

Sequence comparison of fungal beta-tubulins

Protein Alignments for Fungal β -Tubulin Proteins Compared to Human β -Tubulin (v1.1 2011-08-24)

		1	50
<i>NP_821133-HsTUBB1</i>	(1)	MREI VHIQAGQCGNQIGAKFW EVISDEHGIDPTGTYHG SSDLQLDRISVY	
AAA34375-CaB	(1)	MREI IHLSTGQCGNQIGAAF WETICGEHGLD NNGT YVGN NELQKSKLDVY	
P02557-ScB1	(1)	MREI IHI STGQCGNQIGAAF WETI CGEHGLDFNGTYHG HDDIQKERLNVY	
AAC21454-SpB1	(1)	MREI VHIQAGQCGNQVGA AFW STIA DEHGLDSAGI YHGT SEA QHERLNVY	
AW324553-AbB*	(1)	MREI VHLQ TGQCGNQIGAK FW EV VS DEHG IERD GLY KGT N DLQLERISVY	
BAE64122-Aor-B1	(1)	MREI VHLQ TGQCGNQIGAAF W Q TIS GEHGLD GS GV YNG SSDL QLERMNVY	
XP_752456-AfuB1*	(1)	MREI VHLQ TGQCGNQIGAAF W Q TIS GEHGLD GS GV YN - GSSDLQLERMNVY	
XP_658786-AniB1	(1)	MREI VHLQ TGQCGNQIGAAF W Q TIS GEHGLD GS GV YNG TS DLQLERMNVY	
Fungal Consensus	(1)	MREIVHLQ TGQCGNQIGAAF W TIS GEHGLD SGVY G TS DLQLERLNVY	
		51	100
<i>NP_821133-HsTUBB1</i>	(51)	YNEATGGKYVPR AILVDLE P GT MDSV RSG PFGQIFR PDNFV FGQSGAGNN	
AAA34375-CaB	(51)	FNEAT SGKYV PRAVL VDLE P GT IDNV KTSQ IGNL FRPD N IF FGQSSAGNV	
P02557-ScB1	(51)	FNEA SSGKW VPR SINVDLE P GT IDAV RNSA IGNL FRPD N YIF FGQSSAGNV	
AAC21454-SpB1	(51)	FNEA AGGKYV PRAVL VDLE P GT MDAV KSG KF GNLFRPD N I Y FG QSGAGNI	
AW324553-AbB*	(51)	YNEI GANKYV PRAVL VDLE P GT MDSV RSG P LGNLFRPD N FV FGQSGAGNN	
BAE64122-Aor-B1	(51)	FNEA SGNKYV PRAVL VDLE P GT MDAV RAG PFGQLFR PDNFV FGQSGAGNN	
XP_752456-AfuB1*	(50)	FNEA NGDKYV PRAVL VDLE P GT MDAV RAG PFGELFR PDNFV FGQSGAGNN	
XP_658786-AniB1	(51)	FNEA SGNKYV PRAVL VDLE P GT MDAV RAG PFGELFR PDNFV FGQSGAGNN	
Fungal Consensus	(51)	FNEASG KYV PRAVL VDLE P GT MDAV RAG PFGNLFR PDNFV FGQSGAGNN	
		101	150
<i>NP_821133-HsTUBB1</i>	(101)	WAKGHYTEGAELVDSV LDV V RR KEAES CD CLQGFQ L THSLGGGTGSGMGTL	
AAA34375-CaB	(101)	WAKGHYTEGAELVDSV LDV V RR EAEG CD SLQGFQ I THSLGGGTGSGMGTL	
P02557-ScB1	(101)	WAKGHYTEGAELVDSV MDV IR RE EAEG CD SLQGFQ I THSLGGGTGSGMGTL	
AAC21454-SpB1	(101)	WAKGHYTEGAELADAV LDV V RR EAEA CD ALQGFQ L THSLGGGTGSGMGTL	
AW324553-AbB*	(101)	WAKGHYTEGAELVD AVLDV V RR EAEG TD CLQGFQ I THSLGGGTGAGMGTL	
BAE64122-Aor-B1	(101)	WAKGHYTEGAELVDQ VVDV V RR EAEG CD CLQGFQ I THSLGGGTGAGMGTL	
XP_752456-AfuB1*	(100)	WAKGHYTEGAELVDQ V ID V V RR EAEG CD CLQGFQ V THSLGGGTGAGMGTL	
XP_658786-AniB1	(101)	WAKGHYTEGAELVDN VVDV V RR EAEG CD CLQGFQ I THSLGGGTGAGMGTL	
Fungal Consensus	(101)	WAKGHYTEGAELVDAV LDV V RR EAEG CD CLQGFQ I THSLGGGTGAGMGTL	



