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Male Reproductive System

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Abstract-The overall reproductive process consists of both the human sex organs which include the male and female reproductive system. The ability to produce off springs that have similar characteristic as their parents is the goal of reproduction. The sexual type of reproduction takes place in human and both male and female reproductive system is required. Male reproductive system is mainly concerned with production of semen (whitish viscous fluid emitted from the male reproductive tract that contains sperm and fluids) and transferring it into the female reproductive tract. In this review, we will discuss the latest findings in the research pertaining the male reproductive system and its contribution towards the research in advancement of reproductive physiology.

Keywords: Male reproductive system, reproduction, reproductive anatomy, physiology

Introduction

Reproduction refers to the production new offspring, also known as breeding in animals. It involves series of physiological processes that take place (usually) in the female reproductive system with the association of behaviors and anatomical structures which are vital to ensure the birth of the next generation of species in humans, domestic, wild, as well as in laboratory vertebrates. Although these processes take place within the female's system, it is as a result of the fusion of haploid gametes each from male (sperm) and female (ovum) termed, fertilization in vertebrates. Testes, ductus deferens, epididymis, accessory glands, and penis make up the male reproductive system (Starr and Mcmillan, 2010). The males' reproductive system functions mainly in the production, nourishment and temporary storage of male gametes (spermatozoa), which is produced via spermatogenesis. It produces androgens and estrogen through steroidogenesis (Stevens and Lowe, 2005) and very importantly, connected to the organ of copulation (penis) which serves to introduce semen containing spermatozoa into the female genital system via mating.

Testis

The testis serves mainly to produce semen and synthesizes steroids (Carreau *et al.*, 2007). The seminiferous tubules account for 90% of the weight of adult testis while the interstitial tissue is a thin web of connective tissue containing Leydig cells (Ridge *et al.*, 2004).

The testis is the pivotal organ of the male reproductive system. It is responsible for steroidogenesis, primarily the production of androgen, as well as the generation of haploid germ cells by spermatogenesis, these two functions occur in the Leydig cells and seminiferous tubules, respectively. The testis has three compartments which consist of the interstitial tissue, containing the Leydig cells which surround the seminiferous tubules and supply them with fluid rich testosterone and the remaining two compartments reside within the seminiferous tubules (Cunningham and Klein, 2007).

Structure

The testis is a solid oval-shaped of approximately 4 cm long and 2.5 cm width in size in adult humans. Testes are housed in the scrotum which controls its temperature to about 2 – 3^{o}C below the normal body temperature (Stevens and Lowe, 2005; Saladin, 2008; Marieb and Hoehn, 2010). There is normally two testis, each weighing approximately 11 – 17 g with the right one usually slightly larger and heavier than 963+0the left (Stevens and Lowe, 2005). Within the scrotum, a testis (singular) is surrounded by a saccular extension of the peritoneum, called tunica vaginalis. Tunica albuginea is found underneath the tunica vaginalis and forms the white fibrous capsule of the testis (Stevens and Lowe, 2005; Saladin, 2008; Marieb and Hoehn, 2010) as indicated in (Figure 1). Tunica albuginea is thickened posteriorly assembling mediastinum of the testis from which fibrous septa penetrates the testis and divides into approximately 200 to 300 wedge-shaped lobules. Each testicular lobule contains one to four tightly coiled seminiferous tubules where sperm is being produced (Stevens and Lowe, 2005; Saladin, 2008; Marieb and Hoehn, 2010).

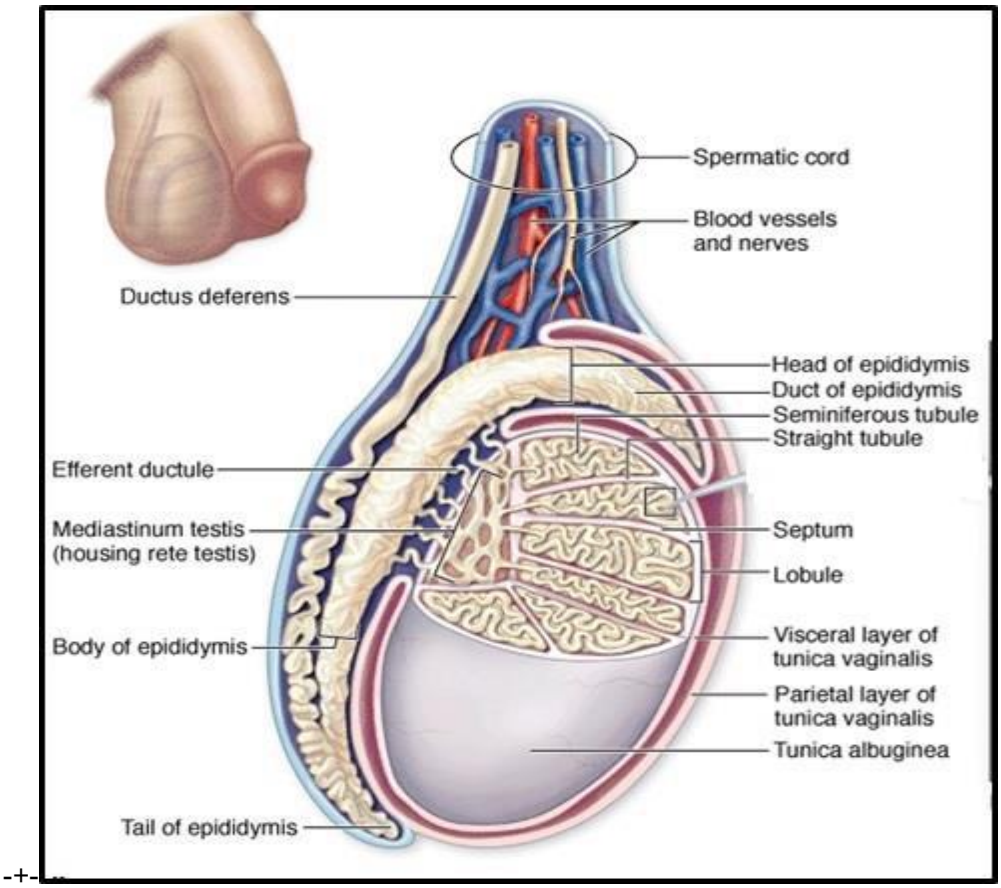

Figure 1: Structure of the testis. (Marieb and Hoehn, 2010).

