

Mitosis and Meiosis

MITOSIS: Creation of two daughter cells with identical chromosome number and composition to one another and to mother cell.

Cell cycle:

Interphase - phase between cellular division phase during which cell grows and duplicates necessary organelles and chromosomes

chromosomes are uncoiled as chromatin, nuclear envelope and nucleolus visible, chromosomes not visible

G1 (gap 1): growth of cell, DNA damage check

S phase: chromosomes are replicated (still invisible)

G2 (gap 2): growth to roughly double 'original' size, check replication

M phase - divisional phase of cell cycle wherein cells undergo either mitosis or meiosis.

Prophase: two pairs centrioles migrate to poles (animals); disintegration of nuclear envelope and nucleolus; invisible chromatin condenses into visible chromosomes (each paired to duplicate at centromere - the pair are sister chromatids).

Prometaphase and Metaphase: prometaphase involves movement of condensed sister chromatids (centromeres) away from poles to the equatorial plane of the cell - the metaphase plate; metaphase is the arrangement of these sister chromatids on the metaphase plate after movement away from poles has ceased and before movement towards poles begins. Microtubules of tubulin attach to kinetochore of centromere from the centrioles at opposite poles (spindle fibers). Adding and subtracting tubulin to microtubules is like lengthening and shortening a chain, thus chromatid movement can be controlled.

Anaphase: Centromere splits and paired sister chromatids become independent, daughter chromosomes. One member of each pair is pulled from metaphase plate to opposite poles by shortening of attached spindle fibers.

Telophase and Cytokinesis: Final division of mother cell into two duplicate daughter cells. Cytokinesis of animals with cell furrow; middle lamella and new cell plate at metaphase plate of plants.

Checkpoints: Points in the healthy cell cycle at which progress through the cycle is assessed for adequate progress to continue.

G1/S - sufficient cell growth to pull off chromosome duplication; DNA repair prior to replication if necessary.

G2/M - adequate cell growth and reserves for cellular division; DNA repair.

M checkpoint - adequate and accurate spindle fiber formation prior to division of cell and chromosomes.

MEIOSIS: Creation of gametes, or sex cells, with half the chromosome number as original mother cell.

Interphase: essentially the same as in mitosis

M-phase: involves two cycles of cellular division from Prophase I through Telophase II

Prophase I: most complex phase of meiosis wherein replicated chromosomes condense, search for their homologous chromosomes, begin to align at the metaphase plate, and exchange pieces of chromosome between them.

Leptonema: **condensation of chromatin begins, homology search begins, crossing over begins**

Zygonema: condensation of chromatin continues, homologous chromosomes enter '**rough' pairing** or alignment, **lateral elements** form between homologs, homologs form bivalents (future tetrads), **synapsis begins**.

Pachynema: continued condensation of chromosomes, more extensive formation of synaptonemal complex between bivalents, bivalents visible as duplicate structures, **synapsis accomplished**, (sister chromatids vs. non-sister chromatids), **crossing-over** occurs.

Diplonema: **chiasmata of crossing-over** events are visible, non-sister chromatids begin to separate

Diakinesis: non-sister chromatids move further apart, **terminalization** of chiasmata, **final alignment** of homologous centromeres on equatorial plate, **nuclear envelope breaks**, nucleolus disintegrates (visually), **spindle fibers attach** to centromeres.

Metaphase I: end-point of prophase I, where final alignment on the equatorial (metaphase) plate has been achieved; spindle fibers attached to each centromere, future movement of non-sister chromatids will be toward opposite poles of mother cell.

Anaphase I: movement of non-sister chromatids to opposite poles of mother cell, centromeres still intact, tetrad becomes two dyads, at completion a series of dyads equal to the haploid number of the organism is present at each pole.

Telophase I: generally, **division of mother cell into two independently active daughter cells** of unlike chromosomal make-up and only half the original chromosome number (sister chromatids are still considered one chromosome so long as the centromere between them is unbroken).

Meiosis II

Prophase II: movement of sister chromatids to new equatorial plane.

Metaphase II: final alignment of sister chromatids (or centromeres) along metaphase plate.

Anaphase II: splitting of centromere and division of sister chromatids into daughter chromosomes, movement of daughter chromosomes to opposite poles of cell.

Telophase II: division of Meiosis I daughter cell into two Meiosis II daughter cells each with half of the chromosome types and half of the chromosome number as the original mother cell.

Gametogenesis:

Spermatogenesis -	spermatogonium (one)	pre-growth for division
	primary spermatocyte (one)	just prior to Meiosis I
	secondary spermatocyte (two)	just prior to Meiosis II
	spermatids (four)	just after Meiosis II
	sperm(atozoa)	after differentiation (specialization)

Oogenesis -	oogonium (one)	pre-growth for division
	primary oocyte (one)	just prior to Meiosis I
	secondary oocyte (one) & first polar body (one - twice the chromosomes of second)	just prior to Meiosis II
	ootid (one) & second polar body (one)	just after Meiosis II
	ovum	after differentiation (specialization)

Organismic Life Cycles:

Animals - diploid organisms with haploid gametes

Plants and Fungi - often diploid and haploid organism stages of the life cycle, i.e. the haploid cells undergo mitosis to generate gametes and grow structurally also

Non-disjunction: creation of organisms of incorrect chromosome number (e.g. $2n - 1$) due to incorrect meiotic division