Department of Medical Biophysics

Schulich School of Medicine & Dentistry

Western University

Draft Academic Plan – 2016 to 2018

Executive Summary

Medical Biophysics is multi-disciplinary field that encompasses the applications of physics, engineering, and mathematics to quantitative studies of biological and physiological processes.

Medical Biophysics Mission

Medical Biophysics is a multi-disciplinary field that encompasses the applications of physics, engineering, and mathematics to quantitative studies of biological and physiological processes. The long-range mission is to develop novel or improved diagnostics and therapeutics for a wide range of human illnesses, including cardiovascular disease and cancer. We believe that this goal is best achieved through interdisciplinary learning and collaborative research that crosses the traditional boundaries of scientific and medical disciplines.

The Department of Medical Biophysics, Schulich School of Medicine & Dentistry was founded as Canada's first biophysics department by Professor A.C. Burton in 1946. The Department is regarded as one of North America's top schools in its field, with international recognition for its research in biomedical imaging - from microscopy to functional imaging of the human body. This Department is the primary academic home for 31 faculty members, of which 9 are designated core members situated in the primary department space (Medical and Natural Sciences Buildings). An additional 68 members are associated through cross-appointments from other Departments. The home department is housed within the Medical Sciences Building with administrative offices and laboratories for intravital microscopy, computer modeling of the microcirculation, image processing, elastography, and audiology. The Department has a very diverse and distributed faculty with strong interdisciplinary teaching and translational research capabilities through involvement of clinicians. The annual core operating budget amounts to $2.3M (2015-2016) and it supports home faculty members and staff who provide important administrative and technical services.

The small undergraduate program in Medical Biophysics (13 fourth year students with Honours Specialization in 2015) results in BMSc (Bachelor of Medical Sciences) or BSc degrees, offering a diverse range of choices in modules of specialization. Graduates are well prepared for entry into professional or graduate schools, as well as for work placements in education or biomedical industry.

The graduate program is built upon a robust city-wide infrastructure including facilities at the Robarts Research Institute, now formally a part of Western; and the Lawson Health Research Institute (LHRI), which includes laboratories at Victoria hospital, the London Regional Cancer Program, and St. Joseph's hospital. Six themes are recognized by the Ontario Council for Graduate Studies (OCGS): (1) Medical Imaging, (2) Hemodynamics and Cardiovascular Biomechanics, (3) Microcirculation and Cellular Biophysics, (4) Orthopedic Biomechanics and Biomaterials, (5) Radiobiology and Medical Physics in Cancer Treatment and Research, (6) Bioelectromagnetics. A clinical stream also exists as part of the graduate program accredited by the Commission on Accreditation of Medical Physics Educational Programs (CAMPEP). The total graduate student enrolment is the largest in Schulich with approximately 100. Of these, 24 students are in the CAMPEP program and 50 are PhD students. In 2013-14, 24 students graduated. Graduate students have access to 84 potential supervisors or advisory committees members, each with membership in the School of Graduate and Postdoctoral Studies. Research

revenue from primary faculty amounts to $5.7M/yr (2012-2013). If grants held by *all* associated faculty members are included, operating grant revenues reach approximately $30M/yr (2013). The quality of our faculty members has been recognized through Canada Research Chair awards (3), Ontario Early Research Awards (4 awardees in past 3 years), CIHR industry-sponsored Chairs (1), a Premier's Discovery Award for Innovation & Leadership (1) and Western's Hellmuth Prizes (3). The quality of scientific contributions by both graduate students and faculty at conferences and through peer-reviewed publications produces regular awards at the university, national, and international level.

The Department has a diverse faculty with strong multidisciplinary teaching and research capabilities, offering modern laboratory facilities for learning and for research to a growing pool of undergraduate and graduate students. Future growth will be focused on increased enrolment in the undergraduate program, mid career faculty recruitment for teaching and research including leadership renewal in imaging and radiation sciences, and consolidation of space for the core department.

