Walkthrough of the MORS User Interface

Here, we provide a step by step guide for setting up the parameters in the MORS Graphical User Interface (GUI), to run the route search for Example 1 from the main paper. Example 1 finds routes from L-tryptophan to indoxyl sulfate. Modifying a few of the steps below for searching routes that have different start and goal metabolites, or differing organism sets, should be straight forward.

Each figure captures one step in the procedure, and shows a screen snapshot from a Web browser that depicts the result of the operation that is described in the figure's legend.

A modern Web browser is recommended. MORS needs SVG graphics, which does not work correctly on Safari, Chrome, and Internet Explorer. Please choose Firefox as the browser. We tested on Firefox 56.0.2 on MacOS High Sierra (10.13.6) and on Firefox 65.0.1 on MacOS 10.11.6. Because of the problems with SVG, we are looking into changing the display code to use HTML 5 technology, instead of SVG. Once this is done, hopefully the full range of modern browsers will be supported in a future BioCyc release.

ome	Search -	Genome 🔻	Metabolism 🕶	Analysis 🔻	SmartTables -	Help 🔻			richia coli K-12 substr. MG1655 (EcoC	ycy change or	janishi databa
					I						
				Metaboli	c Route Sea	rch of	Escherichia coli K-1	2 subs	str. MG1655		
					Pleas	se read th	e detailed HowTo instructions.				
					Rout	es across	Multiple Organisms? 🛙 🗆				
		Start compo	ound 😧				Native reaction cost @	5			
		Goal compo	ound 😧					100	All atoms		
		Number of ro					Avoid compounds 0		elect a SmartTable of Compounds		
		iximum time (·				Avoid side compounds 0	None. S	elect a SmartTable of Compounds		
		mum route lei					Avoid reactions 0	None. S	elect a SmartTable of Reactions	\$	
		arch Routes	10								
			olving MetaCyc r	eactions in ac	dition to reaction	s from this	PGDB, install Pathway Tools	locally an	nd supply the -metroute-metacyc co	mmandline arg	jument.
	Errors or Bro	vide Feedbac	k								

Figure 1: On BioCyc, accessible at https://biocyc.org/, select the menu command Metabolism \rightarrow Metabolic Route Search, which then displays the Route Search page, which is an editable form for specifying the parameters of a search. Directly underneath the title is a link to additional detailed HowTo instructions, which should be read. Those instructions can also be consulted for discussions of parameters not mentioned in the walkthrough example here. Please also note that each parameter entry box has a green icon containing a question mark. Clicking on these help buttons will show specific help information in a small popup window.

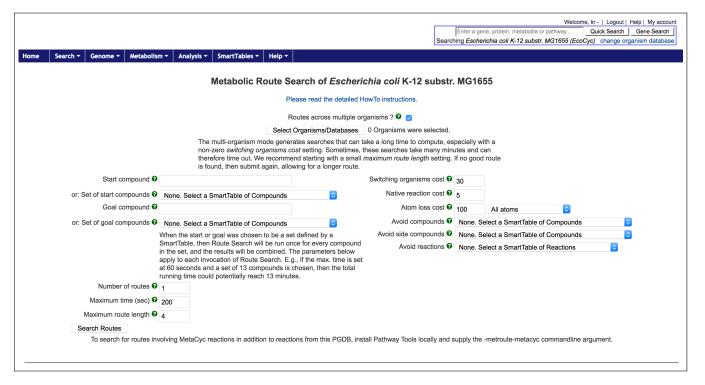


Figure 2: Select the MORS mode by clicking the checkbox called **Routes across Multiple Organisms** ?. Thereafter, additional GUI controls are exposed, including the **Select Organisms/Databases** button.

Specify List o	f Organism Databa	ases				×
Select One By Name	or More Databas	ses: By Organism Prope	erties My Lists	Add - Removi Clear	e ← 0 databases or taxonon	nic groups currently
DEF GHIJKLMNOPQRSTUVWXYZ	idium homopropior sapiens	2 matching data	bases available ge and gray backgrounds	5,		
Re	member Current S	Selection: As new n As update	amed list: ed existing list: helico	Save Save		OK Cancel

Figure 3: Click on the **Select Organisms/Databases** button to bring up this popup shown here, which is the selector titled **Specify List of Organism Databases**. First, choose the tab **By Name**, where typing a substring of an organism shows an increasingly narrowed choice of matching names. Click on "Homo sapiens" to select this organism and add it to the **Current Selection** column on the right hand side.

Specify List of Organism Databases		x
Select One or More Databases: By Name By Taxonomy By Organism Properties My Lists	$\begin{array}{c} Add \rightarrow \\ \\ Remove \leftarrow \\ \\ \\ \\ \\ Clear All \end{array}$	Current Selection 1 databases or taxonomic groups currently selected.
Find organisms whose property: Select Property Image: Select Property		Homo sapiens
Find Organisms		
Tier 1 and Tier 2 databases are displayed with orange and gray backgrounds, respectively.		
Remember Current Selection: As new named list:	Save	
As updated existing list: helico	Save	OK Cancel

Figure 4: Second, choose the tab **By Organism Properties**. The additionally revealed controls enable selecting organisms based on metadata recorded by the genome-sequencing project.

Specify List of Organism Databases			x
Specify List of Organism Databases Select One or More Databases: By Name By Taxonomy By Organism Prope Find organisms whose property: Select Property # Enzymes (13079) # Go-Terms (13079) # Gene Essentiality Datasets (32) # Genes (13079) # Genes with Essentiality Data (37) # Pathways (13079) # Denotype Microarray Datasets (2) # Transcriptional Regulatory Interactions (36) # Transporters (13079) Biotic Relationship (524) Collection Date (Year) (4556) Depth/Altitude (m) (133) Environment (7396) Genome Size (13068) Geographic Location (6017) Health/Disease State (404)	erties My Lists has values	Add → Remove ← Clear All	Current Selection 1 databases or taxonomic groups currently selected. Homo sapiens
Geographic Location (6017) Health/Disease State (404) Host (3250) Human Microbiome Body Site (1880) Latitude (1554) Tier 1 and Tier 2 databases are displayed with orang respectively. Remember Current Selection: As new n		Save	
As upuale		Cave	

Figure 5: As the first step, click on **Select Properties** to list the provided choices. For this example, choose **Human Microbiome Body Site**. The number in parentheses states how many organisms were labelled with the respective property.

ect One or More Databases:	$Add \rightarrow$	Current Selection
v Name By Taxonomy By Organism Properties My Lists	Remove ← Clear All	1 databases or taxonomic groups currently selected.
nd organisms whose property: Human Microbiome Body Site (1880)		Homo sapiens
Human Microbiome Body Site (1880) ᅌ has values ᅌ		
airways (78)		
plood (245)		
bone (3)		
central-nervous-system (22)		
ear (2)		
jastrointestinal-tract (480) neart (2)		
ymph-nodes (2)		
nose (3)		
not-specified (458)		
oral (274)		
skin (138) Jrogenital-tract (172)		
vound (24)		
1 and Tier 2 databases are displayed with orange and gray backgrounds,		
bectively.		
Remember Current Selection: As new named list:	Save	
	Save	
As updated existing list: helico	Save	OK Cano

