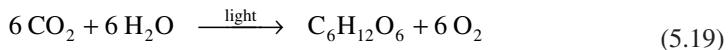
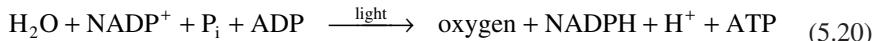


Figure 5.12. Schematic representation of the Calvin–Benson cycle, illustrating its three phases: CO_2 fixation, reduction of fixed CO_2 , and regeneration of the CO_2 acceptor. (With permission, from R. Y. Stanier and others, *The Microbial World*, 5th ed., Pearson Education, Upper Saddle River, NJ, 1986, p. 96.)

Photosynthesis takes place in two phases. The overall reaction is



The first phase of photosynthesis is known as the *light phase*. Light energy is captured and converted into biochemical energy in the form of ATP and reducing agents, such as NADPH. In this process, hydrogen atoms are removed from water molecules and are used to reduce NADP, leaving behind molecular oxygen. Simultaneously, ADP is phosphorylated to ATP. The light-phase reaction of photosynthesis is



In the second phase, the energy-rich products of the first phase, NADPH and ATP, are used as the sources of energy to reduce the CO_2 to yield glucose (see Fig 5.12). Simultaneously, NADPH is reoxidized to NADP^+ , and the ATP is converted into ADP and phosphate. This *dark phase* is described by the following reaction:



Both prokaryotic and eucaryotic cells can fix CO_2 by photosynthesis. In prokaryotes (e.g., cyanobacteria), photosynthesis takes place in stacked membranes, whereas in eucaryotes an organelle called the *chloroplast* conducts photosynthesis. Both systems contain chlorophyll to absorb light. Light absorption by chlorophyll molecules results in an electronic excitation. The excited chlorophyll molecule returns to the normal state by emitting light quanta in a process known as *fluorescence*. The excited chlorophyll donates an electron to a sequence of enzymes, and ATP is produced as the electrons travel through the chain. This ATP generation process is called *photophosphorylation*. Electron carriers in this process are ferrodoxin and several cytochromes.