



UvA-DARE (Digital Academic Repository)

Gene expression in identified rat hippocampal neurons: Modulation by corticosteroids and stress

Qin, Y.J.

Publication date
2004

[Link to publication](#)

Citation for published version (APA):

Qin, Y. J. (2004). *Gene expression in identified rat hippocampal neurons: Modulation by corticosteroids and stress*.

General rights

It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations

If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: <https://uba.uva.nl/en/contact>, or a letter to: Library of the University of Amsterdam, Secretariat, Singel 425, 1012 WP Amsterdam, The Netherlands. You will be contacted as soon as possible.

References

- Abel HJ, Lee JC, Callaway JC, Fochring RC (2004) Relationships between intracellular calcium and afterhyperpolarizations in neocortical pyramidal neurons. *J Neurophysiol* 91:324-335.
- Adams M, Meijer OC, Wang J, Bhargava A, Pearce D (2003) Homodimerization of the glucocorticoid receptor is not essential for response element binding: activation of the phenylethanolamine N-methyltransferase gene by dimerization-defective mutants. *Mol Endocrinol* 17:2583-2592.
- Aguilera G, Rabadan-Diehl C (2000) Vasopressinergic regulation of the hypothalamic-pituitary-adrenal axis: implications for stress adaptation. *Regul Pept* 96:23-29.
- Ahima RS, Harlan RE (1991) Differential corticosteroid regulation of type II glucocorticoid receptor-like immunoreactivity in the rat central nervous system: topography and implications. *Endocrinology* 129:226-236.
- Ahlijanian MK, Westenbroek RE, Catterall WA (1990) Subunit structure and localization of dihydropyridine-sensitive calcium channels in mammalian brain, spinal cord, and retina. *Neuron* 4:819-832.
- Akana SF, Scribner KA, Bradbury MJ, Strack AM, Walker CD, Dallman MF (1992) Feedback sensitivity of the rat hypothalamo-pituitary-adrenal axis and its capacity to adjust to exogenous corticosterone. *Endocrinology* 131:585-594.
- Alfarez DN, Joels M, Krugers HJ (2003) Chronic unpredictable stress impairs long-term potentiation in rat hippocampal CA1 area and dentate gyrus in vitro. *Eur J Neurosci* 17:1928-1934.
- Alfarez DN, Wiegert O, Joels M, Krugers HJ (2002) Corticosterone and stress reduce synaptic potentiation in mouse hippocampal slices with mild stimulation. *Neuroscience* 115:1119-1126.
- Alfonso J, Pollevick GD, Van Der Hart MG, Flugge G, Fuchs E, Frasch AC (2004) Identification of genes regulated by chronic psychosocial stress and antidepressant treatment in the hippocampus. *Eur J Neurosci* 19:659-666.
- Almeida OF, Conde GL, Crochemore C, Demeneix BA, Fischer D, Hassan AH, Meyer M, Holsboer F, Michaelidis TM (2000) Subtle shifts in the ratio between pro- and antiapoptotic molecules after activation of corticosteroid receptors decide neuronal fate. *Faseb J* 14:779-790.
- Alvarez P, Zola-Morgan S, Squire LR (1995) Damage limited to the hippocampal region produces long-lasting memory impairment in monkeys. *J Neurosci* 15:3796-3807.
- Arriza JL, Weinberger C, Cerelli G, Glaser TM, Handelin BL, Housman DE, Evans RM (1987) Cloning of human mineralocorticoid receptor complementary DNA: structural and functional kinship with the glucocorticoid receptor. *Science* 237:268-275.
- Ascher P, Dieudonne S, Macdonald J, Sather W (1992) Kinetics of activation, deactivation and desensitization of the "NMDA" glutamate receptor. *C R Acad Sci III* 314:75-77.
- Bamberger CM, Bamberger AM, de Castro M, Chrousos GP (1995) Glucocorticoid receptor beta, a potential endogenous inhibitor of glucocorticoid action in humans. *J Clin Invest* 95:2435-2441.
- Barlow C, Lockhart DJ (2002) DNA arrays and neurobiology--what's new and what's next? *Curr Opin Neurobiol* 12:554-561.
- Barrett TJ, Spelsberg TC (1998) Steroid receptors at the nexus of transcriptional regulation. *J Cell Biochem Suppl* 30-31:185-193.
- Bartanusz V, Jezova D, Bertini LT, Tilders FJ, Aubry JM, Kiss JZ (1993) Stress-induced increase in vasopressin and corticotropin-releasing factor expression in hypophysiotrophic paraventricular neurons. *Endocrinology* 132:895-902.

- Bartlett JM (2002) Approaches to the analysis of gene expression using mRNA: a technical overview. *Mol Biotechnol* 21:149-160.
- Beato M, Sanchez-Pacheco A (1996) Interaction of steroid hormone receptors with the transcription initiation complex. *Endocr Rev* 17:587-609.
- Beato M, Arnemann J, Chalepakis G, Slater E, Willmann T (1987) Gene regulation by steroid hormones. *J Steroid Biochem* 27:9-14.
- Bekkers JM (2000) Distribution and activation of voltage-gated potassium channels in cell-attached and outside-out patches from large layer 5 cortical pyramidal neurons of the rat. *J Physiol* 525 Pt 3:611-620.
- Benson DF (1984) The neurology of human emotion. *Bull Clin Neurosci* 49:23-42.
- Berridge MJ (1998) Neuronal calcium signaling. *Neuron* 21:13-26.
- Bi WL, Keller-McGandy C, Standaert DG, Augood SJ (2002) Identification of nitric oxide synthase neurons for laser capture microdissection and mRNA quantification. *Biotechniques* 33:1274-1283.
- Bito H, Deisseroth K, Tsien RW (1997) Ca²⁺-dependent regulation in neuronal gene expression. *Curr Opin Neurobiol* 7:419-429.
- Blair LA, Marshall J (1997) IGF-1 modulates N and L calcium channels in a PI 3-kinase-dependent manner. *Neuron* 19:421-429.
- Blohm DH, Guiseppi-Elie A (2001) New developments in microarray technology. *Curr Opin Biotechnol* 12:41-47.
- Bodnoff SR, Humphreys AG, Lehman JC, Diamond DM, Rose GM, Meaney MJ (1995) Enduring effects of chronic corticosterone treatment on spatial learning, synaptic plasticity, and hippocampal neuropathology in young and mid-aged rats. *J Neurosci* 15:61-69.
- Bonaventure P, Guo H, Tian B, Liu X, Bittner A, Roland B, Salunga R, Ma XJ, Kamme F, Meurers B, Bakker M, Jurzak M, Leysen JE, Erlander MG (2002) Nuclei and subnuclei gene expression profiling in mammalian brain. *Brain Res* 943:38-47.
- Bond CT, Herson PS, Strassmaier T, Hammond R, Stackman R, Maylie J, Adelman JP (2004) Small conductance Ca²⁺-activated K⁺ channel knock-out mice reveal the identity of calcium-dependent afterhyperpolarization currents. *J Neurosci* 24:5301-5306.
- Bourgeois S, Gruol DJ, Newby RF, Rajah FM (1993) Expression of an *mdr* gene is associated with a new form of resistance to dexamethasone-induced apoptosis. *Mol Endocrinol* 7:840-851.
- Bowden SE, Fletcher S, Loane DJ, Marrion NV (2001) Somatic colocalization of rat SK1 and D class (Ca(v)1.2) L-type calcium channels in rat CA1 hippocampal pyramidal neurons. *J Neurosci* 21:RC175.
- Bradbury MJ, Akana SF, Dallman MF (1994) Roles of type I and II corticosteroid receptors in regulation of basal activity in the hypothalamo-pituitary-adrenal axis during the diurnal trough and the peak: evidence for a nonadditive effect of combined receptor occupation. *Endocrinology* 134:1286-1296.
- Bradshaw KD, Emptage NJ, Bliss TV (2003) A role for dendritic protein synthesis in hippocampal late LTP. *Eur J Neurosci* 18:3150-3152.
- Breuner CW, Orchinik M (2002) Plasma binding proteins as mediators of corticosteroid action in vertebrates. *J Endocrinol* 175:99-112.
- Brice NL, Dolphin AC (1999) Differential plasma membrane targeting of voltage-dependent calcium channel subunits expressed in a polarized epithelial cell line. *J Physiol* 515 (Pt 3):685-694.
- Brooks-Kayal AR, Shumate MD, Jin H, Lin DD, Rikhter TY, Holloway KL, Coulter DA (1999) Human neuronal gamma-aminobutyric acid(A) receptors: coordinated

