The University of British Columbia

Faculty of Applied Science
Faculty of Medicine

A Proposal to:

Establish the UBC School of Biomedical Engineering

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Establishment of the UBC School of Biomedical Engineering

Proposal: To establish the UBC School of Biomedical Engineering

Executive Summary

The Faculties of Applied Science and Medicine propose to establish a School of Biomedical Engineering. Through collaborative, innovative, and interdisciplinary approach and building on our academic and research excellence and strengths, UBC will be well positioned to explore new and emerging areas of focus, and to strengthen translation capabilities to accelerate the transfer of research to care.

Students in the School will participate in innovative and interdisciplinary programs at the undergraduate and graduate levels that emphasize a balance of biomedical engineering and life science study with a focus on clinical and industrial application. These programs bring together students, faculty mentors, engineers, and clinicians in various settings to collaborate and create solutions and technologies to improve health care outcomes and delivery. Paradigm shifts in care represents tremendous opportunity for the field of biomedical engineering to shape and respond to health care demands and needs of society.

The School for Biomedical Engineering will provide opportunities for dialogue and engagement with communities, public, patient, industry, health authorities, and government, establishing shared agendas and accountabilities, and alignment of priorities to create an infrastructure to support sustained education and research excellence, innovation, and translation, impacting health care outcomes and delivery of care in both urban and rural settings.

Vision

The UBC School of Biomedical Engineering aspires to be a world leading biomedical engineering research school that will leverage UBC strengths to improve the lives of Canadians.

Mission

The School will be a nucleus for education, innovation, and research in biomedical engineering, creating new knowledge, new academic and training programs, and fostering technology transfer that results in innovative products and services that improve patient care and outcomes.
Overview

The Faculties of Applied Science and Medicine jointly propose taking UBC into the future of life sciences research and education with the development of the UBC School of Biomedical Engineering (henceforth referred to as “the School”).

Biomedical Engineering (BME) fuses engineering, medicine, life sciences, computer science, and mathematics to address fundamental and translational problems that impact human health. Widespread use of quantitative approaches to fundamental problems in life sciences and medicine, together with advances in materials science, nanotechnology, robotics, and artificial intelligence now permits innovative, improved, cost-effective innovations in health care. BME is an increasingly dominant source for disruptive discoveries and technologies in health research. Compelling recent examples include: hybrid cellular and mechanical pumps for insulin management to treat diabetes; electrical and biological patches to guide limb and nerve regeneration; light-controlled neural circuits to manage brain degeneration; and rational engineering of immune-cell responses using intelligent biomaterials. BME is important for Canada’s leadership in health sciences training and research, and for sustaining our health care system.

Biomedical engineers work in hospitals, education, and medical institutions, industrial and government research facilities, government and regulatory agencies, and manufacturing. Increasingly, biomedical engineers are leading entrepreneurial innovation in the health care sector. These interdisciplin ary bioengineers must be skilled in mathematics, biology, physiology, physics, materials design, and applications of technology and engineering to enable them to discover, design, develop and evaluate biotechnologies in medical or research facilities. Biomedical engineers innovate to create new therapies based on molecular and cellular systems, and work at the interface of biology with artificial organs, devices, and prostheses. In partnership with health care systems, biomedical engineers contribute to instrumentation, monitoring and medical information systems, and to healthcare management.

The primary mission of the School is to provide the University of British Columbia and its BC clinical partner institutions with programs that deliver an excellent and comprehensive education for its trainees, and perform internationally ranked research in BME, with an emphasis on high impact discoveries, clinical translation, and innovation in the biomedical field. Through its faculty members, staff, and trainees, and by collaboration with faculty in related departments (associate members), clinicians, and the staff of hospitals and other institutions governed by health authorities, the School will seek:

• To deliver innovative interdisciplinary training to personnel at the undergraduate, graduate, and post-doctoral level to meet the biomedical engineering needs of society and to train our trainees for the future;
• To conduct a program of fundamental and applied research and development;
• To create specialized infrastructure and resources to provide expert advice and facilities, to accelerate the impact of research and education at BC universities, hospitals, government, and industry.

The School will support entrepreneurialism and innovation through specialized education and training programs, research, technology transfer and creation of spinoff companies, translating
fundamental research into products and services that improve health outcomes and delivery of care.

