	Protein	Phosphorylation sites	Notes	References
Transcription Factors	AML1 (RUNX1)	Ser249, Ser266	Phosphorylation of the acute myelogenous leukemia 1 (AML1) potentially regulates its transactivation potential and thereby modifies myeloid hematopoietic differentiation.	(Tanaka et al., 1996)
	Androgen receptor	Ser514	Phosphorylation of androgen receptor by ERKs is controversial. May play a role in survival and proliferation of prostate cells.	(Yeh et al., 1999)
	Arix/Phox2a	Ser36, Ser71	Phosphorylation of Arix by ERK1/2 inhibits its ability to interact with target genes.	(Hsieh et al., 2005)
	ATF2	Thr71	This phosphorylation together with the phosphorylation of Thr69 by p38MAPK induces activation of ATF2.	(Ouwens et al., 2002)
	Beta2 (Neuro D1)	Ser274	Phosphorylation of this HLH transcription factor induces its glucose-sensitive transactivation and enhances its capability to heterodimerize with E47/12 and bind to DNA.	(Khoo et al. 2003)
	BCL-6	Ser333, Ser343	Phosphorylation of BCL-6 induces its degradation that is important for B-cell differentiation and antibody response.	(Niu et al., 1998)
	BMAL1	Ser527, Thr534, Ser599 (chicken)	Phosphorylation of this helix-loop-helix-PAS transcription factor inhibits its activity as a clock oscillator.	(Sanada et al., 2002)
	CBP	Thr188	Phosphorylation of the C-terminal region of the CREB binding protein (CBP, and also its homolog p300) enhances its transactivation potential.	(Janknecht and Nordheim, 1996)
	C/EBP□	Thr188 (rat)	Phosphorylation of the CCAAT/enhancer-binding protein-□ (C/EBP□) by ERK2 (not ERK1) enhances its interaction with SRF and its transactivation activity.	(Hanlon et al., 2001)
	CRY1/2	Ser265, Ser557 (CRY1, mouse)	Phosphorylation of the Cryptochromes proteins CRY1 and 2 results in attenuation of their ability to inhibit BMAL1:CLOCK-mediated transcription.	(Sanada et al., 2004)
	E47/E12	Ser352, Thr355, Ser359	Phosphorylation of E47/E12 regulates its heterodimerization with Beta2 and subsequent DNA binding.	(Khoo et al. 2003)
	Elk1	Ser324?, Thr336? Thr353, Thr363, Thr-368, Ser383, Ser389, Thr417,Ser422?	Phosphorylation of this Ets transcription factor enhances its activity, which is mainly the transcription of c-Fos.	(Gille et al., 1992) (Cruzalegui et al., 1999)
	ER81	Ser94, Thr139, Thr-143, Ser146, Ser152, Thr158 (mouse)	Phosphorylation of this Ets transcription factor induces its activity and thereby regulates developmental processes.	(Janknecht, 1996)

	Protein	Phosphorylation sites	Notes	References
Transcription Factors	ERF	Thr526 (mouse)	Phosphorylation of this Ets transcription factor decreases its transcriptional repression and thereby regulates differentiation.	(Sgouras et al., 1995)
	Estrogen receptor	Ser118	Phosphorylation of the estrogen receptor results in its activation and propagation of estrogen signaling.	(Kato et al., 1995)
	c-Fos	Thr325, Thr331, Ser374	Phosphorylation stabilizes the c-Fos protein, and is required for its maximal transactivation. It plays a role as a sensor for ERKs' signal duration.	(Murphy et al., 2002)
	Fra-1	Thr231 (mouse)	Phosphorylation enhances DNA binding of Fra-1, and is required for its participation in AP-1 transactivation.	(Young et al., 2002)
	GATA-1/2	Ser26, Ser178 (GATA-1)	This phosphorylation increases the protein-protein interaction of GATA-1, and is involved in the regulation of differentiation and development of erythroid cells.	(Towatari et al., 2004)
	HIF-1α		Phosphorylation enhances the transcriptional activity of hypoxia induced factor1α (HIF-1α).	(Richard et al., 1999)
	HSF-1	Ser307	Phosphorylation of the heat shock factor-1 (HSF-1) represses its transcriptional activation.	(Chu et al., 1996)
	ICER	Ser41 (rat)	Phosphorylation of inducible cAMP early repressor (ICER) targets it to ubiquitination and degradation.	(Yehia et al., 2001)
