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Evaluating Genomic Science: A Conversation with Dr. Samantha Evans, Director of Evaluation, Genome Canada

May 21st 2014 from 9:00 a.m. to 12:00 p.m.

UBC Pharmaceutical Sciences– Room 3340

2405 Wesbrook Mall

GenomeCanada Genome BritishColumbia

Definitions in Evaluation

Achievements: Something that has been done or achieved through effort either as an output, deliverable, outcome or as an impact.

Accountability: Obligation to demonstrate that work has been conducted in compliance with agreed rules and standards or to report fairly and accurately on performance results vis a vis mandated roles and/or plans. This may require a careful, even legally defensible, demonstration that the work is consistent with the contract terms.

Activities: Activities are the actions that an organization undertakes using inputs such as funds, technological assistance and other types of resources to produce one or more outputs and demonstrate the "how" of the programs.

Assumptions: Hypotheses about factors or risks which could affect the progress or success of a project activity or intervention.

Attribution: The ascription of a causal link between observed (or expected to be observed) changes and a specific intervention.

Base-line study: An analysis describing the situation prior to a development intervention, against which progress can be assessed or comparisons made.

Benchmark: Reference point or standard against which performance or achievements can be assessed. A benchmark refers to the performance that has been achieved in the recent past by other comparable organizations, or what can be reasonably inferred to have been achieved in the circumstances**.**

Benefits: something that will provide an advantage for others either economic (i.e. cost minimization - least cost alternative; cost effectiveness- cost per unit of consequence; cost benefit- net $ cost: benefit ratio.) or social (i.e. inclusion, integration, safe living, equality). Benefits can be either direct (i.e. reduced health care costs or improved patient health) or indirect benefits (i.e. Savings in productivity or improved quality of life of family and friends of patient)

Beneficiaries: The individuals, groups, or organizations, whether targeted or not, that benefit, directly or indirectly, from the development intervention**.**

Commercialization: The process of extracting economic value from new products, processes, and knowledge through the use of IP rights, licensing agreements, and the creation of spin-off companies[1].

Counterfactual: The situation or condition which hypothetically may prevail for individuals, organizations, or groups were there no development intervention.

Deliverable: a term used in project management to describe a tangible or intangible object produced as a result of an intervention project / initiative / intervention that is intended to be delivered to a reporting entity. It can be an outcome to be achieved or an output to be provided (for example a report, a document, or any other building block of an overall project). A deliverable differs from a project milestone in that a milestone is a measurement of progress toward an output whereas the deliverable is the result of the process. For a typical project, a milestone might be the completion of a research phase while the deliverable might be a genome sequence.

Effect: Intended or unintended change due directly or indirectly to an intervention. Related terms: results, outcome.

Evaluation Plan: is a clear and concise framework that establishes the evaluations to be undertaken over a five-year period, in accordance with the Policy on Evaluation and supporting directive and standard.

Economy: minimizing the use of resources. Economy is achieved when the cost of resources used approximates the minimum amount of resources needed to achieve expected outcomes.

Economic evaluation: The comparative analysis of alternative courses of action in terms of both their costs and consequences in order to assist decision making.

- Costs and consequences - efficiency
- Comparative - relative efficiency

Effectiveness: the extent to which a program is achieving expected outcomes. The term "program effectiveness" refers here to the degree to which a program:

i. makes sense in terms of the relationships between its activities and its expected results;
ii. achieves its objectives;
iii. produces intended and unintended results; and
iv. is cost-effective.

Efficiency: the extent to which resources are used such that a greater level of output is produced with the same level of input or, a lower level of input is used to produce the same level of output. The level of input and output could be increases or decreases in quantity, quality, or both.

[1] Joly Y, Caulfield T, Knoppers BM, Harmsen E, Pastinen T. The commercialization of genomic research in Canada. Healthcare Policy 2010, 6(2): 24-32.

Evaluability: Extent to which an activity or a program can be evaluated in a reliable and credible fashion. Evaluability assessment calls for the early review of a proposed activity in order to ascertain whether its objectives are adequately defined and its results verifiable.

Evaluation: The systematic and objective collection and analysis of evidence on the outcomes of programs or polices to make judgments about their relevance, performance and alternative ways to deliver them or to achieve the same results. The aim is to determine the relevance and fulfillment of objectives, development efficiency, impact and sustainability. An evaluation should provide information that is credible and useful, enabling the incorporation of lessons learned into the decision– making process of both recipients and donors. Evaluation also refers to the process of determining the worth or significance of an activity, policy or program. An assessment, as systematic and objective as possible, of a planned, on-going, or completed development intervention.

