1. Phylogeny  
   Proto‐oncogene serine/threonine‐protein kinase Mos (c‐Mos, MOS; UniProt P00540) is a highly conserved kinase expressed in the oocytes of diverse vertebrate species, including amphibians such as Xenopus laevis and mammals such as mice and humans (cao2020positivefeedbackstimulation pages 1-2, kishimoto2018mpfbasedmeioticcell pages 12-13). It is classified within the serine/threonine kinase family and occupies an evolutionarily ancient branch of the kinome—a group of regulators of the mitogen‐activated protein kinase (MAPK) cascade—that appears to have diverged early in metazoan evolution (charlesworth2006musashiregulatesthe pages 1-2, kishimoto2018mpfbasedmeioticcell pages 12-13).
2. Reaction Catalyzed  
   Mos catalyzes the transfer of the γ‐phosphate group from ATP to specific serine or threonine hydroxyl groups on target proteins, thereby converting ATP to ADP and generating phosphorylated protein substrates (cao2020positivefeedbackstimulation pages 1-2, russo2009kickedbymos pages 13-13).
3. Cofactor Requirements  
   The kinase activity of Mos is dependent on the presence of ATP and requires divalent cations—most notably Mg²⁺—which coordinate ATP binding in the catalytic cleft and enable efficient phosphate transfer (qian2001thepololikekinase pages 7-8, cao2020positivefeedbackstimulation pages 1-2).
4. Substrate Specificity  
   Mos exhibits substrate specificity toward regulatory proteins that are integral to the MAPK cascade and cell cycle control. In particular, it phosphorylates key components such as MAP kinase kinase 1 (MEK1) to initiate downstream activation of ERK1/2, and it has been implicated in the phosphorylation of proteins such as CPEB1 and Xe‐Wee1 in oocyte models (cao2020positivefeedbackstimulation pages 1-2, murakami1999mospositivelyregulates pages 2-3). Although a strict consensus motif is not explicitly defined in the available literature, Mos is known to target serine/threonine residues within substrates that regulate meiotic progression (murakami1999mospositivelyregulates pages 2-3).
5. Structure  
   Mos is characterized by a central catalytic kinase domain that harbors well‐conserved motifs—including VAIK, HLD, and DFG—which are essential for ATP binding and the catalytic transfer of phosphate groups (stroehlein2016analysesofcompact pages 7-7). Structural models indicate that Mos adopts a canonical kinase fold featuring an activation loop, a C‐helix, and a hydrophobic spine that collectively contribute to its enzymatic activity (russo2009kickedbymos pages 3-4). In addition to its catalytic core, Mos possesses less conserved regulatory regions that may influence its localization and protein–protein interactions during oocyte maturation (stroehlein2016analysesofcompact pages 7-8).
6. Regulation  
   Mos is stringently regulated at both the translational and post‐translational levels. Its mRNA is stored in oocytes in a dormant state until hormonal cues—such as progesterone stimulation—trigger cytoplasmic polyadenylation via cis‐acting elements (CPEs and PREs) in the 3′‐UTR. This translational activation is mediated by RNA‐binding proteins such as CPEB1 and Musashi, which enable timely MOS protein synthesis during oocyte maturation (cao2020positivefeedbackstimulation pages 4-6, charlesworth2006musashiregulatesthe pages 5-5). Post‐translationally, Mos undergoes phosphorylation at defined residues (for example, at Ser-3 and Ser-105), which modulate its catalytic efficiency and stability. These phosphorylation events are part of positive feedback loops involving downstream MAPK and maturation promoting factor (MPF) activities that ultimately safeguard the steady accumulation of MOS during meiosis while ensuring its rapid degradation following fertilization (russo2009kickedbymos pages 2-3, murakami1999mospositivelyregulates pages 11-12).
7. Function  
   Mos functions as an essential activator of the MAPK/ERK signaling cascade during oocyte maturation. Following germinal vesicle breakdown, de novo synthesis of MOS protein drives the phosphorylation of MEK1; this event propagates through the cascade to activate ERK1/2, ultimately leading to proper meiotic spindle assembly, chromosomal segregation, and the maintenance of metaphase II arrest (cao2020positivefeedbackstimulation pages 1-2, kalab1996activationofp90rsk pages 6-8). In Xenopus oocytes, Mos additionally mediates regulatory crosstalk with cell cycle components, such as by modulating Xe‐Wee1 activity, thereby contributing to the precise timing of cell cycle transitions during early embryonic development (murakami1999mospositivelyregulates pages 2-3, kishimoto2018mpfbasedmeioticcell pages 20-21).
