Write short note on the following

**1 Spermatogenesis**

**Spermatogenesis** is the process by which [haploid](https://en.wikipedia.org/wiki/Haploid) [spermatozoa](https://en.wikipedia.org/wiki/Spermatozoa) develop from [germ cells](https://en.wikipedia.org/wiki/Germ_cell) in the [seminiferous tubules](https://en.wikipedia.org/wiki/Seminiferous_tubules) of the [testis](https://en.wikipedia.org/wiki/Testis). This process starts with the [mitotic division](https://en.wikipedia.org/wiki/Mitosis) of the [stem cells](https://en.wikipedia.org/wiki/Stem_cell) located close to the basement membrane of the tubules. These cells are called [spermatogonial stem cells](https://en.wikipedia.org/wiki/Spermatogonial_Stem_Cells). The mitotic division of these produces two types of cells. Types A cells replenish the stem cells, and type B cells differentiate into primary [spermatocytes](https://en.wikipedia.org/wiki/Spermatocyte). The primary spermatocyte divides meiotically ([Meiosis](https://en.wikipedia.org/wiki/Meiosis) I) into two secondary spermatocytes; each secondary spermatocyte divides into two equal haploid [spermatids](https://en.wikipedia.org/wiki/Spermatids) by Meiosis II. The spermatids are transformed into spermatozoa (sperm) by the process of [spermiogenesis](https://en.wikipedia.org/wiki/Spermiogenesis). These develop into mature spermatozoa, also known as [sperm cells](https://en.wikipedia.org/wiki/Sperm). Thus, the primary spermatocytes gives rises to two cells, the secondary spermatocytes, and the two secondary spermatocytes by their subdivision produce four spermatozoa and four haploid cells.

Spermatozoa are the mature male [gametes](https://en.wikipedia.org/wiki/Gamete) in many sexually reproducing organisms. Thus, spermatogenesis is the male version of [gametogenesis](https://en.wikipedia.org/wiki/Gametogenesis), of which the female equivalent is [oogenesis](https://en.wikipedia.org/wiki/Oogenesis). In [mammals](https://en.wikipedia.org/wiki/Mammal) it occurs in the [seminiferous tubules](https://en.wikipedia.org/wiki/Seminiferous_tubules) of the male [testes](https://en.wikipedia.org/wiki/Testes) in a stepwise fashion. Spermatogenesis is highly dependent upon optimal conditions for the process to occur correctly, and is essential for [sexual reproduction](https://en.wikipedia.org/wiki/Sexual_reproduction). [DNA methylation](https://en.wikipedia.org/wiki/DNA_methylation) and [histone modification](https://en.wikipedia.org/wiki/Histone_modification) have been implicated in the regulation of this process. It starts at [puberty](https://en.wikipedia.org/wiki/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](https://en.wikipedia.org/wiki/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 synchronically; 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.

**Purpose of spermatogenesis**

Spermatogenesis produces mature male gametes, commonly called *sperm* but more specifically known as *spermatozoa*, which are able to fertilize the counterpart female gamete, the [oocytes](https://en.wikipedia.org/wiki/Oocyte), during [conception](https://en.wikipedia.org/wiki/Conception_%28biology%29) to produce a single-celled individual known as a [zygote](https://en.wikipedia.org/wiki/Zygote). This is the cornerstone of [sexual reproduction](https://en.wikipedia.org/wiki/Sexual_reproduction) and involves the two gametes both contributing half the normal set of [chromosomes](https://en.wikipedia.org/wiki/Chromosome) ([haploid](https://en.wikipedia.org/wiki/Haploid)) to result in a chromosomally normal ([diploid](https://en.wikipedia.org/wiki/Diploid)) zygote.

To preserve the number of chromosomes in the offspring – which differs between [species](https://en.wikipedia.org/wiki/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](https://en.wikipedia.org/wiki/Down_syndrome), [Klinefelter syndrome](https://en.wikipedia.org/wiki/Klinefelter_syndrome)) and in most cases, [spontaneous abortion](https://en.wikipedia.org/wiki/Spontaneous_abortion) of the developing foetus.

**Where spermatogenesis is located in the body**

Spermatogenesis takes place within several structures of the [male reproductive system](https://en.wikipedia.org/wiki/Male_reproductive_system). The initial stages occur within the testes and progress to the [epididymis](https://en.wikipedia.org/wiki/Epididymis) where the developing gametes mature and are stored until [ejaculation](https://en.wikipedia.org/wiki/Ejaculation). The [seminiferous tubules](https://en.wikipedia.org/wiki/Seminiferous_tubule) of the testes are the starting point for the process, where [spermatogonial stem cells](https://en.wikipedia.org/wiki/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). Clinically, small fluctuations in temperature such as from an athletic support strap, causes no impairment in sperm viability or count.

**Duration of spermatogenesis**

For humans, the entire process of spermatogenesis is variously estimated as taking 74 days (according to tritium-labelled biopsies) and approximately 120 days (according to DNA clock measurements). Including the transport on ductal system, it takes 3 months. Testes produce 200 to 300 million spermatozoa daily. However, only about half or 100 million of these become viable sperm.

