



ECFG15
ROME • ITALY 2020

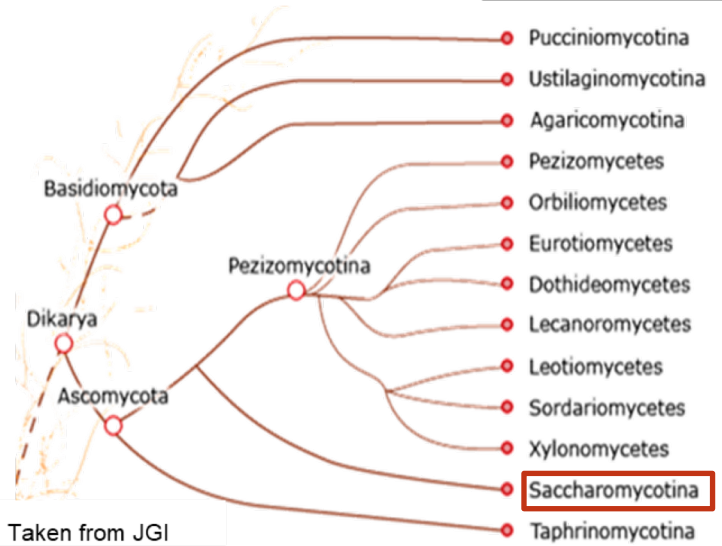
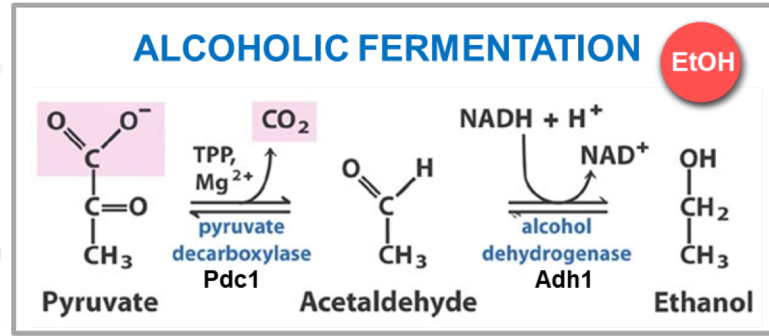
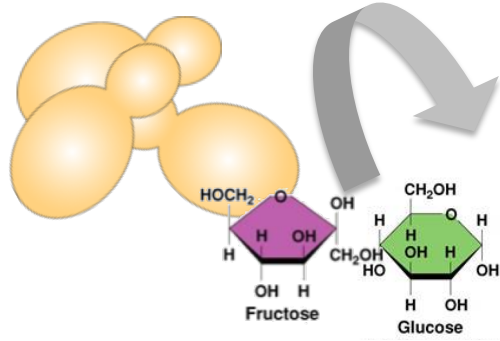


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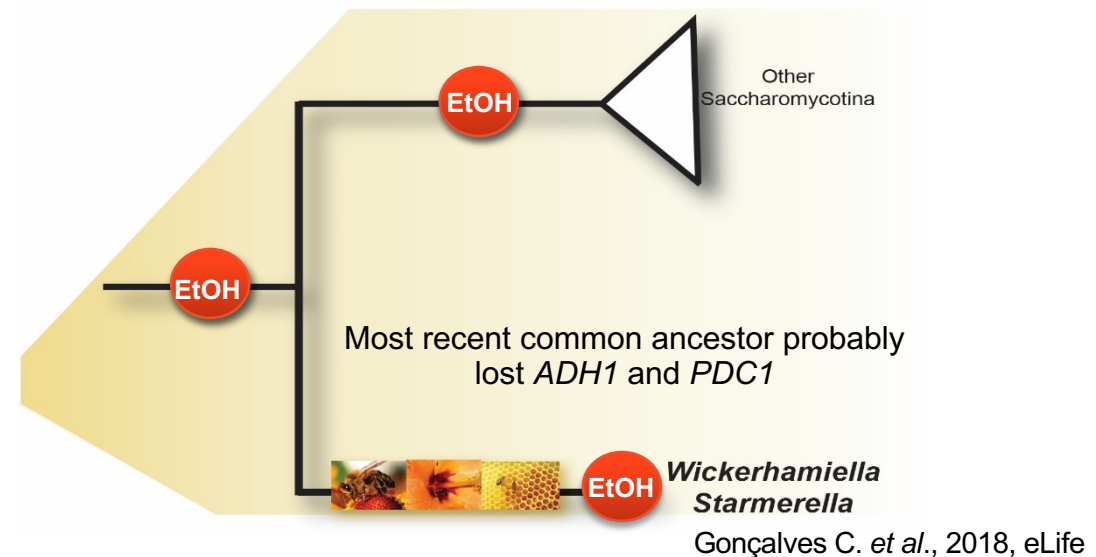
A mosaic thiamine biosynthetic pathway in yeasts reconstructed by multiple horizontal gene transfers

