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Calcitonin receptors (version 2019.4) in the IUPHAR/BPS Guide to Pharmacology Database

Debbie Hay[1], David R. Poyner[2] and Christopher S. Walker[1]

1. University of Auckland, New Zealand
2. Aston University, UK

Abstract

This receptor family comprises a group of receptors for the calcitonin/CGRP family of peptides. The calcitonin (CT), amylin (AMY), calcitonin gene-related peptide (CGRP) and adrenomedullin (AM) receptors (**nomenclature as agreed by the NC-IUPHAR Subcommittee on CGRP, AM, AMY, and CT receptors [122, 67]**) are generated by the genes *CALCR* (which codes for the CT receptor) and *CALCRL* (which codes for the calcitonin receptor-like receptor, CLR, previously known as CRLR). Their function and pharmacology are altered in the presence of RAMPs (receptor activity-modifying proteins), which are single TM domain proteins of *ca.* 130 amino acids, identified as a family of three members; RAMP1, RAMP2 and RAMP3. There are splice variants of the CT receptor; these in turn produce variants of the AMY receptor [122], some of which can be potently activated by CGRP. The endogenous agonists are the peptides calcitonin, α-CGRP (formerly known as CGRP-I), β-CGRP (formerly known as CGRP-II), amylin (occasionally called islet-amyloid polypeptide, diabetes-associated polypeptide), adrenomedullin and adrenomedullin 2/intermedin. There are species differences in peptide sequences, particularly for the CTs. CTR-stimulating peptide (CRSP) is another member of the family with selectivity for the CT receptor but it is not expressed in humans [87]. olcegepant (also known as BIBN4096BS, *p*Ki~10.5) and telcagepant (also known as MK0974, *p*Ki~9) are the most selective antagonists available, showing selectivity for CGRP receptors, with a particular preference for those of primate origin. CLR (calcitonin receptor-like receptor) by itself binds no known endogenous ligand, but in the presence of RAMPs it gives receptors for CGRP, adrenomedullin and adrenomedullin 2/intermedin.

Contents

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References

1. Aiyar N, Disa J, Pullen M and Nambi P. (2001) Receptor activity modifying proteins interaction with human and porcine calcitonin receptor-like receptor (CRLR) in HEK-293 cells. *Mol. Cell. Biochem.* **224**: 123-33 [PMID:11693189]
2. Aiyar N, Disa J, Stadel JM and Lysko PG. (1999) Calcitonin gene-related peptide receptor independently stimulates 3',5'-cyclic adenosine monophosphate and Ca2+ signaling pathways. *Mol. Cell. Biochem.* **197**: 179-85 [PMID:10485337]
3. Albrandt K, Brady EM, Moore CX, Mull E, Sierzega ME and Beaumont K. (1995) Molecular cloning and

functional expression of a third isoform of the human calcitonin receptor and partial characterization of the calcitonin receptor gene. *Endocrinology* **136**: 5377-84 [PMID:7588285]

4. Aldecoa A, Gujer R, Fischer JA and Born W. (2000) Mammalian calcitonin receptor-like receptor/receptor activity modifying protein complexes define calcitonin gene-related peptide and adrenomedullin receptors in Drosophila Schneider 2 cells. *FEBS Lett.* **471**: 156-60 [PMID:10767413]
5. Ali N, Yousufzai SY and Abdel-Latif AA. (2000) Activation of particulate guanylate cyclase by adrenomedullin in cultured SV-40 transformed cat iris sphincter smooth muscle (SV-CISM-2) cells. *Cell Signal.* **12**: 491-498 [PMID:10989285]
6. Allen MA and Ferguson AV. (1996) In vitro recordings from area postrema neurons demonstrate responsiveness to adrenomedullin. *Am. J. Physiol.* **270**: R920-5 [PMID:8967423]
7. Amara SG, Jonas V, Rosenfeld MG, Ong ES and Evans RM. (1982) Alternative RNA processing in calcitonin gene expression generates mRNAs encoding different polypeptide products. *Nature* **298**: 240-4 [PMID:6283379]
8. Andreis PG, Mazzocchi G, Rebuffat P and Nussdorfer GG. (1997) Effects of adrenomedullin and proadrenomedullin N-terminal 20 peptide on rat zona glomerulosa cells. *Life Sci.* **60**: 1693-7 [PMID:9129124]
9. Andreis PG, Neri G, Prayer-Galetti T, Rossi GP, Gottardo G, Malendowicz LK and Nussdorfer GG. (1997) Effects of adrenomedullin on the human adrenal glands: an in vitro study. *J. Clin. Endocrinol. Metab.* **82**: 1167-70 [PMID:9100590]
10. Archbold JK, Flanagan JU, Watkins HA, Gingell JJ and Hay DL. (2011) Structural insights into RAMP modification of secretin family G protein-coupled receptors: implications for drug development. *Trends Pharmacol. Sci.* **32**: 591-600 [PMID:21722971]
11. Armour SL, Foord S, Kenakin T and Chen WJ. (1999) Pharmacological characterization of receptor-activity-modifying proteins (RAMPs) and the human calcitonin receptor. *J Pharmacol Toxicol Methods* **42**: 217-24 [PMID:11033437]
12. Arulmani U, Schuijt MP, Heiligers JP, Willems EW, Villalón CM and Saxena PR. (2004) Effects of the calcitonin gene-related peptide (CGRP) receptor antagonist BIBN4096BS on alpha-CGRP-induced regional haemodynamic changes in anaesthetised rats. *Basic Clin. Pharmacol. Toxicol.* **94**: 291-7 [PMID:15228501]
13. Bailey RJ and Hay DL. (2006) Pharmacology of the human CGRP1 receptor in Cos 7 cells *Peptides* **27**: 1367-75 [PMID:16375989]
14. Bailey RJ, Walker CS, Ferner AH, Loomes KM, Prijic G, Halim A, Whiting L, Phillips AR and Hay DL. (2012) Pharmacological characterization of rat amylin receptors: implications for the identification of amylin receptor subtypes. *Br. J. Pharmacol.* **166**: 151-67 [PMID:22014233]
15. Barrick CJ, Lenhart PM, Dackor RT, Nagle E and Caron KM. (2012) Loss of receptor activity-modifying protein 3 exacerbates cardiac hypertrophy and transition to heart failure in a sex-dependent manner. *J. Mol. Cell. Cardiol.* **52**: 165-74 [PMID:22100352]
16. Becskei C, Riediger T, Zünd D, Wookey P and Lutz TA. (2004) Immunohistochemical mapping of calcitonin receptors in the adult rat brain. *Brain Res.* **1030**: 221-33 [PMID:15571671]
17. Bell D and McDermott BJ. (1994) Calcitonin gene-related peptide stimulates a positive contractile response in rat ventricular cardiomyocytes. *J. Cardiovasc. Pharmacol.* **23**: 1011-21 [PMID:7523774]
18. Bell IM and Fraley ME. (2012) Piperidinone carboxamide azaindane CGRP receptor antagonists. Patent number: US20120122911.
19. Bhogal R, Smith DM and Bloom SR. (1992) Investigation and characterization of binding sites for islet amyloid polypeptide in rat membranes. *Endocrinology* **130**: 906-13 [PMID:1310282]
20. Bomberger JM, Parameswaran N, Hall CS, Aiyar N and Spielman WS. (2005) Novel function for receptor activity-modifying proteins (RAMPs) in post-endocytic receptor trafficking. *J. Biol. Chem.* **280**: 9297-307 [PMID:15613468]
21. Booe JM, Walker CS, Barwell J, Kuteyi G, Simms J, Jamaluddin MA, Warner ML, Bill RM, Harris PW and Brimble MA *et al.*. (2015) Structural Basis for Receptor Activity-Modifying Protein-Dependent Selective

