DEVELOPMENT AND MATURATION OF THE MALE GAMETES

- **Embryology** is a science that studies the formation and development of organisms.
- It examines their life before the birth of humans and animals. It also examines the hatching period of poultry.

- Life begins with the union of spermatozoon and ovum. The resulting structure is called **zygote**.
- **Prenatal period** is the process, in which a human or animal embryo during pregnancy, from fertilization to birth.
- **Postnatal period** is the life of a human or an animal after birth.
- The prenatal period passes through in the **uterus** in human and animals. The prenatal period in poultry is the incubation period in the **egg**.

Prenatal period is divided into two parts.

Embryonic period: It is the period between zygote formation and organs occurrence. The developing organism is called **embryo.**

Fetal period: It is the period between from organs formation and until to birth. The developing organism is called **fetus.**

- Birth occurs when the fetus matures in mammals. And begins postnatal life.
- In the poultry, this period corresponds to the hatching.
- The events from the zygote to the formation of the organs are examined at the general embryology.
- The changes in the formation of the organs in the fetal stage are examined at the special embryology.
- In order to understand the embryonic period, male and female reproductive cells must be known.

- A zygote is a single cell, which has formed as the result of the merging of an egg cell and a sperm.
- In the zygote contains chromosomes and genes from the mother and father. It is a single cell (unicellular) and divides into several times.

  The dividing cells migrate, grow, differentiate and form a multicellular organism.

- For fertilization, it is necessary the production of germ cells.
- Mature germ cells are called gametes.
- Male germ cells are called spermatozoa (spermium).
- Femail germ cells are called ovum (oocyte).

Spermatogenesis is the process, in which spermatozoa are produced from male primordial germ cells by way of mitosis and meiosis.

Oogenesis is the process of development of female gametes (also called ova or eggs), that takes place in ovaries. The process of oogenesis begins before birth with the formation of diploid germ cells, called oogonia that have the ability to develop into mature ova.

Both spermatogenesis and ovogenesis are called gametogenesis.

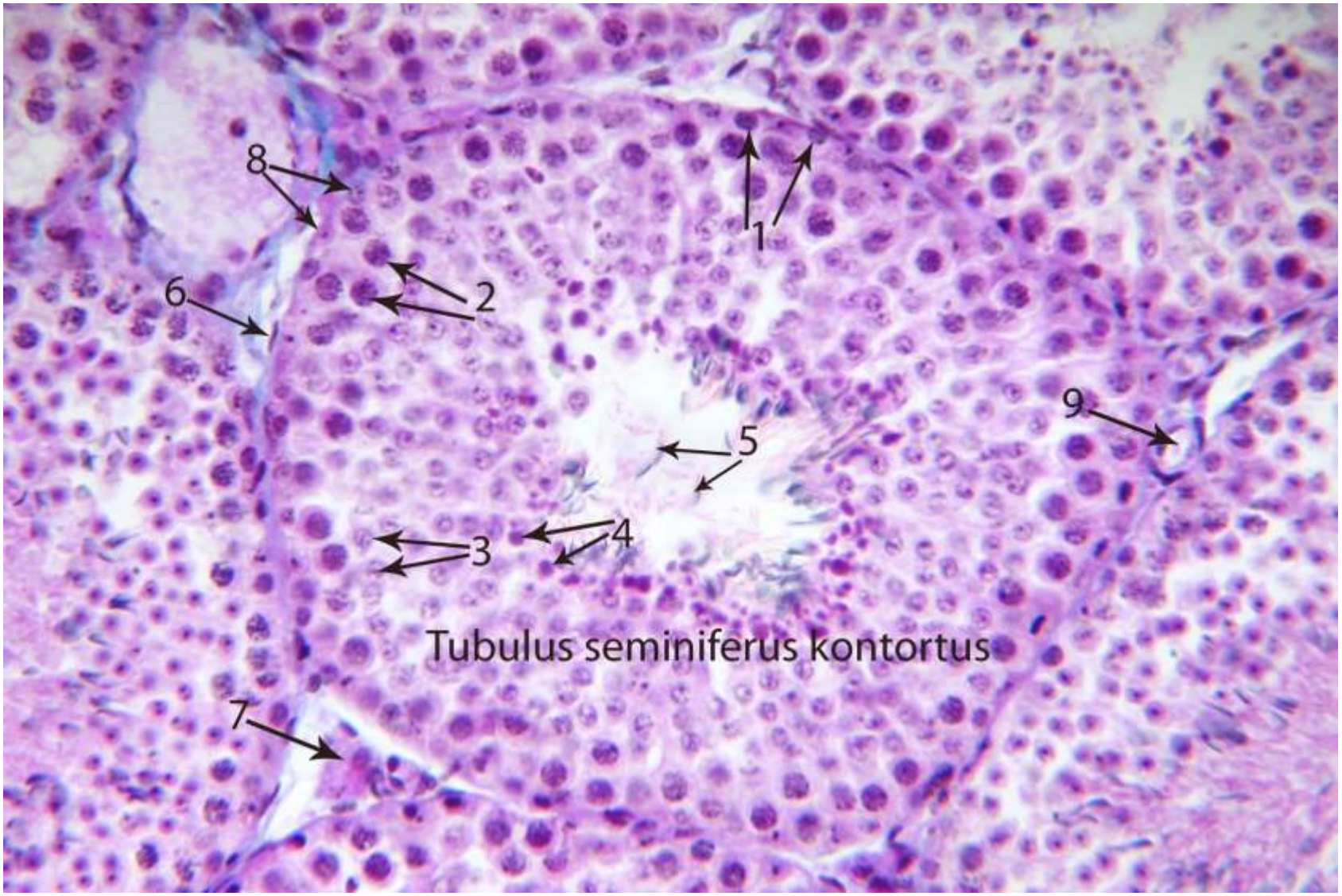
Gametogenesis is a biological process, by which diploid or haploid precursor cells undergo cell division and differentiation to form mature haploid gametes. Depending on the biological life cycle of the organism, gametogenesis occurs by meiotic division of diploid gametocytes into various gametes, or by mitotic division of haploid gametogenous cells.

