

Prostanoid receptors (version 2020.4) in the IUPHAR/BPS Guide to Pharmacology Database

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Abstract

Prostanoid receptors (nomenclature as agreed by the **NC-IUPHAR Subcommittee on Prostanoid Receptors [661]**) are activated by the endogenous ligands prostaglandins **PGD₂**, **PGE₁**, **PGE₂**, **PGF_{2α}**, **PGH₂**, prostacyclin [**PGI₂**] and **thromboxane A₂**. Differences and similarities between human and rodent prostanoid receptor orthologues, and their specific roles in pathophysiologic conditions are reviewed in [423]. Measurement of the potency of **PGI₂** and **thromboxane A₂** is hampered by their instability in physiological salt solution; they are often replaced by **cicaprost** and **U46619**, respectively, in receptor characterization studies.

Contents

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References

1. Abe H, Takeshita T, Nagata K, Arita T, Endo Y, Fujita T, Takayama H, Kubo M and Sugamura K. (1999) Molecular cloning, chromosome mapping and characterization of the mouse CRTH2 gene, a putative member of the leukocyte chemoattractant receptor family. *Gene* **227**: 71-7 [PMID:9931443]
2. Abe T, Takeuchi K, Takahashi N, Tsutsumi E, Taniyama Y and Abe K. (1995) Rat kidney thromboxane receptor: molecular cloning, signal transduction, and intrarenal expression localization. *J. Clin. Invest.* **96**: 657-64 [PMID:7635958]
3. Abramovitz M, Adam M, Boie Y, Carrière M, Denis D, Godbout C, Lamontagne S, Rochette C, Sawyer N and Tremblay NM *et al.*. (2000) The utilization of recombinant prostanoid receptors to determine the affinities and selectivities of prostaglandins and related analogs. *Biochim. Biophys. Acta* **1483**: 285-93 [PMID:10634944]
4. Abramovitz M, Boie Y, Nguyen T, Rushmore TH, Bayne MA, Metters KM, Slipetz DM and Grygorczyk R. (1994) Cloning and expression of a cDNA for the human prostanoid FP receptor. *J. Biol. Chem.* **269**: 2632-6 [PMID:8300593]
5. Adam M, Boie Y, Rushmore TH, Müller G, Bastien L, McKee KT, Metters KM and Abramovitz M. (1994) Cloning and expression of three isoforms of the human EP3 prostanoid receptor. *FEBS Lett* **338**: 170-174 [PMID:8307176]
6. Adams JL, Smothers J, Srinivasan R and Hoos A. (2015) Big opportunities for small molecules in immuno-oncology. *Nat Rev Drug Discov* **14**: 603-22 [PMID:26228631]
7. af Forselles KJ, Root J, Clarke T, Davey D, Aughton K, Dack K and Pullen N. (2011) In vitro and in vivo characterization of PF-04418948, a novel, potent and selective prostaglandin EP₂ receptor antagonist. *Br. J. Pharmacol.* **164**: 1847-56 [PMID:21595651]
8. Ahmad AS, Maruyama T, Narumiya S and Doré S. (2013) PGE₂ EP₁ receptor deletion attenuates 6-OHDA-induced Parkinsonism in mice: old switch, new target. *Neurotox Res* **23**: 260-6 [PMID:23385625]
9. Aihara E, Nomura Y, Sasaki Y, Ise F, Kita K and Takeuchi K. (2007) Involvement of prostaglandin E receptor EP₃ subtype in duodenal bicarbonate secretion in rats. *Life Sci.* **80**: 2446-53 [PMID:17512019]
10. Akhter MP, Cullen DM, Gong G and Recker RR. (2001) Bone biomechanical properties in prostaglandin EP₁ and EP₂ knockout mice. *Bone* **29**: 121-5 [PMID:11502472]
11. Akhter MP, Cullen DM and Pan LC. (2006) Bone biomechanical properties in EP₄ knockout mice *Calcif. Tissue Int.* **78**: 357-62 [PMID:16830205]
12. Allen IC, Hartney JM, Coffman TM, Penn RB, Wess J and Koller BH. (2006) Thromboxane A₂ induces airway constriction through an M₃ muscarinic acetylcholine receptor-dependent mechanism. *Am. J. Physiol. Lung Cell Mol. Physiol.* **290**: L526-33 [PMID:16243899]
13. Alvarez R, Eglen RM, Chang LF, Bruno JJ, Artis DR, Kluge AF and Whiting RL. (1991) Stimulation of prostaglandin D₂ receptors on human platelets by analogs of prostacyclin. *Prostaglandins* **42**: 105-119 [PMID:1775633]
14. Alvarez R, Taylor A, Fazzari JJ and Jacobs JR. (1981) Regulation of cyclic AMP metabolism in human platelets. Sequential activation of adenylate cyclase and cyclic AMP phosphodiesterase by prostaglandins. *Mol. Pharmacol.* **20**: 302-9 [PMID:6272089]
15. Amano H, Hayashi I, Endo H, Kitasato H, Yamashina S, Maruyama T, Kobayashi M, Satoh K, Narita M and Sugimoto Y *et al.*. (2003) Host prostaglandin E₂-EP₃ signaling regulates tumor-associated angiogenesis and tumor growth. *J. Exp. Med.* **197**: 221-32 [PMID:12538661]
16. Amaradhi R, Banik A, Mohammed S, Patro V, Rojas A, Wang W, Motati DR, Dingleline R and Ganesh T. (2020) Potent, Selective, Water Soluble, Brain-Permeable EP₂ Receptor Antagonist for Use in Central Nervous System Disease Models. *J. Med. Chem.* **63**: 1032-1050 [PMID:31904232]
17. An S, Yang J, So SW, Zeng L and Goetzl EJ. (1994) Isoforms of the EP₃ subtype of human prostaglandin E₂ receptor transduce both intracellular calcium and cAMP signals. *Biochemistry* **33**: 14496-502

- [PMID:7981210]
18. An S, Yang J, Xia M and Goetzl EJ. (1993) Cloning and expression of the EP2 subtype of human receptors for prostaglandin E2. *Biochem. Biophys. Res. Commun.* **197**: 263-70 [PMID:8250933]
 19. Ando T, Ichijo T, Katafuchi T and Hori T. (1995) Intracerebroventricular injection of prostaglandin E2 increases splenic sympathetic nerve activity in rats. *Am. J. Physiol.* **269**: R662-8 [PMID:7573569]
 20. Andoh T, Nishikawa Y, Yamaguchi-Miyamoto T, Nojima H, Narumiya S and Kuraishi Y. (2007) Thromboxane A2 induces itch-associated responses through TP receptors in the skin in mice. *J. Invest. Dermatol.* **127**: 2042-7 [PMID:17429442]
 21. Anthony TL, Lindsey JD, Aihara M and Weinreb RN. (2001) Detection of prostaglandin EP(1), EP(2), and FP receptor subtypes in human sclera. *Invest. Ophthalmol. Vis. Sci.* **42**: 3182-6 [PMID:11726620]
 22. Aoyama T, Liang B, Okamoto T, Matsusaki T, Nishijo K, Ishibe T, Yasura K, Nagayama S, Nakayama T and Nakamura T *et al.*. (2005) PGE2 signal through EP2 promotes the growth of articular chondrocytes. *J. Bone Miner. Res.* **20**: 377-89 [PMID:15746982]
 23. Araki H, Ukawa H, Sugawa Y, Yagi K, Suzuki K and Takeuchi K. (2000) The roles of prostaglandin E receptor subtypes in the cytoprotective action of prostaglandin E2 in rat stomach. *Aliment. Pharmacol. Ther.* **14 Suppl 1**: 116-24 [PMID:10807413]
 24. Arehart E, Stitham J, Asselbergs FW, Douville K, MacKenzie T, Fetalvero KM, Gleim S, Kasza Z, Rao Y and Martel L *et al.*. (2008) Acceleration of cardiovascular disease by a dysfunctional prostacyclin receptor mutation: potential implications for cyclooxygenase-2 inhibition. *Circ. Res.* **102**: 986-93 [PMID:18323528]
 25. Arima M and Fukuda T. (2011) Prostaglandin D₂ and T(H)₂ inflammation in the pathogenesis of bronchial asthma. *Korean J. Intern. Med.* **26**: 8-18 [PMID:21437156]
 26. Arimura A, Yasui K, Kishino J, Asanuma F, Hasegawa H, Kakudo S, Ohtani M and Arita H. (2001) Prevention of allergic inflammation by a novel prostaglandin receptor antagonist, S-5751. *J. Pharmacol. Exp. Ther.* **298**: 411-9 [PMID:11454901]
 27. Ariumi H, Takano Y, Masumi A, Takahashi S, Hirabara Y, Honda K, Saito R and Kamiya HO. (2002) Roles of the central prostaglandin EP3 receptors in cardiovascular regulation in rats. *Neurosci. Lett.* **324**: 61-4 [PMID:11983295]
 28. Armstrong RA, Humphrey PP and Lumley P. (1993) Characteristics of the binding of [3H]-GR32191 to the thromboxane (TP-) receptor of human platelets. *Br. J. Pharmacol.* **110**: 539-47 [PMID:8242228]
 29. Armstrong RA, Jones RL, MacDermot J and Wilson NH. (1986) Prostaglandin endoperoxide analogues which are both thromboxane receptor antagonists and prostacyclin mimetics. *Br. J. Pharmacol.* **87**: 543-51 [PMID:3026540]
 30. Armstrong RA, Lawrence RA, Jones RL, Wilson NH and Collier A. (1989) Functional and ligand binding studies suggest heterogeneity of platelet prostacyclin receptors. *Br. J. Pharmacol.* **97**: 657-668 [PMID:2474350]
 31. Aronoff DM, Canetti C and Peters-Golden M. (2004) Prostaglandin E2 inhibits alveolar macrophage phagocytosis through an E-prostanoid 2 receptor-mediated increase in intracellular cyclic AMP. *J. Immunol.* **173**: 559-65 [PMID:15210817]
 32. Aronoff DM, Lewis C, Serezani CH, Eaton KA, Goel D, Phipps JC, Peters-Golden M and Mancuso P. (2009) E-prostanoid 3 receptor deletion improves pulmonary host defense and protects mice from death in severe *Streptococcus pneumoniae* infection. *J. Immunol.* **183**: 2642-9 [PMID:19635910]
 33. Arulkumar S, Kandola MK, Hoffman B, Hanyaloglu AC, Johnson MR and Bennett PR. (2012) The roles of prostaglandin EP 1 and 3 receptors in the control of human myometrial contractility. *J. Clin. Endocrinol. Metab.* **97**: 489-98 [PMID:22162473]
 34. Asaki T, Hamamoto T, Sugiyama Y, Kuwano K and Kuwabara K. (2007) Structure-activity studies on diphenylpyrazine derivatives: a novel class of prostacyclin receptor agonists. *Bioorg. Med. Chem.* **15**: 6692-704 [PMID:17764960]
 35. Asbóth G, Phaneuf S, Europe-Finner GN, Toth M and Bernal AL. (1996) Prostaglandin E2 activates phospholipase C and elevates intracellular calcium in cultured myometrial cells: involvement of EP1 and EP3 receptor subtypes. *Endocrinology* **137**: 2572-2579 [PMID:8641211]
 36. Asbóth G, Phaneuf S and López Bernal AL. (1997) Prostaglandin E receptors in myometrial cells. *Acta Physiol Hung* **85**: 39-50 [PMID:9530435]
 37. Ashton AW, Mukherjee S, Nagajyothi FN, Huang H, Braunstein VL, Desruisseaux MS, Factor SM, Lopez L, Berman JW and Wittner M *et al.*. (2007) Thromboxane A2 is a key regulator of pathogenesis during *Trypanosoma cruzi* infection. *J. Exp. Med.* **204**: 929-40 [PMID:17420269]
 38. Aso H, Ito S, Mori A, Suganuma N, Morioka M, Takahara N, Kondo M and Hasegawa Y. (2013) Differential regulation of airway smooth muscle cell migration by e-prostanoid receptor subtypes. *Am. J. Respir. Cell Mol. Biol.* **48**: 322-9 [PMID:23221043]
 39. Attur M, Al-Mussawir HE, Patel J, Kitay A, Dave M, Palmer G, Pillinger MH and Abramson SB. (2008) Prostaglandin E2 exerts catabolic effects in osteoarthritis cartilage: evidence for signaling via the EP4 receptor. *J. Immunol.* **181**: 5082-8 [PMID:18802112]
 40. Audoly LP, Ruan X, Wagner VA, Goulet JL, Tilley SL, Koller BH, Coffman TM and Arendshorst WJ. (2001) Role of EP(2) and EP(3) PGE(2) receptors in control of murine renal hemodynamics. *Am. J. Physiol. Heart Circ. Physiol.* **280**: H327-33 [PMID:11123248]
 41. Audoly LP, Tilley SL, Goulet J, Key M, Nguyen M, Stock JL, McNeish JD, Koller BH and Coffman TM. (1999) Identification of specific EP receptors responsible for the hemodynamic effects of PGE2. *Am. J. Physiol.* **277**: H924-30 [PMID:10484412]
 42. Ayabe S, Murata T, Maruyama T, Hori M and Ozaki H. (2009) Prostaglandin E2 induces contraction of

- liver myofibroblasts by activating EP3 and FP prostanoid receptors. *Br. J. Pharmacol.* **156**: 835-45 [PMID:19239477]
43. Ayer LM, Wilson SM, Traves SL, Proud D and Giembycz MA. (2008) 4,5-Dihydro-1H-imidazol-2-yl)-[4-(4-isopropoxy-benzyl)-phenyl]-amine (RO1138452) is a selective, pseudo-irreversible orthosteric antagonist at the prostacyclin (IP)-receptor expressed by human airway epithelial cells: IP-receptor-mediated inhibition of CXCL9 and CXCL10 release. *J. Pharmacol. Exp. Ther.* **324**: 815-26 [PMID:17962517]
 44. Baba H, Kohno T, Moore KA and Woolf CJ. (2001) Direct activation of rat spinal dorsal horn neurons by prostaglandin E2. *J. Neurosci.* **21**: 1750-6 [PMID:11222664]
 45. Badzyska B and Sadowski J. (2008) Opposed effects of prostaglandin E2 on perfusion of rat renal cortex and medulla: interactions with the renin-angiotensin system. *Exp. Physiol.* **93**: 1292-302 [PMID:18586855]
 46. Bastien L, Sawyer N, Grygorczyk R, Metters KM and Adam M. (1994) Cloning, functional expression, and characterization of the human prostaglandin E2 receptor EP2 subtype. *J. Biol. Chem.* **269**: 11873-7 [PMID:8163486]
 47. Bateman ED, O'Brien C, Rugman P, Luke S, Ivanov S and Uddin M. (2018) Efficacy and safety of the CRTh2 antagonist AZD1981 as add-on therapy to inhaled corticosteroids and long-acting β_2 -agonists in patients with atopic asthma. *Drug Des Devel Ther* **12**: 1093-1106 [PMID:29765200]
 48. Baxter GS, Clayton JK, Coleman RA, Marshall K, Sangha R and Senior J. (1995) Characterization of the prostanoid receptors mediating constriction and relaxation of human isolated uterine artery. *Br. J. Pharmacol.* **116**: 1692-6 [PMID:8564239]
 49. Bayston T, Ramessur S, Reise J, Jones KG and Powell JT. (2003) Prostaglandin E2 receptors in abdominal aortic aneurysm and human aortic smooth muscle cells. *J. Vasc. Surg.* **38**: 354-9 [PMID:12891120]
 50. Belley A and Chadee K. (1999) Prostaglandin E(2) stimulates rat and human colonic mucin exocytosis via the EP(4) receptor. *Gastroenterology* **117**: 1352-62 [PMID:10579976]
 51. Belley M, Gallant M, Roy B, Houde K, Lachance N, Labelle M, Trimble LA, Chauré N, Li C and Sawyer N *et al.* (2005) Structure-activity relationship studies on ortho-substituted cinnamic acids, a new class of selective EP(3) antagonists. *Bioorg. Med. Chem. Lett.* **15**: 527-30 [PMID:15664806]
 52. Benyahia C, Boukais K, Gomez I, Silverstein A, Clapp L, Fabre A, Danel C, Leséche G, Longrois D and Norel X. (2013) A comparative study of PGI2 mimetics used clinically on the vasorelaxation of human pulmonary arteries and veins, role of the DP-receptor. *Prostaglandins Other Lipid Mediat.* **107**: 48-55 [PMID:23850788]
 53. Benyahia C, Gomez I, Kanyinda L, Boukais K, Danel C, Leséche G, Longrois D and Norel X. (2012) PGE(2) receptor (EP(4)) agonists: potent dilators of human bronchi and future asthma therapy? *Pulm Pharmacol Ther* **25**: 115-8 [PMID:22244823]
 54. Betz R, Lagercrantz J, Kedra D, Dumanski JP and Nordenskjöld A. (1999) Genomic structure, 5' flanking sequences, and precise localization in 1P31.1 of the human prostaglandin F receptor gene. *Biochem. Biophys. Res. Commun.* **254**: 413-6 [PMID:9918852]
 55. Bexis S, McCormick PA and Docherty JR. (2008) Vascular actions of the prostacyclin receptor antagonist BAY 73-1449 in the portal hypertensive rat. *Eur. J. Pharmacol.* **590**: 322-6 [PMID:18603238]
 56. Bhattacherjee P, Mukhopadhyay P, Tilley SL, Koller BH, Geoghegan T and Paterson CA. (2002) Blood-aqueous barrier in prostaglandin EP2 receptor knockout mice. *Ocul. Immunol. Inflamm.* **10**: 187-96 [PMID:12789594]
 57. Bilson HA, Mitchell DL and Ashby B. (2004) Human prostaglandin EP3 receptor isoforms show different agonist-induced internalization patterns. *FEBS Lett.* **572**: 271-5 [PMID:15304361]
 58. Birrell MA, Maher SA, Buckley J, Dale N, Bonvini S, Raemdonck K, Pullen N, Giembycz MA and Belvisi MG. (2013) Selectivity profiling of the novel EP2 receptor antagonist, PF-04418948, in functional bioassay systems: atypical affinity at the guinea pig EP2 receptor. *Br. J. Pharmacol.* **168**: 129-38 [PMID:22747912]
 59. Biswas S, Bhattacherjee P, Paterson CA, Maruyama T and Narumiya S. (2007) Modulation of ocular inflammatory responses by EP1 receptors in mice. *Exp. Eye Res.* **84**: 39-43 [PMID:17052707]
 60. Biswas S, Bhattacherjee P, Paterson CA, Tilley SL and Koller BH. (2006) Ocular inflammatory responses in the EP2 and EP4 receptor knockout mice. *Ocul. Immunol. Inflamm.* **14**: 157-63 [PMID:16766399]
 61. Bley KR, Bhattacharya A, Daniels DV, Gever J, Jahangir A, O'Yang C, Smith S, Srinivasan D, Ford AP and Jett MF. (2006) RO1138452 and RO3244794: characterization of structurally distinct, potent and selective IP (prostacyclin) receptor antagonists. *Br. J. Pharmacol.* **147**: 335-45 [PMID:16331286]
 62. Blouin M, Han Y, Burch J, Farand J, Mellon C, Gaudreault M, Wrona M, Lévesque JF, Denis D and Mathieu MC *et al.* (2010) The discovery of 4-{1-[(2,5-dimethyl-4-[4-(trifluoromethyl)benzyl]-3-thienyl]carbonyl)amino]cyclopropyl}benzoic acid (MK-2894), a potent and selective prostaglandin E2 subtype 4 receptor antagonist. *J. Med. Chem.* **53**: 2227-38 [PMID:20163116]
 63. Boie Y, Rushmore TH, Darmon-Goodwin A, Grygorczyk R, Slipetz DM, Metters KM and Abramovitz M. (1994) Cloning and expression of a cDNA for the human prostanoid IP receptor. *J. Biol. Chem.* **269**: 12173-8 [PMID:7512962]
 64. Boie Y, Sawyer N, Slipetz DM, Metters KM and Abramovitz M. (1995) Molecular cloning and characterization of the human prostanoid DP receptor. *J. Biol. Chem.* **270**: 18910-6 [PMID:7642548]
 65. Boie Y, Stocco R, Sawyer N, Slipetz DM, Ungrin MD, Neuschäfer-Rube F, Püschel GP, Metters KM and Abramovitz M. (1997) Molecular cloning and characterization of the four rat prostaglandin E2 prostanoid receptor subtypes. *Eur. J. Pharmacol.* **340**: 227-41 [PMID:9537820]
 66. Bondesen BA, Jones KA, Glasgow WC and Pavlath GK. (2007) Inhibition of myoblast migration by

- prostacyclin is associated with enhanced cell fusion. *FASEB J.* **21**: 3338-45 [PMID:17488951]
67. Breyer MD and Breyer RM. (2001) G protein-coupled prostanoid receptors and the kidney. *Annu. Rev. Physiol.* **63**: 579-605 [PMID:11181968]
 68. Breyer MD, Davis L, Jacobson HR and Breyer RM. (1996) Differential localization of prostaglandin E receptor subtypes in human kidney. *Am. J. Physiol.* **270**: F912-8 [PMID:8928854]
 69. Brittan JE, King CD and Stearns BA. (2011) DP2 ANTAGONIST AND USES THEREOF Patent number: WO2011085033.
 70. Brouxhon S, Konger RL, VanBuskirk J, Sheu TJ, Ryan J, Erdle B, Almudevar A, Breyer RM, Scott G and Pentland AP. (2007) Deletion of prostaglandin E2 EP2 receptor protects against ultraviolet-induced carcinogenesis, but increases tumor aggressiveness. *J. Invest. Dermatol.* **127**: 439-46 [PMID:16977324]
 71. Buckley J, Birrell MA, Maher SA, Nials AT, Clarke DL and Belvisi MG. (2011) EP4 receptor as a new target for bronchodilator therapy. *Thorax* **66**: 1029-35 [PMID:21606476]
 72. Burgess LE, Clark CT, Cook A, Corrette CP, Delise RK, Doherty GA, Hunt KW and Romoff T. (2009) 6-substituted phenoxchroman carboxylic acid derivatives Patent number: WO2009158426A1.
 73. Båtshake B, Nilsson C and Sundelin J. (1995) Molecular characterization of the mouse prostanoid EP1 receptor gene. *Eur. J. Biochem.* **231**: 809-14 [PMID:7649181]
 74. Båtshake B, Nilsson C and Sundelin J. (1999) Structure and expression of the murine thromboxane A2 receptor gene. *Biochem. Biophys. Res. Commun.* **256**: 391-7 [PMID:10079195]
 75. Böhm E, Sturm GJ, Weiglhofer I, Sandig H, Shichijo M, McNamee A, Pease JE, Kollroser M, Peskar BA and Heinemann A. (2004) 11-Dehydro-thromboxane B2, a stable thromboxane metabolite, is a full agonist of chemoattractant receptor-homologous molecule expressed on TH2 cells (CRTH2) in human eosinophils and basophils. *J. Biol. Chem.* **279**: 7663-70 [PMID:14668348]
 76. Caggiano AO and Kraig RP. (1999) Prostaglandin E receptor subtypes in cultured rat microglia and their role in reducing lipopolysaccharide-induced interleukin-1beta production. *J. Neurochem.* **72**: 565-75 [PMID:9930728]
 77. Cameron KO, Lefker BA, Ke HZ, Li M, Zawistoski MP, Tjoa CM, Wright AS, DeNinno SL, Paralkar VM and Owen TA *et al.* (2009) Discovery of CP-533536: an EP2 receptor selective prostaglandin E2 (PGE2) agonist that induces local bone formation. *Bioorg. Med. Chem. Lett.* **19**: 2075-8 [PMID:19250823]
 78. Candelario-Jalil E, Slawik H, Ridelis I, Waschbisch A, Akundi RS, Hüll M and Fiebich BL. (2005) Regional distribution of the prostaglandin E2 receptor EP1 in the rat brain: accumulation in Purkinje cells of the cerebellum. *J. Mol. Neurosci.* **27**: 303-10 [PMID:16280600]
 79. Cao J, Shayibuzhati M, Tajima T, Kitazawa T and Taneike T. (2002) In vitro pharmacological characterization of the prostanoid receptor population in the non-pregnant porcine myometrium. *Eur. J. Pharmacol.* **442**: 115-23 [PMID:12020689]
 80. Cao RY, St Amand T, Li X, Yoon SH, Wang CP, Song H, Maruyama T, Brown PM, Zelt DT and Funk CD. (2012) Prostaglandin receptor EP4 in abdominal aortic aneurysms. *Am. J. Pathol.* **181**: 313-21 [PMID:22595380]
 81. Carrasco MP, Asbóth G, Phaneuf S and López Bernal A. (1997) Activation of the prostaglandin FP receptor in human granulosa cells. *J. Reprod. Fertil.* **111**: 309-17 [PMID:9462300]
 82. Caselli G, Bonazzi A, Lanza M, Ferrari F, Maggioni D, Ferioli C, Giambelli R, Comi E, Zerbi S and Perrella M *et al.* (2018) Pharmacological characterisation of CR6086, a potent prostaglandin E₂ receptor 4 antagonist, as a new potential disease-modifying anti-rheumatic drug. *Arthritis Res. Ther.* **20**: 39 [PMID:29490676]
 83. Chan CL, Jones RL and Lau HY. (2000) Characterization of prostanoid receptors mediating inhibition of histamine release from anti-IgE-activated rat peritoneal mast cells. *Br. J. Pharmacol.* **129**: 589-97 [PMID:10711359]
 84. Chan EC, Dusting GJ, Guo N, Peshavariya HM, Taylor CJ, Dilley R, Narumiya S and Jiang F. (2010) Prostacyclin receptor suppresses cardiac fibrosis: role of CREB phosphorylation. *J. Mol. Cell. Cardiol.* **49**: 176-85 [PMID:20403362]
 85. Chang CS, Negishi M, Nakano T, Morizawa Y, Matsumura Y and Ichikawa A. (1997) 7,7-Difluoroprostacyclin derivative, AFP-07, a highly selective and potent agonist for the prostacyclin receptor. *Prostaglandins* **53**: 83-90 [PMID:9112287]
 86. Chen Q, Muramoto K, Masaaki N, Ding Y, Yang H, Mackey M, Li W, Inoue Y, Ackermann K and Shirota H *et al.* (2010) A novel antagonist of the prostaglandin E(2) EP(4) receptor inhibits Th1 differentiation and Th17 expansion and is orally active in arthritis models. *Br. J. Pharmacol.* **160**: 292-310 [PMID:20423341]
 87. Cheng K, Wu TJ, Wu KK, Sturino C, Metters K, Gottesdiener K, Wright SD, Wang Z, O'Neill G and Lai *et al.* (2006) Antagonism of the prostaglandin D2 receptor 1 suppresses nicotinic acid-induced vasodilation in mice and humans. *Proc. Natl. Acad. Sci. U.S.A.* **103**: 6682-7 [PMID:16617107]
 88. Cheng Y, Austin SC, Rocca B, Koller BH, Coffman TM, Grosser T, Lawson JA and FitzGerald GA. (2002) Role of prostacyclin in the cardiovascular response to thromboxane A2. *Science* **296**: 539-41 [PMID:11964481]
 89. Chevalier E, Stock J, Fisher T, Dupont M, Fric M, Fargeau H, Leport M, Soler S, Fabien S and Pruniaux MP *et al.* (2005) Cutting edge: chemoattractant receptor-homologous molecule expressed on Th2 cells plays a restricting role on IL-5 production and eosinophil recruitment. *J. Immunol.* **175**: 2056-60 [PMID:16081770]
 90. Chow KB, Wong YH and Wise H. (2001) Prostacyclin receptor-independent inhibition of phospholipase C activity by non-prostanoid prostacyclin mimetics. *Br. J. Pharmacol.* **134**: 1375-84 [PMID:11724742]

