

Genes Regulated by Drugs of Abuse

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Gene Name	Gene Abbreviation	Accession Number, human	Accession Number, rat	Accession Number, mouse	Drug	Gene Expression (Up/Down)	Representative Reference(s)
5-hydroxytryptamine1A receptor, serotonin receptor 1A	5-HT receptor 1A		J05276		MDMA	Both	Yau et al. (1997) <i>Neuroscience</i> 78 (1):111-21.
5-hydroxytryptamine 2C receptor	5-HT receptor 2C				MDMA	Down	Yau et al. (1997) <i>Neuroscience</i> 78 (1):111-21.
activity and neurotransmitter-induced early gene-1	ania-1		AF030086		cocaine	Up	Berke et al. (1998). <i>J. Neurosci.</i> 18 (14):5301-5310.
activity and neurotransmitter-induced early gene-10	ania-10		AF050662		cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
activity and neurotransmitter-induced early gene-11	ania-11		AF050663		cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
activity and neurotransmitter-induced early gene-12	ania-12		AF050664		cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
activity and neurotransmitter-induced early gene-2	ania-2		AF030087		cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
activity and neurotransmitter-induced early gene-3	ania-3		AF030088		cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
activity and neurotransmitter-induced early gene-4	ania-4		AF030089		cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
activity and neurotransmitter-induced early gene-5	ania-5		AF030090		cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.

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activity and neurotransmitter-induced early gene-6	ania-6	AF180920	AF030091	AF159159	cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
activity and neurotransmitter-induced early gene-7	ania-7		AF050659		cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
activity and neurotransmitter-induced early gene-8	ania-8		AF050659		cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
activity and neurotransmitter-induced early gene-9	ania-9		AF050661		cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
activity-regulated cytoskeleton-associated gene	arc		U19866	AF162777	phencyclidine	Up	Nakahara et al. (2000) <i>Neuroreport</i> 11 (3):551-5.
alpha 2(I) collagen	COL1A2			X58251	ethanol	Up	Nieto et al. (2000) <i>J Biol Chem</i> 275 (26):20136-45.
aromatic L-amino acid decarboxylase	AADC	AB037497	AH004181		LSD, phencyclidine, amphetamine	Both	Buckland et al. (1997) <i>Brain Res Mol Brain Res</i> 49 (1-2):266-70. Buckland et al. (1996) <i>Brain Res Mol Brain Res.</i> 35 (1-2):69-76.
B-cell leukemia/lymphoma 2	Bcl-2	M14745	U34964	NM_009741	cocaine, marijuana	Both	Zhang et al. (1999) <i>Anat Rec</i> 257 (6):208-16. Zhu et al. (1998). <i>J Pharmacol Exp Ther</i> 286 (2):1103-9.
Bcl-2 associated X protein	Bax	NM_004324	S76511	NM_007527	cocaine	Up	Zhang et al. (1999) <i>Anat Rec</i> 257 (6):208-16.
c-fos	c-fos	V01512	X06769	V00727	cocaine, amphetamine, haloperidol, MDMA, morphine	Up	Couceyro et al. (1994) <i>Mol Pharmacol</i> 46 (4):667-7. Schatz et al. (2000) <i>Synapse</i> 36 :75-83.
c-jun	c-jun	J04111	X17215	NM_010591	cocaine	Up	Couceyro et al. (1994) <i>Mol Pharmacol</i> 46 (4):667-7.
cAMP responsive element binding protein	CREB	X55545	X14788	M95106	Opiates	Up	Lane-Ladd et al. (1997) <i>J. Neurosci.</i> 17 :7890-7901.

