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The lecture (9) Human Physiology/The male reproductive system

Introduction

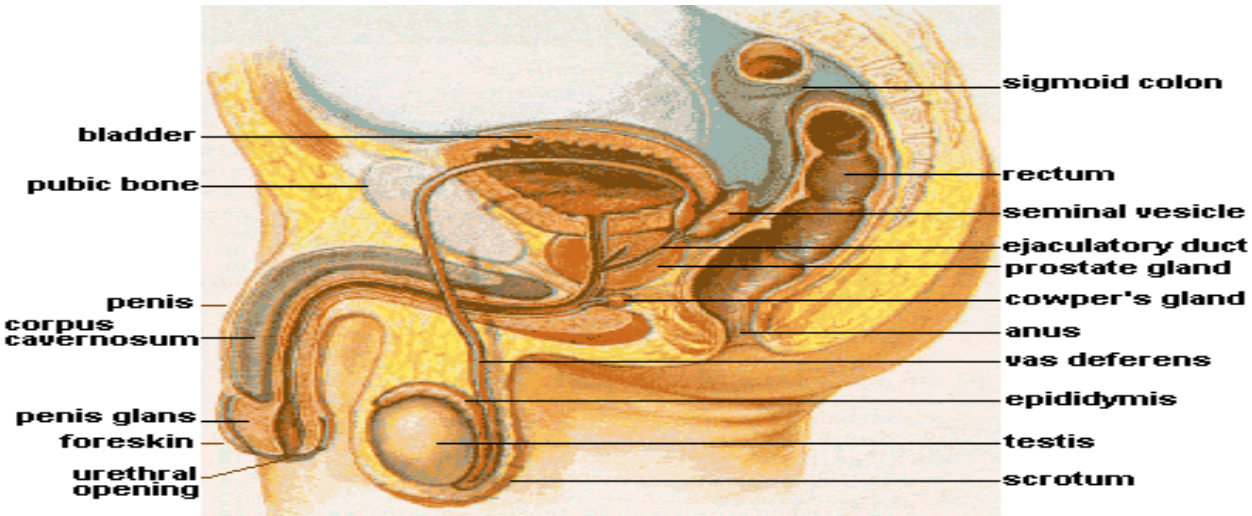
In simple terms, reproduction is the process by which organisms create descendants. This miracle is a characteristic that all living things have in common and sets them apart from nonliving things. But even though the reproductive system is essential to keeping a species alive.

In human reproduction, two kinds of sex cells or gametes are involved. Sperm, the male gamete, and an egg or ovum, the female gamete must meet in the female reproductive system to create a new individual. For reproduction to occur, both the female and male reproductive systems are essential.

Structure

Testes

The testes are located in the scrotum . In the male fetus the testes develop near the kidneys, then descend into the scrotum just before birth. Each testis is about 1 1/2 inches long by 1 inch wide. Testosterone is produced in the testes which stimulates the production of sperm as well as give secondary sex characteristics beginning at puberty.



Scrotum

The two testicles are each held in a fleshy sac called the scrotum. The major function of the scrotal sac is to keep the testes cooler than thirty-seven degrees Celsius .The external appearance of the scrotum vaires at different times in the same individual depending upon temperature and the subsequent contraction or relaxation of two muscles.

This causes the scrotum to appear tightly wrinkled. On the contrary, they relax in warm temperatures causing the testes to lower and the scrotum to become flaccid. The temperature of the testes is maintained at about thirty-five degrees Celsius .which is below normal body temperature. Temperature has to be lower than normal in order for spermatogenis (sperm production) to take place.

The two muscles that regulate the temperature of the testes are the dartos and

cremaster muscles:

1- Dartos Muscle

The dartos muscle is a layer of smooth muscle fibers in the subcutaneous tissue of the scrotum . This muscle is responsible for wrinkling up the scrotum, in conditions of cold weather, in order to maintain the correct temperature for spermatogenisis.

Cremaster Muscle

The cremaster muscle is a thin strand of skeletal muscle associated with the testes and spermatic cord. Seminiferous Tubules Each testis contains over 100 yards of tightly packed seminiferous tubules. Around 90% of the weight of each testes consists of seminiferous tubules. The seminiferous tubules are the functional units of the testis, where spermatogenisis takes place. Once the sperm are produced, they moved from the seminiferous tubules into the rete testis for further maturation.