91. Cimetière B, Dubuffet T, Muller O, Descombes JJ, Simonet S, Laubie M, Verbeuren TJ and Lavielle G. (1998) Synthesis and biological evaluation of new tetrahydronaphthalene derivatives as thromboxane receptor antagonists. *Bioorg. Med. Chem. Lett.* **8**: 1375-80 [PMID:9871769]
92. Cipollone F, Fazia ML, Iezzi A, Cuccurullo C, De Cesare D, Uchino S, Spigonardo F, Marchetti A, Buttitta F and Paloscia L *et al.*. (2005) Association between prostaglandin E receptor subtype EP4 overexpression and unstable phenotype in atherosclerotic plaques in human. *Arterioscler. Thromb. Vasc. Biol.* **25**: 1925-31 [PMID:16020747]
93. Cirillo R, Tos EG, Page P, Missotten M, Quattropiani A, Scheer A, Schwarz MK and Chollet A. (2007) Arrest of preterm labor in rat and mouse by an oral and selective nonprostanoid antagonist of the prostaglandin F2alpha receptor (FP). *Am. J. Obstet. Gynecol.* **197**: 54.e1-9 [PMID:17618756]
94. Clapp LH and Gurung R. (2015) The mechanistic basis of prostacyclin and its stable analogues in pulmonary arterial hypertension: Role of membrane versus nuclear receptors. *Prostaglandins Other Lipid Mediat.* **120**: 56-71 [PMID:25917921]
95. Clark P, Rowland SE, Denis D, Mathieu MC, Stocco R, Poirier H, Burch J, Han Y, Audoly L and Therien AG *et al.*. (2008) MF498 [N-[[4-(5,9-Diethoxy-6-oxo-6,8-dihydro-7H-pyrrolo[3,4-g]quinolin-7-yl)-3-methylbenzyl]sulfonyl]-2-(2-methoxyphenyl)acetamide], a selective E prostanoid receptor 4 antagonist, relieves joint inflammation and pain in rodent models of rheumatoid and osteoarthritis. *J. Pharmacol. Exp. Ther.* **325**: 425-34 [PMID:18287210]
96. Clarke DL, Belvisi MG, Catley MC, Yacoub MH, Newton R and Giembycz MA. (2004) Identification in human airways smooth muscle cells of the prostanoid receptor and signalling pathway through which PGE2 inhibits the release of GM-CSF. *Br. J. Pharmacol.* **141**: 1141-50 [PMID:15023863]
97. Clarke DL, Belvisi MG, Smith SJ, Hardaker E, Yacoub MH, Meja KK, Newton R, Slater DM and Giembycz MA. (2005) Prostanoid receptor expression by human airway smooth muscle cells and regulation of the secretion of granulocyte colony-stimulating factor. *Am. J. Physiol. Lung Cell Mol. Physiol.* **288**: L238-50 [PMID:15640521]
98. Clarke DL, Giembycz MA, Patel HJ and Belvisi MG. (2004) E-ring 8-isoprostanes inhibit ACh release from parasympathetic nerves innervating guinea-pig trachea through agonism of prostanoid receptors of the EP3-subtype. *Br. J. Pharmacol.* **141**: 600-9 [PMID:14744812]
99. Coleman RA, Kennedy I, Humphrey PPA, Bunce K and Lumley P. (1990) Prostanoids and their receptors. *In Comprehensive Medicinal Chemistry* Edited by Hansch C, Sammes PG, Taylor JB: Pergamon Press: 643-714 [ISBN: 0080370616]
100. Coleman RA, Kennedy I and Sheldrick RL. (1987) New evidence with selective agonists and antagonists for the subclassification of PGE2-sensitive (EP) receptors. *Adv. Prostaglandin Thromboxane Leukot. Res.* **17A**: 467-70 [PMID:2889338]
101. Coleman RA and Sheldrick RL. (1989) Prostanoid-induced contraction of human bronchial smooth muscle is mediated by TP-receptors. *Br J Pharmacol* **96**: 688-692 [PMID:2720298]
102. Coleman RA, Smith WL and Narumiya S. (1994) International Union of Pharmacology classification of prostanoid receptors: properties, distribution, and structure of the receptors and their subtypes. *Pharmacol. Rev.* **46**: 205-29 [PMID:7938166]
103. Coleman RA, Woodrooffe AJ, Clark KL, Toris CB, Fan S, Wang JW and Woodward DF. (2019) The affinity, intrinsic activity and selectivity of a structurally novel EP₂ receptor agonist at human prostanoid receptors. *Br. J. Pharmacol.* **176**: 687-698 [PMID:30341781]
104. Cooper B and Ahern D. (1979) Characterization of the platelet prostaglandin D2 receptor. Loss of prostaglandin D2 receptors in platelets of patients with myeloproliferative disorders. *J. Clin. Invest.* **64**: 586-90 [PMID:222813]
105. Crosignani S, Jorand-Lebrun C, Campbell G, Prête A, Grippi-Vallotton T, Quattropiani A, Bouscary-Desforges G, Bombrun A, Missotten M and Humbert Y *et al.*. (2011) Discovery of a Novel Series of CRTH2 (DP2) Receptor Antagonists Devoid of Carboxylic Acids. *ACS Med Chem Lett* **2**: 938-42 [PMID:24900284]
106. Crowston JG, Lindsey JD, Aihara M and Weinreb RN. (2004) Effect of latanoprost on intraocular pressure in mice lacking the prostaglandin FP receptor. *Invest. Ophthalmol. Vis. Sci.* **45**: 3555-9 [PMID:15452062]
107. Crowston JG, Lindsey JD, Morris CA, Wheeler L, Medeiros FA and Weinreb RN. (2005) Effect of bimatoprost on intraocular pressure in prostaglandin FP receptor knockout mice. *Invest. Ophthalmol. Vis. Sci.* **46**: 4571-7 [PMID:16303950]
108. Croy BA, Chantakru S, Narumiya S, Ichikawa A and Sugimoto Y. (2000) Prolonged gestation does not extend survival of uterine natural killer lymphocytes in mice deleted in the receptor for prostaglandin F2alpha. *J. Reprod. Immunol.* **46**: 125-9 [PMID:10706943]
109. Cyphert JM, Allen IC, Church RJ, Latour AM, Snouwaert JN, Coffman TM and Koller BH. (2012) Allergic inflammation induces a persistent mechanistic switch in thromboxane-mediated airway constriction in the mouse. *Am. J. Physiol. Lung Cell Mol. Physiol.* **302**: L140-51 [PMID:21984570]
110. Davis TL and Sharif NA. (2000) Pharmacological characterization of [(3)H]-prostaglandin E(2) binding to the cloned human EP(4) prostanoid receptor. *Br J Pharmacol* **130**: 1919-1926 [PMID:10952683]
111. Diamond JM, Akimova T, Kazi A, Shah RJ, Cantu E, Feng R, Levine MH, Kawut SM, Meyer NJ and Lee JC *et al.*. (2014) Genetic variation in the prostaglandin E2 pathway is associated with primary graft dysfunction. *Am. J. Respir. Crit. Care Med.* **189**: 567-75 [PMID:24467603]
112. Ding M, Kinoshita Y, Kishi K, Nakata H, Hassan S, Kawanami C, Sugimoto Y, Katsuyama M, Negishi M and Narumiya S *et al.*. (1997) Distribution of prostaglandin E receptors in the rat gastrointestinal tract.

- Prostaglandins* **53**: 199-216 [PMID:9206801]
113. Dong YJ, Jones RL and Wilson NH. (1986) Prostaglandin E receptor subtypes in smooth muscle: agonist activities of stable prostacyclin analogues. *Br. J. Pharmacol.* **87**: 97-107 [PMID:2420404]
 114. Downey JD, Sanders CR and Breyer RM. (2011) Evidence for the presence of a critical disulfide bond in the mouse EP3 γ receptor. *Prostaglandins Other Lipid Mediat.* **94**: 53-8 [PMID:21236356]
 115. Duffin R, O'Connor RA, Crittenden S, Forster T, Yu C, Zheng X, Smyth D, Robb CT, Rossi F and Skouras C *et al.* (2016) Prostaglandin E₂ constrains systemic inflammation through an innate lymphoid cell-IL-22 axis. *Science* **351**: 1333-8 [PMID:26989254]
 116. El-Nefiawy N, Abdel-Hakim K, Kanayama N and Terao T. (2005) Role of prostaglandin E2 receptor subtypes in ovarian follicle growth in the rat in vivo. Correlation with interleukin-8 and neutrophils. *Histol. Histopathol.* **20**: 825-31 [PMID:15944932]
 117. Esaki Y, Li Y, Sakata D, Yao C, Segi-Nishida E, Matsuoka T, Fukuda K and Narumiya S. (2010) Dual roles of PGE2-EP4 signaling in mouse experimental autoimmune encephalomyelitis. *Proc. Natl. Acad. Sci. U.S.A.* **107**: 12233-8 [PMID:20566843]
 118. Exner HJ and Schlicker E. (1995) Prostanoid receptors of the EP3 subtype mediate the inhibitory effect of prostaglandin E2 on noradrenaline release in the mouse brain cortex. *Naunyn Schmiedebergs Arch. Pharmacol.* **351**: 46-52 [PMID:7715741]
 119. Fabre JE, Nguyen M, Athirakul K, Coggins K, McNeish JD, Austin S, Parise LK, FitzGerald GA, Coffman TM and Koller BH. (2001) Activation of the murine EP3 receptor for PGE2 inhibits cAMP production and promotes platelet aggregation. *J. Clin. Invest.* **107**: 603-10 [PMID:11238561]
 120. Facemire CS, Nguyen M, Jania L, Beierwaltes WH, Kim HS, Koller BH and Coffman TM. (2011) A major role for the EP4 receptor in regulation of renin. *Am. J. Physiol. Renal Physiol.* **301**: F1035-41 [PMID:21835766]
 121. Falcetti E, Hall SM, Phillips PG, Patel J, Morrell NW, Haworth SG and Clapp LH. (2010) Smooth muscle proliferation and role of the prostacyclin (IP) receptor in idiopathic pulmonary arterial hypertension. *Am. J. Respir. Crit. Care Med.* **182**: 1161-70 [PMID:20622039]
 122. Feng C, Beller EM, Bagga S and Boyce JA. (2006) Human mast cells express multiple EP receptors for prostaglandin E2 that differentially modulate activation responses. *Blood* **107**: 3243-50 [PMID:16357326]
 123. Fennekohl A, Sugimoto Y, Segi E, Maruyama T, Ichikawa A and Püschel GP. (2002) Contribution of the two Gs-coupled PGE2-receptors EP2-receptor and EP4-receptor to the inhibition by PGE2 of the LPS-induced TNF α -formation in Kupffer cells from EP2-or EP4-receptor-deficient mice. Pivotal role for the EP4-receptor in wild type Kupffer cells. *J. Hepatol.* **36**: 328-34 [PMID:11867175]
 124. Feoktistov I, Breyer RM and Biaggioni I. (1997) Prostanoid receptor with a novel pharmacological profile in human erythroleukemia cells. *Biochem. Pharmacol.* **54**: 917-26 [PMID:9354592]
 125. Fernandes B and Crankshaw D. (1995) Functional characterization of the prostanoid DP receptor in human myometrium. *Eur. J. Pharmacol.* **283**: 73-81 [PMID:7498323]
 126. Fleming EF, Athirakul K, Oliverio MI, Key M, Goulet J, Koller BH and Coffman TM. (1998) Urinary concentrating function in mice lacking EP3 receptors for prostaglandin E2. *Am. J. Physiol.* **275**: F955-61 [PMID:9843913]
 127. Foord SM, Marks B, Stolz M, Bufflier E, Fraser NJ and Lee MG. (1996) The structure of the prostaglandin EP4 receptor gene and related pseudogenes. *Genomics* **35**: 182-8 [PMID:8661119]
 128. Fortner CN, Breyer RM and Paul RJ. (2001) EP2 receptors mediate airway relaxation to substance P, ATP, and PGE2. *Am. J. Physiol. Lung Cell Mol. Physiol.* **281**: L469-74 [PMID:11435222]
 129. Foudi N, Gomez I, Benyahia C, Longrois D and Norel X. (2012) Prostaglandin E2 receptor subtypes in human blood and vascular cells. *Eur. J. Pharmacol.* **695**: 1-6 [PMID:22964467]
 130. Foudi N, Kotelevets L, Gomez I, Louedec L, Longrois D, Chastre E and Norel X. (2011) Differential reactivity of human mammary artery and saphenous vein to prostaglandin E(2) : implication for cardiovascular grafts. *Br. J. Pharmacol.* **163**: 826-34 [PMID:21323896]
 131. Foudi N, Kotelevets L, Louedec L, Leséche G, Henin D, Chastre E and Norel X. (2008) Vasorelaxation induced by prostaglandin E2 in human pulmonary vein: role of the EP4 receptor subtype. *Br. J. Pharmacol.* **154**: 1631-9 [PMID:18516068]
 132. Fox SC, May JA, Johnson A, Hermann D, Strieter D, Hartman D and Heptinstall S. (2013) Effects on platelet function of an EP3 receptor antagonist used alone and in combination with a P2Y12 antagonist both in-vitro and ex-vivo in human volunteers. *Platelets* **24**: 392-400 [PMID:22866894]
 133. Francois H, Athirakul K, Howell D, Dash R, Mao L, Kim HS, Rockman HA, Fitzgerald GA, Koller BH and Coffman TM. (2005) Prostacyclin protects against elevated blood pressure and cardiac fibrosis. *Cell Metab.* **2**: 201-7 [PMID:16154102]
 134. Francois H, Makhanova N, Ruiz P, Ellison J, Mao L, Rockman HA and Coffman TM. (2008) A role for the thromboxane receptor in L-NAME hypertension. *Am. J. Physiol. Renal Physiol.* **295**: F1096-102 [PMID:18684890]
 135. Fretz H, Valdenaire A, Pothier J, Hilpert K, Gnerre C, Peter O, Leroy X and Riederer MA. (2013) Identification of 2-(2-(1-naphthoyl)-8-fluoro-3,4-dihydro-1H-pyrido[4,3-b]indol-5(2H)-yl)acetic acid (setiprant/ACT-129968), a potent, selective, and orally bioavailable chemoattractant receptor-homologous molecule expressed on Th2 cells (CRTH2) antagonist. *J. Med. Chem.* **56**: 4899-911 [PMID:23721423]
 136. Friel AM, O'Reilly MW, Sexton DJ and Morrison JJ. (2005) Specific PGF(2 α) receptor (FP) antagonism and human uterine contractility in vitro. *BJOG* **112**: 1034-1042 [PMID:16045514]
 137. Fujino H, Salvi S and Regan JW. (2005) Differential regulation of phosphorylation of the cAMP response

- element-binding protein after activation of EP2 and EP4 prostanoid receptors by prostaglandin E2. *Mol. Pharmacol.* **68**: 251-9 [PMID:15855407]
138. Fujino H, Srinivasan D, Pierce KL and Regan JW. (2000) Differential regulation of prostaglandin F(2alpha) receptor isoforms by protein kinase C. *Mol. Pharmacol.* **57**: 353-8 [PMID:10648645]
 139. Fujino H, West KA and Regan JW. (2002) Phosphorylation of glycogen synthase kinase-3 and stimulation of T-cell factor signaling following activation of EP2 and EP4 prostanoid receptors by prostaglandin E2. *J. Biol. Chem.* **277**: 2614-9 [PMID:11706038]
 140. Fujino H, Xu W and Regan JW. (2003) Prostaglandin E2 induced functional expression of early growth response factor-1 by EP4, but not EP2, prostanoid receptors via the phosphatidylinositol 3-kinase and extracellular signal-regulated kinases. *J. Biol. Chem.* **278**: 12151-6 [PMID:12566441]
 141. Fukunaga M, Makita N, Roberts 2nd LJ, Morrow JD, Takahashi K and Badr KF. (1993) Evidence for the existence of F2-isoprostane receptors on rat vascular smooth muscle cells. *Am. J. Physiol.* **264**: C1619-24 [PMID:8333509]
 142. Fullerton DA, Agrafojo J and McIntyre Jr RC. (1996) Pulmonary vascular smooth muscle relaxation by cAMP-mediated pathways. *J. Surg. Res.* **61**: 444-8 [PMID:8656622]
 143. Funk CD, Furci L, FitzGerald GA, Grygorczyk R, Rochette C, Bayne MA, Abramovitz M, Adam M and Metters KM. (1993) Cloning and expression of a cDNA for the human prostaglandin E receptor EP1 subtype. *J. Biol. Chem.* **268**: 26767-72 [PMID:8253813]
 144. Furuyashiki T and Narumiya S. (2009) Roles of prostaglandin E receptors in stress responses. *Curr Opin Pharmacol* **9**: 31-8 [PMID:19157987]
 145. Gallant M, Belley M, Carrière MC, Chateauneuf A, Denis D, Lachance N, Lamontagne S, Metters KM, Sawyer N and Slipetz D *et al.*. (2003) Structure-activity relationship of triaryl propionic acid analogues on the human EP3 prostanoid receptor. *Bioorg. Med. Chem. Lett.* **13**: 3813-6 [PMID:14552786]
 146. Gallant M, Carrière MC, Chateauneuf A, Denis D, Gareau Y, Godbout C, Greig G, Juteau H, Lachance N and Lacombe P *et al.*. (2002) Structure-activity relationship of biaryl acylsulfonamide analogues on the human EP(3) prostanoid receptor. *Bioorg. Med. Chem. Lett.* **12**: 2583-6 [PMID:12182865]
 147. Gallant MA, Slipetz D, Hamelin E, Rochdi MD, Talbot S, de Brum-Fernandes AJ and Parent JL. (2007) Differential regulation of the signaling and trafficking of the two prostaglandin D2 receptors, prostanoid DP receptor and CRTH2. *Eur. J. Pharmacol.* **557**: 115-23 [PMID:17207480]
 148. Ganesh T, Jiang J and Dingledine R. (2014) Development of second generation EP2 antagonists with high selectivity. *Eur J Med Chem* **82**: 521-35 [PMID:24937185]
 149. Ganesh T, Jiang J, Shashidharamurthy R and Dingledine R. (2013) Discovery and characterization of carbamothioylacrylamides as EP2 selective antagonists. *ACS Med Chem Lett* **4**: 616-621 [PMID:23914286]
 150. Gannon AM and Kinsella BT. (2008) Regulation of the human thromboxane A2 receptor gene by Sp1, Egr1, NF-E2, GATA-1, and Ets-1 in megakaryocytes. *J. Lipid Res.* **49**: 2590-604 [PMID:18698092]
 151. Gazi L, Gyles S, Rose J, Lees S, Allan C, Xue L, Jassal R, Speight G, Gamble V and Pettipher R. (2005) Delta12-prostaglandin D2 is a potent and selective CRTH2 receptor agonist and causes activation of human eosinophils and Th2 lymphocytes. *Prostaglandins Other Lipid Mediat.* **75**: 153-67 [PMID:15789622]
 152. Gervais FG, Cruz RP, Chateauneuf A, Gale S, Sawyer N, Nantel F, Metters KM and O'neill GP. (2001) Selective modulation of chemokinesis, degranulation, and apoptosis in eosinophils through the PGD2 receptors CRTH2 and DP. *J. Allergy Clin. Immunol.* **108**: 982-8 [PMID:11742277]
 153. Gervais FG, Morello JP, Beaulieu C, Sawyer N, Denis D, Greig G, Malebranche AD and O'Neill GP. (2005) Identification of a potent and selective synthetic agonist at the CRTH2 receptor. *Mol. Pharmacol.* **67**: 1834-9 [PMID:15755909]
 154. Giblin GM, Bit RA, Brown SH, Chaignot HM, Chowdhury A, Chessell IP, Clayton NM, Coleman T, Hall A and Hammond B *et al.*. (2007) The discovery of 6-[2-(5-chloro-2-((2,4-difluorophenyl)methyl)oxy)phenyl]-1-cyclopenten-1-yl]-2-pyridinecarboxylic acid, GW848687X, a potent and selective prostaglandin EP1 receptor antagonist for the treatment of inflammatory pain. *Bioorg. Med. Chem. Lett.* **17**: 385-9 [PMID:17084082]
 155. Giles H, Leff P, Boloflo ML, Kelly MG and Robertson AD. (1989) The classification of prostaglandin DP-receptors in platelets and vasculature using BW A868C, a novel, selective, and potent competitive antagonist. *Br. J. Pharmacol.* **96**: 291-300 [PMID:2924081]
 156. Gomez I, Foudi N, Longrois D and Norel X. (2013) The role of prostaglandin E2 in human vascular inflammation. *Prostaglandins Leukot. Essent. Fatty Acids* **89**: 55-63 [PMID:23756023]
 157. Gray T, Nettesheim P, Loftin C, Koo JS, Bonner J, Peddada S and Langenbach R. (2004) Interleukin-1beta-induced mucin production in human airway epithelium is mediated by cyclooxygenase-2, prostaglandin E2 receptors, and cyclic AMP-protein kinase A signaling. *Mol. Pharmacol.* **66**: 337-46 [PMID:15266025]
 158. Gresele P, Arnout J, Deckmyn H, Huybrechts E, Pieters G and Vermynen J. (1987) Role of proaggregatory and antiaggregatory prostaglandins in hemostasis. Studies with combined thromboxane synthase inhibition and thromboxane receptor antagonism. *J. Clin. Invest.* **80**: 1435-45 [PMID:2960694]
 159. Griffin BW, Klimko P, Crider JY and Sharif NA. (1999) AL-8810: a novel prostaglandin F2 alpha analog with selective antagonist effects at the prostaglandin F2 alpha (FP) receptor. *J. Pharmacol. Exp. Ther.* **290**: 1278-84 [PMID:10454504]
 160. Grisaru-Granovsky S, Altarescu G, Finci S, Weintraub A, Tevet A, Samueloff A and Schimmel MS. (2010) Prostanoid DP receptor (PTGDR) variants in mothers with post-coital associated preterm births:

- preliminary observations. *J Perinatol* **30**: 33-7 [PMID:19710676]
161. Gross S, Tilly P, Hentsch D, Vonesch JL and Fabre JE. (2007) Vascular wall-produced prostaglandin E2 exacerbates arterial thrombosis and atherothrombosis through platelet EP3 receptors. *J. Exp. Med.* **204**: 311-20 [PMID:17242161]
 162. Grosser T, Yu Y and Fitzgerald GA. (2010) Emotion recollected in tranquility: lessons learned from the COX-2 saga. *Annu. Rev. Med.* **61**: 17-33 [PMID:20059330]
 163. Grygorczyk R, Abramovitz M, Boie Y, Bastien L and Adam M. (1995) Detection of adenylate cyclase-coupled receptors in *Xenopus* oocytes by coexpression with cystic fibrosis transmembrane conductance regulator. *Anal Biochem* **227**: 27-31 [PMID:7545356]
 164. Guan Y, Zhang Y, Wu J, Qi Z, Yang G, Dou D, Gao Y, Chen L, Zhang X and Davis LS *et al.*. (2007) Antihypertensive effects of selective prostaglandin E2 receptor subtype 1 targeting. *J. Clin. Invest.* **117**: 2496-505 [PMID:17710229]
 165. Guo M, Pascual RM, Wang S, Fontana MF, Valancius CA, Panettieri Jr RA, Tilley SL and Penn RB. (2005) Cytokines regulate beta-2-adrenergic receptor responsiveness in airway smooth muscle via multiple PKA- and EP2 receptor-dependent mechanisms. *Biochemistry* **44**: 13771-82 [PMID:16229467]
 166. Géhin M, Strasser DS, Zisowsky J, Farine H, Groenen PM, Dingemans J and Sidharta PN. (2015) A novel CRTH2 antagonist: Single- and multiple-dose tolerability, pharmacokinetics, and pharmacodynamics of ACT-453859 in healthy subjects. *J Clin Pharmacol* **55**: 787-97 [PMID:25655470]
 167. Göggel R, Hoffman S, Nüsing R, Narumiya S and Uhlig S. (2002) Platelet-activating factor-induced pulmonary edema is partly mediated by prostaglandin E(2), E-prostanoid 3-receptors, and potassium channels. *Am. J. Respir. Crit. Care Med.* **166**: 657-62 [PMID:12204861]
 168. Günther J, Schulte K, Wenzel D, Malinowska B and Schlicker E. (2010) Prostaglandins of the E series inhibit monoamine release via EP3 receptors: proof with the competitive EP3 receptor antagonist L-826,266. *Naunyn Schmiedebergs Arch. Pharmacol.* **381**: 21-31 [PMID:20012265]
 169. Hallinan EA, Stapelfeld A, and Reichman M. (1994) 8-chlorodibenz[b,f][1,4]oxazepine-10(11H)-carboxylic acid, 2-[3-[2-(furanylmethyl)thio]-1-oxopropyl]hydrazide (SC-51322): A potent PGE2 antagonist and analgesic. *Bioorg. Med. Chem. Lett.* **4**: 509-514
 170. Halushka PV, Kochel PJ and Mais DE. (1987) Binding of thromboxane A2/prostaglandin H2 agonists to human platelets. *Br. J. Pharmacol.* **91**: 223-7 [PMID:3594077]
 171. Hamaguchi K, Yamamoto N, Nakagawa T, Furuyashiki T, Narumiya S and Ito J. (2012) Role of PGE-type receptor 4 in auditory function and noise-induced hearing loss in mice. *Neuropharmacology* **62**: 1841-7 [PMID:22198478]
 172. Hamanaka N, Takahashi K, Nagao Y, Torisu K, Tokumoto H and Kondo K. (1995) Molecular design of novel PGI₂ agonists without PG skeleton. *Bioorg. Med. Chem. Lett.* **5**: 1065-1070
 173. Hanada R, Leibbrandt A, Hanada T, Kitaoka S, Furuyashiki T, Fujihara H, Trichereau J, Paolino M, Qadri F and Plehm R *et al.*. (2009) Central control of fever and female body temperature by RANKL/RANK. *Nature* **462**: 505-9 [PMID:19940926]
 174. Hara A, Yuhki K, Fujino T, Yamada T, Takayama K, Kuriyama S, Takahata O, Karibe H, Okada Y and Xiao CY *et al.*. (2005) Augmented cardiac hypertrophy in response to pressure overload in mice lacking the prostaglandin I2 receptor. *Circulation* **112**: 84-92 [PMID:15983244]
 175. Hashimoto K, Graham BS, Geraci MW, FitzGerald GA, Egan K, Zhou W, Goleniewska K, O'Neal JF, Morrow JD and Durbin RK *et al.*. (2004) Signaling through the prostaglandin I2 receptor IP protects against respiratory syncytial virus-induced illness. *J. Virol.* **78**: 10303-9 [PMID:15367596]
 176. Hata AN, Lybrand TP and Breyer RM. (2005) Identification of determinants of ligand binding affinity and selectivity in the prostaglandin D2 receptor CRTH2. *J Biol Chem* **280**: 32442-32451 [PMID:16030019]
 177. Hata AN, Zent R, Breyer MD and Breyer RM. (2003) Expression and molecular pharmacology of the mouse CRTH2 receptor. *J. Pharmacol. Exp. Ther.* **306**: 463-70 [PMID:12721327]
 178. Hattori K, Tanaka A, Okitsu O, Tabuchi S, Taniguchi K, Nishio M, Koyama S, Higaki M, Seki J and Sakane K. (2005) Discovery of diphenylcarbamate derivatives as highly potent and selective IP receptor agonists: orally active prostacyclin mimetics. Part 3. *Bioorg. Med. Chem. Lett.* **15**: 3091-5 [PMID:15914004]
 179. Hattori R, Shimizu S, Majima Y and Shimizu T. (2008) EP4 agonist inhibits lipopolysaccharide-induced mucus secretion in airway epithelial cells. *Ann. Otol. Rhinol. Laryngol.* **117**: 51-8 [PMID:18254372]
 180. Hattori R, Shimizu S, Majima Y and Shimizu T. (2009) Prostaglandin E2 receptor EP2, EP3, and EP4 agonists inhibit antigen-induced mucus hypersecretion in the nasal epithelium of sensitized rats. *Ann. Otol. Rhinol. Laryngol.* **118**: 536-41 [PMID:19708495]
 181. Haye-Legrand I, Bourdillat B, Labat C, Cerrina J, Norel X, Benveniste J and Brink C. (1987) Relaxation of isolated human pulmonary muscle preparations with prostacyclin (PGI₂) and its analogs. *Prostaglandins* **33**: 845-54 [PMID:2445003]
 182. Hedberg A, Hall SE, Ogletree ML, Harris DN and Liu EC. (1988) Characterization of [5,6-³H]SQ 29,548 as a high affinity radioligand, binding to thromboxane A2/prostaglandin H2-receptors in human platelets. *J. Pharmacol. Exp. Ther.* **245**: 786-92 [PMID:2968449]
 183. Heptinstall S, Espinosa DI, Manolopoulos P, Glenn JR, White AE, Johnson A, Dovlatova N, Fox SC, May JA and Hermann D *et al.*. (2008) DG-041 inhibits the EP3 prostanoid receptor--a new target for inhibition of platelet function in atherothrombotic disease. *Platelets* **19**: 605-13 [PMID:19012178]
 184. Hervé M, Angeli V, Pinzar E, Wintjens R, Faveeuw C, Narumiya S, Capron A, Urade Y, Capron M, Riveau G and Trottein F. (2003) Pivotal roles of the parasite PGD2 synthase and of the host D prostanoid receptor 1 in schistosome immune evasion. *Eur J Immunol* **33**: 2764-2772 [PMID:14515260]