**Rationale – Why Now?**

Driving forces behind the worldwide growth in BME include an aging population, advances in biomedical technology, an explosion of cellular and molecular data, opportunities in precision medicine, and increased complexity and cost of healthcare delivery. Last year, for the first time in its history, Canada had more senior citizens than children, and this trend will continue for at least a decade. As life expectancy increase, more Canadians will develop cancer, heart and musculoskeletal disease, stroke, diabetes and blindness that will challenge our health care system and society. There have now been sufficient advances life sciences, data science, and technology to design treatments targeted at specific patient needs (precision medicine).

The complexity of these conditions means that real breakthroughs are unlikely to emerge from researchers working within individual disciplines. As argued in a 2015 editorial in Nature¹ working across disciplines drives researchers to ask questions and solve problems that have never come up before, but can also address old problems, especially those that have not yielded to conventional approaches. Researchers at the Massachusetts Institute of Technology have argued that convergence, the integration of historically distinct disciplines and technologies into a unified whole that creates new pathways and opportunities, offers potentially revolutionary change for biomedical sciences². Indeed we have argued that BME will play a growing role in Canada new healthcare models.

Universities like Harvard, Stanford, Johns Hopkins, Columbia and Imperial College have strong BME programs. Tellingly, younger universities that are rising rapidly in world rankings like EPFL, Nanyang Technical University and the National University of Singapore are focusing in this area because it attracts the best professors and students, and helps the institutions create biotechnology innovation clusters. In Canada, The Institute of Biomaterials and Biomedical Engineering, which integrates researchers from Engineering, Medicine and Dentistry was established at the University of Toronto in 1999. In addition to research and graduate programs, Johns Hopkins, Stanford, University of California San Diego, Massachusetts Institute of Technology (MIT), Georgia Tech, Rice, Trinity College Dublin, the University of Washington, and the École Polytechnique Fédéral de Lausanne (EPFL) offer undergraduate degrees in BME.

According to the US Bureau of Labor Statistics, BME is the fastest growing engineering discipline in the USA³ with the demand growing more than 3 times the national average for all occupations, and more than twice as fast as all other engineering disciplines. Graduates from the school can expect to have immediate opportunities to help solve some of the world’s most pressing problems.

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Why UBC?

The University of British Columbia creates and advances knowledge and understanding, and improves the quality of life the discovery, dissemination, and application of research with and across disciplines. As a top 40 university UBC is a world leader. In stark contrast, UBC stands out among the top 40 institutions for not having a significant formal presence in BME. Despite the lack of formal structures, UBC has many areas of excellence in BME distributed among the Faculties of Applied Science, Medicine, and Science. Notably, The Michael Smith Laboratories (MSL), founded in 1987 by Nobel laureate Michael Smith at UBC, was among the very first research units in the world to integrate the health, physical, engineering, and computational sciences. In addition, there are significant contributions to BME in the Biomedical Research Centre (BRC), Life Sciences Institute (LSI), the Djavad Mowafaghian Centre for Brain Health (DMCBH), the Centre for Hip Health and Mobility (CHHM), and International Collaboration on Repair Discoveries (ICORD).

This proposal fully aligns with the strategic priorities of Applied Science and Medicine, specifically: 1) focus on strengthening translation capabilities and transformation solutions; 2) pursuit of new program development and expansion where UBC excellence aligns with provincial and global demand. In addition, the UBC strategic plan states “The University embodies the highest standards of service and stewardship of resources and works within the wider community to enhance societal good”. Thus, the School will look to establish links with the Entrepreneurship at UBC (e@UBC) program, the UBC Biomedical Engineering Student Team, and Hatching Health.

UBC has existing Masters of Applied Science, Masters of Engineering, and PhD graduate programs in Biomedical Engineering, and related programs in Mechanical, and Electrical and Computer Engineering (Appendix D). A proposal to establish a Bachelors of Applied Science has been approved by Senate and the Board of Governors, and has been submitted for approval to the Ministry of Advanced Education (Appendix E). These program offerings combined with the many UBC faculty members appointed at UBC and with external partners including the Terry Fox Laboratory, BC Cancer agency, Genome Sciences Centre (ranked number one in Canada), hospitals, and other research groups associated with health authorities create a cross discipline, innovative and dynamic environment, that supports interdisciplinary education, training, and research collaborations. In turn, such an environment supports the advancement of regional and provincial priorities and structures, notably the recent provincial Technology Strategy.

The School has been a collaborative vision between the Faculties of Applied Science and Medicine with advice and guidance of many others.

The life sciences sector adds $14.4 billion (12%) to the BC economy. The BC Knowledge Development Fund has invested $215 million in nearly 300 health and biotechnology-related infrastructure projects [ref].