Interstitial Cells (Cells of Leydig)

In between the seminiferous tubules within the testes, are instititial cells or Cells of Leydig. They are responsible for secreting the male sex hormones (i.e., testosterone).

Sertoli Cells

A Sertoli cell of the testes which is part of a seminiferous tubule. It is activated by follicle-stimulating hormone, and has FSH-receptor on its membranes. Its main function is to nurture the developing sperm cells through the stages of spermatogenesis. Because of this, it has also been called the "mother cell." It provides both secretory and structural support. functions During the Maturation phase of spermiogenesis, the Sertoli cells consume the unneeded portions of the spermatazoa.

Efferent ductules

The sperm are transported out of the testis and into the epididymis through a series of efferent ductules.

Epididymis

The seminiferous tubules join together to become the epididymis. The epididymis is a tube that is about 20 feet long that is coiled on the posterior surface of each testis. Within the epididymis the sperm complete their maturation and their flagella become functional. This is also a site to store sperm until the next ejaculation. Smooth muscle in the wall of the epididymis propels the sperm into the ductus deferens.. Vasa efferentia from the rete testis open into the epididymis which is a highly coiled tubule.

The epididymis has three parts- 1)head it is the proximal part of the epididymis. It caries the sperms from the testis. 2)body it the highly convoluted middle part of the epididymis 3)tail it is the last part that takes part in carrying the sperms to the

vas differens. Epididymis keeps sperms for sometimes, gives nourishment to it. The cauda epididymis continues to form less convoluted vas differens.

Seminal Vesicles

The pair of seminal vesicles are posterior to the urinary bladder. They secrete fructose to provide an energy source for sperm and alkalinity to enhance sperm mobility. The duct of each seminal vesicle joins the ductus deferens on that side to form the ejaculatory duct.

Ejaculatory Ducts

There are two ejaculatory ducts. Each receives sperm from the ductus deferens and the secretions of the seminal vesicle on its own side. Both ejaculatory ducts empty into the single urethra.

Prostate Gland

The prostate gland is a muscular gland that surrounds the first inch of the urethra as it emerges from the bladder. The smooth muscle of the prostate gland contracts during ejaculation to contribute to the expulsion of semen from the urethra.

Bulbourethral Glands

The bulbourethral glands also called Cowper's glands are located below the prostate gland and empty into the urethra. The alkalinity of seminal fluid helps neutralize the acidic vaginal pH and permits sperm mobility in what might otherwise be an unfavorable environment.

Penis

The penis is an external genital organ. The distal end of the penis is called the glans penis and is covered with a fold of skin called the prepuce or foreskin. Within the penis are masses of erectile tissue. Each consists of a framework of smooth muscle and connective tissue that contains blood sinuses, which are large, irregular vascular channels.

Composition of human semen

GLAND	APPROXIMATE %	DESCRIPTION
testes	2-5%	Approximately 200- to 500-million spermatozoa (also called sperm or spermatozoans), produced in the testes, are released per ejaculation
seminal vesicle	65-75%	amino acids, citrate, enzymes, flavins, fructose (the main energy source of sperm cells, which rely entirely on sugars from the seminal plasma for energy), hosphorylcholine, prostaglandins (involved in suppressing an immune response by the female against the foreign semen), proteins, vitamin C
prostate	25-30%	acid phosphatase, citric acid, fibrinolysin, prostate specific antigen, proteolytic enzymes, zinc (serves to help to stabilize the DNA-containing chromatin in the sperm cells. A zinc deficiency may result in lowered fertility because of increased sperm fragility. Zinc deficiency can also adversely affect spermatogenesis.)
bulbourethral glands	< 1%	galactose, mucus (serve to increase the mobility of sperm cells in the vagina and cervix by creating a less viscous channel for the sperm cells to swim through, and preventing their diffusion out of the semen. Contributes to the cohesive jelly-like texture of semen.), pre-ejaculate, sialic acid

Erection

A penile erection occurs when two tubular structures that run the length of the penis, the corpora cavernosa, become engorged with venous blood. This is a result of parasympathetic nerve induced vasodilation. This may result from any of various physiological stimuli. The corpus spongiosum is a single tubular structure located just below the corpora cavernosa, which contains the urethra, through

which urine and semen pass during urination and ejaculation, respectively. This may also become slightly engorged with blood, but less so than the corpora cavernosa.