Key Strategies and Goals

Separate goals are defined for both research and teaching within the department over the next 3-5 years:

A. The four key research strategies are to:

1. Increase Departmental cohesion and identity
2. Build research capacity through recruitment in key areas of strength
3. Increase collaborative funding and industrial partnerships
4. Creation of Burton Laboratory Core Research facilities

The following goals have been developed for each strategy:

Strategies	Goals
1. Increase departmental cohesion and identity	1-1 Department is spread across London. Identify mechanisms to increase city-wide interaction between faculty and students. 1-2 Increase and expand signage for core and external department to improve visibility and boost the presence of the department 1-3 Provide a common area for undergrad students to assemble 1-4 Increase faculty and student interactions with the core department 1-5 Review current departmental research grouping to ensure they accurately reflect actual operational groups and faculty expertise 1-6 Increase the national and international profile of the department
2. Build research capacity through recruitment in key areas of strength	2-1 Develop tenure track positions for current areas of strength and interest within the Department that align with clinical partners and capitalize on the research interests of non-tenured institute scientists 2-2 Recruit new faculty members in areas of future research strength to ensure leadership renewal in areas including

	microcirculation, computational modeling, imaging, and medical physics. 2-3 Encourage recruitment in public health areas to support and complimentary basic science faculty 2-4 Strengthen relationships with existing Western clusters of excellence (Cognitive Neuroscience & Musculoskeletal)
3. Increase collaborative funding and industrial partnerships	3-1 Lead novel team grant applications that build on combining the strengths in imaging, microcirculation, and biomechanics 3-2 Strengthen linkages with clinical departments by offering greater opportunities for clinically focused MSc training. 3-3 Lead initiative to increase graduate student training support from granting agencies and/or industry partnerships
4. Creation of Burton Laboratory Core Research facilities	4-1 Clarify leadership and faculty responsibilities within the lab 4-2 Create a viable business plan for long term sustainability 4-3 Increase Schulich/Western user base 4-4 Actively seek core support through Schulich, grants, and industrial contracts.

B. The three key teaching strategies are to:

1. Increase undergraduate enrolment
2. Increase quality of graduate student experience
3. Enrich the CAMPEP program

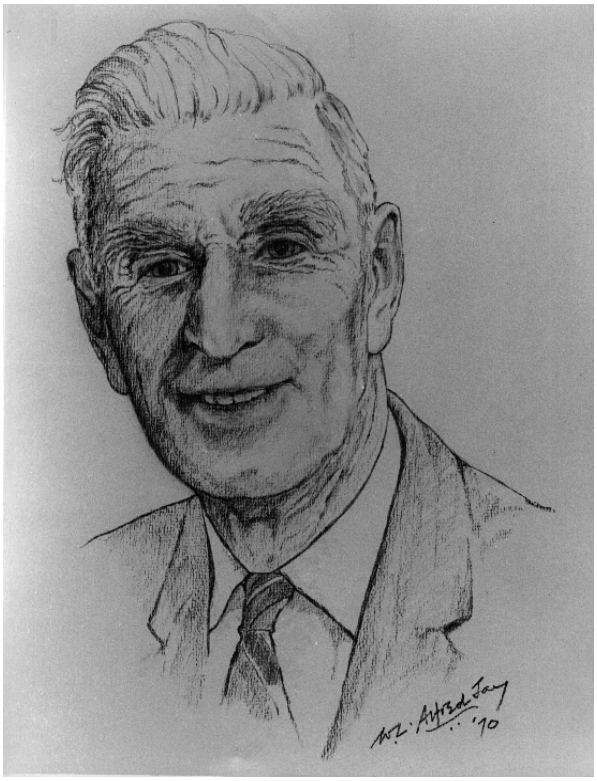
The following goals have been developed for Teaching:

Strategies	Goals
1. Increase undergraduate enrolment	1-1 Ensure adequate faculty are available to teach undergraduate course offerings (succession planning). Hire a faculty member dedicated to outstanding teaching for a second year Biophysics in Medicine course to attract students to the program, as well as core CAMPEP and graduate courses, and summer student program. 1-2 Re-evaluate course requirements to enter Medical Biophysics. 1-3 Increase second year course offerings to stimulate students to consider Medical Biophysics. Consider an introductory course in "Biophysics" or "Biophysics in Medicine" 1-4 Explore options to increase enrolment in existing Medical Biophysics second year courses or insert content into existing first and second year courses. 1-5 Establish a summer student program to target first year students in Bachelors of Medical Sciences Program