Evaluation products: any output of the evaluation function, which may include, but is not limited to, the evaluation plan, terms of reference for individual evaluations, evaluability assessments, evaluation frameworks, evaluation reports, and advice.

Formative evaluation: including pre-testing, is designed to assess the strengths and weaknesses of programs before implementation. Formative evaluation permits necessary revisions before the full effort goes forward. Its basic purpose is to maximize the change for program success before the activity starts.

Interim and final evaluations: focus on the outcomes of the project and the likelihood that they will achieve impact. Evaluations provide an opportunity for in-depth reflection on the strategy and assumptions guiding the project. They assess progress made towards the achievement of a project's objectives and may recommend adjustments to its strategy. They are also a means by which to assess how well project-level actions link to and support higher level strategies and objectives.

Impact: is defined as the positive and negative, primary and secondary long-term effects produced by an intervention, directly or indirectly, intended or unintended.[2] Impact is often only detectable after several years and usually not attained during the life cycle of one project. A project is accountable for achieving outcomes and contributing to impact. Since the achievement of broad, long-term changes depends on many factors, it is usually not possible to attribute impact to one project. All outcomes of a project should contribute to the intended impact.

Impact evaluations and assessments: determine whether project interventions have contributed to longer-term impact. They can be ex-post evaluations of projects or they can be part of thematic or program evaluations that also consider linkages between different projects and interventions.

[2] OECD/DAC definition

Indicators: Quantitative or qualitative factor or variable that provides a simple and reliable means to measure achievement, to reflect the changes connected to an intervention, or to help assess the performance of a development. Indicators enable decision-makers to assess progress towards the achievement of intended outputs, outcomes, goals, and objectives. Indicators can measure inputs, process, outputs, and outcomes.

- Input indicators measure resources, both human and financial, devoted to a particular program or intervention (i.e., number of researcher, amount of funding/cofunding).
- Process indicators measure ways in which project/program research is undertaken (i.e., no cost extensions, milestones met).
- Output indicators measure the quantity and quality of research produced and the efficiency of production (i.e., number of publication, number of conference presentation, number of citations, number of patents).
- Outcome indicators measure the broader results achieved through the provision of new knowledge. These indicators can exist at various levels: societal, economic, institution, program or project. Societal indicators measure changes in the condition or well-being of the population. Changes in societal level indicators are often long-term results of the efforts of a number of different programs, institutions, and initiatives.
- Institution level indicators measure results for which an institution is responsible;
- Program-level indicators measure the results for which a program or sub-program is responsible.
- Project Level indicators measure results for which an project is responsible

Inputs: Inputs are the human, financial and other resources used to deliver activities, produce outputs and accomplish outcomes

Logical framework (Logframe): Management tool used to improve the design of interventions, most often at the project level. It involves identifying strategic elements (inputs, outputs, outcomes, impact) and their causal relationships, indicators, and the assumptions or risks that may influence success and failure. It thus facilitates planning, execution and evaluation of an intervention.

Monitoring: A continuing function that uses systematic collection of data on specified indicators to provide management and the main stakeholders of an ongoing development intervention with indications of the extent of progress and achievement of objectives and progress in the use of allocated funds. Related term: performance monitoring, indicator

Neutral: is an attribute required of the evaluation function and evaluators that is characterized by impartiality in behaviour and process. In carrying out their evaluation responsibilities evaluators do not allow official, professional, personal or financial relationships or interests to influence or limit the scope of the evaluation or evaluation questions and the rigour of their methodology, limit disclosure, or weaken or bias findings. In addition, they will not allow preconceived ideas, prejudices or social/political biases to affect their analysis; the development

of evaluation findings, conclusions, recommendations; and the tone and content of an evaluation report.

Outcomes:
Outcomes are the changes or the differences that result from program activities and outputs. They demonstrate the "why" of the program. Outcomes are sometimes referred to as results. They are defined as short, medium or long-term effects of project outputs. Outcomes are observable changes that can be linked to project interventions. They are logically linked to the intended impact. Outcomes are not within the control of a single element of an organisational activity but can be influenced by a whole range of contextual issues. There are three typical outcomes detailed in logic models:

- **Immediate outcomes**: are directly attributable to the outputs delivered and occur within a short-term timeframe generally considered to be one to three years
- **Intermediate outcomes:** are those which are logically expected to occur once one or more immediate outcomes have been achieved. Often, intermediate outcomes describe behavioural changes that result from increases in a target population's skills, knowledge, awareness and/or access. The change may occur at the individual, group, organizational or community level
- **Ultimate or final outcome:** are the highest-level outcomes that can be reasonably and causally attributed to a policy, program or initiative. They are a consequence of one or more intermediate outcomes having been achieved

Outcome evaluation is used to obtain descriptive data on a project and to document short, medium and long-term results. Task-focused results are those that describe the output of the activity (e.g., the number of public inquiries received as a result of a public service announcement). Short-term results describe the immediate effects of the project on the target audience (e.g., percent of the target audience showing increased awareness of the subject).