Carla Gonçalves

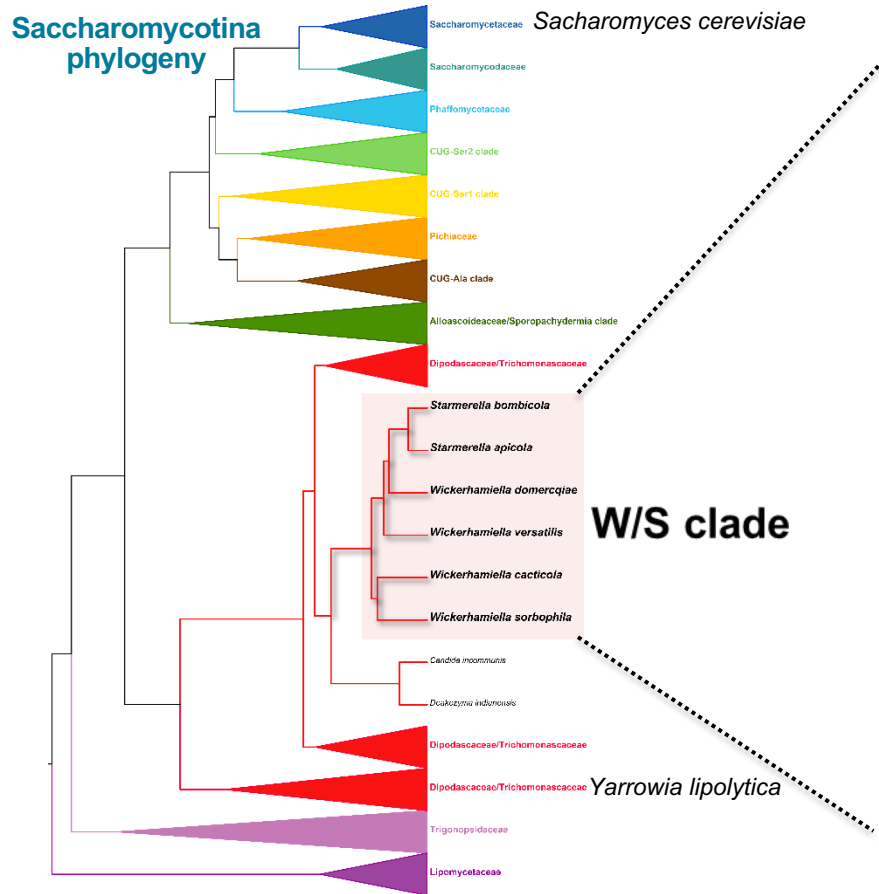
Loss of alcoholic fermentation in a yeast lineage



Taken from JGI



The *Wickerhamiella*/*Starmerella* (W/S) clade



Ecology:



Thrive in sugar (fructose) rich environments

Metabolism:

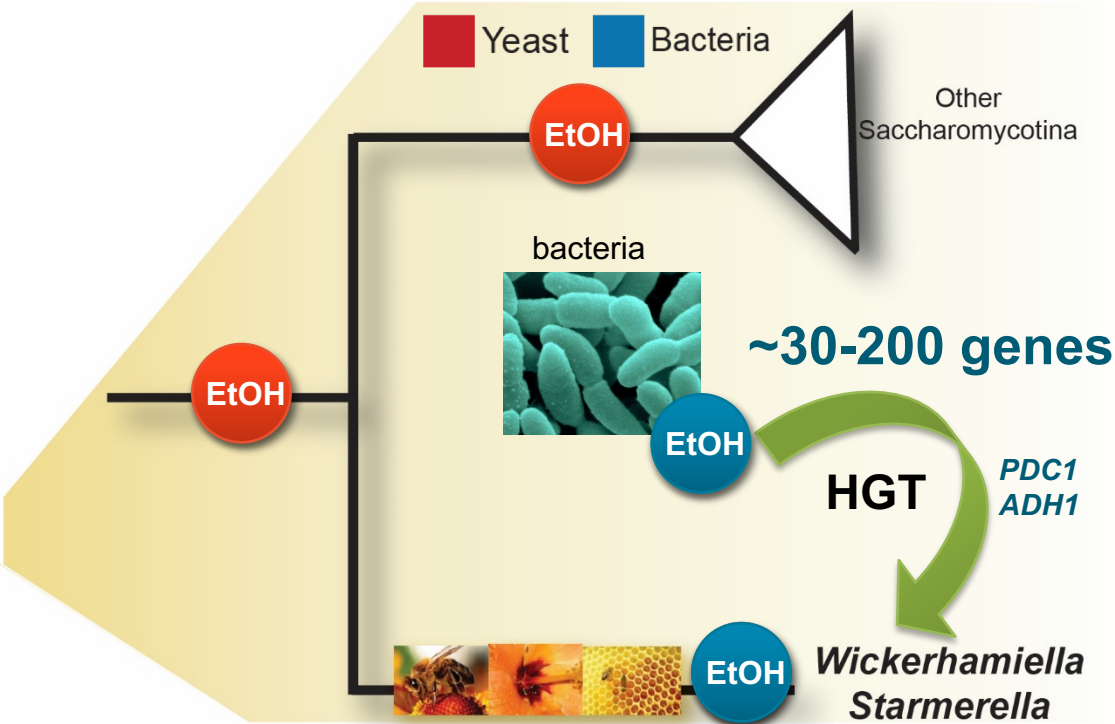
Prefer fructose over glucose (fructophily)

