

References

- Baillie, G. S. (2009). Compartmentalized signalling: Spatial regulation of cAMP by the action of compartmentalized phosphodiesterases. *The FEBS Journal*, 276(7), 1790–1799.
- Beazely, M. A., & Watts, V. J. (2006). Regulatory properties of adenylate cyclases type 5 and 6: A progress report. *European Journal of Pharmacology*, 535(1–3), 1–12.
- Biel, M., & Michalakis, S. (2009). Cyclic nucleotide-gated channels. *Handbook of Experimental Pharmacology*(191), 111–136.
- Blokland, A., Schreiber, R., & Prickaerts, J. (2006). Improving memory: A role for phosphodiesterases. *Current Pharmaceutical Design*, 12(20), 2511–2523.
- Bredt, D. S., & Snyder, S. H. (1992). Nitric oxide, a novel neuronal messenger. *Neuron*, 8(1), 3–11.
- Cali, J. J., Zwaagstra, J. C., Mons, N., Cooper, D. M., & Krupinski, J. (1994). Type VIII adenylyl cyclase. A Ca^{2+} /calmodulin-stimulated enzyme expressed in discrete regions of rat brain. *Journal of Biological Chemistry*, 269(16), 12190–12195.
- Cao, J. L., Vialou, V. F., Lobo, M. K., Robison, A. J., Neve, R. L., Cooper, D. C., et al. (2010). Essential role of the cAMP–cAMP response-element binding protein pathway in opiate-induced homeostatic adaptations of locus coeruleus neurons. *Proceedings of the National Academy of Sciences of the United States of America*, 107(39), 17011–17016.
- Chen, Y., Cann, M. J., Litvin, T. N., Iourgenko, V., Sinclair, M. L., Levin, L. R., et al. (2000). Soluble adenylyl cyclase as an evolutionarily conserved bicarbonate sensor. *Science*, 289(5479), 625–628.
- Conti, A. C., Maas, J. W., Jr., Muglia, L. M., Dave, B. A., Vogt, S. K., Tran, T. T., et al. (2007). Distinct regional and subcellular localization of adenylyl

- cyclases type 1 and 8 in mouse brain. *Neuroscience*, 146(2), 713–729.
- Coskran, T. M., Morton, D., Menniti, F. S., Adamowicz, W. O., Kleiman, R. J., Ryan, A. M., et al. (2006). Immunohistochemical localization of phosphodiesterase 10A in multiple mammalian species. *Journal of Histochemistry and Cytochemistry*, 54(11), 1205–1213.
- Defer, N., Best-Belpomme, M., & Hanoune, J. (2000). Tissue specificity and physiological relevance of various isoforms of adenylyl cyclase. *American Journal of Physiology – Renal Physiology*, 279(3), F400–F416.
- Domek-Lopacinska, K., & Strosznajder, J. B. (2005). Cyclic GMP metabolism and its role in brain physiology. *Journal of Physiology and Pharmacology*, 56(Suppl. 2), 15–34.
- Domek-Lopacinska, K. U., & Strosznajder, J. B. (2010). Cyclic GMP and nitric oxide synthase in aging and Alzheimer's disease. *Molecular Neurobiology*, 41(2–3), 129–137.
- Duman, R. S., & Enna, S. J. (1987). Modulation of receptor-mediated cyclic AMP production in brain. *Neuropharmacology*, 26(7B), 981–986.
- Esposito, G., Jaiswal, B. S., Xie, F., Krajnc-Franken, M. A., Robben, T. J., Strik, A. M., et al. (2004). Mice deficient for soluble adenylyl cyclase are infertile because of a severe sperm-motility defect. *Proceedings of the National Academy of Sciences of the United States of America*, 101(9), 2993–2998.
- Feil, R., & Kleppisch, T. (2008). NO/cGMP-dependent modulation of synaptic transmission. *Handbook of Experimental Pharmacology*(184), 529–560.
- Francis, S. H., Busch, J. L., Corbin, J. D., & Sibley, D. (2010). cGMP-dependent protein kinases and cGMP phosphodiesterases in nitric oxide and cGMP action. *Pharmacological Reviews*, 62(3), 525–563.
- Gloerich, M., & Bos, J. L. (2010). Epac: Defining a new mechanism for cAMP action. *Annual*

Review of Pharmacology and Toxicology, 50, 355–375.

