

## DAFTAR PUSTAKA

- Alvarez-Castelao, B., & Schuman, E. M. (2015). The Regulation of Synaptic Protein Turnover. *Journal of Biological Chemistry*, 290(48), 28623–28630. <https://doi.org/10.1074/jbc.R115.657130>
- Alves, P. K. N., Cruz, A., Silva, W. J., Melazzo, A. M., Labeit, S., Adams, V., & Moriscot, A. S. (2025). Leucine Supplementation Counteracts the Atrophic Effects of HDAC4 in Rat Skeletal Muscle Submitted to Hindlimb Immobilization. *Muscle & Nerve*, 72(1), 139–148. <https://doi.org/10.1002/mus.28411>
- Apsorn, S., & Koomhin, P. (2020). A Low-Cost Analytical Method for the Morris Water Maze Task using ImageJ. *Walailak Journal of Science and Technology (WJST)*, 17(11), 1194–1199. <https://doi.org/10.48048/wjst.2020.10728>
- Aristoy, M.-C., & Toldrá, F. (2012). *Handbook of Analysis of Active Compounds in Functional Foods* (L. M. L. Nollet & F. Toldra (eds.)). CRC Press. <https://doi.org/10.1201/b11653>
- Bae, H.-G., Kim, T. K., Suk, H. Y., Jung, S., & Jo, D.-G. (2020). White matter and neurological disorders. *Archives of Pharmacal Research*, 43(9), 920–931. <https://doi.org/10.1007/s12272-020-01270-x>
- Bahrani, S., & Drabløs, F. (2016). Gene regulation in the immediate-early response process. *Advances in Biological Regulation*, 62, 37–49. <https://doi.org/10.1016/j.jbior.2016.05.001>
- Beckers, P., Doyen, P. J., & Hermans, E. (2024). Modulation of Type 5 Metabotropic Glutamate Receptor-Mediated Intracellular Calcium Mobilization by Regulator of G Protein Signaling 4 (RGS4) in Cultured Astrocytes. *Cells*, 13(4), 291. <https://doi.org/10.3390/cells13040291>
- Bettio, L. E. B., Rajendran, L., & Gil-Mohapel, J. (2017). The effects of aging in the hippocampus and cognitive decline. *Neuroscience & Biobehavioral Reviews*, 79, 66–86. <https://doi.org/10.1016/j.neubiorev.2017.04.030>
- Blinkouskaya, Y., & Weickenmeier, J. (2021). Brain Shape Changes Associated With Cerebral Atrophy in Healthy Aging and Alzheimer’s Disease. *Frontiers in Mechanical Engineering*, 7. <https://doi.org/10.3389/fmech.2021.705653>
- Bramham, C. R., Worley, P. F., Moore, M. J., & Guzowski, J. F. (2008). The Immediate Early Gene Arc / Arg3.1 : Regulation, Mechanisms, and Function. *The Journal of Neuroscience*, 28(46), 11760–11767. <https://doi.org/10.1523/JNEUROSCI.3864-08.2008>
- Bregestovski, P. D. (2012). The Physiology of Synapses: From Molecular Modules to Retrograde Modulation. *Neuroscience and Behavioral Physiology*, 42(2), 167–179. <https://doi.org/10.1007/s11055-011-9550-2>
- Buel, G. R., Dang, H. Q., Asara, J. M., Blenis, J., & Mutvei, A. P. (2022). Prolonged deprivation of arginine or leucine induces PI3K/Akt-dependent reactivation of mTORC1. *Journal of Biological Chemistry*, 298(6), 102030. <https://doi.org/10.1016/j.jbc.2022.102030>
- Buonarati, O. R., Hammes, E. A., Watson, J. F., Greger, I. H., & Hell, J. W. (2019). Mechanisms of postsynaptic localization of AMPA-type glutamate receptors

- and their regulation during long-term potentiation. *Science Signaling*, *12*(562). <https://doi.org/10.1126/scisignal.aar6889>
- Buscemi, L., Ginet, V., Lopatar, J., Montana, V., Pucci, L., Spagnuolo, P., Zehnder, T., Grubišić, V., Truttman, A., Sala, C., Hirt, L., Parpura, V., Puyal, J., & Bezzi, P. (2017). Homer1 Scaffold Proteins Govern Ca<sup>2+</sup> Dynamics in Normal and Reactive Astrocytes. *Cerebral Cortex*, *27*(3), 2365–2384. <https://doi.org/10.1093/cercor/bhw078>
- Castillo-Vazquez, S. K., Massieu, L., Rincón-Heredia, R., García-de la Torre, P., Quiroz-Baez, R., Gomez-Verjan, J. C., & Rivero-Segura, N. A. (2024). Glutamatergic Neurotransmission in Aging and Neurodegenerative Diseases: A Potential Target to Improve Cognitive Impairment in Aging. *Archives of Medical Research*, *55*(6), 103039. <https://doi.org/10.1016/j.arcmed.2024.103039>
- Caterino, C., Ugolini, M., Durso, W., Jevdokimenko, K., Groth, M., Riege, K., Görlach, M., Fornasiero, E., Ori, A., Hoffmann, S., & Cellerino, A. (2025). Translational Remodeling of the Synaptic Proteome During Aging. *Aging Cell*, *24*(12). <https://doi.org/10.1111/ace1.70262>
