Human Reproduction - Part 1

Objectives

After going through this lesson, the learners will be able to understand the following:

- The Male Reproductive System
- Male accessory glands
- Spermatogenesis
- Structure of sperm

Content Outline

Introduction

All living things reproduce. This is something that sets the living apart from non-living. Even though the reproductive system is essential to keeping a species alive, it is not essential to keeping an individual alive. Humans are sexually reproducing and viviparous. Reproduction can be defined as the process by which an organism continues its species. In the human reproductive process, two kinds of sex cells (gametes) are involved: the male gamete (sperm), and the female gamete (egg or ovum). These are specialized reproductive cells created in a process called meiosis. While normal cells contains 46 chromosomes, 23 pairs, gamete cells only contain 23 chromosomes, and it is when these two cells merge into one zygote cell that genetic recombination occurs and the new zygote contains 23 chromosomes from each parent, giving them 23 pairs. These two gametes meet within the female's uterine tubes located one on each side of the upper pelvic cavity, and begin to create a new individual. After a gestation period, typically for nine months, is followed by childbirth.

Sexual Reproduction

Sexual reproduction is a form of reproduction where two morphologically distinct types of specialized reproductive cells called gametes fuse together, involving a female's large ovum (or egg) and a male's smaller sperm.

The maintenance of sexual reproduction in a highly competitive world has long been one of the major mysteries of biology given that asexual reproduction can reproduce much more quickly as 50% of offspring in sexual reproduction are males, unable to produce offspring themselves.

Sexual reproduction must offer significant fitness advantages to a species because despite the two-fold cost of sex, it dominates among multicellular forms of life, implying that the fitness of offspring produced outweighs the costs. Sexual reproduction derives from recombination, where parent genotypes are reorganized and shared with the offspring. This stands in contrast to single-parent asexual replication, where the offspring is identical to the parents.

Sexual reproduction has probably contributed to the evolution of sexual dimorphism, where organisms within species adopted different strategies of parental investment. Males adopt strategies with lower investment in individual gametes and may present a higher mutation rate, while females may invest more resources and serve to conserve better-adapted solutions.

Sexual Dimorphism

The condition where the two sexes of the same species exhibit different characteristics beyond the is differences in their sexual organs. The condition occurs in many animals, insects, birds and some plants. Differences may include secondary sex characteristics, size, color, markings, and may also include behavioral differences. These differences may be subtle or exaggerated, and may be subjected to sexual selection.

Reproductive Events in Humans

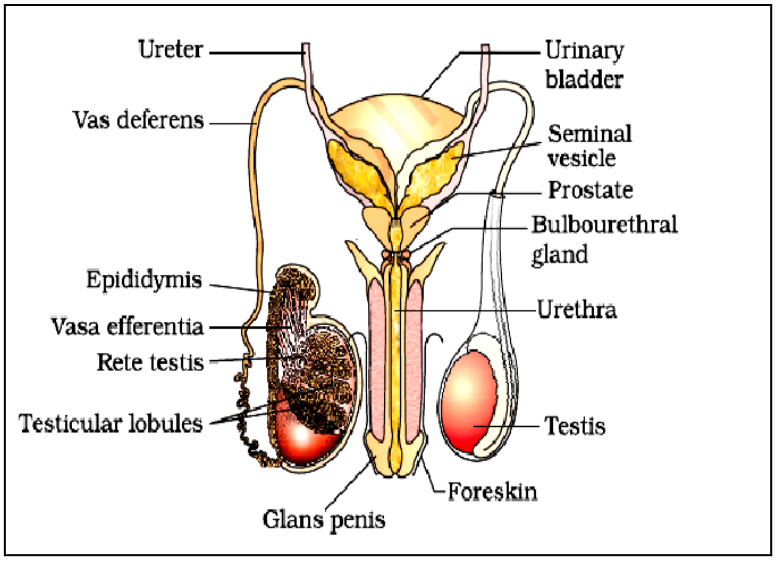
The reproductive events occur after puberty. There are remarkable differences between the reproductive events in the male and in the female, for example, sperm formation continues even in old men, but formation of ovum ceases in women around the age of fifty years.

