

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 (=FKBP4; and high MW plant homologs), FKBP51 (=FKBP5), FKBP8 (=FKBP38), FKBP36 (=FKBP6), *Plasmodium* FKBP35, plant TWD1, 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)
- Prefoldin 4 and 6
- S100A1
- Sse1, Sse2
- Tel2-Tti1-Tti2 complex
- *Toxoplasma* Sis1-like

- valosin-containing protein (VCP)/p97

- USP19
- Tsc1
- ZMYND10
- GIGANTEA
- Ids2
- TIMP2
- Cereblon

Transcription factors

- 12(S)-HETE receptor
- AF9/MLLT3
- all vertebrate steroid receptors (GR, MR, ERα, ERβ, PR, AR)
- AGL24
- ATF3
- BBX
- BCL-6
- Bclaf1
- BES1
- BrZ7
- BZR1
- C20orf194
- CAR
- C/EBPβ
- CEBPE (C/EBPε)
- Cwt1
- CXXC1
- cytoplasmic v-erbA
- DLX6
- DMRTA1
- E1A
- E2F1 and E2F2
- EcR
- FOXD4L6
- FOXM1
- FOXP2
- GTF2IRD2
- Hap1
- HCFC1
- HMGA1, HMGA2
- HNF4A
- HP1BP3
- HSF1
- HSF2
- HsfA1, HsfA2, HsfB1
- IRF2
- IRF3
- ISX

- LFY
- MAFG
- Mal63
- MalR
- MAX
- Met1
- MeSRS1
- MeWRKY20
- MKX
- mod(mdg4)
- c-Myc
- 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, PPARδ
- PRDM1
- PREB
- PXR
- REST
- REV-ERBα
- RlmA (of *Aspergillus*)
- 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

- ACVR1B
- ACVR1C
- ACVR2B
- Akt/PKB
- AKT2
- ALK
- ALK1, ALK5
- ALPK1
- AMHR2
- AMPK α , AMPK γ
- ARAF
- ASK1
- ATM
- AURKC
- Aurora B
- AXL
- Bcr-Abl
- BCR-FGFR1
- BGLF4 of EBV
- BLK
- BMPR1A
- BMX
- BTK
- c-Abl
- c-Kit
- c-Mos
- CAMK1G
- CAMK2A
- CAMK2B
- CAMK2D
- CAMK2G
- CAMK4
- CAMKK1
- CAMKK2
- CAMKV
- casein kinase II α 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
- DLK
- DMPK
- DYRK1B
- DYRK2
- DYRK3
- 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
- GSK3 β
- HCK
- HER3

- HIPK2
- HIPK4
- HopBF1 effectors
- ICK
- INSRR
- Insulin receptor
- Insulin-like growth factor 1 receptor
- Integrin-linked kinase
- IP6K2
- IRAK-1
- IRAK2
- IRAK3
- Ire1 α
- ITK
- I κ B kinases (IKK) α , β , γ , ϵ
- JAK1
- JNK
- KSR
- LATS1, LATS2
- LCK
- LIMK1
- LIMK2
- Lkb1
- LMTK3
- LRRK2
- LYN
- MAP2K5
- MAP2K7
- MAP3K12
- MAP3K15
- MAP3K2
- MAP3K6
- MAP3K9
- MAP4K1
- MAP4K2
- MAP4K4
- MAPKKK (MEKK) YODA
- MAPK15
- MAPK4
- MAPK6
- MAPK7
- MAST1
- MAST2
- MATK
- MEK
- MEKK1 and MEKK3
- MERTK
- MET
- Mik1
- MINK1
- MLK3
- MLKL
- MOK, MAK, MRK
- MpkA (of *Aspergillus*)
- Mps1 (=TTK)
- mTOR
- MUSK
- MYLK2

