

Table S4. The enzyme/protein encoded by the functional genes shown in figure 3, 4, S7, S8, S9 and S10.

Gene category	Subcategory	Gene/enzyme name	Phylogenetic group	Enzyme/ protein encoded	
C fixation	Calvin cycle	Rubisco	Bacteria	Ribulose biphosphate carboxylase	
	Reductive acetyl-CoA pathway	CODH	Bacteria	Carbon monoxide dehydrogenase	
	3-hydroxypropionate cycle	PCC	Bacteria	Propionyl-CoA carboxylase	
	Reverse tricarboxylic acid cycle	<i>aclB</i>	Bacteria	ATP citrate lyase beta subunit	
C degradation	Starch	glucoamylase	Bacteria/Fungi	Glucoamylase	
	Starch	<i>cda</i>	Bacteria	Cyclomaltodextrinase	
	Starch	<i>amyA</i>	Bacteria	Alpha-amylase	
	Starch	<i>amyx</i>	Bacteria	Pullulanase	
	Starch	<i>nplT</i>	Bacteria	Neopullulanase	
	Starch	<i>apu</i>	Bacteria	Amylopullulanase	
	Starch	isopullulanase	Bacteria	Isopullulanase	
	Starch	<i>pulA</i>	Bacteria	Pullulanase	
	Inulin	inulinase	Bacteria/Fungi	Inulinase	
	Hemicellulose	xylanase	Bacteria	Xylanase	
	Hemicellulose	mannanase	Bacteria/Fungi	Mannanase	
	Hemicellulose	<i>xylA</i>	Bacteria	Xylose isomerase	
	Hemicellulose	xylose isomerase	Oomycetes	Xylose isomerase	
	Hemicellulose	<i>ara</i>	Bacteria/Fungi	Arabinofuranosidase	
	Lactose	lactase	Fungi	Lactase	
	Pectin	pectinase	Bacteria	Pectinase	
	Pectin	pectin lyase	Oomycetes	Pectin lyase	
	Pectin	<i>pg</i>	Oomycetes	Polygalacturonase	
	Pectin	<i>pme</i>	Fungi	Pectin methylesterase	
	Pectin	<i>pec</i>	Fungi	Pectate lyase	
	Pectin	<i>rgh</i>	Bacteria/Fungi	rhamnogalacturonase	
	Pectin	<i>pme</i>	Bacteria	Pectinesterase	
	Pectin	exopolygalacturonase	Fungi	Exopolygalacturonase	
	Pectin	<i>rgaE</i>	Bacteria/Fungi	lipolytic enzyme	
	Pectin	<i>rgl</i>	Bacteria/Fungi	Polysaccharide lyase	
	Pectin	pectate lyase	Oomycetes	Pectate lyase	
	Pectin	endopolygalacturonase	Fungi	Endopolygalacturonase	
	Cellulose	<i>axe</i>	Fungi	Acetyl xylan esterase	
	Cellulose	cellobiase	Bacteria/Fungi	Cellobiase	
	Cellulose	endoglucanase	Bacteria/Fungi	Endoglucanase	
	Cellulose	cellulase	Parabasalia	Cellulase	
	Cellulose	exoglucanase	Bacteria/Fungi	Exoglucanase	
	Phospholipids	phospholipase C	Fungi	Phospholipase subunit C	
	Phospholipids	phospholipase A2	Fungi	Phospholipase subunit A2	
	Phospholipids	phospholipase D	Fungi	Phospholipase subunit D	
	Camphor	camdcab	Bacteria	Camphor 5-monooxygenase	
	Terpenes			Bacteria	Limonene-1,2-epoxide hydrolase
	Terpenes		<i>lmeH</i>		
	Terpenes			Bacteria	Limonene 1,2-monooxygenase
	Terpenes		<i>lmo</i>		

