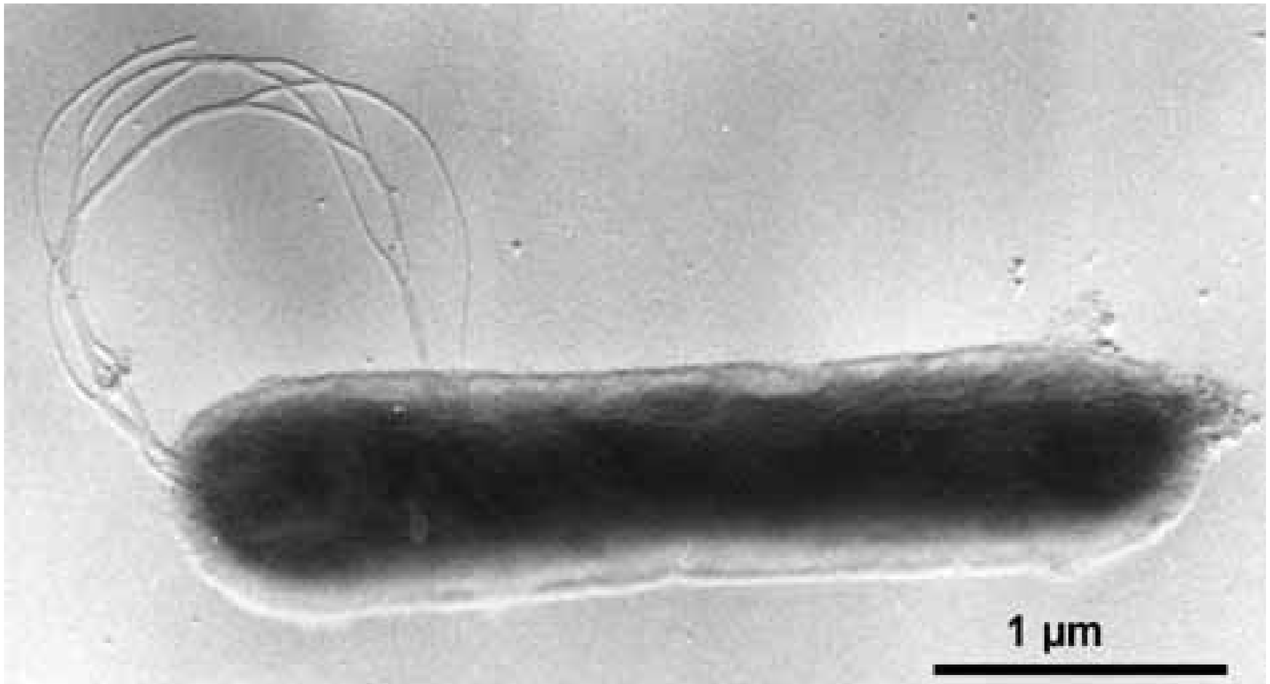
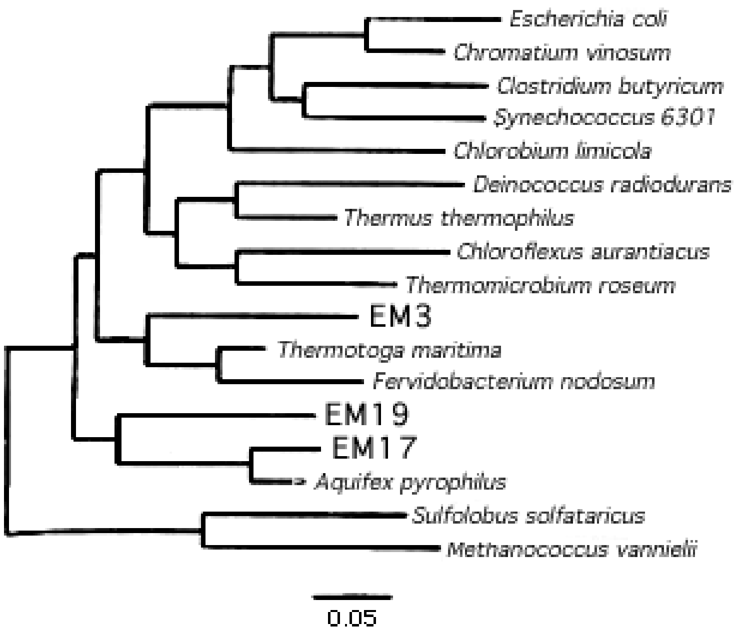
Identification for the Octopus Spring Pink Filaments



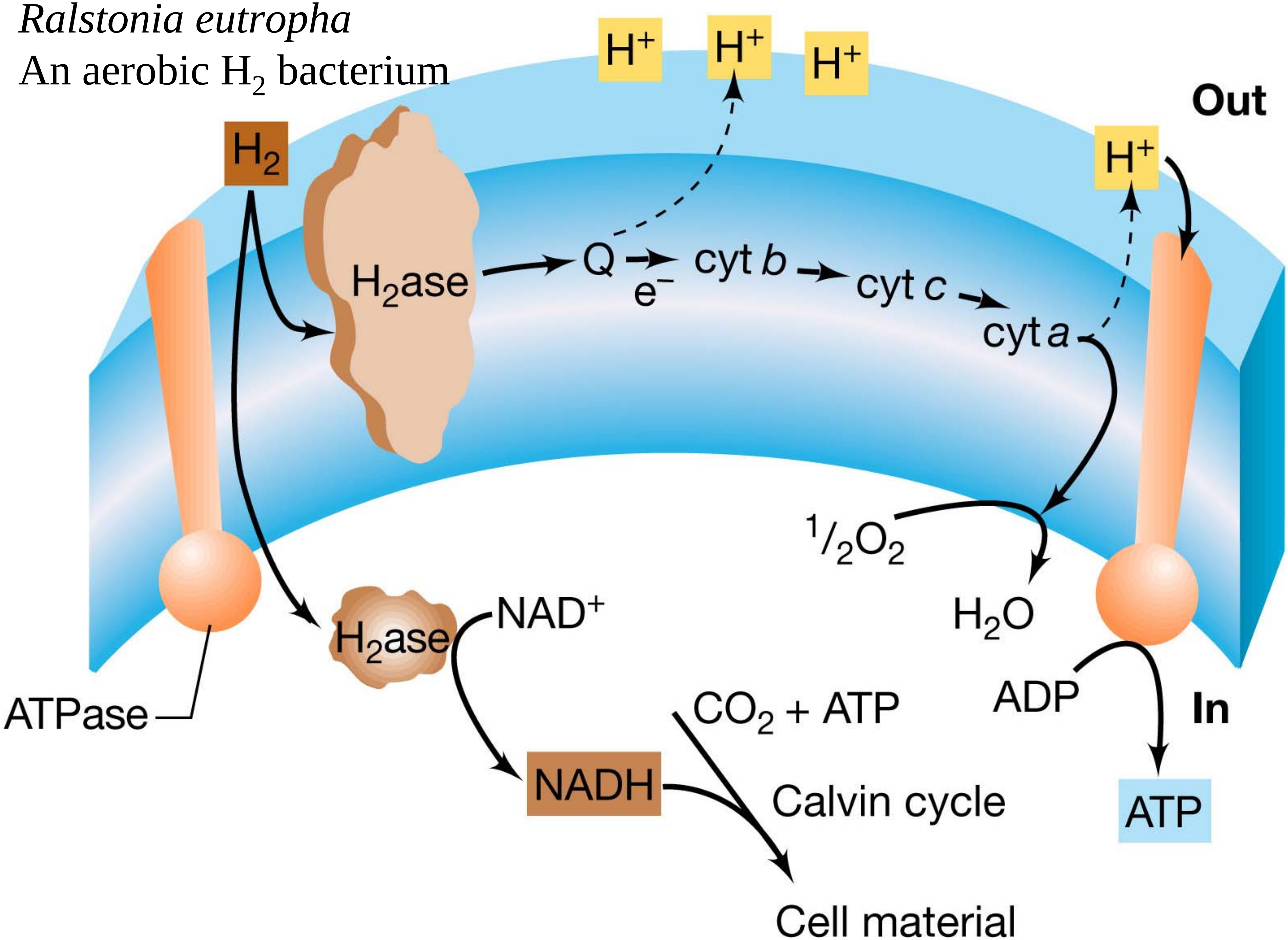
Aquifex pyrophilus



Yellowstone "Pink Filament"
Isolates

Ralstonia eutropha

An aerobic H_2 bacterium



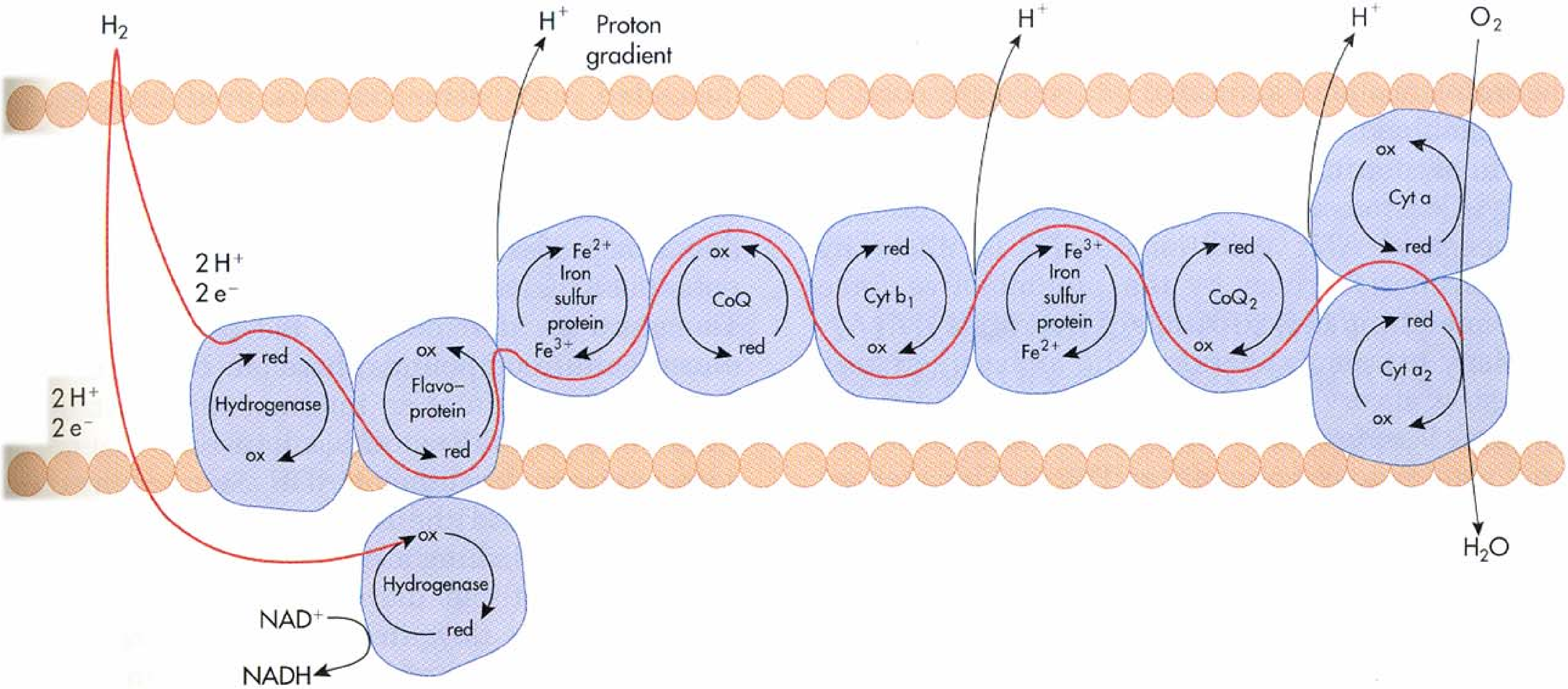


Fig. 4-21 Hydrogenase and Chemolithotrophic Metabolism. Hydrogenase splits hydrogen into protons and electrons that are transported via a membrane-bound electron transport system. This transport establishes a proton gradient.