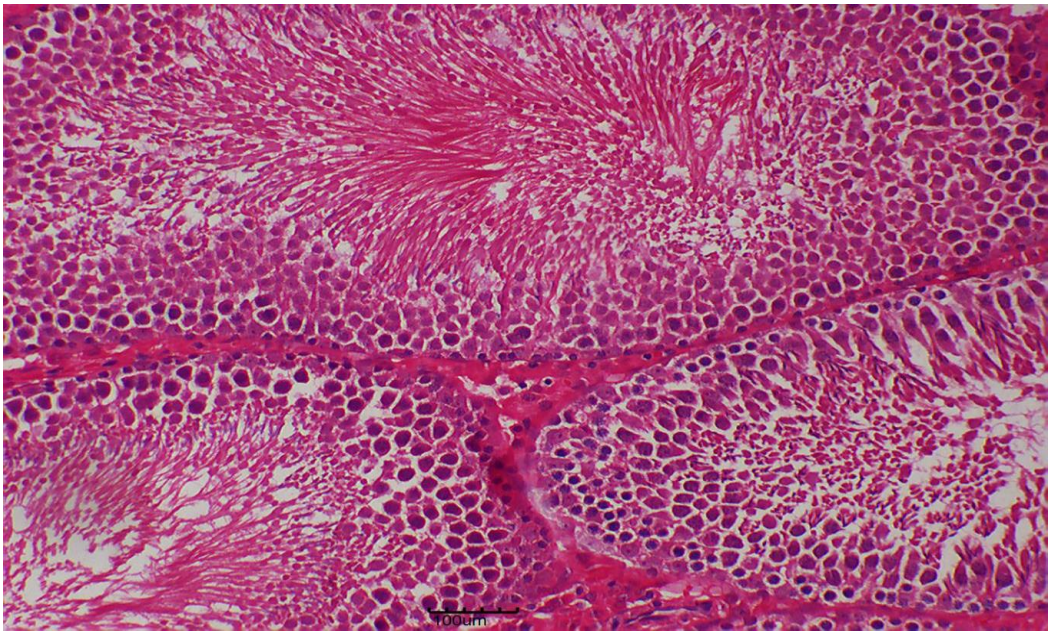

Figure 2: Photomicrograph of the normal testis (Assi *et al.*, 2017).

Accessory gland (prostate, bulbourethral, vesicular gland (seminal vesical))

Prostate Gland

Structure

The prostate gland is one of the accessory glands in the male reproductive system. It is a dense secreting gland surrounding the urethra inferior to the bladder (Saladin, 2008; Mescher, 2010; Marieb and Hoehn, 2010). It has a diameter of approximately 2 × 3 × 4 cm and weighs approximately 20 g (Saladin, 2008; Mescher, 2010). It is made up of 30 to 50 tubuloalveolar glands embedded in a supporting dense fibromuscular stroma (Figure 2) (Saladin, 2008; Mescher, 2010; Marieb and Hoehn, 2010). The epithelial lining of the tubuloalveolar glands varies from simple or columnar to pseudostratified epithelia and is supported by lamina propria (Stevens and Lowe, 2005; Mescher, 2010; Eroschenko, 2013).

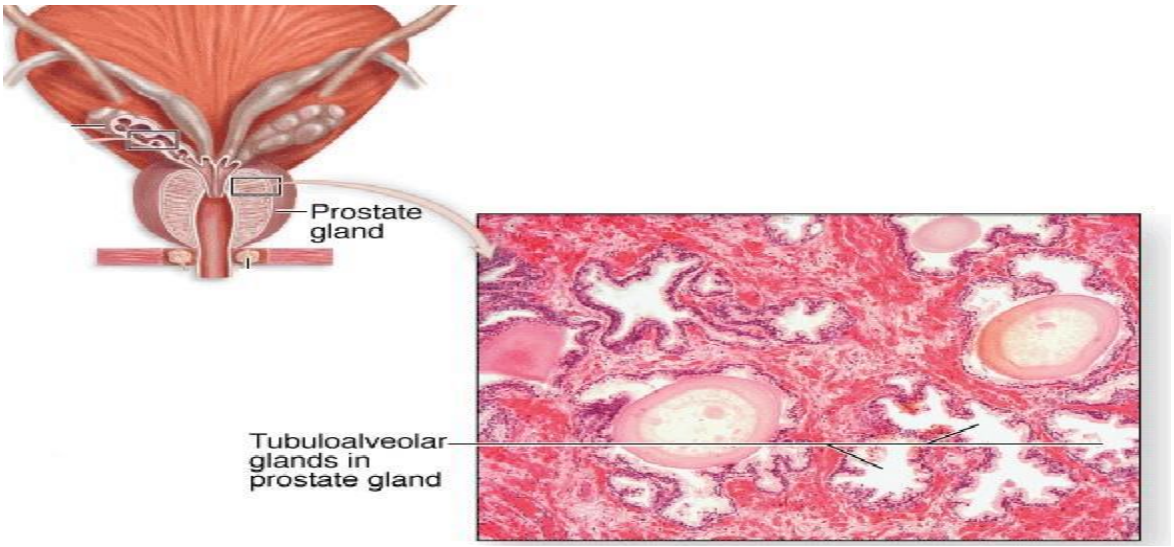

Figure 3: Photomicrograph shows the characteristic of individual tubuloalveolar glands of the prostate. (Mescher, 2010).

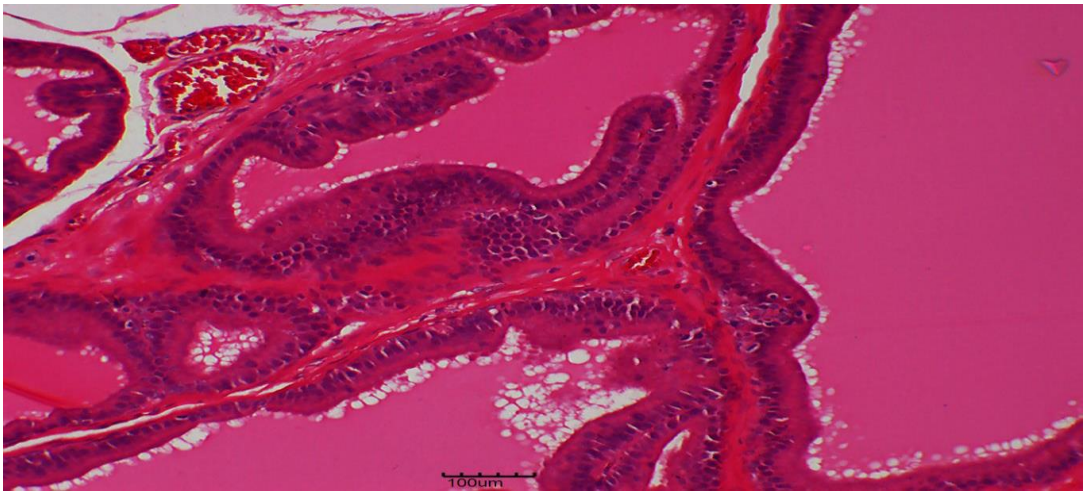

Figure 4: Photomicrograph of the normal prostate gland (Assi *et al.*, 2017).