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cAMP-responsive element modulator	CREM			M60285	cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
catalase	catalase	X04076		L25069	cocaine	Down	Diez-Fernandez et al. (1999) <i>Biochem Pharmacol</i> 58 (5):797-805.
CB1 cannabinoid receptor	CB1 cannabinoid receptor	U73304		AF153345	marijuana	Down	Corchero et al. (1999) <i>Brain Res Mol Brain Res</i> 67 (1):148-57.
chemokine (C-C motif) receptor 5	CCR5	NM_000579	U77350	AF022990	cocaine	Up	Nair et al. (2000) <i>Clin Diagn Lab Immunol</i> , 7 (1):96-100
cocaine and amphetamine regulated transcript	CART	NM_004291	U10071	AF148071	cocaine, amphetamine	Up	Kuhar and Dall Vechia (1999) <i>TINS</i> 22 (7):316-20.
connexin32, gap junction protein	Cx32, GJB1		AJ271753	X84214	cocaine	Down	Bennett et al. (1999) <i>Eur J Neurosci</i> 11 (9):3329-38.
cyclooxygenase-2	COX-2	M90100	AF233596	M94967	phencyclidine	Up	Hashimoto et al. (1997) <i>Brain Res</i> 762 (1-2):259-63.
cysteinestring protein	Csp1			NM_016775	amphetamine	Down	Bowyer and Davies (1999) <i>Ann N Y Acad Sci</i> 890 :314-29.
cytochrome c oxidase, subunits I,III,IV	CO	NC_001807	NC_001665	NC_001569	cocaine	Up	Walker and Sevarino (1995) <i>J. Neurochem</i> 64 :497-502.
cytochrome P450 2C11	CYP2C11		X79081	D17674	phencyclidine	Down	Shelnutt et al. (1997) <i>J Pharmacol Exp Ther</i> 281 (1):574-81
D3 Dopamine Receptor	D3 DA receptor, DRD3	U25441	X53944	AH004782	cocaine	Up	Mash and Staley (1999) <i>Ann N Y Acad Sci</i> 877 :507-22
dopamine- and cAMP-regulated phosphoprotein of 32 kDa	DARPP-32	AF233349		S80640	cocaine	Up	Svenningsson et al. (2000) <i>PNAS</i> 97 (4): 1856-1860.
dopamine D1 receptor	DA D1 receptor	NM_000794	S46131		cocaine, GHB	Up	Schmidt-Mutter et al. (1999) <i>Neuropsychopharmacology</i> 21 (5):662-9.

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dopamine D2-receptor	DA D2 receptor	X51645	X53278	X55674	cocaine, GHB	Both	Volkow et al. (1999) <i>J Psychopharmacol</i> 13 (4):337-345. Schmidt-Mutter et al. (1999) <i>Neuropsychopharmacology</i> 21 (5):662-9.
dopamine Transporter	DAT	AH007215	M80570	AF109072	cocaine, amphetamine	Down	Xia et al. (1992) <i>J Neurochem</i> 59 (3):1179-1182.
dynorphin, enkephalin B	enkB	K02268	AH002169	U64968	cocaine, amphetamine, methamphetamine	Up	Hurd and Herkenham 1992. <i>Brain Res Mol Brain Res</i> 16 (1-2):97-104. Smith and McGinty (1994) <i>Brain Res Mol Brain Res</i> 21 (3-4):359-62.
early growth response gene-2	krox20, egr-2	NM_000399	U78102	X06746	cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
early growth response gene-3	egr-3	X63741	U12428	AF132128	cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310
enkephelin, proenkephalin	enk	AH005276	M28263	M13227	cocaine, marijuana	Both	Hurd and Herkenham (1992) <i>Brain Res Mol Brain Res</i> 16 (1-2):97-104. Perez-Rosado et al. (2000) <i>Brain Res Dev Brain Res</i> 120 (1):77-81.
fos-related antigen-2	fra-2	NM_012954	U18913	X83971	cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
G-protein, beta subunit 1	Gbeta1		U88324	NM_008142	cocaine, amphetamine	Up	Wang et al. (1997) <i>J Neurosci</i> 17 (15):5993-6000.
gamma aminobutyric acid A receptor, subunit alpha 1	GABAA receptor, alpha 1 subunit	S69334	L08490	NM_010250	benzodiazepenes, barbiturates, ethanol	Up	Holt et al. (1996) <i>Neuropharmacology</i> 35 :1457-1463.
gamma aminobutyric acid A receptor, subunit alpha 3	GABAA receptor, subunit alpha 3	S62908	L08492	NM_008067	benzodiazepenes, barbiturates, ethanol	Up	Holt et al. (1996) <i>Neuropharmacology</i> 35 :1457-1463.

