

Computer Applications in Genomics:
Visualization, Research and Training



Genomics of Plant Responses
to Environmental Stresses



Development of New Genomics and
Proteomics Instruments



Genomics of Immunity to Infections



Genomics of Seed Development
and Composition

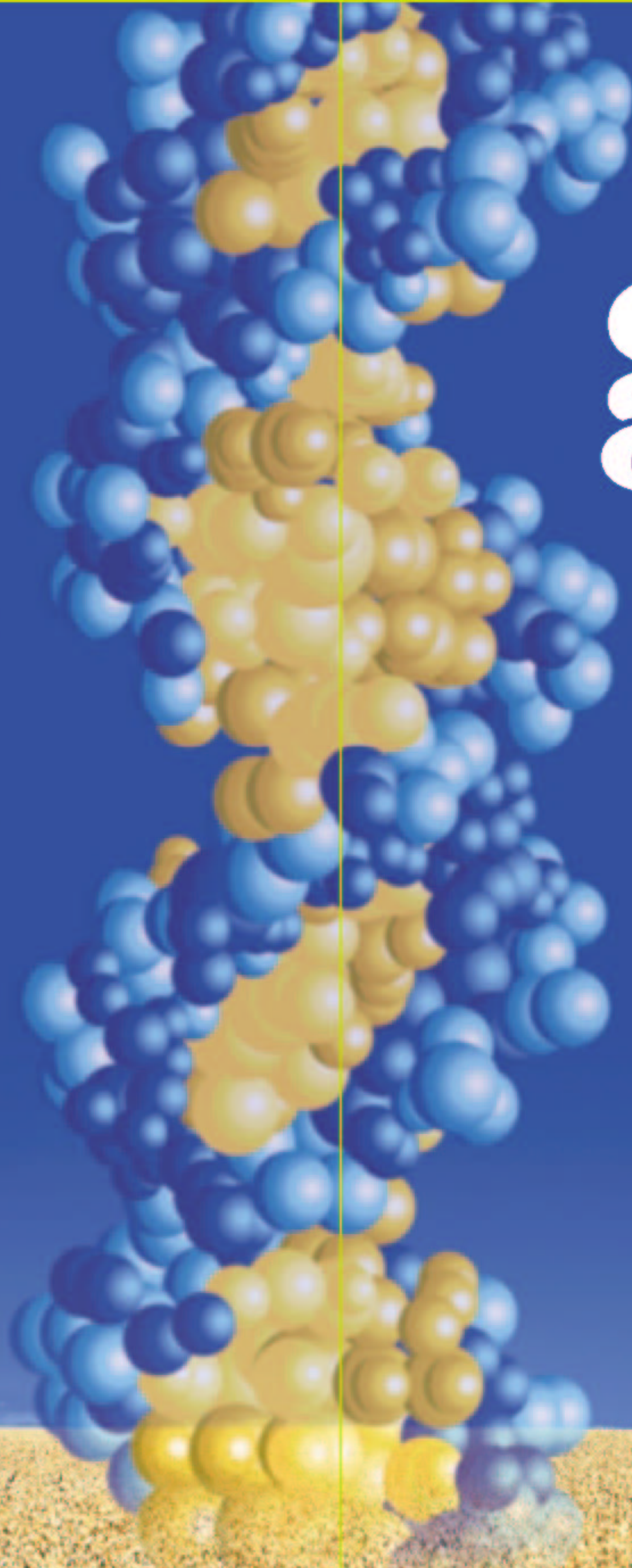


Commercialization and Social Impact
of Genomics



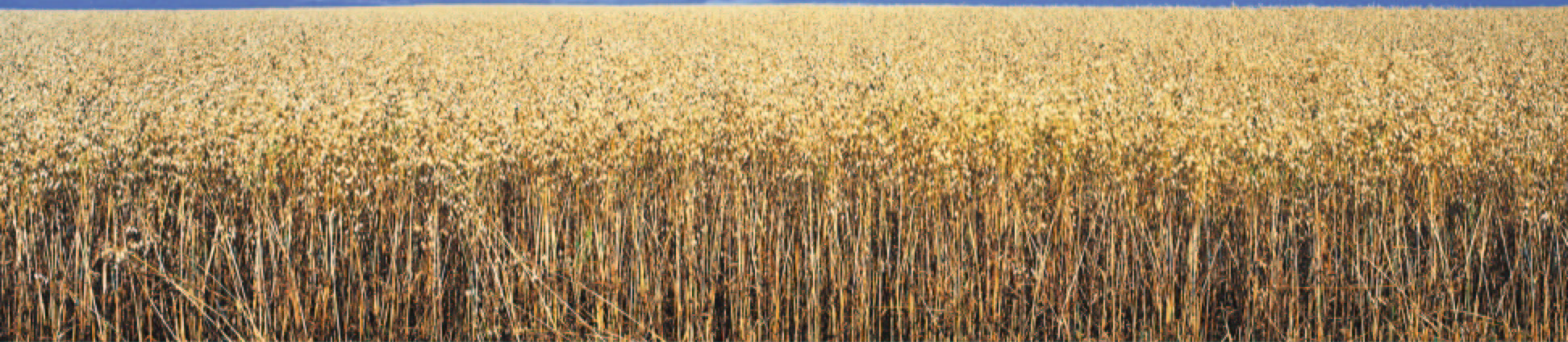
Annual Report
2002-2003


GenomePrairie



"There is nothing more difficult and dangerous,
or more doubtful of success, than an attempt
to introduce a new order of things in any state.
For the innovator has for enemies all those
who derived advantages from the old order of things,
whilst those who expect to be benefited by the new
institutions will be but lukewarm defenders.
This indifference arises in part from fear of
their adversaries who were favoured by the
existing laws, and partly from the incredulity
of men who have no faith in anything new
that is not the result of well-established experience."

*From "The Prince" by Niccolo Machiavelli
as quoted in Nature 418:259(2002).*



A photograph of a vast, flat field of golden wheat stretching to the horizon under a clear, solid blue sky. The wheat is in full bloom, with its heads clearly visible. The horizon line is straight and divides the image roughly in half.

