Unleashing Alberta's Potential: A Call to Action in Bioinformatics

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The purpose of this paper is to provide an initial analysis of bioinformatics activities, a key driver in harnessing the value and potential from Alberta's vast data resources, in Alberta and offer strategic guidance for policymakers. By examining the current state of bioinformatics and identifying key opportunities and challenges, this paper aims to provide actionable recommendations that can shape the future of this critical field, and empower stakeholders to drive innovation, economic growth, and societal benefit in Alberta and beyond.

EXECUTIVE SUMMARY

In 2003, the Human Genome Project successfully sequenced 90% of the human genome and humanity gained unprecedented insights into the intricate code that defines us. This first sequencing of the human genome took 13 years and 3 billion dollars (Nurk, 2022). Today, an entire genome can be sequenced in under 24-hours at a fraction of cost and with technologies readily available across Alberta. What began as a scientific milestone has since evolved into a multidisciplinary endeavor at the intersection of life sciences, computer sciences, and data sciences and the formation of modern-day Bioinformatics. Bioinformatics, through its ability to study and interpret datasets in extreme detail, has emerged as a linchpin of modern science, and will underpin future advancements in genome biology, precision health, and precision agriculture by providing essential tools for analyzing genetic data, predicting traits, optimizing crop breeding, and enhancing livestock productivity and disease resistance. Now, as Alberta stands on the precipice of a new era of discovery, it is imperative that we recognize the transformative potential of bioinformatics and harness it to drive scientific breakthroughs, foster economic growth, and enhance societal well-being across our province.

Alberta's bioinformatics landscape continues to grow despite facing formidable challenges, including a deficiency in training programs and a prevailing perception of bioinformatics as a secondary player rather than a driver in broader initiatives. Across academic institutions and research funding agencies, bioinformatics often receives inadequate support within interdisciplinary research initiatives, frequently being treated as an ancillary component rather than an equal partner. With the continuous innovation of more powerful computational devices, data generation will continue to increase along with increasingly accessible data storage and access. The surge in data generation within biological research globally accentuates the pressing need to leverage bioinformatics to unlock its vast potential. Governments, research institutions, and private enterprises worldwide are increasing their investment in the field of bioinformatics to meet areas of opportunity in omics research.

To realize Alberta's full potential in the era of data-driven science and industry, urgent investment in bioinformatics training is essential. By cultivating a pipeline of skilled bioinformaticians trained in or recruited to Alberta, we can not only address the immediate deficiencies in expertise but also position ourselves for sustained economic growth. By nurturing a cadre of talented individuals proficient in bioinformatics, we can drive innovation, foster economic growth, and address pressing societal challenges, thereby unlocking the full potential of Alberta's bioinformatics ecosystem, and connecting it with national and international networks.

INTRODUCTION

Investing in bioinformatics in Alberta is not just about embracing a cutting-edge field; it's about securing our future across critical sectors like healthcare, agriculture, forestry, and environmental monitoring. By recognizing bioinformatics as a primary research discipline and committing to its development through robust funding, collaborative initiatives, and comprehensive training programs, we empower our researchers to unlock the full potential of biological data. This investment doesn't just drive innovation; it safeguards our economic prosperity, enhances our global competitiveness, and ensures the well-being of our communities for generations to come. Nestled amidst the pristine wilderness and vibrant urban centers, Alberta's research institutions, industry pioneers, and academic visionaries converge to harness the power of bioinformatics for societal benefit and economic growth. Now is the time to prioritize bioinformatics, not as a supporting player, but as a cornerstone of Alberta's scientific landscape, paving the way for a healthier, more sustainable future.

This report explores the essential role of bioinformatics in Alberta's innovation landscape, illuminating its transformative potential and the challenges that accompany it, and also outlines ways to integrate Alberta's bioinformatics ecosystem with national and international networks. Through a comprehensive analysis of Alberta's current bioinformatics ecosystem, we aim to chart a course for strategic collaboration and investment, empowering stakeholders to capitalize on opportunities and overcome obstacles, ultimately driving significant economic growth, and encouraging scientific excellence.

