JGI Fungal Genomics Program

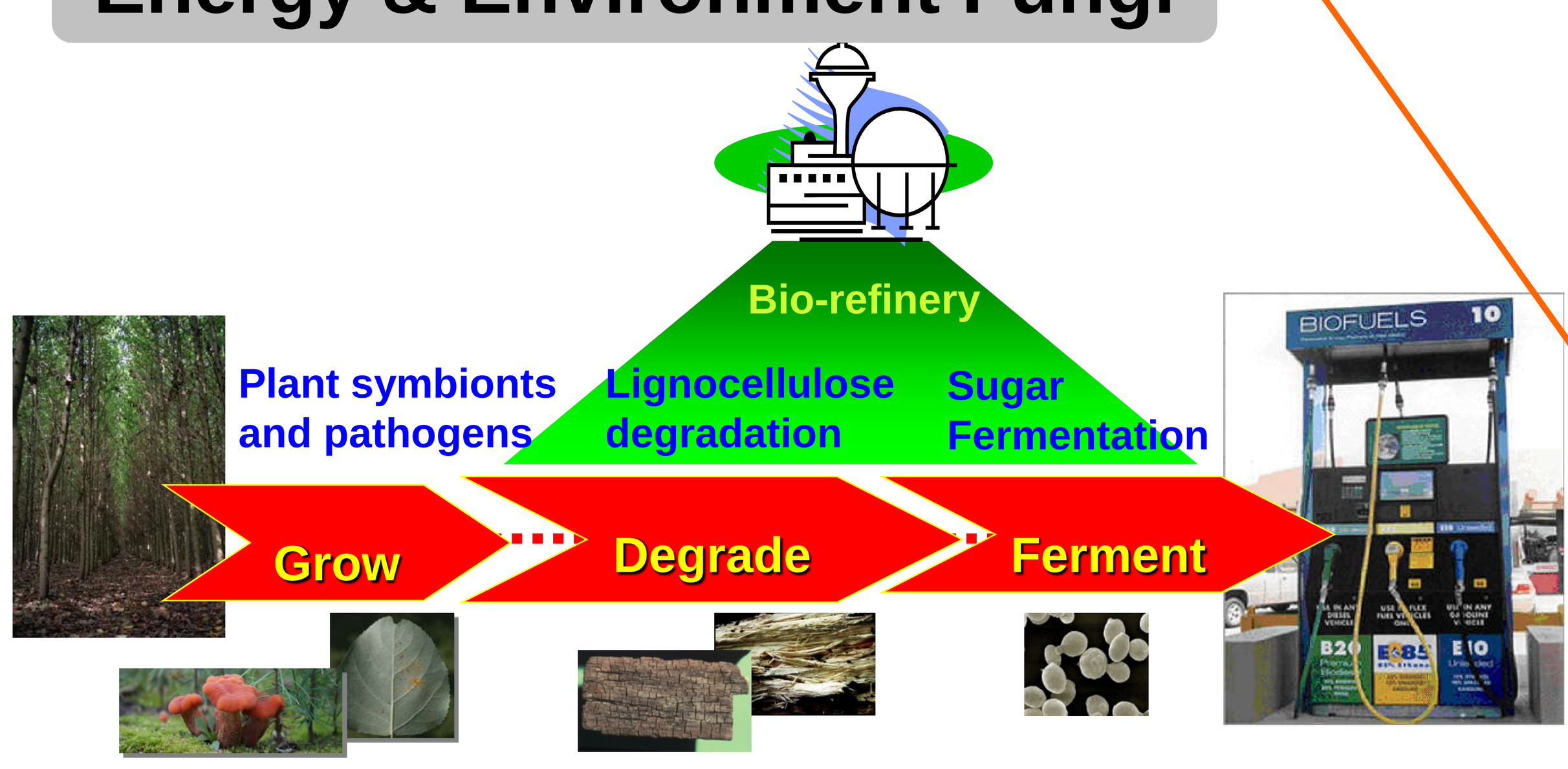
Contact: Igor Grigoriev <ivgrigoriev@lbl.gov>