"Canada has become a
major player in biotechnology,
which promises the most radical
scientific revolution since Einstein."

Time Magazine, Special Report on biotechnology, May, 2002

Report from the Chair

Dr. Pete Desai

Genomic research in Canada continues to gain momentum as Genome Canada and the Regional Genome Centers support significant large scale research programs. Genome Prairie now has all its approved projects from competition one and two underway. This has not been an easy task for the management of Genome Prairie, which had to balance the interests of Provinces, the research institutes, the industrial partners and the scientists to get agreements in place. Now we must work with the Prairie scientists to deliver what was proposed in the projects. I have no doubt that we will.

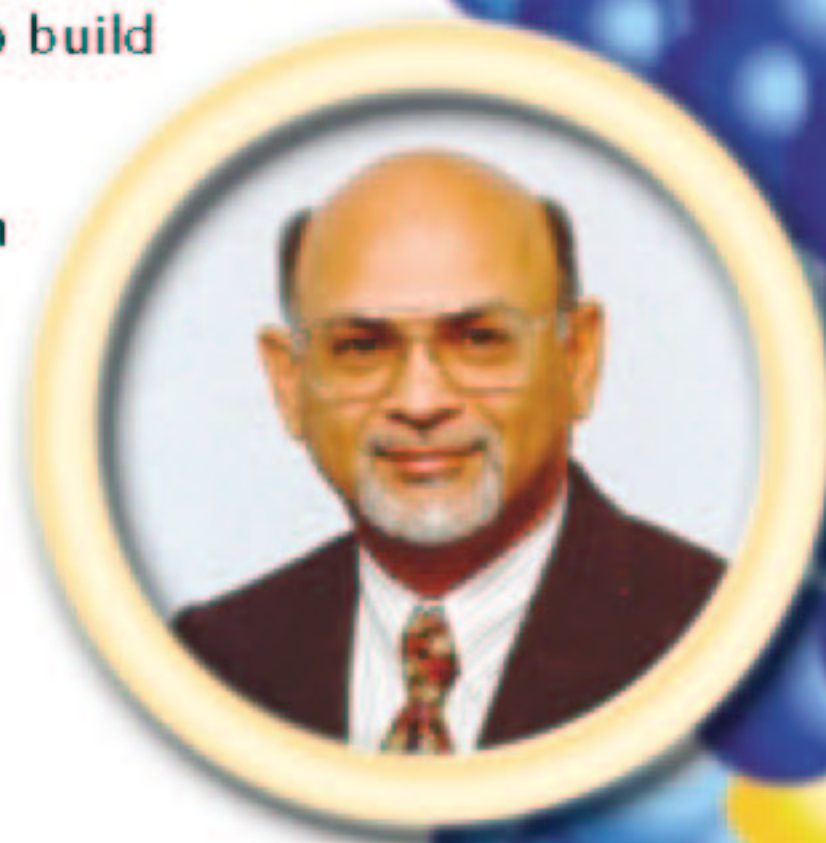
The GP TEAM, under the leadership of Dr. Randy Johnston, President and CEO, has done an excellent job in getting most of the matching funds for the approved projects. Matching funds continue to be a significant issue for operating Genome Prairie's corporate office and progress in this area will help to give stability to the genomic research community in the Prairies.

