Biotic and abiotic chemical transformations

Much of the previous information regarding contaminant fate assumes little or no degradation.

A) Biotic transformations

Principle of infallibility

B) Types of microorganisms

Bacteria

Mineralization

Detoxification

Methylation

Fungi

Lignin peroxidase

Methylation

Algae

Biosorption

N-removal

Other "large" eukaryotes also help to breakdown contaminants

C) Nutritional classification of microbes

Group	Energy	C source
Photoautotrophs		
Photoheterotrophs		
Chemoheterotrophs		
Chemolithoautotrophs		

D) Metabolism

Type	e- donor	Terminal e- acceptor
Fermentation		
Respiration		
aerobic		
anaerobic		

E) Energetics of chemical transformations

Typically, organic contaminants serve as an electron donor

$CH_2O + H_2O \rightarrow CO_2 + H^+ + e^-$

Electron acceptors listed in order of energy gain

$O_2 \rightarrow H_2O$

$NO_3^- \rightarrow N_2$

$NO_3^- \rightarrow NO_2$

$Fe^{3+} \rightarrow Fe^{2+}$

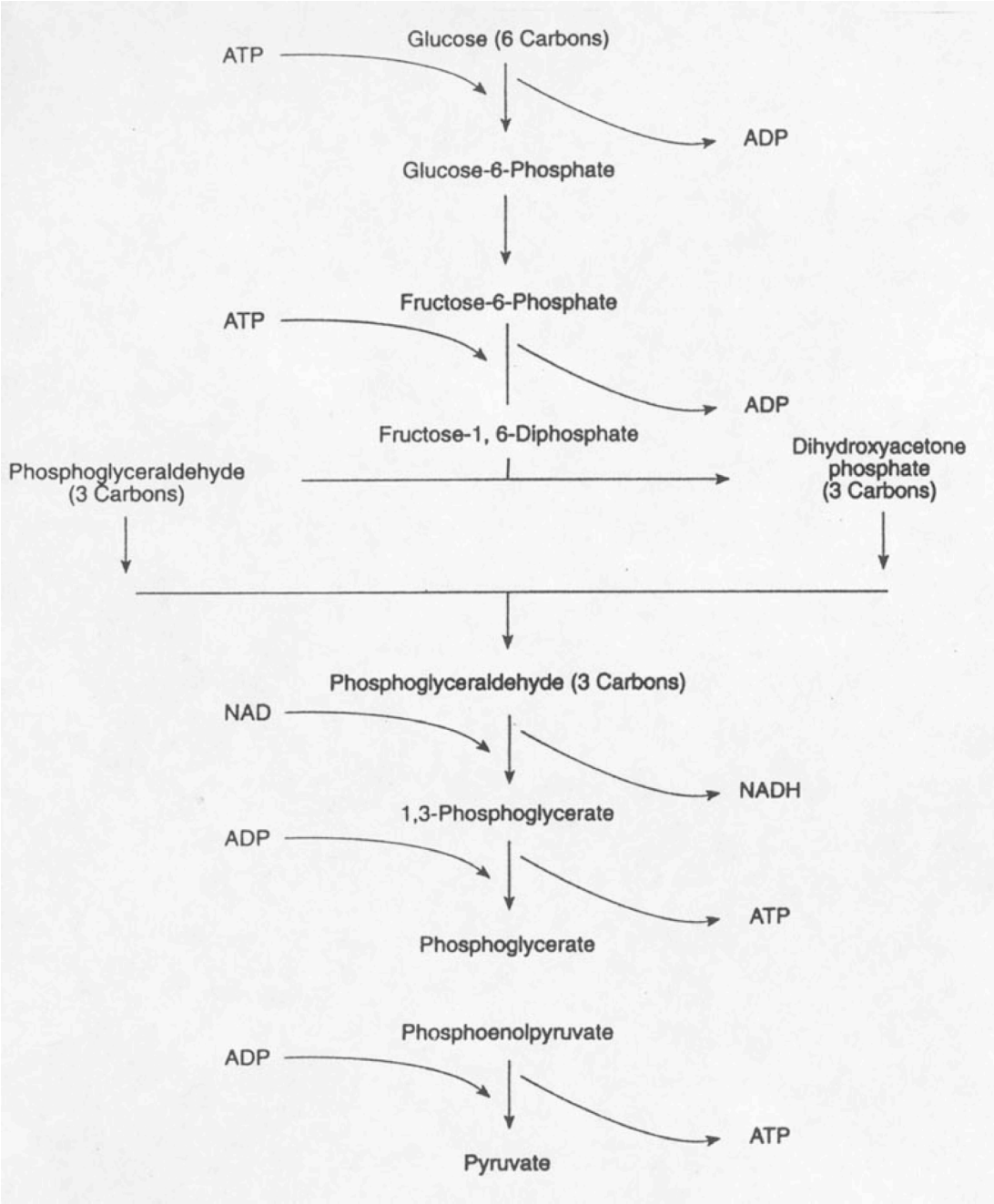
$SO_4^{2-} \rightarrow H_2S$

$CO_2 \rightarrow CH_4$

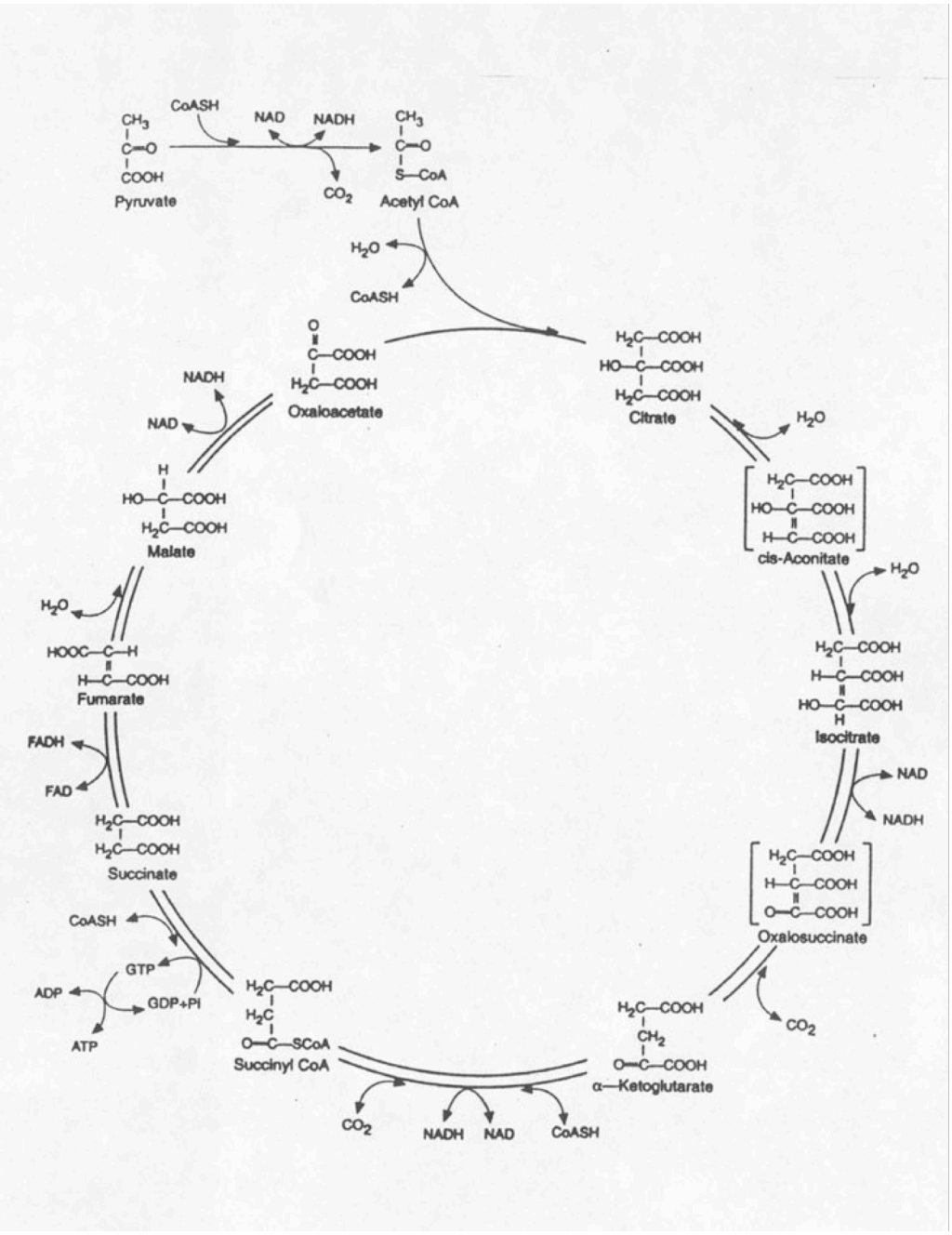
F) Biochemistry of organic contaminant degradation

In order for an organic contaminant to be mineralized it must be converted into a compound involved in the central metabolic pathways.

