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Discuss the factors facilitating the movement of sperm in the female reproductive tract

**Sperm cells** are gametes (sex cells) that are produced in the testicular organ (gonad) of male human beings and animals. Like the female gamete (Oocyte), sperm cells carry a total of 23 chromosomes that are a result of a process known as meiosis. In both animals and human beings, among many other organisms, these cells are involved in the sexual mode of reproduction which involves the interaction of male and female gametes. The general morphology of sperm cells consists of the following parts:

* Distinctive head
* Midpiece (body)
* Tail

A sperm cell consists of a head, body (mid-section) and a tail. Each of these parts is equipped with various molecules and smaller structure that allow the sperm as a whole to function properly.

 **The Sperm Head**

The head is the most important part of the cell given that it contains the nucleus (genetic material with 23 chromosomes) required to form a new organism. Apart from the nucleus, the head is also made up of a several parts that include:

[**Acrosome and Acrosomal Cap**](https://www.microscopemaster.com/acrosome.html)

Together, the two (acrosome and acrosomal cap) make up the acrosomal region. Formed during spermiogenesis, the acrosome is the product of Golgi complex and contains a number of contents such as acrosin enzyme in the acrosomal matrix. Apart from the enzymes, the acrosome also contains such polysaccharides as mannose, hexosmine and galactose.

Once the sperm cell comes in contact with the diffusible molecules from the egg jelly, this stimulates the cell to swim towards the eggs. This recognition of the egg based on molecule composition is known as chemotaxis. Having identified a high concentration of the molecule, the cell swims towards the egg (area of high molecule concentration) and makes physical contact. In turn, physical contact results in acrosome reaction.

**\*** Chemotaxis allows the sperm to navigate towards the eggs through chemical signals. Therefore, this is an important process that ensures that the sperm fertilizes a conspecific egg (within the same species).

**\*** Primary ligands (proteins) located near the acrosome recognize the target gamete.

 **Acrosome Reaction**

The acrosome reaction is an important event that occurs when the sperm comes in contact with oocyte membrane at different sites. For instance, in some animals, sperm contact with zona pellucida on the plasma membrane of the oocyte initiates acrosome reaction. This is a calcium-dependent event that results in exocytosis (action in which cell molecules are released from the cell) of the outer acrosome membrane thus exposing contents (enzymes) of the acrosome. This allows acrosome enzymes (e.g. acrosin) to be released and support sperm entry into the egg. Acrosin/proacrosin, one of the secondary ligands, is involved in lysis of the thick membrane covering the ovum (zona pellucida). Essentially, the enzyme (Acrosin) is stored in the acrosome in an inactive form known as zymogen. The pH level inside the acrosome is lower which causes the enzyme to remain inactive. When it comes in contact with the glycoproteins of the ovum membrane (zona pellucida), the enzyme is converted into acrosin, an active form that is capable of acting on the membrane. This, in turn, allows the sperm cell to penetrate and enter the egg for fertilization to take place.

**\*** Acrosome enzymes are also known as lysosomal enzymes.

[**Nucleus**](https://www.microscopemaster.com/nucleus.html) - The sperm head is the part of the cell that contains the nucleus. The nucleus takes up 65 percent of the head and consists of 23 chromosomes. Once the sperm cell enters the egg, the chromosomes combine with the female gamete to make up 46 chromosomes - It is the total of 46 chromosomes that determine the characteristics of the new organism (fetus etc).

**\*** The sperm head makes up about 10 percent of the entire cell.

**Midpiece**

The midpiece is the central part of the sperm cell between the head and the tail. Like the head, the midpiece makes up about 10 percent of the total sperm length. Unlike the sperm head that carries genetic material, the midpiece contains tightly packed mitochondria that provide the energy requires for swimming. In addition to providing the energy required for swimming, mitochondria is also suggested to play a role in controlled cell death known as apoptosis.

**Centriole**- The centriole is part of the sperm cell located between the head and the midpiece. In a complex referred to as the centriole-centrosome complex, the centriole is involved in the formation of sperm aster and zygote aster. These are essential for movement of the pronuclear for union with the female genome. Moreover, the centriole is involved in the production of mitotic apparatus involved in separating chromosomes during cell division while at the same time being the template for all subsequent centrioles.

**Tail**

The sperm tail is a thin, elongated structure that makes up about 80 percent of the entire length of the sperm. While the tail may appear to be one long continuous structure, it is divided into several parts that include:

Connecting piece – This is the part that connects the flagellum to the sperm head

Midpiece - In some books, the midpiece is described as part of the tail. It contains mitochondria and thus provided the energy required for movement

Principal piece (axial filament)

End piece

 The principal piece and the end piece of the flagella help generate the waveform that allows for movement.

**Motility**

Motility is one of the main characteristics of a well-developed sperm cell. In mammals, two types of physiological motility have been identified.

These include: **Activated motility** - This is the type observed in the early stages of motility (in the epididymis as well as freshly ejaculated sperm). In this type of motility, the sperm's flagella beat gently from one side to another as the cell moves along what may appear to be a straight path.

**Hyperactivated motility** (hyperactivation) - Hyperactivated motility is the second type of physiological motility. Compared to activated motility, this type of motility occurs is in the female reproductive tract (site of fertilization). Hyperactivated motility is also more erratic, with the flagellum depicting a symmetrical, lower-amplitude waveform. Due to the erratic pattern of motion in hyperactivated motility, more energy is used for movement.

**\*** Hyperactivated motility serves to prevent the sperm cell from getting trapped, propelling through the reproductive tract (of the female) as well as enhancing sperm penetration into the egg (oocyte).

**\*** Motility is only possible if the flagellum is well developed and fully functional and if the cell has a source of energy to support movement.

**\*** Sperm cells have been shown to swim at an average rate of 3mm a minute.

**Axoneme and Molecular Mechanism of Motility**

The axoneme is the central strand of the tail (flagellum). It is one of the main structures of the flagellum and is commonly known as the motility motor. The axoneme is made up of structures referred to as microtubule doublets (containing inner and outer axonemal dynein) and a central pair (9+2 structure) and extends from the connecting piece of the tail to the end piece.Within the flagellum (tail), the microtubules (nine microtubule doublets) are connected by nexin links. In addition, they are linked to the central pair through radial spokes. These projections (radial spokes) also play an important role of aligning the microtubules around the central pair.During motion, dynein in the microtubules causes the microtubule to slide in relation to the adjacent microtubules, which promote motility. With the energy provided from the mitochondria (ATP energy), axonemal moves towards the flagellum base, which causes the microtubule to slide down. Given that the microtubules are connected to the connecting piece located behind the head, there is some resistance to the movement which in turn causes the flagellum to bend. Through this action, the flagellum forms a whip like bend.

Movement, however, is promoted by several other actions that include:

Detachment of the dynein from an adjacent microtubule

The processes take place at one side of the axoneme