Abstract

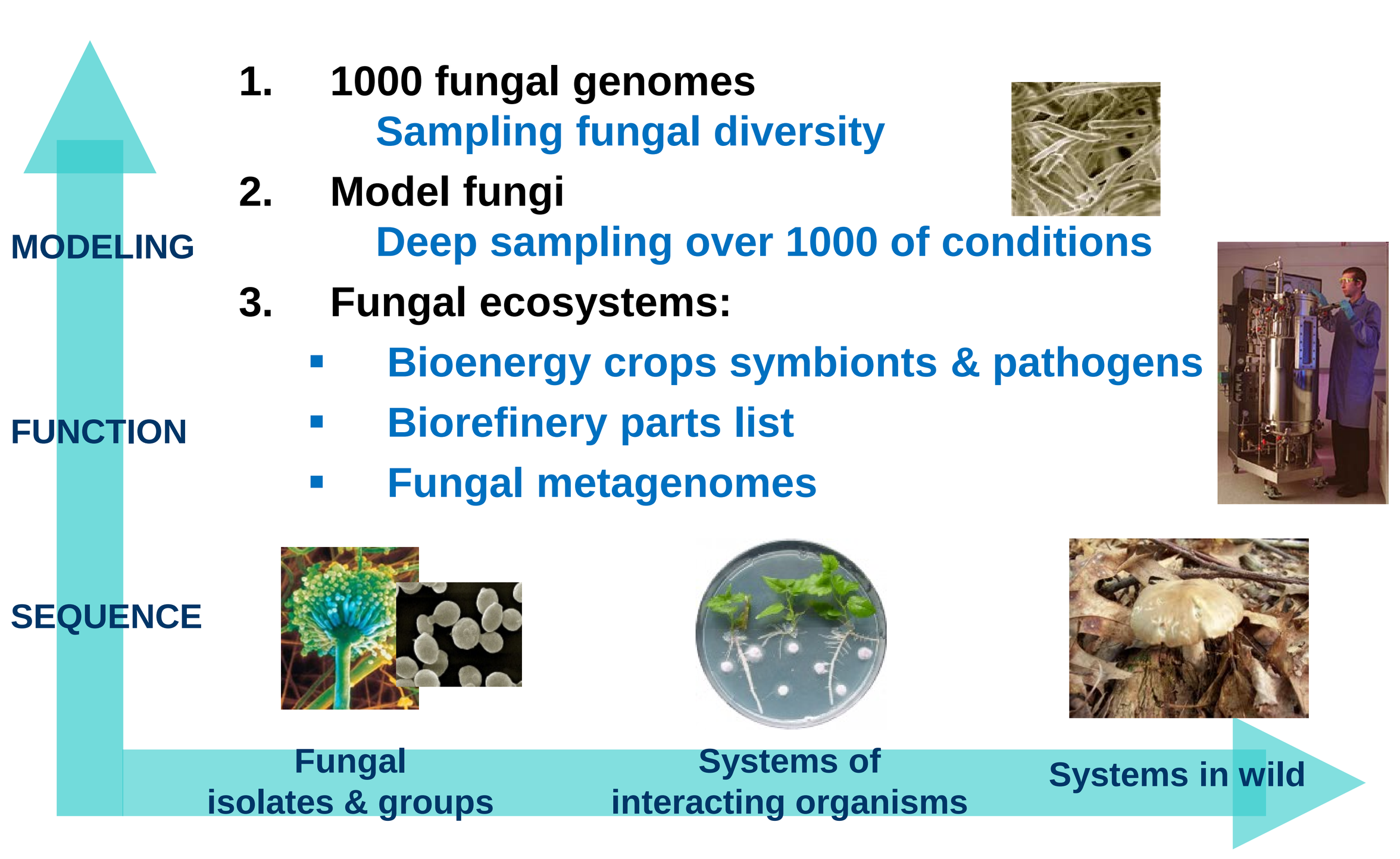
Genomes of energy and environment fungi are in focus of the Fungal Genomic Program at the US Department of Energy Joint Genome Institute (JGI). Its key project, the Genomics Encyclopedia of Fungi, targets fungi related to plant health (symbionts, pathogens, and biocontrol agents) and biorefinery processes (cellulose degradation, sugar fermentation, industrial hosts), and explores fungal diversity by means of genome sequencing and analysis. Over 50 fungal genomes have been sequenced by JGI to date and released through MycoCosm (www.jgi.doe.gov/fungi), a fungal web-portal, which integrates sequence and functional data with genome analysis tools for user community. Sequence analysis supported by functional genomics leads to developing parts list for complex systems ranging from ecosystems of biofuel crops to biorefineries. Recent examples of such 'parts' suggested by comparative genomics and functional analysis in these areas are presented here.

Genomic Encyclopedia of Fungi
- Plant Feedstock Health
- Biorefinery
- Fungal Diversity

Energy & Environment Fungi



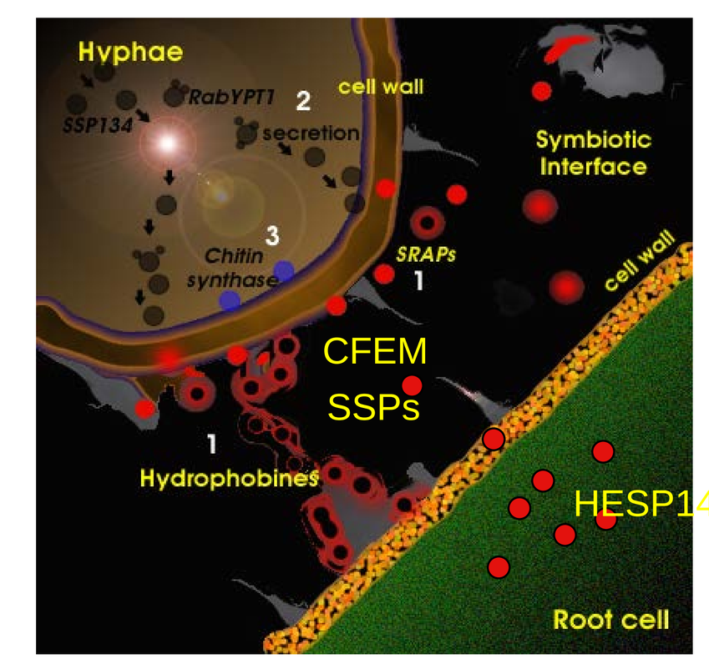
Future Grand Challenges



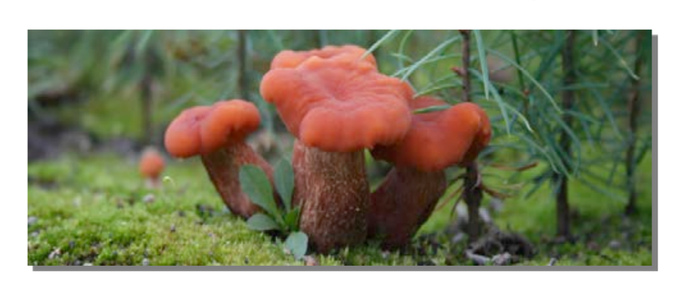
1. 1000 fungal genomes
   Sampling fungal diversity
2. Model fungi
   Deep sampling over 1000 of conditions
3. Fungal ecosystems:
   - Bioenergy crops symbionts & pathogens
   - Biorefinery parts list
   - Fungal metagenomes

