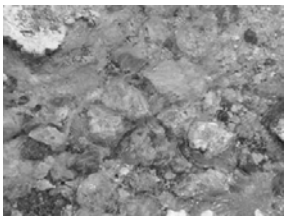
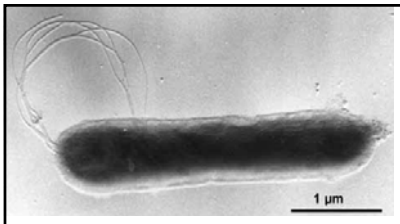
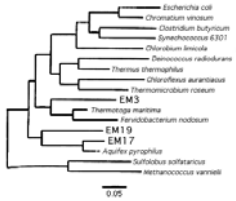
Identification for the Octopus Spring Pink Filaments



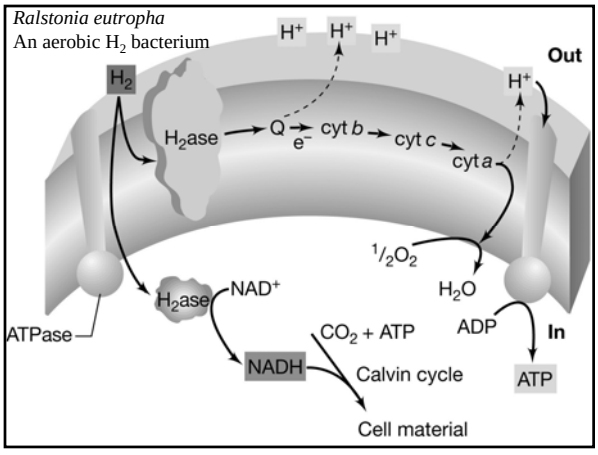


Aquifex pyrophilus



Yellowstone "Pink Filament" Isolates

Ralstonia eutropha
An aerobic H_2 bacterium



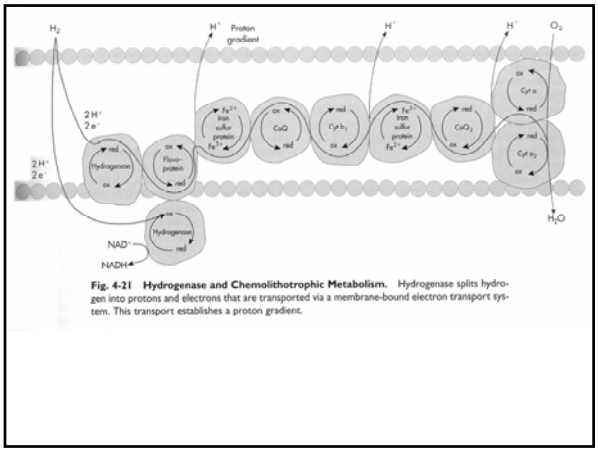


Fig. 4-21 Hydrogenase and Chemolithotrophic Metabolism. Hydrogenase splits hydrogen into protons and electrons that are transported via a membrane-bound electron transport system. This transport establishes a proton gradient.

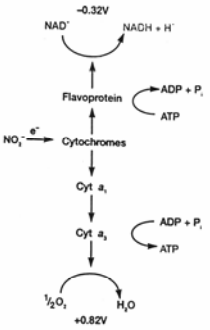
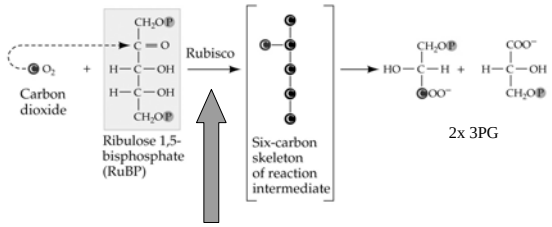


Figure 9.20 Reversed Electron Flow. The flow of electrons in the transport chain of *Nitrobacter*. Electrons flowing from nitrite to oxygen (down the reduction potential gradient) will release energy. It requires protonmotive force or ATP energy to force electrons to flow in the reverse direction from nitrite to NAD+.