Figure 6: As the second step, click on the newly revealed selector that states **Click to see possible values**. For this example, choose **gastrointestinal-tract**. The number in parentheses again states how many organisms were labelled with the respective property.

pecify List of Organism Databases					
elect One or More Databases: By Name By Taxonomy By Organism Pro	perties My Lists	$\begin{array}{c} Add \rightarrow \\ Remove \leftarrow \\ Clear All \end{array}$	Current Selection 1 databases or taxonomic groups currently selected.		
Find organisms whose property:					
Human Microbiome Body Site (1880)	 has values 		Homo sapiens		
gastrointestinal-tract (480) ×					
Add Constraint Find Organisms 480	matching organisms were found.				
Organism	Human Microbiome Body Site ≑				
Acidaminococcus sp. D21	gastrointestinal-tract				
Acinetobacter iunii SH205	gastrointestinal-tract				
cinetobacter radioresistens SH164	gastrointestinal-tract				
Alistipes indistinctus YIT 12060	gastrointestinal-tract				
Alistipes putredinis DSM 17216	gastrointestinal-tract				
Alistipes sp. HGB5	gastrointestinal-tract				
Anaerobaculum hydrogeniformans ATCC 3AA-1850	gastrointestinal-tract				
Anaerococcus hydrogenalis DSM 7454	gastrointestinal-tract				
Anaerofustis stercorihominis DSM 17244	gastrointestinal-tract				
Anaerostipes caccae DSM 14662	gastrointestinal-tract				
Anaerostipes hadrus DSM 3319	gastrointestinal-tract				
Anaerostipes sp. 3_2_56FAA	gastrointestinal-tract				
Anaerotruncus colihominis DSM 17241	gastrointestinal-tract				
Aneurinibacillus aneurinilyticus ATCC 12856	gastrointestinal-tract				
Arcobacter butzleri JV22	gastrointestinal-tract				
Bacillus alcalophilus ATCC 27647 = CGMCC 1.3604	gastrointestinal-tract				
Bacillus niacini F8	gastrointestinal-tract				
Bacillus smithii 7_3_47FAA	gastrointestinal-tract				
Bacillus sp. 7_6_55CFAA_CT2	gastrointestinal-tract				
Bacteroides clarus YIT 12056	gastrointestinal-tract				
er 1 and Tier 2 databases are displayed with ora spectively.	nge and gray backgrounds,				
Remember Current Selection: As new	named list:	Save			
As upd	ated existing list: helico	Save	OK Car	ncel	

Figure 7: As the third step, click on the button labelled **Find Organisms**. As the result, all the organisms that fulfill the search criteria are listed underneath, to enable selecting a subset of organisms.

elect One or More Databases:		$\begin{array}{c} Add \rightarrow \\ \\ Remove \leftarrow \end{array}$	Current Selection
By Name By Taxonomy By Organism Pro	operties My Lists	Clear All	1 databases or taxonomic groups currently selected.
-ind organisms whose property:			Homo sapiens
Human Microbiome Body Site (1880)	ᅌ has values 📀		
gastrointestinal-tract (480) 🗙			
Add Constraint Find Organisms 480) matching organisms were found.		
Aud Constraint Prind Organisms 460	matching organisms were found.		
Organism A	Human Microbiome Body Site 🌻		
Acidaminococcus sp. D21	gastrointestinal-tract		
Acinetobacter junii SH205	gastrointestinal-tract		
Acinetobacter radioresistens SH164	gastrointestinal-tract		
Alistipes indistinctus YIT 12060	gastrointestinal-tract		
Alistipes putredinis DSM 17216	gastrointestinal-tract		
Alistipes sp. HGB5	gastrointestinal-tract		
Anaerobaculum hydrogeniformans ATCC BAA-1850	gastrointestinal-tract		
Anaerococcus hydrogenalis DSM 7454	gastrointestinal-tract		
Anaerofustis stercorihominis DSM 17244	gastrointestinal-tract		
Anaerostipes caccae DSM 14662	gastrointestinal-tract		
Anaerostipes hadrus DSM 3319	gastrointestinal-tract		
Anaerostipes sp. 3 2 56FAA	gastrointestinal-tract		
Anaerotruncus colihominis DSM 17241	gastrointestinal-tract		
Aneurinibacillus aneurinilyticus ATCC 12856	gastrointestinal-tract		
Arcobacter butzleri JV22	gastrointestinal-tract		
Bacillus alcalophilus ATCC 27647 = CGMCC 1.3604	gastrointestinal-tract		
Bacillus niacini F8	gastrointestinal-tract		
Bacillus smithii 7_3_47FAA	gastrointestinal-tract		
Bacillus sp. 7_6_55CFAA_CT2	gastrointestinal-tract		
Bacteroides clarus YIT 12056	gastrointestinal-tract		
er 1 and Tier 2 databases are displayed with ora spectively.	ange and gray backgrounds,	1	

Figure 8: To select one organism, simply click on it, which marks it green, thereby indicating its selected status.