	1-6 Evaluate teaching infrastructure (e.g. laboratory equipment) to determine whether upgrades are required.
2. Increase quality of graduate student experience	2-1 Increase administrative support for large graduate program and graduate executive committee to facilitate upcoming (2017) graduate program review (IQAP) 2-2 Improve faculty sustainability for teaching graduate courses. Department relies on many off-site non-tenured faculty for teaching with no control of succession planning. 2-3 Strengthen linkages with clinical departments by offering greater opportunities for clinically focused MSc training. 2-4 Review graduate course content to ensure all learning objectives are met. Where required or desired and with input from course co-ordinators/instructors use the existing Pedagogy course to update graduate course content, one course at a time (per year). 2-5 Develop resources for interested students to gain knowledge in non-science skills including: leadership, writing, career development, financial planning 2-6 Increase mentorship and graduate training support opportunities for new faculty to increase success in recruiting top graduate students 2-7 Promote course in Success in Research: Problem Discovery to Solution. Train entry-level PhD students the thinking processes necessary to become successful researchers.
3. Enrich the CAMPEP program	3-1 Support the CAMPEP program to ensure all CAMPEP course requirements are available to maintain CAMPEP accreditation. 3-2 Increase administrative support to add value for students including creating observerships, QAships, receptors identified for residency placements, CV enhancements, invited speakers, preparation for CCPM exams, and career guidance. 3-3 Revise the CAMPEP funding model to more closely align with competitive programs across Canada. 3-4 Acknowledge the sponsors of hospital-based paid assignments

Introduction

The Department of Medical Biophysics started as Canada's first biophysics department within the Faculty of Medicine at Western in 1946. Under strong leadership of Professor Alan C. Burton (sketched below by one of his graduate students, Dr. Alfred Jay), graduate programs for MSc and PhD degrees began at that time. Until 1965, Alan Burton was the sole faculty member, and graduate research focused on the biophysics of body temperature regulation, hemodynamics and the red cell, for which Dr. Burton became internationally recognized. Dr. Burton was inducted to the Canadian Medical Hall of Fame in 2010 on the basis of his outstanding scientific contributions and also as a visionary builder of multi-disciplinary science in Canada. After 1965, additional faculty members were appointed, bringing more broadly-based research to the department with the start of the Honours Biophysics undergraduate program in 1966. Medical Biophysics has since gained an international reputation, through the continuing leadership of chairs following Alan Burton (1946 - 1970): Margot Roach (1970-1978), Alan Groom (1978-1987), Peter Canham (1987-2004), and Jerry Battista (2004 - 2015).



The geographic nucleus of the Department is in the Medical Sciences Building on the main campus of Western University and has core space (5,760 sq. ft) for (a) research laboratories for small animal surgery, cell culturing, intravital microscopy, digital image processing, elastography, and auditory research and (b) offices for core faculty members with primary appointments in Medical Biophysics, and for administrative and technical support. The department also has access to shared undergraduate classrooms and teaching laboratories.

The on-site core faculty members include:

- 2 Professors Emeritus (Canham, and MacDonald)
- 2 tenured Professors (Battista, Ellis)
- 5 tenured Associate Professors (Goldman, Jackson, Ladak, McKenzie, Samani)

Note that Drs. Ladak and Samani are joint-appointees and associated with the Department of Electrical and Computer Engineering, as faculty members of the Biomedical Engineering Program (BME) established in 2001. Two additional joint-appointees have their home appointments in other Faculties, Dr. James Lacefield in the Department of Electrical and Computer Engineering and Greg Marsh in the School of Kinesiology. Four new faculty members were successfully recruited during the past nine years (Goldman, McKenzie, St. Lawrence, Jackson), as part of a faculty succession plan. Additional faculty members, with appointments in Medical Biophysics are located in affiliated research institutes (see section below). Four new "home" members (Bartha, Drangova, Parraga, Menon) were added when the Robarts Research Institute was incorporated into the University of Western Ontario (July 2007).

Related Programs

The Department has strong collaboration with the Science and Engineering Faculties at Western. Specifically, our faculty members have played a large role in the evolution of the Medical Physics module within the Department of Physics & Astronomy. This Department has offered graduate Physics degrees in this field for decades, and has recently recruited 3 medical physicists (Chronik, Poepping, Wong) to form the Medical Physics group on-campus. An additional member (Allemang) has an important role in teaching physics to health sciences students and has produced several textbooks for undergraduates. New courses have now been introduced in a cooperative effort with Medical Biophysics

The Biomedical Engineering Program was established in 2001 as a joint venture of the Faculty of Engineering and of the Schulich School of Medicine & Dentistry. A number of our faculty members were instrumental in the launch of this program (e.g. Fenster, Canham, Peters). To this day, 25 of the active BME faculty (i.e. 50% of their members) are cross-appointees from Medical Biophysics. The BME program currently hosts 50 graduate students.

The development of programs similar to Medical Biophysics did raise some early concerns, but it was our belief that the presence of allied disciplines would expand the overall graduate student pool by attracting students to Western who would otherwise be absorbed by other programs or universities. This seems to be the case in that all 3 units (Medical Biophysics, Medical Physics, Biomedical Engineering) have experienced steady growth, without turbulent internal competition. Each program has attracted students with different backgrounds and career aspirations, and all programs have benefited by offering a greater variety of options through shared courses and synergistic combinations.