Penile erection usually results from sexual stimulation and/or arousal, but can also occur by such causes as a full urinary bladder or spontaneously during the course of a day or at night, often during erotic or wet dreams. An erection results in swelling and enlargement of the penis. Erection enables sexual intercourse and other sexual activities (sexual functions), though it is not essential for all sexual activities.

Sperm Production

The entire process of sperm formation and maturation takes about 9-10 weeks. The separate divisions that take place and what happens in each are as follows:

First division: The first division is done by mitosis, and ensures a constant supply of spermatocytes, each with the diploid number of chromosomes.

Second division: Spermatocytes then undergo a series of two cell divisions during meiosis to become secondary spermatocytes.

Third division: Secondary Spermatocytes finally become spermatids. Spermatids, which are haploid cells, mature slowly to become the male gametes, or sperm.

Sperm Pathway

Spermatogenesis takes place inside a male's testes, specifically in the walls of the seminiferous tubules. The epididymis is a tortuously coiled structure topping the testis, it receives immature sperm from the testis and stores it for several days. When ejaculation occurs, sperm is forcefully expelled from the tail of the epididymis into the ductus deferens. Sperm travels through the ductus deferens and up the spermatic cord into the pelvic cavity, over the ureter to the prostate behind the bladder.

Here, the vas deferens joins with the seminal vesicle to form the ejaculatory

duct, which passes through the prostate and empties into the urethra. Sperm cells become even more active when they begin to interact with the fertilizing layer of an egg cell. They swim faster and their tail movements become more forceful and erratic. This behavior is called "hyper activation."

A recent discovery links hyper activation to a sudden influx of calcium ions into the tails, The sudden rise in calcium levels causes the flagellum to form deeper bends, propelling the sperm more forcefully through the viscous environment. The sperm use their tails to push themselves into the epididymis, where they complete their development. It takes sperm about 4 to 6 weeks to travel through the epididymis. The sperm then move to the vas deferens. The seminal vesicles and prostate gland produce a whitish fluid called seminal fluid, which mixes with sperm to form semen when a male is sexually stimulated.

Semen is pushed out of the male's body through his urethra - ejaculation. The speed of the semen is about 70 mph when ejaculation comes and it can contain 100 to 600 million sperm cells. When the male ejaculates during intercourse, semen is deposited into the fornix at the base of the female's vagina, near the cervix. From the fornix, the sperm make their way up through the cervix and move through the uterus with help from uterine contractions.

Sperm hyperactivity is necessary for breaking through two physical barriers that protect the egg from fertilization. **The first barrier** to sperm is made up of so-called cumulus cells embedded in a gel-like substance made primarily of hyaluronic acid. The cumulus cells develop in the ovary with the egg and support it as it grows.

The second barrier coating the oocyte is a thick shell formed by glycoproteins called the zona pellucida. One of the proteins that make up the zona pellucida binds to a partner molecule on the sperm. This lock-and-key type mechanism is species-specific and prevents the sperm and egg of different species from fusing.

There is some evidence that this binding is what triggers the acrosome to release the enzymes that allow the sperm to fuse with the egg.

When a sperm cell reaches the egg the acrosome releases its enzymes. These enzymes weaken the shell, allowing the sperm cell to penetrate it and reach the plasma membrane of the egg. Part of the sperm's cell membrane then fuses with the egg cell's membrane, and the sperm cell sinks into the egg .

Upon penetration, the egg cell membrane undergoes a change and becomes impenetrable, preventing further fertilization. The binding of the sperm to an ovum is called a zygote. A zygote is a single cell, with a complete set of chromosomes, that normally develops into an embryo.

Puberty

In addition to producing sperm, the male reproductive system also produces sex hormones, which help a boy develop into a sexually mature man during puberty.

Testicular function and fertility

The testes have two primary functions: to produce hormones and to produce sperm. The Leydig cells produce testosterone , which in turn produces most of the changes of male puberty. However, most of the increasing bulk of testicular tissue is spermatogenic tissue (primarily Sertoli and interstitial cells). The development of sperm production and fertility in males is not as well researched. Sperm can be detected in the morning urine of most boys after the first year of pubertal changes .

Testicular cancer. This is one of the most common cancers in men younger than 40. It occurs when cells in the testicle divide abnormally and form a tumor. Testicular cancer can spread to other parts of the body.

Inflammation of the penis. Symptoms of penile inflammation include redness, itching, swelling, and pain. Balanitis occurs when the glans becomes inflamed. Posthitis is foreskin inflammation, which is usually due to a yeast or bacterial infection.