The prostate gland is enclosed in a connective tissue capsule which penetrates into the gland as septa dividing the gland into indistinct lobes (Stevens and Lowe, 2005; Mescher, 2010; Marieb and Hoehn, 2010). In rodents, the prostate gland consists of dorsal, ventral and lateral lobes (Hayashi *et al.*, 1991; Favaro and Cagnon, 2006). Dorsal lobe is located interior and posterior to the urinary bladder, at the same time below behind the attachment of both the seminal vesicles and coagulating glands (Hayashi *et al.*, 1991). The ventral lobes are located anterior to urethra just below the urinary bladder while the lateral lobes are located immediately below both seminal vesicles and coagulating glands (Tlachi-Lopez *et al.*, 2011).

Function

Prostatic secretion makes up about 75% of the seminal fluid and is slightly acidic (pH 6.6) (Kumar and Majumder, 1995). It is rich in citric acid and hydrolytic enzymes, especially fibrinolysin enzyme. Fibrinolysin helps to liquefy coagulated semen after it had been deposited in the female genital tract. Furthermore, albumin in prostatic secretion facilitates and enhances sperm motility while acid phosphates are involved in providing nutrition for the spermatozoa (Walsh *et al.*, 1992). Moreover, the prostatic zinc acts as an antibacterial agent in the seminal fluid (Fair and Wehner, 1976).

Seminal Vesicle

Structure

Another male secondary sex organ is the seminal vesicle which is a pair of glands located on the posterior side of the bladder (Akinsola *et al.*, 2012; Eroschenko, 2013), which open into the vas deferens near to its junction with the urethra. They are highly convoluted glands of approximately 10 to 15 cm long (Mescher, 2010; Akinsola *et al.*, 2012). The excretory duct of seminal vesicle adheres to the ampulla of vas deferens and forms ejaculatory duct which enter the prostate gland (Akinsola *et al.*, 2012; Eroschenko, 2013). The lumen of the seminal vesicle is lined with thin and complex mucosal lining. The mucosal layer is made up of columnar epithelial cells that are supported by fibro-elastic lamina propria and surrounded by circular and outer longitudinal smooth muscle layers (Stevens and Lowe, 2005; Mescher, 2010; Eroschenko, 2013) as shown in (Figure 3).

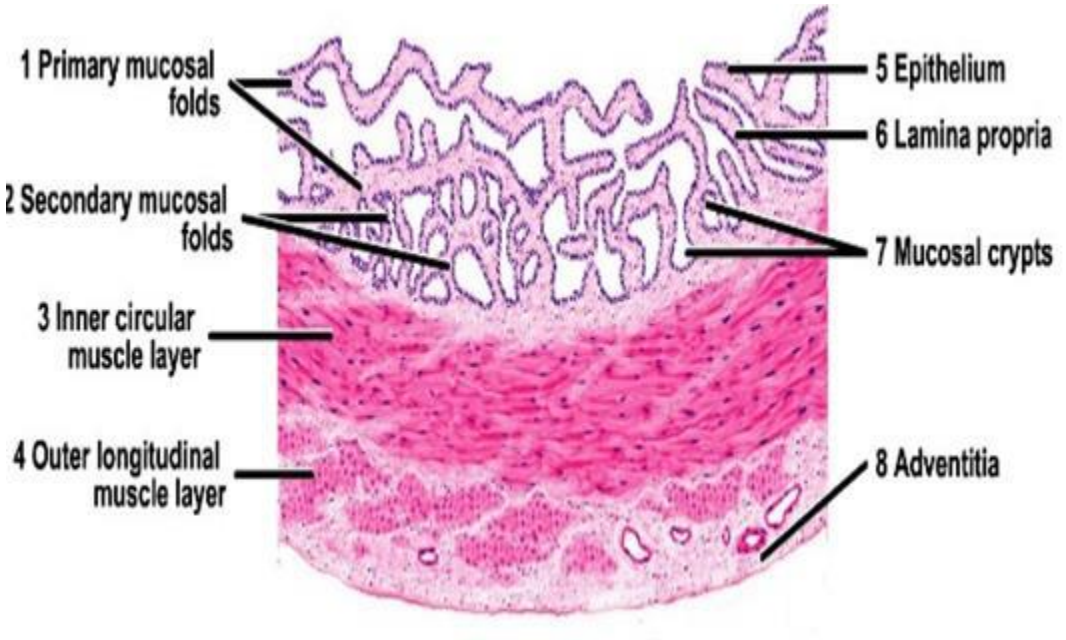

Figure 5: The seminal vesicle is surrounded by muscle layers. (Eroschenko, 2013).

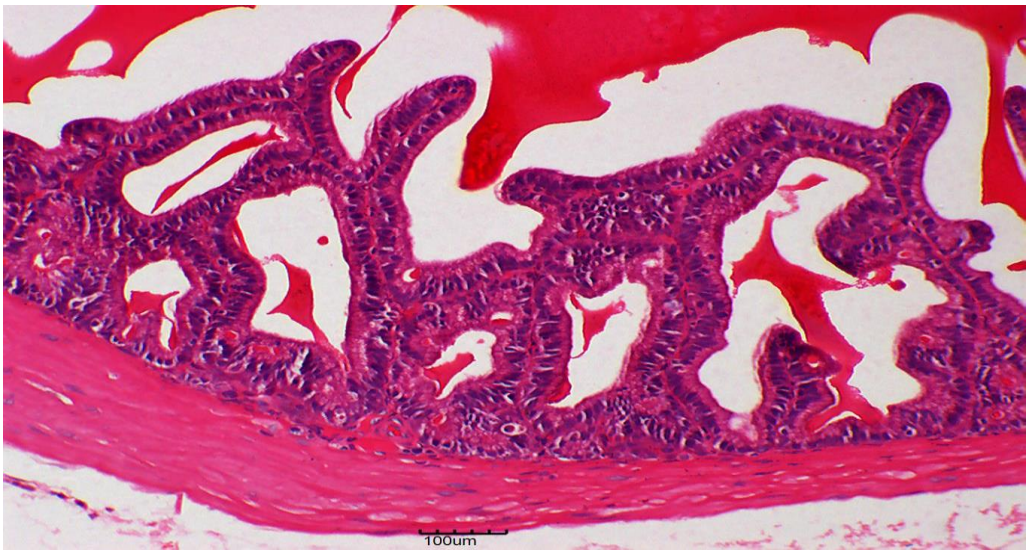

Figure 6: Photomicrograph of the normal seminal vesicle (Assi *et al.,* 2017).

