

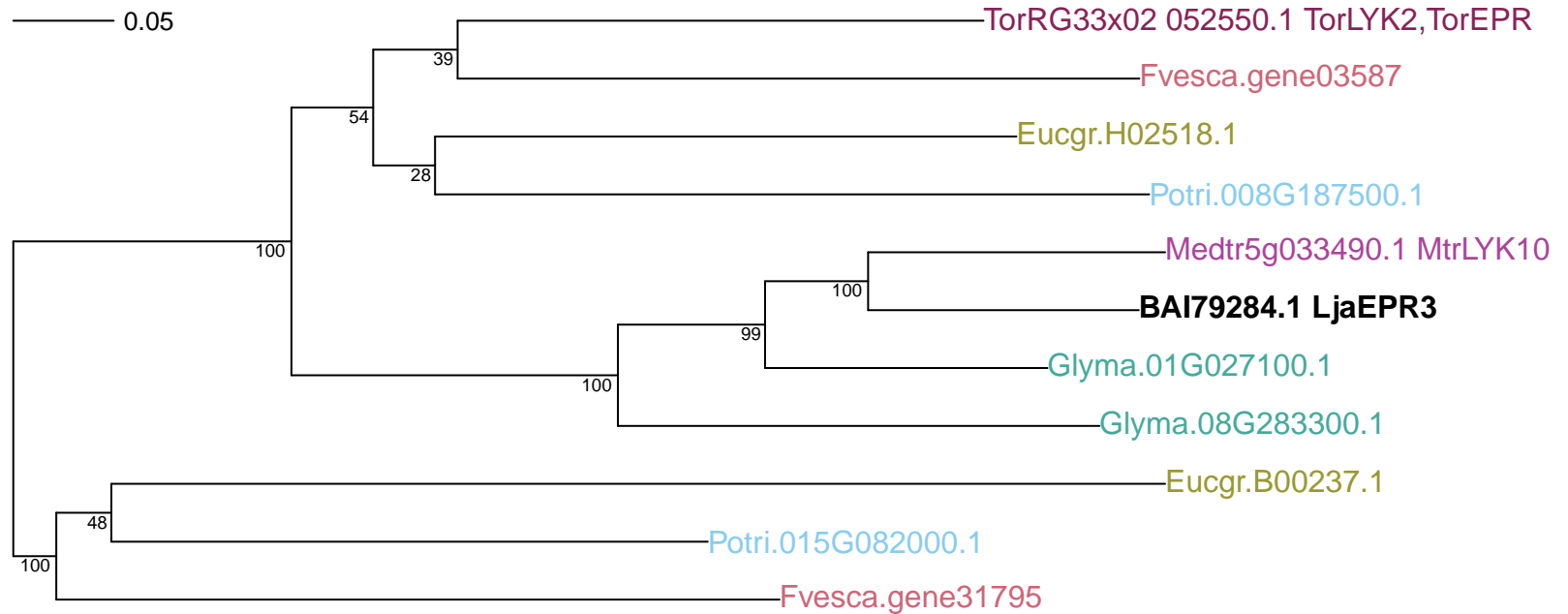
Comparative genomics of the non-legume *Parasponia* reveals insights into evolution of nitrogen-fixing rhizobium symbioses

Robin van Velzen, Rens Holmer, Fengjiao Bu, Luuk Rutten, Arjan van Zeijl, Wei Liu, Luca Santuari, Qingqin Cao, Trupti Sharma, Defeng Shen, Yuda Roswanjaya, Titis A.K. Wardhani, Maryam Seifi Kalhor, Joelle Jansen, Johan van den Hoogen, Berivan Güngör, Marijke Hartog, Jan Hontelez, Jan Verver, Wei-Cai Yang, Elio Schijlen, Rimi Repin, Menno Schilthuizen, M. Eric Schranz, Renze Heidstra, Kana Miyata, Elena Fedorova, Wouter Kohlen, Ton Bisseling, Sandra Smit, & Rene Geurts

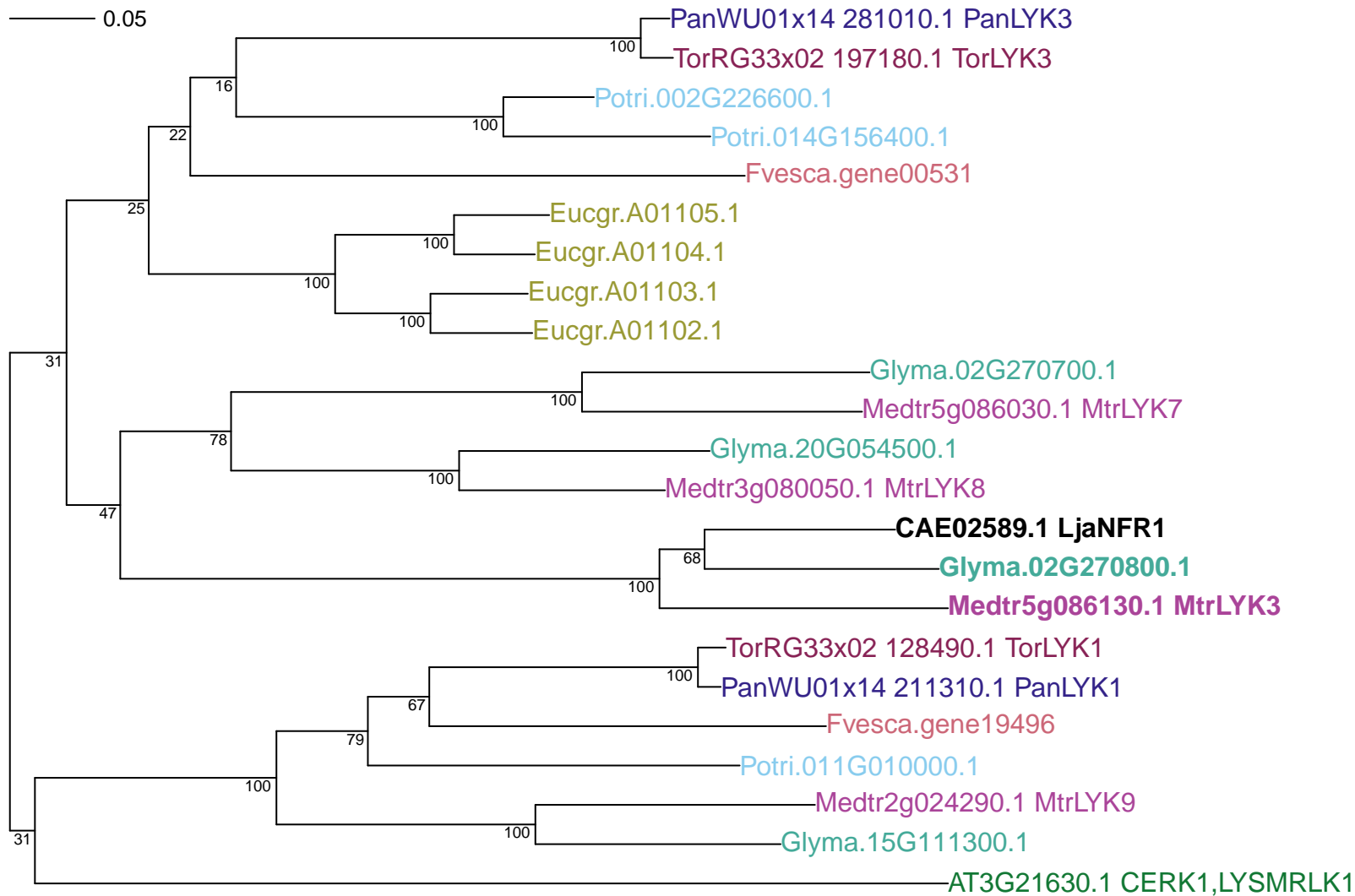
Phylogenetic analysis of *Parasponia andersonii* and *Trema orientalis* RG33 putative orthologs of legume genes that function in symbioses.

Phylogenetic trees (based on Maximum Likelihood) of orthogroups containing published genes that function in symbiosis (see also Dataset S1). OrthoGroup number corresponds to Dataset S2. Node labels indicate bootstrap support values; scale bars represent evolutionary distance in substitutions per site. Legume genes that function in symbioses are marked in bold. Proteins from *Arabidopsis thaliana* (AT) are marked in green, *Eucalyptus grandis* (Eucgr) in olive, *Populus trichocarpa* (Potri) in light blue, *Medicago truncatula* (Medtr) in purple, *Glycine max* (Glyma) in mint, *Fragaria vesca* (Fvesca) in pink, *P. andersonii* (Pan) in dark blue, and *T. orientalis* RG33 (Tor) in dark red. Legume or actinorrhizal symbiosis genes from species not included in the orthogroup inferences are in black. Agl = *Alnus glutinosa*, Cgl = *Casuarina glauca*, Dgl = *Datisca glomerata*, Lja = *Lotus japonicus*, Msa = *Medicago sativa*, Mtr = *Medicago truncatula*, Phy = *Petunia hybrida*, Psa = *Pisum sativum*, Pvu = *Phaseolus vulgaris*.

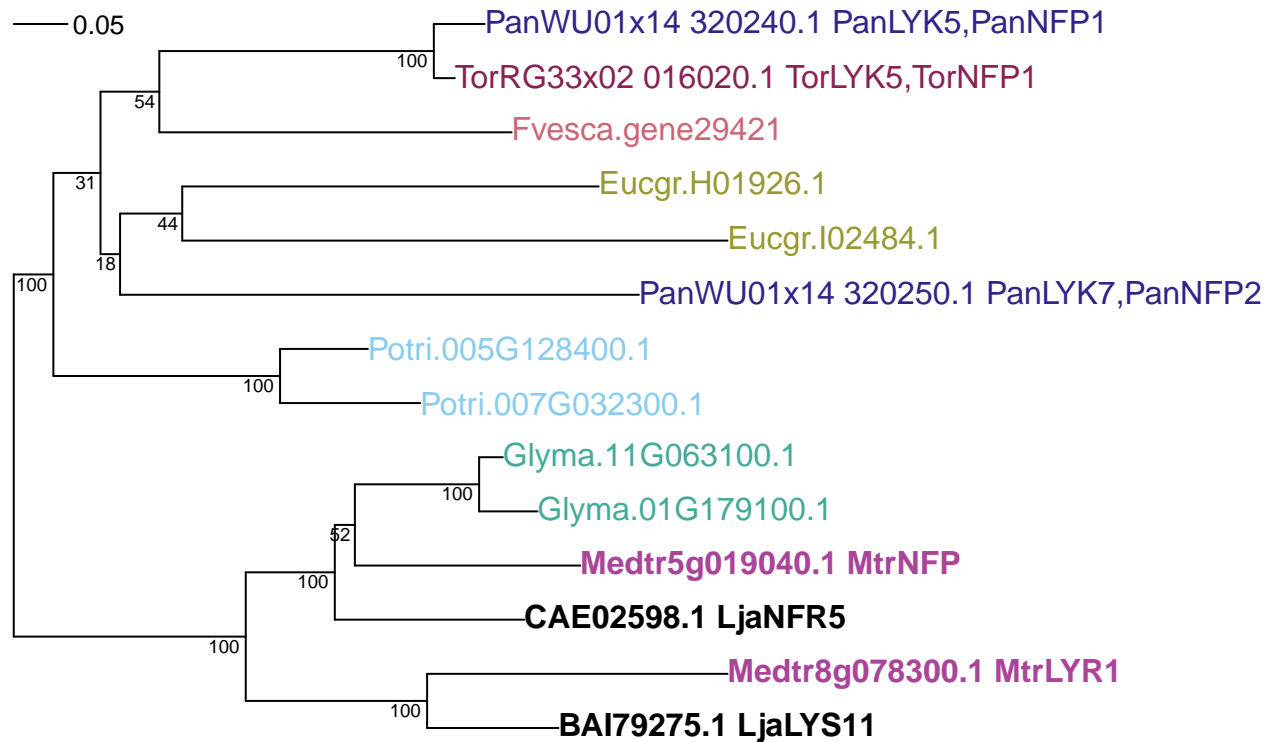
OG0007755: Receptor complexes. LysM receptor kinase (type 1)



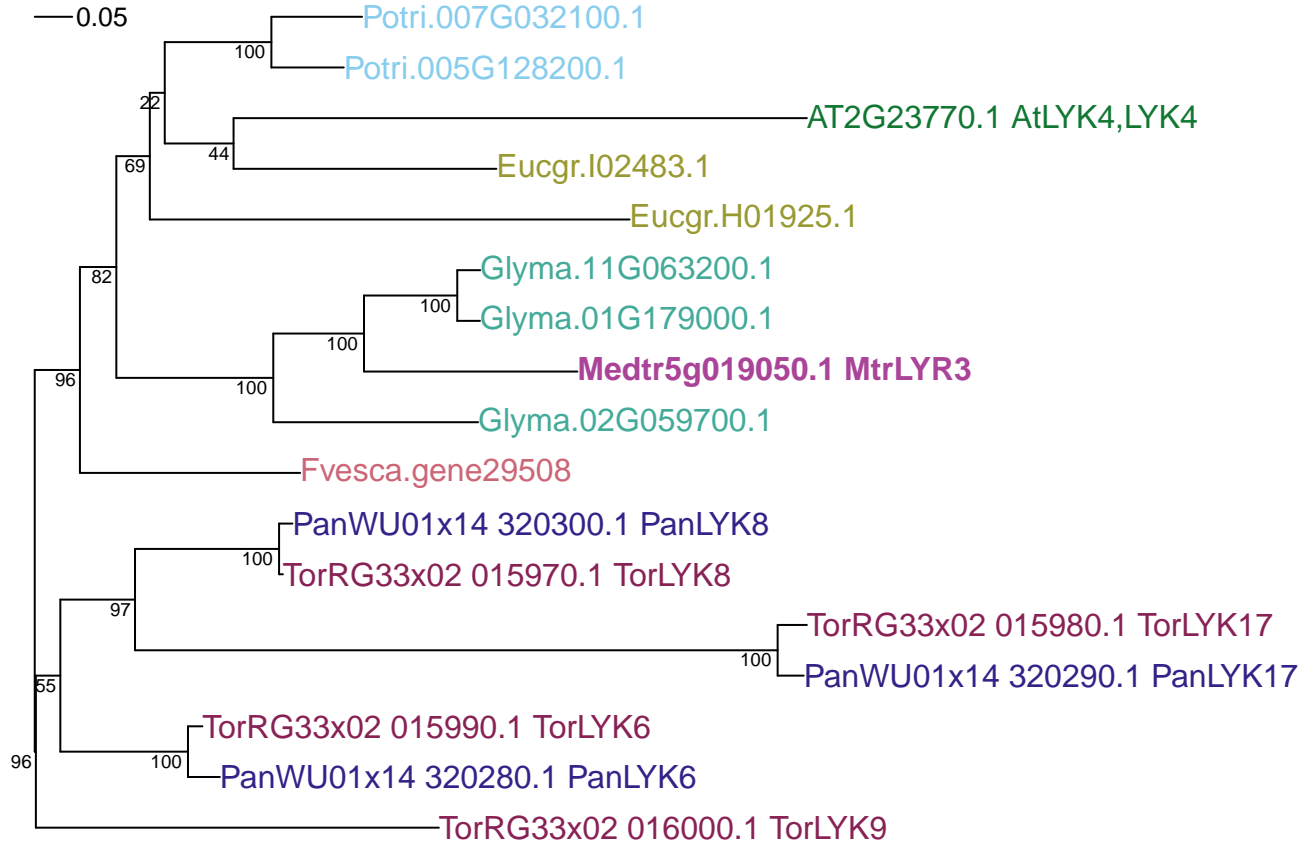
OG0002182: Receptor complexes. LysM receptor kinase (type 1)



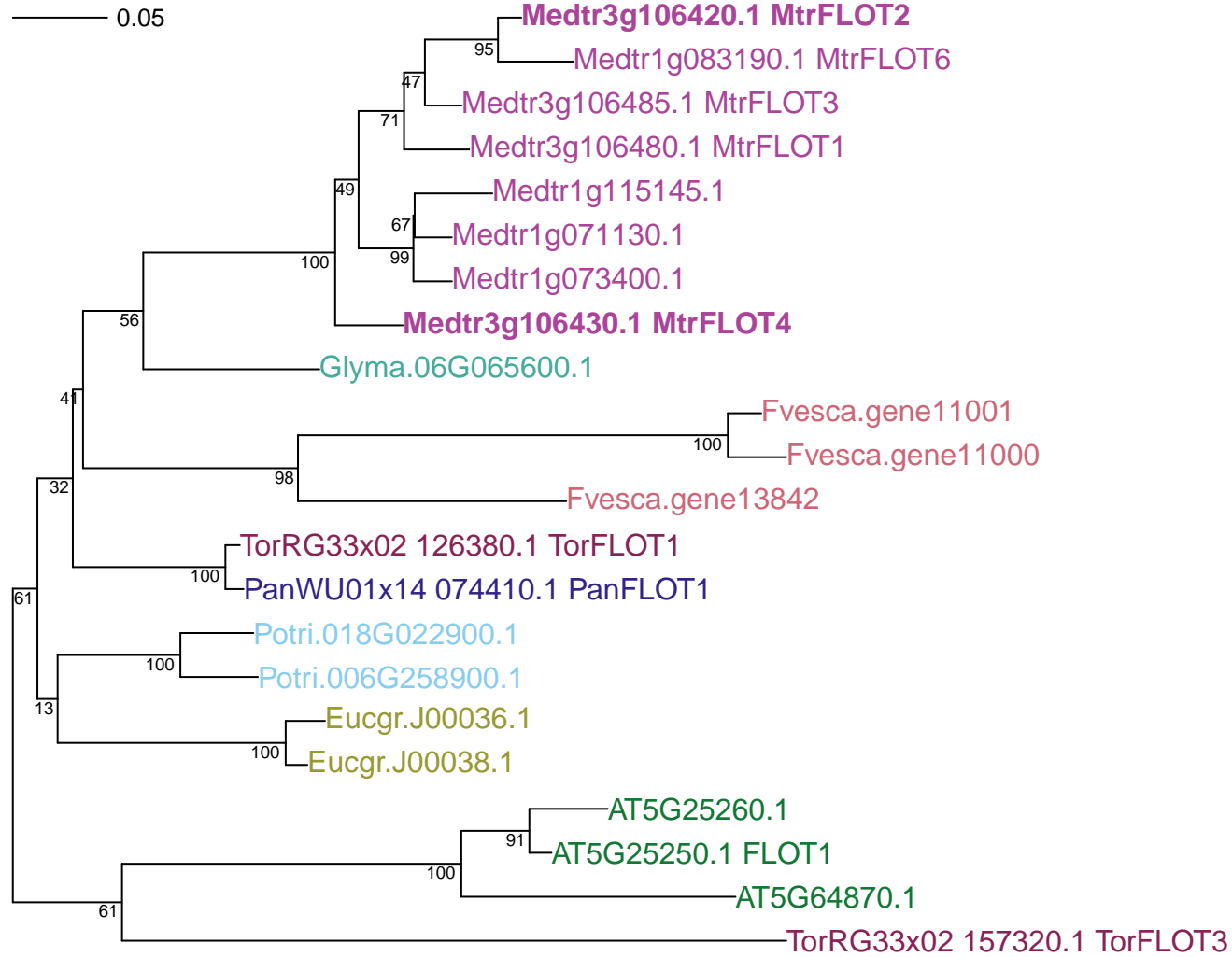
OG0006376: Receptor complexes. LysM receptor kinase (type 2)



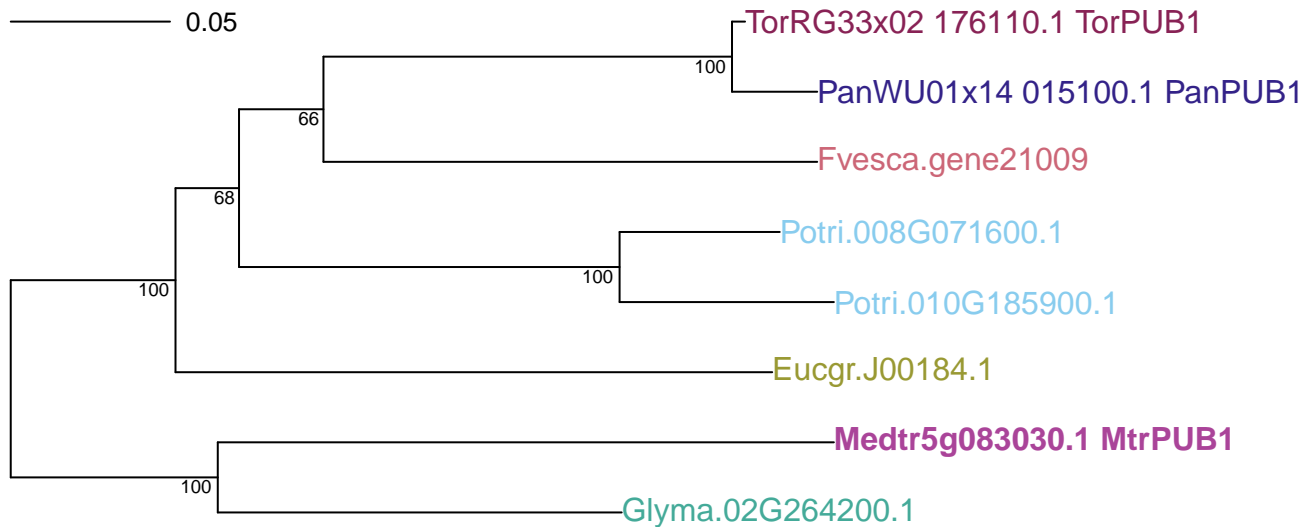
OG0003224-0018959: Receptor complexes. LysM receptor kinase (type 2)



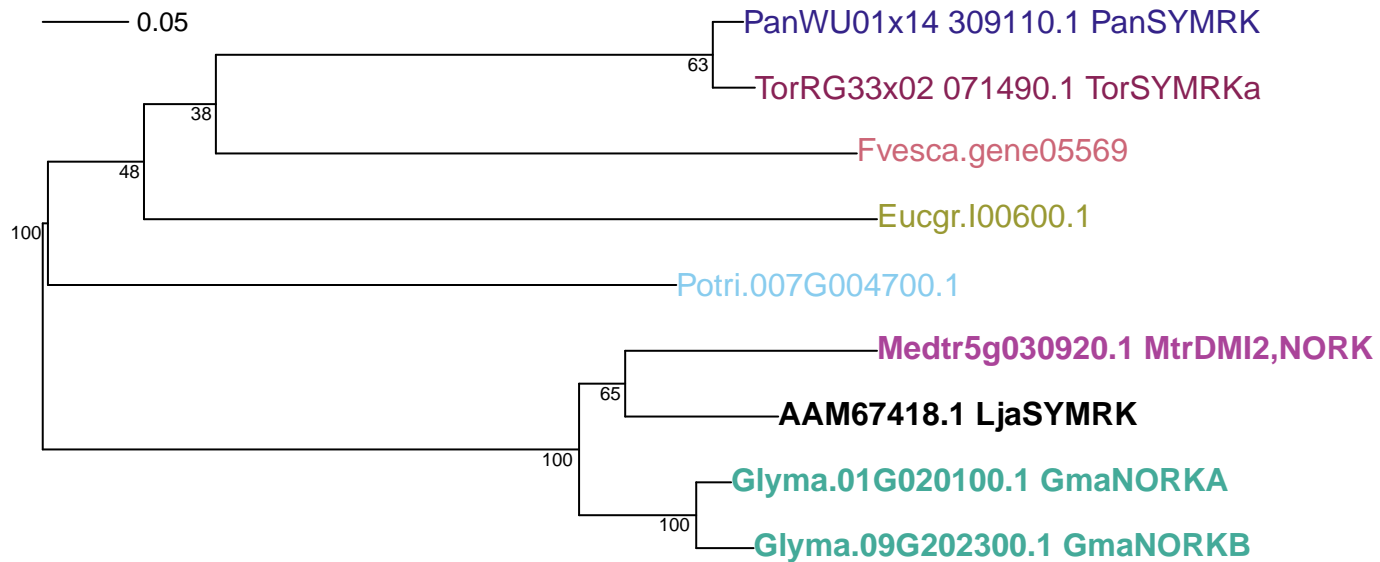
OG0001771: Receptor complexes. Flotilin



OG0013351: Receptor complexes. Plant U-box protein PUB1

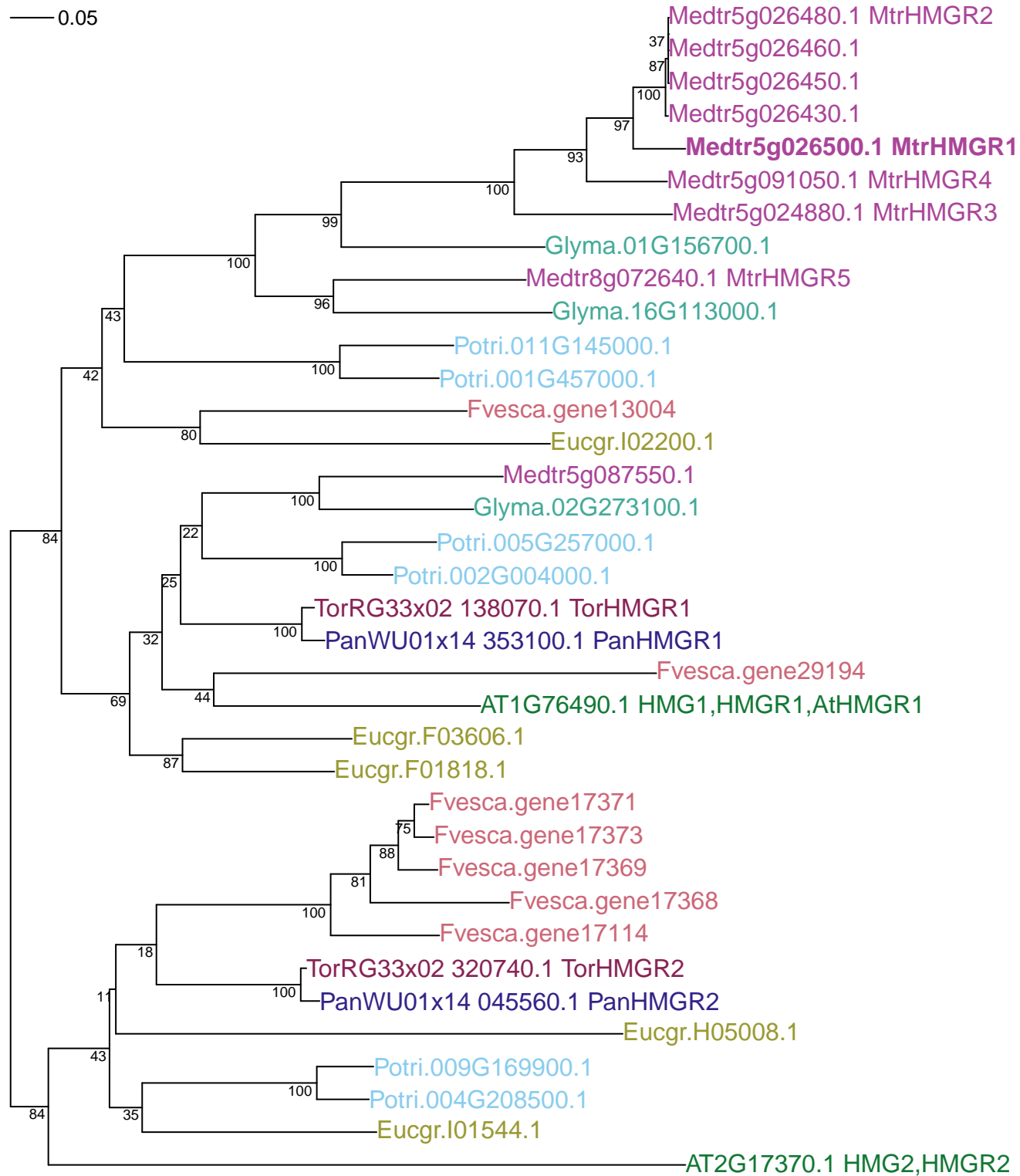


OG0012091: Receptor complexes. SYMRK symbiotic receptor kinase

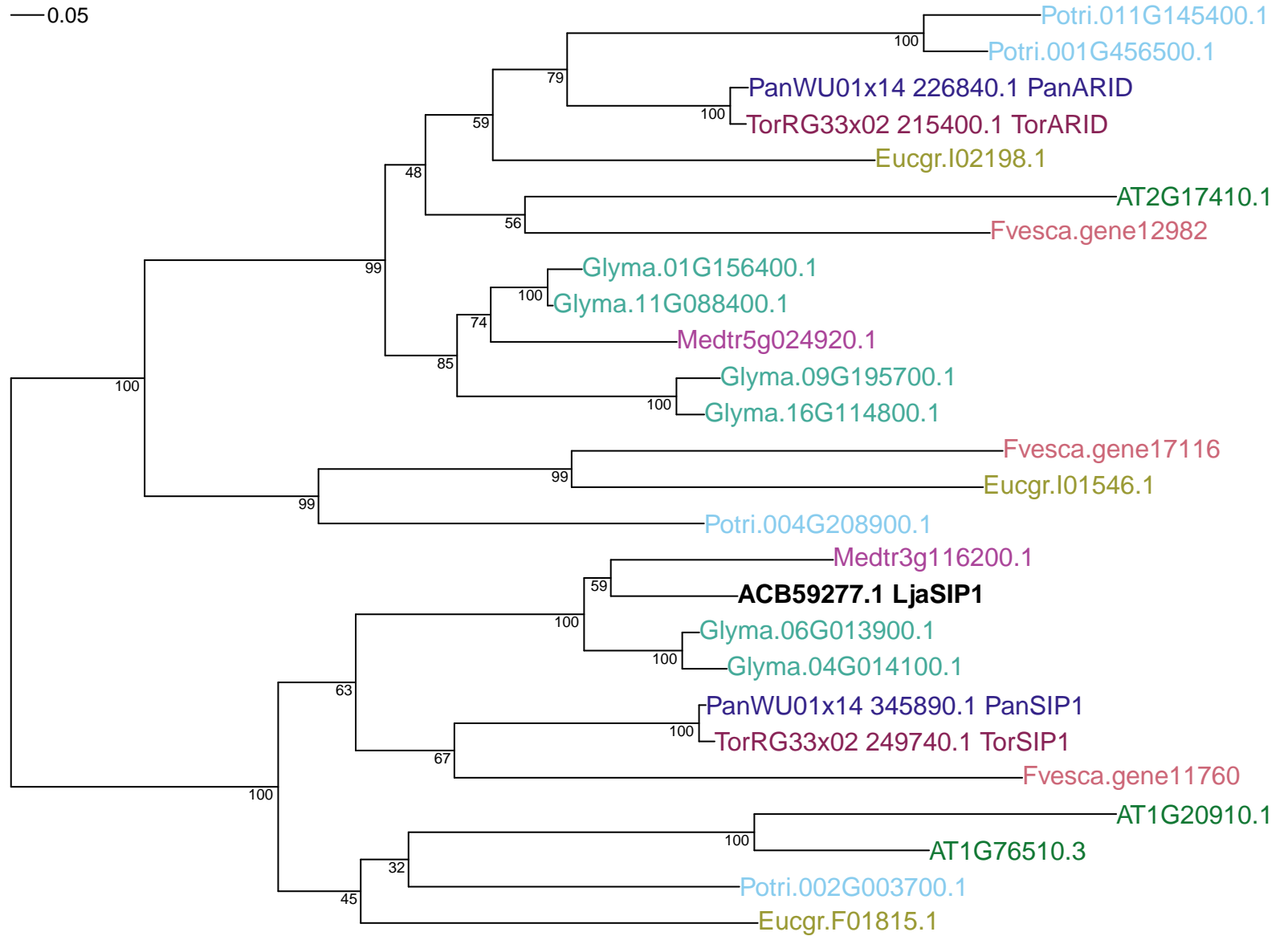


OG0000580: Receptor complexes. SYMRK interacting protein HMGR

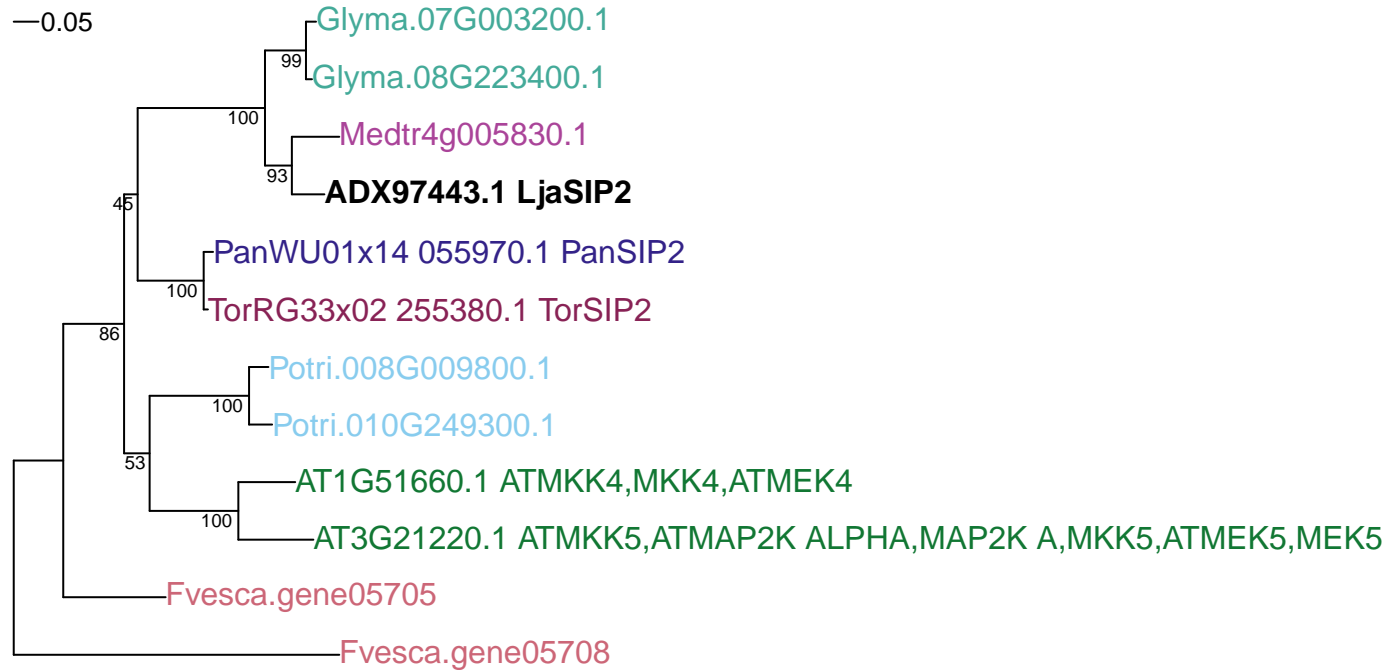
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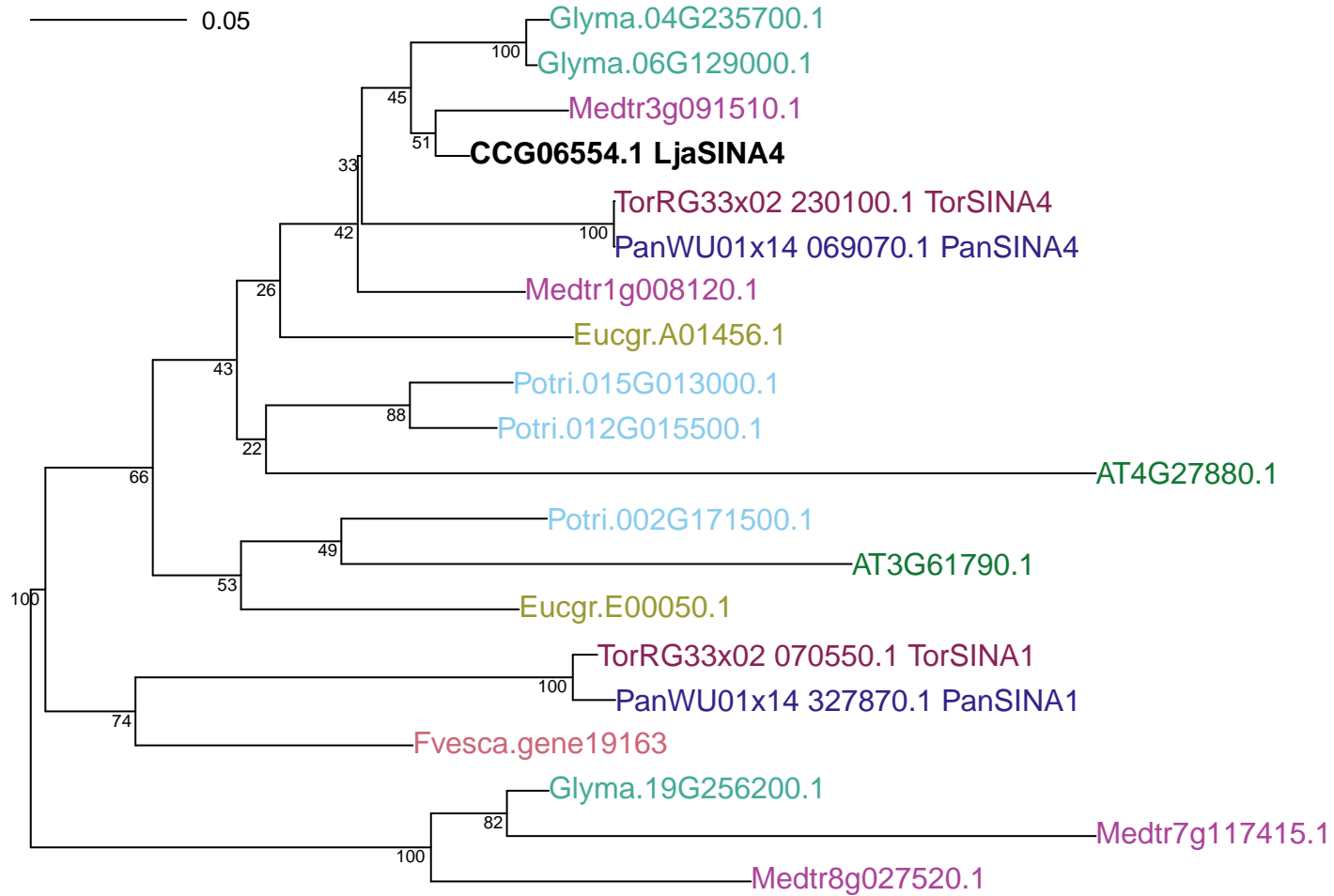
OG0001217: Receptor complexes. SYMRK interacting protein SIP1



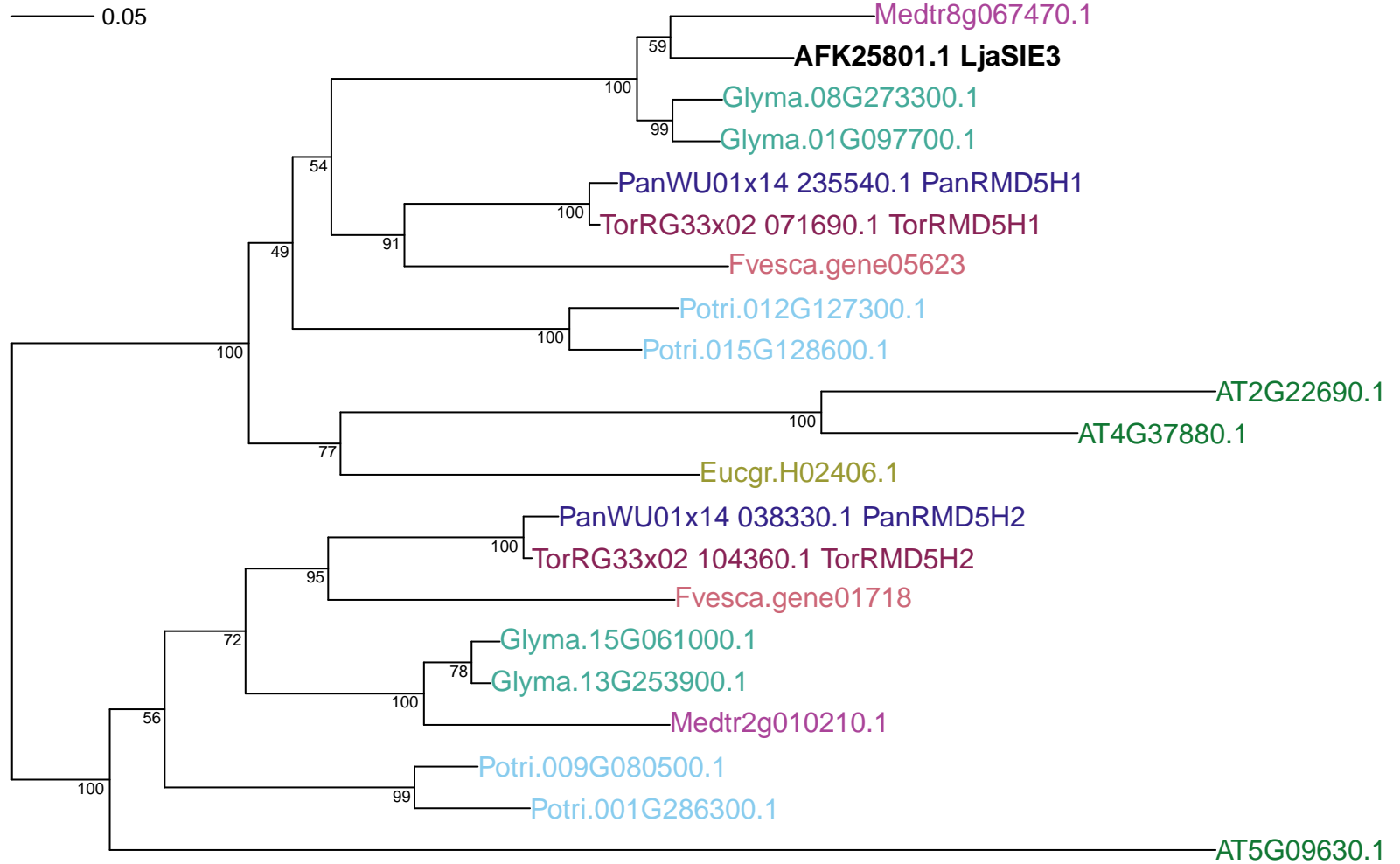
OG0006630: Receptor complexes. SYMRK interacting protein SIP2



OG0002406: Receptor complexes. SYMRK interacting protein SINA4

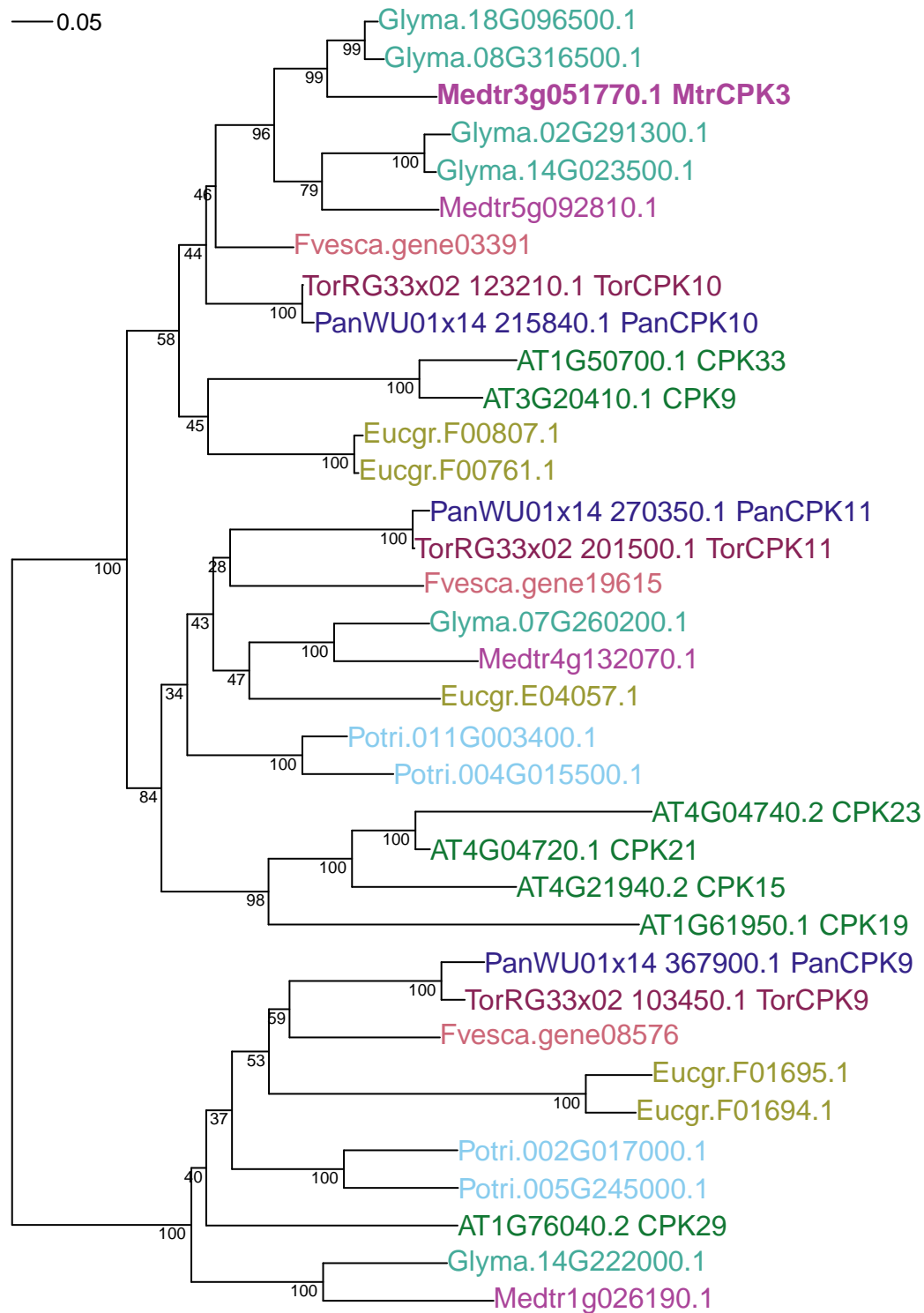


OG0002105: Receptor complexes. SYMRK interacting protein SIE3



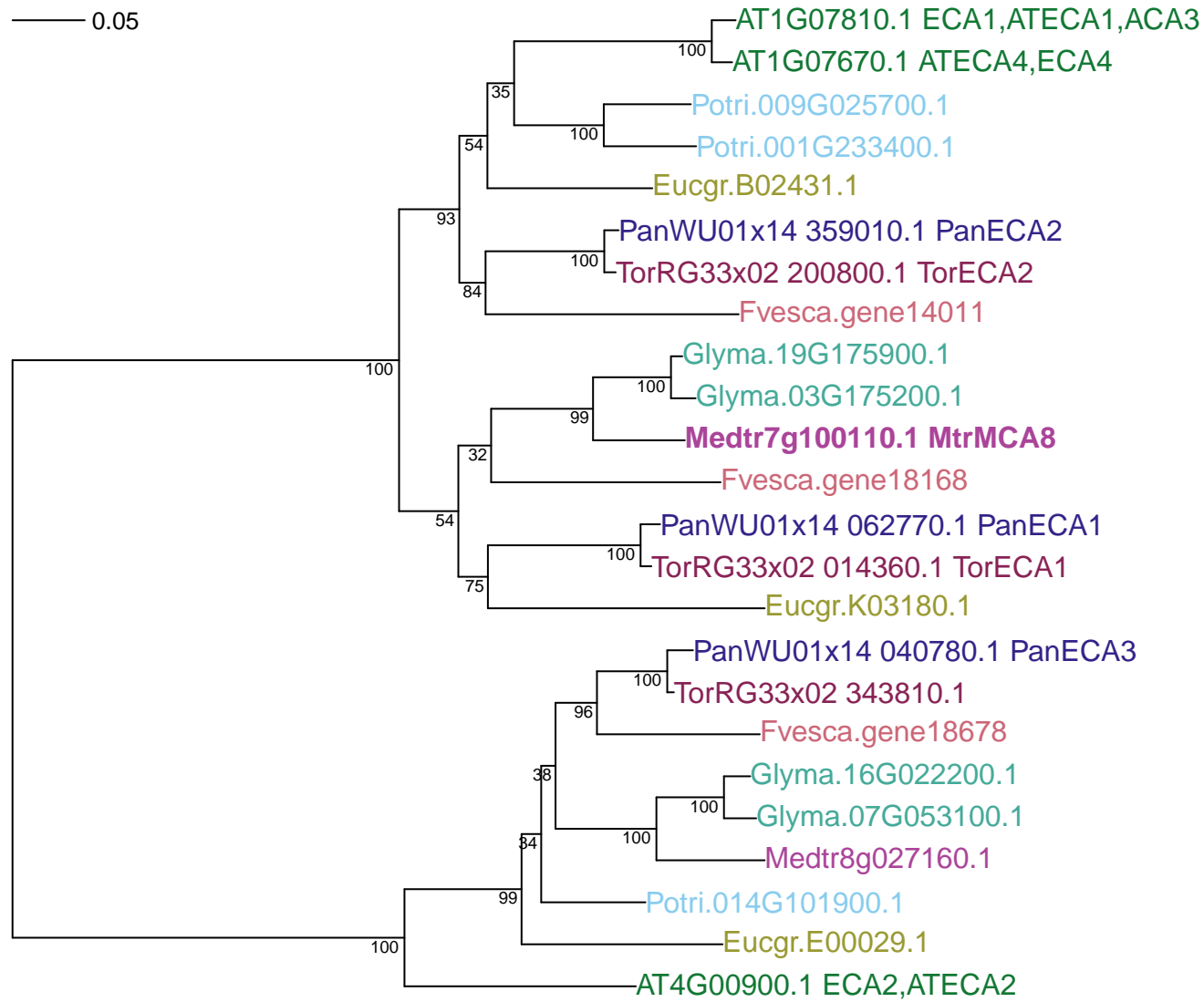
OG0000601: Receptor complexes. Calcium-dependent protein kinase

