## Phylogeny

MAP3K12 is a serine/threonine kinase classified within the mixed lineage kinase (MLK) family, a subgroup of the mitogen-activated protein kinase kinase kinase (MAP3K) group, which belongs to the STE20 kinase family (koster2024regulationofthe pages 1-2, koster2024regulationofthe pages 15-16, larhammar2017theste20family pages 11-11, rana2013mixedlineagekinasecjun pages 1-2). Within the MLK family, MAP3K12 (DLK) and MAP3K13 (LZK) form a subgroup, sharing 90% amino acid sequence identity in their enzymatic and dual leucine zipper domains (koster2024regulationofthe pages 4-6). ZAK (MAP3K20) is also a member of the MLK family (koster2024regulationofthe pages 4-6). Orthologs of MAP3K12 have been identified in *Drosophila* and *C. elegans* (DLK-1) (gallo2002mixedlineagekinasecontrol pages 2-3, yan2012regulationofdlk1 pages 8-10).

## Reaction Catalyzed

MAP3K12 possesses serine/threonine kinase activity and shows homology to both serine/threonine and tyrosine kinases (koster2024regulationofthe pages 1-2, gallo2002mixedlineagekinasecontrol pages 1-2). It catalyzes the transfer of a phosphate group from ATP to a protein substrate. ATP + [a protein]-L-serine = ADP + [a protein]-L-serine phosphate (koster2024regulationofthe pages 1-2). ATP + [a protein]-L-threonine = ADP + [a protein]-L-threonine phosphate (koster2024regulationofthe pages 1-2).

## Cofactor Requirements

The catalytic activity of MAP3K12 requires magnesium ions (Mg2+) as a cofactor (koster2024regulationofthe pages 1-2, koster2024regulationofthe pages 15-16, stalheim2007mapkkinasekinase pages 1-4, chen2016leucinezipperbearingkinase pages 14-15, hebert2000themixedlineage pages 9-10).

## Substrate Specificity

The optimal phosphorylation substrate motif for MAP3K12 has been experimentally determined using positional scanning peptide arrays as part of a comprehensive atlas of human Ser/Thr kinase specificities (johnson2023anatlasof pages 1-2). This resource specifies the preferred amino acids at positions -3, -2, -1, +1, +2, and +3 relative to the phosphorylation site (johnson2023anatlasof pages 1-2, johnson2023anatlasof pages 12-18, johnson2023anatlasof pages 18-20). The specific amino acid preferences for the MAP3K12 motif are contained within the supplementary data files of the Johnson et al., 2023 publication, but are not explicitly stated within the provided text excerpts (johnson2023anatlasof pages 21-23, johnson2023anatlasof pages 4-5). Based on hierarchical clustering of motif selectivity, MAP3K12 is grouped within the MAP3K cluster (cluster 9) (johnson2023anatlasof pages 4-5).

## Structure

The domain organization of MAP3K12 is described with some contradiction. Most sources describe an N-terminal dual leucine zipper motif followed by a C-terminal kinase domain (koster2024regulationofthe pages 1-2, koster2024regulationofthe pages 8-9, gallo2002mixedlineagekinasecontrol pages 3-4, mooney2004dockinginteractionsin pages 1-2). Other sources place the kinase domain at the N-terminus followed by leucine zippers (hebert2000themixedlineage pages 1-1, gallo2002mixedlineagekinasecontrol pages 1-2). \* **Dual Leucine Zipper Motifs**: These motifs mediate protein-protein interactions, including the homodimerization essential for kinase activation and interaction with scaffold proteins like JIP-1 (koster2024regulationofthe pages 1-2, gallo2002mixedlineagekinasecontrol pages 2-3, gallo2002mixedlineagekinasecontrol pages 3-4, nihalani2001mixedlineagekinasedependent pages 1-2). \* **Kinase Domain**: This domain possesses serine/threonine kinase activity and contains an activation loop that requires phosphorylation for full activity (koster2024regulationofthe pages 1-2, koster2024regulationofthe pages 11-12, gallo2002mixedlineagekinasecontrol pages 3-4). \* **Other domains/motifs**: The protein also contains a proline-rich region, bipartite nuclear localization signals (NLS), nuclear export signals (NES), and a φLxVP motif (amino acids 362–365) for interacting with calcineurin (koster2024regulationofthe pages 11-12, koster2024regulationofthe pages 9-11, rana2013mixedlineagekinasecjun pages 2-3). One source reports an N-terminal SH3 domain and a Cdc42/Rac interacting binding (CRIB) motif, while another states the SH3 and CRIB domains are absent (koster2024regulationofthe pages 4-6, rana2013mixedlineagekinasecjun pages 1-2, rana2013mixedlineagekinasecjun pages 2-3). AlphaFold predictions indicate the kinase domain has a typical bilobal structure containing a C-helix, which is critical for activation, and a hydrophobic spine that stabilizes the active conformation (koster2024regulationofthe pages 1-2). The activation loop is a flexible region that modulates kinase activity by controlling substrate access (koster2024regulationofthe pages 1-2).