Over the following pages, we will delve into the economic significance of bioinformatics in Alberta, examining its pivotal role in driving industrial innovation, enhancing productivity, and sustainable growth. By fostering a culture of innovation, collaboration, and investment in bioinformatics education and infrastructure, Alberta can lead the charge in shaping the future of industrial progress and economic prosperity in Canada and beyond.

Bioinformatics: Revolutionizing Data Analysis and Interpretation

The fundamental importance of bioinformatics and computational capacity cannot be overstated. It serves as the necessary infrastructure for storing, analyzing, and interpreting complex biological data, ranging from DNA and RNA sequences to protein structures and public health information crucial during urgent situations like the COVID-19 pandemic. By amalgamating biological, computational, and mathematical sciences, bioinformatics empowers researchers to extract invaluable insights from complex datasets that were previously inaccessible. In essence, bioinformatics serves as a foundation of modern scientific inquiry, driving advancements across diverse fields and shaping the future of biology, medicine, agriculture, industry, and environmental stewardship.

THE CURRENT LANDSCAPE OF BIOINFORMATICS IN ALBERTA

Bioinformatics expertise is needed to drive Albertan institutions.

1. Bioinformatics capacity is important for academic and industrial sectors in Alberta.

2. Alberta's public health agencies, Alberta Health Services and Alberta Precision Laboratories require Bioinformatics and Computational Biology (B/CB) expertise, and these needs will rise into the future.

3. Alberta is home to multiple federal level government research stations who will require B/CB capacity and can draw from local talent pools to fill this need.

4. BioNet Alberta stands as a unifying force in B/CB that has set the stage for further expansion of this ecosystem.

1. Bioinformatics capacity is important for academic and industrial sectors in Alberta.

Bioinformatics research in Alberta thrives within a dynamic and diverse ecosystem encompassing academic, government, and industrial sectors. Alberta's geographic location and abundant natural resources have led to the formation of a rich research environment in energy and oil sands, environmental science, and agriculture. The economic climate of Alberta has attracted and retained numerous biosciences and biotechnology start-ups which operate in tandem with local hospitals and research enterprises making it a hub for biomedical research. These disciplines currently require and will continue to require additional expertise in bioinformatics, computational biology, and data science. At the forefront of bioinformatics research are Alberta's three major post-secondary institutions: the University of Alberta, the University of Calgary, and the University of Lethbridge. These institutions house biology and computer science programs which provide a fertile ground for the interdisciplinary collaboration and innovation required to develop bioinformatics expertise, however, at present day these post-secondary institutions offer limited B/CB training opportunities. This creates an imbalance where recent graduates do not have the training required to enter impactful post-graduate training programs at these same institutions, providing a requirement for recruitment from outside Alberta to fill open positions.

Alberta's healthcare, agriculture, energy, and biotechnology industries require bioinformatics expertise. Bioinformatics plays a crucial role in genetic analysis, biodiversity monitoring, and product development across sectors, fostering innovation and addressing complex challenges in Alberta's economy. In a study undertaken by Deloitte and BioAlberta, one of the top challenges cited by Alberta life sciences employers was their need to access top qualified talent to support and enable the growth of their business (Deloitte/BioAlberta, 2021). This underscores the critical importance of investing in bioinformatics education and training programs to meet the evolving needs of industry stakeholders. Moreover, the presence of a skilled workforce in bioinformatics can attract industry stakeholders, startups, and offshoots to the province, creating opportunities for collaboration, innovation, and economic growth.

2. Alberta's public health agencies, Alberta Health Services and Alberta Precision Laboratories require B/CB expertise, and these needs will rise into the future.

