Metabolism

CE421/521

Lecture Notes

Sept. 12, 2006

Biodegradation Processes

- cometabolism, mineralization, and biodegradation
  - biodegradation: b_____ of organic compounds by microorganisms
  - mineralization: c_____ biodegradation of organic compounds to CO2 and water
  - cometabolism: breakdown of an organic compound where the degrading community derives no b_____ (i.e., carbon or energy) from degradation (requires a growth substrate) TCE degradation is a common example of cometabolism via methane monooxygenase

Structure, Toxicity, and Biodegradability

- Factors determining the rate and potential for biodegradation:
  - G_____ potential. Appropriate genes for transport and metabolism of substrate
  - B_____. Limited water solubility may limit biodegradation.
  - Contaminant s_____: steric and electronic effects.
    - Steric effects include substituent groups h_____ recognition of active site for enzyme attachment and activity.
    - Electronic effects include the extent to which the substituent group e_____ interferes with the interaction between the enzyme active site and the contaminant
  - T_____ or inhibitory effect of the contaminant on cellular metabolism

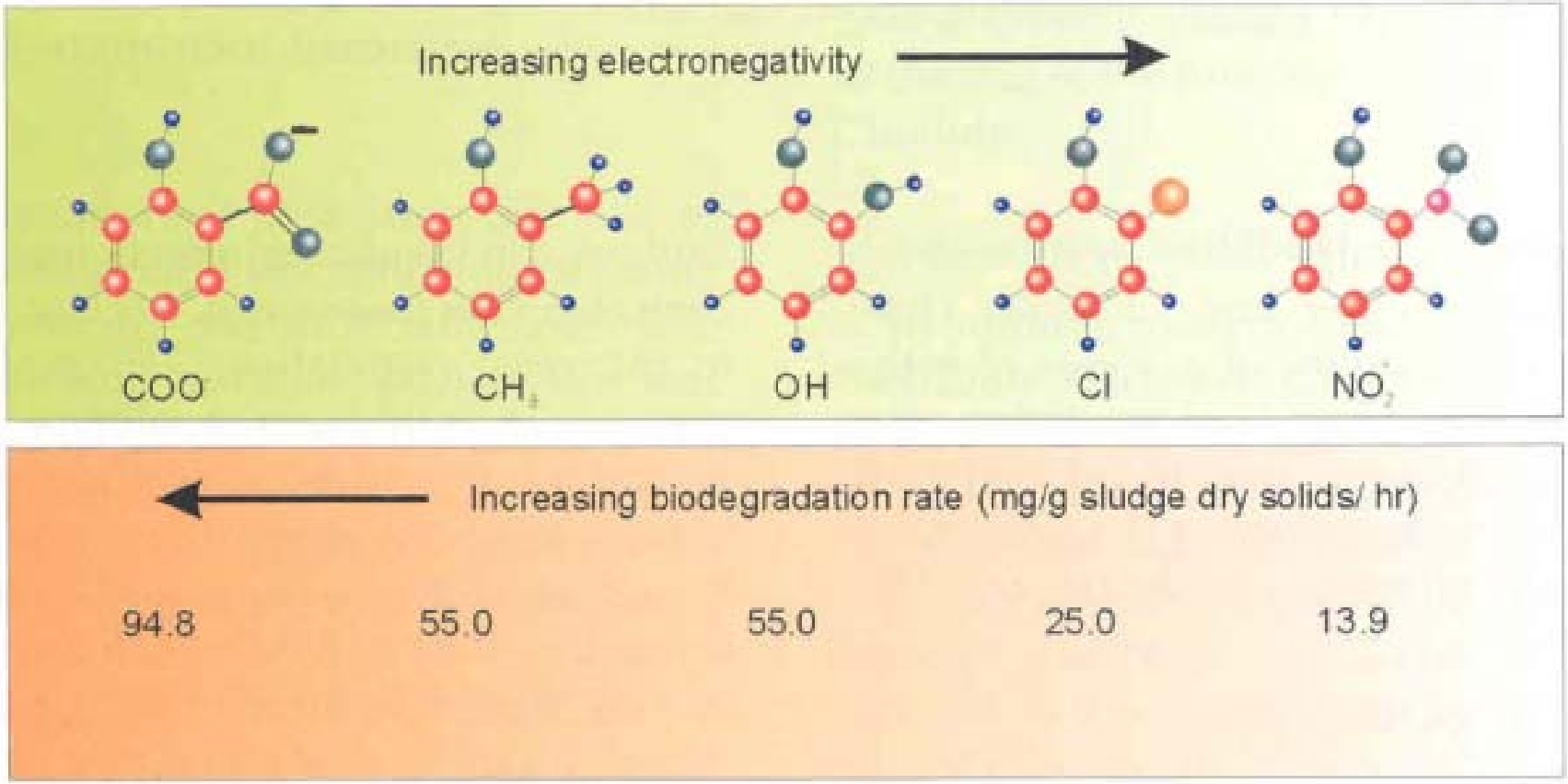


FIGURE 16.11 Various ortho-substituted phenols and their respective biodegradation rates. (Adapted from Pitter and Chudoba, 1990.)

Ten Growth Requirements for Microorganisms

1. _____ source
2. _____ source
3. Terminal _____ acceptor
4. _____nutrients: C, N, H, O, P, K, S
5. _____nutrients: Fe, Ni, Co, Mb, Zn, etc.
6. M_____
7. Appropriate t_____
8. Appropriate p_____
9. Absence of I_____
10. Mixing/c_____

Metabolism

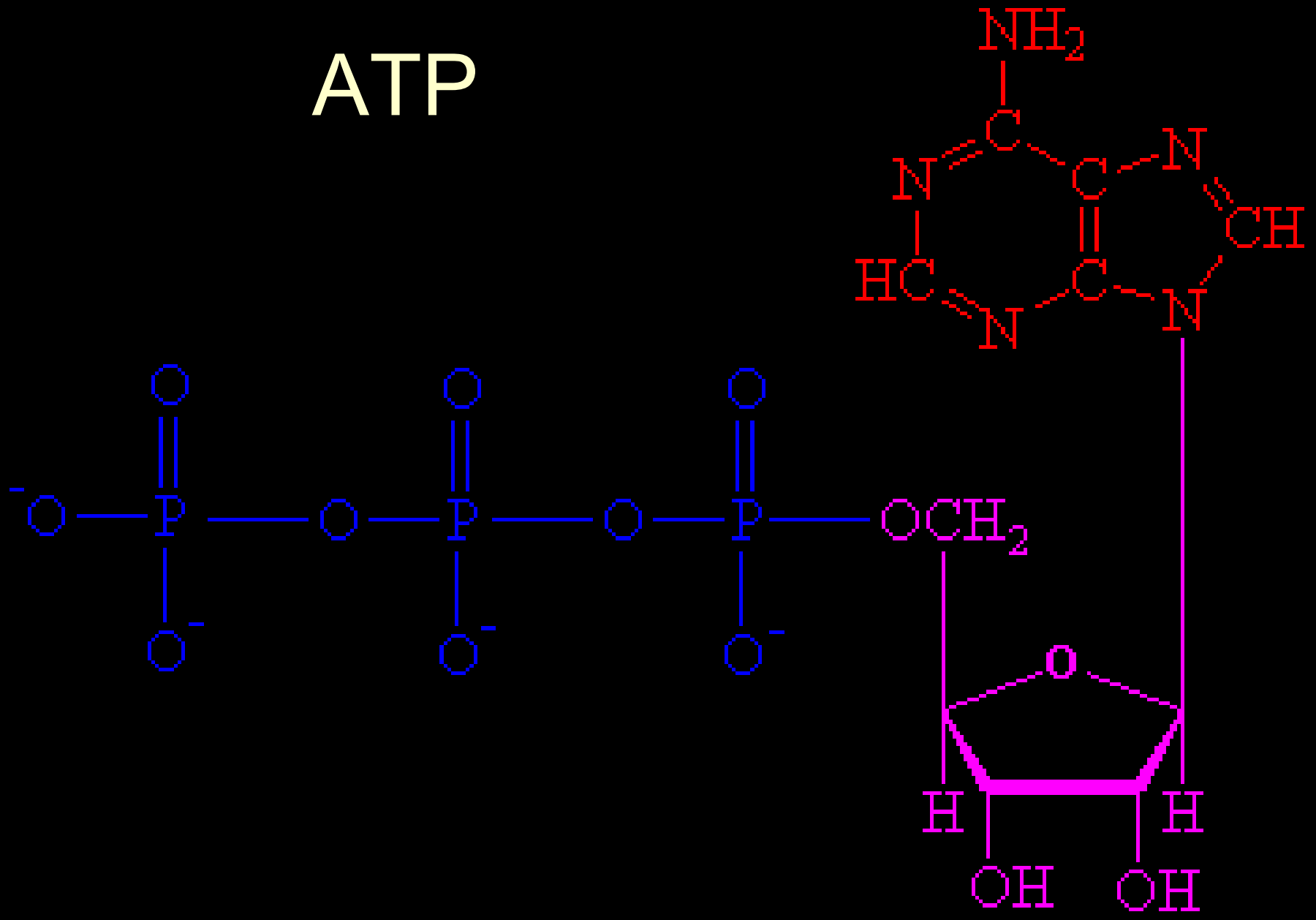
- catabolism – produce energy to drive cell machinery, exergonic
- anabolism – biosynthetic reactions, endogonic
- Energy storage:
  - ADP – adenosine diphosphate
  - ATP – adenosine triphosphate

