

HSP90 INTERACTORS

Chaperones and relatives

- Aha1 and its homolog Hch1
- Cdc37 (p50) and its relative Hsc70 (= Cdc37L1)
- p23 (=Sba1)
- proteins with TPR motifs: Hop (=Sti1), FKBP52 (and high MW plant homologs), FKBP51, FKBP8 (=FKBP38), FKBP36 (= FKBP6), Plasmodium FKBP35, cyclophilin-40 (Cpr6 and Cpr7), PP5 (and yeast Ppt1), Tom70, probably also related Tom71=Tom72, XAP-2 (=AIP=ARA9), Cns1 and its Drosophila and human relatives Dpit47 and TTC4, CHIP, UNC45A (GC-UNC45) and UNC45B, She4, DnaJC7 (=Tpr2=mDj11=CCRP), CRN, WISp39 (=FKBPL), Tah1 (=Spaghetti=RPAP3), Spag1, NASP, Toc64 and OM64, TPR1 (=Ttc1), SGT (=αSGT=SGTA), DYX1C1, AtTPR1, AtTPR2, AtTPR7, AIPL1, Tom34, Tetrahymena Coi12p
- CS-containing p23 relatives AARSD1, SGT1 (=SUGT1), RAR1, Siah-1-interacting protein (SIP), Chp1/CHORDC1/Morgana, B-ind1, melusin, NudC and NudCL2 (=Nudcd2)
- FNIP1, FNIP2
- Hsc70/Hsp70/Hsp72/DnaK
- Hsp60
- mtHsp70/Grp75/mortalin
- Human DnaJ homolog Hsj1b, cyanobacterial DnaJ2
- PhLP2A
- Pih1 (=Nop17) (mostly through Tah1)
- S100A1
- Sse1, Sse2
- Tel2-Tti1-Tti2 complex
- Toxoplasma Sis1-like
- valosin-containing protein (VCP)/p97
- GIGANTEA

Ids2

Transcription factors

- 12(S)-HETE receptor
- AF9/MLLT3
- all vertebrate steroid receptors (GR, MR, ERα, ERβ, PR, AR)
- AGL24
- ATF3
- BBX
- BCL-6
- BES1
- BrZ7
- BZR1
- C20orf194
- CAR
- CEBPE
- CXXC1
- cytoplasmic v-erbA
- DLX6
- DMRTA1
- EcR
- FOXD4L6
- FOXM1
- FOXP2
- GTF2IRD2
- Hap1
- HMGA1, HMGA2
- HNF4A
- HP1BP3
- HSF-1
- HsfA1, HsfA2, HsfB1
- IRF2
- IRF3
- ISX
- LFY
- MAFG
- Mal63
- MalR
- MAX
- Met1
- MKX
- mod(mdg4)
- Nanog
- NFIC
- NFRKB
- Notch1 (ICN1)
- NR1H3
- NR1I2
- Oct4
- p53

- p73
- PAS family members: Dioxin receptor (=AhR), Sim, HIF-1α, HIF-2α, HIF-3α
- PCGF6
- POGK
- PPARα, PPARβ, PPARγ
- PRDM1
- PREB
- PXR
- REV-ERBα
- SETDB1
- SIM2
- SLFN11
- SOC1
- SOX11
- Sp1
- SREBF1
- SREBP1
- SREBP2
- Stat2
- Stat3 (also in caveolin-1 complexes in rafts)
- Stat5
- SUP
- TADA2A
- TBX22
- TCF25
- TDP-43
- TEAD2
- TFDP3
- THAP4
- TonEBP/OREBP
- TRIM32
- Tup1
- Twist1
- Ure2
- USP1
- VDR
- VP16
- water mold *Achlya* steroid (antheridiol) receptor
- WT1
- ZBED4
- ZBTB17
- ZBTB20
- ZC3H7B
- ZNF215
- ZNF509
- ZNF74

