

Extending Horizons

University of Saskatchewan Research, Scholarly and Artistic Landscape

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Executive Summary

This document is the outcome of a key commitment made in the *Research, Scholarly and Artistic Work (RSA) Foundational Document*, approved by University Council in January 2004, to undertake a process to identify institutional areas of research, scholarly and artistic strength and promise. Such an initiative was intended to provide the University community with a unique opportunity to describe its research, scholarly and artistic work landscape, to identify and build upon synergies across areas, and to celebrate outstanding achievements. The result is more than just an overview of research, scholarly and artistic activity. The process has resulted in an identification of areas of strength and promise at the University of Saskatchewan which are articulated within five thematic areas. The main groups and subgroups are summarized below.

Culture and Society

University of Saskatchewan research, scholarly and artistic activities in Culture and Society examine who we are as individuals, civilizations and nations in order to advance knowledge of society and the human condition, and contribute to the development of our institutions and culture. Sub-themes of this area are: Society in a Global Context, Creativity and Innovation in the Arts, Institutions and Society, and Humanities and the Foundations of Learning.

Indigenous Peoples

One of the key goals of the University of Saskatchewan is to recognize and acknowledge the importance of our province's Aboriginal population to our past, present and future, and to develop programs that reflect and celebrate the diversity of Aboriginal cultures. Areas of study in this group include: History and Social Justice, Health, Administration and Business, and Education.

Frontiers of Science and Technology

Innovations in science and technology have had a profound impact on our lives and the world in which we live. Today, this rate of change is exponential, and expertise in science and technology even more critical. Researchers at the University of Saskatchewan are at the forefront of several broad and interdisciplinary areas of scientific investigation: Discovery and Reasoning, Synchrotron Science, Materials Science, Social Contexts for Technology, Information and Communication Technologies, and Biotechnology.

Human and Animal Health

The health of a community and a nation can be gauged by the strength of their health care system, both in clinical practice and in medical research. The University of Saskatchewan has the largest range of health-sciences research in Canada including: medicine, nursing, pharmacy and nutrition, dentistry, kinesiology, clinical psychology, physical therapy, and veterinary medicine. This research is classified under five major themes: Public and Community Health and Wellness, Infectious Diseases, Chronic Diseases, Reproductive Health, and Molecular Design and Drug Development.

Environment, Resources and Sustainability

The environment is a foremost area of concern in today's society. Scholars across campus are undertaking critical fundamental and applied research to increase our knowledge of the environment and the complex interaction of evolving physical and man-made systems in order to improve the management of our natural resources and to inform public policy. The University has identified four broad areas of expertise: Resource Management and Public Policy, Sustainable Agriculture, Alternative Energy, and Earth Systems Science, Climate and Environmental Change.

Introduction

As part of today's global community, institutions and individuals alike feel the ripple effects of events taking place around the world. Interconnected economies, technological advances, global health and environmental issues, and a shift in government funding toward more targeted research initiatives require Canadian universities to become increasingly innovative. The University of Saskatchewan's future success depends not only on how well we create and share knowledge, but on how we define and advance our distinct research, scholarly and artistic landscape within the national and global academic community.

Since the University's inception nearly 100 years ago, the process of growth and renewal has been rooted in the very landscape in which we live, the communities we serve, and the strong sense of place that the people of Saskatchewan have for their province. The University of Saskatchewan recognizes the important connection between quality academic programs, strong teacher–scholar models, and internationally recognized research, scholarly and artistic activities. Our continued relevance to the community and our success nationally and internationally will be based on how clearly we identify our areas of strength and promise, how proudly we champion them, and how well we develop the infrastructures needed to support them.

The purpose of this document is to define the University's research landscape by identifying our areas of strength and promise. It is also a call to share our achievements, build upon our successes, capture synergies among disciplines, and in doing so recognize the breadth and diversity of research, scholarly and artistic activity at the University of Saskatchewan.

Extending Horizons is the result of an intense, university-wide consultation process, which began in December 2004 with the formation of the Advisory Committee on Areas of Research, Scholarly and Artistic Strength and Promise. With consultation from the Committees of Council (Planning, Budget and Research, Scholarly and Artistic), the Associate Deans Research Committee and the Deans forum a process and broad consultation strategy was developed to engage the academy to gather information on areas of strength and promise, based upon defined indicators and evidence. The committee received over 150 submissions from across campus. These were compiled, reviewed, analyzed, and edited to form the backbone of this document, which then underwent extensive honing and revision, guided by the appraisal of the various committees mentioned previously as well as faculty from across campus. As a living document, it will be continually reviewed and updated to reflect new achievements, collaborations and areas of strength and emerging strength.

Extending Horizons outlines the research, scholarly and artistic activities of five broad research clusters and their subgroups—Society and Culture; Indigenous Peoples; Frontiers of Science and Technology; Human and Animal Health; and Environment and Natural Resources. Within an increasingly diverse community and global research landscape, the University of Saskatchewan must continue to build synergies and continue to develop areas of promise within these key areas of research, scholarly and artistic achievement.

1. Culture and Society

Understanding and celebrating who we are as individuals, societies and nations is fundamental to the study of the arts, humanities and social sciences. Scholars in the social sciences contribute to building civil and sustainable civilizations by investigating—and providing insight into—the ways in which we structure our relationships, institutions and societies. Broad issues of social concern such as government, education, legal systems, and public policy are fundamental components of the social sciences. Scholars in the humanities and fine arts provide complementary insight into the history and mores of world cultures. U of S scholarship in Culture and Society defines areas of strength and promise that will advance knowledge of society and the human condition, and contribute to the development of our institutions and culture in the 21st Century.

1.1 **Society in a Global Context**

In a rapidly evolving global environment, humanities scholarship and research is increasingly fundamental to understanding cultural differences and societal change. U of S faculty members working in intercultural discourse, literature and language analysis study the organization of language beyond the clause or sentence, in such contexts as conversational exchanges and written texts. Today, this area of scholarship is particularly important in analyzing texts that originate from a culture foreign to the reader, and it emphasizes the use of language as a social action, tied to social relations and identities, power, inequality, and art. Group research includes cross-cultural dialogue, literary analysis, theory and practice of translation, second-language acquisition, digital text studies, and the construction of identity and gender.

At the University of Saskatchewan, scholarship in women's and gender studies incorporates diverse disciplinary perspectives—historical, anthropological, curatorial, literary, and sociological, with particular strength in cultural studies and health-and-body studies. In the area of gender and sexuality, U of S scholars have expertise in Victorian Britain, modern Canadian history, crowd psychology and masculinity, and the history of medicine and gender, particularly the gendered nature of health care. University faculty in women's and gender studies are active in public policy development through work with the National Network in Environment and Women's Health, the Canadian Institutes of Health Research (CIHR), the Canada Council, and the Social Sciences and Humanities Research Council (SSHRC). U of S researchers have partnerships with immigrant organizations, health centres, professional associations, and international women's organizations. Research in women's and gender studies has strong ties to research in the Aboriginal Peoples cluster through collaborations with the Aboriginal Healing Foundation, the Family Healing Lodge and tribal councils.

Defining the University's research, scholarly and artistic landscape in a global context involves recognizing its commitment to fostering a strong sense of place, and to serving the people of Saskatchewan whose identity is rooted in the history of the Canadian West. U of S scholarship in Great Plains research supports and complements key university initiatives in environmental studies and public policy. Scholars have mapped the history of the province from the earliest days of European settlement to the present, and their expertise in public policy, particularly relating to Saskatchewan's economy, is nationally recognized. Work in the area of political studies is fundamental in contextualizing the western experience within broader issues of Canadian government democracy and public policy. Great Plains research involves collaborations with the scientific community, community-based organizations and Aboriginal organizations, and is also important to trade, ecological, and cultural exchanges with the United States. Faculty members in this area have authored several noted books, including

Saskatchewan: A New History, in celebration of the province's centennial; *Minding the Public Purse* on Saskatchewan public policy; and *On the Great Plains*, which won the President's Book Award of the Social Science History Association. Great Plains research complements and strengthens research in the Native–Newcomer area, and has made the U of S a leading institution for scholars in these fields.

University researchers are examining the issues surrounding immigration, race, ethnicity, and diversity. Researchers in sociology, economics and political science have produced ground-breaking work on the economic performance and contributions of Canadian immigrants, and are exploring issues related to integration of immigrants with the broader population and the experience of minority groups with societal institutions. U of S faculty are key participants in the Prairie Centre of Excellence for Research on Immigration and Integration, and in the Metropolis Project—a SSHRC funded national centre of excellence. From a different perspective, U of S psychologists study social and psychological aspects of immigrants' integration into Canadian society. In particular, they are investigating the role of schools and families in helping refugee and immigrant children to adjust to a new socio-cultural environment, as well as the difficulty immigrants experience in obtaining recognition for foreign credentials and work experience. Others working in the area of inter-group relations have been examining how the strength of cultural and national identities relates to discrimination, cultural incompatibilities and multiculturalism. Investigators are also pursuing the nature of basic numerical and arithmetic skills and the origins of cross-cultural educational differences in arithmetic performance in linguistics and social practice.

Social scientists at the University of Saskatchewan contribute to public and academic dialogues related to international studies and globalization. Faculty have established expertise in subjects such as human trafficking, labour and global capital. A core of scholars in the humanities and social sciences are exploring issues related to democracy in the international arena. Research includes studies on transitions from authoritarian rule to electoral democracy, management of resources in regional societies, and the impact of federalism and regionalism on the move to democracy. Social science departments have fostered international links through both their research and undergraduate and graduate programming initiatives, such as the new joint M.A. in Sociology with Xi'an Jiaotong University.

1.2 Creativity and Innovation in the Arts

Since the beginning of recorded history, societies have been defined, distinguished, celebrated, and commemorated by their musicians, artists and storytellers. The fine and performing arts help to shape the character of individuals and communities, and provide modes of reflection with which to contemplate and question social, cultural and technological change. The University of Saskatchewan is recognized nationally and internationally for academic programs and achievements in the fine and performing arts. For example, the University has received external recognition for the strength of its scholarship in art history, particularly with respect to First Nations, Western Canadian and post-colonial studies. The U of S has developed cooperative ties with Tribe, the acclaimed Aboriginal artist centre in Saskatoon, as part of a mandate to develop inter-social understanding and respect for all forms of identity, and to ensure that the University's research landscape includes all areas of the visual arts community in the province. Faculty have exhibited in and curated national and international exhibitions at galleries in the community, and the international art journal *BlackFlash: Lens, Site, Scene* is published by U of S faculty and students.

