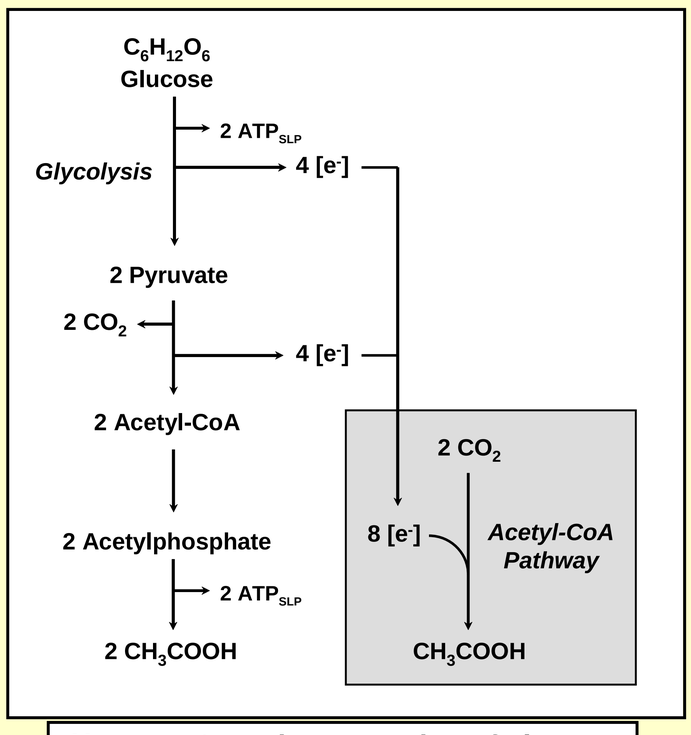
From *Clostridium thermoaceticum* to *Moorella thermoacetica*: By Viewing the Old, We Learn the New

Steven L. Daniel[1] and Harold L. Drake[2]

Department of Biological Sciences, Eastern Illinois University, Charleston, Illinois 61920, USA[1] and
Department of Ecological Microbiology, University of Bayreuth, D-95440 Bayreuth, Germany[2]



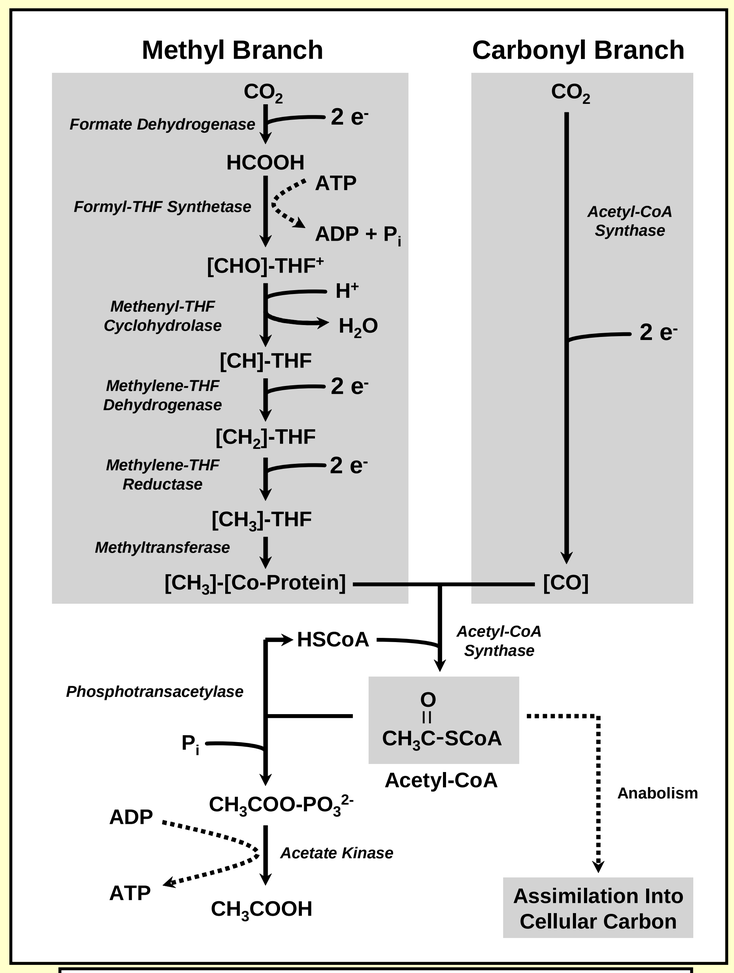
Homoacetogenic conversion of glucose to acetate by *C. thermoaceticum*

Thanks Lars!

