HSP90 INTERACTORS

Chaperones and relatives:

- Aha1 and its homolog Hch1
- Cdc37 (p50) and its relative Harc
- 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, GCUNC-45 (also UNC-45 and She4), DnaJC7 (=Tpr2=mDj11=CCRP), CRN, WISp39 (=FKBPL), Tah1 (=Spaghetti=RPAP3), NASP, Toc64, TPR1 (=Ttc1), SGT (=αSGT=SGTA), DYX1C1, AtTPR1, AtTPR2, AIPL1
- CS-containing p23 relatives SGT1 (=SUGT1), RAR1, Siah-1-interacting protein (SIP), Chp1/Morgana, B-ind1, melusin, CHORDC1, NudC and NudCL2 (=Nudcd2)
- Hsp60
- Hsc70/Hsp70/Hsp72
- Human DnaJ homolog Hsj1b
- S100A1
- Sse1, Sse2
- valosin-containing protein (VCP)/p97
- Pih1 (=Nop17) (mostly through Tah1)
- Cullin5
- Tel2-Tti1-Tti2 complex

Transcription factors:

- 12(S)-HETE receptor
- AF9/MLLT3
- all vertebrate steroid receptors (GR, MR, ERα, ERβ, PR, AR)
- BCL-6
- CAR
- cytoplasmic v-erbA
- EcR
- PPARα (PPARβ)
- PXR
- Hap1
- HSF-1
- IRF3
- Mal63
- p53
- PAS family members: Dioxin receptor (=AhR), Sim, HIF–1α, HIF-2α, HIF-3α
- Sp1
- Stat3 (also in caveolin-1 complexes in rafts)
- Stat5
- TonEBP/OREBP
- Ure2
- VDR
- water mold *Achlya* steroid (antheridiol) receptor
- WT1

Kinases:

- Akt/PKB
- ASK1
- Aurora B
- Bcr-Abl
- BTK
- c-Abl
- casein kinase IIα catalytic subunit
- Cdc2 (=Cdk1)
- Cdc25c
- Cdk2, Cdk4, Cdk6, Cdk9, Cdk11
- Chk1
- Cot = Tpl-2
- Death-associated kinases DAPK, DAPK2, DAPK3
- death domain kinase RIP
- eEF-2 kinase
- eIF2-α kinases HRI, Gcn2, Perk, PKR
- Eml4-Alk
- EphA2
- ErbB2 (and mutant EGF receptor)
- ERK5
- FGFR3 and FGFR4
- FOP2-FGFR1
- Flt3
- Fused
- GRK2 and GRK6
- GSK3β
- HER3
- IκB kinases α, β, γ, ε
- Insulin receptor
- Insulin-like growth factor 1 receptor

- **Integrin-linked kinase**
- **IP6K2**
- **IRAK-1**
- **Ire1**
- **JAK1**
- **JNK**
- **c-Kit**
- **KSR**
- **LATS1, LATS2**
- **Lkb1**
- **LRRK2**
- **MAPK6**
- **MEK**
- **MEKK1 and MEKK3**
- **Mik1**
- **MLK3**
- **MOK, MAK, MRK**
- **c-Mos**
- **mTOR**
- **NIK**
- **Nucleophosmin-Anaplastic Lymphoma Kinase**
- **p38**
- **p90RSK**
- **platelet-derived growth factor receptor α**
- **PDK1**
- **PI4KIIβ**
- **Pim-1**
- **Pink1**
- **PKCλ, PKCε and other PKCs**
- **Plk1**
- **Pnck**
- **pp60v-src, c-src**
- **PRKD2**
- **src related tyrosine kinases: fer, fes, fgr, fps, lck, yes**
- **PRKDC**
- **Raf-1, B-Raf, Ste11**
- **RET**
- **RET/PTC1**
- **Ron**
- **Ryk**
- **SGK-1**
- **Slt2**
- **SRPK1**
- **SSCMK1**
- **SSTK (= Tssk6)**
- **TAK1**
- **TBK1**
- **TGFβ receptors I and II**
- **TrkB**
- **TrkAI and III**
- **Tyk2**
- **Ulk1**
- **VEGFR1, VEGFR2**
- **Wee1, Swe1**
- **ZAP-70**

Others:

- **α_{2C} adrenergic receptor**
- **AID**
- **Annexin II**
- **ANP receptor**
- **Apaf-1**
- **apoB**
- **Argonaute-1**
- **Argonaute-2 (= GERp95)**
- **ATG8 proteins**
- **Bcl-2**
- **Bcl-xL**
- **Beclin 1**
- **Bid**
- **BLM helicase**
- **Bms1**
- **BRMS1**
- **calcineurin (Cna2; catalytic subunit)**
- **calmodulin**
- **calponin**
- **CARM1**
- **CB2 cannabinoid receptor**
- **CD91**
- **Cdc13**
- **Cdk5 activator p35**
- **Clostridium toxin CDT**
- **CFTR (nascent and mutant polypeptide)**
- **Chronophin**
- **ClC-2 chloride channel**
- **Cineole synthase 1**
- **COG complex**
- **CTA1**
- **Ctf13/Skp1 component of CBF3**
- **Cup**
- **cyclin B**
- **cyclophilin D (mitochondrial)**
- **cytoskelettal proteins: actin, tubulin (including ciliary β4-tubulin), myosin**
- **DEDD**
- **Diphtheria toxin**
- **Dengue virus protein E**
- **DNA polymerase α**
- **DNA polymerase η**
- **DNMT1**
- **Dsn1**
- **eNOS, nNOS (?)**
- **ether-a-gogo-related cardiac potassium channel**
- **F1F0-ATP synthase**
- **$FLIP_S$ and $FLIP_L$**