As a leader in interdisciplinary theatre scholarship, the University of Saskatchewan was first in the British Commonwealth to offer a distinct degree in theatre arts, integrating performance and academic training. Faculty expertise in drama includes criticism and theory, theatre history, playwriting, dramaturgy, acting, directing, voice and movement, production management, set and costume design, lighting and sound. U of S faculty members have fostered the creation of nationally renowned

professional theatre companies (Persephone, Twenty-Fifth Street House, and Dancing Sky) and have received multiple national theatre awards. A testament to community engagement, the City of Saskatoon supports five alternative theatre groups that provide performance venues for young artists. In music, U of S scholarship encompasses traditional Western music, jazz history, popular music history, West African music, and World music. The Saskatoon Symphony Orchestra and the Saskatoon Jazz Society have also evolved from the University's dynamic performing arts programs. Composers, performers, musicologists, and music educators work collaboratively to train students.

1.3 Institutions and Society

The province of Saskatchewan is renowned for setting innovative public policies that are now fundamental to the fabric of our nation. The University is home to many outstanding senior and emerging scholars in public policy in several disciplines and departments. In a province of diverse communities—rural, remote, urban, Aboriginal—the U of S has established a national reputation for community–university research partnerships involving social sciences, health sciences and humanities, as well as other sciences and professions, and for contributing knowledge that supports community agencies and institutions working in these disciplines.

University faculty have produced critical research and public commentary on the historical background to contemporary events, with particular expertise in international relations in the Pacific Region, as well as the politics of the Cold War and modern Europe. Changes occurring within societies around the world—whether economic, social or technological—have put increasing pressure on public and private institutions and authorities to create new models for policy development that ensure community input and public accountability. U of S expertise in public policy and governance focuses on policy development at the global, continental, national, local, and organizational levels. Research in public policy includes decisions regarding the allocation of resources, entitlements and benefits, and the regulation of individual and collective behaviour. The study of governance entails the processes and systems by which public policies are made, including systems in both non-profit and for-profit sectors. Faculty in these areas include a number of former elected officials, including two premiers, a provincial finance minister and Canadian authority on fiscal management in government and federal–provincial relations, a number of past deputy ministers, and a provincial assistant deputy minister.

Around the globe in developed and developing nations, democracy is a central issue of the 21st century. U of S political studies scholars examine democracy through several thematic lenses: Aboriginal–state relations, political identity, federalism and regionalism, ethnicity, state–civil–society relations, corruption, and community development. Research areas of expertise include the reconciliation between Indigenous and non-Indigenous peoples in Canada and around the world; the transition to electoral democracy from authoritarian rule in Latin America and the Caribbean; nationalism, ethnic conflict and state–minority relations; and democracy, diversity and development in Melanesia, East Africa and Ethiopia.

Scholarship in human geography and agricultural economics has become increasingly important in helping governments and policy-makers bridge the growing rural–urban divide. U of S researchers are working to solve problems essential to the human dimension of cities and society. Their work spans Aboriginal studies, population geography, behavioural geography, economic, social and health geography, and urban dynamics and regional planning. U of S researchers have participated on the Urban Research Team for the Royal Commission on Aboriginal Peoples, provided expertise for annual population estimates for the City of Saskatoon, and created an Internet atlas of urban Aboriginal people. On the opposite side of urban–rural dynamics, University of Saskatchewan research activities focus on the evolution of prairie communities, rural population and labour force dynamics, and rural economic

restructuring—offering a framework for place-based rather than person-based or industry-based policies. Research contributions in rural, regional and place-based economies have been influential in public policy development in agriculture, rural development, transportation, and public service delivery locally and throughout North America. U of S faculty have participated in several national policy-making conferences on Aboriginal issues, and they have close links with research in the Aboriginal Peoples research cluster.

Co-operatives and producer associations have historically played an integral role in Saskatchewan's agricultural and rural economy by helping local residents adapt to changing economic and social conditions. The Centre for the Study of Co-operatives at the U of S is a world-leading teaching and research institute devoted to studying the contributions and potential of co-operatives in Canadian economy and society. The Centre's broadly interdisciplinary research involves colleges and departments across campus. International partnerships include academic, governmental and community-based organizations (CBOs) in the US, Europe, China, Brazil, Sri Lanka, and Mongolia, and involve nearly 20 universities and institutes in Canada. The University of Saskatchewan engages in community–university applied research at the local level, with the goal of enhancing the social, economic and cultural vitality of our communities. The U of S Community–University Institute for Social Research (CUISR) has developed partnerships with 51 community-based organizations and government agencies. Internationally, faculty have served on regulatory bodies and have helped to develop training programs for nascent farming associations in China as part of a Canadian International Development Agency (CIDA) initiative, as well as programs for administrators and teachers from China, Korea, Kuwait, and the Ukraine.

Globalization and technology have drastically changed the way society conducts business and the way individuals make their livings. University expertise in the evolving nature of the workplace includes employment law and labour standards, compensation, downsizing, workplace diversity, and changing demographics. Research in entrepreneurship includes agribusiness and small business strategy. In the related area of performance management, researchers are working to develop new tools and techniques to help organizations from small businesses to hospitals, government departments, crown corporations, and educational institutions in planning, decision making, reporting, and performance evaluation. The U of S also conducts interdisciplinary research involving health professionals and the way their workplace is organized, with the goal of providing effective delivery systems that provide high-quality health services to the public and a rewarding working environment for health-care professionals. This research involves ongoing collaborations with the Saskatchewan Medical Association, the British Columbia Medical Association and the Canadian Medical Association. Effective administration and management in any sector requires rigorous accounting practices. In a related area of scholarship, the U of S offers the country's leading graduate professional accounting program (Master of Professional Accounting), and faculty members are recognized for their contributions to developing application-based competency and skills.

Research and scholarly activities in ethics and society confront not only the perennial issues of ethical theory, but concrete social issues such as technological change, Aboriginal justice, and the psychology of sport. U of S faculty studying the social dimension of science and technology have specific foci on biotechnology and society, health and health care, and knowledge utilization. Scholarship in management and marketing includes highly-cited research examining the purposes and effectiveness of visual images in advertising. Faculty have published seminal papers on the dynamics of public transit systems, fare evasion and tax collection. Research in tobacco marketing includes the targeting of youth, consumer perceptions of risk, and sports sponsorship and public policy. Faculty in education, leadership and ethics have been recognized nationally for their work in preparing professionals who provide

leadership in educational infrastructures in the province and beyond, and leadership training for rural, urban and First Nations communities.

1.4 Humanities and Foundations of Learning

University of Saskatchewan faculty in the arts, humanities and social sciences collaborate with researchers in other disciplines in the promotion of traditional and new humanities locally, nationally and internationally. The Humanities Research Unit is home of *The Indigenous Humanities*, an ongoing project to reconfigure relations between Indigenous knowledge and the traditional humanities, providing another important bridge to Aboriginal Peoples research. Another interdisciplinary group of researchers investigate process philosophy and its relationship to science, culture, ecology, society, and education. The distinctive approaches of process thought to the advancement and dissemination of knowledge are particularly appropriate today, when knowledge has become a source of social and economic value.

U of S expertise in the history of science, medicine and environment includes the areas of chemistry, medical experimentation and social reform, medicine and gender, and environmental history. Faculty in history and education have key collaborations with Great Plains research and Aboriginal Peoples research, particularly with Native–Newcomer history, the study of Indigenous peoples of the circumpolar north, and the environmental and medical impact of American nuclear testing on resident Aboriginal populations.

The goals of rigour and fruitfulness in the human and natural sciences assume an understanding of the fundamental epistemological issues of reason, method and experimentation, as well as overlapping metaphysical issues of nature, mind and language. To this end, U of S scholarship in the foundation of human and natural sciences involves research in areas as diverse as experimental reasoning in physics (particularly the physics of dark matter) and brain research, the nature of mathematical reality, mind and its place in nature, and language and its place in the mind. Research in psychology examines the mind as an instrument of rationality and the means by which people can integrate new information with existing belief systems, and analyse facts and arguments that pose challenges to that belief system.

The book has been the vehicle for much of the academic literature upon which disciplines depend in order to advance knowledge. Over the past ten years, University scholars have investigated the implications for knowledge transfer in the shift from books to digital communication. Studying hypertext theory and practice (hypertext adapts texts from the printed page to the digital environment), and the history and future of the book itself as a form of technology, has led to the development of the Humanities and Fine Arts Digital Media Centre and collaborations with scholars and universities worldwide.

The implications of literacy and textuality are the focus of significant scholarly work, including studies of orality and literacy across disciplinary boundaries. Classical, Medieval and Renaissance scholars at the University of Saskatchewan have made major contributions to the history and philosophy of the word through their expertise in the study of ancient inscriptions, medieval manuscripts and early printed books. The University has one of the strongest concentrations of Renaissance and Reformation scholars in Canada.

2. Indigenous Peoples

By the year 2045, it is estimated that Aboriginal people will make up one-third of the population of Saskatchewan. One of the key goals of the University of Saskatchewan is to recognize and acknowledge the importance of our province's Aboriginal population to our past, present and future, and to develop programs that reflect and celebrate the diversity of Aboriginal cultures. Areas of expertise encompass education, health, justice, and Indigenous ways of knowing.

2.1 History and Social Justice

The University of Saskatchewan provides an intellectual milieu where research and teaching are grounded in the history, priorities and knowledge of Saskatchewan's Aboriginal communities, while placing them within the larger framework of the Canadian and global Indigenous experience. Native Studies provides an innovative program that focuses solely on Aboriginal societies, with an emphasis on understanding them from within their own cultural perspectives, rather than from the exogenous approach used in other disciplines. The University of Saskatchewan is nationally and internationally recognized for research in Native–Newcomer history and for the formation of vital outreach programs with Aboriginal communities and organizations to help them benefit from this research. Of significant importance to the U of S commitment to place is the recent work undertaken by native studies scholars focussing on the Métis population in Saskatchewan. University researchers are collaborating with other partners on an ambitious project to collect, map and manage traditional land use patterns with the overall aim of facilitating Métis communities' participation in the regional economy. Faculty members have authored several acclaimed books, including *Shingwauk's Vision*, a history of residential schools, and *Loyal Till Death*, an historical account of Aboriginal participation in the 1885 Rebellions.