More recently, Western University has established clusters of research excellence. The first two clusters focus on Cognitive Neuroscience and Musckuloskeletal research with strong ties to Medical Biophysics including several existing faculty that participate in and lead these initiatives.

Affiliated Research Institutes

The core Department is the primary academic home, although not necessarily the geographic home, for some extramural scientists working in research institutes but paid, at least in part, through the Medical Biophysics budget. Such faculty are found at the Lawson Health Research Institute scientists (LHRI) and the Robarts Research Institute (Robarts). The Robarts was incorporated into the University of Western Ontario on July 1, 2007. Through additional partnerships with the clinical Departments (e.g. Oncology, Psychiatry, Medical Imaging), our department benefits from synergy in research and educational programs at extramural research institutes. Each principal geographic site has its own core of scientists and graduate students well above critical size needed for collaboration, and encourages participation of clinical researchers. Most of the senior undergraduate Honours students and graduate students, conduct their research projects outside of the core department in extramural research institutes, where they have access to equipment at the forefront of their fields of research.

Alignment with Schulich School of Medicine and Dentistry and Western University Strategic Goals

Our department is well aligned with the strategic vision and goals of both the Faculty of Medicine and Dentistry and Western University. The strategic plan of Western University includes the creation of a world-class research and scholarship culture and to provide Canada's best education for tomorrows global leaders. The strategic plan and vision of the Schulich school of Medicine and Dentistry emphasizes six key directions: 1) create knowledge in the science of healthy and successful development and aging across the lifespan; 2) strengthen knowledge translation to achieve health benefits for individuals and populations; 3) become a destination of choice for exceptional education and learning; 4) develop sustainable partnerships, networks, and global initiatives; 5) lead in programs that foster growth and success of faculty and staff; and 6) enhance communications and profile for greater impact.

The Department of Medical Biophysics is actively engaged in the strategic objectives articulated by Western University, in the first three objectives of the Schulich school, and strongly supports the efforts of the school in its last three objectives.

Medical Biophysics is the academic home to internationally-recognized groups specializing in biomedical imaging - from intravital microscopy studies of the microcirculation to macroscopic functional studies (CT, MRI, PET, SPECT, optical) of small animals and humans. The evolution towards molecular and cellular imaging is well underway. In addition, the Department has an emerging role in oncology, particularly in biophysical studies of cancer metastasis, and has had a long history in innovative radiation therapy. Specifically, our goals to increase research capacity as described below are to create new knowledge in the science of health across the lifespan. To continue to develop our research programs into world class endeavours we must ensure a proper succession plan is in place for senior faculty and mentor junior faculty to reach their full potential. Our department excels in translational research through collaborations with clinical faculty. One of the largest research areas in Medical Biophysics is related to Medical Imaging. We have a large nexus of faculty spread across the city working in this area including in the core department, at Robarts Research Institute, at Lawson Research Institute, and at the London Regional Cancer Program. This work is by nature interdisciplinary, involving basic scientists and clinicians, and highly translational, with many examples of direct impact on patients. Finally, we are actively increasing our commitment to the highest quality teaching and education. This strategy is centred around a new pedagogy course that is used as a tool to update other courses in our department – making them more current and more interesting to students. In addition, our CAMPEP accredited PhD program has become a destination of choice for clinical physics training in Canada. The success of this program must be nurtured in the coming years to become the most comprehensive CAMPEP training program in Canada. Our Medical Biophysics students learn in traditional classrooms and through "hands-on" research in modern laboratories and clinical facilities throughout London's research institutions. Our students progressively become independent researchers through laboratory experience. The graduate program requires specific training in the art and science of scientific communications with a strong emphasis on frequent presentations and a publication-based thesis. Our students have won many national and international awards for the quality of their presentations and publications.

In summary, the Department of Medical Biophysics is highly research-oriented and well aligned with the University's plans for education and research in a multidisciplinary environment.

To further elevate the department over the next three years, the following key research and teaching objectives are described below.

Research

Medical Biophysics Key Strategies, Goals and Actions

Research Strategy 1:

Increase Departmental Cohesion and Identity

During reconstruction of the Medical Sciences Building over a decade ago, the department lost about one-third of its area, resulting in limited research space and no provision for office space for new faculty or graduate students. Since then, the space available for core Department activity (5760 sq. ft) has been augmented to accommodate new faculty members, including a new Canada Research Chair. However this renovated space (3500 sq. ft) within the basement of the Natural Sciences Building is less than ideal for two reasons. First it is physically separated from the core department, further diluting an already small complement of core researchers, leaving them fragmented and isolated. Second the space is dark making it undesirable and considered second rate.

