Overview of Soka University Life Science Concentration Planning

Soka University Life Sciences

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SOKA UNIVERSITY

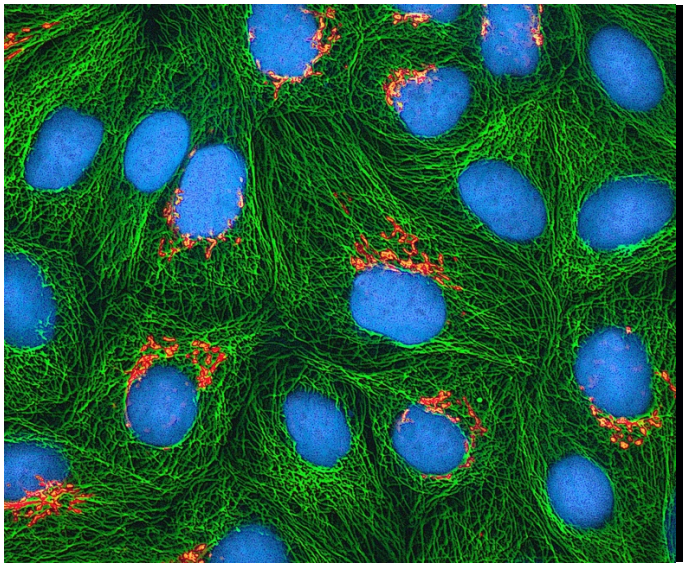
Vision for Life Sciences at Soka University

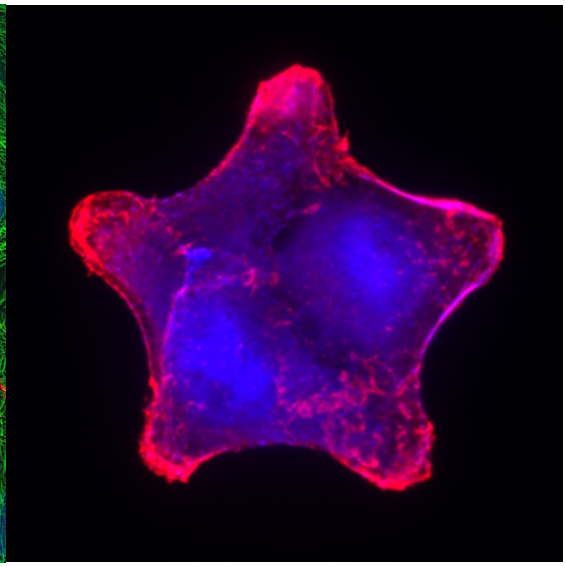
The Life Sciences Concentration at Soka University will offer a rigorous curriculum that provides a solid foundation in the sciences, including courses that embody the latest emerging discoveries in biology and chemistry, and a student-centered pedagogy that challenges students to apply what they have learned. The BA in Liberal Arts with a concentration in Life Sciences will feature inquiry-based learning through student-led experiments, giving valuable research experience on topics of interest in current scientific research. The Life Science curriculum will also be integrated with Soka University's innovative Core and General Education curriculum and will prepare well-rounded students that are more than technically proficient and scientifically knowledgeable. The curriculum will enable students to help develop scientific breakthroughs in the Life Sciences that will enhance the sustainability of our planet and promote human health, and to encourage ethical uses of technology that incorporate Soka University's core values of peace and global citizenship.

Summary of Life Science Concentration for Admissions

From the discussions within the SUA Life Science planning task force, we developed the concise summary of our new Life Science concentration below. This summary was shared with the SUA Admissions office, and will be included in future admissions materials as we build up to the implementation of our new Life Science Concentration in 2020:

> The BA in Liberal Arts with a concentration in Life Sciences at Soka University of America will prepare students to engage in the dynamic fields of biology, biomedical research, biotechnology, as well as providing a pathway toward careers in medicine or public health. The concentration will feature an interdisciplinary curriculum that provides a solid foundation in the sciences with courses that embody the latest discoveries in biology and chemistry, and a pedagogy that challenges students to apply what they have learned to realistic scenarios. The Life Science Concentration will feature inquiry-based courses that train students in experiment design, data collection and analysis, and presentation of experimental results. The Life Science Concentration will feature a global outlook that considers the societal and cultural implications of new advances in the Life Sciences.





Planning for Life Science Concentration – Overview

Between 2015-2017, a group of Soka University science faculty initiated the planning for the Life Science Concentration with the Dean of Faculty, Ed Feasel, to provide a timeline of the hiring for new faculty and a listing of essential courses within the new Life Science Concentration. This planning has been very successful, and can be considered as Phase I of the planning. The Phase I planning also helped define the requirements for the new Soka University Life Science Building, which is now under construction and will feature a state of the art 91,370 square foot facility that will include 8 teaching labs, 10 research labs, a lecture hall and a mix of office and interaction spaces. The new science building will be staffed with a mix of faculty that will include a set of 6 newly hired science faculty, along with additional faculty from a variety of disciplines to make for an exciting and interdisciplinary intellectual environment. The work of the Science Planning Committee during AY 2015/16, 2016/17 is attached as Appendix I, and includes a basic set of courses that will need to be offered to prepare students to apply for postgraduate study in the Health Professions as well as for further studies in other Life Science fields. This planning also has defined the basic outlines of a hiring plan which is also included in Appendix I. During the Phase I planning, a sample pathway through the Life Science curriculum for students wishing to enter the Health professions was prepared and this document is attached in Appendix II. Both documents provide useful background and context for our new discussions in Phase II with the Science Advisory Board and task force.

Phase II for Life Science Concentration – Task Force and Science Advisory Board

For the 2017-18 academic year, we established a Science Planning Task Force, which has built upon the work from Phase I of the planning, and engaged in a discussion with outside experts who have agreed to serve on a Science Advisory Board. The task force included: Bryan Penprase, Dean of Faculty; Robert Hamersley, Associate Professor of Microbiology and Lab Director; Zahra Afrasiabi, Associate Professor of Chemistry; Lisa Crummett, Assistant Professor of Biology; Phat Vu, Associate Professor of Physics, and Ed Feasel, Vice President of Academic Affairs. During the second half of Spring 2018, Anthony Mazeroll, Professor of Biology, joined our discussions after returning from his sabbatical travels.

The work of the Phase II of our Life Science Concentration planning explored in more detail how to build a program that is well aligned with the mission and academic curriculum of Soka University and which is distinctive in its design and implementation. The unique opportunity to develop the Life Science curriculum “from scratch” includes the chance to incorporate the latest developments in life science and biotechnology, and to build upon the advances in teaching and learning science

that have created new perspectives on how people learn. Widespread use of experiential learning, problem-based learning, and team-based learning will be incorporated into the curriculum, and the impact of this new form of pedagogy will be discussed as it may shape our curriculum. The distinctiveness will be further enhanced by the integration of interdisciplinary perspectives from social sciences, arts and humanities from complementary courses within the GE Curriculum. As the requirements for medical school also have evolved, our Life Science program will incorporate the latest and most modern perspectives of medical training, to prepare students for careers in the new era of medicine – with its greater emphasis on leadership, interpersonal skills, and the incorporation of gene therapies, large databases and advanced technologies.

Our next phase of planning has examined how these advances in life science and technology coupled with developments in learning science will shape our Life Science curriculum. The Science Advisory Board has been comprised to include thought leaders across academia that represent the latest trends in life science, higher education, curriculum design and educational research. They have provided a stimulating series of discussions that has enabled our Life Science Concentration to develop a new level of specificity and a uniquely modern approach to preparing life scientists to be both deeply trained in rigorous science, and broadly trained with a global perspective that cultivates ethical and wise uses of science and technology.

Advisory Board Members and Specialties

David Oxtoby, Chemist - Former President of Pomona College, and former President of Harvard's Board of Overseers; now based at Harvard. David is an expert on undergraduate education, and is also the author of one of the most widely used Chemistry textbooks.

Andrew Endy, Bioengineering, **Stanford University** – Professor of Bioengineering at Stanford, Drew is the Founder of the BIOFAB and IGEM groups, and one of the world's leading synthetic biologists. Drew is a visionary thinker about the frontiers of biology, and will help us define some of the emerging discoveries and think about how they should be incorporated into the curriculum.

Elizabeth Orwin, Biomechanics, Harvey Mudd College - Biomechanics expert, and Chair of Harvey Mudd Engineering, Liz is an expert on experiential learning and linkages between Life Science and Biotechnology. Liz has led the Harvey Mudd Clinic with several projects in collaboration with tech companies.

Emily Wiley, Biology, Keck Science Department – Professor of Biology at Scripps/CMC/Pitzer Colleges Keck Science Department, Emily is one of the leaders of the Keck Science curriculum development effort that has produced accelerated introductory science sequences that merge the disciplines of Physics, Biology and Chemistry. She is also an expert in using DNA sequences in undergraduate classes, and in linkages between life science and undergraduate research, as well as having over a decade working in an interdisciplinary science department.

Bob Kamei, Medical Education/Learning Science, NUS – Associate Provost, National University of Singapore, and former Professor at the Duke-NUS Medical School, Bob is one of the founders of the educational program at Duke-NUS, and developed new forms of Team Based Learning and assessment within the Duke-NUS program that is being emulated worldwide. Bob is now an Associate Provost at NUS directing a new Learning Science Institute known as ALSET which conducts educational research on how to optimize learning environments for students.

Martha Cyert, Stanford University - Biology Professor at Stanford University, Martha is a leader in reshaping Stanford's undergraduate Biology curriculum and a leader of BioX, one of the most innovative interdisciplinary biology programs at Stanford. Martha has a dynamic research program that investigates interdisciplinary life science problems, and has led an effort to bring research experiment design into the first-year biology curriculum at Stanford.

Brian Greene, Columbia University – Physics Professor at Columbia University. Brian is a well-known author and speaker, as well as a leading physicist in string theory. Brian's skills as an interpreter of science and the intersections between science, philosophy, music and the arts will be

very powerful in shaping our vision of the Soka University Life Science curriculum. Brian will be extremely helpful in promoting Soka University with a large audience and helping us develop effective general education science courses and effective programming for conveying the relations between science, humanities, social sciences and the arts.

Five key questions for the Life Science Planning Task Force, and Science Advisory Board

Our Phase II planning in Year 1 has focused on five key questions that will enable us to move forward with a fully developed plan for our new Life Science Concentration. These questions have been discussed with the Life Science Task force and Science Advisory Board and with our academic community:

1. What are the emerging technologies and discoveries that are changing and redefining life science, and how do we incorporate them fully into our curriculum?

2. What are the new developments in medical education and how should we adapt our curriculum to prepare doctors for 2024 and beyond?

3. How can we fully incorporate advances in STEM education into our course design and hiring plan to enable students to learn in an active and student-centered environment?

4. How do we integrate this Life Science concentration fully into our liberal arts curriculum, and prepare science graduates to be fully informed of the ethical, philosophical, cultural and societal implications of their work?

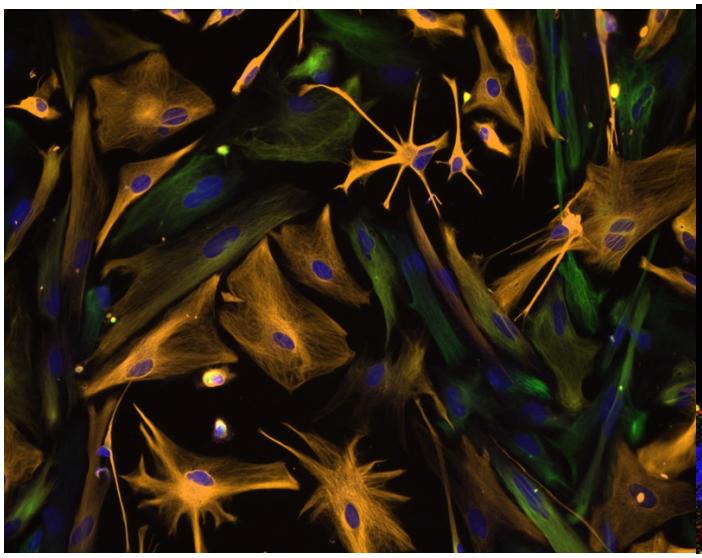
5. What kinds of curriculum – discipline-based or interdisciplinary – is best suited to our new Life Science concentration, given our limited number of hires and our need to establish our new program with graduate programs and employers?

