Microbial Loop
The organic carbon cycle

- Allochthonous DOC, POC
- CO₂
- Littoral flora, Phytoplankton, Bacteria
- Detritus
- Heterotrophic organisms
- CO₂
- Outflow DOC, POC
Traditional view of food web

- Phytoplankton
- Zooplankton
- Fish
- Nutrients
Microbial loop—Stone & Weisburd, 1992

- Phytoplankton
- Zooplankton
- Bacteria
- Protozoa
- Nutrients
- Fish
The *microbial loop* is simply a model of the pathways of carbon and nutrient cycling through microbial components of pelagic aquatic communities. (Wetzel, pp409)
Life at small size scales

1. Picoplankton (less than 2 µm)
   . In the North Atlantic, 60% of primary production
   . In oligotrophic seas, 80-90% of primary production

2. Bacteria
   . Consume 20-60% of primary production
   . Three major ways: faeces and sloppy feeding of ZP, release of exudates from algae, hydrolysis of organic particles from bacteria.
Life at small size scales (con.)

3. Virus

4. Protozoa (dominant bacterivores)
   - Microflagellates and protozoan ciliates
   - High intrinsic growth rates
   - Active bacterivores.
   - Graze on picophytoplankton
   - Mineralize nutrients efficiently.
Control of bacterioplankton by biota (Fig 17-6)

**FIGURE 17-6** Idealized patterns of seasonal dynamics and regulation of bacterioplankton abundance and production in temperate, mesotrophic Lake Constance, southern Germany. BN = bacterial numbers; BP = bacterial production; WI = winter; SB = spring increase in phytoplankton abundance; CW = “clearwater” phase, which is highly variable from year-to-year depending on the relative abundance of daphnid zooplankton and their effectiveness in grazing of phytoplankton algae; SU/FALL = summer and autumn periods. Upward arrows = net positive effect, and downward arrows = net negative effects on bacterioplankton. (Modified from Simon et al., 1998a.)
Functions of Microbes

• Small, high surface area to biomass ratios, permitting a more intimate contact with the environment, a greater uptake potential for nutrients and a more rapid turnover of nutrients and organic matter than larger organisms.

• Slow sinking rates and tend to remain in the upper waters of lakes and oceans for long periods before settling out to greater depths. So the nutrients enter the microbial loop have a greater likelihood of remaining in the photic zone longer than those incorporated directly into larger metazoans with faster sinking rates.
Conclusions (microbial loop)

• The microbial loop is a model of pathways of carbon and nutrient cycling through microbial components of pelagic aquatic communities.

• Protistan zooplankton are the most important microbial consumers and have major functions in organic carbon utilization and nutrient recycling.
Food production Pyramid

- Carnivore (1)
- Herbivore (11)

Primary producers (plants, algae, bacteria) (millions of individuals)
Fish

Copepods

Regenerated production

NH₄

"Net" phytoplankton

NH₄/NO₃

"New" production

NO₃

"Export" production N,C

Bacterial degradation, remineralization and nitrification
Food Production Pyramid

Primary producers (plants, algae, bacteria) (millions of individuals)

Carnivore (1)

Herbivore (11)
dissolved organic matter $\rightarrow$ bacterial biomass .... 60%
bacterial biomass $\rightarrow$ flagellate biomass ............... 40%
flagellate biomass $\rightarrow$ ciliate biomass ................. 40%