This space allocation has resulted in sub-standard laboratory conditions for several new and senior faculty members. Investment is critically needed to bring the standards to that of other Basic Sciences Departments in the Schulich School. At the very least, a renovation budget must be allocated to move Medical Biophysics a contiguous 8000-9000 sq. ft facility; its researchers and students merit such an investment.

The loss of designated Medical Biophysics laboratory space for undergraduate training has meant undergraduate students have no physical relationship with the department leading to a loss of identity with the program. There is no space for undergraduates to meet, work on assignments or laboratories together other than during designated tutorial hours in non-Medical Biophysics locations. With a small undergraduate program in a discipline that is unfamiliar to many students, this has a significant impact on our ability to increase undergraduate enrolment.

With the majority of graduate students located off-campus in affiliated research institutes, most of the physical resources needed to run the graduate program are not supplied directly by the University. These resources include office and laboratory space, research equipment and clinical medical imaging facilities found at the Robarts and Lawson Research Institutes, including the Victoria Research Labs and London Regional Cancer Centre. It is important to note that as hospitals face chronic budgetary challenges, a clearer demarcation between research and clinical services is always made, and research programs are at persistent risk of space compression. A reduction of institute research space (or salary support) has already had a serious impact on our departmental research and teaching capacity. For example Medical/Diagnostic imaging has gone from 8 FTE Physicists who had a mandate and time allotment for research and/or teaching along with their clinical responsibilities to currently 2FTE's with no mandate or time for research. This has impacted on the departmental research capacity.

The following goals and actions are proposed:

Goals	Proposed Actions
1-1 Department is spread across London. Identify mechanisms to increase city-wide interaction between faculty and students.	• Consolidate all core Medical Biophysics space at Western in one newly identified location within Schulich to maintain critical mass of core faculty • Improve quality of space for off-site faculty coming to the main campus to teach or perform research
1-2 Increase and expand signage for core and external department to improve visibility and boost the presence of the department	• Medical Biophysics main offices are located along a single isolated corridor on the 4th floor of the Medical Sciences building. Signage should be increased along main corridor near Burton lab to identify the department. • Currently no signage exists for the department space located in Natural Sciences. Signage should be expanded in this area.
1-3 Provide a common area for undergrad students to assemble	• Identify a small space for undergraduate students to assemble including access to fridge and microwave. Such an area could dramatically improve the culture and identity of the Medical Biophysics undergrad population.
1-4 Increase faculty and student interactions with the core department	• Increase faculty participation in weekly Medical Biophysics seminars • Invest in virtual meeting infrastructure for the Medical Biophysics conference room to allow more frequent an better quality meetings between Medical Biophysics faculty across the city
1-5 Review current departmental research grouping to ensure they accurately reflect actual operational groups and faculty expertise	• Establish a task force to establish criteria for departmental research groupings • Evaluate existing research groupings to determine whether they meet the established criteria • Revise research groupings with approval from SGPS if needed
1-6 Increase the national and international profile of the department	• Ensure all faculty promote the department be listing affiliations on all scientific presentations and papers • Update website to include most recent successes in undergraduate student teaching, graduate student training, and faculty research. • Highlight core research strengths within the department with translational impact on the Medical Biophysics website • Provide Schulich fundraising team with information for targeted asks

Research Strategy 2:

Build research capacity through recruitment in key areas of strength

Medical Biophysics boasts an outstanding multi-disciplinary faculty with strong research productivity and profile. Fundamental and "translational" research activity is conducted in the core department and in affiliation with the major research institutes in London. Some faculty have industrial collaborations and hence students establish important contacts for future employment and they can also apply for special programs (e.g. NSERC-IPS). The core Department *per se* has a critical mass of excellent teachers, modern facilities, and respected scientific researchers. Strong research areas in more fundamental studies of biophysics can be marginalized by higher profile activity such as Imaging. External faculty members give the impression (to our core staff) that the core Department is there *only* to "serve". This perception and attitude needs to gradually change. Effort will be made to boost departmental cohesion by increased collaboration and application for joint funding, and further recruitment in key areas of strength.

