

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 (=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)
- Cereblon
- FNIP1, FNIP2
- GIGANTEA
- Hsc70/Hsp70/Hsp72/DnaK
- Hsp60
- Ids2
- Other J-domain proteins: *E. coli* CbpA and DnaJ, human DnaJ homolog Hsj1b, cyanobacterial DnaJ2, yeast Ydj1
- mtHsp70/Grp75/mortalin
- PhLP2A

- Pih1 (=Nop17) (mostly through Tah1)
- Prefoldin 4 and 6
- S100A1
- Sse1, Sse2
- Tel2-Tti1-Tti2 complex
- TIMP2
- TPR15, TPR16
- *Toxoplasma* Sis1-like
- Tsc1
- valosin-containing protein (VCP)/p97
- ZMYND10

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
- ELF3
- ERCC3
- FOXD4L6
- FOXM1
- FOXP2
- GTF2IRD2
- Hap1
- HCFC1
- HMGA1, HMGA2
- HMGB1
- HNF4A
- HP1BP3
- HSF1
- HSF2
- HsfA1, HsfA2, HsfB1
- IRF2
- IRF3
- ISX
- LFY
- LXRα (NR1H3)
- MAFG
- Mal63
- MalR
- MAX
- Met1
- MeSRs1
- MeWRKY20
- MKX
- mod(mdg4)
- c-Myc
- Nanog
- NFIC
- NFκB-p65 (RelA)
- NFRKB
- Notch1 (ICN1)
- NR1H3
- NR1I2
- Nrf2
- Oct4
- p53
- p73
- PAS family members: Dioxin receptor (=AhR), Sim, HIF-1α, HIF-2α, HIF-3α
- PCGF6
- PER2
- PHOX2B
- POGK
- PPARα, PPARβ, PPARγ, PPARδ
- PRDM1
- PREB
- PXR
- REST
- REV-ERBα
- RlmA (of *Aspergillus*)
- SETDB1
- SIM2
- SLFN11
- SOC1
- SOX11
- Sp1
- SREBP1 (=SREBF1)
- SREBP2
- STAT1
- STAT2

- STAT3 (also in caveolin-1 complexes in rafts)
- STAT5
- SUP
- TADA2A
- TBX22
- TCF25
- TDP-43
- TEAD2
- TFEB
- TFDP3
- THAP4
- TonEBP/OREBP
- TR β
- TRIM32
- Tup1
- Twist1
- Upc2
- Ure2
- USP1
- VDR
- VP16
- water mold *Achlya* steroid (antheridiol) receptor
- WT1
- YAP1
- ZBED4
- ZBTB7A
- 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
- CPK1
- CSF1R
- CSNK1A1
- DCK
- 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-TACC3
- 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
- Irf1 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