- Cechetto, D. F., & Weishaupt, N. (2017). *The Cerebral Cortex in Neurodegenerative and Neuropsychiatric Disorders*. Elsevier. <https://doi.org/10.1016/C2014-0-00060-3>
- Chen, T., Chen, S., Wang, D., & Hung, H. (2020). High-fat diet reduces novelty-induced expression of activity-regulated cytoskeleton-associated protein. *Journal of Cellular Physiology*, *235*(2), 1065–1075. <https://doi.org/10.1002/jcp.29021>
- Chen, T., Zhu, J., Yang, L.-K., Feng, Y., Lin, W., & Wang, Y.-H. (2017). Glutamate-induced rapid induction of Arc/Arg3.1 requires NMDA receptor-mediated phosphorylation of ERK and CREB. *Neuroscience Letters*, *661*, 23–28. <https://doi.org/10.1016/j.neulet.2017.09.024>
- Chiechio, S., Copani, A., Zammataro, M., Battaglia, G., IV, R. W. G., & Nicoletti, F. (2010). Transcriptional regulation of type-2 metabotropic glutamate receptors: an epigenetic path to novel treatments for chronic pain. *Trends in Pharmacological Sciences*, *31*(4), 153–160. <https://doi.org/10.1016/j.tips.2009.12.003>
- Chou, C. J., Affolter, M., & Kussmann, M. (2012). A Nutrigenomics View of Protein Intake. In *Progress in Molecular Biology and Translational Science* (pp. 51–74). <https://doi.org/10.1016/B978-0-12-398397-8.00003-4>
- Chowdhury, S., Shepherd, J. D., Okuno, H., Lyford, G., Petralia, R. S., Plath, N., Kuhl, D., Haganir, R. L., & Worley, P. F. (2006). Arc/Arg3.1 Interacts with the Endocytic Machinery to Regulate AMPA Receptor Trafficking. *Neuron*, *52*(3), 445–459. <https://doi.org/10.1016/j.neuron.2006.08.033>
- Church, D. D., Hirsch, K. R., Kviatkovsky, S. A., Matthews, J. J., Henderson, R. A., Azhar, G., Wolfe, R. R., & Ferrando, A. A. (2025). Effect of 3 Different Daily Protein Intakes in a 2-Meal Eating Pattern on Protein Turnover in Middle Age and Older Adults: A Randomized Controlled Trial. *The Journal of Nutrition*, *155*(5), 1364–1372. <https://doi.org/10.1016/j.tjnut.2024.12.025>
- Correa, A. M. B., Guimarães, J. D. S., dos Santos e Alhadas, E., & Kushmerick, C.

- (2017). Control of neuronal excitability by Group I metabotropic glutamate receptors. *Biophysical Reviews*, 9(5), 835–845. <https://doi.org/10.1007/s12551-017-0301-7>
- Dang, M., Yang, C., Chen, K., Lu, P., Li, H., & Zhang, Z. (2023). Hippocampus-centred grey matter covariance networks predict the development and reversion of mild cognitive impairment. *Alzheimer's Research & Therapy*, 15(1), 27. <https://doi.org/10.1186/s13195-023-01167-z>
- Dauvermann, M. R., Lee, G., & Dawson, N. (2017). Glutamatergic regulation of cognition and functional brain connectivity: insights from pharmacological, genetic and translational schizophrenia research. *British Journal of Pharmacology*, 174(19), 3136–3160. <https://doi.org/10.1111/bph.13919>
- de Souza, J. M., Ferreira-Vieira, T. H., Maciel, E. M. A., Silva, N. C., Lima, I. B. Q., Doria, J. G., Olmo, I. G., & Ribeiro, F. M. (2022). mGluR5 ablation leads to age-related synaptic plasticity impairments and does not improve Huntington's disease phenotype. *Scientific Reports*, 12(1), 8982. <https://doi.org/10.1038/s41598-022-13029-z>
- Deutz, N. E. P., Bauer, J. M., Barazzoni, R., Biolo, G., Boirie, Y., Bosy-Westphal, A., Cederholm, T., Cruz-Jentoft, A., Krznarić, Z., Nair, K. S., Singer, P., Teta, D., Tipton, K., & Calder, P. C. (2014). Protein intake and exercise for optimal muscle function with aging: Recommendations from the ESPEN Expert Group. *Clinical Nutrition*, 33(6), 929–936. <https://doi.org/10.1016/j.clnu.2014.04.007>
- Diehl, K., Hull, R., Morton, D., Pfister, R., Rabemampianina, Y., Smith, D., Vidal, J., & Vorstenbosch, C. Van De. (2001). A good practice guide to the administration of substances and removal of blood, including routes and volumes. *Journal of Applied Toxicology*, 21(1), 15–23. <https://doi.org/10.1002/jat.727>
- Ebert, D. H., & Greenberg, M. E. (2013). Activity-dependent neuronal signalling and autism spectrum disorder. *Nature*, 493(7432), 327–337. <https://doi.org/10.1038/nature11860>
- Eyvani, K., Letafatkar, N., & Babaei, P. (2025). AMPA Receptors Endocytosis Inhibition Attenuates Cognition Deficit Via c-Fos/BDNF Signaling in Amyloid  $\beta$  Neurotoxicity. *Experimental Aging Research*, 51(3), 303–315. <https://doi.org/10.1080/0361073X.2024.2377440>
