Table of Contents

About the BioTalent Canada bio-economy skills profiles

Biotechnology's fusion of science and business creates unique requirements for occupations in the sector. Executives and managers must have technical expertise; technical staff often need entrepreneurial skill sets. Occupational descriptions from other sources don't always fit the bio-economy context. That's why, in partnership with industry stakeholders, BioTalent Canada has developed skills profiles specific to the bio-economy including this description of the role Bioinformatician.

Occupational Definition

Bioinformatics involves the application of mathematical principles and computational technologies to the understanding, modification and utilization of biological substances, organisms, processes and systems. More recently, the application of bioinformatics in genomic sciences has grown rapidly to provide computational methods with which to extract, view and analyze genomic information both at the level of the individual and the population. Bioinformaticians develop methods, standards, guidelines and documentation for the data management team of companies. They work with and support the functions of data capture and analysis, laboratory automation, database mining, software development and scientific management systems. Bioinformaticians use computational approaches to extract information from chemical, biological and ecological measurements, enabling them to analyze and interpret the experimental data. They are often involved in drug design and gene expression work by performing analysis on the data obtained. Working as part of a team they collaborate with scientists, IT personnel, government agencies and executives. Bioinformaticians may work for Canadian biotechnology companies of different sizes (i.e., small, medium, large) and in various biotechnology areas, such as:

- Agriculture
- Aquaculture
- Bioenergy
- Bioproducts
- Biosciences
- Environment
- Food processing
- Forestry
- Genomics
- Human health
- Industrial
- Life Sciences
- Natural resources
- Nutraceuticals
- Pharmaceuticals

Components of the skills profile

Every BioTalent Canada skills profile presents the areas of competence, tasks and sub-tasks associated with a specific occupation.

Area of competence (AC): This describes a major function or responsibility associated with the profession, trade or position.

Task: This is a specific, observable unit of work with definite start and end points. Tasks can be broken down into two or more steps and are generally performed in a limited period of time. Tasks and ACs are identified in behavioural terms, beginning with a verb that describes the applied behaviour.

Subtask: This is a distinct, observable activity that comprises the steps involved in a task.

Important Action/Performance Standard: This provides a criterion for assessing competence and may be used as a performance indicator.

Focus on competencies

The BioTalent Canada skills profiles are built around *areas of competence* because competencies are flexible, inclusive and linked directly to performance: they are the traits or qualities a professional must have to succeed in a given role within a given organization, and can be used for recruiting, professional development, curriculum planning and many other purposes.

How to use the profiles

The complete contents of this or any BioTalent Canada skills profile are unlikely to be used for any one position. Because they are comprehensive, they include every area of competence, task and subtask that *could* be required for a specific occupation. In reality, the definition of a given job will encompass a narrower subset of the profile. Hiring organizations must choose the elements of the profiles that are relevant to their businesses—and tailor those elements as necessary to more precisely describe their particular job requirements.

The profiles can be put to many uses:

- ***Employers*** can use them to develop job descriptions, performance evaluations, professional development, succession planning, team building, target skills needed, and recruitment plans.
- ***Job seekers*** can use them to tailor their resumes, prepare for interviews, see job descriptions and identify additional professional development needs.
- ***Educators*** can build industry-oriented curricula from the profiles to produce job-ready graduates.
- ***Students*** can enhance their understanding of employers' expectations and choose the right educational programs to equip themselves with the skills for success.

Scenario

The following illustrates how an employer might use the BioTalent Canada skills profiles to identify professional development priorities for his or her team.

Step 1

The employer would review the ACs for each occupation and identify which apply to the related positions within his or her company, omitting those that are not relevant.

Step 2

Under the selected ACs, the employer then notes which of the associated tasks, subtasks and important actions are relevant to that specific position within his or her business.

Step 3

Now with a complete, tailored profile, the employer can assess employee performance. Needs areas are easily identified and defined—to a significant depth of detail.

Step 4

Based on the needs analysis, the employer can either develop or seek out professional development programs that address employee

needs areas.