	c-Jun	Ser63, Ser73, Ser243	Phosphorylation of Ser63 and Ser73 induces the transcriptional activity of c-Jun. The phosphorylation of Ser243 may participate in its downregulation.	(Morton et al., 2003)
	Microph-thalmia (Mi)	Ser73	Phosphorylation of Mi (also termed MITF) leads to its activation and subsequent degradation that are essential for melanocyte development.	(Wu et al., 2000)
	c-Myc	Ser62	It is not clear whether this activatory phosphorylation occurs *in vivo*.	(Alvarez et al., 1991)
	N-Myc	Ser51	Phosphorylation is required for the transcriptional repression activity of N-Myc.	(Manabe et al., 1996)
	Net (Sap-2)	Ser365, possibly other (mouse)	Phosphorylation of this Ets transcription factor participates in converting its activity from repression to activation.	(Price et al., 1995)
	NFATc4	Ser676	Phosphorylation of the nuclear factor of activated T cells (NFAT) is involved in assembly of its transcription complex.	(Yang et al., 2005)
	NF-IL6	Thr235	Phosphorylation of the nuclear factor for IL6 (NF-IL6), which is a member of the C/EBP family (see above), stimulates its transactivation potential.	(Nakajima et al., 1993)

	Protein	Phosphorylation sites	Notes	References
Transcription factors	NGFI-B/TR3/ Nur77	Thr142	Phosphorylation of this factor probably inhibits its proapoptotic action.	(Slagsvold et al., 2002)
	Pax6	Ser413 (zebrafish)	Phosphorylation enhances transactivation activity of Pax6 that is important for the development of the central nerve system.	(Mikkola et al., 1999)
	PDX-1	Ser61, Ser66	The homeodomain-containing transcription factor PDX-1 regulates transactivation activities.	(Khoo et al. 2003)
	PPAR□	Ser84 (PPAR□1), Ser-112 (PPAR□2, mouse)	Phosphorylation of the peroxisome proliferators-activated receptor □ (PPAR□) inhibits its activity and suppresses adipogenesis.	(Hu et al., 1996)
	p53	Thr73, Thr83 (mice), Thr55 (human)	Phosphorylation of Thr55 is necessary for doxorubicin-induced p53 activation and cell death. The role of the other phosphorylations of theis tumor suppressor protein is not entirely clear.	(Milne et al., 1994; Yeh et al., 2004)
	Progesterone receptor	Ser294	Phosphorylation of this nuclear receptor leads to its proteosomal degradation and inhibits progesterone signaling.	(Lange et al., 2000)
	c-Rel	Ser451 (mouse)	It is not clear whether the phosphorylation is by ERK or another proline directed kinase.	(Fognani et al. 2000
	RNA polymerase-II	Multiple sites	Phosphorylation of the C-terminal of this protein induces its transcriptional activity.	(Markowitz et al., 1995)
	RUNX2	Ser14?	Phosphorylation of RUNX2 is required for responsiveness of osteoblasts to extracellular matrix signals.	(Xiao et al., 2000)
	Sap-1	Ser381, Ser387	Phosphorylation activates this Ets transcription factor and thereby facilitates IEG transcription.	(Janknecht et al., 1995)
	Smad1	Ser187, Ser195, Ser206, Ser214	Phosphorylation inhibits nuclear accumulation of Smad1 and its TGF-□-induced transcriptional activity.	(Kretzschmar et al., 1997)
	Smad2/3	Thr220, Ser245, Ser250, Ser255 (Smad 2)	Phosphorylation of Smad2/3 inhibits TGF-□-induced transcription.	(Kretzschmar et al., 1999)
	Smad4	Thr276	Phosphorylation of Smad4 accelerates the rate of its nuclear accumulation and therefore facilitates its TGF-□-induced transcriptional activity.	(Roelen et al., 2003)
	SP-1	Thr453, Thr739	Phosphorylation of this transcription factor stimulates its DNA binding and increases VEGF expression in fibroblasts.	(Merchant et al., 1999) (Milanini-Mongiat et al., 2002)

	Protein	Phosphorylation sites	Notes	References
Transcription factors	SRC-1	Ser395, Thr1179, Ser1185	Phosphorylation of the steroid receptor coactivator 1 (SRC-1) stimulates its ligand-dependent, and progesterone receptor-mediated activity.	(Rowan et al., 2000)