## Regulation

Regulation of MAP3K12 involves protein interactions, post-translational modifications, and control of its expression levels (koster2024regulationofthe pages 1-2, koster2024regulationofthe pages 4-6). \* **Phosphorylation/Dephosphorylation**: Activation requires homodimerization-induced trans-autophosphorylation at Ser-302 within the activation loop (koster2024regulationofthe pages 8-9). PKA can also phosphorylate Ser-302 (koster2024regulationofthe pages 8-9). Additional phosphorylation by JNK and MAP4K family kinases at sites including Thr-43 and Ser-535 stabilizes the protein by inhibiting its interaction with the E3 ligase PHR1 (koster2024regulationofthe pages 8-9). DLK can also be activated by Src kinase-dependent tyrosine phosphorylation (koster2024regulationofthe pages 8-9). The phosphatases PP2A and calcineurin (PP2B) dephosphorylate and negatively regulate DLK (koster2024regulationofthe pages 8-9, koster2024regulationofthe pages 9-11). \* **Ubiquitination**: The E3 ubiquitin ligase PHR (or Highwire/RPM-1) targets DLK for proteasomal degradation (koster2024regulationofthe pages 11-12). This is antagonized by the deubiquitinase USP9X, which stabilizes DLK (koster2024regulationofthe pages 11-12). Interactions with FKBPL and FKBP8 also mediate DLK degradation (koster2024regulationofthe pages 11-12). \* **Palmitoylation**: Palmitoylation at Cys-127, mediated by palmitoyl acyl transferases like ZDHHC17, localizes DLK to vesicles, facilitating its interaction with the JIP3 scaffold protein and activation of JNK signaling (koster2024regulationofthe pages 11-12). \* **Other Modifications**: DLK undergoes SUMOylation and can be inactivated by covalent cross-linking (transglutamination) catalyzed by tissue transglutaminase during apoptosis (koster2024regulationofthe pages 11-12, hebert2000themixedlineage pages 1-1). \* **Protein Interactions**: In a basal state, DLK is held inactive by the scaffold protein JIP/IB1 (koster2024regulationofthe pages 4-6, nihalani2001mixedlineagekinasedependent pages 1-2). Dissociation from JIP allows DLK to homodimerize via its leucine zippers, leading to its activation (koster2024regulationofthe pages 4-6, nihalani2001mixedlineagekinasedependent pages 1-2, gallo2002mixedlineagekinasecontrol pages 2-3). \* **Expression**: Transcriptional regulation involves the Sp3 factor and PPARγ pathways (koster2024regulationofthe pages 4-6). Post-transcriptional downregulation is mediated by microRNAs, including miRNA-130a, miRNA-191-5p, and miR-150-5p, which target MAP3K12 mRNA (koster2024regulationofthe pages 8-9).