Alberta maintains two public agencies in Alberta Precision Laboratories (APL) and Alberta Health Services (AHS) that heavily rely on bioinformatics for various tasks ranging from pathogen tracking to healthcare diagnostics. During the SARs-CoV-2 pandemic, APL developed novel PCR assays to detect variants of concern (Kanti Pabbaraju, 2022), as data from these assays accrued, bioinformaticians were called upon and required to process, store, and analyse this exponentially expanding information. Beyond SARs-CoV-2 APL has tracked and continues to track potential pathogenic agents of concern with relevant examples in swine influenza (Kanji JN, 2021) and tuberculosis (Richard Long, 2024). Beyond the wet lab work of identifying and tracking pathogens of concern, these agencies also endeavor to develop novel computational tools that aid in data storage, harmonization, and validation (Gill IS, 2023). These are a few of many potential examples of the importance of bioinformatics in disease surveillance and outbreak response, by strengthening bioinformatics capabilities within these organizations, and cultivating a strong culture of bioinformatics expertise within Alberta we can improve public health outcomes in both day-to-day and crisis situations.

3. Alberta is home to multiple federal level government research stations who will require B/CB capacity and can draw from local talent pools to fill this need.

In addition to academic institutions, Alberta is home to multiple federal government research centers in Agriculture and Agri-Food Canada (AAFC) and the Canadian Food Inspection Agency (CFIA). These organizations play a vital role in driving economic growth and competitiveness, combating recent challenges with food supply / demands and safeguarding food, animals and plants enhancing the health and well-being of Canadians, the environment and economy. They employ staff bioinformaticians and are currently hiring additional capacity in these areas, recognizing that up-front investments in this sector will pay dividends, helping to mitigate significant impactful events before they occur and maintaining a cutting-edge work-force capable of managing and handling large datasets generated by these organizations.

4. BioNet Alberta stands as a unifying force in B/CB that has set the stage for further expansion of this ecosystem.

Supported by Genome Canada, Genome Alberta, Alberta Innovates, and the Government of Alberta, BioNet Alberta stands as a pioneering initiative in bioinformatics and computational biology. Established in 2019, initially with the name Bioinformatics Network Alberta (BioNet Alberta), and most recently as BioNet, BioNet has successfully cultivated a diverse membership base comprising over 200 individual researchers, with 158 located within Alberta and strong connections with the other Western provinces. This network encompasses a wide array of expertise from academia, government, and industry, offering a comprehensive and unified approach to addressing the challenges and opportunities in the field of bioinformatics.

With a shared goal of fostering innovation and driving progress, BioNet members contribute their expertise and insights to propel the province towards a future where bioinformatics plays a central role in scientific discovery, technological advancement, and economic growth. With a significant amount of

work already devoted to finding and identifying pockets of bioinformatics expertise already present within the province; we believe now is the time to unify and invest in training programs that will provide the high calibre bioinformatics expertise required to meet these goals. BioNet can continue to be the driver of bioinformatics growth and returns in Alberta, working towards fostering a collaborative ecosystem that nurtures innovation, drives growth and improves societal well-being. BioNet is committed to working with provincial stakeholders to generate a provincial research and training program, it is a key foundational investment that can be leveraged in part to achieve the long-term goals detailed in this document.

Addressing Alberta's Fragmented Bioinformatics Landscape: A Call for Unified Action

While Alberta possesses significant bioinformatics capacity and infrastructure and BioNet has laid a stable foundation for growth there continues to be opportunities for increased unity. Efforts in bioinformatics research, education, and application are dispersed across various academic institutions, government agencies, and private enterprises without a cohesive framework or collaborative network. As a result, there is a pressing need to consolidate and coordinate bioinformatics efforts in Alberta to maximize their impact and foster a more integrated approach to harnessing the potential of bioinformatics across sectors. Moreover, investing in bioinformatics education and training programs is crucial to developing a skilled workforce that can drive innovation and support the growing demands of the bioinformatics sector in Alberta. By enhancing training opportunities, we can ensure a steady supply of qualified professionals equipped with the necessary expertise to propel bioinformatics forward and contribute to Alberta's economic growth and competitiveness.

Albertans have a longstanding tradition of coming together to tackle challenges, and the province's bioinformatics community is no exception. Comprising diverse research groups and facilities, Alberta's bioinformaticians bring a wealth of knowledge, experience, and technical expertise to the table. This vibrant community is well-positioned to embrace collaboration, celebrate diversity, and support the growth of existing groups through the infusion of additional resources. In the following sections we outline the current gaps, challenges and opportunities in the bioinformatics and computational biology sphere in Alberta and provide actionable solutions that will enhance this community now and into the future.

