The organs of both reproductive systems may be grouped according to function. They include: (1) gonads, (2) ducts and (3) accessory glands.

**STRUCTURES OF THE MALE REPRODUCTIVE SYSTEM**

(1) **Testes**

The testes are located in the scrotum, a sac that is divided into two chambers and suspends the testes on the body surface to facilitate temperature control. The raphe is the external ridge of skin that separates the scrotum into two chambers. The scrotum is divided internally by the septum, which consists of superficial fascia and contractile smooth muscle tissue called dartos muscles. Dartos muscles produce wrinkling of the skin. Cremaster muscles help provide contractions that readjust the position of the testes for temperature control.

The testes are paired oval glands measuring about 5 cm (2 inches) in length and 2.5 cm (1 inch) in width. They weigh approximately 10-15 grams. A dense layer of white fibrous CT called the tunica albuginea covers the testes and extends into each testis to divide them into compartments called lobules. Each lobule contains a coiled seminiferous tubule. The seminiferous tubules consist of sustentacular (Sertoli or nurse) cells that produce secretions to nourish sperm and interstitial (Leydig) cells, which secrete male hormones (testosterone). Sperm mature and move from the seminiferous tubules into the straight tubules that lead to a network of tubules called the rete testis. The sperm are then transported out of the testes via a series of coiled efferent ducts that lead into the epididymis.

(2) **Epididymis** (plural: epididymides)

The two epididymides are comma-shaped organs that lie along the posterior border of each testis. Each contains a tightly coiled tube called the ductus epididymis. The ductus epididymides are the site of sperm maturation. The epididymides are divided into three sections (1) the head, (2) body and (3) tail. The epididymides store sperm, do a quality control check on them and maintain them for up to four weeks. If not used within four weeks, the sperm are reabsorbed. Sperm require between 18 hours and 10 days for completion of their maturation process so that they become capacitated (capable of fertilization).

(3) **Ductus (vas) deferens**

The ductus is about 18 inches long, ascends along the posterior border of each testis, penetrates the inguinal canal and enters the pelvic cavity. Once in the pelvic cavity it loops over the side and down the posterior surface of the urinary bladder. The ductus can store sperm for several months. It propels sperm through the urethra by peristalsis during ejaculation.

(4) **Spermatic cord**

The testicular artery, ductus deferens, autonomic nerves, veins that drain the testes, lymphatics and the cremaster muscles all pass from the testes through the inguinal canal into the abdomen as the spermatic cord.
(5) Ejaculatory ducts

These ducts are located posterior to the urinary bladder. Each duct is about 2 cm (1 inch) in length. The two ductus deferens and the ducts from the seminal vesicles form the ejaculatory ducts. The ejaculatory ducts release sperm into the prostatic urethra.

(6) Urethra

This is the terminal duct of the system. It passes through the prostate gland, the urogenital diaphragm and the penis.

(7) Penis

The penis is the copulatory organ of the male. This organ releases sperm into the female vaginal canal. Distal end is termed the glans, which is covered by a foreskin (prepuce). The penis is composed of three cylindrical masses of tissue bound together by fibrous tissue. Two dorsolateral cylindrical masses are termed the corpora cavernosa. The smaller midventral cylindrical mass is the corpus spongiosum. The urethra passes through the corpus spongiosum. All three masses of tissue are erectile and therefore contain blood sinuses. Sexual stimulation will cause the arteries supplying the tissue masses to dilate and large quantities of blood will then enter the sinuses, causing the penis to become erect. Expansion of the blood sinuses creates pressure on veins that drain the penis so that the blood is retained. During ejaculation the smooth muscle sphincter at the base of the urinary bladder is closed because of the higher pressure in the urethra caused by the expansion of the corpus spongiosum.