We have an opportunity at UBC to create a School of Biomedical Engineering that is distinctive by building on UBC’s research excellence, transformative educational programs and training, strong partnerships with Health Authorities, and diverse faculty expertise, by designing a School.
that provides innovative undergraduate, graduate, and professional programs, and a infrastructure for research excellence.

**Governance, Membership, and Programs**

**Governance Structure**

The governance structure of the School described below is adapted from similar interdisciplinary Institutes, Centres, or Laboratories already existing at UBC.

The School will be jointly and equally governed, administered and supported by the Faculties of Medicine and Applied Science. The Director of the School will report to the Deans of Applied Science and Medicine. All issues that require a Dean’s approval will require the approval of both Deans. A governance committee comprised of the Faculties of Medicine and Applied Science Deans, the Director of the School, the Associate Deans of Research, and the Associate Deans Education will meet twice a year to review the progress of the School and to ensure alignment of School strategy and direction with the Faculties’ goals.

The Director of the School will be primarily responsible for developing and implementing the vision, establishing conditions for creating, piloting, adopting, and sun setting programs and initiatives, identifying metrics for success, and creating an appropriate review cycle. The Director will work collaboratively with departments and internal and external units that have faculty members with joint appointments in the School.

Associate Directors for Undergraduate and Graduate Programs, as well as for Research and Administration will be appointed to assist the Director.

The School will have an Executive Council drawn from faculty within the School and key BC external stakeholders. The Council will meet regularly to provide the Director with advice on key issues, but final decisions will remain with the Director. The School will also have an International Advisory Committee that will meet once a year composed of BME leaders from across the world.

This structure for the School is illustrated in Figure 1 below.
Membership of the UBC School of Biomedical Engineering

If approved, the initial faculty complement of the School will include the Director and 8 full time faculty to be recruited over the next 2 years. Funding for these positions is provided by the Provost, and the Faculties of Applied Science and Medicine. In addition the Faculties will contribute 2 CRC chairs. Responsibility for bridged CRC positions will be assumed by the School, and costs will be split equally between the Faculties of Applied Science and Medicine.

The unique and interdisciplinary nature of the School is expected to attract faculty members who hold joint appointments in the School and existing Departments in the Faculties of Applied Science, Medicine, Science, and other Faculties. Over the course of the next several weeks consultations and discussions will be ongoing to determine joint appointments and these details will be included in the final proposal. It may be that some faculty members now appointed in other units will transfer their appointments to the School. Combining the proposed full-time and joint appointed members, the initial faculty complement of the proposed School will be 15 FTE.

Matters pertaining to appointment, reappointment, and promotion and tenure (APRT) of core faculty will be handled as follows. Where the School constitutes the home department, a home Faculty will be identified for presentation of the case to the Dean’s Advisory Committee on Promotion and Tenure, and the Dean of the home Faculty will present the case to the President’s Senior Advisory Committee. Appointments in more than one academic unit will be
handled as usual, ensuring that procedures with respect to career progress are clearly laid out in writing at the time of appointment or transfer of appointment.

Faculty members holding full-time or joint appointments will be voting members, and are eligible to serve on governance committees described above.

Associate members may be appointed to the School. Associate members will maintain their full appointment in their home departments, and will have status only appointments in the School. They will participate in teaching, research, and service as mutually beneficial to the School and the faculty member, and be eligible to supervise graduate students in accordance with Faculty of Graduate and Postdoctoral Studies guidelines. Associate membership will be renewed on a rolling basis, and will require approval of the Director.

The School will also appoint adjunct members following Policy 42, adjunct professors are individuals with special professional expertise without formal appointments at UBC. They will contribute to the teaching and research activities of the School in an honorary capacity. Potential adjunct professors will be appointed by the Director, in consultation with the School faculty, in the usual manner for honorary appointments.

**Student Programs**

Addressing a strong and growing demand for BME education and biomedical engineering locally and further afield, the Faculty of Applied Science has proposed a new BASc in Biomedical Engineering. The program was approved by the UBC Board of Governors in December 2016 and is now before the Ministry of Advanced Education. This new degree program is a comprehensive joint-faculty program combining a solid foundation in medicine, life sciences, science, and engineering; innovative and entrepreneurial opportunities to support the training of our students for the future to have impact on health care outcomes and delivery. (See Appendix E for more detail). The new BASc in BME will be eligible for accreditation by the Canadian Engineering Accreditation Board, and its structure parallels that of existing BASc degrees, so if the School is not approved, it will be housed in the Faculty of Applied Science. However, the innovative curriculum and pedagogy was designed from the outset to be housed in the School to take advantage of the cross-disciplinary faculty.