 2 **Testosterone**

**Testosterone** is the primary [male](https://en.wikipedia.org/wiki/Male) [sex hormone](https://en.wikipedia.org/wiki/Sex_hormone) and [anabolic steroid](https://en.wikipedia.org/wiki/Anabolic_steroid). In male humans, testosterone plays a key role in the development of [male reproductive](https://en.wikipedia.org/wiki/Male_reproductive_system) tissues such as [testes](https://en.wikipedia.org/wiki/Testes) and [prostate](https://en.wikipedia.org/wiki/Prostate), as well as promoting [secondary sexual characteristics](https://en.wikipedia.org/wiki/Secondary_sexual_characteristic) such as increased [muscle](https://en.wikipedia.org/wiki/Muscle) and [bone](https://en.wikipedia.org/wiki/Bone) mass, and the growth of [body hair](https://en.wikipedia.org/wiki/Androgenic_hair). In addition, testosterone is involved in health and well-being, and the prevention of [osteoporosis](https://en.wikipedia.org/wiki/Osteoporosis). Insufficient levels of testosterone in men may lead to abnormalities including frailty and bone loss.

Testosterone is a [steroid](https://en.wikipedia.org/wiki/Steroid) from the [androstane](https://en.wikipedia.org/wiki/Androstane) class containing a [keto](https://en.wikipedia.org/wiki/Ketone) and [hydroxyl](https://en.wikipedia.org/wiki/Hydroxyl) groups at positions three and seventeen respectively. It is [biosynthesized](https://en.wikipedia.org/wiki/Biosynthesis) 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](https://en.wikipedia.org/wiki/Androgen_receptor). In humans and most other [vertebrates](https://en.wikipedia.org/wiki/Vertebrate), testosterone is secreted primarily by the [testicles](https://en.wikipedia.org/wiki/Testicles) of [males](https://en.wikipedia.org/wiki/Male) and, to a lesser extent, the [ovaries](https://en.wikipedia.org/wiki/Ovaries) of [females](https://en.wikipedia.org/wiki/Female). 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](https://en.wikipedia.org/wiki/Medication) in the treatment of [low testosterone levels in men](https://en.wikipedia.org/wiki/Male_hypogonadism), [transgender hormone therapy](https://en.wikipedia.org/wiki/Transgender_hormone_therapy) for [transgender men](https://en.wikipedia.org/wiki/Transgender_men), and [breast cancer](https://en.wikipedia.org/wiki/Breast_cancer) in women. Since [testosterone levels decrease as men age](https://en.wikipedia.org/wiki/Andropause), testosterone is sometimes used in older men to counteract this deficiency. It is also used illicitly to [enhance physique and performance](https://en.wikipedia.org/wiki/Performance-enhancing_substance), for instance in [athletes](https://en.wikipedia.org/wiki/Athlete).

## Biological effects of testosterone

In general, [androgens](https://en.wikipedia.org/wiki/Androgens) such as testosterone promote [protein synthesis](https://en.wikipedia.org/wiki/Protein_synthesis) and thus growth of tissues with [androgen receptors](https://en.wikipedia.org/wiki/Androgen_receptors). Testosterone can be described as having [virilising](https://en.wikipedia.org/wiki/Virilization) and [anabolic](https://en.wikipedia.org/wiki/Anabolism) effects (though these categorical descriptions are somewhat arbitrary, as there is a great deal of mutual overlap between them).

* *Anabolic effects* include growth of [muscle mass](https://en.wikipedia.org/wiki/Muscle_mass) and strength, increased [bone density](https://en.wikipedia.org/wiki/Bone_density) and strength, and stimulation of linear growth and [bone maturation](https://en.wikipedia.org/wiki/Bone_maturation).
* *Androgenic effects* include [maturation](https://en.wikipedia.org/wiki/Developmental_biology) of the [sex organs](https://en.wikipedia.org/wiki/Sex_organs), particularly the [penis](https://en.wikipedia.org/wiki/Penis) and the formation of the [scrotum](https://en.wikipedia.org/wiki/Scrotum) in the fetus, and after birth (usually at [puberty](https://en.wikipedia.org/wiki/Puberty)) a deepening of the [voice](https://en.wikipedia.org/wiki/Human_voice), growth of [facial hair](https://en.wikipedia.org/wiki/Facial_hair) (such as the [beard](https://en.wikipedia.org/wiki/Beard)) and [axillary (underarm) hair](https://en.wikipedia.org/wiki/Axillary_hair). Many of these fall into the category of male [secondary sex characteristics](https://en.wikipedia.org/wiki/Secondary_sex_characteristics).

Testosterone effects can also be classified by the age of usual occurrence. For [postnatal](https://en.wikipedia.org/wiki/Postnatal) effects in both males and females, these are mostly dependent on the levels and duration of circulating free testosterone.

### Before birth

Effects before birth are divided into two categories, classified in relation to the stages of development.

The first period occurs between 4 and 6 weeks of the gestation. Examples include genital virilisation such as midline fusion, [phallic](https://en.wikipedia.org/wiki/Phallus) [urethra](https://en.wikipedia.org/wiki/Urethra), [scrotal](https://en.wikipedia.org/wiki/Scrotum) thinning and [rugation](https://en.wikipedia.org/wiki/Rugae), and [phallic](https://en.wikipedia.org/wiki/Phallic) enlargement; although the role of testosterone is far smaller than that of [dihydrotestosterone](https://en.wikipedia.org/wiki/Dihydrotestosterone). There is also development of the [prostate](https://en.wikipedia.org/wiki/Prostate) gland and [seminal vesicles](https://en.wikipedia.org/wiki/Seminal_vesicle).

