CELLULAR REPRODUCTION

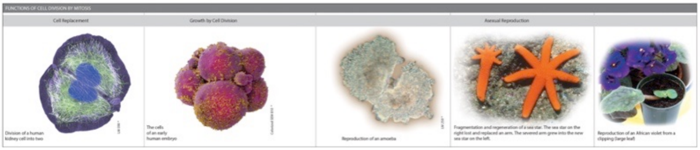
AND WHAT IT ACCOMPLISHES ...

reproduction?

- reproduction occurs at the cellular level
- [EXAMPLE] like the skin on your arm → skin cells are constantly reproducing themselves and moving toward the outer surface, replacing dead cells that have rubbed off. this removal of the skin goes on throughout life and when the skin gets injured the reproduction of cells is what helps to heal the wound.
- **REMEMBER** when a cell undergoes reproduction, the process is called cell division. The 2 "daughter" cells that result from cell division are genetically identical to each other and to the original "parent" cell. Before the parent cell splits in 2, it duplicates chromosomes and then during cell division, each daughter cell receives one identical set of chromosomes from the original parent cell.

the functions of cell division

- cell division plays several important roles in the lives of organisms
  [EXAMPLE] within the body, millions of cells must divide every second to replace damaged or lost cells.
- another function of cell division is growth
  ↳ all of the many cells in your body are the result of repeated cell divisions that began in the mother's body w/ a single fertalized egg.



- reproduction is another vital function of cell division. Many single celled organisms, like amoebas, reproduce by dividing in half, and the offspring are genetic replicas of the parent.
  ↳ this is asexual reproduction

asexual reproduction

- asexual reproduction : the creation of genetically identical off– by a single parent, without the participation of sperm and egg.
  ↳ offspring produced by asexual reproduction inherit all their chromosomes from a single parent and therefore there are genetic duplicates An individual that reproduces asexually gives rise to a clone (a group of genetically identical individuals)
- many multicellular organisms can reproduce asexually as well.
  [EXAMPLE] Some sea star species can grow new individuals from fragmented pieces. (or) in growing houseplants from clippings ⟹ asexual reproduction in plants
- in asexual reproduction, there is one simple principle of inheritance :
  The lone parent and each of its offspring have identical genes. The type of cell division responsible for asexual reproduction and for the growth & maintenence of multicellular organisms is called mitosis.

sexual reproduction

- sexual reproduction requires the fertilization of an egg by a sperm
- the production of gametes (sperm & egg) meiosis
  - ↳ meiosis:
    - ▫ a special kind of cell division that only occurs in reproductive organs
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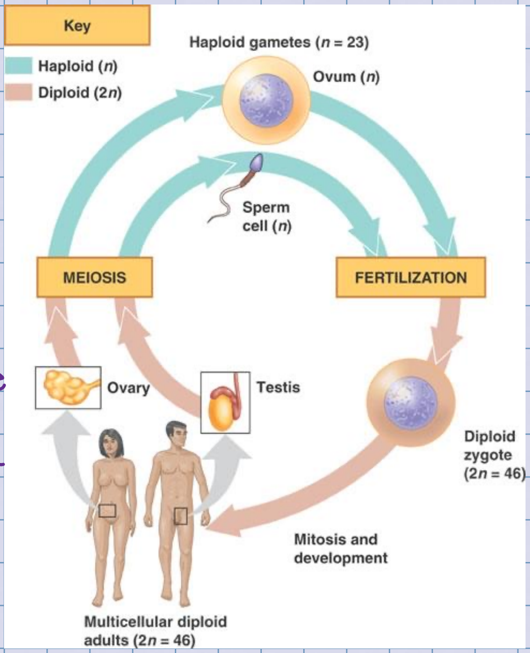
meiosis

- GAMETES & THE LIFE CYCLE OF A SEXUAL ORGANISM

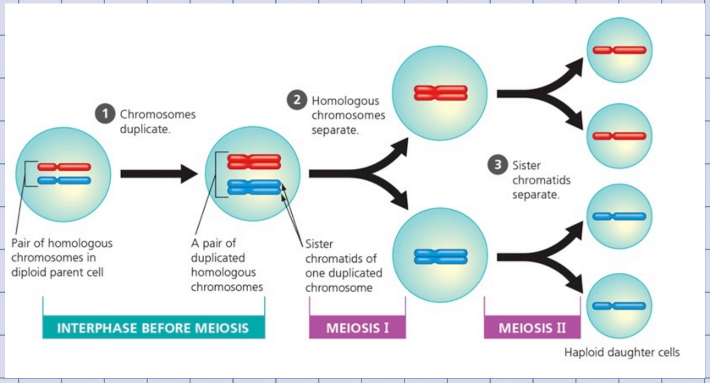
- the life cycle of a multicellular organism is the sequence of generation to generation stages from fertilization to the production of its own offspring
- the key factor to the life cycle is having 2 sets of chromosomes, one inherited from each parent
- humans are diploid organisms b/c all typical body cells (somatic cells) contain pairs of homologous chromosomes (matching sets)
- the gametes, egg, and sperm cells aren't diploid.
  - ↳ ▫ made by meiosis in an ovary or testis
    - ▫ each gamete has a single set of chromosomes: 22 autosomes + 1 sex chromosome, either X or Y
- REMEMBER: a single cell chromosome set is a haploid cell; it only has one pair of homologous chromosomes



