

Classification I	Classification II	Subsystem	Preference	Comparison
Amino Acids and Derivatives black vs. amd	Alanine, serine, and glycine	Alanine Biosynthesis	AMD	
Amino Acids and Derivatives black vs. amd	Alanine, serine, and glycine	Glycine cleavage system	AMD	
Amino Acids and Derivatives black vs. amd	Arginine; urea cycle, polyamines	Arginine Biosynthesis	AMD	
Amino Acids and Derivatives black vs. amd	Aromatic amino acids and derivatives	Phenylalanine synthesis	AMD	
Amino Acids and Derivatives Asp-Glu-tRNA(Asn-Gln) transamidation	Glutamine, glutamate, aspartate, asparagine; ammonia assimilation	AMD	black vs. amd	
Carbohydrates amd	Central carbohydrate metabolism	Acetogenesis from Pyruvate	AMD	black vs.
Carbohydrates black vs. amd	Central carbohydrate metabolism	Butyrate and Butanol Acetone fermentation		AMD
Carbohydrates amd	Central carbohydrate metabolism	Methylglyoxal Metabolism	AMD	black vs.
Carbohydrates	CO2 fixation	Carboxysome	AMD	black vs. amd
Carbohydrates	CO2 fixation	Cyanobacterial CO2 uptake	AMD	black vs. amd
Carbohydrates	Di- and oligosaccharides	Trehalose biosynthesis	AMD	black vs. amd
Carbohydrates	Monosaccharides	Fucose and rhamnose degradation	AMD	black vs. amd
Carbohydrates	Monosaccharides	Ketogluconate metabolism	AMD	black vs. amd
Clustering-based Subsystems		LMPTP YwIe cluster	AMD	black vs. amd
Cofactors, Vitamins, Prosthetic Groups, Pigments amd		Cobalamin synthesis	AMD	black vs.
Cofactors, Vitamins, Prosthetic Groups, Pigments AMD		Folate and pterines		Folate Biosynthesis
Cofactors, Vitamins, Prosthetic Groups, Pigments AMD		NAD and NADP	NAD and NADP tutorial 10	
Cofactors, Vitamins, Prosthetic Groups, Pigments Phylloquinone Biosynthesis		Quinone cofactors		Menaquinone and
Cofactors, Vitamins, Prosthetic Groups, Pigments Biosynthesis		Quinone cofactors		Ubiquinone
Cofactors, Vitamins, Prosthetic Groups, Pigments biosynthesis		Riboflavin, FMN, FAD		FMN and FAD
Cofactors, Vitamins, Prosthetic Groups, Pigments biosynthesis in pathogens		Riboflavin, FMN, FAD		FMN and FAD
Cofactors, Vitamins, Prosthetic Groups, Pigments metabolism		Riboflavin, FMN, FAD		Riboflavin
Cofactors, Vitamins, Prosthetic Groups, Pigments AMD		Tetrapyrroles		Chlorophyll Biosynthesis
Degradation of Xenobiotics metabolism	Anaerobic degradation of aromatic compounds			Anaerobic benzoate
Fatty Acids and Lipids	Fatty acids	fatty acid metabolism	AMD	black vs. amd
Fatty Acids and Lipids	Fatty acids	fatty acid oxidation pathway	AMD	black vs. amd
Fatty Acids and Lipids	Phospholipids	Betaine biosynthesis	AMD	black vs. amd
Membrane Transport black vs. amd	ABC transporters	ABC transporter dipeptide (TC 3.A.1.5.2)		AMD
Membrane Transport black vs. amd	ABC transporters	ABC transporter glycerol (TC 3.A.1.1.3)	AMD	
Membrane Transport	ABC transporters	ABC transporter maltose	AMD	black vs. amd
Membrane Transport AMD	ABC transporters	P-type ATPase transporter potassium (TC 3.A.3.7.1)		
Metabolism of aromatic compounds		Metabolism of central aromatic intermediates		
Phenylacetate pathway of aromatic compound degradation		AMD	black vs. amd	
Metabolism of aromatic compounds		Peripheral pathways for catabolism of aromatic compounds		
Benzoate degradation		AMD	black vs. amd	
Metabolism of aromatic compounds		Peripheral pathways for catabolism of aromatic compounds		
p-Hydroxybenzoate degradation		AMD	black vs. amd	
Motility and Chemotaxis amd	Chemotaxis in Prokaryota	Bacterial Chemotaxis	AMD	black vs.
Motility and Chemotaxis amd	Flagellar motility in Prokaryota	Flagellum	AMD	black vs.
Nitrogen Metabolism	Allantoin degradation	AMD	black vs. amd	
Protein Metabolism black vs. amd	Protein Biosynthesis	Ribosome LSU eukaryotic and archaeal		AMD
Protein Metabolism black vs. amd	Protein Biosynthesis	Ribosome SSU eukaryotic and archaeal		AMD
Protein Metabolism archaeal	Protein Biosynthesis	Translation initiation factors eukaryotic and		
Protein Metabolism	Protein Degradation	Proteasome archaeal	AMD	black vs. amd
Protein Metabolism	Protein Degradation	Protein degradation	AMD	black vs. amd
Protein Metabolism reductase	Selenoproteins	Glycine reductase, sarcosine reductase and betaine		
Protein Metabolism	Selenoproteins	Selenocysteine metabolism	AMD	black vs. amd
Respiration	ATP synthases	V-Type ATP synthase	AMD	black vs. amd
Respiration	Electron donating reactions	Formate hydrogenase	AMD	black vs. amd
Respiration	Electron donating reactions	Hydrogenases	AMD	black vs. amd
Respiration	Electron donating reactions	Respiratory Complex I	AMD	black vs. amd
Respiration	Electron donating reactions	Respiratory dehydrogenases 1	AMD	black vs.

amd									
Respiration	Soluble electron carriers		Soluble cytochromes and functionally related						
electron carriers	AMD	black vs. amd							
Virulence	Adhesion and colonization factors		Mannose-sensitive hemagglutinin type 4						
pilus	AMD	black vs. amd							
Virulence	Detection	MLST	AMD	black vs. amd					
Amino Acids and Derivatives	Arginine; urea cycle, polyamines				Urea decomposition				
black	black vs. amd								
Amino Acids and Derivatives	Aromatic amino acids and derivatives				Chorismate Synthesis				
black	black vs. amd								
Amino Acids and Derivatives	Branched-chain amino acids				Branched-Chain Amino Acid				
Biosynthesis	black	black vs. amd							
Amino Acids and Derivatives	Branched-chain amino acids				Isoleucine degradation	black			
black	vs. amd								
Amino Acids and Derivatives	Branched-chain amino acids				Leucine Biosynthesis v2	black			
black	vs. amd								
Amino Acids and Derivatives	Branched-chain amino acids				Leucine Degradation and HMG-CoA				
Metabolism	black	black vs. amd							
Amino Acids and Derivatives	Branched-chain amino acids				Valine degradation	black			
black	vs. amd								
Amino Acids and Derivatives	Lysine, threonine, methionine, and cysteine				Methionine Salvage				
black	black vs. amd								
Carbohydrates	Central carbohydrate metabolism		Glyoxylate Synthesis	black	black vs. amd				
Carbohydrates	Monosaccharides	Mannose and fructose metabolism	black	black vs. amd					
Carbohydrates	Sugar alcohols	Hexitol degradation	black	black vs. amd					
Cell Wall and Capsule	Glycosylation	N-linked Glycosylation in Bacteria			black	black vs.			
amd									
Cell Wall and Capsule	Gram-Negative cell wall components		dTDP-rhamnose synthesis	black					
black	vs. amd								
Cell Wall and Capsule	Gram-Positive cell wall components		Teichoic acid Biosynthesis						
black	black vs. amd								
Cell Wall and Capsule	Peptidoglycan biosynthesis		Peptidoglycan Biosynthesis	black					
black	vs. amd								
Cofactors, Vitamins, Prosthetic Groups, Pigments			Isoprenoids	Carotenoids	black				
black	vs. amd								
Cofactors, Vitamins, Prosthetic Groups, Pigments			Isoprenoids	polyisoprenoid biosynthesis					
black	black vs. amd								
Cofactors, Vitamins, Prosthetic Groups, Pigments			NAD and NADP	NAD and NADP cofactor					
biosynthesis global	black	black vs. amd							
Cofactors, Vitamins, Prosthetic Groups, Pigments			Siderophores	Siderophore enterobactin					
biosynthesis and ferric enterobactin transport	black	black vs. amd							
DNA metabolism	DNA Replication	DNA-replication	black	black vs. amd					
Experimental Subsystems	Auxiliary Subsystems		Fructose-bisphosphate aldolase protein family						
black	black vs. amd								
Experimental Subsystems	Temporary subsystems		Test ADP-ribose	black	black vs. amd				
Membrane Transport	ABC transporters		ABC transporter alkylphosphonate (TC 3.A.1.9.1)						
black	black vs. amd								
Membrane Transport	ABC transporters		ABC transporter branched-chain amino acid (TC						
3.A.1.4.1)	black	black vs. amd							
Membrane Transport	ABC transporters		ABC transporter heme (TC3.A.1.107.1)	black					
black	vs. amd								
Membrane Transport	ABC transporters		ABC transporter ribose (TC 3.A.1.2.1)	black					
black	vs. amd								
Metabolism of aromatic compounds			Metabolism of central aromatic intermediates						
Homogenisate pathway of aromatic compound degradation	black	black vs. amd							
Motility and Chemotaxis	Social motility and nonflagellar swimming in bacteria		Bacterial						
motility:Gliding	black	black vs. amd							
Nitrogen Metabolism			Denitrification	black	black vs. amd				
Protein Metabolism	Protein Export and Secretion		General secretory pathway (Sec-SRP) complex						
(TC 3.A.5.1.1)	black	black vs. amd							
Protein Metabolism	Protein Folding GroEL GroES		black	black vs. amd					
Respiration	Electron accepting reactions		Terminal cytochrome C oxidases	black	black vs.				
amd									
Respiration	Electron donating reactions		NiFe hydrogenase maturation	black	black vs.				
amd									
RNA metabolism	RNA polymerase bacterial		black	black vs. amd					
RNA metabolism	Transcription factors bacterial		black	black vs. amd					
Amino Acids and Derivatives	Arginine; urea cycle, polyamines				Urea decomposition				
black	black vs. farm								
Amino Acids and Derivatives	Aromatic amino acids and derivatives				Chorismate Synthesis				
black	black vs. farm								
Amino Acids and Derivatives	Branched-chain amino acids				Branched-Chain Amino Acid				
Biosynthesis	black	black vs. farm							
Amino Acids and Derivatives	Branched-chain amino acids				Isoleucine degradation	black			
black	vs. farm								
Amino Acids and Derivatives	Branched-chain amino acids				Leucine Biosynthesis v2	black			
black	vs. farm								
Amino Acids and Derivatives	Branched-chain amino acids				Valine degradation	black			
black	vs. farm								
Amino Acids and Derivatives	Lysine, threonine, methionine, and cysteine				Methionine Salvage				
black	black vs. farm								