The following goals and actions are proposed:

Goals	Proposed Actions
2-1 Develop tenure track positions for current areas of strength and interest within the Department that align with clinical partners and capitalize on the research interests of non-tenured institute scientists	• Explore possibility of joint recruitment with Clinical Departments and Lawson Research Institute • Prepare for Western internal opportunities to fund future positions
2-2 Recruit new faculty members in areas of future research strength and to ensure leadership renewal in areas including microcirculation and computational modeling.	• Partner with other faculties and identified Western clusters of research excellence to recruit faculty in the areas that strengthen the core research areas within the department • Explore funding options through upcoming CRC competitions • Identify upcoming retirements and develop succession plans to ensure continuity of research programs and teaching
2-3 Encourage recruitment in public health areas to support and compliment basic science faculty	• Internally promote the recruitment of faculty with public health expertise with interest in applications to basic biomedical research • Establish a partnership to provide educational opportunities to Medical Biophysics faculty in important public health considerations that can be used to strengthen grant applications

Goals	Proposed Actions
2-4 Strengthen relationships with existing Western clusters of excellence (Cognitive Neurosciences & Musculoskeletal)	• Meet with leaders of Western clusters of research excellence to identify common goals that elevate / benefit faculty both within the department and the cluster

Research Strategy 3:

Increase Collaborative Funding and Industrial Partnerships

The following goals and actions are proposed:

Goals	Proposed Actions
3-1 Lead novel team grant applications that build on combining the strengths in imaging, microcirculation, and biomechanics	• Identify leaders to plan team grant applications that capitalize on existing and emerging research strengths within the department • Establish a research team with a long term plan to increase funding for mid career and junior faculty. • Provide more opportunities for core faculty to discuss ideas about big science questions. Facilitate the grant application process by providing administrative support for large applications. • Explore ORF partnerships with other institutions to leverage current industrial support • Team grant in microcirculation (Western has largest group of researchers in this area in Canada and most in Medical Biophysics) including medical imaging, radiation physics, vascular biology, musculoskeletal, diabetes – including other national laboratories.
3-2 Strengthen linkages with clinical departments by offering greater opportunities for clinically focused MSc training.	• Identify clinical departments with strong research focus and interest in MSc training (e.g. Neurology, Orthopaedics, Nephrology, Paediatrics, Anaesthesia) • Establish a process that allows clinical trainees to receive research training resulting in an MSc degree through Medical Biophysics.
3-3 Lead and support initiative to increase graduate student training support from granting agencies and/or industry partnerships	• Identify leaders to establish graduate training programs funded by CIHR/NSERC opportunities.

Research Strategy 4:

Creation of Burton Laboratory Core Research Facilities

The following goals and actions are proposed:

Goals		Proposed Actions
4-1	Clarify leadership and faculty responsibilities within the lab	• Elect or appoint a team of faculty members to create a governance structure • Create governance structure that is documented and transparent • Define terms of reference for members
4-2	Create a viable business plan for long term sustainability	• Determine expenses and sources of revenues • Apply for CFI funding • Attract new stakeholders • Initiate fundraising
4-3	Increase Schulich/Western user base	• Core leader to give talks at various departmental seminars to describe the facilites • Increase presence on web page • List core facility on Schulich core facilities page
4-4	Actively seek core support through Schulich, grants, and industrial contracts.	• Apply to Schulich for core facility support • Actively promote the facilities to existing industrial partners and other potential collaborators.

Teaching

Medical Biophysics Key Strategies, Goals and Actions

Teaching Strategy 1:

Increase Undergraduate Enrolment

Undergraduate Program

During the past decade, there have been major changes in the structure of programs leading to a degree in Medical Biophysics and in the facilities for teaching our courses. Rather than offering a single Honors BSc degree in Medical Biophysics the Department now offers five modules (a set of courses that count towards a degree) in 5 Honors Specializations (medical sciences, clinical physics, biological sciences, physical sciences, and medical biophysics and biochemistry); a Specialization, a Major, and a Minor. Individually, or in combination with other modules, these lead to a variety of degrees including Honors BMSc (Bachelor of Medical Sciences), Honors BSc (based on Honors Specialization or double Major), 4-year BSc (based on Specialization or Major) and 3-year B.Sc. (based on Major or double Minor). On average, approximately 15 students graduate with an Honors degree in Medical Biophysics. In addition, there are a number of students (typically 7 per year) who include a Medical Biophysics module in another degree.

In addition to our own modules the Medical Biophysics courses contribute to Medical Sciences modules, and to several of the modules offered by the Departments of Biology, and Physics & Astronomy. We offer concurrent degrees in conjunction with Chemical, Electrical and Mechanical Engineering. In addition, Medical Biophysics contributes to the undergraduate curricula in Medicine and Dentistry (selected topics). We continue to add and update courses to add capacity and breadth.

The curriculum in undergraduate Medical Biophysics has never been intended to serve as training towards a specific career. It is intended to teach students to examine medical and biological phenomena and problems from a physical and mathematical perspective, both from the biomechanical and physiological systems point of view and through the modern instrumentation that provides an interface between biological systems and the medical and research communities. Students learn that concepts taught in the courses can be applied to a wide range of situations in research, medicine, industry, and in the community.