Vibrio cholerae HC-61A2 gastrointestinal-tract Vibrio cholerae HC-65A1 gastrointestinal-tract Vibrio cholerae HC-65A1 gastrointestinal-tract Vibrio cholerae HC-78A1 gastrointestinal-tract Vibrio cholerae HC-78A1 gastrointestinal-tract Vibrio cholerae HC-78A1 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. NHCC-004A gastrointestinal-tract Vibrio cholerae O1 str. NHCC-006C gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008G gastrointestinal-tract Clostridium asparagiforme] DSM 15981 gastrointestinal-tract Clostridium jcitoniae WAL-17108 gastrointestinal-tract Clostridium lostM 15275 gastrointestinal-tract Clostridium hiranonis DSM 15053 gastrointestinal-tract Clostridium jetpum DSM 753 gastrointestinal-tract Clostridium jetpum DSM 753 gastrointestinal-tract Clostridium spinoforme DSM 1552 gastrointestinal-tract Clostridium spinoforme DSM 3353 gastrointestinal-tract Clostridium jetli DSM 3353 gastrointestinal-tract Clostridium jetli DSM 3353 gastrointestinal-tract Clostridium jetli DSM 3353 gastrointestinal-tract Clostridium jetli DSM 3353 gastrointestinal-tract	elect One	ect One or More Databases:				Add →	Current Selection	
Vibrio cholerae HC-47A1 gastrointestinal-tract Vibrio cholerae HC-57A2 gastrointestinal-tract Vibrio cholerae HC-57A2 gastrointestinal-tract Vibrio cholerae HC-65A1 gastrointestinal-tract Vibrio cholerae HC-66A1 gastrointestinal-tract Vibrio cholerae HC-61A2 gastrointestinal-tract Vibrio cholerae HC-61A2 gastrointestinal-tract Vibrio cholerae HC-67A1 gastrointestinal-tract Vibrio cholerae HC-78A1 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. NHCC-006C gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Clostridium paramesenteroides ATCC 33313 gastrointestinal-tract Clostridium Citroliae WAL-17108 gastrointestinal-tract Clostridium plotmonze DSM 15053 gastrointestinal-tract Clostridium plotmonze DSM 15053 gastrointestinal-tract Clostridium plotmonze DSM 15053 gastrointestinal-tract Clostridium plotmonze DSM 15053 gastrointestinal-tract Clostridium plotmonze DSM 1525 gastrointestinal-tract Clostridium plotmonze DSM 15476 gastrointestinal-tract Clostridium plotmonze DSM 15476 gastrointestinal-tract Clostridium plotmonze DSM 1552 gastrointestinal-tract Clostridium plotmonze DSM 1552 gastrointestinal-tract Clostridium plotmonze DSM 1552 gastrointestinal-tract Clostridium plotmonze DSM 15476 gastrointestinal-tract Clostridium plotmonze DSM 15476 gastrointestinal-tract Clostridium plotmonze DSM 1552 gastrointestinal-tract Clostridium plotmonze DSM 1552 gastrointestinal-tract Clostridium plotenze DSM 1552 gastrointestinal-tract Clostridium plotenze DSM 1552 gastrointestinal-tract Clostridium plotexed DSM 1552 ga	By Name	By Taxonomy	By Organism Pro	perties	My Lists			
Vibrio cholerae HC-57A1 gastrointestinal-tract Homo sapiens Vibrio cholerae HC-57A2 gastrointestinal-tract Vibrio cholerae HC-59B1 gastrointestinal-tract Vibrio cholerae HC-60A1 gastrointestinal-tract Vibrio cholerae HC-61A1 gastrointestinal-tract Vibrio cholerae HC-61A2 gastrointestinal-tract Vibrio cholerae HC-61A1 gastrointestinal-tract Vibrio cholerae HC-65A1 gastrointestinal-tract Vibrio cholerae HC-65A1 gastrointestinal-tract Vibrio cholerae HC-67A1 gastrointestinal-tract Vibrio cholerae HC-67A1 gastrointestinal-tract Vibrio cholerae HC-67A1 gastrointestinal-tract Vibrio cholerae HC-67A1 gastrointestinal-tract Vibrio cholerae HC-77A1 gastrointestinal-tract Vibrio cholerae HC-78A1 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. NHCC-006C gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Clostridium citroniae VAL-17108 gastrointestinal-tract Clostridium jotroniae DSM 15053 gastrointestinal-tract Clostridium hiranonis DSM 13275 gastrointestinal-tract Clostridium hiranonis DSM 13527 gastrointestinal-tract Clostridium pletum DSM 753 gastrointestinal-tract Clostridium pletum DSM 753 gastrointestinal-tract Clostridium spiroforme DSM 1552 gastrointestinal-tract Clos	Vibrio chole			astroir	ntestinal-tract		selected.	
Vibrio cholerae HC-57A2 gastrointestinal-tract Vibrio cholerae HC-69A1 gastrointestinal-tract Vibrio cholerae HC-61A1 gastrointestinal-tract Vibrio cholerae HC-61A1 gastrointestinal-tract Vibrio cholerae HC-61A1 gastrointestinal-tract Vibrio cholerae HC-65A1 gastrointestinal-tract Vibrio cholerae HC-65A1 gastrointestinal-tract Vibrio cholerae HC-67A1 gastrointestinal-tract Vibrio cholerae HC-77A1 gastrointestinal-tract Vibrio cholerae HC-78A1 gastrointestinal-tract Vibrio cholerae HC-78A1 gastrointestinal-tract Vibrio cholerae HC-78A1 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. NG-7404 gastrointestinal-tract Vibrio cholerae O1 str. NG-7404 gastrointestinal-tract Vibrio cholerae O1 str. NG-7404 gastrointestinal-tract Vibrio cholerae O1 str. NG-2006 gastrointestinal-tract Vibrio cholerae O1 str. NGC-008D gastrointestinal-tract Clostridium gaspragiformej DSM 15981 gastrointestinal-tract Clostridium citroniae WAL-17108 gastrointestinal-tract Clostridium citroniae WAL-17108 gastrointestinal-tract Clostridium phylemonae DSM 15053 gastrointestinal-tract Clostridium phylemosum WAL-14673 gastrointestinal-tract Eubacterium hallii DSM 3353 gastrointestinal-tract							Homo sapiens	
Vibrio cholerae HC-63B1 gastrointestinal-tract Vibrio cholerae HC-61A1 gastrointestinal-tract Vibrio cholerae HC-61A1 gastrointestinal-tract Vibrio cholerae HC-63A1 gastrointestinal-tract Vibrio cholerae HC-63A1 gastrointestinal-tract Vibrio cholerae HC-63A1 gastrointestinal-tract Vibrio cholerae HC-67A1 gastrointestinal-tract Vibrio cholerae HC-77A1 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. NHCC-004A gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Clostridium asparagiforme] DSM 15981 gastrointestinal-tract Clostridium dostroidoforme 2 1 49FAA gastrointestinal-tract Clostridium dostroidoforme 2 1 49FAA gastrointestinal-tract Clostridium hiranonis DSM 13275 gastrointestinal-tract Clostridium joheronae DSM 15053 gastrointestinal-tract Clostridium joheronae ATCC 35704 gastrointestinal-tract Clostridium joheronae ATCC 35704 gastrointestinal-tract Clostridium joheronae ATCC 35704 gastrointestinal-tract Clostridium joheronae ATCC 35704 gastrointestinal-tract Clostridium joheronae ATCC 3704 gas	Vibrio chole	rae HC-57A2						
Vibrio cholerae HC-60A1 gastrointestinal-tract Vibrio cholerae HC-61A2 gastrointestinal-tract Vibrio cholerae HC-61A2 gastrointestinal-tract Vibrio cholerae HC-67A1 gastrointestinal-tract Vibrio cholerae HC-67A1 gastrointestinal-tract Vibrio cholerae HC-77A1 gastrointestinal-tract Vibrio cholerae HC-78A1 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. NHCC-004A gastrointestinal-tract Vibrio cholerae O1 str. NHCC-004A gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008B gastrointestinal-tract Clostridium asparagiforme] DSM 15981 gastrointestinal-tract Clostridium asparagiforme] DSM 15981 gastrointestinal-tract Clostridium lotstroinforme 2_1_49FAA gastrointestinal-tract Clostridium hiranonis DSM 13275 gastrointestinal-tract Clostridium hiranonis DSM 15053 gastrointestinal-tract Clostridium pletum DSM 753 gastrointestinal-tract Clostridium jotroonae NAL-14053 gastrointestinal-tract Clostridium jotroonae DSM 150547 gastrointestinal-tract Clostridium jentoms DSM 15476 gastrointestinal-tract Clostridium jentoms DSM 15476 gastrointestinal-tract Clostridium jentoms DSM 15476 gastrointestinal-tract Clostridium jentoms DSM 1552 gastrointestinal-tract Clostridium jentoms DSM 15476 gastrointestinal-tract Clostridium jentoms DSM 15476 gastrointestinal-tract Clostridium jentoms DSM 15476 gastrointestinal-tract Clostridium jentoms DSM 15476 gastrointestinal-tract Clostridium jentoms DSM 15473 gastrointestinal-tract Clostridium jentoms DSM 15473 gastrointestinal-tract Clostridium jentoms DSM 15473 gastrointestinal-tract Clostridium jentoms DSM 15473 gastrointestinal-tract Clostridium jentoms DSM 15476 gastrointestinal-t	Vibrio chole	rae HC-59A1						
Vibrio cholerae HC-61A1 gastrointestinal-tract Vibrio cholerae HC-65A1 gastrointestinal-tract Vibrio cholerae HC-65A1 gastrointestinal-tract Vibrio cholerae HC-65A1 gastrointestinal-tract Vibrio cholerae HC-7A1 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. NHCC-004A gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Clostridium asparagforme] DSM 15981 gastrointestinal-tract Clostridium] citroniae WAL-17108 gastrointestinal-tract Clostridium] hiranonis DSM 13275 gastrointestinal-tract Clostridium] hiranonis DSM 15053 gastrointestinal-tract Clostridium] lostridioforme 2 1 49FAA gastrointestinal-tract Clostridium] hiranonis DSM 51552 gastrointestinal-tract Clostridium] hiranonis DSM 5476 gastrointestinal-tract Clostridium] spinoforum DSM 5476 gastrointestinal-tract Clostridium] scindens ATCC 35704 gastrointestinal-tract Clostridium] spinoforum DSM 5476 gastrointestinal-tract Clostridium] spinoforum DSM 5476 gastrointestinal-tract Clostridium] spinoforum DSM 5473 gastrointestinal-tract Clost	Vibrio chole	rae HC-59B1		gastroir	ntestinal-tract			
Vibrio cholerae HC-61A2 gastrointestinal-tract Vibrio cholerae HC-67A1 gastrointestinal-tract Vibrio cholerae HC-77A1 gastrointestinal-tract Vibrio cholerae HC-78A1 gastrointestinal-tract Vibrio cholerae HC-78A1 gastrointestinal-tract Vibrio cholerae HC-78A1 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. NHCC-004A gastrointestinal-tract Vibrio cholerae O1 str. NHCC-006C gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Clostridium asparagiformej DSM 15981 gastrointestinal-tract Clostridium citroniae WAL-17108 gastrointestinal-tract Clostridium j citroniae WAL-17108 gastrointestinal-tract Clostridium j hiranonis DSM 13275 gastrointestinal-tract Clostridium j hiranonis DSM 15053 gastrointestinal-tract Clostridium jeptum DSM 753 gastrointestinal-tract Clostridium jeptum DSM 753 gastrointestinal-tract Clostridium spinoforme DSM 1552 gastrointestinal-tract Clostridium spinoforme DSM 1552 gastrointestinal-tract Clostridium spinoforme DSM 1552 gastrointestinal-tract Clostridium spinoforme DSM 3353 gastrointestinal-tract Clostridium jendinesum WAL-14673 gastrointestinal-tract								
