Chapter 19
Female Reproductive System

19.1. Introduction

The female reproductive system is composed of: (1) internal organs located in the pelvic cavity consisting of the ovaries, oviducts, uterus, and vagina (2) external organs, termed the External Genitalia, including the mons pubis, clitoris, labia minora, and labia majora (3) and one often considers the mammary glands, an important adjunct to this system.

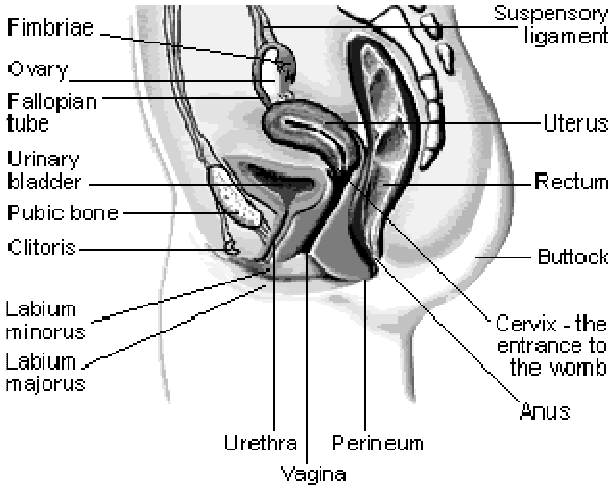

Fig.19.1. Female Reproductive System

18.2. The Ovaries

The ovaries are the female gonads. They are suspended within the pelvic cavity by a series of peritoneal folds termed "ligaments". They include:

a] Suspensory Ligaments which attach the ovaries to the posterior abdominal wall.

b] Mesovarium which connects the ovary to the uterus via the ovarian ligament. The mesovarium is also important because it the passageway for blood vessels entering and exiting the hilus of the ovary.

18.2.1. The Structure of the Ovary

The ovary can be divided into a cortex and a medulla. The Medulla is the inner region of the ovary. It is continuous with the hilus. The medulla is composed of a loose connective tissue which is well vascularized and contains the nerves of the ovary. The Cortex is external to the medulla. It consists of a connective tissue stroma that contains the Ovarian Follicles. The stroma is a compact, highly cellular loose connective tissue. External to the cortex is a capsule of fibrous, dense connective tissue called the Tunica Albuginea. The tunica albuginea is continuous with the mesovarium. External to the tunica albuginea is a the Germinal Epithelium. The germinal epithelium is a simple epithelium that is typically cuboidal but will include some low columanr cells. It is also continuous with the mesovarium. It originates from the mesovarium.

