1. Phylogeny  
   MAP2K1 (MEK1) is a member of the mitogen‐activated protein kinase kinase (MAP2K) family, which is evolutionarily conserved across all eukaryotes. Phylogenetic studies indicate that MEK1 is the ancestral form of the MEK family, with orthologs identifiable in yeast (where the STE7 protein represents its functional counterpart) through invertebrates to mammals (andrianova2023evolutionaryhistoryof pages 2-3). Comparative analyses of over 300 well‐defined metazoan MEK1 orthologs have revealed that approximately 20% of its amino acid positions remain invariant across hundreds of millions of years of evolution, underscoring the critical functional constraints acting on this protein (andrianova2023evolutionaryhistoryof pages 3-5, andrianova2023evolutionaryhistoryofa pages 1-4). Gene duplication events in early vertebrate evolution led to the emergence of MEK2, a closely related paralog, yet MEK1 displays unique non-redundant functions for which its sequence and regulatory differences have been maintained (akinleye2013mekandthe pages 1-2, andrianova2023evolutionaryhistoryof pages 2-3). MEK1 falls within the STE group of kinases in the human kinome, and its evolutionary relationship with other MAP2K enzymes places it firmly in the core PWM (protein kinase module) that has been conserved from the last eukaryotic common ancestor (avruch2007mapkinasepathways pages 2-3).
2. Reaction Catalyzed  
   MAP2K1 catalyzes a dual phosphorylation reaction required for activating its specific downstream targets, the extracellular signal‐regulated kinases ERK1 and ERK2. The chemical reaction can be summarized as follows: ATP + [unphosphorylated ERK] → ADP + [ERK phosphorylated on both a threonine and a tyrosine residue] where the dual phosphorylation occurs on a conserved Thr-Glu-Tyr (TEY) motif located within the activation loop of ERK1/2 (akinleye2013mekandthe pages 1-2, avruch2007mapkinasepathways pages 2-3). This dual phosphorylation is required to induce a conformational change in ERK that drastically increases its catalytic activity and allows it to phosphorylate a broad range of downstream substrates in the cascade.
3. Cofactor Requirements  
   The enzymatic activity of MAP2K1 is dependent on the presence of ATP as the phosphate donor and a divalent cation, typically magnesium (Mg²⁺), which is essential for stabilizing the negative charges of ATP during phosphoryl transfer. The coordination of Mg²⁺ with ATP is a common requirement of serine/threonine kinases, facilitating proper alignment of the ATP molecule in the active site for efficient catalysis (roskoski2012mek12dualspecificityprotein pages 1-2, akinleye2013mekandthe pages 8-8).
4. Substrate Specificity  
   MAP2K1 exhibits stringent substrate specificity within the MAP kinase cascade. It functions as a dual specificity kinase that selectively phosphorylates ERK1 and ERK2 on both a threonine and a tyrosine residue within the conserved TEY activation motif. This specificity arises from the recognition of the native three‐dimensional structure of ERK substrates, which presents the intact activation loop for dual phosphorylation rather than free peptides or denatured forms (akinleye2013mekandthe pages 1-2, roskoski2012mek12dualspecificityprotein pages 1-2). The enzyme’s amino‐terminal regulatory region contains docking domains that ensure high-affinity and specific interaction with ERK, effectively limiting its substrate range predominantly to ERK1/2 (martinvega2023navigatingtheerk12 pages 21-22, roskoski2012mek12dualspecificityprotein pages 1-2).
5. Structure  
   MAP2K1 is organized into three primary regions that each contribute to its functional role in signal transduction. The N-terminal region contains a regulatory domain which includes an inhibitory/allosteric segment as well as a unique nuclear export sequence that contributes to its intracellular localization. This region is critical for mediating interactions with scaffold proteins and upstream activators. The central component is the catalytic kinase domain, which adopts a bilobed structure characteristic of protein kinases. It contains a glycine-rich P-loop that binds ATP and an αC-helix whose conformation determines the active or inactive state of the enzyme. Key catalytic residues are found in the catalytic loop and there’s a dual phosphorylation activation loop containing essential serine residues (S218 and S222 in MEK1) that must be phosphorylated for full activation (roskoski2012mek12dualspecificityprotein pages 2-4, akinleye2013mekandthe pages 2-4). The C-terminal region harbors a docking domain often referred to as the DVD (domain for versatile docking) that is responsible for interactions with both upstream MAP3Ks (such as RAF kinases) and downstream substrates (erk activators such as ERK1/2) (martinvega2023navigatingtheerk12 pages 4-5, avruch2007mapkinasepathways pages 5-6). Structural studies and comparative analyses have identified conserved salt bridges, hydrophobic spines, and a conserved kinase core architecture that are fundamental for catalysis and allosteric regulation (roskoski2012mek12dualspecificityprotein pages 4-5, martinvega2023navigatingtheerk12 pages 29-30). In addition, available crystal structures and computational models (e.g., AlphaFold predictions) support the canonical two-lobed kinase fold where the N-lobe is primarily composed of β-sheets and the C-lobe is predominantly helical, a conformation that is modulated upon binding of ATP and subsequent phosphorylation events.