Function

The seminal vesicles are considered essential infertility process (Gonzales, 2001). It is androgen-dependent sex gland that produces and secretes approximately 50 to 80% of seminal plasma during ejaculation (Kim *et al.,* 2009; Noorafshan and Karbalay-Doust, 2012; Kierszenbaum and Tres, 2015). The secretion of the seminal vesicle contains prostaglandins, proteins, amino acids, citrate, fructose, flavins, enzymes, vitamin C and phosphoryl choline (Pang *et al.*, 1979; Gonzales, 2001; Thomson and Marker, 2006). The alkaline secretion helps to neutralize the acidity of vaginal tract, subsequently expanding the lifespan of sperm (Thomson and Marker, 2006; Akinsola *et al.,* 2012). Seminal vesicle secretion in semen also helps to raise the stability of sperm chromatin (Noorafshan and Karbalay-Doust, 2012). Besides, spermatozoa obtain their main energy source from the fructose found in the seminal secretion (Thomson and Marker, 2006; Noorafshan and Karbalay-Doust, 2012). The presence of prostaglandins in the seminal secretion also helps to prevent any adverse immune response in the female reproductive tract towards the semen (Pang *et al.,* 1979; Gonzales, 2001).

The bulbourethral glands are part of the male reproductive system. They may also be referred to as the Cowper's glands since they were first documented by anatomist William Cowper in the late 1600s.

The paired bulbourethral glands are roughly the size of a pea and are located in the deep perineal pouch. They are at the base of the penis and are lateral (to the side) and posterior to (behind) the urethra, which is the tube through which semen and urine exit the body.

They are exocrine glands with approximately 2.5 cm ducts that pass through the perineal membrane and into the nearby portion of the spongy urethra. When sexually aroused, the glands produce a mucous-like fluid called pre-ejaculate. The pre-ejaculate fluid is a viscous, clear, and salty liquid that neutralizes any residual acidity in the urethra. The now neutralized urethra is a more hospitable (as opposed to harmful) environment for the sperm to travel in.

Sertoli cells

Sertoli cells are somatic cell large, irregularly shaped Sertoli cells are attached to one another near their base by tight junctions. Sertoli cells are critical to germ cell development, as indicated by their close contact. As many as 6 to 12 spermatids may be attached to a Sertoli cell. Sertoli cells assist in the process of spermiation, where the final detachment of mature spermatozoa into the lumen of seminiferous tubule (Rhoades and Tanner, 2004) takes place. They also target and phagocytized excess cytoplasm resulting from the transformation of spermatids to spermatozoa, as well as damaged germ cells. In addition, the Sertoli cells also provide structural support and nutrition for germ cells, secrete fluid. The columnar cells that extend from the basal to the luminal compartment are found to occupy a volume of approximately 17-19% in the seminiferous epithelium of adult rats (Wong and Russell, 1983; Russell *et al.*, 1990). Sertoli cell secretes inhibin, which is a nonsteroidal pituitary inhibitory of gonadal origin (Pineda and Dooley, 2003). A continuous layer of non-germinal Sertoli cells formed the tight junctions around the circumference of each tubule which result into blood-testis barrier. Molecules from the blood enter the germinal cells through the cytoplasm of the Sertoli cells. Sertoli cells also secrete a protein called androgen-binding protein into the lumen of the seminiferous tubules. The cytoplasm of the Sertoli cells extends from the periphery to the lumen of tubule and envelopes the developing germ cells. It helps protect the seminiferous tubules from immune attack; the Sertoli cells produce FAS ligand that binds to the FAS receptor on the surface of T lymphocytes. This way, it prevents the immune attack of the developing sperm by triggering the apoptosis of T lymphocytes (Ridge *et al.*, 2004).

Sertoli cells refer to the somatic cells of the testes which are essential for the formation of testes and also spermatogenesis. These cells (Sertoli) facilitate the progression of germ cells to spermatozoa by direct contact and the control of the environment milieu within the seminiferous tubules (Griswold, 1998). The blood-testis barrier (BTB), which is created by adjacent Sertoli cells near the basement membrane, serves as a "gatekeeper" to prohibit harmful substances from reaching developing germ cells, most notably during postmeiotic spermatids. The BTB also divides the seminiferous epithelium into the basal and luminal (apical) compartment so that postmeiotic spermatid development, namely spermiogenesis, can take place in a specialized microenvironment in the apical compartment behind the BTB. The BTB also contributes, at least in part, to the immune privilege status of the testis, so that anti-sperm antibodies are not developed against antigens that are expressed transiently during spermatogenesis (Su *et al.*, 2011). Sertoli cells have been extremely difficult to stay morphologically stable because they have a constantly changing, three-dimensional relationship with developing germ cells throughout the 14 stages of the epithelial cycle (Morales and Clermont, 1993). Several Sertoli cell functions, most of which are directly related to germ cell development and movement, have been described. These include 1) providing structural support; 2) creating an impermeable and immunological barrier; 3) participating in germ cell movement and spermiation; 4) nourishing germ cells via their secretory products (Bardin *et al.*, 1988; Griswold, 1998).

Leydig cells

Leydig cells are polygonal in shape and are the major cell type within the interstitial tissue where they are often found adjacent to blood vessels and the seminiferous tubules. In addition to Leydig cells, other types of cells such as fibroblast, macrophages, and a small number of mast cells are also present in the interstitial space. The Leydig cells are the principal source of testosterone in systemic circulation in males (Ge *et al.*, 2008). The cytoplasm of a Leydig cell contains a lot of mitochondria, a

granular endoplasmic reticulum, lipid droplets and occasionally some protein crystals (Naraghi *et al.*, 2010). Leydig cells do not have follicle stimulating hormone FSH receptors. Therefore their growth is influenced indirectly rather than directly by the FSH. FSH stimulates the production growth stimulators from Sertoli cells which in turn, enhanced the growth of the developing Leydig cells. In addition, the proliferation of developing Leydig cells can also be stimulated by the androgens. However, proliferation and activity of these cells are reduced by the Estrogen receptors that are present the Leydig cells. Leydig cells have LH receptors, and the major effect of Luteinizing hormone LH is to stimulate androgen secretion via a cAMP-dependent mechanism (Figure 4). The main product of Leydig cells is testosterone, but two other androgens of less biological activity, dehydroepiandrosterone (DHEA) and androstenedione, are also a product from Leydig cells (Rhoades and Bell, 2012).