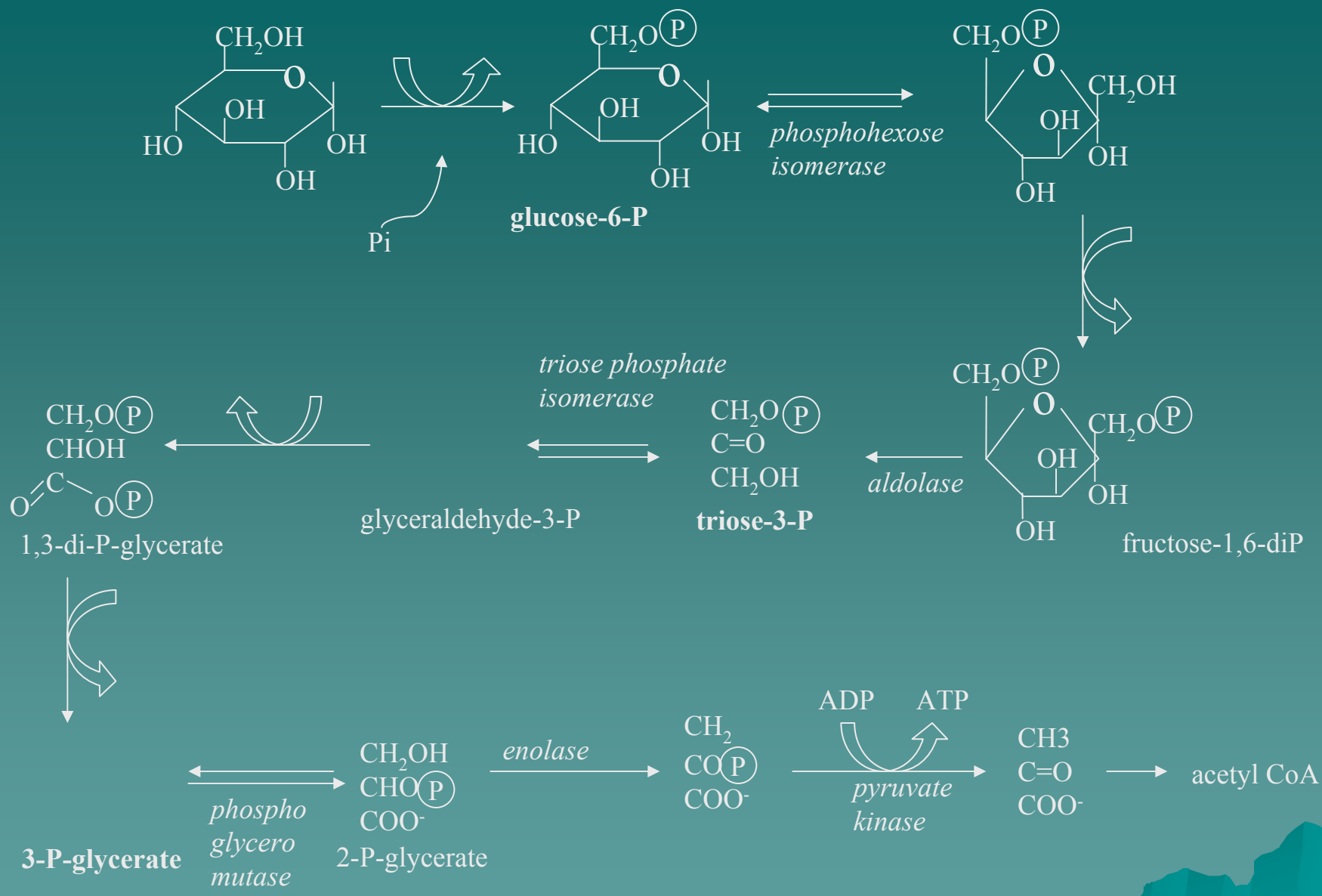
  7500 cal/bond

ATP Production

- formed in 3 ways:
  1. Substrate level phosphorylation (SLP): occurs during fermentation, e.g., glycolysis - breakdown of glucose in EMP pathway to pyruvate produces 4 ATP, consumes 2 ATP, nets 2 ATP
  2. Oxidative phosphorylation: electron transport, proton motive force
  3. Photophosphorylation

