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**Factors facilitating the movement of sperm in the reproductive tract:**

1. The optimal pH for sperm viability is between 7.0 and 8.5 and a reduction in sperm motility is seen at a pH less than 6.0.Normal vaginal pH is only 3.5 to 4.0, and the acidic environment of the vagina is thus toxic to sperm. However, both seminal fluid and cervical mucus present within the posterior vagina are alkaline and act as buffers. Fox and coworkers have shown that vaginal pH rises to 7.0 within just seconds after ejaculation and this decrease in acidity can be maintained for up to two hours after ejaculation.
2. The Cervix: Several important functions have been attributed to the cervix, and these include:

* Providing a receptive environment for sperm entry near the time of ovulation
* Preventing access of sperm, microorganisms, and particulate matter to the upper reproductive tract and thus, the peritoneal cavity
* Filtering spermatozoa and removal of seminal plasma
* Preventing sperm phagocytosis by white blood cells within the female reproductive tract
* Providing a biochemical environment sufficient for sperm storage, capacitation, and migration

The structure of the human cervix facilitates performance of these stated functions. The endocervical canal has an average length of 3.0 cm, and it is lined by two types of columnar epithelial cells, ciliated and nonciliated. The cervix does not contain true glandular units; rather, the mucosa is arranged with a series of inholding’s that form crypts off the central canal. The nonciliated columnar epithelial cells secrete mucin granules, and the ciliated cells propel the cervical mucus from the crypt of origination toward the external cervicalos. Production of mucus is perhaps the most important function of the cervix, and this is discussed at length later in the chapter. Finally, cervical pH is alkaline, with a peak pH during the periovulatory period. This environment is much more hospitable to spermatozoa than the acidic pH of the vagina.

1. Cervical Mucus: Cervical mucus is continuously secreted through exocytosis by the nonciliated epithelial cells that line the cervical canal. This biomaterial serves many important functions, including exclusion of seminal plasma, exclusion of morphologically abnormal sperm, and support of viable sperm for subsequent migration to the uterus and oviduct. It is a heterogeneous fluid with both high- and low-viscosity components. The amount of mucus produced and its composition and characteristics fluctuate with circulating progesterone and estrogen levels. As estrogen levels peak at midcycle, cervical mucus is abundant in volume and thin in consistency because of increased water content.[18](https://www.glowm.com/section_view/item/315#r18) Under the influence of progesterone, water content decreases, and the mucus has a much higher viscosity.

Ultra structurally, cervical mucus can be seen as a complex biphasic fluid with high viscosity and low viscosity components. The high viscosity gel phase is composed of a network of filamentous glycoproteins called *mucin.* Collectively, mucin macromolecules form a complex of interconnected micelles, which comprise a lattice whose interstices are capable of supporting the low viscosity phase, which is predominantly water. Sperm movement through the cervical mucus is primarily through the interstitial spaces between the mucin micelles, and the sperm's progression depends on the size of these spaces. The size of the interstices is usually smaller than the size of the sperm heads; thus, sperm must push their way through the mucus as they proceed through the lower female genital tract.

Another potentially important feature of human cervical mucus is the belief that it is able to restrict migration of human spermatozoa with abnormal morphology. The percentage of spermatozoa with normal morphology in the cervical mucus and in the uterine fluid is significantly higher than usually seen in semen. Quantitatively, these findings have been demonstrated following artificial insemination in which the percentage of sperm with normal morphology from the inseminated specimen was known ahead of time, thus allowing a more accurate comparison of the postinseminate semen within the cervical mucus. These results suggest that spermatozoa with abnormal morphology may be constrained by a process of restricted entry into cervical mucus. Comparison of morphologically normal versus abnormal human sperm in semen has shown that abnormal sperm are less likely to be motile, and those that are motile tend to swim with a lower velocity than normal cells.

1. Sperm motility does not appear to be the only force directing the sperm toward the oviducts, because inert particles deposited within the uterus are transported to the Fallopian tubes.[44](https://www.glowm.com/section_view/item/315#r44) Uterine muscular contractions likely play a role in this process. Unfortunately, much difficulty has been met in attempts to recover and quantify uterine sperm.
2. Fallopian Tube

The adult human Fallopian tube, about 9 to 11 cm long, consists of five distinct segments: the fimbria, infundibulum, ampulla, isthmus, and intramural segment. The epithelial lining of the tube is composed of four cell types: ciliated, secretory, intercalary (peg), and undifferentiated cells. Epithelial cells undergo histologic changes in response to cyclic estrogen and progesterone variations, with the height of the epithelial cells being greatest at the time of the estrogen peak near midcycle. Tubal musculature is organized in a spiral fashion, and at the tubouterine junction these muscles become continuous with the myometrium. Sperm movement through the Fallopian tube relies on a combination of forces: intrinsic sperm motility, tubular muscular contraction, and fluid flow. Tubal fluid production is maximal at the time of ovulation, and this fluid sustains the sperm before fertilization. Tubal fluid may also facilitate both sperm capacitation and acrosomal reaction.

Although the uterotubal junction does not act as a barrier to inert particles, it may serve as an additional functional barrier to sperm with abnormal morphology or motility. The number of sperm that reach the oviduct is many orders of magnitude lower than the total number of sperm in the ejaculate. Although tens of millions to hundreds of millions of sperm are deposited in the vagina at the time of ejaculation, anatomic studies have shown that typically only hundreds of sperm are present in the oviduct at various postcoital timepoints.

1. Capacitation is now commonly regarded as the reversible, prefertilization activation process of sperm which results in the spermatozoa gaining the ability to:

* Develop hyperactivated motility, with vigorous nonlinear flagellar motion
* Bind to the zona pellucida
* Undergo the acrosome reaction
* Proceed eventually to fusion with the oolemma and egg fertilization

Many substances within the female reproductive tract have been examined as potential capacitating factors, but at this time none has been uniquely identified. Nonetheless, we do know that at the molecular level, several key changes are noted to occur in the spermatozoa as a result of capacitation. These changes include:

* Alteration or removal of sperm coating materials. These coating materials become adsorbed to or integrated within the sperm plasma membrane during epididymal transport and also during exposure to seminal plasma
* A decrease in the net negative surface charge
* Changes in the content and location of surface antigens
* Conformational changes to intrinsic membrane proteins
* Changes in the permeability of the membrane to various ions, especially calcium

Capacitation in Human Spermatozoa

Very little is known about human sperm capacitation in the female reproductive tract. We do know that human sperm that are recovered from the cervical mucus and placed into a noncapacitating medium are able to penetrate the zona pellucida of the human oocyte and also fuse with zona-free hamster oocytes. Thus, it appears that human sperm capacitation can occur in the cervical mucus. Because of the inherent difficulty in manipulating and subsequently evaluating the *in vivo* environment of the female reproductive tract, much of what we now know about human sperm capacitation is the result of *in vitro* studies.