The University has a strong commitment to support policy-relevant research devoted to Aboriginal history and social justice. Work in political studies focuses on exploring existing and emerging governance and management structures that impact the lives of Aboriginal peoples, and examines how non-aboriginal and Aboriginal organizations interact. Human geographers are working with Aboriginal people in the urban setting in examining strategies for creating culturally meaningful environments. The *Atlas of Urban Aboriginal Populations* maps changing settlement patterns and a range of social and economic material. Research in both areas is fundamental to ongoing public discussion of Aboriginal self-government. The Indigenous Peoples and Justice Program and the Aboriginal Justice and Criminology Program are integral to the University's research strength in these areas. Faculty in the Native Law Centre at the U of S include a noted Aboriginal human rights lawyer and authority on protecting Indigenous heritage and culture, who served as an expert advisor on UN Human Rights forums and on UNESCO's Experts Advisory Group on International Cultural Diversity. Scholarship in Aboriginal history and social justice complements Great Plains research initiatives.

The discipline of archaeology provides the tools and methodology that help reveal the history and heritage of cultures and societies. The University of Saskatchewan is unique in Canada for its specialization in the archaeology of the northern plains and the boreal forest. The University played a key role in the development of Wanuskewin Heritage Park for the study of northern plains Aboriginal culture. The national heritage park and interpretive centre situated on the South Saskatchewan River showcases 6000 years of Aboriginal history and culture. University research in northern plains and boreal forest archaeology provides links to First Nations communities and non-native communities through the heritage park and public archaeology programs.

2.2 Health

Health care is the foremost concern of most Canadians, and in Saskatchewan, health care for Indigenous peoples is a particular concern. Externally imposed health strategies rarely reconcile biomedical and social-science ways of knowing with Indigenous knowledge systems and understandings of health and wellness. The University of Saskatchewan, in partnership with the University of Regina and the First Nations University of Canada, conducts Aboriginal health research that spans a number of disciplines: medicine, psychology, sociology, epidemiology, anthropology, and education, with knowledge translation a major priority. Key areas include chronic disease, nutrition and lifestyle, Indigenous healing, addiction, mental health, community development, and environmental health. Researchers in this area receive core funding from SSHRC, CIHR and the Saskatchewan Health Research Foundation (SHRF). Since 2002, this joint initiative has funded 24 developmental research partnerships between research faculty and the Indigenous communities. Faculty include an internationally respected elder and teacher and several researchers receiving CIHR and Canada Research Chair awards. Members collaborate with health organizations and First Nations and Métis communities across Canada, and in the US, Australia, Belize, and New Zealand. Recently, a strong cohort of health researchers has emerged in social science. Scholars in sociology and geography are exploring social causes of disease and health among Aboriginal populations and utilizing geographic information systems to better understand spatial patterns of health. Encompassing a historical as well as contemporary dimension, the work of researchers in sociology and geography includes research into body weight, tuberculosis and breast cancer.

2.3 Administration and Business

Aboriginal self-governance and socio-economic development are critical issues in Canada that pose unique challenges and opportunities for our society and educational institutions. Recent trends toward decentralization and devolution of governance to local, regional and Aboriginal communities have enormous consequences for the economic and political development. Scholars at the University of Saskatchewan conduct multidisciplinary research that aims to build understanding about Aboriginal (First Nations, Métis and Inuit) peoples and their identities, rights, cultures, and aspirations in order to help form better policies and to rebuild relationships and communities. Scholars in Aboriginal administration and business have expertise in community development and governance, Aboriginal organizations and management, law and culture, public policy, economic development, Aboriginal justice, business–government relations, women in management, and Aboriginal land claims and self-governance. Much of this research takes place under the auspices of the Centre for the Study of Cooperatives and the Community–University Institute for Social Research, and among scholars associated with the Aboriginal Public Administration Program. U of S faculty have authored key reports for the federal Commission on First Nations and Métis Justice Reform, and co-drafted the Declaration of Indigenous Teachings for 21st Century Civilization, Canadian Council on UNESCO.

2.4 Education

The University of Saskatchewan is recognized internationally for its contributions to Aboriginal education. Programs and research reinforce Aboriginal identity, values and culture in order to assist Aboriginal peoples in attaining their rightful position within society as professionals, leaders and role models. Since the inception of programs in Aboriginal Education—the first in 1961—the University has gained wide experience in the development of courses and programs both *about* Aboriginal education for non-Aboriginal teachers and *for* Aboriginal teacher candidates. The U of S now has several undergraduate and graduate programs in Aboriginal Education, and over 1,500 graduates have become leaders in education, First Nations governance, administration, business, and law. Faculty members

participate on national committees and boards, including the Canada Council on Learning, International Development Research Centre, and the Canadian Aboriginal Language Task Force. A complementary area of study is First Nations and early Canadian literatures, with emphasis on the complex effects of colonialism. This work is key in understanding past social and cultural associations in order to improve present and future relationships. At the U of S, scholarship in literature that reflects these cultural interconnections is an emerging area of expertise. Research includes the interaction of oral and literary traditions and humour in Aboriginal literature, as well as Native–Newcomer literatures, and involves interdisciplinary connections across campus through the Humanities Research Unit.

The area of education and youth is profoundly important for the Province of Saskatchewan and is central to the development of an education system that encompasses matters of race, class, gender, age, and geography. U of S research involves issues of Aboriginal ancestry, education and social justice for children and youth. The group has ongoing collaborations with Saskatchewan Learning to assess community schools in the province; with Saskatchewan Health to study youth gambling; and with the Saskatchewan Teacher’s Federation to examine the transition experiences of beginning teachers. Education research with Aboriginal peoples has a long history at the U of S, culminating with the development of the Aboriginal Education Research Centre (AERC). Researchers examine Aboriginal epistemology, governance and management of First Nations schools, adaptation of instruction, student retention, leadership, cross-cultural education, violence prevention with youth, and literacy and lifestyle skills for children with fetal alcohol syndrome.

3. Frontiers of Science and Technology

Over the past 25 years, advances in science and technology have profoundly changed our lives and the world in which we live. From personal computers to global positioning systems, or from genomics to nanotechnology, every area of society is affected by—and now reliant upon—developments in science and technology. Researchers at the University of Saskatchewan are at the forefront of several critical fields of study in the following categories: Discovery and Reasoning, Synchrotron Science, Materials Science, Social Contexts for Technology, Information and Communication Technologies, and Biotechnology.

3.1 **Discovery and Reasoning**

Inherent in all creative and intellectual endeavours are the processes of reasoning and discovery. In science and technology, these processes amalgamate analytical and creative thinking to produce qualitative and quantitative research upon which discoveries are recognized and acknowledged.

The Cognitive Neuro-imaging Laboratory at the U of S bridges work by psychology’s cognitive neuroscientists (mapping the mind onto the brain) with the Royal University Hospital Medical Imaging Department’s Magnetic Resonance Imaging facility. This laboratory has contributed to the development of new, leading-edge methods for mapping language functions onto neuroanatomy using functional Magnetic Resonance Imaging (fMRI).

The connection between the molecular mechanisms of gene expression and ecosystem functions requires knowledge of the developmental processes that occur within individual organisms. Research in integrative organismal biology takes a systems-level approach to understanding the molecular mechanisms that underlie complex physiological processes and how they interact with information from the external environment. At the University of Saskatchewan this area involves faculty in biology, the basic health sciences, veterinary medicine, toxicology, and the Canadian Food Inspection Agency.

Computational modelling and statistical analysis have become critical tools in all disciplines, and mathematical methods form the basis of most computer applications. U of S research in algebraic structures, model theory and applications facilitates understanding of the natural and technological world. For example, scholars in real algebraic and analytic geometry (RAAG) study geometrical objects arising in connection with the mathematical modelling of natural and man-made objects and processes. The University of Saskatchewan is internationally recognized in this area and has been a key collaborator in the European Research and Training Network RAAG since 1997. Another area of expertise, symbolic and algebraic computation, involves two directions of research: theoretical analysis of algorithms for mathematical computation, and computational methods applied to pure mathematical research. Recent foci include DNA computing, bioinformatics and applications of abstract algebra to mathematical biology.

Research in complex-systems modelling intersects with research in bioinformatics, computational modelling and high-performance computing. The overarching theme is the search for the simple laws or principles behind complex systems. Areas of interest include criticality and phase change (communications networks and chemical, physical and biological systems), statistical modelling (bioinformatics, Internet traffic), dynamic systems (meteorology, oceanography, geophysical and atmospheric processes), risk modelling, and advanced computation. U of S scholars in complex systems modelling have organized workshops and projects for the Banff International Research Station (BIRS) and have served on an international advisory committee for the NATO Workshop on High Pressure Science.

At the University of Saskatchewan the chemical sciences are a broadly based and expanding section of the research landscape that span both traditional and emerging sub-disciplines, including agricultural chemistry, biochemistry, chemical engineering, computational chemistry, environmental chemistry, mathematical chemistry, physical chemistry, and structural biology. Chemistry is concerned with the preparation, characterization and rationalization of materials to picometre sizes—all key aspects of nanoscience. U of S chemistry research involves a comprehensive approach to nanochemistry, and covers the fabrication and characterization of nanoscale molecular materials, as well as the theoretical studies of their physical properties. One area of strength is bio-nanochemistry, which is based on precisely synthesized and well characterized functional biomaterials. At least nine Canada Research Chairs with backgrounds or interests in chemistry have been appointed at the University. Two Nobel Prizes in Chemistry have been awarded to scientists associated with the U of S for innovations in molecular spectroscopy and redox (oxidation-reduction) reactions. The university has received two large CFI grants to establish the Saskatchewan Structural Sciences Centre to support research initiatives in materials chemistry and biomolecular chemistry, areas that involve faculty who are major users of the Canadian Light Source.

The University of Saskatchewan has a long tradition of excellence and innovation in subatomic physics and the related field of radiation physics. Researchers at the Subatomic Physics Institute form a diverse interdisciplinary group that encompasses subatomic theory and experimentation, medical imaging, psychology, anatomy and cell biology, medical and health physics, cancer research, and accelerator physics. Their work overlaps with several other areas in the University's research landscape, including Synchrotron Science and Human and Animal Health. Expertise developed at the Saskatchewan Accelerator Laboratory was instrumental in the decision to build a synchrotron at the University of Saskatchewan.

