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Question

DISCUS THE FACTORS FACILITATING THE MOVEMENT OF SPERM IN THE FEMALE REPRODUCTIVE TRACT

Sperm motility describes the ability of sperm to move properly through the female reproductive tract to reach the egg. Sperm motility can also be thought of as the quality, which is a factor in successful conception; sperm that do not "swim" properly will not reach the egg in order to fertilize it

Key factors facilitating the migration of sperm cells to the female reproductive tract are :

1. 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.

2. A decrease in the net negative surface charge

3. Changes in the content and location of surface antigens

4. Conformational changes to intrinsic membrane proteins.

5. 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.

pH

Sperm transport within the female reproductive tract is a cooperative effort between the functional properties of the sperm and seminal fluid on the one hand and cyclic adaptations of the female reproductive tract that facilitate the transport of sperm toward the ovulated egg. Sperm transport in the female reproductive system involves the penetration by the sperm of various barriers along their way toward the egg. During coitus in the human, semen is deposited in the upper vagina close to the cervix. The normal environment of the vagina is inhospitable to the survival of sperm, principally because of its low pH (<5.0). The low pH of the vagina is a protective mechanism for the woman against many sexually transmitted pathogens, because no tissue barrier exists between the vagina outside and the peritoneal cavity inside. The acidic pH of the vagina is bacteriocidal and is the reflection of an unusual functional adaptation of the vaginal epithelium. Alone among the stratified squamous epithelia in the body, the cells of the vaginal lining contain large amounts of glycogen. Anaerobic lactobacilli within the vagina break down the glycogen from shed vaginal epithelial cells, with the production of lactic acid as a byproduct. The lactic acid is responsible for the lowered vaginal pH.

Sperm Membrane Changes

The sperm plasma membrane is composed of a lipid bilayer interspersed with a number of proteins. Lipid types present include cholesterol, glycolipids, and phospholipids. The proteins found here can traverse the entire membrane from cytosolic compartment to extracellular space. These proteins have important functions, including activation of receptors and transport of ions.

The Acrosome Reaction

The mature human ovum possesses a number of surrounding layers that must be penetrated by the spermatozoa for normal fertilization to occur. To assist with this task, the spermatozoa has a caplike region called the acrosome covering the anterior 80% of its head. This structure contains a number of digestive enzymes, such as hyaluronidase, corona-penetrating enzyme, and acrosin to facilitate membrane fusion and sperm entry into the ovum.

Ultrastructurally, the acrosome reaction involves regional fusion of areas of the outer acrosomal membrane and the overlying sperm plasma membrane. These fused areas then lyse, serving as portals through which soluble contents of the acrosome can be dispersed to act on the vestments of the ovum.

The acrosome reaction is initiated as the spermatozoa arrives at the ovum. The outermost covering of the ovum, the cumulus oophorus, is degraded by hyaluronidase located on the plasma membrane of the spermatozoa. Subsequently, corona-penetrating enzyme is released to facilitate spermatozoal transit through the corona radiata. After transit through the corona radiata is completed, the sperm binds to the zona pellucida. Next, proacrosin, a zymogen within the acrosomal region, is converted to acrosin, and this facilitates breakdown of the zona pellucida glycoproteins. For this biologic process to occur, the spermatozoa plasma membrane and the outer acrosomal membrane must be removed. This, in essence, is the hallmark of the acrosomal reaction. After the spermatozoa has proceeded through the zona pellucida, the sperm head crosses the perivitelline space and attaches to the cell membrane of the ovum. Subsequently, the sperm and ovum plasma membranes fuse, transcript

The acrosome reaction is a key component of the fertilization process, and its proper timing is essential. Inappropriately early release of the acrosomal enzymes within the female reproductive tract would result in spermatozoa being unable to fertilize. Initiation of the acrosome reaction seems to hinge specifically on spermatozoal binding to the zona pellucida. Although the human model is not entirely understood, the murine model has been extensively studied. With the murine model, spermatozoal exposure and binding to the structural zona glycoproteins, ZP3 (zona pellucida protein #3) have been identified as the molecule that sets the events of the acrosome reaction into motion.

After this binding has occurred, several changes follow:

Influx of calcium into the spermatozoa