<ul style="list-style-type: none"> - MYLK3 - MYLK4 - NEK11 - NEK8 - NEK9 - NIK - NPM-Aik - NPR2 - NTRK1 - NTRK2 - NTRK3 - NUAK2 - Nucleophosmin-Anaplastic Lymphoma Kinase - p38 - p90RSK - PAK6 - PASK - Pbs2 - PDGFRB - PDIK1L - PDK1 - PGK1 - PI4KIIβ - Pim-1 - PIM2 - PIM3 - Pink1 - PKCλ, PKCϵ and other PKCs - PKM2 - PKN1 - PKN2 - platelet-derived growth factor receptor α - Pik1 - Pik3 - 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 	<ul style="list-style-type: none"> - Raf-1, B-Raf, Ste11 - RET - RET/PTC1 - RIP1 - RIP3 - Ron - ROR1 - ROR2 - RPS6KA1 - RPS6KA2 - RPS6KA3 - RPS6KA5 - RPS6KA6 - RPS6KB1 - RPS6KC1 - RPS6KL1 - Ryk - SGK-1 - SGK2 - SGK223 - SGK3 - Sit2 - 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 - TrkA1 and III - TrkB - TSSK1B - TSSK2 - TSSK3 - TSSK4 - TSSK6 - Tyk2 - TYRO3 - Uik1 - VEGFR1, VEGFR2 - Wee1, Swe1 - WNK4 - ZAP-70 	<div style="border: 1px solid black; background-color: #e0f7fa; padding: 5px; text-align: center; margin-bottom: 10px;">Others</div> <ul style="list-style-type: none"> - Act1 (=TRAF3IP2) - Adenosine A_{2A} receptor - α_{2C} adrenergic receptor - Ago3 - AID - AIP56 - Aldo-keto reductase 1B10 - ANAPC2 - ANKMY2 - Annexin A2 - ANP receptor - ANP32C/D - Apaf-1 - APH1 - apoB - APOBEC-3B, -3C, -3G - Arb1 - ARD1 - Argonaute-1 (Ago1) - Argonaute-2 (=Ago2=GERp95) - Argonaute-4 (Ago4) - ARMC5 - ArtAB - ASB17 - ASB2 - ASB3 - ASB4 - ASB6 - ASL - ASS1 - ATG8 (GABARAP) proteins - ATG8b, ATG8c, ATG8e, ATG12 - Atp3 - Axin 1 - BCAP (PIK3AP1) - BALF5 of EBV - Bcl-2 - Bcl-xL - Beclin 1 - Bid - BIN2 - BLM helicase - Bms1 - BPIFB4 - BRAT1 - BRCA1 - BRCA2 - BRD4 - BRMS1 - BTRC - c-IAP1 - calcineurin (Cna2; catalytic subunit) - calmodulin
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| <ul style="list-style-type: none"> - calmodulin methyltransferase - calpain-1 - calponin - CARM1 - Caspase-8 - β-catenin - CB2 cannabinoid receptor - Ccp1 - CCDC117 - CD38 type III - CD79a - Cdc13 - Cdc14 - Cdc25a and Cdc25c - Cdk5 activator p35 - CPEB1, CPEB2, CPEB3 - CFTR (nascent and mutant polypeptide) - ChAT - CheZ (E. coli) - Chl1 - Chronophin - Cineole synthase 1 - Clathrin heavy chain - CLC-1 chloride channel - CLC-2 chloride channel - Clostridium toxin CDT - Clostridium toxin iota - Clusterin - COG complex - COI1 - Complement C9 - COX-2 - Cry toxins - CTA1 = CtxA1 - Ctf13/Skp1 component of CBF3 - CUL1 - CUL2 - CUL3 - CUL4A - CUL4B - Cup - cyclin B - cyclophilin D (mitochondrial) - Cyr1 - cytoskeletal proteins: actin, tubulin (including ciliary β4-tubulin), myosin (including Myo3B) - DBC2 - DDX5 - DEDD - Dengue virus protein E - Dengue virus proteins NS1/2B/3/4B/5 - DET1 | <ul style="list-style-type: none"> - Diphtheria toxin A - DNA helicase Ssl2 - DNA polymerase α - DNA polymerase λ - DNA polymerase η - DnaA (E. coli) - DNMT1 - Dsn1 - DTX4 - E6^AE7 - EBAX-1 - EEF1A2 - Emc2 - ENC1 - eNOS, nNOS (?) - ether-a-gogo-related potassium channel (ERG = HERG = KCNH2) - EZH2 - F1F0-ATP synthase - FANCA - FBXL12 - FBXL13 - FBXL14 - FBXL15 - FBXL18 - FBXL2 - FBXL3 - FBXL6 - FBXL8 - FBXL8 - FBXO10 - FBXO17 - FBXO18 - FBXO24 - FBXO25 - FBXO27 - FBXO28 - FBXO3 - FBXO34 - FBXO38 - FBXO4 - FBXO40 - FBXO6 - FBXO9 - FBXW11 - FBXW2 - FBXW5 - FBXW7 - FGAMS - Fibronectin - Filamin A - FliN, Flil (E. coli) - FLIP_S and FLIP_L - Folliculin - free β subunit of G protein - FtsZ - G2E3 - GAN - GBP1 | <ul style="list-style-type: none"> - Gln1 - GLT-1 - GluR1 - glutathione S-transferase subunit 3 (KS type) - Guanylate cyclase, soluble - Gα_0, Gα_{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 - HMGCR - Hsp27 - Humanin - Huntingtin - IDH1 - IDO1 - Importin 4 (IPO4) - Importin β1 - Importin-α6 (KPNA5) - Ino80 - Inositol 1,4,5-trisphosphate receptor 3 - Integrin α2 - Integrin α4 - Integrin αL - IL-1β - IRS-2 - Japanese encephalitis virus E protein - JlpA - KAP1 - KAT5 - KBTBD4 - KBTBD7 - KCBP - KCNA5 - KCNA6 - KCNG1 - KCNS3 - KCNQ4 - KCTD8 - KDM3A/JMJD1A - KDM4B/JMJD2B - KEAP1 - KIAA0317 - Kir6.2 |