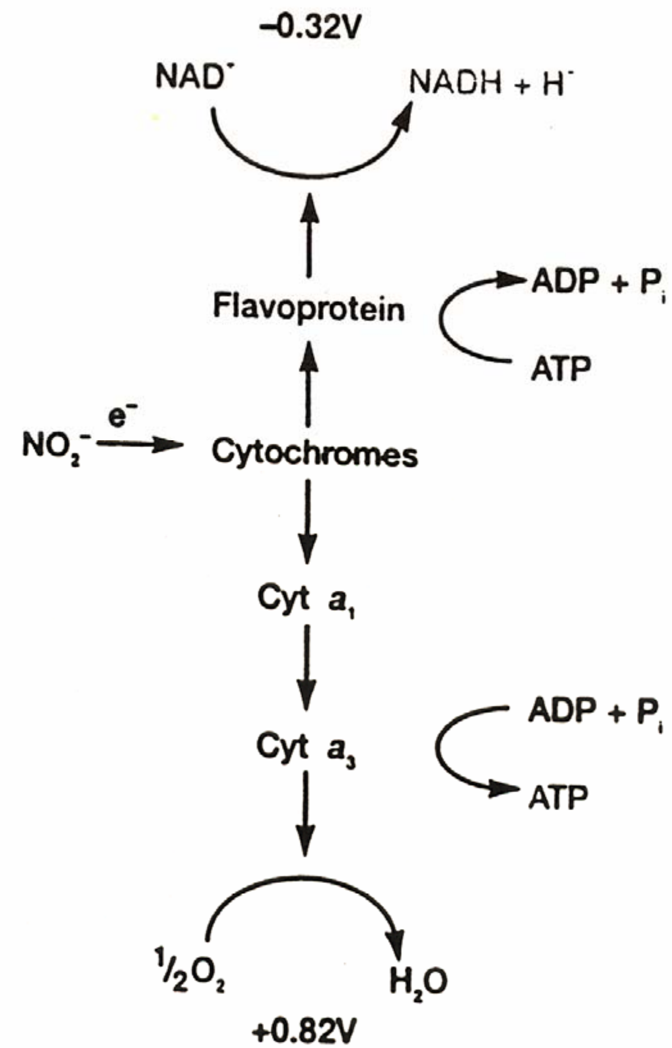
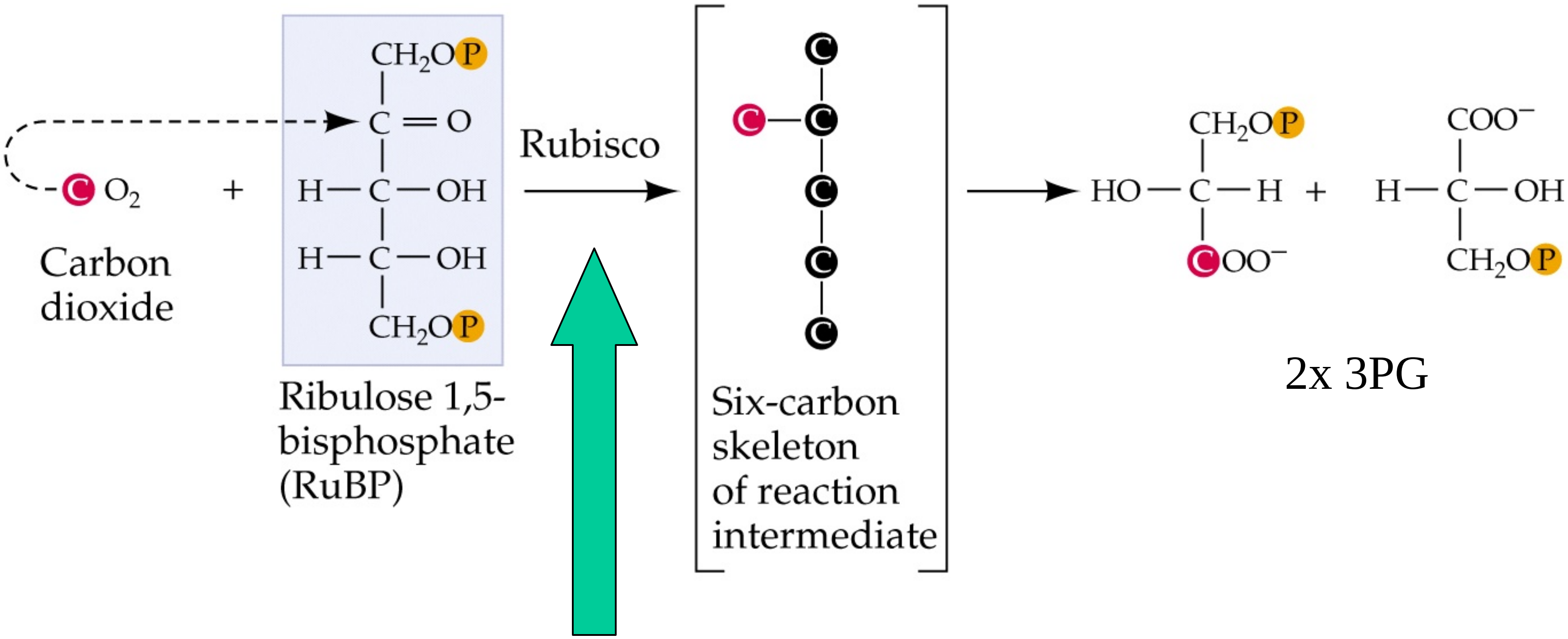


Figure 9.20 Reversed Electron Flow. The flow of electrons in the transport chain of *Nitrobacter*. Electrons flowing from nitrite to oxygen (down the reduction potential gradient) will release energy. It requires protonmotive force or ATP energy to force electrons to flow in the reverse direction from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

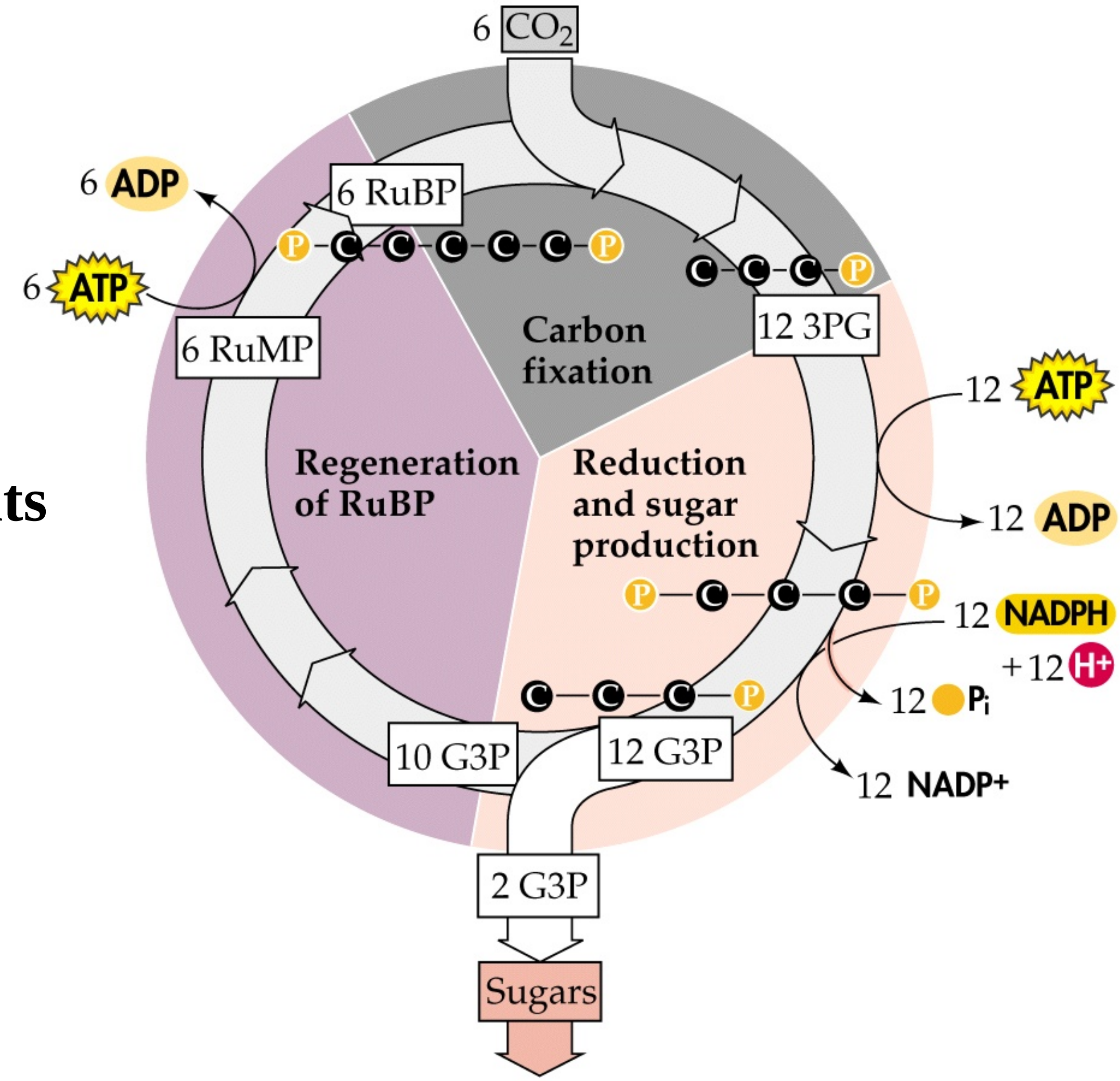


2x 3PG

World's Most Abundant Protein!

