1. Phylogeny  
   MAPK15, also commonly referred to as ERK7 or ERK8, is an atypical member of the mitogen‐activated protein kinase (MAPK) family that can be traced across diverse metazoan species. In rodents, the protein is typically named ERK7 and is orthologous to human ERK8, with orthologs also identified in zebrafish and predicted in chicken and Xenopus, establishing a broad evolutionary distribution among vertebrates (cargnello2011activationandfunction pages 6-8, krens1887molecularcellbiolog(ibl)a pages 14-16). Its evolutionary affiliation with typical MAPKs is underscored by the presence of a conserved serine/threonine kinase domain while its atypical classification is due to an extended C-terminal domain and non-canonical activation mechanisms, setting it apart from classical MAPKs such as ERK1/2 (cargnello2011activationandfunction pages 2-4, thun2012theroleofc pages 33-37).
2. Reaction Catalyzed  
   MAPK15 catalyzes the transfer of a phosphate group from ATP to serine or threonine residues on target protein substrates, resulting in the formation of ADP, a phosphorylated protein, and the release of a proton (cargnello2011activationandfunction pages 1-1).
3. Cofactor Requirements  
   Like most protein kinases, the catalytic activity of MAPK15 is dependent on the presence of divalent cations such as Mg²⁺, which are required to coordinate the binding of ATP within the active site (cargnello2011activationandfunction pages 1-1).
4. Substrate Specificity  
   MAPK15 exhibits serine/threonine kinase activity and, in vitro, is capable of phosphorylating classical MAPK substrates such as myelin basic protein (MBP) and the proto-oncogene FOS, although its substrate specificity in vivo remains incompletely characterized (thun2012theroleof pages 33-37, thun2012theroleofa pages 33-37). Studies using the Entamoeba invadens ortholog of MAPK15 demonstrate that the kinase domain encompasses all 11 conserved catalytic subdomains and contains a dual phosphorylation motif (TxY) in the activation loop, suggesting a substrate specificity consistent with other MAPKs; however, no definitive consensus substrate motif has yet been firmly established for MAPK15 in higher eukaryotes (singh2018identificationandfunctional pages 4-5, nguyen2015coconservedmapkfeatures pages 1-2).
5. Structure  
   MAPK15 is organized with a conserved N-terminal kinase domain that encompasses the 11 subdomains typical of serine/threonine kinases and houses the activation loop containing a unique Thr-Glu-Tyr (TxY) motif that undergoes autophosphorylation, which is critical for its catalytic activity (cargnello2011activationandfunction pages 6-8, thun2012theroleofc pages 33-37). In addition to the catalytic core, MAPK15 features an extended C-terminal domain that is absent in classical MAPKs; this domain includes a putative nuclear localization signal, multiple proline-rich regions that may serve as SH3 domain ligands, and motifs for interacting with proteins such as ATG8 and PCNA as reported in studies on the Entamoeba ortholog (singh2018identificationandfunctional pages 4-5). Structural studies and molecular dynamics analyses performed on related MAPKs indicate that the kinase adopts the typical two-lobe structure, wherein the smaller N-terminal lobe binds ATP and the larger C-terminal lobe contributes to substrate recognition, with the αC-helix and activation loop playing pivotal roles in regulating the enzyme’s conformation and activity (nguyen2015coconservedmapkfeatures pages 6-8, tillmann2015sec16asan pages 69-72). Notably, unique features in MAPK15 include substitutions within the C-tail region and the absence of a typical β4–β5 insert found in canonical MAPKs, suggesting divergent modes of allosteric regulation and substrate docking (nguyen2015coconservedmapkfeatures pages 6-8, tillmann2015sec16asanb pages 69-72).
6. Regulation  
   MAPK15 is regulated predominantly through autophosphorylation of its activation loop containing the Thr-Glu-Tyr motif, a process that appears to occur in a constitutive manner and is not strictly dependent on upstream MAPKKs (cargnello2011activationandfunction pages 6-8, thun2012theroleof pages 33-37). In addition to autophosphorylation, regulation of MAPK15 activity is modulated by protein turnover via the ubiquitin–proteasome pathway; its N-terminal region contains putative ubiquitination sites that target it for degradation, thereby influencing its cellular levels and activity (singh2018identificationandfunctional pages 4-5, dahm2025atypicalmapksin pages 7-8). The extended C-terminal domain also plays a role in subcellular localization by harboring a nuclear localization signal and multiple motifs required for protein–protein interactions, which collectively contribute to the enzyme’s spatial regulation within the cell (thun2012theroleofc pages 33-37, tillmann2015sec16asana pages 69-72).
