

Functional Anatomy of the Female genital system

I. Ovary

A. General - The ovary, unlike the testis, remains in a abdominal position throughout life. The ovary has a gametogenic (produces ova) and an endocrine function (produces a number of hormones).

B. Structure - The ovary is divided into the outer cortex and central medulla regions. The medulla is composed mainly of connective tissue. Blood vessels and nerves enter the ovary at the hilus and traverse the medulla to the cortex. The cortex is the main functional area of the ovary and performs the gametogenic and endocrine functions. The outermost layer of the ovary retains the name of germinal epithelium even though it is no longer capable of being "germinal". Immediately beneath the germinal epithelium is a layer of connective tissue known as the tunica albuginea (analogous to the connective tissue covering the testis).

1. Gametogenic structures:

1. Primordial follicle - a resting oocyte which is surrounded by flattened follicle cells.
2. Primary follicle - oocyte surrounded by a single layer of follicle cells; these follicle cells are cuboidal in the growing follicle and are called granulosa cells.
3. Secondary follicle - oocyte with a zona pellucida and two or more layers of granulosa cells but without an antrum.
4. Tertiary follicle - (Graafian follicle) follicle with an antrum.

A number of cell layers or structures are evident in a cross section of a tertiary follicle. The structures play key roles in reproduction in the female and it is important that you incorporate the following terms in your vocabulary. From the oocyte outward:

1. Zona pellucida - A noncellular layer surrounding the oocyte made of 3 glycoproteins. Plays a role in fertilization and cleavage.
2. Corona radiata - Single layer of columnar cells surrounding the oocyte and penetrating the zona pellucida. Plays a role both in providing nutrients for the oocyte and in regulating the maturation of the oocyte.
3. Cumulus oophorus - Mass of cells on which the oocyte sits and which is shed with the egg at ovulation. Plays a role in fertilization and egg transport.
4. Follicular fluid - A fluid which is secreted by granulosa cells. Ironically it is similar to blood plasma. However, it contains high concentrations of steroids, and certain glycosaminoglycans (GAGS). It plays a role at the time of ovulation.

5. Granulosa cells - (membrana granulosa). These cells multiply rapidly during follicular growth, secrete the follicular fluid, and produce steroids. Before ovulation the granulosa cells produce mostly estrogens whereas after ovulation, these cells form the bulk of the corpus luteum and produce progesterone.
 6. Basement membrane - Noncellular layer separating the granulosa and the theca interna. In normal follicles, blood vessels do not cross the basement membrane until the time of ovulation.
 7. Theca interna - These cells work with the granulosa cells to produce steroids, particularly estrogen, by the follicle.
 8. Theca externa - Outer layer of connective tissue with doubtful endocrine function but probably does play a role in ovulation.
 9. Follicles can be classified as normal, i.e., healthy or as atretic. Atretic follicles are follicles that are degenerating usually due to insufficient or improper hormonal support.
2. Endocrine structures - The endocrine and gametogenic structures of the ovary overlap and will be discussed in greater detail in subsequent lectures. Basically, the endocrine functions of the ovary are carried out by the cells of the theca interna, granulosa, corpora lutea and by a number of different cell types known collectively as the interstitial gland. Much of the interstitial glands arise from the remains of atretic follicles.

The corpora lutea deserve special mention because they are prominent structures on the ovary and because they play an important role in sexual cycles and in pregnancy. The life cycle of the corpus is encompassed in the following terms.

1. corpus hemorrhagicum - Bloody-appearing structure formed from the freshly ovulated follicle and found from 1 to 3 days after ovulation. Thus, it is the beginning stage of the corpus luteum and what is left of the follicle after ovulation.
2. corpus luteum - Literally means yellow body. An endocrine gland with a limited lifespan that produces progesterone.
3. corpus albicans - Pale white, yellow or brown structure that is left when the corpus luteum regresses. It is mostly connective tissue and serves no known function.

II. Oviduct

A. General - The anterior end of the Mullerian ducts give rise to the oviducts (Fallopian tubes or uterine tubes). The oviducts are the functional links between the ovary and the uterus (site of gestation). The oviduct is also the site of fertilization.