— 0.05

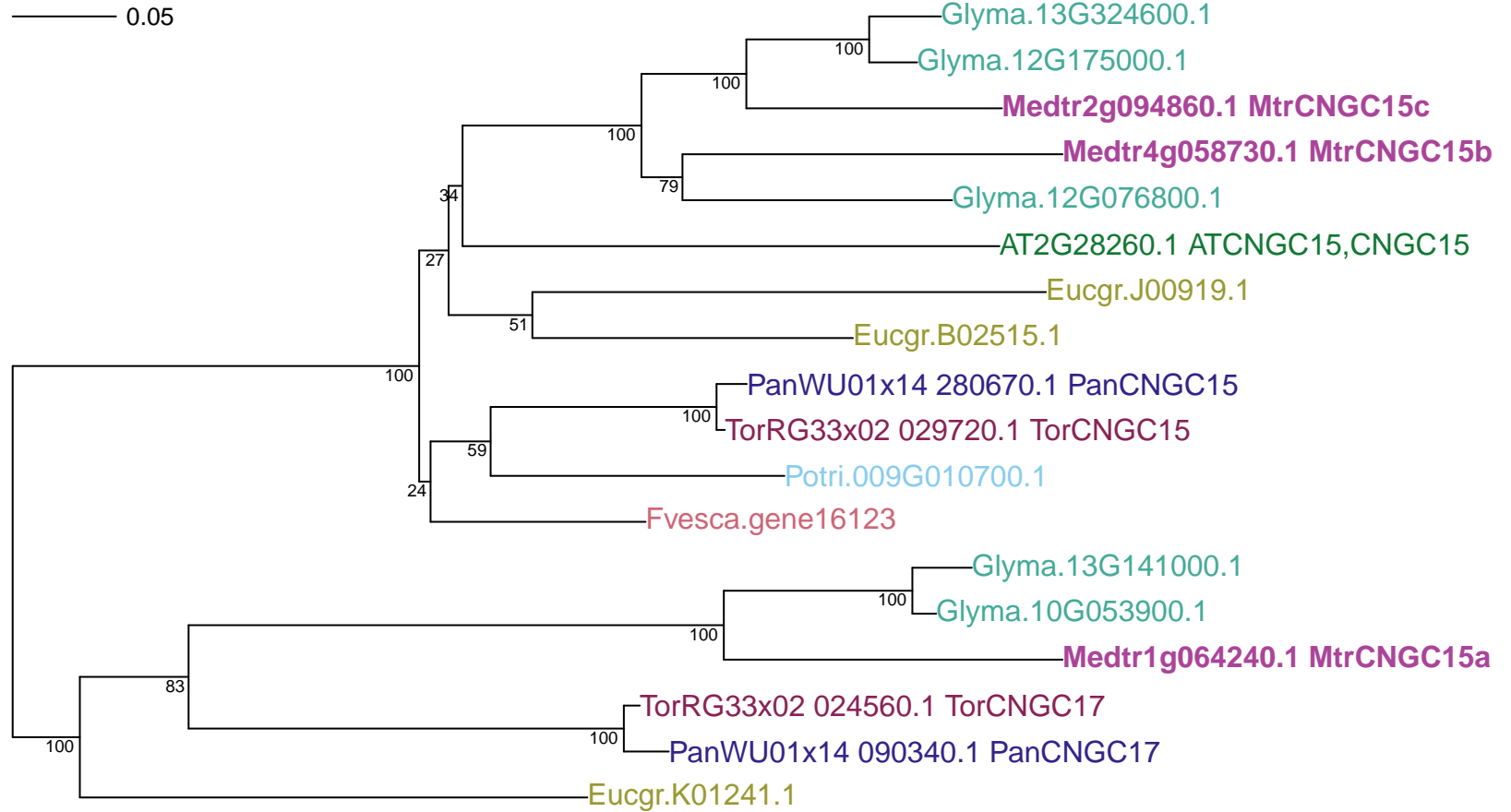


OG0001336: Nuclear signaling. Calcium ATP-ase

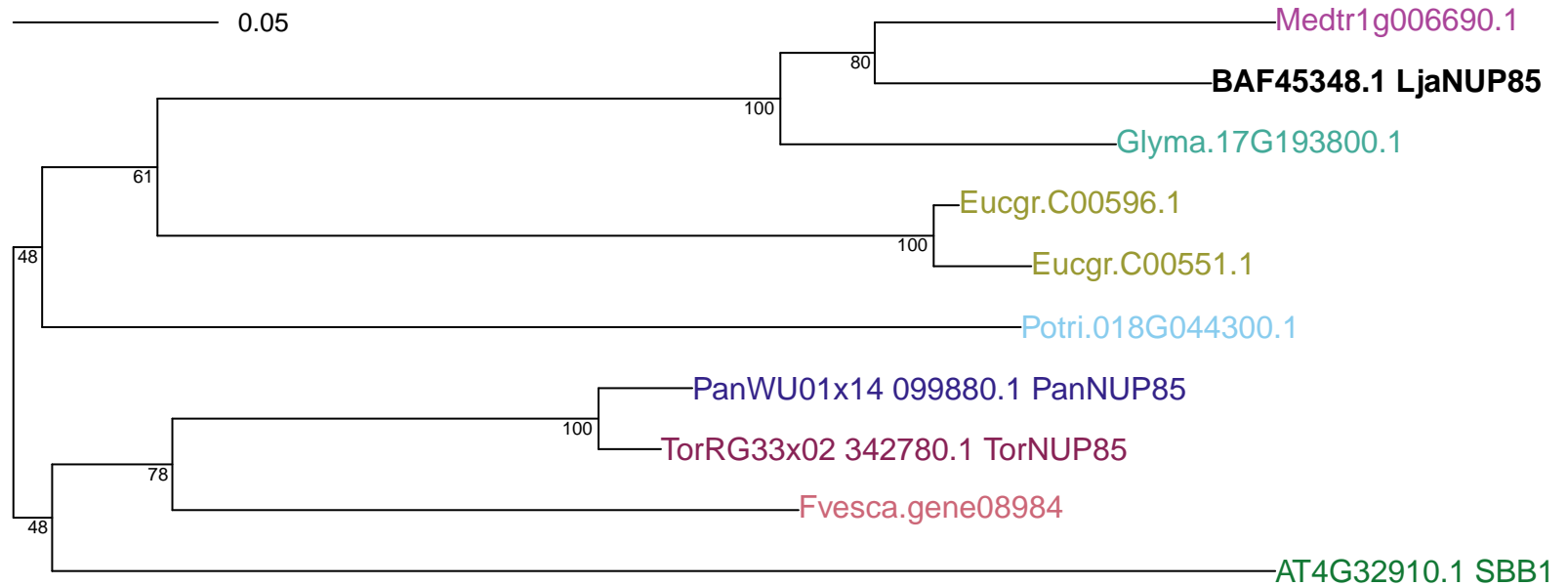
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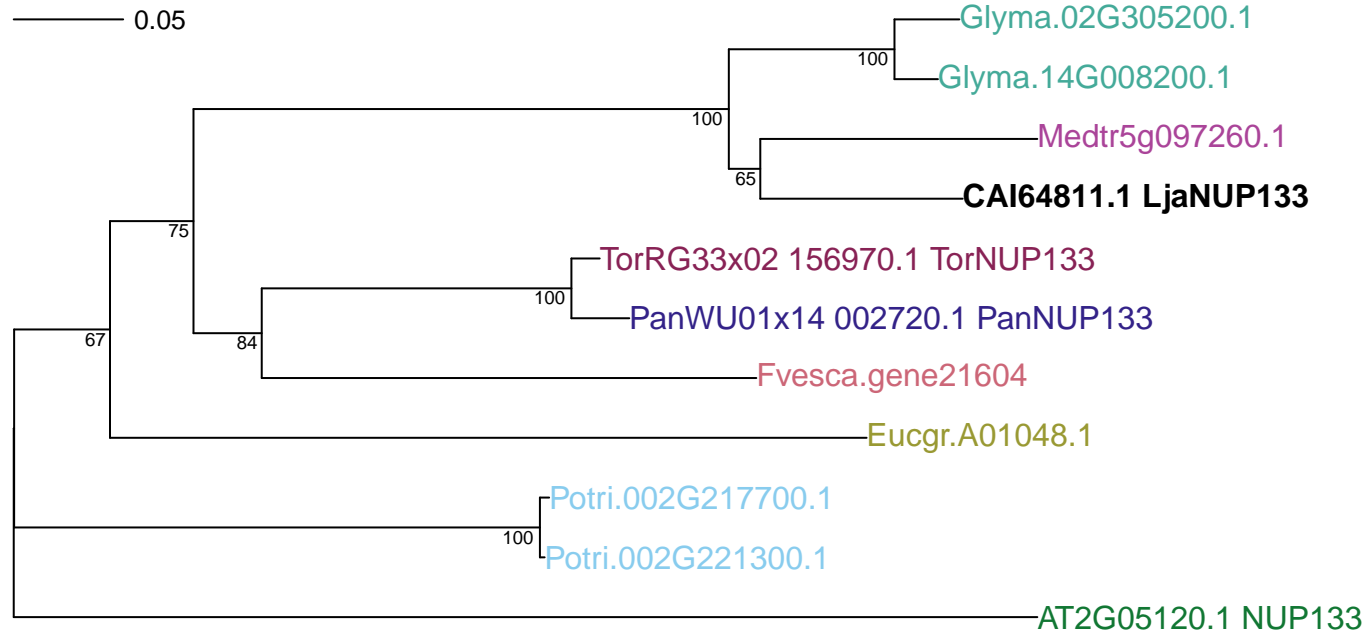
OG0002604: Nuclear signaling. Cyclic nucleotide-gated Ca²⁺ channel



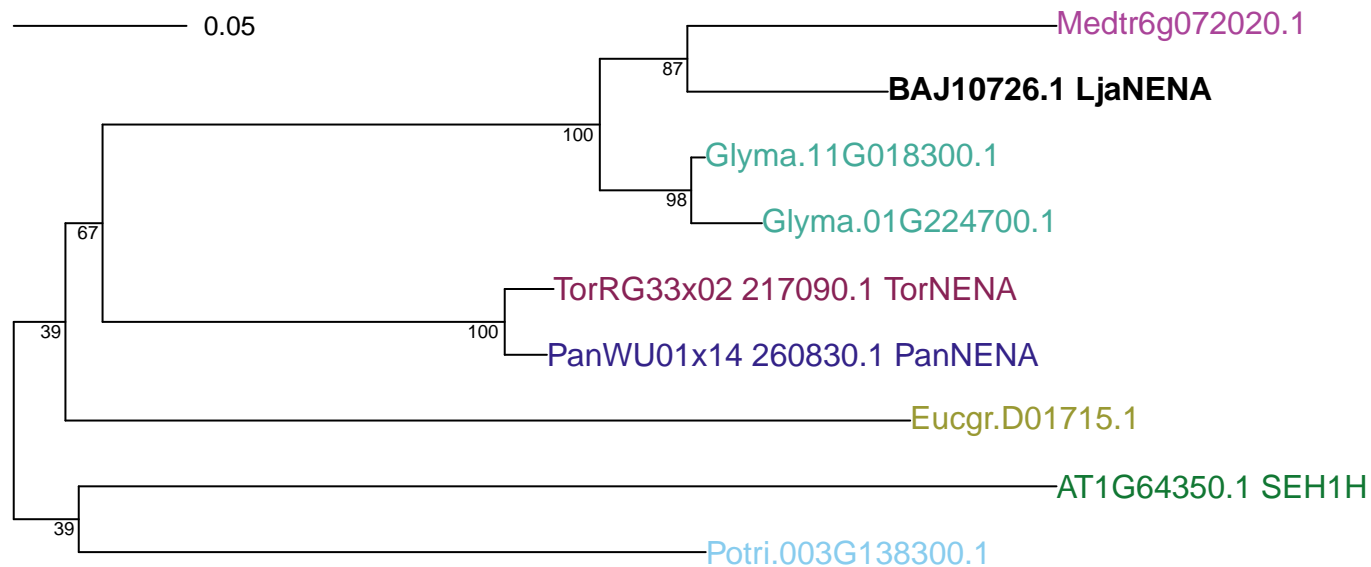
OG0011366: Nuclear signaling. Nucleoporin



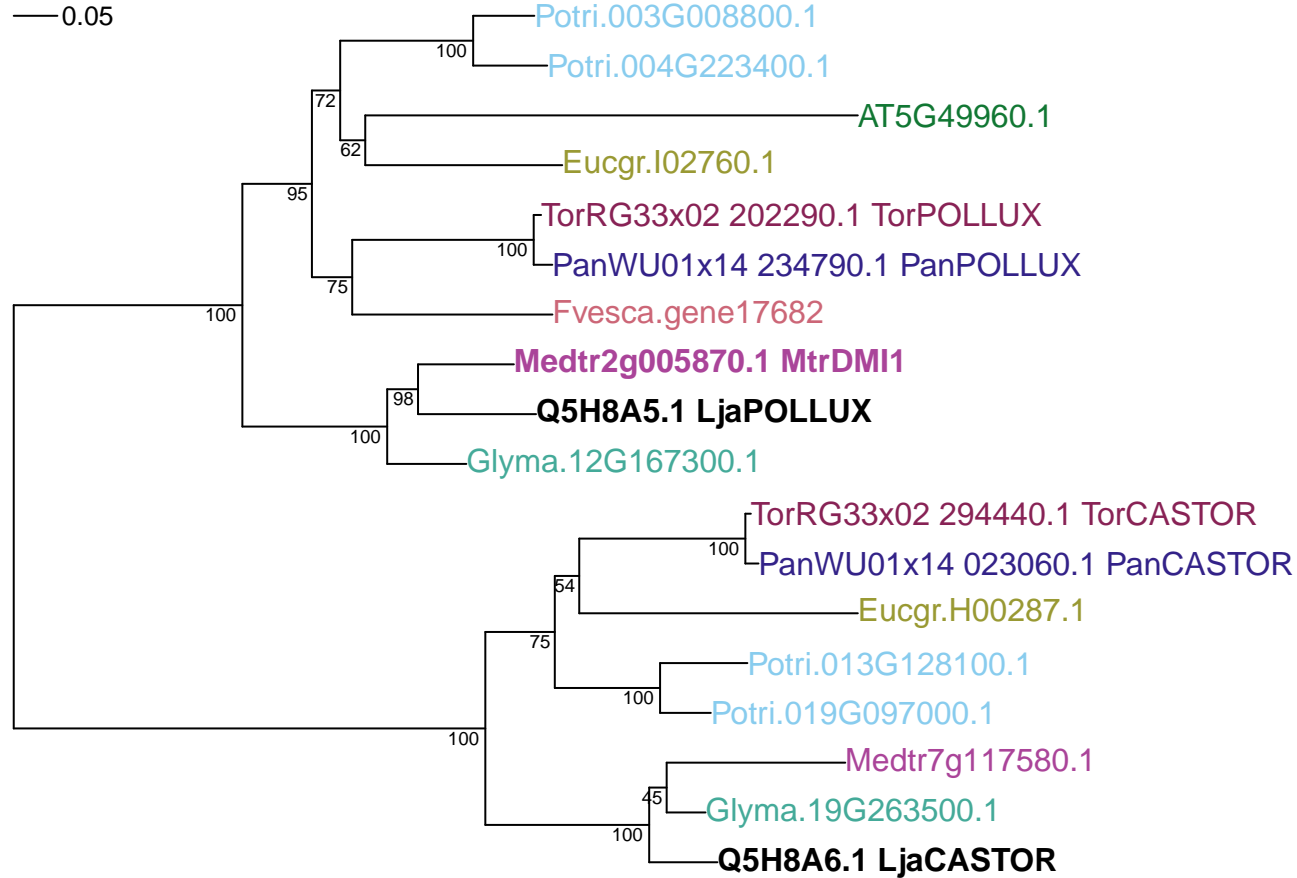
OG0008434: Nuclear signaling. Nucleoporin



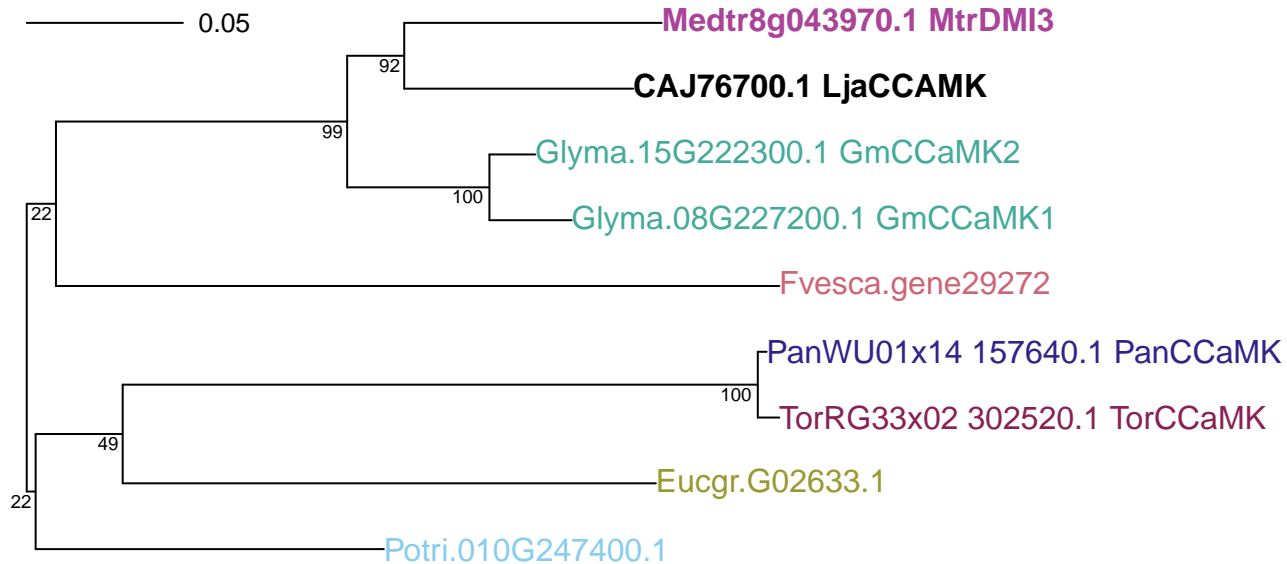
OG0012376: Nuclear signaling. Nucleoporin



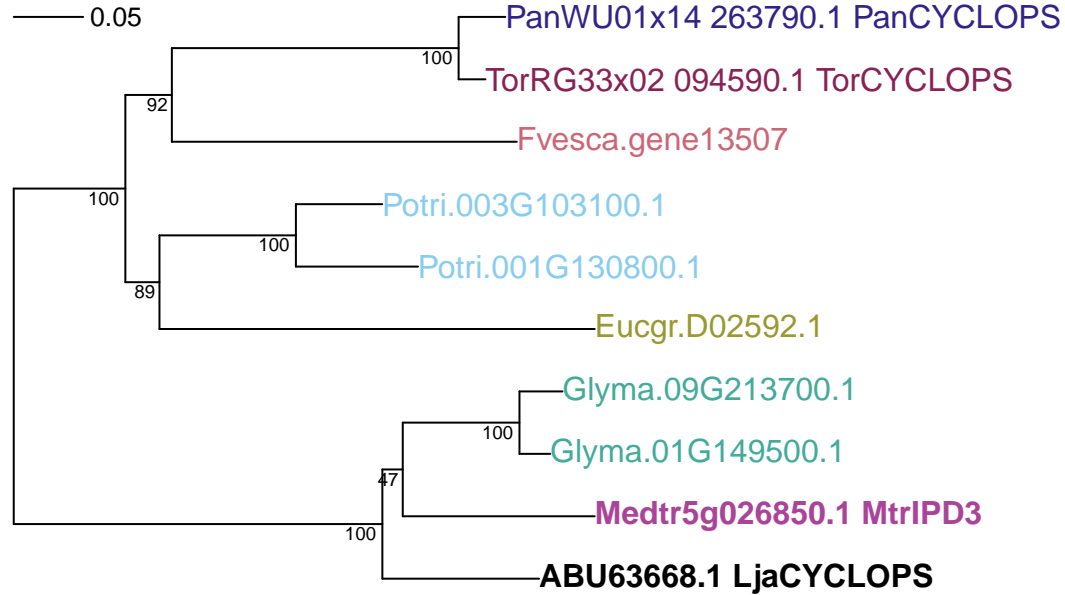
OG0003393: Nuclear signaling. Potassium channel



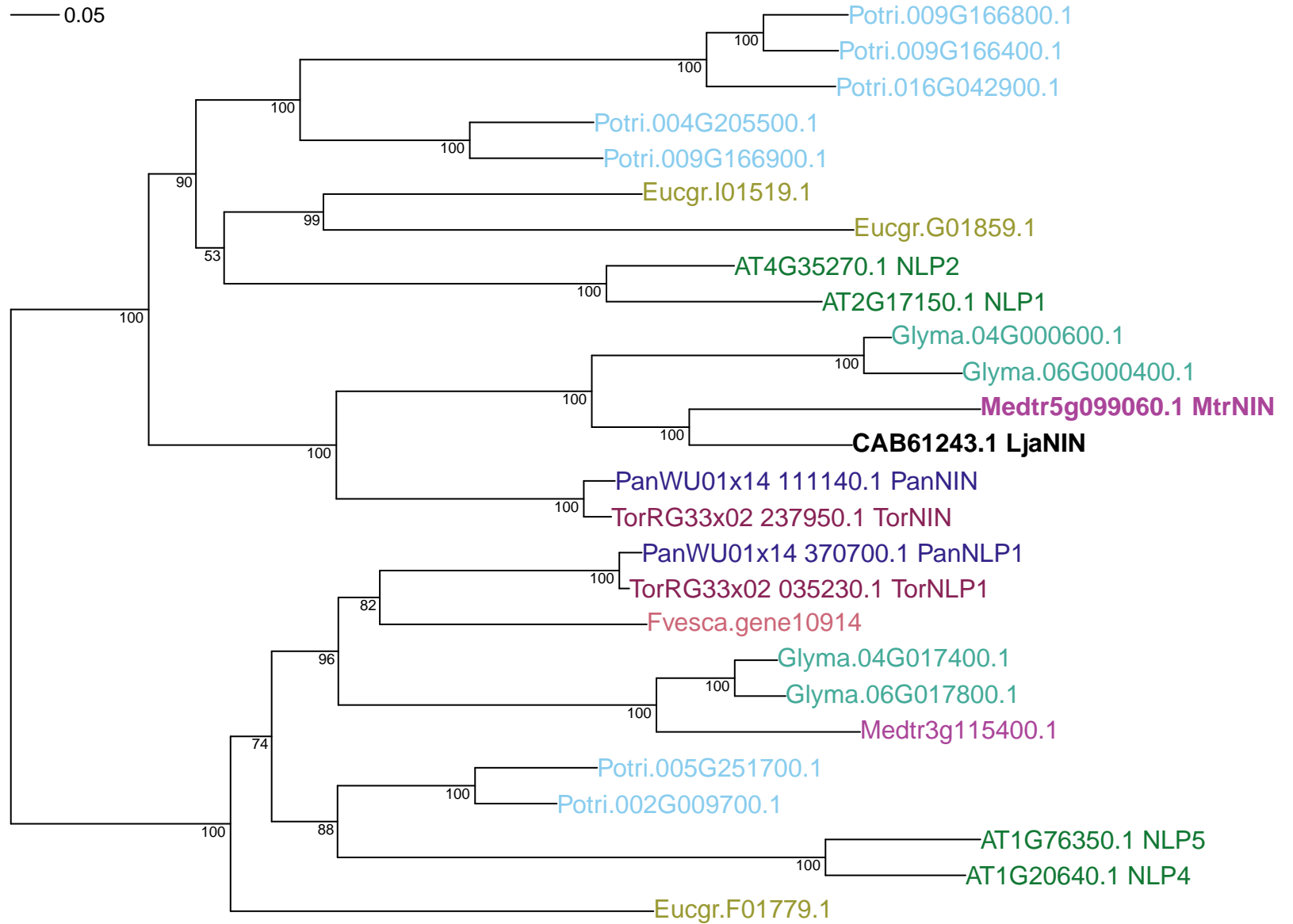
OG0013507: Nuclear signaling. Calcium Calmodulin dependent kinase



OG0012045: Transcriptional regulators. CYCLOPS transcription factor

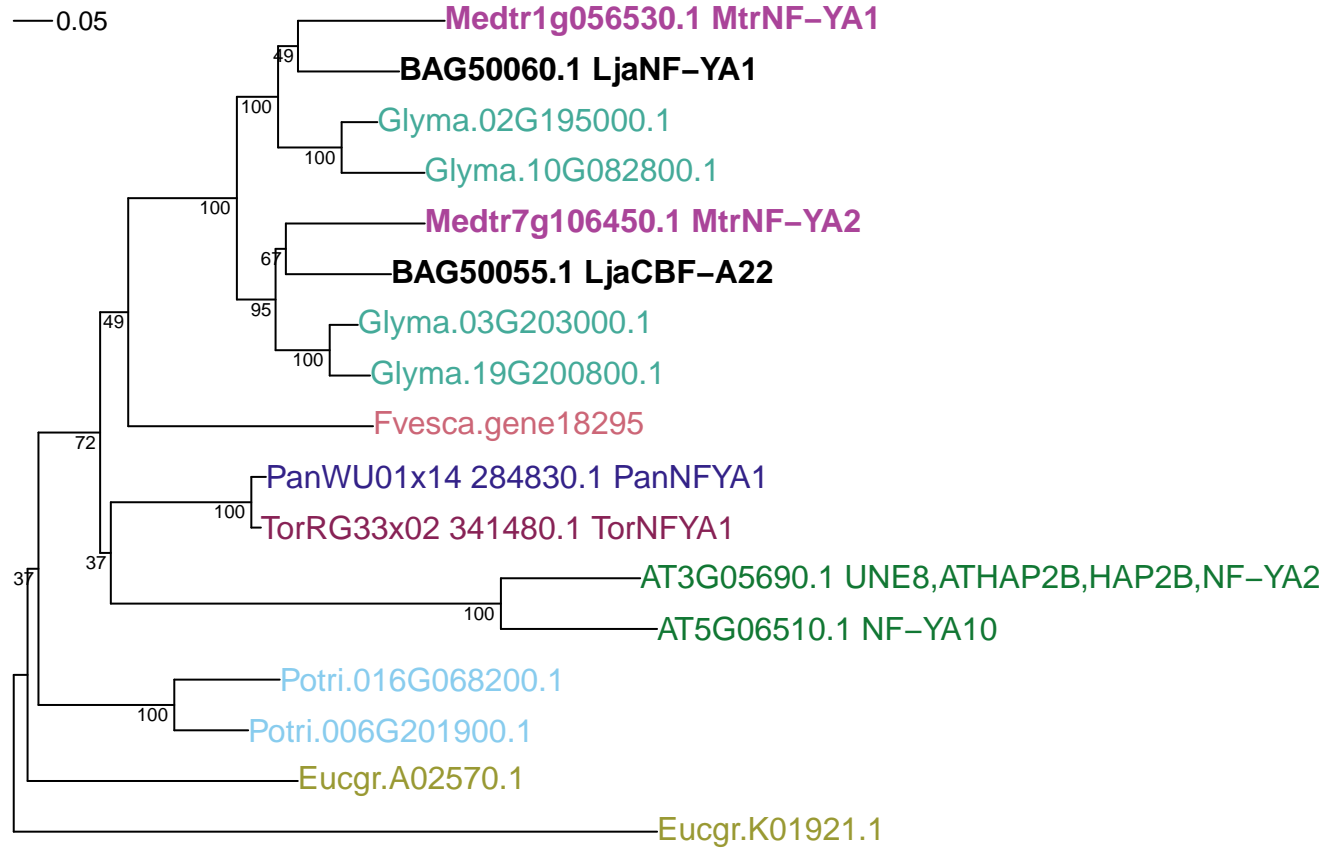


OG0001118: Transcriptional regulators. NODULE INCEPTION transcription factor

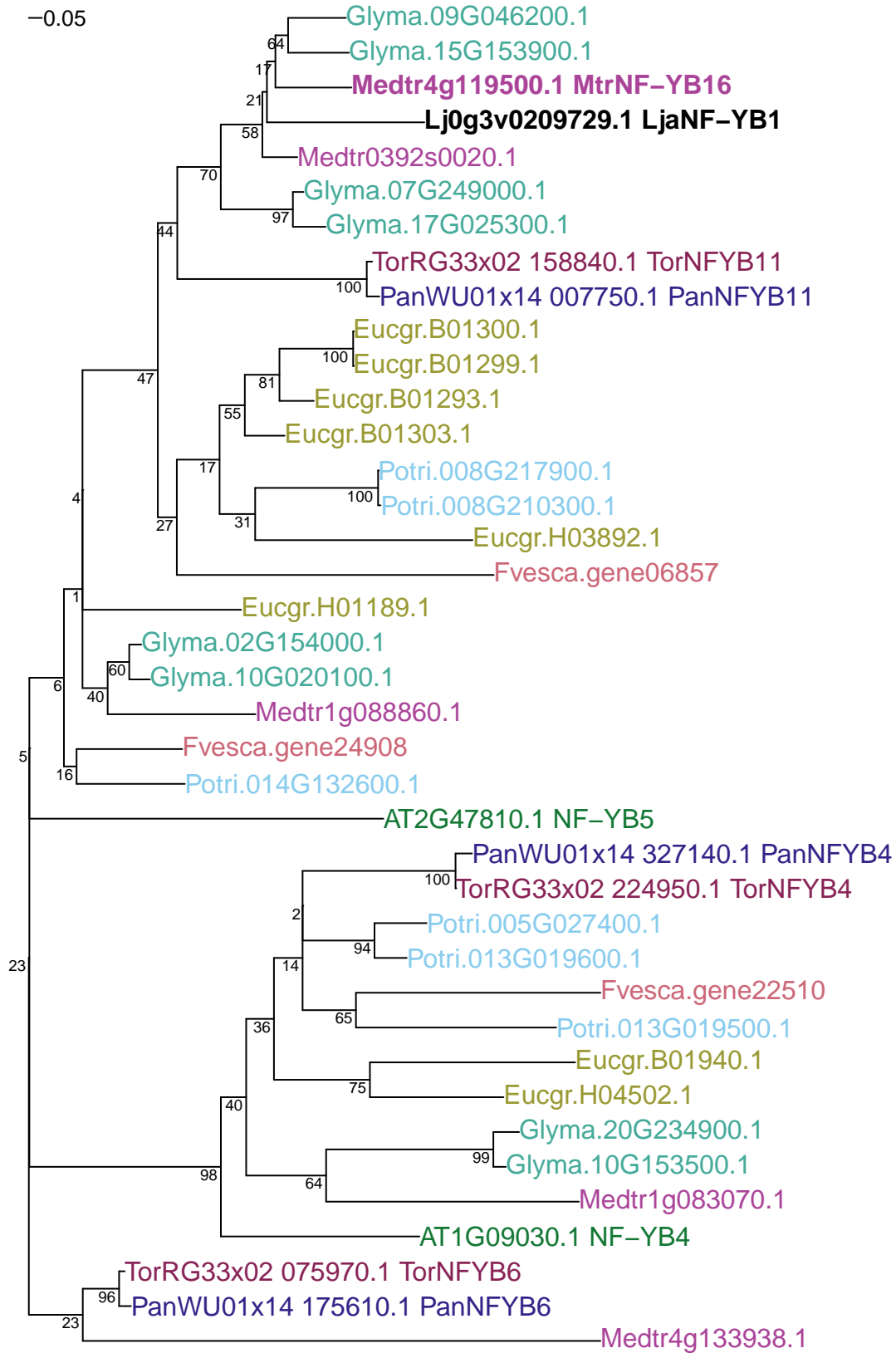


OG0003683: Transcriptional regulators. Nuclear Factor YA transcription factor

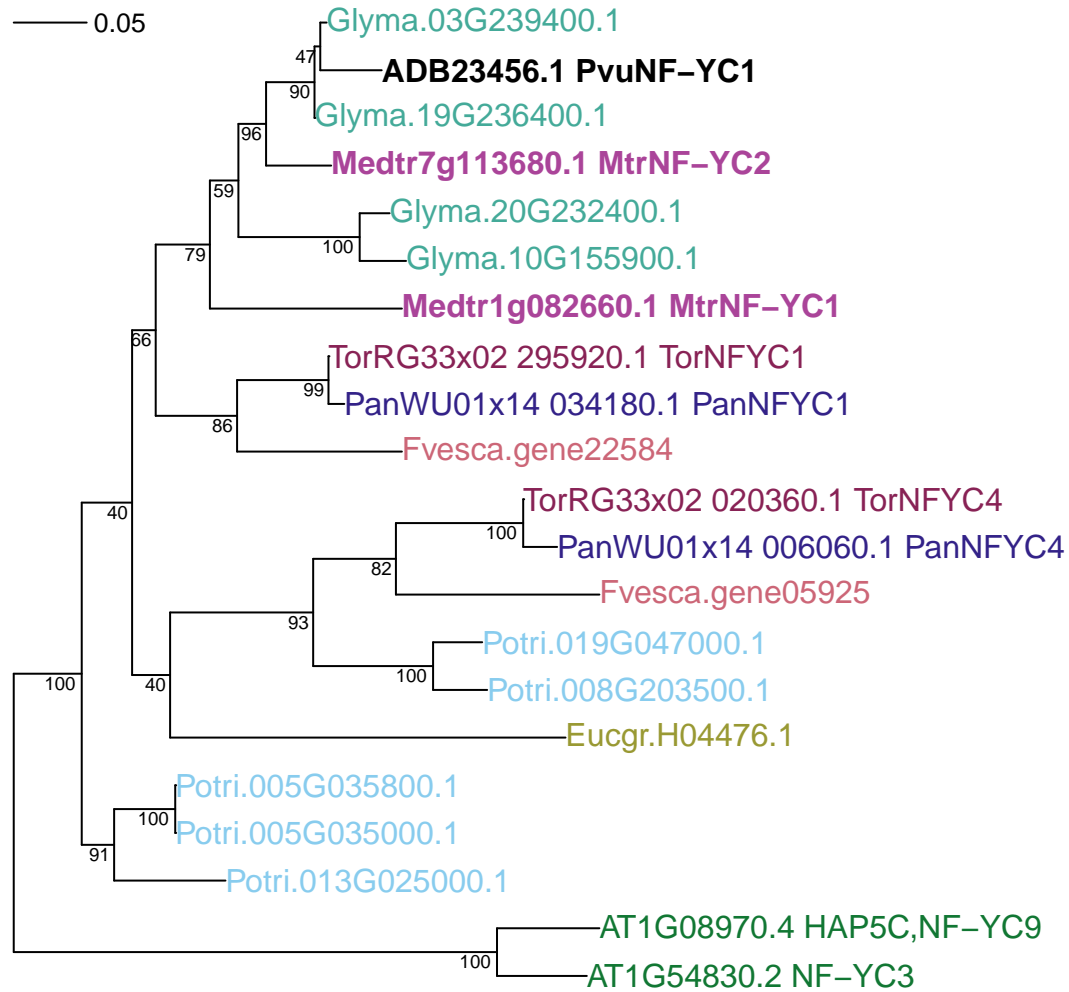
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OG0000523: Transcriptional regulators. Nuclear Factor YB transcription factor

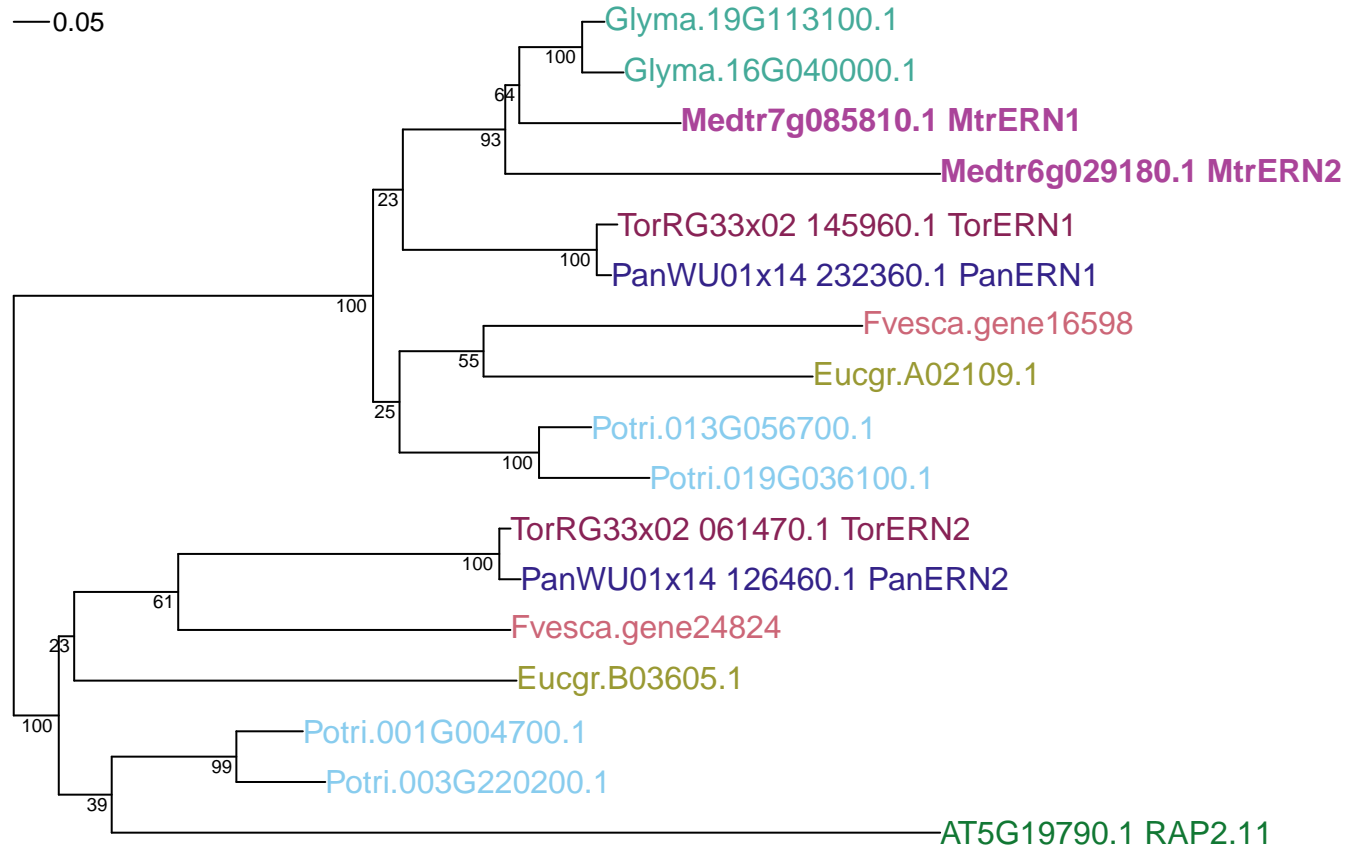


OG0002046: Transcriptional regulators. Nuclear Factor YC transcription factor



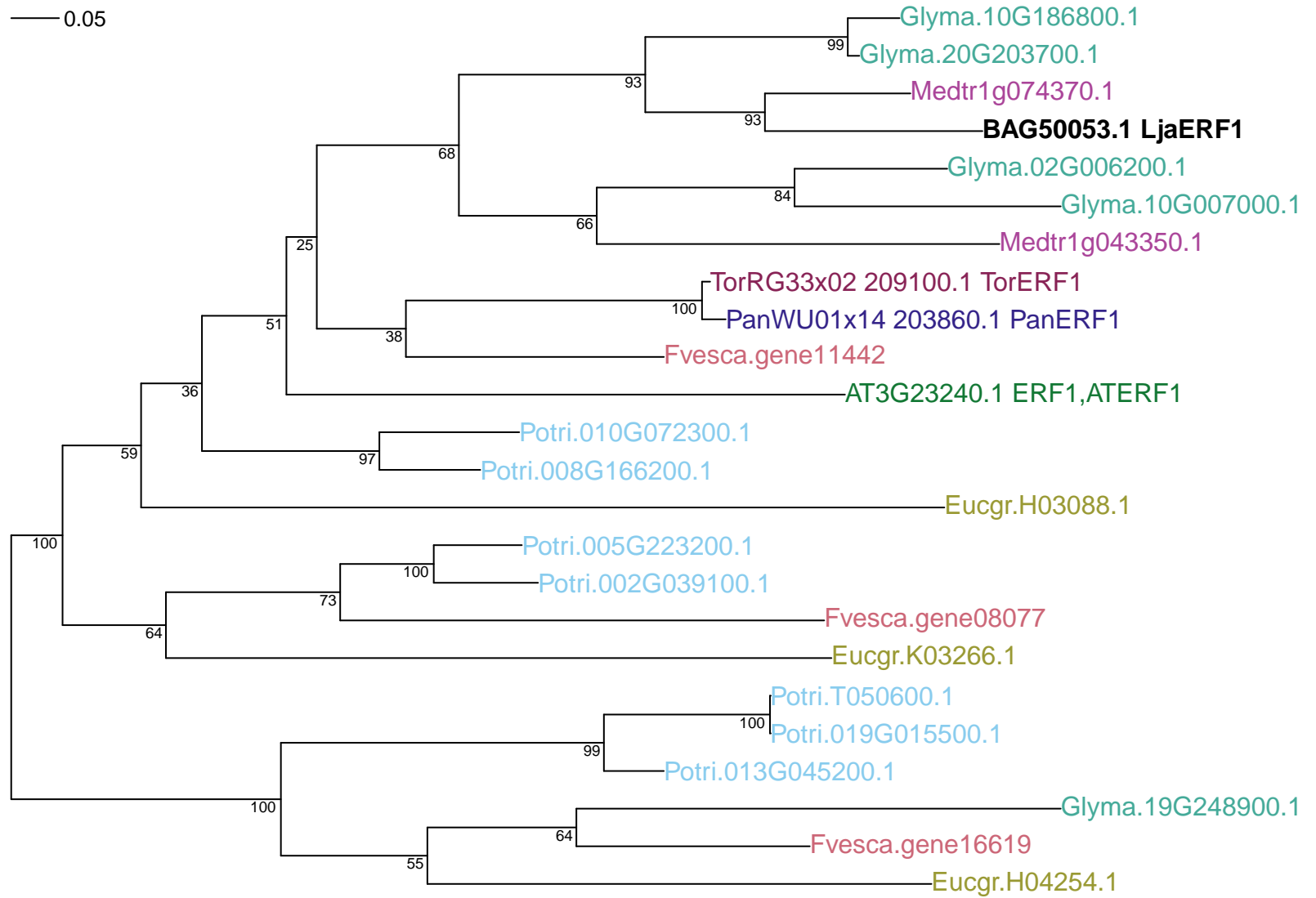
OG0003025: Transcriptional regulators. AP2-ERF transcription factor

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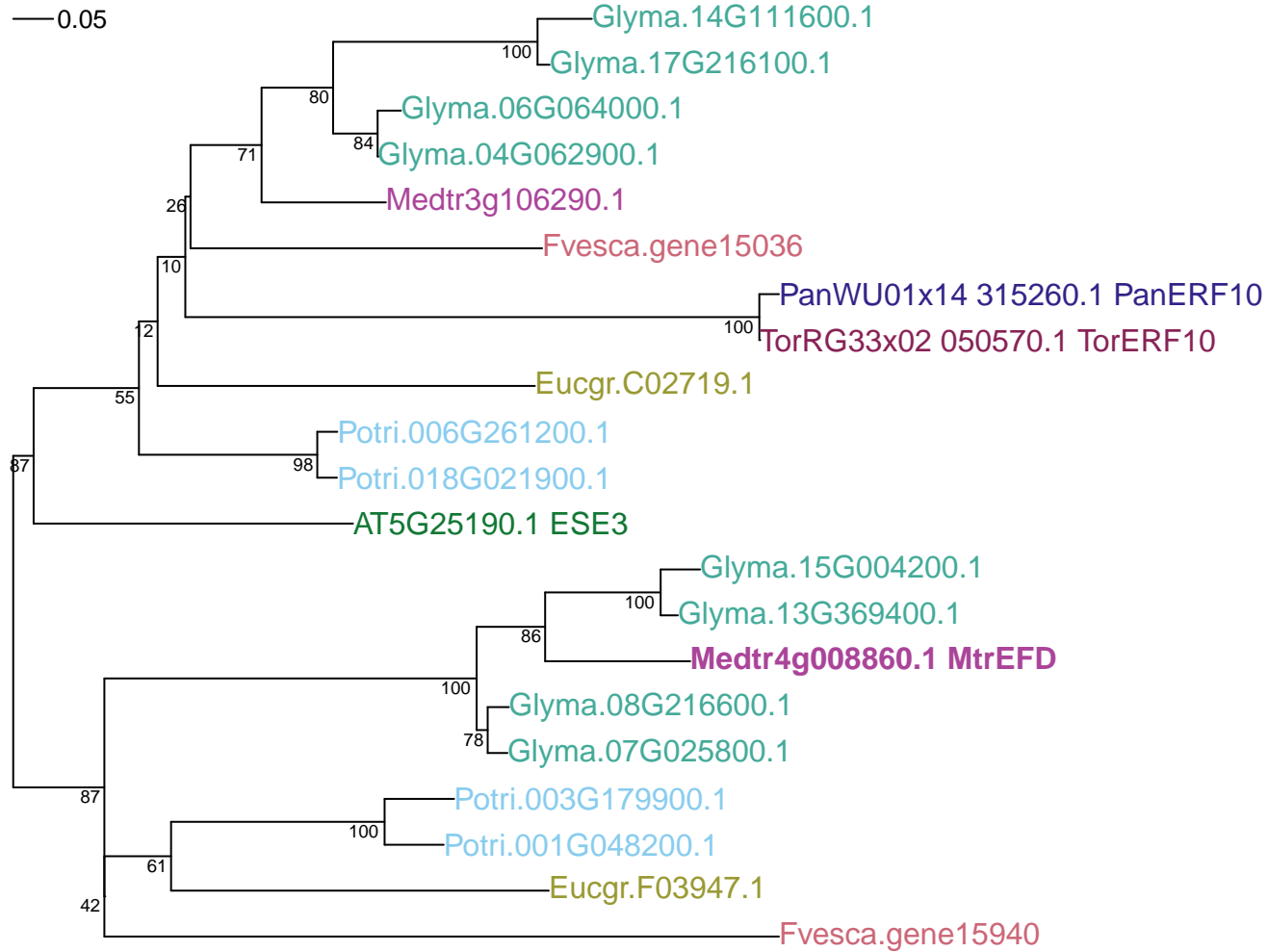