With the announcement of competition three we are once again in a good position to capitalize on the strength of our research community that is focused on health. This will be an excellent opportunity for our researchers to demonstrate the breadth and depth of the excellent science we do in the Prairies. We must strive to develop strategic projects that are multidisciplinary and national in scope and that will enhance Canada's stature in health genomics. One of the top priorities for the GP Board and GP Team will be, therefore, to find innovative ways to match funds for these genomics proposals in order to build from the strong base of the already approved Genome Canada projects. This will demonstrate that GP adds value to the scientific community and is instrumental in developing a culture that will help build research capacity in the Prairies.

I am looking forward to working with the Board, GP's President/CEO and CSO, and the other Genome Centers to establish Canada as a key player in genomic research.



Pete Desai, Chairman of the Board





President's Report

Dr. Randal N. Johnston



Genome Prairie now has five projects and one technology platform approved and underway, arising from the first and second competitions for funding through Genome Canada. These projects are:

- ***Functional Genomics of Abiotic Stress***, led by Dr. Graham Scoles of the University of Saskatchewan and coordinated together with Genome Quebec
- ***Commercialization and Society: Its Policy and Strategic Implication***, led by Dr. Edna Einsiedel of the University of Calgary
- ***The Development of Enabling Technologies for Proteomic and Genomic Research***, led by Dr. Bill Davidson of MDS Sciex and co-led by Drs. Jed Harrison and Liang Li of the University of Alberta
- ***Functional Pathogenomics of Mucosal Immunity***, led by Dr. Lorne Babiuk of the Vaccine and Infectious Diseases Organization at the University of Saskatchewan and co-led by Dr. Bob Hancock of the University of British Columbia; this project is coordinated together with Genome BC
- ***Enhancing Canola through Genomics***, led by Dr. Wilf Keller of the NRC Plant Biotechnology Institute in Saskatoon
- ***An Integrated and Distributed Bioinformatics Platform for Genome Canada***, led by Dr. Christoph Sensen of the University of Calgary.

Project highlights...

With a total of \$90 million in funds committed or projected for Genome Prairie and its six projects, this is a strong record of accomplishment. We now have the highest average level of funding per project of any Genome Centre in Canada. Among many highlights are the fact that our Pathogenomics project, led by Drs. Babiuk and Hancock, received the largest award in Canada in the second competition. Our GELS project, led by Dr. Einsiedel, and the Enabling Technologies project, led by Dr. Bill Davidson, received the largest amounts of funding in their categories as well. Importantly, we have been able to obtain several major corporate partners for our Phase II projects, including MDS Sciex, Inimex Pharmaceuticals, Pyxis Genomics and SUN Microsystems. A clear area of focus is emerging in agricultural genomics, with secondary strengths in technology development, bioinformatics and GELS research. Among all of the Genome Centres in Canada, our proposals have the greatest level of participation from researchers across the country. While this makes their coordination complex, it also maximizes the strength and impact of the studies we have undertaken. Collaborative efforts with other similar projects across the country are beginning to emerge in several sectors, with Genome Prairie researchers adopting leading roles in the agricultural, GELS and bioinformatics sectors. Much effort is being devoted to the activation of these projects, and for several of them we anticipate the early emergence of products with significant market potential.