- **free βγ subunit of G protein**
- **$G\alpha_0$, $G\alpha_{12}$**
- **glutathione S-transferase subunit 3 (KS type)**
- **HDAC6**
- **Hepatitis B virus core protein**
- **Hepatitis C virus protein NS3**
- **Hepatitis E virus capsid protein**
- **HERG**
- **Histones H1, H2A, H2B, H3 and H4**
- **c-IAP1**
- **Importin β1**
- **Importin 4 (IPO4)**
- **Importin-α6 (KPNA5)**
- **Inositol 1,4,5-trisphosphate receptor 3**
- **INrf2 (=Keap1)**
- **Clostridium toxin iota**
- **IRS-2**
- **Japanese encephalitis virus E protein**
- **JlpA**
- **KSHV K1**
- **Kir6.2**
- **knob complexes** (in the membrane of Plasmodium-infected erythrocytes)
- **LAMP-2A**
- **LAP**
- **LIS1**
- **macromolecular aminoacyl-tRNA synthetase complex**
- **Macrophage scavenger receptor**
- **Mdm2**
- **MMP2, MMP9**
- **MRE11/Rad50/NBS1 (MRN) complex**
- **Msps/XMAP215/ch-TOG**
- **MTG8**
- **MUC1**
- **NadA**
- **Na^+-K^+-Cl^- cotransporter 1**
- **NB-LRR proteins: RPM1 and RPS2, Nod1, Nod2, NALP2, NALP3, NALP4, NALP12, IPAF**
- **Neuropeptide Y**
- **N-myc downstream-regulated gene 1 (NRDG1)**
- **Nox1, Nox2, Nox3, Nox5**
- **Nsl1**
- **NS1**
- **NSP3**
- **Nup62**
- **N-WASP**
- **OsCERK1**
- **P1** (picornaviral capsid precursor protein P1)
- **p300**
- **P450 CYP2E1**
- **$P2X_7$ purinergic receptor**
- **PARK7 (DJ-1)**
- **PB1 and PB2 subunits of influenza RNA pol.**
- **PCNA**
- **perilipin**
- **PIDD**
- **Piwi**
- **Mg^{2+}-dependent phosphatidate phosphohydrolase**
- **polysomal ribonuclease 1 (PMR1)**
- **PRMT5**
- **prolactin receptor**
- **prostacyclin synthase**
- **proteasome**
- **R2TP complex through Pih1**
- **Rab-αGDI**
- **Rab11a**
- **Rac/Rop GTPase Rac1 (rice)**
- **Rac1**
- **Ral-binding protein 1**
- **Rapsyn**
- **Raptor**
- **reovirus protein σ1**
- **REV1**
- **reverse transcriptase of hepatitis B virus**
- **ribosomal proteins S3 and S6**
- **ribosomal protein L2 (E. coli)**
- **ricin catalytic A chain**
- **RIG-I**
- **Rpb1**
- **R-protein I-2**
- **SENP3**
- **SIR2 (SIR2RP1 in Leishmania)**
- **SKP2 complexes**
- **SMYD1, SMYD2, SMYD3**
- **snoRNP complexes**
- **SREC-I**
- **DNA helicase Ssl2**
- **SUR1** (subunit of β-cell ATP-sensitive potassium channel)
- **survivin**
- **SV40 large T-antigen**
- **α-synuclein**
- **Tab2/3**
- **Tau protein**
- **telomerase**
- **thiopurine S-methyltransferase**
- **thrombin receptor (PAR-1)**
- **thromboxane synthase**
- **Tissue plasminogen activator (tPA)**
- **TLR4/MD-2 complex**
- **TOM40**
- **TRIM8**
- **Triosephosphate isomerase**
- **Trithorax (and ortholog MLL)**
- **Tyrosine hydroxylase**

- **UCH-L1**
- **Uroporphyrinogen decarboxylase (HemE) [in cyanobacteria]**
- **Vaccinia core protein 4a**
- **misfolded VHL**
- **Vimentin**
- **XPO1**
- **XPORT**
- **ZEITLUPE**

Notes:
- Only the cytosolic form of Hsp90 was considered.
- Only proteins are listed for which biochemical evidence for an interaction is available (i.e. geldanamycin effects alone were not considered 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), 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), and in a pharmacological survey of kinases (Citri et al. [2006] J. Biol. Chem. 281, 14361).
- See **Hsp90Int.db** for the comprehensive 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).
- **Looking for references? See http://www.picard.ch/downloads/Hsp90facts.pdf.**