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| <ul style="list-style-type: none"> - 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 - L protein of SHV - Lamin A/C - LAMP-2A - LANA of KS-HSV - LAP - LARP4B - Legumain - LGALS3BP - LIS1 - LNX1 - LOC440248 - LOX1 (OLR1) - LOXL2 - Lpl1 (<i>S. aureus</i>) - LRP1 (=CD91) - LRP5 - LRSAM1 - LSD1 - LSM8 - macromolecular aminoacyl-tRNA synthetase complex - Macrophage scavenger receptor - MAP1B - MAP4 - MARCH9 - Mdm2 - MDM4 - MeCatalase1 - Mg²⁺-dependent phosphatidate phosphohydrolase - MIF - misfolded VHL - MMP2, MMP3, MMP9 - μ-opioid receptor | <ul style="list-style-type: none"> - MRE11/Rad50/NBS1 (MRN) complex - MRP1 - Msps/XMAP215/ch-TOG - MTA1 - MTG8 - MUC1 - Myoglobin - N-myc downstream-regulated gene 1 (NRDG1) - N-WASP - Na⁺-K⁺-Cl⁻ cotransporter 1 - NadA - NAP1 - NB-LRR proteins: RPM1 and RPS2, Nod1, Nod2, NALP2, NALP3, NALP4, NALP12, IPAF, RPP4 - NBR1 - NCC - NCT - NDRG1 - NDRG2 - NELF-E - Nervous necrosis virus capsid protein - Neuraminidase - Neuropeptide Y - NHE1 - NHLRC1 - Nibrin - NleH1 and NleH2 - NMNAT2 - Norovirus capsid protein VP1 - Nox1, Nox2, Nox3, Nox5 - NS1 - Nsl1 - nsP3 and nsP4 of Chikungunya virus - Nucleoprotein (NP) of MERS-CoV - Nup62 - Nwd1 - 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 | <ul style="list-style-type: none"> - PCNA - Peli1 - perilipin - PfCRT - PIDD - Piwi - PIWIL2 - PLCγ - PLN - polysomal ribonuclease 1 (PMR1) - PPAT - PRDM14 - PRMT5 - pro-Dcp1 - prolactin receptor - prostacyclin synthase - proteasome - PRPF8 - PRPF19 - PTPN22 - Ptx - PUS7 - 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 - RCP - Reovirus protein σ1 - REV1 - reverse transcriptase of hepatitis B virus - RFWD3 - RGS11 - RGS6 - RGS7 - RGS9 - RhoB - RHOBTB1 - ribosomal protein L2 (<i>E. coli</i>) - ribosomal proteins S3 and S6 - ricin catalytic A chain - RIG-I |
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- RNA-dep. RNA polymerase
(of Bamboo mosaic virus)
- RNF10
- RNF111
- RNF19B
- RNF40
- RNGTT
- Rnr4
- Rpb1
- SA- β -galactosidase (GLB1)
- SCAP
- SDF2
- SENP3
- SERCA2a
- SERT (SLC6A4)
- SF3B3
- SH3RF2
- Sicily
- SIR2 (SIR2RP1 in
Leishmania)
- SIRT1
- SIRT2
- SKP2
- SKP2 complexes
- SLC6A14
- SMYD1, SMYD2, SMYD3
- snoRNP complexes
- SNRNP200
- SOCS6
- SPSB1
- SPSB3
- SREC-1
- STING
- SUR1 (subunit of β -cell ATP-
sensitive potassium channel)
- survivin
- SUV39H1
- SV40 large T-antigen
- Swr1
- α -synuclein
- Tab2/3
- Tas3
- Tau protein
- Tax
- TCL1A
- 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 (=A20)
- TOM40
- TRIM10
- TRIM17
- TRIM2
- TRIM36
- TRIM37
- TRIM41
- TRIM49
- TRIM56
- TRIM7
- TRIM73
- TRIM74
- TRIM8
- Triosephosphate isomerase
- Trithorax (and ortholog
MLL)
- Trx1
- TrxR
- TSG101
- Tyrosine hydroxylase
- UCH-L1
- UHRF1
- Ulp1
- uPA
- Ura2
- URI complex
- Uroporphyrinogen
decarboxylase (HemE) [in
cyanobacteria]
- Us11 (of HSV-1)
- Utp21
- Vaccinia core protein 4a
- vFLIP (of KSHV)
- Vimentin
- VIP1
- VP5 of pseudorabies virus
- VPS18
- VPS41
- WASF3
- WSB2
- WTAP
- 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; Buljan et al. [2020] Mol. Cell 79, 504; Taipale et al. [2014] Cell 158, 434; Truman et al. [2015] J. Proteomics 112, 285; Savitsky et al. [2018] Cell 173, 260; Zhao et al. [2021] Mol. Cell 81, 2914), 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); O'Meara et al. [2019] PLoS Biol. 17, e3000358; Tsvetkov et al. (2020) Cell Rep. 32, 108001; 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 <https://www.picard.ch/Hsp90Int>). Hsp90Int.db also uses exclusively the official NCBI names.
- Looking for references? See <https://www.picard.ch/downloads/Hsp90facts.pdf>.