The light phase of photosynthesis consists of two photosystems. Photosystem I (PS I) can be excited by light of wavelength shorter than 700 nm and generates NADPH. Photosystem II (PS II) requires light of wavelength shorter than 680 nm and splits H_2O into $\frac{1}{2}\ O_2 + 2\ H^+$. ATPs are formed as electrons flow from PS II to PS I.

5.12. SUMMARY

Cellular metabolism is concerned with two primary functions: *catabolism* and *anabolism*. Catabolism involves the degradation of a substrate to more highly oxidized end products for the purpose of generating energy and reducing power. Anabolism is the biosynthesis of more complex compounds from simpler compounds, usually with the consumption of energy and reducing power. The key compound to store and release energy is adenosine triphosphate or *ATP*. Reducing power is stored by nicotinamide adenine dinucleotide (*NADH*) or nicotinamide adenine dinucleotide phosphate (*NADPH*).

Three of the most important pathways in the cell are (1) the *Embden–Meyerhof–Parnas* (EMP) pathway, or *glycolysis*, which converts glucose into pyruvate; (2) the *tricarboxylic acid cycle*, which can oxidize pyruvate through acetyl-CoA into CO_2 and H_2O; and (3) the *pentose–phosphate* or *hexose–monophosphate* (HMP) pathway, which converts glucose-6-phosphate into a variety of carbon skeletons (C_3, C_4, C_5, C_6, and C_7), with glyceraldehyde-3-phosphate as the end product. Although all three pathways can have catabolic and anabolic roles, the EMP pathway and TCA cycle are the primary means for energy generation, and HMP plays a key role in supplying carbon skeletons and reducing power for direct use in biosynthesis. In this chapter we have briefly considered the relationship of these pathways to amino acid, fatty acid, and polysaccharide biosynthesis. The conversion of pyruvate to glucose, necessary for polysaccharide biosynthesis when the carbon source does not have six carbons, is called *glucogenesis*.

Reducing power can be used to generate ATP through the *electron transport chain*. If oxygen is the final electron acceptor for this reducing power, the process is called *aerobic respiration*. If another electron acceptor is used in conjunction with the electron transport chain, then the process is called *anaerobic respiration*. Cells that obtain energy without using the electron transport chain use *fermentation*. *Substrate-level phosphorylation* supplies ATP. The end products of fermentative metabolism (e.g., ethanol, acetone–butanol, and lactic acid) are important commercially and are formed in response to the cell's need to balance consumption and the production of reducing power.

Autotrophic organisms use CO_2 as their carbon source and rely on the *Calvin* (or *Calvin–Benson*) cycle to incorporate (or fix) carbon from CO_2 into cellular material. Energy is obtained either through light (*photoautotroph*) or oxidation of inorganic chemicals (*chemoautotroph*). Figure 5.13 summarizes the major metabolic pathways and their interrelationship.