Steps of Mitosis

Goal of Mitosis: two daughter cells inherit an equal and identical complement of chromosomes

3 things that Mitosis does: 1.) development 2.) growth cell replacement 3.) asexual reproduction

Interphase: Period when cell isn't in non dividing state; consists of G1, S-phase, G2

S-Phase: DNA replication

G1 Phase: the cell grows physically and increases the volume of both protein and organelles.

G2 Phase: Organelles and proteins for cell division are produced; Getting ready for Mitosis

Prophase: Condensation of chromosomes,the movement of the centrosomes, the formation of the mitotic spindle, and the beginning of nucleoli break down

Metaphase: Duplicated chromosomes move to the middle, spindle fibers connect to centromeres

Anaphase: Sister chromatids separate from one another and are pulled into opposite poles of the cell

Telophase: Chromosomes begin to decondense, spindle breaks down, nuclear membrane and nucleoli re-form (nuclear envelope)

Cytokinesis: splits the parent cell into two identical daughter cells

Oogenesis

diploid oogonium go through mitosis until one develops into a primary oocyte, which will begin the first meiotic division, but then arrest (in prophase 1) ; it will finish this division as it develops in the follicle, giving rise to a haploid secondary oocyte and a smaller polar body

- Meiosis starts in fetus

Oogenesis -> 1 haploid, ovum + 2-3 polar bodies

Arrest in Oogensis

• At birth, Primary oocyte, Arrest Prophase I
• Prophase I
arrest in fetal
development
• Continue at
puberty, Completes meiosis I, Secondary oocyte, Continue meiosis II, Arrest Metaphase II
• Continue and
complete Meiosis
II only upon
fertilization

Spermatogenesis

The origin and development of the sperm cells within the male reproductive organs, the testes.

- diploid spermatogonium, produces two diploid intermediate cells called primary spermatocytes.

- Haploid sperm, only the egg and sperm cells are haploid.

Spermatogenesis -> 4 haploid sperm

Polar Bodies

- Asymmetric cell divisions in Meiosis I and II

- Asymmetric partitioning of cellular material

- After 2 rounds of meiosis, only 1 haploid ovum vs. 4 as with sperm

A polar body is the byproduct of an oocyte meiotic division

Comparison of Mitosis and Meiosis

Table 3.1 Comparison of Mitosis and Meiosis

Mitosis	Meiosis
One division	Two divisions
Two daughter cells per cycle	Four daughter cells per cycle
Daughter cells genetically identical	Daughter cells genetically different
Chromosome number of daughter cells same as that of parent cell (2*n*)	Chromosome number of daughter cells half that of parent cell (1*n*)
Occurs in somatic cells	Occurs in germline cells
Occurs throughout life cycle	In humans, completes after sexual maturity
Used for growth, repair, and asexual reproduction	Used for sexual reproduction, producing new gene combinations

Mutations with Meiosis

• Inherited mutations are present in the parents, inherited from their parents, and can be passed to gametes

• But NEW spontaneous mutations can also occur in germline cells in meiosis

• New mutations in gametes more likely to develop or accumulate with age

• Oocytes more often have chromosomal imbalances

• Missing or extra entire chromosomes, usually due to non-disjunction

• Sperm more often have dominant single gene mutations

• “Paternal age effect”

Vocabulary

Sister Chromatid = identical copies formed by the DNA replication of a chromosome, with both copies joined together by a common centromere. In Mitosis

Homologs = Two chromosomes in a pair – normally one inherited from the mother and one from the father. In Meiosis

Haploid = the presence of a single set of chromosomes in an organism's cells (1n)

Diploid = A cell containing two copies of each chromosome (2n)

Somatic Cell = any cell of a living organism other than the reproductive cells

Germline Cell = The cells that form eggs in females and sperm in males

Allele = variation of the same sequence of nucleotides at the same place on a long DNA molecule

Crossing Over = When two chromosomes — one from the mother and one from the father — line up, parts of the chromosome can be switched

Ploidy = number of complete sets of chromosomes in a cell

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Vocabulary (cont)

Reductional division = The first cell division in meiosis, the process by which germ cells are formed, MEIOSIS

Equational division = the process of cell division wherein the chromosomes replicate and get equally distributed into two daughter cells, MITOSIS

Steps of Meiosis

Meiosis = Reductional division

Goal of Meiosis: produce gametes, the sperm and eggs, with half of the genetic complement of the parent cells.

Prophase 1: replicated chromosomes condense, homologous chromsomes pair up, crossing over occurs between homologous chromosomes, the spindle is formed, and the nuclear envelope breaks apart into vesicles

Metaphase 1: chromosomes condense and move together, aligning in the center of the dividing cell.

Anaphase 1: Homologous chromosomes are pulled to opposite poles of the cell but sister chromatids remain joined at their centromeres

Telophase 1: the chromosomes are enclosed in nuclei, four haploid daughter cells, generates genetic diversity

Meiosis 2

Prophase 2: chromosomes condense, and a new set of spindle fibers forms. NO crossing over

Metaphase 2: INDIVIDUAL centromeres of the paired chromatids align along the equatorial plate in both cells

Anaphase 2: Sister chromatids SEGREGATE from each other and migrate to opposite ends of the cell

Telophase 2: cell division begins again in each of the two daughter cells, creating 4 daughter cells

Mitosis = Equational division

Difference of Meiosis 1 and Meiosis 2

The goal of meiosis I is to separate homologous chromosomes. The goal of meiosis II is to separate sister chromatids