- subunit mRNA expression and functional correlates in individual dentate granule cells. *J Neurosci* 19:8312-8318.
- Brussaard AB, Baker RE (1995) Antisense oligonucleotide-induced block of individual GABAA receptor alpha subunits in cultured visual cortex slices reduces amplitude of evoked inhibitory postsynaptic currents. *Neurosci Lett* 191:111-115.
- Budde T, Meuth S, Pape HC (2002) Calcium-dependent inactivation of neuronal calcium channels. *Nat Rev Neurosci* 3:873-883.
- Burgess DL, Biddlecome GH, McDonough SI, Diaz ME, Zilinski CA, Bean BP, Campbell KP, Noebels JL (1999) beta subunit reshuffling modifies N- and P/Q-type Ca²⁺ channel subunit compositions in lethargic mouse brain. *Mol Cell Neurosci* 13:293-311.
- Cameron HA, Gould E (1996) Distinct populations of cells in the adult dentate gyrus undergo mitosis or apoptosis in response to adrenalectomy. *J Comp Neurol* 369:56-63.
- Cameron HA, Hazel TG, McKay RD (1998) Regulation of neurogenesis by growth factors and neurotransmitters. *J Neurobiol* 36:287-306.
- Carter TA, Del Rio JA, Greenhall JA, Latronica ML, Lockhart DJ, Barlow C (2001) Chipping away at complex behavior: transcriptome/phenotype correlations in the mouse brain. *Physiol Behav* 73:849-857.
- Castillo PE, Weisskopf MG, Nicoll RA (1994) The role of Ca²⁺ channels in hippocampal mossy fiber synaptic transmission and long-term potentiation. *Neuron* 12:261-269.
- Catterall WA, de Jongh K, Rotman E, Hell J, Westenbroek R, Dubel SJ, Snutch TP (1993) Molecular properties of calcium channels in skeletal muscle and neurons. *Ann N Y Acad Sci* 681:342-355.
- Chadi G, Rosen L, Cintra A, Tinner B, Zoli M, Pettersson RF, Fuxe K (1993) Corticosterone increases FGF-2 (bFGF) immunoreactivity in the substantia nigra of the rat. *Neuroreport* 4:783-786.
- Chalmers DT, Kwak SP, Mansour A, Akil H, Watson SJ (1993) Corticosteroids regulate brain hippocampal 5-HT_{1A} receptor mRNA expression. *J Neurosci* 13:914-923.
- Chao HM, McEwen BS (1994) Glucocorticoids and the expression of mRNAs for neurotrophins, their receptors and GAP-43 in the rat hippocampus. *Brain Res Mol Brain Res* 26:271-276.
- Chao HM, Sakai RR, Ma LY, McEwen BS (1998a) Adrenal steroid regulation of neurotrophic factor expression in the rat hippocampus. *Endocrinology* 139:3112-3118.
- Chao HM, Ma LY, McEwen BS, Sakai RR (1998b) Regulation of glucocorticoid receptor and mineralocorticoid receptor messenger ribonucleic acids by selective agonists in the rat hippocampus. *Endocrinology* 139:1810-1814.
- Chien AJ, Zhao X, Shirokov RE, Puri TS, Chang CF, Sun D, Rios E, Hosey MM (1995) Roles of a membrane-localized beta subunit in the formation and targeting of functional L-type Ca²⁺ channels. *J Biol Chem* 270:30036-30044.
- Christie BR, Eliot LS, Ito K, Miyakawa H, Johnston D (1995) Different Ca²⁺ channels in soma and dendrites of hippocampal pyramidal neurons mediate spike-induced Ca²⁺ influx. *J Neurophysiol* 73:2553-2557.
- Chrousos GP (1998) Stressors, stress, and neuroendocrine integration of the adaptive response. The 1997 Hans Selye Memorial Lecture. *Ann N Y Acad Sci* 851:311-335.
- Chrousos GP, Gold PW (1992) The concepts of stress and stress system disorders. Overview of physical and behavioral homeostasis. *Jama* 267:1244-1252.

- Civitelli R, Kim YS, Gunsten SL, Fujimori A, Huskey M, Avioli LV, Hruska KA (1990) Nongenomic activation of the calcium message system by vitamin D metabolites in osteoblast-like cells. *Endocrinology* 127:2253-2262.
- Coburn-Litvak PS, Tata DA, Gorby HE, McCloskey DP, Richardson G, Anderson BJ (2004) Chronic corticosterone affects brain weight, and mitochondrial, but not glial volume fraction in hippocampal area CA3. *Neuroscience* 124:429-438.
- Colantuoni C, Purcell AE, Bouton CM, Pevsner J (2000) High throughput analysis of gene expression in the human brain. *J Neurosci Res* 59:1-10.
- Cole TJ, Blendy JA, Monaghan AP, Kriegstein K, Schmid W, Aguzzi A, Fantuzzi G, Hummler E, Unsicker K, Schutz G (1995) Targeted disruption of the glucocorticoid receptor gene blocks adrenergic chromaffin cell development and severely retards lung maturation. *Genes Dev* 9:1608-1621.
- Cordon-Cardo C, O'Brien JP, Casals D, Rittman-Grauer L, Biedler JL, Melamed MR, Bertino JR (1989) Multidrug-resistance gene (P-glycoprotein) is expressed by endothelial cells at blood-brain barrier sites. *Proc Natl Acad Sci U S A* 86:695-698.
- Cullinan WE, Wolfe TJ (2000) Chronic stress regulates levels of mRNA transcripts encoding beta subunits of the GABA(A) receptor in the rat stress axis. *Brain Res* 887:118-124.
- Cummings TJ, Strum JC, Yoon LW, Szymanski MH, Hulette CM (2001) Recovery and expression of messenger RNA from postmortem human brain tissue. *Mod Pathol* 14:1157-1161.
- Dallman MF, Akana SF, Levin N, Walker CD, Bradbury MJ, Suemaru S, Scribner KS (1994) Corticosteroids and the control of function in the hypothalamo-pituitary-adrenal (HPA) axis. *Ann N Y Acad Sci* 746:22-31; discussion 31-22, 64-27.
- Datson NA, van der Perk J, de Kloet ER, Vreugdenhil E (2001) Identification of corticosteroid-responsive genes in rat hippocampus using serial analysis of gene expression. *Eur J Neurosci* 14:675-689.
- Datta SR, Brunet A, Greenberg ME (1999) Cellular survival: a play in three Acts. *Genes Dev* 13:2905-2927.
- de Boland AR, Norman A (1990) Evidence for involvement of protein kinase C and cyclic adenosine 3',5' monophosphate-dependent protein kinase in the 1,25-dihydroxy-vitamin D3-mediated rapid stimulation of intestinal calcium transport, (transcaltachia). *Endocrinology* 127:39-45.
- De Bosscher K, Vanden Berghe W, Haegeman G (2003) The interplay between the glucocorticoid receptor and nuclear factor-kappaB or activator protein-1: molecular mechanisms for gene repression. *Endocr Rev* 24:488-522.
- de Castro M, Elliot S, Kino T, Bamberger C, Karl M, Webster E, Chrousos GP (1996) The non-ligand binding beta-isoform of the human glucocorticoid receptor (hGR beta): tissue levels, mechanism of action, and potential physiologic role. *Mol Med* 2:597-607.
- De Kloet ER (1991) Brain corticosterone receptor balance and homeostatic control. *Neuroendocrinology* 12:95-164.
- De Kloet ER (1997) Why Dexamethasone Poorly Penetrates in Brain. *Stress* 2:13-20.
- de Kloet ER (2003) Hormones, brain and stress. *Endocr Regul* 37:51-68.
- De Kloet ER, Vreugdenhil E, Oitzl MS, Joels M (1998) Brain corticosteroid receptor balance in health and disease. *Endocr Rev* 19:269-301.
- De Kloet R, Wallach G, McEwen BS (1975) Differences in corticosterone and dexamethasone binding to rat brain and pituitary. *Endocrinology* 96:598-609.
- Derfoul A, Robertson NM, Hall DJ, Litwack G (2000) The N-terminal domain of the mineralocorticoid receptor modulates both mineralocorticoid receptor- and

- glucocorticoid receptor-mediated transactivation from Na/K ATPase beta1 target gene promoter. *Endocrine* 13:287-295.
- Diamond DM, Bennett MC, Fleshner M, Rose GM (1992) Inverted-U relationship between the level of peripheral corticosterone and the magnitude of hippocampal primed burst potentiation. *Hippocampus* 2:421-430.
- Diamond MI, Miner JN, Yoshinaga SK, Yamamoto KR (1990) Transcription factor interactions: selectors of positive or negative regulation from a single DNA element. *Science* 249:1266-1272.
- Ding C, Cantor CR (2003a) Direct molecular haplotyping of long-range genomic DNA with M1-PCR. *Proc Natl Acad Sci U S A* 100:7449-7453.
- Ding C, Cantor CR (2003b) A high-throughput gene expression analysis technique using competitive PCR and matrix-assisted laser desorption ionization time-of-flight MS. *Proc Natl Acad Sci U S A* 100:3059-3064.
- Dixon AK, Richardson PJ, Pinnock RD, Lee K (2000) Gene-expression analysis at the single-cell level. *Trends Pharmacol Sci* 21:65-70.
- Dolter KE, Braman JC (2001) Small-sample total RNA purification: laser capture microdissection and cultured cell applications. *Biotechniques* 30:1358-1361.
- Douglas RJ (1967) The hippocampus and behavior. *Psychol Bull* 67:416-422.
- Eberwine J (2001) Single-cell molecular biology. *Nat Neurosci* 4 Suppl:1155-1156.
- Eberwine J, Belt B, Kacharina JE, Miyashiro K (2002) Analysis of subcellularly localized mRNAs using in situ hybridization, mRNA amplification, and expression profiling. *Neurochem Res* 27:1065-1077.
- Eberwine J, Yeh H, Miyashiro K, Cao Y, Nair S, Finnell R, Zettel M, Coleman P (1992) Analysis of gene expression in single live neurons. *Proc Natl Acad Sci U S A* 89:3010-3014.
- Edwards CR, Stewart PM, Burt D, Brett L, McIntyre MA, Sutanto WS, de Kloet ER, Monder C (1988) Localisation of 11 beta-hydroxysteroid dehydrogenase--tissue specific protector of the mineralocorticoid receptor. *Lancet* 2:986-989.
- Edwardson JA, Bennett GW (1974) Modulation of corticotrophin-releasing factor release from hypothalamic synaptosomes. *Nature* 251:425-427.
- Eisen MB, Spellman PT, Brown PO, Botstein D (1998) Cluster analysis and display of genome-wide expression patterns. *Proc Natl Acad Sci U S A* 95:14863-14868.
- Elliott EM, Malouf AT, Catterall WA (1995) Role of calcium channel subtypes in calcium transients in hippocampal CA3 neurons. *J Neurosci* 15:6433-6444.
- Emmert-Buck MR, Bonner RF, Smith PD, Chuaqui RF, Zhuang Z, Goldstein SR, Weiss RA, Liotta LA (1996) Laser capture microdissection. *Science* 274:998-1001.
- Encio IJ, Detera-Wadleigh SD (1991) The genomic structure of the human glucocorticoid receptor. *J Biol Chem* 266:7182-7188.
- Evans RM (1988) The steroid and thyroid hormone receptor superfamily. *Science* 240:889-895.
- Falkenstein E, Tillmann HC, Christ M, Feuring M, Wehling M (2000) Multiple actions of steroid hormones--a focus on rapid, nongenomic effects. *Pharmacol Rev* 52:513-556.
- Feldker DE, de Kloet ER, Kruk MR, Datson NA (2003a) Large-scale gene expression profiling of discrete brain regions: potential, limitations, and application in genetics of aggressive behavior. *Behav Genet* 33:537-548.
- Feldker DE, Datson NA, Veenema AH, Proutski V, Lathouwers D, De Kloet ER, Vreugdenhil E (2003b) GeneChip analysis of hippocampal gene expression profiles of short- and long-attack-latency mice: technical and biological implications. *J Neurosci Res* 74:701-716.

