Gametogenesis (gametocytogenesis)

Gametogenesis is the creation of sex cells - gametes (from Greek γαμετης = married). Sex cells are formed by reductional division - meiosis. This process is evolutionarily younger than mitosis. As a result of meiosis, gametes have a haploid set of chromosomes. They develop from the germinal epithelial cells of the male gonads - testes and the female gonads - ovaries.

Gametogenesis takes place in two stages:

- **growth phase** (proliferation) - primary germ cells - gametogonia - have a diploid set of chromosomes and they are formed by mitosis;
- **maturation phase** - gametogonia change to gametes by meiosis, take place in the gonads.

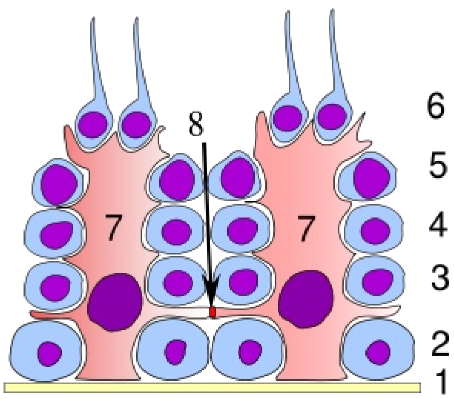
The development of male and female gametes is very different.

Spermatogenesis

Spermatogenesis last throughout the period of sexual activity of the man. Spermatogenesis consists of two successive processes - **spermatocytogenesis** which is followed by **spermatohistogenesis**. After spermiohistogenesis, sperms are released into the lumen of the ducts and are passively carried into the epididymis. **Each germ cell gives rise to four full-blown sperms.**

Spermatocytogenesis

Male sex cells - sperms - develop in the seminiferous tubules of the testis. The maturation begins under the influence of sex hormones at puberty. The diploid germ cells - spermatogonia - grow, enrich themselves with nutrients and divide during mitosis. They divide into the still undifferentiated spermatogonia A or into already differentiated spermatogonia B, which develop into primary spermatocytes. The primary spermatocytes develop during first meiosis into secondary spermatocytes (prespermatids). This progess is followed by a short interkinesis in which no DNA replication occurs. In the second meiotic division the secondary spermatocytes develop into spermatids - small cells with haploid sets of chromosomes. The prespermatids and spermatids remain connected by intercellular cytoplasmic bridges. This connection ensure synchronized development and exchange of gene products between cells. Spermatids remain in the folds of Sertoli cells, which supply them with nutrients and energy essential for their development.



Spermatogenesis

> **Summary:**
>
> **spermatogonia → primary spermatocytes → secondary spermatocytes → prespermatids → spermatids → spermatozoa (sperm)**

Spermiohistogenesis (spermiogenesis)

The spermiohistogenesis is the final maturation of male sex cells. The spermatids obtain the shape and function, which are necessary for penetration into the ovum and its fertilization:

- **Golgi stage:**
  - small PAS-positive granules accumulate in the Golgi apparatus and fuse to form the acrosomal lysosome;
  - the axoneme of flagellum starts to form;
  - chromosomes of the nucleus become condensed; DNA is fixed into crystalloid form by basic proteins - protamines (replacing histones); all gene activity is repressed.
- **Cap stage:**
  - the acrosome vesicle grows and creates cap-like structure on the nucleus.
- **Acrosomal phase:**
  - the final acrosome is formed, it contains hydrolytic enzymes (hyaluronidase - breaks down corona radiata during fertilization, acid phosphatase, protease acrosin, and others);
  - the cell rotates so that the anterior pole faces the edge of the seminiferous tubules;
  - the nucleus stretches due to microtubules
  - the distal centriole grows to form the basal body of the flagellum (the proximal centriole, will form the meiotic spindle in the ovum after fertilization);
  - the mitochondria move to the proximal part of the flagellum, and form the central segment of the sperm;
- **Maturation phase:**
  - the excess cytoplasm is separated and degraded by Sertoli cells;