Sophorolipid producers (eco-friendly biosurfactants)

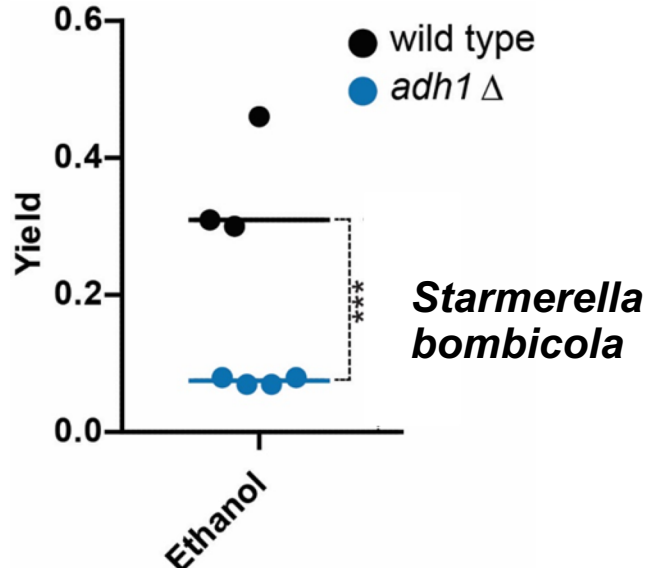
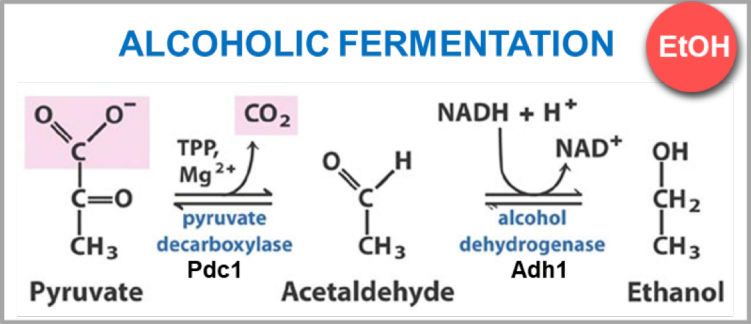
Strong mannitol and erythritol producers