3.2 Synchrotron Science

When the Canadian Light Source (CLS) opened in 2004, this University of Saskatchewan facility was the largest national collaborative science project in the past 30 years. The only synchrotron light source in Canada, the CLS produces extremely brilliant beams of light using powerful magnets and radio frequency waves to focus and accelerate electrons to nearly the speed of light. Infrared, ultraviolet and X-ray light is shone down beamlines to endstations, where scientists can select different frequencies of the light spectrum to study the nature of matter. When the CLS project was finalized in 1999, only two U of S scientists used synchrotron light in their research. With the completion of Phase I and seven beamlines, that number has grown to over 50 faculty members who work alongside government, industry and academic colleagues from across Canada and the world. The primary research themes of the CLS are materials and molecular science, earth and environmental science, and life science.

Many of the technological advances taken for granted today are a result of basic research driven by curiosity and serendipity (lasers are a common example). Synchrotron light allows scientists to probe the properties of matter down to the atomic and molecular level. One prominent area of basic research involves understanding how electrons move between atoms within peptide molecules (the building blocks of proteins)—a process essential to life. This work has practical potential as well. By adding metal atoms to these peptide chains, electrons can be made to move across the peptides like tiny wires, raising the possibility of creating molecular wires for new kinds of computers and nanotechnology devices.

The U of S and the CLS worked together to recruit two renowned synchrotron scientists who developed a technique known as diffraction enhanced imaging (DEI), which produces images of the body's tissues with much greater clarity than any other method. They are now working with a team of U of S researchers, as well as national and international collaborators, to build the new \$17-million Biomedical Imaging and Therapy (BMIT) beamline. Research outcomes from BMIT could lead to improved diagnosis and treatment of cancer, circulatory and respiratory disease, neurological and behavioural diseases, reproductive dysfunction, musculo-skeletal disease, and dental disease.

The University has recently developed health research groups that have major responsibilities for a number of these beamlines and the research associated with them. Notably, the Molecular Design Group, focuses on macromolecular structure determination with an aim of rational drug design. The group Gene Expression Mapping using Synchrotron Light will combine both advanced beamline technologies with cell and molecular biology to continue to produce innovative discoveries about the interactions of metals within biological systems.

Complementing basic research, the U of S is developing expertise in a host of commercial applications for synchrotron science in environmental science, life sciences, materials science, and pharmaceuticals. In the environmental sciences, University faculty and colleagues from New Zealand are using synchrotron light to observe how microbes, metals and minerals interact. They are exploring bioremediation by harnessing extremeophiles—microbes that thrive in environments that would kill anything else. For example, organisms living inside volcanoes can withstand near-boiling temperatures, high pressure and extreme levels of dissolved minerals. Microbes that thrive in frigid arctic conditions could also be useful in cleaning up groundwater sites in northern mines, where by-products of ore production include arsenic and mercury. U of S researchers are also using synchrotron techniques to track contamination in groundwater from livestock operations, and the movement of toxins from soils to plants to insects and the parasites that prey upon them. In agriculture and food processing, synchrotron light is used to identify where oil protein and starch are concentrated in plant seeds and how plants react to heat and frost, in order to develop improved crops.

Phase II of the CLS project currently underway will add another seven beamlines for academic and industrial applications in six new and distinct research areas. They include micro-characterization of materials using medium-energy X-rays; resonant elastic and inelastic X-ray scattering; high-throughput protein crystallography; a combined elemental and structural micro-probe; a laboratory for micro and nano devices; and biomedical imaging and therapy. Beyond that, new beamlines have been proposed in the areas of ultra-sensitive X-ray absorption spectroscopy for biological applications, hard X-ray scattering for advanced materials characterization and angle and spin resolved photoemission for the study of quantum materials. The CLS and its beamlines represent an internationally competitive multi-user facility that is unique in Canada.

3.3 Materials Science

Materials science is both very basic and very applied—from the study of molecular structure to understanding the properties of materials and how they can be modified by specific manufacturing techniques. The University of Saskatchewan is internationally recognized as a leader in this field for its innovative research and state-of-the-art infrastructure. Along with the CLS, the University houses the Saskatchewan Structural Sciences Centre (SSSC), the Saskatchewan Isotope Laboratory (SIL), the Plasma Physics Laboratory, and the Subatomic Physics Institute (SPIN). Materials research at the U of S is inherently multidisciplinary, involving researchers in physics, engineering, chemistry, geology, the biological sciences, and computer science. University researchers have established world-class beamlines at the CLS, which provide powerful diagnostic tools for materials scientists nationally and internationally. In addition to several electron microscopes and scanning tunnelling microscopes, university facilities include two CFI-funded computer clusters dedicated to this research. U of S faculty include several research chairs with foci in electronic materials and devices, synchrotron radiation, plasma science, and nanotechnologies.

The study of molecular structure is integral to most scientific disciplines. The University's newly created Saskatchewan Structural Science Centre (SSSC) is one of the finest structural science labs in the country, housing a diverse array of spectroscopic technology, including nuclear magnetic resonance, X-ray crystallography, Raman spectroscopy, mass spectrometry, and others. Over 50 U of S researchers use the SSSC in studies ranging from the structure of small molecules to complex biopolymers such as peptides, proteins and nucleic acid.

Electronic materials research focuses on the fabrication and characterization of X-ray photoconductors and photosensitive devices for optoelectronic and medical imaging applications. U of S scientists have expertise in property–structure relationships and superconductivity in high-pressure solids and high-temperature superconductors. This research is both basic and applied, from discovering the mechanism behind why electrons in exotic metals traverse the atomic lattice in pairs (rather than repelling each other) to exploring applications in magnetic resonance imaging (MRI) and power transmission.

Synchrotron radiation and surface science research focuses on the characterization of the electronic structure of complex materials, magnetic systems, strong ferromagnetic thin films and magnetic semiconductors and biomaterials, including the novel research into the use of DNA as a molecular wire. Research in synchrotron nanofabrication is used for applications in microwave circuits used in radio, radar and communications devices. Other areas include materials performance analysis and composite and computational materials, which deals with the development of materials for industrial applications.

Since the establishment of the Plasma Physics Laboratory in 1959, the University of Saskatchewan has been an international leader in plasma physics research. In 2000, research on plasma-based material

synthesis was initiated at the Laboratory, which has since become a major centre for carbon-based materials research, including the synthesis of carbon nanotubes, diamond nanocones, diamond-like coating on polymer films, and most recently, synthesis of tungsten-based nanorods. All of these synthesized materials have significant potential for industrial and medical applications. Carbon nanotube manufacturing techniques are used in the fabrication of ultra-strong fibres. U of S research on coating medical-grade polymers with diamond-like carbon coating is intended to improve the haemocompatibility of artificial blood vessels in cardiovascular surgery. University expertise in diamond nanocone research and ion implantation extends into photonics, where investigations are underway to design and fabricate nanostructures for light emission from silicon and other material. Applications of photonics include telecommunications, information processing, spectroscopy, material processing, robotics, and medicine.

University of Saskatchewan research in isotope science is among the most advanced in the world. Isotopes are forms of a chemical element that have the same number of protons (atomic number) but different numbers of neutrons and different atomic weights. Since the 1970s, isotope science has been driven by technological innovation in mass spectrometry. With recent CFI infrastructure funding, the Saskatchewan Isotope Laboratory (SIL) consists of a suite of seven mass spectrometers, complemented by an ultraclean sample preparation laboratory which allows researchers to use a multi-isotope approach towards problem solving. The study of isotopic variations in elements is a primary branch of numerous disciplines, including earth and ocean sciences, environment and atmospheric sciences, soil and agricultural sciences, archaeology, earth systems science, and medical science. In addition to using isotopes as tracers of natural processes, the SIL is used to measure and date rocks, minerals and sediments. U of S isotope scientists are affiliated with the California Institute of Technology, Harvard University, Pennsylvania State University, the University of Michigan, the US Jet Propulsion Laboratory, NASA, and the US National Oceanic and Atmospheric Administration.

3.4 Social Contexts for Technology

Interaction with technology is now a pervasive and ubiquitous part of daily life, encompassing communications, transportation, commerce, education, employment, and leisure activities. The University of Saskatchewan undertakes prominent interdisciplinary research on people and technology. Research in science and society, technology and health care, cognitive science and neuropsychology, health and sports training, educational technology, intellectual property of digital media, and electronic commerce—all fall under this broad umbrella. In addition, research in computer security and privacy, advanced-learning technologies and human–computer interaction (HCI) relate directly to the interface between people and technology. U of S researchers in HCI have built internationally recognized research programs in next-generation groupware, interaction design, information visualization, and collaborative learning. Faculty have participated in the development of standards for the International Standards Organization, the Canadian Standards Association, and the American National Standards Institute.

The impact of the transformation from a post-industrial economy to a knowledge-based one is particularly significant for agriculturally-based economies like that of Saskatchewan. The University of Saskatchewan is internationally recognized for its contributions to the management of transformative technological change. Researchers in this area are working to understand how ideas are exchanged, how technology is best managed, how new products are marketed, what social structures and relations are required for innovation, and how discourse around new technologies should be carried out. Faculty in technology management have served as principal researchers for the UN Food and Agricultural Organization and the UN Secretariat in Biodiversity.

Advanced learning technologies (ALT) are playing an increasing role in education at all levels. The University of Saskatchewan's Laboratory for Advanced Research in Intelligent Systems (ARIES) is one of the top labs in the world in this field. This research encompasses computer science, human-computer interaction, artificial intelligence, and software-agent technologies to enhance and improve students' learning experiences. Advances in the Internet and Web technology have made possible new techniques and tools to support collaboration at a distance. U of S researchers use methodologies from education, computer science and the social sciences to build software systems and test them on human subjects in realistic learning environments. The University of Saskatchewan, through ARIES, is leading research in Active and Adaptive Learning Objects. University faculty in ALT are involved in two national Networks of Centres of Excellence and the NSERC Research Network LORNET, as well as other federal, provincial and industrial initiatives. The U of S is one of five partner universities in the Learning Object Repositories Network, a major initiative to identify, formalize and sustain e-learning technologies.

3.5 Information and Communications Technologies

Recent advances in computer networks and wireless sensor networks means that the nature of computation is increasingly distributed. However, the models and principles required for working with stand-alone computers do not translate to such complex distributed computer systems. Researchers at the U of S have expertise in three key areas of distributed systems research: applications, infrastructure and programming. This includes real-time distributed groupware, (software designed to allow a group of users on a network to work simultaneously on a project); HCI; scientific computing; bioinformatics; service and content delivery; integration of mobile devices with existing infrastructure; systems performance; and wireless network applications. University faculty are collaborating with the University of Illinois and the University of Paris on research in large-scale multi-agent systems, where software agents, robots or humans are engaged in dynamic, mutual interaction. Research in distributed systems overlaps with—and is integral to—many areas of investigation at the University of Saskatchewan, including HCI and work in the ARIES lab. The U of S has several industrial partners in distributed systems research, including IBM, Hewlett-Packard Labs, TRILabs, and PMC-Sierra.