- Filley, C. M., & Fields, R. D. (2016). White matter and cognition: making the connection. *Journal of Neurophysiology*, 116(5), 2093–2104. <https://doi.org/10.1152/jn.00221.2016>
- Galván, E. J., & Griego, E. (2025). Aging-related adaptations of metabotropic glutamate receptors within the CA3 region of the rat hippocampus. *Neurobiology of Aging*, 156, 111–122. <https://doi.org/10.1016/j.neurobiolaging.2025.08.008>
- Gao, R., Yang, Z., Yan, W., Du, W., Zhou, Y., & Zhu, F. (2022). Protein intake from different sources and cognitive decline over 9 years in community-dwelling older adults. *Frontiers in Public Health*, 10, 1016016. <https://doi.org/10.3389/fpubh.2022.1016016>
- Gasiorowska, A., Wydrych, M., Drapich, P., Zadrozny, M., Steczkowska, M.,

- Niewiadomski, W., & Niewiadomska, G. (2021). The Biology and Pathobiology of Glutamatergic, Cholinergic, and Dopaminergic Signaling in the Aging Brain. *Frontiers in Aging Neuroscience*, 13. <https://doi.org/10.3389/fnagi.2021.654931>
- Giovannini, M. G. (2006). The Role of the Extracellular Signal-regulated Kinase Pathway in Memory Encoding. *Reviews in the Neurosciences*, 17(6). <https://doi.org/10.1515/REVNEURO.2006.17.6.619>
- Hajieva, P., Kuhlmann, C., Luhmann, H. J., & Behl, C. (2009). Impaired calcium homeostasis in aged hippocampal neurons. *Neuroscience Letters*, 451(2), 119–123. <https://doi.org/10.1016/j.neulet.2008.11.068>
- Hasan, G., & Sharma, A. (2020). Regulation of neuronal physiology by Ca<sup>2+</sup> release through the IP3R. *Current Opinion in Physiology*, 17, 1–8. <https://doi.org/10.1016/j.cophys.2020.06.001>
- Hayashi, K., Sekaran, S., Simpson, P., Ebmeier, C. C., Michel, C. R., & Ahn, N. G. (2026). Variable thresholds for phosphorylation targets of the ERK signaling pathway. *Proceedings of the National Academy of Sciences*, 123(6). <https://doi.org/10.1073/pnas.2517889123>
- He, W., & Wu, G. (2020). *Metabolism of Amino Acids in the Brain and Their Roles in Regulating Food Intake* (pp. 167–185). [https://doi.org/10.1007/978-3-030-45328-2\\_10](https://doi.org/10.1007/978-3-030-45328-2_10)
- Henry, F. E., Wang, X., Serrano, D., Perez, A. S., Carruthers, C. J. L., Stuenkel, E. L., & Sutton, M. A. (2018). A Unique Homeostatic Signaling Pathway Links Synaptic Inactivity to Postsynaptic mTORC1. *The Journal of Neuroscience*, 38(9), 2207–2225. <https://doi.org/10.1523/JNEUROSCI.1843-17.2017>
- Hernandez, C. M., McQuail, J. A., Schwabe, M. R., Burke, S. N., Setlow, B., & Bizon, J. L. (2018). Age-Related Declines in Prefrontal Cortical Expression of Metabotropic Glutamate Receptors that Support Working Memory. *Eneuro*, 5(3), ENEURO.0164-18.2018. <https://doi.org/10.1523/ENEURO.0164-18.2018>
- Hu, J.-Y., Wu, F., & Schacher, S. (2006). Two Signaling Pathways Regulate the Expression and Secretion of a Neuropeptide Required for Long-Term Facilitation in Aplysia. *The Journal of Neuroscience*, 26(3), 1026–1035. <https://doi.org/10.1523/JNEUROSCI.4258-05.2006>
- Huang, C., Deng, W., Xu, H., Zhou, C., Zhang, F., Chen, J., Bao, Q., Zhou, X., Liu, M., Li, J., & Liu, C. (2023). Short-chain fatty acids reprogram metabolic profiles with the induction of reactive oxygen species production in human colorectal adenocarcinoma cells. *Computational and Structural Biotechnology Journal*, 21, 1606–1620. <https://doi.org/https://doi.org/10.1016/j.csbj.2023.02.022>
- Ihle-Hansen, H., & Ihle-Hansen, H. (2018). *Aging Brain and Neurological Changes* (pp. 15–20). [https://doi.org/10.1007/978-3-319-57406-6\\_2](https://doi.org/10.1007/978-3-319-57406-6_2)
- Jian Hua, Z., Li, M. C., Hu, Q., Donoghue, P., Jiang, S., Li, J., Li, S., Ren, X., Zhang, Z., Du, J., Yu, Y., Chazot, P., & Lu, C. (2025). CaMKII $\alpha$ -TARPy8 signaling mediates hippocampal synaptic impairment in aging. *Aging Cell*, 24(1). <https://doi.org/10.1111/acel.14349>
- Joint WHO/FAO/UNU Expert Consultation. (2007). Protein and amino acid

- requirements in human nutrition. *World Health Organization Technical Report Series*, 935, 1–265, back cover.