Provided all organs are present, normally constructed, and functioning properly, the essential features of human reproduction are:

1. Formation and liberation of gametes (gametogenesis), i.e., sperms in males and ovum in females at a specific time in the reproductive cycle.
2. Transfer of sperms into the female genital tract (insemination).

3. Internal fertilization of the ovum by spermatozoa, or sperm cells (fusion of male and female gametes) leading to formation of zygote.
4. Transport of the fertilized ovum (Zygote) to the uterus, or womb.
5. Formation and development of blastocyst and its attachment to the uterine wall (implantation).
6. The early embryo developed from the fertilized ovum, in the wall of the uterus.
7. Formation of a placenta and maintenance of the unborn child during the entire period of gestation (embryonic development).
8. Birth of the child or delivery of the baby (parturition) and expulsion of the placenta, and
9. Suckling and care of the child, with an eventual return of the maternal organs to virtually their original state.

The Male Reproductive System



External genital organs

Penis

The penis is the male external sexual organ located superior to the scrotum and inferior to the umbilicus. The penis is roughly cylindrical in shape and contains the urethra and the external opening of the urethra. Large pockets of erectile tissue in the penis allow it to fill with blood and become erect. The erection of the penis causes it to increase in size and become turgid. The function of the penis is to deliver semen into the vagina during sexual intercourse. In

addition to its reproductive function, the penis also allows for the excretion of urine through the urethra to the exterior of the body.