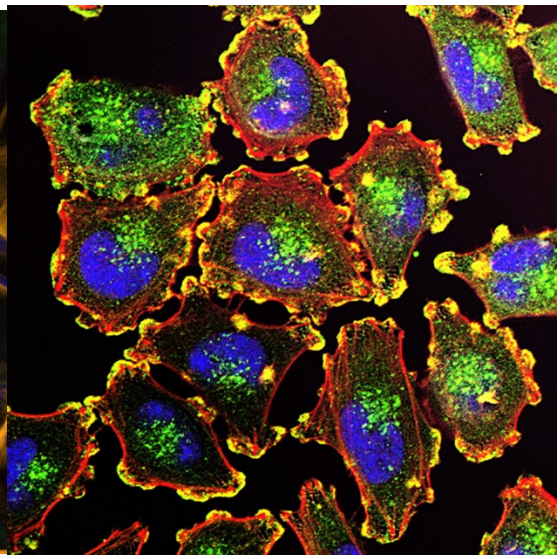
Each of these questions has been explored with focused discussions between our Science Advisory Board and our Life Science Planning Task Force, and with our Soka University community during a series of Life Science Symposia events. As we develop answers to these questions they will necessarily provide insights on the mix of courses and the use of our new Life Science Building, as well as the types of individuals and the expertise that will be needed within the faculty to implement our Life Science Concentration.

The events planned for 2017-18 have included two afternoon Life Science Symposia focusing on Biology and Life Science Education. A third meeting was convened to focus on pre-Medical and

Medical education. These meetings have enabled our advisory board members to visit Soka University to learn more about our programs, and to present some of their perspectives on the subject.

During the Spring Semester, an outline of our Life Science curriculum, and a proposal for a hiring plan has been developed with our Science Planning Task Force, along with detailed answers to the questions posed above, based on discussions with our Science Advisory Board. These materials will help us determine the mix of expertise needed within the faculty for our first round of hiring in 2018. These discussions have helped shape the curriculum that will be developed with our newly hired faculty, working closely with our current Soka University faculty and with inputs from our Science Advisory Board. The report includes key elements of the Soka University Life Science curriculum that emerged from our discussions in 2017-18, and an outline of a recommended hiring plan for the upcoming five years as we design and implement our new curriculum.





Timeline for Phase II of Life Science Planning at Soka University 2017-18

Science Advisory Board implementation: October, 2017. A group of experts in Life Science and Higher Education has been convened to help guide the Life Science planning in answering our five key questions, and in developing a detailed plan that incorporates emerging trends in Life Science, new developments in pedagogy and curriculum, and linkages to the latest trends in medical education and real-world experiences.

Site visit to the Claremont Colleges: November 2, 2017. During a visit to the Claremont Colleges, some of the advisory board met with our Task Force to help shape our initial process, as well as to share in detail how the Claremont Colleges has developed new courses and curriculum to optimize the training of life science students and pre-medical students.

Life Science Symposium I: December 12, 2017: Liz Orwin, Emily Wiley, Martha Cyert.

Half of the Science Advisory Board attended our first event, and a public symposium enabled them to present their perspectives on biology education and curriculum. A dialog with the speakers and our Life Science Planning Task Force has provided the basis for our planning of the curriculum in the Life Science Concentration.

Life Science Symposium II: January 16, 2018: Drew Endy, David Oxtoby, Bob Kamei

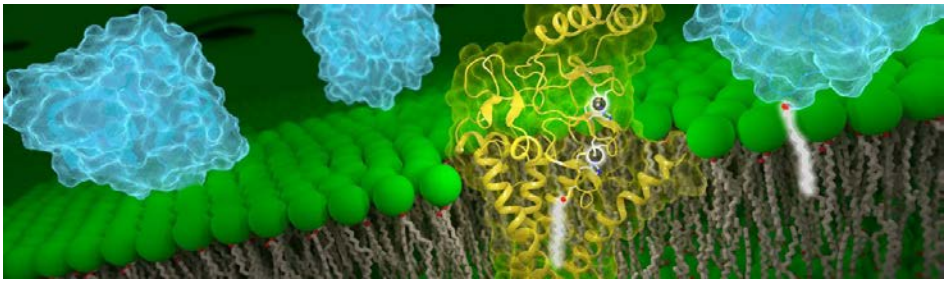
During this event the other half of our Science Advisory Board attended Soka University, and also presented at a public symposium their perspectives on emerging frontiers of biology, medical education and science in liberal arts colleges. A dialogue with the speakers and our Life Science Planning Task Force has provided insights that have helped us refine our plan for hiring and curriculum design.

Medical and Pre-Medical Education Symposium - April 18, 2018: Bob Kamei, M.D., Linton Yee, M.D., and Dr. Richard Lewis

Medical education experts from leading medical schools has convened with the Task Force to discuss requirements for admissions into Medical School, and other aspects of Medical Education. These discussions included discussions with Bob Kamei, M.D., (NUS, formerly Duke-NUS Medical Center and UCSF Medical School), Linton Yee (Duke Medical School Professor and Admissions Chair), and Richard Lewis (Professor of Neuroscience and pre-medical advisor at Pomona College).

Life Science Concentration planning report issued - August, 2018 – Our first draft of the report has been circulated, including recommendations for hiring and plan for future curriculum development efforts. This report describes the work of the Life Science Concentration planning Task Force, who have met with the Science Advisory Board, and who have been working to plan for our next four years of faculty hiring, and to outline the features of our initial Life Science concentration courses.

Brian Greene - Dialogue on Science, Creativity and Reality - Public Event for AY 2018-19 (Feb 2019). During the Dialogue on Science, Creativity and Reality, we will feature Brian Greene and two other thought leaders who will examine the deeper implications of science on our perspectives of reality and on what it means to be human. The panel will include experts in arts, philosophy and life sciences who will engage Brian Greene in a wide-ranging dialogue on these important topics. A workshop involving representatives from all four Soka University concentrations will discuss how best to integrate Life Science Concentration faculty and courses into our existing Soka GE curriculum, and to discuss the relationships between the Life Science Concentration and other Concentrations, Programs and Areas at Soka University.



Science Advisory Board and Medical Advisory Meetings

Our Advisory Board was invited to visit Soka University to engage in discussions with our Life Science Planning Task Force and to share their perspectives with the Soka University community. Two Advisory Board meetings, one on December 12, 2017, and one on January 16, 2018, allowed for each of our Advisory Board members to present to the Science Planning Task Force their perspectives on Life Science curriculum, pedagogy and emerging discoveries. After each presentation, a dialogue involving all three of the Advisory Board members and the Task Force explored how their insights can be incorporated into our planned curriculum, hiring strategy and other programs within our Life Science Concentration. In addition to the two meetings with the Science Advisory Board members, a third meeting was scheduled with a group of experts in Medical Education on April 18, 2018. This meeting took the same format as our Science Advisory Board meetings, with a series of presentations and discussions with our Science Planning Task Force, followed by a panel presentation to the Soka University community on medical and pre-medical Education. Schedules and details from each of the three meetings are presented below in separate sections.

December 12, 2017 Science Advisory Board Meeting I

Our first Advisory Board meeting focused on the undergraduate science curriculum and explored methods for incorporating new types of pedagogy that are more active, project based and inclusive, to enable maximum student learning. The theme for the meeting was pedagogy, curriculum and undergraduate experience in Life Science Education.

Our panelists for this day are listed below.

Elizabeth Orwin, Biomechanics, Harvey Mudd College - Chair of Harvey Mudd Engineering, Liz is an expert on experiential learning and linkages between Life Science and Biotechnology. Liz has led the Harvey Mudd Clinic with several projects in collaboration with tech companies.

Emily Wiley, Biology, Keck Science Department - Biology Professor at Scripps/CMC/Pitzer Colleges Keck Science Department, Emily is one of the leaders of the Keck Science curriculum development effort that has produced accelerated introductory science sequences that merge the disciplines of Physics, Biology and Chemistry.

Martha Cyert, Biology, Stanford - Biology Professor at Stanford University, Martha is a leader in reshaping Stanford's undergraduate Biology curriculum and a leader of BioX, one of the most innovative interdisciplinary biology programs at Stanford. Martha has a dynamic research program that investigates interdisciplinary life science problems, and has led an effort to bring research

experiment design into the first-year biology curriculum at Stanford.

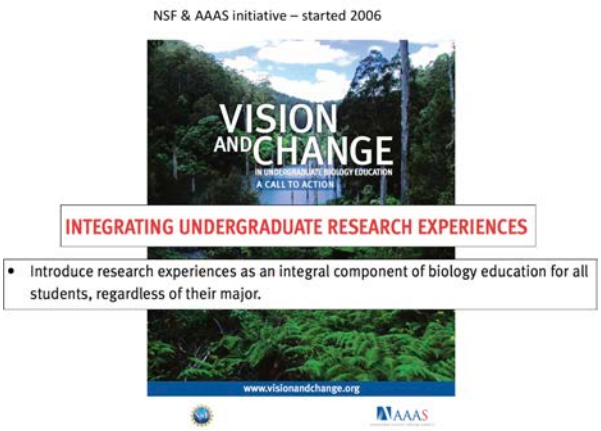
Schedule for Meeting I

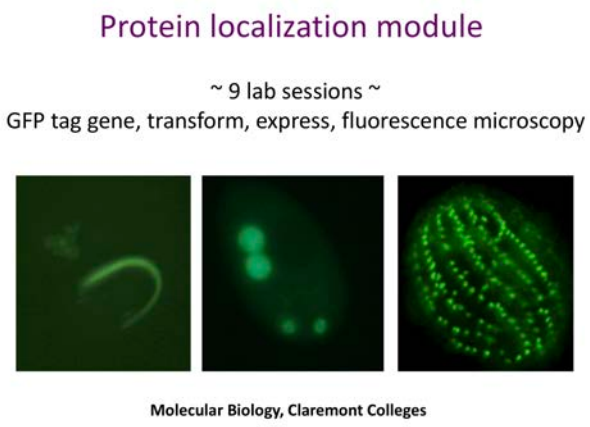
- 11:00AM – Advisory Board members arrive to Soka University campus. Orientation meeting, and quick tour of campus with Ed Feasel and Bryan Penprase
- 11:30AM - Gather for introductions and lunch with Life Science Planning Task Force.
- 1:00 PM – Session I: Experiential Learning, and linkages with Industry (Elizabeth Orwin). Will discuss the HMC clinic program, ways to build multi-level hands-on design projects within classes, and how hands-on exercises and small teams of students can improve learning.
- 1:45PM – Session II: Integrated Curriculum and Research-based case studies (Emily Wiley). Will discuss how the Keck Science Department AISS and IBC courses have integrated Physics, Biology and Chemistry, as well as Biology and Chemistry, and the particular units that have been most effective. Will also describe how students can advance science research within lab courses, and ways to structure such experiences for introductory students in Life Science.
- 2:30-2:45 PM Break
- 2:45 PM – Session III: Project-based Learning and Experiment Design in Intro Biology (Martha Cyert). Will discuss how Stanford's Life Science Curriculum has been redesigned to include research experiment design, and ways that the new Curriculum embodies some of the frontier areas of Life Science.
- 4:00PM – break and reception – Faculty and Students invited to meet and interact with the Science Advisory Board members and Life Science Planning Committee
- 4:30PM – Panel presentation – Perspectives on Curriculum, Pedagogy, and Student Experience in Life Science Education. Each panelist will present for 10-12 minutes, followed by questions.
- 5:30PM - Refreshments available for further informal discussions.
- 6:45PM – Dinner – at restaurant in town – for Life Science Planning Task Force and Advisor Board members.

