the downward flux of materials (e.g., detrital or waste and decomposition (after death) components). Together, the solubility and biological pumps are now believed to affect atmospheric carbon dioxide levels significantly.

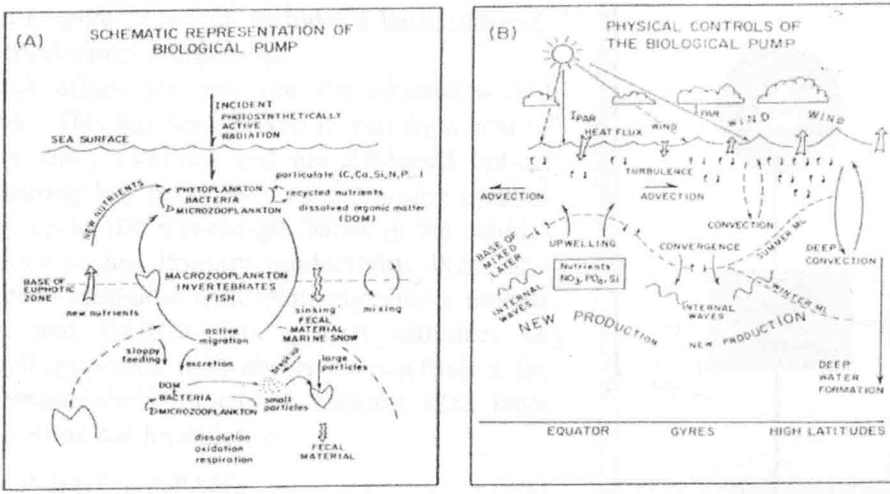

Figure 1.(a) Schematic representation of the biological pump and the various contributing biological processes. (b) Illustration of some of the physical mechanisms affecting the biological pump from equatorial regions to mid to high latitudes. Based on figure by Bishop (1989).

Here we introduce a few of the key issues regarding primary productivity in relation to the biological pump. This line of research offers several opportunities to cross traditional disciplinary boundaries. For our interests, we highlight several connections between biogeochemistry, bio-optics (the study of biological effects on the subsurface light field and *vice versa*), upper ocean physics, and the biological pump (see Dickey and Falkowski, 2002). Phytoplankton biomass depends on photosynthetic processes, which involve the availability of light (e.g., photosynthetically available radiation or PAR, simply light in the visible wavelengths) and plant nutrients. Two classes of plant nutrients, macro-nutrients (e.g., nitrate, silicate, and phosphate) and micro-nutrients (e.g., iron), are important. The spectral quality and intensity of light vary with depth and are also important for specific phytoplankton species with special pigmentation or photoadaptive characteristics and niches (e.g., Bidigare et al., 1990). Light exposure for individual phytoplankton is affected by variation in physical conditions such as mixed layer depth, turbulent mixing, and currents and of course the incident light field, which varies spectrally (e.g., blue light penetrates more deeply than other wavelengths in the open ocean) and in time and space (e.g., daily or diel cycle, seasonal cycle, cloud variability, etc.). An interesting feedback