Plant Health

Symbionts

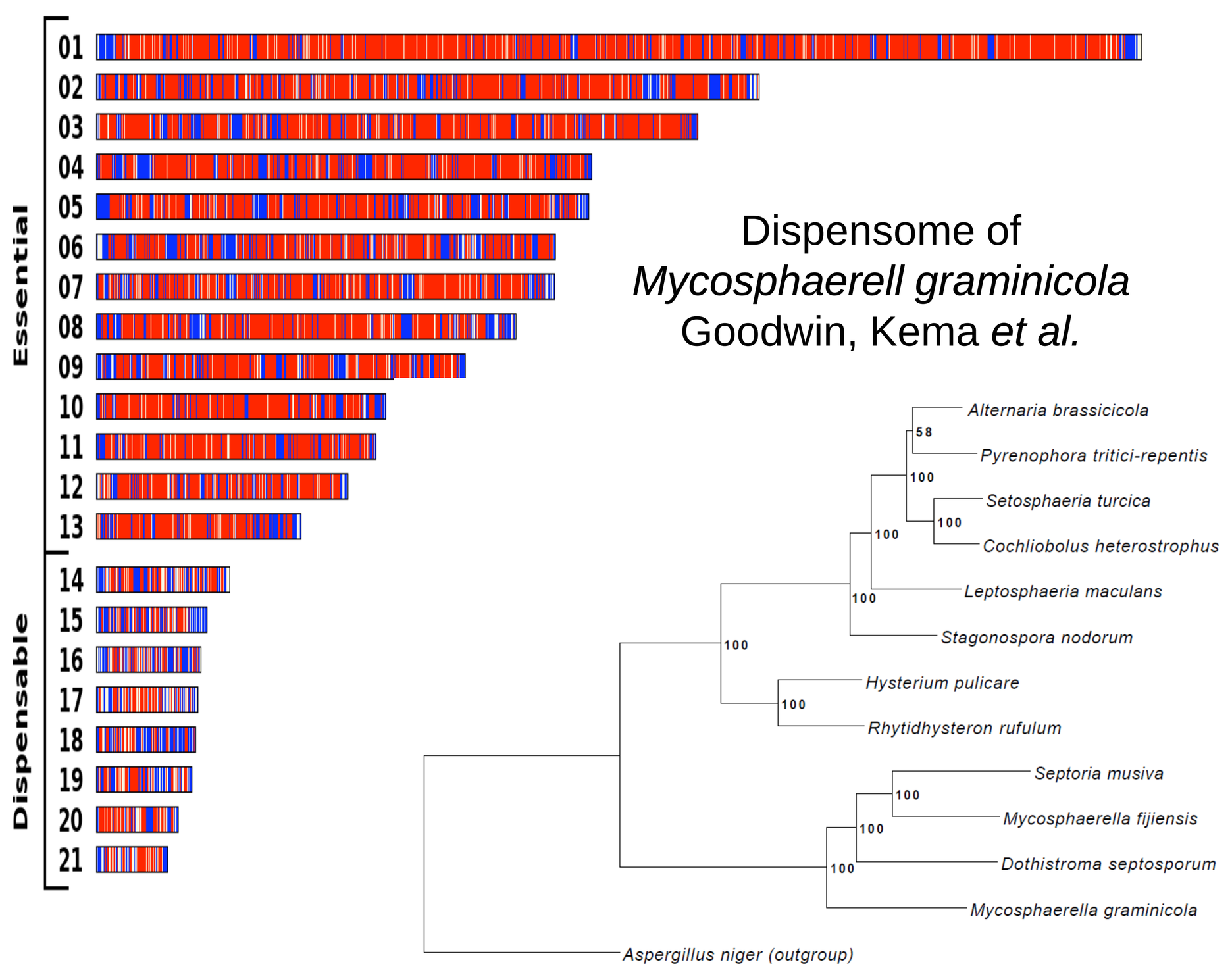


Laccaria bicolor:
Ectomycorrhyzal symbiont of poplar.
Martin et al, *Nature* 2008



Xanthoria parietina:
lichen fungus
(PI: Paul Dyer)