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gamma aminobutyric acid A receptor, subunit alpha 4,	GABAA receptor, alpha 4-subunit	U30461	L08493	AF090373	benzodiazepenes, barbiturates, ethanol	Up	Holt et al. (1996) <i>Neuropharmacology</i> 35 :1457-1463.
gamma aminobutyric acid A receptor, subunit beta 1	GABAA receptor, beta 1 subunit	NM_000812	NM_012956	NM_008069	benzodiazepenes, barbiturates, ethanol	Up	Holt et al. (1996) <i>Neuropharmacology</i> 35 :1457-1463.
gamma aminobutyric acid A receptor, subunit beta 2	GABAA receptor, beta 2-subunit	A28108	NM_012957	NM_008070	benzodiazepenes, barbiturates, ethanol	Down	Holt et al. (1996) <i>Neuropharmacology</i> 35 :1457-1463. Holt et al. (1997) <i>Mol Brain Res</i> 48 :164-166.
gamma aminobutyric acid A receptor, subunit gamma 2	GABAA receptor, gamma 2 subunit	NM_000816	L08497	NM_008073	benzodiazepenes, barbiturates, ethanol	Down	Holt et al. (1996) <i>Neuropharmacology</i> 35 :1457-1463.
gamma aminobutyric acid A receptor, subunit gamma 3	GABAA receptor, gamma 3 subunit		X63324	NM_008074	benzodiazepenes, barbiturates, ethanol	Up	Holt et al. (1996) <i>Neuropharmacology</i> 35 :1457-1463.
GLGF-domain protein Homer	homer, Ves1-1S		U92079	NM_011982	cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
glial cell-derived neurotrophic factor	GDNF	NM_000514	AJ011432	D88264	cocaine	Down	Lipton et al. (1999) <i>Brain Res Dev Brain Res</i> 118 (1-2):231-5.
glucocorticoid receptor					MDMA	Down	Yau, et al. (1997) <i>Neuroscience</i> 78 (1):111-21.
glutamate dehydrogenase	GDH	M37154	NM_012570	NM_008133	phencylidine	Up	Shimizu et al. (1997) <i>Schizophr Res</i> 25 (3):251-8.
glutamate receptor subunit 2	GluR2			X57498	cocaine	Up	Ghasemzadeh et al. (1999) <i>J Neurochem</i> 72 (1):157-65.
glutamate receptor subunit 3	GluR3		M85036		cocaine	Down	Ghasemzadeh et al. (1999) <i>J Neurochem</i> 72 (1):157-65.
glutamate receptor subunit 4	GluR4				cocaine	Down	Ghasemzadeh et al. (1999) <i>J Neurochem</i> 72 (1):157-65.
glutamate receptor subunit 5	GluR5		M83561	X66118	cocaine	Up	Ghasemzadeh et al. (1999) <i>J Neurochem</i> 72 (1):157-65.