Undergraduate student matters and affairs including admissions, promotion through the year, calendar policy, accreditation, and appeals will be administered by the Faculty of Applied Science in collaboration with School following the normal collaborative processes for all undergraduate engineering programs administered by engineering departments at the Vancouver campus.

The proposed program conforms to the accreditation standards of the Canadian Engineering Accreditation Board (CEAB). As such, an accreditation site visit will occur during the fall of the year during which the first cohort is scheduled to graduate and at least every 6 years thereafter.

The School Director will appoint an Associate Director, Undergraduate Programs, who, supported by appropriate staff, will lead the program curriculum, delivery and assessment for the undergraduate program.
The representative group for the biomedical engineering undergraduate students will be formed following AMS rules and regulations. Students have expressed the interest to have this undergraduate group be part of the Engineering Undergraduate Society and both faculties are supportive.

The Director will work with the elected representatives of the student group to form a student advisory committee to discuss issues around curriculum, teaching and learning, professional development and to advise regarding the Biomedical Engineering Program fee.

If the School is approved, the existing Masters of Engineering, Masters of Applied Science, and PhD in BME programs will be transferred to the School from the Faculty of Applied Science. This exceptionally strong group of high quality and high demand programs provides a key reason to establish a School rather than a research group. The creation of the School signals a clear “home” for students in these programs creating a nucleus for research, innovation, and education, and connecting students to basic scientists, clinicians, and engineers across campuses, health authorities, and hospitals.

Additionally, the School will offer applied and professional BME programs to students from a variety of backgrounds (e.g. engineering, medicine, science, math, computer science) so that they can train, retrain, or move to leadership and management positions that have a direct impact on health care.

**Partnerships with Existing Units**

The ethos of the School supports partnerships that cross disciplines, encourage team-based approaches, innovative education and training programs, and translational research. The Faculties of Applied Science, Medicine and Science are expected to contribute the majority of researchers to the School, but at least 5 other Faculties (Arts, Dentistry, Forestry, Land and Food Systems, Pharmaceutical Sciences, Science) are potential partners. The School will welcome participation, partnerships and collaboration with units from across the UBCs two campuses – Vancouver and Okanagan, medical, clinical and biomedical-research institutions, units and campuses across the province. Potential partners will be invited to join the School to expand the community of engaged scholars, enhance academic and research opportunities for UBC students and support the pursuit of the School’s vision and mission. In the course of our consultations (Appendix G), we have encountered many faculty members and units interested in engaging with the School of Biomedical Engineering as noted in the list of potential affiliated units (Appendix C). Our consultation process has identified a number of ways that academic units could participate in the School: i) teach or cross-list courses in the BME undergraduate or graduate program or other applied or professional programs that may be offered by the School; ii) participation in advisory boards, scholarship committees, and thesis committees; iii) mentoring, advising or participating as a client for student capstone or graduate biomedical engineering projects, student teams; and iv) participate in joint research in biomedical engineering;
Potential Evolution of the School

In the near term, the focus will be on ensuring the structure and governance model described above is stable, expandable, and flexible enough to accommodate expansion, using existing budget and facilities. Nevertheless, the expectation is that membership and partnerships will evolve over time as the reputation of the School grows. In addition, the Deans of Applied Science and Medicine, together with Faculties of Medicine and Applied Science’s Development and Alumni Engagement units will lead efforts to secure philanthropic support. We anticipate several opportunities for donor options including: chairs and professorships, undergraduate and graduate student fellowships, visiting scholar programs, and research support opportunities.

The existing ecosystem of research groups is large, fluid and is changing quickly as the fields underlying BME transition from discipline-focused to convergent. In a resource-constrained environment, changes in research funding priorities, availability of provincial or federal funding initiatives for training, infrastructure or facilities, industrial partnerships, or philanthropic gifts can be expected to accelerate and shape future directions. The ability of the School to attract increasing number of researchers as full or associate members, along with philanthropic support, will be a key indicator for its success.

Budget and Facilities

The new BASc in Biomedical Engineering\(^4\) budget will be the framework of which to build and develop the School’s budget. The School’s budget is currently under development and these details will be included in the final proposal.