185. Hirai H, Tanaka K, Takano S, Ichimasa M, Nakamura M and Nagata K. (2002) Cutting edge: agonistic effect of indomethacin on a prostaglandin D2 receptor, CRTH2. *J. Immunol.* **168**: 981-5 [PMID:11801628]
186. Hirai H, Tanaka K, Yoshie O, Ogawa K, Kenmotsu K, Takamori Y, Ichimasa M, Sugamura K, Nakamura M and Takano S *et al.*. (2001) Prostaglandin D2 selectively induces chemotaxis in T helper type 2 cells, eosinophils, and basophils via seven-transmembrane receptor CRTH2. *J. Exp. Med.* **193**: 255-61 [PMID:11208866]
187. Hirata M, Hayashi Y, Ushikubi F, Yokota Y, Kageyama R, Nakanishi S and Narumiya S. (1991) Cloning and expression of cDNA for a human thromboxane A2 receptor. *Nature* **349**: 617-20 [PMID:1825698]
188. Hirata M, Kakizuka A, Aizawa M, Ushikubi F and Narumiya S. (1994) Molecular characterization of a mouse prostaglandin D receptor and functional expression of the cloned gene. *Proc. Natl. Acad. Sci. U.S.A.* **91**: 11192-6 [PMID:7972033]
189. Hirata T, Kakizuka A, Ushikubi F, Fuse I, Okuma M and Narumiya S. (1994) Arg60 to Leu mutation of the human thromboxane A2 receptor in a dominantly inherited bleeding disorder. *J. Clin. Invest.* **94**: 1662-7 [PMID:7929844]
190. Hirata T and Narumiya S. (2011) Prostanoid receptors. *Chem. Rev.* **111**: 6209-30 [PMID:21819041]
191. Hirata T, Ushikubi F, Kakizuka A, Okuma M and Narumiya S. (1996) Two thromboxane A2 receptor isoforms in human platelets. Opposite coupling to adenylyl cyclase with different sensitivity to Arg60 to Leu mutation. *J. Clin. Invest.* **97**: 949-56 [PMID:8613548]
192. Hishikari K, Suzuki J, Ogawa M, Isobe K, Takahashi T, Onishi M, Takayama K and Isobe M. (2009) Pharmacological activation of the prostaglandin E2 receptor EP4 improves cardiac function after myocardial ischaemia/reperfusion injury. *Cardiovasc. Res.* **81**: 123-32 [PMID:18805784]
193. Hizaki H, Segi E, Sugimoto Y, Hirose M, Saji T, Ushikubi F, Matsuoka T, Noda Y, Tanaka T and Yoshida N *et al.*. (1999) Abortive expansion of the cumulus and impaired fertility in mice lacking the prostaglandin E receptor subtype EP(2). *Proc. Natl. Acad. Sci. U.S.A.* **96**: 10501-6 [PMID:10468638]
194. Hohjoh H, Inazumi T, Tsuchiya S and Sugimoto Y. (2014) Prostanoid receptors and acute inflammation in skin. *Biochimie* **107 Pt A**: 78-81 [PMID:25179301]
195. Honda A, Sugimoto Y, Namba T, Watabe A, Irie A, Negishi M, Narumiya S and Ichikawa A. (1993) Cloning and expression of a cDNA for mouse prostaglandin E receptor EP2 subtype. *J. Biol. Chem.* **268**: 7759-62 [PMID:8385118]
196. Honda T, Matsuoka T, Ueta M, Kabashima K, Miyachi Y and Narumiya S. (2009) Prostaglandin E(2)-EP(3) signaling suppresses skin inflammation in murine contact hypersensitivity. *J. Allergy Clin. Immunol.* **124**: 809-18.e2 [PMID:19541354]
197. Honda T, Segi-Nishida E, Miyachi Y and Narumiya S. (2006) Prostacyclin-IP signaling and prostaglandin E2-EP2/EP4 signaling both mediate joint inflammation in mouse collagen-induced arthritis. *J. Exp. Med.* **203**: 325-35 [PMID:16446378]
198. Hoshikawa Y, Voelkel NF, Gesell TL, Moore MD, Morris KG, Alger LA, Narumiya S and Geraci MW. (2001) Prostacyclin receptor-dependent modulation of pulmonary vascular remodeling. *Am. J. Respir. Crit. Care Med.* **164**: 314-8 [PMID:11463607]
199. Hosoi M, Oka T and Hori T. (1997) Prostaglandin E receptor EP3 subtype is involved in thermal hyperalgesia through its actions in the preoptic hypothalamus and the diagonal band of Broca in rats. *Pain* **71**: 303-311 [PMID:9231874]
200. Hristovska AM, Rasmussen LE, Hansen PB, Nielsen SS, Nüsing RM, Narumiya S, Vanhoutte P, Skøtt O and Jensen BL. (2007) Prostaglandin E2 induces vascular relaxation by E-prostanoid 4 receptor-mediated activation of endothelial nitric oxide synthase. *Hypertension* **50**: 525-30 [PMID:17635857]
201. Hung GH, Jones RL, Lam FF, Chan KM, Hidaka H, Suzuki M and Sasaki Y. (2006) Investigation of the pronounced synergism between prostaglandin E2 and other constrictor agents on rat femoral artery. *Prostaglandins Leukot. Essent. Fatty Acids* **74**: 401-15 [PMID:16737803]
202. Hébert RL, O'Connor T, Neville C, Burns KD, Laneville O and Peterson LN. (1998) Prostanoid signaling, localization, and expression of IP receptors in rat thick ascending limb cells. *Am. J. Physiol.* **275**: F904-14 [PMID:9843907]
203. Ibrahim NM, Young LG and Fröhlich O. (2001) Epididymal specificity and androgen regulation of rat EP2. *Biol. Reprod.* **65**: 575-80 [PMID:11466228]
204. Ibrahim S, McCartney A, Markosyan N and Smyth EM. (2013) Heterodimerization with the prostacyclin receptor triggers thromboxane receptor relocation to lipid rafts. *Arterioscler. Thromb. Vasc. Biol.* **33**: 60-6 [PMID:23162015]
205. Ichikawa A, Negishi M and Hasegawa H. (1997) Three isoforms of the prostaglandin E receptor EP3 subtype different in agonist-independent constitutive Gi activity and agonist-dependent Gs activity. *Adv. Exp. Med. Biol.* **433**: 239-42 [PMID:9561144]
206. Ichikawa A, Sugimoto Y and Tanaka S. (2010) Molecular biology of histidine decarboxylase and prostaglandin receptors. *Proc. Jpn. Acad., Ser. B, Phys. Biol. Sci.* **86**: 848-66 [PMID:20948178]
207. Ikeda M, Kawatani M, Maruyama T and Ishihama H. (2006) Prostaglandin facilitates afferent nerve activity via EP1 receptors during urinary bladder inflammation in rats. *Biomed. Res.* **27**: 49-54 [PMID:16707842]
208. Ikeda-Matsuo Y, Tanji H, Narumiya S and Sasaki Y. (2011) Inhibition of prostaglandin E2 EP3 receptors improves stroke injury via anti-inflammatory and anti-apoptotic mechanisms. *J. Neuroimmunol.* **238**: 34-43 [PMID:21803432]
209. Imig JD, Breyer MD and Breyer RM. (2002) Contribution of prostaglandin EP(2) receptors to renal microvascular reactivity in mice. *Am. J. Physiol. Renal Physiol.* **283**: F415-22 [PMID:12167591]
210. Ishida N, Odani-Kawabata N, Shimazaki A and Hara H. (2006) Prostanoids in the therapy of glaucoma.

- Cardiovasc Drug Rev* **24**: 1-10 [PMID:16939629]
211. Ishiguro S, Arie S, Monden K, Adachi Y, Funaki N, Higashitsuji H, Fujita S, Furutani M, Mise M and Kitao T *et al.*. (1994) Identification of the thromboxane A2 receptor in hepatic sinusoidal endothelial cells and its role in endotoxin-induced liver injury in rats. *Hepatology* **20**: 1281-6 [PMID:7927263]
 212. Ishikawa TO, Tamai Y, Rochelle JM, Hirata M, Namba T, Sugimoto Y, Ichikawa A, Narumiya S, Taketo MM and Seldin MF. (1996) Mapping of the genes encoding mouse prostaglandin D, E, and F and prostacyclin receptors. *Genomics* **32**: 285-8 [PMID:8833158]
 213. Israel DD and Regan JW. (2009) EP(3) prostanoid receptor isoforms utilize distinct mechanisms to regulate ERK 1/2 activation. *Biochim. Biophys. Acta* **1791**: 238-45 [PMID:19416642]
 214. Ito S, Negishi M, Sugama K, Okuda-Ashitaka E and Hayaishi O. (1991) Signal transduction coupled to prostaglandin D2. *Adv. Prostaglandin Thromboxane Leukot. Res.* **21A**: 371-4 [PMID:1705384]
 215. Ito S, Sakamoto K, Mochizuki-Oda N, Ezashi T, Miwa K, Okuda-Ashitaka E, Shevchenko VI, Kiso Y and Hayaishi O. (1994) Prostaglandin F2 alpha receptor is coupled to Gq in cDNA-transfected Chinese hamster ovary cells. *Biochem. Biophys. Res. Commun.* **200**: 756-62 [PMID:8179609]
 216. Itoh T, Ueno H and Kuriyama H. (1985) Calcium-induced calcium release mechanism in vascular smooth muscles--assessments based on contractions evoked in intact and saponin-treated skinned muscles. *Experientia* **41**: 989-96 [PMID:2990997]
 217. Iyú D, Glenn JR, White AE, Johnson AJ, Fox SC and Heptinstall S. (2010) The role of prostanoid receptors in mediating the effects of PGE(2) on human platelet function. *Platelets* **21**: 329-42 [PMID:20433310]
 218. Jaffar Z, Ferrini ME, Buford MC, Fitzgerald GA and Roberts K. (2007) Prostaglandin I2-IP signaling blocks allergic pulmonary inflammation by preventing recruitment of CD4+ Th2 cells into the airways in a mouse model of asthma. *J. Immunol.* **179**: 6193-203 [PMID:17947695]
 219. Jaffar Z, Ferrini ME, Shaw PK, FitzGerald GA and Roberts K. (2011) Prostaglandin I₂ promotes the development of IL-17-producing $\gamma\delta$ T cells that associate with the epithelium during allergic lung inflammation. *J. Immunol.* **187**: 5380-91 [PMID:21976777]
 220. Jain S, Chakraborty G, Raja R, Kale S and Kundu GC. (2008) Prostaglandin E2 regulates tumor angiogenesis in prostate cancer. *Cancer Res.* **68**: 7750-9 [PMID:18829529]
 221. Jandl K, Stacher E, Bálint Z, Sturm EM, Maric J, Peinhaupt M, Luschnig P, Aringer I, Fauland A and Konya V *et al.*. (2016) Activated prostaglandin D2 receptors on macrophages enhance neutrophil recruitment into the lung. *J. Allergy Clin. Immunol.* **137**: 833-43 [PMID:26792210]
 222. Jenkins DW, Feniuk W and Humphrey PP. (2001) Characterization of the prostanoid receptor types involved in mediating calcitonin gene-related peptide release from cultured rat trigeminal neurones. *Br. J. Pharmacol.* **134**: 1296-302 [PMID:11704650]
 223. Jensen BL, Mann B, Skøtt O and Kurtz A. (1999) Differential regulation of renal prostaglandin receptor mRNAs by dietary salt intake in the rat. *Kidney Int.* **56**: 528-37 [PMID:10432392]
 224. Jewell ML, Breyer RM and Currie KP. (2011) Regulation of calcium channels and exocytosis in mouse adrenal chromaffin cells by prostaglandin EP3 receptors. *Mol. Pharmacol.* **79**: 987-96 [PMID:21383044]
 225. Jiang J and Dingledine R. (2013) Role of prostaglandin receptor EP2 in the regulations of cancer cell proliferation, invasion, and inflammation. *J. Pharmacol. Exp. Ther.* **344**: 360-7 [PMID:23192657]
 226. Jiang J, Ganesh T, Du Y, Quan Y, Serrano G, Qui M, Speigel I, Rojas A, Lelutiu N and Dingledine R. (2012) Small molecule antagonist reveals seizure-induced mediation of neuronal injury by prostaglandin E2 receptor subtype EP2. *Proc. Natl. Acad. Sci. U.S.A.* **109**: 3149-54 [PMID:22323596]
 227. Jiang J, Ganesh T, Du Y, Thepchatri P, Rojas A, Lewis I, Kurtkaya S, Li L, Qui M and Serrano G *et al.*. (2010) Neuroprotection by selective allosteric potentiators of the EP2 prostaglandin receptor. *Proc. Natl. Acad. Sci. U.S.A.* **107**: 2307-12 [PMID:20080612]
 228. Jin J, Mao GF and Ashby B. (1997) Constitutive activity of human prostaglandin E receptor EP3 isoforms. *Br. J. Pharmacol.* **121**: 317-23 [PMID:9154343]
 229. Johansson T, Narumiya S and Zeilhofer HU. (2011) Contribution of peripheral versus central EP1 prostaglandin receptors to inflammatory pain. *Neurosci. Lett.* **495**: 98-101 [PMID:21440042]
 230. Johnston SL, Freezer NJ, Ritter W, O'Toole S and Howarth PH. (1995) Prostaglandin D2-induced bronchoconstriction is mediated only in part by the thromboxane prostanoid receptor. *Eur Respir J* **8**: 411-415 [PMID:7789486]
 231. Johnston SL, Smith S, Harrison J, Ritter W and Howarth PH. (1993) The effect of BAY u 3405, a thromboxane receptor antagonist, on prostaglandin D2-induced nasal blockage. *J. Allergy Clin. Immunol.* **91**: 903-9 [PMID:8473679]
 232. Jones CL, Li T and Cowley EA. (2012) The prostaglandin E₂ type 4 receptor participates in the response to acute oxidant stress in airway epithelial cells. *J. Pharmacol. Exp. Ther.* **341**: 552-63 [PMID:22362924]
 233. Jones RL. (1978) Definition of prostaglandin-sensitive arterial constrictor systems. *Acta Biol. Med. Ger.* **37**: 837-44 [PMID:742299]
 234. Jones RL, Giembycz MA and Woodward DF. (2009) Prostanoid receptor antagonists: development strategies and therapeutic applications. *Br. J. Pharmacol.* **158**: 104-45 [PMID:19624532]
 235. Jones RL and Marr CG. (1977) Actions of 16-aryloxy analogues of prostaglandin F2alpha on preparations responsive to prostaglandin endoperoxides. *Br. J. Pharmacol.* **61**: 694-6 [PMID:597671]
 236. Jones RL, Peesapati V and Wilson NH. (1982) Antagonism of the thromboxane-sensitive contractile systems of the rabbit aorta, dog saphenous vein and guinea-pig trachea. *Br. J. Pharmacol.* **76**: 423-38 [PMID:6286023]
 237. Jones RL, Qian YM, Chan KM and Yim AP. (1998) Characterization of a prostanoid EP3-receptor in

- guinea-pig aorta: partial agonist action of the non-prostanoid ONO-AP-324. *Br. J. Pharmacol.* **125**: 1288-96 [PMID:9863659]
238. Jones RL, Qian YM, Wise H, Wong HN, Lam WL, Chan HW, Yim AP and Ho JK. (1997) Relaxant actions of nonprostanoid prostacyclin mimetics on human pulmonary artery. *J. Cardiovasc. Pharmacol.* **29**: 525-35 [PMID:9156364]
 239. Jones RL, Wan Ahmad WA, Woodward DF and Wang J. (2013) Nature of the slow relaxation of smooth muscle induced by a EP2 receptor agonist with a non-prostanoid structure. *Prostaglandins Leukot. Essent. Fatty Acids* **88**: 321-30 [PMID:23419768]
 240. Jones RL, Wilson NH and Lawrence RA. (1989) EP 171: a high affinity thromboxane A2-mimetic, the actions of which are slowly reversed by receptor blockade. *Br. J. Pharmacol.* **96**: 875-87 [PMID:2743082]
 241. Jones RL, Wilson NH, Marr CG, Muir G and Armstrong RA. (1993) Diphenylmethylazine prostanoids with prostacyclin-like actions on human platelets. *J Lipid Mediat* **6**: 405-10 [PMID:8357998]
 242. Jones RL, Wise H, Clark R, Whiting RL and Bley KR. (2006) Investigation of the prostacyclin (IP) receptor antagonist RO1138452 on isolated blood vessel and platelet preparations. *Br. J. Pharmacol.* **149**: 110-20 [PMID:16880763]
 243. Jones RL, Woodward DF, Wang JW and Clark RL. (2011) Roles of affinity and lipophilicity in the slow kinetics of prostanoid receptor antagonists on isolated smooth muscle preparations. *Br. J. Pharmacol.* **162**: 863-79 [PMID:20973775]
 244. Jugus MJ, Jaworski JP, Patra PB, Jin J, Morrow DM, Laping NJ, Edwards RM and Thorneloe KS. (2009) Dual modulation of urinary bladder activity and urine flow by prostanoid EP3 receptors in the conscious rat. *Br. J. Pharmacol.* **158**: 372-81 [PMID:19486006]
 245. Jumblatt MM, Neltner AA, Coca-Prados M and Paterson CA. (1994) EP2-receptor stimulated cyclic AMP synthesis in cultured human non-pigmented ciliary epithelium. *Exp. Eye Res.* **58**: 563-6 [PMID:7925693]
 246. Juteau H, Gareau Y, Labelle M, Sturino CF, Sawyer N, Tremblay N, Lamontagne S, Carrière MC, Denis D and Metters KM. (2001) Structure-activity relationship of cinnamic acylsulfonamide analogues on the human EP3 prostanoid receptor. *Bioorg. Med. Chem.* **9**: 1977-84 [PMID:11504634]
 247. Kabashima K, Murata T, Tanaka H, Matsuoka T, Sakata D, Yoshida N, Katagiri K, Kinashi T, Tanaka T and Miyasaka M *et al.*. (2003) Thromboxane A2 modulates interaction of dendritic cells and T cells and regulates acquired immunity. *Nat. Immunol.* **4**: 694-701 [PMID:12778172]
 248. Kabashima K, Saji T, Murata T, Nagamachi M, Matsuoka T, Segi E, Tsuboi K, Sugimoto Y, Kobayashi T and Miyachi Y *et al.*. (2002) The prostaglandin receptor EP4 suppresses colitis, mucosal damage and CD4 cell activation in the gut. *J. Clin. Invest.* **109**: 883-93 [PMID:11927615]
 249. Kabashima K, Sakata D, Nagamachi M, Miyachi Y, Inaba K and Narumiya S. (2003) Prostaglandin E2-EP4 signaling initiates skin immune responses by promoting migration and maturation of Langerhans cells. *Nat. Med.* **9**: 744-9 [PMID:12740571]
 250. Kajikawa N, Nogimori K, Murata T, Nishio S and Uchiyama S. (1989) Specific binding of the new stable epoprostenol analogue beraprost sodium to prostacyclin receptors on human and rat platelets. *Arzneimittelforschung* **39**: 495-9 [PMID:2665758]
 251. Kambe T, Maruyama T, Nakano M, Nakai Y, Yoshida T, Matsunaga N, Oida H, Konaka A, Maruyama T and Nakai H *et al.*. (2012) Discovery of a novel EP2/EP4 dual agonist with high subtype-selectivity *Bioorg. Med. Chem. Lett.* **22**: 396-401 [PMID:22119471]
 252. Kamiyama M, Pozzi A, Yang L, DeBusk LM, Breyer RM and Lin PC. (2006) EP2, a receptor for PGE2, regulates tumor angiogenesis through direct effects on endothelial cell motility and survival. *Oncogene* **25**: 7019-28 [PMID:16732324]
 253. Kanamori Y, Niwa M, Kohno K, Al-Essa LY, Matsuno H, Kozawa O and Uematsu T. (1997) Migration of neutrophils from blood to tissue: alteration of modulatory effects of prostanoid on superoxide generation in rabbits and humans. *Life Sci.* **60**: 1407-17 [PMID:9096262]
 254. Kaneko Y, Nakayama T, Saito K, Morita A, Sato I, Maruyama A, Soma M, Takahashi T and Sato N. (2006) Relationship between the thromboxane A2 receptor gene and susceptibility to cerebral infarction. *Hypertens. Res.* **29**: 665-71 [PMID:17249521]
 255. Katagiri H, Ito Y, Murata T, Yukihiko S, Narumiya S, Watanabe M and Majima M. (2008) TNF-alpha induces thromboxane receptor signaling-dependent microcirculatory dysfunction in mouse liver. *Shock* **30**: 463-7 [PMID:18800000]
 256. Kataoka H, Sakanaka M, Semma M, Yamamoto T, Hirota S, Tanaka S and Ichikawa A. (2008) PGE2-receptor subtype EP4-dependent adherence of mastocytoma P-815 cells to matrix components in subcutaneous tissues overlaying inside surface of air pouch cavity in CDF1 mouse. *Inflamm. Res.* **57**: 362-6 [PMID:18787774]
 257. Kato S, Aihara E, Yoshii K and Takeuchi K. (2005) Dual action of prostaglandin E2 on gastric acid secretion through different EP-receptor subtypes in the rat. *Am. J. Physiol. Gastrointest. Liver Physiol.* **289**: G64-9 [PMID:15961884]
 258. Katoh H, Watabe A, Sugimoto Y, Ichikawa A and Negishi M. (1995) Characterization of the signal transduction of prostaglandin E receptor EP1 subtype in cDNA-transfected Chinese hamster ovary cells. *Biochim. Biophys. Acta* **1244**: 41-8 [PMID:7766667]
 259. Katsuyama M, Nishigaki N, Sugimoto Y, Morimoto K, Negishi M, Narumiya S and Ichikawa A. (1995) The mouse prostaglandin E receptor EP2 subtype: cloning, expression, and northern blot analysis. *FEBS Lett.* **372**: 151-6 [PMID:7556658]
 260. Kattelman EJ, Venton DL and Le Breton GC. (1986) Characterization of U46619 binding in unactivated, intact human platelets and determination of binding site affinities of four TXA2/PGH2 receptor antagonists