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	151	200
<i>NP_821133-HsTUBB1</i>	(151)	LISKIREEYPDRIMNTFSVVPSPKVS DTVVEPYNATLSVHQLVENT DETY
AAA34375-CaB	(151)	LISKIREEF PD MMATFSVVPSPKVS DTV IE PYNATLSVHQLVENS SD ETF
P02557-ScB1	(151)	LISKIREEF PDR MMATFSVLPSPKT SDTVVEPYNATLSVHQLVEHS DETF
AAC21454-SpB1	(151)	LISKIREEYPDR MMATFSV APAPKSS DTVVEPYNATLS M HQLVENS SD ETF
AW324553-AbB*	(151)	LISKIREEYPDR MMCTYS SVVPSPKVS -----
BAE64122-Aor-B1	(151)	LISKIREEF PDR MMATFSVVPSPKVS DTVVEPYNATLSVHQLVEHS DETF
XP_752456-AfuB1*	(150)	LISKIREEF PDR MMATFSVVPSPKVS DTVVEPYNATLSVHQLVEHS DETF
XP_658786-AniB1	(151)	LISKIREEF PDR MMATFSVVPSPKVS DTVVEPYNATLSVHQLVEHS DETF
Fungal Consensus	(151)	LISKIREEF PDR MMATFSVVPSPKVS DTVVEPYNATLSVHQLVEHS DETF
	201	250
<i>NP_821133-HsTUBB1</i>	(201)	CIDNEALYD IC FRTLKLT PT Y GD L NHLV SAT MSGVTT CL RFPGQL NADL
AAA34375-CaB	(201)	CIDNEALYN ICQ N TL KLP Q PSY AEL N LV SS VMSGVTT SL RYPGQL NSDL
P02557-ScB1	(201)	CIDNEALYD IC Q RTL KL N Q PSY GD L N LV SS VMSGVTT SL RYPGQL NSDL
AAC21454-SpB1	(201)	CIDNEALSS IF ANT TL K IK S PSY D DL N HLV S AV M AGVTT S FR F PG E L NSDL
AW324553-AbB*	(177)	-----
BAE64122-Aor-B1	(201)	CIDNEALYD IC M RTL KL SN PSY GD L NHLV S AV M SGVTT CL RFPGQL NSDL
XP_752456-AfuB1*	(200)	CIDNEALYD IC M RTL KL SN PSY GD L NHLV S AV M SGVTT CL RFPGQL NSDL
XP_658786-AniB1	(201)	CIDNEALYD IC M RTL KL SN PSY GD L NHLV S AV M SGVTT CL RFPGQL NSDL
Fungal Consensus	(201)	CIDNEALYD IC RTLKLN PSY GD L S AV M SGVTT LRF PGQL NSDL
	251	300
<i>NP_821133-HsTUBB1</i>	(251)	RKLAVNMV PF PRLHFF MPGF APL TS RGS Q QY R AL TV PELT Q QV FD AKNMM
AAA34375-CaB	(251)	RKLAVNL VP F PRL HFF MP GY AP L TS M GS K S F RS SV TV PELT Q Q M F DA KNMM
P02557-ScB1	(251)	RKLAVNL VP F PRL HFF MP GY AP L TA I GS Q S F RS SL TV PELT Q Q M F DA KNMM
AAC21454-SpB1	(251)	RKLAVNMV PF PRLHFF MPGF APL AA I GS SS F Q AV S VP ELT Q Q M F DA NNMM
AW324553-AbB*	(177)	-----
BAE64122-Aor-B1	(251)	RKLAVNMV PF PRLHFF MPGF APL TS RGA H S FRA V SV PELT Q Q M F D PK N MM
XP_752456-AfuB1*	(250)	RKLAVNMV PF PRLHFF MPGF APL TS RGA H S FRA V SV PELT Q Q M F D PK N MM
XP_658786-AniB1	(251)	RKLAVNMV PF PRLHFF MPGF APL TS RGA Y S F RA V SV PELT Q Q M F D PK N MM
Fungal Consensus	(251)	RKLAVNMV PF PRLHFF MPGF APL TS GA S FRA V SV PELT Q Q M F D KN MM