Harland G. Wood

Lars G. Ljungdahl

Clostridium thermoaceticum **ATCC 39073 (A) and the two biochemists (B, C) who were primarily responsible for resolving the acetyl-CoA or Wood-Ljungdahl pathway in *C. thermoaceticum***

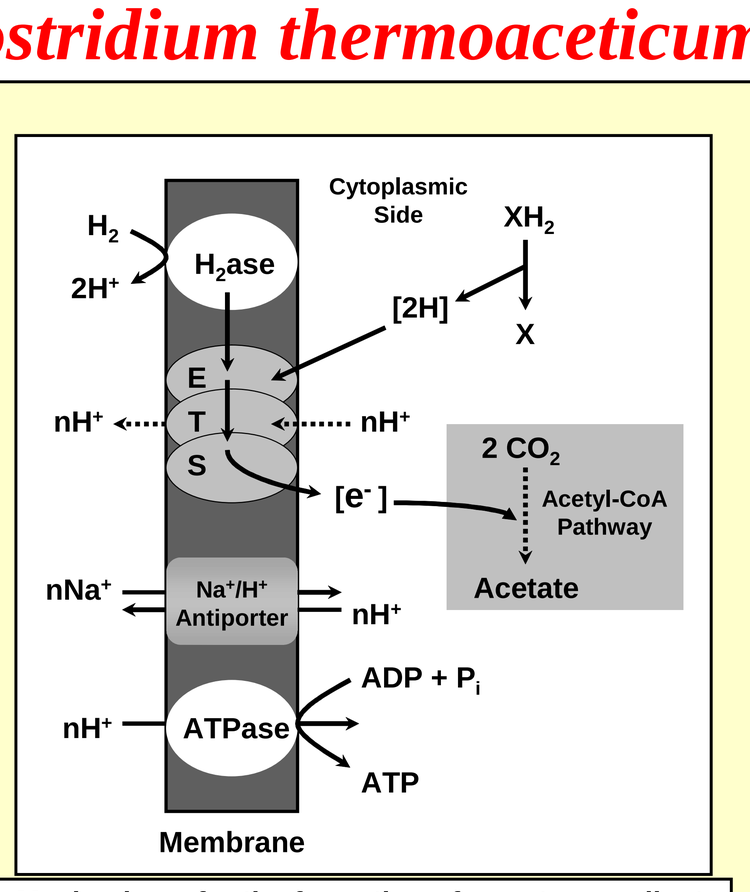


The acetyl-CoA or Wood-Ljungdahl pathway as resolved from *C. thermoaceticum*

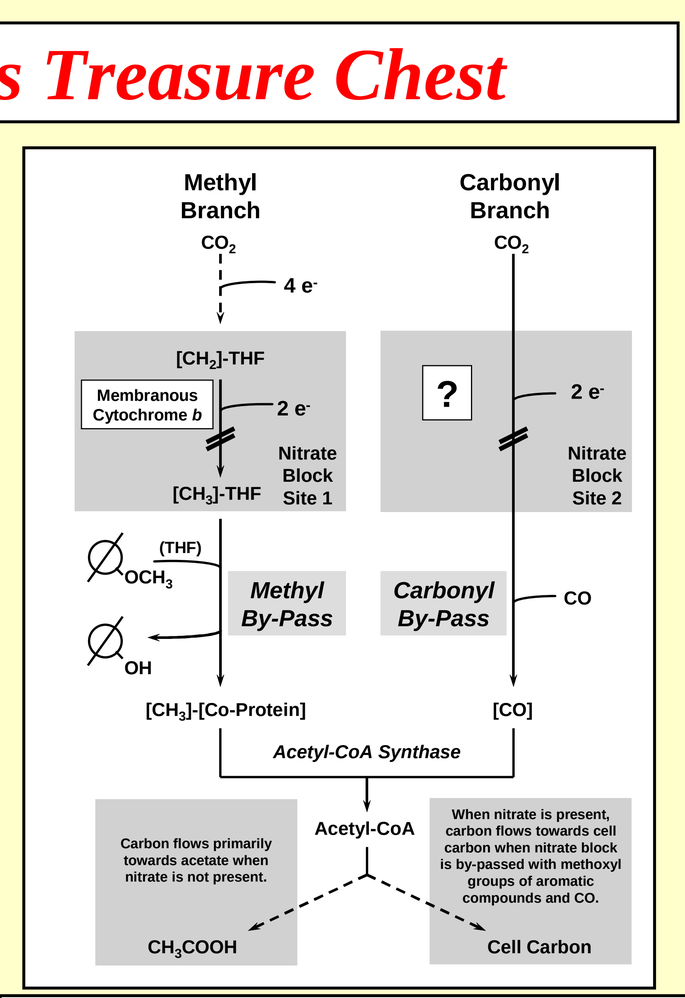
A Few of the Gems in Clostridium thermoaceticum's Treasure Chest