ECONOMIC IMPACT OF BIOINFORMATICS IN ALBERTA

Bioinformatics is a significant economic contributor in Alberta.

1. Bioinformatics is an essential component of the digitalization of healthcare to reduce costs and inefficiencies.

2. Agricultural breeding programs and precision agriculture generate massive datasets requiring bioinformatics expertise to parse and store.

3. Alberta houses significant Antimicrobial Resistance (AMR) research capacity, a multidisciplinary field that benefits greatly from the inclusion of bioinformatics expertise.

4. With vast swathes of land and abundance natural resources, Alberta requires substantial environmental monitoring programs that rely on bioinformatic interpretation and data storage to be fully effective.

Bioinformatics: Catalyzing Economic Growth and Innovation

Bioinformatics stands as a transformative force, revolutionizing our capacity to interpret diverse datasets and extract additional value from new and existing datasets. In cancer research, bioinformatics plays a pivotal role in identifying cancer-associated genes and biomarkers, offering insights into personalized therapies and precision medicine by analyzing vast genomic, transcriptomic, and proteomic datasets. During the COVID-19 pandemic, bioinformatics expertise proved critical in swiftly identifying and characterizing SARS-CoV-2 virus samples, enabling real-time tracking of variants, and expediting vaccine development.

Beyond healthcare, bioinformatics drives innovation in other sectors, including agriculture, forestry, and environmental monitoring. In agriculture, it enhances crop development by identifying genes associated with favorable traits, improving crop resilience, and ensuring food security amidst climate change challenges. Similarly, in forestry, bioinformatics aids in understanding wood quality and plant-based pathogens, contributing to sustainable forestry practices and environmental conservation efforts.

In industry, bioinformatics optimizes bioprocesses, accelerates bio-based product development, and supports environmental monitoring initiatives. The economic implications of investing in bioinformatics capacity are significant. It attracts research funding, fosters innovation, and creates high-skilled job opportunities, driving economic growth and positioning Alberta as a leader in the global bioeconomy. Moreover, bioinformatics enhances the competitiveness of industries reliant on biological data analysis, further contributing to economic prosperity and societal well-being.

1. Bioinformatics is an essential component of the digitalization of healthcare to reduce costs and inefficiencies.

The healthcare industry in Alberta has an estimated annual expenditure of $24.5 billion in 2023 (Alberta, Alberta.ca, 2023). Studies have shown that this industry has and will continue to benefit from the

increased inclusion of technological advancement to reduce existing costs (Gentili A, 2022). These studies indicate that increased digitalization of the health care system reduces inefficiencies and redundancies, implementation of these interventions would require a significant increase in data collection and storage. Investing in an increase in bioinformatics capacity now readies the workforce for this shift and will lead to reduced waste in healthcare spending in the long-term.

2. Agricultural breeding programs and precision agriculture generate massive datasets requiring bioinformatics expertise to parse and store.

In agriculture, bioinformatics plays a pivotal role in enhancing breeding programs and developing resilient crop varieties, essential for mitigating the effects of climate change and ensuring optimal yields across Alberta's diverse regions (Novak, 2001). Furthermore, precision agriculture, enabled by modeling of large-scale datasets, maximizes crop productivity, contributing to the sector's estimated $14 billion economic output in 2021 (Alberta, Alberta Trader Services, 2023). Bioinformatics algorithms are necessary to interpret genomic data capable of improving yield and combating the impacts of climate change on Alberta forests (Cappa, 2022) (Service., 2004), maintaining and potentially growing this sector's economic output in future years.

3. Alberta houses significant AMR research capacity, a multidisciplinary field that benefits greatly from the inclusion of bioinformatics expertise.