OG0001539: Transcriptional regulators. AP2-ERF transcription factor

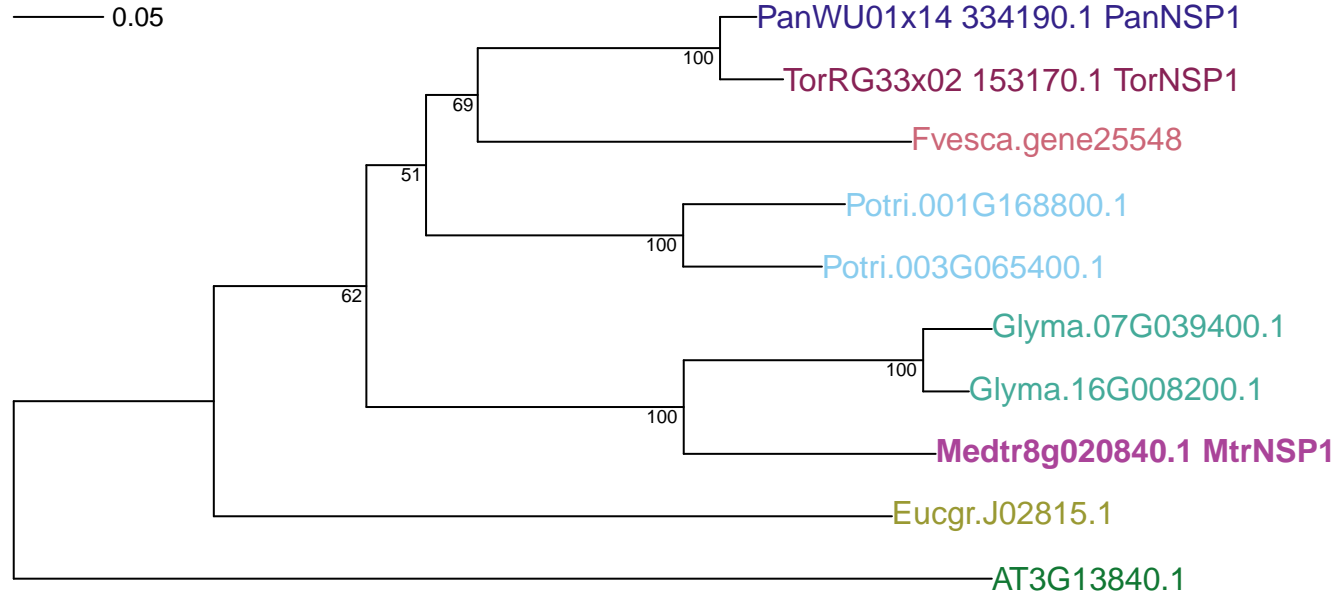
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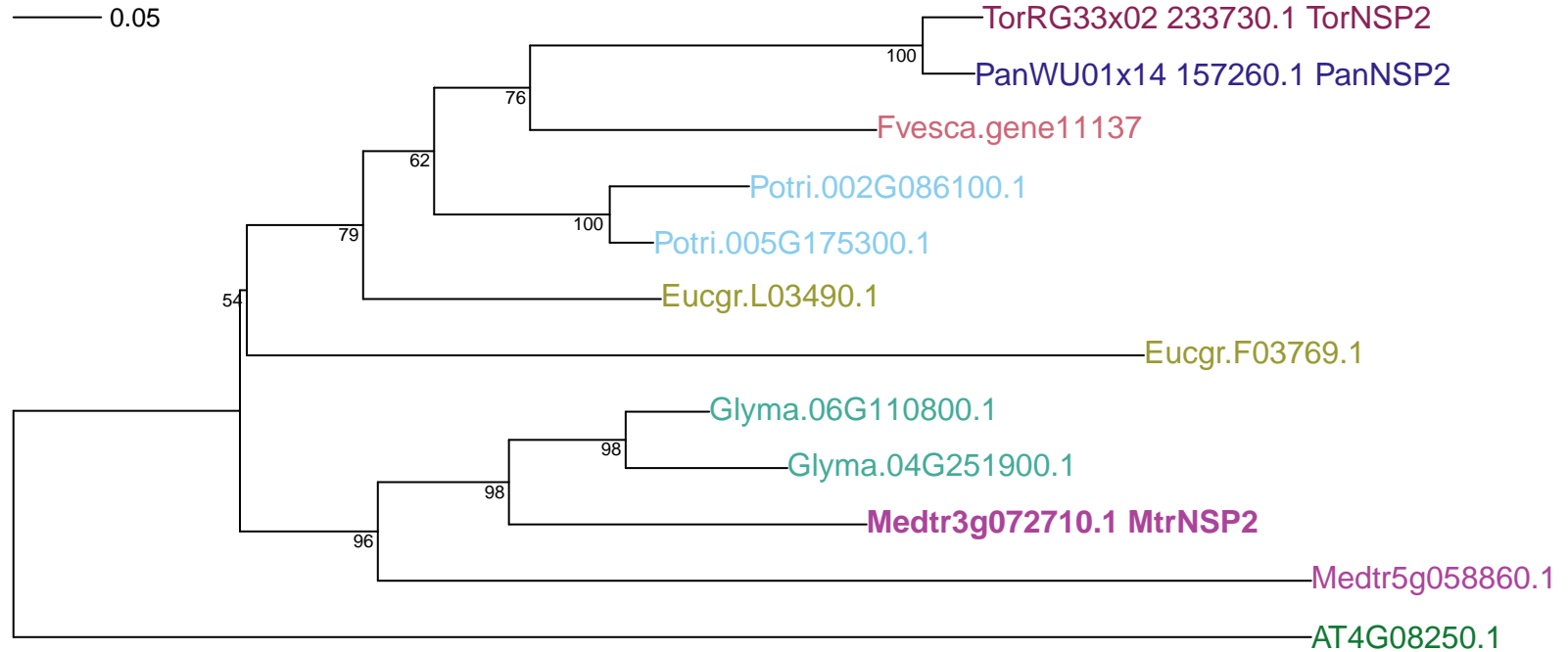
OG0001773: Transcriptional regulators. AP2-ERF transcription factor



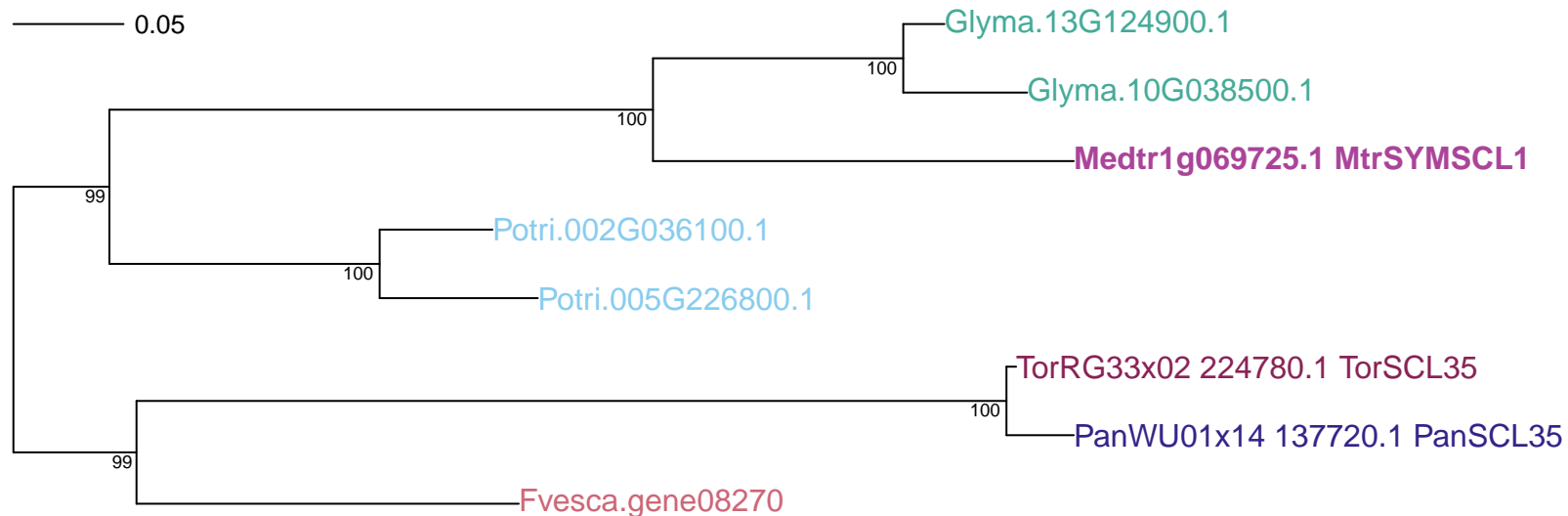
OG0008769: Transcriptional regulators. GRAS-type transcriptional regulator



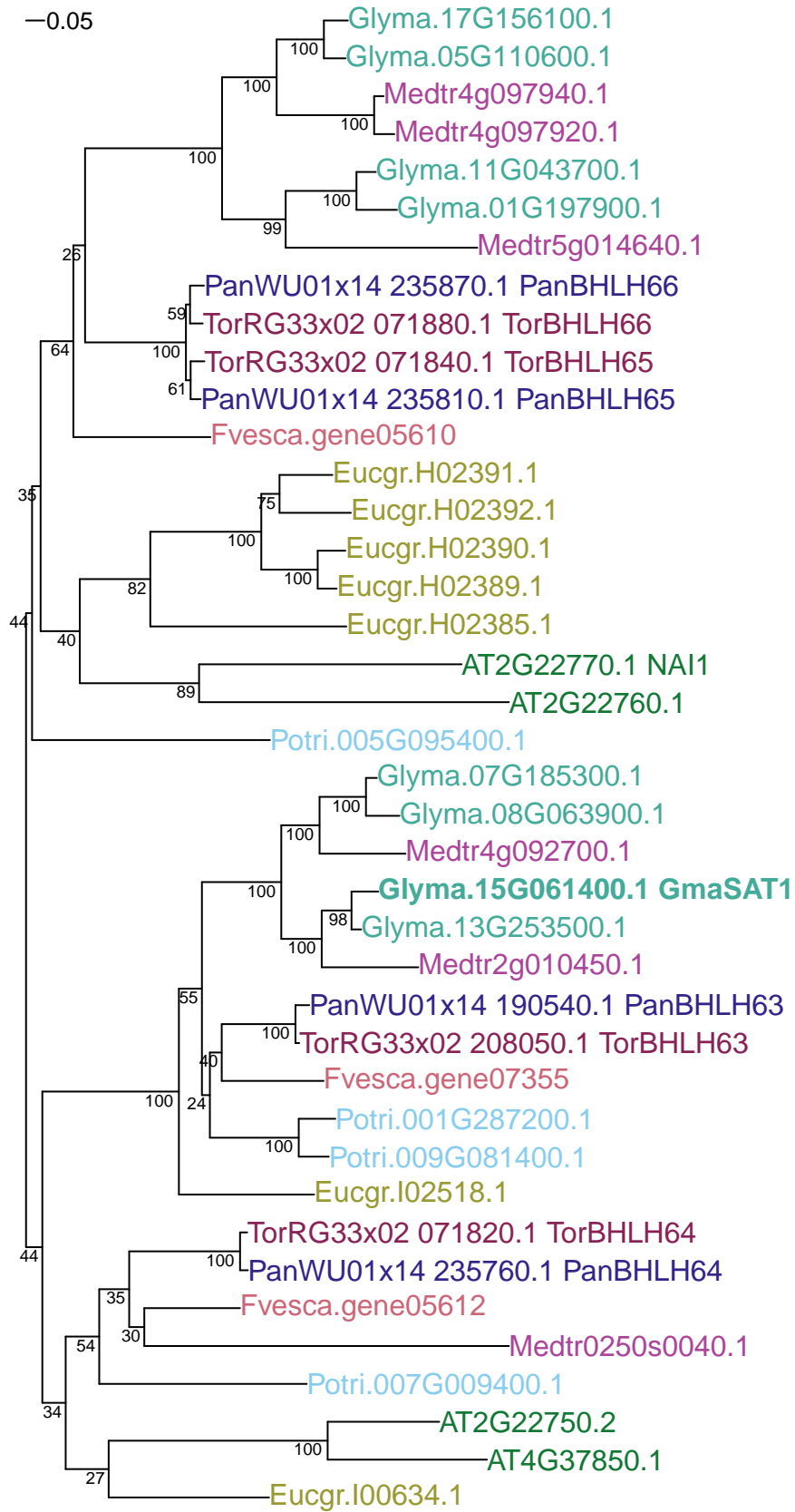
OG0006113: Transcriptional regulators. GRAS-type transcriptional regulator



OG0013541: Transcriptional regulators. GRAS-type transcriptional regulator

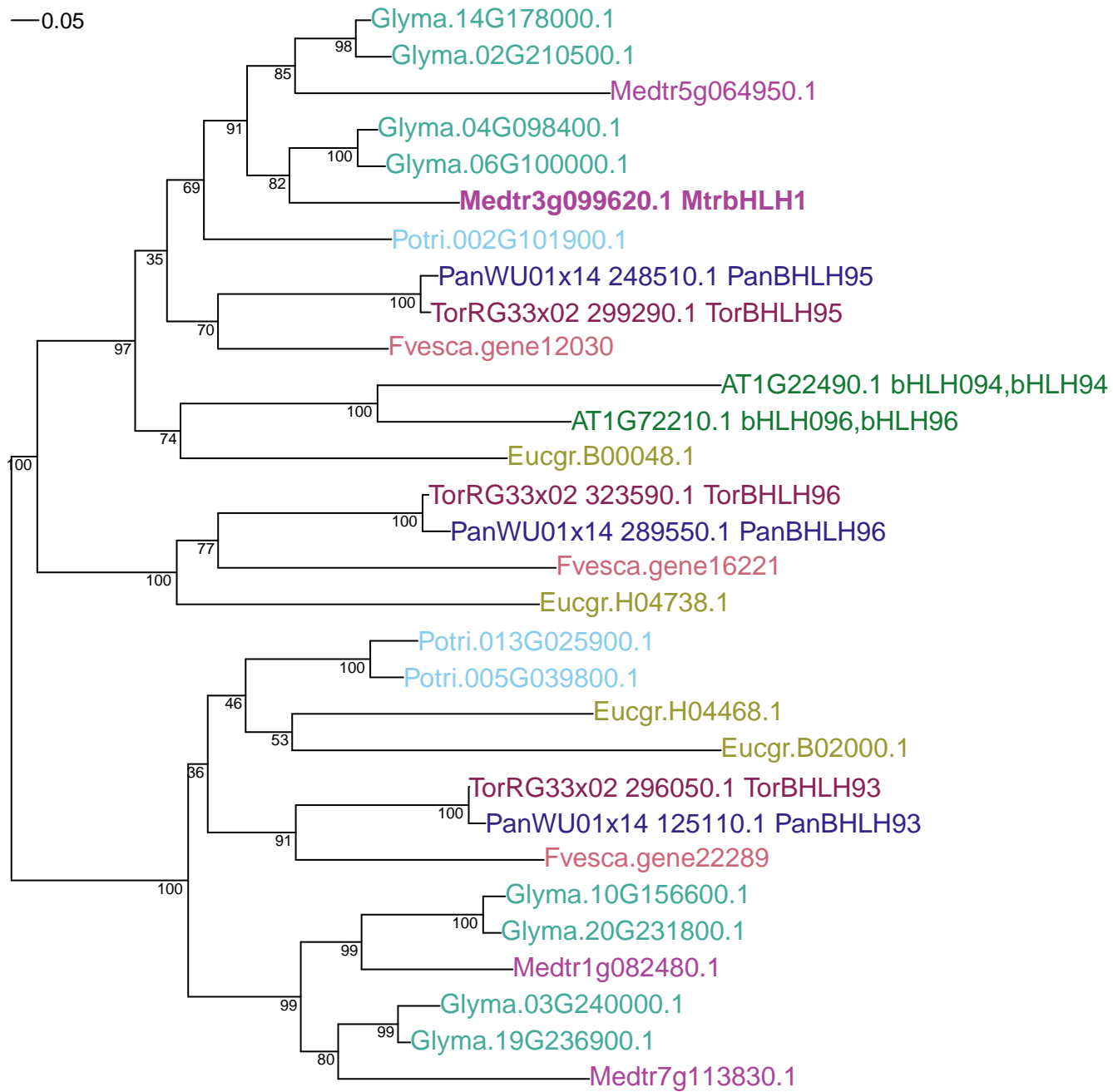


OG0000482: Transcriptional regulators. bHLH transcription factor

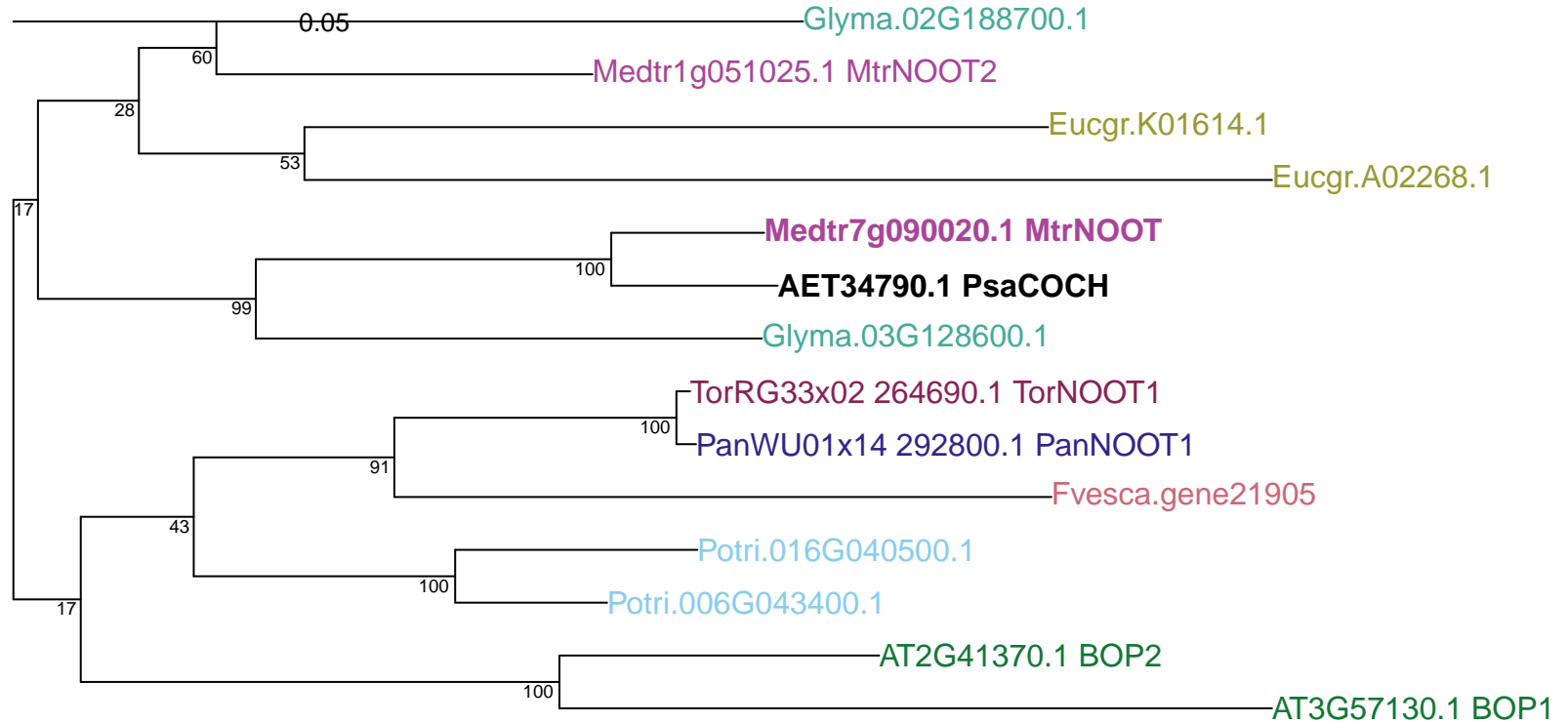


OG0000817: Transcriptional regulators. bHLH transcription factor

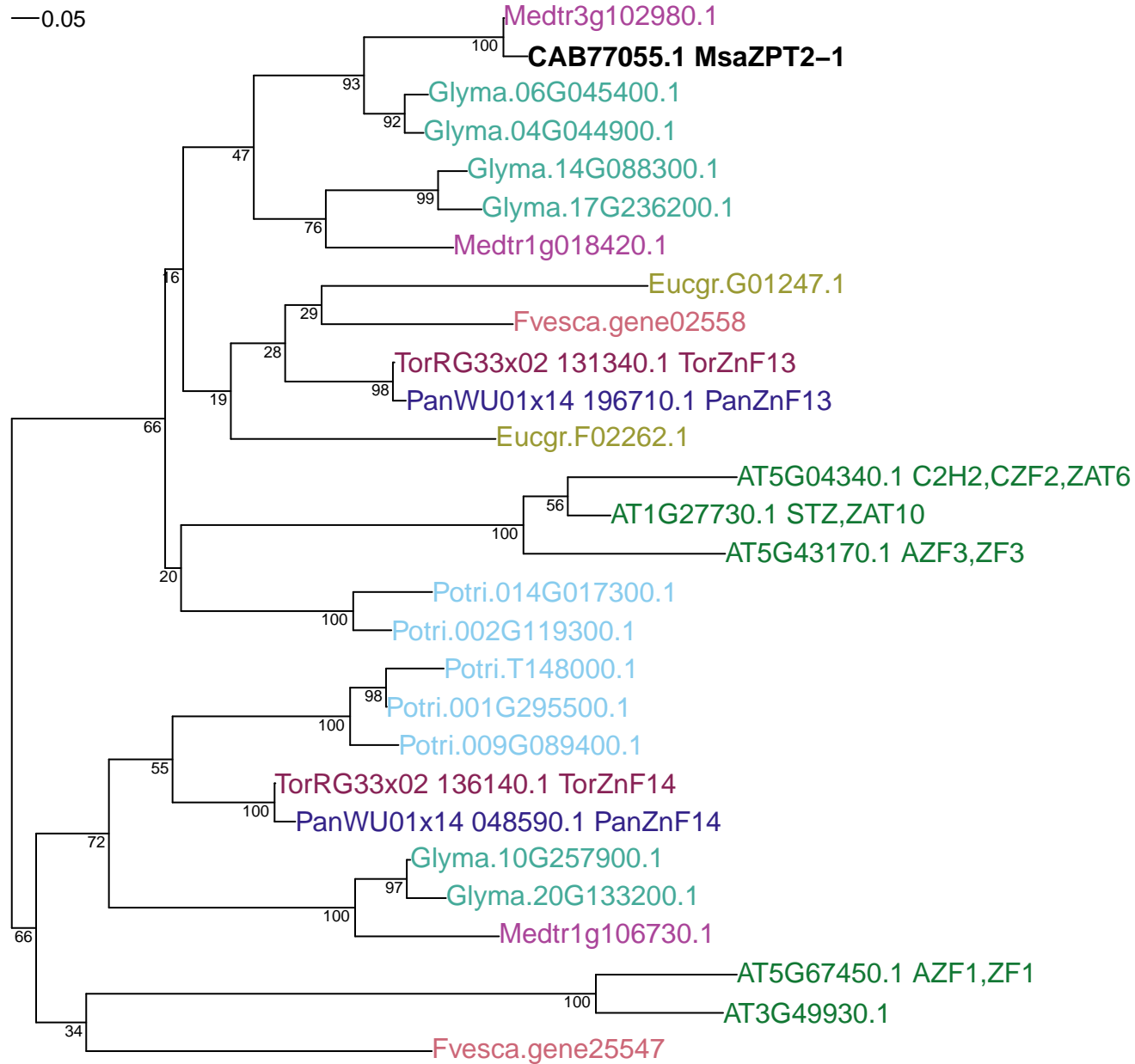
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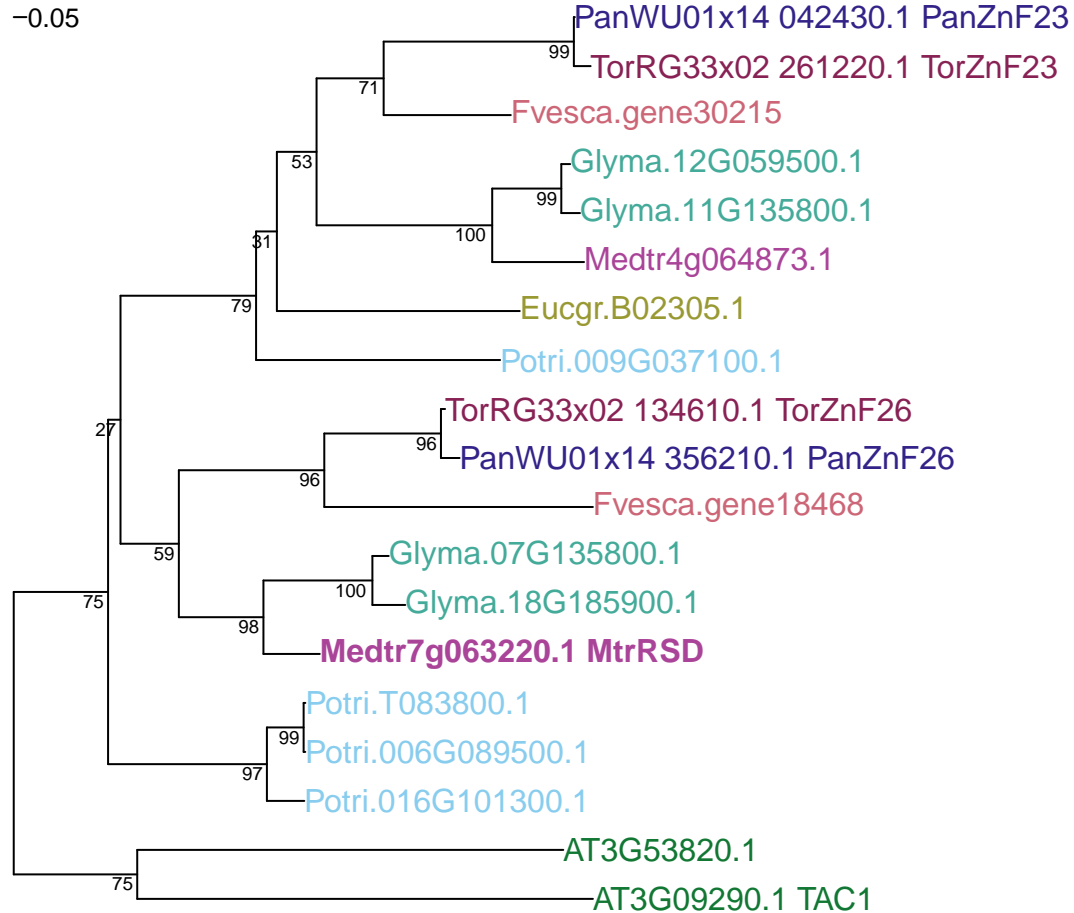
OG0004789: Transcriptional regulators. BOP-type transcriptional regulator



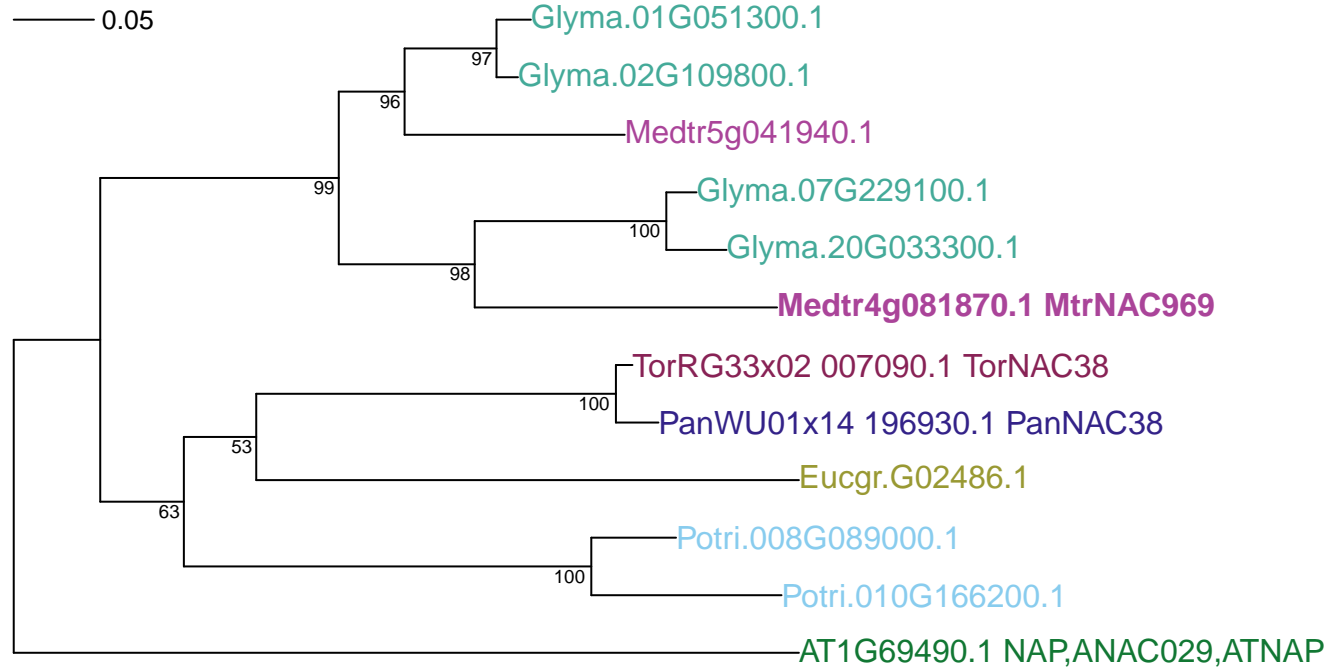
OG0001033: Transcriptional regulators. C2H2 transcription factor



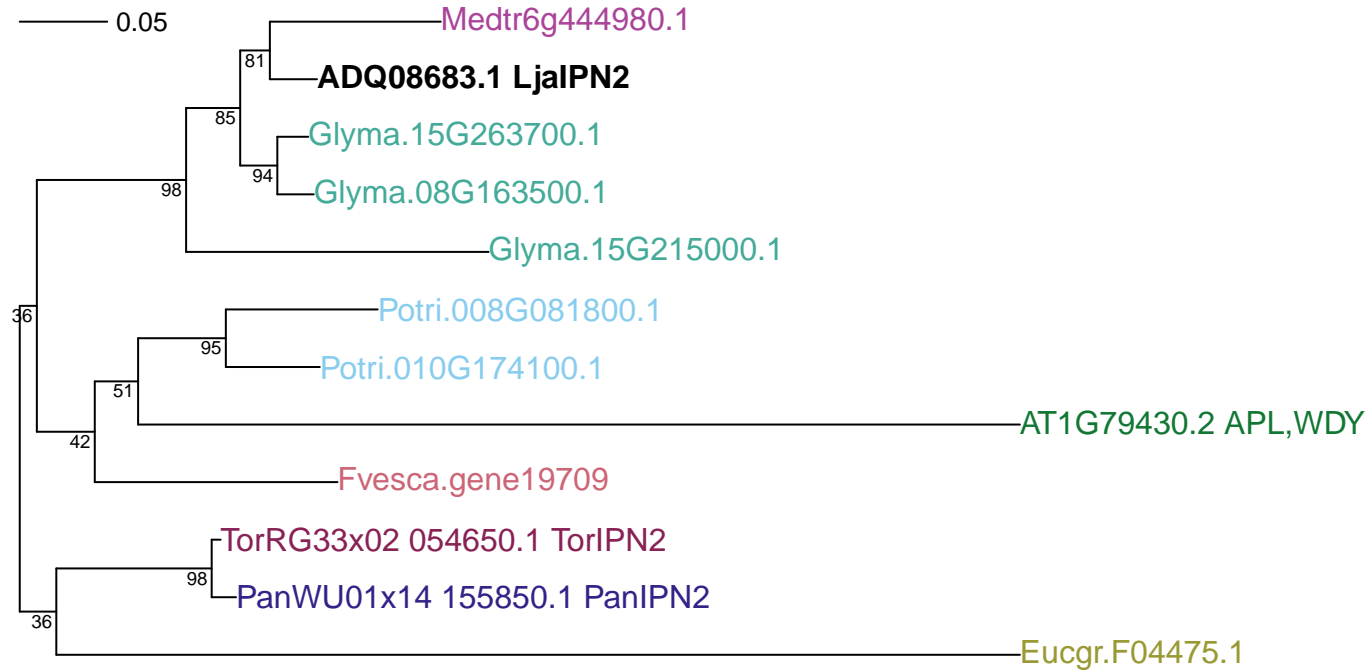
OG0002397: Transcriptional regulators. C2H2 transcription factor



OG0005509: Transcriptional regulators. NAC transcription factor

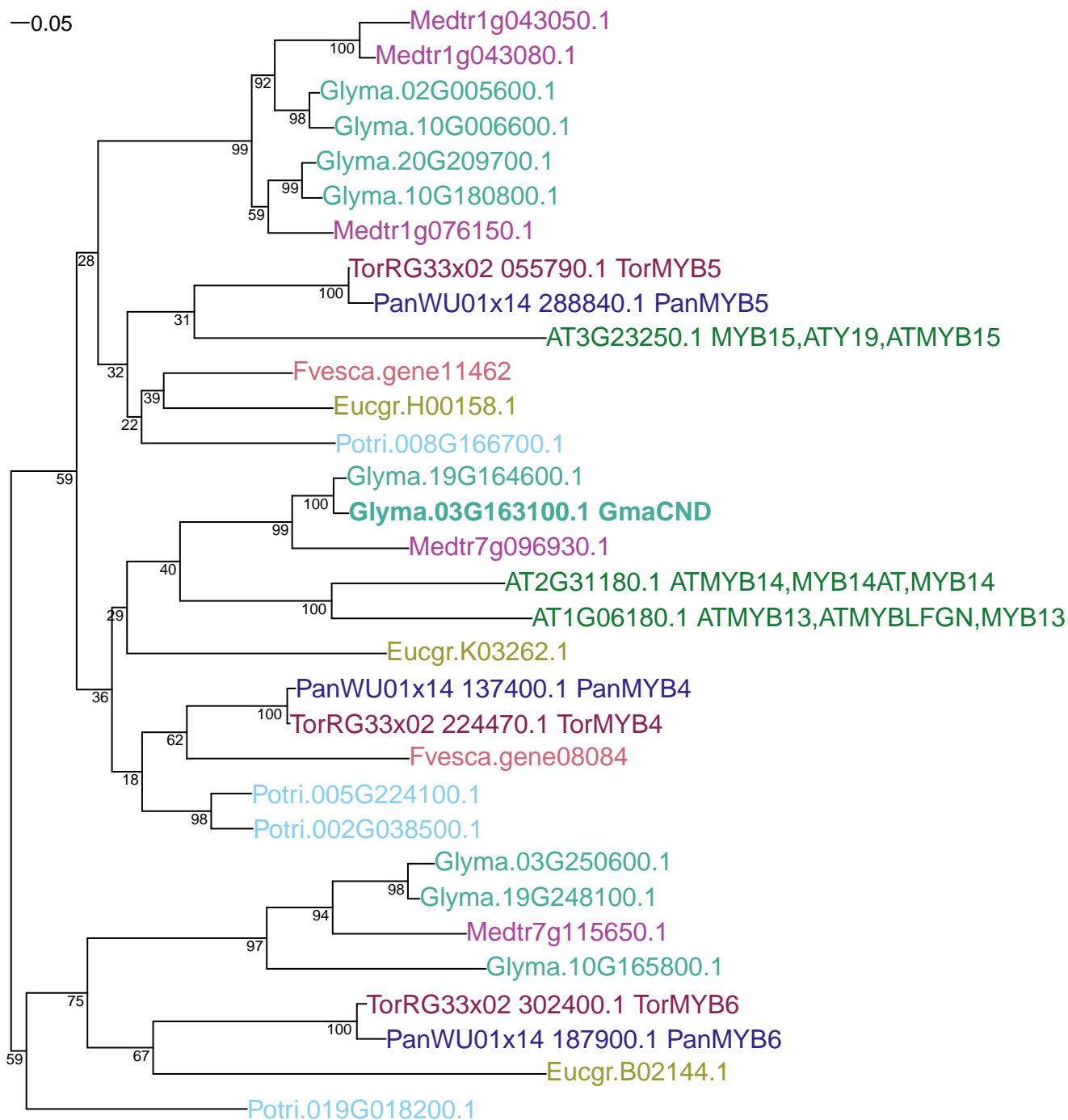


OG0006786: Transcriptional regulators. MYB transcription factor

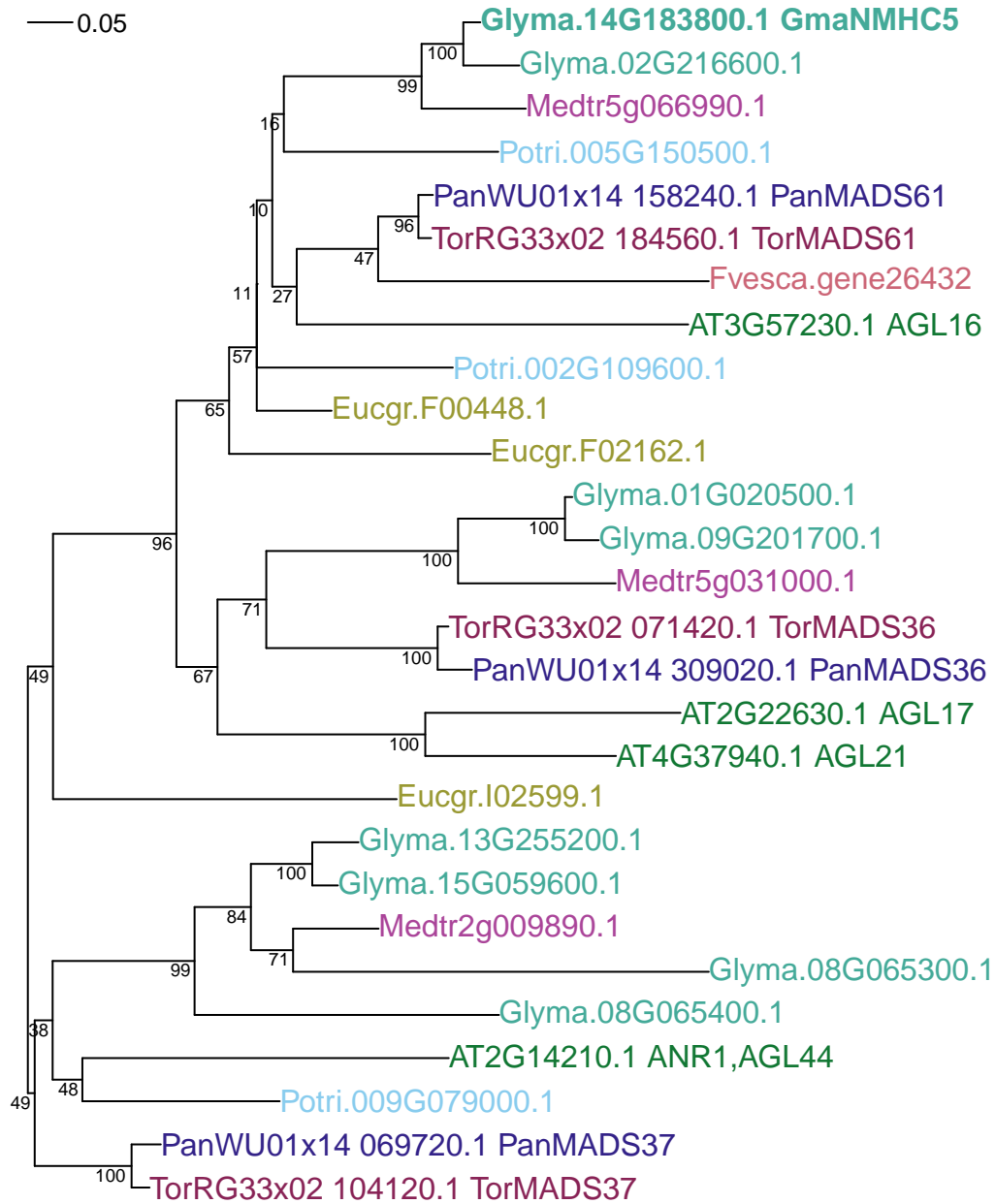


OG0000726: Transcriptional regulators. MYB transcription factor

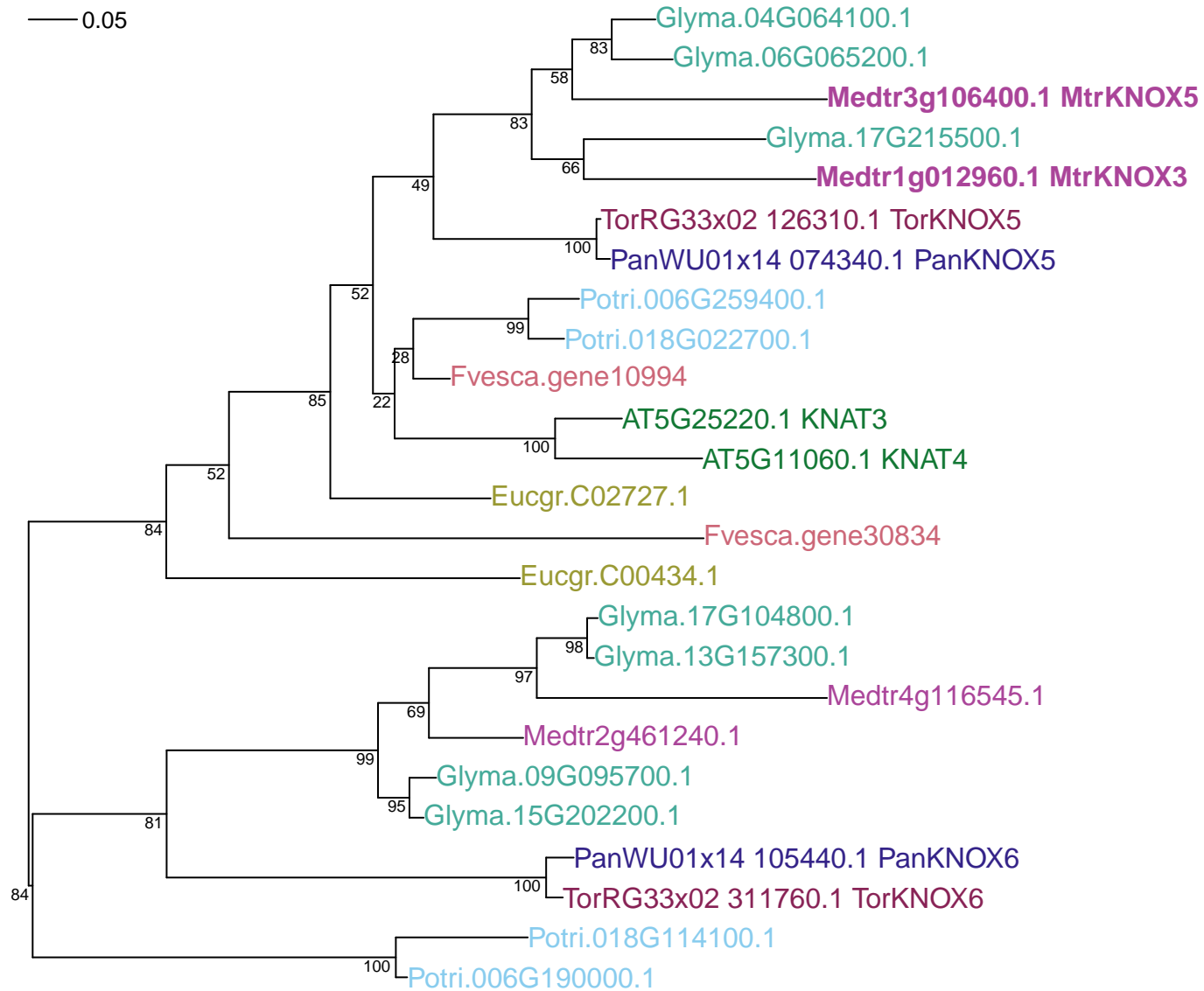
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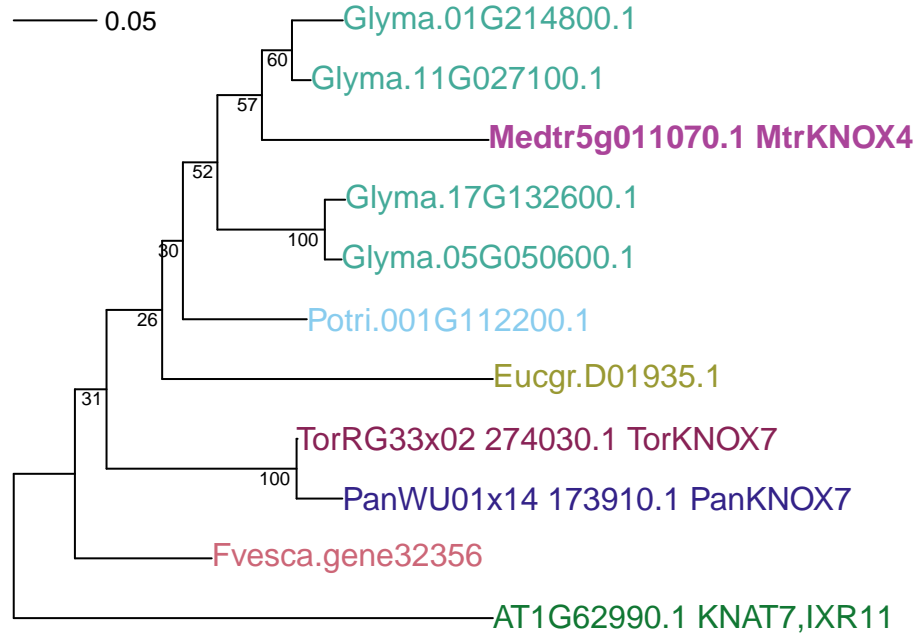
OG0000972: Transcriptional regulators. MADS box transcription factor