During the second trimester, androgen level is associated with [sex](https://en.wikipedia.org/wiki/Sex) formation. Specifically, testosterone, along with anti-Müllerian hormone (AMH) promote growth of the Wolffian duct and degeneration of the Müllerian duct respectively. This period affects the femininization or masculinization of the fetus and can be a better predictor of feminine or masculine behaviours such as sex typed behaviour than an adult's own levels. Prenatal androgens apparently influence interests and engagement in gendered activities and have moderate effects on spatial abilities. Among women with [CAH](https://en.wikipedia.org/wiki/Congenital_adrenal_hyperplasia), a male-typical play in childhood correlated with reduced satisfaction with the female gender and reduced heterosexual interest in adulthood.

### Early infancy

### Early infancy androgen effects are the least understood. In the first weeks of life for male infants, testosterone levels rise. The levels remain in a pubertal range for a few months, but usually reach the barely detectable levels of childhood by 4–7 months of age. The function of this rise in humans is unknown. It has been theorized that brain [masculinization](https://en.wikipedia.org/wiki/Virilization) is occurring since no significant changes have been identified in other parts of the body. The male brain is masculinized by the aromatization of testosterone into [estrogen](https://en.wikipedia.org/wiki/Estrogen), which crosses the [blood–brain barrier](https://en.wikipedia.org/wiki/Blood%E2%80%93brain_barrier) and enters the male brain, whereas female fetuses have [α-fetoprotein](https://en.wikipedia.org/wiki/%CE%91-fetoprotein), which binds the estrogen so that female brains are not affected. efore puberty

Before puberty effects of rising androgen levels occur in both boys and girls. These include adult-type [body odor](https://en.wikipedia.org/wiki/Body_odor), increased oiliness of skin and hair, [acne](https://en.wikipedia.org/wiki/Acne_vulgaris), [pubarche](https://en.wikipedia.org/wiki/Pubarche) (appearance of [pubic hair](https://en.wikipedia.org/wiki/Pubic_hair)), [axillary hair](https://en.wikipedia.org/wiki/Axillary_hair) (armpit hair), [growth spurt](https://en.wikipedia.org/wiki/Growth_spurt), accelerated [bone maturation](https://en.wikipedia.org/wiki/Epiphysis), and [facial hair](https://en.wikipedia.org/wiki/Facial_hair).

### pubertal

[Pubertal](https://en.wikipedia.org/wiki/Puberty) effects begin to occur when androgen has been higher than normal adult female levels for months or years. In males, these are usual late pubertal effects, and occur in women after prolonged periods of heightened levels of free testosterone in the blood. The effects include:

Growth of [spermatogenic](https://en.wikipedia.org/wiki/Spermatogenic) tissue in testicles, male [fertility](https://en.wikipedia.org/wiki/Fertility), [penis](https://en.wikipedia.org/wiki/Human_penis) or [clitoris](https://en.wikipedia.org/wiki/Clitoris) enlargement, increased [libido](https://en.wikipedia.org/wiki/Libido) and frequency of [erection](https://en.wikipedia.org/wiki/Erection) or clitoral engorgement occurs. Growth of [jaw](https://en.wikipedia.org/wiki/Jaw), brow, chin, and nose and remodeling of facial bone contours, in conjunction with [human growth hormone](https://en.wikipedia.org/wiki/Human_growth_hormone) occurs. Completion of bone maturation and termination of growth. This occurs indirectly via [estradiol](https://en.wikipedia.org/wiki/Estradiol) [metabolites](https://en.wikipedia.org/wiki/Metabolites) and hence more gradually in men than women. Increased muscle strength and mass, shoulders become broader and rib cage expands, deepening of voice, growth of the [Adam's apple](https://en.wikipedia.org/wiki/Adam%27s_apple). Enlargement of [sebaceous glands](https://en.wikipedia.org/wiki/Sebaceous_glands). This might cause acne, subcutaneous [fat](https://en.wikipedia.org/wiki/Body_fat) in face decreases. Pubic hair extends to thighs and up toward [umbilicus](https://en.wikipedia.org/wiki/Navel), development of [facial hair](https://en.wikipedia.org/wiki/Facial_hair) ([sideburns](https://en.wikipedia.org/wiki/Sideburns), [beard](https://en.wikipedia.org/wiki/Beard), [moustache](https://en.wikipedia.org/wiki/Moustache)), loss of scalp hair (androgenetic alopecia), increase in [chest hair](https://en.wikipedia.org/wiki/Chest_hair), periareolar hair, [perianal](https://en.wikipedia.org/wiki/Perianal) hair, [leg hair](https://en.wikipedia.org/wiki/Leg_hair), [armpit hair](https://en.wikipedia.org/wiki/Axillary_hair).

### Adult

Testosterone is necessary for normal [sperm](https://en.wikipedia.org/wiki/Sperm) development. It activates genes in [Sertoli cells](https://en.wikipedia.org/wiki/Sertoli_cell), which promote differentiation of [spermatogonia](https://en.wikipedia.org/wiki/Spermatogonia). It regulates acute HPA ([hypothalamic–pituitary–adrenal axis](https://en.wikipedia.org/wiki/Hypothalamic%E2%80%93pituitary%E2%80%93adrenal_axis)) response under dominance challenge. Androgen including testosterone enhances muscle growth. Testosterone also regulates the population of [thromboxane A2](https://en.wikipedia.org/wiki/Thromboxane_A2) receptors on [megakaryocytes](https://en.wikipedia.org/wiki/Megakaryocytes) and [platelets](https://en.wikipedia.org/wiki/Platelets) and hence platelet aggregation in humans.

