1. **Metabolic Diversity: Phototrophy, Autotrophy, Chemolithotrophy, and Nitrogen Fixation**
   Chapter 20
2. **20.1 Photosynthesis**
   - *Phototrophs*
     - Most are *autotrophs*
   - *Chlorophyll*
     - light-sensitive pigments
   - oxygenic photosynthesis
   - anoxygenic photosynsthesis
3. **20.2 Chlorophylls and Bacteriochlorophylls**
   - must produce chlorophyll (oxygenic) or bacteriochlorophyll (anoxygenic)
   - Chlorophyll is a porphyrin
     - Different chlorophylls have different absorption spectra
4. **20.3 Carotenoids and Phycobilins**
   - accessory pigments
     - *Carotenoids*
       - yellow, red, brown, or green
     - *Phycobiliproteins*
       - cyanobacteria and red algae
5. **20.4 Anoxygenic Photosynthesis**
   - *Anoxygenic photosynthesis*
     - four phyla of *Bacteria*
   - Reducing power for CO_2 fixation comes from reductants present in the environment
     - H_2S, Fe^{2+}, or NO^{2-}
     - Requires reverse electron transport
       - NADH production in purple phototrophs
6. **20.5 Oxygenic Photosynthesis**
   - light to generates ATP and NADPH
   - *photosystem I* & *photosystem II*
   - "*Z scheme*"
     - Photosystem II transfers energy to photosystem I
7. **20.6 The Calvin Cycle**
   - Discovered by Melvin Calvin
     - Fixes CO_2 into cellular material for autotrophic growth
     - Requires *NADPH, ATP, ribulose bisphophate carboxylase (RubisCO),* and *phosphoribulokinase*
     - 6 molecules of CO_2 are required to make 1 molecule of glucose
8. **20.8 The Energetics of Chemolithotrophy**
   - *Chemolithotrophs*
     - obtain energy from the oxidation of inorganic compounds
     - *Mixotrophs* are chemolithotrophs that require organic carbon as a carbon source
9. **20.10 Oxidation of Reduced Sulfur Compounds**
   - reduced sulfur compounds are used as electron donors
   - Discovered by *Sergei Winogradsky*
   - H_2S, S^0, $S_2O_3^-$ are commonly used
   - Usually aerobic, some can use nitrate as electron acceptor
10. **20.11 Iron Oxidation**
    - Ferrous iron (Fe^{2+}) oxidized to ferric iron (Fe^{3+})
    - Ferric hydroxide precipitates in water

This is only a guideline topics discussed in-class as well as the assigned pages from the text and supplemental material may also be on the exam.

- Many Fe oxidizers can grow at pH <1
  - associated with acidic pollution from coal mining

11 **20.12 Nitrification**

- NH_3 and NO_2- are oxidized by *nitrifying bacteria* during the process of *nitrification*
- Ecological roles in soil & water column
  - Ammonia to nitrate (plant nutrient)
  - Sewage & wastewater treatment
  - Removing toxic amines & ammonia

12 **20.14 Nitrogenase and Nitrogen Fixation**

- Only certain prokaryotes can fix nitrogen
- Some are free living others are symbiotic
- Reaction catalyzed by *nitrogenase*