Computational modelling is now used in almost every research science. It involves formulating predictive models of phenomena that may be difficult or expensive to study in the real environment. At the U of S, research expertise in computational modelling, visualization and analysis spans computer science, synchrotron science, geography, agriculture, and medicine. Today, a major challenge in computing and information systems is that the amount of data generated is often greater than the computational power and capacity needed to store, track and analyse it. In addition, recent advances in technologies such as genome sequencing have resulted in an explosion in the amount of biologically driven data. The University of Saskatchewan's expertise in high-performance computing allows researchers to transform vast amounts of data into knowledge and insight. In a related area, U of S researchers in bioinformatics and computational biology are working to develop novel types of computation and information processing for analyzing, organizing and retrieving biologically-driven data. Research in bioinformatics includes intelligent vaccine design, analysis of gene expression data, plant proteomics, modelling of gene regulation pathways, and DNA editing and descrambling. In addition to significant tri-council funding, researchers have received funding from MITACS, NATO, and Imperial Oil. Bioinformatics research also involves U of S faculty from the Vaccine and Infectious Disease Organization (VIDO) and the Western College of Veterinary Medicine (WCVM). U of S faculty also have expertise in high-performance computing for modelling seismic and satellite imagery data, which more than doubles every year.

Research in information and communications technology (ICT) and intelligent systems (IS) are strategic areas of focus nationally and internationally. The University of Saskatchewan specializes in ICT and IS

research in three major areas: advanced materials and devices (including fabrication of nanoscale structures using synchrotron deep X-ray lithography); information and communication technology (such as ultra-wideband rural communications systems); and intelligent systems (including fault detection and condition monitoring systems). Health and safety applications of this research include real-time detection of water contamination, fault detection in flight systems, technologies for cancer treatment using the CLS, early detection of breast cancer by digital X-ray, and biomedical devices. The Synchrotron Laboratory for Micro and Nano Devices (SYLMAND), currently under construction at the U of S will provide academic and industrial partners with the facilities required to conduct research in micro and nanostructures for wireless communications. U of S research has resulted in three spin-off companies and significant technology transfer.

3.6 Biotechnology

In the broadest sense, biotechnology refers to any technological application that uses biological systems or living organisms to make or modify products or processes for a specific use. In that respect, the University of Saskatchewan has been conducting pioneering research in biotechnology since its inception, with a history of excellence in crop development and animal breeding. Today, biotechnology more commonly refers to processes based on recombinant DNA and tissue culture research. The University conducts globally competitive biotechnology research that is broadly-based, involving faculty in the Colleges of Agriculture and Bioresources, Engineering, Medicine, Pharmacy and Nutrition, Arts and Science, as well as researchers of the CLS, the NRC/Plant Biotechnology Institute, Agriculture and Agri-Food Canada, and AgWestBio, and commercial partners at Innovation Place. Current research in crop management systems and sustainable agriculture primarily carried out through the Crop Development Centre, has biotechnology at its core (section 5.2).

As a result of Canada's strong role in bioresources such as agriculture and forestry, University of Saskatchewan research in biosciences, bio-engineering and bio-processing has major implications for provincial and national economic development. Bioproducts derived from natural or synthetic materials are pivotal to the agriculture, forestry and life sciences industries. Scientists are working on technological advances to add value to these resources, to synthesize or extract new products, and provide more economically efficient and environmentally safe techniques for waste management, the production of biofuels, and both nutraceutical and pharmaceutical health products.

U of S researchers have extensive expertise in environmental microbiology and food sciences, including water and food safety, fermentation science, meat science, food ingredient bioprocessing and analysis, safe food packaging and transport, and cereal and oilseed bioprocessing. Research in biological insect management led to a bacterial control of the sunflower moth, now registered for use in Canada, and the development of fungal control of the coffee bean borer and whiteflies for South America. U of S contributions to the federal government's biotechnology policy over the past 25 years have had significant impact on the national agenda for education, research, trade, regulation, and economics. University research in biosciences and bio-engineering overlaps with other areas of expertise in materials science, energy and sustainability.

University research in tissue engineering involves modelling and control of cellular fluids and the design and fabrication of more sophisticated cell culture media, with the long-term goal of providing an effective tool for regenerative medicine in animals and humans. Research in cell and molecular biology focuses on the understanding of molecular diversity and cell functioning in plants, animals, fungi, and microbes, aided by the University's state-of-the-art research laboratory for DNA sequencing, with advanced imaging equipment and a confocal microscope.

Biotechnology is a transformative technology that raises challenging questions for social scientists and public policy makers. A significant number of U of S scholars are internationally recognized for their social science research on the new bio-economy. Faculty from agricultural economics, commerce, law, philosophy, political studies, and sociology examine innovations in biotechnology, where genetic material is identified and harnessed for commercial or social application, and bioresources are used to enhance environmental sustainability. Along with other scholars in the area of sustainability, they are investigating the potential of biofuels, bioplastics and biofibres, the regulation and competitiveness of organic agriculture, and an array of new genetically modified plants, animals and microbes. U of S faculty are also actively engaged in the discovery, commercialization and regulation of new human diagnostics, gene therapies, drugs and delivery systems, bioinformatics, and nanotechnology—research which has links across campus. Group members regularly advise organizations such as the World Bank, the Inter-American Development Bank, and the Asian Development Bank, the World Health Organization, the World Trade Organization, the Food and Agriculture Organization, and many of the centres of the Consultative Group on International Agricultural Research (CGIAR).

International business acumen and technology commercialization is essential to world-class biotechnology research. The U of S has international expertise in technology access and adoption in small and medium-sized enterprises, technology commercialization, and the regulation of biotechnologies and products. University faculty expertise has been sought on institutional development and assessment in Bulgaria, China, Indonesia, the Philippines, Russia, Ukraine, and virtually all member states of the Organization for Economic Cooperation and Development (OECD), particularly in the US, EU, France, UK, Australia, and Mexico. Faculty have served on the Education Committee of the Canada–Saudi Arabia Joint Economic Commission and conducted research projects for Fortune 500 companies in Canada, the US and France, and engaged in business-to-business research in 15 countries in Europe.

4. [Human and Animal Health](#)

The health of a community and a nation can be gauged by the strength of their health care system, both in clinical practice and in medical research. The University of Saskatchewan has the largest range of health-sciences research in Canada including: medicine, nursing, pharmacy and nutrition, dentistry, kinesiology, clinical psychology, physical therapy, and veterinary medicine. This research is classified under five major themes: Public and Community Health and Wellness, Infectious Diseases, Chronic Diseases, Reproductive Health, and Molecular Design and Drug Development.

4.1 Public and Community Health and Wellness

In community development and public health, U of S nursing faculty have expertise in pharmacotherapeutics and cost-effectiveness, occupational and environmental epidemiology, neuroepidemiology, and community-based research. Researchers in end-of-life care are studying the effectiveness of hope interventions to improve health services and palliative care. Research in agricultural, rural and remote populations includes a national study of nursing practice in Canada's rural and remote regions and environmental determinants of childhood asthma. In the emerging area of health and health-care policy, the University has ongoing collaborations with Aboriginal communities and with Saskatchewan Health on issues related to youth gambling. Health-care policy research also covers major projects in breast cancer and obesity.

Clinical psychology involves explorations of psychological factors affecting health, the psychological repercussions of physical illness, and the socio-cultural factors that affect health-care delivery, disease

prevention, health promotion, and medical decision-making. University researchers are examining the cause of health-damaging (i.e. substance misuse), health-protecting (i.e. physical activity) and health-enhancing behaviours. Another focus of study is the relationship between personality factors and the development of physical illness, such as hostility and cardiovascular function and disease. Other interests include defence mechanisms and personal health, treatment of eating disorders, and the efficacy of psychotherapeutic intervention for fibromyalgia. In gender and health, faculty are studying stigmatized groups such as gay men and lesbian women, and the effect on their physical health and well-being.

The study of pain in early childhood includes the social response of parents and peers to a child's expression of pain, subsequent reaction to pain and the development of coping strategies and pain management. The University of Saskatchewan is one of five CIHR-supported Canadian centers for training in pediatric pain research. Related research in applied and community psychology includes child care, depression, trauma, aggression, and dementia. Interdisciplinary community-based research in culture and human development addresses issues related to adjustment of immigrant youth and families, peer culture and victimization, suicide among First Nations youth, and family and the social context in which healing occurs.

U of S contributions to regional and national primary health care research initiatives include the study of acquired antimicrobial resistant bacteria in northern communities, ethics in primary care, and the development of practical methods to implement the Personal Health Information Protection Act within physicians' offices in Saskatchewan. University faculty were also involved in the development of the new West Winds Primary Health Care Centre in Saskatoon. They have extensive collaborations with researchers in reproductive biology and veterinary medicine on the design of safer and more effective contraception. Other cross-campus collaborations involve faculty in Indigenous peoples' health research, community health and epidemiology, and nursing. University researchers are working in areas of pharmacoepidemiology and cardiovascular risk reduction, non-prescription drugs, consumer behaviour, organizations of health-care providers, and health economics. Innovative technology under development will be used to treat individuals with suspected stroke in a pre-hospital setting.

The field of animal nutrition and feed sciences is a long-established multidisciplinary area of excellence at the University of Saskatchewan. University research in this area is aligned with Government of Saskatchewan agriculture priorities and with the Government of Canada strategy to center crop bioprocessing research and development in Saskatoon. The scope of research includes nutrition of farm animals and fish for health and productivity, as well as animal product properties related to food safety and human health; the nutritional evaluation of feeds and forages; the response of microbial communities in the gastrointestinal tract of animals to feeds, including pro-biotics, pre-biotics and anti-biotics; the use of enzymes and other feed additives for improved digestion and nutrient availability; and crop breeding to improve nutrient profiles for both animals and humans. The group works closely with U of S researchers in the Toxicology Centre, the CLS, and the WCVN, and has strong partnerships with industry in applied product research and commercialization.