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301                                     350
NP_821133-HsTUBB1 (301) AACDPRHGRYLTVAAVFRGRMSMKEVDEQMLNVQNKNSSYFVEWIPNNVK

AAA34375-CaB (301) AASDPRNGRYLTVAAFVRGKVSVKEVDEMHIQTRNSSYFVDWIPNNVQ
P02557-ScB1 (301) AAADPRNGRYLTVAAFVRGKVSVKEVEDEMHKVQSKNSDYFVEWIPNNVQ
AAC21454-SpB1 (301) VAADPRHGRYLTVAAVFRGKVSVMKEVDEQIRSVQTKNSAYFVEWIPDNVL
AW324553-AbB* (177) -----
BAE64122-Aor-B1 (301) AASDFRNGRYLTCSAIFRGKVSVMKEVEDQMRNIQSKNQTYFVEWIPNNIQ
XP_752456-AfuB1* (300) AASDFRNGRYLTCSAIFRGKVSVMKEVEDQMRNIQSKNQSYFVEWIPNNIQ
XP_658786-AniB1 (301) AASDFRNGRYLTCSAIFRGKVSVMKEVEDQMRNIQSKNQSYFVEWIPNNIQ
Fungal Consensus (301) AASD RNGRYLT AAI FRGKVSVMKEVEDQMR IQSKN SYFVEWIPNNIQ

351                                     400
NP_821133-HsTUBB1 (351) TAVCDIPPRGLKMAVTFIGNSTAIQELFKRITSEQFTAMFRRKAFLHWYTG

AAA34375-CaB (351) TAVCSVPPKDLDMSATFIGNSTSIQELFKRVGDQFSAMFRRKAFLHWYTS
P02557-ScB1 (351) TAVCSVAPQGLDMAATFIANSTSIQELFKRVGDQFSAMFKRKAFLHWYTS
AAC21454-SpB1 (351) KAVCSVPPKDLKMSATFIGNSTSIQELFRRLGDQFSAMFRRKAFLHWYTG
AW324553-AbB* (177) -----
BAE64122-Aor-B1 (351) TALCSIPPRGLKMSSTFIGNSTSIQELFKRVGDQFTAMFRRKAFLHWYTG
XP_752456-AfuB1* (350) TALCSIPPRGLKMSSTFIGNSTSIQELFKRVGDQFTAMFRRKAFLHWYTG
XP_658786-AniB1 (351) TALCSIPPRGLKMSSTFIGNSTSIQELFKRVGDQFTAMFRRKAFLHWYTG
Fungal Consensus (351) TALCSIPPRGLKMSATFIGNSTSIQELFKRVGDQFSAMFRRKAFLHWYTG