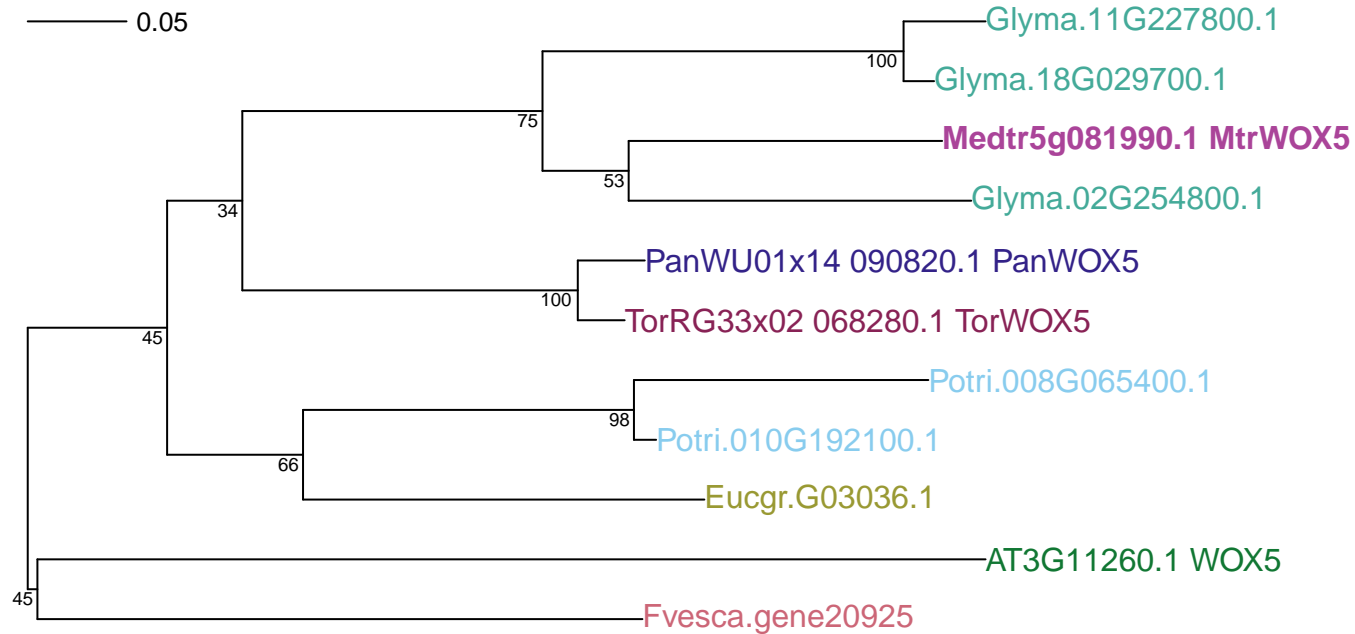
OG0001293: Transcriptional regulators. KNOX homeodomain transcription factor



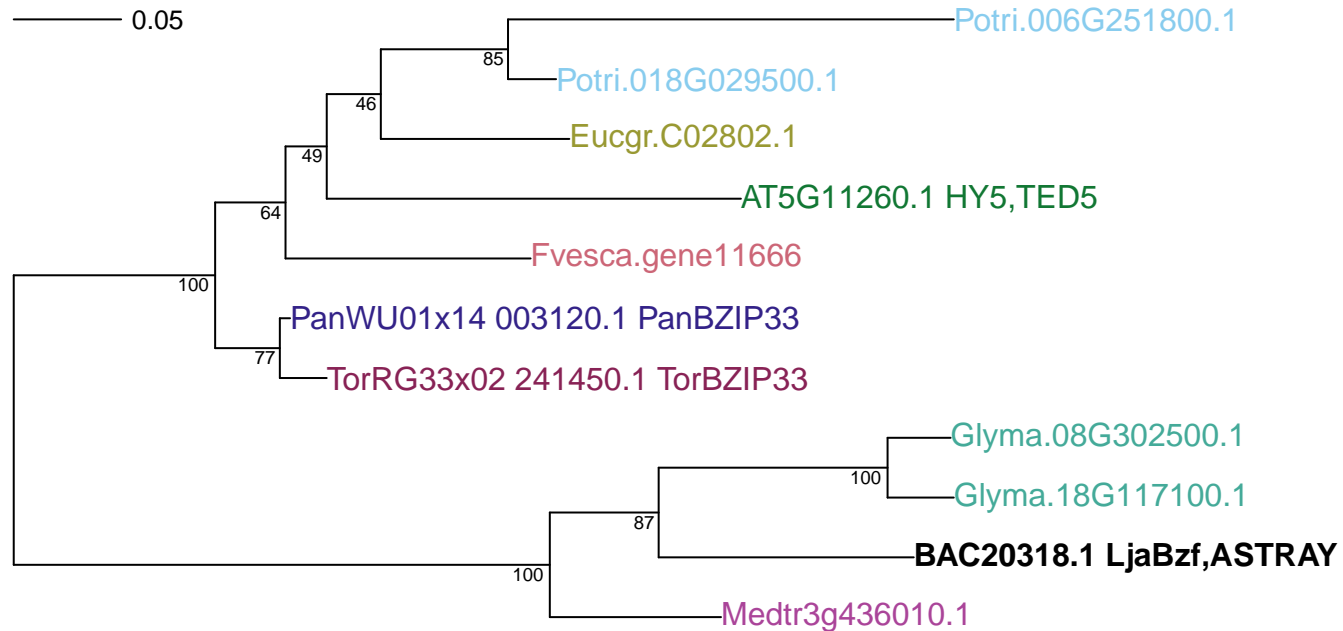
OG0006742: Transcriptional regulators. KNOX homeodomain transcription factor



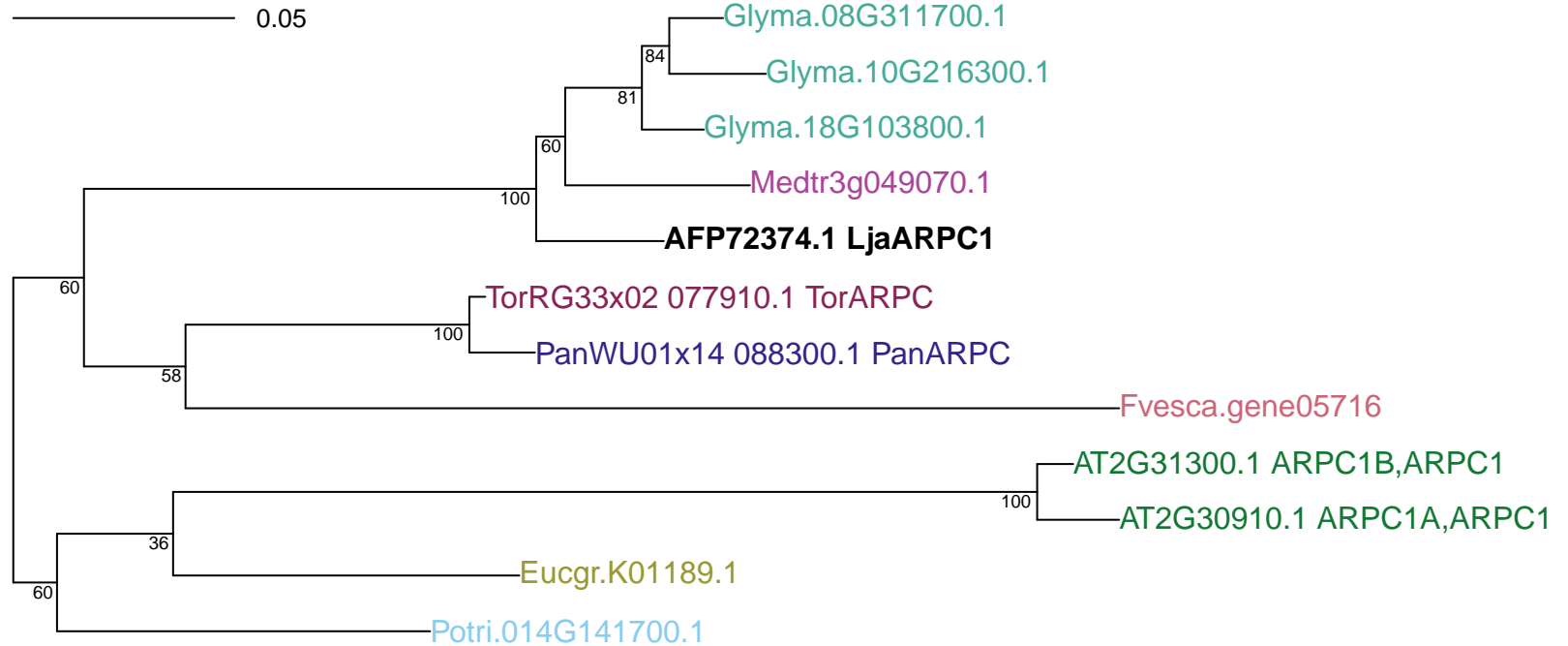
OG0007076: Transcriptional regulators. WOX homeobox transcription factor



OG0009597: Transcriptional regulators. bZIP transcription factor

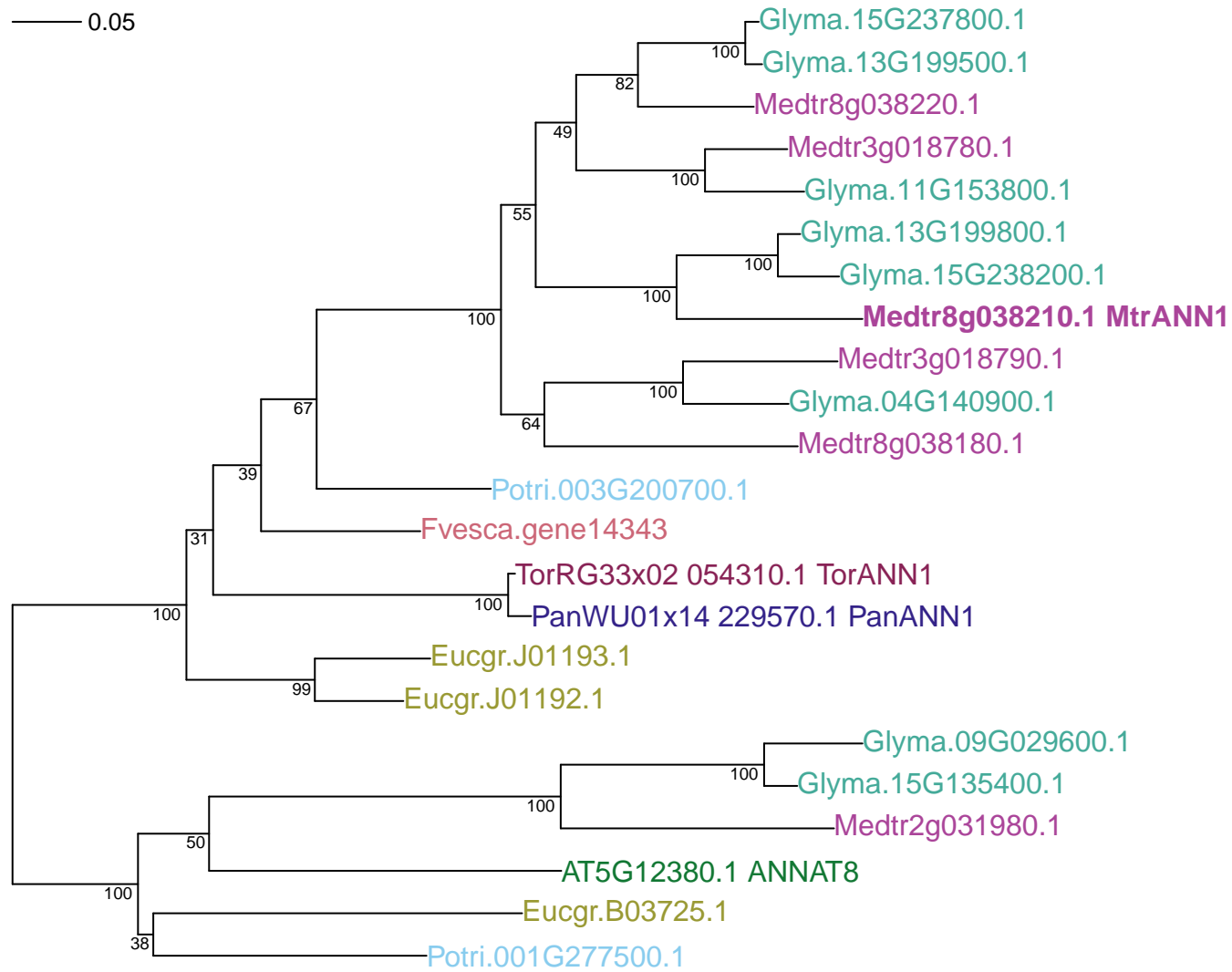


OG0006889: Infection related. actin-related protein component

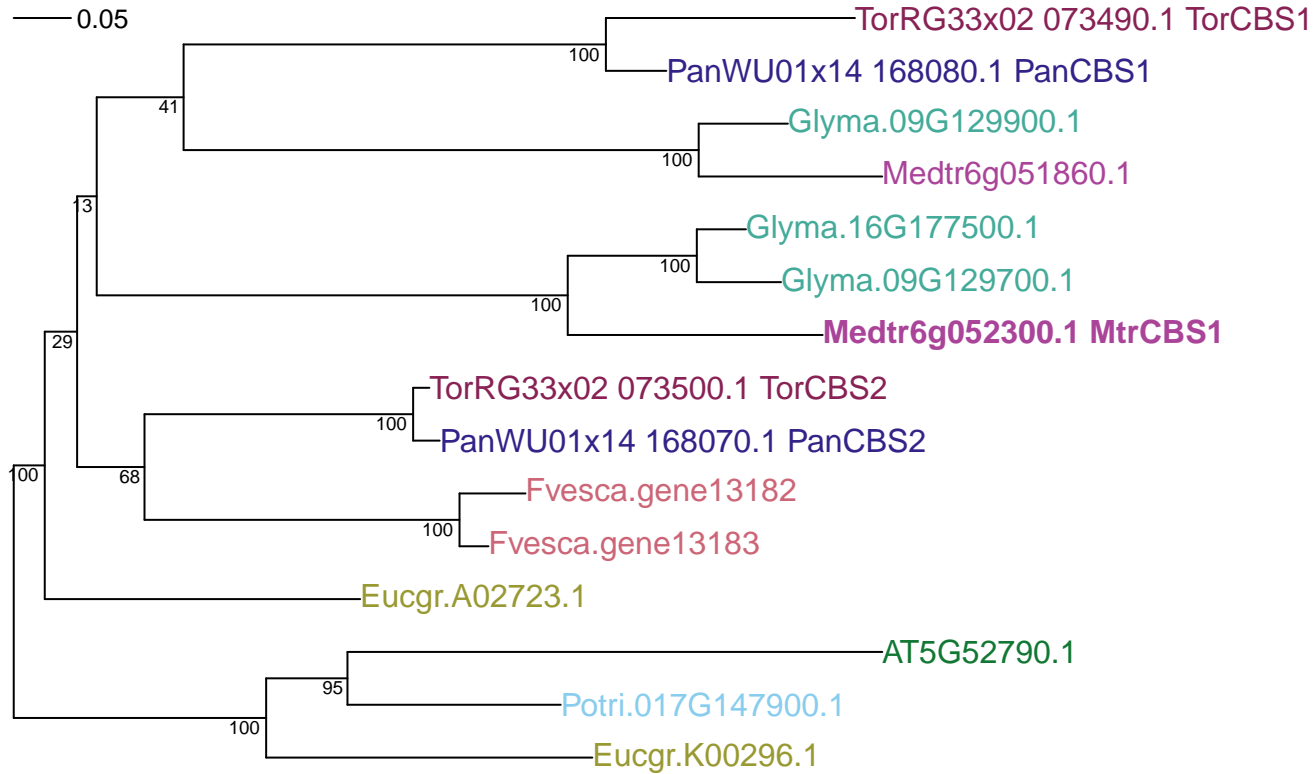


OG0001569: Infection related. Annexin

— 0.05

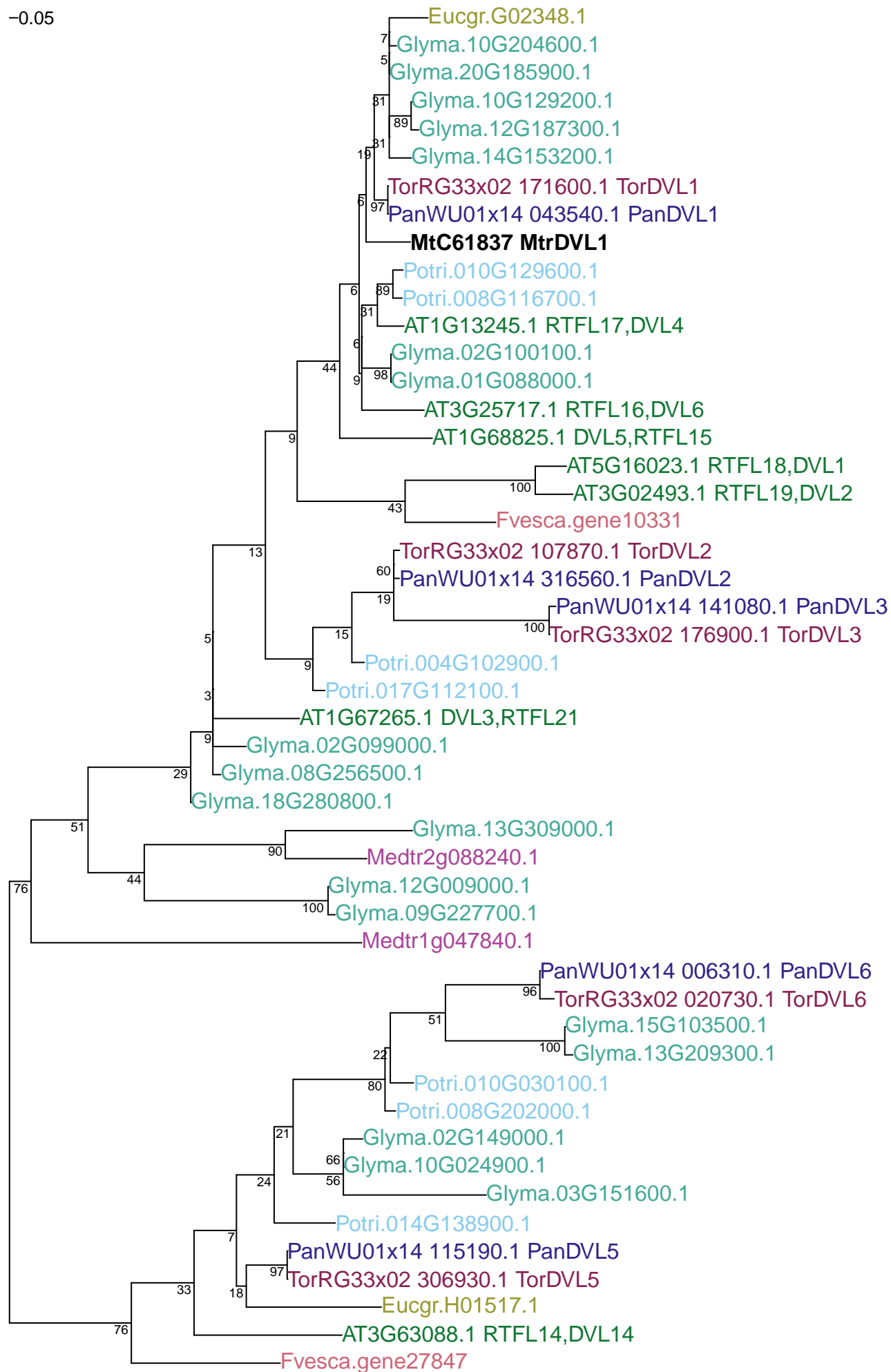


OG0003786: Infection related. Cystathionine-beta-Synthase

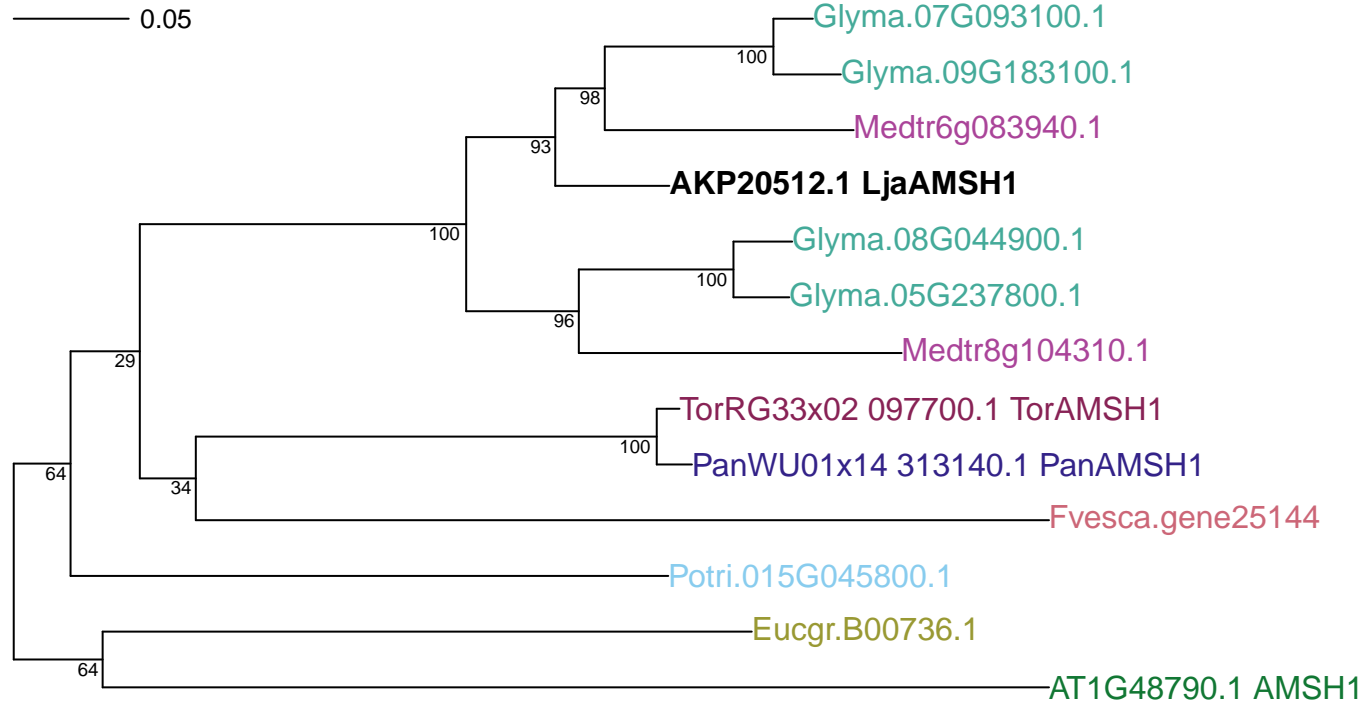


OG0000343: Infection related. Devil-type peptide

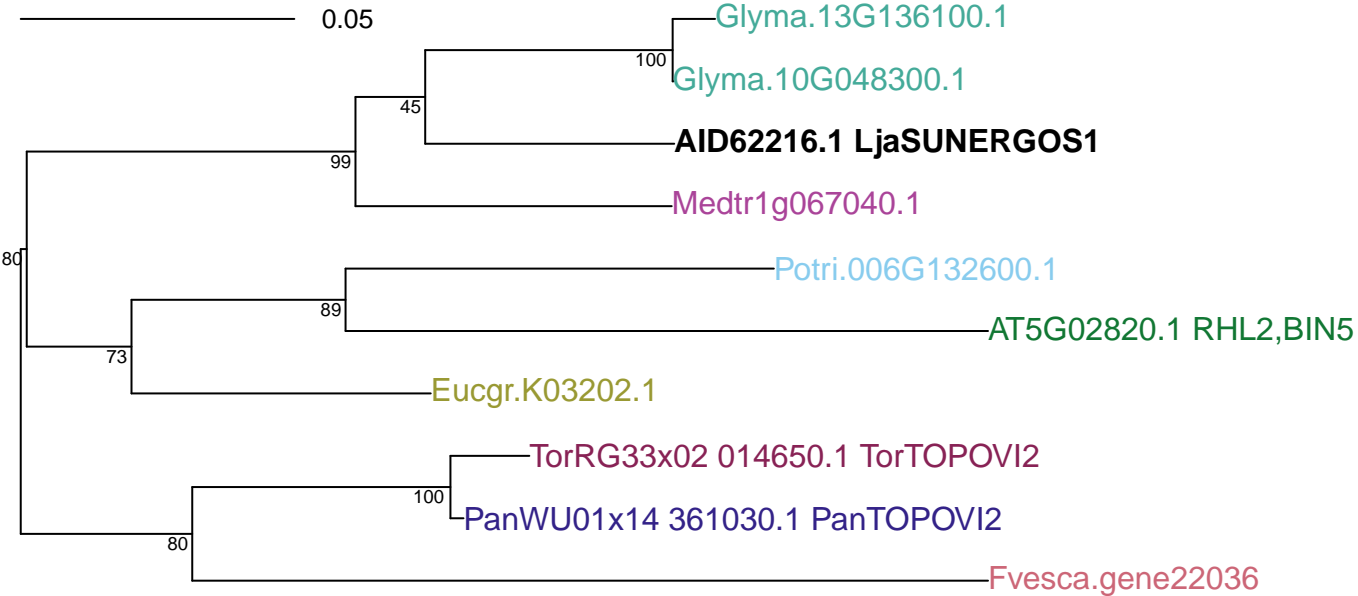
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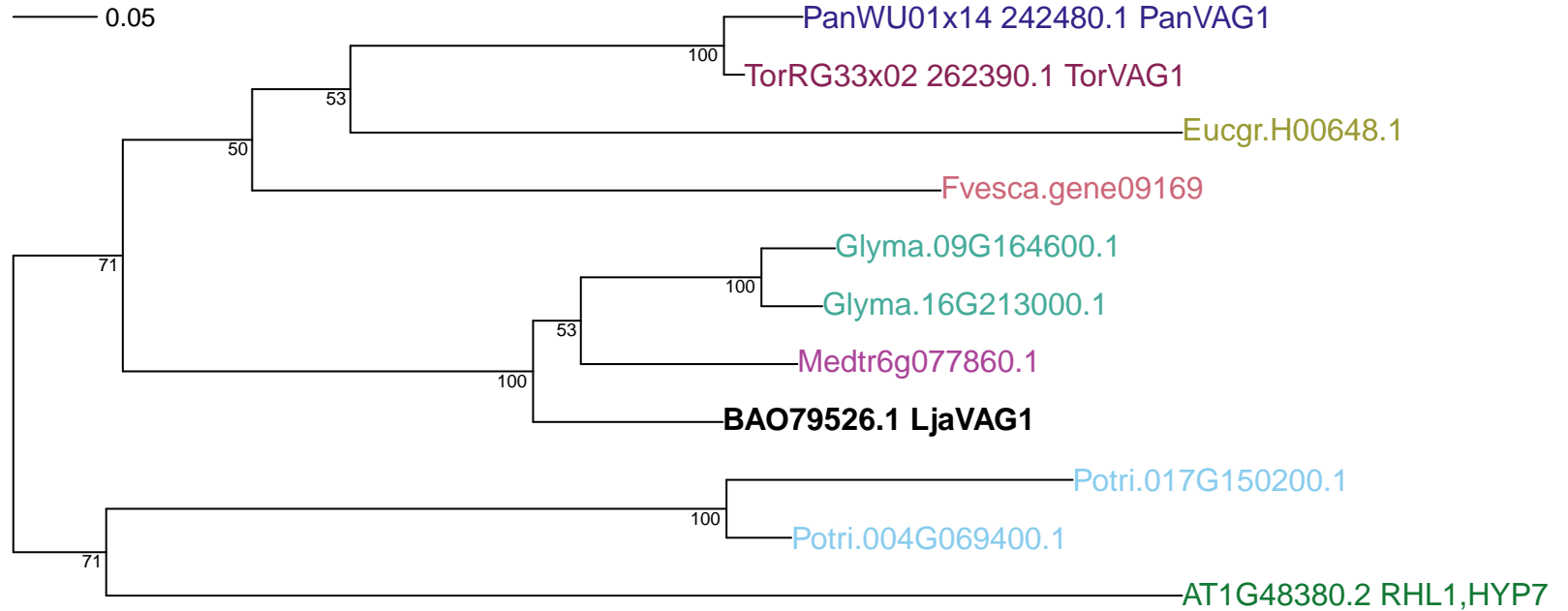
OG0005590: Infection related. deubiquitinating enzyme



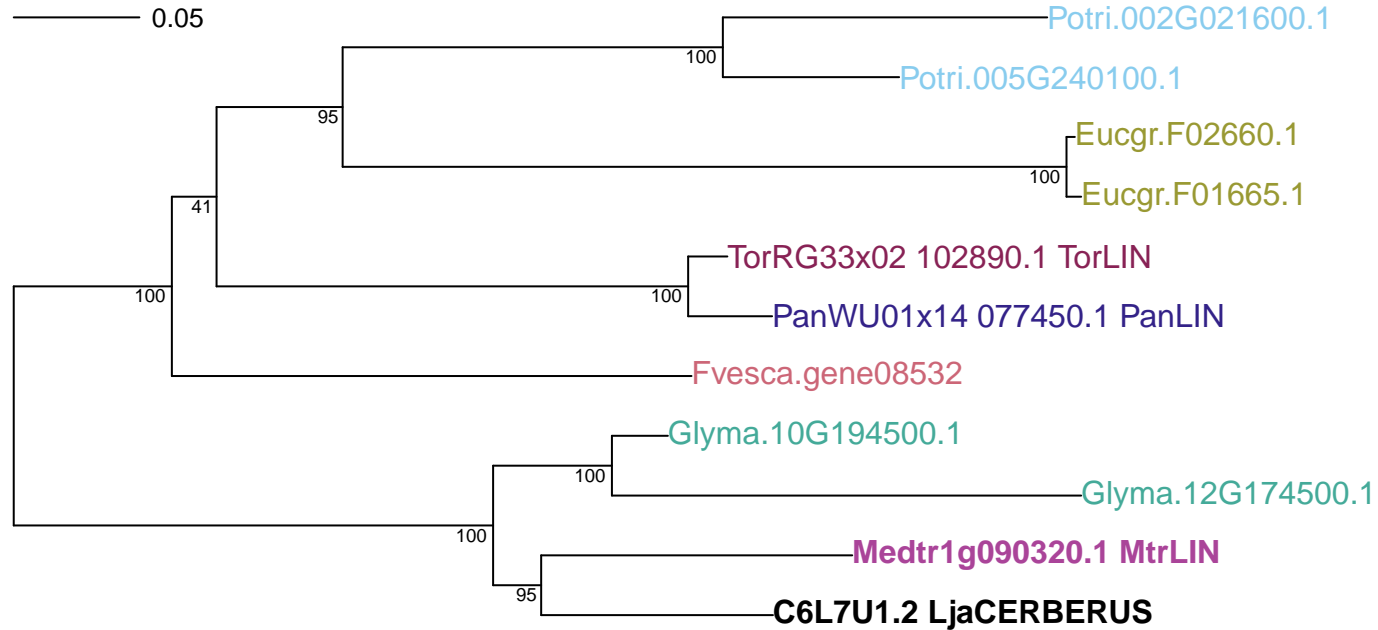
OG0011786: Infection related. DNA topoisomerase VI subunit A



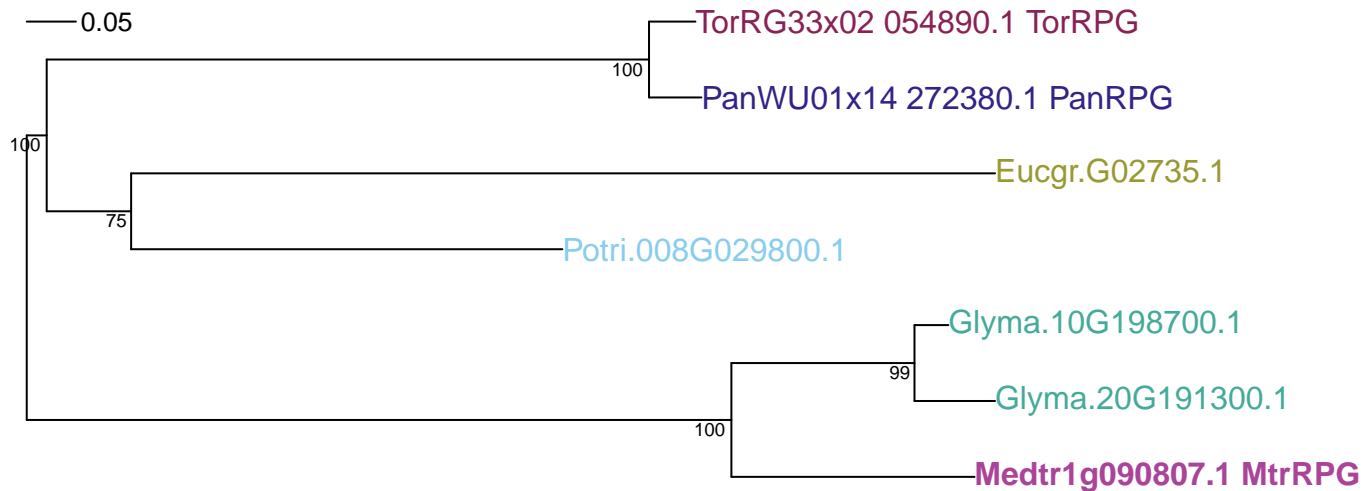
OG0008368: Infection related. DNA topoisomerase VI RHL1



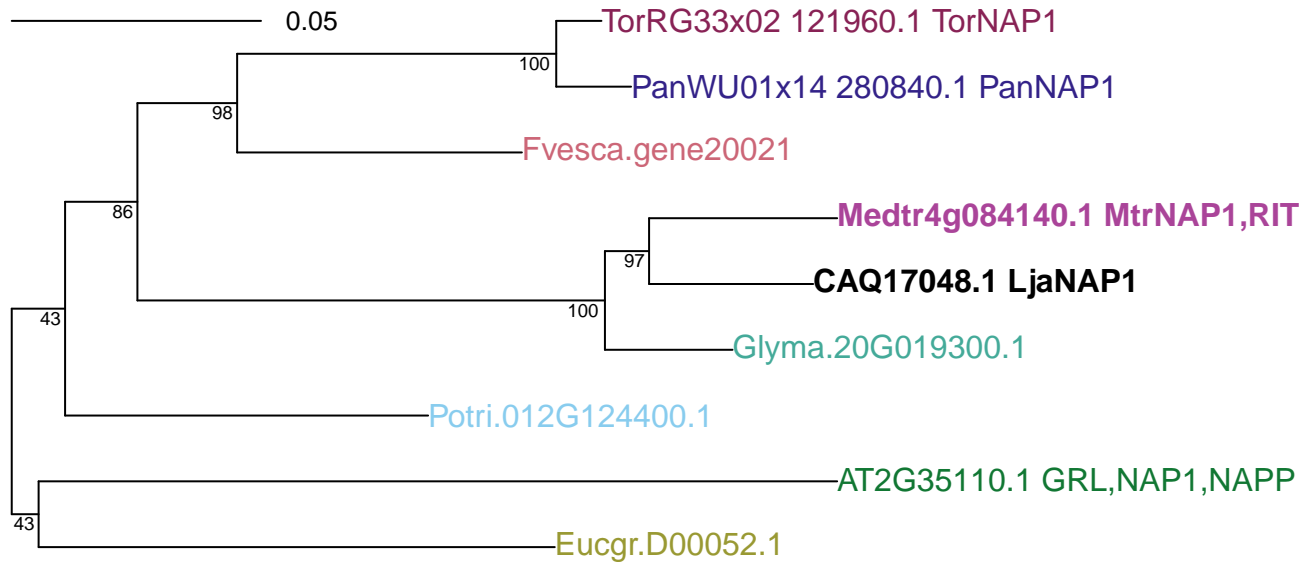
OG0009774: Infection related. E3 ubiquitin ligase



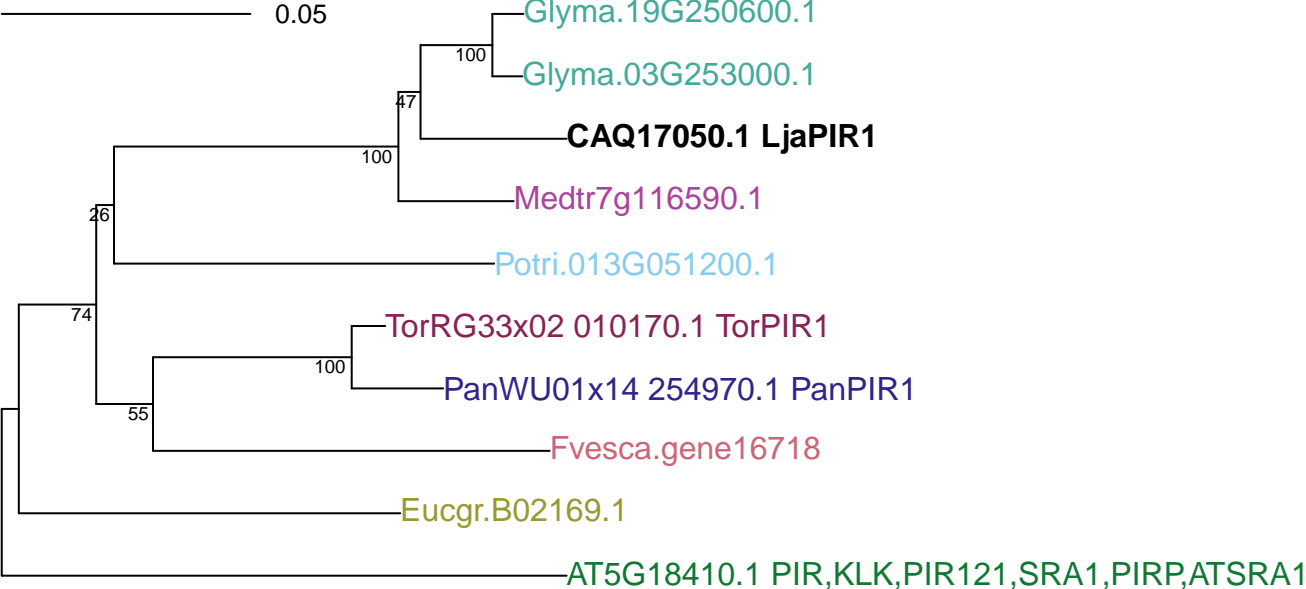
OG0014072: Infection related. Long coiled-coil proetin



OG0012612: Infection related. SCAR/WAVE protein

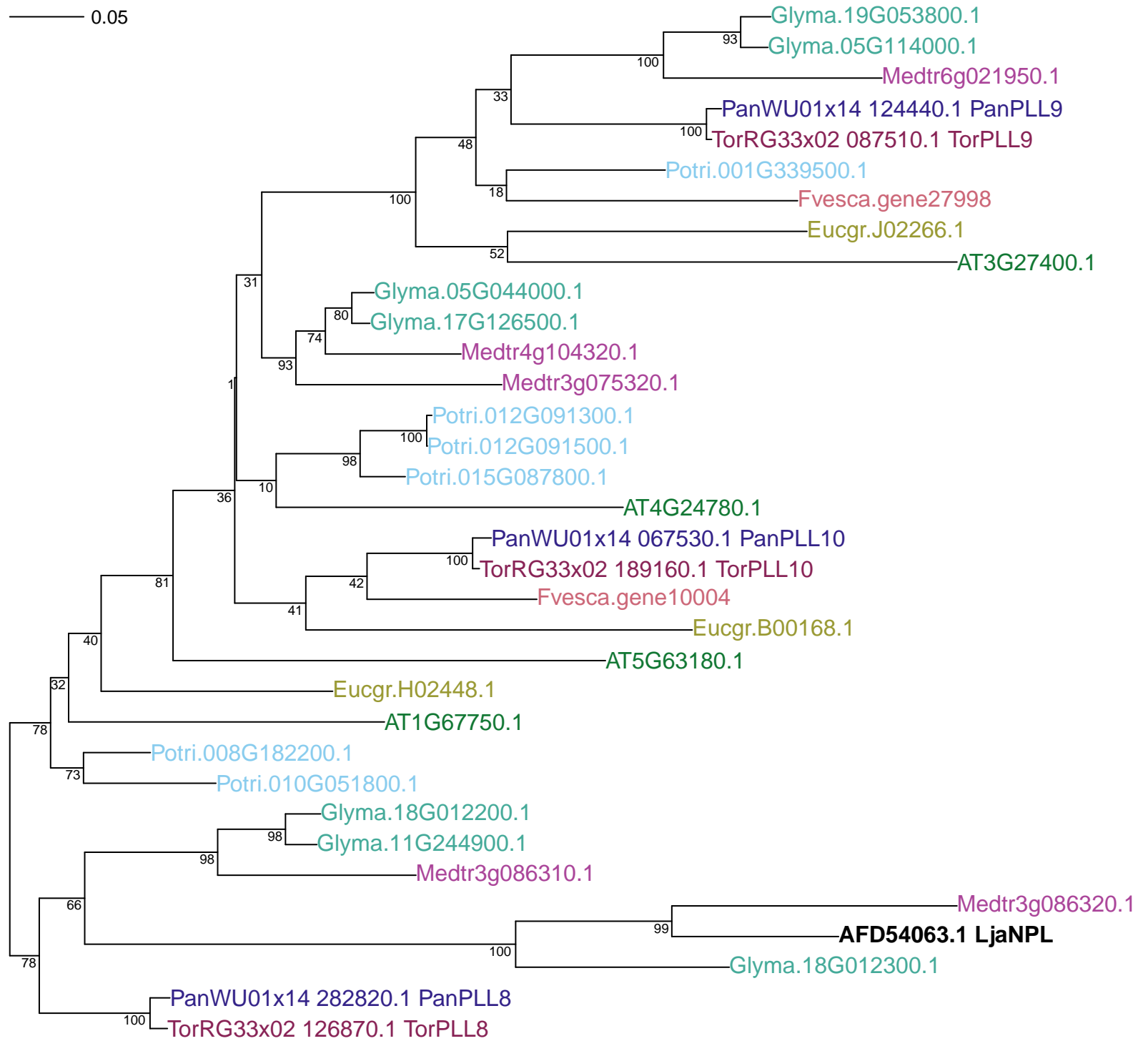


OG0011867: Infection related. p53 inducible RNA



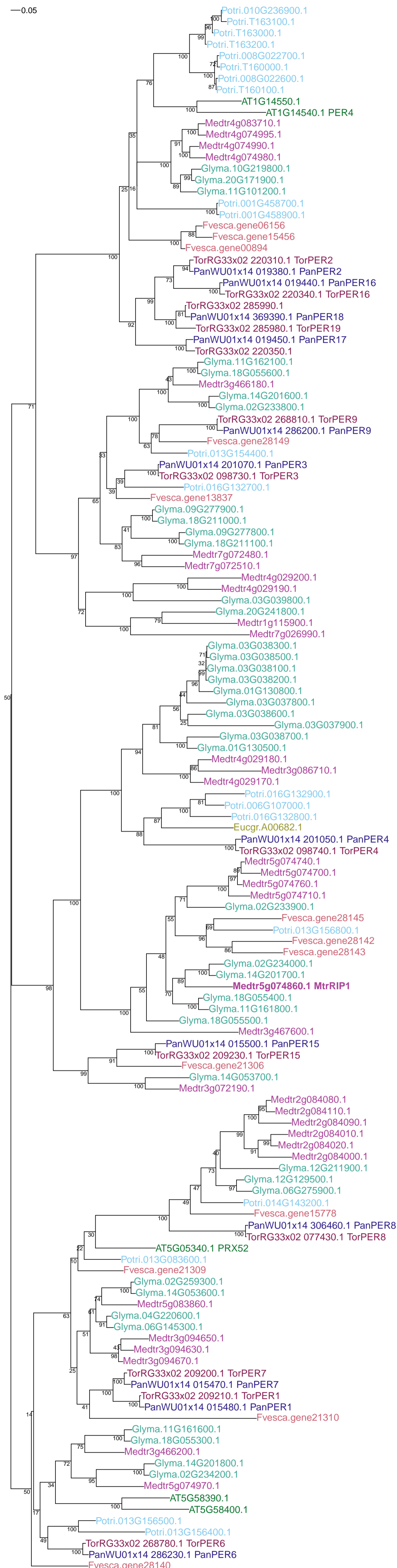
OG0000686: Infection related. pectate lyase

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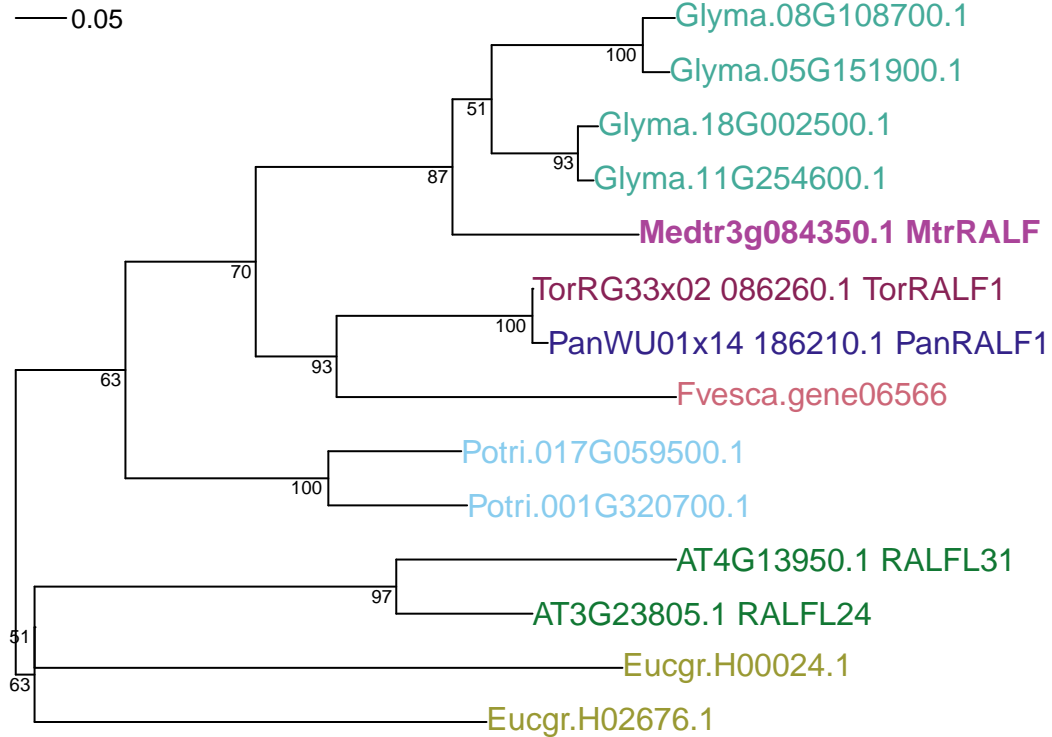