The University of Saskatchewan has become a leader in food safety, public health, infectious diseases, and emerging diseases research. Areas include the dynamics of pathogen entry and exclusion from the food chain, the molecular evolution of pathogen properties, such as resistance to antimicrobial agents, and the environmental and ecological determinants of human health. Current foci are antimicrobial resistance of zoonotic pathogens (animal diseases that can be transferred to humans) in the human food chain, and the means by which these pathogens are transmitted from wild and domestic animals to humans. U of S faculty, experts in Chronic Wasting Disease (CWD), have a leadership role in PrioNet, part of Canada's Networks of Centres of Excellence established to study prion disease, and in the

creation of the Canadian Cooperative Wildlife Health Centre and nation-wide surveillance programs for zoonotic diseases such as West Nile virus. They are also major consultants on the management of bovine tuberculosis, CWD and the response to BSE in Canadian cattle. Molecular diagnostic test development has produced approximately 30 new tests now commercialized in Saskatchewan, including several for zoonotic pathogens in livestock.

Medical anthropology brings together biological and cultural anthropologists in the study of disease, health problems, health-care systems, and theories about illness in different cultures and ethnic groups. At the University of Saskatchewan, this research spans medicine, the social sciences and humanities, epidemiology, and several research centres. Collaborations involve studies of sex-trade workers, people with intellectual disabilities and/or chemical dependencies, incarcerated populations, young homeless women, and those who live in remote and isolated areas. Faculty are working with local and national Aboriginal organizations across five countries. In a related area of medical anthropology, U of S researchers are studying the use of alternative medical systems, including Aboriginal healing methods, traditional Chinese medicine, naturopathy and homeopathy, among others. University scholars are working to identify these systems and healing traditions, particularly in a Saskatchewan context, and to study the behaviours, attitudes and level of satisfaction among patients and participants. The aim is to further the understanding of alternative medicines and health-oriented behaviours in disease prevention and health maintenance.

Forensic sciences from the fields of nursing, psychiatry, psychology, archaeology, and sociology constitute an important link between research at the University of Saskatchewan and Canada's justice system. Studies have examined clinical services and decision making with respect to a wide range of offenders, including violent, mentally disordered, and sexual offenders in both the youth and adult justice systems. In addition, application of new techniques, such as isotopic or DNA analysis, ensures that U of S research in forensic archaeology is competitive with any institution in North America. The University's affiliation agreement with the Regional Psychiatric Centre (RPC) and the Correctional Service of Canada, and faculty investigative and teaching roles with law enforcement agencies, represent an important relationship between academia and the correctional system and has provided an opportunity for innovative forensic clinical and justice-related public policy research in the areas of offender risk assessment and rehabilitation. University scholarship related to offender assessment and therapeutic intervention also involves partnerships with the Saskatchewan Health Research Foundation (SHRF) and the Alzheimer Society of Saskatchewan.

The Saskatchewan Population Health and Evaluation Research Unit (SPHERU), is a collaboration between the University of Saskatchewan, the University of Regina, and the Prairie Region Health Promotion Research Centre in which university- and community-based researchers investigate the social and environmental determinants of population health. Particular programs of note include children's health, rural and Aboriginal health, mental health, and health economics. Faculty expertise in health governance and policy is highlighted by work with the Romanow Commission and the Saskatchewan Institute of Public Policy. The Canadian Centre for Health and Safety In Agriculture (CCHSA) is a national centre located at the University of Saskatchewan, which evolved from the Institute for Agricultural, Rural and Environmental Health (IAREH). The CCHSA, the WCVM, the College of Medicine, VIDO, and other health science colleges will play significant roles in the development of the School of Public Health at U of S.

Health and wellness depends, to a large degree, on individual behaviour and lifestyle, and research emphasizing behaviour change and community programs is integral to health promotion. U of S Researchers have earned a collective national reputation for University-community initiatives such as *In Motion*, which is unique in Canada and exemplifies a successful collaborative program in physical

activity and health. The program was highlighted by the Canadian Institute for Health Information as a “best practice” for improving the health of Canadians and as a strategy for community-based health promotion. Researchers in physical growth and development are working to understand how the human body develops through four critical periods of life: intrauterine, infancy and childhood, adolescence and adulthood, and old age. Underlying these investigations are the study of diet and physical activity—the two primary influences on the growth and development of the human body. Leading research in this area includes the world’s longest- running longitudinal study of children’s bone development. This research group is also studying the combined effects of exercise therapy and isoflavone (a phytoestrogen made by plants such as soy) on the prevention of osteoporosis. Related work in the biomedical aspects of aging investigates osteoporosis and aging-related nutrition, nutrient intake in healthy and clinical populations, and protein–amino acid metabolism and obesity.

4.2 Infectious Diseases

The economic impact of infectious diseases such as SARS, BSE and avian flu has been devastating to local, regional and global economies. The study of infectious diseases and immunology has been revolutionized by genomics and rapid analysis platforms, which facilitate the development of diagnostic tools, as well as the study of cellular and molecular pathogenesis and the identification of new therapeutic targets. University of Saskatchewan research in infectious diseases encompasses viral, bacterial and parasitic infection. Research in arctic parasitology has influenced policy initiatives on ecology and wildlife in the Canadian arctic. The development of new technologies and their commercialization has contributed to Canada’s innovation agenda.

Two research groups, the Immunology and Infectious Diseases Group and the Vaccine and Infectious Disease Organization (VIDO) provide complementary and collaborative approaches to research in this area. With the development of the \$110 million Level 3 biocontainment facility the International Vaccine Centre (InterVac), to begin construction in 2007, research in this area will be a priority. The Immunology and Infectious Disease Group has developed new approaches to tuberculosis vaccination by stimulating cellular responses. This approach has been a subject of international investigations. This group also has members who are among the most cited in the area of infectious veterinary diseases.

In the last three decades, 30 emerging diseases have been identified, and almost 80 percent have a link to animals. VIDO at the University of Saskatchewan is a world leader in research, development and commercialization of vaccines and novel delivery systems for diseases affecting livestock and humans. Current research interests include vaccines against a number of food-borne organisms, and needle-free vaccination. VIDO researchers have over 30 years of experience studying veterinary infectious diseases, such as bovine spongiform encephalitis (BSE), which had such a devastating effect on the Canadian cattle industry. Researchers are at the forefront of developing vaccines for existing and emerging human diseases, such as SARS, hepatitis C, whooping cough, and tuberculosis. VIDO is a unique institute of national and international stature built on a combined academic–commercial model. VIDO research at the U of S has resulted in three spin-off companies, 62 patents and 30 research and licensing agreements with most major biopharmaceutical companies working in the area of vaccinology. VIDO has membership in several major research networks, including the international SARS Accelerated Vaccine Initiative, and U of S researchers have collaborated in the development of three vaccine candidates.

4.3 Chronic Diseases

The aging population in Canada—and especially the rise in the number of elderly in Saskatchewan—and the associated rise in chronic disease are creating an increased burden on health-care delivery and

services. The Health Science Colleges at the University of Saskatchewan have many established and newly-formed research groups to investigate the etiology, treatment and prevention of human chronic diseases. University researchers have established excellence in the research of Alzheimer's Disease (Neuropsychiatric Research Unit), multiple sclerosis (MS Cameco Neuroscience Research Unit), and neurological disorders, as well as studying how the brain and spinal cord recover from injury (Neuroscience & Plasticity Research Group). Other research groups in chronic disease include heart and vascular disease (e.g. hypertension, stroke), movement disorders (e.g. Parkinsonism), juvenile and adult arthritis, cancer, aging and obesity, and schizophrenia. The new Academic Health Science Biomedical Research Building to begin construction in 2007 will bring these researchers together under one roof, facilitating dynamic interactions of ideas, and skill development for all faculty and students that study these related chronic diseases.

New research at the U of S in chronic disease and aging includes studies on terminally ill patients, informal and formal caregivers, and bereavement and health service utilization in rural and urban communities. This scholarship encompasses a continuum of care which includes acute and chronic illness across the life span. The University has established community partnerships with the Saskatoon Cancer Centre, the Health Quality Council, Saskatchewan's health regions, and key international collaborations with the Mayo Clinic in Rochester and the University of Utah, Salt Lake City.

Neuroscience research spans a broad range of scholarship, from the study of individual molecules and the function of individual neurons, to the study of human behaviour and cognition. U of S research in neural systems and plasticity research is multifaceted, with foci in molecular neuroscience (ion channels in membranes, genome of neurons), neuroanatomy, neurophysiology, neurochemistry, and behavioural and cognitive function and neural network modelling. Areas of impact include epilepsy, anxiety and depression, schizophrenia, recovery of motor control after spinal cord injury, aging and Alzheimer's disease, hormonal control of memory, multiple sclerosis (MS), marijuana use, and nutrition. While the approach of these groups has been primarily biomedical, applied and clinical research studies in the Neuropsychiatric Research Unit (NRU) overlap with research in public and community health and include dementia in rural and remote populations, stimulant use and bipolar mood disorder, and the social determinants of depression and emotional well-being. The Neural Systems and Plasticity Group's integrated approach includes behavioural studies.

Clinical and basic research in movement disorders such as Parkinson's disease has been ongoing at the University of Saskatchewan since 1968. Seminal work in clinical assessment and pathological studies has attracted international attention and involves multidisciplinary collaborations with local, national and international scientists. U of S movement disorder research is supported by the Saskatchewan Parkinson's Disease Foundation, the Parkinson Society of Canada, the Canadian Institute of Health Research, the National Institute of Health in the US, and the Parkinson Foundation USA.

Ophthalmology researchers collaborate with colleagues in paediatrics, physical and rehabilitative medicine, the CLS, and the WCVI. Of key relevance to human eye diseases is the work undertaken by U of S faculty in veterinary ophthalmology, who have pioneered the development of a novel surgical device for glaucoma in many species. Another goal of their research is to identify mutations of unusual retinal diseases, such as bullous retinal detachments. U of S scholars were the first to describe these inherited conditions in detail. The development of molecular genetics and biochemical expertise within this group is crucial to the investigation of many basic ophthalmic diseases, including retinopathies and dysplasias, stationary night blindness, glaucomas, and numerous lab models of inherited ocular disorders.