Situational Analysis

Bioinformaticians typically work in full-time positions within large biotechnology companies or organizations with extensive research and development departments focusing on, for example, DNA science, gene networks, -omics technologies, and systems biology analyses. Many Bioinformaticians work as faculty within post-secondary educational institutions where they many contribute to companies' research and bioinformatics needs on a contractual basis. As members of the core research and development team of a company, Bioinformaticians are part of a highly collaborative, fast-paced, multi-disciplinary research environment. Bioinformaticians often interface between biology, chemistry, biochemistry, computer science, and mathematics, creating new solutions for a wide range of applications including high-throughput chemistry, designing analysis systems for drug design, and many other processes. Bioinformaticians must be able to demonstrate an ability to deliver high quality methods and tools to support chemists, biologists, biochemists and other company researchers engaged in a wide range of fields. They work in close collaboration with bench scientists, helping them to plan and organize experiments and data collection so as to maximize the production of reliable and useful information.

Bioinformaticians perform a range of tasks depending on company requirements. They generally develop methods, standards, guidelines and documentation for the data management team. Bioinformaticians provide expertise and tools to various parts of research and development phases, depending on specific project needs. As a key part of the project team, they work with the research team to anticipate where bioinformatics may contribute to research productivity and to determine appropriate bioinformatics tools. They may offer input related to genome annotation, to the development of gene or metabolic networks. They may infer evolutionary relationships, protein structures and functions, conduct systems biology analyses, and contribute to bio-product development processes and to the identification of biomarkers. They use computer simulations to analyze biological networks and sub-systems. They use their computer expertise to design algorithms, write computer programs, create web-based tools, and to create, maintain and administer databases and data warehouses. They perform statistical inferences and simulations and interpret statistical results. Bioinformaticians manipulate and manage project data in a variety of ways: they respond to clustering and classification requests, interpret data mining results, interpret search findings from data repositories, and respond to data organizing and archiving needs. They also are responsible for disseminating information to team members and to external audiences through reports, presentations, and scientific papers. They work with and support the functions of data capture and analysis, laboratory automation, database mining, software development and scientific management systems. They must be able to evaluate the tools currently available in the bioinformatics group, identify and evaluate commercially-available tools and then carry out the planning, quantitative analysis, and scientific curation of a virtual compound library.

Bioinformaticians should possess strong technical and analytical skills for performing the tasks inherent to bioinformatics work. They should be highly motivated self-starters who enjoy an element of ambiguity in their work. They should be detail-oriented problem solvers who are able to apply scientific methods in practical, useful and creative ways. Bioinformaticians must be willing to adapt to changing environments and be great team players as they interface with personnel from various departments in their companies. They should have excellent interpersonal skills, open minds and the courage to question conventional thinking and take on challenges.

Bioinformaticians need to have an eclectic, multi-disciplinary background that blends biology, chemistry and biochemistry with mathematics and computer science. They should possess undergraduate or graduate-level degrees in computer science and/or applicable scientific field such as biology, chemistry, biochemistry, in order to work effectively in the biotechnology industry. This initial degree should be complemented by education or training in the secondary area of focus – a scientific field or computer science - as needed. Alternative areas of focus which provide a sound base for work in bioinformatics include Biochemistry, Mathematics, Statistics, Molecular Biology, Computer Science, Computational Chemistry, or other related field. Many academic institutions require a PhD for Bioinformaticians looking to carry out research work and teaching.

Many bioinformatics positions in industry require that job incumbents have 3-4 years of industry experience in the area of bioinformatics or cheminformatics, computational or medicinal chemistry. Job incumbents should also bring working knowledge of: public domain biofinformatics data sources; public sequence databases; sequence assembly tools; gene expression analysis software; basic programming knowledge and proficiency in a range of programming languages. Organizations and companies may also seek a Bioinformatician who can demonstrate strong subject-specific knowledge pertinent to a company's area of focus (e.g., cancer biology, structure-based drug design, pharmacology, etc.). Continuous learning is extremely important for Bioinformaticians given the fast-evolving nature of the work. Bioinformaticians should take advantage of professional development courses through the Canadian Bioinformatics Workshop Series, or learn about current research techniques, tools and developments though industry journals and published academic research studies.

Essential Skills

The most important Essential Skill(s) for this Profile: ✓

	Reading Text	✓	Thinking Skills – Problem Solving		Working With Others
	Document Use		Thinking Skills – Decision Making	✓	Computer Use
	Writing		Thinking Skills – Critical Thinking		Continuous Learning
✓	Numeracy		Thinking Skills – Job Task Planning & Organizing		
	Oral Communication		Thinking Skills – Significant Use of Memory		
			Thinking Skills – Finding Information		

Bioinformaticians need to have a multi-disciplinary skill set that blends biology, chemistry and biochemistry with mathematics and computer science. They should be detail-oriented problem solvers who are able to apply scientific methods in practical, useful and creative ways. They need up to date expertise and experience in computer programming, data analysis and information storage/retrieval. As key members of research teams they also require strong interpersonal skills and the ability to work well with others.

