains the same after mitosis.	The number of chromosomes get reduced to half after meiosis.	
(d) No crossing over takes place.	Crossing over takes place in prophase - I.	

Regulation of cell cycle

- The cell cycle is controlled by checkpoints to ensure that a previous phase is fully completed before advancing to the next phase.
 - a. Feedback from the cell determines whether the cycle switches to the next stage.
 - **b.** Three principal checkpoints i.e. G₁, G₂ and M checkpoints: Control the cycle in eukaryotes.

Key Terms

- > Amitosis : Cell divides without spindle formation.
- > **Disjunction** : It is the separation of homologous chromosomes during cell division.
- Non-disjunction : It is the non-separation of homologous chromosomes during anaphase I of meiosis I. It is not normal and happens in unusual conditions.

- Congression : Chromosome fibres contract and bring the chromosome over the equator.
- > Mitogens : The agents which stimulate the cell division are called mitogens, e.g., cytokinins and some steroids.
- Mitotic poisons : There are some chemicals which inhibit cell division, e.g., azides, cyanides, colchicine. It results in polyploid cells.
- Intranuclear mitosis and pre-mitosis : In protists, fungi and algae, the nuclear envelop does not degenerate during mitosis, instead spindle is formed inside the nucleus.
- Crossing over: Exchange of respective chromatid segments in a homologous pair.
- > **Spindle fibres:** The fibres which are present between the poles of the cell during cell division.



Mnemonics

Concept: Cell cycle stages		Concept: Mitotic s	Concept: Mitotic stages	
Mnemonic: Get Set Go! Make a Call		Mnemonic: I Prefe	Mnemonic: I Prefer Milk And Tea – Coffee	
Interpretation : Interpretation :				
$\mathbf{G}: \mathbf{G}_1$ Phase	$\mathbf{G}: \mathbf{G}_2$ Phase	I : Interphase	A : Anaphase	
S : S Phase	M: M Phase	P : Prophase	T : Telophase	
C : Cytokinesis		M : Metaphase	C : Cytokinesis	

Topic-2 Structure of Chromosome



Revision Notes

Introduction:

Chromosomes are rod-shaped or thread like deeply stainable condensed chromatin fibres which are hereditary vehicles.

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> Hofmeister(1848) first observed the chromosome. The term chromosome was proposed by W. Waldeyer (1888).

Role of Chromosome:

- Role of chromosome in hereditary process was discovered by Morgan (1933).
- A set of paired chromosomes or two sets of chromosomes is known as diploid, e.g., Human 23 pairs of Chromosomes.
- A set of unpaired chromosome or a single set of chromosome is said to be a haploid.

Types of Chromosome:

- Each chromosome consists of 2 units or arms, called chromatids attached at a point called primary constriction or centromere.
- Depending on the location of centromere, chromosomes are classified into four types -
 - (i) Telocentric Centromere at one tip.
 - (ii) Acrocentric Centromere is just below the tip.
 - (iii) Sub-metacentric Centromere is in between the centre and the tip of the chromosome.
 - (iv) Metacentric Centromere is in the middle.





- Depending on number of centromeres:
 - (i) Monocentric—1 centromere
 - (ii) Acentric- no centromere

- (iii) Holo centric-Diffused centromere
- (iv) Dicentric-2 centromere
- Chromatin fibre: A chromatin fibre is a continuous linear DNA double strand associated with proteins of two types basic histones and acid or neutral non-histones.
- It also contains some RNA and some enzymes such as DNA and RNA polymerases.
- The term chromatin means "coloured material." The chromatin occurs in a non-dividing nucleus as fine filaments termed as the chromatin fibres.
- Double helical model to explain the structure of DNA was given by Watson & Crick in 1953.
- The organisms which contain a segment of foreign DNA or gene are known as transgenic organisms.



Concept: Nucleotide Base Pairs of DNA.

Mnemonics: Apple on **Tree**, **C**ar in Garage **Interpretation:** Adenine, Thymine, Cytosine, Guanine

Key Terms

- Centromeric Index : It is the ratio of lengths of the two arms of chromosome.
- Allosomes : These are sex chromosomes whose presence, absence and particular form determines the sex of the individual.
- > Autosomes : Chromosomes other than sex chromosomes are called autosomes.
- Homogametic : Individuals having homomorphic sex chromosomes produce similar gametes e.g., human female (XX).
- Heterogametic : Individuals with heteromorphic sex chromosome produce two types of gametes e.g., human male (XY).
- Karyotype : Karyotype is a chromosome complement of a cell / organism providing description of various aspects of all the chromosomes like number, relative size, position of centromere, length of arms and satellite.
- Satellite / Trabant : A satellite chromosome or SAT chromosome has a chromosome segment that is separated from the main body of the chromosome by a secondary constriction.
- > **Nucleosomes:** Nucleosomes are the basic unit of chromatin. It is 10 nm in the diameter.