

## **LANDMARK AREA OF EXCELLENCE: BIOMEDICAL GENOMICS**

### **Introduction**

Genomics is a key and rapidly expanding research discipline that is adding new dimensions to the changing structure of modern biomedicine. Animal genomics has witnessed astonishing expansion and diversification during the past decade. The completion of the human and mouse genome sequences sparked enormous interest in annotation of these genomes through comparative analysis. As a result, genome sequences are now available for nearly all major mammalian companion and livestock species, including cattle, pig, dog, horse and cat, as well as biomedical models such as the rat, rabbit, and opossum genomes. Rapid technical and methodological advancements afforded by genome sequence data are providing the means for new areas of research that could barely be imagined just a few years ago. The study and analysis of animal genomes provides new technologies to better understand phenotypes of biomedical and economic importance in these species, while at the same time informing human biology.

### **Significance**

For more than 25 years, Texas A&M University has played a leading role in the analysis of the genomes of livestock species. The current livestock and companion animal genomics program at Texas A&M University comprises nine faculty at the College of Veterinary Medicine and two faculty at the College of Agriculture & Life Sciences. This program is indisputably one of the most robust animal genomics programs in the world. The nationally and internationally acclaimed faculty (National Academy Science member, President/member of international organizations, international awards recipient, Chair/members of national organizations) specializes in cattle, horse, dog, cat, and marsupial genomics. At no other institution are so many diverse species being simultaneously analyzed. Additionally, expertise exists in wildlife genomics (bison, deer, wild cats, etc.), phylogenomics, traditional & molecular cytogenetics, immunogenetics, and bioinformatics. This broad competence is enabling us to maximally exploit emerging genomic technologies for application in all areas of animal health and disease, while at the same time contributing novel information concerning genome structure and function that promotes greater understanding of human genetic conditions that predispose to, or directly cause, disease and developmental anomalies.

The faculty in Animal Genomics forms the backbone of a number of teaching, research and training programs within and outside the University. These include the Biomedical Sciences undergraduate education program (BIMS)), The Professional Program in Biotechnology, The Center for Animal Genomics and Biomedical Research, and The Interdisciplinary Faculty of Genetics. These programs are the pillars of undergraduate/graduate education and research in basic biology and biomedicine at A&M. In addition, the faculty has significant interaction with a number of national and international groups/institutes in many pivotal areas of animal genomics. It is essential to incorporate emerging areas now, target new faculty enrollment, and establish new programs that will propel our program through the next decade and beyond as a benchmark in genomics education and research.

## **Rationale**

The Animal Genomics Program is one of the research showcases of Texas A&M University. Importantly, the impact of this research is not restricted to agricultural and companion animal models. Knowledge gained from research with animal models of many kinds, including agricultural, companion, and wildlife species, has provided and will continue to provide critically important insights into molecular mechanisms of human development, physiology, and disease conditions that simply cannot be studied by experimental means directly in human subjects. This is especially significant in light of growing realization that rodents are not ideal models for many human genetic conditions. With faculty distributed not only within the CVM but also at the College of Agriculture and Life Sciences, the program dynamically interacts within the Interdisciplinary Genetics Program and with departments/institutes within and outside the University System.

Despite the overall excellence and eminence of this program, to maintain the world class reputation of our genomics program will require diligence and a serious commitment to remain among the most prestigious, well-funded and sought-after genomics education and research programs in the world. This can only be achieved by keeping pace with the latest developments in the field and by investing in faculty recruitment and infrastructure that could provide the basis for ground-breaking research and advanced educational initiatives. Such an investment will be critical for:

- maintaining current national leadership and international prominence in animal genomics
- promoting high quality education in this field for students, and an informative/interactive platform for commodity groups
- preserving and expanding longstanding Texas A&M values to conduct cutting-edge research

## **Interdisciplinary Impact**

There is growing emphasis worldwide to understand the molecular underpinnings of individual diseases, study the proximal and global molecular mechanism(s) of disease and disease-susceptibility, and devise improved ways for prevention and treatment. Understanding these fundamental processes and mechanisms requires the acquisition and implementation of a diverse set of skills, technologies and resources that enable investigators and their students to:

- assimilate and utilize available and new sequence data from various livestock & companion animal species,
- perform functional analysis of genomes to focus on improved production, reproduction, disease resistance and overall health; and
- transition research from genomics studies to devise new diagnostic and preventative treatment approaches.

The current depth and breadth of expertise in animal genomics weaves extremely well with the internationally recognized clinics and departments of Small and Large Animal Medicine Clinical Sciences, the Veterinary Medical Teaching Hospital and the Texas Veterinary Medical Diagnostics Laboratory. The synergy arising from the combined strengths of these two programs puts CVM in a unique position to embark on a leadership role in developing bridges between genomics and translational veterinary medical research, as well as with systems biology initiatives planned across

campus and within the new Interdisciplinary Life Sciences Building. Fostering links between these areas will pave the way for the CVM to conduct cutting-edge research that will attract resources from a broader assemblage of state and federal research funding agencies as well as private agencies with interests in livestock and companion animal medicine.