- Finke J, Fritzen R, Ternes P, Lange W, Dolken G (1993) An improved strategy and a useful housekeeping gene for RNA analysis from formalin-fixed, paraffin-embedded tissues by PCR. *Biotechniques* 14:448-453.
- Finotto S, Krieglstein K, Schober A, Deimling F, Lindner K, Bruhl B, Beier K, Metz J, Garcia-Ararras JE, Roig-Lopez JL, Monaghan P, Schmid W, Cole TJ, Kellendonk C, Tronche F, Schutz G, Unsicker K (1999) Analysis of mice carrying targeted mutations of the glucocorticoid receptor gene argues against an essential role of glucocorticoid signalling for generating adrenal chromaffin cells. *Development* 126:2935-2944.
- Fischer AK, von Rosenstiel P, Fuchs E, Goula D, Almeida OF, Czeh B (2002) The prototypic mineralocorticoid receptor agonist aldosterone influences neurogenesis in the dentate gyrus of the adrenalectomized rat. *Brain Res* 947:290-293.
- Foss RD, Guha-Thakurta N, Conran RM, Gutman P (1994) Effects of fixative and fixation time on the extraction and polymerase chain reaction amplification of RNA from paraffin-embedded tissue. Comparison of two housekeeping gene mRNA controls. *Diagn Mol Pathol* 3:148-155.
- Fuse H, Kitagawa H, Kato S (2000) Characterization of transactivational property and coactivator mediation of rat mineralocorticoid receptor activation function-1 (AF-1). *Mol Endocrinol* 14:889-899.
- Fuxe K, Wikstrom AC, Okret S, Agnati LF, Harfstrand A, Yu ZY, Granholm L, Zoli M, Vale W, Gustafsson JA (1985) Mapping of glucocorticoid receptor immunoreactive neurons in the rat tel- and diencephalon using a monoclonal antibody against rat liver glucocorticoid receptor. *Endocrinology* 117:1803-1812.
- Galea LA, McEwen BS, Tanapat P, Deak T, Spencer RL, Dhabhar FS (1997) Sex differences in dendritic atrophy of CA3 pyramidal neurons in response to chronic restraint stress. *Neuroscience* 81:689-697.
- Gallin WJ, Greenberg ME (1995) Calcium regulation of gene expression in neurons: the mode of entry matters. *Curr Opin Neurobiol* 5:367-374.
- Gao T, Chien AJ, Hosey MM (1999) Complexes of the alpha1C and beta subunits generate the necessary signal for membrane targeting of class C L-type calcium channels. *J Biol Chem* 274:2137-2144.
- Gao T, Bunemann M, Gerhardstein BL, Ma H, Hosey MM (2000) Role of the C terminus of the alpha 1C (CaV1.2) subunit in membrane targeting of cardiac L-type calcium channels. *J Biol Chem* 275:25436-25444.
- Gerges NZ, Stringer JL, Alkadhi KA (2001) Combination of hypothyroidism and stress abolishes early LTP in the CA1 but not dentate gyrus of hippocampus of adult rats. *Brain Res* 922:250-260.
- Gerlach JL, McEwen BS (1972) Rat brain binds adrenal steroid hormone: radioautography of hippocampus with corticosterone. *Science* 175:1133-1136.
- Geschwind DH (2000) Mice, microarrays, and the genetic diversity of the brain. *Proc Natl Acad Sci U S A* 97:10676-10678.
- Gesing A, Bilang-Bleuel A, Droste SK, Linthorst AC, Holsboer F, Reul JM (2001) Psychological stress increases hippocampal mineralocorticoid receptor levels: involvement of corticotropin-releasing hormone. *J Neurosci* 21:4822-4829.
- Gillies GE, Linton EA, Lowry PJ (1982) Corticotropin releasing activity of the new CRF is potentiated several times by vasopressin. *Nature* 299:355-357.
- Ginsberg SD, Che S (2002) RNA amplification in brain tissues. *Neurochem Res* 27:981-992.
- Giuditta A, Kaplan BB, van Minnen J, Alvarez J, Koenig E (2002) Axonal and presynaptic protein synthesis: new insights into the biology of the neuron. *Trends Neurosci* 25:400-404.

- Glanzer JG, Eberwine JH (2003) Mechanisms of translational control in dendrites. *Neurobiol Aging* 24:1105-1111.
- Goldstein PA, Elsen FP, Ying SW, Ferguson C, Homanics GE, Harrison NL (2002) Prolongation of hippocampal miniature inhibitory postsynaptic currents in mice lacking the GABA(A) receptor alpha1 subunit. *J Neurophysiol* 88:3208-3217.
- Goldsworthy SM, Stockton PS, Trempus CS, Foley JF, Maronpot RR (1999) Effects of fixation on RNA extraction and amplification from laser capture microdissected tissue. *Mol Carcinog* 25:86-91.
- Gottlicher M, Heck S, Herrlich P (1998) Transcriptional cross-talk, the second mode of steroid hormone receptor action. *J Mol Med* 76:480-489.
- Gould E, McEwen BS, Tanapat P, Galea LA, Fuchs E (1997) Neurogenesis in the dentate gyrus of the adult tree shrew is regulated by psychosocial stress and NMDA receptor activation. *J Neurosci* 17:2492-2498.
- Gutierrez A, Khan ZU, Ruano D, Miralles CP, Vitorica J, De Blas AL (1996) Aging-related subunit expression changes of the GABAA receptor in the rat hippocampus. *Neuroscience* 74:341-348.
- Hamill OP, Marty A, Neher E, Sakmann B, Sigworth FJ (1981) Improved patch-clamp techniques for high-resolution current recording from cells and cell-free membrane patches. *Pflugers Arch* 391:85-100.
- Hanlon MR, Wallace BA (2002) Structure and function of voltage-dependent ion channel regulatory beta subunits. *Biochemistry* 41:2886-2894.
- Hansson AC, Sommer W, Andbjør B, Bader M, Ganten D, Fuxe K (2001) Induction of hippocampal glial cells expressing basic fibroblast growth factor RNA by corticosterone. *Neuroreport* 12:141-145.
- Hansson AC, Cintra A, Belluardo N, Sommer W, Bhatnagar M, Bader M, Ganten D, Fuxe K (2000) Gluco- and mineralocorticoid receptor-mediated regulation of neurotrophic factor gene expression in the dorsal hippocampus and the neocortex of the rat. *Eur J Neurosci* 12:2918-2934.
- Hart SM (2002) Modulation of nuclear receptor dependent transcription. *Biol Res* 35:295-303.
- Haseroth K, Gerdes D, Berger S, Feuring M, Gunther A, Herbst C, Christ M, Wehling M (1999) Rapid nongenomic effects of aldosterone in mineralocorticoid-receptor-knockout mice. *Biochem Biophys Res Commun* 266:257-261.
- Heine VM, Maslam S, Zareno J, Joels M, Lucassen PJ (2004) Suppressed proliferation and apoptotic changes in the rat dentate gyrus after acute and chronic stress are reversible. *Eur J Neurosci* 19:131-144.
- Heine VM MS, Joëls M, and Lucassen, PJ (2003) Prominent decline of newborn cell proliferation, differentiation and apoptosis in the aging dentate gyrus, in absence of an age related hypothalamus-pituitary-adrenal axis activation. *Neurobiol Aging* in press.
- Hell JW, Westenbroek RE, Warner C, Ahljianian MK, Prystay W, Gilbert MM, Snutch TP, Catterall WA (1993) Identification and differential subcellular localization of the neuronal class C and class D L-type calcium channel alpha 1 subunits. *J Cell Biol* 123:949-962.
- Heller MJ (2002) DNA microarray technology: devices, systems, and applications. *Annu Rev Biomed Eng* 4:129-153.
- Helm KA, Han JS, Gallagher M (2002) Effects of cholinergic lesions produced by infusions of 192 IgG-saporin on glucocorticoid receptor mRNA expression in hippocampus and medial prefrontal cortex of the rat. *Neuroscience* 115:765-774.

- Hemby SE, Ginsberg SD, Brunk B, Arnold SE, Trojanowski JQ, Eberwine JH (2002) Gene expression profile for schizophrenia: discrete neuron transcription patterns in the entorhinal cortex. *Arch Gen Psychiatry* 59:631-640.
- Herman JP, Spencer R (1998) Regulation of hippocampal glucocorticoid receptor gene transcription and protein expression in vivo. *J Neurosci* 18:7462-7473.
- Herman JP, Adams D, Prewitt C (1995) Regulatory changes in neuroendocrine stress-integrative circuitry produced by a variable stress paradigm. *Neuroendocrinology* 61:180-190.
- Hesen W, Karst H, Meijer O, Cole TJ, Schmid W, de Kloet ER, Schutz G, Joels M (1996) Hippocampal cell responses in mice with a targeted glucocorticoid receptor gene disruption. *J Neurosci* 16:6766-6774.
- Hinkle DA, Eberwine JH (2003) Single-cell molecular biology: implications for diagnosis and treatment of neurologic disease. *Biol Psychiatry* 54:413-417.
- Hollenberg SM, Weinberger C, Ong ES, Cerelli G, Oro A, Lebo R, Thompson EB, Rosenfeld MG, Evans RM (1985) Primary structure and expression of a functional human glucocorticoid receptor cDNA. *Nature* 318:635-641.
- Holsboer F, Barden N (1996) Antidepressants and hypothalamic-pituitary-adrenocortical regulation. *Endocr Rev* 17:187-205.
- Horne AL, Kemp JA (1991) The effect of omega-conotoxin GVIA on synaptic transmission within the nucleus accumbens and hippocampus of the rat in vitro. *Br J Pharmacol* 103:1733-1739.
- Hsiao PW, Fryer CJ, Trotter KW, Wang W, Archer TK (2003) BAF60a mediates critical interactions between nuclear receptors and the BRG1 chromatin-remodeling complex for transactivation. *Mol Cell Biol* 23:6210-6220.
- Hsu SY, Hsueh AJ (2001) Human stresscopin and stresscopin-related peptide are selective ligands for the type 2 corticotropin-releasing hormone receptor. *Nat Med* 7:605-611.
- Hu Z, Yuri K, Ozawa H, Lu H, Kawata M (1997) The in vivo time course for elimination of adrenalectomy-induced apoptotic profiles from the granule cell layer of the rat hippocampus. *J Neurosci* 17:3981-3989.
- Huber KM, Kayser MS, Bear MF (2000) Role for rapid dendritic protein synthesis in hippocampal mGluR-dependent long-term depression. *Science* 288:1254-1257.
- Hughes PE, Alexi T, Walton M, Williams CE, Dragunow M, Clark RG, Gluckman PD (1999) Activity and injury-dependent expression of inducible transcription factors, growth factors and apoptosis-related genes within the central nervous system. *Prog Neurobiol* 57:421-450.
- Hui A, Ellinor PT, Krizanova O, Wang JJ, Diebold RJ, Schwartz A (1991) Molecular cloning of multiple subtypes of a novel rat brain isoform of the alpha 1 subunit of the voltage-dependent calcium channel. *Neuron* 7:35-44.
- Hutchison KA, Dittmar KD, Pratt WB (1994) All of the factors required for assembly of the glucocorticoid receptor into a functional heterocomplex with heat shock protein 90 are preassociated in a self-sufficient protein folding structure, a "foldosome". *J Biol Chem* 269:27894-27899.
- Isom LL, De Jongh KS, Catterall WA (1994) Auxiliary subunits of voltage-gated ion channels. *Neuron* 12:1183-1194.
- Jena PK, Liu AH, Smith DS, Wysocki LJ (1996) Amplification of genes, single transcripts and cDNA libraries from one cell and direct sequence analysis of amplified products derived from one molecule. *J Immunol Methods* 190:199-213.

