**MALE REPRODUCTIVE SYSTEM**

**Reproductive and Hormonal Functions of the Male**

The three major reproductive functions of the male are

(1) spermatogenesis—the formation of sperm,

 (2) performance of the male sexual act, and

(3) regulation of male reproductive functions by the various hormones.

Associated with these reproductive functions are the effects of the male sex hormones on the accessory sexual organs, cellular metabolism, growth, and other functions of the body.

**SPERMATOGENESIS**

Spermatogenesis Is the Process of Formation of Spermatocytes from Spermatogonia. Spermatogenesis is initiated at puberty, continues throughout the remainder of a man’s life, and takes place in the walls of the seminiferous tubules.

The walls of the tubules are composed of two compartments separated by tight junctions between the Sertoli cells:

• Thee basal layer, which consists of the Leydig cells and the spermatogonia

• The adluminal layer, which is made up of Sertoli cells and spermatocytes

The initial step in the process is transformation of type A spermatogonia, which are epithelioid-like cells, to type B spermatogonia, a process involving four divisions. The type B cells embed in the Sertoli cells. In association with the Sertoli cells, the type B cells are transformed to primary spermatocytes and then, in a step involving the first meiotic division, to secondary spermatocytes. The secondary spermatocytes undergo

a second meiotic division, yielding spermatids, each of which has 23 unpaired chromosomes. The steps described are stimulated by testosterone and follicle stimulating hormone (FSH).

Spermiogenesis Is the Process of Transformation of the Spermatids, Which Are Still Epithelioid, to Sperm Cells. The process of spermiogenesis takes place with the cells embedded in the Sertoli cells; it requires estrogen and FSH. Once the sperm cells are formed, they are extruded into the lumen of the tubule in a process stimulated by luteinizing hormone (LH). The first division of the type A spermatogonia to extrusion of the sperm cells requires a period of approximately 64 days. The newly formed sperm cells are not functional and require a maturation process, which takes place in the epididymis over a period of 12 days. Maturation

requires both testosterone and estrogen. The mature sperm are stored in the vas deferens.

**MALE SEXUAL ACT**

The male sexual act is the process that culminates in ejaculation of several hundred million viable sperm. The sperm cells are contained in a mixture of fluids produced by the male reproductive organs that is called semen and includes the following:

• Seminal vesicle fluid, which makes up 60 percent of the total volume of the semen. It contains mucoid, prostaglandin E2, fructose, and fibrinogen.

• Prostatic fluid, which makes up 20 percent of the semen volume and contains NaHCO3 (pH 7.5), clotting enzyme, calcium, and profibrinolysin.

• Sperm cells.

The average volume of semen ejaculated at each coitus is 3.5 milliliters, and each milliliter of semen contains approximately 120 million sperm cells. For normal fertility, the sperm count per milliliter must be greater than 20 million.

The sexual act takes place in three stages:

• *Erection and lubrication*. Erection is the process of filling the erectile tissue of the penis with blood at a pressure level near that of the arterial pressure. The arteries leading to the erectile tissue dilate in response to parasympathetic impulses, which stimulate release of nitric oxide at the nerve endings on the arterial smooth muscle. Parasympathetic reflexes also stimulate secretion of mucus by the urethral glands and bulbourethral glands. The mucus aids in vaginal lubrication during coitus.

• *Emission*. Emission is the process of stimulating the smooth muscle surrounding the seminal vesicles, vas deferens, and prostate gland, causing the organs to empty their contents into the internal urethra, a process elicited by sympathetic reflexes from L1

and L2.

• *Ejaculation*. Ejaculation is a reflex elicited in response to distention of the internal urethra. The reflex results in contraction of the ischiocavernosus and bulbocavernosus muscles and the muscles of the pelvis, causing compression in the internal urethra

and propulsion of the semen out of the urethra.

**MALE SEX HORMONES**

Testosterone Is an Anabolic Steroid Hormone Secreted by the Leydig Cells of the Testes. Testosterone is formed from cholesterol in amounts ranging from 2 to 10 mg/day. In the blood, testosterone is carried in association with albumin or is tightly bound to sex hormone–binding globulin. The hormone is removed from the blood

within 30 to 60 minutes of secretion by fixation to target tissue cells or degradation to inactive compounds. It is metabolized to *dihydrotestosterone* (the biologically active androgen) in target tissues and to estrogen in adipose tissue.

Testosterone Has Effects on Reproductive and Nonreproductive Organs. Testosterone is required for stimulation of prenatal differentiation and pubertal development of the testes, penis, epididymis, seminal vesicles, and prostate. Testosterone is also required in adult men for maintenance and normal function of the primary sex organs. Testosterone has effects on bone, stimulating growth and proliferation of bone cells, resulting in increased density of the bones. It also has effects on hair distribution and causes the skin to thicken. Testosterone affects the liver, causing synthesis of clotting factors and hepatic lipases. Under the influence of testosterone, blood high-density lipoprotein levels decrease and low-density lipoprotein levels increase. Haematocrit and haemoglobin concentrations are elevated because of the effect of testosterone to stimulate production of erythropoietin. The hormone has a generalized effect in many tissues to enhance the rate of protein synthesis. Being a steroid hormone, testosterone readily enters the cytoplasm of target tissue cells by diffusion through the cell membrane. The enzyme *5-alpha-ketoreductase* converts it to dihydrotestosterone, which then binds with a cytoplasmic receptor protein. This combination migrates to the nucleus, where it binds with a nuclear protein that induces DNA-RNA transcription.

Gonadotropin-Releasing Hormone Increases Release of LH and FSH From the Anterior Pituitary Gland. The polypeptide hormone, which is also referred to as

gonadotropin-releasing hormone (GnRH), is secreted from the hypothalamus into the hypothalamic-hypophysial portal system. Its formation is inhibited by testosterone and oestrogen.

LH Stimulates Testosterone Formation by the Leydig Cells, and FSH Stimulates Spermatogenesis and Spermiogenesis. LH and FSH are secreted from the basophilic cells of the anterior pituitary. Their release is stimulated by GnRH.

Inhibin Is Formed by Sertoli Cells and Inhibits FSH Secretion. Inhibin formation increases as the rate of sperm cell production increases.

**MALE INFERTILITY**

Some important causes of male infertility include the following:

• Androgen dysfunction with normal sperm cell production, caused by hypothalamic-pituitary defects, Leydig cell defects, or androgen resistance

• Isolated dysfunction of sperm cell production with normal androgen levels, resulting from infection or trauma, congenital deformation of passages, or formation of nonmotile or otherwise abnormal sperm

• Combined androgen and sperm cell production defects resulting from

1. developmental defects, such as Klinefelter’s syndrome or abnormal testicular descent,
2. acquired testicular defects, such as infections, autoimmune reactions, or systemic diseases such as chronic liver and kidney diseases

Unknown causes: In 50 percent of infertile males, no cause can be identified