The following goals and actions are proposed:

Goals	Proposed Actions
1-1 Ensure adequate faculty are available to teach undergraduate course offerings (succession planning). Hire a faculty	• Develop an inventory of courses and instructors. • Identify courses that are vulnerable due to faculty retirements or taught by faculty not responsible to Medical Biophysics. • Initiate process to hire a faculty member with outstanding

Goals		Proposed Actions
	member dedicated to outstanding teaching of second year Introductory Biophysics to attract students to the program, core CAMPEP and graduate courses, and summer student program.	teaching abilities and interest
1-2	Re-evaluate course requirements to enter undergraduate Medical Biophysics.	• During current review of course learning outcomes, also review and where necessary update pre-requisites for courses and modules
1-3	Increase second year course offerings to stimulate students to consider Medical Biophysics. Consider an introductory course in "Biophysics."	• Develop a plan to introduce a second year Introductory Medical Biophysics course • *Biophysics of the Cardiovascular System* (Dwayne Jackson's course) • *Biophysics in Medicine* (imaging, cancer, orthopaedics, hearing, critical care, etc)
1-4	Explore options to increase enrolment in Medical Biophysics second year courses or insert content into existing first and second year courses.	• Provide more second year Medical Biophysics course options • Consult with Biology and Physics to determine if small amount of MBP content (e.g., guest lecture) could be added to 1st or 2nd year courses
1-5	Establish a summer student program to target first year students in Bachelors of Medical Sciences Program	• Develop a plan to initiate a cohesive summer student experience for students supervised by Medical Biophysics faculty starting in Summer 2016.
1-6	Evaluate teaching infrastructure (e.g. laboratory equipment) to determine whether upgrades are required.	• During current review of course learning outcomes, also review infrastructure and consult with current students on possible infrastructure improvements

Teaching Strategy 2: Increase Quality of Graduate Student Experience

While the basic principles of biophysical studies have remained unchanged throughout the years, the application of those principles to current research in new and innovative ways is emphasized in our graduate training. The Medical Biophysics graduate degrees emphasize research excellence across all areas within the department. The Medical Biophysics PhD program is also CAMPEP accredited, and interest in this aspect of the program has increased steadily in the past five years. Over the next three to five years it will be important to maintain graduate enrolment despite decreased research support and increase the quality and stability of graduate course offerings. The availability of the CAMPEP course curriculum is required to maintain CAMPEP accreditation.

Graduate Program

The Graduate Program in Medical Biophysics is a research-intensive program for scientific training of graduate students with diverse backgrounds in the application of concepts and instruments from physics and engineering to the solution of problems in biology and medicine.

The objectives of our program are consistent with the general objectives of the University's mission and Strategic Plan. The University has recently re-emphasized a high priority on achieving excellence in graduate studies.

Our specific objectives are:

- to train students to carry out independent research in Medical Biophysics, research of a quality that can be published in first-tier journals of the discipline,
- to provide experience for all students in writing scientific abstracts and manuscripts for publication, responding to reviewers comments, preparing scholarship applications and research grant proposals, and making conference presentations of their work at scientific meetings (both oral and poster presentations),
- to ensure that students understand and can discuss both the technical aspects of their research project (e.g. appropriate application and accuracy of equipment, physical principles) and the biological or medical significance (e.g. physiological or pharmacological mechanisms, impact on diagnosis or therapy, societal implications),
- to ensure that students have a broad understanding of the major research strengths within the overall department (encompassed by the cross-appointed or jointly-appointed researchers and their students and postdoctoral fellows), and have an area of scholarship outside the main thrust of their thesis research,
- to train students in the ethical practice of scientific and medical research and in the appropriate use of animals and clinical trials for research purposes,
- to train students, where there is opportunity, in the responsibilities and challenges of working on contract research and industry-sponsored projects that may or may not contribute to their core thesis research,

Over the past decade years we have maintained a steady cohort of approximately 100 graduate students per year. However recent data suggests that we are not fulfilling all of the demand for students expressed

by potential supervisors. It is estimated that the saturation capacity is approximately 120 students with current faculty's aggregate supervisory power, lab facilities, and financial resources.

Graduate students are at the heart of the Department's success. They contribute to their supervisor's research program, serve as excellent role models for undergraduate students, and serve as ambassadors to attract more highly qualified students to Western. Graduate students receive steady stipends throughout the course of their studies; they do not have to consider external part-time work and can focus almost exclusively on research.