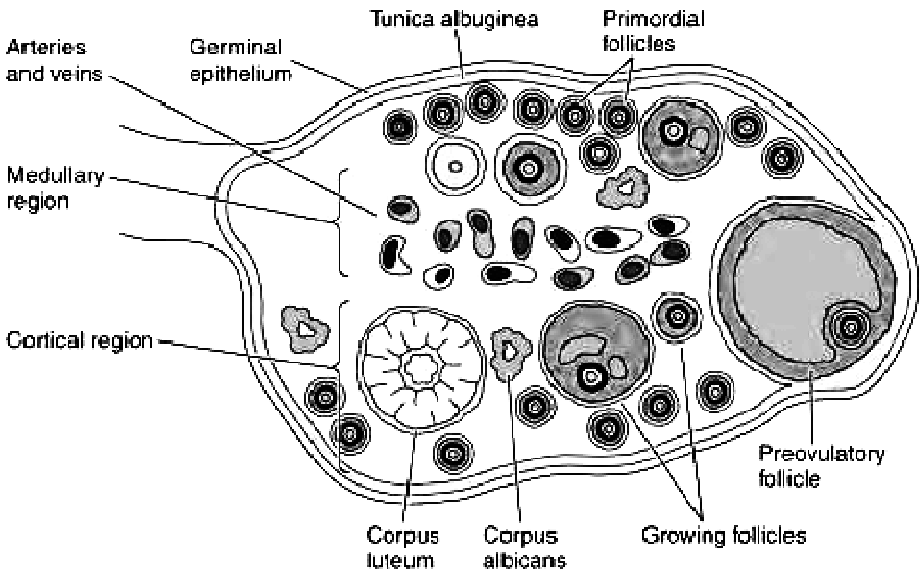

Fig.19.2. The CS of the Ovary

18.2.2.The Ovarian Follicles

a) Primordial Follicles

The primordial follicles represent the stored primary oocytes of the human female. A woman is born with her full compliment of gametes within the primordial follicles. They remain stored in a suspended state of meiosis until stimulated by FSH to undergo maturation. The primordial follicle is composed of two cell populations: [1] a centrally located, large Primary Oocyte, [2] and a surrounding layer of simple squamous epithelium.These squamous cells are called Follicular Cells. Adjacent primordial follicles are separated by stromal elements. FSH will signal several primordial follicles to simultaneously begin the process of maturation usually once a month. Typically only one will reach the maturation point and is termed the Graafian Follicle. It will be subsequently ovulated. The others will undergo degeneration, termed Atresia, and are termed Atretic Follicles.

b) Primary Follicles

Primary follicles begin to show three developments: The follicular cells undergo mitosis and give rise to a stratified cuboidal epithelium. The follicular cells are now often referred to as Granulosa Cells. The oocyte enlargens and it begins to develop microvilli which project into the newly forming Zona Pellucida. The zona pellucida is an eosinophilic glycoprotein secretion produced by both the oocyte and the granulosa cells. The zona pellucida separates the oocyte from the granulosa cells. The connective tissue surrounding the follicle begins to condense forming a Theca which encapsulates the follicle.

c) Secondary Follicles

Secondary follicles show developmental changes from primary follicles: The theca develops into two layers:

a} Theca Interna - the inner layer. It is an epitheloid-like vascular layer. It produces estrogen.

b} Theca Externa - the outer layer. It is a fibrous connective tissue which forms an encapsulating structure around the follicle.

The oocyte continues to enlargen as oogenesis progresses. The Antrum begins to form. Within the follicle irregular fluid-filled structures appear amid the 6 to 12 layers of granulosa cells. These fluid-filled structures will coalesce into one large fluid-filled structure called the antrum. The fluid within the antrum is called the Liquor Folliculi. The fluid will accumulate which will further cause the follicle to increase in size. As a result of the formation of the antrum the oocyte will be forced into an acentric position. The oocyte will be located in a mound of granulosa cells called the Cumulus Oophorous.

d) Graafian Follicles

The Graafian follicle represents the mature follicle. Usually only one follicle will reach this point. It takes between 10 to 14 days from the initiation of follicular maturation by FSH for the Graafian follicle to form. The Graafian follicle is quite large, due primarily to the increase in liquor folliculi, and will bulge outward. The wall of the ovary directly over the Graafian follicle will progressively weaken. The oocyte is now a Secondary Oocyte and ready for fertilization. Due to a massive release of LH by the anterior pituitary ovulation will occur. In ovulation the secondary oocyte, a few surrounding granulosa cells (called the Corona Radiata), and the liquor folliculi erupt from the ovary. The ovulated oocyte and corona radiata will include the zona pellucida and between 1 to 2 layers of granulosa cells. The ovulated follicle will move into the oviduct.

e) Corpus Luteum

The corpus luteum is an endocrine structure representing those granulosa cells remaining in the ovary after their follicle has undergone ovulation. The antrum fills with connective tissue. The remaining granulosa cells are now termed Lutein Cells. The functional lifespan of this endocrine structure is dependent on whether or not fertilization occurs: If fertilizations does not occur the corpus luteum will last for about two weeks (i.e.; until menstruation). If fertilization does occur the corpus luteum will last for three months, until the end of the first trimester. The corpus luteum produces progesterone and estrogen which maintains the endometrium in a state of preparation for embryonic implantation. At the end of the first trimester the placenta takes over this role and the corpus luteum degenerates. The remnants of the degenerated corpus luteum are called the Corpus Albicans.

f) Atretic Follicles

Atretic follicles represent follicles in various arrested states of development. Although they were arrested in different states of development, atretic follicles demonstrate some common features: The nuclei of the follicular cells become Pycnotic, becoming smaller and darker. The cytoplasm of the oocyte degenerates. The follicle becomes invaded by connective tissue elements including macrophages.The zona pellucida enfolds. The follicular cells begin to degenerate.