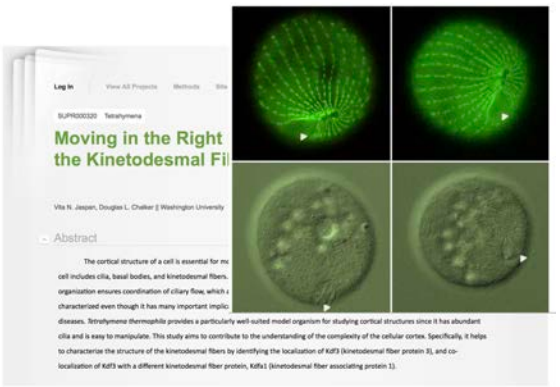
Notes and Details from Science Advisory Board Meeting I

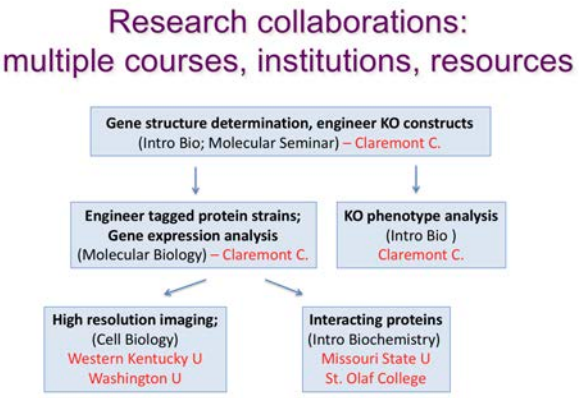
The meeting began with a presentation from Emily Wiley about the new science curriculum she helped develop and implement at the Keck Science department of the Claremont Colleges. Emily made reference to one major publication that guided their work, the 2006 "Vision and Change" report from the NSF and AAAS which studied undergraduate biology education and documented the most effective elements of pedagogy and curriculum for future life science and biology programs. Emily then described her work with the Ciliate Genomics Consortium, where students are able to develop new discoveries in class that are published in a database available to other researchers, and the new course at Keck Science known as Integrated Biology and Chemistry (IBC). Emily described some of the lessons learned at Keck Science from the Accelerated Integrated Science Sequence (AISS), a

team-taught course that offers full-year introductions to biology, chemistry, and physics during a year-long double-credit course taught by three faculty members.

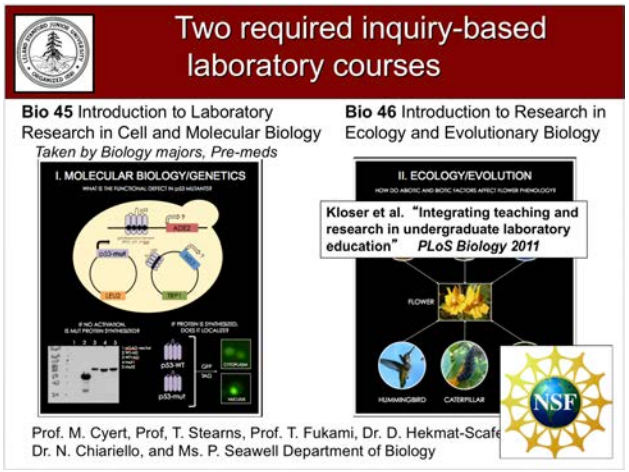


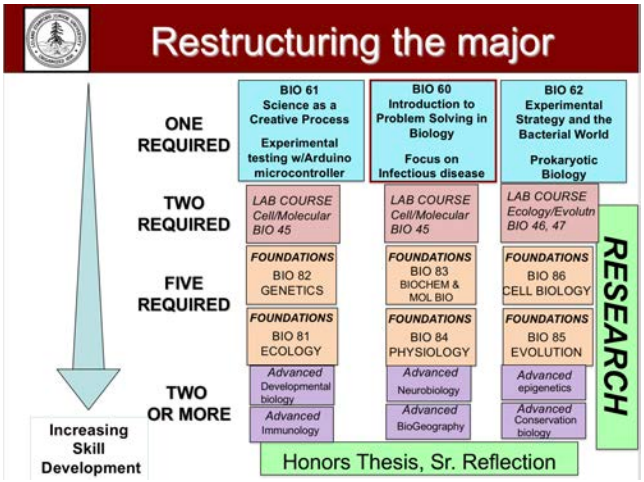






Martha Cyert described the new biology curriculum at Stanford, and offered details of two of the laboratory courses she helped design and teach. These courses included Biology 45, an Intro to Lab Research in Cell and Molecular Biology, and Biology 46, an Intro to Lab Research in Ecology and Environmental Biology. She described how her new laboratory course, Biology 45, offered benefits to students by locating all laboratory experiments within a stand-alone inquiry-based course within the curriculum. This allowed Stanford faculty to move away from numerous "cookbook" labs, which were predictable and used standard protocols, into a new format which provided more authentic research experiences within the laboratory course. Within these dedicated laboratory courses, students can engage in critical thinking, data analysis, and gain a sense of ownership of the data and even the experiment design. The laboratory class also enabled students to learn about how science is presented in both presentations and written reports.





The laboratory course does spend some time reviewing scientific literature, and then splits students into separate teams where they conduct experiments of their own, sharing the results and findings with the group. She gave an example of how each section would divide into pairs of students each working on a different mutant organism, and then these students would become experts on that organism and report their discoveries back to the lab section. With multiple sections, groups of field experts could also come together, providing something resembling a scientific conference among the students. Martha also mentioned that this course is graded P/F and featured pre and post testing to assess how student perceptions of their ability to "think as a scientist" have changed. Martha also described the Bio 60 course at Stanford entitled "Thinking and Communicating about science" in which students created TED talks and even designed new products based on their projects.

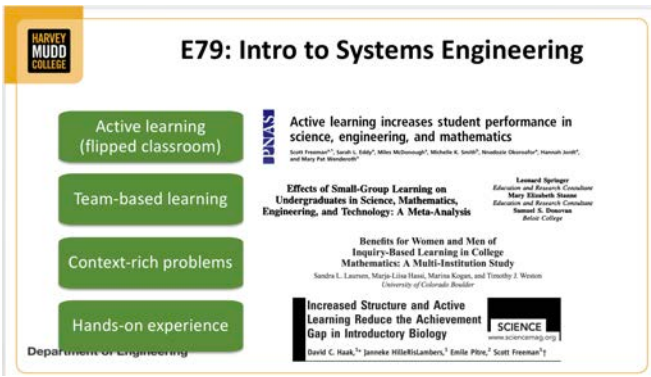
Emily and Martha made several recommendations which included:

1). Integrate Undergraduate Research Experiences as early as possible. She mentioned that research should be integral to the biology curriculum and there should be the appropriate balance between laboratory experience and teaching, with authentic research-like materials in both.

2). Separate Lab from Course Content. At Stanford, the ability to break out laboratory courses from content courses enabled them to teach transferrable skills and create a more authentic research environment within the curriculum. She suggested more detailed laboratory experiments lasting several weeks in which students gain experience with experiment design and in disseminating results. This kind of course teaches students what it means to do research.

3). Integrate Computer Science Skills into Life Sciences. Martha Cyert was especially emphatic about the necessity of computer skills within a Life Science or Biology curriculum, to enable students to work with genomic datasets and at Stanford they use a short course known as "Software / Data Carpentry" and this has helped their students quickly gain programming skills.

An additional presentation from Liz Orwin from Harvey Mudd College (HMC) described her process in revising a key core curriculum course in HMC Engineering. The new Systems Engineering Course employs Team Based Learning, and uses a "flipped" classroom environment, makes continuous reference to when and how the abstract concepts were applied, and then features a two hour "practicum" where students work together to build small robots to measure temperature and other quantities within a nearby lake. Within the practicum, HMC faculty consciously have developed an "inclusive" pedagogy where students work in pairs, and frequent consultation with student proctors enables them to have an interactive experience. Built into the project is a requirement that students trade off duties within the team so both of the pair have equal experience with all parts of the project and there is not a "lead" in the lab group. Liz also described how Harvey Mudd includes the HMC Clinic project as an option for capstones, and how this very successful program allows students in teams of 6 to solve real engineering problems for industrial partners. The necessity to work effectively as a team, to develop leadership and communication ability and to fulfill a contract with the industrial partner all provide valuable skills for the students.



The meeting concluded with a panel presentation attended by faculty, staff and students from across the university, and a lively question and answer session explored the latest developments in life science education between our panelists and with the audience. The images below are from our December 12 Life Science Symposium.

January 16, 2018 Science Advisory Board Meeting II

This meeting focused on the emerging areas within Life Science that will shape the future of Life Sciences and future biomedical research, and the impacts of these advances on our new Life Science curriculum. We discussed the implications of these frontier areas on medical e ducation, as well as the implications of the new Soka Life Science curriculum for peer liberal arts colleges. The theme of this meeting was Interdisciplinary Science, Emerging Frontiers and Medical Education. Our panelists for this day are listed below.

Andrew Endy, Bioengineering, **Stanford** – Professor of Bioengineering at Stanford, Drew is the Founder of the BIOFAB and IGEM groups, and one of the world's leading synthetic biologists. Drew is a visionary thinker about the frontiers of biology, and will help us define some of the emerging discoveries and think about how they should be incorporated into the curriculum

David Oxtoby, Chemist, Pomona/Harvard - Former President of Pomona College, and former President of Harvard's Board of Overseers; now based at Harvard. David is an expert on

undergraduate education, and is also the author of one of the most widely used Chemistry textbooks.

Bob Kamei, Medical Education/Learning Science, NUS (presenting by Skype) – Associate Provost, National University of Singapore, and former Professor at the Duke-NUS Medical School, Bob is one of the founders of the educational program at Duke-NUS, and developed new forms of Team Based Learning and assessment within the Duke-NUS program that is being emulated worldwide. Bob is now an Associate Provost at NUS directing a new Learning Science Institute known as ALSET which conducts educational research on how to optimize learning environments for students.

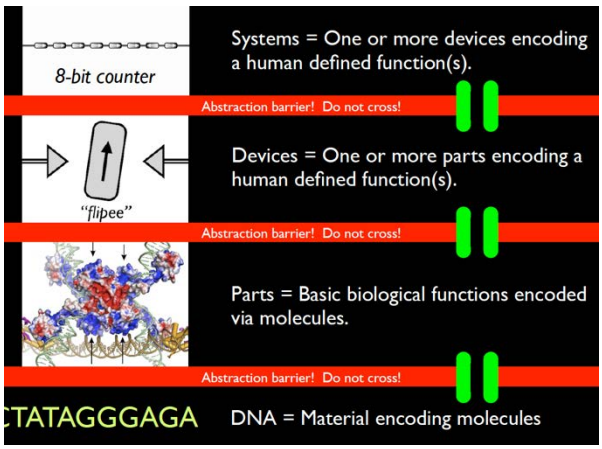
Schedule for Meeting II

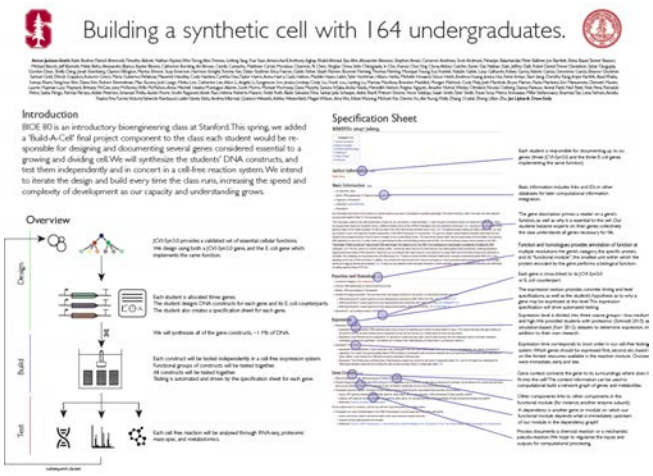
- 11:00AM – arrive to Soka University campus. Orientation meeting, and quick tour of campus with Ed Feasel and Bryan Penprase.
- 11:30AM - Gather for introductions and lunch with Life Science Planning Task Force.
- 1:00PM – Session I: Frontier Areas in Life Science (Andrew Endy). Will discuss the emerging field of Synthetic Biology, and how the new biotechnologies will shape our future and our curriculum.
- 2:05PM – break
- 2:15PM -- Session II: Undergraduate Science Education in Liberal Arts Colleges (David Oxtoby). Will discuss how liberal arts colleges can integrate research experiences into the undergraduate experience, the role of summer research, and ways that science curriculum and research programs are managed at peer liberal arts colleges.
- 3:20PM - break
- 3:30PM – Session III: New Models of Medical Education (Bob Kamei). Will describe ways that medical schools in the US and internationally are responding to advances in biomedical research and learning science.
- 4:00PM – break and reception – Faculty and Students invited to meet and interact with the Science Advisory Board members and Life Science Planning Committee
- 4:30PM – Panel presentation – Perspectives on Frontiers in Life Science, Liberal Arts Colleges Science and Pre-Medical Education. Each panelist will present for 10-12 minutes, followed by questions.
- 5:30PM – Refreshment and Reception - and further informal discussions with faculty and public.
- 6:45PM – Dinner – at restaurant in town – for Life Science Planning Task Force and Advisor Board members.

