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Review

Second Messengers, Steroids and Signaling Cascades: Crosstalk in Sperm Development and Function

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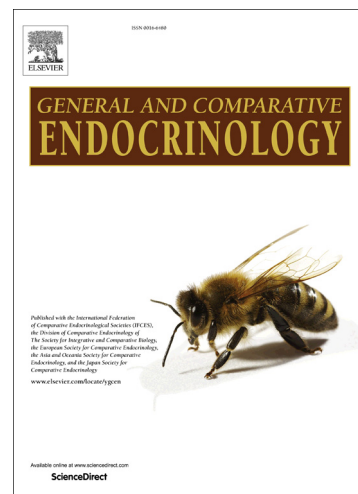
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1 **Second Messengers, Steroids and Signaling Cascades: Crosstalk in Sperm Development and**  
2 **Function**

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6 **Abstract:**

7 Signaling cascades control numerous aspects of sperm physiology, ranging from creation to  
8 fertilization. Novel aspects of several kinases and their influence on sperm development will be  
9 discussed in the first section and cover proliferation, chromatin remodeling and morphology.  
10 In the second section, protein kinases (A, B and C)<sup>1</sup> that affect sperm function and their  
11 regulation by second messengers, cyclic-AMP and phosphoinositides, as well as steroids will be  
12 featured. Key areas of integration will be presented on the topics of sperm motility,  
13 capacitation, acrosome reaction and fertilization.

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<sup>1</sup> List of Abbreviations: AC, Adenylyl cyclase; AKT, Protein kinase B; AMPK, AMP-activated protein kinase; AnR, Androgen receptor; ARF6, ADP ribosylation factor 6; CaMK, Ca<sup>2+</sup>-calmodulin dependent kinase; CaMKK, CaMK kinase; cAMP, Cyclic adenosine 3',5'-monophosphate; CDK5, Cyclin-dependent kinase 5; CFTR, Cystic fibrosis transmembrane conductance regulator; CREB, cAMP-response element (CRE) binding protein; CREM, CRE modulator; Ck2, Casein kinase II; DAPK-3, Death-associated protein kinase-3; DHT, Dihydrotestosterone; EGFR, Epidermal growth factor receptor; Epac, Exchange protein directly activated by cAMP; ER, Estrogen receptor; ERK/MAPK, Extracellular signal-regulated protein kinases or Mitogen-activated protein kinases; FAK, Focal adhesion kinase; GABA,  $\gamma$ -aminobutyric acid; GSK3, Glycogen synthase kinase-3; IGF, Insulin-like growth factor; IGF1R, IGF-1 Receptor; IP3, Inositol 1,4,5-trisphosphate; JNK1, c-Jun N-terminal kinase; MARCKS, Myristoylated alanine-rich C-kinase substrate; MEK, MAPK kinase; MRP4, Multidrug resistance associated protein 4; Nek2, Never-in-Mitosis (NIMA)-related kinase 2; NO, Nitric oxide; NOS, Nitric oxide synthase; Odf, Outer dense fibers; P4, Progesterone; PDGF, Platelet-derived growth factor; PDK1, Phosphoinositide-dependent kinase 1; PI(3,4,5)P3, Phosphatidylinositol-3,4,5-trisphosphate; PI3K, Phosphoinositide-3 kinase; PIP(2), Phosphatidylinositol 4,5-bisphosphate; PKA, Protein Kinase A; PKC, Protein Kinase C; PLC, Phospholipase C; PLD, Phospholipase D; PTEN, Phosphatase and tensin homologue deleted on chromosome 10; PTP, Protein tyrosine phosphorylation; PTP-PEST, Protein tyrosine phosphatase/ proline-glutamic acid-serine-threonine; PYK2, Proline-rich tyrosine kinase 2; RAPGEF, Rap guanine nucleotide exchange factor; ROS, Reactive oxygen species; Rsk2, Ribosomal S6 kinase; StAR, Steroidogenic acute regulatory protein; Syk, Spleen tyrosine kinase; TCP10L, Transcription factor T-complex 10 like; ZIP kinase, Zipper interacting protein kinase

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