- fertilization: cycle a haploid sperm fuses w/ a haploid egg
  - ↳ the resulting fertilized egg (zygote) ⟹ diploid egg. It has 2 sets of chromosomes, one set from each parent. The life cycle is completed as a sexually mature adult develops from the zygote.
- miotic cell division ensures that all somatic cells of the human body receive a copy of all of the zygote's 46 chromosomes ⟹ every one of the trillions of cells in the body can trace its ancestry back through miotic divisions to the single zygote produced
- producing haploid gametes by meiosis keeps the chromosome # from doubling in every generation.

[EXAMPLE]

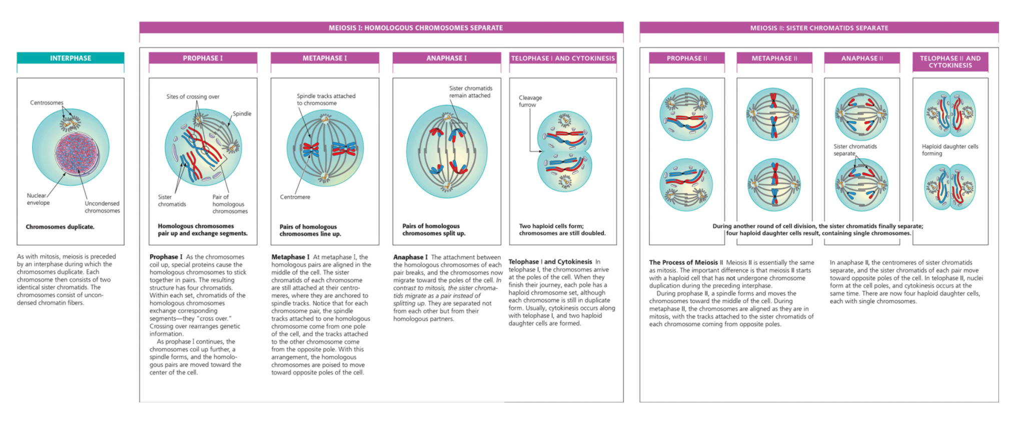
- HOW MEISOSIS HALVES CHROMOSOME NUMBER



the process of meiosis

- meiosis produces haploid gametes in diploid organisms
- during meiosis the number of chromosomes is cut in half
- in meiosis, a cell that has duplicated its chromosomes undergoes 2 consecutive divisions: meiosis I and meiosis II
- each of the 4 daughter cells resulting from meiosis has a haploid set of chromosomes – 1/2 as many chromosomes as the starting cell
  - ↳ this is b/c one duplication of the chromosomes is followed by 2 divisions
- meiosis also involves an exchange of genetic material – pieces of chromosomes – between homologous chromosomes
  - ↳ this exchange is called crossing over, which is the first prophase of meiosis

- STAGES OF MEIOSIS



Chromosomes duplicate.

Homologous chromosomes pair up and exchange segments.

Pairs of homologous chromosomes line up.

Pairs of homologous chromosomes split up.

Two haploid cells form; chromosomes are still doubled.

During another round of cell division, the sister chromatids finally separate; four haploid daughter cells result, containing single chromosomes.

As with mitosis, meiosis is preceded by an interphase during which the chromosomes duplicate. Each chromosome then consists of two identical sister chromatids. The chromosomes consist of uncondensed chromatin fibers.

Prophase I As the chromosomes coil up, special proteins cause the homologous chromosomes to stick together in pairs. The resulting structure has four chromatids. Within each set, chromatids of the homologous chromosomes exchange corresponding segments—they "cross over." Crossing over rearranges genetic information.

As prophase I continues, the chromosomes coil up further, a spindle forms, and the homologous pairs are moved toward the center of the cell.

Metaphase I At metaphase I, the homologous pairs are aligned in the middle of the cell. The sister chromatids of each chromosome are still attached at their centromeres, where they are anchored to spindle tracks. Notice that for each chromosome pair, the spindle tracks attached to one homologous chromosome come from one pole of the cell, and the tracks attached to the other chromosome come from the opposite pole. With this arrangement, the homologous chromosomes are poised to move toward opposite poles of the cell.