Carbohydrates	Central carbohydrate metabolism	Glyoxylate Synthesis	black	black vs. farm
Carbohydrates	Central carbohydrate metabolism	TCA Cycle	black	black vs. farm
Cofactors, Vitamins, Prosthetic Groups, Pigments		Isoprenoids		polyisoprenoid biosynthesis
black	black vs. farm			
Cofactors, Vitamins, Prosthetic Groups, Pigments		NAD and NADP		NAD and NADP cofactor
biosynthesis global	black	black vs. farm		
Experimental Subsystems	Temporary subsystems	Test ADP-ribose	black	black vs. farm
Metabolism of aromatic compounds		Metabolism of central aromatic intermediates		
Homogentisate pathway of aromatic compound degradation		black	black vs. farm	
Nitrogen Metabolism	Denitrification	black	black vs. farm	
Nucleosides and Nucleotides	Pyrimidines	De Novo Pyrimidine Synthesis	black	black vs. farm
farm				
Respiration	Electron donating reactions	NiFe hydrogenase maturation	black	black vs. farm
farm				
Amino Acids and Derivatives	Arginine; urea cycle, polyamines			Arginine Biosynthesis
farm	black vs. farm			
Amino Acids and Derivatives	Branched-chain amino acids	HMG CoA Synthesis		farm
black vs. farm				
Carbohydrates	Central carbohydrate metabolism	Butyrate and Butanol	Acetone fermentation	
farm	black vs. farm			
Carbohydrates	Central carbohydrate metabolism	Methylglyoxal Metabolism	farm	black vs. farm
farm				
Carbohydrates	Sugar alcohols	Ethanolamine utilization	farm	black vs. farm
Cell Division and Cell Cycle	Cell cycle in Prokaryota			Cyanobacterial Circadian Clock
farm	black vs. farm			
Degradation of Xenobiotics	Anaerobic degradation of aromatic compounds			Anaerobic benzoate
metabolism	farm	black vs. farm		
Fatty Acids and Lipids	Fatty acids	fatty acid metabolism	farm	black vs. farm
Fatty Acids and Lipids	Fatty acids	fatty acid oxidation pathway	farm	black vs. farm
Membrane Transport	ABC transporters	ABC transporter branched-chain amino acid (TC		
3.A.1.4.1)	farm	black vs. farm		
Membrane Transport	ABC transporters	ABC transporter macrolide	farm	black vs. farm
farm				
Membrane Transport	ABC transporters	ABC transporter ribose (TC 3.A.1.2.1)	farm	
black vs. farm				
Metabolism of aromatic compounds		Metabolism of central aromatic intermediates		
Phenylacetate pathway of aromatic compound degradation		farm	black vs. farm	
Motility and Chemotaxis	Chemotaxis in Prokaryota	Bacterial Chemotaxis	farm	black vs. farm
farm				
Motility and Chemotaxis	Flagellar motility in Prokaryota	Flagellum	farm	black vs. farm
farm				
Nitrogen Metabolism	Nitrate and nitrite ammonification		farm	black vs. farm
Respiration	Electron donating reactions	Respiratory dehydrogenases 1	farm	black vs. farm
farm				
Membrane Transport	ABC transporters	ABC transporter ferrichrome (TC 3.A.1.14.3)		
black	black vs. Sargasso			
Amino Acids and Derivatives	Branched-chain amino acids	Valine degradation		black
black vs. Sargasso				
Membrane Transport	ABC transporters	ABC transporter heme (TC3.A.1.107.1)		black
black vs. Sargasso				
Carbohydrates	Central carbohydrate metabolism	TCA Cycle	black	black vs. Sargasso
DNA metabolism	DNA Replication	DNA-replication	black	black vs. Sargasso
Carbohydrates	Central carbohydrate metabolism	Embden-Meyerhof and Gluconeogenesis		black
black vs. Sargasso				
Experimental Subsystems	Temporary subsystems	Test ADP-ribose	black	black vs. Sargasso
Carbohydrates	Central carbohydrate metabolism	Entner-Doudoroff Pathway		black
Sargasso				black vs. farm
Carbohydrates	Central carbohydrate metabolism	Pentose phosphate pathway		black
Sargasso				black vs. farm
Nitrogen Metabolism	Denitrification	black	black vs. Sargasso	
Carbohydrates	Central carbohydrate metabolism	Glyoxylate Synthesis	black	black vs. Sargasso
Amino Acids and Derivatives	Branched-chain amino acids	Leucine Biosynthesis v2	black	
black vs. Sargasso				
Amino Acids and Derivatives	Branched-chain amino acids	Leucine Degradation and HMG-CoA		
Metabolism	black	black vs. Sargasso		
Carbohydrates	Organic acids	Methylcitrate cycle	black	black vs. Sargasso
Cofactors, Vitamins, Prosthetic Groups, Pigments		NAD and NADP		NAD and NADP cofactor
biosynthesis global	black	black vs. Sargasso		
Amino Acids and Derivatives	Lysine, threonine, methionine, and cysteine			Methionine Salvage
black	black vs. Sargasso			
Cofactors, Vitamins, Prosthetic Groups, Pigments		Isoprenoids		polyisoprenoid biosynthesis
black	black vs. Sargasso			
Cofactors, Vitamins, Prosthetic Groups, Pigments		Tetrapyrroles		Porphyrin, Heme, and
Siroheme Biosynthesis	black	black vs. Sargasso		
RNA metabolism	tRNA aminoacylation	black	black vs. Sargasso	
Cofactors, Vitamins, Prosthetic Groups, Pigments		Quinone cofactors		Pyroloquinoline
Quinone biosynthesis	black	black vs. Sargasso		
Metabolism of aromatic compounds		Metabolism of central aromatic intermediates		
Homogentisate pathway of aromatic compound degradation		black	black vs. Sargasso	
Amino Acids and Derivatives	Arginine; urea cycle, polyamines			Urea decomposition
black	black vs. Sargasso			

Amino Acids and Derivatives	Branched-chain amino acids	Isoleucine degradation	black	
black vs. Sargasso				
Cell Wall and Capsule	Gram-Positive cell wall components	Teichoic acid Biosynthesis		
black vs. Sargasso				
Respiration	Electron accepting reactions	Terminal cytochrome oxidases	black	black vs. Sargasso
Sargasso				
Stress response	Oxidative stress	Protection from Reactive Oxygen Species	black	black vs. Sargasso
Sargasso				
Amino Acids and Derivatives	Branched-chain amino acids	Branched-Chain Amino Acid		
Biosynthesis	black	black vs. Sargasso		
Respiration	Electron donating reactions	NiFe hydrogenase maturation	black	black vs. Sargasso
Sargasso				
Cofactors, Vitamins, Prosthetic Groups, Pigments		Quinone cofactors	Coenzyme PQQ	
synthesis	black	black vs. Sargasso		
Membrane Transport	Uni-, Sym- and Antiporters	Sodium Hydrogen Antiporter		black
black vs. Sargasso				
Cofactors, Vitamins, Prosthetic Groups, Pigments		Folate and pterines	Molybdopterin	
biosynthesis	black	black vs. Sargasso		
Protein Metabolism	Protein Degradation	Proteolysis in bacteria, ATP-dependent		black
black vs. Sargasso				
Respiration	Electron donating reactions	Hydrogenases	Sargasso	black vs. Sargasso
RNA metabolism	Transcription factors	cyanobacterial RpoD-like sigma factors		Sargasso
black vs. Sargasso				
Membrane Transport	ABC transporters	ABC transporter maltose	Sargasso	black vs. Sargasso
Sargasso				
Carbohydrates	CO2 fixation	Cyanobacterial CO2 uptake	Sargasso	black vs. Sargasso
Carbohydrates	Monosaccharides	Fucose and rhamnose degradation	Sargasso	black vs. Sargasso
Carbohydrates	Central carbohydrate metabolism	Acetogenesis from Pyruvate		Sargasso
black vs. Sargasso				
Nitrogen Metabolism		Allantoin degradation	Sargasso	black vs. Sargasso
Nitrogen Metabolism		Ammonia assimilation	Sargasso	black vs. Sargasso
Amino Acids and Derivatives		Arginine; urea cycle, polyamines		Arginine Biosynthesis
Sargasso		black vs. Sargasso		
Respiration	Electron donating reactions	Respiratory Complex I	Sargasso	black vs. Sargasso
Sargasso				
Fatty Acids and Lipids	Phospholipids	Betaine biosynthesis	Sargasso	black vs. Sargasso
Carbohydrates	Central carbohydrate metabolism	Butyrate and Butanol Acetone fermentation		
Sargasso		black vs. Sargasso		
Fatty Acids and Lipids	Fatty acids	carnitine metabolism	Sargasso	black vs. Sargasso
Protein Metabolism	Protein Biosynthesis	Ribosome LSU chloroplast		Sargasso
black vs. Sargasso				
Amino Acids and Derivatives		Lysine, threonine, methionine, and cysteine		cysteine
biosynthesis	Sargasso	black vs. Sargasso		
Carbohydrates	Monosaccharides	D-galacturonate degradation	Sargasso	black vs. Sargasso
Fatty Acids and Lipids	Fatty acids	Fatty Acid Biosynthesis	FASII	Sargasso
Sargasso				black vs. Sargasso
Fatty Acids and Lipids	Fatty acids	fatty acid metabolism	Sargasso	black vs. Sargasso
Fatty Acids and Lipids	Fatty acids	fatty acid oxidation pathway	Sargasso	black vs. Sargasso
Sargasso				
Motility and Chemotaxis	Flagellar motility in Prokaryota	Flagellum		Sargasso
black vs. Sargasso				
Cofactors, Vitamins, Prosthetic Groups, Pigments		Folate and pterines		Folate Biosynthesis
Sargasso		black vs. Sargasso		
Amino Acids and Derivatives		Aromatic amino acids and derivatives		Tryptophan synthesis
Sargasso		black vs. Sargasso		
Amino Acids and Derivatives		Histidine	Histidine Biosynthesis	Sargasso
Sargasso				black vs. Sargasso
Amino Acids and Derivatives		Branched-chain amino acids	HMG CoA Synthesis	Sargasso
black vs. Sargasso				
Carbohydrates	Fermentation	Homofermentative lactate fermentation	Sargasso	black vs. Sargasso
Sargasso				
Cofactors, Vitamins, Prosthetic Groups, Pigments		Folate and pterines		Pterin biosynthesis
Sargasso		black vs. Sargasso		
Cofactors, Vitamins, Prosthetic Groups, Pigments		Quinone cofactors		Menaquinone and
Phylloquinone Biosynthesis	Sargasso	black vs. Sargasso		
Membrane Transport	ABC transporters	Choline Transport	Sargasso	black vs. Sargasso
Sargasso				
Carbohydrates	Monosaccharides	Ketogluconate metabolism	Sargasso	black vs. Sargasso
Membrane Transport	ABC transporters	ABC transporter glutamate aspartate (TC 3.A.1.3.4)		
Sargasso		black vs. Sargasso		
Amino Acids and Derivatives		Lysine, threonine, methionine, and cysteine		Lysine Biosynthesis
DAP Pathway	Sargasso	black vs. Sargasso		
Cell Wall and Capsule	Cell wall of Mycobacteria	mycolic acid synthesis		Sargasso
black vs. Sargasso				
Carbohydrates	Sugar alcohols	Inositol catabolism	Sargasso	black vs. Sargasso
Phosphorus Metabolism		P uptake (cyanobacteria)	Sargasso	black vs. Sargasso
Stress response	Starvation response	ppGpp biosynthesis	Sargasso	black vs. Sargasso
Respiration	ATP synthases	FOF1-type ATP synthase	Sargasso	black vs. Sargasso
Carbohydrates	Fermentation	Fermentations: Homofermentative lactate fermentation		Sargasso
black vs. Sargasso				
Carbohydrates	Central carbohydrate metabolism	Pyruvate Alanine Serine Interconversions		

