

# HSP90 INTERACTORS

## Chaperones and relatives:

- Aha1 and its homolog Hch1
- Cdc37 (p50) and its relative Harc
- p23 (=Sba1)
- proteins with TPR motifs, including 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), NASP, Toc64, TPR1 (=Ttc1), SGT (=αSGT=SGTA), DYX1C1
- CS-containing p23 relatives SGT1 (=SUGT1), RAR1, Siah-1-interacting protein (SIP), Chp1, B-ind1, melusin
- Hsp60
- Hsc70/Hsp70/Hsp72
- Human DnaJ homolog Hsj1b
- S100A1
- Sse1
- valosin-containing protein (VCP)/p97
- NudC
- Pih1 (=Nop17) (only through Tah1?)
- Cullin5

## Transcription factors:

- 12(S)-HETE receptor
- all vertebrate steroid receptors (GR, MR, ERα, 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)
- TonEBP/OREBP
- Ure2
- water mold *Achlya* steroid (antheridiol) receptor

## Kinases:

- Akt/PKB
- ASK1
- Aurora B
- Bcr-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
- EphA2
- ErbB2 (and mutant EGF receptor)
- ERK5
- Flt3
- Fused
- GRK2
- GSK3β
- HER3
- IκB kinases α, β, γ, ε
- Insulin receptor
- Insulin-like growth factor 1 receptor
- Integrin-linked kinase
- IP6K2
- IRAK-1
- Irf1
- JAK1
- JNK
- c-Kit
- KSR
- Lkb1
- LRRK2

- MEK
  - MEKK1 and MEKK3
  - Mik1
  - MLK3
  - MOK, MAK, MRK
  - c-Mos
  - NIK
  - Nucleophosmin-Anaplastic Lymphoma Kinase
  - p90RSK
  - platelet-derived growth factor receptor  $\alpha$
  - PDK1
  - Pim-1
  - Pink1
  - PKC $\lambda$  and other PKCs
  - PIk1
  - pp60v-src, c-src
  - src related tyrosine kinases: fer, fes, fgr, fps, lck, yes
  - Raf-1, B-Raf, Ste11
  - RET/PTC1
  - Ron
  - Ryk
  - SGK-1
  - Sit2
  - SRPK1
  - SSTK (= Tssk6)
  - TAK1
  - TBK1
  - TGF $\beta$  receptors I and II
  - TrkB
  - TrkAII and III
  - Tyk2
  - VEGFR1, VEGFR2
  - Wee1, Swe1
  - ZAP-70
- Others:**
- Annexin II
  - ANP receptor
  - Apaf-1
  - apoB
  - Argonaute-2 (= GERp95)
  - Bcl-xL
  - Bid
  - BLM helicase
  - calcineurin (Cna2; catalytic subunit)
  - calmodulin
  - calponin
  - CB2 cannabinoid receptor
  - CD91
  - Cdc13
  - Cdk5 activator p35
  - CFTR (nascent polypeptide)
  - Chronophin
  - CIC-2 chloride channel
  - COG complex
  - Ctf13/Skp1 component of CBF3
  - Cup
  - cyclin B
  - cyclophilin D (mitochondrial)
  - cytoskeletal proteins: actin, tubulin (including ciliary  $\beta$ 4-tubulin), myosin
  - Dengue virus protein E
  - DNA polymerase  $\alpha$
  - DNA polymerase  $\eta$
  - DNMT1
  - eNOS, nNOS (?)
  - ether-a-gogo-related cardiac potassium channel
  - FLIP<sub>S</sub> and FLIP<sub>L</sub>
  - free  $\beta\gamma$  subunit of G protein
  - G $\alpha_0$ , G $\alpha_{12}$
  - glutathione S-transferase subunit 3 (KS type)
  - HDAC6
  - Hepatitis virus C protein NS3
  - HERG
  - Histones H1, H2A, H2B, H3 and H4
  - c-IAP1
  - Importin  $\beta$
  - Inositol 1,4,5-trisphosphate receptor 3
  - Kir6.2
  - knob complexes (in the membrane of Plasmodium-infected erythrocytes)
  - LAMP-2A
  - macromolecular aminoacyl-tRNA synthetase complex
  - Macrophage scavenger receptor
  - Mdm2
  - MMP2
  - MRE11/Rad50/NBS1 (MRN) complex
  - Msp/XPAP215/ch-TOG
  - MTG8
  - MUC1
  - Na<sup>+</sup>-K<sup>+</sup>-Cl<sup>-</sup> cotransporter 1
  - NB-LRR proteins: RPM1 and RPS2, Nod1, Nod2, NALP2, NALP3, NALP4, NALP12, IPAF
  - Neuropeptide Y
  - N-myc downstream-regulated gene 1 (NRDG1)
  - Nup62
  - N-WASP
  - P1 (picornaviral capsid precursor protein P1)
  - p300
  - P450 CYP2E1
  - P2X<sub>7</sub> purinergic receptor
  - PB2 subunit of influenza RNA pol.

- perilipin
- Mg<sup>2+</sup>-dependent phosphatidate phosphohydrolase
- polysomal ribonuclease 1 (PMR1)
- PRMT5
- prolactin receptor
- proteasome
- R2TP complex through Pih1
- Rab- $\alpha$ GDI
- Rab11a
- Rac/Rop GTPase Rac1 (rice)
- Ral-binding protein 1
- Raptor
- reovirus protein  $\sigma$ 1
- reverse transcriptase of hepatitis B virus
- ribosomal proteins S3 and S6
- ricin catalytic A chain
- RIG-I
- R-protein I-2
- SIR2 (SIR2RP1 in Leishmania)
- SKP2 complexes
- SMYD1, SMYD2, SMYD3
- snoRNP complexes
- DNA helicase Ssl2
- survivin
- SV40 large T-antigen
- $\alpha$ -synuclein
- Tab2/3
- Tau protein
- telomerase
- thiopurine S-methyltransferase
- thrombin receptor (PAR-1)
- TLR4/MD-2 complex
- TOM40
- Trithorax (and ortholog MLL)
- Tyrosine hydroxylase
- UCH-L1
- Uroporphyrinogen decarboxylase (HemE) [in cyanobacteria]
- Vaccinia core protein 4a
- misfolded VHL
- Vimentin

#### 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), 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), and in a pharmacological survey of kinases (Citri et al. [2006] J. Biol. Chem. 281, 14361).
- **Looking for references? See <http://www.picard.ch/downloads/Hsp90facts.pdf>.**