Vibrio cholerae HC-65A1 gastrointestinal-tract Vibrio cholerae HC-68A1 gastrointestinal-tract Vibrio cholerae HC-77A1 gastrointestinal-tract Vibrio cholerae HC-77A1 gastrointestinal-tract Vibrio cholerae HC-78A1 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. NHCC-004A gastrointestinal-tract Vibrio cholerae O1 str. NHCC-006C gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008B gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008B gastrointestinal-tract Clostridium gaspargirome] DSM 15981 gastrointestinal-tract Clostridium clostridiorome 2_1 49FAA gastrointestinal-tract Clostridium hiranonis DSM 13275 gastrointestinal-tract Clostridium hiranonis DSM 15053 gastrointestinal-tract Clostridium hiranonis DSM 15053 gastrointestinal-tract Clostridium hiranonis DSM 1575 gastrointestinal-tract Clostridium pehvpentosum DSM 5476 gastrointestinal-tract Clostridium spiroforme DSM 1552 gastrointestinal-tract Clostridium spiroforme DSM 1552 gastrointestinal-tract Clostridium spiroforme DSM 1574 gastrointestinal-tract Clostridium spiroforme DSM 1574 gastrointestinal-tract Clostridium spiroforme DSM 1575 gastrointestinal-tract Clostridium spiroforme DSM 1572 gastrointestinal-tract Clostridium spiroforme DSM 15								
Vibrio cholerae HC-67A1 gastrointestinal-tract Vibrio cholerae HC-77A1 gastrointestinal-tract Vibrio cholerae HC-78A1 gastrointestinal-tract Vibrio cholerae HC-80A1 gastrointestinal-tract Vibrio cholerae HC-80A1 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. NHCC-004A gastrointestinal-tract Vibrio cholerae O1 str. NHCC-004A gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Vibrio cholerae O1 str. NHCC-03313 gastrointestinal-tract Clostridium asparagiforme] DSM 15981 gastrointestinal-tract Clostridium citroniae WAL-17108 gastrointestinal-tract Clostridium citroniae WAL-17108 gastrointestinal-tract Clostridium litranonis DSM 13275 gastrointestinal-tract Clostridium hiranonis DSM 13275 gastrointestinal-tract Clostridium hiranonis DSM 15053 gastrointestinal-tract Clostridium spinders ATCC 35704 gastrointestinal-tract Clostridium spinders MTS52 gastrointestinal-tract Clostridium spinders MTS53 gastrointestinal-tract Clostri								
Vibrio cholerae HC-68A1 gastrointestinal-tract Vibrio cholerae HC-77A1 gastrointestinal-tract Vibrio cholerae HC-80A1 gastrointestinal-tract Vibrio cholerae O1 str. AG-704 gastrointestinal-tract Vibrio cholerae O1 str. AG-704 gastrointestinal-tract Vibrio cholerae O1 str. AG-8040 gastrointestinal-tract Vibrio cholerae O1 str. NHCC-004A gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Vibrio cholerae O1 str. NHCC-108D gastrointestinal-tract Vibrio cholerae O1 str. NHCC-108D gastrointestinal-tract Clostridium asparagiforme] DSM 15981 gastrointestinal-tract Clostridium clostridioforme 2 1 49FAA gastrointestinal-tract Clostridium Johranonis DSM 13275 gastrointestinal-tract Clostridium] hiranonis DSM 13275 gastrointestinal-tract Clostridium] leptum DSM 753 gastrointestinal-tract Clostridium] methylpentosum DSM 5476 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] symbiosum WAL-14163 gastrointestinal-tract Clostridium] symbiosum WAL-14673 gastrointestinal-tract Clostridium] symbiosum WAL-14673 gastrointestinal-tract Clostridium] SM 3353 gastrointestinal-tract								
Vibrio cholerae HC-77A1 gastrointestinal-tract Vibrio cholerae HC-80A1 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. NHCC-004A gastrointestinal-tract Vibrio cholerae O1 str. NHCC-004A gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Vibrio cholerae O1 str. NHCC-108D gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Clostridium asparagiforme] DSM 15981 gastrointestinal-tract Clostridium citroniae WAL-17108 gastrointestinal-tract Clostridium fitoniae WAL-17108 gastrointestinal-tract Clostridium hylemonae DSM 15053 gastrointestinal-tract Clostridium Jeptum DSM 753 gastrointestinal-tract Clostridium jeptum DSM 753 gastrointestinal-tract Clostridium gentypentosum DSM 5476 gastrointestinal-tract Clostridium scindens ATCC 35704 gastrointestinal-tract Clostridium spiroforme DSM 1552 gastrointestinal-tract Clostridium spiroforme DSM 1552 gastrointestinal-tract Clostridium spiroforme DSM 1552 gastrointestinal-tract Clostridium spiroforme DSM 1552 gastrointestinal-tract Clostridium spiroforme DSM 1553 gastrointestinal-tract Clostridium spiroforme DSM 1553 gastrointestinal-tract Clostridium spiroforme DSM 1552 gastrointestinal-tract Clostridium spiroforme DSM 1553 gastrointestinal-tract Clostridium spiroforme DSM 1553 gastrointestinal-tract Clostridium symbiosum WAL-141673 gastrointestinal-tract Clostridium symbiosum WAL-14673 gastrointestinal-tract Clostridium symbiosum WAL-14673 gastrointestinal-tract Clostridium jaymbiosum WAL-14673 gastrointestinal-tract Clostridi								
Vibrio cholerae HC-78A1 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. NHCC-004A gastrointestinal-tract Vibrio cholerae O1 str. NHCC-006C gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Weissella paramesenteroides ATCC 33313 gastrointestinal-tract Weissella paramesenteroides ATCC 33313 gastrointestinal-tract Clostridium asparagiforme] DSM 15981 gastrointestinal-tract Clostridium] citroniae WAL-17108 gastrointestinal-tract Clostridium] citroniae WAL-17108 gastrointestinal-tract Clostridium] lostM 13275 gastrointestinal-tract Clostridium] hylemonae DSM 15053 gastrointestinal-tract Clostridium] hylemonae DSM 15053 gastrointestinal-tract Clostridium] methylpentosum DSM 5476 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] symbiosum WAL-14163 gastrointestinal-tract Clostridium] symbiosum WAL-14673 gastrointestinal-tract Clostridium] spiroforme DSM 552 gastrointestinal-tract Clostridium] spiroforme DSM 553 gastrointestinal-tract Clostridium] spiroforme DSM 553 gastrointestinal-tract Clostridium] spiroforme DSM 555 gastrointestinal-tract Clostridium] spiroforme DSM 55								
Vibrio cholerae HC-80A1 gastrointestinal-tract Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. AG-8040 gastrointestinal-tract Vibrio cholerae O1 str. NHCC-004A gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Weissella paramesenteroides ATCC 33313 gastrointestinal-tract Vokenella regensburgei ATCC 43003 gastrointestinal-tract Clostridium asparagiforme] DSM 15981 gastrointestinal-tract Clostridium] citroniae WAL-17108 gastrointestinal-tract Clostridium] clostridioforme 2 1 49FAA gastrointestinal-tract Clostridium] hylemonae DSM 13275 gastrointestinal-tract Clostridium] hylemonae DSM 15053 gastrointestinal-tract Clostridium] hylemonae DSM 5476 gastrointestinal-tract Clostridium] scinches ATCC 35704 gastrointestinal-tract Clostridium] scinches ATCS 3704 gastrointestinal-tract Clostridium] symbiosum WAL-14163 gastrointestinal-tract Clostridium] symbiosum WAL-14673 gastrointestinal-tract Clostridium] hylemosum DSM 353 gastrointestinal-tract Clostridium] symbiosum WAL-14673 gastrointestinal-tract Clostridium] symbiosum WAL-14673 gastrointestinal-tract Clostridium] hylemosum DSM 353 gastrointestinal-tract Clostridium] hylemosum WAL-14673 gastrointestinal-tract Clostridium] symbiosum WAL-14673 gastrointestinal-tract Clostridium] hylemosum bAL-14673 gastrointestinal-tract								
Vibrio cholerae O1 str. AG-7404 gastrointestinal-tract Vibrio cholerae O1 str. AG-8040 gastrointestinal-tract Vibrio cholerae O1 str. NHCC-004A gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Weissella paramesenteroides ATCC 33313 gastrointestinal-tract Vokenella regensburgei ATCC 43003 gastrointestinal-tract Clostridium asparagiforme] DSM 15981 gastrointestinal-tract Clostridium] citorniae WAL-17108 gastrointestinal-tract Clostridium] clostridioforme 2_1_49FAA gastrointestinal-tract Clostridium] hylemonae DSM 13275 gastrointestinal-tract Clostridium] hylemonae DSM 13275 gastrointestinal-tract Clostridium] hylemonae DSM 15053 gastrointestinal-tract Clostridium] hylemonae DSM 5476 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 353 gastrointestinal-tract								
Vibrio cholerae 01 str. AG-8040 gastrointestinal-tract Vibrio cholerae 01 str. NHCC-004A gastrointestinal-tract Vibrio cholerae 01 str. NHCC-008C gastrointestinal-tract Vibrio cholerae 01 str. NHCC-008D gastrointestinal-tract Vibrio cholerae 01 str. NHCC-008D gastrointestinal-tract Vibrio cholerae 01 str. NHCC-008D gastrointestinal-tract Clostridium asparagiforme] DSM 15981 gastrointestinal-tract Clostridium] citorniae WAL-17108 gastrointestinal-tract Clostridium] clostridioforme 2 1 49FAA gastrointestinal-tract Clostridium] hiranonis DSM 13275 gastrointestinal-tract Clostridium] hiranonis DSM 13275 gastrointestinal-tract Clostridium] leptm DSM 753 gastrointestinal-tract Clostridium] hiranonis DSM 15053 gastrointestinal-tract Clostridium] hiranonis DSM 15053 gastrointestinal-tract Clostridium] spiroforme DSM 5476 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1554 gastrointestinal-tract Clostridium] spiroforme DSM 1555 gastrointestinal-tract Clostridium] spiroforme DSM 1555 gastrointestinal-tract Clostridium] spiroforme DSM 1555 gastrointestinal-tract Clostridium] spiroforme DSM 1555 gastrointestinal-tract			104					
Vibrio cholerae O1 str. NHCC-004A gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Weissella paramesenteroides ATCC 33313 gastrointestinal-tract Weissella paramesenteroides ATCC 33313 gastrointestinal-tract Clostridium asparagiforme] DSM 15981 gastrointestinal-tract Clostridium] citroniae WAL-17108 gastrointestinal-tract Clostridium] citroniae WAL-17108 gastrointestinal-tract Clostridium] citroniae WAL-17103 gastrointestinal-tract Clostridium] hiranonis DSM 13275 gastrointestinal-tract Clostridium] hylemonae DSM 15053 gastrointestinal-tract Clostridium] hylemonae DSM 15053 gastrointestinal-tract Clostridium] spiroforme DSM 15053 gastrointestinal-tract Clostridium] spiroforme DSM 5476 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1554 gastrointestinal-tract Clostridium] spiroforme DSM 1555 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 2553 gastrointestinal-tract Clostridium] spiroforme DSM 2553 gastrointestinal-tract Clostridium] spiroforme DSM 2553 gastrointestinal-tract Clostridium] spiroforme DSM 2553 gastrointestinal-tract								