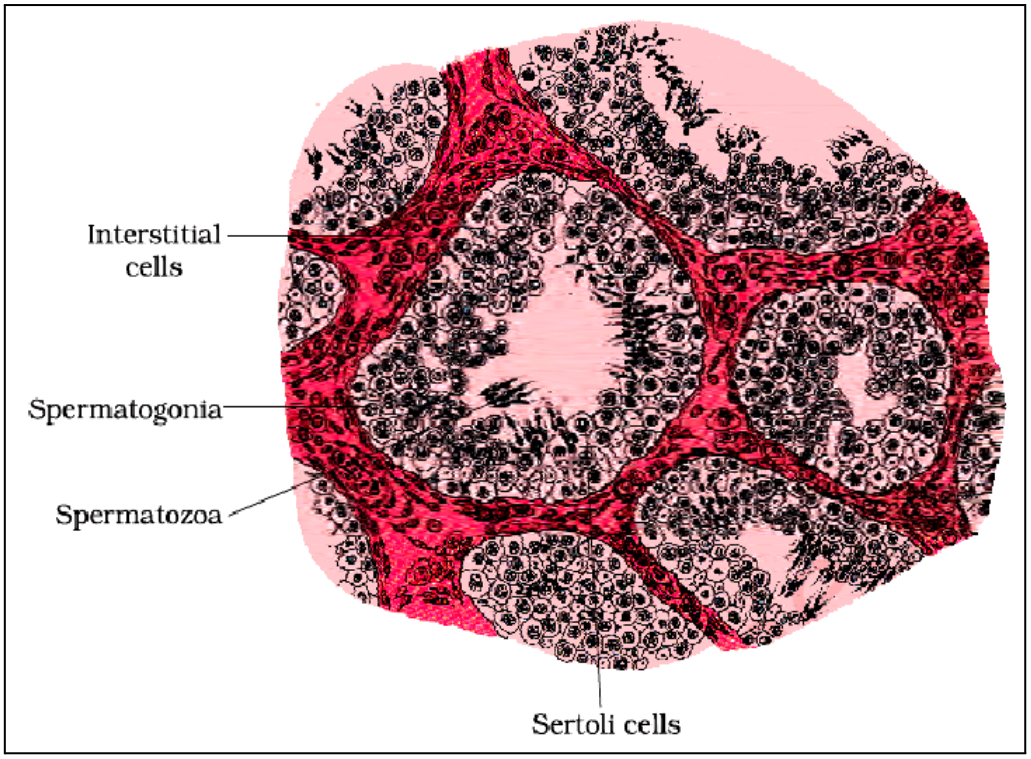
Scrotum

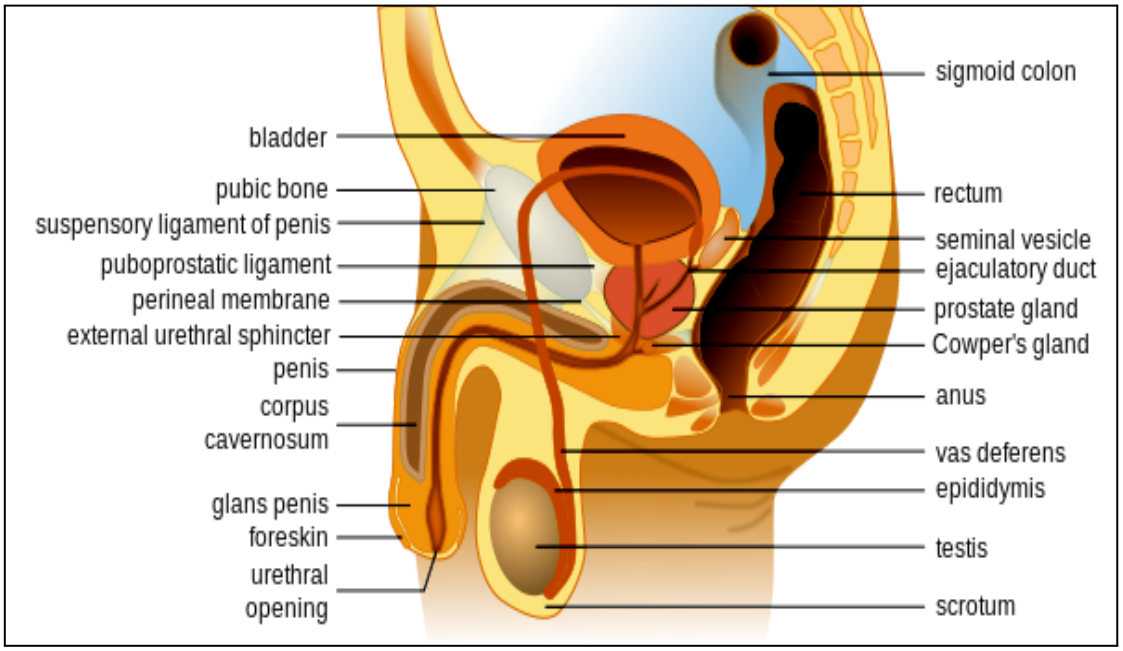
The scrotum is a sac-like organ made of skin and muscles that houses the testes. It is located inferior to the penis in the pubic region. The scrotum helps in maintaining the low temperature of the testes (2-2.5 oC lower than the normal internal body temperature) necessary for spermatogenesis. The scrotum is made up of 2 side-by-side pouches with a testis located in each pouch. The smooth muscles that make up the scrotum allow it to regulate the distance between the testes and the rest of the body. When the testes become too warm to support spermatogenesis, the scrotum relaxes to move the testes away from the body's heat. Conversely, the scrotum contracts to move the testes closer to the body's core heat when temperatures drop below the ideal range for spermatogenesis.

Testes

The testes, also known as testicles, are the male gonads responsible for the production of sperm and testosterone. The testes are ellipsoid glandular organs around 1.5 to 2 inches long and an inch in diameter. Each testis is found inside its own pouch on one side of the scrotum and is connected to the abdomen by a spermatic cord and cremaster muscle. The cremaster muscles contract and relax along with the scrotum to regulate the temperature of the testes. The inside of the testes is divided into about 250 small compartments known as lobules. Each lobule contains a section of seminiferous tubule lined with epithelial cells.