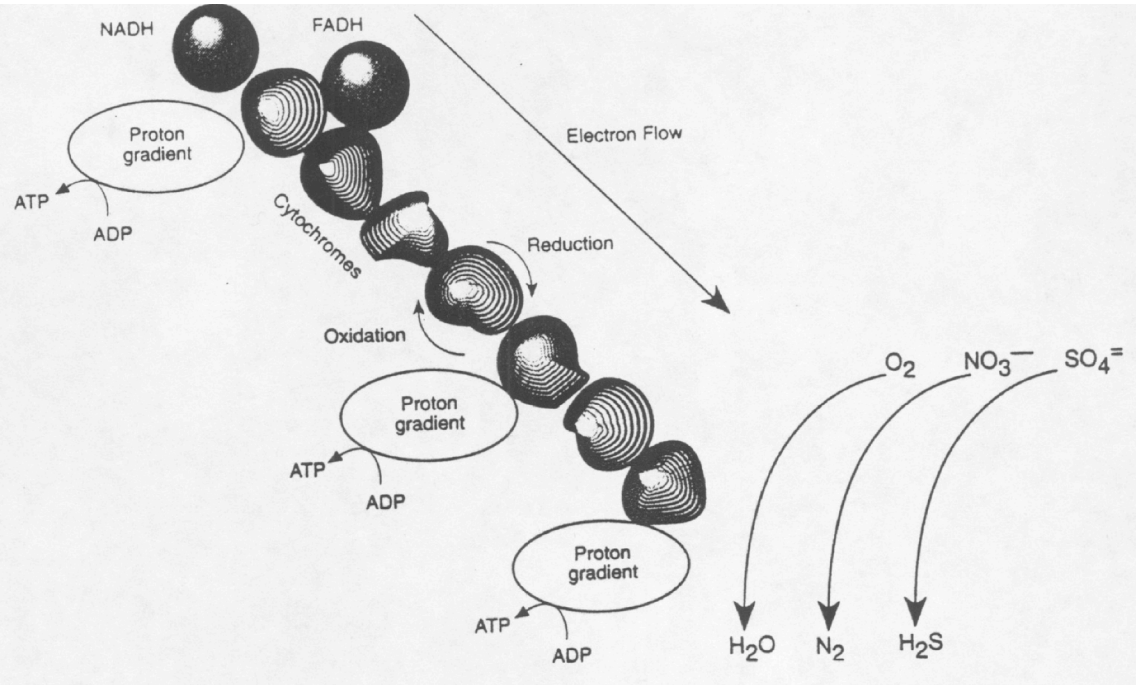
1) Glycolysis



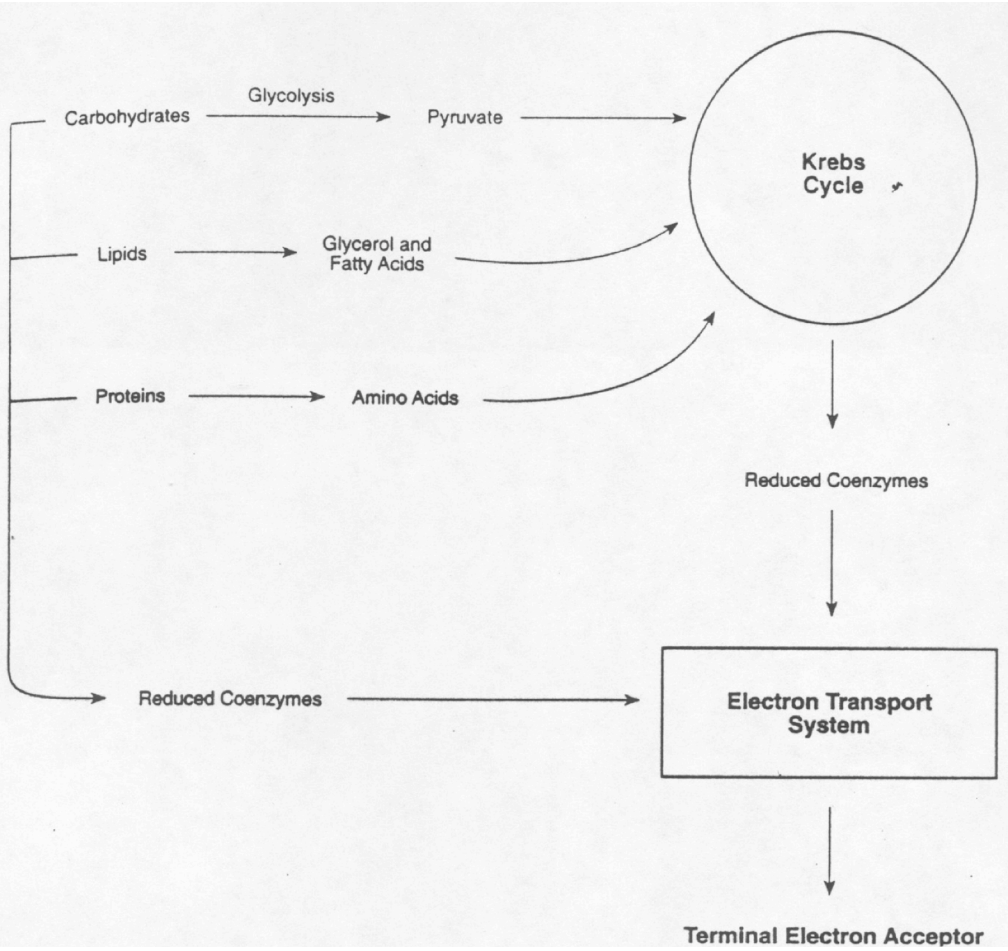
2) Krebs cycle



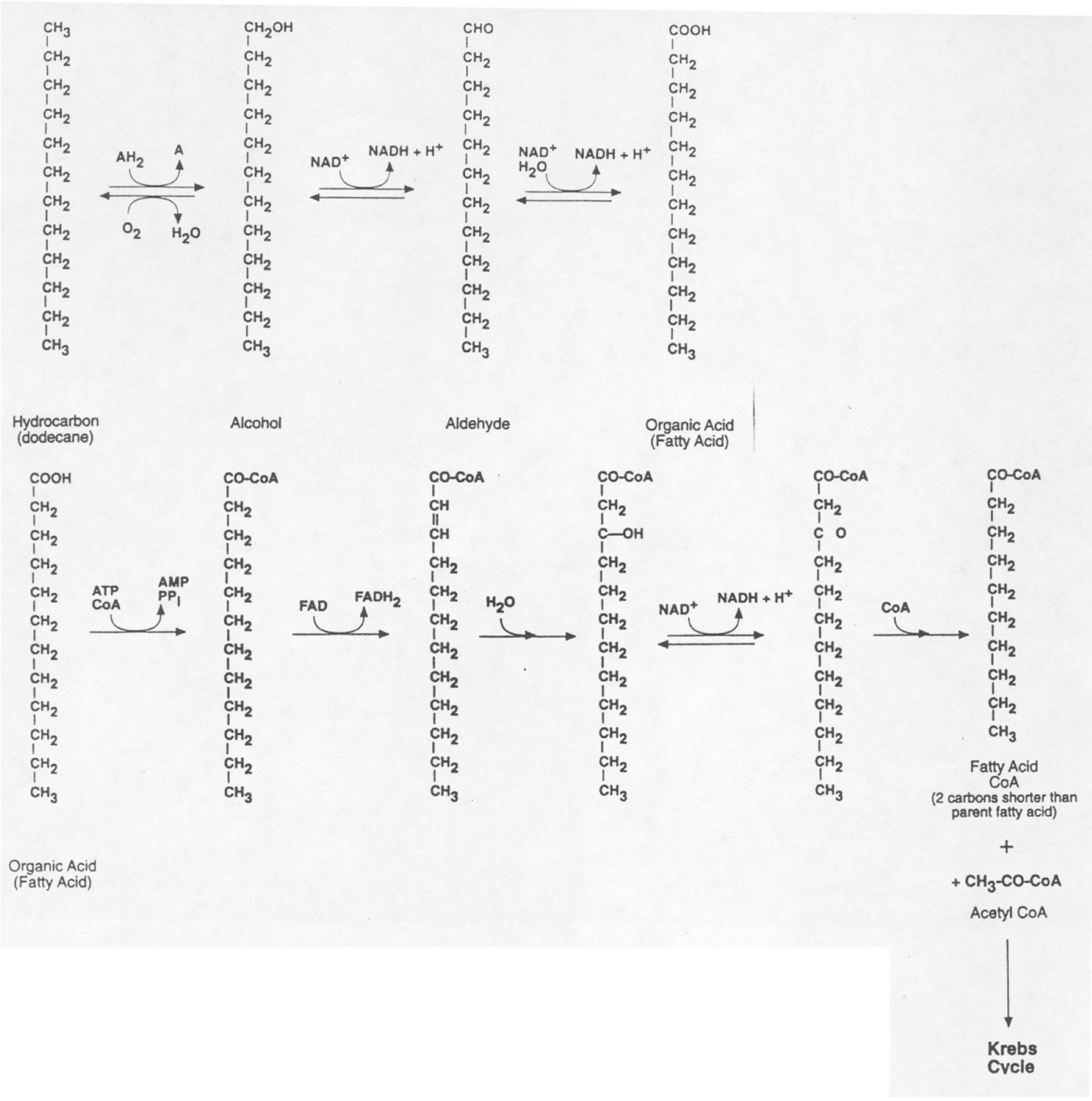
3) e- transport system