Language Benchmarks

Bioinformaticians must be able to work effectively as part of the data management team and will need an upper language benchmark level of CLB 9.

Competency Profile

A Bioinformatician must be able to:

A. Provide Bioinformatics Expertise to Molecular Biology

TASKS	SUBTASKS	IMPORTANT ACTIONS / PERFORMANCE STANDARDS
1. Infer evolutionary relationships	1.1 Obtain data on components to be aligned [e.g. protein or DNA sequence data]	
	1.2 Generate multiple sequence alignments	
	1.3 Generate phylogenetic trees	
	1.4 Choose appropriate methods to generate multiple sequence alignments and phylogenetic trees	
	1.5 Predict the evolutionary behaviour of organisms over time	
	1.6 Track and share evolutionary information on a large number of species and organisms	
2. Infer protein sequence, structure and function	2.1 Perform molecular modelling	
	2.2 Search similarities in protein structures by homology analysis and modelling	
	2.3 Infer structures of unknown proteins	
	2.4 Use bio-analytical techniques as necessary, for example: • Mass spectrometry • Nuclear magnetic resonance	

TASKS	SUBTASKS	IMPORTANT ACTIONS / PERFORMANCE STANDARDS
	• X-ray crystallography	
3. Annotate genomes	3.1 Use software and tools to analyze genomic DNA	
	3.2 Find new genes in genome	
	3.3 Find the transfer mRNA	
	3.4 Make initial assignments of the function of genes	
	3.5 Find exons and introns, as required	
	3.6 Align the known sequences of one species to that of another species whose the genome is being annotated	
4. Identify gene networks	4.1 Establish correspondence between genes, i.e., orthology analysis or coexpression analysis	
	4.2 Develop predictive mathematical models for these correspondences	
	4.3 Find common regulatory mechanisms	
	4.4 Use computer simulations to analyze networks of genes (e.g., Cytoscape)	
5. Identify metabolic networks	5.1 Establish associations between metabolic pathways	
	5.2 Use computer simulations to analyze networks of metabolites	
	5.3 Use computer simulations to analyze networks of metabolic enzymes	

6. Apply principles of bio-analytical chemistry	6.1 Understand the analytical techniques behind, for example: • Proteomics • Transcriptomics • Metabolomics • Lipidomics • Glycomics • Chemical • Genomics	
7. Conduct systems biology analyses	7.1 Combine information from various -omics technologies and studies to answer specific questions and for hypothesis generation	
	7.2 Perform computer simulations of cellular sub-systems (e.g., signal transduction pathways and gene regulatory networks) to analyze and visualize the connections	
	7.3 Use machine-based learning tools (e.g. hierarchical clustering, principal component analysis) to find links between various data	
8. Contribute to identification of biomarkers	8.1 Use -omics technologies (e.g., genomics, proteomics, transcriptomics, metabolomics, lipidomics, glycomics) to develop markers for scientific applications	
	8.2 Collaborate with specialists, especially pharmacologists, clinical research physicians, statisticians and epidemiologists	

	8.3 Use statistical analyses to mine -omics data for new biomarks	
	8.4 Validate predictive power of new biomarkers by evaluating -omics data from other clinical samples	
9. Contribute to bio-product development processes	9.1 Contribute to, for example: • Drug development processes • Development of neutraceuticals • Development of novel crops • Development of industrial enzymes and fermentation organisms • Food science research	

A Bioinformatician must be able to:

B. Create and Modify Bioinformatics Software

TASKS	SUBTASKS	IMPORTANT ACTIONS / PERFORMANCE STANDARDS
1. Define bioinformatics needs	1.1 Fully understand projects and questions involved	
	1.2 Communicate with research team	
	1.3 Anticipate where bioinformatics may contribute to research	
	1.4 Determine appropriate bioinformatics tools for given projects (e.g., expert systems)	
	1.5 Express bioinformatics needs and obtain feedback	
	1.6 Model the biological requirements to computational problems	
2. Design algorithms	2.1 Find appropriate existing algorithms	
	2.2 Modify if needed	
	2.3 Design new algorithms if needed	
	2.4 Test new algorithms relative to old algorithms using data	
3. Write computer programs	3.1 Be familiar with suitable programming languages	
	3.2 Design, implement and test programs and ensure that they are properly documented	
	3.3 Write user manuals and perform training, as required	