- Jenson SD, Robetorye RS, Bohling SD, Schumacher JA, Morgan JW, Lim MS, Elenitoba-Johnson KS (2003) Validation of cDNA microarray gene expression data obtained from linearly amplified RNA. *Mol Pathol* 56:307-312.
- Jepsen K, Hermanson O, Onami TM, Gleiberman AS, Lunyak V, McEvelly RJ, Kurokawa R, Kumar V, Liu F, Seto E, Hedrick SM, Mandel G, Glass CK, Rose DW, Rosenfeld MG (2000) Combinatorial roles of the nuclear receptor corepressor in transcription and development. *Cell* 102:753-763.
- Jin L, Tsumanuma I, Ruebel KH, Bayliss JM, Lloyd RV (2001) Analysis of homogeneous populations of anterior pituitary folliculostellate cells by laser capture microdissection and reverse transcription-polymerase chain reaction. *Endocrinology* 142:1703-1709.
- Job C, Eberwine J (2001) Localization and translation of mRNA in dendrites and axons. *Nat Rev Neurosci* 2:889-898.
- Joels M (1997) Steroid hormones and excitability in the mammalian brain. *Front Neuroendocrinol* 18:2-48.
- Joels M (2001) Corticosteroid actions in the hippocampus. *J Neuroendocrinol* 13:657-669.
- Joels M, de Kloet ER (1989) Effects of glucocorticoids and norepinephrine on the excitability in the hippocampus. *Science* 245:1502-1505.
- Joels M, de Kloet ER (1993) Corticosteroid actions on amino acid-mediated transmission in rat CA1 hippocampal cells. *J Neurosci* 13:4082-4090.
- Joels M, Heslen W, Karst H, de Kloet ER (1994) Steroids and electrical activity in the brain. *J Steroid Biochem Mol Biol* 49:391-398.
- Joels M, Karten Y, Heslen W, de Kloet ER (1997) Corticosteroid effects on electrical properties of brain cells: temporal aspects and role of antiglucocorticoids. *Psychoneuroendocrinology* 22:S81-86.
- Joels M, Velzing E, Nair S, Verkuyl JM, Karst H (2003) Acute stress increases calcium current amplitude in rat hippocampus: temporal changes in physiology and gene expression. *Eur J Neurosci* 18:1315-1324.
- Jones TJ, Li D, Wolf IM, Wadekar SA, Periyasamy S, Sanchez ER (2004) Enhancement of glucocorticoid receptor-mediated gene expression by constitutively active heat shock factor 1. *Mol Endocrinol* 18:509-520.
- Kalsbeek A, van Heerikhuizen JJ, Wortel J, Buijs RM (1996) A diurnal rhythm of stimulatory input to the hypothalamo-pituitary-adrenal system as revealed by timed intrahypothalamic administration of the vasopressin V1 antagonist. *J Neurosci* 16:5555-5565.
- Karlsen F, Kalantari M, Chitmerere M, Johansson B, Hagmar B (1994) Modifications of human and viral deoxyribonucleic acid by formaldehyde fixation. *Lab Invest* 71:604-611.
- Karssen AM, Meijer OC, van der Sandt IC, De Boer AG, De Lange EC, De Kloet ER (2002) The role of the efflux transporter P-glycoprotein in brain penetration of prednisolone. *J Endocrinol* 175:251-260.
- Karst H, Joels M (2001) Calcium currents in rat dentate granule cells are altered after adrenalectomy. *Eur J Neurosci* 14:503-512.
- Karst H, Joels M (2003) Effect of chronic stress on synaptic currents in rat hippocampal dentate gyrus neurons. *J Neurophysiol* 89:625-633.
- Karst H, Wadman WJ, Joels M (1994a) Corticosteroid receptor-dependent modulation of calcium currents in rat hippocampal CA1 neurons. *Brain Res* 649:234-242.
- Karst H, Joels M, Wadman WJ, Piek T (1994b) Philanthotoxin inhibits Ca²⁺ currents in rat hippocampal CA1 neurons. *Eur J Pharmacol* 270:357-360.

- Karst H, Werkman TR, Struik M, Bosma A, Joels M (1997) Effects of adrenalectomy on Ca²⁺ currents and Ca²⁺ channel subunit mRNA expression in hippocampal CA1 neurons of young rats. *Synapse* 26:155-164.
- Karst H, Karten YJ, Reichardt HM, de Kloet ER, Schutz G, Joels M (2000) Corticosteroid actions in hippocampus require DNA binding of glucocorticoid receptor homodimers. *Nat Neurosci* 3:977-978.
- Karst H, Nair S, Velzing E, Rumpff-van Essen L, Slagter E, Shinnick-Gallagher P, Joels M (2002) Glucocorticoids alter calcium conductances and calcium channel subunit expression in basolateral amygdala neurons. *Eur J Neurosci* 16:1083-1089.
- Karsten SL, Van Deerlin VM, Sabatti C, Gill LH, Geschwind DH (2002) An evaluation of tyramide signal amplification and archived fixed and frozen tissue in microarray gene expression analysis. *Nucleic Acids Res* 30:E4.
- Karten YJ, Stienstra CM, Joels M (2001) Corticosteroid effects on serotonin responses in granule cells of the rat dentate gyrus. *J Neuroendocrinol* 13:233-238.
- Karten YJ, Nair SM, van Essen L, Sibug R, Joels M (1999) Long-term exposure to high corticosterone levels attenuates serotonin responses in rat hippocampal CA1 neurons. *Proc Natl Acad Sci U S A* 96:13456-13461.
- Kellendonk C, Gass P, Kretz O, Schutz G, Tronche F (2002) Corticosteroid receptors in the brain: gene targeting studies. *Brain Res Bull* 57:73-83.
- Kerr DS, Campbell LW, Hao SY, Landfield PW (1989) Corticosteroid modulation of hippocampal potentials: increased effect with aging. *Science* 245:1505-1509.
- Kerr DS, Campbell LW, Thibault O, Landfield PW (1992) Hippocampal glucocorticoid receptor activation enhances voltage-dependent Ca²⁺ conductances: relevance to brain aging. *Proc Natl Acad Sci U S A* 89:8527-8531.
- Kim JJ, Diamond DM (2002) The stressed hippocampus, synaptic plasticity and lost memories. *Nat Rev Neurosci* 3:453-462.
- Kino T, Souvatzoglou E, De Martino MU, Tsopanomihalu M, Wan Y, Chrousos GP (2003) Protein 14-3-3sigma interacts with and favors cytoplasmic subcellular localization of the glucocorticoid receptor, acting as a negative regulator of the glucocorticoid signaling pathway. *J Biol Chem* 278:25651-25656.
- Kitchener P, Di Blasi F., Le Moal M., Borrelli E. and Piazza PV (2001) Effects of chronic stress on glucocorticoid receptor (GR) functional activity in the hippocampus. *Soc. Neurosci. Abstract* 176.4.
- Klein K, Henk W (1963) [Clinical experimental studies on the influence of aldosterone on hemodynamics and blood coagulation]. *Z Kreislaufforsch* 52:40-53.
- Knutti D, Kaul A, Kralli A (2000) A tissue-specific coactivator of steroid receptors, identified in a functional genetic screen. *Mol Cell Biol* 20:2411-2422.
- Kodama T, Shimizu N, Yoshikawa N, Makino Y, Ouchida R, Okamoto K, Hisada T, Nakamura H, Morimoto C, Tanaka H (2003) Role of the glucocorticoid receptor for regulation of hypoxia-dependent gene expression. *J Biol Chem* 278:33384-33391.
- Kole MH, Swan L, Fuchs E (2002) The antidepressant tianeptine persistently modulates glutamate receptor currents of the hippocampal CA3 commissural associational synapse in chronically stressed rats. *Eur J Neurosci* 16:807-816.
- Kovacs KJ (1998) Functional neuroanatomy of the parvocellular vasopressinergic system: transcriptional responses to stress and glucocorticoid feedback. *Prog Brain Res* 119:31-43.
- Kovacs KJ, Foldes A, Sawchenko PE (2000) Glucocorticoid negative feedback selectively targets vasopressin transcription in parvocellular neurosecretory neurons. *J Neurosci* 20:3843-3852.