Weak fermenters **But some do ferment!**

Loss and reacquisition of alcoholic fermentation

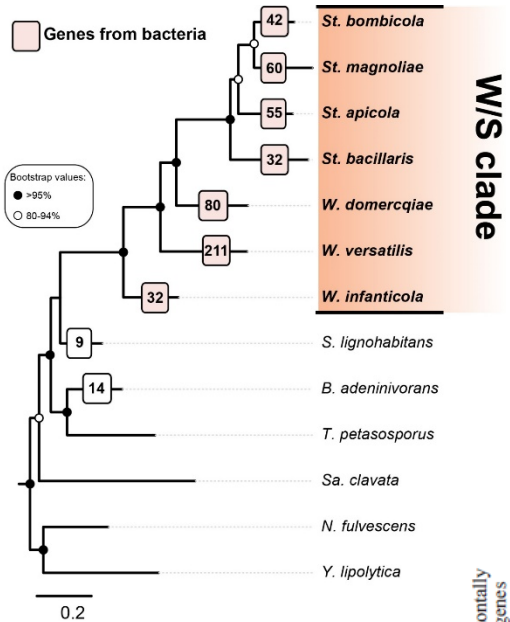


Gonçalves C. et al., 2018, eLife

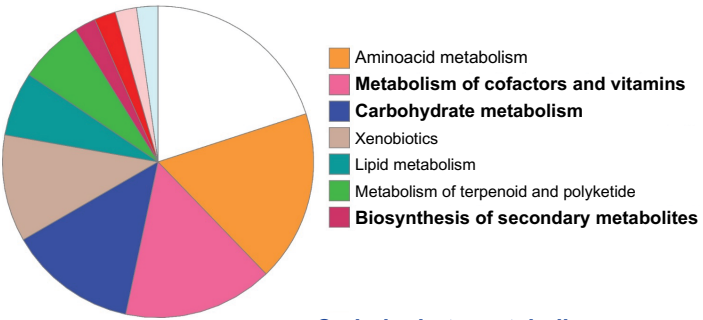


HGT- horizontal gene transfer

Incidence of HGT in the W/S clade



Functional categories of bacterial genes in the W/S clade



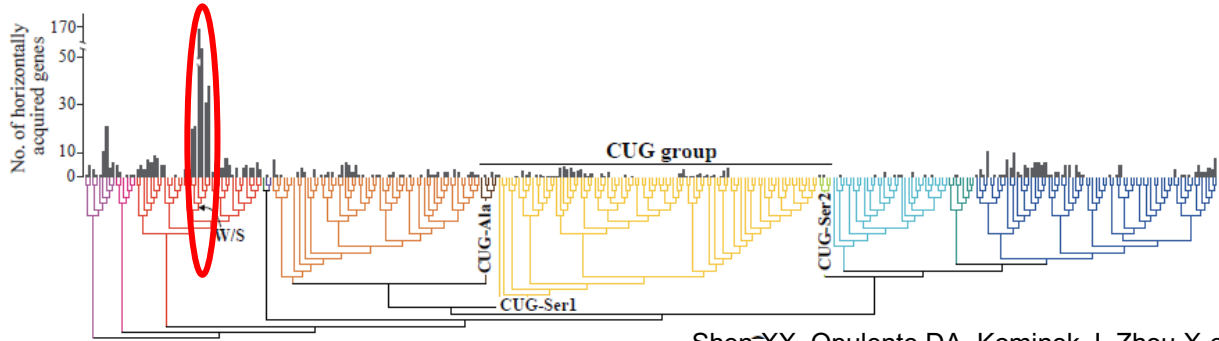
Metabolism of cofactors and vitamins
Thiamine biosynthesis



Carbohydrate metabolism
Gonçalves C. *et al.*, 2018, eLife

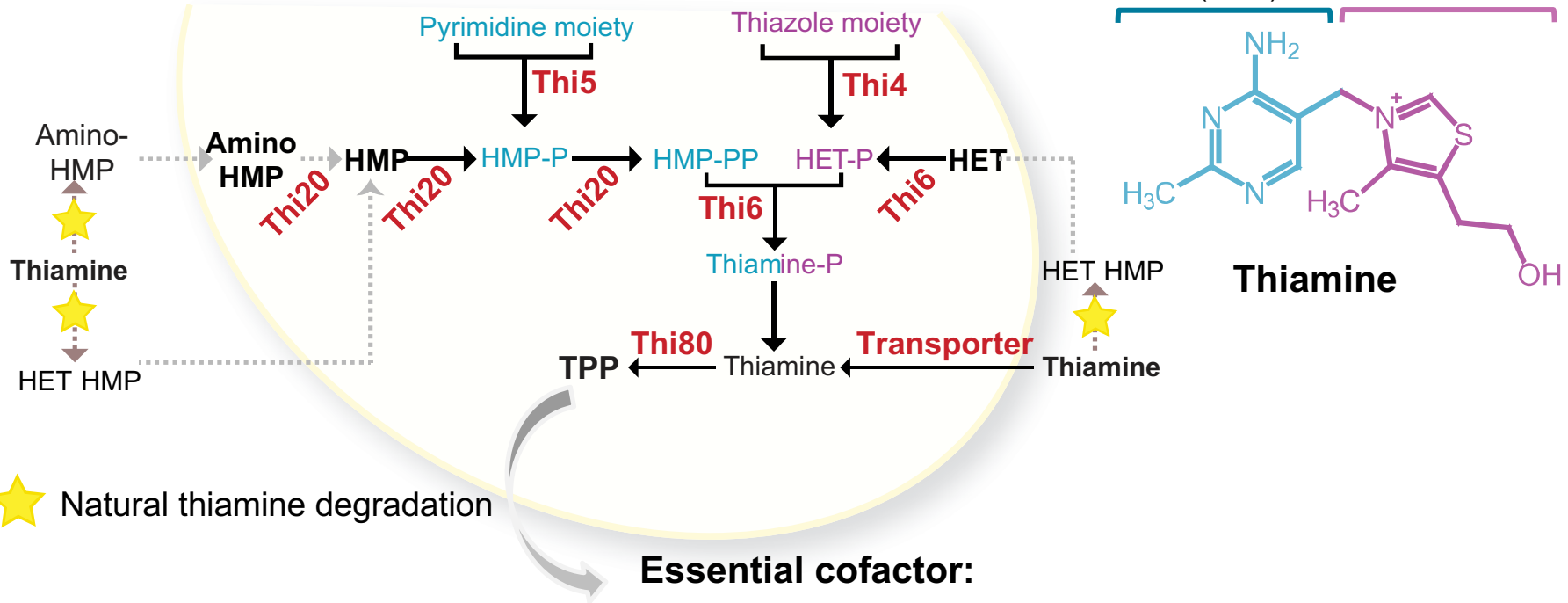
Biosynthesis of secondary metabolites
Kominek J, Droering D, *et al.*, CELL, 2019

