POULTRY RESEARCH IN THE POST-GENOME ERA

Eric Wong

The completion of a draft sequence of the chicken genome provides another powerful tool for poultry scientists. The challenge will be to utilize this information for improving avian growth, reproduction, and health. Clearly, the integration of all of the current resources (genetic and physical maps, QTL markers, EST libraries and microarrays, whole genome sequence, and proteomics) will be key to unraveling the molecular mechanisms that control complex biological systems.

The genome sequence should facilitate studies of functional genomics that aim to identify genes and their regulatory elements, the encoded gene products and the gene expression patterns for various metabolic processes. For the molecular biologist, no longer will chicken genes need to be cloned by the laborious process of screening lambda or BAC libraries; instead, the genes can now be “cloned” in silico. In the rapidly developing field of proteomics, the genome sequence will be essential to predict the amino acid sequences of encoded proteins/peptides. With a complete genome sequence, the search for candidate genes that are in close proximity to a marker linked to a desirable trait is greatly simplified.

Poultry nutritionists and physiologists will also benefit from genomic and proteomic technologies. Microarrays and proteome analysis will reveal groups of genes that are coordinately regulated in a metabolic pathway. The complete sequence of the chicken genome will facilitate the search for avian genes. For example, the identification of chicken genes that are involved in nutrient transport can be completed by a search of the avian genome for homologues to known transporter genes from other species. This type of genome scan has revealed that chickens and mammals share many transporters, however some mammalian transporters do not appear to be present in the avian genome.

Avian health is another area that should benefit from the genome sequence. Understanding the cellular genes regulating a host-pathogen interaction will be essential for developing strategies to enhance disease resistance. The development of cDNA microarrays for expression profiling of immune genes will reveal key genes or groups of genes involved in host response to infection. The identification of these genes will lead to the development of healthier birds, which in turn will have a direct impact on food safety issues.

Likely the major advances will come from an integrated approach that combines the genetic and physical maps and EST libraries and microarrays with the whole genome sequence. For example, the approach being used by Hans H. Cheng (hcheng@msu.edu) to dissect the molecular basis for Marek’s disease virus infection involves themapping of candidate genes by QTL analysis, categorizing differential gene expression by microarray analysis, and examining protein-protein interactions using a yeast two-hybrid screen. This multi-faceted approach is most likely to reveal the key genes involved in Marek’s disease infection.

In addition to avian health, human health should also be improved because of advances in avian biotechnology. Transgenic chickens have been long proposed as bioreactors for the production of pharmaceutical proteins for human medicine. Some of the advantages of chickens as bioreactors are that a chicken egg contains approximately six grams of protein, an egg is a sterile container that can be obtained non-invasively, and an industry is already in place for the automated collection and processing of eggs. For these reasons, the development of technologies for generating transgenic poultry has been a major goal.

Two companies, Origen Therapeutics (California) and Avigenics (Georgia), have developed efficient methods for producing transgenic chickens. Both companies have shown that large genomic BAC (bacterial artificial chromosome) expression vectors can be introduced into chicken cells and can express genes of interest from chicken promoters. The advantage of being able to transfer large DNA molecules is the ability to include most if not all of the normal regulatory elements required for tissue-specific expression. Both companies have
already developed transgenic chickens that express human monoclonal antibodies and other proteins into eggs. These successes demonstrate that transgenic chickens represent a viable alternative to transgenic mammals as bioreactors.

It is an exciting time to be working with chickens both as an important agricultural species and as a model system. The number and variety of resources available will greatly facilitate the study of metabolic processes in avian species. These advances in avian biotechnology will ultimately benefit the poultry industry by producing a more economical and healthier bird. Furthermore, the human population will benefit by having a safer food product and a ready supply of egg-derived pharmaceuticals.

Eric A. Wong
Department of Animal and Poultry Sciences
Virginia Tech
ewong@vt.edu