**Artificial Insemination**

Lec. 1 Spermatogensis

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Spermatogenesis

**Spermatogenesis** is the process by which [spermatozoa](http://en.wikipedia.org/wiki/Spermatozoa) are produced from male primordial germ cells through mitosis and meiosis. The initial cells in this pathway are called [spermatogonia](http://en.wikipedia.org/wiki/Spermatogonia" \o "Spermatogonia), which yield primary [spermatocytes](http://en.wikipedia.org/wiki/Spermatocytes" \o "Spermatocytes) by mitosis. The primary spermatocyte divides meiotically into two secondary spermatocytes; each secondary spermatocyte then completes meiosis as it divides into two [spermatids](http://en.wikipedia.org/wiki/Spermatids" \o "Spermatids). These develop into mature spermatozoa, also known as [sperm](http://en.wikipedia.org/wiki/Sperm) cells. Thus, the primary spermatocyte gives rise to two cells, the secondary spermatocytes, and the two secondary spermatocytes by their subdivision produce four spermatozoa.

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

**Purpose**

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

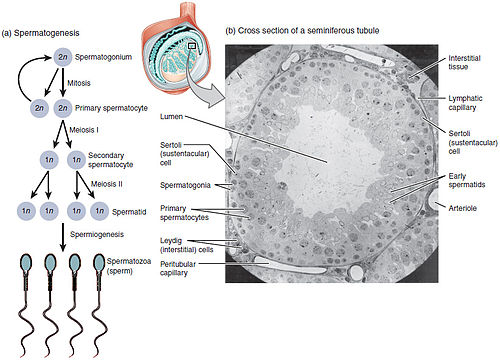
To preserve the number of chromosomes in the offspring – which differs between [species](http://en.wikipedia.org/wiki/Species) – each gamete must have half the usual number of chromosomes present in other body cells. Otherwise, the offspring will have twice the normal number of chromosomes, and serious abnormalities may result. In humans, chromosomal abnormalities arising from incorrect spermatogenesis can result in [Down Syndrome](http://en.wikipedia.org/wiki/Down_Syndrome), [Klinefelter's Syndrome](http://en.wikipedia.org/wiki/Klinefelter%27s_Syndrome" \o "Klinefelter's Syndrome), and [spontaneous abortion](http://en.wikipedia.org/wiki/Spontaneous_abortion).

**Location**

Spermatogenesis takes place within several structures of the [male reproductive system](http://en.wikipedia.org/wiki/Male_reproductive_system). The initial stages occur within the testes and progress to the [epididymis](http://en.wikipedia.org/wiki/Epididymis" \o "Epididymis) where the developing gametes mature and are stored until [ejaculation](http://en.wikipedia.org/wiki/Ejaculation). The [seminiferous tubules](http://en.wikipedia.org/wiki/Seminiferous_tubule" \o "Seminiferous tubule) of the testes are the starting point for the process, where 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.

Duration :- For humans, entire process of spermatogenesis takes 74 days. Including the transport on ductal system, it takes 3 months. Testes produce 200 to 300 million spermatozoa daily.

**Spermatocytogenesis**

[](http://en.wikipedia.org/wiki/File:Figure_28_01_04.jpg)

[http://bits.wikimedia.org/static-1.23wmf12/skins/common/images/magnify-clip.png](http://en.wikipedia.org/wiki/File:Figure_28_01_04.jpg)

The process of spermatogenesis as the cells progress from primary spermatocytes, to secondary spermatocytes, to spermatids, to Sperm

[*Spermatocytogenesis*](http://en.wikipedia.org/wiki/Spermatocytogenesis)