- Kwak SP, Patel PD, Thompson RC, Akil H, Watson SJ (1993) 5'-Heterogeneity of the mineralocorticoid receptor messenger ribonucleic acid: differential expression and regulation of splice variants within the rat hippocampus. *Endocrinology* 133:2344-2350.
- Lancaster B, Zucker RS (1994) Photolytic manipulation of Ca²⁺ and the time course of slow, Ca(2+)-activated K⁺ current in rat hippocampal neurones. *J Physiol* 475:229-239.
- Laurie DJ, Seeburg PH (1994) Ligand affinities at recombinant N-methyl-D-aspartate receptors depend on subunit composition. *Eur J Pharmacol* 268:335-345.
- Lauterborn J, Berschauer R, Gall C (1995) Cell-specific modulation of basal and seizure-induced neurotrophin expression by adrenalectomy. *Neuroscience* 68:363-378.
- Le Corre S, Sharp T, Young AH, Harrison PJ (1997) Increase of 5-HT₇ (serotonin-7) and 5-HT_{1A} (serotonin-1A) receptor mRNA expression in rat hippocampus after adrenalectomy. *Psychopharmacology (Berl)* 130:368-374.
- Leo C, Chen JD (2000) The SRC family of nuclear receptor coactivators. *Gene* 245:1-11.
- Leung DY, Hamid Q, Vottero A, Szeffler SJ, Surs W, Minshall E, Chrousos GP, Klemm DJ (1997) Association of glucocorticoid insensitivity with increased expression of glucocorticoid receptor beta. *J Exp Med* 186:1567-1574.
- Liang P (2002) A decade of differential display. *Biotechniques* 33:338-344, 346.
- Liang P, Pardee AB (1992) Differential display of eukaryotic messenger RNA by means of the polymerase chain reaction. *Science* 257:967-971.
- Lightman SL, Windle RJ, Ma XM, Harbuz MS, Shanks NM, Julian MD, Wood SA, Kershaw YM, Ingram CD (2002) Hypothalamic-pituitary-adrenal function. *Arch Physiol Biochem* 110:90-93.
- Liu H, Felix R, Gurnett CA, De Waard M, Witcher DR, Campbell KP (1996) Expression and subunit interaction of voltage-dependent Ca²⁺ channels in PC12 cells. *J Neurosci* 16:7557-7565.
- Livak KJ, Schmittgen TD (2001) Analysis of relative gene expression data using real-time quantitative PCR and the 2^{(-Delta Delta C(T))} Method. *Methods* 25:402-408.
- Losel R, Feuring M, Wehling M (2002) Non-genomic aldosterone action: from the cell membrane to human physiology. *J Steroid Biochem Mol Biol* 83:167-171.
- Losel RM, Falkenstein E, Feuring M, Schultz A, Tillmann HC, Rossol-Haseroth K, Wehling M (2003) Nongenomic steroid action: controversies, questions, and answers. *Physiol Rev* 83:965-1016.
- Lowenstein DH, Arsenault L (1996) The effects of growth factors on the survival and differentiation of cultured dentate gyrus neurons. *J Neurosci* 16:1759-1769.
- Luisi BF, Xu WX, Otwinowski Z, Freedman LP, Yamamoto KR, Sigler PB (1991) Crystallographic analysis of the interaction of the glucocorticoid receptor with DNA. *Nature* 352:497-505.
- Luo Z, Geschwind DH (2001) Microarray applications in neuroscience. *Neurobiol Dis* 8:183-193.
- Ma H, Hong H, Huang SM, Irvine RA, Webb P, Kushner PJ, Coetzee GA, Stallcup MR (1999) Multiple signal input and output domains of the 160-kilodalton nuclear receptor coactivator proteins. *Mol Cell Biol* 19:6164-6173.
- Macabeo-Ong M, Ginzinger DG, Dekker N, McMillan A, Regezi JA, Wong DT, Jordan RC (2002) Effect of duration of fixation on quantitative reverse transcription polymerase chain reaction analyses. *Mod Pathol* 15:979-987.
- Mackler SA, Brooks BP, Eberwine JH (1992) Stimulus-induced coordinate changes in mRNA abundance in single postsynaptic hippocampal CA1 neurons. *Neuron* 9:539-548.

- Madison RD, Robinson GA (1998) lambda RNA internal standards quantify sensitivity and amplification efficiency of mammalian gene expression profiling. *Biotechniques* 25:504-508, 510, 512, passim.
- Magarinos AM, McEwen BS (1995) Stress-induced atrophy of apical dendrites of hippocampal CA3c neurons: involvement of glucocorticoid secretion and excitatory amino acid receptors. *Neuroscience* 69:89-98.
- Magarinos AM, Verdugo JM, McEwen BS (1997) Chronic stress alters synaptic terminal structure in hippocampus. *Proc Natl Acad Sci U S A* 94:14002-14008.
- Magarinos AM, McEwen BS, Flugge G, Fuchs E (1996) Chronic psychosocial stress causes apical dendritic atrophy of hippocampal CA3 pyramidal neurons in subordinate tree shrews. *J Neurosci* 16:3534-3540.
- Magee JC, Avery RB, Christie BR, Johnston D (1996) Dihydropyridine-sensitive, voltage-gated Ca²⁺ channels contribute to the resting intracellular Ca²⁺ concentration of hippocampal CA1 pyramidal neurons. *J Neurophysiol* 76:3460-3470.
- Mahanthappa NK, Schwarting GA (1993) Peptide growth factor control of olfactory neurogenesis and neuron survival in vitro: roles of EGF and TGF-beta s. *Neuron* 10:293-305.
- Manabe Y, Warita H, Murakami T, Shiote M, Hayashi T, Nagano I, Shoji M, Abe K (2001) Early decrease of redox factor-1 in spinal motor neurons of presymptomatic transgenic mice with a mutant SOD1 gene. *Brain Res* 915:104-107.
- Marrion NV, Tavalin SJ (1998) Selective activation of Ca²⁺-activated K⁺ channels by co-localized Ca²⁺ channels in hippocampal neurons. *Nature* 395:900-905.
- McEwen BS (1999) Stress and hippocampal plasticity. *Annu Rev Neurosci* 22:105-122.
- McEwen BS, Weiss JM, Schwartz LS (1968) Selective retention of corticosterone by limbic structures in rat brain. *Nature* 220:911-912.
- McEwen BS, De Kloet ER, Rostene W (1986) Adrenal steroid receptors and actions in the nervous system. *Physiol Rev* 66:1121-1188.
- McGhee JD, von Hippel PH (1977) Formaldehyde as a probe of DNA structure. r. Mechanism of the initial reaction of Formaldehyde with DNA. *Biochemistry* 16:3276-3293.
- McKenna NJ, O'Malley BW (2002) Combinatorial control of gene expression by nuclear receptors and coregulators. *Cell* 108:465-474.
- McKenna NJ, Lanz RB, O'Malley BW (1999) Nuclear receptor coregulators: cellular and molecular biology. *Endocr Rev* 20:321-344.
- McRory JE, Santi CM, Hamming KS, Mezeyova J, Sutton KG, Baillie DL, Stea A, Snutch TP (2001) Molecular and functional characterization of a family of rat brain T-type calcium channels. *J Biol Chem* 276:3999-4011.
- Meijer OC (2002) Coregulator proteins and corticosteroid action in the brain. *J Neuroendocrinol* 14:499-505.
- Meijer OC, de Kloet ER (1994) Corticosterone suppresses the expression of 5-HT1A receptor mRNA in rat dentate gyrus. *Eur J Pharmacol* 266:255-261.
- Meijer OC, de Kloet ER (1995) A role for the mineralocorticoid receptor in a rapid and transient suppression of hippocampal 5-HT1A receptor mRNA by corticosterone. *J Neuroendocrinol* 7:653-657.
- Meijer OC, de Lange EC, Breimer DD, de Boer AG, Workel JO, de Kloet ER (1998) Penetration of dexamethasone into brain glucocorticoid targets is enhanced in mdr1A P-glycoprotein knockout mice. *Endocrinology* 139:1789-1793.
- Meir A, Dolphin AC (1998) Known calcium channel alpha1 subunits can form low threshold small conductance channels with similarities to native T-type channels. *Neuron* 20:341-351.

- Mendel CM (1989) The free hormone hypothesis: a physiologically based mathematical model. *Endocr Rev* 10:232-274.
- Mikulowska-Mennis A, Taylor TB, Vishnu P, Michie SA, Raja R, Horner N, Kunitake ST (2002) High-quality RNA from cells isolated by laser capture microdissection. *Biotechniques* 33:176-179.
- Mittelstadt PR, Ashwell JD (2003) Disruption of glucocorticoid receptor exon 2 yields a ligand-responsive C-terminal fragment that regulates gene expression. *Mol Endocrinol* 17:1534-1542.
- Monteil A, Chemin J, Bourinet E, Mennessier G, Lory P, Nargeot J (2000) Molecular and functional properties of the human alpha(1G) subunit that forms T-type calcium channels. *J Biol Chem* 275:6090-6100.
- Moore FL, Orchinik M (1994) Membrane receptors for corticosterone: a mechanism for rapid behavioral responses in an amphibian. *Horm Behav* 28:512-519.
- Moore FL, Orchinik M, Lowry C (1995) Functional studies of corticosterone receptors in neuronal membranes. *Receptor* 5:21-28.
- Morrison TB, Weis JJ, Wittwer CT (1998) Quantification of low-copy transcripts by continuous SYBR Green I monitoring during amplification. *Biotechniques* 24:954-958, 960, 962.
- Moyer JR, Jr., Thompson LT, Black JP, Disterhoft JF (1992) Nimodipine increases excitability of rabbit CA1 pyramidal neurons in an age- and concentration-dependent manner. *J Neurophysiol* 68:2100-2109.
- Moyer ML, Borror KC, Bona BJ, DeFranco DB, Nordeen SK (1993) Modulation of cell signaling pathways can enhance or impair glucocorticoid-induced gene expression without altering the state of receptor phosphorylation. *J Biol Chem* 268:22933-22940.
- Mullick J, Anandatheerthavarada HK, Amuthan G, Bhagwat SV, Biswas G, Camasamudram V, Bhat NK, Reddy SE, Rao V, Avadhani NG (2001) Physical interaction and functional synergy between glucocorticoid receptor and Ets2 proteins for transcription activation of the rat cytochrome P-450c27 promoter. *J Biol Chem* 276:18007-18017.
- Naar AM, Boutin JM, Lipkin SM, Yu VC, Holloway JM, Glass CK, Rosenfeld MG (1991) The orientation and spacing of core DNA-binding motifs dictate selective transcriptional responses to three nuclear receptors. *Cell* 65:1267-1279.
- Nair SM, Werkman TR, Craig J, Finnell R, Joels M, Eberwine JH (1998) Corticosteroid regulation of ion channel conductances and mRNA levels in individual hippocampal CA1 neurons. *J Neurosci* 18:2685-2696.
- Namkung Y, Smith SM, Lee SB, Skrypnik NV, Kim HL, Chin H, Scheller RH, Tsien RW, Shin HS (1998) Targeted disruption of the Ca²⁺ channel beta3 subunit reduces N- and L-type Ca²⁺ channel activity and alters the voltage-dependent activation of P/Q-type Ca²⁺ channels in neurons. *Proc Natl Acad Sci U S A* 95:12010-12015.
- Nathan DF, Lindquist S (1995) Mutational analysis of Hsp90 function: interactions with a steroid receptor and a protein kinase. *Mol Cell Biol* 15:3917-3925.
- Nordeen SK, Bona BJ, Moyer ML (1993) Latent agonist activity of the steroid antagonist, RU486, is unmasked in cells treated with activators of protein kinase A. *Mol Endocrinol* 7:731-742.
- Nordeen SK, Moyer ML, Bona BJ (1994) The coupling of multiple signal transduction pathways with steroid response mechanisms. *Endocrinology* 134:1723-1732.
- Oakley RH, Sar M, Cidlowski JA (1996) The human glucocorticoid receptor beta isoform. Expression, biochemical properties, and putative function. *J Biol Chem* 271:9550-9559.