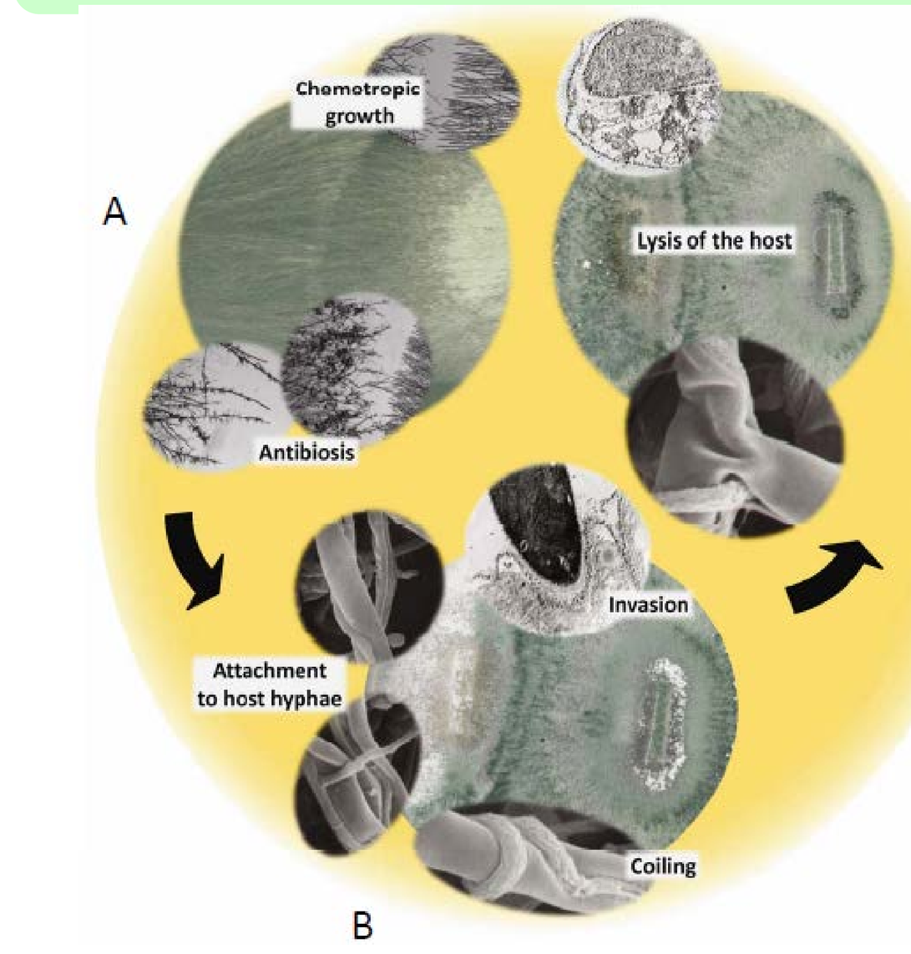
Plant Pathogens



Dispensome of
Mycosphaerell graminicola
Goodwin, Kema *et al.*

Comparative analysis of 12 Dothideomycetes. Ohm *et al.*, *in prep.*

Biocontrol



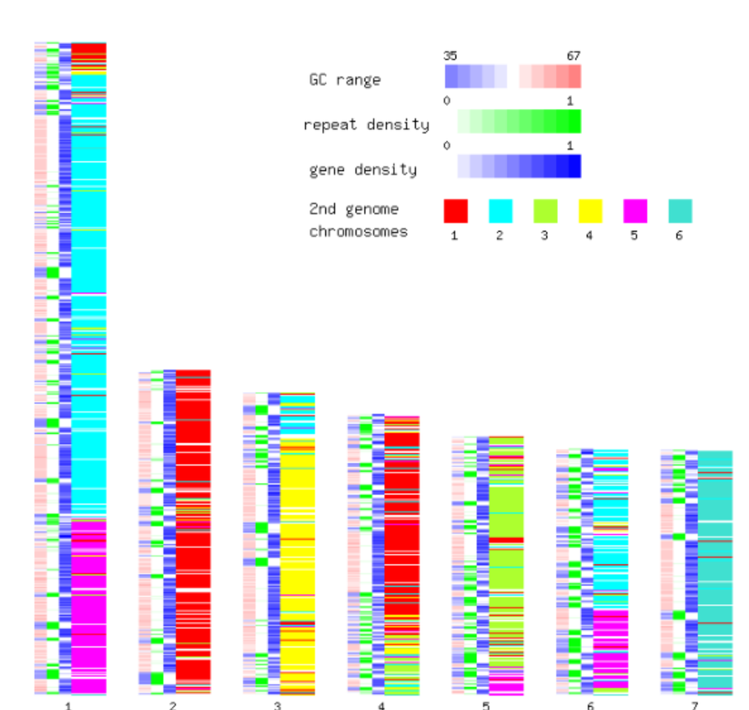
	Chitin/chitosan		ß-glucan				
GH family	18	75	17	55	64	81	217
Trichoderma atroviride	**29**	**5**	**5**	**8**	**3**	**2**	**18**
Trichoderma virens	**36**	**5**	**4**	**10**	**3**	**1**	**18**
Trichoderma reesei	**20**	**3**	**4**	**6**	**3**	**2**	**15**
Aspergillus nidulans	19	2	5	6	0	1	**12**
Aspergillus niger	14	2	5	3	0	1	**9**
Fusarium graminearum	19	1	6	3	2	1	**12**
Laccaria bicolor	10	0	4	2	0	0	**6**
Magnaporthe grisea	14	1	7	3	1	2	**13**
Nectria haematococca	28	2	6	5	2	1	**14**
Neurospora crassa	12	1	4	6	2	1	**13**
Penicillium chrysogenum	9	1	5	3	2	1	**11**
P.chrysosporium	11	0	2	2	0	0	**4**
Podospora anserina	20	1	4	7	1	1	**13**
Postia placenta	20	0	4	6	0	0	**10**
S.cerevisiae	2	0	4	0	0	2	**6**
S.pombe	1	0	1	0	0	1	**2**
Tuber melanosporum	5	1	4	2	0	3	**9**

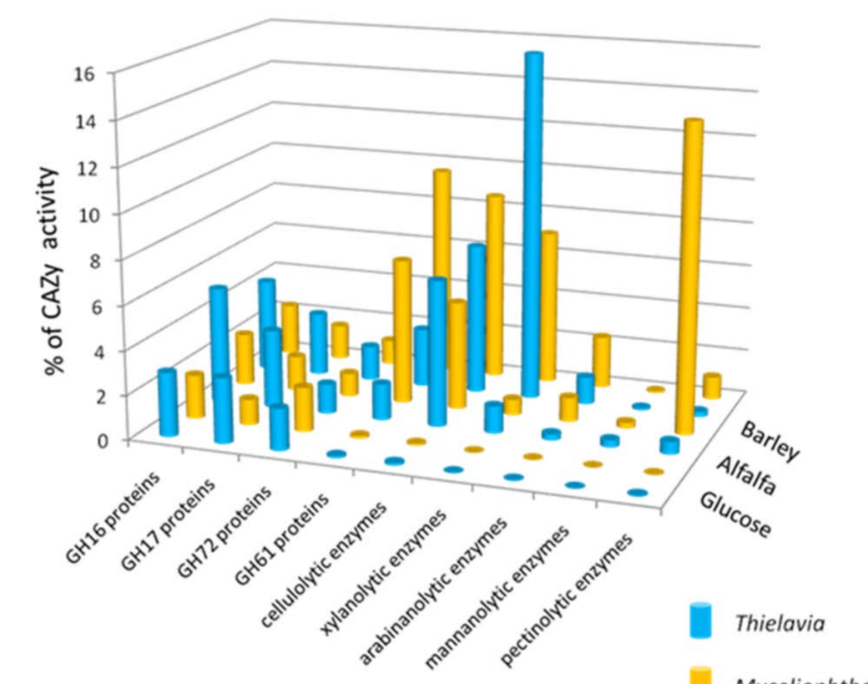
Integrated genomic and transcriptomic analysis reveals mycoparasitism as the ancestoral life style of *Trichoderma.*

Kubicek, *et al.*

Biorefinery

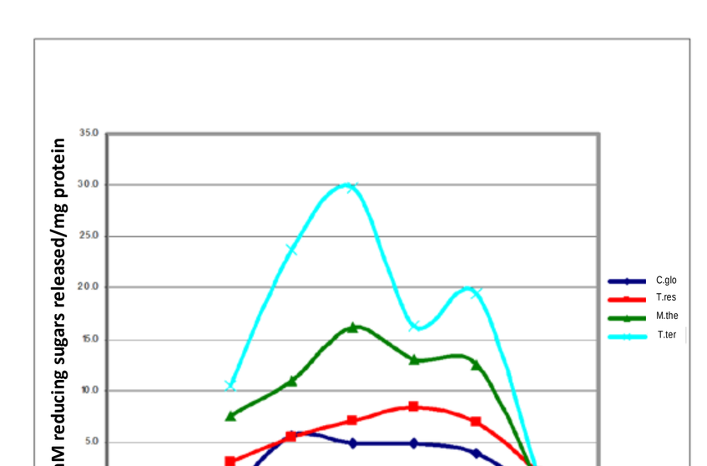
Thermophiles





Thermophilic biomass-degrading fungi *Myceliophthora thermophila* and *Thielavia terrestris* are the first with completely finished genomes, new candidate for cell factories with secreted thermostable enzymes.