- Katsiardanis, K., Diamantaras, A.-A., Dessypris, N., Michelakos, T., Anastasiou, A., Katsiardani, K.-P., Kanavidis, P., Papadopoulos, F. C., Stefanadis, C., Panagiotakos, D. B., & Petridou, E. T. (2013). Cognitive Impairment and Dietary Habits Among Elders: The Velestino Study. *Journal of Medicinal Food*, 16(4), 343–350. <https://doi.org/10.1089/jmf.2012.0225>
- Keum, M., Lee, B. C., Choe, Y. M., Suh, G.-H., Kim, S. G., Kim, H. S., Hwang, J., Yi, D., & Kim, J. W. (2024). Protein intake and episodic memory: the moderating role of the apolipoprotein E  $\epsilon$ 4 status. *Alzheimer's Research & Therapy*, 16(1), 181. <https://doi.org/10.1186/s13195-024-01546-0>
- Kim, M. J., Dunah, A. W., Wang, Y. T., & Sheng, M. (2005). Differential Roles of NR2A- and NR2B-Containing NMDA Receptors in Ras-ERK Signaling and AMPA Receptor Trafficking. *Neuron*, 46(5), 745–760. <https://doi.org/10.1016/j.neuron.2005.04.031>
- Kim, S., Kim, H., & Um, J. W. (2018). Synapse development organized by neuronal activity-regulated immediate-early genes. *Experimental & Molecular Medicine*, 50(4), 1–7. <https://doi.org/10.1038/s12276-018-0025-1>
- Köhncke, Y., Düzel, S., Sander, M. C., Lindenberger, U., Kühn, S., & Brandmaier, A. M. (2021). Hippocampal and Parahippocampal Gray Matter Structural Integrity Assessed by Multimodal Imaging Is Associated with Episodic Memory in Old Age. *Cerebral Cortex (New York, N.Y. : 1991)*, 31(3), 1464–1477. <https://doi.org/10.1093/cercor/bhaa287>
- Kougias, D. G., Hankosky, E. R., Gulley, J. M., & Juraska, J. M. (2017). Beta-hydroxy-beta-methylbutyrate (HMB) ameliorates age-related deficits in water maze performance, especially in male rats. *Physiology & Behavior*, 170(1), 93–99. <https://doi.org/10.1016/j.physbeh.2016.12.025>
- Krisdyana, B., Hanim, D., & Sugiarto, S. (2021). The Correlation Between Energy, Carbohydrate, Fat and Protein Consumption Level with Demensia in Elderly. *Media Gizi Indonesia*, 16(1), 72. <https://doi.org/10.20473/mgi.v16i1.72-78>
- Langille, J. J., & Brown, R. E. (2018). The Synaptic Theory of Memory: A Historical Survey and Reconciliation of Recent Opposition. *Frontiers in Systems Neuroscience*, 12. <https://doi.org/10.3389/fnsys.2018.00052>
- Li, F., He, R., Yue, Z., Yi, H., Lu, L., Zhang, L., Shi, J., Zheng, C., Jiao, J., Peng, J., Li, B., & Rong, S. (2025). Effect of a 12-mo intervention with whey protein powder on cognitive function in older adults with mild cognitive impairment: a randomized controlled trial. *The American Journal of Clinical Nutrition*, 121(2), 256–264. <https://doi.org/10.1016/j.ajcnut.2024.11.019>
- Livak, K. J., & Schmittgen, T. D. (2001). Analysis of Relative Gene Expression Data Using Real-Time Quantitative PCR and the 2 $^{-\Delta\Delta CT}$  Method. *Methods*, 25(4), 402–408. <https://doi.org/10.1006/meth.2001.1262>
- Lutzu, S., & Castillo, P. E. (2021). Modulation of NMDA Receptors by G-protein-coupled receptors: Role in Synaptic Transmission, Plasticity and Beyond. *Neuroscience*, 456, 27–42. <https://doi.org/10.1016/j.neuroscience.2020.02.019>
- Mabb, A. M., & Ehlers, M. D. (2018). Arc ubiquitination in synaptic plasticity.