Vibrio cholerae O1 str. NHCC-006C gastrointestinal-tract Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Weissella paramesenteroides ATCC 33313 gastrointestinal-tract Okenella regensburgei ATCC 43003 gastrointestinal-tract Clostridium aparagiforme] DSM 15981 gastrointestinal-tract Clostridium] citroniae WAL-17108 gastrointestinal-tract Clostridium] clostridioforme 2 1 49FAA gastrointestinal-tract Clostridium] hylemonae DSM 13275 gastrointestinal-tract Clostridium] hylemonae DSM 15053 gastrointestinal-tract Clostridium] hylemonae DSM 15053 gastrointestinal-tract Clostridium] hylemonse DSM 5476 gastrointestinal-tract Clostridium] scindens ATCC 35704 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1553 gastrointestinal-tract Clostridium] spiroforme DSM 55704 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] spiroforme DSM 353 gastrointestinal-tract								
Vibrio cholerae O1 str. NHCC-008D gastrointestinal-tract Weissella paramesenteroides ATCC 33313 gastrointestinal-tract Okenella regensburgei ATCC 43003 gastrointestinal-tract [Clostridium] citroniae WAL-17108 gastrointestinal-tract [Clostridium] citroniae WAL-17108 gastrointestinal-tract [Clostridium] citroniae WAL-17108 gastrointestinal-tract [Clostridium] hiranonis DSM 13275 gastrointestinal-tract [Clostridium] hylemonae DSM 15053 gastrointestinal-tract [Clostridium] leptm DSM 753 gastrointestinal-tract [Clostridium] leptm DSM 753 gastrointestinal-tract [Clostridium] scindens ATCC 35704 gastrointestinal-tract [Clostridium] spiroforme DSM 1552 gastrointestinal-tract [Clostridium] symbiosum WAL-14163 gastrointestinal-tract [Clostridium] symbiosum WAL-14673 gastrointestinal-tract [Clostridium] spiroforme DSM 353 gastrointestinal-tract								
Weissella paramesenteroides ATCC 33313gastrointestinal-tractYokenella regensburgei ATCC 43003gastrointestinal-tract[Clostridium] asparagiforme] DSM 15981gastrointestinal-tract[Clostridium] citroniae WAL-17108gastrointestinal-tract[Clostridium] citroniae WAL-17108gastrointestinal-tract[Clostridium] citroniae DSM 13275gastrointestinal-tract[Clostridium] hiranonis DSM 13275gastrointestinal-tract[Clostridium] hylemonae DSM 15053gastrointestinal-tract[Clostridium] hylemonae DSM 553gastrointestinal-tract[Clostridium] seindens ATCC 35704gastrointestinal-tract[Clostridium] spiroforme DSM 1552gastrointestinal-tract[Clostridium] spiroforme DSM 1552gastrointestinal-tract[Clostridium] symbiosum WAL-14163gastrointestinal-tract[Clostridium] symbiosum WAL-14673gastrointestinal-tract[Clostridium] symbiosum WAL-14673gastrointestinal-tract[Clostridium] symbiosum WAL-14673gastrointestinal-tract[Clostridium] symbiosum WAL-14673gastrointestinal-tract[Clostridium] sumbiosum WAL-14673gastrointestinal-tract[Clostridium] hylin DSM 3353gastrointestinal-tract								
Yokenella regensburgei ATCC 43003gastrointestinal-tract[Clostridium asparagiforme] DSM 15981gastrointestinal-tract[Clostridium] citroniae WAL-17108gastrointestinal-tract[Clostridium] clostridioforme 2_1_49FAAgastrointestinal-tract[Clostridium] hiranonis DSM 13275gastrointestinal-tract[Clostridium] hiranonis DSM 15053gastrointestinal-tract[Clostridium] hylemonae DSM 15053gastrointestinal-tract[Clostridium] hylemonae DSM 573gastrointestinal-tract[Clostridium] hylemosum DSM 5476gastrointestinal-tract[Clostridium] seindens ATCC 35704gastrointestinal-tract[Clostridium] spiroforme DSM 1552gastrointestinal-tract[Clostridium] symbiosum WAL-14163gastrointestinal-tract[Clostridium] symbiosum WAL-14673gastrointestinal-tract								
[Clostridium asparagiforme] DSM 15981gastrointestinal-tract[Clostridium] citroniae WAL-17108gastrointestinal-tract[Clostridium] clostridioforme 2_1_49FAAgastrointestinal-tract[Clostridium] hiranonis DSM 13275gastrointestinal-tract[Clostridium] hylemonae DSM 15053gastrointestinal-tract[Clostridium] leptum DSM 753gastrointestinal-tract[Clostridium] explored DSM 15053gastrointestinal-tract[Clostridium] leptum DSM 753gastrointestinal-tract[Clostridium] scindens ATCC 35704gastrointestinal-tract[Clostridium] spiroforme DSM 1552gastrointestinal-tract[Clostridium] symbiosum WAL-14163gastrointestinal-tract[Clostridium] symbiosum WAL-14673gastrointestinal-tract[Clostridium] symbiosum WAL-14673gastrointestinal-trac								
[Clostridium] citroniãe WAL-17108gastrointestinal-tract[Clostridium] clostridioforme 2_1 49FAAgastrointestinal-tract[Clostridium] hiranonis DSM 13275gastrointestinal-tract[Clostridium] hylemonae DSM 15053gastrointestinal-tract[Clostridium] leptum DSM 753gastrointestinal-tract[Clostridium] eptum DSM 753gastrointestinal-tract[Clostridium] scindens ATCC 35704gastrointestinal-tract[Clostridium] spiroforme DSM 1552gastrointestinal-tract[Clostridium] spiroforme DSM 1552gastrointestinal-tract[Clostridium] spiroforme DSM 1552gastrointestinal-tract[Clostridium] spiroforme DSM 1553gastrointestinal-tract[Clostridium] spiroforme DSM 1552gastrointestinal-tract[Clostridium] spiroforme DSM 353gastrointestinal-tract[Clostridium] symbiosum WAL-14163gastrointestinal-tract[Clostridium] spiroforme DSM 353gastrointestinal-tract[Clostridium] symbiosum WAL-14673gastrointestinal-tract[Clostridium] solum Ada-14673gastrointestinal-tract[Clostridium] hallii DSM 3353gastrointestinal-tract[Eubacterium] hallii DSM 3353gastrointestinal-tract								
[Clostridium] hiranonis DSM 13275 gastrointestinal-tract [Clostridium] hylemonae DSM 15053 gastrointestinal-tract [Clostridium] leptum DSM 753 gastrointestinal-tract [Clostridium] methylpentosum DSM 5476 gastrointestinal-tract [Clostridium] scindens ATCC 35704 gastrointestinal-tract [Clostridium] spiroforme DSM 1552 gastrointestinal-tract [Clostridium] spiroforme DSM 1552 gastrointestinal-tract [Clostridium] symbiosum WAL-14163 gastrointestinal-tract [Clostridium] symbiosum WAL-14673 gastrointestinal-tract [Clostridium] spiroformer gastrointestinal-tract [Clostridium] symbiosum WAL-14673 gastrointestinal-tract [Clostridium] symbiosum WAL-14673 gastrointestinal-tract [Eubacterium] hallii DSM 3353 gastrointestinal-tract [er 1 and Tier 2 databases are displayed with orange and gray backgrounds, [endition] spiroformer	Clostridium	l citroniae WAL-1	7108					
Clostridium] hiranonis DSM 13275 gastrointestinal-tract Clostridium] hylemonae DSM 15053 gastrointestinal-tract Clostridium] leptum DSM 753 gastrointestinal-tract Clostridium] methylpentosum DSM 5476 gastrointestinal-tract Clostridium] scindens ATCC 35704 gastrointestinal-tract Clostridium] spiroforme DSM 1552 gastrointestinal-tract Clostridium] symbiosum WAL-14163 gastrointestinal-tract Clostridium] symbiosum WAL-14673 gastrointestinal-tract Clostridium] symbiosum WAL-14673 gastrointestinal-tract Clostridium] symbiosum WAL-14673 gastrointestinal-tract Clostridium] spiroformer DSM 353 gastrointestinal-tract Clostridium] symbiosum WAL-14673 gastrointestinal-tract Clostridium] hyllin DSM 3353 gastrointestinal-tract er 1 and Tier 2 databases are displayed with orange and gray backgrounds, gastrointestinal-tract	Clostridium	clostridioforme	2 1 49FAA	gastroir	ntestinal-tract			
[Clostridium] leptum DSM 753 gastrointestinal-tract [Clostridium] sepidens ATCC 35704 gastrointestinal-tract [Clostridium] sepidens ATCC 35704 gastrointestinal-tract [Clostridium] spiroforme DSM 1552 gastrointestinal-tract [Clostridium] symbiosum WAL-14163 gastrointestinal-tract [Clostridium] symbiosum WAL-14673 gastrointestinal-tract [Clostridium] symbiosum WAL-14673 gastrointestinal-tract [Clostridium] halli DSM 3353 gastrointestinal-tract [er 1 and Tier 2 databases are displayed with orange and gray backgrounds, [et 1 and Tier 2 databases are displayed with orange and gray backgrounds,				gastroir	ntestinal-tract			
[Clostridium] methylpentosum DSM 5476 gastrointestinal-tract [Clostridium] scindens ATCC 35704 gastrointestinal-tract [Clostridium] spiroforme DSM 1552 gastrointestinal-tract [Clostridium] symbiosum WAL-14163 gastrointestinal-tract [Eubacterium] hallii DSM 3353 gastrointestinal-tract [er 1 and Tier 2 databases are displayed with orange and gray backgrounds,	Clostridium	hylemonae DSN	/ 15053	gastroir	ntestinal-tract			
Clostridium scindens ATCC 35704 gastrointestinal-tract Clostridium spiroforme DSM 1552 gastrointestinal-tract Clostridium symbiosum WAL-14163 gastrointestinal-tract Clostridium symbiosum WAL-14673 gastrointestinal-tract [Clostridium] symbiosum WAL-14673 gastrointestinal-tract [Eubacterium] hallii DSM 3353 gastrointestinal-tract [er 1 and Tier 2 databases are displayed with orange and gray backgrounds,	Clostridium	leptum DSM 75	3					
[Clostridium] spiroforme DSM 1552 gastrointestinal-tract [Clostridium] symbiosum WAL-14163 gastrointestinal-tract [Clostridium] symbiosum WAL-14673 gastrointestinal-tract [Eubacterium] hallii DSM 3353 gastrointestinal-tract [er 1 and Tier 2 databases are displayed with orange and gray backgrounds,								
Clostridium symbiosum WAL-14163 gastrointestinal-tract Clostridium symbiosum WAL-14673 gastrointestinal-tract [Eubacterium] hallii DSM 3353 gastrointestinal-tract er 1 and Tier 2 databases are displayed with orange and gray backgrounds, gastrointestinal-tract	Clostridium	scindens ATCC	35704					
Clostridium] sýmbiosum WAL-14673 gastrointestinal-tract [Eubacterium] hallii DSM 3353 gastrointestinal-tract er 1 and Tier 2 databases are displayed with orange and gray backgrounds,								
Eubacterium] hallii DSM 3353 gastrointestinal-tract er 1 and Tier 2 databases are displayed with orange and gray backgrounds,	Clostridium	symbiosum WA	L-14163					
ier 1 and Tier 2 databases are displayed with orange and gray backgrounds,								
		-		9				
spectively.		r 2 databases ar	e displayed with ora	nge and	gray backgrounds,			
	spectively.							
Remember Current Selection: As new named list: Save			_					