More progress...

Clearly we are establishing a strong foundation for our research and development programs, but just as clearly much remains to be accomplished over the next months and years. To help Genome Prairie achieve these goals, we are very pleased to welcome Dr. Gijs van Rooijen, who joined us in January, 2003 as our Chief Scientific Officer.

Formerly with Sembiosys, Dr. van Rooijen brings a wealth of corporate research experience in the plant genomics field to the benefit of Genome Prairie. Other signs of progress for Genome Prairie over the past year include the streamlining of our Board of Directors (from 17 to 9 members) and its renewal with a majority of independent members – this is a valuable step forward in these times of increased attention to corporate governance issues. We have been very active in the realm of communications and public outreach. As evidence of this, participation among aspiring genomics researchers in the Prairies tripled at the Canada-wide Youth Science Fair in Calgary, for which we were one of the local sponsors. Our Communications Officer Donna Coad performed wonderfully in this regard. Finally, we now have a complete set of Project Managers for each of our Projects – a highly talented and diverse group of individuals upon whom much of the responsibility for success will reside.



Dr. Gijs van Rooijen
Chief Scientific Officer

Challenges, opportunities and priorities...

Although most of the matching funds we require for our projects and the corporate office are now in place, it remains as an important challenge to secure the remaining funds we will require from a variety of co-funding partners. In addition, we will be providing assistance to our projects as they navigate the Interim Review process mandated by Genome Canada. Furthermore, the new competition announced by Genome Canada in Applied Genomics and Proteomics Research in Human Health, plus a targeted competition for international projects with Genome Spain, will create new funding opportunities. Thus our priorities over the coming year will be to:

- Secure remaining co-funding for existing projects and corporate office
- Recruit additional research staff for ongoing projects
- Develop international partnerships
- Promote research training & project integration
- Promote public awareness & communication
- Promote translation, commercialization, company creation
- Encourage new project development & funding

As with last year, the extent to which we can achieve these broad goals will place us in a strong position not only to sponsor world-class genomics research, but also to see the emergence of economic, medical and social benefits for the Prairies and Canada. This has been a good year for Genome Prairie. Next year promises to be even better.



Dr. Randal N. Johnston, President and CEO
Genome Prairie

“One of the most far-reaching developments will be the discovery of the genes that cause us to age. Once we understand those genes, we will be able to counteract them... [and] slow down the aging process dramatically. My great-grandchildren might live to 150 and not look very old at the end of it.”

Matt Ridley “Genome: The Autobiography of a Species in 23 Chapters”



GenomePrairie

Communications Officer

Donna Coad



It has been a very exciting adventure in the area of Communications at Genome Prairie, where we collaborate and work closely with Genome Canada and the other Genome Centres in meeting our national goals. Genome Prairie is constantly building new relationships with partners and institutions, cultivating media recognition and increasing public awareness on genomic issues, opportunities and challenges.

Over the past year we focused our outreach activities around a number of initiatives to celebrate the 50th Anniversary of the elucidation by Watson and Crick of the structure of the DNA double helix. We used this opportunity to educate the public in genomics research through articles published in selected local papers and regional magazines, numerous guest speaker engagements throughout the Prairie Provinces, and assisting in organizing and supporting various events. We have been involved in a number of educational programs at the university and high school level and active in judging entries at competitions such as the Aventis Challenge, the Canadian Medical Hall of Fame, and Bioscience Communicators.

Genome Prairie was also a proud co-sponsor of the regional Youth Science Fairs throughout Alberta, Saskatchewan and Manitoba; we provided cash rewards for the winners in each category as well as travel funds for those selected to compete in the National competition. This year the National Science Fair was held in Calgary in May, 2003. We sponsored a social evening for the competitors, provided leaders for the mentorship program and participated as judges. There were nine National winners overall in the genomics category and of those, three were from the Prairie Provinces. (Please visit our website for further information and photos of winners).

Genome Prairie's strategic plans are to continue to build on our relationships, educate the public, and encourage and support our youth of today as promising candidates for our scientists and researchers of tomorrow.