401                                     450
NP_821133-HsTUBB1 (401) EGMDEMEFTEAESNMNDLVSEYQQYQDATAEDEEDFGEEAEDEA-----

AAA34375-CaB (401) EGMDEMEFTEAESNMNDLVSEYQQYQFEASIDEELELYADEIPLEDAAME-
P02557-ScB1 (401) EGMDELEFSEAESNMNDLVSEYQQYQEATVEDDEEVDENGDFGAPQNQDE
AAC21454-SpB1 (401) EGMDEMEFTEAESNMNDLVSEYQQYQEAAGIDEGDEEDYEIEEKEPLEY--
AW324553-AbB* (177) -----
BAE64122-Aor-B1 (401) EGMDEMEFTEAESNMNDLVSEYQQYQDASISEGEEYLEEEPLEHEE--
XP_752456-AfuB1* (400) EGMDEMEFTEAESNMNDLVSEYQQYQDASISEGEEYGEEL-PLAEE--
XP_658786-AniB1 (401) EGMDEMEFTEAESNMNDLVSEYQQYQDASISEGEEYAEDEIMEGE E---
Fungal Consensus (401) EGMDEMEFTEAESNMNDLVSEYQQYQDASI EGE EEE E

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                                     451
NP_821133-HsTUBB1  (445)  -----
    AAA34375-CaB    (450)  -----
    P02557-ScB1     (451)  PITENFE
    AAC21454-SpB1   (449)  -----
    AW324553-AbB*   (177)  -----
    BAE64122-Aor-B1 (449)  -----
    XP_752456-AfuB1* (447)  -----
    XP_658786-AniB1 (448)  -----
Fungal Consensus (451)
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Notes & Comments:

Fungal consensus is based on fungal beta-1 tubulins only, but the human beta tubulin is included in the alignment for reference purposes (above alignment, *italics* and underlined).

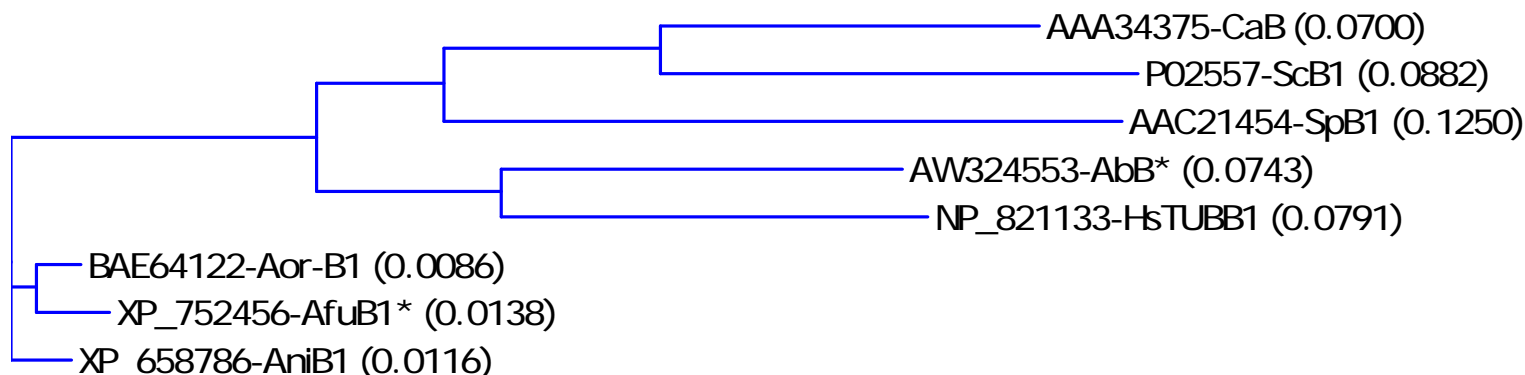
The direct translation of the *Agaricus bisporus* EST (AW324553 indicated with an asterix *) results in 14 additional residues (**HASATSLFRLKPSI**) at amino terminus of the protein, but are probably NOT real.