4. Create web-based bioinformatics tools	4.1 Be familiar with web development environment and collaborate with web design experts as needed	
	4.2 Design, implement and test web-based tools	
	4.3 Obtain user feedback and expert advice/assistance to improve and refine web-based tools	
5. Create, maintain and administer databases	5.1 Design and create databases	
	5.2 Design maintenance tools	
	5.3 Set user permissions	
	5.4 Perform database maintenance regularly	
	5.5 Import databases and tools from existing sources for in-house use	
6. Create and maintain data warehouses	6.1 Design and create data warehouses	
	6.2 Perform maintenance regularly	
7. Create and maintain sample tracking software	7.1 Design and create sample tracking software	
	7.2 Interface with existing relevant databases	
	7.3 Set user permissions	
	7.4 Perform maintenance	
	7.5 Write user manuals and perform training, as required	

A Bioinformatician must be able to:

C. Perform Statistical Analyses

TASKS	SUBTASKS	IMPORTANT ACTIONS / PERFORMANCE STANDARDS
1. Perform statistical design of experiments (DOE)	1.1 Understand the client's overall needs	
	1.2 Understand the sampling needs	
	1.3 Understand sources of statistical error	
	1.4 Be aware of economic constraints associated with the experiment	
2. Perform statistical inference	2.1 Determine hypotheses to be tested	
	2.2 Determine confidence level	
	2.3 Determine the distributional characteristics of data	
	2.4 Determine appropriate models to fit data	
	2.5 Determine statistical correlations	
	2.6 Perform data visualization to visualize the nature of the data before and after analyses	
3. Perform statistical simulations	3.1 Use simulations to mitigate excessive experimentation (e.g., Monte Carlo simulations)	
4. Develop methods for pattern recognition	4.1 Develop methods for supervised and/or unsupervised pattern recognition (e.g., classification, clustering, sub-space estimation for	

TASKS	SUBTASKS	IMPORTANT ACTIONS / PERFORMANCE STANDARDS
	data visualization)	
5. Interpret statistical results	5.1 Interpret results for dissemination to, for example: • The research team • Other scientists and statisticians • Non-technical personnel	
	5.2 Communicate results of statistical analyses (e.g., using charts, PowerPoint presentations)	

A Bioinformatician must be able to:

D. Perform Data Mining

TASKS	SUBTASKS	IMPORTANT ACTIONS / PERFORMANCE STANDARDS
1. Obtain data from data warehouses	1.1 Identify appropriate data warehouses	
	1.2 Obtain data according to project needs	
2. Respond to requests for clustering and classification	2.1 Determine when to use clustering or classification, i.e., perform classification when classes are well defined, and perform clustering for raw data	*Supervised vs. unsupervised pattern recognition*
	2.2 Find suitable training sample for classification	
	2.3 Provide feedback to the requestors	
3. Interpret data mining results	3.1 Interpret results for dissemination (e.g., to public, statisticians, molecular biologists, and other scientists)	
	3.2 Communicate results of data mining (e.g., using charts, PowerPoint presentations)	
4. Organize data	4.1 Plan data set organization to enhance data accessibility	
	4.2 Organize and track data sources	

TASKS	SUBTASKS	IMPORTANT ACTIONS / PERFORMANCE STANDARDS
	(e.g., clinical data, field data)	

	4.3 Write manuals that describe data set organization	
5. Archive data	5.1 Follow organizational policies and procedures to archive data	
	5.2 Ensure appropriate backup systems are in place [e.g., work with IT (Information Technology) staff to ensure backup systems are adequate for project needs]	

A Bioinformatician must be able to:

E. Utilize Data Repositories

TASKS	SUBTASKS	IMPORTANT ACTIONS / PERFORMANCE STANDARDS
1. Interact with clients (biologists, chemists and other disciplines)	1.1 Understand scientific basis of the project	
	1.2 Understand project objectives	
	1.3 Understand possible errors in data	
	1.4 Identify proper bioinformatics needs	
2. Use public repositories	2.1 Identify appropriate databases within public repositories	
	2.2 Determine appropriate queries and parameters	
	2.3 Iterate the process, as required	
	2.4 Save search results and perform further bioinformatics tasks	
	2.5 Download data repositories for internal use, as required	
	2.6 Integrate data from various data repositories	
3. Interpret search findings from data repositories	3.1 Refine/process data for further interpretation	
	3.2 Communicate results of searches or processing to team members	
4. Submit data to data repositories	4.1 Ensure data to be submitted is valid and potentially useful	