B. Structure - The oviduct is divided into a number of parts, each of which has a slightly different structure and function. Starting at the end closest to the ovary, the parts are: infundibulum, ampulla, ampullary-isthmic junction, isthmus, and the uterotubal junction. In cross section, all of these parts have the same basic three layers but the complexity of the inner two layers varies with the section being examined. The outermost layer or serosa is epithelium and connective tissue and is continuous with

the suspensory ligaments. The next general layer from the outside in is the muscularis. The muscularis is usually composed of an inner circular and outer longitudinal muscle layer. The innermost layer is the mucosa. The mucosa consist of a single layer of epithelia cells varying from tall, columnar to almost cuboidal. In cross section, the mucosa may be thrown into a number of folds which gives a glandular appearance. Many of the cells are ciliated. A subsequent lecture will devote considerable time to the function and structure of the muscularis and mucosa. For now, it is sufficient to know that the oviduct transports gametes and embryos and provides environments for fertilization and cleavage. The functional link between the ovary and uterus is divided into the following parts starting at the ovary:

Ovarian bursa - Not usually considered a part of the oviduct. The bursa is a sac of connective tissue and ligaments surrounding the ovary. It is poorly developed in the ewe and cow, prominent in the pig, and extremely well developed in rodents. The bursa is made up of parts of the mesosalpinx, mesovarium, fimbria and infundibulum. The bursa probably plays a role in insuring that the ovulated egg is picked up by the oviduct.

Infundibulum - This is the funnel-shaped end of the oviduct. The edges of the funnel may have finger-like projections called fimbria. Another descriptive term sometimes used is fibrated funnel. At ovulation, the ciliated surface of the fimbria and infundibulum "catch" the ovulated egg and transport it to the base of the infundibulum through the ostium and into the ampulla.

Ampulla - The ampulla comprises about one-half the length of the oviduct. The mucosa is highly convoluted and well developed, whereas the muscularis is thin. It feels soft to the touch and its diameter is larger than the isthmus. The ampulla region grades into the isthmic region at the ampullary isthmic junction.

Ampullary isthmic junction - This is about midway between the ovary and the uterus. It is approximately the site at which fertilization occurs.

Isthmus - The part between the ampulla and the uterotubal junction is the isthmus and comprises about one-half the length of the oviduct. The muscularis is well developed which gives the isthmus its hard feel.

Uterotubal junction - This is the transition between the uterus and the oviduct.

III. Uterus

A. General - The paired Mullerian ducts of the embryo fuse to different degrees and the degree of fusion determines the type of uterus present in the adult. If there is little fusion, as in rodents, rabbits, and opossums, there are two separate uterine horns and two cervical openings. This type of uterus is called duplex. The other extreme is where the Mullerian ducts fuse and there are no uterine horns. This type is known as simplex and occurs in primates. Farm animals fall in between these two extremes and the type found is bicornuate.

B. Structure - In cross section, the uterus has the same basic three layers as the oviduct: serosa, muscularis and mucosa. In the uterus, however, these layers have special names: Perimetrium, myometrium and endometrium.

Perimetrium - This is the outermost layer that is continuous with the broad ligament and functions in support.

Myometrium - There is a thick inner circular layer and a thinner outer longitudinal layer. The myometrium which has a noticeable muscular layer functions in all aspects of reproduction from sperm transport to parturition. Endometrium - This is the innermost layer of the uterus. It has many simple tubular glands whose secretion's create a special environment in the uterus that is conducive for development of the embryo. In cows and ewes, there are prominent structures on the endometrium known as caruncles. These serve as the site of attachment of the cotyledons of the embryo and are the main areas of exchange between mother and fetus.

C. Function - Considerable attention will be given to uterine function in subsequent material. In general, the uterus provides a suitable environment for embryos throughout pregnancy. In the absence of pregnancy, the uterus, through its luteolytic function, causes regression of the corpus luteum.

IV. Cervix

The cervix of farm animals is a thick-walled sphincter-like structure that separates the external environment (vagina and outside) from the internal environment of the uterus. Internally, the cervix of the cow has several apposing ridges known as annular rings or folds. The sow has similar ridges but they are arranged as interdigitated pads. The cervix plays important roles in sperm transport, maintenance of pregnancy and parturition.

V. Vagina

The vagina connects the cervix to the external genitalia. The penis is inserted into the vagina and the semen is then deposited at the anterior end of the vagina or in the cervix. The vagina plays an important function in the mating process. Urine enters the vagina at the suburethral diverticulum and is then expelled outside the body.

VI. External Genitalia:

The clitoris, which is the female's analog of the penis, is positioned at the ventral surface of the posterior vagina. The vulva, which is the external opening of the reproductive tract, consists of both the labia majora (which is analogous to the scrotum of the male) and the labia minora.

VII. Suspensory Ligaments:

The reproductive tract is suspended by ligaments from the dorsal lateral body wall. The general name given to the ligament in the male is the mesorchium whereas in the female it is the broad ligament. In the adult female, the broad ligament has a number of subdivisions which are not sharply demarcated. They are:

mesosalpinx - the mesentery of the oviduct (salpinx is another term for oviduct)

mesovarium - suspensory ligament of the ovary

mesometrium - suspensory ligament of the uterus