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| <ul style="list-style-type: none"> - ARMC5 - ArtAB - ASB17 - ASB2 - ASB3 - ASB4 - ASB6 - ASL - ASS1 - ATG8 (GABARAP) proteins - ATG8b, ATG8c, ATG8e, ATG12 - Atp3 - Axin 1 - BAK1 - BALF5 of EBV - βC1 (begomovirus) - BCAP (PIK3AP1) - Bcl-2 - Bcl-xL - Beclin 1 - Bid - BIN2 - BLM helicase - Bms1 - BPIFB4 - BRAT1 - BRCA1 - BRCA2 - BRD4 - BRI1 - BRMS1 - BTRC - C1QL1 - c-IAP1 - Calcineurin (PPP3CA; Cna2; catalytic subunit) - Calmodulin - Calmodulin methyltransferase - Calnexin - Calpain-1 - Calponin - CARM1 - Caspase-8 - β-catenin - Ca_v1.2 - CB2 cannabinoid receptor - Ccp1 - CCDC117 - CD38 type III - CD47 - CD79a - CD80 (B7-1) - CD147 (Basigin) - Cdc13 - Cdc14 - Cdc25a and Cdc25c - Cdk5 activator p35 | <ul style="list-style-type: none"> - CFTR (nascent and mutant polypeptide) - ChAT - CheZ (E. coli) - Chl1 - CHMP4B - Chronophin - Cineole synthase 1 - Clathrin heavy chain - CLC-1 chloride channel - CLC-2 chloride channel - Clostridium toxin CDT - Clostridium toxin iota - Clusterin - CND1 (Arabidopsis gene <i>At1g32730</i>) - COG complex - COI1 - Collagen-1 - Complement C9 - COX-2 - CPEB1, CPEB2, CPEB3 - Cry1 prototoxins - CTA1 = CtxA1 - Ctf13/Skp1 component of CBF3 - CTNNAL1 - CUL1 - CUL2 - CUL3 - CUL4A - CUL4B - Cup - Cx43 - cyclin B - cyclophilin D (mitochondrial) - CYP2D6 - CYP2E1 - CYP3A4 - Cyr1 - CdtB from <i>Helicobacter hepaticus</i> - cytoskeletal proteins: actin, tubulin (including ciliary β4-tubulin), myosin (including Myo3B) - DBC2 - DDX5 - Ded1 - DEDD - Dengue virus protein E - Dengue virus proteins NS1/2B/3/4B/5 - DET1 - Dicer 1 - Diphtheria toxin A - DNA helicase Ssl2 - DNA polymerase α | <ul style="list-style-type: none"> - DNA polymerase λ - DNA polymerase η - DnaA (E. coli) - DNMT1 - Drp1 - Dsn1 - DTX4 - DYNC2H1 - DYNC2I2 - DYNC2LI1 - E protein (of Japanese encephalitis virus) - E6^AE7 - EBAX-1 - EEF1A2 - Emc2 - ENC1 - ENO1 - eNOS, nNOS (?) - EPRS - Erbin - Ether-a-gogo-related potassium channel (ERG = HERG = KCNH2) - EZH2 - F1F0-ATP synthase - FANCA - FASN - FBXL12 - FBXL13 - FBXL14 - FBXL15 - FBXL18 - FBXL2 - FBXL3 - FBXL6 - FBXL8 - FBXO10 - FBXO17 - FBXO18 - FBXO24 - FBXO25 - FBXO27 - FBXO28 - FBXO3 - FBXO34 - FBXO38 - FBXO4 - FBXO40 - FBXO6 - FBXO9 - FBXW11 - FBXW2 - FBXW5 - FBXW7 - FDFT1 - FGAMS - FHIT - Fibronectin |
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- Filamin A
- FliN, FliI (E. coli)
- FLIP_S and FLIP_L
- Folliculin
- free $\beta\gamma$ subunit of G protein
- FtsZ
- G2E3
- G α_0 , G α_{12}
- GAN
- GART
- GSDMD
- GBP1
- GC-A (ANP receptor)
- GC-C
- GF14-4
- GLCCI1
- Gln1
- GLT-1
- Glucocerebrosidase
- GluR1
- Glut1
- Glutathione S-transferase subunit 3 (KS type)
- GPX4
- GREB1
- Guanylate cyclase, soluble
- HAX-1
- HDAC1
- HDAC6
- HDAC11
- HECTD3
- Hepatitis A virus capsid proteins
- 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
- IFI6
- Importin 4 (IPO4)
- Importin β 1
- Importin- α 6 (KPNA5)
- Ino80
- Inositol 1,4,5-trisphosphate receptor 3
- Integrin α 2
- Integrin α 4
- Integrin α L
- Integrin α M β 2
- Integrin α V β 5
- IL-1 β
- IRS-2
- JlpA
- KAP1
- KAT5
- KAT8
- KBTBD4
- KBTBD7
- KCBP
- 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
- α Klotho
- knob complexes (in the membrane of *Plasmodium*-infected erythrocytes)
- KSHV K1
- KSR1
- KSR2
- L protein of HRSV
- L protein of SHV
- L protein of RVFV
- Lamin A/C
- LAMP-2A
- LANA of KS-HSV
- LAP
- LARP4B
- LDHA
- Legumain
- LGALS3BP
- LGR5
- LIS1
- LNX1
- LOC440248
- LOX1 (OLR1)
- LOXL2
- Lpl1 (*S. aureus*)
- Lr13 (wheat)
- LRP1 (=CD91)
- LRP5
- LRSAM1
- LSD1
- LSM8
- macromolecular aminoacyl-tRNA synthetase complex
- Macrophage scavenger receptor
- MAP1B
- MAP1LC3B
- MAP4
- MARCH9
- Mdm2
- MDM4
- MeCatalase1
- METTL3
- Mg²⁺-dependent phosphatidate phosphohydrolase
- MIF
- misfolded VHL
- MMP2, MMP3, MMP9
- μ -opioid receptor
- MRE11/Rad50/NBS1 (MRN) complex
- MRP1
- Msps/XMAP215/ch-TOG
- MTA1
- MTG8
- MUC1
- MYG1
- Myoglobin
- N-myc downstream-regulated gene 1 (NRDG1)
- N-WASP
- Na⁺-K⁺-Cl⁻ cotransporter 1
- NadA
- NAMPT
- NAP1
- NB-LRR proteins: RPM1 and RPS2, Nod1, Nod2, NALP2, NALP3, NALP4, NALP12, IPAF, RPP4
- NBR1
- N-cadherin
- NCC
- NCT
- NDRG1
- NDRG2
- NEDD4
- NELF-E
- Nervous necrosis virus capsid protein
- Neuraminidase