	SREBP1/2	Ser432, Ser455 (SREBP2)	Phosphorylation of the sterol regulatory element binding protein (SREBP) enhances its transactivation activity.	(Kotzka et al., 2000)
	STAT1/3	Ser727 (mouse)	Phosphorylation of the signal transducers and activators of transcription (Stats) inhibits their tyrosine phosphorylation and thereby their transcriptional activity.	(Chung et al., 1997)
	STAT5a	Ser780	Phosphorylation of Stat5a prevents its nuclear translocation and its transcriptional activity.	(Pircher et al., 1999)
	TAL-1/SCL	Ser122	Phosphorylation of the T-cell acute lymphocytic leukemia 1 (TAL-1) enhances its transactivation activity.	(Cheng et al., 1993)
	TFII-I	Ser627, Ser633	Phosphorylation of the transcription initiation factor (TFII-I) facilitates its transcriptional activity on the c-Fos promotor.	(Kim and Cochran, 2000)
	TFIIIB	Thr145	Phosphorylation of the RNA polymerase IIIB (TFIIIB) stimulates its activity and induces synthesis of tRNA.	(Felton-Edkins et al., 2003)
	TGIF	Thr235, Thr239	Phosphorylation of the TGFβ inhibitory factor (TGIF), which is a Smad co-repressor, leads to the stabilization of TGIF, and to the formation of TGIF-Smad2 co-repressing complexes.	(Lo et al., 2001)
	TIF-1A	Ser633	Phosphorylation of the RNA-Polymerase specific transcription initiation factor (TIF)-IA is required for RNA Polymerase I transcription and cell growth.	(Zhao et al., 2003)
	Tob	Ser152, Ser154, Ser164	Phosphorylation of this protein probably prevents its anti-proliferative activity.	(Maekawa et al., 2002)
	UBF	Thr117, Thr201 (rat)	Phosphorylation of this so-called upstream binding factor (UBF), which is a multiple HMG box architectural factor, prevents its interaction with DNA and allows ribosomal transcription.	(Stefanovsky et al., 2001)
Kinases and Phosphatases	DAPK	Ser735	Phosphorylation of the death associated protein kinase (DAPK) promotes apoptosis. DAPK also anchors ERKs in the cytosol.	(Chen et al., 2005)
	ERK1/2	Tyr185 (ERK2)	The role of the autophosphorylation is not clear. Can be followed by a slow Thr183 phosphorylation and a small activation.	(Seger et al., 1991)
	FAK1	Ser910	Phosphorylation may inhibit the interaction of the focal adhesion Tyr kinase 1 (FAK1) with paxillin and thereby inhibits its downstream signaling.	(Hunger-Glaser et al., 2003)

	Protein	Phosphorylation sites	Notes	References
Kinases and phosphatases	GRK2	Ser670 (bovine)	Phosphorylation of the G protein-coupled receptor kinase 2 (GRK2) inhibits its activity and thereby can prolong G-protein coupled receptor signaling.	(Pitcher et al., 1999)
	GSK3β	Thr43	Phosphorylation of glycogen synthase kinase 3 beta (GSK3β) primes it for phosphorylation by p90RSK, resulting in inactivation of GSK3β and upregulation of β-catenin.	(Ding et al., 2005)
	Inhibitor-2	Thr72	Phosphorylation of this subunit of ATP-Mg-dependent protein phosphatase 1 stimulates phosphatase activity.	(Wang et al., 1995)
	Lck	Ser59	Phosphorylation of this T-cell Src family protein Tyr kinase regulates the specificity of its SH2 domain.	(Winkler et al., 1993)
	MAPKAPK3	Thr201, Thr313	Phosphorylation of the MAPK activated protein kinase 3 (MAPKAPK3) stimulates its activity. It is phosphorylated and activated also by p38MAPK.	(Sithanandam et al., 1996)
	MAPKAPK5	Thr182 (mouse)	Phosphorylation stimulates MAPKAPK5 activity. It is activated also by p38MAPK.	(Ni et al., 1998)
	MEK1/2	Thr292, Ser386, Thr286? (MEK1)	Phosphorylation of Thr292 inhibits the phosphorylation of Ser298 by PAK and thereby reduces association with ERK. Phosphorylation of Ser386 can facilitate the binding of MEK1 to Grb10, and thereby increase the rate of ERK activation.	(Matsuda et al., 1993)