The testis is covered by a dense covering. Each lobule contains one to three highly coiled seminiferous tubules in which sperms are produced. Each seminiferous tubule is lined on its inside by two types of cells called male germ cells (spermatogonia) and Sertoli cells. The male germ cells undergo meiotic divisions finally leading to sperm formation, while Sertoli cells provide nutrition to the germ cells. The regions outside the seminiferous tubules called interstitial spaces contain small blood vessels and interstitial cells or Leydig cells. Leydig cells synthesise and secrete testicular hormones called androgens. Other immunologically competent cells are also present.





Internal genital organs

Epididymis

The epididymis is a sperm storage area that wraps around the superior and posterior edge of the testes. The epididymis is made up of several feet of long, thin tubules that are tightly coiled into a small mass. Sperm produced in the testes moves into the epididymis to mature

before being passed on through the male reproductive organs. The length of the epididymis delays the release of the sperm and allows them time to mature.

Spermatic Cords and Ductus Deferens

Within the scrotum, a pair of spermatic cords connects the testes to the abdominal cavity. The spermatic cords contain the ductus deferens along with nerves, veins, arteries, and lymphatic vessels that support the function of the testes.

The ductus deferens, also known as the vas deferens, is a muscular tube that carries sperm superiorly from the epididymis into the abdominal cavity to the ejaculatory duct. The ductus deferens is wider in diameter than the epididymis and uses its internal space to store mature sperm. The smooth muscles of the walls of the ductus deferens are used to move sperm towards the ejaculatory duct through peristalsis.

Seminal Vesicles

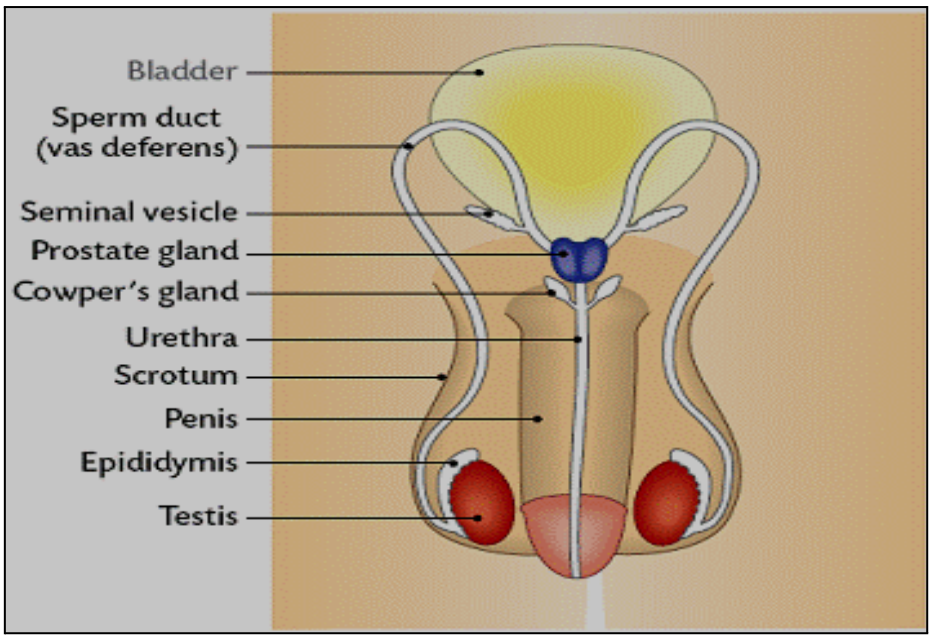
The seminal vesicles are a pair of lumpy exocrine glands that store and produce some of the liquid portion of semen. The seminal vesicles are about 2 inches in length and located posterior to the urinary bladder and anterior to the rectum. The liquid produced by the seminal vesicles contains proteins and mucus and has an alkaline pH to help sperm survive in the acidic environment of the vagina. The liquid also contains fructose to feed sperm cells so that they survive long enough to fertilize the oocyte.