Making Sugar from CO_2: The Calvin–Benson Cycle

- The Calvin–Benson cycle has three phases:
- Fixation of CO_2
- Reduction (and carbohydrate production)
- Regeneration of RuBP.
- RuBP is the initial CO_2 acceptor, 3PG is the first stable product of CO_2 fixation. Rubisco catalyzes the reaction of CO_2 and RuBP to form 3PG.

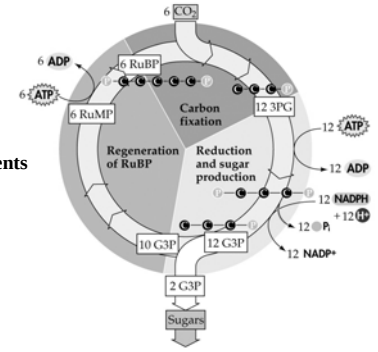
RuBP is the CO_2 Acceptor



World's Most Abundant Protein!

18 ATP
12 NADH+H$^+$

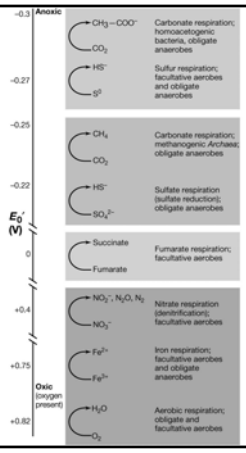
1Glucose for
54 ATP equivalents

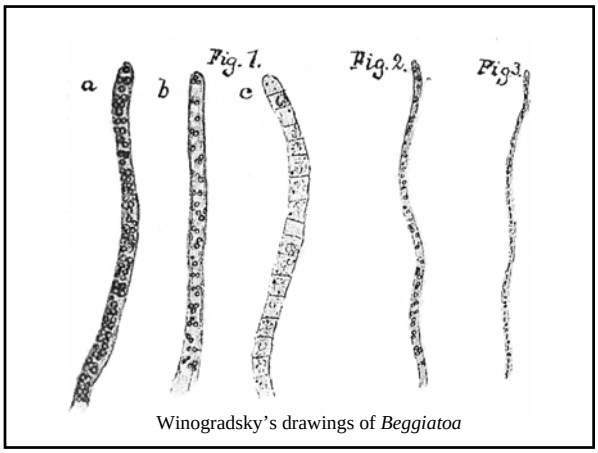


Organic Carbon Compounds

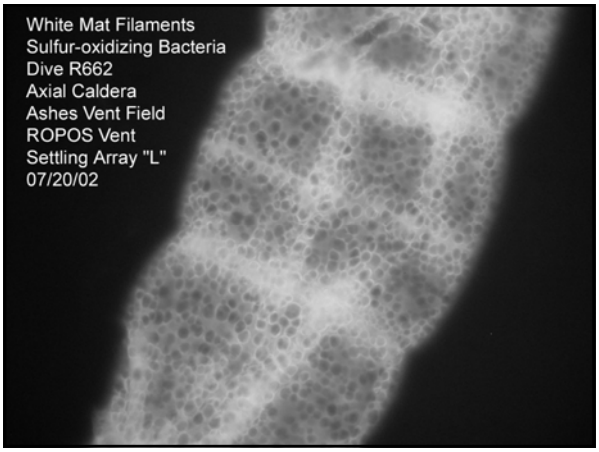
Anaerobic Respirations

Assimilative vs. Dissimilative Metabolisms





Winogradsky's drawings of *Beggiatoa*



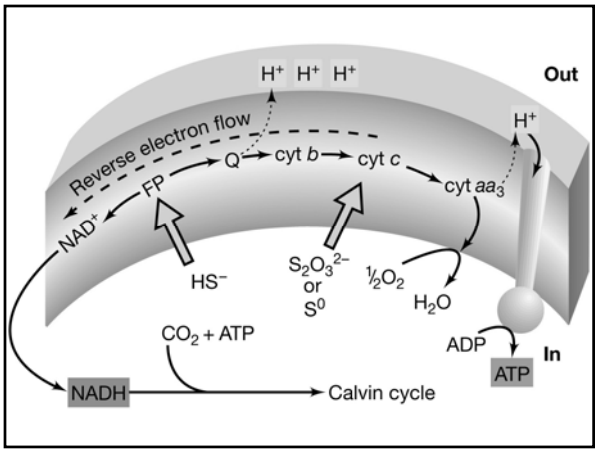
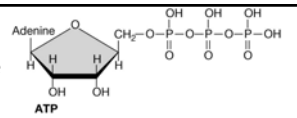
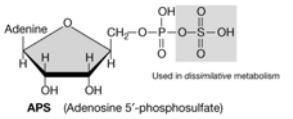


TABLE 17.3 Sulfur compounds and electron donors for sulfate reduction