- Seminars in Cell & Developmental Biology*, 77, 10–16. <https://doi.org/10.1016/j.semcd.2017.09.009>
- Manhas, R., & Rath, P. C. (2020). Ribosome, Protein Synthesis, and Aging. In *Models, Molecules and Mechanisms in Biogerontology* (pp. 67–87). Springer Singapore. [https://doi.org/10.1007/978-981-32-9005-1\\_4](https://doi.org/10.1007/978-981-32-9005-1_4)
- Márquez-Mota, C., Rodriguez-Gaytan, C., Adjibade, P., Mazroui, R., Gálvez, A., Granados, O., Tovar, A., & Torres, N. (2016). The mTORC1-Signaling Pathway and Hepatic Polyribosome Profile Are Enhanced after the Recovery of a Protein Restricted Diet by a Combination of Soy or Black Bean with Corn Protein. *Nutrients*, 8(9), 573. <https://doi.org/10.3390/nu8090573>
- Mateos-Aparicio, P., & Rodríguez-Moreno, A. (2020). *Calcium Dynamics and Synaptic Plasticity* (pp. 965–984). [https://doi.org/10.1007/978-3-030-12457-1\\_38](https://doi.org/10.1007/978-3-030-12457-1_38)
- Ménard, C., & Quirion, R. (2012). Successful Cognitive Aging in Rats: A Role for mGluR5 Glutamate Receptors, Homer 1 Proteins and Downstream Signaling Pathways. *PLoS ONE*, 7(1), e28666. <https://doi.org/10.1371/journal.pone.0028666>
- Merlo, S. A., Belluscio, M. A., Pedreira, M. E., & Merlo, E. (2024). Memory persistence: from fundamental mechanisms to translational opportunities. *Translational Psychiatry*, 14(1), 98. <https://doi.org/10.1038/s41398-024-02808-z>
- Messaoudi, E., Kanhema, T., Soulé, J., Tiron, A., Dageyte, G., da Silva, B., & Bramham, C. R. (2007). Sustained Arc/Arg3.1 Synthesis Controls Long-Term Potentiation Consolidation through Regulation of Local Actin Polymerization in the Dentate Gyrus In Vivo. *The Journal of Neuroscience*, 27(39), 10445–10455. <https://doi.org/10.1523/JNEUROSCI.2883-07.2007>
- Mohammadi, H., Jamshidi, S., Khajepour, H., Adibi, I., Rahimiforoushani, A., Karimi, S., Serej, N. D., & Alam, N. R. (2024). Unveiling Glutamate Dynamics: Cognitive Demands in Human Short-Term Memory Learning Across Frontal and Parieto-Occipital Cortex: A Functional MRS Study. *Journal of Biomedical Physics and Engineering*, 14(6), 519–532. <https://doi.org/10.31661/jbpe.v0i0.2407-1789>
- Mozafari, R., Karimi-Haghighi, S., Fattahi, M., Kalivas, P., & Haghparast, A. (2023). A review on the role of metabotropic glutamate receptors in neuroplasticity following psychostimulant use disorder. *Progress in Neuro-Psychopharmacology and Biological Psychiatry*, 124, 110735. <https://doi.org/10.1016/j.pnpbp.2023.110735>
- Musumeci, G., Castrogiovanni, P., Castorina, S., Imbesi, R., Szychlinska, M. A., Scuderi, S., Loreto, C., & Giunta, S. (2015). Changes in serotonin (5-HT) and brain-derived neurotrophic factor (BDNF) expression in frontal cortex and hippocampus of aged rat treated with high tryptophan diet. *Brain Research Bulletin*, 119, 12–18. <https://doi.org/10.1016/j.brainresbull.2015.09.010>
- Nair, A. B., & Jacob, S. (2016). A simple practice guide for dose conversion between animals and human. *Journal of Basic and Clinical Pharmacy*, 7(2), 27–31. <https://doi.org/10.4103/0976-0105.177703>
- Nakayama, K., Saito, Y., Sanbongi, C., Murata, K., & Urashima, T. (2021). Effects

- of low-dose milk protein supplementation following low-to-moderate intensity exercise training on muscle mass in healthy older adults: a randomized placebo-controlled trial. *European Journal of Nutrition*, 60(2), 917–928. <https://doi.org/10.1007/s00394-020-02302-4>
- Nikolaienko, O., Patil, S., Eriksen, M. S., & Bramham, C. R. (2018). Arc protein: a flexible hub for synaptic plasticity and cognition. *Seminars in Cell & Developmental Biology*, 77, 33–42. <https://doi.org/10.1016/j.semdb.2017.09.006>
- Niswender, C. M., & Conn, P. J. (2010). Metabotropic Glutamate Receptors: Physiology, Pharmacology, and Disease. *Annual Review of Pharmacology and Toxicology*, 50(1), 295–322. <https://doi.org/10.1146/annurev.pharmtox.011008.145533>
- Niu, Y., Zeng, X., Zhao, L., Zhou, Y., Qin, G., Zhang, D., Fu, Q., Zhou, J., & Chen, L. (2020). Metabotropic glutamate receptor 5 regulates synaptic plasticity in a chronic migraine rat model through the PKC/NR2B signal. *The Journal of Headache and Pain*, 21(1), 139. <https://doi.org/10.1186/s10194-020-01206-2>
- Oran, D. S., Temel, Z., Başer, İ. G., Temizyürek, A., & Selcan, A. (2024). Optimization of Morris Water Maze Protocols: Effects of Water Temperature and Hypothermia on Spatial Learning and Memory in Aged Female Rats. *Turkish Journal of Geriatrics*, 27(4), 398–408. <https://doi.org/10.29400/tjgeri.2024.413>
