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DEPARTMENT: BIOMEDICAL ENGINEERING

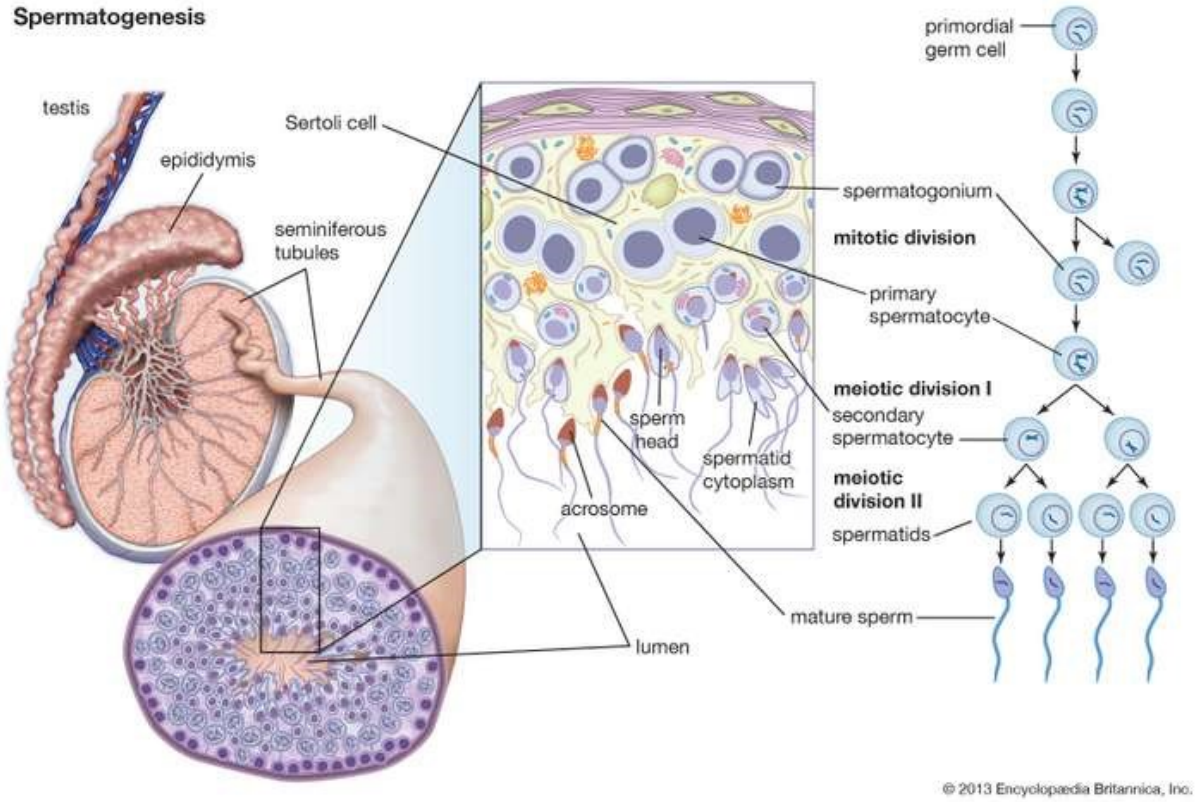
COURSE: HUMAN PHYSIOLOGY II (PHS 212)

ASSIGNMENT TITLE: Write short notes on the following

1. Spermatogenesis
2. Testosterone
3. Semen
4. Male orgasm
5. Male infertility

Spermatogenesis

Spermatogenesis is the origin and development of the sperm cells within the male reproductive organs, the testes. The testes are composed of numerous thin, tightly coiled tubules known as the seminiferous tubules; the sperm cells are produced within the walls of the tubules. Within the walls of the tubules, also, are many randomly scattered cells, called Sertoli cells, that function to support and nourish the immature sperm cells by giving them nutrients and blood products. As the young germ cells grow, the Sertoli cells help to transport them from the outer surface of the seminiferous tubule to the central channel of the tubule.



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Sperm cells are continually being produced by the testes, but not all areas of the seminiferous tubules produce sperm cells at the same time. One immature germ cell takes as long as 74 days to reach final maturation, and during this growth process there are intermittent resting phases.