- Haghikia, A., Mergia, E., Fribe, A., Eysel, U. T., Koesling, D., & Mittmann, T. (2007). Long-term potentiation in the visual cortex requires both nitric oxide receptor guanylyl cyclases. *Journal of Neuroscience*, 27(4), 818–823.
- Hashimoto, Y., Sharma, R. K., & Soderling, T. R. (1989). Regulation of Ca^{2+} /calmodulin-dependent cyclic nucleotide phosphodiesterase by the autophosphorylated form of Ca^{2+} /calmodulin-dependent protein kinase II. *Journal of Biological Chemistry*, 264(18), 10884–10887.
- Hofmann, F., Bernhard, D., Lukowski, R., & Weinmeister, P. (2009). cGMP regulated protein kinases (cGK). *Handbook of Experimental Pharmacology*(191), 137–162.
- Hope, B. T., Michael, G. J., Knigge, K. M., & Vincent, S. R. (1991). Neuronal NADPH diaphorase is a nitric oxide synthase. *Proceedings of the National Academy of Sciences of the United States of America*, 88(7), 2811–2814.
- Hu, B., Nakata, H., Gu, C., De Beer, T., & Cooper, D. M. (2002). A critical interplay between Ca^{2+} inhibition and activation by Mg^{2+} of AC5 revealed by mutants and chimeric constructs. *Journal of Biological Chemistry*, 277(36), 33139–33147.
- Iwamoto, T., Okumura, S., Iwatsubo, K., Kawabe, J., Ohtsu, K., Sakai, I., et al. (2003). Motor dysfunction in type 5 adenylyl cyclase-null mice. *Journal of Biological Chemistry*, 278(19), 16936–16940.
- Jaiswal, B. S., & Conti, M. (2003). Calcium regulation of the soluble adenylyl cyclase expressed in mammalian spermatozoa. *Proceedings of the National Academy of Sciences of the United States of America*, 100(19), 10676–10681.
- Kamenetsky, M., Middelhaufe, S., Bank, E. M., Levin, L. R., Buck, J., & Steegborn, C. (2006).

Molecular details of cAMP generation in mammalian cells: A tale of two systems.

Journal of Molecular Biology, 362(4), 623–639.

Kaupp, U. B., & Seifert, R. (2002). Cyclic nucleotide-gated ion channels. *Physiological Reviews*, 82(3), 769–824.

Kinasource. (2010). [cited 2010 Dec. 20, 2010]; Available from: [□http://www.kinasource.co.uk/Database/P%20substrates/PKA%20substrates.html□](http://www.kinasource.co.uk/Database/P%20substrates/PKA%20substrates.html).

Kleppisch, T., & Feil, R. (2009). cGMP signalling in the mammalian brain: Role in synaptic plasticity and behaviour. *Handbook of Experimental Pharmacology*(191), 549–579.

Kuhn, M. (2009). Function and dysfunction of mammalian membrane guanylyl cyclase receptors: Lessons from genetic mouse models and implications for human diseases. *Handbook of Experimental Pharmacology*(191), 47–69.

Martinez, S. E., Beavo, J. A., & Hol, W. G. (2002). GAF domains: Two-billion-year-old molecular switches that bind cyclic nucleotides. *Molecular Interventions*, 2(5), 317–323.

Matsuoka, I., Giuili, G., Poyard, M., Stengel, D., Parma, J., Guellaen, G., et al. (1992). Localization of adenylyl and guanylyl cyclase in rat brain by in situ hybridization: Comparison with calmodulin mRNA distribution. *Journal of Neuroscience*, 12(9), 3350–3360.

McPhee, I., Pooley, L., Lobban, M., Bolger, G., & Houslay, M. D. (1995). Identification, characterization and regional distribution in brain of RPDE-6 (RNPDE4A5), a novel splice variant of the PDE4A cyclic AMP phosphodiesterase family. *The Biochemical Journal*, 310(Pt 3), 965–974.

McPhee, I., Gibson, L. C., Kewney, J., Darroch, C., Stevens, P. A., Spinks, D., et al. (2005). Cyclic nucleotide signalling: A molecular approach to drug discovery for Alzheimer's

