CHAPTER - 10

CELL CYCLE AND CELL DIVISON

- Growth and reproduction are characteristics of cell indeed of all living organism.
- Cells reproduce by dividing into two, with each parental cell giving rise to two daughter cells.

CELL CYCLE

- The sequence of events by which a cell duplicates its genome, synthesises the other constituents of the cell and eventually divides into two daughter cells is termed cell cycle.

Phases of Cell Cycle

- Human cells divide once in approximately every 24 hours.
- Duration of cell cycle vary from organism to organism and

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also from cell type to cell type.

- Yeast for example, can progress through the cell cycle in only about 90 minutes.

- The cell cycle is divided into two basic phases
- Interphase
- M Phase (Mitosis phase)

- M Phase represents the phase when the actual cell division or mitosis occurs.

- The successive M phases.

- The interphase lasts more than 95% of the duration of cell cycle.

- Karyokinesis : Divison of Chromosome.
- Cytokinesis : Divison of ~~Cyt~~ Cytoplasm.

- M phase starts with the nuclear division, corresponding to the Karyakinesis and usually ends with cytokinesis.

- Interphase, though called the Resting phase is the time during which the cell is preparing for division by undergoing both cell growth and DNA replicatio in an orderly manner.

- The interphase is divided into three further phases:

- G_1 phases (Gap 1)
- S phase (synthesis)
- G_2 phase (Gap 2)

1. G_1 phase:

- Interval between mitosis and initiation of DNA replication.
- Cell is Metabolically active and continuously grows but does Not replicate its DNA.

2. S phase:

- Synthesis phase period during which DNA synthesis or replication takes place. ~~amount~~
- Amount of DNA per cell doubles the initial amount of DNA is denoted as 2C then it increases to 4C there is no increase in the chromosome number.
- In animal cells DNA replication begins in the nucleus, and the centriole dupli-cates in the cytoplasm.

3- G_2 phase :

- G_2 phase, proteins are synthesised in preparation for mitosis while cell growth continues.

4- Quiescent Stage [G_0]

- Some cells in the adult animals Do not exhibit division (e.g. heart cells) and many other cells divide only occasionally as needed to replace cells. These cells that do not divide further exit G_1 phase to enter an inactive stage called Quiescent stage (G_0).

- Metabolically active.

2. M PHASE

→ also known as Equational Division.
→ No of chromosomes in parent and progeny Cell is Same.
→ Mitosis is divided into four stage.

(i) Prophase
[ii] Metaphase
[iii] Anaphase
[iv] Telophase

2.i Prophase

- First Stage of Mitosis.

→ In the S and G_2 phase the new DNA molecules formed are not distinct but intertwind.

→ Start by the initiation of Condensation of Chromosomal material

→ Chromosomal material become Untangled during the process of chromatin Condensation.

→ The Centriole which Undergone ~~during~~ duplication during S-phase of interphase, begins to move towards opposite poles of cell.

- Completion of prophase marked by following events.

[i] Chromosomes material Condense to form Compact mitotic chromosomes. Chromosomes are Composed of two Chromatids attached together at Centromere

[ii] Initiation of assembly of mitotic Spindle, the microtubules, the proteinaceous Components of Cell Cytoplasm help in process.

→ Cells at the end of prophase, do not show golgi Complexes, Endoplasmic reticulum, nucleolus and the nuclear envelop when seen under microscope.

2.ii Metaphase

→ Complete disintegration of nuclear envelops marks the start of Secound phase of mitosis.

→ Condensation of chromosomes is Completed and observe Clearly under the microscope.

→ Metaphase is Stage at which morphology of chromosome is most easily studied.

- Kinetochores: Small disc-shaped Structure at the Surface of Centromeres.

→ Serve as a Site of attachment of Spindle fibres to the chromosome that are moved into position at the Centre of Cell.

→ Metaphase is characterised by all the chromosome coming to lie at equator with one chromatid of each chromosome connected by it's kinetochore to spindle fibres from one pole and it's Sister chromatid ~~Conn~~ Connected by it's kinetochore to Spindle fibre from the opposite pole.

- Metaphase plate: The plane of alignment of chromosomes at metaphase.

▷ Key features of Metaphase

- Spindle fibres attach to kinetochores of chromosomes.

- Chromosomes are moved to spindle Equator and get aligned along metaphase plate through Spindle fibres to both poles.

2.iii Anaphase

→ Chromosome arranged at the metaphase plate is Split Simultaneously and the two daughter Chromatids [Chromosome of future daughter nuclei] begin their migration towards the two opposite poles.

→ Chromosomes of future daughter nuclei, begin their migration towards two Opposite poles.

→ Chromosome moves away from the equatorial plate, the Centromere of each chromosome is towards the pole.

- Key Feature

→ Centromeres Split and Chromatid Separate.

→ Chromatids move to Opposite pole.