Notes and Details from Science Advisory Board Meeting II

Our second Advisory Board meeting began with a presentation on Synthetic Biology from Drew Endy from Stanford University, who offered perspectives on what some have called an emerging "Biological Century." The rapid development of standards and technology for sequencing genes has caused a reconsideration of the nature of life itself. One definition Drew offered for life and for organisms is as a "nature-compatible matter compiler" – and he stressed that the more general

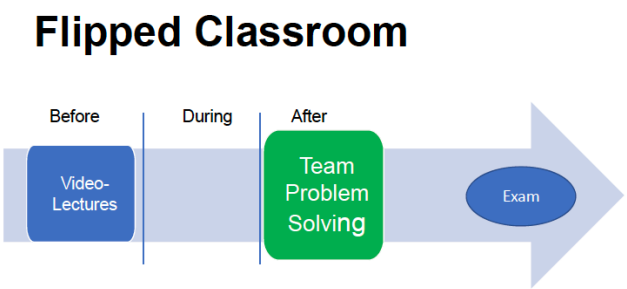
definition of life-forms offers opportunities to develop new organisms that can provide a vital role in producing fuels, food and pharmaceuticals. Drew also described the iGEM.org competition, which he began at MIT about a decade ago, and which has grown to include over 10,000 students each year who design and build their own lifeforms using genetic sequencing tools. Drew described the role of the new CRISPR technology for editing genes, and how he has developed a course at Stanford in which the class designs and synthesizes a bacterial genome, with his last 2017 section building 10,000,000 base pairs of DNA in the course. The larger future of biology includes the consideration of how to mitigate the risks of programmable life, and how to intelligently harness the 90 terawatts of power residing within life on earth. Successfully managing the vast potential of programmable life could have a transformative benefit for civilization.

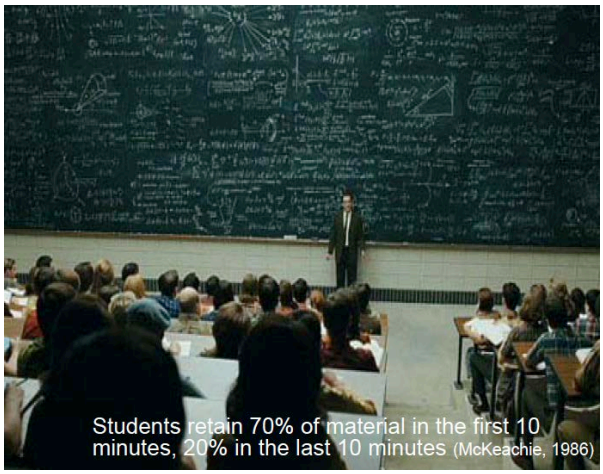




David Oxtoby provided remarks about his work as President of Pomona College, and gave an overview of the unique role of research for undergraduates in liberal arts colleges, and the ways in which institutions like Pomona College or Soka University can help students both focus on specialized projects, but also to "de-magnify" to see the larger picture. David recognized that Soka University has an opportunity to train students to be able to work on some of the big problems facing the world. He also stressed the importance of building into the curriculum the ability for students to ask new questions; as David put it, "too much science education is answering questions no one is asking." Because of SUA's emphasis on global citizenship, David recommended that we consider thinking about global health, and build on our small number of students and majors. He advised for us to not "try to do here what too many other places have done." His final set of advice was for us to be sensitive in our curriculum design and teaching to not be too content driven. As David put it, the job of teachers "is not to cover but to uncover." He suggests we think about our basic material in courses in more creative ways and to allow for moving in new directions.

Bob Kamei gave a presentation describing the new Duke-NUS medical center in Singapore, and described how the medical school incorporated the most recent research in pedagogy and learning science in the design of the program. He mentioned a study showing that students retain 70% of materials in the first 10 minutes, but only 20% in the last 10 minutes (McKeachie, 1986), and also noted that the traditional exam-based course concentrates studying into the very last part of the course, further reducing student learning. Within the Duke-NUS medical school is a flipped classroom, combined with team-based learning and problem solving, giving students repeated practice and feedback as they build proficiency, and move toward higher levels of difficulty within Bloom's taxonomy of learning. The Duke-NUS program also includes a year of research training and alternates clinical work with basic science to provide a better grounding in practice for their future medical professionals.





The meeting concluded with presentations for the Soka University community, and a chance to share the advances in biology and education from the perspective of our Advisory Board members with a large group of students, staff and faculty across the University. Photos below capture some of the dynamics of the event, which included three formal presentations, question and answers from our Soka University community, and a reception with a chance for more informal questions and interaction.


What might we dream with biology?
EXIT

April 18, 2018 Medical and Pre-Medical Education Meeting

After the two Life Science Symposia from December 2017 and January 2018, our Life Sciences Planning Task Force met several times to build a plan for the Life Science curriculum and a hiring plan. These meetings occurred throughout the Spring semester, and from these discussions came an awareness that the changing requirements for medical school and the evolving conceptions of medical education needed to be included in our thinking about our new Life Science concentration. In addition, the highly international nature of our Soka University student body required us to know more about their prospects for admissions within both US and international medical schools.

To answer these questions, we assembled a panel of experts to visit our campus and discuss in more detail with us trends in pre-medical and medical education. Some of the questions we hoped could be answered by our medical education experts included:

- What is the ideal preparation for students who would like to go to medical school and health careers?
- Which courses are particularly important for pre-medical students, and what courses less important in current thinking?
- How do medical schools regard integrative, interdisciplinary or project-based courses?
- What are the options for international students who graduate from a place like SUA with a Life Science concentration?
- How well would our students (who will take our proposed curriculum) be received by Medical schools?
- How can we help improve our students' chances for admissions into medical school?

Our panel of medical education experts included:

Bob Kamei, M.D., Medical Education/Learning Science, NUS - Associate Provost, National University of Singapore, and former Professor at both UCSF and the Duke-NUS Medical School, Bob is licensed as a pediatrician, and is one of the architects of the new Duke-NUS Medical school in Singapore.

Linton Yee, M.D., Chair of Admissions and Associate Professor, Duke University School of Medicine – Linton serves as Associate Dean of Admissions at Duke University Medical school, and is licensed in Pediatric Emergency Medicine. His work includes all phases of medical education and practice, as well as admissions and curriculum design for medical schools.

Dr. Richard Lewis, Department of Psychology and Neuroscience, Pomona College – Richard Lewis is chair of the psychology at Pomona College, and has directed its pre-medical advising program for over 15 years. He was part of a national advisory committee that recently redesigned the MCAT examination.

Schedule for Medical Education Meeting

- 11:00-12:00 - tour of campus and overview of Soka University by Ed Feasel
- 12:15-1:15 catered lunch at the Athenaeum
- 1:15-1:45PM 20 minute presentation by Linton Yee, M.D., followed by questions and short break
- 2:00-2:30PM 20 minute presentation by Bob Kamei, M.D., followed by questions and short break
- 2:45-3:15PM 20 minute presentation by Dr. Richard Lewis , followed by questions and break
- 3:30-4:30PM break + informal discussion
- Symposium III – April 18 | Soka Athenaeum: **Medical and pre-Medical Education**
- 4:30 – 5:30 pm Panel Presentation (each panelist presents 10-12 minutes; with time for questions and discussion)
- 5:30-6:15 pm Reception with Soka University Community
- 6:30 pm - dinner in town

Notes and Details from the Medical and pre-Medical Education Meeting

Our medical and pre-medical education meeting began with an overview of the MCAT exam and medical admissions by Dr. Linton Yee. Linton described in detail the breakdown of questions within the MCAT, with details such as the breakdown of the questions which include 59 questions on chemical and physical foundations of biological systems and 53 questions on critical analysis and reasoning. This places a premium on liberal arts skills. The Duke Medical School requires additional materials such as letters of recommendation, essays from students, and interview, and a consideration of the unique attributes and contributions of applicants. These more holistic admissions criteria look for students who have 'grit' according to Dr. Yee, and favor students with broad interests and deep passions, including athletes, musicians, and others with a deep commitment to what they are doing. The medical experts commented on how many students take gap years and these can be effective ways of refining interests and improving admissions chances if they are aligned with the student's interests in medicine or helping others.

Key Components

- Academics (GPA, MCAT, upper division courses)
- Community service/leadership
- Clinical exposure
- Research

MCAT Categories

Range 118-132
Average 124-125 set as 50%

- Chemical and Physical Foundations of Biological Systems (59 questions in 95 minutes)
- Critical Analysis and Reasoning Skills (53 questions in 90 minutes)
- Biological and Biochemical Foundations of Living Systems (59 questions in 95 minutes)
- Psychological, Social and Biological Foundations of Behavior (59 questions in 95 minutes)

Curriculum Components

- Productive and constructive collaboration
- Integration of the non-science disciplines into medicine
- Open to learning from others, embracing other viewpoints, willingness to extend outside of one's comfort zone
- Emotional intelligence

Medical Education

- Change to "expectations" instead of requirements
- New ways of learning and teaching –team-based learning, problem-based learning, self directed learning
- Integration of material
- Efficiency in learning

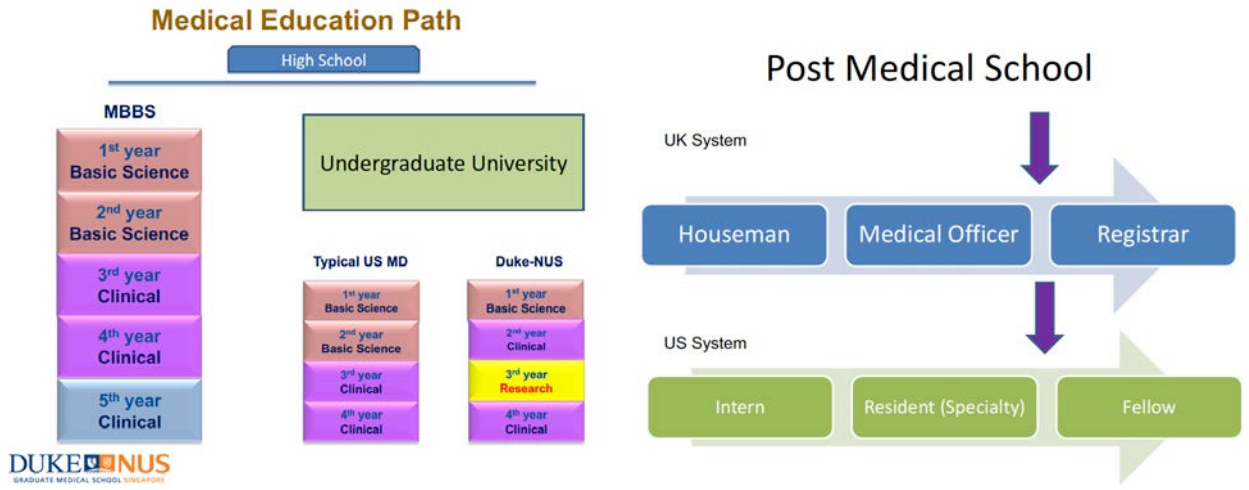
Linton shared the statistics for the 51,680 applicants to US medical schools, which includes 1,917 non-US applicants, amounting to about 4% of the applicant pool. Of those applicants 21,338 matriculate, with only 275 non-US students getting into US medical schools. The statistic reflects both the relatively good odds of medical admissions (42% for US students), but also the lower rate of admissions for international students (approximately 15%).