Need for a School and Benefits to UBC

As has been described above, there are multiple foci and areas of excellence at UBC in research areas that fall under the convergent disciplines that make up BME. Some, like the Michael Smith Laboratory, the Genome Science Centre, the Jack Bell Prostate Centre, or the BC Cancer Agency are world class, and will continue to be so for the foreseeable future. There are existing undergraduate courses, graduate programs, and research clusters such as the Centre for Hip Health and Mobility, the Pacific Parkinson’s Research Centre, and the Nanotechnology Biomedical research group that clearly embrace the ethos of BME. Notably, MSL was one of the first research groups in Canada to incorporate faculty members with wide disciplinary focus proposed for the School.

Despite the excellence of existing faculty research activity, and units, and the high quality of students, courses, and programs, the whole of potential or actual BME activity at UBC is less than the sum of its parts. It is uncoordinated, unintegrated, and there are challenges scaling up opportunities for collaboration. For students, professors, health or industrial partners, and granting agencies, our system is confusing to navigate, lacks coherence, deliberate identification of priorities, and makes it difficult to rapidly seize new opportunities. The sections below outline

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\(^4\)The new BASc in Biomedical Engineering was approved by the UBC Board of Governors in December 2016.
how the integrated, coherent approach proposed for the school will advance the ability of UBC to become a world leader in BME.

Unlike research units (Centres, Institutes, Michael Smith Laboratory), a School can hold faculty appointments and academic programs. If approved, the School will house the BASc., M.Eng., MASc, and PhD programs in BME, thus providing a focus and academic home for students from any background with an interest in BME. Therefore the School will have a primary function that distinguishes it from research groups at UBC with overlapping research interests.

**UBC**

New opportunities are emerging at the interface of engineering and biology that will transform biomedical research and UBC should be at the forefront of this. There is growing recognition of the impact of quantitative design-based biology on biomedical research discovery and innovation. The local biotechnology sector is growing rapidly and should emerge as a major component of the BC knowledge economy. This requires students with new skills in biology and engineering. UBC can leverage its expertise and reputation in Medicine and Engineering (and Science) to impact BC and Canadian science and innovation. Multiple faculties are needed to contribute expertise to realize the envisioned impact and there is broad interest in realizing this potential. BME is a discipline that could contribute to academic and research excellence and innovation in multiple Faculties.

For UBC, the School of BME represents an important place to pioneer convergent approaches to education and research. There are important opportunities to develop research support, infrastructure, operational and administrative structures flexible and agile enough to support a convergent approach. What the University learns while creating the School could later be applied to issues like sustainability, poverty, health, advanced materials, or inequality.

As the School gains prominence, critical mass, and funding, it will contribute to UBC’s ability to recruit world-leading researchers, teachers, students and staff. In turn, this will drive the training and development of BME students and trainees through creation of a seamless multi-modal interdisciplinary environment that coordinates integration of undergraduate, graduate and professional programs with research. BME faculty will increase our research opportunities in areas of global importance such as molecular and cellular engineering and synthetic biology, genomics and nano-devices; immune-engineering and advanced biomaterials, regenerative medicine, AI and simulation systems with biomedical application, visualization and imaging from nanomolecular to physiological scales.

The School will build on regional strengths, namely a world-class network of hospitals, medical research institutions, centres, and universities, and one of the fastest growing biotechnology corridors in North America. By investing in the best people, projects and programs focused on creating and translating biological insights to value-added health services, the School will accelerate technology commercialization and adoption across the province and country. UBC hopes to expand markets for BC technology by building the ability to develop and export cost-effective and world-leading solutions for reducing health care delivery costs.
Faculty

Faculty will benefit from facilitated interdisciplinary opportunities, dedicated interdisciplinary research space, and formalized opportunities for interdisciplinary collaboration. We predict increased competitiveness in grant competitions because the convergent, translational approach proposed for the School fits with evolving criteria for funding, including the need for identifying industry partners, impact, and societal benefits.

Students

Great faculty, visiting scholars, and high quality students create a virtuous circle when coupled with access to cutting edge facilities, technologies, training, and experiential learning. The School will create opportunities for life-long learning, career transition and advancement programs drawing on resources of entire BME community.
Appendices

Appendix A: Advisory process

At the request of the Provost, and the Deans of Applied Science and Medicine, this draft proposal was prepared by the Biomedical Engineering School Core Team: Elizabeth Croft, Associate Dean, Education and Professional Development, Faculty of Applied Science; Robert McMaster, Associate Dean, Research, Faculty of Medicine; Peter Zandstra, Professor, Samantha Reid, Director Strategic Initiatives, Faculty of Medicine; Hugh Brock, Associate-Provost Academic Innovation. The team was informed through a 6-month discussion and consultation phase engaging with subject area experts from within and outside academia.