Figure 9: To select all organisms, select the first organism in the list (as just described above). Then, after scrolling all the way down to the end of the list, also select the last organism by holding down the shift key and clicking. This sequence of operations selects the entire range of organisms. Click on the Add \rightarrow button to add this set of organisms to the **Current Selection** column on the right hand side. To finalize the selection and return the organism list to MORS, click on the **OK** button, which also closes the organism selector popup.

			Search	Welcome, kr - Logout Help My account Enter a gene, protein, metabolite or pathway Quick Search Gene Search Ining Escherichia coll K-12 substr. MG1655 (EcoCyc) change organism database
Home Search - Genome - Metabolisi	m 🔻 🛛 Analysis 👻 SmartTables 👻 Help 🔻			
	Metabolic Route S	Search of Escheric	<i>hia coli</i> K-12 substr.	MG1655
	I	Please read the detailed Ho	wTo instructions.	
		Routes across multiple orga	anisms ? 😧 🧹	
	Select	Organisms/Databases 67	5 Organisms were selected.	
	The multi-organism mode gen non-zero <i>switching organisms</i> therefore time out. We recomn is found, then submit again, all	cost setting. Sometimes, the nend starting with a small m owing for a longer route.	ese searches take many minu aximum route length setting.	utes and can If no good route
Start compound 2	I-tryptop	_	Switching organisms cost @	
or: Set of start compounds 🕑	L-tryptophan		Native reaction cost 0	5
Goal compound 🕑	L-tryptophanamide α-methyltryptophan		Atom loss cost 0	100 All atoms
or: Set of goal compounds 🕑	glycyl-L-tryptophan		Avoid compounds 0	None. Select a SmartTable of Compounds
	2-methyl-L-tryptophan	et defined by a	Avoid side compounds 0	None. Select a SmartTable of Compounds
	3-methyl- L-tryptop han 4-fluoro- L-tryptop han 5-chloro- L-tryptop han 6-chloro- L-tryptop han	nce for every compound The parameters below .g., if the max. time is set chosen, then the total tes.	Avoid reactions 9	None. Select a SmartTable of Reactions
Number of routes @	7-chloro-L-tryptophan			
Maximum time (sec) 0	7-methyl -L-tryptop han <i>N-</i> acetyl -L-tryptop han			
Maximum route length @	N-methyl-L-tryptophan			
Search Routes	4-hydroxy-L-tryptophan			
To search for routes inv	5-hydroxy- L-tryptop han 5-methyl-D L-tryptop han D,L-6-methyl tryptop han	tions from this PGDB, insta	Il Pathway Tools locally and s	supply the -metroute-metacyc commandline argument.
Report Errors or Provide Feedback Page generated by Pathway Tools version 23 EcoCyc version 22.6.	L-tryptophanhydroxamate N ² -hydroxy-L-tryptophan 9-N-hydroxy-L-tryptophan	15, 2019.		