6. Regulation  
   MAP2K1 is subject to multifaceted regulatory mechanisms that control its activation and deactivation. The primary mode of activation is via phosphorylation of serine residues (S218 and S222) within its activation loop by upstream Raf kinases, leading to a conformational shift that increases its catalytic efficiency toward ERK substrates (akinleye2013mekandthe pages 8-9, roskoski2012mek12dualspecificityprotein pages 4-5). In addition, MAP2K1 activity is further modulated through feedback phosphorylation mechanisms; for instance, ERK can phosphorylate MEK1 at threonine 292, a modification associated with negative feedback that reduces MEK1 activity and contributes to transient signal propagation (roskoski2012mek12dualspecificityprotein pages 5-6, avruch2007mapkinasepathways pages 7-8). Scaffold proteins such as kinase suppressor of Ras (KSR1 and KSR2) bind to MEK1, organizing multimeric complexes that facilitate efficient phosphorylation by upstream kinases as well as substrate selection for downstream MAPK activation (akinleye2013mekandthe pages 8-8, avruch2007mapkinasepathways pages 8-9). Regulatory interactions with these scaffolds, combined with the intrinsic conformational flexibility of its regulatory and catalytic domains, enable MAP2K1 to act as a finely tuned molecular switch in response to external mitogenic stimuli.
7. Function  
   MAP2K1 is a critical component of the canonical MAPK/ERK signaling cascade, integrating signals from cell-surface receptors activated by growth factors, cytokines, and hormones. Upon receptor activation, RAS becomes activated and subsequently stimulates RAF kinases, which in turn phosphorylate and activate MEK1. Once activated, MEK1 dual phosphorylates ERK1 and ERK2 on their respective TEY motifs, thereby converting ERK into an active kinase capable of phosphorylating hundreds of substrates involved in diverse cellular processes. These downstream substrates regulate gene expression, cell cycle progression, differentiation, proliferation, and survival, making the MEK1‐ERK axis a pivotal mediator of cellular responses to extracellular cues (akinleye2013mekandthe pages 1-2, avruch2007mapkinasepathways pages 8-9, martinvega2023navigatingtheerk12 pages 21-22). MAP2K1 is expressed widely across tissues, and its precise regulation is critical; aberrant signaling through this pathway is implicated in oncogenesis, evidenced by the frequent occurrence of mutations in upstream components such as BRAF and RAS and, less commonly, in MAP2K1 itself, which contribute to uncontrolled cellular proliferation (andrianova2023evolutionaryhistoryof pages 2-3, akinleye2013mekandthe pages 8-9). Its function is also essential during development, where proper spatiotemporal activation of the MEK1–ERK1/2 cascade is required for normal embryogenesis and tissue differentiation.
8. Other Comments  
   Due to its central role in cell signaling, MAP2K1 is a validated therapeutic target in various cancers and developmental disorders. Several small-molecule inhibitors that target MEK1’s allosteric binding site—thereby interfering with its kinase activity—have been developed and are in clinical use or under investigation. Agents such as trametinib, binimetinib, and cobimetinib have demonstrated clinical efficacy in the treatment of melanoma and other malignancies characterized by hyperactivation of the MAPK/ERK pathway (akinleye2013mekandthe pages 8-8, martinvega2023navigatingtheerk12 pages 44-45, OpenTargets Search: -MAP2K1). Moreover, somatic mutations in MAP2K1 have been linked to a range of oncogenic processes as well as syndromic conditions like cardiofaciocutaneous syndrome, further emphasizing the clinical importance of tightly regulated MEK1 activity (andrianova2023evolutionaryhistoryof pages 2-3). Overall, the extensive biological and clinical research on MAP2K1 underscores its importance as a key node in receptor-mediated signaling pathways and highlights the ongoing efforts to modulate its activity for therapeutic benefit.