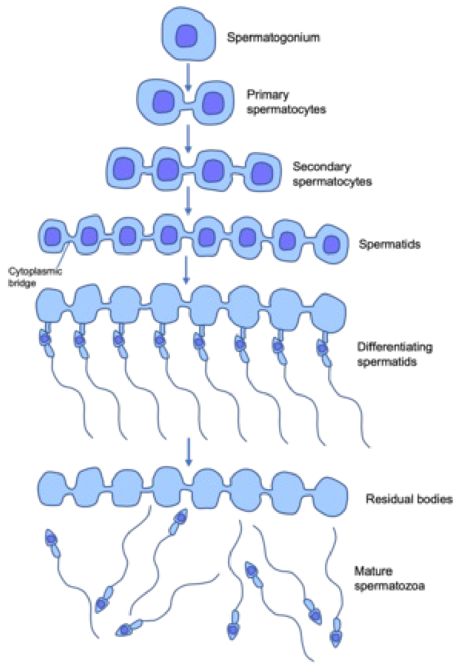
- the intercellular bridges between spermatids are changes into residual bodies

Oogenesis

Female sex cell - **ovum** - develops in the ovaries. The diameter of the human ovum is 0.1 mm, the size is specific for each species. The ovum is formed from the cells of germline in the ovarian cortex. There are established about 2 million germ cells - **oogonia** in the ovary. The ovum, like every gamete, contains half number of chromosomes (22 somatic + 1 sex chromosome).

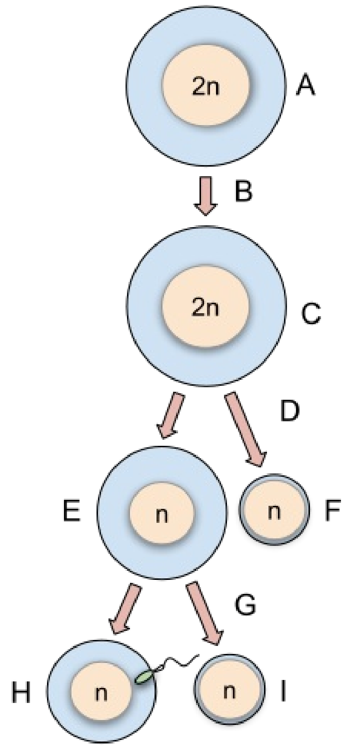
Reproduction of oogonia by mitotic division begins at the end of the 2nd month and ends at the 5th month of intrauterine development in the first stage of reproductive division (meiosis). Coelomic epithelial cells attach to the oogonia in a single layer and form so-called primordial follicles. In about 50% of oogonia, this layer does not form and the cells die by apoptosis. The **primary oocytes** are created from oogonia by mitosis (in women, their formation - the growth stage - ends by the third month after birth). Primary oocytes enter meiosis. The prophase of the **first meiotic division** lasts to the diplotene stage, in which the oocytes remain until the hormonal initiation of further maturation, the so-called **dictyotene stage**

The maturation of individual follicles then continues due to **hormones** after puberty. The stimulus for the continuation of the first maturation division is progesterone in some species, in others the change in level of estrogen and progesterone during the cycle. The maturation takes place throughout the generation period (in a female the cycle lasts Ø 28 days - each time matures only one egg). During a woman's life, 300-400 ova are released from the ovary, but **only about 400-500 ova mature**. The first meiotic division (in metaphase) of the developing oocyte produces two haploid cells: one **secondary oocyte** and one rudimentary cell, so-called first polar body. The cell remains undivided.



Spermatogenesis

The second meiotic division is completed after ovulation, after the sperm penetrates to the ovum. The secondary oocyte divides into **ovum** and the second polar body. At the same time, the 1st polar body undergoes mitosis, divides into two other bodies and then all 3 polar bodies disappear. During the maturation of the ovum before the ovulation, some genes of the ovum are intensively expressed. RNA, protein and reserve materials are synthesized, and some mRNAs are transported to the cytoplasm where they are stored in an inactive form and activated only after fertilization of the egg. Other nutrients, proteins and RNA of all types are transported into the egg from the cells of follicle. Some reserve materials are synthesized in the mother's liver and transported by the blood into the ovum. The structure of the ovum and the amount of substances are thus significantly influenced by the genes of the maternal somatic cells. When hormonal regulation is disturbed, the proliferative phase of the cycle is prolonged. It is called over-ripeness of the ovum. The consequence is disintegration of the cell structure, disruption of the spindle apparatus and creation of chromosome nondisjunction and fetal aneuploidy.



Oogenesis

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