Web Chapter

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Energy and Enzymes

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Energy flow is a universal feature of living systems. It is also at the core of atomic and molecular motions and reactions that characterize nonliving systems as well. Water molecules would not move through the soil, into the plant, up the xylem, into the leaf, and out into the atmosphere without the appropriate energy gradients to drive them. Sunlight, the visible portion of the electromagnetic spectrum, must be captured and converted to chemical energy to allow the synthesis of the complex organic molecules required for life. Indeed, there is not a single physical or chemical process in plants that does not involve energy transformations of some kind. Thus the study of energy in living systems—or bioenergetics—is central to an understanding of plant physiology.

This chapter reviews the basic concepts and principles of energy transformations, called *thermodynamics,* as they apply to plants and other organisms. The concept of free energy provides a framework for understanding the direction of spontaneous processes. The presence of semipermeable membranes in living cells allows the formation of energy gradients that drive a host of reactions necessary for life. This chapter provides an introduction to basic concepts of membrane transport, which are treated more extensively in later chapters on water relations (Chapters 3 and 4) and solute transport (Chapter 6).

Finally, life would be impossible without the presence of protein catalysts, called *enzymes,* which speed up reactions that would ordinarily occur much too slowly for living processes to be carried out. This chapter therefore ends with a brief overview of protein structure, the mechanisms of enzyme-catalyzed reactions, and the fundamental ways in which enzymes are regulated in living cells.

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