OG0000054: Infection related. peroxidase

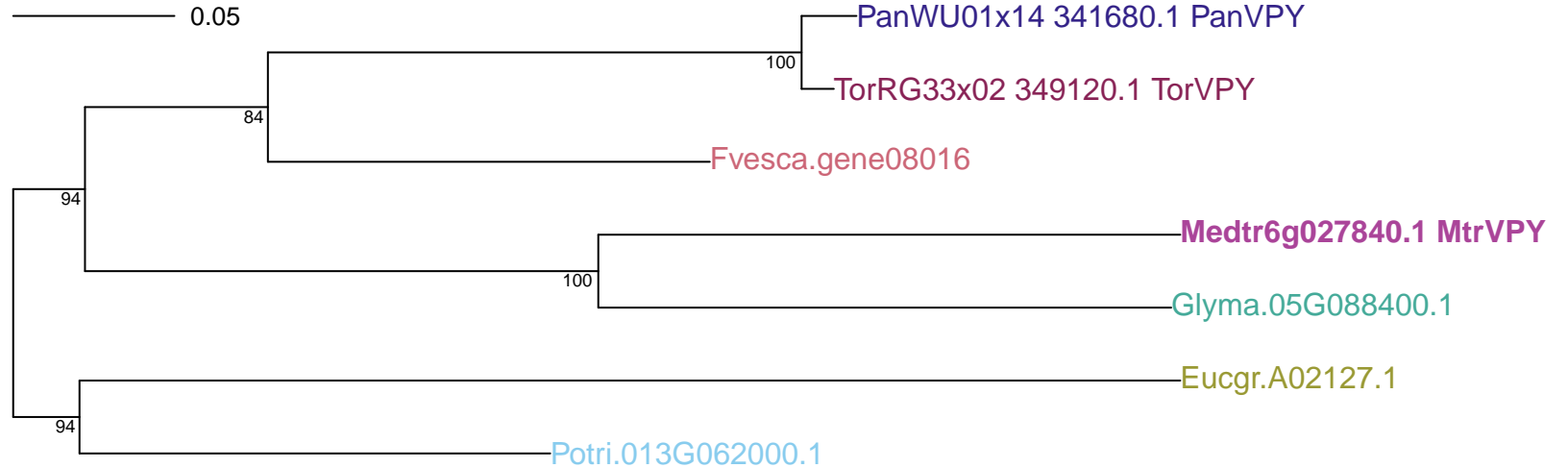
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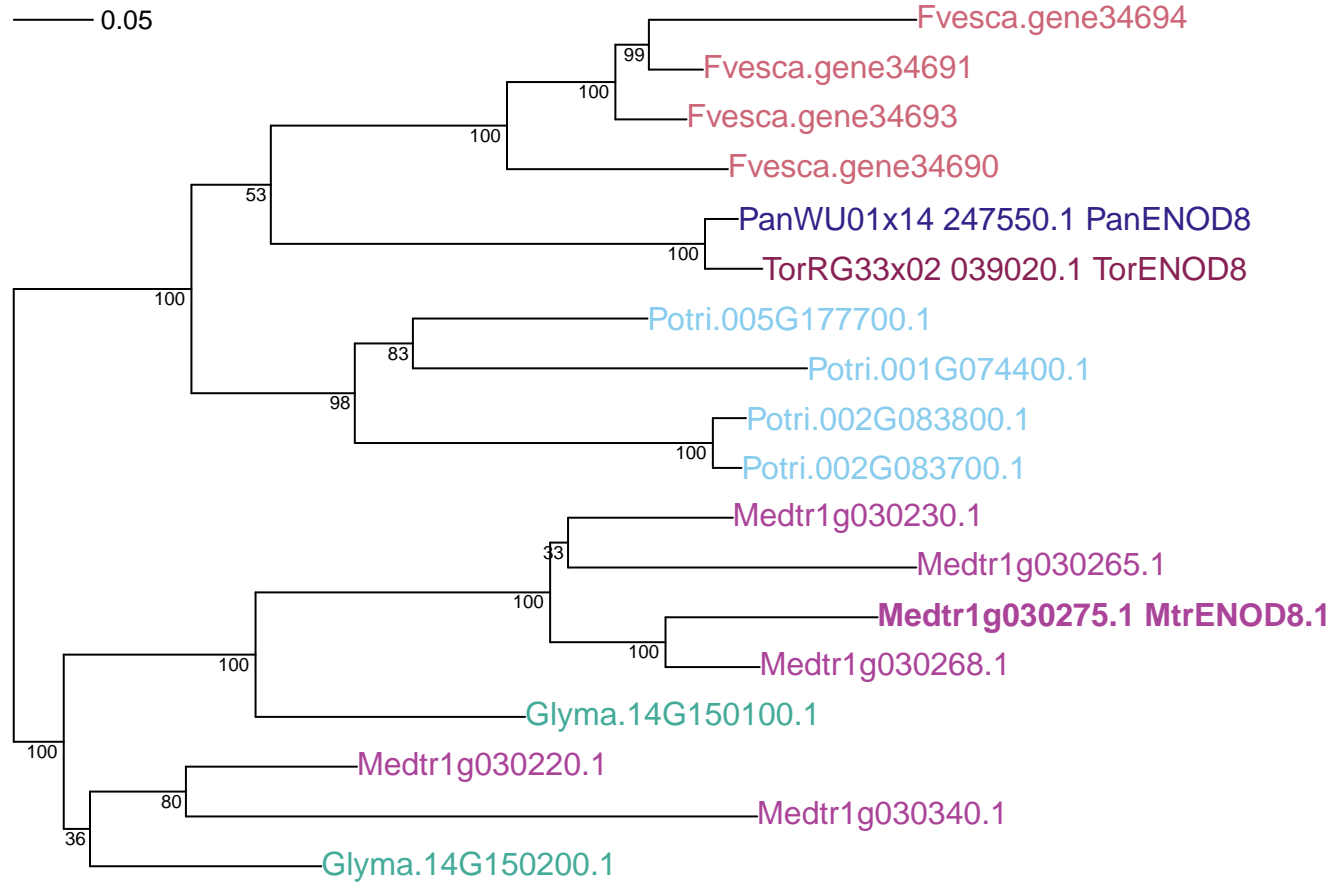
OG0004210: Infection related. Rapid alkalization factor (RALF) peptide



OG0013991: Infection related. Vapyrin

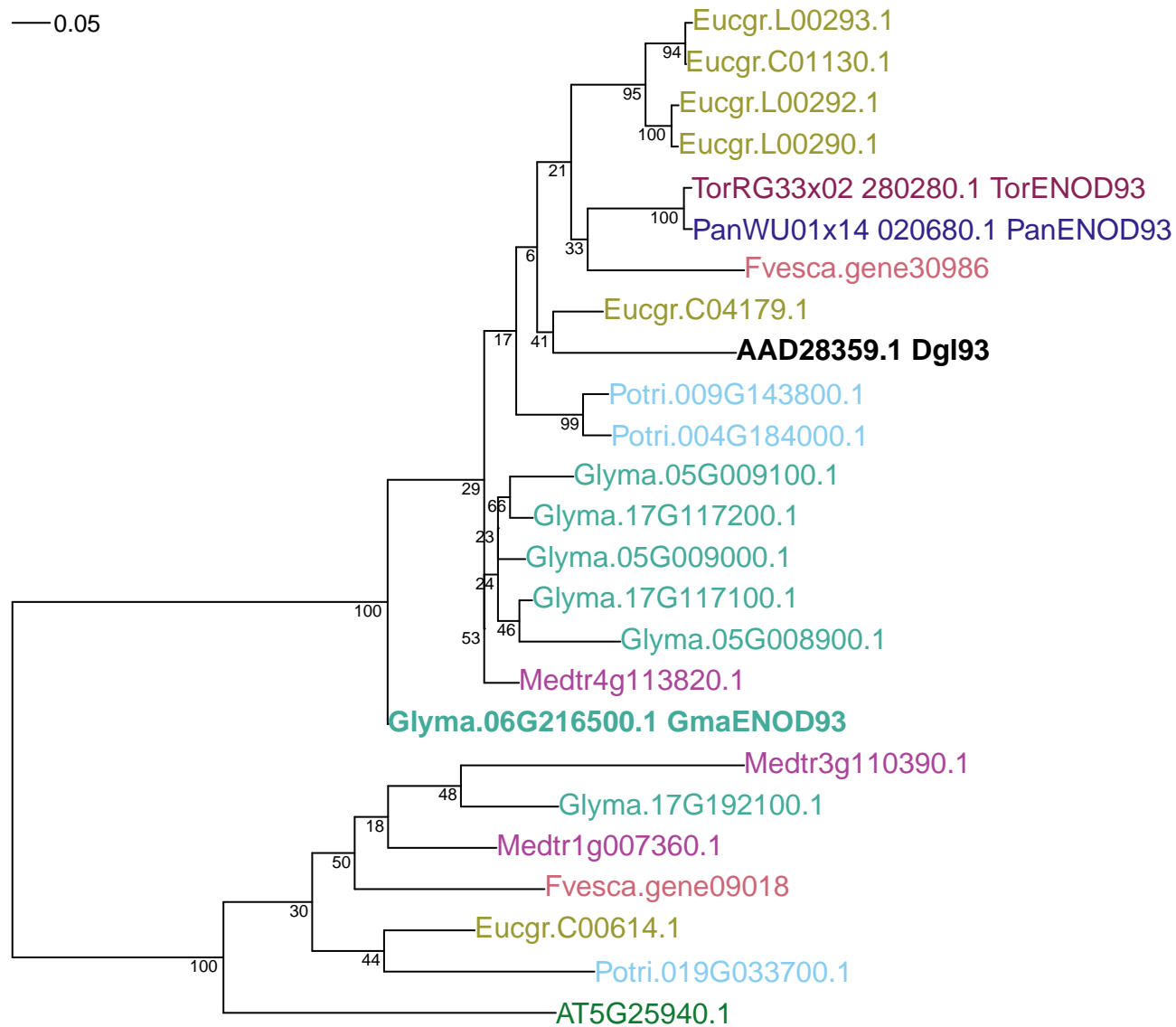


OG0002788: Nodule & symbiosome development. Symbiosome localized esterase

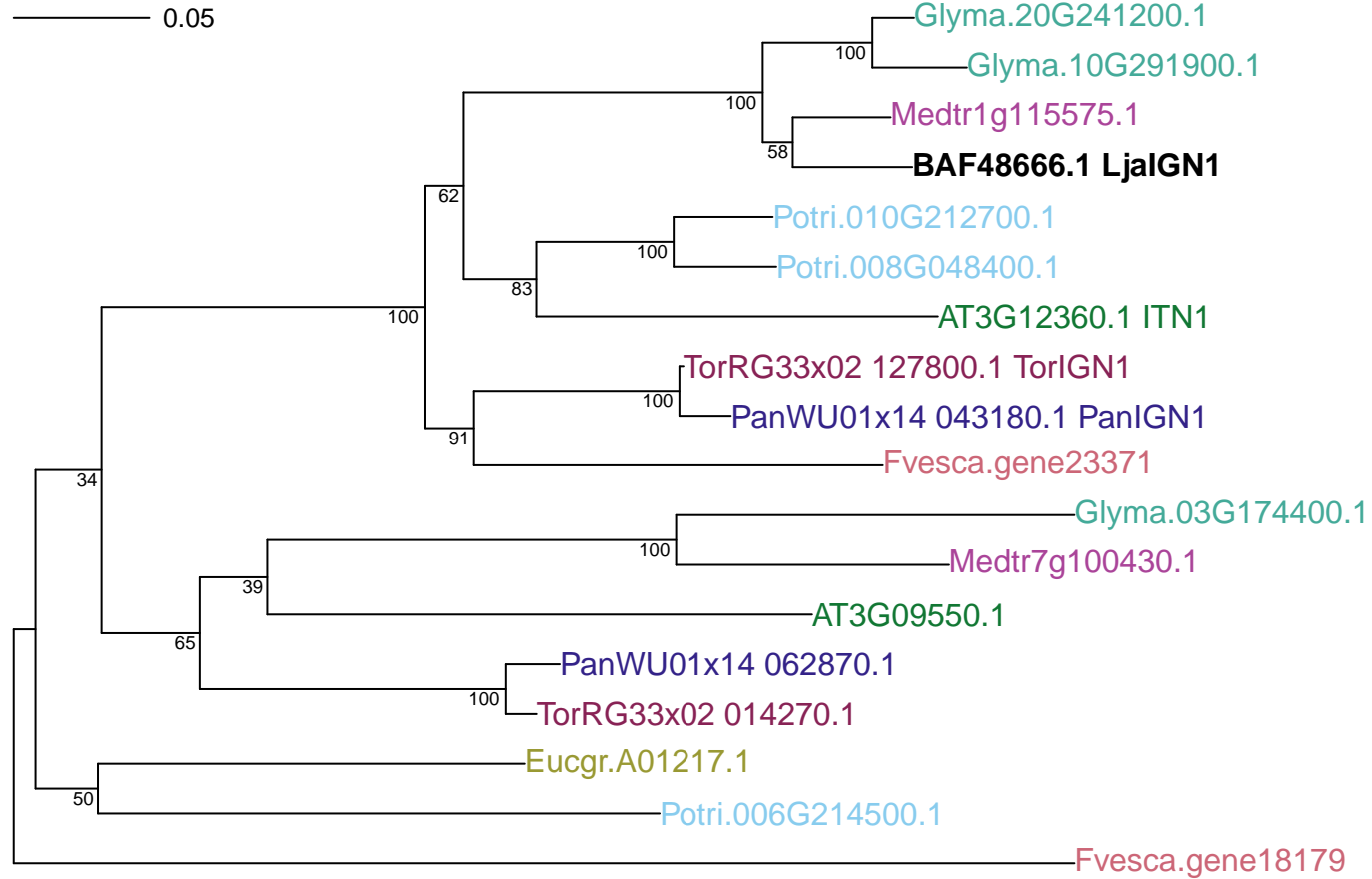


OG0001416: Nodule & symbiosome development. early nodulin

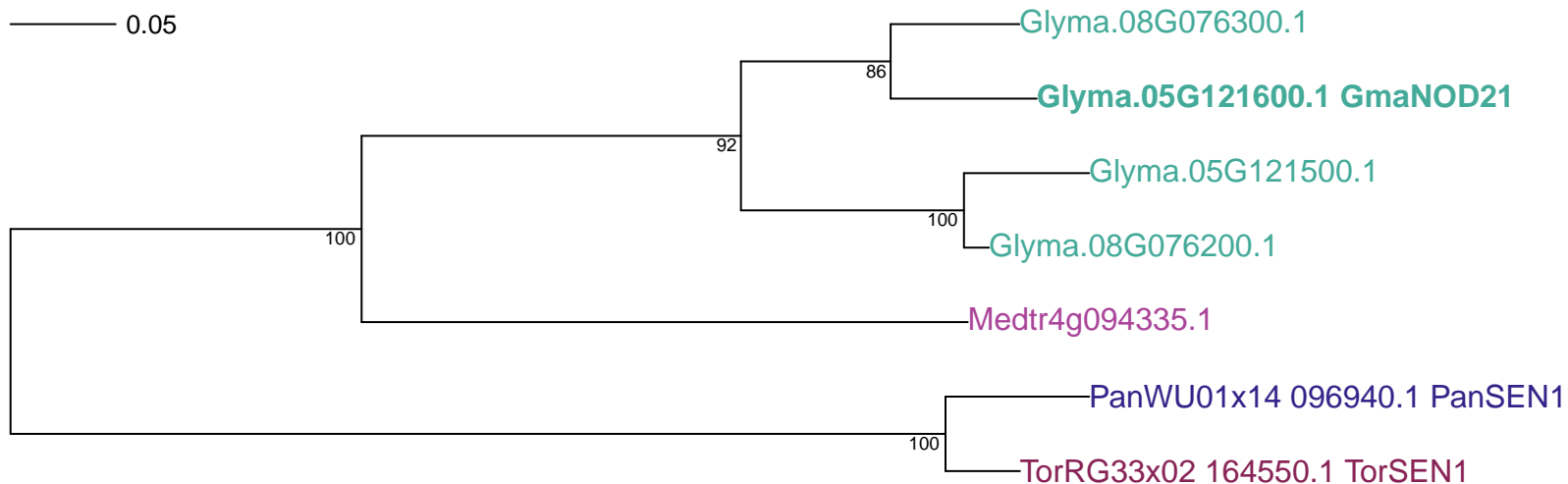
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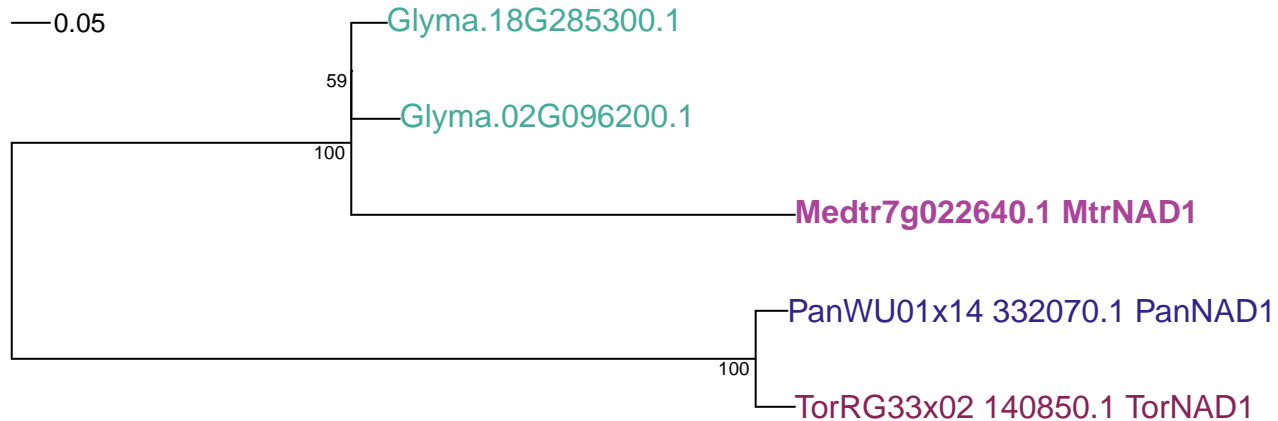
OG0002946: Nodule & symbiosome development. Ankyrin-repeat membrane protein



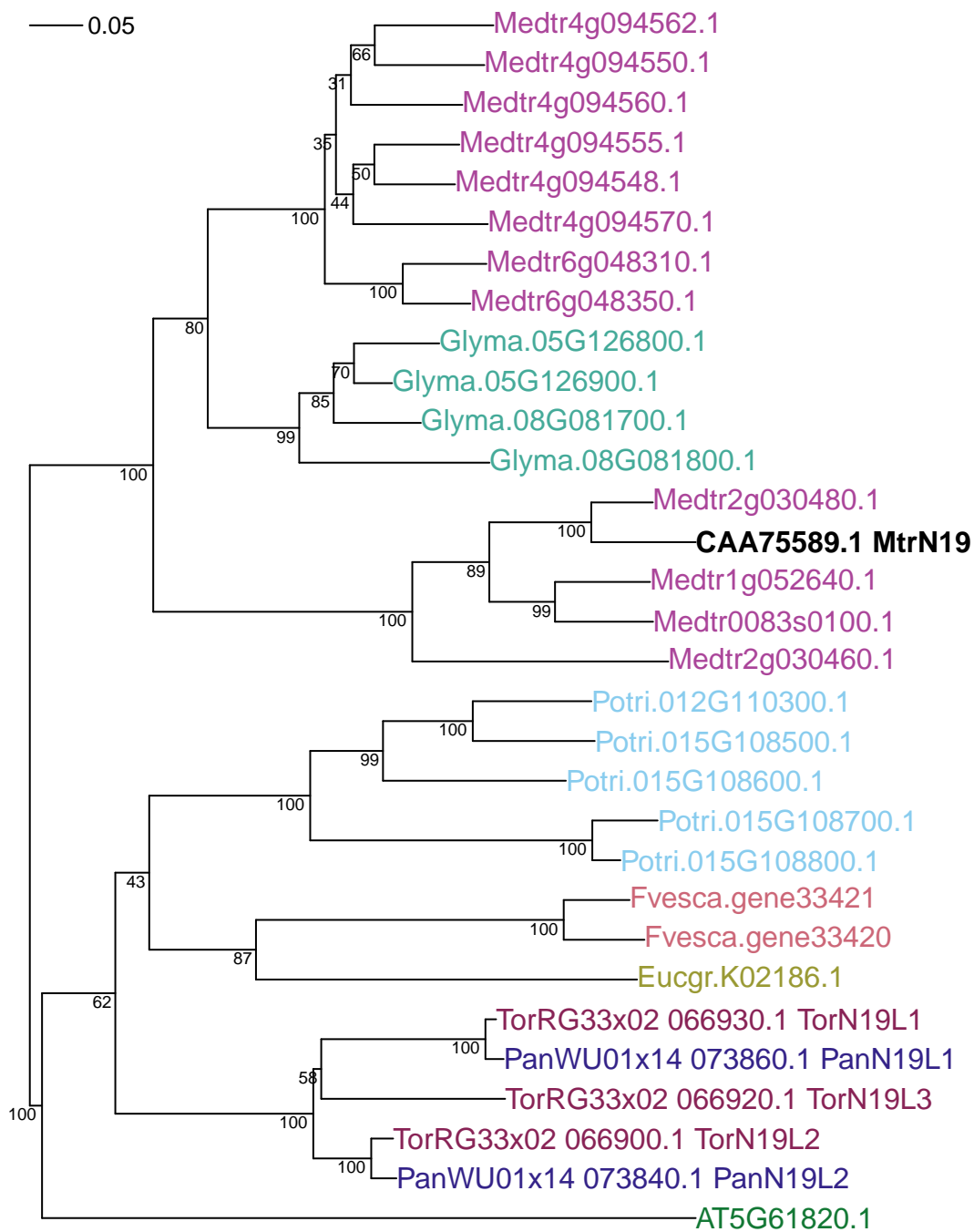
OG0015109–0018304: Nodule & symbiosome development. methionine–rich membrane protein



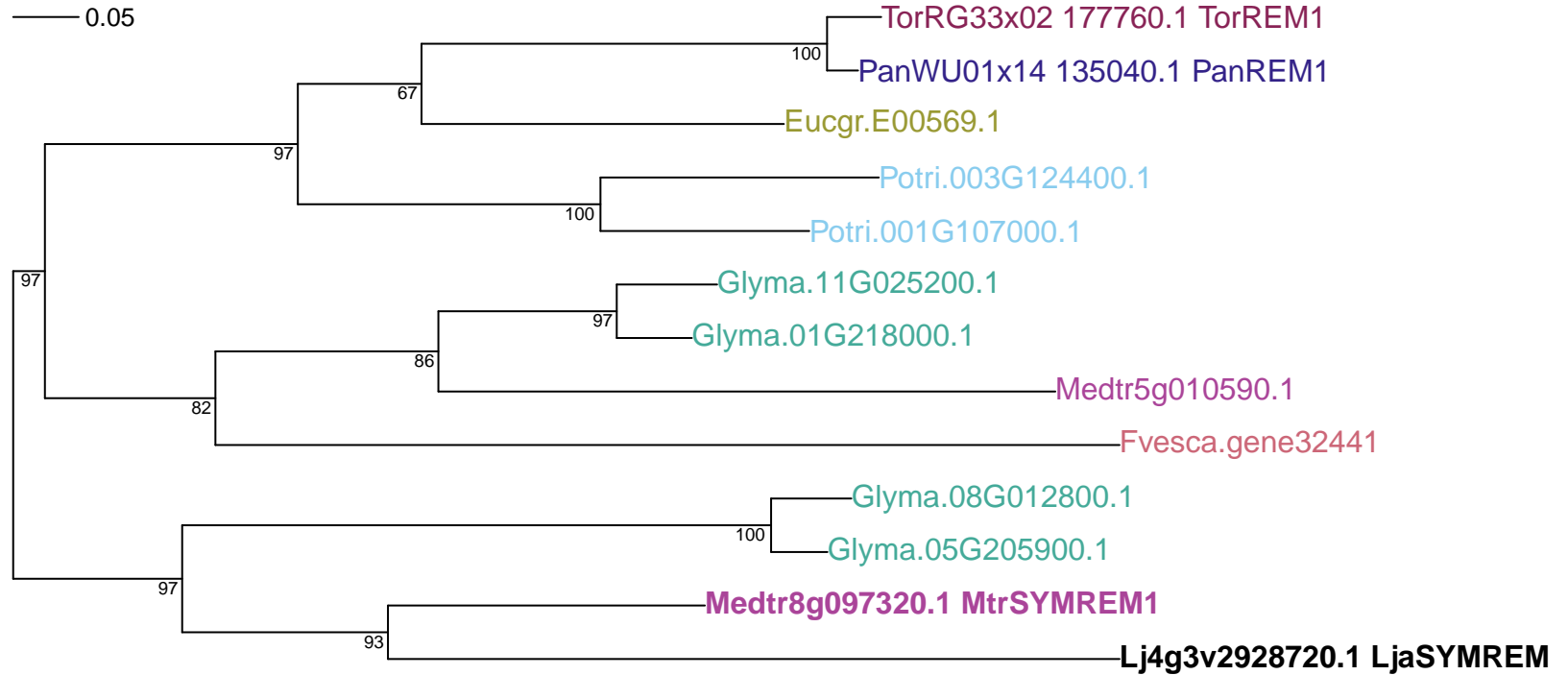
OG0015095: Nodule & symbiosome development. small membrane localised protein



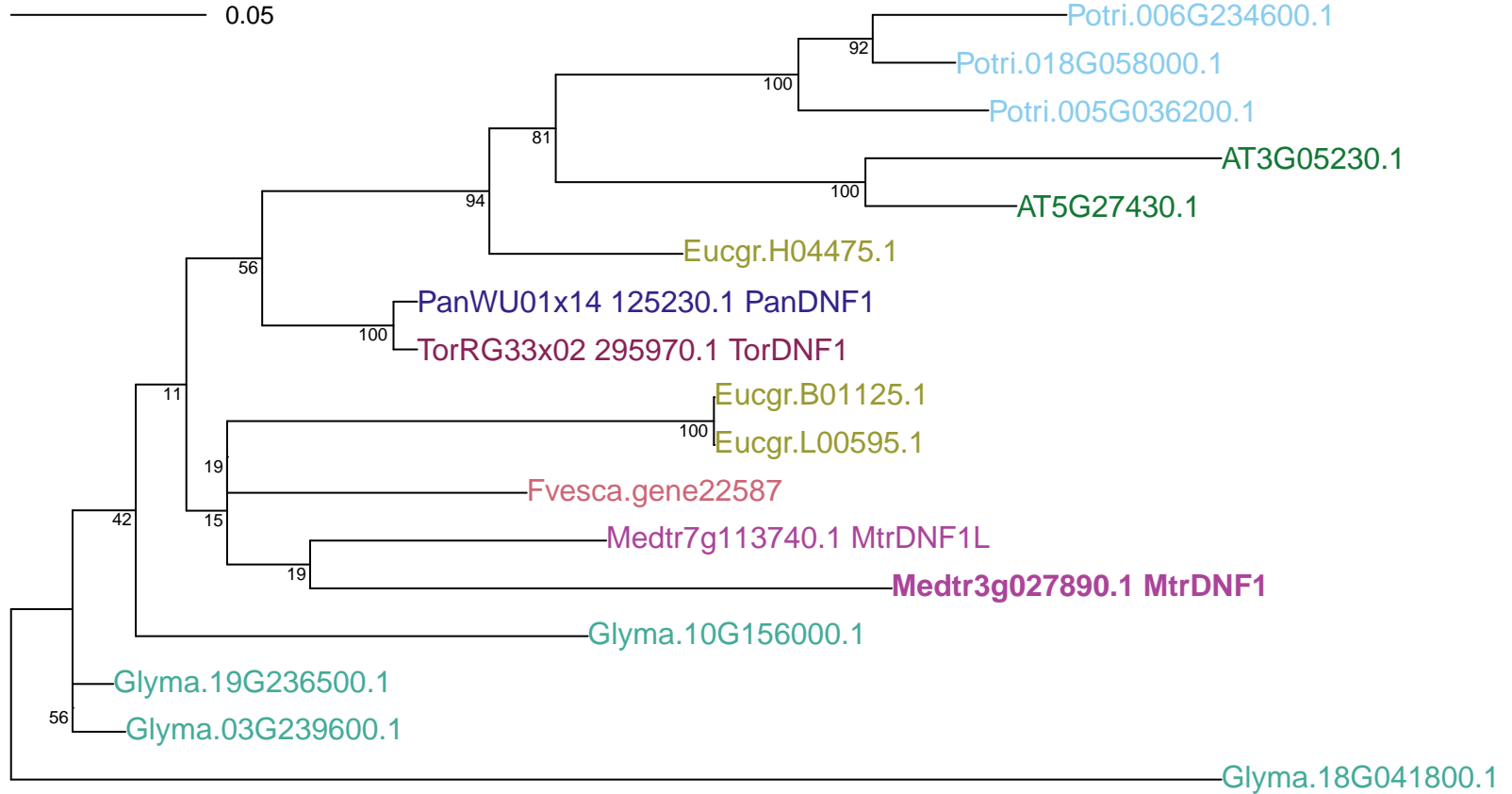
OG0000842: Nodule & symbiosome development. Stress up-regulated Nod 19



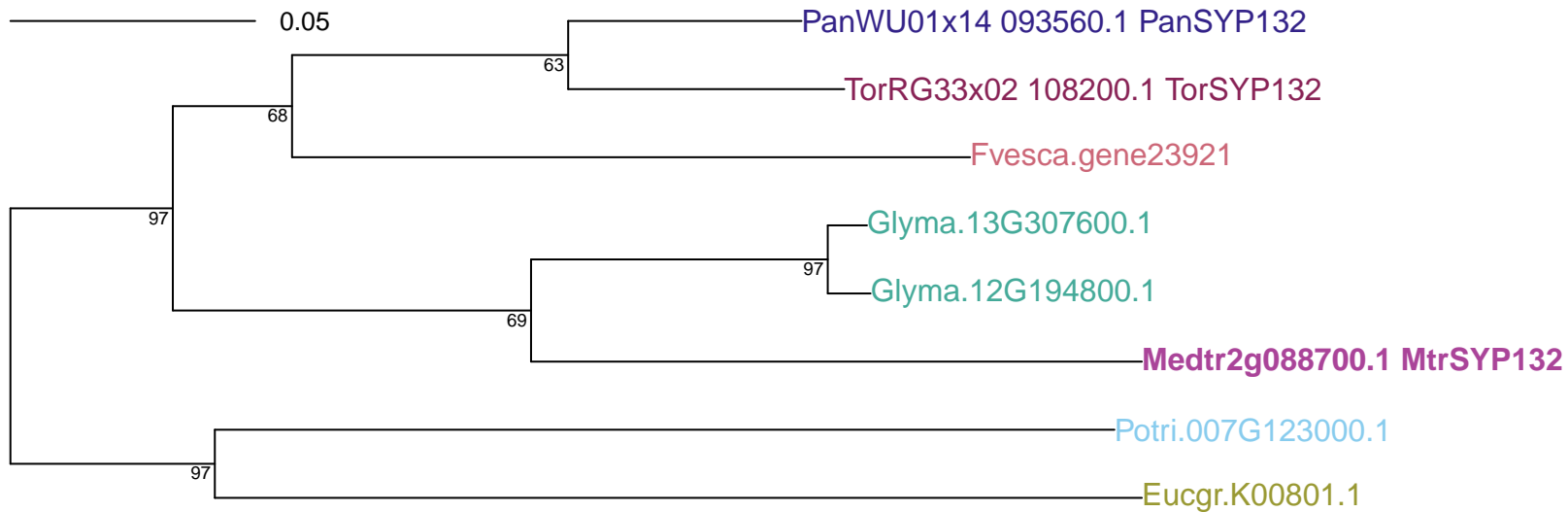
OG0006355: Nodule & symbiosome development. Remorin



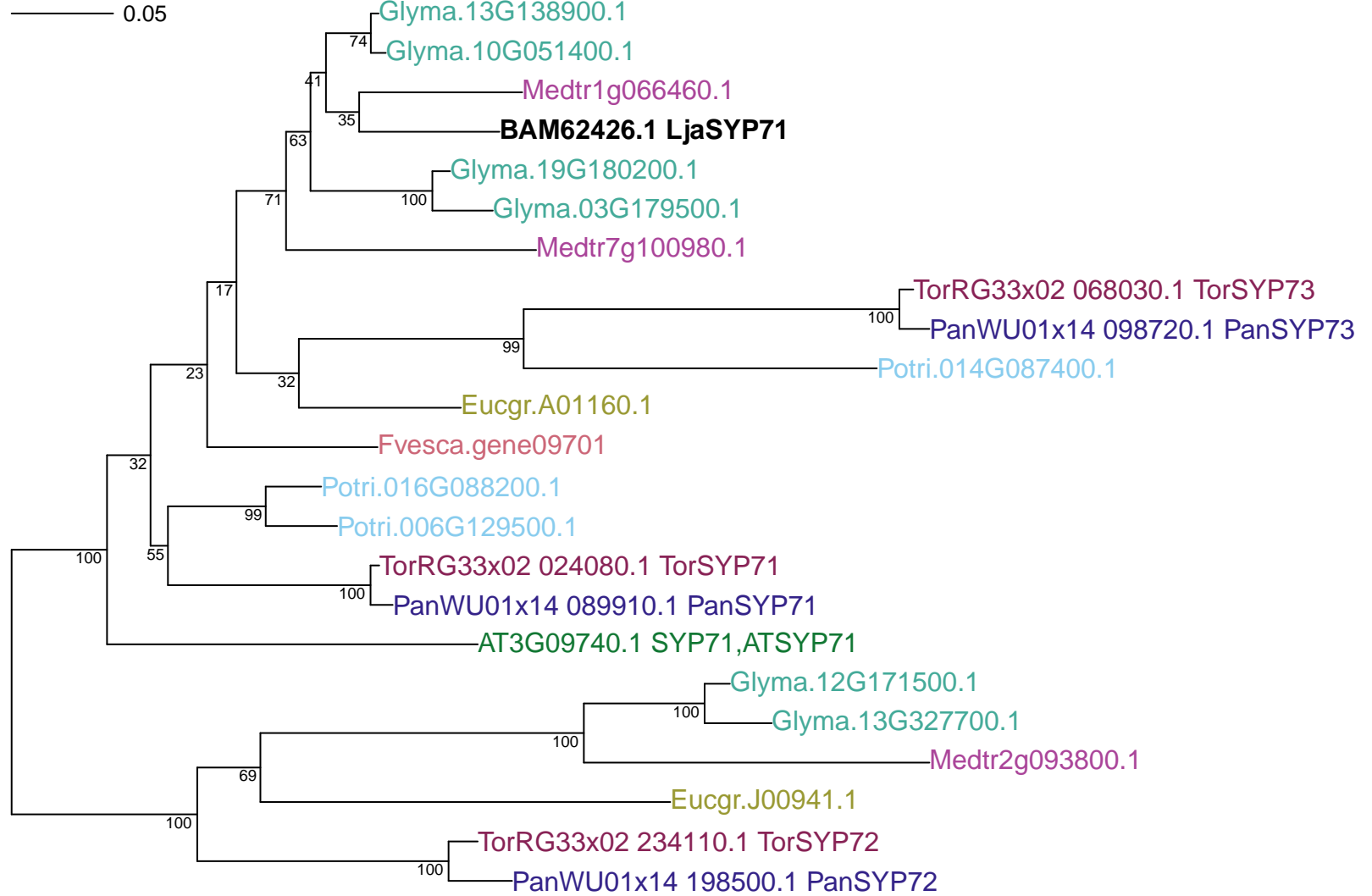
OG0002964: Nodule & symbiosome development. signal peptidase



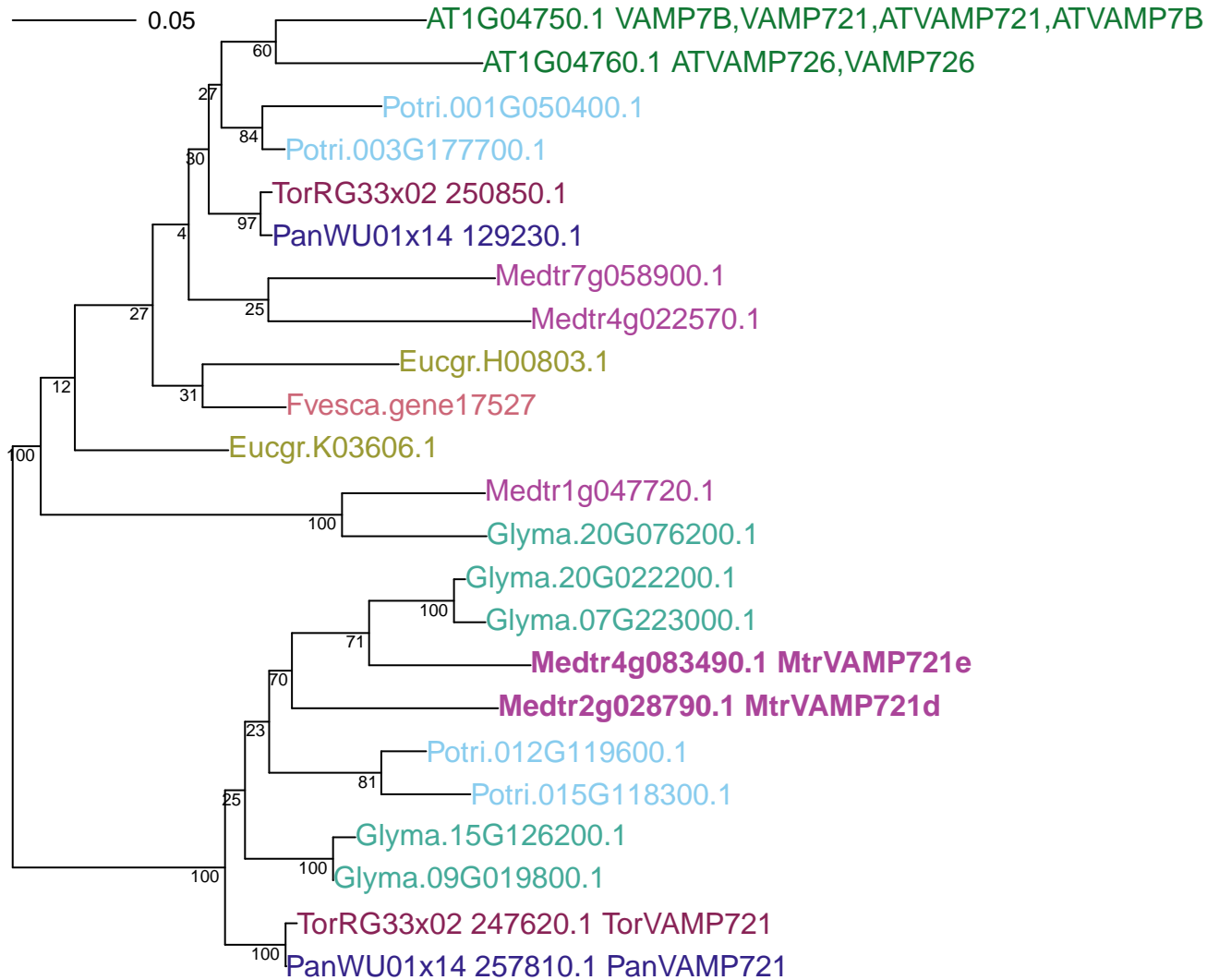
OG0013491: Nodule & symbiosome development. t-SNARE syntaxin



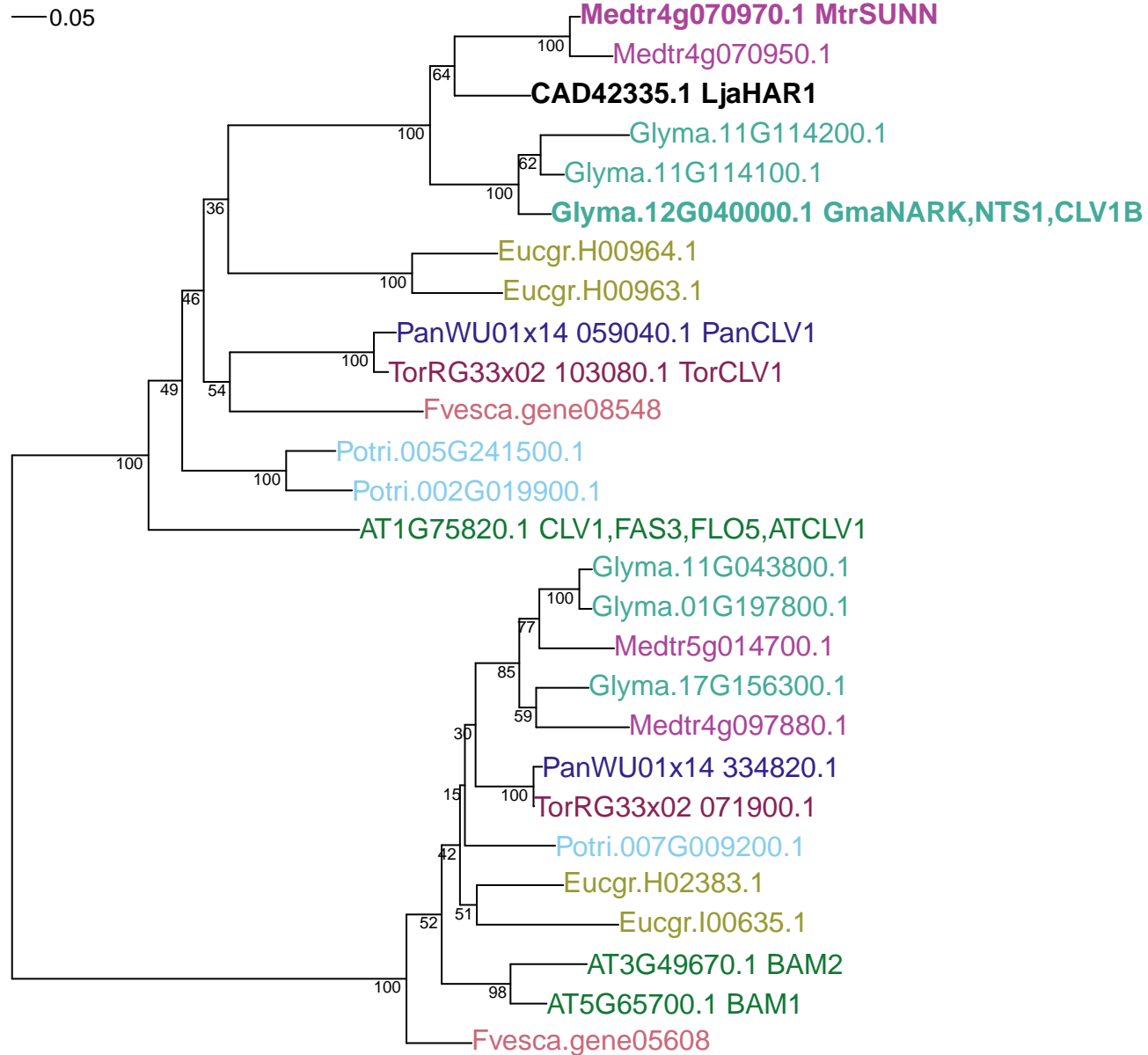
OG0001731: Nodule & symbiosome development. v-SNARE syntaxin



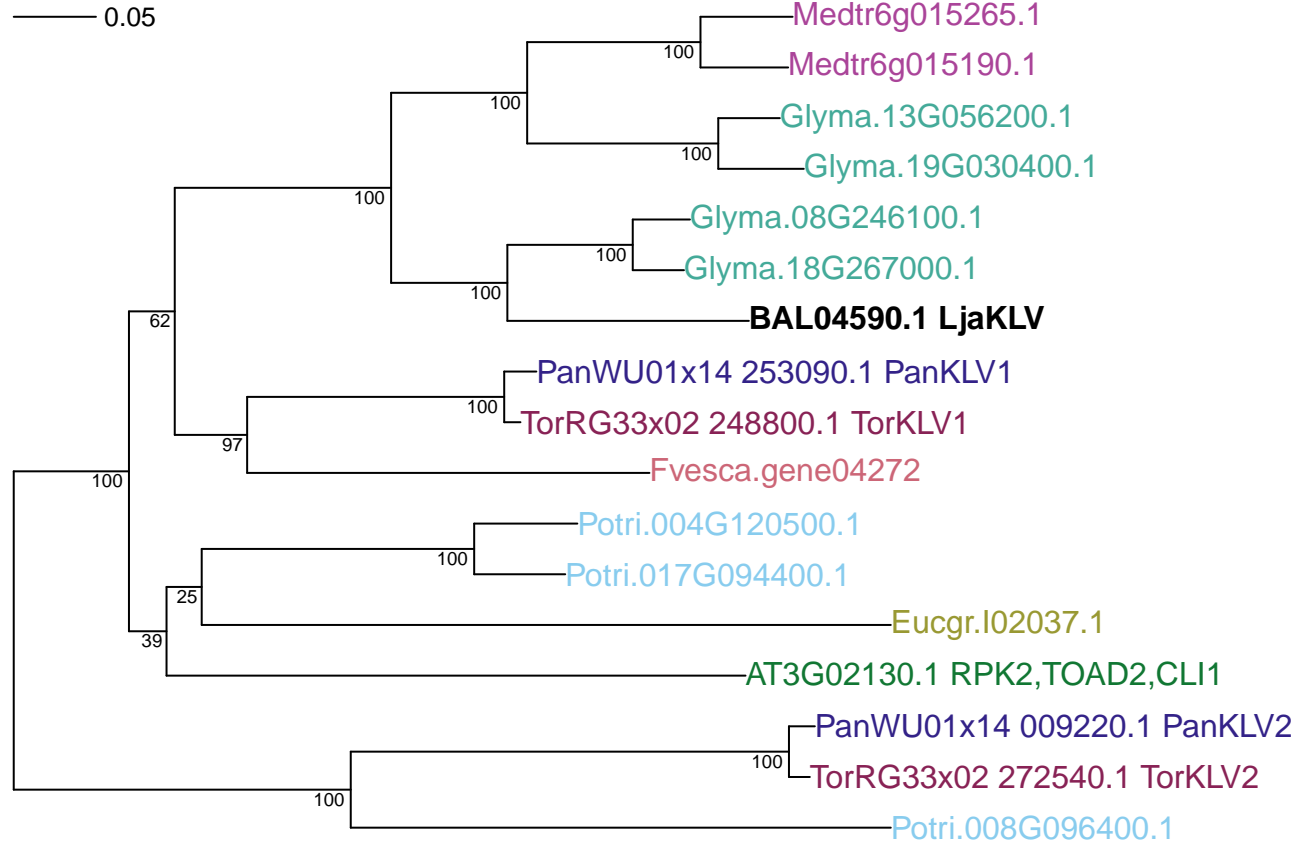
OG0001468: Nodule & symbiosome development. v-SNARE syntaxin



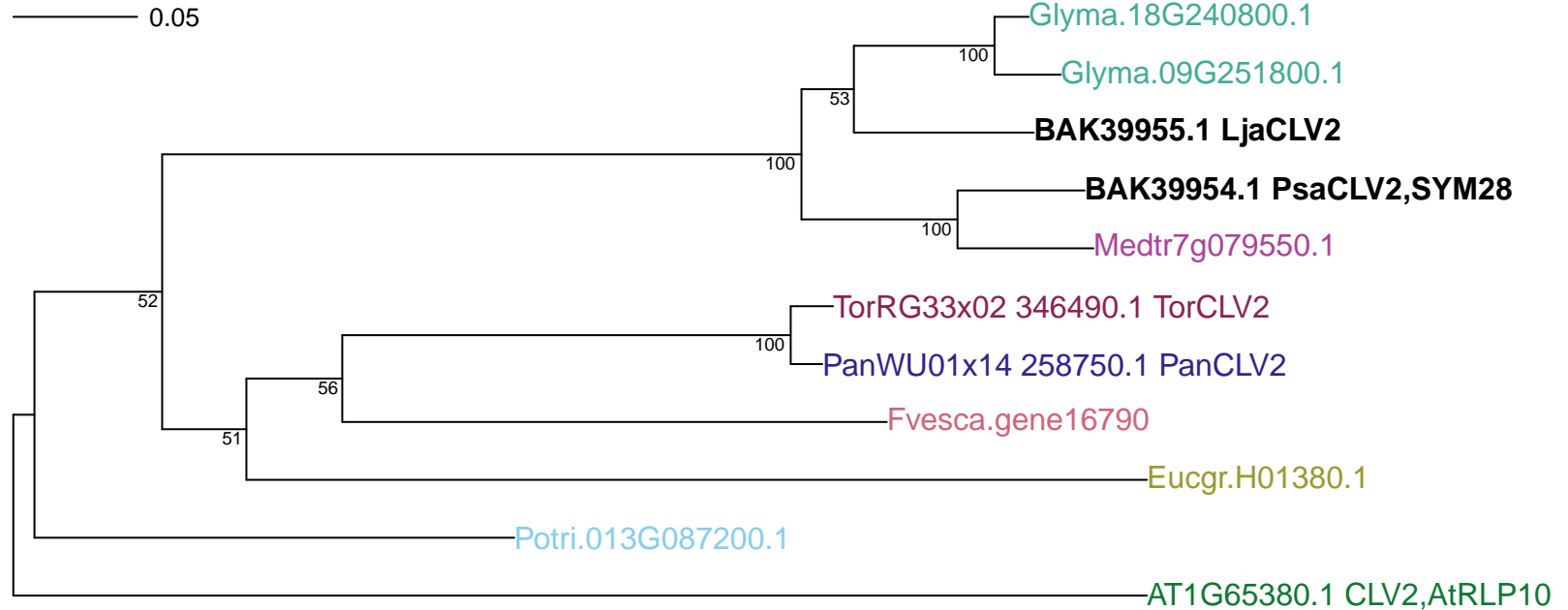
OG0001133: Systemic signaling. CLV1-type LRR-receptor kinase



