HSP90 INTERACTORS

Chaperones and relatives

- Aha1 and its homolog Hch1
- Cdc37 (p50) and its relative Harc (= 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, cynobacterial DnaJ2
- PhLP2A
- Pih1 (=Nop17) (mostly through Tah1)
- S100A1
- Sse1, Sse2
- Tel2-Tti1-Tti2 complex
- Toxoplasma Sis1-like
- valosin-containing protein (VCP)/p97
- GIGANTEA

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
- 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
- Ure2
- USP1
- VDR
- water mold *Achlya* steroid (antheridiol) receptor
- WT1
- ZBED4
- ZBTB17
- ZBTB20
- ZC3H7B
- ZNF215
- ZNF509
- ZNF74

Kinases

- 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**
- **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**
- **Flt3**
- **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 α, β, γ, ε**
- **JAK1**
- **JNK**
- **KSR**
- **LATS1, LATS2**
- **LCK**
- **LIMK1**
- **LIMK2**
- **Lkb1**
- **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**
- **PRKCQ**
- **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**
- **TGFβ receptors I and II**
- **TIE1**
- **TNK1**
- **TNK2**
- **TNNI3K**
- **TP53RK**
- **TrkAI 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**
- **COG complex**
- **Complement C9**
- **CTA1**
- **Ctf13/Skp1 component of CBF3**
- **CUL1**
- **CUL2**
- **CUL3**
- **CUL4A**
- **CUL4B**
- **Cup**
- **cyclin B**
- **cyclophilin D (mitochondrial)**
- **Cyr1**
- **cytoskelettal proteins: actin, tubulin (including ciliary β4-tubulin), myosin (including Myo3B)**
- **DBC2**
- **DEDD**
- **Dengue virus protein E**
- **Dengue virus proteins NS1/2B/3/4B/5**

- **DET1**
- **Diphtheria toxin A**
- **DNA helicase Ssl2**
- **DNA polymerase α**
- **DNA polymerase λ**
- **DNA polymerase η**
- **DnaA (E. coli)**
- **DNMT1**
- **Dsn1**
- **DTX4**
- **E6^E7**
- **EBAX-1**
- **ENC1**
- **eNOS, nNOS (?)**
- **ether-a-gogo-related potassium channel (ERG = HERG = KCNH2)**
- **EZH2**
- **F1F0-ATP synthase**
- **FANCA**
- **FBXL12**
- **FBXL13**
- **FBXL14**
- **FBXL15**
- **FBXL18**
- **FBXL2**
- **FBXL3**
- **FBXL8**
- **FBXO10**
- **FBXO17**
- **FBXO18**
- **FBXO24**
- **FBXO25**
- **FBXO27**
- **FBXO28**
- **FBXO3**
- **FBXO34**
- **FBXO38**
- **FBXO4**
- **FBXO40**
- **FBXO6**
- **FBXO9**
- **FBXW11**
- **FBXW2**
- **FBXW5**
- **FBXW7**
- **FGAMS**
- **Fibronectin**
- **FliN, FliI (E. coli)**
- **$FLIP_S$ and $FLIP_L$**
- **Folliculin**
- **free βγ subunit of G protein**
- **G2E3**
- **GAN**
- **GLT-1**
- **glutathione S-transferase subunit 3 (KS type)**
- **Guanylate cyclase, soluble**
- **$G\alpha_0$, $G\alpha_{12}$**
- **Glucocerebrosidase**
- **GREB1**
- **HAX-1**
- **HDAC1**
- **HDAC6**
- **HECTD3**
- **Hepatitis B virus core protein**
- **Hepatitis C virus protein NS3**
- **Hepatitis E virus capsid protein**
- **HERC4**
- **HERC6**
- **Histones H1, H2A, H2B, H3 and H4**
- **Hsp27**
- **Humanin**
- **Huntingtin**
- **Importin 4 (IPO4)**
- **Importin β1**
- **Importin-α6 (KPNA5)**
- **Inositol 1,4,5-trisphosphate receptor 3**
- **Integrin α2**
- **Integrin αL**
- **IL-1β**
- **IRS-2**
- **Japanese encephalitis virus E protein**
- **JlpA**
- **KAP1**
- **KAT5**
- **KBTBD4**
- **KBTBD7**
- **KCNA5**
- **KCNA6**
- **KCNG1**
- **KCNS3**
- **KCNQ4**
- **KCTD8**
- **KDM3A/JMJD1A**
- **KDM4B/JMJD2B**
- **KEAP1**
- **KIAA0317**
- **Kir6.2**
- **KLHL1**
- **KLHL10**
- **KLHL13**
- **KLHL14**
- **KLHL15**
- **KLHL22**
- **KLHL23**
- **KLHL25**
- **KLHL26**
- **KLHL29**
- **KLHL32**
- **KLHL34**
- **KLHL36**
- **KLHL38**
- **KLHL6**
- **knob complexes** (in the membrane of Plasmodium-infected erythrocytes)
- **KSHV K1**
- **KSR1**
- **KSR2**
- **L protein of HRSV**
- **Lamin A/C**
- **LAMP-2A**
- **LANA of KS-HSV**
- **LAP**
- **LARP4B**
- **Legumain**
- **LGALS3BP**
- **LIS1**
- **LNX1**
- **LOC440248**
- **LOX1 (OLR1)**
- **LOXL2**
- **LRP1 (=CD91)**
- **LRSAM1**
- **LSD1**
- **macromolecular aminoacyl-tRNA synthetase complex**
- **Macrophage scavenger receptor**
- **MARCH9**
- **Mdm2**
- **MDM4**
- **Mg^{2+}-dependent phosphatidate phosphohydrolase**
- **MIF**
- **misfolded VHL**
- **MMP2, MMP3, MMP9**
- **MRE11/Rad50/NBS1 (MRN) complex**
- **MRP1**
- **Msps/XMAP215/ch-TOG**
- **MTA1**
- **MTG8**
- **MUC1**
- **N-myc downstream-regulated gene 1 (NRDG1)**
- **N-WASP**
- **Na^+-K^+-Cl^- cotransporter 1**
- **NadA**
- **NB-LRR proteins: RPM1 and RPS2, Nod1, Nod2, NALP2, NALP3, NALP4, NALP12, IPAF, RPP4**
- **NCC**
- **NELF-E**
- **Neuropeptide Y**
- **NHE1**
- **NHLRC1**
- **Nibrin**

- **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**
- **$P2X_7$ 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**
- **Rnr4**
- **Rpb1**
- **SCAP**
- **SDF2**
- **SENP3**
- **SERCA2a**
- **SERT (SLC6A4)**
- **SF3B3**
- **SH3RF2**
- **Sicily**
- **SIR2 (SIR2RP1 in Leishmania)**
- **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**
- **TilS**
- **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**
- **WWP1**
- **XPO1**
- **XPORT**
- **XRCC1**
- **ZEITLUPE**

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), 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.**