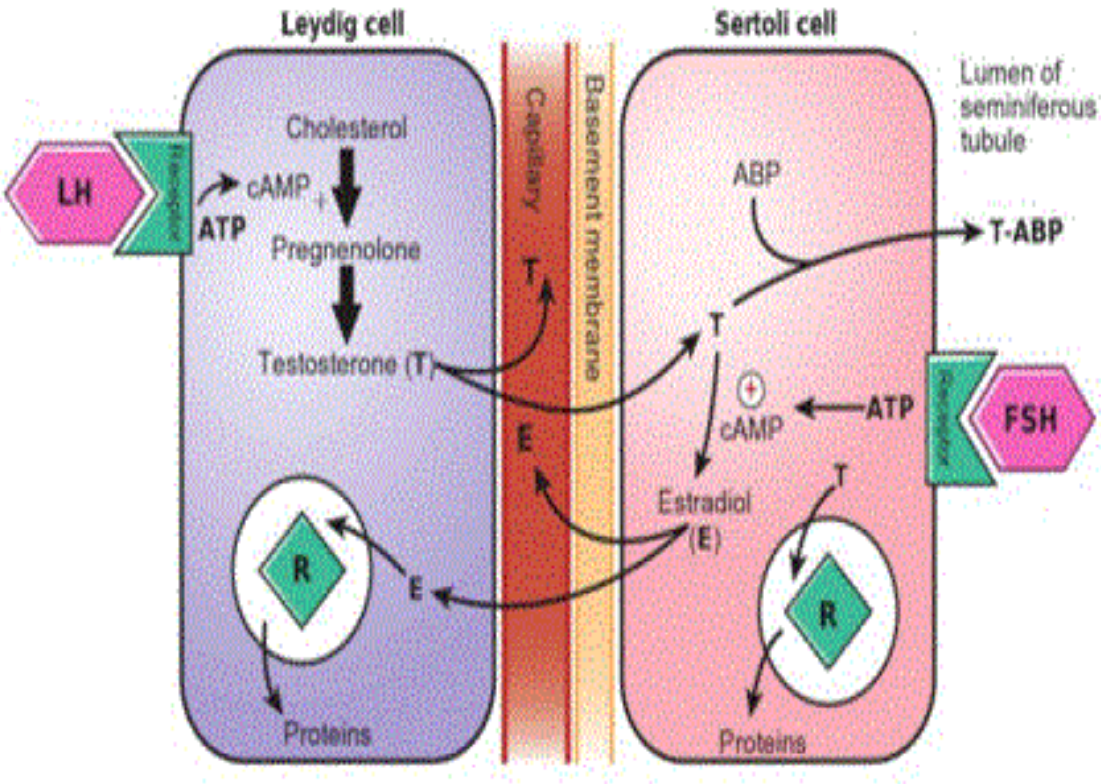

Figure 7: The main product of Leydig cells is testosterone, Regulation, hormonal products, of interactions between Leydig and Sertoli cells. ABP, androgen binding protein; ATP, adenosine triphosphate; cAMP, cyclic adenosine monophosphate; E, estradiol; FSH, follicle-stimulating hormone; LH, luteinizing hormone; T, testosterone. (Rhoades and Bell, 2012).

Spermatogenesis

The cellular divisions and developmental changes that occur within the seminiferous tubules of the testes are termed spermatogenesis, and it consists of two major parts. In part 1, spermatocytogenesis occurs in which it starts with spermatogonia which involve mitotic division of stem cells to form spermatocytes that take place in the early stage, followed by meiosis where the number of chromosomes is reduced to form spermatids. In part 2, spermiogenesis occurs in which the spermatids are transformed in regards to metamorphic changes to sperm (Poolperm, 2001; Gribbins *et al.*, 2005). Spermatogenesis is a highly organized but complex process and it normally continuous throughout life (Ohmura *et al.*, 2003). The above description categories spermatogenesis into majorly three divisions; spermatocytogenesis, meiosis and spermiogenesis respectively (Johnson and Everrit, 2000). The process starts from spermatogonial stem cells that reside on the basement membrane of the seminiferous tubules, which proliferate for self-renewal and give rise to a progeny of the

differentiating spermatogenic cells such as primary spermatocytes, secondary spermatocytes, spermatids and spermatozoa (Nakamoto *et al.,* 2004). The spermatogonia are duplicated mitotic division, one of the duplicate member called primary spermatocyte undergoes meiotic division in order to form secondary spermatocytes. When the spermatogonia (which are a diploid primary spermatocyte) complete the first meiosis, two daughter haploid cells will be produced a result which is termed secondary spermatocytes. By the end of the second meiotic division, each of the two secondary spermatocytes formed two haploid spermatids (Ridge *et al.,* 2004). In the beginning, the spermatids still pose the usual characteristics of epithelioid cells, but they would soon differentiate and elongate into become spermatozoa. A matured spermatozoon consists of a head and a tail. The head contains a condensed nuclear material, a thin cytoplasm and a surrounding membranous layer (Guyton and Hall, 2006). The major features of spermiogenesis include the formation of the acrosome from the Golgi apparatus, condensation, and elongation of the nucleus, formation of the flagellum and extensive shedding of the cytoplasm of the spermiated, spermatozoa consists of a head, middle piece and tail (Cunningham and Klein, 2007).

Hormonal regulation of spermatogenesis

The hypothalamic-pituitary-gonadal (HPG) axis regulates spermatogenesis. The HPG-axis is composed of the hypothalamus, anterior pituitary, and testes which coordinate themselves in a classic negative feedback mechanism. The anterior pituitary slows down its responsiveness from stimulation of GnRH, as testosterone levels in blood rising in a process which results in reduced LH and FSH secretion due to LH induces testosterone production reduced LH secretion given rise to low testosterone levels. Conversely, if for some reason such as testicular injury, cause a decline in blood testosterone levels, there would be increased in anterior pituitary response to GnRH which results to more secretion of LH and FSH, thereby given rise to more testosterone production by Leydig cells (Emanuele and Emanuele, 1998). Spermatocytes maturation is partly supported by the testosterone hormone; however, facilitating round to elongate spermatid progression is critical especially in rats. Spermiation requires testosterone as well as FSH (McLachlan *et al.,* 2002). Previous studies revealed that Sertoli cells in gonadotropin-deficient males (such as in men and hamsters) remain proliferative and can re-acquire features reminiscent of immature Sertoli cells (Tarulli *et al.,* 2006; Meachem *et al.,* 2007). There is an interaction between endocrine and paracrine in functional testis. For example, the testosterone secreted by Leydig cells under the stimulus of luteinizing hormone (LH), diffuses into seminiferous tubules and derives spermatogenesis together with another gonadotropic hormone, follicle-stimulating hormone (FSH) (Ge *et al.,* 2008). Estrogens are thought to be essential for spermiogenesis; these estrogens are formed by testosterone (produced by Sertoli cells, when stimulated by FSH). Growth hormone (GH) is also required to control the background metabolic functions of the testes. It contributes in early spermatogonia division; the absence of which results in pituitary dwarfism and subsequently affecting spermatogenesis. Severely deficient or absent of GH causes infertility (Guyton and Hall, 2006) (Figure 5).