Outputs: Outputs are the direct products that result from the activities undertaken by the organization. These are usually within the control of the organization and are intended to be illustrative of the work being completed rather than a comprehensive list.

Performance: The extent to which an intervention/project/program operates according to specific criteria/standards/guidelines or achieves results in accordance with stated goals or plans. Issues also considered include effectiveness, efficiency and economy.

Performance indicators: A performance indicator or key performance indicator (KPI) is a variable that allows the verification of changes in an intervention/project or shows results relative to what was planned. Most organizations and initiatives use KPIs to evaluate their success, or to evaluate the success of a particular activity in which it is engaged. Success in an evaluation context is defined in terms of making progress toward goals. When developing indicators they should be assessed in terms of the cost of collection (time, resources) versus the benefit derived from the data. Types of indicators include:

- Quantitative indicators.
- Qualitative indicators
- Leading indicators that can predict the outcome of a process

- Lagging indicators that present the success or failure post hoc
- Input indicators that measure the amount of resources consumed during the generation of the outcome
- Process indicators that represent the efficiency or the productivity of the process
- Output indicators that reflect the direct products of activities
- Outcome indicators that reflect the outcome or results of the process activities
- Directional indicators specifying whether or not an organization is getting better.
- Actionable indicators are sufficiently in an organization's control to effect change.
- Financial indicators

Performance measurement: A system for assessing performance of development interventions against stated goals.

Performance measurement framework is often developed as part of an evaluation strategy to guide the evaluation process. It sets out the performance indicators and the methods for collecting the required data for the outcomes that have been described in the logic model. Information captured in the framework include the outputs / outcomes anticipated; performance indicators; a baseline data point; targets; whether it's a qualitative or quantitative measure; frequency of collection; data source (i.e. a particular database or file) and the function responsible for data collection.

Performance measurement strategy: the selection, development and ongoing use of performance measures for program management or decision-making.

Performance monitoring: A continuous process of collecting and analyzing data to compare how well a project, program, or policy is being implemented against expected results.

Policy: official guidelines or operating principles that influence behaviour towards a stated outcome.

Process evaluation: examines the procedures and tasks involved in implementing a program. This type of evaluation also can look at the administrative and organizational aspects of the program. Process evaluation monitors the program to ensure feedback during the course of the program.

Program: a group of related activities that are designed and managed to meet a specific public need and are often treated as a budgetary unit.

Relevance: the extent to which a program addresses a demonstrable need, is appropriate and responsive to that needs.

Reliability: Consistency or dependability of data and evaluation judgments, with reference to the quality of the instruments, procedures and analyses used to collect and interpret evaluation data.

Results: The output, outcome or impact (intended or unintended, positive and/or negative) of an intervention/initiative/project. Related terms: outcome, effect, impacts.

Results Chain: The causal sequence for an intervention /initiative/project that stipulates the necessary sequence to achieve desired objectives beginning with inputs, moving through activities and outputs, and culminating in outcomes, impacts, and feedback. Related terms: assumptions, results framework.

Results framework: The program logic that explains how the development objective is to be achieved, including causal relationships and underlying assumptions.

Summative Evaluation: Any combination of measurements and judgments that permit conclusions to be drawn about impact, outcome, or benefits of a program or method after it has been completed.

Technology transfer: Moving advances in knowledge and technology into the commercial stream, where they can be put to work for the public good[3] .

Triangulation: The use of three or more theories, sources or types of information, or types of analysis to verify and substantiate an assessment. Note: by combining multiple data sources, methods, analyses or theories, evaluators seek to overcome the bias that comes from single informants, single methods, single observer or single theory studies.

Valorization: A broad concept encompassing all channels that contributes to ensuring that the outcomes of scientific knowledge add value beyond the scientific domain[4]. It is a "process of realization" of relevant added value products (e.g. novel systems or devices derived from genome-based technologies) in a given domain for broad, societal benefit[5] . The importance of both economic and social values should be recognized[6]. Valorization is broader than commercialization, which is motivated primarily by profit[7].