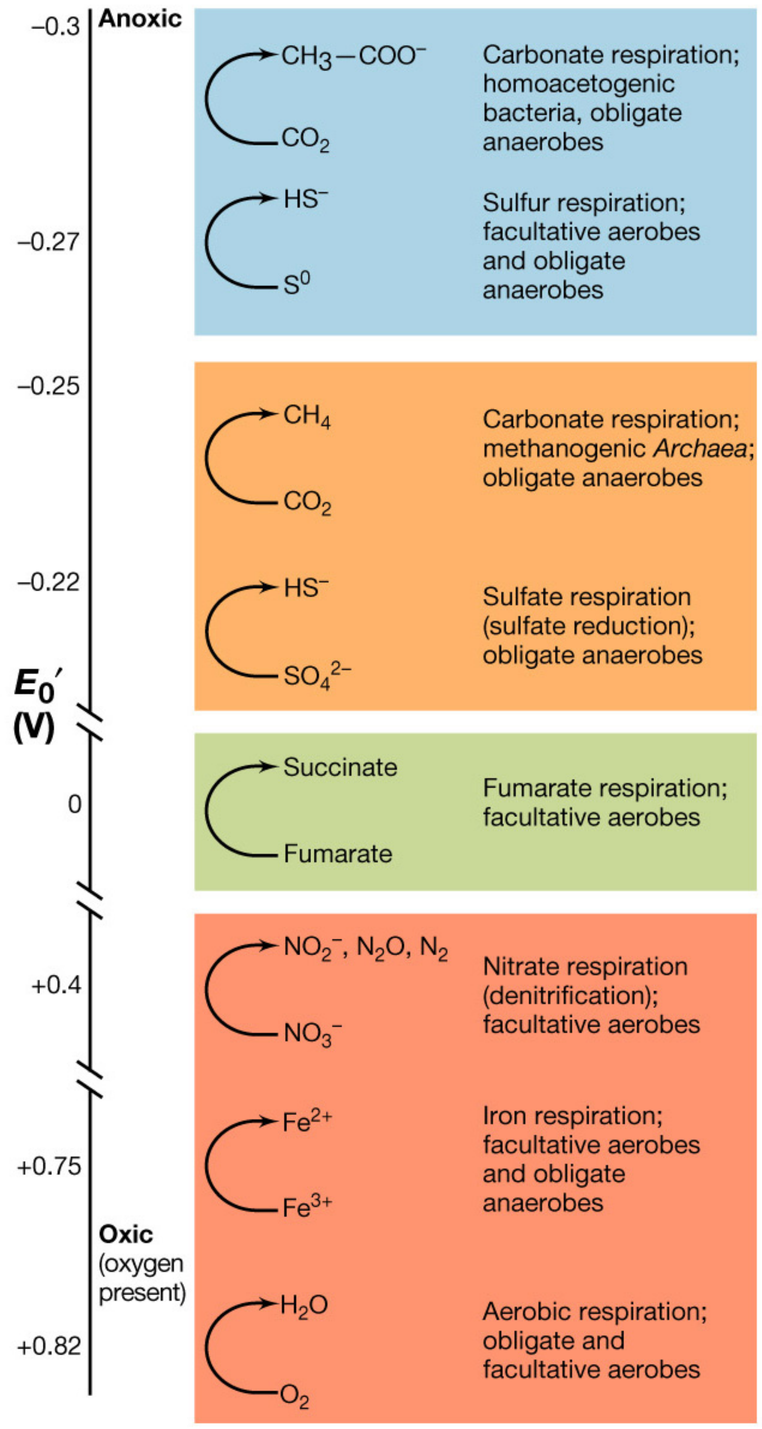
18 ATP
12 NADH+H^+

1Glucose for
54 ATP equivalents

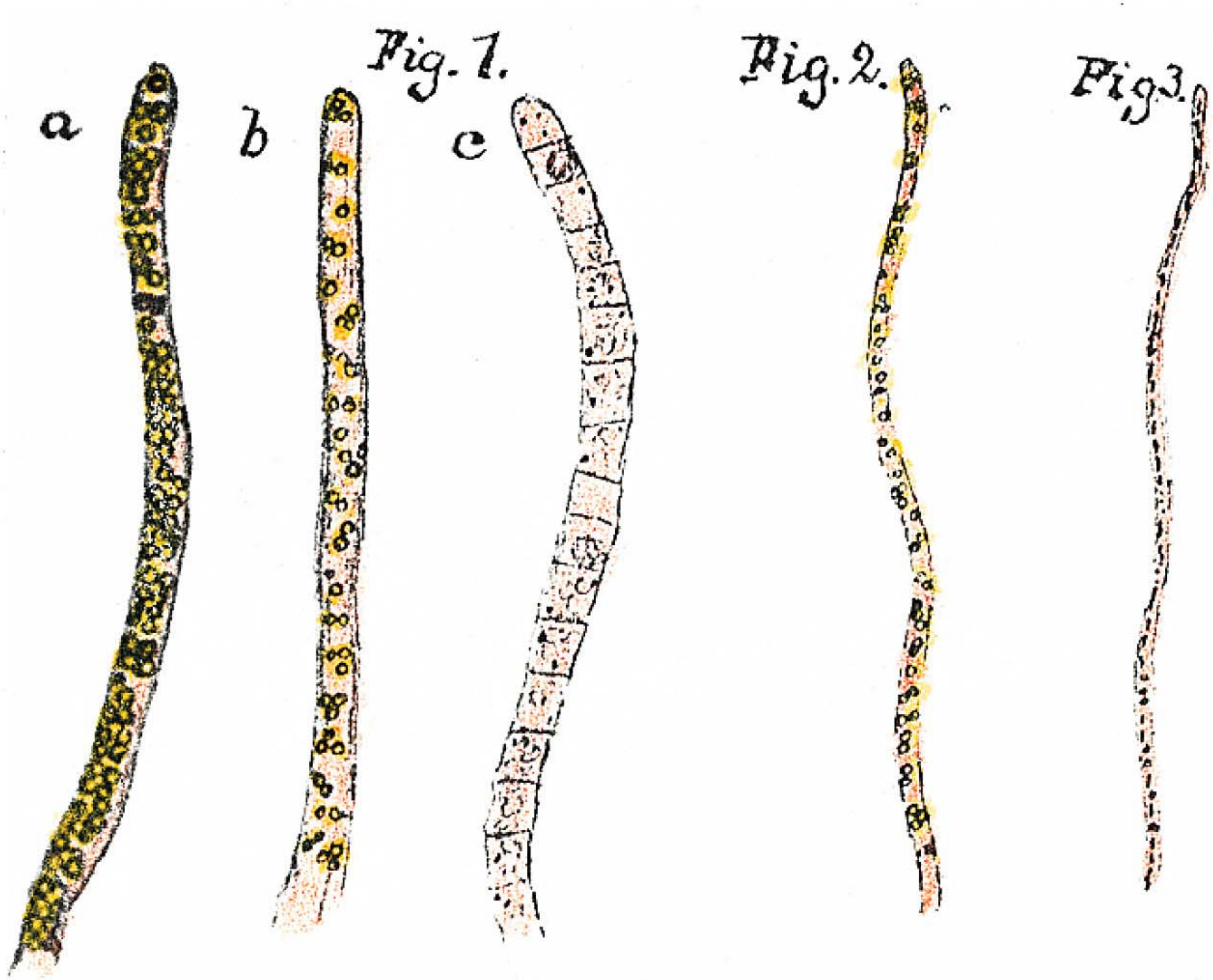


Organic Carbon Compounds

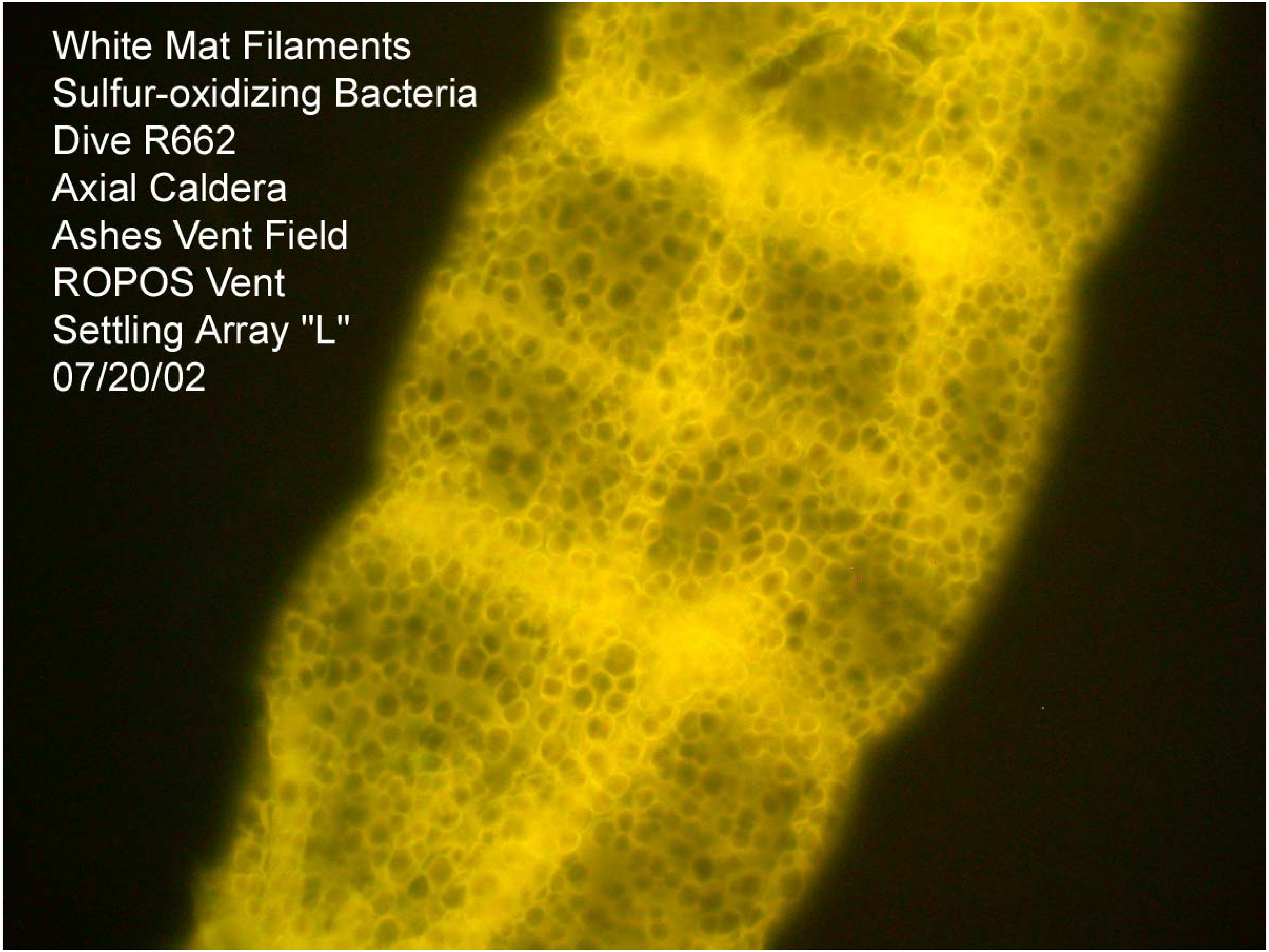
Anaerobic Respirations

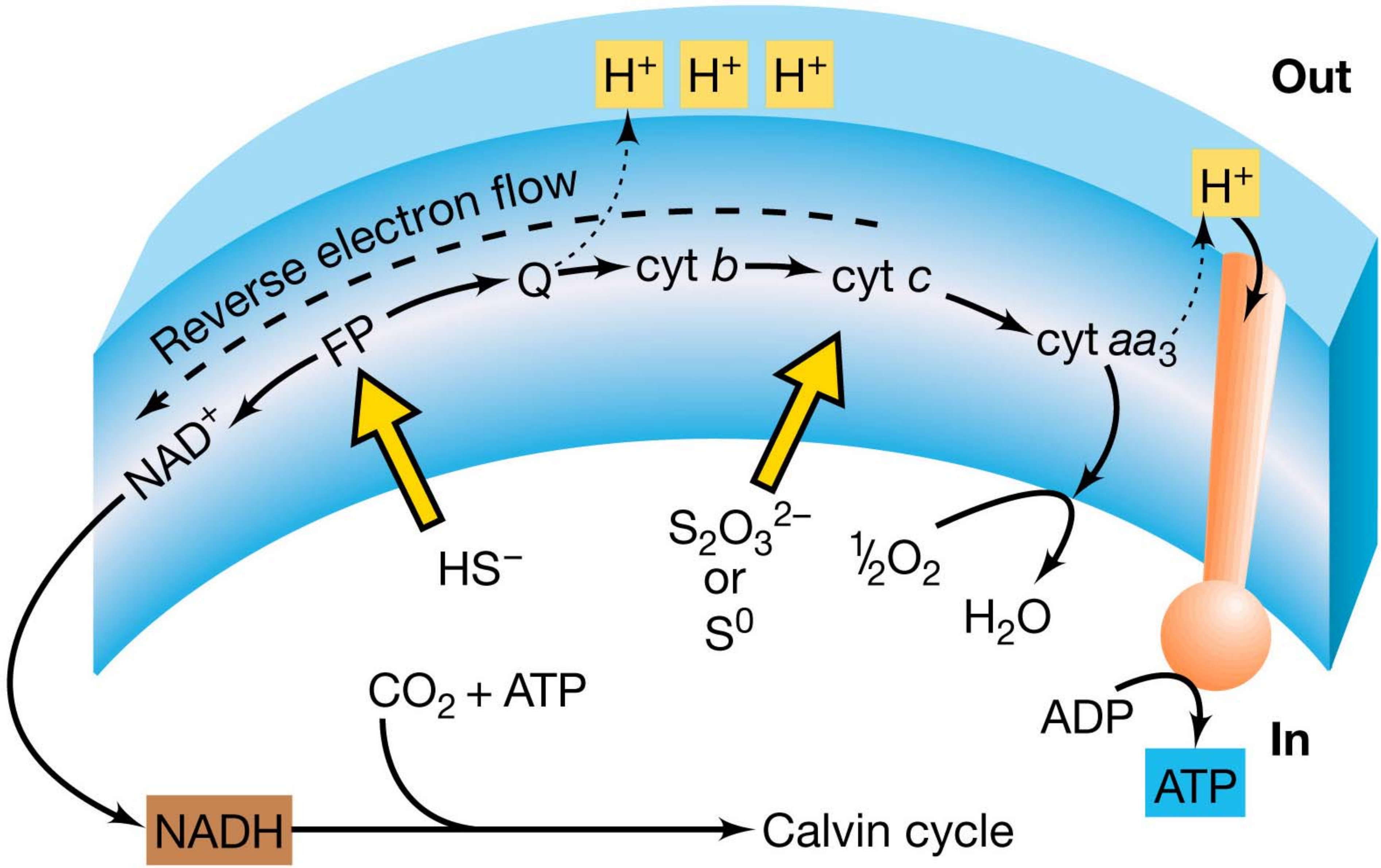


Assimilative vs. Dissimilative Metabolisms



Winogradsky’s drawings of *Beggiatoa*


White Mat Filaments
Sulfur-oxidizing Bacteria
Dive R662
Axial Caldera
Ashes Vent Field
ROPOS Vent
Settling Array "L"
07/20/02