Linton also described some of the "pillars" of medical education, and of future doctors. These pillars include beneficence, non-maleficence, a respect for patient autonomy, and fairness. The future medical practitioner needs to be worthy of immense trust – to assure that they will take care of patients. This leads Duke Medical school to select candidates who are going to be future leaders in medicine, who are well-rounded, who are willing to venture outside of their comfort zone, and who display humanism and a commitment to others.

In terms of academic qualifications, medical admissions include GPA, MCAT, community service and leadership, clinical exposure, and an examination of the upper-level electives taken by students. The medical admissions panel also favors candidates with research experience. Within the medical

curriculum is a large emphasis on integration of material, and courses of most use include statistics, organic and biochemistry, good writing skills, genetics and immunology. Linton reported that "soft skills" can help deal with patients, and a premium is placed on students who are good with the written and spoken word, who are open to learning from others, who display emotional intelligence, integrity, teamwork and who are capable of critical thinking.

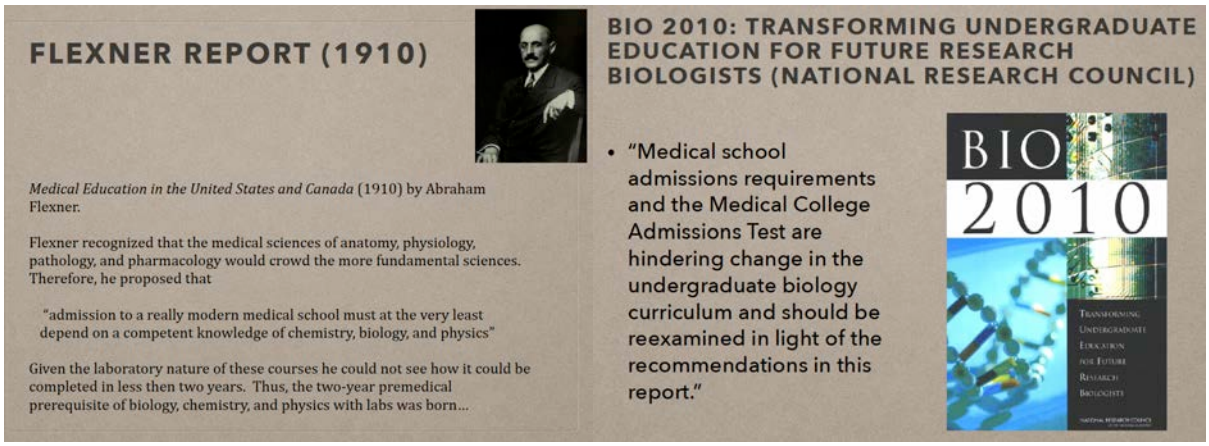
Bob Kamei in his presentation stressed that future medical practitioners are increasingly members of health care "teams" that might include experts who specialize in education, research and administration as well as the more traditional role of a doctor as a clinician. We learned that medical education internationally is primarily during the undergraduate years through the MBBS program, with only a few places offering medical school after a bachelor's degree. Medical schools in Australia and the US favor a "post-bac" medical education, along with a few schools in Asia, such as Duke-NUS in Singapore, a new medical school in Malaysia, and one in Japan.



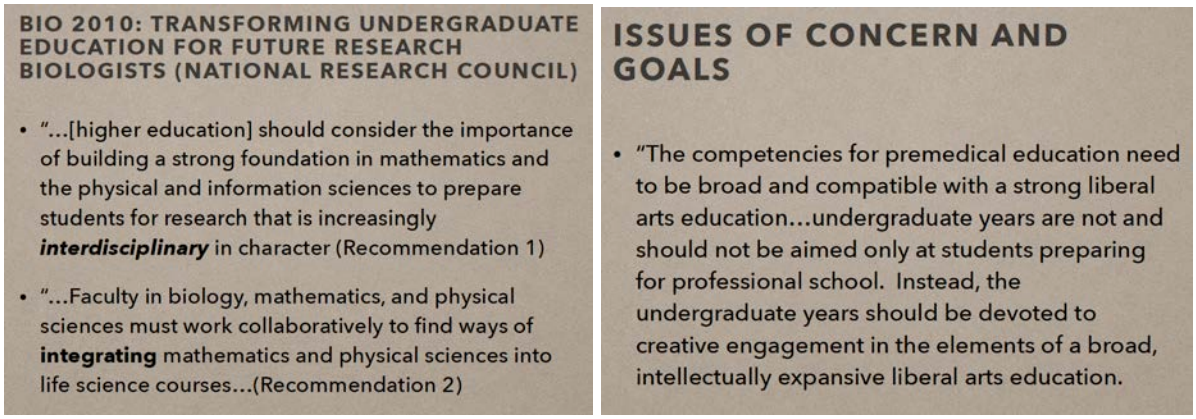
Bob gave some details of these international programs in medical education, such as the Australian medical programs which admit students after a bachelor's degree, but stressed that in all cases admissions to medical school does not assure a residency. One pathway which did seem promising, however, was for a student from a developing country with a bachelor's degree to gain admission to a US or Australian medical school after graduation, and then take a residency within their own country, where there is a more acute need for people trained with the M.D. to help develop their medical system. This pathway could be one that some of our Soka University international students might consider after graduation.

Richard Lewis provided an overview of pre-medical education from the past 100 years, beginning with the very influential Flexner Report of 1910, which provided the beginning of the standard 2-year pre-med sequence of courses in the sciences, that included the standard required courses in

biology, chemistry and physics. This change in 1910 locked in a set of courses for pre-medical students which then changed very little over the subsequent 100 years.

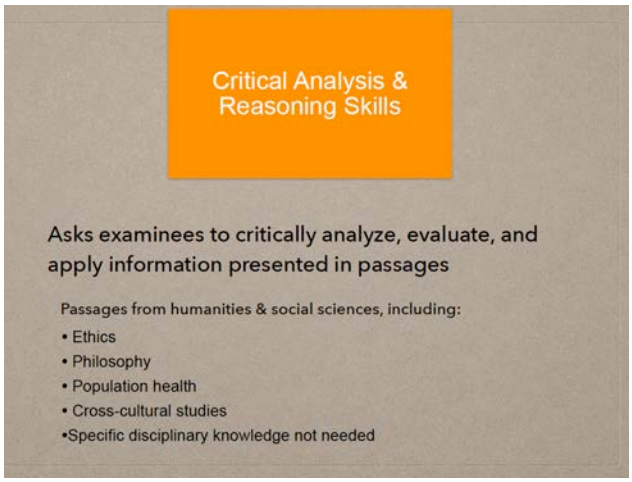


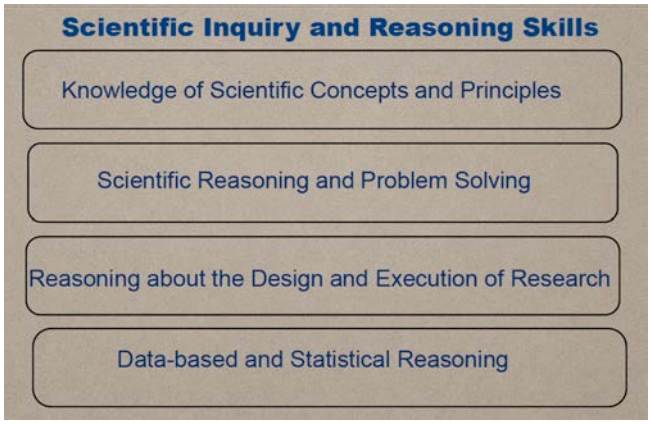
Richard pointed out that a very influential report entitled Bio 2010, commissioned by the National Research Council, recognized that the lack of evolution of the science curriculum and fixed expectations of medical schools for admissions was hindering advances in life science and medicine. The report recommended a greater emphasis on interdisciplinary and integrative courses, that could combine materials from multiple disciplines. Rather than disciplinary approaches, the Bio 2010 report recommended a curriculum that would create inquisitive graduates conversant with the latest scientific discoveries. The report also suggested moving away from course requirements into a set of "competencies" that could be fulfilled by a wide range of courses and from new interdisciplinary courses.



Richard went through a detailed presentation of both the Bio 2010 report, and the 2009 HHMI report on the Scientific Foundations of Future Physicians, and how both urge more interdisciplinary and integrative courses and laboratories. A thorough review of the MCAT questions, and the mix of required courses from various medical schools provided our Task Force with many insights on the evolving requirements and expectations of medical schools. These requirements are moving away

from required courses, and toward competencies, with a greater emphasis on critical thinking, data-based statistical reasoning, and social sciences.





Our panel of medical education experts suggested that quantitative reasoning and problem solving was an essential skill to develop within students, as well as the other qualities mentioned earlier. An emphasis on data-based statistical reasoning, cognitive skills and reasoning, intercultural understanding, teamwork, psychology and social sciences, leadership and service all were seen as increasingly important for future medical professionals. Such a broad range of skills also seems very well developed within our Soka University liberal arts curriculum – which provides both validation and encouragement for us as we develop our new Life Sciences concentration.

The meeting concluded with presentations from all three of our medical education experts for the Soka University community, and a discussion with our audience about the evolving requirements for medical students and the increasing emphasis on liberal arts skills within medical education. The symposium was attended by a large audience of students, staff and faculty from Soka University.


Developing Physician Leaders (who are different)

Life Science Planning Task Force Meetings

In addition to the visits and public presentations from our Science Advisory Board and Medical Advisory group, our Soka University Life Science Planning Task Force met frequently throughout the Spring 2018 semester to discuss our plan for the Life Science curriculum, and the hiring plan for our upcoming years until the opening of the Life Science Concentration and new Science Building in 2020. Our Life Science Planning Task Force, consisting of Zahra Afrasiabi, Robert Hamersley, Lisa Crummett, and Phat Vu met 5 times during Spring 2018. The meeting dates included February 14, Feburary 24, April 4, April 25, and May 2. For some of the later meetings, Anthony Mazeroll joined the discussions, having returned recently from sabbatical. Below in outline form are some of the conclusions reached during our Life Science meetings, which have defined some of the key elements of the new Life Science curriculum at Soka University.

Life Science Curriculum Elements

Integrated Biology and Chemistry Course. One of our early conclusions, based on the discussions with the Science Advisory Board, was to develop some of our introductory courses in an "integrated" fashion, patterned after the Claremont Colleges IBC course. We decided that an integration of introductory materials in chemistry and biology could lead to greater efficiency and increased understanding for essential concepts. Zahra Afrasiabi and Lisa Crummett developed a short report, included below, that describes some of the major features of an Integrated Biology and Chemistry report, tentatively named IBC. This course could be offered as either a double credit, 6-unit course in one semester, or as two 3-unit courses spread out over the first academic year. It would be the introductory course for our Life Science concentration.

Separate Project-Based Laboratory Course. By bringing a 3-unit laboratory course to stand as a separate course, students could experience a more authentic learning environment that included more of the processes of actual scientific research than would be possible in a more typical 1-unit laboratory course. This course could be patterned after the Stanford Biology laboratory courses, which we learned about from Martha Cyert. The course would provide research problems that students could solve over several weeks, and could be integrative and study topics that would span multiple disciplines, such as Physics and Biology, or Biology and Chemistry. The course would include a mix of in-class experiments, and out-of-class independent work by students to acquire background, analyze results, and prepare presentations of results.