Kinases

- | | | |
|--|--|---|
| <ul style="list-style-type: none"> - ACVR1B - ACVR1C - ACVR2B - Akt/PKB - AKT2 - ALK - ALK1, ALK5 - ALPK1 - AMHR2 - AMPKα, AMPKγ - ASK1 - ATM - AURKC - Aurora B - AXL - Bcr-Abl - BGLF4 of EBV - BLK - BMPR1A - BMX - BTK - c-Abl - c-Kit - c-Mos - CAMK1G - CAMK2A - CAMK2B - CAMK2D - CAMK2G - CAMK4 - CAMKK1 - CAMKK2 - CAMKV - casein kinase IIα catalytic subunit - Cdc2 (=Cdk1) - CDK11B - CDK14 - CDK15 - CDK18 - Cdk2, Cdk4, Cdk6, Cdk9, Cdk11 - CDK3 - CheA (E. coli) - Chk1 - Cla4 - CLK2 - CLK3 - Cot = Tpl-2 - CSF1R - CSNK1A1 - DCLK2 - DDR1 - DDR2 - Death-associated kinases DAPK, DAPK2, DAPK3 | <ul style="list-style-type: none"> - DLK - DMPK - DYRK1B - DYRK2 - DYRK4 - eEF-2 kinase - EGF receptor (mutant and wt) - eIF2-α kinases HRI, Gcn2, Perk, PKR - Eml4-Alk - EPHA1 - EphA2 - EPHA4 - EPHB1 - EPHB6 - ErbB2 - ERBB3 - ERBB4 - ERK5 - FASTK - FGFR1 - FGFR3 and FGFR4 - FIt3 - FLT4 - FOP2-FGFR1 - FRK - Fused - FYN - Gal1 - GRK2 and GRK6 - GRK4 - GRK7 - GSK3A - GSK3β - HCK - HER3 - HIPK4 - ICK - INSRR - Insulin receptor - Insulin-like growth factor 1 receptor - Integrin-linked kinase - IP6K2 - IRAK-1 - IRAK2 - IRAK3 - Ire1α - ITK - IκB kinases (IKK) α, β, γ, ϵ - JAK1 - JNK - KSR - LATS1, LATS2 - LCK - LIMK1 - LIMK2 - Lkb1 | <ul style="list-style-type: none"> - LRRK2 - LYN - MAP2K5 - MAP2K7 - MAP3K12 - MAP3K15 - MAP3K2 - MAP3K6 - MAP3K9 - MAP4K1 - MAP4K2 - MAP4K4 - MAPK15 - MAPK4 - MAPK6 - MAPK7 - MAST2 - MATK - MEK - MEKK1 and MEKK3 - MERTK - MET - Mik1 - MINK1 - MLK3 - MLKL - MOK, MAK, MRK - Mps1 - mTOR - MUSK - MYLK2 - MYLK3 - MYLK4 - NEK11 - NEK8 - NEK9 - NIK - NPM-Alk - NPR2 - NTRK1 - NTRK2 - NTRK3 - NUAK2 - Nucleophosmin-Anaplastic Lymphoma Kinase - p38 - p90RSK - PAK6 - PASK - PDGFRB - PDIK1L - PDK1 - PGK1 - PI4KIIβ - Pim-1 - PIM2 - PIM3 - Pink1 - PKCλ, PKCϵ and other PKCs |
|--|--|---|

- PKM2
- PKN1
- PKN2
- platelet-derived growth factor receptor α
- Plk1
- Pnck
- pp60v-src, c-src
- PRKAA2
- PRKACB
- PRKCA
- PRKCB
- PRKCG
- PRKCH
- PRKCI
- PRKQC
- PRKCZ
- PRKD1
- PRKD2
- PRKDC
- PRKG2
- PRKX
- PRKY
- PSKH1
- PSKH2
- PTK2
- PTK2B
- PTK6
- PTK6
- Raf-1, B-Raf, Ste11
- RET
- RET/PTC1
- RIP1
- RIP3
- Ron
- ROR2
- RPS6KA1
- RPS6KA2
- RPS6KA3
- RPS6KA5
- RPS6KA6
- RPS6KB1
- RPS6KC1
- RPS6KL1
- Ryk
- SGK-1
- SGK2
- SGK223
- SGK3
- Slt2
- src related tyrosine kinases: fer, fes, fgr, fps, lck, yes
- SRPK1
- SRPK3
- SSCMK1
- STK32B
- STK32C
- STK33
- STK38