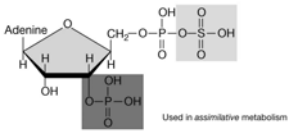
Compound	Oxidation state
Oxidation states of key sulfur compounds	
Organic S (R—SH)	−2
Sulfide (H_2S)	−2
Elemental sulfur (S^0)	0
Thiosulfate ($S_2O_3^{2-}$)	+2 (average per S)
Sulfur dioxide (SO_2)	+4
Sulfite (SO_3^{2-})	+4
Sulfate (SO_4^{2-})	+6
Some electron donors used for sulfate reduction	
H_2	Acetate
Lactate	Propionate
Pyruvate	Butyrate
Ethanol and other alcohols	Long-chain fatty acids
Fumarate	Benzoate
Malate	Indole
Choline	Hexadecane

SRB's can make active sulfate compounds



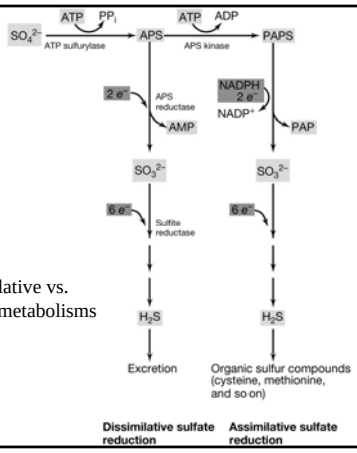


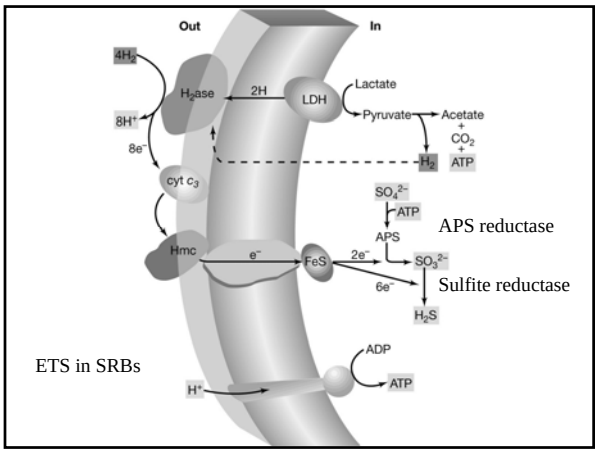
APS (Adenosine 5′-phosphosulfate)



PAPS (Phosphoadenosine 5′-phosphosulfate)

SRB dissimilative vs. assimilative metabolisms





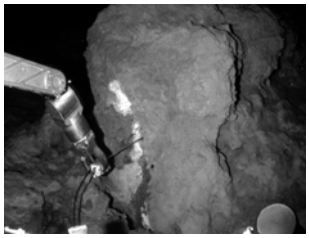
ETS in SRBs

Sulfur Disproportionation

$S_2O_3^{2-} + H_2O \rightarrow SO_4^{2-} + H_2S$

$\Delta G^{0'} = -21.9$ kJ/rxn

Get your cake and eat it too!