- Obradovic D, Tirard M, Nemethy Z, Hirsch O, Gronemeyer H, Almeida OF (2004) DAXX, FLASH, and FAF-1 modulate mineralocorticoid and glucocorticoid receptor-mediated transcription in hippocampal cells--toward a basis for the opposite actions elicited by two nuclear receptors? *Mol Pharmacol* 65:761-769.
- O'Dell DM, Raghupathi R, Crino PB, Morrison B, 3rd, Eberwine JH, McIntosh TK (1998) Amplification of mRNAs from single, fixed, TUNEL-positive cells. *Biotechniques* 25:566-568, 570.
- Ogawa H, Nishi M, Kawata M (2001) Localization of nuclear coactivators p300 and steroid receptor coactivator 1 in the rat hippocampus. *Brain Res* 890:197-202.
- O'Keefe J (1990) A computational theory of the hippocampal cognitive map. *Prog Brain Res* 83:301-312.
- Orchinik M, Murray TF, Moore FL (1991) A corticosteroid receptor in neuronal membranes. *Science* 252:1848-1851.
- Orchinik M, Weiland NG, McEwen BS (1995) Chronic exposure to stress levels of corticosterone alters GABAA receptor subunit mRNA levels in rat hippocampus. *Brain Res Mol Brain Res* 34:29-37.
- Orchinik M, Carroll SS, Li YH, McEwen BS, Weiland NG (2001) Heterogeneity of hippocampal GABA(A) receptors: regulation by corticosterone. *J Neurosci* 21:330-339.
- Otto C, Reichardt HM, Schutz G (1997) Absence of glucocorticoid receptor-beta in mice. *J Biol Chem* 272:26665-26668.
- Ou XM, Storrington JM, Kushwaha N, Albert PR (2001) Heterodimerization of mineralocorticoid and glucocorticoid receptors at a novel negative response element of the 5-HT1A receptor gene. *J Biol Chem* 276:14299-14307.
- Pagliusi SR, Gerrard P, Abdallah M, Talabot D, Catsicas S (1994) Age-related changes in expression of AMPA-selective glutamate receptor subunits: is calcium-permeability altered in hippocampal neurons? *Neuroscience* 61:429-433.
- Parker KL, Schimmer BP (1994) The role of nuclear receptors in steroid hormone production. *Semin Cancer Biol* 5:317-325.
- Paskitti ME, McCreary BJ, Herman JP (2000) Stress regulation of adrenocorticosteroid receptor gene transcription and mRNA expression in rat hippocampus: time-course analysis. *Brain Res Mol Brain Res* 80:142-152.
- Pavlidis C, Nivon LG, McEwen BS (2002) Effects of chronic stress on hippocampal long-term potentiation. *Hippocampus* 12:245-257.
- Pavlidis C, Kimura A, Magarinos AM, McEwen BS (1995) Hippocampal homosynaptic long-term depression/depotentiation induced by adrenal steroids. *Neuroscience* 68:379-385.
- Pepin MC, Pothier F, Barden N (1992) Impaired type II glucocorticoid-receptor function in mice bearing antisense RNA transgene. *Nature* 355:725-728.
- Perez-Reyes E, Cribbs LL, Daud A, Lacerda AE, Barclay J, Williamson MP, Fox M, Rees M, Lee JH (1998) Molecular characterization of a neuronal low-voltage-activated T-type calcium channel. *Nature* 391:896-900.
- Pfaff DW, Silva MT, Weiss JM (1971) Telemetered recording of hormone effects on hippocampal neurons. *Science* 172:394-395.
- Pham K, Nacher J, Hof PR, McEwen BS (2003) Repeated restraint stress suppresses neurogenesis and induces biphasic PSA-NCAM expression in the adult rat dentate gyrus. *Eur J Neurosci* 17:879-886.
- Pinnock SB, Herbert J (2001) Corticosterone differentially modulates expression of corticotropin releasing factor and arginine vasopressin mRNA in the hypothalamic

- paraventricular nucleus following either acute or repeated restraint stress. *Eur J Neurosci* 13:576-584.
- Portera-Cailliau C, Price DL, Martin LJ (1997) Non-NMDA and NMDA receptor-mediated excitotoxic neuronal deaths in adult brain are morphologically distinct: further evidence for an apoptosis-necrosis continuum. *J Comp Neurol* 378:88-104.
- Powell CE, Watson CS, Gametchu B (1999) Immunoaffinity isolation of native membrane glucocorticoid receptor from S-49++ lymphoma cells: biochemical characterization and interaction with Hsp 70 and Hsp 90. *Endocrine* 10:271-280.
- Pujic Z, Matsumoto I, Wilce PA (1993) Expression of the gene coding for the NR1 subunit of the NMDA receptor during rat brain development. *Neurosci Lett* 162:67-70.
- Puskas LG, Zvara A, Hackler L, Jr., Van Hummelen P (2002) RNA amplification results in reproducible microarray data with slight ratio bias. *Biotechniques* 32:1330-1334, 1336, 1338, 1340.
- Qin Y, Nair S, Karst H, Vreugdenhil E, Datson N, Joels M (2003) Gene expression changes in single dentate granule neurons after adrenalectomy of rats. *Brain Res Mol Brain Res* 111:17-23.
- Rajeevan MS, Dimulescu IM, Vernon SD, Verma M, Unger ER (2003) Global amplification of sense RNA: a novel method to replicate and archive mRNA for gene expression analysis. *Genomics* 82:491-497.
- Ramakers C, Ruijter JM, Deprez RH, Moorman AF (2003) Assumption-free analysis of quantitative real-time polymerase chain reaction (PCR) data. *Neurosci Lett* 339:62-66.
- Randall AD (1998) The molecular basis of voltage-gated Ca²⁺ channel diversity: is it time for T? *J Membr Biol* 161:207-213.
- Rascol O, Potier B, Lamour Y, Dutar P (1991) Effects of calcium channel agonist and antagonists on calcium-dependent events in CA1 hippocampal neurons. *Fundam Clin Pharmacol* 5:299-317.
- Ratka A, Sutanto W, Bloemers M, de Kloet ER (1989) On the role of brain mineralocorticoid (type I) and glucocorticoid (type II) receptors in neuroendocrine regulation. *Neuroendocrinology* 50:117-123.
- Reichardt HM, Kaestner KH, Tuckermann J, Kretz O, Wessely O, Bock R, Gass P, Schmid W, Herrlich P, Angel P, Schutz G (1998a) DNA binding of the glucocorticoid receptor is not essential for survival. *Cell* 93:531-541.
- Reichardt HM, Kaestner KH, Tuckermann J, Kretz O, Wessely O, Bock R, Gass P, Schmid W, Herrlich P, Angel P, Schutz G (1998b) DNA binding of the glucocorticoid receptor is not essential for survival. *Cell* 93:531-541.
- Relf BL, Machaalani R, Waters KA (2002) Retrieval of mRNA from paraffin-embedded human infant brain tissue for non-radioactive in situ hybridization using oligonucleotides. *J Neurosci Methods* 115:129-136.
- Reul JM, de Kloet ER (1985) Two receptor systems for corticosterone in rat brain: microdistribution and differential occupation. *Endocrinology* 117:2505-2511.
- Reul JM, van den Bosch FR, de Kloet ER (1987a) Differential response of type I and type II corticosteroid receptors to changes in plasma steroid level and circadian rhythmicity. *Neuroendocrinology* 45:407-412.
- Reul JM, van den Bosch FR, de Kloet ER (1987b) Relative occupation of type-I and type-II corticosteroid receptors in rat brain following stress and dexamethasone treatment: functional implications. *J Endocrinol* 115:459-467.
- Reul JM, Probst JC, Skutella T, Hirschmann M, Stec IS, Montkowski A, Landgraf R, Holsboer F (1997) Increased stress-induced adrenocorticotropin response after long-