8. Other Comments  
   To date, no small‐molecule inhibitors have been reported that specifically target Mos; rather, its signaling can be indirectly modulated through inhibitors of upstream or downstream kinases in the MAPK pathway, such as the MEK inhibitor U0126 or the CDK inhibitor roscovitine (russo2009kickedbymos pages 11-12, qian2001thepololikekinase pages 3-5). Abnormal regulation of Mos has been associated with defects in oocyte maturation and has been implicated in certain forms of female infertility—as observed in conditions involving mutated PATL2 that lead to decreased MOS translation (cao2021therecurrentmutation pages 8-10). Furthermore, owing to its proto–oncogene status, dysregulation of Mos in somatic cells may contribute to oncogenic transformation, although detailed disease associations remain to be fully elucidated (russo2009kickedbymos pages 11-12, murakami1999mospositivelyregulates pages 2-3).
9. References
10. Cao, L.-R., Jiang, J.-C., & Fan, H.-Y. “Positive feedback stimulation of ccnb1 and mos mrna translation by mapk cascade during mouse oocyte maturation.” Frontiers in Cell and Developmental Biology, Nov 2020, doi:10.3389/fcell.2020.609430. (cao2020positivefeedbackstimulation pages 1-2, 4-6, 6-9)
11. Charlesworth, A., Wilczynska, A., Thampi, P., Cox, L. L., & MacNicol, A. M., “Musashi regulates the temporal order of mrna translation during xenopus oocyte maturation.” The EMBO Journal, Jun 2006, doi:10.1038/sj.emboj.7601159. (charlesworth2006musashiregulatesthe pages 1-2, 2-3, 5-5, 8-9)
12. Kalab, P., Kubiak, J. Z., Verlhac, M.-H., Colledge, W. H., & Maro, B., “Activation of p90rsk during meiotic maturation and first mitosis in mouse oocytes and eggs: map kinase-independent and -dependent activation.” Development, Jun 1996, doi:10.1242/dev.122.6.1957. (kalab1996activationofp90rsk pages 1-2, 6-8, 8-8)
13. Kishimoto, T., “Mpf-based meiotic cell cycle control: half a century of lessons from starfish oocytes.” Proceedings of the Japan Academy. Series B, Apr 2018, doi:10.2183/pjab.94.013. (kishimoto2018mpfbasedmeioticcell pages 12-13, 20-21, 22-23)
14. Li, R., Chen, D.-F., Zhou, R., Jia, S.-N., Yang, J.-S., Clegg, J. S., & Yang, W.-J., “Involvement of polo-like kinase 1 (plk1) in mitotic arrest by inhibition of mek-erk-rsk1 cascade.” Journal of Biological Chemistry, May 2012, doi:10.1074/jbc.m111.312413. (li2012involvementofpololikekinase pages 12-13)
15. Murakami, M., Copeland, T., & Vande Woude, G. V., “Mos positively regulates xe-wee1 to lengthen the first mitotic cell cycle of xenopus.” Genes & Development, Mar 1999, doi:10.1101/gad.13.5.620. (murakami1999mospositivelyregulates pages 1-2, 2-3, 10-11, 11-12)
16. Russo, C., Beaujois, R., Bodart, J.-F., & Blossey, R., “Kicked by mos and tuned by mpf—the initiation of the mapk cascade in xenopus oocytes.” HFSP Journal, Dec 2009, doi:10.2976/1.3265771. (russo2009kickedbymos pages 1-2, 2-3, 3-4, 6-8, 8-10, 11-12, 12-13, 13-13, 4-6)
17. Suzuki, T., Suzuki, E., Yoshida, N., Kubo, A., Li, H., Okuda, E., Amanai, M., & Perry, A. C., “Mouse emi2 as a distinctive regulatory hub in second meiotic metaphase.” Development, Oct 2010, doi:10.1242/dev.052480. (suzuki2010mouseemi2as pages 10-11, 11-11, 3-4)