Figure 10: After the organism set has been selected, enter the start metabolite by typing a substring of the name in the text box, which causes a list of plausible completions to be shown underneath. After typing enough characters, select **L-tryptophan** from the list.

		Searc	Welcome, kr - Logout Help My account Enter a gene, protein, metabolite or pathway Quick Search Gene Search hing Escherichia coli K-12 substr. MG1655 (EccOyc) change organism database
Home Search - Genome - Metabolis	m 🔻 🛛 Analysis 👻 SmartTables 👻 Help 👻		
	Metabolic Route S	earch of <i>Escherichia coli</i> K-12 substr	. MG1655
	F	lease read the detailed HowTo instructions.	
	I	Routes across multiple organisms ? 🚱 🔽	
	Select C	Organisms/Databases 675 Organisms were selected.	
	non-zero <i>switching organisms</i> of therefore time out. We recomm is found, then submit again, allo	rates searches that can take a long time to compute, es cost setting. Sometimes, these searches take many min end starting with a small maximum route length setting, wing for a longer route.	utes and can
Start compound 2	L-tryptophan	Switching organisms cost 0	30
or: Set of start compounds 🔮	None. Select a SmartTable of Compounds	Native reaction cost 2	5
Goal compound 2	indoxy	Atom loss cost 🕑	100 All atoms
or: Set of goal compounds 🕑	indoxyl	Avoid compounds 🕑	None. Select a SmartTable of Compounds
		et defined by a Avoid side compounds 🛛	None. Select a SmartTable of Compounds
		chosen, then the total	None. Select a SmartTable of Reactions
Number of routes 2	1		
Maximum time (sec) 🔮	200		
Maximum route length @	4		
Search Routes			
	volving MetaCyc reactions in addition to reac	tions from this PGDB, install Pathway Tools locally and s	supply the -metroute-metacyc commandline argument.
Report Errors or Provide Feedback Page generated by Pathway Tools version 23 EcoCyc version 22.6.	.0 (software by SRI International) on Fri Feb	15, 2019.	