- disease. *Biochemical Society Transactions*, 33(Pt6), 1330–1332.
- Menniti, F. S., Faraci, W. S., & Schmidt, C. J. (2006). Phosphodiesterases in the CNS: Targets for drug development. *Nature Reviews Drug Discovery*, 5(8), 660–670.
- Miro, X., Perez-Torres, S., Palacios, J. M., Puigdomenech, P., & Mengod, G. (2001). Differential distribution of cAMP-specific phosphodiesterase 7A mRNA in rat brain and peripheral organs. *Synapse*, 40(3), 201–214.
- Nestler, E. J., & Aghajanian, G. K. (1997). Molecular and cellular basis of addiction. *Science*, 278(5335), 58–63.
- Peace, A. G., & Shewan, D. A. (2011). New perspectives in cyclic AMP-mediated axon growth and guidance: The emerging epoch of Epac. *Brain Research Bulletin*, 84(45), 280–288.
- Penzes, P., Woolfrey, K. M., & Srivastava, D. P. (2011). Epac2-mediated dendritic spine remodeling: Implications for disease. *Molecular and Cellular Neurosciences*, 46(2), 368–380.
- Perez-Torres, S., Cortes, R., Tolnay, M., Probst, A., Palacios, J. M., & Mengod, G. (2003). Alterations on phosphodiesterase type 7 and 8 isozyme mRNA expression in Alzheimer's disease brains examined by in situ hybridization. *Experimental Neurology*, 182(2), 322–334.
- Pittenger, C., & Duman, R. S. (2008). Stress, depression, and neuroplasticity: A convergence of mechanisms. *Neuropsychopharmacology*, 33(1), 88–109.
- Premont, R. T., Matsuoka, I., Mattei, M. G., Pouille, Y., Defer, N., & Hanoune, J. (1996). Identification and characterization of a widely expressed form of adenylyl cyclase. *Journal of Biological Chemistry*, 271(23), 13900–13907.
- Reinhardt, R. R., Chin, E., Zhou, J., Taira, M., Murata, T.,

- Manganiello, V. C., et al. (1995). Distinctive anatomical patterns of gene expression for cGMP-inhibited cyclic nucleotide phosphodiesterases. *Journal of Clinical Investigation*, 95(4), 1528–1538.
- Reinhardt, R. R., & Bondy, C. A. (1996). Differential cellular pattern of gene expression for two distinct cGMP-inhibited cyclic nucleotide phosphodiesterases in developing and mature rat brain. *Neuroscience*, 72(2), 567–578.
- Reyes-Irisarri, E., Perez-Torres, S., & Mengod, G. (2005). Neuronal expression of cAMP-specific phosphodiesterase 7B mRNA in the rat brain. *Neuroscience*, 132(4), 1173–1185.
- Sadana, R., & Dessauer, C. W. (2009). Physiological roles for G protein-regulated adenylyl cyclase isoforms: Insights from knockout and overexpression studies. *Neuro-Signals*, 17(1), 5–22.
- Schmidtko, A., Gao, W., Konig, P., Heine, S., Motterlini, R., Ruth, P., et al. (2008). cGMP produced by NO-sensitive guanylyl cyclase essentially contributes to inflammatory and neuropathic pain by using targets different from cGMP-dependent protein kinase I. *Journal of Neuroscience*, 28(34), 8568–8576.
- Sette, C., Vicini, E., & Conti, M. (1994). The ratPDE3/IVd phosphodiesterase gene codes for multiple proteins differentially activated by cAMP-dependent protein kinase. *Journal of Biological Chemistry*, 269(28), 18271–18274.
- Sharma, R. K., & Wang, J. H. (1985). Differential regulation of bovine brain calmodulin-dependent cyclic nucleotide phosphodiesterase isoenzymes by cyclic AMP-dependent protein kinase and calmodulin-dependent phosphatase. *Proceedings of the National Academy of Sciences of the United States of America*, 82(9), 2603–2607.

- Siuciak, J. A. (2008). The role of phosphodiesterases in schizophrenia: Therapeutic implications. *CNS Drugs*, 22(12), 983–993.
- Soderling, S. H., Bayuga, S. J., & Beavo, J. A. (1999). Isolation and characterization of a dual-substrate phosphodiesterase gene family: PDE10A. *Proceedings of the National Academy of Sciences of the United States of America*, 96(12), 7071–7076.
- Sutherland, E. W., & Sutherland, E. W., Jr. (1992). Nobel lecture. In J. Lindsten (Ed.), *Nobel lectures, physiology or medicine 1971–1980*. Singapore: World Scientific Publishing Co..
- Taqatqeh, F., Mergia, E., Neitz, A., Eysel, U. T., Koesling, D., & Mittmann, T. (2009). More than a retrograde messenger: Nitric oxide needs two cGMP pathways to induce hippocampal long-term potentiation. *Journal of Neuroscience*, 29(29), 9344–9350.
- Taylor, S. S., Kim, C., Cheng, C. Y., Brown, S. H., Wu, J., & Kannan, N. (2008). Signaling through cAMP and cAMP-dependent protein kinase: Diverse strategies for drug design. *Biochimica et Biophysica Acta*, 1784(1), 16–26.
- Tesmer, J. J., Sunahara, R. K., Gilman, A. G., & Sprang, S. R. (1997). Crystal structure of the catalytic domains of adenylyl cyclase in a complex with $Gs\cdot GTP\cdot S$. *Science*, 278(5345), 1907–1916.
- Van Staveren, W. C., Steinbusch, H. W., Markerink-Van Ittersum, M., Repaske, D. R., Goy, M. F., Kotera, J., et al. (2003). mRNA expression patterns of the cGMP-hydrolyzing phosphodiesterases types 2, 5, and 9 during development of the rat brain. *Journal of Comparative Neurology*, 467(4), 566–580.
- Wang, M., Ramos, B. P., Paspalas, C. D., Shu, Y., Simen, A., Duque, A., et al. (2007). Alpha2A-adrenoceptors strengthen working memory networks by inhibiting cAMP–HCN channel signaling in prefrontal cortex. *Cell*, 129(2), 397–410.