Single Semester Organic Chemistry + Biochemistry. An alternative to the traditional year-long organic chemistry sequence is to offer a semester of Organic Chemistry, followed by a semester of

Biochemistry. This combination is now favored by most of our peer undergraduate institutions for preparing pre-medical students, and provides more biochemistry which is critical within modern biology.

Developing a new Physics for Life Science course. Rather that offering a physics course to prepare engineers or future physicists, our new Life Science concentration could develop an interesting course that would feature applications of physics in biological contexts. This course could fulfill the pre-medical physics requirements and prepare students for the MCAT, while also providing very interesting examples of physics in action within organisms. Phat Vu prepared a report on this Physics for Life Science course, which is included below.

Recommended Hiring Plan

Hiring Plan for new faculty in Biochemistry, Biology and other fields. After discussing the key features of our Life Science curriculum, the courses were mapped back to a hiring plan that would bring in new faculty with the necessary expertise to offer some of the courses discussed in our meetings. From our discussions of curriculum came an awareness of the need for experts in a range of fields in biology – notably fields that promote an awareness of both molecular and organismal biology. Interdisciplinary subject experts in biochemistry and biophysics would also be helpful in our curriculum, as well as additional expertise in computer science and mathematics. From our discussions with the Science Advisory Board, the importance of computer science for modern biology was stressed and we hope to find candidates who can contribute to data-intensive forms of biology research. Robert Hamersley and Phat Vu prepared a report on our a recommended hiring plan which is summarized in outline form below, and included in Appendix III along with a pathway for students concentration in Life Sciences.

Academic Year 2019/20:

- Mathematician hire (early to cover Anna Varvak sabbatical)
- Biologist I hire (can cover GE)
- Biologist II hire (can cover GE)
- Biochemist I hire (can cover GE)

Academic Year 2020/21

- Biochemist II hire (can cover GE)

Academic Year 2021/22

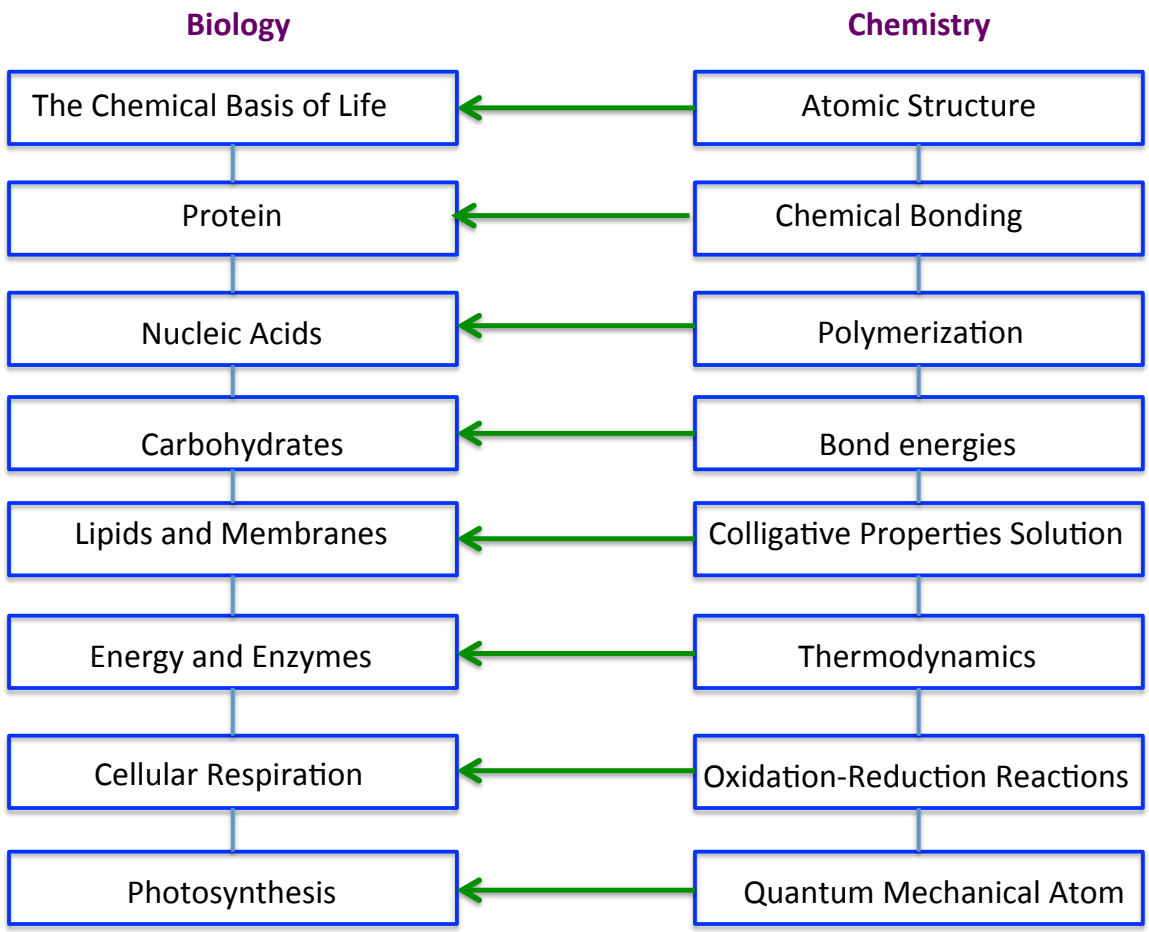
- Biologist III hire (can cover GE)
- Biochemist III hire (can cover GE)

Academic Year 2022/23

- Biophysicist I hire (can cover GE)
- Biochemist IV hire (can cover GE)

Integrated Biology and Chemistry Course (from Z. Afrasiabi and L. Crummett)

An understanding of fundamental concepts in both biology and chemistry is required for a firm understanding of molecular and cellular processes in living organisms. The following flowchart outlines topics in general chemistry that are associated with book chapters that are traditionally taught in the first semester of an Introductory Biology course for science majors (Ex. Biology 140 at SUA).



The following section represents more detailed outline of the topics in general chemistry (bullet points) that would facilitate greater understanding of the biological concepts (in blue) that are typically covered in the first semester of an introductory biology course for science majors (Ex. Biology 140 at SUA). This outline illustrates how seamlessly biology and chemistry could be taught together in a single integrative biology/general chemistry course at SUA. This single integrative course would take the place of a traditional first semester introductory biology course for science majors (Ex, Bio 140) as well as the first semester of a general chemistry course for

science majors (Ex. Chemistry 140). After completing this integrative course, students could then take Biology 141 and Chemistry 141 concurrently, fulfilling all of their biology and chemistry-related prerequisites during their first year and allowing them to begin taking upper division biology and chemistry courses during their sophomore year.

The Chemical Basis of Life

- Atoms, ions, molecules
- Periodic Table
- Atomic structure
- Molecular geometry and Lewis structure
- Bonding types
- Acid-Base reactions
- pH
- Properties of water
- Polarity

Proteins

- Functional groups
- Polarity
- Polymerization
- Bond formation
- Basics of chemical bonding

Nucleic Acids

- Polymerization
- Bond formation

Carbohydrates

- Polymerization
- Chemical bond energy calculation

Lipids and membranes

- Introduction to organic chemistry
- Polarity
- Osmosis
- Diffusion
- Ions

Energy and enzymes

- Thermodynamic laws
- Enthalpy, entropy, and Gibbs free energy
- Activation energy
- Exothermic and Endothermic reactions
- Energy of chemical reactions

Cellular respiration

- Redox reactions
- Stoichiometry and redox reactions
- Electron transport

Photosynthesis

- Electromagnetic spectrum
- Wavelength and Energy calculations
- Bohr theory
- Absorption spectroscopy
- Electronic configuration
- Atomic energy levels
- Fluorescence

Development of Physics in the Life Sciences Course (from P. Vu)

April 2, 2018

<u>Organization of Content</u>

One potential way to organize is to use the labels physics of the body, by the body, and for the body:

1. Physics of the body— statics, motion, mechanical properties, muscles, metabolism, fluids, cardiovascular system, lungs and breathing, sound/speech/hearing, light/eyes/vision, electrical/magnetic properties, and feedback and control; using mathematical modeling throughout. The above can be organized via life cycle events such as pregnancy, injuries, diseases/disorders, and aging/dying or organized via four areas such as locomotion on land, energetics of the body metabolism, locomotion of humans in fluids and motion of fluids in humans, and waves and signals.

2. Physics by the body—physics of common locomotion and that during sports and collisions.

3. Physics for the body—physics of measurement analysis, diagnosis and treatment that use light, ultrasound, x-rays, radioactivity, and magnetic resonance imaging.

Another potential way to organize is to use the labels physics of physiology, biomedical engineering/biomechanics, medical/health physics, and biophysics:

1. Physics of physiology—the human body/anatomy/machine.

2. Biomedical engineering/biomechanics—forces, torques, center of gravity, rotations, simple machines, muscle force, and bones.

3. Medical/health physics—use of ionizing radiation, imaging, instrumentation to diagnose and treat disease.

4. Biophysics—emphasis on molecular/cellular basis but can include higher-level integration and combinations of molecular/cellular systems such as memory, control of movement, visual integration, and consciousness and thinking; can cover molecular structure, energetics and dynamics, physical factors of the environment, and kinetics of biological systems.

While these seven labels each have thick books devoted to them and each can sustain one or more semesters of instruction, my current preference is to start out nimble and opportunistic and design a one or two semester intro survey sequence that utilizes the best modules from these seven labels.

By best I mean content that is intrinsically motivating and generates enthusiasm and lends itself to practical and effective instruction.

I would also look beyond the human and see what is happening in zoology and botany and look to ecology and the environment and maybe even astrobiology to see if the full gamut of scales can be included from molecules to *E. coli* to the human heart to populations, etc.

As the concentration develops over time and interesting modules accrue, I can see the potential to develop more focused intro/advanced courses that better serve different types of students and that may go further than the limited integration with chemistry that is currently envisioned and may include computer science modules.

If you're curious about what some of these phys/bio books look like on the inside, here are five pdfs of such books: https://soka.box.com/s/bn33sktewn53k82v0f10ms8idofj9973

Pedagogy & Course Materials (thanks, Bryan!)

Essay on Biology and Physics Competencies for Pre-Health and Other Life Sciences Students: https://soka.box.com/s/03thska0gvphz4lt3aq2jw68r1m5gs6p

Research-based models for effective physics instruction: http://www2.physics.umd.edu/~redish/Book/

The National Experiment in Undergraduate Science Education (NEXUS) which is to develop new science and math support courses for bio majors and pre-health students building on competencies outlined in the reports Scientific Foundations for Future Physicians and Vision and Change in Undergraduate Biology Education and which is to have high level of coordination among bio, physics, chem, and math. Here you can see syllabi, readings, problems, clicker questions, recitation activities, labs, threads, modules, workshop materials, papers/presentations, etc. for a two-semester intro physics class for life science students: http://umdberg.pbworks.com/w/page/44091483/Project%20NEXUS%20UMCP

Appendix I: Phase I Planning Document

This background document was prepared by the Soka University science faculty during the Phase I of our planning in AY 2015-16, and 2016-17, and provided a blueprint for the Life Science Concentration and a preliminary hiring plan and curriculum outline. It provides a strong starting point for our Phase II planning effort, and will be revised after our discussions with the Science Advisory Board during 2017-18.

Provisional Course Catalog Entry for Proposed Life Sciences Concentration
(To Be Revised/Rewritten by Life Sciences Faculty)

Life Sciences Concentration

OVERVIEW

The Life Sciences (LS) concentration offers introductory and intermediate-level courses in math, physics, chemistry, and biology (through cross-listings with the Math and Science Area) as well as advanced study in biology and biochemistry with an emphasis on subjects pertinent to the health sciences. Students will have an opportunity to study the physiology and genetics of the human body and topics such as microbial disease. To fulfill the concentration requirements, students must take five concentration courses, three of which must be at the 300 or 400 level, and complete a senior Capstone thesis.

