The Biological Carbon Pump

Key concepts:

1. Photosynthesis in the (upper) ocean

Simply,
CO_2 + H_2O + Nitrogen (NO_3^- or NH_4^+) + Phosphorus + (as PO_4^{3-}) + micronutrients (e.g. iron) = Organic matter (simplified as 106 atoms C, 16 atoms N, 1 atom P) + Oxygen (O_2)

2. Respiration, at all depths in the sea:

Organic matter ($C_{106}N_{16}P$)+ O_2 = Dissolved CO_2 + Nitrate (NO_3^-) + Phosphate (PO_4^{3-}) + H_2O + micronutrients + dissolved organic compounds (e.g. carbohydrates, amino acids)

3. Sinking detritus (faecal pellets, cells, organic aggregates or clumps etc) transports both carbon and nutrients into the ocean interior (the deep sea) whereupon they will be resident for relatively long periods of time (how long, as a rough average?) until they become welled up somewhere in the sea.

4. Result of photosynthesis in the surface/upper ocean and respiration at depth, coupled with thermohaline and surface circulation:

- Oxygen depletion at depth
- Oxygen minimum zone in upper intermediate waters
- Nitrate and phosphate enrichments at depth
- Increased total CO2 at depth
- Decreased carbon dioxide in surface waters
- Enriched nutrients and carbon dioxide in upwelling zones (divergences especially, but also far northern Pacific)
- North Pacific deep waters contain higher dissolved nutrient and total carbon dioxide concentrations than do North Atlantic deep waters.