Sargasso	black vs. Sargasso				
Carbohydrates	Central carbohydrate metabolism	Methylglyoxal Metabolism		Sargasso	
black vs. Sargasso					
Protein Metabolism	Protein Biosynthesis	Ribosome SSU chloroplast		Sargasso	
black vs. Sargasso					
Cofactors, Vitamins, Prosthetic metabolism	Groups, Pigments	Riboflavin, FMN, FAD		Riboflavin	
Protein Metabolism	Protein Biosynthesis	Ribosome LSU bacterial	Sargasso		black vs. Sargasso
Sargasso					
Clustering-based Subsystems	LMPTP YwIE cluster		Sargasso		black vs. Sargasso
Metabolism of aromatic compounds	Peripheral pathways for catabolism of aromatic compounds				
Quinate degradation	Sargasso	black vs. Sargasso			
Membrane Transport	ABC transporters	ABC transporter glutamine (TC 3.A.1.3.2)			
Sargasso	black vs. Sargasso				
Cofactors, Vitamins, Prosthetic	Groups, Pigments	Quinone cofactors		Ubiquinone	
Menaquinone-cytochrome c reductase complexes	Sargasso	black vs. Sargasso			
Metabolism of aromatic compounds	Peripheral pathways for catabolism of aromatic compounds				
n-Phenylalkanoic acid degradation	Sargasso	black vs. Sargasso			
Degradation of Xenobiotics	Anaerobic degradation of aromatic compounds			Anaerobic benzoate	
metabolism	Sargasso	black vs. Sargasso			
RNA metabolism	RNA polymerase chloroplast		Sargasso		black vs. Sargasso
Amino Acids and Derivatives	Aromatic amino acids and derivatives			Aromatic amino acid	
degradation	Sargasso	black vs. Sargasso			
Amino Acids and Derivatives	Aromatic amino acids and derivatives			Central meta-cleavage	
pathway of aromatic compound degradation	Sargasso	black vs. Sargasso			
Experimental Subsystems	Temporary subsystems	NAD and NADP tutorial 10		Sargasso	
black vs. Sargasso					
Metabolism of aromatic compounds	Metabolism of central aromatic intermediates				
Phenylacetate pathway of aromatic compound degradation	Sargasso	black vs. Sargasso			
Protein Metabolism	Protein Biosynthesis	Ribosome LSU mitochondrial		Sargasso	
black vs. Sargasso					
Protein Metabolism	Protein Biosynthesis	Ribosome SSU mitochondrial		Sargasso	
black vs. Sargasso					
RNA metabolism	tRNA aminoacylation, mitochondrial		Sargasso		black vs. Sargasso
Sulfur Metabolism	Inorganic sulfur assimilation	Inorganic Sulfur Assimilation		Sargasso	
black vs. Sargasso					
Membrane Transport	ABC transporters	ABC transporter polyamine putrescine spermidine (TC 3.A.1.11.1)			
Sargasso	black vs. Sargasso				
Cell Wall and Capsule	Capsular and extracellular polysacchrides			Capsular polysaccharide	
biosynthesis	Sargasso	black vs. Sargasso			
Motility and Chemotaxis	Chemotaxis in Prokaryota	Bacterial Chemotaxis		Sargasso	
black vs. Sargasso					
Respiration	Electron donating reactions	Coenzyme F420-H2 dehydrogenase (methanophenazine)			
Sargasso	black vs. Sargasso				
Clustering-based Subsystems	EC699-706		Sargasso		black vs. Sargasso
Respiration	Electron donating reactions	Formate dehydrogenase	Sargasso		black vs. Sargasso
Sargasso					
Amino Acids and Derivatives	Arginine; urea cycle, polyamines			Urea decomposition	
black	black vs. seed				
Amino Acids and Derivatives	Aromatic amino acids and derivatives			Chorismate Synthesis	
black	black vs. seed				
Amino Acids and Derivatives	Branched-chain amino acids	Branched-Chain Amino Acid			
Biosynthesis	black	black vs. seed			
Amino Acids and Derivatives	Branched-chain amino acids	Isoleucine degradation	black		
black vs. seed					
Amino Acids and Derivatives	Branched-chain amino acids	Leucine Biosynthesis v2	black		
black vs. seed					
Amino Acids and Derivatives	Branched-chain amino acids	Leucine Degradation and HMG-CoA			
Metabolism	black	black vs. seed			
Amino Acids and Derivatives	Branched-chain amino acids	Valine degradation	black		
black vs. seed					
Amino Acids and Derivatives	Glutamine, glutamate, aspartate, asparagine; ammonia assimilation				
Glutamate biosynthesis	black	black vs. seed			
Amino Acids and Derivatives	Glutamine, glutamate, aspartate, asparagine; ammonia assimilation				
Glutamate, aspartate and asparagine biosynthesis	black	black vs. seed			
Amino Acids and Derivatives	Lysine, threonine, methionine, and cysteine	Methionine Salvage			
black	black vs. seed				
Carbohydrates	Central carbohydrate metabolism	Embden-Meyerhof and Gluconeogenesis		black	
black vs. seed					
Carbohydrates	Central carbohydrate metabolism	Glyoxylate Synthesis	black	black vs. seed	
Carbohydrates	Central carbohydrate metabolism	Pentose phosphate pathway	black	black vs. seed	
seed					
Carbohydrates	Central carbohydrate metabolism	TCA Cycle	black	black vs. seed	
Carbohydrates	Organic acids	Methylcitrate cycle	black	black vs. seed	
Cell Wall and Capsule	Gram-Negative cell wall components	dTDP-rhamnose synthesis	black		
black vs. seed					
Cell Wall and Capsule	Gram-Positive cell wall components	Teichoic acid Biosynthesis			
black	black vs. seed				
Cell Wall and Capsule	Peptidoglycan biosynthesis	Peptidoglycan Biosynthesis		black	
black vs. seed					
Clustering-based Subsystems	NusA-TFII Cluster		black	black vs. seed	

Clustering-based Subsystems	SA:14-24	black	black vs. seed		
Cofactors, Vitamins, Prosthetic Groups, Pigments biosynthesis	black	black vs. seed		Folate and pterines	Molybdopterin
Cofactors, Vitamins, Prosthetic Groups, Pigments	black	black vs. seed		Isoprenoids	polyisoprenoid biosynthesis
Cofactors, Vitamins, Prosthetic Groups, Pigments biosynthesis global	black	black vs. seed		NAD and NADP	NAD and NADP cofactor
Cofactors, Vitamins, Prosthetic Groups, Pigments synthesis	black	black vs. seed		Quinone cofactors	Coenzyme PQQ
Cofactors, Vitamins, Prosthetic Groups, Pigments Quinone biosynthesis	black	black vs. seed		Quinone cofactors	Pyrrroloquinoline
Cofactors, Vitamins, Prosthetic Groups, Pigments Siroheme Biosynthesis	black	black vs. seed		Tetrapyrroles	Porphyrin, Heme, and
DNA metabolism	DNA Replication	DNA-replication	black	black vs. seed	
Experimental Subsystems	Temporary subsystems	Test	ADP-ribose	black	black vs. seed
Membrane Transport	Uni-, Sym- and Antiporters		Sodium Hydrogen Antiporter		black
Metabolism of aromatic compounds	Metabolism of central aromatic intermediates				
Homogentisate pathway of aromatic compound degradation	black	black vs. seed			
Nitrogen Metabolism	Denitrification	black	black vs. seed		
Nucleosides and Nucleotides	Purines De Novo Purine Biosynthesis	black	black vs. seed		
Nucleosides and Nucleotides	Purines Purine conversions	black	black vs. seed		
Nucleosides and Nucleotides	Pyrimidines	De Novo Pyrimidine Synthesis	black	black vs. seed	
Protein Metabolism	Protein Biosynthesis	Universal GTPases	black	black vs. seed	
Protein Metabolism	Protein Degradation	Proteolysis in bacteria, ATP-dependent	black		
Respiration	Electron donating reactions	NiFe hydrogenase maturation	black	black vs. seed	
RNA metabolism	tRNA aminoacylation	black	black vs. seed		
Virulence	Resistance to Antibiotics	Resistance to fluoroquinolones	black	black vs. seed	
Amino Acids and Derivatives	Arginine; urea cycle, polyamines	Arginine Biosynthesis			
SEED	black vs. seed				
Amino Acids and Derivatives	Aromatic amino acids and derivatives	Central meta-cleavage			
pathway of aromatic compound degradation	SEED	black vs. seed			
Amino Acids and Derivatives	Branched-chain amino acids	HMG CoA Synthesis	SEED		
black vs. seed					
Amino Acids and Derivatives	Lysine, threonine, methionine, and cysteine	cysteine			
SEED	black vs. seed				
Carbohydrates	Aminosugars	N-Acetyl-D-Glucosamine Utilization	SEED	black vs. seed	
Carbohydrates	Central carbohydrate metabolism	Butyrate and Butanol Acetone fermentation			
SEED	black vs. seed				
Carbohydrates	Central carbohydrate metabolism	Methylglyoxal Metabolism	SEED	black vs. seed	
seed					
Carbohydrates	Central carbohydrate metabolism	Pyruvate Alanine Serine Interconversions			
SEED	black vs. seed				
Carbohydrates	CO2 fixation	Carboxysome	SEED	black vs. seed	
Carbohydrates	CO2 fixation	Cyanobacterial CO2 uptake	SEED	black vs. seed	
Carbohydrates	Methanogenesis	Methanogenesis	SEED	black vs. seed	
Carbohydrates	Monosaccharides	D-galacturonate degradation	SEED	black vs. seed	
Carbohydrates	Monosaccharides	Fucose and rhamnose degradation	SEED	black vs. seed	
Carbohydrates	Organic acids	Citrate Metabolism, Transport, and Regulation	SEED	black vs. seed	
seed					
Carbohydrates	Organic acids	Propanediol utilization	SEED	black vs. seed	
Carbohydrates	Sugar alcohols	Inositol catabolism	SEED	black vs. seed	
Cell signaling	Signal transduction in prokaryota	Phytochromes	SEED	black vs. seed	
Cell signaling	Signal transduction in Prokaryota	Rrf2 family transcriptional regulators			
SEED	black vs. seed				
Cell Wall and Capsule biosynthesis	Capsular and extracellular polysacchrides	Capsular polysaccharide			
SEED	black vs. seed				
Cell Wall and Capsule	Cell wall of Mycobacteria	mycolic acid synthesis	SEED	black vs. seed	
seed					
Cell Wall and Capsule loci	Gram-Negative cell wall components	Capsular surface virulence antigen			
SEED	black vs. seed				
Clustering-based Subsystems	LMPTP Yw1E cluster	SEED	black vs. seed		
Cofactors, Vitamins, Prosthetic Groups, Pigments	Cobalamin synthesis	SEED	black vs. seed		
seed					
Cofactors, Vitamins, Prosthetic Groups, Pigments	Folate and pterines	Folate Biosynthesis			
SEED	black vs. seed				
Cofactors, Vitamins, Prosthetic Groups, Pigments	Folate and pterines	Pterin biosynthesis			
SEED	black vs. seed				
Cofactors, Vitamins, Prosthetic Groups, Pigments	Isoprenoids	polyprenyl synthesis			
SEED	black vs. seed				
Cofactors, Vitamins, Prosthetic Groups, Pigments	NAD and NADP	NAD and NADP tutorial 10			
SEED	black vs. seed				
Cofactors, Vitamins, Prosthetic Groups, Pigments	Quinone cofactors	Menaquinone and			
Phylloquinone Biosynthesis	SEED	black vs. seed			
Cofactors, Vitamins, Prosthetic Groups, Pigments	Quinone cofactors	Ubiquinone			
Biosynthesis	SEED	black vs. seed			
Cofactors, Vitamins, Prosthetic Groups, Pigments	Quinone cofactors	Ubiquinone			