Adult testosterone effects are more clearly demonstrable in males than in females, but are likely important to both sexes. Some of these effects may decline as testosterone levels might decrease in the later decades of adult life.

#### Health risks

Testosterone does not appear to increase the risk of developing [prostate cancer](https://en.wikipedia.org/wiki/Prostate_cancer). In people who have undergone testosterone deprivation therapy, testosterone increases beyond the castrate level have been shown to increase the rate of spread of an existing prostate cancer.

Conflicting results have been obtained concerning the importance of [testosterone in maintaining cardiovascular health](https://en.wikipedia.org/wiki/Testosterone_and_cardiovascular_system). Nevertheless, maintaining normal testosterone levels in elderly men has been shown to improve many parameters that are thought to reduce cardiovascular disease risk, such as increased lean body mass, decreased visceral fat mass, decreased total cholesterol, and glycemic control.

High androgen levels are associated with [menstrual cycle](https://en.wikipedia.org/wiki/Menstrual_cycle) irregularities in both clinical populations and healthy women.

**3 Semen**

**Semen**, also known as **seminal fluid**, is an organic [fluid](https://en.wikipedia.org/wiki/Fluid) that contains [spermatozoa](https://en.wikipedia.org/wiki/Spermatozoon). It is secreted by the [gonads](https://en.wikipedia.org/wiki/Gonad) (sexual glands) and other sexual organs of [male](https://en.wikipedia.org/wiki/Male) or [hermaphroditic](https://en.wikipedia.org/wiki/Hermaphrodite) [animals](https://en.wikipedia.org/wiki/Animal) and can [fertilize](https://en.wikipedia.org/wiki/Fertilization) the [female](https://en.wikipedia.org/wiki/Female) [ovum](https://en.wikipedia.org/wiki/Ovum). In humans, seminal fluid contains several components besides spermatozoa: proteolytic and other enzymes as well as fructose are elements of seminal fluid which promote the survival of spermatozoa, and provide a medium through which they can move or "swim". Semen is produced and originates from the [seminal vesicle](https://en.wikipedia.org/wiki/Seminal_vesicle), which is located in the pelvis. The process that results in the discharge of semen is called [*ejaculation*](https://en.wikipedia.org/wiki/Ejaculation). Semen is also a form of genetic material. In animals, semen has been collected for cryoconservation. [Cryoconservation of animal genetic resources](https://en.wikipedia.org/wiki/Cryoconservation_of_animal_genetic_resources) is a practice that calls for the collection of genetic material in efforts for conservation of a particular breed.

### Fertilization

Depending on the [species](https://en.wikipedia.org/wiki/Species), spermatozoa can fertilize ova externally or internally. In [external fertilization](https://en.wikipedia.org/wiki/External_fertilization), the spermatozoa fertilize the ova directly, outside of the female's sexual organs. Female [fish](https://en.wikipedia.org/wiki/Fish), for example, [spawn](https://en.wikipedia.org/wiki/Spawn_%28biology%29) ova into their aquatic environment, where they are fertilized by the semen of the male fish.

During [internal fertilization](https://en.wikipedia.org/wiki/Internal_fertilization), however, fertilization occurs inside the female's sexual organs. Internal fertilization takes place after [insemination](https://en.wikipedia.org/wiki/Insemination) of a female by a male through [copulation](https://en.wikipedia.org/wiki/Copulation_%28zoology%29). In most [vertebrates](https://en.wikipedia.org/wiki/Vertebrate), including [amphibians](https://en.wikipedia.org/wiki/Amphibian), [reptiles](https://en.wikipedia.org/wiki/Reptile), [birds](https://en.wikipedia.org/wiki/Bird) and [monotreme](https://en.wikipedia.org/wiki/Monotreme) mammals, copulation is achieved through the physical mating of the [cloaca](https://en.wikipedia.org/wiki/Cloaca) of the male and female. In [marsupial](https://en.wikipedia.org/wiki/Marsupial) and [placental mammals](https://en.wikipedia.org/wiki/Placentalia), copulation occurs through the [vagina](https://en.wikipedia.org/wiki/Vagina).

### Human semen

#### Composition

During the process of [ejaculation](https://en.wikipedia.org/wiki/Ejaculation), sperm passes through the [ejaculatory ducts](https://en.wikipedia.org/wiki/Ejaculatory_duct) and mixes with fluids from the [seminal vesicles](https://en.wikipedia.org/wiki/Seminal_vesicle), the [prostate](https://en.wikipedia.org/wiki/Prostate), and the [bulbourethral glands](https://en.wikipedia.org/wiki/Bulbourethral_gland) to form the semen. The seminal vesicles produce a yellowish viscous fluid rich in fructose and other substances that makes up about 70% of human semen. The prostatic secretion, influenced by dihydrotestosterone, is a whitish (sometimes clear), thin fluid containing proteolytic enzymes, citric acid, acid phosphatase and lipids. The bulbourethral glands secrete a clear secretion into the lumen of the [urethra](https://en.wikipedia.org/wiki/Urethra) to lubricate it.