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Go alpha protein	Go alpha	M19182	M12671	NM_010308	cocaine, morphine	Both	Przewlocka et al. (1994) <i>Neuroscience</i> 63 :1111-1116.
growth arrest DNA damage induced gene-153	CHOP, GADD153	S62138	U36994	X67083	cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
growth hormone	GH	NM_000515	E00002	NM_008117	ethanol	Down	Emanuele et al. (1992). <i>Endocrinology</i> 131 (5):2077-82.
Gs alpha protein	Gs alpha	AH002748	M12673	NM_010309	morphine, cocaine	Both	Przewlocka et al. (1994) <i>Neuroscience</i> 63 :1111-1116.
haem oxygenase-1	haem oxygenase-1			X13356	phencyclidine	Up	Rajdev et al. (1998) <i>Eur J Neurosci</i> 10 (12):3840-52.
heat shock protein 70	hsp70	NM_005345	X77207	M35021	phencyclidine	Up	Nakahara et al. (1999) <i>Brain Res Mol Brain Res</i> 73 (1-2):193-7.
heme oxygenase-2	HO-2	NM_010443		NM_002134	morphine	Up	Li and Clark (2000) <i>Brain Res Mol Brain Res</i> 75 (2):179-84
homologue of vaccinia virus H1 phosphatase gene clone 5	hVH-5				cocaine, amphetamine, caffeine	Up	Thiriet et al. (1998) <i>Brain Res Mol Brain Res</i> 62 (2):150-7.
inducible nitric oxide synthase	iNOS	NM_010927	NM_012611	NM_000625	heroin	Down	Lysle and How (2000) <i>Immunopharmacology</i> 46 (3):181-92
interleukin-1 alpha	IL-1alpha		D00403	NM_010554	marijuana	Down	Puffenbarger et al. (2000) <i>Glia</i> 29 (1):58-69.
interleukin-1 beta	IL-1beta			NM_008361	marijuana	Down	Puffenbarger et al. (2000) <i>Glia</i> 29 (1):58-69.
interleukin-6	IL-6	M14584	NM_012589	X54542	marijuana	Down	Puffenbarger et al. (2000) <i>Glia</i> 29 (1):58-69.
junB	junB	NM_002229	X54686	NM_008416	morphine, cocaine	Up	Sharp et al. (1995) <i>Behav Brain Res</i> 66 (1-2):225-30.
junD	junD	NM_005354	D26307	J05205	cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
kappa opioid receptor	kappa opioid receptor	U17298	D16829	AH004745	cocaine, ethanol	Down	Rosin A et al. (1999) <i>Neurosci Lett</i> 275 (1):1-4.

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macrophage inflammatory protein-1	MIP-1beta		U06434	M35590	cocaine	Down	Nair et al. (2000) <i>Clin Diagn Lab Immunol</i> 7 (1):96-100
manganese-superoxide dismutase	Mn-SOD	X14322		Z18857	cocaine	Down	Diez-Fernandez et al. (1999) <i>Biochem Pharmacol</i> 58 (5):797-805.
MAP kinase phosphatase-1, oxidative stress-inducible protein tyrosine phosphatase	MKP-1, 3CH134/CL100-PTPase		S81478	NM_013642	cocaine	Up	Berke et al. (1998) <i>J. Neurosci</i> 18 (14):5301-5310.
mineralocorticoid receptor			NM_013131		MDMA	Up	Yau et al. (1997) <i>Neuroscience</i> 78 (1):111-21.
mu opioid receptor	mu opioid receptor	AF153500	U02083	U19380	morphine,lithium	Up	Raynor et al. (1996) <i>NIDA Research Monograph</i> 161. de Gandarias JM et al. (2000) <i>Neurosci Lett</i> 279 (1):9-12.
N-methyl-D-aspartate receptor	NMDA receptor		U11419	D10217	morphine, ethanol, cocaine	Both	Sharp et al. (1995) <i>Behav Brain Res</i> 66 (1-2):225-230. Ikonomidou et al. (2000) <i>Science</i> 287 :1056-1060. Itzhak and Martin. (2000) <i>Neuropharmacology</i> 39 (1):32-9.
NAC-1	NAC-1		AF015911		cocaine	Up	Kalivas PW et al. (1999) <i>Synapse</i> 33 (2):153-9.
NADH dehydrogenase	ND	NC_001807	NC_001665	NC_001569	cocaine	Both	Couceyro et al. (1997) <i>NeuroReport</i> 8 :2437-2441.
nerve growth factor induced clone-B	NGFI-B (rat), NAK1(human), nur77(mouse)	D49728	U17254	AB014889	caffeine, cocaine	Both	Torres G et al. (1996) <i>Brain Res Mol Brain Res</i> 43 (1-2):225-32.
nerve growth factor-induced clone A; also called zif/268, erg-1, and Krox-24.	NGFI-A, zif268, erg-1, Krox-24	NM_001964	U75398	AH003568	cocaine and amphetamine, caffeine, phencyclidine	Both	Kuzmin A and Johansson B(1999) <i>Eur J Neurosci</i> 11 (10):3694-700. Bhat et al. (1995) <i>J Pharmacol Exp Ther</i> 263 (1):343-9. Rodriguez et al. (1999) <i>Exp Neurol</i> 159 :139-152.