- term intracerebroventricular treatment of rats with antisense mineralocorticoid receptor oligodeoxynucleotides. *Neuroendocrinology* 65:189-199.
- Riva MA, Tascetta F, Molteni R, Racagni G (1994) Regulation of NMDA receptor subunit mRNA expression in the rat brain during postnatal development. *Brain Res Mol Brain Res* 25:209-216.
- Riva MA, Fumagalli F, Blom JM, Donati E, Racagni G (1995) Adrenalectomy reduces FGF-1 and FGF-2 gene expression in specific rat brain regions and differently affects their induction by seizures. *Brain Res Mol Brain Res* 34:190-196.
- Rosa ML, Guimaraes FS, Pearson RC, Del Bel EA (2002) Effects of single or repeated restraint stress on GluR1 and GluR2 flip and flop mRNA expression in the hippocampal formation. *Brain Res Bull* 59:117-124.
- Rose JD, Moore FL, Orchinik M (1993) Rapid neurophysiological effects of corticosterone on medullary neurons: relationship to stress-induced suppression of courtship clasping in an amphibian. *Neuroendocrinology* 57:815-824.
- Rosenfeld MG, Glass CK (2001) Coregulator codes of transcriptional regulation by nuclear receptors. *J Biol Chem* 276:36865-36868.
- Rupp GM, Locker J (1988) Purification and analysis of RNA from paraffin-embedded tissues. *Biotechniques* 6:56-60.
- Sah P (1996) Ca(2+)-activated K⁺ currents in neurones: types, physiological roles and modulation. *Trends Neurosci* 19:150-154.
- Sah P, Faber ES (2002) Channels underlying neuronal calcium-activated potassium currents. *Prog Neurobiol* 66:345-353.
- Sandberg R, Yasuda R, Pankratz DG, Carter TA, Del Rio JA, Wodicka L, Mayford M, Lockhart DJ, Barlow C (2000) Regional and strain-specific gene expression mapping in the adult mouse brain. *Proc Natl Acad Sci U S A* 97:11038-11043.
- Sandi C, Venero C, Guaza C (1996) Novelty-related rapid locomotor effects of corticosterone in rats. *Eur J Neurosci* 8:794-800.
- Sapolsky RM, Krey LC, McEwen BS (1985) Prolonged glucocorticoid exposure reduces hippocampal neuron number: implications for aging. *J Neurosci* 5:1222-1227.
- Sapolsky RM, Stein-Behrens BA, Armanini MP (1991) Long-term adrenalectomy causes loss of dentate gyrus and pyramidal neurons in the adult hippocampus. *Exp Neurol* 114:246-249.
- Scaccianoce S, Mattei V, Del Bianco P, Gizzi C, Sorice M, Hiraiwa M, Misasi R (2004) Hippocampal prosaposin changes during stress: a glucocorticoid-independent event. *Hippocampus* 14:275-280.
- Schaaf MJ, Hoetelmans RW, de Kloet ER, Vreugdenhil E (1997) Corticosterone regulates expression of BDNF and trkB but not NT-3 and trkC mRNA in the rat hippocampus. *J Neurosci Res* 48:334-341.
- Scheidt SJ, Nilsson S, Kalen M, Hellstrom M, Takemoto M, Hakansson J, Lindahl P (2002) mRNA expression profiling of laser microbeam microdissected cells from slender embryonic structures. *Am J Pathol* 160:801-813.
- Schena M, Shalon D, Davis RW, Brown PO (1995) Quantitative monitoring of gene expression patterns with a complementary DNA microarray. *Science* 270:467-470.
- Schinkel AH, Wagenaar E, van Deemter L, Mol CA, Borst P (1995) Absence of the mdrla P-Glycoprotein in mice affects tissue distribution and pharmacokinetics of dexamethasone, digoxin, and cyclosporin A. *J Clin Invest* 96:1698-1705.
- Schjott JM, Hsu SC, Plummer MR (2003) The neuronal beta 4 subunit increases the unitary conductance of L-type voltage-gated calcium channels in PC12 cells. *J Biol Chem* 278:33936-33942.

- Schmidt BM, Gerdes D, Feuring M, Falkenstein E, Christ M, Wehling M (2000) Rapid, nongenomic steroid actions: A new age? *Front Neuroendocrinol* 21:57-94.
- Schutze K, Lahr G (1998) Identification of expressed genes by laser-mediated manipulation of single cells. *Nat Biotechnol* 16:737-742.
- Schwendt M, Jezova D (2000) Gene expression of two glutamate receptor subunits in response to repeated stress exposure in rat hippocampus. *Cell Mol Neurobiol* 20:319-329.
- Seckl JR (1997) Glucocorticoids, feto-placental 11 beta-hydroxysteroid dehydrogenase type 2, and the early life origins of adult disease. *Steroids* 62:89-94.
- Serth J, Kuczyk MA, Paeslack U, Lichtinghagen R, Jonas U (2000) Quantitation of DNA extracted after micropreparation of cells from frozen and formalin-fixed tissue sections. *Am J Pathol* 156:1189-1196.
- Shaw CA (2002) Theoretical consideration of amplification strategies. *Neurochem Res* 27:1123-1131.
- Sheppard KA, Phelps KM, Williams AJ, Thanos D, Glass CK, Rosenfeld MG, Gerritsen ME, Collins T (1998) Nuclear integration of glucocorticoid receptor and nuclear factor-kappaB signaling by CREB-binding protein and steroid receptor coactivator-1. *J Biol Chem* 273:29291-29294.
- Shibutani M, Uneyama C, Miyazaki K, Toyoda K, Hirose M (2000) Methacarn fixation: a novel tool for analysis of gene expressions in paraffin-embedded tissue specimens. *Lab Invest* 80:199-208.
- Sloviter RS, Valiquette G, Abrams GM, Ronk EC, Sollas AL, Paul LA, Neubort S (1989) Selective loss of hippocampal granule cells in the mature rat brain after adrenalectomy. *Science* 243:535-538.
- Smith CL, Hammond GL (1992) Hormonal regulation of corticosteroid-binding globulin biosynthesis in the male rat. *Endocrinology* 130:2245-2251.
- Smith DF, Toft DO (1993) Steroid receptors and their associated proteins. *Mol Endocrinol* 7:4-11.
- Snutch TP, Leonard JP, Gilbert MM, Lester HA, Davidson N (1990) Rat brain expresses a heterogeneous family of calcium channels. *Proc Natl Acad Sci U S A* 87:3391-3395.
- Sousa AR, Lane SJ, Cidowski JA, Staynov DZ, Lee TH (2000) Glucocorticoid resistance in asthma is associated with elevated in vivo expression of the glucocorticoid receptor beta-isoform. *J Allergy Clin Immunol* 105:943-950.
- Southern EM (2001) DNA microarrays. History and overview. *Methods Mol Biol* 170:1-15.
- Specht K, Richter T, Muller U, Walch A, Werner M, Hofler H (2001) Quantitative gene expression analysis in microdissected archival formalin-fixed and paraffin-embedded tumor tissue. *Am J Pathol* 158:419-429.
- Spencer RL, Young EA, Choo PH, McEwen BS (1990) Adrenal steroid type I and type II receptor binding: estimates of in vivo receptor number, occupancy, and activation with varying level of steroid. *Brain Res* 514:37-48.
- Squire LR, Ojemann JG, Miezin FM, Petersen SE, Videen TO, Raichle ME (1992) Activation of the hippocampus in normal humans: a functional anatomical study of memory. *Proc Natl Acad Sci U S A* 89:1837-1841.
- Srinivasan M, Sedmak D, Jewell S (2002) Effect of fixatives and tissue processing on the content and integrity of nucleic acids. *Am J Pathol* 161:1961-1971.
- Stanta G, Schneider C (1991) RNA extracted from paraffin-embedded human tissues is amenable to analysis by PCR amplification. *Biotechniques* 11:304, 306, 308.
- Steward O, Schuman EM (2001) Protein synthesis at synaptic sites on dendrites. *Annu Rev Neurosci* 24:299-325.

- Stienstra CM, Van Der Graaf F, Bosma A, Karten YJ, Heszen W, Joels M (1998) Synaptic transmission in the rat dentate gyrus after adrenalectomy. *Neuroscience* 85:1061-1071.
- Stoecklin E, Wissler M, Schaetzle D, Pfitzner E, Groner B (1999) Interactions in the transcriptional regulation exerted by Stat5 and by members of the steroid hormone receptor family. *J Steroid Biochem Mol Biol* 69:195-204.
- Strickland I, Kisich K, Hauk PJ, Vottero A, Chrousos GP, Klemm DJ, Leung DY (2001) High constitutive glucocorticoid receptor beta in human neutrophils enables them to reduce their spontaneous rate of cell death in response to corticosteroids. *J Exp Med* 193:585-593.
- Sylvia VL, Schwartz Z, Schuman L, Morgan RT, Mackey S, Gomez R, Boyan BD (1993) Maturation-dependent regulation of protein kinase C activity by vitamin D3 metabolites in chondrocyte cultures. *J Cell Physiol* 157:271-278.
- Sze PY, Iqbal Z (1994) Regulation of calmodulin content in synaptic plasma membranes by glucocorticoids. *Neurochem Res* 19:1455-1461.
- Takahashi T, Kimoto T, Tanabe N, Hattori TA, Yasumatsu N, Kawato S (2002) Corticosterone acutely prolonged N-methyl-D-aspartate receptor-mediated Ca²⁺ elevation in cultured rat hippocampal neurons. *J Neurochem* 83:1441-1451.
- Talley EM, Cribbs LL, Lee JH, Daud A, Perez-Reyes E, Bayliss DA (1999) Differential distribution of three members of a gene family encoding low voltage-activated (T-type) calcium channels. *J Neurosci* 19:1895-1911.
- Tenbaum S, Banihmad A (1997) Nuclear receptors: structure, function and involvement in disease. *Int J Biochem Cell Biol* 29:1325-1341.
- Thibonnier M, Berti-Mattera LN, Dulin N, Conarty DM, Mattera R (1998) Signal transduction pathways of the human V1-vascular, V2-renal, V3-pituitary vasopressin and oxytocin receptors. *Prog Brain Res* 119:147-161.
- Trapp T, Rupprecht R, Castren M, Reul JM, Holsboer F (1994) Heterodimerization between mineralocorticoid and glucocorticoid receptor: a new principle of glucocorticoid action in the CNS. *Neuron* 13:1457-1462.
- Tronche F, Kellendonk C, Kretz O, Gass P, Anlag K, Orban PC, Bock R, Klein R, Schutz G (1999) Disruption of the glucocorticoid receptor gene in the nervous system results in reduced anxiety. *Nat Genet* 23:99-103.
- Tsien RW, Lipscombe D, Madison D, Bley K, Fox A (1995) Reflections on Ca²⁺-channel diversity, 1988-1994. *Trends Neurosci* 18:52-54.
- Umesono K, Murakami KK, Thompson CC, Evans RM (1991) Direct repeats as selective response elements for the thyroid hormone, retinoic acid, and vitamin D3 receptors. *Cell* 65:1255-1266.
- Van Deerlin VM, Gill LH, Nelson PT (2002) Optimizing gene expression analysis in archival brain tissue. *Neurochem Res* 27:993-1003.
- Van Eekelen JA, Jiang W, De Kloet ER, Bohn MC (1988) Distribution of the mineralocorticoid and the glucocorticoid receptor mRNAs in the rat hippocampus. *J Neurosci Res* 21:88-94.
- van Riel E, Meijer OC, Steenbergen PJ, Joels M (2003) Chronic unpredictable stress causes attenuation of serotonin responses in cornu ammonis 1 pyramidal neurons. *Neuroscience* 120:649-658.
- van Steensel B, van Binnendijk EP, Hornsby CD, van der Voort HT, Krozowski ZS, de Kloet ER, van Driel R (1996) Partial colocalization of glucocorticoid and mineralocorticoid receptors in discrete compartments in nuclei of rat hippocampus neurons. *J Cell Sci* 109 (Pt 4):787-792.