- Oran, D. S., Yildiz, Z., Temizyürek, A., & Selcan, A. (2022). Effects of waiting time between trials and water temperature on cognitive functions, body temperature and body weight in rats in Morris water maze. *Journal of Istanbul Veterinary Sciences*, 6(2), 70–75. <https://doi.org/10.30704/http-www-jivs-net.1115170>
- Othman, M. Z., Hassan, Z., & Che Has, A. T. (2022). Morris water maze: a versatile and pertinent tool for assessing spatial learning and memory. *Experimental Animals*, 71(3), 21–0120. <https://doi.org/10.1538/expanim.21-0120>
- Park, H., Han, K.-S., Seo, J., Lee, J., Dravid, S. M., Woo, J., Chun, H., Cho, S., Bae, J. Y., An, H., Koh, W., Yoon, B.-E., Berlinguer-Palmini, R., Mannaioni, G., Traynelis, S. F., Bae, Y. C., Choi, S.-Y., & Lee, C. J. (2015). Channel-mediated astrocytic glutamate modulates hippocampal synaptic plasticity by activating postsynaptic NMDA receptors. *Molecular Brain*, 8(1), 7. <https://doi.org/10.1186/s13041-015-0097-y>
- Paudel, S., Wu, G., & Wang, X. (2021). *Amino Acids in Cell Signaling: Regulation and Function* (pp. 17–33). [https://doi.org/10.1007/978-3-030-74180-8\\_2](https://doi.org/10.1007/978-3-030-74180-8_2)
- Penner, M. R., Roth, T. L., Chawla, M. K., Hoang, L. T., Roth, E. D., Lubin, F. D., Sweatt, J. D., Worley, P. F., & Barnes, C. A. (2011). Age-related changes in Arc transcription and DNA methylation within the hippocampus. *Neurobiology of Aging*, 32(12), 2198–2210. <https://doi.org/10.1016/j.neurobiolaging.2010.01.009>
- Pereda, D., Al-Osta, I., Okorochoa, A. E., Easton, A., & Hartell, N. A. (2019). Changes in presynaptic calcium signalling accompany age-related deficits in hippocampal LTP and cognitive impairment. *Aging Cell*, 18(5). <https://doi.org/10.1111/acel.13008>

- Purgert, C. A., Izumi, Y., Jong, Y.-J. I., Kumar, V., Zorumski, C. F., & O'Malley, K. L. (2014). Intracellular mGluR5 Can Mediate Synaptic Plasticity in the Hippocampus. *The Journal of Neuroscience*, *34*(13), 4589–4598. <https://doi.org/10.1523/JNEUROSCI.3451-13.2014>
- Qiu, L., Huang, Q., Li, W., Zhang, Q., Zhou, J., Chen, J., Li, Y., Wang, R., Wang, P., Liu, S., Fang, B., & Wang, X. (2025). Aging influences protein digestion, absorption and amino acid metabolism. *Biogerontology*, *26*(4), 146. <https://doi.org/10.1007/s10522-025-10289-w>
- Reagan-Shaw, S., Nihal, M., & Ahmad, N. (2008). Dose translation from animal to human studies revisited. *The FASEB Journal*, *22*(3), 659–661. <https://doi.org/10.1096/fj.07-9574LSF>
- Rial Verde, E. M., Lee-Osbourne, J., Worley, P. F., Malinow, R., & Cline, H. T. (2006). Increased Expression of the Immediate-Early Gene Arc/Arg3.1 Reduces AMPA Receptor-Mediated Synaptic Transmission. *Neuron*, *52*(3), 461–474. <https://doi.org/10.1016/j.neuron.2006.09.031>
- Ringsevjen, H., Umbach Hansen, H. M., Hussain, S., Hvalby, Ø., Jensen, V., Walaas, S. I., & Davanger, S. (2019). Presynaptic increase in IP3 receptor type 1 concentration in the early phase of hippocampal synaptic plasticity. *Brain Research*, *1706*, 125–134. <https://doi.org/10.1016/j.brainres.2018.10.030>
- Rogers, J., Churilov, L., Hannan, A. J., & Renoir, T. (2017). Search strategy selection in the Morris water maze indicates allocentric map formation during learning that underpins spatial memory formation. *Neurobiology of Learning and Memory*, *139*, 37–49. <https://doi.org/10.1016/j.nlm.2016.12.007>
- Salcedo, C., Andersen, J. V., Vinten, K. T., Pinborg, L. H., Waagepetersen, H. S., Freude, K. K., & Aldana, B. I. (2021). Functional Metabolic Mapping Reveals Highly Active Branched-Chain Amino Acid Metabolism in Human Astrocytes, Which Is Impaired in iPSC-Derived Astrocytes in Alzheimer's Disease. *Frontiers in Aging Neuroscience*, *13*. <https://doi.org/10.3389/fnagi.2021.736580>
- Sato, H., Tsukamoto-Yasui, M., Takado, Y., Kawasaki, N., Matsunaga, K., Ueno, S., Kanda, M., Nishimura, M., Karakawa, S., Isokawa, M., Suzuki, K., Nagao, K., Higuchi, M., & Kitamura, A. (2020). Protein Deficiency-Induced Behavioral Abnormalities and Neurotransmitter Loss in Aged Mice Are Ameliorated by Essential Amino Acids. *Frontiers in Nutrition*, *7*. <https://doi.org/10.3389/fnut.2020.00023>
- Schimanski, L. A., & Barnes, C. A. (2010). Neural protein synthesis during aging: effects on plasticity and memory. *Frontiers in Aging Neuroscience*. <https://doi.org/10.3389/fnagi.2010.00026>
