Male Reproductive system

Sexual reproduction requires two types of gametes or sex cells. In the male these cells are the spermatozoa and in the female they are the ova.

The reproductive systems are unique in three respects

1. They are specialized in perpetuating the species and passing genetic information.
2. The anatomy and physiology between the male and female reproductive systems are different.
3. They exhibit latent development under hormonal control.

The structures of the male reproductive system can be divided into three categories.

1. Primary sex organs - the gonads (testes). These produce sperm and sex hormones.
2. Secondary sex organs - the structures necessary for caring for and transportation of the sperm.
    - A. Sperm transporting ducts
        1. epididymus
        2. ductus deferens
        3. ejaculatory ducts
        4. urethra
    - B. Accessory glands
        1. seminal vesicle
        2. prostate gland
        3. bulbourethral (Cowper's) glands
    - C. Copulatory organ - penis. Also includes the scrotum (the skin enclosing the testes)
3. Secondary sex characteristics - These are not reproductively necessary, but are considered sexual attractants. They include things such as body hair, body physique, and voice pitch.

Sexual determination - Sex is determined at the time of conception. As we will see, all ova have an x chromosome and sperm are 50:50 X and Y. If an ova is fertilized by an x sperm then we have a female. If an ova is fertilized by a Y sperm then we have a male. Sometimes we see more than one X in an ovum. As long as there is a Y chromosome we will have a male. ie. XXXY = male.

The first sign of sexual development begins in the 5th embryonic week when we see a formation of a gonadal ridge behind the developing peritoneum. By the 6th week primary sex cords begin to develop within the gonadal ridge.

The primary sex cords in the male will become the seminiferous tubules in the adult.

During the 6th week, and on, primordial germ cells (spermatogonia and oogonia) are forming and migrating from the yolk sac to the area around the primary sex cords.

At 7 weeks of development the gonads still have the ability to become either testes or ovaries. This reminds us that both develop from the same embryologic tissues and thus are considered to be homologous structures.

Between 7 and 8 weeks you can tell if the fetus will be a male or a female. This is mainly by default... ie. by 8 weeks the ovary resembles an ovary, but the testes will not resemble a teste until the 10th week. Thus at 8 weeks if the ovary looks like an ovary then the fetus is female. If it does not look like an ovary then the fetus is a male.

It is the Y chromosome that masculinizes the gonad via the production of cell surface proteins coded for the Y chromosome. These markers are called H-Y antigens. Females have no Y chromosome and therefore no H-Y antigen. In the absence of H-Y antigen the gonad becomes an ovary.

At 8 to 10 weeks after conception the testes begin to secrete Androgens from the interstitial cells of Leydig. This is mainly testosterone and is at low levels.

Seminiferous tubules - the area where sperm is produced. It forms at 40 - 45 days (6-7 weeks)

Accessory sex organs - most come from 2 systems of embryonic ducts.

1. Male accessory organs come from mesonephric (Wolffian) ducts
2. female accessory organs come from paramesonephric (Mullerian) ducts

Female accessory organs develop due to an absence of testes Not the presence of ovaries. The developing seminiferous tubule secretes Mullerian inhibiting factor (MIF) which causes the regression of the paramesonephric ducts (approx 60 days). The testosterone from the interstitial cells causes growth and development of the mesonephric ducts.

The remaining sex organs, i.e. urogenital sinus, genital tubercle, urogenital folds, and labioscrotal folds are masculinized by the secretions of the testes.

The masculinizing effect is very important. Androgens must be responsible for the production of male structures. If they are not (if estrogens were) all fetuses would be female in appearance since they all develop in an estrogen rich environment (from ovaries of mother and placenta).

Realize that the testes develops inside the body cavity and must descend into the scrotum. This descent occurs around the 28th week, but it may occur later or even shortly after birth. Sometimes descent does not occur at all.

Descent leaves the testes attached via the spermatic cord which contains:

1. gonadal artery
2. gonadal vein which forms the pampiniform plexus
3. nerves
4. lymphatics
5. ductus deferens
6. artery to the ductus deferens

Scrotum - a sac of skin that contains the testes. Since formation of sperm requires a cooler temperature than body temperature (95° F or about 3.6° F lower than body temp) the testes are kept outside of the body. The cremaster and dartos muscles regulate the distance the testes are separated from the body. This involves both temperature regulation and protection (cremaster reflex). In the cremaster reflex, if the inside of the thigh is scratched in an upward direction the testicles will draw closer to the body. This is a protective mechanism. Try and think back about 40 thousand years when men had to chase down food (maybe a Gazelle) and kill it in order to eat. If while chasing the Gazelle the man were to fall and a large stick were to moving up the inside of the thigh the testicles would stand a good chance of being injured. At the animal (biological) level the two most important things are food and reproduction. An animal's purpose is to fill its niche and to produce more of its own kind to continue to fill the niche after the animal has died. Try the cremaster test at home. When the male is not suspecting anything (if he knows what is happening the reflex does not work) quickly scratch the inside of his thigh in an upward direction. The testicles should draw closer to the body. The same muscles draw the testicle closer to the body if the temperature of the scrotum falls too low, such as in swimming or bathing in cold water.