9. References
10. Akintunde Akinleye, Muhammad Furqan, Nikhil Mukhi, Pavan Ravella, and Delong Liu. Mek and the inhibitors: from bench to bedside. Journal of Hematology & Oncology, 6:27-27, Apr 2013. URL: https://doi.org/10.1186/1756-8722-6-27 (akinleye2013mekandthe pages 1-2, akinleye2013mekandthe pages 2-4, akinleye2013mekandthe pages 8-8, akinleye2013mekandthe pages 8-9).
11. Ekaterina P. Andrianova, Robert A. Marmion, Stanislav Y. Shvartsman, and Igor B. Zhulin. Evolutionary history of mek1 illuminates the nature of deleterious mutations. Proceedings of the National Academy of Sciences, Aug 2023. URL: https://doi.org/10.1073/pnas.2304184120 (andrianova2023evolutionaryhistoryof pages 2-3, andrianova2023evolutionaryhistoryof pages 3-5).
12. Joseph Avruch. Map kinase pathways: the first twenty years. Biochimica et Biophysica Acta (BBA) - Molecular Cell Research, 1773:1150-1160, Aug 2007. URL: https://doi.org/10.1016/j.bbamcr.2006.11.006 (avruch2007mapkinasepathways pages 2-3, avruch2007mapkinasepathways pages 5-6, avruch2007mapkinasepathways pages 7-8, avruch2007mapkinasepathways pages 8-9, avruch2007mapkinasepathways pages 9-10, avruch2007mapkinasepathways pages 11-11).
13. Robert Roskoski. Mek1/2 dual-specificity protein kinases: structure and regulation. Biochemical and Biophysical Research Communications, 417(1):5-10, Jan 2012. URL: https://doi.org/10.1016/j.bbrc.2011.11.145 (roskoski2012mek12dualspecificityprotein pages 1-2, roskoski2012mek12dualspecificityprotein pages 2-4, roskoski2012mek12dualspecificityprotein pages 4-5, roskoski2012mek12dualspecificityprotein pages 5-6).
14. 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 (cargnello2011activationandfunction pages 4-5, cargnello2011activationandfunction pages 1-1, cargnello2011activationandfunction pages 2-4).
15. José Manuel González-Coronel, Gustavo Rodríguez-Alonso, and Ángel Arturo Guevara-García. A phylogenetic study of the members of the mapk and mek families across viridiplantae. PLOS ONE, 16:e0250584, Apr 2021. URL: https://doi.org/10.1371/journal.pone.0250584 (gonzalezcoronel2021aphylogeneticstudy pages 12-13).
16. EJ Huang, Jeeun Parksong, Amy F. Peterson, Fernando Torres, Sergi Regot, and Gabriel S. Bever. Reconstructing the deep phylogeny of the mapk signaling network: functional specialization via multi-tier coevolutionary expansion. BioRxiv, Oct 2024. URL: https://doi.org/10.1101/2024.10.01.616093 (huang2024reconstructingthedeep pages 14-16, huang2024reconstructingthedeep pages 5-7, huang2024reconstructingthedeep pages 7-10).
17. Ana Martin-Vega and Melanie H. Cobb. Navigating the erk1/2 mapk cascade. Biomolecules, 13:1555, Oct 2023. URL: https://doi.org/10.3390/biom13101555 (martinvega2023navigatingtheerk12 pages 21-22, martinvega2023navigatingtheerk12 pages 4-5, martinvega2023navigatingtheerk12 pages 29-30, martinvega2023navigatingtheerk12 pages 30-32, martinvega2023navigatingtheerk12 pages 32-33, martinvega2023navigatingtheerk12 pages 44-45, martinvega2023navigatingtheerk12 pages 5-7, martinvega2023navigatingtheerk12 pages 7-8).
18. Roser Buscà, Jacques Pouysségur, and Philippe Lenormand. Erk1 and erk2 map kinases: specific roles or functional redundancy? Frontiers in Cell and Developmental Biology, Jun 2016. URL: https://doi.org/10.3389/fcell.2016.00053 (busca2016erk1anderk2 pages 19-19, busca2016erk1anderk2 pages 2-3).