Peptide Recognition by a G Protein-Coupled Receptor. *Mol. Cell* **58**: 1040-52 [PMID:25982113]
22. Brain SD and Grant AD. (2004) Vascular actions of calcitonin gene-related peptide and adrenomedullin. *Physiol. Rev.* **84**: 903-34 [PMID:15269340]
23. Brain SD, Poyner DR and Hill RG. (2002) CGRP receptors: a headache to study, but will antagonists prove therapeutic in migraine? *Trends Pharmacol. Sci.* **23**: 51-3 [PMID:11830255]
24. Bullock CM, Wookey P, Bennett A, Mobasheri A, Dickerson I and Kelly S. (2014) Peripheral calcitonin gene-related peptide receptor activation and mechanical sensitization of the joint in rat models of osteoarthritis pain. *Arthritis Rheumatol* **66**: 2188-200 [PMID:24719311]
25. Bühlmann N, Leuthäuser K, Muff R, Fischer JA and Born W. (1999) A receptor activity modifying protein (RAMP)2-dependent adrenomedullin receptor is a calcitonin gene-related peptide receptor when coexpressed with human RAMP1. *Endocrinology* **140**: 2883-90 [PMID:10342881]
26. Caron KM and Smithies O. (2001) Extreme hydrops fetalis and cardiovascular abnormalities in mice lacking a functional Adrenomedullin gene. *Proc. Natl. Acad. Sci. U.S.A.* **98**: 615-9 [PMID:11149956]
27. Chait A, Suaudeau C and De Beaurepaire R. (1995) Extensive brain mapping of calcitonin-induced anorexia. *Brain Res Bull* **36**: 467-472 [PMID:7712209]
28. Chambers TJ and Magnus CJ. (1982) Calcitonin alters behaviour of isolated osteoclasts *J. Pathol.* **136**: 27-39 [PMID:7057295]
29. Champion HC, Bivalacqua TJ, Pierce RL, Murphy WA, Coy DH, Hyman AL and Kadowitz PJ. (2003) Responses to human CGRP, ADM, and PAMP in human thymic arteries. *Am. J. Physiol. Regul. Integr. Comp. Physiol.* **284**: R531-7 [PMID:12529288]
30. Chausmer A, Stuart C and Stevens M. (1980) Identification of testicular cell plasma membrane receptors for calcitonin. *J. Lab. Clin. Med.* **96**: 933-8 [PMID:6252270]
31. Chausmer AB, Stevens MD and Severn C. (1982) Autoradiographic evidence for a calcitonin receptor on testicular Leydig cells. *Science* **216**: 735-6 [PMID:6281881]
32. Chiba T, Yamaguchi A, Yamatani T, Nakamura A, Morishita T, Inui T, Fukase M, Noda T and Fujita T. (1989) Calcitonin gene-related peptide receptor antagonist human CGRP-(8-37). *Am. J. Physiol.* **256**: E331-5 [PMID:2537579]
33. Christopoulos G, Perry KJ, Morfis M, Tilakaratne N, Gao Y, Fraser NJ, Main MJ, Foord SM and Sexton PM. (1999) Multiple amylin receptors arise from receptor activity-modifying protein interaction with the calcitonin receptor gene product. *Mol. Pharmacol.* **56**: 235-42 [PMID:10385705]
34. Clarke MV, Russell PK, Findlay DM, Sastra S, Anderson PH, Skinner JP, Atkins GJ, Zajac JD and Davey RA. (2015) A Role for the Calcitonin Receptor to Limit Bone Loss During Lactation in Female Mice by Inhibiting Osteocytic Osteolysis. *Endocrinology* **156**: 3203-14 [PMID:26135836]
35. Cohen DP, Nussenzveig DR and Gershengorn MC. (1996) Iodocalcitonin binds to human calcitonin receptors with higher affinity than calcitonin. *Endocrinology* **137**: 4507-10 [PMID:8828514]
36. Cooper GJ, Leighton B, Dimitriadis GD, Parry-Billings M, Kowalchuk JM, Howland K, Rothbard JB, Willis AC and Reid KB. (1988) Amylin found in amyloid deposits in human type 2 diabetes mellitus may be a hormone that regulates glycogen metabolism in skeletal muscle. *Proc. Natl. Acad. Sci. U.S.A.* **85**: 7763-6 [PMID:3051005]
37. Cooper GJ, Willis AC, Clark A, Turner RC, Sim RB and Reid KB. (1987) Purification and characterization of a peptide from amyloid-rich pancreases of type 2 diabetic patients. *Proc. Natl. Acad. Sci. U.S.A.* **84**: 8628-32 [PMID:3317417]
38. Cornish J, Callon KE, Lin CQ, Xiao CL, Gamble GD, Cooper GJ and Reid IR. (1999) Comparison of the effects of calcitonin gene-related peptide and amylin on osteoblasts. *J. Bone Miner. Res.* **14**: 1302-9 [PMID:10457262]
39. Dackor R, Fritz-Six K, Smithies O and Caron K. (2007) Receptor activity-modifying proteins 2 and 3 have distinct physiological functions from embryogenesis to old age. *J. Biol. Chem.* **282**: 18094-9 [PMID:17470425]
40. Dackor RT, Fritz-Six K, Dunworth WP, Gibbons CL, Smithies O and Caron KM. (2006) Hydrops fetalis, cardiovascular defects, and embryonic lethality in mice lacking the calcitonin receptor-like receptor gene.