Analysis of HGT in 332 yeast genomes



TPP (active form of thiamine) is an essential cofactor

Thiamine biosynthetic pathway in yeasts

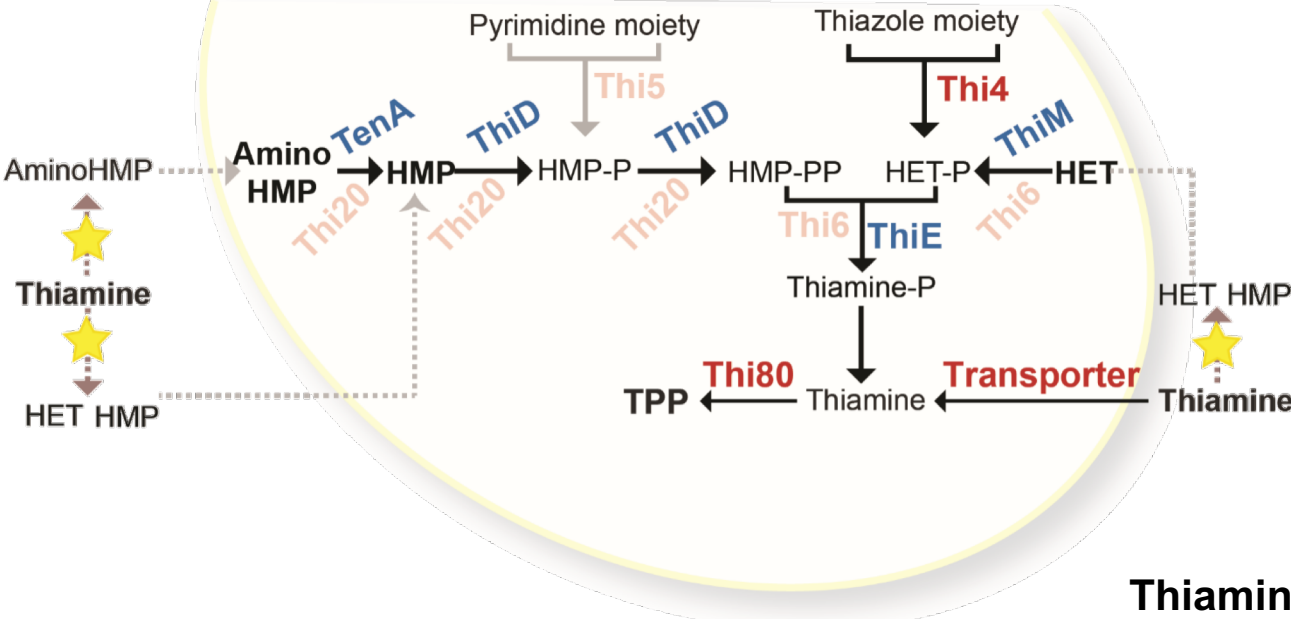


Essential cofactor:

Carbohydrate metabolism

Aminoacid metabolism

Bacterial genes form a thiamine salvage pathway in W/S yeasts



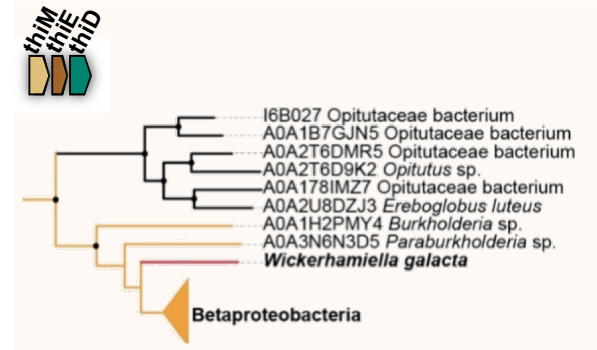
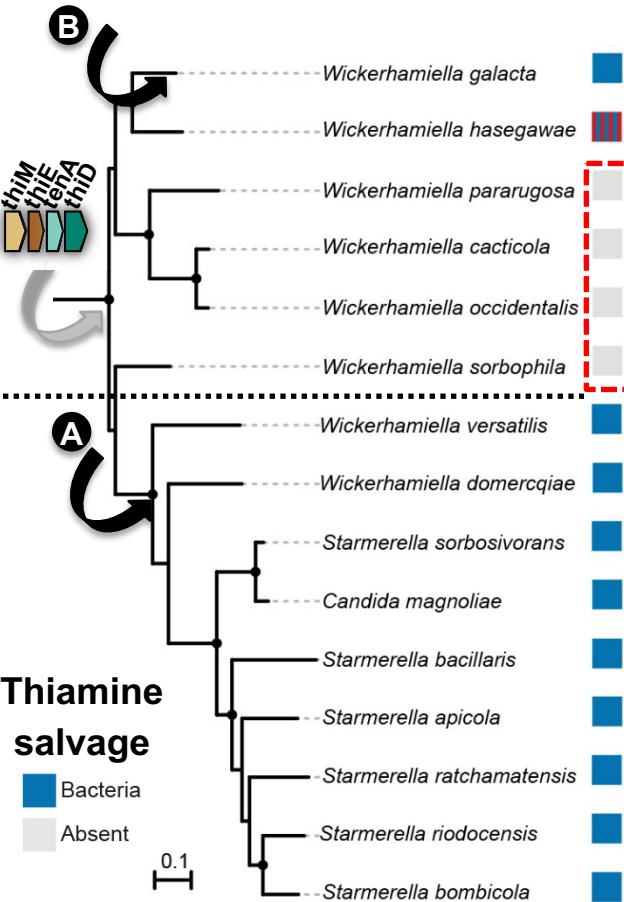
Gene origin
■ Yeast ■ Bacteria