Note, there is an apparent 19 amino acid insertion (**HGGNTENKEEADACLMGNN**) in the *Aspergillus fumigatus* beta-1 tubulin not seen in any other fungal (including *Afu*- β 2) or human tubulins. However, this is at a point in the protein where some fungal tubulins have 1 or 2 additional bases. So, this might be real, or it might be an artifact, perhaps a cryptic splice site not recognized during the “virtual transcription/translation” used to generate this sequence from the fungal genome sequence. There is no independent sequence data to confirm or reject inclusion. For now it has been manually removed from the sequence (indicated with *) and removed from the alignments, and calculations for phylogenetic trees and identity/conservation tables.

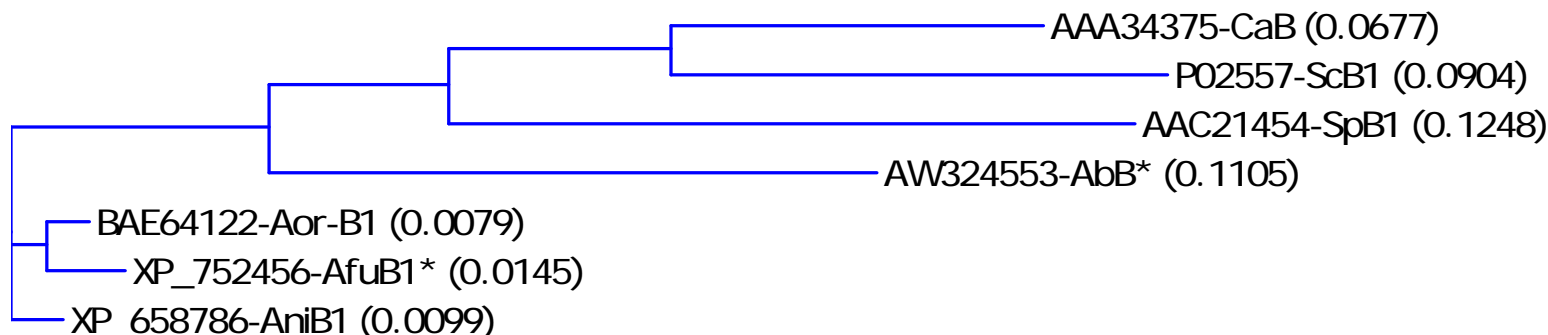


Sequence comparison of fungal beta-tubulins

Phylogenetic Tree for Fungal β -tubulin Proteins Compared to Human β -tubulin



Phylogenetic Tree for Fungal β -tubulin Proteins





Sequence comparison of fungal beta-tubulins

Amino-Acid Identity of Fungal β -tubulin Proteins Compared to Human β -tubulin

	NP_821133- HsTUBB1	AAA34375- CaB	P02557- ScB1	AAC21454- SpB1	AW324553- AbB*	BAE64122- Aor-B1	XP_752456- AfuB1*	XP_658786- AniB1
NP_821133-HsTUBB1	100	75	75	75	85	81	81	81
AAA34375-CaB		100	84	76	75	79	80	80
P02557-ScB1			100	74	71	78	78	78
AAC21454-SpB1				100	74	78	78	78
AW324553-AbB*					100	83	82	84
BAE64122-Aor-B1						100	98	98
XP_752456-AfuB1*							100	97
XP_658786-AniB1								100

Protein Similarity of Fungal β -tubulin Proteins Compared to Human β -tubulin

	NP_821133- HsTUBB1	AAA34375- CaB	P02557- ScB1	AAC21454- SpB1	AW324553- AbB*	BAE64122- Aor-B1	XP_752456- AfuB1*	XP_658786- AniB1
NP_821133-HsTUBB1	100	89	90	88	92	92	92	92
AAA34375-CaB		100	94	89	88	90	90	91
P02557-ScB1			100	88	89	90	90	90
AAC21454-SpB1				100	86	90	89	90
AW324553-AbB*					100	93	91	93
BAE64122-Aor-B1						100	99	98
XP_752456-AfuB1*							100	98
XP_658786-AniB1								100