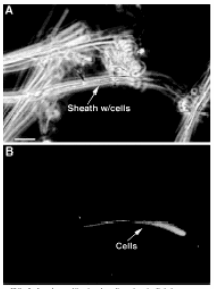
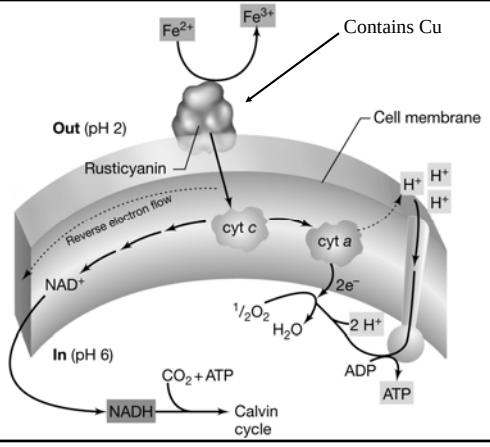


FIG. 3. *L. ochracea*-like sheaths collected at the Pohaku warm mat marker 27. The sample has been stained with Syto. Panel B is the same image as in panel A but viewed by epifluorescence to reveal a filament of cells inside the iron-encrusted sheath. The cells are only visible when stained; most of the sheaths are empty. Bar, 5 μm.