The immature cells (called spermatogonia) are all derived from cells called stem cells in the outer wall of the seminiferous tubules. The stem cells are composed almost entirely of nuclear material. (The nucleus of the cell is the portion containing the chromosomes.) The stem cells begin their process by multiplying in the process of cell duplication known as mitosis. Half of the new cells from this initial crop go on to become the future sperm cells, and the other half remain as stem cells so that there is a constant source of additional germ cells. Spermatogonia destined to develop into mature sperm cells are

known as primary sperm cells. These move from the outer portion of the seminiferous tubule to a more central location and attach themselves around the Sertoli cells. The primary sperm cells then develop somewhat by increasing the amount of cytoplasm (substances outside of the nucleus) and structures called organelles within the cytoplasm. After a resting phase the primary cells divide into a form called a secondary sperm cell. During this cell division there is a splitting of the nuclear material. In the nucleus of the primary sperm cells there are 46 chromosomes; in each of the secondary sperm cells there are only 23 chromosomes, as there are in the egg. When the egg and sperm combine and their chromosomes unite, the characteristics of both individuals blend and the new organism starts to grow.
The secondary sperm cell still must mature before it can fertilize an egg; maturation entails certain changes in the shape and form of the sperm cell. The nuclear material becomes more condensed and oval in shape; this area develops as the head of the sperm. The head is covered partially by a cap, called the acrosome, which is important in helping the sperm to gain entry into the egg. Attached to the opposite end of the head is the tailpiece. The tail is derived from the secondary sperm cell's cytoplasm. In the mature sperm, it consists of a long, slender bundle of filaments that propel the sperm by their undulating movement. Once the sperm has matured, it is transported through the long seminiferous tubules and stored in the epididymis of the testes until it is ready to leave the male body.

Testosterone

Testosterone, hormone produced by the male testis that is responsible for development of the male sex organs and masculine characteristics, including facial hair and deepening of the voice.
Testosterone is the primary male sex hormone and anabolic steroid. In male humans, testosterone plays a key role in the development of male reproductive tissues such as testes and prostate, as well as promoting secondary sexual characteristics such as increased muscle and bone mass, and the growth of body hair.

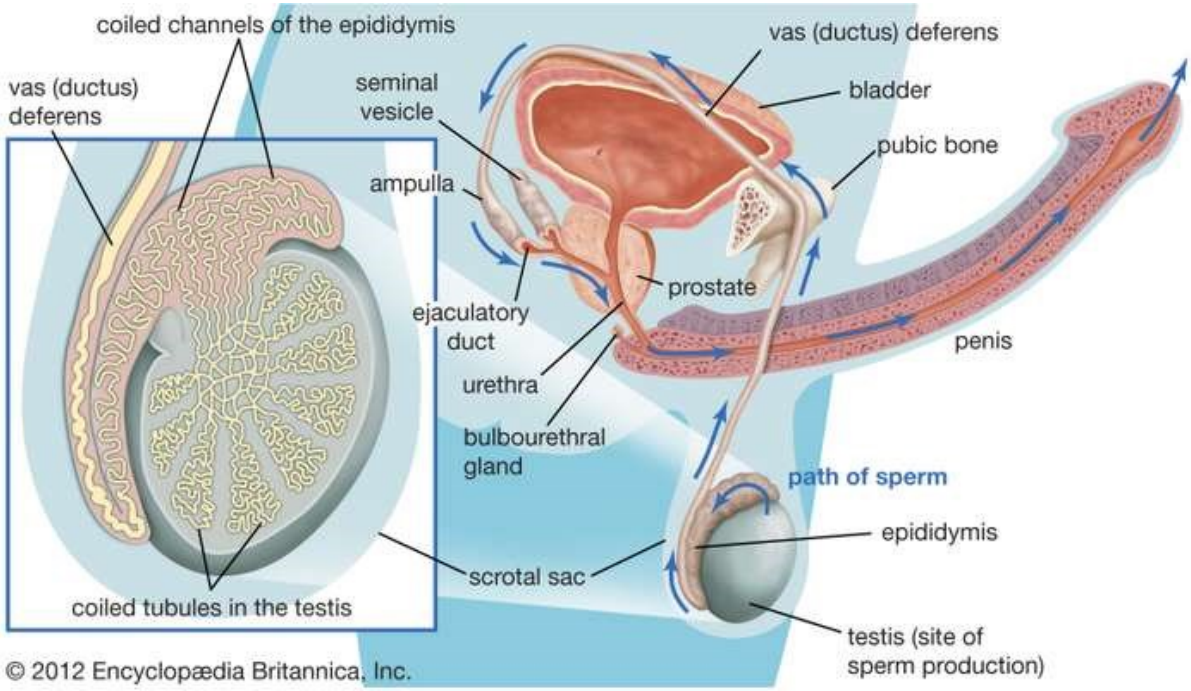
Formula: $C_{19}H_{28}O_2$
A healthy man produces about 5 mg (1.8×10^{-4} ounces) of testosterone daily. Testosterone serves as a circulating prohormone for a more active androgen called dihydrotestosterone. Testosterone is converted to dihydrotestosterone in most tissues that are sensitive to androgens, including the testes, prostate gland, hair follicles, and muscles. Although testosterone itself has androgenic actions, its conversion to dihydrotestosterone is critical to the development of external genitalia in boys. Testosterone is also converted to estradiol in adipose tissue (and to a lesser extent in some other tissues), which is the most important source of estrogen in men. Furthermore, testosterone is interconvertible with androstenedione, which can be converted into estrogens. When androstenedione is formed in adipose tissue, it may be converted to a form of estrogen called estrone.
Similar to other steroid hormones, testosterone exists in serum in two forms. Most testosterone in the serum is bound to sex hormone-binding globulin and to albumin,