Mol. Cell. Biol. **26**: 2511-8 [PMID:16537897]
41. Dacquin R, Davey RA, Laplace C, Levasseur R, Morris HA, Goldring SR, Gebre-Medhin S, Galson DL, Zajac JD and Karsenty G. (2004) Amylin inhibits bone resorption while the calcitonin receptor controls bone formation in vivo. *J. Cell Biol.* **164**: 509-14 [PMID:14970190]
42. Davey RA, Turner A, McManus JF, Chiu WS, Tjahyono F, Moore AJ, Atkins GJ, Anderson PH, Ma C, Glatt V, Maclean HE, Vincent C, Bouxsein M, Morris HA, Findlay DM and Zajac JD. (2008) The Calcitonin Receptor Plays a Physiological Role to Protect Against Hypercalcemia in Mice. *J Bone Miner Res* **8**: 1182-1193 [PMID:18627265]
43. Dennis T, Fournier A, St Pierre S and Quirion R. (1989) Structure-activity profile of calcitonin gene-related peptide in peripheral and brain tissues. Evidence for receptor multiplicity. *J. Pharmacol. Exp. Ther.* **251**: 718-25 [PMID:2553933]
44. Devesa I, Ferrándiz-Huertas C, Mathivanan S, Wolf C, Luján R, Changeux JP and Ferrer-Montiel A. (2014) αCGRP is essential for algesic exocytotic mobilization of TRPV1 channels in peptidergic nociceptors. *Proc. Natl. Acad. Sci. U.S.A.* **111**: 18345-50 [PMID:25489075]
45. Dong M, Cox RF and Miller LJ. (2009) Juxtamembranous region of the amino terminus of the family B G protein-coupled calcitonin receptor plays a critical role in small-molecule agonist action. *J. Biol. Chem.* **284**: 21839-47 [PMID:19447889]
46. Doods H, Hallermayer G, Wu D, Entzeroth M, Rudolf K, Engel W and Eberlein W. (2000) Pharmacological profile of BIBN4096BS, the first selective small molecule CGRP antagonist. *Br. J. Pharmacol.* **129**: 420-3 [PMID:10711339]
47. Edvinsson L, Gulbenkian S, Barroso CP, Cunha e Sá M, Polak JM, Mortensen A, Jørgensen L and Jansen-Olesen I. (1998) Innervation of the human middle meningeal artery: immunohistochemistry, ultrastructure, and role of endothelium for vasomotility. *Peptides* **19**: 1213-25 [PMID:9786171]
48. Edvinsson L, Sams A, Jansen-Olesen I, Tajti J, Kane SA, Rutledge RZ, Koblan KS, Hill RG and Longmore J. (2001) Characterisation of the effects of a non-peptide CGRP receptor antagonist in SK-N-MC cells and isolated human cerebral arteries. *Eur. J. Pharmacol.* **415**: 39-44 [PMID:11245850]
49. Evans BN, Rosenblatt MI, Mnayer LO, Oliver KR and Dickerson IM. (2000) CGRP-RCP, a novel protein required for signal transduction at calcitonin gene-related peptide and adrenomedullin receptors. *J. Biol. Chem.* **275**: 31438-43 [PMID:10903324]
50. Felsenfeld AJ and Levine BS. (2015) Calcitonin, the forgotten hormone: does it deserve to be forgotten? *Clin Kidney J* **8**: 180-7 [PMID:25815174]
51. Fraser NJ, Wise A, Brown J, McLatchie LM, Main MJ and Foord SM. (1999) The amino terminus of receptor activity modifying proteins is a critical determinant of glycosylation state and ligand binding of calcitonin receptor-like receptor. *Mol Pharmacol.* **55**: 1054-1059 [PMID:10347248]
52. Fritz-Six KL, Dunworth WP, Li M and Caron KM. (2008) Adrenomedullin signaling is necessary for murine lymphatic vascular development. *J. Clin. Invest.* **118**: 40-50 [PMID:18097475]
53. Galvin RJ, Bryan P, Venugopalan M, Smith DP and Thomas JE. (1998) Calcitonin responsiveness and receptor expression in porcine and murine osteoclasts: a comparative study. *Bone* **23**: 233-40 [PMID:9737345]
54. Gebre-Medhin S, Mulder H, Pekny M, Westermark G, Törnell J, Westermark P, Sundler F, Ahrén B and Betsholtz C. (1998) Increased insulin secretion and glucose tolerance in mice lacking islet amyloid polypeptide (amylin). *Biochem. Biophys. Res. Commun.* **250**: 271-7 [PMID:9753619]
55. Gingell JJ, Burns ER and Hay DL. (2014) Activity of pramlintide, rat and human amylin but not Aβ1-42 at human amylin receptors. *Endocrinology* **155**: 21-6 [PMID:24169554]
56. Gorn AH, Lin HY, Yamin M, Auron PE, Flannery MR, Tapp DR, Manning CA, Lodish HF, Krane SM and Goldring SR. (1992) Cloning, characterization, and expression of a human calcitonin receptor from an ovarian carcinoma cell line. *J. Clin. Invest.* **90**: 1726-35 [PMID:1331173]
57. Gorn AH, Rudolph SM, Flannery MR, Morton CC, Weremowicz S, Wang TZ, Krane SM and Goldring SR. (1995) Expression of two human skeletal calcitonin receptor isoforms cloned from a giant cell tumor of bone. The first intracellular domain modulates ligand binding and signal transduction. *J Clin Invest.* **95**:

2680-2691 [PMID:7769107]
58. Han SP, Naes L and Westfall TC. (1990) Calcitonin gene-related peptide is the endogenous mediator of nonadrenergic-noncholinergic vasodilation in rat mesentery. *J. Pharmacol. Exp. Ther.* **255**: 423-8 [PMID:2243334]
59. Hay DL. (2007) What makes a CGRP2 receptor?*Clin. Exp. Pharmacol. Physiol.* **34**: 963-71 [PMID:17714080]
60. Hay DL. (2018) CGRP Receptor Biology: Is There More Than One Receptor?*Handb Exp Pharmacol* [PMID:29797087]
61. Hay DL, Chen S, Lutz TA, Parkes DG and Roth JD. (2015) Amylin: Pharmacology, Physiology, and Clinical Potential. *Pharmacol. Rev.* **67**: 564-600 [PMID:26071095]
62. Hay DL, Christopoulos G, Christopoulos A, Poyner DR and Sexton PM. (2005) Pharmacological discrimination of calcitonin receptor: receptor activity-modifying protein complexes. *Mol. Pharmacol.* **67**: 1655-65 [PMID:15692146]
63. Hay DL, Christopoulos G, Christopoulos A and Sexton PM. (2006) Determinants of 1-piperidinecarboxamide, N-[2-[[5-amino-l-[[4-(4-pyridinyl)-l-piperazinyl]carbonyl]pentyl]amino]-1-[(3,5-dibromo-4-hydroxyphenyl)methyl]-2-oxoethyl]-4-(1,4-dihydro-2-oxo-3(2H)-quinazolinyl) (BIBN4096BS) affinity for calcitonin gene-related peptide and amylin receptors--the role of receptor activity modifying protein 1. *Mol Pharmacol* **70**: 1984-1991 [PMID:16959943]
64. Hay DL, Conner AC, Howitt SG, Takhshid MA, Simms J, Mahmoud K and Poyner DR. (2004) The pharmacology of CGRP-responsive receptors in cultured and transfected cells. *Peptides.* **25**: 2019-2026 [PMID:15501536]
65. Hay DL, Howitt SG, Conner AC, Schindler M, Smith DM and Poyner DR. (2003) CL/RAMP2 and CL/RAMP3 produce pharmacologically distinct adrenomedullin receptors: a comparison of effects of adrenomedullin22-52, CGRP8-37 and BIBN4096BS. *Br. J. Pharmacol.* **140**: 477-86 [PMID:12970090]
66. Hay DL and Pioszak AA. (2016) Receptor Activity-Modifying Proteins (RAMPs): New Insights and Roles. *Annu. Rev. Pharmacol. Toxicol.* **56**: 469-87 [PMID:26514202]
67. Hay DL, Poyner DR, Quirion R and International Union of Pharmacology. (2008) International Union of Pharmacology. LXIX. Status of the calcitonin gene-related peptide subtype 2 receptor. *Pharmacol. Rev.* **60**: 143-5 [PMID:18552275]
68. Hay DL, Poyner DR and Sexton PM. (2006) GPCR modulation by RAMPs.*Pharmacol. Ther.* **109**: 173-97 [PMID:16111761]
69. Haynes JM and Cooper ME. (1995) Adrenomedullin and calcitonin gene-related peptide in the rat isolated kidney and in the anaesthetised rat: in vitro and in vivo effects. *Eur. J. Pharmacol.* **280**: 91-4 [PMID:7498258]
70. Hilton JM, Dowton M, Houssami S and Sexton PM. (2000) Identification of key components in the irreversibility of salmon calcitonin binding to calcitonin receptors. *J. Endocrinol.* **166**: 213-26 [PMID:10856900]
71. Hinson JP, Kapas S and Smith DM. (2000) Adrenomedullin, a multifunctional regulatory peptide.*Endocr. Rev.* **21**: 138-67 [PMID:10782362]
72. Hoare SR. (2005) Mechanisms of peptide and nonpeptide ligand binding to Class B G-protein-coupled receptors. *Drug Discov. Today* **10**: 417-27 [PMID:15808821]
73. Hong Y, Hay DL, Quirion R and Poyner DR. (2012) The pharmacology of adrenomedullin 2/intermedin.*Br. J. Pharmacol.* **166**: 110-20 [PMID:21658025]
74. Hoshiya H, Meguro M, Kashiwagi A, Okita C and Oshimura M. (2003) Calcr, a brain-specific imprinted mouse calcitonin receptor gene in the imprinted cluster of the proximal region of chromosome 6. *J. Hum. Genet.* **48**: 208-11 [PMID:12730726]
75. Husmann K, Born W, Fischer JA and Muff R. (2003) Three receptor-activity-modifying proteins define calcitonin gene-related peptide or adrenomedullin selectivity of the mouse calcitonin-like receptor in COS-7 cells. *Biochem. Pharmacol.* **66**: 2107-15 [PMID:14609735]
76. Husmann K, Sexton PM, Fischer JA and Born W. (2000) Mouse receptor-activity-modifying proteins 1, -2