Value for Money: Assesses the cost of a product or service against the quality of provision.

[3] National Research Council of the National Academies (Merrill SA, Mazza A-M, eds.) Managing University Intellectual Property in the Public Interest. Washington, D.C.: National Academy Press, 2010.
[4] Benneworth P, Jongbloed BW. Who matters to universities? A stakeholder perspective on humanities, arts and social sciences valorisation. Journal of Higher Education 2010, 59(5): 567-588.
[5] Lal JA, Schulte In den Baumen T, Morre SA, Brand A. Public health and valorization of genome-based technologies: a new model. Journal of Translational Medicine 2011, 9(1): 207.
[6] Netherlands Consortium for Healthy Ageing. NCHA vision and strategy on social valorization of research: Discussion paper (February 2010). Discussion paper on file with authors.
[7] Slaughter S, Leslie L. Expanding and elaborating the concept of academic capitalism. Organization 2001, 8(2): 154-161.

Community of Practice for the Development of Science, Technology and Innovation Indicators

In 2013, Industry Canada's Audit and Evaluation Branch undertook a project to determine the feasibility of identifying a set of commonly used key performance indicators (KPI) by the seven partner organizations funded by its Science and Technology portfolios. The partner organizations include:

1. Canadian Institute for Advanced Research;
2. Canada Foundation for Innovation;
3. CANARIE;
4. Genome Canada;
5. Perimeter Institute for Theoretical Physics;
6. Institute for Quantum Computing; and;
7. Mitacs.

Overleaf, diagram1 attempts to articulate a draft horizontal logic model that details the key areas of overlap (in terms of activities, outputs, outcomes and impact) across partner organizations and Table 2 provides a draft list of indicators that partner organization have in common.

The next steps towards a Community of Practice for the development of science, technology and innovation indicators is proposed in two phases. The first phase would be to establish a Community of Practice that is tasked with the creation of those common indicators. The second phase would require a commitment to maintain the common set of indicators not only through their continuous use, but also through their continued refinement while affirming the robustness and validity of those indicators over the life the program. Whereas that the first phase requires an elevated level of intensity much like a sprint, the second phase can be likened to a marathon of sustain effort and commitment over the longer term.