7. Function  
   MAPK15 functions as an atypical MAPK with roles extending across several key cellular processes. It has been shown to regulate autophagy—controlling both basal and starvation-induced autophagy—through interactions with proteins such as GABARAP, MAP1LC3B, and GABARAPL1, which promote autophagosome formation and subsequent degradation of SQSTM1 (Information section). It also plays a crucial role in ciliogenesis by regulating primary cilium formation and the localization of ciliary proteins that are essential for cilium structure, transport, and signaling (Information section). Furthermore, MAPK15 modulates protein trafficking and secretion by preventing the relocation of sugar-adding enzymes from the Golgi to the endoplasmic reticulum, thereby restricting the production of heavily glycosylated proteins (Information section). In addition, it contributes to genome integrity through its binding to chromatin and interaction with proliferating cell nuclear antigen (PCNA), which stabilizes PCNA and protects it from MDM2-mediated degradation (Information section). Other documented functions include regulation of dopamine transporter (DAT) activity via RhoA activation and modulation of mRNA stability through phosphorylation of ELAVL1 in response to oxidative stress (Information section), with in vitro studies demonstrating its capacity to phosphorylate substrates such as FOS and MBP (cargnello2011activationandfunction pages 8-9, thun2012theroleof pages 33-37).
8. Other Comments  
   At present, there are no specific catalytic inhibitors that have been definitively established to target MAPK15/ERK7/ERK8, which presents a challenge for detailed experimental dissection of its enzymatic function (cargnello2011activationandfunction pages 6-8, tillmann2015sec16asan pages 69-72). MAPK15 has been implicated in a number of disease-related processes; for instance, reduced expression levels have been observed in certain breast cancer samples, suggesting a potential tumor suppressor role, and its regulation of genome integrity via interaction with PCNA underscores its relevance in maintaining cellular homeostasis (thun2012theroleof pages 33-37, thun2012theroleofb pages 33-37). Additionally, its involvement in the regulation of autophagy and secretion, as well as its modulation of dopaminergic signaling, highlights its multifaceted roles in cellular stress responses and signal transduction. Further exploration of its substrate specificity and identification of potential inhibitors remain active areas of research given the therapeutic implications of modulating MAPK15 activity (dahm2025atypicalmapksin pages 7-8).
9. References
10. cargnello2011activationandfunction pages 1-1
11. cargnello2011activationandfunction pages 2-4
12. cargnello2011activationandfunction pages 6-8
13. cargnello2011activationandfunction pages 8-9
14. cargnello2011activationandfunction pages 10-12
15. cargnello2011activationandfunction pages 13-15
16. cargnello2011activationandfunction pages 26-27
17. cargnello2011activationandfunction pages 28-29
18. cargnello2011activationandfunction pages 29-30
19. cargnello2011activationandfunction pages 32-32
20. cargnello2011activationandfunction pages 32-33
21. dahm2025atypicalmapksin pages 7-8
22. krens1887molecularcellbiolog(ibl)a pages 14-16
23. krens1887molecularcellbiolog(ibl) pages 14-16
24. lu2019extracellularsignalregulatedkinase pages 1-3
25. lu2019extracellularsignalregulatedkinase pages 11-12
26. nguyen2015coconservedmapkfeatures pages 1-2
27. nguyen2015coconservedmapkfeatures pages 5-6
28. nguyen2015coconservedmapkfeatures pages 6-8
29. nguyen2015coconservedmapkfeatures pages 8-11
30. nguyen2015coconservedmapkfeatures pages 11-14
31. nguyen2015coconservedmapkfeatures pages 14-15
32. nguyen2015coconservedmapkfeatures pages 15-17
33. nguyen2015coconservedmapkfeatures pages 18-19
34. shrestha2022theregulationofb pages 31-34
35. singh2018identificationandfunctional pages 4-5
36. thun2012theroleof pages 33-37
37. thun2012theroleofa pages 33-37
38. thun2012theroleofb pages 33-37
39. thun2012theroleofc pages 33-37
40. tillmann2015sec16asan pages 69-72
41. tillmann2015sec16asana pages 69-72
42. tillmann2015sec16asanb pages 69-72
43. coulombe2003rapidturnoverof pages 17-17
44. maheshwari2012identificationofconserved pages 38-43
45. roux2004erkandp38 pages 1-2
46. roux2004erkandp38 pages 4-5
47. roux2004erkandp38 pages 7-8
48. roux2004erkandp38 pages 9-11
49. roux2004erkandp38 pages 20-21
50. roux2004erkandp38 pages 22-22
51. roux2004erkandp38 pages 22-23
52. roux2004erkandp38 pages 23-24

References

1. (cargnello2011activationandfunction pages 6-8): 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 3999 citations and is from a domain leading peer-reviewed journal.