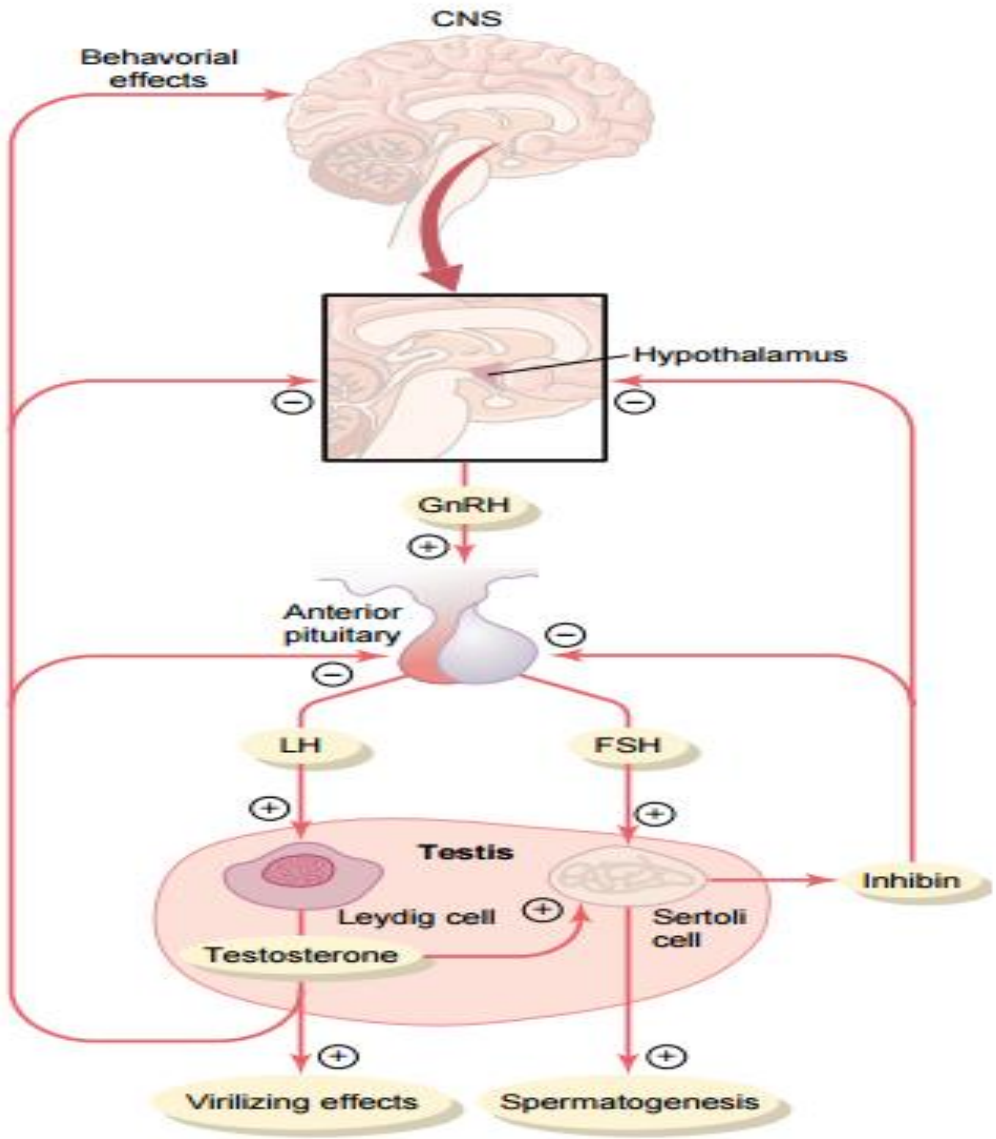

Figure 8: Feedback regulation of the hypothalamic-pituitary-testicular axis in males. Stimulatory effects are shown by + and negative feedback inhibitory effects are shown by – GnRH, gonadotropin-releasing hormone; LH, luteinizing hormone; FSH, Follicle-stimulating hormone. (Guyton and Hall, 2006).

Sperm abnormalities

Sperm anomalies are usually based on sperm concentration, motility, and morphology, which include: oligospermia (low sperm concentration): sperm concentration that is less than 20 million/ml is regarded as low sperm. This supported by (Iammarrone *et al.*, 2003), which showed low conception rate in human sperm counts with a concentration less than 20 million/ml. Complete lack of sperm in an ejaculate is termed azoospermia, is found to accounts for 10-15% of male infertility cases. Partial obstruction of sperm duct also influenced sperm concentration (García-González, 2004). Asthenospermia (poor sperm motility), is a condition in which spermatozoa are too slow in movement, not able to strive in a straight line along the cervical mucous within the female reproductive tract and or fertilize the egg. When 60% or more sperm actively move in a straight line, the percentage motility is said to be normal, and quality is at least average. In cases where percentage motility is less than 40%, the sperm the condition is as less qualitative (Isidori *et al.*, 2005). Genetic or otherwise sperm defects may be responsible for sluggishly sperm movement and renders them incapable of fertilizing the egg. Poor sperm motility that is associated with DNA fragmentation may increase the chance of passing on genetic diseases to offspring. Sperm motility is rated in two ways:

percentage of the total motility (general motility), or the individual forward progressive sperm movement (progressive motility) (Kishore and Raju, 2011). The latter is a classification that is based on the pattern displayed by the majority of motile sperm. It ranges from zero (no movement) to 4 (excellent forward progression). Typically, a sperm sample needs to have at least 50% progressive motility (World Health Organization, 1999). Teratospermia or morphologic abnormalities are usually categorized based location of the deformity of a spermatozoon, whether it is on the head, neck (midpiece), or tail (Speroff and Fritz, 2005). The most basic type of classification scheme differentiates primary and secondary abnormalities: primary abnormalities are the anatomical site defects, involving either the head, midpiece or tail. A more primary severe defect is thought to originate while the sperm was still within the seminiferous epithelium of the testis whereas, secondary defects are considered less serious and thought to arise during passage through the epididymis or by mishandling after ejaculation (sperm) (Kishore and Raju, 2011). Teratozoospermia is a heterogeneous condition comprising of alterations in the shape of different sperm components. There is a close association between morphological defects and sperm fertilizing potential because structures of mature spermatozoa provide the best organization to serve specific functions. Therefore, teratozoospermia should be understood as the combination of morphologic abnormalities with the corresponding impairments in sperm function (Ostermeier *et al.,* 2001).