Sequence comparison of fungal beta-tubulins

Amino-Acid Identity of Fungal β -tubulin Proteins

	AAA34375- CaB	P02557- ScB1	AAC21454- SpB1	AW324553- AbB*	BAE64122- Aor-B1	XP_752456- AfuB1*	XP_658786- AniB1
AAA34375-CaB	100	84	76	75	79	80	80
P02557-ScB1		100	74	71	78	78	78
AAC21454-SpB1			100	74	78	78	78
AW324553-AbB*				100	83	82	84
BAE64122-Aor-B1					100	98	98
XP_752456-AfuB1*						100	97
XP_658786-AniB1							100

Protein Similarity of Fungal β -tubulin Proteins

	AAA34375- CaB	P02557- ScB1	AAC21454- SpB1	AW324553- AbB*	BAE64122- Aor-B1	XP_752456- AfuB1*	XP_658786- AniB1
AAA34375-CaB	100	94	89	88	90	90	91
P02557-ScB1		100	88	89	90	90	90
AAC21454-SpB1			100	86	90	89	90
AW324553-AbB*				100	93	91	93
BAE64122-Aor-B1					100	99	98
XP_752456-AfuB1*						100	98
XP_658786-AniB1							100



Sequence comparison of fungal beta-tubulins

Accessions and Citations

Aspergillus fumigatus (Af293) Note, alignments use manually edited protein sequence to eliminate “insertion”

Protein: XP_752456 (*)
DNA: XM_747636
Evidence: Beta1 designation based on sequence homology, not supported by known biological data

Aspergillus nidulans (FGSC A4)

Protein: XP_658786 (see also P10653)
DNA: XM_653694 (see also M17519)
Evidence: BenA involved in both vegetative growth & asexual sporulation, but tubC is mostly used during sporulation only (see May et al. 1987. *Gene* 55:231-43; Oakley 2004. *Fungal Genet. Biol.* 41: 420-7; see also *Asp. nidulans* gene index – TC5874)

Aspergillus oryzae (RIB40)

Protein: BAE64122
DNA: AP007169
Evidence: Virtual translation based homolog, and similarity to partial sequence of benA56 of strain NRR4469 (Acc.AF036805); strong homology to *Asp. flavus* (Acc. M38265).

Candida albicans (original source Strain B792 not ATCC 10231 as used for α -tubulin)

Protein: AAA34375
DNA: M19389
Evidence: TUB2 is only β -tubulin gene in *C. albicans* based on Southern-blot analysis (Smith *et al.* 1988. *Gene*, **63**: 53-63)



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Saccharomyces cerevisiae

Protein: P02557
DNA: V01296
Evidence: Tub2, (see Neff et al. 1983. Cell, 33: 211-219)

Schizosaccharomyces pombe

Protein: AAC21454
DNA: AF042827 (and see M10347 for genomic DNA)
Evidence: Nda3 is beta tubulin, (see Hiraoka et al. 1984. Cell, 39: 349-58)

Agaricus bisporus

Protein: Virtual translation of EST below, manually edited to eliminate apparent N-terminal addition (indicated by *)
DNA: AW324553 is short EST attributed as β -tubulin.
Evidence: Homolog of β 1 based on short EST sequence (see Ospina-Giraldo *et al.* 2000. Fungal Genet. 29: 81-94)

Homo sapiens

Protein: NP_821133
DNA: NM_178014
Evidence: Known variously as: constitutive; human $h\beta$ 1; tubulin- β 2; TUBB; TUB2A, TUBB2
Unigene: TUBB = Hs.533059