Cellular and metabolic properties of *M. thermoacetica*

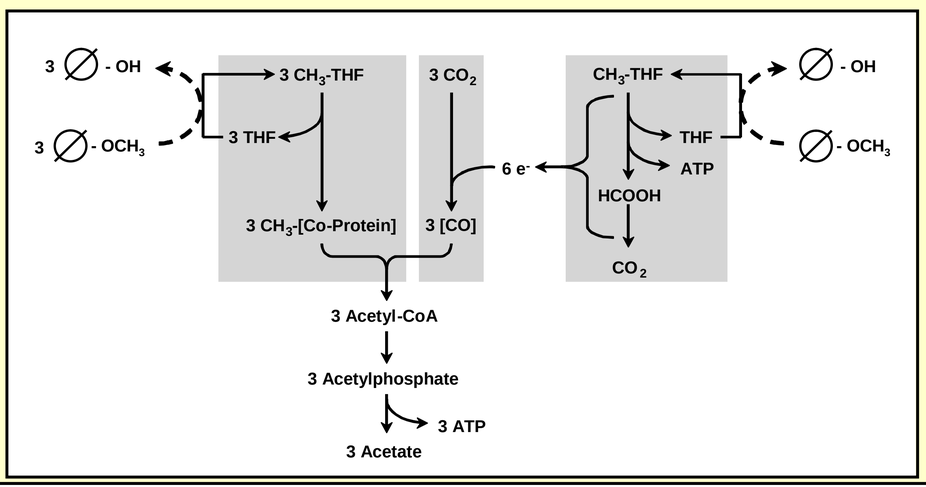
Property	*M. thermoacetica*
Classification	Low G + C, Gram-positive bacteria, *Clostridium,* Cluster VI *Bacteria, Firmicutes, Clostridia*, *Thermoanaerobacteriales*, *Thermoanaerobacteriaceae*, *Moorella* group, *Moorella*
Habitat	Soils
Colony morphology	Circular, smooth, opaque, beige
Cell	
morphology	Rod-shaped
typical size	0.4 x 2.8 µm
arrangement	Single, pairs, and chains
Gram reaction	+
G + C content (mol %)	54
Spore	
shape	Spherical
location	Subterminal, bulged sporangium
D value @ 121ºC	83-111 min
Flagellum	
flagellation pattern	Peritrichous
motility	-
Nutritional requirement	Nicotinic acid and trace metals (e.g., Ni, Se, Zn, Mo, W, Co, Fe)
Temperature (ºC)	
optimum	55-60
range	45-65
pH	
optimum	6.8
range	5.7- 7.7
Electron donor[a]	
sugars	Glucose, fructose, xylose
gases	H_2, CO
alcohols	Methanol, ethanol, *n*-propanol, *n*-butanol
organic acids	Formate, oxalate, glyoxylate, glycolate, pyruvate, lactate
Electron acceptor[b]	
C-based	CO_2, carboxyl groups of aromatics
N-based	nitrate, nitrite
S-based	thiosulfate, dimethylsulfoxide
Metabolic transformation[c]	
	Cystine ⟶ 2 Cysteine
	Glutamate ⟶ 5-Aminolevulinic acid
	2,4,6-Trinitrotoluene ⟶ Hydroxyl-amino-nitrotoluenes
	CCl_4 ⟶ CH_2Cl_2 + CH_3Cl
	O_2 + 4[H] ⟶ 2 H_2O
	H_2O_2 + XH_2 ⟶ X + 2 H_2O
	$CdCl_2$ + cysteine ⟶ CdS
	Inorganic pyrophosphate ⟶ inorganic phosphate