## Function

MAP3K12 is highly expressed in neuronal tissues and insulin-producing beta cells and has also been detected in keratinocytes and regenerating liver (koster2024regulationofthe pages 1-2, koster2024regulationofthe pages 4-6, gallo2002mixedlineagekinasecontrol pages 3-4). \* **Signaling Pathway**: DLK is a key kinase in the JNK/SAPK signaling pathway, acting as an upstream activator (nihalani2001mixedlineagekinasedependent pages 1-2, stalheim2007mapkkinasekinase pages 1-4). It is activated by cellular stress and upstream kinases (e.g., MAP4K4, MINK1, TNIK) (koster2024regulationofthe pages 1-2, koster2024regulationofthe pages 15-16, adib2018anaxonalstress pages 6-7). Activated DLK phosphorylates and activates the downstream MAP2K kinases MKK4 and MKK7, with some reports indicating a preference for MKK7 (koster2024regulationofthe pages 1-2, stalheim2007mapkkinasekinase pages 1-4, mooney2004dockinginteractionsin pages 1-2, gallo2002mixedlineagekinasecontrol pages 8-9). MKK4/7 subsequently activate JNK, which phosphorylates targets such as c-Jun (koster2024regulationofthe pages 1-2, koster2024regulationofthe pages 11-12). The pathway contains a positive feedback loop wherein JNK activation promotes further DLK activity (koster2024regulationofthe pages 4-6, koster2024regulationofthe pages 11-12). \* **Biological Roles**: DLK is critical for neuronal development, axonal growth, and retrograde signaling after neuronal injury (koster2024regulationofthe pages 1-2, koster2024regulationofthe pages 11-12). It mediates both pro-regenerative processes and pathological ones such as neuronal apoptosis and axon degeneration (koster2024regulationofthe pages 4-6, larhammar2017theste20family pages 11-11). It is also involved in postnatal beta-cell proliferation and processes such as cell migration, invasion, and cell cycle regulation (koster2024regulationofthe pages 1-2, rana2013mixedlineagekinasecjun pages 1-2). \* **Interacting Partners**: DLK interacts with scaffold proteins (JIP1, JIP3), ubiquitin-related enzymes (PHR1, USP9X), other kinases (PKA, Src, MAP4Ks), and phosphatases (PP2A, calcineurin) (koster2024regulationofthe pages 11-12, koster2024regulationofthe pages 4-6, nihalani2001mixedlineagekinasedependent pages 1-2, koster2024regulationofthe pages 8-9, koster2024regulationofthe pages 9-11).

## Inhibitors

Experimental inhibitors that target MAP3K12 include GDC-0134 and IACS-52825 (koster2024regulationofthe pages 4-6, koster2024regulationofthe pages 15-16). Pan-MLK inhibitors like CEP-1347 and CEP-11004, and repurposed multi-kinase inhibitors such as sunitinib and tozasertib, have also been shown to inhibit DLK (koster2024regulationofthe pages 4-6, rana2013mixedlineagekinasecjun pages 1-2, rana2013mixedlineagekinasecjun pages 2-3).

## Other Comments

MAP3K12 is implicated in several diseases, primarily neurodegenerative disorders like Alzheimer’s disease, Parkinson’s disease, and ALS (koster2024regulationofthe pages 1-2). It is also associated with glaucoma, peripheral neuropathies, early brain injury, type 2 diabetes mellitus, and cancer (koster2024regulationofthe pages 1-2, koster2024regulationofthe pages 15-16, mooney2004dockinginteractionsin pages 1-2, rana2013mixedlineagekinasecjun pages 1-2). In disease models, experimental inhibition of DLK has shown protective effects against neurodegeneration (koster2024regulationofthe pages 1-2).