- (13-APA, BM 13.177, ONO 3708 and SQ 29,548). *Thromb. Res.* **41**: 471-81 [PMID:3008368]
261. Kawabe J, Yuhki K, Okada M, Kanno T, Yamauchi A, Tashiro N, Sasaki T, Okumura S, Nakagawa N and Aburakawa Y *et al.*. (2010) Prostaglandin I2 promotes recruitment of endothelial progenitor cells and limits vascular remodeling. *Arterioscler. Thromb. Vasc. Biol.* **30**: 464-70 [PMID:20007911]
 262. Kawahara H, Sakamoto A, Takeda S, Onodera H, Imaki J and Ogawa R. (2001) A prostaglandin E2 receptor subtype EP1 receptor antagonist (ONO-8711) reduces hyperalgesia, allodynia, and c-fos gene expression in rats with chronic nerve constriction. *Anesth. Analg.* **93**: 1012-7 [PMID:11574375]
 263. Kawamori T, Kitamura T, Watanabe K, Uchiya N, Maruyama T, Narumiya S, Sugimura T and Wakabayashi K. (2005) Prostaglandin E receptor subtype EP(1) deficiency inhibits colon cancer development. *Carcinogenesis* **26**: 353-7 [PMID:15564292]
 264. Kawamura T, Yamauchi T, Koyama M, Maruyama T, Akira T and Nakamura N. (1997) Expression of prostaglandin EP2 receptor mRNA in the rat spinal cord. *Life Sci.* **61**: 2111-6 [PMID:9395252]
 265. Kawano T, Anrather J, Zhou P, Park L, Wang G, Frys KA, Kunz A, Cho S, Orio M and Iadecola C. (2006) Prostaglandin E2 EP1 receptors: downstream effectors of COX-2 neurotoxicity. *Nat. Med.* **12**: 225-9 [PMID:16432513]
 266. Kay LJ, Gilbert M, Pullen N, Skerratt S, Farrington J, Seward EP and Peachell PT. (2013) Characterization of the EP receptor subtype that mediates the inhibitory effects of prostaglandin E2 on IgE-dependent secretion from human lung mast cells. *Clin. Exp. Allergy* **43**: 741-51 [PMID:23786281]
 267. Keery RJ and Lumley P. (1988) AH6809, a prostaglandin DP-receptor blocking drug on human platelets. *Br. J. Pharmacol.* **94**: 745-54 [PMID:2460179]
 268. Kelly CR, Williams GW and Sharif NA. (2003) Real-time intracellular Ca²⁺ mobilization by travoprost acid, bimatoprost, unoprostone, and other analogs via endogenous mouse, rat, and cloned human FP prostaglandin receptors. *J. Pharmacol. Exp. Ther.* **304**: 238-45 [PMID:12490597]
 269. Kennedy CR, Zhang Y, Brandon S, Guan Y, Coffee K, Funk CD, Magnuson MA, Oates JA, Breyer MD and Breyer RM. (1999) Salt-sensitive hypertension and reduced fertility in mice lacking the prostaglandin EP2 receptor. *Nat. Med.* **5**: 217-20 [PMID:9930871]
 270. Kimball FA, Lauderdale JW, Nelson NA and Jackson RW. (1976) Comparison of luteolytic effectiveness of several prostaglandin analogs in heifers and relative binding affinity for bovine luteal prostaglandin binding sites. *Prostaglandins* **12**: 985-995 [PMID:188076]
 271. Kimura T, Ogita K, Kusui C, Ohashi K, Azuma C and Murata Y. (1999) What knockout mice can tell us about parturition. *Rev Reprod* **4**: 73-80 [PMID:10357094]
 272. Kinsella BT. (2001) Thromboxane A2 signalling in humans: a 'Tail' of two receptors. *Biochem. Soc. Trans.* **29**: 641-54 [PMID:11709048]
 273. Kinsella BT, O'Mahony DJ and Fitzgerald GA. (1997) The human thromboxane A2 receptor alpha isoform (TP alpha) functionally couples to the G proteins Gq and G11 in vivo and is activated by the isoprostane 8-epi prostaglandin F2 alpha. *J. Pharmacol. Exp. Ther.* **281**: 957-64 [PMID:9152406]
 274. Kirihara T, Taniguchi T, Yamamura K, Iwamura R, Yoneda K, Odani-Kawabata N, Shimazaki A, Matsugi T, Shams N and Zhang JZ. (2018) Pharmacologic Characterization of Omidenepeg Isopropyl, a Novel Selective EP2 Receptor Agonist, as an Ocular Hypotensive Agent. *Invest. Ophthalmol. Vis. Sci.* **59**: 145-153 [PMID:29332128]
 275. Kiriya M, Ushikubi F, Kobayashi T, Hirata M, Sugimoto Y and Narumiya S. (1997) Ligand binding specificities of the eight types and subtypes of the mouse prostanoid receptors expressed in Chinese hamster ovary cells. *Br. J. Pharmacol.* **122**: 217-24 [PMID:9313928]
 276. Kishino J, Hanasaki K, Nagasaki T and Arita H. (1991) Kinetic studies on stereospecific recognition by the thromboxane A2/prostaglandin H2 receptor of the antagonist, S-145. *Br. J. Pharmacol.* **103**: 1883-8 [PMID:1833018]
 277. Kitanaka J, Hasimoto H, Sugimoto Y, Negishi M, Aino H, Gotoh M, Ichikawa A and Baba A. (1994) Cloning and expression of a cDNA for rat prostaglandin F2 alpha receptor. *Prostaglandins* **48**: 31-41 [PMID:7972878]
 278. Kitaoka S, Furuyashiki T, Nishi A, Shuto T, Koyasu S, Matsuoka T, Miyasaka M, Greengard P and Narumiya S. (2007) Prostaglandin E2 acts on EP1 receptor and amplifies both dopamine D1 and D2 receptor signaling in the striatum. *J. Neurosci.* **27**: 12900-7 [PMID:18032663]
 279. Kobayashi K, Murata T, Hori M and Ozaki H. (2011) Prostaglandin E2-prostanoid EP3 signal induces vascular contraction via nPKC and ROCK activation in rat mesenteric artery. *Eur. J. Pharmacol.* **660**: 375-80 [PMID:21463619]
 280. Kobayashi T and Narumiya S. (2002) Function of prostanoid receptors: studies on knockout mice. *Prostaglandins Other Lipid Mediat.* **68-69**: 557-73 [PMID:12432943]
 281. Kobayashi T, Tahara Y, Matsumoto M, Iguchi M, Sano H, Murayama T, Arai H, Oida H, Yurugi-Kobayashi T and Yamashita JK *et al.*. (2004) Roles of thromboxane A(2) and prostacyclin in the development of atherosclerosis in apoE-deficient mice. *J. Clin. Invest.* **114**: 784-94 [PMID:15372102]
 282. Kolodnick JE, Peters-Golden M, Larios J, Toews GB, Thannickal VJ and Moore BB. (2003) Prostaglandin E2 inhibits fibroblast to myofibroblast transition via E. prostanoid receptor 2 signaling and cyclic adenosine monophosphate elevation. *Am. J. Respir. Cell Mol. Biol.* **29**: 537-44 [PMID:12738687]
 283. Komuro M, Kamiyama M, Furuya Y, Takihana Y, Araki I and Takeda M. (2006) Gene and protein expression profiles of prostaglandin E2 receptor subtypes in the human corpus cavernosum. *Int. J. Impot. Res.* **18**: 275-81 [PMID:16239896]
 284. Konya V, Philipose S, Bálint Z, Olschewski A, Marsche G, Sturm EM, Schicho R, Peskar BA, Schuligoi R

- and Heinemann A. (2011) Interaction of eosinophils with endothelial cells is modulated by prostaglandin EP4 receptors. *Eur. J. Immunol.* **41**: 2379-89 [PMID:21681739]
285. Kosuge Y, Miyagishi H, Shinomiya T, Nishiyama K, Suzuki S, Osada N, Ishige K, Okubo M, Kawaguchi M and Ito Y. (2015) Characterization of Motor Neuron Prostaglandin E2 EP3 Receptor Isoform in a Mouse Model of Amyotrophic Lateral Sclerosis. *Biol. Pharm. Bull.* **38**: 1964-8 [PMID:26632188]
286. Kotani M, Tanaka I, Ogawa Y, Usui T, Mori K, Ichikawa A, Narumiya S, Yoshimi T and Nakao K. (1995) Molecular cloning and expression of multiple isoforms of human prostaglandin E receptor EP3 subtype generated by alternative messenger RNA splicing: multiple second messenger systems and tissue-specific distributions. *Mol. Pharmacol.* **48**: 869-79 [PMID:7476918]
287. Kotani M, Tanaka I, Ogawa Y, Usui T, Tamura N, Mori K, Narumiya S, Yoshimi T and Nakao K. (1997) Structural organization of the human prostaglandin EP3 receptor subtype gene (PTGER3). *Genomics* **40**: 425-34 [PMID:9073510]
288. Kotani T, Kobata A, Nakamura E, Amagase K and Takeuchi K. (2006) Roles of cyclooxygenase-2 and prostacyclin/IP receptors in mucosal defense against ischemia/reperfusion injury in mouse stomach. *J. Pharmacol. Exp. Ther.* **316**: 547-55 [PMID:16236816]
289. Kotelevets L, Foudi N, Louedec L, Couvelard A, Chastre E and Norel X. (2007) A new mRNA splice variant coding for the human EP3-I receptor isoform. *Prostaglandins Leukot. Essent. Fatty Acids* **77**: 195-201 [PMID:18023986]
290. Krause A, Zisowsky J, Strasser DS, Gehin M, Sidharta PN, Groenen PMA and Dingemans J. (2016) Pharmacokinetic/Pharmacodynamic Modelling of Receptor Internalization with CRTH2 Antagonists to Optimize Dose Selection. *Clin Pharmacokinet* **55**: 813-821 [PMID:26692193]
291. Krauss AH, Impagnatiello F, Toris CB, Gale DC, Prasanna G, Borghi V, Chiroli V, Chong WK, Carreiro ST and Ongini E. (2011) Ocular hypotensive activity of BOL-303259-X, a nitric oxide donating prostaglandin F2 α agonist, in preclinical models. *Exp. Eye Res.* **93**: 250-5 [PMID:21396362]
292. Krauss AH, Woodward DF, Gibson LL, Protzman CE, Williams LS, Burk RM, Gac TS, Roof MB, Abbas F and Marshall K *et al.* (1996) Evidence for human thromboxane receptor heterogeneity using a novel series of 9,11-cyclic carbonate derivatives of prostaglandin F2 alpha. *Br. J. Pharmacol.* **117**: 1171-80 [PMID:8882612]
293. Kubo S, Takahashi HK, Takei M, Iwagaki H, Yoshino T, Tanaka N, Mori S and Nishibori M. (2004) E-prostanoid (EP)2/EP4 receptor-dependent maturation of human monocyte-derived dendritic cells and induction of helper T2 polarization. *J. Pharmacol. Exp. Ther.* **309**: 1213-20 [PMID:14872092]
294. Kunapuli SP, Fen Mao G, Bastepe M, Liu-Chen LY, Li S, Cheung PP, DeRiel JK and Ashby B. (1994) Cloning and expression of a prostaglandin E receptor EP3 subtype from human erythroleukaemia cells. *Biochem. J.* **298** (Pt 2): 263-7 [PMID:8135729]
295. Kunikata T, Araki H, Takeeda M, Kato S and Takeuchi K. (2001) Prostaglandin E prevents indomethacin-induced gastric and intestinal damage through different EP receptor subtypes. *J. Physiol. Paris* **95**: 157-63 [PMID:11595431]
296. Kunikata T, Tanaka A, Miyazawa T, Kato S and Takeuchi K. (2002) 16,16-Dimethyl prostaglandin E2 inhibits indomethacin-induced small intestinal lesions through EP3 and EP4 receptors. *Dig. Dis. Sci.* **47**: 894-904 [PMID:11991626]
297. Kunikata T, Yamane H, Segi E, Matsuoka T, Sugimoto Y, Tanaka S, Tanaka H, Nagai H, Ichikawa A and Narumiya S. (2005) Suppression of allergic inflammation by the prostaglandin E receptor subtype EP3. *Nat. Immunol.* **6**: 524-31 [PMID:15806106]
298. Kuwano K, Hashino A, Asaki T, Hamamoto T, Yamada T, Okubo K and Kuwabara K. (2007) 2-[4-[(5,6-diphenylpyrazin-2-yl)(isopropyl)amino]butoxy]-N-(methylsulfonyl)acetamide (NS-304), an orally available and long-acting prostacyclin receptor agonist prodrug. *J. Pharmacol. Exp. Ther.* **322**: 1181-8 [PMID:17545310]
299. Kvirkvelia N, McMenamin M, Chaudhary K, Bartoli M and Madaio MP. (2013) Prostaglandin E2 promotes cellular recovery from established nephrotoxic serum nephritis in mice, pro-survival, and regenerative effects on glomerular cells. *Am. J. Physiol. Renal Physiol.* **304**: F463-70 [PMID:23283994]
300. Lake S, Gullberg H, Wahlqvist J, Sjögren AM, Kinhult A, Lind P, Hellström-Lindahl E and Stjernschantz J. (1994) Cloning of the rat and human prostaglandin F2 alpha receptors and the expression of the rat prostaglandin F2 alpha receptor. *FEBS Lett.* **355**: 317-25 [PMID:7988697]
301. Lawrence RA and Jones RL. (1992) Investigation of the prostaglandin E (EP-) receptor subtype mediating relaxation of the rabbit jugular vein. *Br. J. Pharmacol.* **105**: 817-24 [PMID:1324050]
302. Lawrence RA, Jones RL and Wilson NH. (1992) Characterization of receptors involved in the direct and indirect actions of prostaglandins E and I on the guinea-pig ileum. *Br. J. Pharmacol.* **105**: 271-8 [PMID:1559125]
303. Lazarus M, Yoshida K, Coppari R, Bass CE, Mochizuki T, Lowell BB and Saper CB. (2007) EP3 prostaglandin receptors in the median preoptic nucleus are critical for fever responses. *Nat. Neurosci.* **10**: 1131-3 [PMID:17676060]
304. Leduc M, Breton B, Galés C, Le Gouill C, Bouvier M, Chemtob S and Heveker N. (2009) Functional selectivity of natural and synthetic prostaglandin EP4 receptor ligands. *J. Pharmacol. Exp. Ther.* **331**: 297-307 [PMID:19584306]
305. Leduc M, Hou X, Hamel D, Sanchez M, Quiniou C, Honoré JC, Roy O, Madaan A, Lubell W and Varma DR *et al.* (2013) Restoration of renal function by a novel prostaglandin EP4 receptor-derived peptide in models of acute renal failure. *Am. J. Physiol. Regul. Integr. Comp. Physiol.* **304**: R10-22 [PMID:23152113]
306. Lee RH, Goodwin TM, Yang W, Li A, Wilson ML, Mullin PM and Felix JC. (2009) Quantitative detection of

- EP3-II, III and VI messenger RNA in gravid and non-gravid human myometrium using real-time RT-PCR. *J. Matern. Fetal. Neonatal. Med.* **22**: 59-64 [PMID:19165680]
307. Leonhardt A, Glaser A, Wegmann M, Hackenberg R and Nüsing RM. (2003) Expression of prostanoid receptors in human lower segment pregnant myometrium. *Prostaglandins Leukot. Essent. Fatty Acids* **69**: 307-13 [PMID:14580364]
308. Lesault PF, Boyer L, Pelle G, Covali-Noroc A, Rideau D, Akakpo S, Teiger E, Dubois-Randé JL and Adnot S. (2011) Daily administration of the TP receptor antagonist terutroban improved endothelial function in high-cardiovascular-risk patients with atherosclerosis. *Br J Clin Pharmacol* **71**: 844-51 [PMID:21564160]
309. Li M, Healy DR, Li Y, Simmons HA, Crawford DT, Ke HZ, Pan LC, Brown TA and Thompson DD. (2005) Osteopenia and impaired fracture healing in aged EP4 receptor knockout mice. *Bone* **37**: 46-54 [PMID:15869929]
310. Li M, Ke HZ, Qi H, Healy DR, Li Y, Crawford DT, Paralkar VM, Owen TA, Cameron KO and Lefker BA *et al.* (2003) A novel, non-prostanoid EP2 receptor-selective prostaglandin E2 agonist stimulates local bone formation and enhances fracture healing. *J. Bone Miner. Res.* **18**: 2033-42 [PMID:14606517]
311. Li X, Okada Y, Pilbeam CC, Lorenzo JA, Kennedy CR, Breyer RM and Raisz LG. (2000) Knockout of the murine prostaglandin EP2 receptor impairs osteoclastogenesis in vitro. *Endocrinology* **141**: 2054-61 [PMID:10830290]
312. Li X and Tai HH. (2013) Activation of thromboxane A2 receptor (TP) increases the expression of monocyte chemoattractant protein -1 (MCP-1)/chemokine (C-C motif) ligand 2 (CCL2) and recruits macrophages to promote invasion of lung cancer cells. *PLoS ONE* **8**: e54073 [PMID:23349788]
313. Li X, Tomita M, Pilbeam CC, Breyer RM and Raisz LG. (2002) Prostaglandin receptor EP2 mediates PGE2 stimulated hypercalcemia in mice in vivo. *Prostaglandins Other Lipid Mediat.* **67**: 173-80 [PMID:12013525]
314. Liang X, Lin L, Woodling NS, Wang Q, Anacker C, Pan T, Merchant M and Andreasson K. (2011) Signaling via the prostaglandin E₂ receptor EP4 exerts neuronal and vascular protection in a mouse model of cerebral ischemia. *J. Clin. Invest.* **121**: 4362-71 [PMID:21965326]
315. Liang X, Wang Q, Hand T, Wu L, Breyer RM, Montine TJ and Andreasson K. (2005) Deletion of the prostaglandin E2 EP2 receptor reduces oxidative damage and amyloid burden in a model of Alzheimer's disease. *J. Neurosci.* **25**: 10180-7 [PMID:16267225]
316. Liljebriis C, Selén G, Resul B, Stjernschantz J and Hacksell U. (1995) Derivatives of 17-phenyl-18,19,20-trinorprostaglandin F2 alpha isopropyl ester: potential antiglaucoma agents. *J. Med. Chem.* **38**: 289-304 [PMID:7830272]
317. Liu D, Wu L, Breyer R, Mattson MP and Andreasson K. (2005) Neuroprotection by the PGE2 EP2 receptor in permanent focal cerebral ischemia. *Ann. Neurol.* **57**: 758-61 [PMID:15852374]
318. Liu J, Li AR, Wang Y, Johnson MG, Su Y, Shen W, Wang X, Lively S, Brown M and Lai S *et al.* (2011) Discovery of AMG 853, a CRTH2 and DP Dual Antagonist. *ACS Med Chem Lett* **2**: 326-30 [PMID:24900313]
319. Longrois D, Gomez I, Foudi N, Topal G, Dhaouadi M, Kotelevets L, Chastre E and Norel X. (2012) Prostaglandin E₂ induced contraction of human intercostal arteries is mediated by the EP₃ receptor. *Eur. J. Pharmacol.* **681**: 55-9 [PMID:22342278]
320. Luker T, Bonnett R, Brough S, Cook AR, Dickinson MR, Dougall I, Logan C, Mohammed RT, Paine S and Sanganeer HJ *et al.* (2011) Substituted indole-1-acetic acids as potent and selective CRTh2 antagonists-discovery of AZD1981. *Bioorg. Med. Chem. Lett.* **21**: 6288-92 [PMID:21944852]
321. Lumley P, White BP and Humphrey PP. (1989) GR32191, a highly potent and specific thromboxane A2 receptor blocking drug on platelets and vascular and airways smooth muscle in vitro. *Br. J. Pharmacol.* **97**: 783-94 [PMID:2527074]
322. Lundblad C, Grände PO and Bentzer P. (2008) Increased cortical cell loss and prolonged hemodynamic depression after traumatic brain injury in mice lacking the IP receptor for prostacyclin. *J. Cereb. Blood Flow Metab.* **28**: 367-76 [PMID:17713464]
323. Luschnig-Schratl P, Sturm EM, Konya V, Philipose S, Marsche G, Fröhlich E, Samberger C, Lang-Loidolt D, Gattenlöhner S and Lippe IT *et al.* (2011) EP4 receptor stimulation down-regulates human eosinophil function. *Cell. Mol. Life Sci.* **68**: 3573-87 [PMID:21365278]
324. Ly TW and Bacon KB. (2005) Small-molecule CRTH2 antagonists for the treatment of allergic inflammation: an overview. *Expert Opin Investig Drugs* **14**: 769-73 [PMID:16022566]
325. Ma H, Hara A, Xiao CY, Okada Y, Takahata O, Nakaya K, Sugimoto Y, Ichikawa A, Narumiya S and Ushikubi F. (2001) Increased bleeding tendency and decreased susceptibility to thromboembolism in mice lacking the prostaglandin E receptor subtype EP(3). *Circulation* **104**: 1176-80 [PMID:11535576]
326. Machwate M, Harada S, Leu CT, Sedor G, Labelle M, Gallant M, Hutchins S, Lachance N, Sawyer N and Slipetz D *et al.* (2001) Prostaglandin receptor EP(4) mediates the bone anabolic effects of PGE(2). *Mol. Pharmacol.* **60**: 36-41 [PMID:11408598]
327. Maher SA, Birrell MA and Belvisi MG. (2009) Prostaglandin E2 mediates cough via the EP3 receptor: implications for future disease therapy. *Am. J. Respir. Crit. Care Med.* **180**: 923-8 [PMID:19729667]
328. Mais DE, DeHoll D, Sightler H and Halushka PV. (1988) Different pharmacologic activities for 13-azapinane thromboxane A2 analogs in platelets and blood vessels. *Eur. J. Pharmacol.* **148**: 309-15 [PMID:2968271]
329. Malinowska B, Godlewski G, Buczek W and Schlicker E. (1994) EP3 receptor-mediated inhibition of the neurogenic vasopressor response in pithed rats. *Eur. J. Pharmacol.* **259**: 315-19 [PMID:7982460]
330. Maruyama T, Asada M, Shiraishi T, Ishida A, Egashira H, Yoshida H, Maruyama T, Ohuchida S, Nakai H

- and Kondo K *et al.*. (2001) Design and synthesis of a highly selective EP4-receptor agonist. Part 1: 3,7-dithiaPG derivatives with high selectivity. *Bioorg. Med. Chem. Lett.* **11**: 2029-31 [PMID:11454473]
331. Masuda A, Mais DE, Oatis Jr JE and Halushka PV. (1991) Platelet and vascular thromboxane A₂/prostaglandin H₂ receptors. Evidence for different subclasses in the rat. *Biochem. Pharmacol.* **42**: 537-44 [PMID:1830482]
332. Masuko K, Murata M, Yudoh K, Shimizu H, Beppu M, Nakamura H and Kato T. (2010) Prostaglandin E₂ regulates the expression of connective tissue growth factor (CTGF/CCN2) in human osteoarthritic chondrocytes via the EP4 receptor. *BMC Res Notes* **3**: 5 [PMID:20205862]
333. Mathiesen JM, Christopoulos A, Ulven T, Royer JF, Campillo M, Heinemann A, Pardo L and Kostenis E. (2006) On the mechanism of interaction of potent surmountable and insurmountable antagonists with the prostaglandin D₂ receptor CRTH2. *Mol. Pharmacol.* **69**: 1441-53 [PMID:16418339]
334. Matsui Y, Amano H, Ito Y, Eshima K, Suzuki T, Ogawa F, Iyoda A, Satoh Y, Kato S and Nakamura M *et al.*. (2012) Thromboxane A₂ receptor signaling facilitates tumor colonization through P-selectin-mediated interaction of tumor cells with platelets and endothelial cells. *Cancer Sci.* **103**: 700-7 [PMID:22296266]
335. Matsumoto T, Sagawa N, Yoshida M, Mori T, Tanaka I, Mukoyama M, Kotani M and Nakao K. (1997) The prostaglandin E₂ and F₂ alpha receptor genes are expressed in human myometrium and are down-regulated during pregnancy. *Biochem Biophys Res Commun* **238**: 838-841 [PMID:9325177]
336. Matsumura S, Abe T, Mabuchi T, Katano T, Takagi K, Okuda-Ashitaka E, Tatsumi S, Nakai Y, Hidaka H and Suzuki M *et al.*. (2005) Rho-kinase mediates spinal nitric oxide formation by prostaglandin E₂ via EP₃ subtype. *Biochem. Biophys. Res. Commun.* **338**: 550-7 [PMID:16188227]
337. Matsuoka T, Hirata M, Tanaka H, Takahashi Y, Murata T, Kabashima K, Sugimoto Y, Kobayashi T, Ushikubi F, Aze Y, Eguchi N, Urade Y, Yoshida N, Kimura K, Mizoguchi A, Honda Y, Nagai H and Narumiya S. (2000) Prostaglandin D₂ as a mediator of allergic asthma. *Science* **287**: 2013-2017 [PMID:10720327]
338. Matsuoka Y, Furuyashiki T, Bito H, Ushikubi F, Tanaka Y, Kobayashi T, Muro S, Satoh N, Kayahara T and Higashi M *et al.*. (2003) Impaired adrenocorticotrophic hormone response to bacterial endotoxin in mice deficient in prostaglandin E receptor EP1 and EP3 subtypes. *Proc. Natl. Acad. Sci. U.S.A.* **100**: 4132-7 [PMID:12642666]
339. Matsuoka Y, Furuyashiki T, Yamada K, Nagai T, Bito H, Tanaka Y, Kitaoka S, Ushikubi F, Nabeshima T and Narumiya S. (2005) Prostaglandin E receptor EP1 controls impulsive behavior under stress. *Proc. Natl. Acad. Sci. U.S.A.* **102**: 16066-71 [PMID:16247016]
340. Maubach KA, Davis RJ, Clark DE, Fenton G, Lockey PM, Clark KL, Oxford AW, Hagan RM, Routledge C and Coleman RA. (2009) BGC20-1531, a novel, potent and selective prostanoid EP receptor antagonist: a putative new treatment for migraine headache. *Br. J. Pharmacol.* **156**: 316-27 [PMID:19154437]
341. Mayeux PR, Morinelli TA, Williams TC, Hazard ES, Mais DE, Oatis JE, Baron DA and Halushka PV. (1991) Differential effect of pH on thromboxane A₂/prostaglandin H₂ receptor agonist and antagonist binding in human platelets. *J. Biol. Chem.* **266**: 13752-8 [PMID:1830308]
342. McCafferty GP, Misajet BA, Laping NJ, Edwards RM and Thorneloe KS. (2008) Enhanced bladder capacity and reduced prostaglandin E₂-mediated bladder hyperactivity in EP₃ receptor knockout mice. *Am. J. Physiol. Renal Physiol.* **295**: F507-14 [PMID:18508878]
343. McCoy JM, Wicks JR and Audoly LP. (2002) The role of prostaglandin E₂ receptors in the pathogenesis of rheumatoid arthritis. *J. Clin. Invest.* **110**: 651-8 [PMID:12208866]
344. McGraw DW, Mihlbachler KA, Schwarb MR, Rahman FF, Small KM, Almoosa KF and Liggett SB. (2006) Airway smooth muscle prostaglandin-EP₁ receptors directly modulate beta₂-adrenergic receptors within a unique heterodimeric complex. *J. Clin. Invest.* **116**: 1400-9 [PMID:16670773]
345. McLaughlin VV, Archer SL, Badesch DB, Barst RJ, Farber HW, Lindner JR, Mathier MA, McGoon MD, Park MH and Rosenson RS *et al.*. (2009) ACCF/AHA 2009 expert consensus document on pulmonary hypertension a report of the American College of Cardiology Foundation Task Force on Expert Consensus Documents and the American Heart Association developed in collaboration with the American College of Chest Physicians; American Thoracic Society, Inc.; and the Pulmonary Hypertension Association. *J. Am. Coll. Cardiol.* **53**: 1573-619 [PMID:19389575]
346. Meanwell NA, Romine JL, Rosenfeld MJ, Martin SW, Trehan AK, Wright JJ, Malley MF, Gougoutas JZ, Brassard CL and Buchanan JO *et al.*. (1993) Nonprostanoid prostacyclin mimetics. 5. Structure-activity relationships associated with [3-[4-(4,5-diphenyl-2-oxazolyl)-5-oxazolyl]phenoxy]acetic acid. *J. Med. Chem.* **36**: 3884-903 [PMID:7504734]
347. Meanwell NA, Romine JL and Seiler SM. (1994) Non-prostanoid prostacyclin mimetics. *Drugs of the Future* **19**: 361-385
348. Miggin SM and Kinsella BT. (2002) Investigation of the mechanisms of G protein: effector coupling by the human and mouse prostacyclin receptors. Identification of critical species-dependent differences. *J. Biol. Chem.* **277**: 27053-64 [PMID:12016224]
349. Miggin SM and Kinsella BT. (2001) Thromboxane A₂ receptor mediated activation of the mitogen activated protein kinase cascades in human uterine smooth muscle cells. *Biochim. Biophys. Acta* **1539**: 147-62 [PMID:11389977]
350. Miggin SM and Kinsella BT. (1998) Expression and tissue distribution of the mRNAs encoding the human thromboxane A₂ receptor (TP) alpha and beta isoforms. *Biochim. Biophys. Acta* **1425**: 543-59 [PMID:9838218]
351. Miki I, Kishibayashi N, Nonaka H, Ohshima E, Takami H, Obase H and Ishii A. (1992) Effects of KW-3635,

