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18/ENG08/025

BIOMEDICAL ENGINEERING

HUMAN PHYSIOLOGY II (PHS 212)

ASSIGNMENT: Write short notes on the following

- Spermatogenesis
- Testosterone
- Semen
- Male orgasm
- Male infertility

## SPERMATOGENESIS

Spermatogenesis involves the differentiation of spermatogonial stem cells into spermatocytes *via* mitotic cell division and the production of haploid spermatids from the tetraploid primary spermatocytes *via* meiotic cell division. Spermatids subsequently give rise to spermatozoa in the final phase of spermatogenesis, called spermiogenesis. These fundamental steps, where mitotic proliferation precedes meiosis during spermatogenesis, are observed in a wide variety of organisms. However, developing a comprehensive understanding of the cell biology and genetics of spermatogenesis is difficult for most species because it occurs within a complex testicular environment characterized by the intimate association of developing sperm with accessory cells. In this Primer, we summarize the processes of spermatogenesis occurring in two pivotal model animals — mouse and *Caenorhabditis elegans* — and compare them to consider which important features might be evolutionarily conserved.

The order goes as followed;

- a. Spermatogenesis begins during puberty and continues throughout life.
- b. Millions of sperm are produced in a 24-hour period. This occurs in the seminiferous tubules (see figure 1-10).

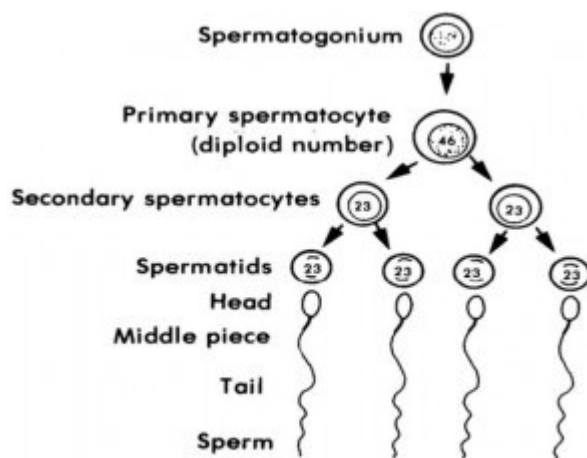


Figure 1-10. Spermatogenesis

- c. The process is begun by primitive stem cells, which are called spermatogonia and are found in the outer region of each tubules. Follicle stimulating hormone is secreted by the anterior pituitary beginning at puberty. Follicle stimulating hormone influences division of spermatogonia into primary spermatocytes.
- d. Each spermatocyte undergoes meiosis and produces four spermatids. All of the male's body cells contain the same 23 pairs of chromosomes. The spermatid contains one chromosome of each of the 23 pairs. The same chromosome configuration occurs in the ovum. When the sperm and egg unite, the normal number of chromosomes is reestablished—46 chromosomes or 23 pairs.

e. The mature sperm contains three regions: the head, which contains deoxyribonucleic acid (DNA), the midpiece, and the tail (see figure 1-11).

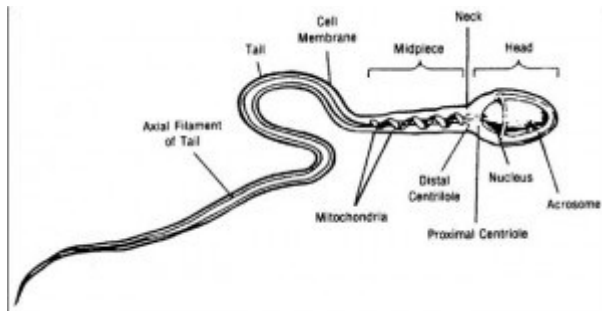


Figure 1-11. Structure of the sperm.

f. The acrosome is anterior to the head of the mature sperm. It contains special enzymes, which help the sperm to penetrate the egg.

## **TESTOSTERONE**

Testosterone is a male sex hormone that is important for sexual and reproductive development. The National Institutes of Health regards testosterone as the most important male hormone. Women also produce testosterone, but at lower levels than men.

Testosterone belongs to a class of male hormones called androgens, which are sometimes called steroids or anabolic steroids. In men, testosterone is produced mainly in the testes, with a small amount made in the adrenal glands. The brain's hypothalamus and pituitary gland control testosterone production. The hypothalamus instructs the pituitary gland on how much testosterone to produce, and the pituitary gland passes the message on to the testes. These communications happen through chemicals and hormones in the bloodstream.

Testosterone is involved in the development of male sex organs before birth, and the development of secondary sex characteristics at puberty, such as voice deepening, increased penis and testes size, and growth of facial and body hair.

The hormone also plays a role in sex drive, sperm production, fat distribution, red cell production, and maintenance of muscle strength and mass, according to the Mayo Clinic. For these reasons, testosterone is associated with overall health and well-being in men. One 2008 study published in the journal *Frontiers of Hormone Research* even linked testosterone to the prevention of osteoporosis in men.