[Sertoli cells](https://en.wikipedia.org/wiki/Sertoli_cell), which nurture and support developing [spermatocytes](https://en.wikipedia.org/wiki/Spermatocyte), secrete a fluid into seminiferous tubules that helps transport sperm to the genital ducts. The ductuli efferentes possess cuboidal cells with [microvilli](https://en.wikipedia.org/wiki/Microvillus) and [lysosomal](https://en.wikipedia.org/wiki/Lysosome) granules that modify the ductal fluid by reabsorbing some fluid. Once the semen enters the ductus epididymis the principal cells, which contain [pinocytotic vessels](https://en.wikipedia.org/w/index.php?title=Pinocytotic_vessel&action=edit&redlink=1) indicating fluid reabsorption, secrete glycerophosphocholine which most likely inhibits premature [capacitation](https://en.wikipedia.org/wiki/Capacitation). The accessory genital ducts, the [seminal vesicle](https://en.wikipedia.org/wiki/Seminal_vesicle), [prostate glands](https://en.wikipedia.org/wiki/Prostate_gland), and the [bulbourethral glands](https://en.wikipedia.org/wiki/Bulbourethral_gland), produce most of the seminal fluid.

Seminal plasma of humans contains a complex range of [organic](https://en.wikipedia.org/wiki/Organic_compound) and [inorganic](https://en.wikipedia.org/wiki/Inorganic) constituents.

The seminal plasma provides a nutritive and protective medium for the spermatozoa during their journey through the female reproductive tract. The normal environment of the [vagina](https://en.wikipedia.org/wiki/Vagina) is a hostile one (c.f. [sexual conflict](https://en.wikipedia.org/wiki/Sexual_conflict)) for [sperm](https://en.wikipedia.org/wiki/Sperm) cells, as it is very [acidic](https://en.wikipedia.org/wiki/Acidic) (from the native microflora producing [lactic acid](https://en.wikipedia.org/wiki/Lactic_acid)), viscous, and patrolled by immune cells. The components in the seminal plasma attempt to compensate for this hostile environment. Basic [amines](https://en.wikipedia.org/wiki/Amines) such as [putrescine](https://en.wikipedia.org/wiki/Putrescine), [spermine](https://en.wikipedia.org/wiki/Spermine), [spermidine](https://en.wikipedia.org/wiki/Spermidine) and [cadaverine](https://en.wikipedia.org/wiki/Cadaverine) are responsible for the smell and flavor of semen. These alkaline bases counteract and buffer the acidic environment of the vaginal canal, and protect [DNA](https://en.wikipedia.org/wiki/DNA) inside the [sperm](https://en.wikipedia.org/wiki/Sperm) from acidic denaturation.

The components and contributions of semen are as follows:

|  |  |  |
| --- | --- | --- |
| **Gland(s)** | **Approximate fraction** | **Description**  |
| [testes](https://en.wikipedia.org/wiki/Testes) | 2–5% | Approximately 200 million – 500 million spermatozoa (also called *sperm* or *spermatozoans*), produced in the [testes](https://en.wikipedia.org/wiki/Testes), are released per ejaculation. If a man has undergone a [vasectomy](https://en.wikipedia.org/wiki/Vasectomy), he will have no sperm in the ejaculation.  |
| [seminal vesicles](https://en.wikipedia.org/wiki/Seminal_vesicles) | 65–75% | [Amino acids](https://en.wikipedia.org/wiki/Amino_acids), [citrate](https://en.wikipedia.org/wiki/Citrate), [enzymes](https://en.wikipedia.org/wiki/Enzyme), [flavins](https://en.wikipedia.org/wiki/Flavin_group), [fructose](https://en.wikipedia.org/wiki/Fructose) (2–5 mg per mL semen,[[5]](https://en.wikipedia.org/wiki/Semen#cite_note-5) the main energy source of sperm cells, which rely entirely on sugars from the seminal plasma for energy), [phosphorylcholine](https://en.wikipedia.org/wiki/Phosphorylcholine), [prostaglandins](https://en.wikipedia.org/wiki/Prostaglandin) (involved in suppressing an immune response by the female against the foreign semen), [proteins](https://en.wikipedia.org/wiki/Protein), [vitamin C](https://en.wikipedia.org/wiki/Vitamin_C).  |
| [prostate](https://en.wikipedia.org/wiki/Prostate) | 25–30% | [Acid phosphatase](https://en.wikipedia.org/wiki/Acid_phosphatase), [citric acid](https://en.wikipedia.org/wiki/Citric_acid), [fibrinolysin](https://en.wikipedia.org/wiki/Fibrinolysin), [prostate specific antigen](https://en.wikipedia.org/wiki/Prostate_specific_antigen), [proteolytic enzymes](https://en.wikipedia.org/wiki/Proteolytic_enzyme), [zinc](https://en.wikipedia.org/wiki/Zinc). (The zinc level is about 135±40/mL for healthy men.[[6]](https://en.wikipedia.org/wiki/Semen#cite_note-CanaleEtal1986-6) Zinc serves to help to stabilize the DNA-containing [chromatin](https://en.wikipedia.org/wiki/Chromatin) in the sperm cells. A zinc deficiency may result in lowered fertility because of increased sperm fragility. Zinc deficiency can also adversely affect [spermatogenesis](https://en.wikipedia.org/wiki/Spermatogenesis).)  |
| [bulbourethral glands](https://en.wikipedia.org/wiki/Bulbourethral_glands) | < 1% | [Galactose](https://en.wikipedia.org/wiki/Galactose), [mucus](https://en.wikipedia.org/wiki/Mucus) (serve to increase the mobility of sperm cells in the vagina and cervix by creating a less viscous channel for the sperm cells to swim through, and preventing their diffusion out of the semen. Contributes to the cohesive jelly-like texture of semen), [pre-ejaculate](https://en.wikipedia.org/wiki/Pre-ejaculate), [sialic acid](https://en.wikipedia.org/wiki/Sialic_acid).  |

A 1992 [World Health Organization](https://en.wikipedia.org/wiki/World_Health_Organization) report described normal human semen as having a volume of 2 mL or greater, [pH](https://en.wikipedia.org/wiki/PH) of 7.2 to 8.0, sperm concentration of 20×106 spermatozoa/mL or more, sperm count of 40×106 spermatozoa per ejaculate or more, and motility of 50% or more with forward progression (categories a and b) of 25% or more with rapid progression (category a) within 60 minutes of ejaculation.

