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**SPERMATOGENESIS**

**Spermatogenesis**, 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. 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 until it is ready to leave the male body.

In the course of spermatogenesis the **germ cells move** towards the lumen as they mature. The following developmental stages are thereby passed through:

**Testosterone is the key male sex hormone that regulates fertility, muscle mass, fat distribution, and red blood cell production.**

When levels of testosterone drop below levels that are healthy, they can lead to conditions like hypogonadism or infertility. There are, however, sources from which people with low testosterone can boost their levels.

Testosterone is the hormone responsible for the development of male sexual characteristics. Hormones are chemical messengers that trigger necessary changes in the body. Females also produce testosterone, usually in smaller amounts.

It is a type of androgen produced primarily by the testicles in cells called the Leydig cells.

In men, testosterone is thought to regulate a number of functions alongside sperm production. These include:

* sex drive
* bone mass
* fat distribution
* muscle size and strength
* red blood cell production

Without adequate amounts of testosterone, men become infertile. This is because testosterone assists the development of mature sperm.

Despite being a male sex hormone, testosterone also contributes to sex drive, bone density, and muscle strength in women. However, an excess of testosterone can also cause women to experience male pattern baldness and infertility.

The brain and pituitary gland control testosterone levels. Once produced, the hormone moves through the blood to carry out its various important functions. High or low levels of testosterone can lead to dysfunction in the parts of the body normally regulated by the hormone.

When a man has low testosterone, or hypogonadism, he may experience:

* reduced sex drive
* erectile dysfunction
* low sperm count
* enlarged or swollen breast tissue

Over time, these symptoms may develop in the following ways:

* loss of body hair
* loss of muscle bulk
* loss of strength
* increased body fat

Chronic, or ongoing, low testosterone may lead to osteoporosis, mood swings, reduced energy, and testicular shrinkage.

Causes can include:

* testicular injury, such as castration
* infection of the testicles
* medications, such as opiate analgesics
* disorders that affect the hormones, such as pituitary tumors or high prolactin levels
* chronic diseases, including type 2 diabetes, kidney and liver disease, obesity, and HIV/AIDS
* genetic diseases, such as Klinefelter syndrome, Prader-Willi syndrome, hemochromatosis, Kallman syndrome, and myotonic dystrophy

Too much testosterone, on the other hand, can lead to the triggering of puberty before the age of 9 years. This condition would mainly affect younger men and is much rarer.

In women, however, high testosterone levels can lead to male pattern baldness, a deep voice, and menstrual irregularities, as well as:

* growth and swelling of the clitoris
* changes in body shape
* reduction in breast size
* oily skin
* acne
* facial hair growth around the body, lips, and chin

Recent studies have also linked high testosterone levels in women to the risk of uterine fibroids.

Testosterone imbalances can be detected with a blood test and treated accordingly. **Testosterone levels and aging**

Testosterone levels naturally decrease as a man ages.

The effects of gradually lowering testosterone levels as men age have received increasing attention in recent years. It is known as late-onset hypogonadism.

After the age of 40, the concentration of circulating testosterone falls by about 1.6 percent every year for most men. By the age of 60, the low levels of testosterone would lead to a diagnosis of hypogonadism in younger men.

About 4 in 10 men have hypogonadism by the time they reach 45 years old. Low testosterone has been associated with increased mortality in male veterans. Late-onset hypogonadism has become a recognized medical condition, although many of the symptoms are associated with normal aging.

The following are symptoms of late-onset hypogonadism:

* diminished erectile quality, particularly at night
* decreased libido
* mood changes
* reduced cognitive function
* fatigue, depression, and anger
* a decrease in muscle mass and strength
* decreased body hair
* skin changes
* decreased bone mass and bone mineral density
* increase in abdominal fat mass

As well as sexual dysfunction, late-onset hypogonadism has also been associated with metabolic disease and cardiovascular disease.

The degree to which testosterone levels decline varies between men, but a growing number of men experience the effects of reduced testosterone levels. Life expectancy has increased, and many men now live beyond the age of 60 years.

As a result, a higher number of men see the effects of age-related testosterone depletion.

**Treatment**

Administering treatment for hypogonadism as the result of a disease differs from treating late-onset hypogonadism in older men.

**Testosterone supplements**

One proposed treatment for low testosterone comes in the form of testosterone supplements.

One type of testosterone supplement, methyltestosterone, has received approval from the United States Food and Drug Administration (FDA). However, guidelines advise doctors not to prescribe this supplement due to the speed with which the liver metabolizes testosterone.

This can lead to liver toxicity. While doctors can legally prescribe the supplement, they generally try to avoid this.

Until stronger evidence is available to support the benefits and safety of testosterone supplementation, only older adults with severe clinical symptoms of low testosterone should be candidates for these supplements.

The FDA have advised that testosterone supplements are not suitable to treat late-onset hypogonadism, and a doctor should only prescribe them for an identifiable cause.

**Testosterone replacement therapy**

Testosterone replacement therapy (TRT) can help restore some affected functions of low testosterone.

Studies have shown that TRT mainly impacts bone strength and hemoglobin levels in the blood, but not mental sharpness.

The treatment can be administered by:

* skin gels and patches
* injections
* tablets that are absorbed through the gums

These can, however, trigger side effects, including:

* increased red blood cell count
* prostate and breast enlargement
* acne
* in rare cases, breathing difficulties during sleep
* increased risk of cardiovascular disease, although this is subject to debate

Deciding to pursue a course of TRT involves deciding between the perceived benefit of the therapy on the symptoms of a particular individual and the risks of the treatment.

A recent study, for example, suggests that TRT provides extra benefit for overall mortality and stroke for men whose testosterone levels have normalized with TRT.

However, the Endocrine Society advises that doctors should not prescribe TRT to men aged less than 65 years, even if they have low testosterone levels. The risks and suggested benefits of TRT for men younger than this are unclear, as are the benefits.