To understand gametogenesis in male and female, we must know the structure of the genital system and their histo-physiological properties.

Male reproductive organs consist of testes, ducts, accessory glands and penis.
Testicles, according to different animal species, different size, and shape, with external and internal secretory function, double glands.

They are located in a skin bag (scrotum) within the inguinal region.
The functional part of the testicle are tubuli seminiferi contorti.

In these channels are produced spermatozoa.



In the connective tissue, among the seminiferous tubules are located Leydig cells. These cells secrete the testosteron.

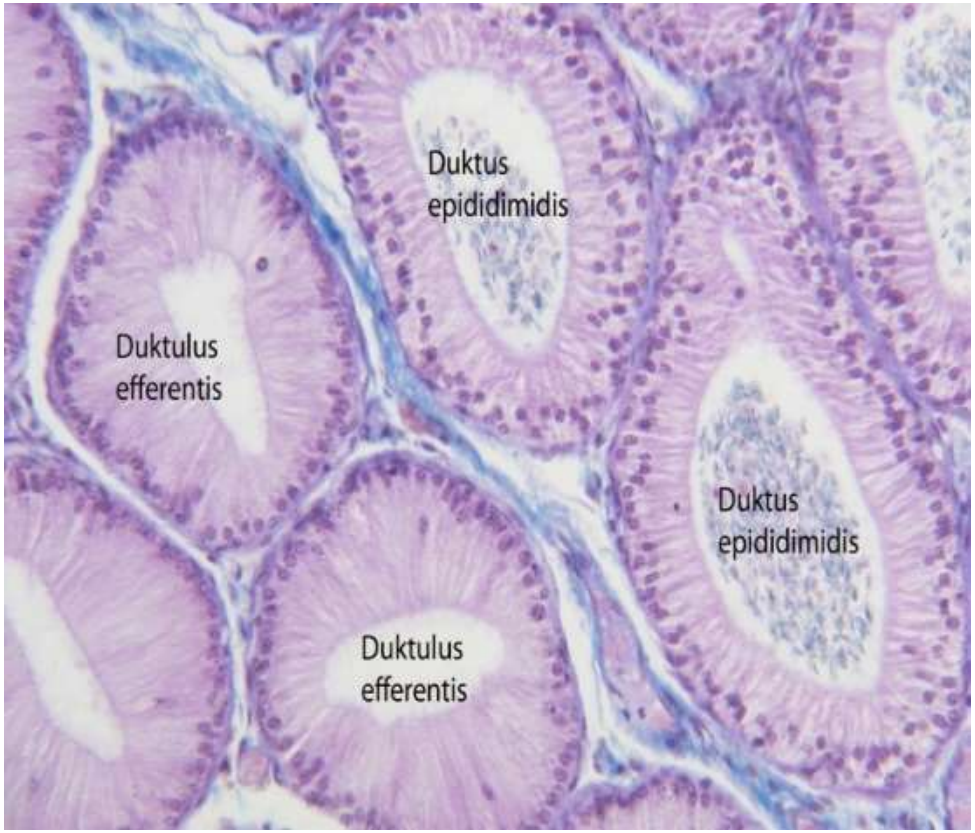
Channels are

- ductuli efferentes,

- ductus epididimidis and

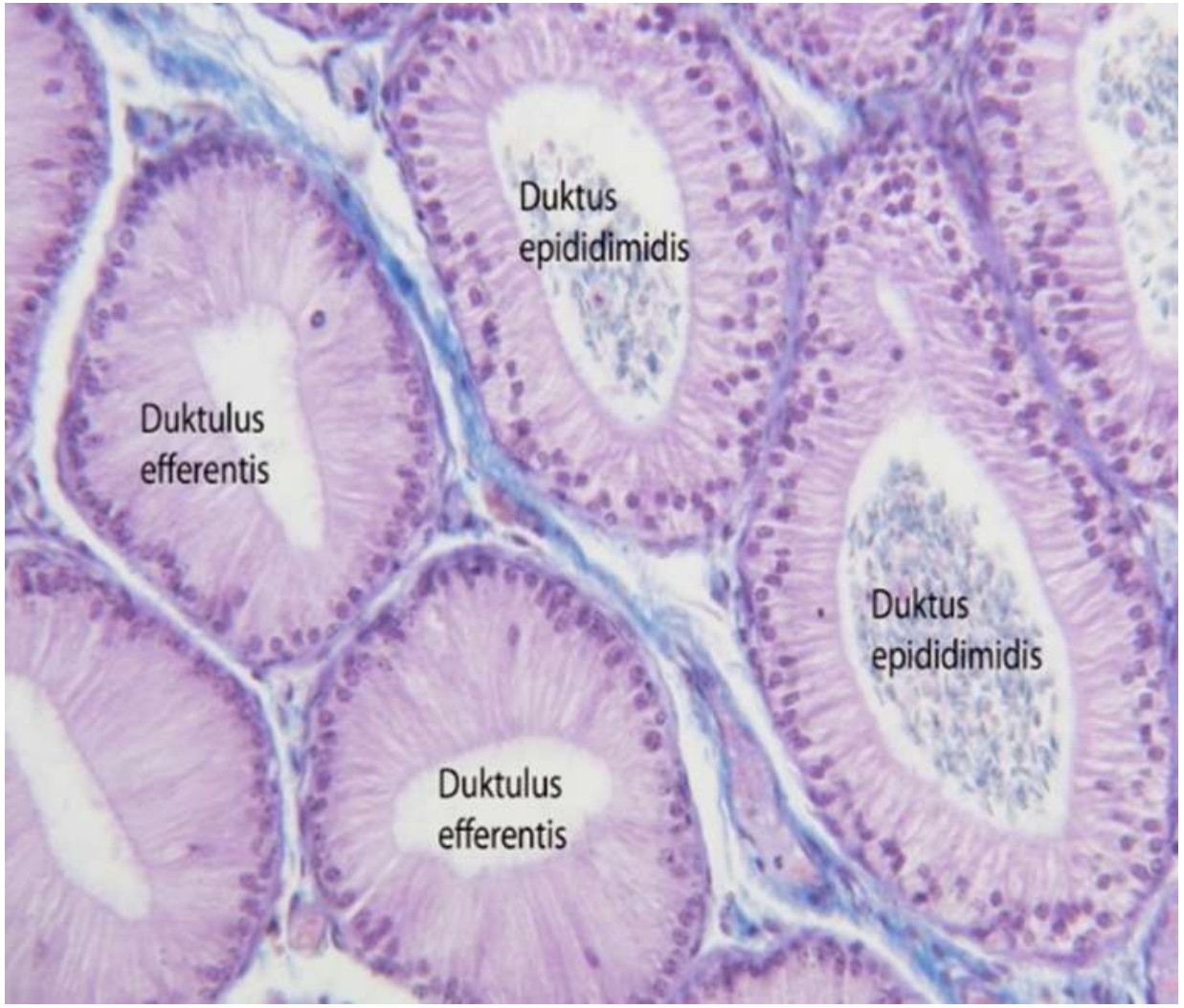
- ductus deferens.