- STK38L
- STYK1
- SYK
- TAK1
- TAOK3
- TBK1
- TESK1
- TESK2
- TGF β receptors I and II
- TIE1
- TNK1
- TNK2
- TNNI3K
- TP53RK
- TrkA1 and III
- TrkB
- TSSK1B
- TSSK2
- TSSK3
- TSSK4
- TSSK6
- Tyk2
- TYRO3
- Ulk1
- VEGFR1, VEGFR2
- Wee1, Swe1
- WNK4
- ZAP-70

Others

- Act1 (=TRAF3IP2)
- Adenosine A_{2A} receptor
- α_{2C} adrenergic receptor
- AID
- Aldo-keto reductase 1B10
- ANAPC2
- ANKMY2
- Annexin II
- ANP receptor
- ANP32C/D
- Apaf-1
- apoB
- APOBEC-3B, -3C, -3G
- ARD1
- Argonaute-1 (Ago1)
- Argonaute-2 (=Ago2=GERp95)
- Argonaute-4 (Ago4)
- ARMC5
- ASB17
- ASB2
- ASB3
- ASB4
- ASB6
- ATG8 (GABARAP) proteins
- Axin 1
- BALF5 of EBV
- Bcl-2

- Bcl-xL
- Beclin 1
- Bid
- BIN2
- BLM helicase
- Bms1
- BPIFB4
- BRAT1
- BRCA1
- BRCA2
- BRMS1
- BTRC
- c-IAP1
- calcineurin (Cna2; catalytic subunit)
- calmodulin
- calmodulin methyltransferase
- calpain-1
- calponin
- CARM1
- Caspase-8
- β -catenin
- CB2 cannabinoid receptor
- Ccp1
- CCDC117
- Cdc13
- Cdc14
- Cdc25a and Cdc25c
- Cdk5 activator p35
- CFTR (nascent and mutant polypeptide)
- ChAT
- CheZ (E. coli)
- Chl1
- Chronophin
- Cineole synthase 1
- CLC-1 chloride channel
- CLC-2 chloride channel
- Clostridium toxin CDT
- Clostridium toxin iota
- Clusterin
- COG complex
- Complement C9
- CTA1
- Ctf13/Skp1 component of CBF3
- CUL1
- CUL2
- CUL3
- CUL4A
- CUL4B
- Cup
- cyclin B
- cyclophilin D (mitochondrial)
- Cyr1
- cytoskeletal proteins: actin, tubulin (including