References

1. (johnson2023anatlasof pages 1-2): Jared L. Johnson, Tomer M. Yaron, Emily M. Huntsman, Alexander Kerelsky, Junho Song, Amit Regev, Ting-Yu Lin, Katarina Liberatore, Daniel M. Cizin, Benjamin M. Cohen, Neil Vasan, Yilun Ma, Konstantin Krismer, Jaylissa Torres Robles, Bert van de Kooij, Anne E. van Vlimmeren, Nicole Andrée-Busch, Norbert F. Käufer, Maxim V. Dorovkov, Alexey G. Ryazanov, Yuichiro Takagi, Edward R. Kastenhuber, Marcus D. Goncalves, Benjamin D. Hopkins, Olivier Elemento, Dylan J. Taatjes, Alexandre Maucuer, Akio Yamashita, Alexei Degterev, Mohamed Uduman, Jingyi Lu, Sean D. Landry, Bin Zhang, Ian Cossentino, Rune Linding, John Blenis, Peter V. Hornbeck, Benjamin E. Turk, Michael B. Yaffe, and Lewis C. Cantley. An atlas of substrate specificities for the human serine/threonine kinome. Nature, 613:759-766, Jan 2023. URL: https://doi.org/10.1038/s41586-022-05575-3, doi:10.1038/s41586-022-05575-3. This article has 446 citations and is from a highest quality peer-reviewed journal.
2. (johnson2023anatlasof pages 12-18): Jared L. Johnson, Tomer M. Yaron, Emily M. Huntsman, Alexander Kerelsky, Junho Song, Amit Regev, Ting-Yu Lin, Katarina Liberatore, Daniel M. Cizin, Benjamin M. Cohen, Neil Vasan, Yilun Ma, Konstantin Krismer, Jaylissa Torres Robles, Bert van de Kooij, Anne E. van Vlimmeren, Nicole Andrée-Busch, Norbert F. Käufer, Maxim V. Dorovkov, Alexey G. Ryazanov, Yuichiro Takagi, Edward R. Kastenhuber, Marcus D. Goncalves, Benjamin D. Hopkins, Olivier Elemento, Dylan J. Taatjes, Alexandre Maucuer, Akio Yamashita, Alexei Degterev, Mohamed Uduman, Jingyi Lu, Sean D. Landry, Bin Zhang, Ian Cossentino, Rune Linding, John Blenis, Peter V. Hornbeck, Benjamin E. Turk, Michael B. Yaffe, and Lewis C. Cantley. An atlas of substrate specificities for the human serine/threonine kinome. Nature, 613:759-766, Jan 2023. URL: https://doi.org/10.1038/s41586-022-05575-3, doi:10.1038/s41586-022-05575-3. This article has 446 citations and is from a highest quality peer-reviewed journal.
3. (johnson2023anatlasof pages 18-20): Jared L. Johnson, Tomer M. Yaron, Emily M. Huntsman, Alexander Kerelsky, Junho Song, Amit Regev, Ting-Yu Lin, Katarina Liberatore, Daniel M. Cizin, Benjamin M. Cohen, Neil Vasan, Yilun Ma, Konstantin Krismer, Jaylissa Torres Robles, Bert van de Kooij, Anne E. van Vlimmeren, Nicole Andrée-Busch, Norbert F. Käufer, Maxim V. Dorovkov, Alexey G. Ryazanov, Yuichiro Takagi, Edward R. Kastenhuber, Marcus D. Goncalves, Benjamin D. Hopkins, Olivier Elemento, Dylan J. Taatjes, Alexandre Maucuer, Akio Yamashita, Alexei Degterev, Mohamed Uduman, Jingyi Lu, Sean D. Landry, Bin Zhang, Ian Cossentino, Rune Linding, John Blenis, Peter V. Hornbeck, Benjamin E. Turk, Michael B. Yaffe, and Lewis C. Cantley. An atlas of substrate specificities for the human serine/threonine kinome. Nature, 613:759-766, Jan 2023. URL: https://doi.org/10.1038/s41586-022-05575-3, doi:10.1038/s41586-022-05575-3. This article has 446 citations and is from a highest quality peer-reviewed journal.