	Mirk	Ser557	Phosphorylation of the minibrain-related kinse (Mirk) may mediate tumor cell survival in solid tumors.	(Lee et al. 2000)
	MKP1/2	Ser359, Ser364 (MKP1, mouse)	Phosphorylation of the MAPK phosphatase-1 (MKP1, DUSP1) reduces its rate of degradation.	(Brondello et al., 1999)
	MKP3	Ser159, Ser197, Ser331?	Phosphorylation of this ERK specific MKP3 (DUSP6) seems to lead to its enhanced degradation.	(Camps et al., 1998) ((Marchetti et al., 2005)
	MKP7	Ser446	Phosphorylation of MKP7 (DUSP16) prevents its degradation, and thereby stabilizes it and blocks JNK activity.	(Masuda et al., 2003)
	MLCK	Ser13, Ser19?	Phosphorylation of the myosin light chain kinase (MLCK) enhances its activity.	(Klemke et al., 1997)
	MNK1/2	Thr197, Thr202 (mouse)	Phosphorylation of the MAPK-interacting protein 1/2 (MNK1/2) induces its catalytic activation. MNK1 can be activated also p38MAPK.	(Fukunaga and Hunter, 1997; Waskiewicz et al., 1997)

	Protein	Phosphorylation sites	Notes	References
Kinases and phosphatases	MSK1/2	Ser360, Thr518	Phosphorylation of the mitogen and stress activated protein kinase 1 (MSK1) induces its activation. It can be catalyzed also by p38MAPK.	(Deak et al., 1998)
	PAK1	Thr212	Phosphorylation of the p21 activated kinase 1 (PAK1) may provide a negative feedback signal to control ERK activation.	(Sundberg-Smith et al., 2005)
	PTP2C		Phosphorylation of the protein Tyr phosphatase 2C (PTP2C) inhibits its activity.	(Peraldi et al., 1994)
	Raf1	Ser29, Ser289, Ser-296, Ser301, Ser642	Hyperphosphorylation of these sites inhibits Ras interaction with Raf-1, and thereby desensitizes Raf-1 to additional stimuli.	(Anderson et al., 1991) (Dougherty et al., 2005)
	B-Raf	Ser750, Thr753	Phopshorylation of B-Raf inhibits its activity, and thereby serves as a negative feedback mechanism for ERK signaling.	(Brummer et al., 2003)
	RSK1-4	Thr359, Ser363, Thr573 (RSK1)	Phosphorylation of the p90 ribosomal S6 kinase 1 (RSK1) leads to its activation and propagates ERK-mediated signals.	(Sturgill et al., 1988)
	S6K	Multiple S/P sites	The role of phosphorylation of p70 S6kinase (S6K) is not clear, but may lead to its stabilization.	(Mukhopadhyay et al., 1992)
	Syk		Phosphorylation of this protein Tyr kinase may facilitate its activation and induce a positive feedback loop in mast cells.	(Xu et al., 1999)
Cytoskeletal proteins	Annexin XI		Phosphorylation of annexin XI (CAP-50) regulates its targeting to phospholipids as well as its subcellular localization.	(Mizutani et al., 1993)
	Caldesmon	Ser739, Ser769 (pig)	Phosphorylation induces a partial dissociation of caldesmon from actin and thereby modulates smooth muscle contraction.	(Adam and Hathaway, 1993)
	Calnexin	Ser563	Phosphorylation of calnexin increases its association with ribosomes.	(Chevet et al., 1999)
	CENP-E		Phosphorylation of the centromere-binding protein E (CENP-E) alters the interactions between chromosomes and microtubules.	(Zecevic et al., 1998)
	Connexin-43	Ser279, Ser282	Phosphorylation of connexin-43 may inhibit GAP junction coupling.	(Kanemitsu & Lau, 1993)
	Cortactin	Ser405, Ser418	Phosphorylation of cortactin enhances its ability to activate N-WASP and induces actin polymerization.	(Martinez-Quiles et al., 2004)
	Crystallin	Ser45	The role of phosphorylation is not entirely understood but may regulate cell survival.	(Kato et al., 1998)

	Protein	Phosphorylation sites	Notes	References
Cytoskeletal proteins	DOC-1R	Thr23? (mouse)	Phosphorylation of the deleted in oral cancer one related (DOC-1R) enhances microtubule organization in metaphase II.	(Terret et al., 2003)
	Dystrophin	C-terminal	The role of the phosphorylation is not clear but may induce scaffolding of the ERK cascade.	(Shemanko et al., 1995)