Spermatocytogenesis is the male form of [gametocytogenesis](http://en.wikipedia.org/wiki/Gametocyte" \o "Gametocyte) and results in the formation of [spermatocytes](http://en.wikipedia.org/wiki/Spermatocyte) possessing half the normal complement of genetic material. In spermatocytogenesis, a diploid [spermatogonium](http://en.wikipedia.org/wiki/Spermatogonium" \o "Spermatogonium) which resides in the basal compartment of seminiferous tubules, divides [mitotically](http://en.wikipedia.org/wiki/Mitosis) to produce two diploid intermediate cells called [primary spermatocytes](http://en.wikipedia.org/wiki/Spermatocyte). Each primary spermatocyte then moves into the [adluminal compartment](http://en.wikipedia.org/w/index.php?title=Adluminal_compartment&action=edit&redlink=1" \o "Adluminal compartment (page does not exist)) of the seminiferous tubules and duplicates its DNA and subsequently undergoes [*meiosis*](http://en.wikipedia.org/wiki/Meiosis)*I* to produce two haploid [secondary spermatocytes](http://en.wikipedia.org/wiki/Spermatocyte), which will later divide once more into [haploid](http://en.wikipedia.org/wiki/Haploid) [spermatids](http://en.wikipedia.org/wiki/Spermatids" \o "Spermatids). This division implicates sources of genetic variation, such as random inclusion of either parental chromosomes, and [chromosomal crossover](http://en.wikipedia.org/wiki/Chromosomal_crossover), to increase the genetic variability of the gamete.

Each cell division from a spermatogonium to a spermatid is incomplete; the cells remain connected to one another by bridges of cytoplasm to allow synchronous development. It should also be noted that not all spermatogonia divide to produce spermatocytes, otherwise the supply would run out. Instead, certain types of spermatogonia divide to produce copies of themselves, thereby ensuring a constant supply of gametogonia to fuel spermatogenesis.

**Spermatidogenesis**

Spermatidogenesis is the creation of [spermatids](http://en.wikipedia.org/wiki/Spermatid" \o "Spermatid) from secondary spermatocytes. Secondary spermatocytes produced earlier rapidly enter meiosis II and divide to produce haploid spermatids. The brevity of this stage means that secondary spermatocytes are rarely seen in [histological](http://en.wikipedia.org/wiki/Histology) studies.

**Spermiogenesis**

During spermiogenesis, the spermatids begin to grow a tail, and develop a thickened mid-piece, where the microtubules gather and form an[axoneme](http://en.wikipedia.org/wiki/Axoneme). Spermatid [DNA](http://en.wikipedia.org/wiki/DNA) also undergoes packaging, becoming highly condensed. The DNA is packaged firstly with specific nuclear basic proteins, which are subsequently replaced with [protamines](http://en.wikipedia.org/wiki/Protamine" \o "Protamine) during spermatid elongation. The resultant tightly packed [chromatin](http://en.wikipedia.org/wiki/Chromatin) is transcriptionally inactive. The [Golgi apparatus](http://en.wikipedia.org/wiki/Golgi_apparatus) surrounds the now condensed nucleus, becoming the [acrosome](http://en.wikipedia.org/wiki/Acrosome" \o "Acrosome). One of the [centrioles](http://en.wikipedia.org/wiki/Centriole" \o "Centriole) of the cell elongates to become the tail of the sperm.

Maturation then takes place under the influence of testosterone, which removes the remaining unnecessary [cytoplasm](http://en.wikipedia.org/wiki/Cytoplasm) and [organelles](http://en.wikipedia.org/wiki/Organelles). The excess cytoplasm, known as *residual bodies*, is [phagocytosed](http://en.wikipedia.org/wiki/Phagocytosed" \o "Phagocytosed) by surrounding Sertoli cells in the [testes](http://en.wikipedia.org/wiki/Testes). The resulting spermatozoa are now mature but lack motility, rendering them sterile. The mature spermatozoa are released from the protective [Sertoli cells](http://en.wikipedia.org/wiki/Sertoli_cell" \o "Sertoli cell) into the lumen of the [seminiferous tubule](http://en.wikipedia.org/wiki/Seminiferous_tubule" \o "Seminiferous tubule) in a process called *spermiation*.

The non-motile spermatozoa are transported to the [epididymis](http://en.wikipedia.org/wiki/Epididymis" \o "Epididymis) in *testicular fluid* secreted by the Sertoli cells with the aid of [peristaltic contraction](http://en.wikipedia.org/wiki/Peristalsis). While in the epididymis the spermatozoa gain motility and become capable of fertilization. However, transport of the mature spermatozoa through the remainder of the [male reproductive system](http://en.wikipedia.org/wiki/Male_reproductive_system) is achieved via muscle contraction rather than the spermatozoon's recently acquired motility.

