

Role of Lactate in Metabolic Regulation and Fertilization Competence of Bovine Sperm

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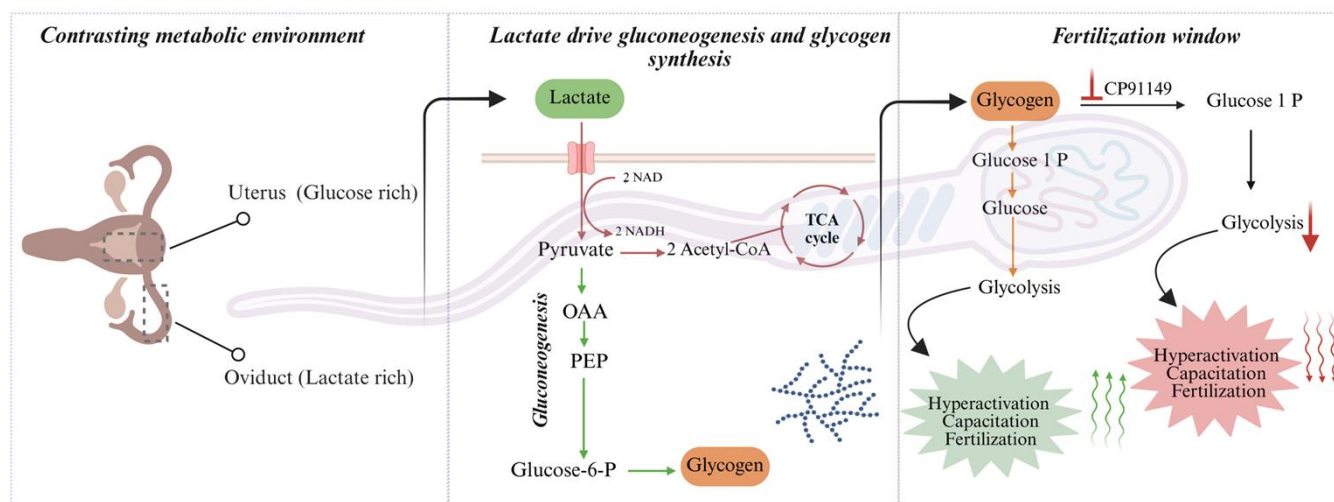
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Abstract

Successful fertilization requires sperm to balance preservation and activation while traversing the female reproductive tract. In cattle, the oviduct is lactate-rich but glucose-limited, raising the question of how sperm maintain function when glycolysis is essential for fertilization. This thesis shows that lactate suppresses glycolysis and shifts metabolism toward oxidative phosphorylation, thereby maintaining linear motility, mitochondrial function, and acrosome integrity. Lactate also promotes endogenous glycogen accumulation and reveals that bovine sperm possess enzymes required for gluconeogenic glycogen synthesis and glycogen mobilization. Following lactate pretreatment and substrate withdrawal, sperm display increased glycolytic activity, hyperactivation-like motility, and improved fertilization rates under glucose-free IVF conditions, whereas blocking glycogen mobilization impairs these responses. Together, these findings support a lactate-driven gluconeogenic–glycogen axis that preserves sperm during transport and prepares them for later activation. This work provides a new framework for bovine sperm metabolic plasticity and has implications for IVF, semen preservation, and fertility management in cattle.



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