Testes There are three layers surrounding/comprising the testes.

1. Tunica vaginalis - thin, serous sac derived from the peritoneum during the descent of the testes.
2. Tunica albugenia - tough fibrous membrane that encapsulates the testes. It divides the testes into lobules (250 - 300)
3. Seminiferous tubules - 3 per lobule. Are highly coiled. There is about 2100 feet of tubule. Spermatogenesis occurs here.
    A. Meiosis in various stages
        1. spermatogonia - at basement membrane of Sertoli (nurse) cells
        2. formed (not yet mature) spermatozoa at lumen
    B. Interstitial Cells of Leydig - between Sertoli cells. These produce and secrete male sex hormones.
    C. Lead to rete testes which is a tubule where further maturation of spermatozoa takes place. From here the pathway leads to the efferent ductules and then to the epididymis for storage.

Notice here that the innervation comes from T10 spinal segment (sympathetic) thus the requirement for sympathetic nervous system for ejaculation. This also explains the condition known as "blue balls".

Spermatic ducts

A. Epididymis - attached to the testes. Is for sperm storage and maturation.
1. head
2. body
3. tail - attached to the ductus deferens

B. Ductus deferens (vas deferens) – is a fibromuscular tube about 18 inches long. It functions to carry sperm from the epididymis to the ejaculatory duct. The first portion is also involved in sperm storage. It is also under sympathetic innervation. The first portion is contained within the spermatic cord however after entering through the inguinal ring it curves down around the urinary bladder where it widens to form an ampulla which connects to the ejaculatory ducts.

C. Ejaculatory duct - is about 1 inch long. It is formed by the union of the ductus deferens and the duct of the seminal vesicle. It passes into the prostate gland where it enters the prostatic urethra.

D. Seminal vesicles - are about 2 inches long. They are found posteriorly at the base of the urinary bladder. They secrete a fluid which serves to enhance sperm movement and longevity. This fluid is mostly fructose, monosaccharide, and citric acid. These structures are under both sympathetic and parasympathetic control.

E. Prostate gland - is found immediately below the urinary bladder. It produces a prostatic secretion which assists sperm motility. This secretion is alkaline (basic) and thus helps to protect the sperm in the acidic environment of the vagina.

F. Bulbourethral glands (Cowper's) - are found inferior to the prostate. They drain into the urethra. Upon sexual excitement and prior to ejaculation they secrete a mucoid substance that neutralizes the pH of urine residue in the urethra. It also lubricates the tip of the penis in preparation for intercourse.

G. Urethra - in the male serves as a common tube for both the urinary and reproductive systems. Both systems cannot function at the same time. The urethra in the male has four regions
1. Preprostatic urethra – passes through the wall of the urinary bladder.
2. prostatic urethra - passes through the prostate gland. It receives secretions from the prostate gland and from the ejaculatory ducts.
3. membranous urethra - passes through the UG diaphragm. It contains the external urethral sphincter.
4. penile urethra (spongy urethra) - runs the length of the penis to exit at the glans. It is embedded in the corpus spongiosum. It also has urethral glands which secrete mucous.

Penis - the copulatory organ of the male. Note that the root of the penis expands to form the bulb of the penis and the cruz of the penis.

1. Bulb of the penis - is found in the urogenital triangle of the perineum where it is attached to the undersurface of the urogenital diaphragm enveloped by the bulbospongiosus muscle.

2. Cruz of the penis - Attaches the root of the penis to the pubic arch and the perineal membrane. It is enveloped by the ischiocavernosus muscle

Shaft of the penis - three columns of tissue

1. 2 columns of erectile tissue called the corpora cavernosa. These are located dorsally.

2. A single column of tissue surrounding the penile urethra called the corpus spongiosum. It is located ventrally.

The glans penis is an extension of the corpus spongiosum and has three regions:

1. Corona glandis - prominent posterior ridge of the glans
2. Frenulum - vertical fold on undersurface of the glans
3. Prepuce (foreskin) - removed in circumcision

Erection - parasympathetic impulses cause a large vasodilation of the arterioles of the penis. There may also be some vasoconstriction of the dorsal vein of the penis. There is more blood entering the penis than is leaving causing a swelling effect known as erection.

Emission - Is the movement of sperm from the epididymis to the ejaculatory ducts. There is also a movement of other accessory secretions to the ejaculatory ducts to form semen. Emission occurs as a result of sympathetic impulses.

Ejaculation - Immediately follows emission. Parasympathetic impulses stimulate the bulbospongiosus muscles to contract rhythmically. Sympathetic stimulation of the smooth muscle in the urethral wall causes peristalsis to help eject semen.

Semen - Mainly fructose and citric acid
- 3.5 ml per ejaculate
- 175 million sperm = normal, although higher is better
- below 70 million is considered sexually impaired
- below 20 million is considered clinically sterile