The Biomedical Engineering School Core Team terms of reference were to:

- Assist with the development of an academic plan, business plan, and governance framework for the School for presentation to UBC;
- Provide rich and well-informed dialogue in terms of the evolution of the School; and,
- Provide advice and counsel to the Deans and leads of the School initiative.

The development of the draft proposal was informed by early feedback and consultations workshops, formal online consultations and workshops, and engagement of the Faculties of Medicine and Sciences faculty at meetings including: Associate Deans of Research, Department Heads, Centre Directors, Full Faculty, and Faculty Executive.


Faculty of Medicine Approvals

- Faculty Executive Meeting - September 27, 2016
  - Motion approved: “that the establishment of the School of Biomedical Engineering, the Biomedical Engineering program and the associated curriculum be approved”
- Full Faculty Meeting - November 23, 2016
  - Motion approved: “the establishment of the School of Biomedical Engineering and the Biomedical Engineering Program and the associated curriculum be approved”

Faculty of Applied Science Approvals

- Faculty Executive Meeting - XXXX
  - Motion approved: “”
- Full Faculty Meeting - XXXX
  - Motion approved: “”
Appendix B: Founding Academic Units and Human Resources

The School of Biomedical Engineering will build initially on a partnership between two faculties with the support of the Faculty of Science.

The Faculty of Medicine educates health professional and life sciences students at the undergraduate, graduate and postgraduate levels, and pursues research – in the laboratory, in clinical settings and at the population and public policy level – to improve the health of people worldwide. Teaching and research in the Faculty of Medicine is delivered through 19 departments, two schools, 21 research institutes and centres. It is home to 552 full time faculty, 8155 clinical faculty, and 2895 undergraduate and graduate students. http://www.med.ubc.ca/

The Faculty of Applied Science oversees administrative procedures for the School of Architecture and Landscape Architecture, the School of Community and Regional Planning, the School of Nursing, and all engineering activities at the Vancouver campus and the UBC Okanagan School of Engineering. It is home to 320 faculty, 5714 undergraduate students, and 1767 graduate students. https://apsc.ubc.ca/

If approved, the initial faculty complement of the School will include the Director and 8 full time faculty to be recruited over the next 2 years, along with 7-10 jointly appointed faculty. It is expected that the School will reach a full complement of 22-30 core and joint faculty within 5 years.

The unique and interdisciplinary nature of the School is expected to attract faculty members who hold joint appointments in the School and existing Departments in the Faculties of Applied Science, Medicine, Science, and other Faculties. It may be that some faculty members now appointed in other units will transfer their appointments to the School. Faculty members holding full-time or joint appointments will be voting members, and are eligible to serve on governance committees described above.

Associate members may be appointed to the School. Associate members will maintain their full appointment in their home departments, and will have status only appointments in the School. They will participate in teaching, research, and service as mutually beneficial to the School and the faculty member, and be eligible to supervise graduate students in accordance with Faculty of Graduate and Postdoctoral Studies guidelines. Associate membership will be renewed on a rolling basis, and will require approval of the Director.

The School will also appoint adjunct members following Policy 42, adjunct professors are individuals with special professional expertise without formal appointments at UBC. They will contribute to the teaching and research activities of the School in an honorary capacity. Potential adjunct professors will be appointed by the Director, in consultation with the School faculty, in the usual manner for honorary appointments.
Appendix C: School Membership and Partnership Details

Over the course of the next several weeks discussions regarding School membership and appointments will continue through consultation. These details will be included in the final proposal.

Listing of Partners in the School of Biomedical Engineering

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Listing of faculty members who will have a joint appointment in the School

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<th>Unit</th>
<th>Faculty Member</th>
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Listing of faculty members who have expressed an interest in having an associate appointment in the School

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<th>Faculty Member</th>
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Listing of Possible Partner Units
(The following is a non-exhaustive list gleaned from UBC consultations to date)

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<th>Unit</th>
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Appendix D: Existing Graduate Programs

Currently, UBC’s Faculty of Applied Science offers innovative graduate programs including the MASc, PhD, and MEng, in BME, which emphasize a balance of biomedical engineering and life science study with a focus on clinical and industrial application. The graduate programs offer students unparalleled access to engineering experts in the fields of chemical and biological, electrical and computer, materials and mechanical engineering. The graduate programs are designed to attract and retain the finest and most promising students from a variety of backgrounds (e.g. engineering, medicine, science, math, computer science etc.). They immerse students in BME through courses, thesis development and the mentorship of world-class faculty who shape the cutting edge of research. These graduate students emerge ready to pursue careers in industry, medicine, academia and government and will have the knowledge, skills, philosophy and values to enable them to reach the forefront of leadership in BME and have a direct impact on healthcare.