FUNCTIONAL GENOMICS of ABIOTIC STRESS

A major focus of the project is to develop molecular genetic insights into how wheat and canola respond to cold, heat, drought and nutrient stress.

Approximately 25,000 Expressed Sequence Tag (EST) sequences have been obtained from cold-acclimated wheat tissues, with bioinformatics infrastructure in place to initiate analyses of these sequences. The EST set is particularly enriched in transcription factors, protein kinases and other candidates for genes that may function in signal transduction. The wheat group is collaborating with international partners to develop a large micro-array set. Over 250 ESTs of transcription factors from 11 gene families have been identified and investigations are underway to identify those regulated by abiotic stress. Mapping of some of the well-characterized ESTs that may function in cold tolerance is also underway.

The Brassica component of the project is using various genomic technologies to study the effects of abiotic stress in Brassica species and Arabidopsis, whose genome has been sequenced. Three Arabidopsis Serial Analysis of Gene Expression (SAGE) libraries have been constructed to study the cold acclimation response and over 150,000 SAGE tags have been identified. A combination of proteomic and transcriptomic approaches to study abiotic stresses have identified over 200 differentially expressed proteins. The role of abscisic acid (ABA) in the stress response is being elucidated through the isolation of ABA binding proteins and the use of ABA analogs, which can both attenuate and disrupt the ABA signal. Seventy genes with substantially different expression patterns in response to ABA have been identified. Comparison of the gene expression profiles between the Crucifers and wheat should help uncover common regulatory pathways responding to abiotic stresses.



Contact Information:

Dr. Amit Shukla, Project Manager

Email: amit.shukla@usask.ca

[www:genomeprairie.ca/research/abiotic.htm](http://www.genomeprairie.ca/research/abiotic.htm)



Commercialization of genomics research promises many benefits to society, while at the same time raising ethical, environmental, social and legal challenges, some of which have aroused considerable public concern. The nature of these concerns, the regulatory responses and the structures and process for managing the innovation process are the focus of the Prairie GE³LS program.

Accomplishments of the program thus far include:

- **Conceptual model development:** The team has developed theoretical frameworks and conceptual models on topics ranging from consumer perceptions of GM food, the impacts of controversy on innovation, to IP management in research clusters.
- **Policy Inputs:** As members of government committees and organizers of interdisciplinary conferences, members of the project have provided policy input on stem cell legislation, human gene patents, DNA bio-banks, GM food labeling and IP management.
- **Linking with Genome Prairie:** The GE³LS program has initiated 4 small project grants to look at agricultural genomics issues associated with Genome Prairie science projects. As well, the science projects are under examination as test cases in the GE³LS work on IP management.
- **Collaborations:** The project has built relationships with the Stem Cell Network, the Canadian Institutes for Health Research, the Innovation Systems Research Network, and the GE³LS programs in BC, Ontario, and Quebec.

The GE³LS project is built on the premise that genomics research and its resulting technological applications are unavoidably embedded in a social and political context. Including opinions from the public sphere, understanding the implications for regulatory systems, and analyzing innovation networks are thus critical components of commercializing genomics technologies in ways that are most appropriate and beneficial to Canadians.



Contact Information:

Jennifer Medlock, Project Manager

Email: jemedloc@ucalgary.ca

[www:genomeprairie.ca/research/GE³LS.htm](http://www.genomeprairie.ca/research/GE³LS.htm)

The rapid escalation of activity in genomics research has been sparked by the introduction of advanced technology such as automated DNA sequencers. The emerging focus of 21st-century biology is shifting to the large-scale analysis of entire cellular proteomes. Technologies that enable researchers to do more, faster, must be developed that provide the depth of information demanded by such studies. Through the Enabling Technologies (ET) Project, research groups from MDS Sciex, Advanced Integrated MicroSystems (AIMS) and five Canadian universities are creating innovative tools that extend the bioanalytical capabilities of scientists in the fields of genomics and proteomics. MDS Sciex, a world-leading manufacturer of mass spectrometry products, acts as the lead research organization for the ET Project.