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| <ul style="list-style-type: none"> - Neuropeptide Y - NHE1 - NHLRC1 - Nibrin - NleH1 and NleH2 - NMNAT2 - Nox1, Nox2, Nox3, Nox5 - NPR3 - NS1 - NS5 (flaviviruses) - 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) - P2X₇ purinergic receptor - p14ARF - p17 (Avian reovirus) - p300 - PARK2 - PARK7 (DJ-1) - PARP1 - PB1 and PB2 subunits of influenza RNA pol. - PBD2 - PCGF1 - PCGF3 - PCNA - PDE6α (PDE6C), β, γ - PDIA4 - Peli1 - PfCRT - PGAM2 - PIDD - Piwi - PIWIL2 - PIWIL4 - PLCγ - PLIN2 (=Perilipin 2) - PLN - polysomal ribonuclease 1 (PMR1) - Porcine deltacoronavirus proteins N, NS7, NSP10 - PPAT - PRDM14 - PRMT5 - pro-Dcp1 - prolactin receptor - prostacyclin synthase - proteasome - PRPF8 | <ul style="list-style-type: none"> - PRPF19 - PsbO - Ptc2 - PTPN22 - Ptx - PUS7 - R-protein I-2 - R2TP complex through Pih1 - Rab-αGDI - Rab3a - Rab11a - RAB40A - Rac/Rop GTPase Rac1 (rice) - Rac1 - RACK1B - Rad51 - Rad52 - RAG1 - Ral-binding protein 1 (RalBP1) - RanBP9 - Rapsyn - Raptor - RCBTB1 - RCBTB2 - RCC2 - RCP - Reovirus protein σ1 - REV1 - reverse transcriptase of hepatitis B virus - RFWD3 - RGS11 - RGS6 - RGS7 - RGS9 - RhoB - 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 - RPAP2 - Rpb1 - RPN6 - Rsc3 - SA-β-galactosidase (GLB1) | <ul style="list-style-type: none"> - SARS-CoV-2 proteins M, N, NSP13, Orf3, Orf7a, Orf7b, Orf9b - SCAP - SDCBP - SDF2 - Senecavirus A proteins VP1-VP4, Lpro, 2B, 2C, 3A - SENP1 - SENP3 - SERCA2a - SERT (SLC6A4) - SF3B3 - sFRP1 - SH3RF2 - Sicily - SIR2 (SIR2RP1 in Leishmania) - SIRT1 - SIRT2 - SKP2 - SKP2 complexes - SLC6A14 - SMURF1 - SMYD1, SMYD2, SMYD3 - snoRNP complexes - SNRNP200 - SOCS6 - SPSB1 - SPSB3 - SREC-I - STING - SUR1 (subunit of β-cell ATP-sensitive potassium channel) - survivin - SUV39H1 - SV40 large T-antigen - Swr1 - α-synuclein - SYVN1 - Tab2/3 - Tas3 - Tau protein - Tax - TCL1A - telomerase - TFR1 - TGFB1 - thiopurine S-methyltransferase - thrombin receptor (PAR-1) - thromboxane synthase - TiIS - TIR1 - Tissue plasminogen activator (tPA) - Titin - TLR4/MD-2 complex - TLR7 |
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- **TLR9**
- **Tm-2²**
- **TNFAIP3 (=A20)**
- **TOM40**
- **TRIM2**
- **TRIM7**
- **TRIM8**
- **TRIM10**
- **TRIM16**
- **TRIM17**
- **TRIM21**
- **TRIM36**
- **TRIM37**
- **TRIM41**
- **TRIM49**
- **TRIM56**
- **TRIM73**
- **TRIM74**
- **Triosephosphate isomerase**
- **Trithorax (and ortholog MLL)**
- **Trx1**
- **TrxR**
- **TSG101**
- **TXNDC9**
- **Tyrosine hydroxylase**
- **UBA52**
- **UCH-L1**
- **UHRF1**
- **UL42 (of HSV-1)**
- **Ulp1**
- **uPA**
- **Ura2**
- **URI complex**
- **Uroporphyrinogen decarboxylase (HemE) [in cyanobacteria]**
- **Us11 (of HSV-1)**
- **USP14**
- **USP19**
- **USP21**
- **USP31**
- **Utp21**
- **Vaccinia core protein 4a**
- **VDAC1**
- **vFLIP (of KSHV)**
- **Vimentin**
- **VIP1**
- **VP1** (capsid proteins of norovirus and feline calicivirus)
- **VP5** of pseudorabies virus
- **VP5, VP7, VP35** of grass carp reovirus
- **VP37** (Broad bean wilt virus 2)
- **VPS18**
- **VPS41**
- **WASF3**
- **WSB2**
- **WSSV322** (white spot syndrome virus)
- **WTAP**
- **WWP1, WWP2**
- **XopC2**
- **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).
- Non-proteinaceous interactors (RNA, DNA, lipids, polysaccharides, etc.) are not listed here. For those, see <https://www.picard.ch/downloads/Hsp90facts.pdf>.
- **Looking for references? See <https://www.picard.ch/downloads/Hsp90facts.pdf>.**
- 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; Liu et al. [2022] Nucleic Acids Res. 50, 6990; Kolhe et al. [2023] Mol. Cell 83, 2035; Huang et al. [2024] PNAS 121, e2319060121); 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; Yan et al. [2023] Plant Cell Environ. 46, 1935; Guo et al. [2024] Data Brief 55, 110583); and in pharmacological surveys 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.