• FEMALE REPRODUCTIVE ANATOMY

- The primary goal of the female reproductive system is the release of a mature egg cell or **ovum** from the **ovary** at a specific time to be fertilized by a sperm. The ovum must be released when the rest of the female reproductive system is prepared to receive the fertilized egg and establish a pregnancy. **Fertilization is the fusion of a haploid (N) sperm with a haploid (N) egg to form a diploid (2N) fertilized egg or zygote (the earliest stage of development).**

- The ovum is the female gamete. So, the **ovary is the primary sex organ** in the female because the ovary performs **gametogenesis (the formation of the gametes)**. In the human female one or two eggs are **ovulated** (released from the ovary) about once every 28 days or so.

- The female reproductive system is well designed for the following functions:

1. the production of eggs or ova **(oogenesis). Oogenesis** involves the production of a number of different egg cell types: **oogonia (least mature), primary oocytes, secondary oocytes and ootids (most mature).**
2. the reception and transportation of sperm from the male
3. maintenance of the developing embryo and fetus via the formation of a placenta
4. giving birth **(parturition)**
5. nourishing the infant after birth by producing milk **(lactation)**

The female reproductive organs lie within the pelvic cavity. The ovaries are paired glands resembling unshelled almonds in size and shape and are homologous to the testes in males. The ovaries descend to the brim of the pelvis during the third month of development and lie in the superior portion of the pelvic cavity, one on each side of the uterus. The ovaries are supported in the pelvic cavity and attached to the uterus by the **broad ligament, ovarian ligament and suspensory ligament.**

• THE FEMALE REPRODUCTIVE ORGANS

Ovary = the female gonad = has two functions:

1. **Oogenesis**, the maturation and production of ova
2. Endocrine function = **makes hormones. The ovary makes the female sex steroids progesterone and estrogen.**

- There are two basic tissue compartments within the testes:

1. **OVARIAN CORTEX =** The outer region within the ovary consisting of dense connective tissue and **ovarian follicles or corpa lutea** depending on the menstrual cycle stage. This region also contains many **corpus albicans**, white scar tissue left over from the breakdown of the corpus luteum from earlier ovarian cycles.
2. **OVARIAN MEDULLA =** the deeper, inner region within the ovary that consists of loose connective tissue and contains blood vessels, lymphatics and nerves.

Uterus = has two functional layers. The underlying smooth muscle layer is called the **myometrium**. The thin, interior layer of the uterus is **endometrium**. Histologically, the endometrium is subdivided into the **stratum functionalis** and the **stratum basalis**. The **stratum basalis (basal layer)** is deeper, permanent and gives rise to the stratum functionalis. The **stratum functionalis (functional layer)** is closer to the uterine cavity and is shed at menstruation. The upper, dome shaped region is the **fundus**, the central portion is the **body**, the narrow muscular ring at the juncture to the vagina is the **cervix**. The **isthmus** is the constricted region between the body and the cervix. The uterus maintains the developing embryo and fetus during a pregnancy and the myometrium helps expel the fetus during parturition. The endometrium undergoes cyclical changes in its structure in response to the steroids made by the ovary. These are the changes associated with the menstrual cycle. In addition to the **broad ligament**, the **round ligament** helps hold the uterus in place in the pelvic cavity.

Fallopian tubes (or oviducts or uterine tubes) = transport ova (eggs) from the ovary to the uterus and sperm from the uterus toward the ovary. There is a fluid that flows through the oviducts and cilia in the walls of the Fallopian tubes which beat to transport the ovulated egg toward the uterus. The infundibulum is the funnel shaped portion of the tube near the ovary, the ampulla is the widest, longest portion and the isthmus is the more medial, short, narrow, thick portion attached to the uterus. ***Fertilization usually occurs in the Fallopian tubes, typically in the ampulla region near to the ovary.***

Fimbriated funnel (or Fimbriae) = a funnel like structure with fingerlike projections that receives the ovulated egg from the ovary and carries it to the Fallopian tubes.

Cervix = a muscular structure that projects from the uterus into the vagina and guards the entrance to the uterus. The cervical canal serves as both a pathway for sperm and as the passageway for delivery at parturition. There is a mucus which is secreted from the cervix which changes in consistency during the menstrual cycle.

Vagina = a fibromuscular expansive tube which connects the uterus to the external environment. At ejaculation, sperm are deposited into the vagina and must be transported through the cervix and uterus to the Fallopian tubes where fertilization usually occurs. The mucosa of the vagina is continuous with that of the uterus and is folded into **rugae**. At the inferior end of the vagina there may be a thin fold of vascularized mucous membrane over the vaginal orifice called the **hymen**. Sometimes the hymen completely covers the orifice and may require surgery to open the orifice and permit the discharge of menstrual flow.

External female genitalia are collectively called the **vulva.** The vulva includes the **mons, clitoris, vestibule, labia majora, labia minora and vaginal opening.**

- **Specifics about the Clitoris**

The clitoris lies at the junction of the upper of the two labia minora above the urethral opening.
- The average length is about 2.5 cm (1 inch) with an average diameter of ½ inch. There is much individual variation with regard to size and shape.
- The **clitoral shaft** (similar to the penile shaft) contains a pair of **corpora cavernosa** spongy tissue cylinders. There is no **corpus spongiosum** in the clitoris. This tissue is the **labia minora** in females (same embryological origin as the corpus spongiosum in the penis).

The clitoral glans (head or tip) is covered by the **clitoral prepuce** (similar to the foreskin of the penis).

The clitoris is rich in deep pressure and temperature receptors with only few touch receptors. Plays an important role in sexual arousal. During the plateau phase the deep pressure receptors are important for detecting stimulation of the retracted clitoris through the clitoral hood and mons.