19.3. The Oviducts/Fallopian Tubes/Uterine Tubes

19.3.1. General Comments

The oviducts are paired structures located in the pelvic cavity. They are held in place by folds of the peritoneum called the Broad Ligaments. They serve to connect the ovaries to the uterus. They allow for the transport of the ovum from the site of ovulation to the site of implantation. The oviducts are about 12 cm in length (5"). The oviducts are divided into four segments. They are:

1] Infundibulum - a flask-shaped opening located proximal to the ovary which receives

the ovulated follicle.
2] Ampulla - the longest portion of the oviduct comprising between half to two thirds of it's overall length.
3] Isthmus - a short segment of narrowing lumenal diameter proximal to the uterus.
Intrauterine Component/Interstitial Component/Intermedial Component a short segment of the oviduct which penetrates the uterus. It is actually embedded in the uterine wall. These four regions demonstrate progressive changes as the oviduct extends from ovary to uterus.These changes include a decrease in lumenal diameter. These changes also include an increase in cell height in the epithelial component of the wall.

19.3.2. Functions

The oviducts conduct the ovum from the ovary to the uterus. This journey takes about three days. The oviducts create an environment which enhances the chance of fertilization. The oviducts create an environment which enhances the chance of embryo development if fertilization occurs.

19.3.3. Histology

a) Tunica Mucosa

The mucosa is arranged into longitudinal folds. The infundibulum has very distinct folds projecting into the lumen and out of the oviduct called Fimbriae. The fimbriae are finger-like extensions of the infundibulumn's mucosa which project out of the oviduct into the intervening space between it and the ovary. The fimbriae increase the surface area (which is also why the infundibulum is flask-shaped) and help to guide the ovum into the oviduct. The ampulla shows a highly complex folding pattern. The folds will have secondary and often tertiary branches. These branches will also extensively anastomize forming a labyrinthian/honeycombed arrangement. The folds in the isthmus are much less branched and of decreased length due to the diminished lumen. The folds are very reduced in the intrauterine component. The epithelium of the tunica mucosa is a simple columnar and has two cell types:
1] **Ciliated Columnar Cells:** These are tall, broad cells. They are only slightly eosinophilic and so will stain palely. Their cilia help to conduct the ovum/embryo towards the uterus.
2] **Peg Cells :** These are nonciliated, secretory cells. They produce a nutrient-rich product for the maintenance of the ovum/embryo. The epithelium is supported by a lamina propria. This lamina propria is a thin, very cellular loose connective tissue. It contains many lymphocytes.

b) Tunica Muscularis

The tunica muscularis is composed of two layers of smooth muscle. The inner layer is a thick layer of circularly arranged smooth muscle. The outer layer is a thinner layer of longitudinally arranged smooth muscle. The longitudinal layer is scattered or discontinuous in some portions of the oviduct.

c) Tunica Serosa

The tunica serosa of the oviduct is simply visceral peritoneum. The tunica serosa increase in thickness closer to the uterus. It is lacking, however, in the intrauterine component.

19.4. The Uterus

19.4.1. General Comments

The uterus is a single, pear-shaped organ located in the pelvic cavity anterior to the rectum and posterior to the urinary bladder. It serves as the site of development for the child. As a result it is quite distensible. The uterus can be divided into two regions which can be further subdivided:

a] Body - makes up the bulk of the uterus. It's lumen is called the Uterine Cavity. A subdivision of the body is the Fundus. The fundus is a dome-shaped portion of the superior uterus located above the entry point of the oviducts.

b] Cervix - is the narrow inferior portion which projects into the vagina. It's lumen is termed the Cervical Canal. The cervical canal terminates at the External Os, the opening into the vagina. The cervical canal begins at the Internal Os where the cervical canal communicates with the uterine cavity. The portion of the body between the cervix and the body is a constricted region called the Isthmus. Several folds of the peritoneum and fibromuscular cords serve to hold the uterus in place. They include: [a] broad ligaments, [b] uterosacral ligaments, [c] cardinal ligaments, [d] and round ligaments.