OG0003324: Systemic signaling. CLI1-type LRR-receptor kinase



OG0010087: Systemic signaling. CLV2-type LRR-receptor

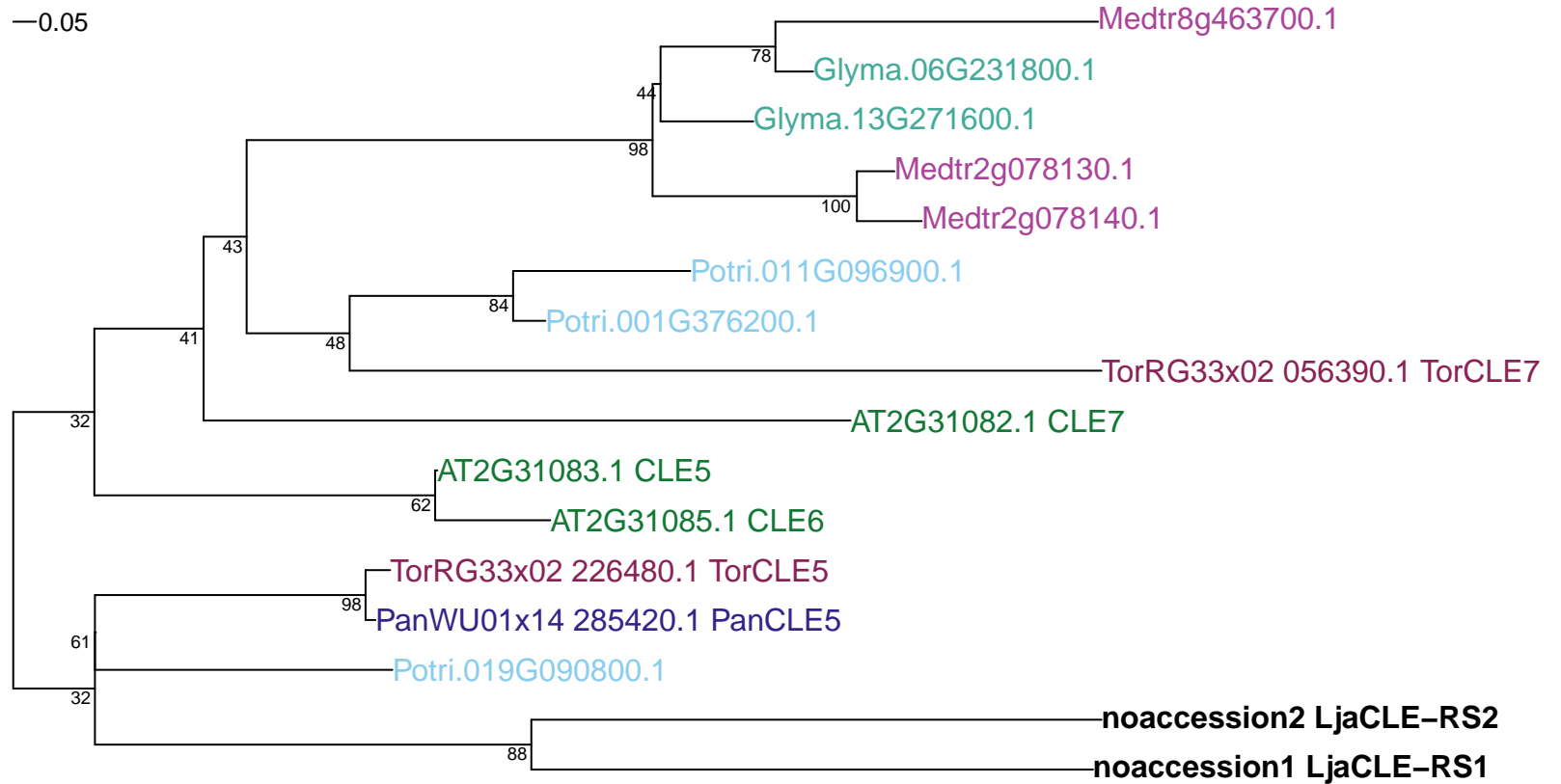


OG0012170: Systemic signaling. CLE peptide



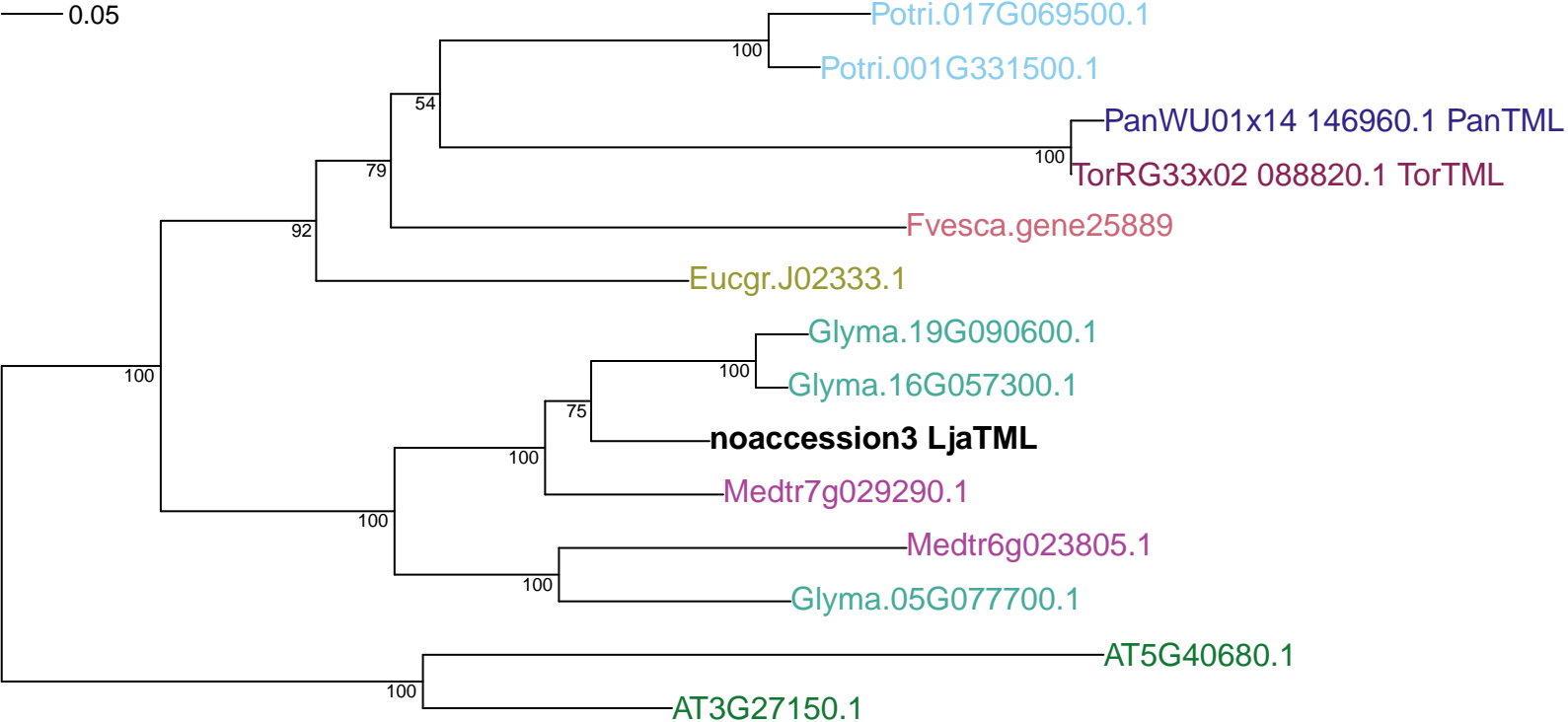
OG0004187: Systemic signaling. CLE peptide

—0.05



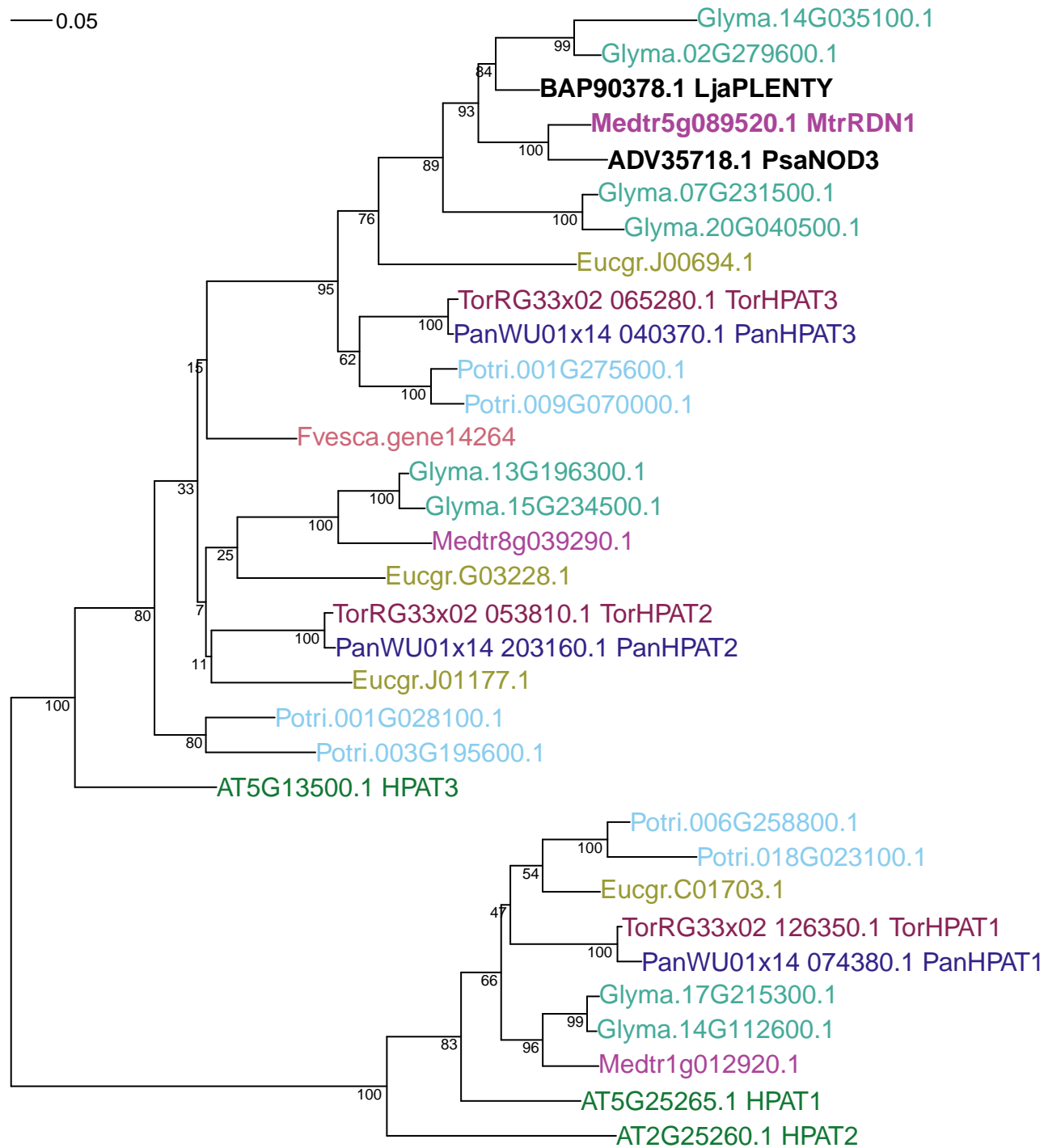
OG0005040: Systemic signaling. Kelch repeat-containing F-box protein

— 0.05

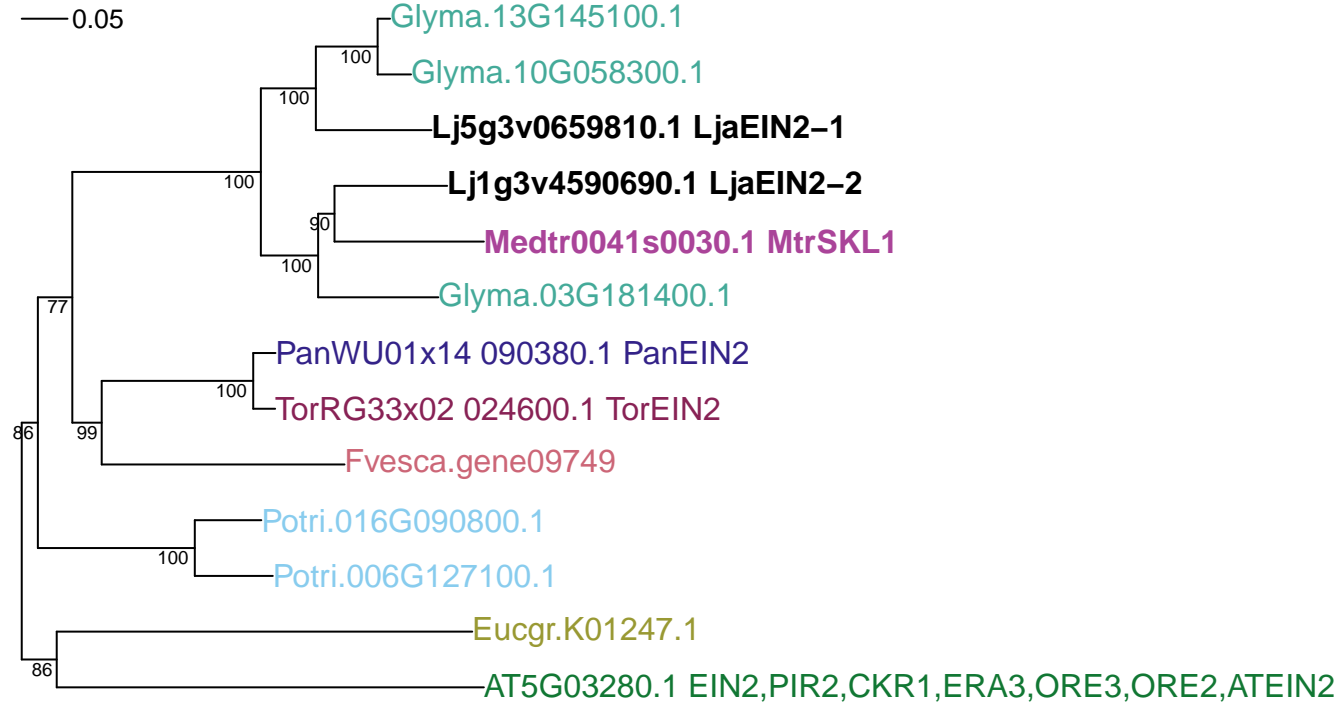


OG0000779: Systemic signaling. arabinosyl transferase

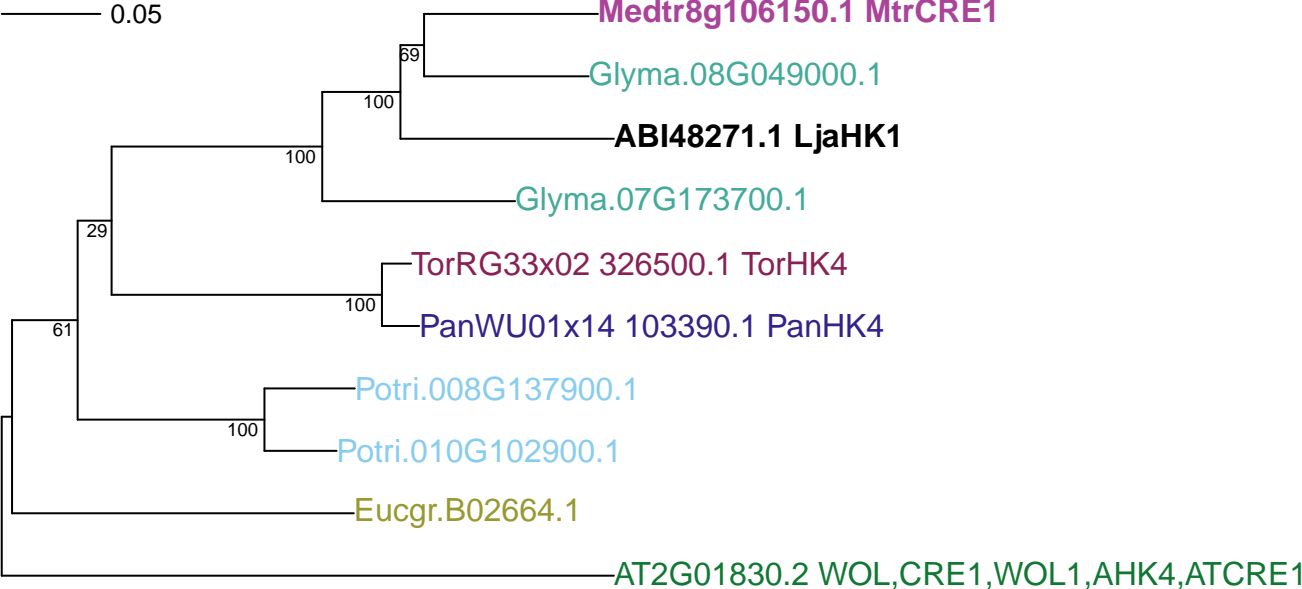
— 0.05



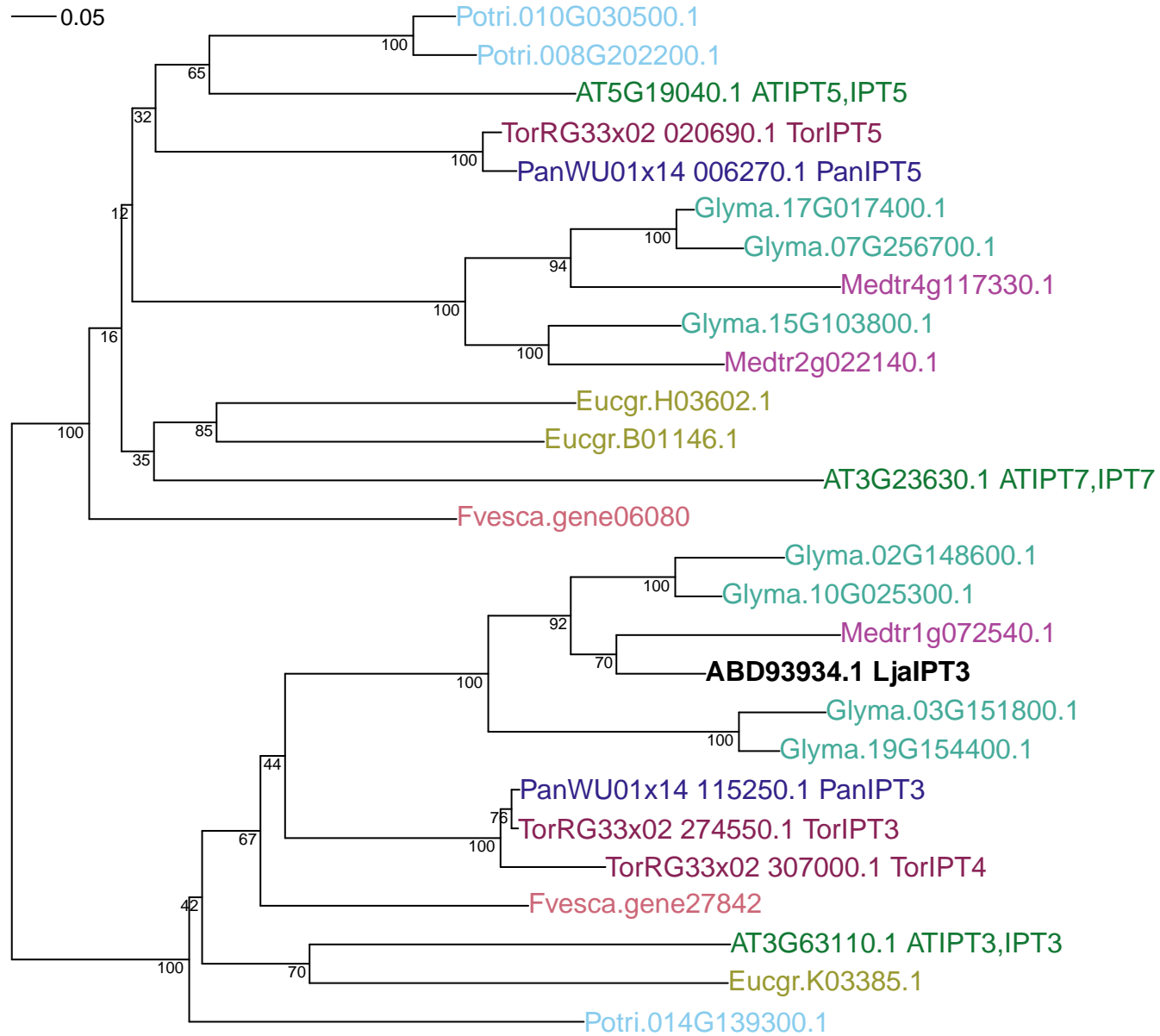
OG0007520: Hormones. essential for ethylene mediated signalling



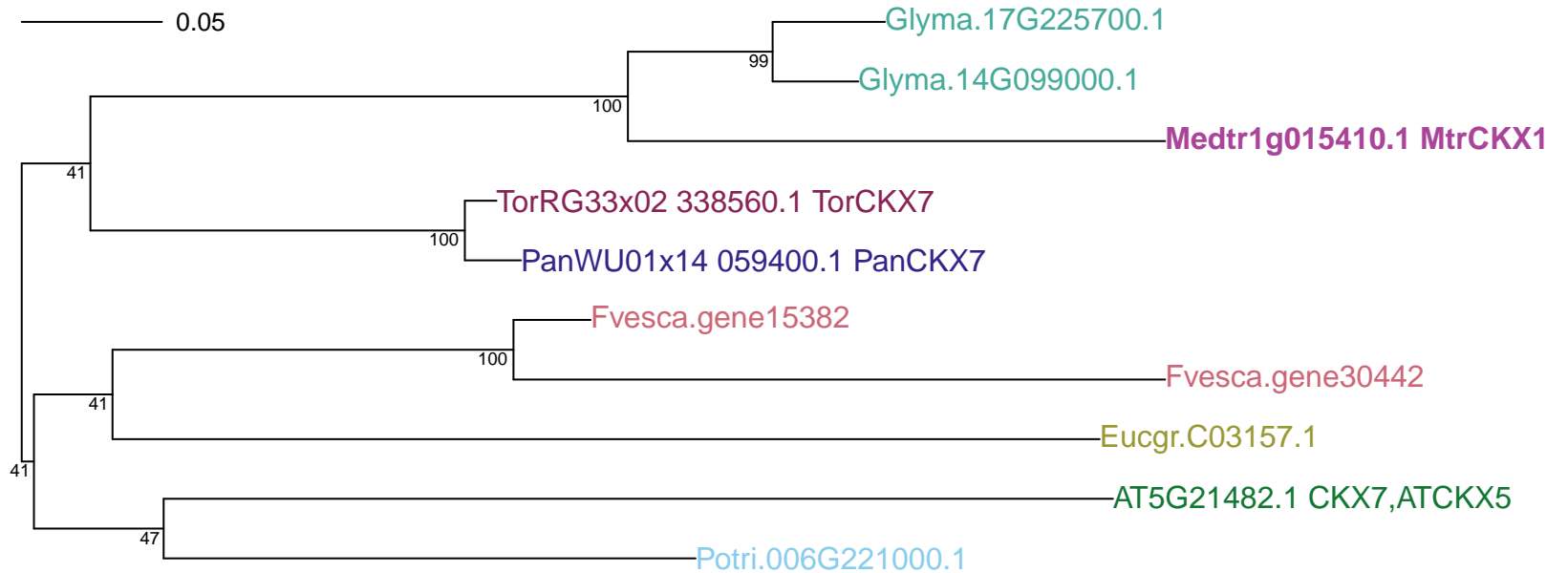
OG0010632: Hormones. Histidine kinase Cytokinin receptor



OG0001173: Hormones. Isopentenyltransferase

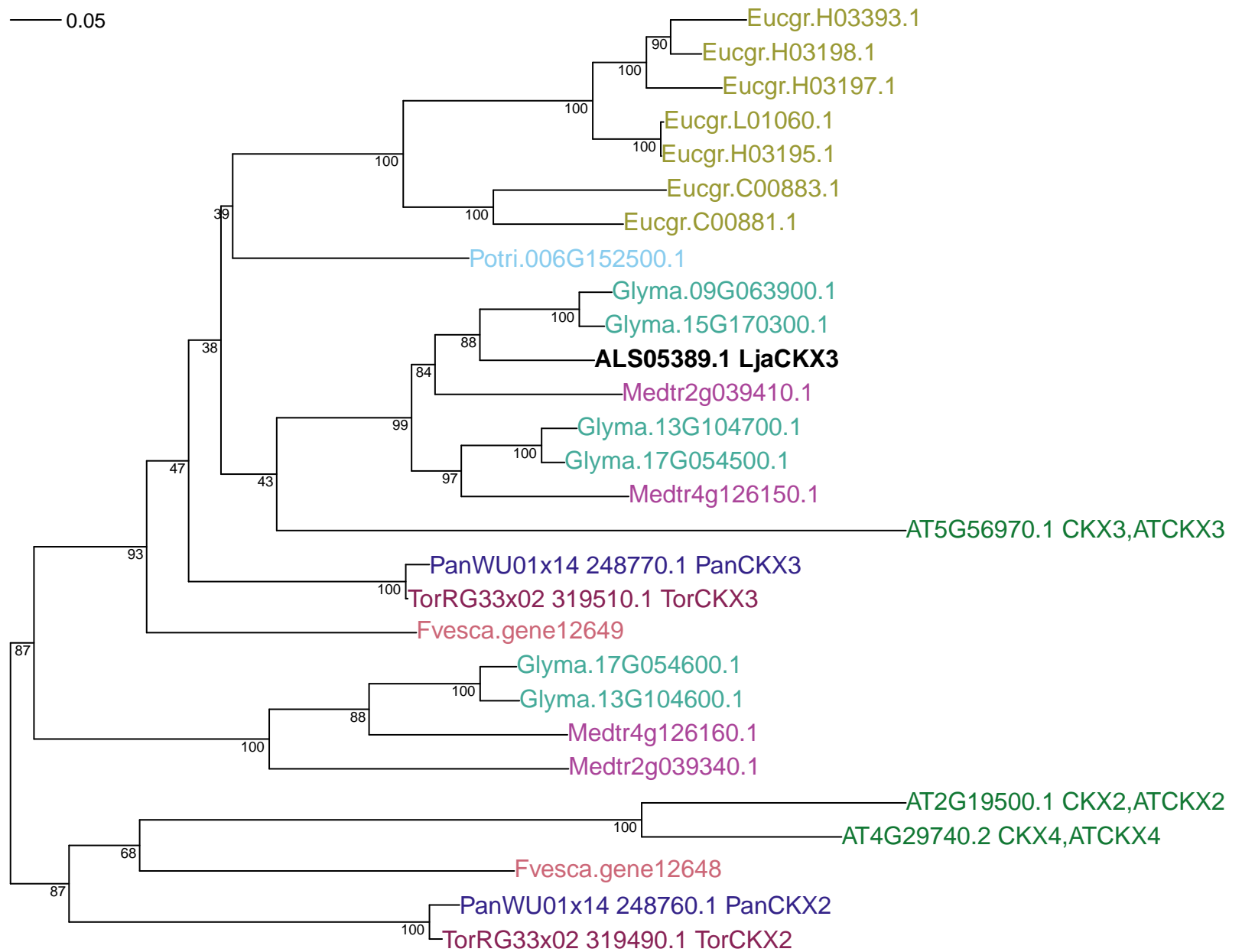


OG0009417: Hormones. cytokinin oxidase / dehydrogenase



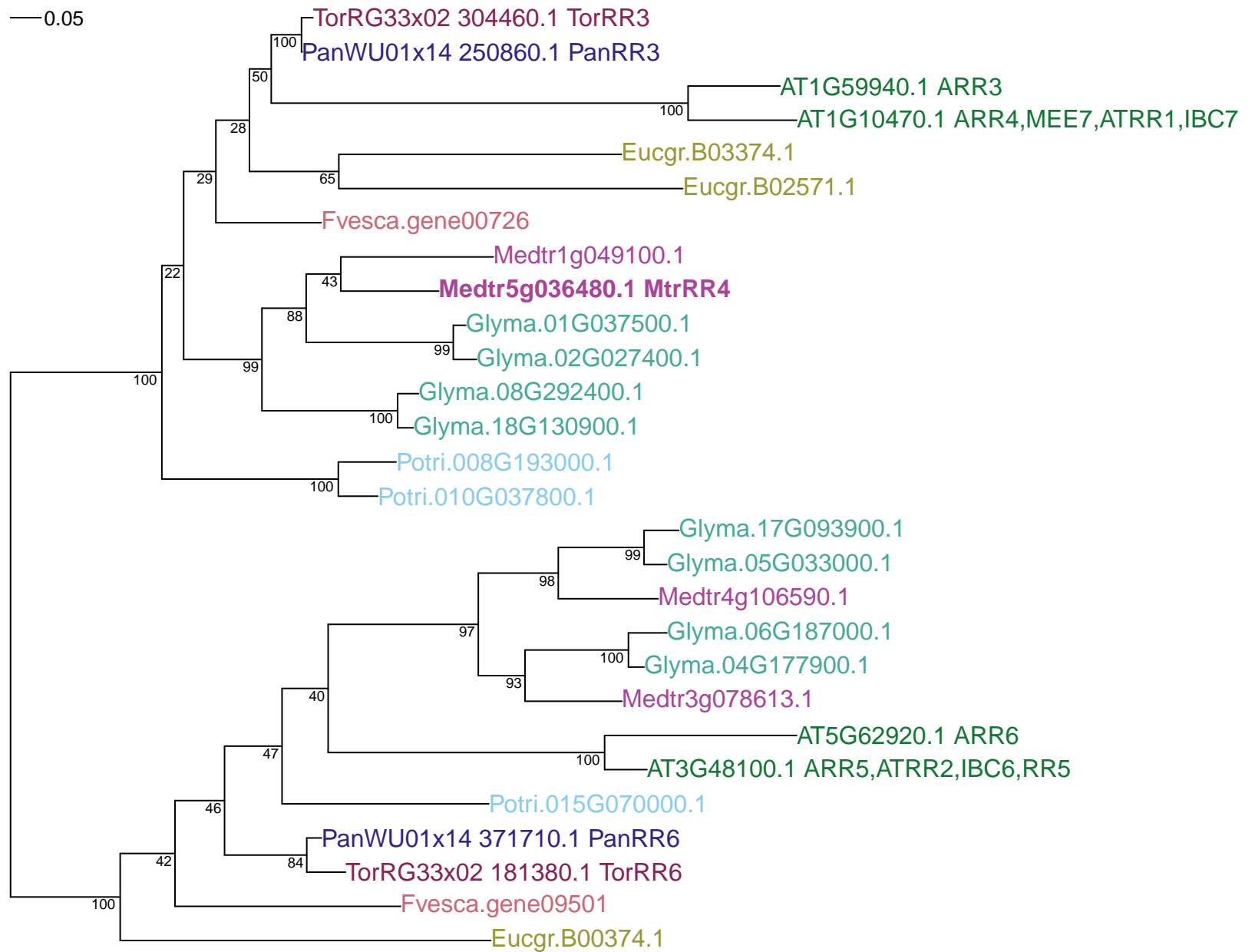
OG0001053: Hormones. cytokinin oxidase / dehydrogenase

— 0.05

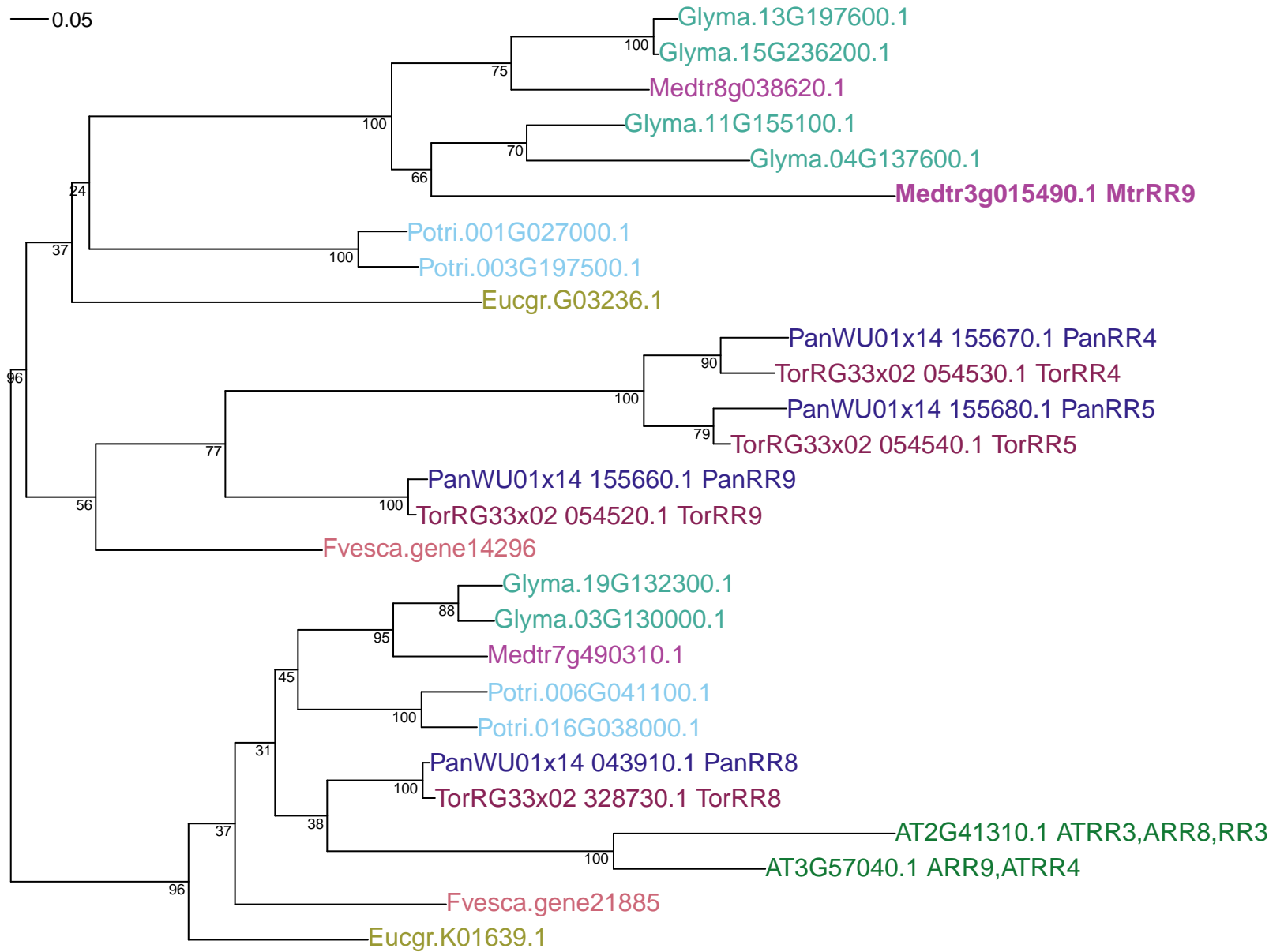


OG0000946: Hormones. Cytokinin type-A Response Regulator

—0.05

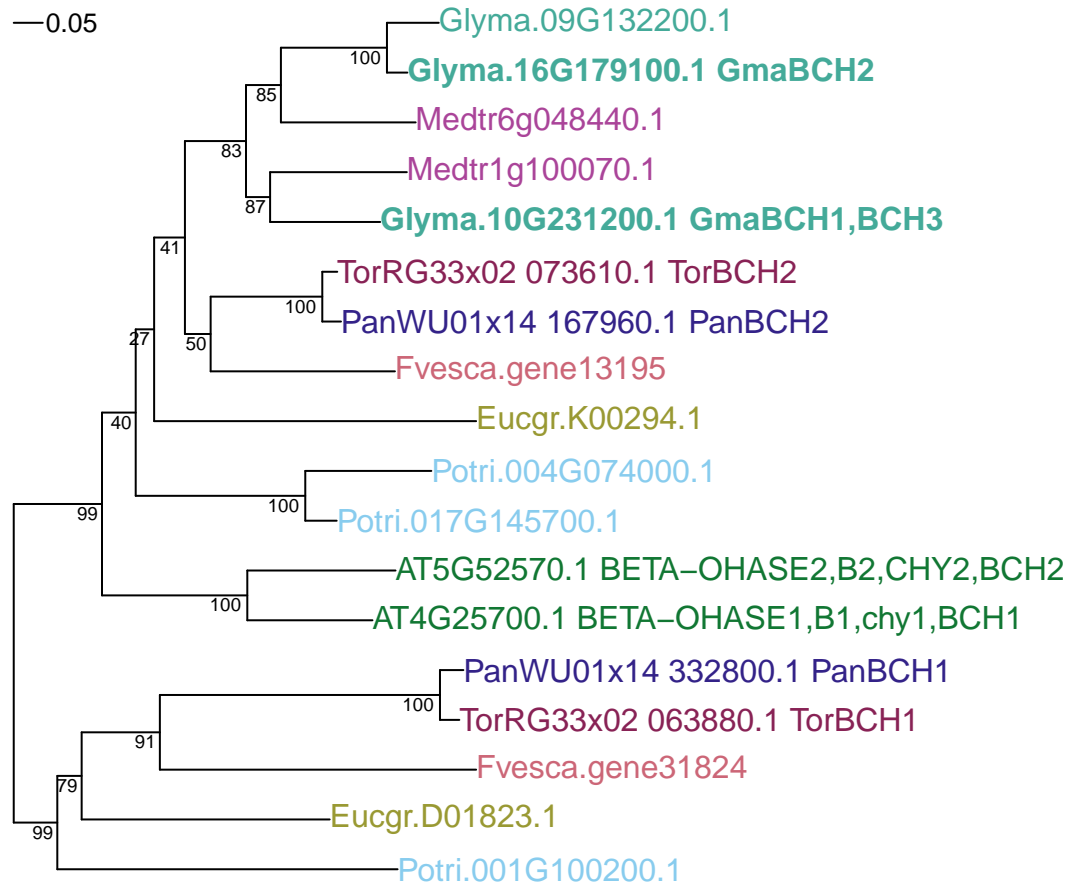


OG0001052: Hormones. Cytokinin type-A Response Regulator

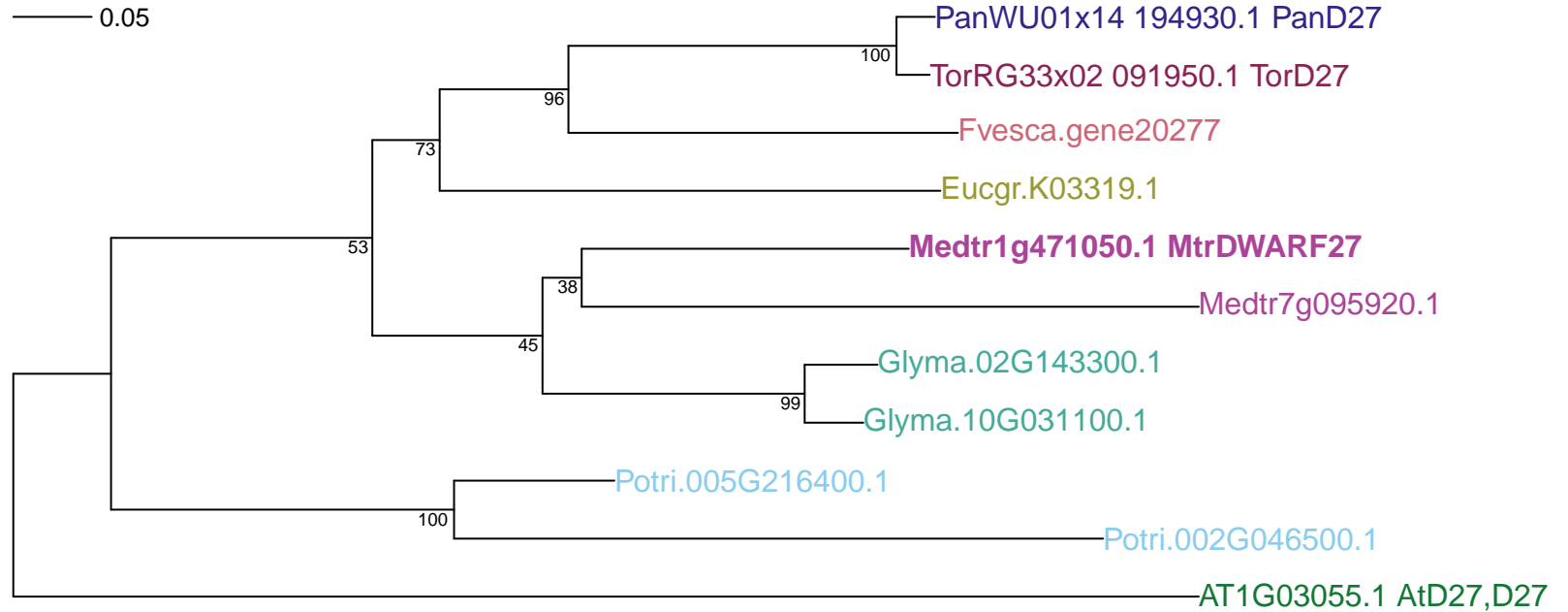


OG0002725: Hormones. Carotene Hydroxylase

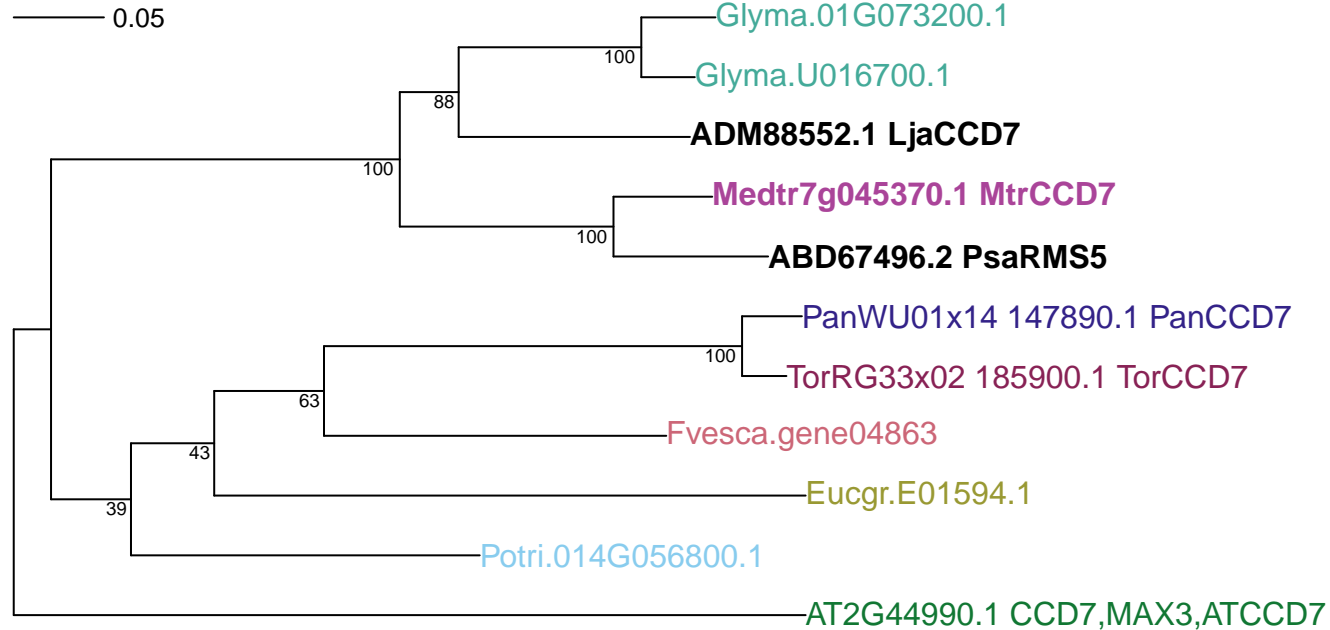
—0.05



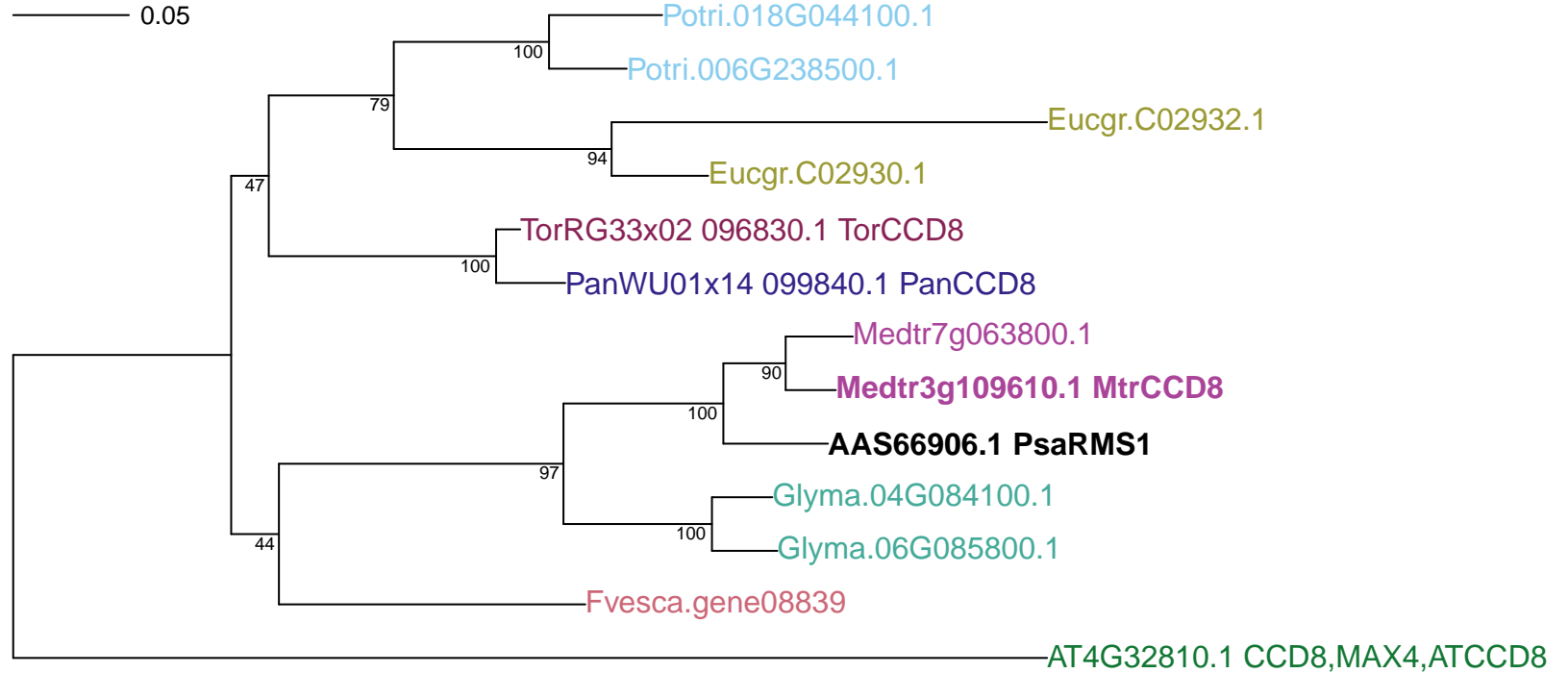
OG0006580: Hormones. carotene isomerase



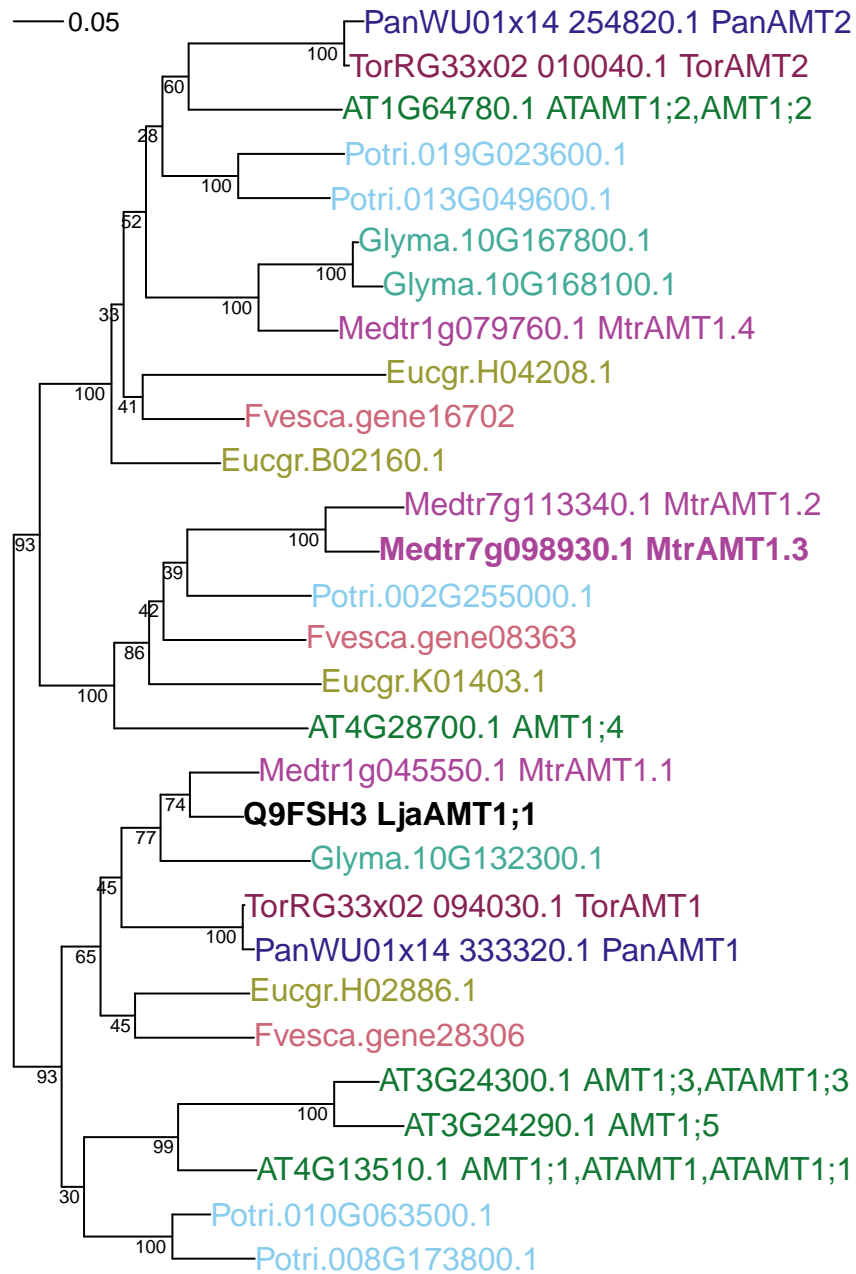
OG0010543: Hormones. carotenoid cleavage dioxygenase