- Watts, V. J. (2002). Molecular mechanisms for heterologous sensitization of adenylyl cyclase. *Journal of Pharmacology and Experimental Therapeutics*, 302(1), 1–7.
- Wensel, T. G. (2008). Signal transducing membrane complexes of photoreceptor outer segments. *Vision Research*, 48(20), 2052–2061.
- Wong, S. T., Athos, J., Figueroa, X. A., Pineda, V. V., Schaefer, M. L., Chavkin, C. C., et al. (1999). Calcium-stimulated adenylyl cyclase activity is critical for hippocampus-dependent long-term memory and late phase LTP. *Neuron*, 23(4), 787–798.
- Wong, S. T., Trinh, K., Hacker, B., Chan, G. C., Lowe, G., Gaggar, A., et al. (2000). Disruption of the type III adenylyl cyclase gene leads to peripheral and behavioral anosmia in transgenic mice. *Neuron*, 27(3), 487–497.
- Wu, K. Y., Zippin, J. H., Huron, D. R., Kamenetsky, M., Hengst, U., Buck, J., et al. (2006). Soluble adenylyl cyclase is required for netrin-1 signaling in nerve growth cones. *Nature Neuroscience*, 9(10), 1257–1264.
- Wu, P., & Wang, P. (2004). Per-Arnt-Sim domain-dependent association of cAMP-phosphodiesterase 8A1 with I \square B proteins. *Proceedings of the National Academy of Sciences of the United States of America*, 101(51), 17634–17639.
- Wu, Z. L., Thomas, S. A., Villacres, E. C., Xia, Z., Simmons, M. L., Chavkin, C., et al. (1995). Altered behavior and long-term potentiation in type I adenylyl cyclase mutant mice. *Proceedings of the National Academy of Sciences of the United States of America*, 92(1), 220–224.
- Yan, C., Bentley, J. K., Sonnenburg, W. K., & Beavo, J. A. (1994). Differential expression of the 61 kDa and 63 kDa calmodulin-dependent phosphodiesterases in the mouse brain. *Journal of Neuroscience*, 14(3 Pt 1), 973–984.

- Yan, C., Zhao, A. Z., Bentley, J. K., Loughney, K., Ferguson, K., & Beavo, J. A. (1995). Molecular cloning and characterization of a calmodulin-dependent phosphodiesterase enriched in olfactory sensory neurons. *Proceedings of the National Academy of Sciences of the United States of America*, 92(21), 9677–9681.
- Yan, S. Z., Huang, Z. H., Andrews, R. K., & Tang, W. J. (1998). Conversion of forskolin-insensitive to forskolin-sensitive (mouse-type IX) adenylyl cyclase. *Molecular Pharmacology*, 53(2), 182–187.
- Zachariou, V., Liu, R., LaPlant, Q., Xiao, G., Renthal, W., Chan, G. C., et al. (2008). Distinct roles of adenylyl cyclases 1 and 8 in opiate dependence: Behavioral, electrophysiological, and molecular studies. *Biological Psychiatry*, 63(11), 1013–1021.
- Zhang, G., Liu, Y., Qin, J., Vo, B., Tang, W. J., Ruoho, A. E., et al. (1997). Characterization and crystallization of a minimal catalytic core domain from mammalian type II adenylyl cyclase. *Protein Science*, 6(4), 903–908.
- Zufall, F., & Munger, S. D. (2010). Receptor guanylyl cyclases in mammalian olfactory function. *Molecular and Cellular Biochemistry*, 334(1–2), 191–197.