19.4.2. Histology

a) Perimetrium/Tunica Serosa - the outermost portion of the uterine wall. The perimetrium is, for the most part, visceral peritoneum. It will fold back over the urinary bladder forming the Vesicouterine Pouch. It will fold back over the rectum forming the Rectouterine Pouch.Those portions of the perimetrium lacking visceral peritoneum will instead be covered by an adventitia of loose connective tissue.

b) Myometrium/Tunica Muscularis - is the middle and by far the thickest portion of the uterine wall. It is composed of bundles of smooth muscle, elastic fibers, and collagen fibers. The distribution and arrangement varies with the different portions of the uterus. The fundus has the most muscular myometrium being composed of three thick sheets of smooth muscle and little collagen. The muscle is arranged: inner is longitudinal, middle is circular to slightly oblique, and the outer is longitudinal. This is the portion of the uterus to generate most of the force for expulsion of the baby. The cervix has the most fibrous myometrium being composed of mostly collagen bundles with a few, scattered smooth muscle bundles.

c) Endometrium -is the innermost and most variable tunic. By definition the endometrium is a mucosa being composed of a secretory epithelium and a lamina propria. The lamina propria is a thick layer of loose connective tissue. [a] It has a high cellular content. [b] It is well vascularized. [c] It will contain glandular invaginations from the above lying epithelium.These glands are called Uterine Glands. The epithelium is generally a simple columnar type but will show some regional variation. The endometrium is divided into two layers:

1] Stratum Basalis - the basal layer, it is contact with the basement membrane. It is the permanent layer and serves to regenerate the other layer.

2] Stratum Functionalis - the variable layer it serves as the site of embryonic implantation and is under hormonal control. The stratum functionalis is rich in glands and will have islands of ciliated epithelial cells. These islands of ciliated epithelial cells are particularly near the intrauterine component of the oviduct. The endometrium of the cervix is modified. [1] It does not have cyclic proliferation and sloughing. [2] It is arranged into folds. [3] It contains numerous mucous secreting epithelial cells.

19.5. The Vagina

The vagina is a hollow, muscular organ. It is approximately 10 cm in length.

19.5.1. Functions

[1]It serves as a receptacle for the penis during coitus.[2]It serves as a passageway for the menstrual flow. [3] It serves in the delivery of the baby.

19.5.2. Histology

The vaginal wall consists of two tunics. Since the vagina penetrates the pelvic floor the loose connective tissue of the pelvic floor replaces an adventitia.

a) Tunica Mucosa

The mucosa is arranged into longitudinal folds called Rugae which allow for distension. The mucosa consists of a stratified squamous epithelium resting on a well vascularized lamina propria. The stratified squamous epithelium is the mucus type although some parakeratinization can occur. The mucosa also has mucus secreting cells and a few associated glands for lubrication.

b) Tunica Muscularis

The tunica muscularis consists of two layers of smooth myofibers arranged into irregular bundles. The inner layer is circularly arranged. The outer layer is longitudinally arranged. The tunica muscularis is responsible for the folding of the mucosa. During the orgasmic response, contractions of the muscularis assist in moving the ejaculate deeper into the female reproductive tract.

19.6. The External Genitalia/Pudenda

19.6.1. Clitoris

The clitoris is homologous to the glans penis and shares many features with it. [a] It is erectile in nature. [b] It is very well vascularized and innervated. [c] Histologically it is very similar to the corpora cavernosa of the penis. [d] Like the penis, the clitoris is covered by a fold of skin called the prepuce.

19.6.2. Labia Majora and Minora

The labia are homologous to the scrotum. The labia majora are the more external portion and are folds of skin. Histologically they are consistent with the integument for that region of the female body. The contain hair, sebaceous glands, and both apocrine and eccrine sudoriferous glands. The labia minora are the inner portion and are folds of a mucus membrane. They are more similar to the mucosa of the vagina and the rest of the vestibule histologically. They lack the hair and adipose tissue found in the labia majora as well as having fewer glands.

