MICROFLUIDIC SPERM SELECTION

Microfluidic Sperm Selection, Microfluidic Sperm Sorting

A technique where microfluidics separate spermatozoa based largely on their density or motility characteristics.

About Microfluidic sperm selection

The mammalian oviduct and uterus under physiological conditions have been studied to aid the design of microfluidic systems (microtechnology) for reproduction techniques.

The oviduct consists of three segments, each with different functions: the uterotubal junction, the isthmus, and the ampulla. The uterotubal junction provides a barrier to infectious microbes that might enter the oviduct from the uterus. The isthmus serves as a sperm storage organ and the ampulla provides an environment conducive to fertilization and early embryonic development. The embryos' motion is caused by peristaltic movement, and non-motile sperm are washed out from the oviduct.

In ART (assisted reproductive technology), selection and sorting of motile sperm are routine processes. Some procedures may take up to 2h for semen processing by conventional protocols, such as density gradient centrifugation and subsequent swim-up. To reduce treatment times and physical damage induced by centrifugation, microfluidic sperm sorting (MFSS) chip devices have been developed for selecting motile sperm for use in ART. Sperm are sorted on the basis of their ability to swim across the streamline into the medium stream, and hence only motile sperm are recovered.

Microfluidic devices (Pic. 1) are powerful tools for handling reproductive cells, because the sizes of these cells are in the micrometer range. A microfluidic device was designed and fabricated to quantify the distribution of sperm in the cross-sectional area of a microchannel. The device consisted of a vertical and a horizontal layer. The vertical layer contained an inlet and a microchannel. The semi-circular inlet served as a guide for sperm to swim into the microchannel. The vertical layer was aligned with the horizontal layer such that the microchannel cross-section was located at the center of the observation. The vertical channel exits into a cylindrical chamber in the horizontal layer. This chamber leads to eight trap reservoirs which use ratchet shape geometries to prevent sperm from re-entering the chamber. The ratchets are arrowhead-shaped with a concave sections around their entrance to redirect sperm back in to the trap, ensuring a unidirectional flux of the cells into the traps.

Success or failure factors

Using an MFSS device, embryologists can perform a 1-step sorting protocol without centrifugation and complete processing within 30 min. Reducing the treatment time and eliminating the centrifugation step minimizes the exposure of sperm to concentrated reactive oxygen species (ROS) and prevents DNA fragmentation.

Complications

Micro-well structures such as micro-grippers are used for single cell manipulation without damage to the cells.
Prognosis

Microfluidic sperm selection is an ideal method for patients which have problems with sperms. Patients with poor sperm motility and morphology benefit from this technology because the immotile sperm are sorted out. This method also decreases sperm DNA fragmentation and DNA damage which is responsible for failure of development of embryos. Studies have shown that DNA defects leads to lower blastocyst formation and implantation rates. This method can reduce the IVF failure.

Gallery

Pic

Schematic view of the device: a microchannel is vertically aligned with an observation chamber in the horizontal layer.

Sources

“Sperm selection in natural conception: what can we learn from Mother Nature to improve assisted reproduction outcomes” [http://humupd.oxfordjournals.org/content/early/2015/09/19/humupd.dmy042.full] — by Sakkas et al. licensed under CC BY 4.0

“Predominance of sperm motion in corners” [http://www.nature.com/articles/srep26669] — by Nosrati et al. licensed under CC BY 4.0