(8) Accessory glands of the male

- Prostate - a single, doughnut-shaped gland located inferior to the bladder. It surrounds the superior portion of the urethra. It secretes an alkaline fluid that makes up 13-33% of the volume of semen and contributes to sperm motility.
- Seminal vesicles - paired, convoluted pouch-like structures lying posterior to and at the base of the urinary bladder. These vesicles secrete an alkaline, viscous fluid, rich in fructose that makes up 60% of the volume of the seminal fluid.
- Bulbourethral (Cowper's) glands - pea-sized structures located beneath the prostate on either side of the urethra. Their ducts open into the lower portion of the urethra. These glands secrete mucus for lubrication and a substance that neutralizes urine.

(9) Male gametes - sperm

Spermatozoa are suicide cells. They are specially designed to carry a payload of chromosomes a specific distance and are to be destroyed in the process of delivering the payload. They have a life expectancy of 48 hours once they are ejaculated into the female tract. They are produced constantly and mature at the rate of about 300 million per day. The sections of the sperm cell's structure are: (1) head, (2) acrosome, (3) midpiece and (4) flagella.

MALE HORMONES

The anterior pituitary secretes hormones that assume a major role in the developmental stages associated with puberty. The release of these hormones is regulated by the hypothalamus via its gonadotropin releasing factors (GnRF). The hormones include: (1) FSH, (2) LH, (3) testosterones and (4) inhibin.
STRUCTURES OF THE FEMALE SYSTEM

(1) Ovaries

The ovaries are the gonads of the female and they are analogous to the testes of the male. They produce ova, discharge ova and secrete female sex hormones, including estrogen and progesterone. Ovaries are paired glands that resemble unshelled almonds. They are positioned in the upper pelvic cavity, one on each side of the uterus. Each ovary has a hilus, which is the point of entrance for blood vessels and nerves. Each ovary is covered with germinal epithelium, which is supported by the tunica albuginea (a capsule of collagenous CT, which is immediately deep to the germinal epithelium). The stroma is the region of CT deep to the tunica, which is composed of an outer, dense layer called the cortex and an inner, looser layer called the medulla.

The ovaries are maintained in position by a series of ligaments, all of which are part of a large ligament called the broad ligament (an extension of the parietal peritoneum). The sections of the broad ligament include: (1) the ovarian ligament, (2) the suspensory ligament and (3) the mesovarium.

(2) Uterine (Fallopian, oviducts) tubes

These tubes extend laterally from the uterus and transport the ova from the ovaries to the uterus. They are positioned between the folds of the broad ligaments of the uterus. The funnel-shaped distal end of each tube is termed the infundibulum. The infundibulum lies close to the ovary and has finger-like extensions called fimbriae. The fimbriae swell during the monthly cycle and brush the surface of the ovary at the time of ovulation. If fertilization is to be successful, it must occur in the distal third (close to ovary) of the uterine tube. The uterine tubes are composed of three layers: the (1) mucosa, (2) muscularis and (3) serosa.

(3) Uterus

The layers of the uterus are: (1) perimetrium (serosa), (2) myometrium and (3) endometrium (stratum basalis and stratum functionalis). The anatomical divisions of the uterus include: (1) fundus, (2) body, (3) uterine cavity (lumen), (4) isthmus, (5) cervix, (6) cervical canal and the (7) internal os.

(4) Vaginal canal

The vaginal canal serves as a passageway for menstrual flow, a birth canal and as a receptacle for the penis during copulation. It is a muscular, tubular organ lined with mucous membrane. A recess, called the fornix. It surrounds the vaginal attachment to the cervix.

The vagina is lined with stratified squamous epithelium and CT that lies in a series of transverse folds called the rugae. The muscularis is composed of smooth muscle with a considerable ability to stretch. Near the vaginal orifice is a thin fold of vascularized tissue called the hymen that partially closes off the vaginal orifice. The mucosa contains a large amount of glycogen, which decomposes to form organic acids creating an acidic pH in the tract.

(6) Vulva (pudentum)

This term is a collective designation for the external genitalia of the female. It consists of: the (1) mons pubis, (2) labia majora, (3) labia minora, (4) clitoris and (5) perineum.
(7) Accessory glands

- Bartholin's glands - located at the base of the labia majora in the vestibule of the vaginal canal. Produce lubricating mucus.