A 2005 review of the literature found that the average reported physical and chemical properties of human semen were as follows:

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| --- | --- | --- |
| **Property**  | **Per 100**[**mL**](https://en.wikipedia.org/wiki/Millilitre) | **In average volume (3.4 mL)**  |
| [Calcium](https://en.wikipedia.org/wiki/Calcium) (mg) | 27.6 | 0.938  |
| [Chloride](https://en.wikipedia.org/wiki/Chloride) (mg) | 142 | 4.83  |
| Citrate (mg) | 528 | 18.0  |
| Fructose (mg) | 272 | 9.25  |
| [Glucose](https://en.wikipedia.org/wiki/Glucose) (mg) | 102 | 3.47  |
| Lactic acid (mg) | 62 | 2.11  |
| [Magnesium](https://en.wikipedia.org/wiki/Magnesium) (mg) | 11 | 0.374  |
| [Potassium](https://en.wikipedia.org/wiki/Potassium) (mg) | 109 | 3.71  |
| Protein (g) | 5.04 | 0.171  |
| [Sodium](https://en.wikipedia.org/wiki/Sodium) (mg) | 300 | 10.2  |
| [Urea](https://en.wikipedia.org/wiki/Urea) (mg) | 45 | 1.53  |
| Zinc (mg) | 16.5 | 0.561  |
| [Buffering capacity](https://en.wikipedia.org/wiki/Buffer_capacity) (β)  | 25  |
| [Osmolarity](https://en.wikipedia.org/wiki/Osmolarity) ([mOsm](https://en.wikipedia.org/wiki/MOsm%22%20%5Co%20%22MOsm))  | 354  |
| pH  | 7.7  |
| [Viscosity](https://en.wikipedia.org/wiki/Viscosity) ([cP](https://en.wikipedia.org/wiki/Poise_%28unit%29%22%20%5Co%20%22Poise%20%28unit%29))  | 3–7  |
| [Volume](https://en.wikipedia.org/wiki/Volume) (mL)  | 3.4  |
| Values for average volume have been calculated and [rounded](https://en.wikipedia.org/wiki/Rounding) to three [significant figures](https://en.wikipedia.org/wiki/Significant_figures). All other values are those given in the review.  |

Semen is typically translucent with white, grey or even yellowish tint. Blood in the semen can cause a pink or reddish colour, known as [*hematospermia*](https://en.wikipedia.org/wiki/Hematospermia), and may indicate a medical problem which should be evaluated by a doctor if the symptom persists.

After ejaculation, the latter part of the ejaculated semen [coagulates](https://en.wikipedia.org/wiki/Coagulation) immediately, forming globules, while the earlier part of the ejaculate typically does not. After a period typically ranging from 15 – 30 minutes, [prostate-specific antigen](https://en.wikipedia.org/wiki/Prostate-specific_antigen) present in the semen causes the decoagulation of the seminal coagulum.It is postulated that the initial clotting helps keep the semen in the vagina,while [liquefaction](https://en.wikipedia.org/wiki/Liquification) frees the sperm to make their journey to the ova.

A 2005 review found that the average reported viscosity of human semen in the literature was 3–7 cP.

### Quality

Main article: [Semen quality](https://en.wikipedia.org/wiki/Semen_quality)

Semen quality is a measure of the ability of semen to accomplish fertilization. Thus, it is a measure of fertility in a man. It is the sperm in the semen that is the fertile component, and therefore semen quality involves both sperm quantity and sperm quality.

### Quantity

The volume of semen ejaculate varies but is generally about 1 teaspoonful or less. A review of 30 studies concluded that the average was around 3.4 milliliters (mL), with some studies finding amounts as high as 5.0 mL or as low as 2.3 mL.[[8]](https://en.wikipedia.org/wiki/Semen%22%20%5Cl%20%22cite_note-Owen2005-8) In a study with Swedish and Danish men, a prolonged interval between [ejaculations](https://en.wikipedia.org/wiki/Ejaculations) caused an increase of the sperm count in the semen but not an increase of its amount.[[14]](https://en.wikipedia.org/wiki/Semen#cite_note-14)

#### Increasing semen volume

Some [dietary supplements](https://en.wikipedia.org/wiki/Dietary_supplement) have been marketed with claims to increase seminal volume. Like other supplements, including so-called [herbal viagra](https://en.wikipedia.org/wiki/Herbal_viagra), these are not approved or regulated by the [Food and Drug Administration](https://en.wikipedia.org/wiki/Food_and_Drug_Administration) (as licensed medications would be), and none of the claims have been scientifically verified. Similar claims are made about traditional [aphrodisiac](https://en.wikipedia.org/wiki/Aphrodisiac) foods, with an equal lack of verification.