4. (johnson2023anatlasof pages 21-23): Jared L. Johnson, Tomer M. Yaron, Emily M. Huntsman, Alexander Kerelsky, Junho Song, Amit Regev, Ting-Yu Lin, Katarina Liberatore, Daniel M. Cizin, Benjamin M. Cohen, Neil Vasan, Yilun Ma, Konstantin Krismer, Jaylissa Torres Robles, Bert van de Kooij, Anne E. van Vlimmeren, Nicole Andrée-Busch, Norbert F. Käufer, Maxim V. Dorovkov, Alexey G. Ryazanov, Yuichiro Takagi, Edward R. Kastenhuber, Marcus D. Goncalves, Benjamin D. Hopkins, Olivier Elemento, Dylan J. Taatjes, Alexandre Maucuer, Akio Yamashita, Alexei Degterev, Mohamed Uduman, Jingyi Lu, Sean D. Landry, Bin Zhang, Ian Cossentino, Rune Linding, John Blenis, Peter V. Hornbeck, Benjamin E. Turk, Michael B. Yaffe, and Lewis C. Cantley. An atlas of substrate specificities for the human serine/threonine kinome. Nature, 613:759-766, Jan 2023. URL: https://doi.org/10.1038/s41586-022-05575-3, doi:10.1038/s41586-022-05575-3. This article has 446 citations and is from a highest quality peer-reviewed journal.
5. (johnson2023anatlasof pages 4-5): Jared L. Johnson, Tomer M. Yaron, Emily M. Huntsman, Alexander Kerelsky, Junho Song, Amit Regev, Ting-Yu Lin, Katarina Liberatore, Daniel M. Cizin, Benjamin M. Cohen, Neil Vasan, Yilun Ma, Konstantin Krismer, Jaylissa Torres Robles, Bert van de Kooij, Anne E. van Vlimmeren, Nicole Andrée-Busch, Norbert F. Käufer, Maxim V. Dorovkov, Alexey G. Ryazanov, Yuichiro Takagi, Edward R. Kastenhuber, Marcus D. Goncalves, Benjamin D. Hopkins, Olivier Elemento, Dylan J. Taatjes, Alexandre Maucuer, Akio Yamashita, Alexei Degterev, Mohamed Uduman, Jingyi Lu, Sean D. Landry, Bin Zhang, Ian Cossentino, Rune Linding, John Blenis, Peter V. Hornbeck, Benjamin E. Turk, Michael B. Yaffe, and Lewis C. Cantley. An atlas of substrate specificities for the human serine/threonine kinome. Nature, 613:759-766, Jan 2023. URL: https://doi.org/10.1038/s41586-022-05575-3, doi:10.1038/s41586-022-05575-3. This article has 446 citations and is from a highest quality peer-reviewed journal.
6. (koster2024regulationofthe pages 1-2): Kyra-Alexandra Köster, Marten Dethlefs, Jorge Duque Escobar, and Elke Oetjen. Regulation of the activity of the dual leucine zipper kinase by distinct mechanisms. Cells, 13:333, Feb 2024. URL: https://doi.org/10.3390/cells13040333, doi:10.3390/cells13040333. This article has 4 citations and is from a peer-reviewed journal.
7. (koster2024regulationofthe pages 11-12): Kyra-Alexandra Köster, Marten Dethlefs, Jorge Duque Escobar, and Elke Oetjen. Regulation of the activity of the dual leucine zipper kinase by distinct mechanisms. Cells, 13:333, Feb 2024. URL: https://doi.org/10.3390/cells13040333, doi:10.3390/cells13040333. This article has 4 citations and is from a peer-reviewed journal.
8. (koster2024regulationofthe pages 15-16): Kyra-Alexandra Köster, Marten Dethlefs, Jorge Duque Escobar, and Elke Oetjen. Regulation of the activity of the dual leucine zipper kinase by distinct mechanisms. Cells, 13:333, Feb 2024. URL: https://doi.org/10.3390/cells13040333, doi:10.3390/cells13040333. This article has 4 citations and is from a peer-reviewed journal.
9. (koster2024regulationofthe pages 4-6): Kyra-Alexandra Köster, Marten Dethlefs, Jorge Duque Escobar, and Elke Oetjen. Regulation of the activity of the dual leucine zipper kinase by distinct mechanisms. Cells, 13:333, Feb 2024. URL: https://doi.org/10.3390/cells13040333, doi:10.3390/cells13040333. This article has 4 citations and is from a peer-reviewed journal.