Menaquinone-cytochrome c reductase complexes	SEED	black vs. seed		
Cofactors, Vitamins, Prosthetic Groups, Pigments		Tetrapyrroles	Chlorophyll Biosynthesis	
SEED	black vs. seed			
Degradation of Xenobiotics	Anaerobic degradation of aromatic compounds		Anaerobic benzoate metabolism	
SEED	black vs. seed			
Experimental Subsystems	Temporary subsystems	Vibrio	Experimental Type III secretion system	
SEED	black vs. seed			
Fatty Acids and Lipids	Fatty acids	carnitine metabolism	SEED	black vs. seed
Fatty Acids and Lipids	Fatty acids	Fatty Acid Biosynthesis	FASII	SEED
Fatty Acids and Lipids	Fatty acids	fatty acid metabolism	SEED	black vs. seed
Fatty Acids and Lipids	Fatty acids	fatty acid oxidation pathway	SEED	black vs. seed
Membrane Transport	ABC transporters	ABC transporter	glutamate aspartate (TC 3.A.1.3.4)	
SEED	black vs. seed			
Membrane Transport (TC 3.A.1.3.1)	ABC transporters	ABC transporter	histidine lysine arginine ornithine	
SEED	black vs. seed			
Membrane Transport	ABC transporters	ABC transporter	iron(III) dicitrate (TC 3.A.1.14.1)	
SEED	black vs. seed			
Membrane Transport	ABC transporters	ABC transporter	maltose	SEED
Membrane Transport	ABC transporters	ABC transporter	molybdenum (TC 3.A.1.8.1)	
SEED	black vs. seed			
Membrane Transport	ABC transporters	ABC transporter	nickel (TC 3.A.1.5.3)	SEED
black vs. seed				
Membrane Transport	ABC transporters	ABC transporter	peptide (TC 3.A.1.5.5)	SEED
black vs. seed				
Membrane Transport	ABC transporters	CbiQO-type ABC transporter systems		SEED
black vs. seed				
Membrane Transport	ABC transporters	Transport of Nickel and Cobalt	SEED	black vs. seed
seed				
Metabolism of aromatic compounds		Metabolism of central aromatic intermediates		
Phenylacetate pathway of aromatic compound degradation	SEED	black vs. seed		
Metabolism of aromatic compounds		Peripheral pathways for catabolism of aromatic compounds		
Benzoate catabolism	SEED	black vs. seed		
Metabolism of aromatic compounds		Peripheral pathways for catabolism of aromatic compounds		
Benzoate degradation	SEED	black vs. seed		
Metabolism of aromatic compounds		Peripheral pathways for catabolism of aromatic compounds		
n-Phenylalkanoic acid degradation	SEED	black vs. seed		
Metabolism of aromatic compounds		Peripheral pathways for catabolism of aromatic compounds		
Phenylpropanoid compound degradation	SEED	black vs. seed		
Metabolism of aromatic compounds		Peripheral pathways for catabolism of aromatic compounds		
Quinate degradation	SEED	black vs. seed		
Motility and Chemotaxis	Chemotaxis in Prokaryota	Bacterial Chemotaxis	SEED	black vs. seed
seed				
Motility and Chemotaxis	Flagellar motility in Prokaryota	Flagellum	SEED	black vs. seed
seed				
Nitrogen Metabolism	Nitrosative stress	SEED	black vs. seed	
Phosphorus Metabolism	P uptake (cyanobacteria)	SEED	black vs. seed	
Protein Metabolism	Protein Biosynthesis	Ribosome biogenesis bacterial	SEED	black vs. seed
seed				
Protein Metabolism	Protein Biosynthesis	Ribosome LSU chloroplast	SEED	black vs. seed
seed				
Protein Metabolism	Protein Biosynthesis	Ribosome LSU eukaryotic and archaeal	SEED	
black vs. seed				
Protein Metabolism	Protein Biosynthesis	Ribosome LSU mitochondrial	SEED	black vs. seed
seed				
Protein Metabolism	Protein Biosynthesis	Ribosome SSU chloroplast	SEED	black vs. seed
seed				
Protein Metabolism	Protein Biosynthesis	Ribosome SSU eukaryotic and archaeal	SEED	
black vs. seed				
Protein Metabolism	Protein Biosynthesis	Ribosome SSU mitochondrial	SEED	black vs. seed
seed				
Protein Metabolism	Protein Biosynthesis	Translation initiation factors eukaryotic and archaeal	SEED	black vs. seed
archaeal				
Protein Metabolism	Protein Degradation	Proteasome eukaryotic	SEED	black vs. seed
Protein Metabolism	Protein Degradation	Protein degradation	SEED	black vs. seed
Protein Metabolism	Selenoproteins	Selenocysteine metabolism	SEED	black vs. seed
Respiration	Electron donating reactions	Coenzyme F420-H2 dehydrogenase (methanophenazine)		
SEED	black vs. seed			
Respiration	Electron donating reactions	Hydrogenases	SEED	black vs. seed
Respiration	Electron donating reactions	Membrane-bound Ni, Fe-hydrogenase	SEED	
black vs. seed				
Respiration	Electron donating reactions	Na(+)-translocating NADH-quinone oxidoreductase and rnf-like group of electron transport complexes	SEED	black vs. seed
Respiration	Electron donating reactions	Respiratory Complex I	SEED	black vs. seed
Respiration	Soluble electron carriers	Soluble cytochromes and functionally related		
electron carriers	SEED	black vs. seed		
RNA metabolism	RNA polymerase chloroplast	SEED	black vs. seed	
RNA metabolism	RNA polymerase II initiation factors	SEED	black vs. seed	
RNA metabolism	Transcription factors cyanobacterial	RpoD-like sigma factors	SEED	
black vs. seed				
RNA metabolism	tRNA aminoacylation, mitochondrial	SEED	black vs. seed	
Sulfur Metabolism	Inorganic sulfur assimilation	Inorganic Sulfur Assimilation	SEED	

black vs. seed					
Sulfur Metabolism	Organic sulfur assimilation	Alkanesulfonates Utilization	SEED		
black vs. seed					
Virulence proteins	Invasion and intracellular resistance	Listeria surface proteins: Internalin-like	SEED	black vs. seed	
Virulence	Invasion and intracellular resistance	Listeria surface proteins: LPXTG motif			
SEED	black vs. seed				
Virulence	Toxins, Superantigens	Cholera toxin	SEED	black vs. seed	
Amino Acids and Derivatives	Arginine; urea cycle, polyamines	Urea decomposition			
black	black vs. whale				
Amino Acids and Derivatives	Aromatic amino acids and derivatives	Chorismate Synthesis			
black	black vs. whale				
Amino Acids and Derivatives	Branched-chain amino acids	Branched-Chain Amino Acid			
Biosynthesis	black	black vs. whale			
Amino Acids and Derivatives	Branched-chain amino acids	Leucine Biosynthesis v2	black		
black vs. whale					
Amino Acids and Derivatives	Lysine, threonine, methionine, and cysteine	Methionine Salvage			
black	black vs. whale				
Carbohydrates	Central carbohydrate metabolism	Embden-Meyerhof and Gluconeogenesis	black		
black vs. whale					
Carbohydrates	Central carbohydrate metabolism	Glyoxylate Synthesis	black	black vs. whale	
Carbohydrates	Central carbohydrate metabolism	Pentose phosphate pathway	black	black vs.	
whale					
Carbohydrates	Central carbohydrate metabolism	TCA Cycle	black	black vs. whale	
Carbohydrates	Organic acids	Methylcitrate cycle	black	black vs. whale	
Cell Wall and Capsule	Gram-Negative cell wall components	dTDP-rhamnose synthesis	black		
black vs. whale					
Cell Wall and Capsule	Gram-Positive cell wall components	Teichoic acid Biosynthesis			
black	black vs. whale				
Cofactors, Vitamins, Prosthetic Groups, Pigments biosynthesis	black	black vs. whale	Folate and pterines	Molybdopterin	
Cofactors, Vitamins, Prosthetic Groups, Pigments	black vs. whale		Isoprenoids	Carotenoids	black
black vs. whale					
Cofactors, Vitamins, Prosthetic Groups, Pigments	black	black vs. whale	Isoprenoids	polyisoprenoid biosynthesis	
black	black vs. whale				
Cofactors, Vitamins, Prosthetic Groups, Pigments biosynthesis global	black	black vs. whale	NAD and NADP	NAD and NADP cofactor	
Cofactors, Vitamins, Prosthetic Groups, Pigments synthesis	black	black vs. whale	Quinone cofactors	Coenzyme PQQ	
Cofactors, Vitamins, Prosthetic Groups, Pigments	black	black vs. whale	Quinone cofactors	Pyroloquinoline	
Quinone biosynthesis	black	black vs. whale			
Experimental Subsystems	Auxiliary Subsystems	Fructose-bisphosphate aldolase protein family			
black	black vs. whale				
Experimental Subsystems	Temporary subsystems	Test ADP-ribose	black	black vs. whale	
Membrane Transport	ABC transporters	ABC transporter heme (TC3.A.1.107.1)	black		
black vs. whale					
Membrane Transport	ABC transporters	CbiQO-type ABC transporter systems	black		
black vs. whale					
Membrane Transport	Uni-, Sym- and Antiporters	Sodium Hydrogen Antiporter	black		
black vs. whale					
Metabolism of aromatic compounds	Metabolism of central aromatic intermediates				
Homogentisate pathway of aromatic compound degradation	black	black vs. whale			
Nitrogen Metabolism	Denitrification	black	black vs. whale		
Nucleosides and Nucleotides	Purines De Novo	Purine Biosynthesis	black	black vs. whale	
Nucleosides and Nucleotides	Pyrimidines	De Novo Pyrimidine Synthesis	black	black vs.	
whale					
Protein Metabolism	Protein Degradation	Proteolysis in bacteria, ATP-dependent	black		
black vs. whale					
Respiration	Electron donating reactions	NiFe hydrogenase maturation	black	black vs.	
whale					
RNA metabolism	tRNA aminoacylation	black	black vs. whale		
Amino Acids and Derivatives	Alanine, serine, and glycine	Alanine Biosynthesis	whale		
black vs. whale					
Amino Acids and Derivatives	Arginine; urea cycle, polyamines	Arginine Biosynthesis			
whale	black vs. whale				
Amino Acids and Derivatives	Aromatic amino acids and derivatives	Central meta-cleavage pathway of aromatic compound degradation	whale	black vs. whale	
Amino Acids and Derivatives	Branched-chain amino acids	HMG CoA Synthesis	whale		
black vs. whale					
Amino Acids and Derivatives	Lysine, threonine, methionine, and cysteine	Lysine Biosynthesis			
DAP Pathway	whale	black vs. whale			
Carbohydrates	Central carbohydrate metabolism	Acetogenesis from Pyruvate	whale	black vs.	
whale					
Carbohydrates	Central carbohydrate metabolism	Butyrate and Butanol Acetone fermentation			
whale	black vs. whale				
Carbohydrates	Central carbohydrate metabolism	Methylglyoxal Metabolism	whale	black vs.	
whale					
Carbohydrates	Central carbohydrate metabolism	Pyruvate metabolism I: anaplerotic reactions, PEP			
whale	black vs. whale				
Carbohydrates	Monosaccharides	Fucose and rhamnose degradation	whale	black vs. whale	
Carbohydrates	Sugar alcohols	Inositol catabolism	whale	black vs. whale	