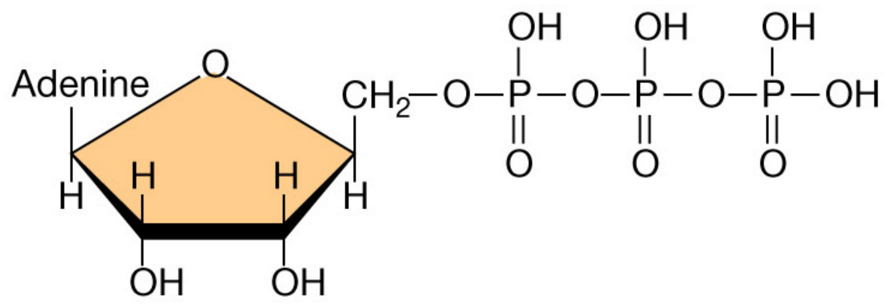


Out
H+
H+
H+
H+
Reverse electron flow
Q
cyt b
cyt c
cyt aa3
FP
NAD+
HS−
S2O3 2− or S0
½O2
H2O
CO2 + ATP
NADH
Calvin cycle
ADP
ATP
In

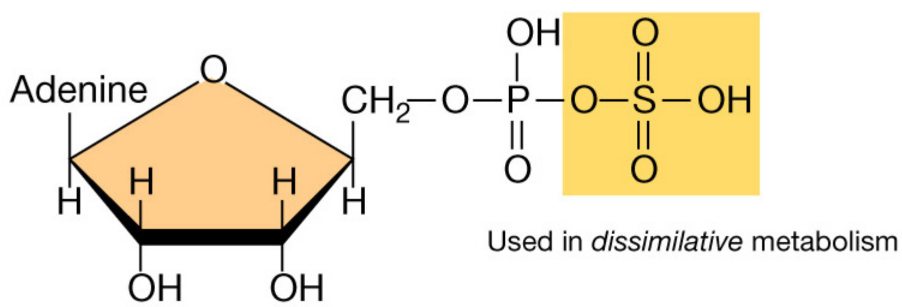
TABLE 17.3 Sulfur compounds and electron donors for sulfate reduction

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

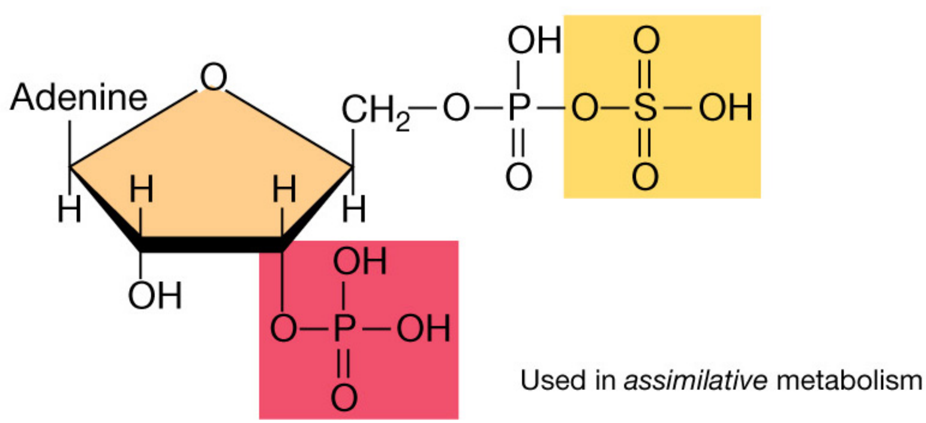
SRB's can make active sulfate compounds



ATP

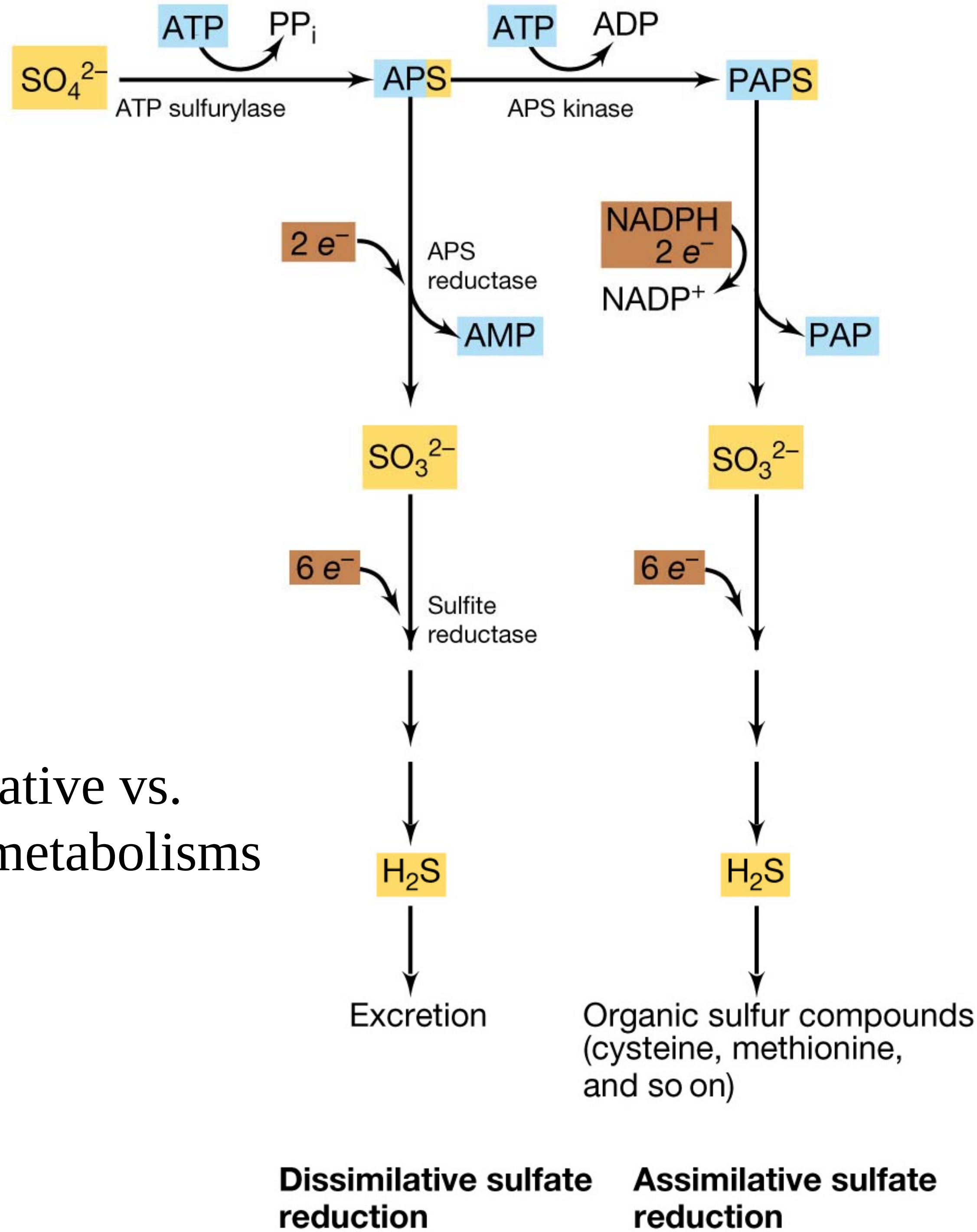


APS (Adenosine 5′-phosphosulfate)

