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Biomedical engineering

Physiology assignment

Mechanisms of mammalian sperm migration through the female reproductive tract.

The perspective is biophysical as well as biochemical and morphological, and the focus is upon the role of sperm motility in these processes. Sperm forward progression is characterized as an interactive process between the cell and its environment, and the mediation of flagellar bend propagation by the physical properties of its surroundings is described. These properties, together with flagellar beat kinematics, sperm morphology, and surface properties, determine the magnitude of the forces generated by sperm and their consequent rate of progression. Sperm interactions with the cervical mucus, the cumulus oophorus, and the zona pellucida are described.

The poorly understood affinity of the sperm surface for the macromolecules of the mucus, cumulus, and zona is stressed, as is the viscoelastic structural mechanical resistance of these biopolymers to sperm motion. The kinematics and consequences of hyperactivated sperm motion are presented, with emphasis on objective characterization of such motion (as a biomarker), along with analysis of the mechanical advantage that such motion may confer on spermatozoa during egg-vestment interaction.

At coitus, human sperm are deposited into the anterior vagina, where, to avoid vaginal acid and immune responses, they quickly contact cervical mucus and enter the cervix. Cervical mucus filters out sperm with poor morphology and motility and as such only a minority of ejaculated sperm actually enter the cervix. In the uterus, muscular contractions may enhance passage of sperm through the uterine cavity. A few thousand sperm swim through the uterotubal junctions to reach the Fallopian tubes (uterine tubes, oviducts) where sperm are stored in a reservoir, or at least maintained in a fertile state, by interacting with endosalpingeal (oviductal) epithelium.

As the time of ovulation approaches, sperm become capacitated and hyperactivated, which enables them to proceed towards the tubal ampulla. Sperm may be guided to the oocyte by a combination of thermotaxis and chemotaxis. Motility hyperactivation assists sperm in penetrating mucus in the tubes and the cumulus oophorus and zona pellucida of the oocyte, so that they may finally fuse with the oocyte plasma membrane.

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