LIFE CYCLES

Life begins with fertilization, which is the union of male and female sex cells otherwise known as gametes. The female sex cell is known as the egg and the male sex cell is called a sperm cell. When the sperm cell fertilizes the egg, the resulting fertilized egg is called a zygote. The zygote divides by mitosis to produce a diploid ($2n$) organism. This process is known as development.

In order to reproduce, the adult organism produces gametes (sperms or eggs) that contain the haploid ($n$) number of chromosomes. The cells that give rise to the gametes undergo a special reduction division process known as meiosis.

In meiosis, there are two divisions called Division I and Division II. Division I is the separation of the chromosome pairs, while Division II is the separation of chromatids. By separating the chromosome pairs, meiosis accomplishes a reduction of the chromosome number. The beginning cell has the $2n$ number. At the end of the process, the resulting four cells each contain the $n$ number.

Many lower plants display alternation of generations. In these plants, meiosis results in haploid spores that produce separate male and female haploid plants. These male and female haploid plants produce male and female gametes, respectively, which unite to form a zygote. The zygote gives rise to a diploid plant that will produce the haploid male and female spores. This process is shown in Figure 17-1.

---

**Figure 17-1.** Alternation of generations in plants. In lower plants, such as the moss plant, fertilization produces a new diploid plant that grows and develops. The adult plant produces reproductive cells that undergo reduction division (meiosis). As a result of meiosis, haploid spores are produced that give rise to male and female haploid plants. The male plants produce sperms and the female plants produce eggs. These unite to produce the diploid plant structure that continues the cycle.
GAMETOGENESIS

Gametogenesis is the formation of sex cells, each with the $n$, or haploid, number of chromosomes. The first step in gametogenesis is meiosis. The process of meiosis consists of two divisions separated by a period of time called interkinesis. The individual chromosomes, however, separate only once.

Stages of meiosis

Meiosis Division I—separation of chromosome pairs

- Prophase I—the chromosomes get short and thick.
- Metaphase I—the chromosome pairs line up in the center of the cell.
- Anaphase I—the chromosome pairs separate. One set goes to one pole of the cell while the other goes to the opposite pole.
- Telophase I—two daughter nuclei form, each containing the $n$ number of chromosomes. Cytokinesis completes the process. The result is two haploid cells.

Interkinesis—a period between the two divisions. The length of interkinesis depends on the organism involved. Some species have interkinesis periods that are very short. Other organisms may have years between the two divisions.

Meiosis Division II—separation of chromatids

- Prophase II—the chromosomes shorten and thicken.
- Metaphase II—the chromosomes line up in the center of the cell.
- Anaphase II—the chromatids separate. One set of chromatids goes to one pole of the cell while the other pair of chromatids goes to the opposite pole of the cell.
- Telophase II—the daughter nuclei form and cytokinesis occurs.

Each of the haploid cells from Division I enters Division II. A total of four nuclei result. The fate of these nuclei depends upon whether the meiosis is part of gametogenesis in a female or gametogenesis in a male.

Oogenesis

Gametogenesis in females is called oogenesis. Oogenesis (pronounced oh-oh-GENesis), results in the formation of the egg cell by meiosis. Each human female receives approximately 700,000 oogonia in her ovaries. During each menstrual cycle, one oogonium becomes the primary oocyte (which is a $2n$ cell) while the cells surrounding it become the follicle.
The primary oocyte divides by Meiosis I to produce a secondary oocyte. The other nucleus resulting from Division I is a throw-away nucleus known as a polar body. A polar body consists of the chromosomes and nucleus resulting from meiotic division but it receives almost no cytoplasm. All the cytoplasm is found in the secondary oocyte.

After interkinesis, the secondary oocyte divides by Meiosis II, to produce the egg cell and a polar body. The earlier polar body also divides to form two polar bodies. The result is the egg cell and three polar bodies that are discarded.

Uneven cytoplasmic division in the formation of the egg cell is advantageous in that the cytoplasm will serve to provide energy for the developing embryo until it can implant in the uterus. In other animals, such as the frog, there is a supply of food associated with the egg cell that will nourish the developing embryo. If the cytoplasmic division were equal, then the egg cell would receive only one-quarter of the cytoplasm and the remaining three-quarters would be wasted.

**Spermatogenesis**

The testes contain millions of spermatogonia. Each of these cells can develop into a primary spermatocyte. A primary spermatocyte will undergo Meiosis I to produce two secondary spermatocytes. Finally, each secondary spermatocyte undergoes Meiosis II resulting in four sperm cells. Each sperm cell receives the same amount of cytoplasm. Spermatogenesis results in equal distribution of the cytoplasm in contrast to oogenesis which has unequal cytoplasmic division.

**FEMALE REPRODUCTIVE SYSTEM**

The female human has two ovaries, each of which is associated with an oviduct. The oviducts connect with the uterus. Sperm are introduced into the uterus via the vagina and the cervix. They swim up the uterus and into the oviducts where fertilization takes place.

Ovulation is the process in which the egg leaves the ovary. Ovulation is under the control of two hormones. Follicle stimulating hormone and leutenizing hormone stimulate the egg and its follicle to develop. During the menstrual cycle, the blood levels of these two hormones increase to a peak. Ovulation occurs just after the levels reach the peak. The uterine lining prepares for nourishing an embryo during this time. If the egg remains unfertilized, the uterine lining breaks down and menstruation occurs. Then the whole cycle repeats itself the next month.
MALE REPRODUCTIVE SYSTEM

Sperm are produced in the testes, which are found outside the body. Upon leaving the testes, the sperm travel up the vas deferens, and into the seminal vesicle from which they are released through the urethra.

Fertilization takes place most often in an oviduct. The sex of the person is determined when the gametes unite. Then the cleavage stages of development begin.