Alberta has a strong research foundation in antimicrobial resistance (AMR) research with the University of Calgary being the home of the AMR – One Health Consortium. As a national leader in AMR, this consortium focuses on responsible antibiotic use and resistance research through a transdisciplinary approach. It is estimated that AMR contributes upwards of $400 million in healthcare costs to Canada annually (Diener A, 2019). Furthermore, it is estimated that combined impacts from loss of gross domestic product were estimated to be between $1.4 and $2 billion in 2018 with potential to lead to a cumulative decline in the range of $388 billion by 2050 (CIHR, 2024). This consortium has diverse research priorities generating vast amounts of data and continues to grow as the current and potential impacts of AMR draw attention from various sectors. These projects will produce significant amounts of raw data requiring interpretation, storage, and analysis all of which will require expertise in bioinformatics and computational biology.

4. With vast swathes of land and abundance natural resources, Alberta requires substantial environmental monitoring programs that rely on bioinformatic interpretation and data storage to be fully effective.

Environmental monitoring programs in Alberta heavily rely on bioinformatics for data analysis and interpretation, spanning crucial areas such as air quality, water management, agriculture, climate research, and oil sands analysis. Investments in bioinformatics strategies are paramount for supporting these efforts, enabling the identification of emerging challenges and driving economic growth through informed decision-making. In essence, bioinformatics serves as a cornerstone of economic growth, innovation, and sustainability in Alberta, reinforcing its status as a leader in scientific discovery and technological advancement across diverse sectors.

GAPS, CHALLENGES AND OPPORTUNITIES

Challenges facing the Albertan bioinformatics sector.

1. The next generation of bioinformaticians do not have access to training in Alberta.

2. Bioinformatics is rarely viewed as a research discipline that requires investment to grow.

3. Alberta lacks a provincial bioinformatics innovation and application strategy.

4. Bioinformaticians are not included in development stages of projects.

5. Lack of funding for basic software creation and long-term storage hampers research and creates a bottleneck.

1. The next generation of bioinformaticians do not have access to training in Alberta.

The burgeoning expansion of data-driven disciplines and the perpetual evolution of computational platforms necessitate a concurrent surge in a skilled workforce adept in bioinformatics across diverse fields. As highlighted in our exploration of Alberta's bioinformatics landscape, the province possesses a rich tapestry of research excellence and collaborative networks, exemplified by initiatives like BioNet Alberta. This robust foundation underscores Alberta's readiness to lead in bioinformatics innovation and application. By aligning with the insights gleaned from our analysis of the economic impact of bioinformatics, targeted investments and funding initiatives can serve as catalysts for nurturing and expanding the existing pool of bioinformatics expertise. Such strategic interventions not only reinforce Alberta's competitive edge but also bolster its position as a frontrunner in scientific discovery and technological advancement, propelling us towards a future defined by innovation, economic prosperity, and societal well-being.

Alberta urgently requires comprehensive training programs province-wide to address the growing demand for bioinformatics expertise across various sectors. While the University of Calgary's Bachelor of Health Sciences in Bioinformatics offers valuable training, its limited student capacity and narrow focus on healthcare underscore the need for additional programs. Moreover, the University of Lethbridge's and Athabasca University's certificates in bioinformatics, though beneficial, lack the depth and breadth of a graduate-level program required to fully equip future bioinformaticians with the necessary skills and knowledge. Expanding and diversifying training offerings throughout the province is essential to meet the evolving needs of Alberta's bioinformatics landscape and ensure a robust pipeline of skilled professionals.

2. Bioinformatics is rarely viewed as a research discipline that requires investment to grow.

Unlike traditional laboratory-based research fields, bioinformatics operates at the intersection of biology, computer science, and data sciences, relying heavily on sophisticated algorithms and computational tools to decipher complex biological data. However, the intangible nature of computational research outputs and the misconception that bioinformatics merely supports

experimental findings rather than driving discovery often relegate it to a secondary role in research funding priorities.

The interdisciplinary nature of bioinformatics presents challenges in defining its scope and establishing dedicated funding streams, leading to a lack of centralized support and resources for bioinformatics research initiatives. This fragmentation further perpetuates the perception of bioinformatics as an ancillary discipline rather than a primary driver of scientific advancement. Additionally, the absence of standardized metrics for assessing the impact of bioinformatics research exacerbates difficulties in demonstrating its tangible contributions to scientific knowledge and innovation.