2. (singh2018identificationandfunctional pages 4-5): Tanya Singh, Tarun Agarwal, and Sudip Kumar Ghosh. Identification and functional analysis of a stress-responsive mapk15 in entamoeba invadens. Molecular and Biochemical Parasitology, 222:34-44, Jun 2018. URL: https://doi.org/10.1016/j.molbiopara.2018.05.002, doi:10.1016/j.molbiopara.2018.05.002. This article has 8 citations and is from a peer-reviewed journal.
3. (thun2012theroleof pages 33-37): A Von Thun. The role of erk2 in controlling tumour cell invasion. Unknown journal, 2012.
4. (thun2012theroleofa pages 33-37): A Von Thun. The role of erk2 in controlling tumour cell invasion. Unknown journal, 2012.
5. (thun2012theroleofc pages 33-37): A Von Thun. The role of erk2 in controlling tumour cell invasion. Unknown journal, 2012.
6. (cargnello2011activationandfunction pages 1-1): 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 3999 citations and is from a domain leading peer-reviewed journal.
7. (cargnello2011activationandfunction pages 2-4): 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 3999 citations and is from a domain leading peer-reviewed journal.
8. (cargnello2011activationandfunction pages 26-27): 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 3999 citations and is from a domain leading peer-reviewed journal.
9. (cargnello2011activationandfunction pages 8-9): 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 3999 citations and is from a domain leading peer-reviewed journal.
10. (dahm2025atypicalmapksin pages 7-8): Katrin Dahm, Parthiban Vijayarangakannan, Hans‐Peter Wollscheid, Hansjörg Schild, and Krishnaraj Rajalingam. Atypical mapks in cancer. The FEBS Journal, Sep 2025. URL: https://doi.org/10.1111/febs.17283, doi:10.1111/febs.17283. This article has 1 citations.
11. (krens1887molecularcellbiolog(ibl)a pages 14-16): SFG Krens. Molecular cell biolog,(ibl) and bioph sics,(lion), facult of science, leiden uni ersit. Unknown journal, 1887.
12. (lu2019extracellularsignalregulatedkinase pages 11-12): Nathan Lu and Charles J. Malemud. Extracellular signal-regulated kinase: a regulator of cell growth, inflammation, chondrocyte and bone cell receptor-mediated gene expression. International Journal of Molecular Sciences, 20:3792, Aug 2019. URL: https://doi.org/10.3390/ijms20153792, doi:10.3390/ijms20153792. This article has 189 citations and is from a peer-reviewed journal.
13. (nguyen2015coconservedmapkfeatures pages 1-2): Tuan Nguyen, Zheng Ruan, Krishnadev Oruganty, and Natarajan Kannan. Co-conserved mapk features couple d-domain docking groove to distal allosteric sites via the c-terminal flanking tail. PLOS ONE, 10:e0119636, Mar 2015. URL: https://doi.org/10.1371/journal.pone.0119636, doi:10.1371/journal.pone.0119636. This article has 28 citations and is from a peer-reviewed journal.
14. (nguyen2015coconservedmapkfeatures pages 11-14): Tuan Nguyen, Zheng Ruan, Krishnadev Oruganty, and Natarajan Kannan. Co-conserved mapk features couple d-domain docking groove to distal allosteric sites via the c-terminal flanking tail. PLOS ONE, 10:e0119636, Mar 2015. URL: https://doi.org/10.1371/journal.pone.0119636, doi:10.1371/journal.pone.0119636. This article has 28 citations and is from a peer-reviewed journal.
15. (nguyen2015coconservedmapkfeatures pages 5-6): Tuan Nguyen, Zheng Ruan, Krishnadev Oruganty, and Natarajan Kannan. Co-conserved mapk features couple d-domain docking groove to distal allosteric sites via the c-terminal flanking tail. PLOS ONE, 10:e0119636, Mar 2015. URL: https://doi.org/10.1371/journal.pone.0119636, doi:10.1371/journal.pone.0119636. This article has 28 citations and is from a peer-reviewed journal.
16. (nguyen2015coconservedmapkfeatures pages 6-8): Tuan Nguyen, Zheng Ruan, Krishnadev Oruganty, and Natarajan Kannan. Co-conserved mapk features couple d-domain docking groove to distal allosteric sites via the c-terminal flanking tail. PLOS ONE, 10:e0119636, Mar 2015. URL: https://doi.org/10.1371/journal.pone.0119636, doi:10.1371/journal.pone.0119636. This article has 28 citations and is from a peer-reviewed journal.