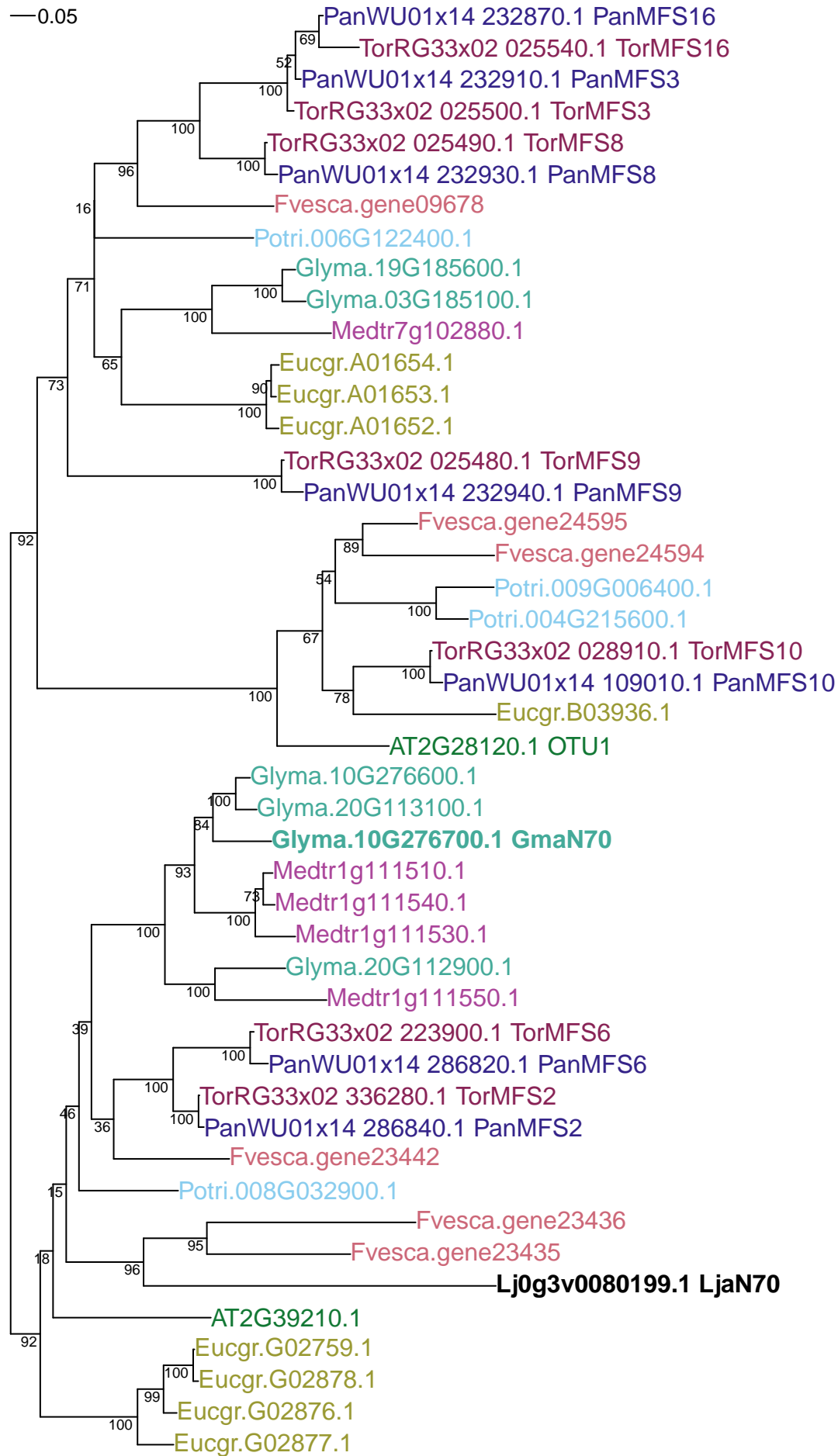
OG0006118: Hormones. carotenoid cleavage dioxygenase



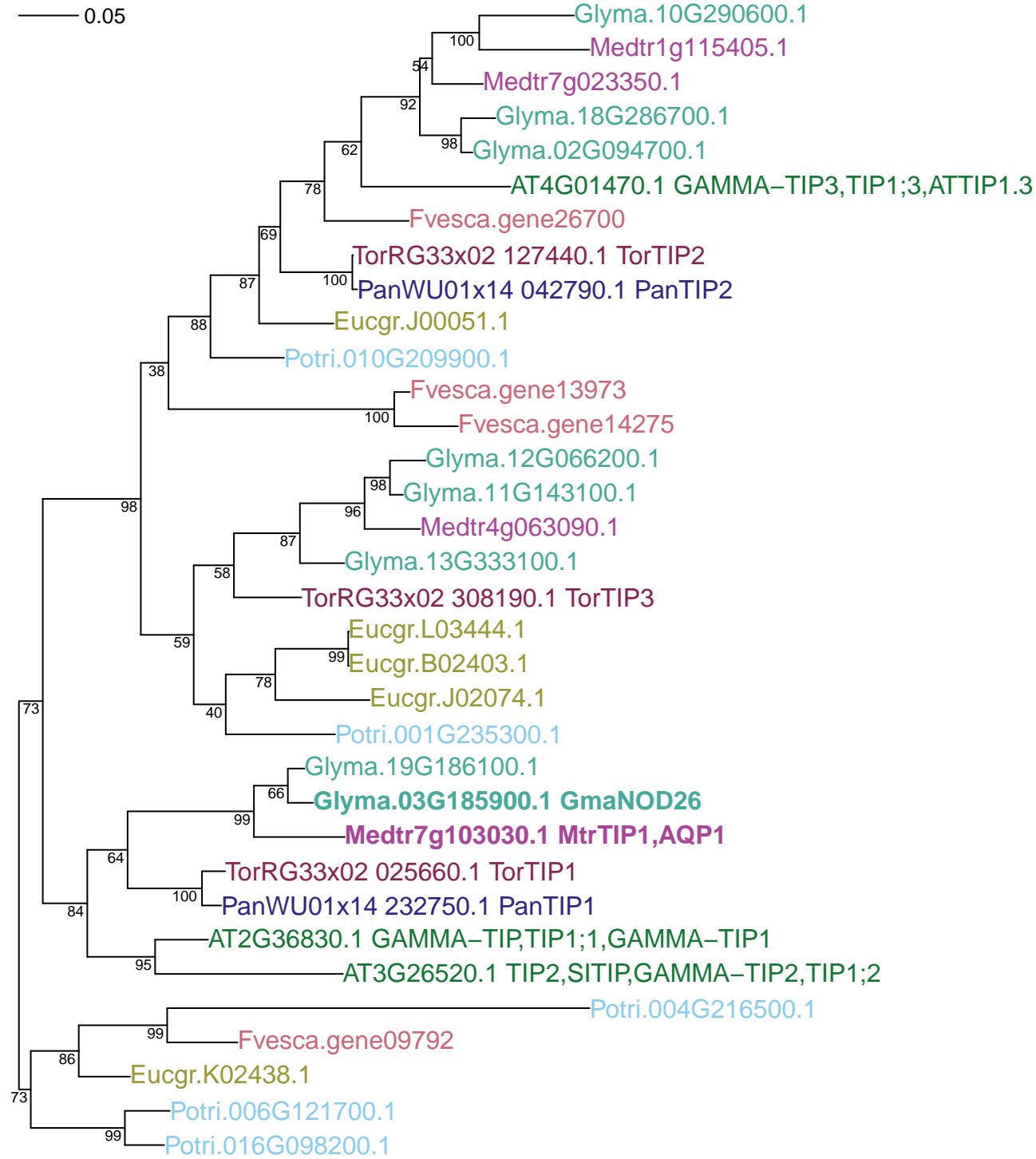
OG0000957: Transporters. ammonium transporter