De novo pathway
Salvage pathway
Transport

Thiamine salvage genes are organized in cluster in all W/S-clade species



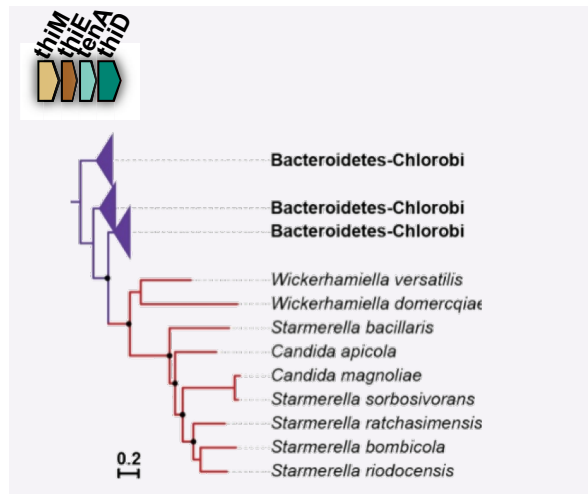
Independent acquisitions of a thiamine operons/genes



Putative donor lineage: Betaproteobacteria

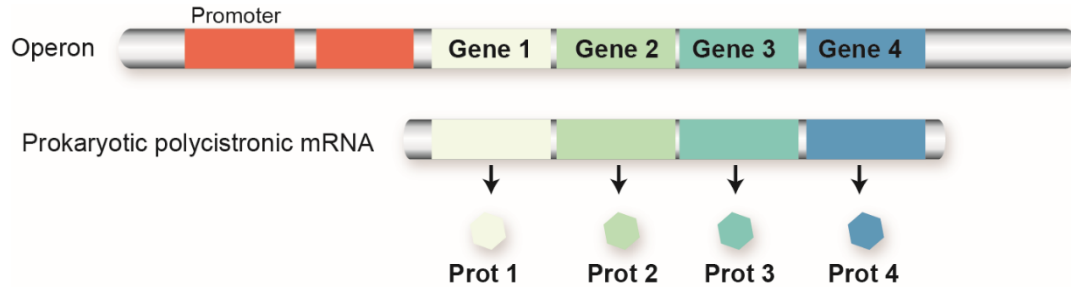


Actinobacteria
independent acquisition of tenA



Putative donor lineage: Bacteroidetes

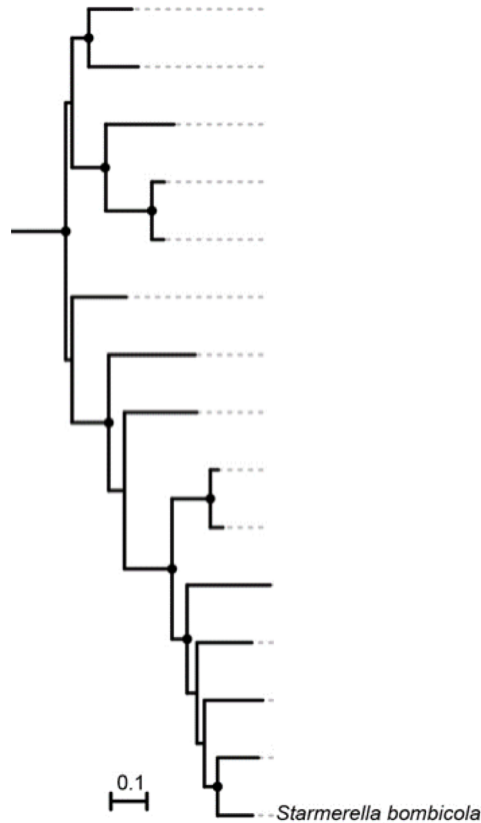
- How did these “operons” evolve in the new eukaryotic setting?