- Mammary glands - modified sweat glands that lie over the pectoralis major muscles and are attached to them by layers of CT. Internally, the mammary glands consist of 15-20 lobes separated by adipose tissue. In each lobe are smaller compartments called lobules that are composed of CT in which milk-secreting cells referred to as alveoli are embedded. Alveoli are arranged in clusters and between the lobules are strands of CT that are termed suspensatory (Cooper’s) ligament of the breasts. Alveoli convey the milk to secondary tubules, which then pass the milk into mammary ducts. The ducts approach the nipple and form sinuses called ampullae where milk may be stored. The ampullae contain lactiferous ducts that terminate in the nipple. The circular pigmented area around the nipple is called the areola and it contains modified sebaceous glands.

(8) Female gamete - ova (eggs)

The gametes start formation from cells of the germinal epithelium of the ovary. Ovarian follicles consist of ova and their surrounding tissues in various stages of development. Follicles proceed through a series of developmental stages from: (1) primordial, (2) primary, (3) secondary and (4) vesicular (Graafian). Technically, a Graafian follicle is an endocrine gland composed of a mature ovum and its surrounding tissues. This structure secretes hormones, specifically estrogens. After release of the ovum from the Graafian follicle, the corpus luteum (endocrine structure) forms from the residual follicular materials. If the ovum is not fertilized, the corpus luteum will shut down and the corpus albicans will form.

FEMALE HORMONES

Specific hormones that regulate the monthly cycle of the female include: (1) GnRF, (2) FSH, (3) LH, (4) estrogens, (5) progesterone and (6) relaxin. Prostaglandins may also have an effect on the female system. They are lipid hormones that cycle and shift with the levels of estrogens and progesterone in the ovarian cycle. They are powerful smooth muscle effectors and if their proper levels are disrupted they can cause severe menstrual cramps.

FEMALE MONTHLY CYCLE

The monthly cycle of the female is termed the ovarian cycle and one phase of this cycle is termed menstruation. The phases of the ovarian cycle include: (1) menstrual, (2) preovulatory, (3) ovulatory (ovulation) and (4) postovulatory. Special terms associated with the female monthly cycle include menses, menarche and menopause.

THE MITOTIC CELL CYCLE OF SOMATIC CELLS

All cells go through a life cycle of formation, growth and aging, which ends in the process of division when growth causes the surface-volume ratio of the cell become inefficient. This life cycle is termed the cell cycle. The cell cycle consists of: (1) interphase (G-1, S and G-2) and (2) the M-phase (prophase, metaphase, anaphase and telophase).
THE MEIOTIC CELL CYCLE FOR GERM CELLS

Meiosis is a variation of the cell cycle that occurs in the ovaries of females and the testes of males. It creates cells that have half the number (haploid cells) of chromosomes. This modified cell cycle is known as meiosis (reduction division) and the offspring cells are known as gametes (egg and sperm). The process of gamete formation is called gametogenesis. The process of meiosis is different from a regular cell cycle that includes mitosis in these ways: (1) meiosis occurs only in selected gonadal cells and (2) meiosis occurs twice (Interphase I/Meiosis I and Interphase II/Meiosis II) before functional daughter cells with a haploid number of chromosomes are produced.

- **Meiosis I** - in interphase-I of meiosis-I replication of chromosomes occurs, but the chromosomes do not separate from one another. During prophase-I of the first meiotic process, crossing-over occurs and forever changes the parental chromosomes. This increases variety among offspring. The result of meiosis-I is two daughter cells, each with 46 chromosomes. The difference between these daughter cells and those formed during a regular cell division in somatic (body) cells is that the process of crossing-over changed the chromosomes by making them 'Mom-Dad mosaics'. This never occurs in a somatic cell.