Cell Wall and Capsule biosynthesis	whale	Capsular and extracellular polysacchrides	black vs. whale	Capsular polysaccharide	
Cell Wall and Capsule	whale	Capsular and extracellular polysacchrides	black vs. whale	Colanic acid biosynthesis	
Cell Wall and Capsule	whale	Cell wall of Mycobacteria	black vs. whale	mycolic acid synthesis	whale
Clustering-based Subsystems		EC699-706	whale	black vs. whale	
Clustering-based Subsystems		LMPTP YwIE cluster	whale	black vs. whale	
Cofactors, Vitamins, Prosthetic Groups, Pigments	whale		black vs. whale	Folate and pterines	Folate Biosynthesis
Cofactors, Vitamins, Prosthetic Groups, Pigments	whale		black vs. whale	NAD and NADP	NAD and NADP tutorial 10
Cofactors, Vitamins, Prosthetic Groups, Pigments	whale		black vs. whale	Quinone cofactors	Menaquinone and
Phylloquinone Biosynthesis	whale		black vs. whale	Quinone cofactors	Ubiquinone
Cofactors, Vitamins, Prosthetic Groups, Pigments	whale		black vs. whale	Riboflavin, FMN, FAD	FMN and FAD
Cofactors, Vitamins, Prosthetic Groups, Pigments	whale		black vs. whale	Riboflavin, FMN, FAD	FMN and FAD
Cofactors, Vitamins, Prosthetic Groups, Pigments	whale		black vs. whale	Riboflavin, FMN, FAD	Riboflavin
Degradation of Xenobiotics	whale	Anaerobic degradation of aromatic compounds	black vs. whale	Anaerobic degradation of aromatic compounds	Anaerobic benzoate
Fatty Acids and Lipids	whale	Fatty acids	black vs. whale	carnitine metabolism	whale
Fatty Acids and Lipids	whale	Fatty acids	black vs. whale	Fatty Acid Biosynthesis FASII	whale
Fatty Acids and Lipids	whale	Fatty acids	black vs. whale	fatty acid metabolism	whale
Fatty Acids and Lipids	whale	Fatty acids	black vs. whale	fatty acid oxidation pathway	whale
Fatty Acids and Lipids	whale	Phospholipids	black vs. whale	Betaine biosynthesis	whale
Membrane Transport	whale	ABC transporters	black vs. whale	ABC transporter iron(III) dicitrate (TC 3.A.1.14.1)	
Membrane Transport	whale	ABC transporters	black vs. whale	ABC transporter macrolide	whale
Membrane Transport	whale	ABC transporters	black vs. whale	ABC transporter polyamine putrescine spermidine (TC 3.A.1.11.1)	
Membrane Transport	whale	ABC transporters	black vs. whale	ABC transporter putrescine (TC 3.A.1.11.2)	
Metabolism of aromatic compounds		Metabolism of central aromatic intermediates		Metabolism of central aromatic intermediates	
Phenylacetate pathway of aromatic compound degradation	whale		black vs. whale	Metabolism of central aromatic intermediates	
Metabolism of aromatic compounds		Metabolism of central aromatic intermediates		Metabolism of central aromatic intermediates	
Protocatechuate branch of beta-ketoadipate pathway	whale		black vs. whale	Peripheral pathways for catabolism of aromatic compounds	
Metabolism of aromatic compounds	whale		black vs. whale	Peripheral pathways for catabolism of aromatic compounds	
Benzoate catabolism	whale		black vs. whale	Peripheral pathways for catabolism of aromatic compounds	
Metabolism of aromatic compounds	whale		black vs. whale	Peripheral pathways for catabolism of aromatic compounds	
n-Phenylalkanoic acid degradation	whale		black vs. whale	Bacterial Chemotaxis	whale
Motility and Chemotaxis	whale	Chemotaxis in Prokaryota	black vs. whale	Bacterial Chemotaxis	whale
Motility and Chemotaxis	whale	Flagellar motility in Prokaryota	black vs. whale	Flagellum	whale
Nitrogen Metabolism		Nitrosative stress	whale	black vs. whale	
Protein Metabolism	whale	Protein Biosynthesis	black vs. whale	Ribosome biogenesis bacterial	whale
Protein Metabolism	whale	Protein Degradation	black vs. whale	Protein degradation	whale
Respiration	whale	Electron accepting reactions	black vs. whale	Anaerobic respiratory reductases	whale
Respiration	whale	Electron donating reactions	black vs. whale	Hydrogenases	whale
Respiration	whale	Electron donating reactions	black vs. whale	Na(+)-translocating NADH-quinone oxidoreductase and	
rnf-like group of electron transport complexes	whale		black vs. whale	Respiratory dehydrogenases 1	whale
Stress response	whale	Oxidative stress	black vs. whale	Glutathione Redox Metabolism	whale
Stress response	whale	Starvation response	black vs. whale	ppGpp biosynthesis	whale
Virulence	whale	Adhesion and colonization factors	black vs. whale	Mannose-sensitive hemagglutinin type 4	
Amino Acids and Derivatives	whale	Alanine, serine, and glycine	black vs. whale	Alanine Biosynthesis	AMD
Amino Acids and Derivatives	whale	Alanine, serine, and glycine	black vs. whale	Glycine cleavage system	AMD
Amino Acids and Derivatives	whale	Arginine; urea cycle, polyamines	black vs. whale	Arginine Biosynthesis	AMD
Amino Acids and Derivatives	whale	Proline and 4-hydroxyproline	black vs. whale	Proline Catabolism	AMD
Carbohydrates	whale	Central carbohydrate metabolism	black vs. whale	Acetogenesis from Pyruvate	AMD
Carbohydrates	whale	Central carbohydrate metabolism	black vs. whale	Butyrate and Butanol Acetone fermentation	AMD
Carbohydrates	whale	Central carbohydrate metabolism	black vs. whale	Methylglyoxal Metabolism	AMD
Carbohydrates	whale	CO2 fixation	black vs. whale	Cyanobacterial CO2 uptake	AMD
Carbohydrates	whale	Di- and oligosaccharides	black vs. whale	Trehalose biosynthesis	AMD
Carbohydrates	whale	Fermentation	black vs. whale	Heterofermentative lactate fermentation	AMD
Carbohydrates	whale	Monosaccharides	black vs. whale	Fucose and rhamnose degradation	AMD
Carbohydrates	whale	Monosaccharides	black vs. whale	Ketogluconate metabolism	AMD

Clustering-based Subsystems	EC49-61	AMD	red vs. amd				
Clustering-based Subsystems	SA:14-24		AMD	red vs. amd			
Cofactors, Vitamins, Prosthetic Groups, Pigments	Cobalamin synthesis		AMD	red vs. amd			
Cofactors, Vitamins, Prosthetic Groups, Pigments	Folate and pterines					Molybdopterin	
Cofactors, Vitamins, Prosthetic Groups, Pigments	Quinone cofactors						Pyrrroloquinoline
Quinone biosynthesis	AMD	red vs. amd					
Cofactors, Vitamins, Prosthetic Groups, Pigments	Riboflavin, FMN, FAD						FMN and FAD
biosynthesis in pathogens	AMD	red vs. amd					
Cofactors, Vitamins, Prosthetic Groups, Pigments	Riboflavin, FMN, FAD						Riboflavin
metabolism	AMD	red vs. amd					
Cofactors, Vitamins, Prosthetic Groups, Pigments	Tetrapyrroles						Chlorophyll Biosynthesis
AMD	red vs. amd						
Cofactors, Vitamins, Prosthetic Groups, Pigments	Tetrapyrroles						Porphyrin, Heme, and
Siroheme Biosynthesis	AMD	red vs. amd					
Degradation of Xenobiotics	Anaerobic degradation of aromatic compounds						Anaerobic benzoate
metabolism	AMD	red vs. amd					
Fatty Acids and Lipids	Fatty acids	fatty acid metabolism	AMD	red vs. amd			
Fatty Acids and Lipids	Fatty acids	fatty acid oxidation pathway	AMD	red vs. amd			
Fatty Acids and Lipids	Glycerolipids	Glycerolipid and glycerphospholipid metabolism	AMD				red
vs. amd							
Membrane Transport	ABC transporters	ABC transporter dipeptide (TC 3.A.1.5.2)					AMD
red vs. amd							
Membrane Transport	Uni-, Sym- and Antiporters	Sodium Hydrogen Antiporter					AMD
vs. amd							red
Metabolism of aromatic compounds	Peripheral pathways for catabolism of aromatic compounds						
Benzoate degradation	AMD	red vs. amd					
Nitrogen Metabolism	Allantoin degradation	AMD	red vs. amd				
Protein Metabolism	Protein Biosynthesis	Ribosome LSU eukaryotic and archaeal	AMD				red
vs. amd							
Protein Metabolism	Protein Biosynthesis	Ribosome SSU eukaryotic and archaeal	AMD				red
vs. amd							
Protein Metabolism	Protein Biosynthesis	Translation initiation factors eukaryotic and					
archaeal	AMD	red vs. amd					
Protein Metabolism	Protein Degradation	Proteasome archaeal	AMD	red vs. amd			
Respiration	ATP synthases	V-Type ATP synthase	AMD	red vs. amd			
Respiration	Electron donating reactions	Formate hydrogenase	AMD	red vs. amd			
Respiration	Soluble electron carries	Soluble cytochromes and functionally related					
electron carriers	AMD	red vs. amd					
Virulence	Detection	MLST	AMD	red vs. amd			
Amino Acids and Derivatives	Arginine; urea cycle, polyamines						Urea decomposition
red vs. amd							red
Amino Acids and Derivatives	Aromatic amino acids and derivatives	Tryptophan synthesis					red
red vs. amd							
Amino Acids and Derivatives	Lysine, threonine, methionine, and cysteine	Methionine					
Biosynthesis	red	red vs. amd					
Carbohydrates	Central carbohydrate metabolism	Glyoxylate Synthesis	red	red vs. amd			
Carbohydrates	Central carbohydrate metabolism	Pyruvate metabolism I: anaplerotic reactions, PEP					
red	red vs. amd						
Cell Wall and Capsule	Capsular and extracellular polysacchrides	Capsular polysaccharide					
biosynthesis	red	red vs. amd					
Cell Wall and Capsule	Peptidoglycan biosynthesis	Peptidoglycan Biosynthesis					red
vs. amd							red
Cofactors, Vitamins, Prosthetic Groups, Pigments	Quinone cofactors	Ubiquinone					
Menaquinone-cytochrome c reductase complexes	red	red vs. amd					
DNA metabolism	DNA Replication DNA-replication	red	red vs. amd				
Membrane Transport	ABC transporters	ABC transporter branched-chain amino acid (TC					
3.A.1.4.1)	red	red vs. amd					
Nucleosides and Nucleotides	Purines	De Novo Purine Biosynthesis	red	red vs. amd			
Nucleosides and Nucleotides	Ribonucleotide reduction	red	red vs. amd				
Protein Metabolism	Protein Biosynthesis	Ribosome biogenesis bacterial	red	red vs. amd			
Protein Metabolism	Protein Biosynthesis	Ribosome LSU bacterial	red	red vs. amd			
Protein Metabolism	Protein Biosynthesis	Ribosome SSU bacterial	red	red vs. amd			
Protein Metabolism	Protein Biosynthesis	Translation factors bacterial	red	red vs. amd			
Protein Metabolism	Protein Biosynthesis	Universal GTPases	red	red vs. amd			
Protein Metabolism	Protein Degradation	Proteolysis in bacteria, ATP-dependent	red	red			
vs. amd							
Protein Metabolism	Protein Export and Secretion	General secretory pathway (Sec-SRP) complex					
(TC 3.A.5.1.1)	red	red vs. amd					
Protein Metabolism	Protein Folding GroEL GroES	red	red vs. amd				
Respiration	ATP synthases	F0F1-type ATP synthase	red	red vs. amd			
Respiration	Electron accepting reactions	Terminal cytochrome C oxidases	red	red vs. amd			
Respiration	Electron donating reactions	Membrane-bound Ni, Fe-hydrogenase	red	red			
vs. amd							
RNA metabolism	RNA processing and modification	Polyadenylation bacterial	red	red vs. amd			
RNA metabolism	RNA polymerase bacterial	red	red vs. amd				
RNA metabolism	Transcription factors bacterial	red	red vs. amd				
RNA metabolism	tRNA aminoacylation	red	red vs. amd				
Stress response	Oxidative stress	Protection from Reactive Oxygen Species	red	red vs. amd			
Stress response	Starvation response	ppGpp biosynthesis	red	red vs. amd			
Sulfur Metabolism	Inorganic sulfur assimilation	Inorganic Sulfur Assimilation	red	red			