Perineum = the diamond shaped area medial to the thighs and buttocks of both males and females that contains the external genitalia and the anus. It is bounded anteriorly by the pubic symphysis, laterally by the ischial tuberosities and posteriorly by the coccyx. A transverse line drawn between the ischial tuberosities dividies the perineum into an anterior **urogential triangle** that contains the external genitalia and a posterior **anal triangle** that contains the anus.

Important muscles of the pelvic floor in both males and females: bulbospongiosus, ischiocavernosus, levator ani (iliococcygeus & pubococcygeus), urogenital diaphragm

HOMOLOGOUS STRUCTURES OF MALE AND FEMALE REPRODUCTIVE SYSTEMS

MALE	FEMALE
TESTES	OVARIES
SPERM	OVUM
SCROTUM	LABIA MAJORA
SPONGY (PENILE) URETHRA (PENOSCROTAL RAPHE)	LABIA MINORA
MEMBRANOUS URETHRA	VESTIBULE
CORPUS SPONGIOSUM AND BULB OF PENIS	BULB OF VESTIBULE
GLANS PENIS (HEAD)	CLITORIS
PROSTATE GLAND	PARAURETHRAL GLANDS
BULBOURETHRAL (COWPER'S) GLANDS	GREATER VESTIBULAR (BARTHOLIN'S) GLANDS
GUBERNACULUM	ROUND LIGAMENT

- **HORMONAL CONTROL OF THE FEMALE REPRODUCTIVE SYSTEM**

- The first day of the menstrual cycle is the first day of menstruation (the first day of blood loss from the uterus). The menses (menstruation) usually last 5 to 7 days. The average menstrual cycle lasts about 28 days.

Testosterone has the following effects in the female: (mostly from the adrenal cortex)
1. responsible for sex drive (libido)
2. maintains muscle mass

THE FOLLICULAR PHASE OF THE MENSTRUAL CYCLE
- During the follicular phase (the first 14 days of the menstrual cycle), the **granulosa cells and theca interna cells** in the developing follicles in the ovary produce increasing amounts of estrogen, but virtually no progesterone. The estrogen (mainly **estradiol**) which is released prepares the rest of the female reproductive tract for a pregnancy.

Estrogen (estradiol) has the following effects in the female during the follicular phase:
1. maintenance and development of the secondary (accessory) sexual organs (e.g. the vagina, uterus, Fallopian tubes, fimbriated funnel, the cervix)
2. maintenance and development of the secondary sexual characteristics (e.g. softer skin, breast development and growth, higher voice, fat deposition around the hips)
3. travels to the follicles to help stimulate oogenesis
4. inhibits the release of FSH from the anterior pituitary (adenohypophysis)
5. stimulates the proliferative phase of the endometrium in the uterus
6. causes the cervical mucus to become copious, watery and hospitable to sperm. This cervical mucus will dry in a characteristic "fern-leaf" pattern on a microscope slide.

- As the follicle matures into a Graafian follicle (the most mature follicle type) estrogen levels increase until **an estrogen surge occurs about 48 hours before ovulation**. The estrogen surge is a sudden, rapid increase in estrogen secretion over a short period of time (less than 24 hours).

- This estrogen surge from the Graafian follicle in the ovary stimulates ovulation by causing a **surge in LH release from the anterior pituitary by positive feedback about 24 hours before ovulation.** That is, the more estrogen that is released, then the more LH that is released. The LH released during the LH surge travels to the ovary and stimulates **ovulation (ovulation is the release of the oocyte from the ovary and into the fimbriated funnel).**

- **During most of the follicular phase, the increasing estrogen levels inhibit FSH release** from the anterior pituitary by negative feedback. This is how the combination oral contraceptive (which contains both estrogen and progesterone) can prevent pregnancy. A woman who is taking the combined oral contraceptive does not typically ovulate because her follicles do not develop (she has low FSH secretion) and her ovaries do not release an estrogen surge (so she does not ovulate).

OVULATION

- At ovulation (near the middle of the menstrual cycle), a secondary oocyte and several granulosa cells are released into the fimbriated funnel and the egg begins its journey down the Fallopian tube where it will either be fertilized or not fertilized. If the secondary oocyte is not fertilized, then it is washed out of the female reproductive tract during menstruation. If the secondary oocyte is fertilized, then it will become a zygote and travel to the uterus and implant in the endometrium and a pregnancy will be established.

THE LUTEAL PHASE OF THE MENSTRUAL CYCLE

- After ovulation, during the luteal phase (the second 14 days of the menstrual cycle), the corpus luteum in the ovary produces increasing amounts of progesterone and estrogen. The corpus luteum is formed from the remnants of the Graafian follicle that remain in the ovary after ovulation. That is, **the corpus luteum is made of two cell types, the luteal cells (which were the granulosa cells in the follicles) and the paraluteal cells (which were the theca interna cells in the follicles).** Much more progesterone is released from the corpus luteum than estrogen. The progesterone that is released helps prepare the female reproductive tract for a pregnancy.

Progesterone has the following effects in the female during the luteal phase:

1. increases basal body temperature by about 1/2 to 1 degree centigrade
2. inhibits the release of LH from the anterior pituitary (adenohypophysis). Prevents ovulation in women who are taking the pill. Women on the pill do not experience an LH surge, so they do not ovulate.
3. stimulates the secretory phase of the endometrium in the uterus
4. causes the cervical mucus to become thick, viscous and inhospitable to sperm. This cervical mucus will not dry in a characteristic "fern-leaf" pattern on a microscope slide.

- Remember that estrogen is also secreted during the luteal phase, but since progesterone levels are higher during the luteal phase the effects of progesterone are more pronounced than those of estrogen during the second half of the menstrual cycle. The estrogen that is secreted helps to maintain the secondary sexual organs and characteristics.