- a novel dibenzoxepin derivative of a selective thromboxane A2 antagonist, on human, guinea pig and rat platelets. *Jpn. J. Pharmacol.* **59**: 357-64 [PMID:1434130]
352. Minami T, Nakano H, Kobayashi T, Sugimoto Y, Ushikubi F, Ichikawa A, Narumiya S and Ito S. (2001) Characterization of EP receptor subtypes responsible for prostaglandin E2-induced pain responses by use of EP1 and EP3 receptor knockout mice. *Br. J. Pharmacol.* **133**: 438-44 [PMID:11375261]
 353. Mitomi H, Yamada H, Ito H, Nozaki Shibata T, Yamasaki Y, Nomoto S, Kusaba A, Yamashita H and Ozaki S. (2013) Hypoxia-induced endogenous prostaglandin E2 negatively regulates hypoxia-enhanced aberrant overgrowth of rheumatoid synovial tissue. *Mod Rheumatol* **23**: 1069-75 [PMID:23183906]
 354. Miyamoto M, Ito H, Mukai S, Kobayashi T, Yamamoto H, Kobayashi M, Maruyama T, Akiyama H and Nakamura T. (2003) Simultaneous stimulation of EP2 and EP4 is essential to the effect of prostaglandin E2 in chondrocyte differentiation. *Osteoarthr. Cartil.* **11**: 644-52 [PMID:12954235]
 355. Miyaura C, Inada M, Suzawa T, Sugimoto Y, Ushikubi F, Ichikawa A, Narumiya S and Suda T. (2000) Impaired bone resorption to prostaglandin E2 in prostaglandin E receptor EP4-knockout mice. *J. Biol. Chem.* **275**: 19819-23 [PMID:10749873]
 356. Mizoguchi A, Eguchi N, Kimura K, Kiyohara Y, Qu WM, Huang ZL, Mochizuki T, Lazarus M, Kobayashi T and Kaneko T *et al.*. (2001) Dominant localization of prostaglandin D receptors on arachnoid trabecular cells in mouse basal forebrain and their involvement in the regulation of non-rapid eye movement sleep. *Proc. Natl. Acad. Sci. U.S.A.* **98**: 11674-9 [PMID:11562489]
 357. Mizuguchi S, Ohno T, Hattori Y, Ae T, Minamino T, Satoh T, Arai K, Saeki T, Hayashi I and Sugimoto Y *et al.*. (2010) Roles of prostaglandin E2-EP1 receptor signaling in regulation of gastric motor activity and emptying. *Am. J. Physiol. Gastrointest. Liver Physiol.* **299**: G1078-86 [PMID:20798358]
 358. Mjösberg JM, Trifari S, Crellin NK, Peters CP, van Drunen CM, Piet B, Fokkens WJ, Cupedo T and Spits H. (2011) Human IL-25- and IL-33-responsive type 2 innate lymphoid cells are defined by expression of CRTH2 and CD161. *Nat. Immunol.* **12**: 1055-62 [PMID:21909091]
 359. Molderings GJ, Colling E, Likungu J, Jakschik J and Göthert M. (1994) Modulation of noradrenaline release from the sympathetic nerves of the human saphenous vein and pulmonary artery by presynaptic EP3- and DP-receptors. *Br. J. Pharmacol.* **111**: 733-8 [PMID:8019753]
 360. Molderings GJ, Likungu J and Göthert M. (1998) Modulation of noradrenaline release from the sympathetic nerves of human right atrial appendages by presynaptic EP3- and DP-receptors. *Naunyn Schmiedebergs Arch. Pharmacol.* **358**: 440-4 [PMID:9826066]
 361. Monneret G, Cossette C, Gravel S, Rokach J and Powell WS. (2003) 15R-methyl-prostaglandin D2 is a potent and selective CRTH2/DP2 receptor agonist in human eosinophils. *J. Pharmacol. Exp. Ther.* **304**: 349-55 [PMID:12490611]
 362. Montine TJ, Milatovic D, Gupta RC, Valyi-Nagy T, Morrow JD and Breyer RM. (2002) Neuronal oxidative damage from activated innate immunity is EP2 receptor-dependent. *J. Neurochem.* **83**: 463-70 [PMID:12423256]
 363. Morath R, Klein T, Seyberth HW and Nüsing RM. (1999) Immunolocalization of the four prostaglandin E2 receptor proteins EP1, EP2, EP3, and EP4 in human kidney. *J. Am. Soc. Nephrol.* **10**: 1851-60 [PMID:10477136]
 364. Moreland RB, Nehra A, Kim NN, Min KS, Albadawi H, Watkins MT, Goldstein I and Traish AM. (2002) Expression of functional prostaglandin D (DP) receptors in human corpus cavernosum smooth muscle. *Int. J. Impot. Res.* **14**: 446-52 [PMID:12494276]
 365. Morimoto K, Sugimoto Y, Katsuyama M, Oida H, Tsuboi K, Kishi K, Kinoshita Y, Negishi M, Chiba T and Narumiya S *et al.*. (1997) Cellular localization of mRNAs for prostaglandin E receptor subtypes in mouse gastrointestinal tract. *Am. J. Physiol.* **272**: G681-7 [PMID:9124591]
 366. Morinelli TA, Oatis JE, Okwu AK, Mais DE, Mayeux PR, Masuda A, Knapp DR and Halushka PV. (1989) Characterization of an 125I-labeled thromboxane A2/prostaglandin H2 receptor agonist. *J Pharmacol Exp Ther* **251**: 557-562 [PMID:2530338]
 367. Morinelli TA, Okwu AK, Mais DE, Halushka PV, John V, Chen CK and Fried J. (1989) Difluorothromboxane A2 and stereoisomers: stable derivatives of thromboxane A2 with differential effects on platelets and blood vessels. *Proc. Natl. Acad. Sci. U.S.A.* **86**: 5600-4 [PMID:2748606]
 368. Moriyama T, Higashi T, Togashi K, Iida T, Segi E, Sugimoto Y, Tominaga T, Narumiya S and Tominaga M. (2005) Sensitization of TRPV1 by EP1 and IP reveals peripheral nociceptive mechanism of prostaglandins. *Mol Pain* **1**: 3 [PMID:15813989]
 369. Morrison SF and Nakamura K. (2011) Central neural pathways for thermoregulation. *Front. Biosci.* **16**: 74-104 [PMID:21196160]
 370. Morrow JD, Hill KE, Burk RF, Nammour TM, Badr KF and Roberts 2nd LJ. (1990) A series of prostaglandin F2-like compounds are produced in vivo in humans by a non-cyclooxygenase, free radical-catalyzed mechanism. *Proc. Natl. Acad. Sci. U.S.A.* **87**: 9383-7 [PMID:2123555]
 371. Morrow JD, Minton TA, Mukundan CR, Campbell MD, Zackert WE, Daniel VC, Badr KF, Blair IA and Roberts 2nd LJ. (1994) Free radical-induced generation of isoprostanes in vivo. Evidence for the formation of D-ring and E-ring isoprostanes. *J. Biol. Chem.* **269**: 4317-26 [PMID:8307999]
 372. Morsy MA, Isohama Y and Miyata T. (2001) Prostaglandin E(2) increases surfactant secretion via the EP(1) receptor in rat alveolar type II cells. *Eur. J. Pharmacol.* **426**: 21-4 [PMID:11525766]
 373. Mosher AA, Rainey KJ, Giembycz MA, Wood S and Slater DM. (2012) Prostaglandin E2 represses interleukin 1 beta-induced inflammatory mediator output from pregnant human myometrial cells through the EP2 and EP4 receptors. *Biol. Reprod.* **87**: 7, 1-10 [PMID:22517618]
 374. Mu J, Kanzaki T, Si X, Tomimatsu T, Fukuda H, Fujii E, Hosono T, Murata Y, Sugimoto Y and Ichikawa A.

- (2002) Apoptosis and related proteins during parturition in prostaglandin F receptor-deficient mice. *Biochem Biophys Res Commun* **292**: 675-681 [PMID:11922619]
375. Mu J, Kanzaki T, Si X, Tomimatsu T, Fukuda H, Shioji M, Murata Y, Sugimoto Y and Ichikawa A. (2003) Apoptosis and related proteins in placenta of intrauterine fetal death in prostaglandin f receptor-deficient mice. *Biol. Reprod.* **68**: 1968-74 [PMID:12606450]
376. Mu J, Kanzaki T, Tomimatsu T, Fukuda H, Wasada K, Fujii E, Endoh M, Kozuki M, Murata Y and Sugimoto Y *et al.*. (2002) Expression of apoptosis in placentae from mice lacking the prostaglandin F receptor. *Placenta* **23**: 215-23 [PMID:11945089]
377. Mukhopadhyay P, Bian L, Yin H, Bhattacharjee P and Paterson C. (2001) Localization of EP(1) and FP receptors in human ocular tissues by in situ hybridization. *Invest. Ophthalmol. Vis. Sci.* **42**: 424-8 [PMID:11157877]
378. Mumford AD, Dawood BB, Daly ME, Murden SL, Williams MD, Protty MB, Spalton JC, Wheatley M, Mundell SJ and Watson SP. (2010) A novel thromboxane A2 receptor D304N variant that abrogates ligand binding in a patient with a bleeding diathesis. *Blood* **115**: 363-9 [PMID:19828703]
379. Mumford AD, Nisar S, Darnige L, Jones ML, Bachelot-Loza C, Gandrille S, Zinzindohoue F, Fischer AM, Mundell SJ and Gaussem P *et al.*. (2013) Platelet dysfunction associated with the novel Trp29Cys thromboxane A₂ receptor variant. *J. Thromb. Haemost.* **11**: 547-54 [PMID:23279270]
380. Murase A, Okumura T, Sakakibara A, Tonai-Kachi H, Nakao K and Takada J. (2008) Effect of prostanoid EP4 receptor antagonist, CJ-042,794, in rat models of pain and inflammation. *Eur. J. Pharmacol.* **580**: 116-21 [PMID:18031725]
381. Murase A, Taniguchi Y, Tonai-Kachi H, Nakao K and Takada J. (2008) In vitro pharmacological characterization of CJ-042794, a novel, potent, and selective prostaglandin EP(4) receptor antagonist. *Life Sci.* **82**: 226-32 [PMID:18155068]
382. Murata T, Lin MI, Aritake K, Matsumoto S, Narumiya S, Ozaki H, Urade Y, Hori M and Sessa WC. (2008) Role of prostaglandin D2 receptor DP as a suppressor of tumor hyperpermeability and angiogenesis in vivo. *Proc. Natl. Acad. Sci. U.S.A.* **105**: 20009-14 [PMID:19060214]
383. Murata T, Ushikubi F, Matsuoka T, Hirata M, Yamasaki A, Sugimoto Y, Ichikawa A, Aze Y, Tanaka T and Yoshida N *et al.*. (1997) Altered pain perception and inflammatory response in mice lacking prostacyclin receptor. *Nature* **388**: 678-82 [PMID:9262402]
384. Murn J, Alibert O, Wu N, Tendil S and Gidrol X. (2008) Prostaglandin E2 regulates B cell proliferation through a candidate tumor suppressor, Ptger4. *J. Exp. Med.* **205**: 3091-103 [PMID:19075289]
385. Mutoh M, Watanabe K, Kitamura T, Shoji Y, Takahashi M, Kawamori T, Tani K, Kobayashi M, Maruyama T and Kobayashi K *et al.*. (2002) Involvement of prostaglandin E receptor subtype EP(4) in colon carcinogenesis. *Cancer Res.* **62**: 28-32 [PMID:11782353]
386. Myren M, Baun M, Ploug KB, Jansen-Olesen I, Olesen J and Gupta S. (2010) Functional and molecular characterization of prostaglandin E2 dilatory receptors in the rat craniovascular system in relevance to migraine. *Cephalalgia* **30**: 1110-22 [PMID:20713561]
387. Müller K, Krieg P, Marks F and Fürstenberger G. (2000) Expression of PGF(2alpha) receptor mRNA in normal, hyperplastic and neoplastic skin. *Carcinogenesis* **21**: 1063-6 [PMID:10783334]
388. Nagamachi M, Sakata D, Kabashima K, Furuyashiki T, Murata T, Segi-Nishida E, Soontrapa K, Matsuoka T, Miyachi Y and Narumiya S. (2007) Facilitation of Th1-mediated immune response by prostaglandin E receptor EP1. *J. Exp. Med.* **204**: 2865-74 [PMID:17967902]
389. Nagao K, Tanaka H, Komai M, Masuda T, Narumiya S and Nagai H. (2003) Role of prostaglandin I2 in airway remodeling induced by repeated allergen challenge in mice. *Am. J. Respir. Cell Mol. Biol.* **29**: 314-20 [PMID:12676807]
390. Nagata K, Hirai H, Tanaka K, Ogawa K, Aso T, Sugamura K, Nakamura M and Takano S. (1999) CRTH2, an orphan receptor of T-helper-2-cells, is expressed on basophils and eosinophils and responds to mast cell-derived factor(s). *FEBS Lett.* **459**: 195-9 [PMID:10518017]
391. Nagata K, Tanaka K, Ogawa K, Kemmotsu K, Imai T, Yoshie O, Abe H, Tada K, Nakamura M and Sugamura K *et al.*. (1999) Selective expression of a novel surface molecule by human Th2 cells in vivo. *J. Immunol.* **162**: 1278-86 [PMID:9973380]
392. Naka M, Mais DE, Morinelli TA, Hamanaka N, Oatis Jr JE and Halushka PV. (1992) 7-[(1R,2S,3S,5R)-6,6-dimethyl-3-(4-iodobenzenesulfonylamino)bicyclo[3.1.1]hept-2-yl]-5(Z)-heptenoic acid: a novel high-affinity radiolabeled antagonist for platelet thromboxane A2/prostaglandin H2 receptors. *J. Pharmacol. Exp. Ther.* **262**: 632-7 [PMID:1386885]
393. Nakae K, Hayashi F, Hayashi M, Yamamoto N, Iino T, Yoshikawa S and Gupta J. (2005) Functional role of prostacyclin receptor in rat dorsal root ganglion neurons. *Neurosci Lett* **388**: 132-137 [PMID:16039053]
394. Nakae K, Saito K, Iino T, Yamamoto N, Wakabayashi M, Yoshikawa S, Matsushima S, Miyashita H, Sugimoto H and Kiba A *et al.*. (2005) A prostacyclin receptor antagonist inhibits the sensitized release of substance P from rat sensory neurons. *J. Pharmacol. Exp. Ther.* **315**: 1136-42 [PMID:16109742]
395. Nakagawa N, Yuhki K, Kawabe J, Fujino T, Takahata O, Kabara M, Abe K, Kojima F, Kashiwagi H and Hasebe N *et al.*. (2012) The intrinsic prostaglandin E2-EP4 system of the renal tubular epithelium limits the development of tubulointerstitial fibrosis in mice. *Kidney Int.* **82**: 158-71 [PMID:22513820]
396. Nakagawa O, Tanaka I, Usui T, Harada M, Sasaki Y, Itoh H, Yoshimasa T, Namba T, Narumiya S and Nakao K. (1994) Molecular cloning of human prostacyclin receptor cDNA and its gene expression in the cardiovascular system. *Circulation* **90**: 1643-7 [PMID:7923647]
397. Nakajima S, Honda T, Sakata D, Egawa G, Tanizaki H, Otsuka A, Moniaga CS, Watanabe T, Miyachi Y

- and Narumiya S *et al.* (2010) Prostaglandin I2-IP signaling promotes Th1 differentiation in a mouse model of contact hypersensitivity. *J. Immunol.* **184**: 5595-603 [PMID:20400695]
398. Nakamura K, Kaneko T, Yamashita Y, Hasegawa H, Katoh H, Ichikawa A and Negishi M. (1999) Immunocytochemical localization of prostaglandin EP3 receptor in the rat hypothalamus. *Neurosci. Lett.* **260**: 117-20 [PMID:10025713]
399. Nakao A, Watanabe T, Taniguchi S, Nakamura M, Honda Z, Shimizu T and Kurokawa K. (1993) Characterization of prostaglandin F2 alpha receptor of mouse 3T3 fibroblasts and its functional expression in *Xenopus laevis* oocytes. *J Cell Physiol* **155**: 257-264 [PMID:8482718]
400. Nakao K, Murase A, Ohshiro H, Okumura T, Taniguchi K, Murata Y, Masuda M, Kato T, Okumura Y and Takada J. (2007) CJ-023,423, a novel, potent and selective prostaglandin EP4 receptor antagonist with antihyperalgesic properties. *J. Pharmacol. Exp. Ther.* **322**: 686-94 [PMID:17495127]
401. Nakayama Y, Omote K and Namiki A. (2002) Role of prostaglandin receptor EP1 in the spinal dorsal horn in carrageenan-induced inflammatory pain. *Anesthesiology* **97**: 1254-62 [PMID:12411813]
402. Namba T, Oida H, Sugimoto Y, Kakizuka A, Negishi M, Ichikawa A and Narumiya S. (1994) cDNA cloning of a mouse prostacyclin receptor. Multiple signaling pathways and expression in thymic medulla. *J. Biol. Chem.* **269**: 9986-92 [PMID:7511597]
403. Namba T, Sugimoto Y, Hirata M, Hayashi Y, Honda A, Watabe A, Negishi M, Ichikawa A and Narumiya S. (1992) Mouse thromboxane A2 receptor: cDNA cloning, expression and northern blot analysis. *Biochem. Biophys. Res. Commun.* **184**: 1197-203 [PMID:1375456]
404. Namba T, Sugimoto Y, Negishi M, Irie A, Ushikubi F, Kakizuka A, Ito S, Ichikawa A and Narumiya S. (1993) Alternative splicing of C-terminal tail of prostaglandin E receptor subtype EP3 determines G-protein specificity. *Nature* **365**: 166-70 [PMID:8396726]
405. Narumiya S. (2009) Prostanoids and inflammation: a new concept arising from receptor knockout mice. *J. Mol. Med.* **87**: 1015-22 [PMID:19609495]
406. Nataraj C, Thomas DW, Tilley SL, Nguyen MT, Mannon R, Koller BH and Coffman TM. (2001) Receptors for prostaglandin E(2) that regulate cellular immune responses in the mouse. *J. Clin. Invest.* **108**: 1229-35 [PMID:11602631]
407. Negishi M, Irie A, Sugimoto Y, Namba T and Ichikawa A. (1995) Selective coupling of prostaglandin E receptor EP3D to Gi and Gs through interaction of alpha-carboxylic acid of agonist and arginine residue of seventh transmembrane domain. *J. Biol. Chem.* **270**: 16122-7 [PMID:7608175]
408. Negishi M, Sugimoto Y, Irie A, Narumiya S and Ichikawa A. (1993) Two isoforms of prostaglandin E receptor EP3 subtype. Different COOH-terminal domains determine sensitivity to agonist-induced desensitization. *J. Biol. Chem.* **268**: 9517-21 [PMID:8387497]
409. Nemoto K, Pilbeam CC, Bilak SR and Raisz LG. (1997) Molecular cloning and expression of a rat prostaglandin E2 receptor of the EP2 subtype. *Prostaglandins* **54**: 713-25 [PMID:9440134]
410. Neuschäfer-Rube F, DeVries C, Hänecke K, Jungermann K and Püschel GP. (1994) Molecular cloning and expression of a prostaglandin E2 receptor of the EP3 beta subtype from rat hepatocytes. *FEBS Lett.* **351**: 119-22 [PMID:8076679]
411. Neuschäfer-Rube F, Engemaier E, Koch S, Böer U and Püschel GP. (2003) Identification by site-directed mutagenesis of amino acids contributing to ligand-binding specificity or signal transduction properties of the human FP prostanoid receptor. *Biochem. J.* **371**: 443-9 [PMID:12519077]
412. Neuschäfer-Rube F, Hermosilla R, Kuna M, Pathe-Neuschäfer-Rube A, Schüle R and Püschel GP. (2005) A Ser/Thr cluster within the C-terminal domain of the rat prostaglandin receptor EP3alpha is essential for agonist-induced phosphorylation, desensitization and internalization. *Br. J. Pharmacol.* **145**: 1132-42 [PMID:15937517]
413. Neuschäfer-Rube F, Hänecke K, Blaschke V, Jungermann K and Püschel GP. (1997) The C-terminal domain of the Gs-coupled EP4 receptor confers agonist-dependent coupling control to Gi but no coupling to Gs in a receptor hybrid with the Gi-coupled EP3 receptor. *FEBS Lett.* **401**: 185-90 [PMID:9013884]
414. Ng KY, Wong YH and Wise H. (2011) Glial cells isolated from dorsal root ganglia express prostaglandin E(2) (EP(4)) and prostacyclin (IP) receptors. *Eur. J. Pharmacol.* **661**: 42-8 [PMID:21549696]
415. Ngoc PB, Suzuki J, Ogawa M, Hishikari K, Takayama K, Hirata Y, Nagai R and Isobe M. (2011) The anti-inflammatory mechanism of prostaglandin e2 receptor 4 activation in rat experimental autoimmune myocarditis. *J. Cardiovasc. Pharmacol.* **57**: 365-72 [PMID:21383594]
416. Nguyen M, Camenisch T, Snouwaert JN, Hicks E, Coffman TM, Anderson PA, Malouf NN and Koller BH. (1997) The prostaglandin receptor EP4 triggers remodelling of the cardiovascular system at birth. *Nature* **390**: 78-81 [PMID:9363893]
417. Nie D, Guo Y, Yang D, Tang Y, Chen Y, Wang MT, Zacharek A, Qiao Y, Che M and Honn KV. (2008) Thromboxane A2 receptors in prostate carcinoma: expression and its role in regulating cell motility via small GTPase Rho. *Cancer Res.* **68**: 115-21 [PMID:18172303]
418. Nishio H, Terashima S, Nakashima M, Aihara E and Takeuchi K. (2007) Involvement of prostaglandin E receptor EP3 subtype and prostacyclin IP receptor in decreased acid response in damaged stomach. *J. Physiol. Pharmacol.* **58**: 407-21 [PMID:17928639]
419. Nishitani K, Ito H, Hiramitsu T, Tsutsumi R, Tanida S, Kitaori T, Yoshitomi H, Kobayashi M and Nakamura T. (2010) PGE2 inhibits MMP expression by suppressing MKK4-JNK MAP kinase-c-JUN pathway via EP4 in human articular chondrocytes. *J. Cell. Biochem.* **109**: 425-33 [PMID:19998410]
420. Noguchi E, Shibasaki M, Kamioka M, Yokouchi Y, Yamakawa-Kobayashi K, Hamaguchi H, Matsui A and Arinami T. (2002) New polymorphisms of haematopoietic prostaglandin D synthase and human prostanoid DP receptor genes. *Clin. Exp. Allergy* **32**: 93-6 [PMID:12002745]

421. Noguchi K, Shitashige M, Endo H, Kondo H and Ishikawa I. (2002) Binary regulation of interleukin (IL)-6 production by EP1 and EP2/EP4 subtypes of PGE2 receptors in IL-1beta-stimulated human gingival fibroblasts. *J. Periodont. Res.* **37**: 29-36 [PMID:11842936]
422. Norel X, de Montpreville V and Brink C. (2004) Vasoconstriction induced by activation of EP1 and EP3 receptors in human lung: effects of ONO-AE-248, ONO-DI-004, ONO-8711 or ONO-8713. *Prostaglandins Other Lipid Mediat.* **74**: 101-12 [PMID:15560119]
423. Norel X, Sugimoto Y, Ozen G, Abdelazeem H, Amgoud Y, Bouhadoun A, Bassiouni W, Goepp M, Mani S and Manikpurage HD *et al.* (2020) International Union of Basic and Clinical Pharmacology. CIX. Differences and Similarities between Human and Rodent Prostaglandin E₂ Receptors (EP1-4) and Prostacyclin Receptor (IP): Specific Roles in Pathophysiologic Conditions. *Pharmacol. Rev.* **72**: 910-968 [PMID:32962984]
424. Norel X, Walch L, Labat C, Gascard JP, Dulmet E and Brink C. (1999) Prostanoid receptors involved in the relaxation of human bronchial preparations. *Br. J. Pharmacol.* **126**: 867-72 [PMID:10193766]
425. Nüsing RM, Treude A, Weissenberger C, Jensen B, Bek M, Wagner C, Narumiya S and Seyberth HW. (2005) Dominant role of prostaglandin E2 EP4 receptor in furosemide-induced salt-losing tubulopathy: a model for hyperprostaglandin E syndrome/antenatal Bartter syndrome. *J. Am. Soc. Nephrol.* **16**: 2354-62 [PMID:15976003]
426. Oga T, Matsuoka T, Yao C, Nonomura K, Kitaoka S, Sakata D, Kita Y, Tanizawa K, Taguchi Y and Chin K *et al.* (2009) Prostaglandin F(2alpha) receptor signaling facilitates bleomycin-induced pulmonary fibrosis independently of transforming growth factor-beta. *Nat. Med.* **15**: 1426-30 [PMID:19966781]
427. Ogletree ML and Allen GT. (1992) Interspecies differences in thromboxane receptors: studies with thromboxane receptor antagonists in rat and guinea-pig smooth muscles. *J. Pharmacol. Exp. Ther.* **260**: 789-794 [PMID:1531361]
428. Ogletree ML, Harris DN, Greenberg R, Haslanger MF and Nakane M. (1985) Pharmacological actions of SQ 29,548, a novel selective thromboxane antagonist. *J. Pharmacol. Exp. Ther.* **234**: 435-41 [PMID:3926986]
429. Ogletree ML, Harris DN, Schumacher WA, Webb ML and Misra RN. (1993) Pharmacological profile of BMS 180,291: a potent, long-acting, orally active thromboxane A2/prostaglandin endoperoxide receptor antagonist. *J. Pharmacol. Exp. Ther.* **264**: 570-8 [PMID:8437108]
430. Oguma T, Palmer LJ, Birben E, Sonna LA, Asano K and Lilly CM. (2004) Role of prostanoid DP receptor variants in susceptibility to asthma. *N. Engl. J. Med.* **351**: 1752-63 [PMID:15496624]
431. Ohno T, Katori M, Majima M, Saeki T, Boku K, Nishiyama K, Hayashi H and Saigenji K. (1999) Dilatation and constriction of rat gastric mucosal microvessels through prostaglandin EP2 and EP3 receptors. *Aliment. Pharmacol. Ther.* **13**: 1243-50 [PMID:10468708]
432. Oida H, Hirata M, Sugimoto Y, Ushikubi F, Ohishi H, Mizuno N, Ichikawa A and Narumiya S. (1997) Expression of messenger RNA for the prostaglandin D receptor in the leptomeninges of the mouse brain. *FEBS Lett.* **417**: 53-6 [PMID:9395073]
433. Oka T, Aou S and Hori T. (1994) Intracerebroventricular injection of prostaglandin E2 induces thermal hyperalgesia in rats: the possible involvement of EP3 receptors. *Brain Res.* **663**: 287-92 [PMID:7874513]
434. Oka T and Hori T. (1994) EP1-receptor mediation of prostaglandin E2-induced hyperthermia in rats. *Am. J. Physiol.* **267**: R289-94 [PMID:7914071]
435. Oka T, Hori T, Hosoi M, Oka K, Abe M and Kubo C. (1997) Biphasic modulation in the trigeminal nociceptive neuronal responses by the intracerebroventricular prostaglandin E2 may be mediated through different EP receptors subtypes in rats. *Brain Res.* **771**: 278-84 [PMID:9401748]
436. Oka T, Oka K, Kobayashi T, Sugimoto Y, Ichikawa A, Ushikubi F, Narumiya S and Saper CB. (2003) Characteristics of thermoregulatory and febrile responses in mice deficient in prostaglandin EP1 and EP3 receptors. *J Physiol* **551**: 945-954 [PMID:12837930]
437. Okada Y, Hara A, Ma H, Xiao CY, Takahata O, Kohgo Y, Narumiya S and Ushikubi F. (2000) Characterization of prostanoid receptors mediating contraction of the gastric fundus and ileum: studies using mice deficient in prostanoid receptors. *Br. J. Pharmacol.* **131**: 745-55 [PMID:11030724]
438. Okada Y, Taniguchi T, Morishima S, Suzuki F, Akagi Y and Muramatsu I. (2006) Characteristics of acid extrusion from Chinese hamster ovary cells expressing different prostaglandin EP receptors. *Life Sci.* **78**: 2454-62 [PMID:16300797]
439. Okamoto F, Kajiya H, Fukushima H, Jimi E and Okabe K. (2004) Prostaglandin E2 activates outwardly rectifying Cl(-) channels via a cAMP-dependent pathway and reduces cell motility in rat osteoclasts. *Am. J. Physiol., Cell Physiol.* **287**: C114-24 [PMID:15044156]
440. Okuda-Ashitaka E, Sakamoto K, Ezashi T, Miwa K, Ito S and Hayaishi O. (1996) Suppression of prostaglandin E receptor signaling by the variant form of EP1 subtype. *J. Biol. Chem.* **271**: 31255-61 [PMID:8940129]
441. Oldfield S, Grubb BD and Donaldson LF. (2001) Identification of a prostaglandin E2 receptor splice variant and its expression in rat tissues. *Prostaglandins Other Lipid Mediat.* **63**: 165-73 [PMID:11305694]
442. Olofsson JI, Leung CH, Bjurulf E, Ohno T, Selstam G, Peng C and Leung PC. (1996) Characterization and regulation of a mRNA encoding the prostaglandin F2alpha receptor in the rat ovary. *Mol. Cell. Endocrinol.* **123**: 45-52 [PMID:8912810]
443. Ono K, Akatsu T, Kugai N, Pilbeam CC and Raisz LG. (2003) The effect of deletion of cyclooxygenase-2, prostaglandin receptor EP2, or EP4 in bone marrow cells on osteoclasts induced by mouse mammary cancer cell lines. *Bone* **33**: 798-804 [PMID:14623055]