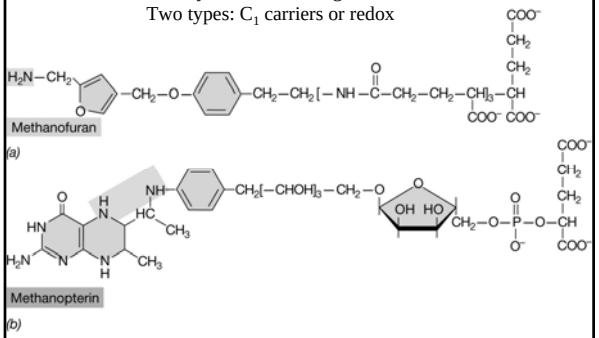
Neutrophilic Fe-Oxidizing Bacteria

Bog in Iceland

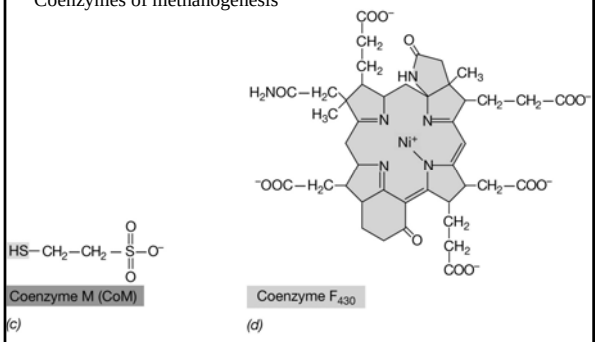
Fe-Oxidizers

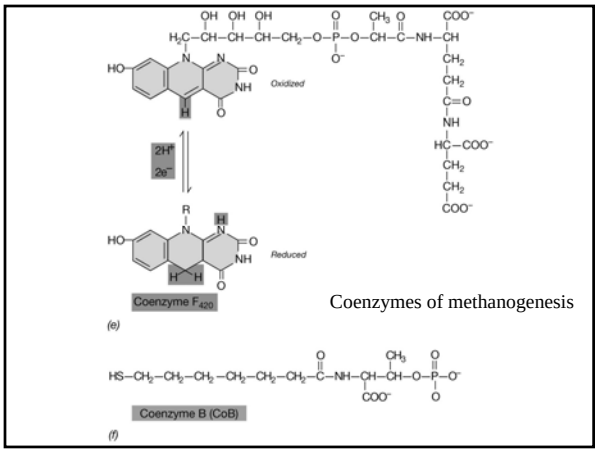


Coenzymes of methanogenesis
Two types: C_1 carriers or redox

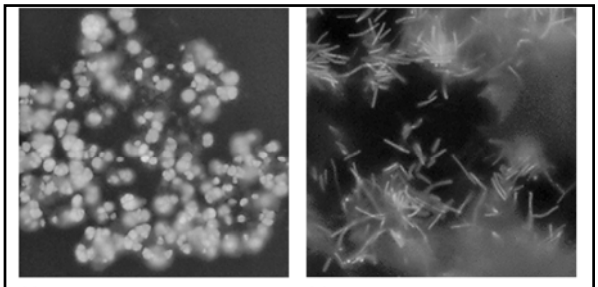


Coenzymes of methanogenesis



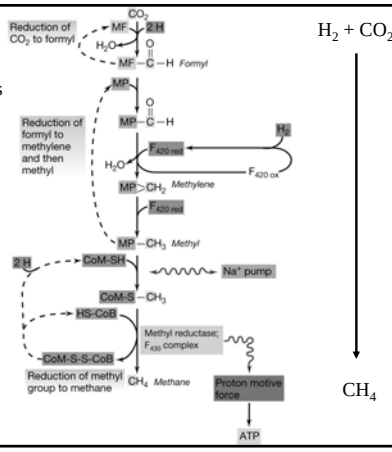


Coenzymes of methanogenesis



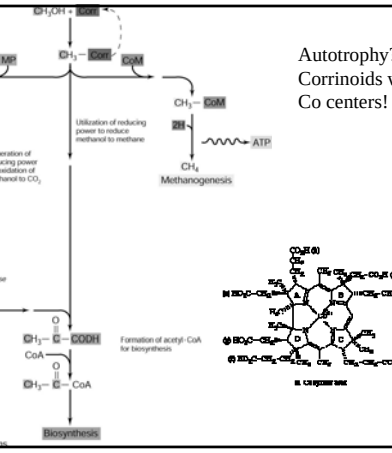
Autofluorescence in methanogen cells due to the presence of the unique electron carrier F_{420}

Methanogenesis



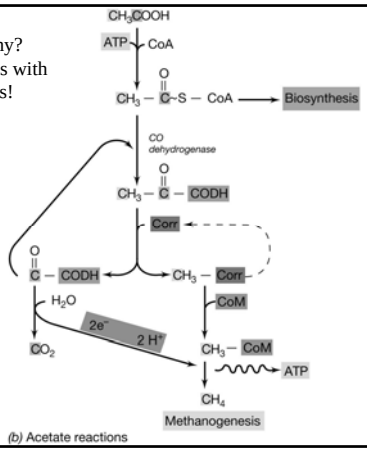
$H_2 + CO_2$

CH_4

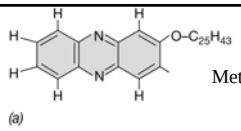


Autotrophy? Corrinoids with Co centers!

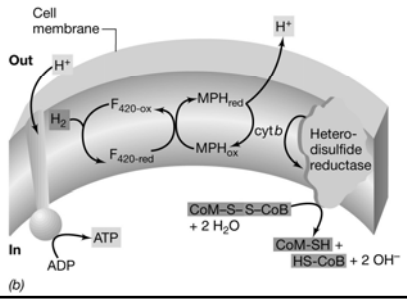
Autotrophy?
Corrinoids with
Co centers!



Conservation of
Energy



Methanophenazine



Methanogenesis

Chemoautotrophs:
CO_2 → CH_4 + Org. C
H_2 as electron donor

Chemoorganotrophs:
Acetate/MeOH → CH_4 + CO_2
Org. C as electron donor

Global Biogenic Methane Production:
1/3 Chemoautotrophs
2/3 Chemoorganotrophs