ciliary β 4-tubulin), myosin (including Myo3B)	- free β subunit of G protein	- KLHL13
- DBC2	- G2E3	- KLHL14
- DEDD	- GAN	- KLHL15
- Dengue virus protein E	- Gln1	- KLHL22
- Dengue virus proteins NS1/2B/3/4B/5	- GLT-1	- KLHL23
- DET1	- glutathione S-transferase subunit 3 (KS type)	- KLHL25
- Diphtheria toxin A	- Guanylate cyclase, soluble	- KLHL26
- DNA helicase Ssl2	- $G\alpha_0$, $G\alpha_{12}$	- KLHL29
- DNA polymerase α	- Glucocerebrosidase	- KLHL32
- DNA polymerase λ	- GREB1	- KLHL34
- DNA polymerase η	- HAX-1	- KLHL36
- DnaA (E. coli)	- HDAC1	- KLHL38
- DNMT1	- HDAC6	- KLHL6
- Dsn1	- HECTD3	- knob complexes (in the membrane of Plasmodium-infected erythrocytes)
- DTX4	- Hepatitis B virus core protein	- KSHV K1
- E6 ^A E7	- Hepatitis C virus protein NS3	- KSR1
- EBAX-1	- Hepatitis E virus capsid protein	- KSR2
- Emc2	- HERC4	- L protein of HRSV
- ENC1	- HERC6	- Lamin A/C
- eNOS, nNOS (?)	- Histones H1, H2A, H2B, H3 and H4	- LAMP-2A
- ether-a-gogo-related potassium channel (ERG = HERG = KCNH2)	- HMGCR	- LANA of KS-HSV
- EZH2	- Hsp27	- LAP
- F1F0-ATP synthase	- Humanin	- LARP4B
- FANCA	- Huntingtin	- Legumain
- FBXL12	- Importin 4 (IPO4)	- LGALS3BP
- FBXL13	- Importin β 1	- LIS1
- FBXL14	- Importin- α 6 (KPNA5)	- LNX1
- FBXL15	- Inositol 1,4,5-trisphosphate receptor 3	- LOC440248
- FBXL18	- Integrin α 2	- LOX1 (OLR1)
- FBXL2	- Integrin α 4	- LOXL2
- FBXL3	- Integrin α L	- LRP1 (=CD91)
- FBXL8	- IL-1 β	- LRSAM1
- FBXO10	- IRS-2	- LSD1
- FBXO17	- Japanese encephalitis virus E protein	- macromolecular aminoacyl-tRNA synthetase complex
- FBXO18	- JlpA	- Macrophage scavenger receptor
- FBXO24	- KAP1	- MARCH9
- FBXO25	- KAT5	- Mdm2
- FBXO27	- KBTBD4	- MDM4
- FBXO28	- KBTBD7	- Mg ²⁺ -dependent phosphatidate phosphohydrolase
- FBXO3	- KCNA5	- MIF
- FBXO34	- KCNA6	- misfolded VHL
- FBXO38	- KCNG1	- MMP2, MMP3, MMP9
- FBXO4	- KCNS3	- MRE11/Rad50/NBS1 (MRN) complex
- FBXO40	- KCNQ4	- MRP1
- FBXO6	- KCTD8	- Msps/XMAP215/ch-TOG
- FBXO9	- KDM3A/JMJD1A	- MTA1
- FBXW11	- KDM4B/JMJD2B	- MTG8
- FBXW2	- KEAP1	- MUC1
- FBXW5	- KIAA0317	- N-myc downstream-regulated gene 1 (NRDG1)
- FBXW7	- Kir6.2	- N-WASP
- FGAMS	- KLHL1	- Na ⁺ -K ⁺ -Cl ⁻ cotransporter 1
- Fibronectin	- KLHL10	
- FliN, FliI (E. coli)		
- FLIP _S and FLIP _L		
- Folliculin		

- NadA
- NB-LRR proteins: RPM1 and RPS2, Nod1, Nod2, NALP2, NALP3, NALP4, NALP12, IPAF, RPP4
- NCC
- NELF-E
- Neuraminidase
- Neuropeptide Y
- NHE1
- NHLRC1
- Nibrin
- NleH1 and NleH2
- NMNAT2
- Norovirus capsid protein VP1
- Nox1, Nox2, Nox3, Nox5
- NS1
- Nsl1
- NSP3
- nsP3 and nsP4 of Chikungunya virus
- Nup62
- OGT
- OsCERK1
- P protein (rabies virus)
- P1 (picornaviral capsid precursor protein P1)
- p14ARF
- P2X₇ purinergic receptor
- p300
- P450 CYP2E1
- PARK2
- PARK7 (DJ-1)
- PB1 and PB2 subunits of influenza RNA pol.
- PCGF1
- PCGF3
- PCNA
- perilipin
- PfCRT
- PIDD
- Piwi
- PIWIL2
- PLN
- polysomal ribonuclease 1 (PMR1)
- PPAT
- PRDM14
- PRMT5
- pro-Dcp1
- prolactin receptor
- prostacyclin synthase
- proteasome
- PRPF8
- PRPF19
- R-protein I-2
- R2TP complex through Pih1
- Rab-αGDI
- Rab3a
- Rab11a
- RAB40A
- Rac/Rop GTPase Rac1 (rice)
- Rac1
- Rad51
- Rad52
- RAG1
- Ral-binding protein 1 (RalBP1)
- RanBP9
- Rapsyn
- Raptor
- RCBTB1
- RCBTB2
- reovirus protein σ1
- REV1
- reverse transcriptase of hepatitis B virus
- RFWD3
- RGS11
- RGS6
- RGS7
- RGS9
- RHOBTB1
- ribosomal protein L2 (E. coli)
- ribosomal proteins S3 and S6
- ricin catalytic A chain
- RIG-I
- RNA-dep. RNA polymerase (of Bamboo mosaic virus)
- RNF10
- RNF111
- RNF19B
- RNF40
- RNGTT
- Rnr4
- Rpb1
- SCAP
- SDF2
- SENP3
- SERCA2a
- SERT (SLC6A4)
- SF3B3
- SH3RF2
- Sicily
- SIR2 (SIR2RP1 in Leishmania)
- SIRT1
- SIRT2
- SKP2
- SKP2 complexes
- SMYD1, SMYD2, SMYD3
- snoRNP complexes
- SNRNP200
- SOCS6
- SPSB1
- SPSB3
- SREC-I
- SUR1 (subunit of β-cell ATP-sensitive potassium channel)
- survivin
- SV40 large T-antigen
- α-synuclein
- Tab2/3
- Tau protein
- Tax
- telomerase
- TFR1
- thiopurine S-methyltransferase
- thrombin receptor (PAR-1)
- thromboxane synthase
- TiIS
- TIR1
- Tissue plasminogen activator (tPA)
- Titin
- TLR4/MD-2 complex
- TLR7
- TLR9
- Tm-2²
- TNFAIP3
- TOM40
- TRIM10
- TRIM17
- TRIM2
- TRIM36
- TRIM37
- TRIM41
- TRIM49
- TRIM56
- TRIM7
- TRIM73
- TRIM74
- TRIM8
- Triosephosphate isomerase
- Trithorax (and ortholog MLL)
- Trx1
- TrxR
- Tyrosine hydroxylase
- UCH-L1
- UHRF1
- uPA
- Ura2
- URI complex
- Uroporphyrinogen decarboxylase (HemE) [in cyanobacteria]
- Us11 (of HSV-1)
- USP19
- Utp21
- Vaccinia core protein 4a
- vFLIP (of KSHV)
- Vimentin