444. Orié NN, Ledwozyw A, Williams DJ, Whittle BJ and Clapp LH. (2013) Differential actions of the prostacyclin analogues treprostinil and iloprost and the selexipag metabolite, MRE-269 (ACT-333679) in rat small pulmonary arteries and veins. *Prostaglandins Other Lipid Mediat.* **106**: 1-7 [PMID:23872196]
445. Orlicky DJ, Fisher L, Dunscomb N and Miller GJ. (1992) Immunohistochemical localization of PGF₂ alpha receptor in the rat ovary. *Prostaglandins Leukot. Essent. Fatty Acids* **46**: 223-9 [PMID:1508956]
446. Ota T, Aihara M, Narumiya S and Araie M. (2005) The effects of prostaglandin analogues on IOP in prostanoid FP-receptor-deficient mice. *Invest. Ophthalmol. Vis. Sci.* **46**: 4159-63 [PMID:16249494]
447. Palikhe NS, Sin HJ, Kim SH, Sin HJ, Hwang EK, Ye YM and Park HS. (2012) Genetic variability of prostaglandin E2 receptor subtype EP4 gene in aspirin-intolerant chronic urticaria. *J. Hum. Genet.* **57**: 494-9 [PMID:22695889]
448. Paralkar VM, Borovecki F, Ke HZ, Cameron KO, Lefker B, Grasser WA, Owen TA, Li M, DaSilva-Jardine P and Zhou M *et al.*. (2003) An EP2 receptor-selective prostaglandin E2 agonist induces bone healing. *Proc. Natl. Acad. Sci. U.S.A.* **100**: 6736-40 [PMID:12748385]
449. Patrignani P, Di Febbo C, Tacconelli S, Douville K, Guglielmi MD, Horvath RJ, Ding M, Sierra K, Stitham J and Gleim S *et al.*. (2008) Differential association between human prostacyclin receptor polymorphisms and the development of venous thrombosis and intimal hyperplasia: a clinical biomarker study. *Pharmacogenet. Genomics* **18**: 611-20 [PMID:18551041]
450. Patrono C and Roth GJ. (1996) Aspirin in ischemic cerebrovascular disease. How strong is the case for a different dosing regimen? *Stroke* **27**: 756-60 [PMID:8614944]
451. Peri KG, Quiniou C, Hou X, Abran D, Varma DR, Lubell WD and Chemtob S. (2002) THG113: a novel selective FP antagonist that delays preterm labor. *Semin. Perinatol.* **26**: 389-97 [PMID:12537309]
452. Pettipher R. (2008) The roles of the prostaglandin D(2) receptors DP(1) and CRTH2 in promoting allergic responses. *Br. J. Pharmacol.* **153 Suppl 1**: S191-9 [PMID:17965752]
453. Pettipher R, Hunter MG, Perkins CM, Collins LP, Lewis T, Baillet M, Steiner J, Bell J and Payton MA. (2014) Heightened response of eosinophilic asthmatic patients to the CRTH2 antagonist OC000459. *Allergy* **69**: 1223-32 [PMID:24866478]
454. Pettipher R, Vinall SL, Xue L, Speight G, Townsend ER, Gazi L, Whelan CJ, Armer RE, Payton MA and Hunter MG. (2012) Pharmacologic profile of OC000459, a potent, selective, and orally active D prostanoid receptor 2 antagonist that inhibits mast cell-dependent activation of T helper 2 lymphocytes and eosinophils. *J. Pharmacol. Exp. Ther.* **340**: 473-82 [PMID:22106101]
455. Philipose S, Konya V, Sreckovic I, Marsche G, Lippe IT, Peskar BA, Heinemann A and Schuligoi R. (2010) The prostaglandin E2 receptor EP4 is expressed by human platelets and potently inhibits platelet aggregation and thrombus formation. *Arterioscler. Thromb. Vasc. Biol.* **30**: 2416-23 [PMID:21071691]
456. Pierce KL, Bailey TJ, Hoyer PB, Gil DW, Woodward DF and Regan JW. (1997) Cloning of a carboxyl-terminal isoform of the prostanoid FP receptor. *J. Biol. Chem.* **272**: 883-7 [PMID:8995377]
457. Poloso NJ, Urquhart P, Nicolaou A, Wang J and Woodward DF. (2013) PGE2 differentially regulates monocyte-derived dendritic cell cytokine responses depending on receptor usage (EP2/EP4). *Mol. Immunol.* **54**: 284-95 [PMID:23337716]
458. Prasanna G, Carreiro S, Anderson S, Gukasyan H, Sartnurak S, Younis H, Gale D, Xiang C, Wells P and Dinh D *et al.*. (2011) Effect of PF-04217329 a prodrug of a selective prostaglandin EP(2) agonist on intraocular pressure in preclinical models of glaucoma. *Exp. Eye Res.* **93**: 256-64 [PMID:21376717]
459. Prasanna G, Fortner J, Xiang C, Zhang E, Carreiro S, Anderson S, Sartnurak S, Wu G, Gukasyan H and Niesman M *et al.*. (2009) Ocular pharmacokinetics and hypotensive activity of PF-04475270, an EP4 prostaglandin agonist in preclinical models. *Exp. Eye Res.* **89**: 608-17 [PMID:19445930]
460. Praticò D, Smyth EM, Violi F and FitzGerald GA. (1996) Local amplification of platelet function by 8-Epi prostaglandin F2alpha is not mediated by thromboxane receptor isoforms. *J. Biol. Chem.* **271**: 14916-24 [PMID:8663015]
461. Pulichino AM, Rowland S, Wu T, Clark P, Xu D, Mathieu MC, Riendeau D and Audoly LP. (2006) Prostacyclin antagonism reduces pain and inflammation in rodent models of hyperalgesia and chronic arthritis. *J. Pharmacol. Exp. Ther.* **319**: 1043-50 [PMID:16973887]
462. Purdy KE and Arendshorst WJ. (2000) EP(1) and EP(4) receptors mediate prostaglandin E(2) actions in the microcirculation of rat kidney. *Am. J. Physiol. Renal Physiol.* **279**: F755-64 [PMID:10997926]
463. Pönicke K, Giessler C, Grapow M, Heinroth-Hoffmann I, Becker K, Osten B and Brodde OE. (2000) FP-receptor mediated trophic effects of prostanoids in rat ventricular cardiomyocytes. *Br. J. Pharmacol.* **129**: 1723-31 [PMID:10780979]
464. Pöschke A, Kern N, Maruyama T, Pavenstädt H, Narumiya S, Jensen BL and Nüsing RM. (2012) The PGE(2)-EP4 receptor is necessary for stimulation of the renin-angiotensin-aldosterone system in response to low dietary salt intake in vivo. *Am. J. Physiol. Renal Physiol.* **303**: F1435-42 [PMID:22993066]
465. Qian JY, Harding P, Liu Y, Shesely E, Yang XP and LaPointe MC. (2008) Reduced cardiac remodeling and function in cardiac-specific EP4 receptor knockout mice with myocardial infarction. *Hypertension* **51**: 560-6 [PMID:18180401]
466. Qian YM, Jones RL, Chan KM, Stock AI and Ho JK. (1994) Potent contractile actions of prostanoid EP3-receptor agonists on human isolated pulmonary artery. *Br. J. Pharmacol.* **113**: 369-74 [PMID:7834185]
467. Qiao N, Reynaud D, Demin P, Halushka PV and Pace-Asciak CR. (2003) The thromboxane receptor antagonist PBT-3, a hepxilin stable analog, selectively antagonizes the TPalpha isoform in transfected COS-7 cells. *J. Pharmacol. Exp. Ther.* **307**: 1142-7 [PMID:14560042]
468. Rachmilewitz D, Chapman JW and Nicholson PA. (1986) A multicenter international controlled comparison of two dosage regimens of misoprostol with cimetidine in treatment of gastric ulcer in outpatients. *Dig. Dis.*

- Sci.* **31**: 75S-80S [PMID:3080293]
469. Racké K, Bähring J, Langer C, Bräutigam M and Wessler I. (1992) Prostanoids inhibit release of endogenous norepinephrine from rat isolated trachea. *Am. Rev. Respir. Dis.* **146**: 1182-6 [PMID:1443867]
 470. Ratcliffe MJ, Walding A, Shelton PA, Flaherty A and Dougall IG. (2007) Activation of E-prostanoid4 and E-prostanoid2 receptors inhibits TNF-alpha release from human alveolar macrophages. *Eur. Respir. J.* **29**: 986-94 [PMID:17331962]
 471. Raychowdhury MK, Yukawa M, Collins LJ, McGrail SH, Kent KC and Ware JA. (1994) Alternative splicing produces a divergent cytoplasmic tail in the human endothelial thromboxane A2 receptor. *J. Biol. Chem.* **269**: 19256-61 [PMID:8034687]
 472. Raymond V, Leung PC and Labrie F. (1983) Stimulation by prostaglandin F2 alpha of phosphatidic acid-phosphatidylinositol turnover in rat luteal cells. *Biochem. Biophys. Res. Commun.* **116**: 39-46 [PMID:6357198]
 473. Reader J, Holt D and Fulton A. (2011) Prostaglandin E2 EP receptors as therapeutic targets in breast cancer. *Cancer Metastasis Rev.* **30**: 449-63 [PMID:22002714]
 474. Regan JW, Bailey TJ, Donello JE, Pierce KL, Pepperl DJ, Zhang D, Kedzie KM, Fairbairn CE, Bogardus AM and Woodward DF *et al.* (1994) Molecular cloning and expression of human EP3 receptors: evidence of three variants with differing carboxyl termini. *Br. J. Pharmacol.* **112**: 377-85 [PMID:8075855]
 475. Regan JW, Bailey TJ, Pepperl DJ, Pierce KL, Bogardus AM, Donello JE, Fairbairn CE, Kedzie KM, Woodward DF and Gil DW. (1994) Cloning of a novel human prostaglandin receptor with characteristics of the pharmacologically defined EP2 subtype. *Mol. Pharmacol.* **46**: 213-20 [PMID:8078484]
 476. Reinheimer T, Harnack E, Racke K and Wessler I. (1998) Prostanoid receptors of the EP3 subtype mediate inhibition of evoked [3H]acetylcholine release from isolated human bronchi. *Br. J. Pharmacol.* **125**: 271-6 [PMID:9786498]
 477. Reinold H, Ahmadi S, Depner UB, Layh B, Heindl C, Hamza M, Pahl A, Brune K, Narumiya S and Müller U *et al.* (2005) Spinal inflammatory hyperalgesia is mediated by prostaglandin E receptors of the EP2 subtype. *J. Clin. Invest.* **115**: 673-9 [PMID:15719070]
 478. Ritchie RH, Rosenkranz AC, Huynh LP, Stephenson T, Kaye DM and Dusting GJ. (2004) Activation of IP prostanoid receptors prevents cardiomyocyte hypertrophy via cAMP-dependent signaling. *Am. J. Physiol. Heart Circ. Physiol.* **287**: H1179-85 [PMID:15072955]
 479. Robb CT, McSorley HJ, Lee J, Aoki T, Yu C, Crittenden S, Astier A, Felton JM, Parkinson N and Ayele Aet *al.* (2018) Prostaglandin E₂ stimulates adaptive IL-22 production and promotes allergic contact dermatitis. *J. Allergy Clin. Immunol.* **141**: 152-162 [PMID:28583370]
 480. Rocha PN, Plumb TJ, Robinson LA, Spurney R, Pisetsky D, Koller BH and Coffman TM. (2005) Role of thromboxane A2 in the induction of apoptosis of immature thymocytes by lipopolysaccharide. *Clin. Diagn. Lab. Immunol.* **12**: 896-903 [PMID:16085905]
 481. Root JA, Davey DA and Af Forselles KJ. (2015) Prostanoid receptors mediating contraction in rat, macaque and human bladder smooth muscle in vitro. *Eur. J. Pharmacol.* **769**: 274-9 [PMID:26607459]
 482. Rosenfield AR, Lowman RM and Taylor KJ. (1976) Urography in preoperative evaluation of abdominal aortic aneurysms. *Urology* **7**: 652-4 [PMID:936389]
 483. Royer JF, Schratl P, Lorenz S, Kostenis E, Ulven T, Schuligoi R, Peskar BA and Heinemann A. (2007) A novel antagonist of CRTH2 blocks eosinophil release from bone marrow, chemotaxis and respiratory burst. *Allergy* **62**: 1401-9 [PMID:17714552]
 484. Ruel R, Lacombe P, Abramovitz M, Godbout C, Lamontagne S, Rochette C, Sawyer N, Stocco R, Tremblay NM and Metters KM *et al.* (1999) New class of biphenylene dibenzazocinones as potent ligands for the human EP1 prostanoid receptor. *Bioorg. Med. Chem. Lett.* **9**: 2699-704 [PMID:10509919]
 485. Rundhaug JE, Simper MS, Surh I and Fischer SM. (2011) The role of the EP receptors for prostaglandin E2 in skin and skin cancer. *Cancer Metastasis Rev.* **30**: 465-80 [PMID:22012553]
 486. Saeki T, Ota T, Aihara M and Araie M. (2009) Effects of prostanoid EP agonists on mouse intraocular pressure. *Invest. Ophthalmol. Vis. Sci.* **50**: 2201-8 [PMID:19117925]
 487. Saito O, Guan Y, Qi Z, Davis LS, Kömhoff M, Sugimoto Y, Narumiya S, Breyer RM and Breyer MD. (2003) Expression of the prostaglandin F receptor (FP) gene along the mouse genitourinary tract. *Am. J. Physiol. Renal Physiol.* **284**: F1164-70 [PMID:12631554]
 488. Sakai M, Minami T, Hara N, Nishihara I, Kitade H, Kamiyama Y, Okuda K, Takahashi H, Mori H and Ito S. (1998) Stimulation of nitric oxide release from rat spinal cord by prostaglandin E2. *Br J Pharmacol* **123**: 890-894 [PMID:9535017]
 489. Sakamoto K, Ezashi T, Miwa K, Okuda-Ashitaka E, Houtani T, Sugimoto T, Ito S and Hayaishi O. (1994) Molecular cloning and expression of a cDNA of the bovine prostaglandin F2 alpha receptor. *J. Biol. Chem.* **269**: 3881-6 [PMID:7508922]
 490. Sakuma Y, Tanaka K, Suda M, Komatsu Y, Yasoda A, Miura M, Ozasa A, Narumiya S, Sugimoto Y and Ichikawa A *et al.* (2000) Impaired bone resorption by lipopolysaccharide in vivo in mice deficient in the prostaglandin E receptor EP4 subtype. *Infect. Immun.* **68**: 6819-25 [PMID:11083800]
 491. Saleem S, Shah ZA, Maruyama T, Narumiya S and Doré S. (2010) Neuroprotective properties of prostaglandin I2 IP receptor in focal cerebral ischemia. *Neuroscience* **170**: 317-23 [PMID:20621166]
 492. Sando T, Usui T, Tanaka I, Mori K, Sasaki Y, Fukuda Y, Namba T, Sugimoto Y, Ichikawa A and Narumiya S *et al.* (1994) Molecular cloning and expression of rat prostaglandin E receptor EP2 subtype. *Biochem. Biophys. Res. Commun.* **200**: 1329-33 [PMID:8185583]
 493. Sanner JH. (1969) Antagonism of prostaglandin E2 by 1-acetyl-2-(8-chloro-10,11-dihydrodibenz (b,f) (1,4)

- oxazepine-10-carbonyl) hydrazine (SC-19220). *Arch Int Pharmacodyn Ther* **180**: 46-56 [PMID:4982414]
494. Sanz C, Isidoro-García M, Dávila I, Moreno E, Laffond E, Avila C and Lorente F. (2006) Promoter genetic variants of prostanoid DP receptor (PTGDR) gene in patients with asthma. *Allergy* **61**: 543-8 [PMID:16629782]
495. Sarkar S, Hobson AR, Hughes A, Growcott J, Woolf CJ, Thompson DG and Aziz Q. (2003) The prostaglandin E2 receptor-1 (EP-1) mediates acid-induced visceral pain hypersensitivity in humans. *Gastroenterology* **124**: 18-25 [PMID:12512025]
496. Sasaki Y, Usui T, Tanaka I, Nakagawa O, Sando T, Takahashi T, Namba T, Narumiya S and Nakao K. (1994) Cloning and expression of a cDNA for rat prostacyclin receptor. *Biochim. Biophys. Acta* **1224**: 601-5 [PMID:7803522]
497. Sato M, Nakayama T, Soma M, Aoi N, Kosuge K, Haketa A, Izumi Y, Matsumoto K, Sato N and Kokubun S. (2007) Association between prostaglandin E2 receptor gene and essential hypertension. *Prostaglandins Leukot. Essent. Fatty Acids* **77**: 15-20 [PMID:17644362]
498. Satoh H and Takeuchi K. (2012) Management of NSAID/aspirin-induced small intestinal damage by GI-sparing NSAIDs, anti-ulcer drugs and food constituents. *Curr. Med. Chem.* **19**: 82-9 [PMID:22300080]
499. Satoh S, Chang Cs, Katoh H, Hasegawa H, Nakamura K, Aoki J, Fujita H, Ichikawa A and Negishi M. (1999) The key amino acid residue of prostaglandin EP3 receptor for governing G protein association and activation steps. *Biochem. Biophys. Res. Commun.* **255**: 164-8 [PMID:10082673]
500. Satoh T, Moroi R, Aritake K, Urade Y, Kanai Y, Sumi K, Yokozeki H, Hirai H, Nagata K and Hara Tet al.. (2006) Prostaglandin D2 plays an essential role in chronic allergic inflammation of the skin via CRTH2 receptor. *J. Immunol.* **177**: 2621-9 [PMID:16888024]
501. Savage MA, Moumami C, Karabatsos PJ and Lanthorn TH. (1993) SC-46275: a potent and highly selective agonist at the EP3 receptor. *Prostaglandins Leukot. Essent. Fatty Acids* **49**: 939-43 [PMID:8140121]
502. Savonenko A, Munoz P, Melnikova T, Wang Q, Liang X, Breyer RM, Montine TJ, Kirkwood A and Andreasson K. (2009) Impaired cognition, sensorimotor gating, and hippocampal long-term depression in mice lacking the prostaglandin E2 EP2 receptor. *Exp. Neurol.* **217**: 63-73 [PMID:19416671]
503. Sawyer N, Cauchon E, Chateauneuf A, Cruz RP, Nicholson DW, Metters KM, O'Neill GP and Gervais FG. (2002) Molecular pharmacology of the human prostaglandin D2 receptor, CRTH2. *Br. J. Pharmacol.* **137**: 1163-72 [PMID:12466225]
504. Schachar RA, Raber S, Courtney R, Zhang M and Bosworth C. (2010) Dose-Escalating, Double-Masked, Vehicle-Controlled Trial of the IOP-Reducing Effect of EP2 Agonist, Taprenepag Isopropyl (PF-04217329). *ARVO Poster #175/A398*
505. Schlötzer-Schrehardt U, Zenkel M and Nüsing RM. (2002) Expression and localization of FP and EP prostanoid receptor subtypes in human ocular tissues. *Invest. Ophthalmol. Vis. Sci.* **43**: 1475-87 [PMID:11980863]
506. Schmid A, Thierauch KH, Schleuning WD and Dinter H. (1995) Splice variants of the human EP3 receptor for prostaglandin E2. *Eur. J. Biochem.* **228**: 23-30 [PMID:7883006]
507. Schmidt JA, Bell FM, Akam E, Marshall C, Dainty IA, Heinemann A, Dougall IG, Bonnert RV and Sargent CA. (2013) Biochemical and pharmacological characterization of AZD1981, an orally available selective DP2 antagonist in clinical development for asthma. *Br. J. Pharmacol.* **168**: 1626-38 [PMID:23146091]
508. Schneider A, Guan Y, Zhang Y, Magnuson MA, Pettepher C, Loftin CD, Langenbach R, Breyer RM and Breyer MD. (2004) Generation of a conditional allele of the mouse prostaglandin EP4 receptor. *Genesis* **40**: 7-14 [PMID:15354288]
509. Schnermann J, Traynor T, Pohl H, Thomas DW, Coffman TM and Briggs JP. (2000) Vasoconstrictor responses in thromboxane receptor knockout mice: tubuloglomerular feedback and ureteral obstruction. *Acta Physiol. Scand.* **168**: 201-7 [PMID:10691801]
510. Schober LJ, Khandoga AL, Dwivedi S, Penz SM, Maruyama T, Brandl R and Siess W. (2011) The role of PGE(2) in human atherosclerotic plaque on platelet EP(3) and EP(4) receptor activation and platelet function in whole blood. *J. Thromb. Thrombolysis* **32**: 158-66 [PMID:21424266]
511. Schwaner I, Offermanns S, Spicher K, Seifert R and Schultz G. (1995) Differential activation of Gi and Gs proteins by E- and I-type prostaglandins in membranes from the human erythroleukaemia cell line, HEL. *Biochim. Biophys. Acta* **1265**: 8-14 [PMID:7532011]
512. Schweda F, Klar J, Narumiya S, Nüsing RM and Kurtz A. (2004) Stimulation of renin release by prostaglandin E2 is mediated by EP2 and EP4 receptors in mouse kidneys. *Am. J. Physiol. Renal Physiol.* **287**: F427-33 [PMID:15113745]
513. Segi E, Sugimoto Y, Yamasaki A, Aze Y, Oida H, Nishimura T, Murata T, Matsuoka T, Ushikubi F and Hirose M et al.. (1998) Patent ductus arteriosus and neonatal death in prostaglandin receptor EP4-deficient mice. *Biochem. Biophys. Res. Commun.* **246**: 7-12 [PMID:9600059]
514. Seiler S, Brassard CL and Federici ME. (1990) SQ-27986 inhibition of platelet aggregation is mediated through activation of platelet prostaglandin D₂ receptors. *Prostaglandins* **40**: 119-130 [PMID:2171039]
515. Seiler SM, Brassard CL, Federici ME, Romine J and Meanwell NA. (1997) [3-[4-(4,5-Diphenyl-2-oxazolyl)-5-oxazolyl]phenoxy]acetic acid (BMJ 45778) is a potent non-prostanoid prostacyclin partial agonist: effects on platelet aggregation, adenylyl cyclase, cAMP levels, protein kinase, and iloprost binding. *Prostaglandins* **53**: 21-35 [PMID:9068064]
516. Senchyna M and Crankshaw DJ. (1996) Characterization of the prostanoid TP receptor population in human nonpregnant myometrium. *J. Pharmacol. Exp. Ther.* **279**: 262-70 [PMID:8859002]
517. Senior J, Sangha R, Baxter GS, Marshall K and Clayton JK. (1992) In vitro characterization of prostanoid