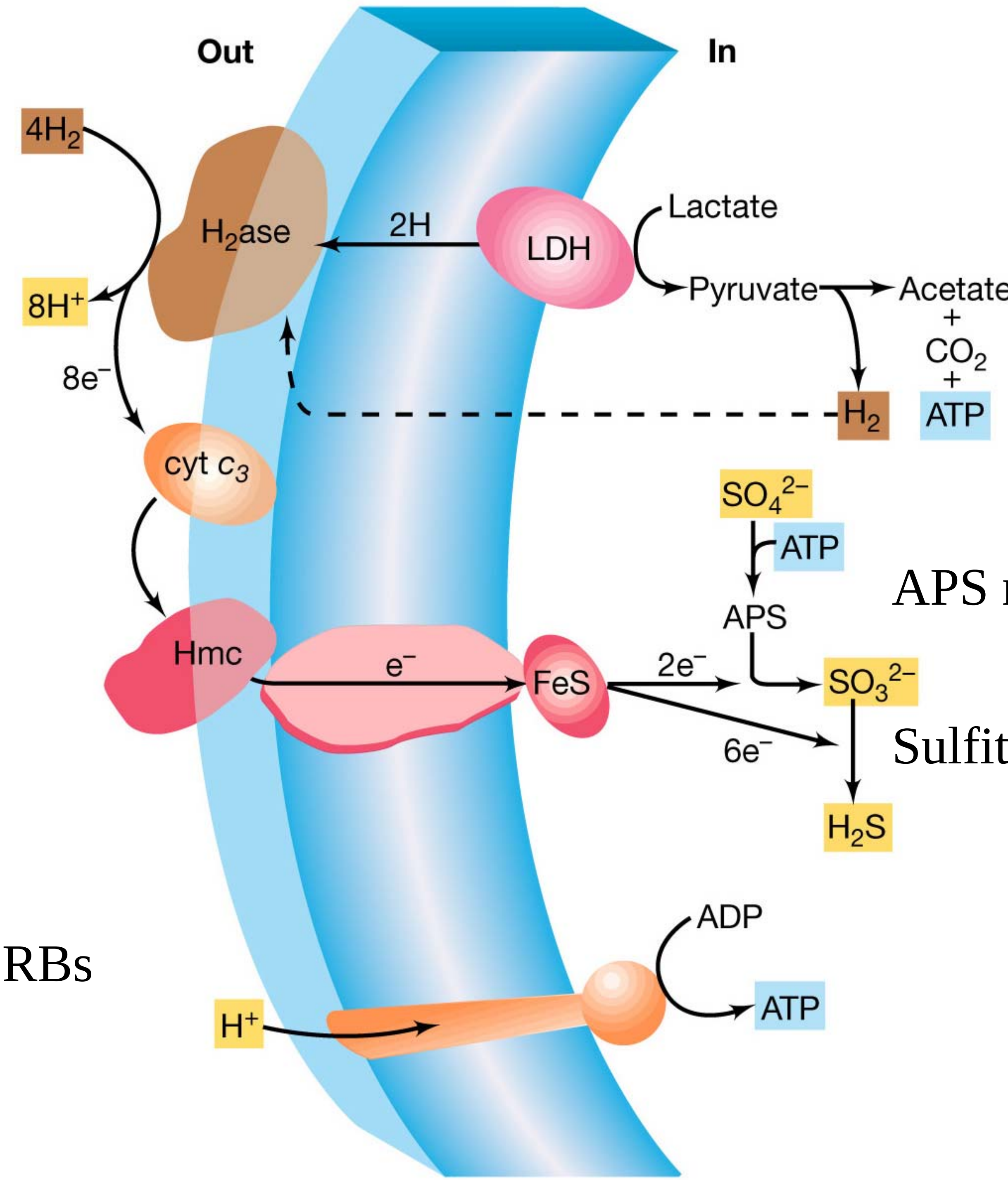


PAPS (Phosphoadenosine 5′-phosphosulfate)

SRB dissimilative vs. assimilative metabolisms



ETS in SRBs



APS reductase

Sulfite reductase

Sulfur Disproportionation

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

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

Get your cake and eat it too!

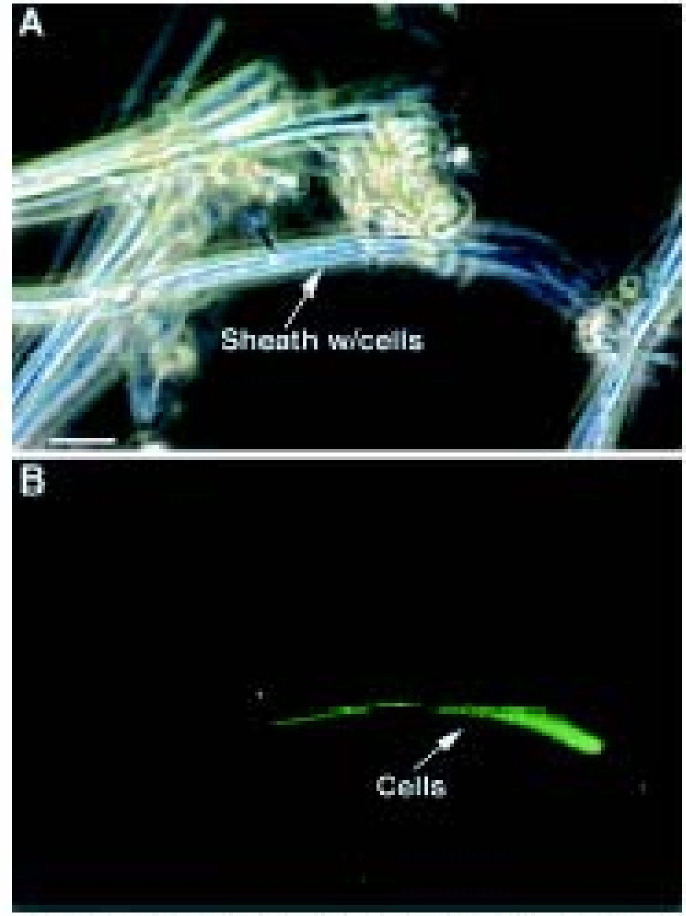
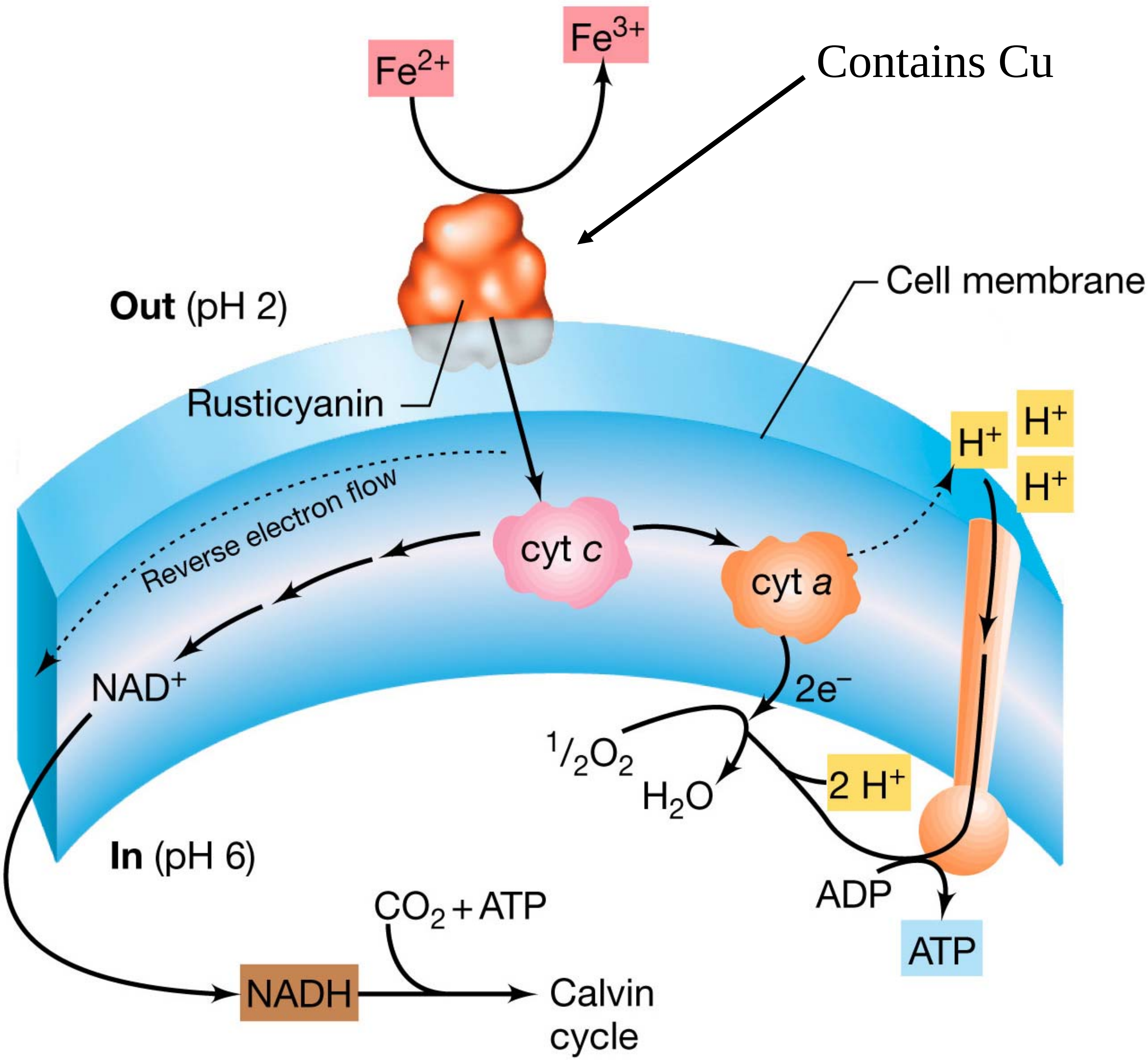


FIG. 3. *L. ochracea*-like sheaths collected at the Pahaku vents near marker 27. The sample has been stained with Syto. Panel B is the same image as in panel A but viewed by epifluorescence to reveal a filament of cells inside the iron-encrusted sheath. The cells are only visible when stained; most of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