10. (nihalani2001mixedlineagekinasedependent pages 1-2): D. Nihalani, D. Meyer, Sangeeta Pajni, and L. Holzman. Mixed lineage kinase-dependent jnk activation is governed by interactions of scaffold protein jip with mapk module components. The EMBO Journal, 20:3447-3458, Jul 2001. URL: https://doi.org/10.1093/emboj/20.13.3447, doi:10.1093/emboj/20.13.3447. This article has 143 citations.
11. (rana2013mixedlineagekinasecjun pages 1-2): A. Rana, B. Rana, Rajakishore Mishra, Gautam Sondarva, Velusamy Rangasamy, Subhasis Das, N. Viswakarma, and A. Kanthasamy. Mixed lineage kinase-c-jun n-terminal kinase axis: a potential therapeutic target in cancer. Genes & Cancer, 4:334-341, Apr 2013. URL: https://doi.org/10.1177/1947601913485415, doi:10.1177/1947601913485415. This article has 42 citations.
12. (rana2013mixedlineagekinasecjun pages 2-3): A. Rana, B. Rana, Rajakishore Mishra, Gautam Sondarva, Velusamy Rangasamy, Subhasis Das, N. Viswakarma, and A. Kanthasamy. Mixed lineage kinase-c-jun n-terminal kinase axis: a potential therapeutic target in cancer. Genes & Cancer, 4:334-341, Apr 2013. URL: https://doi.org/10.1177/1947601913485415, doi:10.1177/1947601913485415. This article has 42 citations.
13. (stalheim2007mapkkinasekinase pages 1-4): Lisa Stalheim and Gary L. Johnson. Mapk kinase kinase regulation of sapk/jnk pathways. Topics in Current Genetics, pages 1-15, 2007. URL: https://doi.org/10.1007/4735\_2007\_0238, doi:10.1007/4735\_2007\_0238. This article has 10 citations and is from a peer-reviewed journal.
14. (adib2018anaxonalstress pages 6-7): Elham Asghari Adib, Laura J Smithson, and Catherine A Collins. An axonal stress response pathway: degenerative and regenerative signaling by dlk. Current Opinion in Neurobiology, 53:110-119, Dec 2018. URL: https://doi.org/10.1016/j.conb.2018.07.002, doi:10.1016/j.conb.2018.07.002. This article has 72 citations and is from a peer-reviewed journal.
15. (chen2016leucinezipperbearingkinase pages 14-15): Meifan Chen, Cédric G. Geoffroy, Hetty N. Wong, Oliver Tress, Mallorie T. Nguyen, Lawrence B. Holzman, Yishi Jin, and Binhai Zheng. Leucine zipper-bearing kinase promotes axon growth in mammalian central nervous system neurons. Scientific Reports, Aug 2016. URL: https://doi.org/10.1038/srep31482, doi:10.1038/srep31482. This article has 43 citations and is from a poor quality or predatory journal.
16. (gallo2002mixedlineagekinasecontrol pages 1-2): Kathleen A. Gallo and Gary L. Johnson. Mixed-lineage kinase control of jnk and p38 mapk pathways. Nature Reviews Molecular Cell Biology, 3:663-672, Sep 2002. URL: https://doi.org/10.1038/nrm906, doi:10.1038/nrm906. This article has 703 citations and is from a domain leading peer-reviewed journal.
17. (gallo2002mixedlineagekinasecontrol pages 2-3): Kathleen A. Gallo and Gary L. Johnson. Mixed-lineage kinase control of jnk and p38 mapk pathways. Nature Reviews Molecular Cell Biology, 3:663-672, Sep 2002. URL: https://doi.org/10.1038/nrm906, doi:10.1038/nrm906. This article has 703 citations and is from a domain leading peer-reviewed journal.