vs. amd								
Sulfur Metabolism	Inorganic sulfur assimilation	Sulfate assimilation	red	red vs. amd				
Sulfur Metabolism	Inorganic sulfur assimilation	Sulfate to Sulfide	red	red vs. amd				
Virulence	Resistance to Antibiotics	Resistance to fluoroquinolones	red	red vs. amd				
Amino Acids and Derivatives	Proline and 4-hydroxyproline	Proline Catabolism	farm	red				
vs. farm								
Carbohydrates	Aminosugars	N-Acetyl-D-Glucosamine Utilization	farm	red vs. farm				
Carbohydrates	Central carbohydrate metabolism	Butyrate and Butanol Acetone fermentation						
farm	red vs. farm							
Carbohydrates	Monosaccharides	Ketogluconate metabolism	farm	red vs. farm				
Carbohydrates	Sugar alcohols	Ethanolamine utilization	farm	red vs. farm				
Cell Division and Cell Cycle	Cell cycle in Prokaryota	Cyanobacterial Circadian Clock						
farm	red vs. farm							
Cell Wall and Capsule	Cell wall of Mycobacteria	mycolic acid synthesis	farm	red vs.				
farm								
Cell Wall and Capsule	Gram-Positive cell wall components	Teichoic acid Biosynthesis						
farm	red vs. farm							
Clustering-based Subsystems	EC49-61	farm	red vs. farm					
Clustering-based Subsystems	SA:14-24	farm	red vs. farm					
Cofactors, Vitamins, Prosthetic Groups, Pigments		Folate and pterines						Molybdopterin
biosynthesis	farm	red vs. farm						
Degradation of Xenobiotics	Anaerobic degradation of aromatic compounds	Anaerobic benzoate						
metabolism	farm	red vs. farm						
Fatty Acids and Lipids	Fatty acids	fatty acid metabolism	farm	red vs. farm				
Fatty Acids and Lipids	Fatty acids	fatty acid oxidation pathway	farm	red vs. farm				
Membrane Transport	ABC transporters	ABC transporter branched-chain amino acid (TC						
3.A.1.4.1)	farm	red vs. farm						
Membrane Transport	ABC transporters	ABC transporter macrolide	farm	red vs.				
farm								
Membrane Transport	ABC transporters	ABC transporter nickel (TC 3.A.1.5.3)	farm	red				
vs. farm								
Membrane Transport	ABC transporters	ABC transporter ribose (TC 3.A.1.2.1)	farm	red				
vs. farm								
Motility and Chemotaxis	Chemotaxis in Prokaryota	Bacterial Chemotaxis	farm	red vs.				
farm								
Nitrogen Metabolism	Nitrate and nitrite ammonification	farm	red vs. farm					
Respiration	Electron accepting reactions	Anaerobic respiratory reductases	farm	red				
vs. farm								
Respiration	Electron donating reactions	Formate dehydrogenase	farm	red vs. farm				
Respiration	Electron donating reactions	Respiratory dehydrogenases 1	farm	red vs.				
farm								
Respiration	Soluble electron carries	Soluble cytochromes and functionally related						
electron carriers	farm	red vs. farm						
RNA metabolism	RNA processing and modification	tRNA processing	farm	red vs. farm				
Amino Acids and Derivatives	Aromatic amino acids and derivatives	Tryptophan synthesis						red
red vs. farm								
Amino Acids and Derivatives	Branched-chain amino acids	Branched-Chain Amino Acid						
Biosynthesis	red	red vs. farm						
Amino Acids and Derivatives	Branched-chain amino acids	Leucine Biosynthesis v2	red	red				
vs. farm								
Amino Acids and Derivatives	Glutamine, glutamate, aspartate, asparagine; ammonia assimilation							
Asp-Glu-tRNA(Asn-Gln) transamidation	red	red vs. farm						
Amino Acids and Derivatives	Glutamine, glutamate, aspartate, asparagine; ammonia assimilation							
Glutamate biosynthesis	red	red vs. farm						
Amino Acids and Derivatives	Lysine, threonine, methionine, and cysteine	Methionine						
Biosynthesis	red	red vs. farm						
Carbohydrates	Central carbohydrate metabolism	Glyoxylate Synthesis	red	red vs. farm				
Carbohydrates	Central carbohydrate metabolism	Pentose phosphate pathway	red	red vs.				
farm								
Carbohydrates	Central carbohydrate metabolism	TCA Cycle	red	red vs. farm				
Carbohydrates	Organic acids	Methylcitrate cycle	red	red vs. farm				
Cell Division and Cell Cycle	Structural elements	Cytoskeleton	red	red vs. farm				
Cofactors, Vitamins, Prosthetic Groups, Pigments		Quinone cofactors						Ubiquinone
Menaquinone-cytochrome c reductase complexes	red	red vs. farm						
DNA metabolism	DNA Repair	DNA repair, bacterial	red	red vs. farm				
Nucleosides and Nucleotides	Purines De Novo	Purine Biosynthesis	red	red vs. farm				
Nucleosides and Nucleotides	Pyrimidines	De Novo Pyrimidine Synthesis	red	red vs.				
farm								
Nucleosides and Nucleotides	Ribonucleotide reduction	red	red vs. farm					
Protein Metabolism	Protein Biosynthesis	Ribosome LSU bacterial	red	red vs. farm				
Protein Metabolism	Protein Biosynthesis	Ribosome SSU bacterial	red	red vs. farm				
Protein Metabolism	Protein Biosynthesis	Translation factors bacterial	red	red vs.				
farm								
Protein Metabolism	Protein Biosynthesis	Universal GTPases	red	red vs. farm				
Protein Metabolism	Protein Degradation	Proteolysis in bacteria, ATP-dependent	red	red				
vs. farm								
Protein Metabolism	Protein Export and Secretion	General secretory pathway (Sec-SRP) complex						
(TC 3.A.5.1.1)	red	red vs. farm						
Protein Metabolism	Protein Folding GroEL GroES	red	red vs. farm					
Respiration	ATP synthases	F0F1-type ATP synthase	red	red vs. farm				
Respiration	Electron accepting reactions	Terminal cytochrome C oxidases	red	red vs.				

farm						
Respiration	Electron donating reactions	Respiratory Complex I	red	red vs. farm		
RNA metabolism	RNA processing and modification	Polyadenylation bacterial	red	red vs.		
farm						
RNA metabolism	RNA polymerase bacterial		red	red vs. farm		
RNA metabolism	tRNA aminoacylation		red	red vs. farm		
Stress response	Starvation response	ppGpp biosynthesis	red	red vs. farm		
Virulence	Resistance to Antibiotics	Resistance to fluoroquinolones	red	red vs.		
farm						
Carbohydrates	Central carbohydrate metabolism	TCA Cycle	red	red vs. Sargasso		
Respiration	Electron accepting reactions	Terminal cytochrome C oxidases	red	red vs.		
Sargasso						
Carbohydrates vs. Sargasso	Central carbohydrate metabolism	Embden-Meyerhof and Gluconeogenesis		red	red	
Respiration	Electron donating reactions	Respiratory Complex I	red	red vs. Sargasso		
Carbohydrates	Central carbohydrate metabolism	Pentose phosphate pathway	red	red vs.		
Sargasso						
Nucleosides and Nucleotides	Purines De Novo	Purine Biosynthesis	red	red vs. Sargasso		
Nitrogen Metabolism	Denitrification		red	red vs. Sargasso		
Protein Metabolism	Protein Export and Secretion	General secretory pathway (Sec-SRP) complex				
(TC 3.A.5.1.1)	red	red vs. Sargasso				
Carbohydrates	Central carbohydrate metabolism	Glyoxylate Synthesis	red	red vs. Sargasso		
Protein Metabolism	Protein Folding GroEL	GroES	red	red vs. Sargasso		
Respiration	Electron donating reactions	Respiratory dehydrogenases 1	red	red vs.		
Sargasso						
Carbohydrates	Organic acids	Methylcitrate cycle	red	red vs. Sargasso		
Stress response	Starvation response	ppGpp biosynthesis	red	red vs. Sargasso		
Respiration	ATP synthases	FOF1-type ATP synthase	red	red vs. Sargasso		
Virulence	Resistance to Antibiotics	Resistance to fluoroquinolones	red	red vs.		
Sargasso						
Nucleosides and Nucleotides		Ribonucleotide reduction	red	red vs. Sargasso		
Protein Metabolism	Protein Biosynthesis	Ribosome SSU bacterial	red	red vs. Sargasso		
RNA metabolism	tRNA aminoacylation		red	red vs. Sargasso		
RNA metabolism	Transcription factors bacterial		red	red vs. Sargasso		
Protein Metabolism	Protein Biosynthesis	Translation factors bacterial	red	red vs.		
Sargasso						
Cofactors, Vitamins, Prosthetic Groups, Pigments		Quinone cofactors		Ubiquinone		
Menaquinone-cytochrome c reductase complexes			red	red vs. Sargasso		
Amino Acids and Derivatives	Glutamine, glutamate, aspartate, asparagine;	ammonia assimilation				
Asp-Glu-tRNA(Asn-Gln)	transamidation		red	red vs. Sargasso		
Respiration	Electron donating reactions	Membrane-bound Ni, Fe-hydrogenase		red	red	
vs. Sargasso						
Stress response	Oxidative stress	Protection from Reactive Oxygen Species	red	red vs.		
Sargasso						
Amino Acids and Derivatives	Branched-chain amino acids	Branched-Chain Amino Acid				
Biosynthesis	red	red vs. Sargasso				
RNA metabolism	RNA processing and modification	Queuosine-Archaeosine Biosynthesis		red	red	
vs. Sargasso						
Protein Metabolism	Protein Biosynthesis	Universal GTPases	red	red vs. Sargasso		
DNA metabolism	DNA Repair	DNA repair, bacterial	red	red vs. Sargasso		
Protein Metabolism	Protein Degradation	Proteolysis in bacteria, ATP-dependent	red	red		
vs. Sargasso						
RNA metabolism	Transcription factors cyanobacterial	RpoD-like sigma factors		Sargasso		
red vs. Sargasso						
Carbohydrates	Monosaccharides	Fucose and rhamnose degradation	Sargasso	red vs. Sargasso		
Carbohydrates vs. Sargasso	Central carbohydrate metabolism	Acetogenesis from Pyruvate	Sargasso	Sargasso	red	
Nitrogen Metabolism	Allantoin degradation		Sargasso	red vs. Sargasso		
Nitrogen Metabolism	Ammonia assimilation		Sargasso	red vs. Sargasso		
Cofactors, Vitamins, Prosthetic Groups, Pigments		Isoprenoids		Carotenoids	Sargasso	
red vs. Sargasso						
Carbohydrates	Central carbohydrate metabolism	Butyrate and Butanol	Acetone fermentation			
Sargasso	red vs. Sargasso					
Protein Metabolism	Protein Biosynthesis	Ribosome LSU chloroplast		Sargasso	red	
vs. Sargasso						
Amino Acids and Derivatives	Aromatic amino acids and derivatives	Chorismate Synthesis				
Sargasso	red vs. Sargasso					
Fatty Acids and Lipids	Fatty acids	Fatty Acid Biosynthesis FASII	Sargasso	red vs.		
Sargasso						
Fatty Acids and Lipids	Fatty acids	fatty acid metabolism	Sargasso	red vs. Sargasso		
Cofactors, Vitamins, Prosthetic Groups, Pigments		Quinone cofactors		Menaquinone and		
Phylloquinone Biosynthesis	Sargasso	red vs. Sargasso				
Carbohydrates	Monosaccharides	Ketogluconate metabolism	Sargasso	red vs. Sargasso		
Cell Wall and Capsule	Gram-Negative cell wall components	Lipid A biosynthesis		Sargasso		
red vs. Sargasso						
Cell Wall and Capsule	Cell wall of Mycobacteria	mycolic acid synthesis	Sargasso	red		
vs. Sargasso						
Carbohydrates	Aminosugars	N-Acetyl-D-Glucosamine Utilization	Sargasso	red vs.		
Sargasso						
Cell Wall and Capsule	Glycosylation	N-linked Glycosylation in Bacteria	Sargasso	red		
vs. Sargasso						