18. Qian, Y.-W., Erikson, E., Taieb, F. E., & Maller, J. L., “The polo-like kinase plx1 is required for activation of the phosphatase cdc25c and cyclin b-cdc2 in xenopus oocytes.” Molecular Biology of the Cell, Jun 2001, doi:10.1091/mbc.12.6.1791. (qian2001thepololikekinase pages 7-8, 8-9, 9-9, 3-5, 5-7)
19. Stroehlein, A. J., Young, N. D., Korhonen, P. K., Chang, B. C. H., Sternberg, P. W., La Rosa, G., Pozio, E., & Gasser, R. B., “Analyses of compact trichinella kinomes reveal a mos-like protein kinase with a unique n-terminal domain.” G3 Genes|Genomes|Genetics, Sep 2016, doi:10.1534/g3.116.032961. (stroehlein2016analysesofcompact pages 7-7, 7-8)
20. Cao, Q., Zhao, C., Wang, C., Cai, L., Xia, M., Zhang, X., Han, J., Xu, Y., Zhang, J., Ling, X., Ma, X., & Huo, R., “The recurrent mutation in patl2 inhibits its degradation thus causing female infertility characterized by oocyte maturation defect through regulation of the mos-mapk pathway.” Frontiers in Cell and Developmental Biology, Feb 2021, doi:10.3389/fcell.2021.628649. (cao2021therecurrentmutation pages 8-10)
21. Cargnello, M., & Roux, P. P., “Activation and function of the mapks and their substrates, the mapk-activated protein kinases.” Microbiology and Molecular Biology Reviews, Mar 2011, doi:10.1128/mmbr.00031-10. (cargnello2011activationandfunction pages 19-20)

References

1. (cao2020positivefeedbackstimulation pages 1-2): Lan-Rui Cao, Jun-Chao Jiang, and Heng-Yu Fan. Positive feedback stimulation of ccnb1 and mos mrna translation by mapk cascade during mouse oocyte maturation. Frontiers in Cell and Developmental Biology, Nov 2020. URL: https://doi.org/10.3389/fcell.2020.609430, doi:10.3389/fcell.2020.609430. This article has 34 citations and is from a peer-reviewed journal.
2. (cao2020positivefeedbackstimulation pages 4-6): Lan-Rui Cao, Jun-Chao Jiang, and Heng-Yu Fan. Positive feedback stimulation of ccnb1 and mos mrna translation by mapk cascade during mouse oocyte maturation. Frontiers in Cell and Developmental Biology, Nov 2020. URL: https://doi.org/10.3389/fcell.2020.609430, doi:10.3389/fcell.2020.609430. This article has 34 citations and is from a peer-reviewed journal.
3. (kalab1996activationofp90rsk pages 6-8): Petr Kalab, Jacek Z. Kubiak, Marie-Hélène Verlhac, William H. Colledge, and Bernard Maro. Activation of p90rsk during meiotic maturation and first mitosis in mouse oocytes and eggs: map kinase-independent and -dependent activation. Development, 122:1957-1964, Jun 1996. URL: https://doi.org/10.1242/dev.122.6.1957, doi:10.1242/dev.122.6.1957. This article has 85 citations and is from a domain leading peer-reviewed journal.
4. (kishimoto2018mpfbasedmeioticcell pages 12-13): T Kishimoto. Mpf-based meiotic cell cycle control: half a century of lessons from starfish oocytes. Proceedings of the Japan Academy. Series B, Physical and Biological Sciences, 94:180-203, Apr 2018. URL: https://doi.org/10.2183/pjab.94.013, doi:10.2183/pjab.94.013. This article has 50 citations.
5. (kishimoto2018mpfbasedmeioticcell pages 20-21): T Kishimoto. Mpf-based meiotic cell cycle control: half a century of lessons from starfish oocytes. Proceedings of the Japan Academy. Series B, Physical and Biological Sciences, 94:180-203, Apr 2018. URL: https://doi.org/10.2183/pjab.94.013, doi:10.2183/pjab.94.013. This article has 50 citations.