ATP





Embden-Meyerhof-Parnas

Aerobic Degradation of Glucose:

Electron Transport System

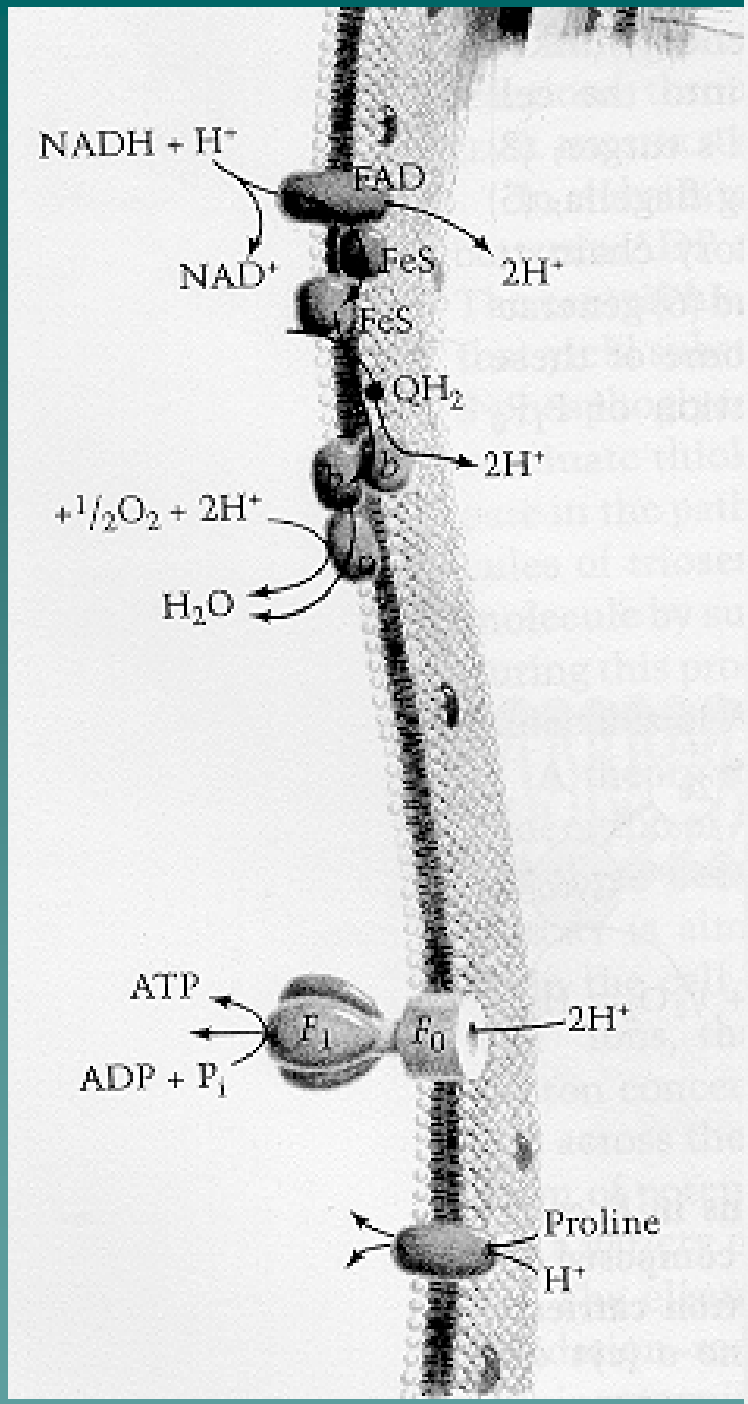
- at the end of the EMP, Krebs (TCA) cycle, Pentose phosphate, or Entner-Doudoroff pathway:
  - reduced nucleotides (electron carriers), some ATP from substrate level phosphorylation
  - reduced nucleotides enter the electron transport system in cytoplasmic membrane