- Sethna, F., Zhang, M., Kaphzan, H., Klann, E., Autio, D., Cox, C. L., & Wang, H. (2016). Calmodulin activity regulates group I metabotropic glutamate receptor-mediated signal transduction and synaptic depression. *Journal of Neuroscience Research*, *94*(5), 401–408. <https://doi.org/10.1002/jnr.23719>
- Shahidi, S., Motamedi, F., & Naghdi, N. (2004). Effect of reversible inactivation of the supramammillary nucleus on spatial learning and memory in rats. *Brain Research*, *1026*(2), 267–274. <https://doi.org/10.1016/j.brainres.2004.08.030>
- Shen, Y., Hua, L., Yeh, C.-K., Shen, L., Ying, M., Zhang, Z., Liu, G., Li, S., Chen,

- S., Chen, X., & Yang, X. (2020). Ultrasound with microbubbles improves memory, ameliorates pathology and modulates hippocampal proteomic changes in a triple transgenic mouse model of Alzheimer's disease. *Theranostics*, *10*(25), 11794–11819. <https://doi.org/10.7150/thno.44152>
- Sheng, R., Zhao, M., Pu, K., Zhou, Y., Zeng, L., Chen, Y., Wang, P., Liu, X., & Xu, S. (2025). Allium Macrostemon Bge. Attenuates the Cognitive Decline of Aging Mice by Enhancing BDNF / TrkB Pathway. *Food Science & Nutrition*, *13*(3). <https://doi.org/10.1002/fsn3.70010>
- Shin, S., Kwon, O., Kang, J. I., Kwon, S., Oh, S., Choi, J., Kim, C. H., & Kim, D. G. (2015). mGluR5 in the nucleus accumbens is critical for promoting resilience to chronic stress. *Nature Neuroscience*, *18*(7), 1017–1024. <https://doi.org/10.1038/nn.4028>
- Siddiqui, N., Sharma, A., Kesharwani, A., Anurag, & Parihar, V. K. (2024). Exploring role of natural compounds in molecular alterations associated with brain ageing: A perspective towards nutrition for ageing brain. *Ageing Research Reviews*, *97*, 102282. <https://doi.org/10.1016/j.arr.2024.102282>
- Siddoway, B., Hou, H., & Xia, H. (2014). Molecular mechanisms of homeostatic synaptic downscaling. *Neuropharmacology*, *78*, 38–44. <https://doi.org/10.1016/j.neuropharm.2013.07.009>
- Simonyi, A., Ngomba, R. T., Storto, M., Catania, M. V., Miller, L. A., Youngs, B., DiGiorgi-Gerevini, V., Nicoletti, F., & Sun, G. Y. (2005). Expression of groups I and II metabotropic glutamate receptors in the rat brain during aging. *Brain Research*, *1043*(1–2), 95–106. <https://doi.org/10.1016/j.brainres.2005.02.046>
- Stein, I. S., Donaldson, M. S., & Hell, J. W. (2014). CaMKII binding to GluN2B is important for massed spatial learning in the Morris water maze. *F1000Research*, *3*, 193. <https://doi.org/10.12688/f1000research.4660.1>
- Su, Z.-W., Liao, J., Zhang, H., Zhang, T., Wu, F., Tian, X.-H., Zhang, F.-T., Sun, W.-W., & Cui, Q. (2015). Postnatal high-protein diet improves learning and memory in premature rats via activation of mTOR signaling. *Brain Research*, *1611*, 1–7. <https://doi.org/10.1016/j.brainres.2015.01.052>
- Sudakov, S. K., Alekseeva, E. V., Nazarova, G. A., & Bashkatova, V. G. (2021). Age-Related Individual Behavioural Characteristics of Adult Wistar Rats. *Animals*, *11*(8), 2282. <https://doi.org/10.3390/ani11082282>
- Tang, Y., Feng, P., Gui, S., Jin, X., Zhu, J., & Lu, X. (2020). The Protective Effects of Protein-Enriched Fraction from Housefly (*Musca domestica*) against Aged-Related Brain Aging. *Journal of Nutritional Science and Vitaminology*, *66*(5), 409–416. <https://doi.org/10.3177/jnsv.66.409>
- Todd, A. C., & Hardingham, G. E. (2020). The Regulation of Astrocytic Glutamate Transporters in Health and Neurodegenerative Diseases. *International Journal of Molecular Sciences*, *21*(24), 9607. <https://doi.org/10.3390/ijms21249607>
- Traylor, D. A., Gorissen, S. H. M., & Phillips, S. M. (2018). Perspective: Protein Requirements and Optimal Intakes in Aging: Are We Ready to Recommend More Than the Recommended Daily Allowance? *Advances in Nutrition*, *9*(3), 171–182. <https://doi.org/10.1093/advances/nmy003>
- Tuena, C., Mancuso, V., Stramba-Badiale, C., Pedroli, E., Stramba-Badiale, M.,

- Riva, G., & Repetto, C. (2021). Egocentric and Allocentric Spatial Memory in Mild Cognitive Impairment with Real-World and Virtual Navigation Tasks: A Systematic Review. *Journal of Alzheimer's Disease*, 79(1), 95–116. <https://doi.org/10.3233/JAD-201017>
- Valdés-Undurraga, I., Lobos, P., Sánchez-Robledo, V., Arias-Cavieres, A., SanMartín, C. D., Barrientos, G., More, J., Muñoz, P., Paula-Lima, A. C., Hidalgo, C., & Adasme, T. (2023). Long-term potentiation and spatial memory training stimulate the hippocampal expression of RyR2 calcium release channels. *Frontiers in Cellular Neuroscience*, 17. <https://doi.org/10.3389/fncel.2023.1132121>