In women, the ovaries and adrenal glands produce testosterone. Women's total testosterone levels are about a tenth to a twentieth of men's levels.

## Low testosterone

Levels of testosterone naturally decrease with age, but exactly what level constitutes "low T," or hypogonadism, is controversial, Harvard Medical School said. Testosterone levels vary wildly, and can even differ depending on the time of day they're measured (levels tend to be lower in the evenings).

The National Institutes of Health includes the following as possible symptoms of low testosterone:

- Reduced sex drive
- Erectile dysfunction or impotence
- Increased breast size
- Lowered sperm count
- Hot flashes
- Depression, irritability and inability to concentrate
- Shrunken and softened testes
- Loss of muscle mass or hair
- Bones becoming prone to fracture

It is important to note, however, that conditions other than low T can cause erectile dysfunction, such as diseases in the nerves or blood.

Doctors typically to treat men for hypogonadism if they have symptoms of low testosterone and their testosterone levels are below 300 nanograms per deciliter.

## High testosterone

High testosterone levels can cause problems in women, including irregular menstrual cycles, increases in body hair and acne, and a deepening of the voice. Women with polycystic ovarian syndrome have high levels of male hormones, including testosterone, which can be a cause of infertility.

## SEMEN

Semen, also known as seminal fluid, is an organic fluid that contains spermatozoa. It is secreted by the gonads (sexual glands) and other sexual organs of male or hermaphroditic animals and can fertilize the female ovum. In humans, seminal fluid contains several components besides spermatozoa: proteolytic and other enzymes as well as fructose are elements of seminal fluid which promote the survival of spermatozoa, and provide a medium through which they can move or "swim". Semen is produced and originates from the seminal vesicle, which is located in the pelvis. The process that results in the discharge of semen is called *ejaculation*. Semen is also a form of genetic material.

## **Male orgasm**

The male orgasm is a complex system involving multiple hormones, organs, and nerve pathways.

The hormone testosterone, produced in the testicles, plays a central role by enhancing the sexual desire (libido) that leads to arousal, erection, and ultimately orgasm. By contrast, low testosterone not only decreases a man's energy and mood, it makes him less responsive to sexual stimuli, both physical and mental.

The male ejaculate, semen, is comprised of sperm cells and seminal fluid, the latter of which contains phosphorylcholine (an enzyme that aids in fertility) and fructose (which provides fuel for sperm).

## **Male infertility**

The causes of male infertility include problems with sperm production, blockage of the sperm-delivery system, the presence of antibodies against sperm, testicular injury, anatomic abnormalities, and the presence of a varicose vein around the testicle (varicocele)—all of which can affect sperm quality or quantity. Infertility is also more likely to occur in men born with a low birth weight compared with those born with an average weight for gestational age.

Evidence suggests that reduced sperm function and male infertility may be risk markers of disease later in life. For instance, although a causal link is lacking, male infertility has been associated with the later development of prostate cancer in some men.

- Abnormalities of sperm production

Sperm number, concentration, motility, and morphology (shape) are usually assessed by means of a microscopic examination of the semen. Sperm count is the total number of sperm in the ejaculate; counts vary widely, but values below 20 million are usually considered low. Low sperm count is generally referred to as oligospermia. In some cases, male infertility is caused by complete absence of spermatozoa in the ejaculate, a condition known as azoospermia. This condition can be caused by an obstruction of the genital tract, by testicular dysfunction associated with congenital disorders such as sickle cell disease, or by various illnesses.

Sperm concentration is the number of sperm per cubic centimetre of semen. Sperm concentrations of 20 million to 250 million per cubic centimetre are usually considered normal, but fertilization of an egg can be achieved by men

with values well below this range. Older men produce fewer and less-motile sperm, and advancing age is associated with a drop in circulating testosterone levels, as well as a decrease in the overall functioning of the testicles.

- Treatment options

If production of sperm is low, couples are typically encouraged to limit their frequency of intercourse and to time their intercourse to coincide with periods of ovulation in the female. A physical blockage of the pathways by which the sperm must travel can in many cases be corrected by surgery to eliminate adhesions that have closed the tubal pathways or to remove obstructive growths such as cysts that may be present.

Intracytoplasmic sperm injection (ICSI) is a treatment for men with very low sperm counts or with sperm that for some other reason are unable to fertilize an egg. The first child conceived by this method was born in 1992. ICSI involves the direct injection of a single sperm into the cytoplasm (cell material surrounding the nucleus) of an egg that has been retrieved for IVF. If a man has an obstruction in the genital tract that prevents sperm from moving through the genital ducts, sperm can be taken directly from the epididymis, the coiled channels that provide nourishment to the sperm. This is done by using a needle in a procedure known as microsurgical epididymal sperm aspiration (MESA). Eggs that are successfully fertilized are placed in the woman's uterus.

Artificial insemination is an alternative method of treating infertility. If the male is normally fertile but for some reason is not transmitting sufficient sperm, he may donate semen whose sperm cells can be concentrated and then introduced into the woman's uterus artificially.