	Lamin B2	Ser16 (chicken)	Phosphorylation of this nuclear envelope protein causes depolymerization of assembled longitudinal lamin polymers.	(Peter et al., 1992)
	MAP1		Phosphorylation of the microtubule-associated protein 1 (MAP1) may induce microtubule association, although this is still controversial.	(Sano, 1992)
	MAP2		The first identified ERKs' substrate. This phosphorylation probably does not occur *in vivo*.	(Sturgill and Ray, 1986)
	MAP4	Ser696	Phosphrylation of MAP4 may modulate organelle transport and chromosome movement.	(Hoshi et al., 1992)
	MISS	Ser14 + other ? (mouse)	Phosphorylation of the MAP kinase–interacting and spindle-stabilizing protein (MISS) probably stabilizes it during the MII phase of oocytes maturation, and specifically regulates MII spindle integrity during oocytic CSF arrest.	(Lefebvre et al., 2002)
	NF-H, NF-M	Many sites	Phosphorylation of the midsized (NF-M) and heavy (NF-H) neurofilament proteins allows their dynamic redistribution and filament formation in nerve cells.	(Veeranna et al., 1998)
	Paxillin	Ser83 (mouse)	Phosphorylation of this member of focal adhesion protein family regulates focal adhesion kinase (FAK) signaling and induces cell morphogenesis.	(Ku and Meier, 2000)
	Stathmin (Oncoprotein18)	Ser25, Ser38	Phosphorylation of stathmin facilitates its effect on cell cycle progression and on cellular differentiation.	(Marklund et al., 1993)
	SWI/SNF		Phosphorylation of this chromatin-remodeling complex inactivates it and thereby allows formation of a repressed chromatin structure during mitosis.	(Sif et al., 1998)
	Synapsin 1	Ser62, Ser67, Ser549 (rat)	Phosphorylation of synapsin 1 contributes to the modulation of synaptic plasticity and regulates neurotransmitter release.	(Jovanovic et al., 1996)
	Tau	Ser199, Ser202, Thr205, Ser235, +	Phosphorylation of this microtubule associated protein transforms it into an Alzheimer-like state.	(Drewes et al., 1992)
	Vinexin	Ser189	Phosphorylation of this cytoskeletal protein facilitates cell spreading upon various stimulations.	(Mitsushima et al., 2004)

	Protein	Phosphorylation sites	Notes	References
Signaling proteins	EGFR	Thr669	The role of this phosphorylation of the epidermal growth factor receptor (EGFR) is not fully understood but may be involved in its downregulation.	(Northwood et al., 1991)
	ENaC□/□	Thr613 (ENaC□, rat), Thr623 (ENaC□ rat)	Phosphorylation of □ and □ subunits of the Epithelial Na^+ Channel (ENaC) downregulates the channel by facilitating its interaction with Nedd4 to induce the degradation of ENaC.	(Shi et al., 2002)
	Fe65	Ser175, Ser287, Ser347, Thr709	Phosphorylation of this neuronal adaptor protein modulates its nuclear signaling activities.	(Standen et al., 2003)
	FRS2		Phosphorylation of FGF receptor substrate 2 (FRS2) reduces its Tyr phosphorylation and inhibits its signaling activity.	(Wu et al., 2003)
	Gab1	Thr312, Ser381, Ser454, Thr476, Ser581, Ser597	Phosphorylation of the Grb2-associated binder 1 (Gab1) may block insulin signaling at the level of PI3K.	(Lehr et al., 2004)
	Gab2	Ser623	Phosphorylation of the Grb2-associated binder 2 (Gab2) reduces its association with the phosphatase SHP-2 and decreases STAT5 activation.	(Arnaud et al., 2004)
	GAIP	Ser151	Phosphorylation of the Galpha-interacting protein (GAIP) stimulates its GTPase accelerating activity.	(Ogier-Denis et al., 2000)
	Grb10	Ser150, Ser476	Phosphorylation of the adaptor molecule Grb10□ provides a negative feedback inhibitory step to insulin-induced signaling.	(Langlais et al., 2005)
	IRS-1	Ser612	Phosphorylation of the insulin receptor substrate-1 (IRS-1) leads to its impaired downstream signaling.	(Andreozzi et al., 2004)
	KSR1	Thr260, Thr274, Ser443 (mouse)	The phosphorylation of the Kinase Suppressor of Ras 1 (KSR1) does not seem to affect its ability to facilitate Ras signaling but may regulate its catalytic activity.	(Cacace et al., 1999)