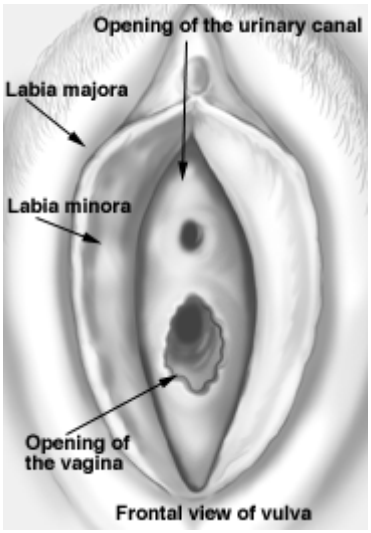

Fig.19.3. External Genitalia

19.7. The Mammary Glands

The mammaries are paired glands located superficial to the pectoralis major and attached to them by a layer of connective tissue. They are modified apocrine sudoriferous glands.

19.7.1. The Stroma

Each mammary gland is divided into 15 to 20 lobes and each lobe will be further divided into several lobules by the stroma. Each lobe will have it's own Lactiferous Duct which will open into the Lactiferous Sinus below the nipple. The lobules consist of a group of acini drained by an Interlobular Duct. The lobes and lobules are separated by connective tissue septa. [1] The septa are called the Interlobar and the Interlobular Septa respectively. [2] The connective tissue of the septa is a dense irregular connective tissue rich in collagen and elastic fibers. [3] The septa will also anchor the mammary to the epimysium pectoralis major. The septa have collagenous extensions called the Suspensory Ligaments of Cooper. [4] The major duct system will travel through the septa and are surrounded by circularly arranged collagen fibers. [5] Adipose tissue is located between septa and will influence the size of the gland. Along with the septa, another portion of the stroma is the loose connective tissue surrounding each acinus and the smallest of the ducts. Another feature of the stroma is the considerable amounts of smooth muscle located within the nipple and areola which may be responsible for nipple erection.

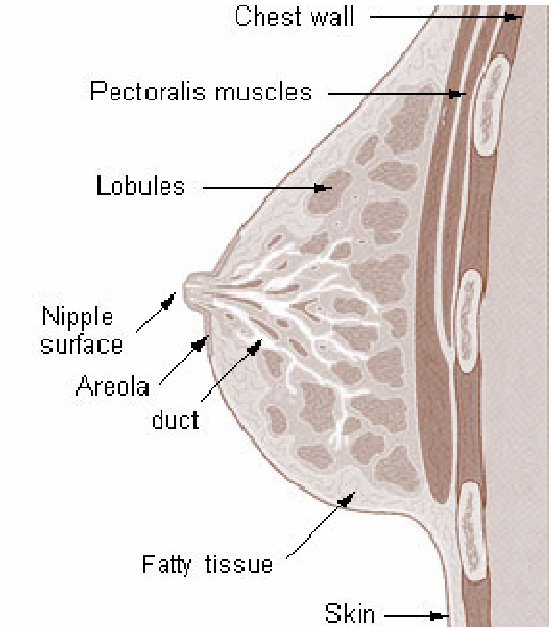

Fig.19.4. Structure of mammary gland

17.7.2. The Parenchyma

The parenchyma will vary depending on the reproductive state; depending if the gland is active or inactive. If the gland is inactive the glandular component is sparse and adipose tissue and dense irregular connective tissue will make up the bulk of the mammary. If the gland is active adipose and the other connective tissue elements will decrease and be replaced by the acini. The acini and interlobular ducts will form during pregnancy. The acini are lined by a simple cuboidal epithelium. These cuboidal cells will have secretory modifications. Between the secretory cells and the basement membrane are myoepithelial cells. The acini are surrounded by loose connective tissue of the stroma.

19.7.3. The Duct System

The smallest ducts are lined by a simple cuboidal to a simple columnar epithelium and surrounded by loose connective tissue. These are the interlobular ducts and the ducts draining the acini directly. Between the simple epithelium and the basement membrane will be some myoepithelial cells. The medium sized ducts are lined by a double layer of cuboidal to a double layer of columnar cells. These are the interlobar ducts. They will be surrounded by circularly arranged collagen fibers of the septa. The larger ducts, such as the lactiferous ducts and the ampulla, are lined by a stratified squamous, non keratinized, epithelium. They will also be surrounded by circularly arranged collagen fibers of the septa.