Phosphorus Metabolism		P uptake (cyanobacteria)	Sargasso	red vs. Sargasso	
Carbohydrates	Central	carbohydrate metabolism	Embden-Meyerhof and Gluconeogenesis	Archaeal	
Sargasso	red vs. Sargasso				
Carbohydrates	Central	carbohydrate metabolism	Pyruvate Alanine Serine Interconversions		
Sargasso	red vs. Sargasso				
Protein Metabolism		Protein Biosynthesis	Ribosome SSU chloroplast	Sargasso	red
vs. Sargasso					
Cofactors, Vitamins, Prosthetic Groups, Pigments			Thiamine and thiamine pyrophosphate		
Thiamin biosynthesis	Sargasso	red vs. Sargasso			
Metabolism of aromatic compounds		Peripheral pathways for catabolism of aromatic compounds			
Quinate degradation	Sargasso	red vs. Sargasso			
Membrane Transport	ABC transporters		ABC transporter glutamine (TC 3.A.1.3.2)		
Sargasso	red vs. Sargasso				
Membrane Transport	ABC transporters		ABC transporter L-proline glycine betaine (TC 3.A.1.12.1)		
Sargasso	red vs. Sargasso				
Degradation of Xenobiotics		Anaerobic degradation of aromatic compounds		Anaerobic benzoate	
metabolism	Sargasso	red vs. Sargasso			
RNA metabolism		RNA polymerase chloroplast	Sargasso	red vs. Sargasso	
Clustering-based Subsystems		SA:14-24	Sargasso	red vs. Sargasso	
Amino Acids and Derivatives		Aromatic amino acids and derivatives	Sargasso	red vs. Sargasso	
pathway of aromatic compound degradation			Sargasso	red vs. Sargasso	
Protein Metabolism	Protein Biosynthesis		Ribosome LSU mitochondrial	Sargasso	red
vs. Sargasso					
Protein Metabolism	Protein Biosynthesis		Ribosome SSU mitochondrial	Sargasso	red
vs. Sargasso					
RNA metabolism		tRNA aminoacylation, mitochondrial	Sargasso	red vs. Sargasso	
Membrane Transport	ABC transporters		ABC transporter polyamine putrescine spermidine (TC 3.A.1.11.1)		
Sargasso	red vs. Sargasso				
Fatty Acids and Lipids	Glycerolipids		Glycerolipid and glycerphospholipid metabolism	Sargasso	
red vs. Sargasso					
Respiration		Electron donating reactions	Coenzyme F420-H2 dehydrogenase (methanophenazine)		
Sargasso	red vs. Sargasso				
Cofactors, Vitamins, Prosthetic Groups, Pigments			Folate and pterines	Molybdopterin	
biosynthesis	Sargasso	red vs. Sargasso			
Virulence	Detection	MLST	Sargasso	red vs. Sargasso	
Amino Acids and Derivatives		Alanine, serine, and glycine	Glycine cleavage system	red	red
vs. seed					
Amino Acids and Derivatives		Aromatic amino acids and derivatives	Tryptophan synthesis	red	red
red vs. seed					
Amino Acids and Derivatives		Branched-chain amino acids	Branched-Chain Amino Acid		
Biosynthesis	red	red vs. seed			
Amino Acids and Derivatives		Branched-chain amino acids	Leucine Biosynthesis v2	red	red
vs. seed					
Amino Acids and Derivatives		Glutamine, glutamate, aspartate, asparagine; ammonia assimilation			
Asp-Glu-tRNA(Asn-Gln) transamidation	red	red vs. seed			
Amino Acids and Derivatives		Glutamine, glutamate, aspartate, asparagine; ammonia assimilation			
Glutamate biosynthesis	red	red vs. seed			
Amino Acids and Derivatives		Glutamine, glutamate, aspartate, asparagine; ammonia assimilation			
Glutamate, aspartate and asparagine biosynthesis	red	red vs. seed			
Amino Acids and Derivatives		Lysine, threonine, methionine, and cysteine	Methionine		
Biosynthesis	red	red vs. seed			
Carbohydrates	Central	carbohydrate metabolism	Embden-Meyerhof and Gluconeogenesis	red	red
vs. seed					
Carbohydrates	Central	carbohydrate metabolism	Glyoxylate Synthesis	red	red vs. seed
Carbohydrates	Central	carbohydrate metabolism	Pentose phosphate pathway	red	red vs. seed
seed					
Carbohydrates	Central	carbohydrate metabolism	Pyruvate metabolism I: anaplerotic reactions, PEP		
red	red vs. seed				
Carbohydrates	Central	carbohydrate metabolism	TCA Cycle	red	red vs. seed
Carbohydrates	Organic acids	Methylcitrate cycle	red	red vs. seed	
Cell Division and Cell Cycle		Structural elements	Cytoskeleton	red	red vs. seed
Cell Wall and Capsule	Gram-Negative cell wall components		dTDP-rhamnose synthesis	red	red
vs. seed					
Cofactors, Vitamins, Prosthetic Groups, Pigments			Quinone cofactors	Ubiquinone	
Menaquinone-cytochrome c reductase complexes	red	red vs. seed			
DNA metabolism	DNA Repair	DNA Repair Base Excision	red	red vs. seed	
DNA metabolism	DNA Repair	DNA repair, bacterial	red	red vs. seed	
DNA metabolism	DNA Replication	DNA-replication	red	red vs. seed	
Nucleosides and Nucleotides		Purines De Novo	Purine Biosynthesis	red	red vs. seed
Nucleosides and Nucleotides		Pyrimidines	De Novo Pyrimidine Synthesis	red	red vs. seed
seed					
Nucleosides and Nucleotides		Ribonucleotide reduction	red	red vs. seed	
Protein Metabolism	Protein Biosynthesis		Ribosome SSU bacterial	red	red vs. seed
Protein Metabolism	Protein Biosynthesis		Translation factors bacterial	red	red vs. seed
seed					
Protein Metabolism	Protein Biosynthesis		Universal GTPases	red	red vs. seed
Protein Metabolism	Protein Degradation		Proteolysis in bacteria, ATP-dependent	red	red
vs. seed					
Protein Metabolism	Protein Export and Secretion		General secretory pathway (Sec-SRP) complex		
(TC 3.A.5.1.1)	red	red vs. seed			
Protein Metabolism	Protein Folding	GroEL GroES	red	red vs. seed	

Respiration	ATP synthases	F0F1-type ATP synthase	red	red vs. seed		
Respiration seed	Electron accepting reactions	Terminal cytochrome C oxidases	red	red vs.		
Respiration	Electron donating reactions	Respiratory Complex I	red	red vs. seed		
Respiration seed	Electron donating reactions	Respiratory dehydrogenases 1	red	red vs.		
RNA metabolism seed	RNA processing and modification	Polyadenylation bacterial		red	red vs.	
RNA metabolism	RNA polymerase	bacterial	red	red vs. seed		
RNA metabolism	Transcription factors	bacterial	red	red vs. seed		
RNA metabolism	tRNA aminoacylation		red	red vs. seed		
Stress response	Starvation response	ppGpp biosynthesis	red	red vs. seed		
Virulence seed	Resistance to Antibiotics	Resistance to fluoroquinolones	red	red vs.		
Carbohydrates	Aminosugars	N-Acetyl-D-Glucosamine Utilization	SEED	red vs. seed		
Carbohydrates SEED	Central carbohydrate metabolism	Pyruvate Alanine Serine Interconversions				
Carbohydrates	Monosaccharides	Fucose and rhamnose degradation	SEED	red vs. seed		
Carbohydrates	Monosaccharides	Ketogluconate metabolism	SEED	red vs. seed		
Carbohydrates	Monosaccharides	L-ascorbate degradation	SEED	red vs. seed		
Carbohydrates	Monosaccharides	The Tartronate Semialdehyde Hub	SEED	red vs. seed		
Carbohydrates	Organic acids	Propanediol utilization	SEED	red vs. seed		
Carbohydrates	Sugar alcohols	Ethanolamine utilization	SEED	red vs. seed		
Carbohydrates	Sugar alcohols	Galactitol degradation	SEED	red vs. seed		
Cell Division and SEED	Cell Cycle	Cell cycle in Prokaryota		Cyanobacterial Circadian Clock		
Cell signaling	Signal transduction in prokaryota		Phytochromes	SEED	red vs. seed	
Cell signaling SEED	Signal transduction in Prokaryota		Rrf2 family transcriptional regulators			
Cell Wall and Capsule seed	Cell wall of Mycobacteria		mycolic acid synthesis	SEED	red vs.	
Cell Wall and Capsule seed	Glycosylation	N-linked Glycosylation in Bacteria		SEED	red vs.	
Cell Wall and Capsule loci SEED	Gram-Negative cell wall components		Capsular surface virulence antigen			
Clustering-based Subsystems		EC49-61 SEED	red vs. seed			
Cofactors, Vitamins, Prosthetic Groups, Pigments seed			Cobalamin synthesis	SEED	red vs.	
Cofactors, Vitamins, Prosthetic Groups, Pigments vs. seed			Biotin Biotin biosynthesis	SEED	red	
Cofactors, Vitamins, Prosthetic Groups, Pigments biosynthesis SEED			Folate and pterines	Molybdopterin		
Cofactors, Vitamins, Prosthetic Groups, Pigments vs. seed			Isoprenoids	Carotenoids	SEED	red
Cofactors, Vitamins, Prosthetic Groups, Pigments Phylloquinone Biosynthesis SEED			Quinone cofactors	Menaquinone and		
Cofactors, Vitamins, Prosthetic Groups, Pigments biosynthesis SEED			Siderophores	Siderophore enterobactin		
Cofactors, Vitamins, Prosthetic Groups, Pigments biosynthesis and ferric enterbactin transport SEED			Siderophores	Siderophore enterobactin		
Cofactors, Vitamins, Prosthetic Groups, Pigments SEED			Tetrapyrroles	Chlorophyll Biosynthesis		
Cofactors, Vitamins, Prosthetic Groups, Pigments Thiamin biosynthesis SEED			Thiamine and thiamine pyrophosphate			
DNA metabolism	DNA uptake, competence	gram plus late competence	SEED	red vs. seed		
Experimental Subsystems vs. seed	Auxiliary Subsystems	Phosphoglycerate mutase protein family	SEED	red		
Experimental Subsystems SEED	Temporary subsystems	Vibrio Experimental Type III secretion system				
Fatty Acids and Lipids vs. seed	Glycerolipids	Glycerolipid and glycerphospholipid metabolism	SEED	red		
Membrane Transport SEED	ABC transporters	ABC transporter alkylphosphonate (TC 3.A.1.9.1)				
Membrane Transport SEED	ABC transporters	ABC transporter ferrichrome (TC 3.A.1.14.3)				
Membrane Transport SEED	ABC transporters	ABC transporter iron(III) dicitrate (TC 3.A.1.14.1)				
Membrane Transport SEED	ABC transporters	ABC transporter molybdenum (TC 3.A.1.8.1)				
Membrane Transport vs. seed	ABC transporters	ABC transporter nickel (TC 3.A.1.5.3)	SEED	red		
Membrane Transport vs. seed	ABC transporters	ABC transporter peptide (TC 3.A.1.5.5)	SEED	red		
Membrane Transport vs. seed	ABC transporters	CbiQO-type ABC transporter systems	SEED	red		
Membrane Transport seed	ABC transporters	Transport of Nickel and Cobalt	SEED	red vs.		
Metabolism of aromatic compounds		Peripheral pathways for catabolism of aromatic compounds				
Benzoate degradation SEED			SEED	red vs. seed		
Metabolism of aromatic compounds		Peripheral pathways for catabolism of aromatic compounds				
Biphenyl Degradation SEED			SEED	red vs. seed		