	LAT	Thr155	Phosphorylation of the linker for activation of T cells (LAT) leads to attenuation of its downstream signaling, which include Ca^{2+} mobilization and activation of the ERK cascade.	(Matsuda et al., 2004)
	LIFR	Ser1044	Phosphorylation of leukemia inhibitory factor receptor (LIFR) leads to its heterologous regulation.	(Schiemann et al., 1995)

	Protein	Phosphorylation sites	Notes	References
Signaling proteins	MARCKS	Ser113 (mouse)	It is not clear whether the phosphorylation of the Myristoylated Alanine-Rich C-Kinase Substrate (MARCKS) by ERK occurs *in vivo*.	(Schonwasser et al., 1996)
	Naf1□		Phsophorylation of the Nef-associated factor 1a (NEF1a) may participate in the prevention of nuclear translocation of ERKs and thereby also inhibition of ERKs' nuclear signaling.	(Zhang et al., 2002)
	PDE4	Ser579	Phosphorylation of this phosphodiesterase inhibits its activity and enhances PKA signaling.	(Hoffmann et al., 1999)
	PLC□1	Ser982 (rat)	Phosphorylation of nuclear PLC□1 plays a role in the activation of the nuclear PI cycle and is also crucial for the mitogenic action of IGF-I.	(Xu et al., 2001)
	PLC□	Thr6, Thr149, Ser451, Thr618, Ser866, Thr1042, Ser1221 (rat)	Phosphorylation of phospholipase C-□1 (PLC□1) significantly reduces its ATP-dependent catalytic activity.	(Buckley et al., 2004)
	Potassium channel Kv 4.2	Thr602, Thr607, Ser616	Phosphorylation of this potassium channel may facilitate excitability of pyramidal neurons in the hippocampus.	(Adams et al., 2000)
	Rab4	Ser199 (mouse)	Phosphorylation of this small GTP-binding protein induces its movement from the Glut-4-containing vesicles to the cytosol.	(Cormont et al., 1994)
	SH2-B	Ser96 (rat)	Phosphorylation of this adaptor protein may serve as a negative feedback mechanism, which is probably important for NGF signaling.	(Rui et al., 1999)
	ShcA	Ser36 (mouse)	Phosphorylation of this 66 kDa adaptor protein is necessary for its signaling towards FOXO3a, and the down-regulation of its target gene p27kip1.	(Hu et al., 2005)
	Sos1	Ser1137, Ser1167, Ser1178, Ser1193, Ser1197	Phosphorylation of this nucleotide exchange factor prevents its association with Grb2, and thereby provides a negative feedback mechanism for growth factor and GPCR signaling.	(Langlois et al., 1995)
	Spin90		Phosphorylation of the SH3 protein interacting with Nck 90 kDa (Spin90) facilitates its complexation and thereby increases cell adhesion.	(Lim et al., 2003)
	TACE	Thr735	Phosphorylation of this TNFa-converting enzyme 9also known as (ADAM17) regulates the shedding of TrkA.	(Diaz-Rodriguez et al., 2002)
	TSC2	Ser664	Phosphorylation of the Tuberous sclerosis protein 2 (TSC2) leads to TSC1-TSC2 dissociation and markedly impairs TSC2 ability to inhibit mTOR signaling.	(Ma et al., 2005)

	Protein	Phosphorylation sites	Notes	References
Apoptotic proteins and proteinases	Bad	Ser112 (mouse)	Phosphorylation of the Bcl2-antagonist of cell death (Bad) is required for the dissociation from Bcl-x(L), and thereby inhibits the proapoptotic activity of Bad.	(Scheid et al., 1999)
	Bim-EL	Ser69? Ser109, Thr110	Phosphorylation of the Bcl2-interacting mediator of cell death EL (Bim-EL) promotes its degradation and thereby inhibits its proapoptotic function.	(Biswas and Greene, 2002)
	Calpain	Ser50	Phosphorylation of the proteinase Calpain II (m-calpain) is required for EGF-mediated cell adhesion and motility.	(Glading et al., 2004)
	Caspase 9	Thr125	Phosphorylation of this proteinase inhibits its activity on caspase 3, and thereby reduces its proapoptotic effect.	(Allan et al., 2003)
	EDD		The role of the phosphorylation of this ubiquitin ligase E3 is not clear but may lead to induction of its activity.	(Eblen et al., 2003)