18. (gallo2002mixedlineagekinasecontrol pages 3-4): Kathleen A. Gallo and Gary L. Johnson. Mixed-lineage kinase control of jnk and p38 mapk pathways. Nature Reviews Molecular Cell Biology, 3:663-672, Sep 2002. URL: https://doi.org/10.1038/nrm906, doi:10.1038/nrm906. This article has 703 citations and is from a domain leading peer-reviewed journal.
19. (gallo2002mixedlineagekinasecontrol pages 8-9): Kathleen A. Gallo and Gary L. Johnson. Mixed-lineage kinase control of jnk and p38 mapk pathways. Nature Reviews Molecular Cell Biology, 3:663-672, Sep 2002. URL: https://doi.org/10.1038/nrm906, doi:10.1038/nrm906. This article has 703 citations and is from a domain leading peer-reviewed journal.
20. (hebert2000themixedlineage pages 1-1): Sébastien S. Hébert, Alex Daviau, Gilles Grondin, Mathieu Latreille, Rémy A. Aubin, and Richard Blouin. The mixed lineage kinase dlk is oligomerized by tissue transglutaminase during apoptosis\*. The Journal of Biological Chemistry, 275:32482-32490, Oct 2000. URL: https://doi.org/10.1074/jbc.m006528200, doi:10.1074/jbc.m006528200. This article has 43 citations.
21. (hebert2000themixedlineage pages 9-10): Sébastien S. Hébert, Alex Daviau, Gilles Grondin, Mathieu Latreille, Rémy A. Aubin, and Richard Blouin. The mixed lineage kinase dlk is oligomerized by tissue transglutaminase during apoptosis\*. The Journal of Biological Chemistry, 275:32482-32490, Oct 2000. URL: https://doi.org/10.1074/jbc.m006528200, doi:10.1074/jbc.m006528200. This article has 43 citations.
22. (koster2024regulationofthe pages 8-9): Kyra-Alexandra Köster, Marten Dethlefs, Jorge Duque Escobar, and Elke Oetjen. Regulation of the activity of the dual leucine zipper kinase by distinct mechanisms. Cells, 13:333, Feb 2024. URL: https://doi.org/10.3390/cells13040333, doi:10.3390/cells13040333. This article has 4 citations and is from a peer-reviewed journal.
23. (koster2024regulationofthe pages 9-11): Kyra-Alexandra Köster, Marten Dethlefs, Jorge Duque Escobar, and Elke Oetjen. Regulation of the activity of the dual leucine zipper kinase by distinct mechanisms. Cells, 13:333, Feb 2024. URL: https://doi.org/10.3390/cells13040333, doi:10.3390/cells13040333. This article has 4 citations and is from a peer-reviewed journal.
24. (larhammar2017theste20family pages 11-11): Martin Larhammar, Sarah Huntwork-Rodriguez, York Rudhard, Arundhati Sengupta-Ghosh, and Joseph W. Lewcock. The ste20 family kinases map4k4, mink1, and tnik converge to regulate stress-induced jnk signaling in neurons. The Journal of Neuroscience, 37:11074-11084, Nov 2017. URL: https://doi.org/10.1523/jneurosci.0905-17.2017, doi:10.1523/jneurosci.0905-17.2017. This article has 100 citations.
25. (mooney2004dockinginteractionsin pages 1-2): Lorraine M. Mooney and Alan J. Whitmarsh. Docking interactions in the c-jun n-terminal kinase pathway\*. Journal of Biological Chemistry, 279:11843-11852, Mar 2004. URL: https://doi.org/10.1074/jbc.m311841200, doi:10.1074/jbc.m311841200. This article has 98 citations and is from a domain leading peer-reviewed journal.
26. (yan2012regulationofdlk1 pages 8-10): D. Yan and Yishi Jin. Regulation of dlk-1 kinase activity by calcium-mediated dissociation from an inhibitory isoform. Neuron, 76:534-548, Nov 2012. URL: https://doi.org/10.1016/j.neuron.2012.08.043, doi:10.1016/j.neuron.2012.08.043. This article has 124 citations and is from a highest quality peer-reviewed journal.