The ductuli efferentes are unilaminar and composed of columnar ciliated cells. The epithelium is surrounded by a band of smooth muscle that helps to propel the sperm toward the epididymis.

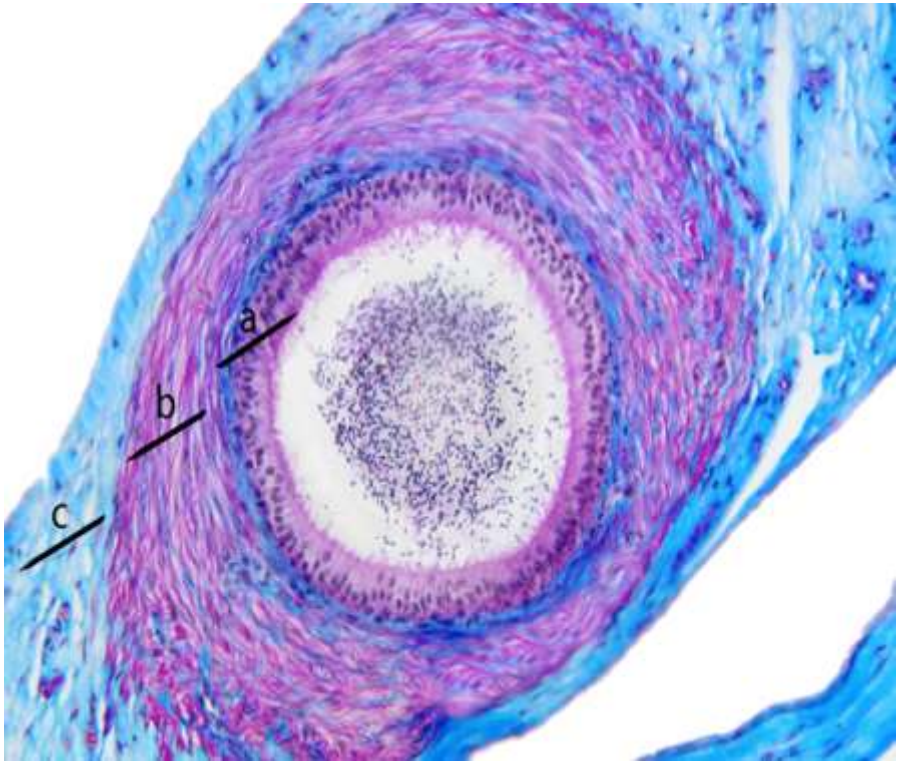


Spermatozoa formed in the testis enter the caput epididymis, progress towards to the corpus, and finally reach the cauda region, where they are stored. Abnormal spermatozoa are phagocytosed, testicular fluid is partially resorbed, spermatozoa are matured and are stored in the ductus epididymidis.

Ductus epididymidis are too long (in bull, 40 m in length; in stallion, 70 m in length).



The ductus deferens, also known as the vas deferens, is a muscular tube in the male reproductive system that carries sperm from the epididymis to the ejaculatory duct.



SPERMATOGENESİS

Spermatogenesis is the process in which spermatozoa are produced from male primordial germ cells by way of mitosis and meiosis. (It is consist of spermatogonia, primary spermatocytes, secondary spermatocytes, spermatids and spermatozoa).

- It is consist of **goniyogenesis (proliferation) spermatocytogenesis (primary spermatocytes, secondary spermatocytes and spermatids formation) and spermiogenesis (differentiation).**
- **Spermatogonia** that form the basal layer of the germinal epithelium, divide mitotically.
- Events, beginning from spermatogonium to spermatozoon formation are stages of **proliferation**, **growth**, **maturation** and **metamorphosis**.

- **The proliferation phase, spermatogonia are increased their numbers divided by mitosis. This period is called GONİYOGENESİS.**

- **There are A and B types of spermatogonia. Spermatogonia A is remain to be cell source (stem cell). The spermatogonia B moves to the tubule lumen. B is greater than A.**
- **Spermatogonia are proliferated with mitosis, and then they grow and form of primary spermatocytes. This period is called the growth phase.**

- After the formation of primary spermatocytes, maturation phase begins.
- Maturation phase consists of meiosis. Meiosis consists of two mitosis.
- End of the first mitosis of primary spermatocytes, secondary spermatocytes are formed.
- After the second mitotic division, from the secondary spermatocytes with haploid chromosomes, spermatids are formed.
- All of these stages are called spermatocytogenesis.
- After meiosis, spermiyogenesis begins and spermatids enter the metamorphosis stage.
- Spermatids, as a result of some changes seen in the cytoplasm and nucleus, they turn into spermatozoa (spermium).

