

NAME: OVBIJE OGHENENYERHOVWO PRECIOUS.

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SPERMATOGENESIS.

Spermatogenesis is the process by which haploid spermatozoa develop from germ cells in the seminiferous tubules of the testis. This process starts with the mitotic division of the stem cells located close to the basement membrane of the

tubules.[1] These cells are called [spermatogonial stem cells](#). The mitotic division of these produces two types of cells. Type A cells replenish the stem cells, and type B cells differentiate into primary [spermatocytes](#). The primary spermatocyte divides meiotically ([Meiosis I](#)) into two secondary spermatocytes; each secondary spermatocyte divides into two equal haploid [spermatids](#) by Meiosis II. The spermatids are transformed into spermatozoa (sperm) by the process of [spermiogenesis](#). These develop into mature spermatozoa, also known as [sperm cells](#). [2] Thus, the primary spermatocyte gives rise to two cells, the secondary spermatocytes, and the two secondary spermatocytes by their subdivision produce four spermatozoa and four haploid cells.[3] Spermatozoa are the mature male [gametes](#) in many sexually reproducing organisms. Thus, spermatogenesis is the male version of [gametogenesis](#), of which the female equivalent is [oogenesis](#). In [mammals](#) 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](#). [DNA methylation](#) and [histone modification](#) have been implicated in the regulation of this process. 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 (see [Male infertility](#)).

Spermatogenesis starts in the bottom part of seminiferous tubes and, progressively, cells go deeper into tubes and moving along it until mature spermatozoa reaches the lumen, where mature spermatozoa are deposited. The division happens asynchronously; if the tube is cut transversally one could observe different maturation states. A group of cells with different maturation states that are being generated at the same time is called a spermatogenic wave.

LOCATION.

Spermatogenesis takes place within several structures of the [male reproductive system](#). The initial stages occur within the testes and progress to the [epididymis](#) where the developing gametes mature and are stored until [ejaculation](#). The [seminiferous tubules](#) of the testes are the starting point for the process, where [spermatogonial stem cells](#) adjacent to the inner tubule wall divide in a centripetal direction—beginning at the walls and proceeding into the innermost part, or *lumen*—to produce immature sperm. Maturation occurs in the epididymis. The location [Testes/Scrotum] is specifically important as the process of spermatogenesis requires a lower temperature to produce viable sperm, specifically 1°-8 °C lower than normal body temperature of 37 °C (98.6 °F).[6] Clinically, small fluctuations in temperature such as from an athletic support strap, causes no impairment in sperm viability or count.

PURPOSE OF SPERMATOGENESIS.

To preserve the number of chromosomes in the offspring – which differs between [species](#) – one of each gamete must have half the usual number of chromosomes present in other body cells. Otherwise, the offspring will have twice the normal number of chromosomes, and serious abnormalities may result. In humans, chromosomal abnormalities arising from incorrect spermatogenesis results in congenital defects and abnormal birth defects ([Down syndrome](#), [Klinefelter syndrome](#)) and in most cases, [spontaneous abortion](#) of the developing foetus.

HORMONE CONTROL.

Hormonal control of spermatogenesis varies among species. In humans the mechanism is not completely understood; however it is known that initiation of spermatogenesis occurs at puberty due to the interaction of the [hypothalamus](#), [pituitary gland](#) and [Leydig cells](#). If the pituitary gland is removed, spermatogenesis can still be initiated by [follicle stimulating hormone](#) (FSH) and [testosterone](#). In contrast to FSH, [luteinizing hormone](#) (LH) appears to have little role in spermatogenesis outside of inducing gonadal testosterone production.

TESTOSTERONE.

Testosterone is the primary [male sex hormone](#) and [anabolic steroid](#).^[3] 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](#). In addition, testosterone is involved in health and well-being, and the prevention of [osteoporosis](#). Insufficient levels of testosterone in men may lead to abnormalities including frailty and bone loss. Testosterone is a [steroid](#) from the [androstane](#) class containing a [keto](#) and [hydroxyl](#) groups at positions three and seventeen respectively. It is [biosynthesized](#) in several steps from cholesterol and is converted in the liver to inactive metabolites. It exerts its action through binding to and activation of the [androgen receptor](#). In humans and most other [vertebrates](#), testosterone is secreted primarily by the [testicles](#) of [males](#) and, to a lesser extent, the [ovaries](#) of [females](#). On average, in adult males, levels of testosterone are about 7 to 8 times as great as in adult females. As the

metabolism of testosterone in males is more pronounced, the daily production is about 20 times greater in men. Females are also more sensitive to the hormone. In addition to its role as a natural hormone, testosterone is used as a [medication](#) in the treatment of [low testosterone levels in men](#), [transgender hormone therapy](#) for [transgender men](#), and [breast cancer](#) in women. Since [testosterone levels decrease as men age](#), testosterone is sometimes used in older men to counteract this deficiency. It is also used illicitly to [enhance physique and performance](#), for instance in [athletes](#).

MEDICAL USE OF TESTOSTERONE.

Testosterone is used as a medication for the treatment of [males with too little or no natural testosterone production](#), certain forms of [breast cancer](#), and gender dysphoria in transgender men and non-binary individuals. This is known as [hormone replacement therapy](#) (HRT) or testosterone replacement therapy (TRT), which maintains serum testosterone levels in the normal range. [Decline of testosterone production with age](#) has led to interest in [androgen replacement therapy](#). It is unclear if the use of testosterone for low levels due to aging is beneficial or harmful.

Common [side effects](#) from testosterone medication include [acne](#), [swelling](#), and [breast enlargement in males](#). Serious side effects may include [liver toxicity](#), [heart disease](#), and behavioral changes. Women and children who are exposed may develop [virilization](#). It is recommended that individuals with [prostate cancer](#) not use the medication. It can cause harm if used during [pregnancy](#) or [breastfeeding](#).