- FP-, DP-, IP- and TP-receptors on the non-pregnant human myometrium. *Br. J. Pharmacol.* **107**: 215-21 [PMID:1422574]
518. Sessa WC, Halushka PV, Okwu A and Nasjletti A. (1990) Characterization of the vascular thromboxane A₂/prostaglandin endoperoxide receptor in rabbit aorta. Regulation by dexamethasone. *Circ. Res.* **67**: 1562-9 [PMID:2147131]
519. Sharif NA, Crider JY, Xu SX and Williams GW. (2000) Affinities, selectivities, potencies, and intrinsic activities of natural and synthetic prostanoids using endogenous receptors: focus on DP class prostanoids. *J. Pharmacol. Exp. Ther.* **293**: 321-8 [PMID:10772998]
520. Sharif NA and Davis TL. (2002) Cloned human EP1 prostanoid receptor pharmacology characterized using radioligand binding techniques. *J. Pharm. Pharmacol.* **54**: 539-47 [PMID:11999132]
521. Sharif NA, McLaughlin MA, Kelly CR, Xu S, Crider JY, Williams GW and Parker JL. (2006) Preclinical pharmacology of AL-12182, a new ocular hypotensive 11-oxa prostaglandin analog. *J. Ocul Pharmacol Ther* **22**: 291-309 [PMID:17076623]
522. Sharif NA, Williams GW and Davis TL. (2000) Pharmacology and autoradiography of human DP prostanoid receptors using [(3)H]-BWA868C, a DP receptor-selective antagonist radioligand. *Br. J. Pharmacol.* **131**: 1025-38 [PMID:11082108]
523. Sharif NA, Xu SX, Williams GW, Crider JY, Griffin BW and Davis TL. (1998) Pharmacology of [3H]prostaglandin E1/[3H]prostaglandin E2 and [3H]prostaglandin F₂α binding to EP3 and FP prostaglandin receptor binding sites in bovine corpus luteum: characterization and correlation with functional data. *J. Pharmacol. Exp. Ther.* **286**: 1094-102 [PMID:9694973]
524. Sheller JR, Mitchell D, Meyrick B, Oates J and Breyer R. (2000) EP(2) receptor mediates bronchodilation by PGE(2) in mice. *J. Appl. Physiol.* **88**: 2214-8 [PMID:10846038]
525. Shibata-Nozaki T, Ito H, Mitomi H, Akaogi J, Komagata T, Kanaji T, Maruyama T, Mori T, Nomoto S and Ozaki S *et al.*. (2011) Endogenous prostaglandin E2 inhibits aberrant overgrowth of rheumatoid synovial tissue and the development of osteoclast activity through EP4 receptor. *Arthritis Rheum.* **63**: 2595-605 [PMID:21898865]
526. Shichijo M, Sugimoto H, Nagao K, Inbe H, Encinas JA, Takeshita K, Bacon KB and Gantner F. (2003) Chemoattractant receptor-homologous molecule expressed on Th2 cells activation in vivo increases blood leukocyte counts and its blockade abrogates 13,14-dihydro-15-keto-prostaglandin D2-induced eosinophilia in rats. *J. Pharmacol. Exp. Ther.* **307**: 518-25 [PMID:12975488]
527. Shioji M, Fukuda H, Kanzaki T, Wasada K, Kanagawa T, Shimoya K, Mu J, Sugimoto Y and Murata Y. (2006) Reduction of aquaporin-8 on fetal membranes under oligohydramnios in mice lacking prostaglandin F₂ α receptor. *J. Obstet. Gynaecol. Res.* **32**: 373-8 [PMID:16882262]
528. Siegl AM, Smith JB, Silver MJ, Nicolaou KC and Ahern D. (1979) Selective binding site for [3H]prostacyclin on platelets. *J. Clin. Invest.* **63**: 215-20 [PMID:372237]
529. Singh J, Zeller W, Zhou N, Hategan G, Mishra RK, Polozov A, Yu P, Onua E, Zhang J and Ramirez J *et al.*. (2010) Structure-activity relationship studies leading to the identification of (2E)-3-[[[(2,4-dichlorophenyl)methyl]-5-fluoro-3-methyl-1H-indol-7-yl]-N-[(4,5-dichloro-2-thienyl)sulfonyl]-2-propenamide (DG-041), a potent and selective prostanoid EP3 receptor antagonist, as a novel antiplatelet agent that does not prolong bleeding. *J. Med. Chem.* **53**: 18-36 [PMID:19957930]
530. Singh J, Zeller W, Zhou N, Hategan G, Mishra R, Polozov A, Yu P, Onua E, Zhang J and Zembower D *et al.*. (2009) Antagonists of the EP3 receptor for prostaglandin E2 are novel antiplatelet agents that do not prolong bleeding. *ACS Chem. Biol.* **4**: 115-26 [PMID:19193156]
531. Sokolova E, Grishina Z, Bühling F, Welte T and Reiser G. (2005) Protease-activated receptor-1 in human lung fibroblasts mediates a negative feedback downregulation via prostaglandin E2. *Am. J. Physiol. Lung Cell Mol. Physiol.* **288**: L793-802 [PMID:15563688]
532. Song WL, Stubbe J, Ricciotti E, Alamuddin N, Ibrahim S, Crichton I, Premph M, Lawson JA, Wilensky RL and Rasmussen LM *et al.*. (2012) Niacin and biosynthesis of PGD₂ by platelet COX-1 in mice and humans. *J. Clin. Invest.* **122**: 1459-68 [PMID:22406532]
533. Soontrapa K, Honda T, Sakata D, Yao C, Hirata T, Hori S, Matsuoka T, Kita Y, Shimizu T and Kabashima K *et al.*. (2011) Prostaglandin E2-prostaglandin E receptor subtype 4 (EP4) signaling mediates UV irradiation-induced systemic immunosuppression. *Proc. Natl. Acad. Sci. U.S.A.* **108**: 6668-73 [PMID:21460251]
534. Sparks MA, Makhanova NA, Griffiths RC, Snouwaert JN, Koller BH and Coffman TM. (2013) Thromboxane receptors in smooth muscle promote hypertension, vascular remodeling, and sudden death. *Hypertension* **61**: 166-73 [PMID:23150508]
535. Sprague PW, Heikes JE, Gougoutas JZ, Malley MF, Harris DN and Greenberg R. (1985) Synthesis and in vitro pharmacology of 7-oxabicyclo[2.2.1]heptane analogues of thromboxane A₂/PGH₂. *J. Med. Chem.* **28**: 1580-90 [PMID:4067988]
536. Srinivas NR. (2015) First-in-man study of ACT-453859, a potent CRTH2 antagonist--Is the metabolite formation influenced by a polymorphic enzyme? *J Clin Pharmacol* **55**: 1432 [PMID:26761218]
537. Stillman BA, Breyer MD and Breyer RM. (1999) Importance of the extracellular domain for prostaglandin EP(2) receptor function. *Mol. Pharmacol.* **56**: 545-51 [PMID:10462542]
538. Stitham J, Arehart E, Elderon L, Gleim SR, Douville K, Kasza Z, Fetalvero K, MacKenzie T, Robb J and Martin KA *et al.*. (2011) Comprehensive biochemical analysis of rare prostacyclin receptor variants: study of association of signaling with coronary artery obstruction. *J. Biol. Chem.* **286**: 7060-9 [PMID:21189259]
539. Stitham J, Arehart E, Gleim SR, Li N, Douville K and Hwa J. (2007) New insights into human prostacyclin receptor structure and function through natural and synthetic mutations of transmembrane charged

- residues. *Br. J. Pharmacol.* **152**: 513-22 [PMID:17704830]
540. Stitham J, Stojanovic A and Hwa J. (2002) Impaired receptor binding and activation associated with a human prostacyclin receptor polymorphism. *J. Biol. Chem.* **277**: 15439-44 [PMID:11854299]
541. Stjernschantz J and Resul B. (1992) Phenyl substituted prostaglandin analogs for glaucoma treatment. *Drugs Future* **17**: 691-704
542. Stocco C, Djiane J and Gibori G. (2003) Prostaglandin F(2alpha) (PGF(2alpha)) and prolactin signaling: PGF(2alpha)-mediated inhibition of prolactin receptor expression in the Corpus luteum. *Endocrinology* **144**: 3301-3305 [PMID:12865306]
543. Stock JL, Shinjo K, Burkhardt J, Roach M, Taniguchi K, Ishikawa T, Kim HS, Flannery PJ, Coffman TM and McNeish JD *et al.*. (2001) The prostaglandin E2 EP1 receptor mediates pain perception and regulates blood pressure. *J. Clin. Invest.* **107**: 325-31 [PMID:11160156]
544. Strong P, Coleman RA and Humphrey PP. (1992) Prostanoid-induced inhibition of lipolysis in rat isolated adipocytes: probable involvement of EP3 receptors. *Prostaglandins* **43**: 559-66 [PMID:1410520]
545. Sturino CF, O'Neill G, Lachance N, Boyd M, Berthelette C, Labelle M, Li L, Roy B, Scheigetz J and Tsou N *et al.*. (2007) Discovery of a potent and selective prostaglandin D2 receptor antagonist, [(3R)-4-(4-chlorobenzyl)-7-fluoro-5-(methylsulfonyl)-1,2,3,4-tetrahydrocyclopenta[b]indol-3-yl]-acetic acid (MK-0524). *J. Med. Chem.* **50**: 794-806 [PMID:17300164]
546. Sturm EM, Schratl P, Schuligoi R, Konya V, Sturm GJ, Lippe IT, Peskar BA and Heinemann A. (2008) Prostaglandin E2 inhibits eosinophil trafficking through E-prostanoid 2 receptors. *J. Immunol.* **181**: 7273-83 [PMID:18981149]
547. Su X, Leon LA, Wu CW, Morrow DM, Jaworski JP, Hieble JP, Lashinger ES, Jin J, Edwards RM and Laping NJ. (2008) Modulation of bladder function by prostaglandin EP3 receptors in the central nervous system. *Am. J. Physiol. Renal Physiol.* **295**: F984-94 [PMID:18632791]
548. Sugimoto H, Shichijo M, Iino T, Manabe Y, Watanabe A, Shimazaki M, Gantner F and Bacon KB. (2003) An orally bioavailable small molecule antagonist of CRTH2, ramatroban (BAY u3405), inhibits prostaglandin D2-induced eosinophil migration in vitro. *J. Pharmacol. Exp. Ther.* **305**: 347-52 [PMID:12649388]
549. Sugimoto H, Shichijo M, Okano M and Bacon KB. (2005) CRTH2-specific binding characteristics of [³H]ramatroban and its effects on PGD₂-, 15-deoxy-Delta¹², 14-PGJ₂- and indomethacin-induced agonist responses. *Eur. J. Pharmacol.* **524**: 30-7 [PMID:16256979]
550. Sugimoto Y, Fukada Y, Mori D, Tanaka S, Yamane H, Okuno Y, Deai K, Tsuchiya S, Tsujimoto G and Ichikawa A. (2005) Prostaglandin E2 stimulates granulocyte colony-stimulating factor production via the prostanoid EP2 receptor in mouse peritoneal neutrophils. *J. Immunol.* **175**: 2606-12 [PMID:16081835]
551. Sugimoto Y, Hasumoto K, Namba T, Irie A, Katsuyama M, Negishi M, Kakizuka A, Narumiya S and Ichikawa A. (1994) Cloning and expression of a cDNA for mouse prostaglandin F receptor. *J. Biol. Chem.* **269**: 1356-60 [PMID:8288601]
552. Sugimoto Y, Nakato T, Kita A, Hatae N, Tabata H, Tanaka S and Ichikawa A. (2003) Functional domains essential for Gs activity in prostaglandin EP2 and EP3 receptors. *Life Sci.* **74**: 135-41 [PMID:14607240]
553. Sugimoto Y, Nakato T, Kita A, Takahashi Y, Hatae N, Tabata H, Tanaka S and Ichikawa A. (2004) A cluster of aromatic amino acids in the i2 loop plays a key role for Gs coupling in prostaglandin EP2 and EP3 receptors. *J. Biol. Chem.* **279**: 11016-26 [PMID:14699136]
554. Sugimoto Y, Namba T, Honda A, Hayashi Y, Negishi M, Ichikawa A and Narumiya S. (1992) Cloning and expression of a cDNA for mouse prostaglandin E receptor EP3 subtype. *J. Biol. Chem.* **267**: 6463-6 [PMID:1372606]
555. Sugimoto Y, Namba T, Shigemoto R, Negishi M, Ichikawa A and Narumiya S. (1994) Distinct cellular localization of mRNAs for three subtypes of prostaglandin E receptor in kidney. *Am. J. Physiol.* **266**: F823-8 [PMID:8203567]
556. Sugimoto Y and Narumiya S. (2007) Prostaglandin E receptors. *J. Biol. Chem.* **282**: 11613-7 [PMID:17329241]
557. Sugimoto Y, Segi E, Tsuboi K, Ichikawa A and Narumiya S. (1998) Female reproduction in mice lacking the prostaglandin F receptor. Roles of prostaglandin and oxytocin receptors in parturition. *Adv. Exp. Med. Biol.* **449**: 317-21 [PMID:10026819]
558. Sugimoto Y, Shigemoto R, Namba T, Negishi M, Mizuno N, Narumiya S and Ichikawa A. (1994) Distribution of the messenger RNA for the prostaglandin E receptor subtype EP3 in the mouse nervous system. *Neuroscience* **62**: 919-28 [PMID:7870313]
559. Sugimoto Y, Yamasaki A, Segi E, Tsuboi K, Aze Y, Nishimura T, Oida H, Yoshida N, Tanaka T and Katsuyama M *et al.*. (1997) Failure of parturition in mice lacking the prostaglandin F receptor. *Science* **277**: 681-3 [PMID:9235889]
560. Sung YM, He G and Fischer SM. (2005) Lack of expression of the EP2 but not EP3 receptor for prostaglandin E2 results in suppression of skin tumor development. *Cancer Res.* **65**: 9304-11 [PMID:16230392]
561. Sung YM, He G, Hwang DH and Fischer SM. (2006) Overexpression of the prostaglandin E2 receptor EP2 results in enhanced skin tumor development. *Oncogene* **25**: 5507-16 [PMID:16607275]
562. Suzawa T, Miyaura C, Inada M, Maruyama T, Sugimoto Y, Ushikubi F, Ichikawa A, Narumiya S and Suda T. (2000) The role of prostaglandin E receptor subtypes (EP1, EP2, EP3, and EP4) in bone resorption: an analysis using specific agonists for the respective EPs. *Endocrinology* **141**: 1554-9 [PMID:10746663]
563. Suzuki C, Miyamoto C, Furuyashiki T, Narumiya S and Ohinata K. (2011) Central PGE2 exhibits anxiolytic-

- like activity via EP1 and EP4 receptors in a manner dependent on serotonin 5-HT_{1A}, dopamine D1 and GABAA receptors. *FEBS Lett.* **585**: 2357-62 [PMID:21693121]
564. Swanson ML, Lei ZM, Swanson PH, Rao CV, Narumiya S and Hirata M. (1992) The expression of thromboxane A₂ synthase and thromboxane A₂ receptor gene in human uterus. *Biol. Reprod.* **47**: 105-17 [PMID:1386258]
565. Swayne GT, Maguire J, Dolan J, Raval P, Dane G, Greener M and Owen DA. (1988) Evidence for homogeneity of thromboxane A₂ receptor using structurally different antagonists. *Eur. J. Pharmacol.* **152**: 311-9 [PMID:2975605]
566. Syed NI and Jones RL. (2015) Assessing the agonist profiles of the prostacyclin analogues treprostinil and naxaprostene, particularly their DP₁ activity. *Prostaglandins Leukot. Essent. Fatty Acids* **95**: 19-29 [PMID:25542069]
567. Sykes D, Bradley M, Riddy D, Willard L, Powell-Herlaar E, Sandham D, Watson S, Bauer C, Dubois G and Charlton S. (2014) QAW039, a slowly dissociating CRTh2 antagonist with potential for improved clinical efficacy. *Eur. Respir. J.* **44**: 4074
568. Sykes DA, Bradley ME, Riddy DM, Willard E, Reilly J, Miah A, Bauer C, Watson SJ, Sandham DA and Dubois G *et al.*. (2016) Fevipiprant (QAW039), a Slowly Dissociating CRTh2 Antagonist with the Potential for Improved Clinical Efficacy. *Mol. Pharmacol.* **89**: 593-605 [PMID:26916831]
569. Sylvia VL, Del Toro Jr F, Hardin RR, Dean DD, Boyan BD and Schwartz Z. (2001) Characterization of PGE₂ receptors (EP) and their role as mediators of 1 α ,25-(OH)₂D₃ effects on growth zone chondrocytes. *J. Steroid Biochem. Mol. Biol.* **78**: 261-74 [PMID:11595507]
570. Takadera T, Shiraishi Y and Ohyashiki T. (2004) Prostaglandin E₂ induced caspase-dependent apoptosis possibly through activation of EP2 receptors in cultured hippocampal neurons. *Neurochem. Int.* **45**: 713-9 [PMID:15234114]
571. Takadera T, Yumoto H, Tozuka Y and Ohyashiki T. (2002) Prostaglandin E₂ induces caspase-dependent apoptosis in rat cortical cells. *Neurosci. Lett.* **317**: 61-4 [PMID:11755240]
572. Takafuji V, Cosme R, Lublin D, Lynch K and Roche JK. (2000) Prostanoid receptors in intestinal epithelium: selective expression, function, and change with inflammation. *Prostaglandins Leukot. Essent. Fatty Acids* **63**: 223-35 [PMID:11049698]
573. Takagi Y, Nakajima T, Shimazaki A, Kageyama M, Matsugi T, Matsumura Y, Gabelt BT, Kaufman PL and Hara H. (2004) Pharmacological characteristics of AFP-168 (tafluprost), a new prostanoid FP receptor agonist, as an ocular hypotensive drug. *Exp. Eye Res.* **78**: 767-76 [PMID:15037111]
574. Takahashi N, Takeuchi K, Abe T, Sugawara A and Abe K. (1996) Immunolocalization of rat thromboxane receptor in the kidney. *Endocrinology* **137**: 5170-3 [PMID:8895394]
575. Takahashi Y, Tokuoka S, Masuda T, Hirano Y, Nagao M, Tanaka H, Inagaki N, Narumiya S and Nagai H. (2002) Augmentation of allergic inflammation in prostanoid IP receptor deficient mice. *Br. J. Pharmacol.* **137**: 315-22 [PMID:12237250]
576. Takasaki I, Nojima H, Shiraki K, Sugimoto Y, Ichikawa A, Ushikubi F, Narumiya S and Kuraishi Y. (2005) Involvement of cyclooxygenase-2 and EP3 prostaglandin receptor in acute herpetic but not postherpetic pain in mice. *Neuropharmacology* **49**: 283-92 [PMID:15925391]
577. Takayama K, García-Cardena G, Sukhova GK, Comander J, Gimbrone MA and Libby P. (2002) Prostaglandin E₂ suppresses chemokine production in human macrophages through the EP4 receptor. *J. Biol. Chem.* **277**: 44147-54 [PMID:12215436]
578. Takayama K, Yuhki K, Ono K, Fujino T, Hara A, Yamada T, Kuriyama S, Karibe H, Okada Y and Takahata O *et al.*. (2005) Thromboxane A₂ and prostaglandin F₂ α mediate inflammatory tachycardia. *Nat. Med.* **11**: 562-6 [PMID:15834430]
579. Takechi H, Matsumura K, Watanabe Y, Kato K, Noyori R, Suzuki M and Watanabe Y. (1996) A novel subtype of the prostacyclin receptor expressed in the central nervous system. *J. Biol. Chem.* **271**: 5901-6 [PMID:8621463]
580. Taketo M, Rochelle JM, Sugimoto Y, Namba T, Honda A, Negishi M, Ichikawa A, Narumiya S and Seldin MF. (1994) Mapping of the genes encoding mouse thromboxane A₂ receptor and prostaglandin E receptor subtypes EP2 and EP3. *Genomics* **19**: 585-8 [PMID:7910583]
581. Taketomi Y, Ueno N, Kojima T, Sato H, Murase R, Yamamoto K, Tanaka S, Sakanaka M, Nakamura M and Nishito Y *et al.*. (2013) Mast cell maturation is driven via a group III phospholipase A₂-prostaglandin D₂-DP1 receptor paracrine axis. *Nat. Immunol.* **14**: 554-63 [PMID:23624557]
582. Takeuchi K, Abe T, Takahashi N and Abe K. (1993) Molecular cloning and intrarenal localization of rat prostaglandin E₂ receptor EP3 subtype. *Biochem. Biophys. Res. Commun.* **194**: 885-91 [PMID:8393672]
583. Takeuchi K, Aihara E, Hayashi M and Sasaki Y. (2005) Role of prostaglandin E receptor subtypes in gastroduodenal HCO₃⁻ secretion. *Med Chem* **1**: 395-403 [PMID:16789896]
584. Takeuchi K, Araki H, Umeda M, Komoike Y and Suzuki K. (2001) Adaptive gastric cytoprotection is mediated by prostaglandin EP1 receptors: a study using rats and knockout mice. *J. Pharmacol. Exp. Ther.* **297**: 1160-5 [PMID:11356942]
585. Takeuchi K, Takahashi N, Abe T and Abe K. (1994) Two isoforms of the rat kidney EP3 receptor derived by alternative RNA splicing: intrarenal expression co-localization. *Biochem. Biophys. Res. Commun.* **199**: 834-40 [PMID:8135830]
586. Takeuchi K, Takahashi N, Abe T, Ito O, Tsutsumi E, Taniyama Y and Abe K. (1994) Functional difference between two isoforms of rat kidney prostaglandin receptor EP3 subtype. *Biochem. Biophys. Res. Commun.* **203**: 1897-903 [PMID:7945343]
587. Takeuchi K, Ukawa H, Furukawa O, Kawauchi S, Araki H, Sugimoto Y, Ishikawa A, Ushikubi F and

- Narumiya S. (1999) Prostaglandin E receptor subtypes involved in stimulation of gastroduodenal bicarbonate secretion in rats and mice. *J. Physiol. Pharmacol.* **50**: 155-67 [PMID:10424714]
588. Takeuchi K, Ukawa H, Kato S, Furukawa O, Araki H, Sugimoto Y, Ichikawa A, Ushikubi F and Narumiya S. (1999) Impaired duodenal bicarbonate secretion and mucosal integrity in mice lacking prostaglandin E-receptor subtype EP(3). *Gastroenterology* **117**: 1128-35 [PMID:10535876]
589. Takeuchi K, Yagi K, Kato S and Ukawa H. (1997) Roles of prostaglandin E-receptor subtypes in gastric and duodenal bicarbonate secretion in rats. *Gastroenterology* **113**: 1553-9 [PMID:9352857]
590. Tanaka A, Hattori K, Taniguchi K, Okitsu O, Tabuchi S, Nishio M, Nagakura Y, Maeda N, Murai H and Seki J. (2006) Replacing the cyclohexene-linker of FR181157 leading to novel IP receptor agonists: orally active prostacyclin mimetics. Part 6. *Bioorg. Med. Chem. Lett.* **16**: 4861-4 [PMID:16837197]
591. Tanaka K, Furuyashiki T, Kitaoka S, Senzai Y, Imoto Y, Segi-Nishida E, Deguchi Y, Breyer RM, Breyer MD and Narumiya S. (2012) Prostaglandin E2-mediated attenuation of mesocortical dopaminergic pathway is critical for susceptibility to repeated social defeat stress in mice. *J. Neurosci.* **32**: 4319-29 [PMID:22442093]
592. Tanaka K, Shibuya I, Kabashima N, Ueta Y and Yamashita H. (1998) Inhibition of voltage-dependent calcium channels by prostaglandin E2 in rat melanotrophs. *Endocrinology* **139**: 4801-10 [PMID:9832416]
593. Tanaka Y, Furuyashiki T, Momiyama T, Namba H, Mizoguchi A, Mitsumori T, Kayahara T, Shichi H, Kimura K and Matsuoka T *et al.*. (2009) Prostaglandin E receptor EP1 enhances GABA-mediated inhibition of dopaminergic neurons in the substantia nigra pars compacta and regulates dopamine level in the dorsal striatum. *Eur. J. Neurosci.* **30**: 2338-46 [PMID:20092576]
594. Tang EH, Libby P, Vanhoutte PM and Xu A. (2012) Anti-inflammation therapy by activation of prostaglandin EP4 receptor in cardiovascular and other inflammatory diseases. *J. Cardiovasc. Pharmacol.* **59**: 116-23 [PMID:21697732]
595. Tang EH, Shimizu K, Christen T, Rocha VZ, Shvartz E, Tesmenitsky Y, Sukhova G, Shi GP and Libby P. (2011) Lack of EP4 receptors on bone marrow-derived cells enhances inflammation in atherosclerotic lesions. *Cardiovasc. Res.* **89**: 234-43 [PMID:20736236]
596. Tang EH, Shvartz E, Shimizu K, Rocha VZ, Zheng C, Fukuda D, Shi GP, Sukhova G and Libby P. (2011) Deletion of EP4 on bone marrow-derived cells enhances inflammation and angiotensin II-induced abdominal aortic aneurysm formation. *Arterioscler. Thromb. Vasc. Biol.* **31**: 261-9 [PMID:21088251]
597. Theiler A, Konya V, Pasterk L, Maric J, Bärnthaler T, Lanz I, Platzer W, Schuligoi R and Heinemann A. (2016) The EP1/EP3 receptor agonist 17-pt-PGE₂ acts as an EP4 receptor agonist on endothelial barrier function and in a model of LPS-induced pulmonary inflammation. *Vascul. Pharmacol.* **87**: 180-189 [PMID:27664754]
598. Theis JG, Dellweg H, Perzborn E and Gross R. (1992) Binding characteristics of the new thromboxane A2/prostaglandin H2 receptor antagonist [3H]BAY U 3405 to washed human platelets and platelet membranes. *Biochem. Pharmacol.* **44**: 495-503 [PMID:1387312]
599. Thomas DW, Mannon RB, Mannon PJ, Latour A, Oliver JA, Hoffman M, Smithies O, Koller BH and Coffman TM. (1998) Coagulation defects and altered hemodynamic responses in mice lacking receptors for thromboxane A2. *J. Clin. Invest.* **102**: 1994-2001 [PMID:9835625]
600. Thomas DW, Rocha PN, Nataraj C, Robinson LA, Spurney RF, Koller BH and Coffman TM. (2003) Proinflammatory actions of thromboxane receptors to enhance cellular immune responses. *J. Immunol.* **171**: 6389-95 [PMID:14662837]
601. Tilley SL, Audoly LP, Hicks EH, Kim HS, Flannery PJ, Coffman TM and Koller BH. (1999) Reproductive failure and reduced blood pressure in mice lacking the EP2 prostaglandin E2 receptor. *J. Clin. Invest.* **103**: 1539-45 [PMID:10359563]
602. Tilley SL, Hartney JM, Erikson CJ, Jania C, Nguyen M, Stock J, McNeisch J, Valancius C, Panettieri Jr RA and Penn RB *et al.*. (2003) Receptors and pathways mediating the effects of prostaglandin E2 on airway tone. *Am. J. Physiol. Lung Cell Mol. Physiol.* **284**: L599-606 [PMID:12618422]
603. Tippin BL, Kwong AM, Inadomi MJ, Lee OJ, Park JM, Materi AM, Buslon VS, Lin AM, Kudo LC and Karsten SL *et al.*. (2014) Intestinal tumor suppression in ApcMin/+ mice by prostaglandin D2 receptor PTGDR. *Cancer Med* **3**: 1041-51 [PMID:24729479]
604. Torisu K, Kobayashi K, Iwahashi M, Nakai Y, Onoda T, Nagase T, Sugimoto I, Okada Y, Matsumoto R and Nanbu F *et al.*. (2004) Discovery of a new class of potent, selective, and orally active prostaglandin D2 receptor antagonists. *Bioorg. Med. Chem.* **12**: 5361-78 [PMID:15388164]
605. Torres D, Paget C, Fontaine J, Malleveay T, Matsuoka T, Maruyama T, Narumiya S, Capron M, Gosset P and Faveeuw C *et al.*. (2008) Prostaglandin D2 inhibits the production of IFN-gamma by invariant NK T cells: consequences in the control of B16 melanoma. *J. Immunol.* **180**: 783-92 [PMID:18178816]
606. Town MH, Dournaud P, Gu Y-Z, Schonbrunn A, Mazella J, Tannenbaum GS, Casals-Stenzel J and Schillinger E. (1983) Pharmacological and cardiovascular properties of a hydantoin derivative, BW245C, with high affinity and selectivity for PGD₂ receptors. *Prostaglandins* **25**: 13-28 [PMID:6302737]
607. Trist DG, Collins BA, Wood J, Kelly MG and Robertson AD. (1989) The antagonism by BW A868C of PGD2 and BW245C activation of human platelet adenylate cyclase. *Br. J. Pharmacol.* **96**: 301-6 [PMID:2466517]
608. Tsai BS, Keith RH, Perkins WE, Walsh RE, Anglin CP, Collins PW, Gasielki AW, Bauer RF, Jones PH and Gaginella TS. (1995) Preferential binding of the novel prostaglandin SC-46275 to canine gastric versus intestinal receptors. *J. Pharmacol. Exp. Ther.* **275**: 368-73 [PMID:7562572]
609. Tsuboi K, Iwane A, Nakazawa S, Sugimoto Y and Ichikawa A. (2003) Role of prostaglandin H2 synthase 2