- VanGuilder, H. D., Yan, H., Farley, J. A., Sonntag, W. E., & Freeman, W. M. (2010). Aging alters the expression of neurotransmission-regulating proteins in the hippocampal synaptoproteome. *Journal of Neurochemistry*, 113(6), 1577–1588. <https://doi.org/10.1111/j.1471-4159.2010.06719.x>
- Velho, S., Marques-Vidal, P., Baptista, F., & Camilo, M. E. (2008). Dietary intake adequacy and cognitive function in free-living active elderly: A cross-sectional and short-term prospective study. *Clinical Nutrition*, 27(1), 77–86. <https://doi.org/10.1016/j.clnu.2007.10.011>
- Venerosi, A., Martire, A., Rungi, A., Pieri, M., Ferrante, A., Zona, C., Popoli, P., & Calamandrei, G. (2011). Complex behavioral and synaptic effects of dietary branched chain amino acids in a mouse model of amyotrophic lateral sclerosis. *Molecular Nutrition & Food Research*, 55(4), 541–552. <https://doi.org/10.1002/mnfr.201000296>
- Vorhees, C. V., & Williams, M. T. (2006). Morris water maze: procedures for assessing spatial and related forms of learning and memory. *Nature Protocols*, 1(2), 848–858. <https://doi.org/10.1038/nprot.2006.116>
- Wan Mohammad, W. M. Z. (2017). Sample Size Calculation in Animal Studies Using Resource Equation Approach. *Malaysian Journal of Medical Sciences*, 24(5), 101–105. <https://doi.org/10.21315/mjms2017.24.5.11>
- Wang, H., & Peng, R.-Y. (2016). Basic roles of key molecules connected with NMDAR signaling pathway on regulating learning and memory and synaptic plasticity. *Military Medical Research*, 3(1), 26. <https://doi.org/10.1186/s40779-016-0095-0>
- Waung, M. W., Pfeiffer, B. E., Nosyreva, E. D., Ronesi, J. A., & Huber, K. M. (2008). Rapid Translation of Arc/Arg3.1 Selectively Mediates mGluR-Dependent LTD through Persistent Increases in AMPAR Endocytosis Rate. *Neuron*, 59(1), 84–97. <https://doi.org/10.1016/j.neuron.2008.05.014>
- Wijetunge, M. N. R., Gayantha, D. W. K., & Chandrasekera, T. (2025). Role of spatial memory in spatial design: A systematic review. *Learning and Motivation*, 92, 102166. <https://doi.org/10.1016/j.lmot.2025.102166>
- Xu, X., Yin, Y., Niu, L., Yang, X., Du, X., & Tian, Q. (2022). Association between Changes in Protein Intake and Risk of Cognitive Impairment: A Prospective Cohort Study. *Nutrients*, 15(1), 2. <https://doi.org/10.3390/nu15010002>
- Yang, L., Liu, W., Shi, L., Wu, J., Zhang, W., Chuang, Y.-A., Redding-Ochoa, J., Kirkwood, A., Savonenko, A. V., & Worley, P. F. (2023). NMDA Receptor–Arc Signaling Is Required for Memory Updating and Is Disrupted in

- Alzheimer's Disease. *Biological Psychiatry*, 94(9), 706–720. <https://doi.org/10.1016/j.biopsych.2023.02.008>
- Yang, Z., Wen, J., Erus, G., Govindarajan, S. T., Melhem, R., Mamourian, E., Cui, Y., Srinivasan, D., Abdulkadir, A., Parmpi, P., Wittfeld, K., Grabe, H. J., Bülow, R., Frenzel, S., Tosun, D., Bilgel, M., An, Y., Yi, D., Marcus, D. S., ... Davatzikos, C. (2024). Brain aging patterns in a large and diverse cohort of 49,482 individuals. *Nature Medicine*, 30(10), 3015–3026. <https://doi.org/10.1038/s41591-024-03144-x>
- Yeh, T.-S., Yuan, C., Ascherio, A., Rosner, B. A., Blacker, D., & Willett, W. C. (2022). Long-term dietary protein intake and subjective cognitive decline in US men and women. *The American Journal of Clinical Nutrition*, 115(1), 199–210. <https://doi.org/10.1093/ajcn/nqab236>
- Yerna, X., Schakman, O., Ratbi, I., Kreis, A., Lepannetier, S., de Clippele, M., Achouri, Y., Tajeddine, N., Tissir, F., Gualdani, R., & Gailly, P. (2020). Role of the TRPC1 Channel in Hippocampal Long-Term Depression and in Spatial Memory Extinction. *International Journal of Molecular Sciences*, 21(5), 1712. <https://doi.org/10.3390/ijms21051712>
- Yu, Y., Fuscoe, J. C., Zhao, C., Guo, C., Jia, M., Qing, T., Bannon, D. I., Lancashire, L., Bao, W., Du, T., Luo, H., Su, Z., Jones, W. D., Moland, C. L., Branham, W. S., Qian, F., Ning, B., Li, Y., Hong, H., ... Wang, C. (2014). A rat RNA-Seq transcriptomic BodyMap across 11 organs and 4 developmental stages. *Nature Communications*, 5(1), 3230. <https://doi.org/10.1038/ncomms4230>
- Yudkoff, M., Daikhin, Y., Nissim, I., Horyn, O., Luhovyy, B., Lazarow, A., & Nissim, I. (2005). Brain Amino Acid Requirements and Toxicity: The Example of Leucine. *The Journal of Nutrition*, 135(6), 1531S-1538S. <https://doi.org/10.1093/jn/135.6.1531S>
- Zheng, X., Zhou, F., Zhang, Q., Zheng, W., Shi, F., Li, R., Lv, J., & Li, Q. (2025). Exploring the Effects of Changes in Dietary Protein Content on Naturally Aging Mice Based on Comprehensive Quantitative Scoring and Metabolomic Analysis. *Nutrients*, 17(9), 1542. <https://doi.org/10.3390/nu17091542>