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Fundamentals of the

HISTOLOGY OF FISH

PART I

HISTOLOGY OF TELEOSTS

An Introductory Text for Veterinary Students

CHAPTER 6

THE REPRODUCTIVE SYSTEM

THE TESTIS

The testis consists of:

A) Framework:

a- Capsule.

b- Septa.

They divide the testis into lobules.

B) Parenchyma:

The parenchyma is composed of:

a) A series of tubules or blind sacs, the seminiferous tubules, which are lined with spermatogenic (or seminiferous) epithelium and Sertoli's cells.

The seminiferous tubule is different from that of higher vertebrates in which a permanent germinal epithelium exists. In fishes the spermatogonium in the resting stage is located at the blind end of the seminiferous tubule but it moves to the wall of the seminiferous tubule in the maturing season.

Spermatogenesis:

The spermatogonium in the early stage is a large oval cell with one large round nucleolus. In the latter stage of proliferation it is small and round. After the proliferation stage the spermatogonium develops into the primary spermatocyte. The primary spermatocyte develops into the secondary spermatocyte by maturation (or meiotic) division and then undergoes a second maturation division to develop into a spermatid. The spermatid then develops into a spermatozoon with a head, middle piece and long tail. The head is rounded and contains a large deeply stained nucleus. The latter presents a nuclear fossa at the side facing the middle piece. The nucleus is surrounded by some irregular membranes. The middle piece contains 6-10 circularly arranged mitochondria. The tail presents 9 pairs of peripheral and a central pair of microtubules, all of which run in the direction of the long axis of the tail. The tail shows two lateral cytoplasmic processes at each side.

Sertoli's cells:

They exist between the germinal cells and are believed to play a role in supplying of nutrients.

b**) Interstitial cells**: (or Leydig's cells)

They exist into the connective tissue of the testis and secrete sex steroids.

Note:

In fishes, the transport route of spermatozoa is basically the same as in the higher vertebrates, but fishes can be classified into two groups according to the length of the sperm duct. Namely, the testis of fishes having a short sperm duct gives the appearance of a lobular structure divided by connective tissue, and the fusion and enlargement of the lobules, which occur during the division and multiplication of the germinal cells in the lobules, cause them to come in contact with the small sperm duct. On the other hand, in fishes with long sperm ducts, the structure of the seminiferous tubule is visible and the sperm duct connects with a network of seminiferous tubules, which extends almost completely throughout the peripheral portion of the testis.

THE OVARY

The ovary of fish is generally a pair of sac-shaped organs covered with an ovarian wall and consisting of an ovarian cavity (ovarian lumen) and numerous ovarian lamellae (ovigerous lamellae) where oogenesis takes place.

The ovarian cavity connects with the oviduct, and the oviducts from each bilateral ovary join together to lead to the genital pore. An ovary with such a structure is called the cyst ovarian type and after a mature oocyte, within a follicle on the lamella, is released by ovulation to the ovarian lumen it leaves the body through the oviduct and genital pore.

The ovary of most teleosts is generally of the cyst ovarian type, but salmon and trout have a pocket-like structure that opens to the body lumen and in place of oviducts, possess a funnel-shaped transporting groove leading to the genital pore. Such an ovary is of the semicyst-ovarian type.

The structure of the eel ovary is the most simple; the ovary hangs down like curtain and after the ovulated eggs are released in body cavity, they are discharged from the body. Such an ovary is of the gym ovarian type.

Oogenesis:

Oogenesis comprises the following stages:

1- **Proliferation stage**: (multiplication stage)

Oogenesis starts with the proliferation of oogonium on the ovarian lamella. The proliferation period varies from species to species. The oogonium in the early stages is a large cell with a

large nucleus including one nucleolus and later, after multiplication, they become considerably smaller.

2 - Leptotene stage:

The oogonium after the multiplication stage develops into the primary oocyte. The size of the cell is not so different but the chromosomes at first appear thread-like and are distributed throughout the nucleus.

3 - Zygotene stage:

The chromosomes then assemble at one side of the nucleus and the nucleolus adjacent to the nuclear membrane localized at the opposite end of the nucleus.

4 - Pachytene stage:

The primary oocyte enters the pachytene stage in which the nucleolus moves to the central part of the nucleus and the bivalents to the edge of the nucleus; at the same time, the nucleus increases in size to become the germinal vesicle. The chromosomes become somewhat slender and distributed throughout the nucleus, and many chromatin nucleoli begin to appear.

5 - Diplotene stage:

The nucleoli become smaller, move to the periphery of the nucleus and arrange themselves in order on the inner side of the

nuclear membrane. The cell body becomes large and the cytoplasm becomes strongly basophilic. Furthermore, the follicle cells surrounding the oocyte become clearly distinguishable constituting a single layer in bony fishes.

Vitellogenesis:

Vitellogenesis means the process of accumulation of yolk substances within the cytoplasm. The cytoplasm, basophilic up to this time, becomes acidophilic.

The essential yolk substances are of three kinds, i.e., yolk vesicles, yolk globules and oil droplets.

a) The yolk vesicles:

The yolk vesicles contain glycoprotein and stain very slightly red with eosin but exhibit a strong positive reaction to PAS, staining deep red. The quantity and properties of the yolk vesicles differ among species. The yolk vesicles later become the cortical alveoli and take part in the formation of the perivitelline space.

b) The yolk globules:

The yolk globule consists mainly of lipoprotein with some carbohydrate and other substances. It is eosinophilic with HE staining and weakly positive to PAS.

c) The oil droplets:

The oil droplets are generally recognized to contain glycerides and a small amount of cholesterol. The oil droplets stain black by Osmic acid .

When the accumulation of yolk substances becomes conspicuous, hyperplasia of follicle cells is recognized, and the squamous theca cells line up in two layers to form an outer and inner theca membrane outside the follicle cell layer.

When vitellogenesis begins, the egg membrane becomes clear and PAS-positive, and in the course of vitellogenosis becomes hyperplastic and differentiates to form inner and outer layers. Moreover, radial striation also becomes clear and this stratum is called the zona radiata. The thickness of the egg membrane decreases just before full maturation.

With the completion of vitellogenesis, movement of the germinal vesicle, fusion of yolk globules and grouping of oil droplets occur and, especially in marine fishes, the egg diameter increases sharply. Marked increase in body weight occurs due to water absorption. The degree of fusion of yolk globules differs among species.

After movement of the germinal vesicle to an animal pole, the first meiotic division occurs and the first polar body is

released. Subsequently, the second meiotic division starts and an egg in which division arrested at the metaphase is ovulated.

SPEMATOZOA OF TELEOSTS

H= Head (rounded). M= Middle piece. T= Tail.
Notice the lateral process on each side of the tail (bottom, right).

PRIMARY OOCYTE AT THE YOLK VESICLE STAGE