The title of this symposium, "Regulation of Digestive Function in Domestic Livestock," should stimulate some readers to reflect upon events of a few years ago when fresh meat products were luxuries that were enjoyed once a week or on special occasions. What was the availability of fresh meat in the U.S. 50 years ago? The answer is that the availability of fresh meat was extremely limited. Public cold storage facilities were nonexistent; therefore, freshly drawn poultry, feathers intact, was delivered daily to small meat markets or butcher shops in cities. Beef was delivered daily, and, depending on the size of the butcher shop, usually one side at a time. Fresh pork was available in the winter and salt pork or cured pork was usually available. Fresh fish was only available to those who lived close to the sea or lakes; otherwise, fish was either smoked or soaked in brine.

After World War II, large-scale refrigeration became available through home freezers, and rental freezer space ("lockers") became popular in rural communities. This placed a new demand on the production of meat products of all kinds. Between 1940 and 1955, industrial and university research unraveled the mysteries of some of the water-soluble vitamins and growth factors. The baby chick was a favorite animal for bioassay on many of the vitamins, so those early experiments helped to pave the way for the expansion of the poultry industry. Another major contribution to the expansion of animal production was the development of the soybean industry in Illinois and other midwestern states.

As animal scientists in various universities explored the multitude of nutritional requirements of domestic livestock, agricultural engineers began to develop different machines for preparation of feed ingredients. Thus, we have seen the development of grinders, hammermills, dry and steamroller mills, pelleting machines, crumbling devices, crushers, extractors, extruders, etc.

Feed ingredients have been acidified, alkalinized, hydrated, dehydrated and rehydrated. Nutritionists have determined the gross energy, digestible energy and metabolizable energy of nearly all major feed sources on the surface of the earth. They have analyzed urine, feces, plasma and respiratory gases for everything that was soluble or insoluble in the air, water and organic solvents. There is information available concerning amino acid composition, fatty acid profiles, mineral content, and digestible and nondigestible carbohydrates for all kinds of feedstuffs. There is information about feeder design, whether to feed once a day, twice a day, hourly or ad libitum. Some animals prefer group feeding; others prefer to dine alone. There are pharmacopoeias filled with antibiotics and growth promotants designed to overcome mismanagement, disease and parasites so that faster and/or more efficient gain can be realized. We have constructed round buildings, square buildings, long and short buildings with wood, concrete, steel and plastic floors. We have made solid walls, curtain sides, under-eve and under-slat ventilation. We have placed poultry and pigs in cages on the floor, double decks and triple decks. Agricultural engineers can recommend a building plan for any place in the world for any species of domestic livestock. With this array of information, the commercial livestock
industry should have the world by the tail on a downhill pull. Yet, year after year, livestock producers barely make ends meet. What seems to be wrong with all that has gone on before? One possible answer is that we have given too little attention to the chemistry and biology of the animal, especially to the process that allows them to grow: digestion, absorption and delivery of nutrients to specific tissues.

The 21st-century animal nutritionist will be expected to provide information to the commercial livestock producers that will allow animals to produce live gain with the bare minimum of feed. If we keep in mind the First Law of Thermodynamics, which states that "energy can neither be created nor destroyed," we should strive to understand all aspects of animal production sufficiently well that we might obtain a pound of gain from a pound of feed (F/G = 1.0). A feed efficiency of 1.0 from start to finish for the primary food-producing animals is not a realistic number, but it is a goal that every animal scientist should keep in mind; better understanding of the basic metabolic processes of the animal should help in reaching that goal.

What are the economics behind livestock production and what would improvement in feed efficiency mean to a producer? The poultry industry becomes concerned about a change in feed efficiency of .01. This "one-point" change in feed efficiency is equivalent to about .4 cents per broiler marketed. A broiler company that produces 1 million birds per week would realize about $4,000 per week difference in profits with a change in feed efficiency of one point. At least 12 companies in the U.S. produce more than 10,000 sows. It is quite obvious what the use of growth hormone would do for commercial enterprises that produce over 200,000 pigs per year. Unfortunately, information is not available concerning the nutritional requirements of rapidly growing, highly efficient, growth hormone-treated animals.

The limiting factors of growth may be the underlying mechanisms that regulate intake, digestion and absorption of nutrients. Cooperative work between USDA and industry already has resulted in the development of a vaccine to immunize pigs against a fragment of the gut peptide CCK-8, which is believed to regulate feed intake. A combination of growth hormone and CCK-8 immunization might produce a pig that has a feed efficiency closer to the magic number of 1.0 and growth rate that exceeds all expectations.

Recent research at various universities has shown that the feed efficiency of "growth hormone"-injected pigs approaches 2.0. Such a feed efficiency is highly competitive with the broiler. Several organizations in the U.S. control swine production facilities with more than 10,000 sows. The 21st century is rapidly approaching. By the time the year 2000 arrives, we probably will have "transgenic" animals ready for distribution to commercial enterprises. Such transgenics will include pigs, chickens, fish, dairy cattle and beef cattle. Ducks, geese and rabbits also may be available. There is no doubt that nutrition will be important for these transgenic animals, but it is possible that our present knowledge of nutrition has only scratched the surface of the real role that it will play in animal growth and development. Regulation of digestion, absorption and delivery of nutrients to specific target tissues will be of utmost importance for the transgenic animals, but the most important role of nutrition may reside in regulation of specific gene expression.

The following presentations should stimulate a critical appraisal of our understanding of gastrointestinal function and foster increased efforts to beneficially manipulate digestive processes to enhance animal production.