2.iv Telophase

- The chromosome that have reached their respective pole & decondense and lose their individuality.
- Chromosome can no longer be seen and chromatin materials tends to collect in mass in two poles.

→ Key Feature

- Chromosome cluster at opposite spindle poles and their identity is lost as discrete elements.
- Nuclear envelop assembles around the chromosome clusters.
- Nucleolus, golgi Complex and ER reform

CYTOKINESIS

- Divison of Cytoplasm
- In animal cell, Cytokinesis is achieved by the appearance of a furrow in plasma membrane.

- The furrow gradually deepens and ultimately joins in the Centre dividing the Cell Cytoplasm into two.

- In plant Cell, wall formation start in the Centre of Cell and grows Outward to meet the Existing laterals walls.

→ The formation of new Cell wall begins with the formation of a Simple precursor, Called the Cell plate that represent middle lamella b/w walls of two adjacent Cell.

- In Some organisms Karyokinesis is not followed by Cytokinesis as a result multinucleate Condition arise.

Significance of ~~Meiosis~~ Mitosis

- Equational divison is restricted to diploid Cell only.

- In Some lower plants and in Some Social insect haploid Cell also divide by mitosis

- Result in production of diploid daughter cells with identical genetic Complement

- Growth in multicellular Organism is due to mitosis.

- The cells of the upper layer of the epidermis, cells of lining of gut and blood cell are constantly replaced through mitosis.
- Mitotic divison in meristemic tissues result in continous growth of plant.

4. MEIOSIS

→ also known as Reductional Divison

$2n \Rightarrow n$

→ It is a specialised kind of cell divison that reduce the chromosome number by half result in production of four haploid cell from one parent cell.

→ Key features of Meiosis.

- Involves two sequential cell cycle of nuclear and cell divison called Meiosis I and Meiosis II. but only a single cycle of DNA replication.
- Meiosis I is initiated after the parental chromosome have replicated to produce identical sister chromatids at S-phase

- Meiosis involves the pairing of homologous chromosome and recombination b/w them.
- Four haploid cells formed at the end of meiosis II.

4.1 Meiosis I

- Prophase I: longer and Complex when Compared with prophase of mitosis.
  → Subdivide into five phases:

a. leptotene b. Zygotene C. Pachytene
d. Diplotene e. Diakinesis.

a. Leptotene: During these Stage, Chromosome become gradually visible under the light microscope.

b. Zygotene: Chromosome start pairing together and this process is called Synapsis
→ Such paired chromosome are called homologous chromosome

→ Chromosome Synapsis is accompanied by the formation of Complex Structure Called Synaptonemal Complex.

→ Complex formed by a pair of Synapsed homologous chromosome is called a bivalent or a tetrad

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C. Pachytene: During this stage bivalent clearly appear as tetrad.

→ Characterised by the appearance of recombination nodules. Site at which Crossing Over occur between non-Sister chromatids of homologous chromosome

→ Crossing Over: It is the exchange of genetic material between two homologous chromosomes.

→ Enzyme mediated process and the enzyme involved is called recombinase.

D. Diplotene: Begining of diplotene is recognised by dissolution of Synaptonemal Complex and the tendency of recombined homologous chromosome of bivalent to seprate from each other except at the site of Crossovers.

→ The X-shaped structure are called chiasmata.

E. Diakinesis: Final stage.

→ Marked by terminalisation of Chiasmata.

→ The chromosome are fully Condensed and the meiotic Spindle is assembled to prepare the homologous chromosome for seprsation.

→ At the end of diakinesis the nucleolus disappears and the nuclear envelop also break down.

- Metaphase I: Bivalent chromosomes align on the equatorial plate.

→ The microtubules from the Opposite pole of the spindle attach to the pair of homologous chromosomes.

- Anaphase I: The homologous chromosome Seprate, while Sister chromatids remain associated at their Centromeres.

- Telophase I: The nuclear membrane and nucleus reappear, Cytokinesis follows and this is called as Dyad of Cells.

Interkinesis: Stage between two meiotic divison is Called interkinesis.

MEIOSIS II

- Prophase II : Initiated immediately after Cytokinesis
→ The nuclear membrane disappears by the end of prophase II.

- Metaphase II : Chromosome align at the equator and the microtubules from opposite pole of Spindle get attached to the Kinetochores.

- Anaphase II : Begins with the Simultaneous Splitting of Centromere of each chromosome. allowing them to move toward opposite poles of Cell.

- Telophase II : Two group of chromosome Once again get enclosed by a nuclear envelope.

⇒ Cytokinesis follows result in formation of tetrad of Cells.

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Significance of Meiosis.

- Mechanism by which Conservation of Specific Chromosome number of each Species is achieved across generation in Sexually reproducing Organism.
- Result in ~~Result~~ reduction of Chromosom number by half.
- Increase the genetic Variability in the population of Organism from One generation to Next.