Ejaculatory Duct

The ductus deferens passes through the prostate and joins with the urethra at a structure known as the ejaculatory duct. The ejaculatory duct contains the ducts from the seminal vesicles as well. During ejaculation, the ejaculatory duct opens and expels sperm and the secretions from the seminal vesicles into the urethra.

Urethra

Semen passes from the ejaculatory duct to the exterior of the body via the urethra, an 8 to 10 inch long muscular tube. The urethra passes through the prostate and ends at the external urethral orifice located at the tip of the penis. Urine exiting the body from the urinary bladder also passes through the urethra.



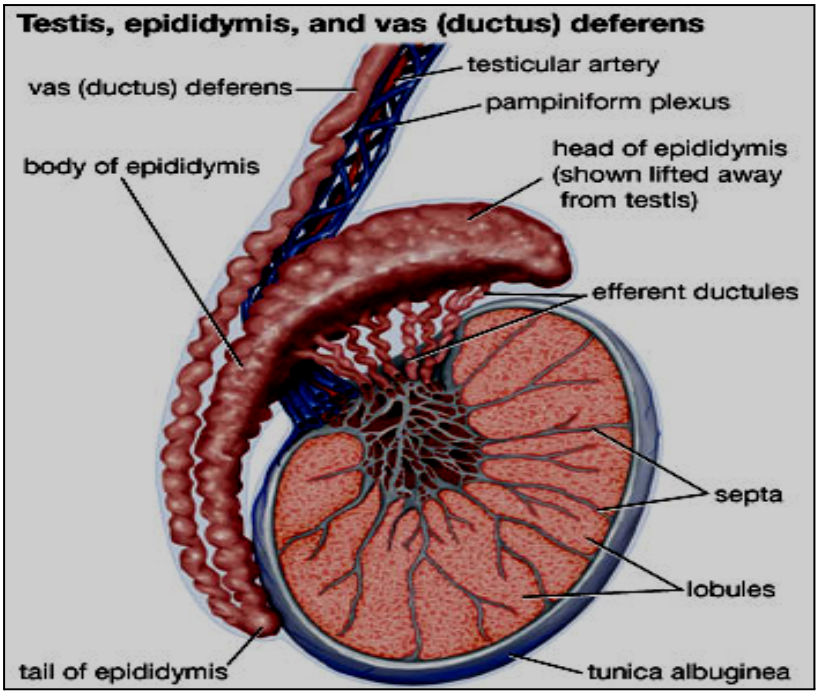
Male Accessory Glands

Prostate

The prostate is a walnut-sized exocrine gland that borders the inferior end of the urinary bladder and surrounds the urethra. The prostate produces a large portion of the fluid that makes up semen. This fluid is milky white in color and contains enzymes, proteins, and other chemicals to support and protect sperm during ejaculation. The prostate also contains smooth muscle tissue that can constrict to prevent the flow of urine or semen.

Cowper's Glands

The Cowper's glands, also known as the bulbourethral glands, are a pair of pea-sized exocrine glands located inferior to the prostate and anterior to the anus. The Cowper's glands secrete a thin alkaline fluid into the urethra that lubricates the urethra and neutralizes acid from urine remaining in the urethra after urination. This fluid enters the urethra during sexual arousal prior to ejaculation to prepare the urethra for the flow of semen.