	IEX-1	Thr18, Thr123, Ser126	Phosphorylation of this survival protein enhances its ability to inhibit cell death. It also further stimulates ERK activity independent of its phosphorylation.	(Garcia et al., 2002)
	MCL1	Thr163	Phosphorylation of this antiapoptotic member of the BCL2 family stabilizes it and thereby enhances its activity.	(Domina et al., 2004)
	TIS21	Ser147, Ser149 (mouse)	Phosphorylation of the TPA inducible sequence 21 (TIS21, also known as BTG2 and PC3) induces its interaction with pin-1 in the cytoplasm, and leads to cell death.	(Hong et al., 2005)
	TNFR CD120a	Thr236, Ser240, Ser-244, Ser270 (mouse)	Phosphorylation of the tumor necrosis factor receptor (TNFR) CD120a (p55) induces changes in its subcellular localization, recruits Bcl2, and protects against apoptosis induced through TNFR signaling.	(Cottin et al., 1999)
Other proteins	Amphiphysin1	Ser285, Ser293	Phosphorylation of this endocytosis-related protein controls NGF receptor/TrkA-mediated endocytosis by terminating the amphiphysin1-AP-2 interaction.	(Shang et al., 2004)
	CCTα	Ser315, Ser319, Ser323	Phosphorylation of this CTP:phosphocholine cytidylyltransferase alpha (CCTα) regulates the synthesis of surfactant PtdCho (Phosphatidylcholine). CCTa is a phosphoenzyme. The precise physiological role in vivo is unknown.	(Agassandian et al., 2005)
	CPSII/CAD	Thr456	Phosphorylation of the carbamoyl phosphate synthetase II (CPSII) part of the carbamoyl-phosphate synthetase 2, aspartate transcarbamylase, and dihydroorotase (CAD) may accelerate de novo biosynthesis of pyrimidine nucleotides.	(Graves et al., 2000)

	Protein	Phosphorylation sites	Notes	References
Other proteins	CR16	Multiple sites	The role of phosphorylation of this glucocorticoid-regulated gene is not clear.	(Weiler et al., 1996)
	GRASP55	Thr222, Thr225	Phosphorylation of the Golgi reassembly stacking protein 55 (GRASP55) may regulate Golgi fragmentation or reassembly during mitosis.	(Jesch et al., 2001)
	GRASP65	Ser277 (rat)	Phosphorylation of GRASO65 plays an important role in cell cycle regulation and may function to integrate cell cycle regulation and growth factor signals. This site can be also phosphorylated by CDK1 during mitosis.	(Yoshimura et al., 2005)
	HABP1	Thr165	Phosphorylation of the hyaluronan-binding protein 1 (HABP1, also known as C1QBP/p32) is required for its nuclear translocation upon mitogenic stimulation.	(Majumdar et al., 2002)
	Histone H3	Ser10	Phosphorylation of Histone H3 is probably important for its involvement in transcription upon UVB irradiation.	(Zhong et al., 2000)
	hnRNP-K	Ser284, Ser353	Phosphorylation of the heterogeneous nuclear ribonucleoproteins-K (hnRNP-K) leads to its cytoplasmic accumulation and inhibition of mRNA translation.	(Habelhah et al., 2001)
	IRS-1	Ser312	Phosphorylation of IRS-1 by ERKs inhibits its association with p85 and therefore may reduce insulin metabolic action.	(Corbould et al., 2006)
	KIP		Phosphorylation of the cell cycle inhibitor p27Kip1 prevents its inhibitory binding to CDK2.	(Kawada et al., 1997)
	MBP	Thr97 (bovine)	Phosphorylation of myelin basic protein (MBP) is not likely to occur *in vivo*. This protein is used as a general non-specific substarte for ERKs.	(Erickson et al., 1990)
	p47Phox	Ser345	Phosphjorylation of this component of NADPH oxidase is essential for priming ROS production by polymorponuclear neutrophil.	(El Benna et al., 1996)
	PHAS-I (4E-BP1)	Ser65 + others	Phosphorylation of the phosphorylated heat-& acid-stable protein regulated by insulin 1 (PHAS1, also known as eukaryotic translation initiation factor 4E binding protein1 (4E-BP1) relives its inhibitory associations and induces translation. The role of ERKs is questionable.	(Haystead et al., 1994)
