Application of Modern Biotechnologies in Sheep Production

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In the last 10-20 years, new biotechnologies have been developed that are on the verge of revolutionizing animal production (Wallace, 1994; Hansel and Godke, 1992; Wilmut et al., 1992). These biotechnologies involve primarily the application of tools derived from molecular genetics, as well as assisted reproductive technologies, to the improvement of animal production (Hansel and Godke, 1992; Wilmut et al., 1992 Nicholas, 1996). These modern biotechnologies include:

Use of molecular markers, such as microsatellite markers with sequence tagged sites (STS), as powerful gene mapping tools;

Use of STS to map genetic loci for quantitative traits (milk production, fleece weight, growth rate, metabolic efficiency, etc.), which are termed quantitative trait loci (QTL);

Use of QTL in animal breeding programs, which is termed marker-assisted selection;

Use of QTL and other molecular markers to map and identify the genes for specific traits or defects, which is termed positional cloning;

Genetic diagnosis using specific molecular probes to identify individuals, including adults and embryos, that carry a specific gene;

Introduction of specific genes, or gene transfer, into individuals to correct a genetic defect or obtain a specific biological product.

The recent development of techniques for production, culture, storage, and transfer of embryos is critical for the application of several of these powerful new molecular tools (Niemann, 1991; Hansel and Godke, 1992; Nicholas, 1996). For example, modern embryo technologies have enabled the development of methods to transfer desired single genes or, alternatively, the entire genome from a desirable individual, to embryos. This latter technique involves the cloning, or duplication, of entire individuals that are genetically identical. Both of these techniques have been made feasible by the development of nuclear transfer, wherein an entire nucleus containing the desired gene or genome is transferred to an early, single-cell, embryo that previously has had its own nucleus removed (Schnieke

et al., 1997; Wilmut et al., 1997). In addition, rapid advances in techniques to manipulate embyros in the laboratory has enabled genetic screening of embryos for genetic defects or quantitative traits using molecular markers.

To enable the application of these modern biotechnologies to the specific needs of North Dakota animal producers, the Animal & Range Sciences (A&RS) Department has recently appointed a new Assistant Professor of Animal Embryology, Dr. Anna T. Grazul-Bilska. Dr. Grazul-Bilska has a strong background in cellular and molecular biology. Her appointment as an Animal Embryologist will enable the Department to continue its commitment to addressing the needs of the livestock industry in North Dakota, by allowing us to adapt the modern biotechnologies to producer needs. In addition, appointment of Dr. Grazul-Bilska to the A&RS faculty will enhance all of the animal research programs in the Department, including Animal Physiology, Nutrition, Genetics, and Meat Science, as well as at the Research and Extension Centers throughout the state, because she will give us ready access to technologies such as gene transfer, genetic analysis of pre-implantation embryos, embryo collection, storage, and transfer, etc.

Dr. Grazul-Bilska will develop a research program emphasizing applied as well as fundamental aspects of animal embryology, with a focus on embryo culture and manipulation in domestic livestock species. In addition, she will provide leadership in animal embryology research and teaching efforts, and will engage in collaborative, interdisciplinary research that will enhance NDSU's animal science research efforts. Initially, Dr. Grazul-Bilska's research program will focus on evaluation of the quality of oocytes and embyros obtained from superovulated and non-superovulated animals under different hormonal and nutritional treatment regiments (Grazul-Bilska et al., 1991); and she also will initiate research to evaluate the importance of cell-to-cell communication in embryo growth and development. In addition, a portion of Dr. Grazul-Bilska's research program initially will focus on sheep embryology because of existing expertise in the A&RS department in manipulation of reproductive processes in sheep (see article in this report by Redmer et al.), and because sheep provide a relatively cheap source of embryos for studies that potentially will benefit the entire livestock industry. Dr. Grazul-Bilska's future research efforts will emphasize collaborations with other biotechnologists and molecular geneticists to ensure that North Dakota's livestock industry has access to expertise in the latest biotechnologies that will impact animal production.

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