17. (thun2012theroleofb pages 33-37): A Von Thun. The role of erk2 in controlling tumour cell invasion. Unknown journal, 2012.
18. (tillmann2015sec16asan pages 69-72): KD Tillmann. Sec16 as an integrator of signaling to the endoplasmic reticulum. Unknown journal, 2015.
19. (tillmann2015sec16asana pages 69-72): KD Tillmann. Sec16 as an integrator of signaling to the endoplasmic reticulum. Unknown journal, 2015.
20. (tillmann2015sec16asanb pages 69-72): KD Tillmann. Sec16 as an integrator of signaling to the endoplasmic reticulum. Unknown journal, 2015.
21. (maheshwari2012identificationofconserved pages 38-43): S Maheshwari. Identification of conserved structural motifs associated with phosphorylation sites in kinases. Unknown journal, 2012.
22. (nguyen2015coconservedmapkfeatures pages 15-17): Tuan Nguyen, Zheng Ruan, Krishnadev Oruganty, and Natarajan Kannan. Co-conserved mapk features couple d-domain docking groove to distal allosteric sites via the c-terminal flanking tail. PLOS ONE, 10:e0119636, Mar 2015. URL: https://doi.org/10.1371/journal.pone.0119636, doi:10.1371/journal.pone.0119636. This article has 28 citations and is from a peer-reviewed journal.
23. (nguyen2015coconservedmapkfeatures pages 18-19): Tuan Nguyen, Zheng Ruan, Krishnadev Oruganty, and Natarajan Kannan. Co-conserved mapk features couple d-domain docking groove to distal allosteric sites via the c-terminal flanking tail. PLOS ONE, 10:e0119636, Mar 2015. URL: https://doi.org/10.1371/journal.pone.0119636, doi:10.1371/journal.pone.0119636. This article has 28 citations and is from a peer-reviewed journal.
24. (cargnello2011activationandfunction pages 29-30): 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 3999 citations and is from a domain leading peer-reviewed journal.
25. (coulombe2003rapidturnoverof pages 17-17): Philippe Coulombe, Geneviève Rodier, Stéphane Pelletier, Johanne Pellerin, and Sylvain Meloche. Rapid turnover of extracellular signal-regulated kinase 3 by the ubiquitin-proteasome pathway defines a novel paradigm of mitogen-activated protein kinase regulation during cellular differentiation. Molecular and Cellular Biology, 23:4542-4558, Jul 2003. URL: https://doi.org/10.1128/mcb.23.13.4542-4558.2003, doi:10.1128/mcb.23.13.4542-4558.2003. This article has 170 citations and is from a domain leading peer-reviewed journal.
26. (krens1887molecularcellbiolog(ibl) pages 14-16): SFG Krens. Molecular cell biolog,(ibl) and bioph sics,(lion), facult of science, leiden uni ersit. Unknown journal, 1887.
27. (lu2019extracellularsignalregulatedkinase pages 1-3): Nathan Lu and Charles J. Malemud. Extracellular signal-regulated kinase: a regulator of cell growth, inflammation, chondrocyte and bone cell receptor-mediated gene expression. International Journal of Molecular Sciences, 20:3792, Aug 2019. URL: https://doi.org/10.3390/ijms20153792, doi:10.3390/ijms20153792. This article has 189 citations and is from a peer-reviewed journal.
28. (nguyen2015coconservedmapkfeatures pages 14-15): Tuan Nguyen, Zheng Ruan, Krishnadev Oruganty, and Natarajan Kannan. Co-conserved mapk features couple d-domain docking groove to distal allosteric sites via the c-terminal flanking tail. PLOS ONE, 10:e0119636, Mar 2015. URL: https://doi.org/10.1371/journal.pone.0119636, doi:10.1371/journal.pone.0119636. This article has 28 citations and is from a peer-reviewed journal.
29. (nguyen2015coconservedmapkfeatures pages 8-11): Tuan Nguyen, Zheng Ruan, Krishnadev Oruganty, and Natarajan Kannan. Co-conserved mapk features couple d-domain docking groove to distal allosteric sites via the c-terminal flanking tail. PLOS ONE, 10:e0119636, Mar 2015. URL: https://doi.org/10.1371/journal.pone.0119636, doi:10.1371/journal.pone.0119636. This article has 28 citations and is from a peer-reviewed journal.