Neutrophilic Fe-Oxidizing Bacteria

Bog in Iceland

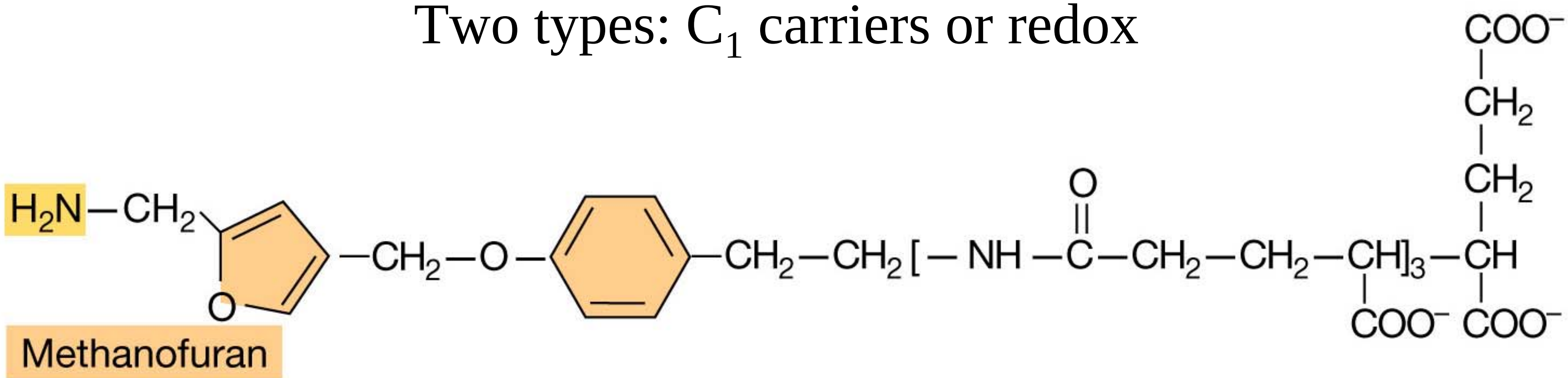
Fe-Oxidizers



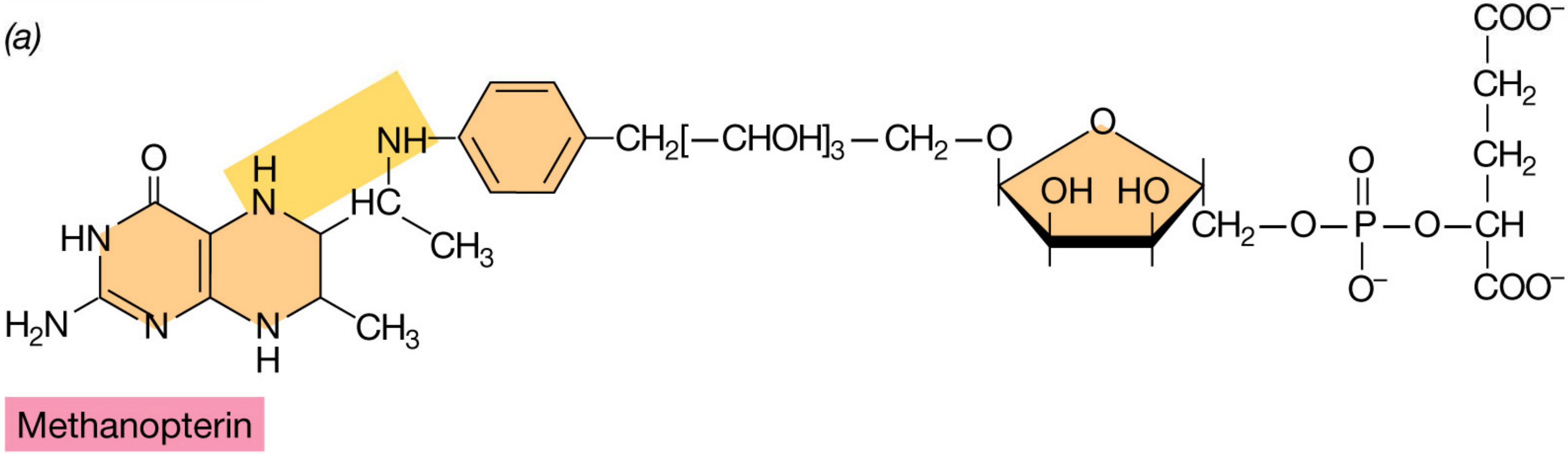
Fe2+
Fe3+
Contains Cu
Out (pH 2)
Cell membrane
Rusticyanin
Reverse electron flow
cyt c
cyt a
H+
H+
H+
NAD+
2e–
1/2O2
H2O
2 H+
In (pH 6)
ADP
ATP
CO2 + ATP
NADH
Calvin cycle

Coenzymes of methanogenesis

Two types: C_1 carriers or redox

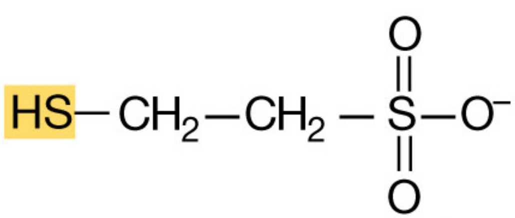


(a)



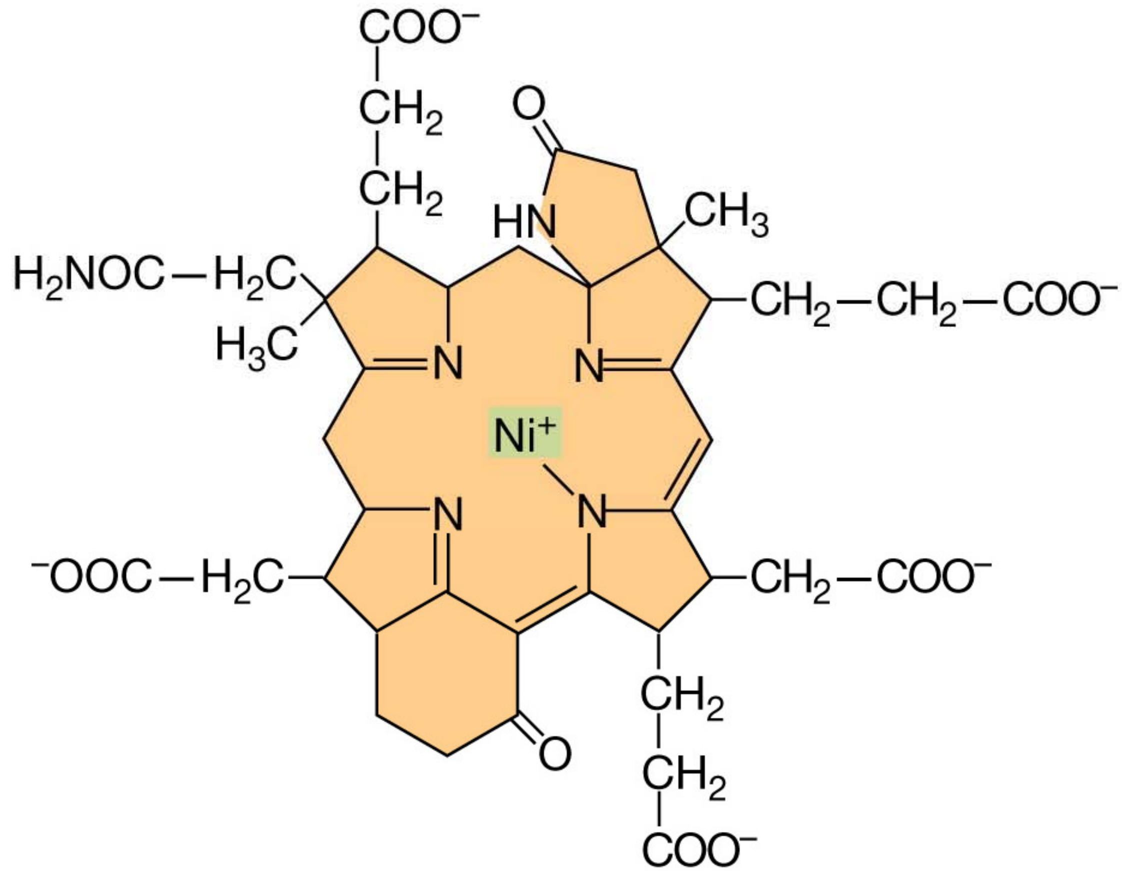
(b)

Coenzymes of methanogenesis



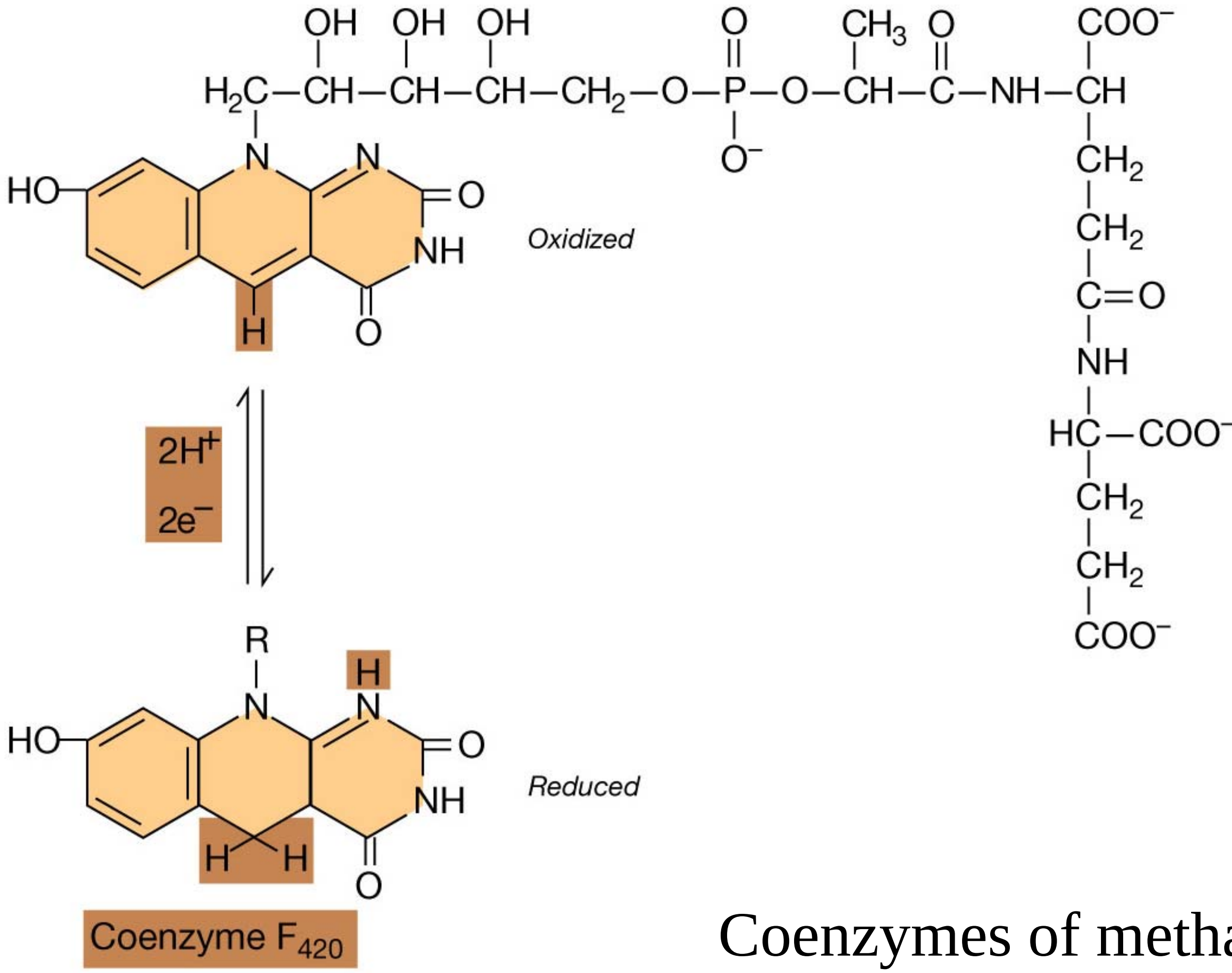
Coenzyme M (CoM)

(c)