- in murine parturition: study on ovariectomy-induced parturition in prostaglandin F receptor-deficient mice. *Biol. Reprod.* **69**: 195-201 [PMID:12620936]
610. Tsuboi K, Sugimoto Y, Iwane A, Yamamoto K, Yamamoto S and Ichikawa A. (2000) Uterine expression of prostaglandin H2 synthase in late pregnancy and during parturition in prostaglandin F receptor-deficient mice. *Endocrinology* **141**: 315-24 [PMID:10614653]
611. Tsuchiya Y, Minami I, Kadotani H and Nishida E. (2005) Resetting of peripheral circadian clock by prostaglandin E2. *EMBO Rep.* **6**: 256-61 [PMID:15723041]
612. Tunaru S, Althoff TF, Nüsing RM, Diener M and Offermanns S. (2012) Castor oil induces laxation and uterus contraction via ricinoleic acid activating prostaglandin EP3 receptors. *Proc. Natl. Acad. Sci. U.S.A.* **109**: 9179-84 [PMID:22615395]
613. Tymkewycz PM, Jones RL, Wilson NH and Marr CG. (1991) Heterogeneity of thromboxane A2 (TP-) receptors: evidence from antagonist but not agonist potency measurements. *Br. J. Pharmacol.* **102**: 607-14 [PMID:1364826]
614. Ueno A, Matsumoto H, Naraba H, Ikeda Y, Ushikubi F, Matsuoka T, Narumiya S, Sugimoto Y, Ichikawa A and Oh-ishi S. (2001) Major roles of prostanoid receptors IP and EP(3) in endotoxin-induced enhancement of pain perception. *Biochem. Pharmacol.* **62**: 157-60 [PMID:11389873]
615. Ueta M, Tamiya G, Tokunaga K, Sotozono C, Ueki M, Sawai H, Inatomi T, Matsuoka T, Akira S and Narumiya S *et al.*. (2012) Epistatic interaction between Toll-like receptor 3 (TLR3) and prostaglandin E receptor 3 (PTGER3) genes. *J. Allergy Clin. Immunol.* **129**: 1413-1416.e11 [PMID:22421267]
616. Ulven T and Kostenis E. (2005) Minor structural modifications convert the dual TP/CRTH2 antagonist ramatroban into a highly selective and potent CRTH2 antagonist. *J. Med. Chem.* **48**: 897-900 [PMID:15715457]
617. Ulven T and Kostenis E. (2010) Novel CRTH2 antagonists: a review of patents from 2006 to 2009 *Expert Opin Ther Pat* **20**: 1505-30 [PMID:20946089]
618. Ungrin MD, Carrière MC, Denis D, Lamontagne S, Sawyer N, Stocco R, Tremblay N, Metters KM and Abramovitz M. (2001) Key structural features of prostaglandin E(2) and prostanoid analogs involved in binding and activation of the human EP(1) prostanoid receptor. *Mol. Pharmacol.* **59**: 1446-56 [PMID:11353805]
619. Unlugedik E, Alfaidy N, Holloway A, Lye S, Bocking A, Challis J and Gibb W. (2010) Expression and regulation of prostaglandin receptors in the human placenta and fetal membranes at term and preterm. *Reprod. Fertil. Dev.* **22**: 796-807 [PMID:20450832]
620. Urade Y and Hayaishi O. (2011) Prostaglandin D2 and sleep/wake regulation. *Sleep Med Rev* **15**: 411-8 [PMID:22024172]
621. Ushikubi F, Aiba Y, Nakamura K, Namba T, Hirata M, Mazda O, Katsura Y and Narumiya S. (1993) Thromboxane A2 receptor is highly expressed in mouse immature thymocytes and mediates DNA fragmentation and apoptosis. *J. Exp. Med.* **178**: 1825-30 [PMID:8228829]
622. Ushikubi F, Hirata M and Narumiya S. (1995) Molecular biology of prostanoid receptors; an overview *J Lipid Mediat Cell Signal* **12**: 343-59 [PMID:8777578]
623. Ushikubi F, Segi E, Sugimoto Y, Murata T, Matsuoka T, Kobayashi T, Hizaki H, Tsuboi K, Katsuyama M and Ichikawa A *et al.*. (1998) Impaired febrile response in mice lacking the prostaglandin E receptor subtype EP3. *Nature* **395**: 281-4 [PMID:9751056]
624. Valentin JP, Bessac AM, Maffre M and John GW. (1996) Nitric oxide regulation of TP receptor-mediated pulmonary vasoconstriction in the anesthetized, open-chest rat. *Eur J Pharmacol* **317**: 335-342 [PMID:8997619]
625. van den Brule S, Huaux F, Uwambayinema F, Ibouaadaten S, Yakoub Y, Palmal-Pallag M, Trottein F, Renauld JC and Lison D. (2014) Lung inflammation and thymic atrophy after bleomycin are controlled by the prostaglandin D2 receptor DP1. *Am. J. Respir. Cell Mol. Biol.* **50**: 212-22 [PMID:24003988]
626. Vasilache AM, Andersson J and Nilsberth C. (2007) Expression of PGE2 EP3 receptor subtypes in the mouse preoptic region. *Neurosci. Lett.* **423**: 179-83 [PMID:17706357]
627. Vermyn J and Deckmyn H. (1992) Thromboxane synthase inhibitors and receptor antagonists. *Cardiovasc Drugs Ther* **6**: 29-33 [PMID:1533533]
628. Vielhauer GA, Fujino H and Regan JW. (2004) Cloning and localization of hFP(S): a six-transmembrane mRNA splice variant of the human FP prostanoid receptor. *Arch. Biochem. Biophys.* **421**: 175-85 [PMID:14984197]
629. Virgolini I, Li S, Sillaber C, Majdic O, Sinzinger H, Lechner K, Bettelheim P and Valent P. (1992) Characterization of prostaglandin (PG)-binding sites expressed on human basophils. Evidence for a prostaglandin E1, I2, and a D2 receptor. *J. Biol. Chem.* **267**: 12700-8 [PMID:1377673]
630. Wacker MJ, Tyburski JB, Ammar CP, Adams MC and Orr JA. (2005) Detection of thromboxane A(2) receptor mRNA in rabbit nodose ganglion neurons. *Neurosci. Lett.* **386**: 121-6 [PMID:15992996]
631. Walch L, de Montpreville V, Brink C and Norel X. (2001) Prostanoid EP(1)- and TP-receptors involved in the contraction of human pulmonary veins. *Br. J. Pharmacol.* **134**: 1671-8 [PMID:11739243]
632. Walch L, Labat C, Gascard JP, de Montpreville V, Brink C and Norel X. (1999) Prostanoid receptors involved in the relaxation of human pulmonary vessels. *Br. J. Pharmacol.* **126**: 859-66 [PMID:10193765]
633. Walsh MT and Kinsella BT. (2000) Regulation of the human prostanoid TPalpha and TPbeta receptor isoforms mediated through activation of the EP(1) and IP receptors. *Br. J. Pharmacol.* **131**: 601-9 [PMID:11015313]
634. Wang JW, Vu C and Poloso NJ. (2017) A Prostacyclin Analog, Cicaprost, Exhibits Potent Anti-Inflammatory Activity in Human Primary Immune Cells and a Uveitis Model. *J Ocul Pharmacol Ther* **33**:

- 186-192 [PMID:28072560]
635. Wang L, Yao D, Deepak RNVK, Liu H, Xiao Q, Fan H, Gong W, Wei Z and Zhang C. (2018) Structures of the Human PGD₂ Receptor CRTH2 Reveal Novel Mechanisms for Ligand Recognition. *Mol. Cell* **72**: 48-59.e4 [PMID:30220562]
636. Wang W, Andersson M, Lönnroth C, Svanberg E and Lundholm K. (2005) Anorexia and cachexia in prostaglandin EP1 and EP3 subtype receptor knockout mice bearing a tumor with high intrinsic PGE2 production and prostaglandin related cachexia. *J. Exp. Clin. Cancer Res.* **24**: 99-107 [PMID:15943039]
637. Wang X, Momota Y, Yanase H, Narumiya S, Maruyama T and Kawatani M. (2008) Urothelium EP1 receptor facilitates the micturition reflex in mice. *Biomed. Res.* **29**: 105-11 [PMID:18480552]
638. Wang Y, Wos JA, Dirr MJ, Soper DL, deLong MA, Mieling GE, De B, Amburgey JS, Suchanek EG and Taylor CJ. (2000) Design and synthesis of 13,14-dihydro prostaglandin F(1alpha) analogues as potent and selective ligands for the human FP receptor. *J. Med. Chem.* **43**: 945-52 [PMID:10715159]
639. Ward CL, Jamieson V, Nabata T, Sharpe J, Dozono K, Suto F, Hashimoto Y and Gussak I. (2016) First Clinical Experience with ONO-4232: A Randomized, Double-blind, Placebo-controlled Healthy Volunteer Study of a Novel Lusitropic Agent for Acutely Decompensated Heart Failure. *Clin Ther* **38**: 1109-21 [PMID:27001444]
640. Watabe A, Sugimoto Y, Honda A, Irie A, Namba T, Negishi M, Ito S, Narumiya S and Ichikawa A. (1993) Cloning and expression of cDNA for a mouse EP1 subtype of prostaglandin E receptor. *J. Biol. Chem.* **268**: 20175-8 [PMID:7690750]
641. Watanabe K, Kawamori T, Nakatsugi S, Ohta T, Ohuchida S, Yamamoto H, Maruyama T, Kondo K, Narumiya S and Sugimura T *et al.*. (2000) Inhibitory effect of a prostaglandin E receptor subtype EP(1) selective antagonist, ONO-8713, on development of azoxymethane-induced aberrant crypt foci in mice. *Cancer Lett.* **156**: 57-61 [PMID:10840160]
642. Watanabe K, Kawamori T, Nakatsugi S, Ohta T, Ohuchida S, Yamamoto H, Maruyama T, Kondo K, Ushikubi F and Narumiya S *et al.*. (1999) Role of the prostaglandin E receptor subtype EP1 in colon carcinogenesis. *Cancer Res.* **59**: 5093-6 [PMID:10537280]
643. Watanabe Y, Matsumura K, Takechi H, Kato K, Morii H, Björkman M, Långström B, Noyori R, Suzuki M and Watanabe Y. (1999) A novel subtype of prostacyclin receptor in the central nervous system. *J. Neurochem.* **72**: 2583-92 [PMID:10349870]
644. Wei G, Kibler KK, Koehler RC, Maruyama T, Narumiya S and Doré S. (2008) Prostacyclin receptor deletion aggravates hippocampal neuronal loss after bilateral common carotid artery occlusion in mouse. *Neuroscience* **156**: 1111-7 [PMID:18790018]
645. West JD, Voss BM, Pavliv L, de Caestecker M, Hemnes AR and Carrier EJ. (2016) Antagonism of the thromboxane-prostanoid receptor is cardioprotective against right ventricular pressure overload. *Pulm Circ* **6**: 211-23 [PMID:27252848]
646. Wheeldon A and Vardey CJ. (1993) Characterization of the inhibitory prostanoid receptors on human neutrophils. *Br J Pharmacol* **108**: 1051-1054 [PMID:8387383]
647. Whittle BJ, Moncada S, Mullane K and Vane JR. (1983) Platelet and cardiovascular activity of the hydantoin BW245C, a potent prostaglandin analogue. *Prostaglandins* **25**: 205-23 [PMID:6344147]
648. Whittle BJ, Silverstein AM, Mottola DM and Clapp LH. (2012) Binding and activity of the prostacyclin receptor (IP) agonists, treprostinil and iloprost, at human prostanoid receptors: treprostinil is a potent DP1 and EP2 agonist. *Biochem. Pharmacol.* **84**: 68-75 [PMID:22480736]
649. Wilson RJ, Giblin GM, Roomans S, Rhodes SA, Cartwright KA, Shield VJ, Brown J, Wise A, Chowdhury J and Pritchard S *et al.*. (2006) GW627368X ((N-{2-[4-(4,9-diethoxy-1-oxo-1,3-dihydro-2H-benzo[f]isindol-2-yl)phenyl]acetyl} benzene sulphonamide): a novel, potent and selective prostanoid EP4 receptor antagonist. *Br. J. Pharmacol.* **148**: 326-39 [PMID:16604093]
650. Wilson RJ and Giles H. (2005) Piglet saphenous vein contains multiple relaxatory prostanoid receptors: evidence for EP4, EP2, DP and IP receptor subtypes. *Br. J. Pharmacol.* **144**: 405-15 [PMID:15655509]
651. Wilson RJ, Rhodes SA, Wood RL, Shield VJ, Noel LS, Gray DW and Giles H. (2004) Functional pharmacology of human prostanoid EP2 and EP4 receptors. *Eur. J. Pharmacol.* **501**: 49-58 [PMID:15464062]
652. Wilson SJ, McGinley K, Huang AJ and Smyth EM. (2007) Heterodimerization of the alpha and beta isoforms of the human thromboxane receptor enhances isoprostane signaling. *Biochem. Biophys. Res. Commun.* **352**: 397-403 [PMID:17134677]
653. Wilson SM, Sheddan NA, Newton R and Giembycz MA. (2011) Evidence for a second receptor for prostacyclin on human airway epithelial cells that mediates inhibition of CXCL9 and CXCL10 release. *Mol. Pharmacol.* **79**: 586-95 [PMID:21173040]
654. Wilson SM, Shen P, Rider CF, Traves SL, Proud D, Newton R and Giembycz MA. (2009) Selective prostacyclin receptor agonism augments glucocorticoid-induced gene expression in human bronchial epithelial cells. *J. Immunol.* **183**: 6788-99 [PMID:19880449]
655. Wilson TW and Quest DW. (2000) Ridogrel: an antiplatelet agent with antihypertensive properties. *Cardiovasc Drug Rev* **18**: 222-231
656. Wise H. (1998) Activation of the prostaglandin EP4-receptor subtype is highly coupled to inhibition of N-formyl-methionyl-leucyl-phenylalanine-stimulated rat neutrophil aggregation. *Prostaglandins Leukot. Essent. Fatty Acids* **58**: 77-84 [PMID:9482170]
657. Wolkowicz PE, Ku DD, Grenett HE and Urthaler F. (2002) Occupation of the prostaglandin E2-type 1 receptor increases rat atrial contractility via a Y-27632-sensitive pathway. *Prostaglandins Other Lipid*

- Mediat.* **70**: 91-105 [PMID:12428681]
658. Woodward DF, Carling RW, Cornell CL, Fliri HG, Martos JL, Pettit SN, Liang Y and Wang JW. (2008) The pharmacology and therapeutic relevance of endocannabinoid derived cyclo-oxygenase (COX)-2 products. *Pharmacol. Ther.* **120**: 71-80 [PMID:18700152]
659. Woodward DF, Fairbairn CE, Goodrum DD, Krauss AH, Ralston TL and Williams LS. (1991) Ca²⁺ transients evoked by prostanoids in Swiss 3T3 cells suggest an FP-receptor mediated response. *Adv. Prostaglandin Thromboxane Leukot. Res.* **21A**: 367-70 [PMID:1825572]
660. Woodward DF, Fairbairn CE, Krauss AH, Lawrence RA and Protzman CE. (1995) Radioligand binding analysis of receptor subtypes in two FP receptor preparations that exhibit different functional rank orders of potency in response to prostaglandins. *J. Pharmacol. Exp. Ther.* **273**: 285-7 [PMID:7714778]
661. Woodward DF, Jones RL and Narumiya S. (2011) International union of basic and clinical pharmacology. LXXXIII: classification of prostanoid receptors, updating 15 years of progress. *Pharmacol. Rev.* **63**: 471-538 [PMID:21752876]
662. Woodward DF, Krauss AH, Chen J, Gil DW, Kedzie KM, Protzman CE, Shi L, Chen R, Krauss HA and Bogardus A *et al.*. (2000) Replacement of the carboxylic acid group of prostaglandin f(2alpha) with a hydroxyl or methoxy substituent provides biologically unique compounds. *Br. J. Pharmacol.* **130**: 1933-43 [PMID:10952685]
663. Woodward DF, Krauss AH, Chen J, Liang Y, Li C, Protzman CE, Bogardus A, Chen R, Kedzie KM and Krauss HA *et al.*. (2003) Pharmacological characterization of a novel antiglaucoma agent, Bimatoprost (AGN 192024). *J. Pharmacol. Exp. Ther.* **305**: 772-85 [PMID:12606640]
664. Woodward DF and Lawrence RA. (1994) Identification of a single (FP) receptor associated with prostanoid-induced Ca²⁺ signals in Swiss 3T3 cells. *Biochem. Pharmacol.* **47**: 1567-74 [PMID:8185669]
665. Woodward DF, Lawrence RA, Fairbairn CE, Shan T and Williams LS. (1993) Intraocular pressure effects of selective prostanoid receptor agonists involve different receptor subtypes according to radioligand binding studies. *J Lipid Mediat* **6**: 545-53 [PMID:8358015]
666. Woodward DF, Liang Y and Krauss AH. (2008) Prostanamides (prostaglandin-ethanolamides) and their pharmacology. *Br. J. Pharmacol.* **153**: 410-9 [PMID:17721551]
667. Wright DH, Ford-Hutchinson AW, Chadee K and Metters KM. (2000) The human prostanoid DP receptor stimulates mucin secretion in LS174T cells. *Br. J. Pharmacol.* **131**: 1537-45 [PMID:11139429]
668. Wright DH, Metters KM, Abramovitz M and Ford-Hutchinson AW. (1998) Characterization of the recombinant human prostanoid DP receptor and identification of L-644,698, a novel selective DP agonist. *Br. J. Pharmacol.* **123**: 1317-24 [PMID:9579725]
669. Wright DH, Nantel F, Metters KM and Ford-Hutchinson AW. (1999) A novel biological role for prostaglandin D2 is suggested by distribution studies of the rat DP prostanoid receptor. *Eur. J. Pharmacol.* **377**: 101-15 [PMID:10448933]
670. Xiao CY, Hara A, Yuhki K, Fujino T, Ma H, Okada Y, Takahata O, Yamada T, Murata T and Narumiya S *et al.*. (2001) Roles of prostaglandin I(2) and thromboxane A(2) in cardiac ischemia-reperfusion injury: a study using mice lacking their respective receptors. *Circulation* **104**: 2210-5 [PMID:11684633]
671. Xu HM, Wei W, Jia XY, Chang Y and Zhang L. (2007) Effects and mechanisms of total glucosides of paeony on adjuvant arthritis in rats. *J Ethnopharmacol* **109**: 442-8 [PMID:17000070]
672. Xue L, Gyles SL, Wettey FR, Gazi L, Townsend E, Hunter MG and Pettipher R. (2005) Prostaglandin D2 causes preferential induction of proinflammatory Th2 cytokine production through an action on chemoattractant receptor-like molecule expressed on Th2 cells. *J. Immunol.* **175**: 6531-6 [PMID:16272307]
673. Yamane H, Sugimoto Y, Tanaka S and Ichikawa A. (2000) Prostaglandin E(2) receptors, EP2 and EP4, differentially modulate TNF-alpha and IL-6 production induced by lipopolysaccharide in mouse peritoneal neutrophils. *Biochem. Biophys. Res. Commun.* **278**: 224-8 [PMID:11071876]
674. Yamane S, Karakawa T, Nakayama S, Nagai K, Moriyuki K, Neki S, Suto F, Kambe T, Hirota Y and Kawabata K. (2015) IOP-Lowering Effect of ONO-9054, A Novel Dual Agonist of Prostanoid EP3 and FP Receptors, in Monkeys. *Invest. Ophthalmol. Vis. Sci.* **56**: 2547-52 [PMID:25788650]
675. Yamaoka K, Yano A, Kuroiwa K, Morimoto K, Inazumi T, Hatae N, Tabata H, Segi-Nishida E, Tanaka S and Ichikawa A *et al.*. (2009) Prostaglandin EP3 receptor superactivates adenylyl cyclase via the Gq/PLC/Ca²⁺ pathway in a lipid raft-dependent manner. *Biochem. Biophys. Res. Commun.* **389**: 678-82 [PMID:19769944]
676. Yang H, Zhang J, Breyer RM and Chen C. (2009) Altered hippocampal long-term synaptic plasticity in mice deficient in the PGE2 EP2 receptor. *J. Neurochem.* **108**: 295-304 [PMID:19012750]
677. Yang J, Xia M, Goetzl EJ and An S. (1994) Cloning and expression of the EP3-subtype of human receptors for prostaglandin E2. *Biochem Biophys Res Commun* **198**: 999-1006 [PMID:8117308]
678. Yang L, Yamagata N, Yadav R, Brandon S, Courtney RL, Morrow JD, Shyr Y, Boothby M, Joyce S and Carbone DP *et al.*. (2003) Cancer-associated immunodeficiency and dendritic cell abnormalities mediated by the prostaglandin EP2 receptor. *J. Clin. Invest.* **111**: 727-35 [PMID:12618527]
679. Yao C, Sakata D, Esaki Y, Li Y, Matsuoka T, Kuroiwa K, Sugimoto Y and Narumiya S. (2009) Prostaglandin E2-EP4 signaling promotes immune inflammation through Th1 cell differentiation and Th17 cell expansion. *Nat. Med.* **15**: 633-40 [PMID:19465928]
680. Yokotani K, Nakamura K and Okada S. (2003) Prostanoid EP3 and TP receptors-mediated inhibition of noradrenaline release from the isolated rat stomach. *Eur. J. Pharmacol.* **459**: 187-93 [PMID:12524145]
681. Yokotani K, Nishihara M, Murakami Y, Hasegawa T, Okuma Y and Osumi Y. (1995) Elevation of plasma noradrenaline levels in urethane-anaesthetized rats by activation of central prostanoid EP3 receptors. *Br J Pharmacol* **115**: 672-676 [PMID:7582489]

682. Yokotani K, Okada S, Nakamura K, Yamaguchi-Shima N, Shimizu T, Arai J, Wakiguchi H and Yokotani K. (2005) Brain prostanoid TP receptor-mediated adrenal noradrenaline secretion and EP3 receptor-mediated sympathetic noradrenaline release in rats. *Eur. J. Pharmacol.* **512**: 29-35 [PMID:15814087]
683. Yokotani K, Okuma Y and Osumi Y. (1996) Inhibition of vagally mediated gastric acid secretion by activation of central prostanoid EP3 receptors in urethane-anaesthetized rats. *Br. J. Pharmacol.* **117**: 653-6 [PMID:8646410]
684. Yokoyama U, Ishiwata R, Jin MH, Kato Y, Suzuki O, Jin H, Ichikawa Y, Kumagaya S, Katayama Y and Fujita T *et al.*. (2012) Inhibition of EP4 signaling attenuates aortic aneurysm formation. *PLoS ONE* **7**: e36724 [PMID:22570740]
685. Yokoyama U, Iwatsubo K, Umemura M, Fujita T and Ishikawa Y. (2013) The prostanoid EP4 receptor and its signaling pathway. *Pharmacol. Rev.* **65**: 1010-52 [PMID:23776144]
686. Yokoyama U, Minamisawa S, Quan H, Ghatak S, Akaike T, Segi-Nishida E, Iwasaki S, Iwamoto M, Misra S and Tamura K *et al.*. (2006) Chronic activation of the prostaglandin receptor EP4 promotes hyaluronan-mediated neointimal formation in the ductus arteriosus. *J. Clin. Invest.* **116**: 3026-34 [PMID:17080198]
687. Yoshida K, Oida H, Kobayashi T, Maruyama T, Tanaka M, Katayama T, Yamaguchi K, Segi E, Tsuboyama T and Matsushita M *et al.*. (2002) Stimulation of bone formation and prevention of bone loss by prostaglandin E EP4 receptor activation. *Proc. Natl. Acad. Sci. U.S.A.* **99**: 4580-5 [PMID:11917107]
688. Yoshida Y, Matsumura H, Nakajima T, Mandai M, Urakami T, Kuroda K and Yoneda H. (2000) Prostaglandin E (EP) receptor subtypes and sleep: promotion by EP4 and inhibition by EP1/EP2. *Neuroreport* **11**: 2127-31 [PMID:10923657]
689. Young RN, Billot X, Han Y, Slipetz DA, Chauret N, Belley M, Metters K, Mathieu MC, Greig GM, Denis D and Girard M. (2004) Discovery and Synthesis of a Potent, Selective and Orally Bioavailable EP4 Receptor Agonist. *Heterocycles* **64**: 437-446
690. Yuhki K, Ushikubi F, Naraba H, Ueno A, Kato H, Kojima F, Narumiya S, Sugimoto Y, Matsushita M and Oh-Ishi S. (2008) Prostaglandin I2 plays a key role in zymosan-induced mouse pleurisy. *J. Pharmacol. Exp. Ther.* **325**: 601-9 [PMID:18256172]
691. Zacharowski K, Olbrich A, Piper J, Hafner G, Kondo K and Thiemermann C. (1999) Selective activation of the prostanoid EP(3) receptor reduces myocardial infarct size in rodents. *Arterioscler. Thromb. Vasc. Biol.* **19**: 2141-7 [PMID:10479656]
692. Zhan P, Alander C, Kaneko H, Pilbeam CC, Guan Y, Zhang Y, Breyer MD and Raisz LG. (2005) Effect of deletion of the prostaglandin EP4 receptor on stimulation of calcium release from cultured mouse calvariae: impaired responsiveness in heterozygotes. *Prostaglandins Other Lipid Mediat.* **78**: 19-26 [PMID:16303601]
693. Zhang J and Rivest S. (1999) Distribution, regulation and colocalization of the genes encoding the EP2- and EP4-PGE2 receptors in the rat brain and neuronal responses to systemic inflammation. *Eur. J. Neurosci.* **11**: 2651-68 [PMID:10457163]
694. Zhang M, Ho HC, Sheu TJ, Breyer MD, Flick LM, Jonason JH, Awad HA, Schwarz EM and O'Keefe RJ. (2011) EP1(-/-) mice have enhanced osteoblast differentiation and accelerated fracture repair. *J. Bone Miner. Res.* **26**: 792-802 [PMID:20939055]
695. Zhang Y, Guan Y, Schneider A, Brandon S, Breyer RM and Breyer MD. (2000) Characterization of murine vasopressor and vasodepressor prostaglandin E(2) receptors. *Hypertension* **35**: 1129-34 [PMID:10818076]
696. Zhang Z and Yin H. (2002) Detection of EP1 and FP receptor mRNAs in the iris-ciliary body using in situ hybridization. *Chin Med J (Engl)* **115**: 1226-1228 [PMID:12215298]
697. Zhen G, Kim YT, Li RC, Yocum J, Kapoor N, Langer J, Dobrowolski P, Maruyama T, Narumiya S and Doré S. (2012) PGE2 EP1 receptor exacerbated neurotoxicity in a mouse model of cerebral ischemia and Alzheimer's disease. *Neurobiol. Aging* **33**: 2215-9 [PMID:22015313]
698. Zheng Y, Ritzenthaler JD, Sun X, Roman J and Han S. (2009) Prostaglandin E2 stimulates human lung carcinoma cell growth through induction of integrin-linked kinase: the involvement of EP4 and Sp1. *Cancer Res.* **69**: 896-904 [PMID:19176380]
699. Zhou W, Blackwell TS, Goleniewska K, O'Neal JF, Fitzgerald GA, Lucitt M, Breyer RM and Peebles RS. (2007) Prostaglandin I2 analogs inhibit Th1 and Th2 effector cytokine production by CD4 T cells. *J. Leukoc. Biol.* **81**: 809-17 [PMID:17135575]
700. Zhou W, Dowell DR, Huckabee MM, Newcomb DC, Boswell MG, Goleniewska K, Lotz MT, Toki S, Yin H and Yao S *et al.*. (2012) Prostaglandin I2 signaling drives Th17 differentiation and exacerbates experimental autoimmune encephalomyelitis. *PLoS ONE* **7**: e33518 [PMID:22590492]
701. Zhou W, Goleniewska K, Zhang J, Dulek DE, Toki S, Lotz MT, Newcomb DC, Boswell MG, Polosukhin VV and Milne GL *et al.*. (2014) Cyclooxygenase inhibition abrogates aeroallergen-induced immune tolerance by suppressing prostaglandin I2 receptor signaling. *J. Allergy Clin. Immunol.* **134**: 698-705.e5 [PMID:25042746]
702. Zhu S, Xue R, Zhao P, Fan FL, Kong X, Zheng S, Han Q, Zhu Y, Wang N and Yang *et al.*. (2011) Targeted disruption of the prostaglandin E2 E-prostanoid 2 receptor exacerbates vascular neointimal formation in mice. *Arterioscler. Thromb. Vasc. Biol.* **31**: 1739-47 [PMID:21636806]