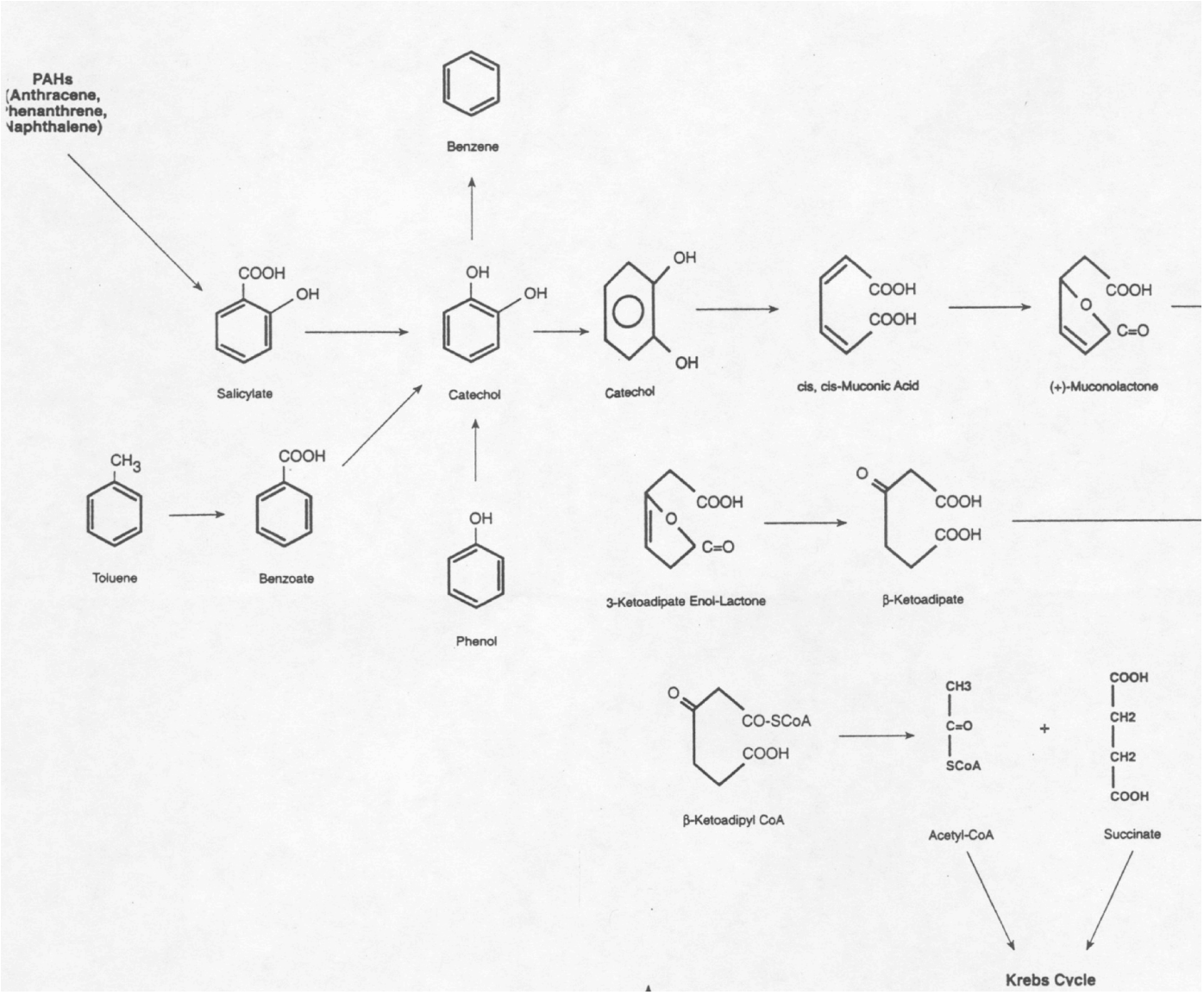
All together



Example 1. Beta-cleavage of alkanes



Example 2. Degradation of aromatics



G) Recalcitrant compounds

1) Unsaturated and substituted alkanes

2) Increased number of rings

Benzene

Naphthalene

Phenanthrene

Chrysene

Benzo[a]pyrene

3) Substituted halogens

Aerobic respiration

Reductive dechlorination

Cometabolism

4) Substituted nitro groups