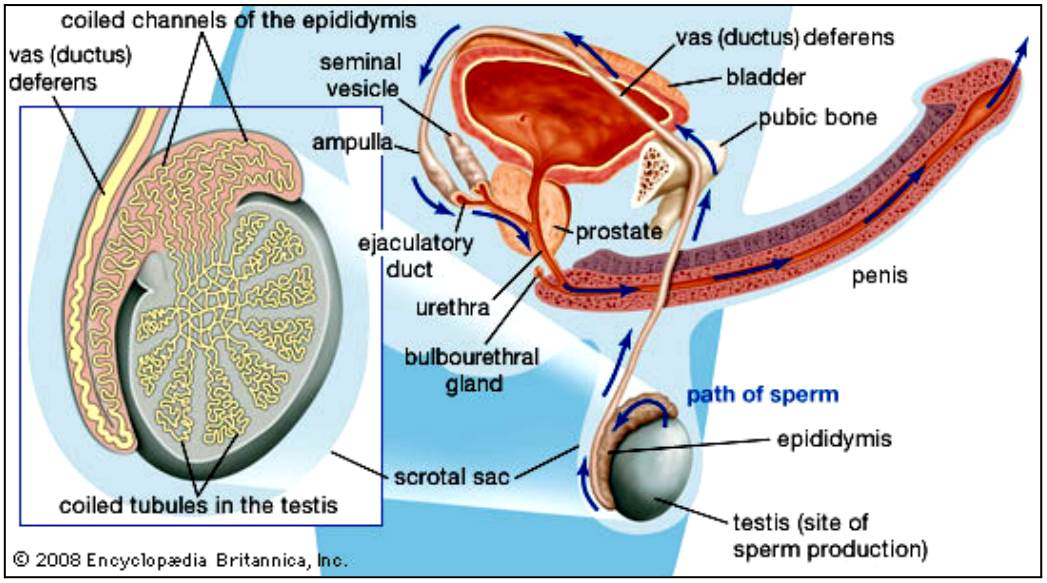


Seminal vesicle

The seminal vesicles are a pair of glands that are positioned below the urinary bladder and lateral to the vas deferens. Each seminal vesicle spans approximately 5 cm, though its full unfolded length is approximately 10 cm, but it is curled up inside the gland's structure.

The seminal vesicles secrete a significant proportion of the fluid that ultimately becomes semen. About 70-85% of the seminal fluid in humans originates from the seminal vesicles. The excretory duct of each seminal gland opens into the corresponding vas deferens as it enters the prostate gland. Seminal vesicle fluid is alkaline, resulting in human semen having a mildly alkaline pH. The alkalinity of semen helps neutralize the acidity of the vaginal tract, prolonging the lifespan of sperm. Acidic ejaculate (pH <7.2) may be associated with ejaculatory duct obstruction. The vesicle produces a substance that causes the semen to become sticky and jelly-like after ejaculation.

The thick secretions from the seminal vesicles contain proteins, enzymes, fructose, mucus and vitamin C etc. The high fructose concentrations provide nutrient energy for the spermatozoa when stored in semen in the laboratory.



Spermatogenesis

Spermatogenesis is the process in which spermatozoa are produced from spermatogonial stem cells by way of mitosis and meiosis. The initial cells in this pathway are called spermatogonia, which yield primary spermatocytes by mitosis. The primary spermatocyte divides meiotically (Meiosis I) into two secondary spermatocytes; each secondary spermatocyte divides into two spermatids by Meiosis II. These develop into mature spermatozoa, also known as sperm cells. Thus, the primary spermatocyte gives rise to two cells, the secondary spermatocytes, and the two secondary spermatocytes by their subdivision produce four spermatozoa.

It occurs in the seminiferous tubules of the male testes in a stepwise fashion. Spermatogenesis is highly dependent upon optimal conditions for the process to occur correctly, and is essential for sexual reproduction. It starts at puberty and usually continues uninterrupted until death, although a slight decrease can be discerned in the quantity of produced sperm with increase in age.

Purpose

Spermatogenesis produces mature male gametes, commonly called sperm but specifically known as spermatozoa, which are able to fertilize the counterpart female gamete, the oocyte, during conception to produce a single-celled individual known as a zygote. This is the cornerstone of sexual reproduction and involves the two gametes both contributing half the normal set of chromosomes (haploid) to result in a chromosomally normal (diploid) zygote.