Steps in ETS:

1. Electrons from substrate transferred to reduced carriers (NAD → NADH + H+, NADP → NADPH + H+)
2. Flavoproteins accept H2 & transport it outside the cell
3. electrons are transported to the iron/sulfur protein
4. Quinones accept electrons and transport additional H+ outside the cell

ETS on Membrane

ATP Production from H gradient



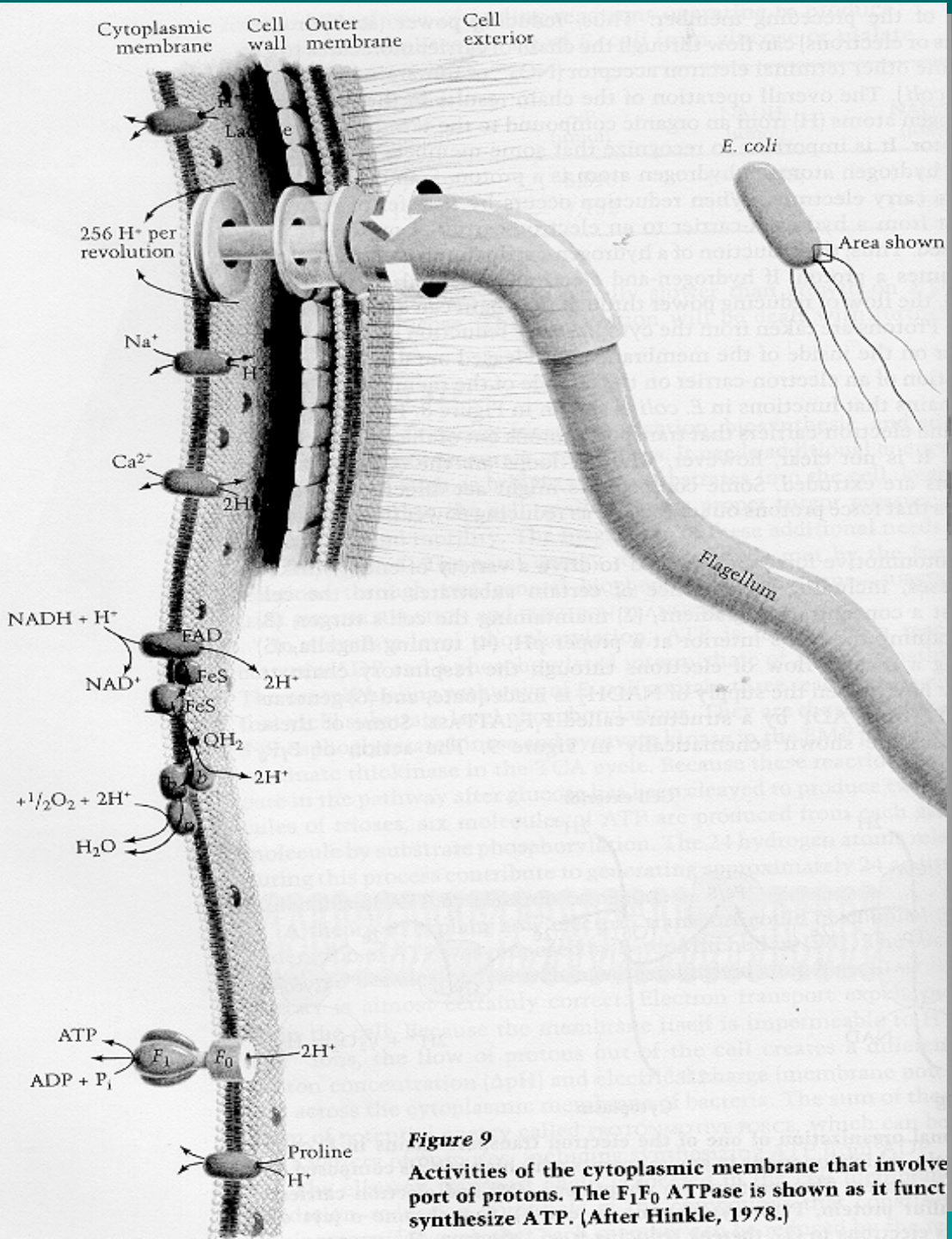


Figure 9

Activities of the cytoplasmic membrane that involve port of protons. The F_1F_0 ATPase is shown as it funct synthesize ATP. (After Hinkle, 1978.)