Unit 33. Enzymes and Hormones

Researchers in the field of biochemistry study the molecules in cells that are fundamental to the processes of life. One of the most important groups of intercellular molecules are the proteins, which are chains of molecular units called amino acids. They play a key role in nearly all organic processes and facilitate a wide range of functions within the body, including the transport and storage of nutrients, coordinated motion, and protection against disease. Two extremely different yet incredibly important types of proteins working in the human body are enzymes and hormones. Without them, the body would take nearly fifty years to digest a meal and would never undergo puberty.

Enzymes are catalysts, meaning they are responsible for the speeding up or slowing down of biochemical reactions. Enzymes can potentially increase a reaction rate by factors as great as 10^{12}. They will not, however, affect just any chemical reaction, but instead act in only certain molecules, called substrates. The enzyme's amino acid chain folds in such a way as to fit into a unique molecular pattern much like how one puzzle piece fits into another. In this way, enzymes will attach themselves to only specific molecules. They then catalyze the conversion of these molecules into biologically useful products. A living cell may contain as many as 3000 different types of enzymes, with each responsible for a different chemical reaction. The various chains of reactions, called metabolic pathways, occurring in a cell depend on the specific set of enzymes present in the cell.

Enzymes do not operate independently. Their actions are controlled by mechanisms that "turn them on" when a cell requires certain products and "turn them off" when the product quota has been achieved. Each enzyme contains one or more active sites, where substrates attach to the enzyme and where reactions take place. In a cell, when concentrations of substrates are high and concentrations of products are low, many active sites are available to receive substrate molecules. As more and more molecules attach themselves to enzymes, the rate of reaction increases. When the concentration of substrates reaches a level at which all active sites are filled, the reaction rate remains

constant. If enzymes create more products than needed by the cell, the concentration of products increases. The excess products can sometimes act as inhibitors by attaching themselves to either the binding sites of substrates or the active sites of enzymes, thus decreasing the rate by which substrates are converted into products. Without enzymes, cells would have no way of acquiring the chemical balances necessary for sustaining life.

Hormones are another type of protein vital to biological functioning. They regulate such physiological processes as metabolism, growth, reproduction, and pigmentation. Organs and tissues secrete hormones directly into the bloodstream. They serve as chemical messengers from one cell, or group of cells, to another. Once in the blood, hormones traverse to all cells of the body, where they interact with special proteins, called receptors, embedded in the cell membrane of their target cell. Certain receptors are built to receive only specific hormones. When a hormone binds to a receptor, it triggers a series of chemical changes in the cell. Through these chemical reactions, the hormone's message eventually reaches the nucleus of the cell, where the process of gene transcription is initiated.

The nucleus of a cell houses all of its genetic information—information that informs a cell how and what type of metabolic proteins to make. This information is encoded in the structure of a molecule called deoxyribonucleic acid, or DNA. In the extraordinary process of gene transcription, strands of DNA are copied in order to efficiently manufacture the specific proteins called for in the hormonal message. These proteins then carry out necessary activities within the cell. Hormones can stimulate cell division, activate immune responses, include the death of malfunctioning cells, regulate the production and release of other hormones, and affect many other cellular processes. Like enzymes, hormones are an essential component in the amazingly complex biological systems of life on Earth.