and -3: amino acid sequence, expression and function. *Mol. Cell. Endocrinol.* **162**: 35-43 [PMID:10854696]
77. Ichikawa I and Brenner BM. (1976) Of unglazed pottery and glomerular sieving.*Kidney Int.* **10**: 264-7 [PMID:787620]
78. Ichikawa-Shindo Y, Sakurai T, Kamiyoshi A, Kawate H, Iinuma N, Yoshizawa T, Koyama T, Fukuchi J, Iimuro S and Moriyama N *et al.*. (2008) The GPCR modulator protein RAMP2 is essential for angiogenesis and vascular integrity. *J. Clin. Invest.* **118**: 29-39 [PMID:18097473]
79. Igarashi K, Sakurai T, Kamiyoshi A, Ichikawa-Shindo Y, Kawate H, Yamauchi A, Toriyama Y, Tanaka M, Liu T and Xian X *et al.*. (2014) Pathophysiological roles of adrenomedullin-RAMP2 system in acute and chronic cerebral ischemia. *Peptides* **62**: 21-31 [PMID:25252154]
80. Joshi P, Anderson C, Binch H, Hadida S, Yoo S, Bergeron D, Decker C, terHaar E, Moore J and Garcia-Guzman M *et al.*. (2014) Identification of potent CNS-penetrant thiazolidinones as novel CGRP receptor antagonists. *Bioorg. Med. Chem. Lett.* **24**: 845-9 [PMID:24405707]
81. Jusek G, Reim D, Tsujikawa K and Holzmann B. (2012) Deficiency of the CGRP receptor component RAMP1 attenuates immunosuppression during the early phase of septic peritonitis. *Immunobiology* **217**: 761-7 [PMID:22656887]
82. Kahn ML. (2008) Blood is thicker than lymph.*J. Clin. Invest.* **118**: 23-6 [PMID:18097477]
83. Kano H, Kohno M, Yasunari K, Yokokawa K, Horio T, Ikeda M, Minami M, Hanehira T, Takeda T and Yoshikawa J. (1996) Adrenomedullin as a novel antiproliferative factor of vascular smooth muscle cells. *J. Hypertens.* **14**: 209-13 [PMID:8728298]
84. Kapoor K, Arulmani U, Heiligers JP, Garrelds IM, Willems EW, Doods H, Villalón CM and Saxena PR. (2003) Effects of the CGRP receptor antagonist BIBN4096BS on capsaicin-induced carotid haemodynamic changes in anaesthetised pigs. *Br. J. Pharmacol.* **140**: 329-38 [PMID:12970078]
85. Kapoor K, Arulmani U, Heiligers JP, Willems EW, Doods H, Villalón CM and Saxena PR. (2003) Effects of BIBN4096BS on cardiac output distribution and on CGRP-induced carotid haemodynamic responses in the pig. *Eur. J. Pharmacol.* **475**: 69-77 [PMID:12954361]
86. Katafuchi T, Hamano K, Kikumoto K and Minamino N. (2003) Identification of second and third calcitonin receptor-stimulating peptides in porcine brain. *Biochem. Biophys. Res. Commun.* **308**: 445-51 [PMID:12914769]
87. Katafuchi T, Kikumoto K, Hamano K, Kangawa K, Matsuo H and Minamino N. (2003) Calcitonin receptor-stimulating peptide, a new member of the calcitonin gene-related peptide family. Its isolation from porcine brain, structure, tissue distribution, and biological activity. *J. Biol. Chem.* **278**: 12046-54 [PMID:12556539]
88. Kiriyama Y, Tsuchiya H, Murakami T, Satoh K and Tokumitsu Y. (2001) Calcitonin induces IL-6 production via both PKA and PKC pathways in the pituitary folliculo-stellate cell line. *Endocrinology* **142**: 3563-9 [PMID:11459804]
89. Kitamura K, Kangawa K, Kawamoto M, Ichiki Y, Nakamura S, Matsuo H and Eto T. (1993) Adrenomedullin: a novel hypotensive peptide isolated from human pheochromocytoma. *Biochem. Biophys. Res. Commun.* **192**: 553-60 [PMID:8387282]
90. Kurashige C, Hosono K, Matsuda H, Tsujikawa K, Okamoto H and Majima M. (2014) Roles of receptor activity-modifying protein 1 in angiogenesis and lymphangiogenesis during skin wound healing in mice. *FASEB J.* **28**: 1237-47 [PMID:24308973]
91. Kusano S, Kukimoto-Niino M, Akasaka R, Toyama M, Terada T, Shirouzu M, Shindo T and Yokoyama S. (2008) Crystal structure of the human receptor activity-modifying protein 1 extracellular domain. *Protein Sci.* **17**: 1907-14 [PMID:18725456]
92. Kusano S, Kukimoto-Niino M, Hino N, Ohsawa N, Okuda K, Sakamoto K, Shirouzu M, Shindo T and Yokoyama S. (2012) Structural basis for extracellular interactions between calcitonin receptor-like receptor and receptor activity-modifying protein 2 for adrenomedullin-specific binding. *Protein Sci.* **21**: 199-210 [PMID:22102369]
93. Kuwasako K, Cao YN, Nagoshi Y, Tsuruda T, Kitamura K and Eto T. (2004) Characterization of the human calcitonin gene-related peptide receptor subtypes associated with receptor activity-modifying proteins. *Mol. Pharmacol.* **65**: 207-13 [PMID:14722252]

94. Kuwasako K, Kitamura K, Nagoshi Y and Eto T. (2003) Novel calcitonin-(8-32)-sensitive adrenomedullin receptors derived from co-expression of calcitonin receptor with receptor activity-modifying proteins. *Biochem. Biophys. Res. Commun.* **301**: 460-4 [PMID:12565884]
95. Leighton B and Cooper GJ. (1988) Pancreatic amylin and calcitonin gene-related peptide cause resistance to insulin in skeletal muscle in vitro. *Nature* **335**: 632-5 [PMID:3050530]
96. Leuthauser K, Gujer R, Aldecoa A, McKinney RA, Muff R, Fischer JA and Born W. (2000) Receptor-activity-modifying protein 1 forms heterodimers with two G-protein-coupled receptors to define ligand recognition. *Biochem J.* **351**: 347-351 [PMID:11023820]
97. Lin HY, Harris TL, Flannery MS, Aruffo A, Kaji EH, Gorn A, Kolakowski Jr LF, Lodish HF and Goldring SR. (1991) Expression cloning of an adenylate cyclase-coupled calcitonin receptor. *Science* **254**: 1022-4 [PMID:1658940]
98. Lutz TA. (2006) Amylinergic control of food intake.*Physiol. Behav.* **89**: 465-71 [PMID:16697020]
99. Main MJ, Brown J, Brown S, Fraser NJ and Foord SM. (1998) The CGRP receptor can couple via pertussis toxin sensitive and insensitive G proteins. *FEBS Lett.* **441**: 6-10 [PMID:9877154]
100. Mallee JJ, Salvatore CA, LeBourdelles B, Oliver KR, Longmore J, Koblan KS and Kane SA. (2002) Receptor activity-modifying protein 1 determines the species selectivity of non-peptide CGRP receptor antagonists. *J. Biol. Chem.* **277**: 14294-8 [PMID:11847213]
101. Martínez V, Cuttitta F and Taché Y. (1997) Central action of adrenomedullin to inhibit gastric emptying in rats. *Endocrinology* **138**: 3749-55 [PMID:9275061]
102. Masi L, Becherini L, Gennari L, Colli E, Mansani R, Falchetti A, Cepollaro C, Gonnelli S, Tanini A and Brandi ML. (1998) Allelic variants of human calcitonin receptor: distribution and association with bone mass in postmenopausal Italian women. *Biochem. Biophys. Res. Commun.* **245**: 622-6 [PMID:9571205]
103. McLatchie LM, Fraser NJ, Main MJ, Wise A, Brown J, Thompson N, Solari R, Lee MG and Foord SM. (1998) RAMPs regulate the transport and ligand specificity of the calcitonin-receptor-like receptor. *Nature* **393**: 333-9 [PMID:9620797]
104. Mikami N, Watanabe K, Hashimoto N, Miyagi Y, Sueda K, Fukada S, Yamamoto H and Tsujikawa K. (2012) Calcitonin gene-related peptide enhances experimental autoimmune encephalomyelitis by promoting Th17-cell functions. *Int. Immunol.* **24**: 681-91 [PMID:22843730]
105. Mitsikostas DD and Rapoport AM. (2015) New players in the preventive treatment of migraine.*BMC Med* **13**: 279 [PMID:26555040]
106. Mogil JS, Miermeister F, Seifert F, Strasburg K, Zimmermann K, Reinold H, Austin JS, Bernardini N, Chesler EJ, Hofmann HA, Hordo C, Messlinger K, Nemmani KV, Rankin AL, Ritchie J, Siegling A, Smith SB, Sotocinal S, Vater A, Lehto SG, Klussmann S, Quirion R, Michaelis M, Devor M and Reeh PW. (2005) Variable sensitivity to noxious heat is mediated by differential expression of the CGRP gene. *Proc Natl Acad Sci U S A* **102**: 12938-12943 [PMID:16118273]
107. Moore EL and Salvatore CA. (2012) Targeting a family B GPCR/RAMP receptor complex: CGRP receptor antagonists and migraine. *Br. J. Pharmacol.* **166**: 66-78 [PMID:21871019]
108. Morfis M, Tilakaratne N, Furness SG, Christopoulos G, Werry TD, Christopoulos A and Sexton PM. (2008) Receptor activity-modifying proteins differentially modulate the G protein-coupling efficiency of amylin receptors. *Endocrinology* **149**: 5423-31 [PMID:18599553]
109. Muff R, Bühlmann N, Fischer JA and Born W. (1999) An amylin receptor is revealed following co-transfection of a calcitonin receptor with receptor activity modifying proteins-1 or -3. *Endocrinology* **140**: 2924-7 [PMID:10342886]
110. Mulderry PK, Ghatei MA, Spokes RA, Jones PM, Pierson AM, Hamid QA, Kanse S, Amara SG, Burrin JM and Legon S *et al.*. (1988) Differential expression of alpha-CGRP and beta-CGRP by primary sensory neurons and enteric autonomic neurons of the rat. *Neuroscience* **25**: 195-205 [PMID:2839796]
111. Nakamura M, Zhang ZQ, Shan L, Hisa T, Sasaki M, Tsukino R, Yokoi T, Kaname A and Kakudo K. (1997) Allelic variants of human calcitonin receptor in the Japanese population. *Hum. Genet.* **99**: 38-41 [PMID:9003491]
112. Nakamuta H, Fukuda Y, Koida M, Fujii N, Otaka A, Funakoshi S, Yajima H, Mitsuyasu N and Orlowski RC.