### Storage

Semen can be stored in diluents such as the *Illini Variable Temperature* (IVT) diluent, which have been reported to be able to preserve high fertility of semen for over seven days. The IVT diluent is composed of several salts, sugars and antibacterial agents and gassed with [CO2](https://en.wikipedia.org/wiki/Carbon_dioxide).

[Semen cryopreservation](https://en.wikipedia.org/wiki/Semen_cryopreservation) can be used for far longer storage durations. For human sperm, the longest reported successful storage with this method is 21 years.

**4 Male orgasm**

**Orgasm** (from [Greek](https://en.wikipedia.org/wiki/Ancient_Greek) ὀργασμός *orgasmos* "excitement, swelling"; also **sexual climax**) is the sudden discharge of accumulated sexual excitement during the [sexual response cycle](https://en.wikipedia.org/wiki/Human_sexual_response_cycle), resulting in rhythmic [muscular contractions](https://en.wikipedia.org/wiki/Muscle_contraction) in the [pelvic](https://en.wikipedia.org/wiki/Human_pelvis) region characterized by sexual pleasure. Experienced by males and females, orgasms are controlled by the involuntary or [autonomic nervous system](https://en.wikipedia.org/wiki/Autonomic_nervous_system). They are often associated with other involuntary actions, including muscular [spasms](https://en.wikipedia.org/wiki/Spasm) in multiple areas of the body, a general [euphoric](https://en.wikipedia.org/wiki/Euphoria) sensation and, frequently, body movements and vocalizations. The period after orgasm (known as the [refractory period](https://en.wikipedia.org/wiki/Refractory_period_%28sex%29)) is often a relaxing experience, attributed to the release of the [neurohormones](https://en.wikipedia.org/wiki/Neurohormone) [oxytocin](https://en.wikipedia.org/wiki/Oxytocin) and [prolactin](https://en.wikipedia.org/wiki/Prolactin) as well as [endorphins](https://en.wikipedia.org/wiki/Endorphins) (or "endogenous [morphine](https://en.wikipedia.org/wiki/Morphine)").

Human orgasms usually result from physical [sexual stimulation](https://en.wikipedia.org/wiki/Sexual_stimulation) of the [penis](https://en.wikipedia.org/wiki/Human_penis) in males (typically accompanying [ejaculation](https://en.wikipedia.org/wiki/Ejaculation)) and of the [clitoris](https://en.wikipedia.org/wiki/Clitoris) in females. Sexual stimulation can be by self-practice ([masturbation](https://en.wikipedia.org/wiki/Masturbation)) or with a [sex partner](https://en.wikipedia.org/wiki/Sex_partner) ([penetrative sex](https://en.wikipedia.org/wiki/Sexual_penetration), [non-penetrative sex](https://en.wikipedia.org/wiki/Non-penetrative_sex), or other [sexual activity](https://en.wikipedia.org/wiki/Human_sexual_activity)).

### The health effects surrounding the human orgasm are diverse. There are many physiological responses during sexual activity, including a relaxed state created by prolactin, as well as changes in the [central nervous system](https://en.wikipedia.org/wiki/Central_nervous_system) such as a temporary decrease in the [metabolic](https://en.wikipedia.org/wiki/Metabolism) activity of large parts of the [cerebral cortex](https://en.wikipedia.org/wiki/Cerebral_cortex) while there is no change or increased metabolic activity in the [limbic](https://en.wikipedia.org/wiki/Limbic_system) (i.e., "bordering") areas of the brain. There is also a wide range of [sexual dysfunctions](https://en.wikipedia.org/wiki/Sexual_dysfunction), such as [anorgasmia](https://en.wikipedia.org/wiki/Anorgasmia). These effects impact cultural views of orgasm, such as the beliefs that orgasm and the frequency/consistency of it are either important or irrelevant for satisfaction in a sexual relationship, and theories about the biological and evolutionary functions of orgasm. Males

#### Variabilities

In men, the most common way of achieving orgasm is by physical sexual stimulation of the [penis](https://en.wikipedia.org/wiki/Human_penis). This is usually accompanied by [ejaculation](https://en.wikipedia.org/wiki/Ejaculation), but it is possible, though also rare, for men to orgasm without ejaculation (known as a "dry orgasm").Prepubescent boys have dry orgasms Dry orgasms can also occur as a result of [retrograde ejaculation](https://en.wikipedia.org/wiki/Retrograde_ejaculation), or [hypogonadism](https://en.wikipedia.org/wiki/Hypogonadism). Men may also ejaculate without reaching orgasm, which is known as [anorgasmic ejaculation](https://en.wikipedia.org/wiki/Anorgasmia). They may also achieve orgasm by stimulation of the [prostate](https://en.wikipedia.org/wiki/Prostate) ([see below](https://en.wikipedia.org/wiki/Orgasm#Anal_and_prostate_stimulation)).

#### Two-stage model

The traditional view of male orgasm is that there are two stages: emission following orgasm, almost instantly followed by a [refractory period](https://en.wikipedia.org/wiki/Refractory_period_%28sex%29). The refractory period is the recovery phase after orgasm during which it is physiologically impossible for a man to have additional orgasms. In 1966, [Masters and Johnson](https://en.wikipedia.org/wiki/Masters_and_Johnson) published pivotal research about the phases of sexual stimulation. Their work included women and men, and, unlike [Alfred Kinsey](https://en.wikipedia.org/wiki/Alfred_Kinsey) in 1948 and 1953,] tried to determine the [physiological](https://en.wikipedia.org/wiki/Physiology) stages before and after orgasm.