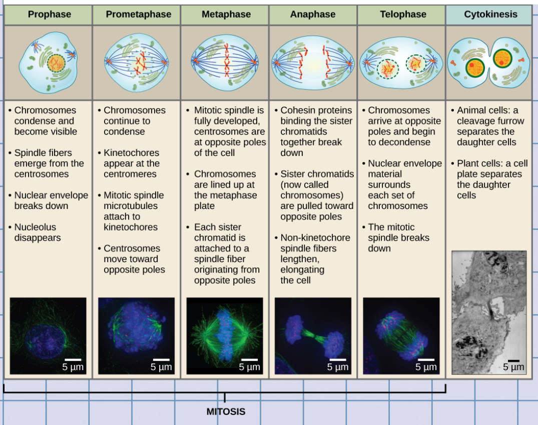
Anaphase I The attachment between the homologous chromosomes of each pair breaks, and the chromosomes now migrate toward the poles of the cell. *In contrast to mitosis, the sister chromatids migrate as a pair instead of splitting up.* They are separated not from each other but from their homologous partners.

Telophase I and Cytokinesis In telophase I, the chromosomes arrive at the poles of the cell. When they finish their journey, each pole has a haploid chromosome set, although each chromosome is still in duplicate form. Usually, cytokinesis occurs along with telophase I, and two haploid daughter cells are formed.

The Process of Meiosis II Meiosis II is essentially the same as mitosis. The important difference is that meiosis II starts with a haploid cell that has **not** undergone chromosome duplication during the preceding interphase.

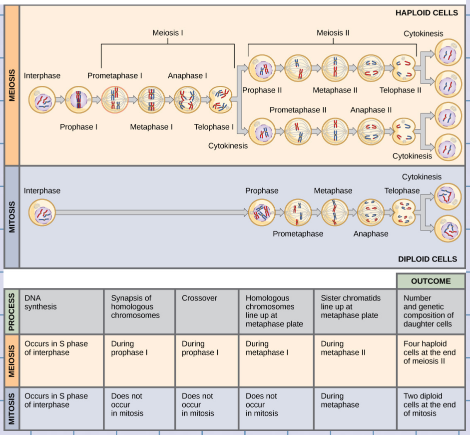
During prophase II, a spindle forms and moves the chromosomes toward the middle of the cell. During metaphase II, the chromosomes are aligned as they are in mitosis, with the tracks attached to the sister chromatids of each chromosome coming from opposite poles.

In anaphase II, the centromeres of sister chromatids separate, and the sister chromatids of each pair move toward opposite poles of the cell. In telophase II, nuclei form at the cell poles, and cytokinesis occurs at the same time. There are now four haploid daughter cells, each with single chromosomes.



Prophase	Prometaphase	Metaphase	Anaphase	Telophase	Cytokinesis
• Chromosomes condense and become visible • Spindle fibers emerge from the centrosomes • Nuclear envelope breaks down • Nucleolus disappears	• Chromosomes continue to condense • Kinetochores appear at the centromeres • Mitotic spindle microtubules attach to kinetochores • Centrosomes move toward opposite poles	• Mitotic spindle is fully developed, centrosomes are at opposite poles of the cell • Chromosomes are lined up at the metaphase plate • Each sister chromatid is attached to a spindle fiber originating from opposite poles	• Cohesin proteins binding the sister chromatids together break down • Sister chromatids (now called chromosomes) are pulled toward opposite poles • Non-kinetochore spindle fibers lengthen, elongating the cell	• Chromosomes arrive at opposite poles and begin to decondense • Nuclear envelope material surrounds each set of chromosomes • The mitotic spindle breaks down	• Animal cells: a cleavage furrow separates the daughter cells • Plant cells: a cell plate separates the daughter cells

MITOSIS



						OUTCOME
PROCESS	DNA synthesis	Synapsis of homologous chromosomes	Crossover	Homologous chromosomes line up at metaphase plate	Sister chromatids line up at metaphase plate	Number and genetic composition of daughter cells
MEIOSIS	Occurs in S phase of interphase	During prophase I	During prophase I	During metaphase I	During metaphase II	Four haploid cells at the end of meiosis II
MITOSIS	Occurs in S phase of interphase	Does not occur in mitosis	Does not occur in mitosis	Does not occur in mitosis	During metaphase	Two diploid cells at the end of mitosis

cancer

- benign tumor: a lump of abnormal cells that remains at the original site even though it grows out of control
- malignant tumor: an abnormally growing mass of cells actively spreading through the body
- metastasis: the spread of cancer cells from their origin site to other sites
- an individual w/ a malignant tumor is said to have cancer