Testosterone hormone

Testosterone hormone is the principal male hormone; it is synthesized by Leydig cells of testes from cholesterol, chemically it consists of (19) carbon atoms with (OH) group on 17th carbon atom (Ganong, 2005). Testosterone hormone is also released from adrenal cortex in small quantities about 5% of testosterone concentration (Johnson and Everitt, 2000).

Testosterone as in adrenal steroidogenesis tissue and cholesterol serves as the substrate for pregnenolone biosynthesis and produced by interstitial or Leydig cells of the testicle under stimulation of the luteinizing hormone (LH) which is also referred to as interstitial cell stimulating hormone (ICSH), from the adenohypophysis. However, conversion of pregnenolone to 17-hydroxylated steroids provides the predominant steroidogenesis pathway in testicular interstitial tissue (Robert and Matthew, 1993; Rhoades and Tanner, 2004) (Figure 6). Testosterone hormone enters the seminiferous tubules, by simple diffusion and has a high concentration in seminiferous tubules, this high concentration maintained by testosterone binding with androgen binding protein which synthesized in Sertoli cells after stimulation by FSH (McLachlan *et al.,* 2002). The adhesion of round spermatids to Sertoli cells shows an absolute need for testosterone (O'donnell *et al.,* 1996). The interaction of LH with receptors in the Leydig cells activates the adenylate cyclase system, protein kinase activation as well as RNA synthesis, bringing about the increase in the production of pregnenolone from cholesterol by the mitochondria in the Leydig cells (Pineda and Dooley, 2003). Testosterone and its active form dihydrotestosterone (DHT) are essential for spermatogenesis and sperm development. They are also responsible for secondary sex characteristics such as an increase in muscle mass, sexual functions, body hair and decreasing the risk of osteoporosis (Hu *et al.,* 2010). When testosterone is withdrawn, the germ cells that have progressed beyond meiosis detach from the Sertoli cells and die. On the other hand, mature sperm is retained by the Sertoli cells which result in infertile testosterone signaling contributing to the maintenance of spermatogenesis and male fertility (Walker, 2010).

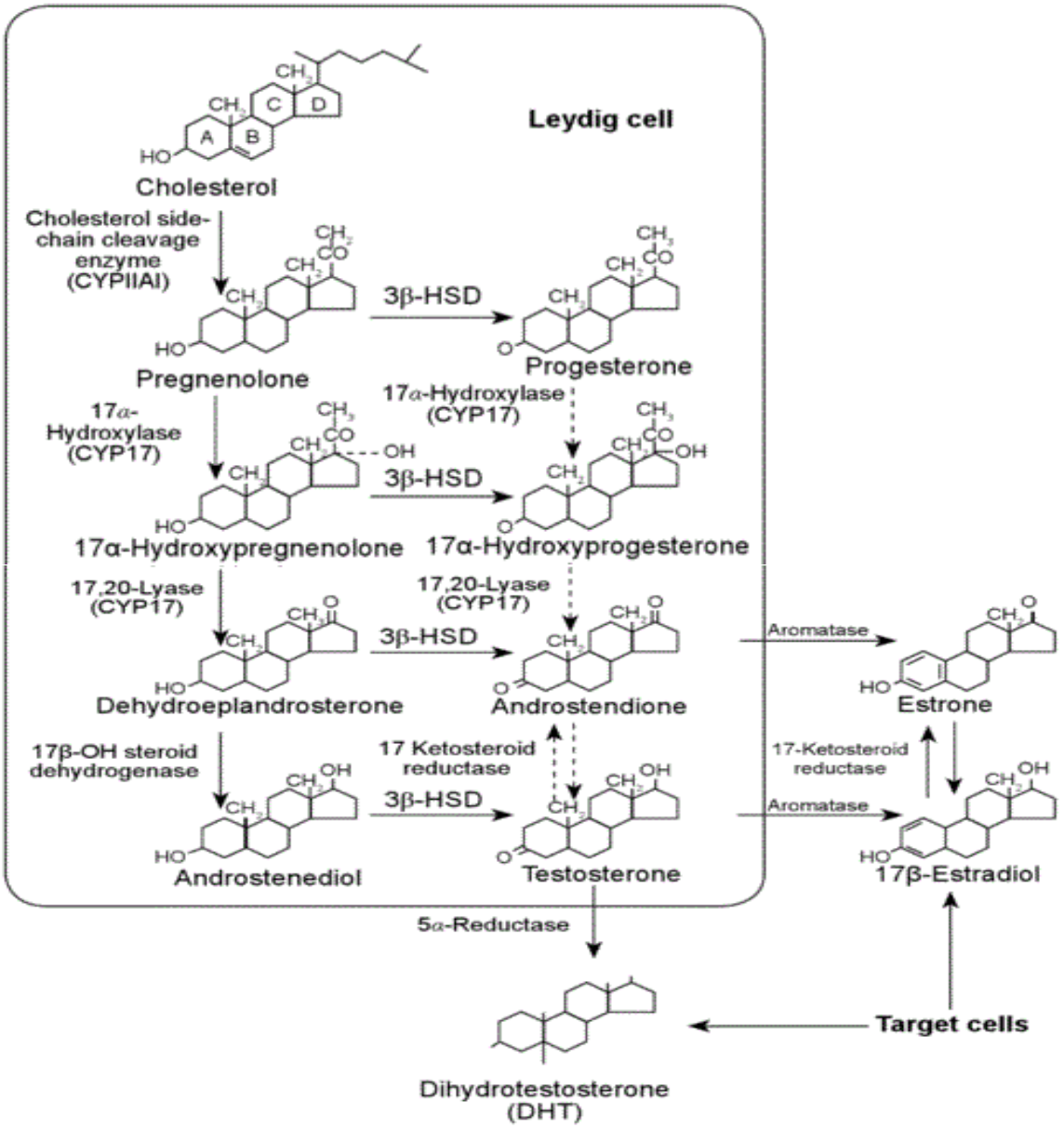

Figure 9: Steroidogenesis Leydig cells and further modifications of androgens in target cells (Rhoades and Tanner, 2004).