Life sciences have applications in health, agriculture, medicine, and the pharmaceutical and food science industries. Thus, the LS concentration at SUA can be an effective preparation for postgraduate studies in the health sciences when combined with participation in the Pre-Health curriculum. The concentration may also be valuable for students wishing to prepare for careers in the allied health professions or in education.

Students in the LS concentration will be able to:

1. Acquire, synthesize, and apply life sciences knowledge.
2. Communicate life sciences effectively.
3. Learn critical thinking and problem-solving skills.
4. Gain life sciences research skills.

CAPSTONE EXPERIENCE

CAPSTONE 390, 400, 450

COURSE DESCRIPTIONS

MATH 170	PHYSICS 1XX	CHEMISTRY 140	BIOLOGY 140
MATH 171	PHYSICS 1XX	CHEMISTRY 141	BIOLOGY 141
MATH 101		CHEMISTRY 2XX	
		CHEMISTRY 2XX	

GENETICS 2XX
PHYSIOLOGY/ANATOMY 2XX
NEUROSCIENCE/NEUROBIOLOGY 2XX

DEVELOPMENTAL BIOLOGY 3XX
BIOCHEMISTRY 3XX

MICROBIOLOGY 3XX

CELL BIOLOGY/MOLECULAR CELL BIOLOGY
BIOMECHANICS
IMMUNOLOGY

LS 290 TOPICS
LS 390, 490 ADVANCED TOPICS

LS 298, 398, 498 SPECIAL STUDY
LS 299, 399, 499 INDEPENDENT STUDY

Courses in purple are cross-listed with the Math and Science Area.

Proposed Pre-Health Curriculum
(Preparation for the Health Professions)

Students wishing to prepare for careers in the health professions requiring postgraduate study (such as medicine, nursing, veterinary medicine, dentistry, or other professions) will be able to satisfy the admissions requirements of most schools while meeting the graduation requirements of any of the 5 concentrations. The Health Professions Advisor (HPA) conducts an orientation for all interested students during 1st-year orientation week; students are encouraged to follow-up with one-on-one meetings with the HPA as early as possible during their time at SUA for advice on how best to prepare for postgraduate study.

The admission requirements of most medical schools are satisfied by the following 12 SUA courses (specific medical schools may require more or fewer; for instance, Calculus II may replace Statistics or Advanced Organic Chem may replace Biochemistry and *vice versa*):

Bio 140 (Foundations of Biology I), Bio 141 (Foundations of Biology II)
Chem 140 (Foundations of Chemistry I), Chem 141 (Foundations of Chemistry II)
Chem 2XX (Intermediate Organic Chem), Chem 2XX (Advanced Organic Chem)
Biochemistry 3XX
Phys 1XX (Intro to Mechanics), Phys 1XX (Electromagnetism & the Physics of Matter)
Writing 101 or higher
Math 170 (Calculus I) or higher
Math 101 (Statistics)

A student **not** [1] concentrating in Life Sciences can include the above 12 courses via degree requirements/electives and by overloading just once (see page 3). An SBS concentrator can additionally take Psych 100 and Soc 100 within SBS, which is strongly recommended for MCAT and medical school entry changes in 2015. It is advisable for students with a humanities-heavy undergraduate curriculum to take at least one more science course beyond the minimum indicated above (overloading at least twice). A student concentrating in Life Sciences can take the above 12 courses and an additional 6 recommended courses without overloading (see page 4). Additional recommended courses can be drawn from:

[1] At Williams, about 75% of pre-meds major in the sciences and 25% in the humanities or social sciences. At Haverford, more than 50% of pre-meds major in biology or chemistry. At Pomona, roughly 85-90% of pre-meds major in the sciences. At Swarthmore, the overwhelming majority of pre-meds have double majors or majors + minors that include one science and one humanities or social science, in various combinations; Swarthmore also has pre-meds with just one major that is typically in the sciences though not unusual for that major to not be in the sciences.

Writing 301/305
Psych 100, Soc 100
Genetics, Microbio, Physiology/Anatomy, Neuroscience/Neurobio, Developmental Bio, Cell Bio/Molecular Cell Bio, Biomechanics, Immunology, and/or Other

Medical schools are increasingly favoring more credits in Humanities and SBS courses, additional languages, as well as internship and research experiences. Thus, SUA's wide GE requirements (Core, Modes, LCs, Language, Study Abroad, Creative Arts, AmEx, PacBasin) and Capstone experience should place SUA students in a competitive position when applying to medical schools.

Sample Curriculum for a Pre-health Student ***Not*** Concentrating in Life Sciences

Graduation Requirements	Credits
Language I	4
Language II	4
Language III	4
Language IV	4
Core I	3
Core II	3
Learning Cluster I	4
Learning Cluster II	4
Writing 101	3
Writing 301/305	3
Modes	3
AmEx	3
PacBasin	3
Creative Arts	3
Creativity Forum	1
Wellness	2
Mathematical World (Math 170/171)	3
Physical World (Chemistry 140)	4
Natural World (Biology 140)	4
Study Abroad	12
My Concentration 1	3
My Concentration 2	3
My Concentration 3	3
My Concentration 4	3
My Concentration 5	3
Other Concentration 1 (Biochemistry 3xx)	4
Other Concentration 2	3
Any Concentration 1 (Chemistry 2xx)	4
Any Concentration 2 (Chemistry 2xx)	4
Capstone Proposal	1
Capstone I	4
Capstone II	4
Curricular-wide Elective 1 (Biology 141)	4
Curricular-wide Elective 2 (Chemistry 141)	4
Curricular-wide Elective 3 (Physics 1xx)	4
Curricular-wide Elective 4 (Physics 1xx)	4
Overload (Math 171/101)	3
Total	132

A non-concentrator will need to overload once in order to take the 12 red courses which are recommended for pre-med students who don't know which med schools they're applying to yet.If the non-concentrator is in the SBS concentration, s/he can take additional recommended pre-med courses, Intro Psych and Intro Soc, within her/his own concentration, SBS. It is advisable for students with a humanities-heavy undergraduate curriculum to take at least one more science course beyond the ones indicated in red (overloading at least twice).

Depending on when the 1-credit Creativity Forum and the 2-credit Wellness are taken, they may or may not technically trigger an overload for that semester.

Sample Curriculum for a Pre-health Student Concentrating in Life Sciences

Graduation Requirements	Credits
Language I	4
Language II	4
Language III	4
Language IV	4
Core I	3
Core II	3
Learning Cluster I	4
Learning Cluster II	4
Writing 101	3
Writing 301/305	3
Modes	3
AmEx	3
PacBasin	3
Creative Arts	3
Creativity Forum	1
Wellness	2
Mathematical World (Math 170/171)	3
Physical World (Chemistry 140)	4
Natural World (Biology 140)	4
Study Abroad	12
My Concentration 1 (Biology 141)	4
My Concentration 2 (Chemistry 141)	4
My Concentration 3 (Life Sciences 300: Genetics or Neuroscience or Physiology/Anatomy)	4
My Concentration 4 (Biochemistry 3xx)	4
My Concentration 5 (Life Sciences 300/400: Developmental Biology)	4
Other Concentration 1 (Psychology 100)	3
Other Concentration 2 (Life Sciences 300/400: Microbiology; cross-listed with Envst)	4
Any Concentration 1 (Chemistry 2xx)	4
Any Concentration 2 (Chemistry 2xx)	4
Capstone Proposal	1
Capstone I	4
Capstone II	4
Curricular-wide Elective 1 (Physics 1xx)	4
Curricular-wide Elective 2 (Physics 1xx)	4
Curricular-wide Elective 3 (Sociology 100)	3
Curricular-wide Elective 4 (Math 171/101)	3
Total	132

The 12 red courses are recommended for pre-med students who don't know which med schools they're applying to yet. The 6 blue courses are typical additional courses recommended for pre-meds beyond the red ones indicated above.

Depending on when the 1-credit Creativity Forum and the 2-credit Wellness are taken, they may or may not technically trigger an overload for that semester.

Proposed New Building

Proposed features:

- A 100,000 sq. ft. state-of-the-art building to be located adjacent to Gandhi.
- Built to LEED Gold or higher sustainable building standards.
- Includes the following facilities:
    - Classrooms
    - Teaching labs
    - Research labs
    - Faculty/Staff/Administrative offices
    - Collaboration spaces
    - Meeting rooms
    - Public spaces
    - 100-seat conference room
    - Break rooms
    - Building support

Appendix II: Preparation for the Health Professions

This background document includes possible pathways through the new Life Sciences Concentration, for students interested in the Health Professions. It is important to stress that at Soka University, our concentration requirements include fewer courses than a major at a typical institution – with 6 courses being standard, in addition to required GE and Core classes.

Preparation for the Health Professions

The following assumes a Life Sciences Concentration with approximately 25 first-years, 25 sophomores, 25 juniors, and 25 seniors. The admission requirements of most medical schools are satisfied by the following minimum of 12 courses:

Bio 101 (The Cell), Bio 102 (The Organism)
Chem 151 (Intro Concepts of Chem), Chem 156 (Intro Organic Chem)
Chem 251 (Intermediate Organic Chem), Chem 256 (Advanced Chem Concepts)
Biochemistry 3XX
Phys 131 (Intro to Mechanics), Phys 132 (Electromagnetism & the Physics of Matter)
Writing 101
Calculus
Statistics

A student not concentrating in Life Sciences can take the above 12 courses by overloading just once (see page 2). An SBS concentrator can additionally take Intro Psych and Intro Soc within SBS, which is strongly recommended for MCAT and medical school entry changes in 2015. It is advisable for HUM concentrators to take at least one more science course beyond the minimum indicated above.

A student concentrating in Life Sciences can take the above 12 courses and an additional 6 recommended courses without overloading (see page 3). Additional recommended courses can be drawn from:

Writing 301/305
Intro Psych, Intro Soc
Genetics, Microbio, Physiology/Anatomy, Neuroscience/Neurobio, Developmental Bio, Cell Bio/Molecular Cell Bio, Biomechanics, Immunology, and/or Other

Medical schools are increasingly favoring more credits in Humanities and SBS courses, additional languages, as well as internship and research experiences. Thus, SUA's wide GE requirements (Core, Modes, LCs, Language, Study Abroad, Creative Arts, AmEx, PacBasin) and Capstone experience place SUA students in an enviable position when applying to medical schools.

Offerings in the Life Sciences Concentration will also be helpful for students wishing to pursue further studies in biological sciences and environmental sciences.

The following pages detail a sample curricular pathway for a student not concentrating in Life Sciences, a sample curricular pathway for a student concentrating in Life Sciences, the 5 new hires needed in Life Sciences, and the new hires (9 FTEs) needed in GE and other concentrations.

Sample Pathway for Non-Concentrator

Class Standing	Fall Block	Fall Semester	Winter Block	Spring Semester
Frosh	Core I	Lang I	LC 1	Lang II
		Writ 101		Calculus (Math)
		Bio 101 (Nat W)		Bio 102 (Cur Elec 1)
		Chem 151 (Phys W)		Chem 156 (Cur Elec 2)
Sophomore		Lang III	LC 2	Lang IV
		Modes		Core 2
		Chem 251 (Con Elec 1)		Chem 256 (Con Elec 2)
		Phys 131 (Cur Elec 3)		Phys 132 (Cur Elec 4)
Junior		SA	LC 3 (optional)	Writ 301/305
				300/400-level Bio Chem (Con Other 1)
				Con 1
				Con 2
				Statistics (Overload)
Senior		Cap P	Cap I	Cap II
		Con 3		CA/CF
		Con 4		PacBasin
		Con 5		AmEx
		Con Other 2		Wellness

A non-concentrator will need to overload once in order to take the 12 red courses which are the minimum recommended for pre-med.The SBS concentration is recommended so that the non-concentrator can take Intro Psych (Con 1) and Intro Soc (Con 2) within their own concentration, SBS. It is advisable for HUM concentrators to take at least one more science course beyond the minimum indicated in red.

Depending on when the 1-credit Creativity Forum (CF) and the 2-credit Wellness are taken, they may or may not technically trigger an overload for that semester.