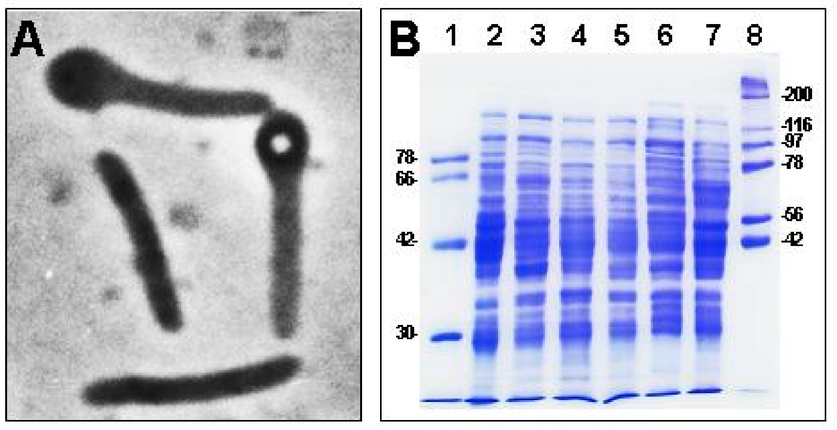
Mechanisms for the formation of a proton gradient and the chemiosmotic conservation of energy by *M. thermoacetica*



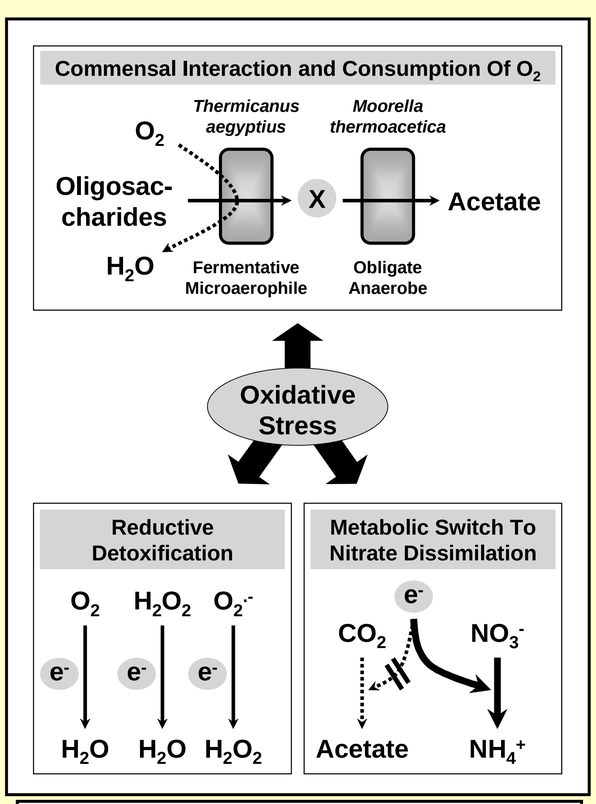
Scheme illustrating where the acetyl-CoA pathway is blocked when nitrate is dissimilated to ammonium by *M. thermoacetica*



Hypothetical routes by which *O*-methyl groups from methoxylated aromatic compounds can be utilized by *M. thermoacetica*



A. *M. thermoacetica* PT1 (DSM 12993) obtained from Kansas prairie soil.
B. Lanes 2-7 are protein profiles of different strains of *M. thermoacetica* obtained from either Kansas soil or Egyptian soil; cells were cultivated on fructose. Lanes 1 and 8 are molecular weight standards. All isolates have nearly identical metabolic capabilities to *M. thermoacetica* ATCC 39073 and grow chemolithoautotrophically at the expense of H_2-CO_2 or CO-CO_2.



Mechanisms by which *M. thermoacetica* copes with O_2 and oxidative stress

All material used with permission from:

Drake, H.L, & S. L. Daniel. 2004.
Physiology of the thermophilic acetogen *Moorella thermoacetica*.
Research in Microbiology 155:869-883.