TASKS	SUBTASKS	IMPORTANT ACTIONS / PERFORMANCE STANDARDS
	4.2 Follow relevant standards for data submission	
	4.3 Update data, as required	
	4.4 Respond to peer review queries	
5. Adapt to data repository changes	5.1 Stay informed about the evolution of public data warehouses (e.g. by skimming through reference material or by subscribing to mailing lists)	
6. Provide input to data repository management	6.1 Propose changes to repositories, as required (e.g., to simplify searches, increase accuracy, enhance reliability)	
	6.2 Participate in repository working groups	

A Bioinformatician must be able to:

F. Disseminate Information

TASKS	SUBTASKS	IMPORTANT ACTIONS / PERFORMANCE STANDARDS
1. Choose appropriate media for data representation	1.1 Gather and collate results	
	1.2 Recognize your audience and select media to suit the audience	
	1.3 Present findings using media, for example: charts, posters, Wikis, oral presentations	
2. Prepare and deliver presentations	2.1 Collaborate with other team members to interpret results [e.g., with molecular biologists, R&D (Research and Development) team]	
	2.2 Prepare and deliver informal and formal presentations	
3. Write standard operating procedures (SOPs)	3.1 Follow formats to write SOPs (e.g., manuals, teaching instructions)	Follow organizational policies and procedures to write and use SOPs
	3.2 Update SOPs, as required	
4. Write technical reports	4.1 Collaborate with other team members (e.g., with molecular biologists, R&D team) to interpret result	
	4.2 Compose interpretation of results	
	4.3 Provide progress reports	
5. Write scientific papers	5.1 Perform literature reviews	

	5.2 Collaborate with other team members (e.g., with molecular biologists, R&D team) to interpret results	
	5.3 Prepare manuscripts in journal format	
	5.4 Respond to peer reviews	
6. Train others	6.1 Identify training needs and opportunities	
	6.2 Prepare training and teaching materials, as required	
	6.3 Mentor others (e.g., students, subordinates)	

A Bioinformatician must be able to:

G. Demonstrate Personal Competencies

TASKS	SUBTASKS	IMPORTANT ACTIONS / PERFORMANCE STANDARDS
1. Demonstrate computational, statistical and molecular biological proficiency	1.1 Be proficient with relevant programming, statistical and molecular biological techniques	
	1.2 Be proficient in algorithm design	
2. Participate in professional development activities	2.1 Keep abreast of relevant scientific literature (e.g., computational technology, statistical analysis trends, molecular biology)	
	2.2 Participate in relevant conferences and forums	
	2.3 Upgrade skills	
	2.4 Take courses, as required, for example: • Time management • Team building • Supervision • Management training • Conflict resolution	
	2.5 Participate in product demonstrations	
3. Demonstrate creativity and innovative approaches	3.1 Devise novel approaches to problem solving	
	3.2 Identify and act on opportunities	
	3.3 Identify and evaluate possibilities	

	3.4 Apply principles of continuous process improvement	
	3.5 Be open to new ideas	
4. Advocate and promote technical policies and procedures	4.1 Advocate and promote technical policies and procedures (e.g., Minimum Information About Microarray Experiment (MIAME) Protocol, and other protocols)	When Bioinformaticians are working in an ISO (International Organization for Standardization) certified environment they must ensure they employ and utilize ISO standards carefully
	4.2 Provide input to organization's policies and procedures	
	4.3 Apply existing policies if no standards have been established	
5. Collaborate	5.1 Collaborate with, for example: • Statisticians • Molecular biologists • Computational biologists • Physicians • Other bioinformaticians	
	5.2 Seek to make computer programs open-source whenever possible to contribute to bioinformatic scientific community	
6. Communicate	6.1 Adapt communication to audience, for example: • Statisticians • Molecular biologists • Physicians • Clients • Students	

	• Public (non-technical) • Other co-workers	
	6.2 Observe discretion when discussing projects (respect confidentiality and privacy requirements for data)	
7. Work within an organizational hierarchy	7.1 Contribute in a positive, proactive way within an organizational hierarchy	
	7.2 Advise management on policy and intellectual property, according to research results	
	7.3 Provide guidance to others, as required	