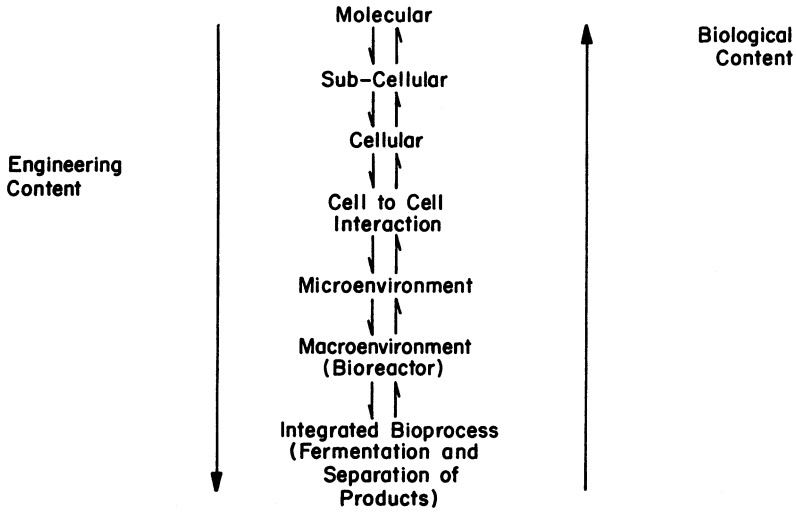

Figure 14.1. Biocatalyst and bioreactor design are strongly interconnected. Choices made at the molecular level can have profound effects on bioreactor design. A multidisciplinary approach is necessary to ensure that a well-designed process is developed.

enhanced capacity to process the precursors to a desired metabolite. However, most current industrial emphasis has been on proteins. Table 14.1 lists examples. The majority of these proteins are human therapeutics, but proteins that can be used in animal husbandry, in food processing, or as industrial catalysts are of interest. Sales in the United States for these products are forecasted to be $32 billion in 2006. Over 200 other proteins are in clinical trials.

With therapeutic proteins that are injectable, the prime concern is the clinical efficiency of the product. Such products must be highly pure, since strong immunogenic reactions by patients or other side effects can be disastrous. The authenticity of the product is often critical. Correct or near correct posttranslational processing of the protein (e.g., glycosylation or phosphorylation) is sometimes essential to its therapeutic action. Any variant forms of the protein (e.g., the modification of side groups on amino acids) are highly undesirable and present very difficult purification problems.

The processing challenges in making therapeutic proteins are to ensure product quality and safety. Process efficiency to reduce manufacturing cost, although important, is of less concern, since these products are required in relatively small amounts, because they can command high prices, and because the selling price is much more determined by the costs of process development and regulatory approvals, particularly clinical trials. Thus, for these products the choice of biological system and processing equipment is dictated by the need to produce highly purified material in an absolutely consistent manner.

Other protein products are purchased strictly on an economic basis, and manufacturing costs play a much more critical role in the viability of a proposed process. In this case, regulatory demands are of lesser importance than in the production of therapeutic proteins. For animal vaccines or animal hormones, the products must be very pure and render favorable cost ratios. For example, the use of bovine somatropin to increase