- VIP1
- VPS18
- VPS41
- WASF3
- WSB2
- WTAP
- WWP1
- XPO1
- XPORT
- XRCC1
- ZEITLUPE
- ZMYND10

Notes:

- Only the cytosolic form(s) of Hsp90 is considered.
- Clients from different species are all mixed together and the protein names are typically those of the original publication (i.e. not necessarily the official protein name).
- Only proteins are listed for which biochemical evidence for an interaction is available (i.e. geldanamycin effects alone are not considered as sufficient).
- more candidate interactors can be found in reports about proteomic approaches (Falsone et al. [2005] FEBS Lett. 579, 6350; Te et al. [2007] J. Proteome Res. 6, 1963; Caldas-Lopes et al. [2009] PNAS 106, 8368; Tsaytler et al. [2009] Cell Stress Chaperones 14, 629; Gong et al. [2009] Mol. Syst. Biol. 5, 275; Gano and Simon [2010] Mol. Cell. Proteomics 9, 255; Behrends et al. [2010] Nature 466, 68; Wang et al. [2010] Cancer Invest. 28, 635; Garcia-Descalzo et al. [2011] Cell Stress Chaperones 16, 203; Skarra et al. [2011] Proteomics 11, 1508, Moulik et al. [2011] Nat. Chem. Biol. 7, 818; Wu et al. [2012] Mol. Cell. Proteomics 11, M111 016675; Taipale et al. [2012] Cell 150, 987; Taipale et al. [2014] Cell 158, 434; Truman et al. [2015] J. Proteomics 112, 285; Savitsky et al. [2018] Cell 173, 260), global analyses (e.g. Zhao et al. [2005] Cell 120, 715; Millson et al. [2005] Euk. Cell 4, 849; McClellan et al. [2007] Cell 131, 121; Franzosa et al. [2011] PLoS One 6, e28211; Sharma et al. [2012] Mol. Cell. Proteomics 11, M111 014654; Rizzolo et al. [2017] Cell Rep. 20, 2735; Miao et al. [2018] Anal. Chem. 90, 11751), and in a pharmacological survey of kinases (Citri et al. [2006] J. Biol. Chem. 281, 14361; Haupt et al. [2012] BMC Cancer 12, 38).
- See **Hsp90Int.db** for the comprehensive (notably human) interactome built with data from public protein-protein interaction databases and the literature (Echeverría et al. [2011] PLoS One 6, e26044; and its associated database at <http://www.picard.ch/Hsp90Int>). Hsp90Int.db also uses exclusively the official NCBI names.
- **Looking for references? See <https://www.picard.ch/downloads/Hsp90facts.pdf>.**