The expertise within this unique collaborative effort is directed at the bottlenecks of sensitivity, accuracy, speed, and throughput that currently limit the determination of cell function. Project areas target the development of technologies that advance instrumentation science relating to protein analysis, and that can become available to proteomics researchers in the near future. The first set of technologies relates to new methodologies for processing low levels of proteins, focusing on the use of microfluidic platforms to process samples prior to mass spectral analysis. The second set of technologies expands the power of mass spectrometry in proteomics research. High performance mass spectrometers are being developed with greater sensitivity, mass range, and resolution than current systems. Each component will lead to commercial products within 3-5 years.

The provision of enabling tools for proteomic research will have scientific, social, and commercial impact in the Prairie region and across Canada. Canadian scientists will have access to these state-of-the-art technologies to support their research. The tools' capabilities will advance scientific research, and hopefully lead to more effective therapeutics and diagnostics in a reduced time frame. The creation of new business opportunities based on these technologies will foster job creation, and the project research will itself lead to the training of highly qualified personnel. The success of this project will help establish Canada, and Canadian research institutions, as world leaders in bio-analytical research.

Contact Information:

Dr. Chris Dambrowitz, Project Manager

Email: Christopher.dambrowitz@sciex.com

www.genomeprairie.ca/research/eabletech.htm





Infectious Diseases cost the livestock industry billions of dollars annually and are responsible for one third of all human deaths worldwide. The majority of these pathogens often initiate infection through the mucous membranes lining the respiratory, digestive and reproductive systems. The Functional Pathogenomics of Mucosal Immunity (FPMI) project is focused on addressing these important social and financial issues by increasing the global understanding of mucosal immune responses against disease agents. To achieve this goal the project has been building the necessary research team and infrastructure. The project's principal investigators, Lorne Babiuk (Director of Vaccine and Infectious Disease Organization) and Bob Hancock (Director, UBC Centre for Microbial Diseases and Immunity Research) oversee a group of internationally recognized researchers at the University of Saskatchewan, the University of British Columbia and Simon Fraser University. Their research is the basis of several recently published scientific manuscripts on mucosal immunity. In addition, the corporate partners, Pyxis Genomics and Inimex Pharmaceuticals, continue to be recognized as leaders in animal and human health respectively. For example, Maple Leaf Foods chose Pyxis Genomics to initiate a food traceability project and Inimex Pharmaceuticals was selected as one of Canada's top 10 Life Sciences investments by an international panel of experts.

In the upcoming year we will continue to pursue the project's ultimate goal: the development of new and effective strategies for improving human health, food safety and the economic viability of the livestock industry worldwide.



Contact Information:

Dr. Paul Hodgson
Project Manager

Email: paul.hodgson@usask.ca
www.genomeprairie.ca/research/immunity.htm
or www.pathogenomics.ca



Ms. Bernadette Mah
Project Coordinator

Email: bmah@cmdr.ubc.ca
www.genomeprairie.ca/research/immunity.htm
or www.pathogenomics.ca



The goal of this project is to develop and employ genomic tools in the studies of seed development and composition in Brassica oilseed crops. The acquired knowledge will also be applied to other important crops such as cereals and pulses.

Researchers from the National Research Council and from Agriculture and Agri-Food Canada will collaborate to achieve various objectives. Under the theme of seed development, long-term objectives include canola seeds that: (1) have superior characteristics using insights from transcript profiling and functional genomics; (2) mature more rapidly and avoid frost damage; (3) mature synchronously; and (4) have seed coats of reduced thickness or that are more amenable to mechanical separation, allowing an increase in meal quality.

Under the theme of seed composition, research is targeted to the production of canola seeds that: (1) have carbon partitioning modified to over-accumulate the most valuable seed storage compounds; (2) accumulate novel or improved proteins at high levels; (3) accumulate specific fatty acids, triglycerides or complex carbohydrate profiles ideally suited to high-value niche markets; (4) have increased levels of desirable micro-nutrients; (5) have reduced levels of anti-nutritional compounds; and (6) accumulate novel compounds of commercial value.

Within three years we expect this project will lead to a better understanding of seed development and composition in Brassica species. The new knowledge will reinforce Canada's strong position in crop genomics and will permit the application of new discoveries to agricultural production and industries in Canada.



