Nurturing and improving quality of oocytes in the IVF laboratory

Laura Rienzi
GENERA Centres for Reproductive Medicine, Italy

The female gamete plays a crucial role in determining embryo competence and therefore in vitro fertilization results. Oocyte quality is not only influenced by the nuclear and mitochondrial genome, but also by the microenvironment provided by the ovary and the pre-ovulatory follicle that influences transcription and translation, and as a consequence, cytoplasmic maturity. In contrast to in vivo processes, the application of ovarian hormone stimulation protocols for in vitro fertilization bypasses the complicated selection procedure that usually occurs during oocyte development and maturation of a single oocyte for ovulation, and allows for the maturation of many oocytes, often with compromised quality.

Once in the lab, nuclear and cytoplasmic oocyte maturation should be already completed and the intrinsic oocyte quality already established. Therefore, the main role of the embryologist is to select the best oocyte for insemination and to preserve the oocyte competence, ensuring it optimal conditions to develop. Owing to the complex mechanisms related to oocyte maturation and acquisition of competence, it is unlikely that a single morphological characteristic can adequately reflect the quality of the cell. In order to obtain information about the competence of the oocyte, morphological assessment should be combined with other approaches (i.e. cumulus–corona cell gene expression, metabolomics and oxygen consumption).
Further predictive value could be obtained by combining the oocyte evaluation with evaluation of preimplantation development.

Once fertilized, the oocyte requires a vast supply of energy to support critical events such as spindle formation, chromatid separation, and cell division. Until blastocyst implantation, the developing zygote is dependent on the existing pool of mitochondria. However, mitochondria obtained from oocytes of women of advanced reproductive age harbor DNA deletions and nucleotide variations that impair function. Methods to improve oocyte quality in the lab (i,e. mitochondrial supplementation by donor cytoplasmic transfer) have been evaluated in animal studies; however, many safety concerns arising from the potential of two distinct populations of mitochondrial genomes in the offspring have prevented the clinical application of this procedure.