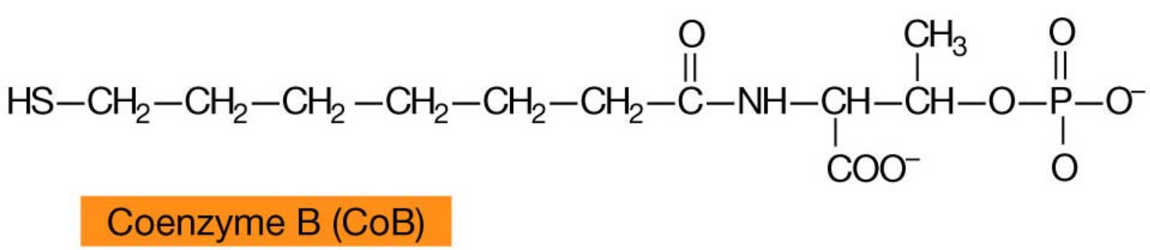
Coenzyme F_{430}

(d)

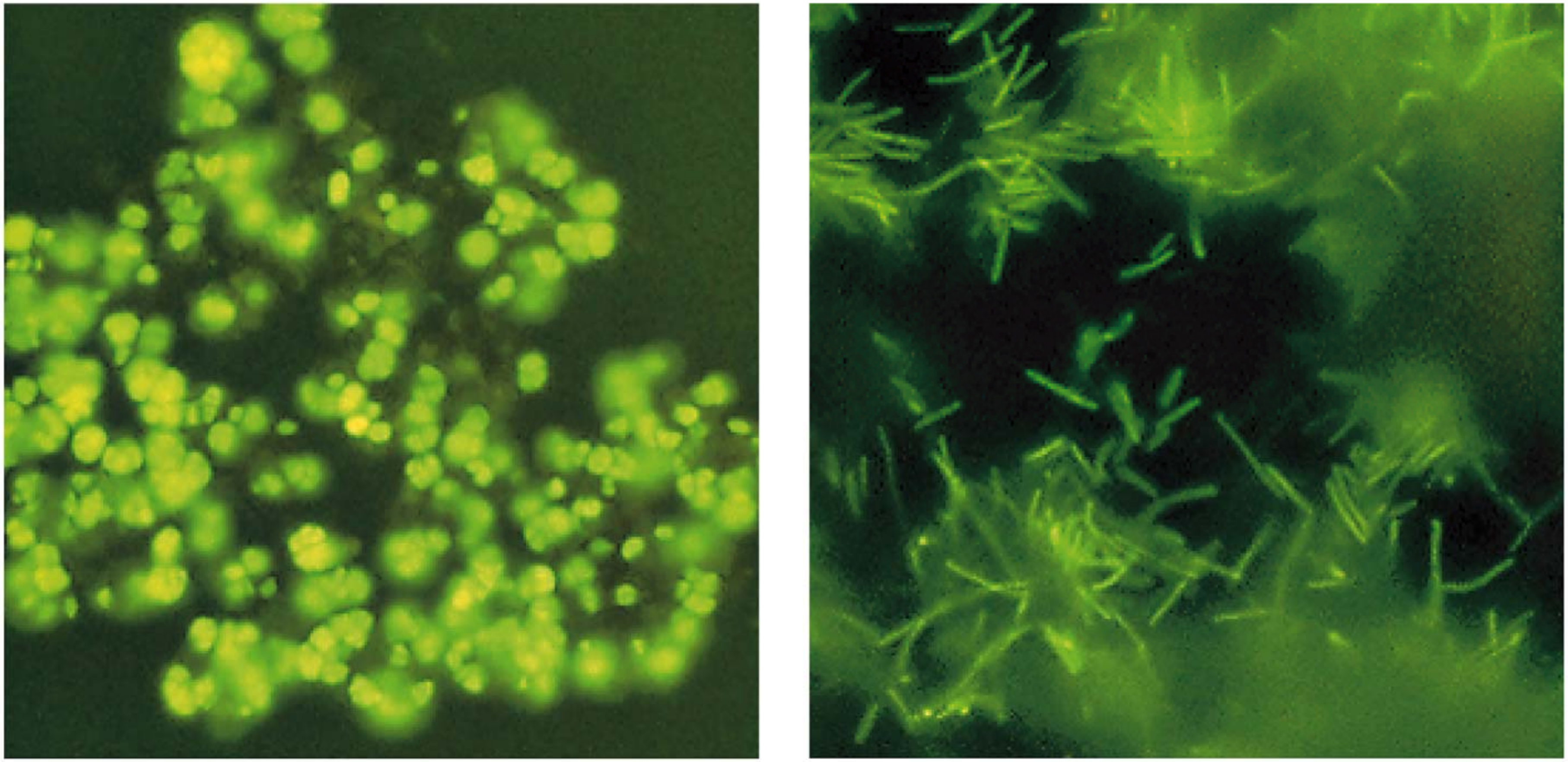


(e)

Coenzymes of methanogenesis



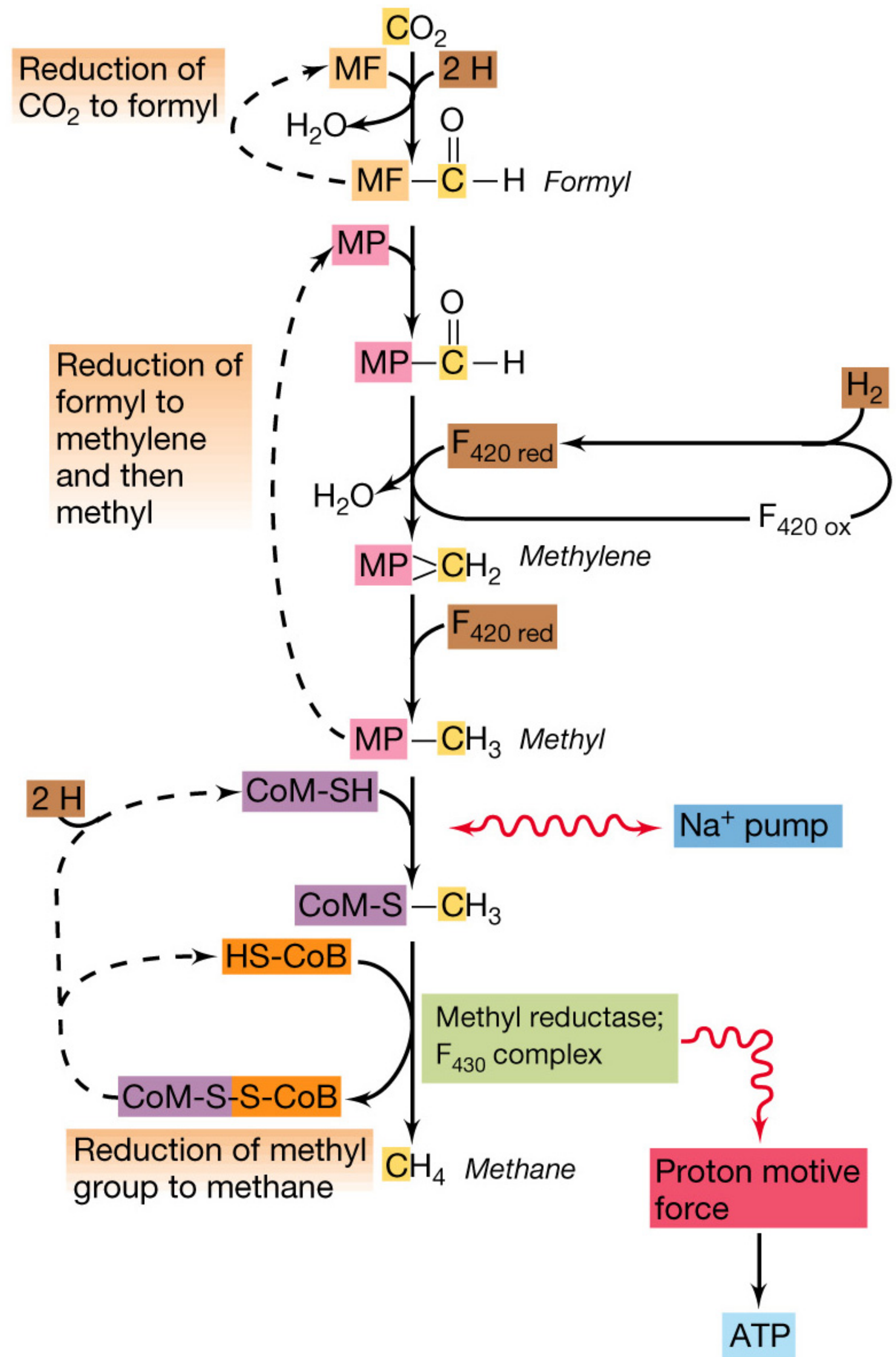
(f)



(a) (b)