Contact Information:

Dr. Faouzi Bekkaoui, Project Manager

Email: Faouzi.bekkaoui@nrc-cnrc.gc.ca

www.genomeprairie.ca/research/crop.htm

Bioinformatics Platform for Genome Canada

Our Bioinformatics platform builds on existing infrastructure, including the Canadian Bioinformatics Resource (CBR) and the Calgary-based Sun Center of Excellence for Visual Genomics.

Research is underway on our main scientific goals. BioMOBY will focus on ensuring that the accessibility and usefulness of biological data is maximized through the creation of common formats for both representation and data distribution. To date, this standardization has not been developed in the biological research arena and with the increase in the amount of data available, standards and common formats will be necessary. Our second scientific goal is the visualization of complex genomic features (Bluejay and Genquire). A test version of the Bluejay software is expected to be released by the Fall of 2003.

Over the next few years the platform will install a computing GRID in which networked computers from many sites in Canada will appear to function as a single computer. At the University of Alberta, we have established a help desk and custom programming facility that began operating in April 2003 and will assist other genomics research projects in Canada.

The project features a major training component. Two Bioinformatics workshops are planned per year. Our first workshop was held in Calgary on June 7-15th, 2003 and attracted 20 researchers from across Canada. A second workshop will be held on November 29th to December 7th, 2003 in Eastern Canada. The courses are structured to enhance the knowledge and skills of wet-lab genome researchers who have a basic understanding of computational biology and programming skills.

The goal for the platform is that all Genome Canada researchers will be able to access and benefit from the platform including utilizing the GRID, adopt the standards recommended by the BioMOBY consortium, and access the software components through our platform website. In addition, we want to train over 100+ Canadian researchers in the area of Bioinformatics and provide continued support and guidance through the Help Desk.



Contact Information:

Nancy Hudak, Project Manager

Email: nancy.hudak@coe01.ucalgary.ca

www.genomeprairie.ca/research/bioplatform.htm



Board of Directors

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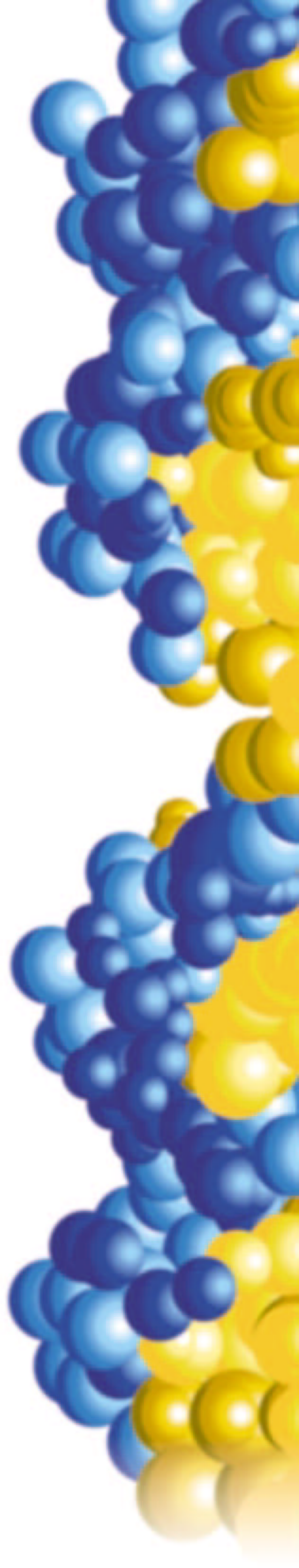
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Section of Cell & Development Biology
University of California, San Diego

"It's almost a cliché to say it,
but it's true nevertheless that
understanding the genome
will completely change medicine."

James Watson, Nobel Laureate, 2003"





Executive and Staff

Dr. Randal N. Johnston
President and CEO

Dr. Gijs van Rooijen
Chief Scientific Officer

Donna M. Coad
Executive Assistant / Communications Officer

Project Teams:

Development of Enabling Technologies
Dr. Chris Dambrowitz, Project Manager

Enhancing Canola through Genomics
Dr. Faouzi Bekkaoui, Project Manager

Functional Genomics of Abiotic Stress
Dr. Amit Shukla, Project Manager

Functional Pathogenomics of Mucosal Immunity
Dr. Paul Hodgson, Project Manager
Ms. Bernadette Mah, Project Co-ordinator

Genomics: Ethical, Environmental, Economic,
Legal and Social Issues
Ms. Jennifer Medlock, Project Manager

Integrated and Distributed Bioinformatics
Platform for Genome Canada
Ms. Nancy Hudak, Project Manager
Ms. Sophie Chung, Training Co-ordinator

Consulting Staff Members

K. Gregory Senda
Legal Counsel
Peterson & Purvis

Beverley Sheridan
President
Technology Now

James J. Szarko
Chartered Accountant
James J. Szarko Prof. Corp.

