**Abstract**
Photosynthetic microorganisms can be engineered to produce pharmaceuticals, chemical intermediates, and clean energy (e.g., hydrogen). They also fix atmospheric carbon dioxide--an important consideration as increased levels of carbon dioxide are linked to global warming. As a first step in the photobioreactor design, the authors investigated the relative significance of the exponential and the linear growth rates during light-limited batch cultivation of photosynthetic cells using various types and sizes of photobioreactors. They also developed a mathematical model that could explain the existence of the various growth phases during the light-limited batch cultivation. Because the cost of electricity is high, use of solar energy is obviously desirable, because it is abundant and free. However, an appropriate method for harvesting the solar energy and distributing the light inside the photobioreactor is required. A light collection device consisting of Fresnel lenses is used to collect the solar light, which is then distributed inside the reactor through the optical fibers. Because the position of the sun changes continuously, the device is equipped with a light-tracking sensor so that the lenses rotate with the position of the sun. Because of diurnal and seasonal changes in the sunlight intensity, however, high volumetric productivity is difficult to achieve if only solar energy is used for reactor illumination. For maximum productivity, therefore, the solar light should be supplemented with an artificial light source at night and on cloudy days.