Diagram 1: Draft Horizontal Logic Model – Organization Overlay

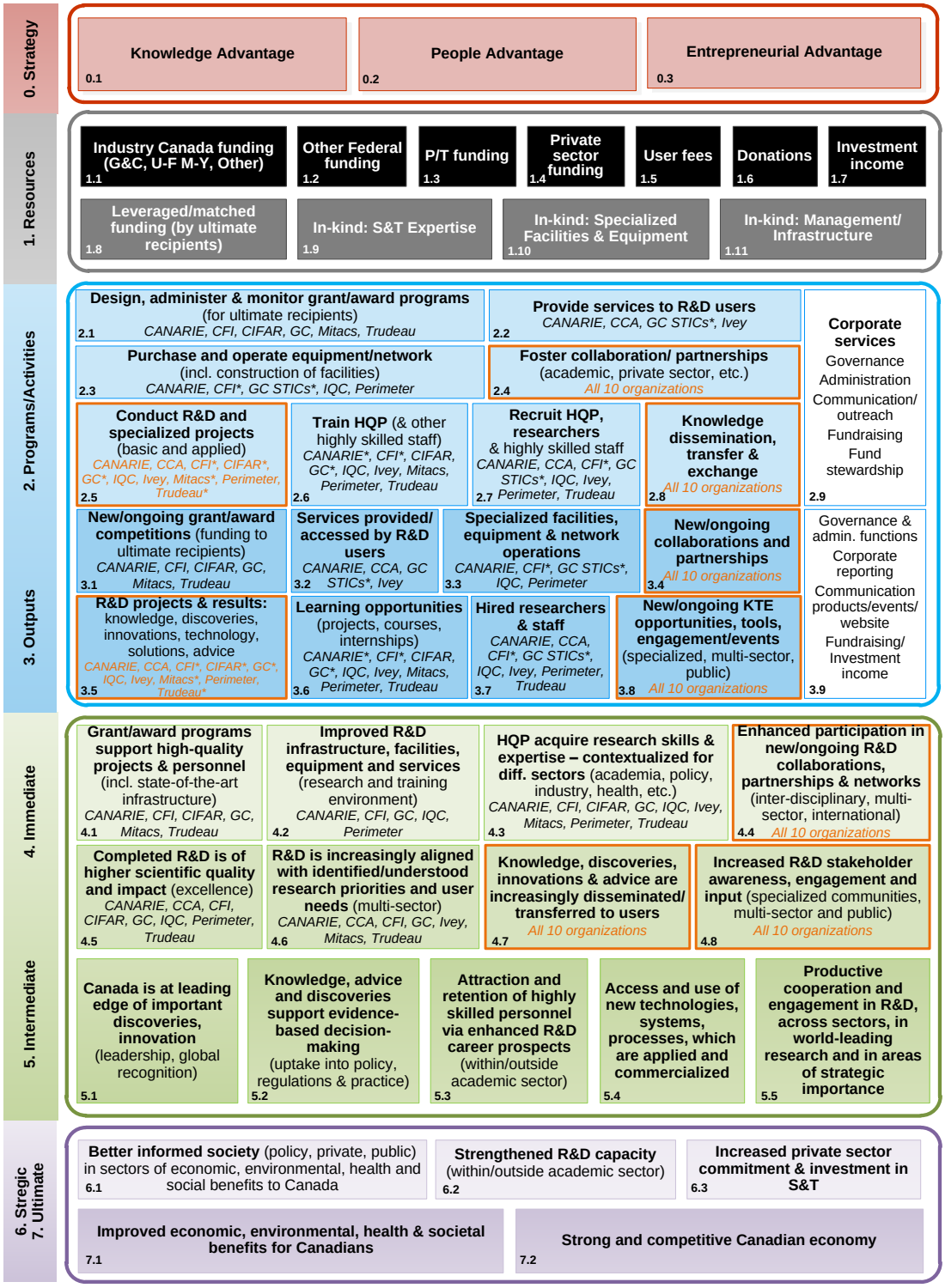

Table 2: Draft List of Commonality in Indicators

	Logic Model #	Performance Indicator	CANARIE	CIFAR	CFI	Genome	ICHIL	IQC	MITACS	Perimeter
Outputs	3.4 - Collaborations	#/type of partnerships/joint research projects with research organizations within/outside Canada (i.e. partnerships of org. or funded/partner institutions)	●	●	●	●	●	●	●	●
		#/type of partnerships/joint research projects with private sector within/outside Canada (i.e. partnerships of org. or funded/partner institutions)	●		●	●	●	●	●	●
		#/type of partnerships/joint research projects with public sector within/outside Canada (i.e. partnerships of org. or funded/partner institutions)	●	●	●	●	●	●	●	●
	3.5 - R&D Results	# research papers produced (incl. non peer-reviewed) by org. members or funded/partner institutions		●	●	●	●	●		●
		# of peer-reviewed publications authored/co-authored by org. members or funded/partner institutions	●	●	●	●		●		●
		#/qualitative evidence of new fundamental research results generated		●		●	●	●		●
		# of patents filed (i.e. by org. or funded/partner institutions)		●	●	●	●	●	●	
		# of spinoffs/start-ups created as a result of org. training/funding/technology	●	●	●	●	●	●		
		# innovations/new technologies/processes/products/services developed (i.e. by org. or funded/partner institutions)	●	●	●	●	●	●	●	
	3.6	#/nature of current training programs and courses		●			●	●	●	●
	3.7 - Researchers, staff	# faculty/research staff recruited/funded (i.e. by org. or funded/partner institutions)		●	●	●	●	●		●
		# PDF fellows recruited/funded (i.e. by org. or funded/partner institutions)	●	●	●	●	●	●		●
		# graduates/Master's students recruited/funded (i.e. by org. or funded/partner institutions)	●	●	●	●		●	●	●
		#/% of international students recruited/funded over % Canadian students (incl. compared to other countries/institutions)		●	●			●	●	●
	3.8	# workshops/conferences by type of audience	●	●	●	●	●	●	●	●
		# presentations/lectures by type of audience	●	●	●	●	●	●		●
Immediate Outcomes	4.3	qualitative evidence of impact of use of organization's services/training on HQP skillset and employability, incl. business and research skills	●	●		●	●		●	●
	4.5	perceptions of impact of research on new technology development	●	●			●	●	●	●
Intermediate Outcomes	5.3	% graduates working in relevant field in Canada, incl. by sector (e.g. public, industry, academia) and by years after graduating/leaving the org.			●		●	●	●	●
	5.4	# new technologies/processes/IT infrastructure implemented (i.e. by funded/partner organizations or end users) within and outside of Canada	●		●	●	●	●		●