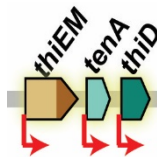
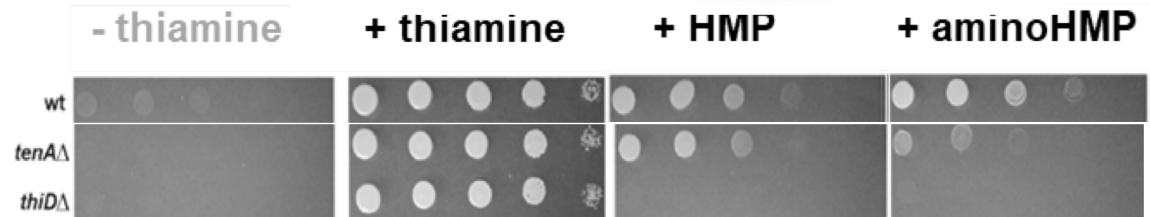
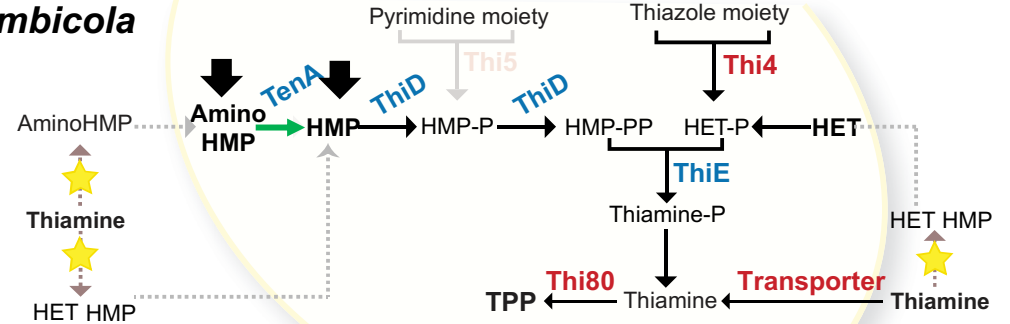
Operons/Polycistronic mRNAs are rare in eukaryotes

- Are they functional?

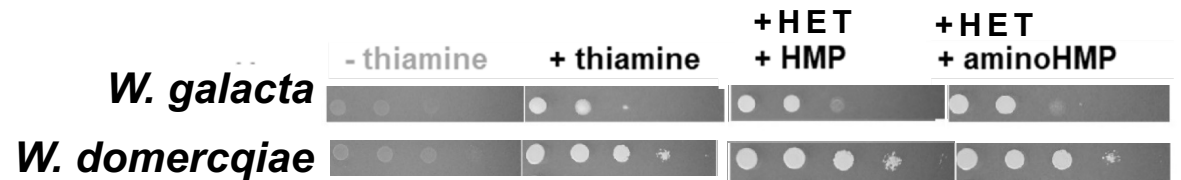
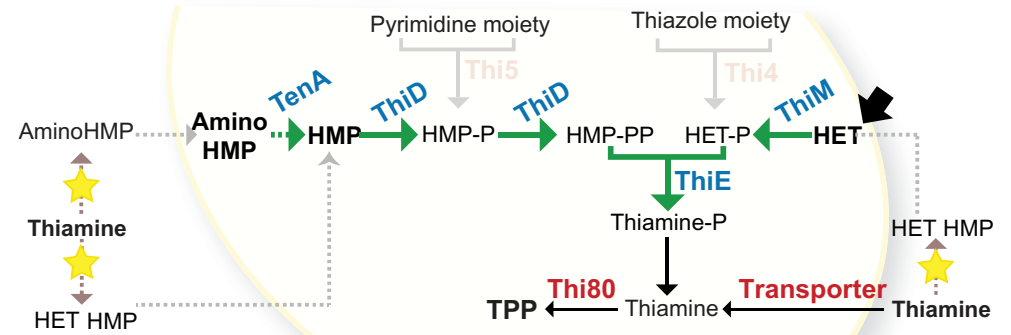
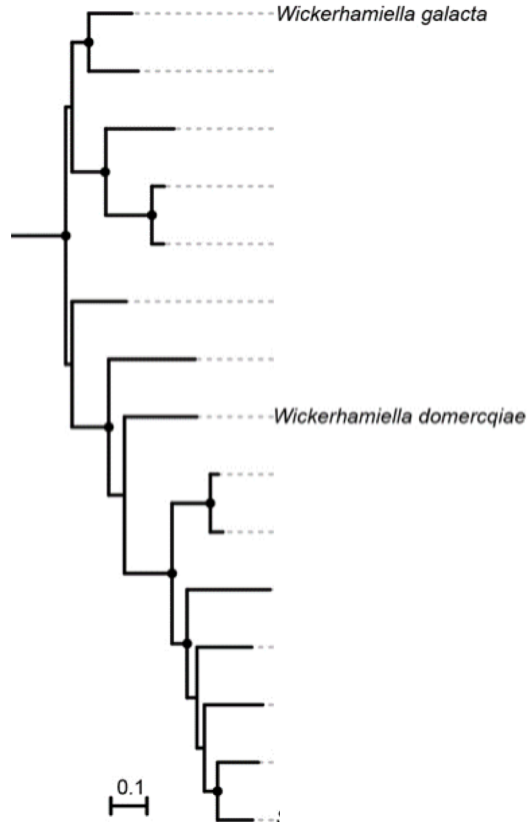
Adaptation and function of thiamine “operons”