Berka, Tsang, *et al.*



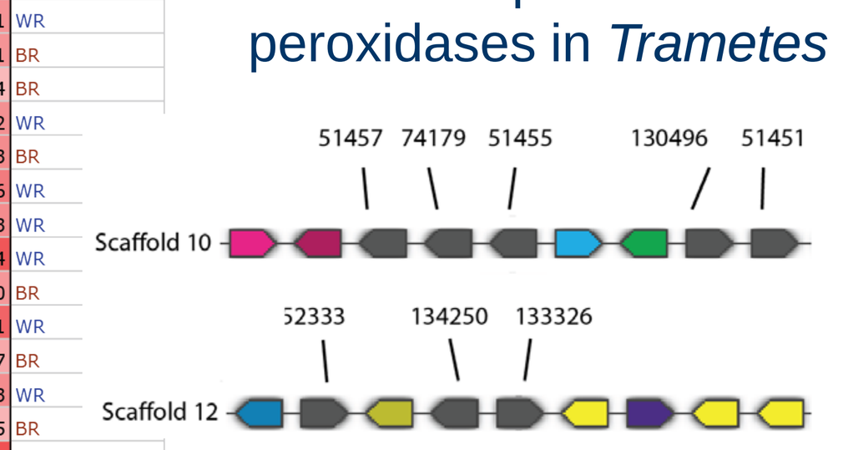
Release of reducing sugars from alfalfa straw by extracellular enzymes

Lignocellulose Degradation

Carbohydrate metabolism enzymes (columns 1–15); Lignin-degrading enzymes (columns 16–18)

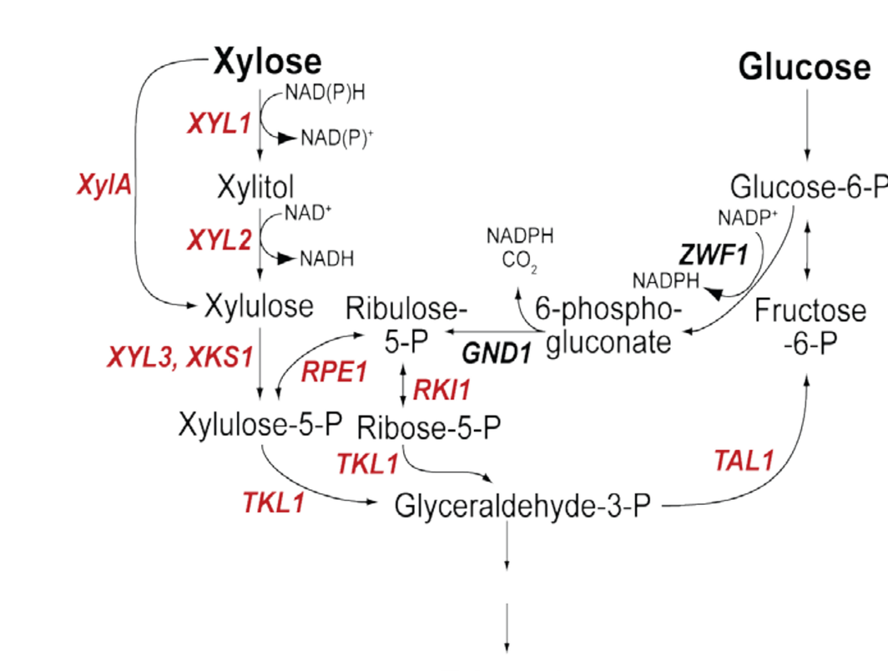
Order	Species	Alpha-amylase	Cellulase	Glyco_hydro_28	Glyco_hydro_10	Glyco_hydro_11	Glyco_hydro_18	Glyco_hydro_16	CBM_1	Glyco_hydro_7	Glyco_hydro_3	Glyco_hydro_31	Glyco_hydro_35	Polysacc_deac_1	Melibiase	Glyco_hydro_43	Cu-oxidase	peroxidase	GMC_oxred_N	Phenotype
Agaricales	*Agaricus bisporus*	6	6	4	2	2	11	4	16	1	7	6	1	10	4	3	13	5	35	SAP
	Coprinopsis cinerea	8	7	3	6	6	9	5	44	6	7	3	0	17	0	3	17	4	36	SAP
	Laccaria bicolor	7	1	3	0	0	11	5	1	0	2	2	1	10	1	0	12	2	9	EM
	Pleurotus ostreatus	9	10	6	3	2	11	6	32	16	12	8	4	12	6	6	12	10	42	Lignin degrader
	Schizophyllum commune	12	4	3	5	1	13	5	4	2	12	4	4	8	1	12	6	1	21	WR
Boletales	*Coniophora puteana*	5	9	13	3	0	13	3	2	2	13	11	2	10	3	6	8	1	21	BR
	Serpula lacrymans	6	9	7	1	0	8	2	8	0	10	5	3	5	3	1	6	1	14	BR
Corticiales	*Punctularia strigosozonata*	9	6	12	5	1	9	5	21	5	13	7	4	5	5	6	13	12	22	WR
Gloeophyllales	*Gloeophyllum trabeum*	8	8	10	3	0	8	5	1	0	9	5	2	7	3	5	5	1	23	BR
Hymenochaetales	*Fomitiporia mediterranea*	5	8	14	4	0	12	4	6	2	8	5	2	7	4	5	11	18	26	WR
Polyporales	*Ceriporiopsis subvermispora*	6	7	6	6	1	11	4	16	3	6	5	1	4	4	1	9	17	23	WR
	Dichomitus squalens	7	9	7	5	0	13	6	16	3	8	6	3	5	6	3	13	14	34	WR
	Fomitopsis pinicola	6	11	12	2	0	16	5	0	0	12	4	2	5	4	5	7	2	20	BR
	Phanerochaete chrysosporium	8	7	3	6	1	10	3	28	7	10	6	3	5	2	3	5	17	31	WR
	Postia placenta	3	10	6	4	0	14	7	0	0	9	7	2	6	2	0	6	1	17	BR
	Trametes versicolor	6	10	9	6	0	11	6	20	4	12	5	2	4	3	2	10	27	23	WR
	Wolfiporia cocos	6	6	9	4	0	9	4	0	0	8	5	2	5	3	0	5	2	15	BR
Russulales	*Heterobasidion annosum*	6	7	8	2	0	8	4	17	1	12	9	4	6	4	3	18	9	35	WR
	Stereum hirsutum	13	10	17	6	1	13	5	17	3	16	8	7	8	5	7	21	7	51	WR
Tremellales	*Cryptococcus neoformans*	9	1	1	0	0	3	1	0	0	7	3	0	4	0	0	5	2	2	AP
	Tremella mesenterica	9	4	0	0	0	3	1	0	0	3	2	0	6	0	0	4	2	2	
Pucciniales	*Melampsora laricis-populina*	6	5	3	5	0	15	1	0	8	3	3	1	19	1	4	17	2	8	Rust
	Puccinia graminis	4	8	1	5	0	16	1	0	8	2	2	1	14	1	0	10	2	8	Rust
Sporidiobolales	*Rhodotorula graminis*	2	1	1	0	0	5	5	2	0	4	1	0	8	0	1	2	2	5	E
	Sporobolomyces roseus	3	0	0	0	0	7	2	0	0	3	1	0	6	0	0	1	2	4	E
Malasseziales	*Malassezia globosa*	0	3	0	0	0	1	1	0	0	1	1	0	4	0	1	6	2	6	AP
Ustilaginales	*Ustilago maydis*	3	3	1	2	1	2	9	0	0	3	3	1	7	1	2	6	4	10	Smut
Wallemiales	*Wallemia sebi*	0	1	0	0	0	2	1	0	0	4	3	0	6	1	0	1	1	6	
	CAZy codes / FOLy codes	GH13	GH5	GH28	GH10	GH11	GH18	GH16	CBM1	GH7	GH3	GH31	GH35	CE4	GH27	GH43	LO1	LO2	LO3	