(1986) Binding sites of calcitonin gene-related peptide (CGRP): abundant occurrence in visceral organs. *Jpn. J. Pharmacol.* **42**: 175-80 [PMID:3025489]

113. Nishimatsu H, Suzuki E, Nagata D, Moriyama N, Satonaka H, Walsh K, Sata M, Kangawa K, Matsuo H and Goto A *et al.*. (2001) Adrenomedullin induces endothelium-dependent vasorelaxation via the phosphatidylinositol 3-kinase/Akt-dependent pathway in rat aorta. *Circ. Res.* **89**: 63-70 [PMID:11440979]
114. Nodin C, Vauquelin G and von Mentzer B. (2005) Cys2,7EtalphaCGRP is a potent agonist for CGRP1 receptors in SK-N-MC cells. *Biochem. Pharmacol.* **69**: 1235-40 [PMID:15794944]
115. Offermanns S, Iida-Klein A, Segre GV and Simon MI. (1996) G alpha q family members couple parathyroid hormone (PTH)/PTH-related peptide and calcitonin receptors to phospholipase C in COS-7 cells. *Mol. Endocrinol.* **10**: 566-74 [PMID:8732687]
116. Oliver KR, Kane SA, Salvatore CA, Mallee JJ, Kinsey AM, Koblan KS, Keyvan-Fouladi N, Heavens RP, Wainwright A and Jacobson M *et al.*. (2001) Cloning, characterization and central nervous system distribution of receptor activity modifying proteins in the rat. *Eur. J. Neurosci.* **14**: 618-28 [PMID:11556887]
117. Owji AA, Smith DM, Coppock HA, Morgan DG, Bhogal R, Ghatei MA and Bloom SR. (1995) An abundant and specific binding site for the novel vasodilator adrenomedullin in the rat. *Endocrinology* **136**: 2127-34 [PMID:7720662]
118. Parameswaran N, Disa J, Spielman WS, Brooks DP, Nambi P and Aiyar N. (2000) Activation of multiple mitogen-activated protein kinases by recombinant calcitonin gene-related peptide receptor. *Eur. J. Pharmacol.* **389**: 125-30 [PMID:10688975]
119. Petersen KA, Birk S, Lassen LH, Kruuse C, Jonassen O, Lesko L and Olesen J. (2005) The CGRP-antagonist, BIBN4096BS does not affect cerebral or systemic haemodynamics in healthy volunteers. *Cephalalgia* **25**: 139-47 [PMID:15658951]
120. Pham V, Wade JD, Purdue BW and Sexton PM. (2004) Spatial proximity between a photolabile residue in position 19 of salmon calcitonin and the amino terminus of the human calcitonin receptor. *J. Biol. Chem.* **279**: 6720-9 [PMID:14623894]
121. Piao FL, Cao C, Han JH, Kim SZ, Cho KW and Kim SH. (2004) Amylin-induced suppression of ANP secretion through receptors for CGRP1 and salmon calcitonin. *Regul Pept* **117**: 159-166 [PMID:14749035]
122. Poyner DR, Sexton PM, Marshall I, Smith DM, Quirion R, Born W, Muff R, Fischer JA and Foord SM. (2002) International Union of Pharmacology. XXXII. The mammalian calcitonin gene-related peptides, adrenomedullin, amylin, and calcitonin receptors. *Pharmacol. Rev.* **54**: 233-46 [PMID:12037140]
123. Purdue BW, Tilakaratne N and Sexton PM. (2002) Molecular pharmacology of the calcitonin receptor. *Recept. Channels* **8**: 243-55 [PMID:12529940]
124. Pérez Jurado LA, Li X and Francke U. (1995) The human calcitonin receptor gene (CALCR) at 7q21.3 is outside the deletion associated with the Williams syndrome. *Cytogenet. Cell Genet.* **70**: 246-9 [PMID:7789182]
125. Qi T, Dong M, Watkins HA, Wootten D, Miller LJ and Hay DL. (2013) Receptor activity-modifying protein-dependent impairment of calcitonin receptor splice variant Δ(1-47)hCT((a)) function. *Br. J. Pharmacol.* **168**: 644-57 [PMID:22946511]
126. Qing X and Keith IM. (2003) Targeted blocking of gene expression for CGRP receptors elevates pulmonary artery pressure in hypoxic rats. *Am. J. Physiol. Lung Cell Mol. Physiol.* **285**: L86-96 [PMID:12626334]
127. Quigley A, Pike ACW, Burgess-Brown N, Krojer T, Shrestha L, Goubin S, Kim J, Das S, Muniz JRC, Canning P, Chaikuad A, Vollmar M, Von Delft F, Arrowsmith CH, Weigelt J, Edwards AM, Bountra C, Barr AJ and Carpenter EP. Structure of the Extracellular Domain of Human Ramp2.
128. Roh J, Chang CL, Bhalla A, Klein C and Hsu SY. (2004) Intermedin is a calcitonin/calcitonin gene-related peptide family peptide acting through the calcitonin receptor-like receptor/receptor activity-modifying protein receptor complexes. *J. Biol. Chem.* **279**: 7264-74 [PMID:14615490]
129. Roth JD, Erickson MR, Chen S and Parkes DG. (2012) GLP-1R and amylin agonism in metabolic disease: complementary mechanisms and future opportunities. *Br. J. Pharmacol.* **166**: 121-36 [PMID:21671898]
130. Russell FA, King R, Smillie SJ, Kodji X and Brain SD. (2014) Calcitonin gene-related peptide: physiology

and pathophysiology. *Physiol. Rev.* **94**: 1099-142 [PMID:25287861]