6. (murakami1999mospositivelyregulates pages 2-3): M. Murakami, T. Copeland, and G. V. Vande Woude. Mos positively regulates xe-wee1 to lengthen the first mitotic cell cycle of xenopus. Genes & development, 13 5:620-31, Mar 1999. URL: https://doi.org/10.1101/gad.13.5.620, doi:10.1101/gad.13.5.620. This article has 49 citations.
7. (russo2009kickedbymos pages 11-12): C. Russo, R. Beaujois, J.‐F. Bodart, and R. Blossey. Kicked by mos and tuned by mpf—the initiation of the mapk cascade inxenopusoocytes. HFSP Journal, 3:428-440, Dec 2009. URL: https://doi.org/10.2976/1.3265771, doi:10.2976/1.3265771. This article has 12 citations.
8. (russo2009kickedbymos pages 13-13): C. Russo, R. Beaujois, J.‐F. Bodart, and R. Blossey. Kicked by mos and tuned by mpf—the initiation of the mapk cascade inxenopusoocytes. HFSP Journal, 3:428-440, Dec 2009. URL: https://doi.org/10.2976/1.3265771, doi:10.2976/1.3265771. This article has 12 citations.
9. (russo2009kickedbymos pages 3-4): C. Russo, R. Beaujois, J.‐F. Bodart, and R. Blossey. Kicked by mos and tuned by mpf—the initiation of the mapk cascade inxenopusoocytes. HFSP Journal, 3:428-440, Dec 2009. URL: https://doi.org/10.2976/1.3265771, doi:10.2976/1.3265771. This article has 12 citations.
10. (suzuki2010mouseemi2as pages 10-11): Toru Suzuki, Emi Suzuki, N. Yoshida, Atsuko Kubo, Hongmei Li, Erina Okuda, Manami Amanai, and A. C. Perry. Mouse emi2 as a distinctive regulatory hub in second meiotic metaphase. Development, 137:3281-3291, Oct 2010. URL: https://doi.org/10.1242/dev.052480, doi:10.1242/dev.052480. This article has 94 citations and is from a domain leading peer-reviewed journal.
11. (charlesworth2006musashiregulatesthe pages 1-2): Amanda Charlesworth, Anna Wilczynska, Prajitha Thampi, Linda L Cox, and Angus M MacNicol. Musashi regulates the temporal order of mrna translation during xenopus oocyte maturation. The EMBO Journal, Jun 2006. URL: https://doi.org/10.1038/sj.emboj.7601159, doi:10.1038/sj.emboj.7601159. This article has 198 citations.
12. (charlesworth2006musashiregulatesthe pages 5-5): Amanda Charlesworth, Anna Wilczynska, Prajitha Thampi, Linda L Cox, and Angus M MacNicol. Musashi regulates the temporal order of mrna translation during xenopus oocyte maturation. The EMBO Journal, Jun 2006. URL: https://doi.org/10.1038/sj.emboj.7601159, doi:10.1038/sj.emboj.7601159. This article has 198 citations.
13. (kalab1996activationofp90rsk pages 1-2): Petr Kalab, Jacek Z. Kubiak, Marie-Hélène Verlhac, William H. Colledge, and Bernard Maro. Activation of p90rsk during meiotic maturation and first mitosis in mouse oocytes and eggs: map kinase-independent and -dependent activation. Development, 122:1957-1964, Jun 1996. URL: https://doi.org/10.1242/dev.122.6.1957, doi:10.1242/dev.122.6.1957. This article has 85 citations and is from a domain leading peer-reviewed journal.
14. (murakami1999mospositivelyregulates pages 1-2): M. Murakami, T. Copeland, and G. V. Vande Woude. Mos positively regulates xe-wee1 to lengthen the first mitotic cell cycle of xenopus. Genes & development, 13 5:620-31, Mar 1999. URL: https://doi.org/10.1101/gad.13.5.620, doi:10.1101/gad.13.5.620. This article has 49 citations.
15. (murakami1999mospositivelyregulates pages 11-12): M. Murakami, T. Copeland, and G. V. Vande Woude. Mos positively regulates xe-wee1 to lengthen the first mitotic cell cycle of xenopus. Genes & development, 13 5:620-31, Mar 1999. URL: https://doi.org/10.1101/gad.13.5.620, doi:10.1101/gad.13.5.620. This article has 49 citations.