The advancement of the Animal Genomics program will be critical in the philosophical merger of disciplines across campus. It will:

- facilitate increased cooperation through collection and archiving of genetic materials and clinical information as a resource for research
- foster important bonds between the current research, teaching and training programs at the University, bringing together the CVM, COALS, and other colleges and institutes,
- provide a vital interface of genomics research with clinical applications by transferring knowledge gained through laboratory research in genomics to clinics, farms, and animal breeders/owners, barns and stables
- attract new funding from private, state, and federal agencies,
- generate additional interest among diverse student groups for education and training.

### **Indices of Excellence**

Stimulated by the support of the Vision 2020 program, the College of Veterinary Medicine & Biomedical Sciences has added six new genomics faculty positions with expertise in diverse research areas and model organisms, including comparative genomics, molecular cytogenetics, clinical and diagnostic genomics, marsupial genomics, immunogenetics, and most recently, epigenetics. Together with existing strengths in bovine, equine and wildlife genomics, this group of nine core investigators, and their lab units, are among the most productive, collaborative, and internationally visible units on campus. These investigators interact with programs in nearly every College on campus, in addition to scientists at greater than 40 U.S. institutions, and over 30 international institutions. As testament to the strength and international visibility of the CVM Genomics program, the current nine faculty members and their labs have:

- been active participants and leaders in various national & international research endeavors, including four genome projects.
- a consistent record of publications in top-tier peer reviewed international journals (>300 during the past 5 years), including *Science*, *Nature*, *Proceedings of the National Academy of Sciences*, *PLoS Genetics* and *Genome Research*.
- obtained over \$13,000,000 in extramural funding as PI/Co-PI's during the past decade. The bulk of these funds come from the major federal funding agencies; NIH, NSF, USDA, DOE, Dept. Interior, supplemented by numerous private foundations.
- trained 48 graduate students and 20 post-doctoral fellows during the past decade, many of whom hold prestigious positions within and outside the USA. In addition, genomics faculty members train approximately 600 undergraduate students annually. At present, there are more than 50 undergraduate students, graduate students and post-docs training in the laboratories of the A&M genomics faculty.

## **Assessment/Expectations**

Based on the past and present success of the Genomics Signature Program, it should continue to be a strong research and educational component of the CVM. Despite our international strength in genomics, collaborative interactions among programs and Colleges, and strong presence among the Genetics Interdisciplinary Program, two areas of expertise/infrastructure must be acquired to remain a competitive force for extramural funding and to maintain our stature as a leading animal genomics program.

First, the departure of two genomics faculty members, Dr. Christine Elsik and Dr. David Adelson, produced a major gap in local access to bioinformatics expertise for the analysis of animal genomic datasets, as well as educational resources for our undergraduate, graduate and post-graduate training programs. Because of this deficit, we must prioritize a programmatic expansion in computational genomics, particularly genomic sequence, microarray and (single-nucleotide polymorphism) SNP analysis. This expansion requires establishing a group with one senior and two junior faculty members (one with a biostatistics background). The recent drop in cost of next-generation sequencing technologies will soon allow individual laboratories or centers to have genome-center-scale sequencing capacity and datasets relevant to disease and phenotypes of biomedical significance. To capitalize on these emerging technologies will require computational genomics expertise and capabilities that are currently not represented at this university.

Second, as genomic moves from assembling and annotating livestock and companion animal genomes, to population and comparative sequencing and SNP analysis, new research efforts will require access to state-of-the-art Next Generation DNA sequencing technologies and SNP genotyping platforms present in a local core facility housed in the CVM. In addition, the cutting-edge bioinformatics infrastructure and facilities will be necessary to deal with ever expanding data sets that are needed to understand today's complex scientific questions related to susceptibility to genetic and infectious diseases, as well as basic research in many areas including systems biology initiatives. With the Veterinary Medical Research Building expansion underway, and two and one half floors of non-dedicated space, an opportunity exists to create a state-of-the-art integrated bioinformatics and genomics core facility to support CVM and University Initiatives in biomedical research. This plan should include teaching laboratory/computer infrastructure. A technical director and staff will be needed to oversee the facility.

## APPENDIX: PARTICIPANTS

<i>Name</i>	<i>Position</i>	<i>Department</i>	<i>Specialty Area in Genomics</i>
Bhanu Chowdhary	Professor	VIBS	Equine Genomics, Cytogenetics
Gus Cothran	Clinical Professor	VIBS	Equine Genomics, DNA Diagnostics
Michael Criscitiello	Assistant Professor	VTPB	Vertebrate Immunogenetics
James Derr	Professor	VTPB	Wildlife/Conservation Genomics
Scott Dindot*	Assistant Professor	VTPB	Mammalian Epigenetics/Disease Genomics
William Murphy	Associate Professor	VIBS	Feline/Mammalian Comparative Genomics
Terje Raudsepp	Assistant Professor	VIBS	Equine Reproductive Genomics, Cytogenetics
Paul Samollow	Professor	VIBS	Marsupial Genomics, Recombination
Loren Skow	Professor	VIBS	Bovine Genomics, Immunogenetics
James Womack	Professor	VTPB	Bovine/Mammalian Comparative Genomics

\* New hire: Start date January 2009

VIBS=Veterinary Integrative Biosciences

VTPB=Veterinary Pathobiology