If the School is approved, the existing Masters of Engineering, Masters of Applied Science, and PhD in BME programs will be transferred to the School from the Faculty of Applied Science. This exceptionally strong group of high quality and high demand programs provides a key reason to establish a School rather than a research group. The creation of the School signals a clear “home” for students in these programs creating a nucleus for research, innovation, and education, and connecting students to basic scientists, clinicians, and engineers across campuses, health authorities, and hospitals. Combined with the undergraduate program the School will provide world-class joint faculty biomedical engineering training that will address the regional and national BME labour demand, and support the advancement of biomedical research and innovation, and transformation in healthcare.

The School will be able to develop professional programs in particular areas of professional demand and strategic priority (e.g. healthcare informatics). Specific programs have not yet been identified, but professional programs are currently part of the long-term vision for the School. Through continued consultations and discussions will look to collaborate and partner with Faculties to develop new and innovative interdisciplinary professional programs that support the training of students for the future.
Table 1. The Table Provides a Summary of the Current BME Graduate Programs Offered at UBC.

<table>
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<th>Master of Engineering (MEng)</th>
<th>Master of Applied Science (MASc)</th>
<th>Doctor of Philosophy (PhD)</th>
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<tbody>
<tr>
<td><strong>Type of Program</strong></td>
<td>Professional</td>
<td>Research</td>
<td>Research</td>
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<tr>
<td><strong>Duration</strong></td>
<td>12-18 months</td>
<td>24 months</td>
<td>48 months</td>
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<td><strong>Specialization Options</strong></td>
<td>N/A</td>
<td>Chemical &amp; Biological</td>
<td>Chemical &amp; Biological</td>
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<td></td>
<td>Mechanical</td>
<td>Mechanical</td>
</tr>
<tr>
<td><strong>Program Components</strong></td>
<td>Coursework</td>
<td>Coursework</td>
<td>Coursework</td>
</tr>
<tr>
<td></td>
<td>Graduate Seminar</td>
<td>Graduate Seminar</td>
<td>Graduate Seminar</td>
</tr>
<tr>
<td></td>
<td>Internship</td>
<td>Thesis</td>
<td>Dissertation</td>
</tr>
<tr>
<td><strong>Cooperative Education</strong></td>
<td>Co-op options available.</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>Approximately 4-8 month terms (Credits not applicable to master’s requirements)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix E: Proposed Undergraduate Program

Addressing the strong and growing demand for BME education and biomedical engineers locally and further afield, the Faculty of Applied Science has proposed a new BASc in Biomedical Engineering. The program was approved by the UBC Board of Governors in December 2016 and is now before the Ministry of Advanced Education. The intent is to move the program into the proposed UBC School of Biomedical Engineering. It is a comprehensive joint-faculty BME program that will address the regional BME labour demand and help rapidly expand biomedical research, development and industry in the Vancouver area. It has been designed to be accredited by the Canadian Engineering Accreditation Board (CEAB) as a Biomedical Engineering degree. At steady state, there will be approximately 100 students enrolling in the program each year with between 400 and 500 total undergraduate students registered in the program at any one time.

Briefly, the program is comprehensive and includes four streams: (1) Cellular Bioengineering; (2) Biomedical Informatics; (3) Biomedical Systems and Signals; and (4) Biomechanics and Biomaterials. Graduates will be in demand in a variety of diverse contexts and environments including government agencies, medical research facilities, manufacturing and health services industries. BME students will be admitted directly into the first year of the BME program and participate in their own common first year, somewhat different from (but still quite similar to) the common year for all other disciplines. BME students have first year exposure to cell, tissue, organ and human biology and physiology, clinical perspectives, physiological modeling, and rapid prototyping that is not available in the common engineering first year, nor are they covered in sufficient depth in existing Science courses.
Appendix F: Canadian Comparators