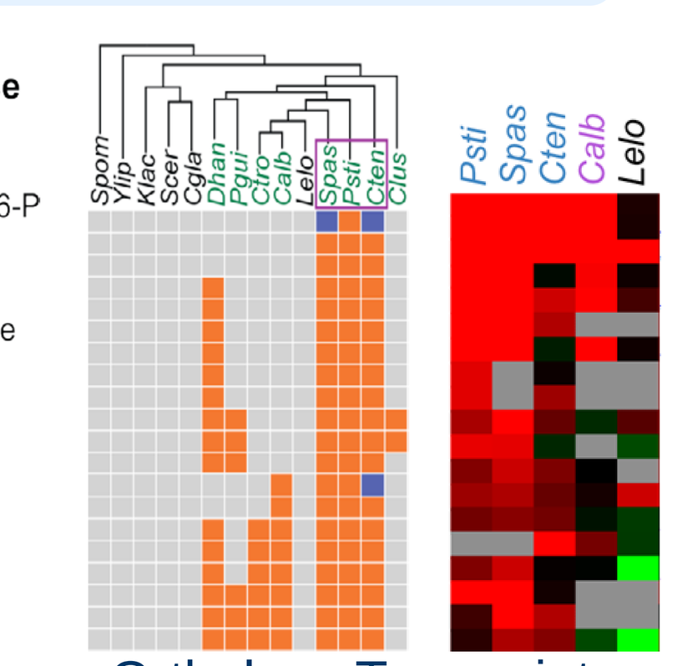
CAZy and FOLy in Basidiomycetes:
Tandem duplication of peroxidases in *Trametes*