Members of the scientific community that handle large datasets view bioinformatics as an essential tool to push forward research projects with complex data generation, however, there is a critical need for greater awareness and advocacy regarding the significance of bioinformatics as a standalone research discipline. This entails educating funding agencies, policymakers, and the broader scientific community about the transformative potential of bioinformatics in unraveling biological complexities, advancing precision medicine, and catalyzing innovation across various domains. In Alberta, acknowledging bioinformatics as a strategic priority and investing in specialized infrastructure, training initiatives, and collaborative networks can unlock its full potential to tackle urgent research challenges and propel scientific advancements.

3. Alberta lacks a provincial bioinformatics innovation and application strategy.

Alberta currently faces a notable absence of a coordinated provincial strategy specifically tailored to foster innovation and application of bioinformatics. In contrast to regions such as Ontario, which has established dedicated initiatives like the Ontario Institute for Cancer Research (OICR) and the Vector Institute for Artificial Intelligence, Alberta lacks a cohesive approach to harnessing the full potential of bioinformatics across sectors. Similarly, jurisdictions like British Columbia have implemented strategic frameworks such as the BC Cancer's Personalized Oncogenomics Program (POG) and the BC Genome Sciences Centre, demonstrating a concerted effort to leverage bioinformatics for scientific and economic growth. This deficiency hampers the province's ability to strategically allocate resources, coordinate research efforts, and capitalize on emerging opportunities in bioinformatics-driven fields such as healthcare, agriculture, and environmental monitoring. Without a comprehensive strategy, Alberta risks falling behind in leveraging bioinformatics to address critical challenges and capitalize on emerging opportunities, thereby impeding its potential for scientific innovation and risks losing potential investments from public or private sectors who view other provinces as better incubators for projects requiring bioinformatics capacity.

4. Bioinformaticians are not included in development stages of projects.

While bioinformaticians work closely with other researchers across diverse research disciplines, they are often viewed as service providers and enlisted too late in the research process. Not including bioinformatics experts in the project design phase is a common issue that leads to critical inefficiencies, wastes time and to often necessitates the costly collection of additional data to ensure the research questions are suitably addressed. This delayed involvement not only undermines the efficiency of

research projects but also compromises the quality and relevance of bioinformatics analyses, as critical insights and considerations may have been overlooked during the initial planning stages. Research groups collecting large amounts of data, especially those employing omics technologies to generate sequencing data, can benefit greatly by consulting and collaborating with bioinformaticians from the beginning of projects.

5. Lack of funding for basic software creation and long-term storage hampers research and creates a bottleneck.

Traditionally, bioinformatics software and tools have been developed by independent investigators, relying on limited government grants dedicated to software development. While this approach has led to the creation of numerous free tools, pipelines, and algorithms, it also presents challenges. These tools often suffer from errors, lack user-friendly interfaces, and have poor documentation and maintenance (Mangul S, 2019). These challenges impede the deployment of bioinformatics solutions in industrial or clinical settings, where reliable and reproducible pipelines are essential for data analysis and decision-making. Without increased support for software development, bioinformatics tools may remain inaccessible for practical applications, hindering progress in fields such as personalized medicine and agriculture.

In contrast, large-scale public funding has supported omics research initiatives like the 1000 Genomes Project (Fairley, 2019) and The Cancer Genome Atlas (Genomics, 2023)), heavily relying on bioinformatics for data management and analysis. Investments in sequence storage platforms like GenBank (Medicine, 2023) and Ensembl Browser (Cunningham, 2021) have also been made. However, the effective utilization of these resources depends on the development of robust bioinformatics infrastructure and tools.

(Gauthier J, 2019)of omics research initiatives and ensure the effective utilization of genomic data for scientific discovery and societal benefits. Strengthening the bioinformatics infrastructure enhances the utility of existing resources and fosters progress in various fields, including medicine and agriculture.

As the volume of publicly available omic sequence data continues to grow exponentially, our need for robust data storage and management systems has become increasingly urgent (Gauthier J, 2019). The existing digital storage platforms in Canada, including the Digital Research Alliance of Canada, are inadequate to handle this escalating demand, necessitating additional funding for computational infrastructure.