The University of Saskatchewan is recognized nationally for excellence in veterinary sports medicine and orthopaedic surgery. Orthopaedic disease accounts for the single largest economic loss to the equine industry in North America. Using advanced diagnostic technologies and the latest developments in molecular biology, U of S researchers are at the forefront of applied clinical research to improve the well-being of horses and companion animals. Specific areas of expertise include developmental orthopaedic disease in foals and the management of advanced arthritis in the performance horse. In companion animals, researchers are investigating the biomechanical aspects of canine fracture repair, dislocation of the kneecap, and spinal fractures in dogs. Several pilot projects are in place, including a proposal to use the CLS synchrotron to assess the bone–implant interface *in vivo*. With five health science colleges on campus, the WCVM at the U of S is distinctive in Canada and North America. Veterinary oncology is a promising area of growth. Treatment of animals now includes specialized MRI, CT and cobalt therapy. Faculty in veterinary oncology are certified in internal medicine, surgery and radiology, and include the first board-certified veterinary radiation oncologist in Canada.

The Cardiovascular Research Group involves biomedical and clinical scientists investigating the mechanisms, treatment and prevention of heart disease and stroke. Researchers from the WCVM, U of S Medical College and the Saskatoon Health Region have a strong history in the hemodynamics of the circulatory system and the cell signalling mechanisms for mediating blood flow and blood pressure. Working with clinical pharmacologists and cardiologists, they have extended their findings to patients in the community recovering from heart failure and stroke.

4.4 Reproductive Health

The strength of U of S research in reproductive science and medicine is a result of trans-disciplinary collaborations and expertise in both human and veterinary medicine. Scholarship in reproductive health also involves interdisciplinary collaborations with faculty members in engineering and agriculture. The work of the long-established reproductive biology group encompasses the development of new animal models for the study of human reproduction, development of new contraceptive technologies, fertility enhancement, and improved food-animal reproduction. Faculty of this research group played an integral role in the development of the BMIT beamline at the CLS (section 3.2). Social science scholars are studying the impact of reproduction and sterilization on mentally disabled people's sexuality, social life and well-being, and the psycho-social impact of reproductive technologies on women, families and society.

The University of Saskatchewan has pioneered several reproductive technologies: *in vivo* and *in vitro* production and transfer of embryos, cryobiology, strict morphological criteria for spermatozoa assessment, detailed analysis of placental function, characterization of ovarian dynamics, ovarian synchronization, and computer-assisted imaging of reproductive events. Many of these techniques are now in widespread clinical use. The release of groundbreaking studies challenging the traditional view of ovarian function during the human menstrual cycle has had a major international impact. U of S research has also been instrumental in bringing the hormonal contraceptive patch to market in Canada, the US and Europe. Thirty-five patents and copyrights have been filed for the protection of intellectual property in reproductive science and medicine. Much of this work intersects with BMIT research and development.

4.5 Molecular Design and Drug Development

Scholarship in the broad area of pharmaceutical and bioactive research has links to many areas of excellence in both fundamental and applied research, and involves faculty in Arts and Science, Chemistry, Medicine, Pharmacy and Nutrition, and Veterinary Medicine. Fundamental aspects of

molecular design and drug development include synthesis of new biologically active molecules, molecular modelling, bioinformatics, and biomolecular structure studies (X-ray crystallography and nuclear magnetic resonance of biopolymers such as enzymes, polypeptides and DNA). U of S research strength in the chemical sciences has fostered leading research in molecular structure studies and drug discovery, including the University's association with two Nobel laureates (section 3.1). U of S research in biochemical and molecular toxicology is a key component of molecular design and drug development.

Much of this research is conducted at the University's state-of-the-art facilities in the CLS, SSSC and VIDO. Primary applications of the analytical techniques used by researchers in the SSSC are in the areas of pharmaceuticals, genomics and proteomics. The Molecular Design Research Group (described under Synchrotron Science) has expertise in drug delivery systems, pharmaceutical nanotechnology and gene therapy, drug design and structural biochemistry, pharmaceutical analysis, medicinal chemistry and drug discovery, toxicology, and nutritional biochemistry. Faculty have contributed to technological advances such as needle-free drug and vaccine delivery systems, anti-cancer drug research, and PCP biodegradation. Scientists from the University and VIDO are working to determine the influence of immunomodulatory agents, such as antimicrobial peptides and vaccines, on host gene expression to help develop novel agents for boosting innate immunity and/or reversing the harmful effects of excessive inflammation. Several U of S spin-off companies have been formed to help transfer important discoveries in molecular design and drug development from bench to bedside.

5. Environment, Resources and Sustainability

The environment is a foremost area of concern in today's society. Nevertheless, the largest sector of the provincial economy depends upon resources from the earth—coal, oil, gas, minerals, and potash. The University of Saskatchewan has a history of excellence in resource discovery, recovery and remediation research. Scholars across campus are undertaking critical fundamental and applied research to increase our knowledge of the environment and the complex interaction of evolving physical and man-made systems in order to improve the management of our natural resources and to inform public policy.

5.1 **Resource Management and Public Policy**

Strong scholarship in infrastructure and sustainable development plays a complementary role in resource management and policy development in the province. This work includes pollution studies, irrigation, wastewater treatment, waste management and containment, mine reclamation, and environmental regulation. In particular, much research targets the agriculture, mining and petroleum industries, which are vital to the economy. Other major research concentrates on the infrastructure systems that form the backbone of society—our bridges, roads, highways, dams, and water and sewage treatment plants. In collaboration with civil engineering colleagues across the country, U of S faculty are developing strategies to guide the rehabilitation, replacement and future development of Canada's infrastructure systems. Group research has led to the formation of three spin-off companies.

Environmental concerns such as water scarcity and quality, biodiversity, sustainable development, climate change, and environment and health all require an understanding of the human institutions, cultural practices and social relations that contribute to—and resolve—these problems. In addition to expertise on the physical aspects of environmental change, an emerging area of scholarship at the University focuses on environment–society relations, with emphasis on environmental assessment, management, land use change, and policy making. Faculty in this area participate in the Sustainable Forest Management Network, the Canadian Water Network, the Canadian Environmental Assessment

Agency, and the International Scientific Advisory Committee on Land Use Planning. The U of S Centre for the Study of Agriculture, Law and the Environment integrates the life sciences, the social sciences and legal knowledge to better understand environmental change and policy development in areas such as land use, greenhouse gases and food safety.

Toxicology research is a major area of strength at the University of Saskatchewan. Currently, 29 departments and units in seven colleges participate in toxicology research. The diversity of research spans both biomedical and environmental toxicology, and includes work on how toxicants behave in the northern environment, how they affect target organisms, and how they affect ecosystems. With the establishment of the Northern Ecosystems Toxicology Initiative (NETI), the University of Saskatchewan has created a critical mass of research in northern and arctic environmental toxicology that is unparalleled in any other Canadian institution. The University has recently recruited research chairs who are experts in the field of ecology and environment and environmental toxicology. With the recent approval of a \$6-million upgrade and expansion, the Toxicology Centre at the U of S will be the largest such facility in Canada. The centre has linkages with several federal departments, including Environment Canada and the National Water Research Institute, the Canadian Wildlife Service and the Canadian Food Inspection Agency. U of S toxicology research has a direct influence on national policies and guidelines for environmental protection.

The importance of land to Indigenous peoples goes beyond legal possession. It is a personal and physical relationship that has profound cultural and spiritual significance. Research and scholarly expertise in agriculture and Indigenous culture and knowledge involves faculty from four colleges and positions the University of Saskatchewan as a world leader in Indigenous land and resource management. The U of S was selected by the Federal department of Indian and Northern Affairs to develop and deliver a \$1-million annual program for Aboriginal land managers.

5.2 Sustainable Agriculture

Research in sustainable crop management systems has been a focus at the University of Saskatchewan since its beginning. With core support from Saskatchewan Agriculture and Food, producer groups and private industry, the University's internationally renowned Crop Development Centre develops new crops and new types of established crops. In the past five years, 89 new crop varieties have been developed by U of S researchers, including 15 varieties of barley, 16 varieties of lentils, 11 varieties of wheat, and 11 varieties of field peas. The University's pioneering development of new crops such as the pulses, winter wheat and canary seed have had a very significant impact on agriculture in Western Canada. Other research into agronomic and post-harvest practices supports these activities. U of S faculty were instrumental in introducing legumes as a means of biological and economic diversification. The combined efforts of researchers, producer groups, industry, and governments led to the building of the multi-million dollar Pulse Research Centre at the U of S in 2005. Today, between 3.5 and 4 million acres of land in Saskatchewan are seeded to pulse crops each year, with a gross value of \$750 million annually. The industry has generated over 120 pulse crop processing plants that employ 1,200 people in the province.

Maintaining healthy soils is essential to sustainable agricultural practices and to safeguarding the environment. The University of Saskatchewan is internationally recognized for its strength in soil science research. Faculty expertise includes nutrition cycling, contaminant rate and transport, soil-organic matter dynamics, microbial diversity and function, root development, and soil salinity. Their research examines sustainability of agricultural systems from both agronomic and environmental perspectives, including the impact of prairie agricultural systems as both sources and sinks of greenhouse gases (GHGs). Research on plant-based bioremediation systems in oil-contaminated sites in cold climates has

received national and international attention. Common to all of these studies is a fundamental understanding of soil processes and soilscares. Related research in agroforestry and afforestation is an important emerging area. Key foci include the study of enhanced soil conservation, nutrient management and water quality. Faculty are also developing hybrid poplar, willow and conifer plantations, which will contribute to the sustainable production of wood fibre, increased carbon stocks and reduced GHG emissions.

Over the past few years, the U of S has emerged at the forefront of organic agricultural research in Canada. Areas of study include chemical-free pest management, sustainable nutrient management, and optimization of agronomic controls for seed yield and quality. Faculty have contributed to the development of the Saskatchewan Biodiversity Action Plan, Environmental Farm Plan Policy, and Sustainable Manure Management for prairie soils.

Infectious diseases such as BSE have intensified pressure on producers worldwide to create safer and more sustainable beef cattle production. The University of Saskatchewan has been conducting critical research aimed at expanding and sustaining the beef cattle industry within the province and across the country. Faculty have expertise in the areas of reproduction, genetics and breeding, feeding and nutrition, behaviour, animal welfare, meat quality, economics, environmentally sustainable production, and possible human health risks. Specific innovations include a motion-measurement device for obtaining objective measurement of stress in cattle, embryo transfer advances, and vaccine development and protocols. U of S research in sustainable beef cattle systems includes faculty from the Colleges of Agriculture, Veterinary Medicine, Engineering, the Western Beef Development Centre, and VIDO. Members hold the Saskatchewan Beef Industry chair, and the Alberta Beef chair. Their multidisciplinary research in both basic and applied science has a strong focus on outreach and commercialization and has generated two spin-off companies.