Riley, *et al.*

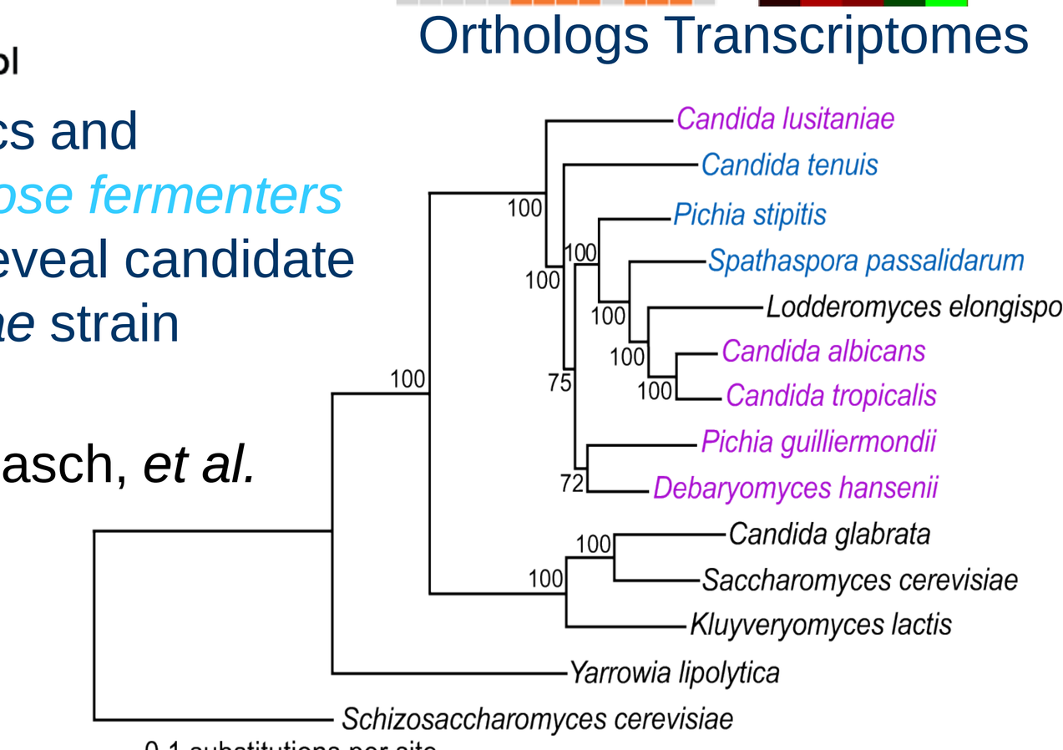
Xylose Fermenters





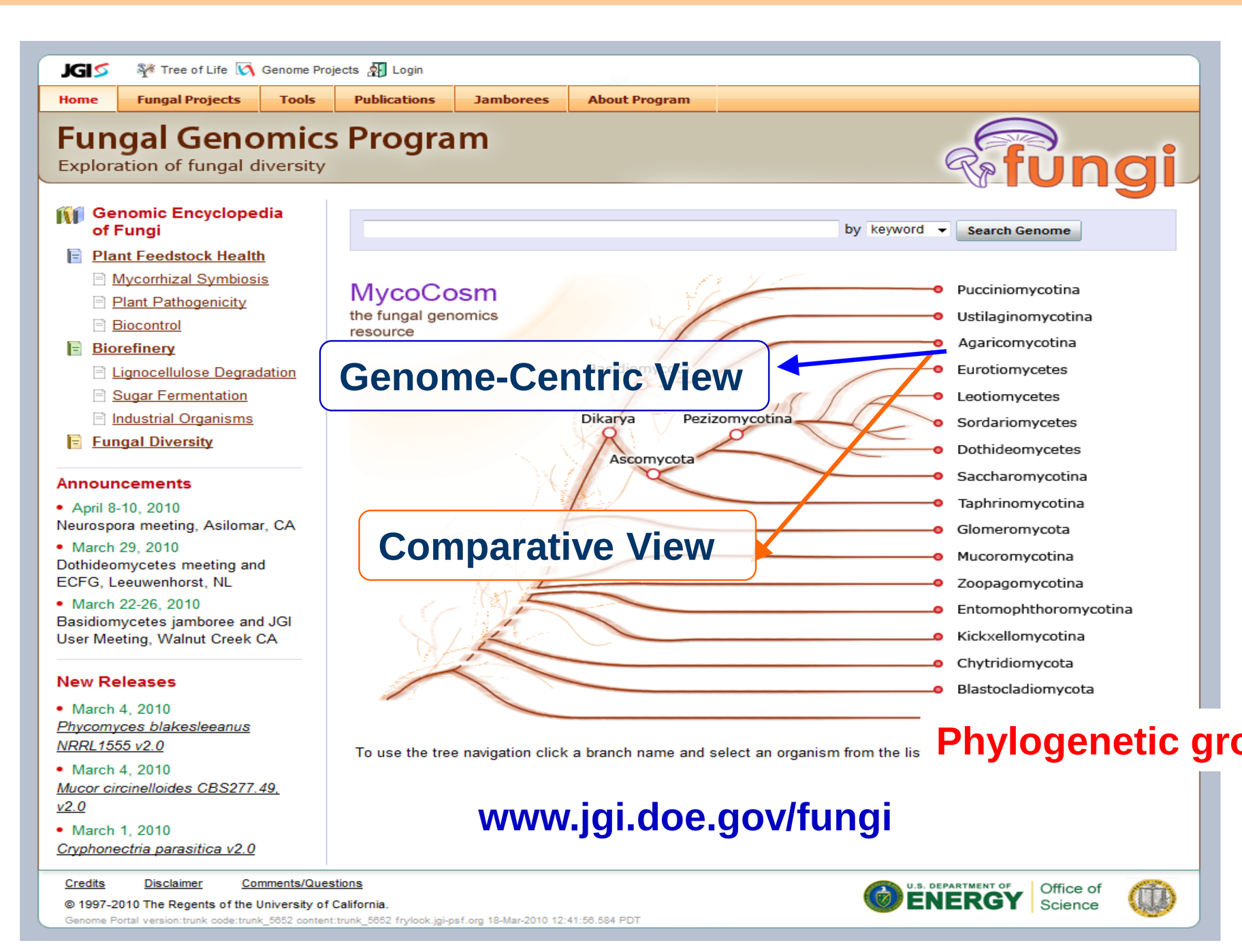
Comparative genomics and transcriptomics of *xylose fermenters* and *xylose growers* reveal candidate genes for *S.cereviseae* strain improvement