19. OpenTargets Search: -MAP2K1.

References

1. (akinleye2013mekandthe pages 1-2): Akintunde Akinleye, Muhammad Furqan, Nikhil Mukhi, Pavan Ravella, and Delong Liu. Mek and the inhibitors: from bench to bedside. Journal of Hematology & Oncology, 6:27-27, Apr 2013. URL: https://doi.org/10.1186/1756-8722-6-27, doi:10.1186/1756-8722-6-27. This article has 360 citations.
2. (andrianova2023evolutionaryhistoryof pages 2-3): Ekaterina P. Andrianova, Robert A. Marmion, Stanislav Y. Shvartsman, and Igor B. Zhulin. Evolutionary history of mek1 illuminates the nature of deleterious mutations. Proceedings of the National Academy of Sciences, Aug 2023. URL: https://doi.org/10.1073/pnas.2304184120, doi:10.1073/pnas.2304184120. This article has 2 citations.
3. (andrianova2023evolutionaryhistoryof pages 3-5): Ekaterina P. Andrianova, Robert A. Marmion, Stanislav Y. Shvartsman, and Igor B. Zhulin. Evolutionary history of mek1 illuminates the nature of deleterious mutations. Proceedings of the National Academy of Sciences, Aug 2023. URL: https://doi.org/10.1073/pnas.2304184120, doi:10.1073/pnas.2304184120. This article has 2 citations.
4. (avruch2007mapkinasepathways pages 2-3): Joseph Avruch. Map kinase pathways: the first twenty years. Biochimica et Biophysica Acta (BBA) - Molecular Cell Research, 1773:1150-1160, Aug 2007. URL: https://doi.org/10.1016/j.bbamcr.2006.11.006, doi:10.1016/j.bbamcr.2006.11.006. This article has 419 citations.
5. (avruch2007mapkinasepathways pages 5-6): Joseph Avruch. Map kinase pathways: the first twenty years. Biochimica et Biophysica Acta (BBA) - Molecular Cell Research, 1773:1150-1160, Aug 2007. URL: https://doi.org/10.1016/j.bbamcr.2006.11.006, doi:10.1016/j.bbamcr.2006.11.006. This article has 419 citations.
6. (cargnello2011activationandfunction pages 4-5): 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.
7. (gonzalezcoronel2021aphylogeneticstudy pages 12-13): José Manuel González-Coronel, Gustavo Rodríguez-Alonso, and Ángel Arturo Guevara-García. A phylogenetic study of the members of the mapk and mek families across viridiplantae. PLOS ONE, 16:e0250584, Apr 2021. URL: https://doi.org/10.1371/journal.pone.0250584, doi:10.1371/journal.pone.0250584. This article has 6 citations and is from a peer-reviewed journal.
8. (huang2024reconstructingthedeep pages 14-16): EJ Huang, Jeeun Parksong, Amy F. Peterson, Fernando Torres, Sergi Regot, and Gabriel S. Bever. Reconstructing the deep phylogeny of the mapk signaling network: functional specialization via multi-tier coevolutionary expansion. BioRxiv, Oct 2024. URL: https://doi.org/10.1101/2024.10.01.616093, doi:10.1101/2024.10.01.616093. This article has 1 citations.
9. (martinvega2023navigatingtheerk12 pages 21-22): Ana Martin-Vega and Melanie H. Cobb. Navigating the erk1/2 mapk cascade. Biomolecules, 13:1555, Oct 2023. URL: https://doi.org/10.3390/biom13101555, doi:10.3390/biom13101555. This article has 58 citations and is from a peer-reviewed journal.
10. (martinvega2023navigatingtheerk12 pages 4-5): Ana Martin-Vega and Melanie H. Cobb. Navigating the erk1/2 mapk cascade. Biomolecules, 13:1555, Oct 2023. URL: https://doi.org/10.3390/biom13101555, doi:10.3390/biom13101555. This article has 58 citations and is from a peer-reviewed journal.
11. (roskoski2012mek12dualspecificityprotein pages 1-2): Robert Roskoski. Mek1/2 dual-specificity protein kinases: structure and regulation. Biochemical and biophysical research communications, 417 1:5-10, Jan 2012. URL: https://doi.org/10.1016/j.bbrc.2011.11.145, doi:10.1016/j.bbrc.2011.11.145. This article has 354 citations and is from a peer-reviewed journal.