5.3 Alternative Energy and Sustainability

Innovation in alternative energy is built on the history and strength of U of S research in conventional energy sources and resource discovery. The University of Saskatchewan has a comprehensive energy-based research program conducted around four main foci: 1) energy production, including bioenergy from animal and agricultural wastes, clean coal technology and alternative energy sources such as solar, wind and fission; 2) energy processing, including bio-ethanol, bio-diesel, biomass conversion, biotechnology applications, and improved oil and gas processing; 3) energy transport and distribution, including oil and gas transport, and power grid and power reliability; and 4) energy utilization and conservation, including building science, heat recovery systems and moisture control.

U of S research in chemical engineering includes catalytic processing of natural gas and liquid fuels for the removal of hydrogen sulfide and mercaptans, hydroprocessing of heavy and light gas oils (including oil sands bitumen), the production of biofuels from lard and vegetable oils, conversion of meat and bone meal to gaseous fuels, advanced modelling of clean coal fluidized-bed technology, and reforming of greenhouse gases.

Faculty in civil engineering investigate leakage potential and prevention during the geological storage of greenhouse gases in depleted oil reservoirs, and analyse borehole for coal bed methane wells. Sustainable energy research in electrical engineering includes power system analysis, reliability, protection, and control. U of S mechanical engineers research advanced home heating and cooling design, moisture exchange in buildings, and biodiesel-fuelled engines. In engineering physics, the University of Saskatchewan has the only tokamak in Canada, STOR-M, devoted to magnetic fusion with an ultimate objective to burn hydrogen isotopes for an abundant, clean, and safe energy source. The

STOR-M tokamak is an experimental fusion reactor used to confine the high temperature plasma with parameters relevant to fusion reaction. Fundamental research in this area is conducted as part of the Plasma Physics Laboratory discussed in Materials Science (section 3.3).

Another example of pioneering research in the area of energy and sustainability is high-gravity fermentation, which provides higher ethanol yields from fermentation and is now in widespread use in the brewery, wine and energy industries. Bioconversion—a key element of renewable energy research at the University—is a process whereby organic materials such as plant and animal waste are converted into usable energy sources through biological processes. The logistics of biomass (organic matter available on a renewable basis) collection and transportation present a major barrier to the commercialization of this process and are a primary interest of researchers in agriculture and bioresource engineering. The Toxicology Centre at the U of S is a national leader in exotoxicological research pertaining to uranium mining, diamond mining, and oil and gas recovery. Researchers are also involved in monitoring rural groundwater quality, including arsenic contamination and human health. Engineering research in alternative energy and sustainability is complemented by work in toxicology (section 5.1) hydrology, particularly tars sands reclamation (5.5), and in environment–society interactions (5.1).

5.4 Earth Systems Science, Climate and Environmental Change

The University of Saskatchewan conducts leading research in environmental sciences and earth systems science. In particular, climate change represents a significant focal point of research in the environmental sciences. The University of Saskatchewan has complementary strengths in the solar influences on atmosphere dynamics, through the Institute of Space and Atmospheric Studies (ISAS), and on the characterization of climate change through time, through the Saskatchewan Isotope Laboratory (SIL).

The Institute of Space and Atmospheric Studies at the University of Saskatchewan is the first institute of its type in Canada devoted to solar–terrestrial and atmospheric sciences. Atmospheric science depends increasingly on satellite technology, which provides communications and remote sensing of our atmosphere and surface resources. In turn, the efficiency of these systems depends upon our knowledge of “space climate” and eventually our ability to predict “space weather.” The U of S is internationally recognized for contributions to this dynamic and critical field. Research areas include ozone, aerosols, cirrus and polar stratospheric clouds, and solar influences upon atmospheric dynamics. ISAS members were responsible for the development of infrared photometers to measure ozone height profiles. Other observational systems and software were developed at the institute. Members have made major contributions in plasma convection using the SuperDARN global radar network, which will be expanded at ISAS to include the polar ice cap. Faculty members have strong links with the Canadian Space Agency (CSA), the Geological Survey of Canada, the Meteorological Service of Canada, NASA, and the European Space Agency.

Paleoenvironmental and climate change research on materials ranging in age from the present to 500 million years in the past is a primary focus of research at the SIL (section 3.3). The U of S has the only robotic micro-milling preparation facility in the country, from which scientists gather high-resolution temperature and other environmental indicators of climate at varying time scales. By gaining a better understanding of modern and ancient climate as recorded by chemical proxies, scientists can better estimate future anthropogenic influence on atmospheric chemistry. U of S climate change research has spanned seven continents and received funding from the European Science Foundation, Canadian Foundation for Climate and Atmospheric Sciences, NSF, and NSERC.

The University has an international reputation for hydrology research—the study of the freshwater systems on Earth and their interaction with terrestrial and atmospheric environments. Research in freshwater systems and water resources is broadly multidisciplinary, encompassing geography, geology, biology, agriculture and bio-resource engineering, civil and geological engineering, soil science, and toxicology. Project areas include the Athabasca oil sands, national hydrological model development, prairie hydrology, and drought. The University provides leadership to major initiatives such as the Mackenzie Global Water and Energy Cycle Experiment, and to programs such as the International Commission on Continental Erosion and the International Commission on Snow and Ice Hydrology. As a result of the strength of hydrology research at the U of S, the National Hydrology Research Centre was constructed at Innovation Place.

Molecular environmental science is an important new area that has emerged out of the strength of research in soil science and sustainable management of prairie and northern ecosystems. This discipline builds on existing macroscale research by performing detailed analysis at the nanoscale level of individual atoms and genes. U of S researchers are using cutting-edge techniques to study environmental issues in ecosystems as diverse as the Canadian Arctic, Antarctica, New Zealand thermal pools, agricultural and wetland soils, and boreal forests. Faculty are leaders in synchrotron-based X-ray absorption spectroscopy (XAS) used to provide essential information about the speciation of contaminants in soils. Advances in biotechnology and molecular techniques are being used to examine microscale controls on mercury, arsenic, nitrogen, and sulphur chemistry and cycling in extreme environments, with the goal of developing strategies to protect and sustain polar ecosystems.

Sedimentary rocks contain the world's supplies of petroleum, natural gas, groundwater, and many mineral deposits, including uranium. Saskatchewan produces nearly 30 percent of all the world's potash, and ranks second in Canada in oil production and third in the production of natural gas. U of S scientists are studying the origin and evolution of the sedimentary rocks containing these resources—work that is important for natural resource development. Research is based on observations in the field, and U of S scientists have worked on all continents. Complementing this geological work is research in deep-earth and resource geophysics. Seismic and geophysical methods are used to map hydrocarbons and monitor mining hazards and earthquakes, and they are the primary source of detailed structural information of the earth. For the past 40 years, seismology has been instrumental in enforcement of nuclear test monitoring and weapons non-proliferation programs. The U of S participates in global earthquake studies and modelling through the US-based Incorporated Research Institutions for Seismology. Faculty have played key roles in the national Lithoprobe program and continue involvement in related projects. Other research involves underground seismic monitoring to improve planning of potash mines.

The study of the earth's crust and of the location and formation of mineral deposits is a prominent area of research at the U of S. Isotopic analysis and synchrotron science are both essential tools in the study of metals in the earth's crust—an important non-renewable resource. Faculty were involved in the development—and are now participating in the operation—of the Inductively Coupled Plasma Mass Spectrometer laboratory for trace element analysis, electron microprobe and scanning electron microscopy for imaging, and the first Electron Paramagnetic Resonance lab in Canada for structural analysis of minerals. University research involves field observations on five continents, and includes the studies of the geochemical evolution of the earth's crust and atmosphere in the early Precambrian period, mineral deposits in China, gold deposits, structural geology of central Canada, recent hot spring deposits, southern Africa mineral deposits, and the geochemistry of volcanic terrains.

The study of human adaptation to environmental change is an important emerging area of strength. Researchers in economics, geography, and sociology are also exploring the socio-economic impacts

and policy implications of climate and environmental change and development. Areas of investigation include protection strategies for biodiversity and habitats, resource management, and environmental regulations in the South Saskatchewan River Basin, Clayoquot Sound, and the Great Sand Hills. U of S faculty routinely advise government and industry on best practices in project- and strategic-impact environmental assessments. U of S research in geoarchaeology examines the nature and rate of post-glacial environmental change, and its influence on landscape evolution and prehistoric human occupation patterns. Faculty members have developed novel applications of geographic information systems (GIS) to better manage data related to artefact description and provenance, site formation factors and palaeontology, in order to facilitate the study of the culture and behaviour of the people who settled the landscape. Three faculty members directed the national Study of Cultural Adaptations in the Prairie Ecozone (SCAPE) project. Work in this area is strongly linked to northern plains and boreal forest archaeology.

Archaeological research has important implications in global environmental studies and climate change. Current work in Near Eastern archaeology at the U of S is focused on the steppe-desert sites of Wadi ath-Thamad (WT-40) in Jordan, and understanding how these cultures adapted to various fluctuations within an arid environment, and is particularly relevant given contemporary concerns with water access and management, environmental degradation and climate change. This work should contribute to our knowledge of early agriculture in transitional zones and of how people have adapted to fluctuating environmental conditions.

Bioarchaeology research attempts to identify and interpret biological remains from archaeological sites in terms of human usage, biogeography, and paleoecology. Researchers apply new techniques such as isotopic analysis to reconstruct ancient diets and environments, or DNA analysis to identify ancient diseases. Innovative U of S research in this field includes human osteology (the study of bones), zooarchaeology (the study of faunal remains), paleopathology (the study of evidence of trauma and disease in fossilized skeletons), and forensic anthropology (the study of skeletal remains to assess the time and cause of death).

Summary Statement

The research, scholarly and artistic landscape at the University of Saskatchewan is shaped by the history and culture of the province, the expansiveness of the landscape, the wealth of natural resources, and the strength, diversity and resourcefulness of the people who live here. The breadth of expertise across all five research clusters reflects the vision of our forefathers and the ongoing commitment to scholarship, creativity and innovation that has allowed the University to grow and flourish in rapidly changing times. *Expanding Horizons* encapsulates the research, scholarly and artistic activities that encompass the University of Saskatchewan's vision—a vision shaped by a horizon that extends out as far as the eye can see—a world-class university in the heart of the Canadian prairie.