	$cPLA_2$	Ser505	Phosphorylation of the cytosolic phospholipase A_2 $(PLA)_2$ induces its activity and thereby the release of arachidonic acid.	(Nemenoff et al., 1993)

	Protein	Phosphorylation sites	Notes	References
Other proteins	Rb	Ser795	Phosphorylation of the retinoblastoma protein (Rb) is associated with its binding to E2F, and relieves the cell cycle arrest induced by non-phosphorylated Rb.	(Garnovskaya et al., 2004)
	SAP90/PSD-95	Thr287, Ser290 (rat)	Phosphorylation of the synapse-associated protein 90 (SAP90, also known as PSD95) is important for the regulation of protein-protein interaction at the synapse upon stress and mitogenic stimuli.	(Sabio et al., 2004)
	Spinophilin	Ser15, Ser205 (mouse)	Phosphorylation of this protein phosphatase-1 and actin-binding protein decreases its binding to, and bundling of, actin filaments, and thereby modulates spine morphology.	(Futter et al., 2005)
	Topoisomerase II		The activation of topoisomerase II is dependent on ERK2 activity, but does not require phosphorylation. Facilitates DNA unwinding and transcriptional activity upon stimulation.	(Shapiro et al., 1999)
	Tpr		The role of the phosphorylation of the translocated promoter region (Tpr) is not fully understood but may participate in the regulation of nuclear shuttling of the Tpr.	(Eblen et al., 2003)
	TTP (Nup475)	Ser220 (mouse)	The role of the phosphorylation of this mRNA binding protein tristetraprolin (TTP, also known as Nup475) is not clear but it may stabilize its protein-RNA interaction.	(Taylor et al., 1995)
	Tyrosine hydroxylase	Ser31 (rat)	Phosphorylation may enhance tyrosine hydroxylase activity upon mitogenic stimulation.	(Haycock et al., 1992)
	Vif	Thr96, Ser165 (virus protein)	Phosphorylation of this regulatory protein of the human immunodeficiency virus type 1 (HIV-1) may enhance HIV-1 replication by enhancing virion infectivity.	(Yang and Gabuzda, 1998)
	Vpx	Ser63, Ser65, Thr67 (virus)	Phosphorylation of this simian immunodeficiency virus protein regulates its nuclear import and virus infectivity.	(Rajendra Kumar et al., 2005)

Table 1 – ERKs' substrates: Amino acid numbering is according to the human sequence unless otherwise specificed (note that in some articles there was no mention of the origin of the protein used for elucidating the phosphorylation site). The phosphorylations mentioned are those by ERKs only.

Gene Symbol	Locus ID	Accession
VIM	7431	NM_003380
GAB1	2549	NM_002039
KSR1	8844	NM_014238
MP1	8649	NM_021970
MAP3K1	4214	XM_042066
MAPK8IP1	9479	NM_005456
MAPK8IP3	23162	NM_015133
KRIT1	889	NM_004912
IMP-1	10642	NM_006546
ITGB3 (integ)	3690	NM_000212
IQGAP1	8826	NM_003870
ITGAV (integ)	3685	NM_002210
MAP3K7IP1	10454	NM_006116
MAP3K7IP2	23118	NM_015093
RAGE	5891	NM_014226
PXN	5829	NM_002859
KSR2	283455	NM_173598
SH3MD2 (posh)	57630	NM_020870
ARRB2	409	NM_004313
RASSF2	9770	NM_014737
IL17RD (Sef)	54756	NM_017563
AKAP6	9472	NM_004274
YWHAB (1433)	7529	NM_003404
AXIN2	8313	NM_004655
GKAP1	9229	NM_004746
VCL	7414	NM_003373
MAGI3	260425	NM_020965
AXIN1	8312	NM_003502
DAG1	1605	NM_004393
PEA15	8682	NM_003768
RASSF5	83593	NM_031437
FLNC	2318	NM_001458
CNN3	1266	NM_001839
MAGI1	9223	NM_015520
ARRB1	408	NM_004041
CNK1	10256	NM_006314
MAGI2	9863	NM_012301
MAPK8IP2	23542	NM_012324
FLNA	2316	NM_001456
CCM2	83605	NM_031443
MORG1	84292	NM_032332
GRB10	2887	NM_005311
SUFU	51684	NM_016169
SORBS3 (vinexi	10174	NM_005775
TAB3	257397	NM_152787
CNN1	1264	NM_001299
FHL1	2273	NM_001449
FHL2	2274	NM_001450
RASSF1	11186	NM_007182
SPAG9	9043	NM_003971
RASSF4	83937	NM_032023
SH2D2A (lad)	9047	NM_003975
RASSF6	166824	NM_177532
RASSF3	283349	NM_178169
SHOC2 (sur8)	8036	NM_007373
PBP (RKIP)	5037	NM_002567
CNN2	1265	NM_004368
FHL3	2275	NM_004468
FLNB	2317	NM_001457
CNK2	22866	NM_014927
GIT1	28964	NM_014030