The following goals and actions are proposed:

Goals	Proposed Actions
2-1 Increase administrative support for large graduate program and graduate executive committee to facilitate upcoming (2017) graduate program review (IQAP)	• Monitor recent changes to the administrative structure of the department to determine whether further refinements are needed
2-2 Improve faculty sustainability for teaching graduate courses. Department relies on many off-site non-tenured faculty for teaching with no control of succession planning.	• Identify courses that are vulnerable because they are taught by faculty that are not remunerated through Medical Biophysics.
2-3 Strengthen linkages with clinical departments by offering greater opportunities for clinically focused MSc training.	• Explore options for facilitating or helping facilitate a clinical MSc degree. This includes identifying interested clinical departments, faculty, resources and compatibility with clinical training; and negotiating policies and governance/administrative models.
2-4 Update graduate course content, one course at a time (per year).	• Identify courses that require updated content to meet learning objectives • Work with faculty / instructors to update course content when required or desired. • Our BIOPHYS 9674B "Pedagogy in Biophysics" course trains students in curriculum and instruction. Their course project is to develop or redevelop an entire Medical Biophysics course. This will serve as the vehicle by which we will update our course content.
2-5 Develop resources for interested students to gain knowledge in non-	• Examine options for a seminar series or course that provides training opportunities for graduate students in aspects of career development

Goals		Proposed Actions
	science skills including: leadership, writing, career development, financial planning	
2-6	Increase mentorship and graduate training support opportunities for new faculty to increase success in recruiting top graduate students	• Identify mechanisms and cultivate a culture of informal ongoing mentorship to all faculty to provide guidance for grant applications, teaching, and student supervision
2-7	Promote course in Success in Research: Problem Discovery to Solution. Train entry-level PhD students the thinking processes necessary to become successful researchers.	• We have developed a completely new course that teaches graduate students skills and strategies for discovering and defining the most important research problems to solve. The course teaches research problem solving strategies, with an emphasis on developing explicit awareness of the steps involves in one's problem solving strategy, so as to harness and control this process for greater efficiency and effectiveness.

Teaching Strategy 3: Enrich the CAMPEP Program

The following goals and actions are proposed:

Goals		Proposed Actions
3-1	Support the CAMPEP program to ensure all CAMPEP course requirements are available to maintain CAMPEP accreditation.	• Short-term: Continue survey of CAMPEP teaching frequencies and risk identification (such as retirement). • Medium-term: Work with Departmental effort to recruit new faculty to assist teaching CAMPEP courses.
3-2	Increase administrative support to add value for students including creating observerships, QAships, receptors identified for residency placements, CV enhancements, invited speakers, preparation for CCPM exams, and career	• Allocate protected time to an Administrative Assistant for CAMPEP program support. • Include consideration for value-adds in revised funding models (item 3-3 below).

guidance.	
3-3 Revise the CAMPEP funding model to more closely align with competitive programs across Canada.	• Develop several funding model alternatives that satisfy and balance the objectives of the faculty, department, and graduate students. • Implement new funding model under the guidance of Schulich administration
3-4 Acknowledge the sponsors of hospital-based paid assignments	• Provide feedback to sponsors regarding the value of their contribution.

Concluding Remarks

The Department currently has a good overall balance of technology-driven research and basic research in mechanistic biology and medicine. This strong combination spans across multiple institutions, involves clinicians, and should guide collaborative planning and recruitment strategies. Where possible, individual faculty members should also broaden their basic funding base for research through collaborative grants, providing 'insurance' opportunities for keeping laboratories and students funded through tougher financial times. The current granting agencies favor "multi-disciplinary translational research" with an explicit "bench-to-bedside" or commercialization link. This is a natural fit to our Department's profile and key to success. We must continue to provide unique educational experiences to our students who will help uncover new clinically-relevant diagnostic and therapeutic approaches for the future of health care.

This period of great opportunities within Western has seen expansion of research following significant research investments in two clusters of research excellence (Cognitive Neuroscience, Muskuloskelatal) as well as a number of Schulich recruitments (some still ongoing) with strong ties to Medical Biophysics. There are great opportunities for the Medical Biophysics Department to become a transformative vehicle to foster increased cohesion, growth, and excellence of biophysical research throughout London. One of the major goals of the Medical Biophysics Department is to be the top Biophysics training program in Canada and within the top 5 such programs in North America, making Western a destination for the best Canadian and international students seeking graduate student research positions. Continued faculty recruitment in new areas of technological advance and biomedical importance will continue to raise Western's profile and lead to the overall success the Schulich School of Medicine and the university as a whole.