Gasch, *et al.*



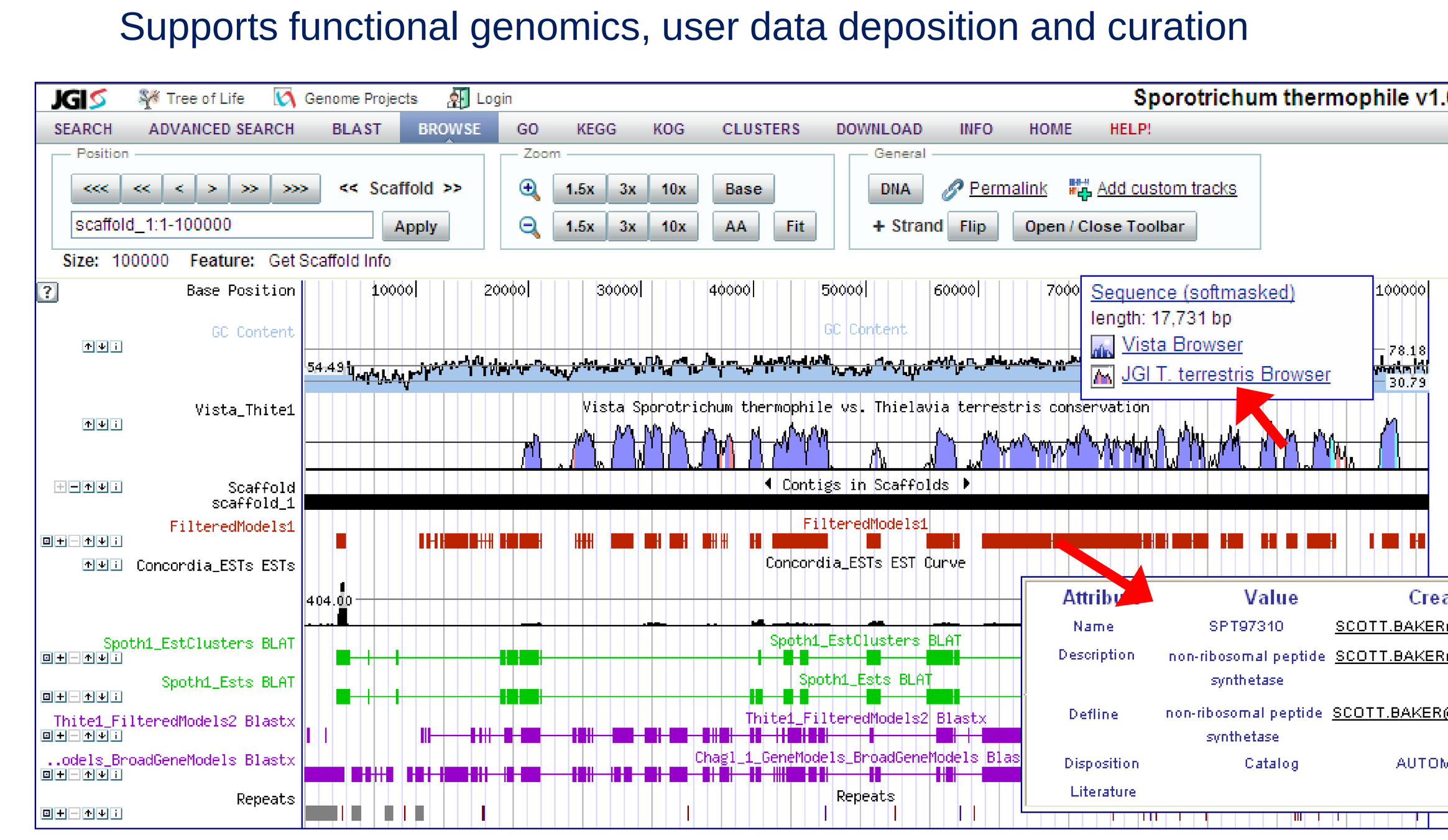
Fungal Diversity

MycoCosm: 60+ fungal genomes



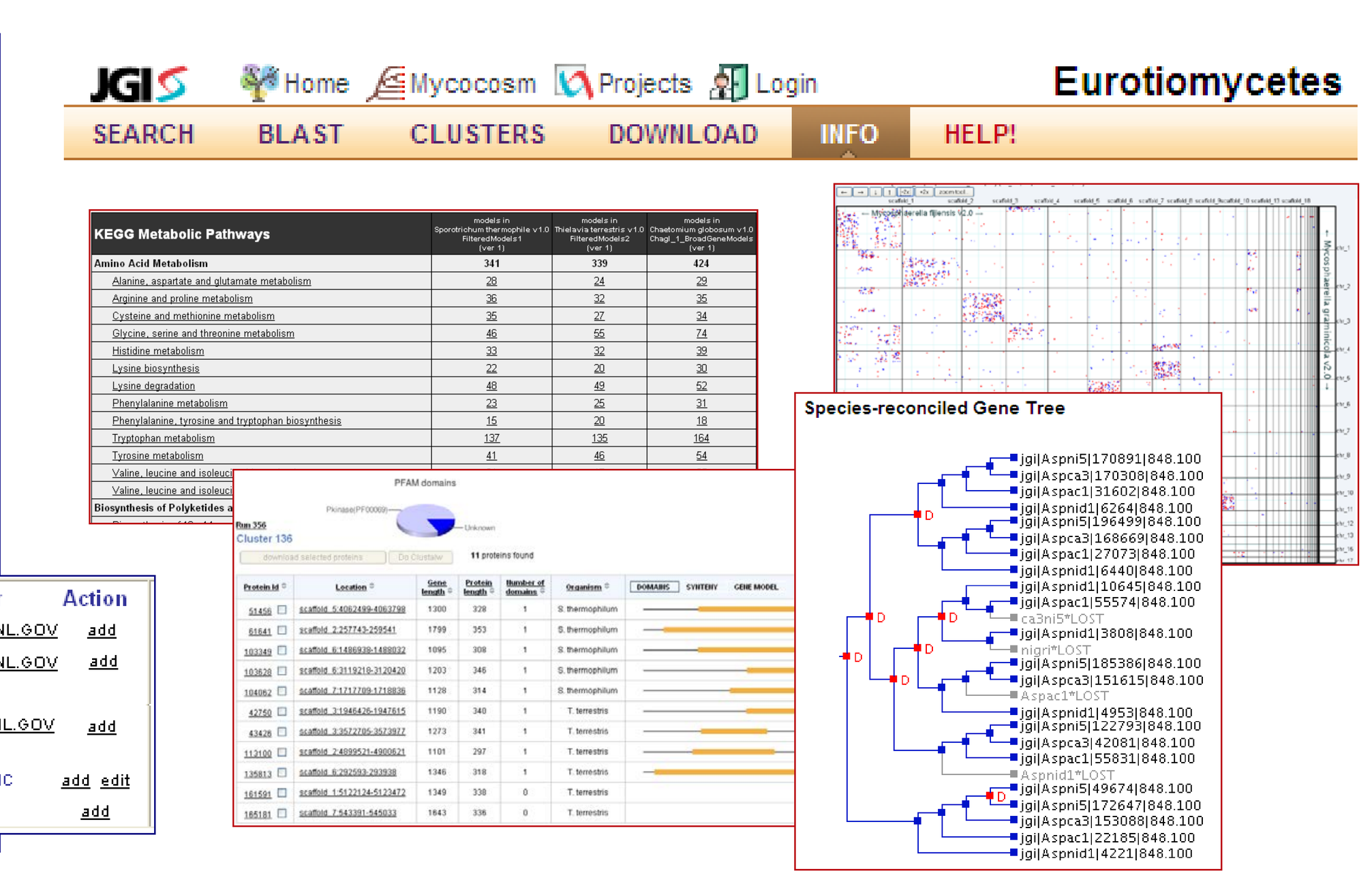
Genome-centric View

Supports functional genomics, user data deposition and curation



Comparative View

Enables analysis of groups of fungi



LBNL-4519E-Poster

The work conducted by the U.S. Department of Energy Joint Genome Institute is supported by the Office of Science of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.