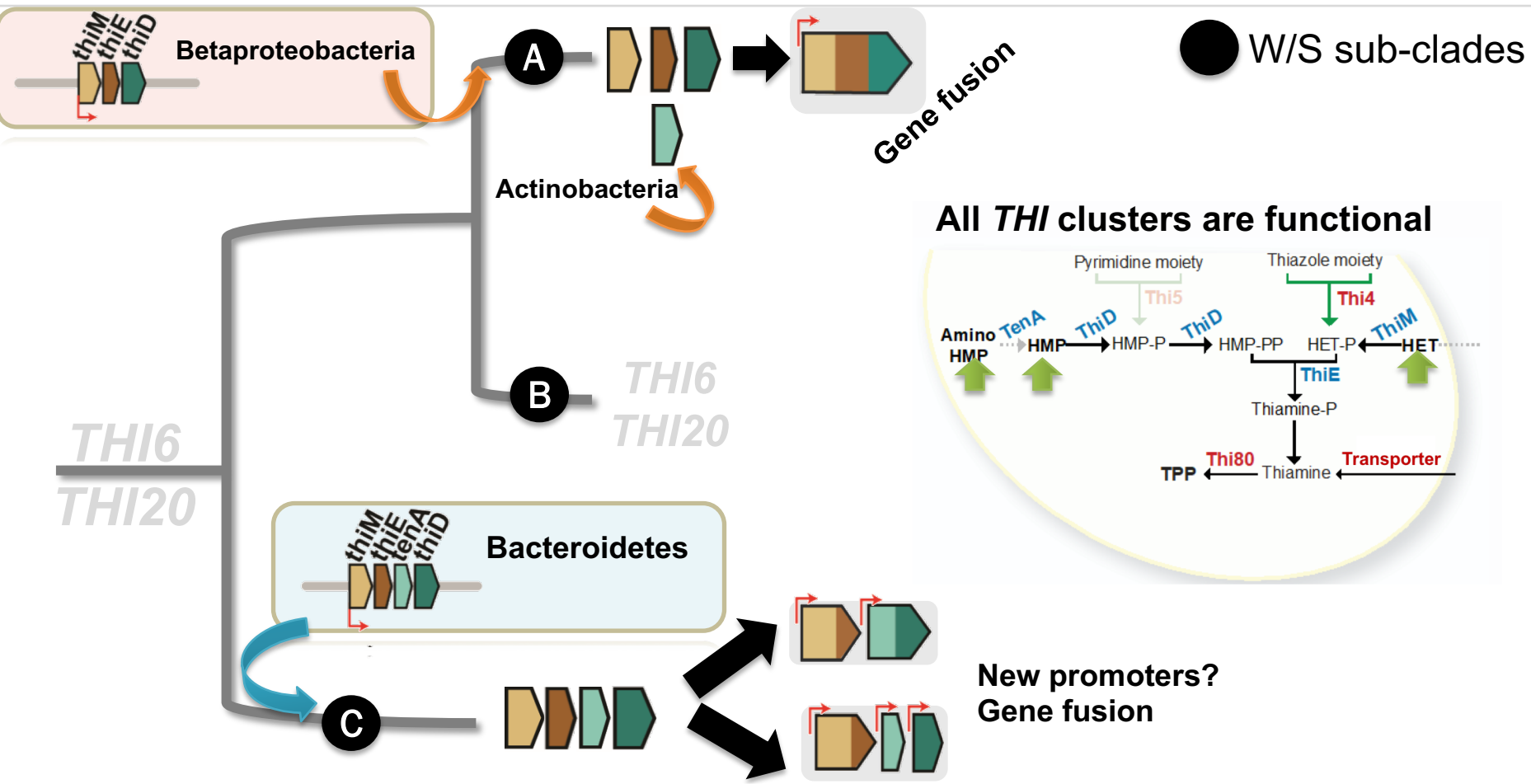
Starmarella bombicola



Adaptation and function of thiamine “operons”



Summary



ACKNOWLEDGMENTS

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Paula Gonçalves (PI)

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Reacquisition of alcoholic fermentation in collaboration with:

Antonis Rokas Lab
Chris Hittinger Lab