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

Methanogenesis

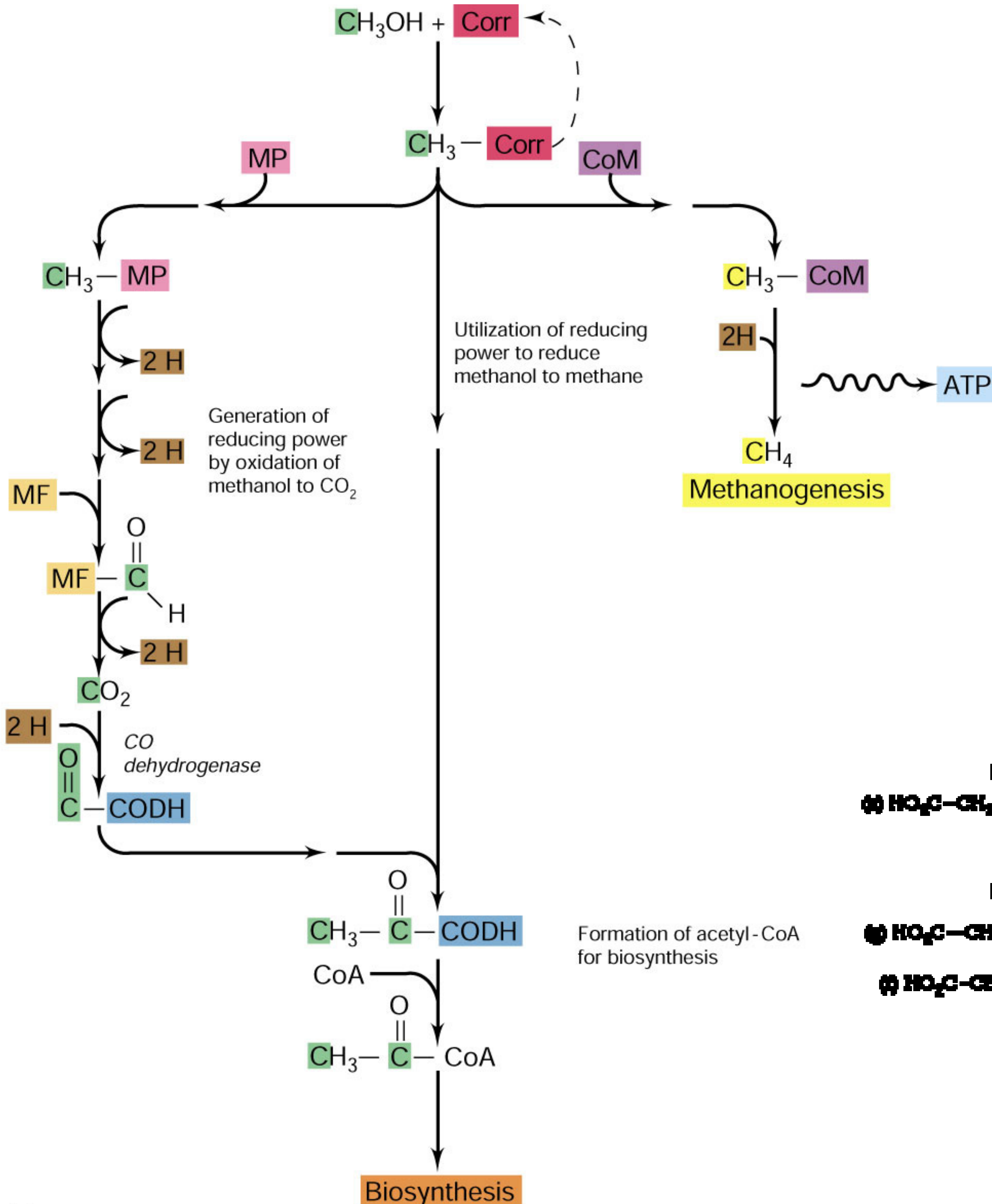


$H_2 + CO_2$

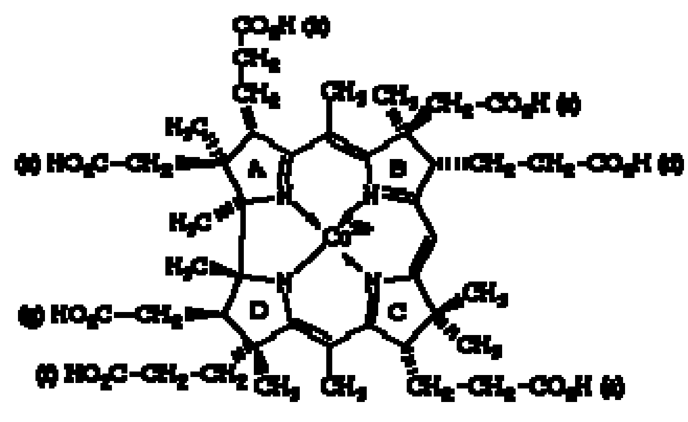
↓

CH_4

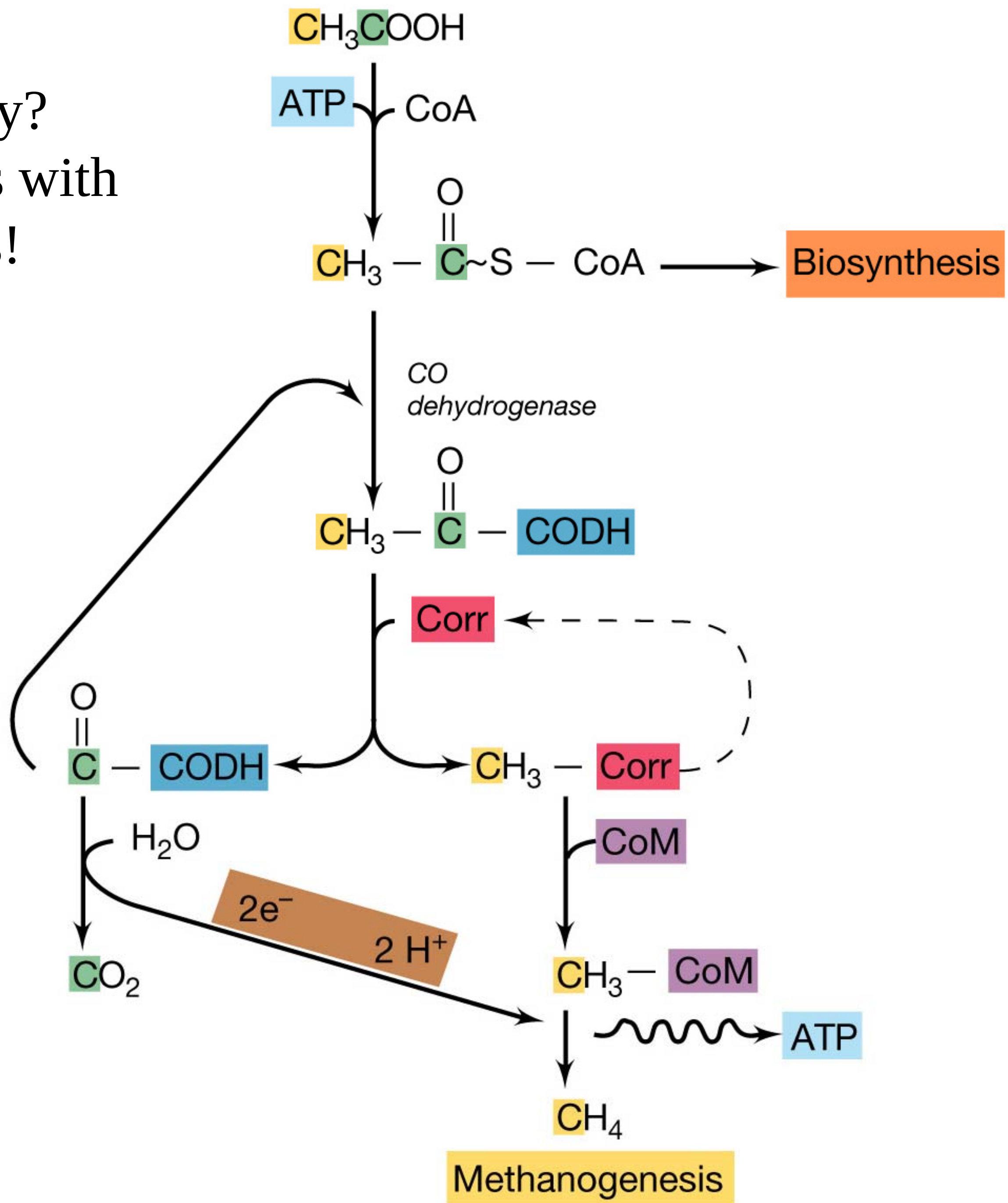
Autotrophy?
Corrinoids with
Co centers!



(*a*) Methanol reactions

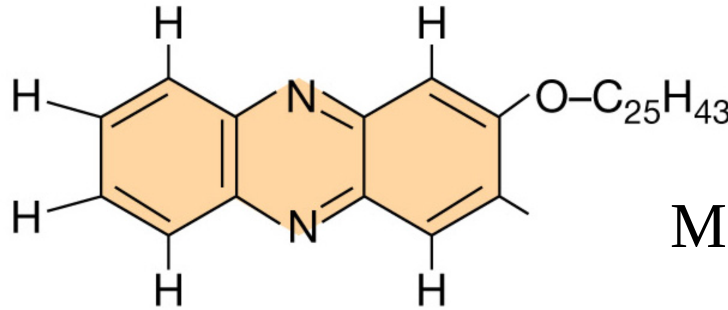

II Cobyrinic acid

Autotrophy?
Corrinoids with
Co centers!



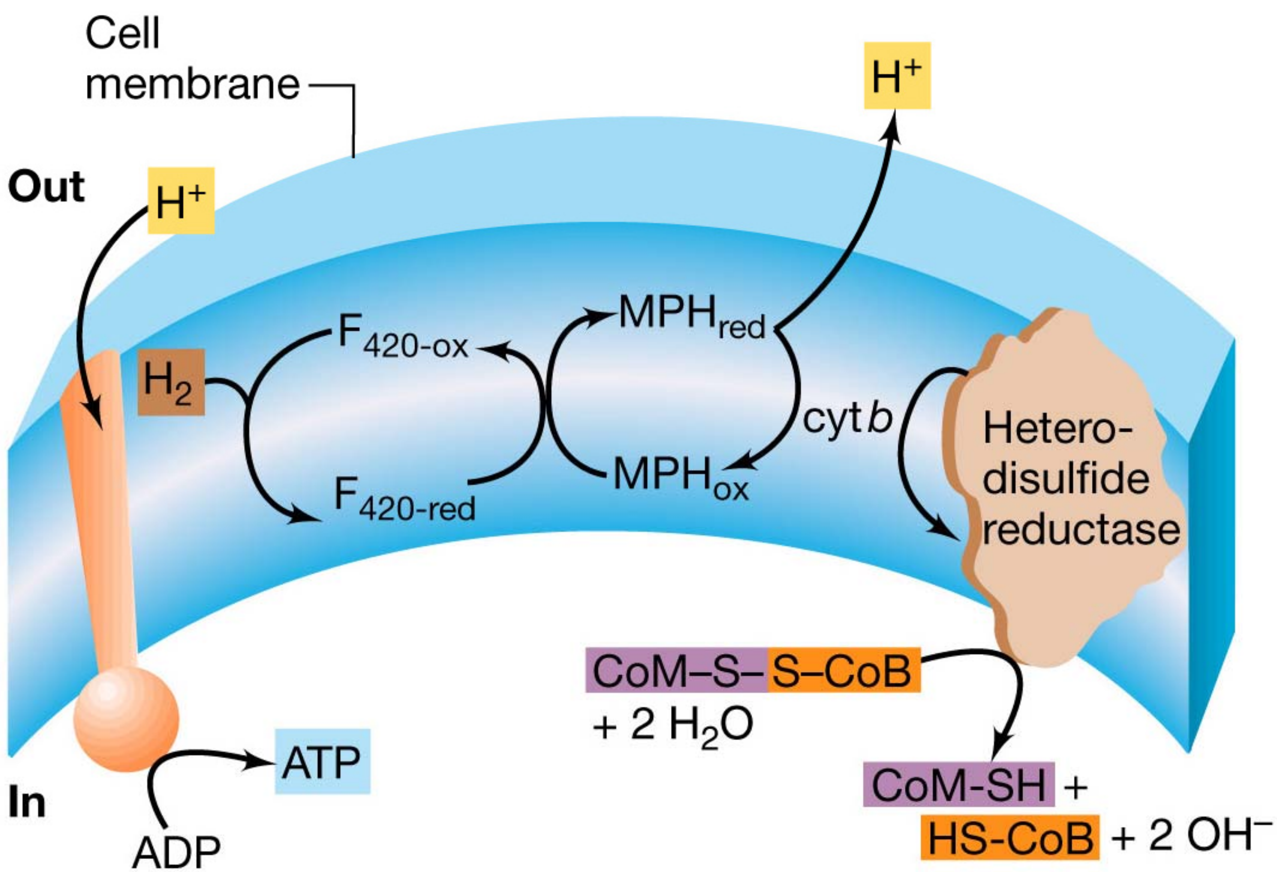
(b) Acetate reactions

Conservation of Energy



(a)

Methanophenazine



(b)

Methanogenesis

Chemoautotrophs:
$CO_2 \rightarrow CH_4$ + Org. C
H_2 as electron donor

Chemoorganotrophs:
Acetate/MeOH $\rightarrow CH_4 + CO_2$
Org. C as electron donor

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