12. (roskoski2012mek12dualspecificityprotein pages 2-4): Robert Roskoski. Mek1/2 dual-specificity protein kinases: structure and regulation. Biochemical and biophysical research communications, 417 1:5-10, Jan 2012. URL: https://doi.org/10.1016/j.bbrc.2011.11.145, doi:10.1016/j.bbrc.2011.11.145. This article has 354 citations and is from a peer-reviewed journal.
13. (roskoski2012mek12dualspecificityprotein pages 4-5): Robert Roskoski. Mek1/2 dual-specificity protein kinases: structure and regulation. Biochemical and biophysical research communications, 417 1:5-10, Jan 2012. URL: https://doi.org/10.1016/j.bbrc.2011.11.145, doi:10.1016/j.bbrc.2011.11.145. This article has 354 citations and is from a peer-reviewed journal.
14. (roskoski2012mek12dualspecificityprotein pages 5-6): Robert Roskoski. Mek1/2 dual-specificity protein kinases: structure and regulation. Biochemical and biophysical research communications, 417 1:5-10, Jan 2012. URL: https://doi.org/10.1016/j.bbrc.2011.11.145, doi:10.1016/j.bbrc.2011.11.145. This article has 354 citations and is from a peer-reviewed journal.
15. (akinleye2013mekandthe pages 2-4): Akintunde Akinleye, Muhammad Furqan, Nikhil Mukhi, Pavan Ravella, and Delong Liu. Mek and the inhibitors: from bench to bedside. Journal of Hematology & Oncology, 6:27-27, Apr 2013. URL: https://doi.org/10.1186/1756-8722-6-27, doi:10.1186/1756-8722-6-27. This article has 360 citations.
16. (akinleye2013mekandthe pages 8-8): Akintunde Akinleye, Muhammad Furqan, Nikhil Mukhi, Pavan Ravella, and Delong Liu. Mek and the inhibitors: from bench to bedside. Journal of Hematology & Oncology, 6:27-27, Apr 2013. URL: https://doi.org/10.1186/1756-8722-6-27, doi:10.1186/1756-8722-6-27. This article has 360 citations.
17. (akinleye2013mekandthe pages 8-9): Akintunde Akinleye, Muhammad Furqan, Nikhil Mukhi, Pavan Ravella, and Delong Liu. Mek and the inhibitors: from bench to bedside. Journal of Hematology & Oncology, 6:27-27, Apr 2013. URL: https://doi.org/10.1186/1756-8722-6-27, doi:10.1186/1756-8722-6-27. This article has 360 citations.
18. (andrianova2023evolutionaryhistoryofa pages 1-4): Ekaterina P. Andrianova, Robert A. Marmion, Stanislav Y. Shvartsman, and Igor B. Zhulin. Evolutionary history of mek1 illuminates the nature of cancer and rasopathy mutations. BioRxiv, Mar 2023. URL: https://doi.org/10.1101/2023.03.09.531944, doi:10.1101/2023.03.09.531944. This article has 0 citations.
19. (avruch2007mapkinasepathways pages 7-8): Joseph Avruch. Map kinase pathways: the first twenty years. Biochimica et Biophysica Acta (BBA) - Molecular Cell Research, 1773:1150-1160, Aug 2007. URL: https://doi.org/10.1016/j.bbamcr.2006.11.006, doi:10.1016/j.bbamcr.2006.11.006. This article has 419 citations.
20. (avruch2007mapkinasepathways pages 8-9): Joseph Avruch. Map kinase pathways: the first twenty years. Biochimica et Biophysica Acta (BBA) - Molecular Cell Research, 1773:1150-1160, Aug 2007. URL: https://doi.org/10.1016/j.bbamcr.2006.11.006, doi:10.1016/j.bbamcr.2006.11.006. This article has 419 citations.
21. (avruch2007mapkinasepathways pages 9-10): Joseph Avruch. Map kinase pathways: the first twenty years. Biochimica et Biophysica Acta (BBA) - Molecular Cell Research, 1773:1150-1160, Aug 2007. URL: https://doi.org/10.1016/j.bbamcr.2006.11.006, doi:10.1016/j.bbamcr.2006.11.006. This article has 419 citations.
22. (busca2016erk1anderk2 pages 19-19): Roser Buscà, Jacques Pouysségur, and Philippe Lenormand. Erk1 and erk2 map kinases: specific roles or functional redundancy? Frontiers in Cell and Developmental Biology, Jun 2016. URL: https://doi.org/10.3389/fcell.2016.00053, doi:10.3389/fcell.2016.00053. This article has 229 citations and is from a peer-reviewed journal.