- **Meiosis II** - interphase-II does not include an S-phase (replication); therefore the final daughter cells are haploid. During meiosis-II the pairs of previously doubled chromosomes separate. Therefore, each daughter cell gets half the number of chromosomes of the original parental cell. In the process of forming ova, the cytoplasm divides unequally and only one cell survives the second division. The other three polar bodies die off. Sperm cells divide their cytoplasm equally and therefore all four cells survive the second division.
<table>
<thead>
<tr>
<th>DISORDERS / DISEASES</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breast cancer</td>
<td>A cancer that originates in the breast tissues of both men and women. Worldwide, breast cancer is the second most common type of cancer after lung cancer.</td>
</tr>
<tr>
<td>Chlamydia</td>
<td>Called the silent epidemic. This is easily treated with tetracycline, but might be difficult to diagnose. Over 50% of all cases of PID in USA are caused by Chlamydia.</td>
</tr>
<tr>
<td>Cryptorchidism</td>
<td>Failure of the testes to descend into the scrotum just prior to birth. Increases risk of testicular cancer.</td>
</tr>
<tr>
<td>Dysmenorrhea</td>
<td>Painful menstruation. May be caused by problems with prostaglandin production or fluctuations in prostaglandin levels.</td>
</tr>
<tr>
<td>Ectopic pregnancy</td>
<td>When the fertilized ovum implants in the uterine tube, or falls into the body cavity and implants on the surface of an abdominal organ.</td>
</tr>
<tr>
<td>Endometriosis</td>
<td>Inflammation of the uterine lining. Tissue grows from uterus into abdominal cavity. May cause sterility, or possibly be pre-cancerous.</td>
</tr>
<tr>
<td>Genital herpes</td>
<td>Caused by herpes simplex, Epstein-Barr virus and probably others. Symptoms range from mild to very severe and include periodic severe outbreaks of blisters and other sores.</td>
</tr>
<tr>
<td>Genital warts</td>
<td>Caused by human papillomavirus (HPV), which is really a family of about 60 different viruses. Increases risk of certain cancers, such as penile, vaginal, cervical and anal cancers.</td>
</tr>
<tr>
<td>Gonorrhea</td>
<td>Caused by the bacterium Neisseria gonorrhoeae, which infects the mucosal linings of both the urinary and reproductive tracts.</td>
</tr>
<tr>
<td>Impotence</td>
<td>Failure to achieve erection. Psychological factors or physiological ones can cause this situation. Some medications can cause impotence.</td>
</tr>
<tr>
<td>Inguinal hernia</td>
<td>Protrusion of a portion of intestine through the wall of the inguinal canal, scrotum, or the lower abdominal wall.</td>
</tr>
<tr>
<td>Male infertility</td>
<td>Variety of possible causes, including blockage in tubular system of reproductive tract, poorly developed flagella on sperm, malformed sperm, effect of chemical therapies and the denaturation of critical sperm-head enzymes (from wearing tight clothing, etc.).</td>
</tr>
<tr>
<td>Orchitis</td>
<td>Inflammation of the testes. Often caused by mumps virus.</td>
</tr>
<tr>
<td>Pelvic inflammatory disease</td>
<td>A / k / a PID. Long-term scarring from bacterial infections, like gonorrhea. Can scar tubular system and cause infertility.</td>
</tr>
<tr>
<td>Prostatitis</td>
<td>Any inflammation of the prostate gland. Long-term inflammation and repeat infection may make structure prime pre-cancerous area.</td>
</tr>
<tr>
<td>Syphilis</td>
<td>Caused by the spiral bacterium Treponema pallidum, which penetrates mucosae and eventually is transmitted to CNS. Initial site of infection is called chancre. Is sexually transmitted, but may also be passed via blood stream of mother to her unborn child.</td>
</tr>
<tr>
<td>Uterine prolapse</td>
<td>Protrusion of the uterus through the vaginal wall.</td>
</tr>
<tr>
<td>Vaginitis</td>
<td>An inflammation of the vaginal canal that is usually caused by either the flagellated protozoan Trichomonas vaginalis or the bacterium Gardnerella vaginalis.</td>
</tr>
</tbody>
</table>