RECOMMENDATIONS FOR ACTION

Coordinate, stimulate, and transform bioinformatics in Alberta.

1. Encourage the recruitment and training of highly qualified personnel in bioinformatics within Alberta's academic and industrial sectors by investing in workforce development.

2. Devise and implement a provincial bioinformatics innovation and application strategy.

3. Promote the integration of bioinformatics expertise in collaborative projects across Alberta's research landscape.

4. Facilitate growth of Alberta-based bioinformatics research and software development through increased field-specific and dedicated funding and its integration to National bioinformatics networks.

1. Encourage the recruitment and training of highly qualified personnel in bioinformatics within Alberta's academic and industrial sectors by investing in workforce development.

Alberta should prioritize the recruitment and training of highly qualified personnel in bioinformatics and computational biology to meet the growing demand for expertise in these fields. Collaborative efforts between government, academic institutions, and industry partners are essential to develop internship programs and facilitate cross-training opportunities that bridge the gap between academia and industry. By fostering these partnerships, Alberta can ensure that its workforce is equipped with the diverse skillsets and expertise required to thrive in the competitive industrial landscape.

The establishment of diverse bioinformatics and computational biology training programs at post-secondary institutions across the province is essential to meet the evolving needs of the workforce. These programs should offer comprehensive curricula that blend theoretical knowledge with practical skills, preparing students for careers in various sectors, including healthcare, agriculture, and environmental monitoring.

Addressing the wage disparity between academic and industry positions is crucial to attract and retain top talent in bioinformatics and computational biology. Increasing funding for scientific research grants would enable researchers at all levels, including graduate, post-graduate, and professional, to receive competitive wages commensurate with their expertise and contributions. This investment not only enhances the attractiveness of research programs but also supports the long-term retention of skilled personnel within Alberta. By investing in education and training, Alberta can cultivate a robust talent pool capable of driving innovation, research excellence, and economic growth in bioinformatics and computational biology.

2. Devise and implement a provincial bioinformatics innovation and application strategy.

To devise and implement a provincial bioinformatics innovation and application strategy, Alberta must undertake a comprehensive and collaborative approach that involves key stakeholders from academia (PSIs), government (AAFC centres, CFIA, APL and AHS), industry, and the broader bioinformatics community (BioNet). Drawing upon successful strategies implemented in other provinces that have established task forces or advisory committees, Alberta can learn from their experiences to guide the development of its own strategy. This collaborative effort will further allow for the identification of priority areas for bioinformatics innovation and application, setting strategic goals akin to those seen in successful provincial initiatives, and outlining actionable steps to achieve them.

Dedicated funding streams for bioinformatics research, as observed in other provinces, will be essential to support a wide range of activities, including:

- basic research,
- software development,
- infrastructure enhancement,
- collaborative initiatives between academia and industry.

By investing strategically in bioinformatics, Alberta can position itself as a leader in cutting-edge research and innovation, following the models of successful initiatives in other provinces. Fostering interdisciplinary collaboration, talent development, infrastructure enhancement will be crucial for Alberta to realize the full potential of bioinformatics in addressing pressing challenges.

Investing in a comprehensive bioinformatics innovation and application strategy now will not only catalyze scientific advancements and economic growth but also yield long-term cost savings. By strategically allocating resources to prioritize bioinformatics research, development, and application, Alberta can address critical challenges, foster innovation, and enhance its competitiveness in the global bioinformatics landscape. Moreover, the proactive investment in will mitigate future costs associated with inefficiencies, missed opportunities, and the potential consequences of lagging in bioinformatics advancements. Therefore, prioritizing bioinformatics now represents a prudent investment that will yield significant dividends in the form of scientific breakthroughs, economic prosperity, and improved societal well-being in the years to come.

3. Promote the integration of bioinformatics expertise in collaborative projects across Alberta's research landscape.

We envision a research environment where bioinformaticians are recognized as equal contributors from the inception of project planning, ensuring that their expertise is integrated into the design phase to optimize data generation and usability. By involving bioinformatics expertise early on, research projects can generate high-quality data while minimizing the production of unusable data. This proactive approach not only streamlines the research process but also enhances the overall quality and reliability of the data collected.