131. Saetrum Opgaard O, Hasbak P, de Vries R, Saxena PR and Edvinsson L. (2000) Positive inotropy mediated via CGRP receptors in isolated human myocardial trabeculae. *Eur. J. Pharmacol.* **397**: 373-82 [PMID:10844137]
132. Salvatore CA, Hershey JC, Corcoran HA, Fay JF, Johnston VK, Moore EL, Mosser SD, Burgey CS, Paone DV and Shaw AW *et al.*. (2008) Pharmacological characterization of MK-0974 [N-[(3R,6S)-6-(2,3-difluorophenyl)-2-oxo-1-(2,2,2-trifluoroethyl)azepan-3-yl]-4-(2-oxo-2,3-dihydro-1H-imidazo[4,5-b]pyridin-1-yl)piperidine-1-carboxamide], a potent and orally active calcitonin gene-related peptide receptor antagonist for the treatment of migraine. *J. Pharmacol. Exp. Ther.* **324**: 416-21 [PMID:18039958]
133. Schütz B, Mauer D, Salmon AM, Changeux JP and Zimmer A. (2004) Analysis of the cellular expression pattern of beta-CGRP in alpha-CGRP-deficient mice. *J. Comp. Neurol.* **476**: 32-43 [PMID:15236465]
134. Sexton PM, Houssami S, Hilton JM, O'Keeffe LM, Center RJ, Gillespie MT, Darcy P and Findlay DM. (1993) Identification of brain isoforms of the rat calcitonin receptor. *Mol. Endocrinol.* **7**: 815-21 [PMID:8395656]
135. Sheward WJ, Lutz EM and Harmar AJ. (1994) The expression of the calcitonin receptor gene in the brain and pituitary gland of the rat. *Neurosci. Lett.* **181**: 31-4 [PMID:7898764]
136. Shi L, Lehto SG, Zhu DX, Sun H, Zhang J, Smith BP, Immke DC, Wild KD and Xu C. (2016) Pharmacologic Characterization of AMG 334, a Potent and Selective Human Monoclonal Antibody against the Calcitonin Gene-Related Peptide Receptor. *J. Pharmacol. Exp. Ther.* **356**: 223-31 [PMID:26559125]
137. Shindo T, Kurihara Y, Nishimatsu H, Moriyama N, Kakoki M, Wang Y, Imai Y, Ebihara A, Kuwaki T and Ju KH *et al.*. (2001) Vascular abnormalities and elevated blood pressure in mice lacking adrenomedullin gene. *Circulation* **104**: 1964-71 [PMID:11602502]
138. Smillie SJ and Brain SD. (2011) Calcitonin gene-related peptide (CGRP) and its role in hypertension. *Neuropeptides* **45**: 93-104 [PMID:21269690]
139. Taboulet J, Frenkian M, Frendo JL, Feingold N, Jullienne A and de Vernejoul MC. (1998) Calcitonin receptor polymorphism is associated with a decreased fracture risk in post-menopausal women. *Hum. Mol. Genet.* **7**: 2129-33 [PMID:9817931]
140. Takei Y, Inoue K, Ogoshi M, Kawahara T, Bannai H and Miyano S. (2004) Identification of novel adrenomedullin in mammals: a potent cardiovascular and renal regulator. *FEBS Lett.* **556**: 53-8 [PMID:14706825]
141. Tam CW, Husmann K, Clark NC, Clark JE, Lazar Z, Ittner LM, Götz J, Douglas G, Grant AD and Sugden D *et al.*. (2006) Enhanced vascular responses to adrenomedullin in mice overexpressing receptor-activity-modifying protein 2. *Circ. Res.* **98**: 262-70 [PMID:16373602]
142. Taylor GM, Meeran K, O'Shea D, Smith DM, Ghatei MA and Bloom SR. (1996) Adrenomedullin inhibits feeding in the rat by a mechanism involving calcitonin gene-related peptide receptors. *Endocrinology* **137**: 3260-4 [PMID:8754748]
143. ter Haar E, Koth CM, Abdul-Manan N, Swenson L, Coll JT, Lippke JA, Lepre CA, Garcia-Guzman M and Moore JM. (2010) Crystal structure of the ectodomain complex of the CGRP receptor, a class-B GPCR, reveals the site of drug antagonism. *Structure* **18**: 1083-93 [PMID:20826335]
144. Tilakaratne N, Christopoulos G, Zumpe ET, Foord SM and Sexton PM. (2000) Amylin receptor phenotypes derived from human calcitonin receptor/RAMP coexpression exhibit pharmacological differences dependent on receptor isoform and host cell environment. *J. Pharmacol. Exp. Ther.* **294**: 61-72 [PMID:10871296]
145. Tsujikawa K, Yayama K, Hayashi T, Matsushita H, Yamaguchi T, Shigeno T, Ogitani Y, Hirayama M, Kato T and Fukada S *et al.*. (2007) Hypertension and dysregulated proinflammatory cytokine production in receptor activity-modifying protein 1-deficient mice. *Proc. Natl. Acad. Sci. U.S.A.* **104**: 16702-7 [PMID:17923674]
146. Uetake R, Sakurai T, Kamiyoshi A, Ichikawa-Shindo Y, Kawate H, Iesato Y, Yoshizawa T, Koyama T, Yang L and Toriyama Y *et al.*. (2014) Adrenomedullin-RAMP2 system suppresses ER stress-induced tubule cell death and is involved in kidney protection. *PLoS ONE* **9**: e87667 [PMID:24505304]