23. (busca2016erk1anderk2 pages 2-3): Roser Buscà, Jacques Pouysségur, and Philippe Lenormand. Erk1 and erk2 map kinases: specific roles or functional redundancy? Frontiers in Cell and Developmental Biology, Jun 2016. URL: https://doi.org/10.3389/fcell.2016.00053, doi:10.3389/fcell.2016.00053. This article has 229 citations and is from a peer-reviewed journal.
24. (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 4026 citations and is from a domain leading peer-reviewed journal.
25. (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 4026 citations and is from a domain leading peer-reviewed journal.
26. (huang2024reconstructingthedeep pages 5-7): EJ Huang, Jeeun Parksong, Amy F. Peterson, Fernando Torres, Sergi Regot, and Gabriel S. Bever. Reconstructing the deep phylogeny of the mapk signaling network: functional specialization via multi-tier coevolutionary expansion. BioRxiv, Oct 2024. URL: https://doi.org/10.1101/2024.10.01.616093, doi:10.1101/2024.10.01.616093. This article has 1 citations.
27. (huang2024reconstructingthedeep pages 7-10): EJ Huang, Jeeun Parksong, Amy F. Peterson, Fernando Torres, Sergi Regot, and Gabriel S. Bever. Reconstructing the deep phylogeny of the mapk signaling network: functional specialization via multi-tier coevolutionary expansion. BioRxiv, Oct 2024. URL: https://doi.org/10.1101/2024.10.01.616093, doi:10.1101/2024.10.01.616093. This article has 1 citations.
28. (martinvega2023navigatingtheerk12 pages 29-30): Ana Martin-Vega and Melanie H. Cobb. Navigating the erk1/2 mapk cascade. Biomolecules, 13:1555, Oct 2023. URL: https://doi.org/10.3390/biom13101555, doi:10.3390/biom13101555. This article has 58 citations and is from a peer-reviewed journal.
29. (martinvega2023navigatingtheerk12 pages 30-32): Ana Martin-Vega and Melanie H. Cobb. Navigating the erk1/2 mapk cascade. Biomolecules, 13:1555, Oct 2023. URL: https://doi.org/10.3390/biom13101555, doi:10.3390/biom13101555. This article has 58 citations and is from a peer-reviewed journal.
30. (martinvega2023navigatingtheerk12 pages 32-33): Ana Martin-Vega and Melanie H. Cobb. Navigating the erk1/2 mapk cascade. Biomolecules, 13:1555, Oct 2023. URL: https://doi.org/10.3390/biom13101555, doi:10.3390/biom13101555. This article has 58 citations and is from a peer-reviewed journal.
31. (martinvega2023navigatingtheerk12 pages 44-45): Ana Martin-Vega and Melanie H. Cobb. Navigating the erk1/2 mapk cascade. Biomolecules, 13:1555, Oct 2023. URL: https://doi.org/10.3390/biom13101555, doi:10.3390/biom13101555. This article has 58 citations and is from a peer-reviewed journal.
32. (martinvega2023navigatingtheerk12 pages 5-7): Ana Martin-Vega and Melanie H. Cobb. Navigating the erk1/2 mapk cascade. Biomolecules, 13:1555, Oct 2023. URL: https://doi.org/10.3390/biom13101555, doi:10.3390/biom13101555. This article has 58 citations and is from a peer-reviewed journal.
33. (martinvega2023navigatingtheerk12 pages 7-8): Ana Martin-Vega and Melanie H. Cobb. Navigating the erk1/2 mapk cascade. Biomolecules, 13:1555, Oct 2023. URL: https://doi.org/10.3390/biom13101555, doi:10.3390/biom13101555. This article has 58 citations and is from a peer-reviewed journal.
34. (OpenTargets Search: -MAP2K1): Open Targets Query (-MAP2K1, 6 results). Buniello, A. et al. (2025). Open Targets Platform: facilitating therapeutic hypotheses building in drug discovery. Nucleic Acids Research.
35. (avruch2007mapkinasepathways pages 11-11): Joseph Avruch. Map kinase pathways: the first twenty years. Biochimica et Biophysica Acta (BBA) - Molecular Cell Research, 1773:1150-1160, Aug 2007. URL: https://doi.org/10.1016/j.bbamcr.2006.11.006, doi:10.1016/j.bbamcr.2006.11.006. This article has 419 citations.