- Velculescu VE, Zhang L, Vogelstein B, Kinzler KW (1995) Serial analysis of gene expression. *Science* 270:484-487.
- Velculescu VE, Zhang L, Zhou W, Vogelstein J, Basrai MA, Bassett DE, Jr., Hieter P, Vogelstein B, Kinzler KW (1997) Characterization of the yeast transcriptome. *Cell* 88:243-251.
- Venero C, Borrell J (1999) Rapid glucocorticoid effects on excitatory amino acid levels in the hippocampus: a microdialysis study in freely moving rats. *Eur J Neurosci* 11:2465-2473.
- Veng LM, Mesches MH, Browning MD (2003) Age-related working memory impairment is correlated with increases in the L-type calcium channel protein alpha1D (Cav1.3) in area CA1 of the hippocampus and both are ameliorated by chronic nimodipine treatment. *Brain Res Mol Brain Res* 110:193-202.
- Verkuyl JM, Joels M (2003) Effect of adrenalectomy on miniature inhibitory postsynaptic currents in the paraventricular nucleus of the hypothalamus. *J Neurophysiol* 89:237-245.
- Verkuyl JM, Scott EH, Joels M (2004) Chronic stress attenuates GABAergic inhibition and alters gene expression profile of parvocellular neurons in the hypothalamus. *Eur J Neurosci.* (in press)
- Villalobos C, Shakkottai VG, Chandy KG, Michelhaugh SK, Andrade R (2004) SKCa channels mediate the medium but not the slow calcium-activated afterhyperpolarization in cortical neurons. *J Neurosci* 24:3537-3542.
- Vincent VA, DeVoss JJ, Ryan HS, Murphy GM, Jr. (2002) Analysis of neuronal gene expression with laser capture microdissection. *J Neurosci Res* 69:578-586.
- Vreugdenhil E, de Jong J, Busscher JS, de Kloet ER (1996a) Kainic acid-induced gene expression in the rat hippocampus is severely affected by adrenalectomy. *Neurosci Lett* 212:75-78.
- Vreugdenhil E, de Kloet ER, Schaaf M, Datson NA (2001) Genetic dissection of corticosterone receptor function in the rat hippocampus. *Eur Neuropsychopharmacol* 11:423-430.
- Vreugdenhil E, de Jong J, Schaaf MJ, Meijer OC, Busscher J, Vuijst C, de Kloet ER (1996b) Molecular dissection of corticosteroid action in the rat hippocampus. Application of the differential display techniques. *J Mol Neurosci* 7:135-146.
- Vreugdenhil E, Datson N, Engels B, de Jong J, van Koningsbruggen S, Schaaf M, de Kloet ER (1999) Kainate-elicited seizures induce mRNA encoding a CaMK-related peptide: a putative modulator of kinase activity in rat hippocampus. *J Neurobiol* 39:41-50.
- Wadekar SA, Li D, Sanchez ER (2004) Agonist-activated glucocorticoid receptor inhibits binding of heat shock factor 1 to the heat shock protein 70 promoter in vivo. *Mol Endocrinol* 18:500-508.
- Walker D, De Waard M (1998) Subunit interaction sites in voltage-dependent Ca²⁺ channels: role in channel function. *Trends Neurosci* 21:148-154.
- Walker D, Bichet D, Geib S, Mori E, Cornet V, Snutch TP, Mori Y, De Waard M (1999) A new beta subtype-specific interaction in alpha1A subunit controls P/Q-type Ca²⁺ channel activation. *J Biol Chem* 274:12383-12390.
- Wallberg AE, Neely KE, Hassan AH, Gustafsson JA, Workman JL, Wright AP (2000) Recruitment of the SWI-SNF chromatin remodeling complex as a mechanism of gene activation by the glucocorticoid receptor tau1 activation domain. *Mol Cell Biol* 20:2004-2013.
- Wang E, Miller LD, Ohnmacht GA, Liu ET, Marincola FM (2000) High-fidelity mRNA amplification for gene profiling. *Nat Biotechnol* 18:457-459.

- Wang J, Hu L, Hamilton SR, Coombes KR, Zhang W (2003) RNA amplification strategies for cDNA microarray experiments. *Biotechniques* 34:394-400.
- Watanabe Y, Weiland NG, McEwen BS (1995) Effects of adrenal steroid manipulations and repeated restraint stress on dynorphin mRNA levels and excitatory amino acid receptor binding in hippocampus. *Brain Res* 680:217-225.
- Webster JC, Oakley RH, Jewell CM, Cidlowski JA (2001) Proinflammatory cytokines regulate human glucocorticoid receptor gene expression and lead to the accumulation of the dominant negative beta isoform: a mechanism for the generation of glucocorticoid resistance. *Proc Natl Acad Sci U S A* 98:6865-6870.
- Wei SK, Colecraft HM, DeMaria CD, Peterson BZ, Zhang R, Kohout TA, Rogers TB, Yue DT (2000) Ca(2+) channel modulation by recombinant auxiliary beta subunits expressed in young adult heart cells. *Circ Res* 86:175-184.
- Weiland NG, Orchinik M, Tanapat P (1997) Chronic corticosterone treatment induces parallel changes in N-methyl-D-aspartate receptor subunit messenger RNA levels and antagonist binding sites in the hippocampus. *Neuroscience* 78:653-662.
- Westenbroek RE, Ahljianian MK, Catterall WA (1990) Clustering of L-type Ca²⁺ channels at the base of major dendrites in hippocampal pyramidal neurons. *Nature* 347:281-284.
- Westenbroek RE, Hell JW, Warner C, Dubel SJ, Snutch TP, Catterall WA (1992) Biochemical properties and subcellular distribution of an N-type calcium channel alpha 1 subunit. *Neuron* 9:1099-1115.
- Westenbroek RE, Sakurai T, Elliott EM, Hell JW, Starr TV, Snutch TP, Catterall WA (1995) Immunochemical identification and subcellular distribution of the alpha 1A subunits of brain calcium channels. *J Neurosci* 15:6403-6418.
- Williams C, Ponten F, Moberg C, Soderkvist P, Uhlen M, Ponten J, Sitbon G, Lundeberg J (1999) A high frequency of sequence alterations is due to formalin fixation of archival specimens. *Am J Pathol* 155:1467-1471.
- Wittemann S, Mark MD, Rettig J, Herlitz S (2000) Synaptic localization and presynaptic function of calcium channel beta 4-subunits in cultured hippocampal neurons. *J Biol Chem* 275:37807-37814.
- Wood GE, Young LT, Reagan LP, Chen B, McEwen BS (2004) Stress-induced structural remodeling in hippocampus: Prevention by lithium treatment. *Proc Natl Acad Sci U S A* 101:3973-3978.
- Woolley CS, Gould E, McEwen BS (1990) Exposure to excess glucocorticoids alters dendritic morphology of adult hippocampal pyramidal neurons. *Brain Res* 531:225-231.
- Woolley CS, Gould E, Sakai RR, Spencer RL, McEwen BS (1991) Effects of aldosterone or RU28362 treatment on adrenalectomy-induced cell death in the dentate gyrus of the adult rat. *Brain Res* 554:312-315.
- Wossink J, Karst H, Mayboroda O, Joels M (2001) Morphological and functional properties of rat dentate granule cells after adrenalectomy. *Neuroscience* 108:263-272.
- Yano S, Tokumitsu H, Soderling TR (1998) Calcium promotes cell survival through CaM-K kinase activation of the protein-kinase-B pathway. *Nature* 396:584-587.
- Yuan J, Yankner BA (2000) Apoptosis in the nervous system. *Nature* 407:802-809.
- Zennaro MC, Keightley MC, Kotelevtsev Y, Conway GS, Soubrier F, Fuller PJ (1995) Human mineralocorticoid receptor genomic structure and identification of expressed isoforms. *J Biol Chem* 270:21016-21020.
- Zhang G, Zhang L, Duff GW (1997a) A negative regulatory region containing a glucocorticosteroid response element (nGRE) in the human interleukin-1beta gene. *DNA Cell Biol* 16:145-152.

- Zhang X, Jeyakumar M, Petukhov S, Bagchi MK (1998) A nuclear receptor corepressor modulates transcriptional activity of antagonist-occupied steroid hormone receptor. *Mol Endocrinol* 12:513-524.
- Zhang Z, Jones S, Hagood JS, Fuentes NL, Fuller GM (1997b) STAT3 acts as a co-activator of glucocorticoid receptor signaling. *J Biol Chem* 272:30607-30610.
- Zhao X, Lein ES, He A, Smith SC, Aston C, Gage FH (2001) Transcriptional profiling reveals strict boundaries between hippocampal subregions. *J Comp Neurol* 441:187-196.
- Zhong J, Carrozza DP, Williams K, Pritchett DB, Molinoff PB (1995) Expression of mRNAs encoding subunits of the NMDA receptor in developing rat brain. *J Neurochem* 64:531-539.
- Zhong P, Ciaranello RD (1995) Transcriptional regulation of hippocampal 5-HT_{1a} receptors by corticosteroid hormones. *Brain Res Mol Brain Res* 29:23-34.
- Zirlinger M, Kreiman G, Anderson DJ (2001) Amygdala-enriched genes identified by microarray technology are restricted to specific amygdaloid subnuclei. *Proc Natl Acad Sci U S A* 98:5270-5275.