Luteinizing hormone

Luteinizing hormone is heterodimeric glycoprotein made up of two non-covalently linked polypeptides the alpha (α) subunit protein, and beta (β) specific for individual gonadotropins of anterior pituitary gland have the ability to synthesize and secrete LH (Figure 7). The release of LH depends on the pulsatile pattern of GnRH secretion when high-frequency GnRH plus induce the release of LH. Binding of LH to the Leydig cells' membrane receptors stimulates the conversion of cholesterol to testosterone by them (Cunningham and Klein, 2007). LH is also essential to successfully produce mature gamete. LH is the key signal for Leydig cells to produce testosterone, the regulation of androgen levels through the release of pituitary LH is responsible for constitution and maintenance of male phenotype. During perinatal development, LH levels are elevated for a short period before they decrease and remain lower until puberty. During puberty, LH levels rise again and stimulate matured Leydig cells to produce androgen (Wistuba *et al.*, 2007). Spermatogenesis is stimulated indirectly by LH-driven testosterone secretion of Leydig cells (Weinbauer *et al.*, 2001). Huang *et al.* (2001) showed a correlation between increased in GnRH dosage and the release of LH.

Testosterone has been found to suppress the GnRH stimulation of LH release in the mouse. The pituitary increase LH release to stimulate testosterone production and thereby increase sperm production (Kamischke and Nieschlag, 2004). The absence of LH activity, which is also known as LH resistance, during development due to inactivating mutations in the LH receptor gene has been found to induce Leydig cell hypoplasia as well as sterility (Laue *et al.*, 1995). LH (Luteinizing Hormone) plays a significant role in reproductive physiology; the anterior pituitary gland secretes LH under the effect of hypothalamic GnRH. It is known that the gonads (testis and ovaries) undergo atrophy after its removal or damage that occur to the pituitary gland that is responsible for the maturity of the ovarian follicles and secretion of estrogen from these follicles (Ganong, 2005).

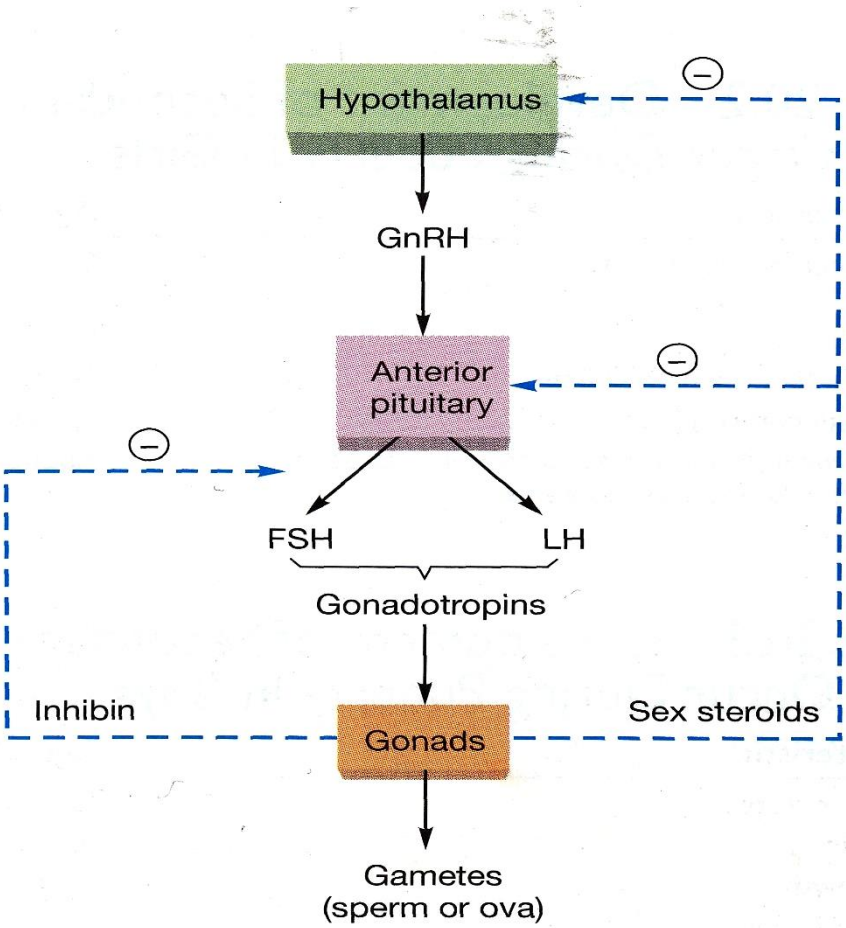

Figure 10: Interactions between the hypothalamus, anterior pituitary, and gonads (Boston *et al*., 2004).

Follicle stimulating hormone

Follicle stimulating hormone (FSH) is heterodimeric glycoprotein made up of two non-covalently linked polypeptides the alpha (α) subunit protein and beta (β) specific for its produced within pituitary gonadotrophic cells, and it is an essential component of the reproductive process, which involve in a lot of activities in male and female reproductive tissues. These include growth, division, and differentiation of Sertoli cells. FSH also involved directly in the production of gametes and production of hormones such as estradiol and inhibin that reverse the influence secretion of FSH from the pituitary (Rozell and Okrainetz, 2009). Follicle stimulating hormone (FSH) is considered essential for mammalian and plays an important role in testicular development and maintenance of spermatogenesis in adult (Grover *et al.*, 2004). FSH plays a significant role in the regulation of spermatogonial population in rodents (McLachlan *et al.*, 2002). FSH acts as a survival factor for spermatogonia and essential for the proliferation of undifferentiated type spermatogonia in immature testis (Boitani *et al.*, 1995; Krishnamurthy *et al.*, 2000). During the first wave of spermiogenesis,

mitosis and meiosis are supported by FSH alone. Therefore, the absence of FSH during development may result to hypogonadism and azoospermia (Phillip *et al.*, 1998; Allan *et al.*, 2004).

Conclusion

The male reproductive system has many functional units. Therefore, maintenance of the normal reproductive function is dependent on the coordinated release of hormones in the hypothalamic−pituitary−testis. Furthermore, the maintenance of an optimal reproductive efficiency depends on the absence of systemic dysfunctions caused by disease or toxicity. Thus, in order to elucidate the complete functionality of the reproductive system, all these functional units have to be understood and evaluated in detail.

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