Jean-Francois Forget
Accountant
James J. Szarko Prof. Corp.

Diane Bender
President, People Interactive Learning
Network Inc.

Major Funding Partners 2002-2003

Agriculture and Agri-Food Canada
Saskatoon Research Centre, Saskatchewan
and Lethbridge Research Centre, Alberta

Alberta Network for Proteomics Innovation
Calgary, Alberta

Alberta Science and Research Authority
Edmonton, Alberta

BioTools Incorporated
Edmonton, Alberta

Genome Canada
Ottawa, Ontario

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Montréal, Quebec

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Plant Biotechnology Institute, Saskatchewan
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Pyxis Genomics Inc.
Chicago, Illinois, USA

Saskatchewan Agriculture and Food
Regina, Saskatchewan

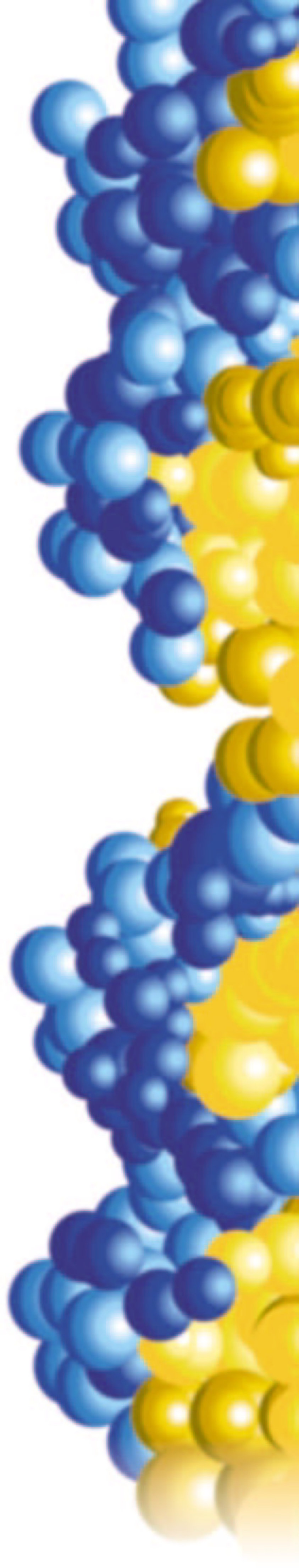
Sun Microsystems of Canada Inc.
Markham, Ontario

University of Alberta
Edmonton, Alberta

University of British Columbia
Vancouver, British Columbia

University of Calgary
Calgary, Alberta

Western Economic Diversification Canada
Edmonton, Alberta





Corporate Information

Genome Prairie

Suite #115, 3553 – 31 Street NW
Calgary, Alberta
T2L 2K7

Telephone: (403) 503-5220

Facsimile: (403) 503-5225

E-mail: info@genomeprairie.ca

Website: www.genomeprairie.ca


Auditors

KPMG

Suite #1200, 205 – 5 Avenue SW
Calgary, Alberta T2P 4B9

Annual General Meeting

June 25th, 2002, Winnipeg, Manitoba

A full-page background image showing a vast, flat field of golden wheat in the foreground, stretching to a distant horizon. The sky above is a deep, clear blue with a few wispy clouds near the horizon.

"Genetics will be the dominant
language of this century.
Those who can 'speak it' will
acquire direct and deliberate control
over all forms of life.
But most countries and individuals
remain illiterate in what is
rapidly becoming the greatest single
driver of the global economy"

*Juan Enriquez Cabot, Director
Life Sciences Project at Harvard Business School
In "As The Future Catches You" (2001)
Crown Publishing, New York*