OG0000407: Transporters. anion transporter

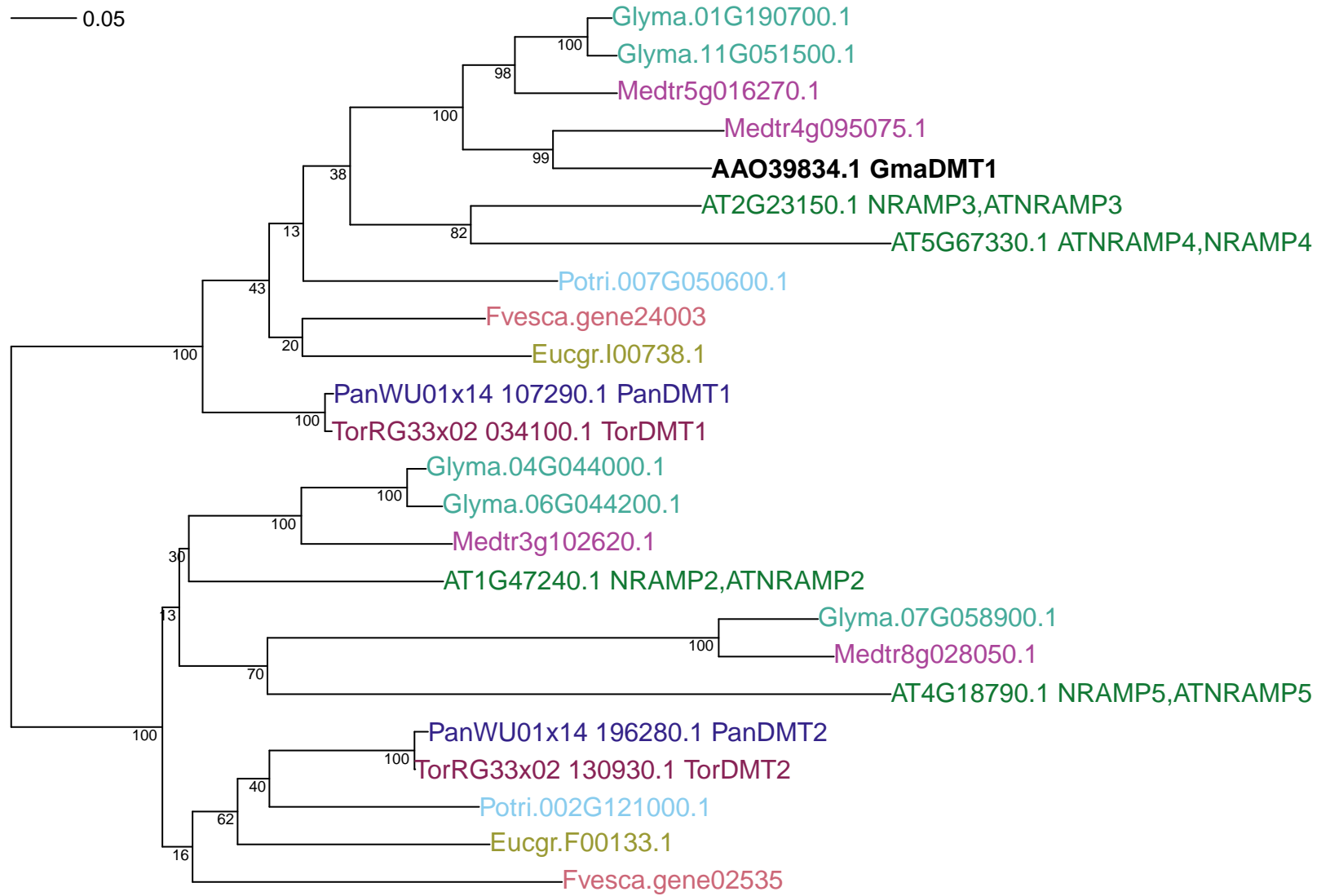


OG0000659: Transporters. Aquaporin

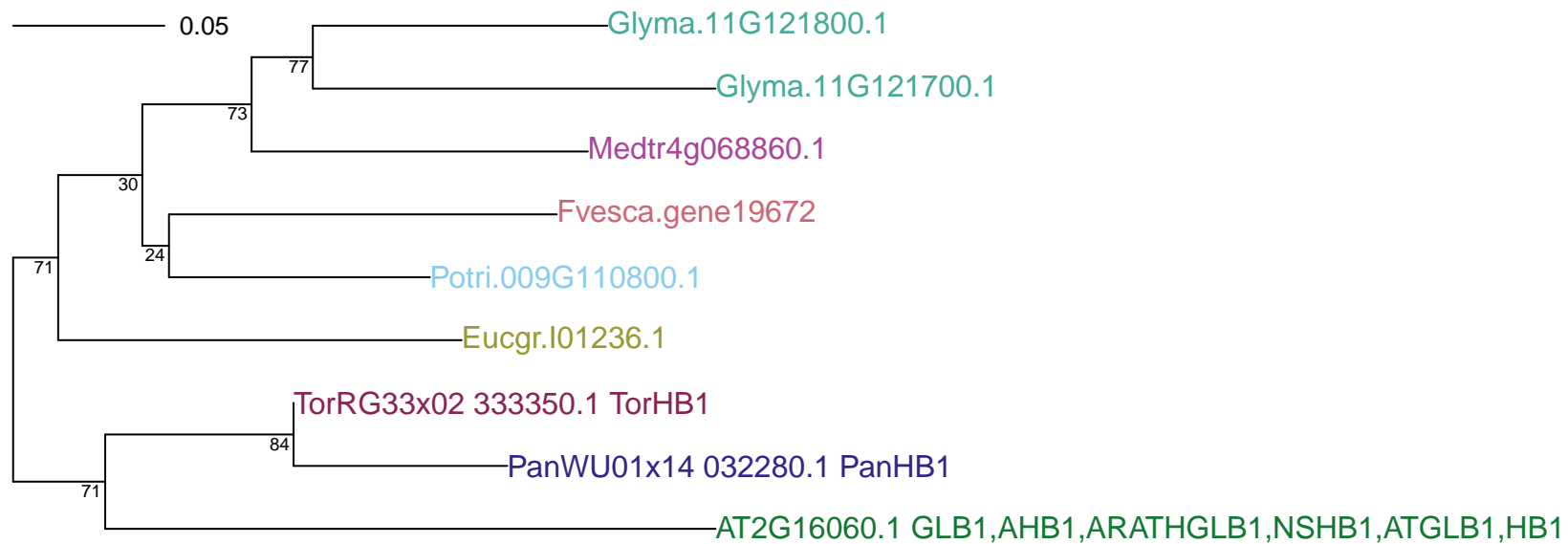


OG0001473: Transporters. divalent metal transporter

— 0.05

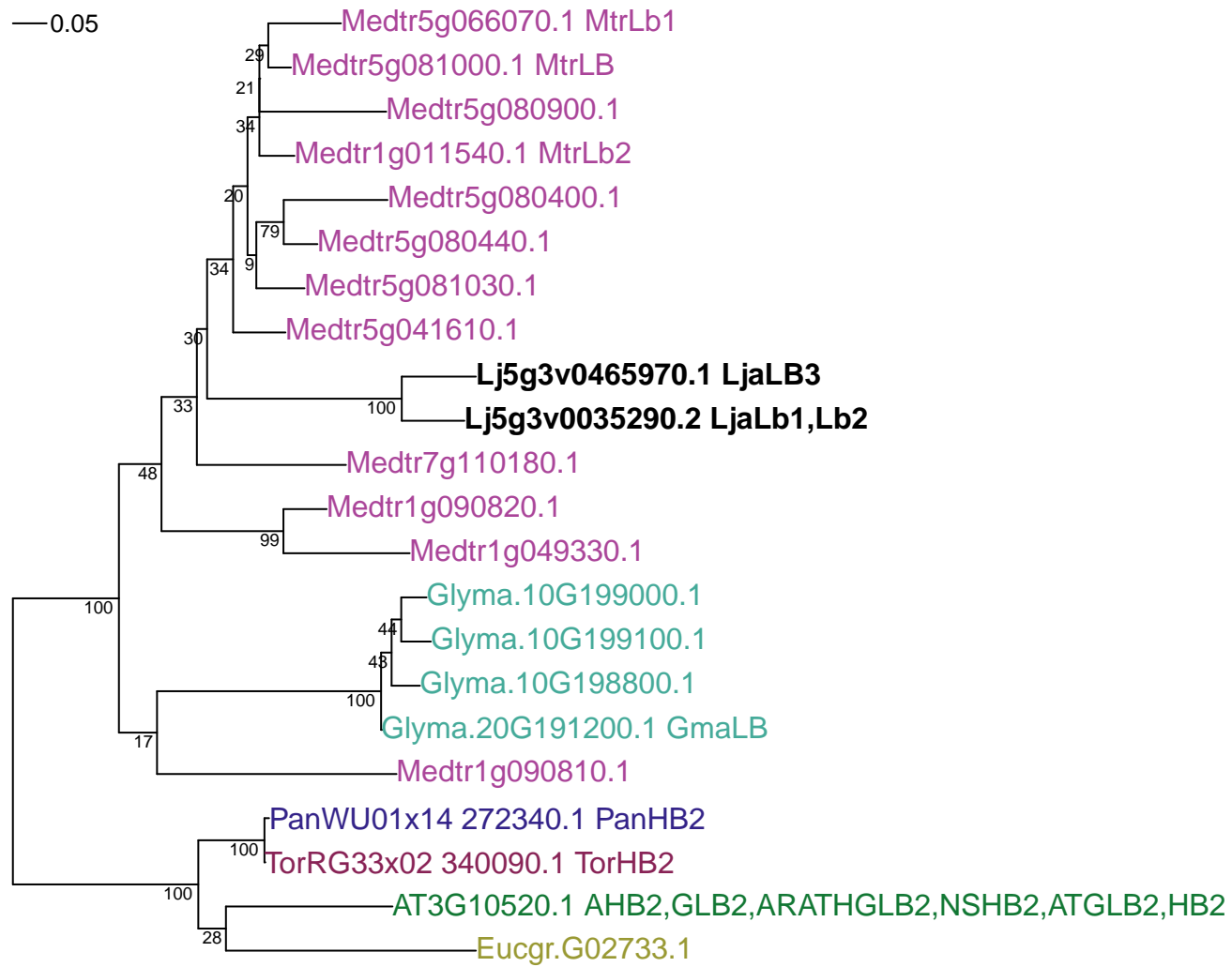


OG0010523: Transporters. class 1 hemoglobin

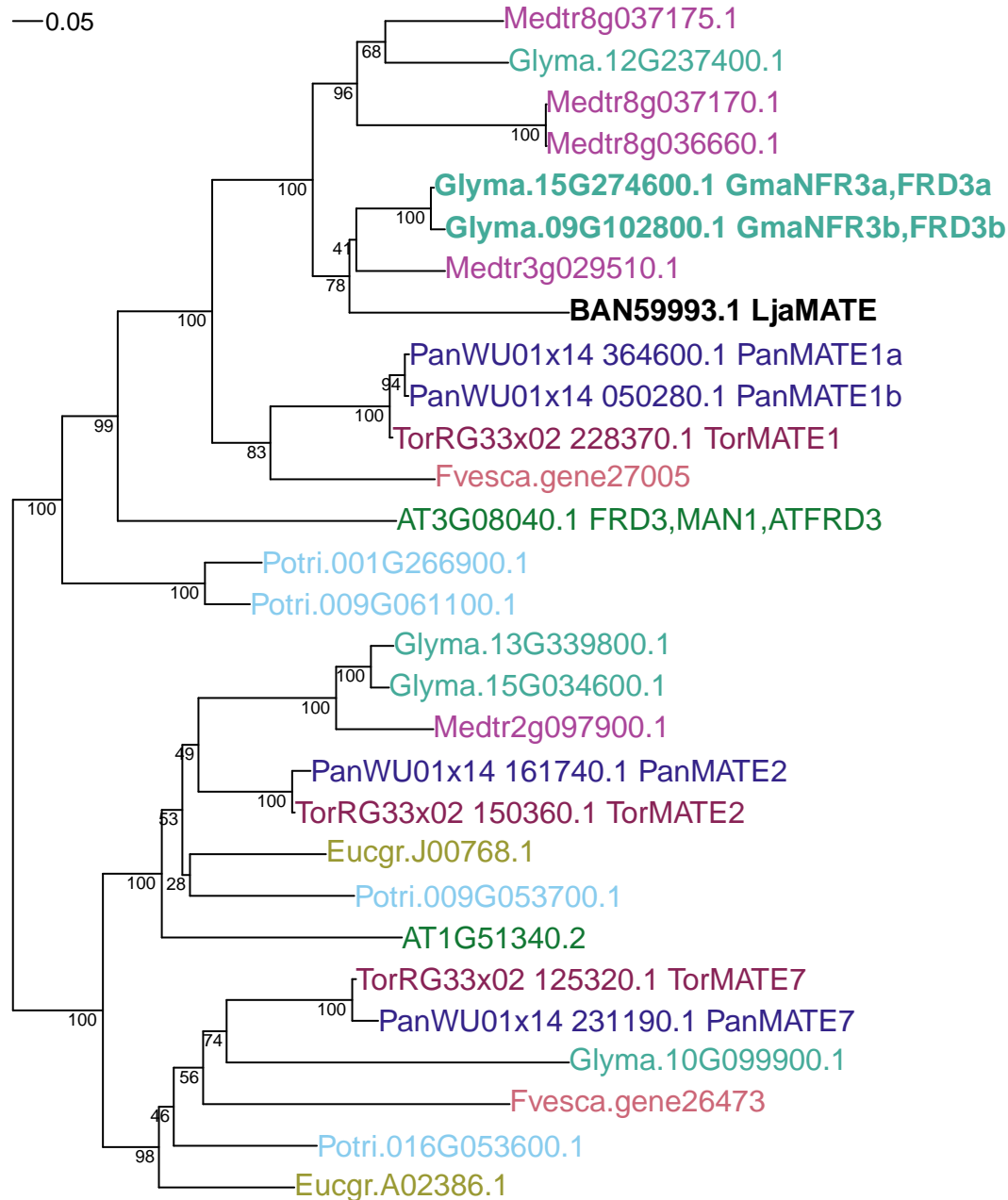


OG0002188: Transporters. class 2 hemoglobin

—0.05

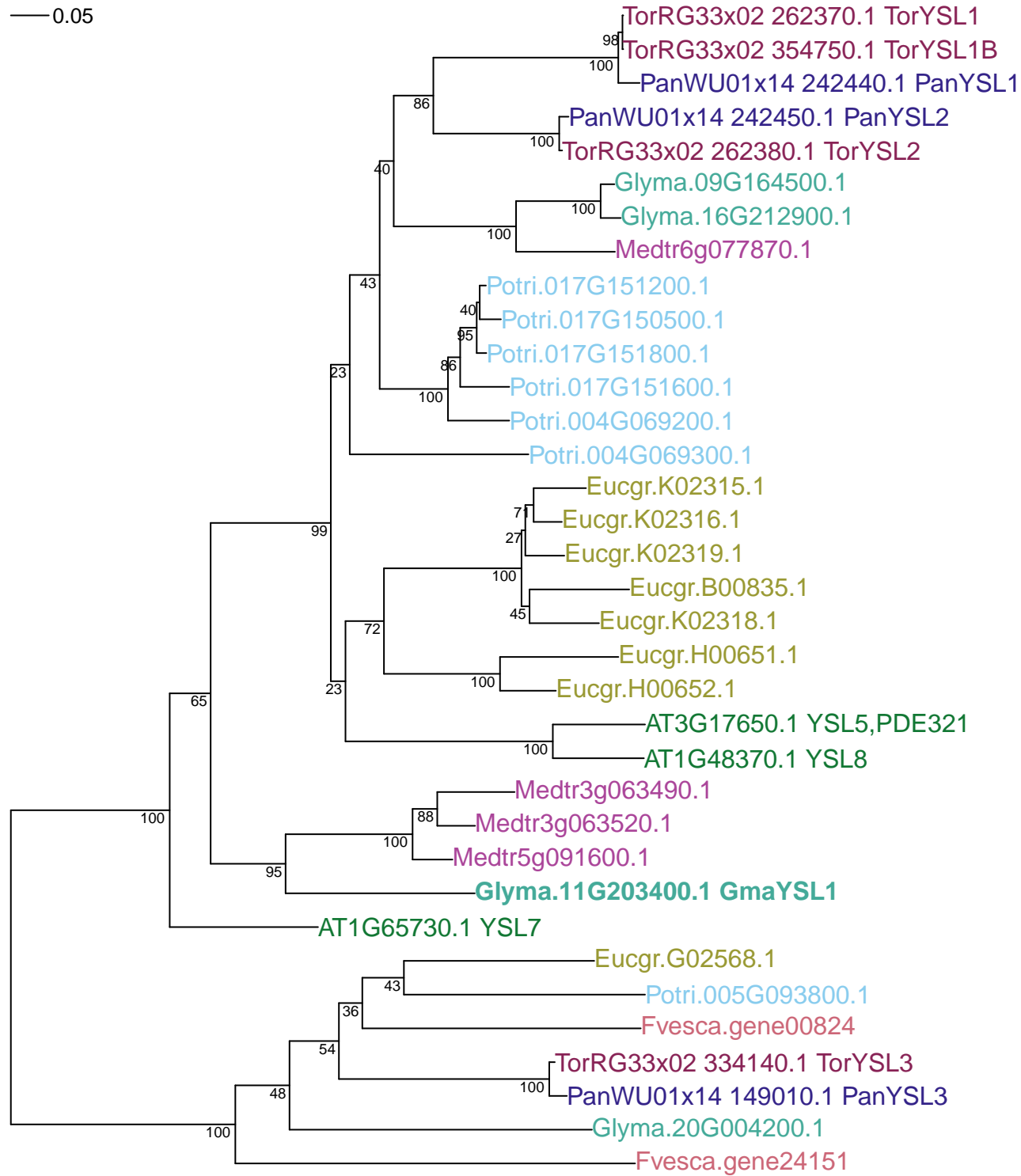


OG0000938: Transporters. multidrug and toxic compound extrusion protein

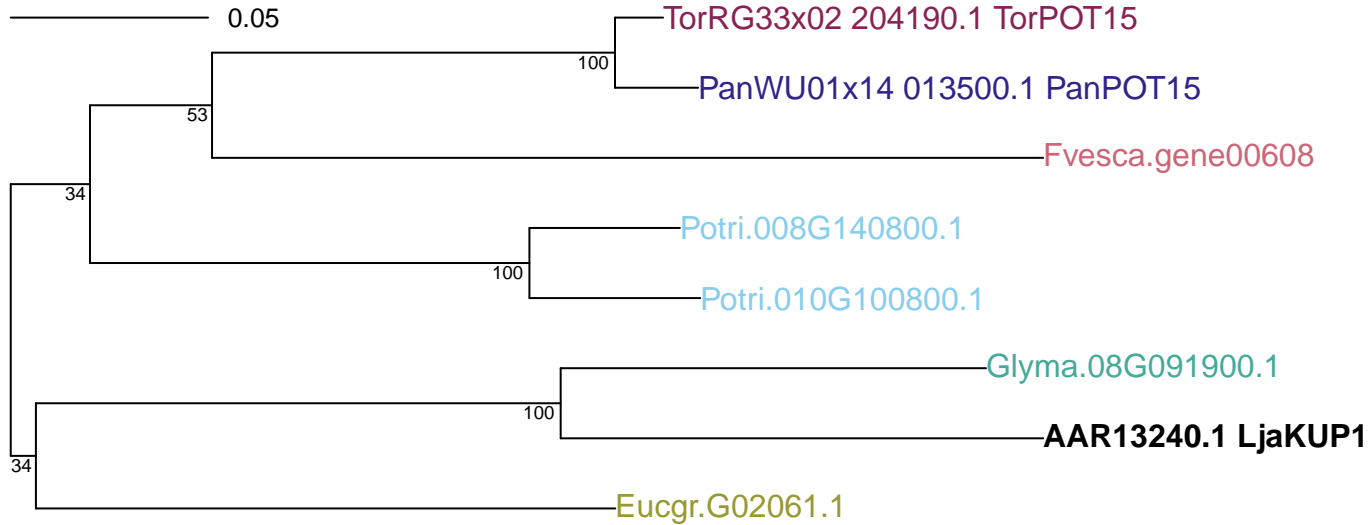


OG0000599: Transporters. Oligopeptide transporter

— 0.05

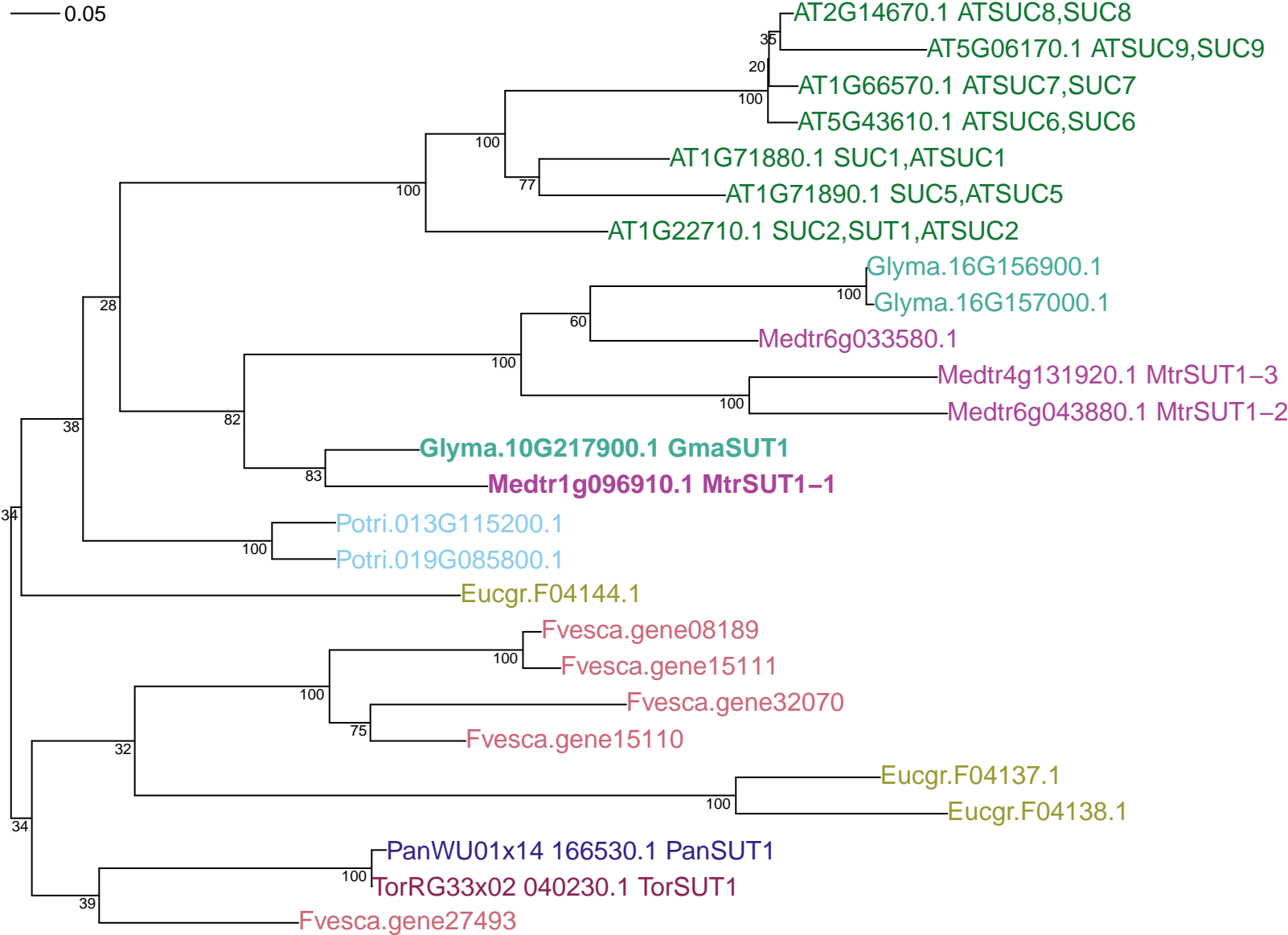


OG0014077: Transporters. potassium transporter

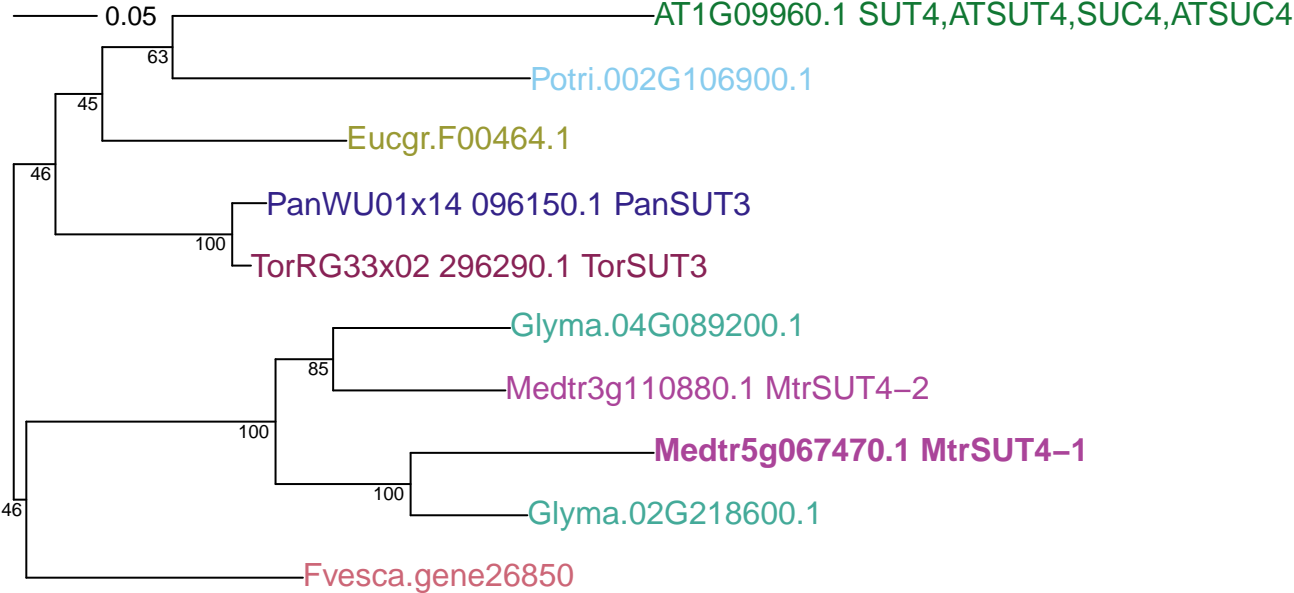


OG0001109: Transporters. sucrose transporter

— 0.05

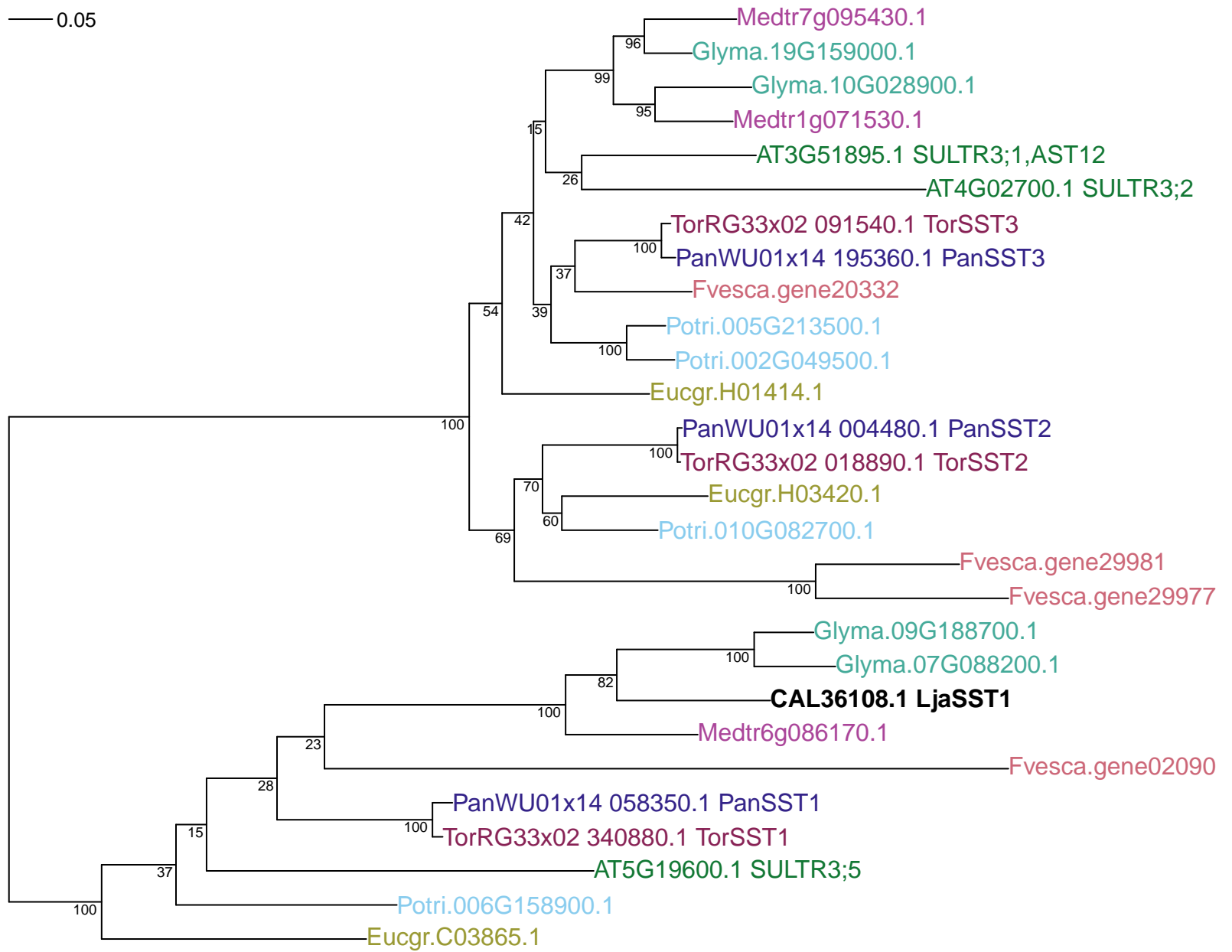


OG0008004: Transporters. sucrose transporter

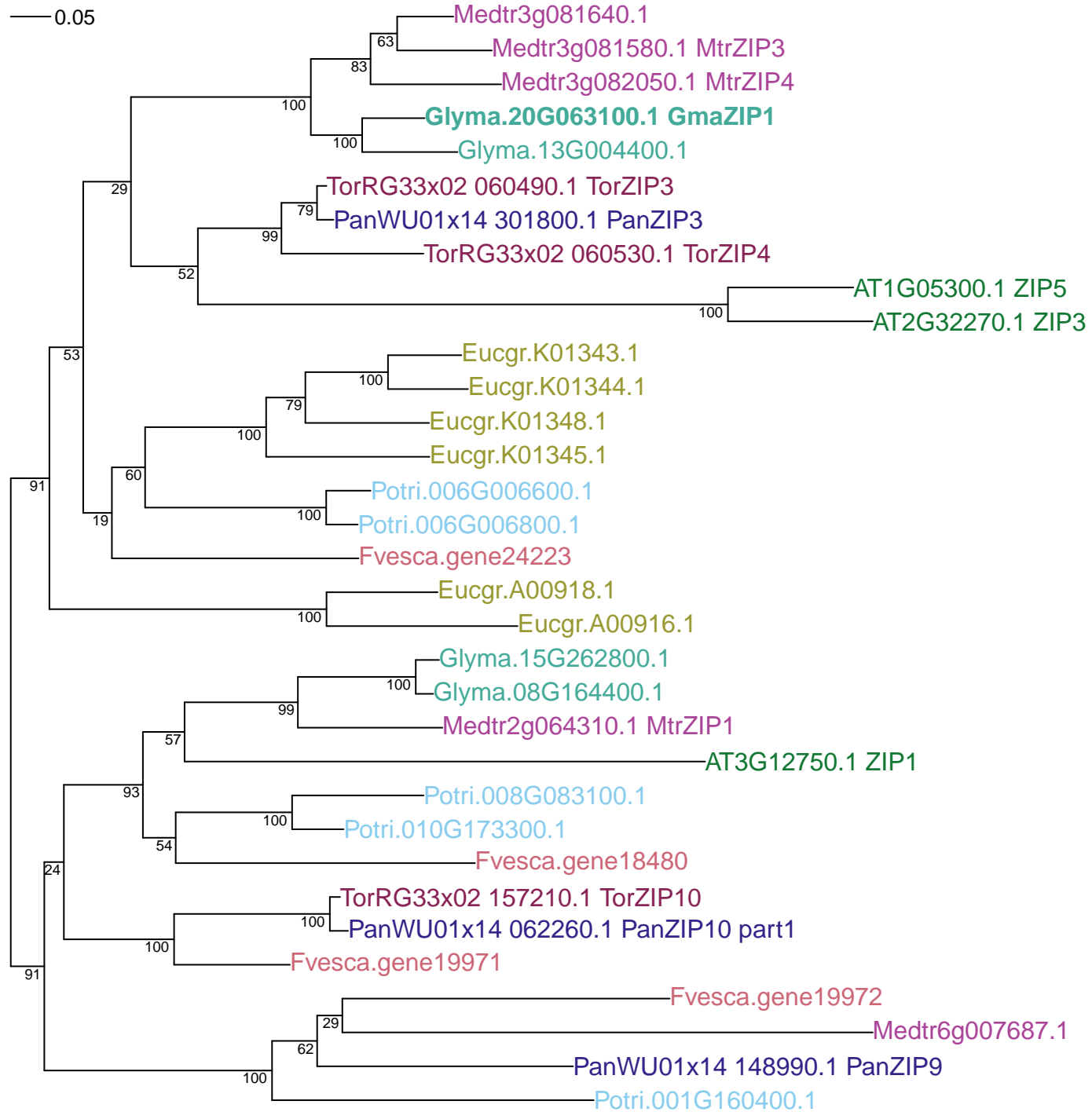


OG0001069: Transporters. sulfate transporter

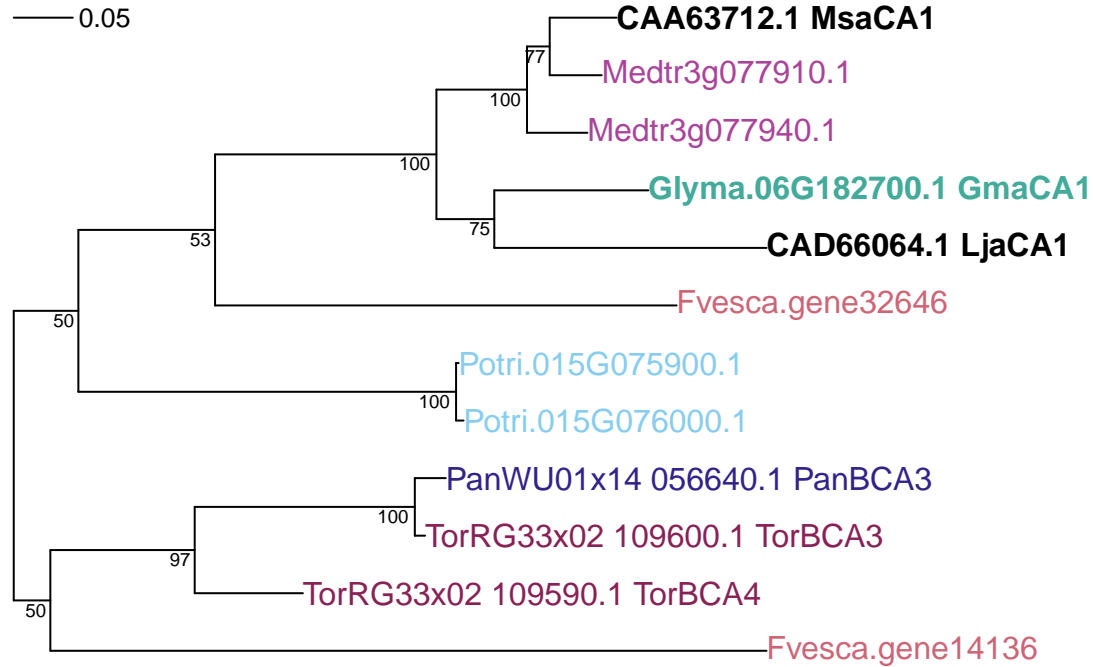
— 0.05



OG0000681: Transporters. Zinc transporter

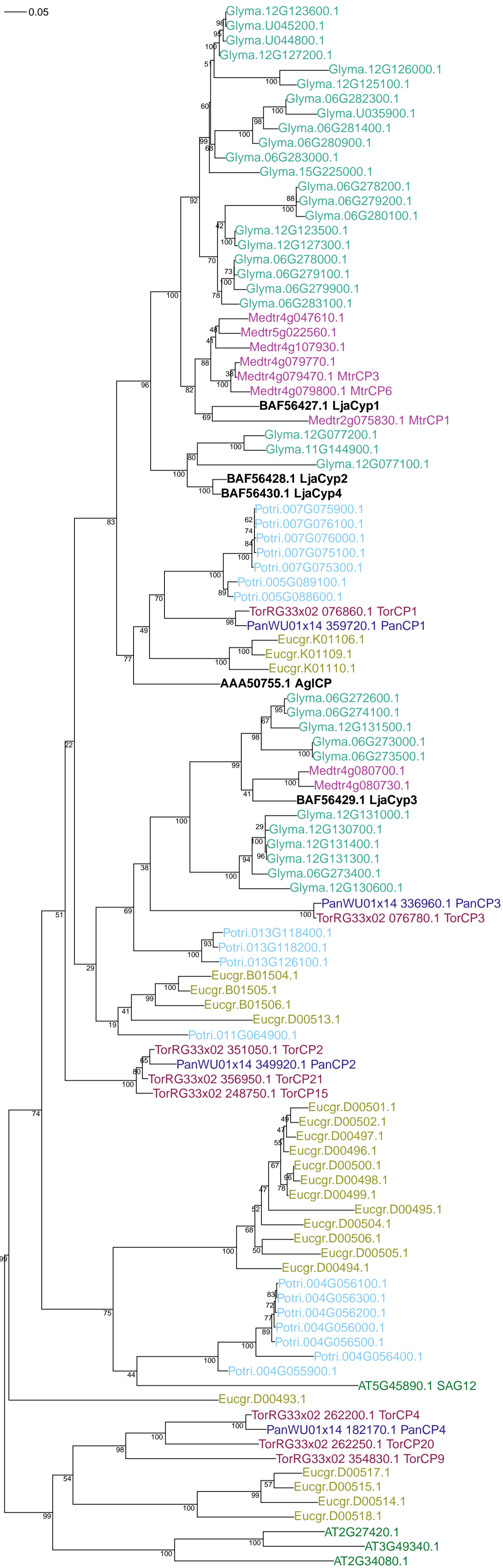


OG0009828: Enzymes. carbonic anhydrase

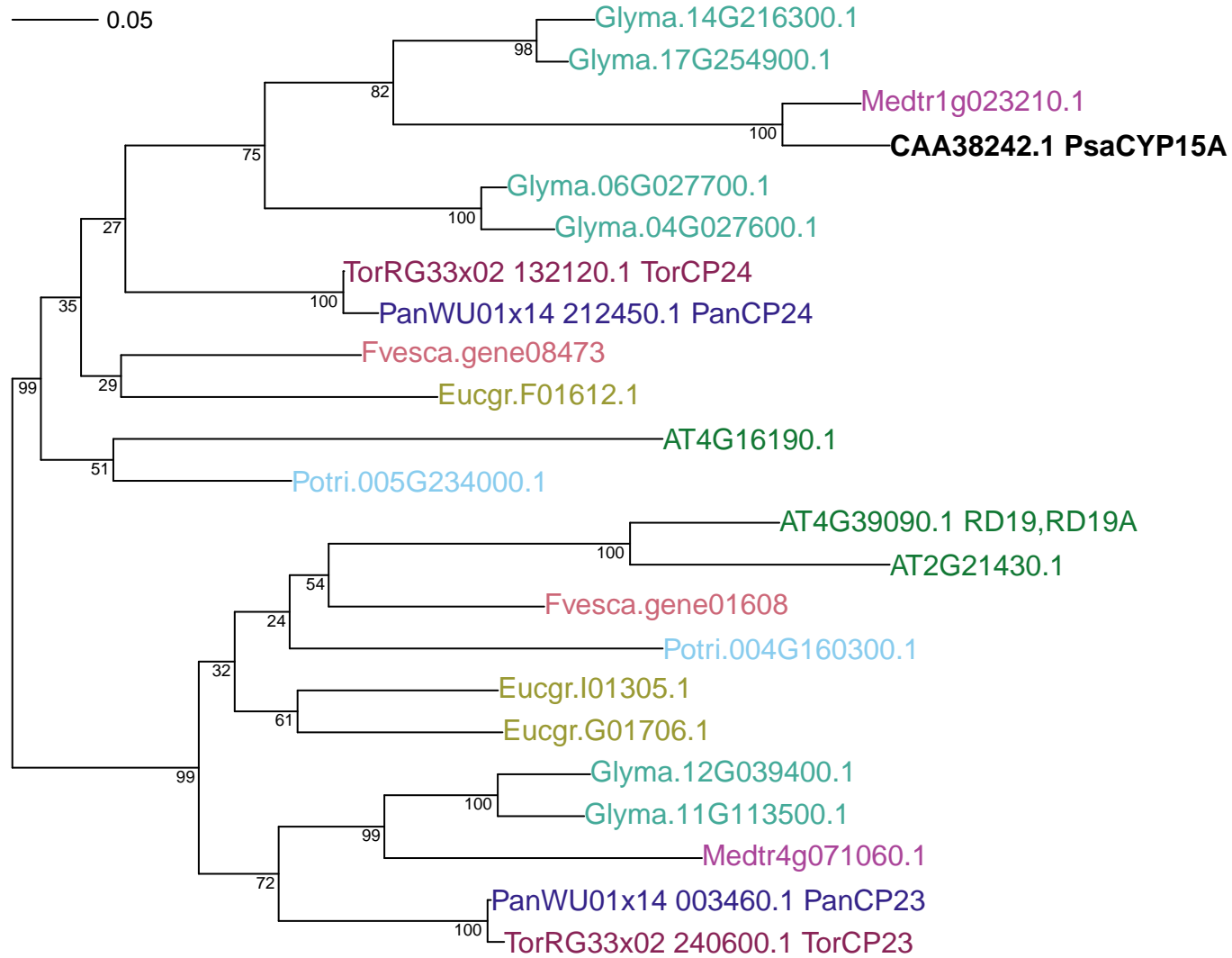


OG0000092: Enzymes. cysteine protease

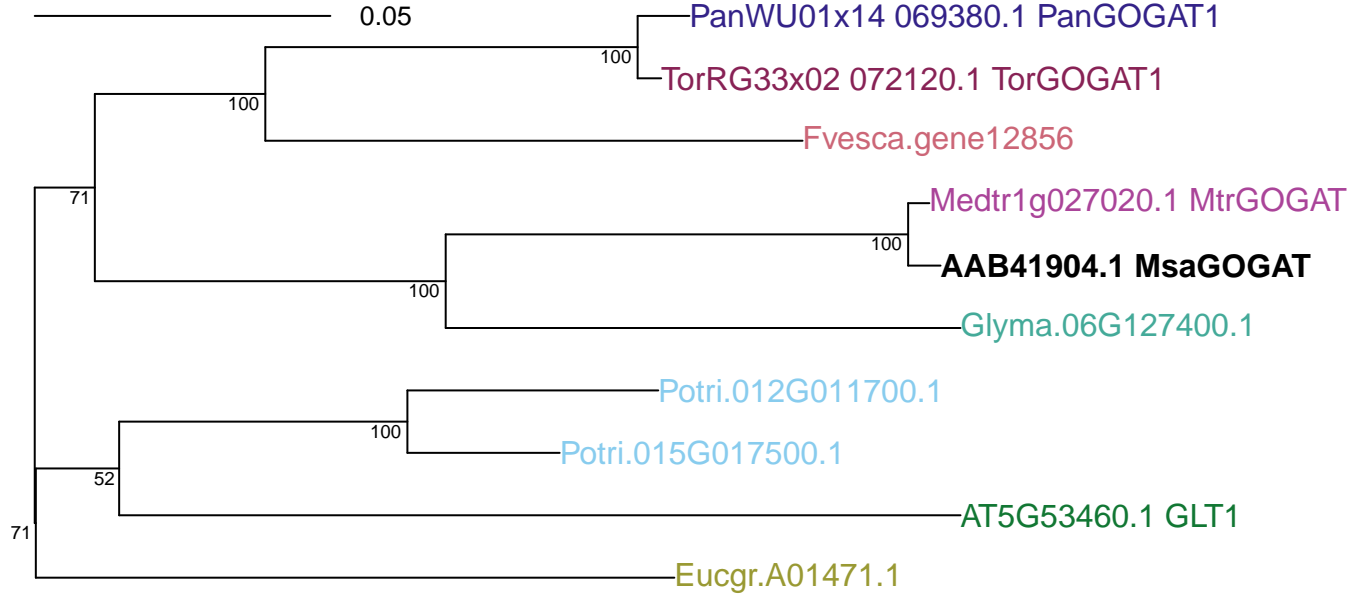
— 0.05



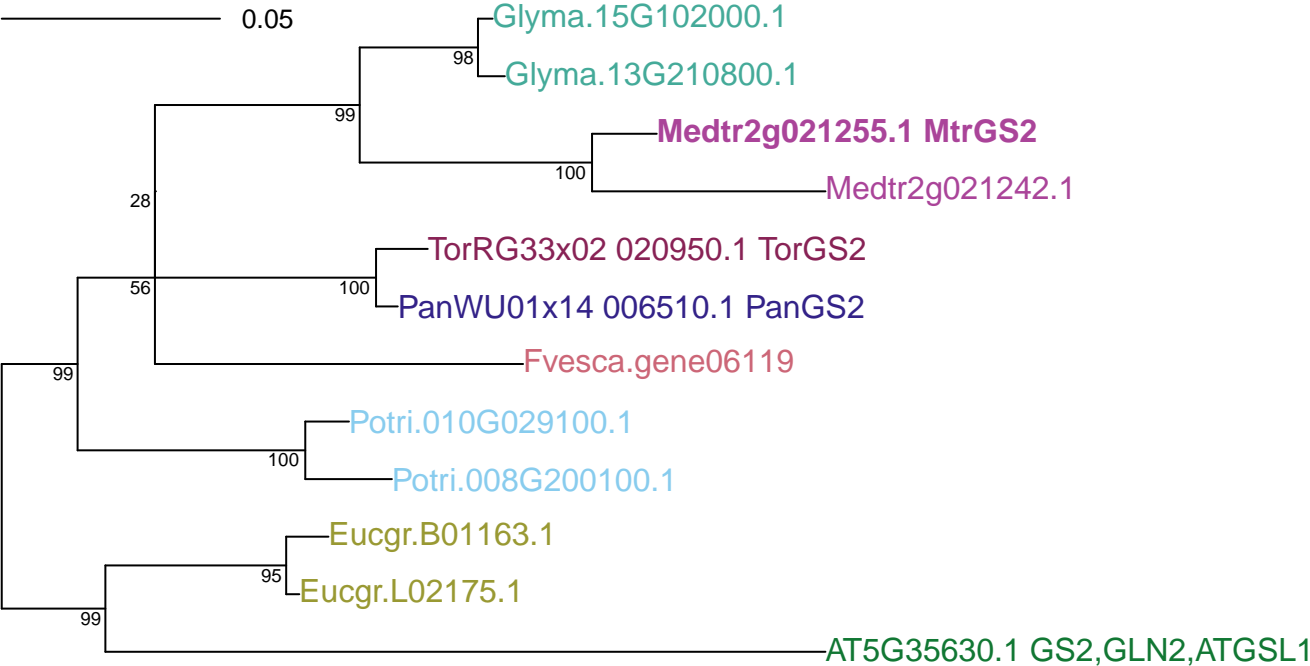
OG0001704: Enzymes. cysteine protease



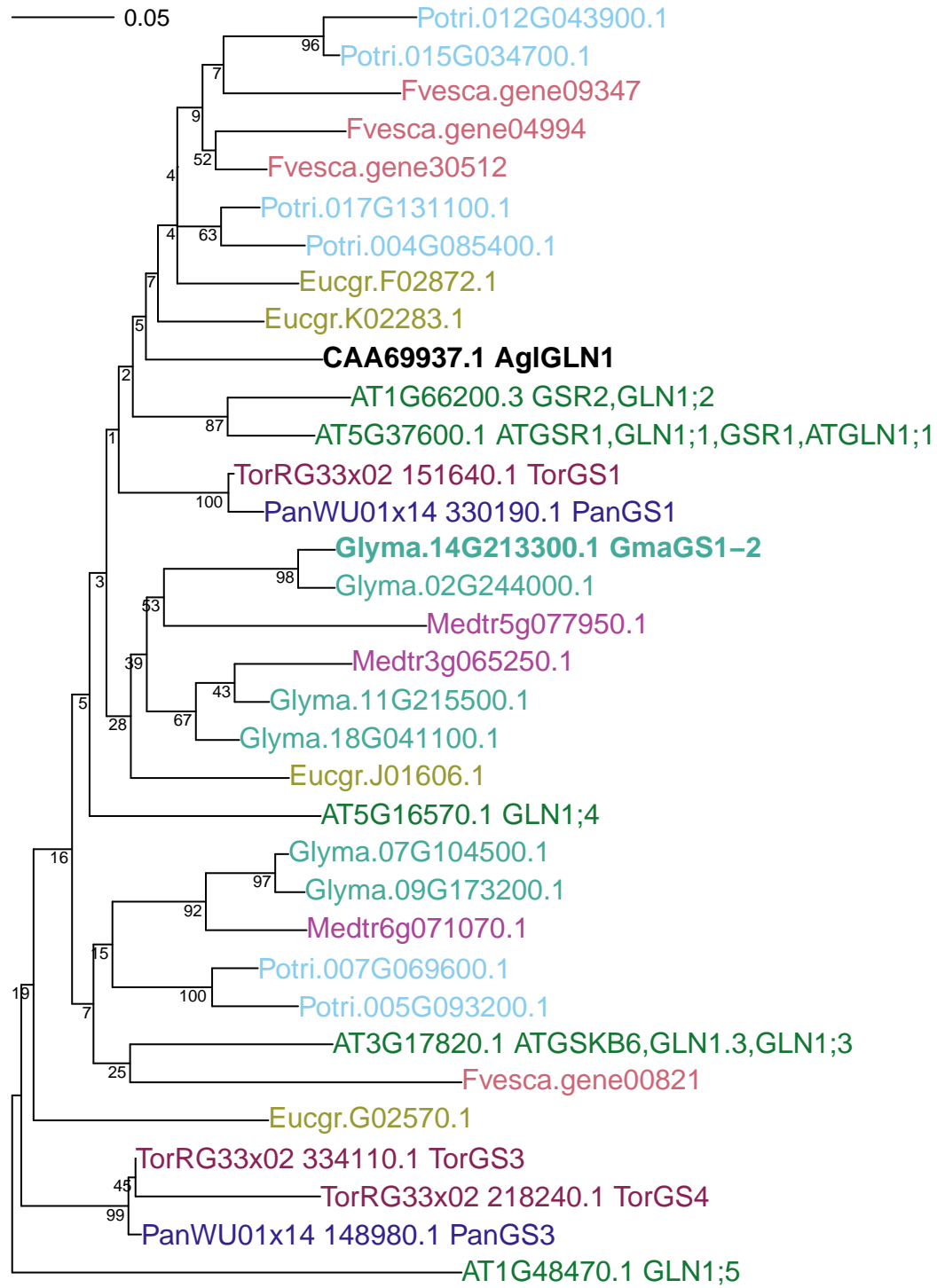
OG0011624: Enzymes. glutamate synthase



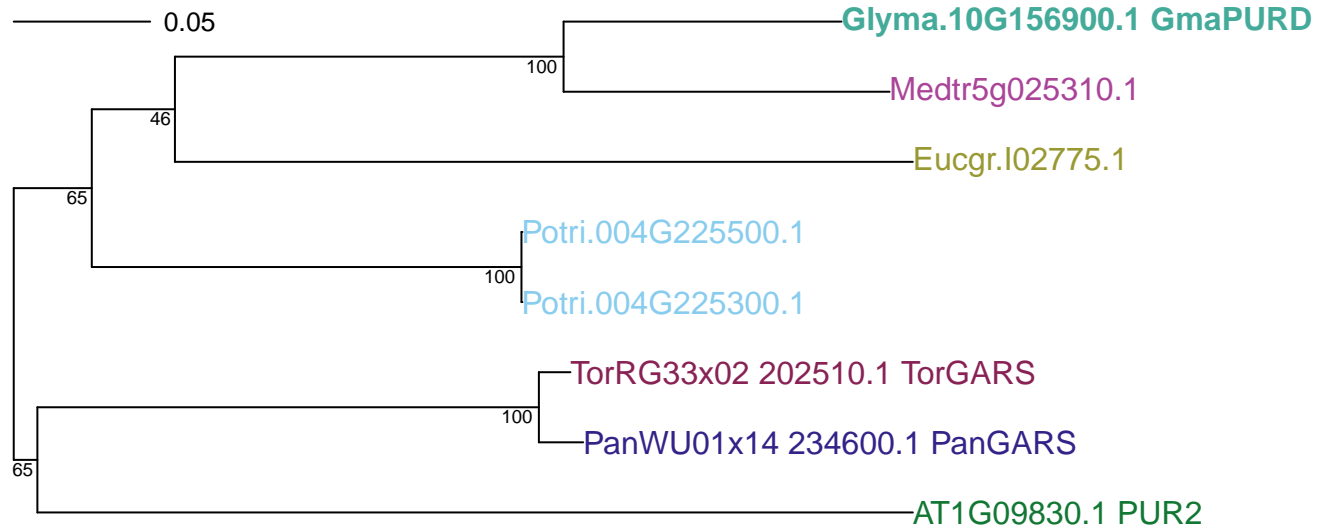
OG0006224: Enzymes. glutamine synthetase



OG0000690: Enzymes. glutamine synthetase

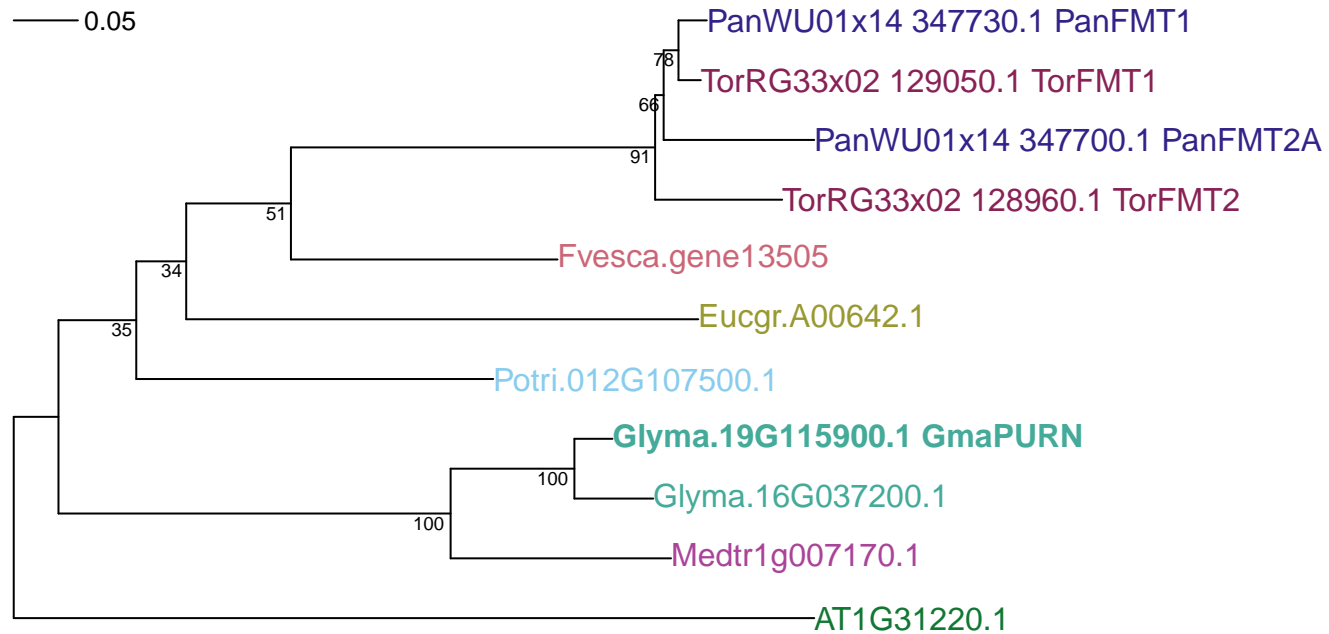


OG0012294: Enzymes. glycinamide ribonucleotide synthetase

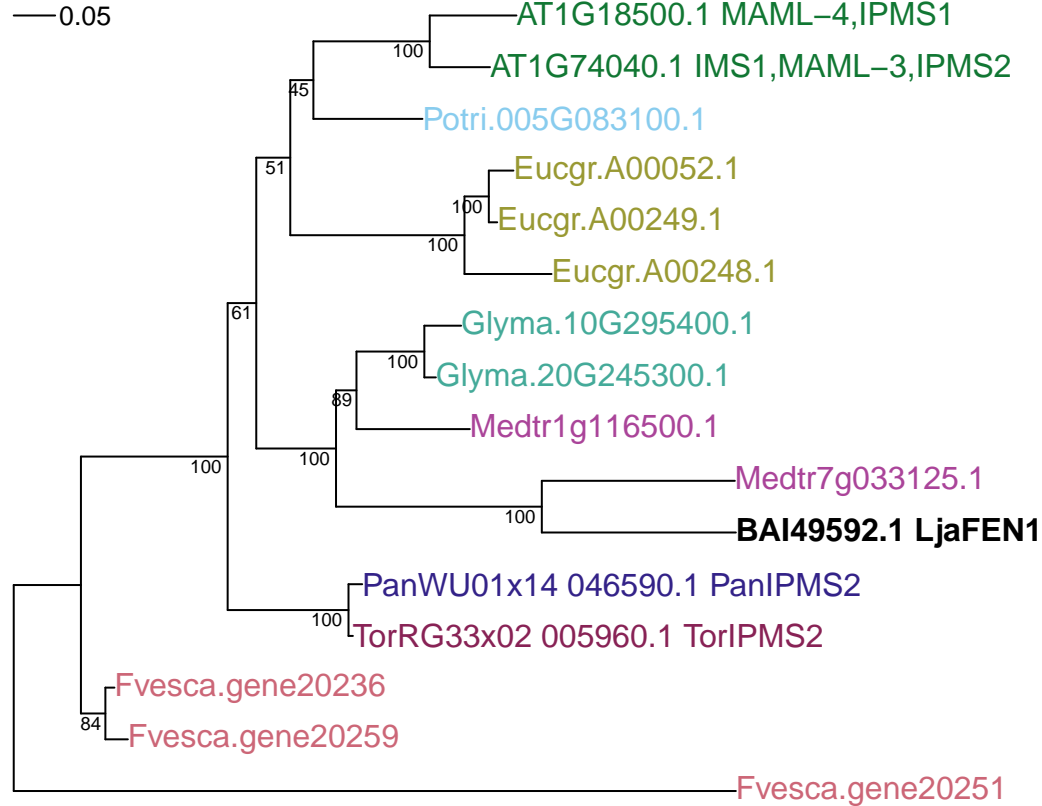


OG0005486: Enzymes. glycinamide ribonucleotide transformylase

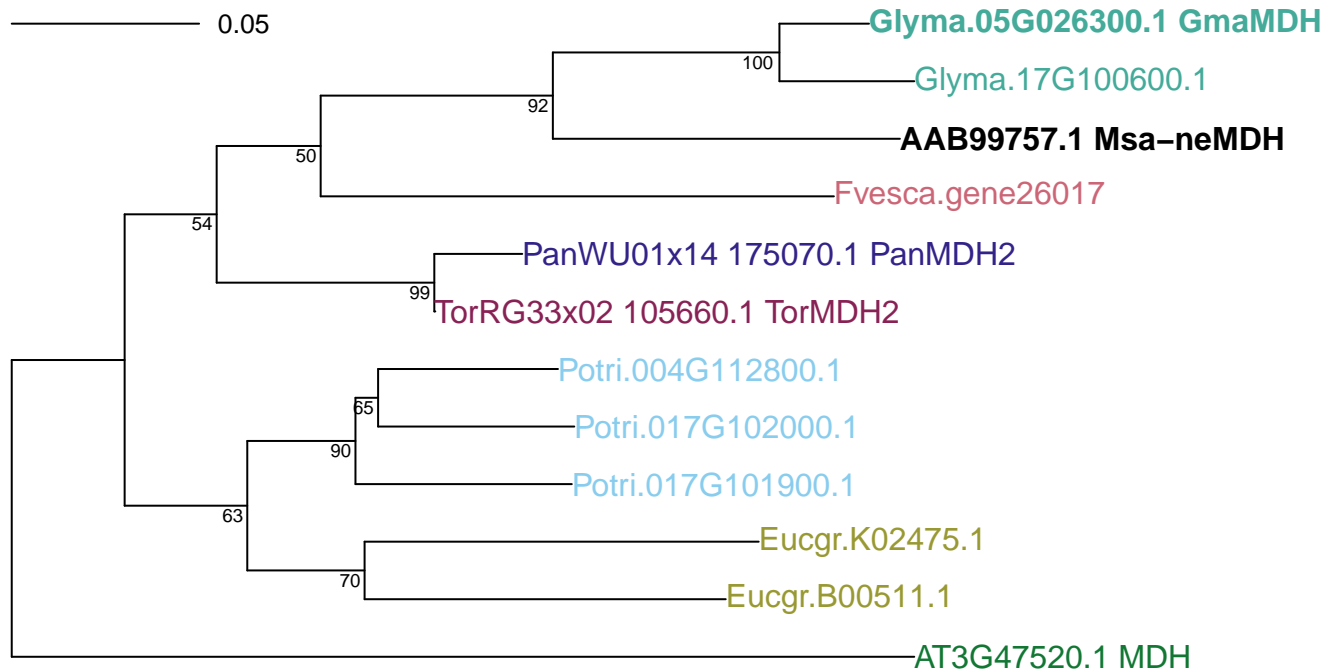
— 0.05



OG0003526: Enzymes. homocitrate synthase

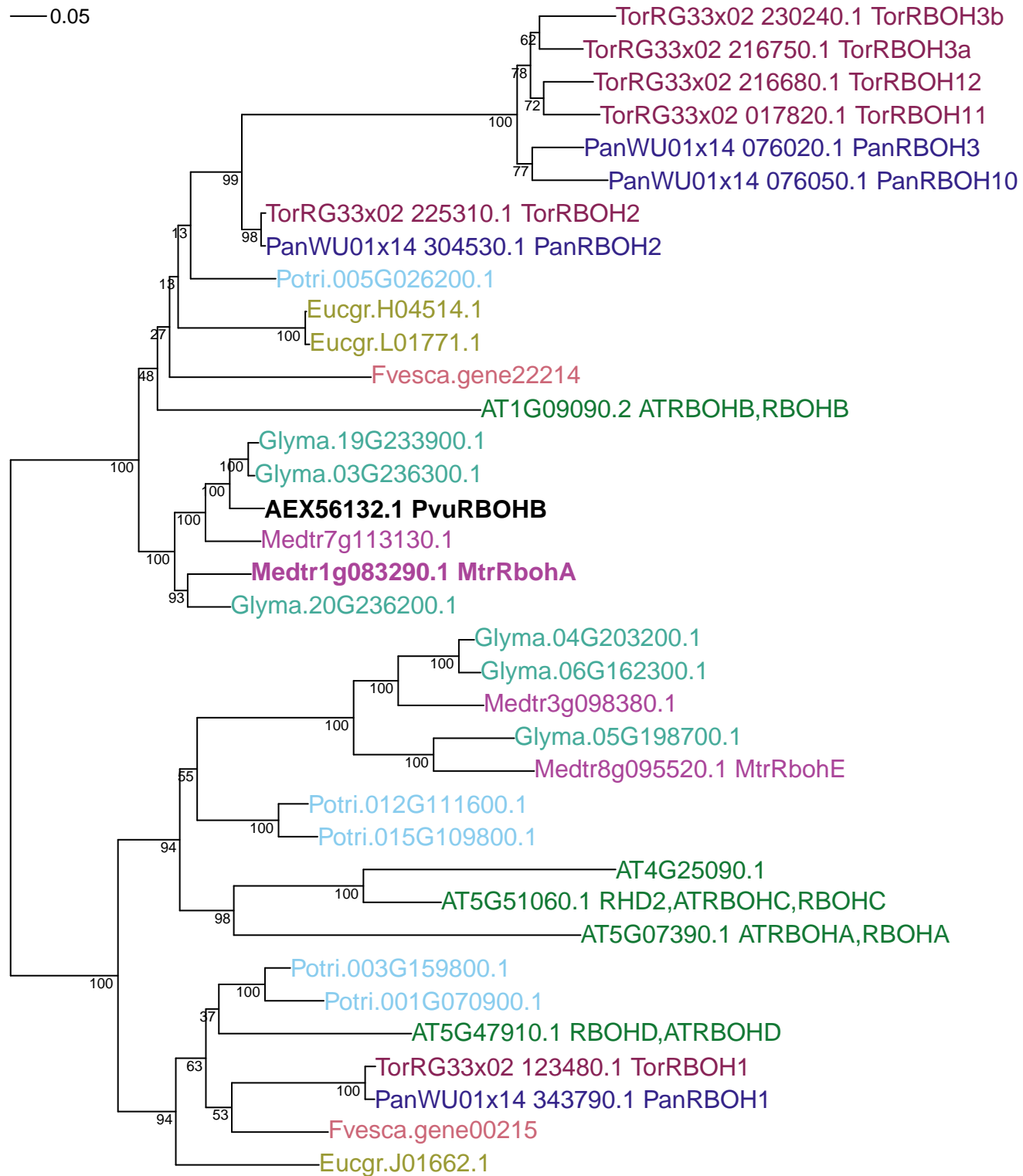


OG0007185: Enzymes. NADH-malate dehydrogenase

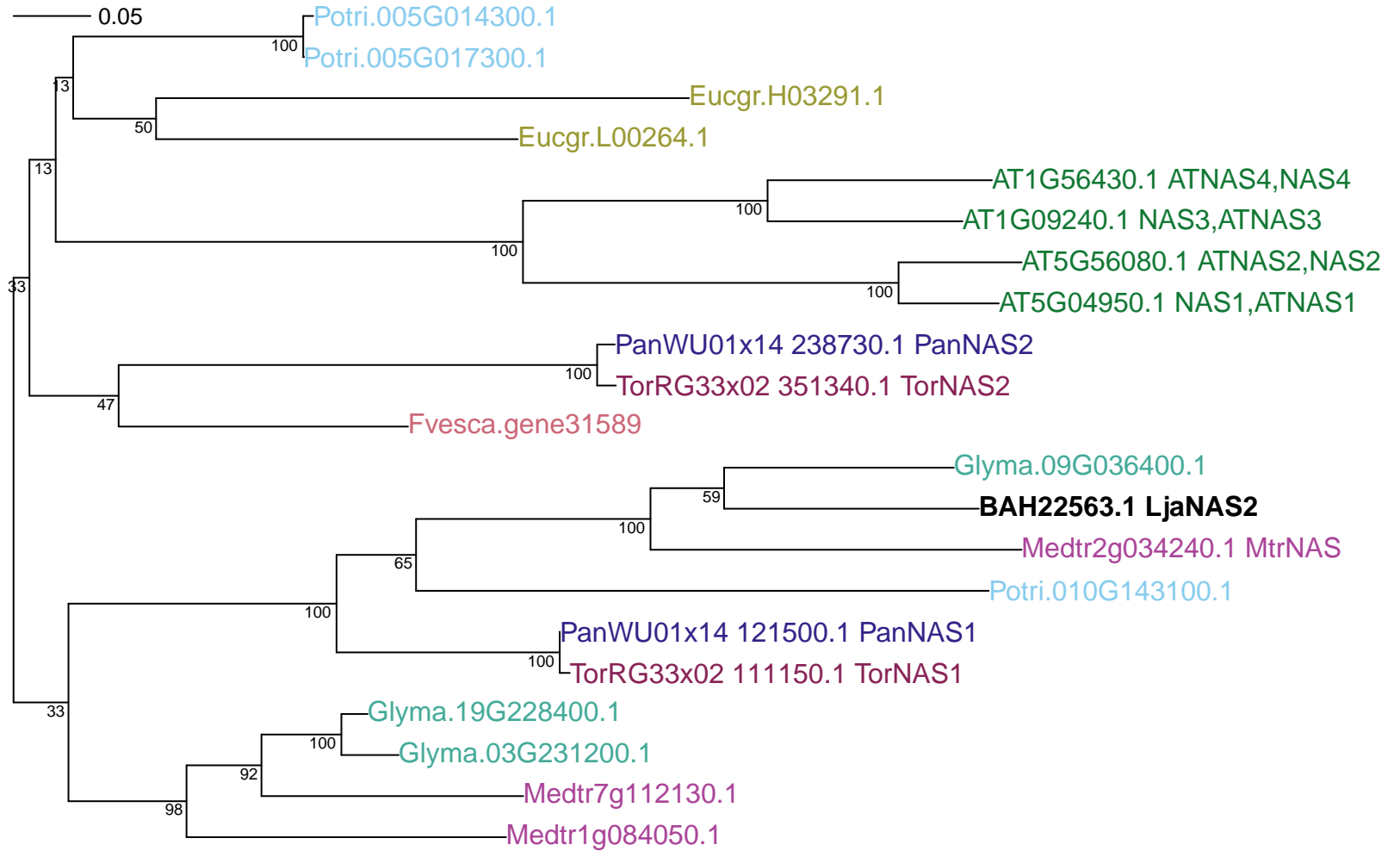


OG0000602: Enzymes. NADPH oxidase

— 0.05

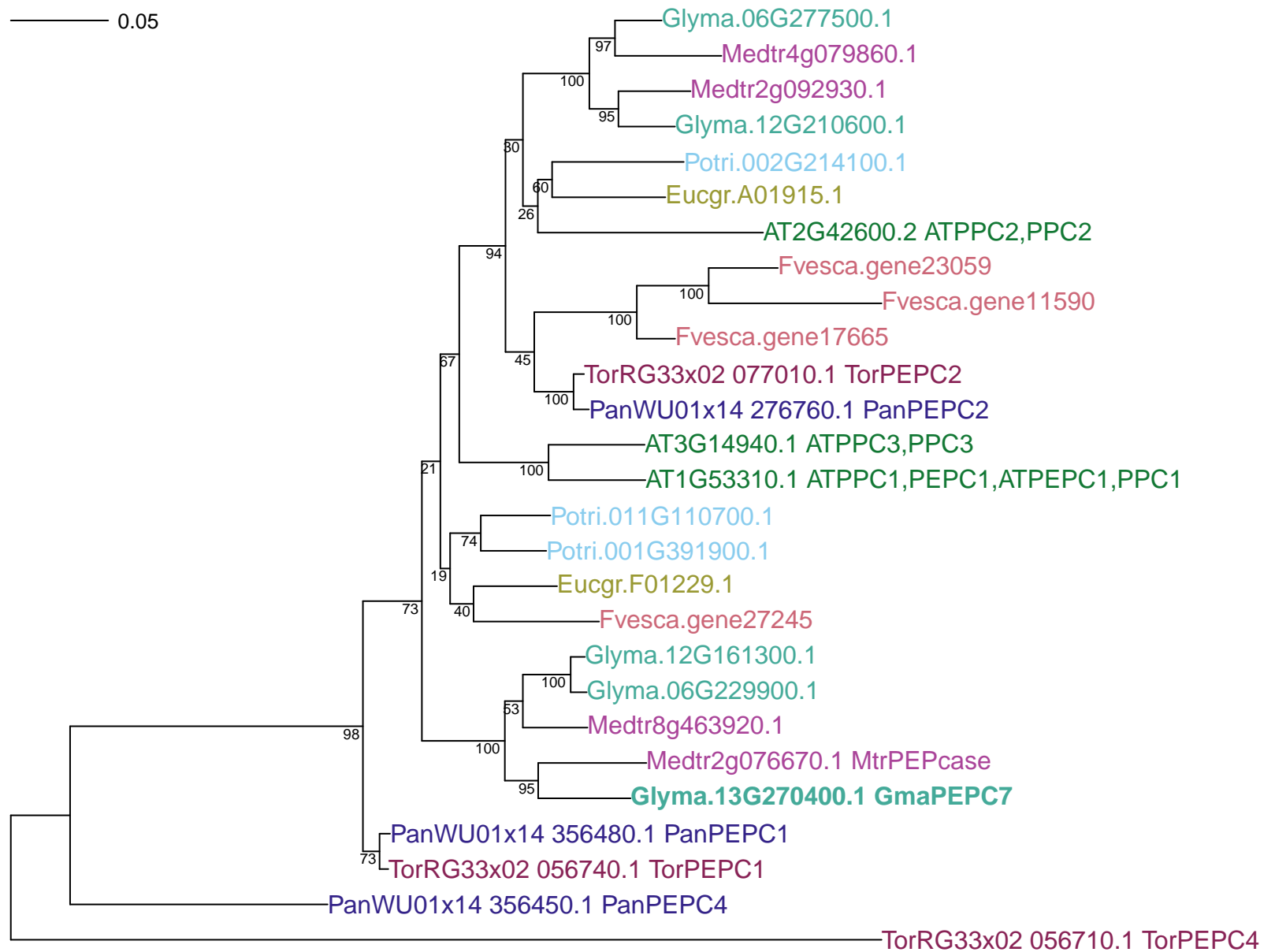


OG0002024: Enzymes. nicotianamine synthase

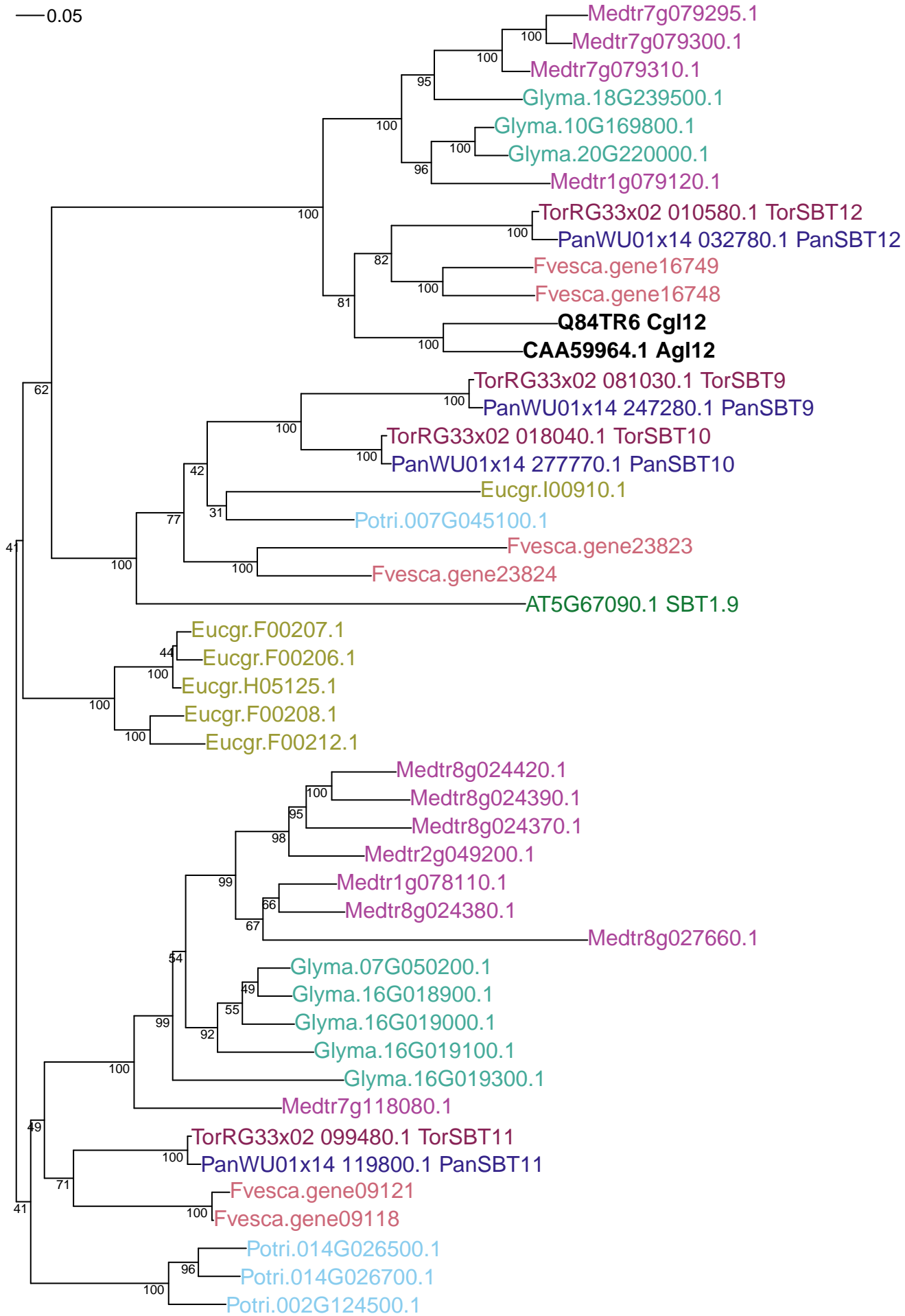


OG0001113: Enzymes. phosphoenolpyruvate carboxylase

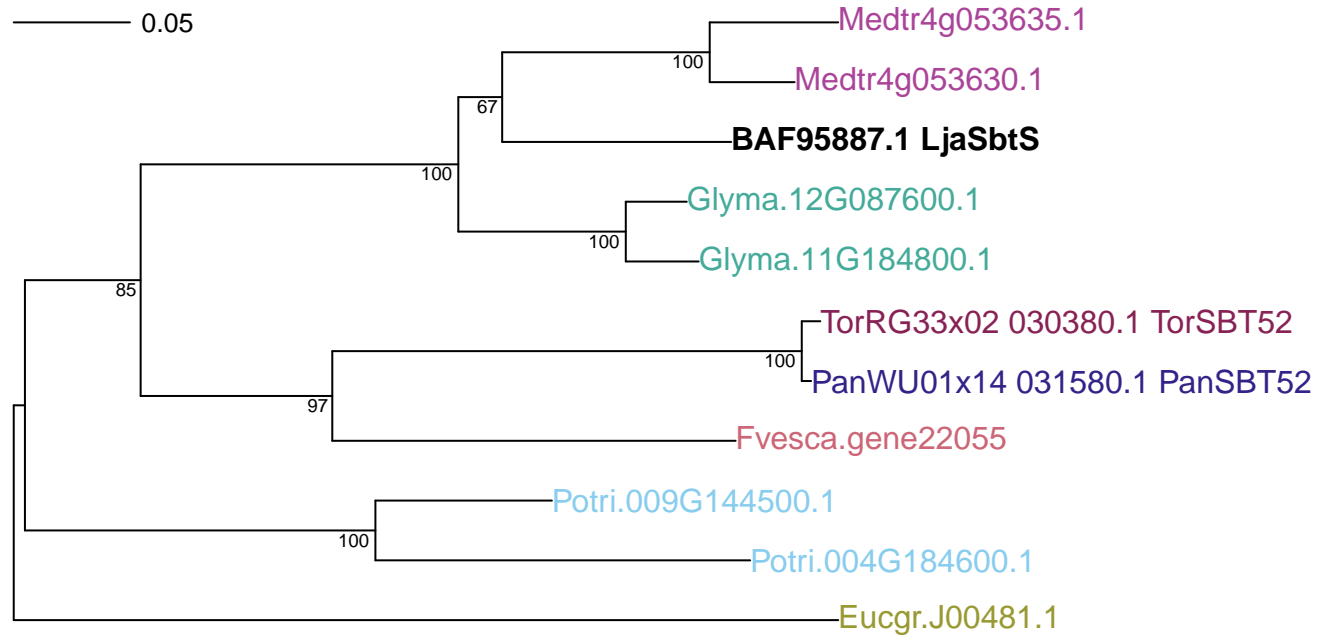
0.05



OG0000392: Enzymes. subtilisin-like protease

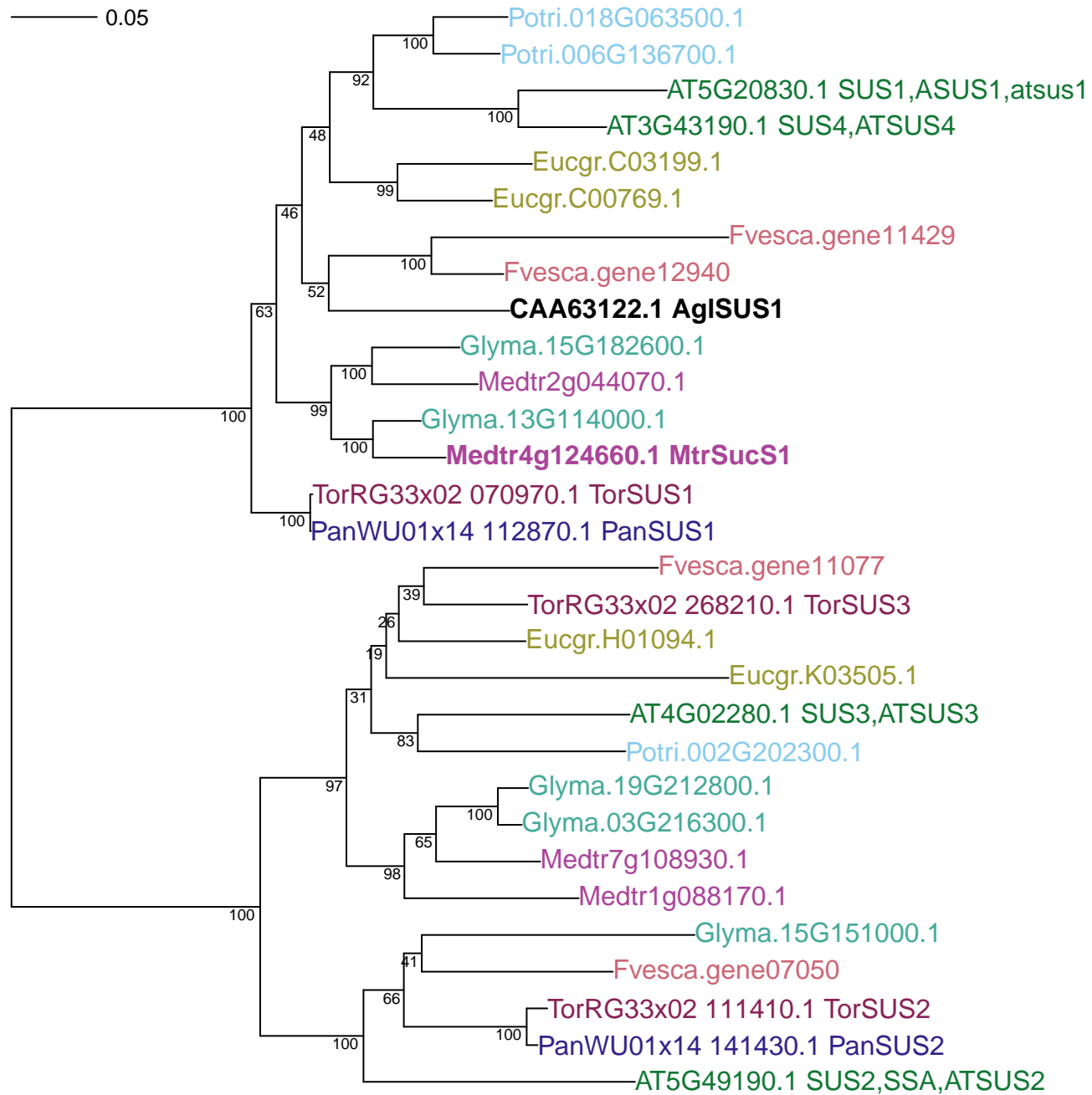


OG0009725: Enzymes. subtilisin-like serine protease



OG0000900: Enzymes. sucrose synthase

0.05



OG0010416: Enzymes. uricase