while the remaining amount (about 1 percent) is free, or unbound. Free testosterone is in equilibrium with bound testosterone so that when free testosterone enters cells, some bound testosterone is immediately freed. In the cytoplasm of target cells, testosterone or dihydrotestosterone binds to specific androgen receptors, and the hormone-receptor complexes enter the cell nucleus, where they modulate protein synthesis by influencing the rate at which particular genes are transcribed.

Testosterone has several major actions. It provides negative feedback inhibition on the secretion of gonadotropin-releasing hormone from the hypothalamus and the secretion of luteinizing hormone from the pituitary gland. It also directs the development of the embryonic Wolffian ducts into the vas deferens (ductus deferens) and seminal vesicles and stimulates the formation of muscle and bone. Dihydrotestosterone is responsible for sperm maturation during spermatogenesis, for the formation of the prostate gland and external genitalia, and for sexual maturation at puberty.

Semen

Semen, also called seminal fluid, fluid that is emitted from the male reproductive tract and that contains sperm cells, which are capable of fertilizing the female eggs. Semen also contains other liquids, known as seminal plasma, which help to keep the sperm cells viable.



In the sexually mature human male, sperm cells are produced by the testes (singular, testis); they constitute only about 2 to 5 percent of the total semen volume. As sperm travel through the male reproductive tract, they are bathed in fluids produced and secreted by the various tubules and glands of the reproductive system. After emerging from the testes, sperm are stored in the epididymis, in which secretions of potassium, sodium, and glycerylphosphorylcholine (an energy source for sperm) are contributed to

the sperm cells. Sperm mature in the epididymis. They then pass through a long tube, called the ductus deferens, or vas deferens, to another storage area, the ampulla. The ampulla secretes a yellowish fluid, ergothioneine, a substance that reduces (removes oxygen from) chemical compounds, and the ampulla also secretes fructose, a sugar that nourishes the sperm. During the process of ejaculation, liquids from the prostate gland and seminal vesicles are added, which help dilute the concentration of sperm and provide a suitable environment for them. Fluids contributed by the seminal vesicles are approximately 60 percent of the total semen volume; these fluids contain fructose, amino acids, citric acid, phosphorus, potassium, and hormones known as prostaglandins. The prostate gland contributes about 30 percent of the seminal fluid; the constituents of its secretions are mainly citric acid, acid phosphatase, calcium, sodium, zinc, potassium, protein-splitting enzymes, and fibrolysin (an enzyme that reduces blood and tissue fibres). A small amount of fluid is secreted by the bulbourethral and urethral glands; this is a thick, clear, lubricating protein commonly known as mucus.
Essential to sperm motility (self-movement) are small quantities of potassium and magnesium, the presence of adequate amounts of oxygen in the plasma, proper temperature, and a slightly alkaline pH of 7 to 7.5. Sulfate chemicals in semen help prevent the sperm cells from swelling; and fructose is the main nutrient to sperm cells.

The total volume of semen for each ejaculation of a human male averages between 2 and 5 ml (0.12 to 0.31 cubic inch); in stallions the average ejaculate is about 125 ml (7.63 cubic inches). In human beings each ejaculation contains normally 200 to 300 million sperm. Semen frequently contains degenerated cells sloughed off from the network of tubules and ducts through which the semen has passed.

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.