Peripheral Metabolism

- Difference between aerobes & anaerobes
- Difference in flexibility of C-substrate use.
  Example: Pseudomonas Putida: > 200 different C-substrates
  Bacillus Fastidiosus: 1 C-substrate (uric acid)
- Over 20 million known C-substrates (primarily products of plants & bacteria)
- Dominance of polymers (because what organisms are composed of)

1. Polymers

   Problem
   - large & insoluble
   - motility & attachment (gain access to polymers by...)
   - extracellular degradation via excretion of hydrolytic enzyme
   - monomers: uptake

   a) Polysaccharides: structure & storage
      example: cellulose

      Glucose $\beta$ 1$\rightarrow$ 4

      \[ \text{Flat ribbons} \]

      - Enzymes
        - Endoglucanases
        - Exoglucanases
        \{ cellulases \}

      - Other enzymes
        - Chitinases
        - Pectinases
        - Xylanases

   b) Lignin
      Secondary component of wood
      - Many aromatic rings
      - Large & irregular structure
• Role is protection from biodegradation
  phenolic rings are toxic, & structural irregularity makes it hard to
degrade
• Oxygenases catalyze initial biodegradation (ring oxidation) of
  phenolic rings

c) Humics
• Conglomerate of organic compounds
• Product of chemical & biological degradation
  core: aromatic rings
  Condense with reactive residues (carboxylic acid groups or
  amino groups) to form very large & insoluble molecules
• Soils & sediments
• Turnover in temperate soils ~ thousands of years

d) Other polymers
• Proteins → proteinases (degrade proteins)
• DNA, RNA → nucleases (degrade nucleotides)

2. Monomers

a) Amino acids deamination → enter TCA cycle, glycolysis
  example: aspartate → oxaloacetate
  alanine → pyruvate

b) Organic acids
• 2, 3 C → glyoxylate cycle
• 4-6 C → TCA
• >6 C → β oxidation

c) Hydrocarbons
• C & H only → most reduced form
• Poorly soluble
• All organisms make some, but they are mostly a product of diagenesis
  (oil)

Aliphatics = straight or branched chains

Oxygenases degrade them most effectively: enzymes that directly
incorporate O into the carbon chain ⇒ primarily aerobic hydrocarbon
degradation

Aromatics = rings
  → Also degraded by oxygenases

Oxygenases:
  Monoxygenases: incorporate O
  Dioxygenases: incorporate O₂
Anaerobic: activation with CoA via ATP expenditure

→ Common intermediate = benzoyl CoA
→ Much less efficient than aerobic degradation
→ Can degrade small hydrocarbons

Polysaccharides

Glucose

Proteins

pyruvate

acetyl CoA

TCA

Short-chain fatty acids

Long-chain fatty acids

Aromatics

Percent Left

Sugar and aa

Cellulose

Lignin

Humics

Hardest to degrade

Time (yrs)