Sample Life Sciences Concentration Pathway

1. Class Standing	Fall Block	Fall Semester	Winter Block	Spring Semester
Frosh	Core I	Lang I	LC 1	Lang II
		Writ 101		Calculus (Math)
		Bio 101 (Nat W)		Bio 102 (Con 1)
		Chem 151 (Phys W)		Chem 156 (Con 2)
Sophomore		Lang III	LC 2	Lang IV
		Modes		Core 2
		Chem 251 (Con Elec 1)		Chem 256 (Con Elec 2)
		Phys 131 (Cur Elec 1)		Phys 132 (Cur Elec 2)
Junior		SA	LC 3 (optional)	Writ 301/305
				Intro Psych (Con Other 1)
				Intro Sociology (Cur Elec 3)
				Statistics (Cur Elec 4)
Senior		Cap P	Cap I	Cap II
		200/300-level Genetics or Neuroscience or Physiology or Anatomy (Con 3)		CA/CF
		300/400-level Bio Chem (Con 4)		PacBasin
		300/400-level Dev Bio (Con 5)		AmEx
		300/400-level Microbio (Con Other 2)		Wellness

12 red courses are minimum recommended for pre-med.

6 purple courses are typical additional courses beyond the minimum recommended for pre-med. Depending on when the 1-credit Creativity Forum (CF) and the 2-credit Wellness are taken, they may or may not technically trigger an overload for that semester.

Appendix III: Recommended Hiring Plan

Based on our discussions within the SUA Life Science Planning Task Force, a plan for hiring new faculty over the next several years was developed. This plan, along with a listing of course offerings from the new Life Science concentration is included below. We are grateful to Robert Hamersley and Phat Vu for developing this plan.

Life Science Concentration Hiring Plan 5/29/2018; revised 8/13/18 RH

Arrival dates of new hires, and needs for additional GE staff

Academic Year 2019/20:

- Mathematician hire (early to cover Anna Varvak sabbatical)
- Biologist I hire
- Biologist II hire
- Biochemist I hire

Academic Year 2020/21

- Biochemist II hire

Academic Year 2021/22

- Biologist III hire
- Biochemist III hire

Academic Year 2022/23

- Biophysicist I hire
- Biochemist IV hire

- All hires are 1 year prior to official program start dates. This allows a "soft" rollout of the program a year earlier than originally planned, contingency if some searches fail, and extra time to develop program and new courses.

Appendix IV: Sample Life Sciences Concentration Pathway

Academic year	Class Standing	F/W Blocks	Units	Fall Semester	Units	Spring Semester	Units
20/21	1st Year	Core I	3	Language I	4	Language II	4
				Writing 101	3	Pacific Basin	3
		LC 1	4	IBC I (Natural World)	3	IBC II (Physical World)	3
				Statistics (Math World)	3	Lab I (Curriculum Elective 1)	3
				Wellness	2	Creativity Forum	1
					15+3		14+4
21/22	2nd Year			Language III	4	Language IV	4
				Modes of Inquiry	3	Core II	3
		LC 2	4	Biology II (Concentration 1)	3	Chemistry II (Concentration 2)	3
				Calculus (Curric Elective 2)	4	American Experience	3
				Social Science (Concentration Other 1)	3	Lab II (Curriculum Elective 3)	3
					17		16+4
22/23	3rd Year			Study Abroad		Writing 301/305	3
						Chemistry III (Concentration Elective 1)	3
						HUM/IS/ENVST (Concentration Other 2)	3
						Lab III (Curriculum Elective 4)	2-3
						LS 300/400 (Concentration 3)	3
					12-16		15
23/24	4th Year			Capstone 390	1	Capstone 450	4
				(Curriculum Elective 5)	3	Creative Arts	3
		Cap 400	4	Chemistry IV/ Biochemistry (Concentration Elective 2)	3	LS 302/402 (Concentration 5)	3
				Physics I (Curriculum Elective 6)	3	Physics II (Curriculum Elective 7)	3
				LS 301/401 (Concentration 4)	3		
					13		13+4

- Semester unit totals include fall or winter blocks.
- Red courses are minimum recommended for pre-health preparation over and above our own GE requirements.
- Purple courses are typical additional recommended courses for pre-health preparation beyond the minimum recommended.

Appendix V: pre-Health Pathway Graphic

To help visualize the flow of courses taken at SUA by students interested in careers in Health and Medicine, we have prepared a pathway for a student's academic program below. The description below also includes some links to external web sites and some of our SUA web site. Our first pathway will meet the graduation requirements for SUA with a Life Science concentration, as well as the course requirements for admission to Medical School. We also have outlined a pathway for students who may choose other concentrations, while fulfilling course requirements for Medical School.

The course requirements for Medical School have been determined from consulting with our Medical Education Advisors, who visited SUA for a series of discussions and consultations about pre-medical education. Our SUA Life Science Planning task force included SUA Science faculty members Robert Hamersley (Microbiology), Lisa Crummett (Biology), Phat Vu (Physics), Zahra Afrasiabi (Chemistry), and Anthony Mazeroll (Biology). The task force incorporated the ideas from the discussions with our Medical Education Advisors to create a plan for our curriculum that includes several innovative courses and which also fully meets the requirements for medical school admissions.

Medical Schools have been revising their required courses to reflect the changing nature of medicine, and many medical schools are placing an increasing emphasis on a broad-based liberal arts education that includes not only science courses but additional courses in Social and Behavioral Sciences, and preparation for leadership and intercultural communication.

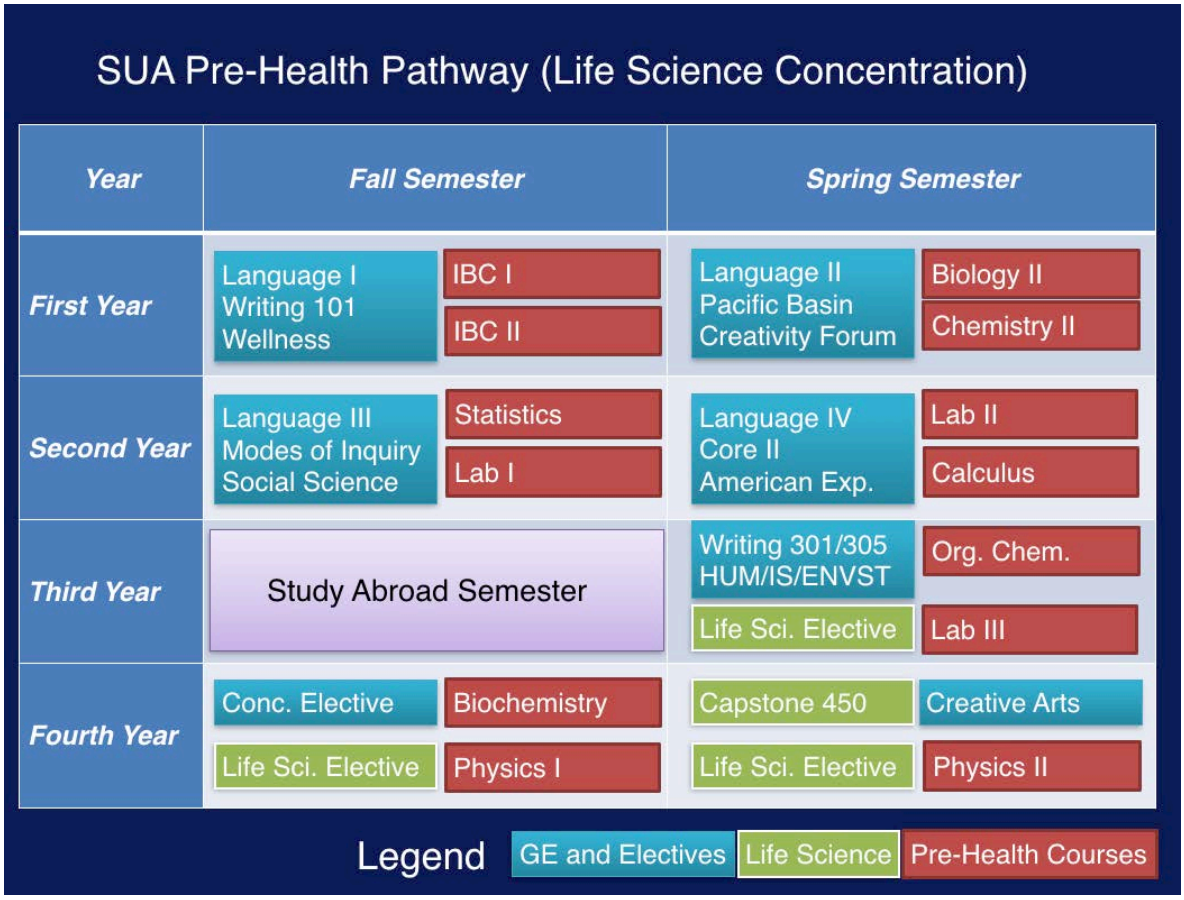
The basic medical school course requirements as outlined by the American Association of Medical Colleges (AAMC), includes the following courses:

- **One Year of Biology**
- **One Year of Physics**
- **One Year of English**
- **Two Years of Chemistry (through Organic Chemistry).**

One very influential report that has helped elucidate the best scientific preparation for medical school is the 2009 AAMC report *Scientific Foundations for Future Physicians.* The AAMC offers a web site that lists medical school admissions requirements for a wide variety of US and international medical schools at the site: https://apps.aamc.org/msar-ui/. Students interested in

Medical Careers should be fully prepared for these requirements, and SUA will also be providing additional pre-medical advising when the Life Science concentration is offered in 2020. We also have designed the curriculum to prepare students well for the MCAT examination, which focuses on four sections, Biological Foundations of Living Systems, Chemical and Physical Foundations of Living Systems, Critical Analysis and Reasoning Skills, and Psychological Foundation of Behavior.

Sample Pathway for SUA Life Science Concentration students. Our sample pathway for pre-Health students includes the necessary pre-medical courses recommended by AAMC (in red), the required SUA General Education and distribution requirements (indicated in blue), and additional Life Science elective courses (in green). The sample pathway is one way to fulfill SUA graduation requirements, while fully meeting the AAMC pre-medical course requirements. For Life Science concentrators, the additional Life Science elective courses can also provide some of the recommended courses for medical school admissions. The courses IBC I and IBC II refer to our Integrated Biology and Chemistry course, and the Lab courses Lab I, Lab II and Lab III refer to our project-based laboratory courses. More details can be found on our Curriculum Overview page.



Sample Pathway for SUA students with other Concentrations. Our meetings with our Medical Education Advisors have shown that medical schools are increasingly interested in students with a wide range of academic interests, and this means that students can also apply to medical schools while choosing other concentrations at SUA. A pathway for students who choose to concentrate in Social and Behavioral Sciences, International Studies, Humanities or International Studies, is shown below. The program allows the students to complete the necessary pre-medical courses recommended by AAMC (in red), the required SUA General Education and distribution requirements (indicated in blue), with one Life Science elective course, and required concentration elective courses (in orange). As in the previous figure, IBC I and IBC II refer to our Integrated Biology and Chemistry course, and the Lab courses Lab I, Lab II and Lab III refer to our project-based laboratory courses. More details can be found on our Curriculum Overview page.

SUA Pre-Health Pathway (Non-Life Science Concentration)

Year	Fall Semester		Spring Semester	
First Year	Language I Writing 101 Wellness	IBC I IBC II	Language II Pacific Basin Creativity Forum	Statistics Lab I
Second Year	Language III Modes of Inquiry Conc. Elective	Biology II Lab II	Language IV Core II American Exp.	Chemistry II Calculus
Third Year	Study Abroad Semester		Writing 301/305 Conc. Elective	Org. Chem. Lab III
Fourth Year	Conc. Elective Conc. Elective Conc. Elective	Biochemistry Physics I	Capstone 450 Conc. Elective	Creative Arts Physics II

Legend: GE and Electives | Non-LS Conc. Elective | Pre-Health Courses