Masters and Johnson argued that, in the first stage, "accessory organs contract and the male can feel the ejaculation coming; two to three seconds later the ejaculation occurs, which the man cannot constrain, delay, or in any way control" and that, in the second stage, "the male feels pleasurable contractions during ejaculation, reporting greater pleasure tied to a greater volume of ejaculate". They reported that, unlike females, "for the man the resolution phase includes a superimposed refractory period" and added that "many males below the age of 30, but relatively few thereafter, have the ability to ejaculate frequently and are subject to only very short refractory periods during the resolution phase". Masters and Johnson equated male orgasm and ejaculation and maintained the necessity for a refractory period between orgasms.

#### Subsequent and multiple orgasms

There has been little scientific study of multiple orgasm in men. Dunn and Trost defined male multiple orgasm as "two or more orgasms with or without ejaculation and without, or with only very limited, detumescence [loss of erection] during one and the same sexual encounter". Although, due to the refractory period, it is rare for men to achieve multiple orgasms, some men have reported having multiple, consecutive orgasms, particularly without ejaculation. Multiple orgasms are more commonly reported in very young men than in older men. In younger men, the refractory period may only last a few minutes, but last more than an hour in older men.

An increased infusion of the [hormone](https://en.wikipedia.org/wiki/Hormone) [oxytocin](https://en.wikipedia.org/wiki/Oxytocin) during ejaculation is believed to be chiefly responsible for the refractory period, and the amount by which oxytocin is increased may affect the length of each refractory period. A scientific study to successfully document natural, fully ejaculatory, multiple orgasms in an adult man was conducted at [Rutgers University](https://en.wikipedia.org/wiki/Rutgers_University) in 1995. During the study, six fully ejaculatory orgasms were experienced in 36 minutes, with no apparent refractory period.

**5 male infertility**

**Infertility** is the inability of a person, animal or plant to [reproduce](https://en.wikipedia.org/wiki/Sexual_reproduction) by natural means. It is usually not the natural state of a healthy adult, except notably among certain [eusocial](https://en.wikipedia.org/wiki/Eusocial) species (mostly [haplodiploid](https://en.wikipedia.org/wiki/Haplodiploid) insects).

In humans, infertility is the inability to become pregnant after one year of intercourse without contraception involving a male and female partner. There are many causes of infertility, including some that [medical intervention](https://en.wikipedia.org/wiki/Assisted_reproductive_technology) can treat. Estimates from 1997 suggest that worldwide about five percent of all heterosexual couples have an unresolved problem with infertility. Many more couples, however, experience involuntary childlessness for at least one year: estimates range from 12% to 28%.[[4]](https://en.wikipedia.org/wiki/Infertility#cite_note-4) [Male infertility](https://en.wikipedia.org/wiki/Male_infertility) is responsible for 20–30% of infertility cases, while 20–35% are due to [female infertility](https://en.wikipedia.org/wiki/Female_infertility), and 25–40% are due to combined problems in both parts. In 10–20% of cases, no cause is found. The most common cause of female infertility is ovulatory problems, which generally manifest themselves by sparse or absent menstrual periods.Male infertility is most commonly due to deficiencies in the [semen](https://en.wikipedia.org/wiki/Semen), and [semen quality](https://en.wikipedia.org/wiki/Semen_quality) is used as a surrogate measure of male [fecundity](https://en.wikipedia.org/wiki/Fecundity).

Women who are [fertile](https://en.wikipedia.org/wiki/Fertility#Human_fertility) experience a natural period of fertility before and during [ovulation](https://en.wikipedia.org/wiki/Ovulation), and they are naturally infertile for the rest of the [menstrual cycle](https://en.wikipedia.org/wiki/Menstrual_cycle). [Fertility awareness](https://en.wikipedia.org/wiki/Fertility_awareness) methods are used to discern when these changes occur by tracking changes in [cervical mucus](https://en.wikipedia.org/wiki/Cervical_mucus) or [basal body temperature](https://en.wikipedia.org/wiki/Basal_body_temperature).

### Males

Further information: [Male infertility](https://en.wikipedia.org/wiki/Male_infertility)

The main cause of male infertility is low semen quality. In men who have the necessary reproductive organs to procreate, infertility can be caused by low sperm count due to endocrine problems, drugs, radiation, or infection. There may be testicular malformations, hormone imbalance, or blockage of the man's duct system. Although many of these can be treated through surgery or hormonal substitutions, some may be indefinite. Infertility associated with viable, but immotile sperm may be caused by [primary ciliary dyskinesia](https://en.wikipedia.org/wiki/Primary_ciliary_dyskinesia). The sperm must provide the zygote with [DNA](https://en.wikipedia.org/wiki/DNA), [centrioles](https://en.wikipedia.org/wiki/Centrioles), and activation factor for the embryo to develop. A defect in any of these sperm structures may result in infertility that will not be detected by semen analysis. [Antisperm antibodies](https://en.wikipedia.org/wiki/Antisperm_antibodies) cause immune infertility. [Cystic fibrosis](https://en.wikipedia.org/wiki/Cystic_fibrosis) can lead to infertility in men.

### Combined infertility

In some cases, both the man and woman may be infertile or sub-fertile, and the couple's infertility arises from the combination of these conditions. In other cases, the cause is suspected to be immunological or genetic; it may be that each partner is independently fertile but the couple cannot conceive together without assistance.