16. (qian2001thepololikekinase pages 7-8): Yue-Wei Qian, Eleanor Erikson, Frédéric E. Taieb, and James L. Maller. The polo-like kinase plx1 is required for activation of the phosphatase cdc25c and cyclin b-cdc2 inxenopusoocytes. Molecular Biology of the Cell, 12:1791-1799, Jun 2001. URL: https://doi.org/10.1091/mbc.12.6.1791, doi:10.1091/mbc.12.6.1791. This article has 224 citations and is from a domain leading peer-reviewed journal.
17. (russo2009kickedbymos pages 1-2): C. Russo, R. Beaujois, J.‐F. Bodart, and R. Blossey. Kicked by mos and tuned by mpf—the initiation of the mapk cascade inxenopusoocytes. HFSP Journal, 3:428-440, Dec 2009. URL: https://doi.org/10.2976/1.3265771, doi:10.2976/1.3265771. This article has 12 citations.
18. (russo2009kickedbymos pages 2-3): C. Russo, R. Beaujois, J.‐F. Bodart, and R. Blossey. Kicked by mos and tuned by mpf—the initiation of the mapk cascade inxenopusoocytes. HFSP Journal, 3:428-440, Dec 2009. URL: https://doi.org/10.2976/1.3265771, doi:10.2976/1.3265771. This article has 12 citations.
19. (stroehlein2016analysesofcompact pages 7-7): Andreas J Stroehlein, Neil D Young, Pasi K Korhonen, Bill C H Chang, Paul W Sternberg, Giuseppe La Rosa, Edoardo Pozio, and Robin B Gasser. Analyses of compact trichinella kinomes reveal a mos-like protein kinase with a unique n-terminal domain. G3 Genes|Genomes|Genetics, 6:2847-2856, Sep 2016. URL: https://doi.org/10.1534/g3.116.032961, doi:10.1534/g3.116.032961. This article has 8 citations.
20. (stroehlein2016analysesofcompact pages 7-8): Andreas J Stroehlein, Neil D Young, Pasi K Korhonen, Bill C H Chang, Paul W Sternberg, Giuseppe La Rosa, Edoardo Pozio, and Robin B Gasser. Analyses of compact trichinella kinomes reveal a mos-like protein kinase with a unique n-terminal domain. G3 Genes|Genomes|Genetics, 6:2847-2856, Sep 2016. URL: https://doi.org/10.1534/g3.116.032961, doi:10.1534/g3.116.032961. This article has 8 citations.
21. (cao2021therecurrentmutation pages 8-10): Qiqi Cao, Chun Zhao, Congjing Wang, Lingbo Cai, Meng Xia, Xiaolan Zhang, Jian Han, Yangyang Xu, Junqiang Zhang, Xiufeng Ling, Xiang Ma, and Ran Huo. The recurrent mutation in patl2 inhibits its degradation thus causing female infertility characterized by oocyte maturation defect through regulation of the mos-mapk pathway. Frontiers in Cell and Developmental Biology, Feb 2021. URL: https://doi.org/10.3389/fcell.2021.628649, doi:10.3389/fcell.2021.628649. This article has 28 citations and is from a peer-reviewed journal.
22. (cargnello2011activationandfunction pages 19-20): Marie Cargnello and Philippe P. Roux. Activation and function of the mapks and their substrates, the mapk-activated protein kinases. Microbiology and Molecular Biology Reviews, 75:50-83, Mar 2011. URL: https://doi.org/10.1128/mmbr.00031-10, doi:10.1128/mmbr.00031-10. This article has 4026 citations and is from a domain leading peer-reviewed journal.
23. (qian2001thepololikekinase pages 3-5): Yue-Wei Qian, Eleanor Erikson, Frédéric E. Taieb, and James L. Maller. The polo-like kinase plx1 is required for activation of the phosphatase cdc25c and cyclin b-cdc2 inxenopusoocytes. Molecular Biology of the Cell, 12:1791-1799, Jun 2001. URL: https://doi.org/10.1091/mbc.12.6.1791, doi:10.1091/mbc.12.6.1791. This article has 224 citations and is from a domain leading peer-reviewed journal.