30. (roux2004erkandp38 pages 1-2): Philippe P. Roux and John Blenis. Erk and p38 mapk-activated protein kinases: a family of protein kinases with diverse biological functions. Microbiology and Molecular Biology Reviews, 68:320-344, Jun 2004. URL: https://doi.org/10.1128/mmbr.68.2.320-344.2004, doi:10.1128/mmbr.68.2.320-344.2004. This article has 3350 citations and is from a domain leading peer-reviewed journal.
31. (roux2004erkandp38 pages 20-21): Philippe P. Roux and John Blenis. Erk and p38 mapk-activated protein kinases: a family of protein kinases with diverse biological functions. Microbiology and Molecular Biology Reviews, 68:320-344, Jun 2004. URL: https://doi.org/10.1128/mmbr.68.2.320-344.2004, doi:10.1128/mmbr.68.2.320-344.2004. This article has 3350 citations and is from a domain leading peer-reviewed journal.
32. (roux2004erkandp38 pages 22-22): Philippe P. Roux and John Blenis. Erk and p38 mapk-activated protein kinases: a family of protein kinases with diverse biological functions. Microbiology and Molecular Biology Reviews, 68:320-344, Jun 2004. URL: https://doi.org/10.1128/mmbr.68.2.320-344.2004, doi:10.1128/mmbr.68.2.320-344.2004. This article has 3350 citations and is from a domain leading peer-reviewed journal.
33. (roux2004erkandp38 pages 22-23): Philippe P. Roux and John Blenis. Erk and p38 mapk-activated protein kinases: a family of protein kinases with diverse biological functions. Microbiology and Molecular Biology Reviews, 68:320-344, Jun 2004. URL: https://doi.org/10.1128/mmbr.68.2.320-344.2004, doi:10.1128/mmbr.68.2.320-344.2004. This article has 3350 citations and is from a domain leading peer-reviewed journal.
34. (roux2004erkandp38 pages 23-24): Philippe P. Roux and John Blenis. Erk and p38 mapk-activated protein kinases: a family of protein kinases with diverse biological functions. Microbiology and Molecular Biology Reviews, 68:320-344, Jun 2004. URL: https://doi.org/10.1128/mmbr.68.2.320-344.2004, doi:10.1128/mmbr.68.2.320-344.2004. This article has 3350 citations and is from a domain leading peer-reviewed journal.
35. (roux2004erkandp38 pages 4-5): Philippe P. Roux and John Blenis. Erk and p38 mapk-activated protein kinases: a family of protein kinases with diverse biological functions. Microbiology and Molecular Biology Reviews, 68:320-344, Jun 2004. URL: https://doi.org/10.1128/mmbr.68.2.320-344.2004, doi:10.1128/mmbr.68.2.320-344.2004. This article has 3350 citations and is from a domain leading peer-reviewed journal.
36. (roux2004erkandp38 pages 7-8): Philippe P. Roux and John Blenis. Erk and p38 mapk-activated protein kinases: a family of protein kinases with diverse biological functions. Microbiology and Molecular Biology Reviews, 68:320-344, Jun 2004. URL: https://doi.org/10.1128/mmbr.68.2.320-344.2004, doi:10.1128/mmbr.68.2.320-344.2004. This article has 3350 citations and is from a domain leading peer-reviewed journal.
37. (roux2004erkandp38 pages 9-11): Philippe P. Roux and John Blenis. Erk and p38 mapk-activated protein kinases: a family of protein kinases with diverse biological functions. Microbiology and Molecular Biology Reviews, 68:320-344, Jun 2004. URL: https://doi.org/10.1128/mmbr.68.2.320-344.2004, doi:10.1128/mmbr.68.2.320-344.2004. This article has 3350 citations and is from a domain leading peer-reviewed journal.
38. (shrestha2022theregulationofb pages 31-34): A Shrestha. The regulation of steroid receptor co-activator-3 activity by p38mapk-mk2 signaling pathway. Unknown journal, 2022.
39. (cargnello2011activationandfunction pages 10-12): 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 3999 citations and is from a domain leading peer-reviewed journal.
40. (cargnello2011activationandfunction pages 13-15): 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 3999 citations and is from a domain leading peer-reviewed journal.
41. (cargnello2011activationandfunction pages 28-29): 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 3999 citations and is from a domain leading peer-reviewed journal.
42. (cargnello2011activationandfunction pages 32-32): 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 3999 citations and is from a domain leading peer-reviewed journal.
43. (cargnello2011activationandfunction pages 32-33): 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 3999 citations and is from a domain leading peer-reviewed journal.