Integrating bioinformatics expertise at the project planning stage facilitates the creation of datasets that are readily shareable across research groups, fostering collaboration and facilitating larger multi-disciplinary research projects. With bioinformaticians guiding data collection and management

practices, concerns related to data security, storage, and standardization can be addressed more effectively and affordably, ensuring that research outcomes are robust, reproducible, and compliant with best practices.

Improving public awareness of bioinformatics and its wide-ranging applications in various research disciplines through outreach efforts is essential for fostering better inclusion of bioinformatics expertise in collaborative research groups. By educating researchers, funding agencies, and the public about the value of computational biology, we can promote a culture of interdisciplinary collaboration and appreciation for the pivotal role that bioinformatics plays in driving scientific discovery and innovation. This increased awareness will further encourage the active involvement of bioinformaticians in research projects, ultimately enhancing the quality and impact of research outcomes across diverse fields.

4. Facilitate growth of Alberta-based bioinformatics research and software development through increased field-specific and dedicated funding and its integration to National bioinformatics networks. To facilitate the growth of Alberta-based bioinformatics research and software development, it is imperative to enhance field-specific and dedicated funding initiatives. Developing appropriate funding models and providing sustained support for bioinformatics endeavors, including software development and maintenance, is essential for advancing this critical research domain.

Specifically, bioinformatics software development stands to benefit significantly from funding competitions tailored to this purpose. Such competitions should prioritize the principles of good software development, placing emphasis on robust coding practices and usability rather than solely on the novelty of the tool. Embracing this approach aligns with common practices outside of research disciplines, where the creation of well-coded tools is routinely supported and funded. By adopting similar standards within the field of bioinformatics, funding providers can foster the development of high-quality software solutions that meet the evolving needs of researchers and industry stakeholders.

Furthermore, continued investment in shared high-performance research computing clusters is paramount. Given the exponential growth in computational demands within bioinformatics, these clusters serve as vital infrastructure for processing and analyzing large-scale biological datasets. Ensuring access to powerful computing resources enables researchers to conduct complex analyses and simulations, driving innovation and discovery in bioinformatics.

In addition to computational resources, it is crucial for funders to recognize the importance of long-term data storage. While existing resources often prioritize short-term storage solutions, researchers frequently encounter challenges in accessing sufficient storage for project resources and data once a project timeline concludes. By acknowledging and addressing this need for sustainable data storage infrastructure, funders can support the preservation and accessibility of valuable research data, facilitating ongoing scientific progress and collaboration.

CONCLUSION

Bioinformatics and computational expertise are essential drivers to handling the large datasets and complex experimental results obtained across multiple research disciplines. Analysis and interpretation of these datasets drives innovation in health, agriculture, forestry, environmental monitoring, and artificial intelligence while storage and security solutions employed by computational biologists ensure appropriate security, accessibility, and maintenance of this material. Alberta should strive to empower bioinformaticians through increased funding for the development and maintenance of good software, encourage collaborative funding opportunities that involve a computational biologist from project inception and continue to invest heavily in training and retention programs for expertise already located in the province. Alberta currently sits at a point where a failure to acknowledge and address the noted problems in this field will have significant downstream effects, hampering economic output in agriculture and forestry, increasing health costs through the bottle necking of precision healthcare practices, reducing the cutting-edge output of research institutions, and providing a less ideal landing spot for start-ups working in these spaces. Bioinformatics should be viewed as a primary research discipline, no longer a sidekick to other research areas and funded as such. As computational power continues to progress rapidly, the need for experienced bioinformaticians will become even more pressing at all levels from academic research, government scientists to industry programs. Investment now into bioinformatics will have long-term positive consequences on numerous economic streams and the overall population and health of Albertans and steps taken today to maintain expertise, strengthen training programs and prepare for challenges both existent and on the horizon will not only be a worthwhile use of existing funds but prevent waste of funds to meet bioinformatic requirements in the future.

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