Human spermatogenesis takes 74 days, ram spermatogenesis takes 50 days, bull, dog and horse spermatogenesis take 60 days.

All the seminiferous tubules in the testes does not exhibit the same activity at the same time.

This situation ensures continuity in the production of spermatozoa.

The importance of meiosis:

1. Species keeps constant the number of chromosomes from generation to generation.
2. Chromosomes from the mother and father are distributed randomly to the gametes.
3. In crossing over, between mother and father's chromosomes leads the segment change. Thus, in each chromosome, mother and father's genes are mixed.

Hormonal control of spermatogenesis

- In spermatogenesis, testosterone, FSH, LH and ABP is important.
- When sexual maturity is reached, FSH is secreted from the anterior lobe of the pituitary gland. And FSH affect the Sertoli cells. And then ABP is secreted from the Sertoli cells.

- Afterward LH is secreted from the anterior lobe of the pituitary gland. And LH affects the Leydig cells in the testicular interstitial tissue. And then Leydig cells secrete testosteron.

- Testosterone constitutes complex with ABP. These complexes affect spermatogonia, and mitosis begins.
- FSH hormone initiates spermatogenesis.
- LH and testosterone hormones are necessary for spermatogenesis continuity.

- Sertoli cells synthesize ABP. Also it secretes inhibin and small amounts of estrogen hormone.
- Inhibin, suppress the secretion of FSH from the anterior lobe of the pituitary.
- In Sertoli cells, testosterone is converted to estrogen.

Anabolic (tissue developer) effective testosterone, has also androgenic effects.

As a result of androgenic effects, libido, voice thickening, horn, mane, comb, beard growth, development of the genital glands are seen as male characteristics.

Spermatozoa=spermium

- Spermatozoa appear, as if consist of the head and tail in the light microscope.
- Whereas, the neck of the spermatozoa is seen under the electron microscop.
- The spermatozoa of different groups of animals exhibit great variety of form. However, shows a remarkable uniformity of structure.
- The spermatozoon, which performs the function of carrying genetic material from the male to the oocyte, consists of two principal parts= head and tail.

Spermatozoa

HEAD: The front part called gale capitis. In the end portion of the galea capitis, contains acrosomal cap which is special types of lysosomal structures. Acrosomal cap is derive of the Golgi apparatus. Hydrolytic enzymes (hyaluronidase, acrosin, aryl sulfatase) are found in the acrosom.

Spermatozoa, thanks to these enzymes, enter the ovum during the fertilization.

Tail: The tail consists of four components—**neck**, **mid-piece**, **principal piece** and **end piece**.

The tail (a flagellum) has the characteristic structure and cilia, with two central microtubules and more peripheral doublets making up the axial filament complex.

The proximal part is surrounded by an end-to-end helix of mitochondria to provide the energy during movement.

- **Ejaculate, semen:** The fluid that is released through the penis during orgasm. Semen is made up of fluid and spermatozoa. The fluid comes from the prostate, seminal vesicles, and other sex glands. The sperm is manufactured in the testicles. The seminal fluid helps transport the spermatozoa during orgasm. Seminal fluid contains sugar as an energy source for sperm.
- Ejaculate constitutes 10 % spermatozoa and the rest of the seminal plasma. The female body, spermatozoa survival time is 2-3 days.

- When a man has reached sexual maturity, has approximately 3 ml of ejaculate. In humans, an ejaculate totally contains 200-300 million spermatozoa.
- Human fertility limit is 50 million spermatozoa per 1 ml of ejaculate.
- If there are 60 – 120 million spermatozoa in 1 ml of ejaculate, called **normospermie.**
- If there are 250 million spermatozoa found in 1 ml, called **polyspermy**.
- If there are 30-60 million spermatozoa found in 1 ml, called **oligospermy**.
- If there are 1-30 million spermatozoa found in 1 ml, called **hypospermy**.
- The absence of spermatozoa in the ejaculate is called **azospermy**.
- If there are spermatozoa in the ejaculate, and motionless and lifeless, then called **necrospermy.**

KAYNAKLAR

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