Table 2. BME Undergraduate Programs at Canadian Universities

<table>
<thead>
<tr>
<th>University</th>
<th>Department</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ryerson University</td>
<td>Department of Electrical and Computer Engineering</td>
<td>Bachelor of Engineering in Biomedical Engineering</td>
</tr>
<tr>
<td>University of Ottawa</td>
<td>Biomedical Mechanical Engineering</td>
<td>B.A.Sc in Biomedical Mechanical Engineering</td>
</tr>
<tr>
<td>University of Guelph</td>
<td>Biomedical Engineering</td>
<td>B.Eng. in Biomedical Engineering</td>
</tr>
<tr>
<td>Carlton University</td>
<td>Mechanical and Aerospace Engineering</td>
<td>B.Eng in Biomedical &amp; Mechanical Engineering</td>
</tr>
<tr>
<td>McMaster University</td>
<td>Electrical and Computer Engineering</td>
<td>B.Eng. in Electrical and Biomedical Engineering</td>
</tr>
<tr>
<td>McGill</td>
<td>Department of Bioengineering</td>
<td>B.Eng. in Bioengineering</td>
</tr>
<tr>
<td>Ecole Polytechnique (University de Montreal)</td>
<td>Genie biomedical</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. Biomedical Engineering Graduate Programs at Canadian Universities

<table>
<thead>
<tr>
<th>University</th>
<th>Faculty / School</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>McMaster University</td>
<td>School of Biomedical Engineering (Joint with Faculties of Engineering &amp; Health Sciences)</td>
<td>MASc in Biomedical Engineering PhD in Biomedical Engineering</td>
</tr>
<tr>
<td>University of Toronto</td>
<td>Institute of Biomaterials &amp; Biomedical Engineering (Joint with Medicine, Engineering, Dentistry)</td>
<td>MEng in Biomedical Engineering MASc in Biomedical Engineering PhD in Biomedical Engineering</td>
</tr>
<tr>
<td>Dalhousie University</td>
<td>School of Biomedical Engineering (Joint with Faculties of Medicine &amp; Engineering)</td>
<td>MASc in Biomedical Engineering PhD in Biomedical Engineering</td>
</tr>
<tr>
<td>University of Calgary</td>
<td>Jointly coordinated : Schulich School of Engineering, Cumming School of Medicine, &amp; Faculty of Kinesiology,</td>
<td>MSc in Biomedical Engineering MEng in Biomedical Engineering PhD in Biomedical Engineering</td>
</tr>
<tr>
<td>McGill</td>
<td>Jointly coordinated between Faculties of Medicine and Engineering</td>
<td>MEng in Biological &amp; Biomedical Engineering</td>
</tr>
</tbody>
</table>
Appendix G: Consultations

The Faculties of Medicine and Applied Science are engaging in substantial consultation and discussion both externally, and with other UBC units and personnel in the development of this proposal. To date, several activities have been or are under way to facilitate the discussions and consultation processes. These include:

1. On December 15, 2016, a short description of the school was circulated widely to UBC units, with a request for feedback. The focus of the early feedback request was on
   - Inviting interested parties to engage in discussions and determining how best to continue discussions and consultations within UBC;
   - The perceived benefits and disadvantages to a new School of BME from a variety of perspectives; and
   - General feedback and ideas for developing the School
   Each participant providing feedback received a response indicating how their feedback would be used.

2. On January 26 and 27, 2017, the Faculties of Medicine and Applied Science hosted two live feedback sessions.
Appendix H: Implementation Timeline and Review Cycles

Hiring for the school, and potential transfer and/or secondment of faculty into the school (including the proposed director) will commence as soon as feasible following approval of the School. It is expected that the School will reach a full complement of 22-30 core and joint faculty within 5 years.

Renovations of existing spaces to support the School will commence immediately. New facilities including the Biomedical Engineering and Environment Engineering Building will take longer; with the completion of this building expected within a 3 year timeline, subject to university and provincial approvals.

Intake of students into the undergraduate program will be undertaken as soon as feasible, subject to AVED approval of the program. Note that, students in the first year of engineering are not classified by program, allowing for the intake students in 2017 that would populate a 2018 second year Biomedical Engineering program cohort.

Following the Senate Policy on Reviews of Administrative Units the School will have a 5 year review cycle. The review committee will be jointly appointed by the Deans of Medicine and Applied Science. Appointment of the Director of the School will follow Policy 22, normally for a five year, renewable term. The appointment of the founding Director will be done jointly by the Deans of Medicine and Applied Science as soon as feasible following the approval of the School.