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neuronal activity-regulated pentraxin	narp	U26662	S82649	AF049124	cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
neuropeptide Y	NPY	NM_000905	NM_012614		cocaine, phencyclidine	Both	Wahlestedt et al. (1991) <i>PNAS</i> 88 :2078-2082. Fukui et al. (1996) <i>J Neural Transm</i> 103 (4):385-90.
neurotensin	neurotensin	NM_006183	M21216		methamphetamine	Up	Castel et al. (1993) <i>Eur J Neurosci.</i> 6 :646-656.
neurotrophin-3	NT-3	NM_002527	M61179	NM_008742	cocaine	Up	Pierce et al. (1999) <i>J Neurosci</i> 19 (19):8685-95.
NMDA receptor 1	NMDAR1	D13515	U11418	D10028	cocaine	Down	Ghasemzadeh et al. (1999) <i>J Neurochem</i> 72 (1):157-65.
norepinephrine transporter	NET	X91117	Y13223	U76306	cocaine, amphetamine	Up	Burchett and Bannon (1997) <i>Brain Res Mol Brain Res</i> 49 (1-2):95-102.
nuclear orphan receptor 1	nor1			NM_015743	cocaine, morphine	Up	Werme et al. (2000) <i>Brain Res Mol Brain Res</i> 76 (1):18-24.
opioid binding cell adhesion molecule	OBCAM	L34774	M88709	R75391	opiates	Down	Loh and Smith. (1996) <i>NIDA Research Monograph</i> 161 :141-153.
prepro-thyrotropin-releasing hormone	ppTRH	M63582	M36317	X59387	cocaine	Down	Sevarino and Primus (1993) <i>J Neurochem</i> 60 (3):1151-1154.
preprocholecystinin	CCK		K01259		MDMA	Down	Wotherspoon et al. (1994) <i>Brain Res Mol Brain Res</i> 25 (1-2):34-40.
preprotachykinin	Tac1, substance P	NM_013996	M34184	NM_009311	cocaine, amphetamine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310. Hurd and Herkenham (1992) <i>Brain Res Mol Brain Res</i> 16 (1-2):97-104.

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prolactin	PRL	NM_000948	NM_012629	NM_011164	ethanol, cocaine	Down	Emanuele et al (1992) <i>Endocrinology</i> 131 (5):2077-82. DeMaria et al. (2000) <i>Endocrinology</i> 141 (1):366-374.
proopiomelanocortin	POMC	NM_000939		NM_008895	marijuana	Up	Corchero et al. (1997) <i>Eur J Pharmacol</i> 323 (2-3):193-5
ras homolog enriched in brain	rheb	NM_005614	NM_013216		cocaine	Up	Berke et al. (1998) <i>J. Neurosci.</i> 18 (14):5301-5310.
secretogranin II	Scg2	NM_003469	M93669	NM_009129	cocaine	Both	Kuzmin A and Johansson B (1999) <i>Eur J Neurosci</i> 11 (10):3694-700. Kuzmin and Johansson (2000) <i>Pharmacol Biochem Behav</i> 65 (3):399-406.
serotonin transporter	5-HT transporter, SERT	NM_001045	NM_013034	NM_010484	cocaine	Down	Burchett and Bannon (1997) <i>Brain Res Mol Brain Res</i> 49 (1-2):95-102.
tissue plasminogen activator	tPA	D01096	M31197	M23697	methamphetamine, cocaine, phencyclidine	Up	Hashimoto et al. (1998) <i>Eur J Neurosci.</i> 10 (11):3387-99.
tumor necrosis factor- alpha	TNF-alpha			NM_013693	marijuana	Down	Puffenbarger et al. (2000) <i>Glia</i> 29 (1):58-69
tyrosine hydroxylase	TH	NM_000360	NM_012740	NM_009377	cocaine, mazindol	Up	DeMaria et al. (2000) <i>Endocrinology</i> 141 (1):366-374.
visinin-like 1, neural visinin protein-1	Vsnl-1, NVP-1			NM_012038	phencyclidine	Down	Kajimoto et al. (1995) <i>J Neural Transm Gen Sect</i> 100 (3):257-62