Figure 11: Likewise, enter the goal metabolite **indoxyl sulfate** in the same type of text box with completion, as was described above for the start metabolite.

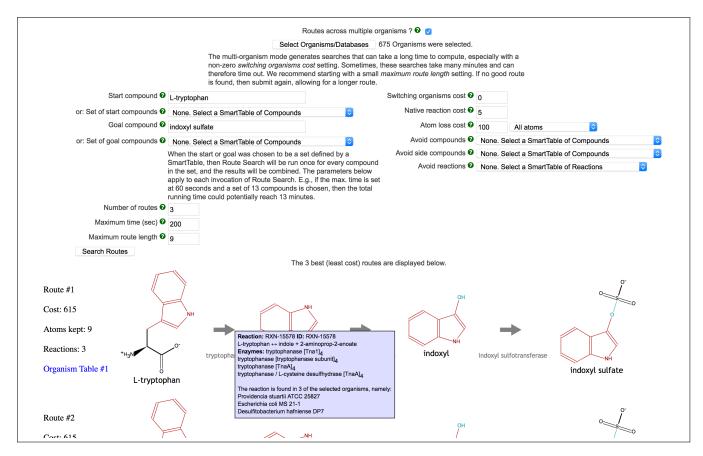


Figure 12: Set the **Number of Routes** to "3" and the **Maximum route length** to "9". Note that this example also has the **Switching organisms cost** set to "0" (zero), to keep the running time fairly short. After all parameters for the search have been entered, as the last step, click on the **Search Routes** button. This launches the search, which generally could take anywhere between seconds to several minutes. A hard server timeout of 15 minutes will terminate any search, to reduce the load of BioCyc servers regarding ill-constrained searches. However, most Web browsers have their own timeout, which is set to only a few minutes. After the search is done, the resulting routes are displayed underneath. The thick gray arrows denote reactions between the primary metabolites. If the cursor is moved over such an arrow, a tooltip popup is displayed, containing information about the reaction, such as the EC classification number, the full reaction equation, names of enzymes catalyzing the reactions, and a count of organisms that could catalyze the reaction. In these graphical visualizations of metabolic routes, the retained atoms are depicted by coloring the conserved molecular fragments with the same colors. In this route, the main fragment is red. In other routes, several colors can be used for fragments that persist over a few reaction steps, but which do not persist through the entire route.

			Enter a gene, protein, metabolite or pathw	/ay	Come, kr - Logout Help My account Quick Search Gene Search
			Searching Escherichia coli K-12 substr. MG16	655 (E	CoCyc) change organism database
Searc	h ▼ Genome ▼ Metabolism ▼ Analysis ▼ SmartTables ▼	He	elp 🕶		
					✓ show operation
martTab	les directory SmartTables Help	~	artTable: Route nr. 1		
ck to ad	Id description	110			
	of ocelot-kb -, Created: 02-Jul-2018 11:27:17				
12345	5 6 7 Next Show all				
	\$		\$	¢	
	L-tryptophan + $H_2O \rightarrow$ indole + pyruvate + ammonium	•	indole + NADH + oxygen + H ⁺ \rightarrow indoxyl + NAD ⁺ + H ₂ O \checkmark		3'-phosphoadenylyl-sulfate + in
01	B. faecis MAJ27		H. sapiens	H. 9	sapiens
2	C. bacterium 1_7_47FAA				
3	E. coli 4_1_47FAA				
□ 4	E. coli E128010				
5	E. coli EPEC C342-62				
6	E. coli EPECa12				
□ 7	E. coli EPECa14				
8 🗌	E. coli HM605				
9	E. coli KTE10				
🗆 10	E. coli KTE104				
🗆 11	E. coli KTE105				
□ 12	E. coli KTE106				
□ 13	E. coli KTE109				
□ 14	E. coli KTE111				
	E. coli KTE112				
0 15	E. COILKTETT2				

Figure 13: At the left side of each route, clicking a link called "Organism Table" will open a new SmartTable (SMT) in a browser tab. The browser's popup blocker may have to be advised to allow creation of a new tab, and the researcher needs to be logged into their BioCyc user account. This table shows the reactions of the route as its columns, and in each column, the rows list the organisms containing the reaction, in alphabetical order. This table is exportable in a Tab-delimited spreadsheet format, for further data analysis. To simplify external analysis, the SMT contains the organism results twice, by repeating the reaction columns and thus showing the route twice. The left side shows human-readable organism names, whereas the repeat on the right side of the table, separated by a blank separator column, records the unique organism IDs, which are easier to computationally process. When organism switching minimization is active, i.e. the "Switching organisms cost" parameter is non-zero, then the positions in a route, where the switches occur, are indicated by an inserted blank column. Additionally, the sorting of the organisms in table columns differs in the following way. We want to emphasize the organisms that can contain the longest stretches of the route, entirely within those organisms. So all the organisms are placed at the top, which can catalyze the entire stretch of reactions between organism switches, such that this property becomes visibly clear. Underneath these top organisms, other organisms will be listed that may only participate in shorter reaction stretches. Because the number of organisms involved per reaction becomes smaller as we move towards the right, the sorting has to be done from the right to the left, such that the few organisms that manage to catalyze the full stretch can determine the organisms to be shown at the top. Even though there might be more than one series of maximal sets of organisms with a minimum number of switching of organisms in a route, our current algorithm provides and displays only one of these series.