	Terpenes	<i>cdh</i>	Bacteria	Carveol dehydrogenase
	Cutin	cutinase	Bacteria/Fungi	Cutinase
	Tannins	tannase	Bacteria	
	Chitin	acetylglucosaminidase	Bacteria/Fungi	Acetylglucosaminidase
	Chitin	chitin deacetylase	Fungi	Chitin deacetylase
	Chitin	chitinase	Bacteria/Fungi	Chitinase
	Vanillin/Lignin	<i>vanA</i>	Bacteria	Vanillate monooxygenase
	Vanillin/Lignin	<i>vdh</i>	Bacteria/Fungi	Vanillin dehydrogenase
	Vanillin/Lignin	Phenol oxidase	Bacteria/Fungi	Phenol oxidase
	Vanillin/Lignin	Ligninase	Fungi	Ligninase
	Vanillin/Lignin	<i>glx</i>	Bacteria/Fungi	glyoxal oxidase
	Vanillin/Lignin	<i>mnp</i>	Fungi	Manganese peroxidase
	Ammonification	<i>gdh</i>	Bacteria/Fungi	Glutamate dehydrogenase
	Ammonification	<i>glnA</i>	Fungi	Glutamine synthetase
	Ammonification	<i>ureC</i>	Bacteria	Urease
	Anammox	<i>hzsA</i>	Bacteria	Hydrazine synthase
	Anammox	<i>hzo</i>	Bacteria	Hydroxylamine oxidoreductase
	Assimilation	Glutamine synthetase	Protists	Glutamine synthetase
	Assimilation	nitrate transporter	Bacteria	Nitrate transporter
	Assimilation	glutamate synthase	Protists	Glutamate synthase
	Assimilation	nitrite reductase	Protists	Nitrite reductase
	Assimilation	nitrite transporter	algae	Nitrite transporter
	Assimilation	ammonium transporter	algae	Ammonium transporter
	Assimilatory N reduction	<i>narB</i>	Bacteria	Nitrate reductase
	Assimilatory N reduction	<i>nir</i>	Bacteria	Nitrite reductase
	Assimilatory N reduction	<i>nirA</i>	Bacteria	Ferredoxin-nitrite reductase
	Assimilatory N reduction	<i>nirB</i>	Bacteria	NADPH-nitrite reductase
N cycling	Assimilatory N reduction	<i>nasA</i>	Bacteria	Nitrate reductase
	Denitrification	<i>norB</i>	Bacteria	Nitric-oxide reductase
	Denitrification	<i>nirK</i>	Bacteria	Nitrite reductase
	Denitrification	<i>nirS</i>	Bacteria	Nitrite reductase
	Denitrification	<i>cnorB</i>	Bacteria	Nitric oxide reductase subunit B
	Denitrification	<i>nosZ</i>	Bacteria	Nitrous-oxide reductase
	Denitrification	<i>narG</i>	Bacteria	Membrane bound nitrate reductase
	Denitrification			Nitrite reductase subunit cytochrome c552
	Dissimilatory N reduction	<i>nrfA</i>	Bacteria	Periplasmic nitrate reductase
	Dissimilatory N reduction	<i>napA</i>	Bacteria	Nitrate reductase
	N Assimilation	Nitrate reductase	Bacteria	Ammonia monooxygenase
	Nitrification	<i>amoA</i>	Bacteria	Hydroxylamine oxidoreductase
	Nitrification	<i>hao</i>	Bacteria	nitrogenase
	Nitrogen fixation	<i>nifH</i>	Bacteria	
	Phosphorus oxidation	<i>htxA</i>	Bacteria	Phytanoyl-CoA dioxygenase
	Phosphorus oxidation	<i>ptxD</i>	Bacteria	Phosphonate dehydrogenase
	Phytic acid hydrolysis	Phytase	Bacteria/Fungi	Phytase
	Polyphosphate degradation	<i>ppk2</i>	Bacteria	Polyphosphate kinase 2

P utilization	Polyphosphate degradation	<i>ppn</i>	Fungi	Endopolyphosphatase
	Polyphosphate degradation	<i>ppx</i>	Bacteria	Exopolyphosphatase
	Polyphosphate synthesis	<i>ppk</i>	Bacteria	Polyphosphate kinase