147. Uezono Y, Nakamura E, Ueda Y, Shibuya I, Ueta Y, Yokoo H, Yanagita T, Toyohira Y, Kobayashi H and Yanagihara N *et al.*. (2001) Production of cAMP by adrenomedullin in human oligodendroglial cell line KG1C: comparison with calcitonin gene-related peptide and amylin. *Brain Res. Mol. Brain Res.* **97**: 59-69 [PMID:11744163]
148. Upton PD, Austin C, Taylor GM, Nandha KA, Clark AJ, Ghatei MA, Bloom SR and Smith DM. (1997) Expression of adrenomedullin (ADM) and its binding sites in the rat uterus: increased number of binding sites and ADM messenger ribonucleic acid in 20-day pregnant rats compared with nonpregnant rats. *Endocrinology* **138**: 2508-14 [PMID:9165042]
149. Venkatanarayan A, Raulji P, Norton W, Chakravarti D, Coarfa C, Su X, Sandur SK, Ramirez MS, Lee J and Kingsley CV *et al.*. (2015) IAPP-driven metabolic reprogramming induces regression of p53-deficient tumours in vivo. *Nature* **517**: 626-30 [PMID:25409149]
150. Villa I, Melzi R, Pagani F, Ravasi F, Rubinacci A and Guidobono F. (2000) Effects of calcitonin gene-related peptide and amylin on human osteoblast-like cells proliferation. *Eur J Pharmacol* **409**: 273-278 [PMID:11108821]
151. Walker CS, Conner AC, Poyner DR and Hay DL. (2010) Regulation of signal transduction by calcitonin gene-related peptide receptors. *Trends Pharmacol. Sci.* **31**: 476-83 [PMID:20633935]
152. Walker CS, Eftekhari S, Bower RL, Wilderman A, Insel PA, Edvinsson L, Waldvogel HJ, Jamaluddin MA, Russo AF and Hay DL. (2015) A second trigeminal CGRP receptor: function and expression of the AMY1 receptor. *Ann Clin Transl Neurol* **2**: 595-608 [PMID:26125036]
153. Walker CS and Hay DL. (2013) CGRP in the trigeminovascular system: a role for CGRP, adrenomedullin and amylin receptors? *Br. J. Pharmacol.* **170**: 1293-307 [PMID:23425327]
154. Walker CS, Li X, Whiting L, Glyn-Jones S, Zhang S, Hickey AJ, Sewell MA, Ruggiero K, Phillips AR and Kraegen EW *et al.*. (2010) Mice lacking the neuropeptide alpha-calcitonin gene-related peptide are protected against diet-induced obesity. *Endocrinology* **151**: 4257-69 [PMID:20610563]
155. Wang Z, Martorell BC, Wälchli T, Vogel O, Fischer J, Born W and Vogel J. (2015) Calcitonin gene-related peptide (CGRP) receptors are important to maintain cerebrovascular reactivity in chronic hypertension. *PLoS ONE* **10**: e0123697 [PMID:25860809]
156. Warshawsky H, Goltzman D, Rouleau MF and Bergeron JJ. (1980) Direct in vivo demonstration by radioautography of specific binding sites for calcitonin in skeletal and renal tissues of the rat. *J. Cell Biol.* **85**: 682-94 [PMID:7391137]
157. Wolfe 3rd LA, Fling ME, Xue Z, Armour S, Kerner SA, Way J, Rimele T and Cox RF. (2003) In vitro characterization of a human calcitonin receptor gene polymorphism. *Mutat. Res.* **522**: 93-105 [PMID:12517415]
158. Wunder F, Rebmann A, Geerts A and Kalthof B. (2008) Pharmacological and kinetic characterization of adrenomedullin 1 and calcitonin gene-related peptide 1 receptor reporter cell lines. *Mol. Pharmacol.* **73**: 1235-43 [PMID:18174292]
159. Yamaguchi M. (1991) Stimulatory effect of calcitonin on Ca2+ inflow in isolated rat hepatocytes.*Mol. Cell. Endocrinol.* **75**: 65-70 [PMID:1646739]
160. Yamaguchi M, Watanabe Y, Ohtani T, Uezumi A, Mikami N, Nakamura M, Sato T, Ikawa M, Hoshino M and Tsuchida K *et al.*. (2015) Calcitonin Receptor Signaling Inhibits Muscle Stem Cells from Escaping the Quiescent State and the Niche. *Cell Rep* **13**: 302-14 [PMID:26440893]
161. Yamauchi A, Sakurai T, Kamiyoshi A, Ichikawa-Shindo Y, Kawate H, Igarashi K, Toriyama Y, Tanaka M, Liu T and Xian X *et al.*. (2014) Functional differentiation of RAMP2 and RAMP3 in their regulation of the vascular system. *J. Mol. Cell. Cardiol.* **77**: 73-85 [PMID:25264174]
162. Yamin M, Gorn AH, Flannery MR, Jenkins NA, Gilbert DJ, Copeland NG, Tapp DR, Krane SM and Goldring SR. (1994) Cloning and characterization of a mouse brain calcitonin receptor complementary deoxyribonucleic acid and mapping of the calcitonin receptor gene. *Endocrinology* **135**: 2635-43 [PMID:7988453]
163. Yoshizawa T, Sakurai T, Kamiyoshi A, Ichikawa-Shindo Y, Kawate H, Iesato Y, Koyama T, Uetake R, Yang L and Yamauchi A *et al.*. (2013) Novel regulation of cardiac metabolism and homeostasis by the

adrenomedullin-receptor activity-modifying protein 2 system. *Hypertension* **61**: 341-51 [PMID:23297372]

164. Young AA, Gedulin B, Gaeta LS, Prickett KS, Beaumont K, Larson E and Rink TJ. (1994) Selective amylin antagonist suppresses rise in plasma lactate after intravenous glucose in the rat. Evidence for a metabolic role of endogenous amylin. *FEBS Lett.* **343**: 237-41 [PMID:8174707]
165. Young AA, Gedulin B, Vine W, Percy A and Rink TJ. (1995) Gastric emptying is accelerated in diabetic BB rats and is slowed by subcutaneous injections of amylin. *Diabetologia* **38**: 642-8 [PMID:7672483]
166. Zhang Z, Liu X, Morgan DA, Kuburas A, Thedens DR, Russo AF and Rahmouni K. (2011) Neuronal receptor activity-modifying protein 1 promotes energy expenditure in mice. *Diabetes* **60**: 1063-71 [PMID:21357463]
167. Zhang Z, Winborn CS, Marquez de Prado B and Russo AF. (2007) Sensitization of calcitonin gene-related peptide receptors by receptor activity-modifying protein-1 in the trigeminal ganglion. *J. Neurosci.* **27**: 2693-703 [PMID:17344407]
168. Zimmermann U, Fluehmann B, Born W, Fischer JA and Muff R. (1997) Coexistence of novel amylin-binding sites with calcitonin receptors in human breast carcinoma MCF-7 cells. *J. Endocrinol.* **155**: 423-31 [PMID:9487987]