MycoCosm KEGG Browser

KEGG stands for Kyoto Encyclopedia of Genes and Genomes at http://www.genome.jp/kegg/, which maintains a curated set of EC-annotated enzymes and their pathways. Each portal's KEGG Browser facilitates display and discovery of MycoCosm's KEGG-annotated genes.

Scenario: You have plated a variety of yeasts on a variety of carbon sources, and discovered that some members of the Pichiaceae grow on galactose (e.g. *Dekkera bruxellensis*) and some do not (e.g. *Pichia membranifaciens*). Use MycoCosm to find genes that could explain this metabolic difference.

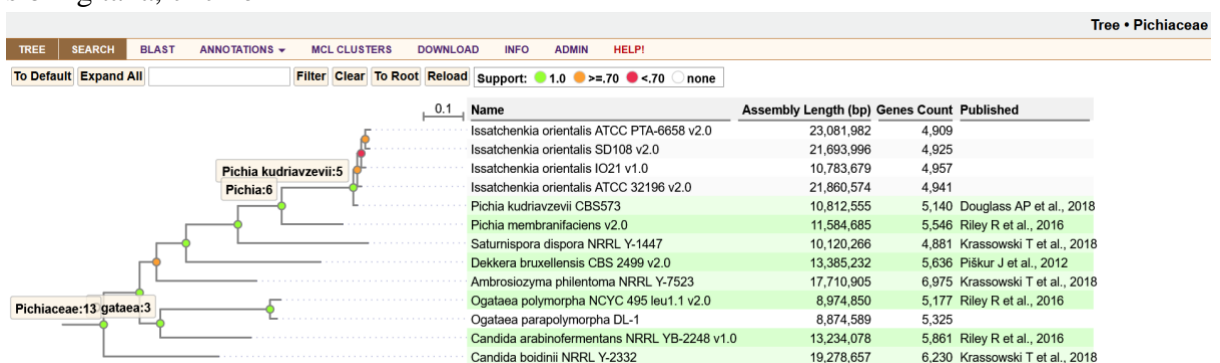1) Go to the MycoCosm Pichiaceae PhyloGroup at mycocosm.jgi.doe.gov/Pichiaceae :

2) To verify that *Dekkera* (which grows on galactose) and *Pichia* (which does not) are sibling taxa, click on 'TREE':

3) Click on 'Dekkera' to go to its genome portal:
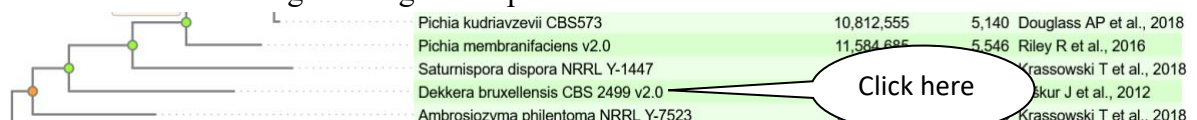
4) Click on "ANNOTATIONS => KEGG" to go to the portal's KEGG browser:

5) Scroll down to the 'Carbohydrate Metabolism' section, and find the subsection 'Galactose metabolism'. Dekkera has 24 genes annotated to this metabolic pathway:

6) Click on 'Galactose metabolism' to drill down into the KEGG hierarchy and list the EC numbers of that pathway.

7) Go to the 'Select Model Set(s) to View' list box and select *Dekkera* and *Pichia* and click the 'apply' button. The *Dekkera* and *Pichia* galactose metabolism gene counts are side-by-side and may be directly compared. Galactokinase (EC = 2.7.1.6) and UDPglucose--hexose-1-phosphate uridylyltransferase (2.7.7.12) are each present in *Dekkera* but not in *Pichia*:

2.7.1.12	glucokinase	1		1	2
2.7.1.58	2-dehydro-3-deoxygalactonokinase	0		0	0
2.7.1.6	galactokinase	1		0	1
2.7.1.69	protein-Npi-phosphohistidine---sugar phosphotransferase	0		0	0
2.7.7.10	UTP---hexose-1-phosphate uridylyltransferase	0		0	0
2.7.7.12	UDP-glucose---hexose-1-phosphate uridylyltransferase	1		0	1
2.7.7.9	UTP---glucose-1-phosphate uridylyltransferase	2		2	4
3.1.1.25	1,4-lactonase	0		0	0
3.1.3.9	glucose-6-phosphatase	0		0	0
3.2.1.108	lactase	0		0	0
3.2.1.20	alpha-glucosidase	6		2	8
3.2.1.22	alpha-galactosidase	0		0	0

8) Scroll back up to the now-familiar 'Select Model Set(s) to View' list box and select *Dekkera* only. Click 'apply' to show the *Dekkera* counts only.

9) Click 'View KEGG Map' to see a graphical display of the pathway. Only those enzyme boxes colored red are annotated as such in *Dekkera*. These include both 2.7.1.6(Galactokinase) and 2.7.7.12 (UDPglucose--hexose-1-phosphate uridylyltransferase):

10) Use the web browser back button return to the now-familiar *Dekkera* galactose metabolism page and select *Pichia* only. Click 'apply' to show the *Pichia* counts only.

| SEARCH | BLAST | BROWSE | **ANNOTATIONS ▾** | MCL CLUSTERS | SYNTENY | DOWNLOAD | INFO | HOME | STATUS | HELP! |

Select Model Set(s) to View:

Dekkera bruxellensis CBS 2499 v2.0/FilteredModels1 (ver 1)
Pichia membranifaciens v2.0/FilteredModels1 (ver 1)
Ogataea polymorpha NCYC 495 leu1.1 v2.0/FilteredModels2 (ver 1)
Candida arabinofermentans NRRL YB-2248 v1.0/FilteredModels1 (ver 1)

Other Functions
View KEGG Metabolic Pathways
View KEGG Regulatory Pathways
Search KEGG

apply

MAP00052: Galactose metabolism
[Summary View | Model View | View KEGG Map]

11) Click 'View KEGG Map' again, and again only those enzyme boxes colored red are annotated as such in *Pichia*. These include neither 2.7.1.6 nor 2.7.7.12. No wonder *Pichia* cannot grow on galactose!

References:

• Riley R, Haridas S, Wolfe KH, Lopes MR, Hittinger CT, Göker M, Salamov AA, Wisecaver JH, Long TM, Calvey CH, Aerts AL, Barry KW, Choi C, Clum A, Coughlan AY, Deshpande S, Douglass AP, Hanson SJ, Klenk HP, LaButti KM, Lapidus A, Lindquist EA, Lipzen AM, Meier-Kolthoff JP, Ohm RA, Otillar RP, Pangilinan JL, Peng Y, Rokas A, Rosa CA, Scheuner C, Sibirny AA, Slot JC, Stielow JB, Sun H, Kurtzman CP, Blackwell M, Grigoriev IV, Jeffries TW. Comparative genomics of biotechnologically important yeasts. Proc Natl Acad Sci U S A. 2016 Aug

30;113(35):9882-7. doi: 10.1073/pnas.1603941113. Epub 2016 Aug 17. PubMed PMID: 27535936; PubMed Central PMCID: PMC5024638.