Metabolism of aromatic compounds	Peripheral pathways for catabolism of aromatic compounds			
Phenylpropanoid compound degradation	SEED	red vs. seed		
Motility and Chemotaxis	Chemotaxis in Prokaryota	Bacterial Chemotaxis	SEED	red vs. seed
Phosphorus Metabolism	P uptake (cyanobacteria)		SEED	red vs. seed
Protein Metabolism	Protein Biosynthesis	Ribosome LSU chloroplast	SEED	red vs. seed
Protein Metabolism vs. seed	Protein Biosynthesis	Ribosome LSU eukaryotic and archaeal	SEED	red vs. seed
Protein Metabolism vs. seed	Protein Biosynthesis	Ribosome LSU mitochondrial	SEED	red vs. seed
Protein Metabolism vs. seed	Protein Biosynthesis	Ribosome SSU chloroplast	SEED	red vs. seed
Protein Metabolism vs. seed	Protein Biosynthesis	Ribosome SSU eukaryotic and archaeal	SEED	red vs. seed
Protein Metabolism vs. seed	Protein Biosynthesis	Ribosome SSU mitochondrial	SEED	red vs. seed
Protein Metabolism archaeal	SEED	red vs. seed	Translation initiation factors eukaryotic and archaeal	
Protein Metabolism vs. seed	Protein Degradation	Phenylpropionate Degradation	SEED	red vs. seed
Protein Metabolism vs. seed	Protein Degradation	Proteasome eukaryotic	SEED	red vs. seed
Respiration vs. seed	Electron accepting reactions	Anaerobic respiratory reductases	SEED	red
Respiration vs. seed	Electron donating reactions	Coenzyme F420-H2 dehydrogenase (methanophenazine)		
Respiration vs. seed	Electron donating reactions	Formate dehydrogenase	SEED	red vs. seed
Respiration vs. seed	Soluble electron carriers	Soluble cytochromes and functionally related		
RNA metabolism	RNA polymerase chloroplast		SEED	red vs. seed
RNA metabolism vs. seed	RNA polymerase II initiation factors		SEED	red vs. seed
RNA metabolism vs. seed	Transcription factors	cyanobacterial RpoD-like sigma factors		SEED red
RNA metabolism vs. seed	tRNA aminoacylation, mitochondrial		SEED	red vs. seed
Sulfur Metabolism vs. seed	Inorganic sulfur assimilation	Inorganic Sulfur Assimilation		SEED red
Sulfur Metabolism vs. seed	Organic sulfur assimilation	Alkanesulfonates Utilization		SEED red
Virulence proteins	Invasion and intracellular resistance	Listeria surface proteins: Internalin-like		
Virulence vs. seed	SEED	red vs. seed		
Virulence vs. seed	Invasion and intracellular resistance	Listeria surface proteins: LPXTG motif		
Virulence vs. seed	Toxins, Superantigens	Cholera toxin	SEED	red vs. seed
Amino Acids and Derivatives	Derivatives	Aromatic amino acids and derivatives		Tryptophan synthesis red
Amino Acids and Derivatives	Derivatives	Branched-chain amino acids		Branched-Chain Amino Acid
Amino Acids and Derivatives	Derivatives	Glutamine, glutamate, aspartate, asparagine; ammonia assimilation		
Asp-Glu-tRNA(Asn-Gln) transamidation	red	red vs. whale		
Amino Acids and Derivatives	Derivatives	Lysine, threonine, methionine, and cysteine		Methionine
Biosynthesis	red	red vs. whale		
Carbohydrates	Central carbohydrate metabolism	Glyoxylate Synthesis	red	red vs. whale
Carbohydrates	Central carbohydrate metabolism	Pentose phosphate pathway		red red vs.
Carbohydrates	Central carbohydrate metabolism	TCA Cycle	red	red vs. whale
Carbohydrates	Organic acids	Methylcitrate cycle	red	red vs. whale
Cell Division and Cell Cycle	Structural elements	Cytoskeleton	red	red vs. whale
Cell Wall and Capsule	Gram-Negative cell wall components	dTDP-rhamnose synthesis	red	red
Cofactors, Vitamins, Prosthetic Groups, Pigments		Quinone cofactors		Ubiquinone
Menaquinone-cytochrome c reductase complexes	red	red vs. whale		
DNA metabolism	DNA Repair	DNA repair, bacterial	red	red vs. whale
Nucleosides and Nucleotides	Purines De Novo	Purine Biosynthesis	red	red vs. whale
Nucleosides and Nucleotides	Pyrimidines	De Novo Pyrimidine Synthesis	red	red vs. whale
Nucleosides and Nucleotides		Ribonucleotide reduction	red	red vs. whale
Protein Metabolism	Protein Biosynthesis	Ribosome LSU bacterial	red	red vs. whale
Protein Metabolism	Protein Biosynthesis	Ribosome SSU bacterial	red	red vs. whale
Protein Metabolism	Protein Biosynthesis	Translation factors bacterial	red	red vs. whale
Protein Metabolism	Protein Biosynthesis	Universal GTPases	red	red vs. whale
Protein Metabolism vs. whale	Protein Degradation	Proteolysis in bacteria, ATP-dependent	red	red
Protein Metabolism (TC 3.A.5.1.1)	Protein Export and Secretion	General secretory pathway (Sec-SRP) complex		
Protein Metabolism	Protein Folding	GroEL GroES	red	red vs. whale
Respiration	ATP synthases	F0F1-type ATP synthase	red	red vs. whale
Respiration	Electron accepting reactions	Terminal cytochrome C oxidases	red	red vs. whale
Respiration	Electron donating reactions	Respiratory Complex I	red	red vs. whale
RNA metabolism	RNA processing and modification	Polyadenylation bacterial	red	red vs. whale

whale						
RNA metabolism		RNA polymerase bacterial	red	red vs. whale		
RNA metabolism		Transcription factors bacterial	red	red vs. whale		
RNA metabolism		tRNA aminoacylation	red	red vs. whale		
Virulence	Resistance to Antibiotics			Resistance to fluoroquinolones	red	red vs.
whale						
Amino Acids and Derivatives		Alanine, serine, and glycine		Alanine Biosynthesis	whale	red
vs. whale						
Amino Acids and Derivatives		Aromatic amino acids and derivatives		Central meta-cleavage		
pathway of aromatic compound degradation		whale	red vs. whale			
Amino Acids and Derivatives		Branched-chain amino acids		HMG CoA Synthesis	whale	red
vs. whale						
Amino Acids and Derivatives		Branched-chain amino acids		Isoleucine degradation	whale	red
vs. whale						
Amino Acids and Derivatives		Branched-chain amino acids		Leucine Degradation and HMG-CoA		
Metabolism	whale red vs. whale					
Amino Acids and Derivatives		Branched-chain amino acids		Valine degradation	whale	red
vs. whale						
Carbohydrates	Aminosugars	N-Acetyl-D-Glucosamine Utilization		whale	red vs. whale	
Carbohydrates	Central carbohydrate metabolism	Acetogenesis from Pyruvate		whale	red vs.	
whale						
Carbohydrates	Central carbohydrate metabolism	Butyrate and Butanol		Acetone fermentation		
whale red vs. whale						
Carbohydrates	Central carbohydrate metabolism	Methylglyoxal Metabolism		whale	red vs.	
whale						
Carbohydrates	Monosaccharides	Fucose and rhamnose degradation	whale	red vs. whale		
Carbohydrates	Monosaccharides	Ketogluconate metabolism	whale	red vs. whale		
Cell Division and Cell Cycle	Cell Cycle	Cell cycle in Prokaryota		Cyanobacterial Circadian Clock		
whale red vs. whale						
Cell Wall and Capsule	Cell wall of Mycobacteria	mycolic acid synthesis	whale	red vs.		
whale						
Cell Wall and Capsule	Gram-Positive cell wall components	Teichoic acid Biosynthesis				
whale red vs. whale						
Clustering-based Subsystems		EC49-61	whale	red vs. whale		
Clustering-based Subsystems		SA:14-24	whale	red vs. whale		
Cofactors, Vitamins, Prosthetic Groups, Pigments				Cobalamin synthesis	whale	red vs.
whale						
Cofactors, Vitamins, Prosthetic Groups, Pigments				Riboflavin, FMN, FAD	FMN and FAD	
biosynthesis in pathogens	whale red vs. whale					
Degradation of Xenobiotics		Anaerobic degradation of aromatic compounds			Anaerobic benzoate	
metabolism	whale red vs. whale					
Fatty Acids and Lipids	Fatty acids	fatty acid metabolism	whale	red vs. whale		
Fatty Acids and Lipids	Fatty acids	fatty acid oxidation pathway	whale	red vs. whale		
Fatty Acids and Lipids	Glycerolipids	Glycerolipid and glycerphospholipid metabolism	whale	red		
vs. whale						
Membrane Transport	ABC transporters	ABC transporter ferrichrome (TC 3.A.1.14.3)				
whale red vs. whale						
Membrane Transport	ABC transporters	ABC transporter iron(III) dicitrate (TC 3.A.1.14.1)				
whale red vs. whale						
Membrane Transport	ABC transporters	ABC transporter macrolide	whale	red vs.		
whale						
Membrane Transport	ABC transporters	ABC transporter polyamine putrescine spermidine (TC 3.A.1.11.1)	whale	red vs. whale		
whale						
Metabolism of aromatic compounds		Metabolism of central aromatic intermediates				
Phenylacetate pathway of aromatic compound degradation		whale	red vs. whale			
Metabolism of aromatic compounds		Metabolism of central aromatic intermediates				
Protocatechuate branch of beta-ketoadipate pathway		whale	red vs. whale			
Metabolism of aromatic compounds		Peripheral pathways for catabolism of aromatic compounds				
Benzoate degradation	whale red vs. whale					
Metabolism of aromatic compounds		Peripheral pathways for catabolism of aromatic compounds				
n-Phenylalkanoic acid degradation	whale red vs. whale					
Motility and Chemotaxis	Chemotaxis in Prokaryota	Bacterial Chemotaxis	whale	red vs.		
whale						
Respiration	Electron accepting reactions	Anaerobic respiratory reductases		whale	red	
vs. whale						
Virulence	Detection	MLST	whale	red vs. whale		